EKG Übungen: ventrikuläre Arrhythmien

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Helios

Introduction

Use of the 12-lead ECG recorded during VT to regionalize its origin was first described by Josephson in 1981. [1]

Seven years later, reported by the same group of investigators, proved that the origin of the VT exit site could be accurately identified based on an analysis of the 12-lead ECG. [2]

the 4 investigators pinpointed the 182 VTs to 1 of 10 approximately equal specific anatomic regions of the LV and demonstrated a remarkable 93% site concordance in site designation for all 4 investigators. [2]

1. Josephson ME, Horowitz LN, Waxman HL, Spielman SR, Greenspan AM, Cain ME, Marchlinski FE, Ezri MD. Sustained ventricular tachycardia: role of the 12-lead electrocardiogram in localizing site of origin. Circulation 1981;64:257–272.
2. Miller JM, Marchlinski FE, Buxton AE, JosephsonME. Relationship between the 12-lead electrocardiogram during ventricular tachycardia and endocardial site of origin in patients with coronary artery disease. Circulation 1988;77:759–766.

Introduction

It should be emphasized that the spatial resolution of the 12-lead ECG is limited, and similar 12-lead QRS complexes can be obtained during pacing at sites up to 5 cm apart with similar ECG patterns confirmed over > 8 cm2 during pace-mapping in at least 10% of VTs.

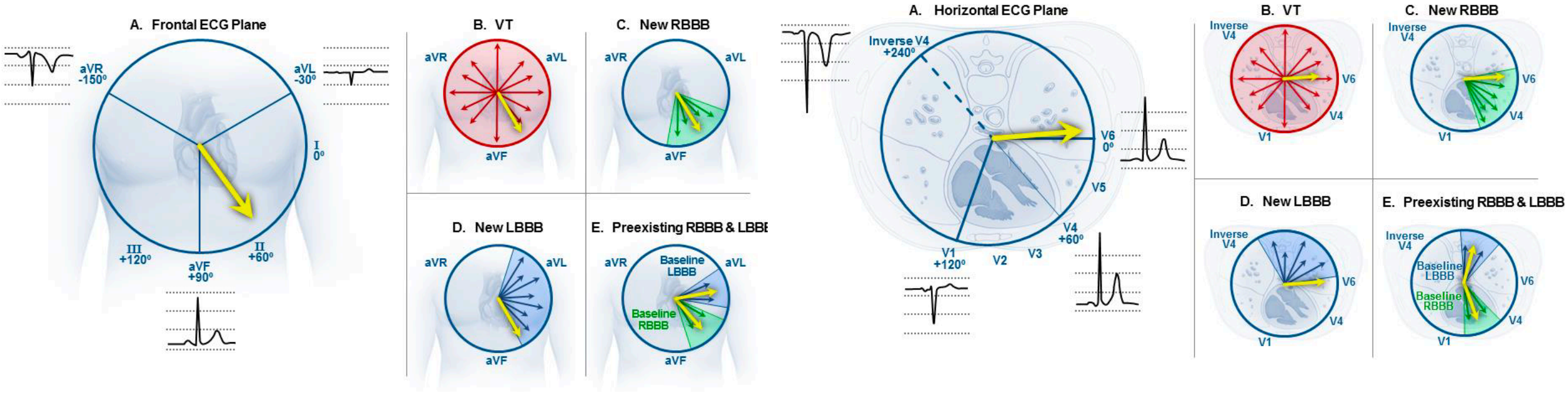
Given that the LV has an end-diastolic area of about 80– 100 cm2 , it makes more sense to divide it into no more than 10– 12 approximately equal segments when localizing a region of interest using the 12-lead ECG of the VT to limit overlapping information

Gopal AS, Keller AM, Rigling R, King DL, King DL. Left ventricular volume and endocardial surface area by three-dimensional echocardiography: comparison with two-dimensional echocardiography and nuclear magnetic resonance imaging. J Am Coll Cardiol 1993;22:258–270.

ECG features

… significant variation may result from several factors, such as body habitus, lead placement and shifts in the relationship of the heart to the chest wall.

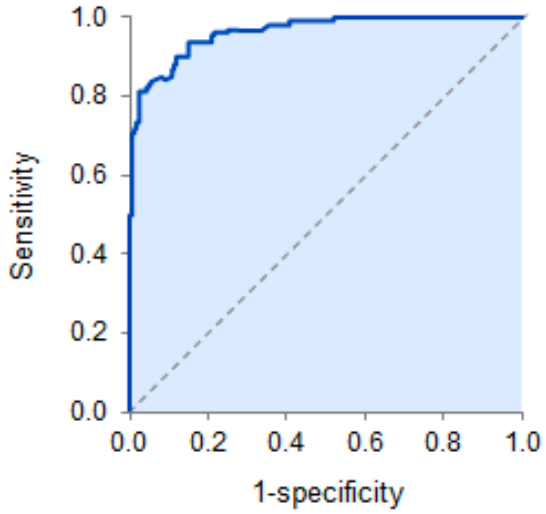
WCT formula: A novel algorithm designed to automatically differentiate wide-complex tachycardias



May et alJ. Electrocardiology 2019: accepted manuscript.
https://doi.org/10.1016/j.jelectrocard.2019.02.008

WCT formula: A novel algorithm designed to automatically differentiate wide-complex tachycardias

	SWCT (n = 160)	VT (n = 157)	P value
Baseline QRS duration (ms)	135.9 (28.1)	147.5 (44.0)	0.03
Baseline QTc duration (ms)	483.2 (43.4)	500.4 (63.2)	0.07
WCT QRS duration (ms)	144.4 (18.1)	177.1 (32.4)	< 0.001
QRS duration change (ms)	18.1 (22.4)	45.1 (34.3)	< 0.001
QRS axis change (°)	24.9 (32.6)	82.2 (56.7)	< 0.001
Frontal PAC (%)	34.9 (28.2)	124.2 (87.1)	< 0.001
Horizontal PAC (%)	44.8 (25.2)	115.3 (62.9)	< 0.001



AOC: 96.6%

May et alJ. Electrocardiology 2019: accepted manuscript.
https://doi.org/10.1016/j.jelectrocard.2019.02.008

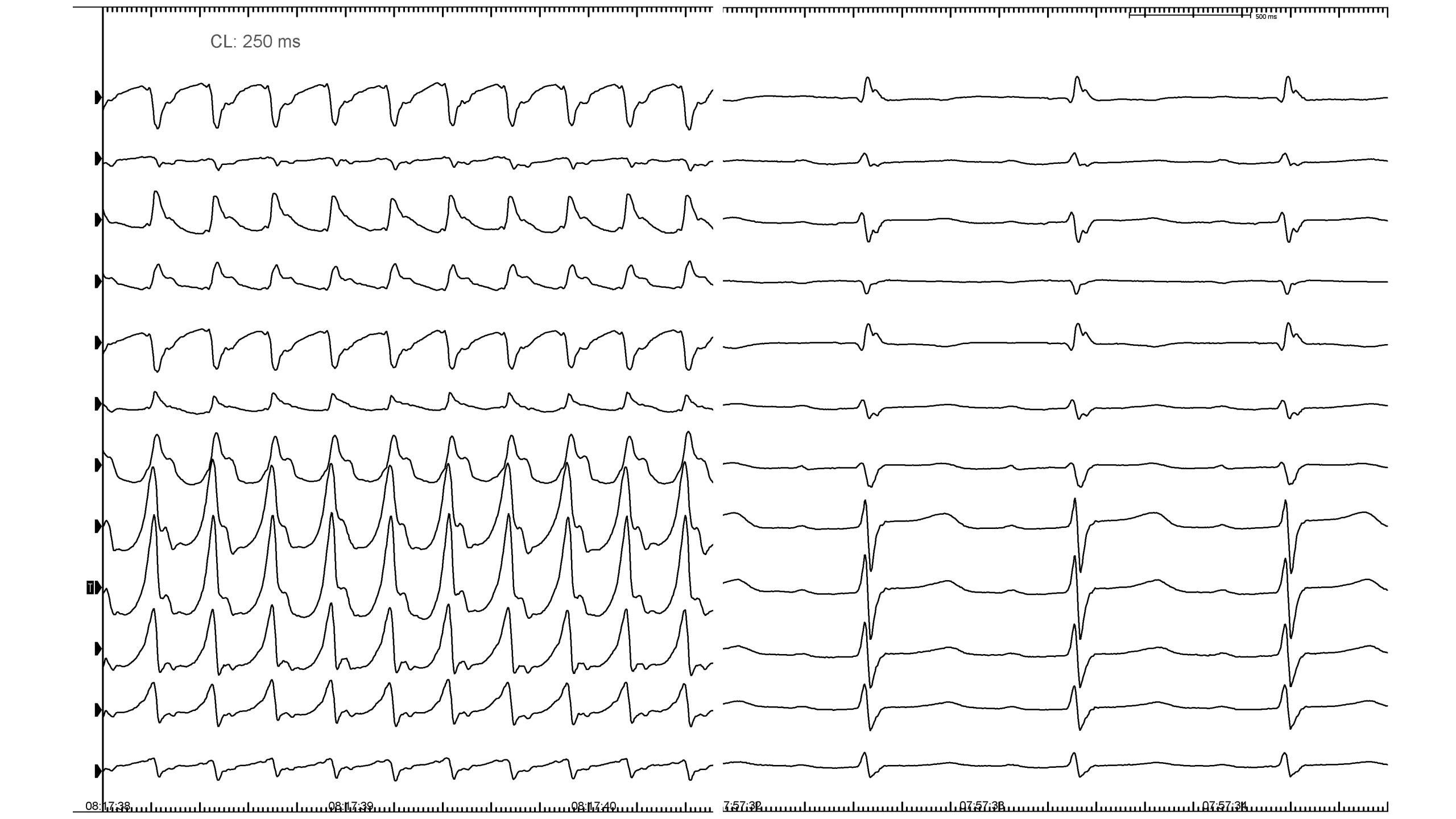
Patient:

79y ♂

Palpitation

LVEF: 63%, no WMA,

CA: Normal.


CL: 250 ms
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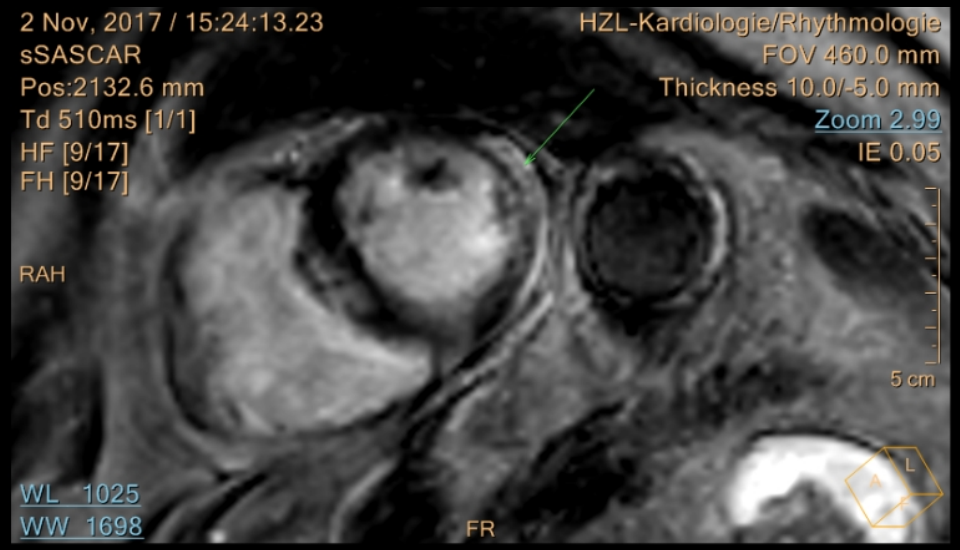
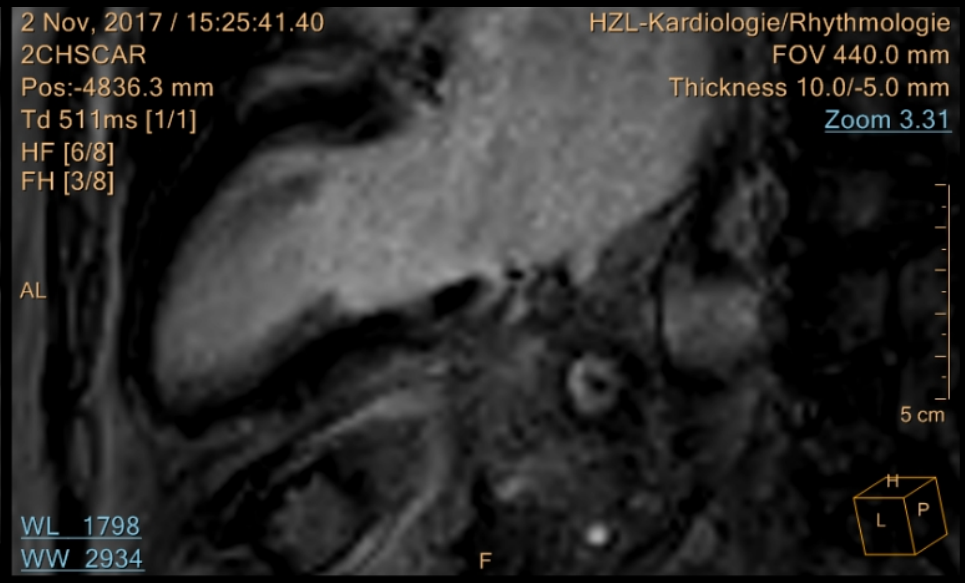
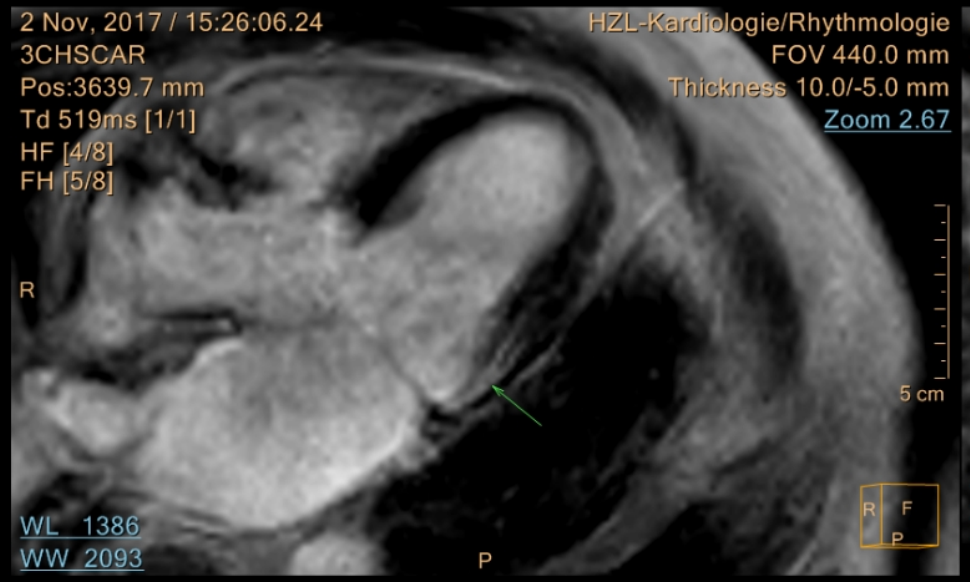
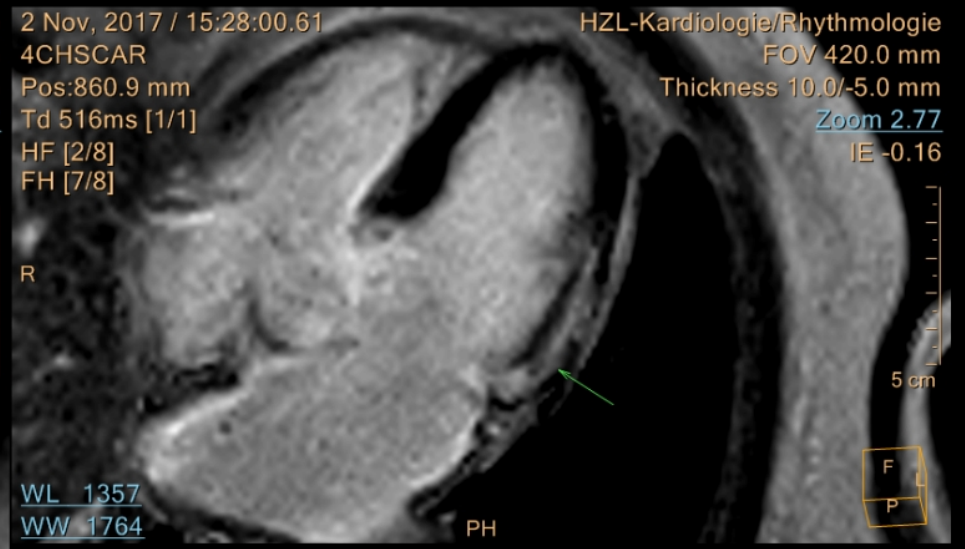








MRT 02.11.2017

ECG features

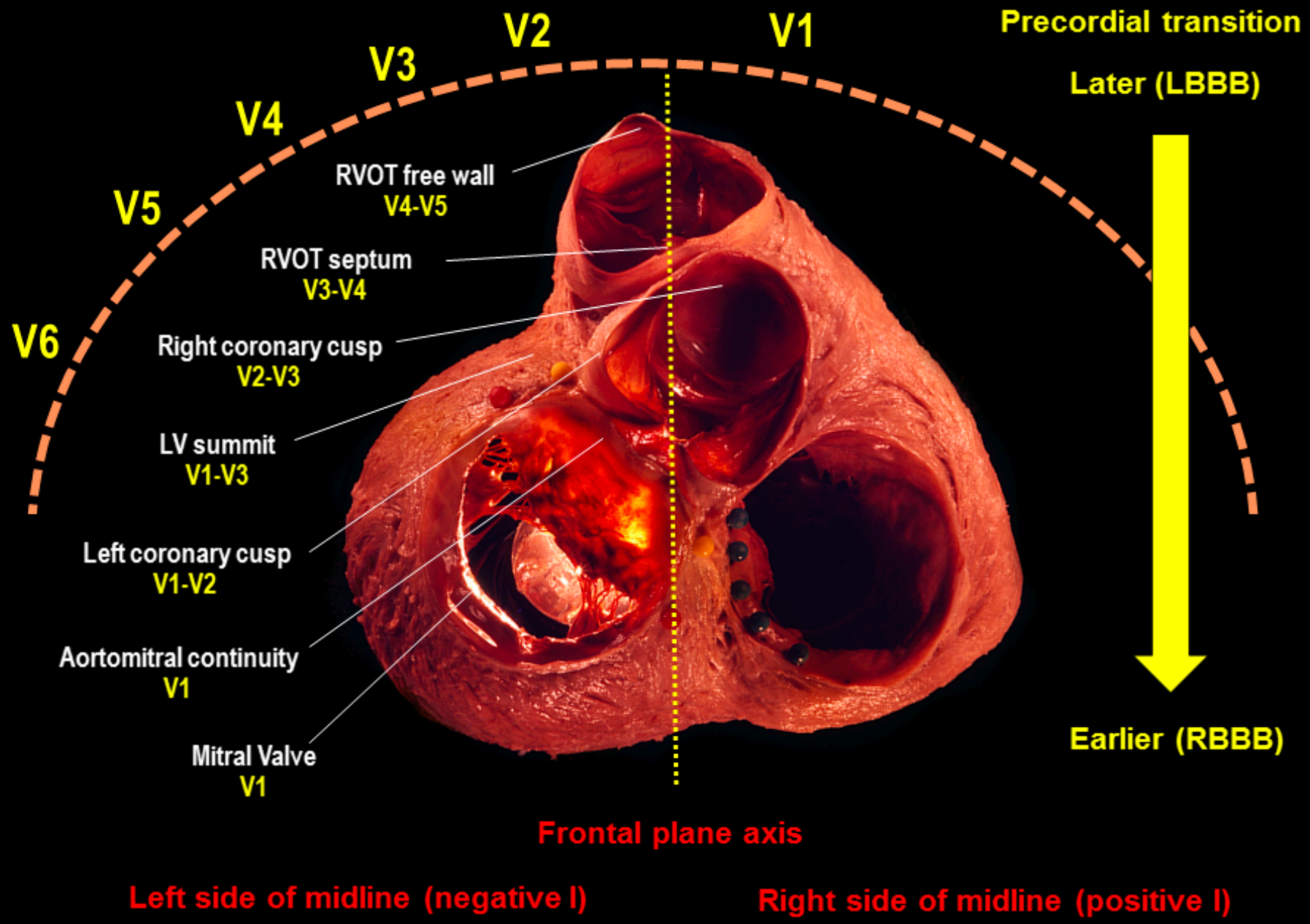
Several ECG features are relevant for localization of a particular VA. The most important are:

(1) QRS axis (both a vertical (superior-inferior) and horizontal (right-left)

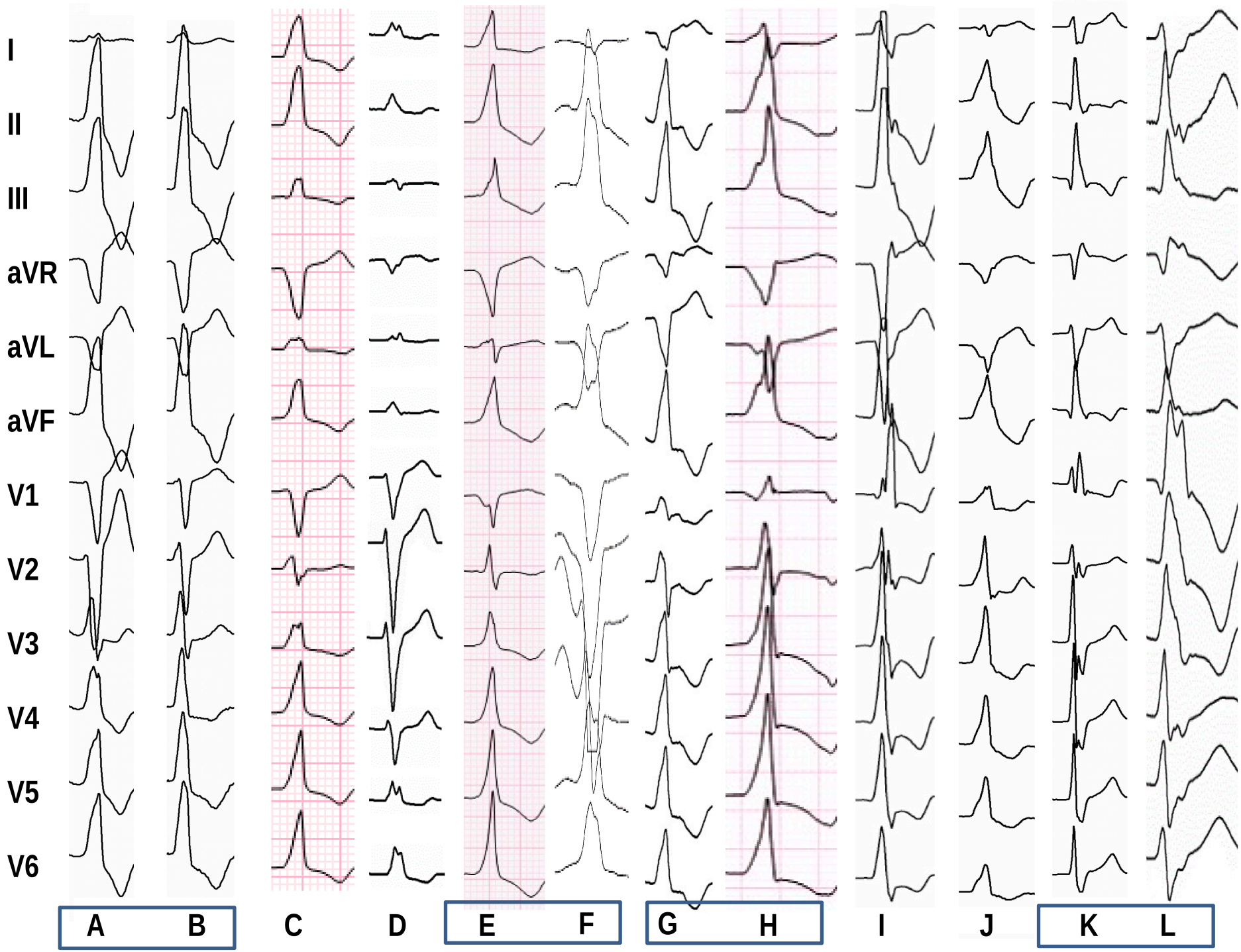
(2) Bundle branch block pattern

(3) Precordial transition

(4) QRS width



Heart Rhythm. 2019 Apr 4. pii: S1547-5271(19)30302-9. doi: 10.1016/j.hrthm.2019.04.002.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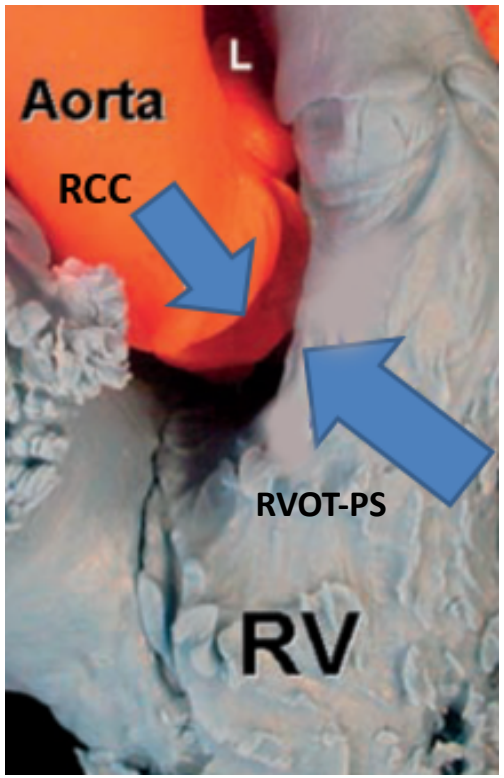
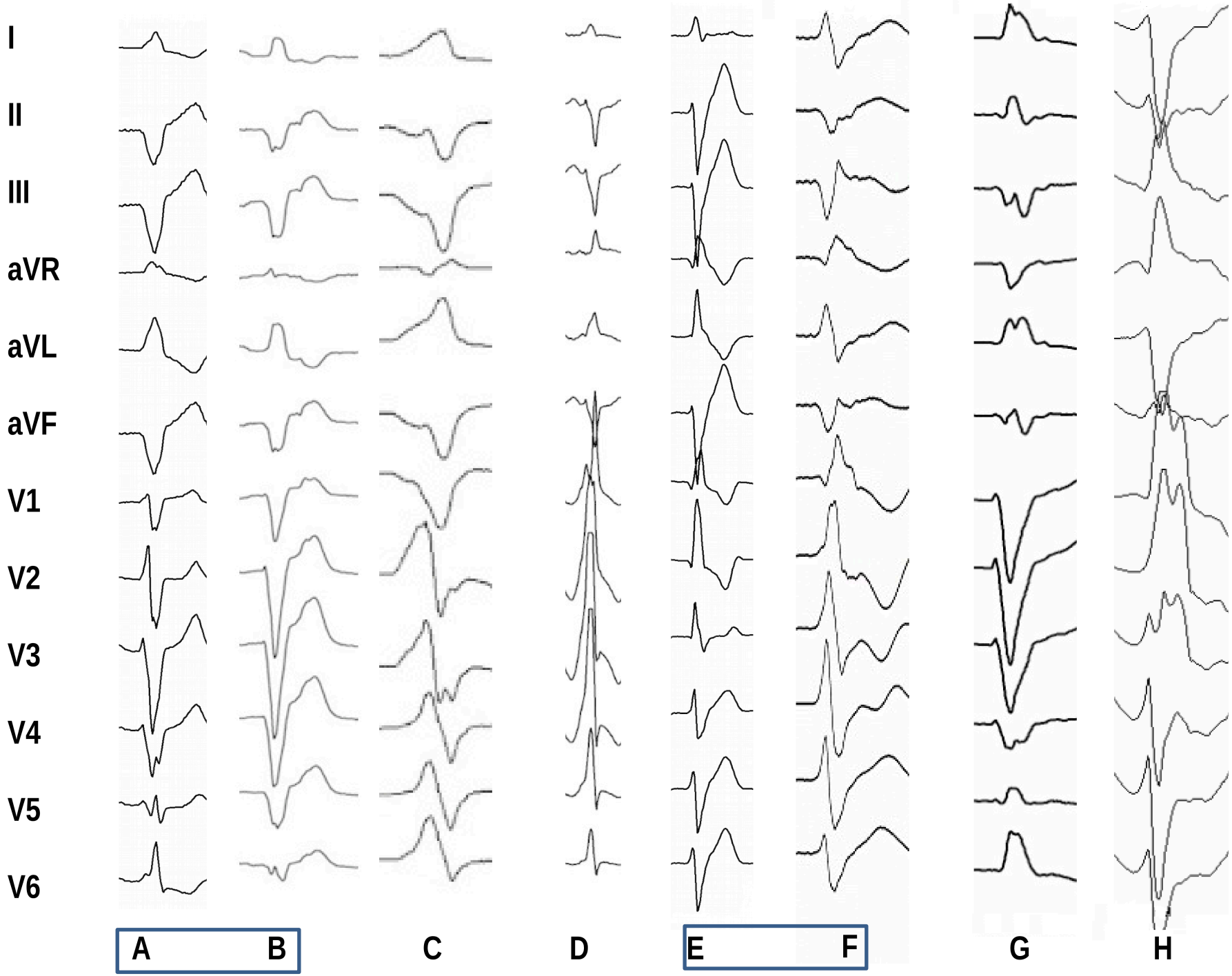

Aorta
L
RCC
RVOT-PS
RV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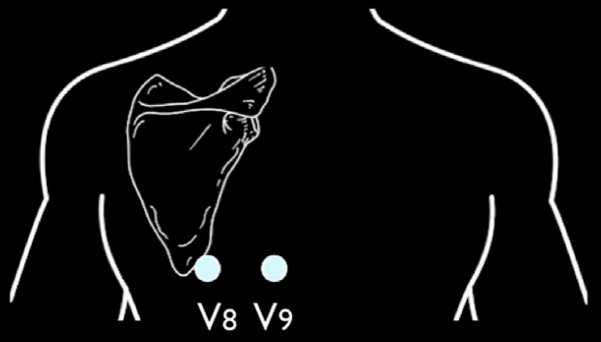
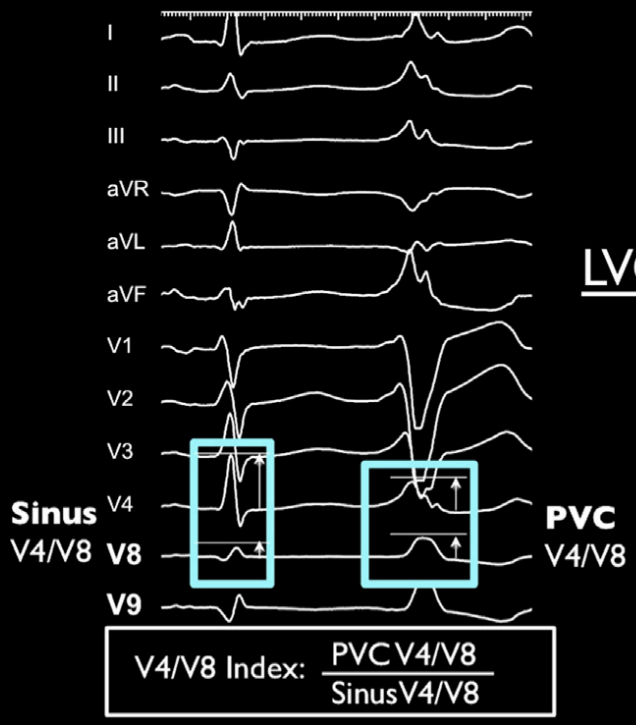
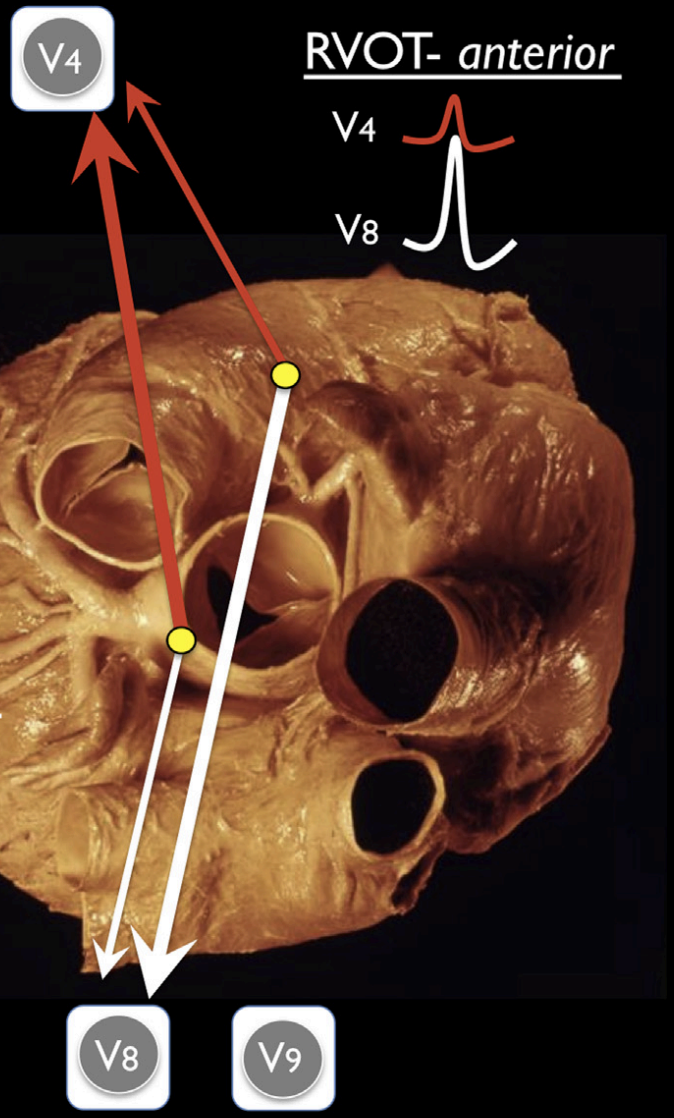
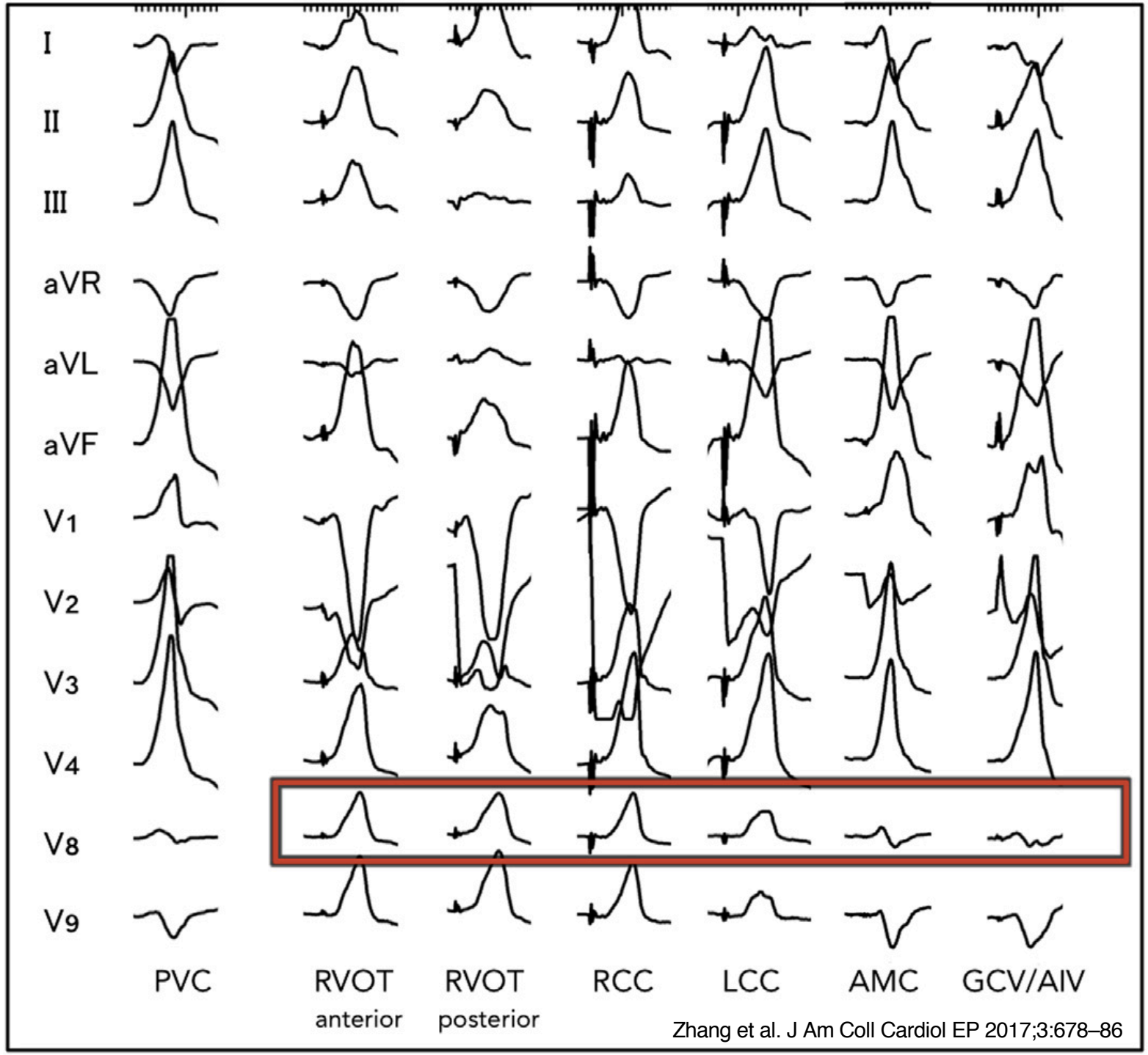
Value of Posterior ECG Leads







Zhang et al. J Am Coll Cardiol EP 2017;3:678–86



Zhang et al. J Am Coll Cardiol EP 2017;3:678–86

TABLE 3 Test Characteristics

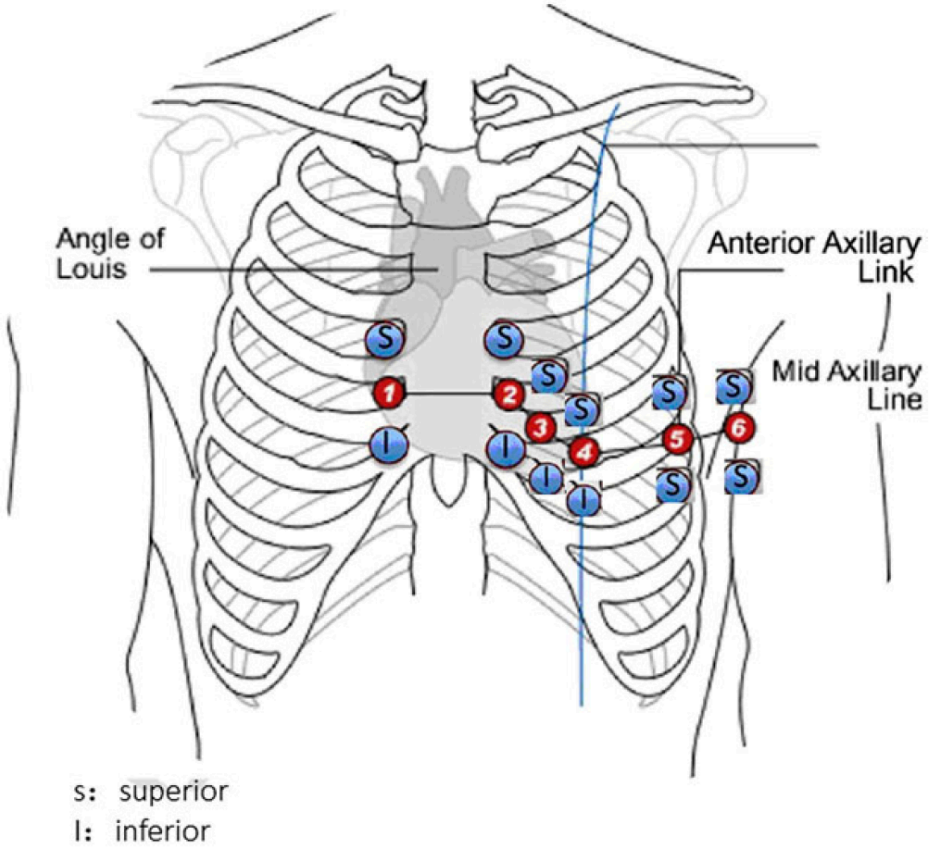
	Sensitivity	Specificity	PPV	NPV
Predictive of left-sided location in the prospective cohort				
V_4/V_8 ratio >3	75	82	64	89
V_4/V_8 index >2.28	67	96	89	87
V_2 transition ratio ≥0.6	67	67	47	82
V_{2S}/V_{3R} ≤1.5	36	71	33	74
PVC with a V_3 precordial transition (n = 19)				
V_4/V_8 ratio >3	67	81	57	87
V_4/V_8 index >2.28	67	100	100	87
V_2 transition ratio ≥0.6	50	54	33	70
V_{2S}/V_{3R} ≤1.5	40	62	29	73

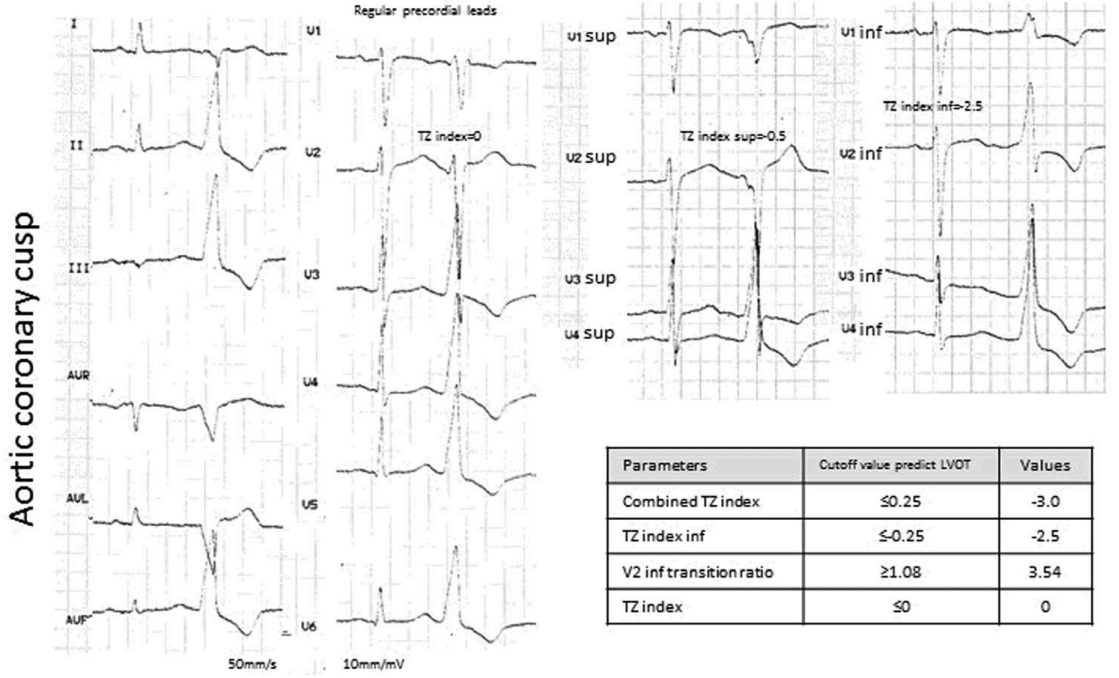
Values are %.

NPV = negative predictive value; PPP = positive predictive value.

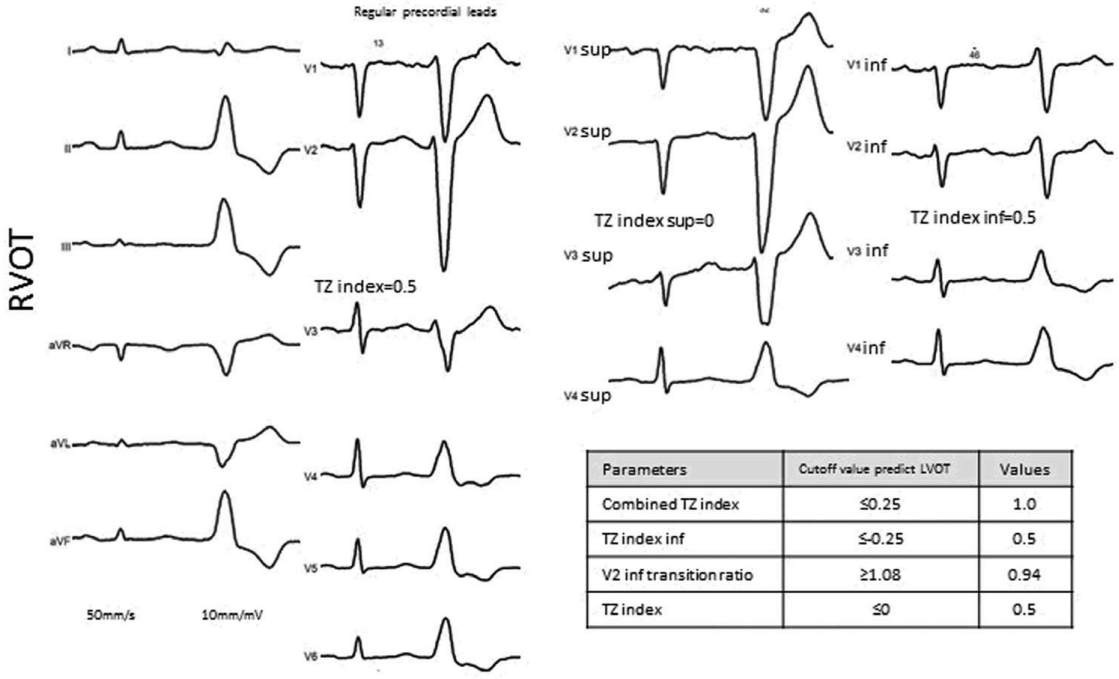
Zhang et al. J Am Coll Cardiol EP 2017;3:678–86

Multiple Intercostal Space Electrocardiogram Allows Accurate Localization of Outflow Tract Ventricular Arrhythmia Origin





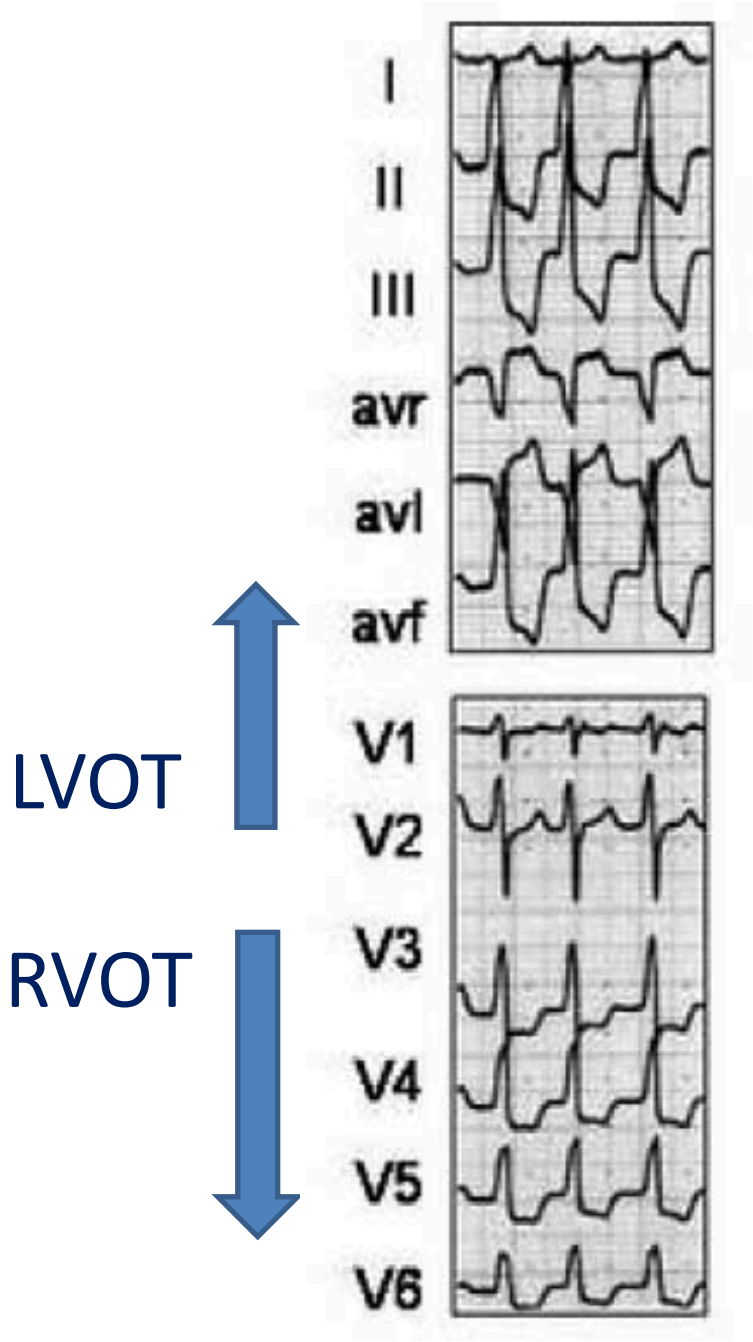
Parameters	Cutoff value predict LVOT	Values
Combined TZ index	≤0.25	-3.0
TZ index inf	≤-0.25	-2.5
V2 inf transition ratio	≥1.08	3.54
TZ index	≤0	0



Parameters	Cutoff value predict LVOT	Values
Combined TZ index	≤0.25	1.0
TZ index inf	≤-0.25	0.5
V2 inf transition ratio	≥1.08	0.94
TZ index	≤0	0.5

The combined TZ index outperformed other ECG criteria to differentiate left from right OT-VA origins.

PACE 2016; 39:173–181



R/S transition V2/V3:

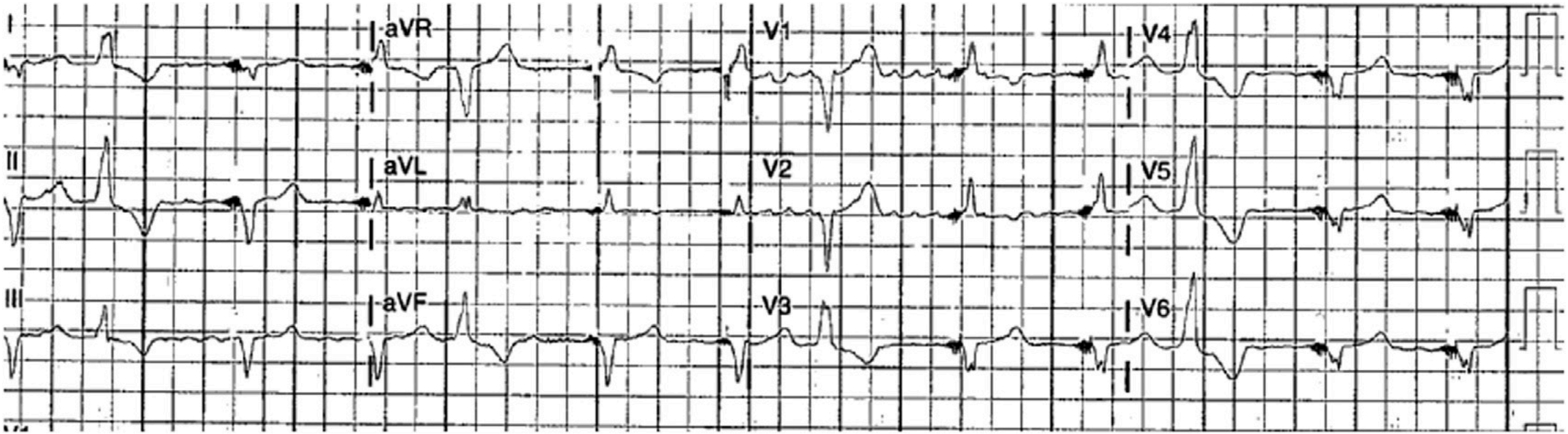
V2R/V2S > 0.3

$V2R_{ms}/V2_{ms}$ >0.5

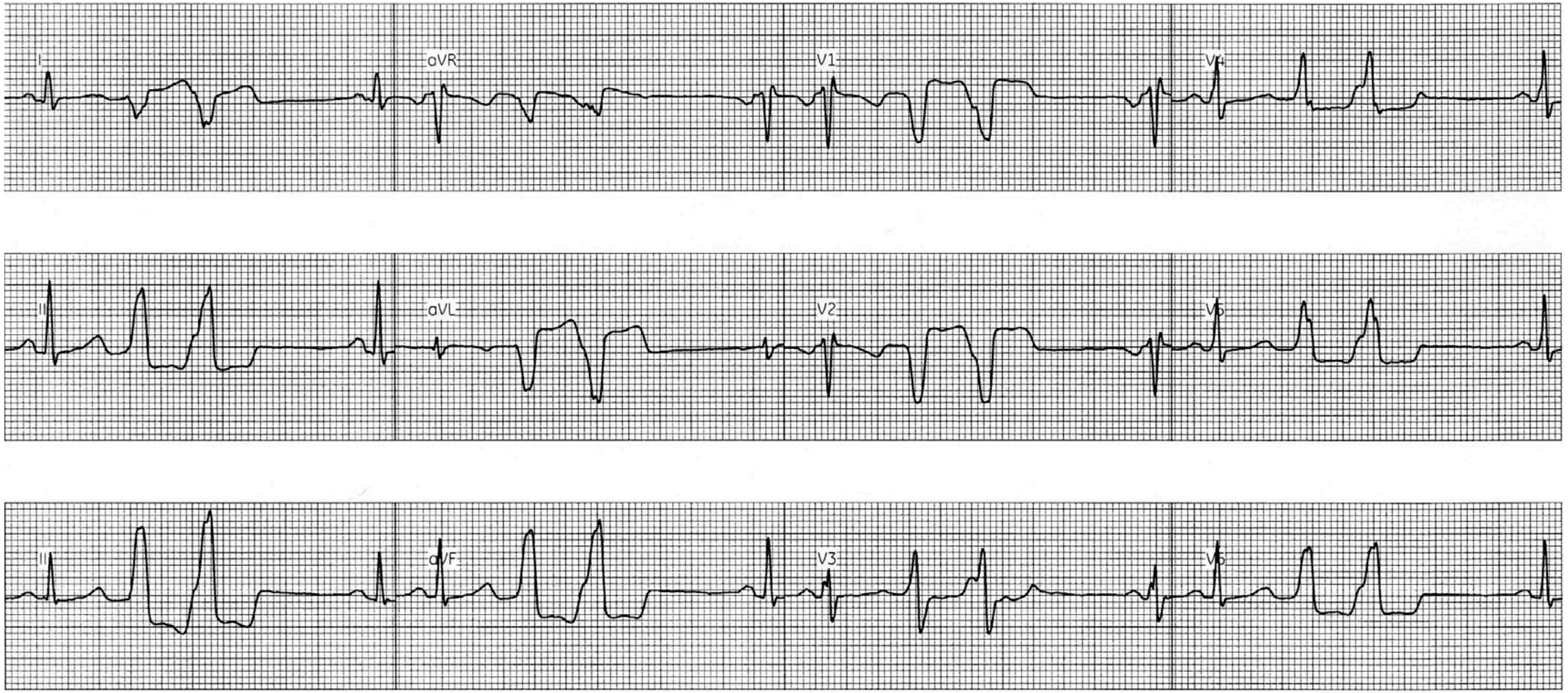
$V2R_{PVC}/V2R_{SR} \geq 0.6$

V2S/V3R ≤ 1.5

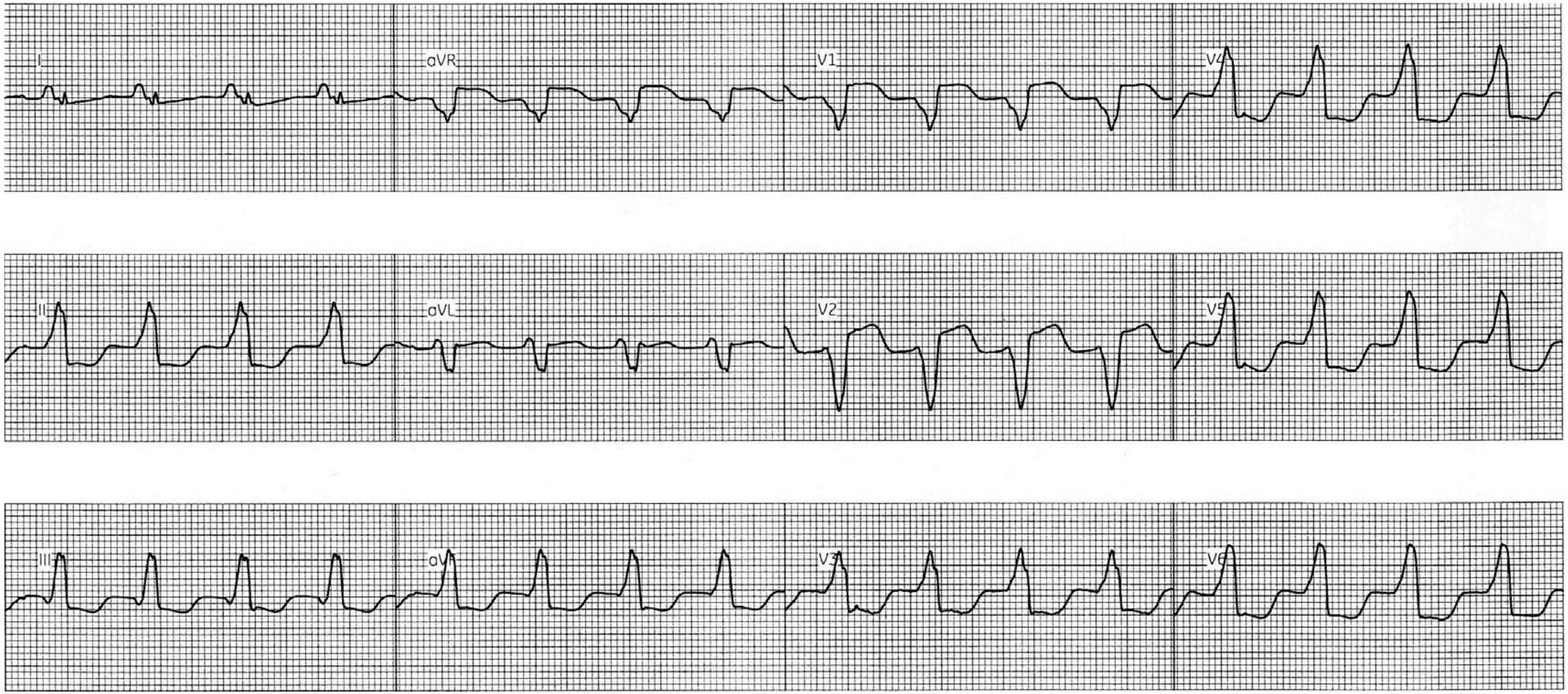
R/S transition in PVC earlier than SR



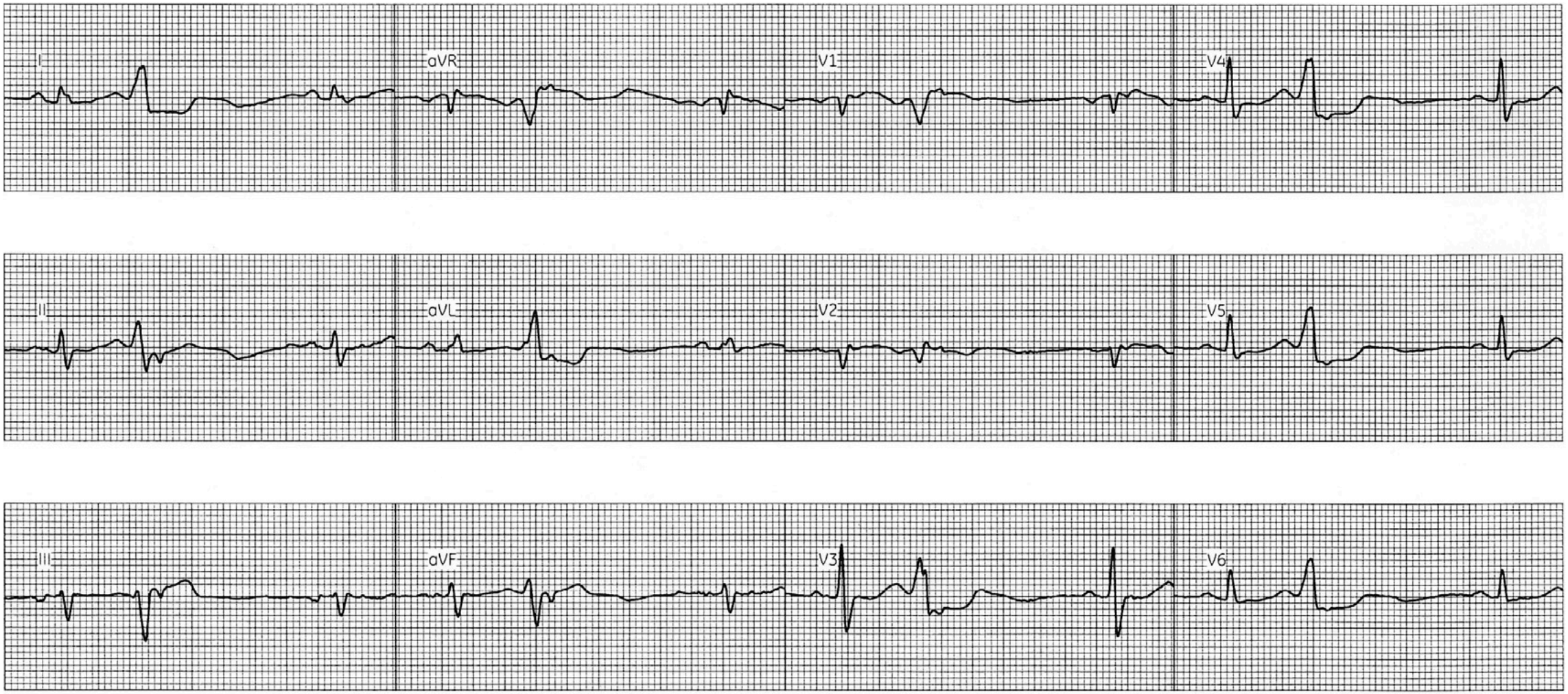
Della Rocca et al. , Card Electrophysiol Clin 10 (2018) 333–354



Della Rocca et al. , Card Electrophysiol Clin 10 (2018) 333–354



Della Rocca et al. , Card Electrophysiol Clin 10 (2018) 333–354



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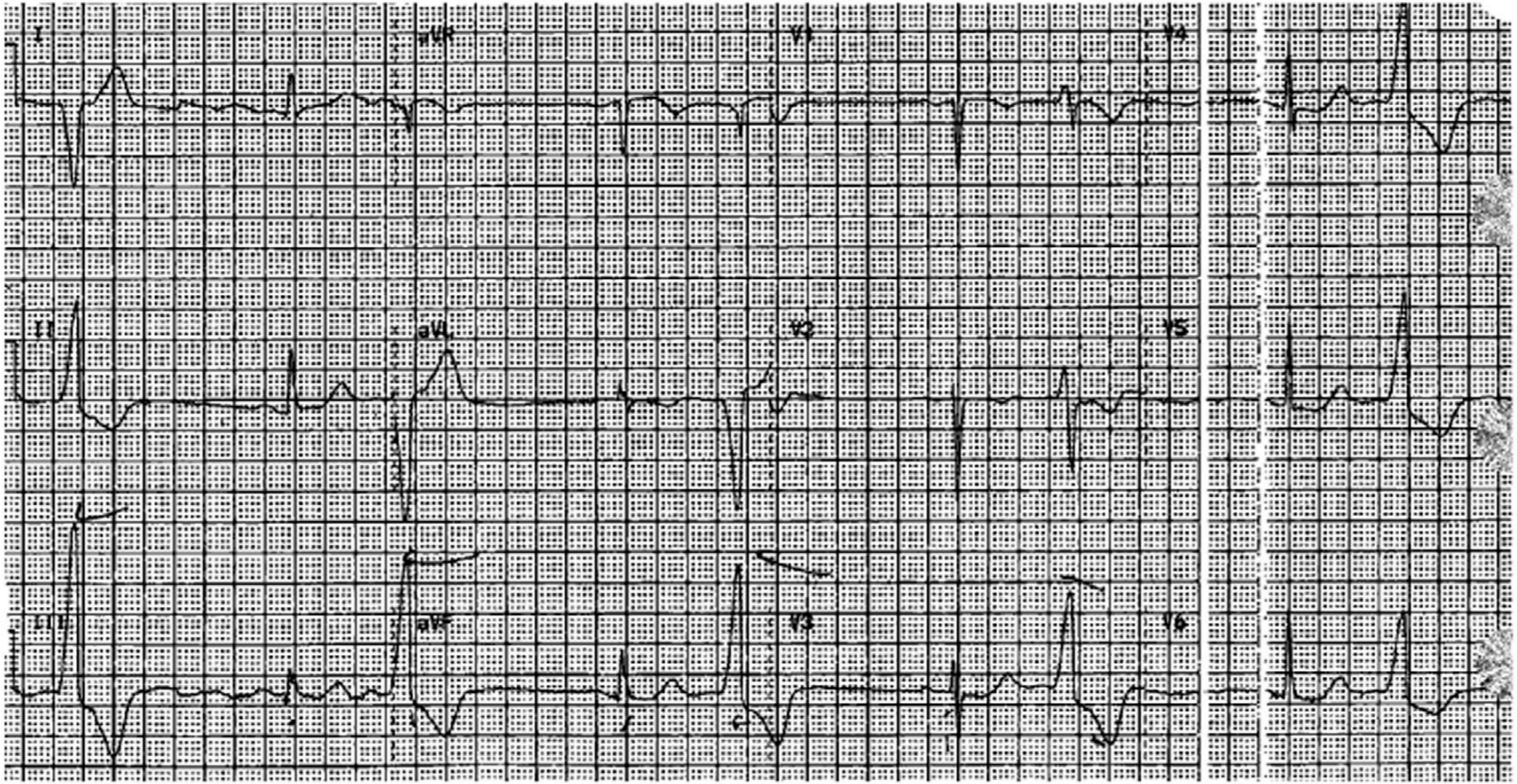

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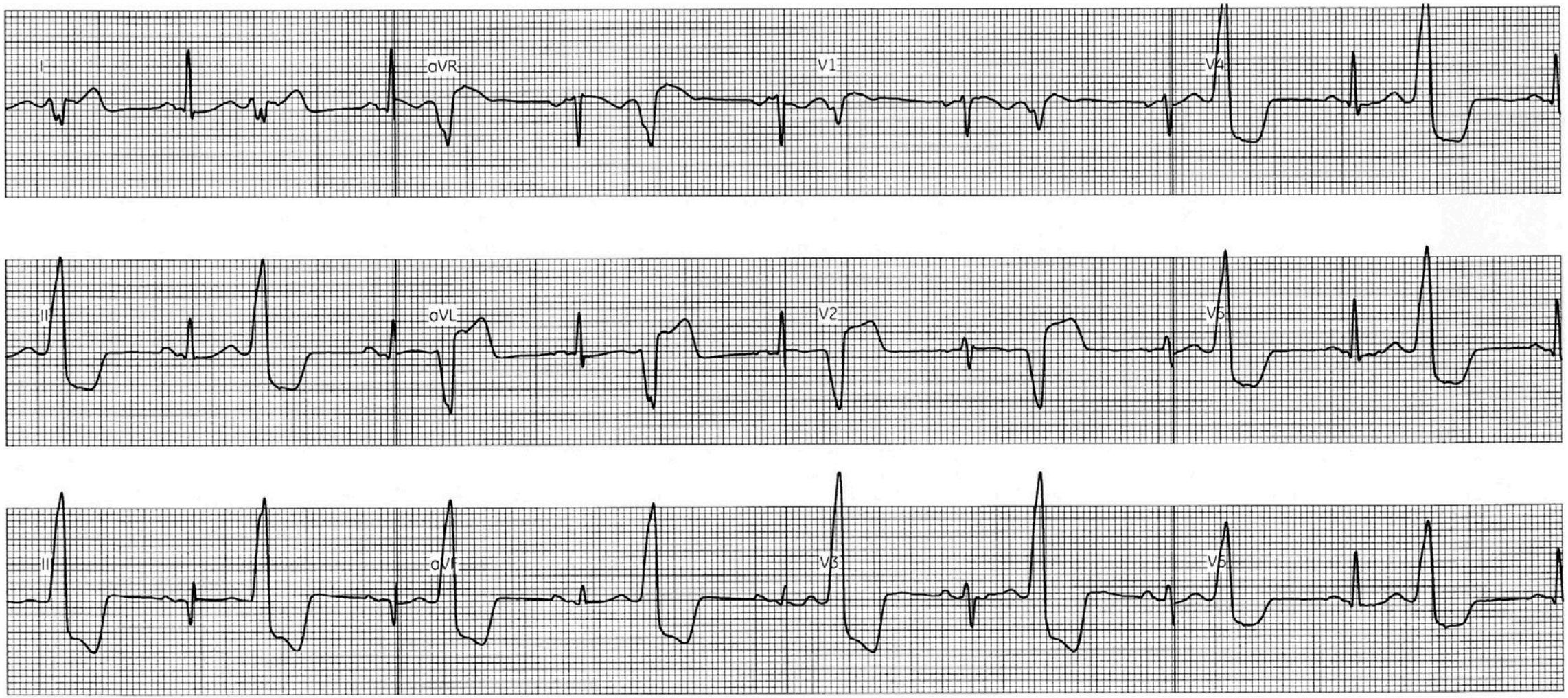

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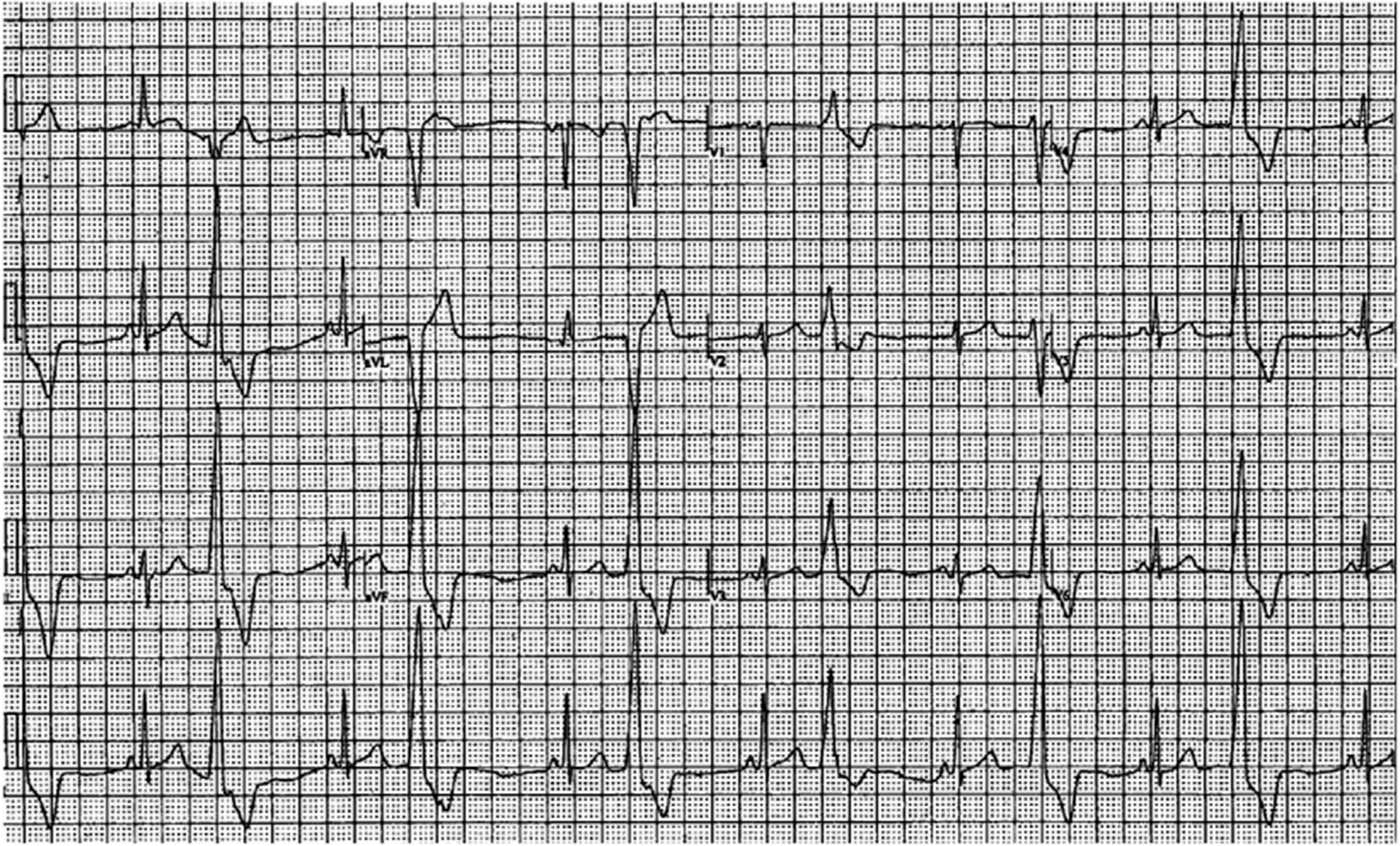

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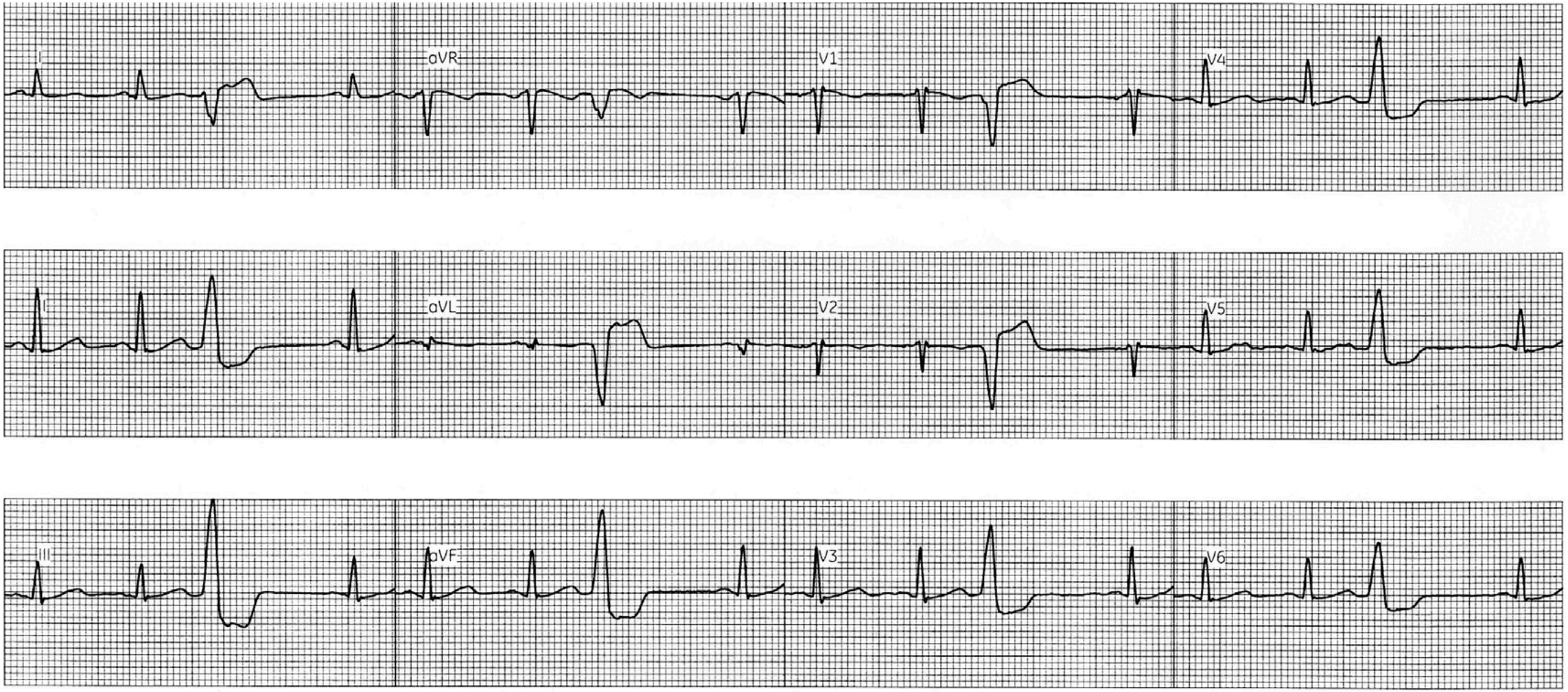
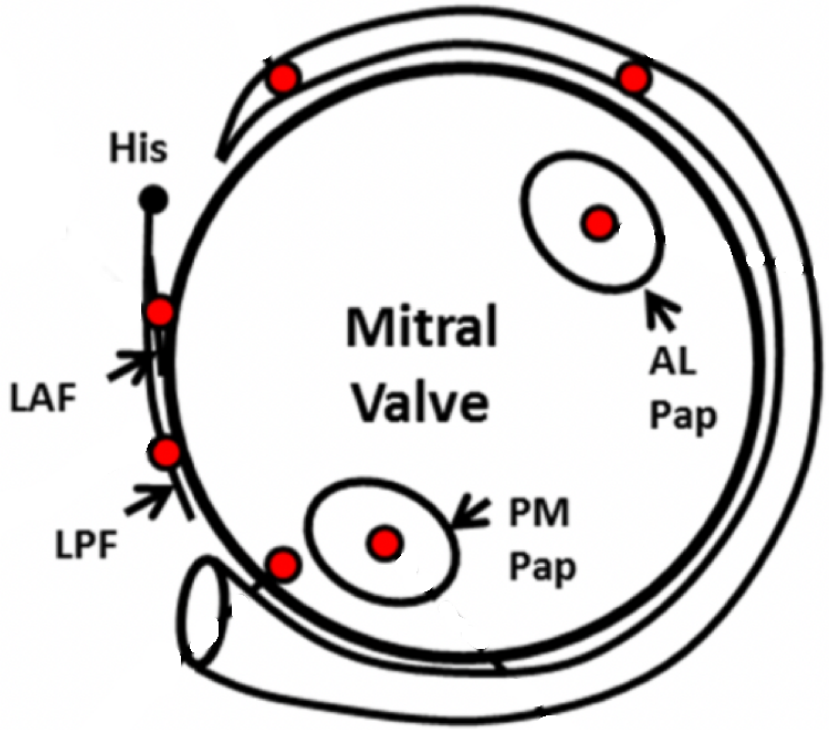
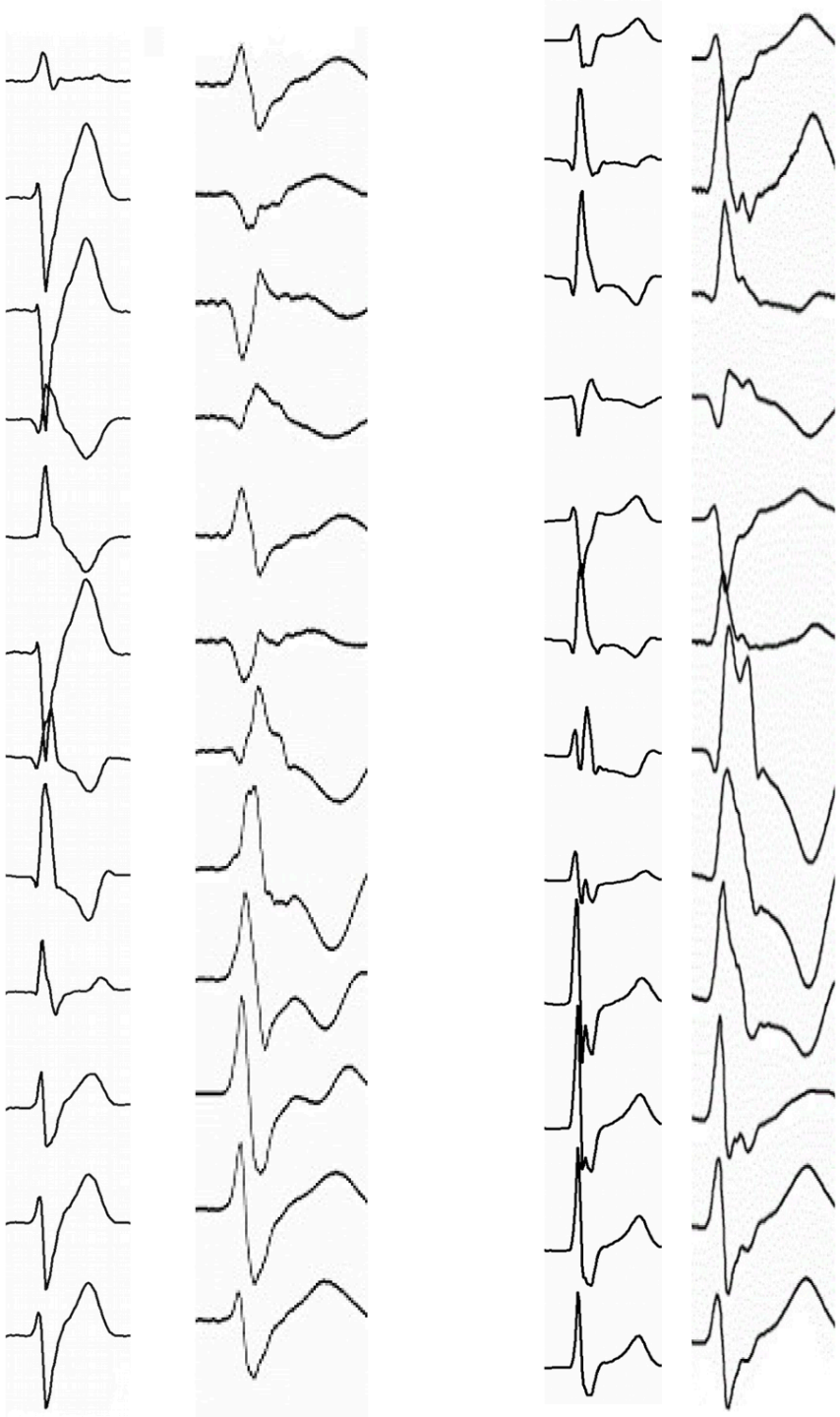


Della Rocca et al. , Card Electrophysiol Clin 10 (2018) 333–354

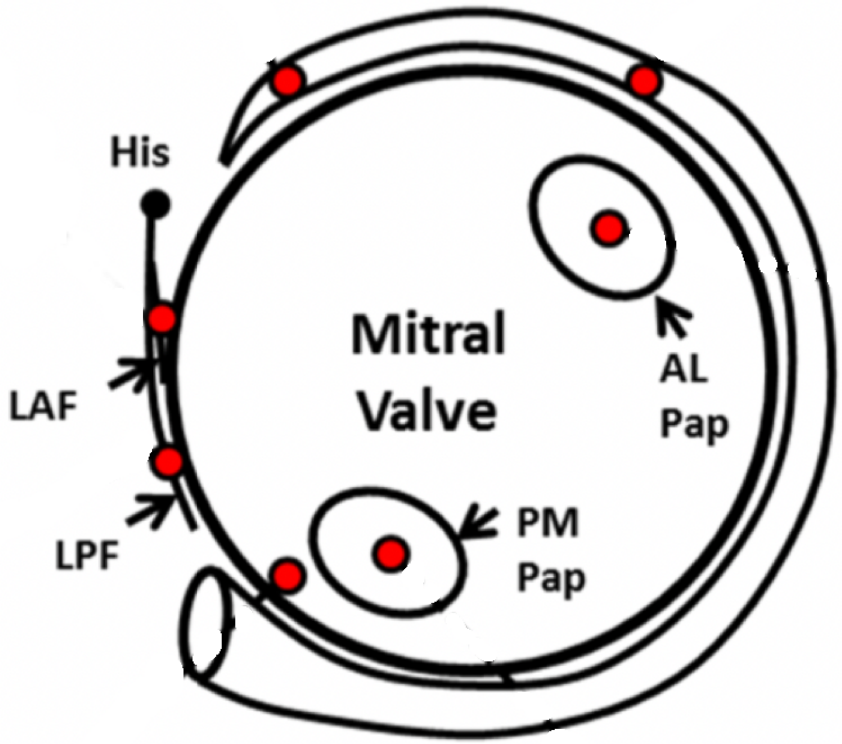
Fascicular or PM VT

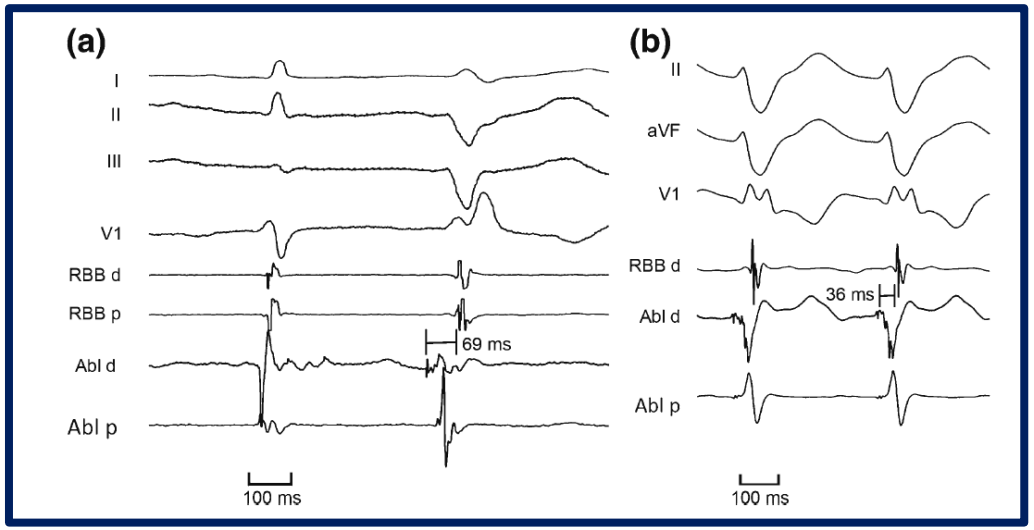


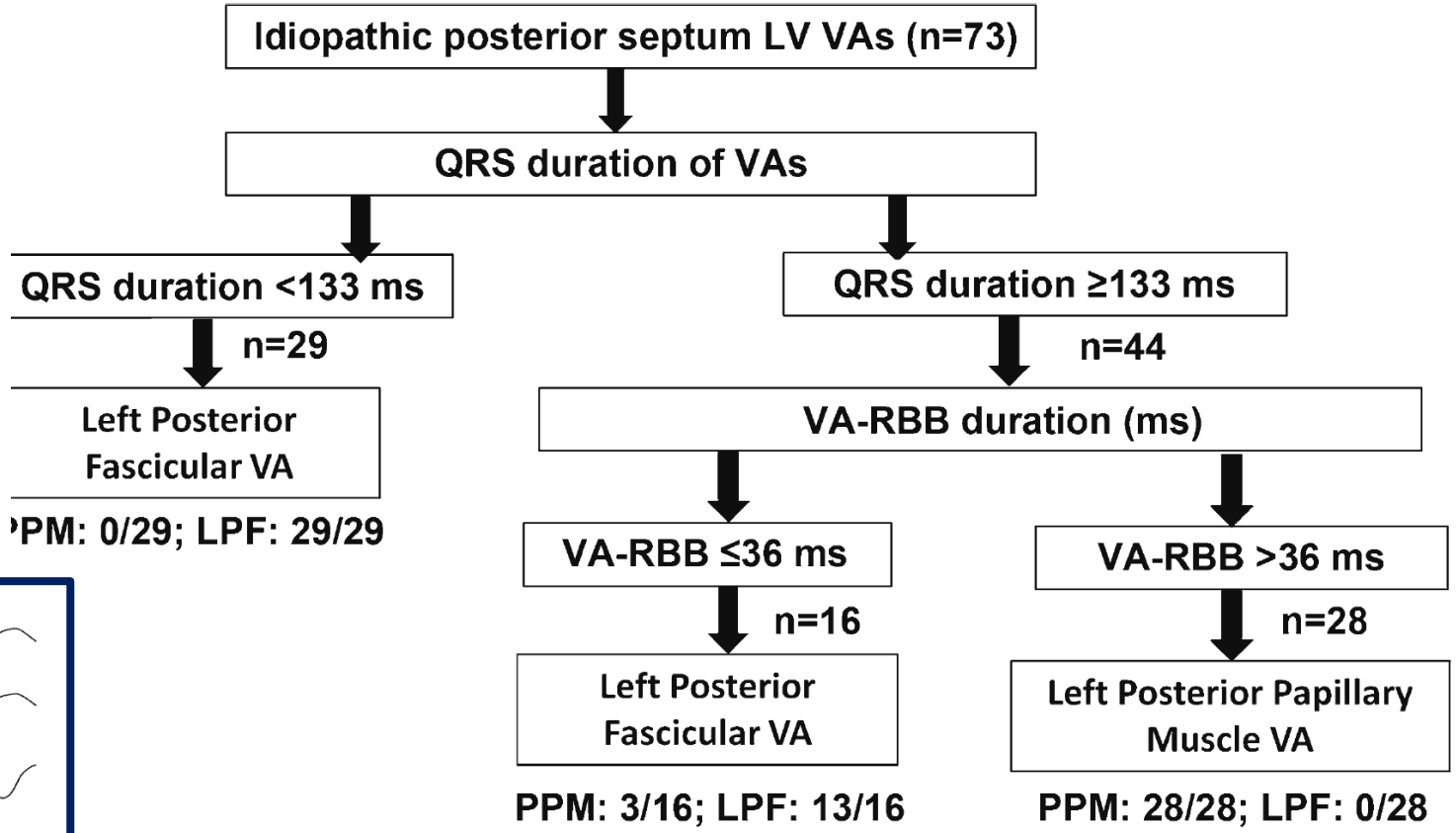
Circ Arrhythm Electrophysiol. 2015;8:616-624.



Fascicular or PM VT

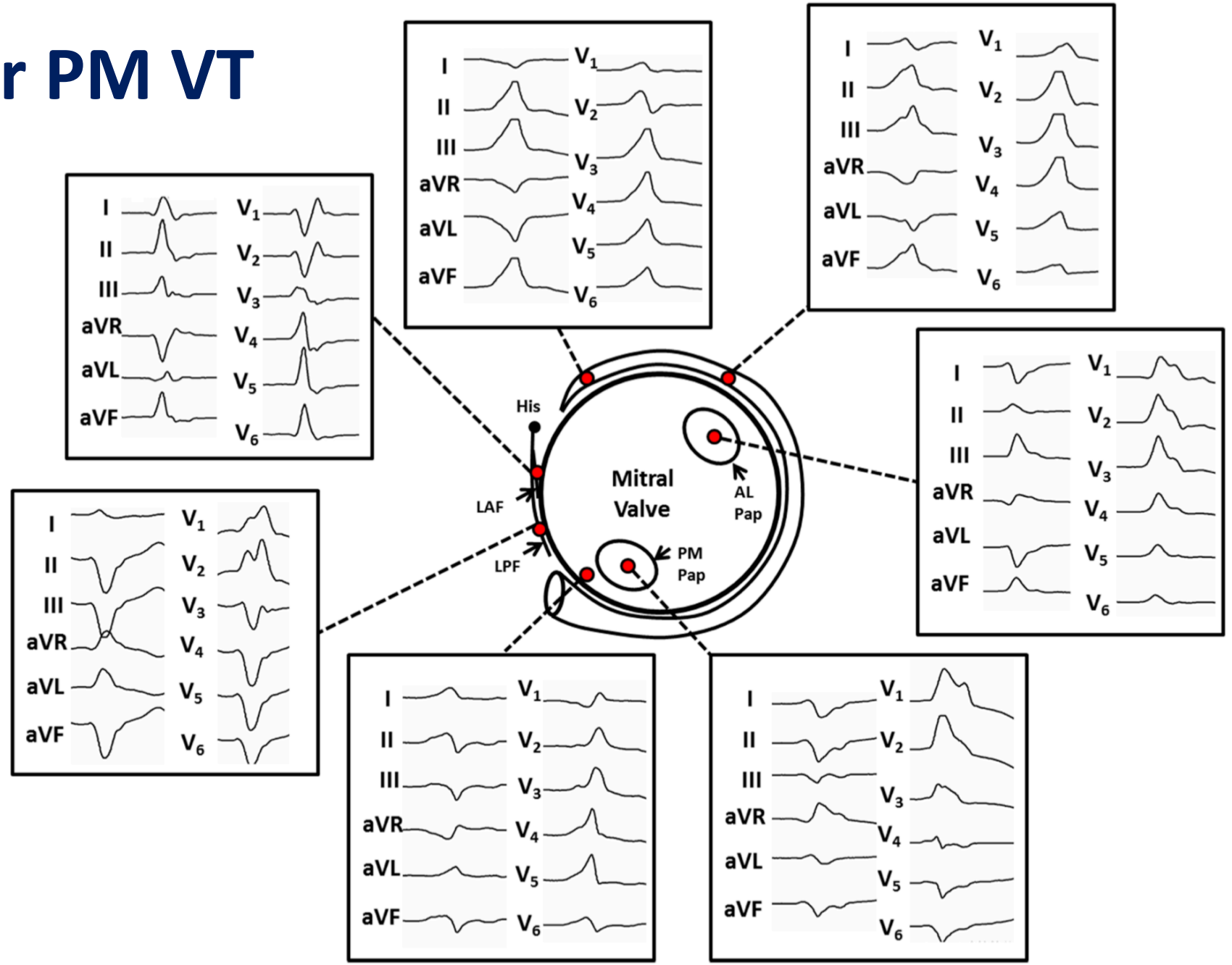






J Interv Card Electrophysiol 2018. DOI 10.1007/s10840-017-0265-3

Fascicular or PM VT

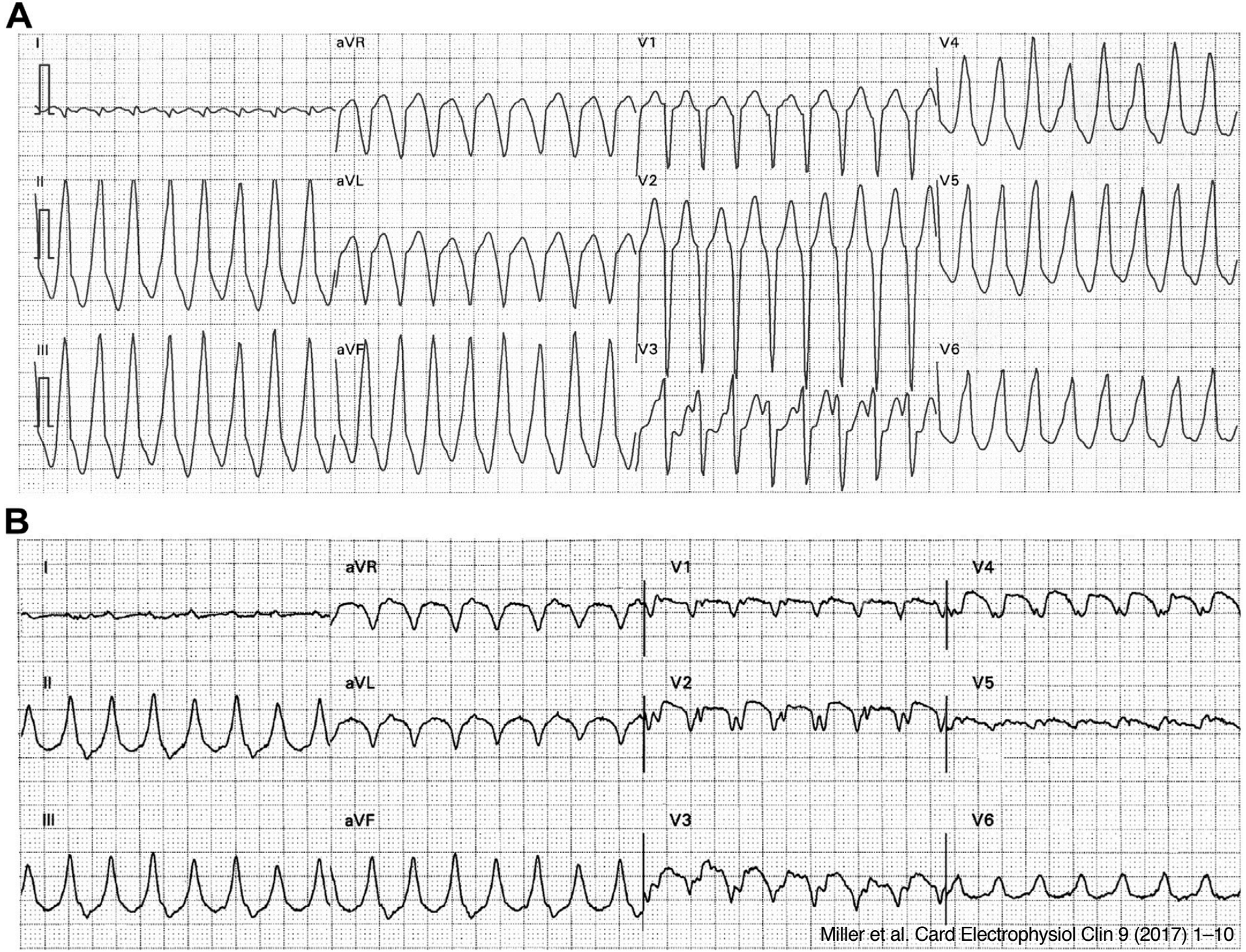


Circ Arrhythm Electrophysiol. 2015;8:616-624.

12 lead ECG and ventricular arrhythmias in patients with structural heart disease

12 lead ECG and ventricular arrhythmias in patients with structural heart disease

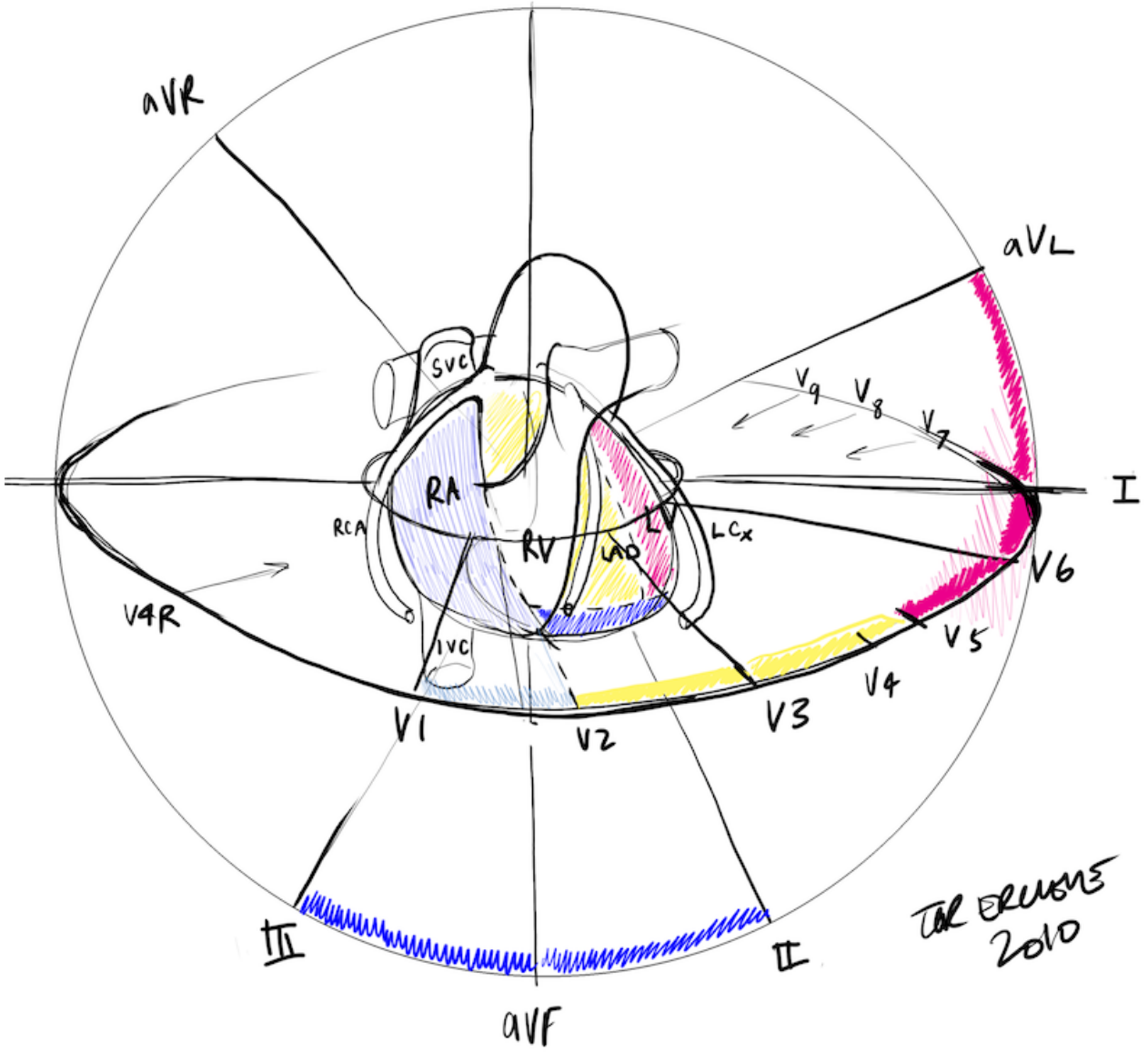
- Presence and size of scar
- Intramyocardial fibrosis
- Shape of the heart (e.g. aneurysm) and its position in the chest
- Site of VT origin in the scar area
- Nonuniform anisotropy
- Acute ischemia
- Integrity of His-Purkinje system
- LVH/RVH



Miller et al. Card Electrophysiol Clin 9 (2017) 1–10

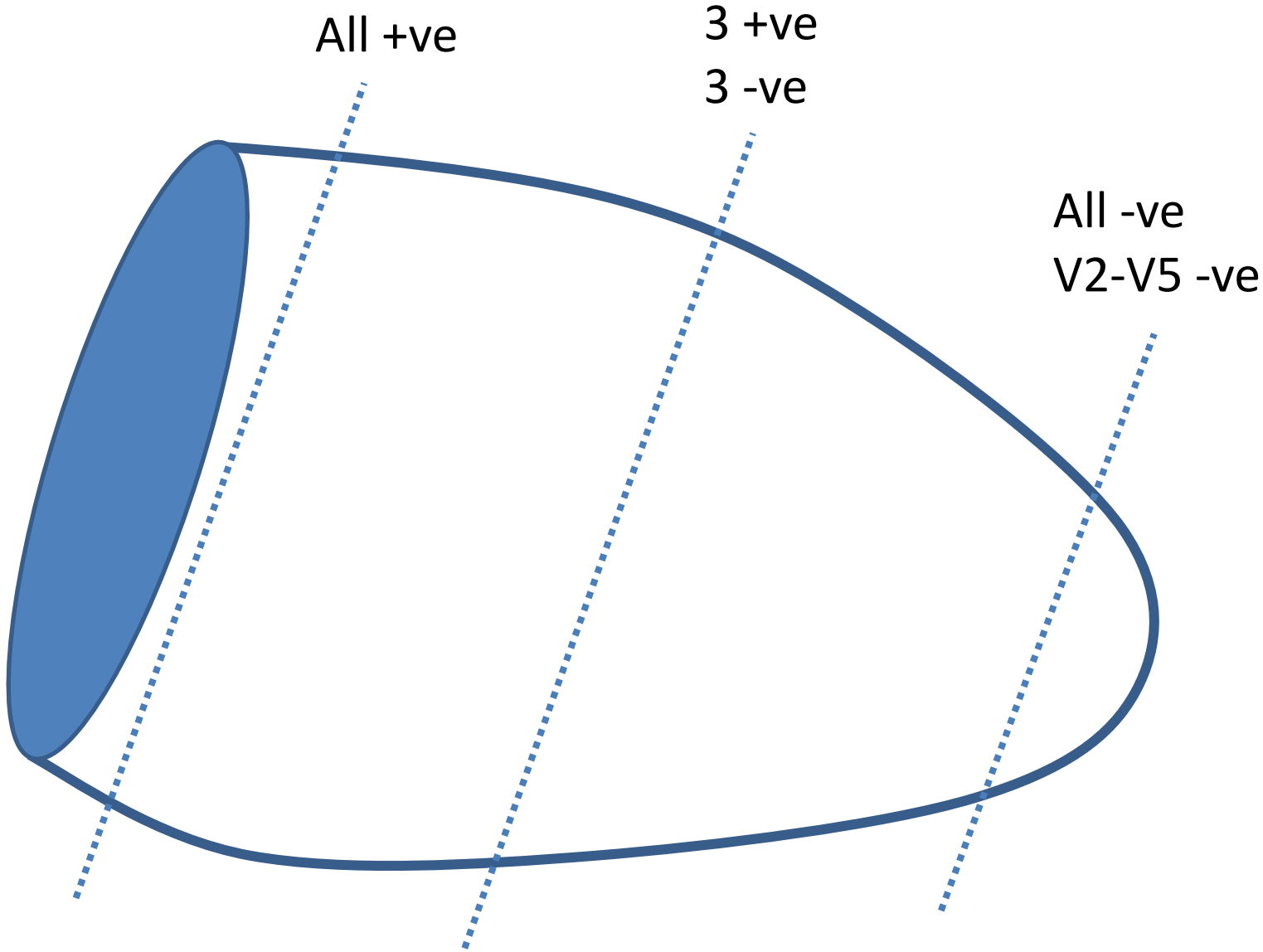
My Simplified Approach

STEP1: V1

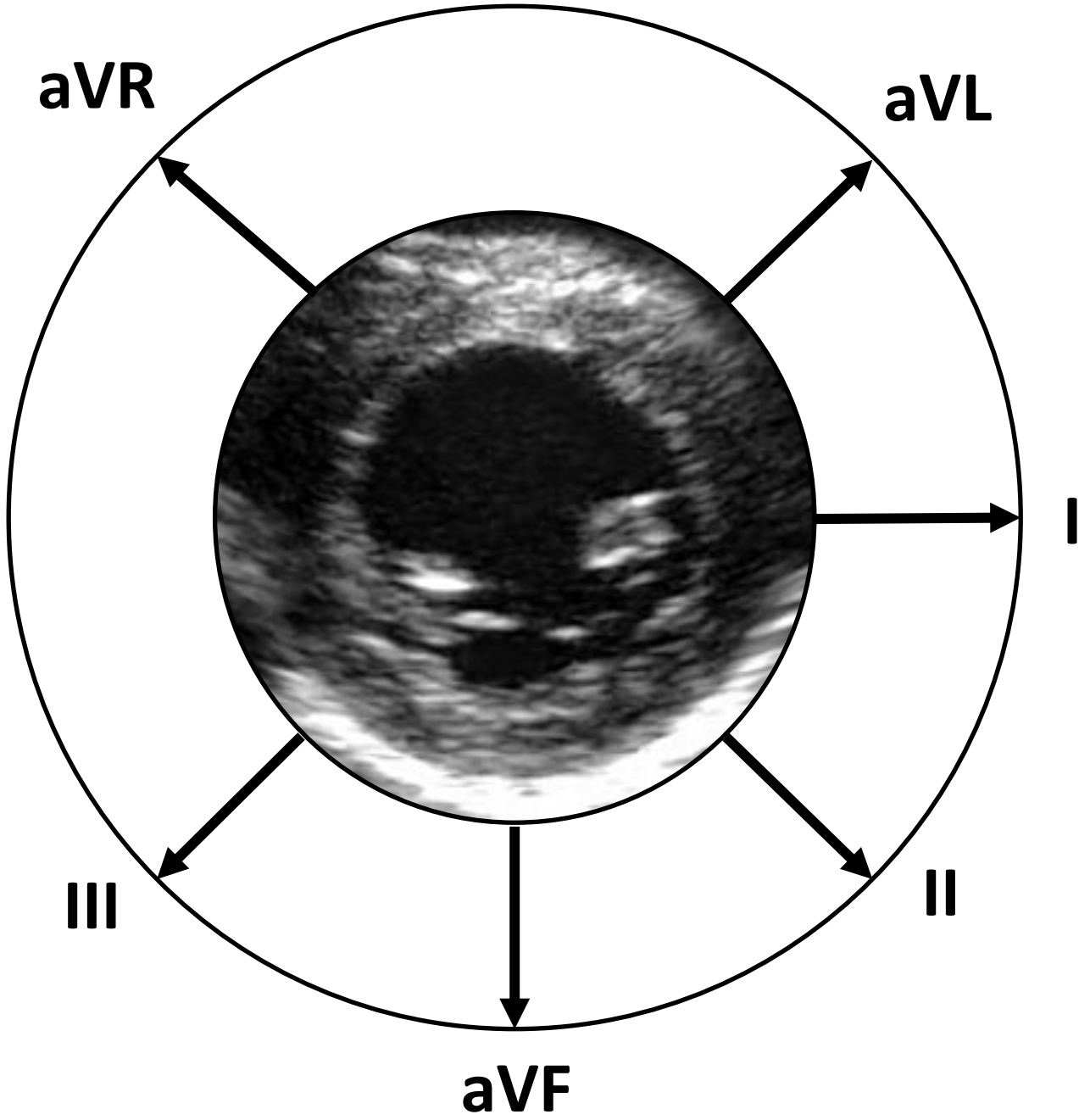


My Simplified Approach

STEP2: V1-V6

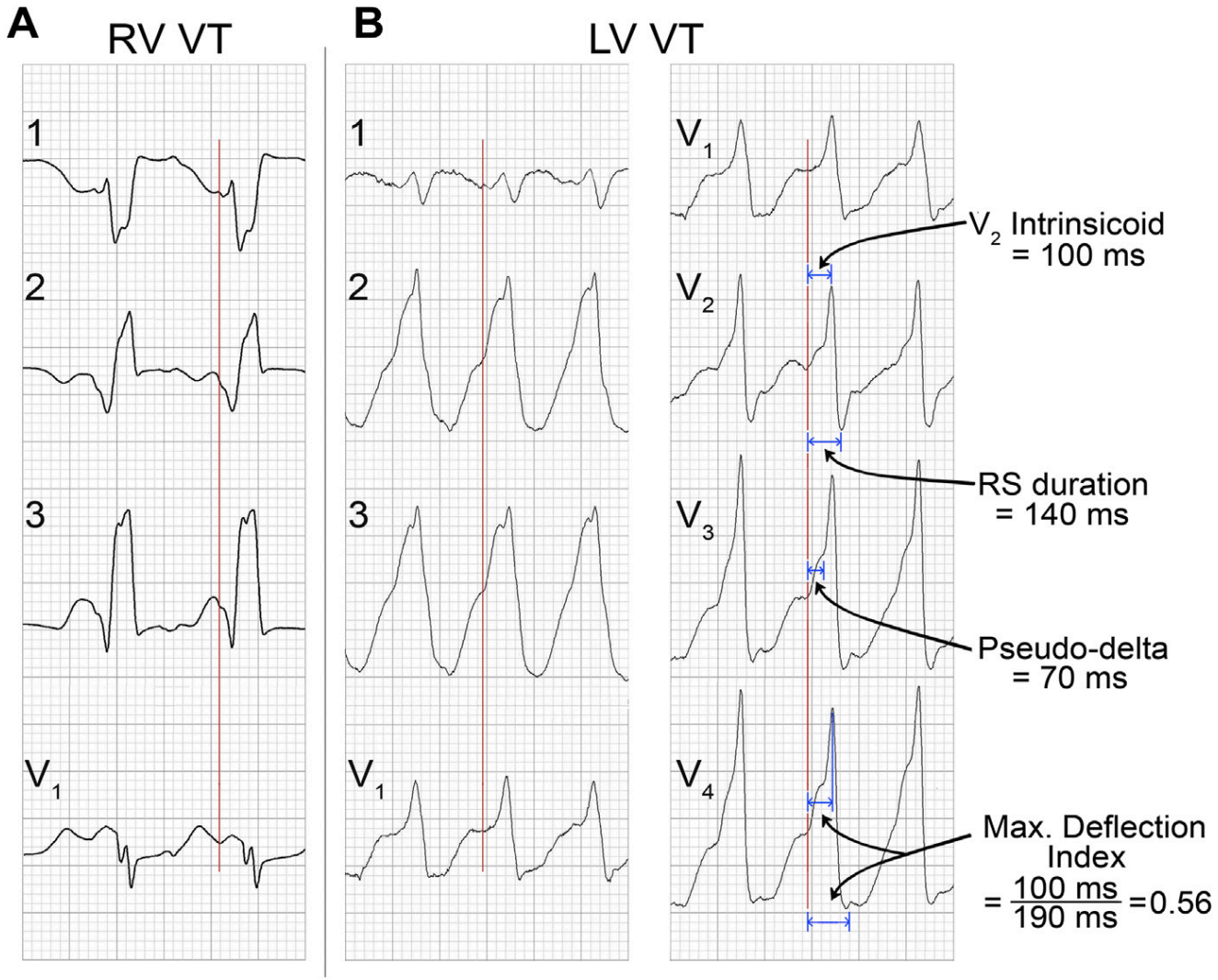


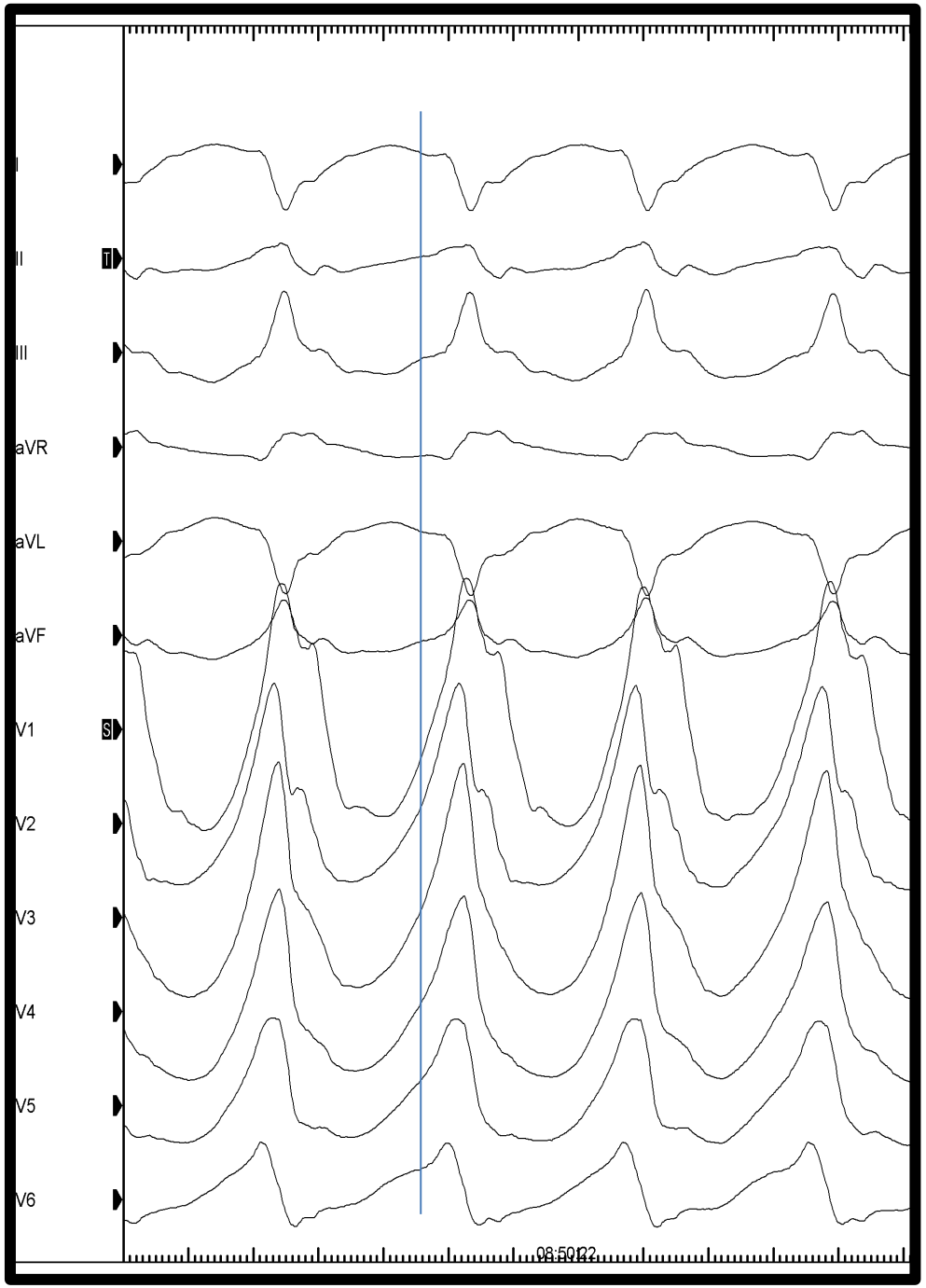
STEP3: Limb Leads



Epicardial Exit

Several criteria have been proposed to identify VTs that require epicardial mapping and ablation; these can be separated into 2 categories, namely, those based on interval/duration and those based on QRS morphologies

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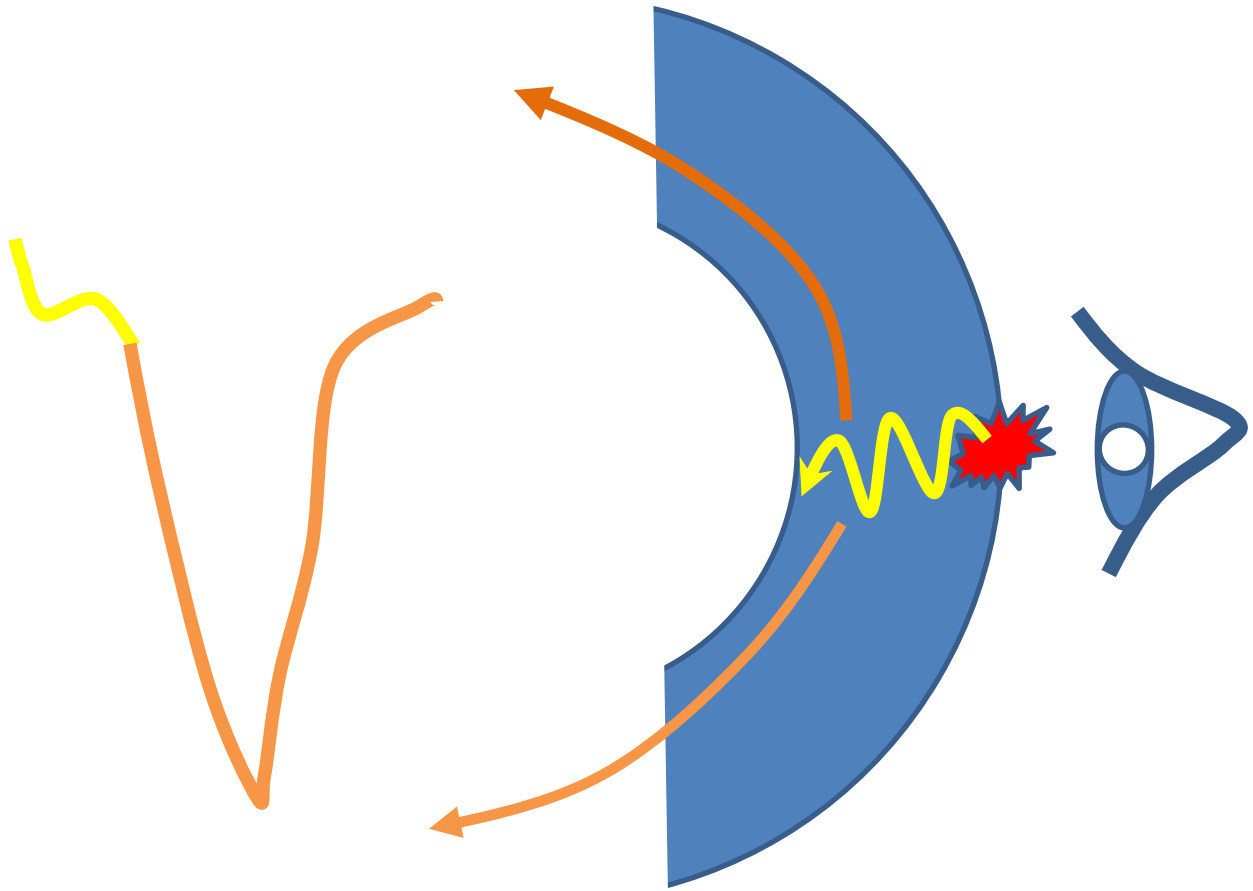
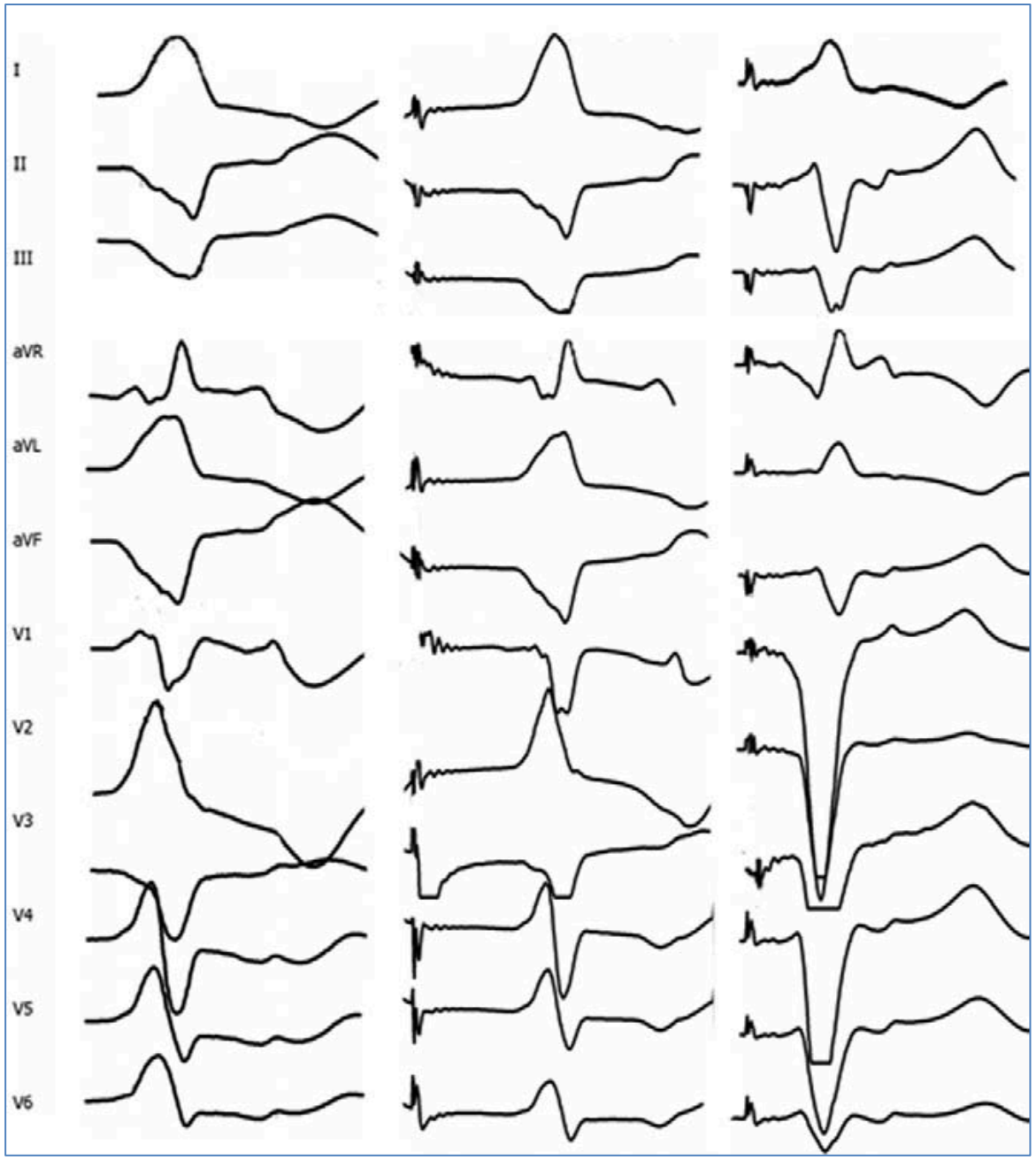
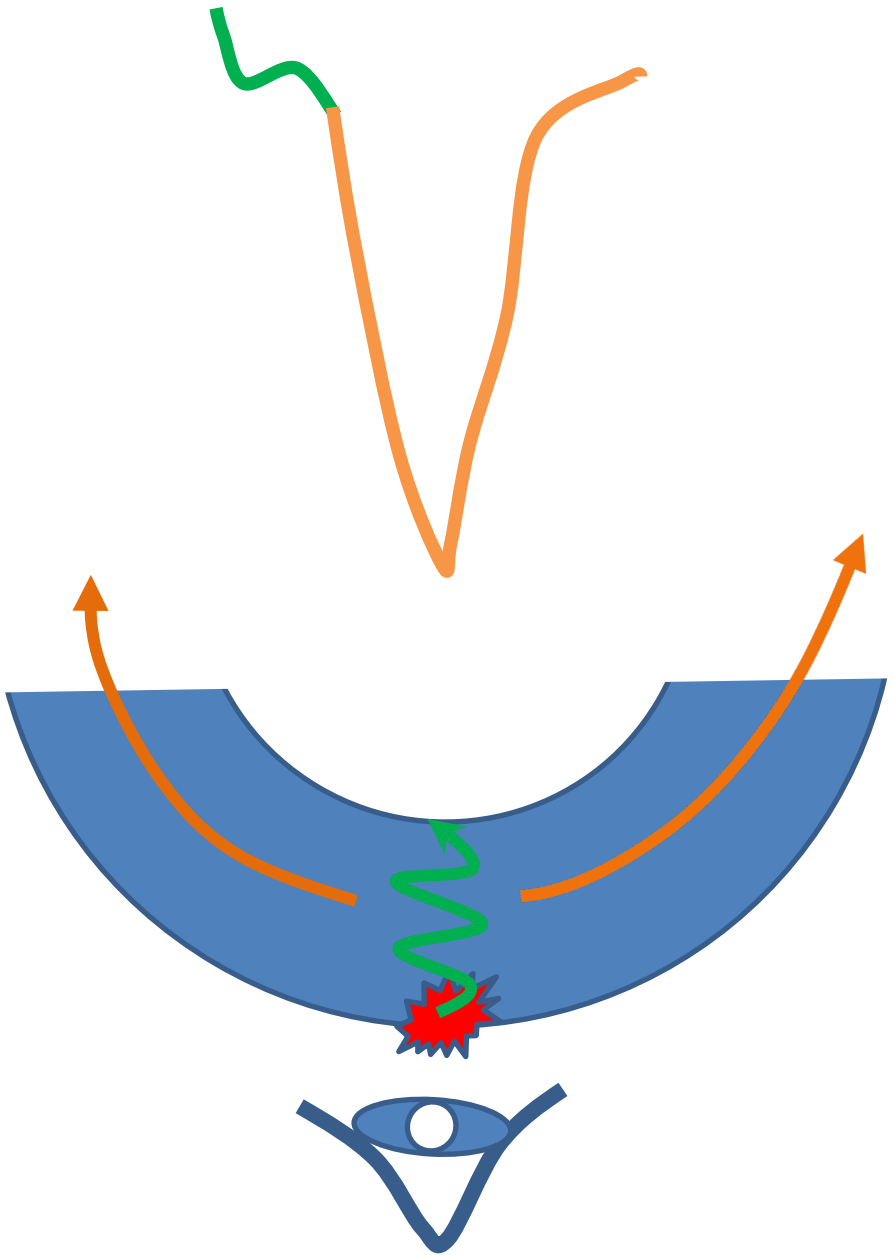
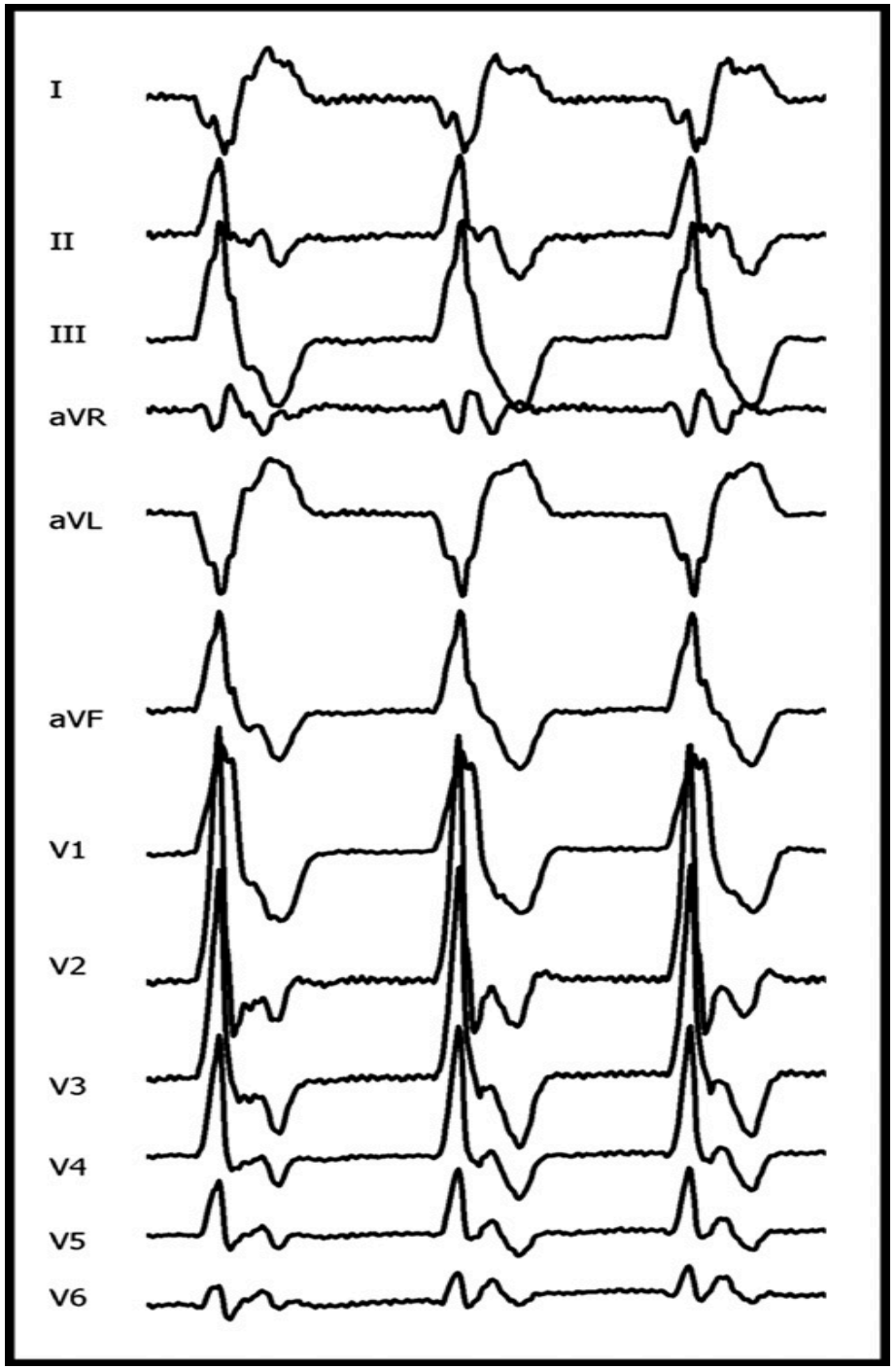




Heart Rhythm 2006;3:1132–1139

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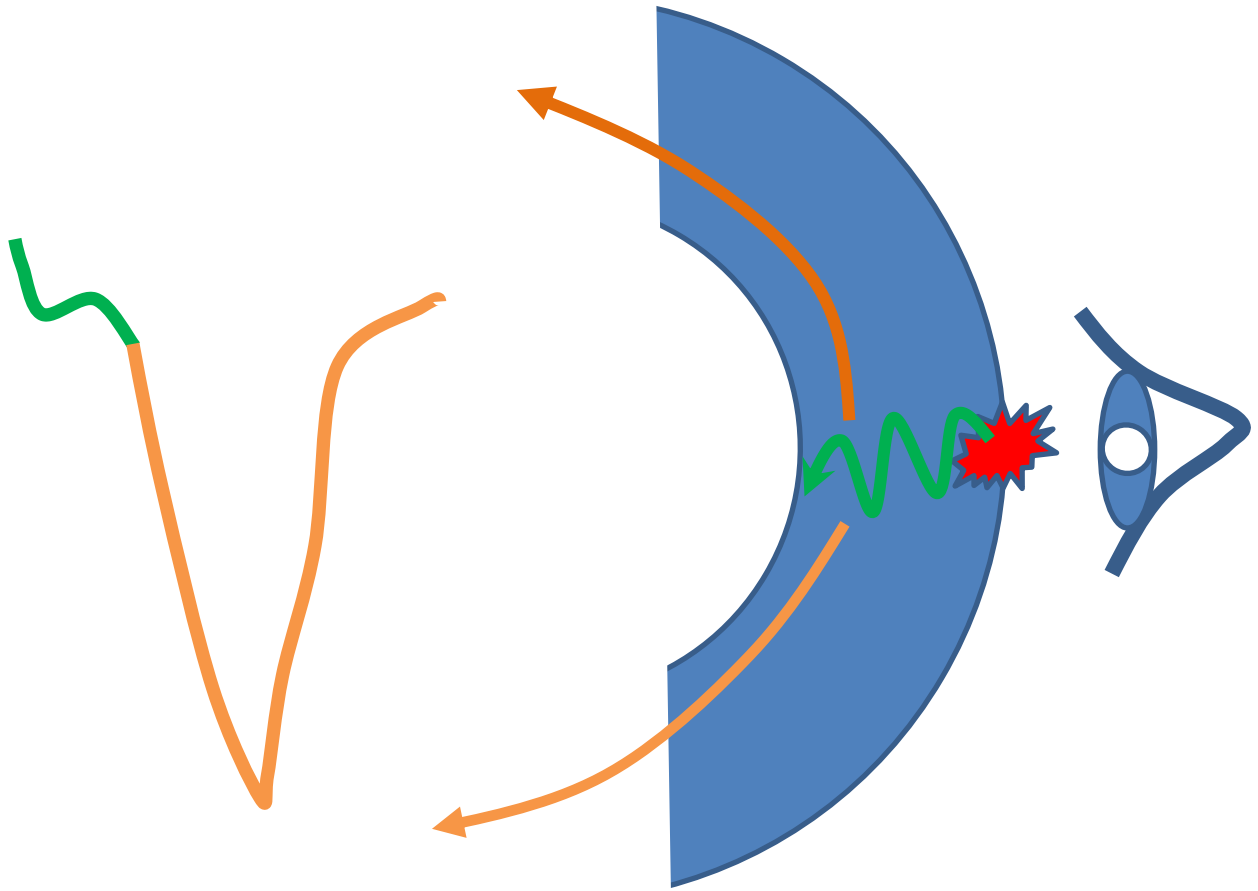
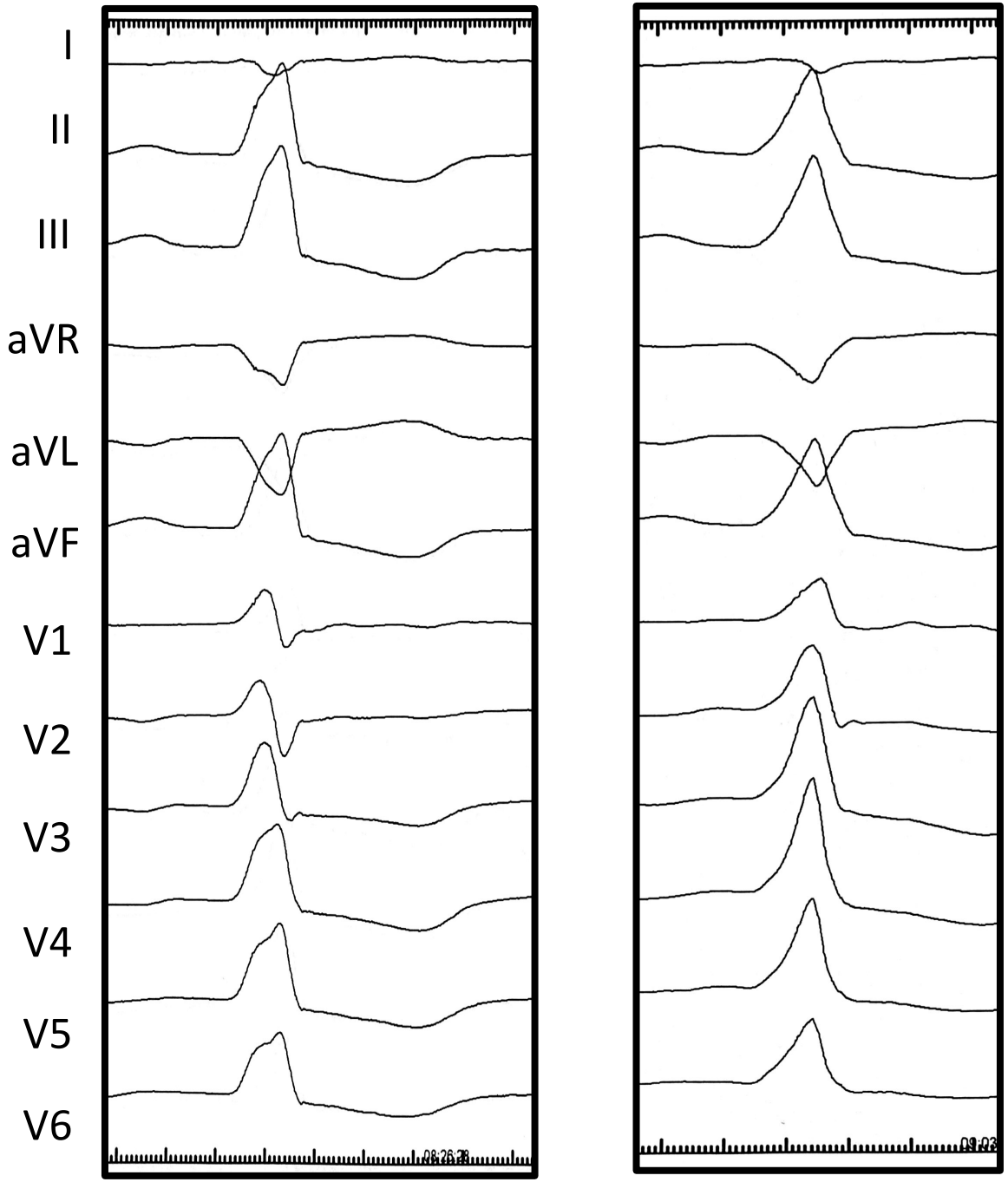
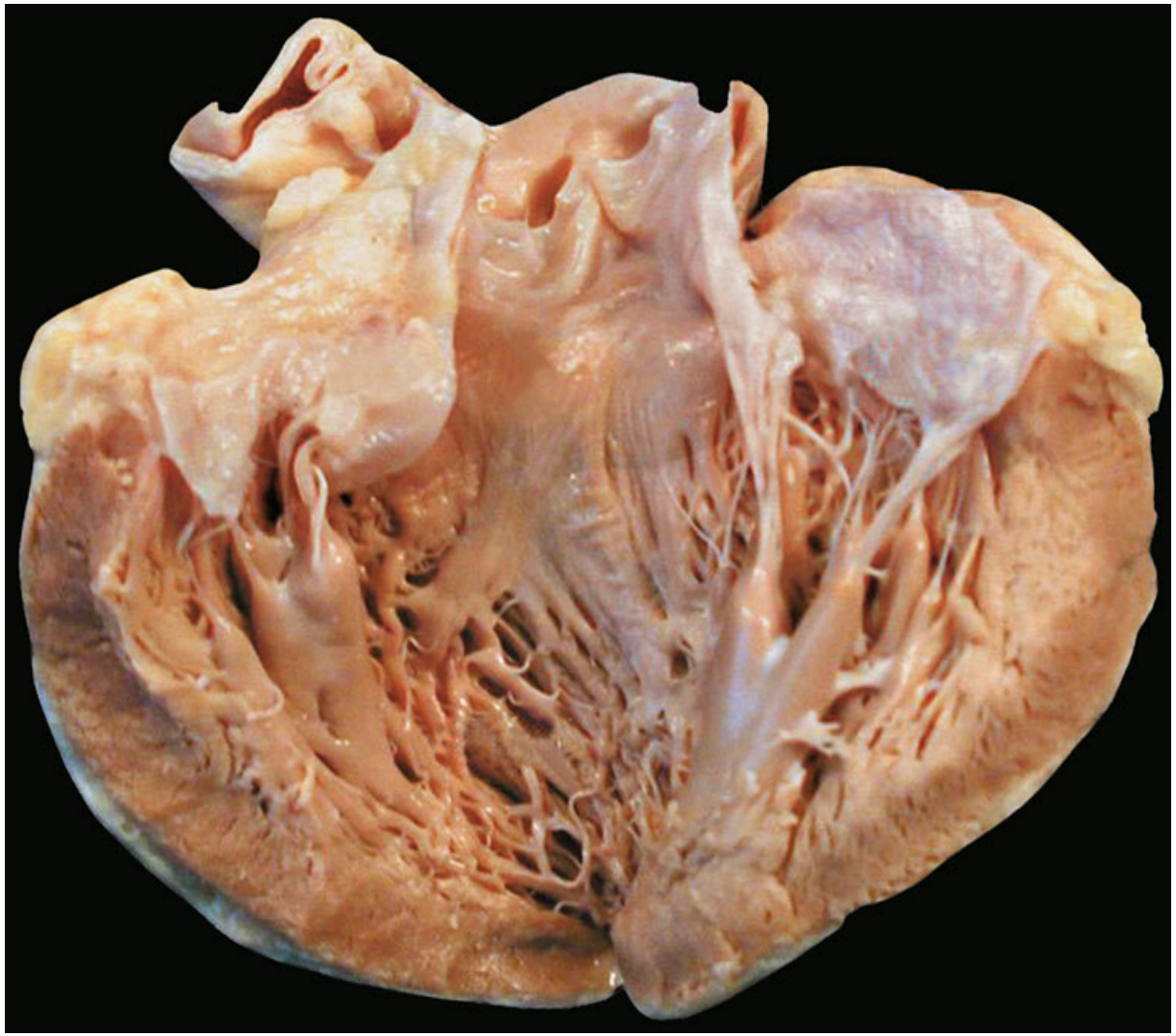
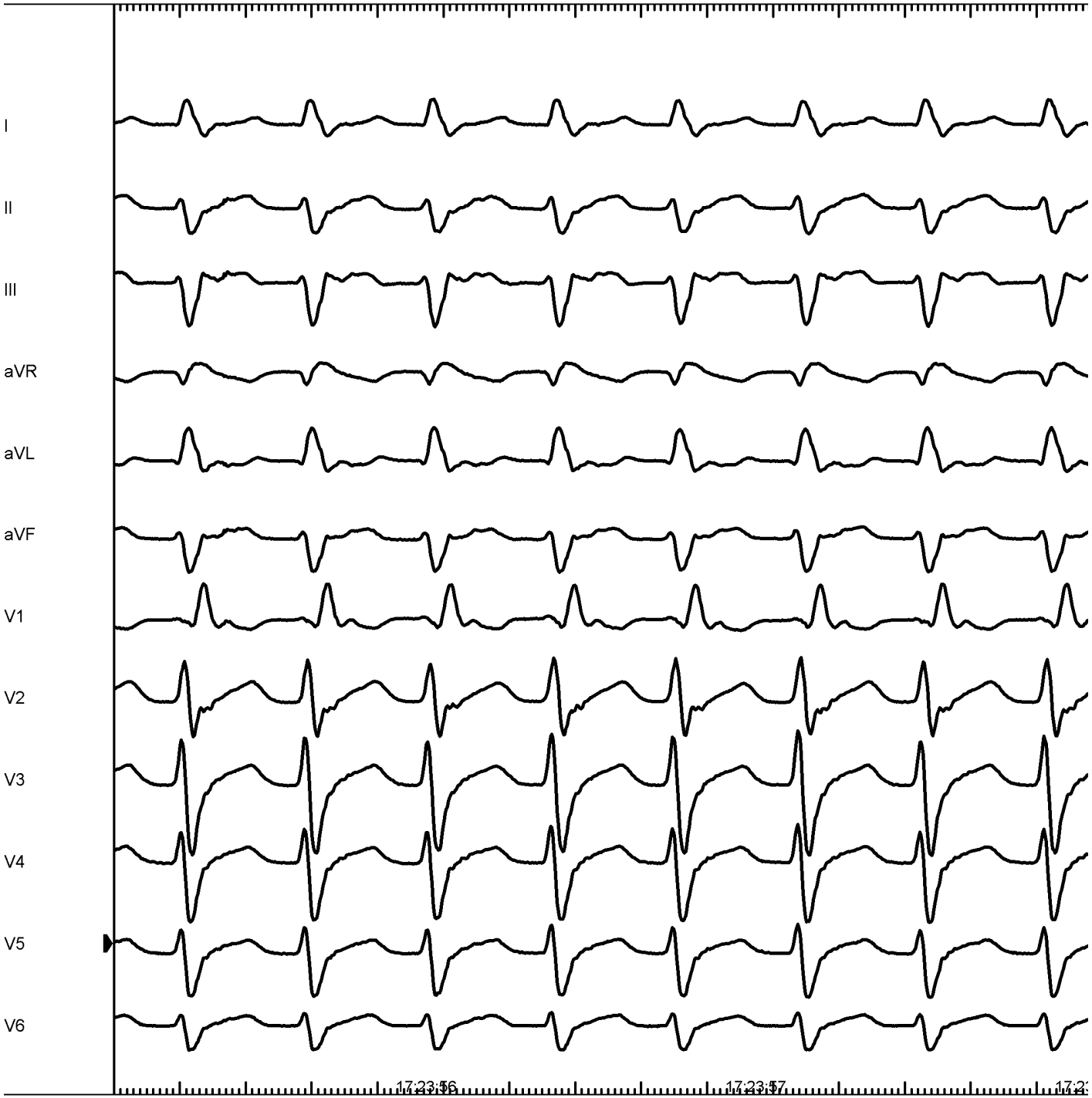
V5
V6

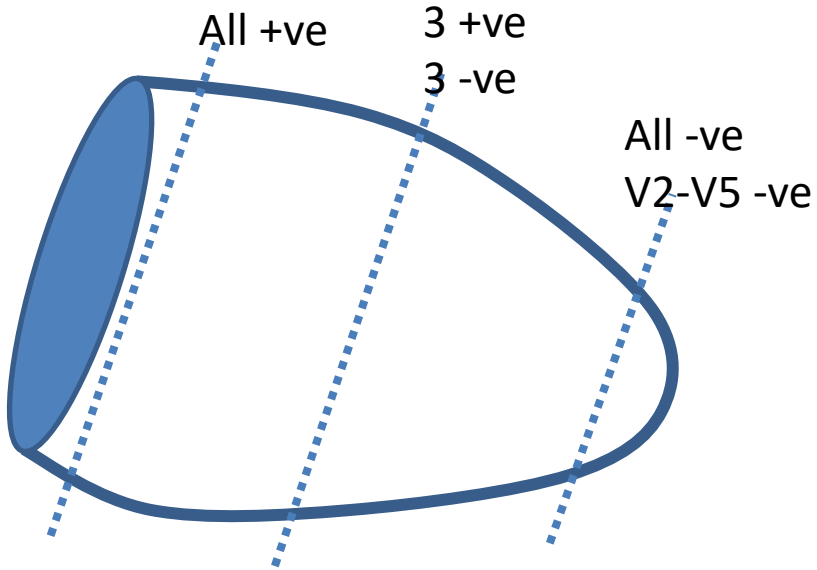


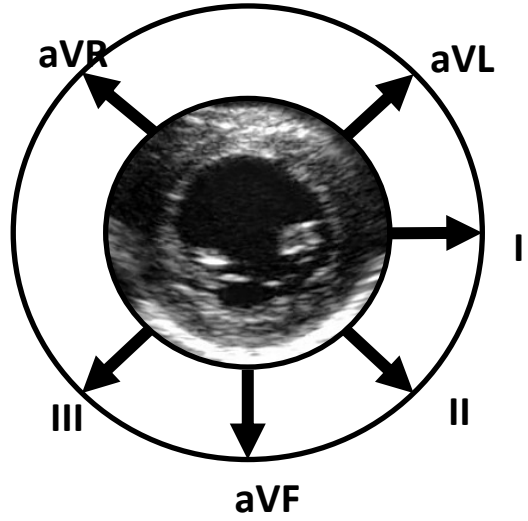
VT Localization: case studies

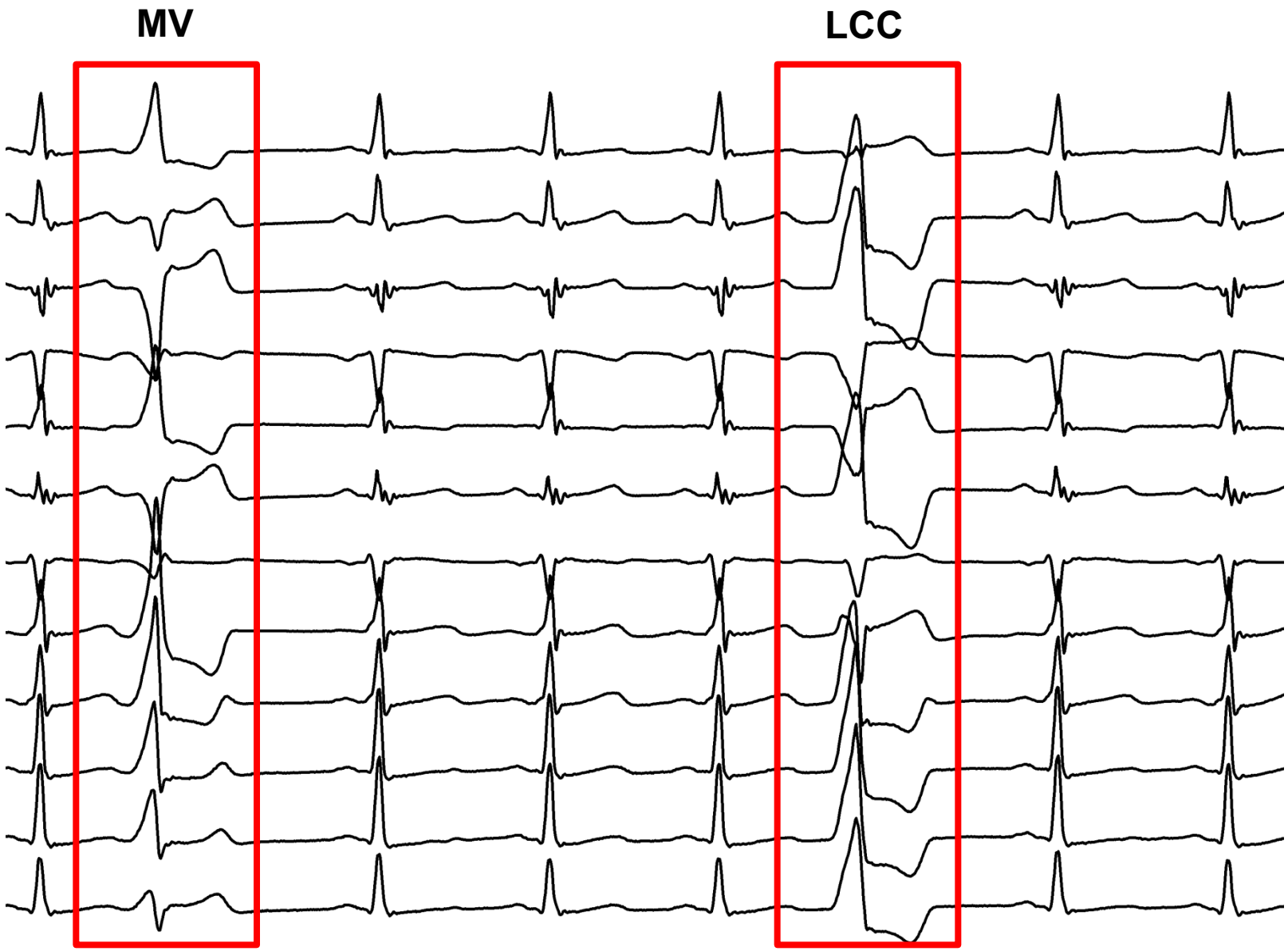

I
II
III
aVR
aVL
aVF
V1
V2
V3
V4
V5
V6



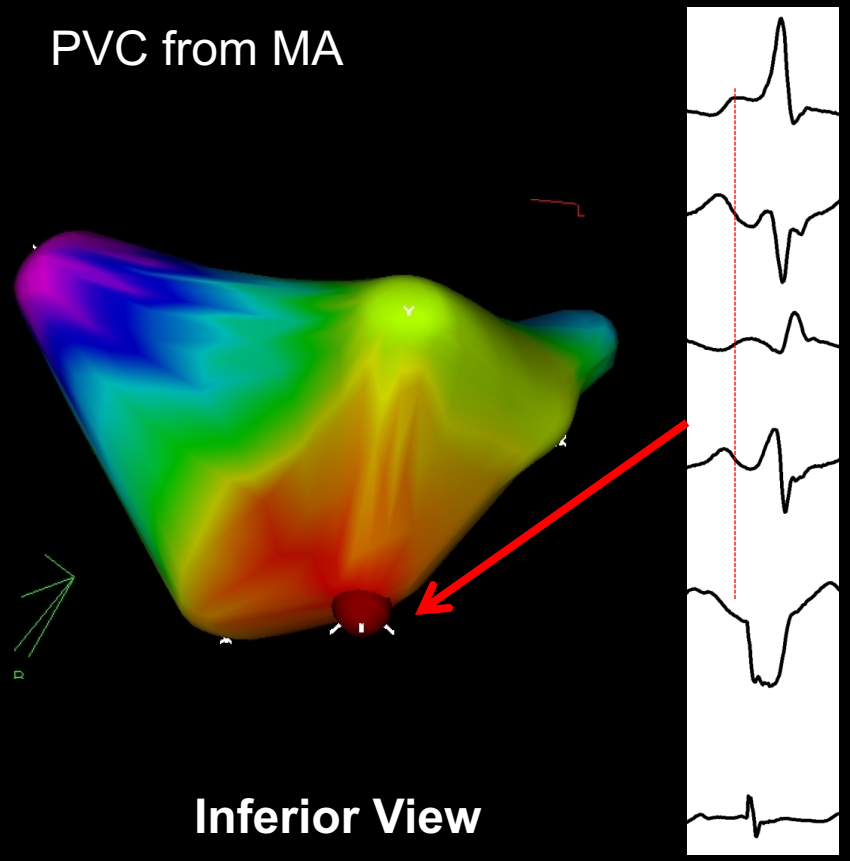

I
II
III
aVR
aVL
aVF
V1
V2
V3
V4
V5
V6


All +ve
3 +ve
3 -ve
All -ve
V2-V5 -ve


aVR
aVL
I
III
II
aVF

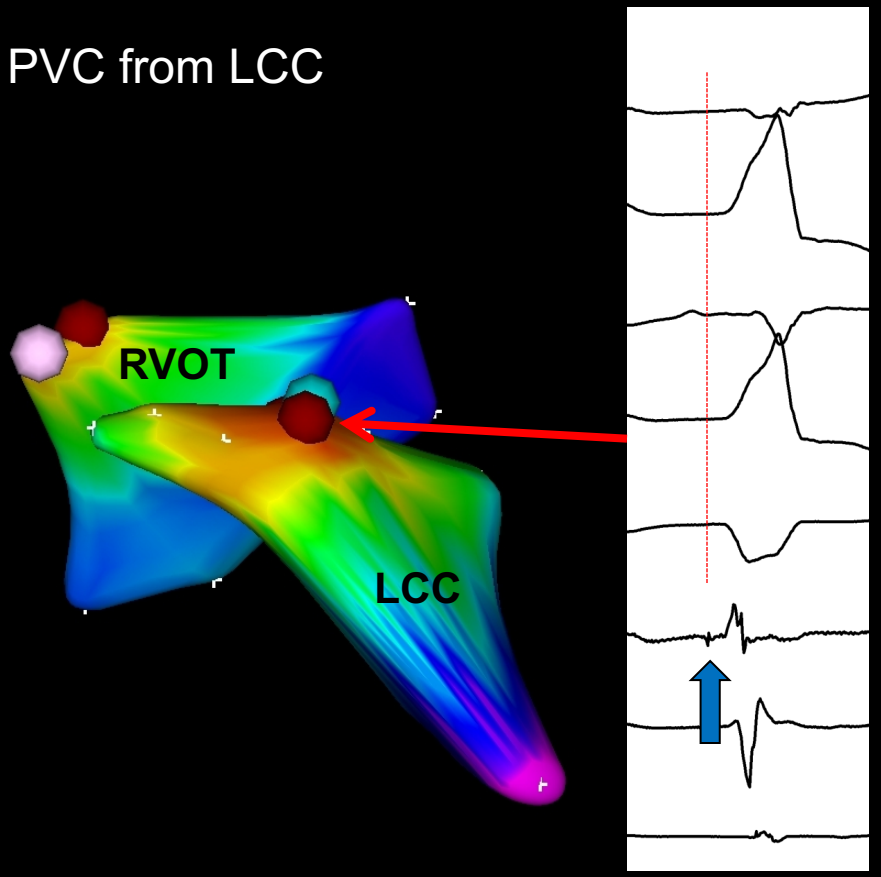

MV
LCC

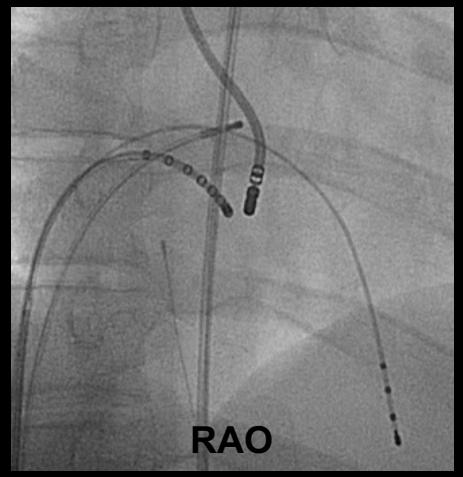
PVC from MA

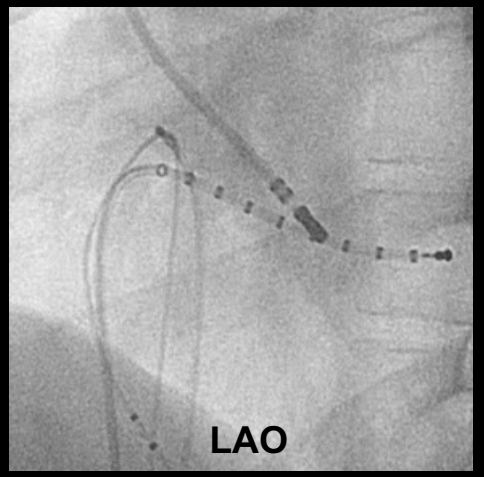


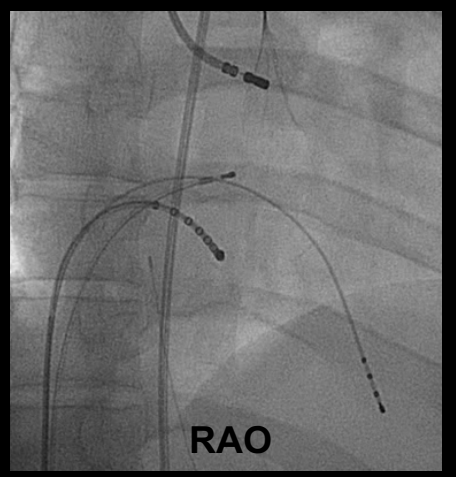
Inferior View

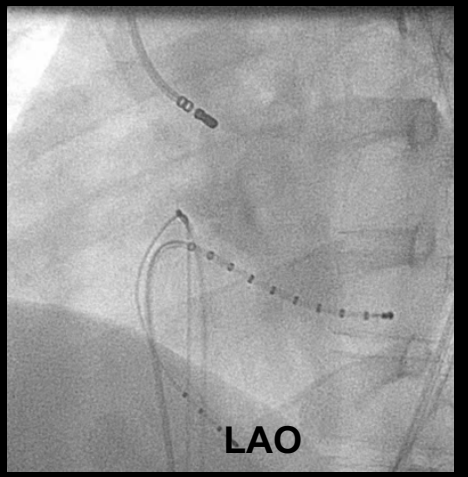
PVC from LCC

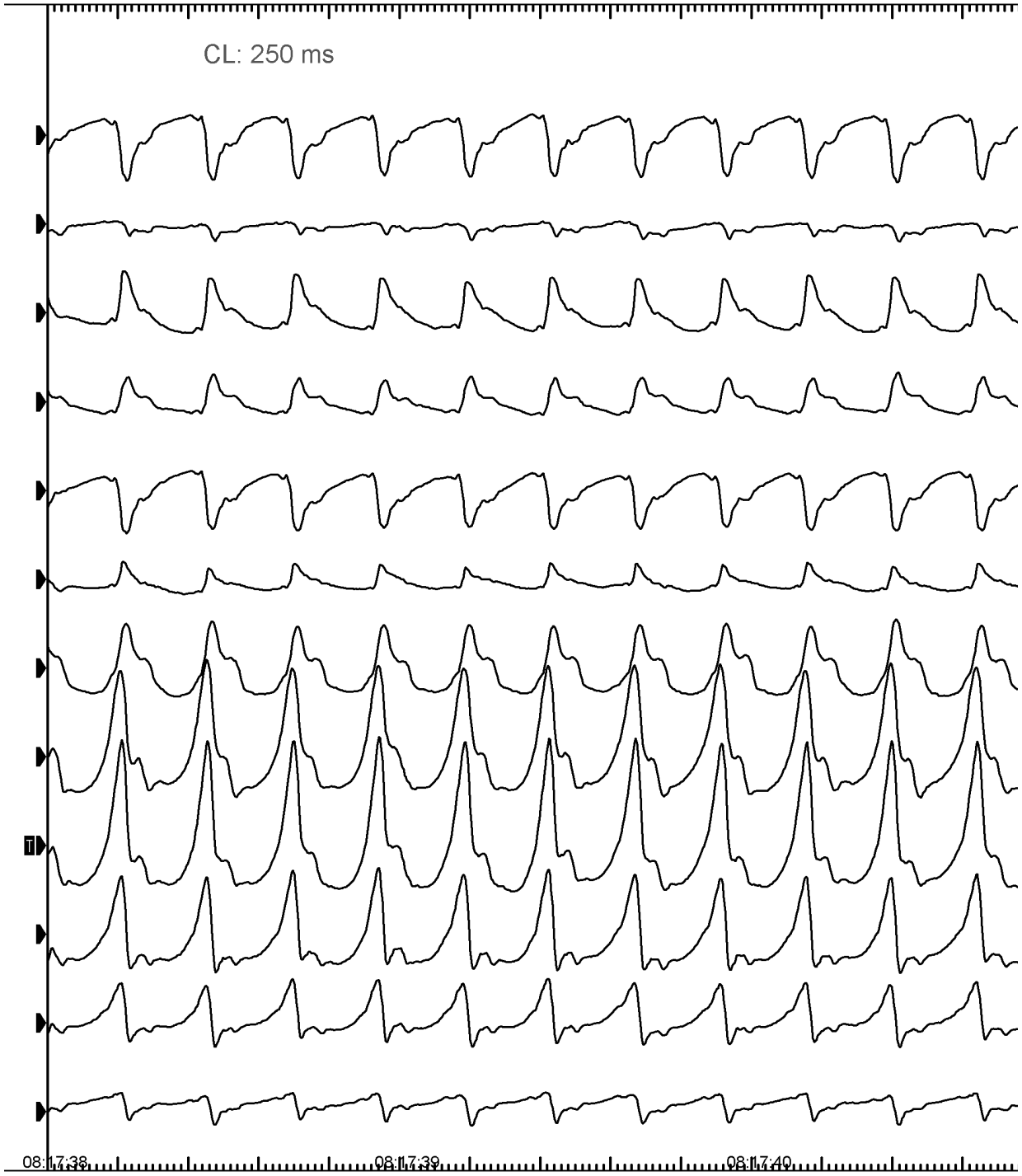


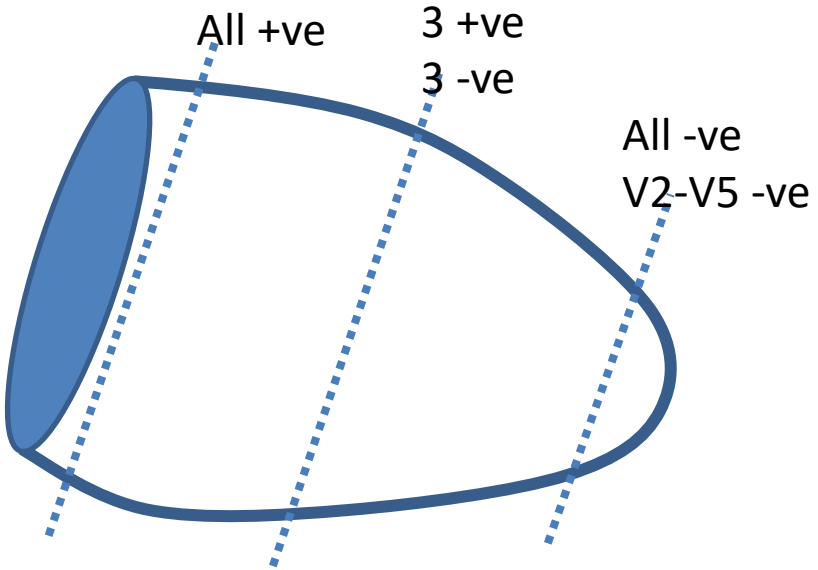


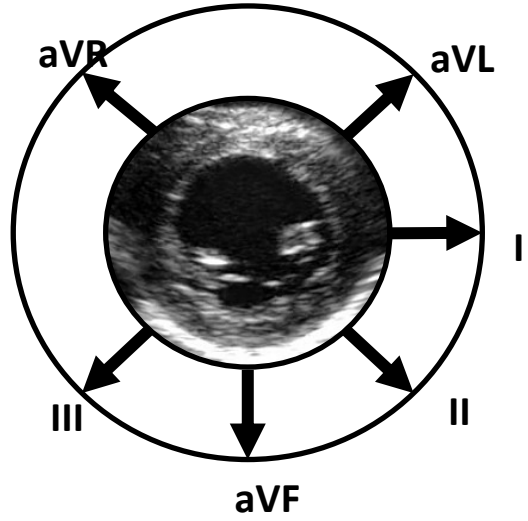


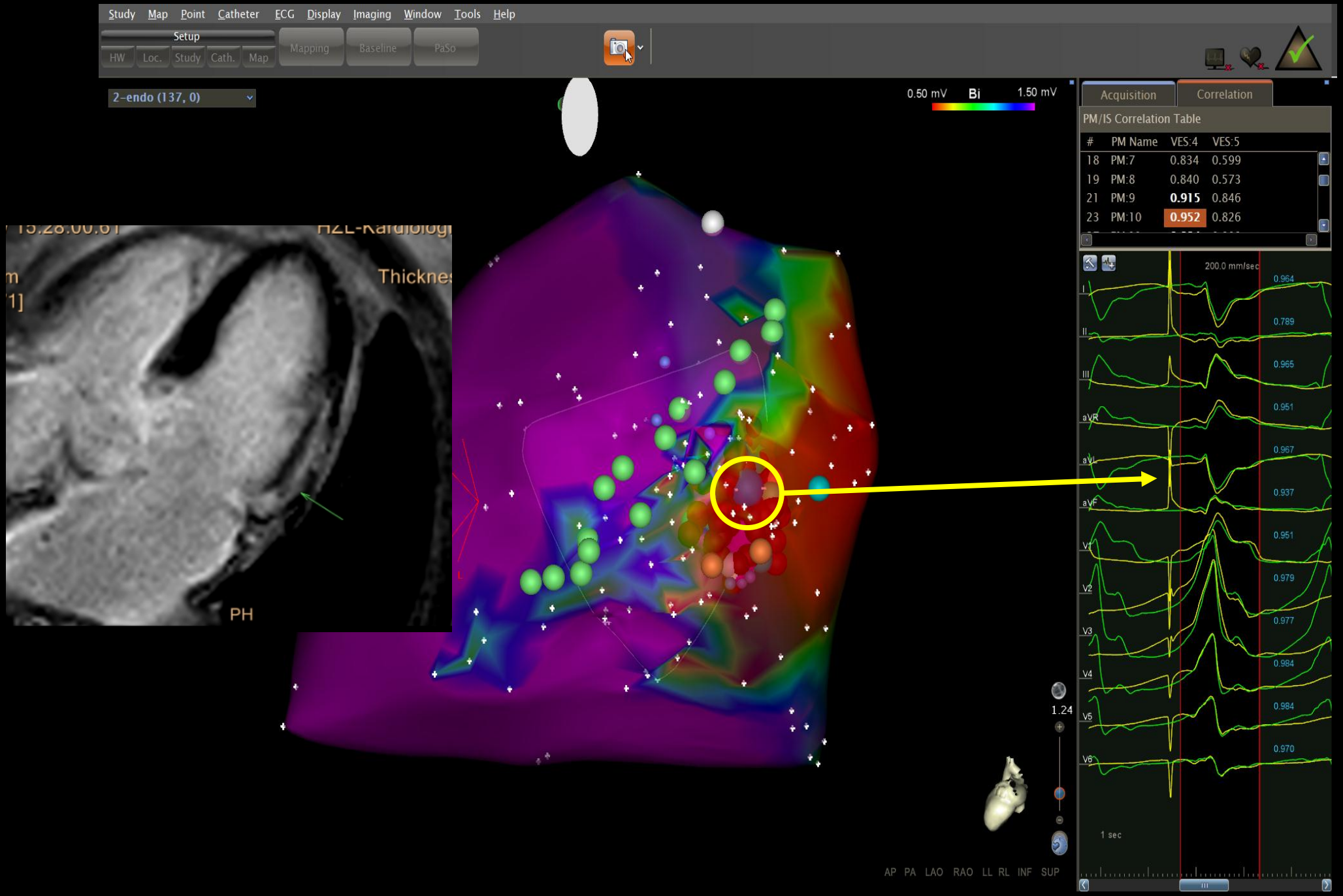


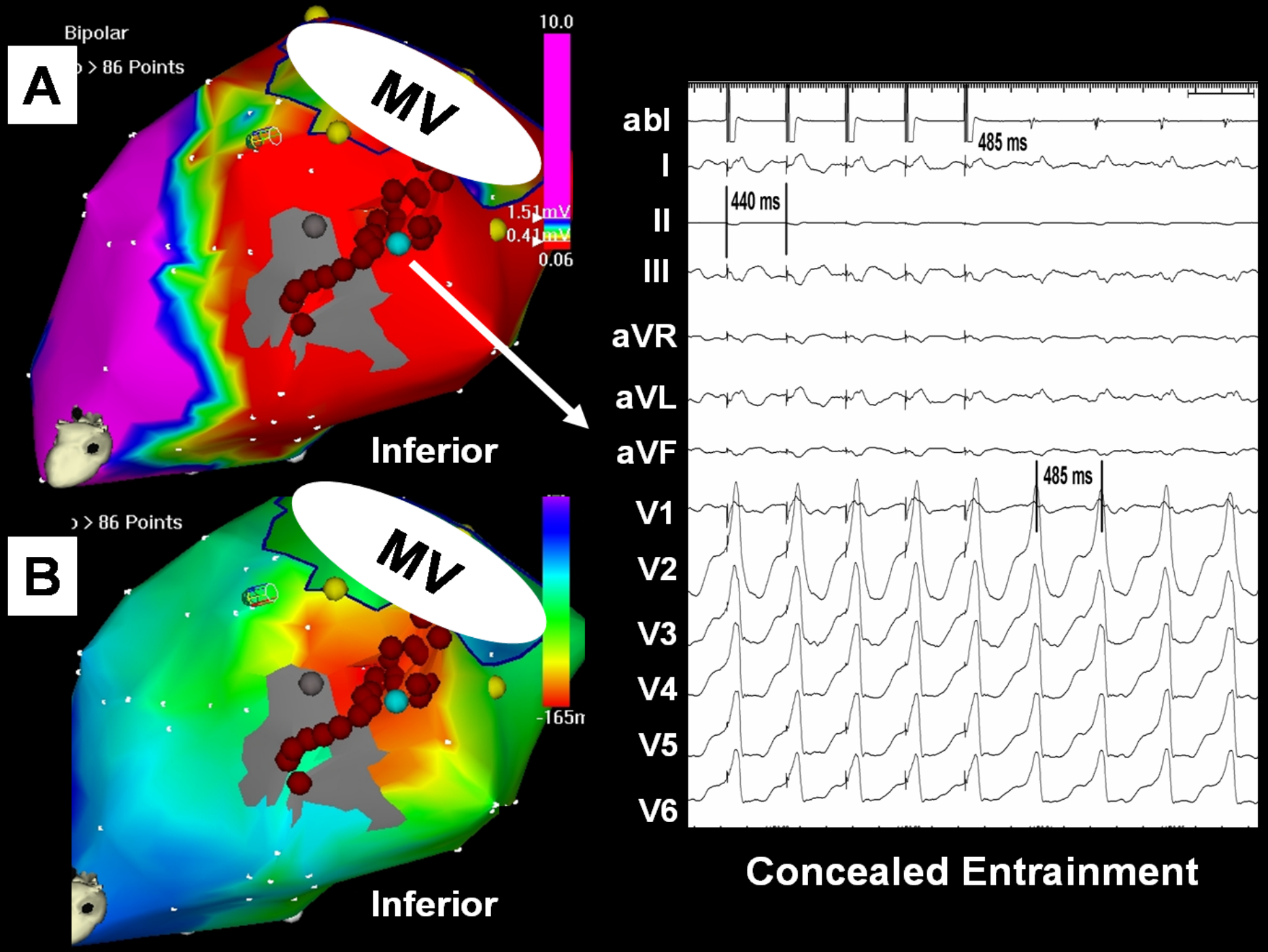



CL: 250 ms
I
08:17:38
08:17:39
08:17:40

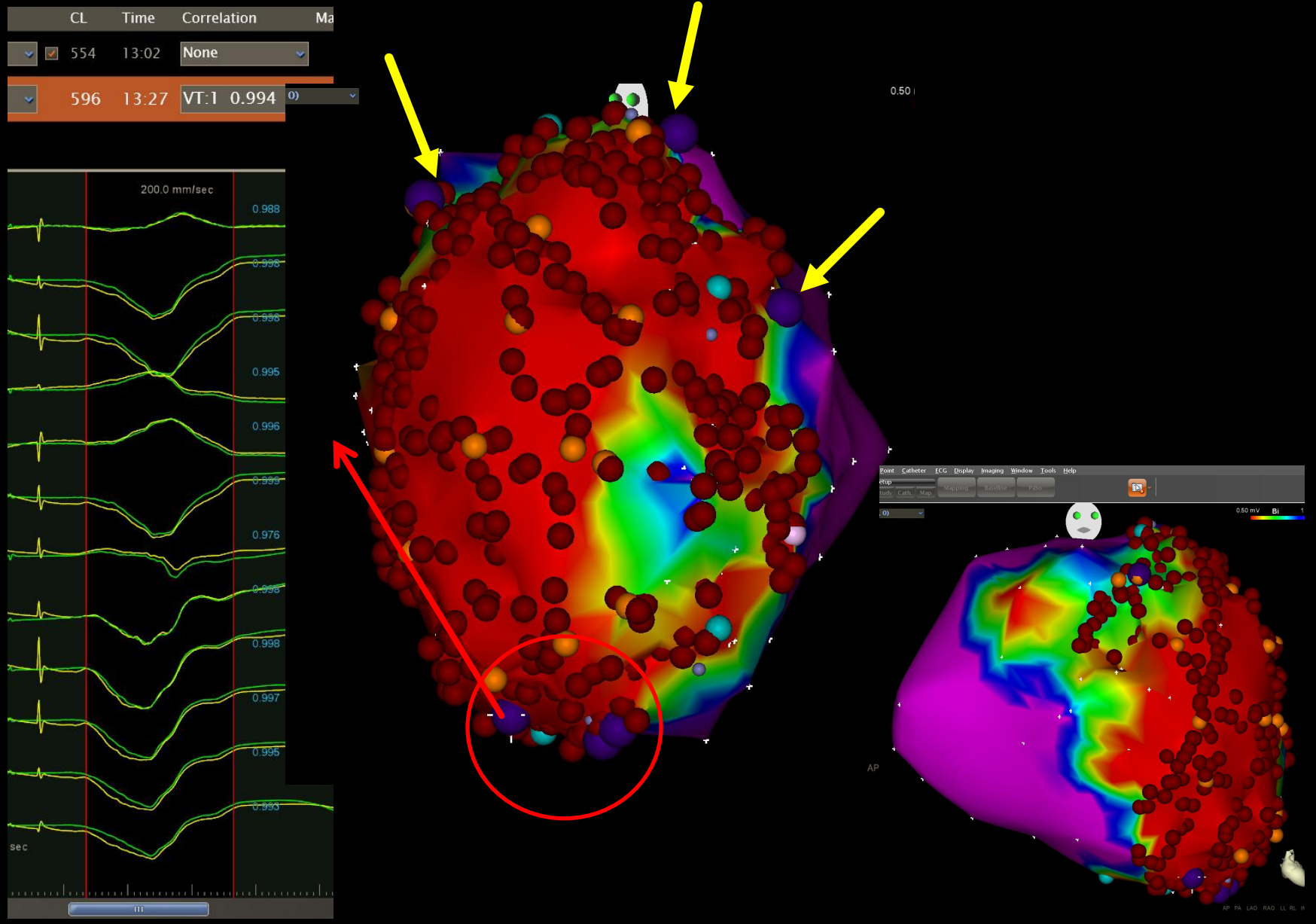

All +ve
3 +ve
3 -ve
All -ve
V2-V5 -ve

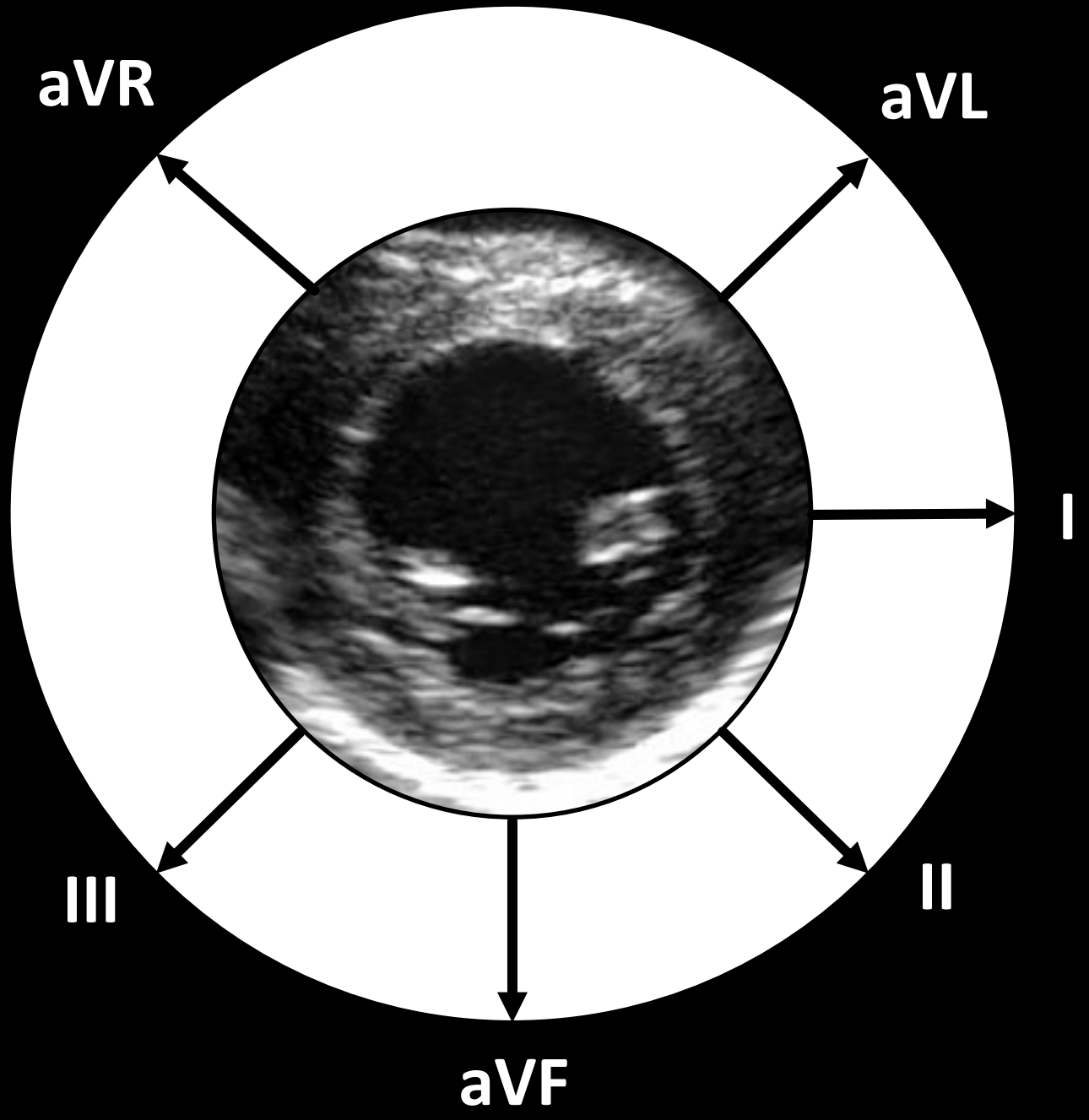

aVR
aVL
I
III
II
aVF

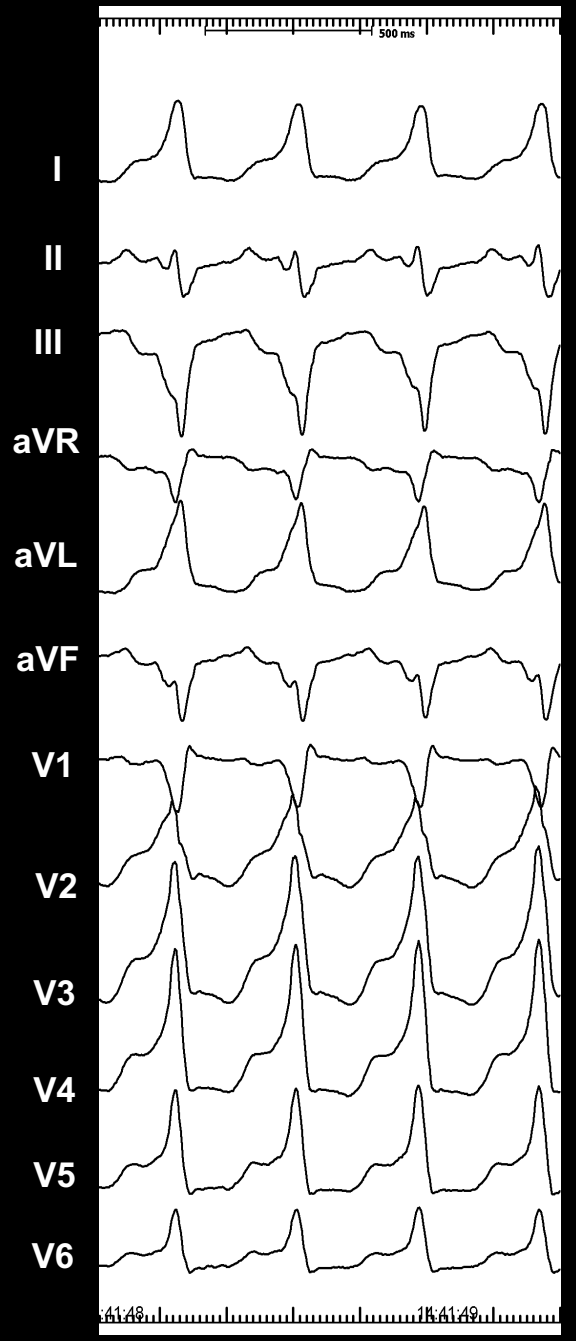

Study Map Point Catheter ECG Display Imaging Window Tools Help
Setup
HW Loc. Study Cath. Map
Mapping
Baseline
PaSo
2-endo (137, 0)
0.50 mV Bi 1.50 mV
Acquisition
Correlation
PM/IS Correlation Table
PM Name VES:4 VES:5
18 PM:7 0.834 0.599
19 PM:8 0.840 0.573
21 PM:9 0.915 0.846
23 PM:10 0.952 0.826
200.0 mm/sec
I 0.964
II 0.789
III 0.965
aVR 0.951
aVL 0.967
aVF 0.937
V1 0.951
V2 0.979
V3 0.977
V4 0.984
V5 0.984
V6 0.970
1 sec
1.24
AP PA LAO RAO LL RL INF SUP
PH


A
Bipolar
> 86 Points
MV
10.0
1.51mV
0.41mV
0.06
Inferior
B
> 86 Points
MV
-165m
Inferior
abl
I
II
III
aVR
aVL
aVF
V1
V2
V3
V4
V5
V6
485 ms
440 ms
485 ms
Concealed Entrainment

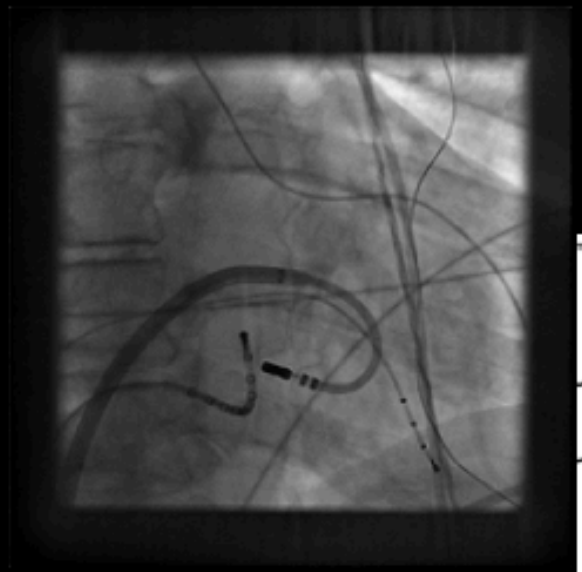
80J, VWI, EF: 20%, NYHA II



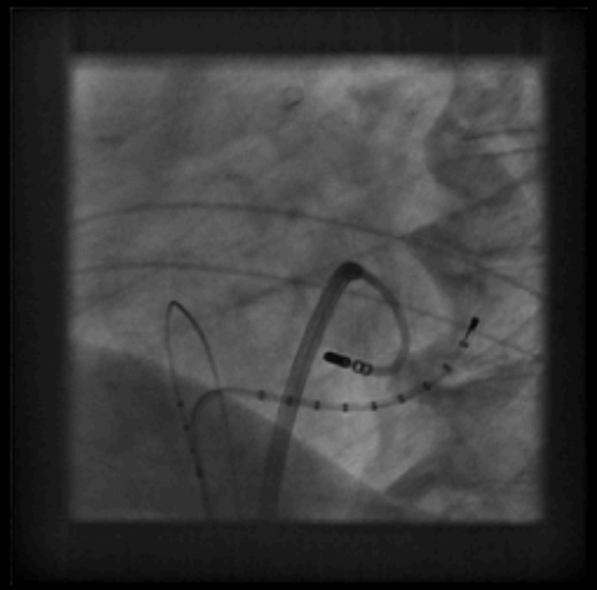

aVR
aVL
I
III
II
aVF

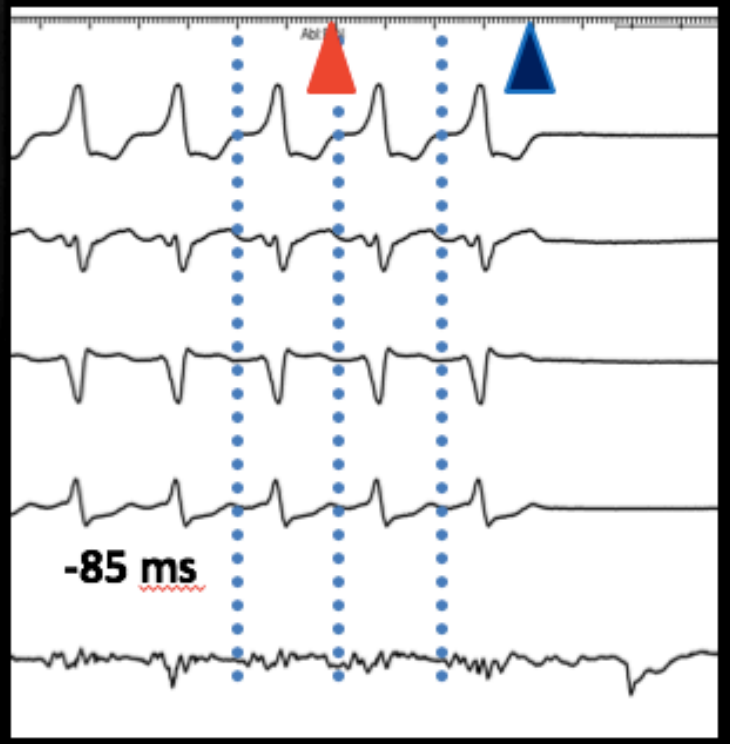

500 ms
I
II
III
aVR
aVL
aVF
V1
V2
V3
V4
V5
V6

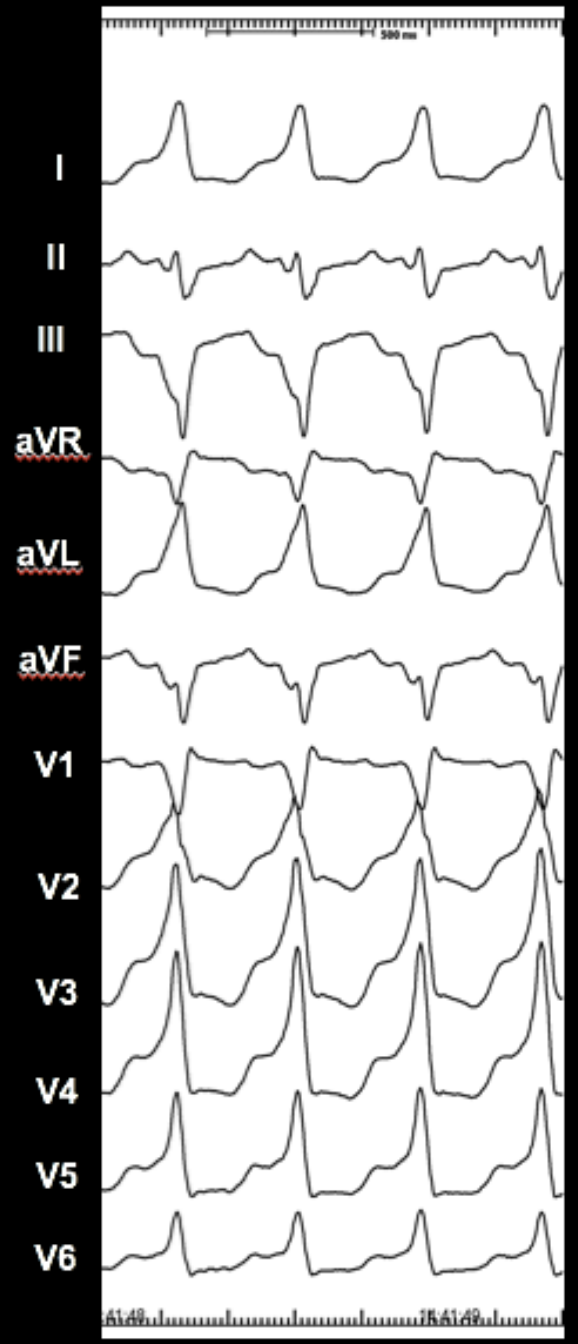
RAO

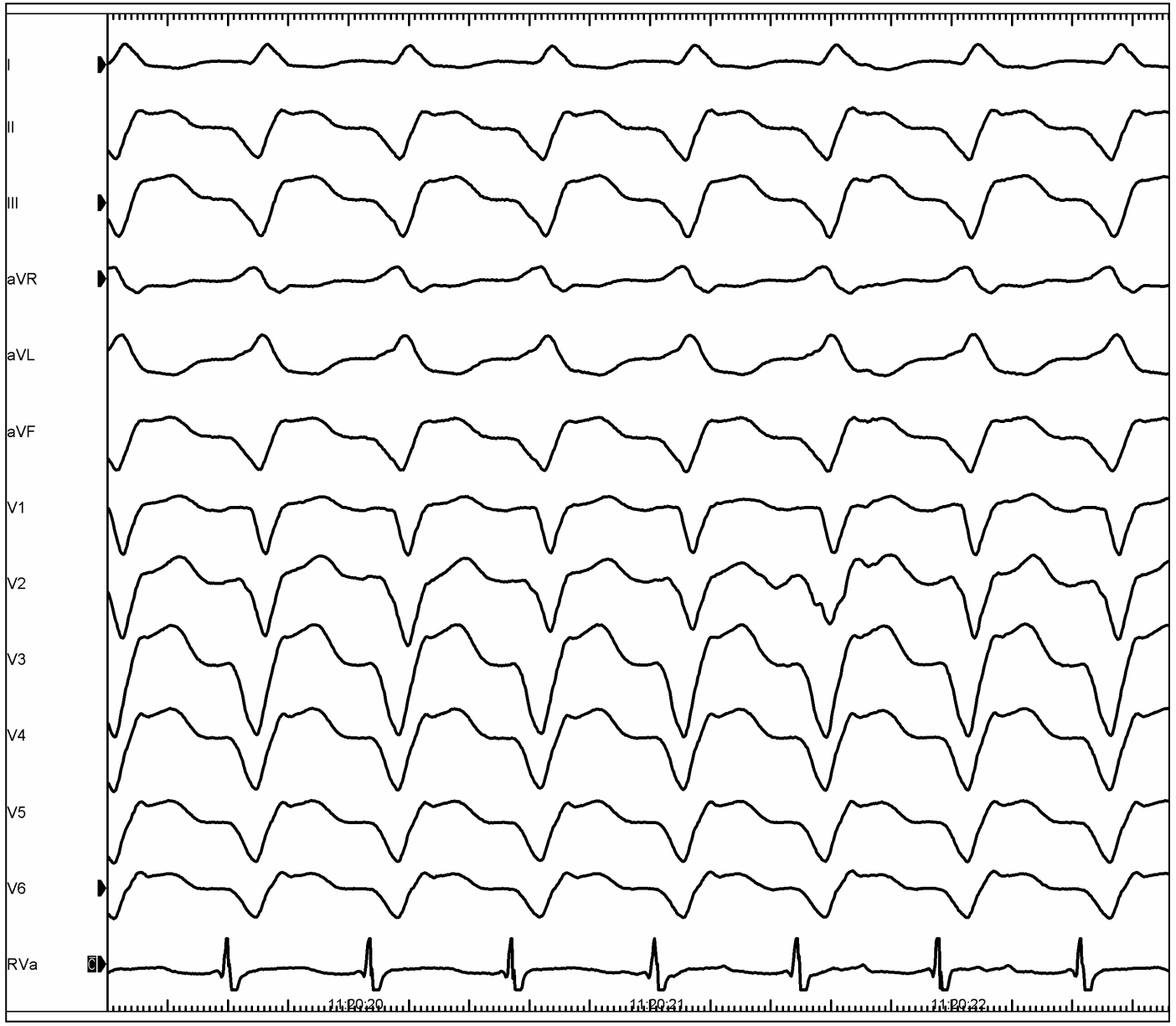


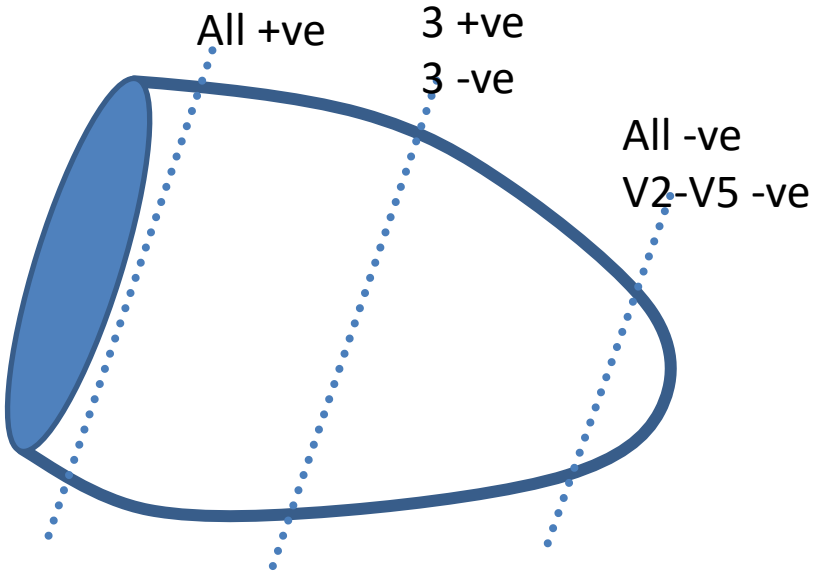
LAO

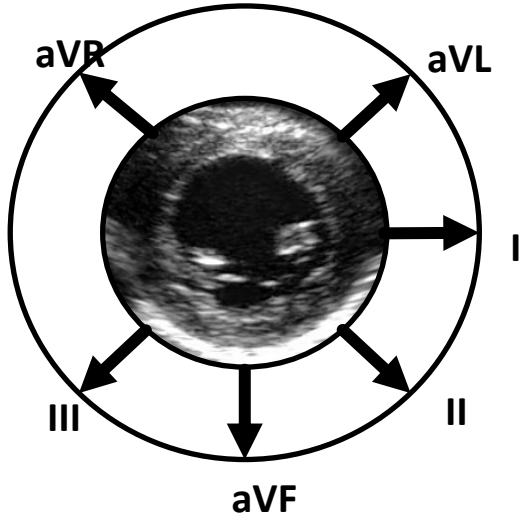






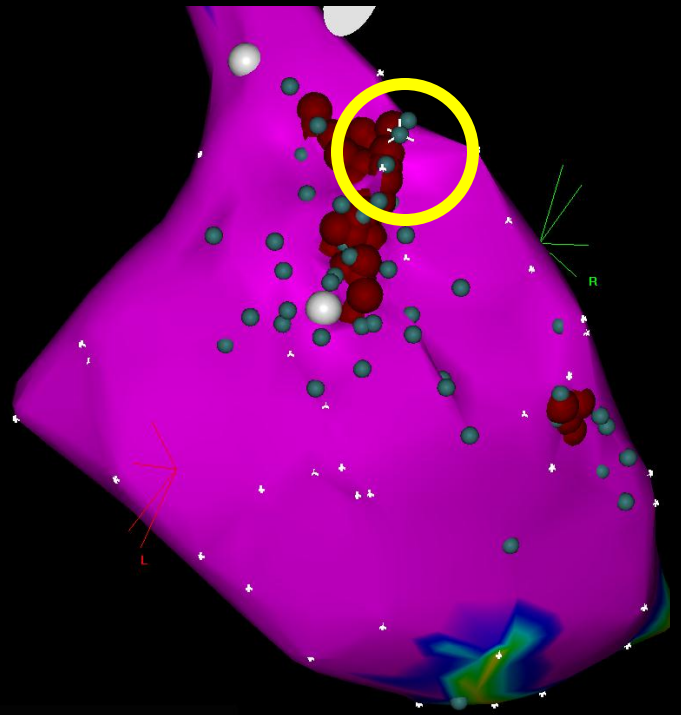

I
II
III
aVR
aVL
aVF
V1
V2
V3
V4
V5
V6
RVa

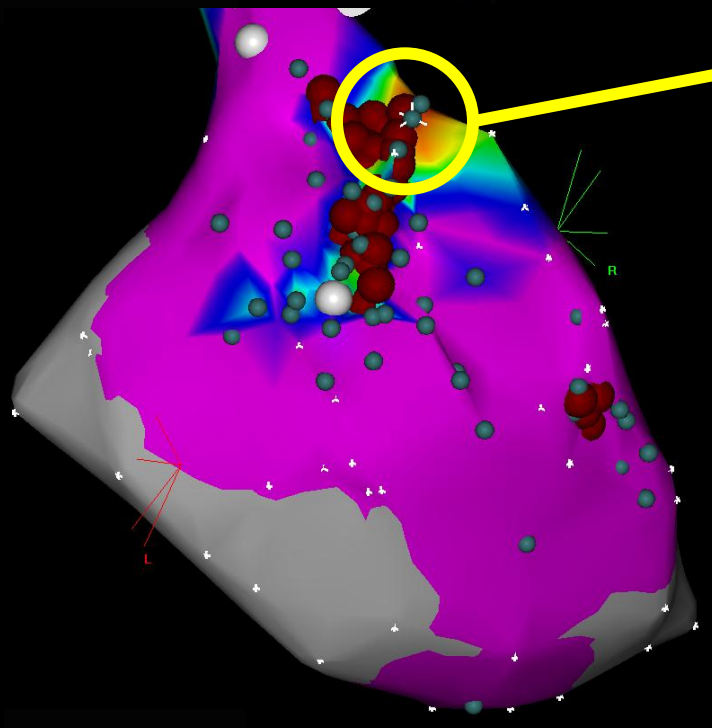

All +ve
3 +ve
3 -ve
All -ve
V2-V5 -ve

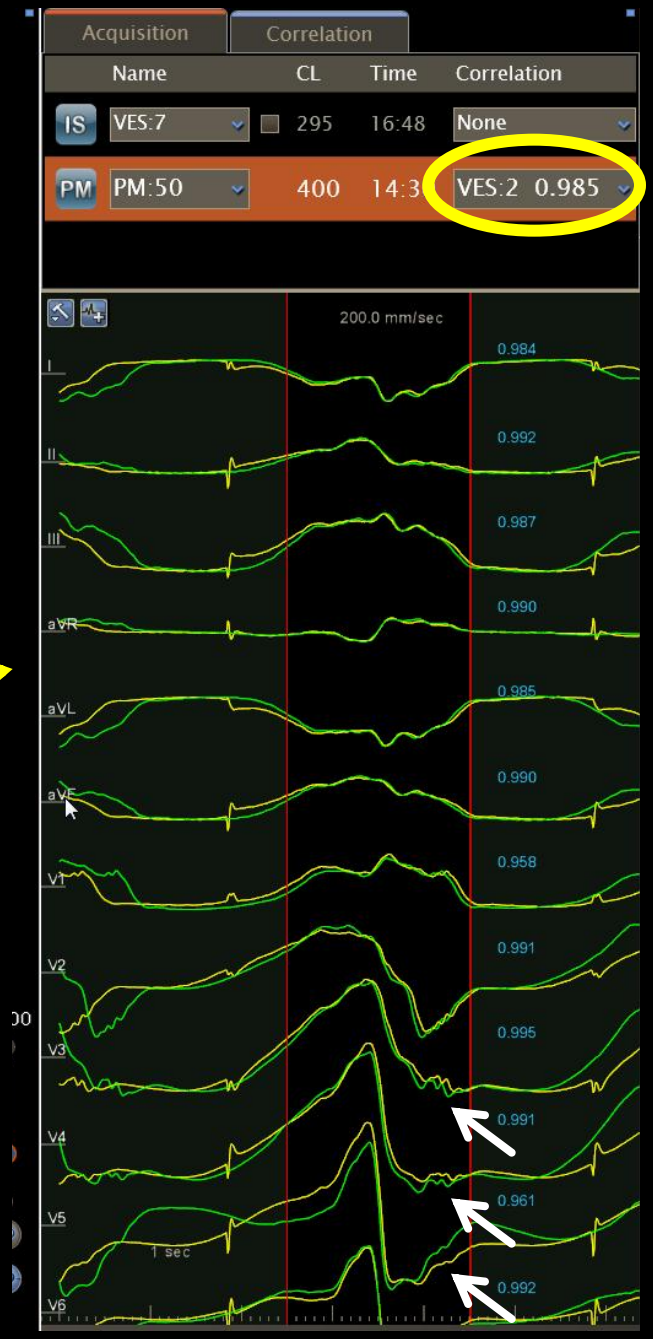

aVR
aVL
I
III
II
aVF

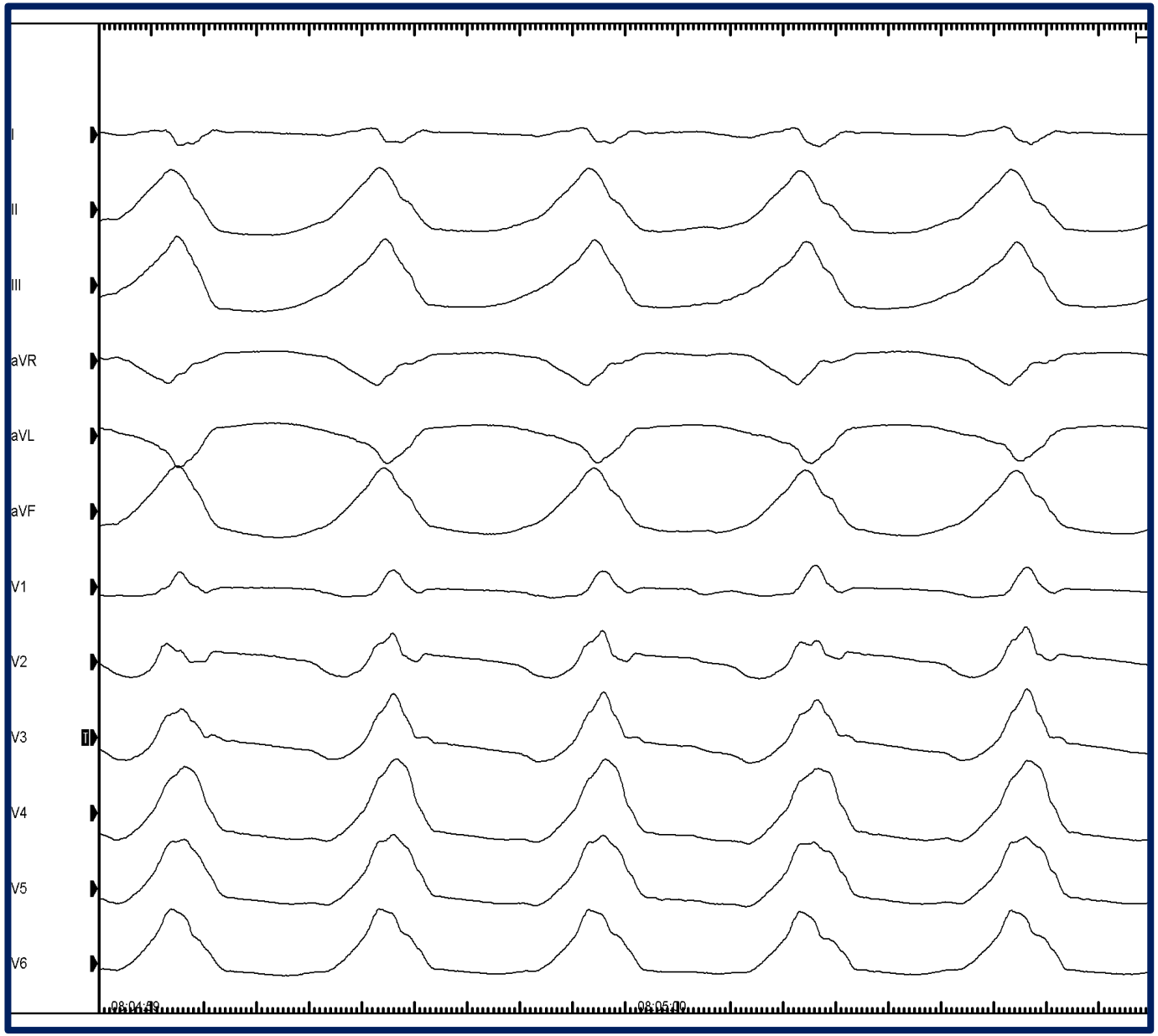
Substrate Mapping

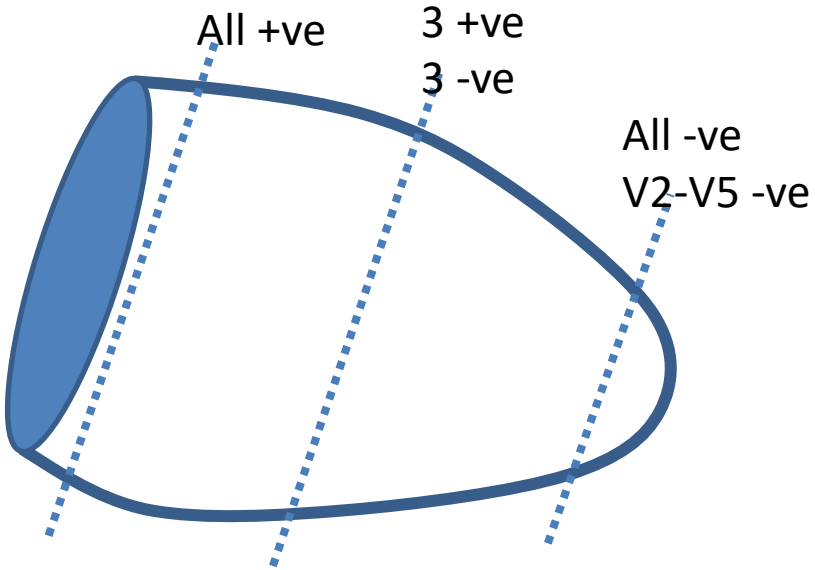
PM Correlation Mapping

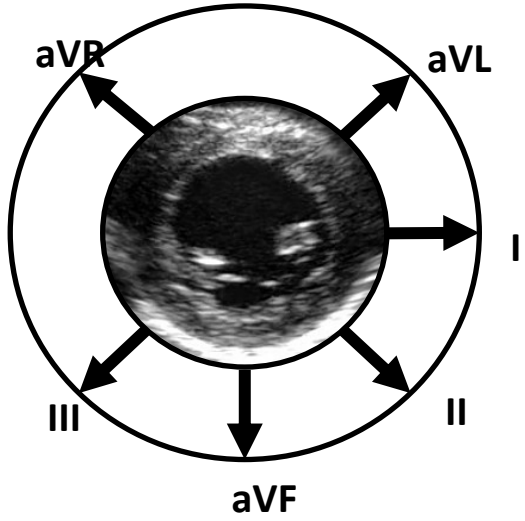






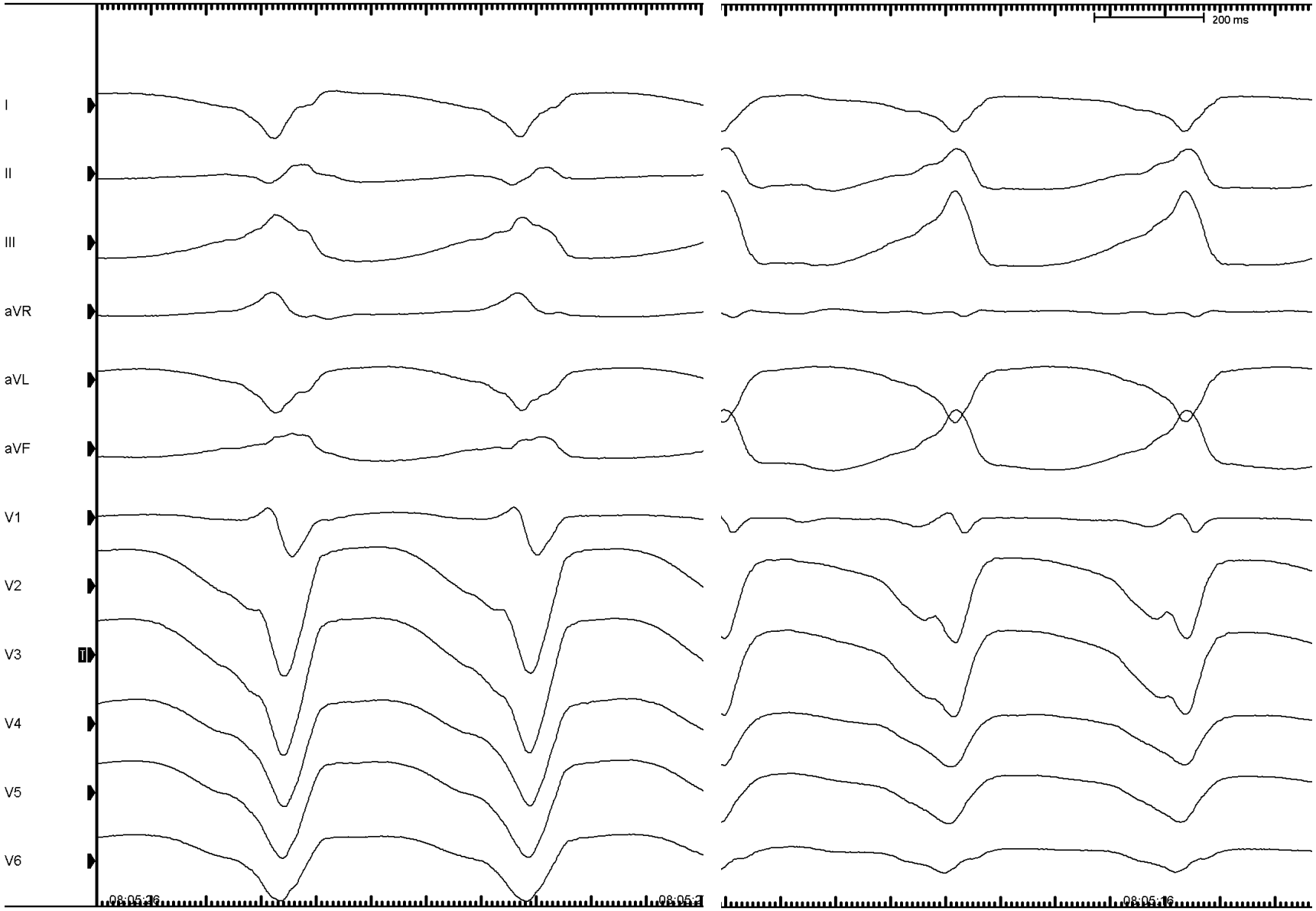

I
II
III
aVR
aVL
aVF
V1
V2
V3
V4
V5
V6

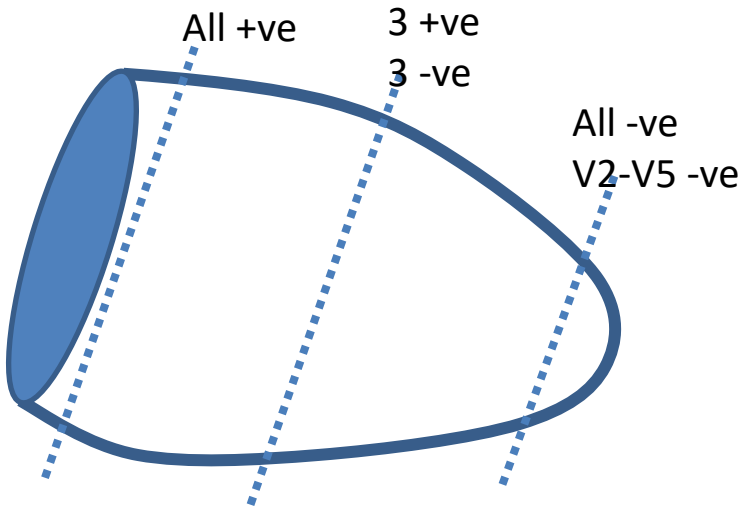

All +ve
3 +ve
3 -ve
All -ve
V2-V5 -ve

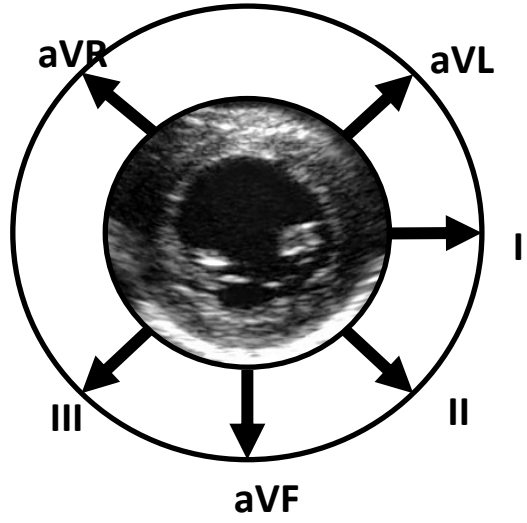

aVR
aVL
I
III
II
aVF

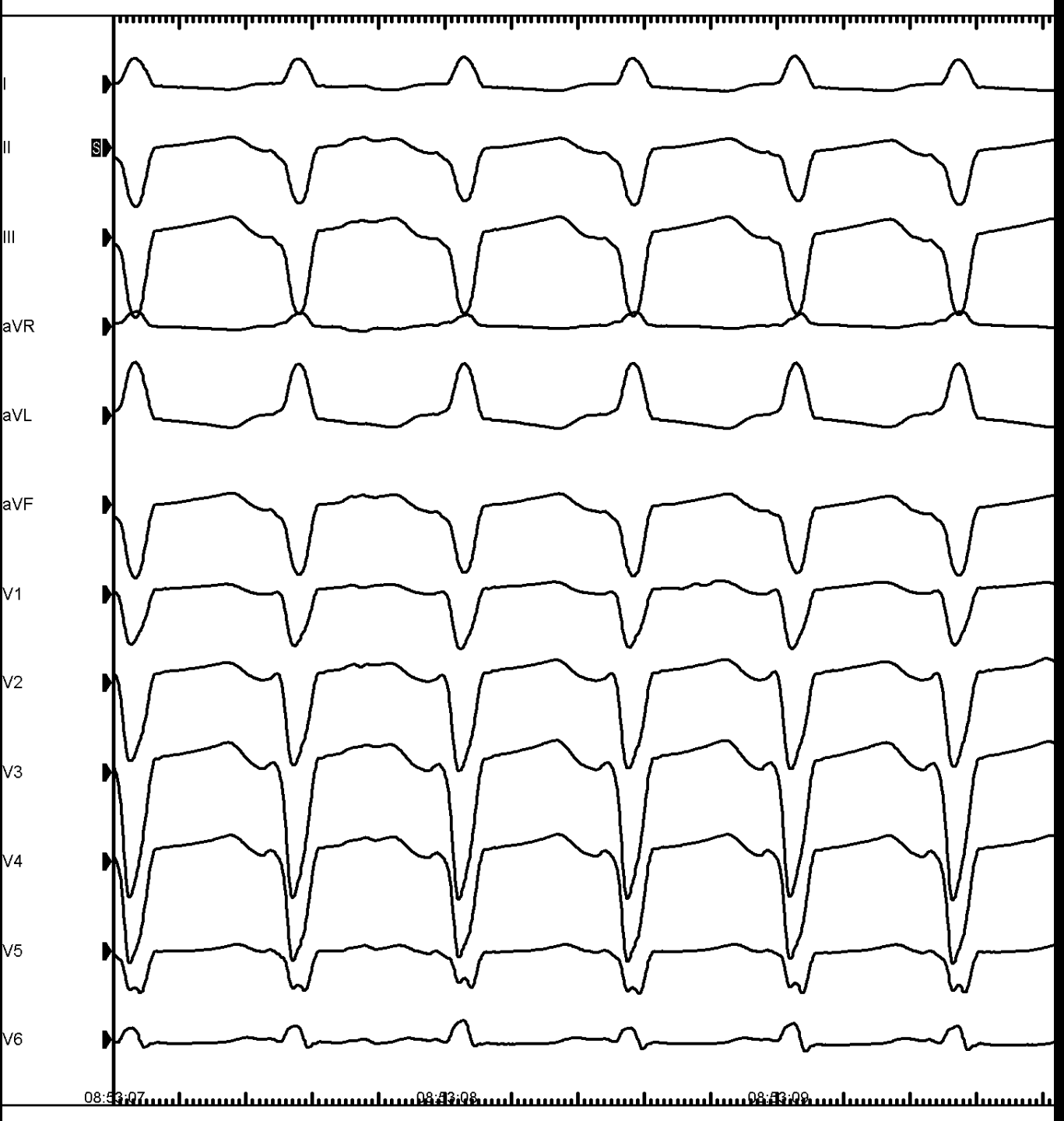
VT1

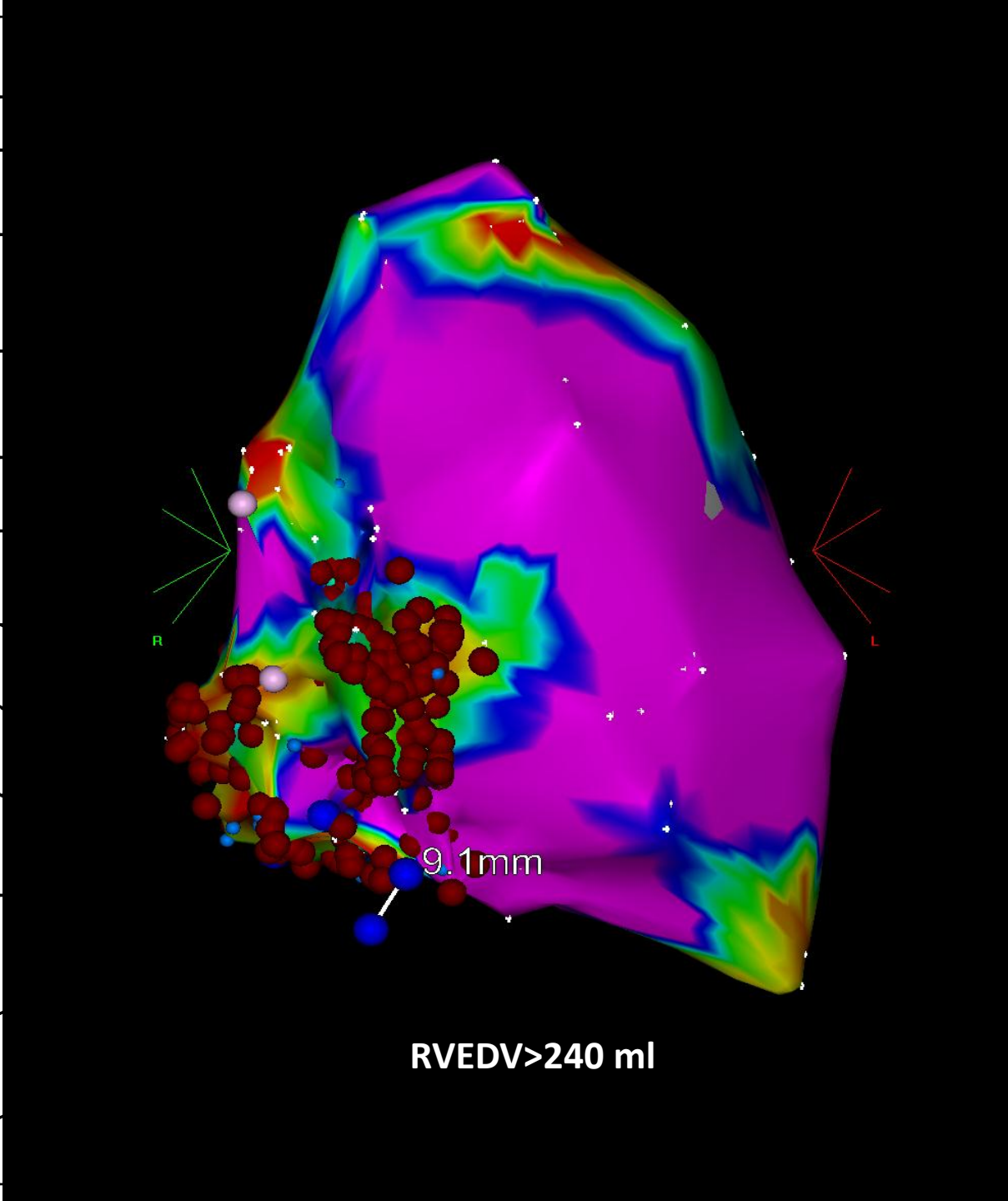
VT2


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

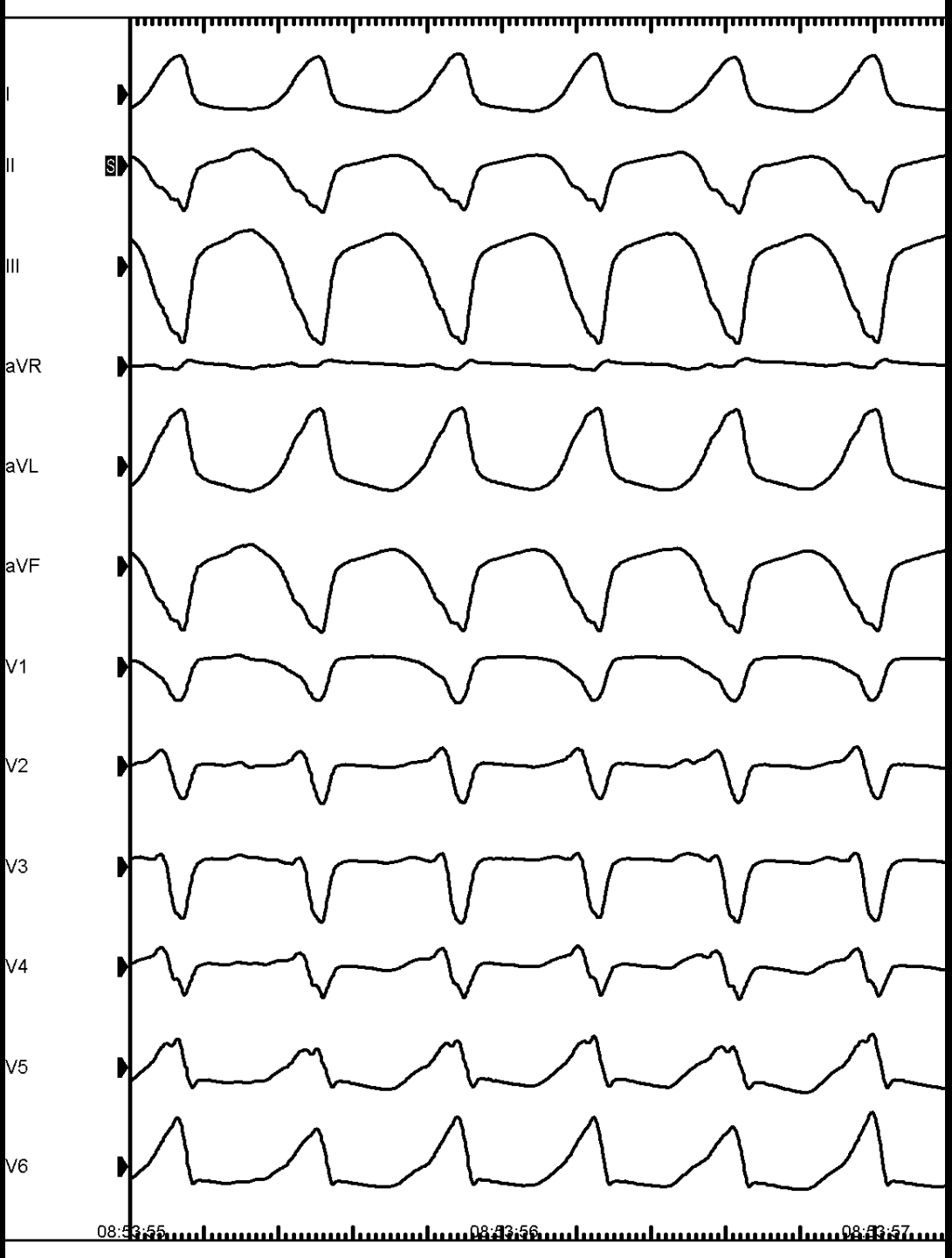

All +ve
3 +ve
3 -ve
All -ve
V2-V5 -ve

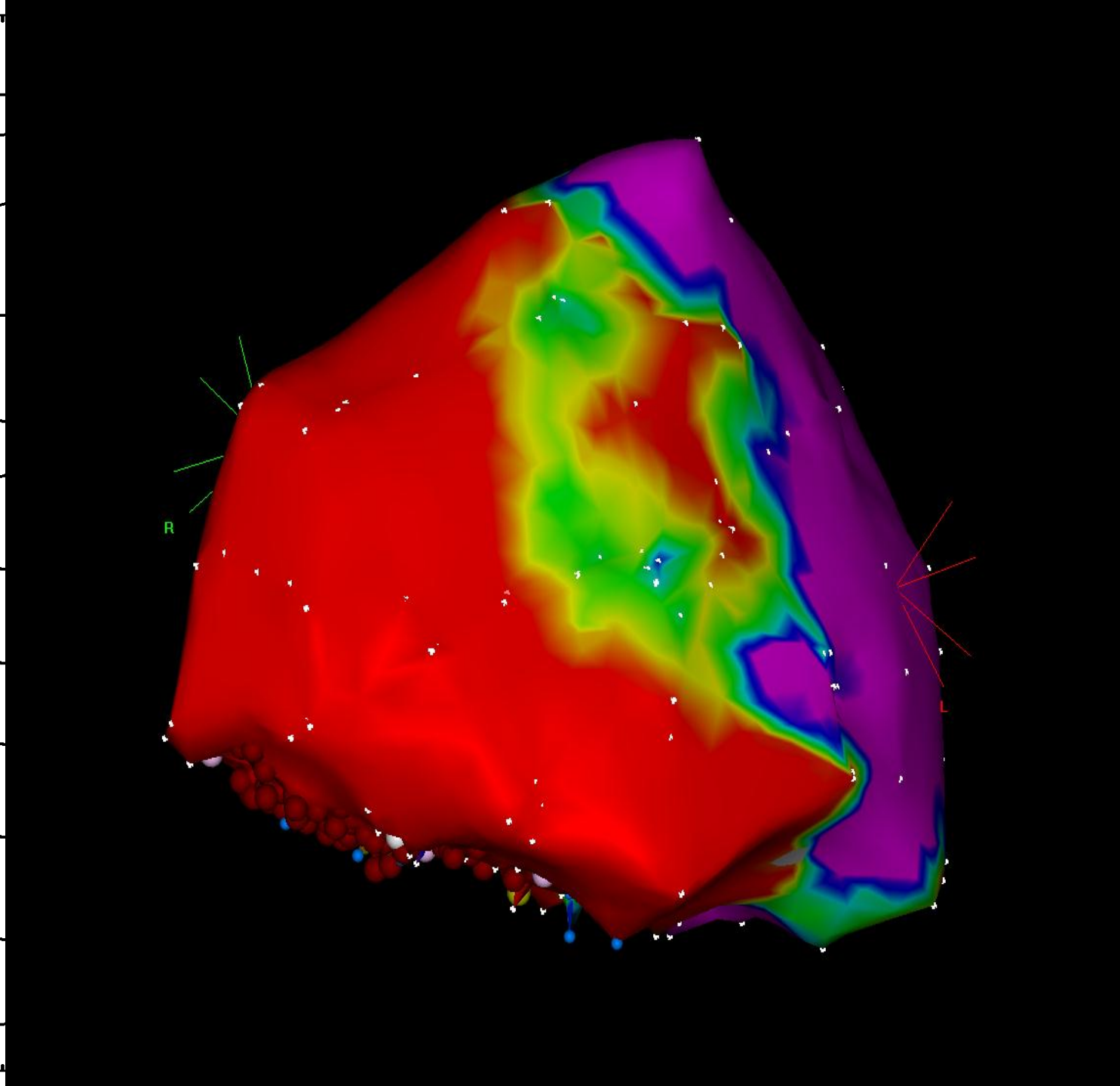

aVR
aVL
I
III
II
aVF





RVEDV>240 ml

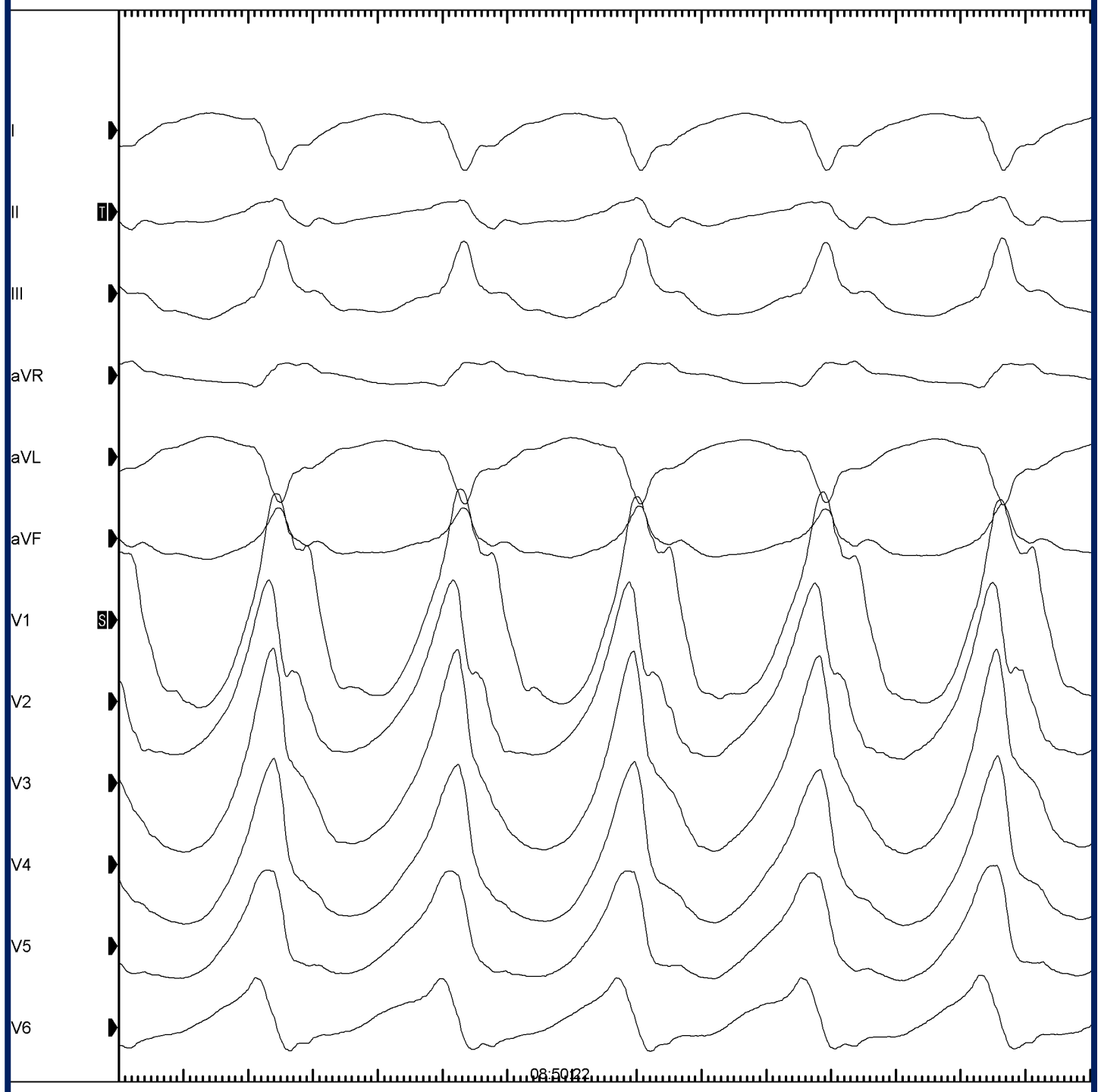

I
II
III
aVR
aVL
aVF
V1
V2
V3
V4
V5
V6
08:53:55
08:53:56
08:53:57

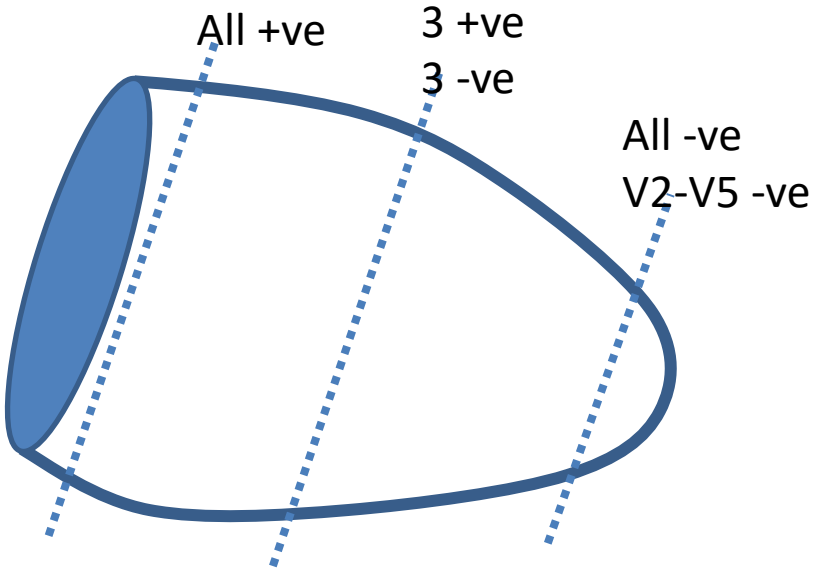

R

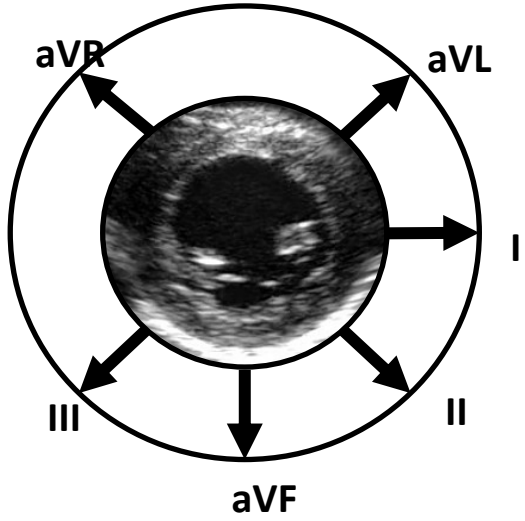
54 years old male patient with palpitation and no syncope were referred to our center for VT ablation

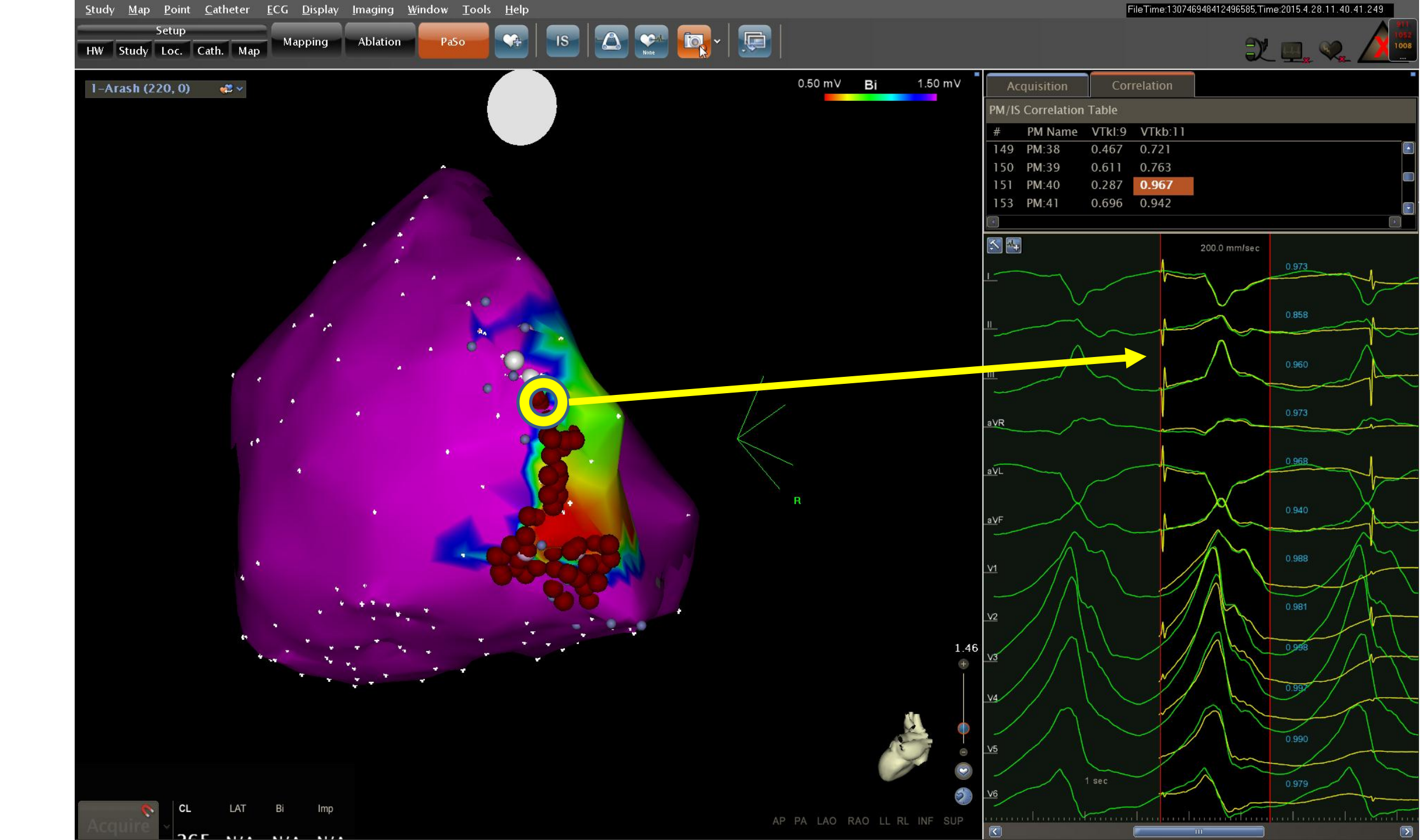
MRT: no scar, LVEF: 54%

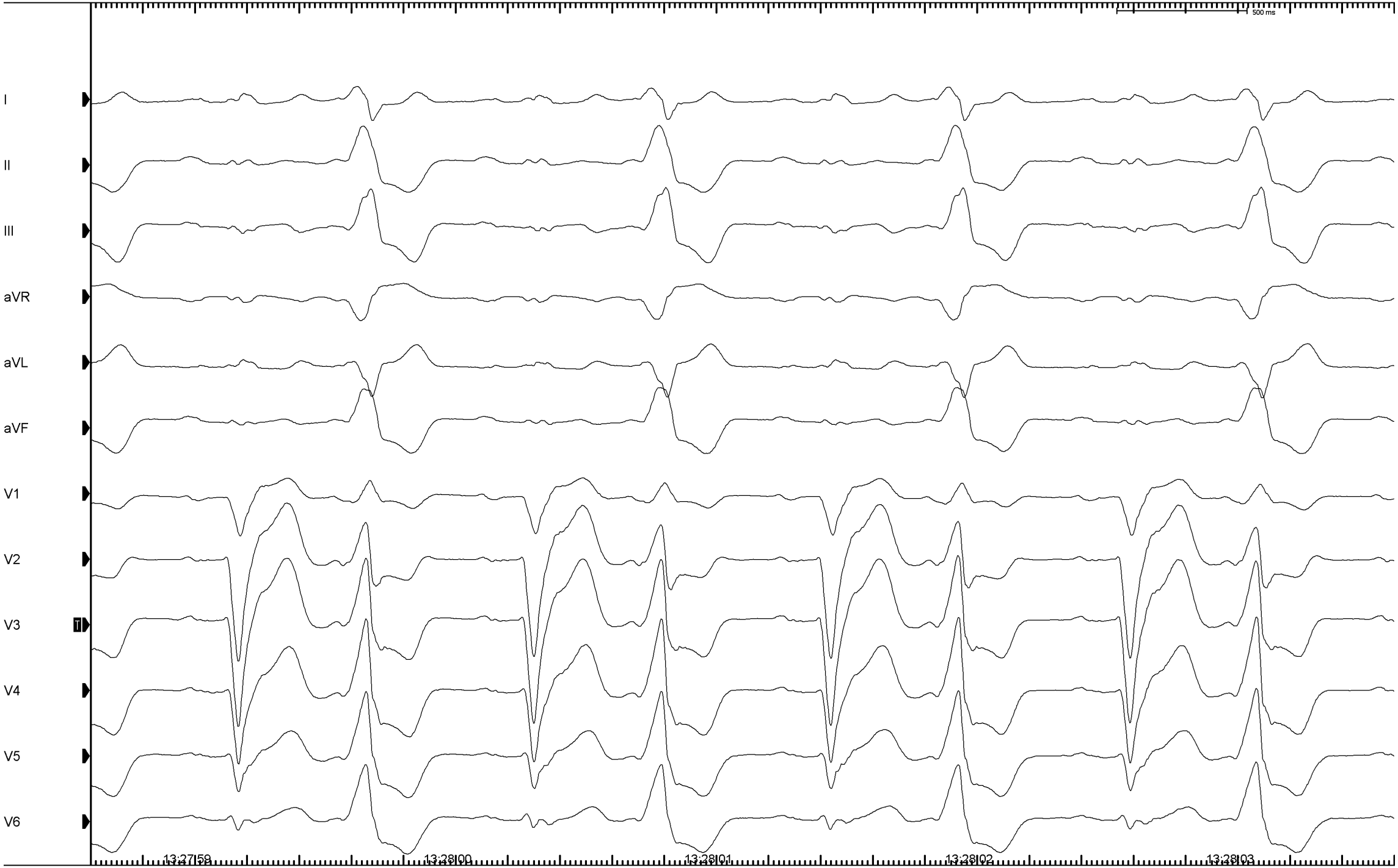
CA: Normal coronary arteries

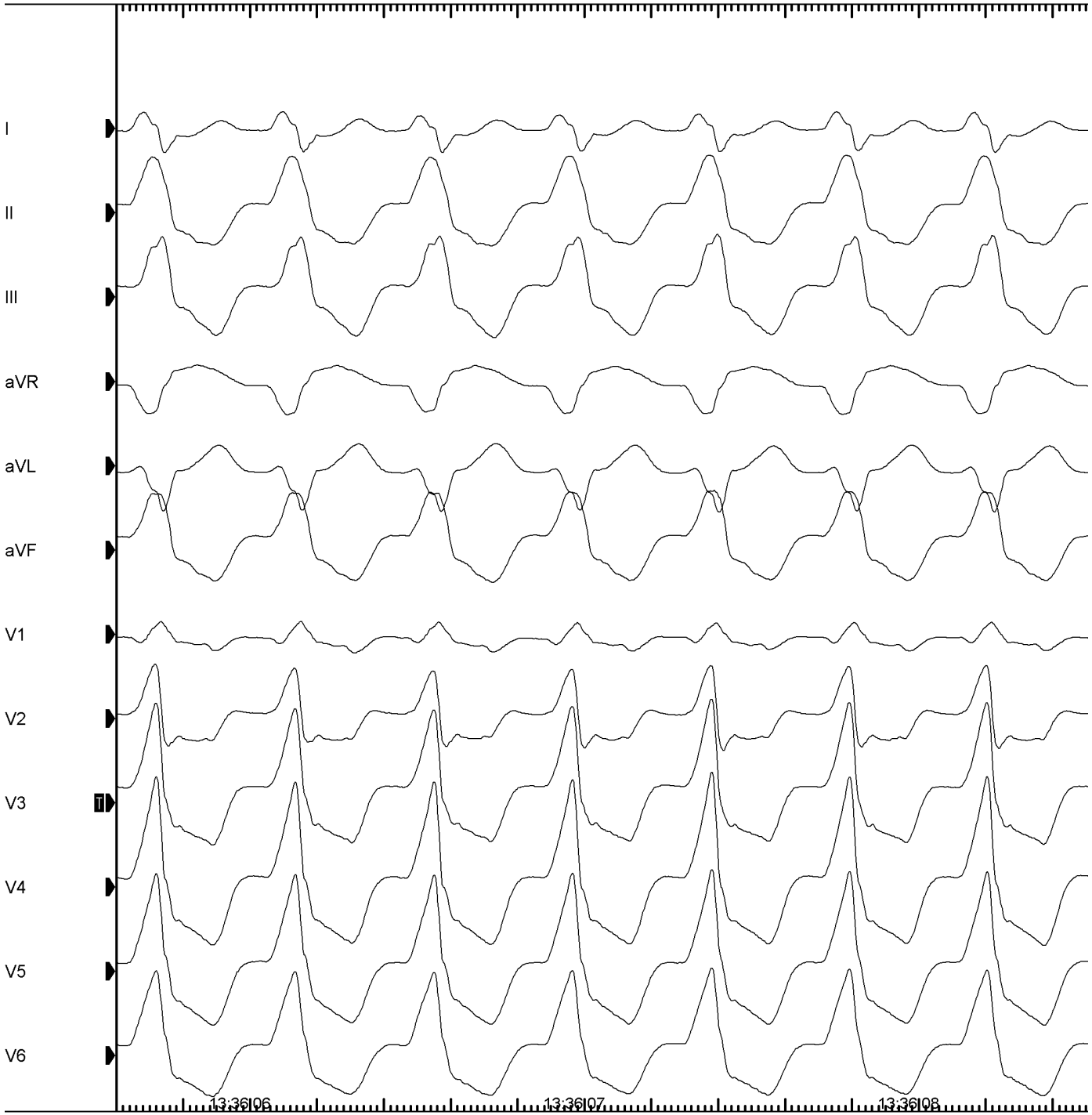

I
II
III
aVR
aVL
aVF
V1
V2
V3
V4
V5
V6

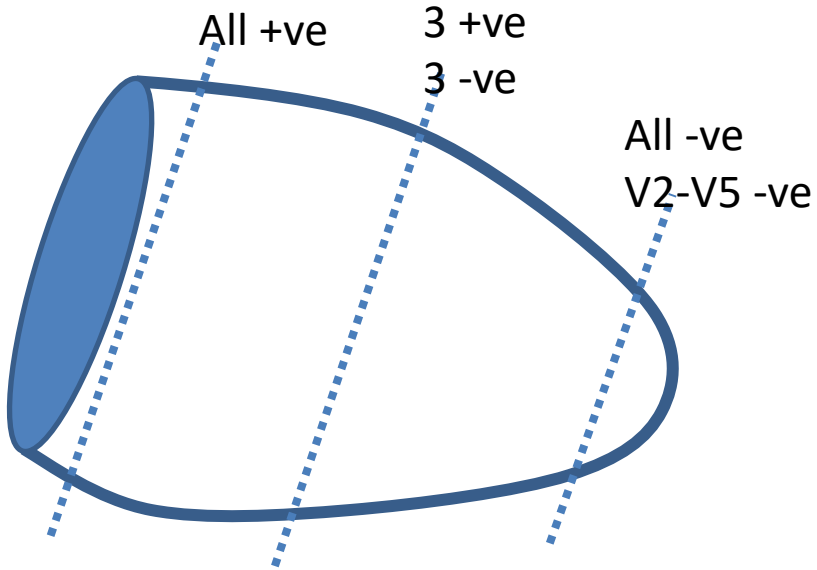

All +ve
3 +ve
3 -ve
All -ve
V2-V5 -ve

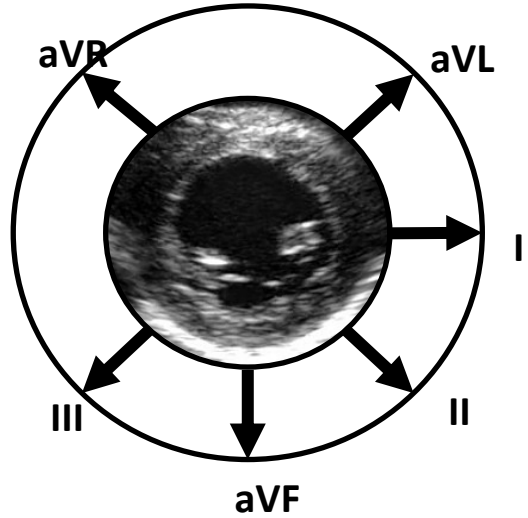

aVR
aVL
I
III
II
aVF

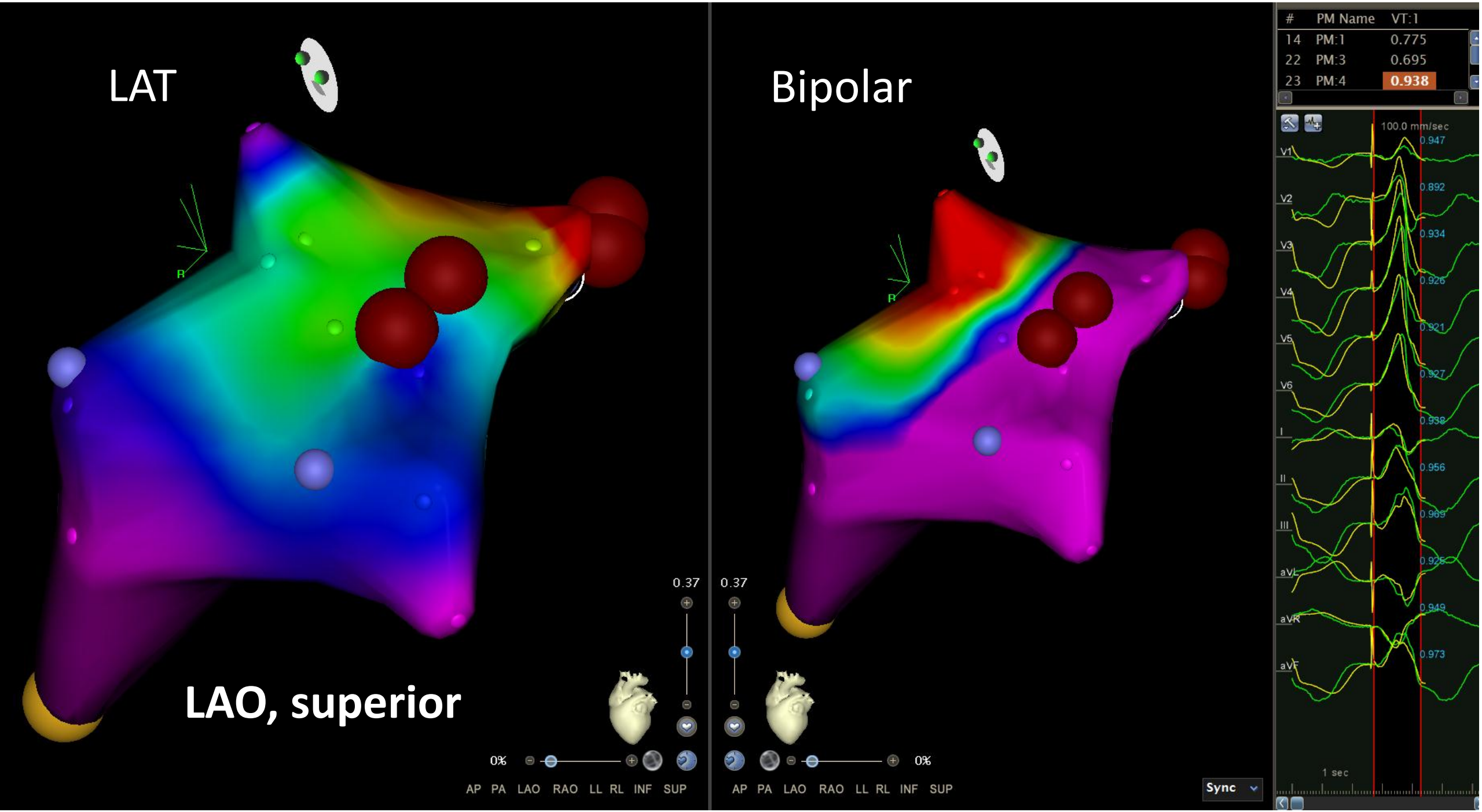

Study Map Point Catheter ECG Display Imaging Window Tools Help
FileTime:130746948412496585,Time:2015.4.28.11.40.41.249
Setup
HW Study Loc. Cath. Map
Mapping
Ablation
PaSo
IS
1-Arash (220, 0)
0.50 mV
Bi
1.50 mV
R
1.46
AP PA LAO RAO LL RL INF SUP
Acquire
CL LAT Bi Imp
Acquisition
Correlation
PM/IS Correlation Table
PM Name VTkl:9 VTkb:11
149 PM:38 0.467 0.721
150 PM:39 0.611 0.763
151 PM:40 0.287 0.967
153 PM:41 0.696 0.942
200.0 mm/sec
I
II
III
aVR
aVL
aVF
V1
V2
V3
V4
V5
V6
0.973
0.858
0.960
0.973
0.968
0.940
0.988
0.981
0.998
0.997
0.990
0.979
1 sec

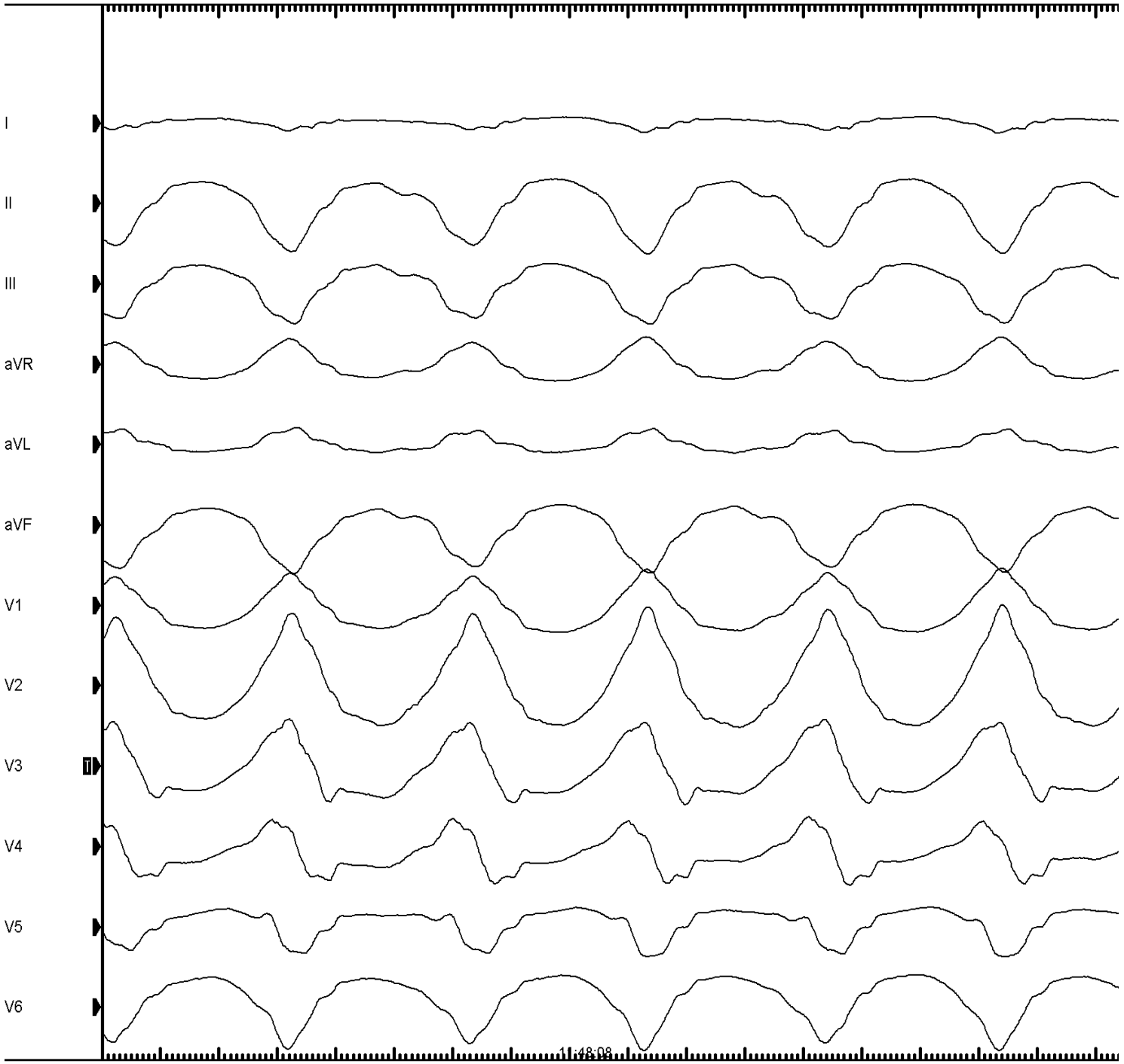

500 ms
I
II
III
aVR
aVL
aVF
V1
V2
V3
V4
V5
V6
13:27:59
13:28:00
13:28:01
13:28:02
13:28:03

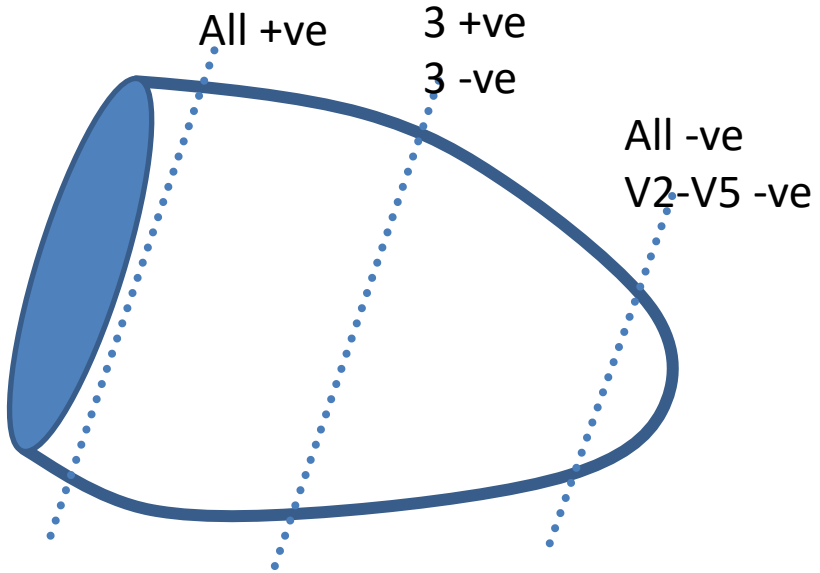

I
II
III
aVR
aVL
aVF
V1
V2
V3
V4
V5
V6
13:36:06
13:36:07
13:36:08

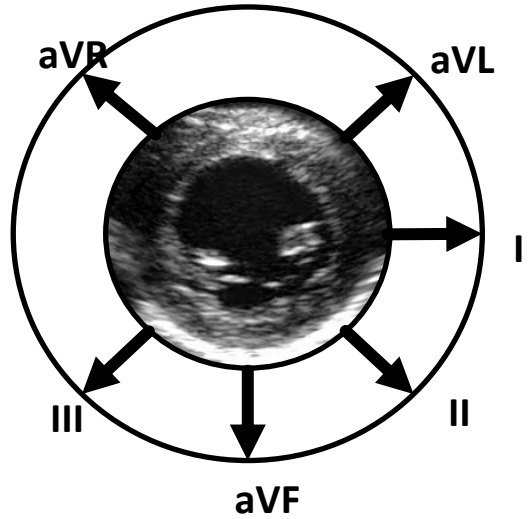

All +ve
3 +ve
3 -ve
All -ve
V2-V5 -ve

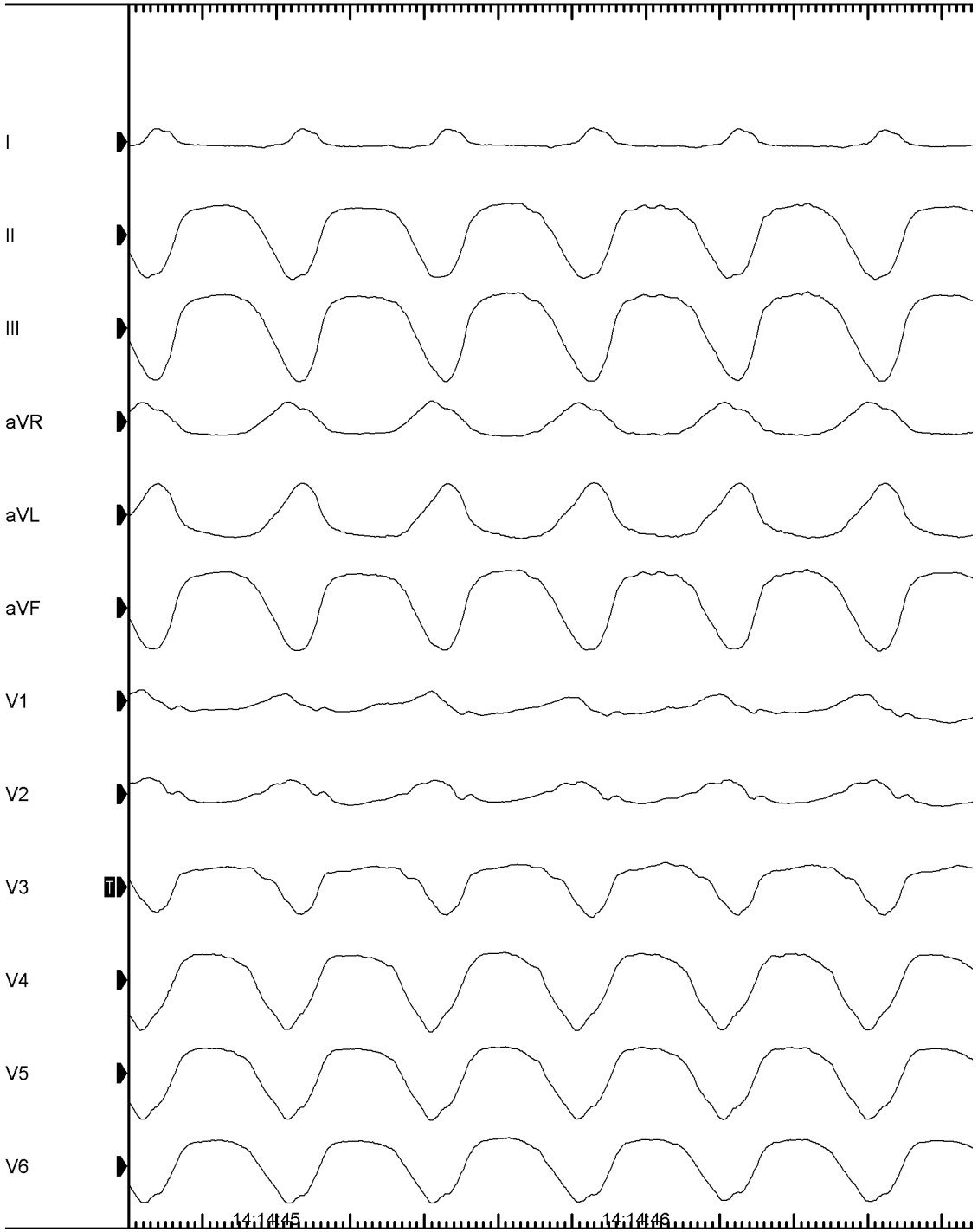

aVR
aVL
I
III
II
aVF

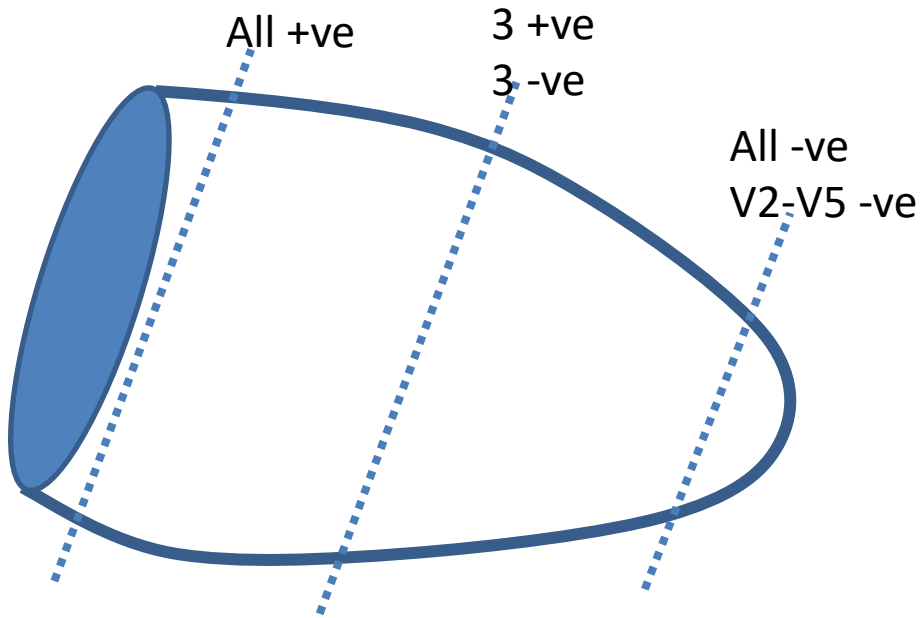

LAT
Bipolar
LAO, superior
0.37
0.37
0%
0%
AP PA LAO RAO LL RL INF SUP
AP PA LAO RAO LL RL INF SUP
Sync
PM Name VT:1
14 PM:1 0.775
22 PM:3 0.695
23 PM:4 0.938
100.0 mm/sec
V1 0.947
V2 0.892
V3 0.934
V4 0.926
V5 0.921
V6 0.927
I 0.938
II 0.956
III 0.969
aVL 0.925
aVR 0.949
aVF 0.973
1 sec

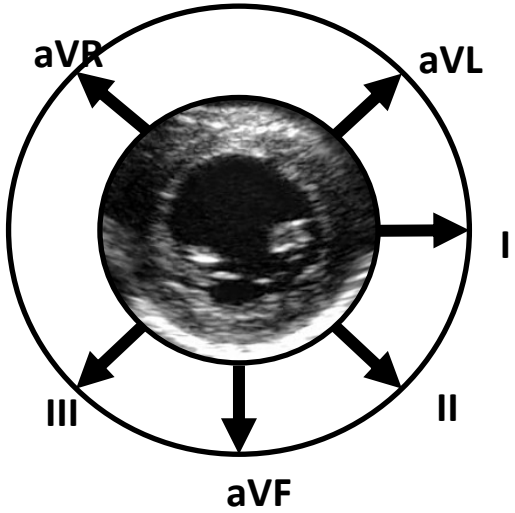

I
II
III
aVR
aVL
aVF
V1
V2
V3
V4
V5
V6


All +ve
3 +ve
3 -ve
All -ve
V2-V5 -ve


aVR
aVL
I
III
II
aVF


I
II
III
aVR
aVL
aVF
V1
V2
V3
V4
V5
V6
14:14:45
14:14:46


All +ve
3 +ve
3 -ve
All -ve
V2-V5 -ve


aVR
aVL
I
III
II
aVF

The future of ECG:
Man versus Machine

The future of ECG

Cardiologist-level arrhythmia detection and classification in ambulatory electrocardiograms using a deep neural network

Awni Y. Hannun[1,6*], Pranav Rajpurkar[1,6], Masoumeh Haghpanahi[2,6], Geoffrey H. Tison[3,6], Codie Bourn[2], Mintu P. Turakhia[4,5] and Andrew Y. Ng[1]

Nature Medicine | VOL 25 | JANUARY 2019 | 65–69 | www.nature.com/naturemedicine

91,232 single-lead ECGs from 53,549 patients who used a **single-lead ambulatory ECG monitoring** device.

ECG data were recorded by the Zio monitor, which is a Food and Drug Administration (FDA)-cleared, single-lead, patch-based ambulatory ECG monitor that continuously records data from a single vector (modified Lead II) at 200 Hz.

The mean and median wear time of the Zio monitor in our dataset was 10.6 and 13.0 days, respectively.

Table 2 | DNN algorithm and cardiologist sensitivity compared to the cardiologist committee consensus, with specificity fixed at the average specificity level achieved by cardiologists

	Specificity	Average cardiologist sensitivity	DNN algorithm sensitivity
Atrial fibrillation and flutter	0.941	0.710	0.861
AVB	0.981	0.731	0.858
Bigeminy	0.996	0.829	0.921
EAR	0.993	0.380	0.445
IVR	0.991	0.611	0.867
Junctional rhythm	0.984	0.634	0.729
Noise	0.983	0.749	0.803
Sinus rhythm	0.859	0.901	0.950
SVT	0.983	0.408	0.487
Ventricular tachycardia	0.996	0.652	0.702
Wenckebach	0.986	0.541	0.651

The future of ECG

Screening for cardiac contractile dysfunction using an artificial intelligence–enabled electrocardiogram

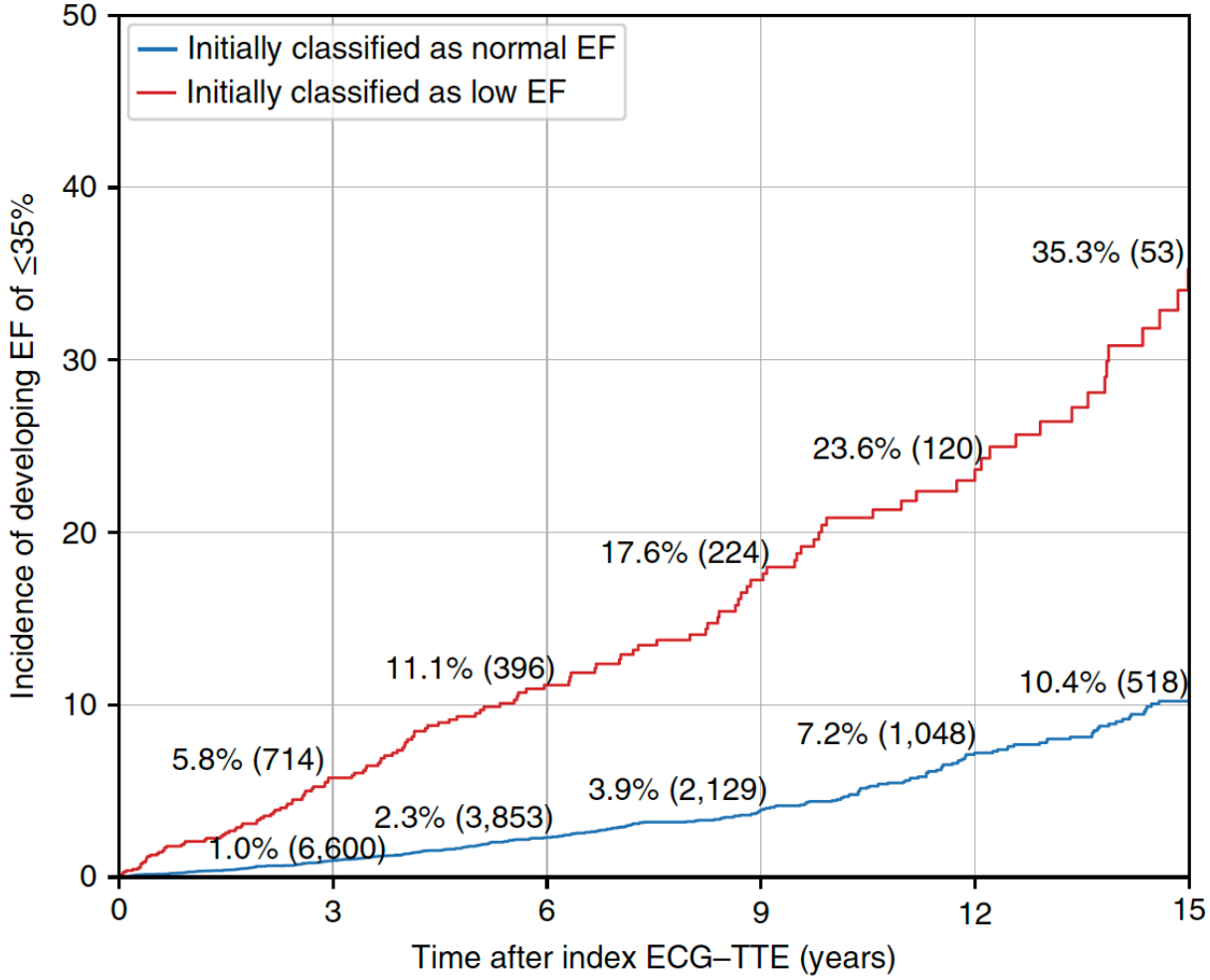
Zachi I. Attia[1], Suraj Kapa[1], Francisco Lopez-Jimenez[1], Paul M. McKie[1], Dorothy J. Ladewig[2], Gaurav Satam[2], Patricia A. Pellikka[1], Maurice Enriquez-Sarano[1], Peter A. Noseworthy[1], Thomas M. Munger[1], Samuel J. Asirvatham[1], Christopher G. Scott[3], Rickey E. Carter[4] and Paul A. Friedman[1]*

Nature Medicine | VOL 25 | 70 JANUARY 2019 | 70–74 | www.nature.com/naturemedicine

Using paired 12-lead ECG and echocardiogram data, including the LVEF, from 44,959 patients at the Mayo Clinic, we trained a convolutional neural network to identify patients with ventricular dysfunction, defined as ejection fraction ≤ 35%, using the ECG data alone.

When tested on an independent set of 52,870 patients, the network model yielded values for the area under the curve, sensitivity, specificity, and accuracy of 0.93, 86.3%, 85.7%, and 85.7%, respectively.

In patients without ventricular dysfunction, those with a positive AI screen *were at 4 times the risk (hazard ratio, 4.1; 95% confidence interval, 3.3 to 5.0) of developing future ventricular dysfunction compared with those with a negative screen.*



Summary

Use of the 12-lead ECG recorded during VT to regionalize its origin was first described by Josephson in 1981.

12-Lead-ECG is a simple ,useful and reliable tool to localize and diagnose the ventricular arrhythmia.

It makes more sense to divide it into no more than 10– 12 approximately equal segments when localizing a region of interest using the 12-lead ECG of the VT to limit overlapping information.