LV summit VT

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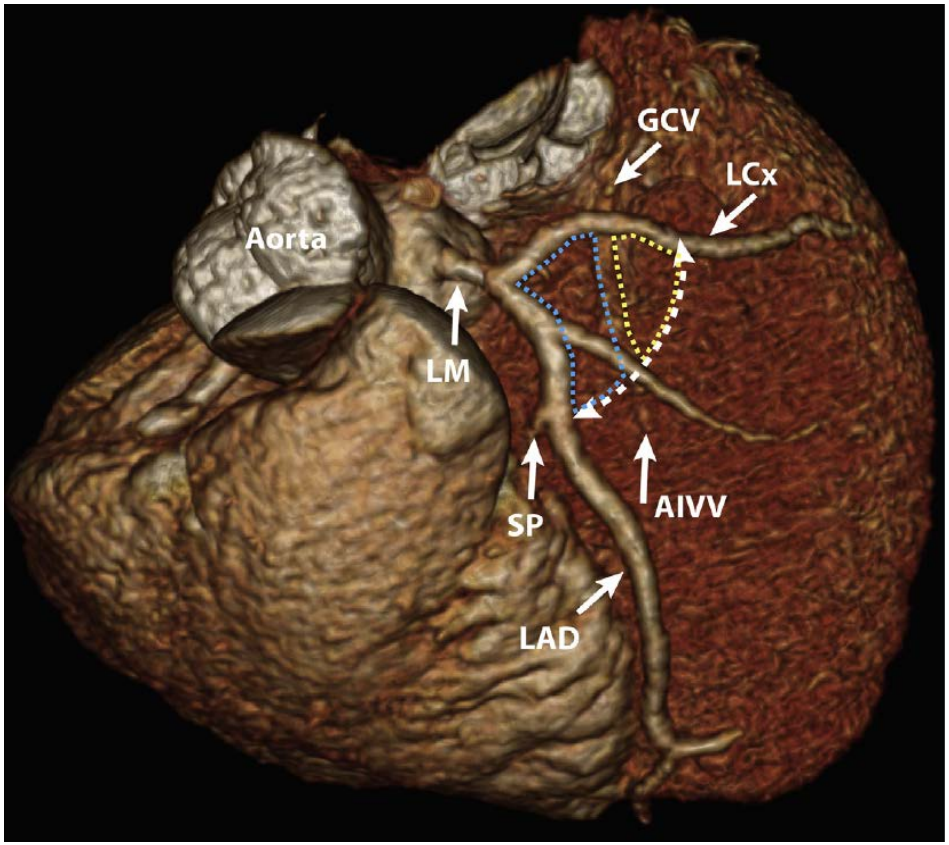
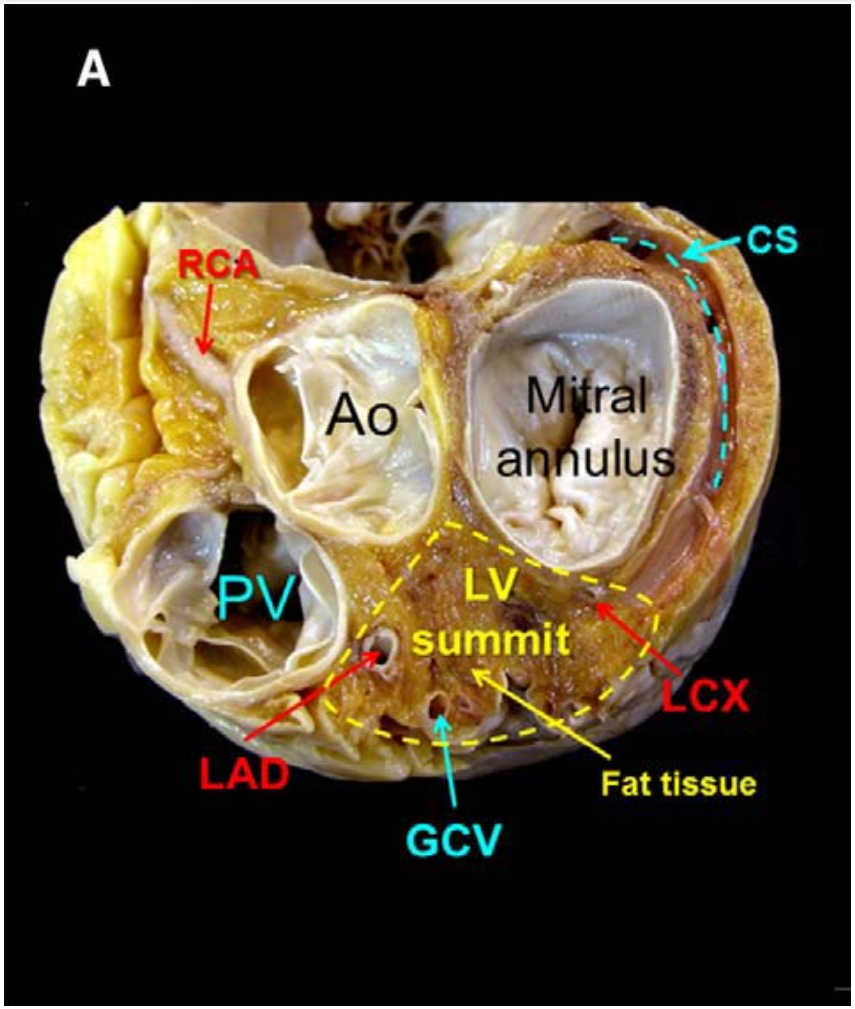
Anatomy of LV summit

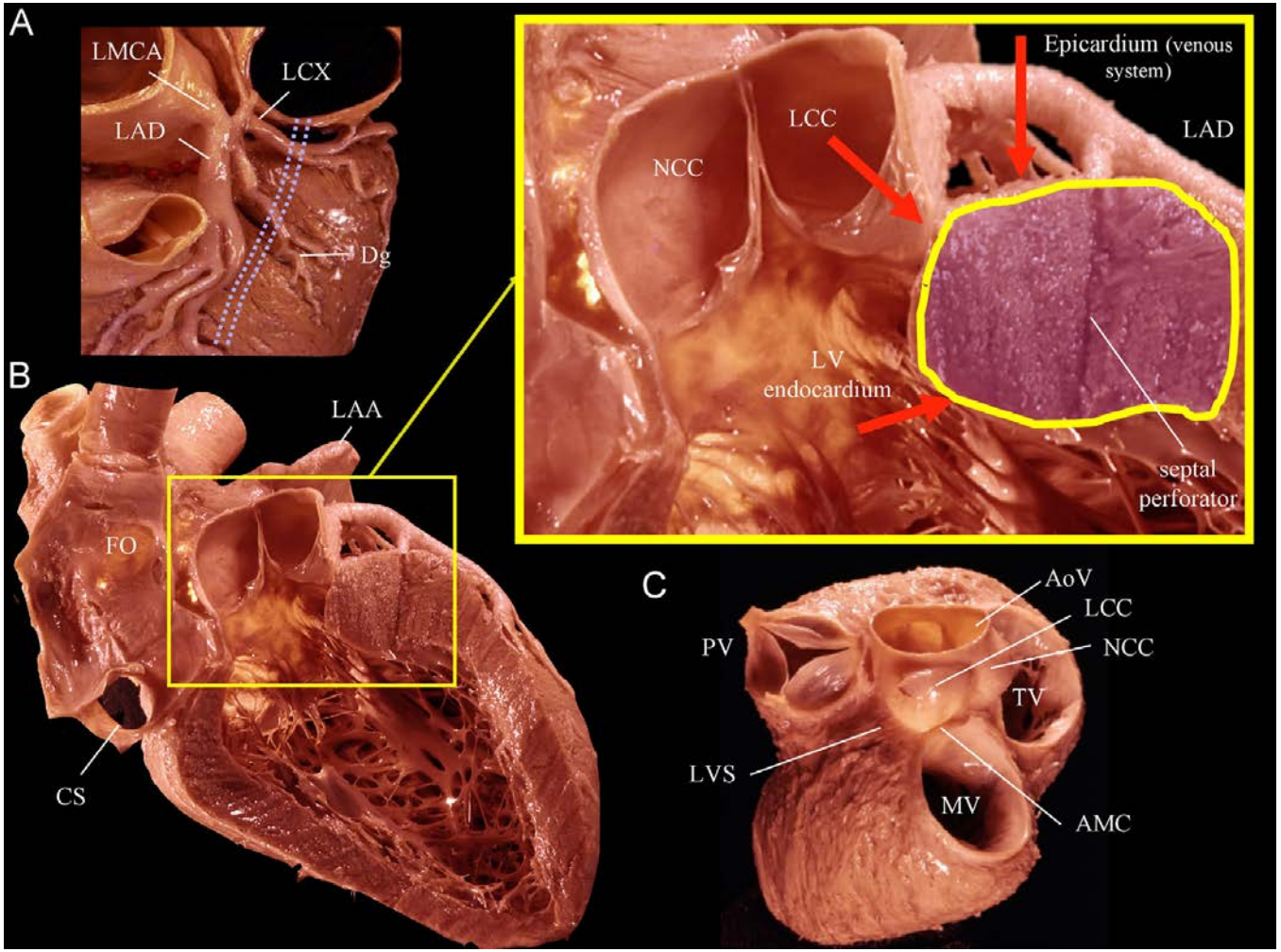




Circ Arrhythm Electrophysiol. 2013;6:e80-e84

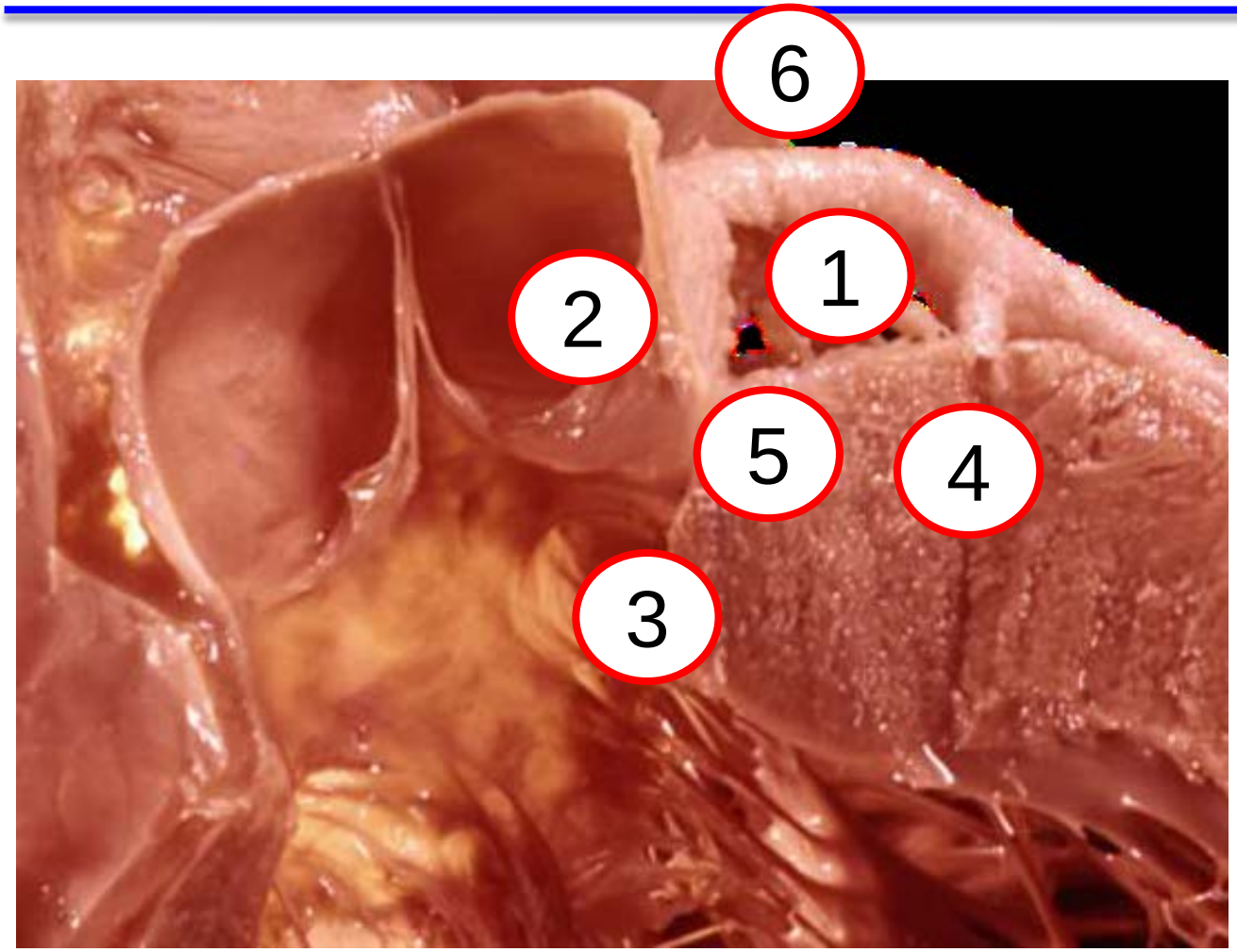
Card Electrophysiol Clin 8 (2016) 99–107

Anatomy of LV summit



McAlpine, Heart and Coronary Arteries, Springer-Verlag, Berlin - Heidelberg, 1975

Approach to LV summit



1. Epicardium

-GCV/AIV

-Epicardial Access

2. LCC

3. LV endocardium

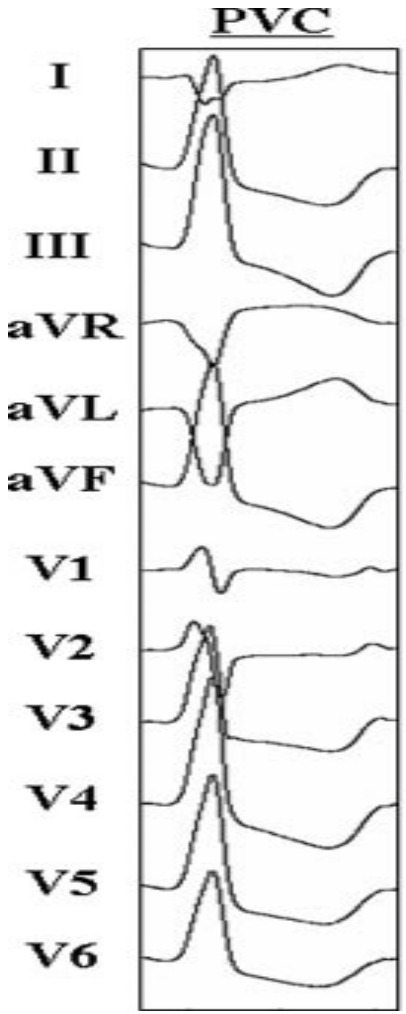
4. Septal branches

5. RVOT

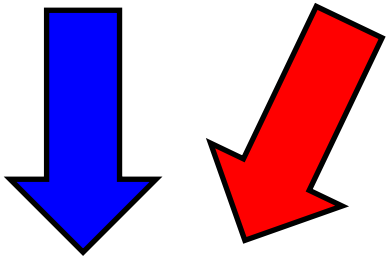
6. LAA

McAlpine, Heart and Coronary Arteries, Springer-Verlag, Berlin - Heidelberg, 1975

ECG characteristics of LV summit



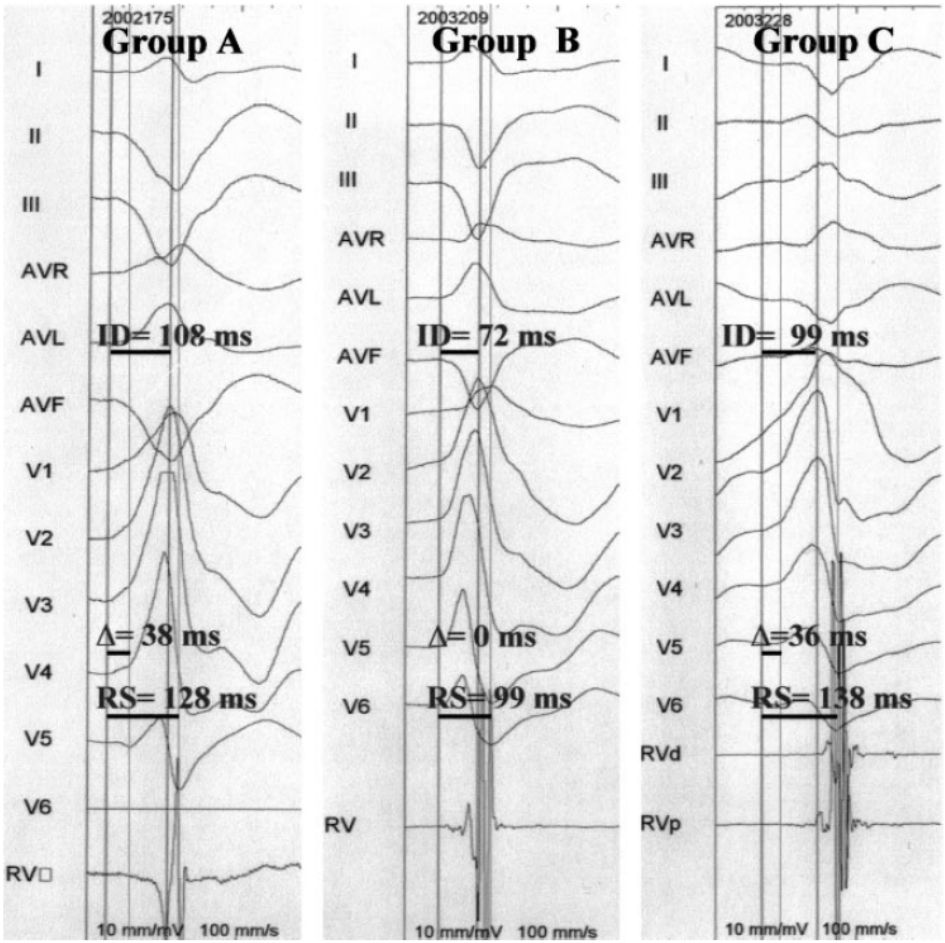
- RBBB with inf axis
- III/II ratio >1.25
- aVL/aVR ratio >1.1



- Early transition zone (V_2 or V_3)
- S waves in V5 or V6
- QS pattern in lead I
  - 30% of patients
- “pattern break” in V_2
  - Abrupt loss of R wave in V2 followed by return of R wave in V3

Electrocardiographic Recognition of the Epicardial Origin of Ventricular Tachycardias

Failed endo	Success endo	Failed endo

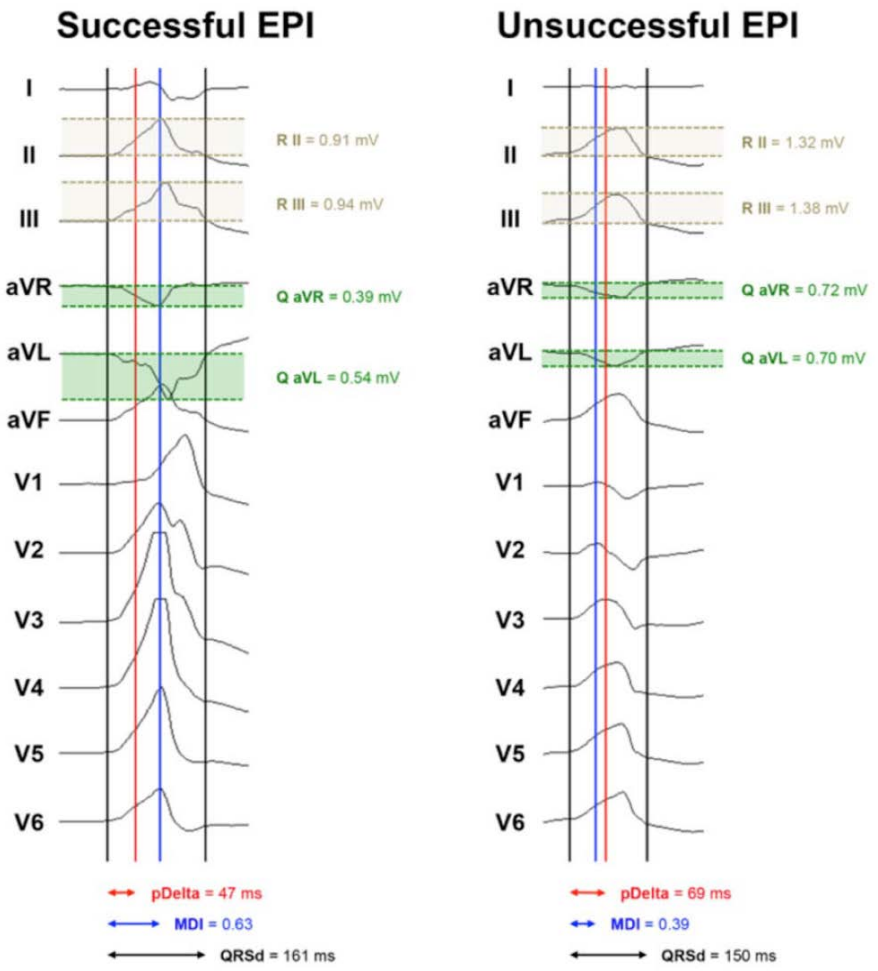


- **Predictors of failure of an endocardial VT ablation**
  - Pseudodelta wave ≥ 34 ms
  - Intrinsicoid deflexion time ≥85 ms
  - Shortest RS interval ≥121ms
  - QRS duration ≥211ms

Berruezo A et al. Circulation 2004

Percutaneous Epicardial Ablation of Ventricular Arrhythmias Arising From the Left Ventricular Summit

Outcomes and Electrocardiogram Correlates of Success



Appropriate candidates for epicardial ablation

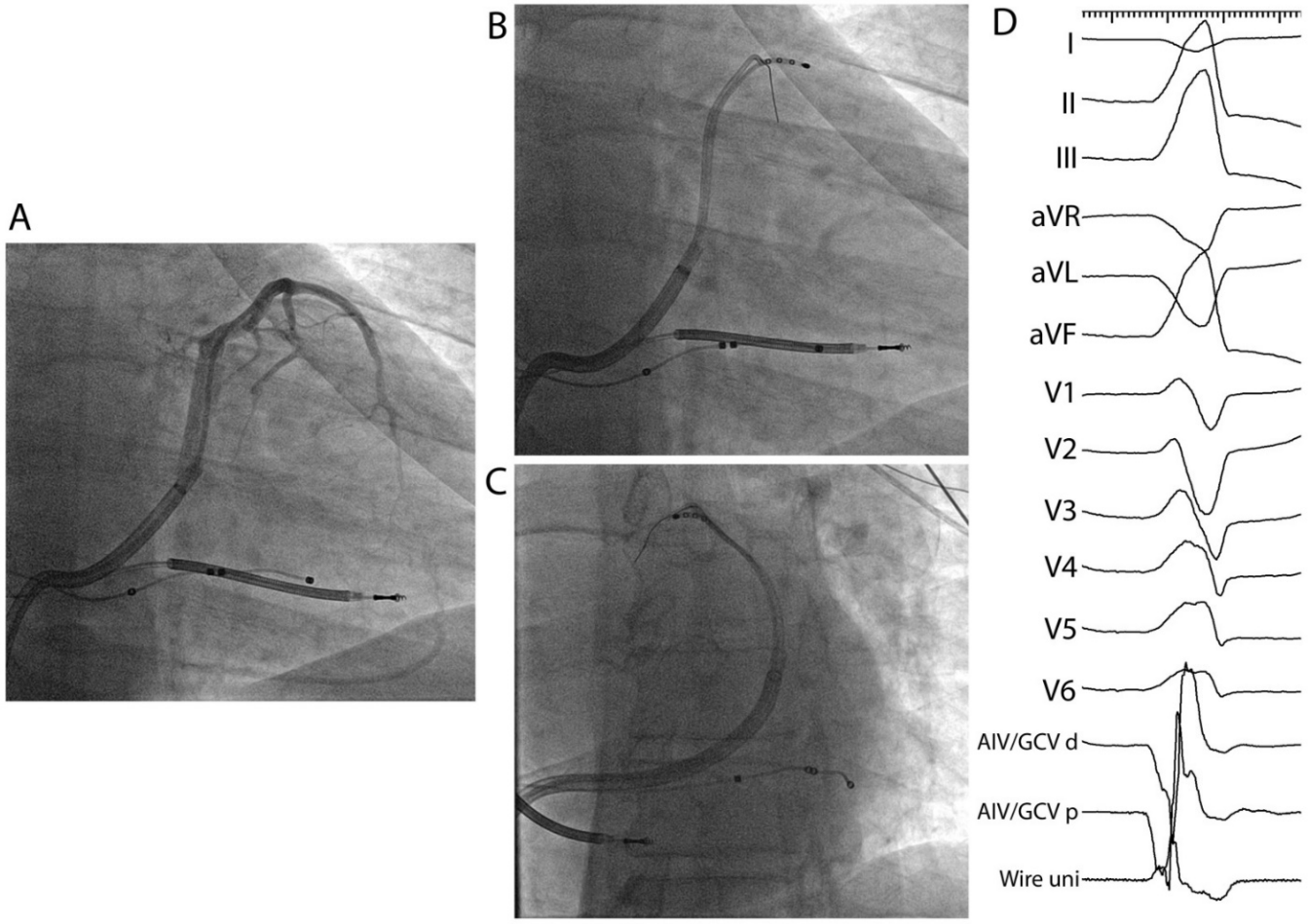
- Q-wave ratio of >1.85 in aVL/aVR
- R/S ratio of >2 in V1
- absence of q waves in lead V1

Santangeli P et al. Circ AE. 2015;8:337-343

Mapping and ablation of LVS VA

- Coronary sinus and GCV/AIV
- Coronary cusps
- LV endocardium below the LCC
- RVOT
- Percutaneous epicardial approach
- Surgical approach
- Others

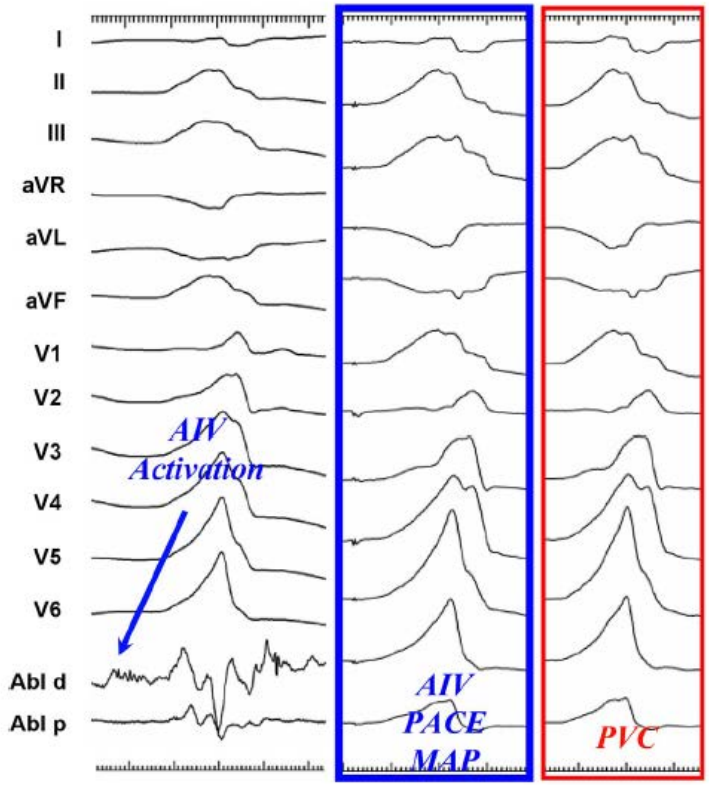
Mapping the coronary sinus and GCV/AIV

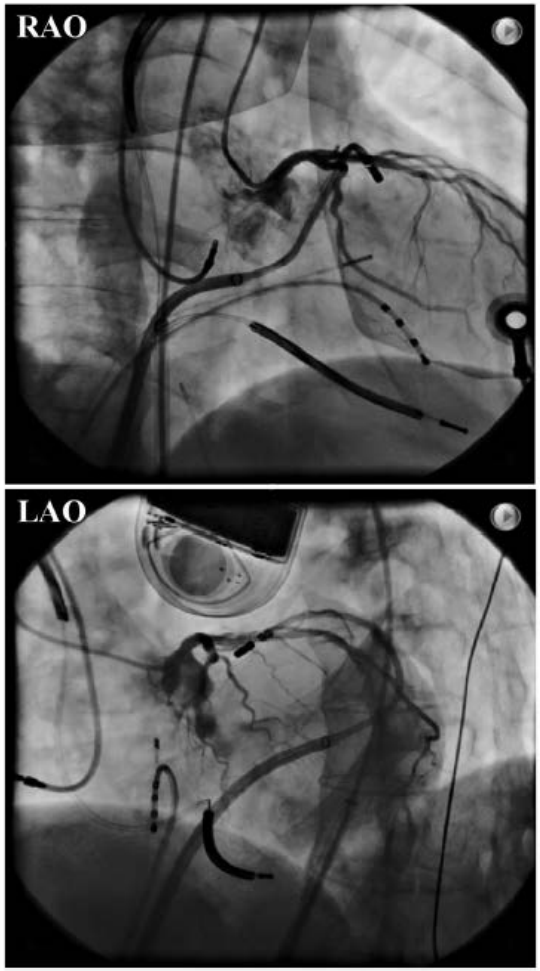


- 4Fr quadripolar catheter (Inquiry, St. Jude Medical, St. Paul, MN)
- 4Fr hydrophilic coated catheter (Glidecath, Terumo Somerset, NJ)
- 0.14-inch, 175-cm wire(Visionwire, Biotronik, Berlin, Germany

Enriquez A, Garcia F et al. Heart Rhythm 2017;14:141–148

Ablation at the GCV/AIV



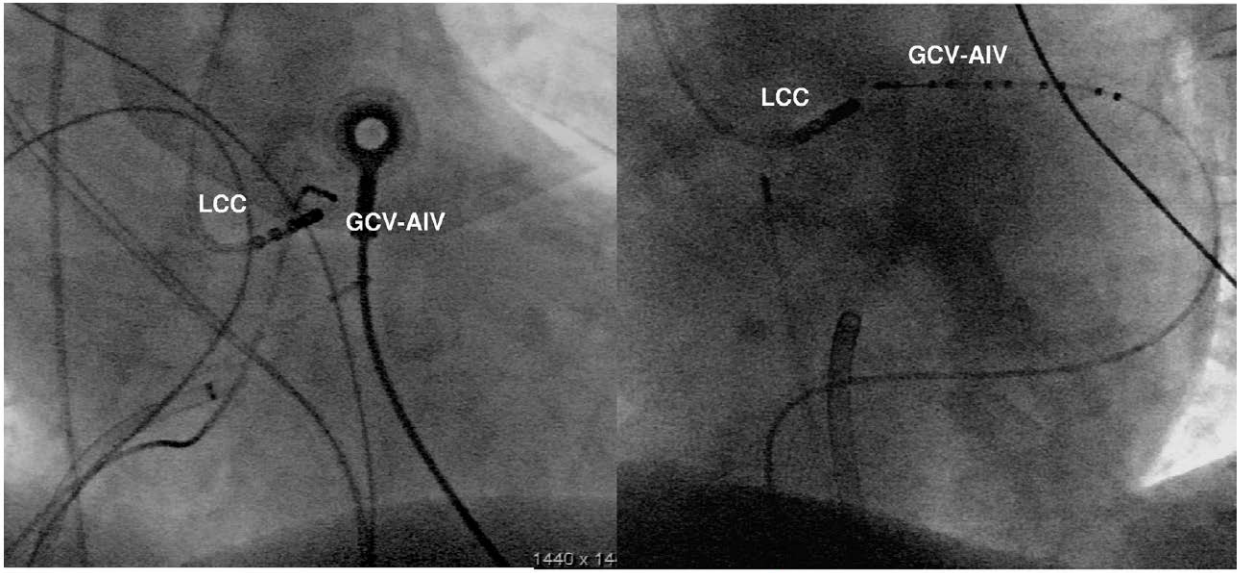


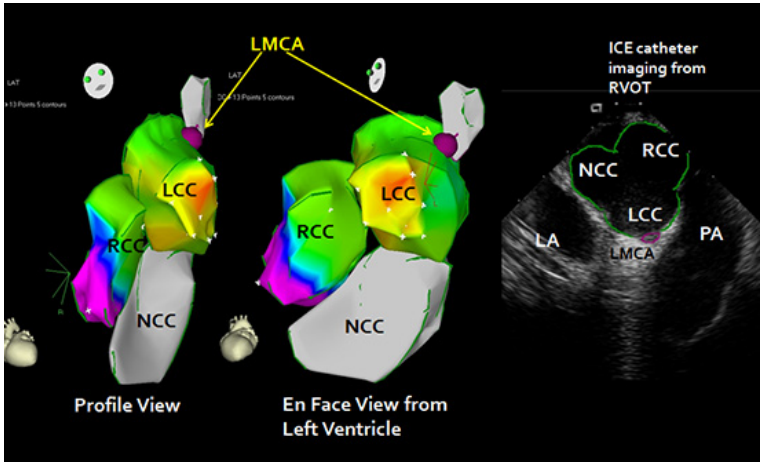
Enriquez A, Garcia F et al. Heart Rhythm 2017;14:141–148

Limitations for ablation within the GCV/AIV

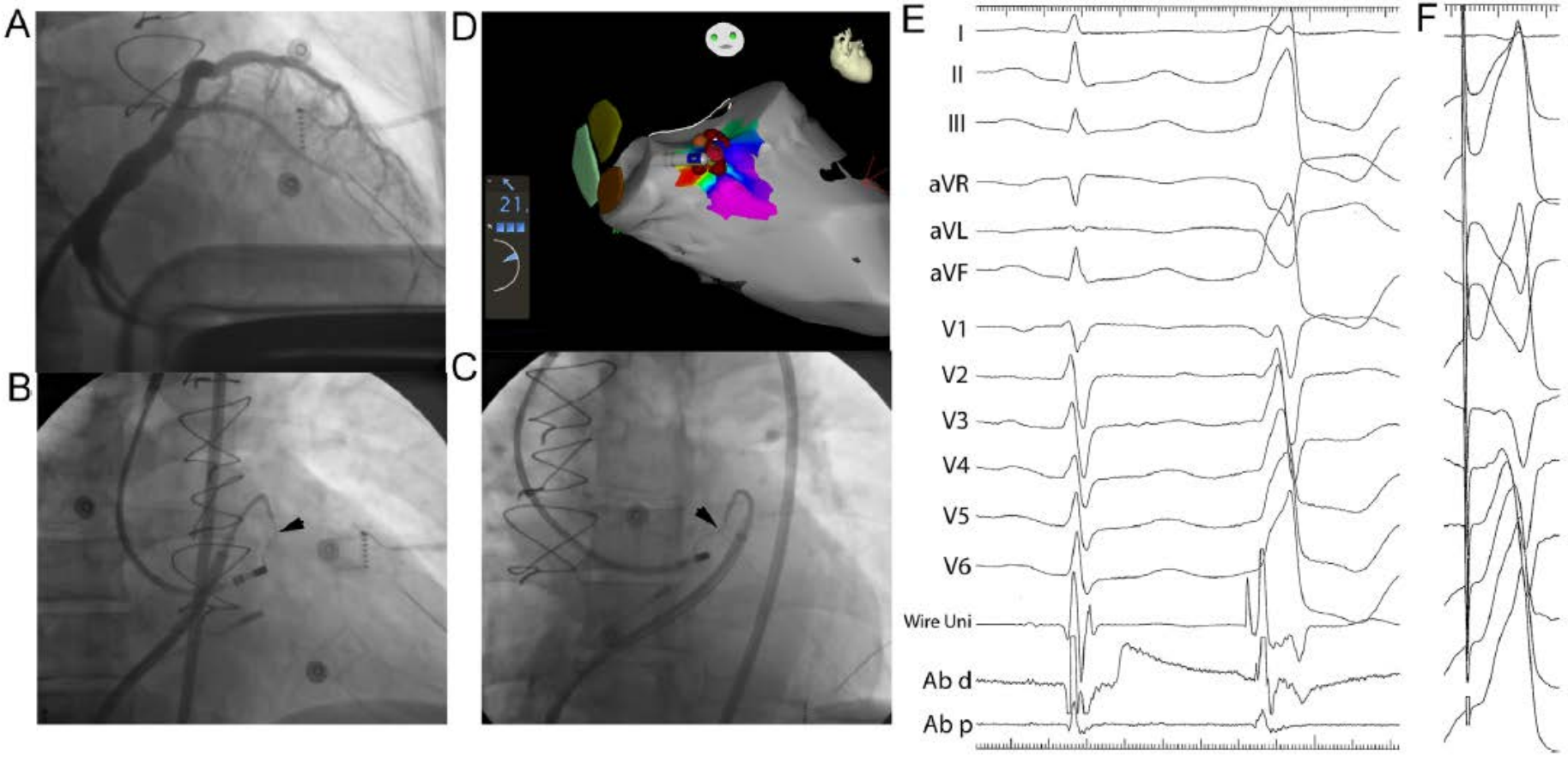
- Difficulty in advancing the ablation catheter to the site of interest
- Inability to achieve adequate power because of impedance or temperature raise
- Proximity to coronary vessels
  - RF ablation is not recommended within 5 mm of a coronary artery visualized in at least 2 fluoroscopic projections
- Stepwise incremental of RF energy if possible (target 20–40W) is recommended

Mapping the coronary cusps



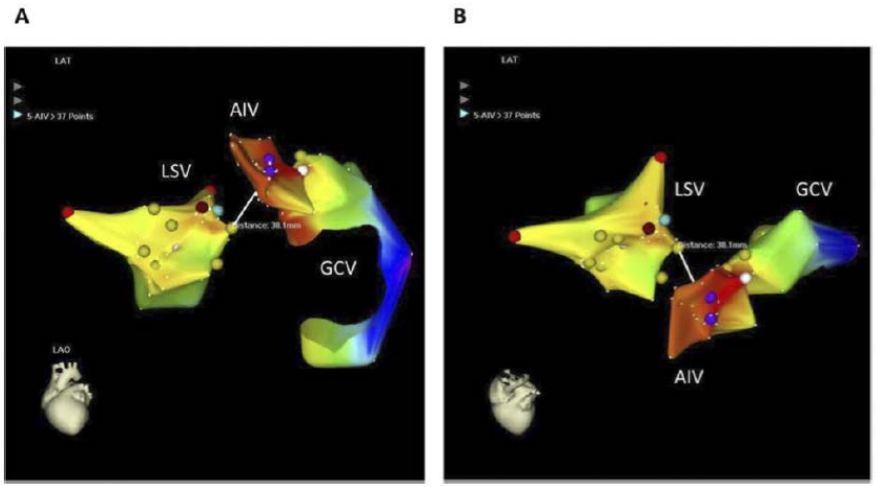


Mapping the LV endocardium below the LCC



Enriquez A, Garcia F et al. Heart Rhythm 2017;14:141–148

Ablation of ventricular arrhythmias arising near the anterior epicardial veins from the left sinus of Valsalva region: ECG features, anatomic distance, and outcome



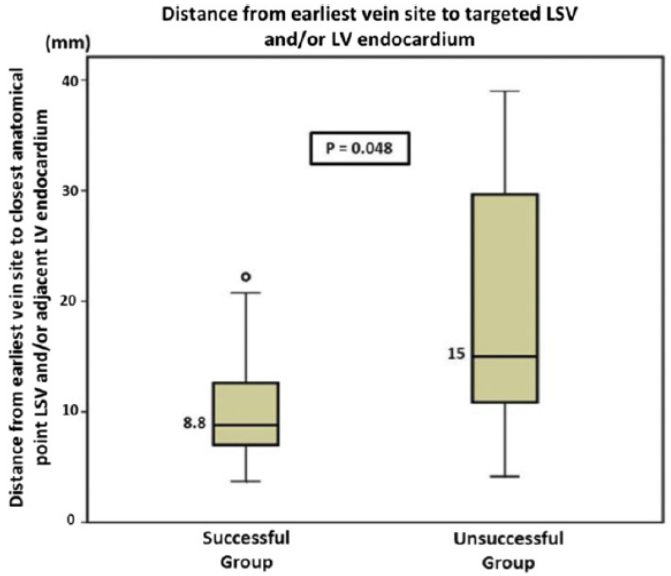


Table 2 Calculated sensitivity, specificity, and predictive values for the anatomical distance and ECG predictors of successful ablation from the LSV region

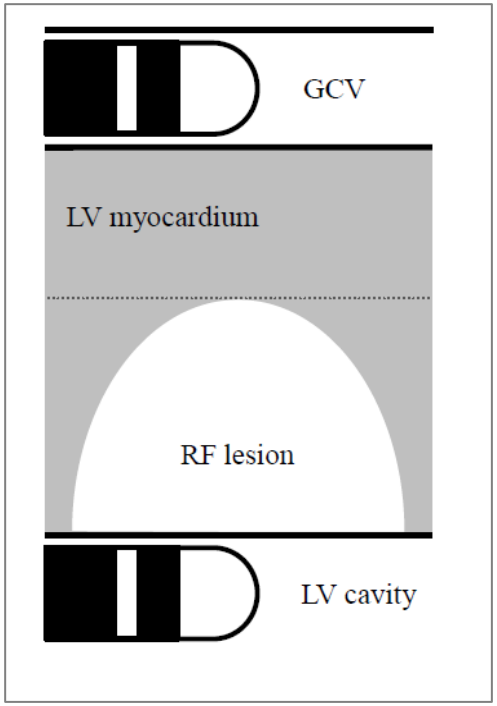
Criteria	Sensitivity (%)	Specificity (%)	PPV (%)	NPV (%)	95% Confidence interval
Anatomical distance <13.5 mm	78	64	64	78	Successful: 5.99–16 mm Unsuccessful: 12.26–28.54 mm
Q-wave ratio in aVL/aVR <1.45	89	75	80	85	Successful: 0.92–1.56 Unsuccessful: 1.27–3.03
R-wave ratio in lead III/II <1.13	78	75	78	75	Successful: 0.95–1.15 Unsuccessful: 1.03–1.64

ECG = electrocardiographic; LSV = left sinus of Valsalva; PPV = positive predictive value; NPV = negative predictive value.

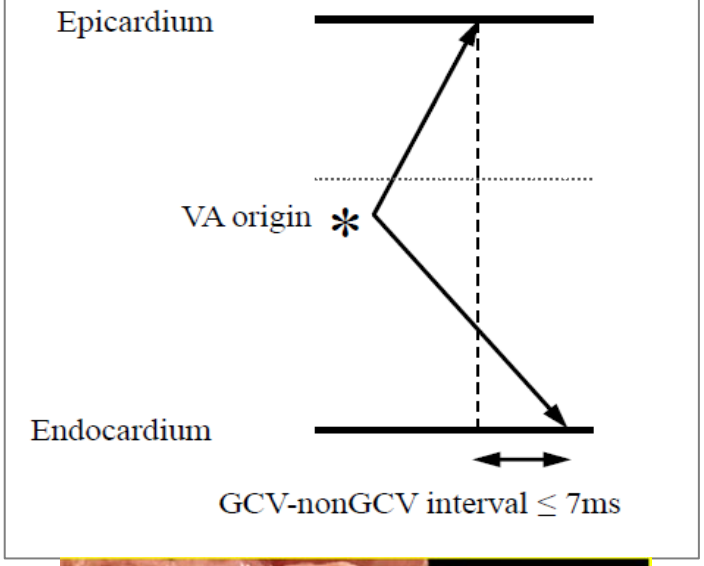
Abularach MEJ, Marchlinski FE et al. Heart Rhythm 2012;9:865– 873

Ventricular Arrhythmias Near the Distal Great Cardiac Vein

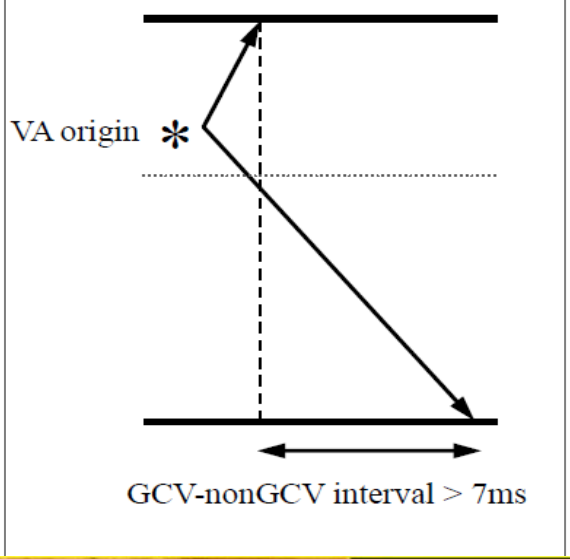
Challenging Arrhythmia for Ablation

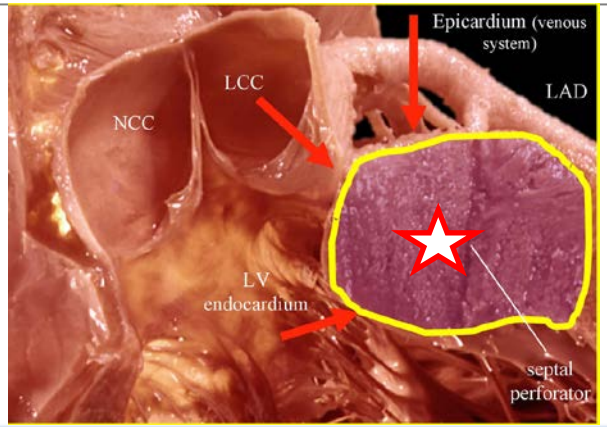


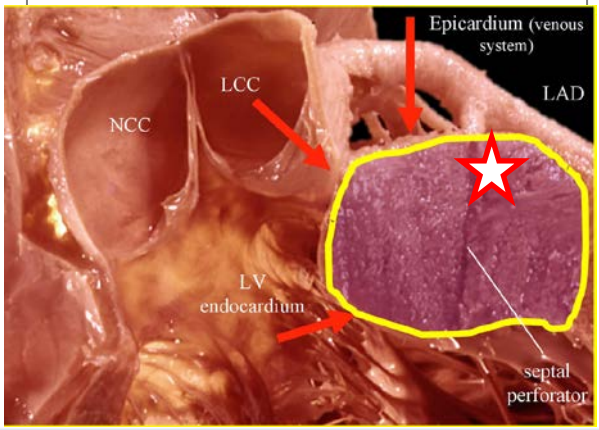
Successful endocardial ablation



Endocardial ablation failure

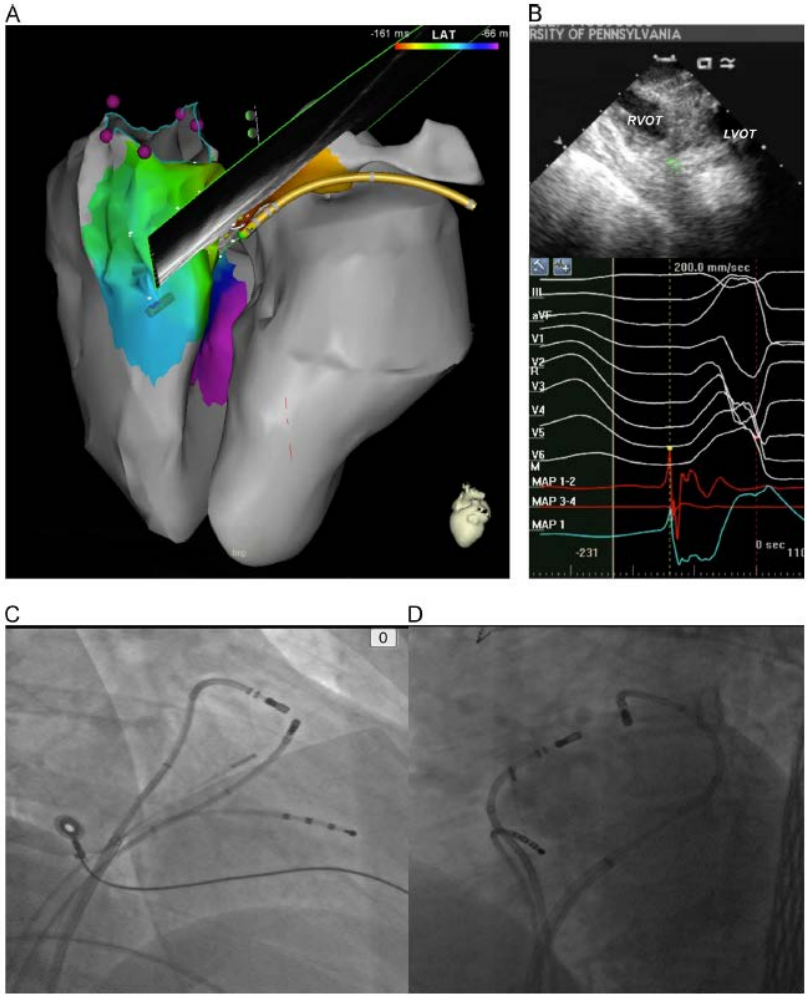


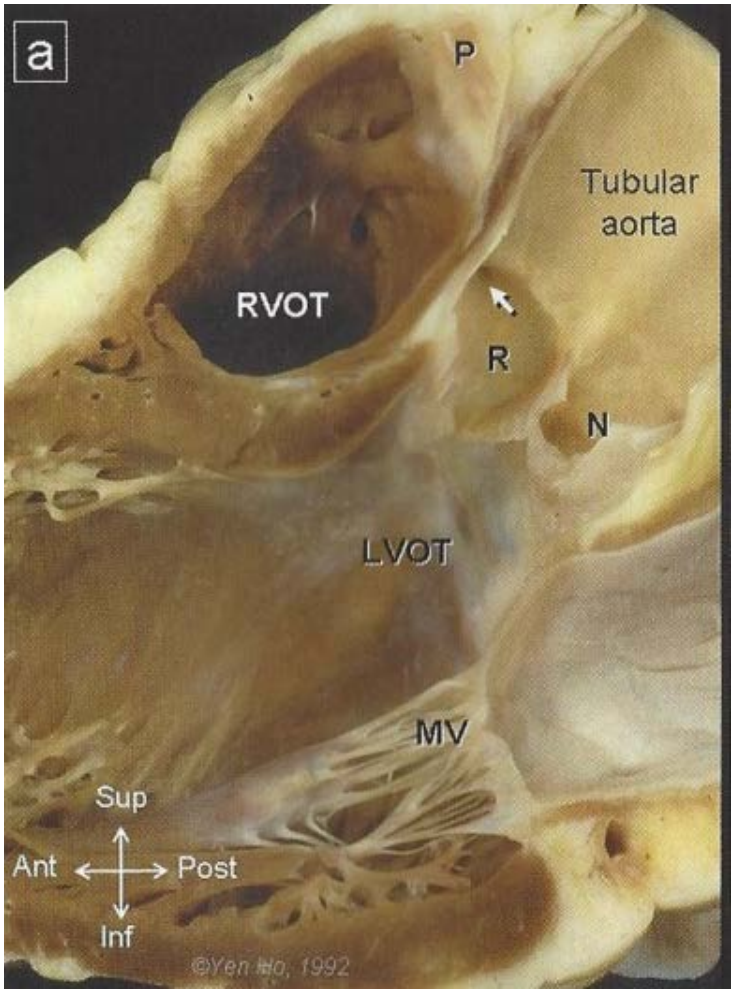




Nagashima K, Stevenson WG et al. Circ AE 2014;7:906-912

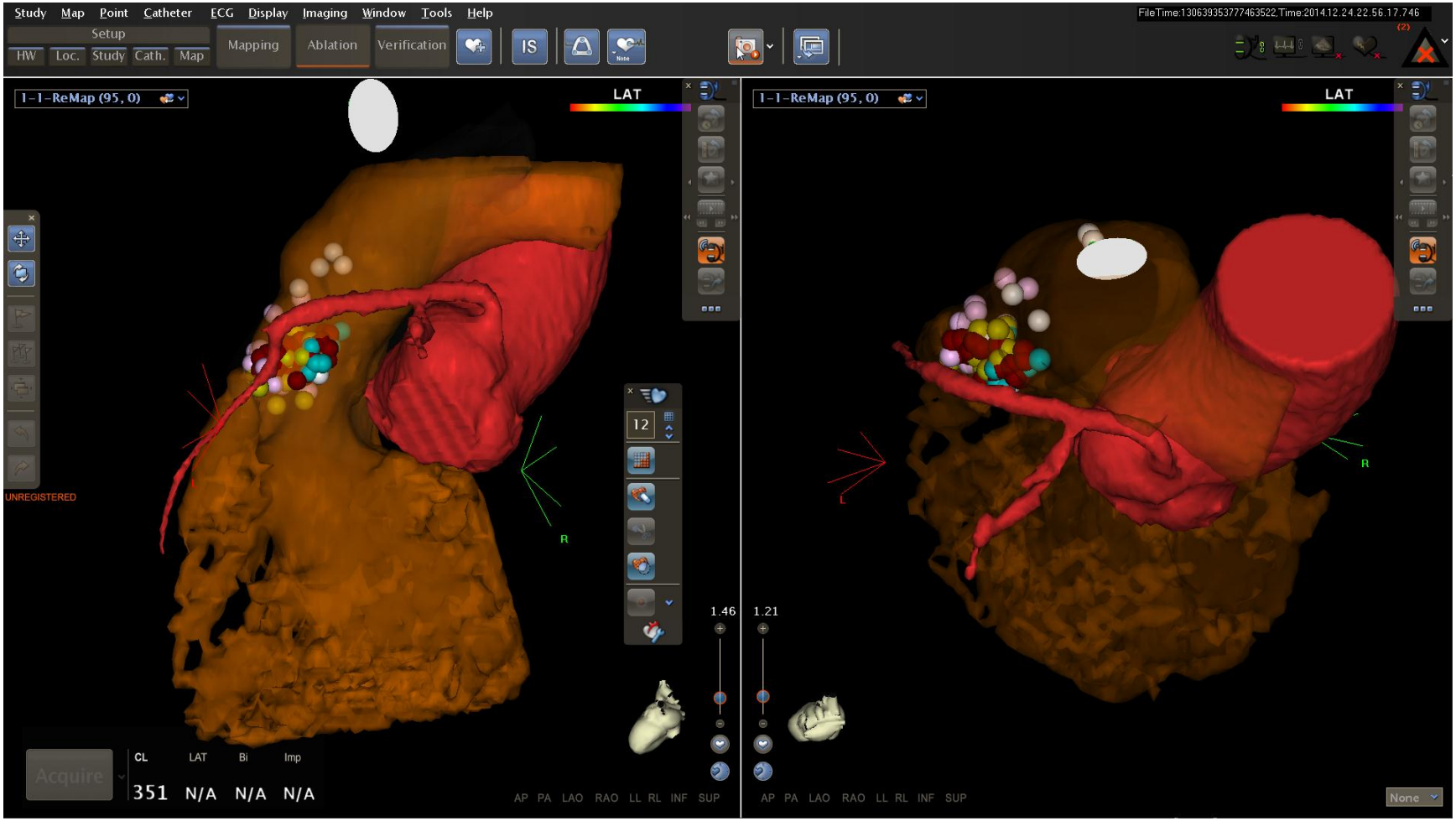
Mapping the RVOT



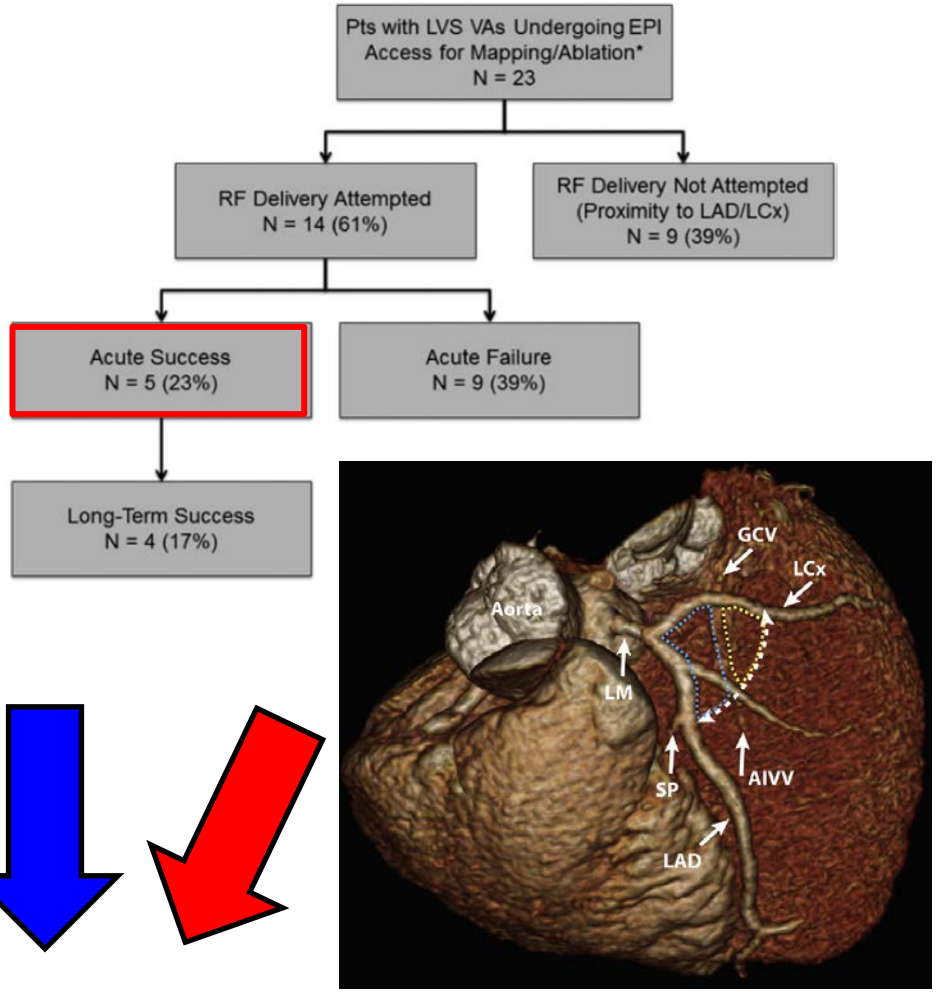


Enriquez A, Garcia F et al. Heart Rhythm 2017;14:141–148
Ho SY. Anatomy for Cardiac Electrophysiologists

RVOT and coronary artery



Epicardial ablation at LVS



- Radiofrequency delivery on the epicardium was attempted only in 14 (61%) patients;
- in the remaining 9 (39%) cases, radiofrequency delivery was aborted because of close proximity to either the left anterior descending or circumflex coronary artery
- Of the 14 patients in whom radiofrequency energy delivery was attempted, it was acutely successful in suppressing the VAs in only 5

Santangeli P et al. Circ AE. 2015;8:337-343

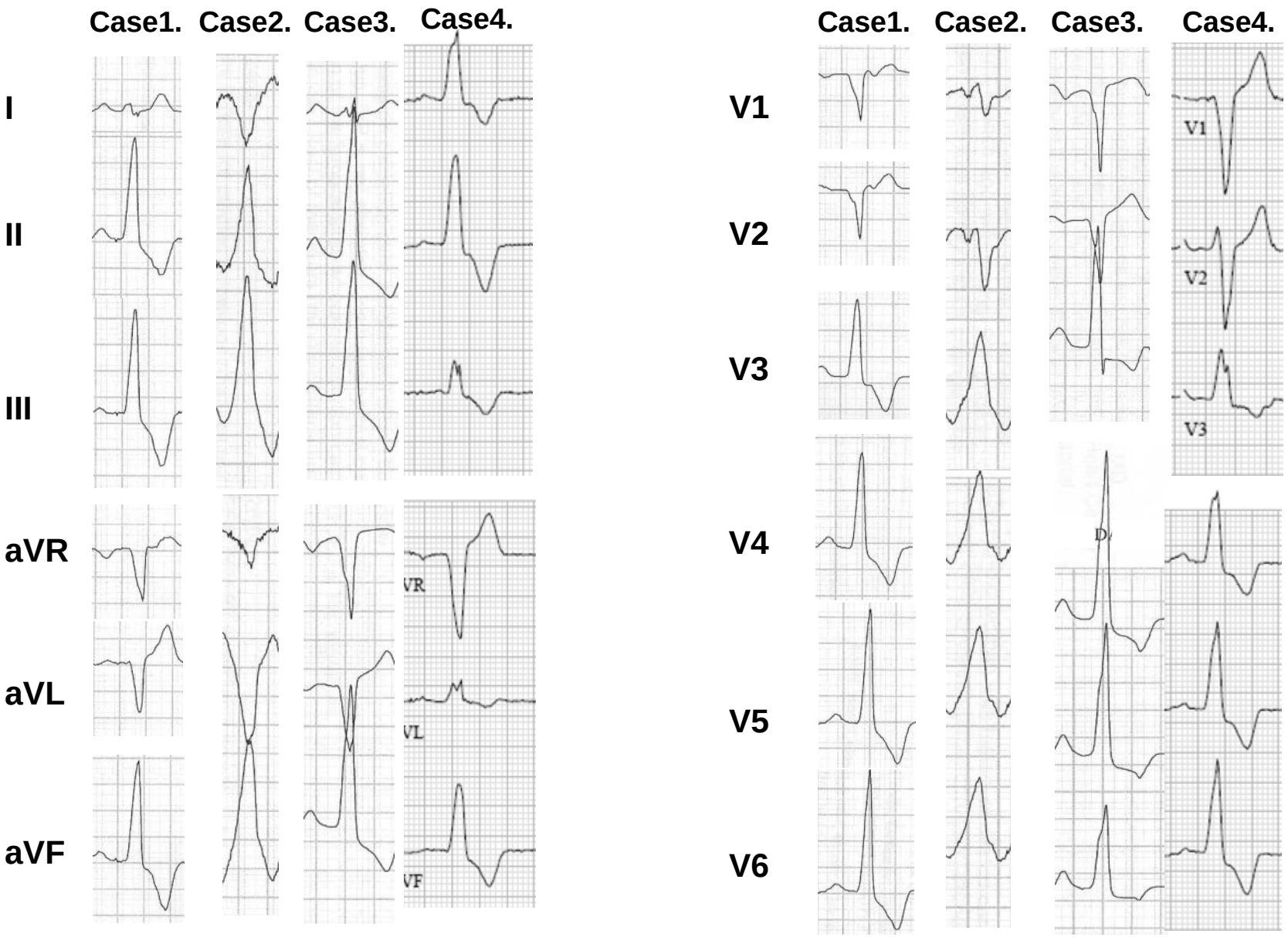
Surgical cryoablation for ventricular tachyarrhythmia arising from the left ventricular outflow tract region

- March 2009 to March 2014
- 190 consecutive pts with focal VA from LVOT ablation
- Brigham and Women's Hospital, Boston
- 4 patients (2%) underwent surgical cryoablation
- Handheld argon-powered probe (Cryoablate CryoFlex surgical ablation probe, Medtronic)

	Case 1	Case 2	Case 3	Case 4
Age	48	56	62	44
Gender	Female	Female	Male	Male
Clinical presentation	Symptomatic PVCs and repetitive monomorphic VT	Sustained and repetitive monomorphic VT with presyncope	Symptomatic PVCs	Symptomatic PVCs
Echocardiogram	Mild global LV hypokinesis (LVEF 0.45)	Moderate global LV hypokinesis (LVEF 0.35)	Moderate to severe global LV dysfunction (LVEF 0.2-0.3)	Low normal LVEF with mildly dilated LV Moderate aortic valve regurgitation
Cardiac MRI	Mild systolic dysfunction (LVEF = 45-50%). No LGE	Mild systolic dysfunction (LVEF = 45-50%). No LGE	Not done	Moderately dilated left ventricle with mild systolic dysfunction (LVEF = 50%) No LGE. Severe aortic insufficiency.
Coronary angiography	Normal	Normal	Diffuse moderate (60%) LAD stenosis	Normal
24-hour Holter or event monitoring	Repetitive monomorphic VT and PVCs	Repetitive monomorphic VT and PVCs	Symptomatic monomorphic PVCs comprising 36% of QRS complexes over 24 hours	Frequent symptomatic PVCs in couplets and triplets correlating with symptoms
Other co-morbidity	No	Prior chemotherapy with adriamycin for osteosarcome	Coronary artery disease with remote balloon angioplasty of LAD	Bicuspid aortic valve with moderate to severe aortic regurgitation
Electrocardiogram				
Precordial leads	LBBB pattern	LBBB pattern	LBBB pattern	LBBB pattern
R-wave transition	V3	V3	V3	V3
QRS axis	Inferior	Inferior	Inferior	Inferior
Lead I	rs	rS	rs	R
S wave in V6	Yes	Yes	Yes	Yes
Q wave amplitude in aVL/aVR	1	2.8	0.9	No Q wave in aVR
R wave amplitude in III/II	1.1	1.4	0.9	0.3
MDI	0.59	0.71	0.68	0.68

LV, left ventricle; LAD, left anterior descending artery; LVEF, left ventricular ejection fraction; LBBB, left bundle branch block; MDI, maximum deflection index

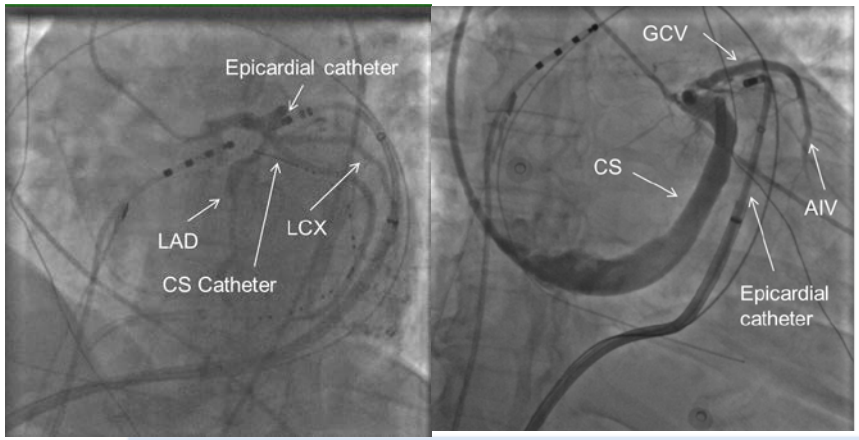
Choi EK, Roy JM et al. Heart Rhythm 2015;12:1128–1136

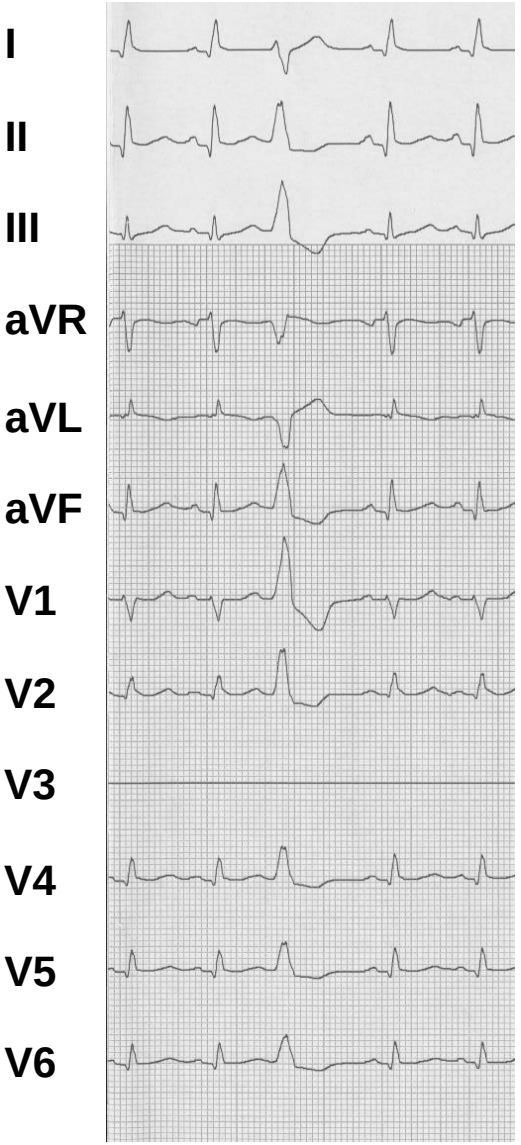


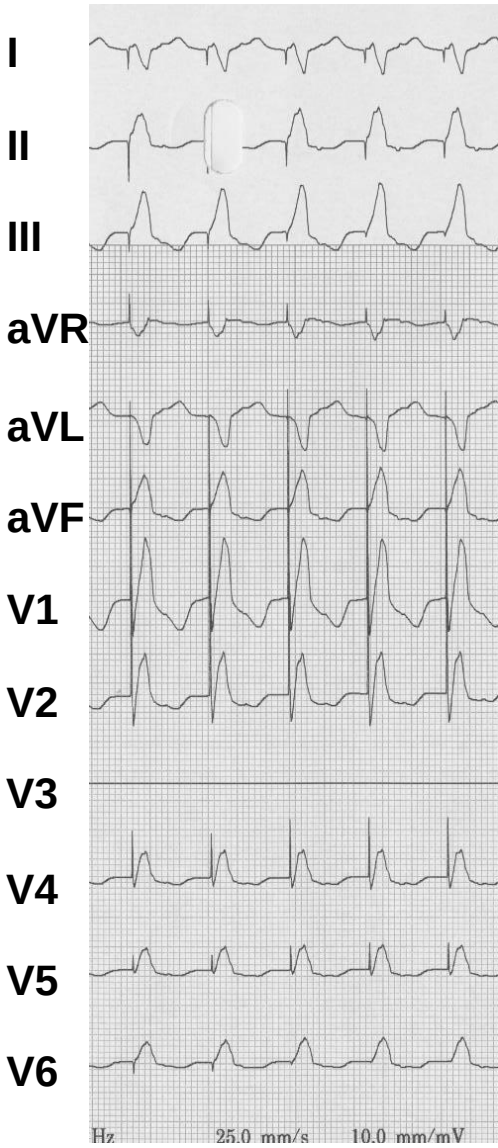
Choi EK, Roy JM et al. Heart Rhythm 2015;12:1128–1136

Case 1.

- Three previous catheter ablation procedures failed
- Earliest activation (20 ms before QRS onset) with a pacemap QRS identical to the VT was recorded in the distal GCV, close to LM
- In OR, frequent PVCs were induced with isoproterenol infusion in escalating doses to 4 μg/min
- Pacing and cryoablation at LV summit area (-150℃ for 3 to 5minutes, total 25 minutes of cryoablation)



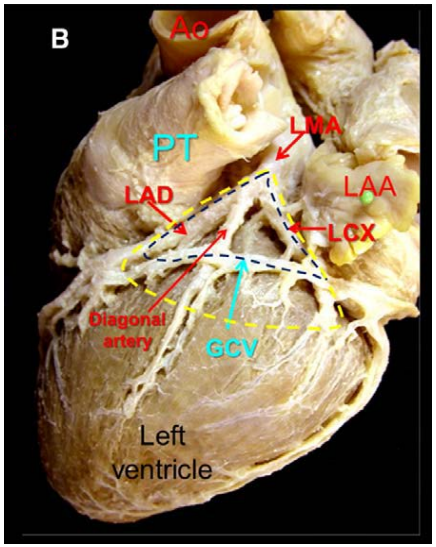


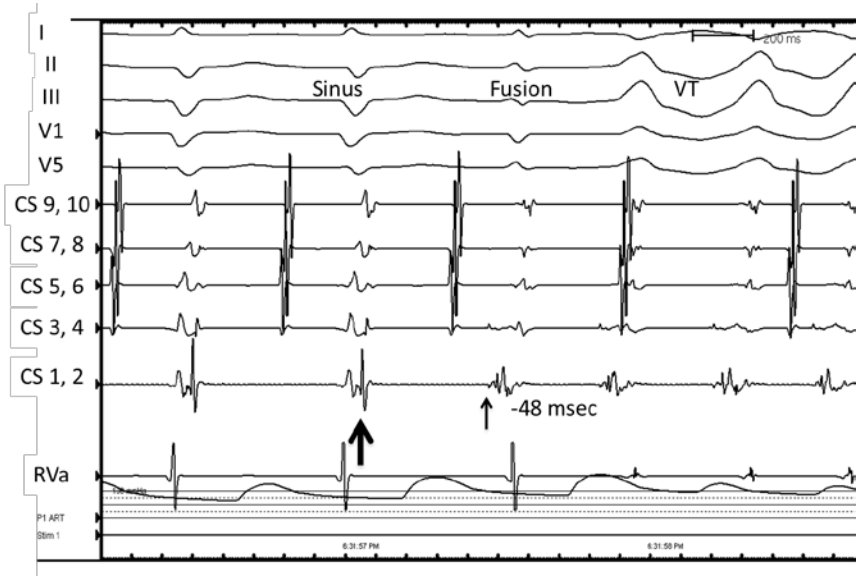


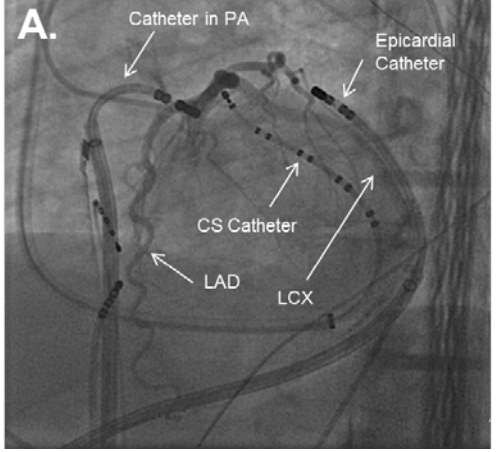
Choi EK, Roy JM et al. Heart Rhythm 2015;12:1128–1136

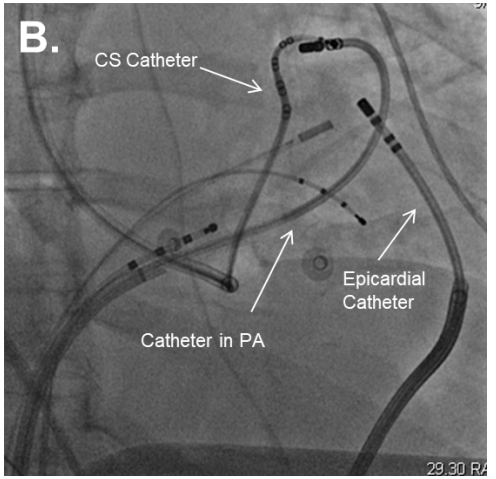
Case 2.

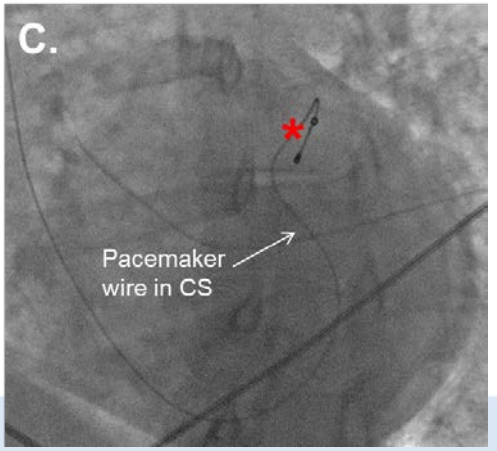
- Three previous catheter ablation procedures failed
- Earliest activation (40 ms before QRS onset) with a pacemap QRS identical to the VT was recorded in the distal GCV, close to LM
- Medtronic model 4196 bipolar pacing lead
- Failed induction PVC/VT at OR room
- Diagonal branch of the LAD overlying the AIV
- Five-minute cryoablation applications (3 lesions)
- Brief ST elevation and high lateral wall LV hypokinesis during the final cryoablation
- No VA during 41 months of FU







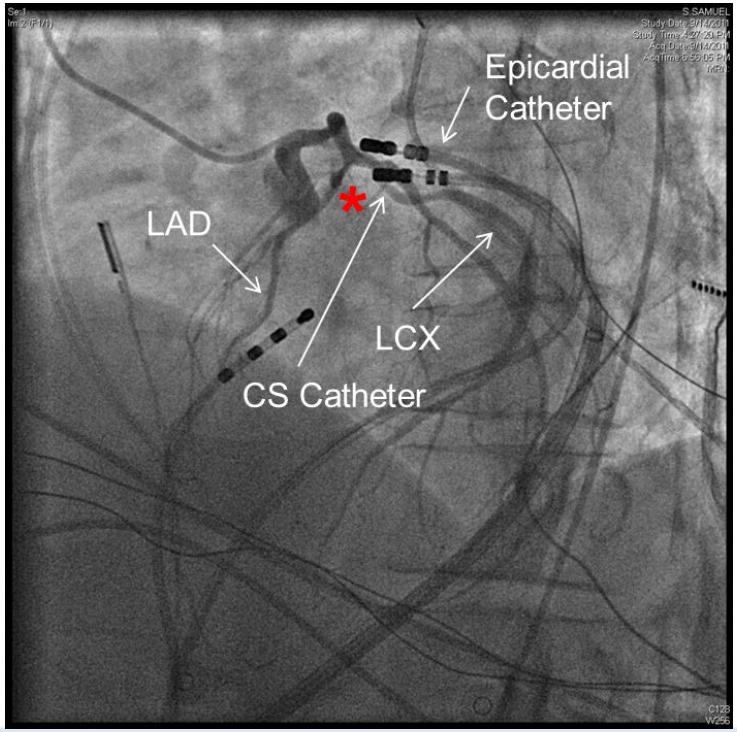


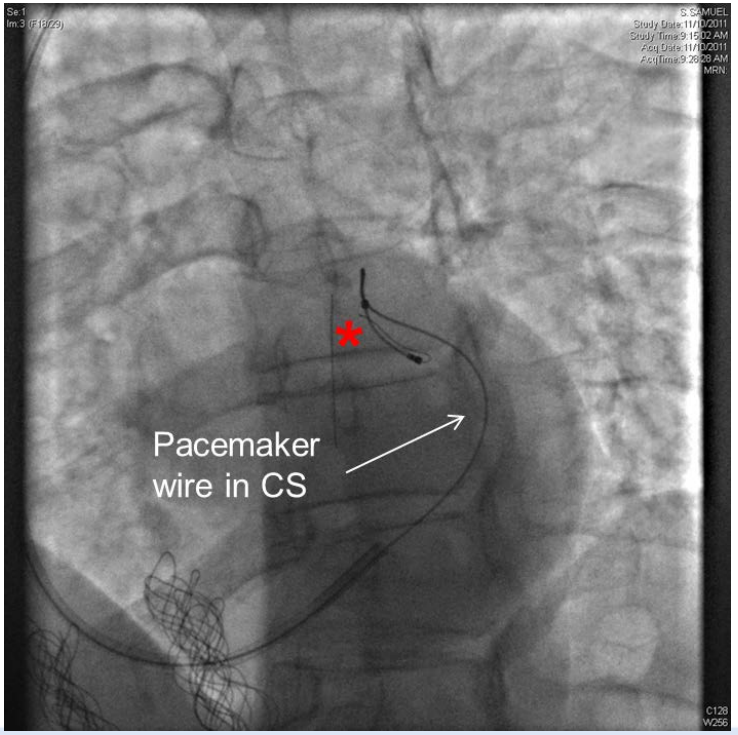


Choi EK, Roy JM et al. Heart Rhythm 2015;12:1128–1136

Case 3.

- Failed catheter ablation via CS (high temp at low energy)
- Epicardial approach: within 2 mm of the LCX and LAD
- Pacing lead was positioned at the junction of the GCV within the anterolateral branch (Medtronic model 4196, 78 cm)
- No inducible PVC at OR room
- Cryoablation at region just beneath the distal GCV
- Anterior ST-segment elevation and LV dysfunction attributed to coronary spasm



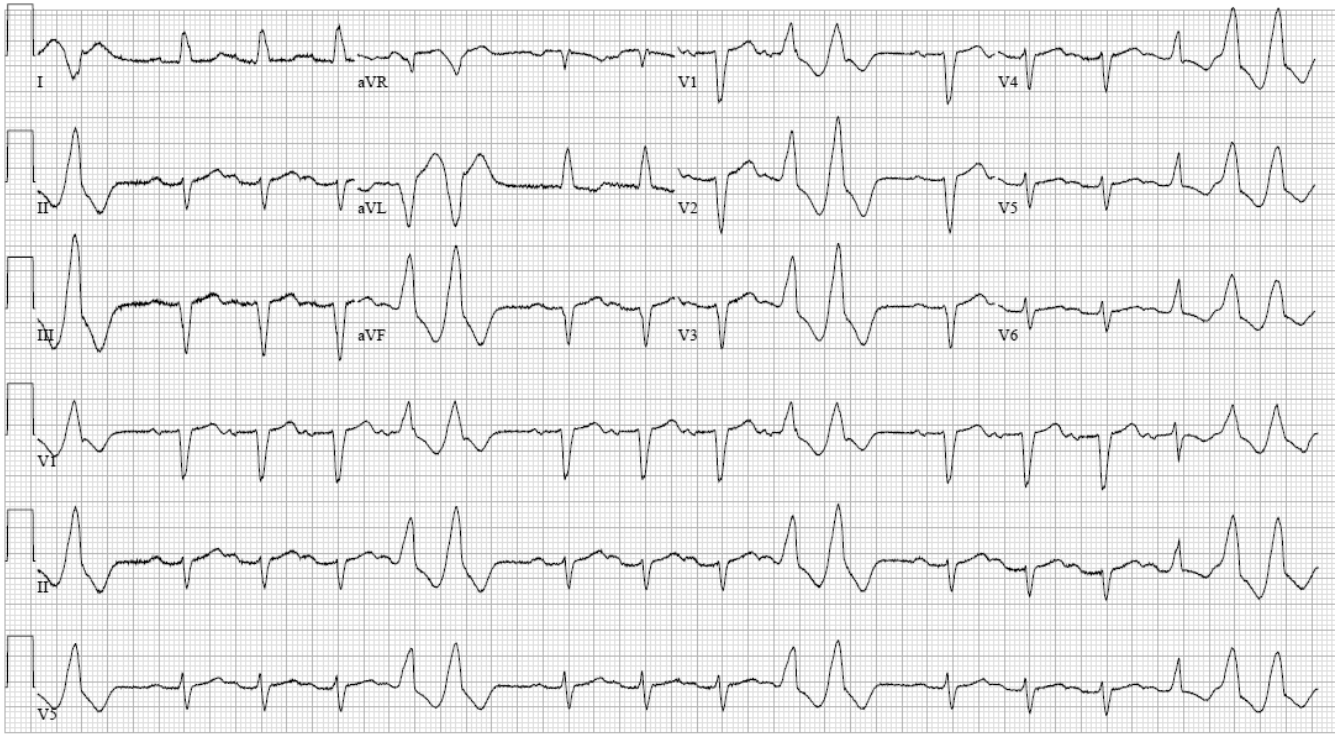


Choi EK, Roy JM et al. Heart Rhythm 2015;12:1128–1136

Case 3.

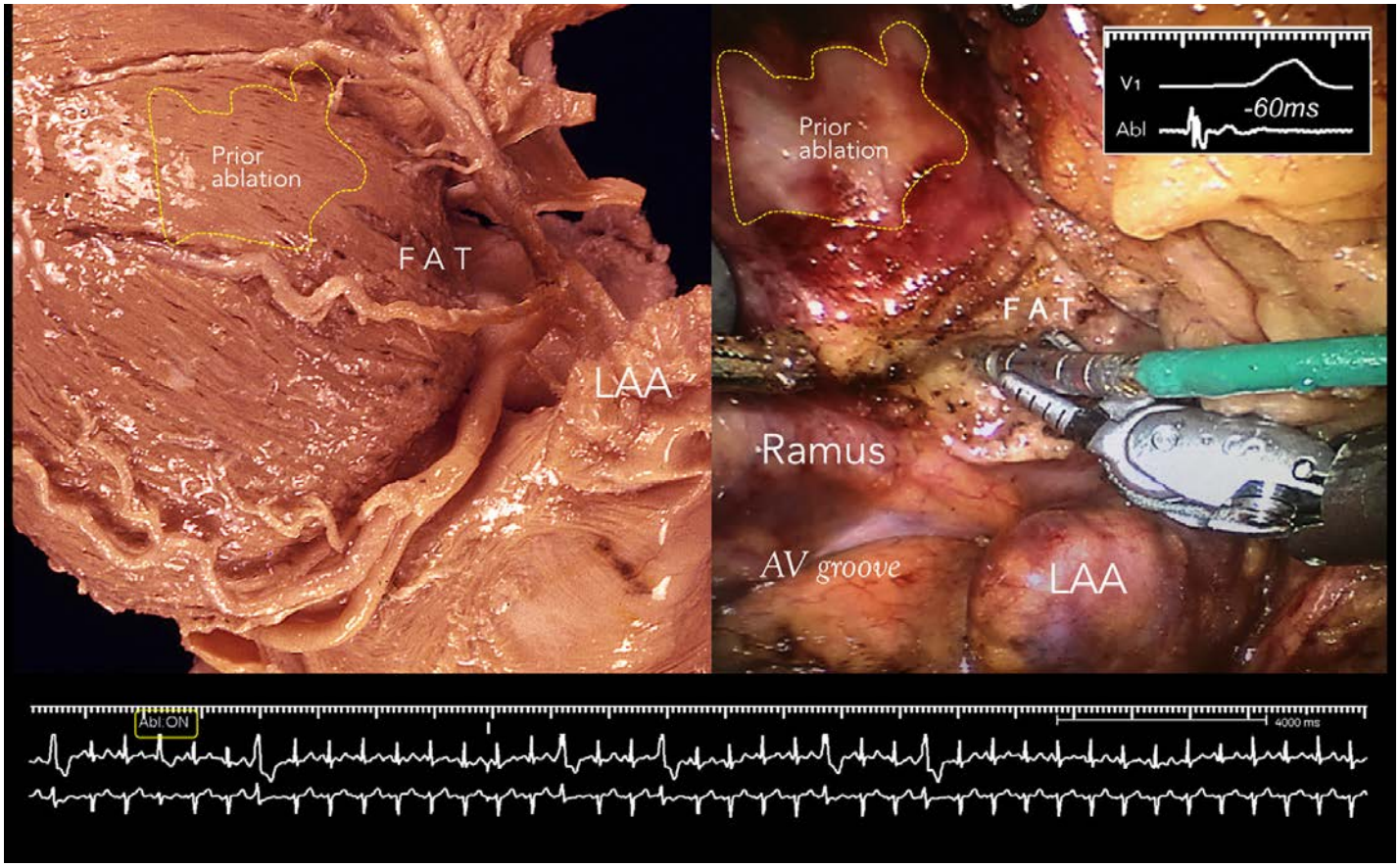
- Different PVC during postop
- RFCA at LVOT endocardium below the epicardial ablation area, below the aortic annulus at the level of jxn of the RCC/LCC commisure

- 3 months later, angina->CAG: 90% stenosis at LAD->PCI
- No VA during 39 months FU



Choi EK, Roy JM et al. Heart Rhythm 2015;12:1128–1136

Totally endoscopic robotic epicardial ablation of refractory left ventricular summit arrhythmia: First-in-man

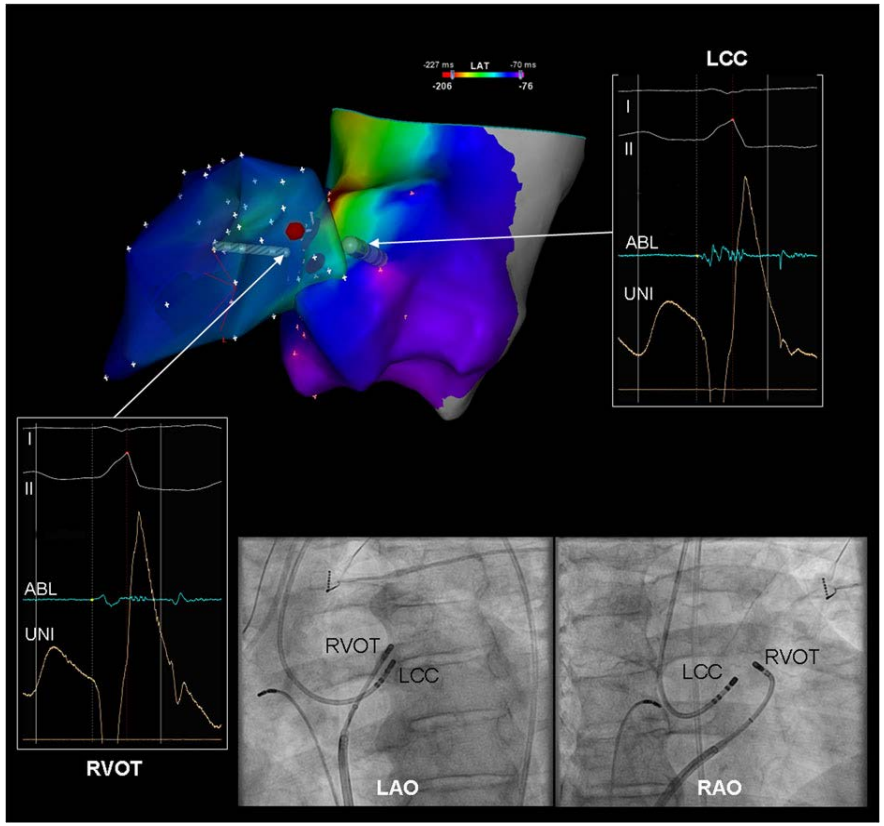


Electrocautery-assisted dissection of 10–15 mm off at to allow for more complete mapping with direct epicardial contact

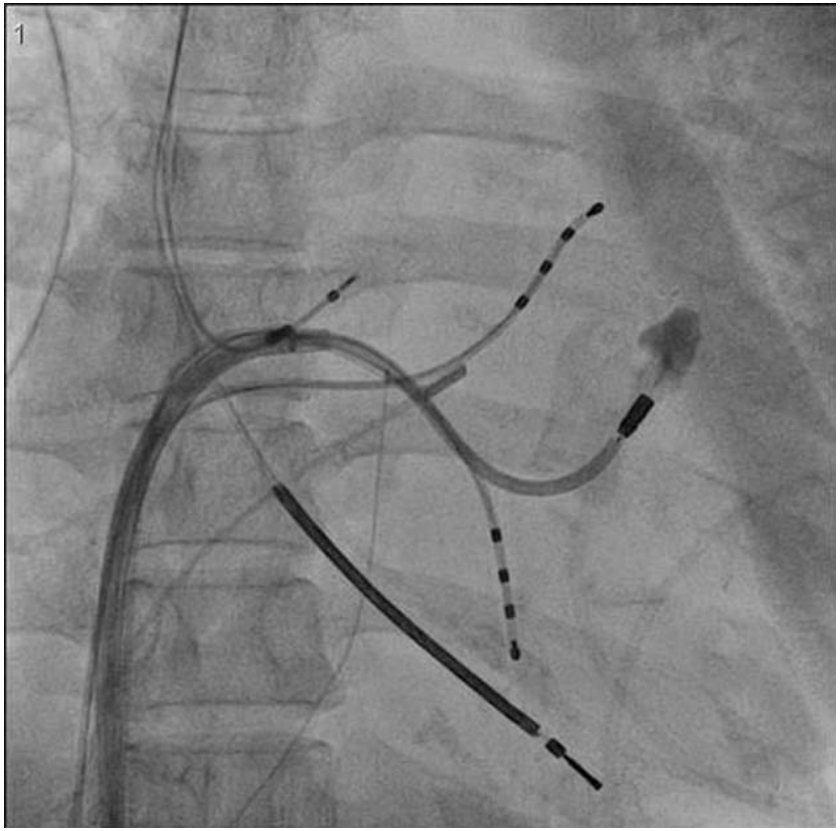
Aziz Z et al. Heart Rhythm 2017;14:135–138

Different ablation strategy

Bipolar ablation

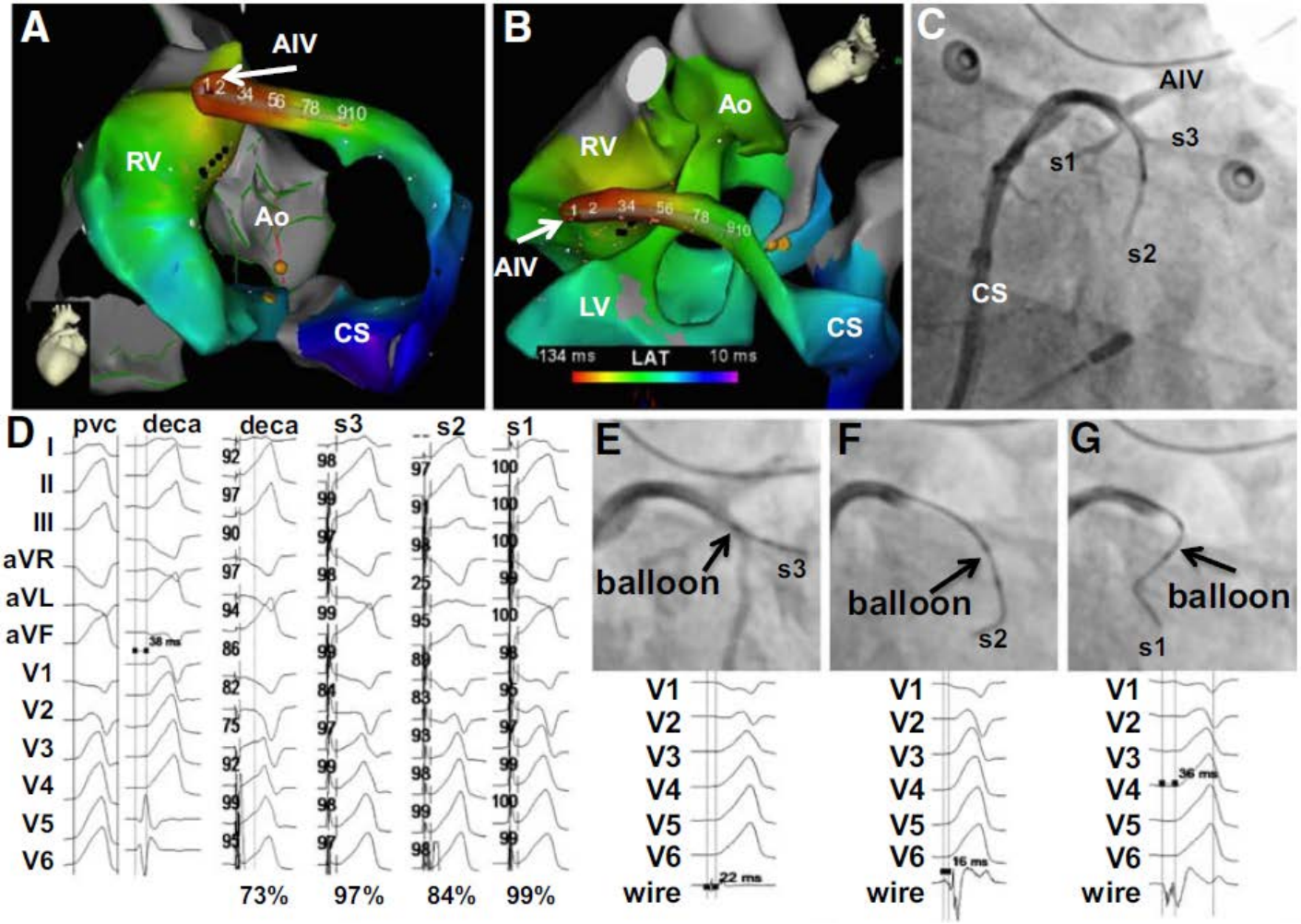


Needle ablation



Circulation. 2013;128:2289–2295
J Cardiovasc Electrophysiol. 2014;25:1093-9

Venous ethanol ablation for LVS VT

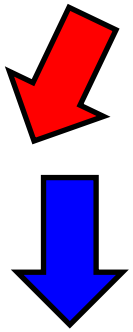


16.0%

Kreideieh B, Valderrábano M et al. Circ AE 2016;9:e004352

Take home message

- Anatomy of LV summit
- ECG characteristics: III/II ratio, aVL/aVR ratio
- Systematic approach in EP lab
  - Coronary sinus and GCV/AIV
  - Coronary cusps
  - LV endocardium below the LCC
  - RVOT
  - Percutaneous epicardial approach
- Ablation: conventional, bipolar, needle, and EtOH
- Surgical approach: cryo, RFCA



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Soon Chun Hyang University Hospital Seoul
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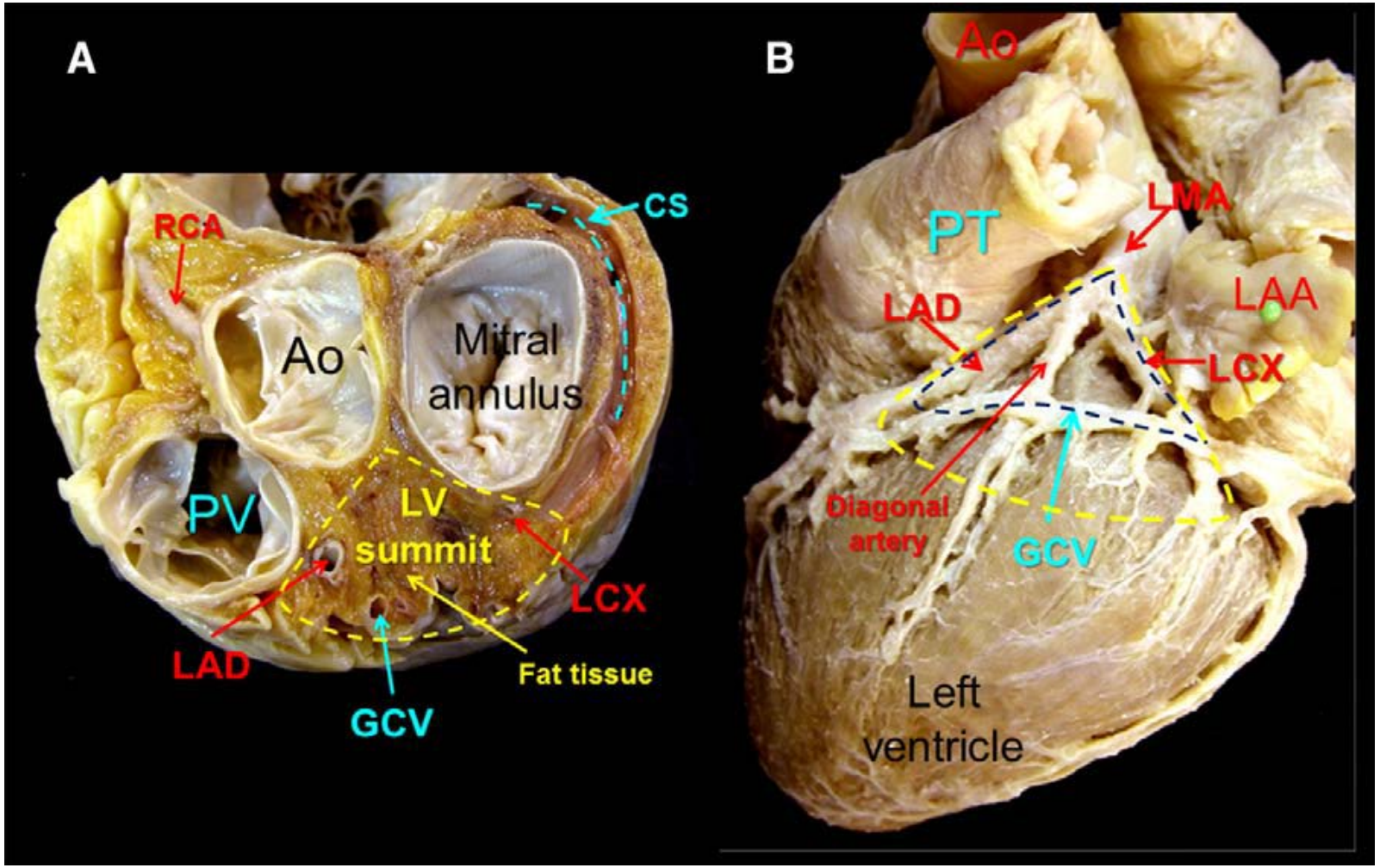
Thank you for your attention

Anatomy of LV summit



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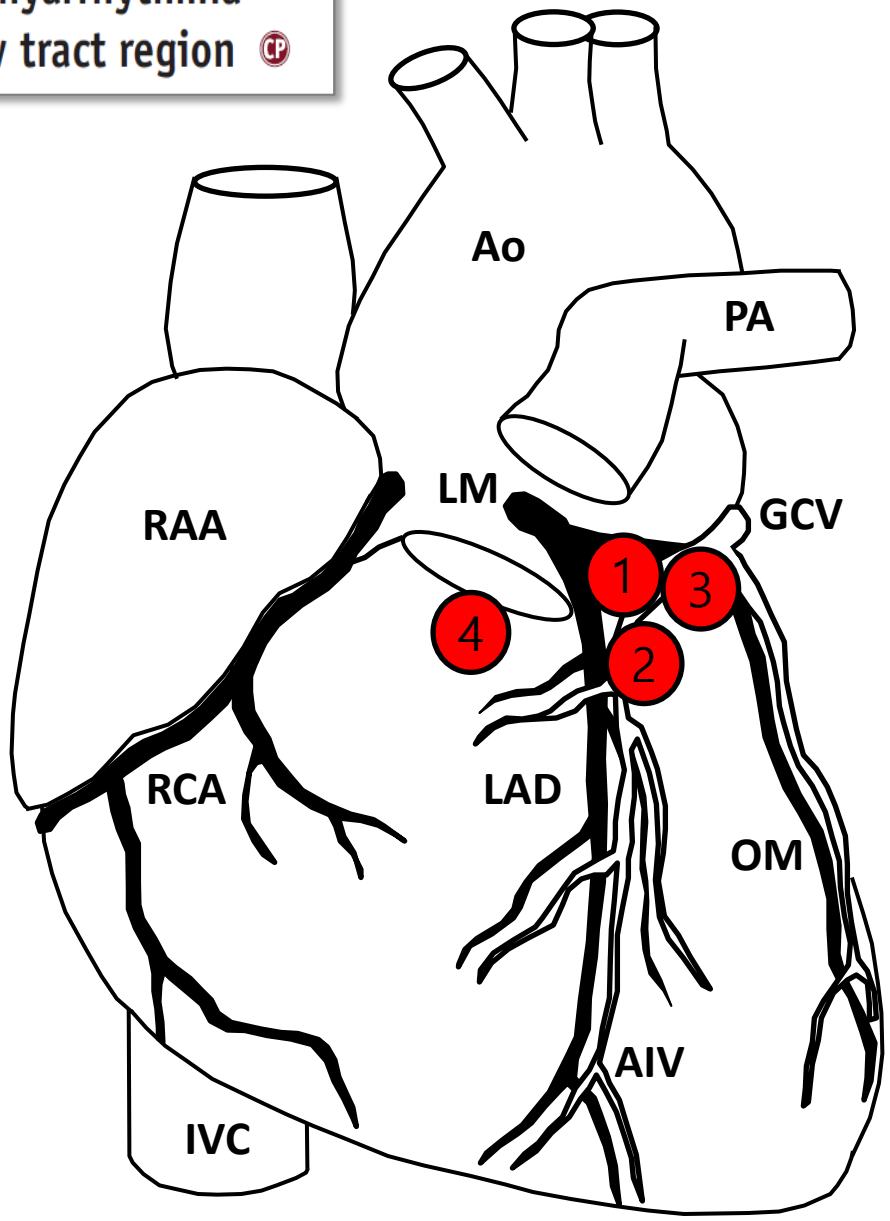
Surgical cryoablation for ventricular tachyarrhythmia arising from the left ventricular outflow tract region



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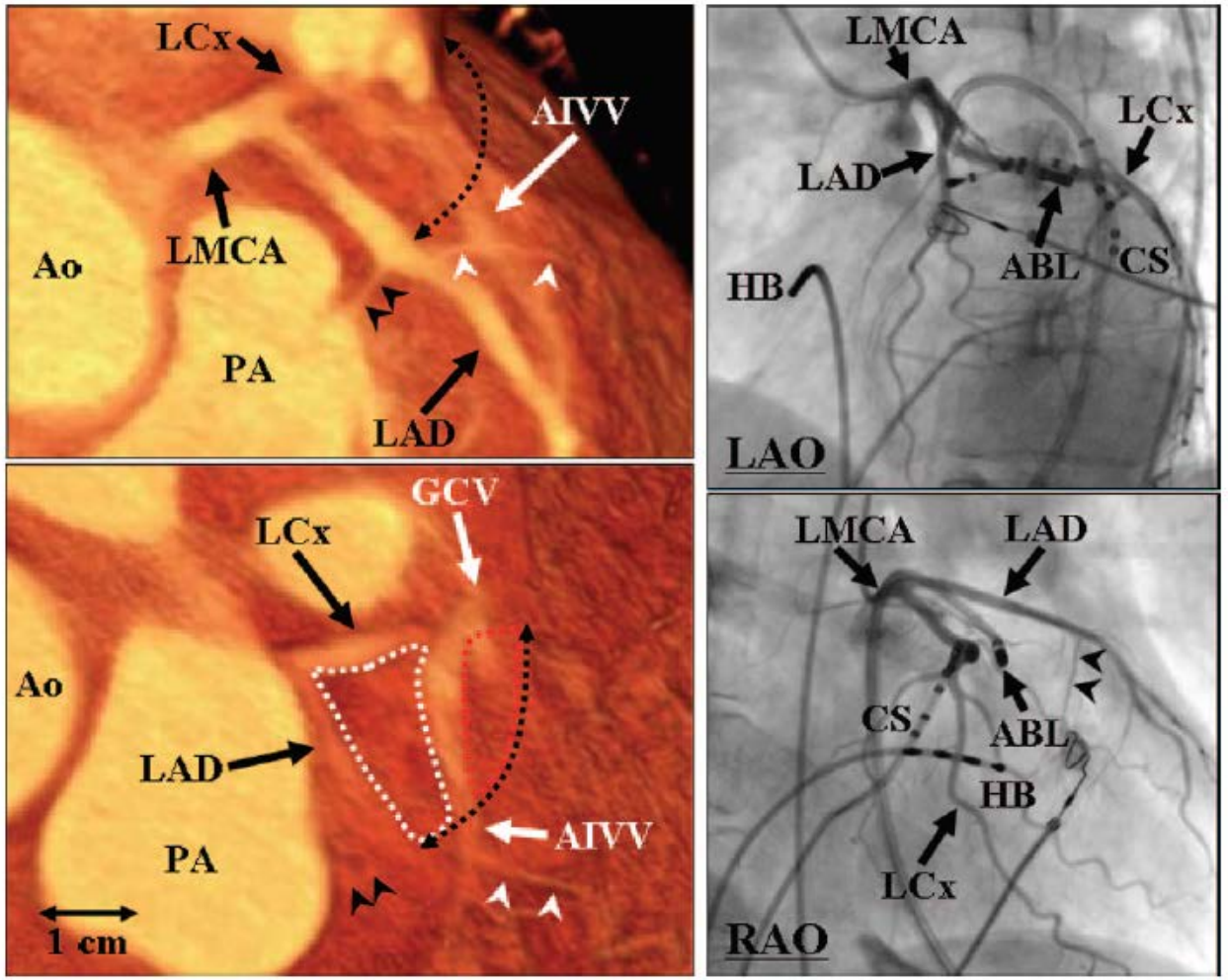
CT and fluoroscopic images of LV summit



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