Ventricular Tachycardia: Catheter Ablation
Four Questions: *Who? When? How? Results?*

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Mount Sinai *Heart*

Disclosures

- Grant support and/or Consultant:
  - Abbott & Biosense-Webster

- I will be discussing off-label use of catheter ablation devices.

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Outline

- Scar-Related VT Ablation
- Outflow-Tract VT/PVCs
- Ventricular Fibrillation

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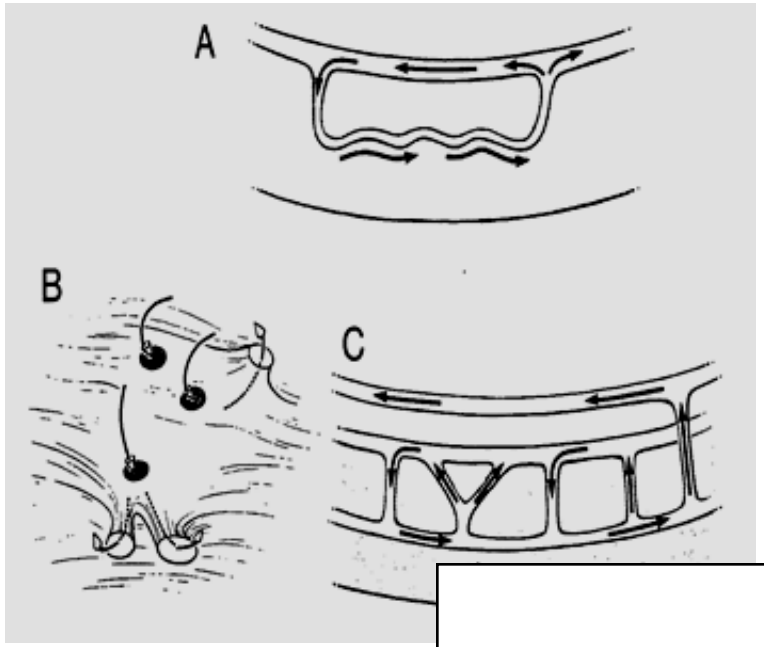
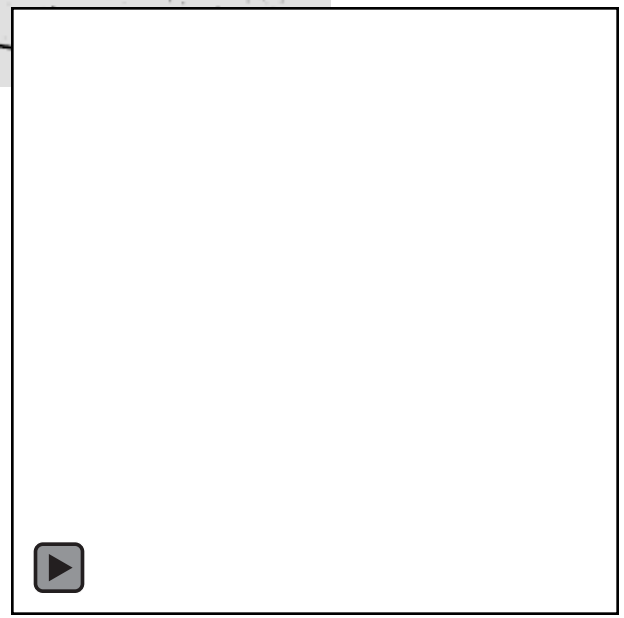
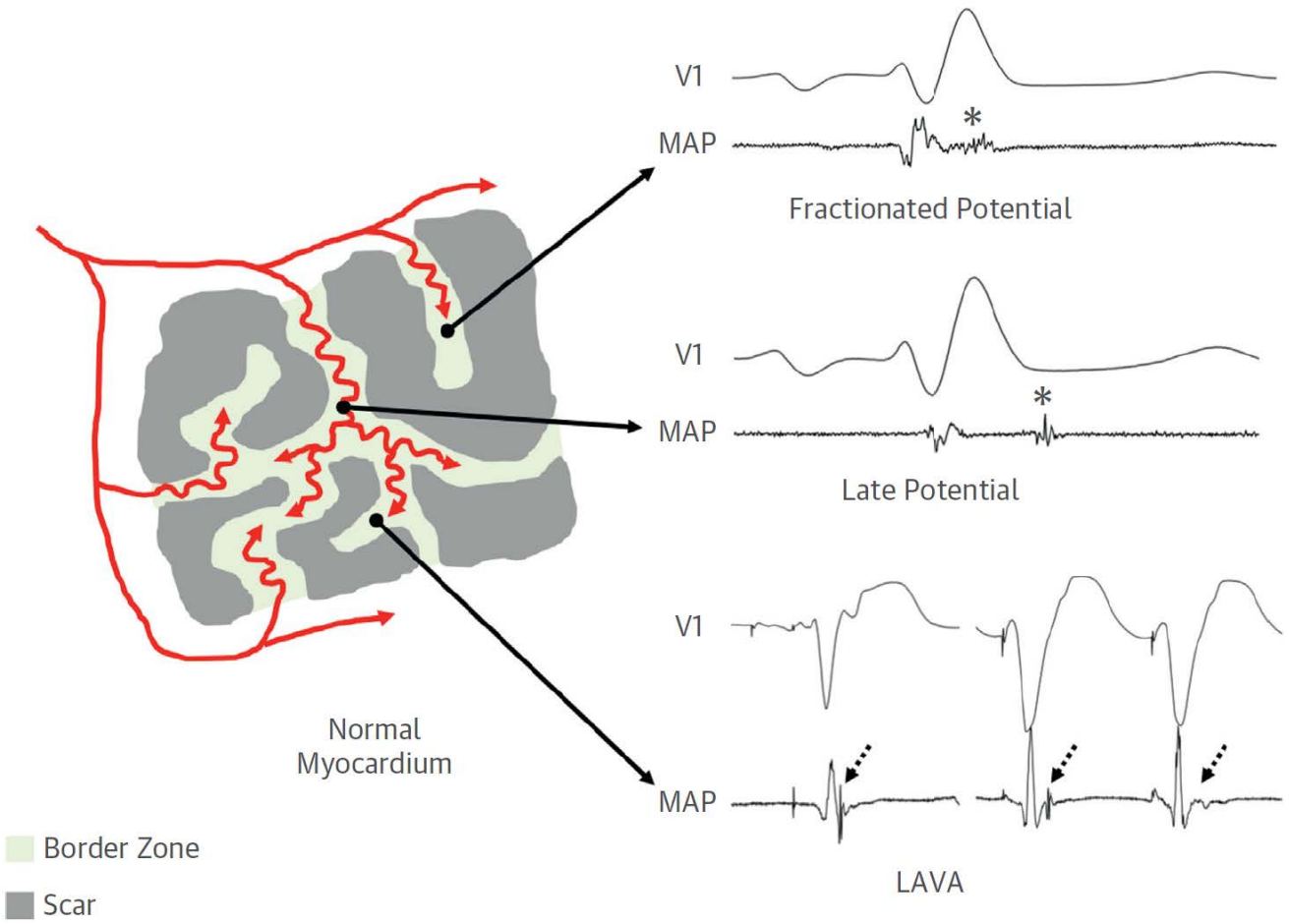
Pathogenesis of Scar-Related VT

Myocardial Fibrils Traversing Through Fibrotic Tissue







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E.Downar et al, *J Am Coll Cardiol* (1988()
S.Dukkipati / V.Reddy, *J Am Coll Cardiol* 70:2924–41 (2017)

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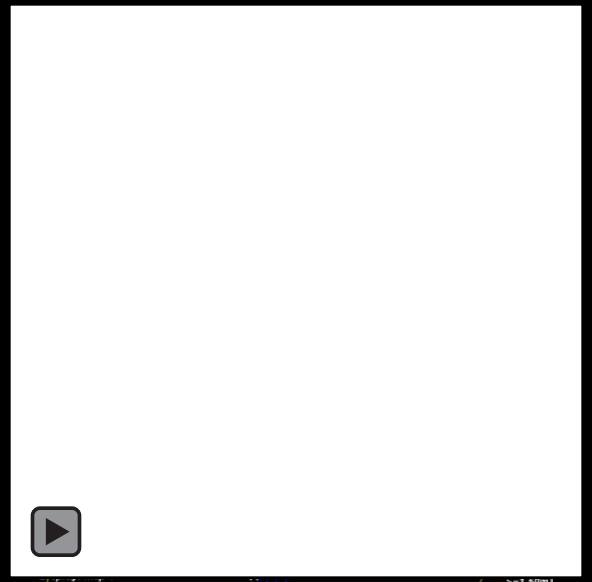
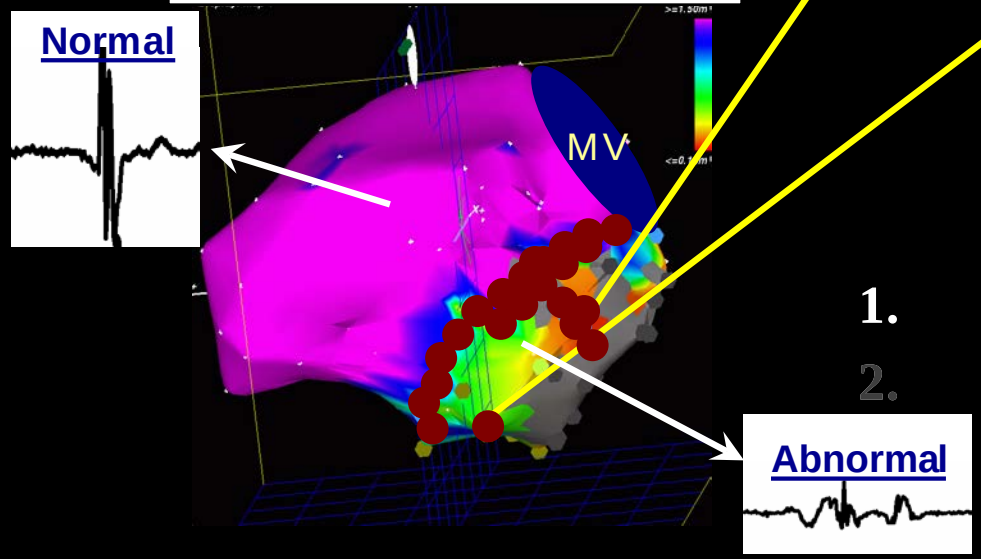
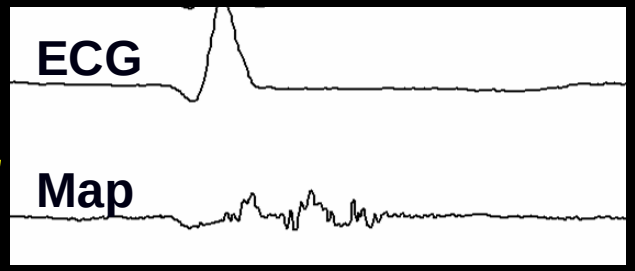
Substrate Mapping & Ablation







1. Target Channels for Ablation
2. Target VT Exit Sites

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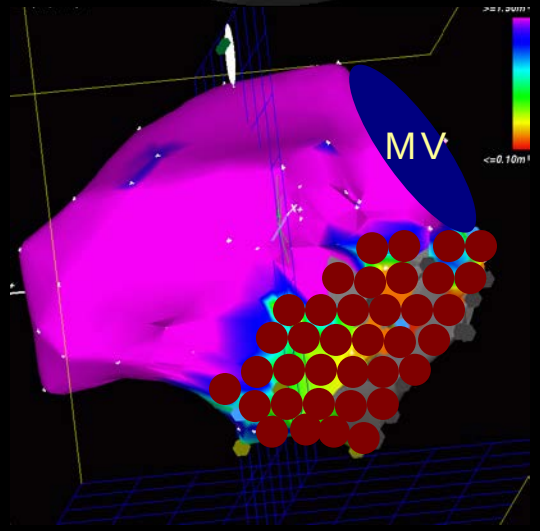
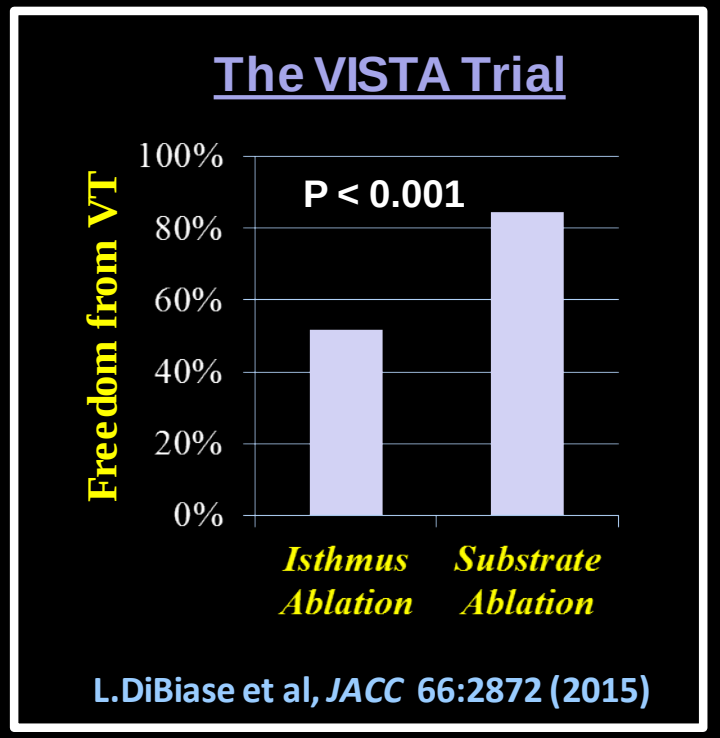
Substrate Mapping & Ablation





3. **Homogenize Scar**

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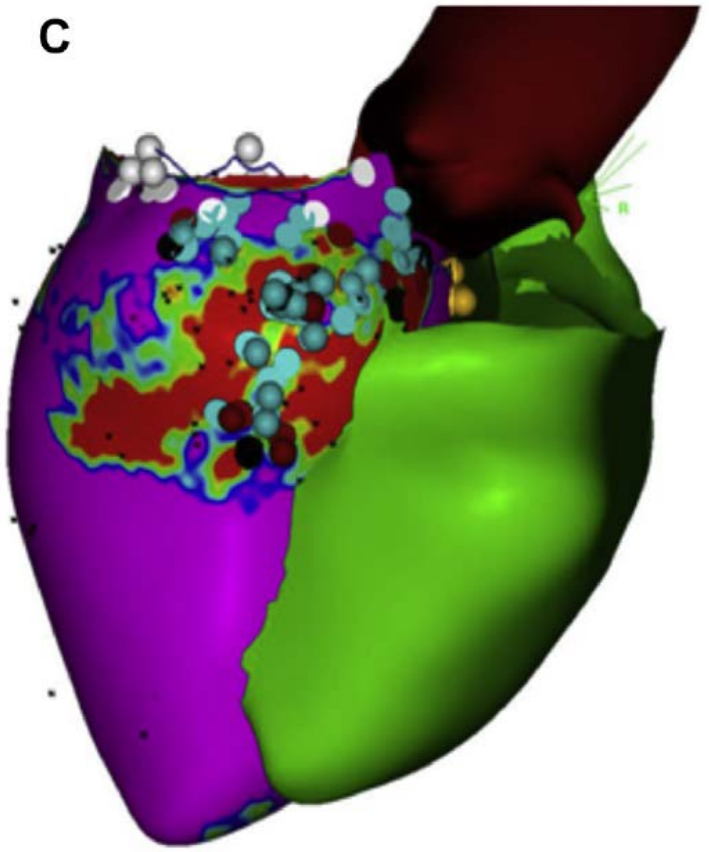
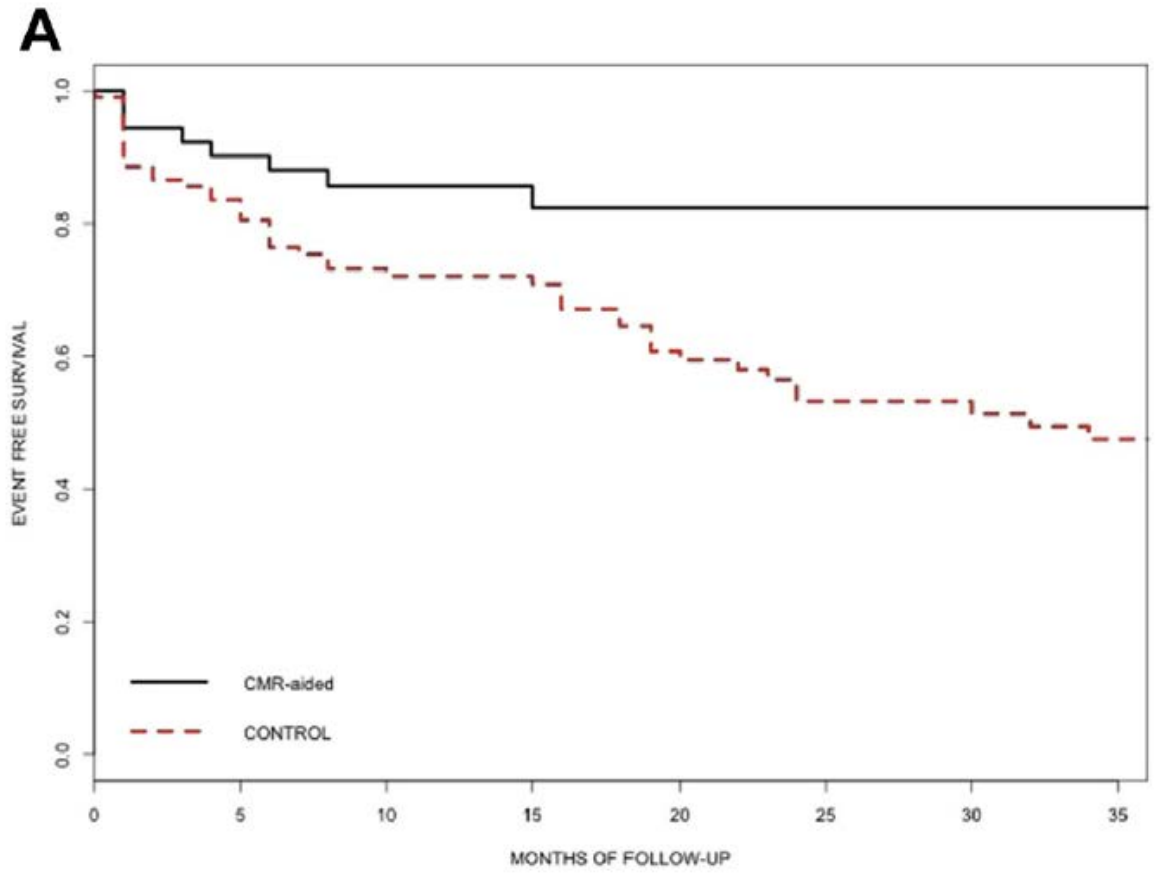
Image-Guided VT Ablation?

MRI-Guided Single-Center Experience





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D.Andreu et al, *Heart Rhythm* 14:1121-1128 (2017)

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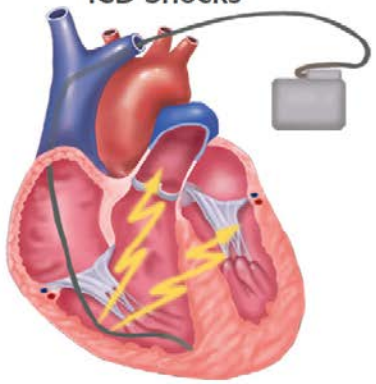
Multicenter Thermocool VT Ablation IDE Trial

Long-Term Outcomes

Coronary Artery Disease

+ Recurrent VT

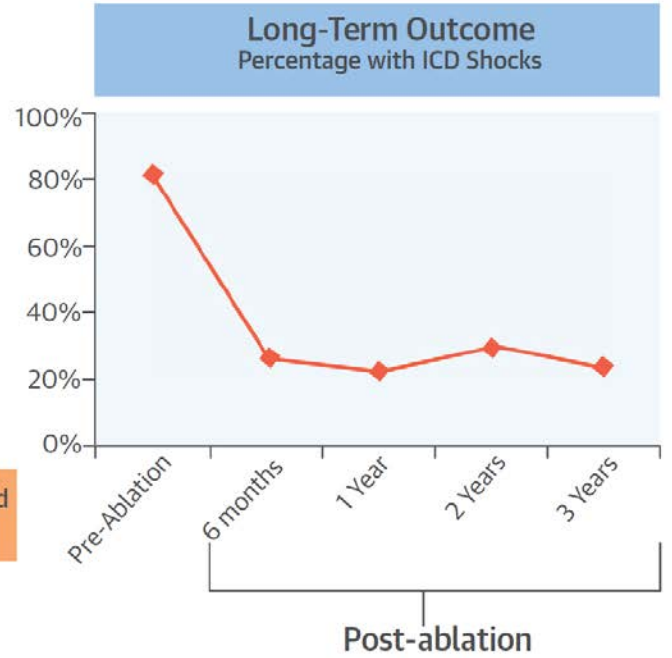
ICD Shocks



Open-Irrigated VT Catheter Ablation

(249 Patients)

No Procedure-Related Strokes



↓Anxiety Score (6 Months)
↓Amiodarone Requirement (6 Months-3 Years)
↓Hospitalizations (6 Months-3 Years)

Marchlinski, F.E. et al. J Am Coll Cardiol. 2016; 67(6):674-83.

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F.Marchlinski, C.Haffajee, J.Bashai et al, *J Am Coll Cardiol* 67:674 (2016)

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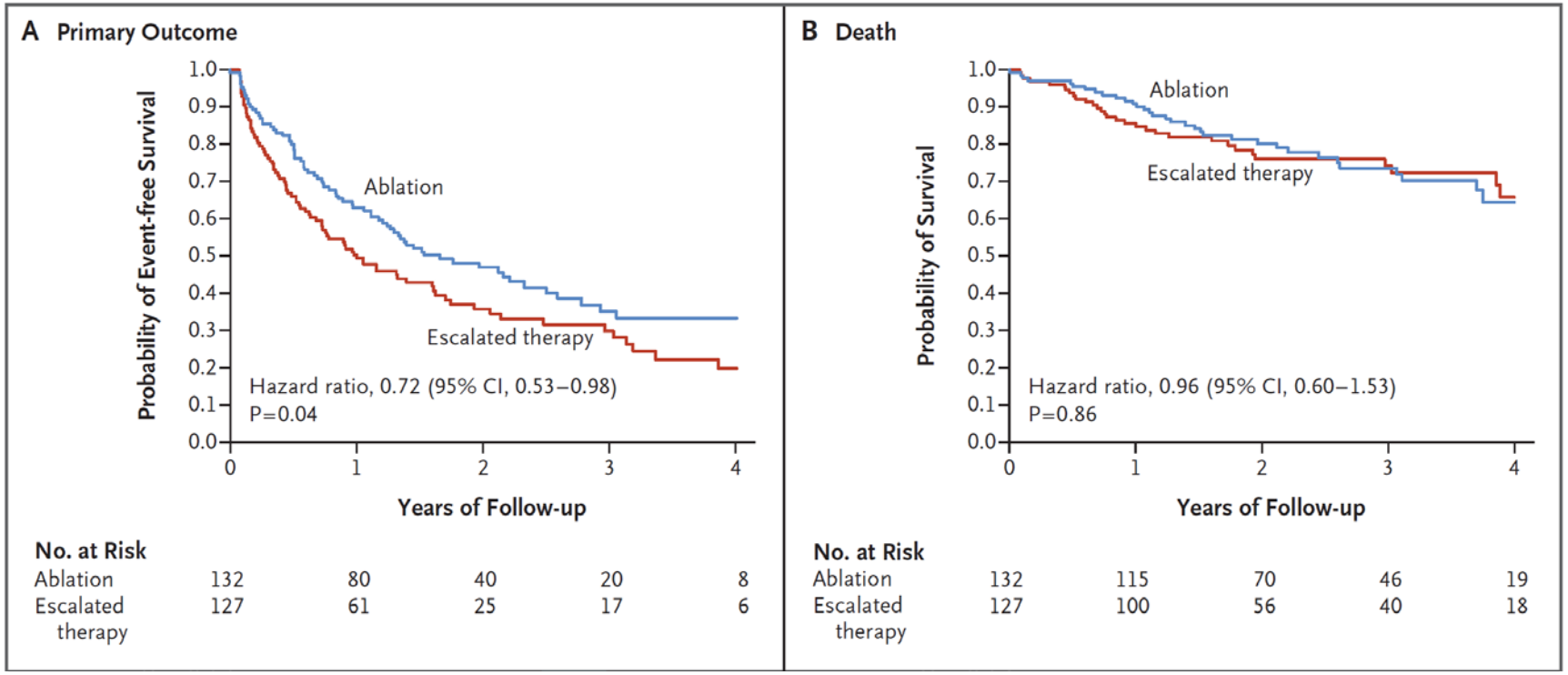
VANISH: Post-MI VT

RCT: AADs *vs* Catheter Ablation



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JL.Sapp, GA.Wells, R.Prakash at al, *NEJM* 375:111 (2016)

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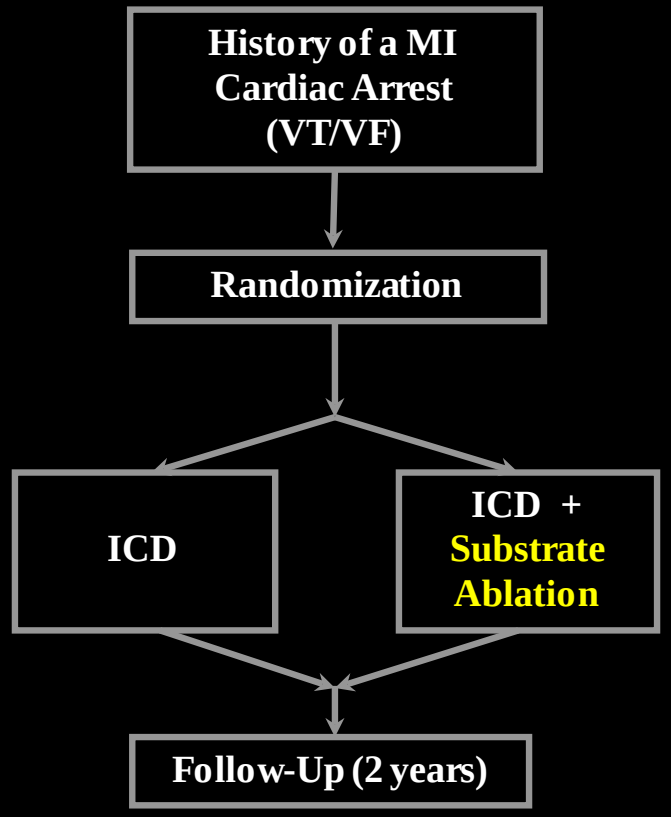
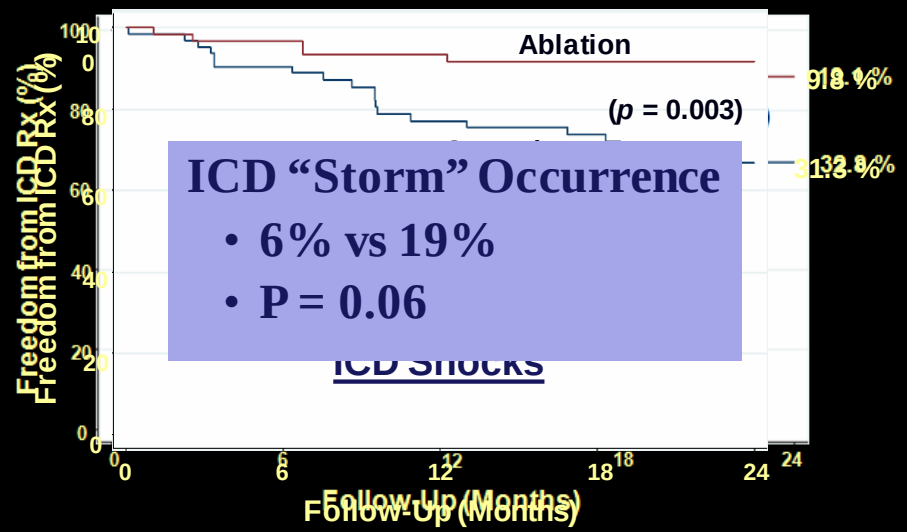
Primary Prevention of ICD Shocks

SMASH-VT

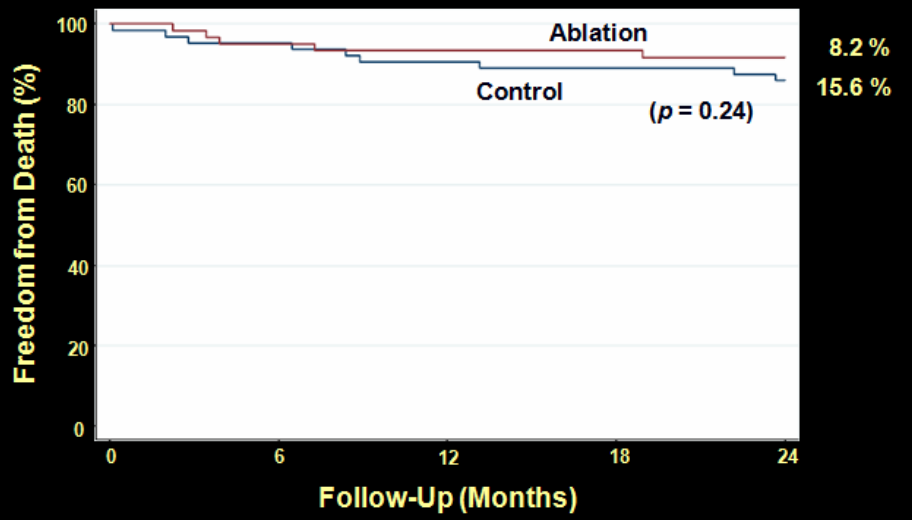
Preventative substrate ablation in preventing ICD shocks in post-MI pts who have sustained a VT/VF event (ie, 2° prevention ICD pts)





ICD "Storm" Occurrence

- 6% vs 19%
- P = 0.06

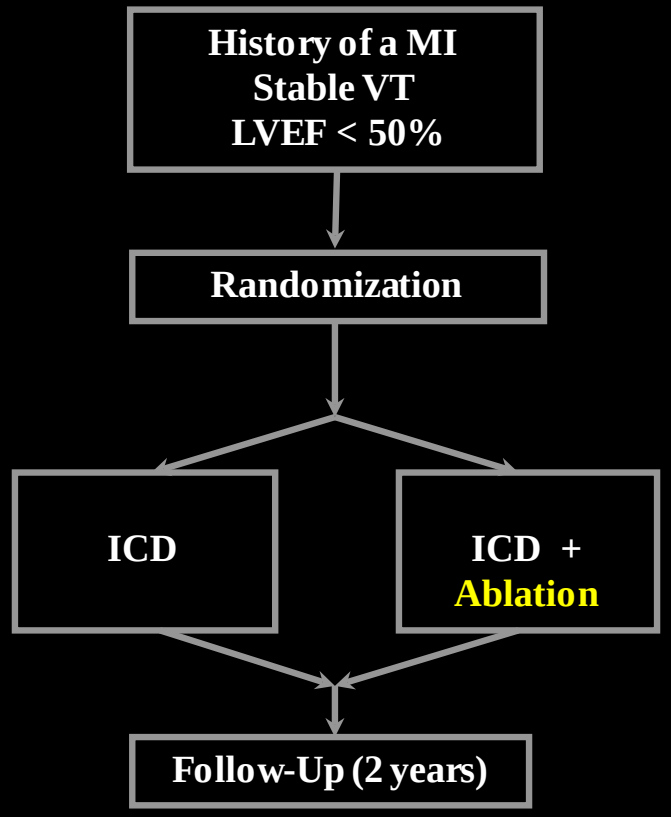


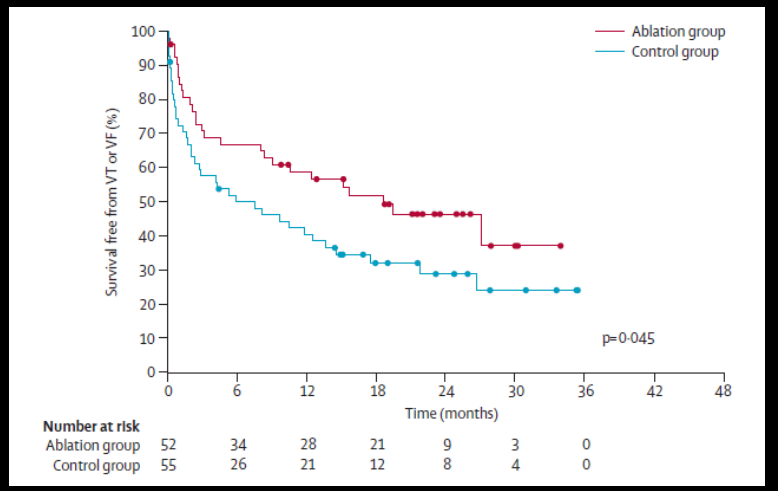
Reddy et al, *NEJM*, 357:2657 (2007)

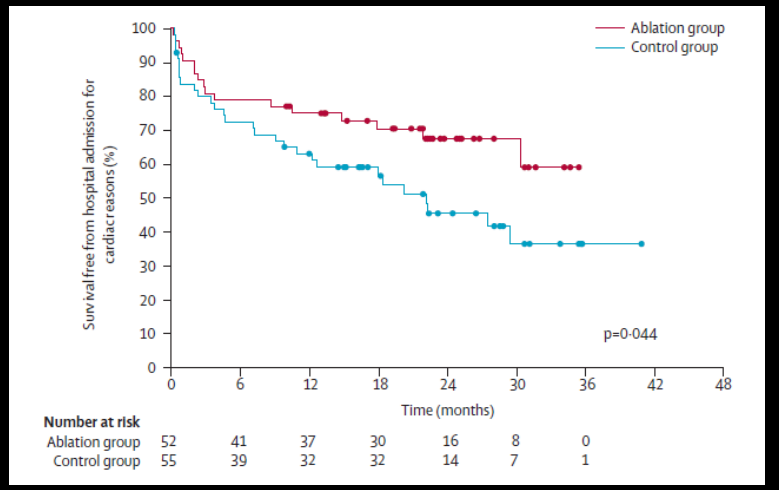
Primary Prevention of ICD Shocks

VTACH Study

Can catheter ablation reduce VT/VF in post-MI patients undergoing ICD implantation for stable VT?



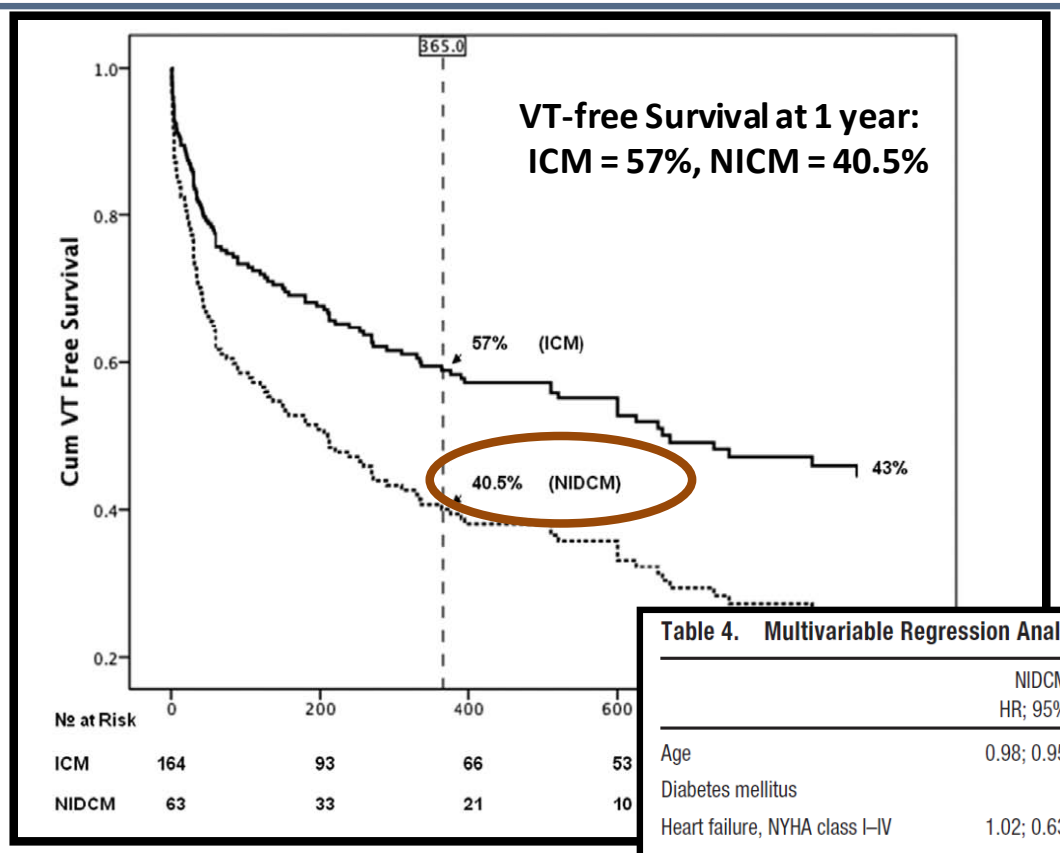




KH Kuck, et al, *Lancet*, 375:31-40 (2010)

Catheter Ablation in DCM-VT

Moderate Success (Compared to Post-MI VT)



For DCM-VT, the only predictors of VT recurrence were "Partial Success" or Failure.

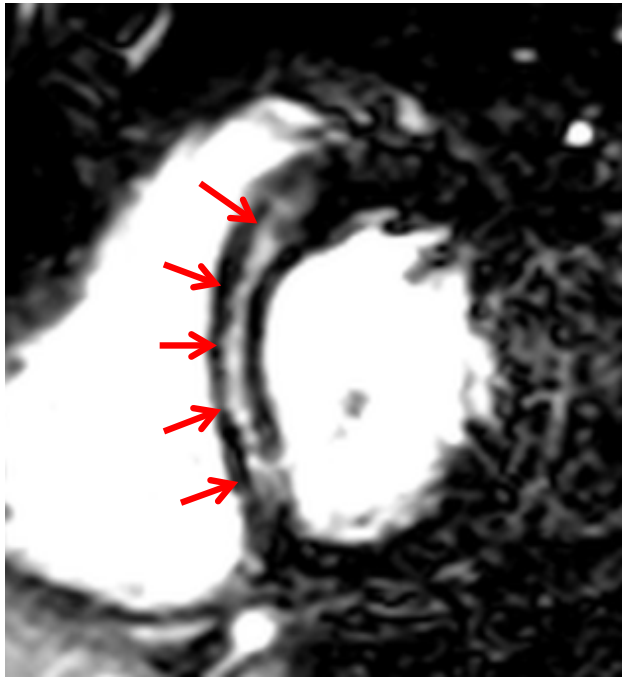


Table 4. Multivariable Regression Analysis for the VT Recurrence in NIDCM and ICM

	NIDCM, HR; 95% CI	*P* Value	ICM, HR; 95% CI	*P* Value
Age	0.98; 0.95–1.015	0.278	0.97; 0.95–0.99	0.038
Diabetes mellitus			1.3; 0.77–2.24	0.313
Heart failure, NYHA class I–IV	1.02; 0.63–1.66	0.929	1.36; 1.02–1.81	0.034
EF, %	1.003; 0.97–1.03	0.853	0.98; 0.96–1.007	0.172
Failure vs complete success	4.12; 1.56–10.89	0.004	4.48; 1.2–16.65	0.025
Partial vs complete success	3.28; 1.25–8.65	0.016	1.9; 1.004–3.58	0.048
No. of VTs	1.13; 0.83–1.53	0.443	1.2; 0.98–1.47	0.076
Epicardial ablation	1.86; 0.76–4.53	0.172		
β-Blocker	2.04; 0.63–6.62	0.236	1.02; 0.24–4.3	0.975
AAM	0.48; 0.22–1.07	0.072	1.71; 0.94–3.1	0.079

Dinov B et al. *Circulation* 129:728-36 (2014)

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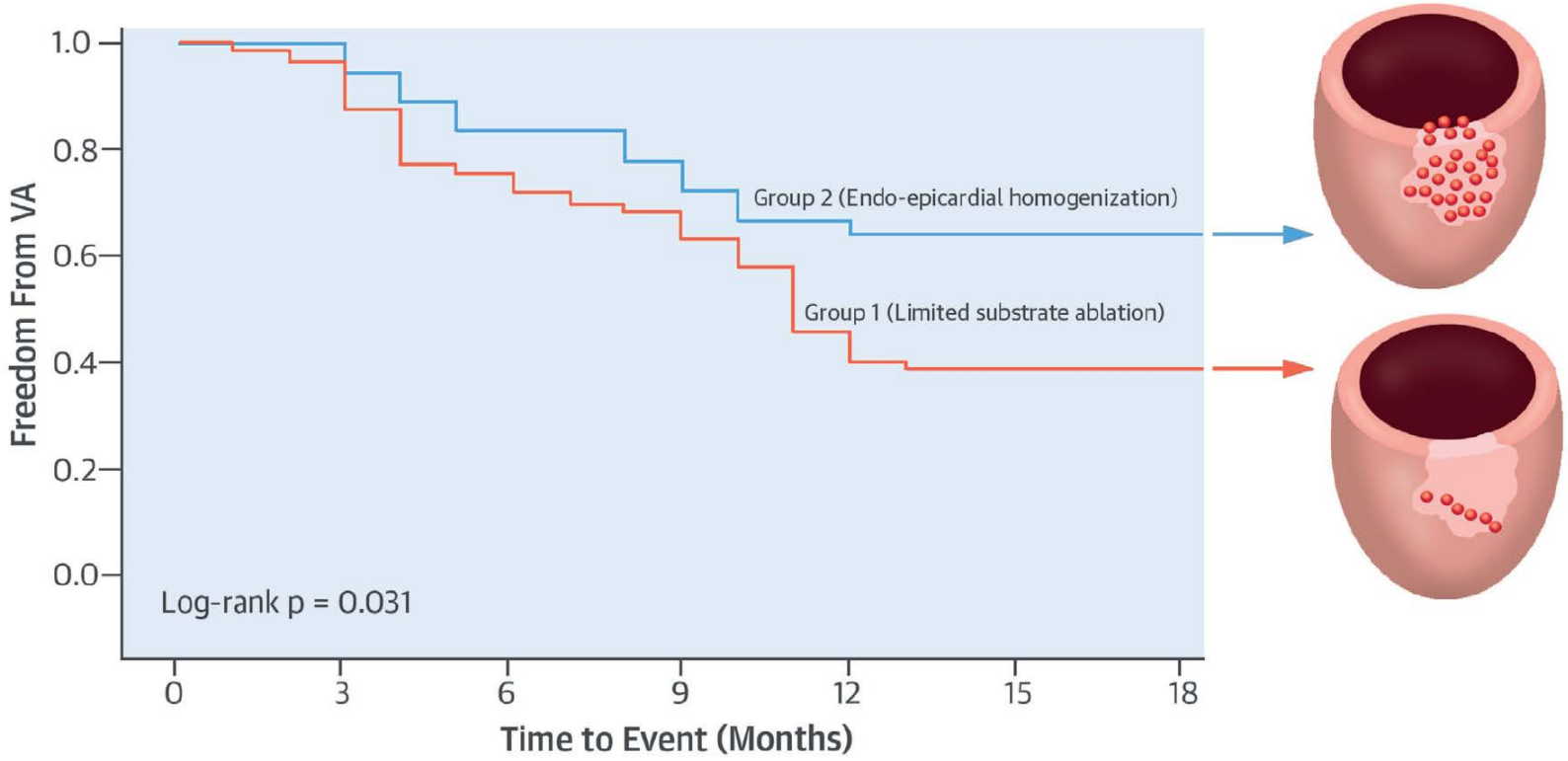
Catheter Ablation in DCM-VT

Improved Success with Scar Homogenization (?)



Number at Risk							
Group 2	38	36	30	28	24	23	23
Group 1	57	55	43	39	26	22	22

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Gökoglan Y et al. *J Am Coll Cardiol* 68:1990-8 (2016)

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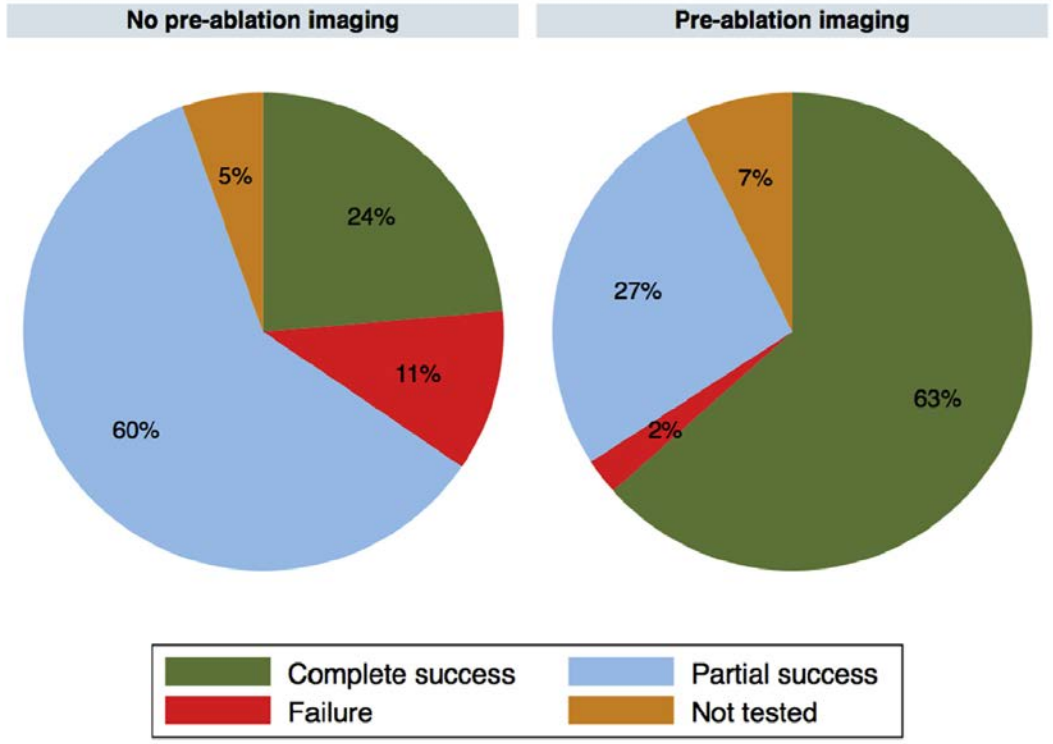
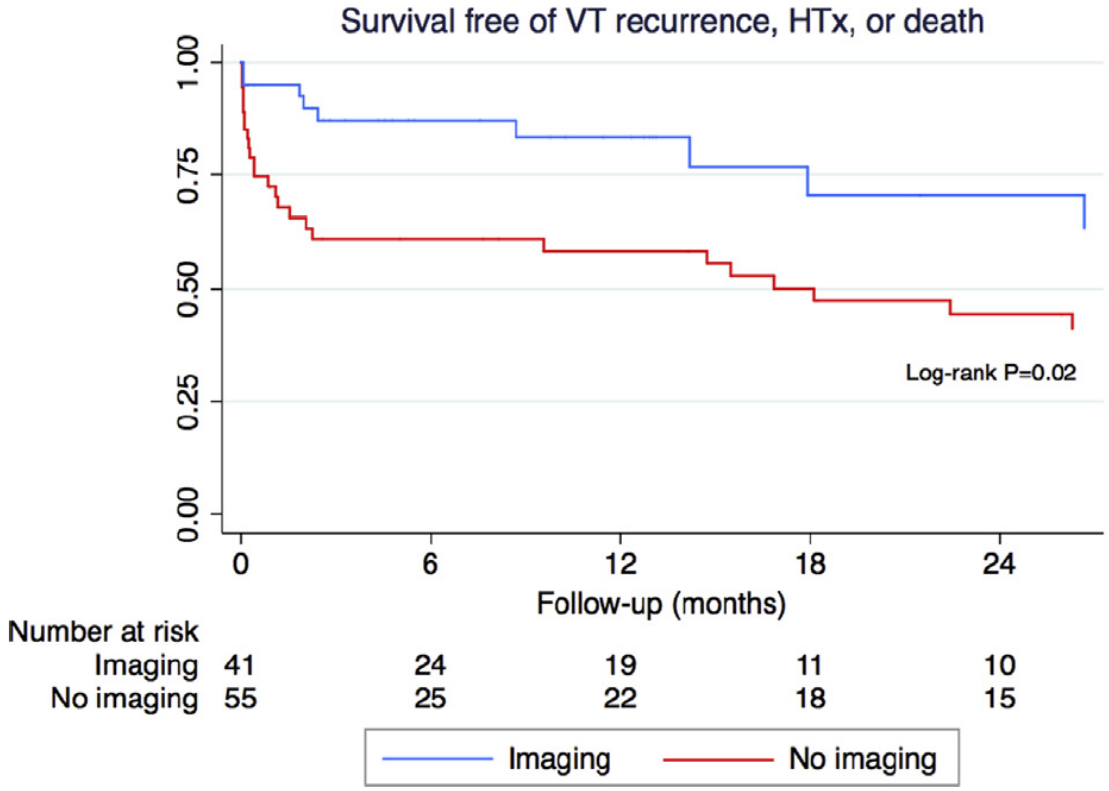
Image-Guided DCM-VT Ablation

MRI-Guided Single-Center Experience





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KC.Siontis et al, *Heart Rhythm* 14:1487-1492 (2017)

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The Difficult VT Ablation

Can we improve outcomes?

- Deep (Septal) Circuits
  - Hemodynamic Support
  - EtOH Ablation
  - Bipolar RF
  - Needle Ablation
- Epicardial Ablation
- Radiotherapy??

Bogun at al, *JACC* 53:1138-45 (2009)

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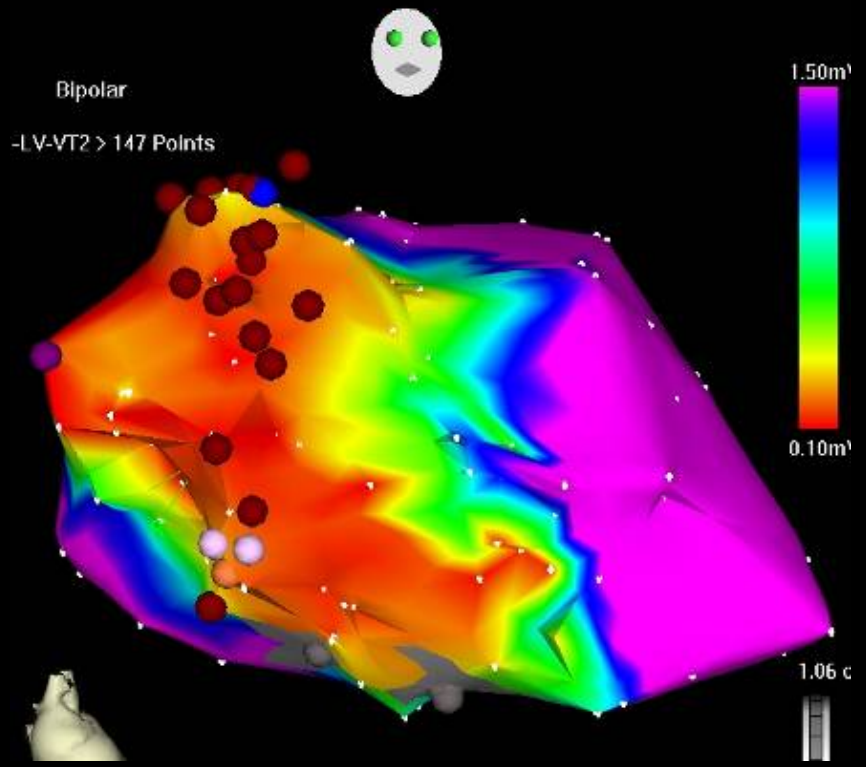
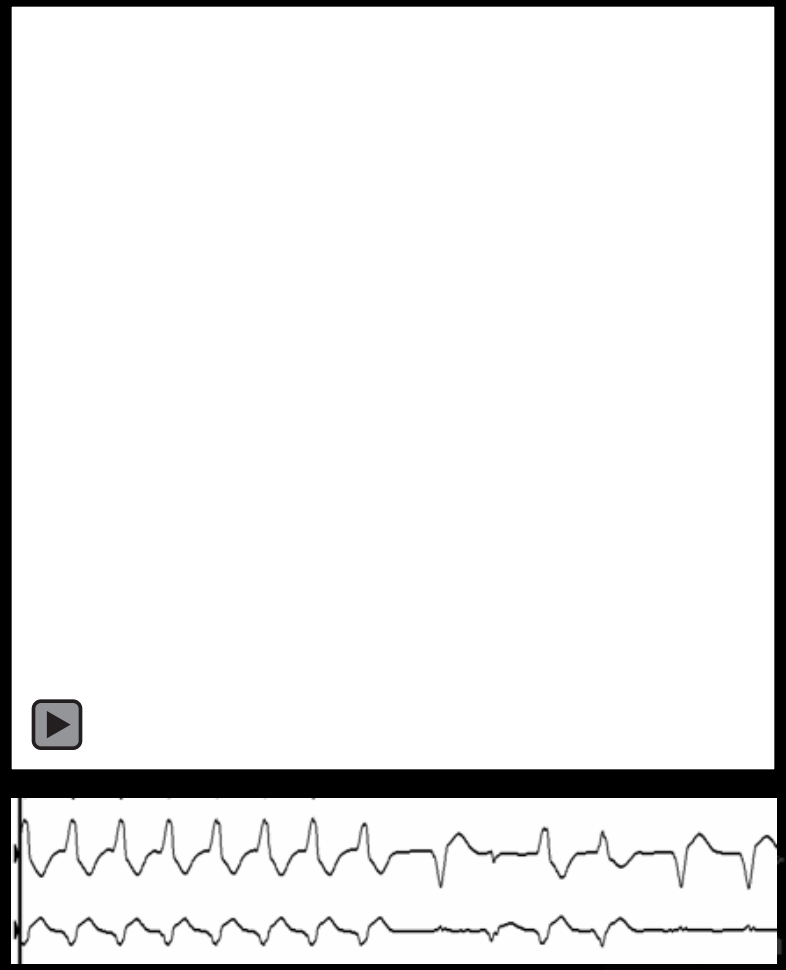
DCM-VT: Septal Scar





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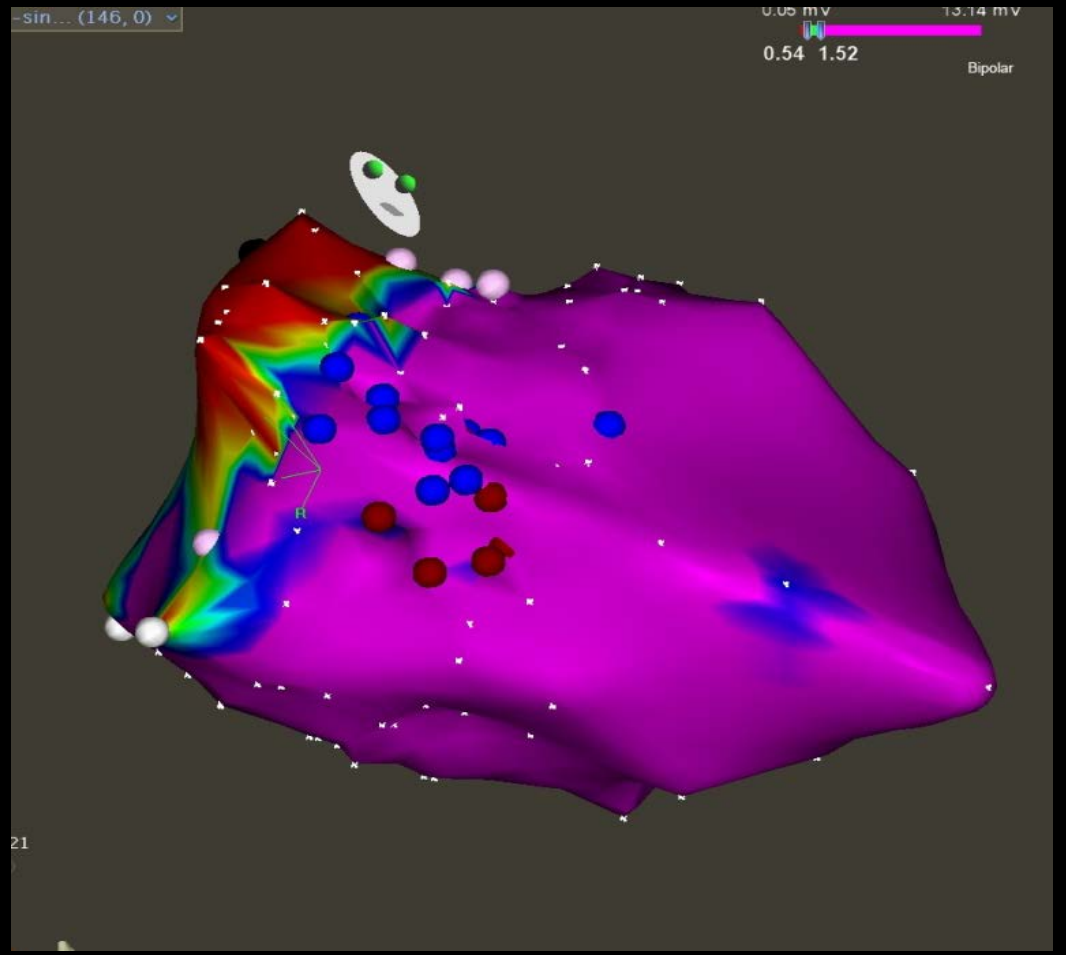
Mostly Intramural Scar:
What can you do?



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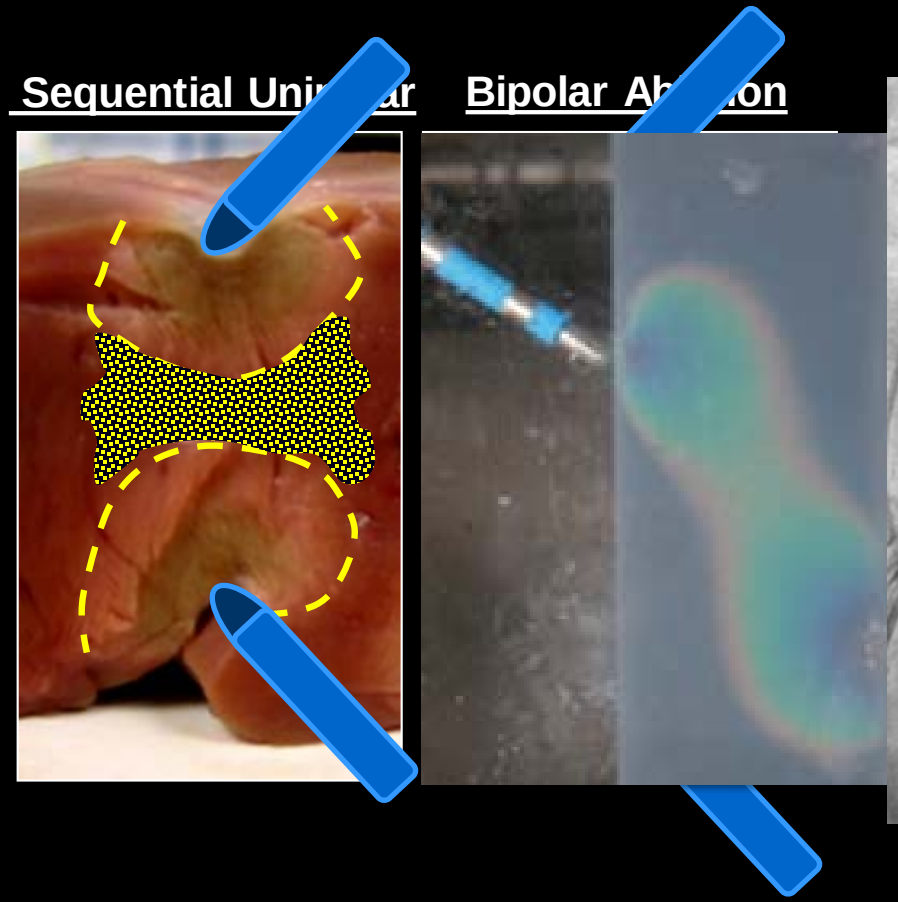
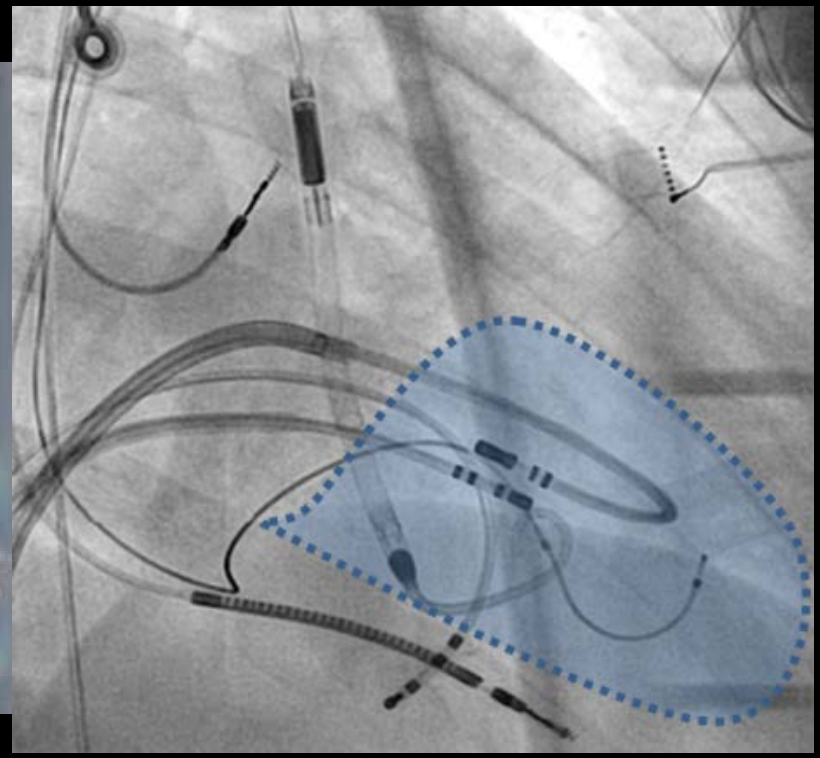


Clinical Case Example



J.Koruth / S.Dukkipati / M.Miller / P.Neuzil / V.Reddy *Heart Rhythm* 9:1932-41 (2012)
Thiagalingam et al, *JCE* 16:508 (2005)

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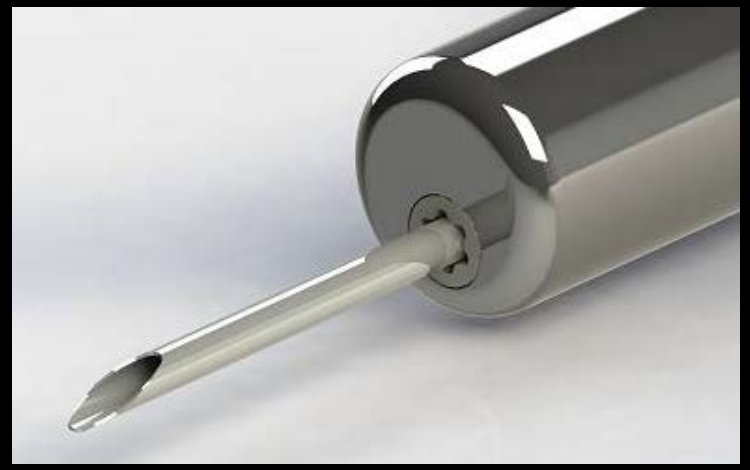

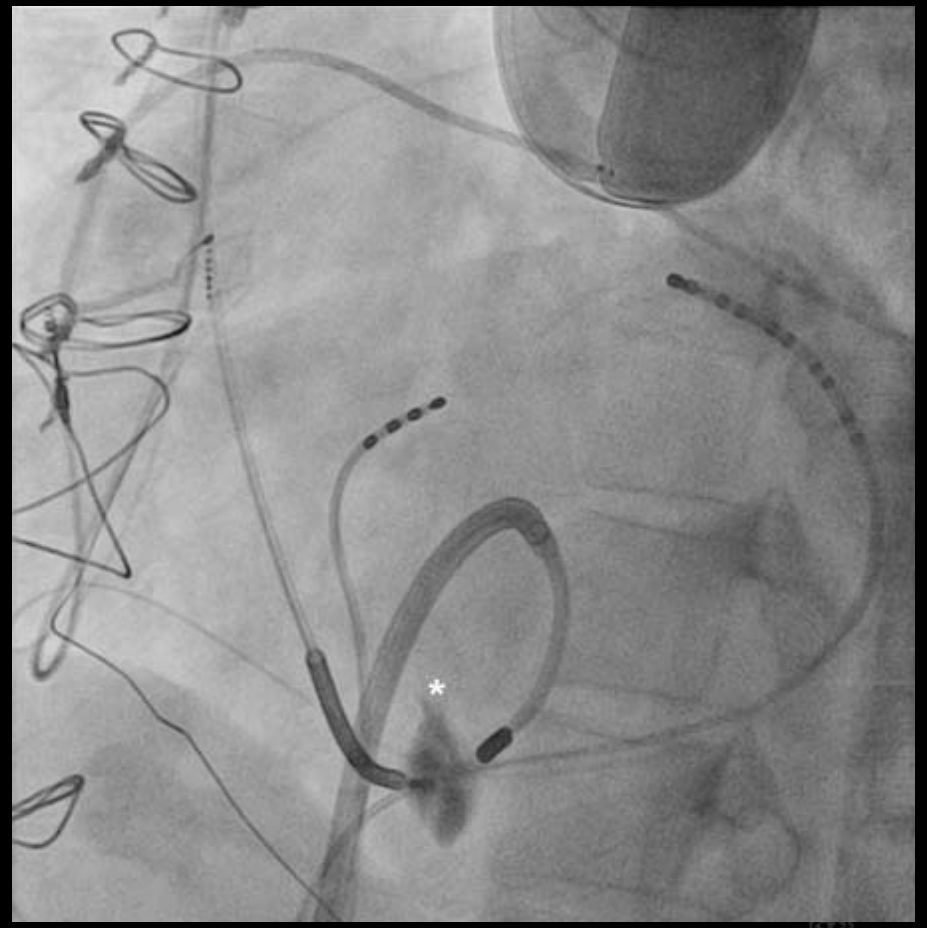

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AbdelWahab at al, *Circulation Arry* 8:1181-1188 (2015)

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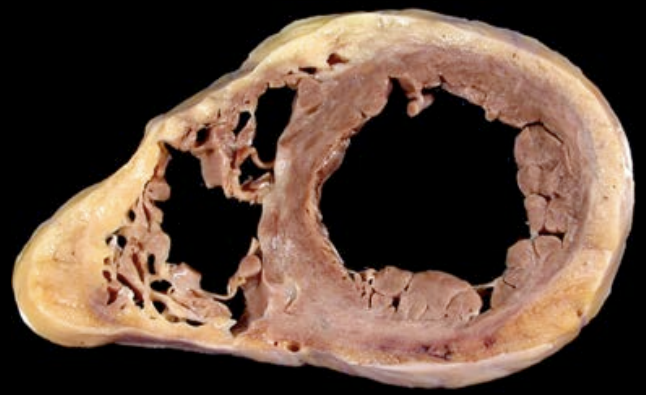
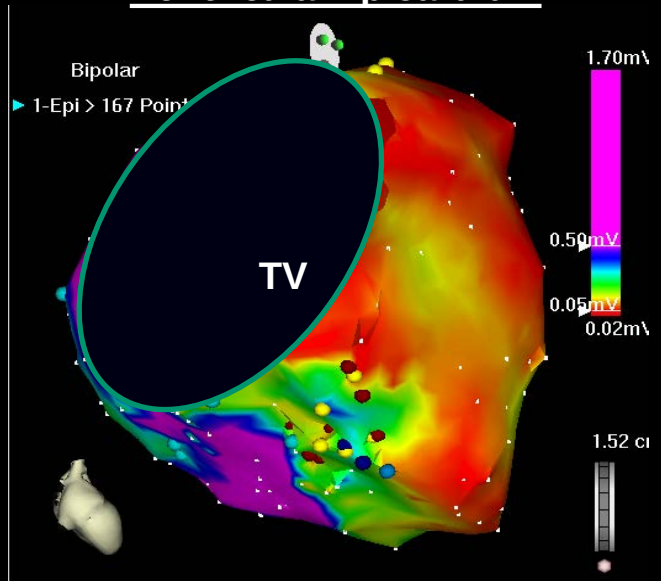
ARVC-VT

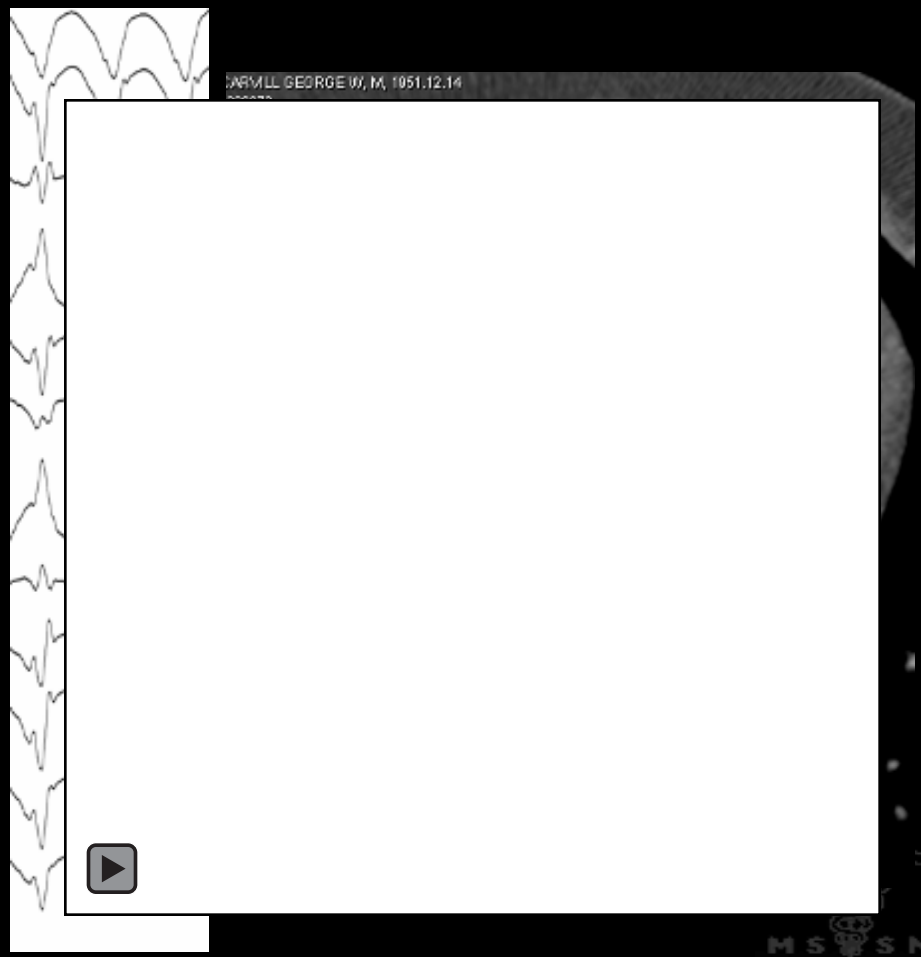


Ventricular Epicardium



AP Burke, *Medscape*, http://emedicine.medscape.com/article/1612324-overview

HCM-VT



S.Dukkipati / F.Marchlinski / V.Reddy, *Circ* Arry (2011) 4(2):185.

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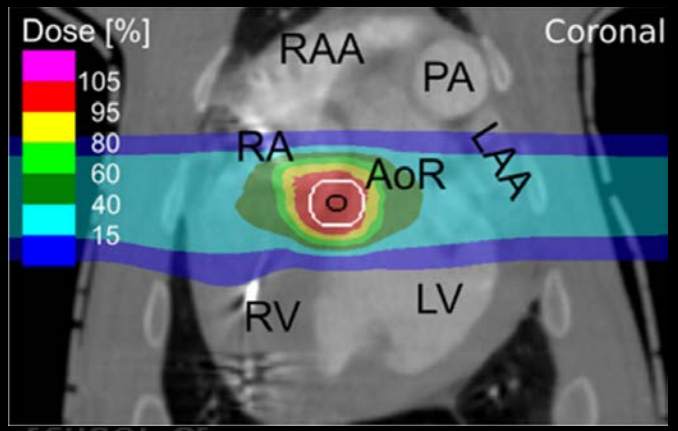
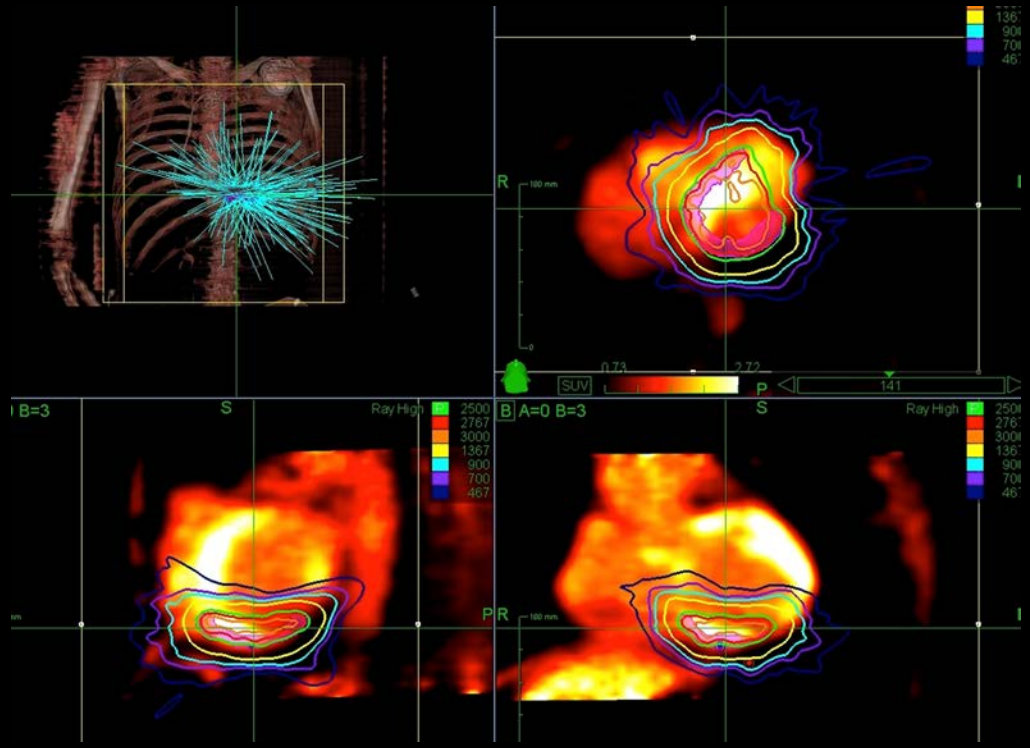
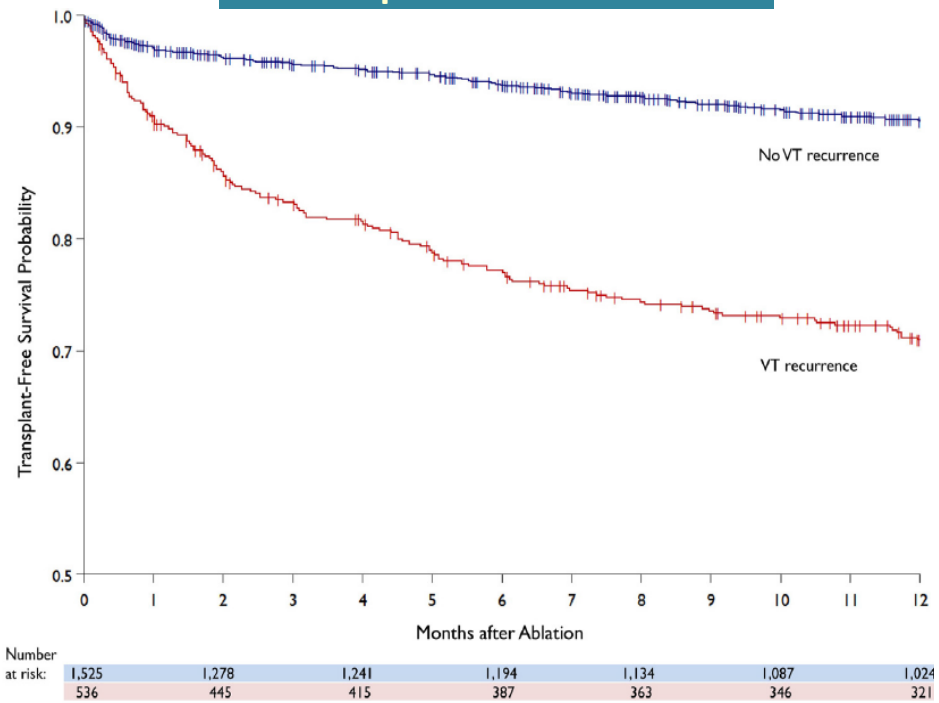




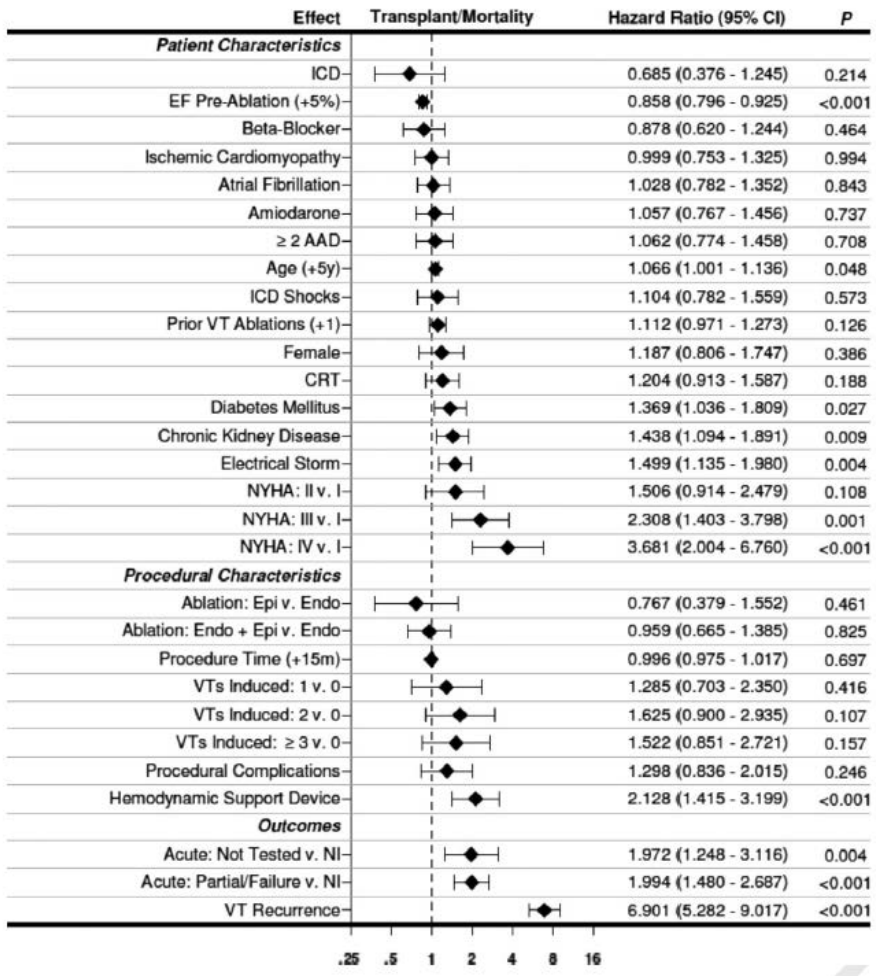
Transplant/Mortality After VT Ablation

Outcome as a Function of Ablation Success

Transplant-Free Survival



Predictors of Transplant/Mortality



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R.Tung, M.Vaseghi, DS.Frankel at al, *Heart Rhythm* 6:351 (2013)

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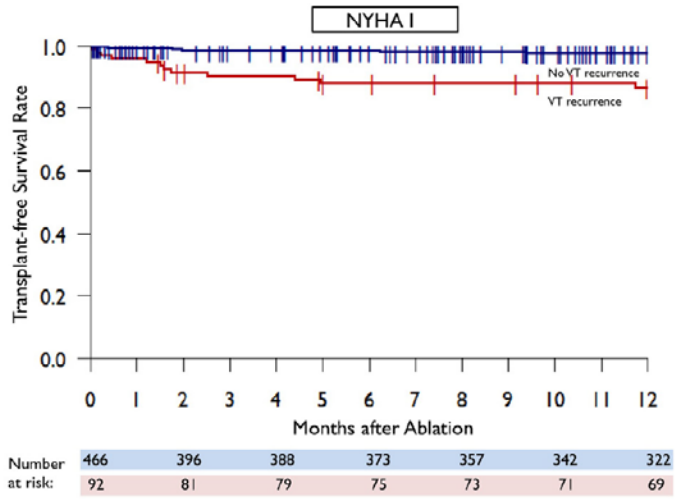
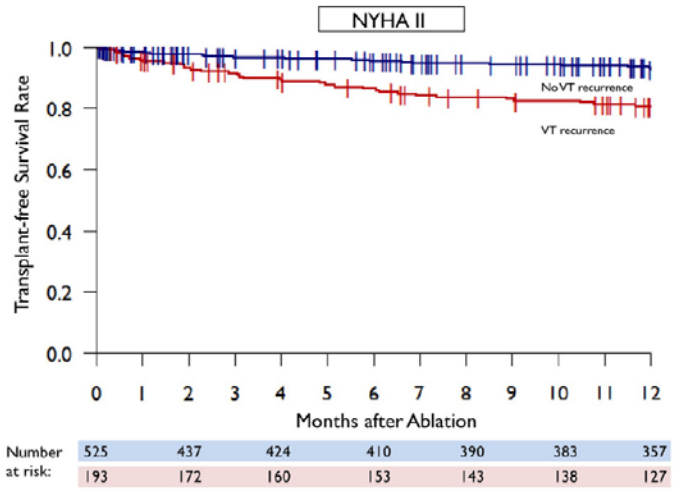
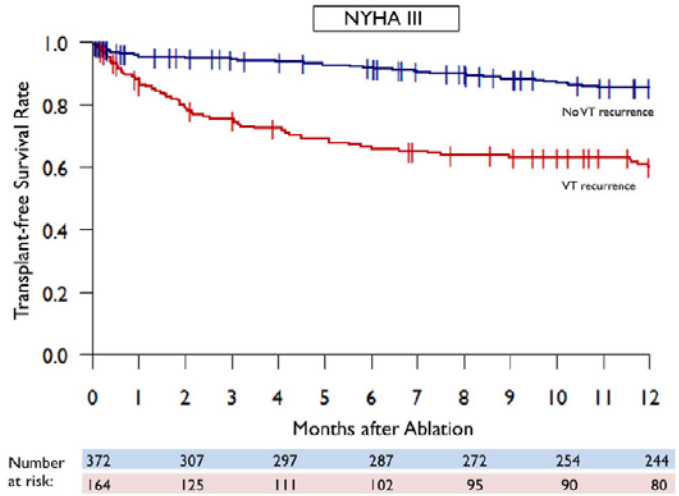
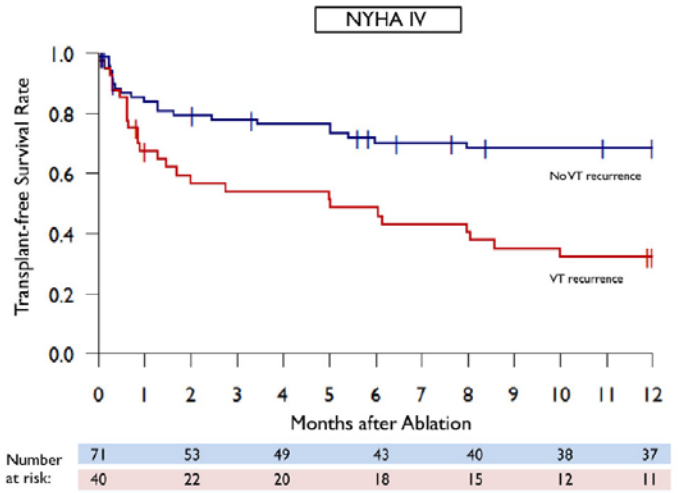
Transplant/Mortality After VT Ablation

Outcome: Relationship to Functional Class









R. Tung, M. Vaseghi, DS. Frankel at al, *Heart Rhythm* 6:351 (2013)

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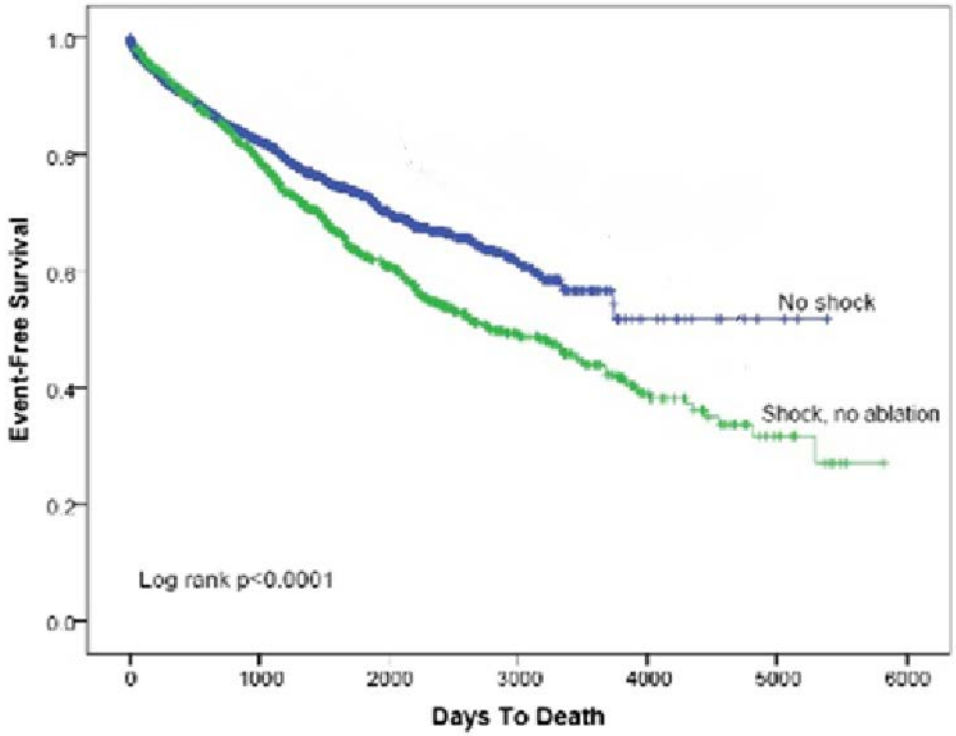
Mortality After VT Ablation

Effect of Acute Inducibility: Mortality

- 102 consecutive pts undergoing scar-VT ablation
- 817 patients with ICDs and a history of appropriate shocks
- 2,088 patients with ICDs and no history of appropriate shocks



Bunch et al, *Heart Rhythm* 11:523 (2014)

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Outline

- Scar-Related VT Ablation
- Outflow-Tract VT/PVCs
- Ventricular Fibrillation

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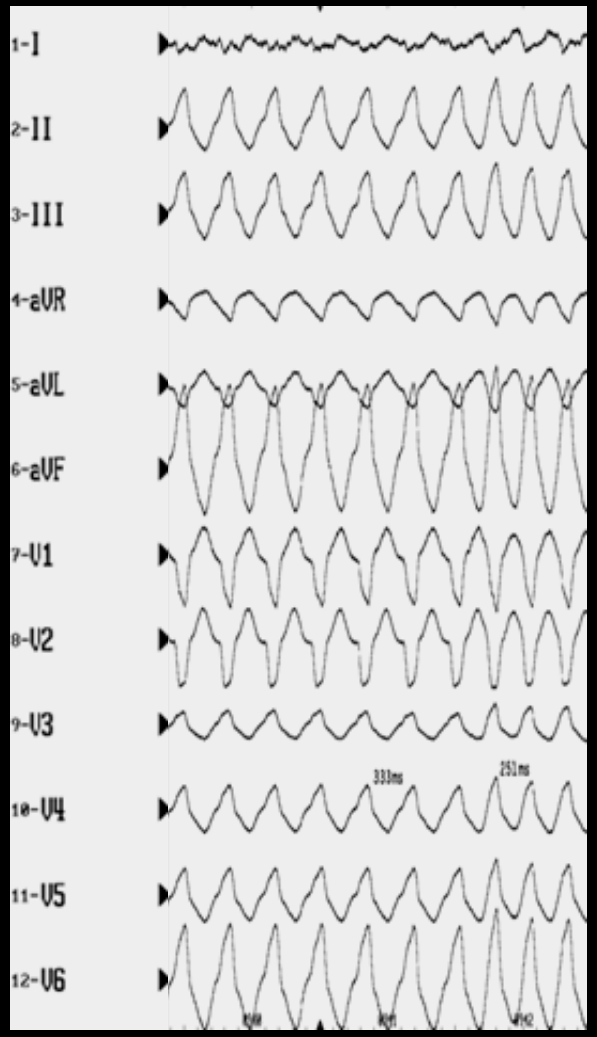
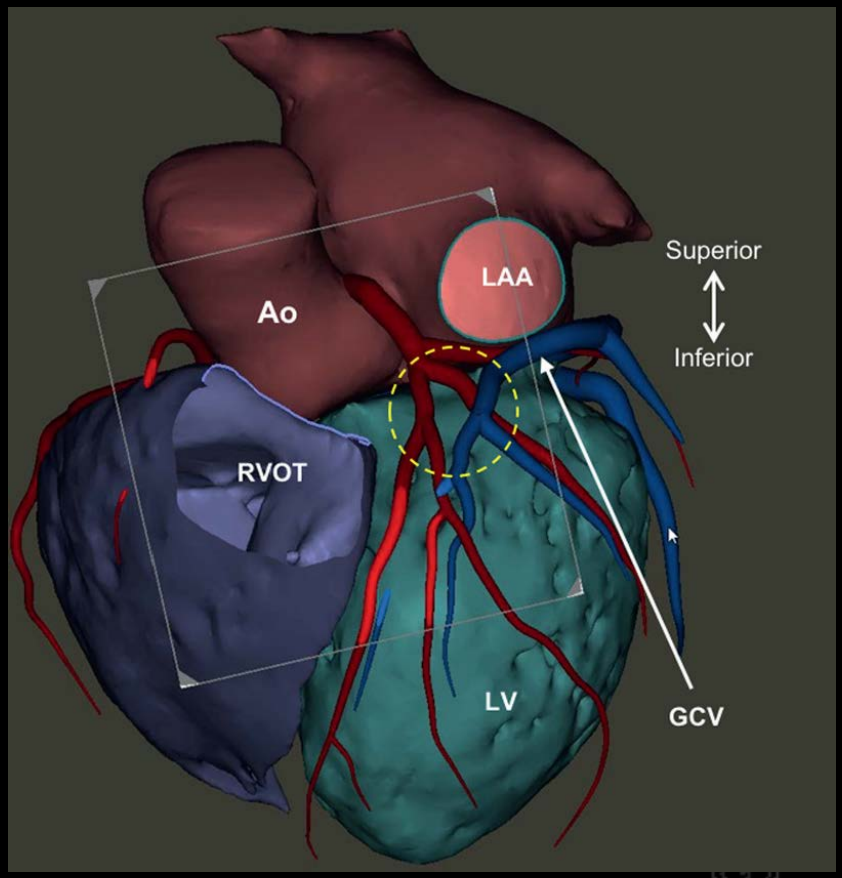
Outflow-Tract VT

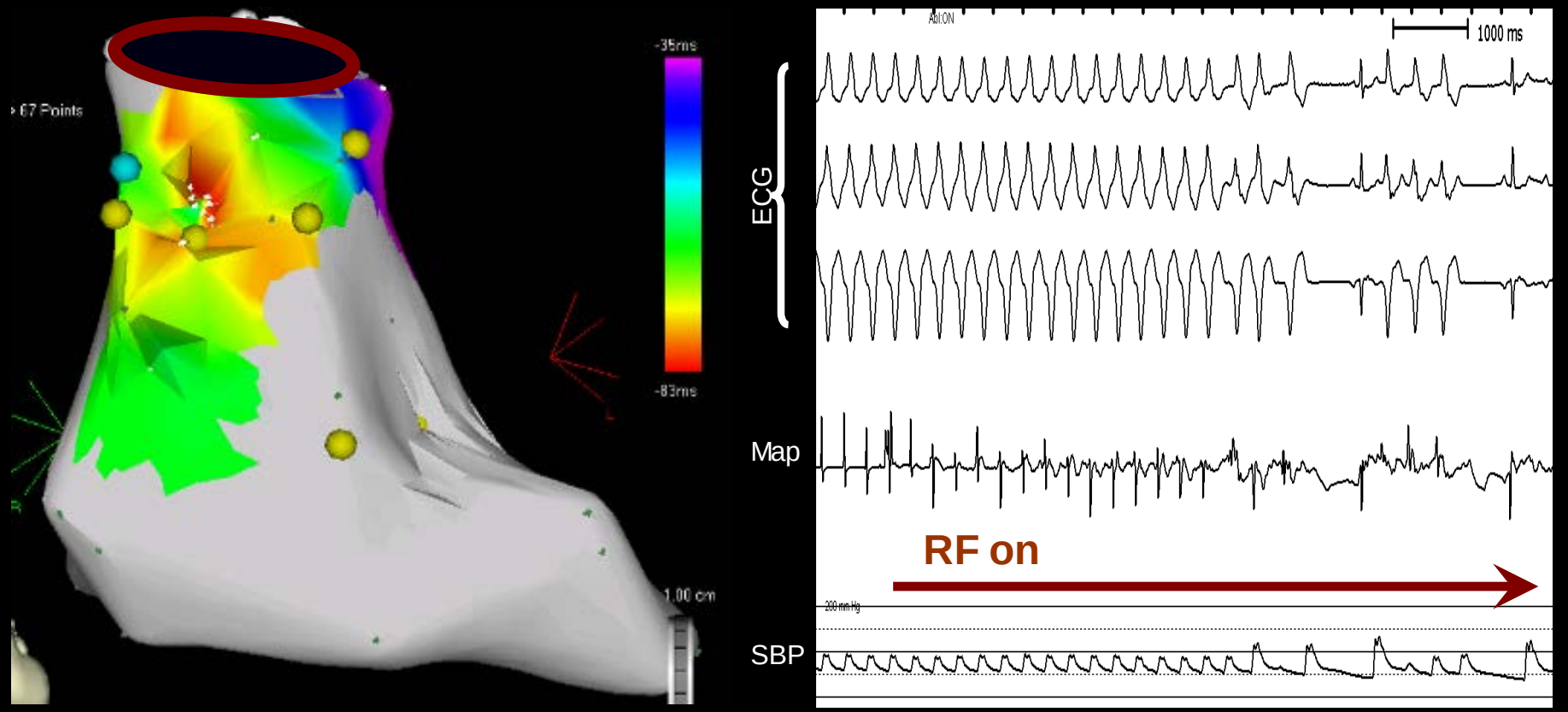
- Structurally-normal heart
- RVOT- or LVOT-VT
- ECG:
  - Typically LBBB (or RBBB)
  - Positive QRS in II / III / aVF
  - QRS transition V3/V4
    - Early transition → LVOT
    - Can be RBBB
- Not life-threatening
  - [rare exceptions]





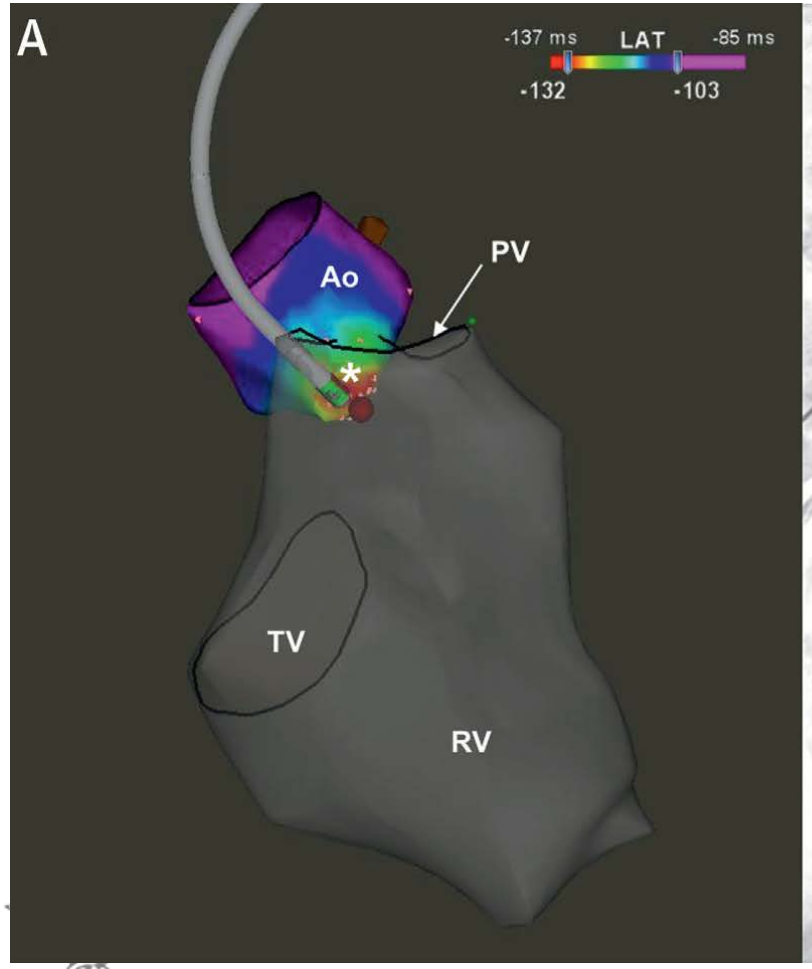
S.Dukkipati / V.Reddy, *J Am Coll Cardiol* 70:2909-23 (2017)

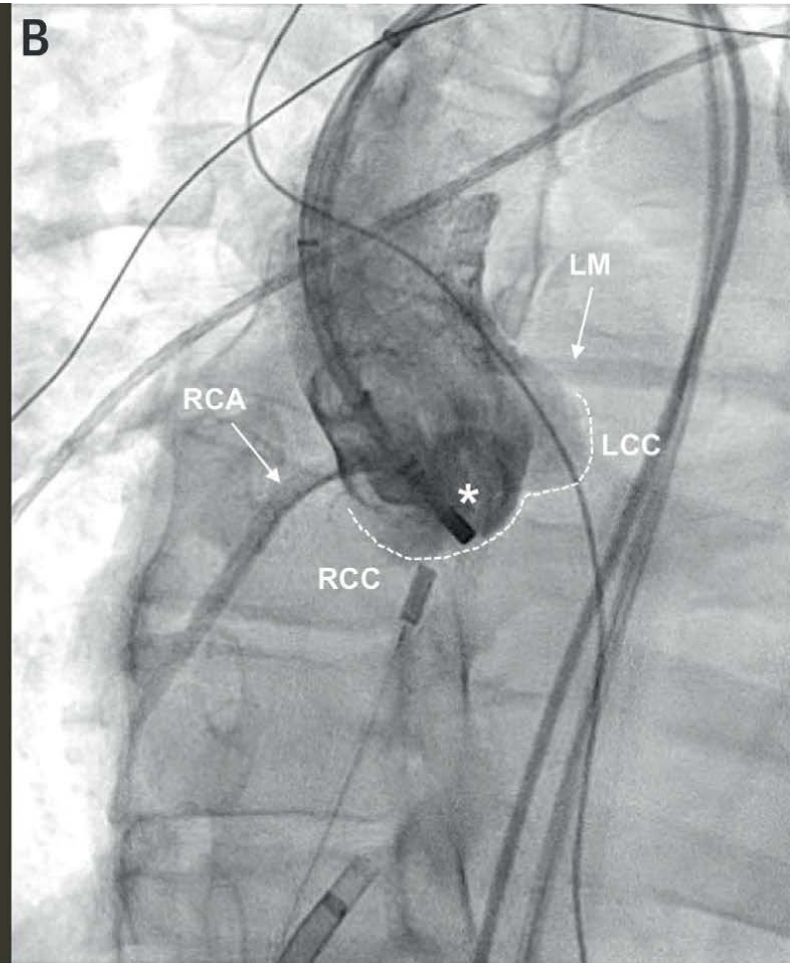
RVOT VT Ablation

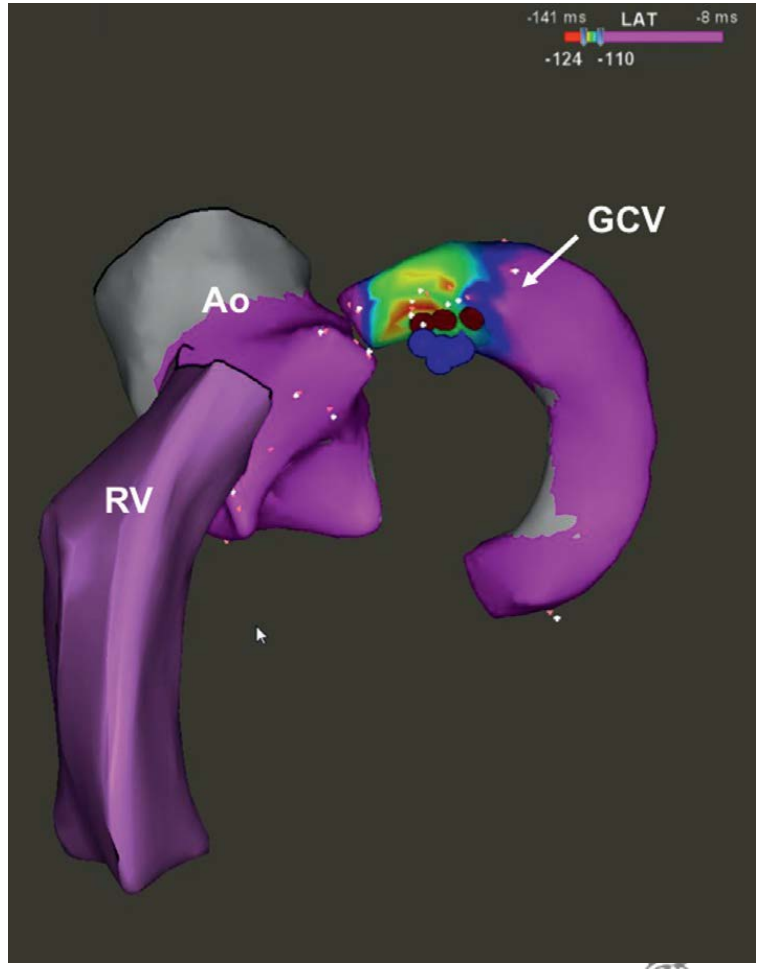


Ablation of Outflow-Tract VT/PVC

LVOT / Ao Cusps / Distal GCV / LV / LAA







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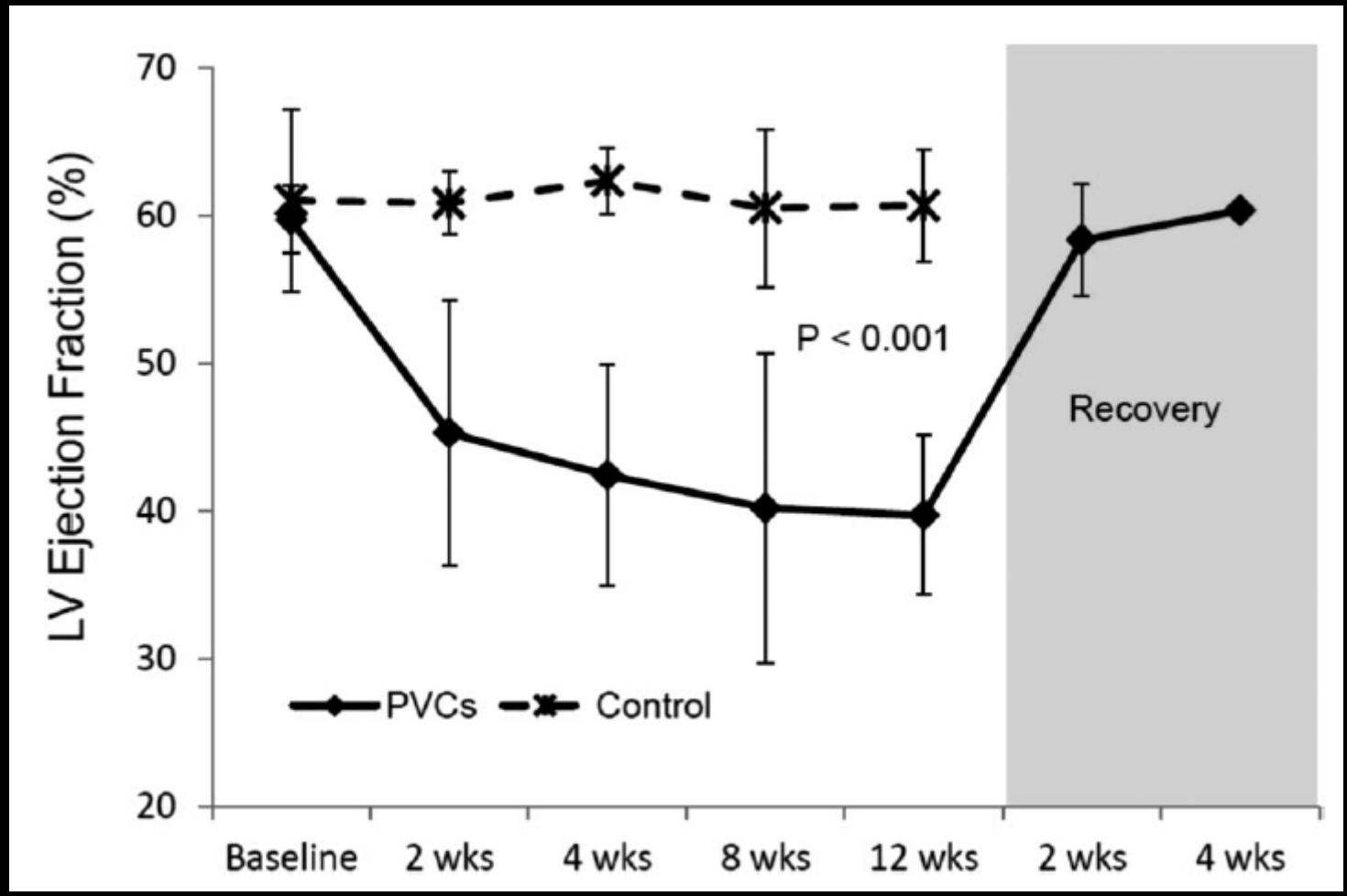
What about PVCs?

Canine Model: Bigeminal PVC Pacing *vs* Control



Huizar JF, et al. *Circ Arry* 2011;4:543-9.

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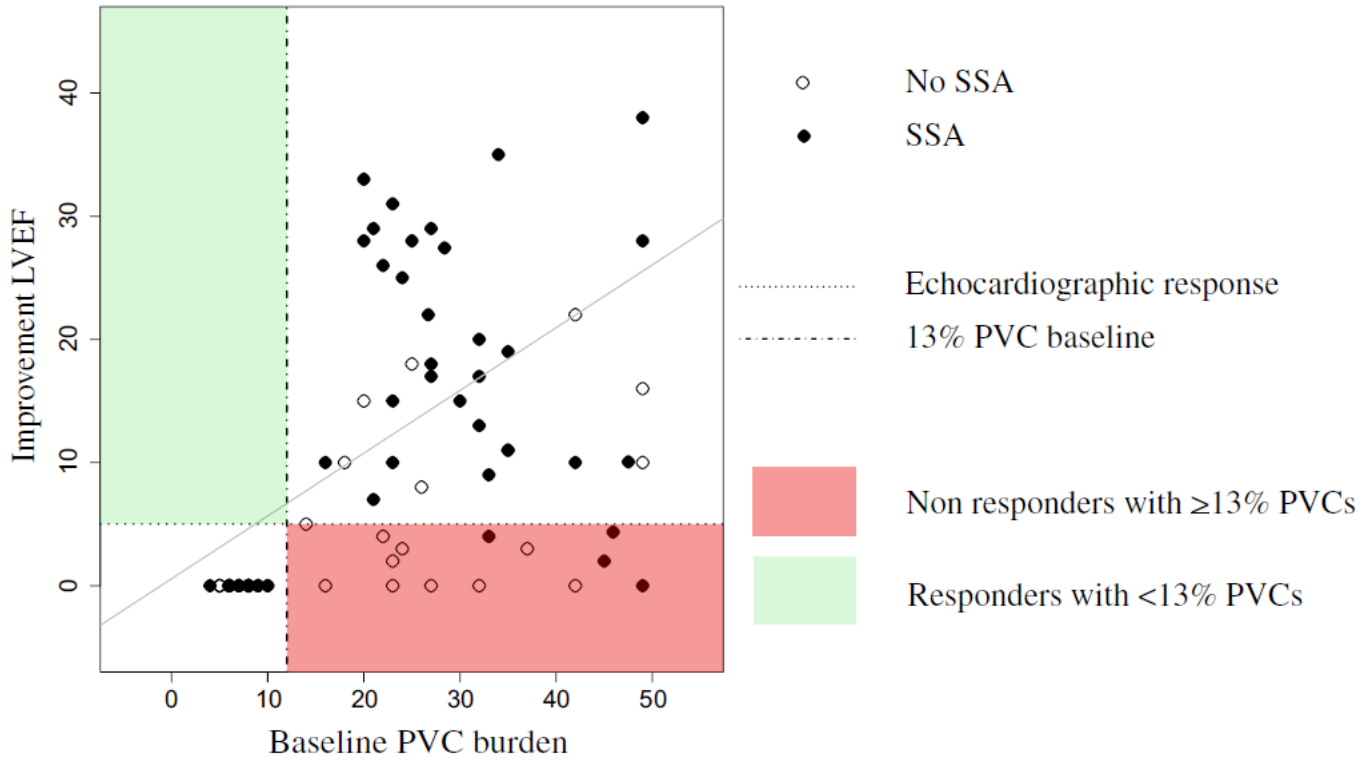
Effect of PVC Ablation

Prospective 4-Center Study (n=80 pts)

- **13% baseline PVC burden**: 100% Sens / 85% Specificity to predict an absolute LVEF increase of 5% after catheter ablation
- 20 patients with Class I ICD indication no longer eligible at 6 months post-ablation.



Penela et al, *JACC*, 62:1195 (2013)

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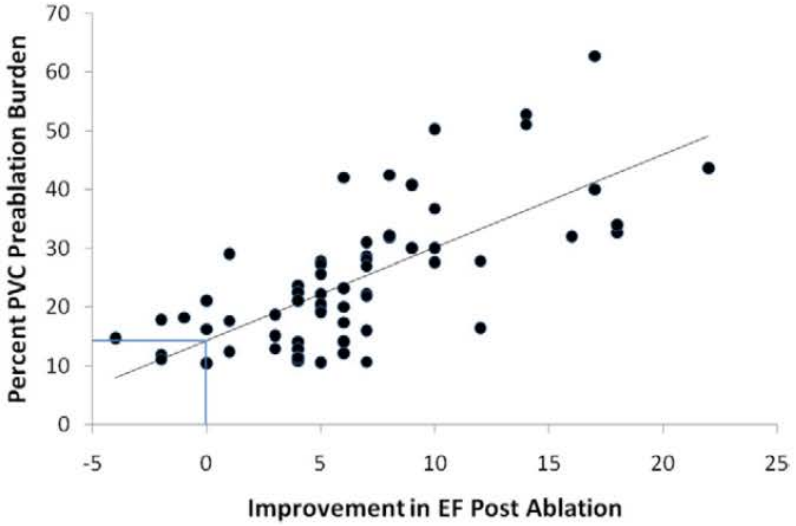
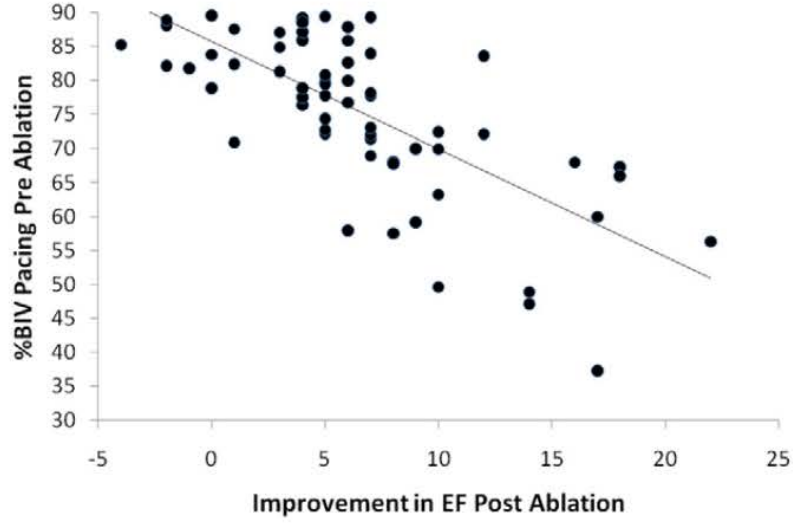
CRT Non-Responders

Effect of PVC Ablation

- 65 CRT Non-Responders with >10,000 PVCs/24h undergoing ablation
- Age 66.6, 78% male, QRS duration = 155±18 msec
- Acute and 12-mo success of ablation: 91% and 88%
- Improvements in LVEF (26.2 → 32.7%, p 0.001)
  - LVESD, LVEDD, LVESV, LVEDV, NYHA (3.0 to 2.0, p 0.001)





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Lakkireddy et al, *JACC* 60:1531 (2012)

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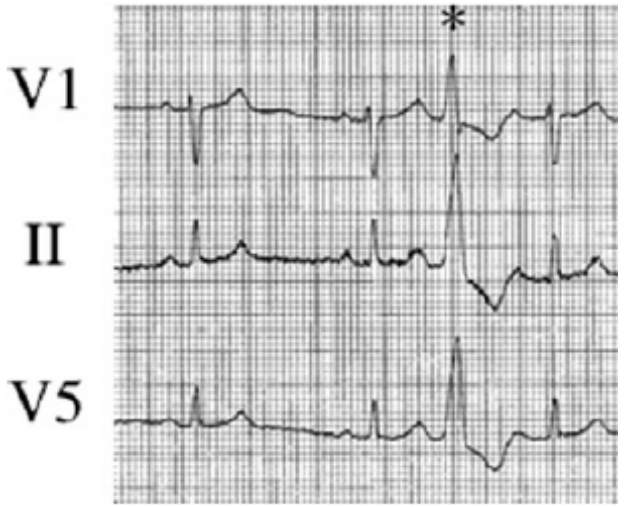
Predictors of PVC-Cardiomyopathy

Interpolated PVCs

- **Interpolated PVCs**
  - Higher risk for Cardiomyopathy
- **Symptoms**
  - Asymptomatic: HR = 13
  - Long duration (>60mo): HR=20
- **QRS Width**
  - QRS >150ms best predictive
  - Sens = 80% / Spec = 52%



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Olgun et al, *Heart Rhythm* 8:1046 (2011)
Yokokawa et al, *Heart Rhythm* 9:92 (2012)
Yokokawa et al, *Heart Rhythm* 9:1460 (2012)

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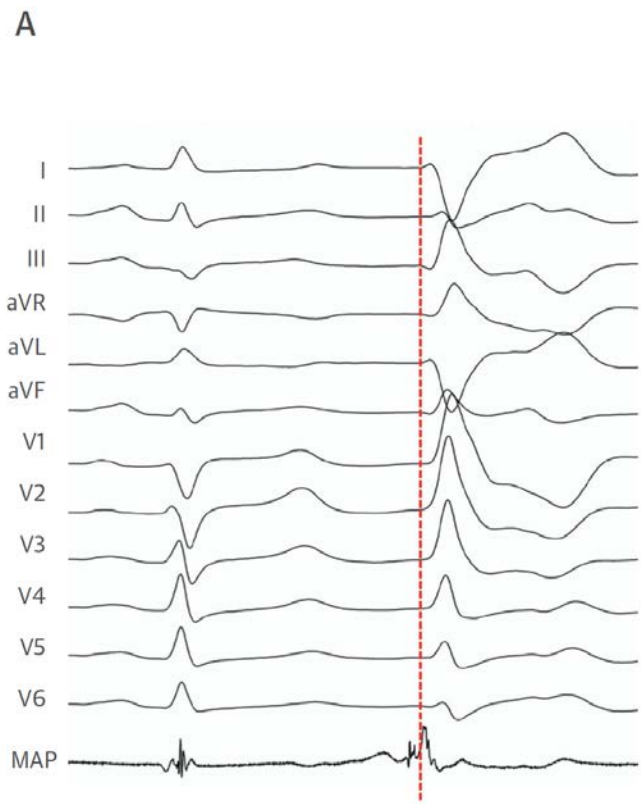
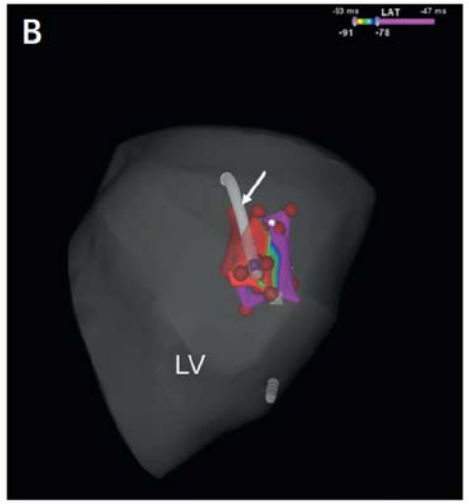
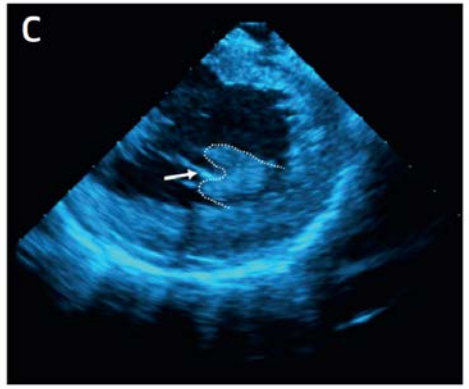
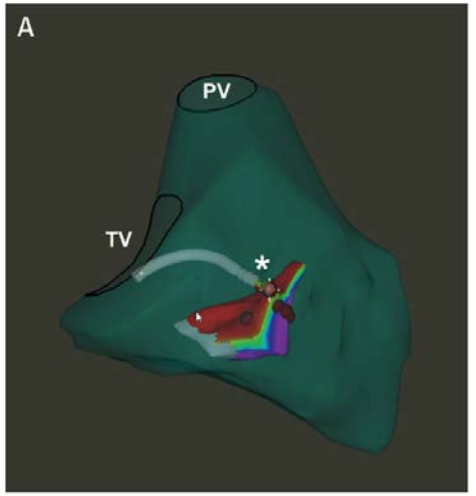
Other Types of PVCs

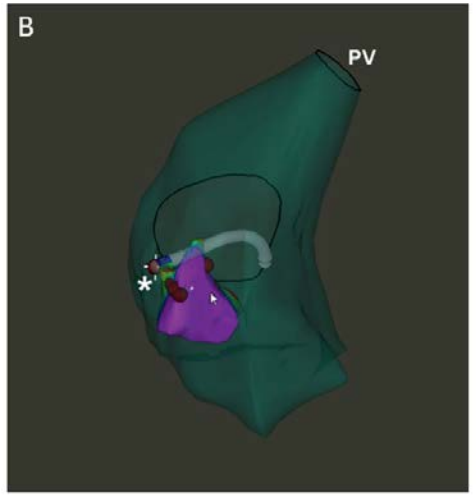
Papillary-Muscle PVCs











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S.Dukkipati / V.Reddy, *J Am Coll Cardiol* 70:2909-23 (2017)

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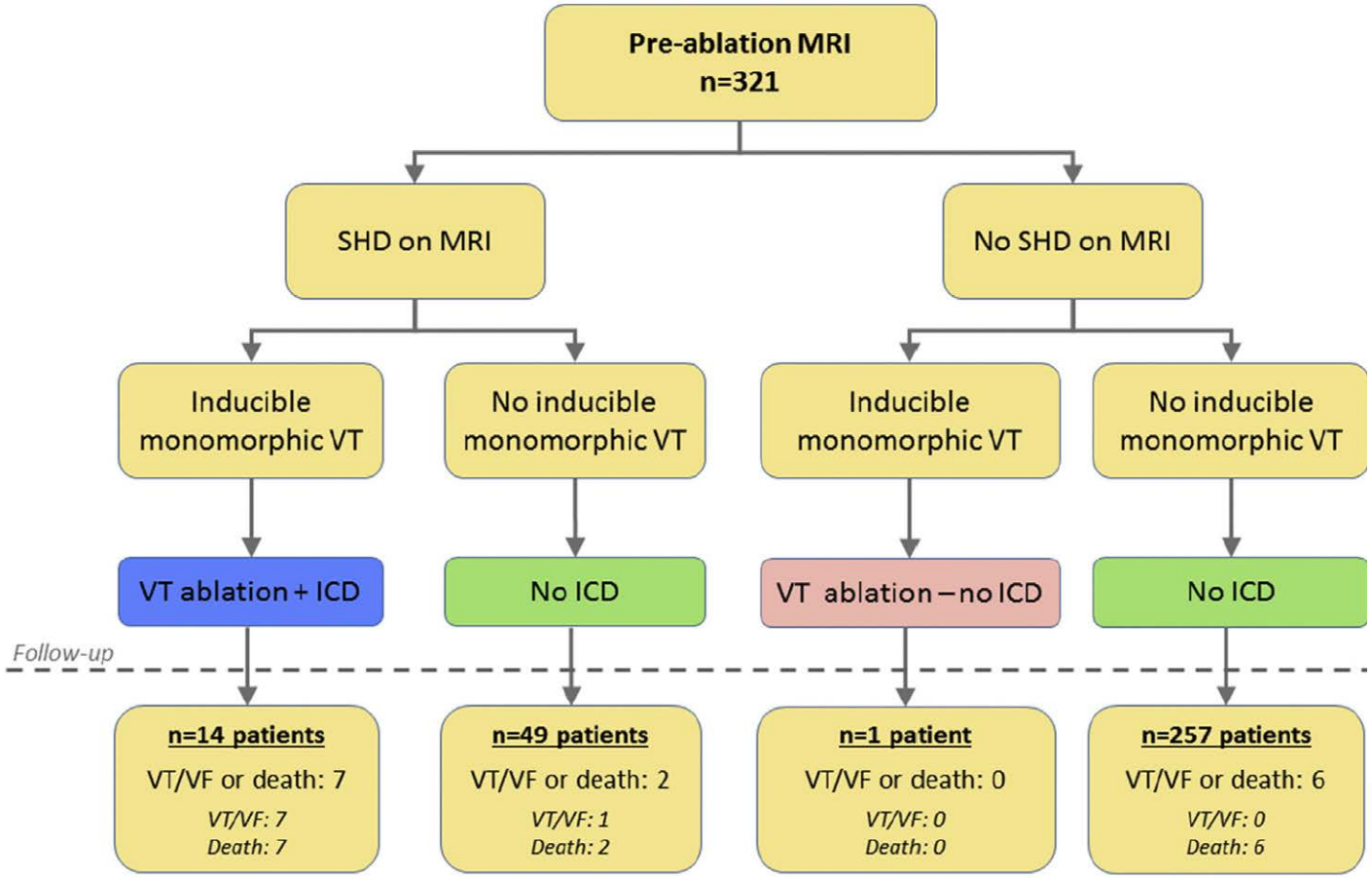
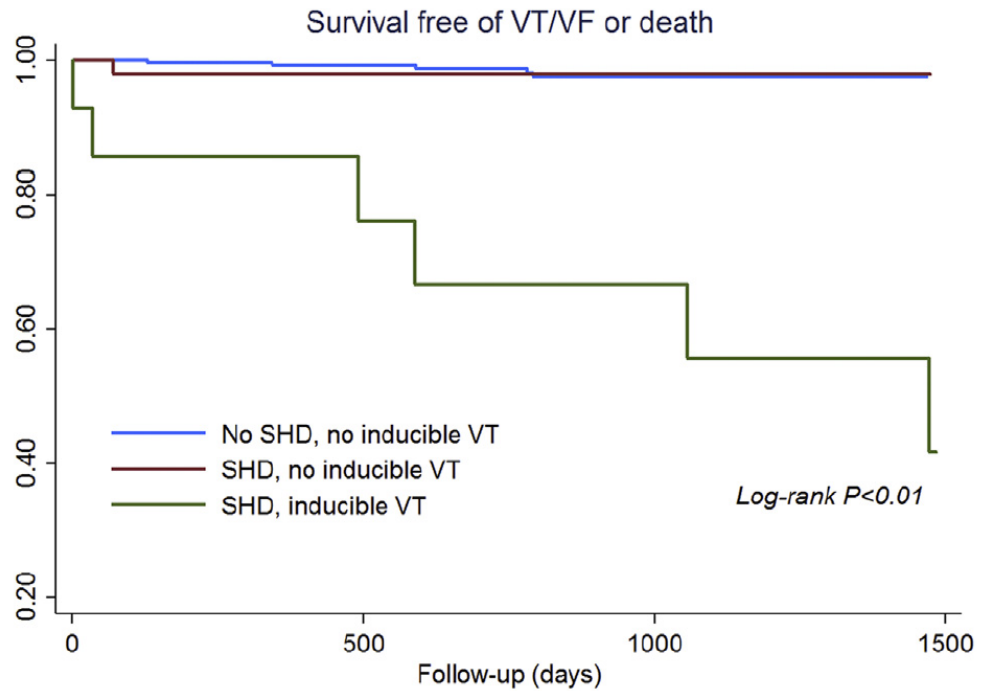
Should all PVC patients undergo MR Imaging?

Single-Center Experience





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M.Yokokawa, *Heart Rhythm 14*:1695-1701 (2017)

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Outline

- Scar-Related VT Ablation
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- Ventricular Fibrillation

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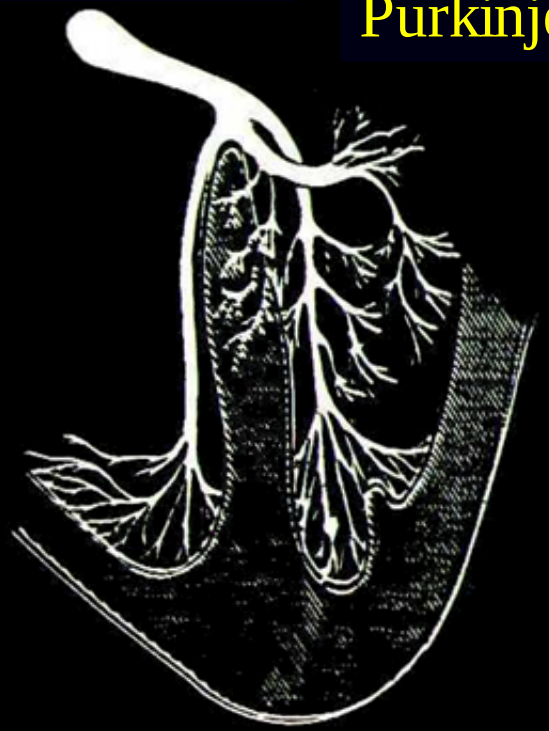
Ventricular Fibrillation

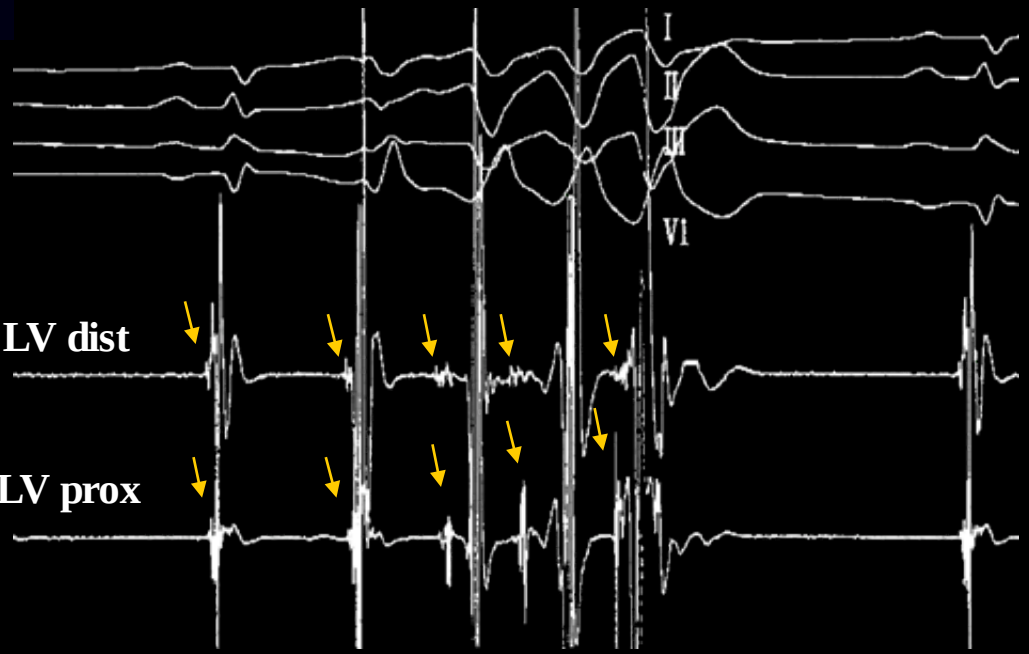
Focal Triggers

RVOT muscle
16%

Purkinje 84%



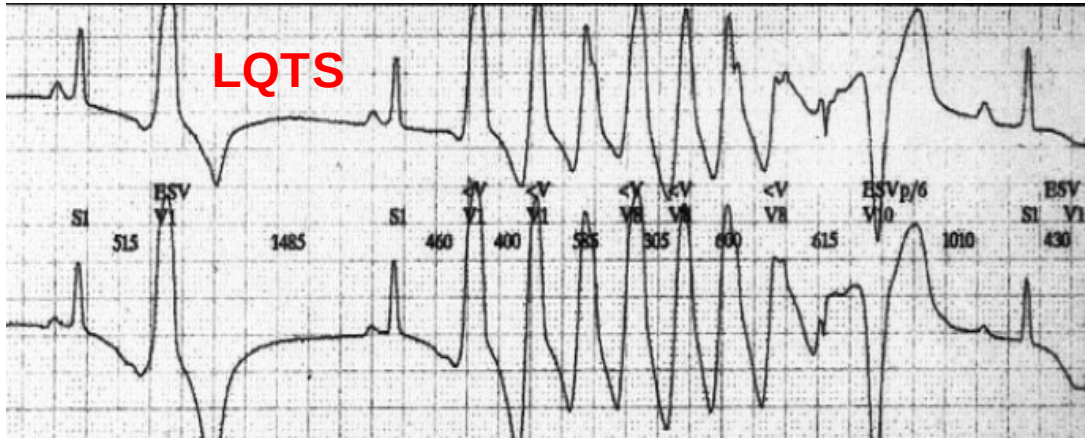
Both foci in 4 pts

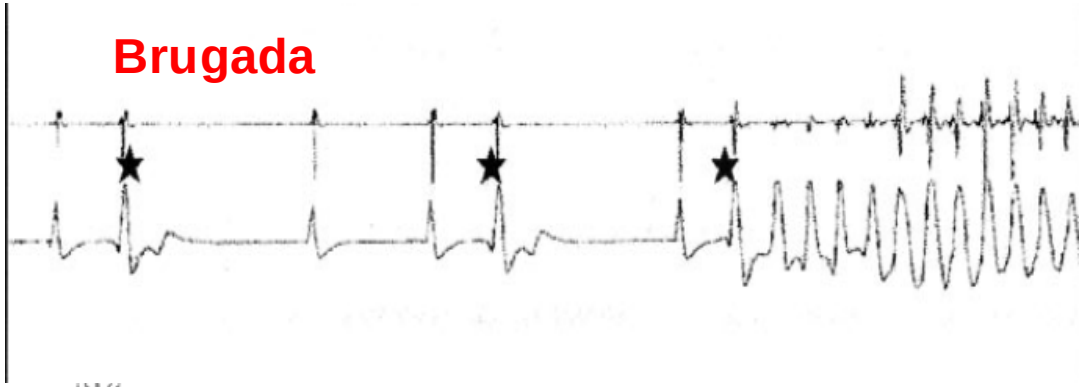


Haissaguerre M, et al, *Lancet* (2012)

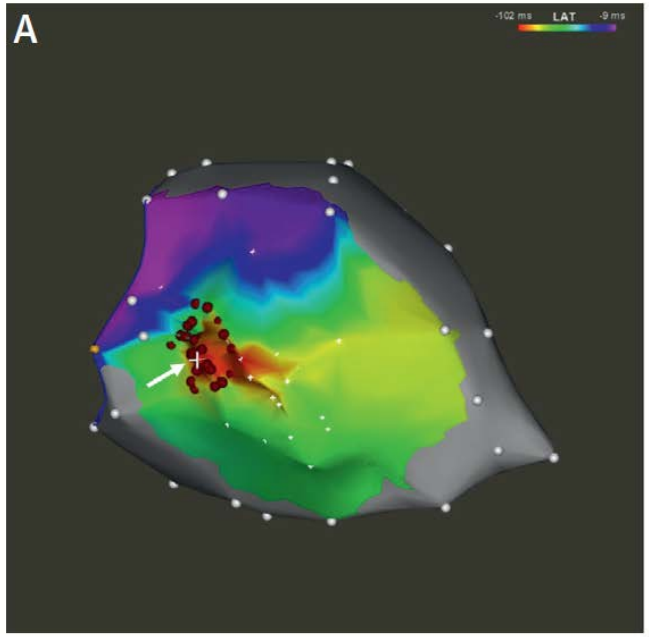
VF Triggers in Other Disease States

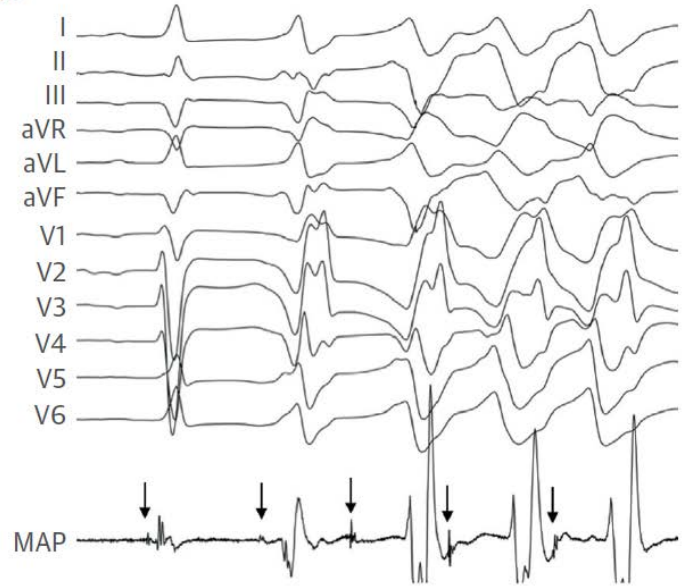
Channelopathy & Post-MI





Post-MI





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Haissaguerre et al, Circ 108:925 (2003)
Bansch et al, Circ 108:3011 (2003)
S.Dukkipati / V.Reddy, *J Am Coll Cardiol* 70:2909-23 (2017)

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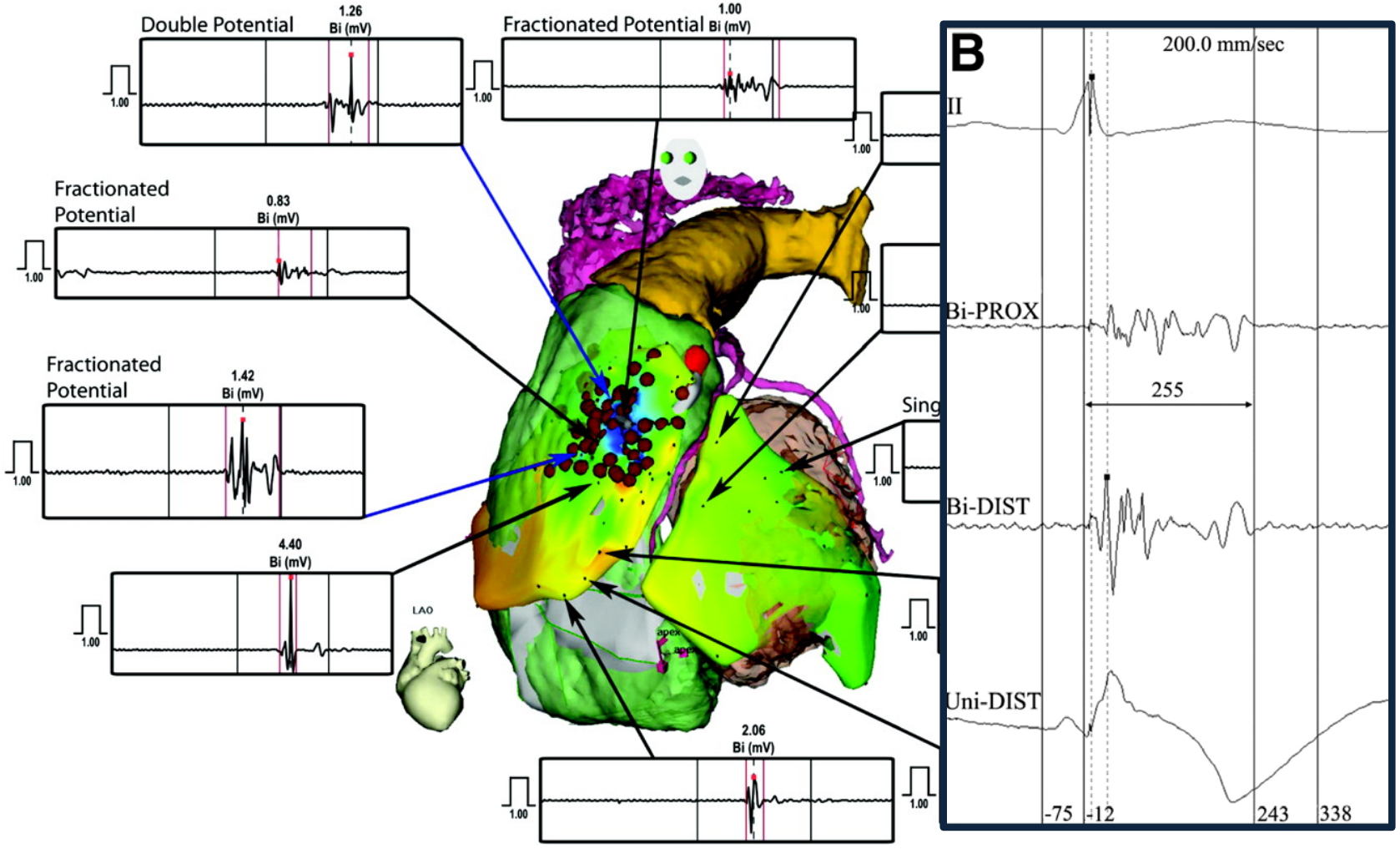
VF Substrate Mapping in Brugada Syndrome

Normal and Abnormal Epicardial Electrograms



K.Nademanee et al, *Circulation* 123:1270 (2011)

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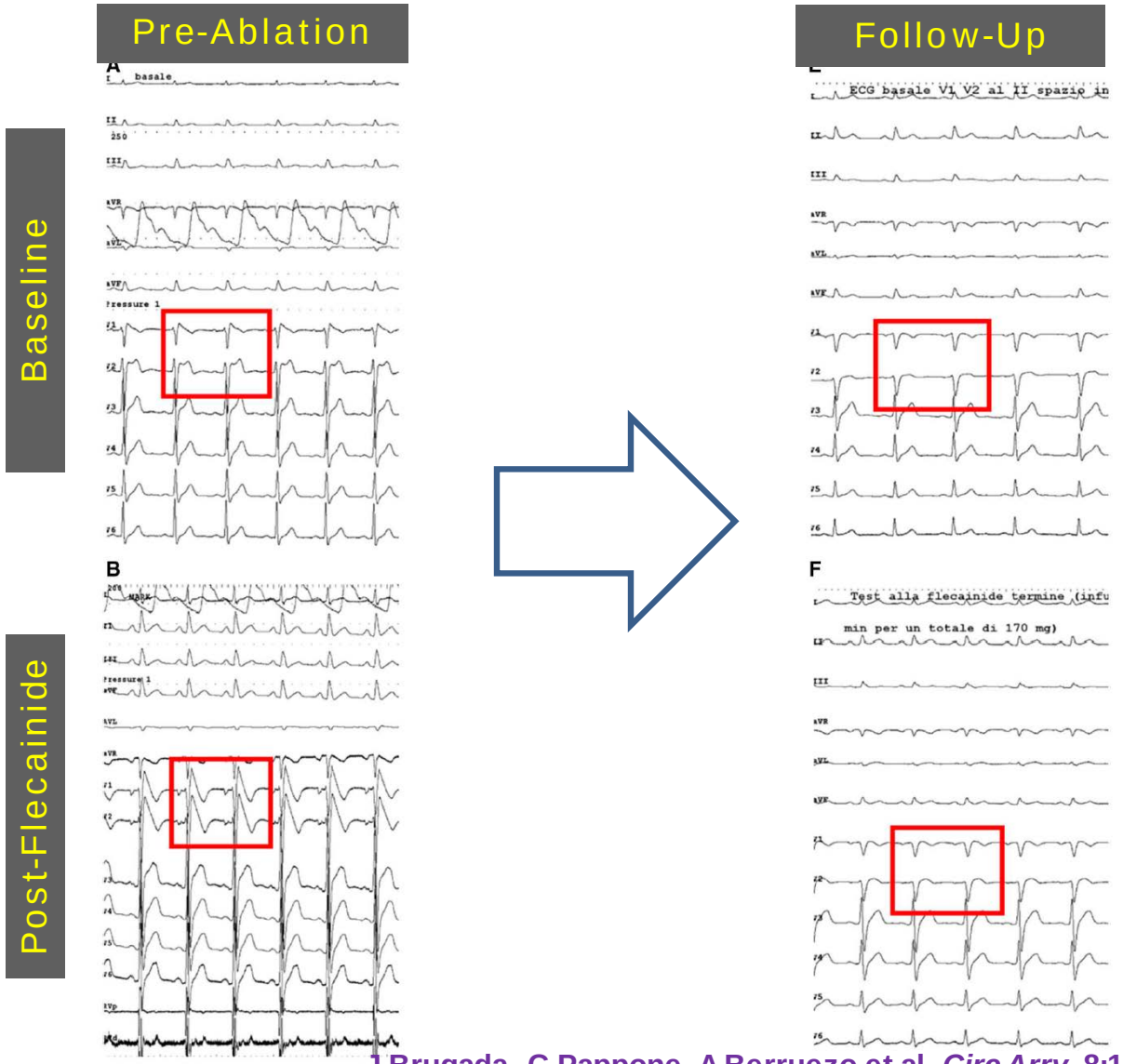
Brugada Syndrome: VF Substrate Ablation

ECG Pattern During Follow-Up



J.Brugada, C.Pappone, A.Berruezo et al, *Circ Arry* 8:1373 (2015)

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Final Thoughts

- Scar-Related VT:
  - Ablation is safe!
  - Ablation success is moderate in DCM
  - ARVC-VT Ablation: Excellent Outcome
- Outflow-Tract VT
  - Recognize it! → ICDs are not indicated
  - PVCs – When to intervene?
    - Symptoms
    - Ventricular Dysfunction / Dilatation
    - High burden??
- Ventricular Fibrillation
  - PVC Triggers
  - Brugada Syndrome: Substrate Ablation

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