- 세 션 명: Ventricular Tachycardia 2: VT Mapping & Ablation
- 세션언어: ENG
- 세션일시: 2023년 6월 24일(토), 13:30-15:00
- 역　　할: Speaker
- 발표주제: Ischemic VT : Role of Radiofrequency (RF) Ablation in Ischemic VT: When, How, and End-Point
- 발표시간: 15분

Role of RF Ablation in Ischemic VT : When, How, and End-Point

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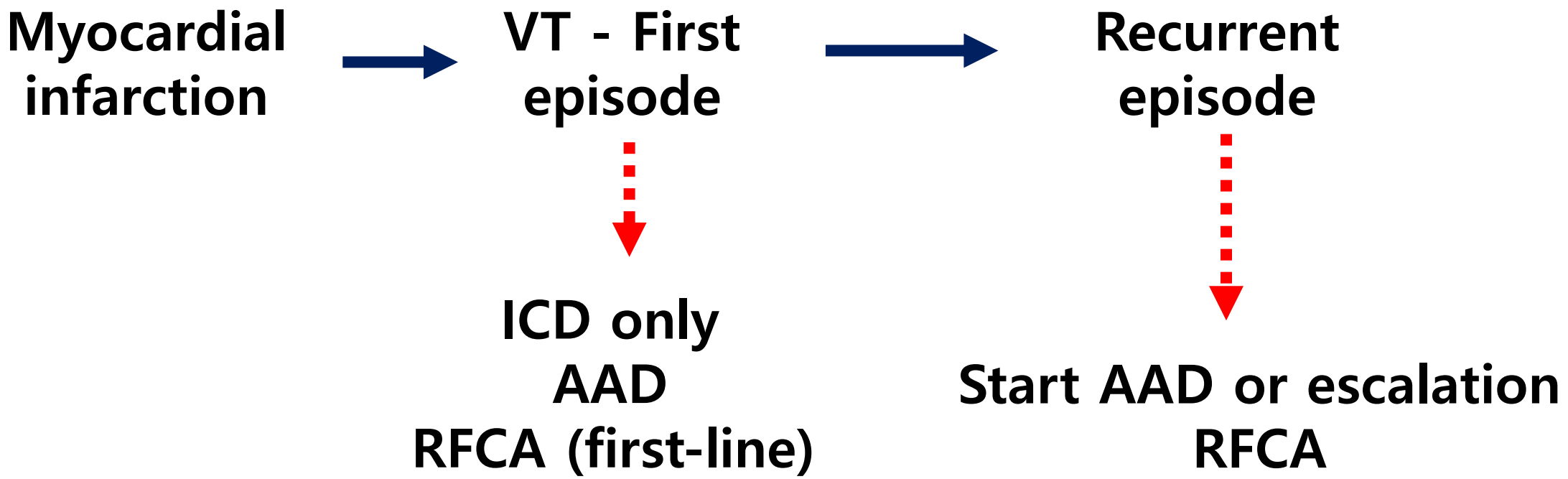
Contents

1. When to ablate – Timing (first line, RF vs AAD)
2. How to ablate - Technique

    epi/endo, lesion design (substrate abl)

3. When to stop - Endpoint

Occurrence of post-MI VT and therapeutic options



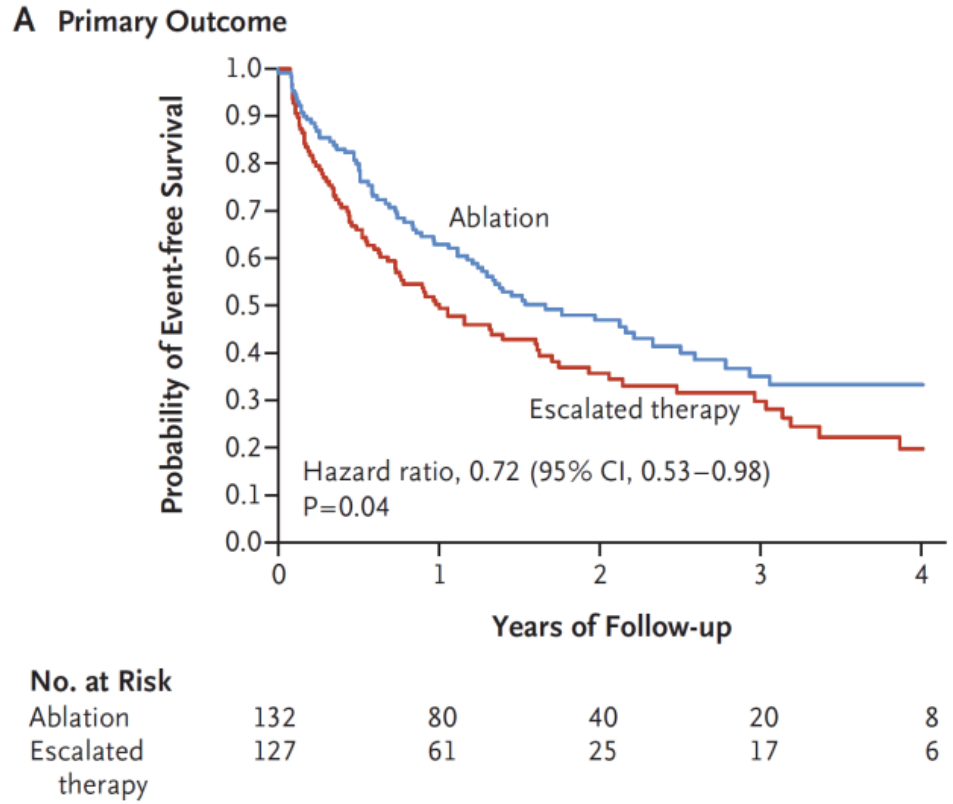
Ventricular Tachycardia Ablation versus Escalation of Antiarrhythmic Drugs: VANISH Trial

a multicenter RCT in patients with ischemic CM and ICD VT despite the use of antiarrhythmic drugs (AAD)

Patients were randomly assigned to
- -catheter ablation(ablation grp, n=132)+baseline AAD or
- -escalated AAD (escalated-therapy group, n=127).

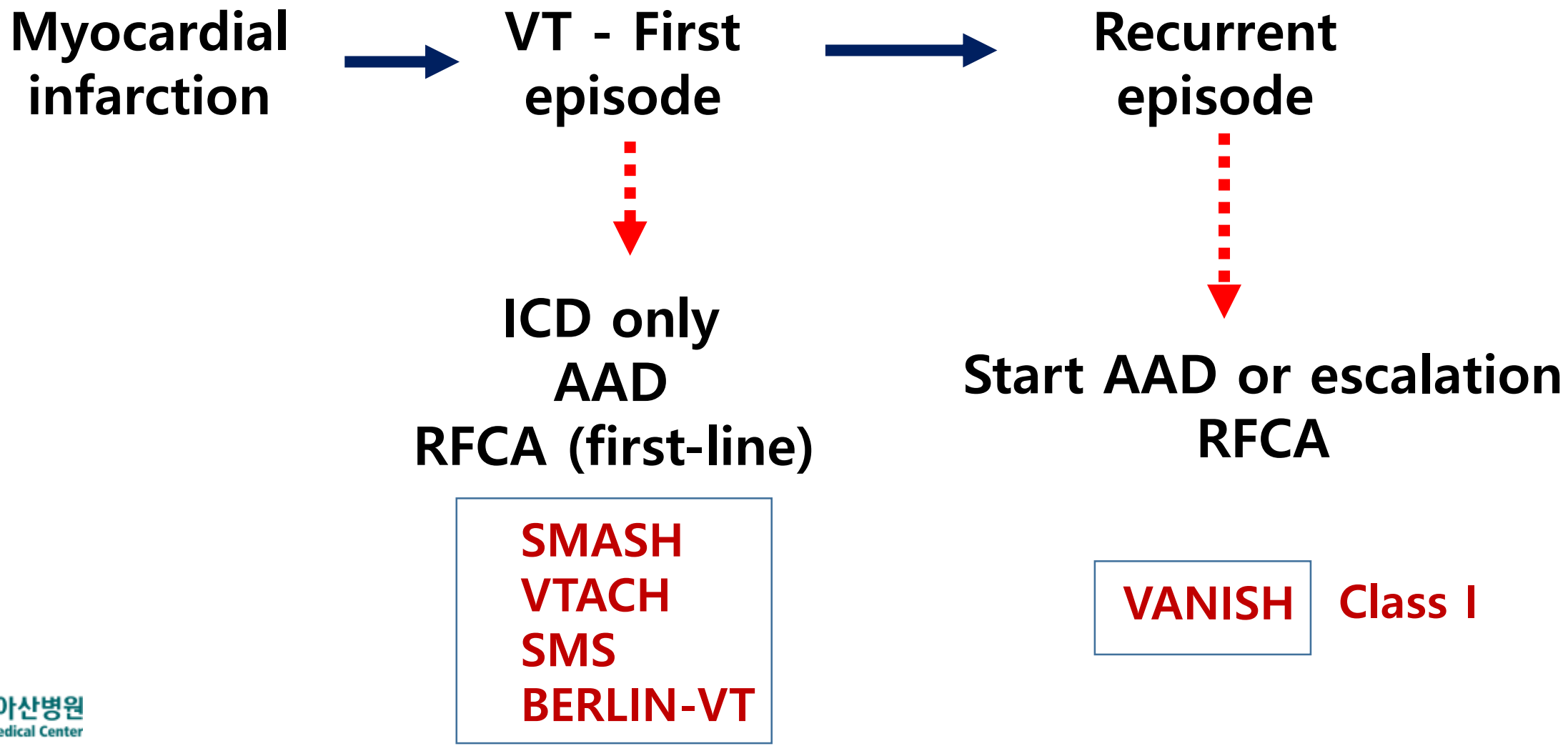
escalated AAD therapy group,
- -amiodarone, newly initiated if previously another agent
- -amiodarone dose increased if < 300 mg per day or
- -mexiletine was added if the dose > 300 mg per day

The primary outcome was a composite of
- death,
- VT storm, or
- appropriate ICD shock.



N Engl J Med 2016;375:111-21.

Occurrence of post-MI VT and therapeutic options

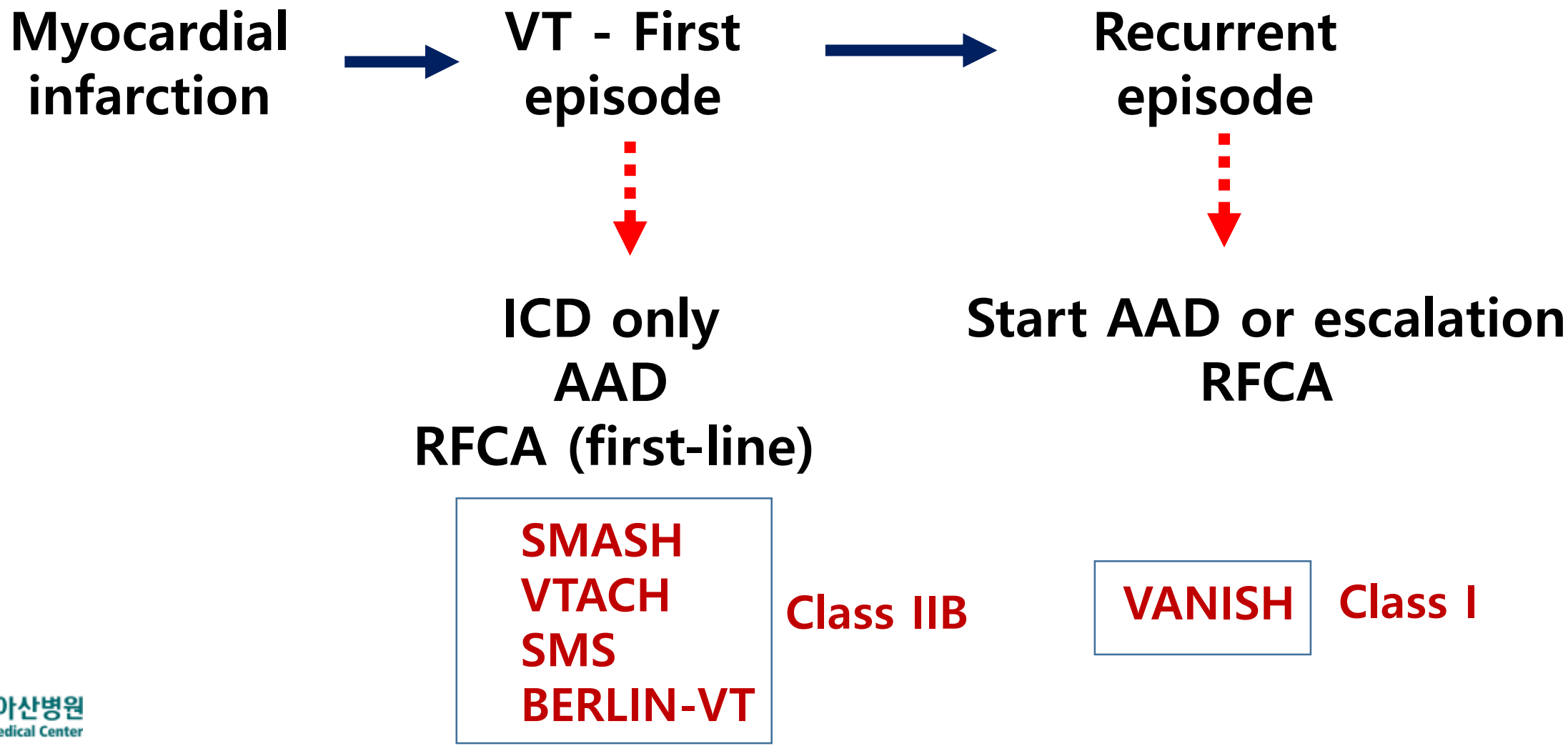


Role of RF ablation (ICD alone vs ICD+ablation)

	SMASH-VT	VTACH	SMS	BERLIN-VT
No of pts	64 vs 64	52 vs 55	57 vs 54	83 vs 76
Inclusion	spontaneous unstabke VT/VF or syncope with inducible VT	ischemic heart disease, LVEF 50%, and stable VT (no LOC or SCD)	LVEF 40% and a Hx of unstable VT/SCD or syncope with inducible VT	LVEF 30-50% plus documented VT
EF	33 vs 31% Post MI	34 vs 34% CAD, MI	30 vs 32% CAD	41 vs 41% Ischemic CM
Class I or III AAD	0%	35 vs 35%	32 vs 29%	33 vs 41%
Randomization	RF vs no RF (planned or recent <6m ICD)	RF vs no RF	RF vs no RF	Early (preventive) RF vs deferred (after 3rd ICD Rx) RF
End point	Appropriate ICD Rx	time to first recurrent VT/VF	time to first recurrent VT/VF	All cause death or unplanned hospitalization
Ablation methods	Substrate ablation in SR	Mapping + substrate modificaiton	Mapping + substrate modificaiton	Substrate ablation for LP
Results	65% relative reduction of approp ICD in RF group	reduction of approp ICD in RF group (hosp. adm reduced-2 end)	No difference (prim) in recur time, but 67% reduced ICD Rx	Premature term. No difference btw Early vs Deferred RF

Heart Rhythm O2 2020;1:297–310

Occurrence of post-MI VT and therapeutic options



Exceptions: RF, first line or lower threshold in… (individualization)

1. VT storm
2. Bundle Branch reentry VT
3. Substrate: ICM vs NICM
4. Hemodynamic factors
5. Individualize…occupation, anxiety etc

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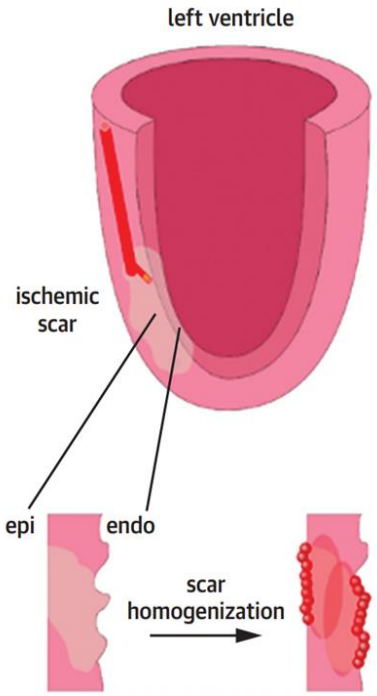
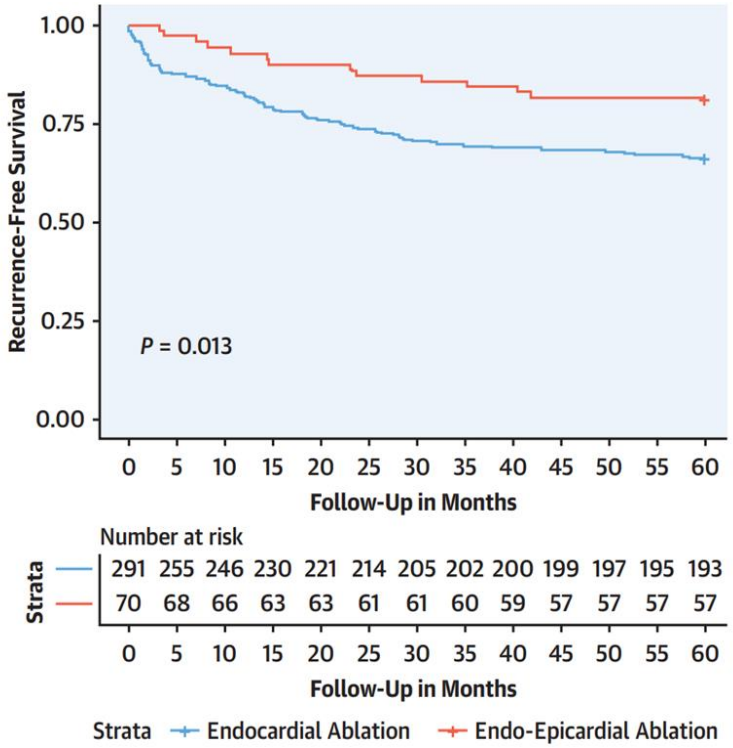
Endocardial Scar-Homogenization with vs without Epicardial Ablation in Ischemic CM





Bipolar substrate mapping with standard scar settings defined as normal tissue >1.5 mV and severe scar <0.5 mV. Epicardial ablation was performed "despite being noninducible" after endocardial ablation in "all" group 1 patients.

Noninducibility of monomorphic VT was the procedural endpoint in both groups.

The combined endo-epicardial scar homogenization was associated with a significantly higher success rate at 5 years of follow-up

J Am Coll Cardiol EP 2022;8:453–46

Endo-epi vs endo-only catheter ablation of ischemic VT: a meta-analysis

FIGURE 3 VT Recurrence by Subgroups

Study or Subgroup	Endo-Epicardial Events	Endo-Epicardial Total	Endocardial Events	Endocardial Total	Weight	Risk Ratio M-H, Fixed, 95% CI
1.1.1 ICM						
Acosta 2016	3	24	18	66	4.8%	0.46 [0.15, 1.42]
Di Biase 2012	8	43	23	49	10.8%	0.40 [0.20, 0.79]
Izquierdo 2015	3	15	16	35	4.8%	0.44 [0.15, 1.28]
Nakahara 2010 (a)	0	3	3	14	0.7%	0.54 [0.03, 8.38]
Tung 2013 (a)	3	20	22	49	6.4%	0.33 [0.11, 0.99]
Vergara 2012 (a)	2	9	6	27	1.5%	1.00 [0.24, 4.10]
Subtotal (95% CI)		**114**		**240**	**29.1%**	**0.43 [0.28, 0.67]**
Total events	19		88			

Heterogeneity: $Chi^2 = 1.66$, df = 5 (P = 0.89); $I^2 = 0\%$

Test for overall effect: Z = 3.73 (P = 0.0002)

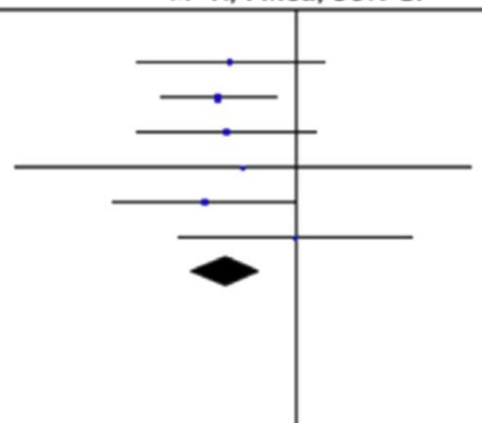
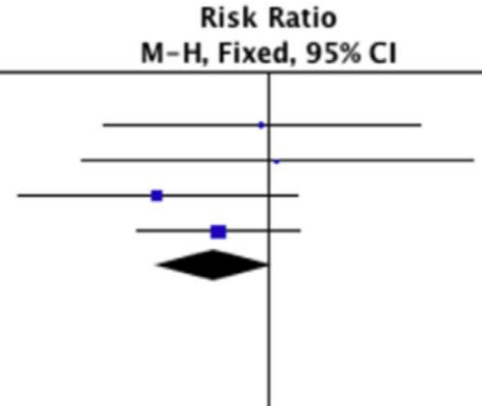


FIGURE 4 All-Cause Mortality by Subgroups

Study or Subgroup	Endo-Epicardial Events	Endo-Epicardial Total	Endocardial Events	Endocardial Total	Weight	Risk Ratio M-H, Fixed, 95% CI
1.4.1 ICM						
Acosta 2016	1	24	3	66	4.9%	0.92 [0.10, 8.39]
Di Biase 2012	1	43	1	49	2.9%	1.14 [0.07, 17.67]
Izquierdo 2015	1	15	11	35	20.3%	0.21 [0.03, 1.50]
Tung 2013 (a)	3	20	14	47	25.7%	0.50 [0.16, 1.56]
Subtotal (95% CI)		**102**		**197**	**53.8%**	**0.47 [0.20, 1.07]**
Total events	6		29			

Heterogeneity: $Chi^2 = 1.41$, df = 3 (P = 0.70); $I^2 = 0\%$

Test for overall effect: Z = 1.79 (P = 0.07)



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J Am Coll Cardiol EP 2019;5:13–24

First-line combined endo-epicardial approach?

1. Limited data, (only 4-6 studies)
2. Retrospective, non-randomized, single-center study
3. Performed in high-volume, experienced centers
4. Epi ablation, necessary in 1/3 or in 10% in other group
5. Selection of pts with a high chance of epi. substrate?

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    epi/endo, **lesion design (substrate abl)**

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Why more ablation than target VT?

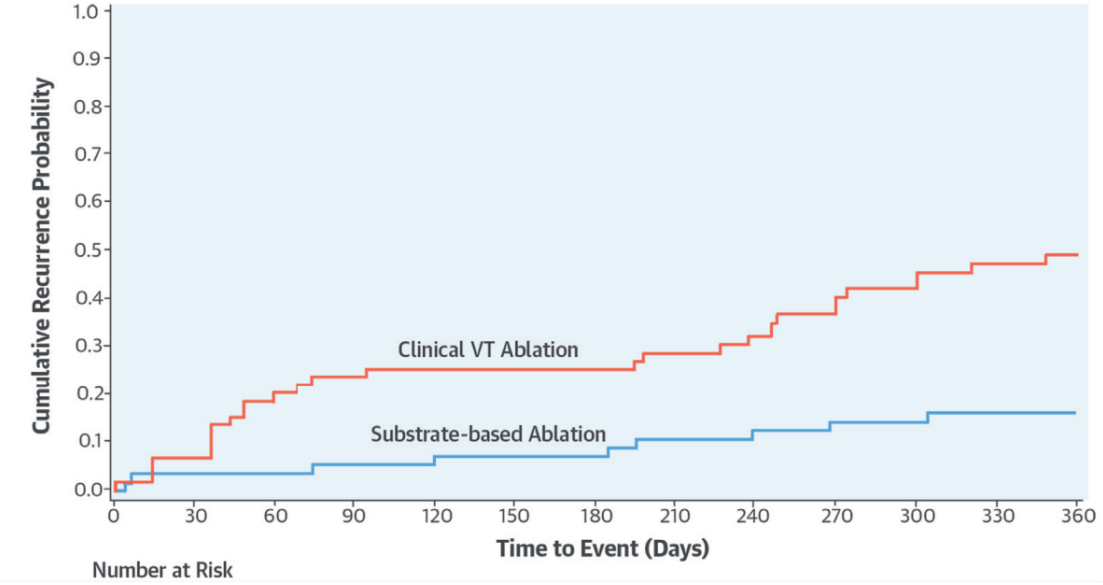
Ablation of Stable VTs vs Substrate Ablation in Ischemic CM : The VISTA Randomized Multicenter Trial

Randomization: clinical ablation (VT-based) vs substrate-based ablation (scar-based, extensive homogenization)

VT induction, not required, (only used as post-RF endpoint)

The endpoint in the substrate-based group: elimination of all abn potentials (usually defined as fractionated and/or late potentials)

Combined incidence of rehospitalization and mortality was significantly lower with substrate ablation (p <0.003).



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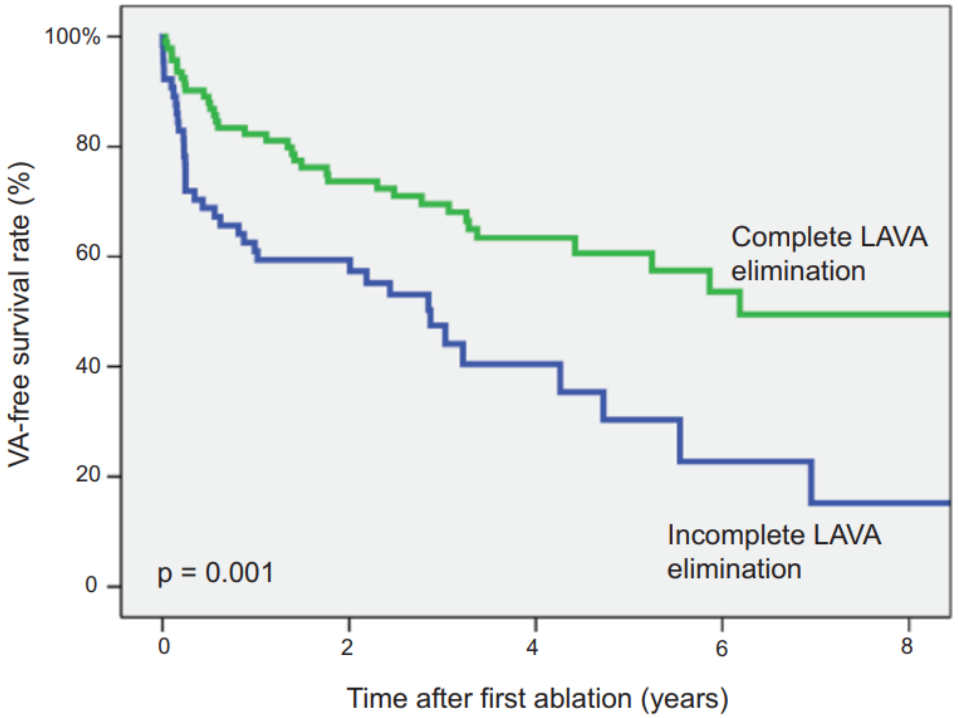
J Am Coll Cardiol 2015;66:2872–82

Long-Term Outcome of Substrate Modification in Ablation of Post–Myocardial Infarction VT



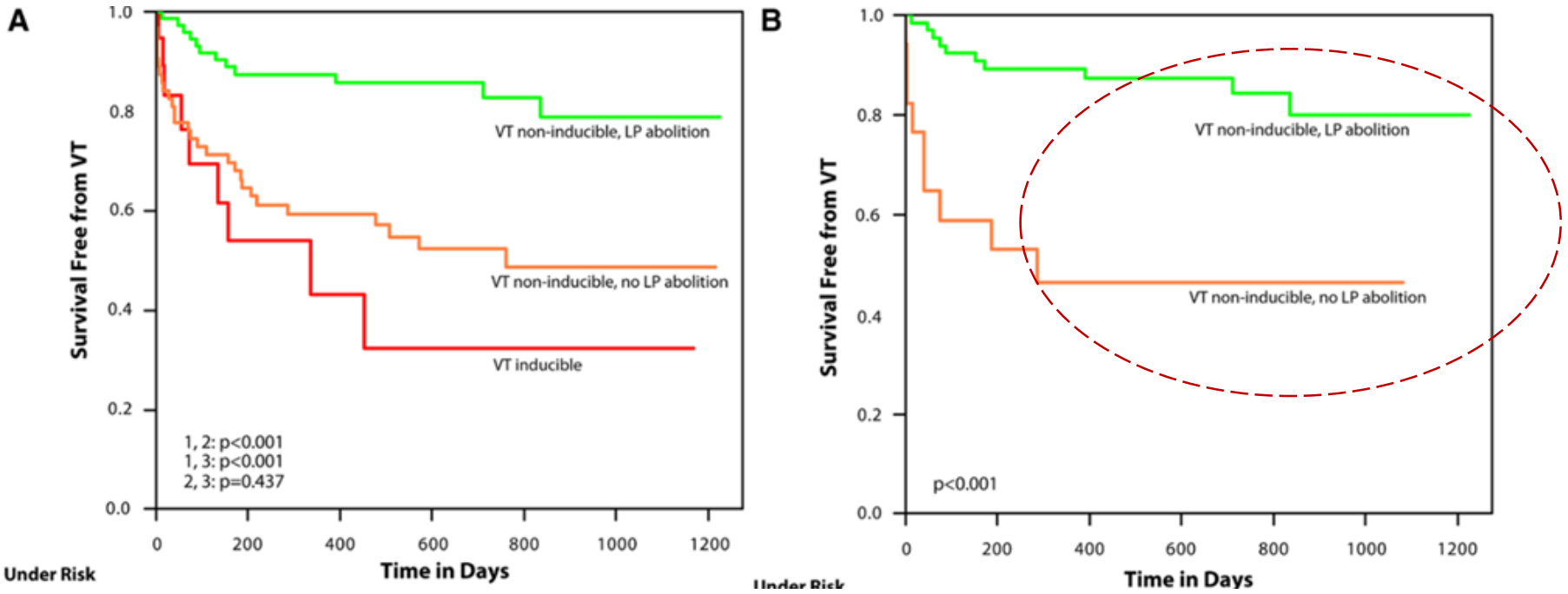
In this monocentric study, substrate modification targeting LAVA for post–myocardial infarction VT resulted in a substantial reduction of VT storm and ICD shocks and up to 49% of patients free from arrhythmia at 5 years after a single procedure.

Michael Wolf, MD, Frédéric Sacher, MD
Circ Arrhythm Electrophysiol. 2018;11:e005635

Noninducibility and Late Potential Abolition

To see the prognostic impact of a combined procedural end point of VT noninducibility and LP abolition in a large series of post–myocardial infarction patients.

Among non-inducible patients, those with "additional LP abolition" (substrate ablation) also had a lower incidence of VT recurrence (16.4% versus 46.0%; log-rank P<0.001). After multivariate analysis, the combined end point of VT noninducibility and LP abolition (hazard ratio, 0.205, P<0.001) was independently associated with VT recurrence and cardiac death (hazard ratio, 0.106; P=0.001).



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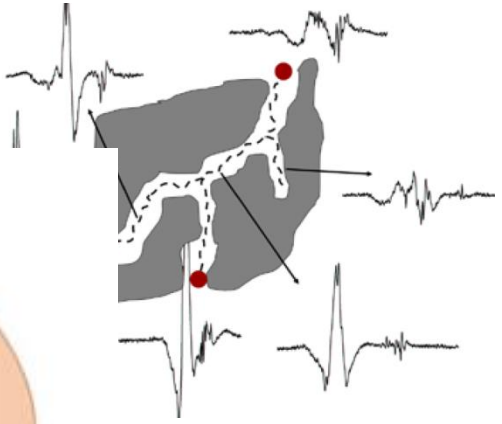
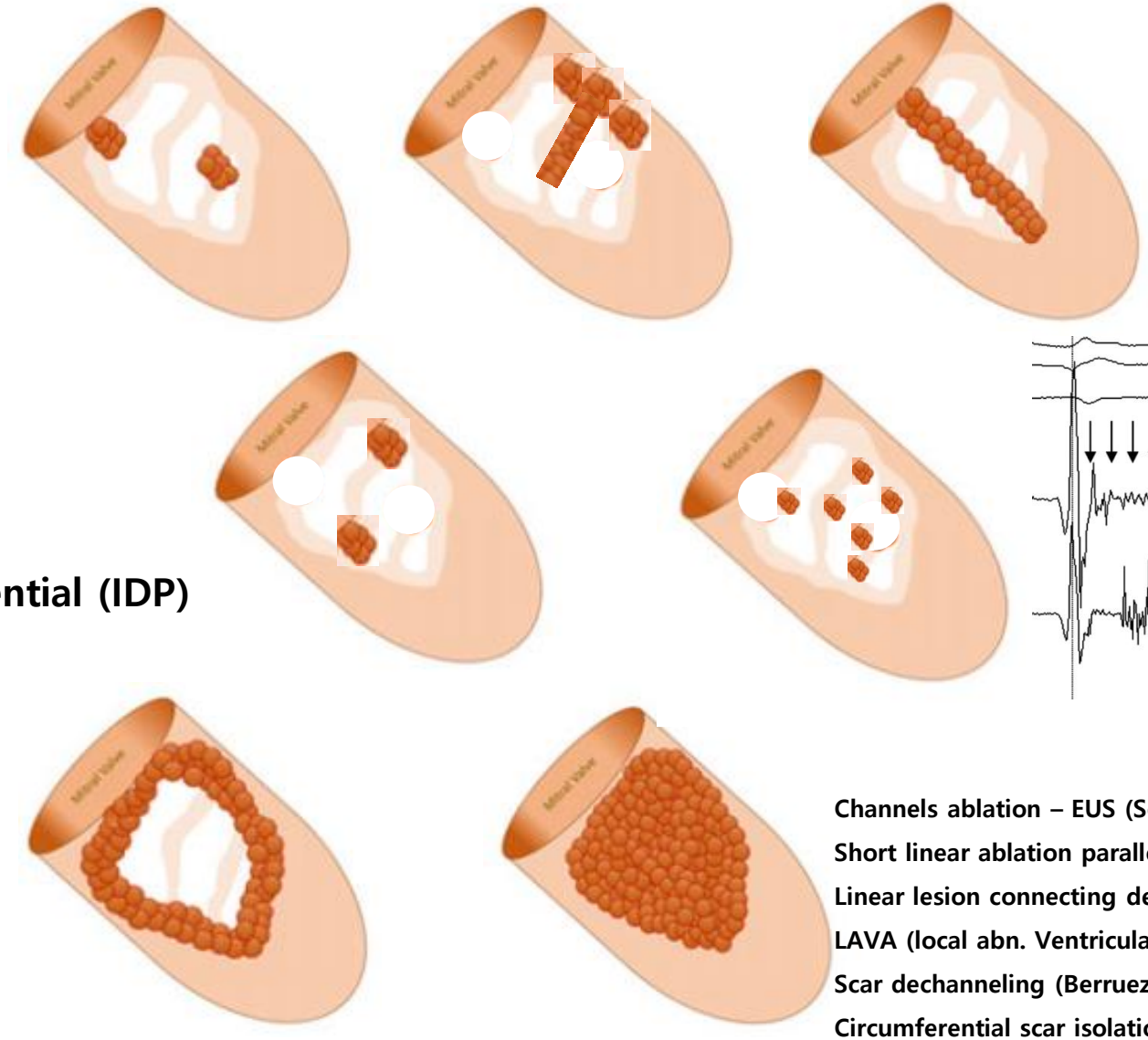
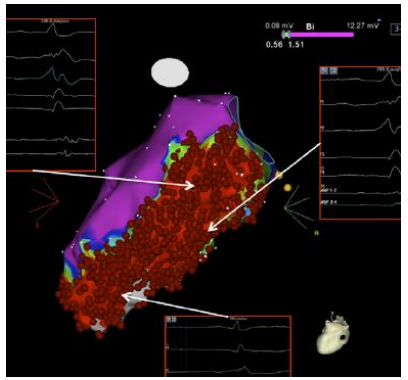
Della Bella Circ Arrhythm Electrophysiol. 2014;7:424-435

Ablation Strategy



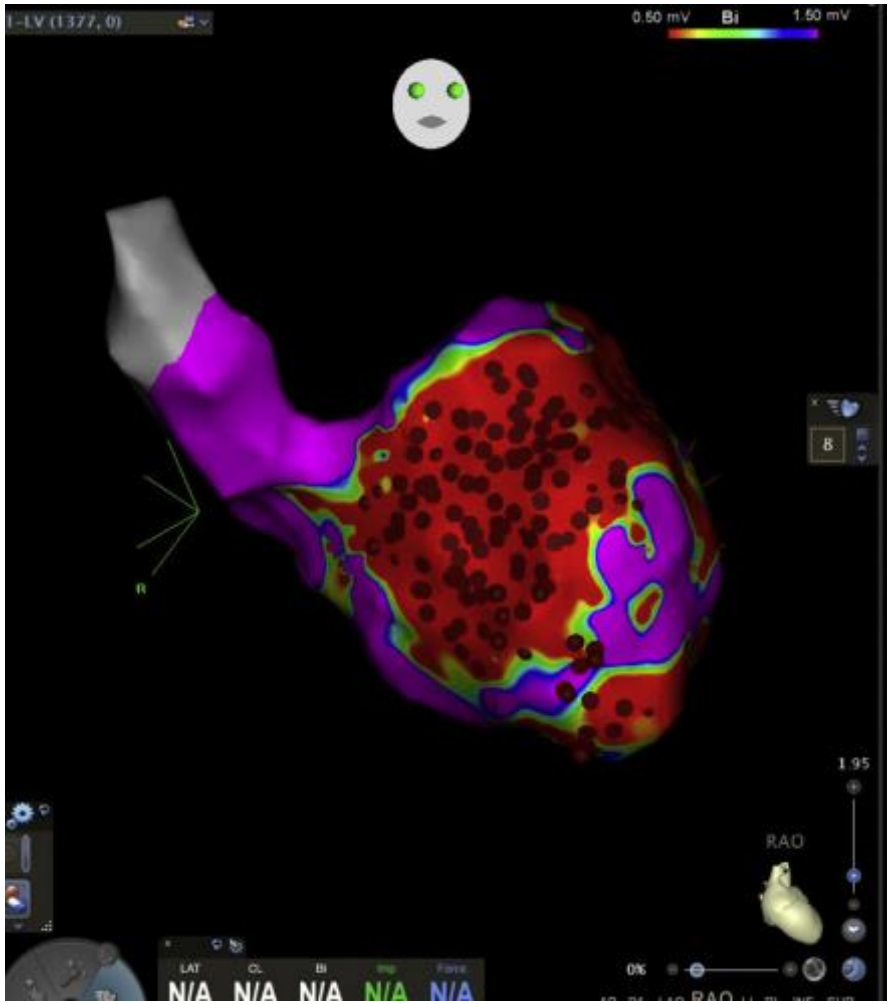




1. Endocardial homogenization
2. Encircling core isolation
3. Dechanneling
4. Late potential ablation (LP)
   or Isolated delayed potential (IDP)
5. LAVA
6. ILAM
7. DEEP
8. Hidden slow conduction

Channels ablation – EUS (Soejima), voltage-define CC (Arenal)
Short linear ablation parallel to the border zone (Soejima)
Linear lesion connecting dense scar to Nl myocardium (Marchlinski)
LAVA (local abn. Ventricular activity) ablation (Jais)
Scar dechanneling (Berruezo)
Circumferential scar isolation (Tilz)
Scar homogenization (Di Biase)

Endocardial scar homogenization



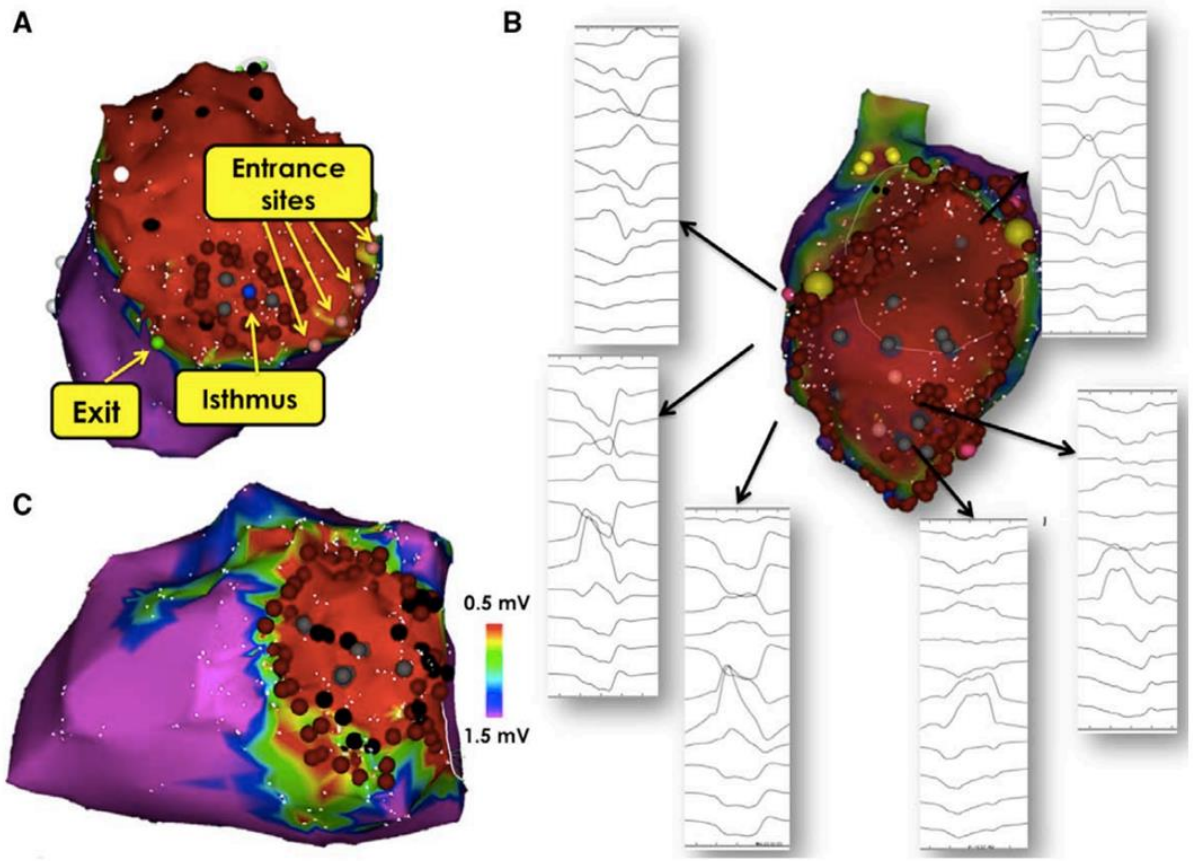
Any electrograms not fitting the definition (>1.5mV, <70ms) were categorized as "abnormal" and targeted for ablation. Delayed potentials even with normal amplitude and duration were also considered abnormal.

Scar homogenization was verified with high-output pacing [20 mA/2 milliseconds]) to confirm non-capture.

Noninducibility of monomorphic VT was the procedural endpoint in both groups.

J Am Coll Cardiol 2012;60:132–41
J Am Coll Cardiol EP 2019;5:13–24

Core Isolation of Critical Arrhythmia Elements for Treatment of Multiple Scar-Based VT



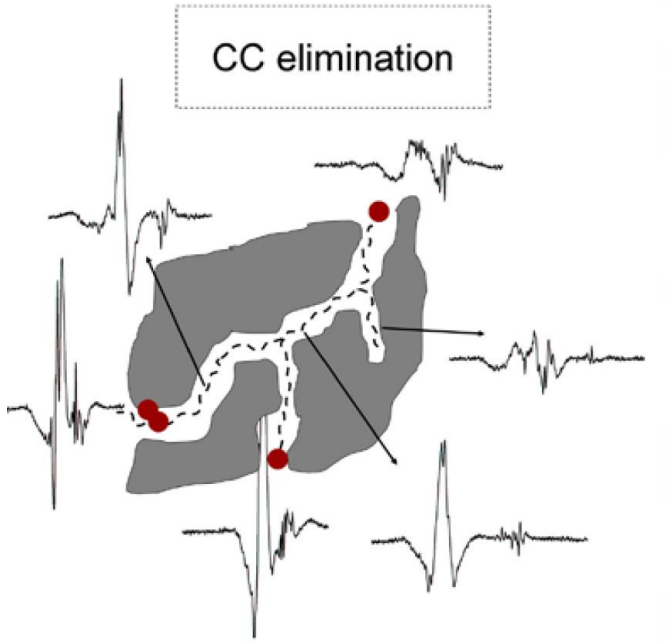
CI within the dense scar (<0.5 mV) at isthmus or entrance and early exit site(s)

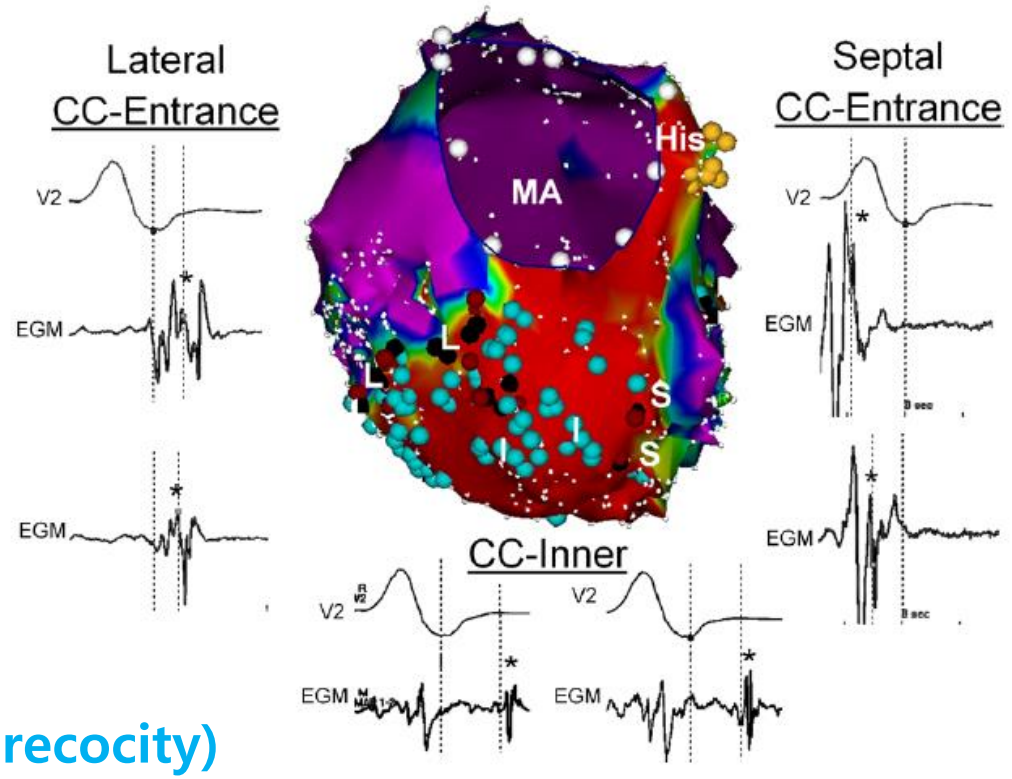
Regions with electrogram voltage <1.0 mV were also targeted if consistent with isthmus, entrance, or early exit sites. If VT was noninducible at the outset, circumferential ablation around dense scar (<0.5 mV) was performed.

Successful CI was defined by failure to capture-output of 20 mA and pulse width of 2 ms from multiple (≥3), discrete sites. Additional, reinforcing lesions were placed at each operator's discretion within the isolated area. Finally, epicardial mapping and ablation were performed in limited cases. (Final inducibility test)

Wendy S. Tzou, Francis E. Marchlinski
Circ Arrhythm Electrophysiol. 2015;8:353-361

Scar Dechanneling New Method for Scar-Related Left Ventricular Tachycardia Substrate Ablation





Entrance or inner CC (delayed-component precocity)
RF at the entrance CC
End point: disappearance, dissociation, sequence reversal
Backup RF inside the core if inner CC remains

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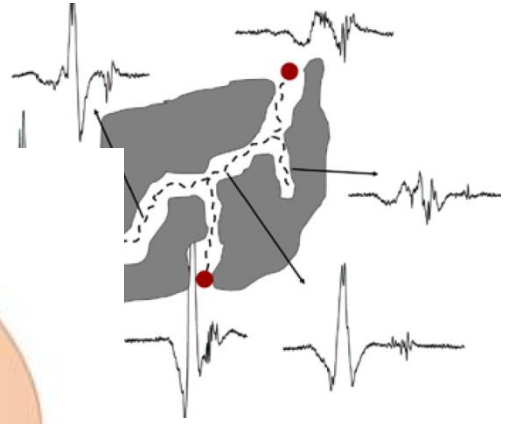
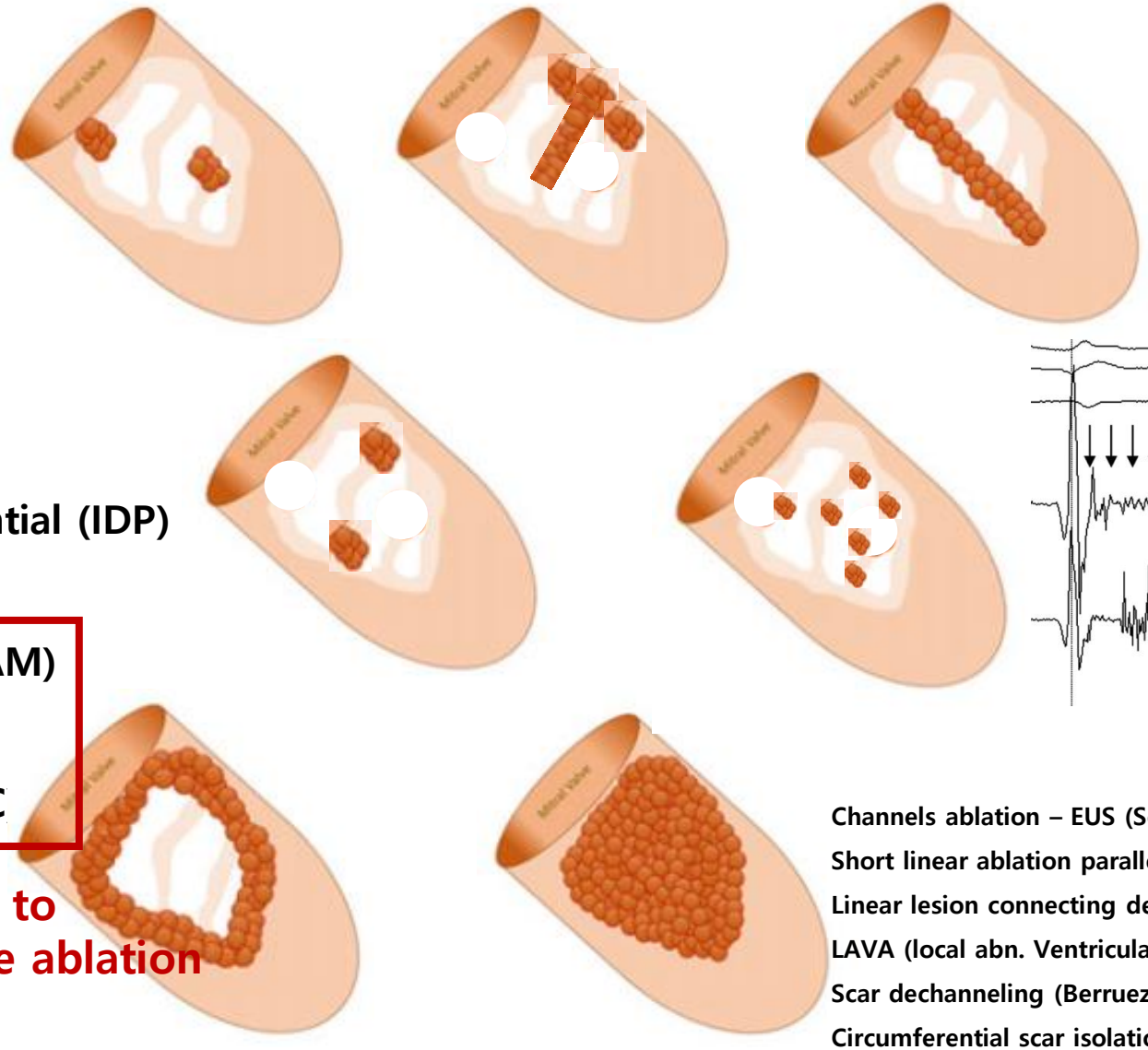
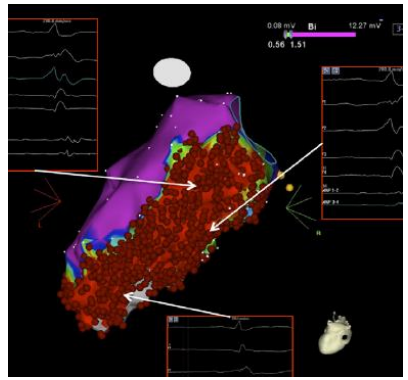
Circ Arrhythm Electrophysiol. 2015;8:326-336.

Ablation Strategy







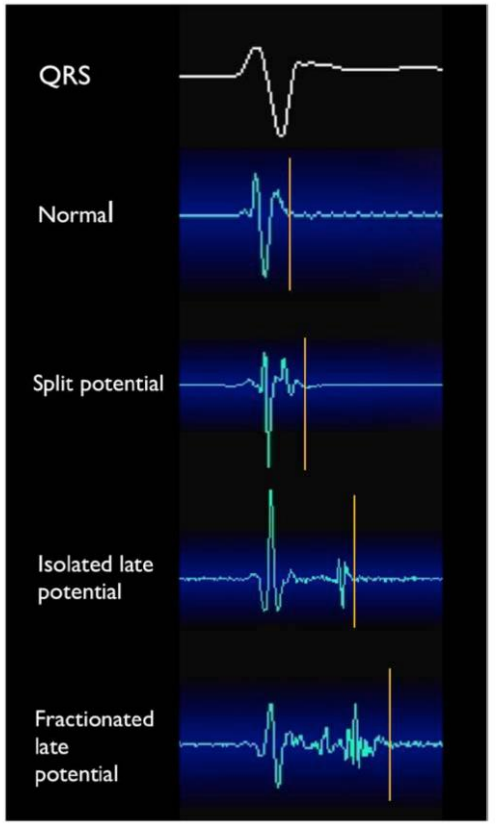
1. Endocardial homogenization
2. Encircling core isolation
3. Dechanneling
4. Late potential ablation (LP)
   or Isolated delayed potential (IDP)
5. LAVA
6. Isochronal late activation (ILAM)
7. Decrement Evoked (DeEP)
8. Hidden slow conduction (HSC

** Functional subst. mapping to increase accuracy of substrate ablation

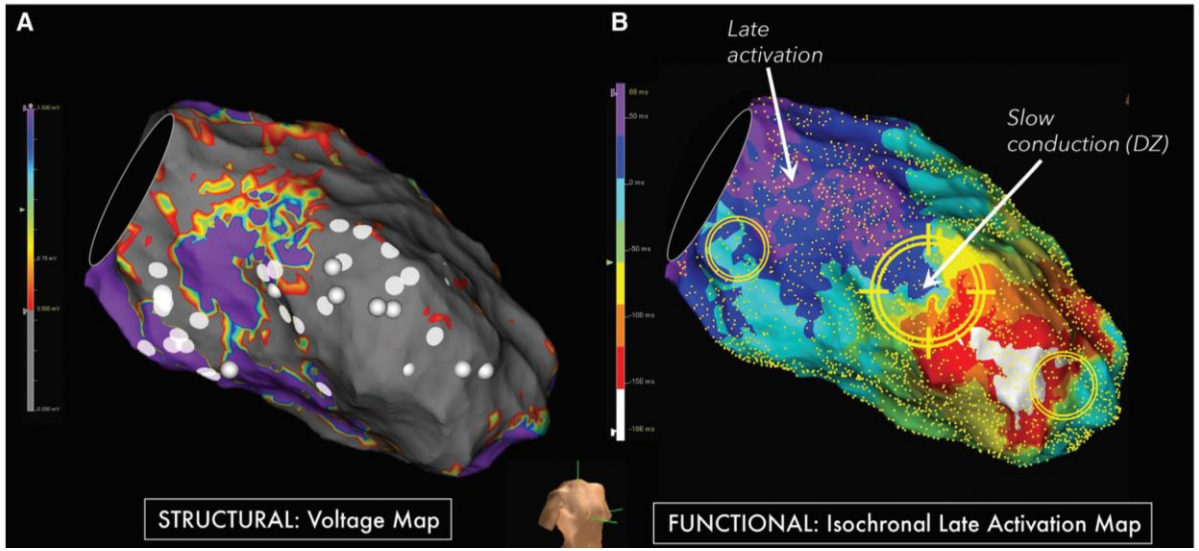
Channels ablation – EUS (Soejima), voltage-define CC (Arenal)
Short linear ablation parallel to the border zone (Soejima)
Linear lesion connecting dense scar to NI myocardium (Marchlinski)
LAVA (local abn. Ventricular activity) ablation (Jais)
Scar dechanneling (Berruezo)
Circumferential scar isolation (Tilz)
Scar homogenization (Di Biase)

Isochronal Late Activation Map (ILAM)

A New Functional Substrate Mapping Strategy
Guide targeted ablation, obviating need for extensive RF delivery
Regions with isochronal crowding (deceleration zones)
- niduses for reentry, predictive of VT termination

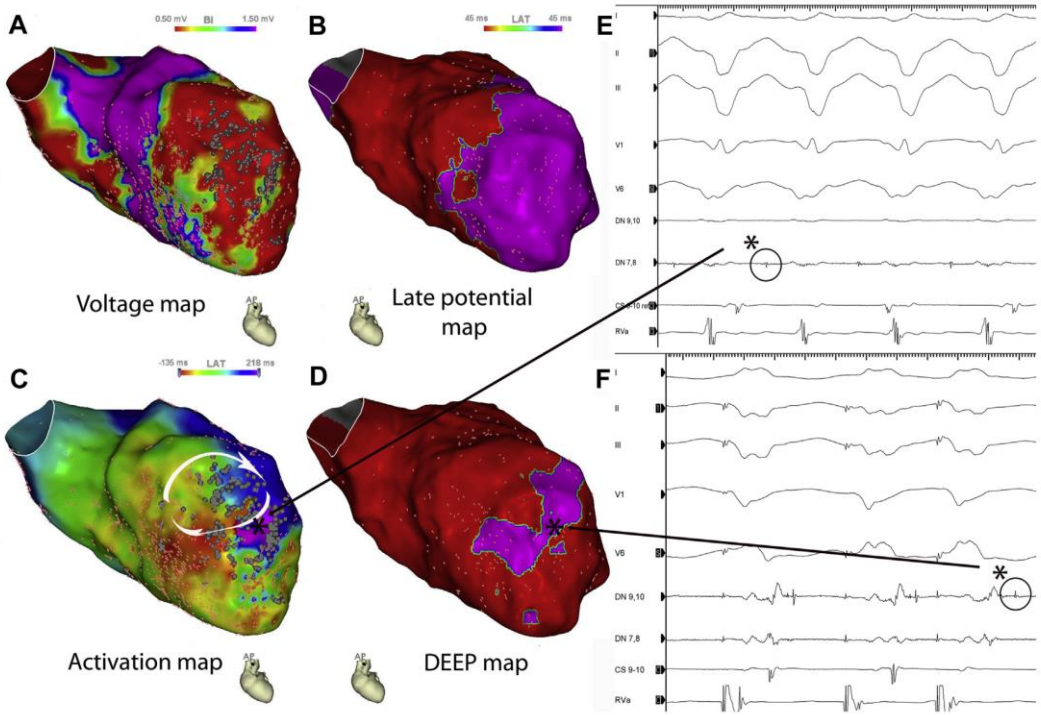


Each electrogram was timed at the offset of the local bipolar electrogram deflection, signifying the completion of local activation. The offset was chosen because of a higher degree of reproducibility and less interobserver variability than the onset, maximum dV/dT, or amplitude of a LP, which are more arbitrary and subjective at sites with continuous and fractionated activity.



Circ Arrhythm Electrophysiol. 2015;8:390-399
Circulation. 2019;140:1383–1397

Decrement Evoked Potentials (DeEP)

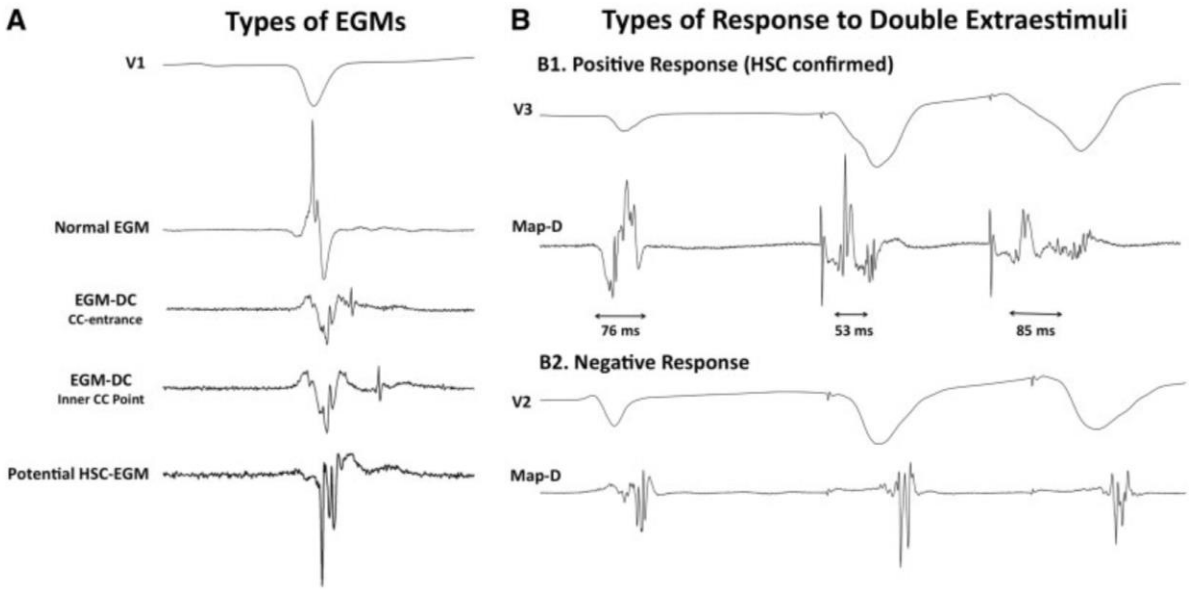


Mechanistic and physiological approach to identify functional substrate.
Single extra, 600, VERP+20
local potential delayed >10 ms

Targets limited regions of the diseased myocardium involved in the initiation and maintenance of VT.

J Am Coll Cardiol EP 2018;4:307–15

Hidden slow conduction (HSC)



SR w Double extrastimulation
VERP+60, +40-20ms
Triple extrastimulation
VERP+60, +40-20ms, +20-10ms

Europace (2018) 20, 337–346

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Several limitations to studies of PES

1. Most, retrospective and observational
2. Post-ablation PES, may be skipped because of concerns
3. Changes in antiarrhythmic drug therapy
4. Stimulation protocols and ablation approaches variable
5. Recurrence in non-inducible pts

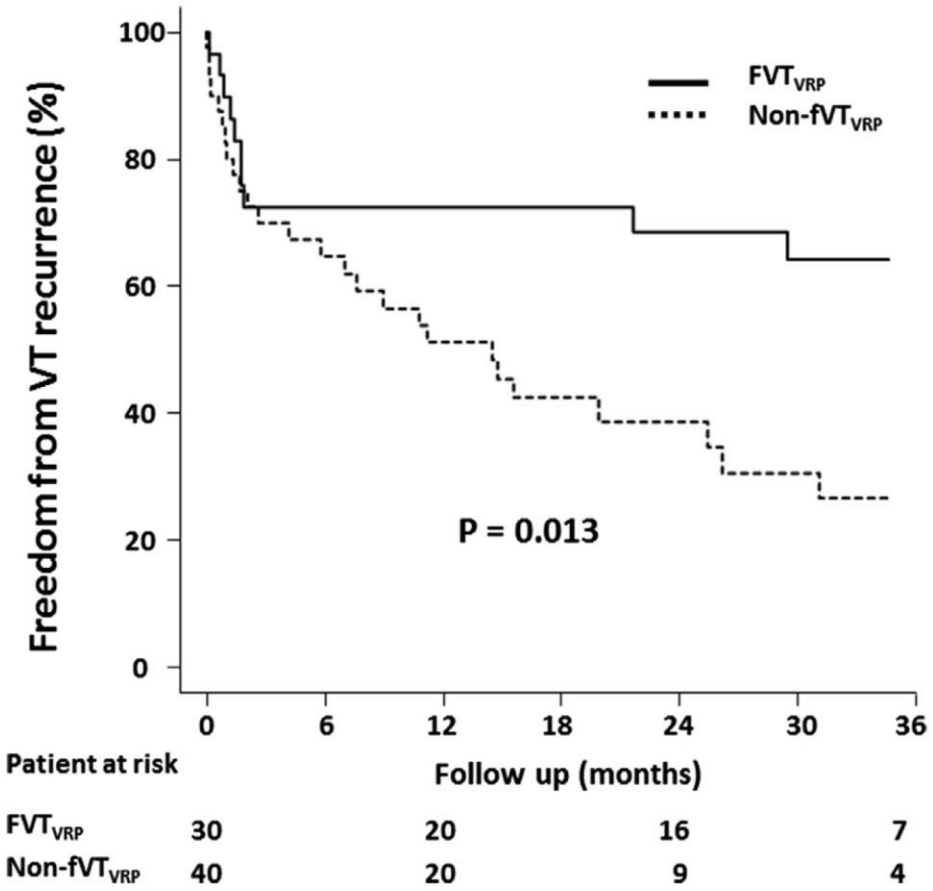
If induced, consider…

- features of induced VT (clinical/nonclinical, slow vs fast etc)
- Patient factors (EF)

Timing of PES

Roy M. John, William G. Stevenson, MD
Circ Arrhythm Electrophysiol. 2018;11:e006246.

Fast non-clinical VT inducible after VT ablation



Of 191 patients with ICM or NICM and VT ablation,
70 (64% ischemic) remained inducible for a **nonclinical** VT
-30 w fast VT
-40 a any slower remaining VT

VTs were defined as fast if VTCL was < VRP400+30 ms (fVTVRP)

Conclusion

Inducibility after ablation of only fVTVRP is associated with low VT recurrence during FU. Eliminating these VTs might not be required, thus putting into question noninducibility of any VT as a prognostically relevant ablation endpoint.

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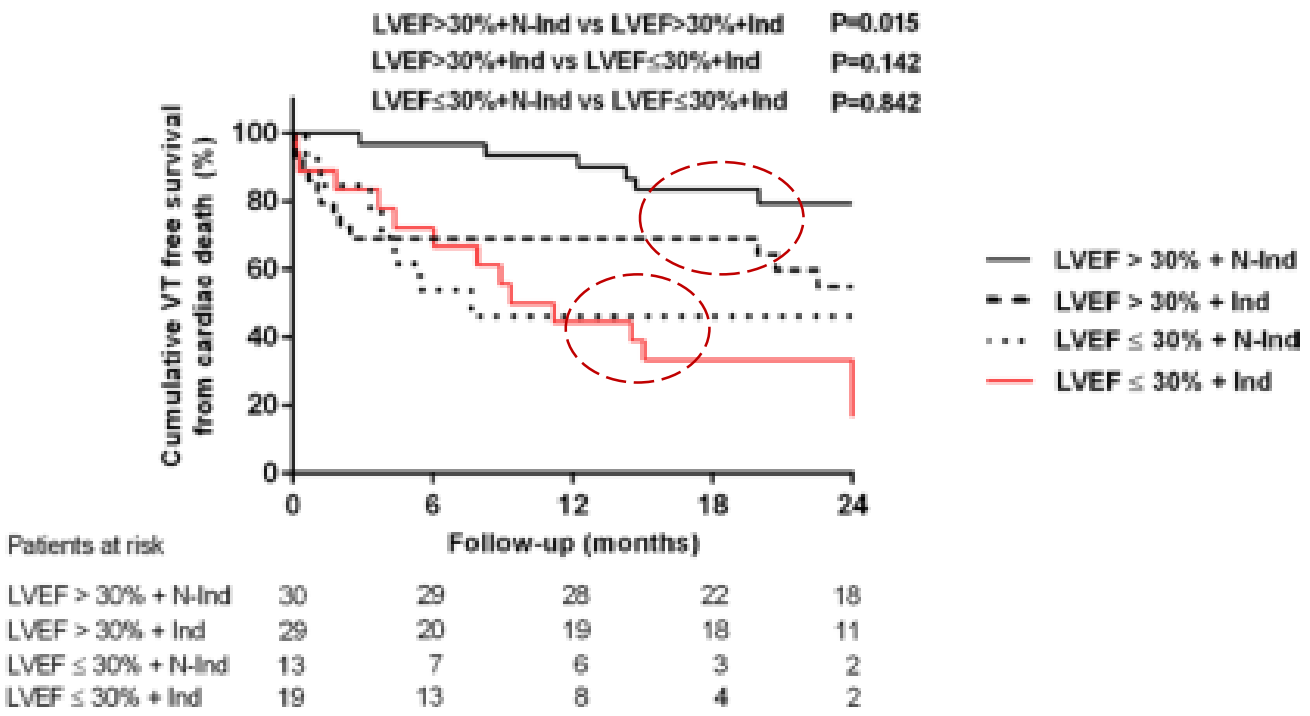
Heart Rhythm 2018;15:668–676

Reassessing Non-inducibility as Ablation Endpoint of Post-Infarction VT - The Impact of LV Function



91 patients (82 men, 67±10 yrs) with MI-VT.
59 (65%) EF>30% (mean 41±7),
32 (35%) LVEF≤30% (mean 20±5).

Noninducible **patients with LVEF>30%** had a recurrence-free survival from SCD of 90% compared with 65% for inducible patients (*P*=0.015).

In the subgroup of **patients with LVEF≤30%,** the survival free from VT recurrence and SCD was 31% for noninducible compared with 39% for those who remained inducible (*P*=0.842).

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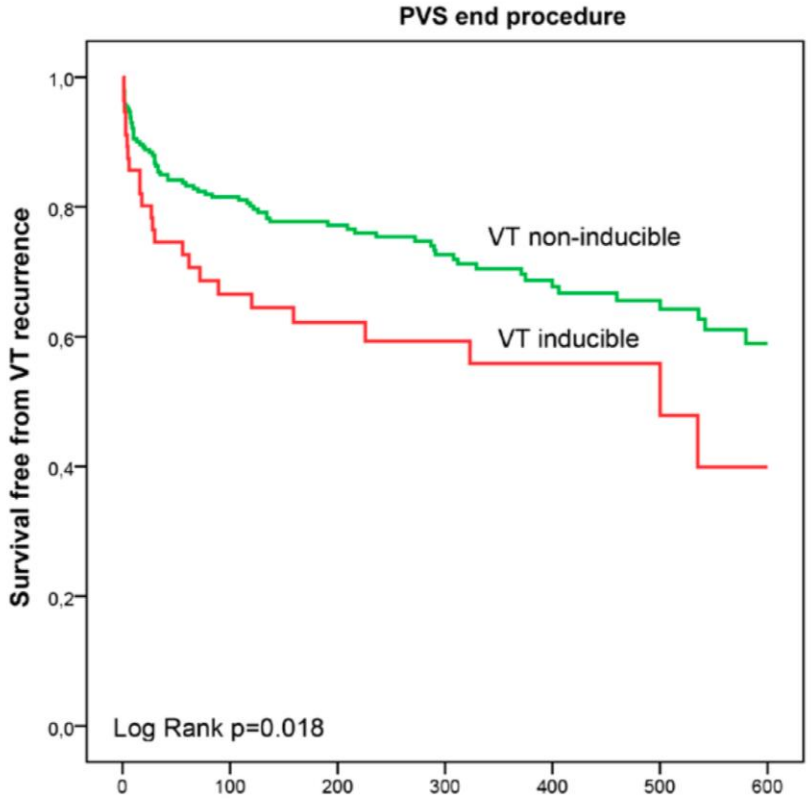
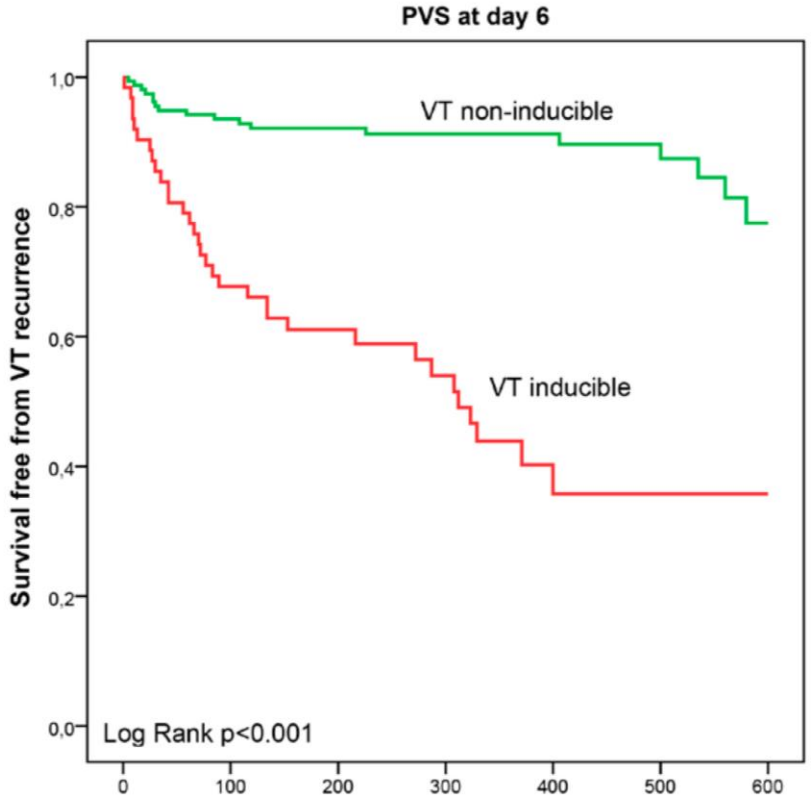
Circ AE. 2015;8:853-862.

Timing, Value of Programmed Ventricular Stimulation

PVSs were performed 6 days (5–7) after ablation (186 noninvasive programmed stimulations and 32 invasive PVS) in 210 consecutive patients (ischemic, 48%;



Under Risk							
VT non-inducible	242	181	134	104	70	49	23
VT inducible	56	32	24	18	10	7	3



Under Risk							
VT non-inducible	156	137	108	88	58	40	17
VT inducible	62	42	29	22	9	4	2

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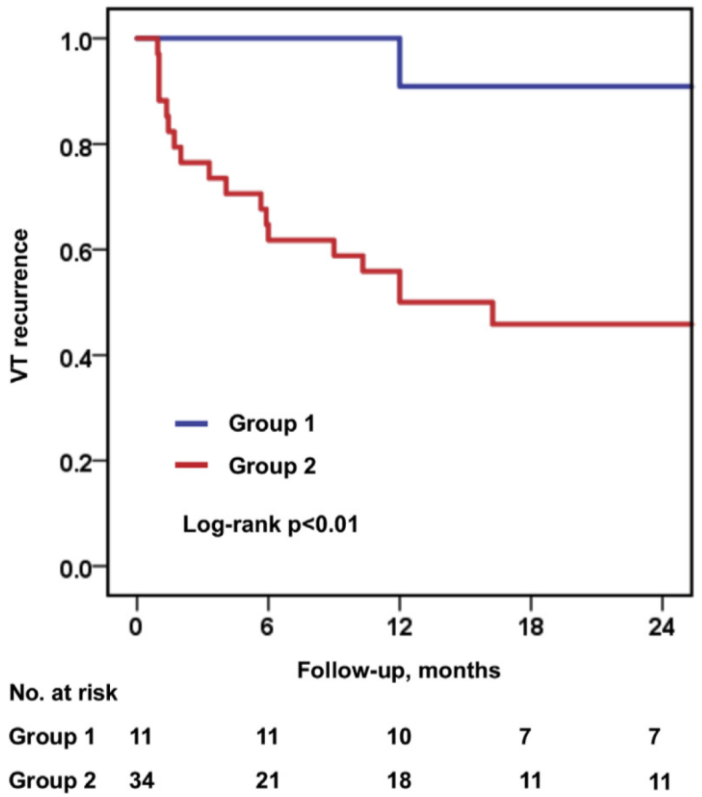
Oloriz and Paolo Della Bella
Circ Arrhythm Electrophysiol. 2018;11:e005602

Conclusion-RF ablation in ischemic CM

1. Timing: first-line?, AAD-escalation vs RF
2. Methods
   - First-line epicardial approach? – non-randomized only
   - VT-based vs Scar-based Ablation
   - Various methods
     : channel/LP, homogenize, encircle, dechannel etc
   - Functional-ILAM,DEEP,HSC
3. End-point: non-inducibility
   - non-clinical VT (slow) cf fast VT
   - EF
   - recently, NIPS-guided inducibility test and RF

Noninvasive Programmed Ventricular Stimulation-Guided Management Following VT Ablation

Among 469 patients (64 12 years of age; 85% males; 60% ischemic), 216 patients (46%) underwent NIPS 3 days (interquartile range: 2 to 4 days) after CA.
Clinical VT was induced in 45 patients (21%).



Response to NIPS

"clinical VT" if any sustained, mono VT (matching spon. ECG or ICD)

"nonclinical VT" if only sustained, mono VT (not matching any of the ECG or ICD)

"no VT inducible" including nonsust. mono VT, poly VT, or VF

Clinical VT was induced in 45 patients (21%). Among those 45, CA was repeated in 11 patients (24%).

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J Am Coll Cardiol EP 2019;5:719–27

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