VT Ablation Endpoints: Where Do We Stand?

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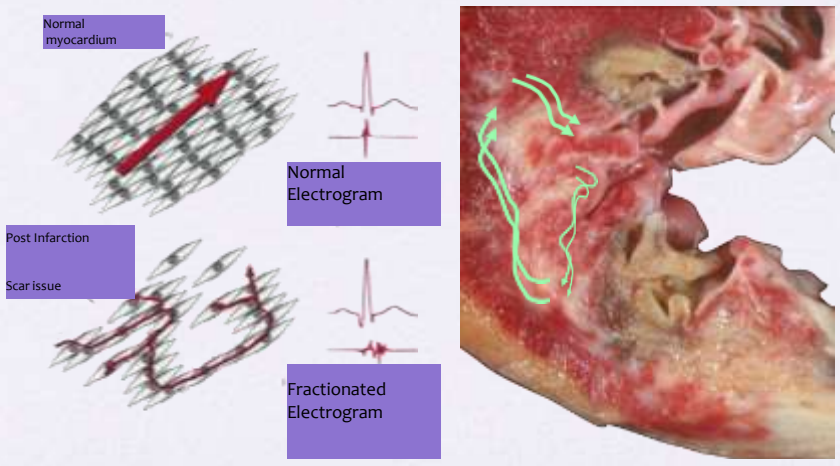
Introduction

- The majority of scar related VTs are caused by reentry
- Surviving myocyte bundles between fibrous tissue create critical isthmuses that allow reentry

Introduction



Introduction

The Rationale of catheter ablation is the interruption of critical areas of slow conduction responsible for development of VT

When should we stop ablating and declare victory?

Criteria of an adequate endpoint

- Should be clearly defined
- Should be practical to measure
- Should be reproducible
- Should have significant predictive impact on long term outcome

Endpoints for ablation of scar related VT

- Non-inducibility of VT at PES or NIPS
- Endpoints for substrate-based techniques

Non-Inducibility

The definition

Study	Year	No. of Patients	EF, %	End Point	PES Protocol	Acute End Point	Follow-Up, mo	VT Recurrence
Calkins et al[9]	2000	119	31	Noninducibility of any mappable VT	NS drive trains, S4, 2 RV sites	89%	8	46%
Borger et al[11]	2002	89	29	Noninducibility of any mappable VT	600/500/400 ms, S4, 2 RV sites	70%	34	23%
Della Bella et al[14]	2002	124	34	Noninducibility of clinical VT	600/500/400 ms, S4, 2 RV sites	73%	41	28%
O'Donnell et al[15]	2002	112	NR	Noninducibility of any VT	600/400 ms, S6, 1 RV site (apex)	38%	61	23%
Segal et al[16]	2005	40	36	Noninducibility of any VT	600/400 ms, S4, 2 RV sites	60%	36	57%
Volkmer et al[17]	2006	47	30	Noninducibility of any VT with a CL <30 ms of the clinical VT	NS drive trains, S4, 2 RV sites	81%	25	25%
Stevenson et al[18]	2008	231	25	Noninducibility of any VT with a CL <20 ms of the clinical VT; faster VTs targeted at the discretion of the operator	600/400 ms, S4, 2 RV sites	48%	6	47%
Carbucicchio et al[7]	2008	95	36	Noninducibility of any VT	600/500/400 ms, S4, multiple RV/LV sites	65%	22	34%
Tanner et al[19]	2010	63	30	Noninducibility of any clinical VT and VTs slower than clinical VT	600/400 ms, S4, 2 RV sites	81%	12	49%
Kuck et al[8]	2010	52	34	No information	No information	52%	23	53%
Tung et al[6]	2010	54	31	Noninducibility of any VT	600/400 ms, S4, 2 RV sites	76%	24	15%
Dinov et al[20]	2012	102	32	Noninducibility of any VT	500/430/370/330 ms, S2, 1 RV site (apex)	76%	14	42%

Practicability

- Lack of inducibility before ablation
- Induction of VT of undetermined clinical relevance
- Factors like sedation, general anaesthesia, transient ischemia or hemodynamic deterioration
- Patient related factors i.e too unstable
- Physician related factors

Reproducibility

Noninvasive Programmed Ventricular Stimulation Early After Ventricular Tachycardia Ablation to Predict Risk of Late Recurrence

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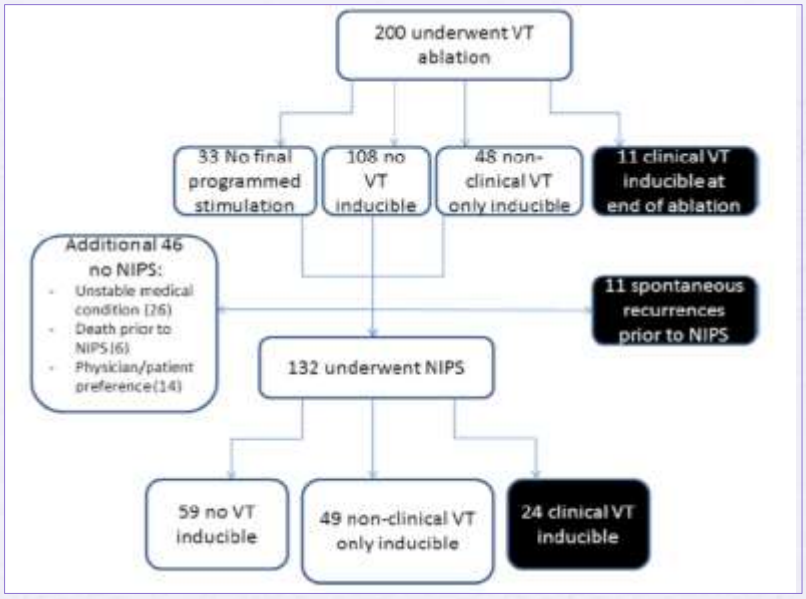
Philadelphia, Pennsylvania; and Manhasset, New York

JACC 2012



JACC 2012

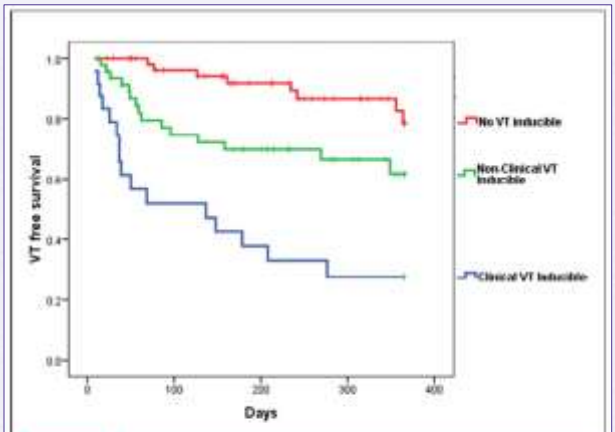


Figure 2 One-Year VT-Free Survival by Inducibility at NIPS

Kaplan-Meier curves are shown for 1-year VT-free survival for the no VT-inducible, nonclinical VT-inducible, and clinical VT-inducible groups. Abbreviations as in Figure 1.

JACC 2012

Predictive value

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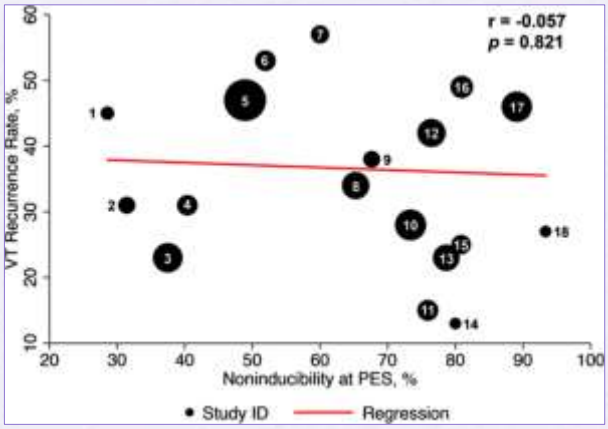
Weighted meta-regression analysis assessing the value of noninducibility at programmed electric stimulation (PES) immediately after the procedure in predicting long-term arrhythmia-free survival in patients undergoing catheter ablation of postinfarct ventricular tachycardia (VT)



Circ Arrhythm Electrophysiol. 2015

American Heart Association.

Reassessing Noninducibility as Ablation Endpoint of Post-Infarction Ventricular Tachycardia

The Impact of Left Ventricular Function

Marta de Riva, MD; Sebastiaan R.D. Piers, MD; Gijs F.L. Kapel, MD; Masaya Watanabe, MD, PhD; Jeroen Venlet, MD; Serge A. Trines, MD, PhD; Martin J. Schalij, MD, PhD; Katja Zeppenfeld, MD, PhD

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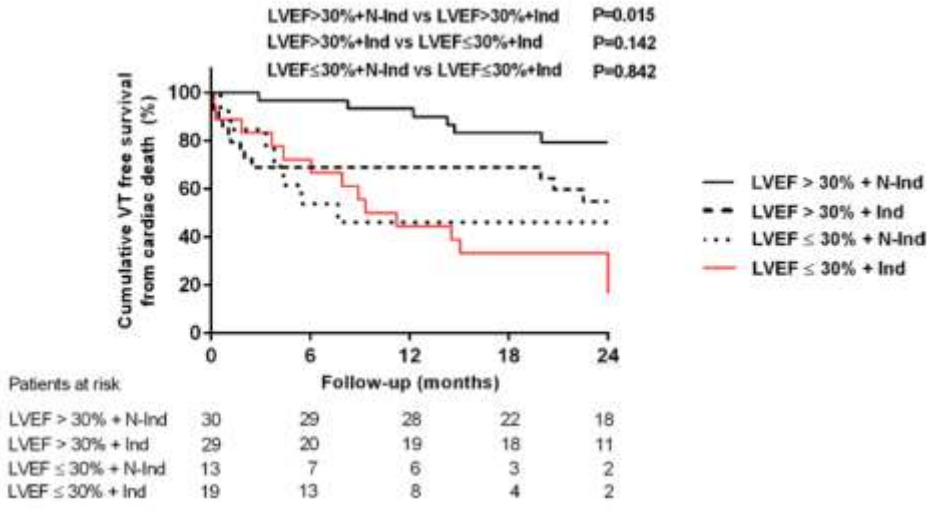

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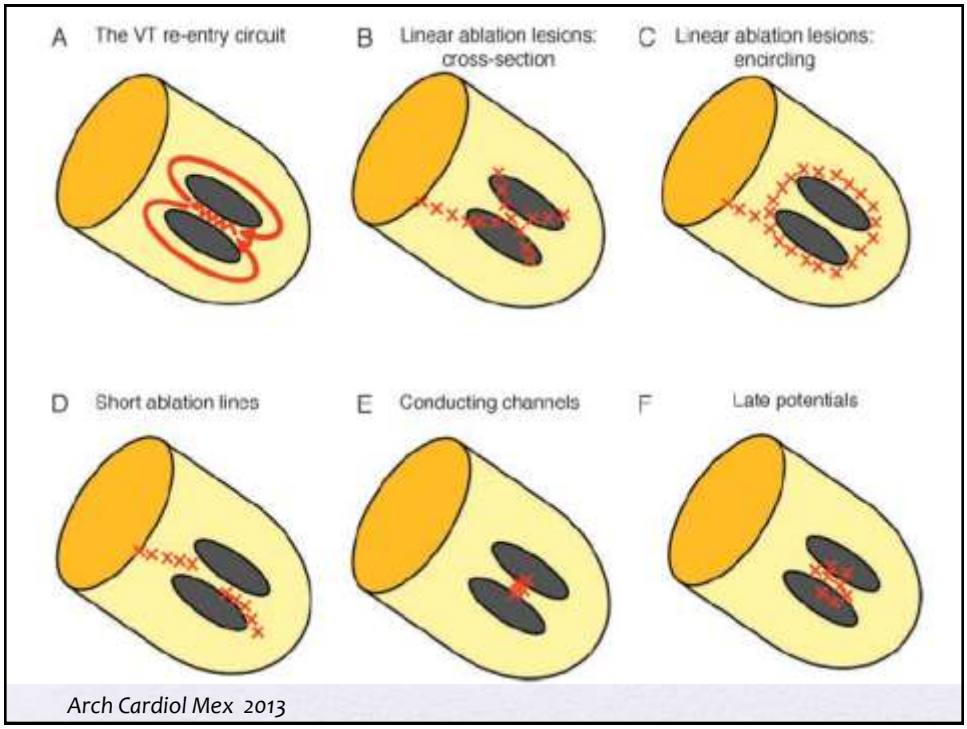
Substrate-based ablation techniques



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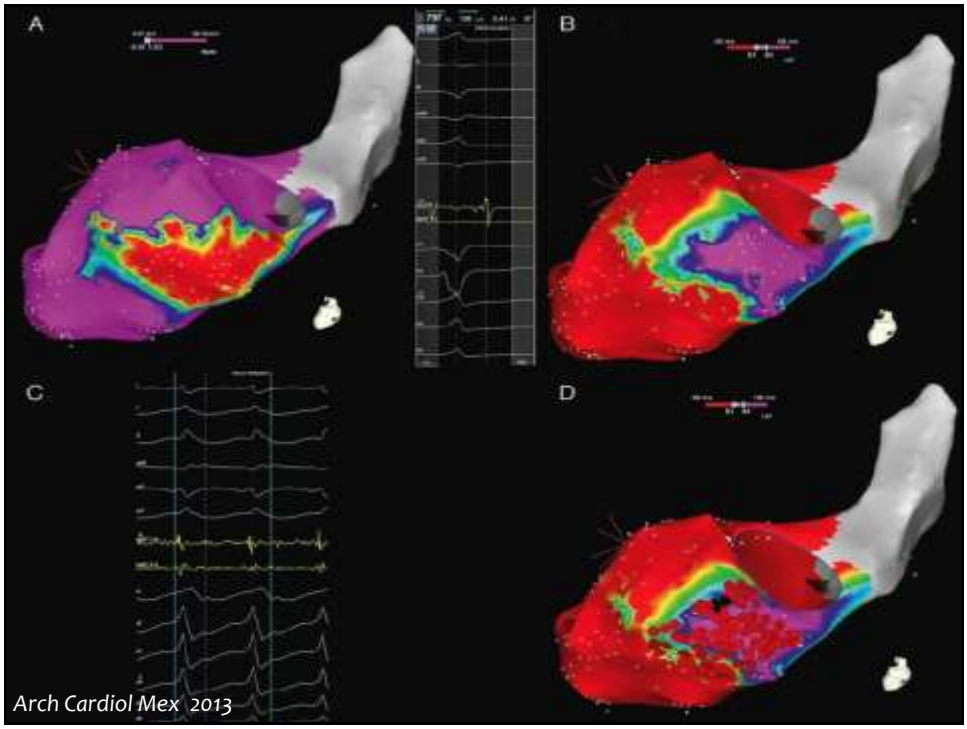
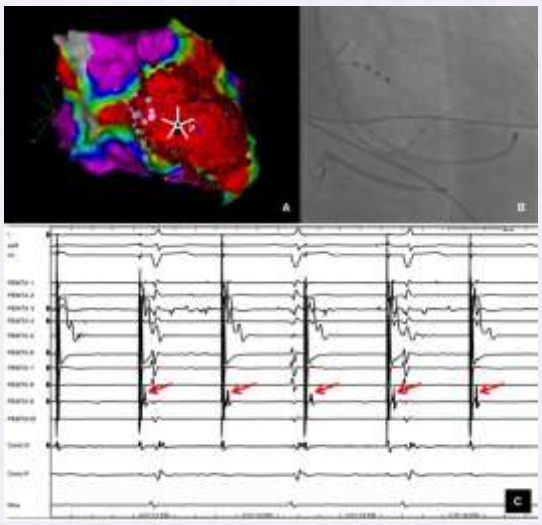
Endpoints of Ablation of abnormal EGMs

- Elimination of late potentials
- Change in late potential activation
- Scar dechanneling
- Isolation of scar core with box lesions



Example of box lesion set with achievement of electric isolation of the core of the ventricular tachycardia (VT) circuit.



Pasquale Santangeli et al. Circ Arrhythm Electrophysiol. 2014;7:949-960

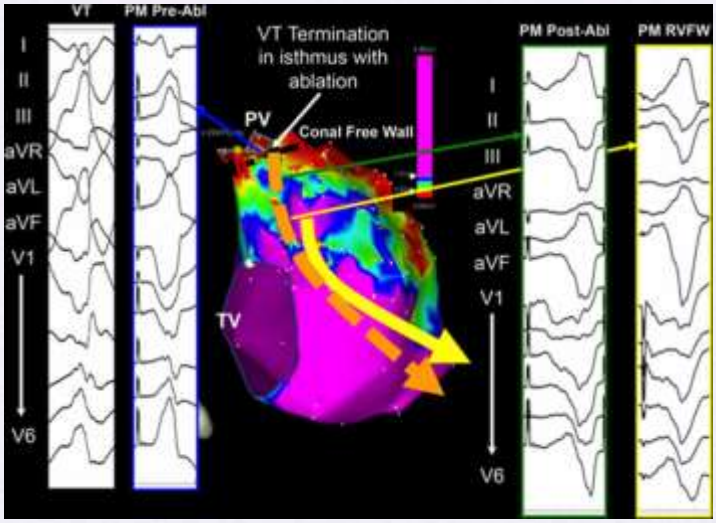
Limitations

- Difficult to achieve
- Time consuming (need for remap)
- Late potentials are not always present
- Require extensive ablation

Endpoints for linear ablation lesions

- Failure to capture at high output
- Change in the QRS morphology with pacing from each side of the line
- Activation map showing conduction block along the line

Right ventricular voltage map of a patient with Tetralogy of Fallot and scar-related ventricular tachycardia (VT).



Pasquale Santangeli et al. Circ Arrhythm Electrophysiol. 2014;7:949-960

American Heart Association.

Limitations

- Optimal pacing output unknown
- Distinction between block and marked conduction delay
- Need for multiple catheters
- No prospective validation

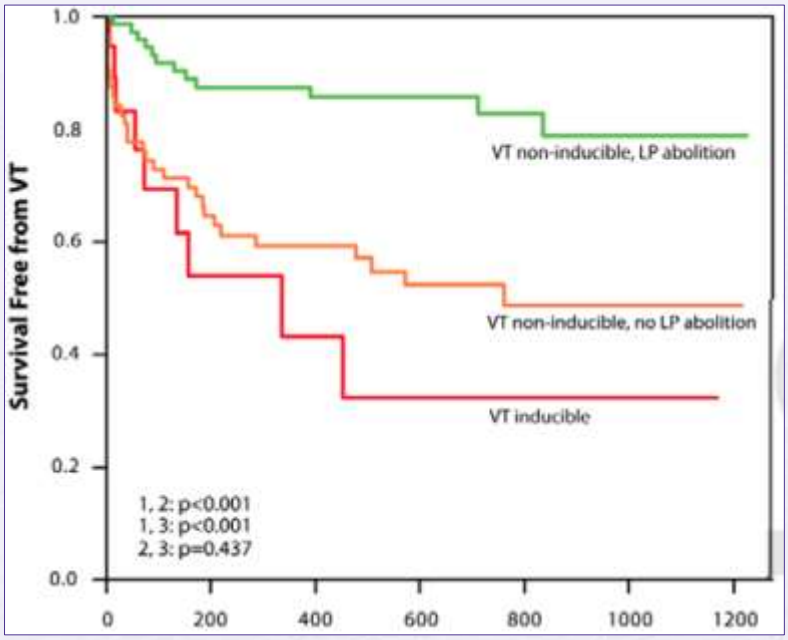
Predictive value

Study	Year	No. of Patients	Type of Substrate	LVEF, %	End Point Assessed	EPI Map/Ablt	FU, mo	VT Recurrence	Complications
Arenal et al[6]	2003	24	21 ICM, 2 NICM, 1 ToF	30±9	Elimination of late potentials	No	9±4	21%	None
Volkmer et al[7]	2006	25	ICM	30±8	Elimination of late potentials	No	26±14	29%	Not reported
Nogami et al[24]	2008	18	ARVC	NR	Change of late potentials*	No	61±38	33%	Not reported
Garcia et al[25]	2009	13	ARVC	NR	Elimination of late potentials	Yes	18±13	33%	None
Bai et al[11]	2011	26	ARVC	53±10	Elimination of late potentials	Yes	39±4	15%	1 groin hematoma
Berruezo et al[26]	2012	11	ARVC	55±7	Elimination of late potentials	Yes	11 (6–24)	9%	1 RV puncture during epicardial access
Di Biase et al[1]	2012	43	ICM	24±8	Elimination of late potentials±failure to capture	Yes	21 (19–25)	19%	1 groin hematoma
Jais et al[2]	2012	70	56 ICM, 14 NICM	35±10	Elimination of late potentials	Yes	22 (14–27)	32%	1 cardiac tamponade, 1 RV perforation
Vergara et al[18]	2012	50	36 ICM, 14 NICM	32±9 ICM; 36±10 NICM	Elimination of late potentials	Yes	13±4	20%	Not reported
Arenal et al[27]	2013	59	ICM	30±11	Elimination of late potentials	No	39±21	42%	No major
Tung et al[13]	2013	21	15 ICM, 2 NICM, 2 ARVC, 1 sarcoid, 1 noncompaction, 1 chagas	25 (25–30)	Change or elimination of late potentials±failure to capture±impedance drop >10	Yes	11 (6–18)	14%	Not reported

Non-Inducibility and Late Potential Abolition: A Novel Combined Prognostic Procedural Endpoint for Catheter Ablation of Post-infarction Ventricular Tachycardia

John Silberbauer, Teresa Oloriz, Giuseppe Maccabelli, Dimitris Tsiachris, Francesca Baratto, Pasquale Vergara, Hiroya Mizuno, Caterina Bisceglia, Alessandra Marzi, Nicoleta Sora, Fabrizio Guarracini, Andrea Radinovic, Manuela Cireddu, Simone Sala, Simone Gulletta, Gabriele Paglino, Patrizio Mazzone, Nicola Trevisi and Paolo Della Bella

Circ Arrhythm Electrophysiol. published online May 15, 2014;



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Take home messages

- Ablation is a well established treatment for VT that is important for shock reduction, but long term results remain suboptimal
- Non-inducibility is a probabilistic rather than deterministic phenomenon, thus multiple evaluations might increase the chance of VT induction
- Combined endpoints, can offer the best long term reduction of VT recurrence but until now not enough to alleviate the need for an ICD