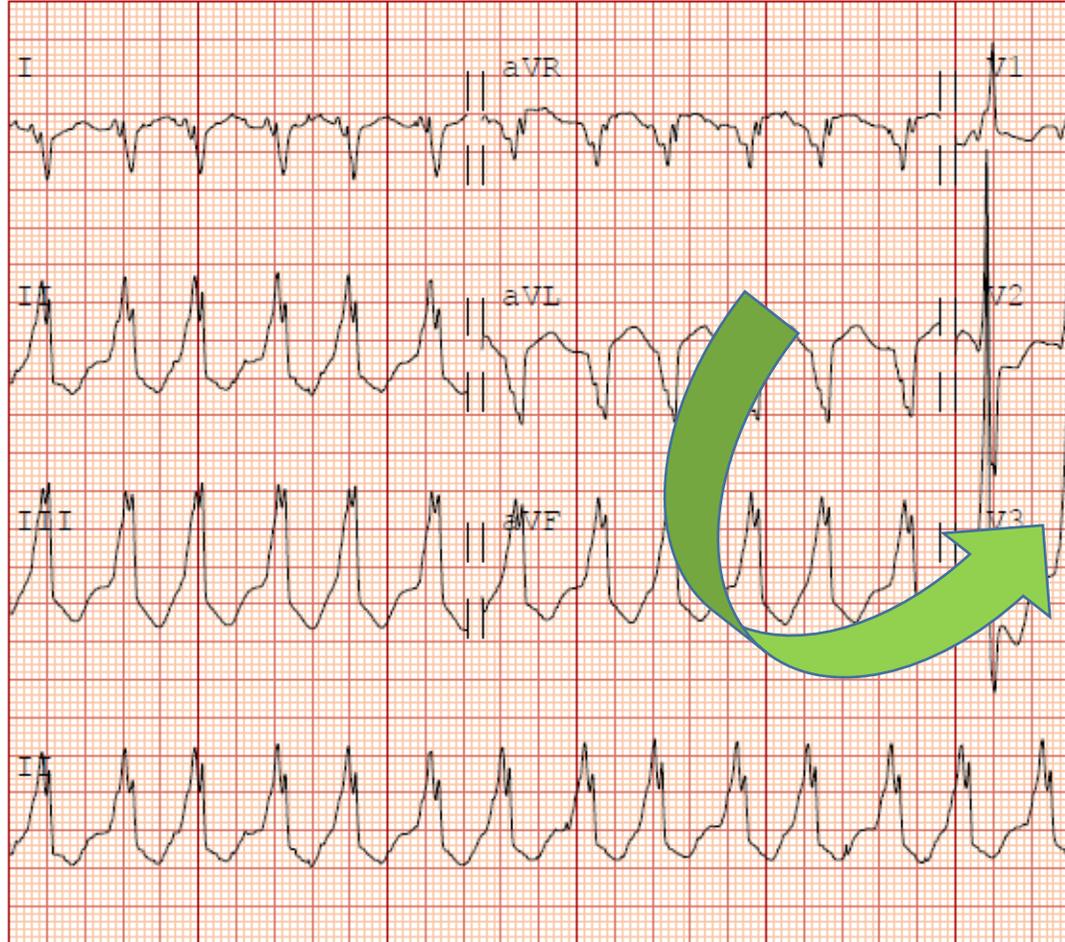


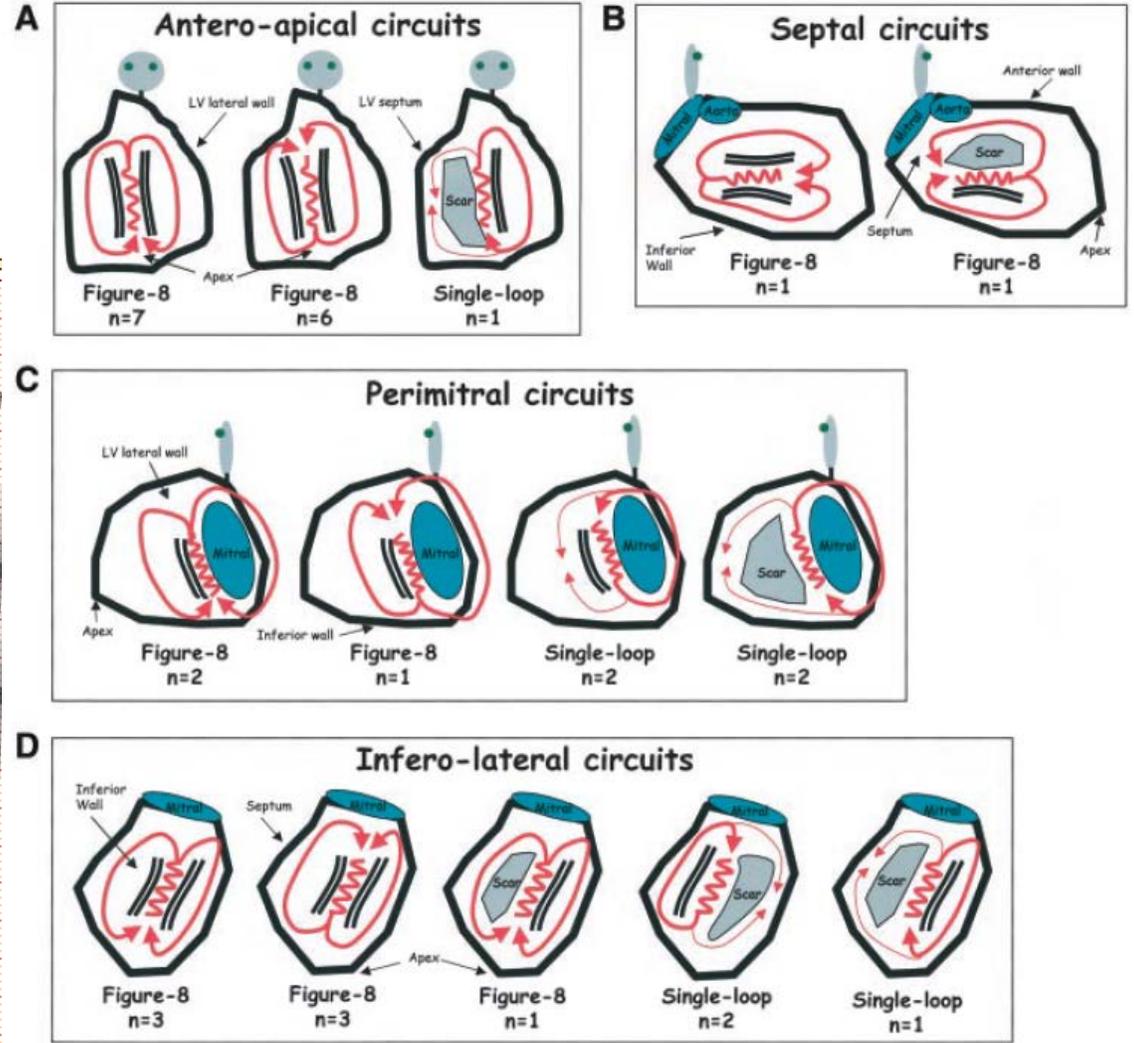
USO DE LA RADIOTERAPIA PARA LA ABLACION DE ARRITMIAS VENTRICULARES

Jesús Jiménez López
Unidad de Arritmias
Hospital del Mar

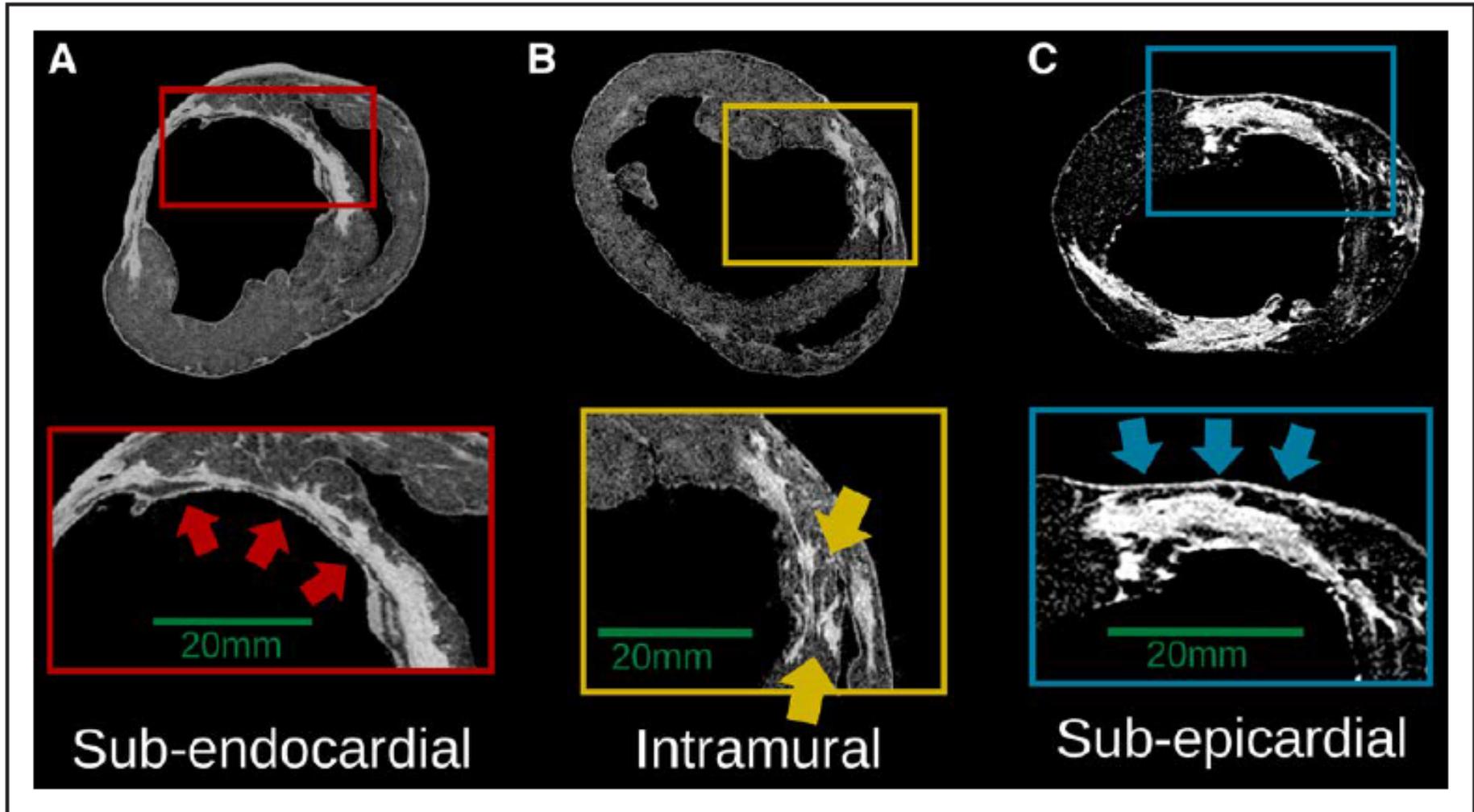
Estudio ant.: 21-May-2017 10:40:17 - Anómalo Sin confirm
12 deriv.: Coloc. estándar No con:

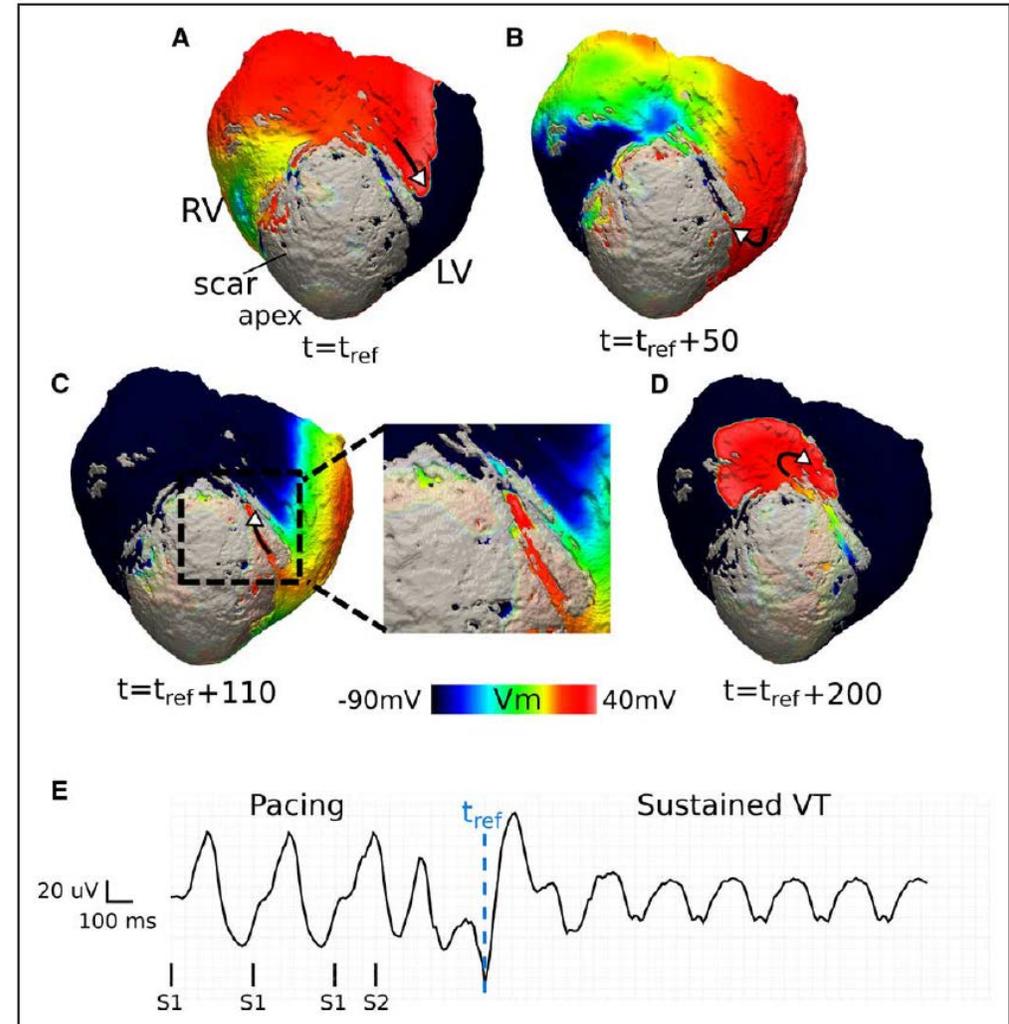
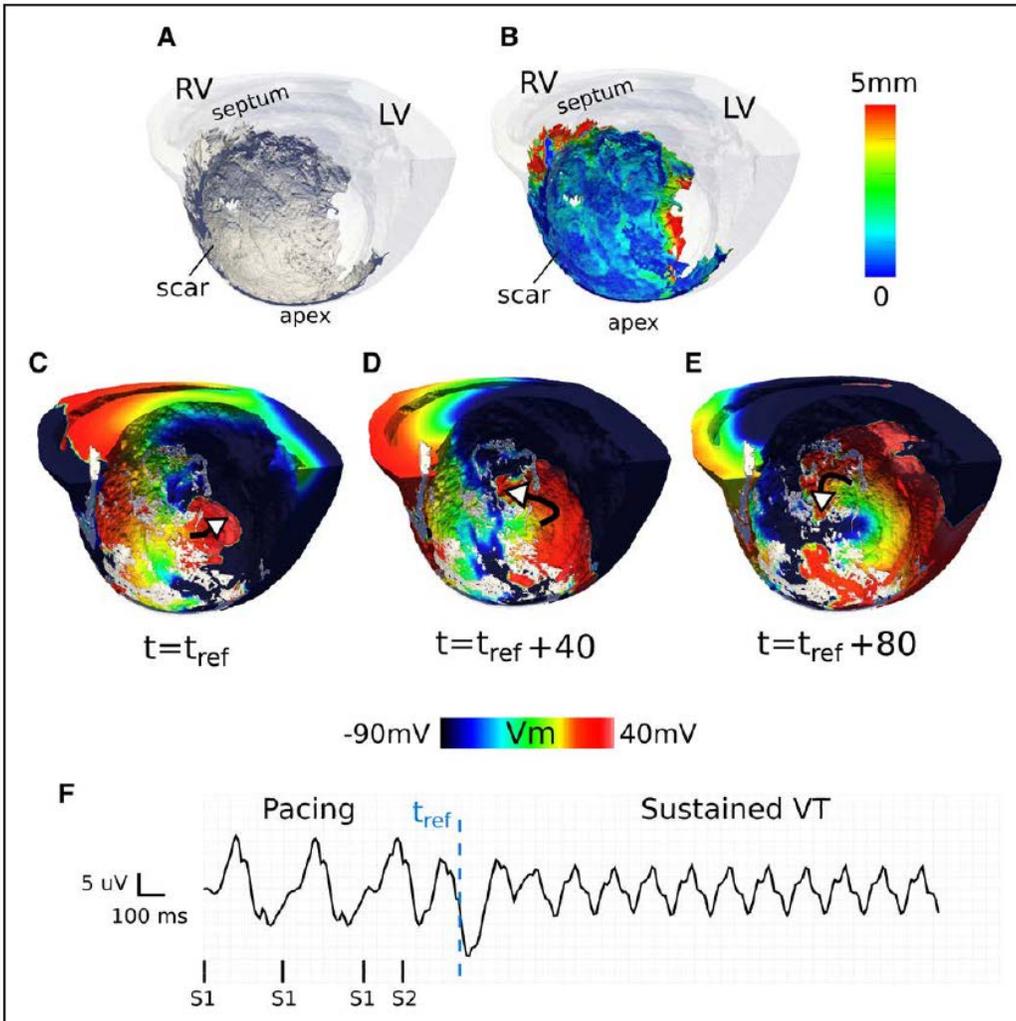


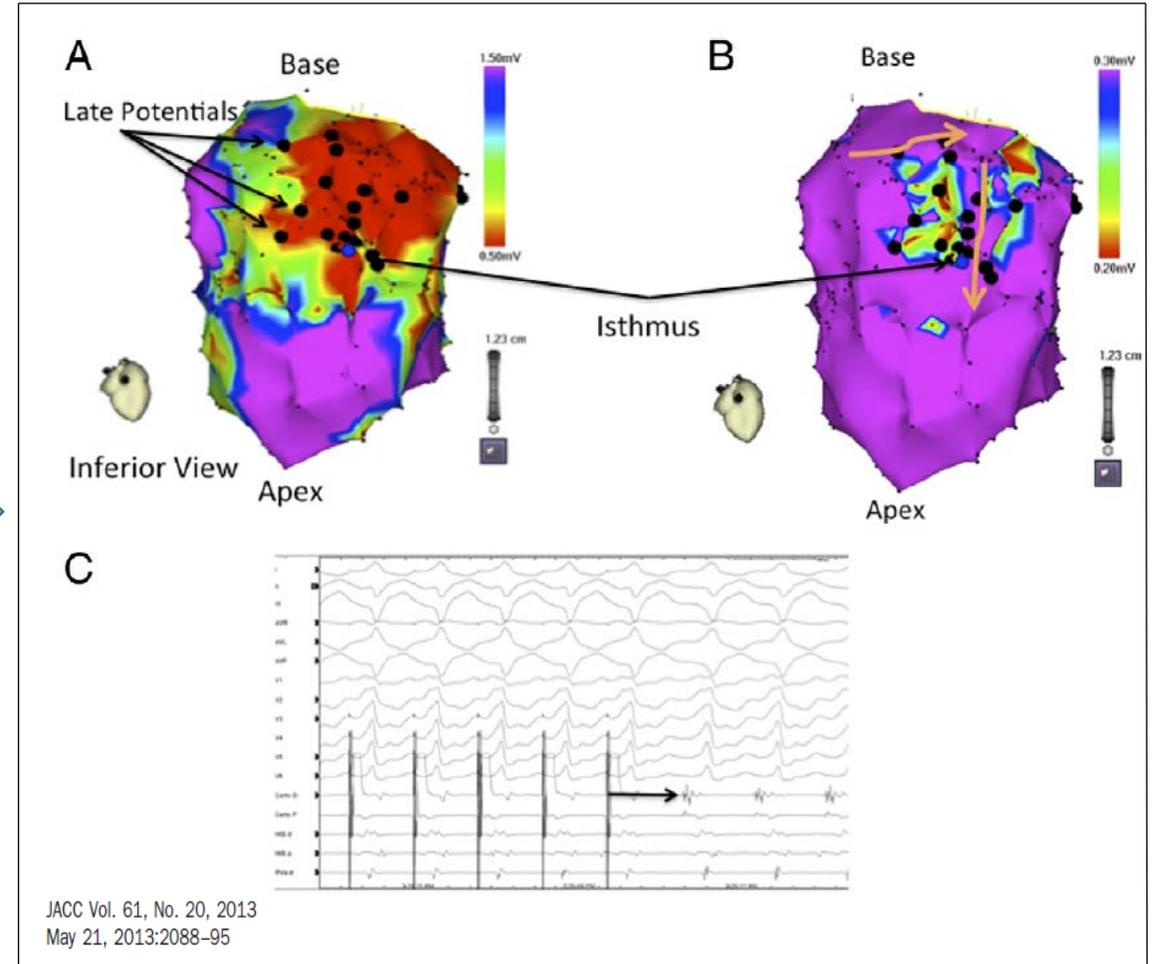
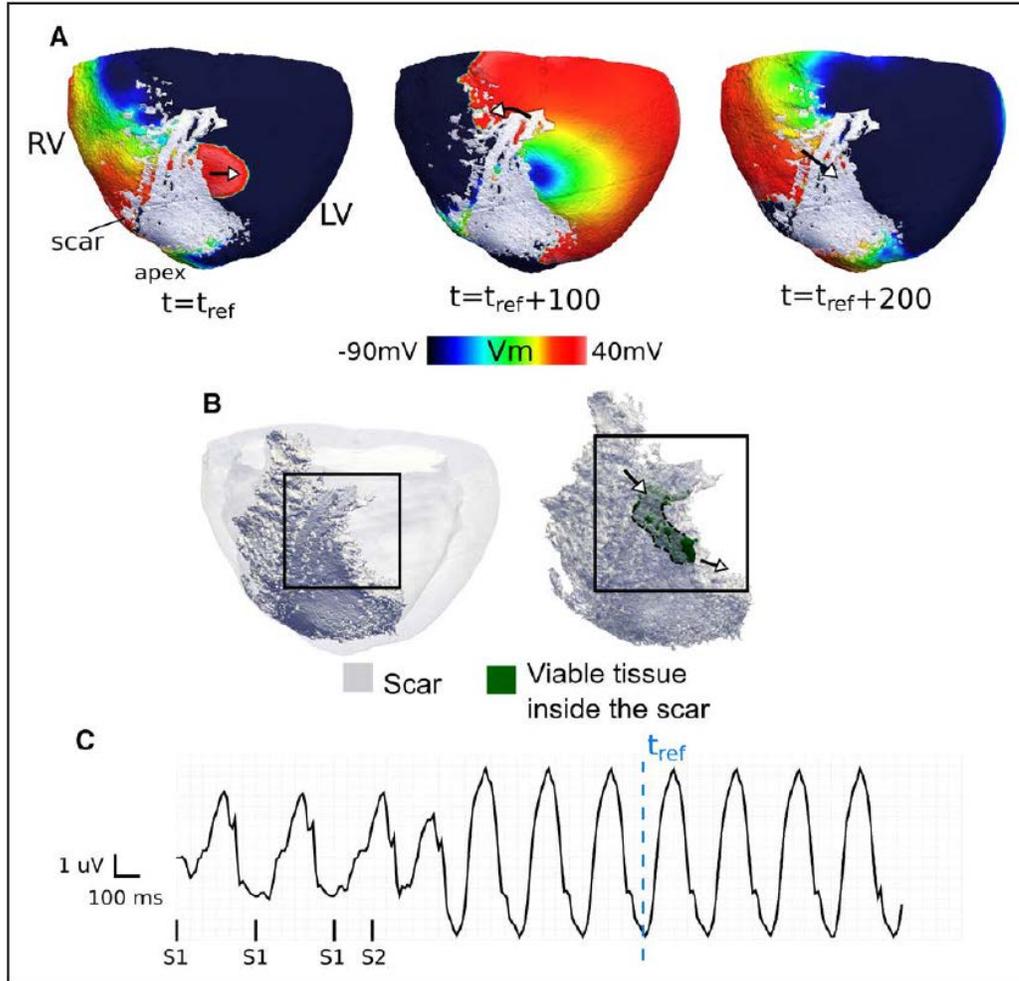
Disp.: UCI_01 Veloc: 25 mm/sec Mmbr: 10 mm/mV Precord: 10 mm/mV F 50~ 0.15-100 Hz PH100B C P?



Circulation. 2002;105:726-731







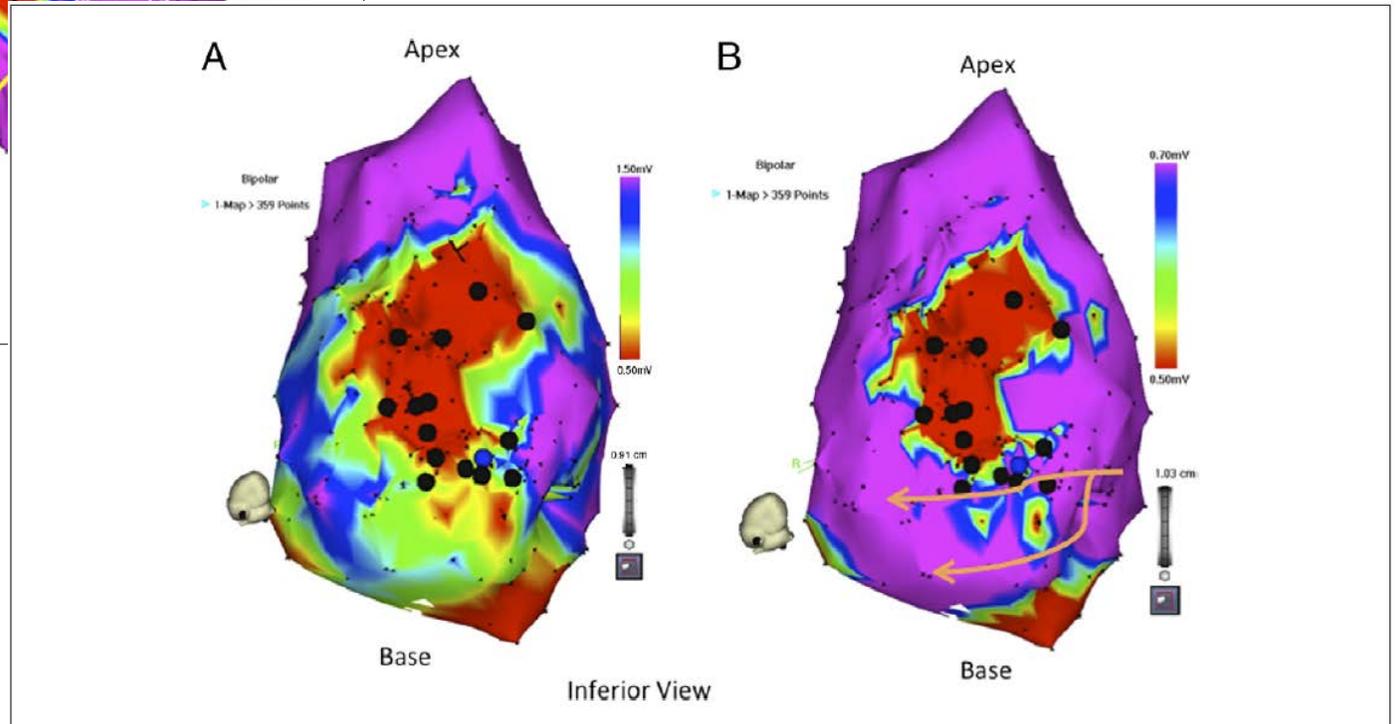
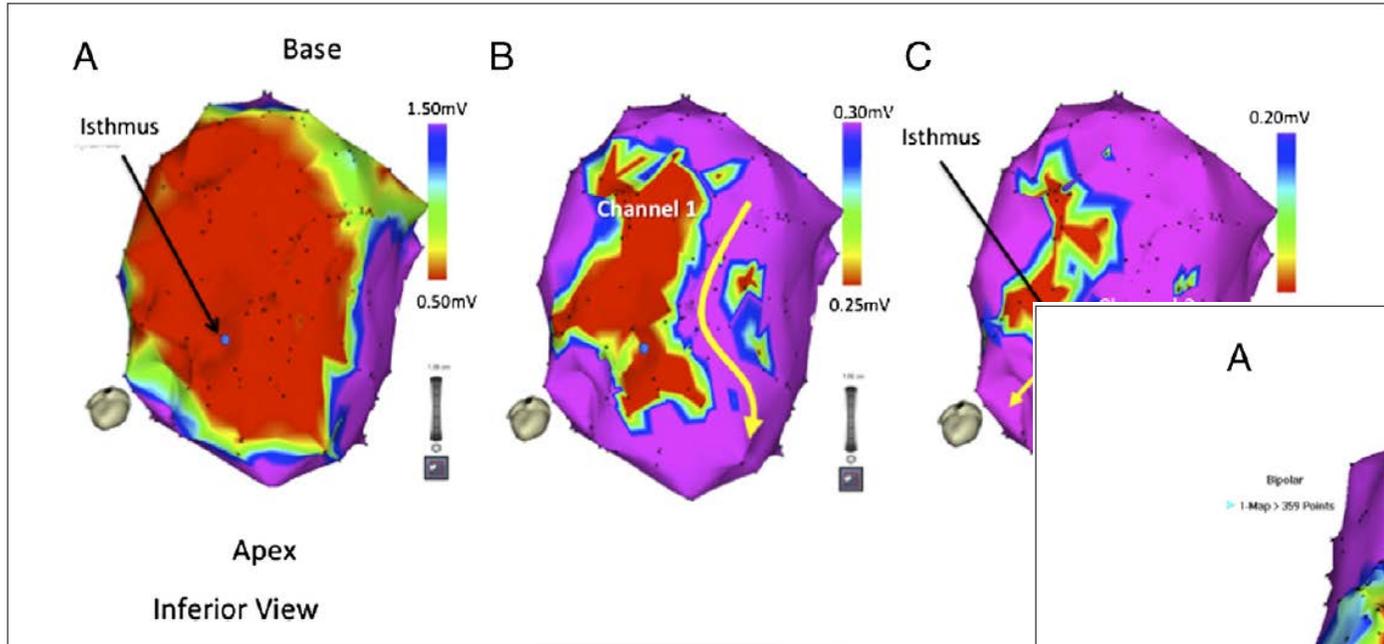


FIGURE 1 Classification of Electrograms

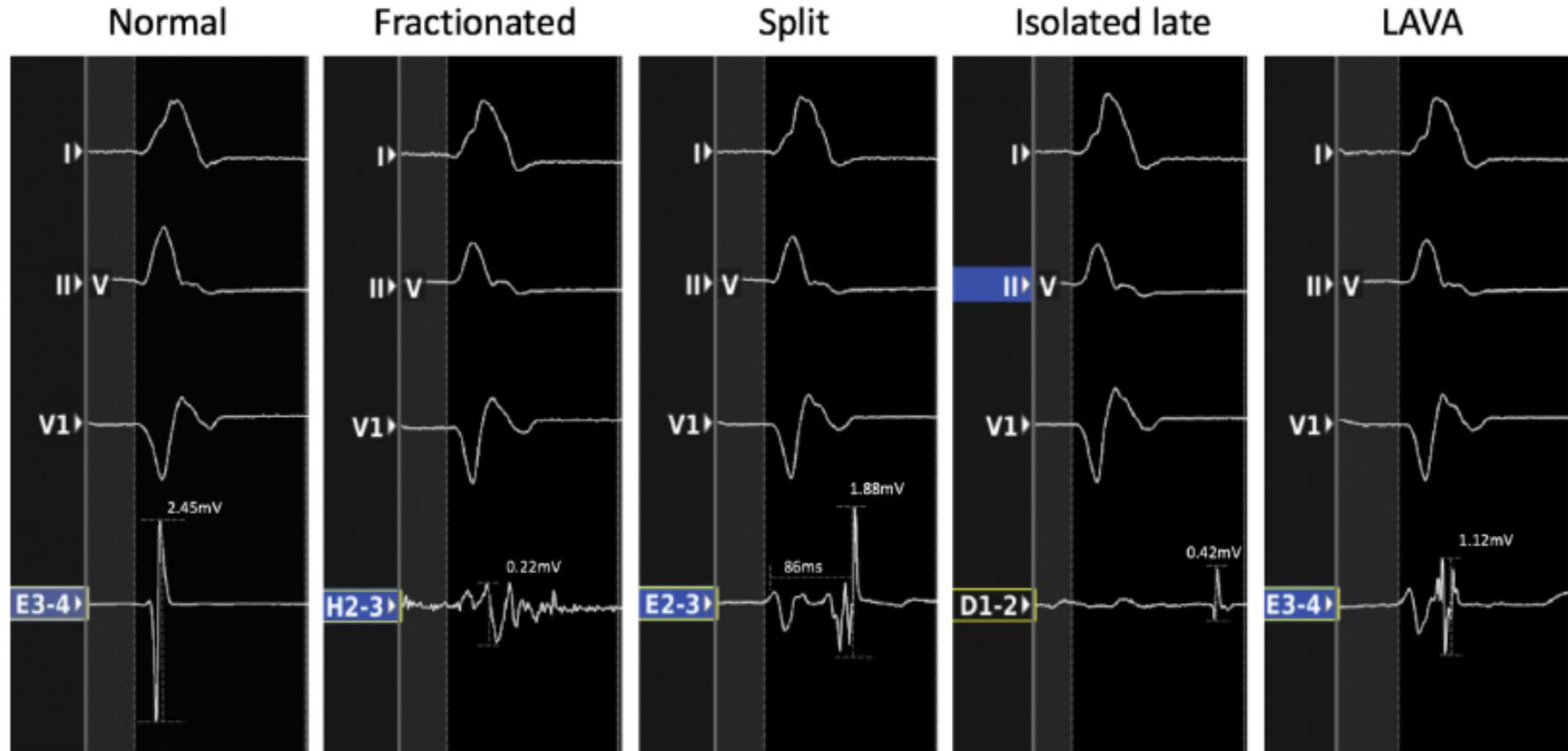


FIGURE 6 Relationship Between the VT Critical Zone and Voltage Amplitude During Sinus Rhythm

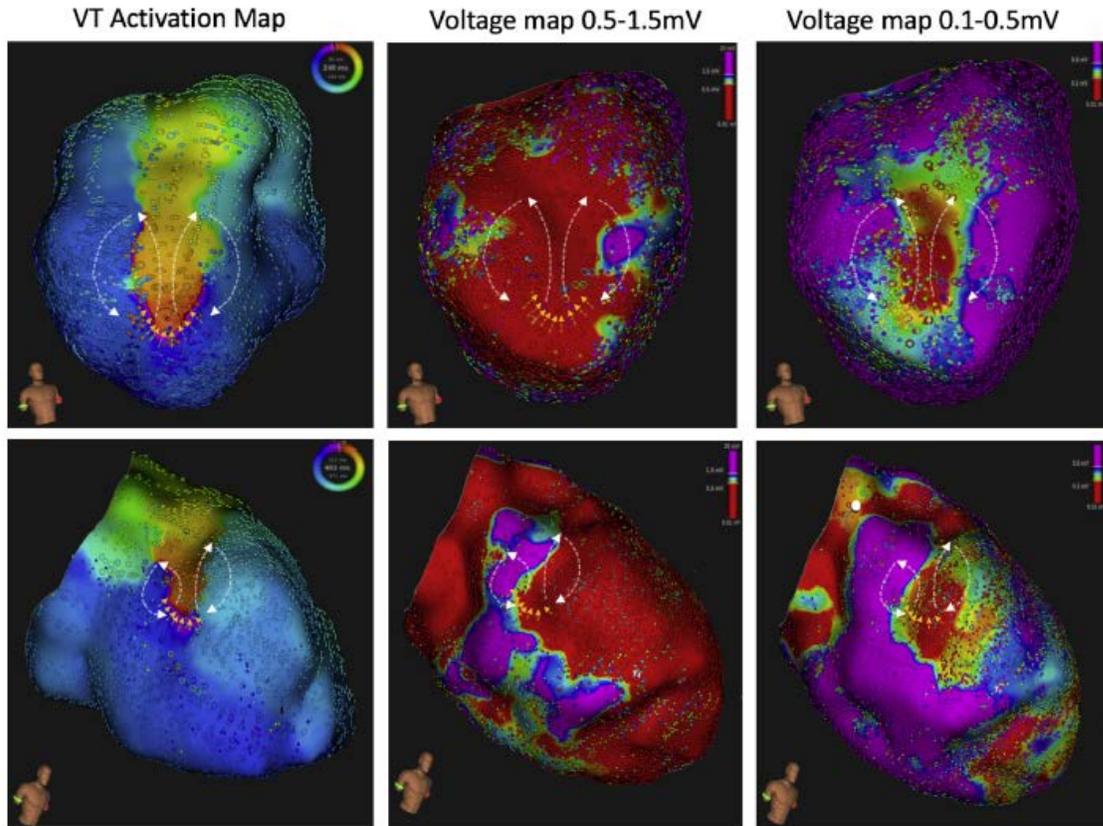


FIGURE 3 Conduction Properties During Sinus Rhythm at Isthmus Sites

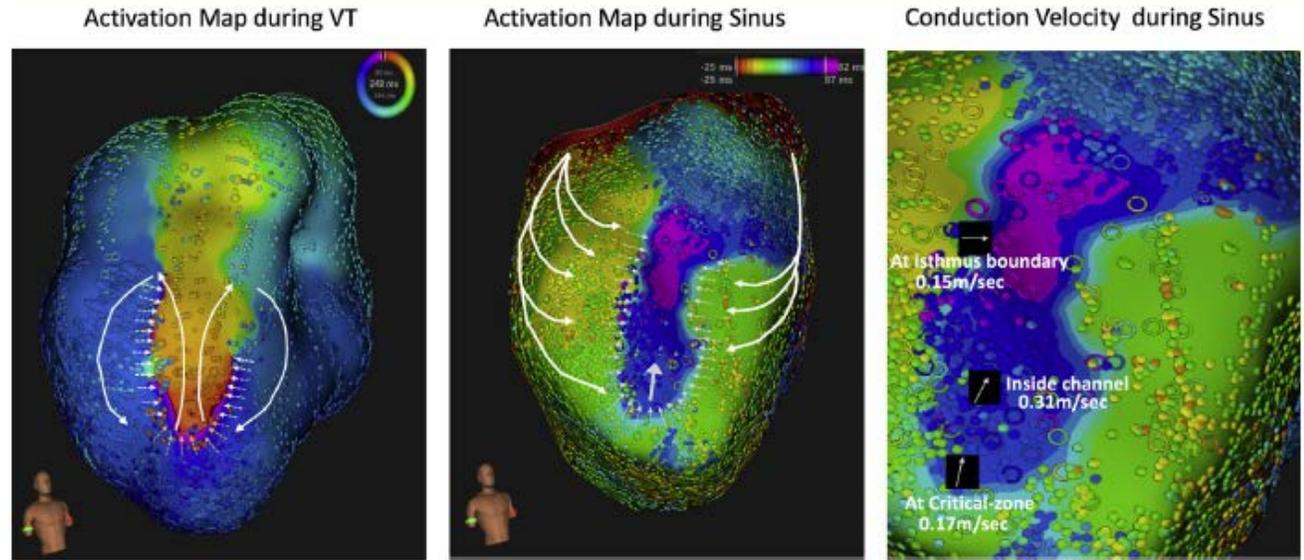


Table 1 Summary of studies evaluating different substrate ablation approaches for unstable VT

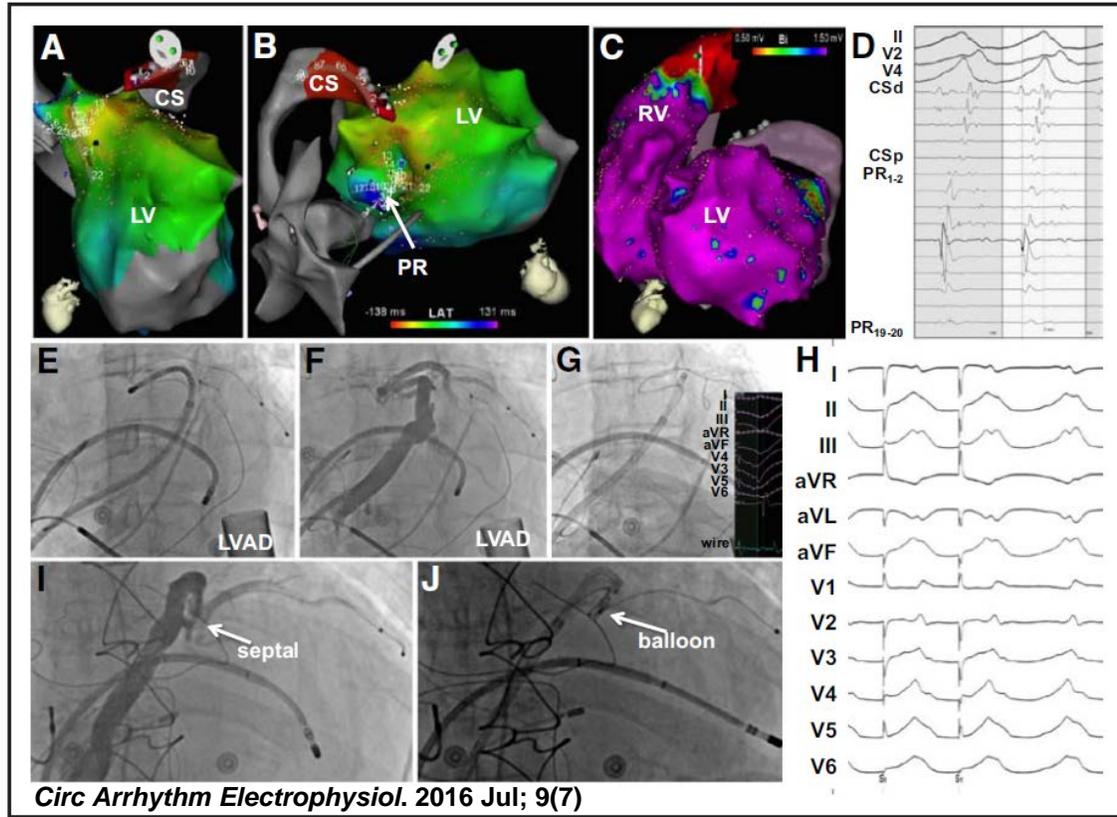
Heart Rhythm, Vol 13, No 2, February 2016

Study	Year	No. of patients	Type of substrate	LVEF (%)	End-point assessed (% achieved)	EPI mapping/ablation	RF duration (lesions or min)	Follow-up (months)	VT recurrence	Complications
Linear ablation lesions										
Marchinski et al ⁴⁶	2000	10	9 ICM, 7 NICM	32 ± 15	Noninducibility (47%)	No	59 ± 34 lesions	8 (3–36)	25%	1 stroke
Soejima et al ⁴⁷	2001	40	ICM	29 ± 10	Noninducibility (58%)	No	21 ± 10 lesions	12 ± 6	47%	4 (iliac artery dissection, femoral artery pseudoaneurysm, embolism to lower leg, retroperitoneal hematoma)
Reddy et al ¹	2007	64	ICM		Noninducibility (76%)	No	NR	31 ± 8	12%	3 (pericardial effusion, CHF, DVT)
Ablation of late potentials										
Arenal et al ⁹	2005	24	21 ICM, 2 NICM, 1 ToF	30 ± 9	Elimination of LPs related to the VT and noninducibility (88%)	No	11 ± 8 lesions	9 ± 4	21%	None
Volkmer et al ¹⁹	2006	25	ICM	30 ± 8	Elimination of LPs and noninducibility (81%)	No	14 ± 6 lesions	26 ± 14	29%	NR
Nogami et al ¹⁶	2008	18	ARVC	NR	Change of LPs ⁺ (67%)	No	17 ± 10 lesions	61 ± 38	33%	NR
Garcia et al ¹⁴	2009	13	ARVC	NR	Elimination of LPs and noninducibility (85%)	Yes	35 ± 26 lesions	18 ± 13	33%	None
Bai et al ¹¹	2011	26	ARVC	53 ± 10	Elimination of LPs and noninducibility (100%)	Yes	26 ± 14 min	39 ± 4	15%	1 groin hematoma
Vergara et al ¹⁸	2012	50	36 ICM, 14 NICM	32 ± 9 ICM; 36 ± 10 NICM	Elimination of LPs (84%)	Yes	NR	13 ± 4	20%	NR
Arenal et al ¹⁰	2013	59	ICM	30 ± 11	Elimination of LPs (78%)	No	11 ± 5 min	39 ± 21	42%	No major
Ablation of LAVA										
Jais et al ¹⁵	2012	70	56 ICM, 14 NICM	35 ± 10	Elimination of LAVA (70%)	Yes	23 ± 11 min	22 (14–27)	32%	1 cardiac tamponade, 1 RV perforation
Scar homogenization										
Di Biase et al ¹³	2012	43	ICM	24 ± 8	Elimination of any abnormal potential ± failure to capture (NR)	Yes	74 ± 21 min	21 (19–25)	19%	1 groin hematoma
Ablation of interconnected channels (scar dechanneling)										
Berruezo et al ²⁰	2012	11	ARVC	55 ± 7	Elimination of LP channels (NR)	Yes	6.3 (4–8.7) lesions	11 (6–24)	9%	1 RV puncture during epicardial access
Tung et al ¹⁷	2013	21	15 ICM, 2 NICM, 2 ARVC, 1 sarcoid, 1 noncompaction, 1 Chagas	25 (25–30)	Change or elimination of LPs ± failure to capture ± impedance drop > 10 Ω plus noninducibility (84%)	Yes	7 (4–14) lesions	11 (6–18)	14%	NR
Berruezo et al ²¹	2015	101	75 ICM, 26 NICM	36 ± 13	Elimination of LP channels (84%)	Yes	28 ± 16 min	24	20%	7 (2 tamponade, 2 CHB, 2 pericardial effusion, 1 TIA, 1 PN palsy)
Core isolation of critical substrate elements										
Tzou et al ²⁰	2015	44	32 ICM, 12 NICM	31 ± 13	Isolation with exit block (84%)	Yes	111 ± 91 lesions	18 ± 9	14%	2 (1 arterial pseudoaneurysm, 1 transient hypotension)

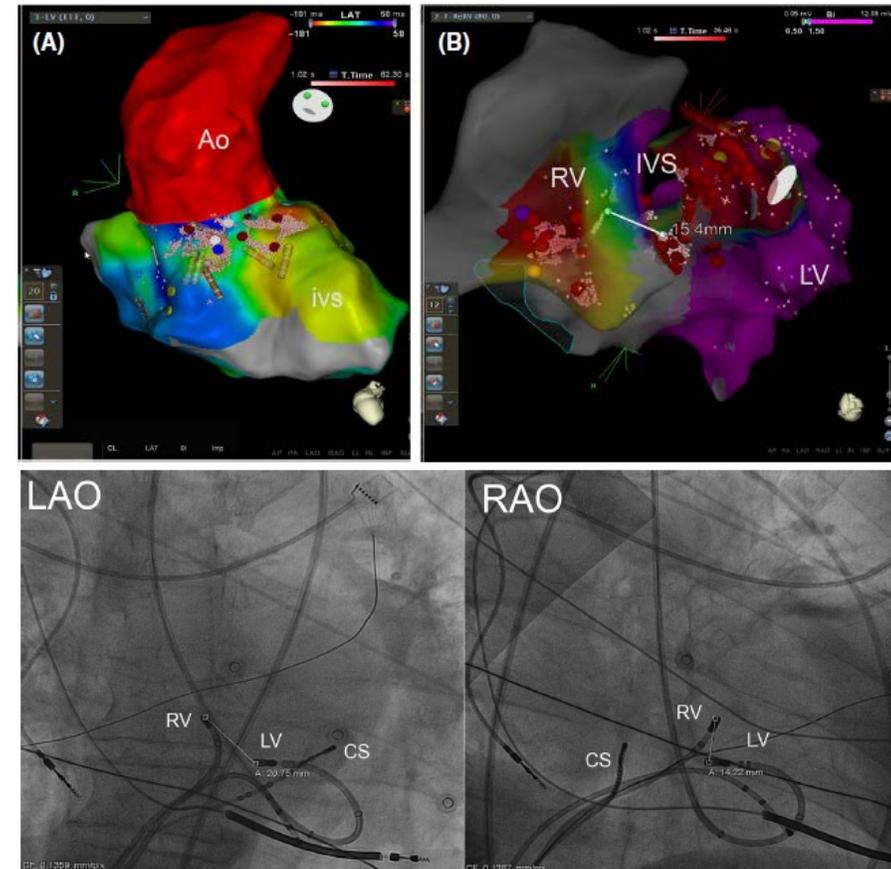
Factores fracaso en la ablación por radiofrecuencia

- Incapacidad de identificar correctamente el sustrato
- Sustrato muy amplio no susceptible de ablación efectiva
- Sustrato inaccesible con la tecnología actual

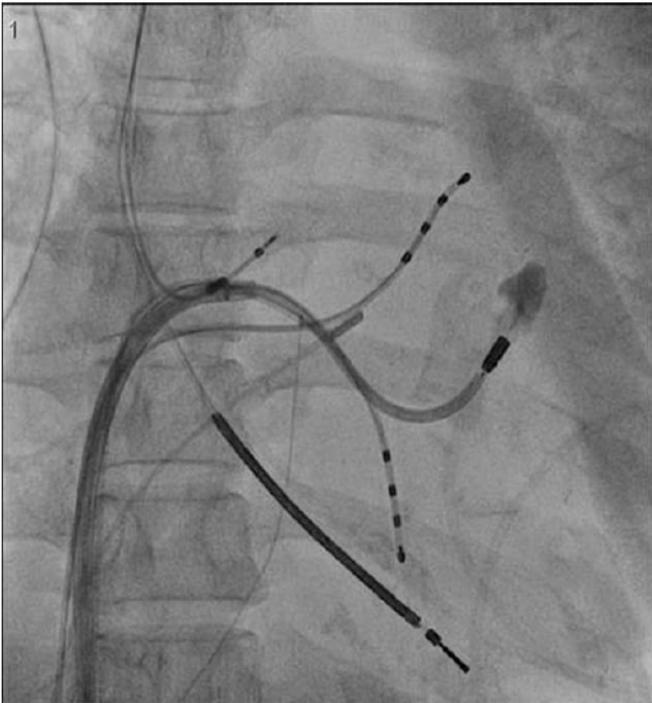
Ablación con etanol



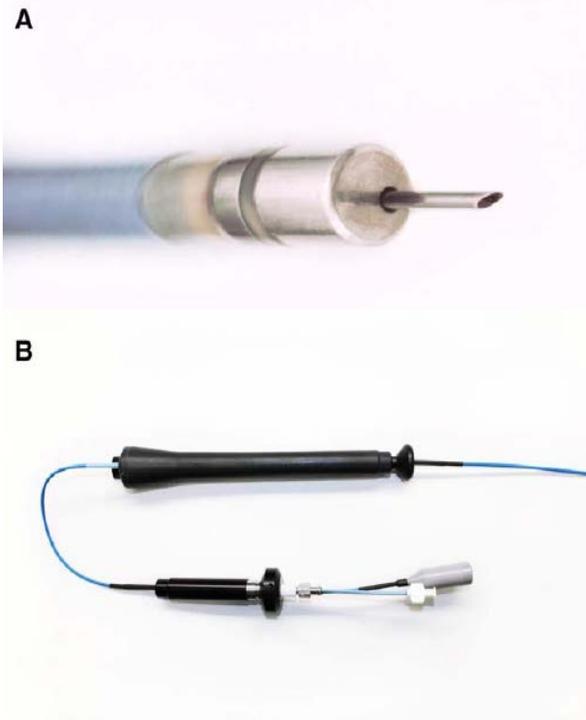
Ablación bipolar



Ablación con aguja

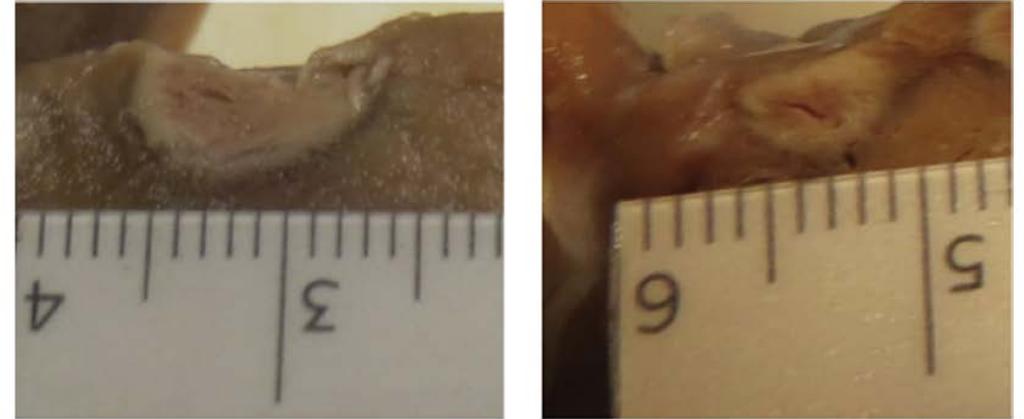


Circulation. 2013;128:2289-2295



Ablación con SS al 0,45%

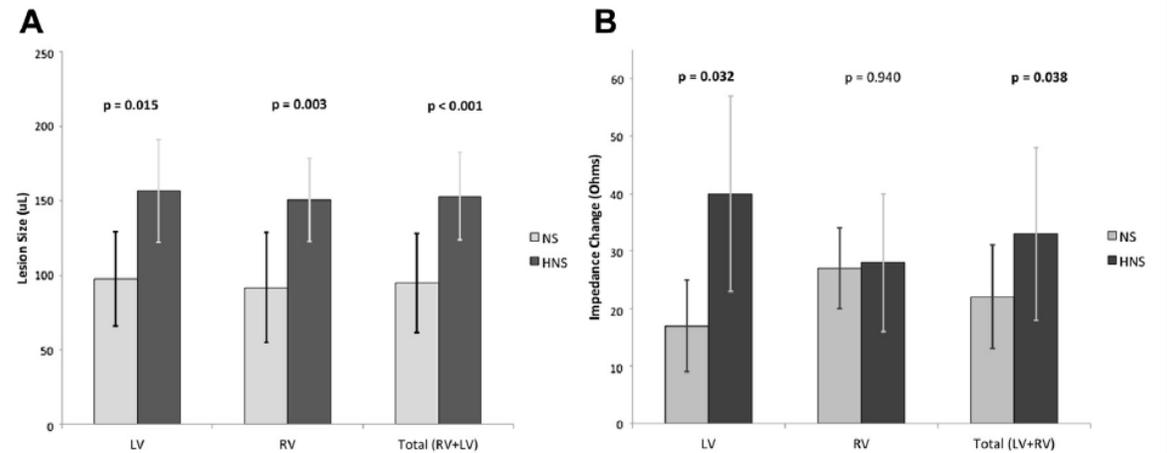
FIGURE 2 In Vivo Porcine Ablation



Half Normal Saline

Normal Saline

FIGURE 3 Lesion Volumes After In Vivo Porcine RV, LV, and Combined RV+LV Ablation



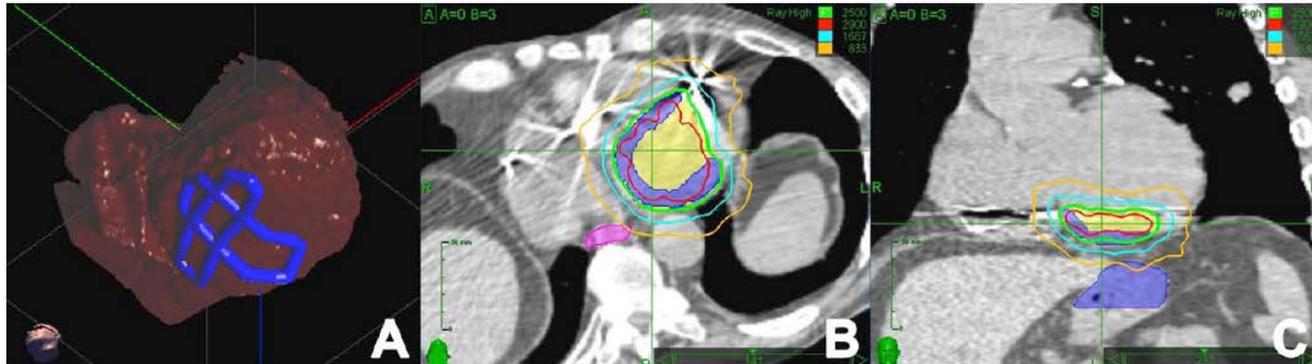
Radioterapia estereotáctica

- Procedimiento no invasivo
- Ambulatorio
- Tto se administra en una única sesión
- Escaso consumo de tiempo
- Volumen/profundidad de la lesión

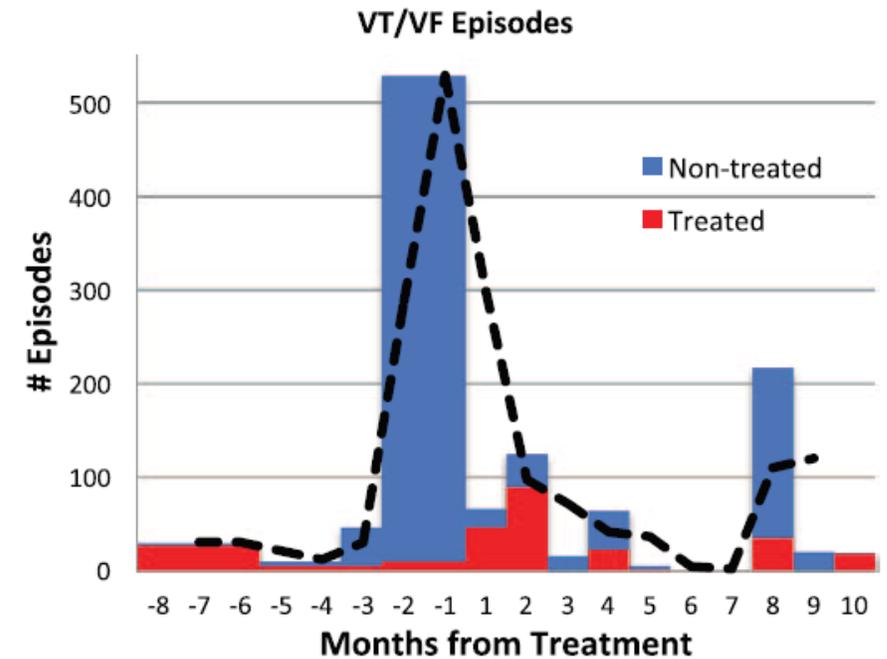
Images and Case Reports in Arrhythmia and Electrophysiology

Stereotactic Ablative Radiotherapy for the Treatment of Refractory Cardiac Ventricular Arrhythmia

Billy W. Loo, MD, PhD*; Scott G. Soltys, MD*; Lei Wang, PhD; Anthony Lo, MS;
Benjamin P. Fahimian, PhD; Andrei Iagaru, MD; Linda Norton, RN, MSN;
Xin Shan, BS, BAH; Edward Gardner, PhD; Thomas Fogarty, MD;
Patrick Maguire, MD, PhD; Amin Al-Ahmad, MD; Paul Zei, MD, PhD



Circ Arrhythm Electrophysiol. 2015;8:748-750.



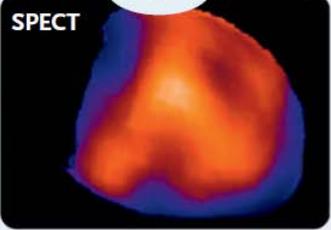
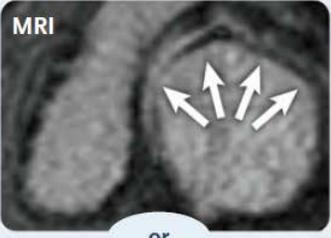
Noninvasive Cardiac Radiation for Ablation of Ventricular Tachycardia

Phillip S. Cuculich, M.D., Matthew R. Schill, M.D., Rojano Kashani, Ph.D.,
Sasa Mutic, Ph.D., Adam Lang, M.D., Daniel Cooper, M.D.,
Mitchell Faddis, M.D., Ph.D., Marye Gleva, M.D., Amit Noheria, M.B., B.S.,
Timothy W. Smith, M.D., D.Phil., Dennis Hallahan, M.D., Yoram Rudy, Ph.D.,
and Clifford G. Robinson, M.D.

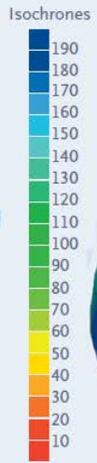
N ENGL J MED 377:24 NEJM.ORG DECEMBER 14, 2017

- Técnicas no invasiva para la inducción y estudio de la taquicardia (EEF mediante DAI + imagen electrocardiográfica + caracterización escara mediante SPECT o RM)
- Técnica no invasiva de ablación (RT estereotáctica)
- 5 pacientes con cardiopatía, DAI, al menos 3 episodios TV 3 meses previos
- Fracaso previo/contraindicación ablación RF y uso ≥ 2 fármacos antiarrítmicos

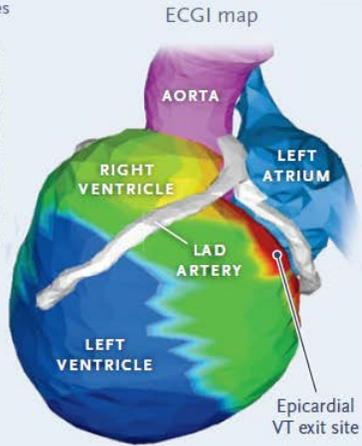
Visualize Anatomical Scar



and



Perform EP Mapping



Identify Arrhythmogenic Scar Substrate

Create a contoured target volume

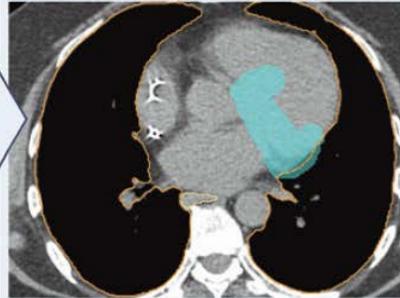
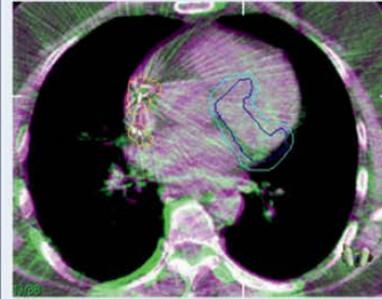
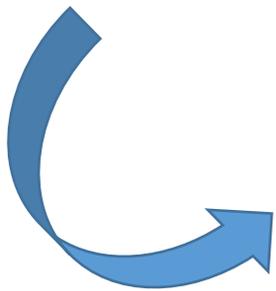
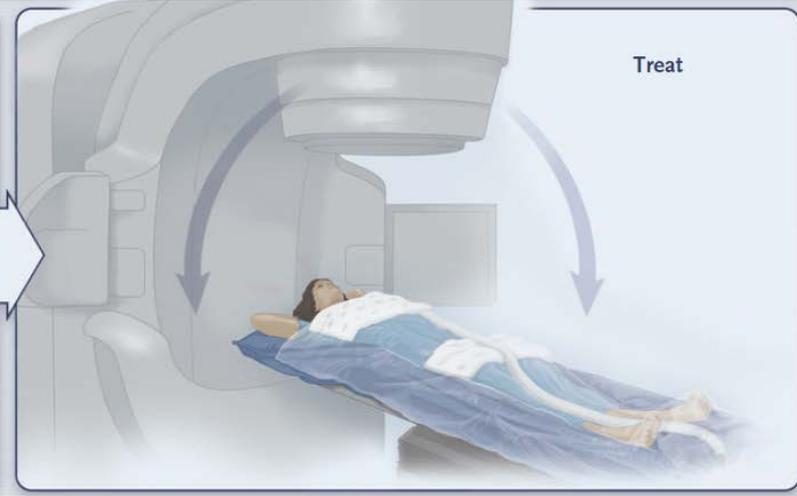


Image and Align



Treat



Position



Develop Plan

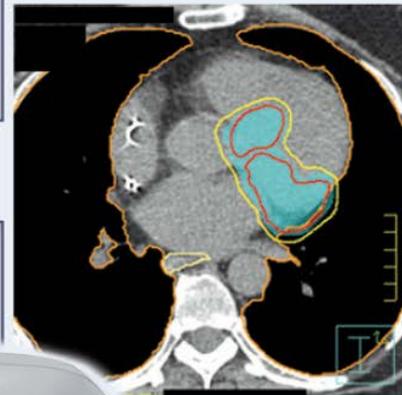
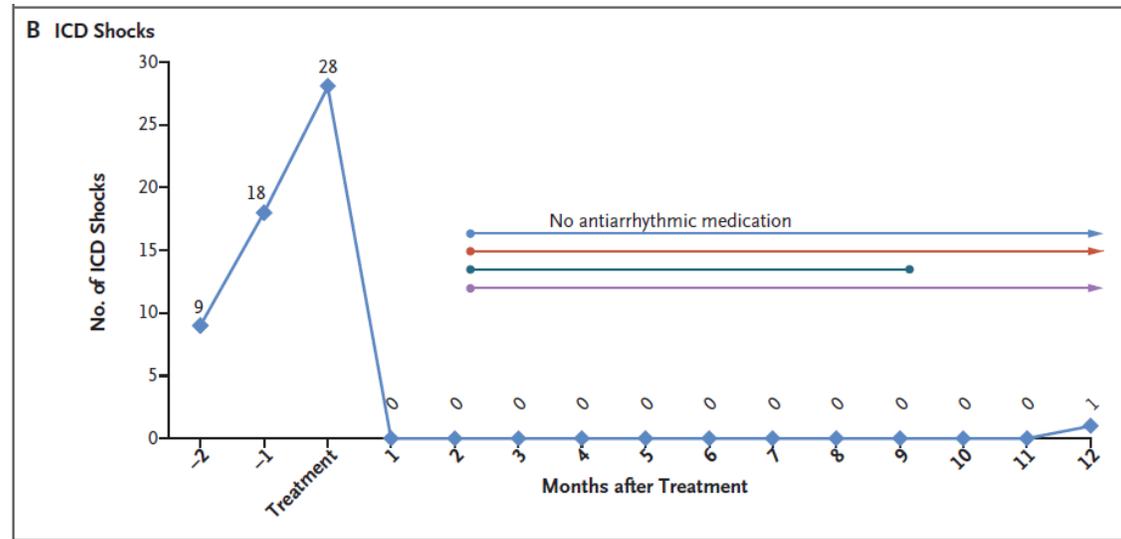
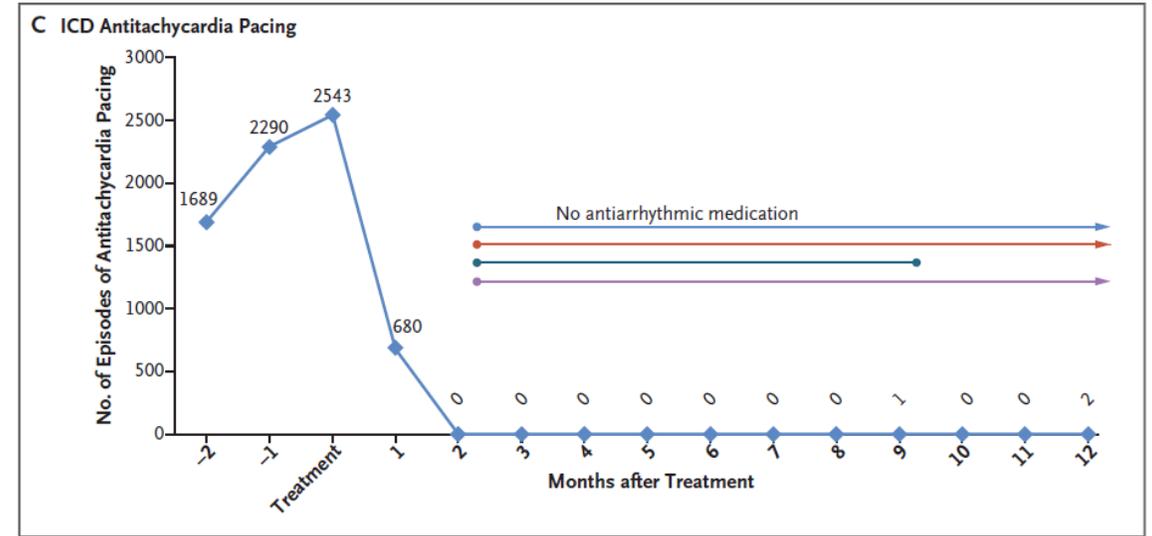
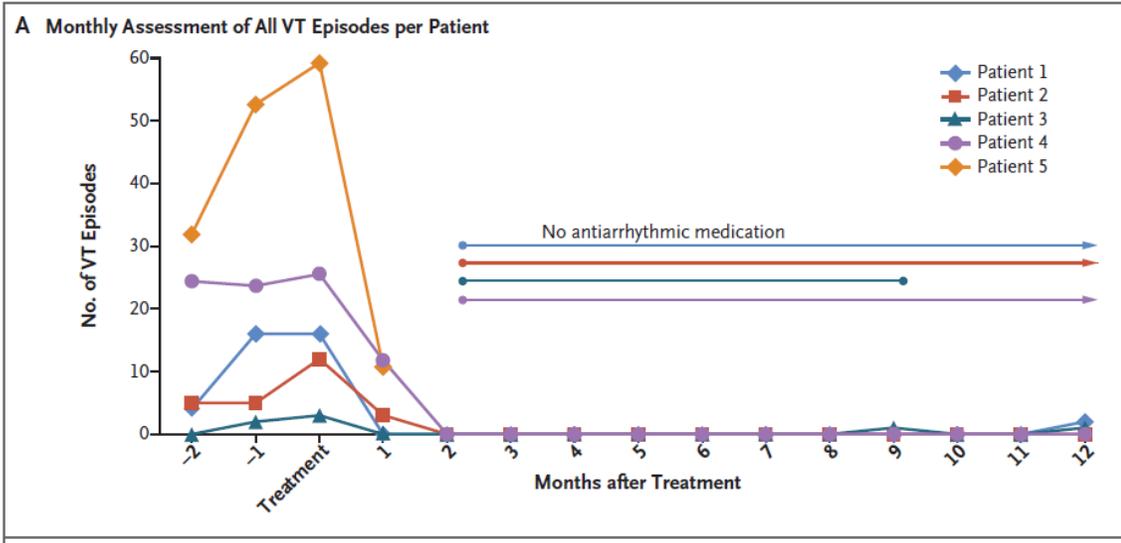


Table 1. Demographic and Clinical Characteristics of the Patients and Treatment Details.*

Variable	Patient 1	Patient 2	Patient 3	Patient 4	Patient 5
Demographic or clinical characteristic					
Age (yr)	61	60	65	62	83
Sex	Male	Male	Male	Male	Female
Type of cardiomyopathy	Nonischemic	Ischemic	Nonischemic	Nonischemic	Ischemic
NYHA class	IV	III	IV	IV	IV
Left ventricular ejection fraction (%)	37	17	22	26	15
No. of previous antiarrhythmic drugs	3	3	3	4	2
No. of previous catheter ablations	1	0	2	4	0
No. of induced episodes of ventricular tachycardia	2	1	0	5	6
No. of episodes of ventricular tachycardia 3 mo before treatment	30	20	5	2210	4312
Treatment					
Ablation target region	Anterior basal left ventricle	Anterolateral basal left ventricle	Inferior left ventricle	Left ventricle outflow and septum	Inferolateral mid left ventricle
Ablation volume (ml)	51.3	17.3	44.5	53.0	81.0
Treatment time (min)	12	11	14	12	18
Length of hospital stay after treatment (days)	2	1	2	2	1
Antiarrhythmic medication at discharge	Amiodarone, mexiletine	Amiodarone, mexiletine	Amiodarone, mexiletine	Amiodarone, mexiletine	Amiodarone, mexiletine
No. of episodes of ventricular tachycardia during 6-wk blanking period	0	3	0	355	322
No. of episodes of ventricular tachycardia 10.5 mo after blanking period	3	0	1	0	NA
No. of additional ablation procedures performed by 1 yr	0	0	0	1 at 4 wk	NA
Antiarrhythmic medication at 1 yr	None	None	Amiodarone (restarted at 9 mo)	None	NA

Noninvasive Cardiac Radiation for Ablation of Ventricular Tachycardia



Noninvasive Cardiac Radiation for Ablation
of Ventricular Tachycardia

Lectura crítica

- Técnica de imagen electrocardiográfica no está extendida en el mundo de la arritmología
- Inducción de TV>3 en zonas no adyacentes
- Fallece un paciente en contexto ACV
- Efectos de la RT sobre estructuras anatómicas cercanas al área de interés



Phase I/II Trial of Electrophysiology-Guided Noninvasive Cardiac Radioablation for Ventricular Tachycardia

Circulation. 2019;139:313–321

- 19 pacientes: 17 TV, 2 EEVV de alta densidad y disfunción ventricular
- Riesgo a corto plazo
- Toxicidad tardía
- Efectos antiarrítmicos



Phase I/II Trial of Electrophysiology-Guided Noninvasive Cardiac Radioablation for Ventricular Tachycardia

Circulation. 2019;139:313–321

- End-point primario de seguridad: ausencia SAE en los primeros 90 días tras tratamiento (grado 3 con necesidad de ingreso, o cualquier grado 4-5).
- End-point primario de eficacia: número de sujetos reducción TV tratadas DAI/disminución carga EEVV comparado con los 6 meses previos a la RT
- Poder de detección del 75% y del 85% respectivamente para determinar SAEs \geq 20% y una eficacia <40%

Phase I/II Trial of Electrophysiology-Guided Noninvasive Cardiac Radioablation for Ventricular Tachycardia

Circulation. 2019;139:313–321

Table 1. Patient Demographics

Variable	N=19
Median age, y (range)	66 (49–81)
Sex, n (%)	
Male	17 (89.5)
Female	2 (10.5)
Race, n (%)	
White	17 (89.5)
Black	1 (5.3)
Asian	1 (5.3)
Median body mass index, kg/m ² (range)	33.0 (24.3–48.6)
Median age-adjusted Charlson score (range)	4 (2–13)
Type of cardiomyopathy, n (%)	
Ischemic	11 (57.9)
Nonischemic	8 (42.1)
Idiopathic	5
Myocarditis (chronic)	2
Valvular	1
NYHA class, n (%)	
I	1 (5.3)
II	4 (21.1)
III	10 (52.6)
IV	4 (21.1)
Median left ventricular ejection fraction, % (range)	25 (15–58)
Median number of previous catheter ablations (range)	1 (0–4)

Total number of prior catheter ablation approaches, n	
Endocardial	25
Epicardial	4
Study eligibility criteria, n (%)	
Incessant VT	2 (10.5)
VT storm, >3 in 24 h	10 (52.6)
ICD therapies, >3 shock or ATP in 6 mo	5 (26.3)
PVC-related cardiomyopathy	2 (10.5)
Device, n (%)	
Single- or dual-chamber ICD	8 (42.1)
Biventricular ICD	10 (52.6)
None	1 (5.3)
Current antiarrhythmic drugs, n (%)	
>1 antiarrhythmic drug at baseline, n (%)	11 (57.9)
High-dose amiodarone, ≥300 mg/d	10 (52.6)
Low-dose amiodarone, <300 mg/d	2 (10.5)
Class III (excluding amiodarone)	7 (36.9)
Class I	11 (57.9)
Other medications, n (%)	
β-Blocker	18 (94.7)
Angiotensin converting enzyme inhibitor	10 (52.6)
Angiotensin receptor blocker	7 (36.8)
Oral anticoagulation	14 (73.7)
Variable	N=19
COPD/emphysema, n (%)	4 (21.1)
Diabetes mellitus, type 2, (n) (%)	7 (36.8)
Hypertension, n (%)	10 (52.6)
Chronic kidney disease, stage ≥3, n (%)	9 (47.4)

Phase I/II Trial of Electrophysiology-Guided Noninvasive Cardiac Radioablation for Ventricular Tachycardia

Circulation. 2019;139:313–321

Table 3. Serious Adverse Events (SAEs) in ≤90 Days of Treatment

CTCAE v4.0 System/Toxicity	Grade 3				Grade 5
	Unrelated	Unlikely	Possible	Probable	Unlikely
Cardiac disorders					
Heart failure			1		
Pericarditis				1	
Gastrointestinal disorders					
Diarrhea	1				
Nausea	1				
General disorders and administration site conditions					
Other: accident					1
Immune system disorders					
Allergic reaction	1				
Investigations					
Alanine aminotransferase increased		1			
Aspartate aminotransferase increased		1			
Respiratory, thoracic, and mediastinal disorders					
Other: influenza	1				
Vascular disorders					
Flushing		1			

Phase I/II Trial of Electrophysiology-Guided Noninvasive Cardiac Radioablation for Ventricular Tachycardia

Circulation. 2019;139:313–321

Lectura crítica

- Validez imagen electrocardiográfica para acotar el sustrato
- Efectos secundarios
- 3 pacientes fallecen en contexto de TV recurrente en seguimiento
- Capacidad RT abarcar grandes porciones miocardio (sobretodo)

CASO CLINICO

- Varón, 64 años
- MA con afectación principal de VD conocida desde 2007 a raíz de episodios de TVMS (Ablación + DAI)
- Ingreso 2015 por terapias apropiadas del DAI -> nueva ablación
- Reingreso en 2018 por TVMS + clínica de IC
- Se realiza nueva ablación guiada por pace mapping y los electrogramas del DAI no efectiva
- RM muestra VD hipocontráctil con realce tardío y cicatriz heterogénea en la región medio basal de la pared libre

CASO CLINICO

Estudio ant.: 02-Dec-2018 02:23:01 - Anómalo Sin confirm
12 deriv.; Coloc. estándar

