Incessant VT and VT storm

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Catheter Ablation of VT in Patients With Structural Heart Disease Using Cooled RF Energy

Table 1. Patient Characteristics

Demographic	n (%)
Age (mean years, SD)	65, 12.6
30–65	67 (46%)
>65	79 (54%)
Gender (% male)	134 (92%)
Ischemic heart disease	119 (82%)
Ejection fraction (mean, SD)	31, 13
0–20	41 (28%)
21–35	66 (45%)
36+	39 (27%)
Group	
Crossover	17 (12%)
Randomized to ablation	63 (43%)
Compassionate use	15 (10%)
Nonrandomized	51 (35%)
Center (n, % patients enrolled)	
High	60 (41%)
Medium	41 (28%)
Low	45 (31%)
Arrhythmia history	
Prior ablation	32 (22%)
Failed amiodarone	58 (40%)
Number prior VT episodes	
0 to 2	27 (19%)
3 to 8	67 (46%)
10 to 99	42 (29%)
100 +	10 (7%)
Only 1 VT, CL >300 ms	33 (23%)
Clinical VT induced	126 (89)
Number of VTs CL >300	
0 to 1	55 (39%)
≥2	87 (61%)
ICD at entry	106 (71%)
ICD at discharge	115 (79%)
Number failed AA drugs (mean, SD)	2.5, 1.5
EP findings	
Induced VTs (mean, SD)	3 (2.1)
VT CL ≤300	0.7 ± 0.6
VTs >300	2.4, 1.9
Noninducible	1 (0.7%)
With 1 VT induced	37 (25%)
With 2 VTs induced	35 (25%)
With >2 VTs induced	70 (49%)

ICD = implantable cardioverter defibrillator; VT = ventricular tachycardia.

Table 3. Procedure-related Complications

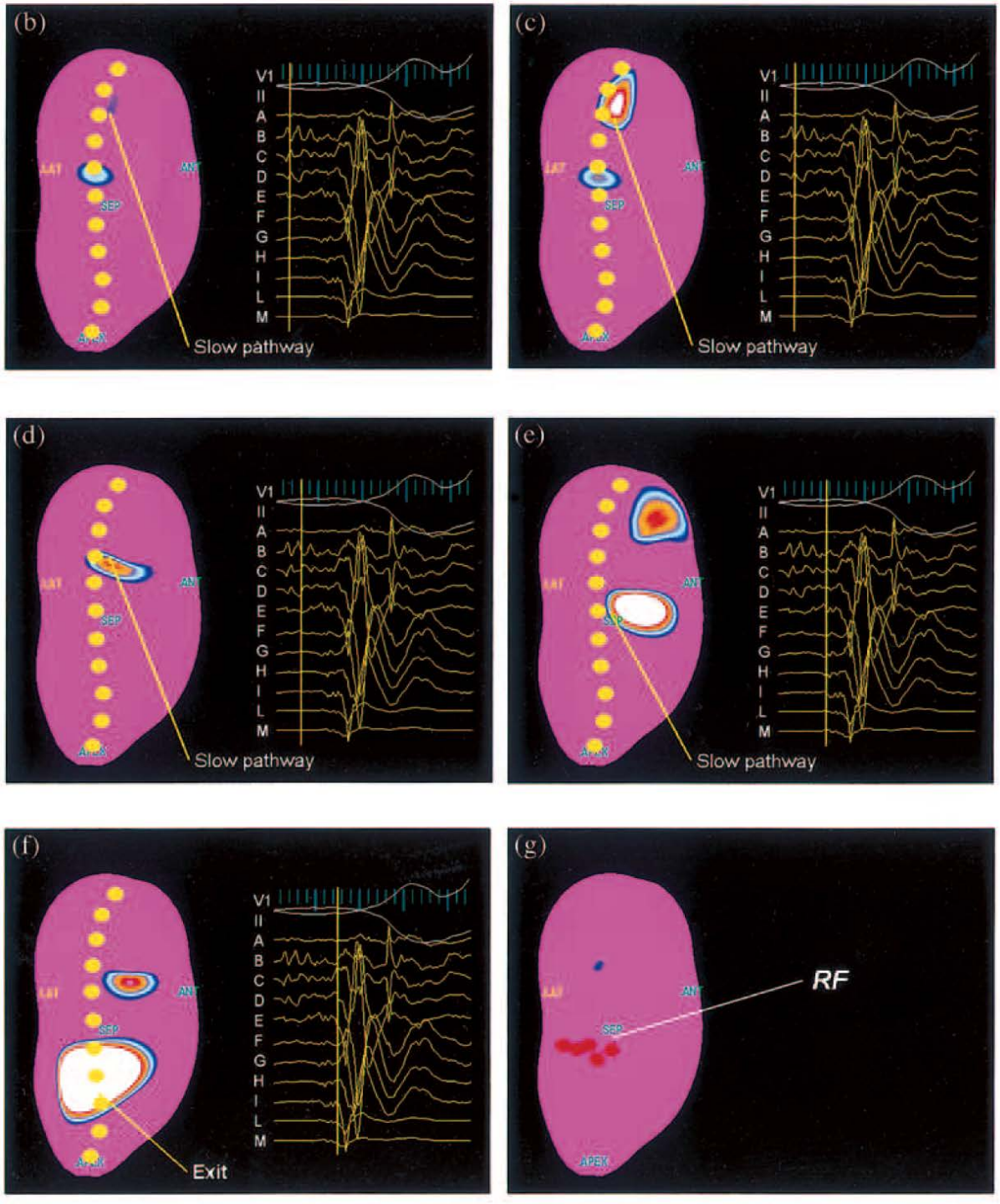
Complication Type	No. of Patients	No. of Deaths
Major complications		
Stroke/TIA	4 (2.7%)	1
Complete AV block	2 (1.4%)	0
Tamponade	4 (2.7%)	1
Valve injury	1 (0.7%)	1
Myocardial infarction	1 (0.7%)	1
Femoral artery laceration	1 (0.7%)	0
No. of patients with a major complication	12 (8%)	4 (2.7%)
Other complications		
Aortic dissection (distal)	1 (0.7%)	
Defibrillation skin burn	1 (0.7%)	
Anxiety and stress	1 (0.7%)	
Peroneal nerve palsy (transient)	1 (0.7%)	
Loss of pulses in extremity (transient)	1 (0.7%)	
Pseudoaneurysm (no treatment required)	1 (0.7%)	
Transient left leg numbness	1 (0.7%)	
Slurred speech due to sedation	1 (0.7%)	
Visual blurring (transient)	1 (0.7%)	
Other AV block*	0 (0%)	
No. of patients with a minor complication	9 (6%)	

*Transient AV block, 1° or 2° AV block.
AV = arterio-ventricular.

- The patient population included 146 patients who participated in the Cooled RF Ablation System clinical trial and underwent an attempt at ablation of VT occurring in the presence of structural heart disease. The duration of follow-up was 243 ± 153 days.
- Catheter ablation was acutely successful, as defined by elimination of all mappable VTs, in 106 patients (**75%**). In 59 patients (**41%**), no VT of any type was inducible after ablation. Twelve patients (8%) experienced a major complication. After catheter ablation, 66 patients (46%) developed one or more episodes of a sustained ventricular arrhythmia.

J Am Coll Cardiol. 2000;35:1905-14.

Non-contact mapping to guide catheter ablation of untolerated VT



- M/72 post-MI (LVEF 32%)
- Diastolic fragmented activity is demonstrated at electrogram A to G (slow pathway), unipolar QS electrograms from I to M (exit site).
- A line of radiofrequency lesions (red dot, panel g) was drawn to interrupt the diastolic pathway, before the exit site.

Eur Heart J. 2002;23:742-52.

Catheter Ablation of Electrical Storm

Table 1. Baseline Clinical and Demographic Characteristics of the Study Population

Age (mean±SD), y	64±13
Gender, M/F	85/10
LV ejection fraction (mean±SD), %	36±11
NYHA class (mean±SD)	2.9±1.1
Underlying heart disease, %	
CAD	72 (76)
IDCM	10 (11)
ARVD	13 (14)
Medications, %	
Amiodarone	89 (94)
β-Blockers	92 (97)
ACE inhibitors or ARBs	81 (85)
Sotalol	5 (5)
Class I antiarrhythmic drugs	6 (6)
VT episodes per patient per day (mean±SD), n	16±8
ICD shocks per patient per day (mean±SD), n	14±8
Time from implant to ES (mean±SD), mo	14±8
Spontaneous VT cycle (mean±SD), ms	381±62
Spontaneous VT pleomorphism, %	36 (38)

ACE indicates angiotensin-converting enzyme; ARBs, angiotensin receptor blockers. n=95.

Table 2. Electrophysiological and Procedural Characteristics of the Study Population

Induced VT cycle (mean±SD), ms	365±77
Pleomorphic VT induced, n (%)	66 (69)
Nontolerated VT induced, n (%)	67 (71)
Median VTs induced per patient (range), n	2 (1–5)
CA acute result, n (%)	
Complete success (class A)	68 (72)
Partial success (class B)	17 (18)
Failure (class C)	10 (11)
Combined endocardial/epicardial CA, n (%)	10 (11)
Nonconventional mapping system, n (%)	65 (68)
Noncontact mapping	17 (23)
Electroanatomic mapping	43 (45)
Noncontact mapping+electroanatomic mapping	5 (5)
Cardiopulmonary support, n (%)	10 (11)
Fluoroscopy time (mean±SD), min	52±17
Total procedure time (mean±SD), min	260±70

n=95.

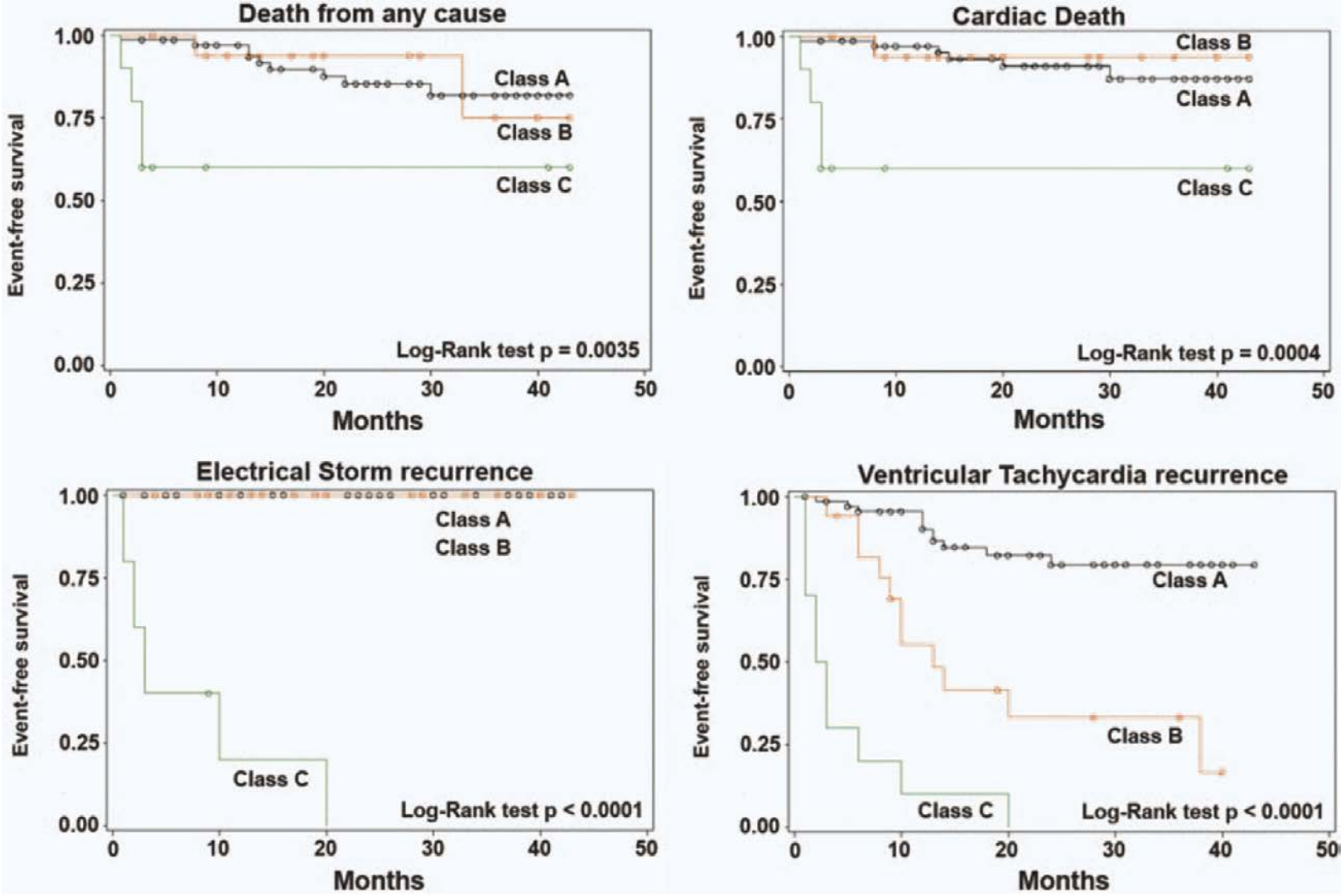
Table 3. Long-Term Outcome According to Acute Results of CA

	ES Recurrence	VT Recurrence	SCD	CD
Complete success (class A) (n=68), n (%)	0/68	11/68 (16)	0/68	6/68 (9)
Partial success (class B) (n=17), n (%)	0/17	11/17 (65)	0/17	1/17 (6)
Failure (class C) (n=10), n (%)	8/10 (80)	10/10 (100)	4/10 (40)	4/10 (40)

Circulation. 2008;117:462-9.

Catheter Ablation of Electrical Storm

KM event-free survival estimates according to acute CA results during FU



Complete success (class A)
Partial success (class B)
Failure (class C)

Circulation. 2008;117:462-9.

Irrigated RF Catheter Ablation Guided by Electroanatomic Mapping for Recurrent VT After MI

Table 1. Patient Characteristics by Primary End Point

	Total		Success		Failure		
	Median or %	25th–75th Percentile	Median or %	25th to 75th Percentile	Median or %	25th to 75th Percentile	*P*
n	231		123		108		
Age, y	68	59–72	65	58–70	69	62–73	0.012
Male, %	89		88		91		0.474
Hypertension, %	58		59		58		0.908
Heart failure, %	62		52		73		0.002
Diabetes, %	26		22		32		0.054
Stroke, %	8		9		8		0.663
COPD, %	16		15		16		0.827
PCI, %	33		36		29		0.228
CABG, %	57		59		55		0.588
History of AF, %	29		23		36		0.02
MI to ablation, mo	107	47–224	136	44–243	98	58–203	0.158
LV ejection fraction, %	25	20–35	25	20–35	25	15–35	0.387
MI location, %							
Anterior MI	26		22		30		0.182
Inferior MI	63		65		60		0.446
Posterior MI	8		6		10		0.204
Multiple MIs	8		5		14		0.016
Prior ablation	37		34		40		0.373
VT episodes in preceding 6 mo, n	11	5–32	10	4–30	14	6–38	0.37
Incessant VT, %	16		22		9		0.009

Circulation. 2008;118:2773-82.

Irrigated RF Catheter Ablation Guided by Electroanatomic Mapping for Recurrent VT After MI

Table 3. Multivariable Analysis for Primary End Point

	OR	95% CI	*P*
Incessant VT	0.33	0.125–0.861	0.024
Total monomorphic VTs	1.28	1.09–1.50	0.003
Atrial fibrillation	2.13	0.99–4.52	0.050
Heart failure	2.40	1.18–4.85	0.015

OR indicates odds ratio. Variables included age, heart failure, diabetes mellitus, prior coronary bypass surgery, atrial fibrillation, anterior wall myocardial infarction, prior ablation, LV ejection fraction, incessant VT, therapy with β-blocker, amiodarone therapy, number of inducible VTs, maximum cycle length of inducible VT, the presence of mappable VT, unmappable VT, and any VT induced after ablation.

- 231 patients (median LVEF, 0.25; HF in 62%) with recurrent episodes of monomorphic VT (median, 11 in the preceding 6 months) caused by prior MI were enrolled.
- All inducible monomorphic VTs with a rate approximating or slower than any spontaneous VTs were targeted for ablation guided by electroanatomic mapping during sinus rhythm and/or VT.
- Ablation abolished all inducible VTs in 49% of patients.
- The primary end point of freedom from recurrent incessant VT or intermittent VT after 6 months of follow-up was achieved for 123 patients (53%).
- In 142 patients with ICD before and after ablation for intermittent VT who survived 6 months, VT episodes were reduced from a median of 11.5 to 0 ($P<0.0001$).
- The 1-year mortality rate was 18%, with 72.5% of deaths attributed to ventricular arrhythmias or HF. The procedure mortality rate was 3%, with no strokes.

Circulation. 2008;118:2773-82.

Catheter Ablation of Recurrent Scar-Related VT Using Electroanatomical Mapping and Irrigated Ablation Technology

TABLE 1

Clinical Characteristics of the Patients (n = 63)

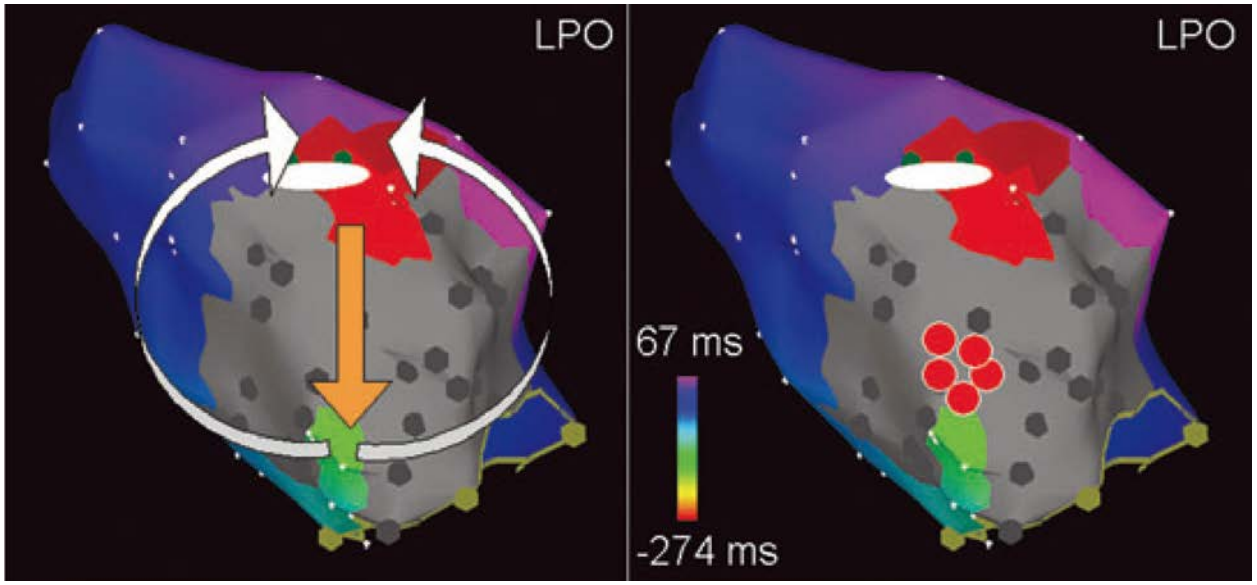
Age (years)	
Mean	64 ± 9
Median (range)	66 (38–80)
Male, n (%)	56 (89)
Site of remote MI, n (%)	
Anterior	24 (38)
Inferior	21 (33)
Lateral	12 (19)
Multiple	6 (10)
LV ejection fraction (%)	
Mean	30 ± 13
Median (range)	28 (10–71)
ICD prior to ablation, n (%)	42 (67)
Amiodarone treatment prior to ablation, n (%)	31 (49)
VT documentation on ICD, n (%) within 6 months	42 (67)
Number of VT per patient	
Mean	55 ± 91
Median (range)	17 (1–380)
VT documentation on ECG, n (%)	40 (63)
Number of VT per patient	
Mean	4 ± 4
Median (range)	2 (1–20)

ICD = implanted cardioverter defibrillator; LV = left ventricular; MI = myocardial infarction; VT = ventricular tachycardia.

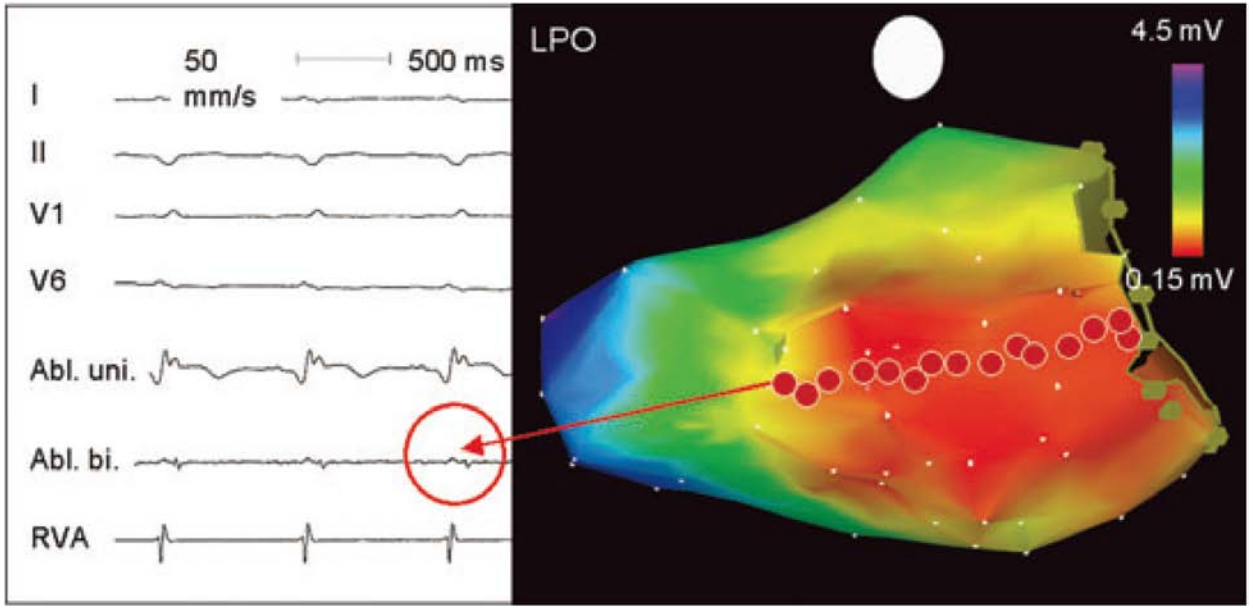
- In 8 European institutions, 63 patients (89% males) were enrolled in the study.
- All patients had remote MI and presented with a median number of 17 (range 1–380) VTs in the preceding 6 months.
- **Incessant VT was present in 14 patients (22%).** LVEF measured 30 ± 13%. A mean of 3 VTs were targeted per patient and 22% of all patients had only unmappable VT. The mean follow-up period was 12 ± 3 months. A total of 164 VTs were targeted during catheter ablation.
- Ablation was acutely successful in 51 patients (81%). One patient (1.5%) experienced a major complication with degeneration of VT into VF necessitating CPR maneuvers. However, no death occurred acutely or within the first 30 days after catheter ablation.
- During the follow-up, 19 of the initially successful ablated patients (37%) and 31 of all ablated patients (49%) developed some type of VT recurrence.

J Cardiovasc Electrophysiol. 2010;21:47-53.

Catheter Ablation of Recurrent Scar-Related VT Using Electroanatomical Mapping and Irrigated Ablation Technology



A LPO view of an electroanatomical activation mapping in a patient with mappable VT in remote MI



Sinus rhythm ECG of a patient with remote inferior MI and unmappable VT due to hemodynamic instability

J Cardiovasc Electrophysiol. 2010;21:47-53.

Catheter Ablation of Recurrent Scar-Related VT Using Electroanatomical Mapping and Irrigated Ablation Technology

TABLE 2

Procedure Data (79 procedures in 63 patients)

Procedure time (minutes)	
Mean	290 ± 158
Median (range)	257 (80–660)
Fluoroscopy time (minutes)	
Mean	43 ± 51
Median (range)	34 (4–399)
RF energy applications, n	
Mean	19 ± 10
Median (range)	18 (4–33)
RF energy time per application (seconds)	
Mean	76 ± 22
Median (range)	79 (32–126)
Total RF energy application time (minutes)	
Mean	24 ± 13
Median (range)	21 (4–65)
Maximal power (Watts)	46 ± 15
Maximal temperature (°C)	43 ± 6
Targeted VT	
Total, n	164
Per patients, n	3 ± 2
Cycle length (ms)	391 ± 84
Patients with, n (%)	
Only mappable VT	19 (37)
Only unmappable VT	11 (22)
Mappable and unmappable VT	21 (41)

RF = radiofrequency; VT = ventricular tachycardia.

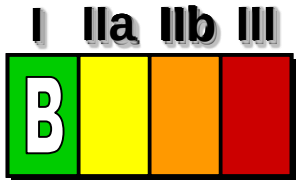
TABLE 3

Predictors of Acute Outcome

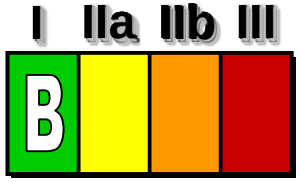
	Success (n = 51)	Failure (n = 12)	P-Value
Age (years)	65 ± 8	62 ± 12	0.42
Male gender, n (%)	47 (92)	9 (75)	0.09
Anterior MI, n(%)	22 (43)	5 (42)	0.93
Inferior MI, n (%)	21 (41)	4 (33)	0.62
LVEF pre (%)	29 ± 13	34 ± 15	0.30
LVEF post (%)	31 ± 14	29 ± 9	0.69
Amiodarone pre, n (%)	23 (45)	8 (67)	0.18
VT ECG, n	4 ± 4	4 ± 2	0.94
VT ICD, n	61 ± 98	23 ± 25	0.32
Targeted VT, n	3 ± 2	3 ± 1	0.48
Focal ablation, n (%)	15 (33)	3 (25)	0.61
One line, n (%)	8 (17)	1 (8)	0.44
Multiple lines, n (%)	20 (43)	6 (50)	0.69
Procedure time (minutes)	312 ± 163	236 ± 133	0.15
Fluoroscopic time (minutes)	45 ± 57	42 ± 23	0.89
RF lesions, n	19 ± 9	20 ± 8	0.76
RF time (minutes)	24 ± 14	23 ± 10	0.82
RF time per lesion (seconds)	78 ± 22	74 ± 17	0.58

LVEF = left ventricular ejection fraction; MI = myocardial infarction; pre, preablation; RF = radiofrequency; VT ECG = ventricular tachycardia documented on electrocardiogram; VT ICD = ventricular tachycardia documented by internal cardioverter defibrillator.

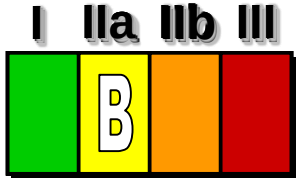
J Cardiovasc Electrophysiol. 2010;21:47-53.



- Urgent catheter ablation is recommended in patients with scar-related heart disease presenting with incessant VT or electrical storm.



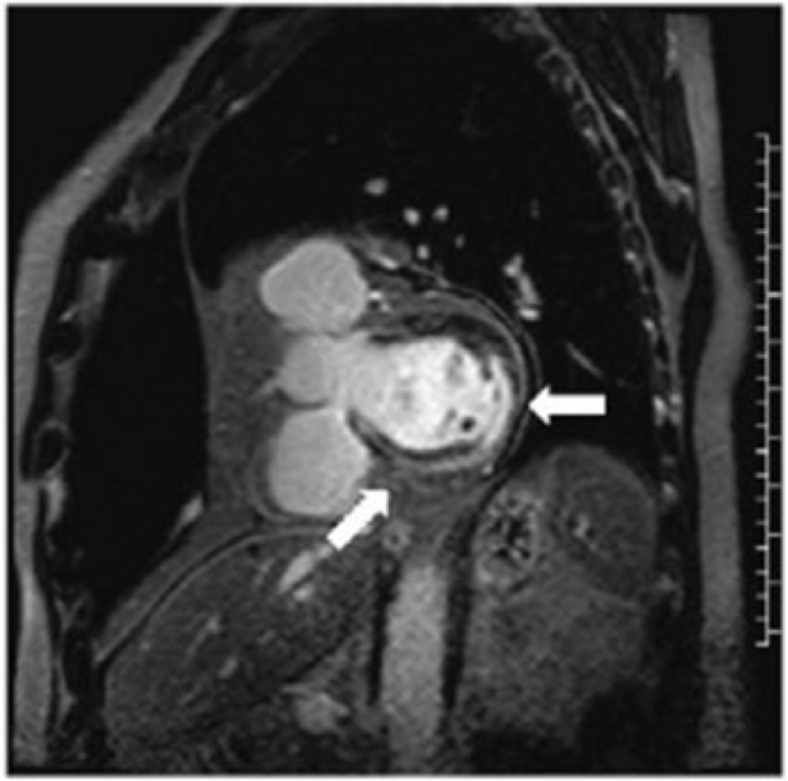
- Catheter ablation is recommended in patients with ischaemic heart disease and recurrent ICD shocks due to sustained VT.

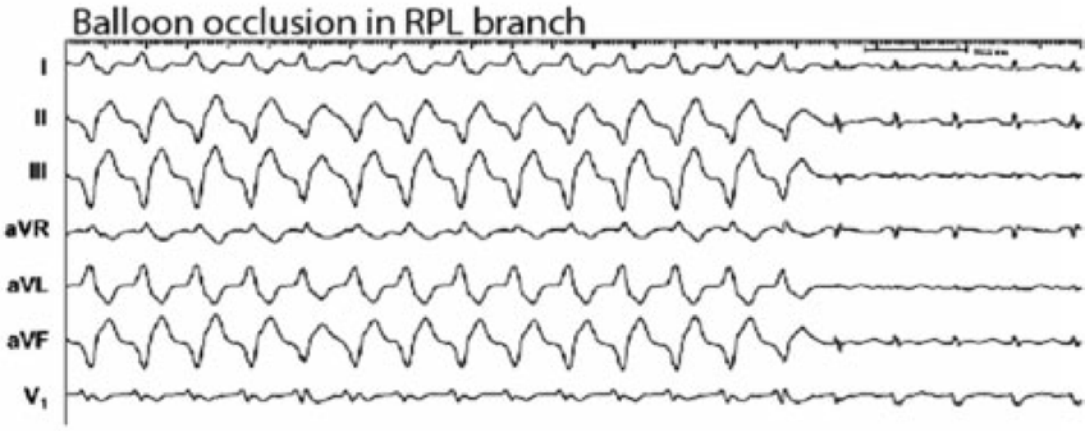


- Catheter ablation should be considered after a first episode of sustained VT in patients with ischaemic heart disease and an ICD.

2015 ESC Guidelines for the management of patients with ventricular arrhythmias

Treatment of intramural VT in cardiac sarcoidosis with transcoronary ethanol ablation.

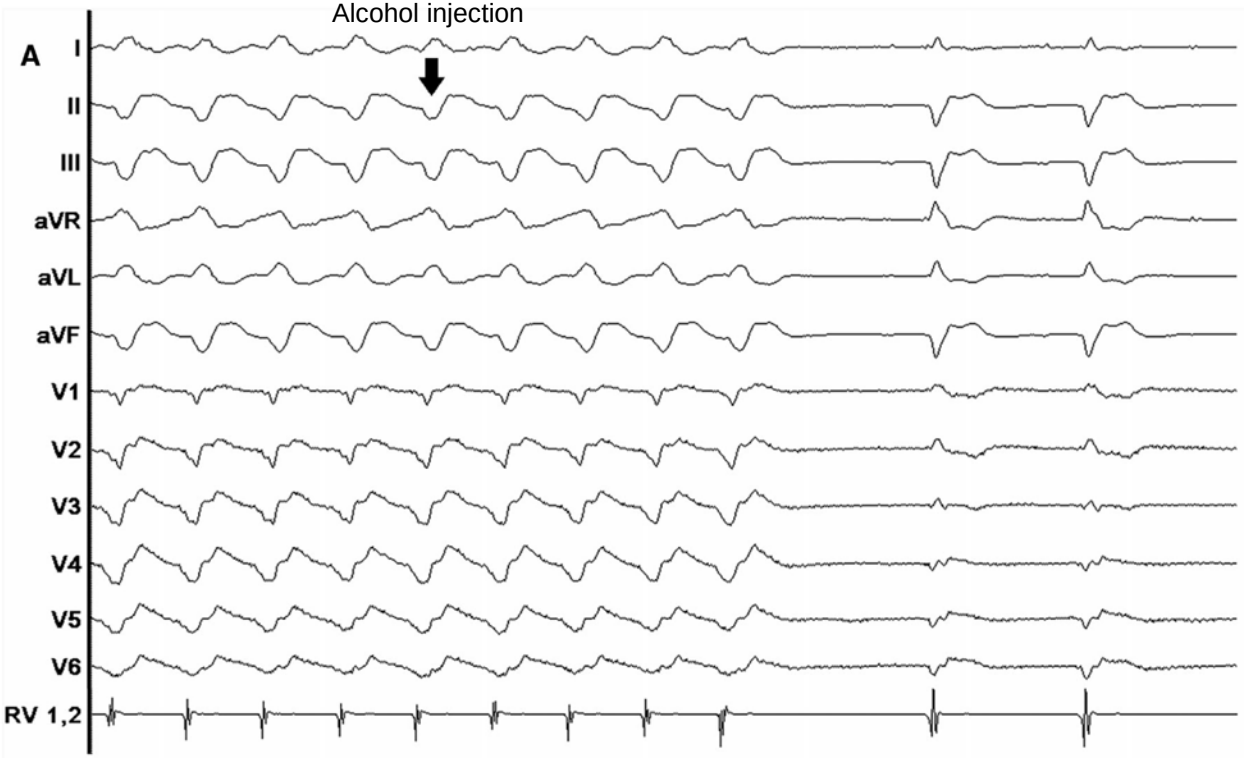


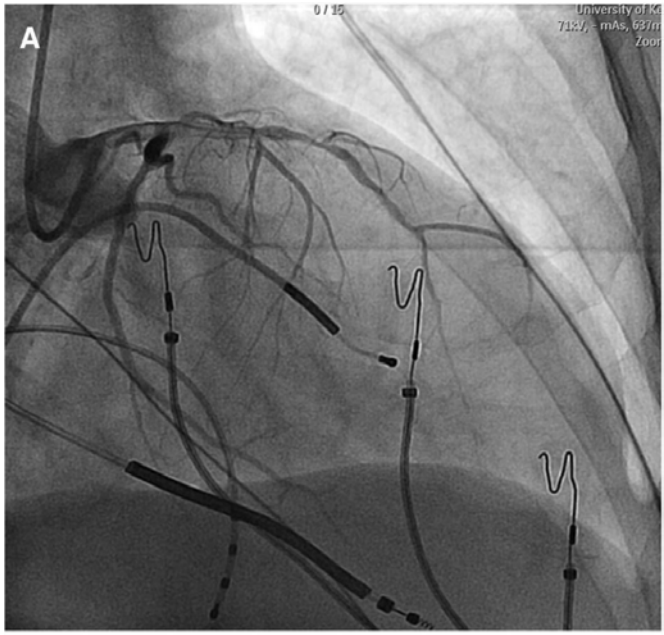


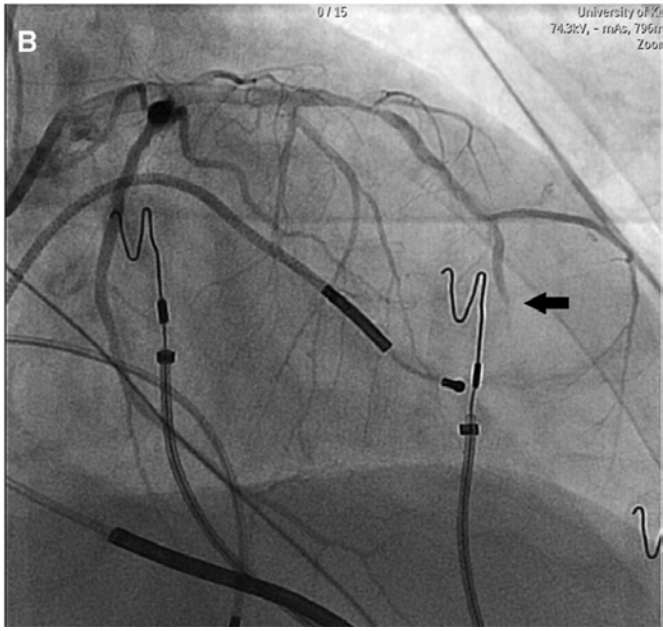
- M/67 Recurrent VT
- Refractory to amiodarone
- Delayed enhancement of the mid-myocardium in the inferolateral wall and septum (MRI) and a perfusion defect with increased uptake of 18F-fluorodeoxyglucose in the same region (PET-CT)
- Prior attempts at radiofrequency (RF) catheter ablation, including epicardial and bipolar transmural RF ablation, as well as haemodynamic support with ECMO, were not successful.
- Because of VT storm, the patient underwent transcoronary ethanol ablation, which targeted a right posterolateral (RPL) branch which supplied this region. Balloon occlusion of the distal RPL during VT reproducibly terminated the tachycardia within 30–50 s.

Europace. 2017;19:1921.

Use of Cardioplegia to Guide Alcohol Ablation for Incessant VT



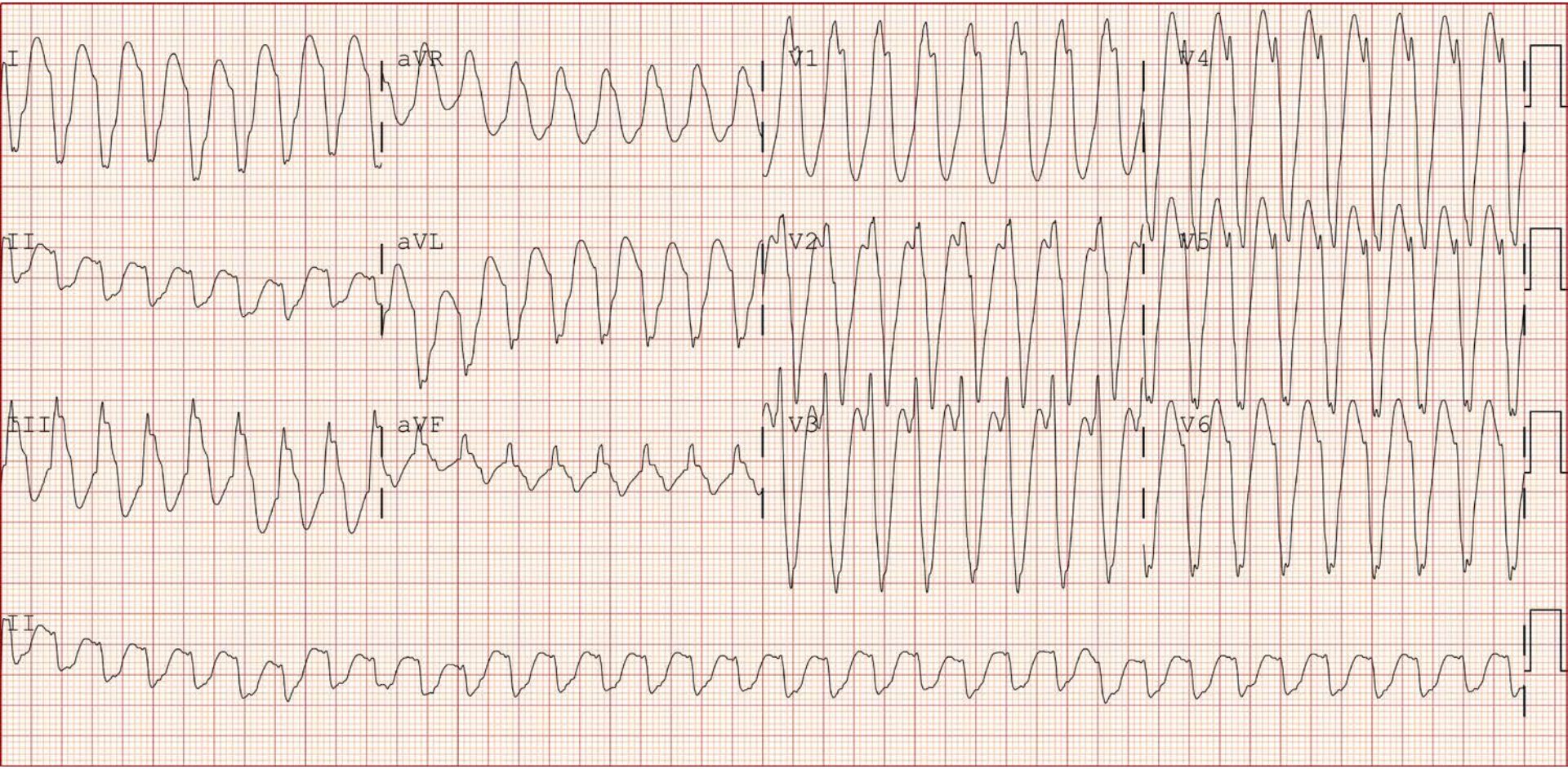




- M/77 Ischemic cardiomyopathy
- Subsequently, cardioplegic solution (Buckberg CAPS2 CP2D compounded at Central Admixture Pharmacy Service) was injected into the distal LAD. Following the administration of 0.5 cc of cardioplegic solution, the VT terminated within 2 seconds.
- We reinduced the same VT with ventricular program stimulation (VPS, with drive train at 400 ms and double extrastimuli) and the VT terminated again immediately after repeat injection of the cardioplegic solution. A similar sequence of stimulation was repeated once more to ensure reproducibility. At this stage, 0.5–2.0 cc of alcohol was administered over 30–120 seconds and the VT was no longer inducible despite aggressive VPS.

Pacing Clin Electrophysiol. 2017;40:213-216.

M/54 Presyncope
s/p ICD implantation (2 years ago)



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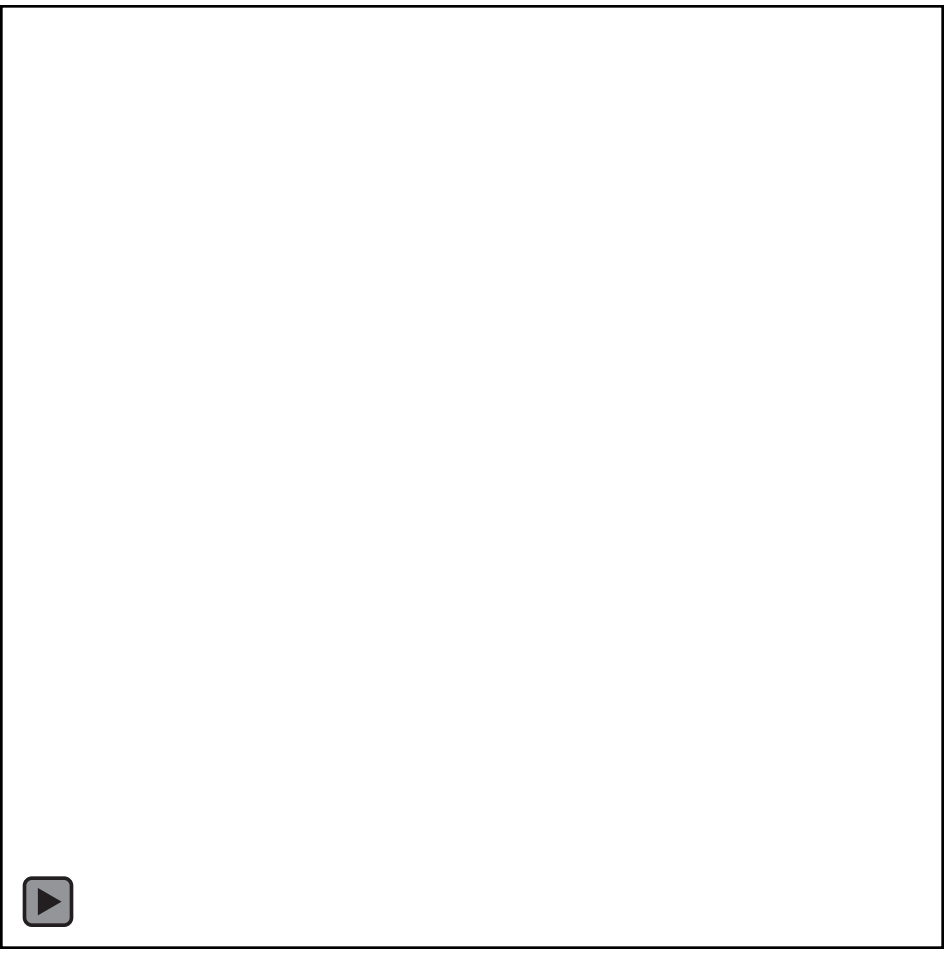
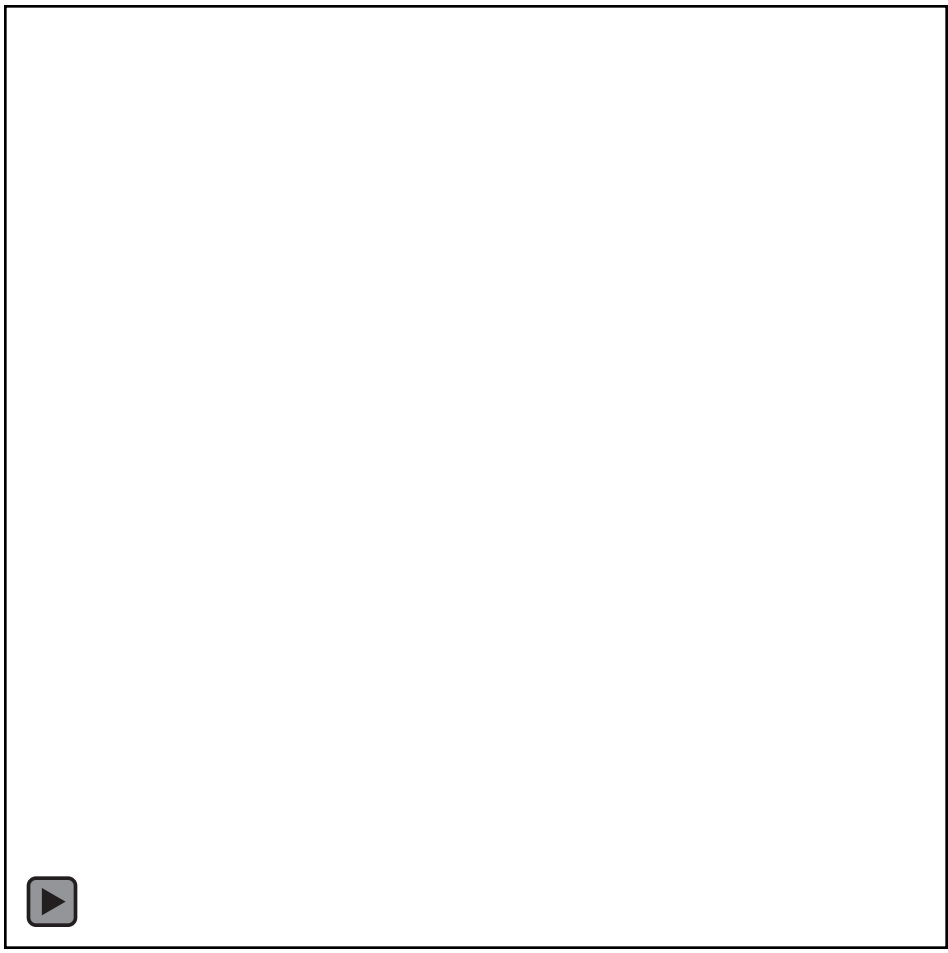
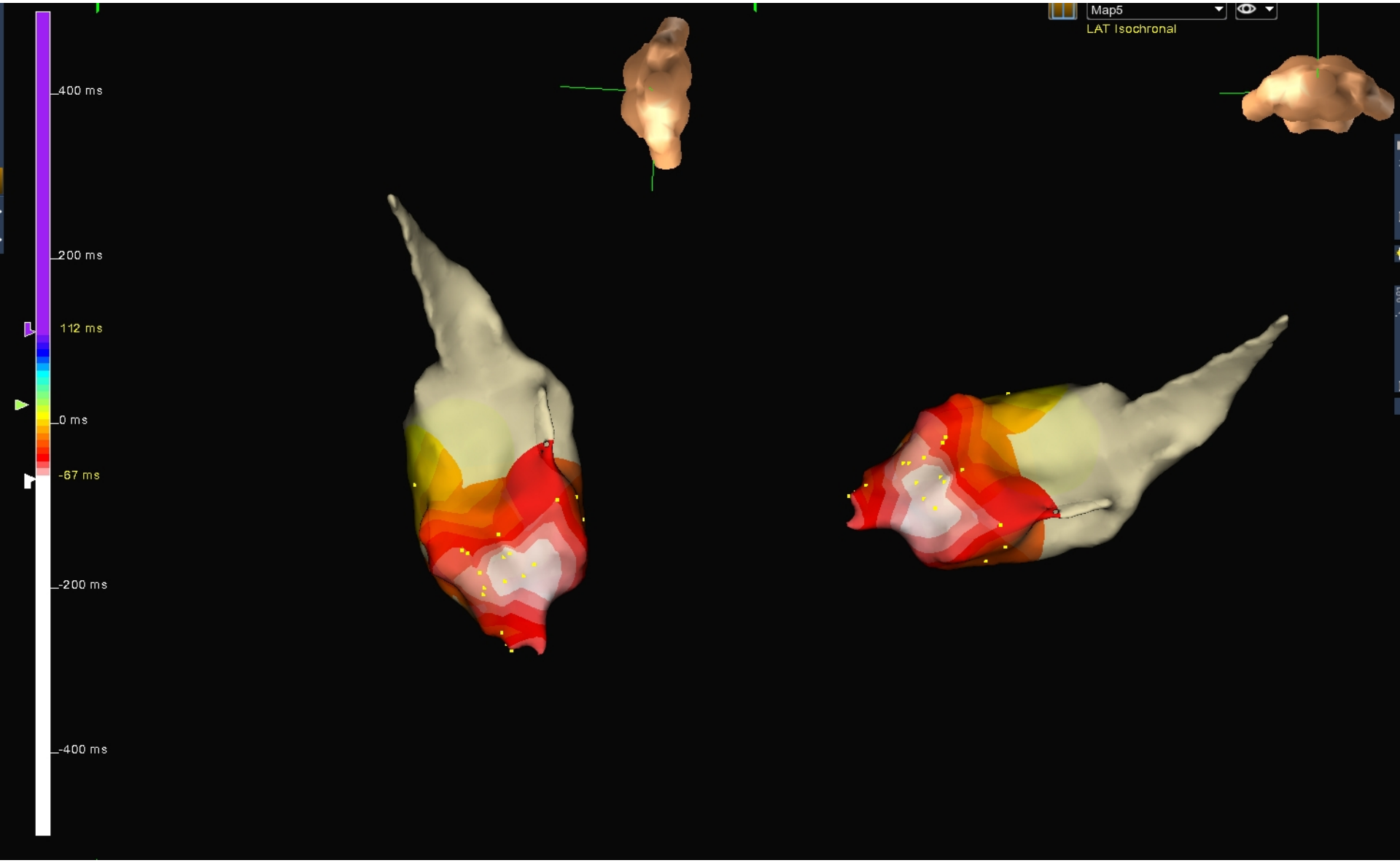
Left ventriculography

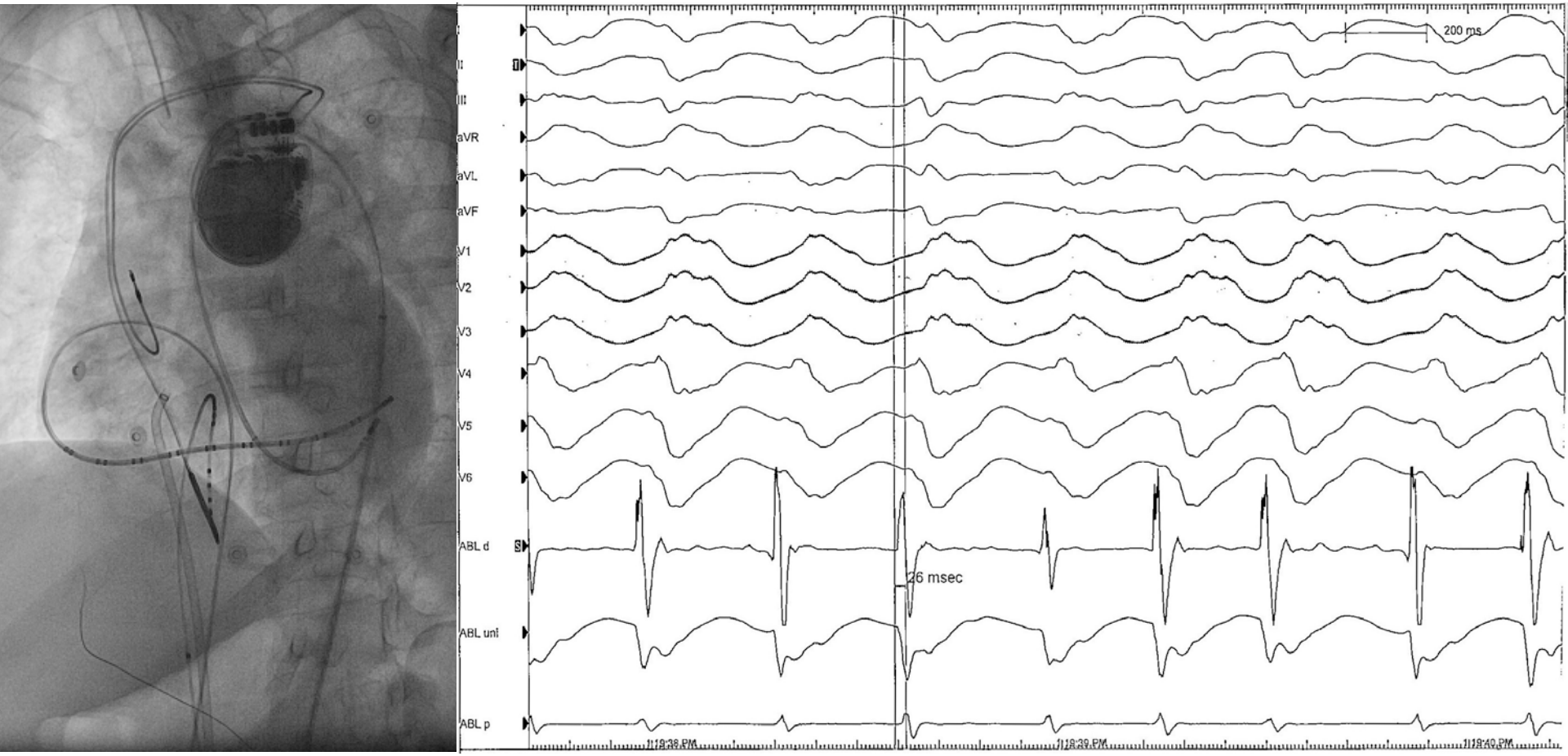




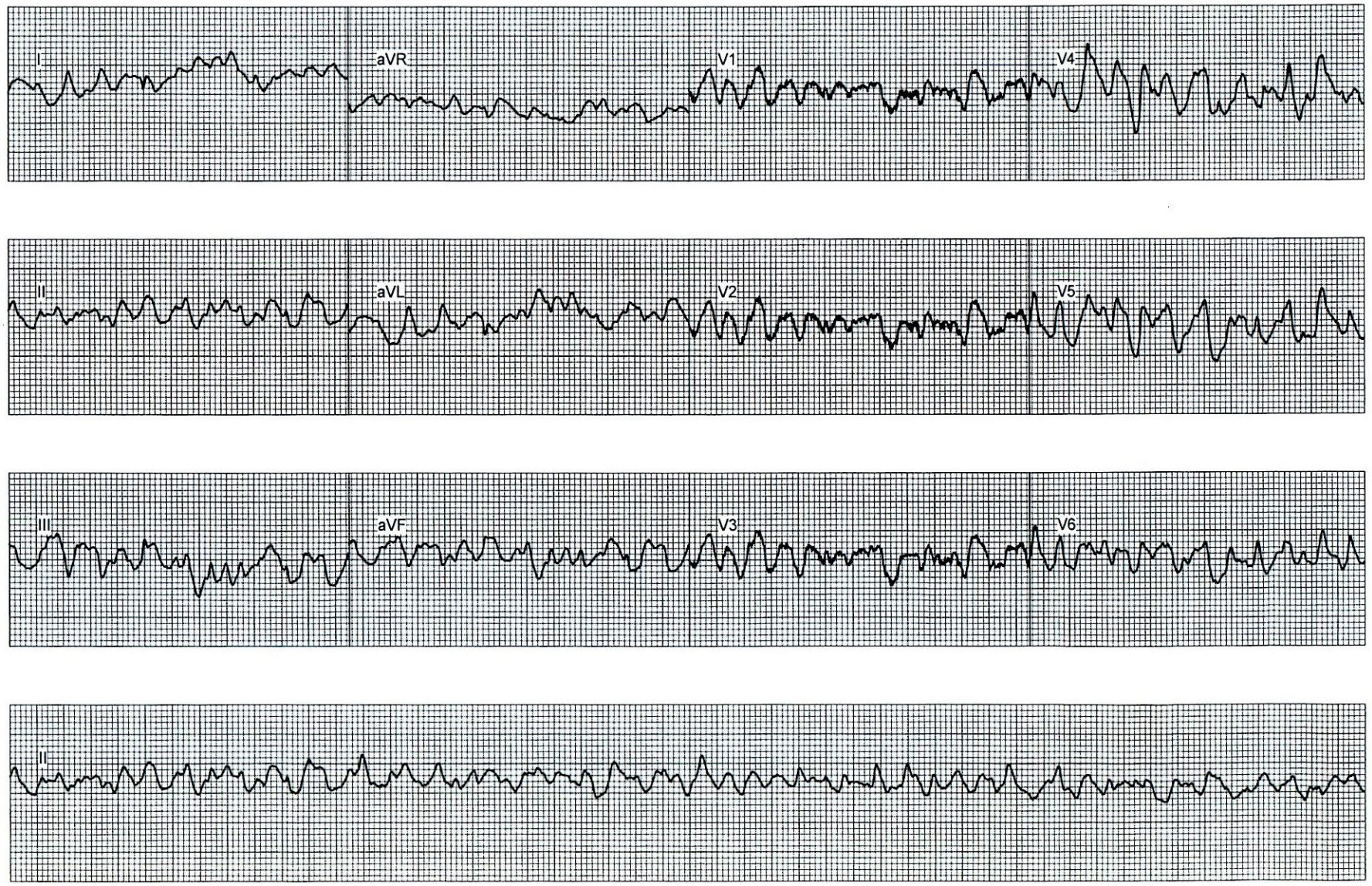
Propagation map



RFCA at anterolateral wall of LV



After RFCA,



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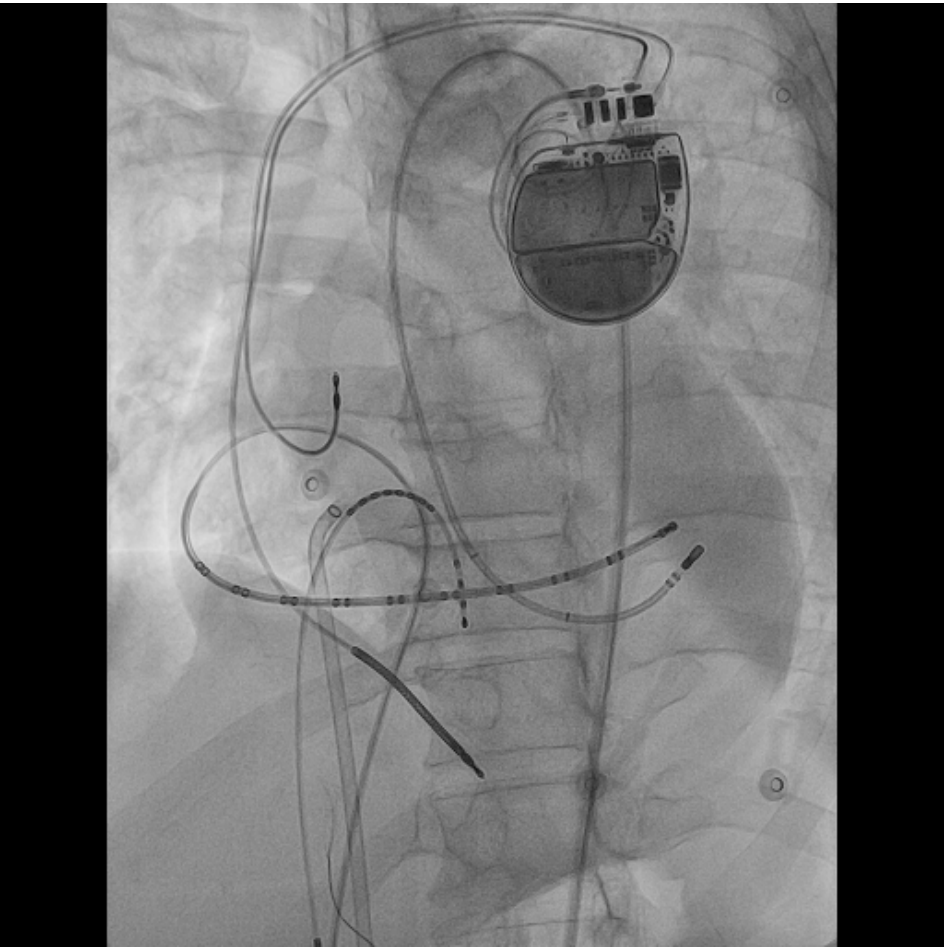

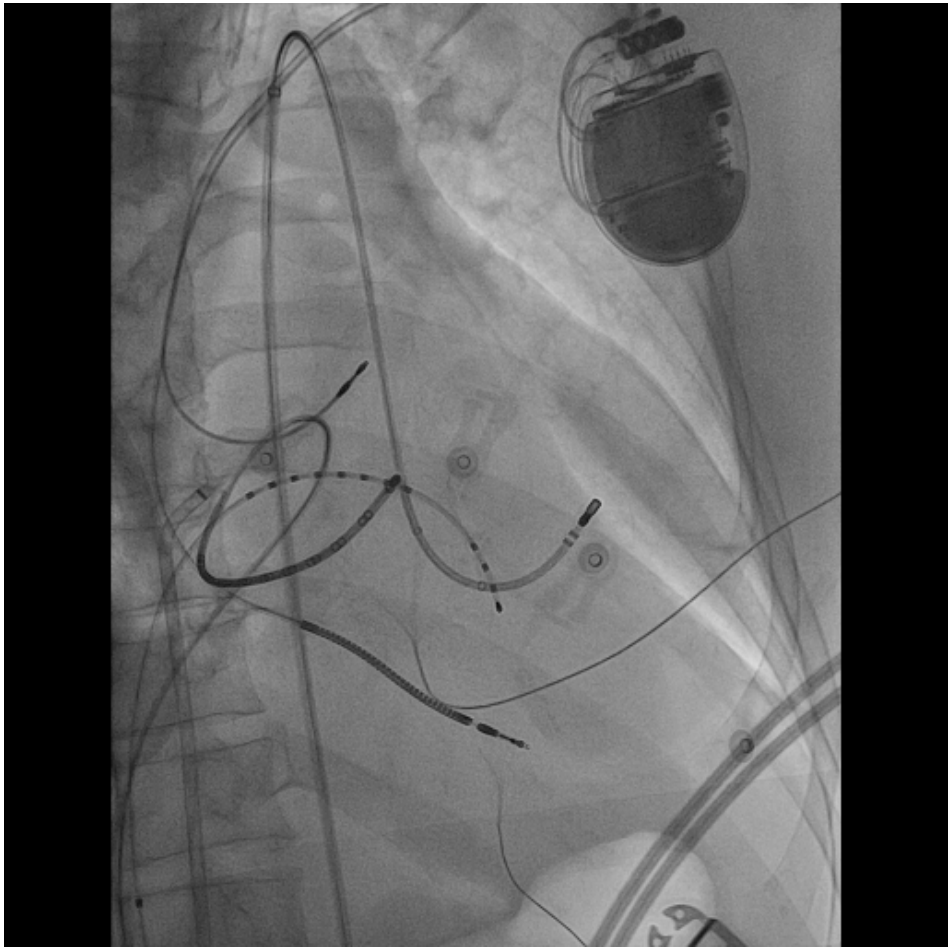

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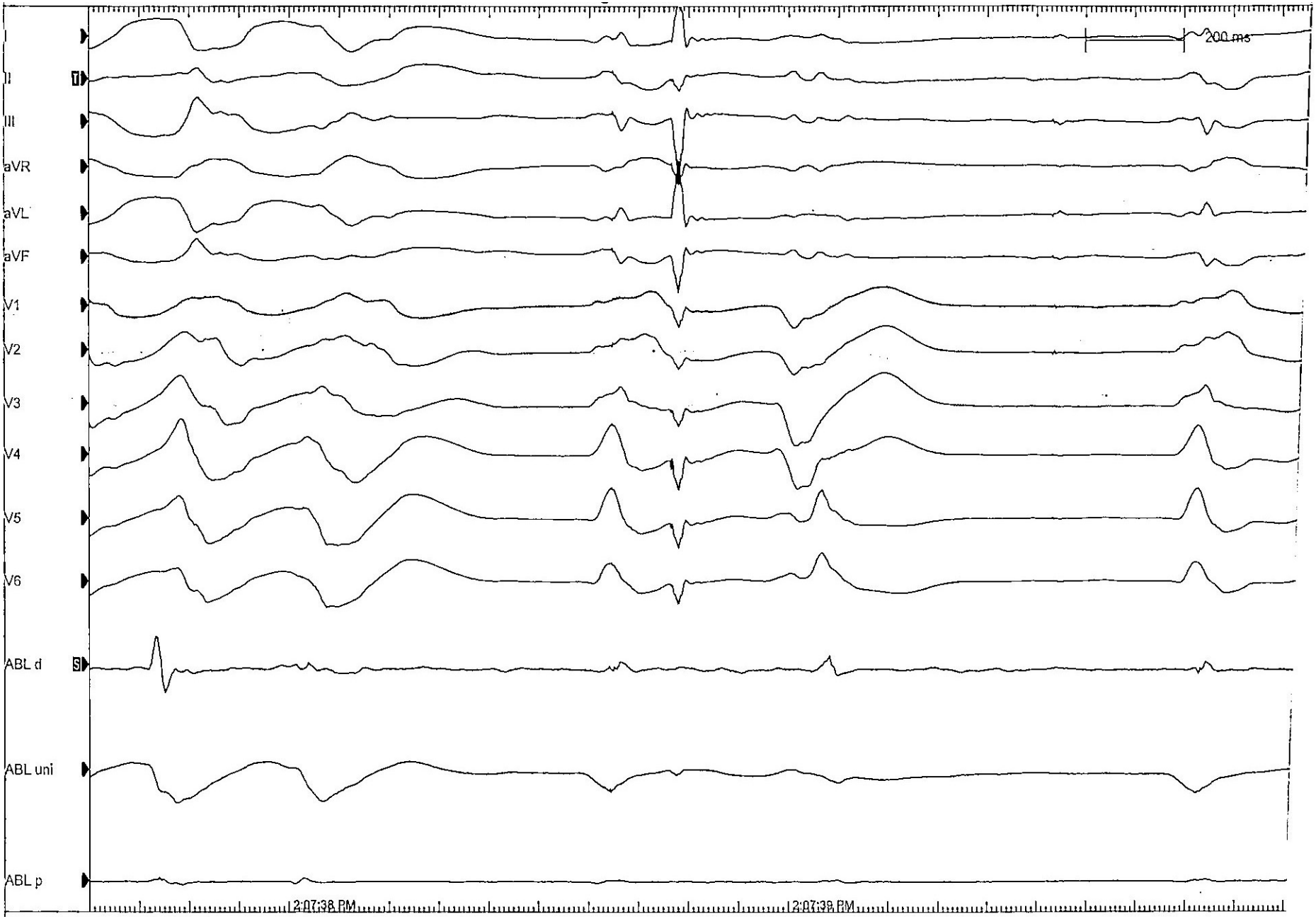
VT termination during ablation



Thank you for your attention!!!