UNIVERSITY OF OTTAWA
HEART INSTITUTE
INSTITUT DE CARDIOLOGIE
DE L'UNIVERSITÉ D'OTTAWA

CATHETER ABLATION IN SUBJECTS WITH PREMATURE VENTRICULAR CONTRACTIONS: WHEN AND IN WHOM?

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DISCLOSURES

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OUTLINE/OBJECTIVES

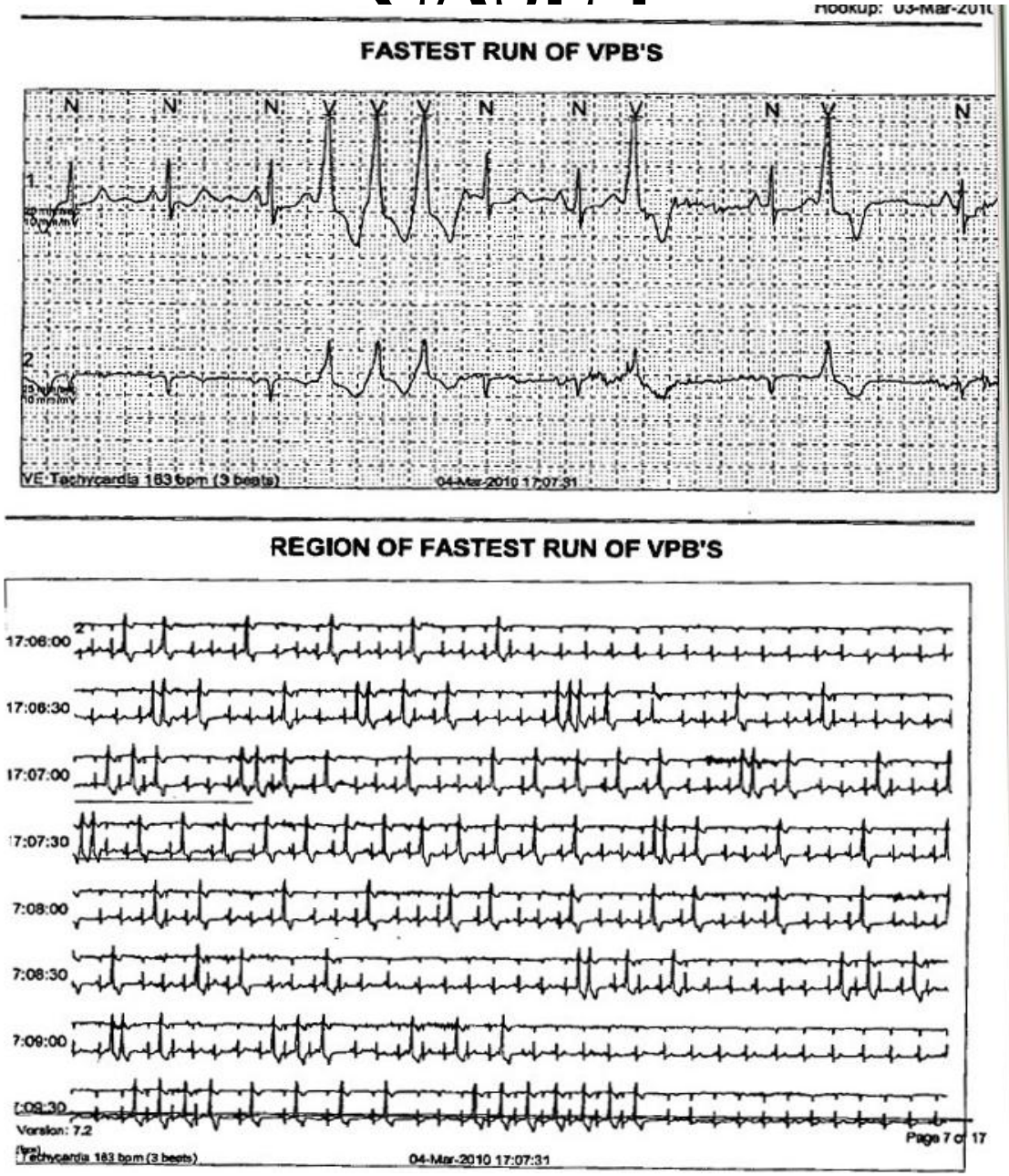
Frequent PVCs: Effects on the heart

Clinical Scenarios:

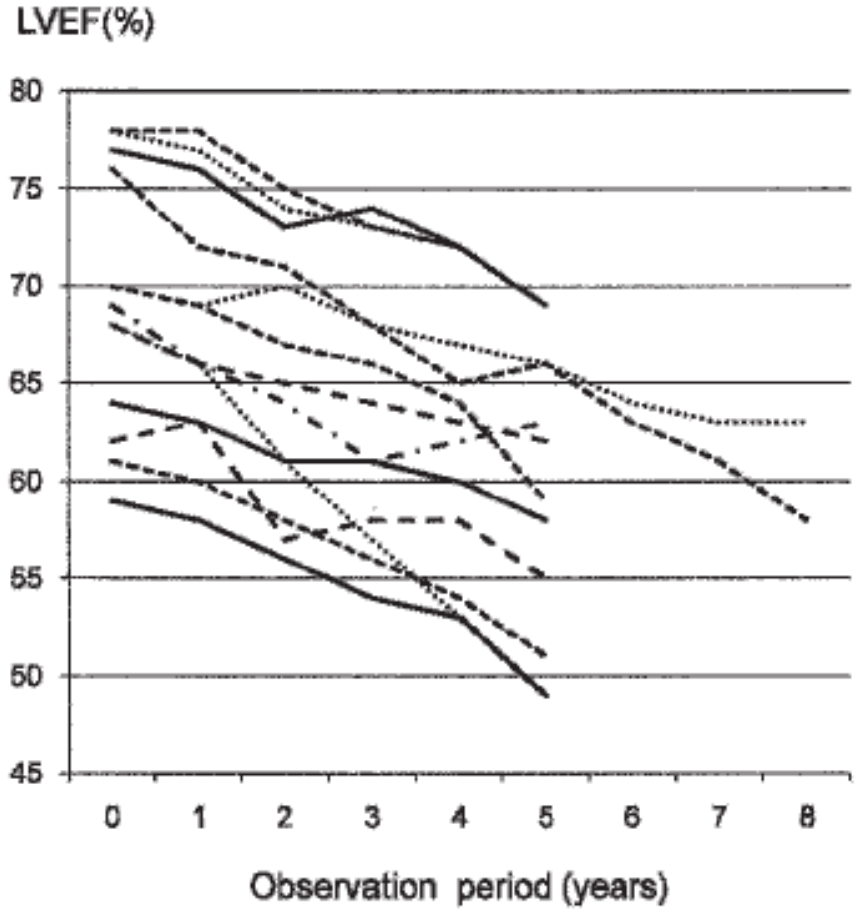
- Symptomatic PVCs / High Burden PVCs / PVC induced Cardiomyopathy
- Dilated Cardiomyopathy with high burden PVCs
- Mitral Valve Prolapse Syndrome with PVCs
- Idiopathic VF/ICD shocks triggered by PVCs
- PVCs interfering with Cardiac Resynchronization therapy

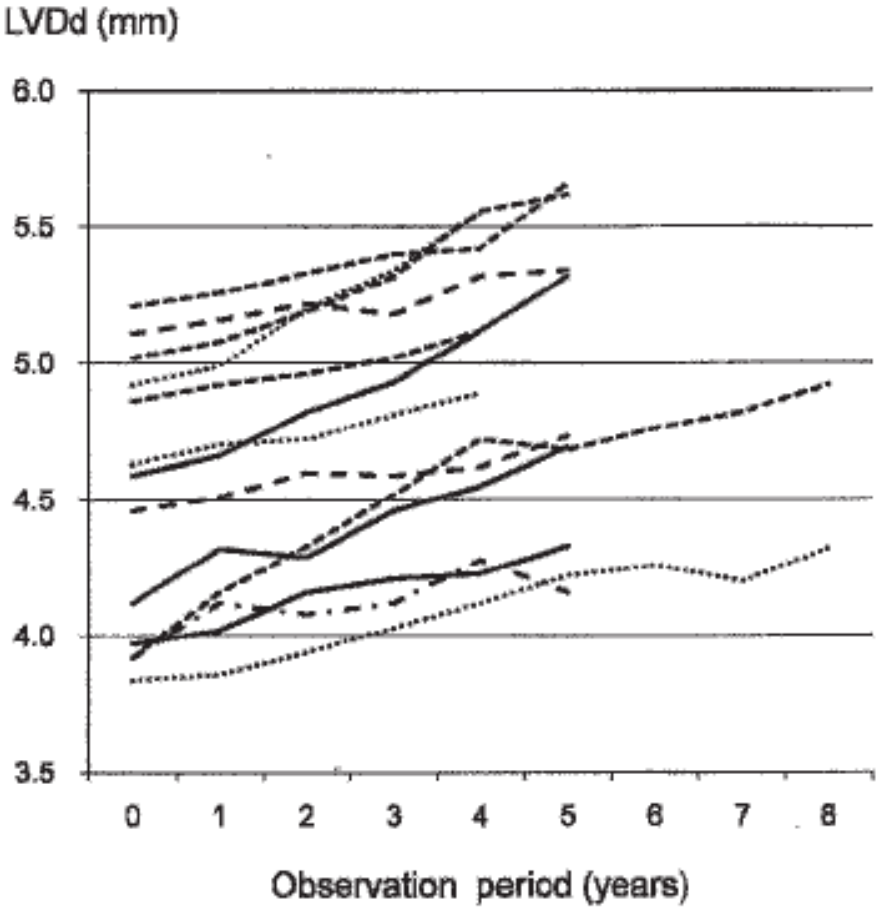
- ***Limited retrospective studies, no trials, evidence not of high quality***

CASE 1

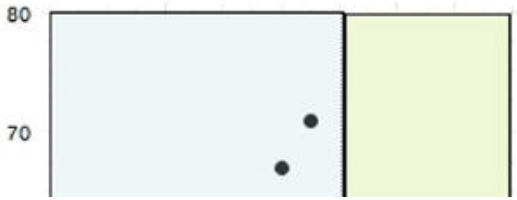

FASTEST RUN OF VPB'S
N N N V V V N N V N V N
1
2
VE-Tachycardia 183 bpm (3 beats)
04-Mar-2010 17:07:31
REGION OF FASTEST RUN OF VPB'S
17:06:00
17:06:30
17:07:00
17:07:30
7:08:00
7:08:30
7:09:00
7:09:30
Version: 7.2
Page 7 of 17
04-Mar-2010 17:07:31

NATURAL HISTORY





Heart 2009;**95**:1230–1237. doi:10.1136/hrt.2008.159558



LV

Table 3 Cutoff data for the PVC burden based on data from the ROC curves with combined sensitivity and specificity

PVC burden (%)	Sensitivity (%)	Specificity (%)
10	100	46
16	90	58
21	80	75
27	70	88
30	60	91
34	50	91
35	40	94
39	30	95
41	20	96
50	10	99

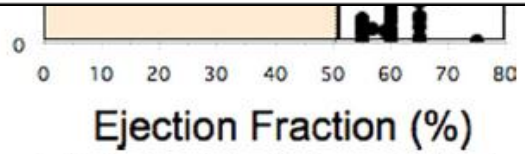


Figure 1 Scattergram indicating the relationship between PVC burden and ejection fraction. PVC = premature ventricular complex.

Munoz et al. **PVCs and Left Ventricular Dysfunction** (*J Cardiovasc Electrophysiol, Vol. 22, pp. 791-798, July 2011*)

Baman et al Premature Ventricular Complex–Mediated Cardiomyopathy Heart Rhythm, Vol 7, No 7, July 2010

PREDICTORS OF LV DYSFUNCTION

TABLE 4

Multivariate Regression Analysis of Predictors of LVEF (%) Preablation

Independent variables	Estimate	Lower 95% confidence limit	Upper 95% confidence limit	P value
History of palpitations	−0.090	−0.146	−0.035	0.001
History of dizziness	−0.020	−0.056	0.015	0.260
PVC burden (%)	−0.003	−0.007	0.000	0.076
Nonsustained VT	−0.065	−0.098	−0.031	0.001
PVC duration ≥140 ms	−0.043	−0.080	−0.006	0.021
Fascicular PVC	0.068	0.004	0.131	0.038
Multiform PVC	−0.011	−0.065	0.043	0.703

Munoz et al. **PVCs and Left Ventricular Dysfunction**

(J Cardiovasc Electrophysiol, Vol. 22, pp. 791-798, July 2011)

LV DYSFUNCTION IN PVC INDUCED TACHYCARDIOMYOPATHY

Table 2. Systolic Function, Morphology, and Fibrosis on CMR at Late Follow-Up

	Healthy Controls (n=20)	AT-Normal EF Patients (n=15)	AT-Low EF Patients (n=16)*	*P* Value†
LV ejection fraction, %	64±4	65±4	60±6‡§	<0.05
LV end-diastolic volume, mL	161±38	162±37	183±43	0.2
LV end-systolic volume, mL	60±19	58±18	75±22	0.06
LV mass, g	105±33	100±33	102±34	1.0
LA volume, mL	76±19	75±17	80±23	0.4
LV end-diastolic volume index, mL/m²	84±14	85±16	102±34‡§	<0.05
LV end-systolic volume index, mL/m²	31±7	30±8	41±11‡§	<0.01
LV mass index, g/m²	55±15	52±16	56±17	0.9
LA volume index, mL/m²	41±10	39±8	45±15	0.4
Delayed enhancement, n (%)	0 (0)	0 (0)	0 (0)	1.0
Global corrected T_1 time, ms	506±61	480±76	442±53‡	<0.05

ACE indicates angiotensin-converting enzyme; AT, atrial tachycardia; CMR, contrast-enhanced cardiac MRI; EF, ejection fraction; and GFR, glomerular filtration rate; LA, left atrium; and LV, left ventricle.

*Of 18 AT-low EF patients, 2 had implantable cardioverter-defibrillators precluding CMR.

†One-way analysis of variance (ANOVA) with Bonferroni correction was used for continuous variables. Fisher Exact test was used for categorical variables.

‡Significant difference compared with controls.

§Significant difference compared with AT-normal EF patients.

SYSTEMATIC REVIEW OF PVC ABLATION

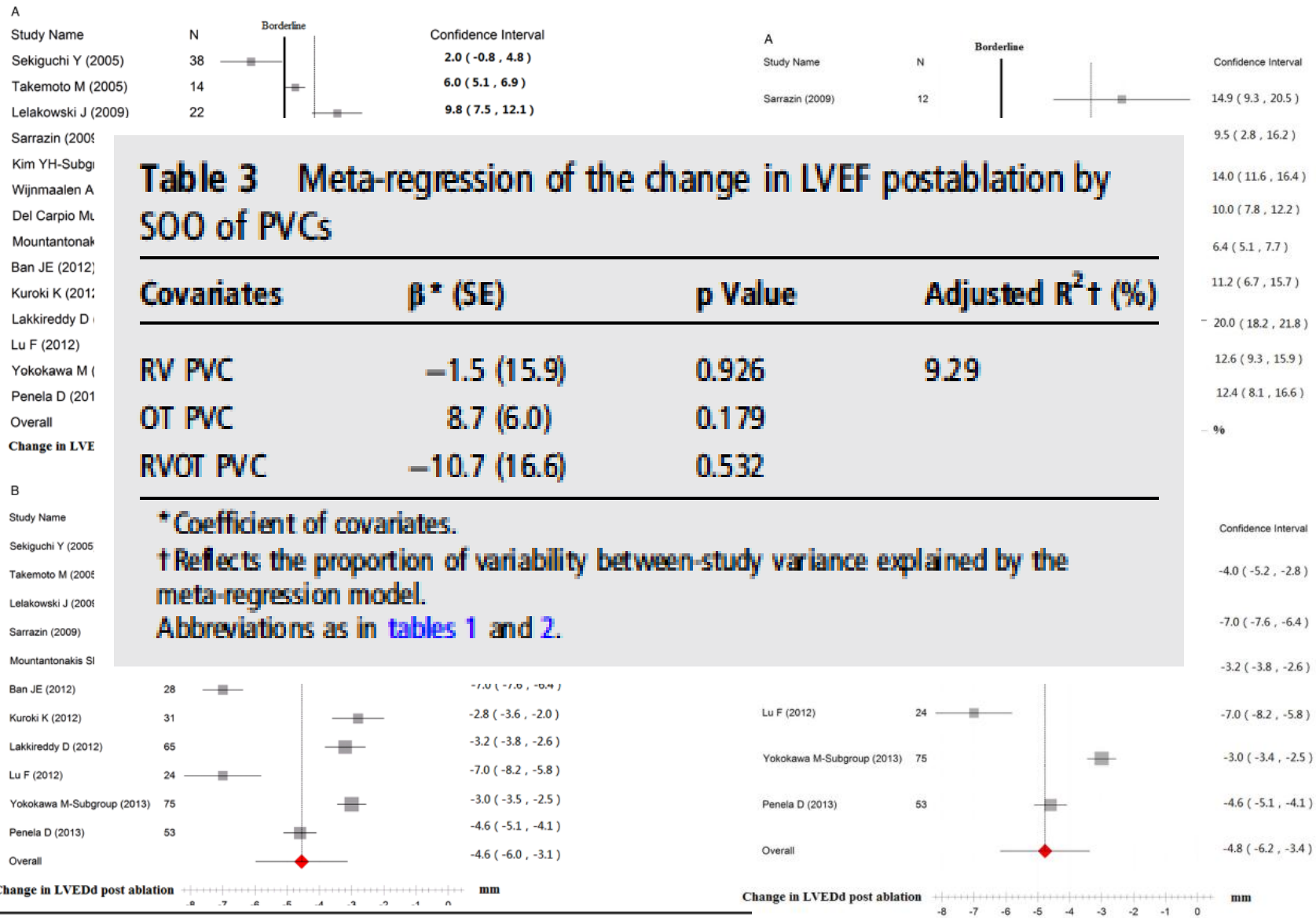


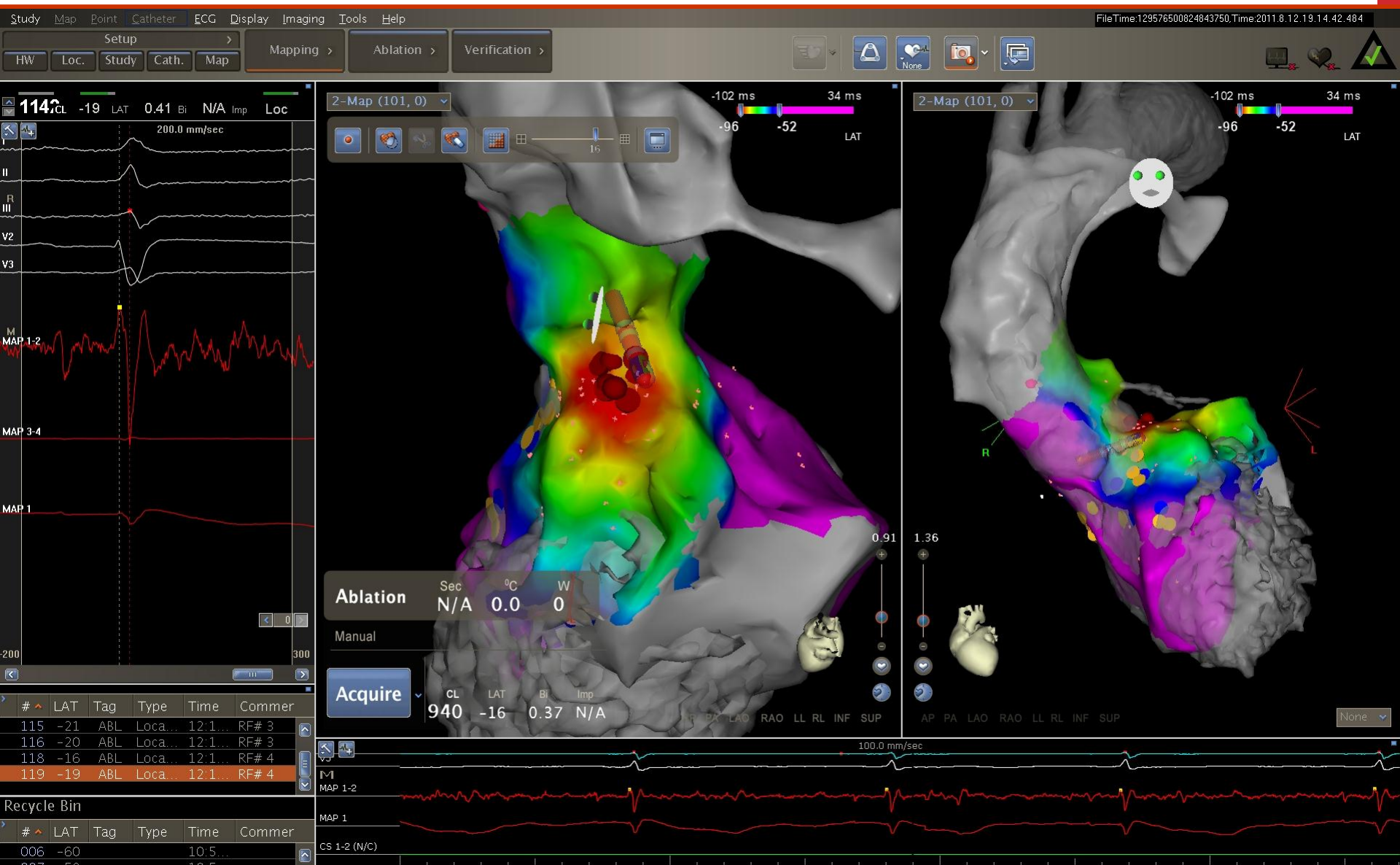
Table 3 Meta-regression of the change in LVEF postablation by SOO of PVCs

Covariates	β* (SE)	p Value	Adjusted R^2† (%)
RV PVC	−1.5 (15.9)	0.926	9.29
OT PVC	8.7 (6.0)	0.179	
RVOT PVC	−10.7 (16.6)	0.532	

*Coefficient of covariates.
†Reflects the proportion of variability between-study variance explained by the meta-regression model.
Abbreviations as in tables 1 and 2.

Zang M, *et al*. *Heart* 2014;**100**:787–793. doi:10.1136/heartjnl-2013-305175

CHALLENGES TO ABLATION



CASE 2

- 48 years old woman; lawyer
- 2 episodes of syncope- description more like reflex mediated neurocardiogenic syncope
- PVCs on holter- 25% >48000 in 48 hrs
- Echo- MVPs with mild-moderate MR
- MRI- no LGE, Fibrosis, EF 47%

What would you do?

A. Amiodarone
B. Beta-blockers
C. ICD
D. Catheter Ablation

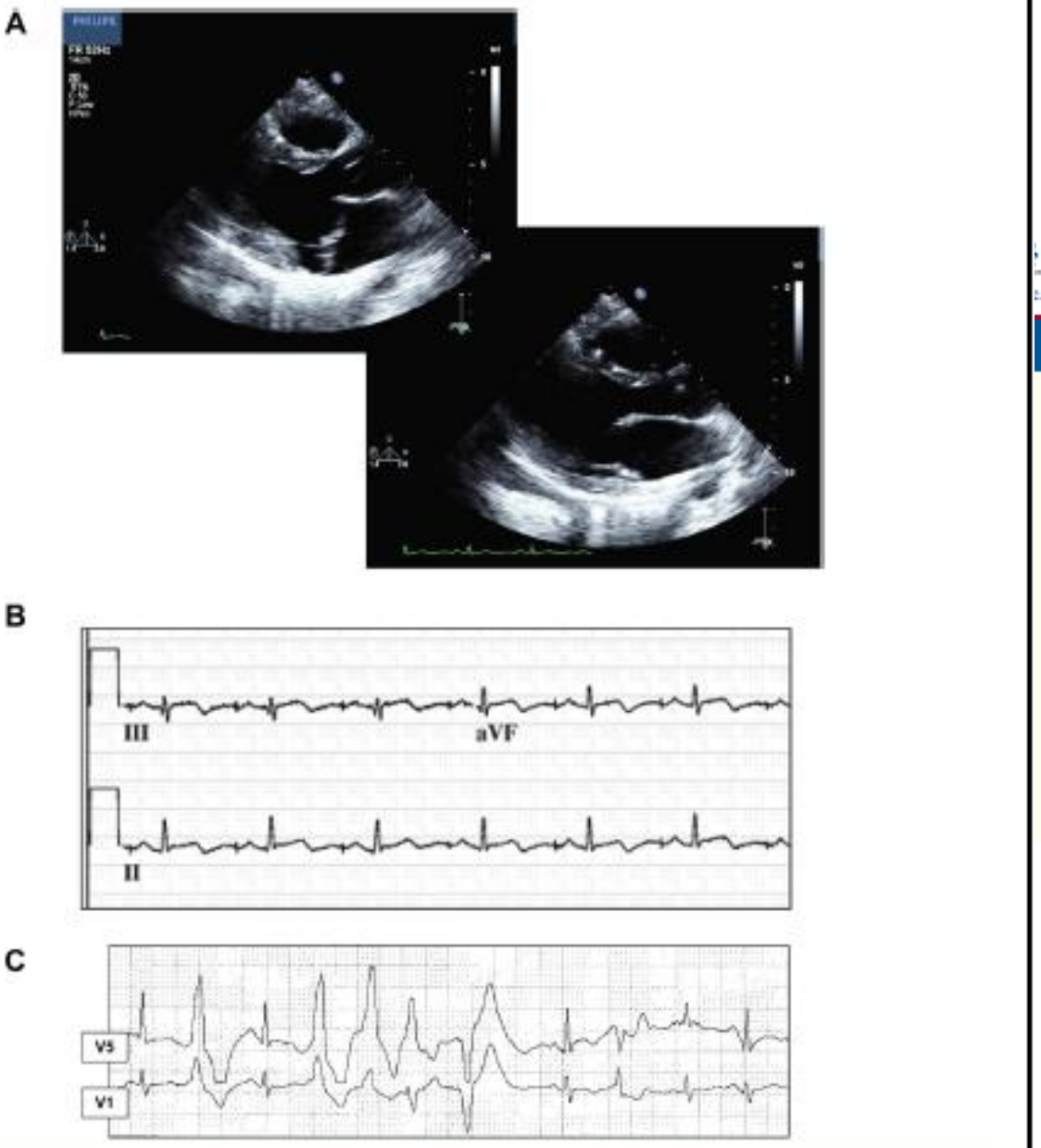


Figure 1 **Triad of Sudden Death Pre-Disposing Bileaflet MVP Syndrome**

Systolic and diastolic parasternal longaxis view of the heart demonstrating (**A**) bileaflet mitral valve thickening and mitral valve prolapse (MVP), (**B**) T-wave changes in the inferior leads, and (**C**) frequent ventricular ectopic activity with premature ventricular beats of outflow tract origin alternating with papillary muscle or fascicular origin.

Table 2 Relationship of Ventricular Ectopic Activity With Bileaflet MVP in OHCA Survivors With Ambulatory Holter Monitoring (n = 19)

Variable	Bileaflet MVP (n = 9)	No MVP (n = 10)	p Value*
PVCs	9/9 (100%)	7/7 (100%)	—
Ventricular ectopic activity burden (PVCs/h)	67 (35–690)	23 (1–258)	0.002†
NSVT/sustained VT	7/9 (78%)	1/10 (10%)	0.006‡
Polymorphic VT	4/9 (44%)	1/10 (10%)	0.14‡
Episodes of NSVT per h	0.3 (0–7.4)	0 (0–0.1)	0.003†
Bigeminal PVCs	9/9 (100%)	1/10 (10%)	<0.0001†
Bigeminal PVCs per h	0.4 (0.05–67.6)	0 (0–0.3)	0.0003†
Ventricular couplets per h	3.0 (0.3–26.5)	0.04 (0–1.6)	0.0015†
Alternating papillary muscle/outflow tract PVCs§	7/9 (78%)	2/10 (20%)	0.02‡
Other sites of PVC origin			
RV free wall	1/9 (11%)	1/10 (10%)	
RV midcavity	2/9 (22%)	1/10 (10%)	
LV midcavity	2/9 (22%)	1/10 (10%)	
Fascicle/papillary muscle alone	0/9 (0%)	1/10 (10%)	
Multiform PVCs	1/9 (11%)	0/10 (0%)	

Values are n/N (%) or median (range). *Comparing bileaflet MVP with no MVP. †Wilcoxon rank sum test. ‡Fisher exact test. §PVCs of alternating morphologies: originating from outflow tract (RV outflow tract alone, n = 0; LV outflow tract alone, n = 4; or RV and LV outflow tracts, n = 5) and papillary muscle or fascicle (n = 9).

LV = left ventricular; NSVT = nonsustained ventricular tachycardia; PVC = premature ventricular contraction; RV = right ventricular; VT = ventricular tachycardia; other abbreviations as in Table 1.

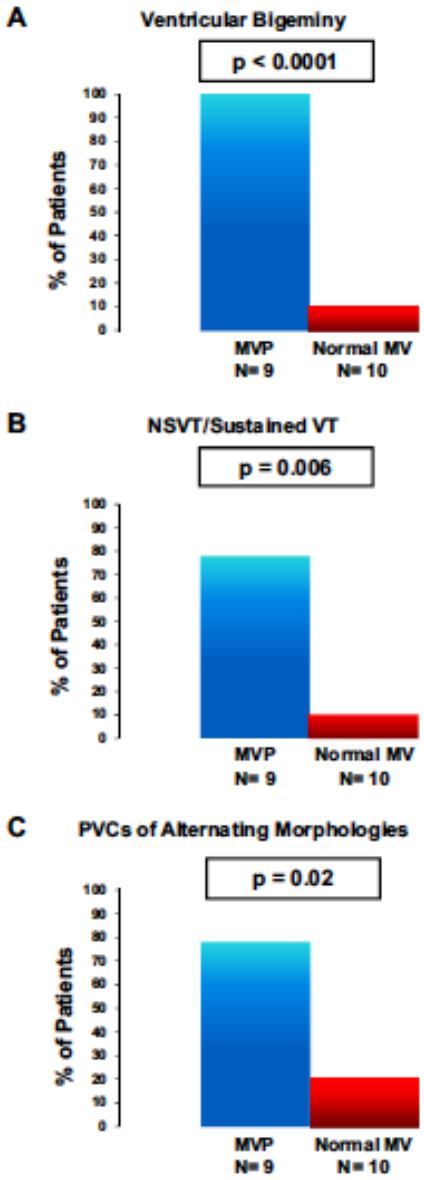


Figure 2 Ventricular Ectopic Activity and Bileaflet MVP

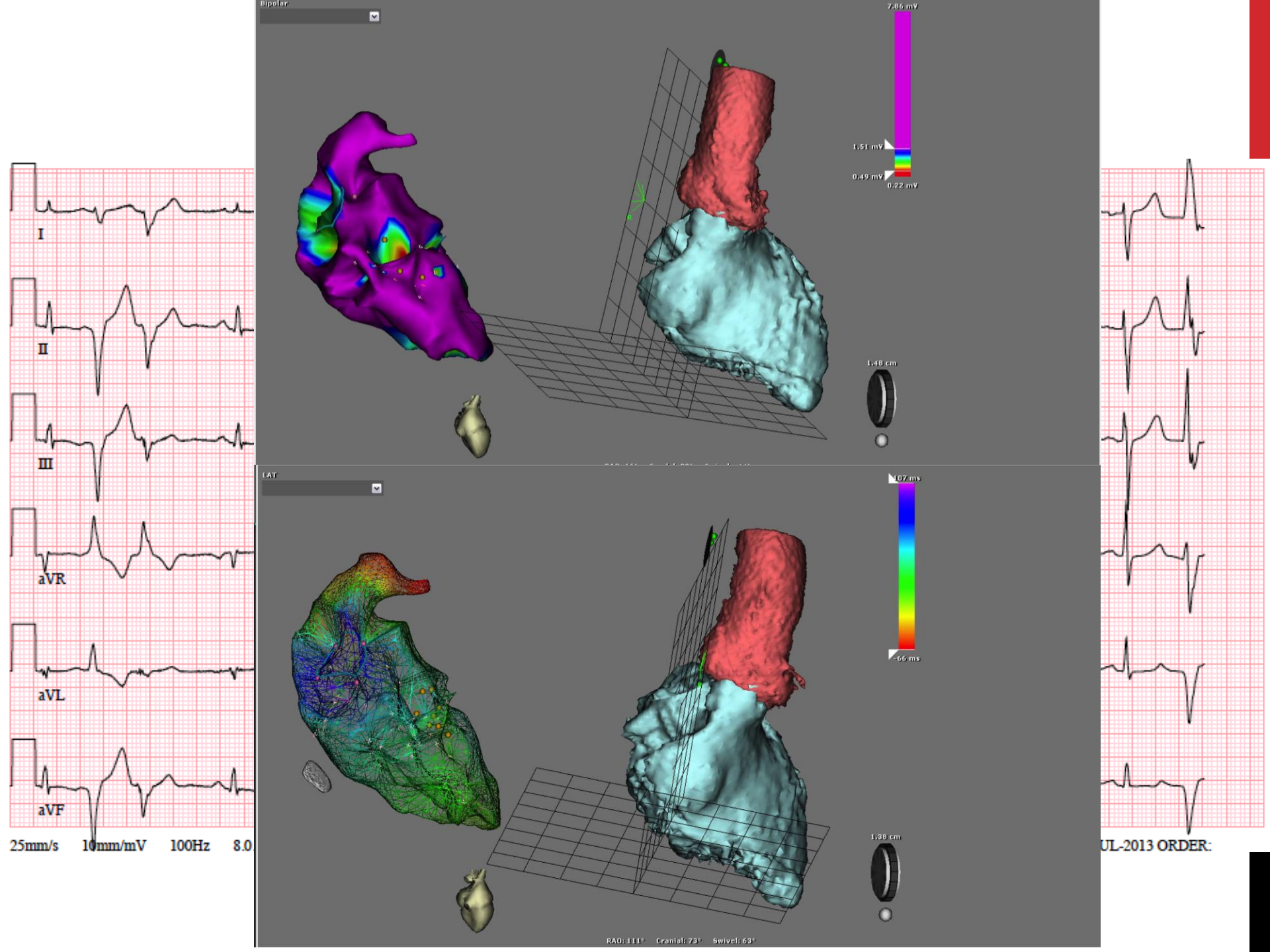
(A) Comparison of the burden of ventricular ectopic activity between patients with bileaflet mitral valve (MV) prolapse (MVP) and those with normal MVs. (B) Prevalence of nonsustained ventricular tachycardia (NSVT) or sustained ventricular tachycardia (VT) between patients with bileaflet MVP and those with normal MVs. (C) Frequency of premature ventricular contractions (PVCs) of alternating configurations (outflow tract alternating with papillary muscle or fascicular region) between those 2 groups.

Table 3 Association of Patient Characteristics, Ventricular Ectopic Activity, and Bileaflet MVP With Appropriate ICD Therapies on Follow-Up

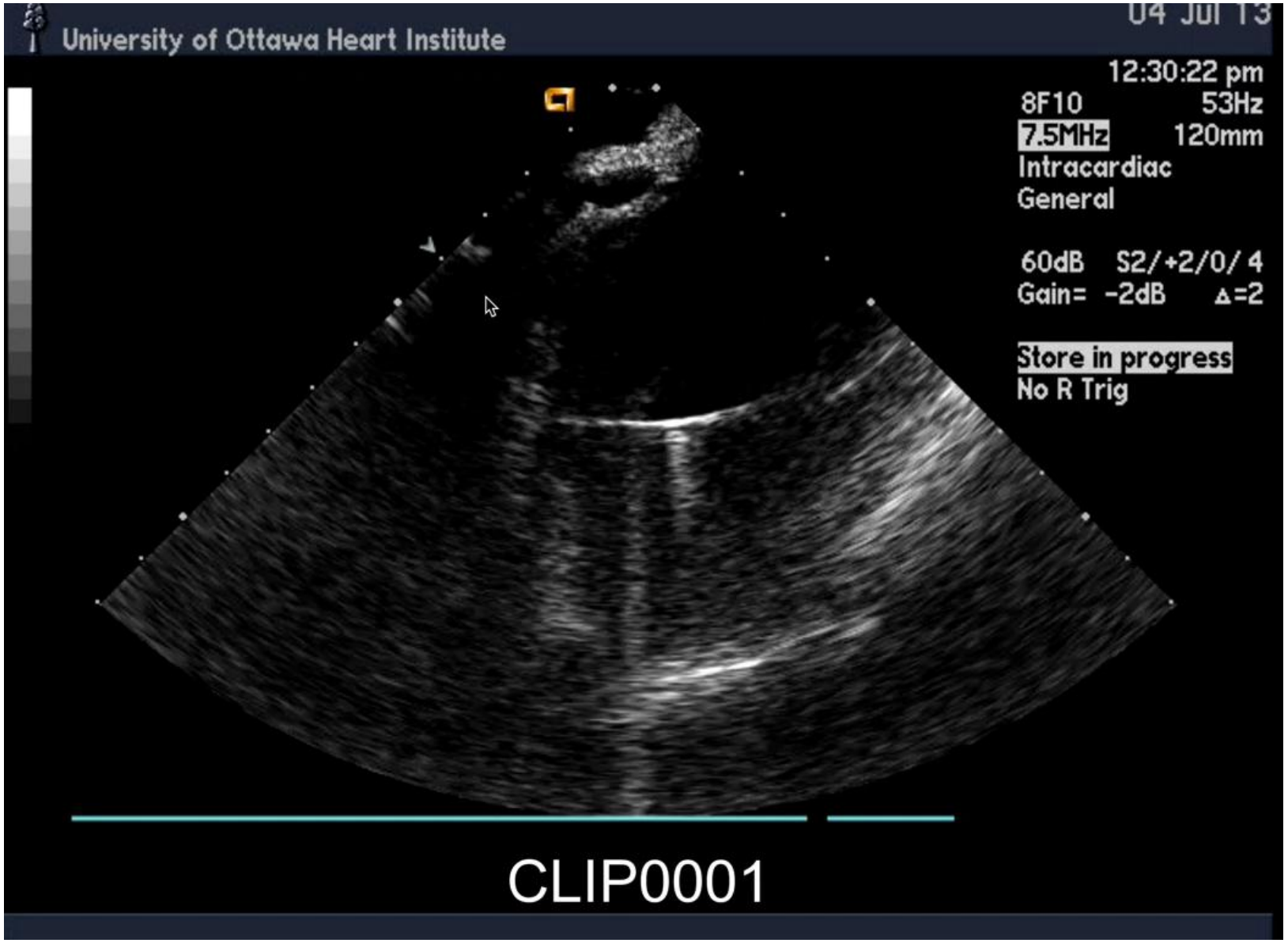
Variable	Appropriate ICD Therapies (n = 13)	No Appropriate ICD Therapies (n = 11)	p Value*
Age at sentinel event (yrs)	39 (5–51)	22 (14–61)	0.30†
Women	10/13 (77%)	6/11 (55%)	0.39‡
QTc interval (ms)	435 ± 19	425 ± 31	0.38§
Ventricular ectopic activity burden (PVCs/hr)	43.2 (9.7–690.3)	27.2 (0.8–258.3)	0.17†
NSVT/sustained VT	7/13 (54%)	1/6 (17%)	0.18‡
Polymorphic VT	5/13 (38%)	0/6 (0%)	0.13‡
Episodes of NSVT per hour	0.1 (0–7.4)	0 (0–0.05)	0.088†
Bigeminal PVCs	8/13 (62%)	2/6 (33%)	0.35‡
Bigeminal PVCs per hour	0.08 (0–67.6)	0 (0–0.9)	0.33†
Ventricular couplets per hour	1.1 (0–26.5)	0.1 (0–1.6)	0.10†
Alternating papillary muscle/outflow tract PVCs	6/13 (46%)	3/6 (50%)	1.00‡
Bileaflet MVP	8/13 (62%)	2/11 (18%)	0.047‡

Values are median (range), n/N (%), or mean ± SD. *Comparing bileaflet MVP with no MVP. †Wilcoxon rank sum test. ‡Fisher exact test. §Student *t* test.

Abbreviations as in Tables 1 and 2.


Bipolar
7.86 mV
1.51 mV
0.49 mV
0.22 mV
1.48 cm
LAT
107 ms
-66 ms
1.38 cm
RAO: 111°
Cranial: 73°
Swivel: 63°
I
II
III
aVR
aVL
aVF
25mm/s
10mm/mV
100Hz
8.0
UL-2013 ORDER:

MVPS WITH PVCS



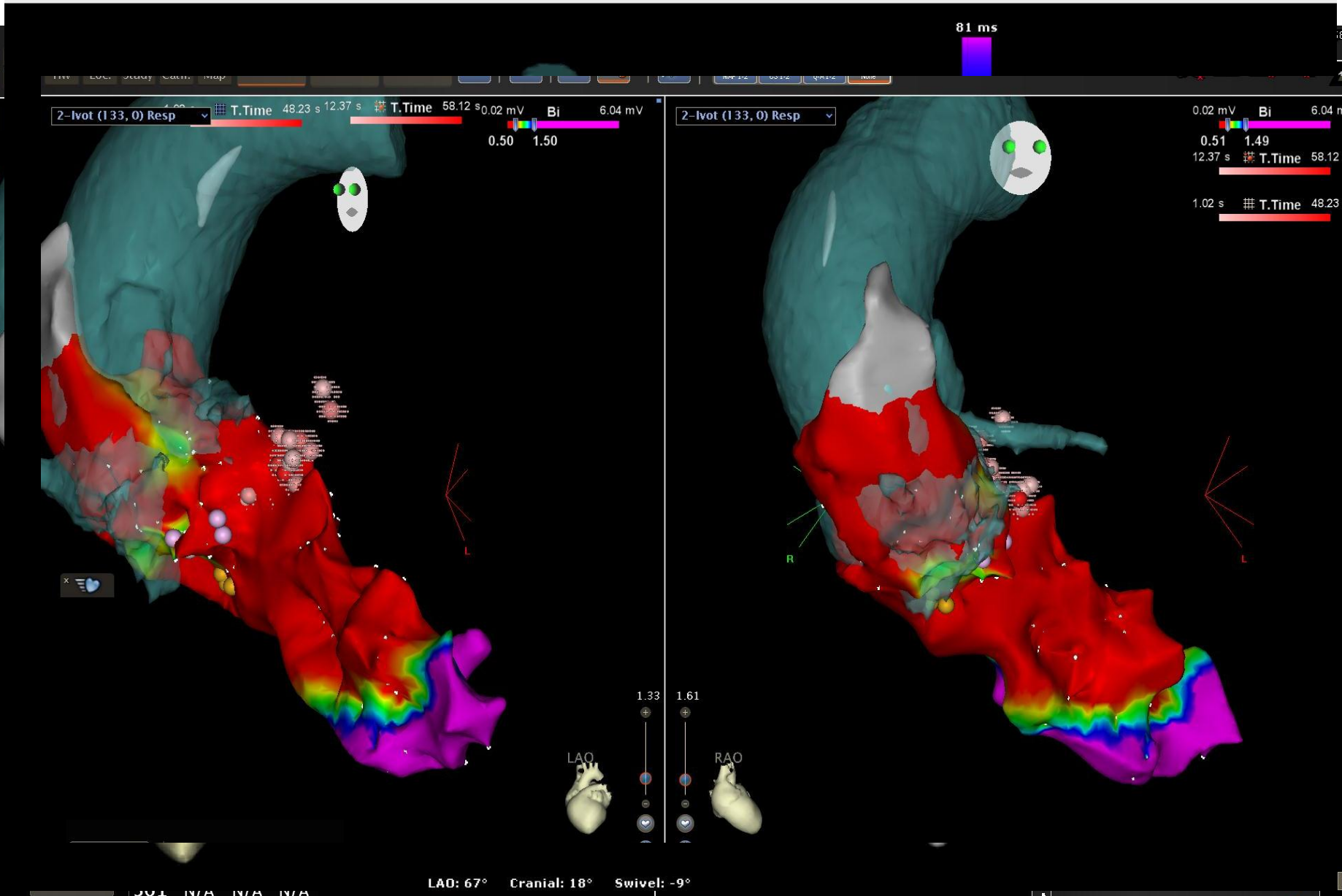
CASE 3

- **54 years old woman; Psychiatry Nurse**
- **Frequent symptomatic PVCs- >22%**
- **EF- 40%**
- **MRI- LVEF-38%; no LGE/Fibrosis**
- **Family history- a brother and sister both have ICDs for dilated cardiomyopathy**

What would you do?

A. Beta Blockers
B. Amiodarone
C. ICD insertion
D. Catheter Ablation

PVCS


81 ms
2-Ivot (133, 0) Resp
T.Time 48.23 s 12.37 s
T.Time 58.12 s
0.02 mV Bi 6.04 mV
0.50 1.50
2-Ivot (133, 0) Resp
0.02 mV Bi 6.04 mV
0.51 1.49
12.37 s T.Time 58.12 s
1.02 s T.Time 48.23 s
1.33
1.61
LAO
RAO
LAO: 67° Cranial: 18° Swivel: -9°
None

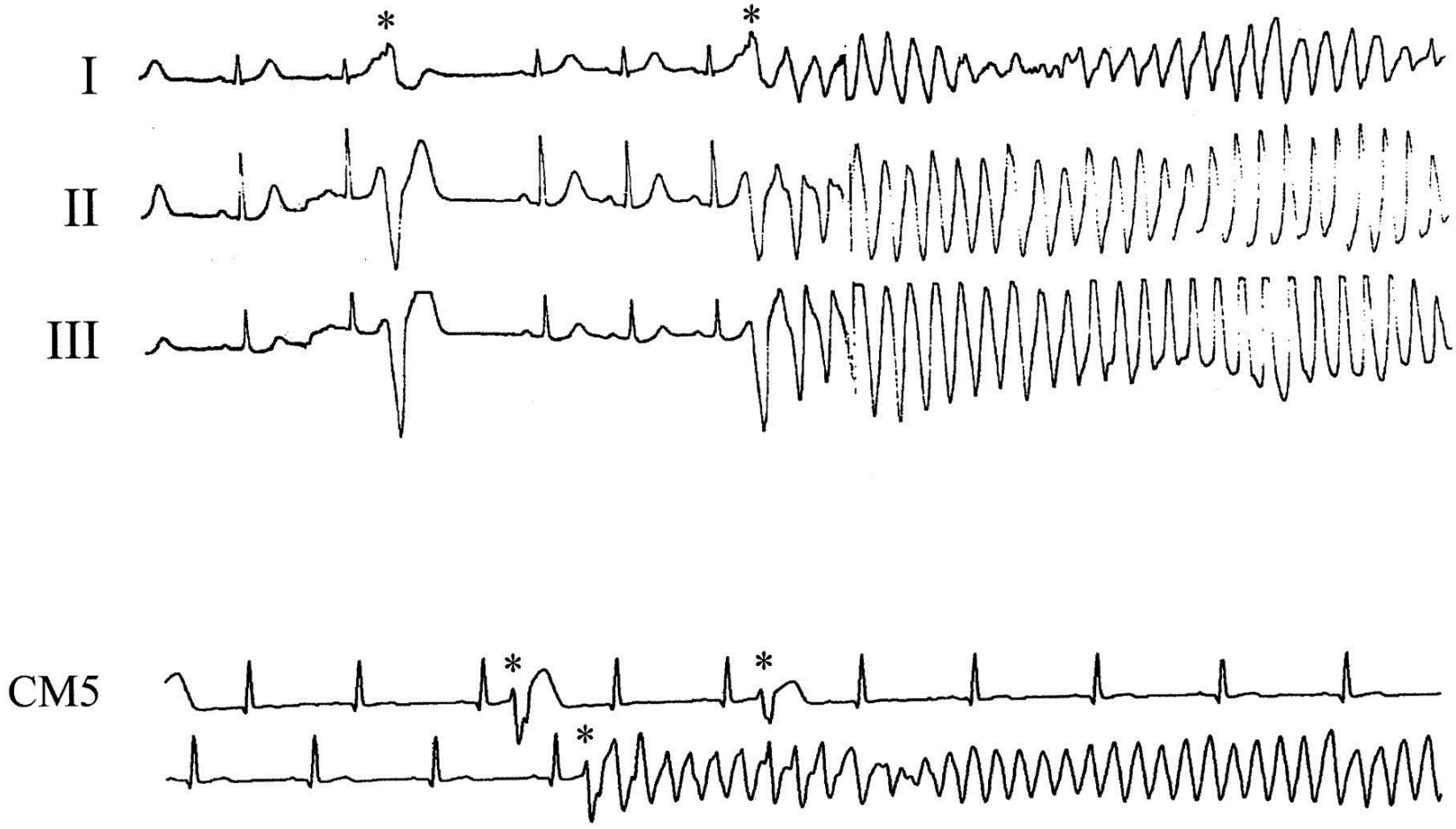
CASE 4

- **34 years old Dentist**
- **2 episodes of cardiac syncope**
- **Polymorphic NSVT, PVCs >30%**
- **ICD**
- **Normal LV function and MRI**

What would you do?

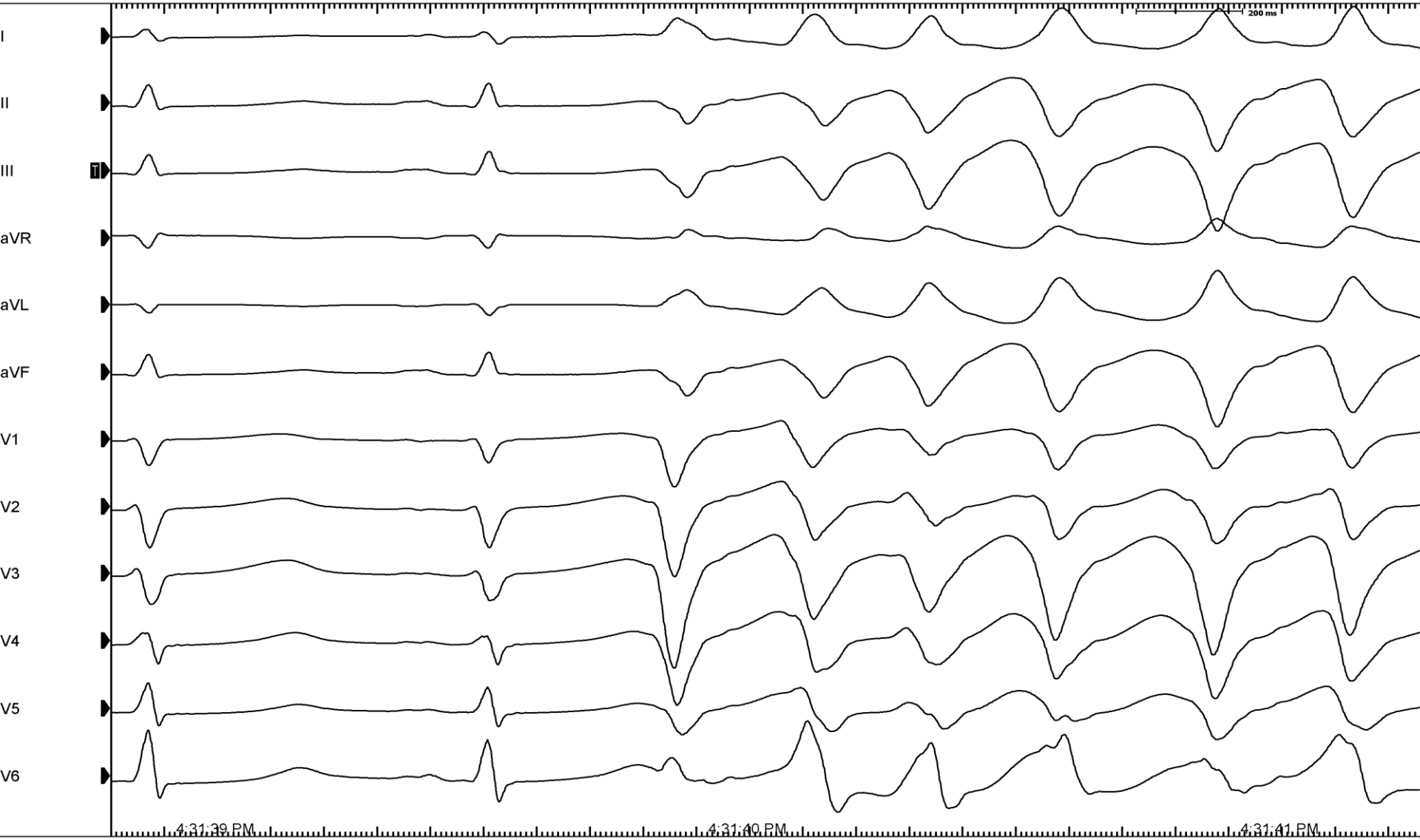
A. ICD insertion
B. Catheter Ablation
C. Amiodarone
D. Loop Recorder

Figure 1. Examples of VF initiation by premature beats later found to originate from the right (top) or left (bottom) ventricle.

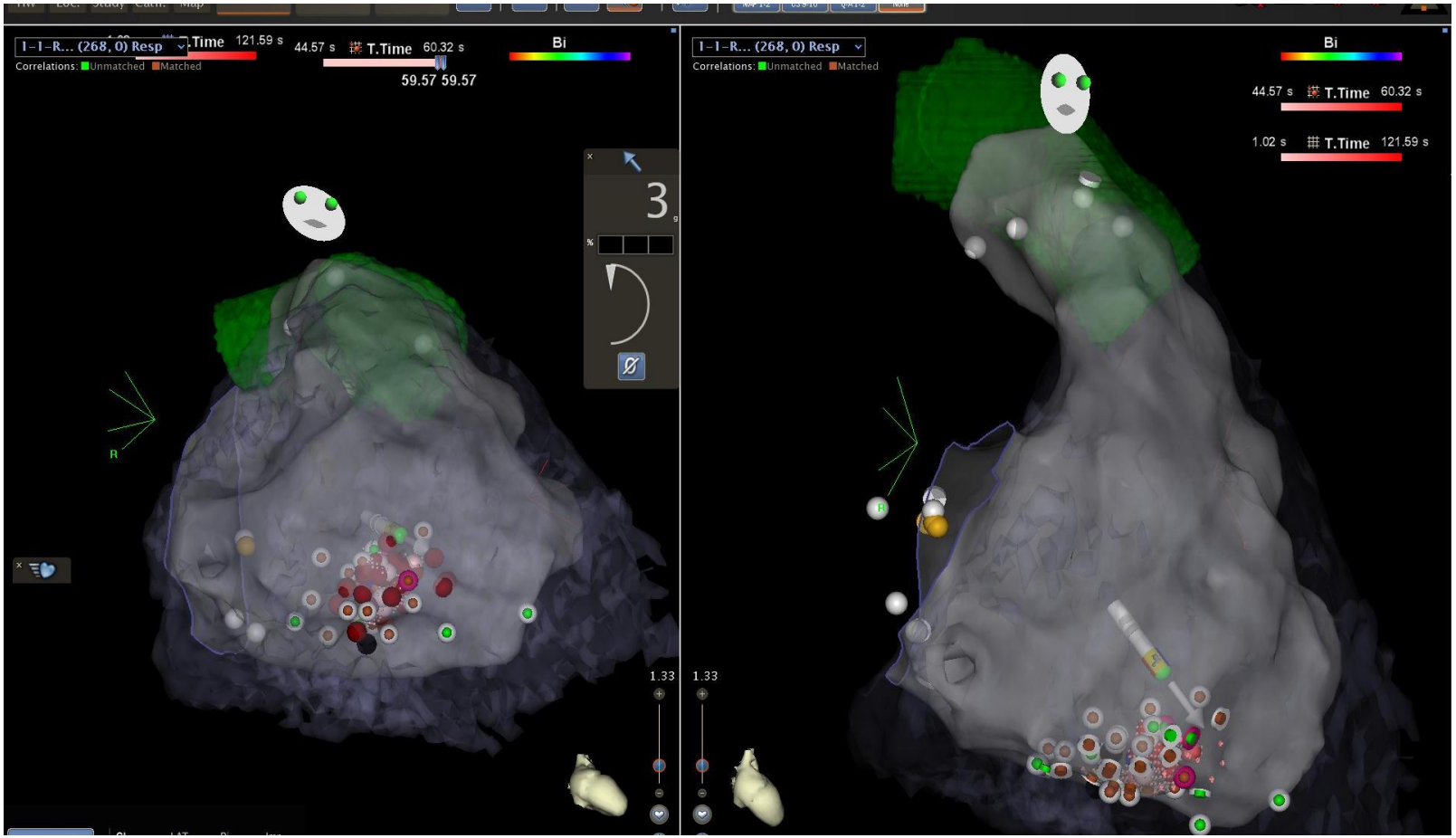


Haïssaguerre M et al. Circulation. 2002;106:962-967

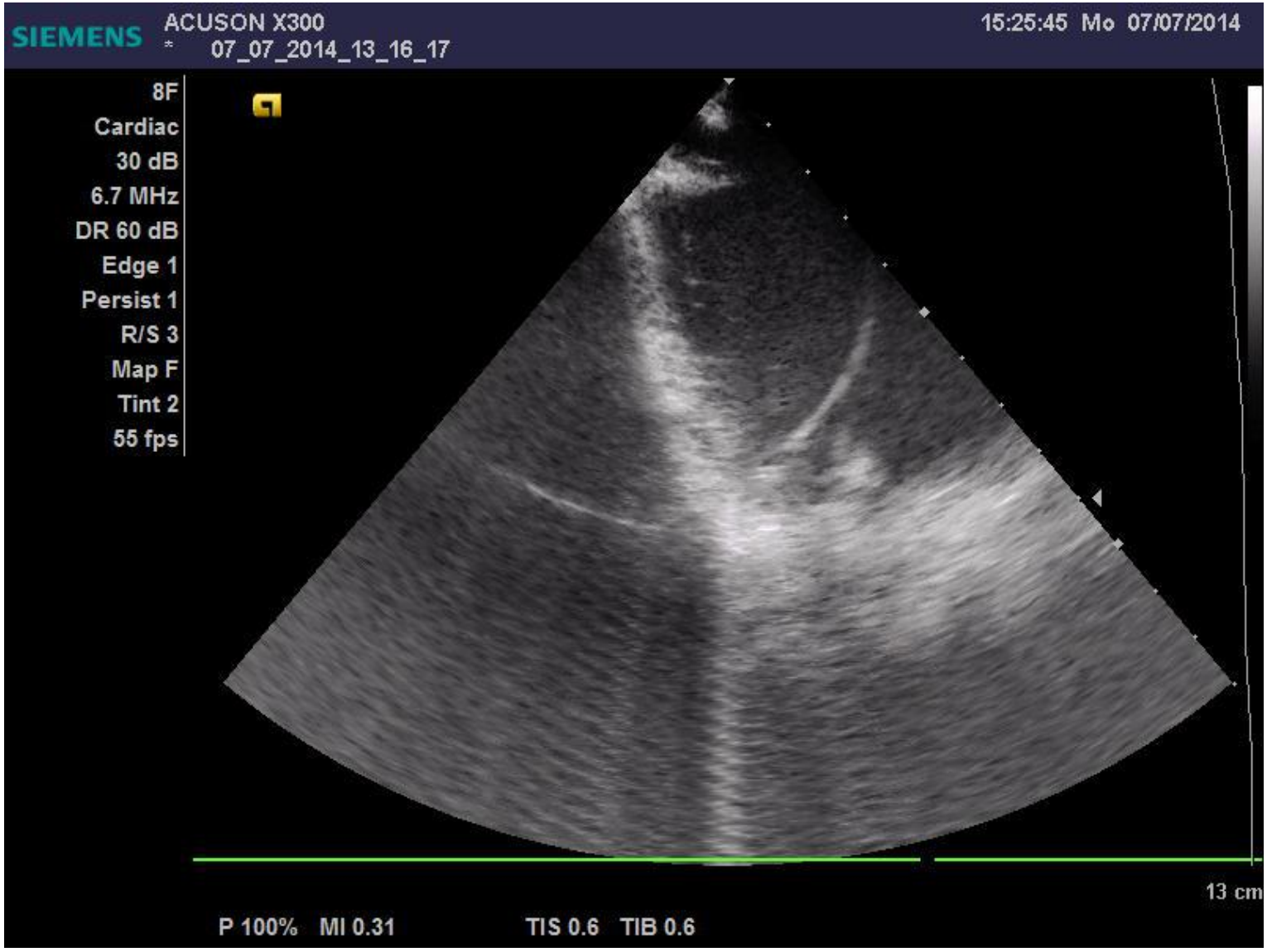
PVC TRIGGERING VT



ORIGIN OF PVCS



PURKINJE FIBRE VT-VF



CASE 5

Cardiac Resynchronization Therapy “Failure”

- **64/Y man- Non-ischemic Dilated CMP, CRT-ICD**
- **CRT responder initially**
- **Presents with mild increase in SOB(NYHA class II-III)**
- **BiV pacing dropped to 85% from initial 99.7 %**

What would you do?

A. Amiodarone
B. Catheter Ablation
C. Beta blockers
D. Reprogram CRT-D

Europace (2007) 9, 285–288
doi:10.1093/europace/eum005

C. Herczku *et al.*

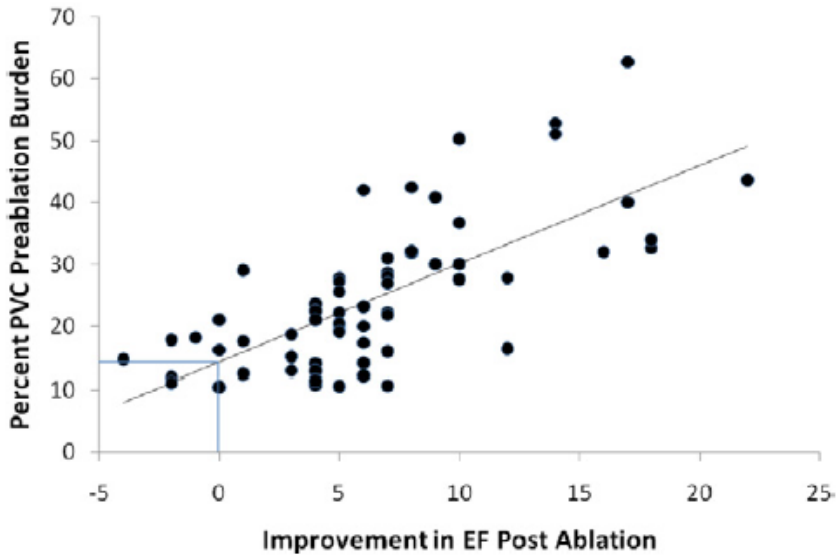


Figure 2 **Correlation Between PVC Burden and EF Change Following Ablation**

Percentage of pre-ablation premature ventricular contraction (PVC) burden and correlation with change in post-ablation ejection fraction (EF). The figure shows a Pearson correlation coefficient of 0.699, which is statistically significant at $p < 0.001$ (2-tailed). BiV = biventricular.

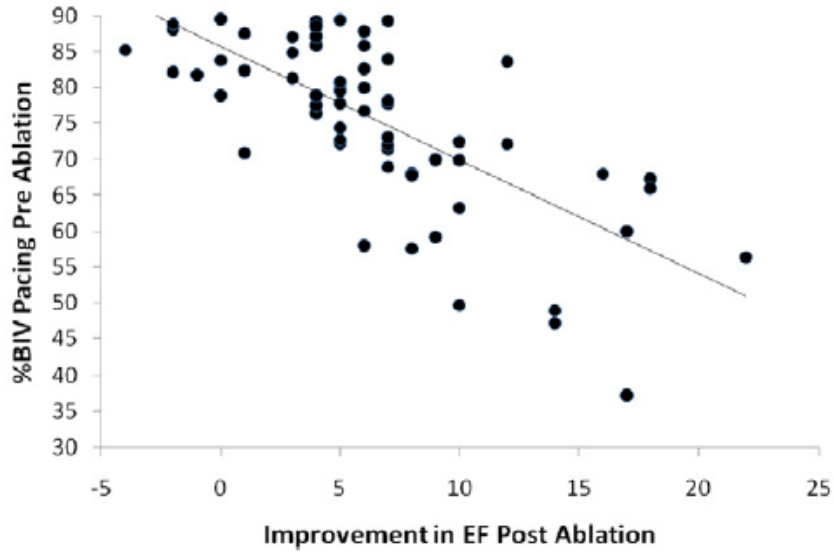
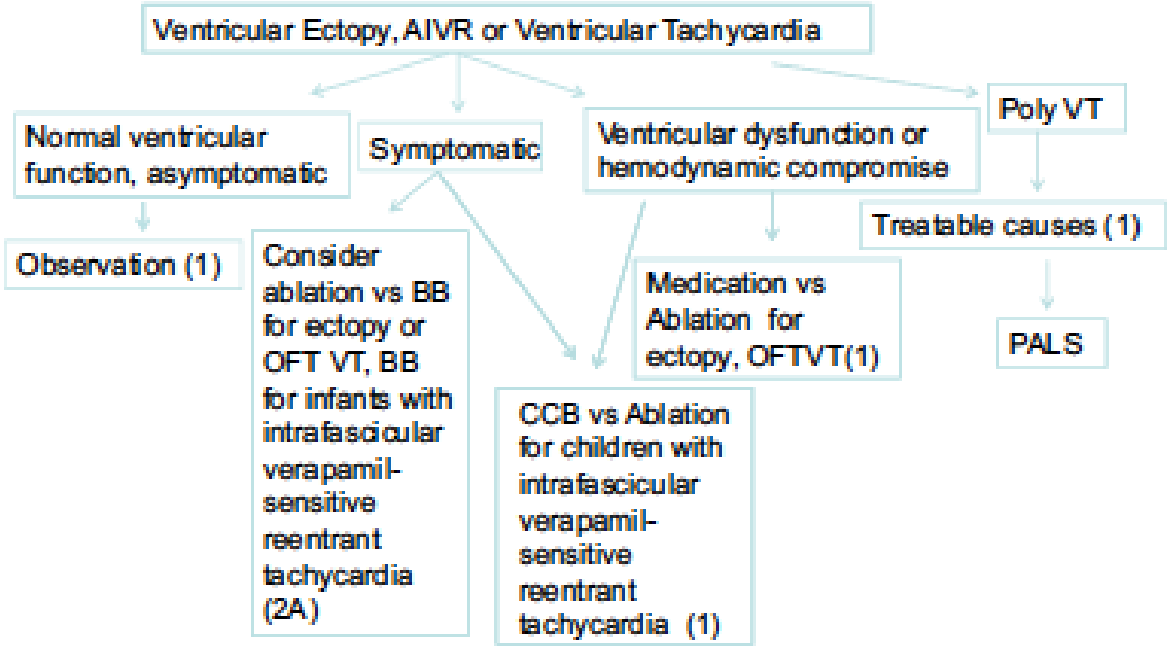


Figure 3 **Correlation Between Pre-Ablation BIV Pacing % and Post-Ablation Improvement in EF**

The figure shows a Pearson's correlation coefficient of 0.699 which is statistically significant at $p < 0.001$ (2-tailed). BIV = biventricular pacinig; EF = ejection fraction.

Diagnosis and quantification of frequent PVCs

- Symptoms: palpitations, presyncope, or decreased effort tolerance
- Physical exam: often normal, premature beats may be appreciated
- ECG: to determine PVC morphology



See text for details. Numbers in parentheses refer to level of recommendation.
Abbreviations not in text: AAD= antiarrhythmic drug; BB= beta blockers; CCB= calcium channel blocker; OFT VT= outflow tract tachycardia; PALS= pediatric advanced life support guidelines.

Figure 5 Treatment algorithm. See text for details. Numbers in parentheses refer to the level of recommendation. AIVR = accelerated idioventricular rhythm; BB = β-blocker; CCB = calcium-channel blocker; OFT VT = outflow tract tachycardia; PALS = Pediatric Advanced Life Support; VT = ventricular tachycardia.

- Follow-up of between 3 and 12 months with repeat Holter monitoring and echocardiography

(*Circ Arrhythm Electrophysiol.* 2012;5:229-236.)

SUMMARY

- **PVC Ablation indicated for-**
  - Frequent PVCs with symptoms and/or tachycardiomyopathy
- **PVC Ablation may be considered for-**
  - MVPS frequent PVCs/ICD
  - Subjects with Dilated Cardiomyopathy and frequent PVCs contributing to LV dysfunction
  - Subjects with PVC triggered VF/ICD shocks
  - CRT subjects with frequent PVCs limiting BiVentricular pacing and loss of response

THANK YOU

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