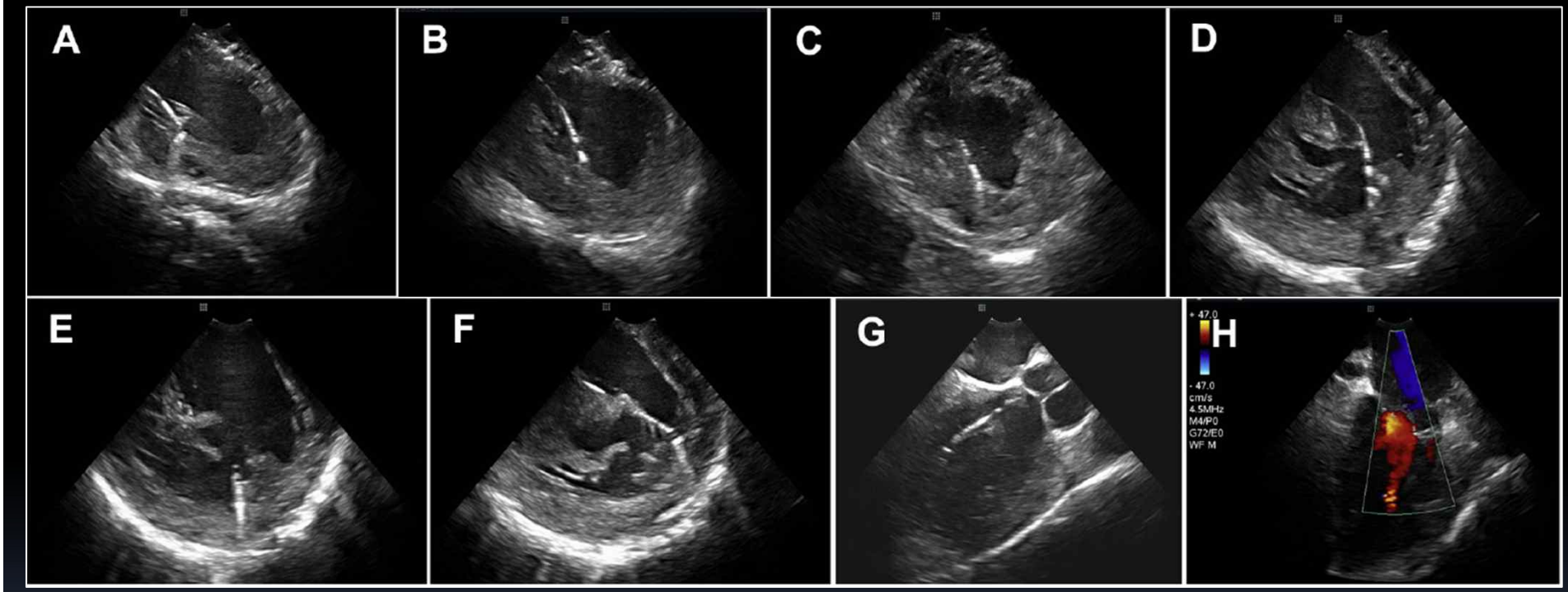
Papillary Muscle VT Ablation

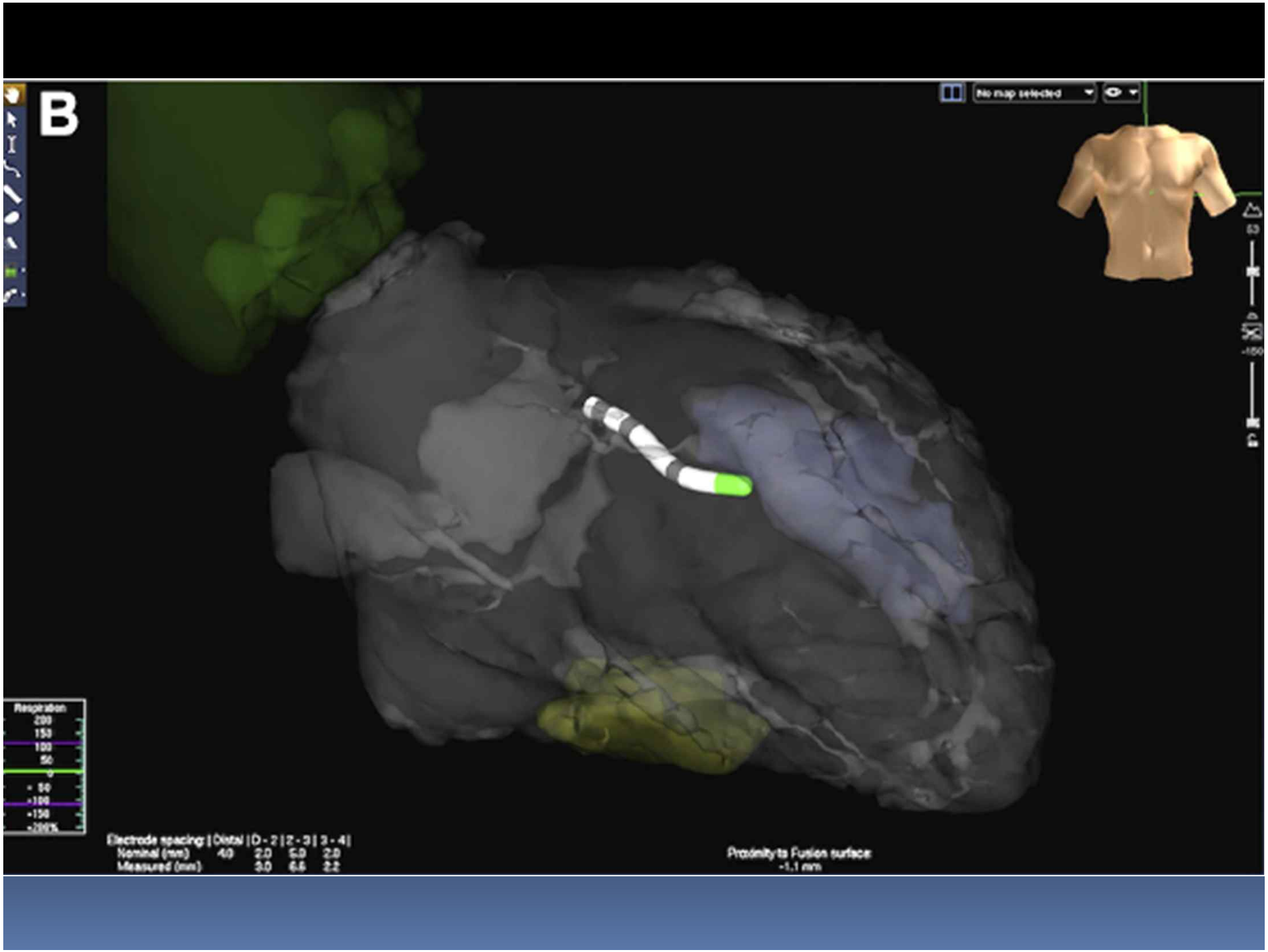
Young-Hoon Kim, MD

Arrhythmia Center
Korea University, Medical College
Seoul, Korea

ICE guided naviagation of ablation catheter around Papillary Muscle



JACC:CLINICALELECTROPHYSIOLOGYVOL.1,NO.6,2015


B
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Respiration
200
150
100
50
0
-50
-100
-150
-200%
Electrode spacing | Distal | D - 2 | 2 - 3 | 3 - 4 |
Nominal (mm) 4.0 2.0 5.0 2.0
Measured (mm) 3.0 6.6 2.2
Proximity to Fusion surface
-1.1 mm

Original Article

http://dx.doi.org/10.4070/kcj.2013.43.12.811
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Korean Circulation Journal

Electrophysiological Characteristics Related to Outcome after Catheter Ablation of Idiopathic Ventricular Arrhythmia Originating from the Papillary Muscle in the Left Ventricle

Ji-Eun Ban, MD[1], Hyun-Soo Lee, MPH[1], Dae-In Lee, MD[1], Hwan-Cheol Park, MD[2], Jae-Seok Park, MD[1], Yasutsugu Nagamoto, MD[1], Jong-Il Choi, MD[1], Hong-Euy Lim, MD[1], Sang-Weon Park, MD[1], and Young-Hoon Kim, MD[1]

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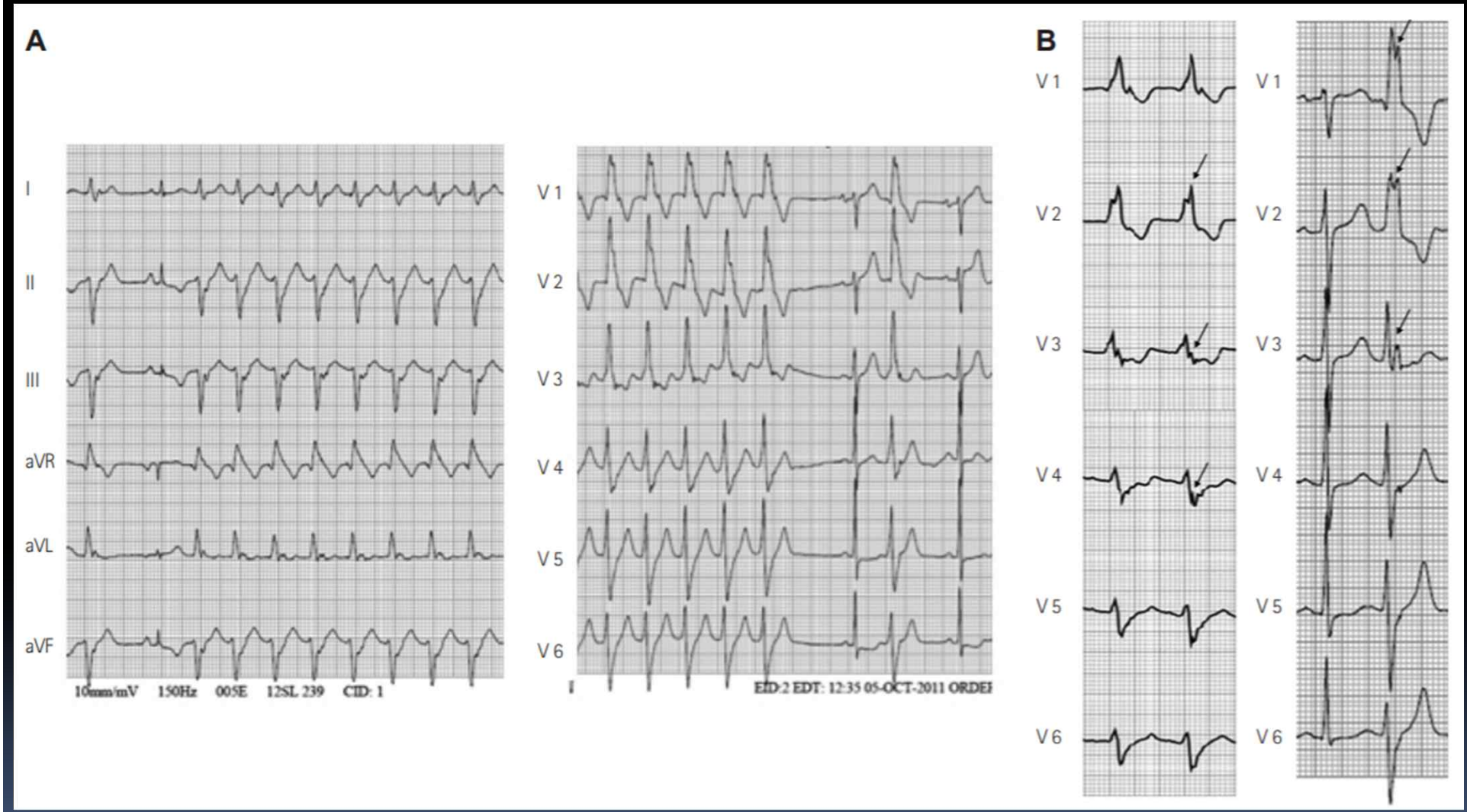
(Korean Circ J 2013;43:811-818)

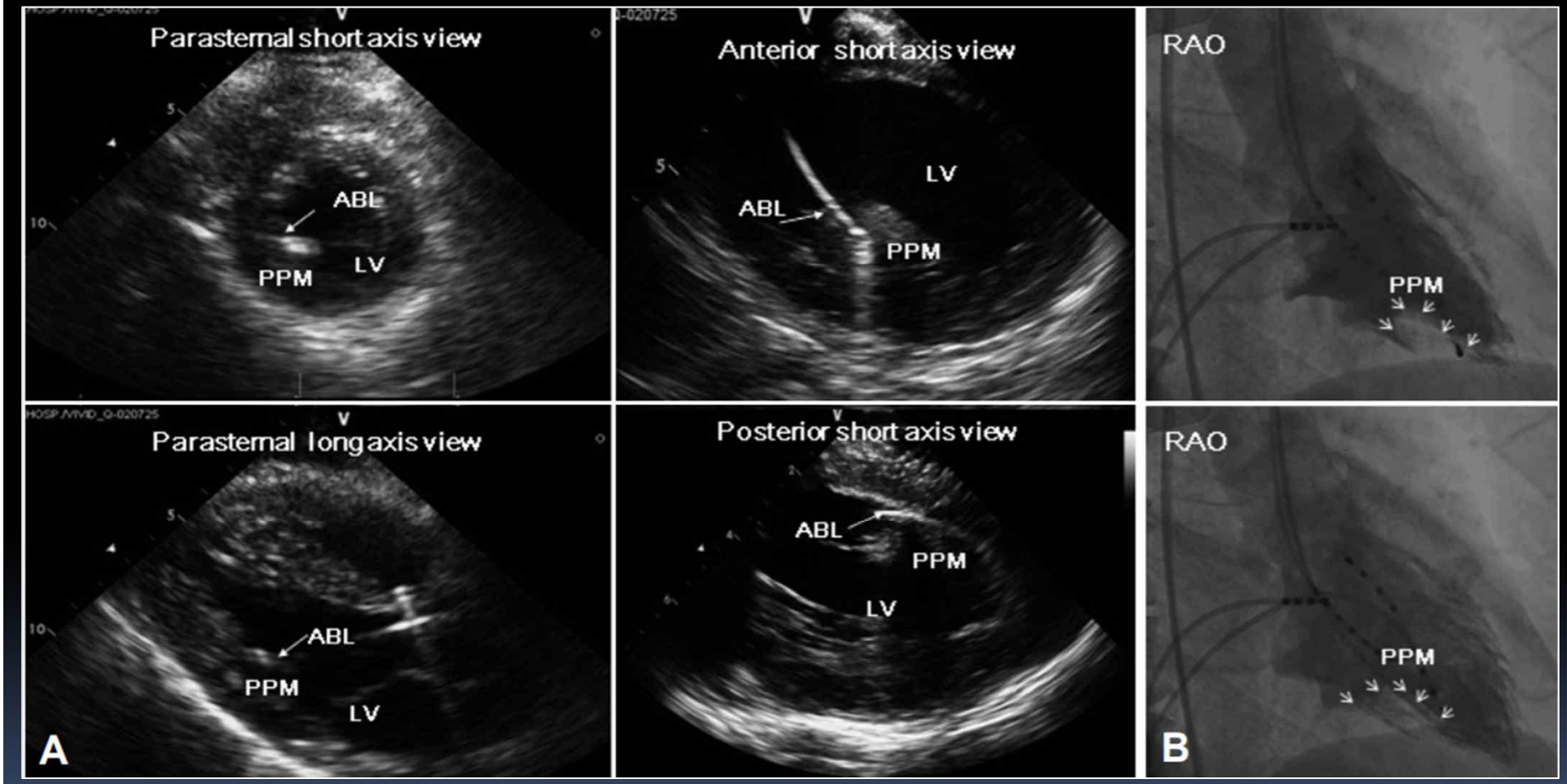
Table 1. Baseline characteristics of study patients

	LV PM VAs (n=12)
Age, years	52±9
Gender, female/male	7/5
Symptom duration, months	8.6±10.9
Ejection fraction (%)	53±9
VT/NSVT/PVC, n	4/6/2
Electrocardiography	
Axis, superior/inferior	11/1
QRS width during arrhythmia (ms)	146±17
Notches in precordial leads, n (%)	8 (66.7)
EP study and ablation	
Site of origin of VA, posterior PM/anterior PM	10/2
Induction with PES, n (%)	1 (8.3)
Provocation with isoproterenol, n (%)	4 (33.3)
Activation time at ablation site (ms)	35±11
Full matched pace map (12/12), n (%)	8 (66.7)
VA acceleration during ablation, n (%)	9 (75.0)
Different VA morphology, n (%)	3 (25.0)
Radiofrequency delivered (minute)	16±16
Procedure time (minute)	156±86
Follow-up duration (month)	12±9

Ji-Eun Ban, et al. Korean Circ J 2013;43:811-818



Ji-Eun Ban, et al. Korean Circ J 2013;43:811-818

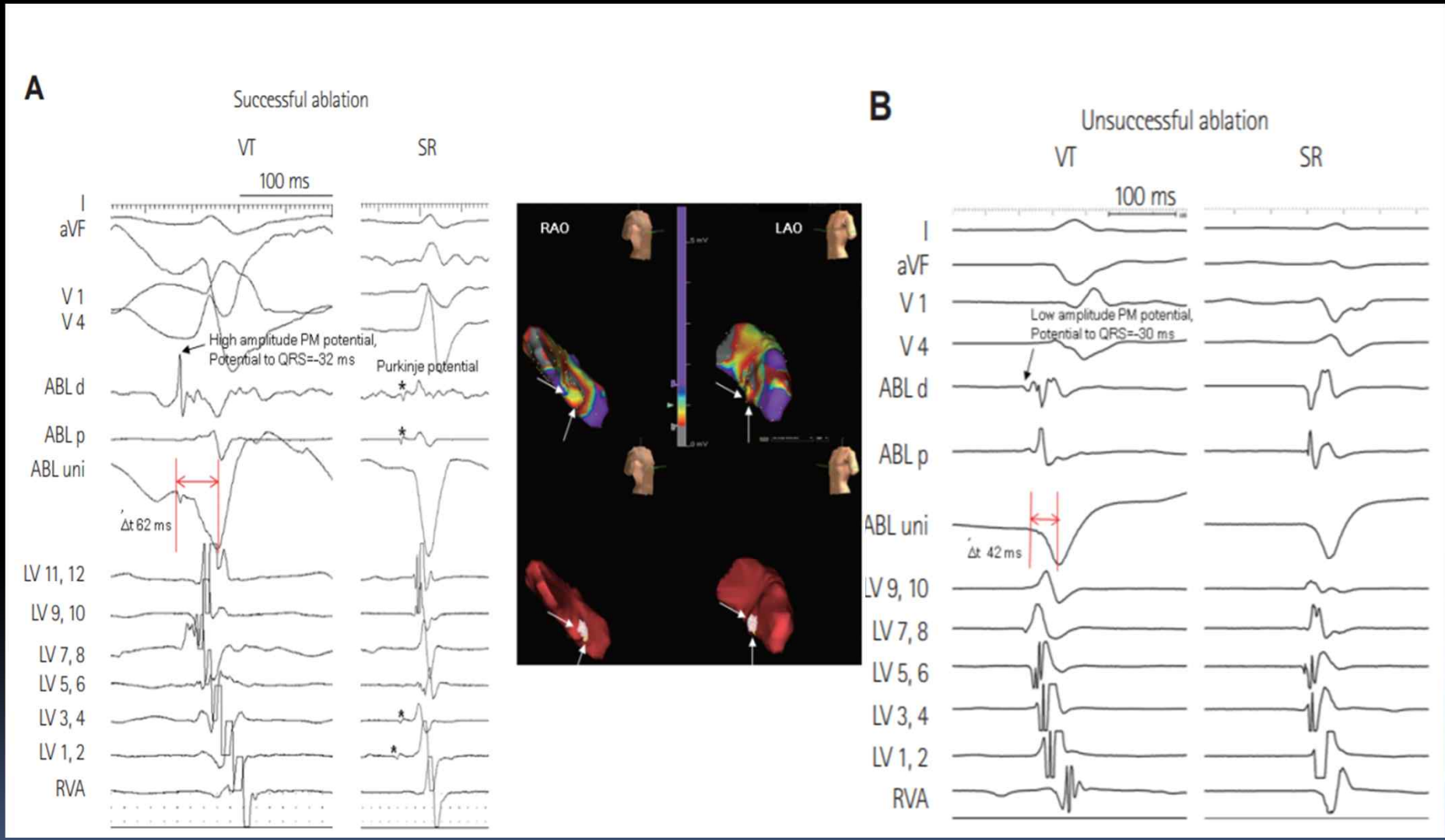


Ji-Eun Ban, et al. Korean Circ J 2013;43:811-818

Table 2. Comparison of patient characteristics between the successful and recurrence groups

	Successful group (n=8)	Recurrence group (n=4)	p
Bipolar electrogram			
R wave duration (ms)	29.2±7.9	37.1±8.5	0.45
R wave amplitude (mV)	1.42±0.55	0.44±0.23	0.01
High amplitude discrete potentials >1.0 mV, n (%)	7 (85.7)	0 (0)	<0.01
Purkinje potential, n (%)	2 (25)	2 (50)	0.34
Unipolar electrogram			
QS morphology, n (%)	8 (100)	3 (75.0)	0.14
Δt (ms)	58±8	37±9	0.04
Slow downstroke >50 ms, n (%)	7 (85.7)	1 (25.0)	0.03

Ji-Eun Ban, et al. Korean Circ J 2013;43:811-818



Ji-Eun Ban, et al. Korean Circ J 2013;43:811-818

Editorial

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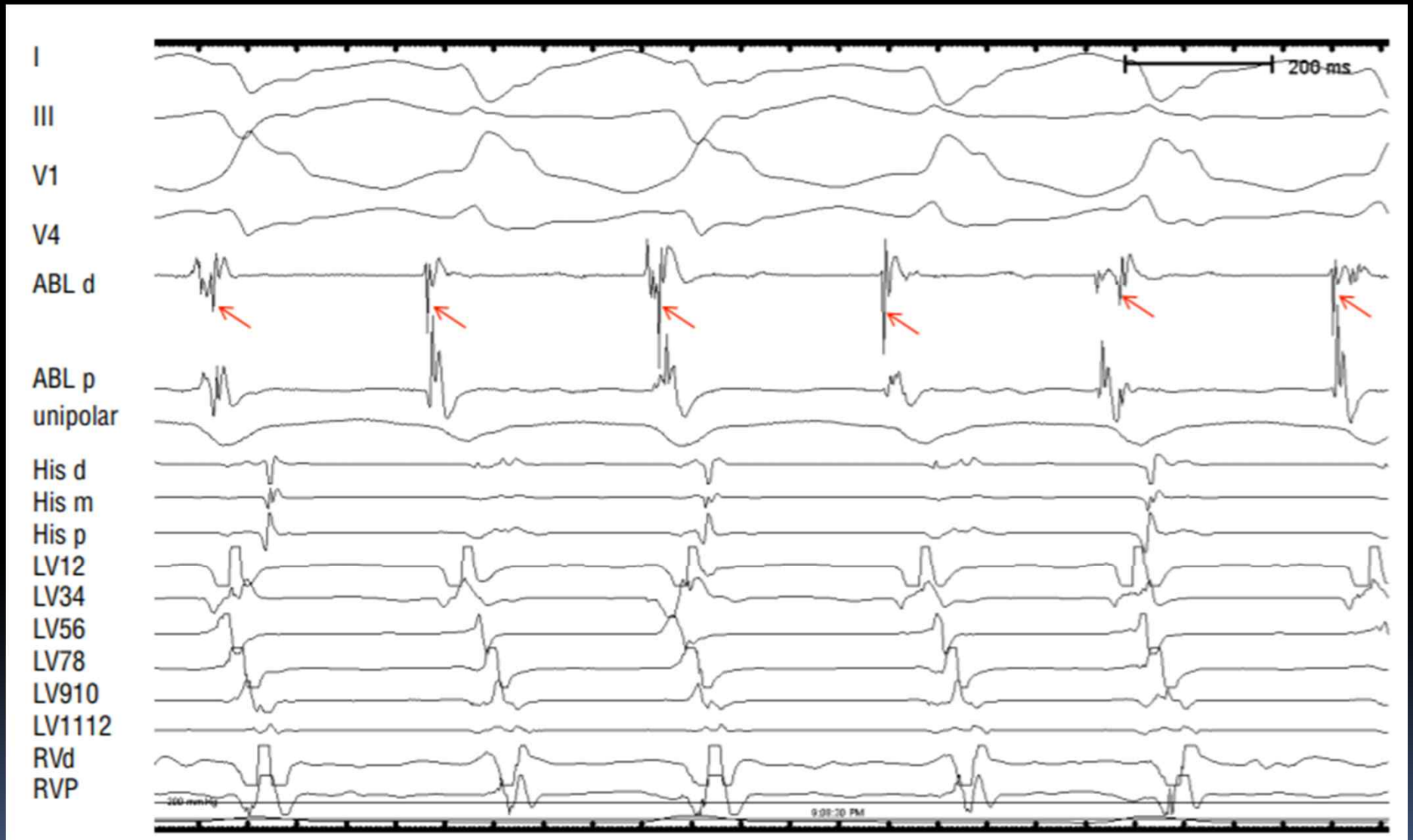
Korean Circulation Journal

Papillary Muscle Ventricular Tachycardia: Another Zigsaw Puzzle to Be Solved

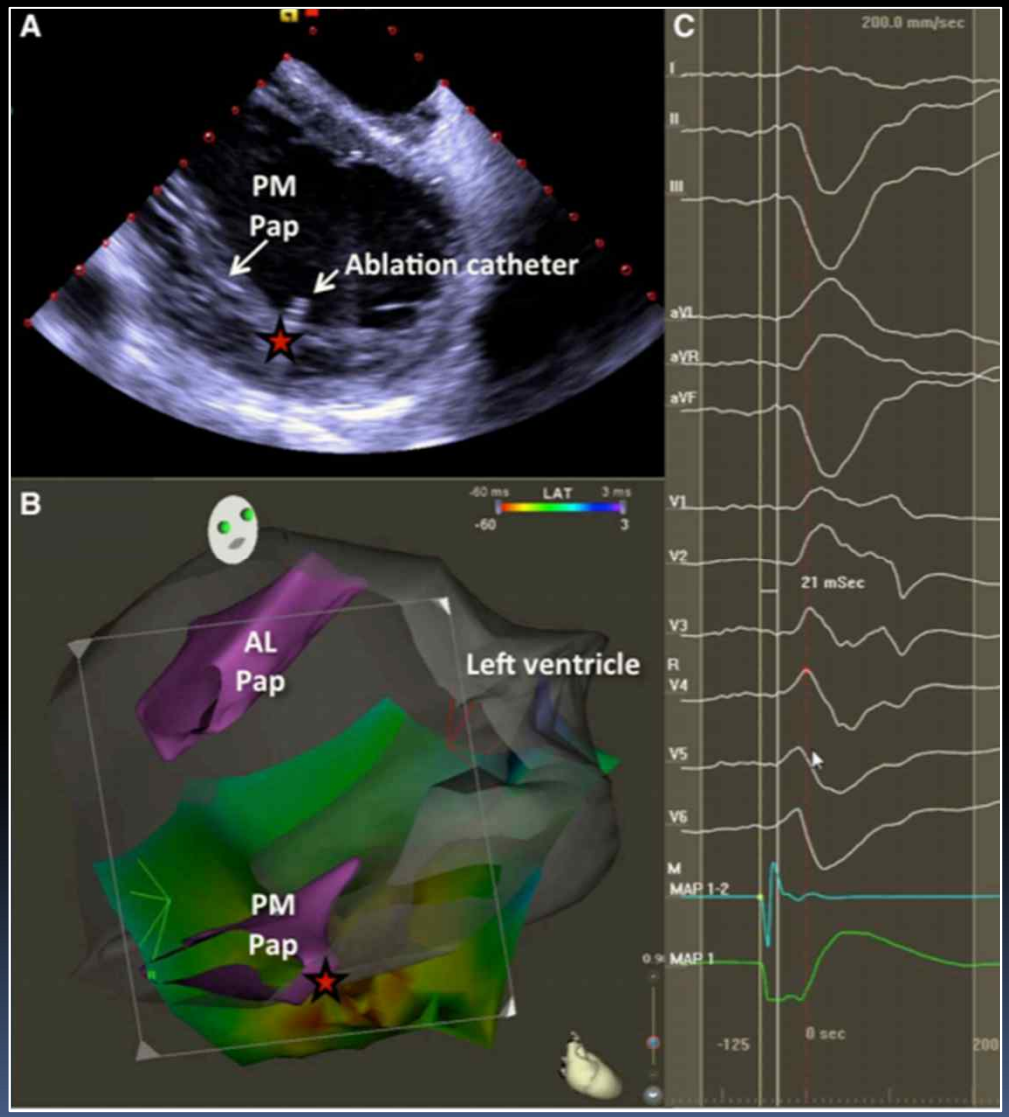
Dong-Gu Shin, MD

Cardiovascular Division, Department of Internal Medicine, Yeungnam University Hospital, Daegu, Korea



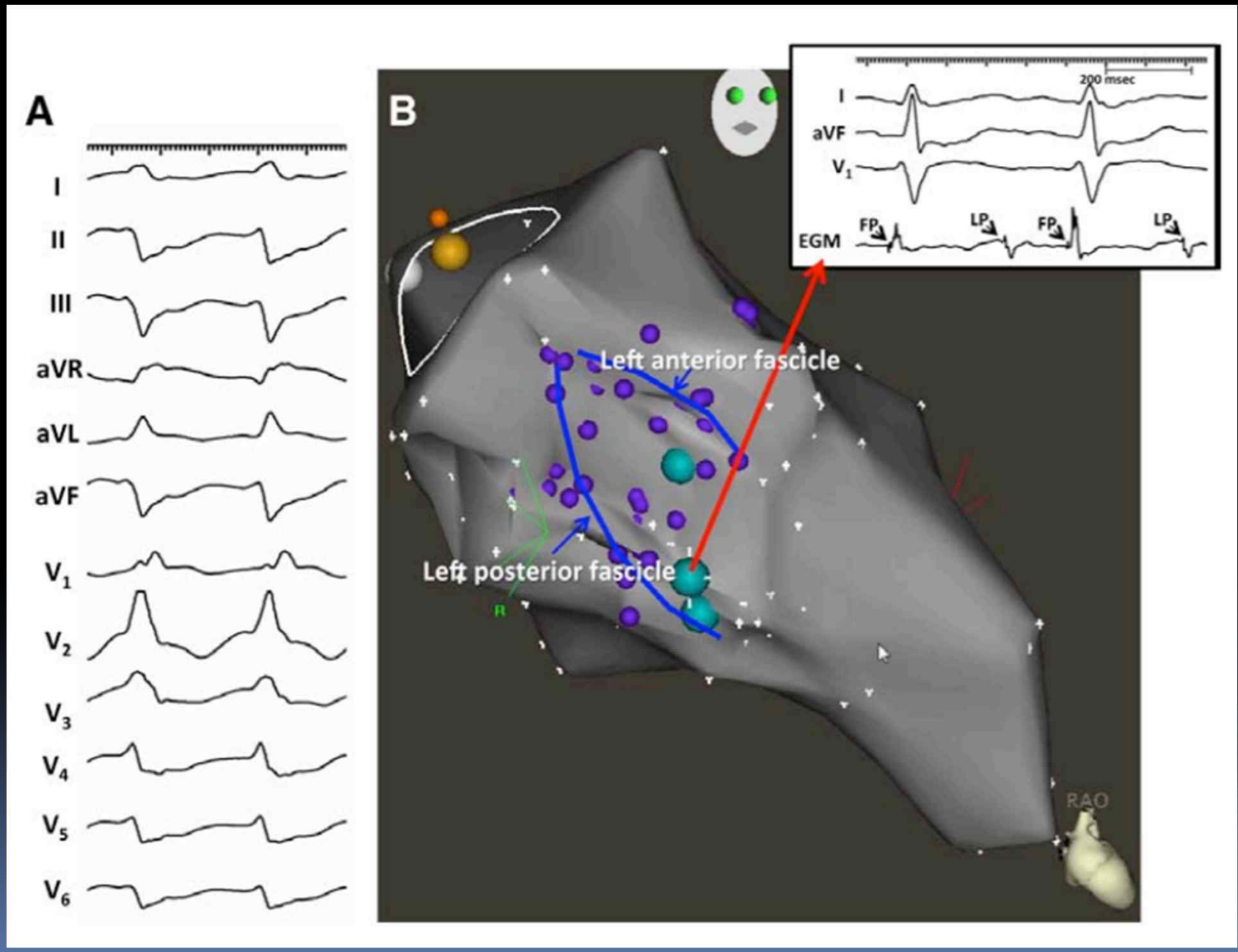
YM Park. International J of Arrhythmia 2015;16(4):219-223

Anatomic and electrophysiological localization of papillary muscle PVC



Circ Arrhythm Electrophysiol. 2015;8:616-624

Left Posterior Fascicular VT



< Previous Article

November 2017 Volume 14, Issue 11, Pages 1721–1728

Next Article >

How to map and ablate papillary muscle ventricular arrhythmias

Andres Enriquez, MD, Gregory E. Supple, MD, FHRS, Francis E. Marchlinski, MD, FHRS, Fermin C. Garcia, MD*

Section of Cardiac Electrophysiology, Hospital of the University of Pennsylvania, Philadelphia, Pennsylvania

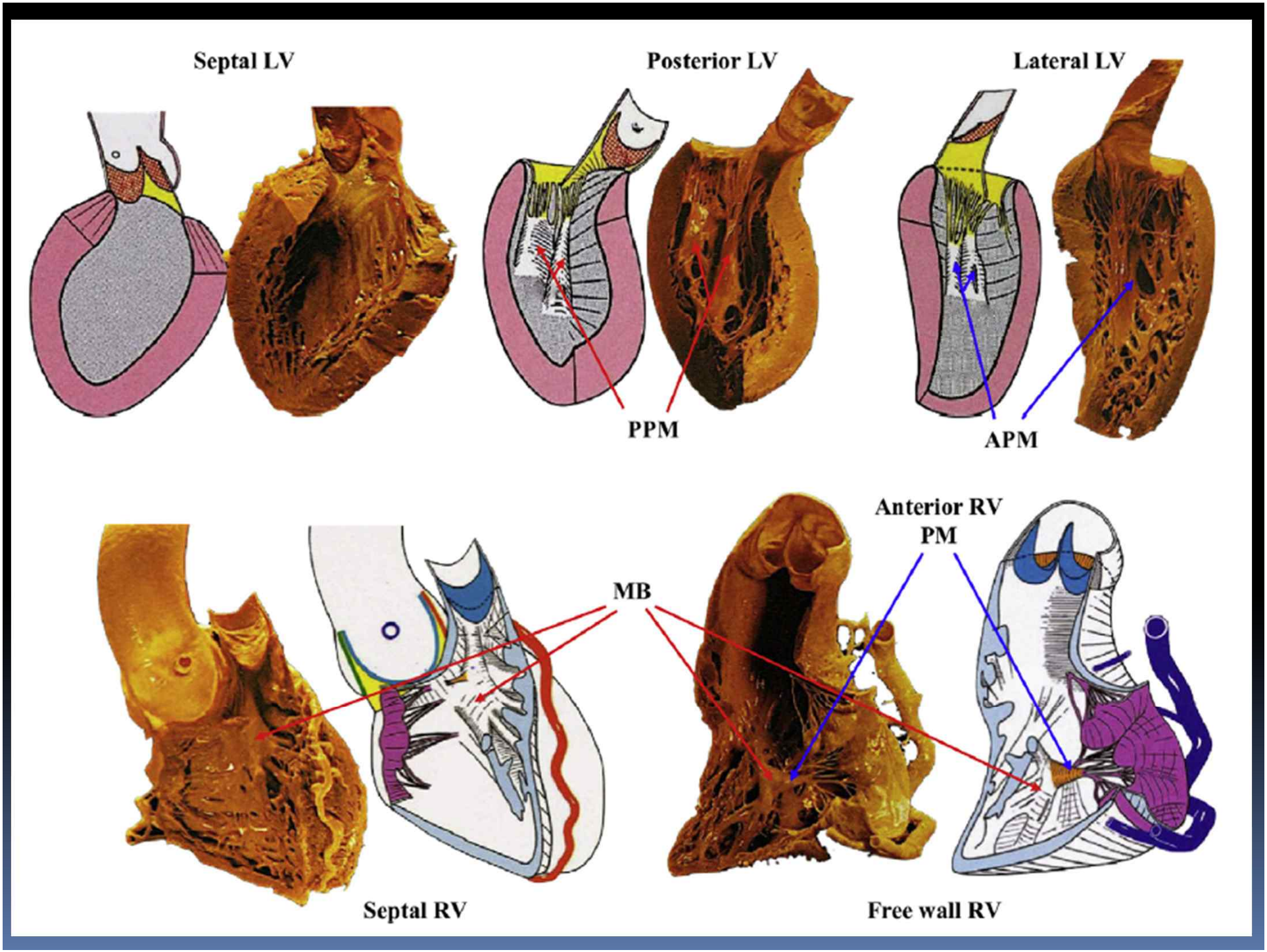
DOI: https://doi.org/10.1016/j.hrthm.2017.06.036 |

Clip slide

Papillary Muscle Ventricular Arrhythmia

Reference:

1. Circ Arrhythmia Electrophysiol. 2008;1:23-29.
2. Heart Rhythm, Vol 5, No 11, November 2008
3. J Cardiovasc Electrophysiol, Vol. 20, pp. 866-872, August 2009
4. J Cardiovasc Electrophysiol, Vol. 21, pp. 62-69, January 2010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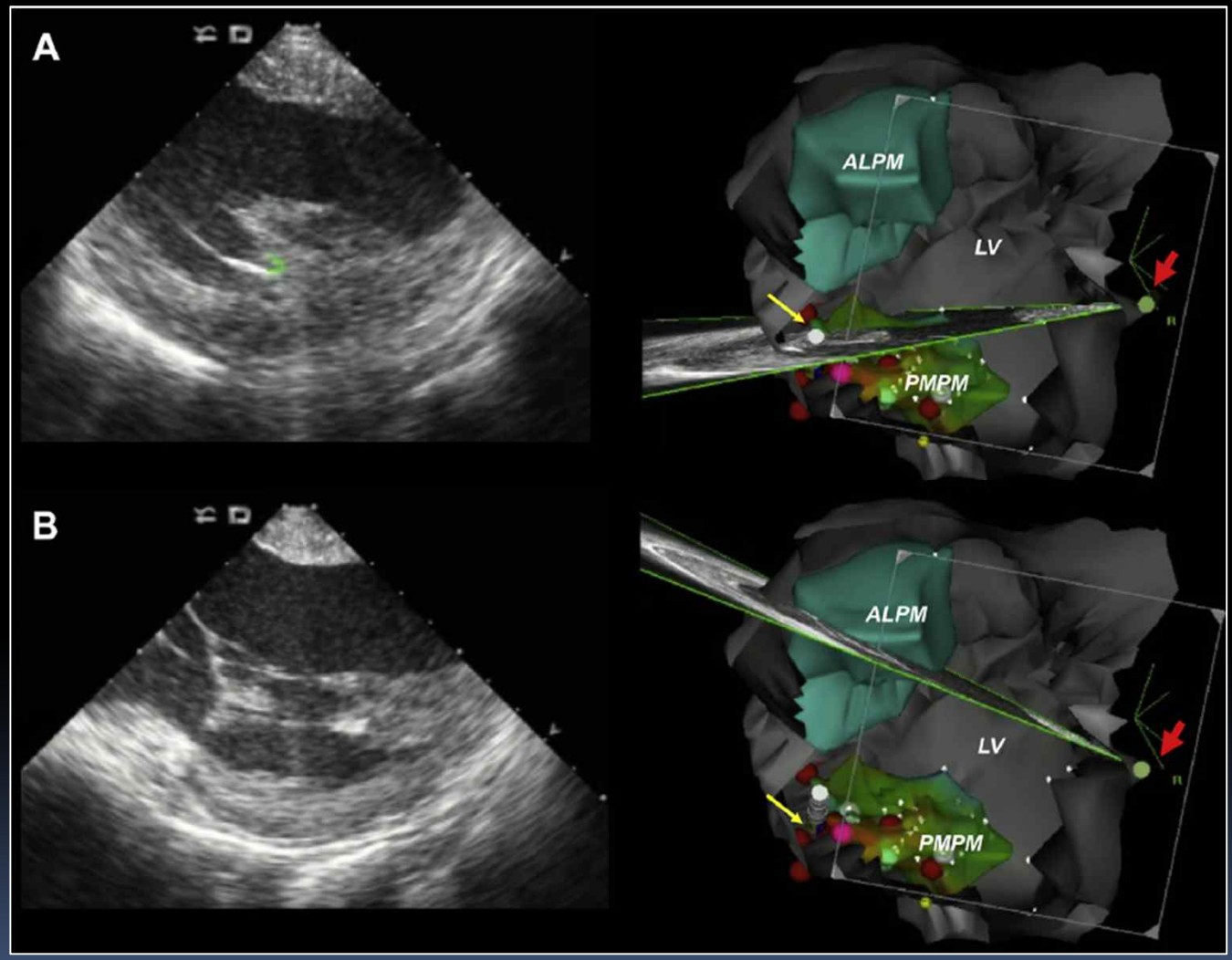
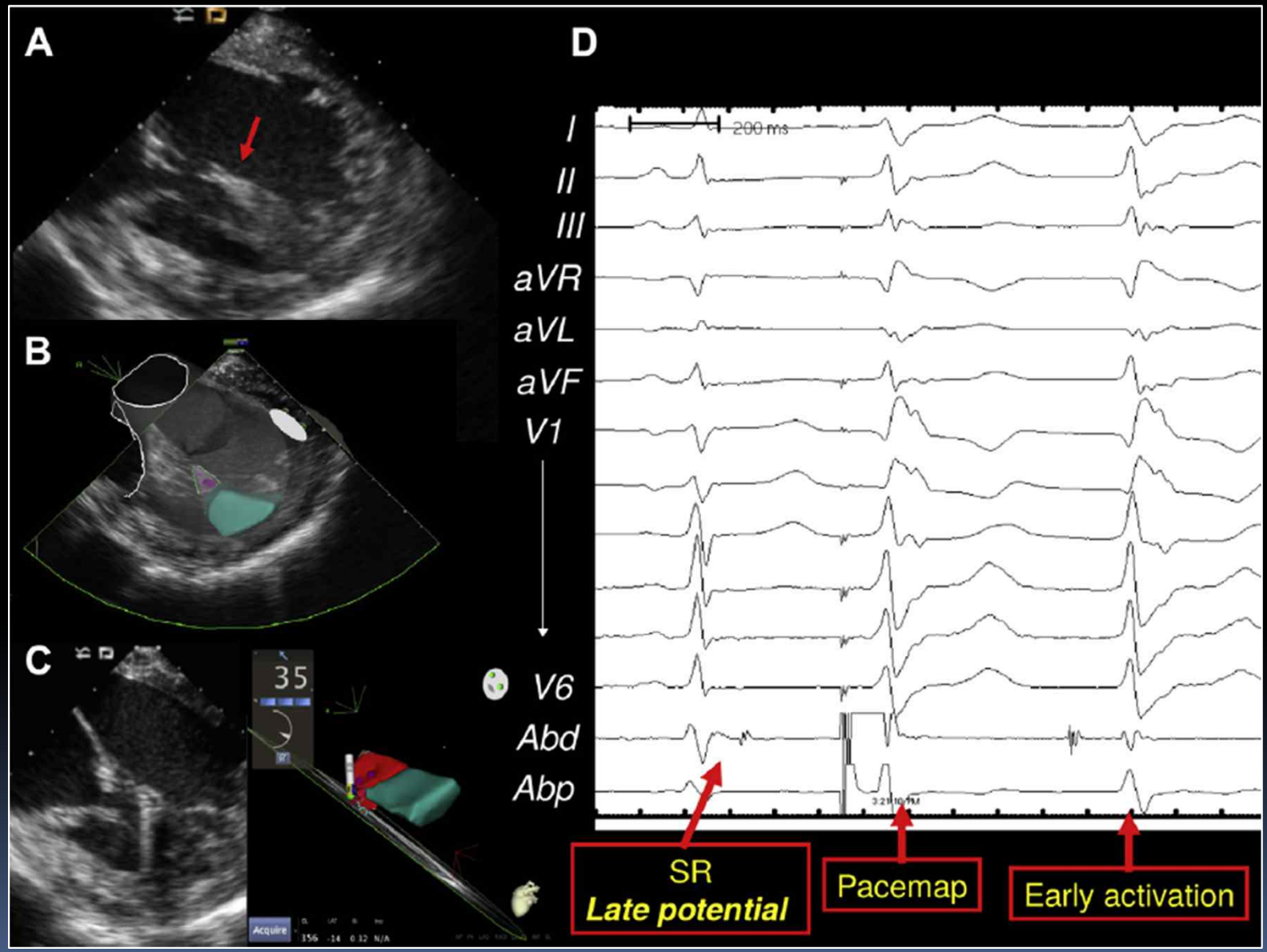
Lateral LV
PPM
APM
Anterior RV
PM
MB
Septal RV
Free wall RV



Heart Rhythm, Vol 14, No 11, November 2017



Heart Rhythm, Vol 14, No 11, November 2017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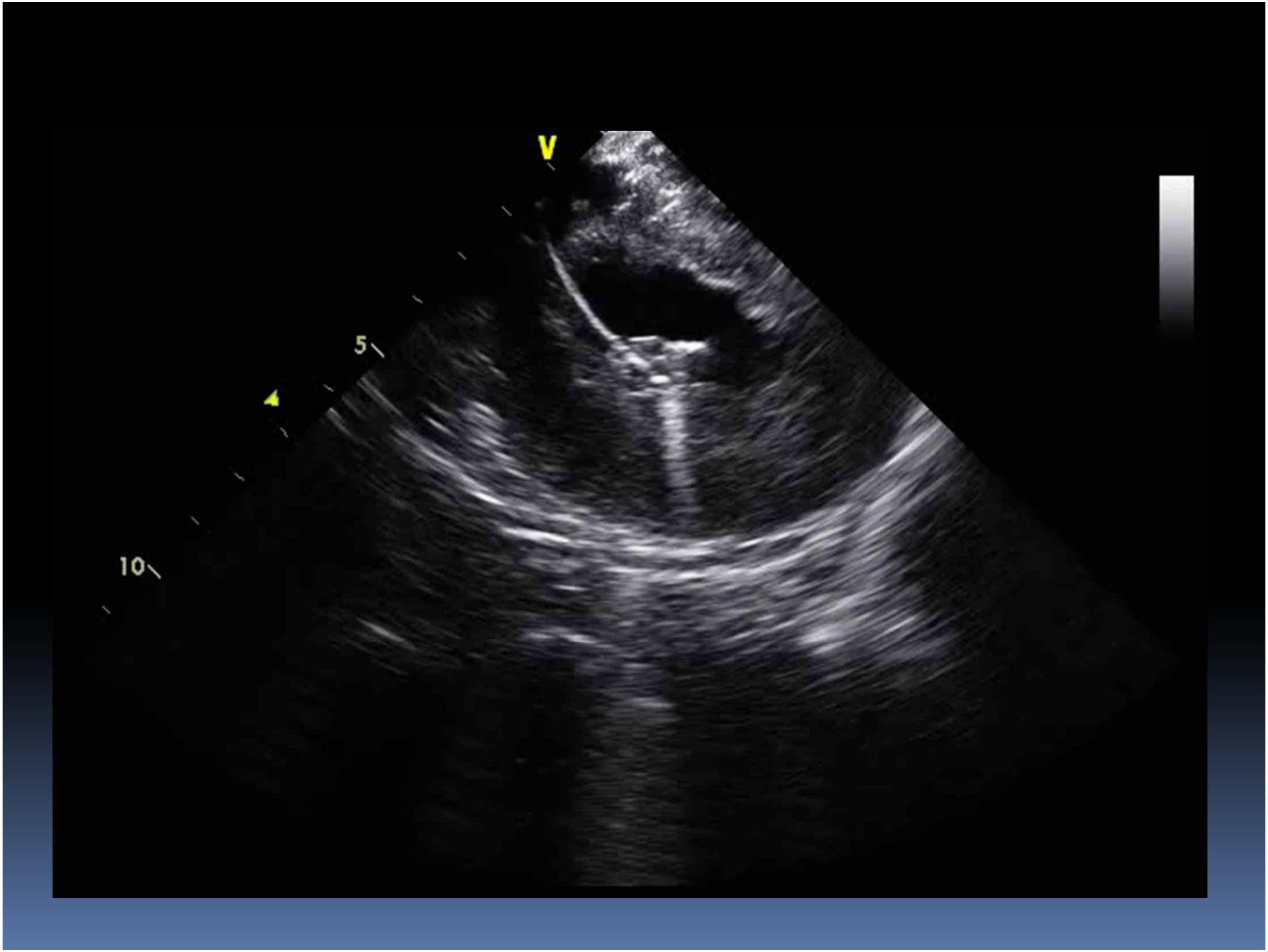
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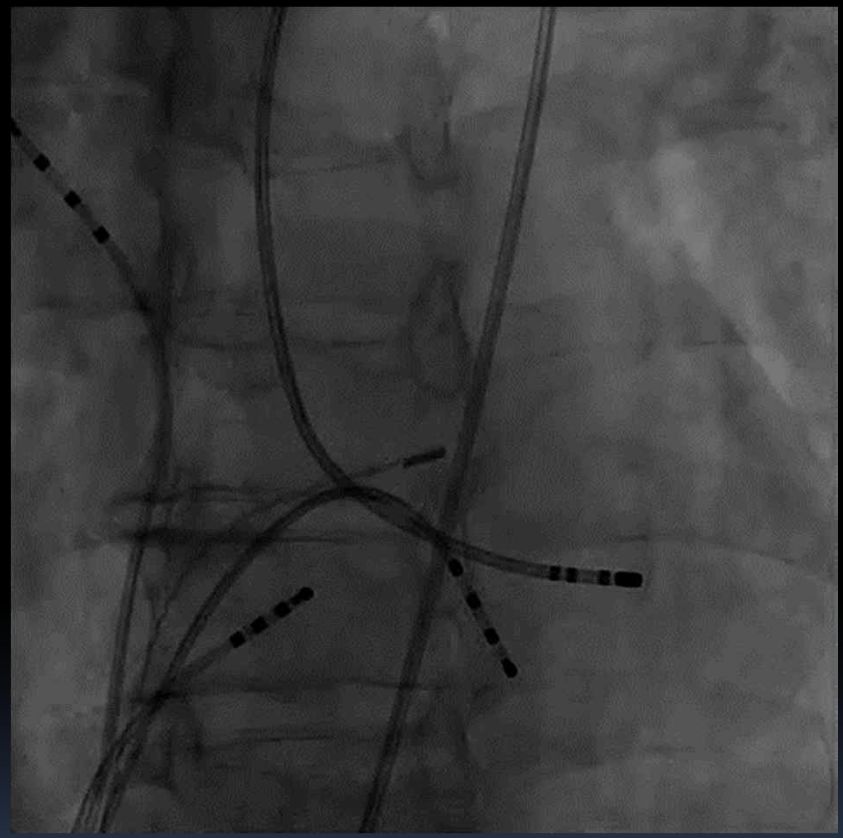
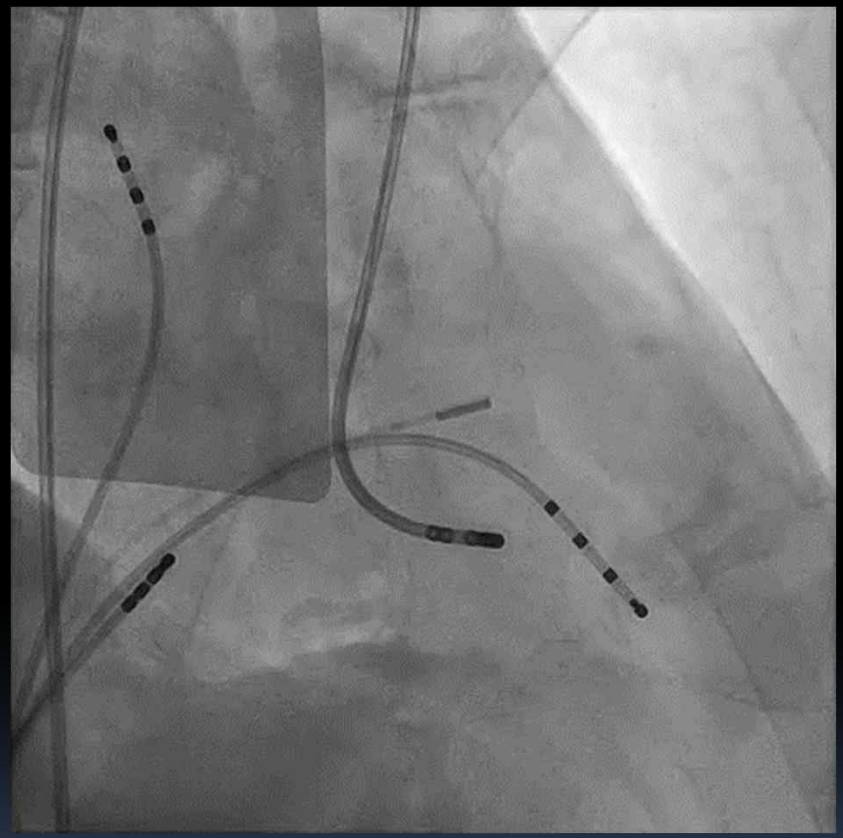
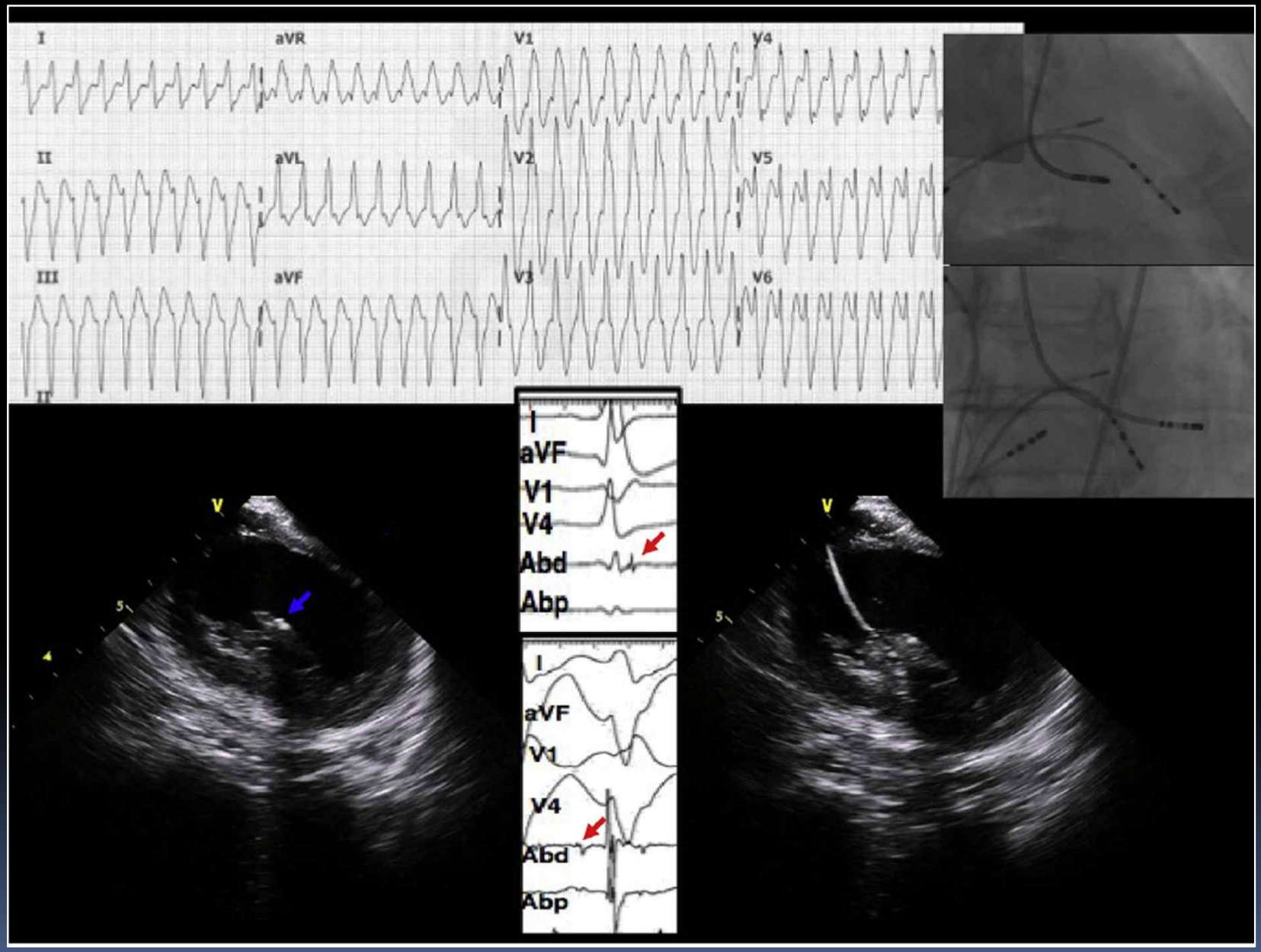
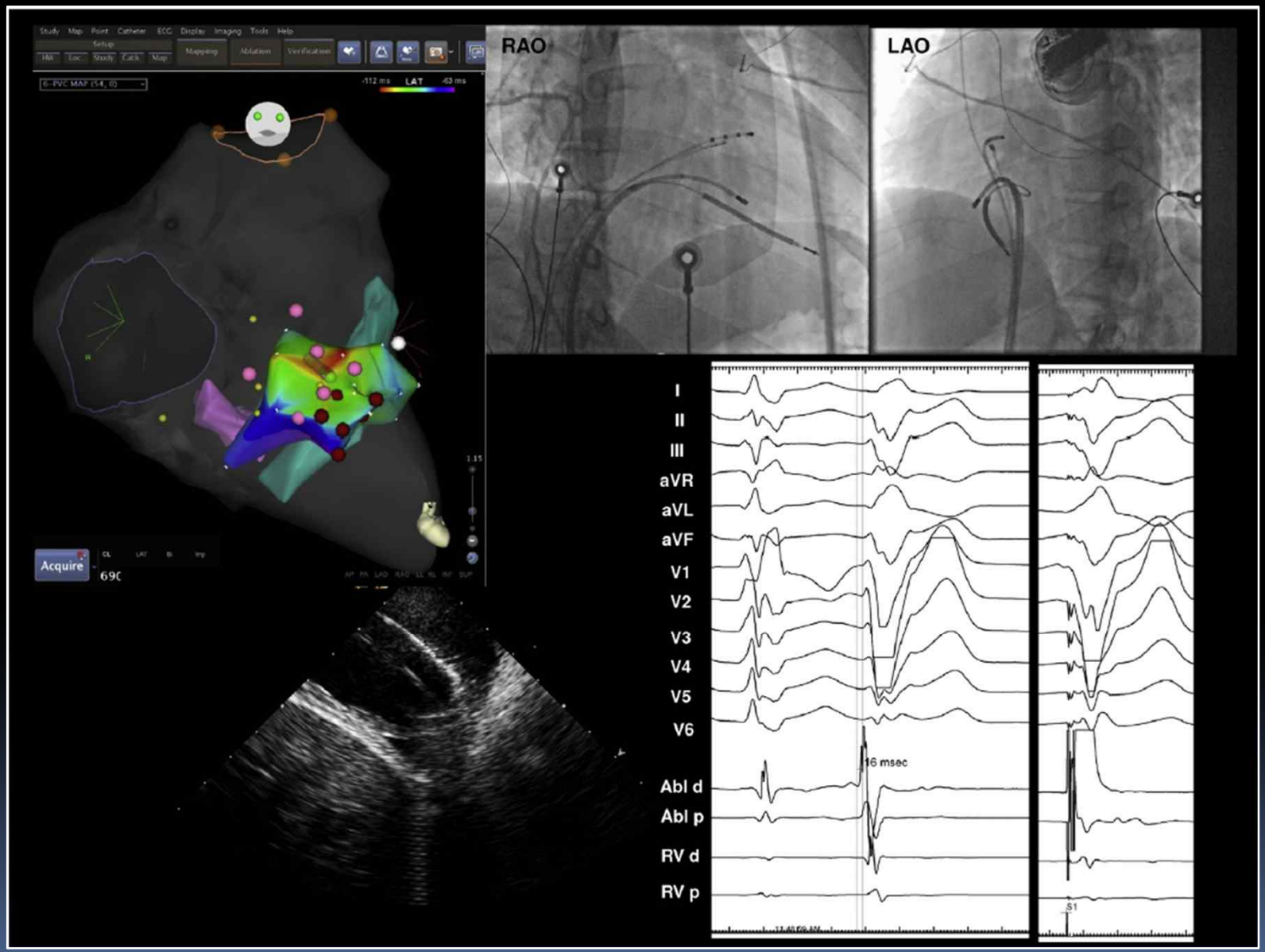






Heart Rhythm, Vol 14, No 11, November 2017

Ablation of PVC-triggered VF in a 28-year-old patient with structurally normal heart and resuscitated sudden cardiac death.



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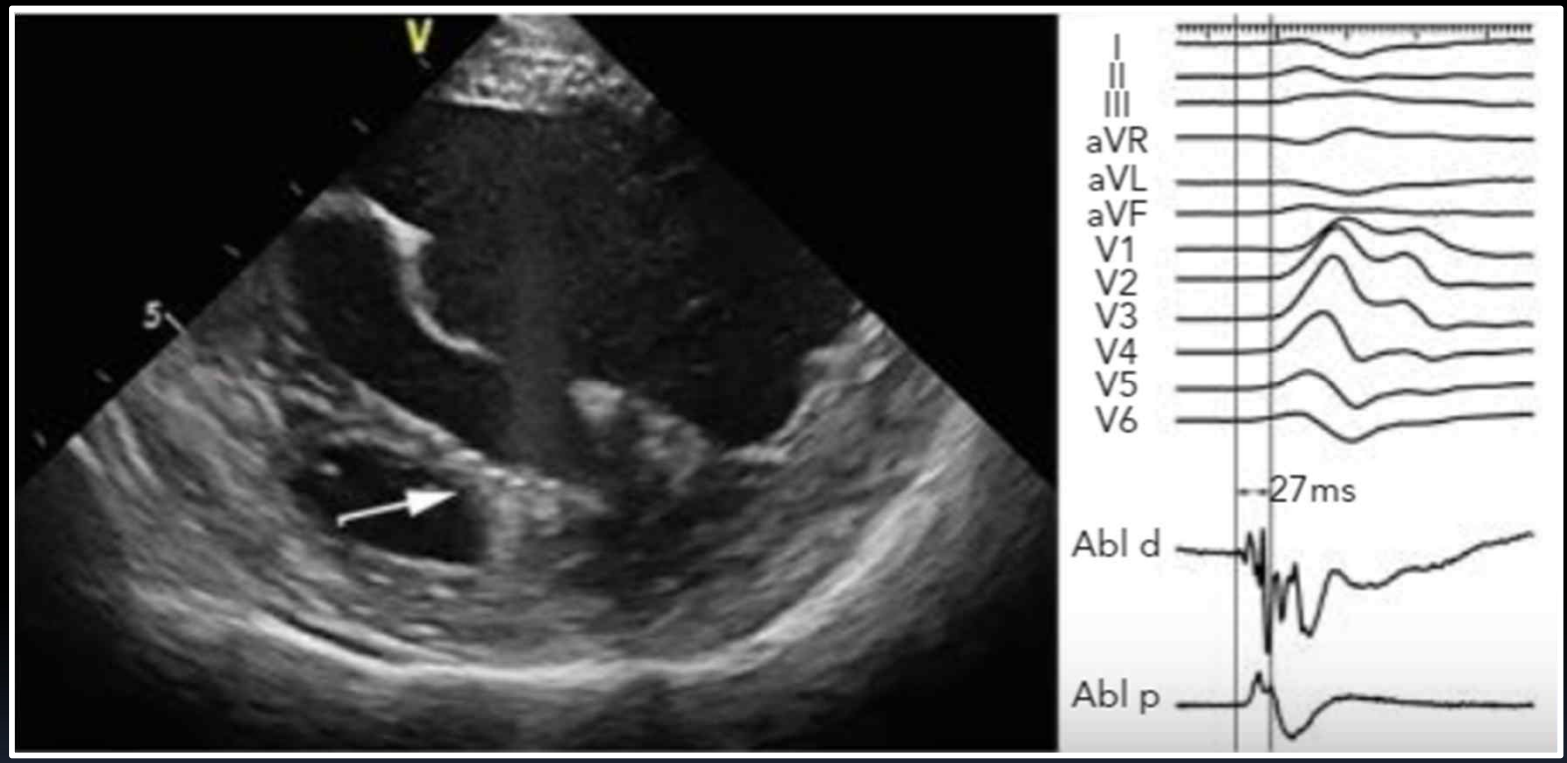
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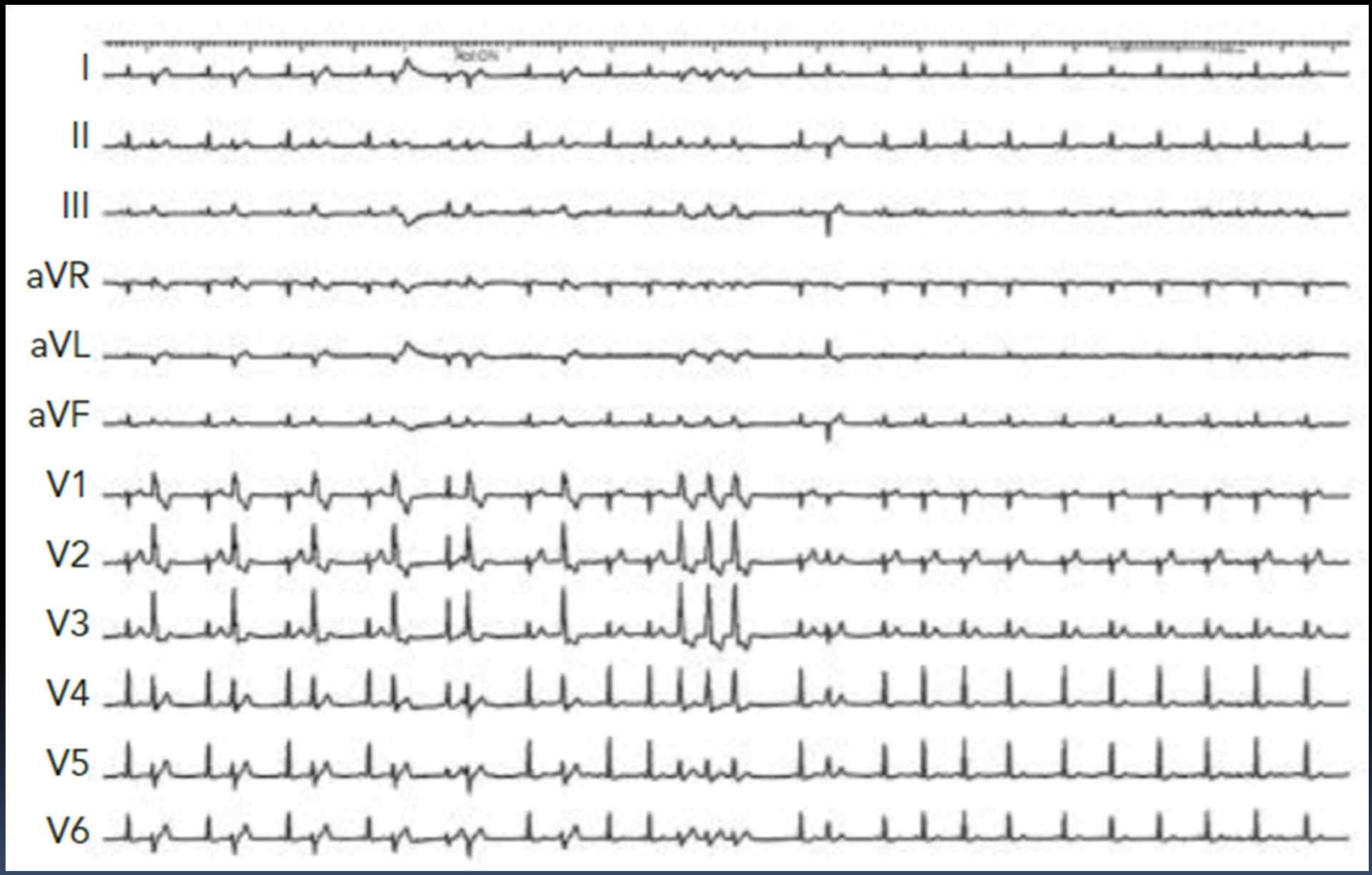
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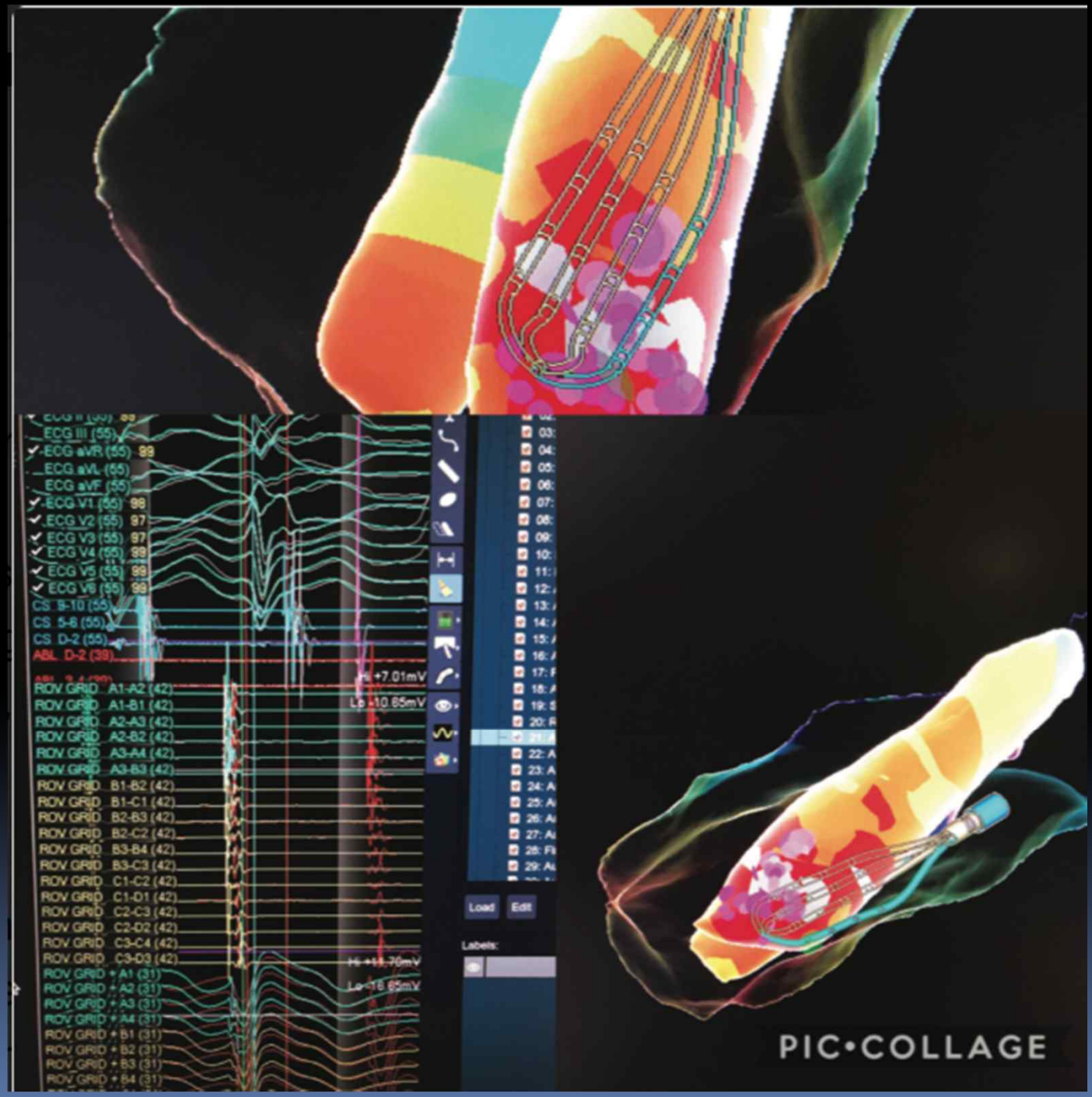
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ECG aVL (55)
ECG aVF (55)
ECG V1 (55)
ECG V2 (55)
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ECG V5 (55)
ECG V6 (55)
CS 9-10 (55)
CS 5-6 (55)
CS D-2 (55)
ABL D-2 (39)
RDV GRID A1-A2 (42)
RDV GRID A1-B1 (42)
RDV GRID A2-A3 (42)
RDV GRID A2-B2 (42)
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RDV GRID A3-B3 (42)
RDV GRID B1-B2 (42)
RDV GRID B1-C1 (42)
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RDV GRID B2-C2 (42)
RDV GRID B3-B4 (42)
RDV GRID B3-C3 (42)
RDV GRID C1-C2 (42)
RDV GRID C1-D1 (42)
RDV GRID C2-C3 (42)
RDV GRID C2-D2 (42)
RDV GRID C3-C4 (42)
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RDV GRID + A1 (31)
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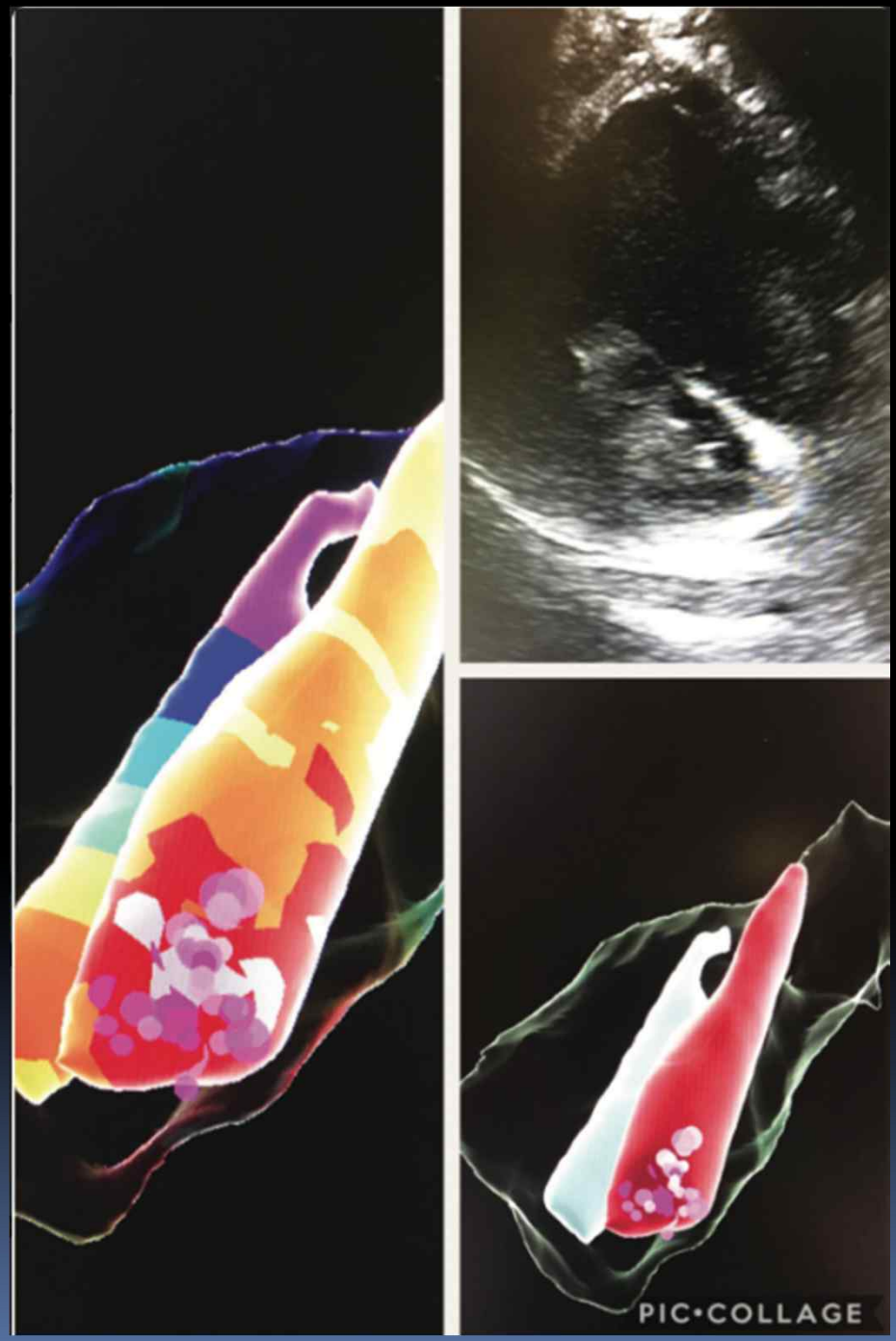
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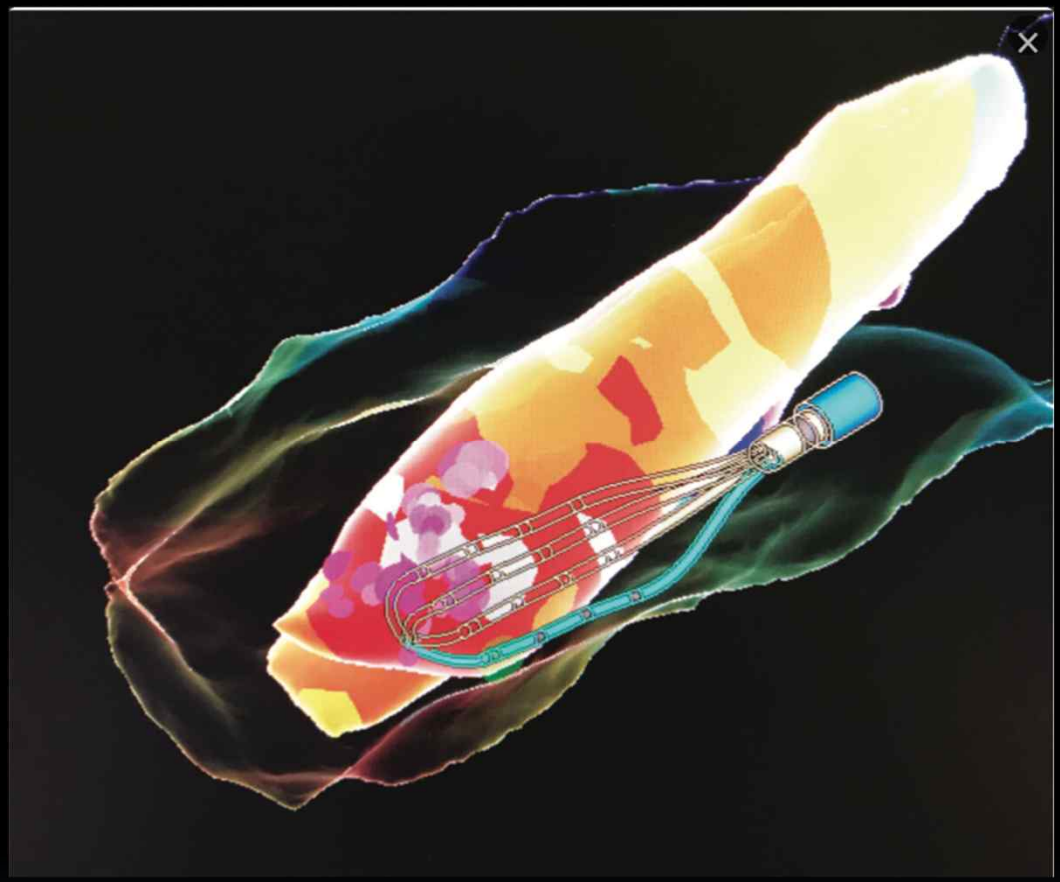


The Advisor HD Grid has revolutionized the art of multi-electrode mapping, providing us with information that we had not seen previously with standard multi-electrode mapping catheters. Use of the EnSite Precision system and intracardiac echo complements this technology well.

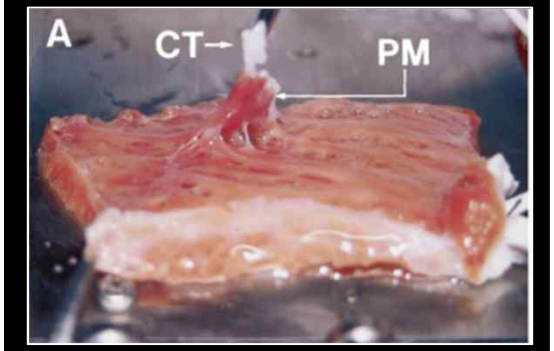
Role of Papillary Muscle in the Generation and Maintenance of Reentry During Ventricular Tachycardia and Fibrillation in Isolated Swine Right Ventricle

Young-Hoon Kim, MD; Fagen Xie, PhD; Masaaki Yashima, MD; Tsu-Juey Wu, MD; Miguel Valderrábano, MD; Moon-Hyoung Lee, MD; Toshihiko Ohara, MD; Olga Voroshilovsky, MS; Rahul N. Doshi, MD; Michael C. Fishbein, MD; Zhilin Qu, PhD; Alan Garfinkel, PhD; James N. Weiss, MD; Hrayr S. Karagueuzian, PhD; Peng-Sheng Chen, MD

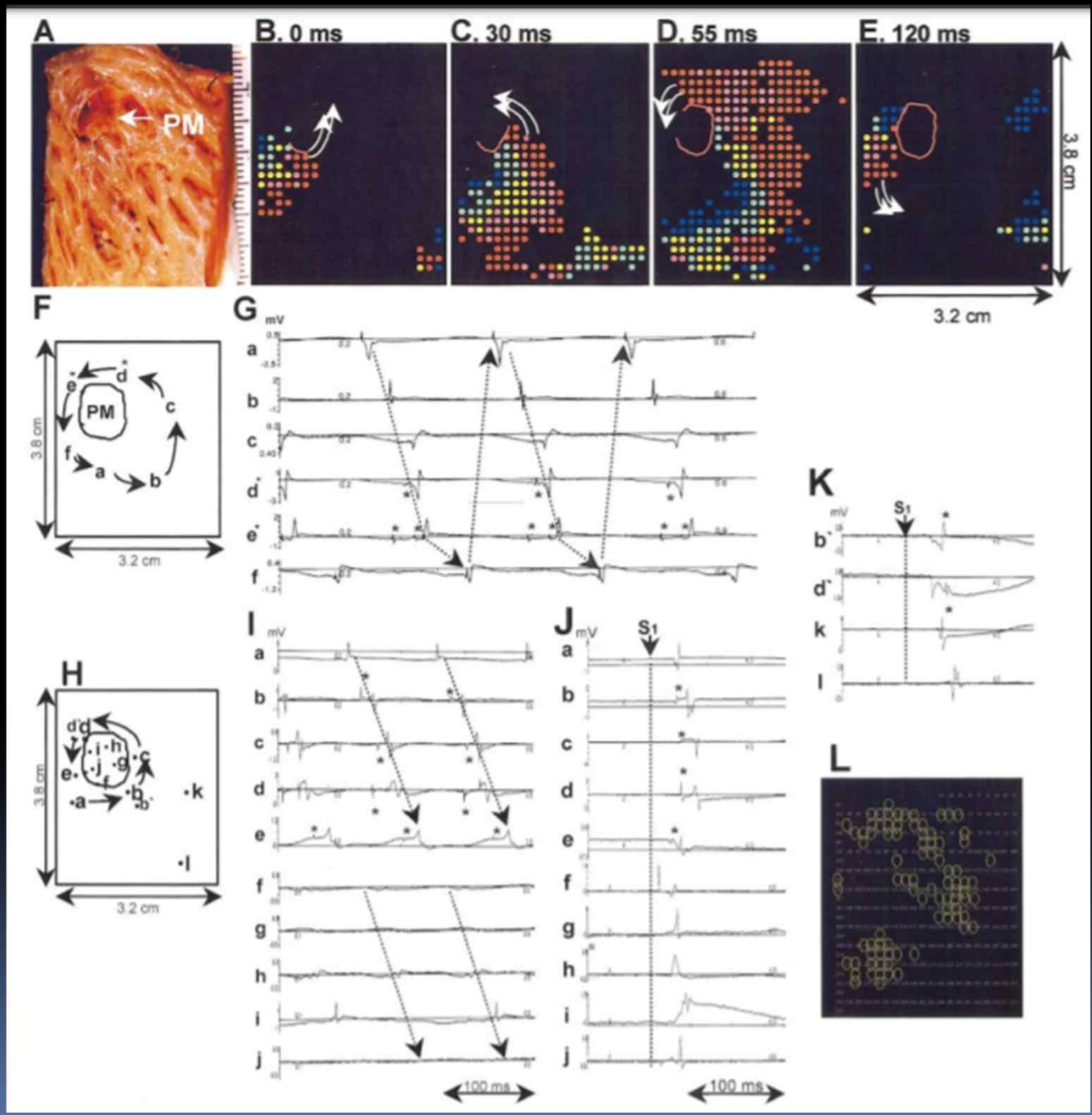
Background—The role of papillary muscle (PM) in the generation and maintenance of reentry is unclear.

Methods and Results—Computerized mapping (477 bipolar electrodes, 1.6-mm resolution) was performed in fibrillating right ventricles (RVs) of swine in vitro. During ventricular fibrillation (VF), reentrant wave fronts often transiently anchored to the PM. Tissue mass reduction was then performed in 10 RVs until VF converted to ventricular tachycardia (VT). In an additional 6 RVs, procainamide infusion converted VF to VT. Maps showed that 77% (34 of 44) of all VT episodes were associated with a single reentrant wave front anchored to the PM. Purkinje fiber potentials preceded the local myocardial activation, and these potentials were recorded mostly around the PM. When PM was trimmed to the level of endocardium (n=4), sustained VT was no longer inducible. Transmembrane potential recordings (n=5) at the PM revealed full action potential during pacing, without evidence of ischemia. Computer simulation studies confirmed the role of PM as a spiral wave anchoring site that stabilized wave conduction.

Conclusions—We conclude that PM is important in the generation and maintenance of reentry during VT and VF.
(*Circulation*. 1999;100:1450-1459.)

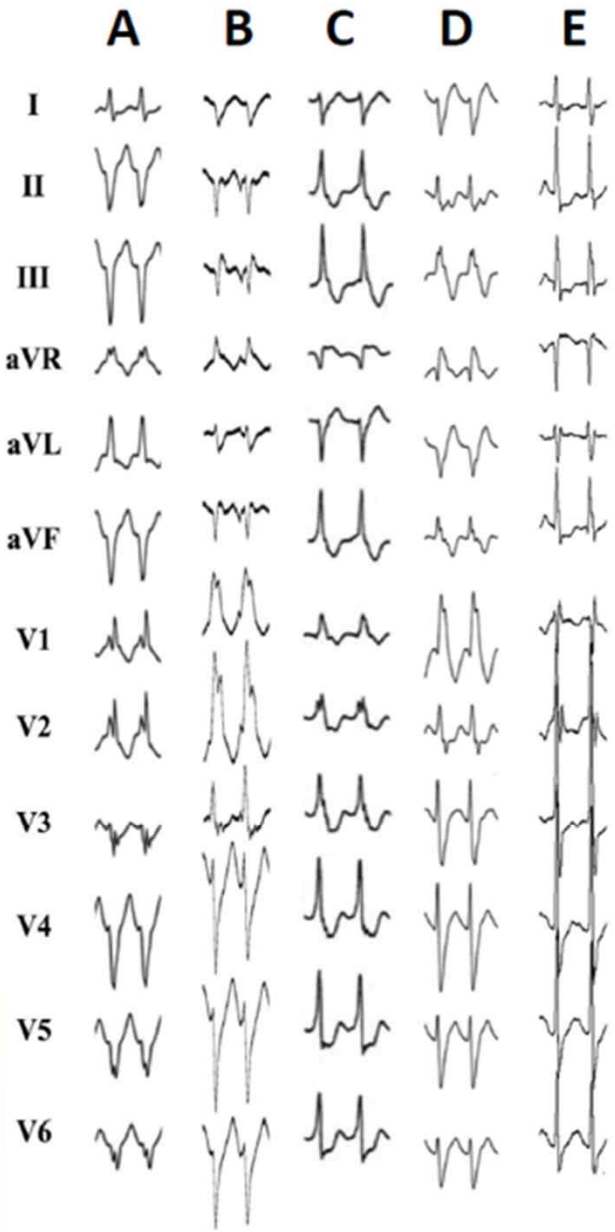


Kim et al Papillary Muscle and Reentry Circulation.
1999;100:1450-1459



2019 APHRS Expert Consensus Statement on Three-Dimensional Mapping Systems for Tachycardia developed in collaboration with HRS, EHRA and LAHRS

Young-Hoon Kim, Shih-Ann Chen, Sabine Ernst, Carlos E. Guzman, Seongwook Han, Zbigniew Kalarus, Carlos Labadet, Yenn-Jian Lin, Li-Wei Lo, Akihiko Nogami, Eduardo B. Saad, John Sapp, Christian Sticherling, Roland Tilz, Roderick Tung, Yun Gi Kim, Martin K. Stiles



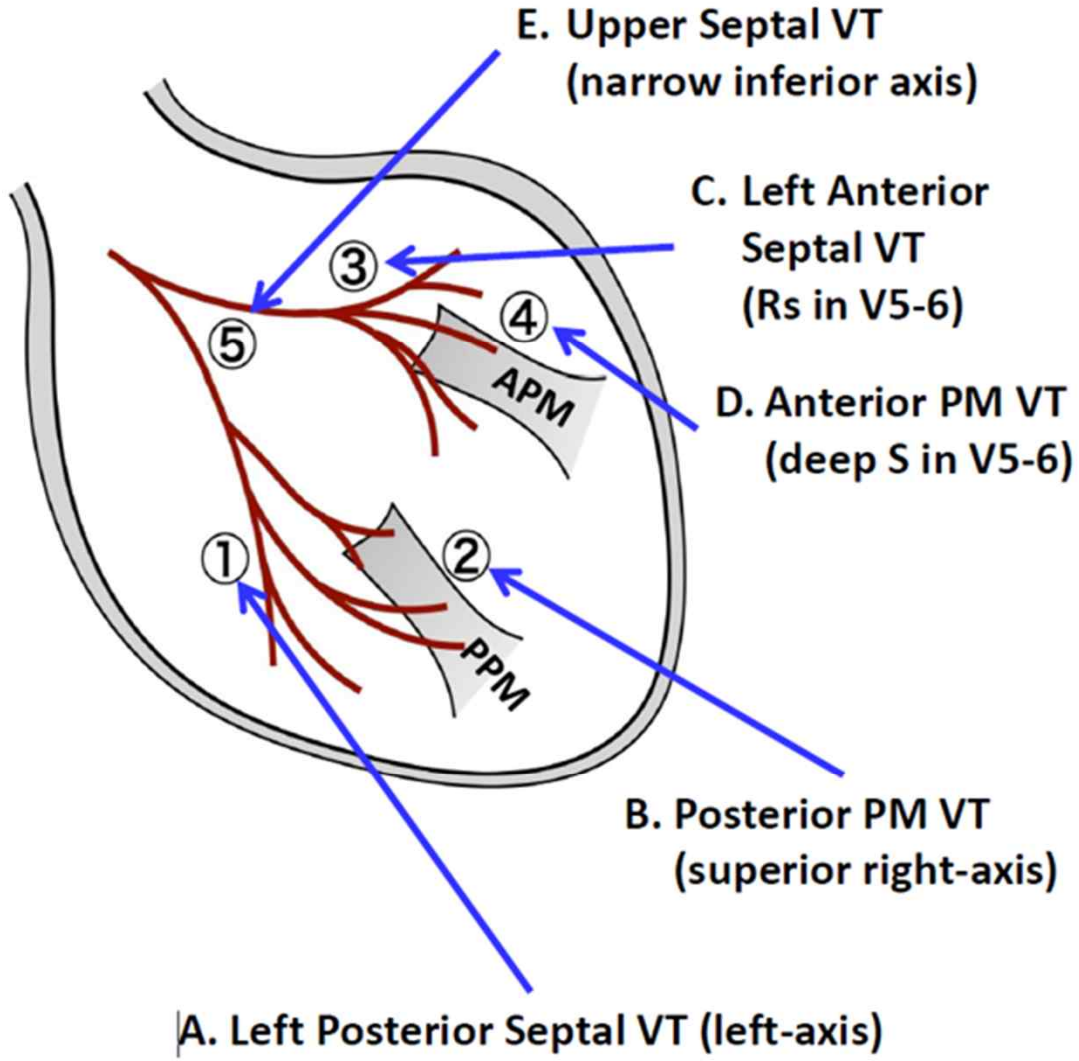


Fig. 1

YH Kim, Nogami A, et al. 2019 APHRS Expert Consensus Statement

Table 9-1. Purkinje-related Monomorphic VTs.

I. Verapamil-sensitive left fascicular-Purkinje VT

1. Left posterior type

i. Left posterior septal fascicular-Purkinje VT

ii. Left posterior papillary muscle fascicular-Purkinje VT

2. Left anterior type

i. Left anterior septal fascicular-Purkinje VT

ii. Left anterior papillary muscle fascicular-Purkinje VT

IV. Bundle branch reentry VT and interfascicular reentry VT

In the papillary muscle fascicular VTs, fibromuscular bands near papillary muscles can be the substrate of the circuit.

YH Kim, Nogami A, et al. 2019 APHRS Expert Consensus Statement

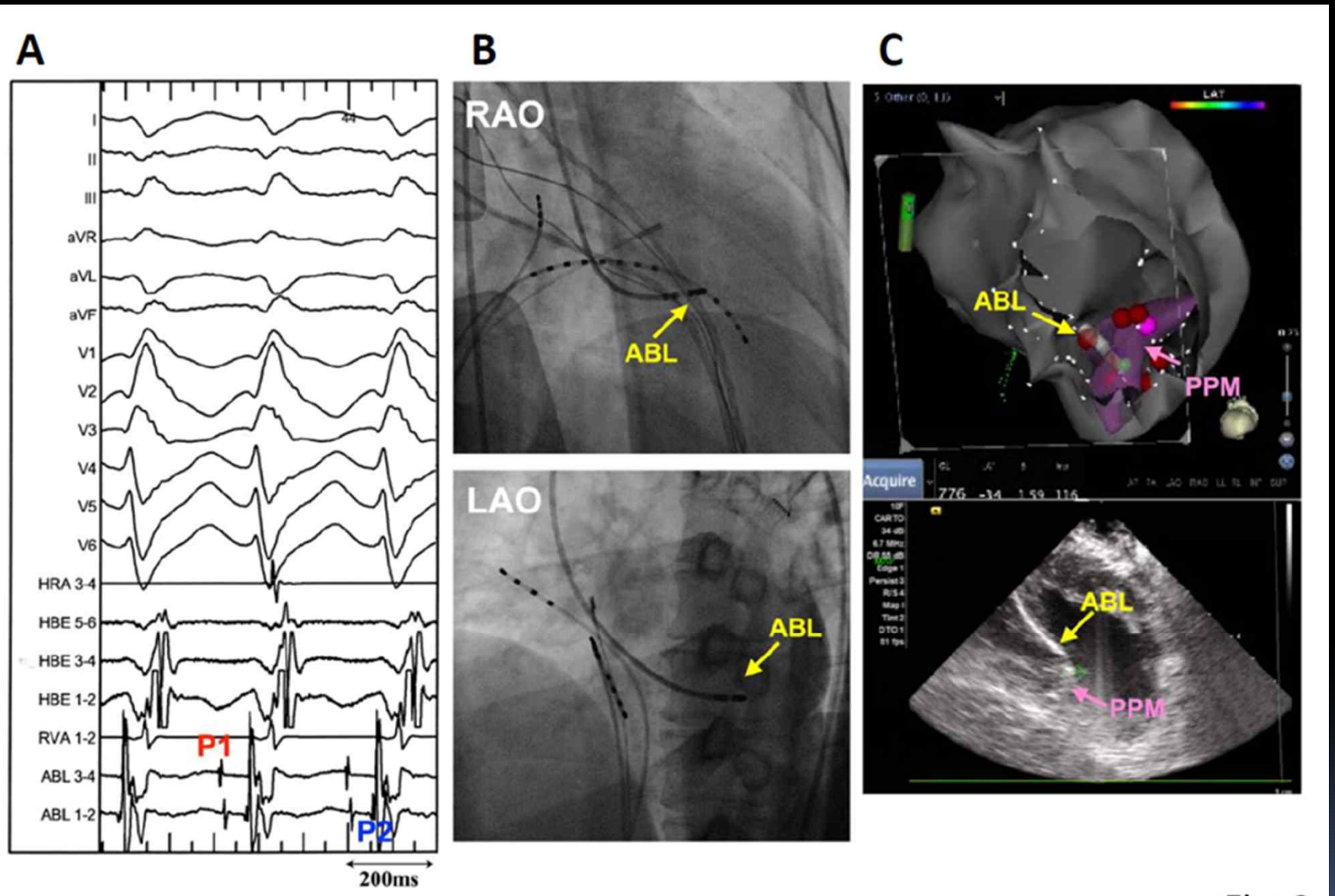


Fig. 3

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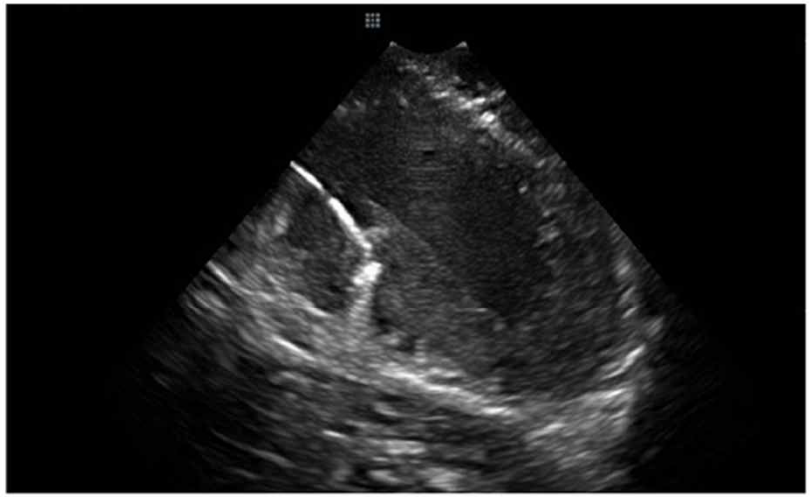
Table 9-1. Consensus recommendations.

Use of 3D Mapping in Ventricular Tachycardia: Fascicular-Purkinje VT and Bundle Branch Reentry VT			
Recommendation	**Class**	**LOE**	**References**
In patients with healed myocardial infarction undergoing ablation of fascicular-Purkinje VT, the use of a 3D mapping system is recommended.	I	C-LD	228-231
The use of a 3D mapping system is recommended for ablation for fascicular-Purkinje VT to better understand the anatomy (e.g. left ventricular septum, papillary muscles, fascicules, Purkinje fiber) to reduce procedure duration and radiation exposure for both the patient and the operator.	I	C-LD	217, 232
For bundle branch reentry VT or interfascicular VT, the use of 3D mapping system is reasonable to detect the optimal ablation target and to reduce the potential risk of atrio-ventricular block.	IIa	C-LD	241, 243
The 3D mapping system may be considered for the anatomical ablation for fascicular-Purkinje VT if tachycardia is noninducible or nonsustained.	IIb	C-LD	227

YH Kim, Nogami A, et al. 2019 APHRS Expert Consensus Statement

Cryoablation

A



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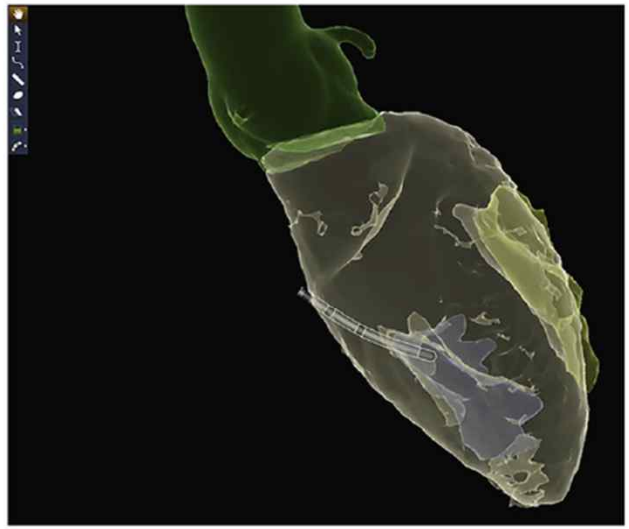
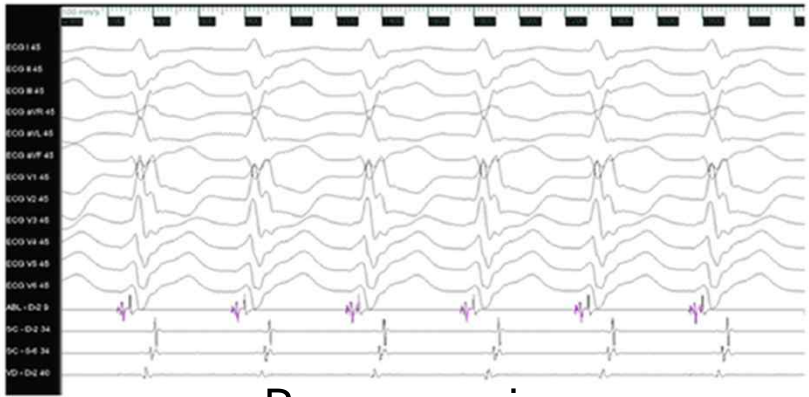
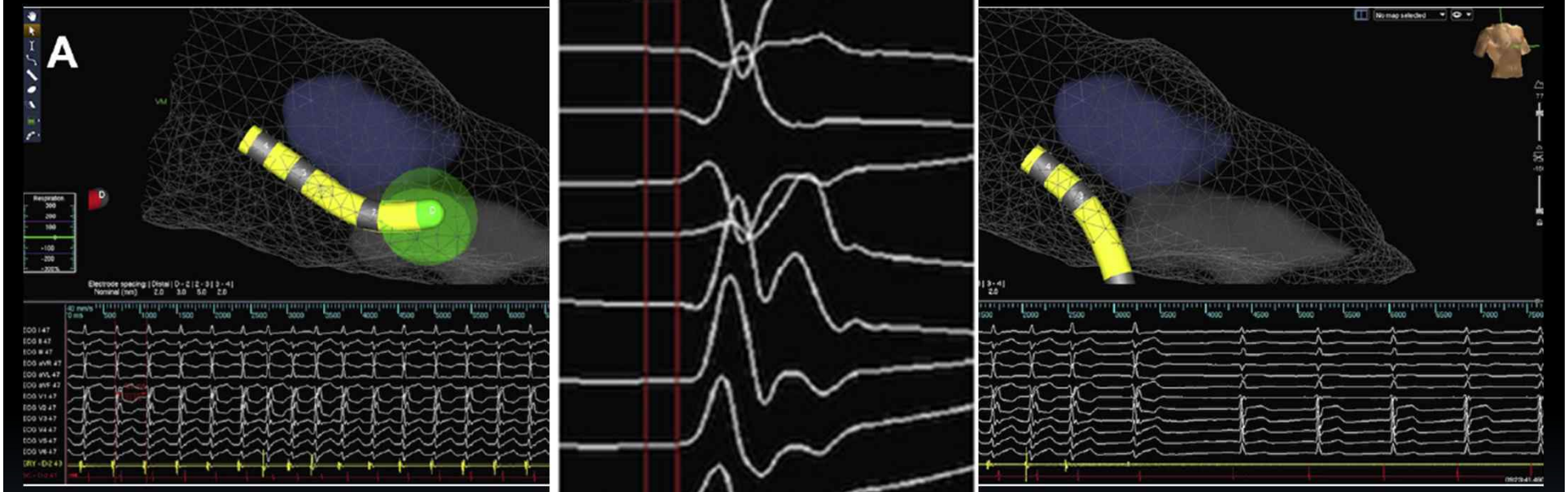




Pace mapping

Cryoablation



Cryoablation

Patient #	Age, yrs	Sex	LVEF	CMP	AADs	VA	VAM	Follow-Up (months)	REC	AADs CA
1	34	M	57	-	-	VT	1	12	-	-
2	49	M	55	-	-	VT	1	10	Yes	-
3	27	F	60	-	-	PVC	1	3	-	-
4	38	M	55	-	-	VT	1	7	-	-
5	37	M	45	TM	Flec	PVC	1	6	-	-
6	38	M	55	-	Diltz	NSVT	2	6	-	-
7	44	M	58	-	-	NSVT	1	6	-	-
8	45	F	55	-	-	NSVT	1	7	-	-
9	21	M	60	-	-	VT	1	12	-	-
10	57	F	55	-	Sot	NSVT	1	4	-	-

Results of Cryoenergy and Radiofrequency-Based Catheter Ablation for Treating Ventricular Arrhythmias Arising From the Papillary Muscles of the Left Ventricle, Guided by Intracardiac Echocardiography and Image Integration

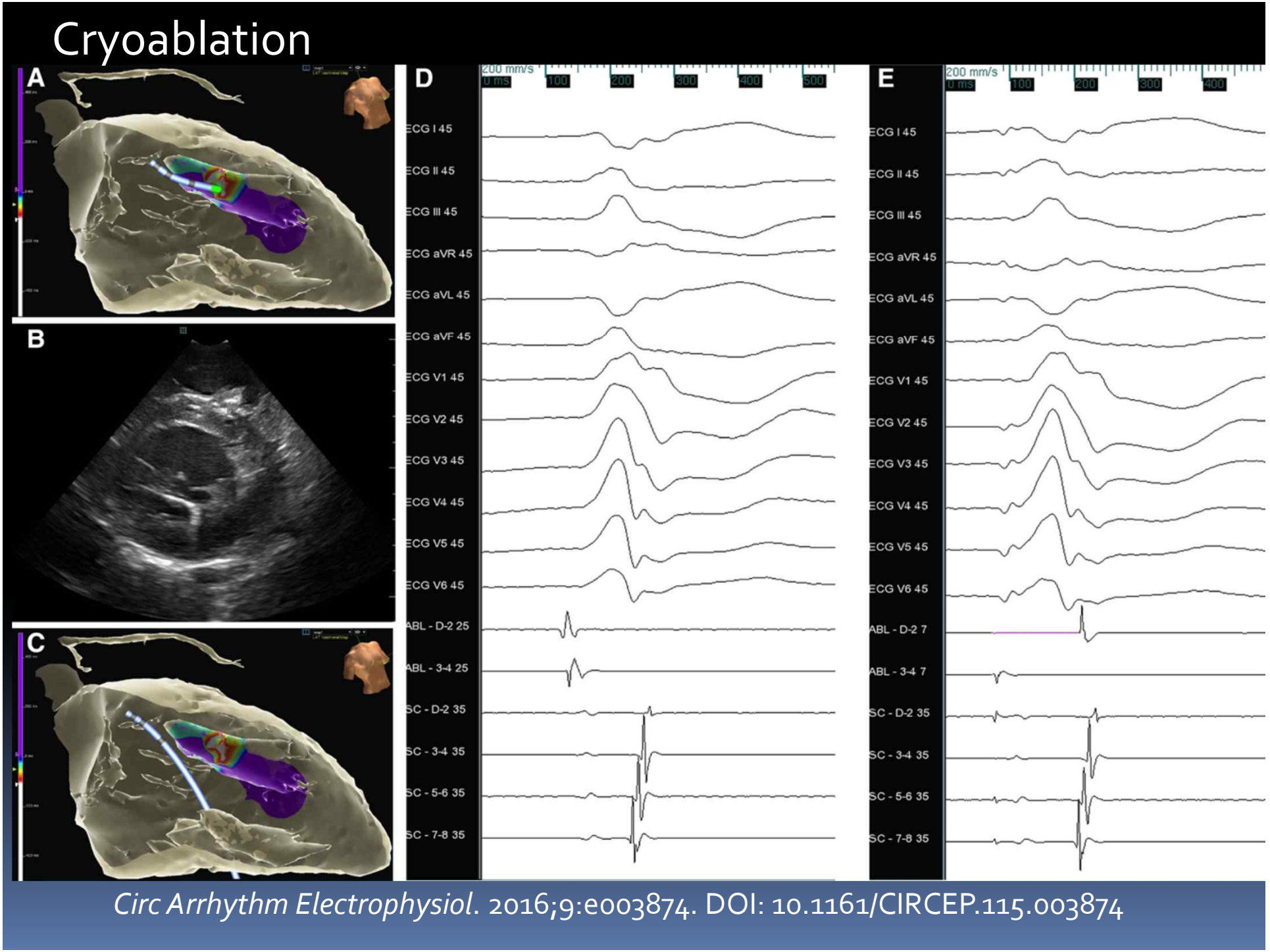
Santiago Rivera, MD; Maria de la Paz Ricapito, MD; Leandro Tomas, MD; Josefina Parodi, MD; Guillermo Bardera Molina, ENG; Rodrigo Banega, ENG; Pablo Bueti, TEC; Agustin Orosco, MD; Marcelo Reinoso, MD; Milagros Caro, MD; Diego Belardi, MD; Gaston Albina, MD; Alberto Giniger, MD; Fernando Scazzuso, MD

Background—Catheter radiofrequency ablation of ventricular arrhythmias (VAs) arising from the left ventricle's papillary muscles has been associated with inconsistent results. The use of cryoenergy versus radiofrequency has not been compared yet. This study compares outcomes and complications of catheter ablation of VA from the papillary muscles of the left ventricle with either cryoenergy or radiofrequency.

Methods and Results—Twenty-one patients (40±12 years old; 47% males; median ejection fraction 59±7.3%) with drug refractory premature ventricular contractions or ventricular tachycardia underwent catheter cryoablation or radiofrequency ablation. VAs were localized using 3-dimensional mapping, multidetector computed tomography, and intracardiac echocardiography, with arrhythmia foci being mapped at either the anterolateral papillary muscle or posteromedial papillary muscles of the left ventricle. Focal ablation was performed using an 8-mm cryoablation catheter or a 4-mm open-irrigated radiofrequency catheter, via transmitral approach. Acute success rate was 100% for cryoenergy (n=12) and 78% for radiofrequency (n=9; P=0.08). Catheter stability was achieved in all patients (100%) treated with cryoenergy, and only in 2 (25%) patients treated with radiofrequency (P=0.001). Incidence of multiple VA morphologies was observed in 7 patients treated with radiofrequency (77.7%), whereas none was observed in those treated with cryoenergy (P=0.001). VA recurrence at 6 months follow-up was 0% for cryoablation and 44% for radiofrequency (P=0.03).

Conclusions—Cryoablation was associated with higher success rates and lower recurrence rates than radiofrequency catheter ablation, better catheter stability, and lesser incidence of polymorphic arrhythmias. (***Circ Arrhythm Electrophysiol.* 2016;9:e003874. DOI: 10.1161/CIRCEP.115.003874.**)

Cryoablation



Circ Arrhythm Electrophysiol. 2016;9:e003874. DOI: 10.1161/CIRCEP.115.003874

Table 2. Procedural Characteristics

Characteristics	RF (n=9)	CRYO (n=12)	*P* value
P Success	7 (77.8%)	12 (100.0%)	0.08
Recurrence	4 (44%)	0	0.03
RF Time	11.3±4.2	11.0±3.0	0.9
Energy time	425.3±86.1	700.0±216.1	0.002
TP Time	131.7±9.0	126.5±25.5	0.4
Complications	0	0	…
ProA	8 (88.9%)	0	0.001
Cath Stab	2 (22.2%)	12 (100.0%)	0.001
Days F-UP	87 (IQR, 65–148)	360 (IQR, 116–365)	…

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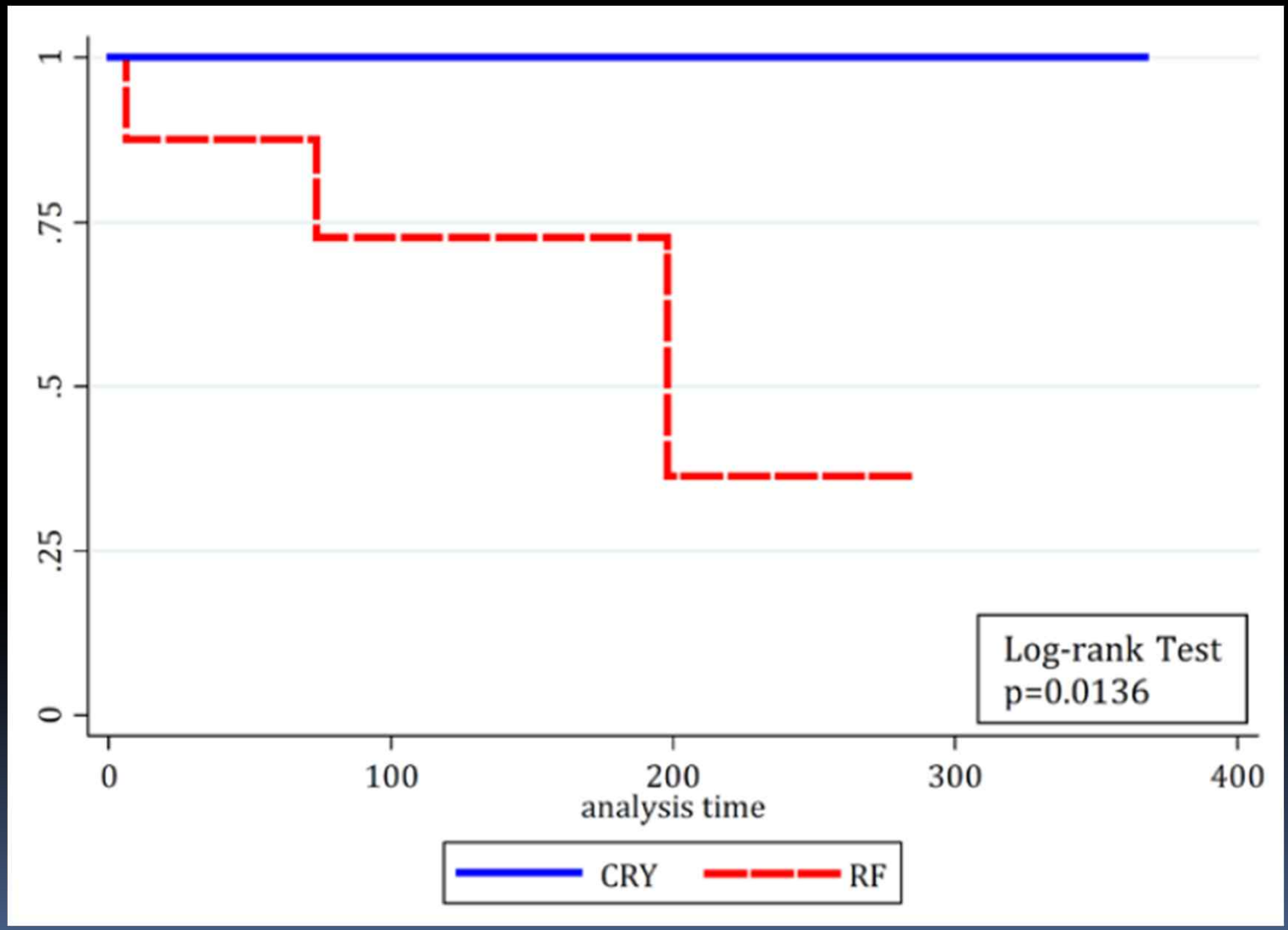
Kaplan–Meier survival estimates for recurrence.
Patients free from ventricular arrhythmias after catheter ablation



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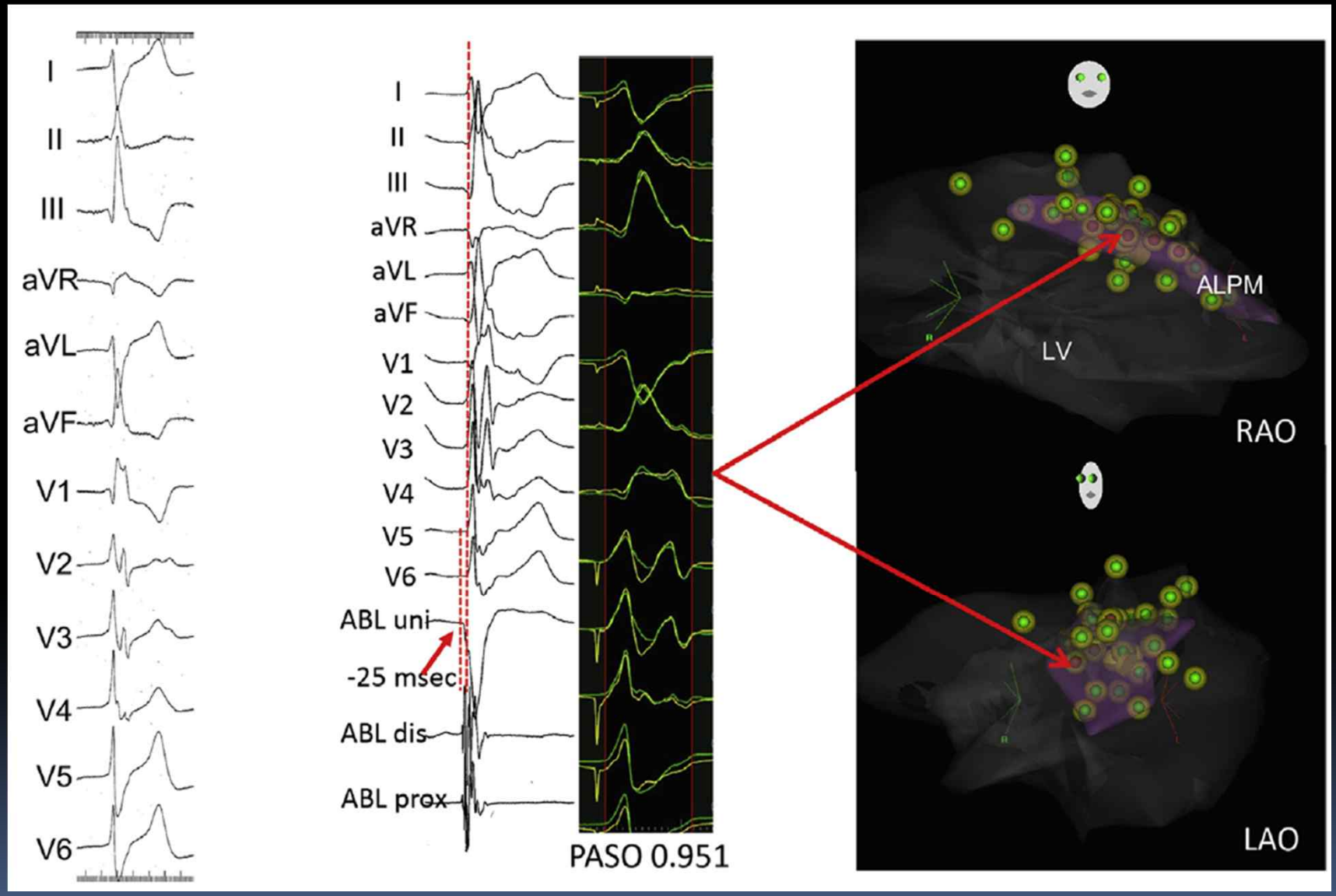

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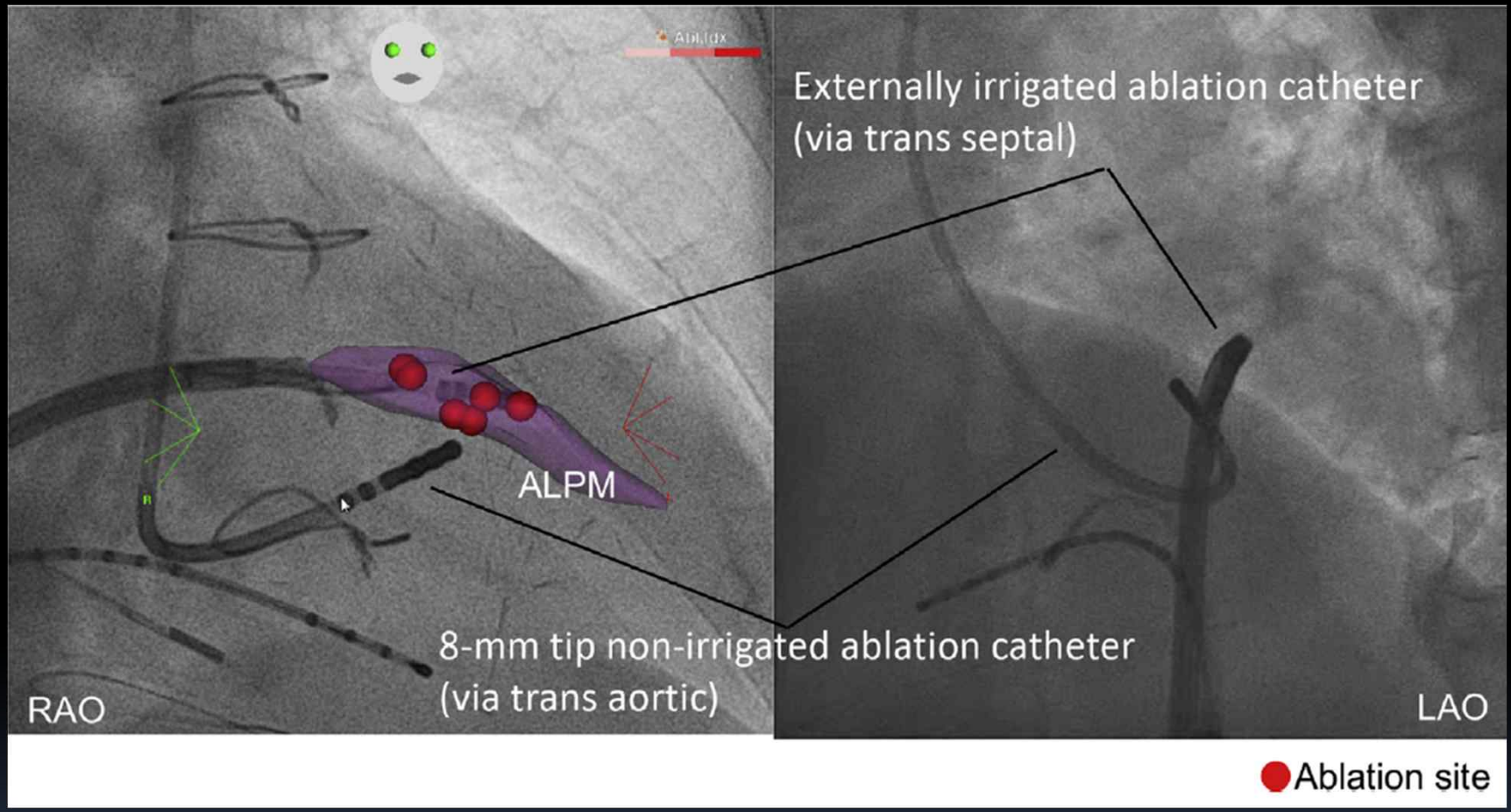
Bipolar Ablation of PM VT



An externally irrigated ablation catheter was inserted into the LV via a transseptal approach, and an 8-mm-tip nonirrigated ablation catheter was inserted via a transaortic approach. RF was administered 3 times. The output was increased from 30 W to 50 W gradually, and Each application was continued for 60 s.

Heart Rhythm Case Reports, Vol 5, No 9, September 2019;5:472–475

Conclusion

- Imaging of papillary muscle, ICE and/or CT, first!
- Understand PM-Purkinje network and its typical electrogram identification
- Catheter instability and deep seated lesion
- Cryo-ablation or bipolar ablation may be a better option.

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