Catheter Ablation for Ventricular Arrhythmias in Hypertrophic Cardiomyopathy

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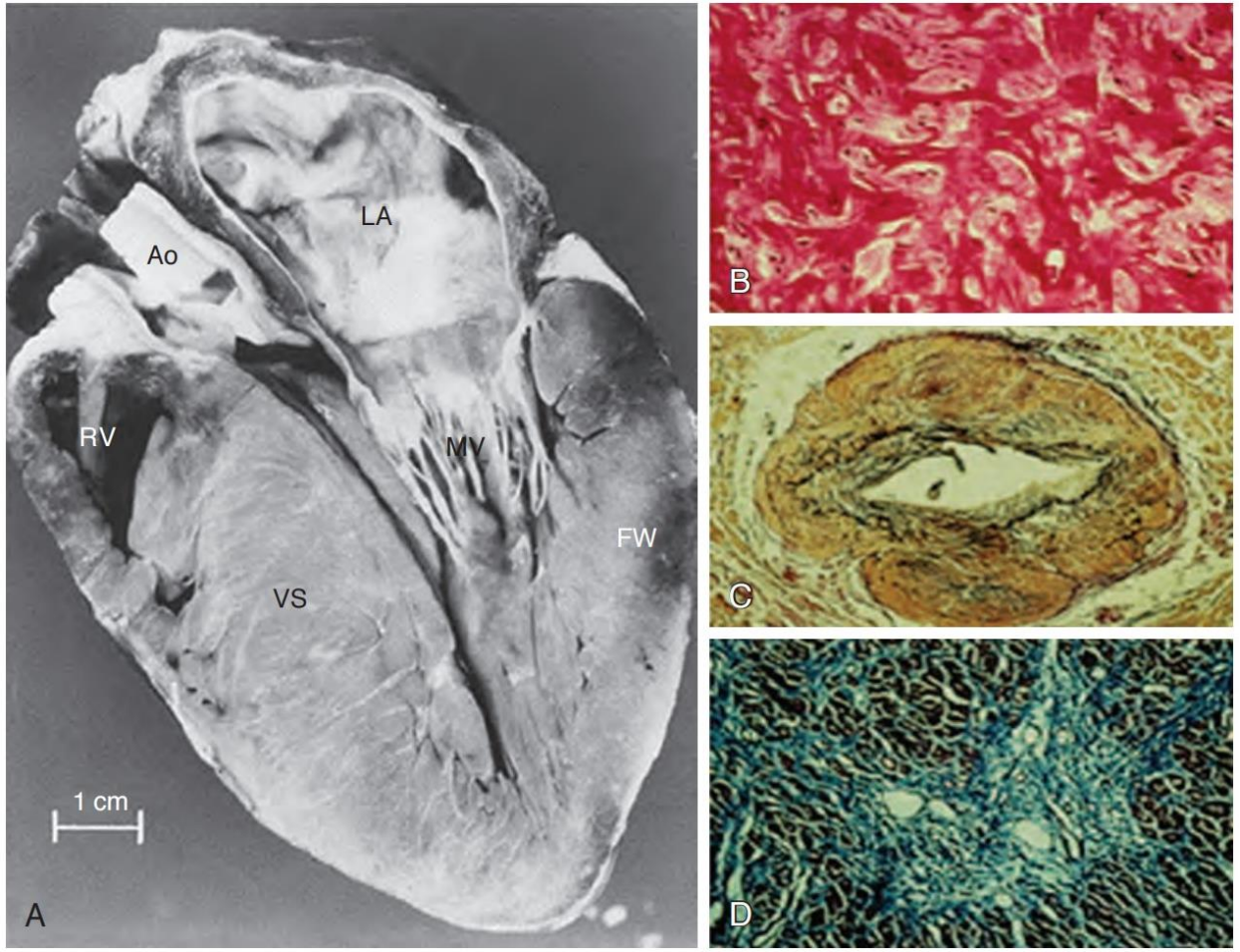
COI Disclosure

Minglong Chen:

The authors have no financial conflicts of interest to disclose concerning the presentation

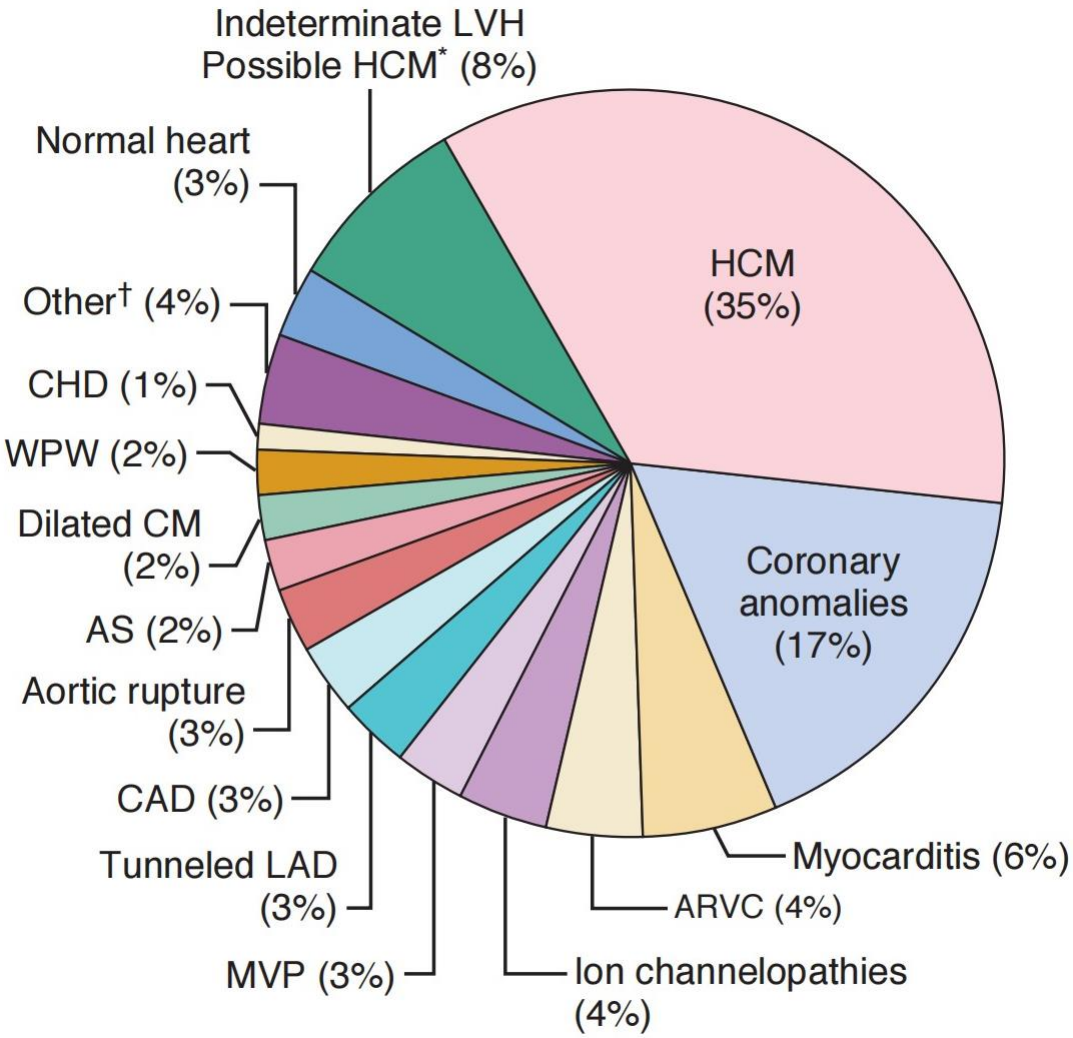
Introduction

- Hypertrophic cardiomyopathy (HCM) is a genetic disease of the sarcomere characterized by abnormal LV hypertrophy with myocyte disarray.
- The combination of myofibrillar disarray and fibrosis likely generates heterogeneous conduction properties and, together with the vulnerability of the hypertrophied myocardium to supply demand ischemia, creates a potentially arrhythmogenic milieu.



Introduction

- Common forms of VAs associated with H CM have been considered to be VF and p olymorphic VT.
- HCM is the most common cardiovascular cause of sudden death in competitive athletes. ICDs are the main stay of therap y for prophylaxis against SCD.



Introduction

- However, the occurrence of monomorphic VT is rare in patients with HCM.
- Ablation is generally performed for monomorphic VT that recurs despite antiarrhythmic therapy, particularly with ICD shocks.
- The ablation experience is limited to case reports and small case series of highly selected patients.

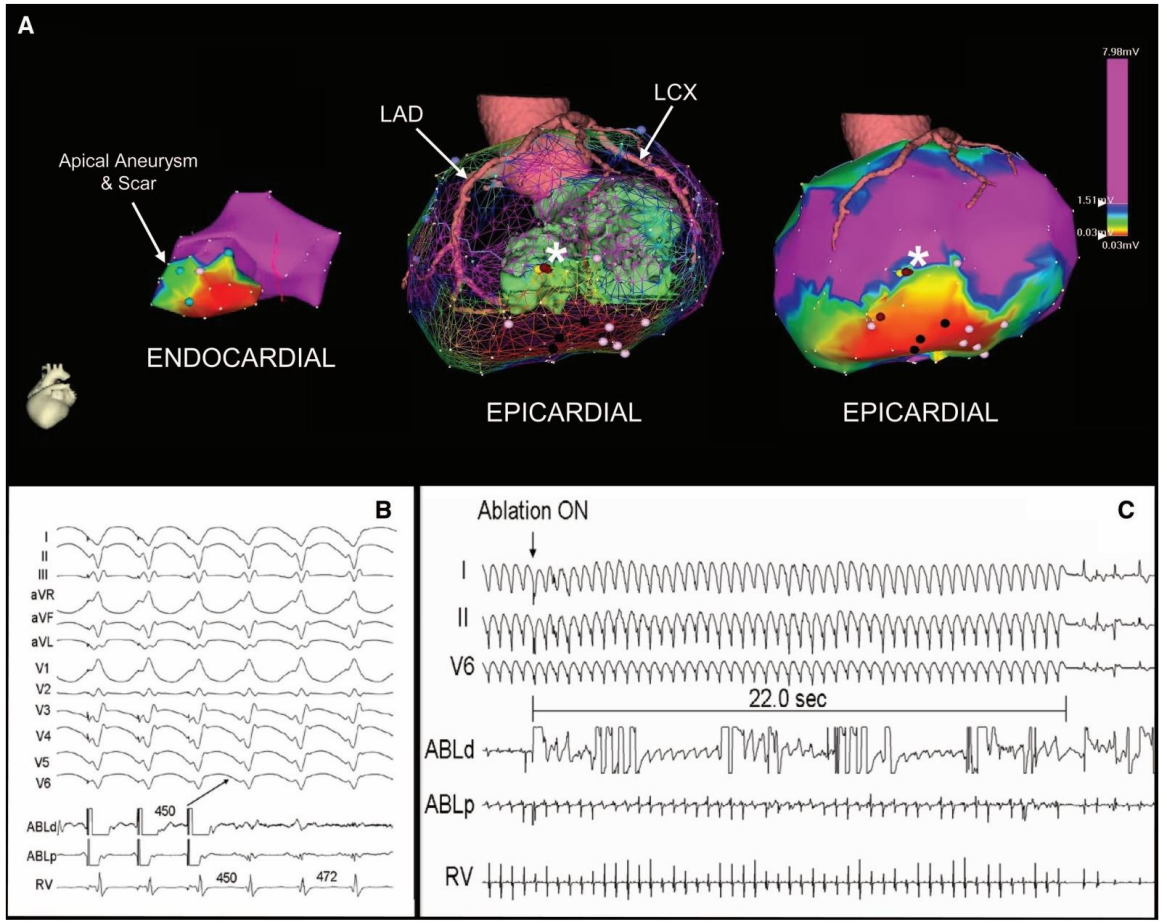
2019 HRS/EHRA/APHRS/LAHRS expert consensus statement on catheter ablation of ventricular arrhythmias

Recommendation for VA ablation in HCM

COR	LOE	Recommendation
IIa	B-NR	1. In patients with HCM and recurrent monomorphic VT in whom AAD therapy is ineffective or not tolerated, catheter ablation can be useful.

Case Series 1: Substrate Map and Long-Term Outcomes of Combined EPI and ENDO Ablation

- 10 patients with HCM-related monomorphic VT;
- Preserved LVEF (LVEF of 57% ± 13%);
- Clinical VT induced in 7/10 patients (2 VTs per patient);
- Ablation sites were identified using a combination of entrainment, activation, late/fractionated potential, and pace mapping.

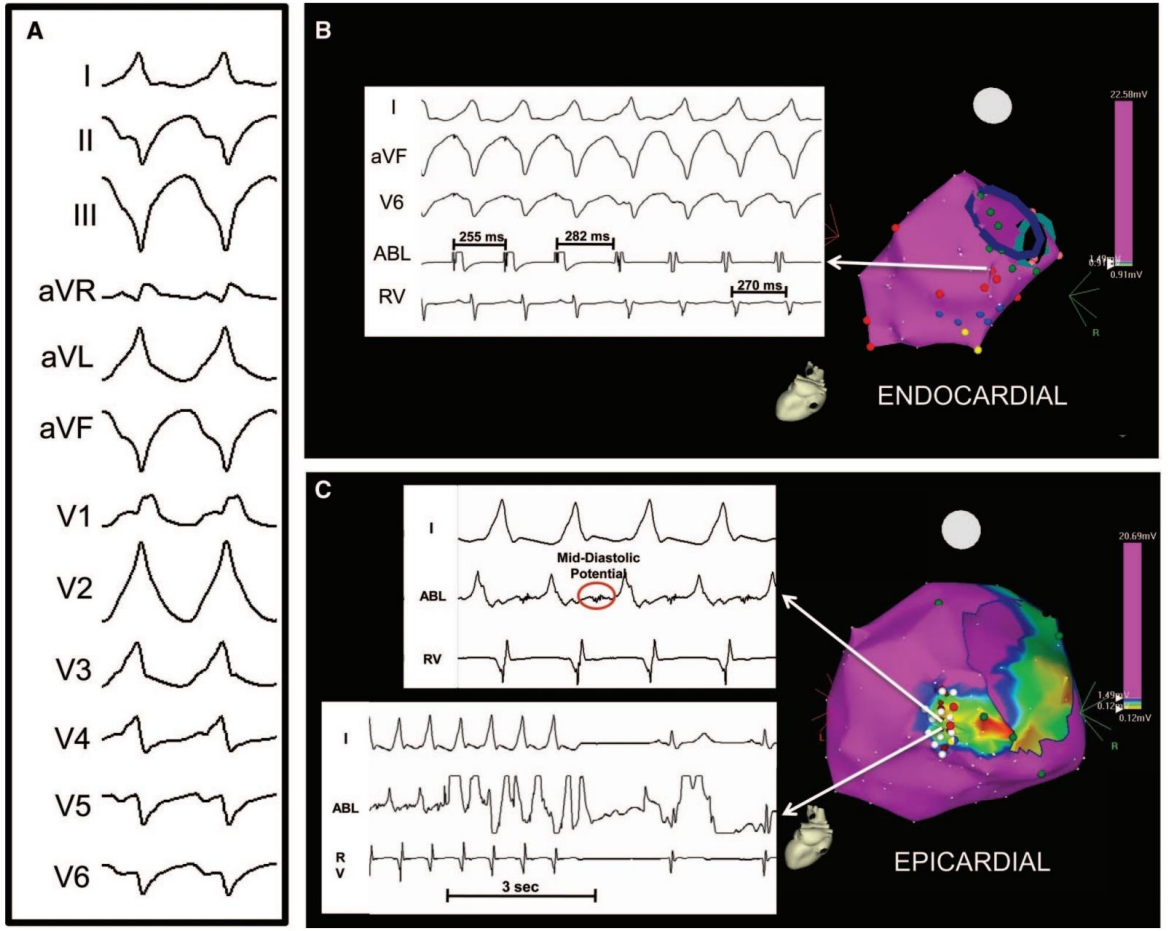


KHRS 2023

Dukkipati SR, et al. Circ Arrhythm Electrophysiol. 2011 Apr;4(2):185-94.

Case Series 1: Substrate Map and Long-Term Outcomes of Combined EPI and ENDO Ablation

- Voltage mapping identified a combination of epicardial and endocardial scars in most patients.
- Combined EPI and ENDO ablation was performed (3 terminated with ablation from EPI and 1 from ENDO).
- During a 3-year follow-up, the freedom from recurrent ICD shocks was 78% (7/9 patients).



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Case Series 2: Safety and Feasibility of Catheter Ablation in patients with HCM and VT

- The first large series of consecutive HCM patients undergoing RFCA of VTs.
- 22 patients with HCM and VTs resistant to medical therapy.
- More advanced disease (LVEF 34.3% ± 9.8%).

Radiofrequency catheter ablation of ventricular arrhythmias in patients with hypertrophic cardiomyopathy: safety and feasibility

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BACKGROUND Management of ventricular tachycardia (VT) in patients with hypertrophic cardiomyopathy (HCM) is challenging.

OBJECTIVE The purpose of this study is to assess the value of radiofrequency catheter ablation (RFCA) for the treatment of the VTs in the setting of HCM.

METHODS Twenty-two patients (18 with ICD) with HCM and multiple episodes of VTs resistant to medical therapy underwent RFCA with an open irrigation catheter. Epicardial access was obtained if required. All patients were followed for at least 1 year after RFCA.

RESULTS Mean age was 50.4 ± 15.3, and mean ejection fraction was 34.3% ± 9.8%. RFCA was performed endocardially in all patients, while epicardial radiofrequency applications were needed in 13 patients. A previous endocardial ablation was unsuccessful in six patients. At 20 ± 9 months of follow-up, elimination of VTs reached 73%. No major complication was observed during and after the procedures in all patients.

CONCLUSION Catheter ablation of VTs in patients with hypertrophic cardiomyopathy refractory to medical therapy is safe, feasible, and successful in eliminating VT. Epicardial VT mapping and ablation should be considered as an important access option for the treatment of these patients to increase the success rate.

KEYWORDS Hypertrophic cardiomyopathy; Ventricular tachycardia; Catheter ablation; Outcomes

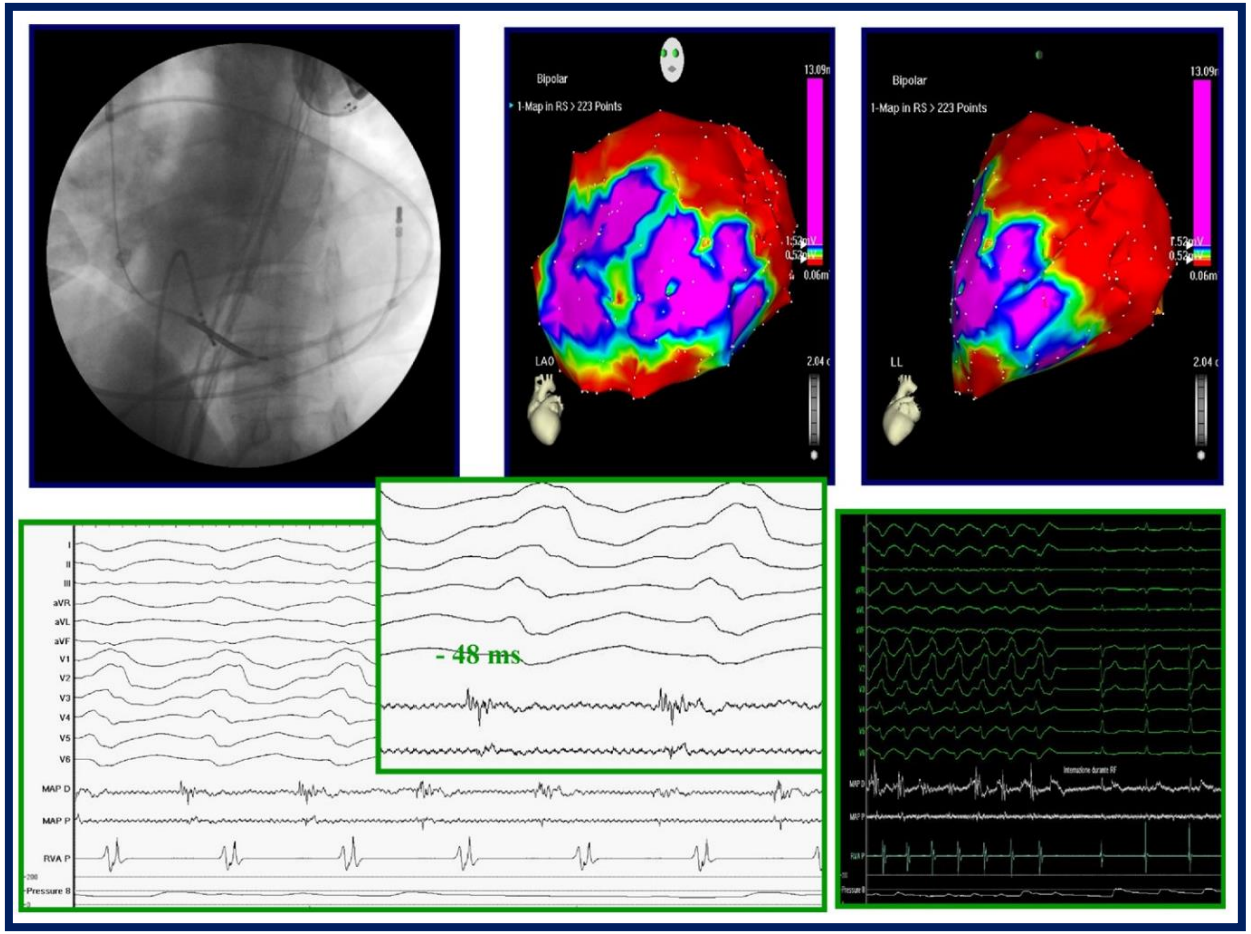
ABBREVIATIONS **ECG** = electrocardiogram; **EF** = ejection fraction; **HCM** = hypertrophic cardiomyopathy; **ICD** = implantable cardioverter-defibrillator; **ICE** = intracardiac echocardiography; **LV** = left ventricle, ventricular; **NYHA** = New York Heart Association; **RF** = radiofrequency; **RFCA** = radiofrequency catheter ablation; **RV** = right ventricle, ventricular; **SD** = standard deviation; **VT** = ventricular tachycardia

(Heart Rhythm 2010;7:1036–1042)

Santangeli P, et al. Heart Rhythm. 2010 Aug;7(8):1036-42.

Case Series 2: Safety and Feasibility of Catheter Ablation in patients with HCM and VT

- Scar-related VTs occurred most often from the LV-RV junctions (60%), the basal (42%) or apical (18%) LV segment level (coinciding with the anatomical regions frequently associated with fibrosis).
- Epicardial ablation was required in almost two-thirds (13/22) of the patients.



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Case Series 2: Safety and Feasibility of Catheter Ablation in patients with HCM and VT

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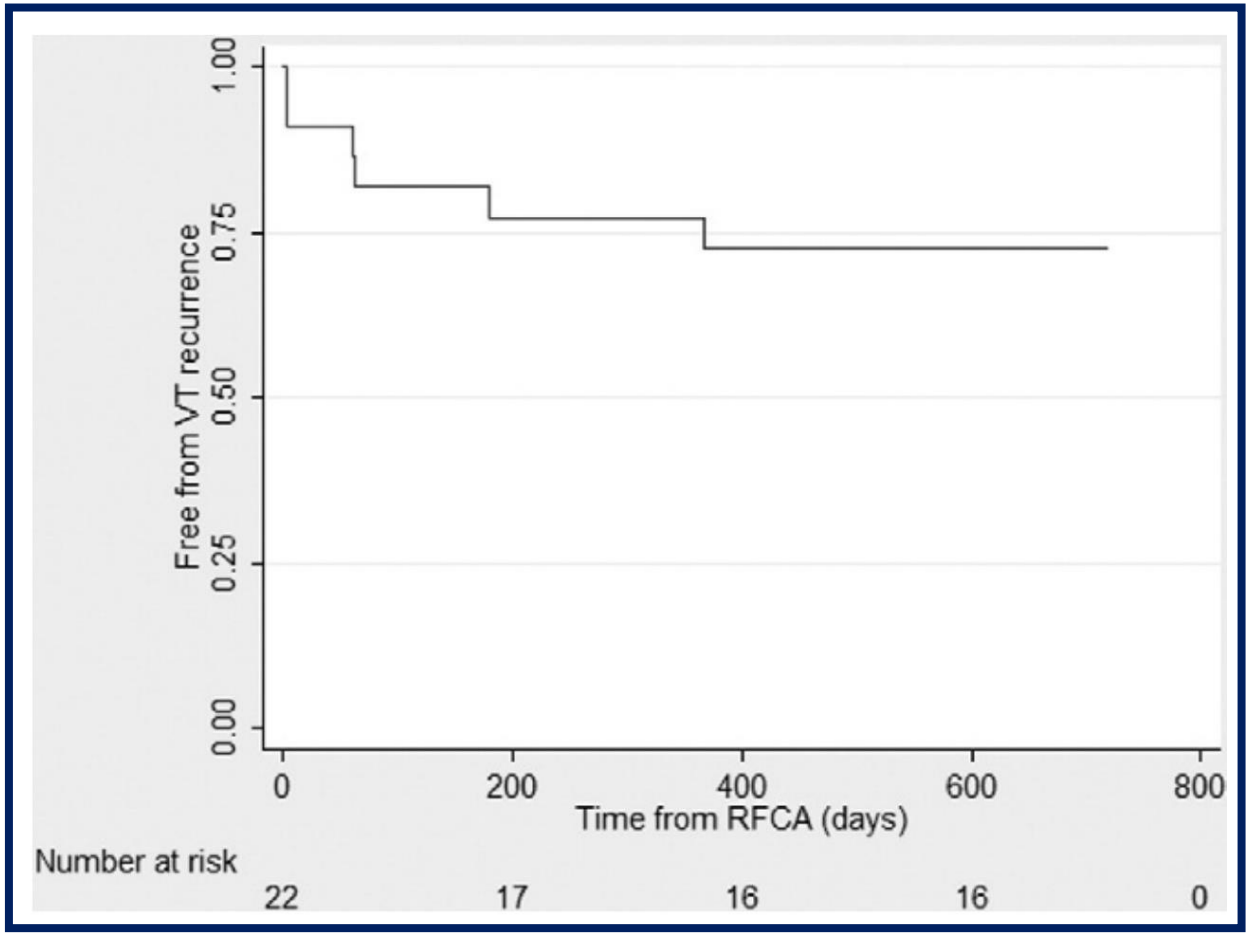
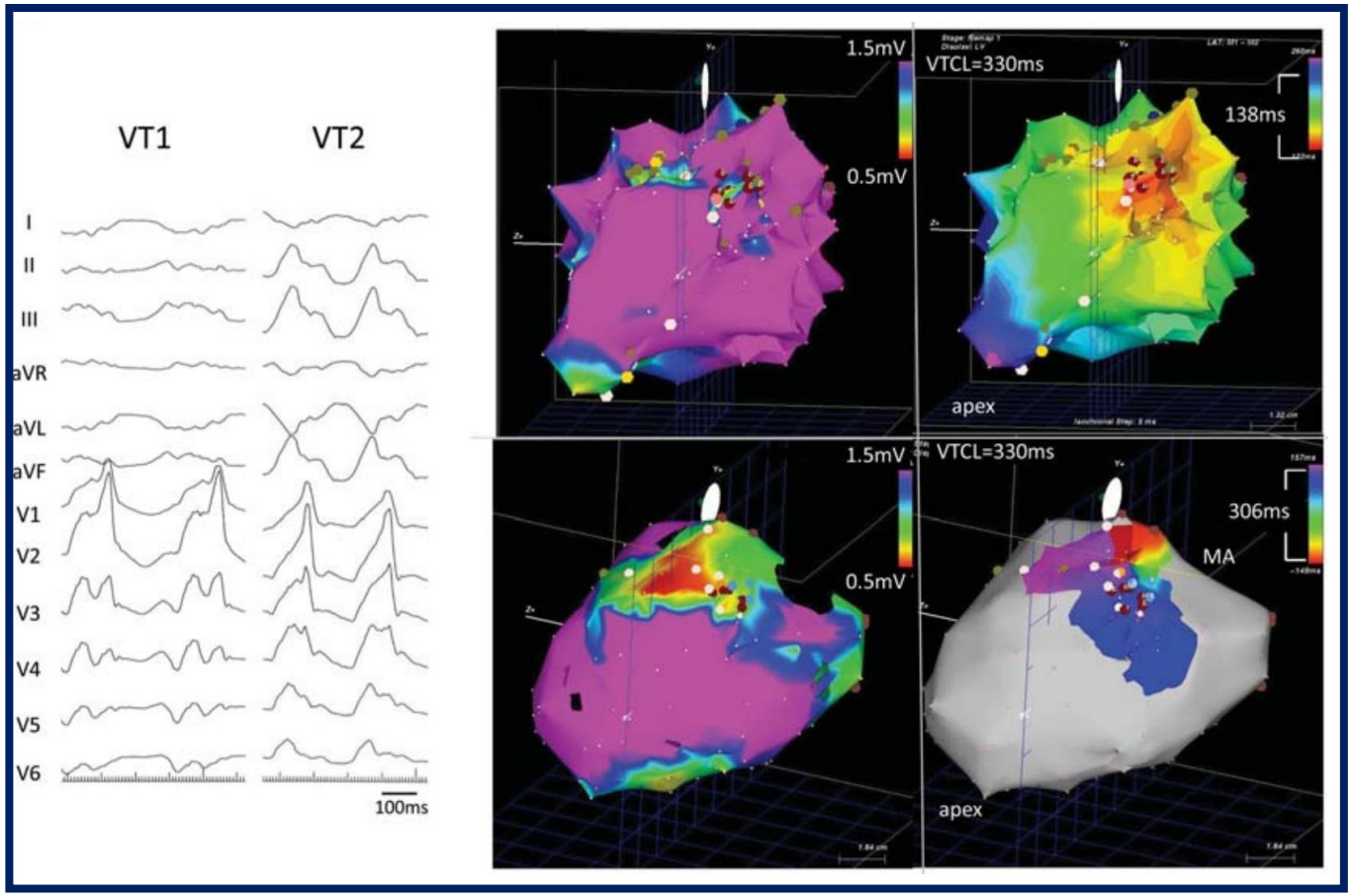


Santangeli P, et al. Heart Rhythm. 2010 Aug;7(8):1036-42.

Case Series 3: VT associated with dilated-phase HCM

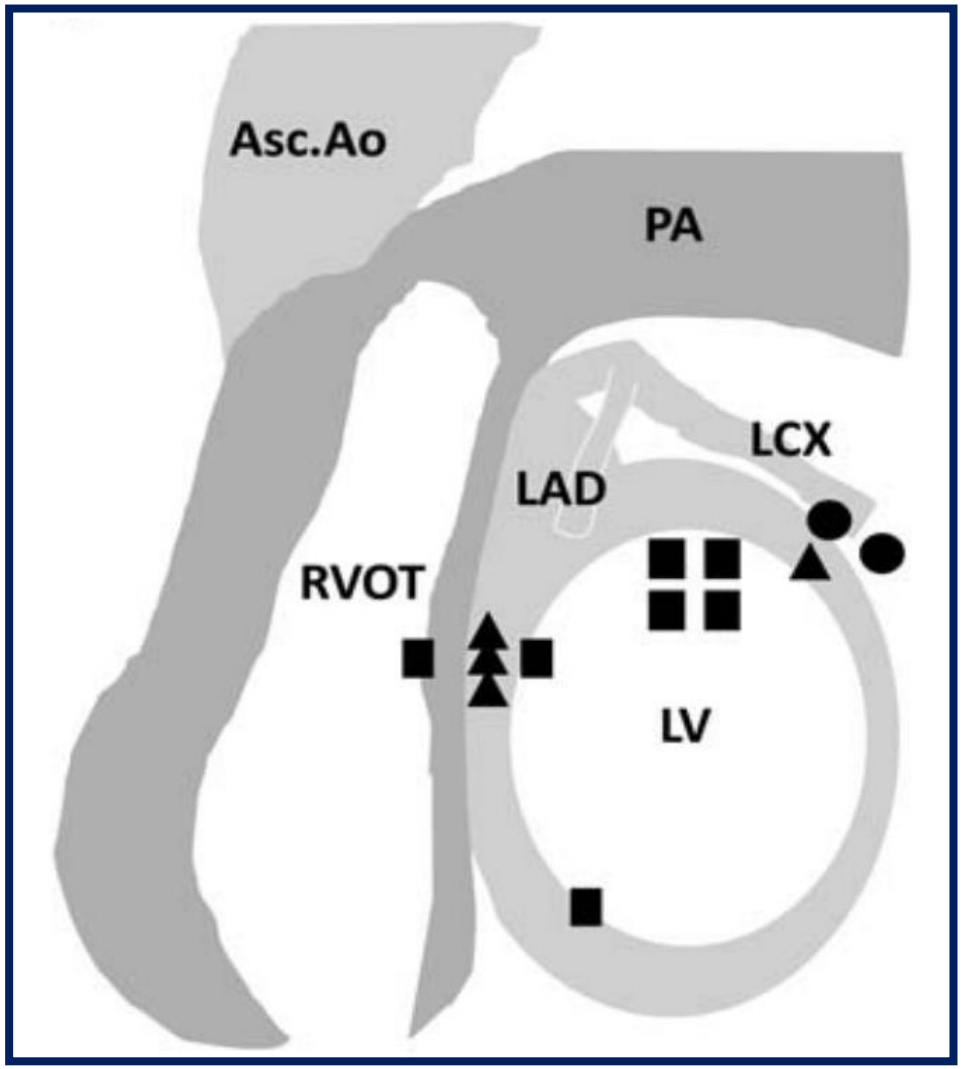
- 5 patients with dilated-phase HCM and monomorphic VT.
- LVDd 57±7.1 mm with reduced EF 36.8 ±8.1%, 2/5 patients with aneurysm.
- 4/5 suffered from electrical storm.
- 13 monomorphic VTs were targeted for ablation.



Ueda A, et al. Europace. 2012 May;14(5):734-40.

Case Series 3: VT associated with dilated-phase HCM

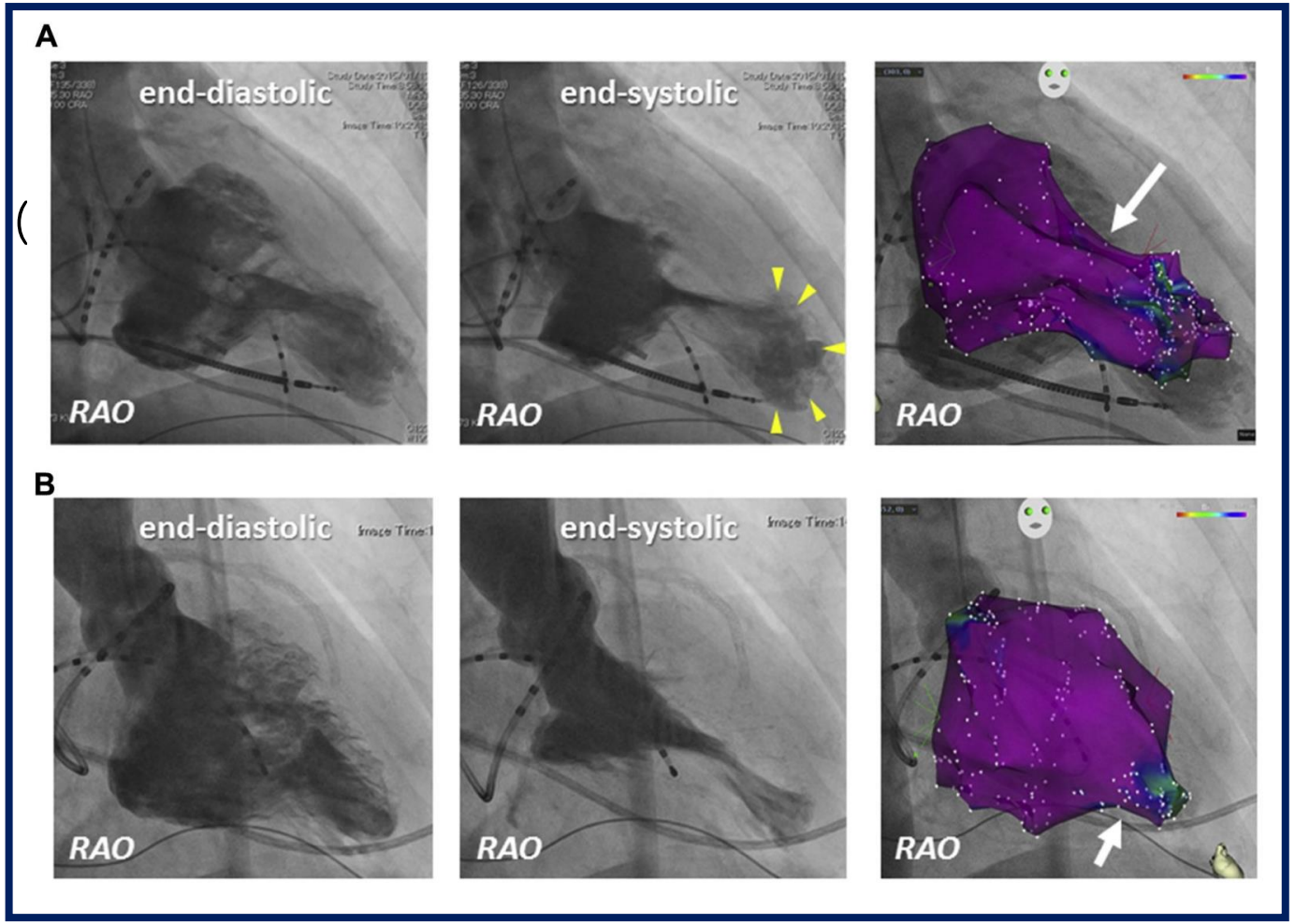
- VT circuits were predominantly distributed in the basal septum and the basal anterior to anterolateral LV.
- In addition to the endocardial ablation, intracoronary ethanol ablation and surgical cryoablation were required in a number of patients (3/5).
- During a 18-month follow-up, 4/5 (80%) patients are free from VT recurrence.



Ueda A, et al. Europace. 2012 May;14(5):734-40.

Case Series 4: Catheter Ablation of VT in Patients with HCM and Apical Aneurysm

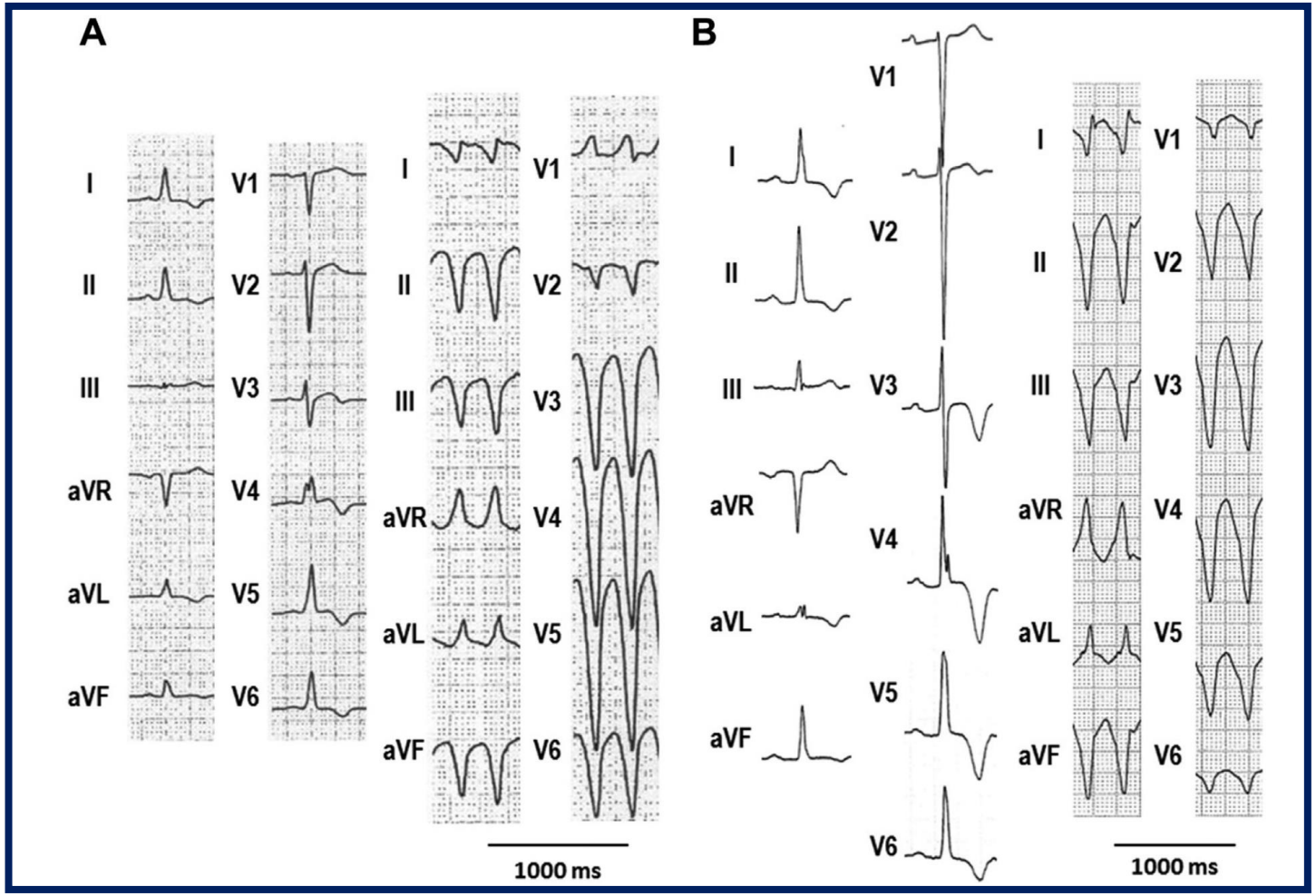
- The thin-walled dyskinetic or akinetic segment can be composed of dense scars with channels of viable myocardium (resembling ischemic substrate).
- Transthoracic contrast echocardiography, left ventriculography, and real-time visualization with ICE can be helpful.
- 15 patients with HCM and apical aneurysm who underwent RFCA for VT.
- Preserved LVEF (LVEF of 64.5% ± 10.5%).



Igarashi M, et al. JACC Clin Electrophysiol. 2018 Mar;4(3):339-350

Case Series 4: Catheter Ablation of VT in Patients with HCM and Apical Aneurysm

- Sustained monomorphic VTs with an RBBB or LBBB pattern in lead V1 can both occur, and inferior lead consistent with an exit from the apical aneurysm.



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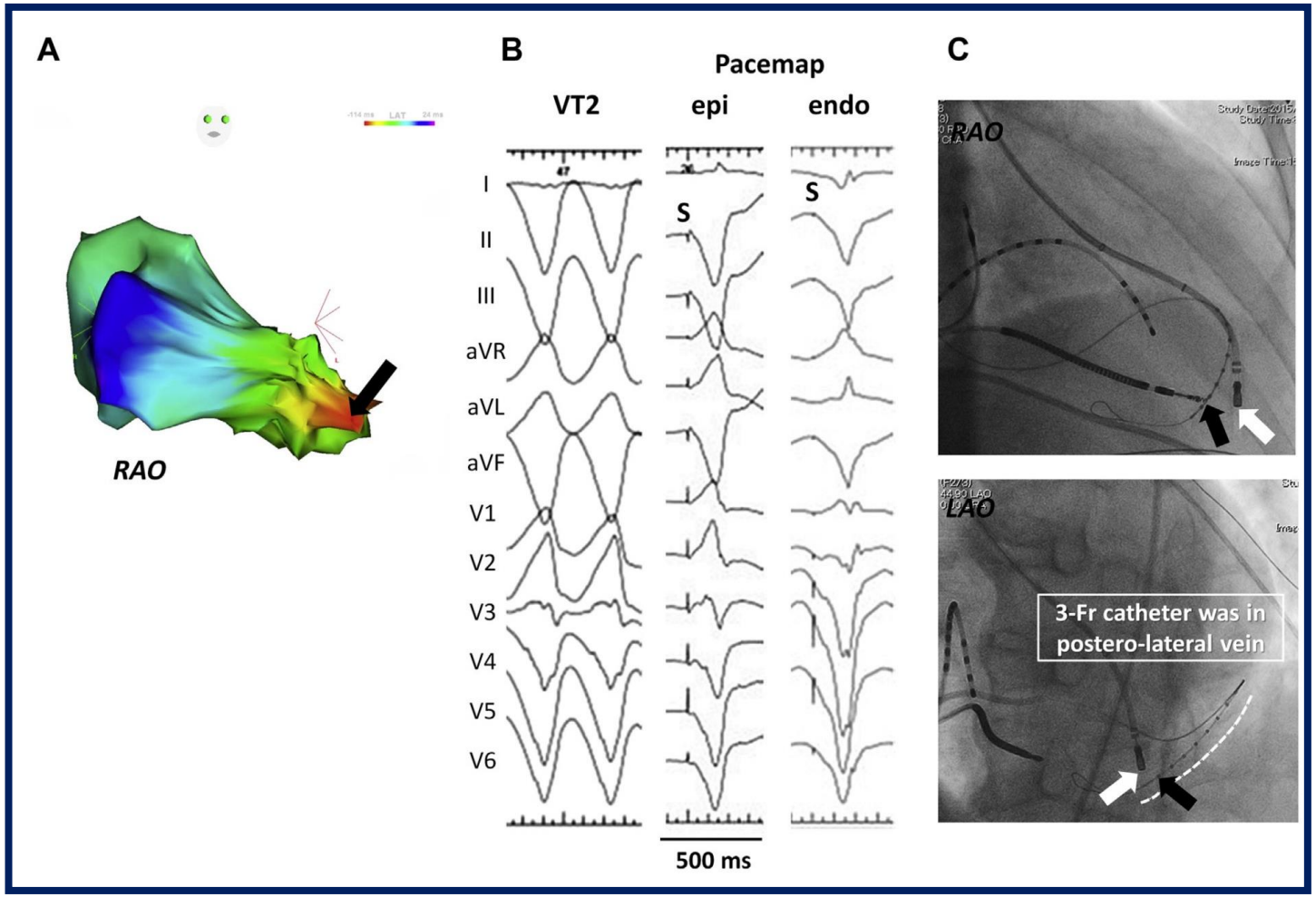
Case Series 4: Catheter Ablation of VT in Patients with HCM and Apical Aneurysm

- Endocardial RFCA successfully suppressed the VT at the LVA border (10/15) or within the LVA (2/15). In 2 of 3 patients without LVA at the endocardial site, linear RFCA at the anterior wall of the aneurysmal neck side was successful.
- In only 1 patient, endocardial RFCA of AA was not effective, and epicardial RFCA site was needed.



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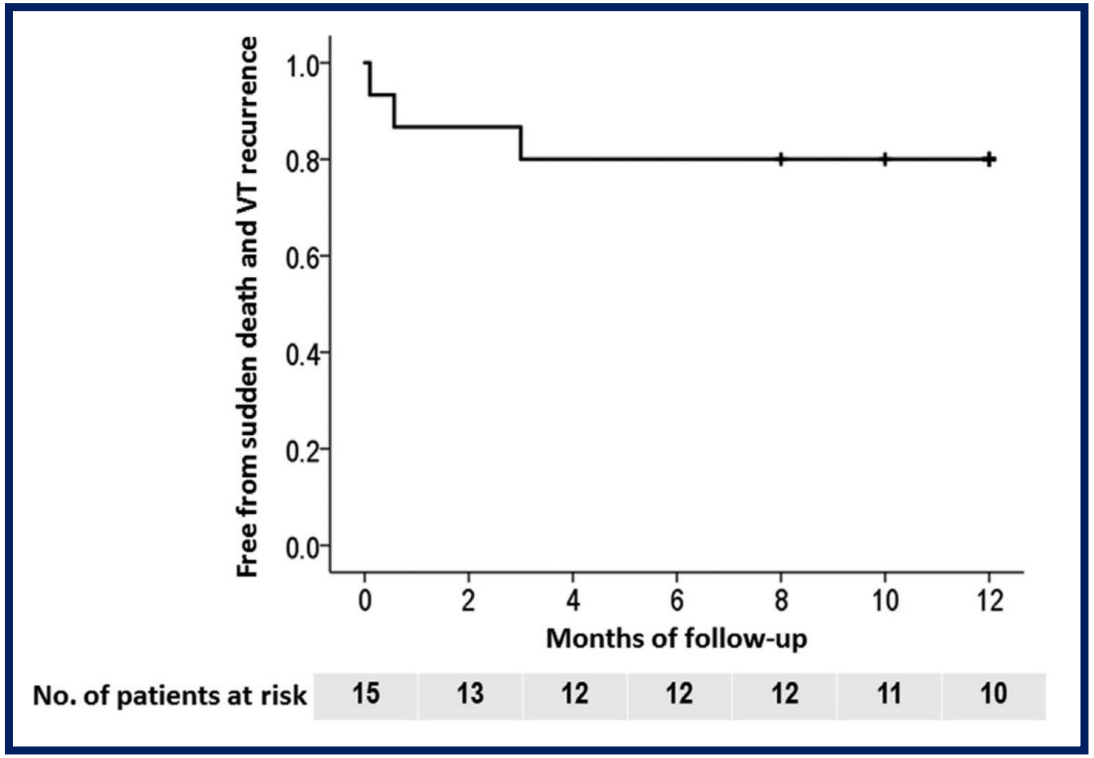
Case Series 4: Catheter Ablation of VT in Patients with HCM and Apical Aneurysm

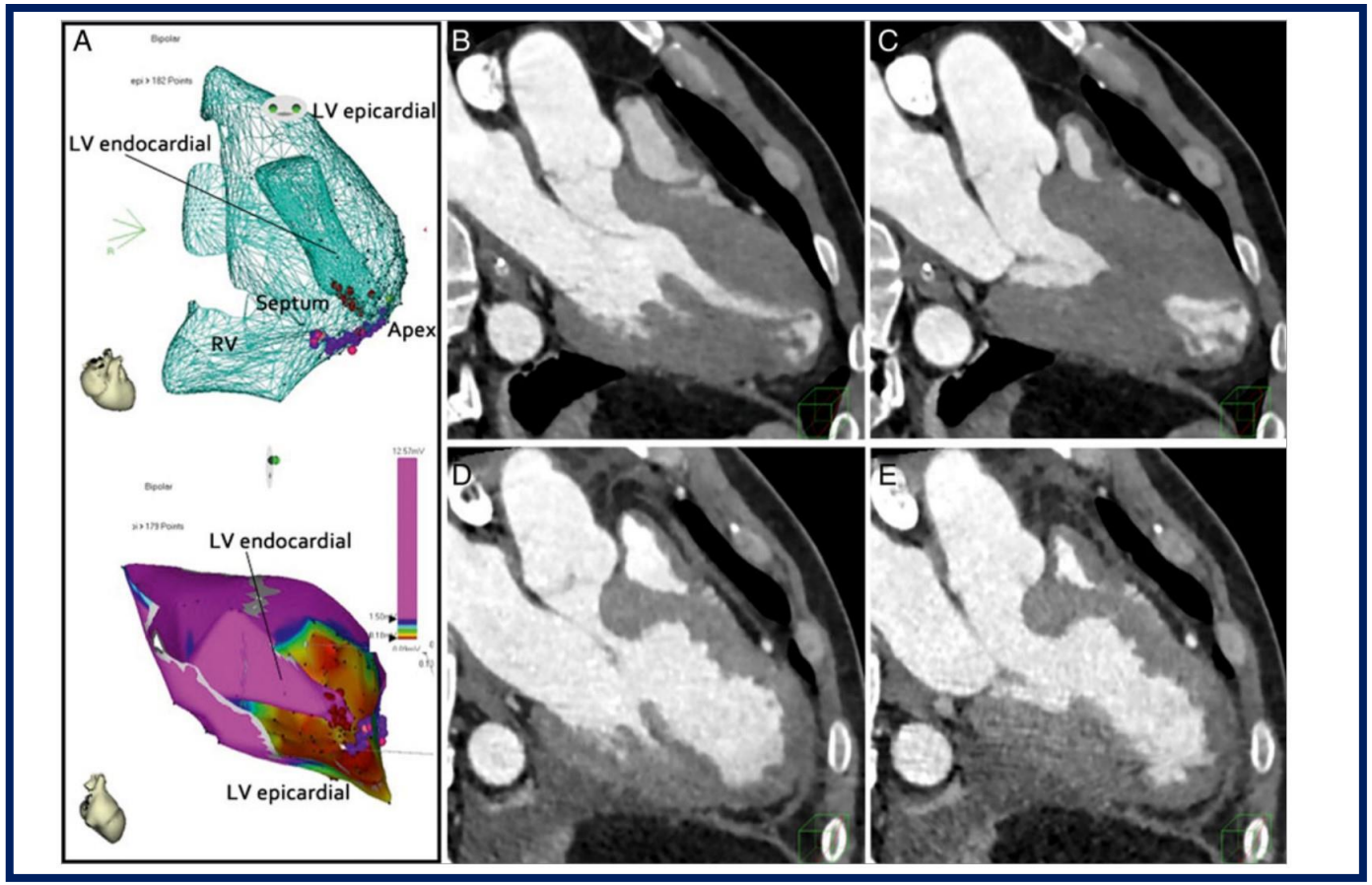
- VT recurrence was observed in 2 patients (13.3 %) during the 12-month follow-up period.
- Cardiac tamponade occurred in 1 patient durin g RFCA applications along the septal border of the LVA from the apex to the aneurysmal neck.
- One patient who refused ICD implantation and was discharged without ICD had sudden cardiac death 17 days after RFCA.



Igarashi M, et al. JACC Clin Electrophysiol. 2018 Mar;4(3):339-350

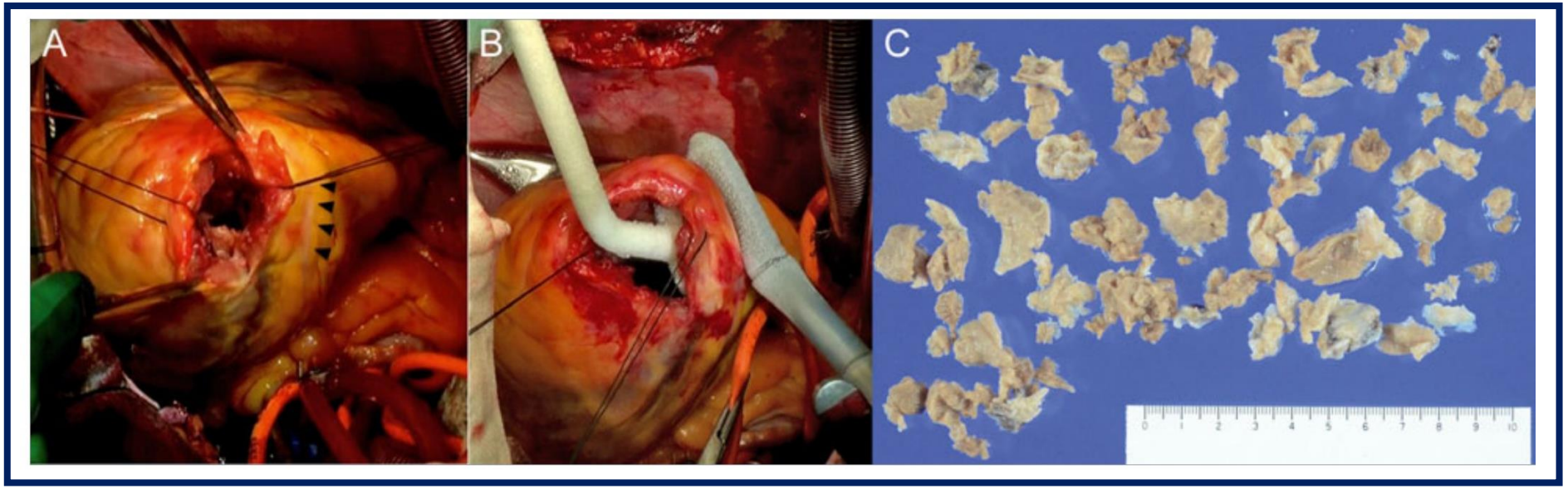
Case Report 5: Transapical myectomy and surgical cryo-ablation for refractory VT due to HCM with apical aneurysm

- When ablation is not possible or is ineffective, surgical approaches could be successful.
- A 44-year old man with HCM and VT despite undergoing catheter ablation.



Shimahara Y, et al. Eur J Cardiothorac Surg. 2015 Aug;48(2):334-5.

Case Report 5: Transapical myectomy and surgical cryo-ablation for refractory VT due to HCM with apical aneurysm



- Resection of a hypertrophied midventricular muscle through an apical incision and surgical cryo-ablation of the aneurysm border from the epicardial and endocardial surface were performed successfully.
- The patient was well without ventricular arrhythmic events at 2 years postoperatively.

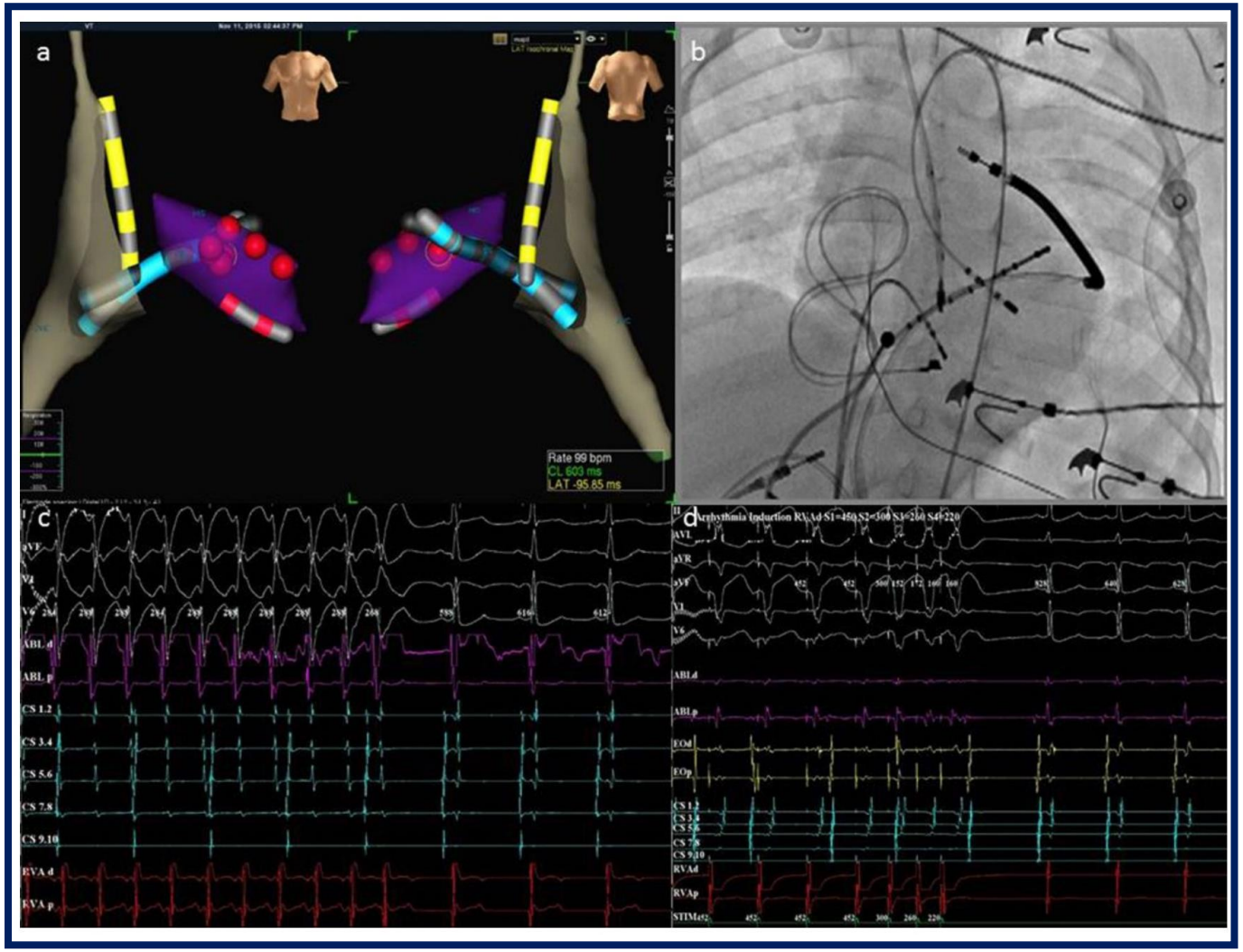
Shimahara Y, et al. Eur J Cardiothorac Surg. 2015 Aug;48(2):334-5.

Studies	Time	Sample size	Patiennts	LVEF	EPI ablation	Follow-up (M)	Success Rate (%)
Dukkipati SR, et al. Circ Arrhythm Electrophysiol. 2011 Apr;4(2):185-94.	2011	10	HCM-related monomorphic VT; Preserved LVEF	57 ± 13	8/9	37	78 (7/9)
Santangeli P, et al. Heart Rhythm. 2010 Aug;7(8):1 036-42.	2010	22	HCM-related monomorphic VT; Reduced LVEF	34 ± 10	13/22	20	73 (16/22)
Ueda A, et al. Europace. 2012 May;14(5):734-40.	2012	5	Dilated-phase HCM; Monomorphic VT	37 ± 8	3/5	18	80 (4/5)
Igarashi M, et al. JACC Clin Electrophysiol. 2018 Mar;4(3):339-350.	2018	15	HCM and apical aneurysm; Monomorphic VT	65 ± 11	1/15	12	83 (10/12)

- Ablation can be challenging due to the thickness of the myocardium, and epicardial access has been required in the majority of patients.
- VTs associated with apical aneurysms are often ablated endocardially.
- The results of ablation are encouraging, acutely eliminating VT in 80% of patients, with more than two-thirds of patients free of VT in the long-term follow-up.

Other VA Mechanisms

- Although the arrhythmia mechanisms for monomorphic VTs in HCM appear to be mostly scar-related reentry, reports have also mentioned ablation of BBR, focal RVOT, papillary muscle VTs, and left posterior fascicular VT.



Ergul Y, et al. Pacing Clin Electrophysiol. 2018 Apr;41(4):425-428.

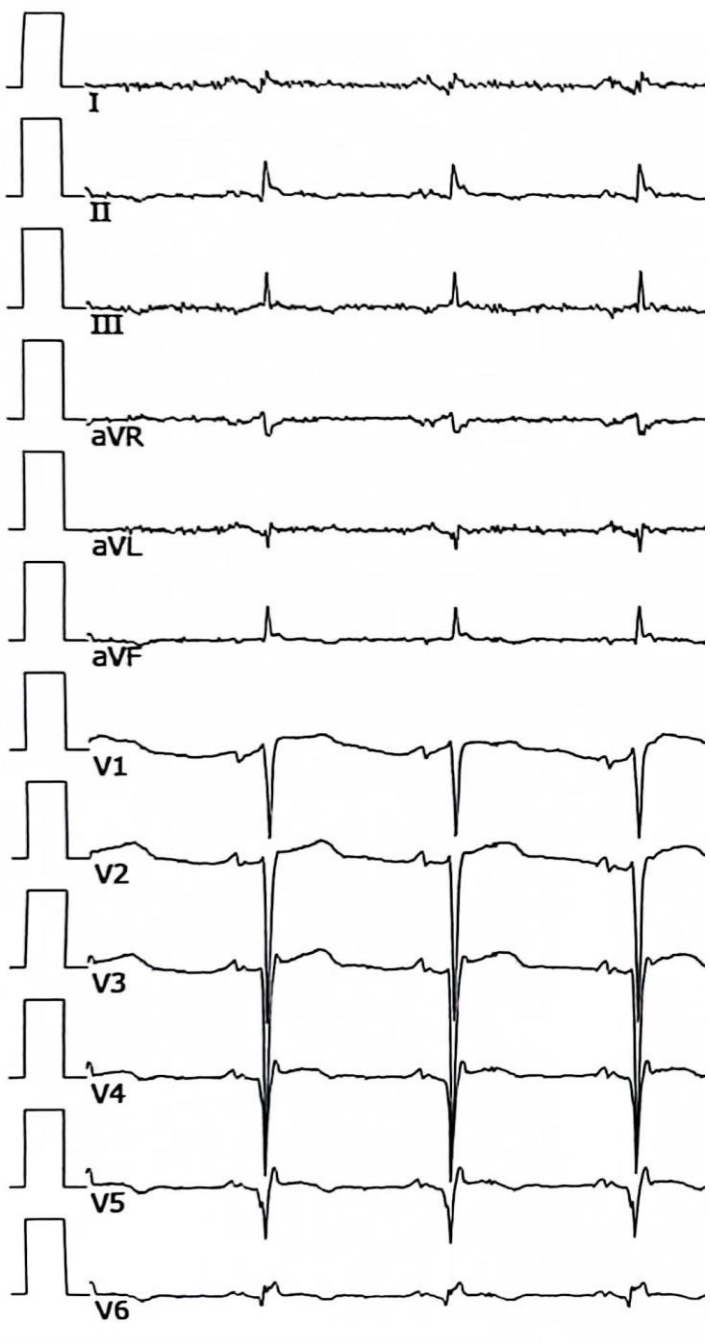
Case Example-1: HCM VT case

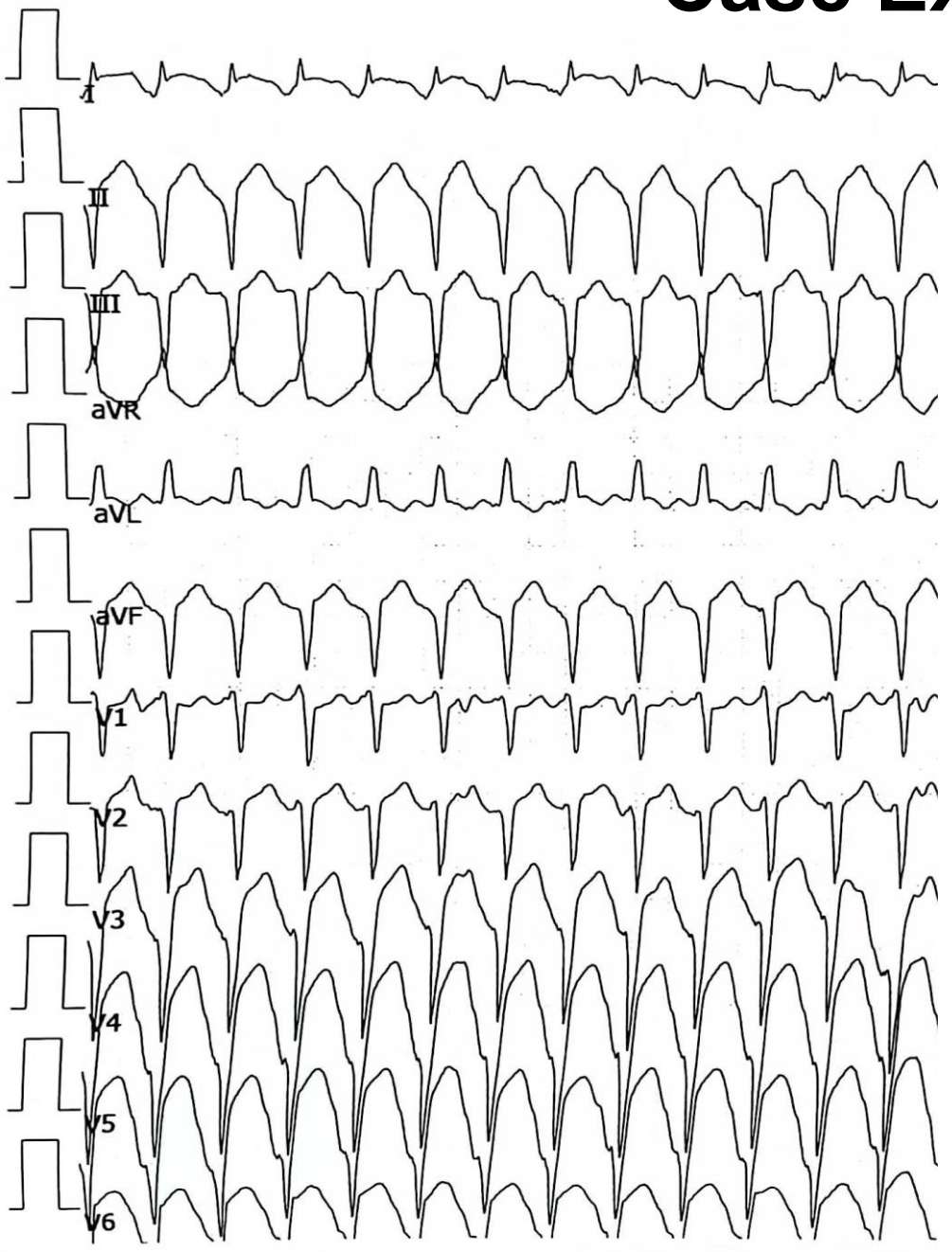
- Male, 58-year-old
- Prior ICD Implantation becasue of Sustained VT
- NYHA: II-III
- Echo: EF= 60%(Simpson)
- Referred for RFCA of monomorphic VT with ICD storm

Hypertrophic Cardiomyopathy

Case Example-1

ECG



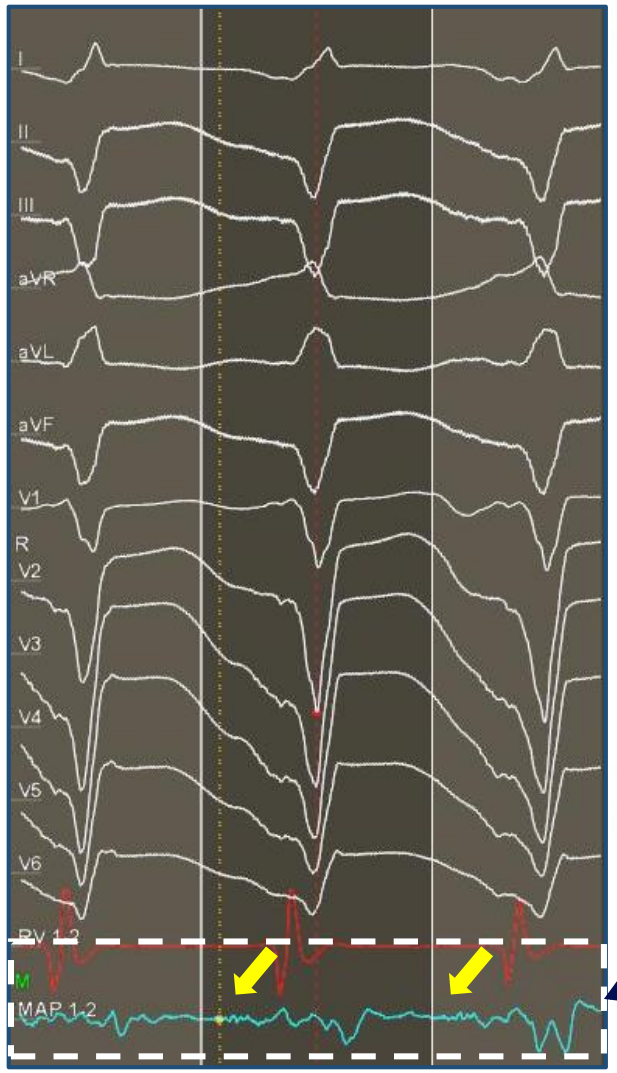


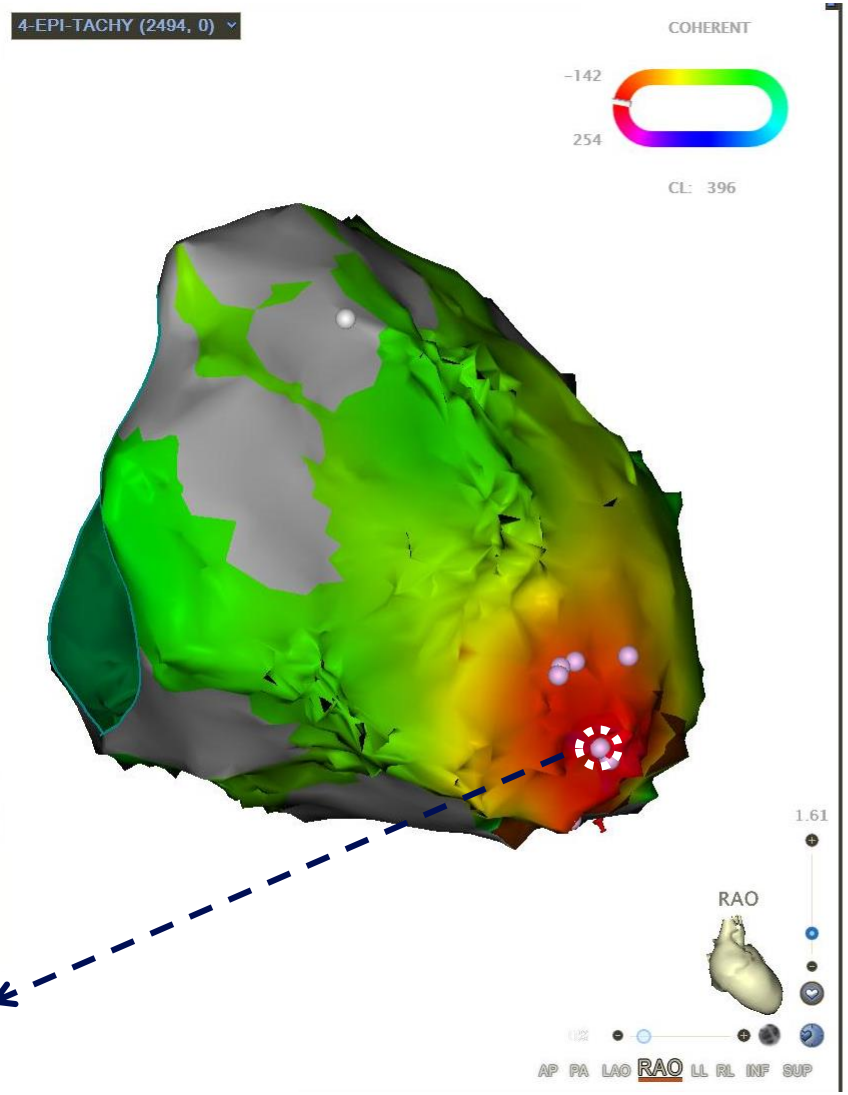
Case Example-1

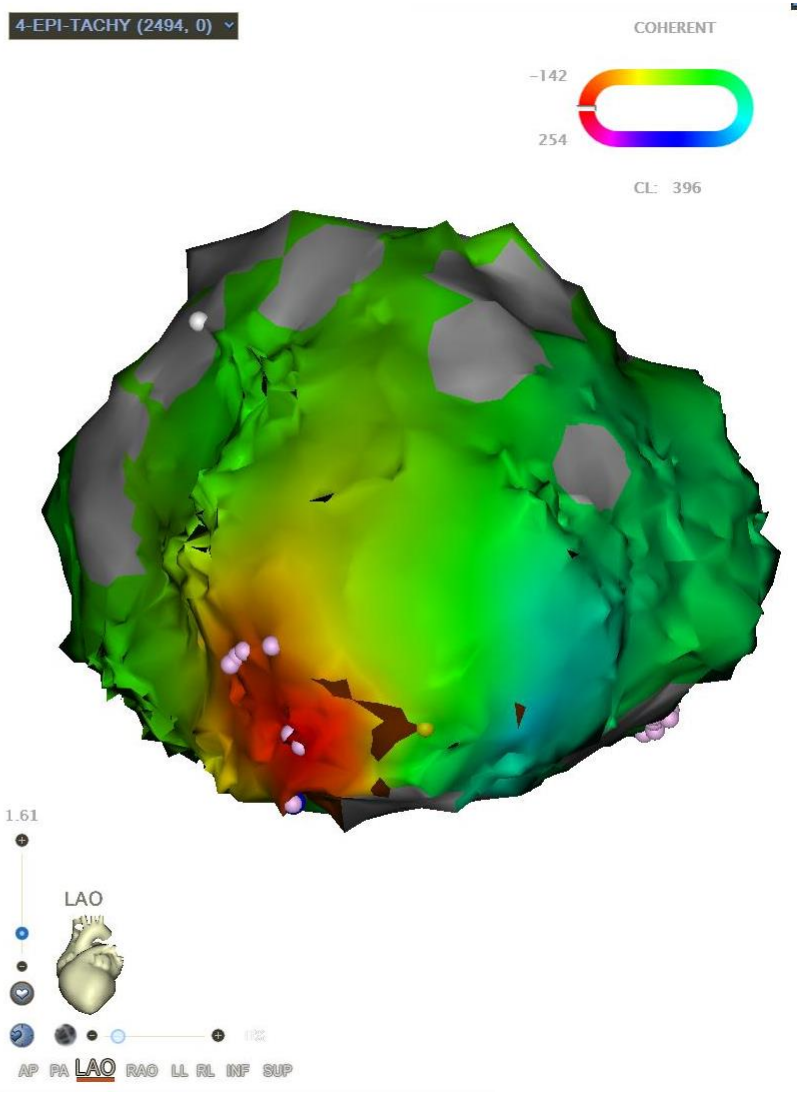
VT1 TCL=396ms

Case Example-1

VT1 TCL=396ms





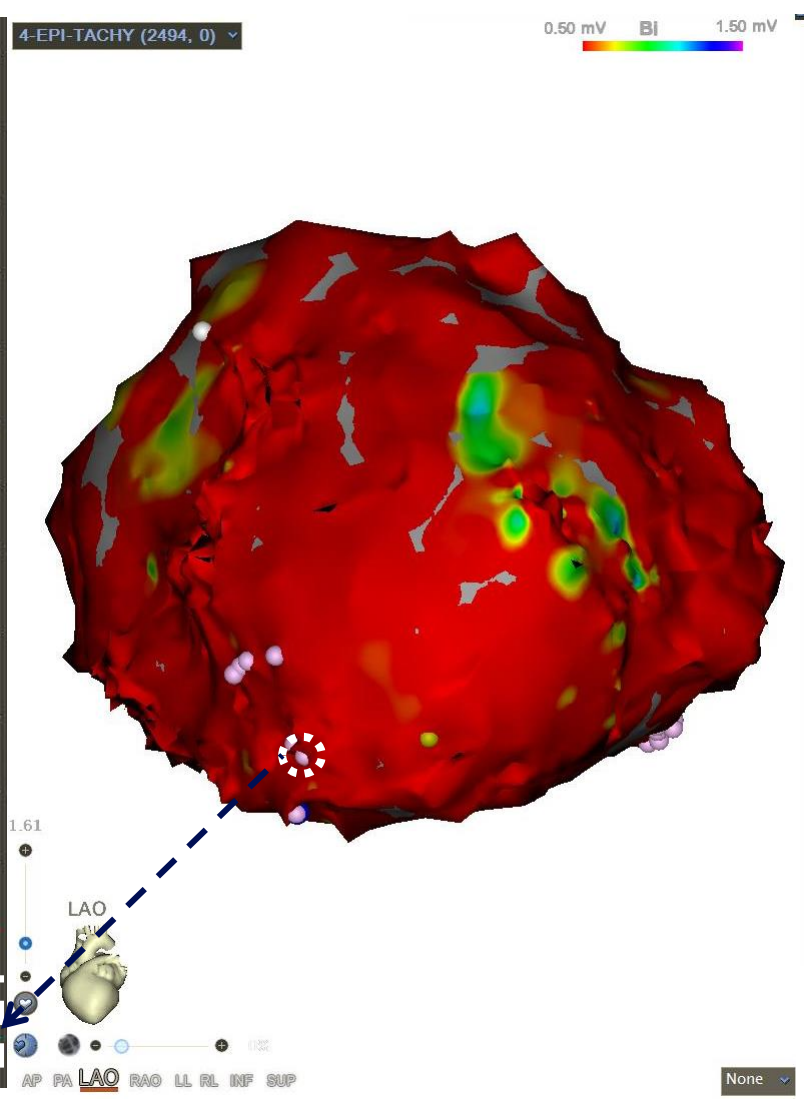


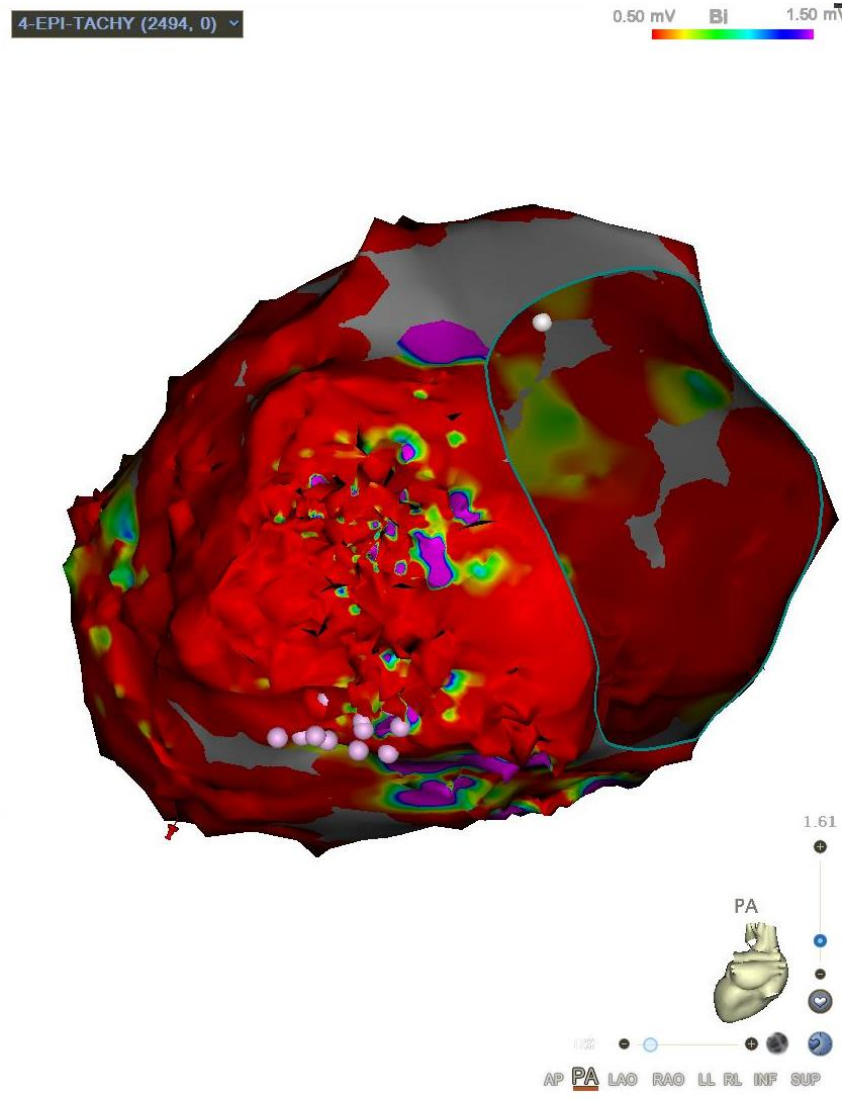
2023

VT1 Terminated by PVC

Case Example-1

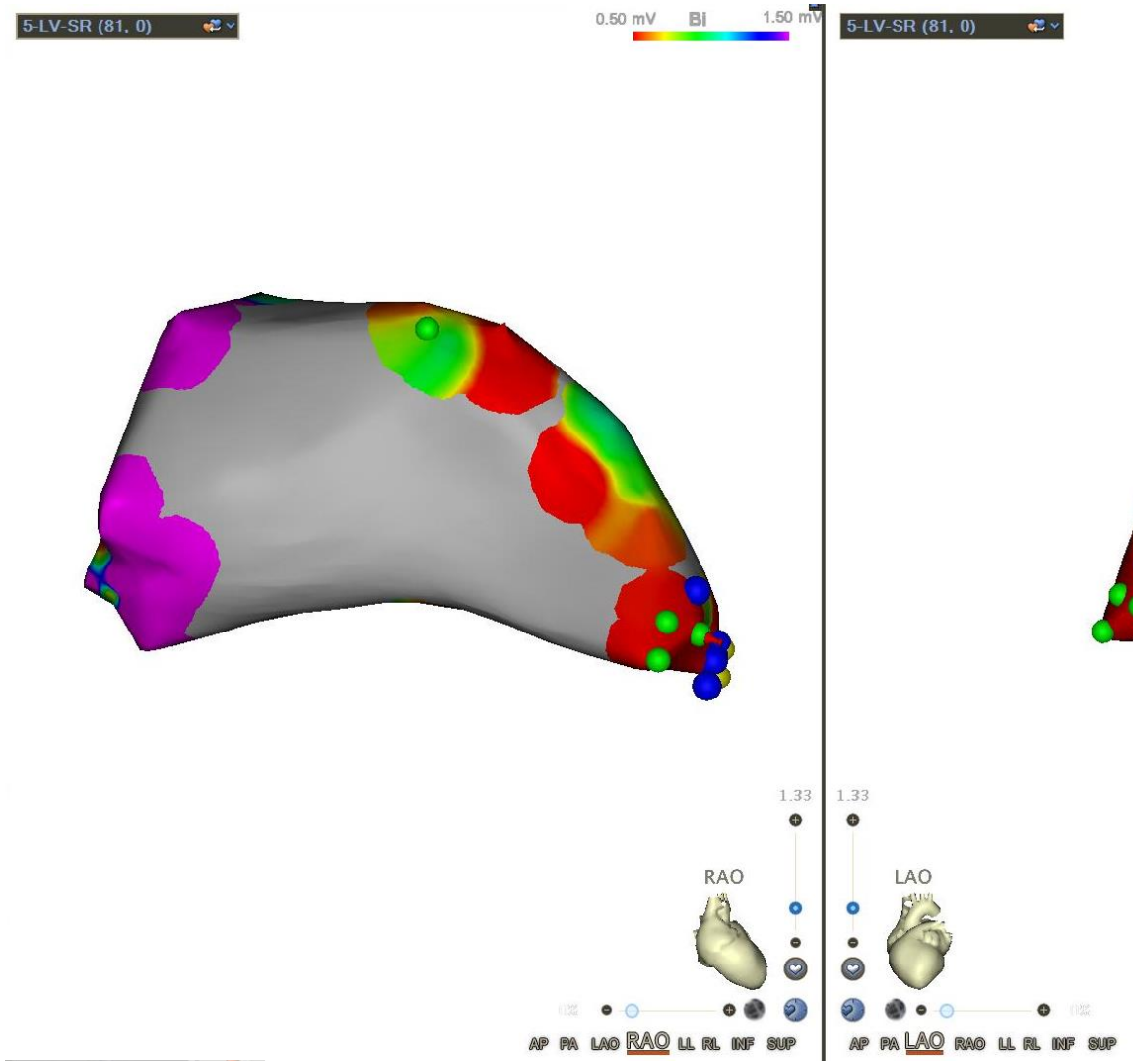
Voltage Map for EPI

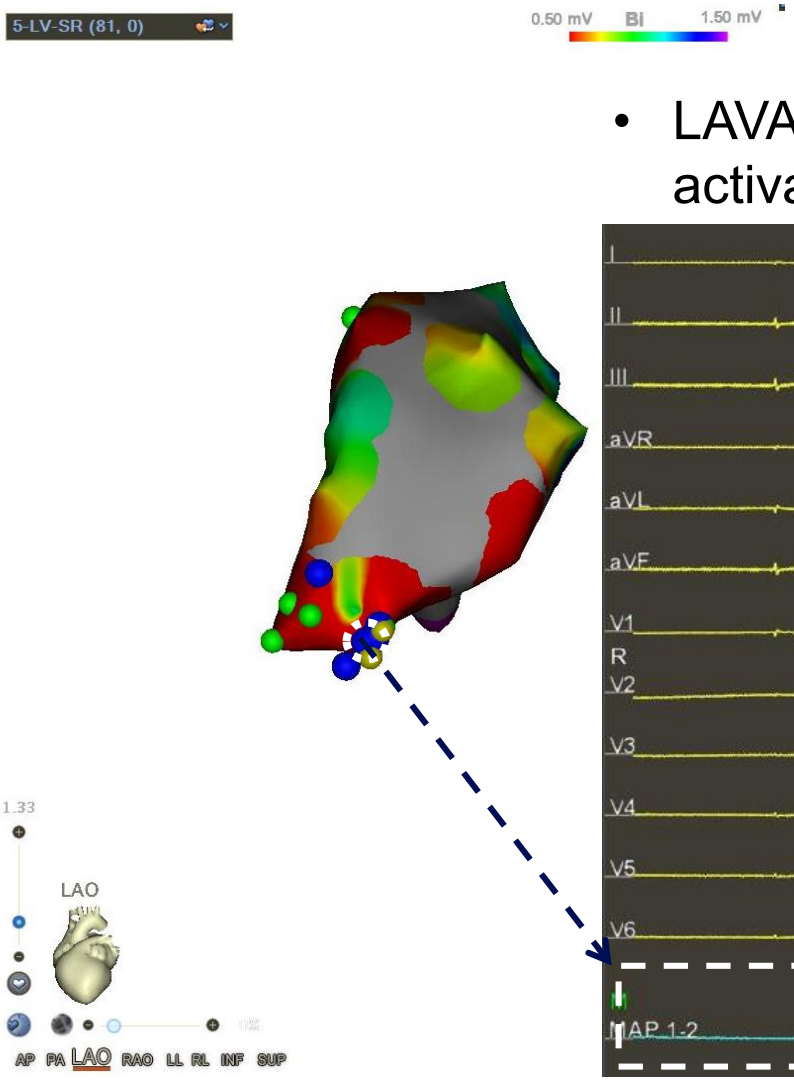




Case Example-1

Voltage Map for LV ENDO

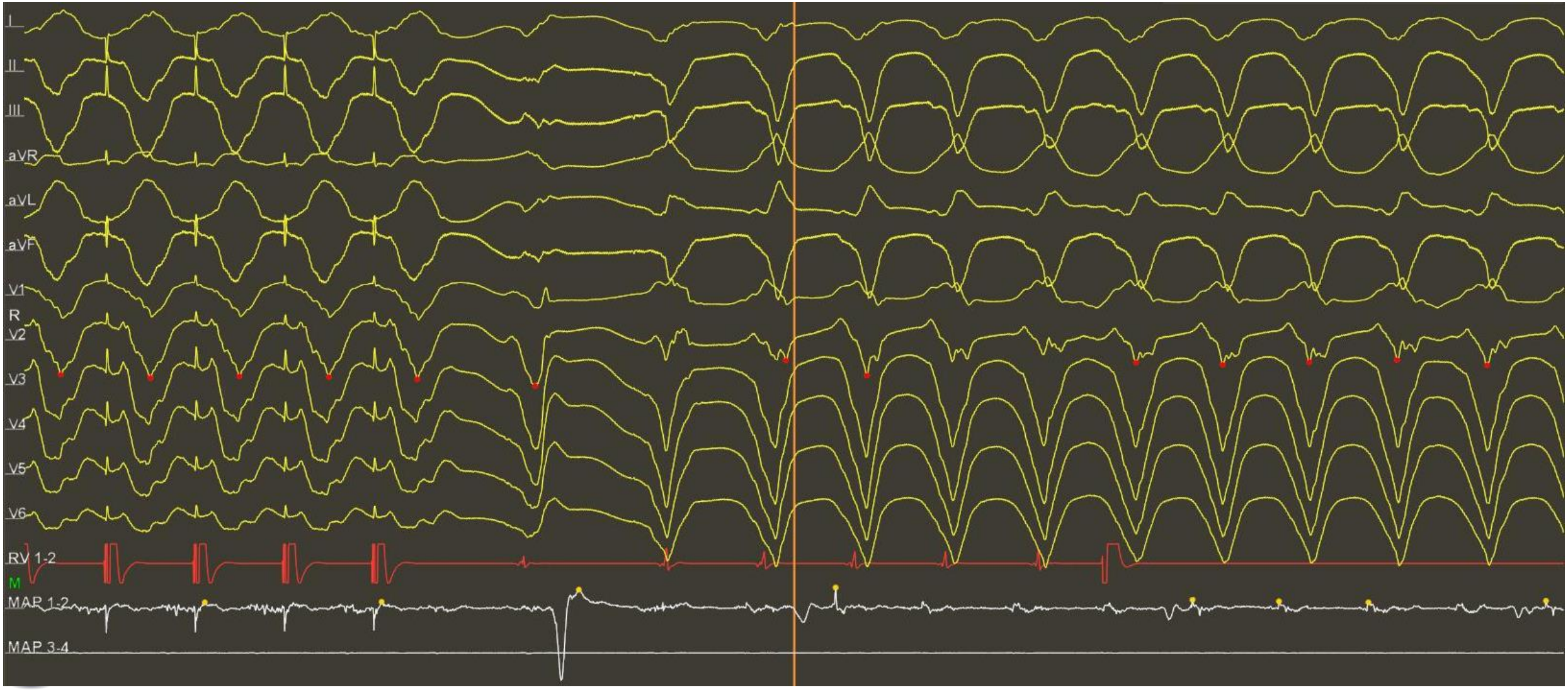




- LAVA in sinus rhythm also demomstrates activation reversal during PVC.

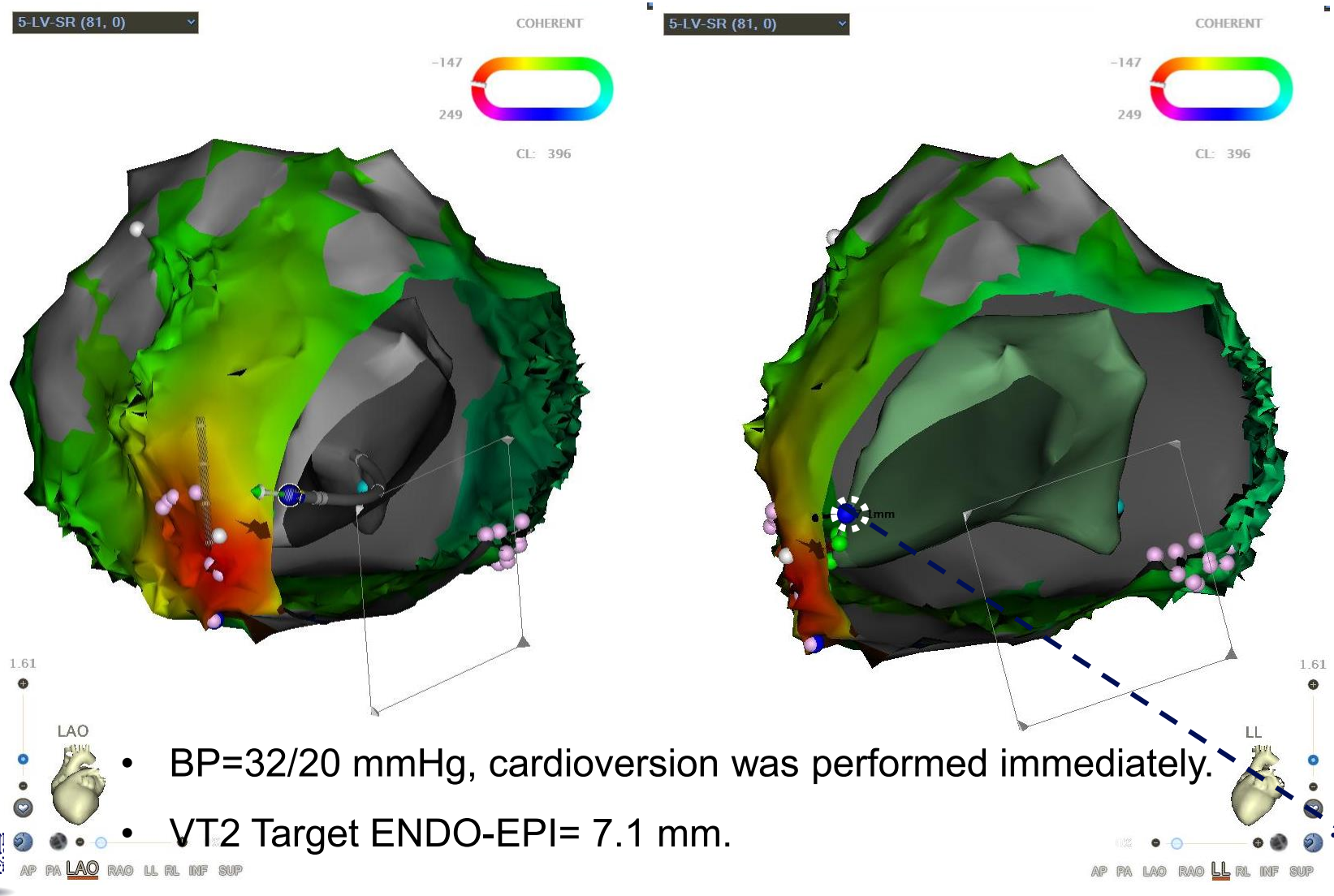
Case Example-1

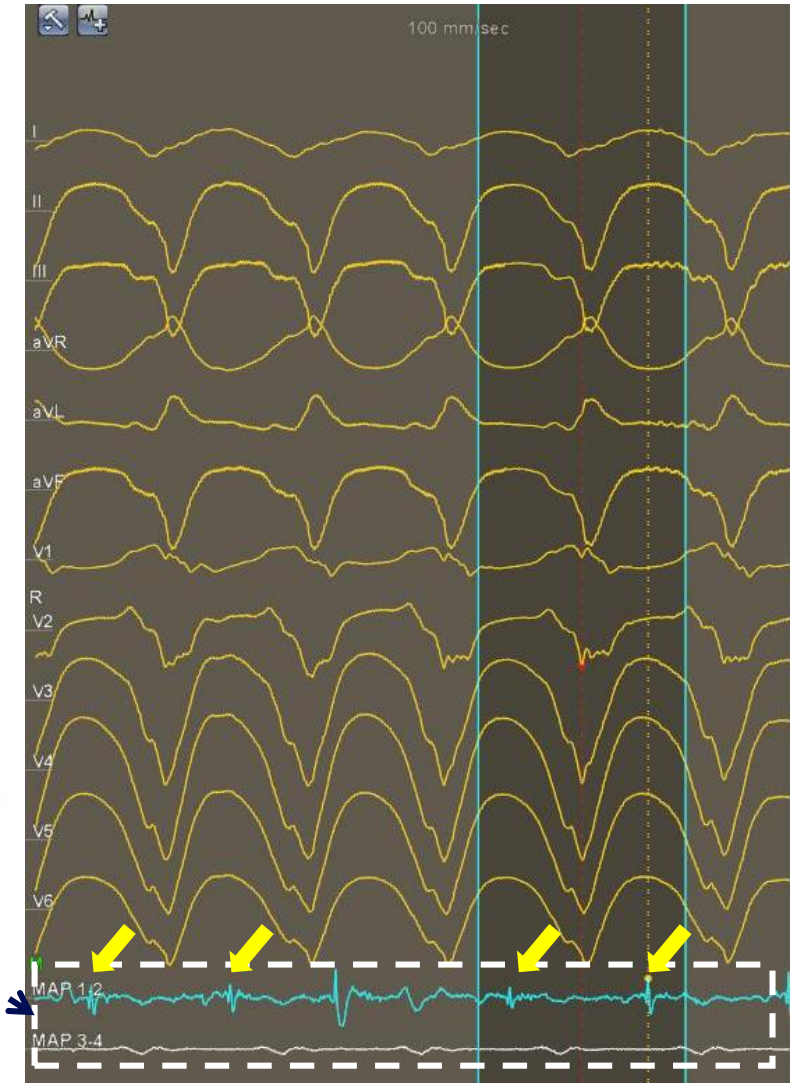
Hemodynamically poorly tolerated VT2 TCL=258ms



Case Example-1

Diastolic Potential during VT2

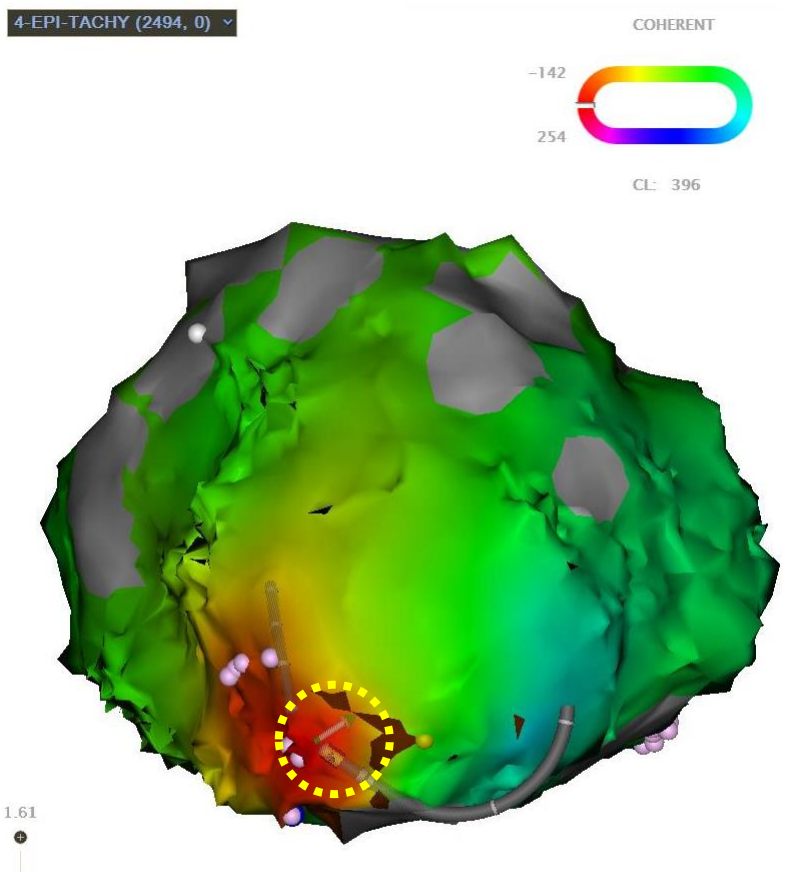


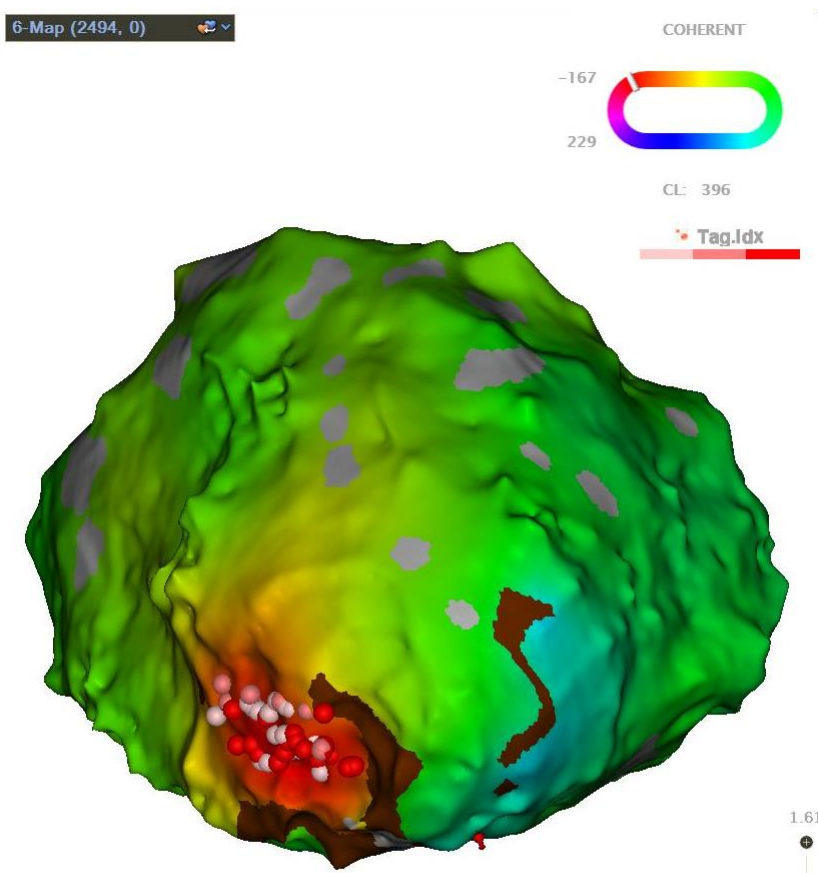


- BP=32/20 mmHg, cardioversion was performed immediately.
- VT2 Target ENDO-EPI= 7.1 mm.

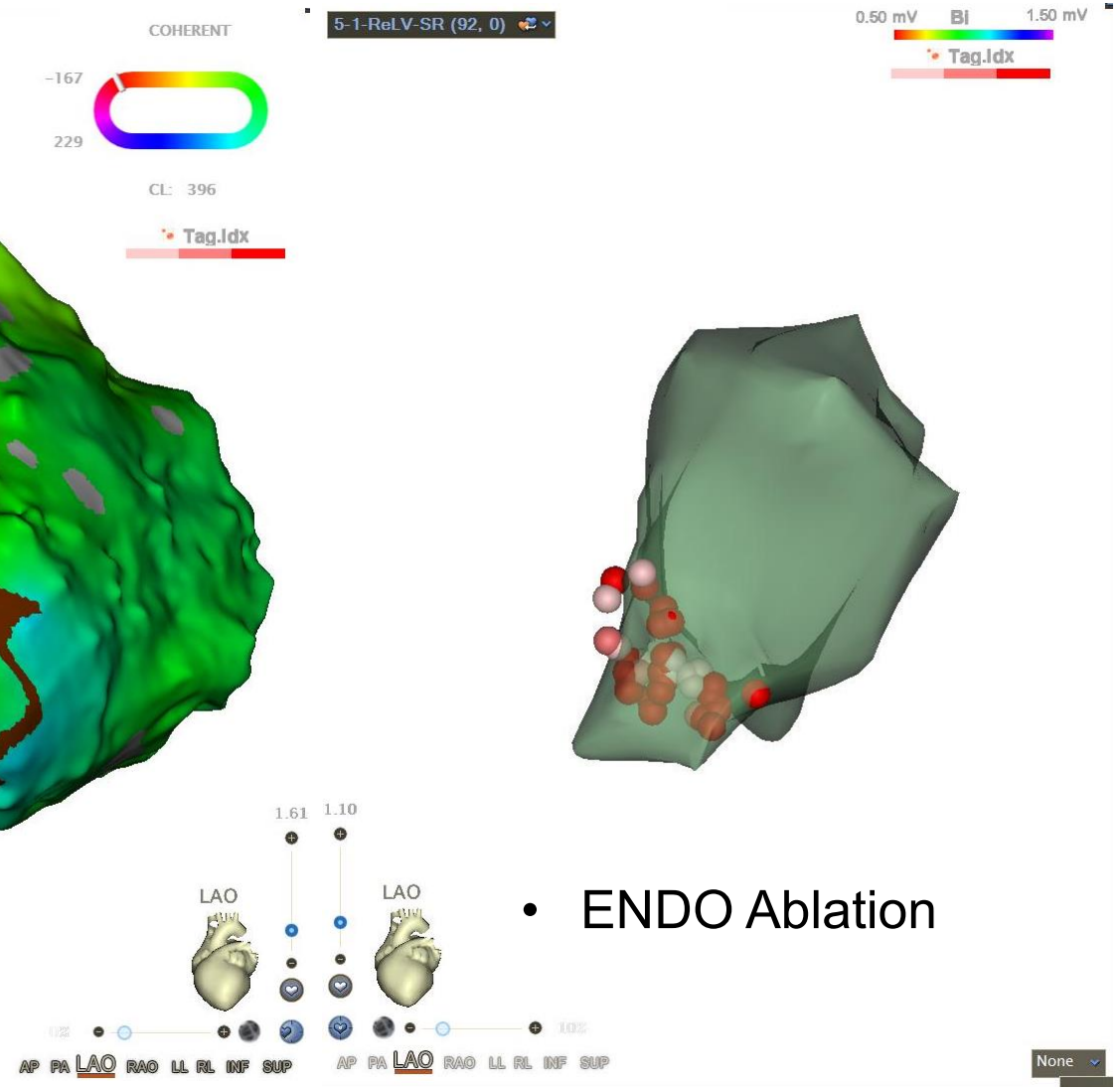
Case Example-1

Ablation Procedure





- EPI Ablation



- ENDO Ablation

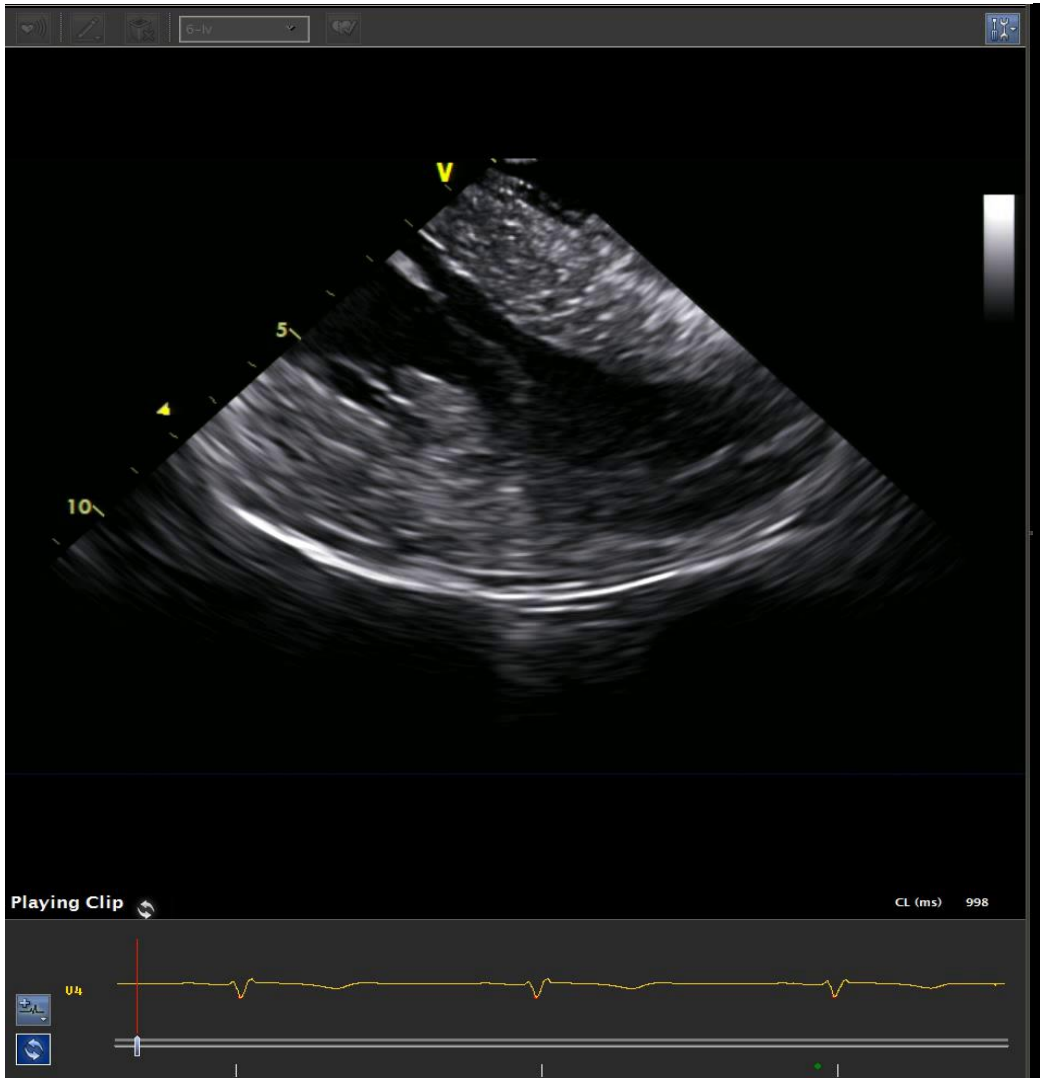
Case Example-2: HCM with apical aneurysm

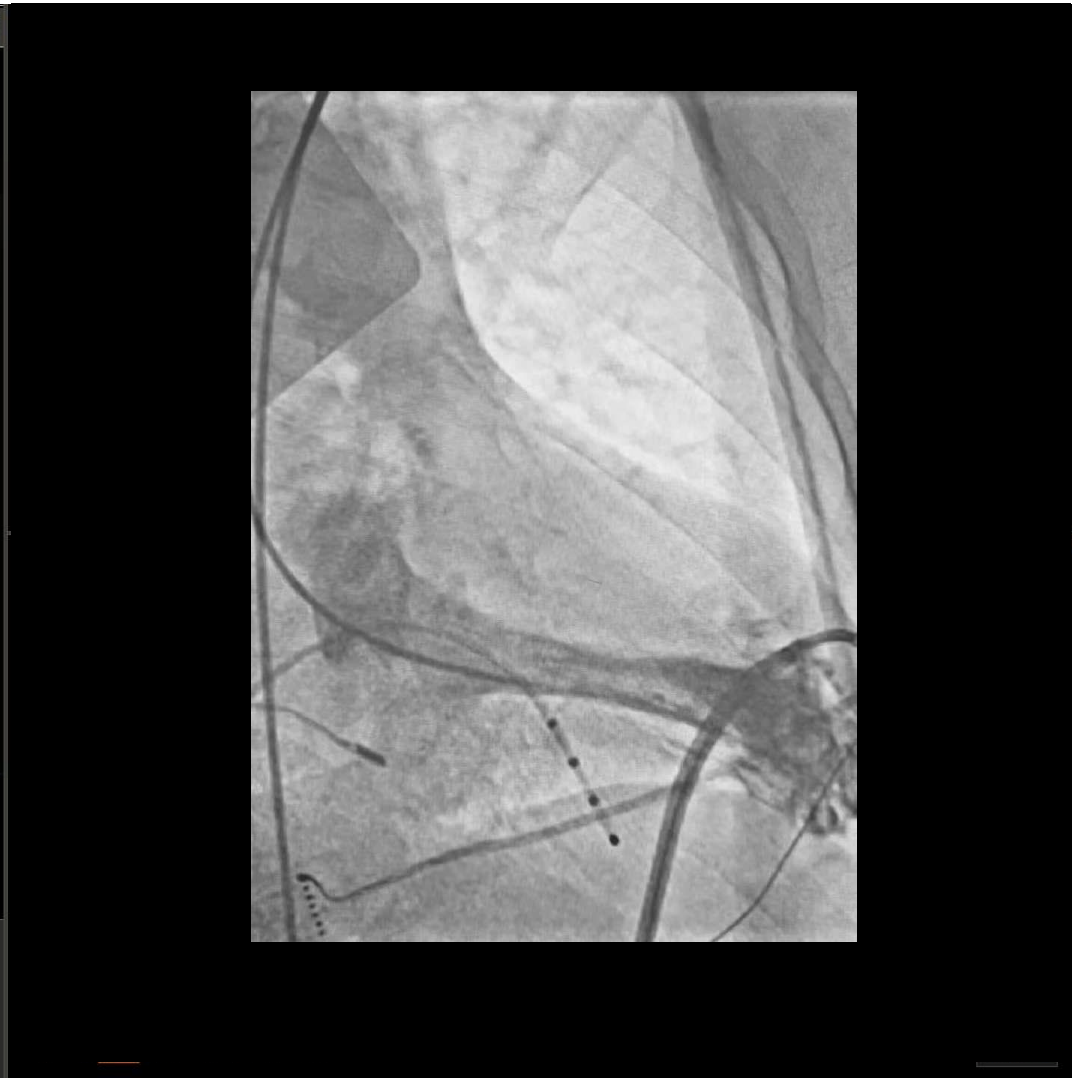
- Male, 51-year-old
- Monomorphic VT with AAD refractory
- NYHA: II
- Echo: EF= 65.4% (Simpson)
- Apical aneurysm in transthoracic contrast echocardiography.

Hypertrophic Cardiomyopathy with Apical Aneurysm

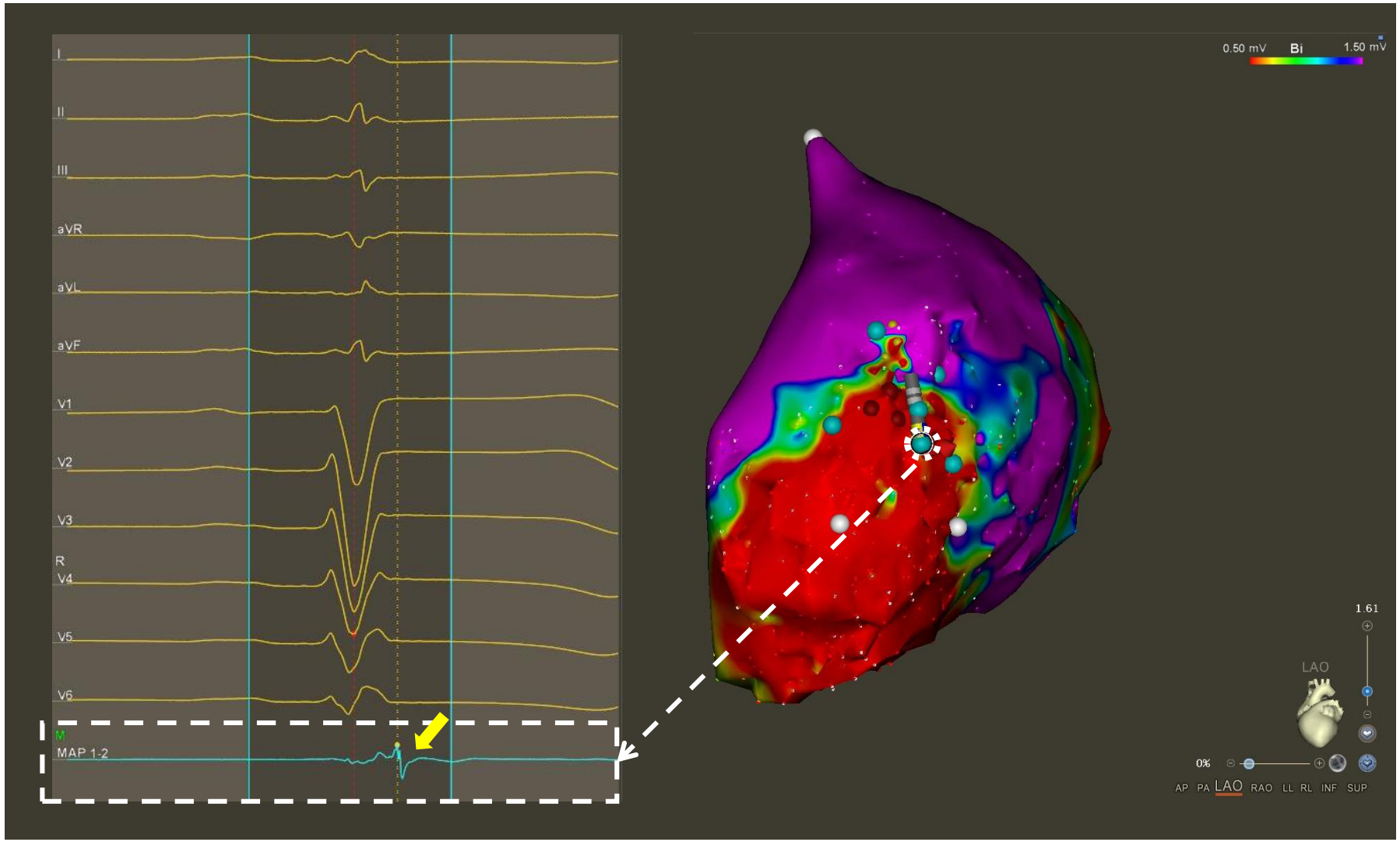
Case Example-2

ICE image and left ventriculography of aneurysm





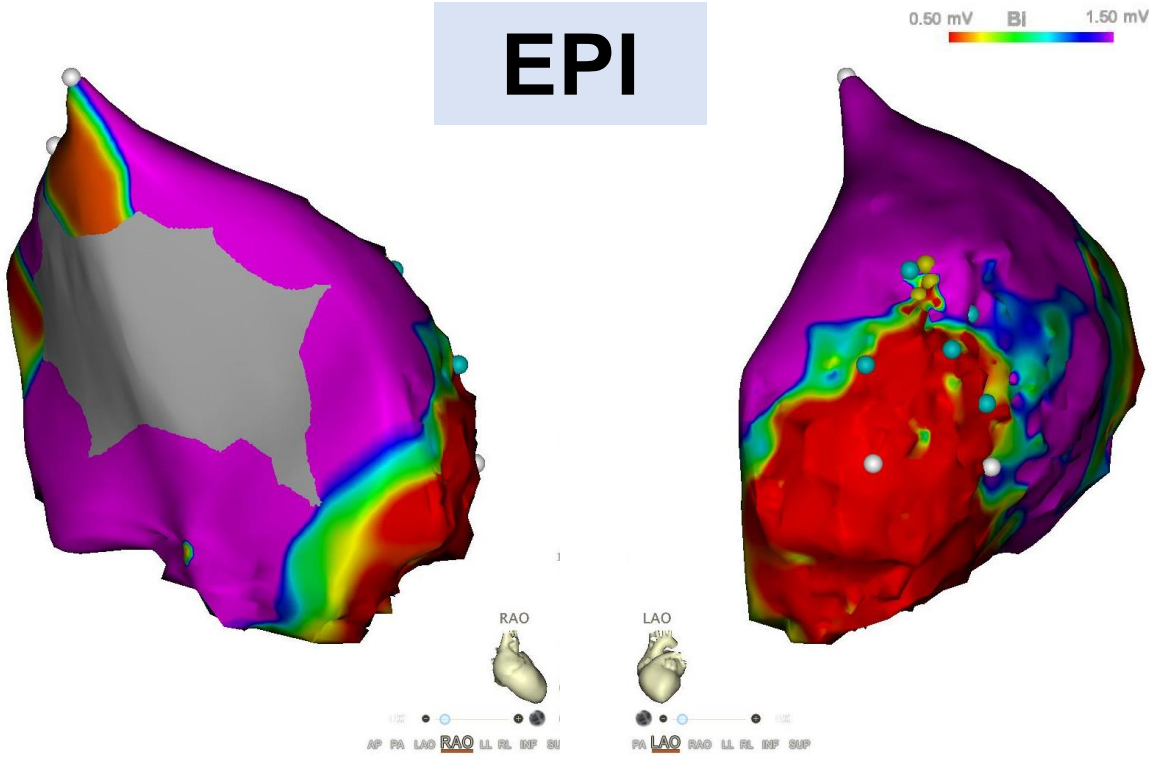
Voltage Map for EPI



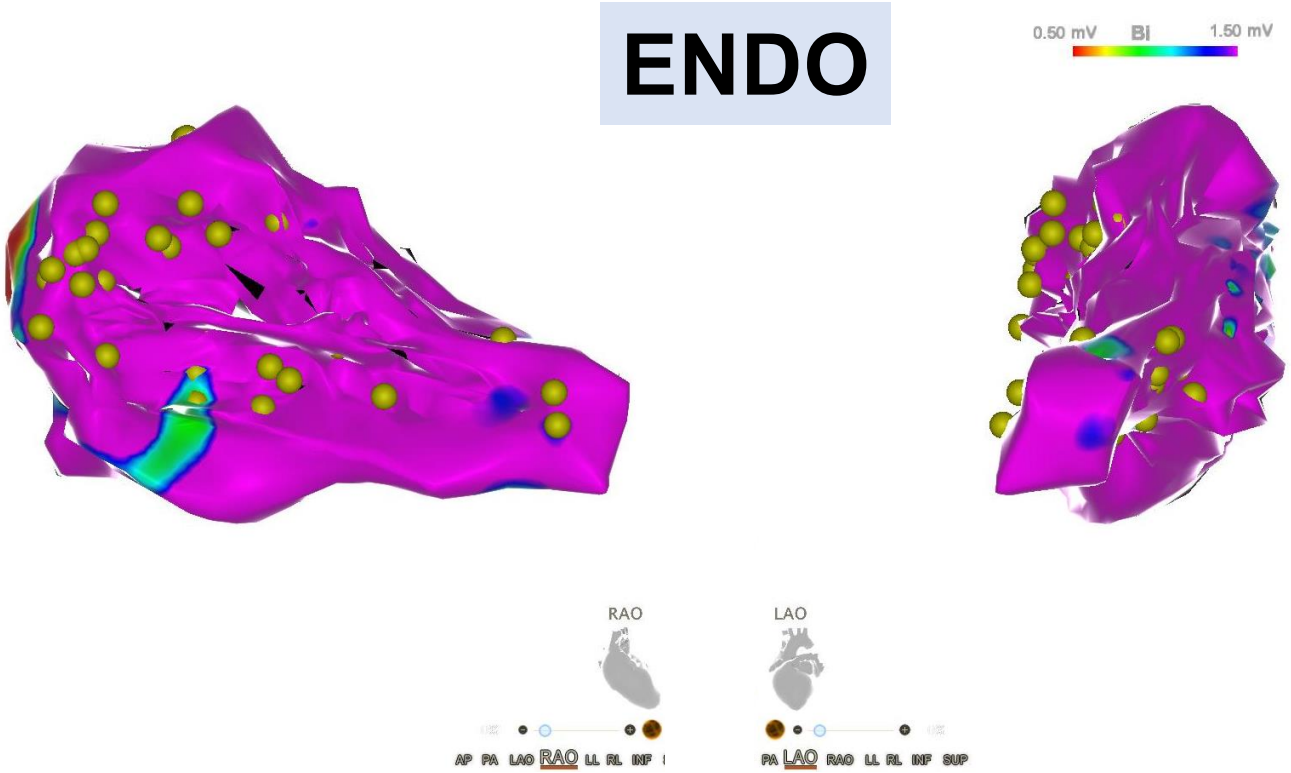
Case Example-2

Voltage Map for EPI and ENDO

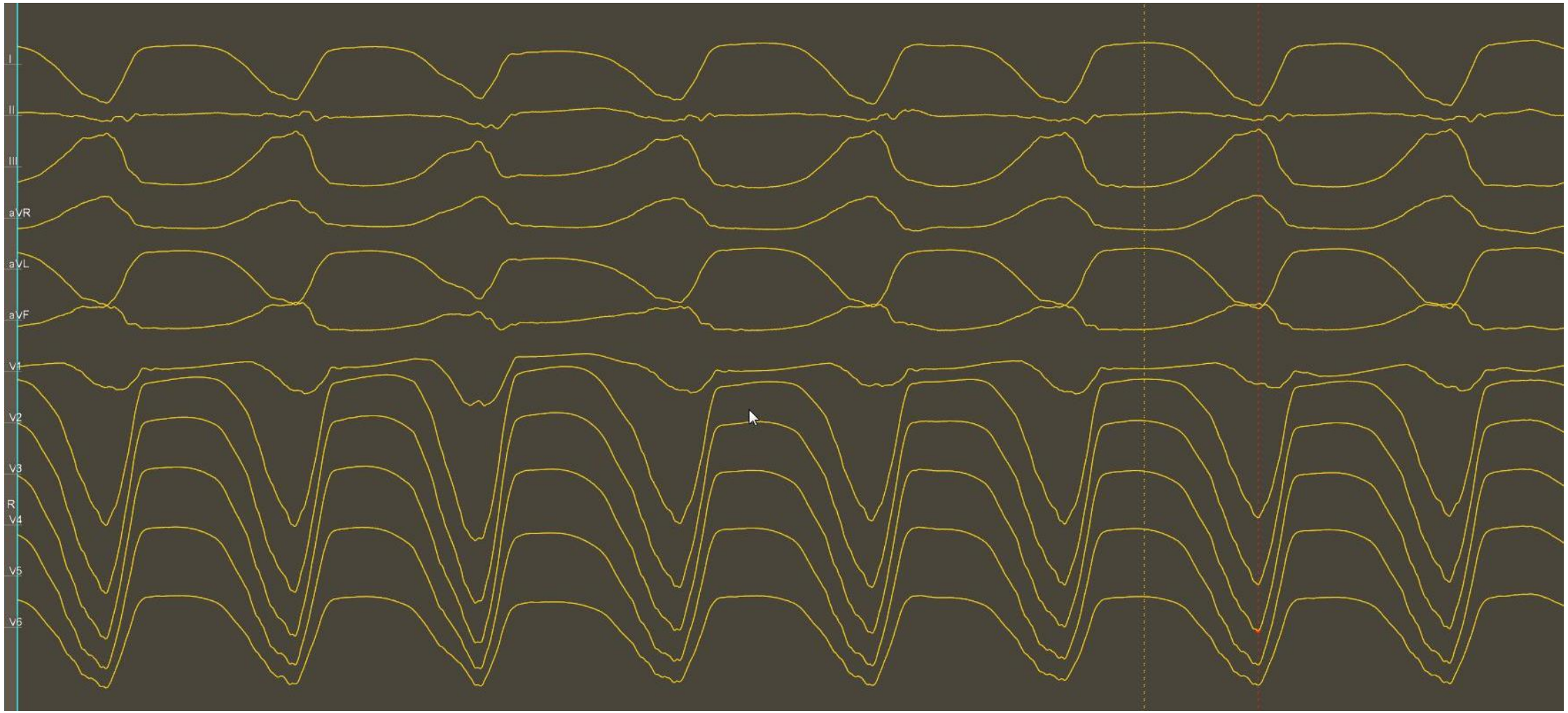
EPI



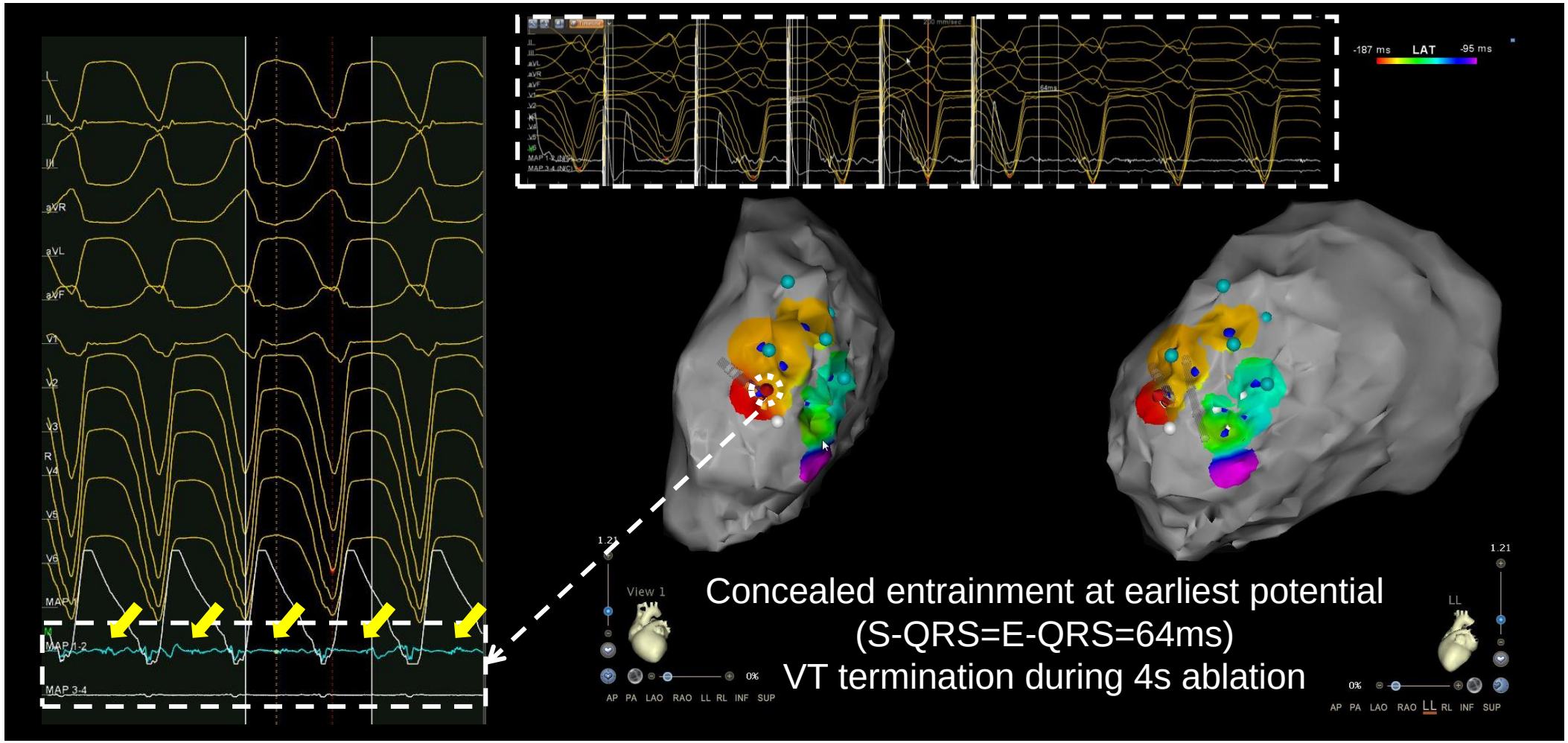
ENDO



Clinical VT induced TCL=295ms



Diastolic Potential during VT (EPI)



Home Messages

- Polymorphic VT and VF are the most common VAs in HCM; monomorphic VT is less common.

- The arrhythmogenic substrate in HCM often involves the septum but can extend to the epicardium, often necessitating combined endocardial and epicardial ablation procedures to eliminate the VT.

- VT associated with apical aneurysms is often ablated endocardially.

Thank you!

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