Radiofrequency Catheter Ablation of Ventricular Tachycardia in the Patients with Hypertrophic Cardiomyopathy

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COI Disclosure

Name of first author: ***Miyako IGARASHI***

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

Introduction

- In patients with HCM, ventricular arrhythmias are high morbidity and responsible for mortality.

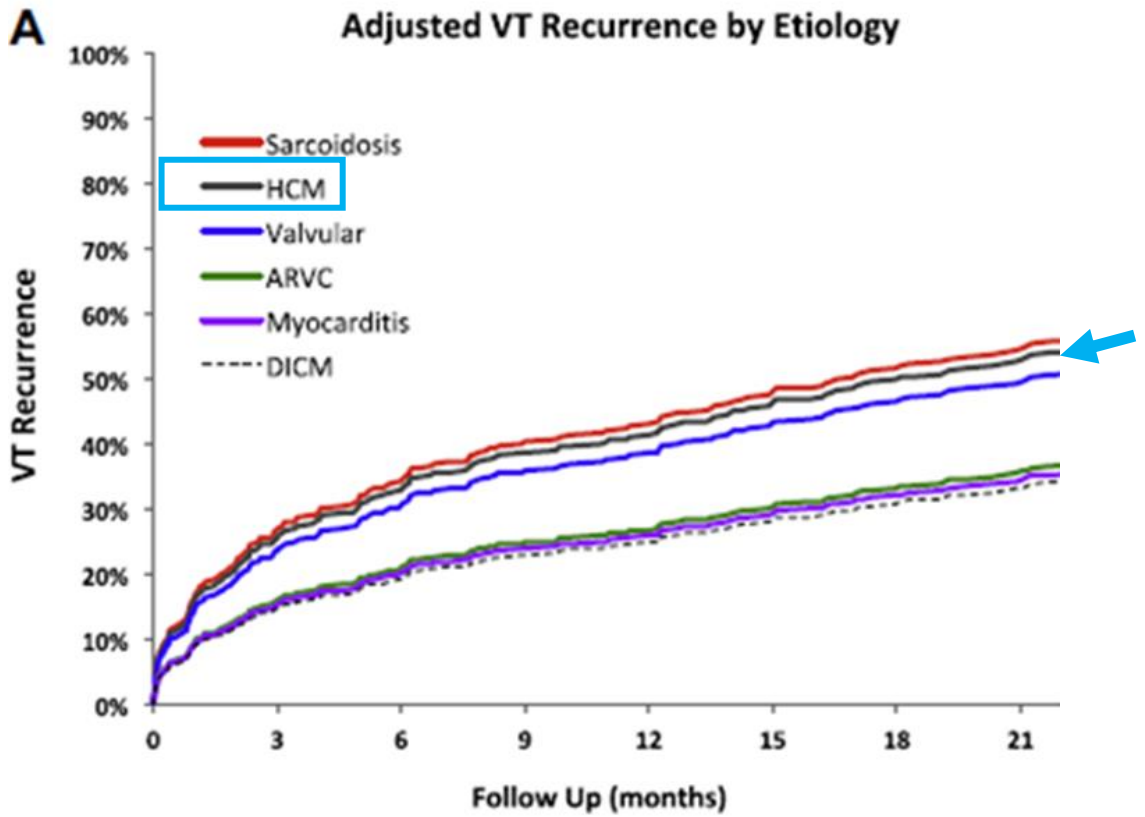
  O'Mahony C et al. Circ Arrhythm Electrophysiol. 2013; 6(2): 443-451

- The potential mechanisms for ventricular arrhythmias in HCM patients include scar-related reentry, abnormal calcium handling, and abnormal interventricular conduction associated with myocyte disarray and varying myocardial size.

  Dukkipati SR et al. Circ Arrhythm Electrophysiol. 2011; 4(2): 185-194
  Baudenbacher F et al.J Clin Invest. 2008; 118(12): 3893-3903
  Saumarez RC et al. Circulation 1995; 91(11): 2762-2768

Outcomes of catheter ablation of VT based on etiology in non-ischemic heart disease

- Of 780 NICM patients, the underlying prevalence of HCM was 4%.



Vaseghi M et al. J Am Coll Cardiol EP 2018; 4: 1141-50

Management of Patients With HCM and Ventricular Arrhythmias

from 2020 AHA/ACC Guideline for Diagnosis and Treatment of Patients With HCM

COR	LOE	Recommendations
1	B-NR	In patients with HCM and recurrent poorly tolerated life-threatening ventricular tachyarrhythmias refractory to **maximal antiarrhythmic drug therapy and ablation, heart transplantation assessment** is indicated in accordance with current listing criteria.
1	Amiodarone : B-NR	In adults with HCM and symptomatic ventricular arrhythmias or recurrent ICD shocks despite beta-blocker use**, antiarrhythmic drug therapy** listed is recommended, with the choice of agent guided by age, underlying comorbidities, severity of disease, patient preferences, and balance between efficacy and safety.
	Dofetilide, Mexiletine, Sotalol: C-LD	
1	C-LD	In patients with HCM and pacing-capable ICDs, programming antitachycardia pacing is recommended to minimize risk of shocks.
2a	C-LD	In patients with HCM and **recurrent symptomatic sustained monomorphic ventricular tachycardia, or recurrent ICD shocks** despite optimal device programming, and in whom antiarrhythmic drug therapy is either ineffective, not tolerated, or not preferred, **catheter ablation** can be useful for reducing arrhythmia burden.

Modified citation from Circulation 2020;142: e553-557

Background

- Common forms of ventricular arrhythmias associated with HCM have been considered to be VF and polymorphic VT.

Baudenbacher F et al.J Clin Invest. 2008; 118(12): 3893-3903
Saumarez RC et al. Circulation 1995; 91(11): 2762-2768

- Sustained monomorphic VT in patients with HCM is mainly scar-reentry.

Dukkipati SR et al. Circ Arrhythm Electrophysiol. 2011; 4(2): 185-194

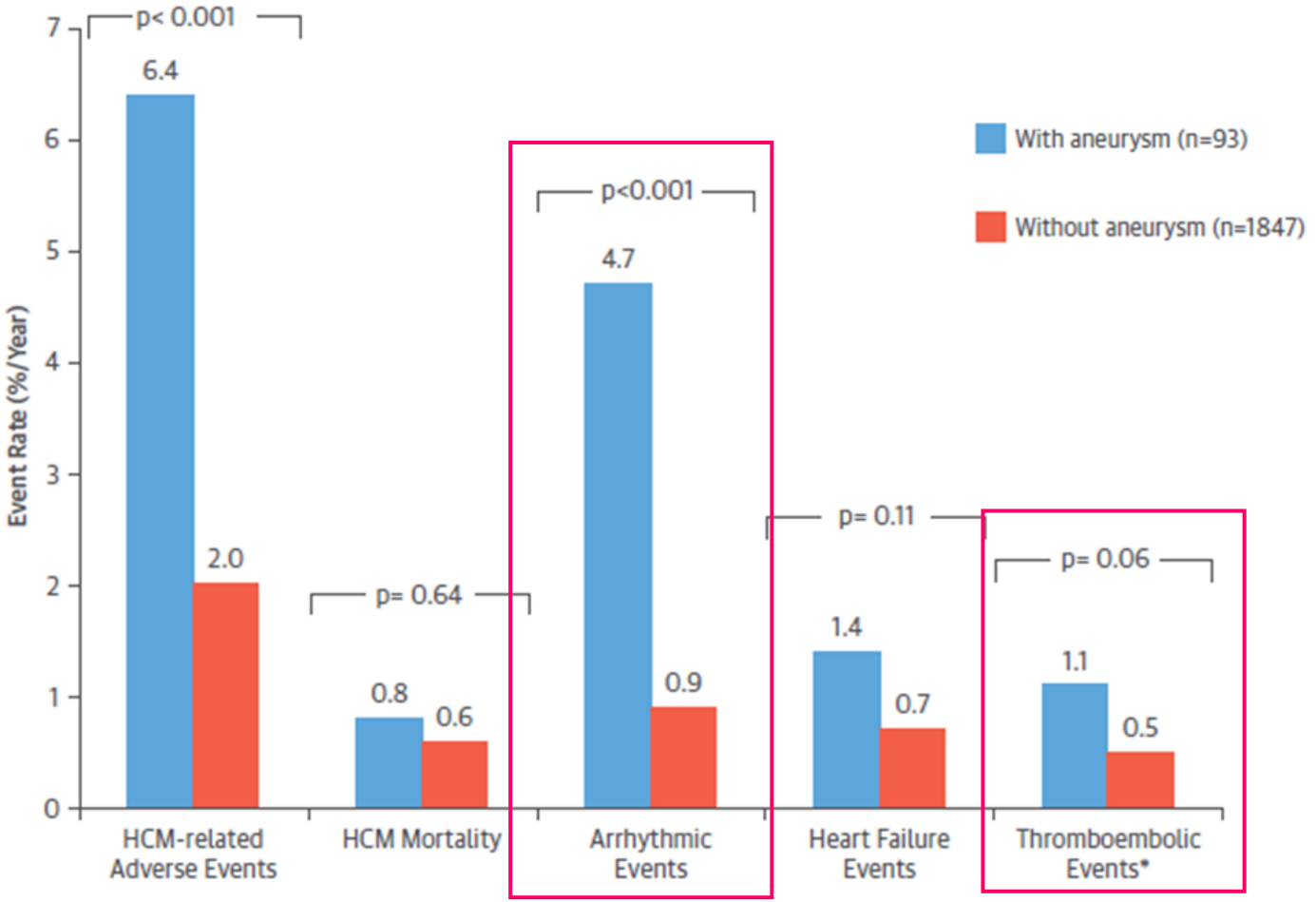
- In the HCM patients with apical aneurysms (AA) or dilated-phase HCM (DHCM) patients, scar-related monomorphic VT is common.

Ueda A et al. Europace 2012; 14: 734-740
Rowin EJ et al. J Am Coll Cardiol 2017; 69): 761-773

(1) VT in HCM patients with apical aneurysm

HCM patients with AA are at high risk for arrhythmic sudden death and thromboembolic events

- Apical aneurysms (AA) are present in 4.8% of patients with HCM.



* Does not include 13 patients with AA who had intracavitary thrombus but did not experience embolic events.

Rowin EJ et al. J Am Coll Cardiol 2017; 69): 761-773

Radiofrequency Catheter Ablation of Ventricular Tachycardia in Patients With Hypertrophic Cardiomyopathy and Apical Aneurysm

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ABSTRACT

OBJECTIVES This study evaluated the characteristics and results of radiofrequency catheter ablation (RFCA) of ventricular tachycardia (VT) in patients with hypertrophic cardiomyopathy (HCM) and left ventricular apical aneurysm (AA).

BACKGROUND Monomorphic VT in patients with HCM and left ventricular AA has been reported. However, outcome data of RFCA are insufficient.

METHODS Fifteen patients with HCM and AA who underwent RFCA for VT at 5 different institutions were included in this study. The data were evaluated retrospectively.

RESULTS Endocardial voltage mapping showed a low-voltage area (LVA), and late potential in the AA was recorded in 12 patients (80%). Although epicardial or intramural origin of VT was suspected in 7 patients, endocardial RFCA successfully suppressed the VT at the LVA border (n = 10) or within the LVA (n = 2). 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 the remaining patient, endocardial RFCA of AA was not effective, and epicardial RFCA site was needed. In all patients, clinical VT became noninducible after RFCA. VT recurrence was observed in 2 patients (13.3%) during the 12-month follow-up period. One patient underwent a second endocardial RFCA, and no VT recurrence was noted. In the other patient, VT recurred 3 months after RFCA and was successfully terminated by antitachycardia pacing of the implantable cardioverter-defibrillator.

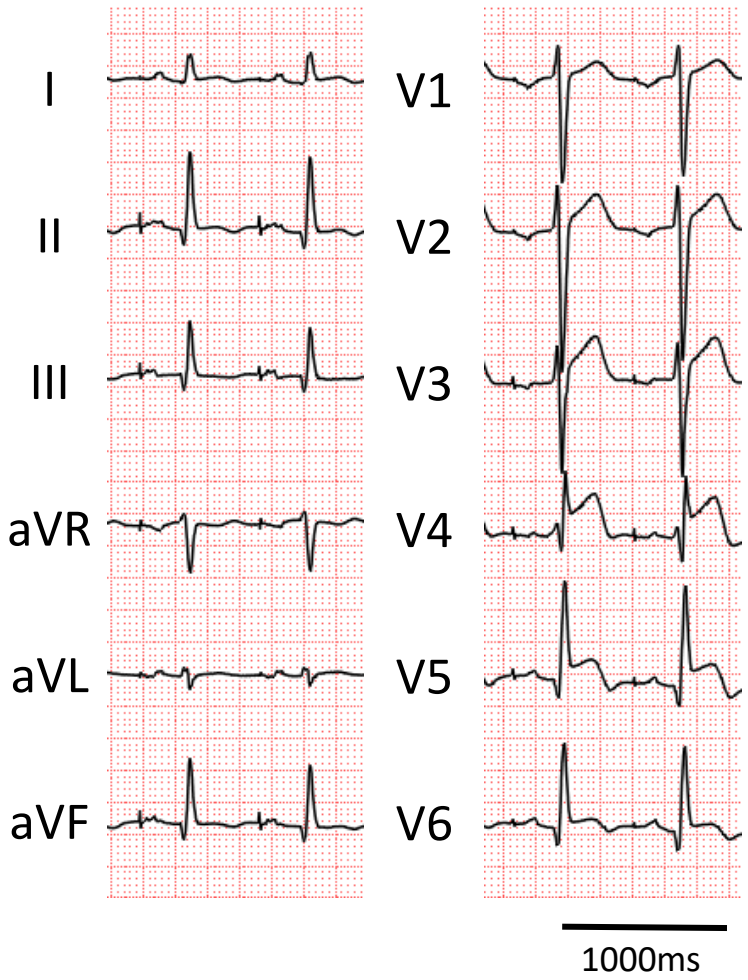
CONCLUSIONS In patients with HCM and AA, endocardial RFCA of AA effectively suppressed monomorphic VT which was related to AA and resulted in satisfactory outcomes. (J Am Coll Cardiol EP 2018;4:339-50) © 2018 by the American College of Cardiology Foundation.

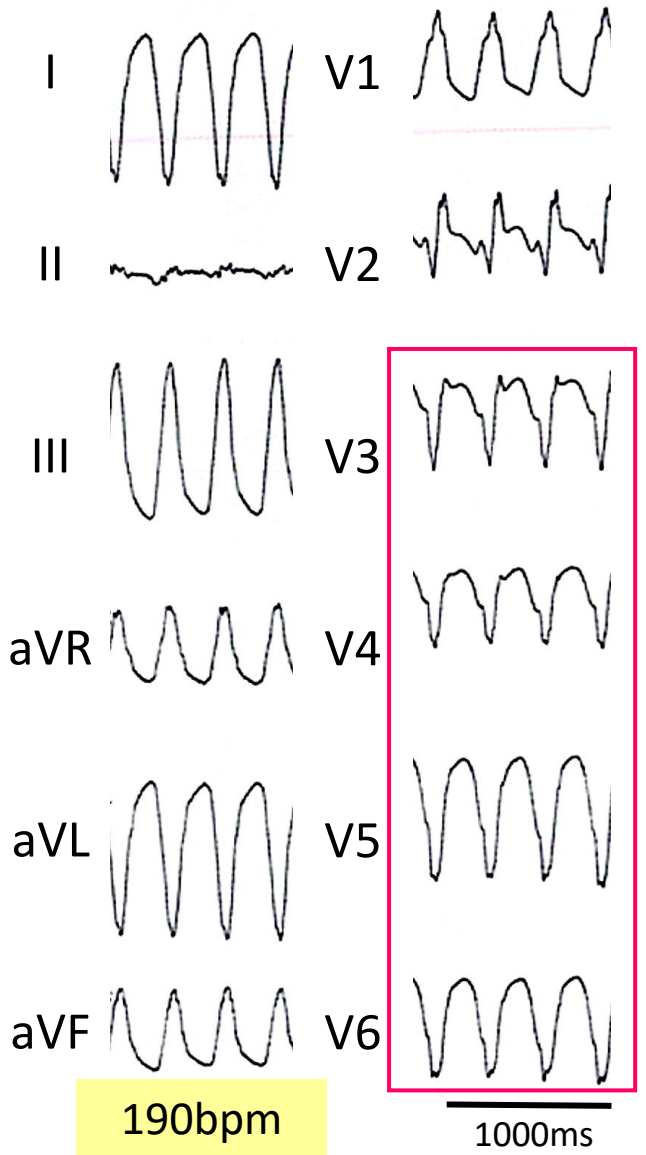
Igarashi M, Nogami A et al. JACC: Clinical Electrophysiol 2018, 4(3) 351-354

Subjects

- Fifteen patients with HCM and AA who underwent RFCA for VT at 5 different institutions from Jan 2005 to Dec 2015 were retrospectively investigated.
- In all patients, monomorphic VT was documented.
- The HCM and AA diagnosis required LV hypertrophy demonstration based on echocardiography and/or cardiac MRI.

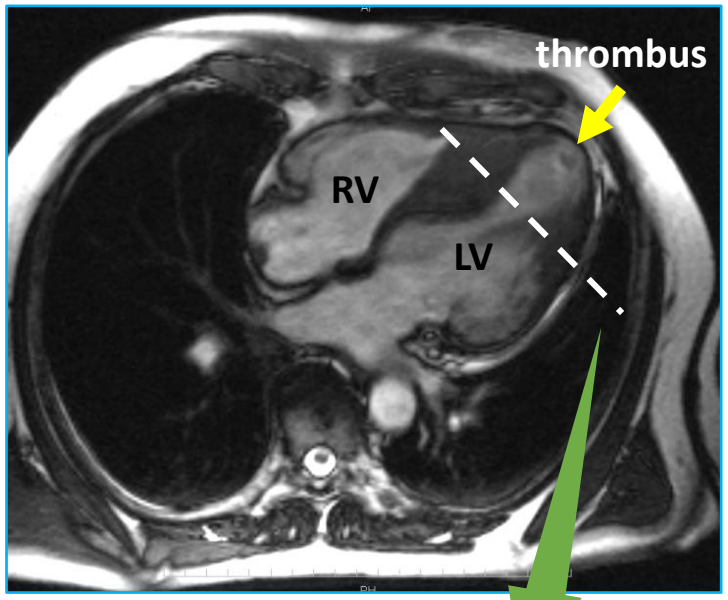
50 years old, a man with HOCM

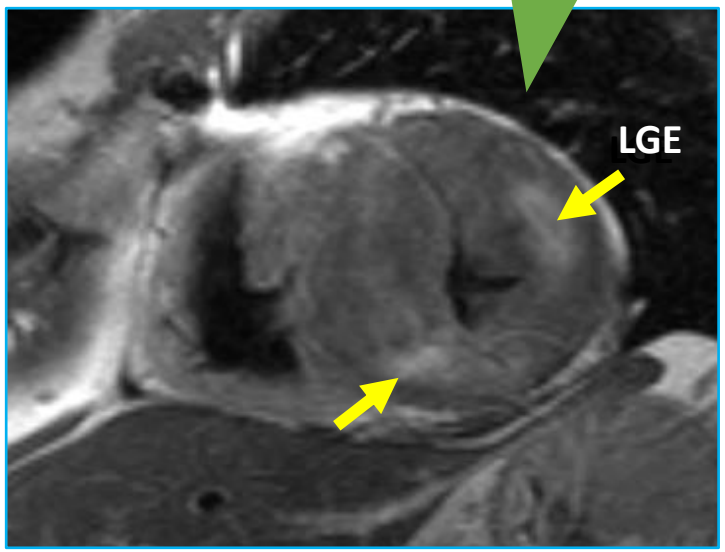




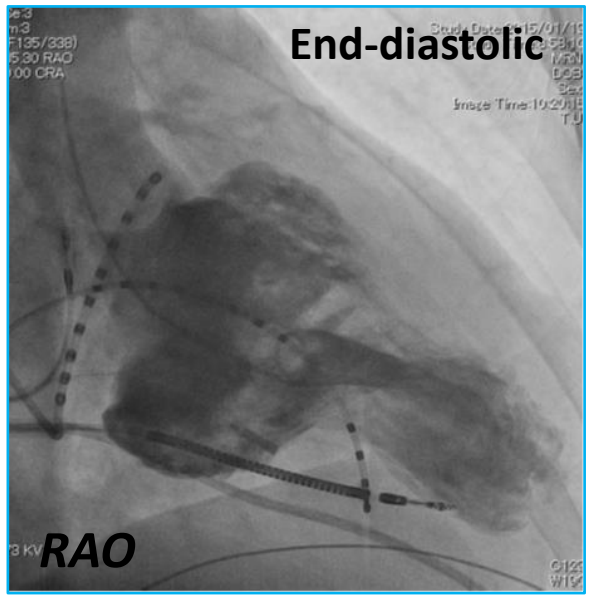
LV apical aneurysm

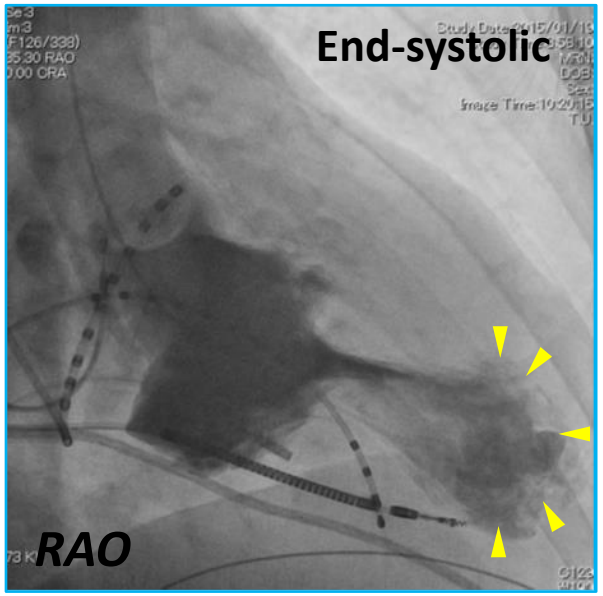
Cardiac MRI





LVG



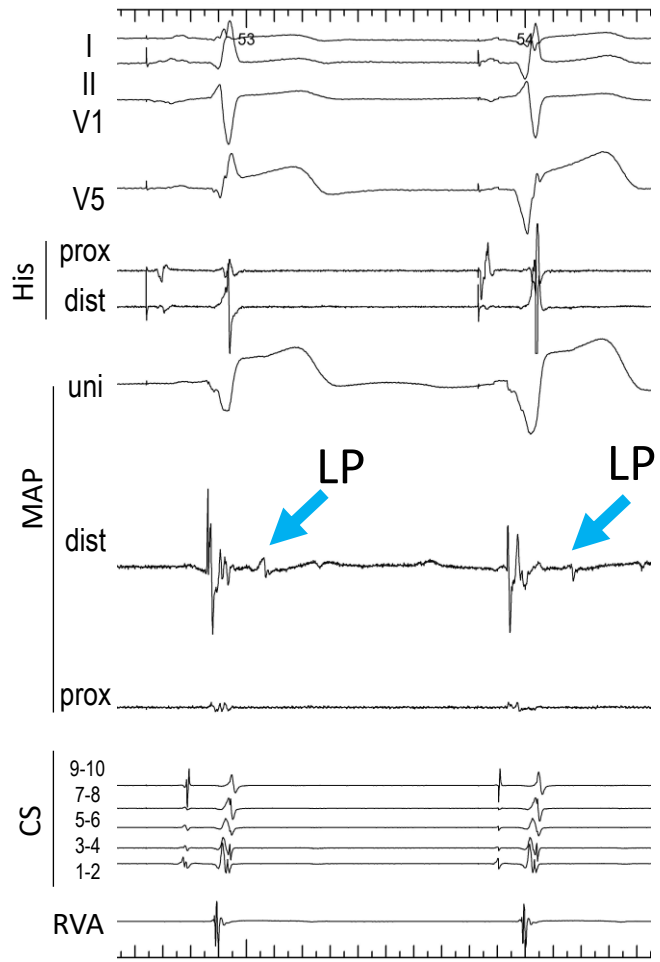


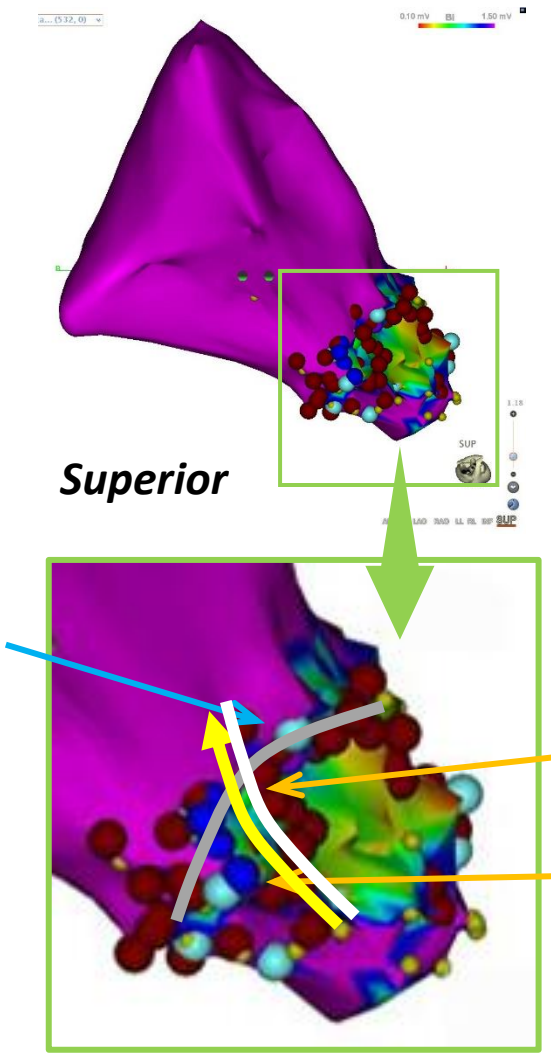
Mid ventricular obstruction (+)

Max pressure gradient= 20mmHg

Mapping in LV aneurysm

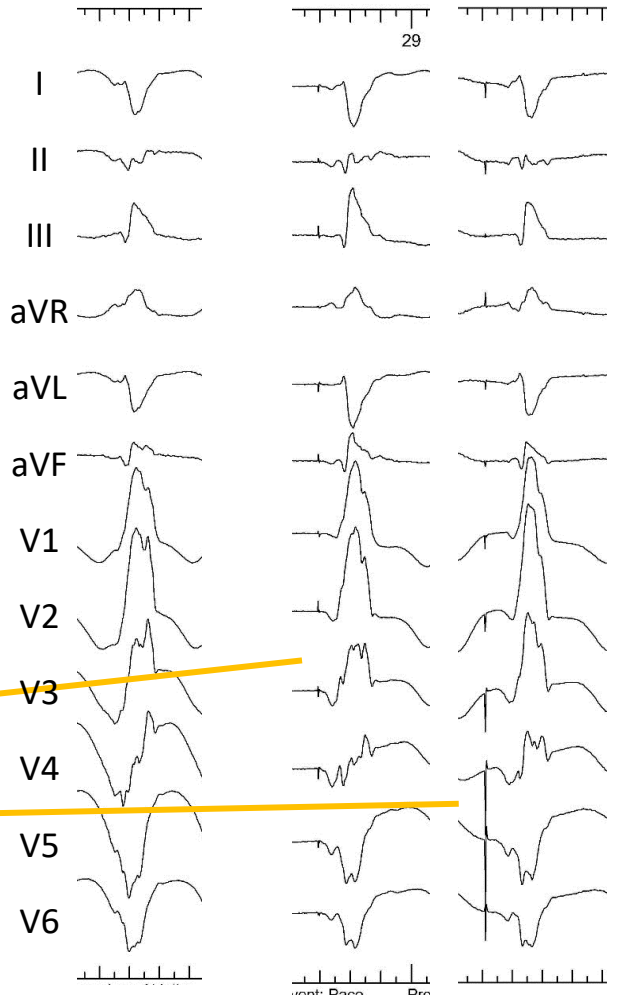
LP at the apical aneurysm





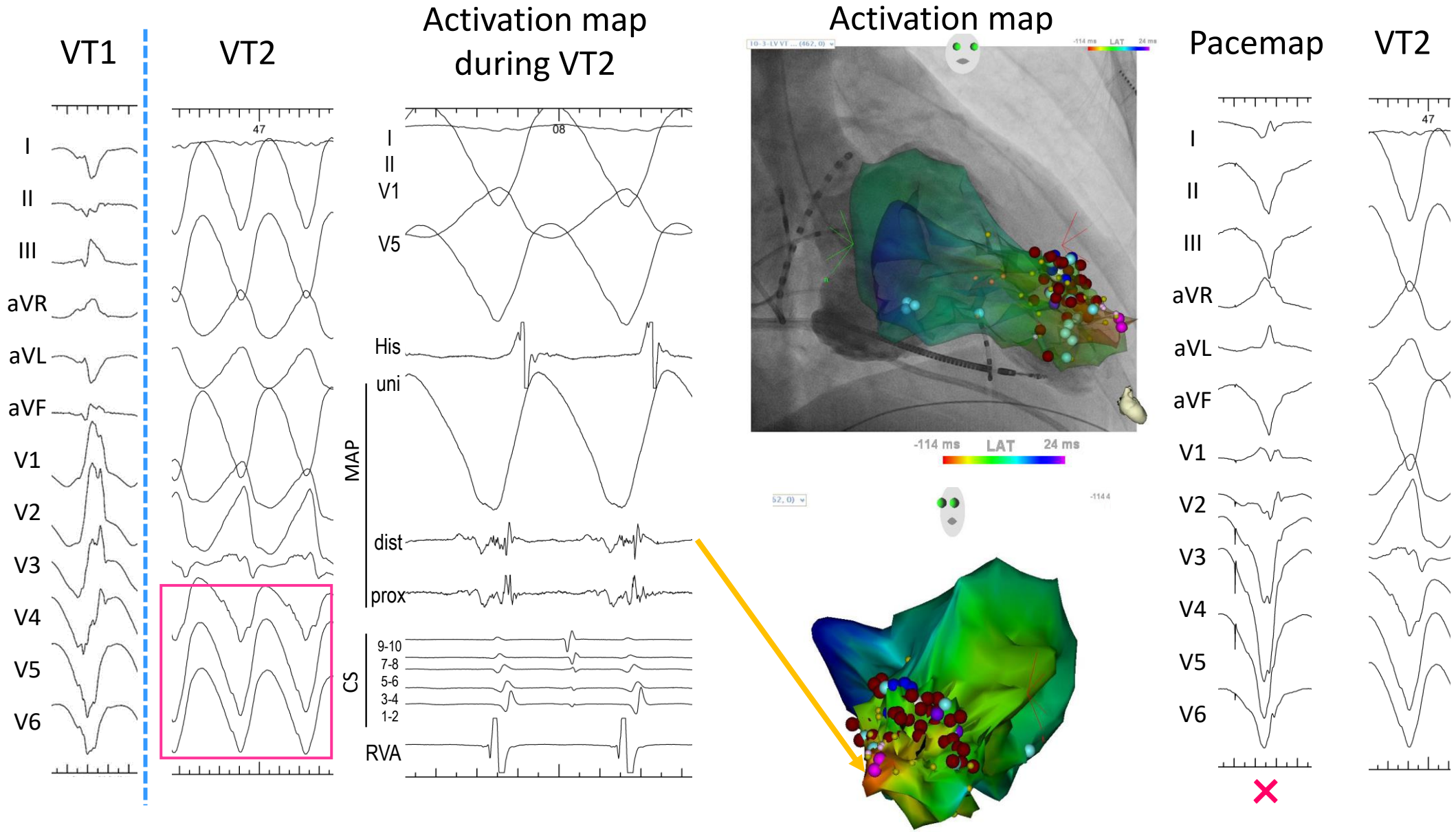
VT1=
Clinical VT

Pacemap

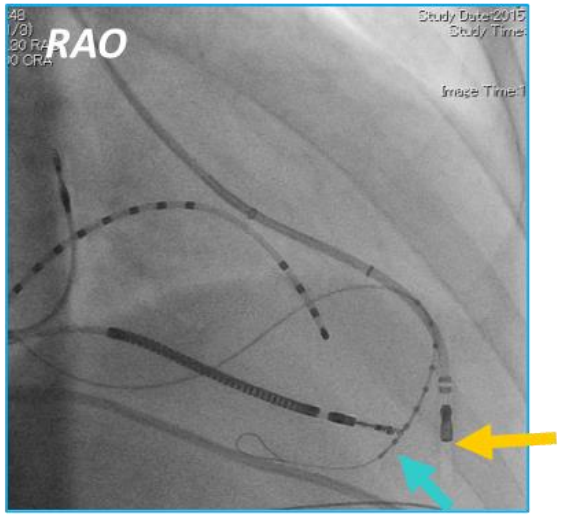


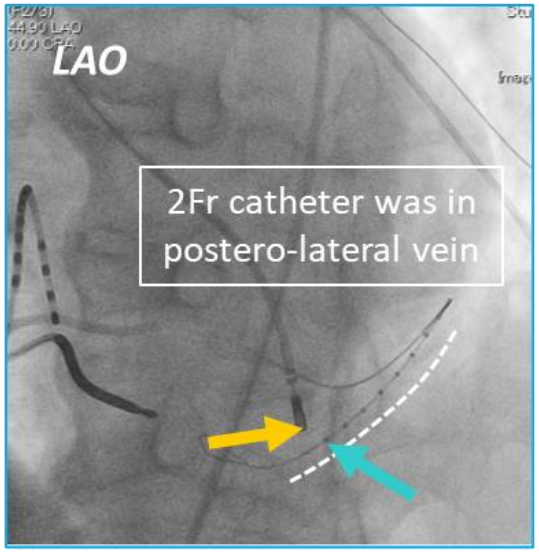
S-QRS = 65ms

Mapping during another VT

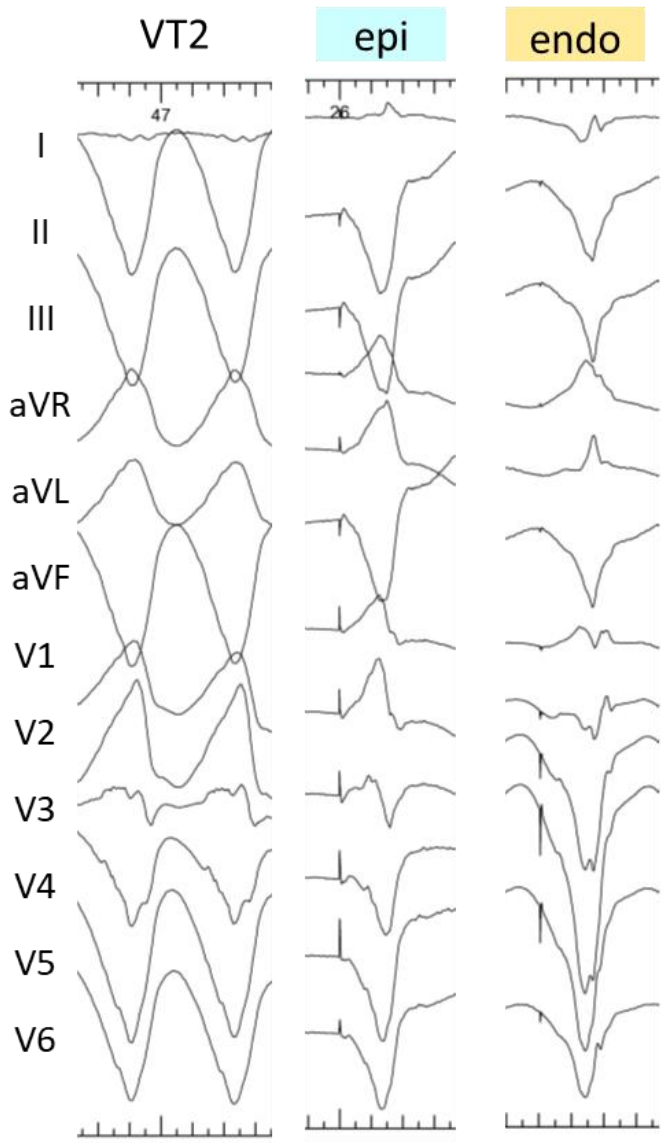


Additional RFCA within AA

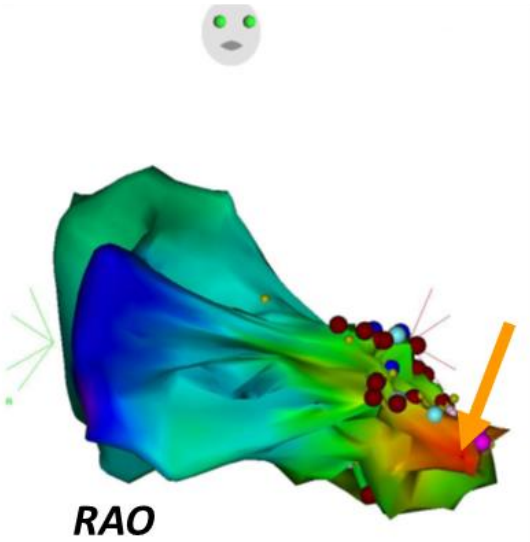


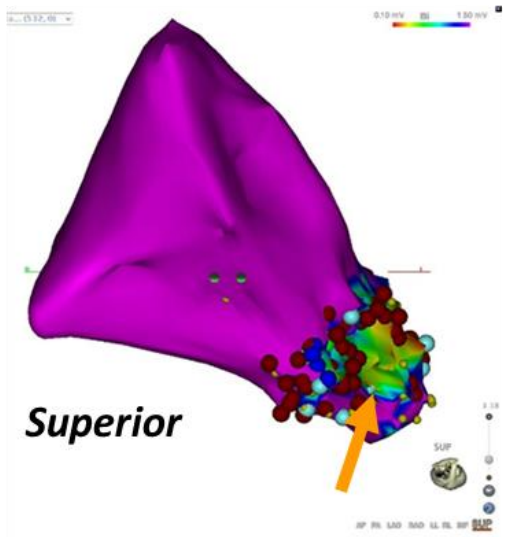


Pacemap



better!





Baseline characteristics

	age (years)	gender	previous medications		ICD implantation (pre or post ablation)	history of VT	history of AF	echocardiography			Other histories
			BB	amiodarone				LVEF (%)	max wall thickness (mm)	LVOT PG (mmHg)	
1	85	F	+	+	none	-	+	47	15	N/A	Post AVN ablation and PMI for AF
2	62	M	+	-	post	NSVT	-	64	15	33	
3	49	M	+	-	none	-	-	68	33	70	
4	57	M	+	+	post	-	-	71	18	23	
5	65	M	-	+	post	-	+	72	18	N/A	
6	66	M	+	+	pre	VT	-	62	16	12	
7	63	M	-	+	pre	VT	+	78	15	7	Post-PVI
8	58	F	+	+	pre	VT	+	73	13	3	Post-PVI, post-PTSMA
9	77	F	+	+	post	-	-	57	16	0	
10	73	M	+	+	pre	VT	-	75	20	28	
11	73	M	+	+	pre	VT	+	74	23	54	
12	50	M	+	+	pre	VT	-	46	24	17	
13	62	M	+	+	post	-	-	60	24	23	
14	73	M	+	+	pre	VT	-	50	15	9	
15	67	M	+	+	post	-	+	70	16	53	
	65.3	F:3	87%	87%		53%	40%	64.5%	18.7mm		

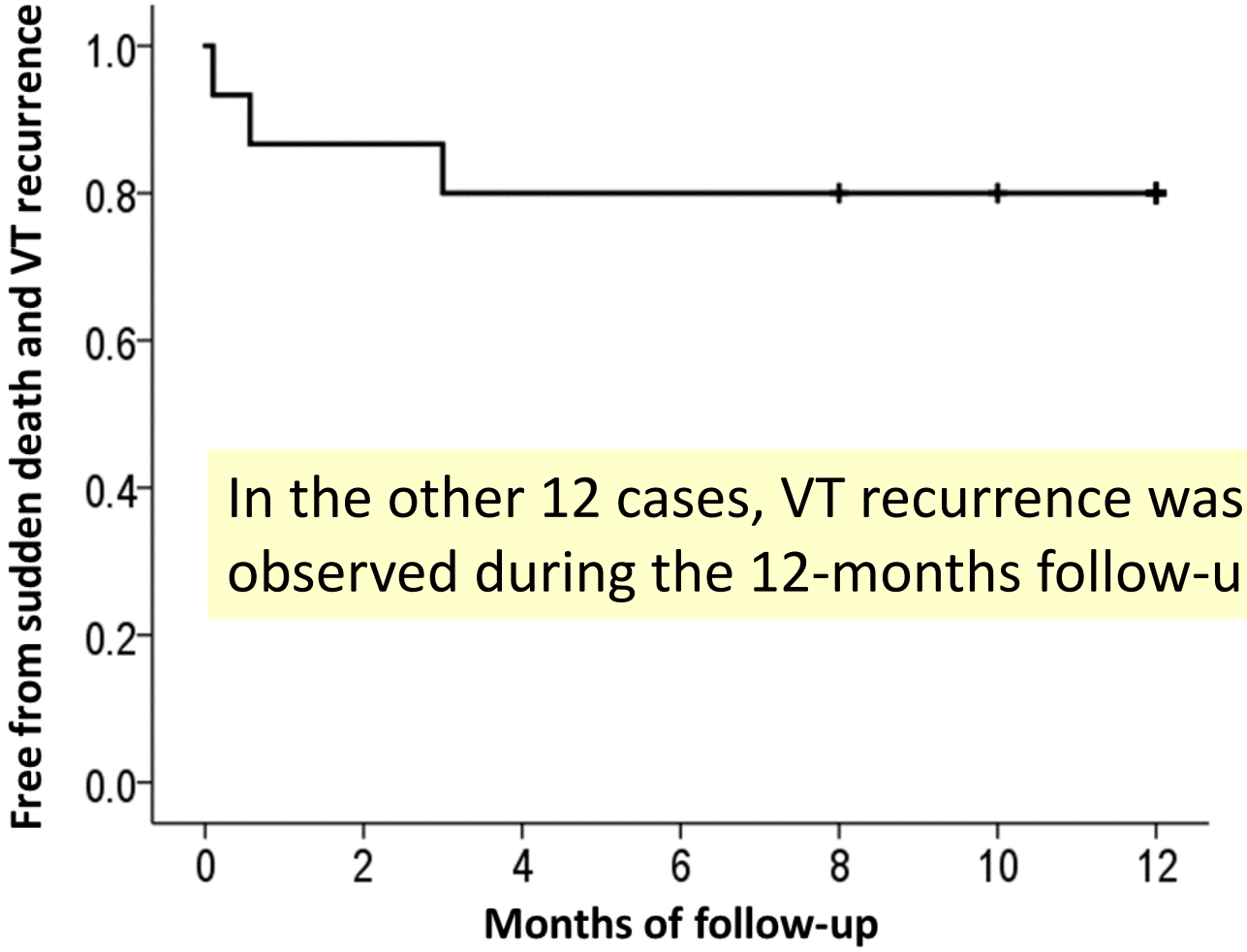
Acute result of RFCA

No.	VT induction		Endocardial map		Estimated exit	Effective ablation site	Acute result of RFCA
	clinical VT	non-clinical VT	LVA at AA	LP in AA			
1	NSVT	0	+	-	epi	anterior wall of AA neck side	non-inducible
2	NSVT	0	+	+	epi	anterior wall of AA neck side	non-inducible
3	SMVT	0	+	+	endo	anterior wall of AA neck side	VT term and non-inducible
4	SMVT	1	+	+	endo	crisscross linear ablation within AA	only non-clinical VT was inducible
5	SMVT	1	+	+	endo/epi	linear ablation within AA	only non-clinical VT was inducible
6	SMVT	0	+	+	epi	anterior wall of AA neck side	VT termination and non-inducible
7	SMVT	0	+	+	epi	anterior and antero-septal scar border in AA	VT termination and non-inducible
8	No	0	+	-	endo	anterior and antero-lateral scar border in AA	non-inducible
9	SMVT	0	+	+	endo	anterior and antero-septal scar border in AA	VT termination and non-inducible
10	SMVT	0	+	+	endo	anterior and antero-septal scar border in AA	non-inducible
11	SMVT	6	-	+	endo	anterior wall of AA neck side	VT termination and non-inducible
12	SMVT	4	+	+	endo/epi	anterior scar border in AA	non-inducible
13	NSVT	0	+	+	endo	anterior and antero-lateral scar border in AA	non-inducible
14	SMVT	0	-	-	epi	epicardial site of AA neck	VT termination and non-inducible
15	SMVT	1	-	+	epi	anterior wall of AA neck side	non-inducible

Mid-term outcome after RFCA

- **<u>Sudden death = 1</u>**
  Case #3, who refused to receive ICD implantation, was transferred because of cardio-pulmonary arrest after discharge (17 days after RFCA).
- **<u>VT recurrence = 2</u>**
  In case #7, a second RFCA was performed.
  In case #14, ATP could terminate VT 3 months after RFCA.
- In the other 12 cases (80%), VT recurrence was not observed during the 12-month follow-up.

Mid-term outcome after RFCA



In the other 12 cases, VT recurrence was not observed during the 12-months follow-up.

No. of patients at risk	15	13	12	12	12	11	10

Igarashi M, Nogami A et al. JACC: Clinical Electrophysiol 2018, 4(3) 351-354

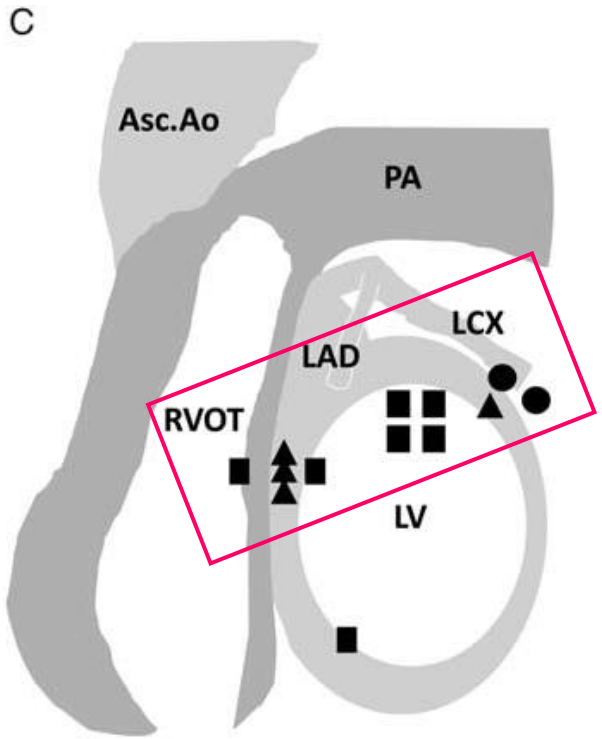
Summary of VT ablation in HCM with AA

- In patients with HCM and AA, monomorphic VT, which was related to the low voltage area at AA, was common.
- Although the circuits or origins of VT could be epicardial or intramural sites, endocardial RFCA at the AA neck side (scar border) was effective in suppressing VT in most patients.
- RFCA could lead good outcome.

(2) VT in dilated-phase HCM patients

Clinical and electrophysiological characteristics in patients with sustained monomorphic VT associated with DHCM

5 patients with DHCM who underwent RFCA for VT were included.



- Mechanism of all VTs was diagnosed as reentry.
- **Endocardial ablation successfully eliminated all VTs in 2 of 5 patients.**
- The remaining 3 patients needed epicardial ablation, intracoronary ethanol ablation, and surgical cryoablation.
- All but one VT arose from the basal septum, basal anterior to anterolateral LV.

A Ueda et al. Europace 2012; 14: 734-740

Catheter Ablation of VT in D-HCM:

Substrate Characterization and Ablation Outcome

Q J Naeemah, Y Komatsu, A Nogami, Y Sekiguchi, M Igarashi,
H Yamasaki, Y Shinoda, K Aonuma, M Ieda
Department of Cardiology, Faculty of Medicine, **University of Tsukuba**

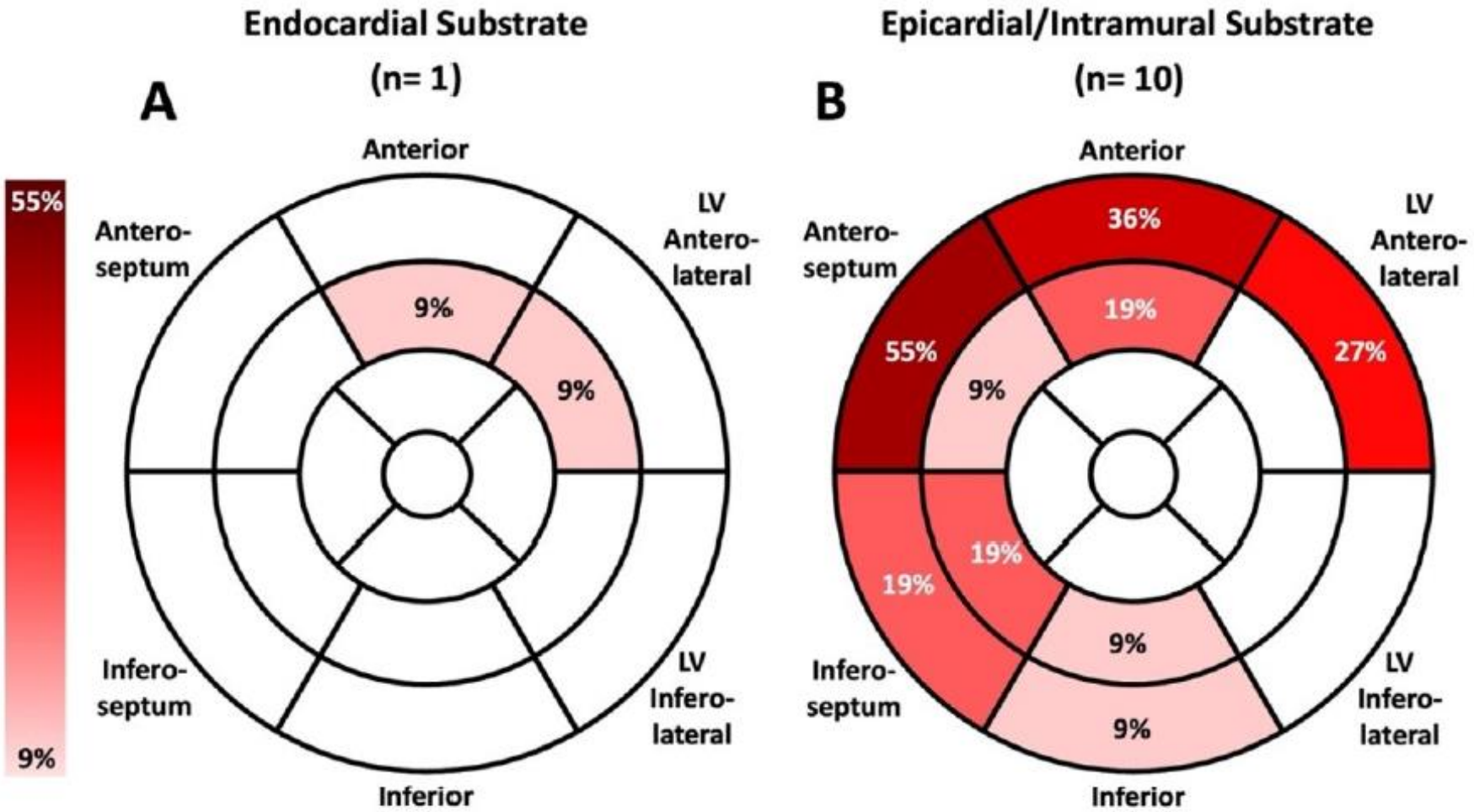
- A total of 23 ablation procedures for drug-refractory sustained monomorphic VTs in **13 DHCM** were performed.
- 60 ± 11 years old, one female,
- LVEF = 39 ± 9%, IVST/PWT = 12.6 ± 4.6/10.5 ± 2.0 mm
  max wall thickness = 14.0 ± 3.5mm

QJ Naeemah et al.Pacing Clin Electrophysiol. 2022 Apr 16. DOI: 10.1111

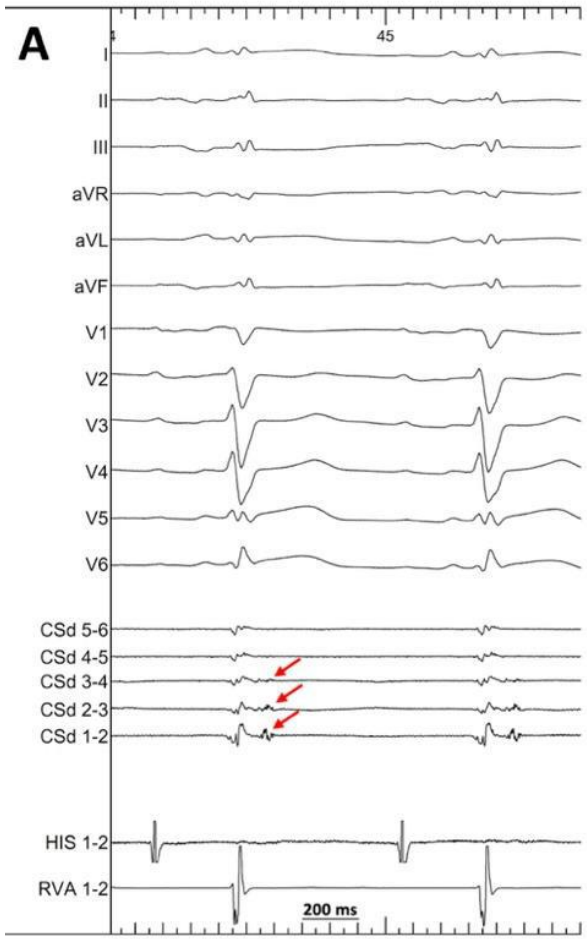
Results of RFCA

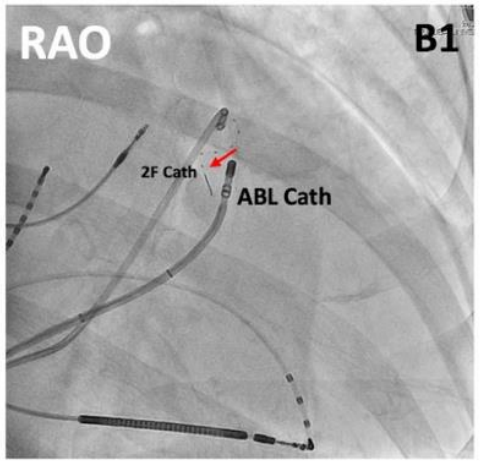
No.	VT Storm	Approach	No. of VTs induced	Ablation Site	Inducibility at the end	Recurrence after last procedure
1	Yes	Endo	1	Endo: basal inferior RV	Not tested	
	No	Endo	1	Endo: RLJ and postero-septal RVOT	Not tested	Yes
2	No	Endo + Epi	0	Epi: mid anterior	Non-inducible	No
3	No	Endo + Epi	0	Endo: LCC above and below. Epi: mid inferior wall	Non-inducible	Yes
4	Yes	Epi (GCV)	0	Epi: Distal CS (GCV-AIVV)	Non-inducible	No
5	Yes	Endo	10	Endo: LV basal anterior, basal LV septum and RV septum	Not tested	
	No	Endo	5	Endo: basal LV and RV septum	Not tested	
	Yes	Endo	3	Endo: basal LV and RV septum. Bipolar ablation of the interventricular septum	Not tested	Yes
6	Yes	Endo + Epi	7	Endo: basal LV and RV septum. Epi: basal antero-lateral. Ethanol injection to LAD branch.	Non-inducible	Yes
7	Yes	Endo + Epi	3	Endo: basal antero-septum. Epi: basal anterior	Non-inducible	
	Yes	Endo	4	Endo: basal antero-septum and LCC	Non-inducible	
	Yes	Endo	1	Endo: basal LV and RV septum	Non-inducible	
	Yes	Endo	5	Endo: LV and RV septum and basal anterior wall	Non-inducible	
	Yes	Endo + Epi (GCV)	2	Endo: LV and RV septum. Bipolar ablation between GCV and LV endocardium	Non-inducible	Yes
8	Yes	Epi	5	Epi: mid A-W	Non-clinical	No
9	Yes	Endo + Epi	14	Endo:Basal A-L, LCC and RCC .Epi: basal antero-lateral. Bipolar ablation between Epi and Endo	Non-clinical	
	Yes	Endo	8	Endo: Basal A-W. Bipolar ablation of the interventricular septum. Ethanol injection to LCX branch	Not tested	
	No	Endo	10	Endo: LCC and basal antero-septum	Not tested	Yes
10	No	Endo	1	Endo: LCC and basal antero-septum	Non-inducible	
	No	Epi	1	Epi: basal anterior	Non-inducible	No follow up
11	No	Endo (RVOT)	0	Endo: RVOT septum and RV septum near the His-bundle	Non-inducible	No
12	No	Endo	3	Endo: mid anterior	Non-clinical	No
13	No	Endo	4	Endo: anterior papillary muscle	Non-inducible	No follow up

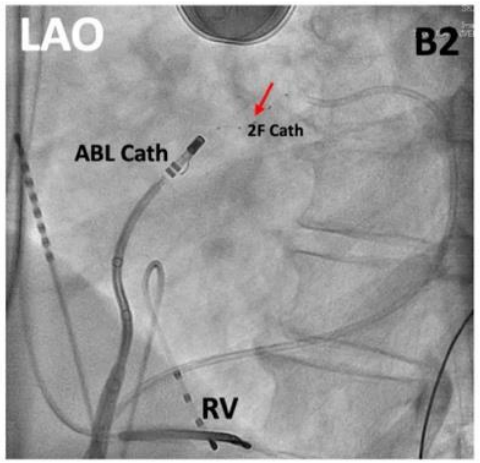
Dominant Substrate location of VT in DHCM

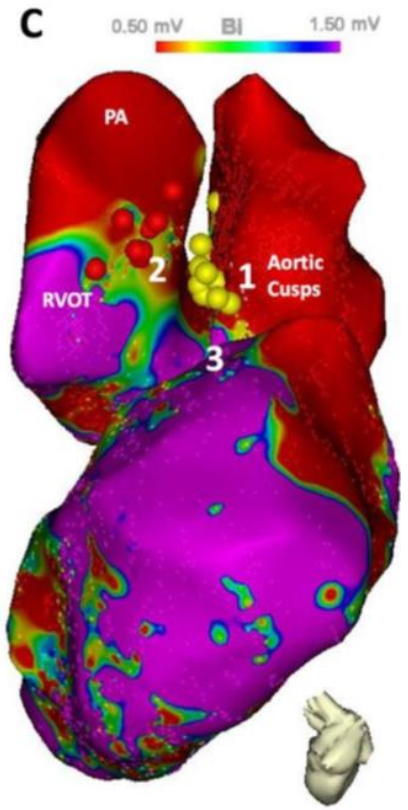


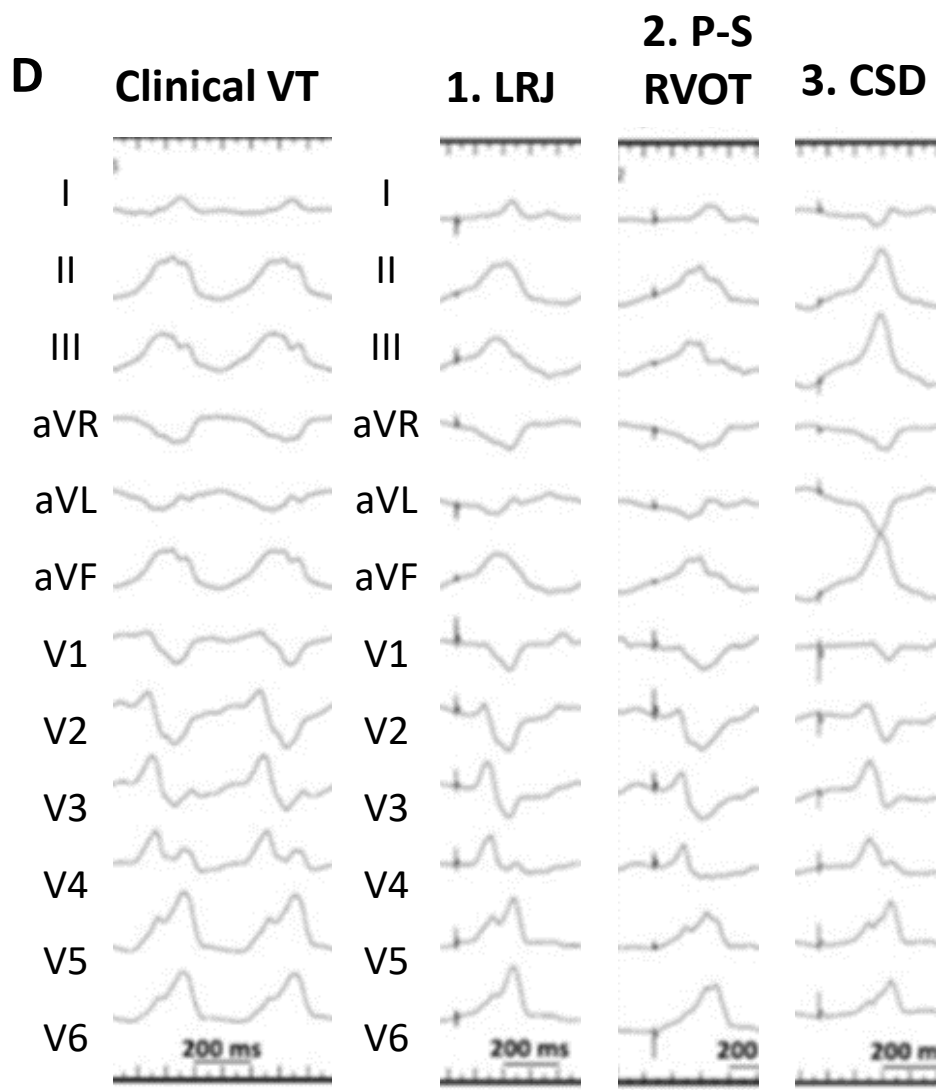
A case with basal septum substrate



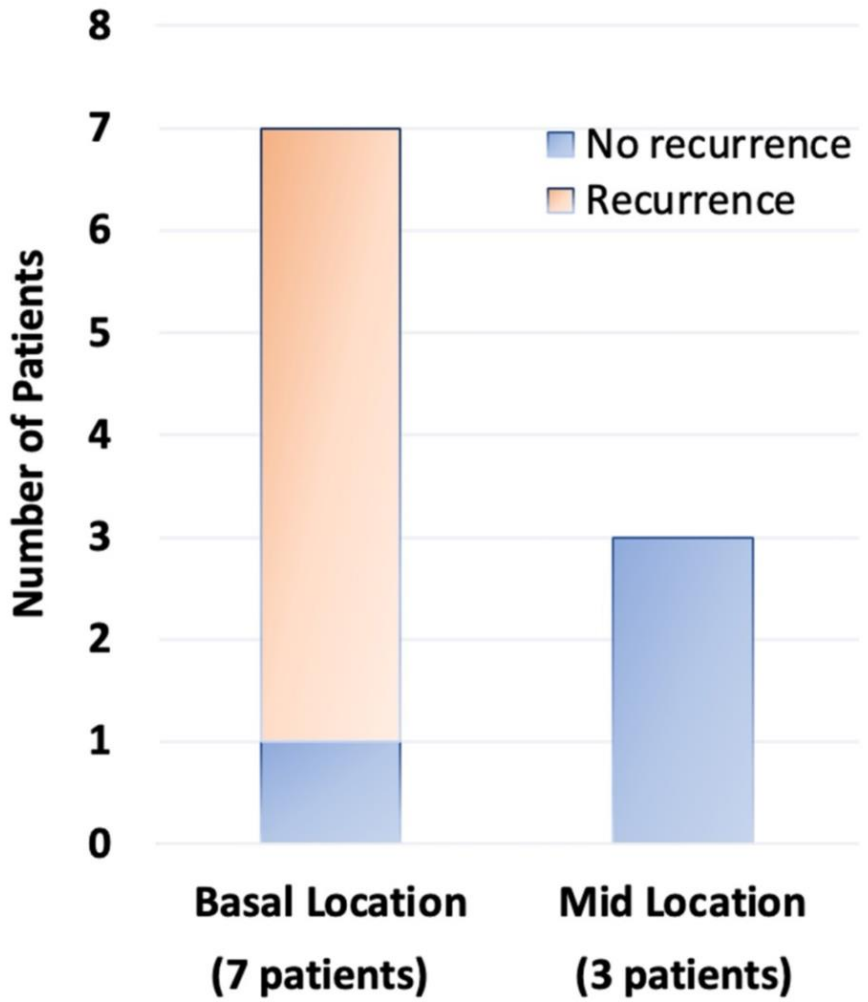




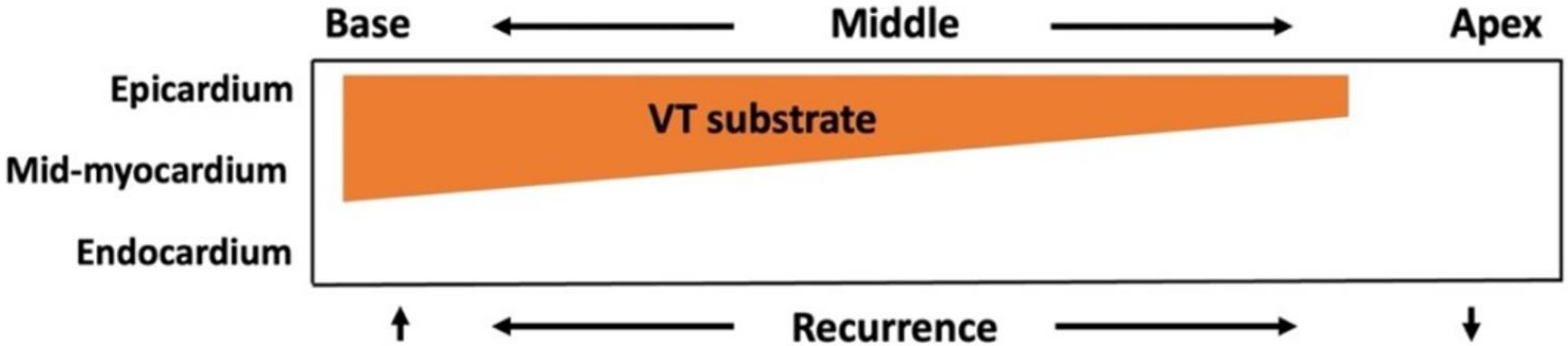




Mid-term ablation outcome based on the substrate location



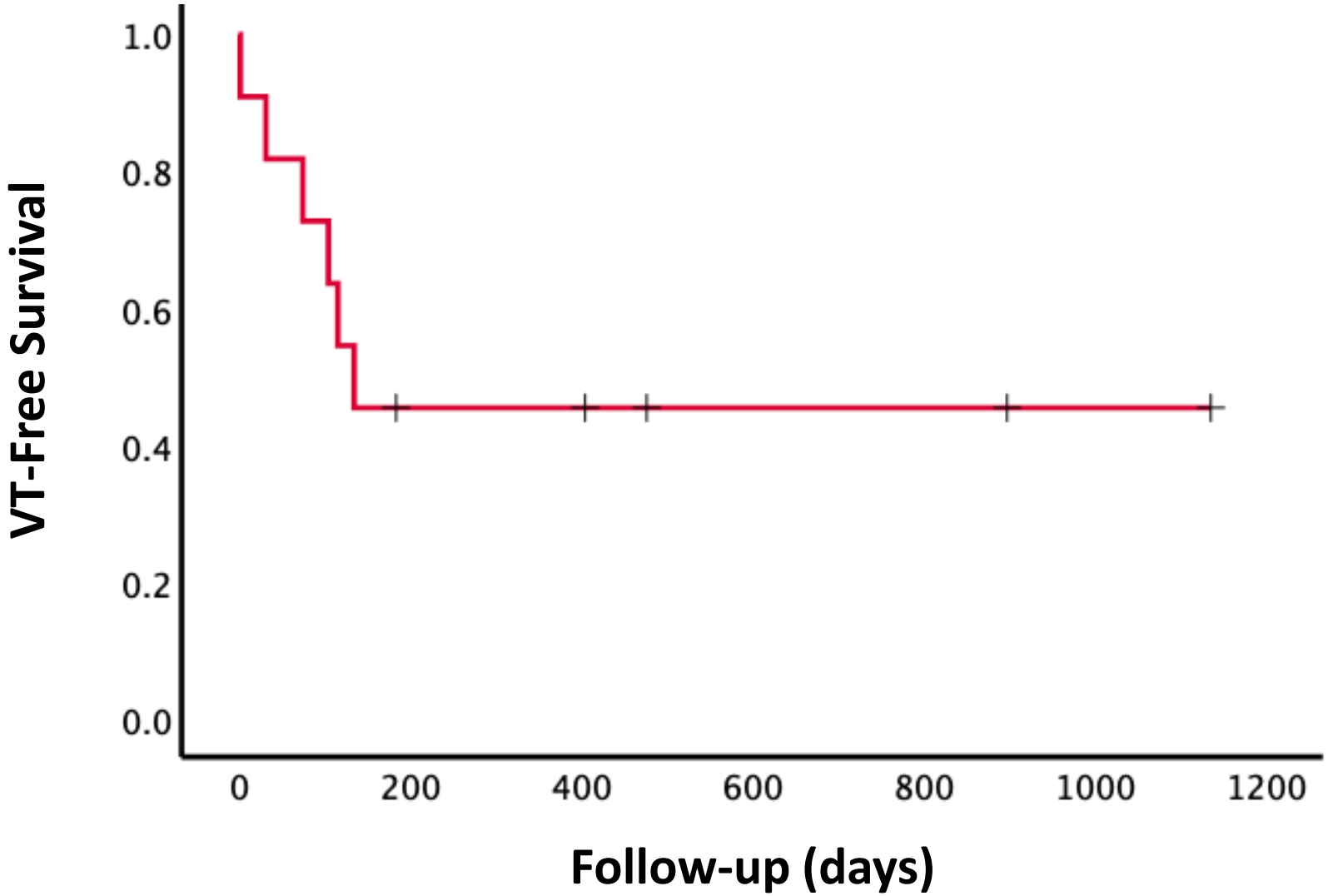
The relationship between substrate location and recurrence in DHCM



- Intramural substrate extension
- Anatomical inaccessiblity (interventricular septum)
- Presence of fat, coronary vessels and outflow trunks

- Epicardial substrate
- No fat or coronary vessels

Outcome after the last procedure of RFCA



Summary

- The arrhythmogenic substrate in the setting of DHCM was mainly distributed in the basal intramural and epicardial antero-septum.

- Catheter ablation of VT in DHCM patients is challenging, and other strategies including trans-coronary ethanol injection and bipolar ablation were needed in some patients with an intramural substrate.

Thank you for your attention!

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