Debate 2

; in patients with VT storm in whom medication are ineffective

VT symposium 2019, 2nd Nov 2019, Seoul

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Debating ?

- **Management of Drug refractory electrical storm.**

Question 1

What is electrical storm?

- ✓ Electrical storm is a state of electrical instability and is characterised by several episodes of ventricular tachycardia (VT) or ventricular fibrillation (VF).
- ✓ three or more separate arrhythmia episodes leading to ICD therapy occurring over a single 24-hour time period.
- ✓ The episodes of VT must be separate, meaning that the persistence of VT following unsuccessful ICD therapy is not considered as a second episode.

EHRA/HRS Expert & Consensus on Catheter Ablation of Ventricular Arrhythmias: developed in a partnership with the European Heart Rhythm Association (EHRA), a registered branch of the European Society of Cardiology (ESC), and the Heart Rhythm Society (HRS); in collaboration with the American College of Cardiology (ACC) and the American Heart Association (AHA). Heart Rhythm 2009; 6: 886–933.

Mechanism underlying electrical storm

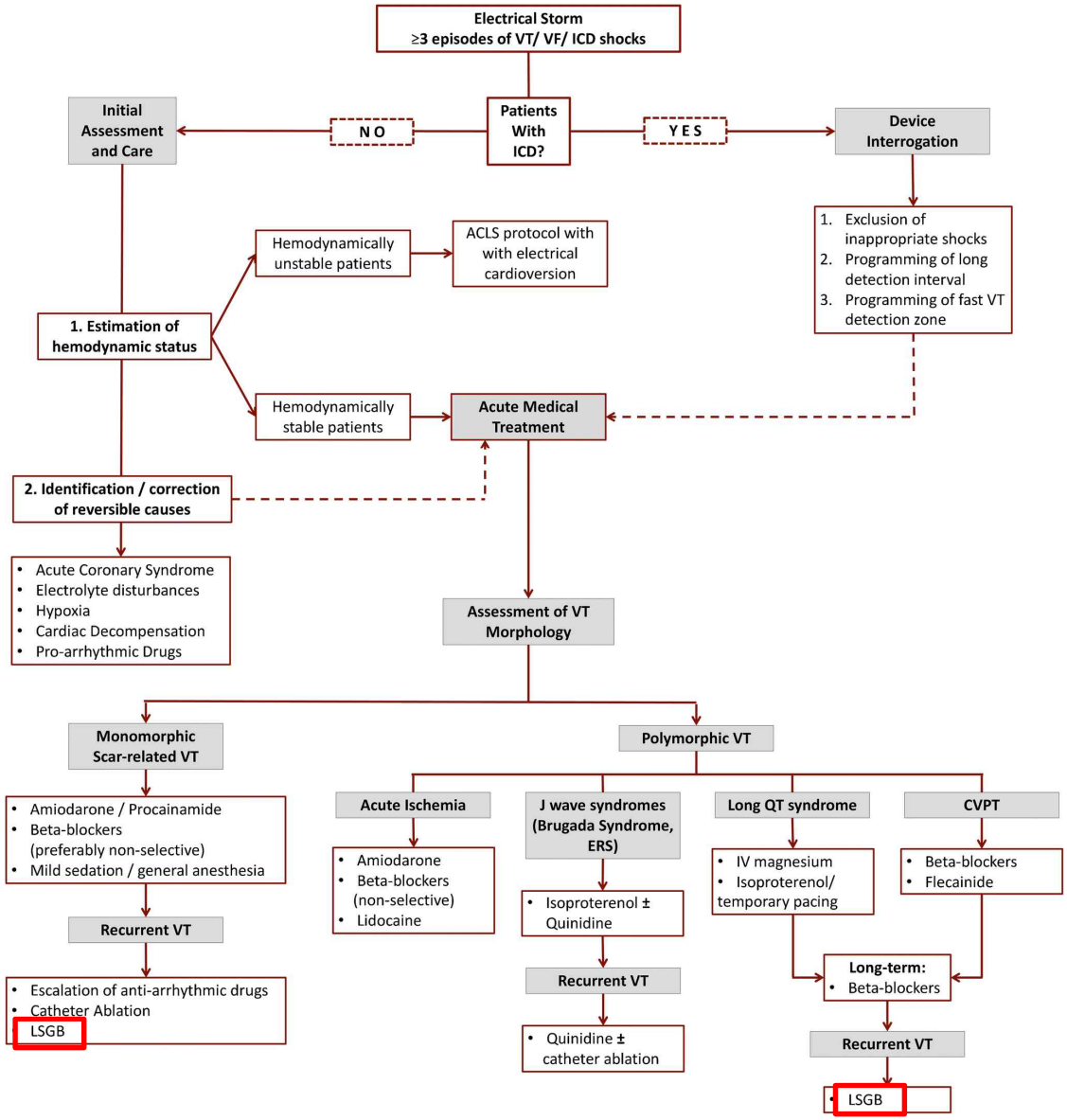
- ✓ The pathophysiological features of an ES are complex and still are not completely understood.
- ✓ the major triggers contributing to the occurrence of an ES are thought to include sympathetic stimulation, acute ischemia, congestive heart failure, aberrant intracellular calcium handling, and electrolyte disturbances.
- ✓ Crucial for the occurrence of electrical storm is an interplay between the autonomic nervous system, cellular milieu and a predisposing electrophysiological substrate.

Vaseghi, M, et al. The role of the autonomic nervous system in sudden cardiac death. Prog Cardiovasc Dis 2008; 50: 404–419

Question 2

How to management electrical storm?

Intervention	Methods	Reference
Sympathetic blockade	β-blocker therapy	Nademanee et al.
	General anesthesia	Burjorjee et al.
	Epidural anesthesia	Bourke et al.
	Sympathetic denervation	Schwartz et al, Ajijola et al.
	Renal denervation	Armaganijan et al
Ablation procedure	Endocardial	Carbucicchio et al.
	Epicardial	Sacher et al.
	Alternatives	Tokuda et al. Kumar et al.
Hemodynamic support	ECMO	Chen et al.
	LVAD	Abuissa et al. Thomas et al.



Curr Cardiol Rep. 2019 Jul 27;21(9):96. doi: 10.1007/s11886-019-1190-0.

Guideline for Neuromodulation

Recommendations	COR	LOE
In patients with symptomatic, non–life-threatening VA, treatment with a beta blocker is reasonable	IIa	C-LD
In patients with a recent MI who have VT/VF that repeatedly recurs despite direct current cardioversion and antiarrhythmic medications (VT/VF storm), an intravenous beta blocker can be useful	IIa	B-NR
In patients with short QT syndrome and VT/VF storm, isoproterenol infusion can be effective	IIa	C-LD
In patients with VT/VF storm in whom a beta blocker, other antiarrhythmic medications, and catheter ablation are ineffective, not tolerated, or not possible, cardiac sympathetic denervation may be reasonable	IIb	C-LD

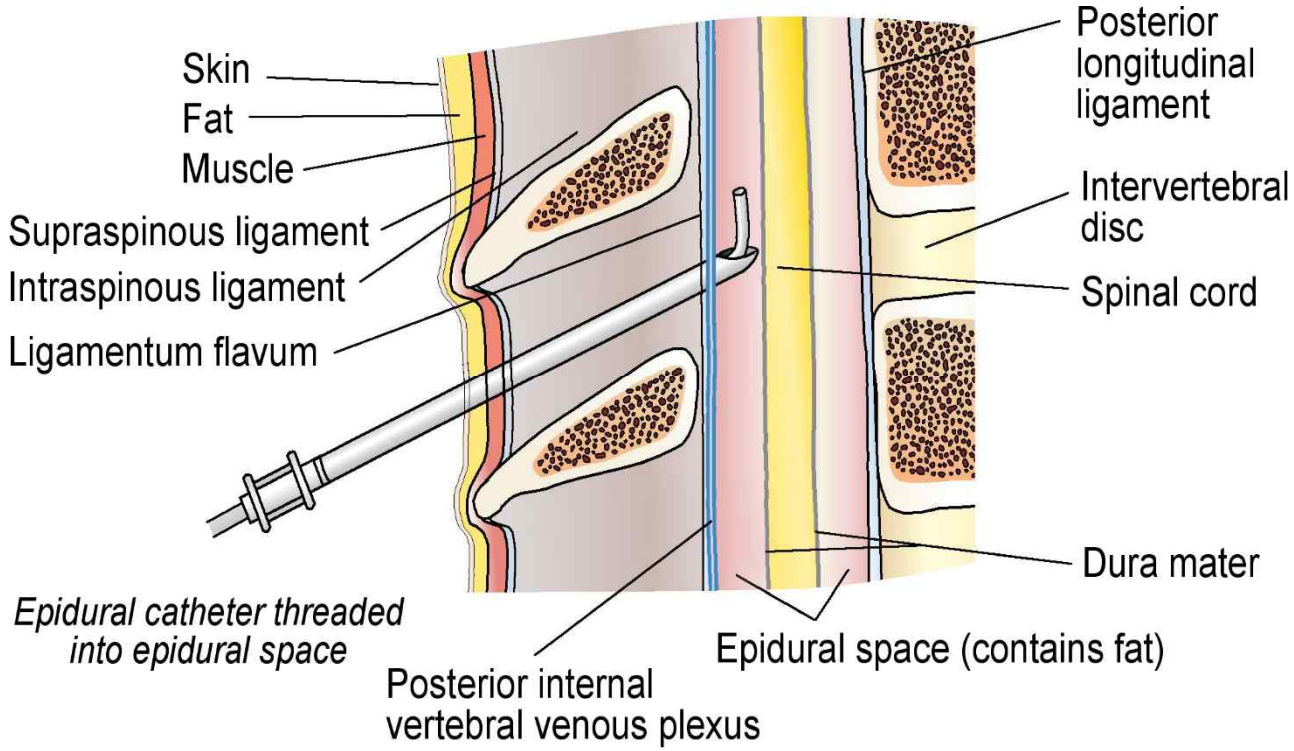
2017 AHA/ACC/HRS guideline for management of patients with ventricular arrhythmias and the prevention of sudden cardiac death

Question 3

Neuromodulation ?

- ✓ Thoracic epidural anesthesia (TEA)
- ✓ Stellate ganglion blockade (SGB)
- ✓ Renal denervation (RDN)

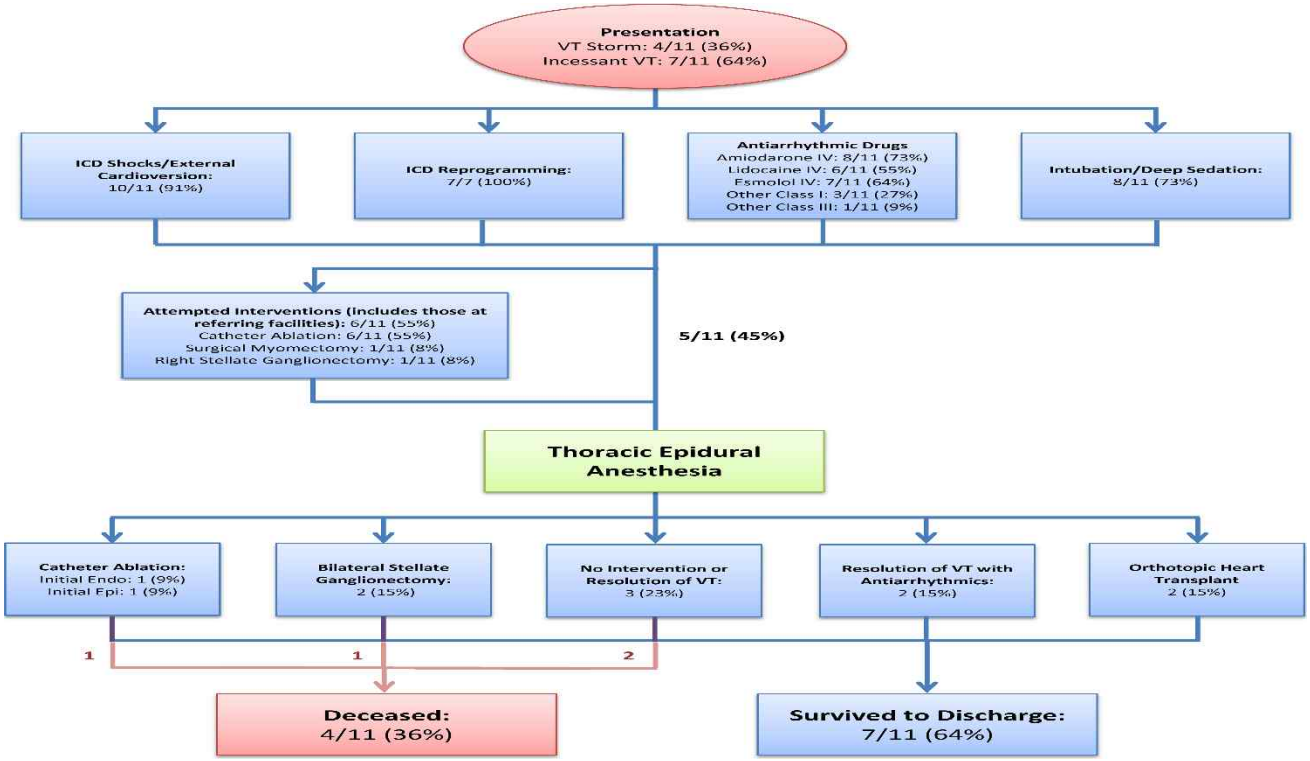
Thoracic Epidural Anesthesia for VT Storm



- ✓ a 17-gauge Touhy or an 18-gauge Perican needle was inserted via a paramedian approach into the T1 to T2 or T2 to T3 interspace via a standard approach.

JAHA;6:e007080, 2017.

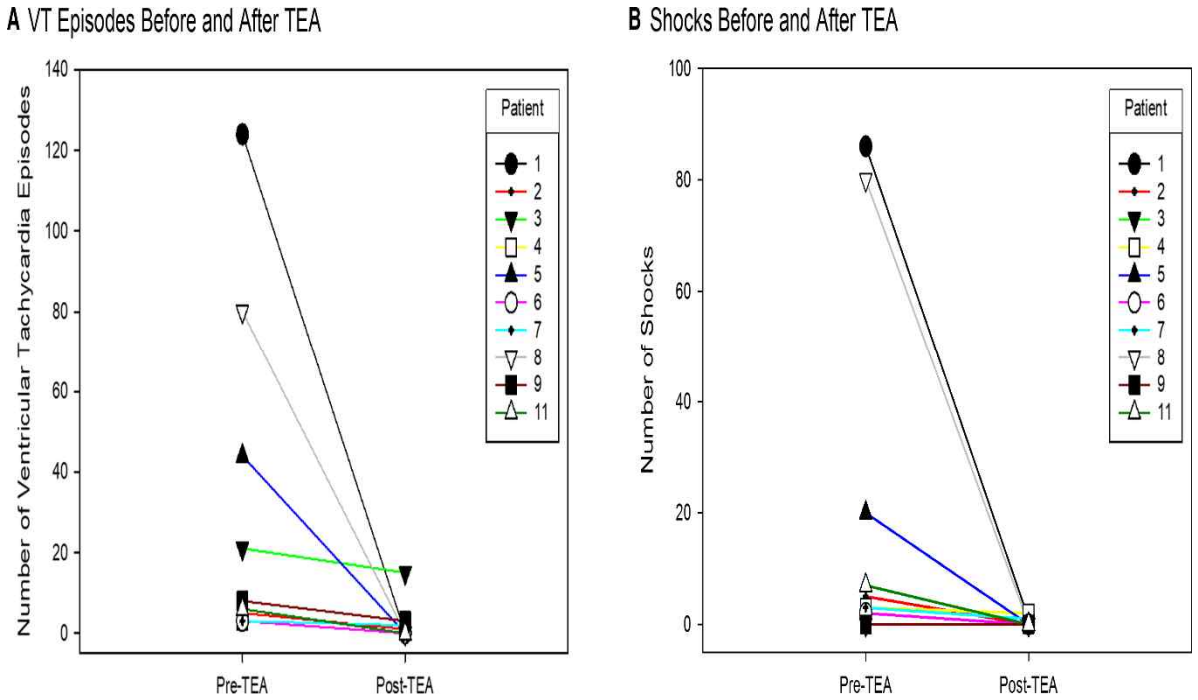
Thoracic Epidural Anesthesia for VT Storm



- ✓ At initiation of TEA, a 1-mL injection of bupivacaine, 0.25%, or a 10-mL injection of ropivacaine, 0.20%, was administered via the epidural catheter, followed by an infusion at 2 mL/h of bupivacaine, 0.25%, or 3 mL/h of ropivacaine, 0.20%. The dose was titrated according to arrhythmic response.

JAHA;6:e007080, 2017.

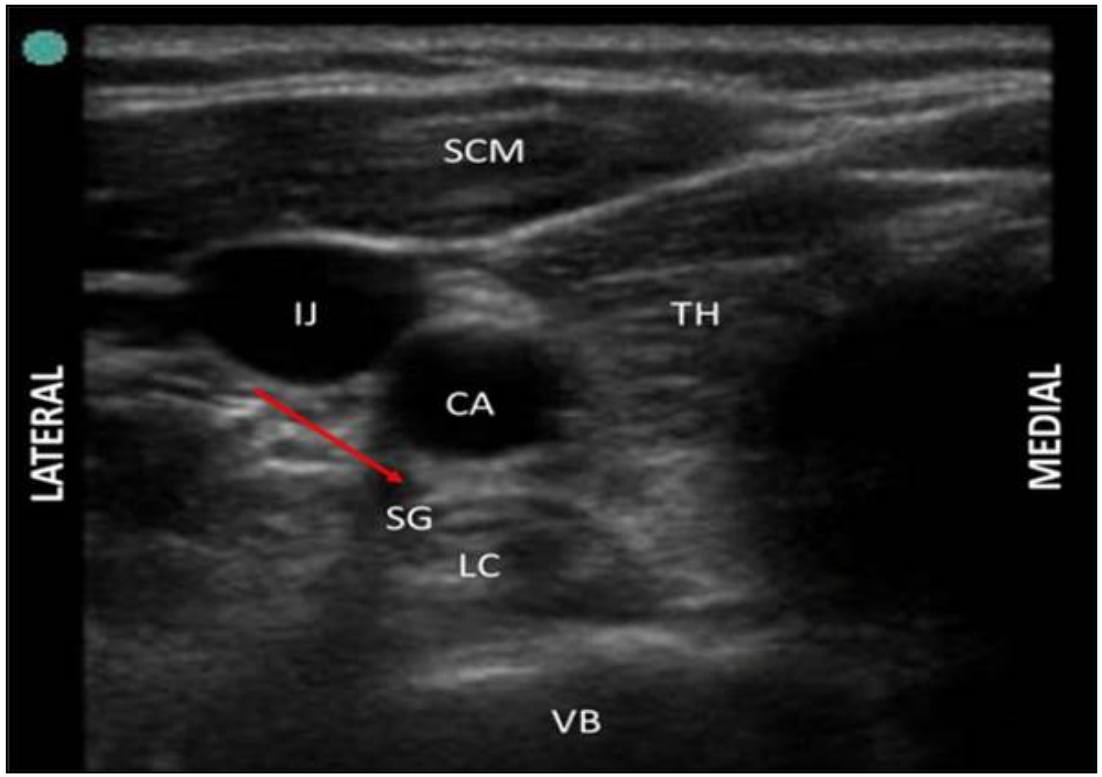
Thoracic Epidural Anesthesia for VT Storm



Number of sustained VT episodes (A) and shocks (B), both external and internal, before and after initiation of TEA for each patient.

JAHA;6:e007080, 2017.

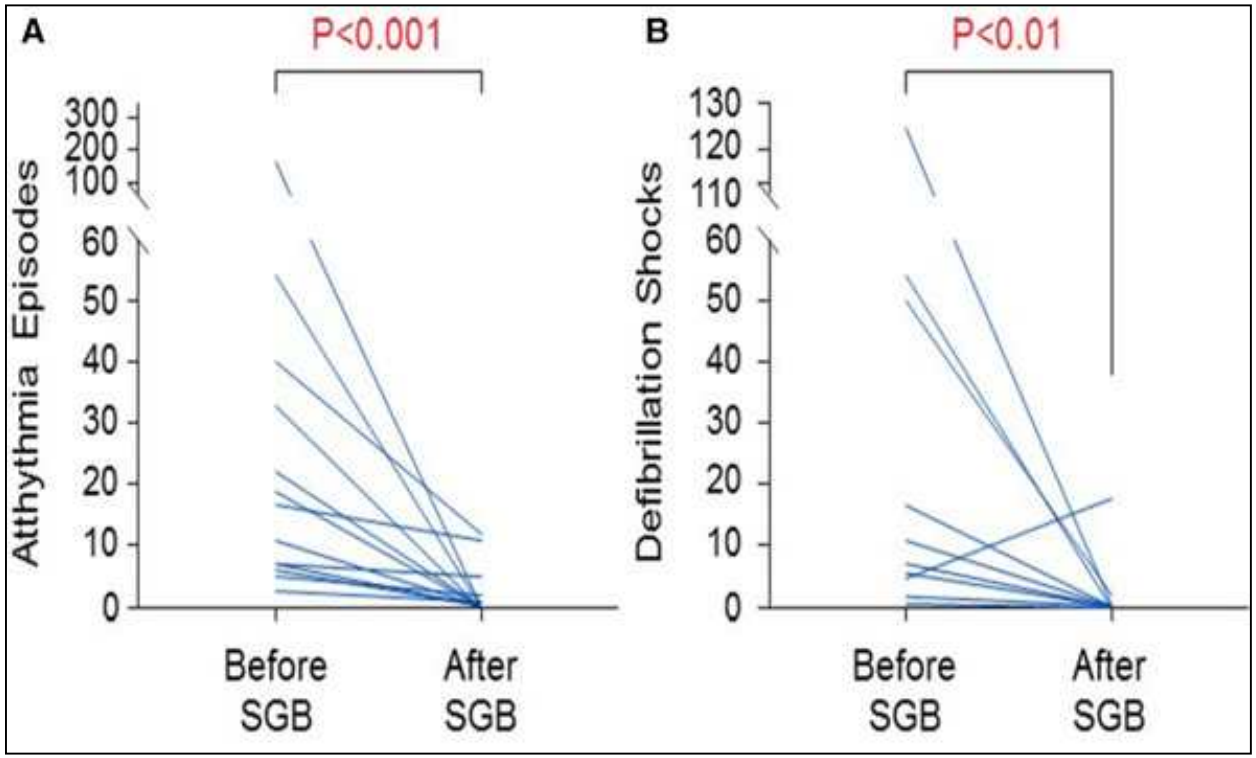
Percutaneous Stellate Ganglion Blockade in Patients With Electrical Storm



All pertinent structures were identified by ultrasonography (carotid artery, left internal jugular vein, longus coli muscle, vertebral artery, anterior scalene muscle, and brachial plexus).

Circulation: Arrhythmia and Electrophysiology. 2019;12(9):e007118.

Percutaneous Stellate Ganglion Blockade in Patients With Electrical Storm



The numbers decreased for both at 72 h. A, VA episodes 72 h before and 72 h after stellate ganglion blockade (SGB). B, ICD shocks 72 h before and 72 h after SGB.

Circulation: Arrhythmia and Electrophysiology. 2019;12(9):e007118.

Outcome of Hospitalization by Patient Characteristics

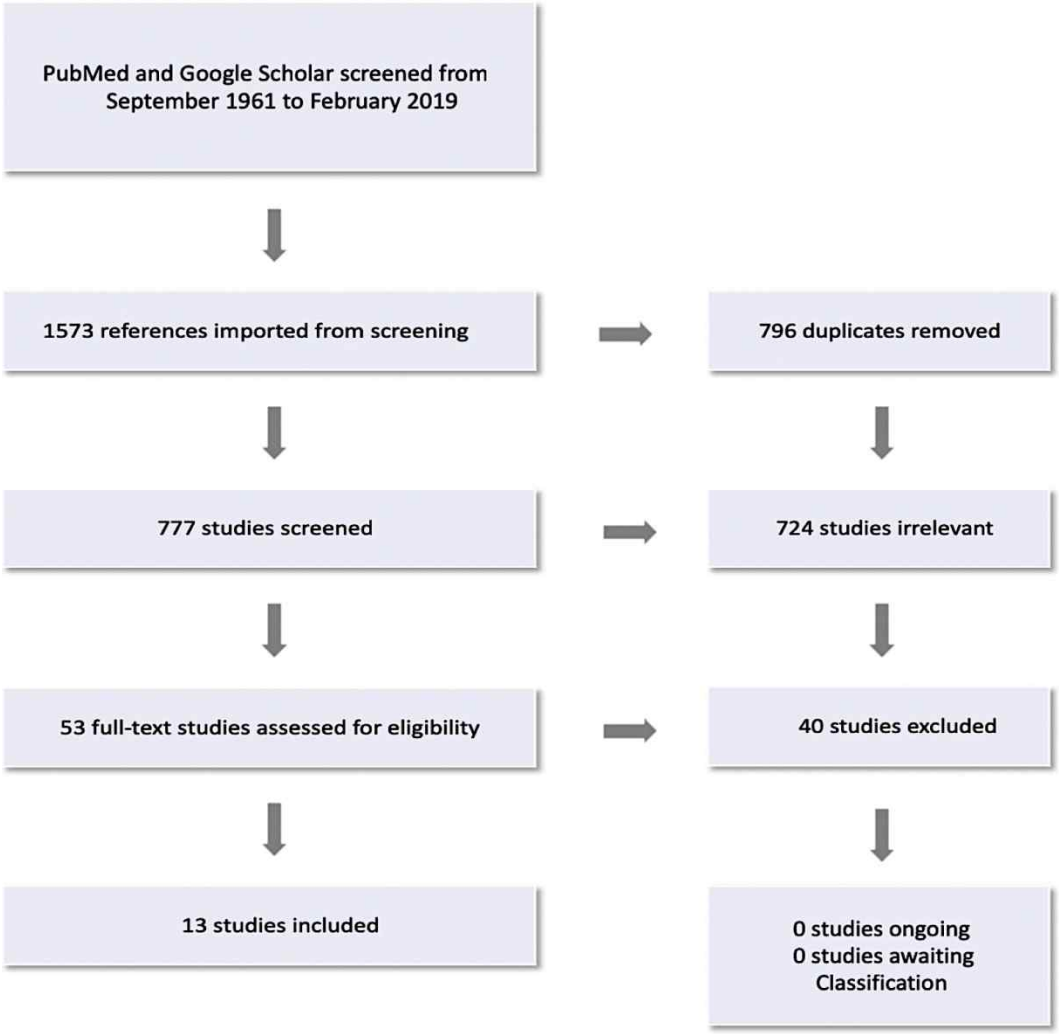
Characteristics	Survived (n=23)	Deceased (n=7)	*P* Value
Men, n (%)	16 (69.6)	6 (85.7)	0.64
Age, y	57±13	59±17	0.76
Body mass index, kg/m²	33±9	34±5	0.69
Echocardiography			
LVEF, %	33±14	36±19	0.64
LVEDD, mm	58±11	66±11	0.12
Cardiac index, L/min per m²	2.32±0.67	2.32±0.61	0.98
RVSP, mm Hg	35±15	56±34	0.03
ES induced by AMI	6 (26.1)	3 (42.9)	0.64
Cardiac surgery within 2 wk	7 (30.4)	3 (42.9)	0.66
Cardiomyopathy			0.03
Ischemic	10 (43.5)	7 (100)	
Nonischemic	10 (43.5)	0 (0)	
Idiopathic VT/long QT	3 (13.0)	0 (0)	
Arrhythmias			0.39
VT	8 (34.8)	4 (57.1)	
VF or VT+VF	15 (65.2)	3 (42.9)	
Shortest VT cycle length, ms	259±75	275±100	0.69
Longest VT cycle length, ms	351±94	443±86	0.06
Widest QRS VT duration, ms	151±30	181±10	0.13
Continued ES at 24 h	6 (26.1)	6 (85.7)	0.009
Continued ES at 72 h	9 (39.1)	6 (85.7)	0.08

Long-term Outcomes

- 23 patients were discharged.
- Mean follow-up of 22+/-16 months (range, 5-57 months; median, 23 months),
- 3 patients underwent orthotopic heart transplantation
- 5 patients died (causes were septic shock, renal failure, heart failure, massive stroke, and unknown cause).
- 10 patients underwent catheter ablation for VA during follow-up.
- 1 patient with idiopathic VF underwent left cardiac sympathetic denervation after achieving partial effect from SGB. This patient had no recurrent sustained VA.
- 10 were free from recurrent VA after discharge.

Circulation: Arrhythmia and Electrophysiology. 2019;12(9):e007118.

Meta-analysis of neuromodulation for refractory VT

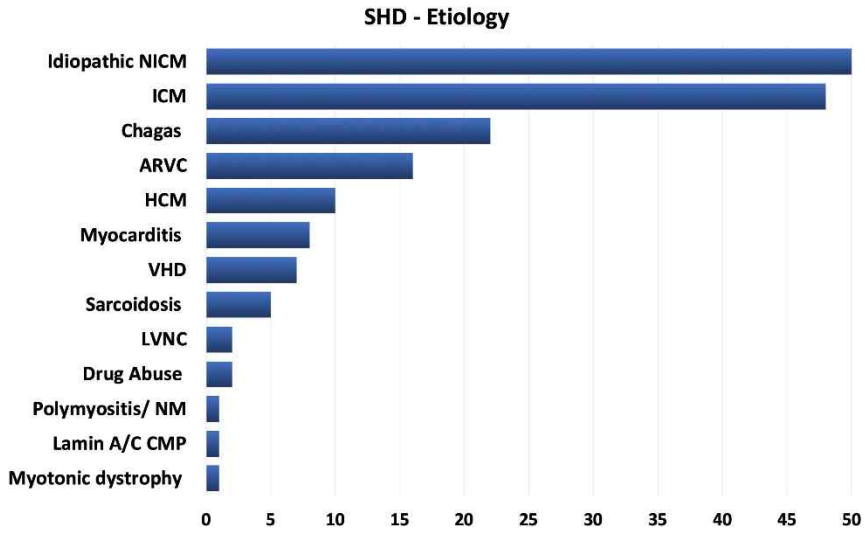


- ✓ Patients with SHD and refractory VA who underwent either left-sided cardiac sympathetic denervation (LCSD) or bilateral cardiac sympathetic denervation (BCSD) were included.
- ✓ Refractory VA was defined as sustained ventricular tachycardia (VT) episodes/electrical storm refractory to treatment with AAD therapy.

Heart Rhythm, 2019;16;10, 1499-1505

Meta-analysis of neuromodulation for refractory VT

Study (n [SHD])	Age (y)	Male	CMP	LVEF (%)	VT storm	VT ablation	>1 AAD	NYHA I II or IV
Vaseghi 2017 (n = 121)	55 ± 13	90 (74)	NICM/ICM	30 ± 13	91 (75)	80 (66)	60 (50)	48%
Richardson 2017 (n = 5)	54.6 ± 13.2	3 (60)	NICM/ICM	NI	0 (0)	5 (100)	3 (60)	NI
Coleman 2012 (n = 5)	26.7 ± 25.5	3 (60)	NICM	NI	NI	NI	NI	NI
Amer 2017 (n = 1)	49	1 (100)	ICM	45	1 (100)	0 (0)	1 (100)	NI
Kopecky 2018 (n = 1)	69	1 (100)	NICM	25	1 (100)	1 (100)	1 (100)	NI
Dusi 2018 (n = 5)	52*	1 (20)†	NICM/ICM	33‡	5 (100)	NA	NA	NI
Gutierrez 2006 (n = 1)	29	1 (100)	NICM	NI	0 (0)	1 (100)	1 (100)	NI
Estes 1961 (n = 1)	35	1 (100)	NICM	NI	0 (0)	0 (0)	1 (100)	NI
Johnson 2011 (n = 1)	3	1 (100)	NICM	NI	1 (100)	0 (0)	0 (0)	NI
Gadhinglajkar 2013 (n = 1)	52	1 (100)	ICM	20	1 (100)	1 (100)	1 (100)	NI
Assis 2019 (n = 7)	34.3 ± 21.7	2 (29)	NICM	57 ± 4.8	6 (85.7)	7(100)	7(100)	14%
Téllez 2019 (n = 19)	57.6 ± 13.9	14 (74)	NICM/ICM	NI	6 (32)	12 (63)	19 (100)	NI
Okada 2019 (n = 5)	53 ± 11	2 (40)	NICM	38 ± 11	3 (60)	5 (100)	5 (100)	40%



Heart Rhythm, 2019;16;10, 1499-1505

Meta-analysis of neuromodulation for refractory VT

Study	Intervention (n)	Pre-BCSD (mo)	Post-BCSD (mo)	Arrhythmic outcome
Vaseghi 2017	BCSD (98) LCSD (23)	12	18 ± 16.8	Freedom from ICD shocks or sustained VT: 58% (at 1 y) Freedom from ICD shocks or sustained VT: 49% at the end of follow-up
Richardson 2017	BCSD (5)	2.2 ± 0.8	5.7 ± 3.9	Freedom from VT/VF: 100%
Coleman 2012	LCSD (5)	NI	35.3 ± 27.9	Freedom from cardiac events: 80%
Amer 2017	LCSD (1)	few days	2.6	Freedom from VT/VF: 100%
Kopecky 2018	BCSD (1)	12	6	Freedom from ICD shocks/ATP: 00%
Dusi 2018	BCSD (5)	NI	11	Freedom from ICD shocks/ATP at the end of follow-up 60%
Gutierrez 2006	BCSD (1)	24	8	Freedom from VT/VF 100% (8 mo)
Estes 1961	BCSD (1)	32	51	Freedom from sustained VT/VF: 100%
Johnson 2011	LCSD (1)	13	24	Freedom from ICD shocks/ATP: 100%
Gadhinglajkar 2013	LCSD (1)	24	8	Freedom from VT/VF: 100%
Assis 2019*	BCSD (8)	12	22.8 ± 10.8	Freedom from ICD shocks/sustained VT at 1 year: 63% Reduction of ICD shocks by 92% at the end of follow-up
Téllez 2019	BCSD (19)	1	2.1 ± 2.2	Freedom from ICD shocks/sustained VT at the end of follow-up: 79%
Okada 2019	BCSD (4) RCSD (1)	6	26	Freedom from ICD shocks/sustained VT at the end of follow-up: 100%

Heart Rhythm, 2019;16;10, 1499-1505

Summary

- ✓ Neuroaxial modulation plays a critical role in the therapeutic management of ES, particularly in cases of long QT syndrome and catecholaminergic ventricular tachyarrhythmias.

- ✓ Recent data support the use of cardiac sympathetic denervation (CSD) as an option in a wider range of ES cases, refractory to medication, and/or ablation treatments

Case Review

52 yr old male

s/p ICD implantation d/t Brugada syndrome

Admission after receiving multiple ICD shocks
Clinically documented ECG was not available

Brief History

’11.10. aborted SCD (새벽에 자다가 발생, VF 있어 defib후 ROSC

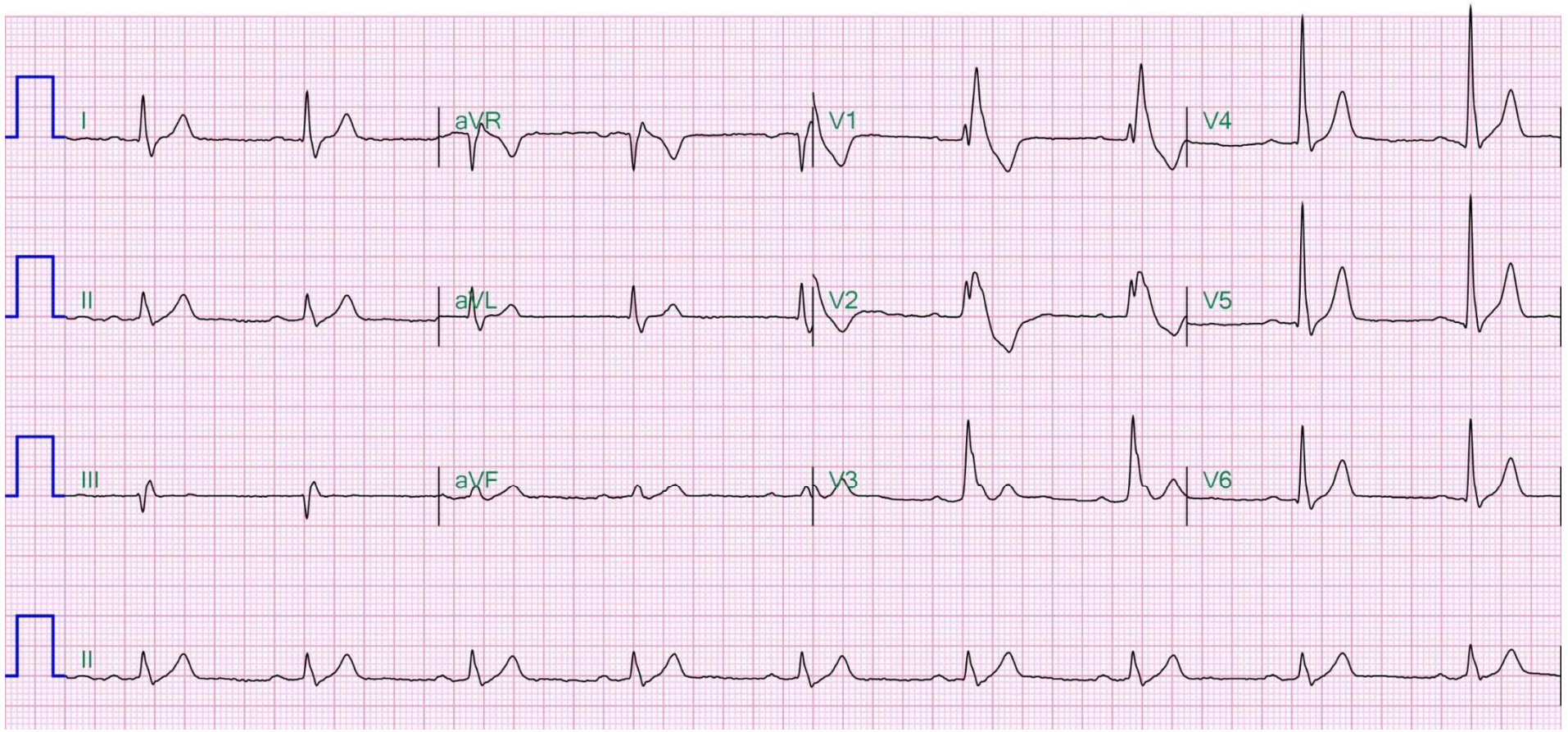
‘12,03. aborted SCD ➔ Brugada SD진단, ICD implantation

Since then, Pt was followed with medication

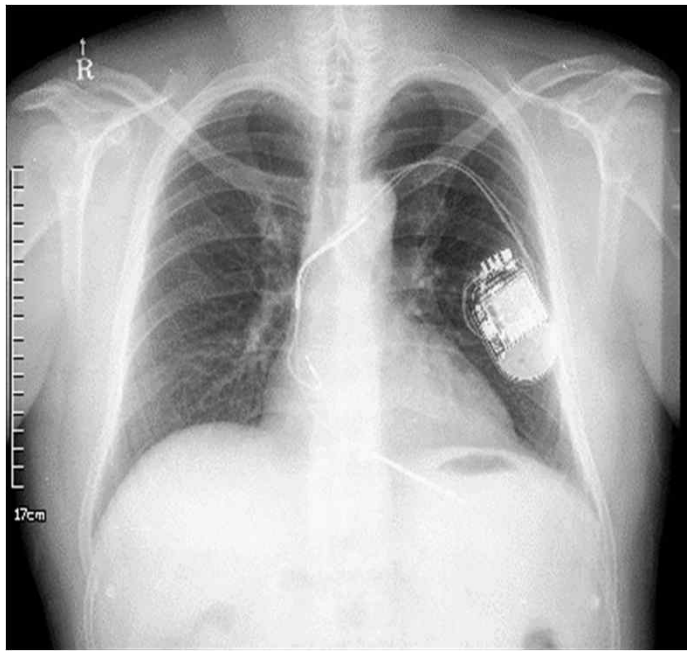
’13.02. VF episode있어 amiodarone start

‘13.04. multiple shock으로 admission

ECG on admission



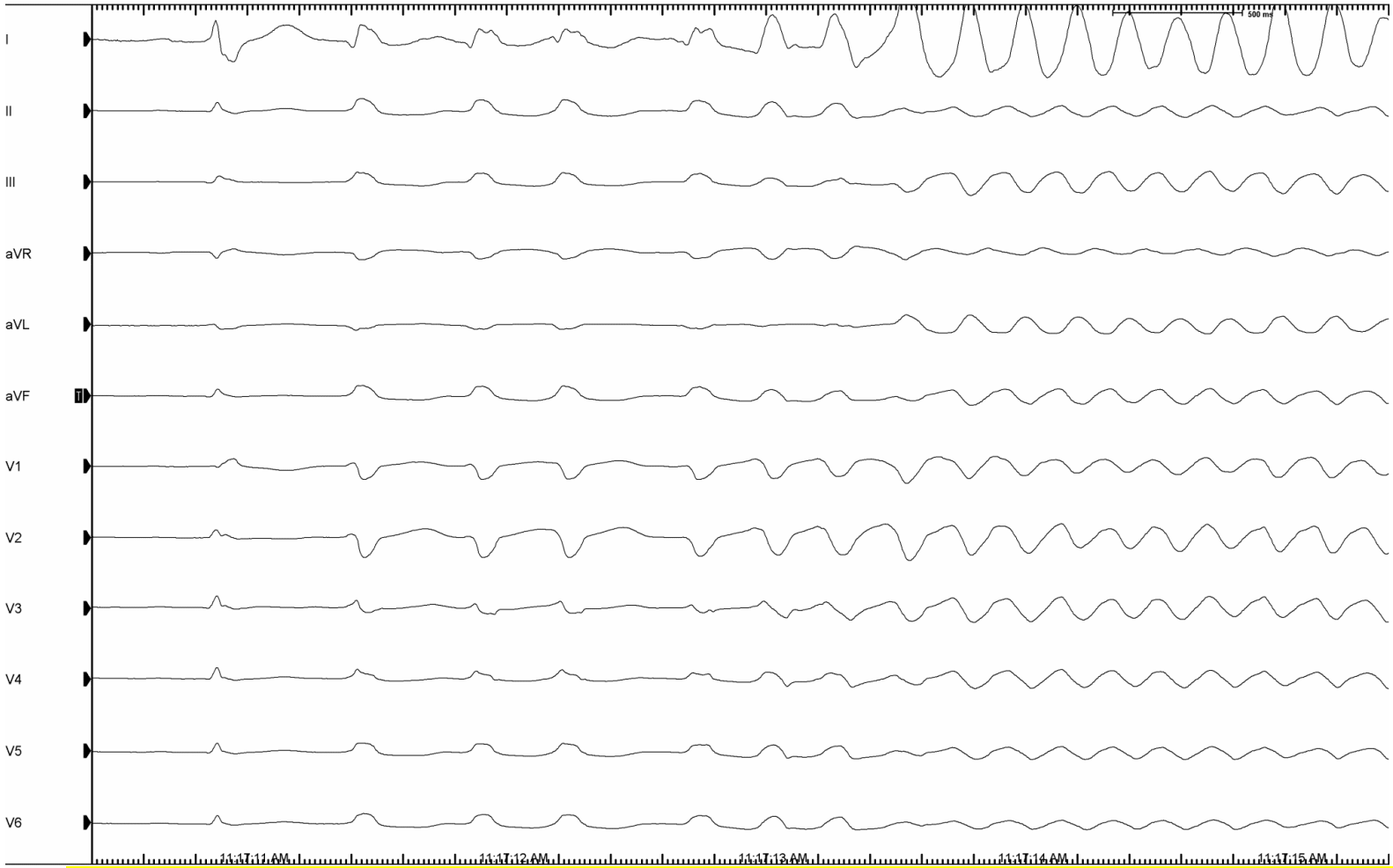
Chest PA



Echocardiography

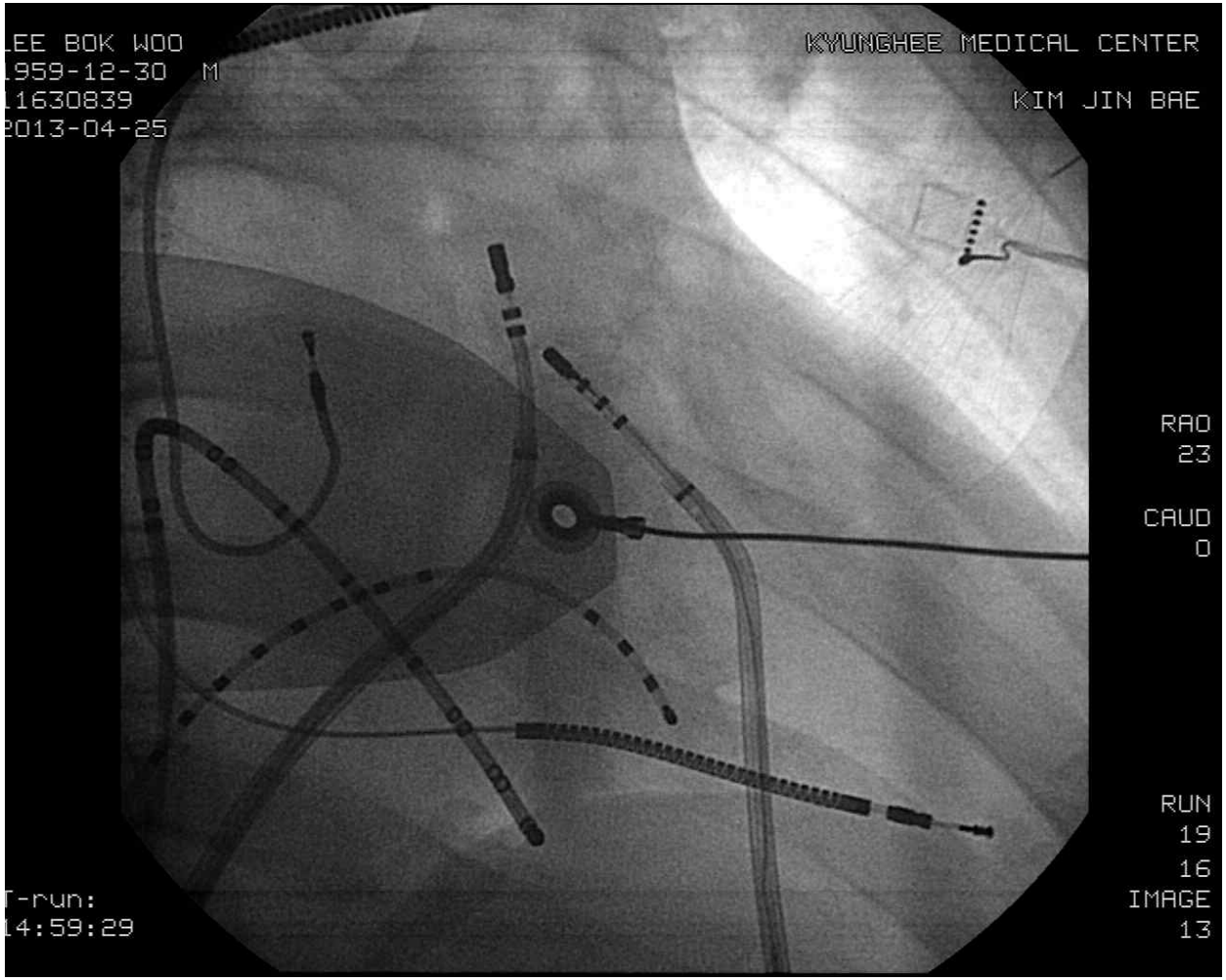
EF = 67 %
Normal cardiac chambers

VT induction

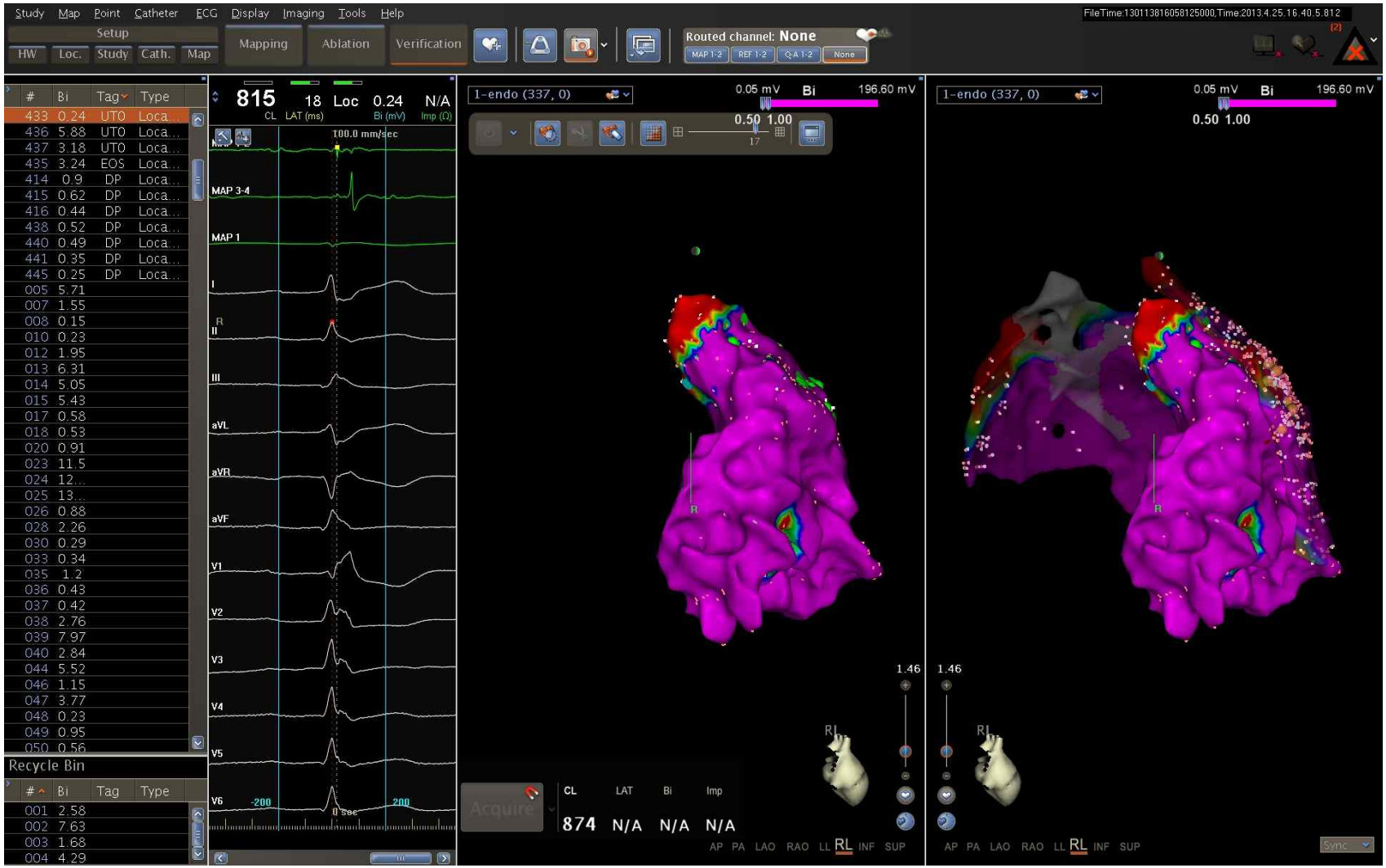


BP dropped, seizure like movement → DC cardioversion

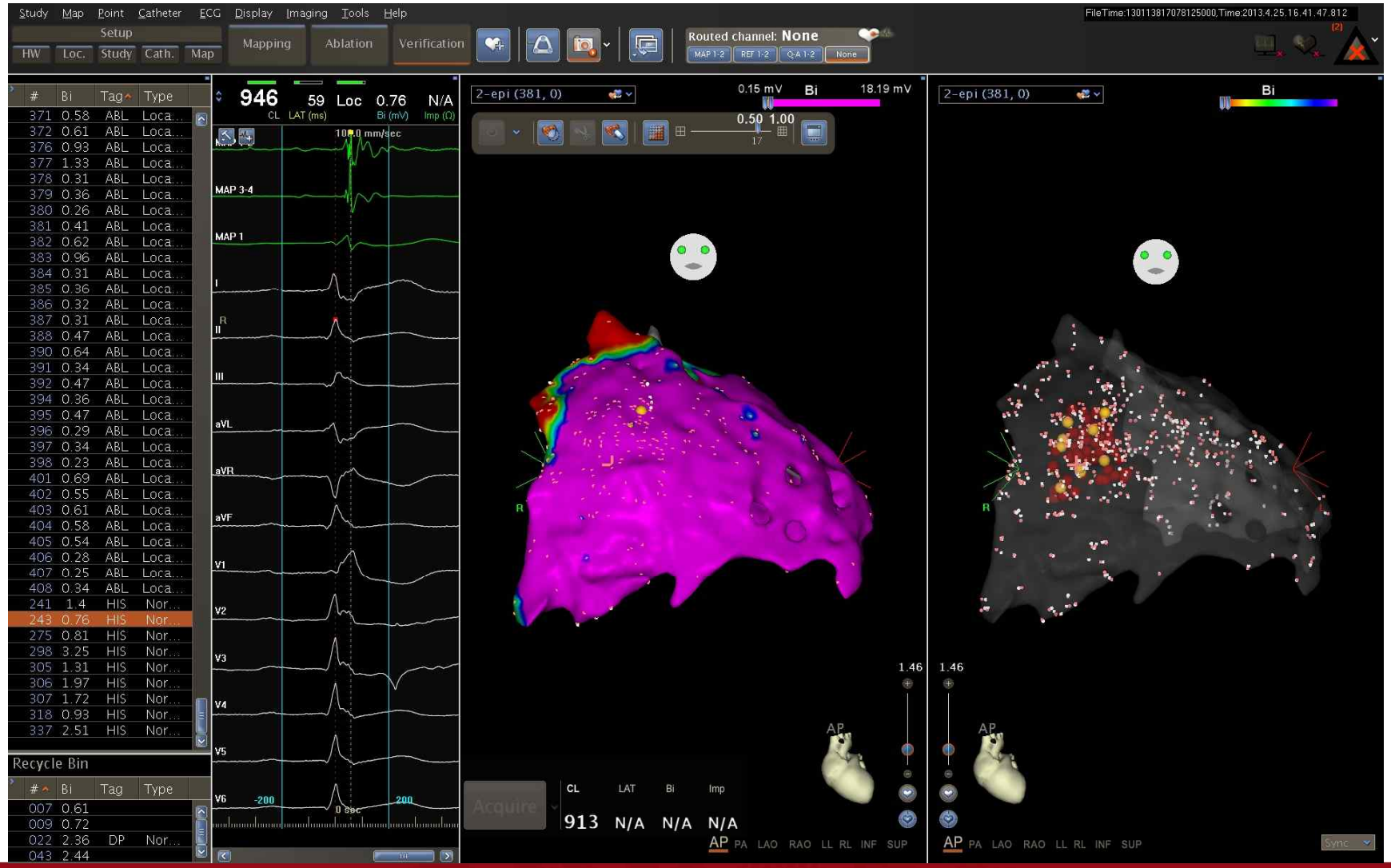
Fluroscopic location of catheter



Endocardial mapping

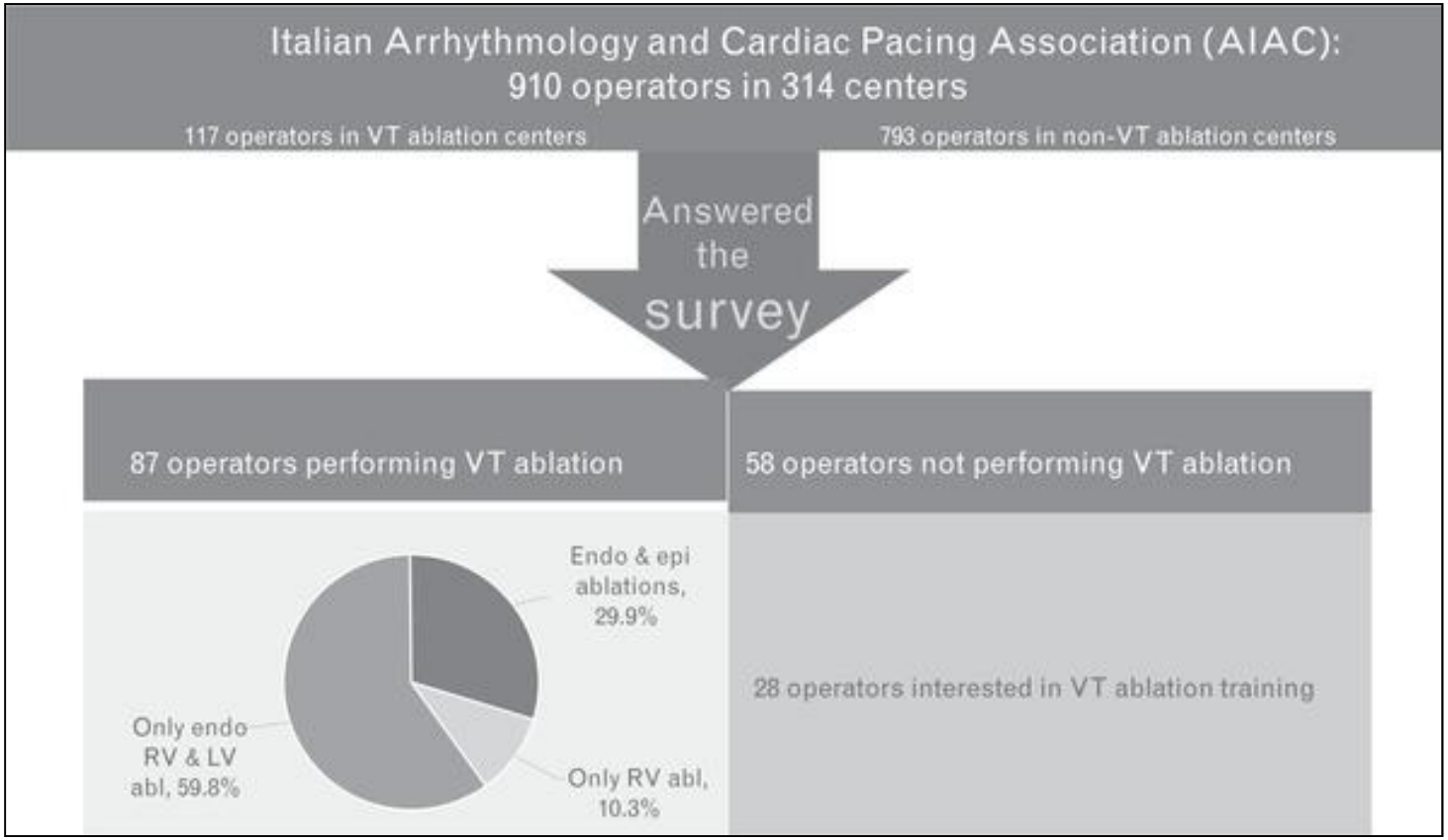


Epicardial mapping



Catheter ablation ??

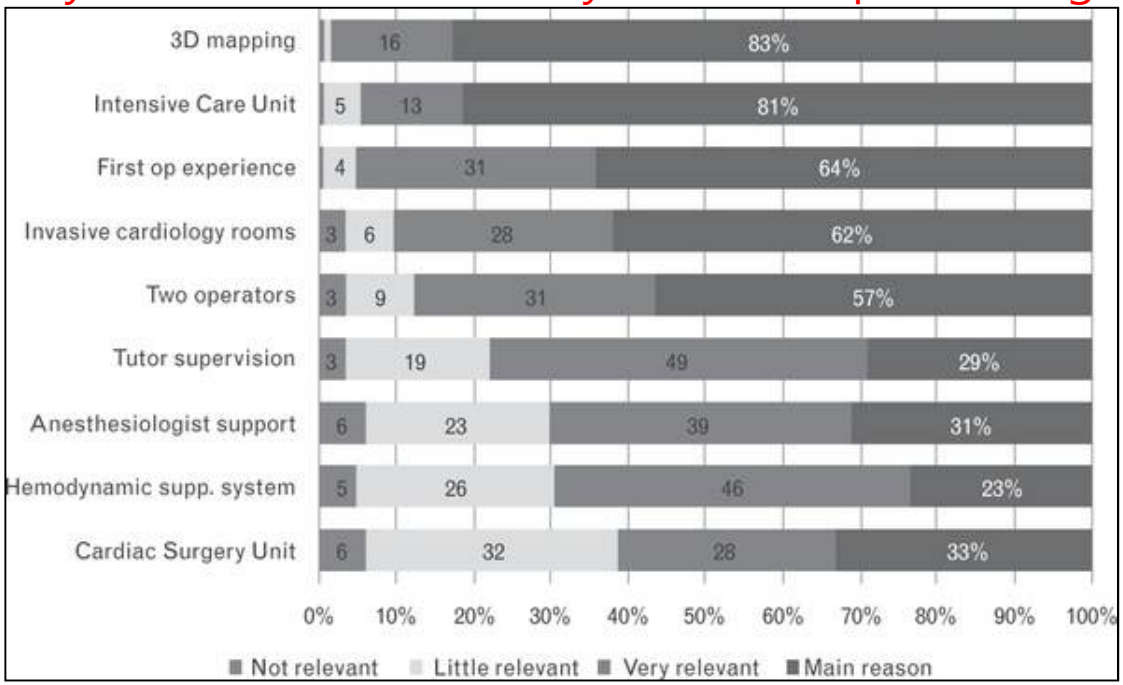
Nationwide survey on the current practice of ventricular tachycardia ablation



J Cardiovasc Med (Hagerstown). 2019 Sep;20(9):597-605

Nationwide survey on the current practice of ventricular tachycardia ablation

Which facilities do you think are mandatory in centers performing VT ablations ?



- ✓ In survey, 28.3% of operators currently perform catheter ablation in electrical storm patients during the acute phase of the electrical storm and 19.3% after a period of hemodynamic stabilization.
- ✓ When asked about the optimal management of electrical storm, the vast majority of them (72.4%) stated that electrical storm patients should be transferred to regional referral centers.

J Cardiovasc Med (Hagerstown). 2019 Sep;20(9):597-605

Your choice

- Beta blocker
- Antiarrhythmic drug
- Catheter ablation
- Neuromodulation

Thank you for your attention