

FACULTY/PRESENTER DISCLOSURE

- Faculty: **Arnold Pinter**
- Relationships with commercial interests:
 - Grants/Research Support: Sorin Canada
 - Speakers Bureau/Honoraria: Medtronic Canada (>10 yrs ago)
 - Consulting Fees: None
 - Other: None

Personal disclosure:

- *I have seen device cases that I could not figure out*
- *I like to have fun (by tricking unsuspecting people)*

ICD Troubleshooting??

(Trouble + Shooting = Troubleshooting)

Arnold Pintér

St. Michael's Hospital

Objectives

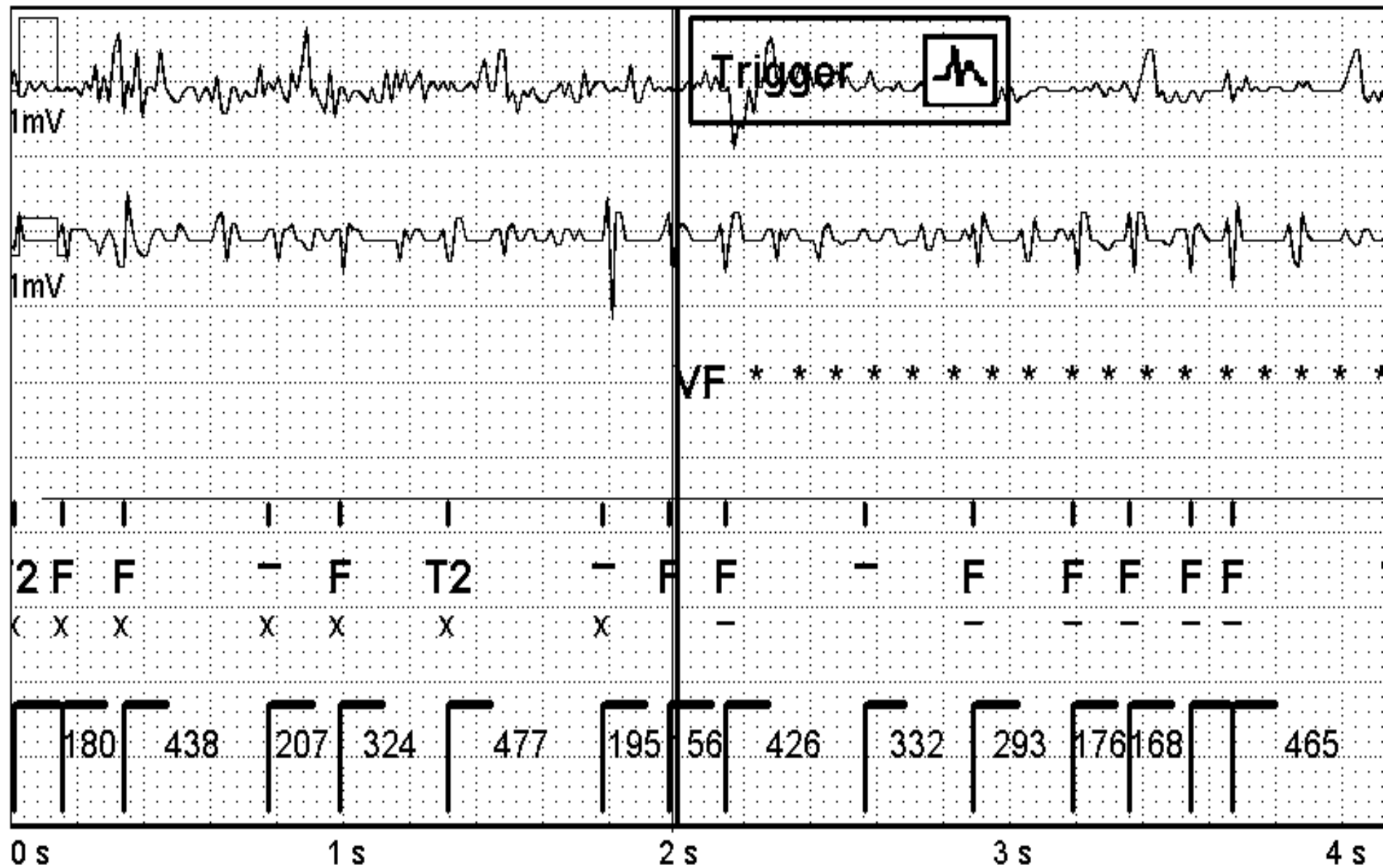
- To review cases of the age old ICD dilemma: SVT or VT?
- To provide insights to troubleshooting
- To show how an ICD can act as a miniature EP lab
- To have an open and interactive discussion
- To have fun

Case 1

- 76 yo female patient
- Anterior MI 1990
- CABGx4 and aneurysmectomy in 2006
- HTN, DM2, AFib
- LVEF 28% (MUGA)
- VVI ICD implantation for primary prophylaxis
- presents 2 months later with a shock from the ICD

Position 1 Leadless ECG Autogain (5.1 mm/mV)

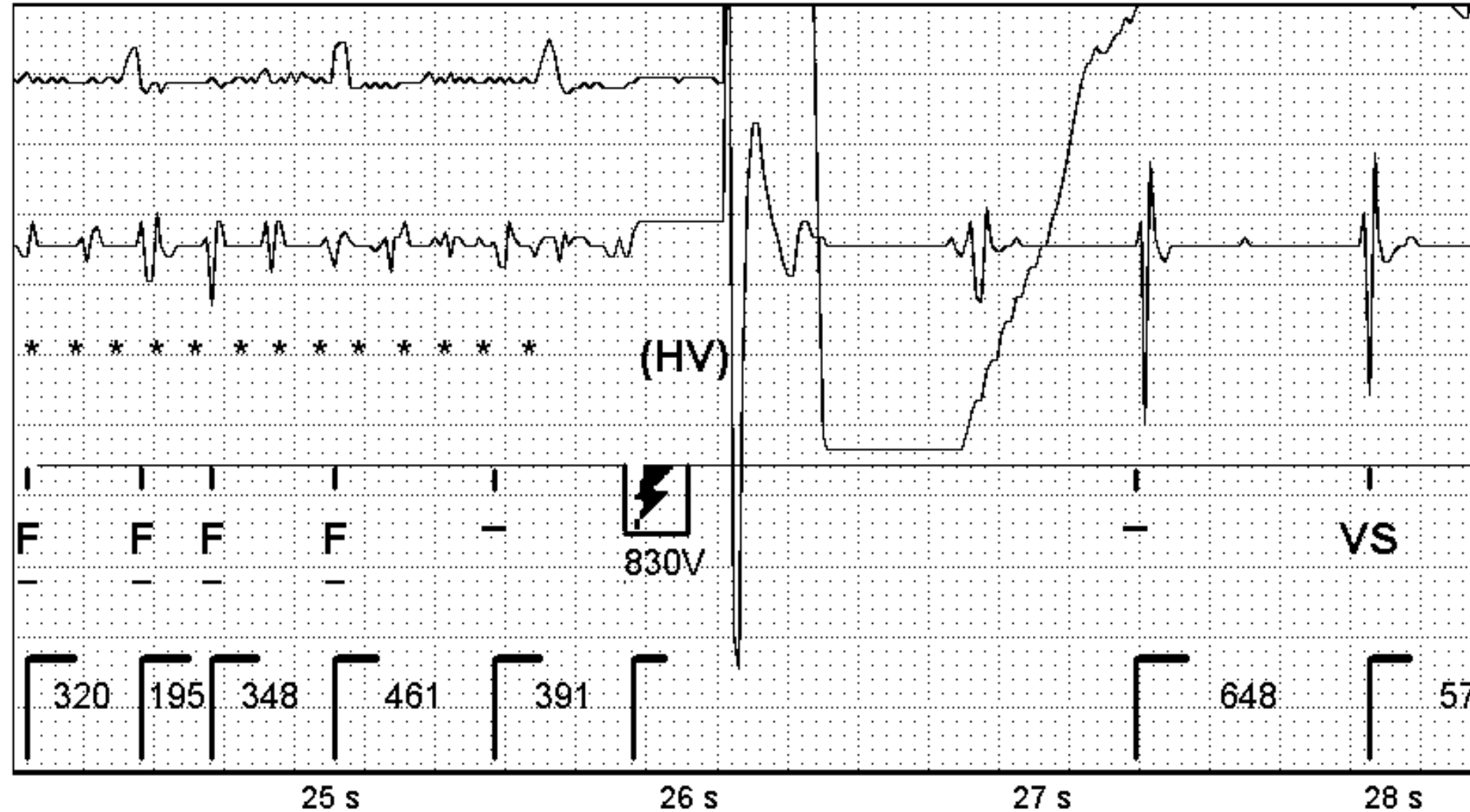
Position 2 V Sense Amp Autogain (2.5 mm/mV)



The therapy was: 1. Appropriate and necessary 2. Appropriate but unnecessary
3. Inappropriate due to SVT 4. Inappropriate due to noise/artefact

(Continued) **VF** 22 Jun 2010 20:46

Position 1 Leadless ECG Autogain (5.1 mm/mV) Position 2 V Sense Amp Autogain (2.5 mm/mV)



Case 2

- 59 yo female patient
- HTN, DM2, OSA, obesity
- ventricular preexcitation
- sudden onset syncope
- echo: LVEF 50%, septal wall motion abnormality
- MRI: no delayed enhancement
- MIBI: no ischemia

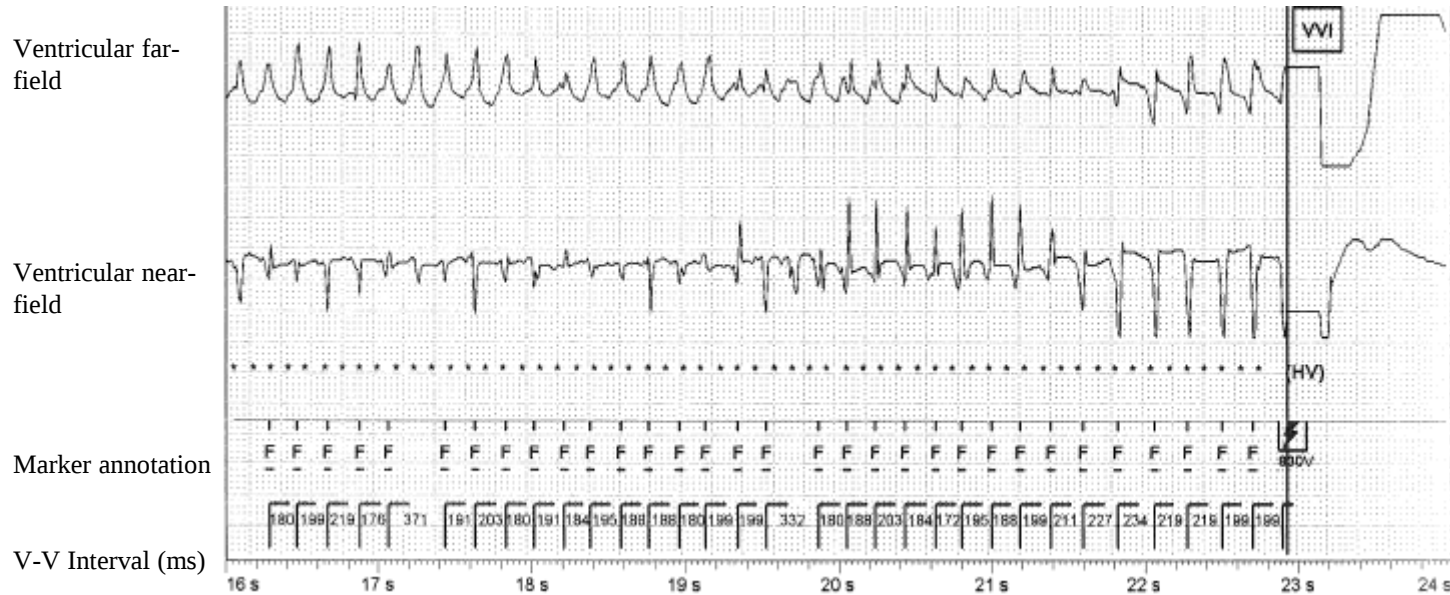
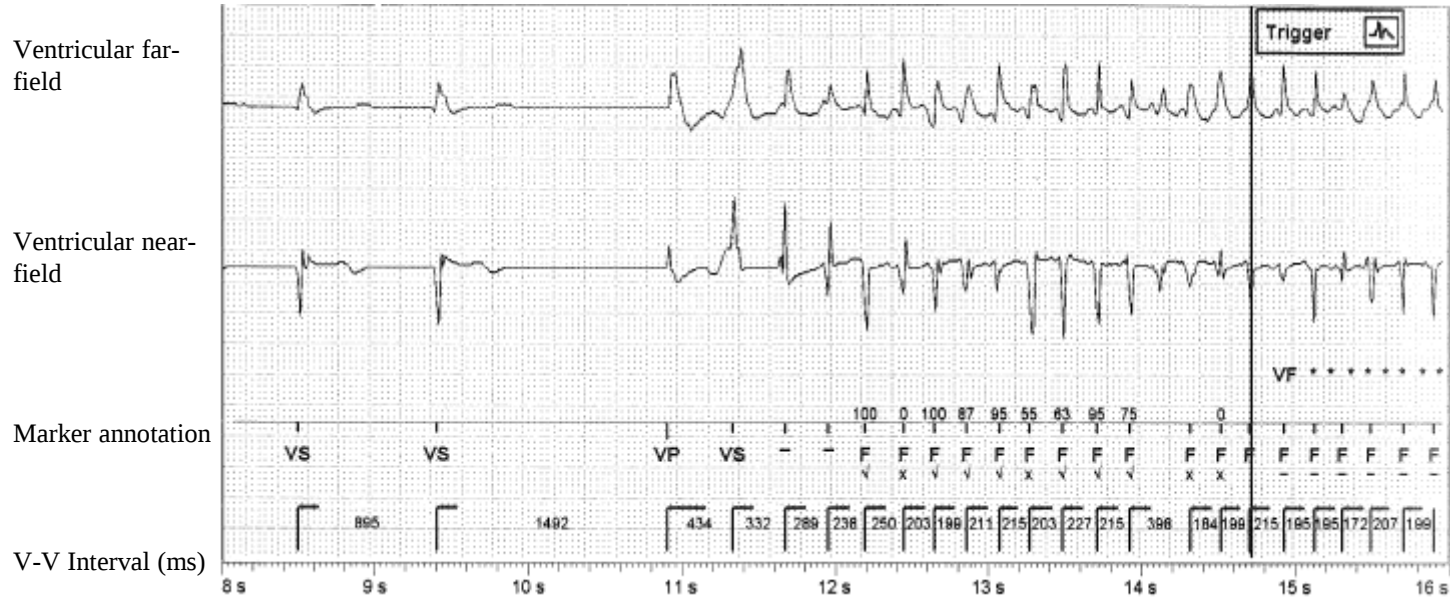
EP study

- Para-His AP
- AP antegrade ERP 600/300 ms, antegrade block CL 470 ms, no VA conduction, no AVRT
- ventricular PES: 600/230/210 ms repeatedly induced polymorphic VT up to 12 s,
- patient's symptoms preceding the syncope were reproduced by the polymorphic VT
- patient received a VVI ICD, active fixation lead into RV apical septum

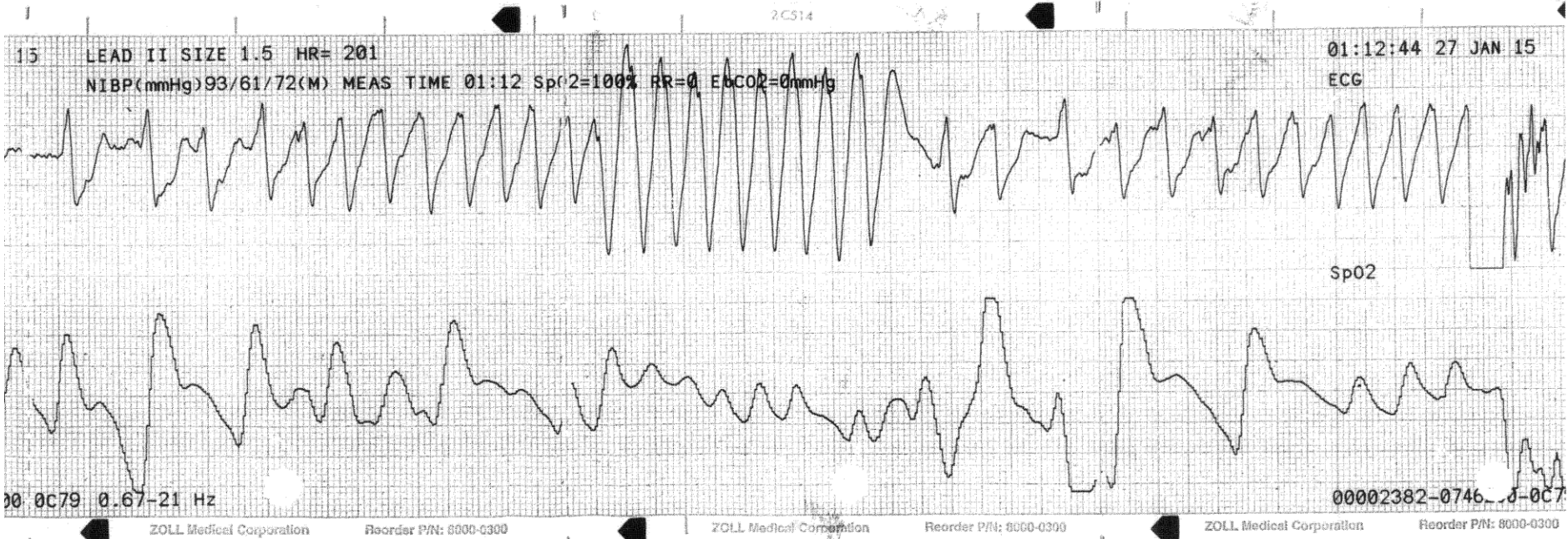
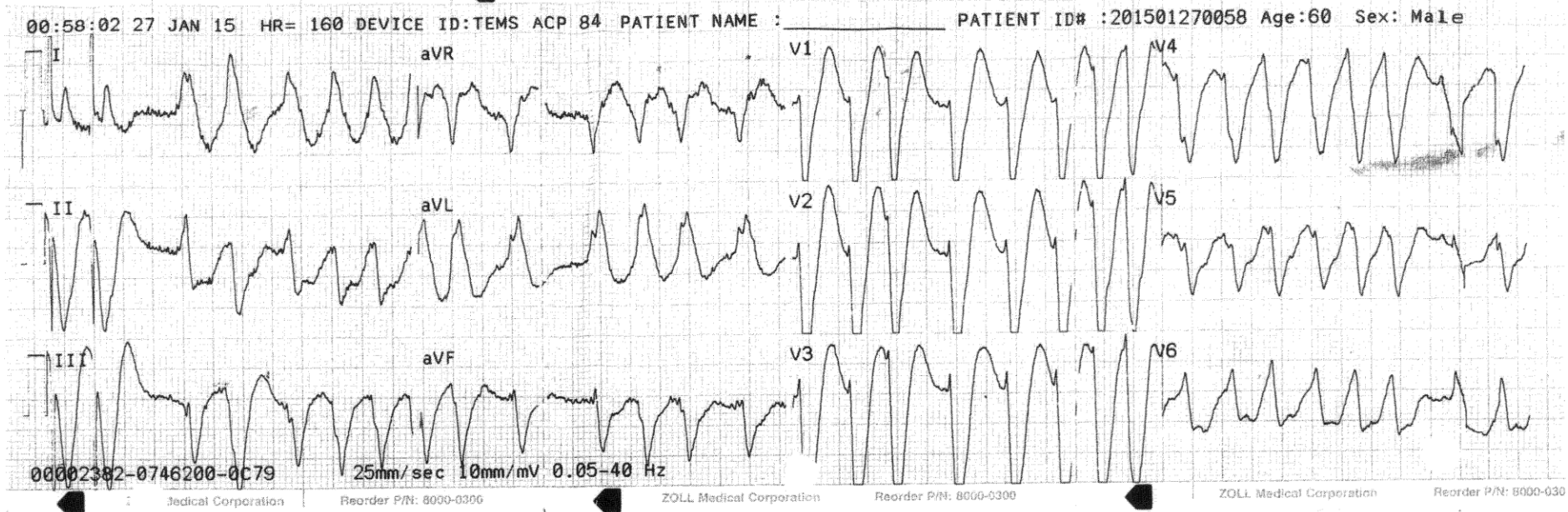
F/U at 6 weeks postop

- 11 episodes
- 8 self-terminated
- 3 episodes received a single shock each
- All episodes looked the same

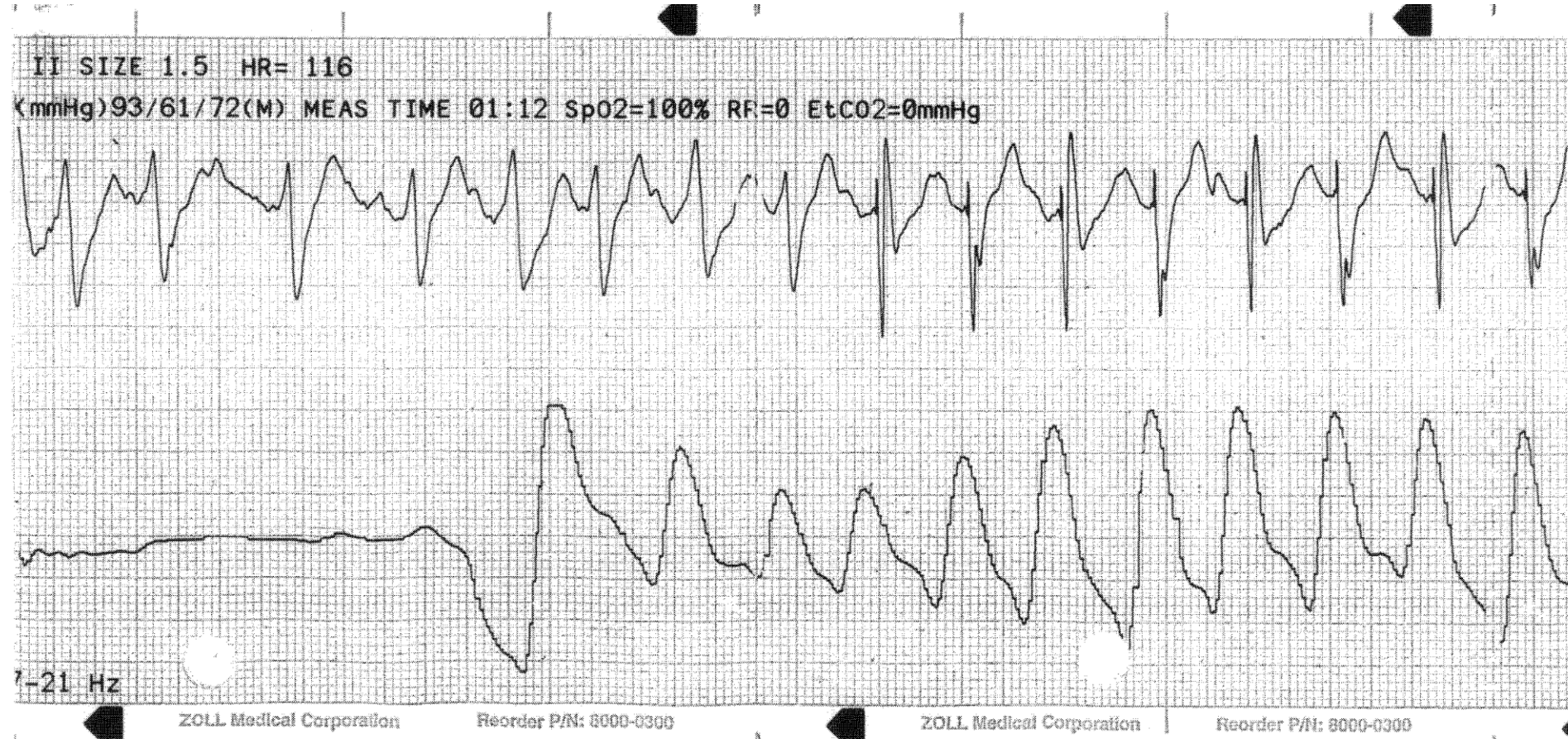
What is your working diagnosis? 1. Idiopathic VF 2. Torsade 3. VF due to acute ischemia 4. Pause-dependent polymorphic VT 5. Pacing triggered polymorphic VT 6. Preexcited AF



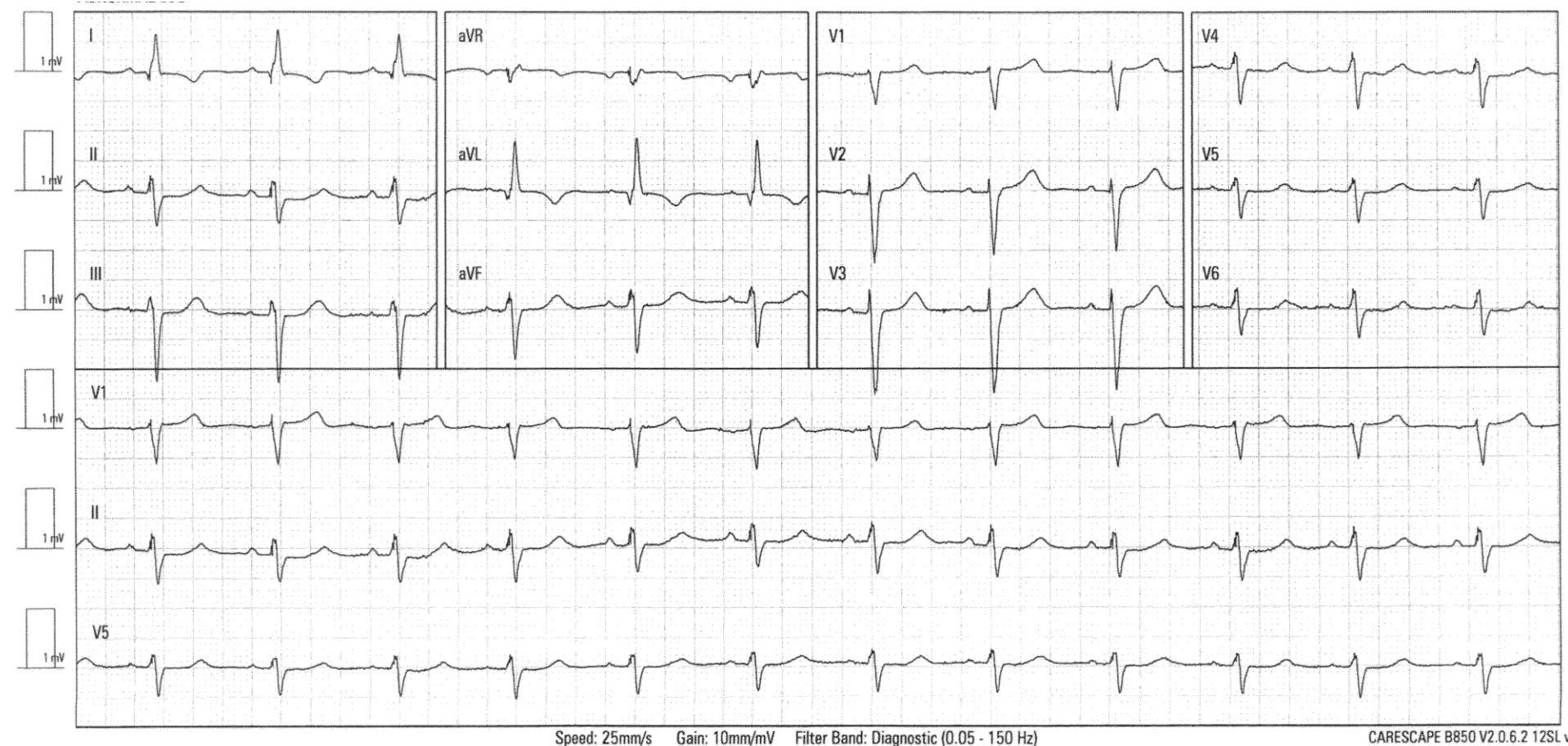
Case 3 EMS strips: 1. VT or 2. SVT?



More EMS strips: 1. VT or 2. SVT?



Upon arrival



Underlying rhythm

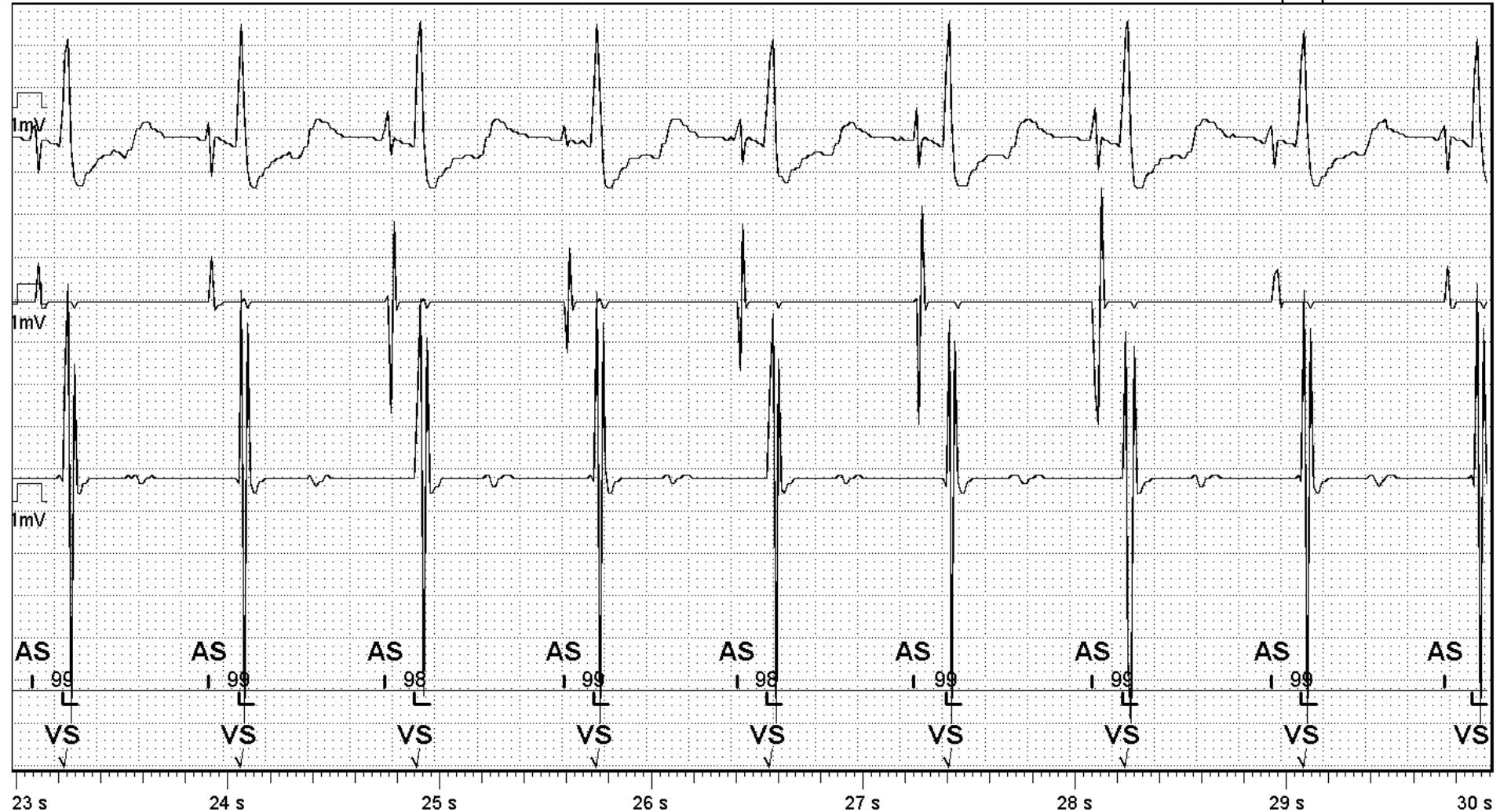
1: Leadless ECG AutoGain (2.1 mm/mV)

4: Markers

2: A Sense Amp AutoGain (2.6 mm/mV)

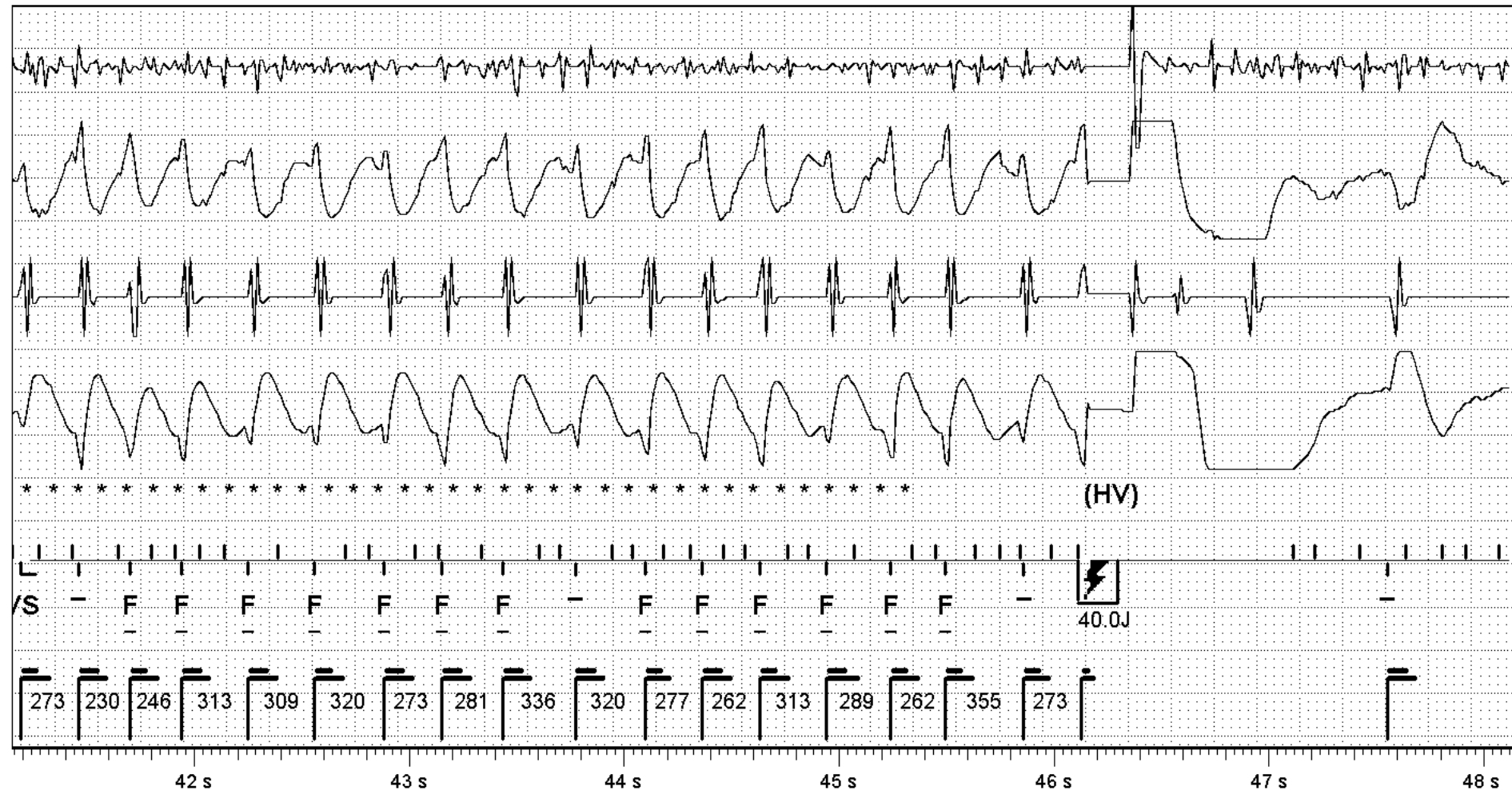
3: V Sense Amp AutoGain (2.4 mm/mV)

Sweep Speed: 25 mm/s



In medias res: Is it 1. SVT or 2. VT?

27 Jan 2015 0:35



1: A Sense Amp AutoGain (1.7 mm/mV)

2: Leadless ECG AutoGain (0.7 mm/mV)

3: V Sense Amp AutoGain (0.4 mm/mV)

4: Discrimination AutoGain (0.7 mm/mV)

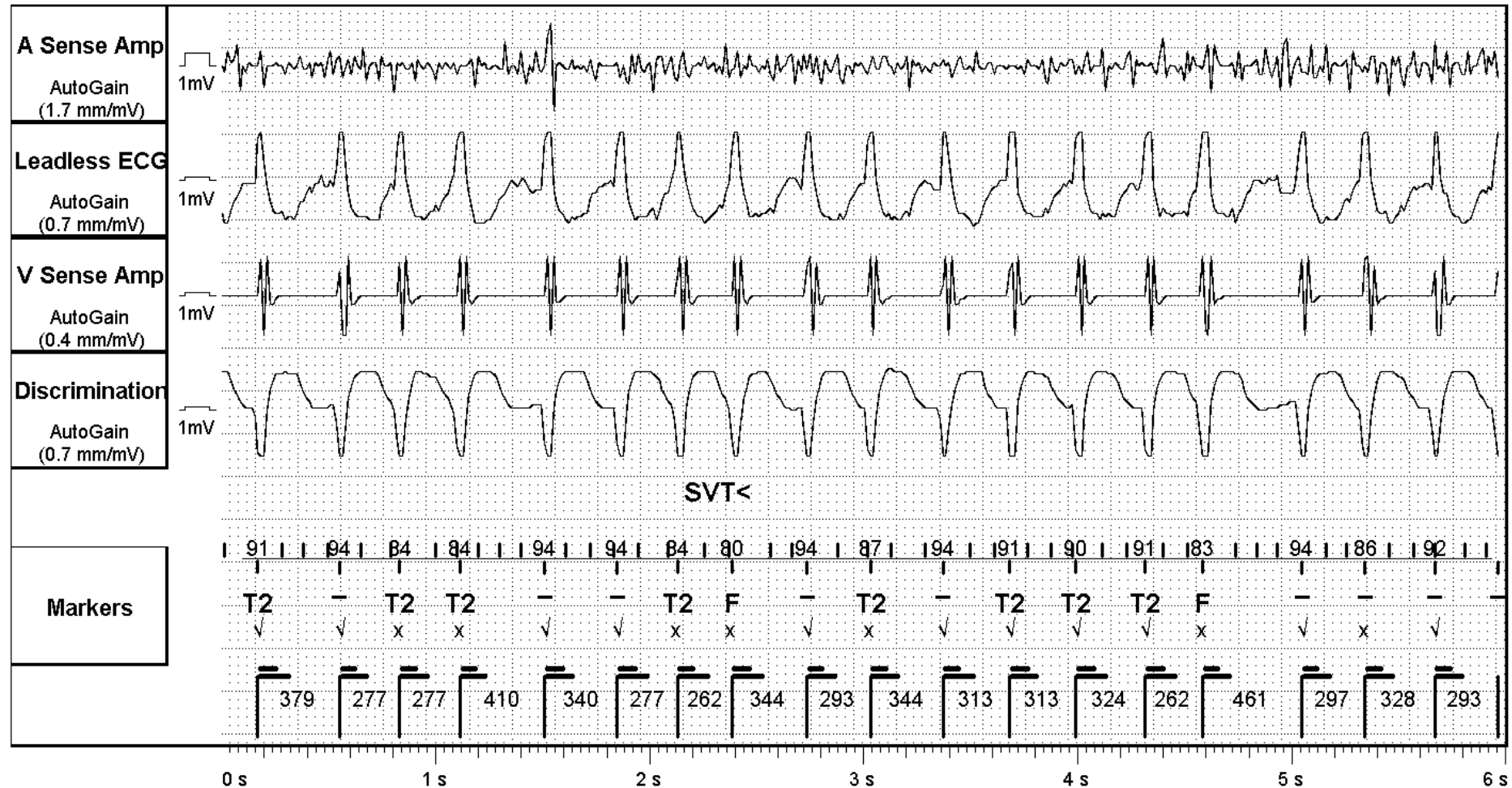
5: Markers

Sweep Speed: 25 mm/s

Figure 1 displays a multi-panel plot showing cardiac cycle data for a patient with a DDD pacemaker. The top panel shows the DDD signal, the second panel shows the VV signal, and the third panel shows the return to sinus rhythm. The bottom panel shows the AMS signal. The x-axis represents time in seconds from 49 s to 55 s. The y-axis represents the signal amplitude. The plot shows a transition from a regular sinus rhythm to a regular DDD rhythm at approximately 50.5 s, followed by a return to sinus rhythm at approximately 51.5 s. The AMS signal shows a series of peaks corresponding to the cardiac cycles.

Wait, there is more! Beginning of the event

27 Jan 2015 0:35



1: A Sense Amp AutoGain (1.7 mm/mV)

2: Leadless ECG AutoGain (0.7 mm/mV)

3: V Sense Amp AutoGain (0.4 mm/mV)

4: Discrimination AutoGain (0.7 mm/mV)

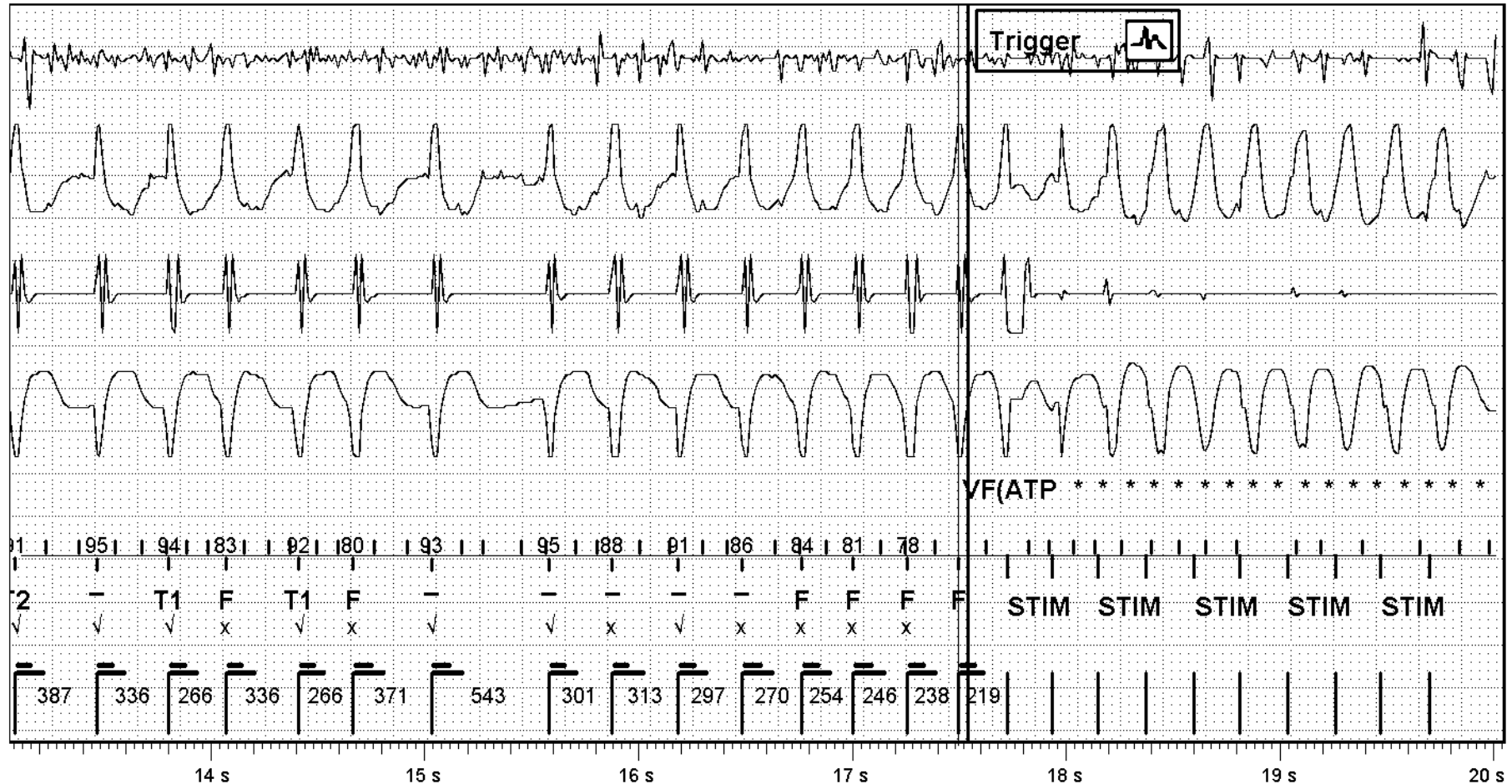
5: Markers

Sweep Speed: 25 mm/s

Why did the device start therapy?

1. SVT timeout
2. Morphology no match
3. No discriminator
4. Not a fair question (show me the programming first)

27 Jan 2015 0:35

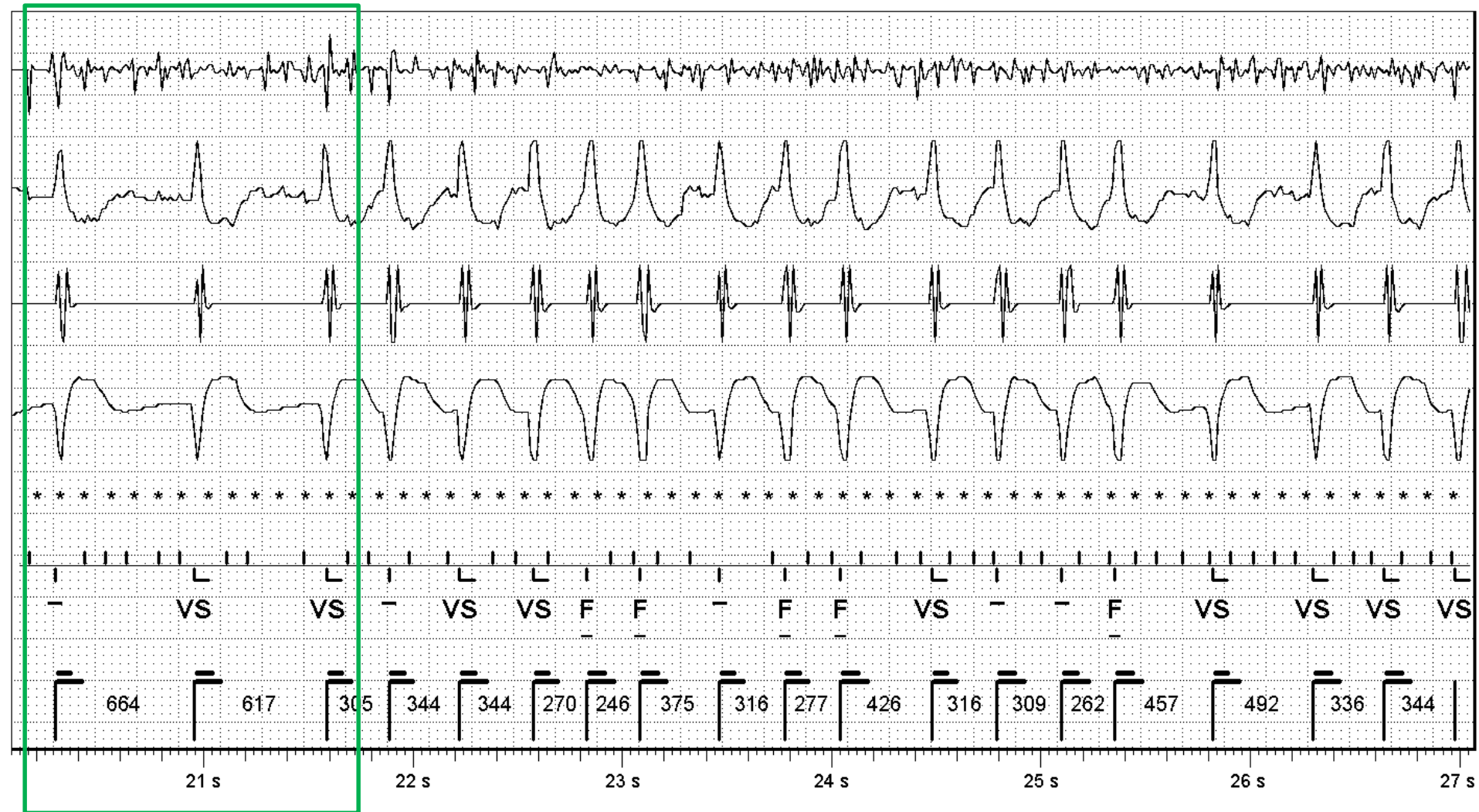


1: A Sense Amp AutoGain (1.7 mm/mV)
2: Leadless ECG AutoGain (0.7 mm/mV)
3: V Sense Amp AutoGain (0.4 mm/mV)

4: Discrimination AutoGain (0.7 mm/mV)
5: Markers

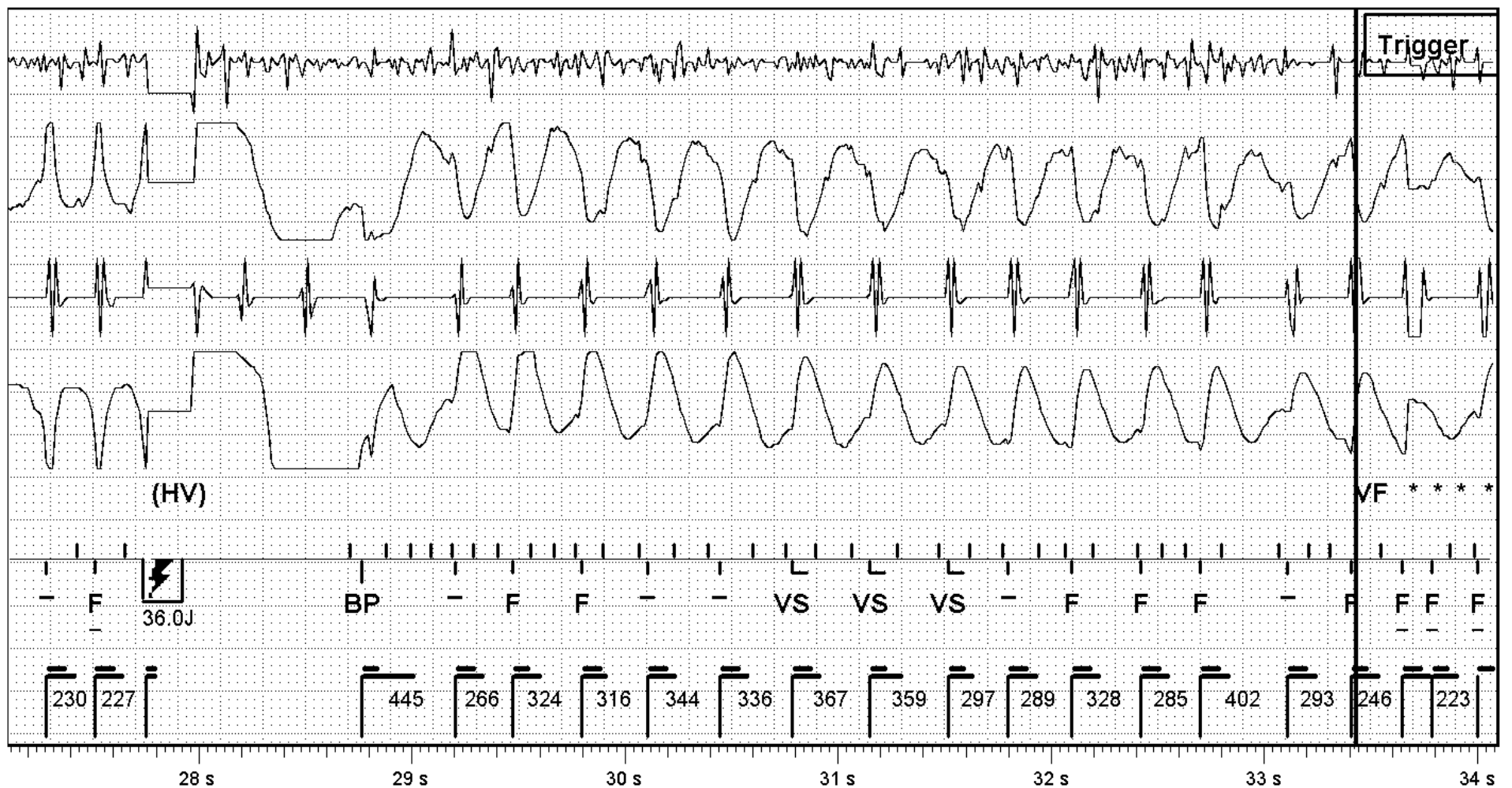
Sweep Speed: 25 mm/s

Post ATP: Did tachycardia terminate?



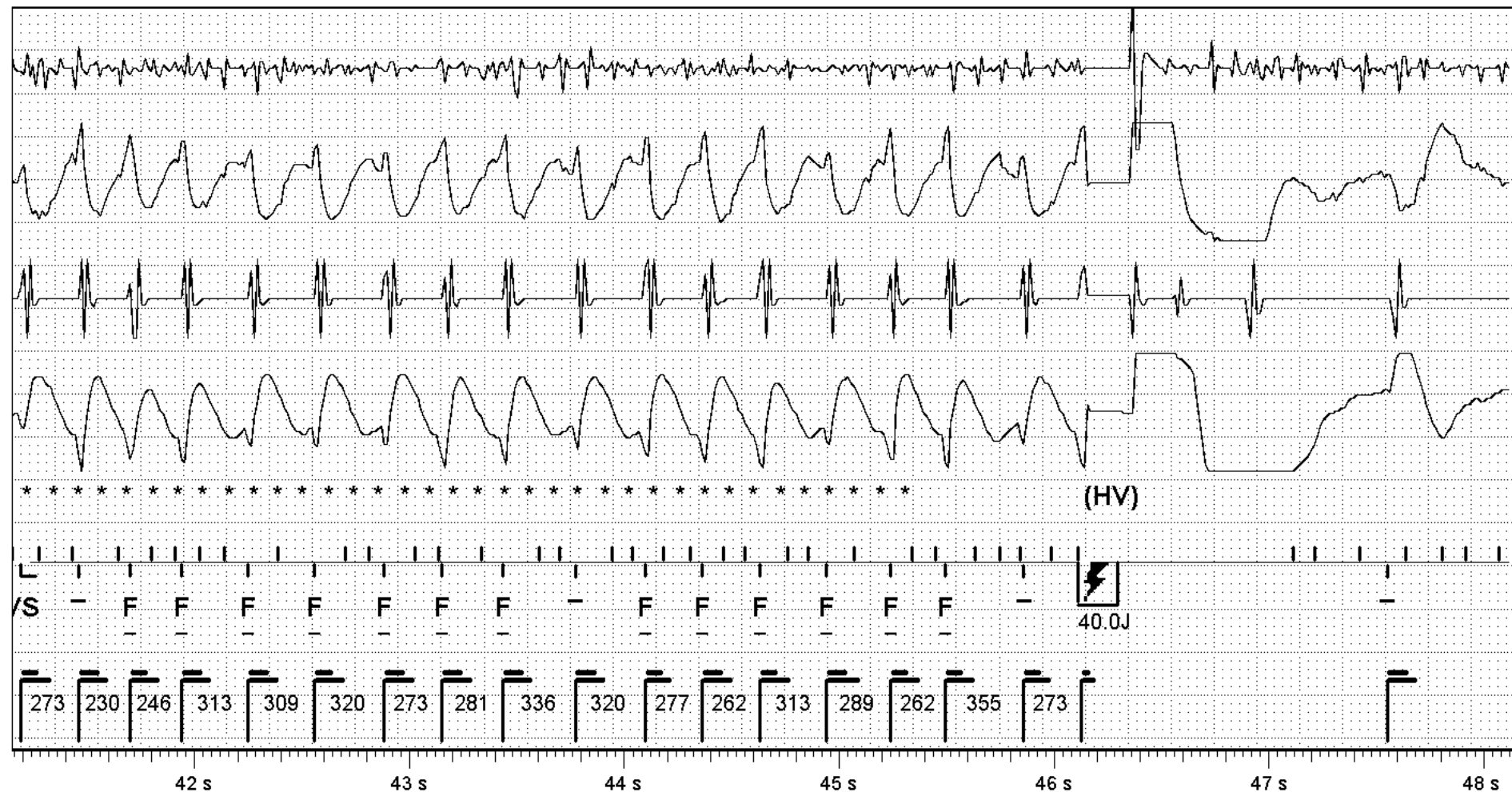
First shock

27 Jan 2015 0:35



Back to where we started: 1. SVT or 2. VT?

27 Jan 2015 0:35



1: A Sense Amp AutoGain (1.7 mm/mV)

2: Leadless ECG AutoGain (0.7 mm/mV)

3: V Sense Amp AutoGain (0.4 mm/mV)

4: Discrimination AutoGain (0.7 mm/mV)

5: Markers

Sweep Speed: 25 mm/s

Therapy Summary

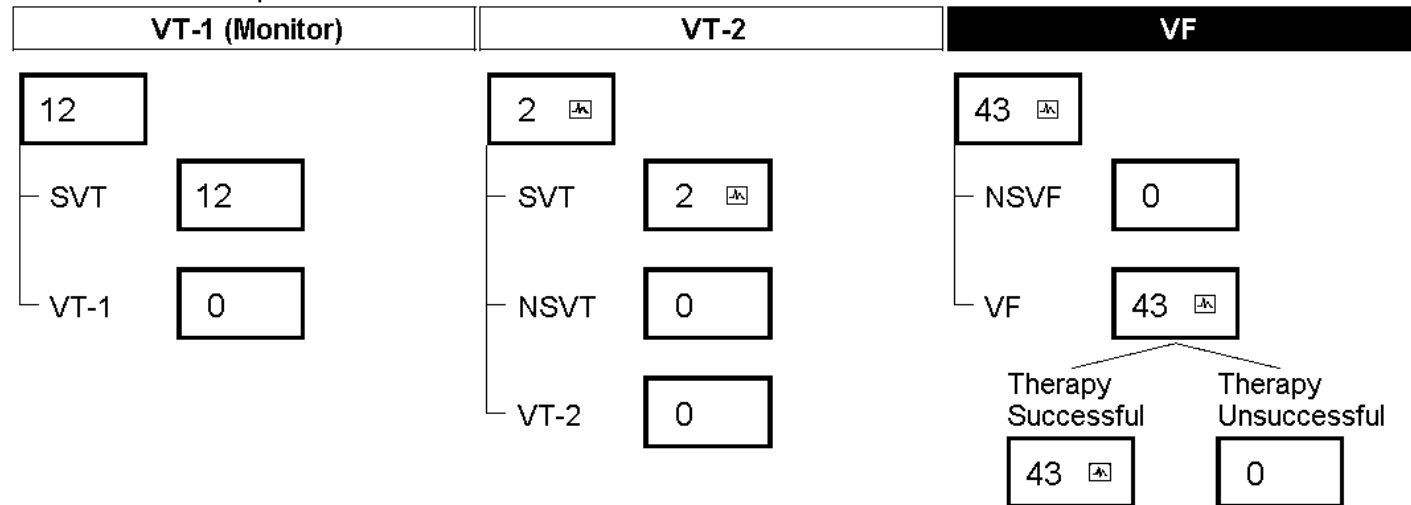
	VT-1	VT-2	VF
ATP Delivered		0	43
Shocks Delivered		0	30
Max Energy Shocks		0	6
Last HV Lead Impedance	VT-1 Zone is Monitor Only 74 Ω		
Total Aborted Shocks	24		

Results of ATP Delivery

	VT-1	VT-2	VF
Episodes Terminated	0	0	19
Episodes Not Terminated	0	0	24
Accelerations	0	0	

Episode Tree

Total VT/VF Episodes	88
SVT Episodes	14
Non-sustained Episodes	31



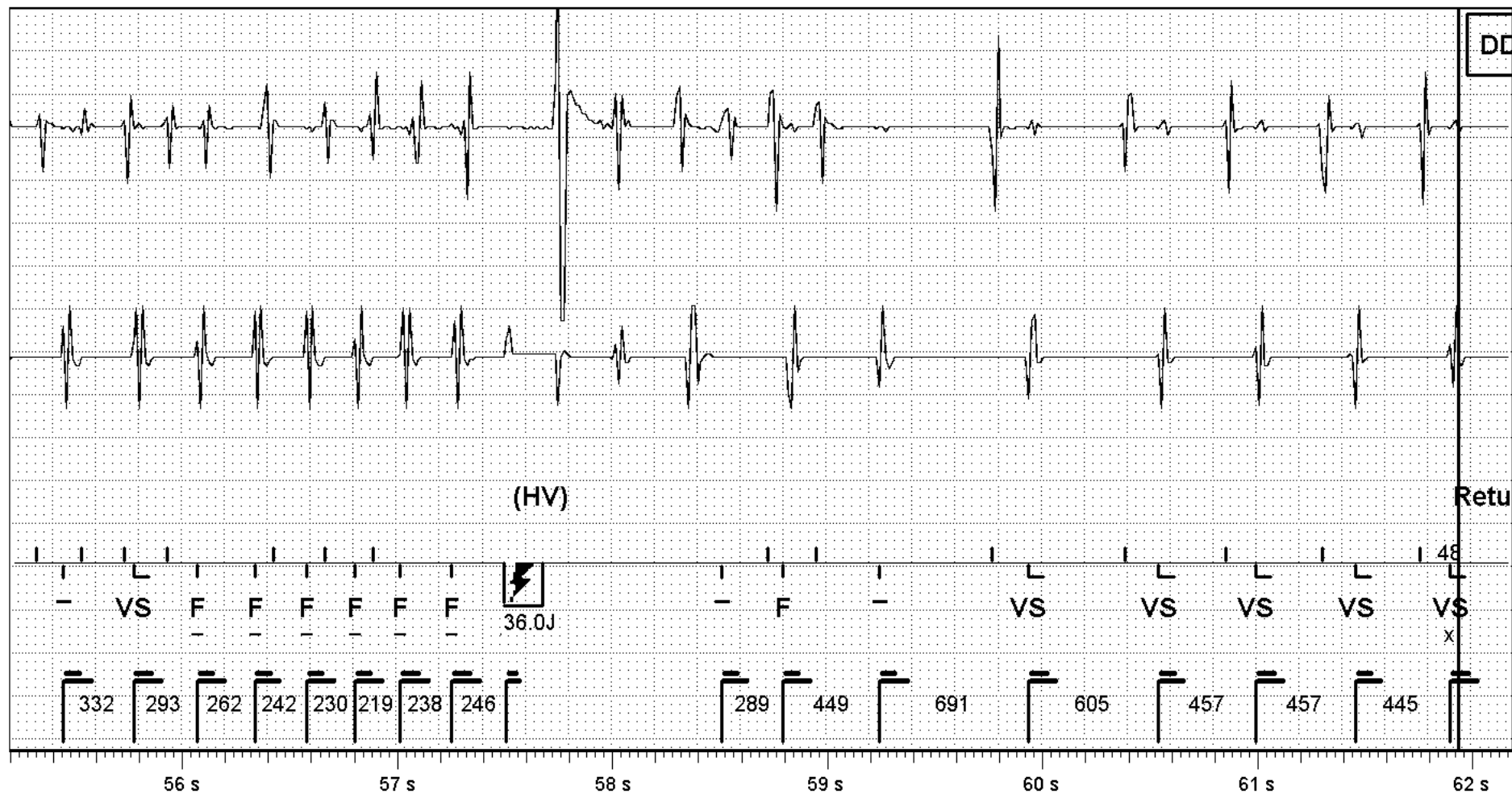
VT /VF Episodes

Date / Time	Type	Rate (min-1)	Duration (M:S)	Therapy Delivered
27 Jan 2015 1:08	VF	235	01:03	ATP, 36J
27 Jan 2015 1:07	VF	244	01:25	ATP
27 Jan 2015 1:05	VF	222	00:27	ATP
27 Jan 2015 1:05	VF	222	00:35	ATP
27 Jan 2015 1:04	SVT	190	00:25	
27 Jan 2015 1:04	VF	240	00:49	ATP
27 Jan 2015 1:03	Non-sustained		00:14	
27 Jan 2015 1:02	Non-sustained		00:38	
27 Jan 2015 1:02	VF	230	00:33	ATP
27 Jan 2015 1:01	Non-sustained		00:18	
27 Jan 2015 1:01	Non-sustained		00:24	
27 Jan 2015 1:00	VF	226	01:31	ATP, 36J
27 Jan 2015 0:59	VF	222	00:23	ATP
27 Jan 2015 0:58	VF	222	00:30	ATP
27 Jan 2015 0:58	VF	230	00:19	ATP
27 Jan 2015 0:58	VF	222	00:33	ATP
27 Jan 2015 0:57	VF	222	00:33	ATP, 36J
27 Jan 2015 0:56	VF	222	00:43	ATP
27 Jan 2015 0:56	VF	222	00:30	ATP, 36J
27 Jan 2015 0:55	VF	222	00:39	ATP, 36J
27 Jan 2015 0:54	VF	222	00:35	ATP
27 Jan 2015 0:54	VF	230	00:31	ATP, 36J
27 Jan 2015 0:53	VF	222	00:20	ATP
27 Jan 2015 0:53	VF	222	01:03	ATP, 36J
27 Jan 2015 0:52	VF	222	00:21	ATP, 36J
27 Jan 2015 0:51	VF	222	00:41	ATP
27 Jan 2015 0:50	VF	235	00:25	ATP, 36J
27 Jan 2015 0:50	Non-sustained		00:22	
27 Jan 2015 0:49	VF	222	00:31	ATP
27 Jan 2015 0:49	VF	222	00:29	ATP
27 Jan 2015 0:48	Non-sustained		00:14	
27 Jan 2015 0:48	VF	222	00:39	ATP, 36J
27 Jan 2015 0:48	VF	250	00:39	ATP
27 Jan 2015 0:47	VF	222	00:32	ATP, 36J
27 Jan 2015 0:46	VF	230	00:32	ATP
27 Jan 2015 0:46	VF	222	00:41	ATP, 36J
27 Jan 2015 0:45	VF	222	00:29	ATP, 36J
27 Jan 2015 0:45	VF	222	00:19	ATP
27 Jan 2015 0:44	VF	222	00:31	ATP
27 Jan 2015 0:43	VF	222	00:39	ATP, 36J
27 Jan 2015 0:43	VF	222	00:34	ATP, 36J
27 Jan 2015 0:42	VF	222	00:39	ATP, 36J
27 Jan 2015 0:41	VF	250	00:36	ATP, 36J
27 Jan 2015 0:41	VF	222	00:27	ATP, 36J
27 Jan 2015 0:40	VF	230	00:21	ATP, 36J
27 Jan 2015 0:39	VF	222	01:35	ATP, 36J, 40J
27 Jan 2015 0:37	VF	222	01:41	ATP, 36J, 40J, 40J X 3
27 Jan 2015 0:36	VF	222	00:35	ATP, 36J
27 Jan 2015 0:36	VF	235	00:39	ATP, 36J
27 Jan 2015 0:35	VF	240	04:23	ATP, 36J, 40J

Electrifying night
(30 shocks in 30 min)

A serendipitous end to misery

27 Jan 2015 1:08



Tachycardia parameters

Parameters

Mode	DDD	Zone Configuration	VT-1	VT-2	VF
Base Rate	40 min ⁻¹	Detection Criteria	150 min ⁻¹	181 min ⁻¹	222 min ⁻¹
Max Track Rate	130 min ⁻¹	Therapy (ENABLED)	Monitor	ATP x3	ATP x1
Paced AV Delay	160 ms			36.0 J	36.0 J
Sensed AV Delay	110 ms			40.0 J	40.0 J
Ventricular Pacing	Simul.			40.0 J x2	40.0 J x4

27 Jan 2015 0:35

Duration

04:23 (M:S)

Detection Criteria

222 min-1

Alerts



At least one shock unsuccessful

Duration over 1 minute

Three or more VT/VF episodes in 24 hours

Therapy

- 1) ATP x 1
- 2) Defib 36.0 J (844V)
- 3) Defib 40.0 J (890V)

Results

- 1) VF
- 2) VF
- 3) Below Rate Detection
(CL 465 ms)

HV Therapy

Last HV Lead Impedance	78 Ω
First Charge Time	9.3 sec
Last Charge Time	11.6 sec
Delivered PW	+8.5 ms, -8.5 ms

ATP Therapy Details

VF ATP Therapy

Therapy

Burst 1 220, 220, 220, 220, 220, 220, 220, 220 ms

Diagnosis Summary

	Initial Diagnosis	Diagnosis
	SVT	VF
Time to Diagnosis		231.00 sec
Rate (CL)	190 min-1 (315 ms)	240 min-1 (250 ms)
Zone	VT-2	
VT Diagnosis Criteria	All	
Rate Branch Classification	AF/AFL (V < A) Rate Branch	

Morphology

Min Match Score	On, $\geq 90\%$ is a match, ≥ 3 matches indicate SVT
Max Non-Match Score	91%
No. Template Matches	89%
	4 of 10 (SVT Indicated)

Interval Stability

Stability Delta	On w/AVA, ≥ 40 ms or AVA < 60 ms indicates SVT
	75 ms (SVT Indicated)

Bradycardia diagnostics

Diagnostics Summary

Events	Since 10 Feb 2014	Lifetime	Events	Since 10 Feb 2014
AP	<1%	<1%	AS-VP	95%
RVP	n/a	0%	AS-VS	4.7%
BP	95%	95%	AP-VP	<1%
VSt	n/a	0%	AP-VS	0%
Includes time in AMS			PVC	<1%, 66K counts
			Excludes time in AMS	

How to fix the problem?

I. The programming

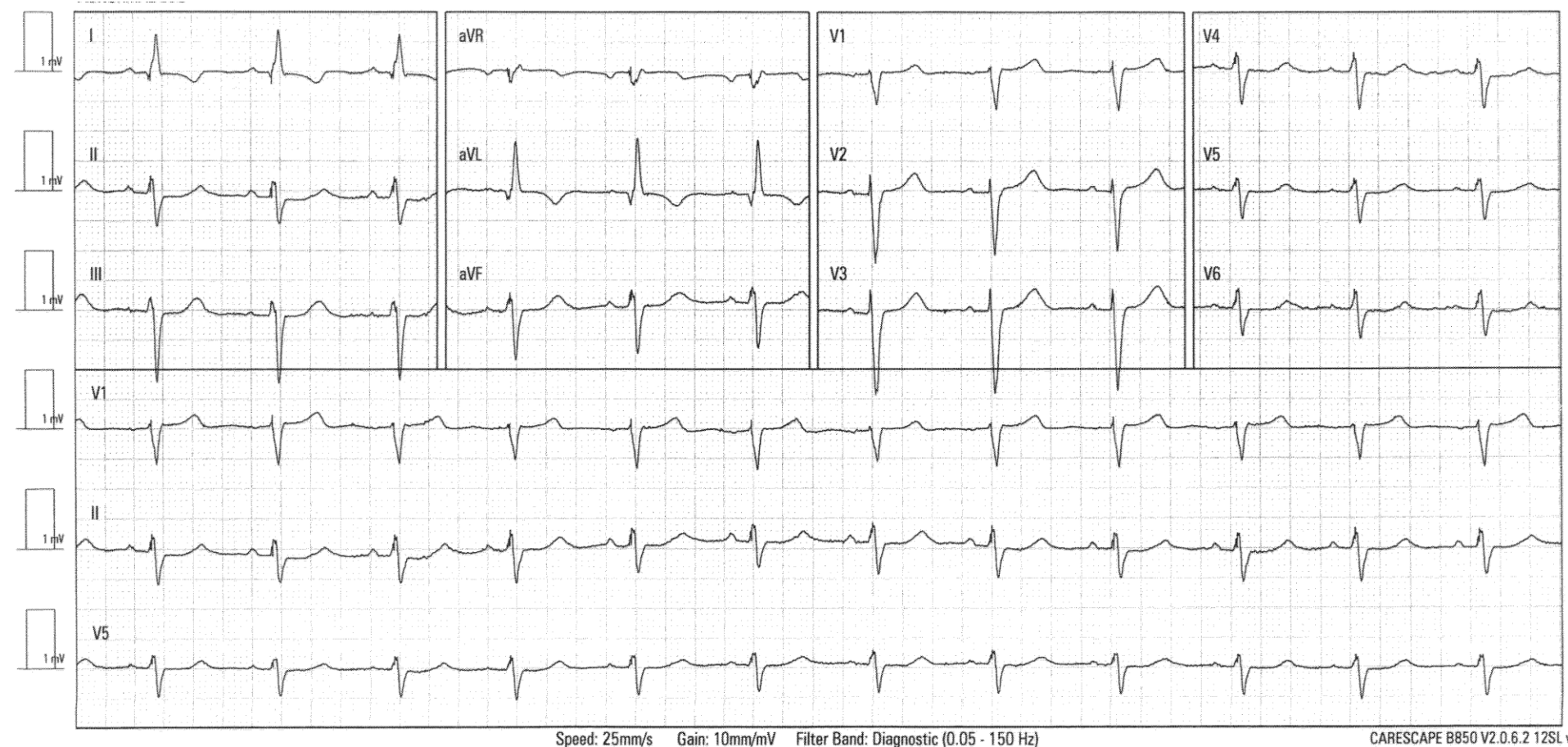
- 1. Increase VF detection zone
- 2. Extend VF detection duration
- 3. Extend SVT timeout
- 4. Some combination of the above

How to fix the problem?

II. The arrhythmia

- 1. Rate controlling medication
- 2. Rhythm controlling medication
- 3. PV ablation
- 4. AVJ ablation

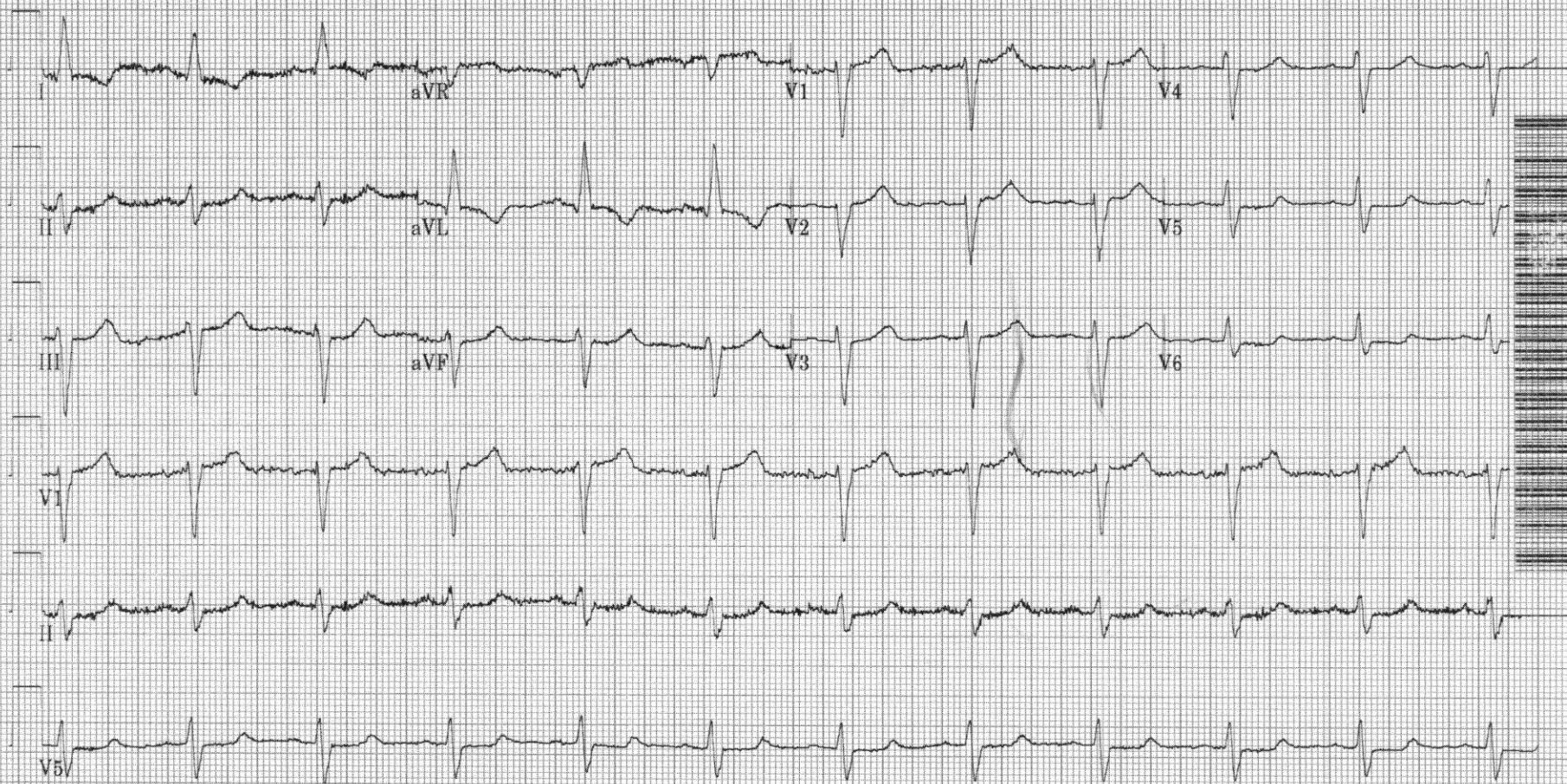
Upon arrival
SAV 160 ms, LV 0 ms



Speed: 25mm/s Gain: 10mm/mV Filter Band: Diagnostic (0.05 - 150 Hz)

CARESCAPE B850 V2.0.6.2 12SL v

Intrinsic QRS



100 Hz 25.0 mm/s 10.0 mm/mV

4 by 2.5s + 3 rhythm lds

MAC5K 002A.1

12SL™ v254

ECG-based optimization

SAV 100 ms, LV +40

