

ECG Differential Diagnosis of Wide QRS Tachycardia, or Wide Complex Tachycardia (WCT)

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Wide QRS Tachycardia

Definition: rate ≥ 120 and QRS ≥ 0.12 sec
(but 5% of VTs are QRS 0.11 or less)

Regular:

- Monomorphic VT
- SVT
 - aberrancy
 - prior IVCD or BBB
 - accessory pathway (antidromic AVRT)

Irregular:

- Atrial fibrillation
 - aberrancy
 - prior IVCD or BBB
 - accessory pathway (rate > 220 or RR < 250 msec)
- Polymorphic VT
- Torsades de Pointes

Question 2: What is the rhythm?

Determining the type of WCT

- Primary diagnostic tool: ECG
- Adjunctive tools
 - Physical examination
 - Variable S1, Intermittent cannon A waves
 - Intracardiac electrogram rarely used acutely
 - AV nodal blocking agents or maneuvers
 - CSM, adenosine, others (esmolol)
 - Therapeutic trial of antiarrhythmic agent

Question 2: What is the rhythm?

ECG Diagnosis of Regular WCT – AV Relationships

- (“Cherchez le P”)
- Independent P waves (complete AV dissociation)
- 2:1 VA conduction (best in V1)
- 1:1 VA conduction with short R-P interval (not conclusive)
- Fusion beat or capture (Dressler) beat

Clinical status usually not helpful to distinguish between VT and SVT with aberrancy

Question 2: What is the rhythm?

ECG Diagnosis of Regular WCT – QRS Morphology

- QRS duration >0.14 favors VT and QRS axis < -30 favors VT, neither is conclusive, especially if SVT with preexisting BBB or if antidromic WPW
- Concordant positive or negative in V1-6 strongly favors VT
- Polymorphic tachycardia usually VT, exclude AF with WPW and multiple tracts

Question 2: What is the rhythm?

ECG Diagnosis of Regular WCT - 2

- RBBB in V1 favoring VT:
 - monophasic R or qR
 - triphasic favors aberrancy
- In V1 favoring VT:
 - R taller than sinus, wider than 30 msec
 - S with notched downslope or > 70 msec to nadir
- In V6 favoring VT:
 - $R/S < 1$, or qR or QS pattern

Question 2: What is the rhythm?

ECG Diagnosis of Regular WCT - 3

- Favors VT: LBBB pattern with RAD
- Bidirectional tachycardia usually VT if regular, SVT if paired beats
- Caveat: VT can be relatively narrow, even narrower than the patient's native BBB beats
- VT usually < 220 BPM, unless ischemic or reperfusion (or bundle branch reentry), which may be 250-280

Ventricular Tachycardia Terminology

- Sustained - >30 sec
- Nonsustained - ≥ 3 spontaneous beats, or ≥ 6 induced beats
- HR 120-200 ventricular tachycardia
- (HR 110-120 ventricular tachycardia)
- HR <110 accelerated ventricular rhythm
- HR >200 (SCD guidelines say >300)
ventricular flutter

Sustained Monomorphic VT

- Rate usually 140-200
- Regular in over 90% of cases
 - Irregularity up to maybe 0.29 sec in RR interval, average difference between longest and shortest RR is 0.13 sec, more irregular at start and stop, longest interval is often first or last
- Most often initiated by PVC, but PAC also possible initiator; R-on-T in only 13%, actually prematurity of PVC initiating VT is generally longer than the usual PVC in that patient; initiating PVC may be different from VT morphology or identical to it

Sustained Monomorphic VT

- AV Dissociation: retrograde conduction may occur 1:1 in 25 - 50%, VA conduction with variable block in 15 - 20%, and AV dissociation in 35%, less VA conduction if VT is rapid (15% if rate 200)
- Ventricular capture or fusion (“Dressler” beats) are occasionally present – maybe 5% of VT

Localizing Site of VT

- RBBB probably comes from LV
- LBBB probably comes from RV if no heart disease, but may be from LV if heart disease such as DCM or ischemia
- Q in I and V_6 anterior septal origin, not basal or posterior septal
- R in I, V_1 and V_2 likely posterior origin
- Superior axis probably comes from near apex

Causes of LBBB Morphology in VT

- Can be LV tachycardia if CAD or DCM
- RV cardiomyopathy (ARVD – arrhythmogenic RV dysplasia)
- Uhl's anomaly (parchment RV)
- Tetralogy of Fallot postoperative
- No structural heart disease

Question 3: What is the underlying structural or functional problem?

Underlying Structure or Function

- Coronary disease
 - Acute MI / Chronic
- LVH
 - Secondary / HCM
- Myopathy
 - DCM (RV, LV)
 - Inflammatory
 - Infiltrative
- Primary electrical
 - Diseased pathways
- Coronary flow changes
 - vasomotion
 - ischemia/reperfusion
- Systemic factors
 - Hemodynamic problems
 - O₂, pH, electrolyte
- Neurophysiologic
- Toxic
 - Proarrhythmic
 - Cardiotoxic

Question 4: Is the problem primary or secondary?

Primary vs Secondary Arrhythmia

- Primary: the cause is the cardiac disease process, so treatment is directed at the arrhythmia with secondary attention to the disease process.
- Secondary: the cause is the hemodynamic or metabolic abnormality, so treatment is directed at the primary problem, with secondary role of antiarrhythmic agents.

Management Depends on Diagnosis

- What is the clinical significance of rhythm?
- What is the rhythm?
- What is the underlying structural problem or the functional factors?
- Is the problem Primary or Secondary?

Overview of Approaches to Arrhythmia Management

- General systemic support
 - Vital Support
 - Milieu control
- Electropharmacologic therapy
 - Control triggers
 - Control sustained arrhythmia
- Catheter ablation
- Surgery
 - Antiarrhythmic
 - Antiischemic
 - Structural repair
- Device application
 - Acute (Cversion, Defib, temp pacer)
 - Chronic (pacer, ICD)

Overview of Acute Approaches to Arrhythmia Management

- General systemic support
 - Vital Support
 - Milieu control
- Electropharmacologic therapy
 - Control triggers
 - Control sustained arrhythmia
- Catheter ablation
- Surgery
 - Antiarrhythmic
 - Antiischemic
 - Structural repair
- Device application
 - Acute (Cversion, Defib, temp pacer)
 - Chronic (pacer, ICD)

Management of PVC's

- No structural disease:
 - Reassure
 - Low-dose beta-blockade or anxiolytic
 - MVP: same
- Chronic disease
 - beta-blockade
 - ?amiodarone
 - other agents
- Acute syndromes
 - no prophylaxis
 - Ischemia or reperfusion - lidocaine
 - Myocarditis/pericarditis - oral agents > 2 months

Management of Ventricular Tachycardia

- Nonsustained VT, similar to PVC's, but higher risk... ultimately possibly ICD
- Repetitive monomorphic VT
 - possibly RVOT tachycardia
 - poss Ca^{++} blockade or beta blockade (no structural disease)
- Sustained VT - cardiovert if ischemia/infarction, poor CNS perfusion

Management of VT - 2

- Amiodarone 150 mg over 10 min, then 1 mg/min for 6 h, then 0.5 mg/min for 18h
- Procainamide 0.2-0.5 mg/kg/min to 500-1000 mg, 2-6 mg/min
- Lidocaine 1-2 mg/kg bolus over 2-5 min, repeat $\frac{1}{2}$ in 20-40 min, 1-4 mg/min (“often ineffective”) - lower if shock or low-output (reduced hepatic blood flow)
- Sotalol (?not available IV in USA)

Management of VT - 3

- Bundle branch reentry
 - cure by RBB ablation
- Catecholamine/metabolic mediated VT
 - initiate with isoproterenol, stress
 - suppress with beta-blockade
 - some may suppress with Ca^{++} blockade
- RV cardiomyopathy
- VT after congenital heart surgery
 - Tetralogy of Fallot, TGA
- Bidirectional VT – may be digitalis toxicity

Management of Torsades de Pointes

- prolonged QT in sinus rhythm
- VT morphology
- Congenital, several types
- Acquired
 - Class IA, class III
 - Worsen: low K, low Mg
 - Phenothiazine, antibiotic, pentamidine, cocaine, terfenadine
- Magnesium SO₄ 2 gm IV over 2 min, then 2 -20 mg/min
- Overdrive pacing
- Isoproterenol (avoid in ischemia)
- Lidocaine

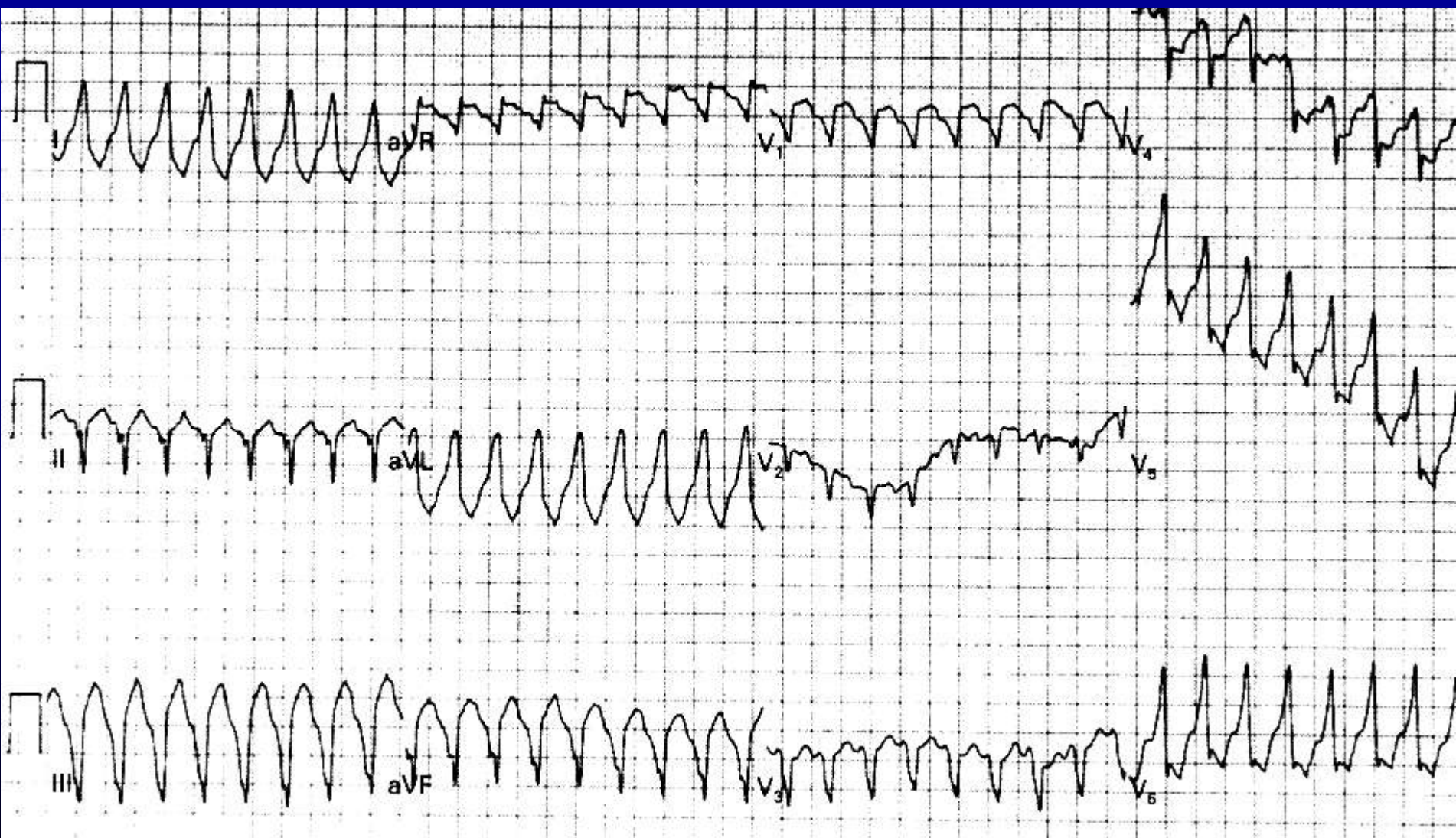
Management of VF

- Defibrillation
- ACLS
- Amiodarone is an option

WCT Case - 1

- 61 yo, assaulted, orbital fracture, subsequent dietary supplements, subsequent GI upset, then racing heart, dyspnea, vomiting
- Pulse 200, 125/75, resp 22, jvp 14, lungs clear, heart sounds normal but rapid
- ECG QRS duration 125 msec

WCT Case 1



[NEJM 2000; 342:1979.](#)

WCT Case 1

Onset R to
nadir S >100ms

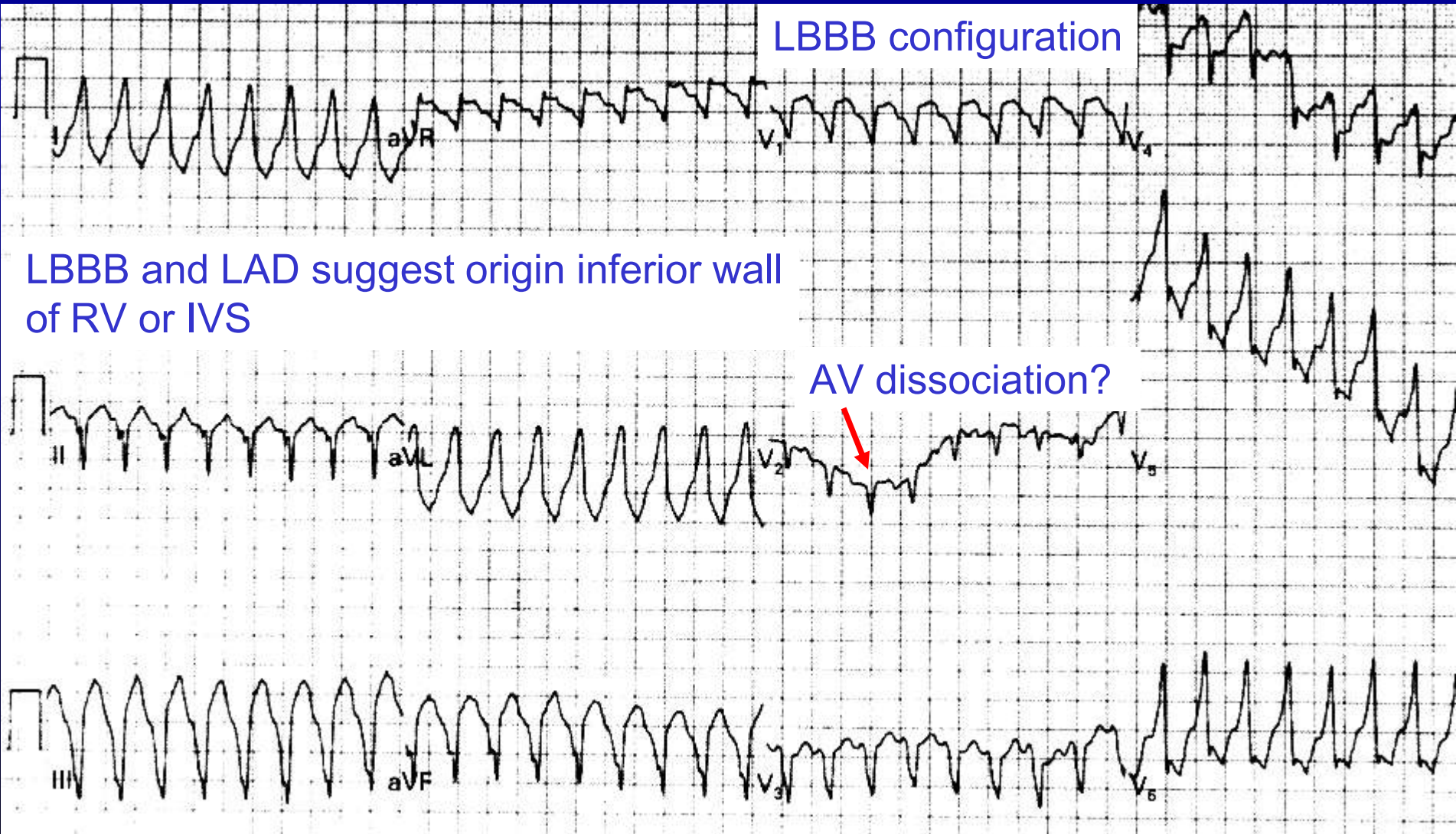
Echo: reduced EF

Native sinus QRS is narrow with left axis deviation

LBBB configuration

LBBB and LAD suggest origin inferior wall
of RV or IVS

AV dissociation?

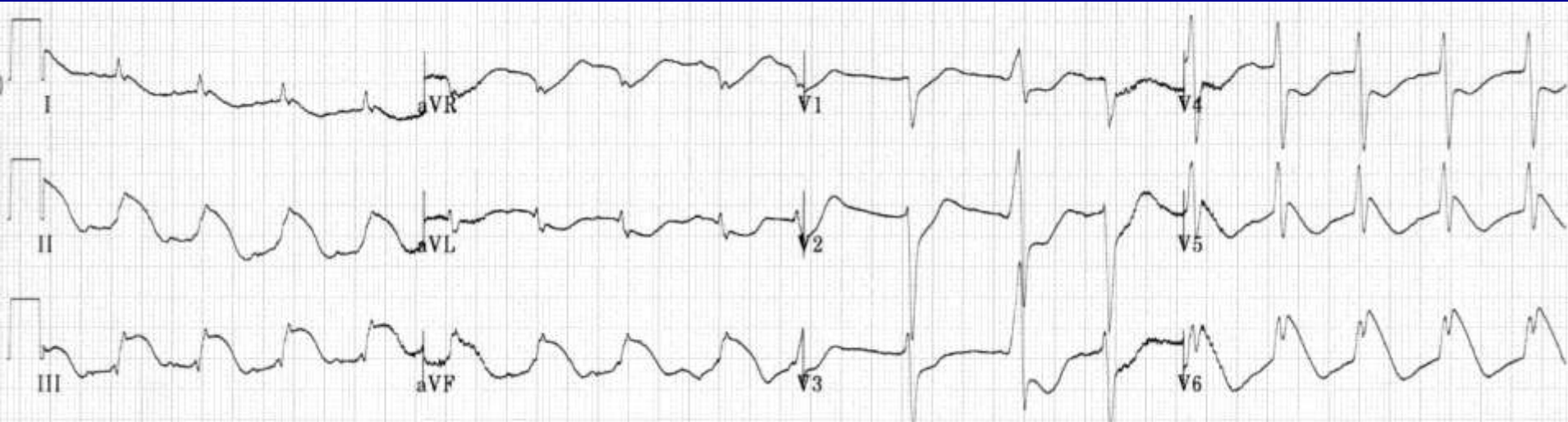


NEJM 2000; 342:1979.

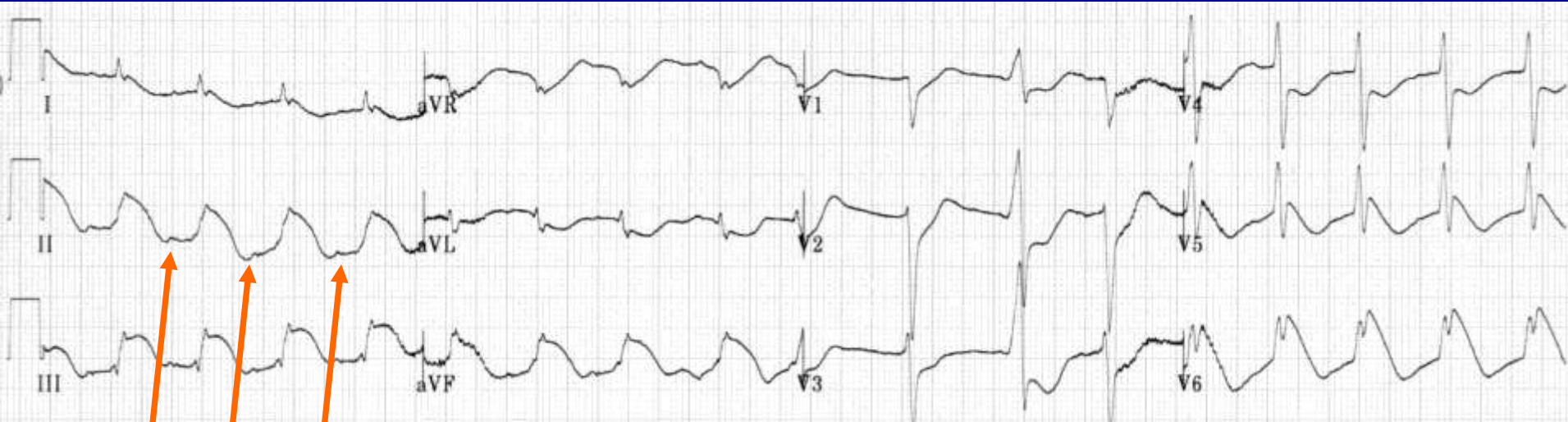
Monomorphic VT - 3 Types

- Focal origin
 - RVOT VT
 - LVOT VT
 - LV VT verapamil sens
- Bundle-branch reentry
 - conduction system
 - cardiomyopathy
 - valvular disease
 - muscular dystrophy
 - CAD
- Scar-related reentry
 - healed MI
 - RV cardiomyopathy
 - DCM
 - Sarcoidosis
 - Scleroderma
 - Giant-cell myocarditis
 - Healed incision
 - repaired Tetralogy

Case 2



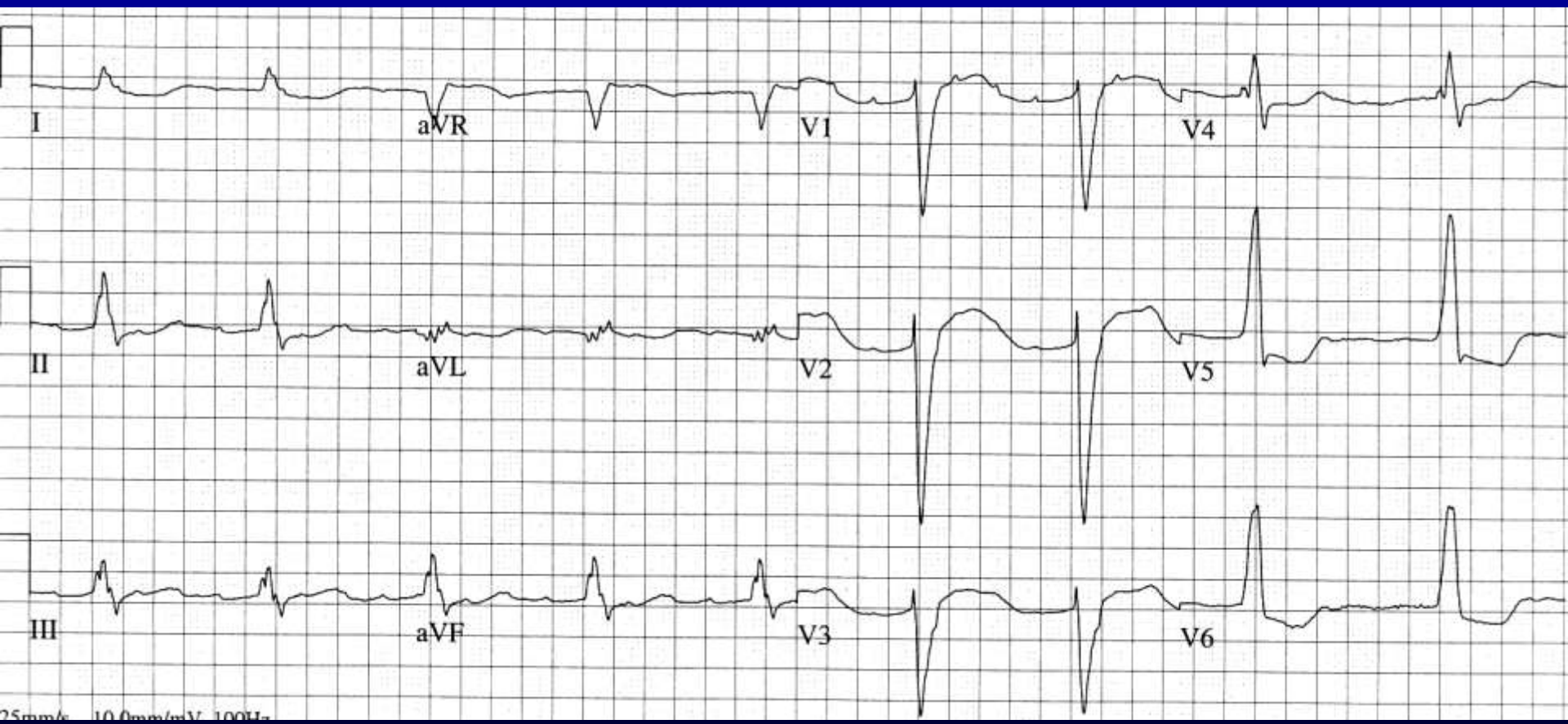
Case 2



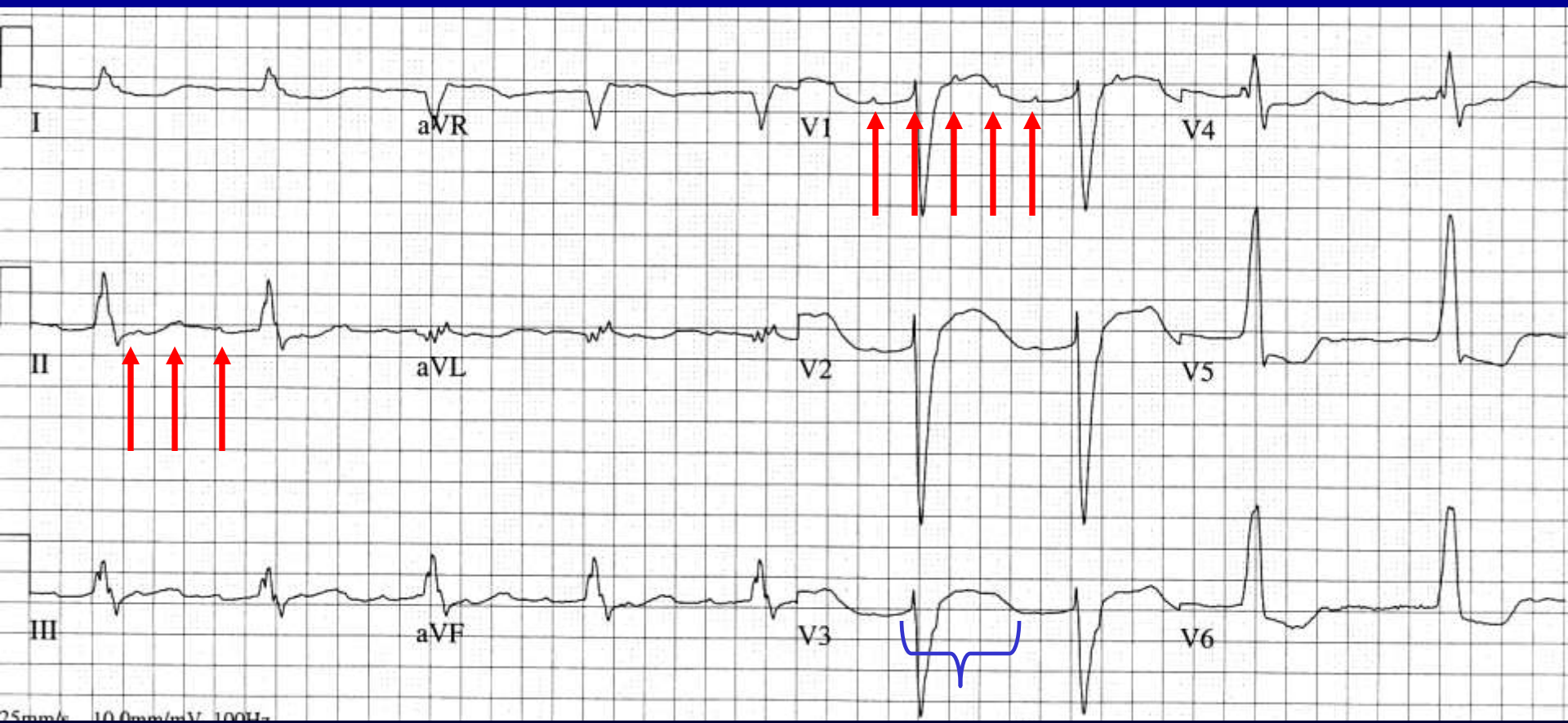
P waves

Sinus tachycardia, dramatic transmural injury

Case 3

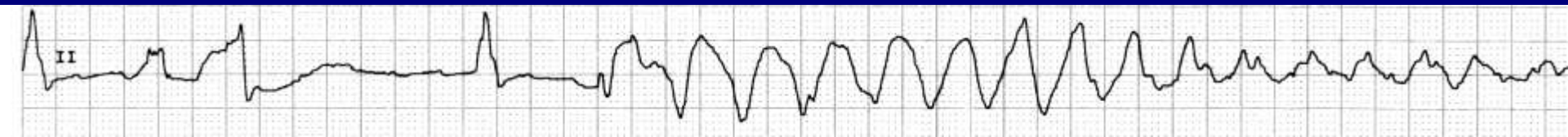


Case 3



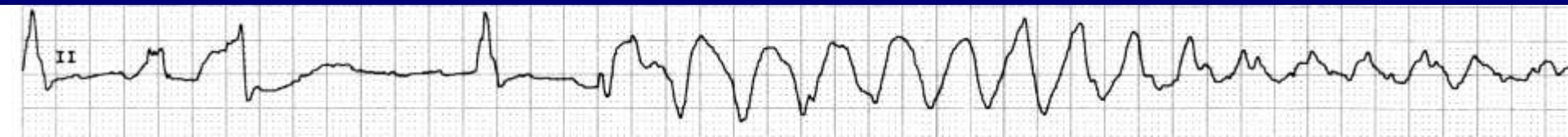
Atrial Flutter, LBBB, prolonged QT best in V3

Case 3



Case 3

Torsade de Pointes



“Long-short”, provokes even more prolonged QT
Set up for VT/VF

Case 3



Sinus rhythm after defibrillation

Case 4

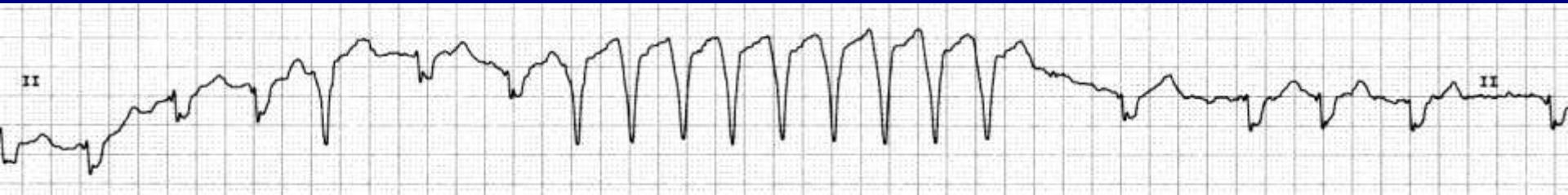


Case 4



Frequently Torsade is preceded by bigeminy

Case 5



Case 5



Atrial fibrillation and nonsustained VT, wide QRS on native beats

Case 6



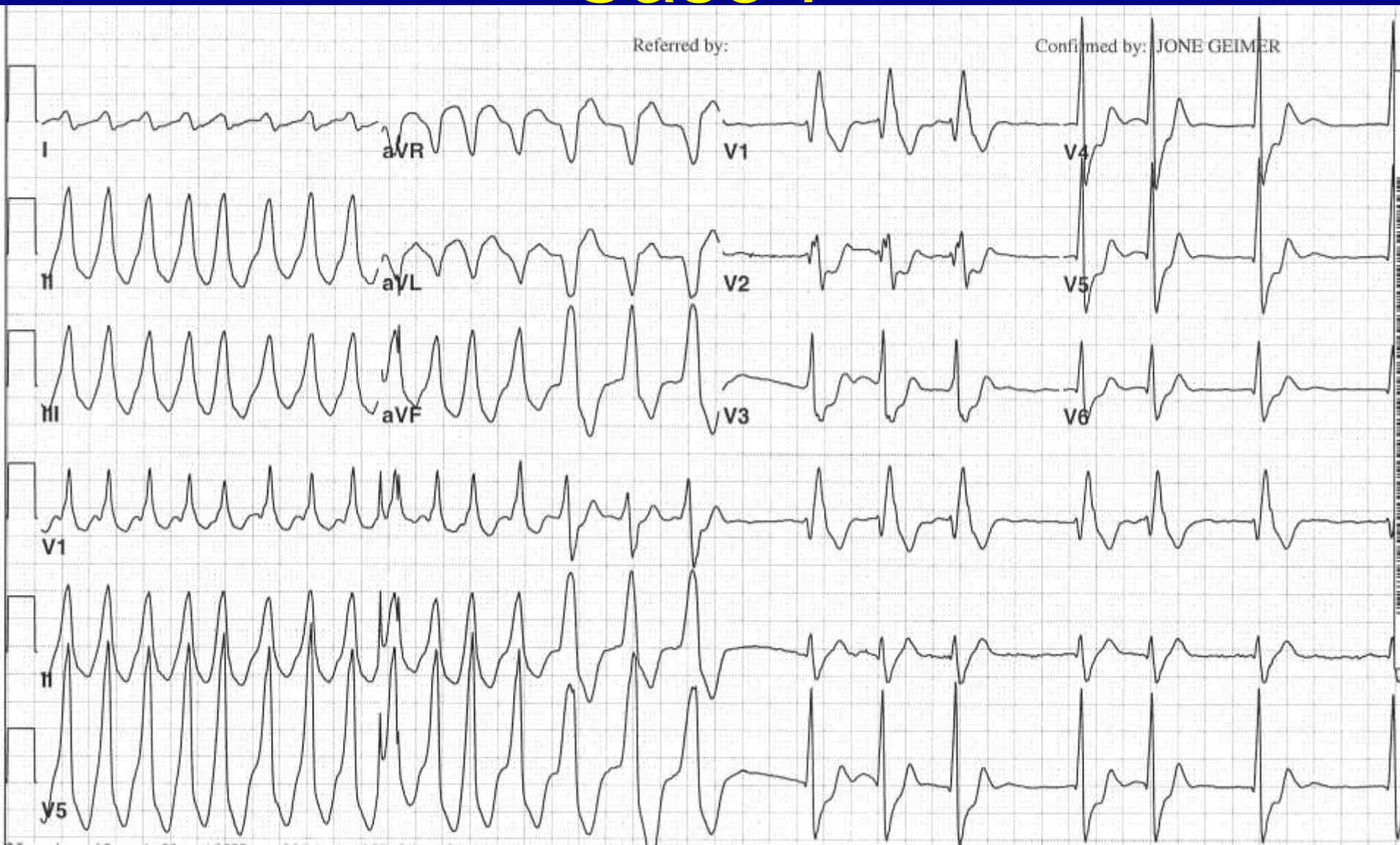
Case 6



Sinus rhythm with narrow QRS, late PVC, with NSVT with retrograde conduction

April 2000

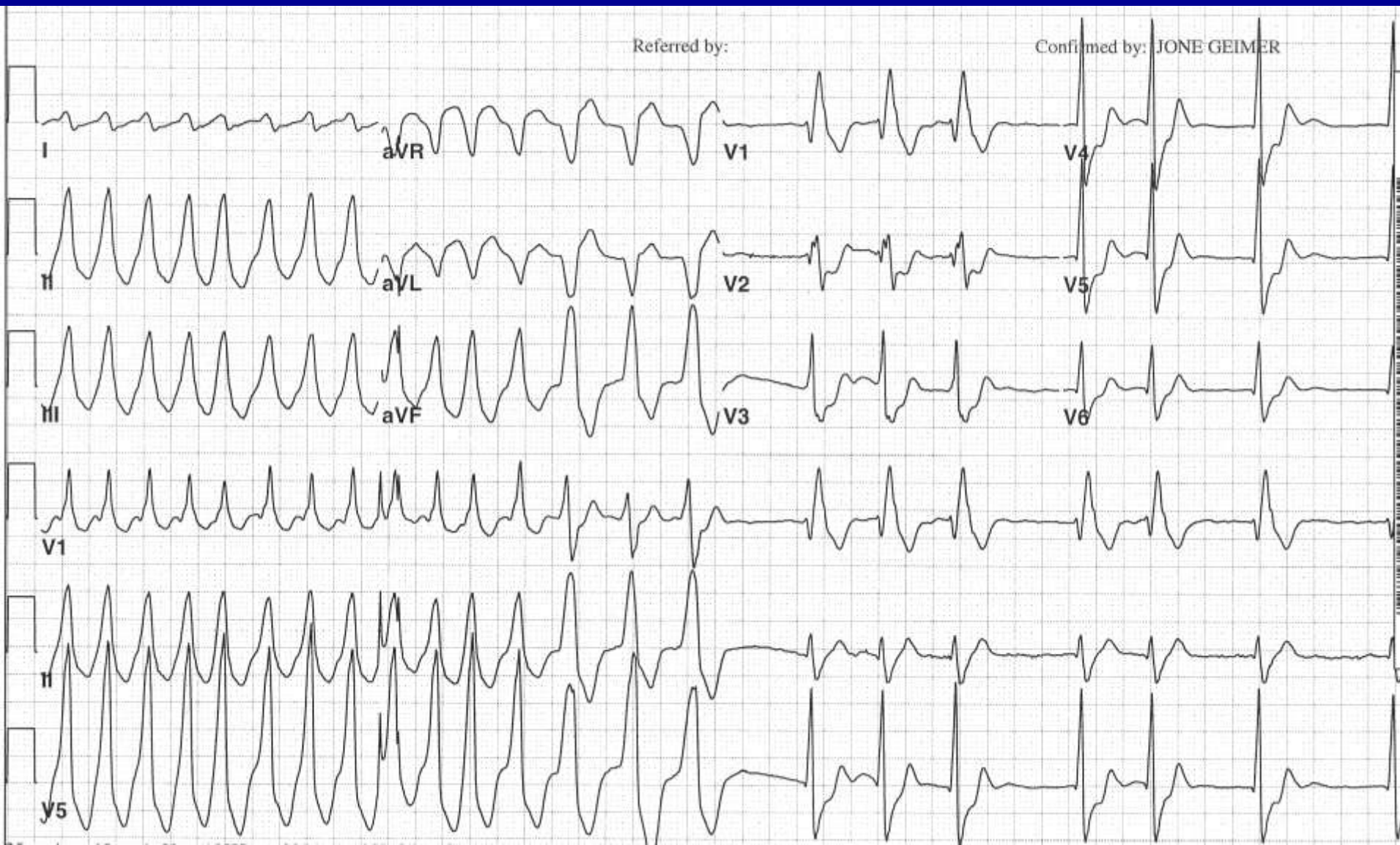
Case 7



Acute ischemia
April 2000

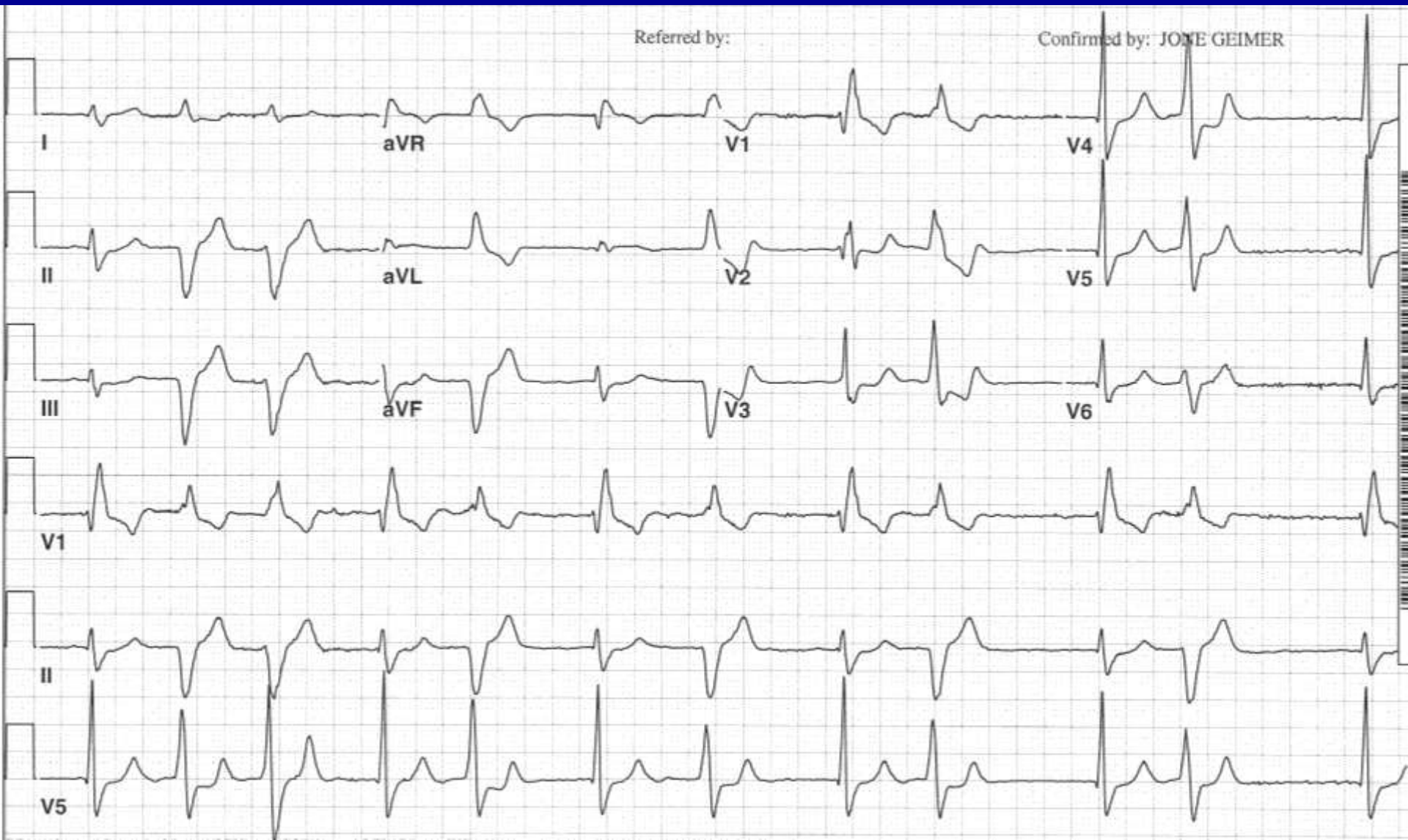
Nonsustained VT, not exactly monomorphic,
baseline atrial fibrillation

Case 7



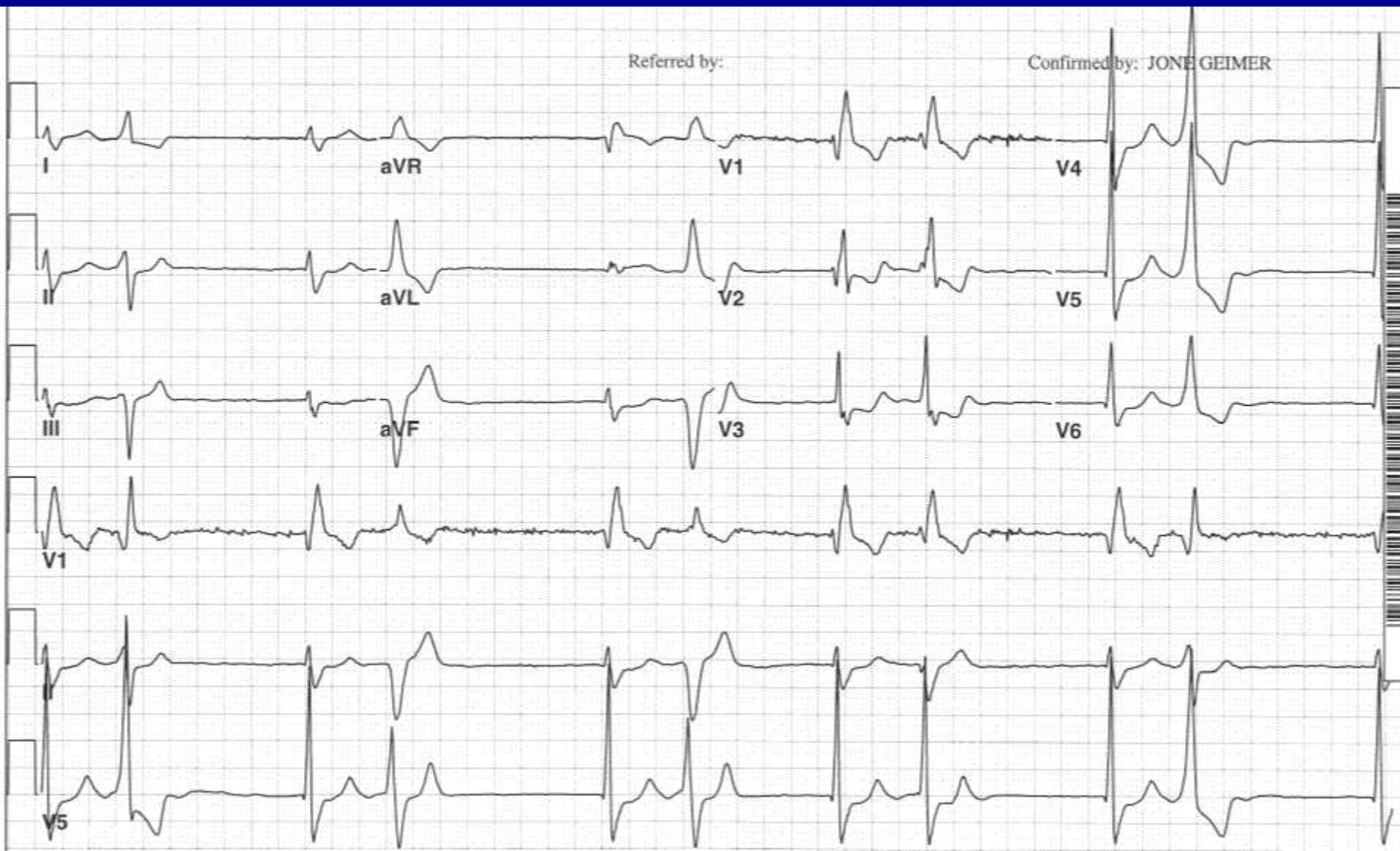
Baseline ECG 14 hr prior
April 2000

Case 7



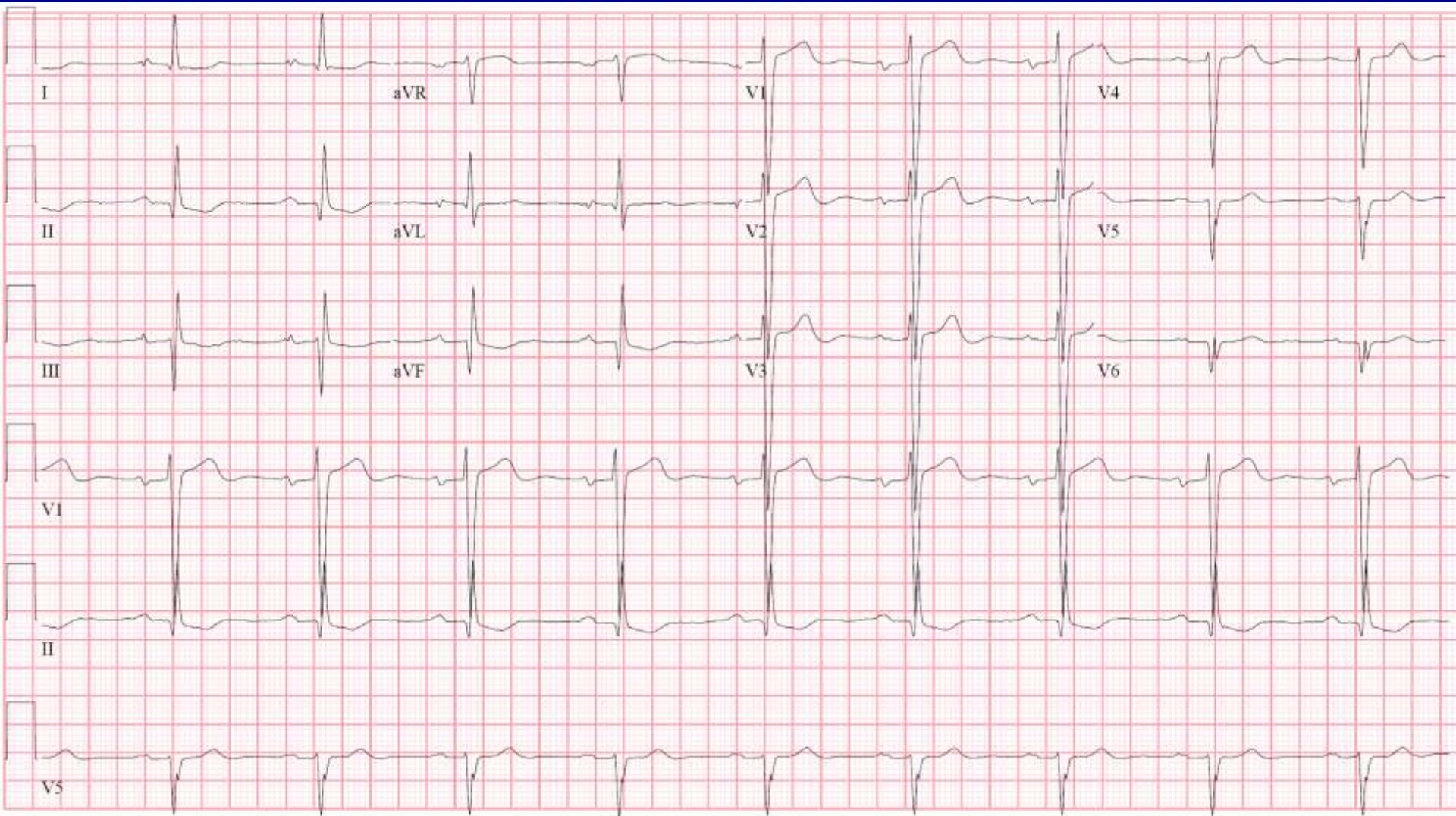
Baseline ECG 1 da prior
April 2000

Case 7



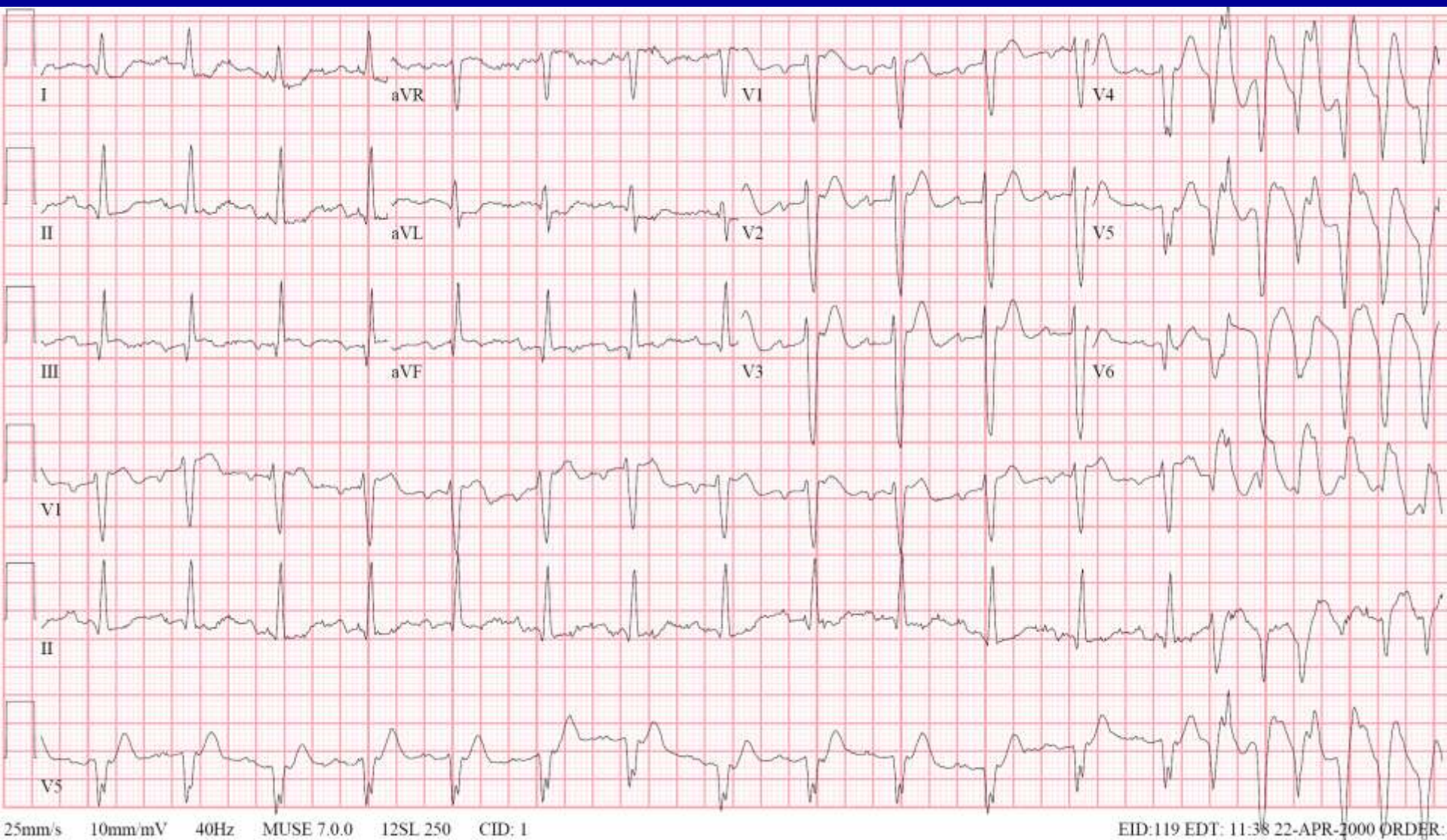
Case 8

31 March 2000



Case 8

April 11, 2000, 08:15:11

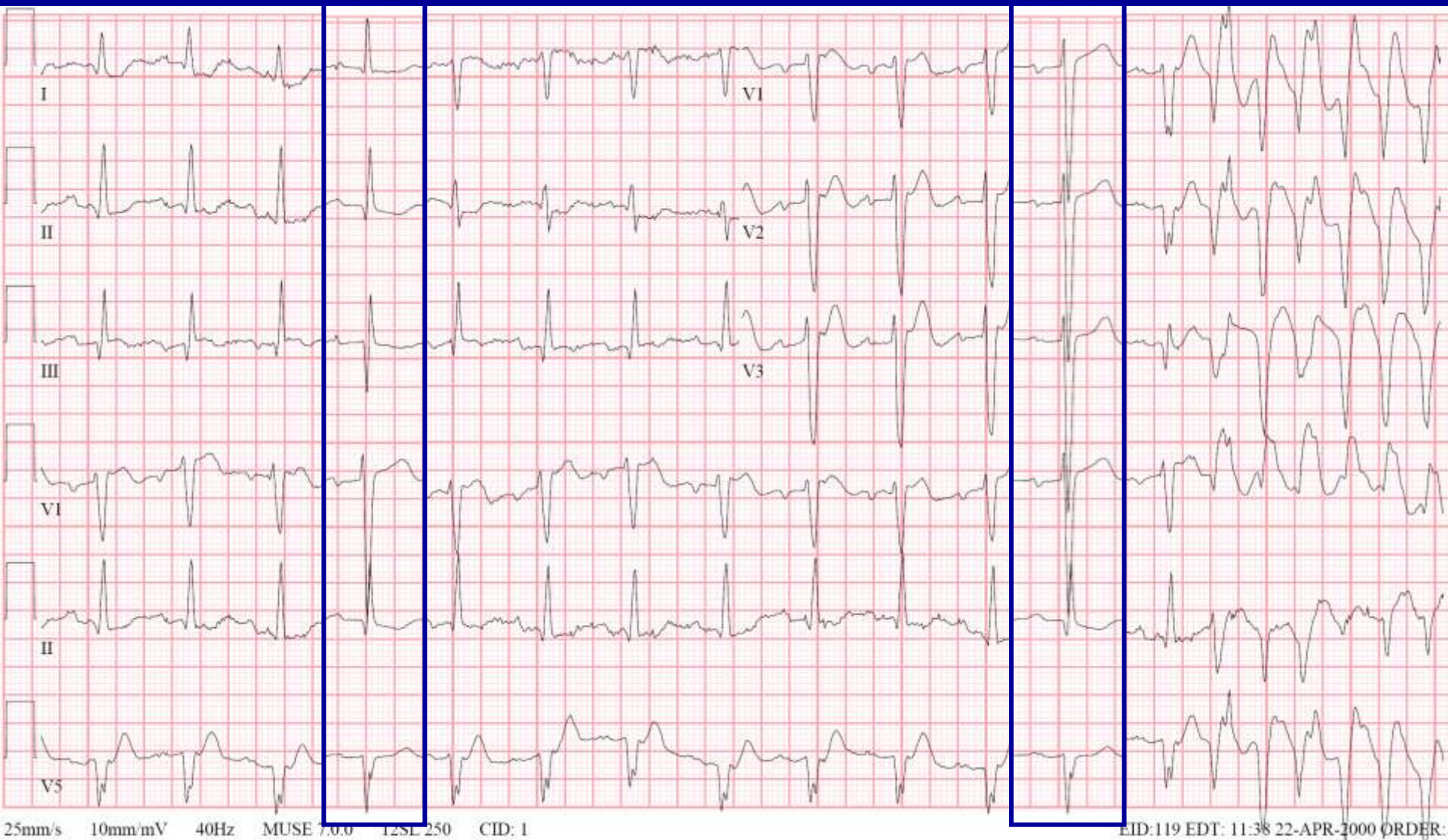


25mm/s 10mm/mV 40Hz MUSE 7.0.0 12SL 250 CID: 1

EID:119 EDT: 11:38 22-APR-2000 ORDER:

Case 8

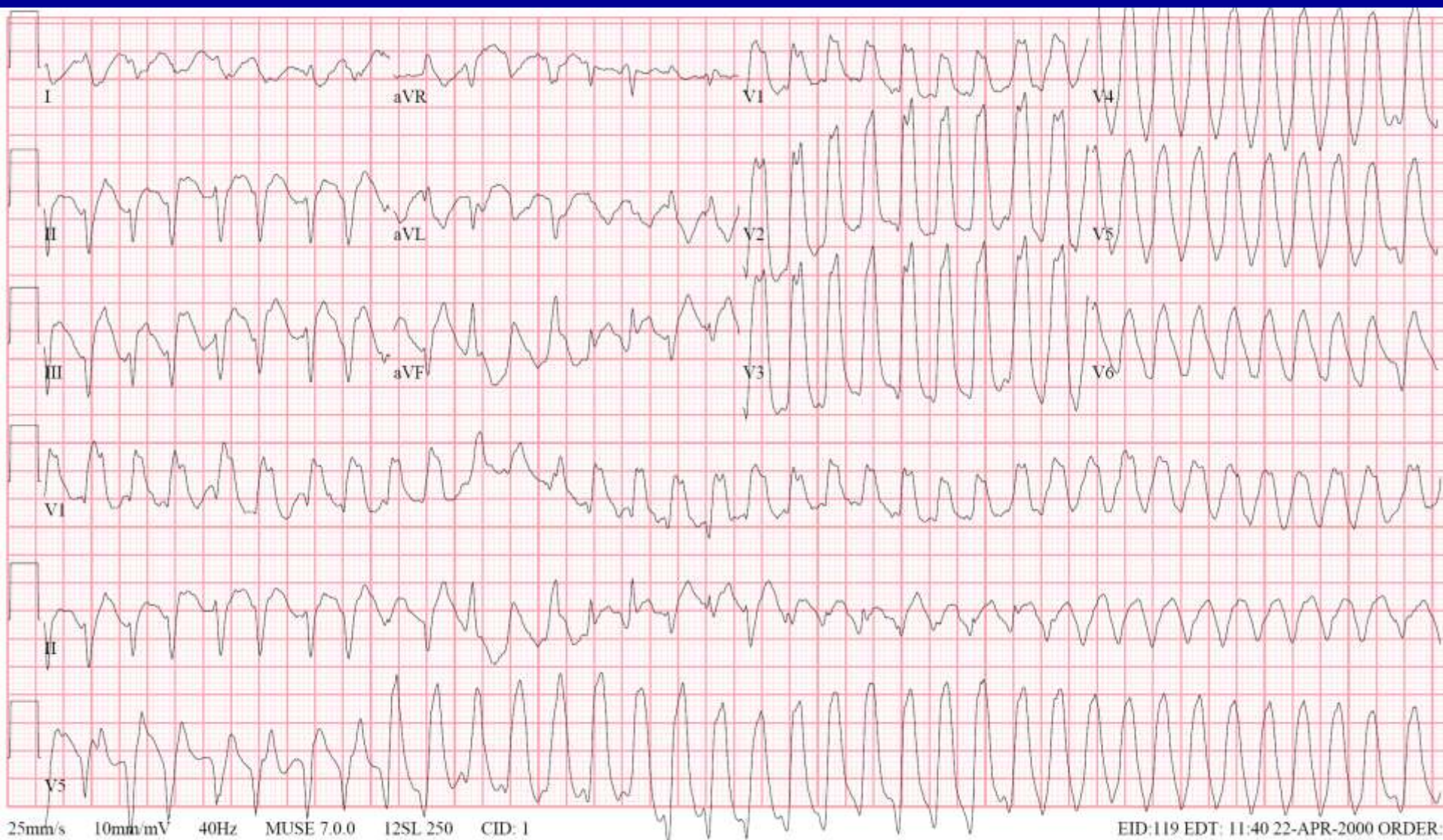
April 11, 2000, 08:15:11



Baseline ECG shows inferior injury and then polymorphic VT

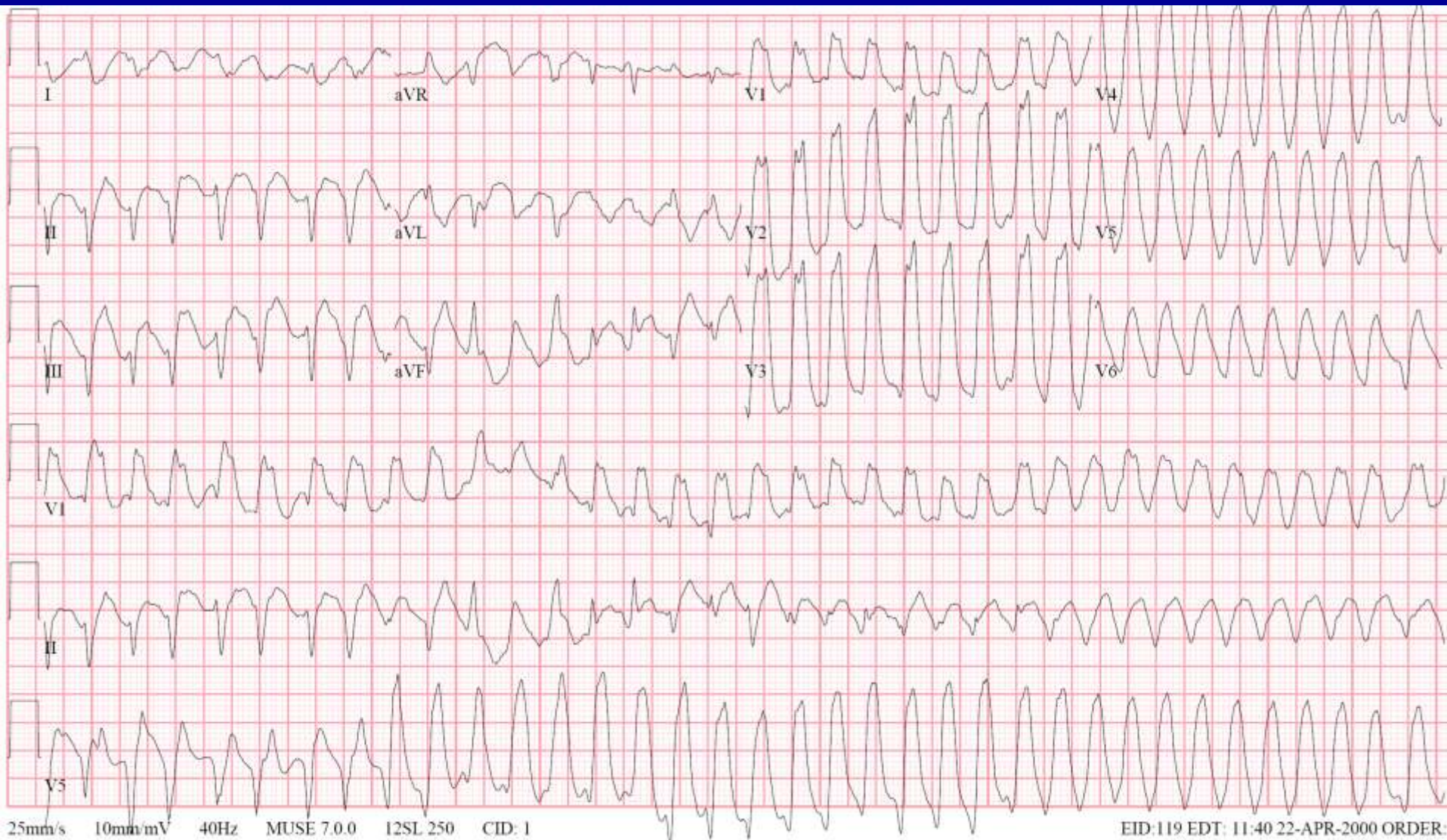
Case 8

April 11, 2000, 08:15:41



Case 8

April 11, 2000, 08:15:41



Same patient few seconds later, better polymorphic VT

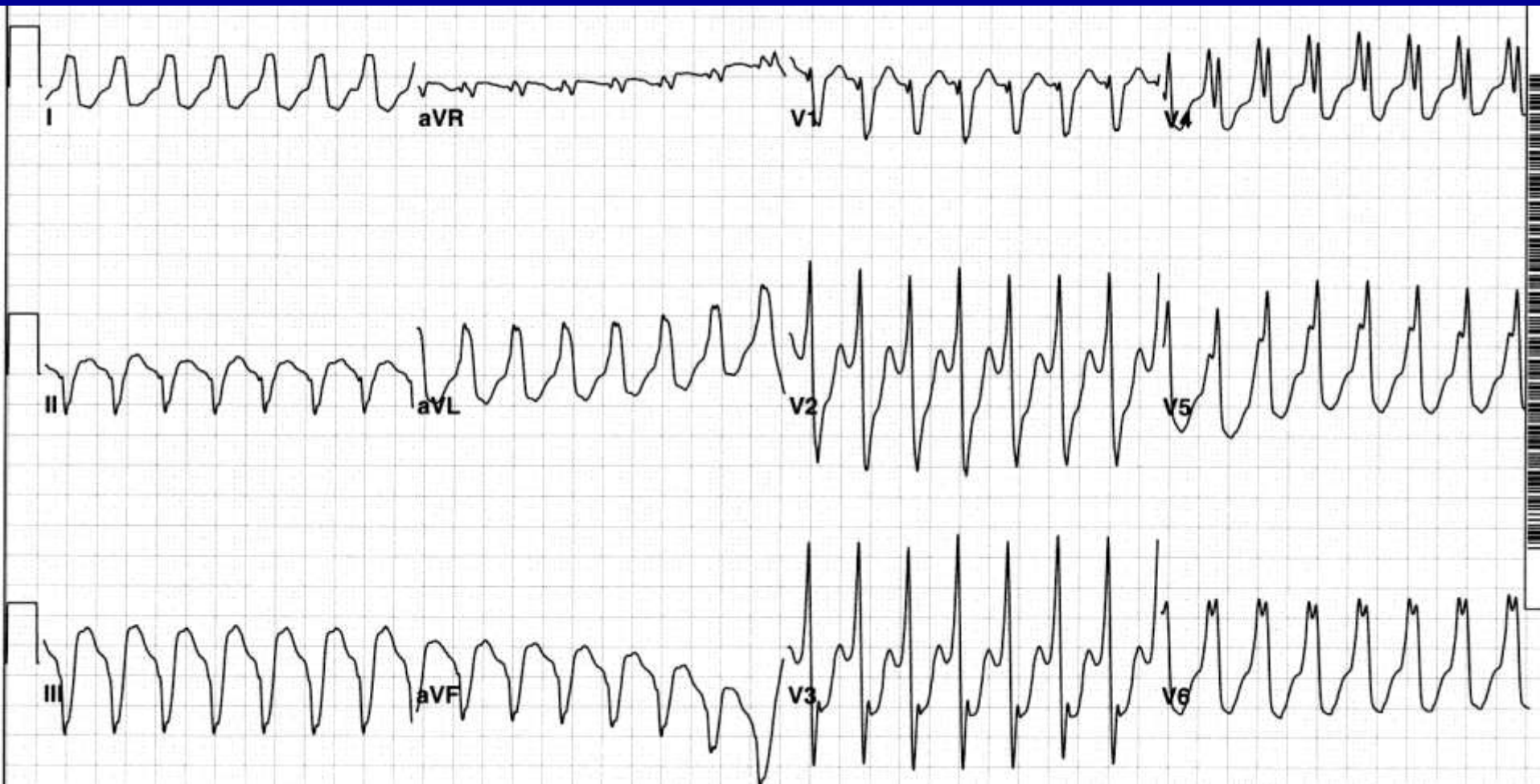
Case 8

4 days later, 15 April 2000



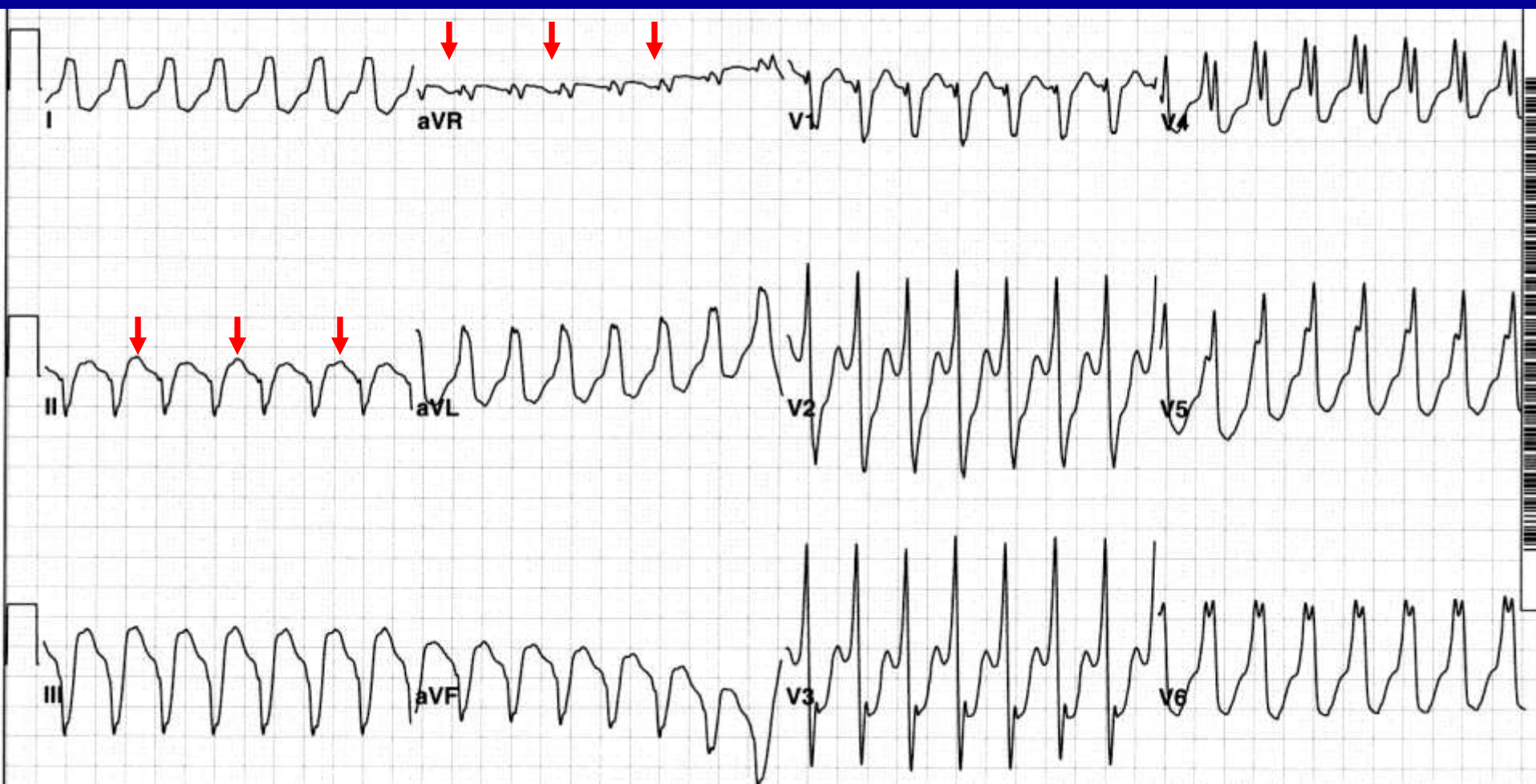
February 1988

Case 9



February 1988

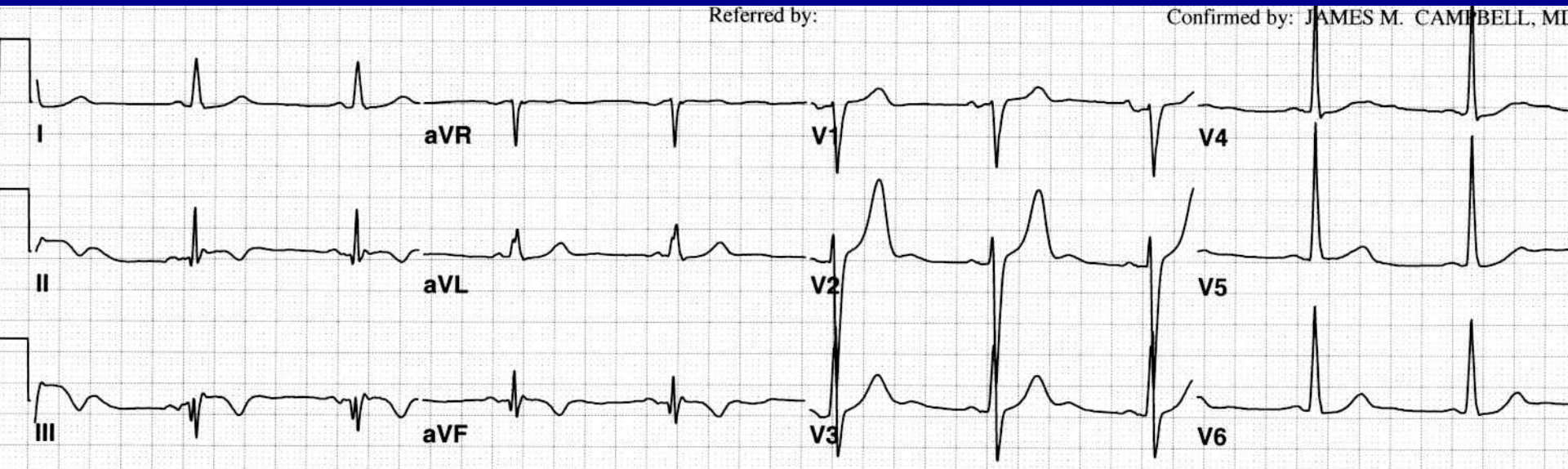
Case 9



Sustained VT, baseline sinus rhythm showed
Inferior MI and normal QRS duration

6 mo prior to Feb 1988

Case 9



Same patient with inferior MI and normal QRS duration

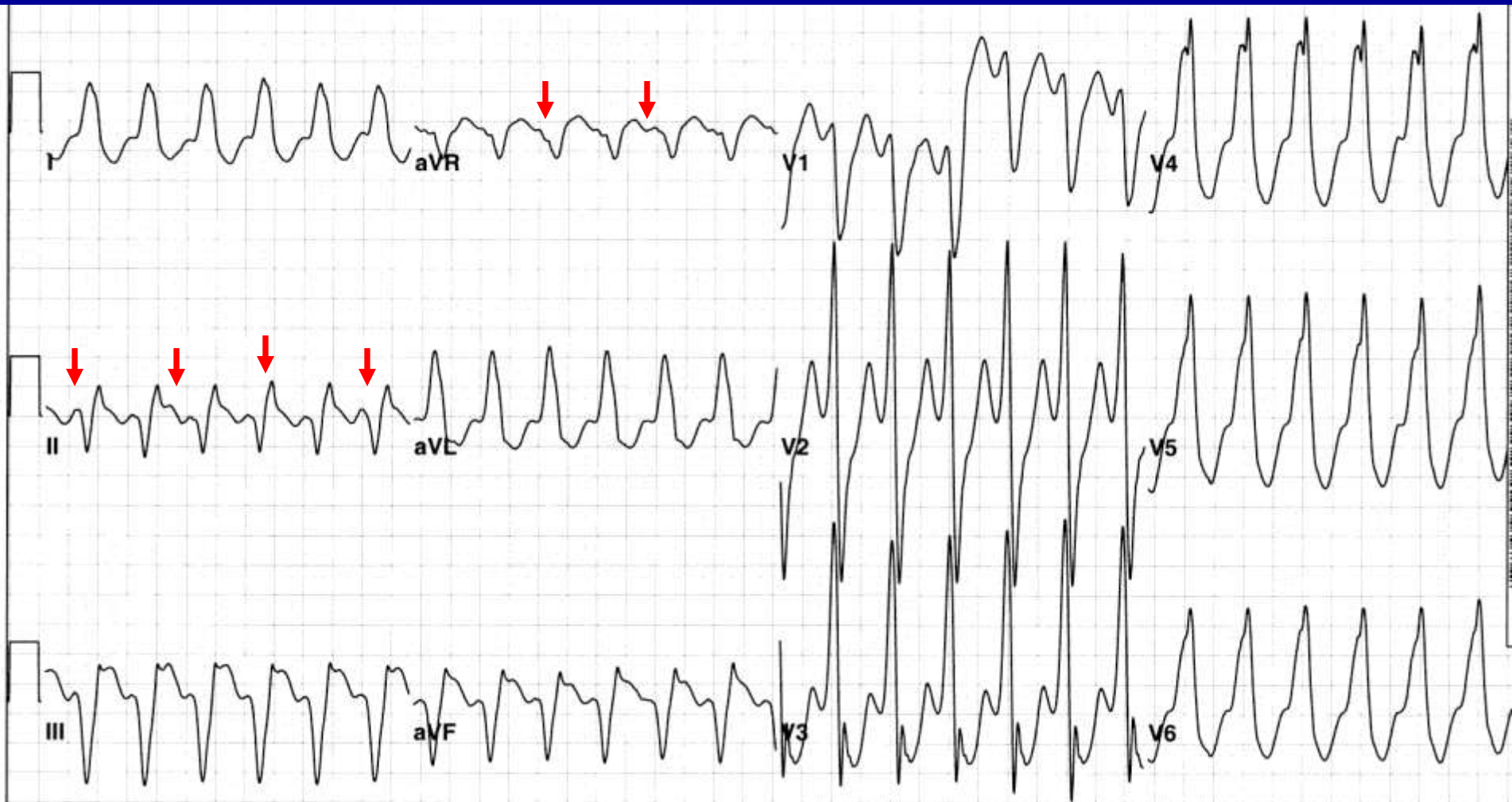
Mar 1986

Case 10



Mar 1986

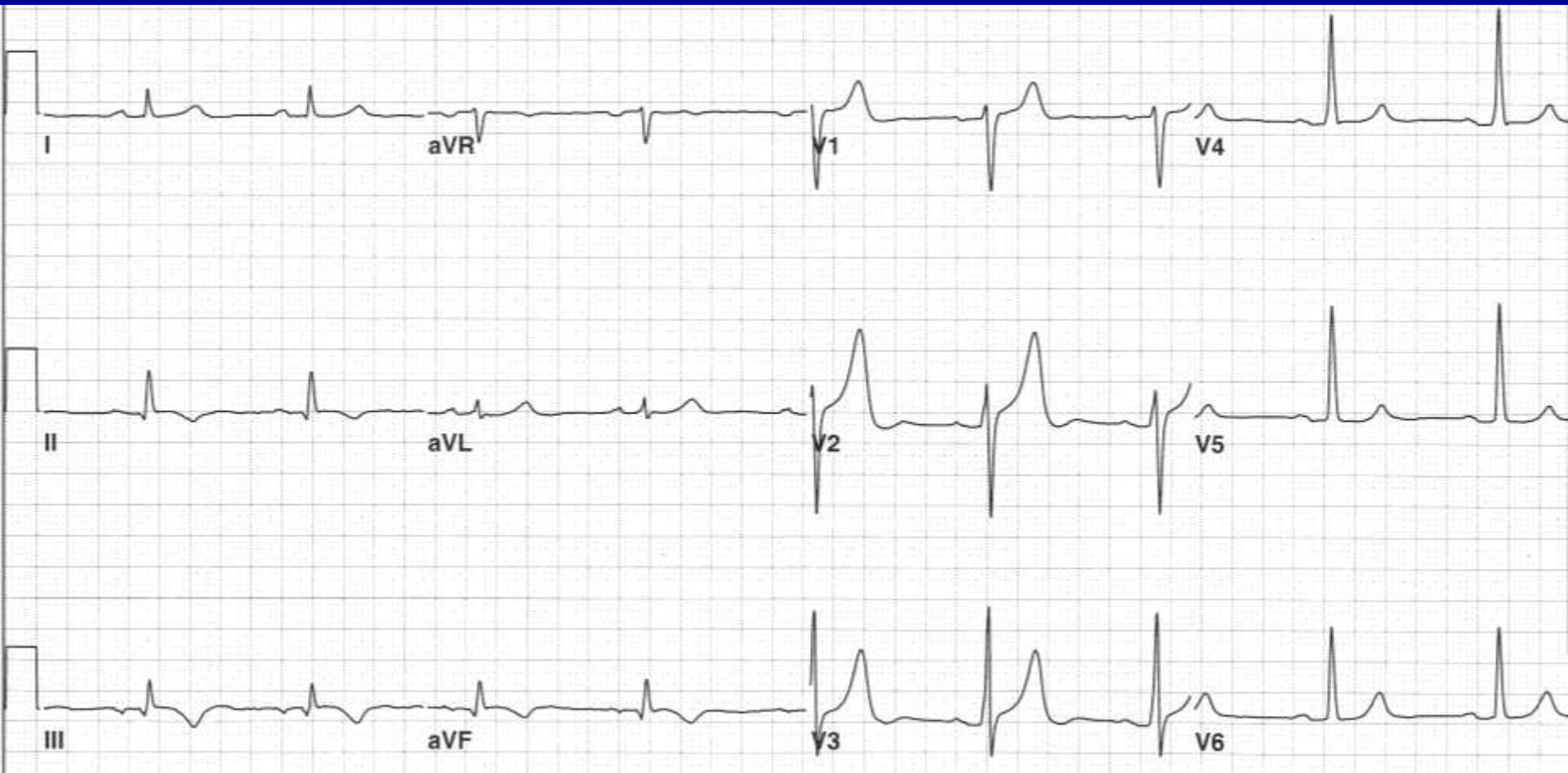
Case 10



Sustained VT, with baseline ECG showing QRS duration of 0.11 sec and inferior MI, probably recent

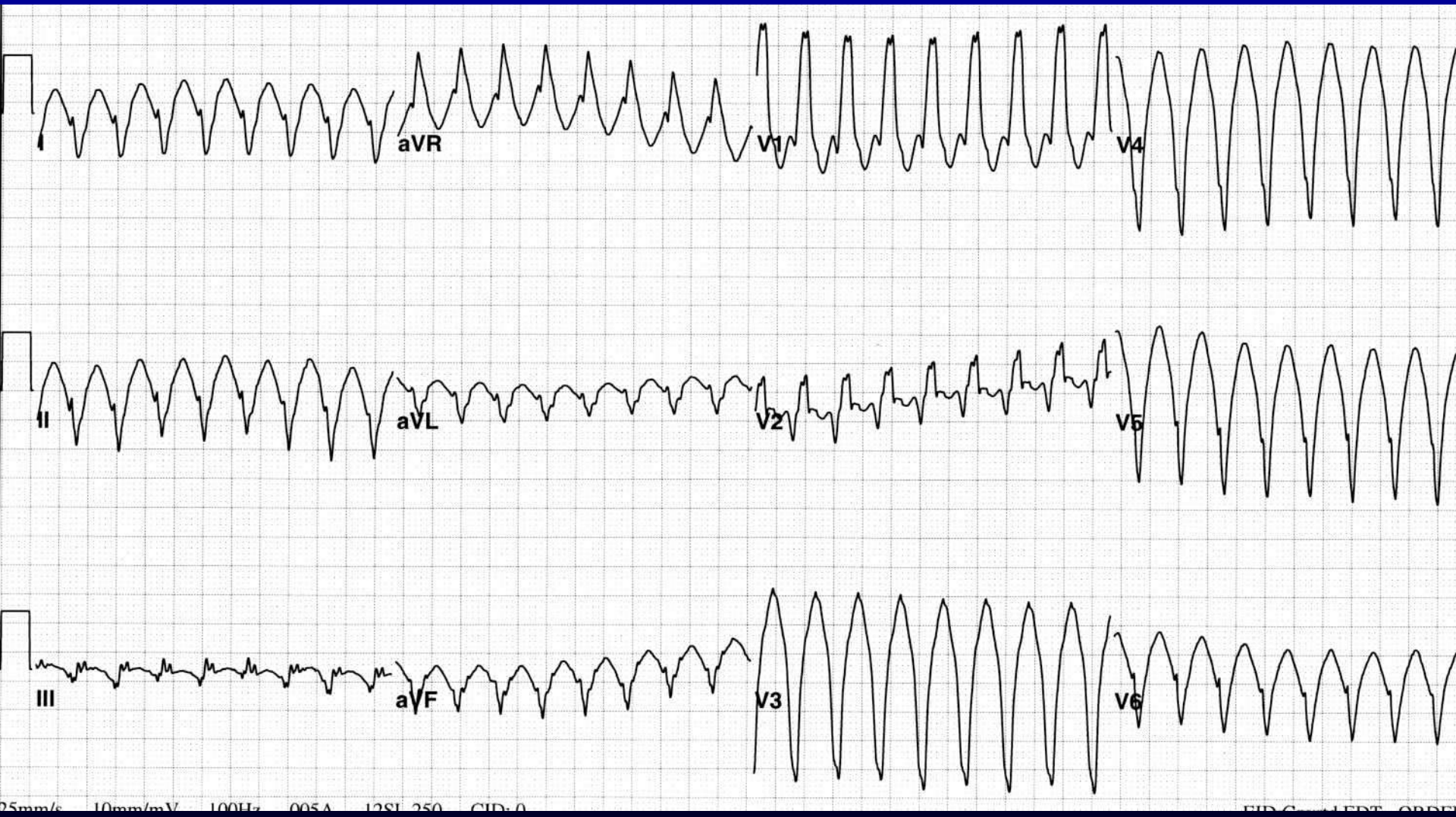
Mar 1986

Case 10

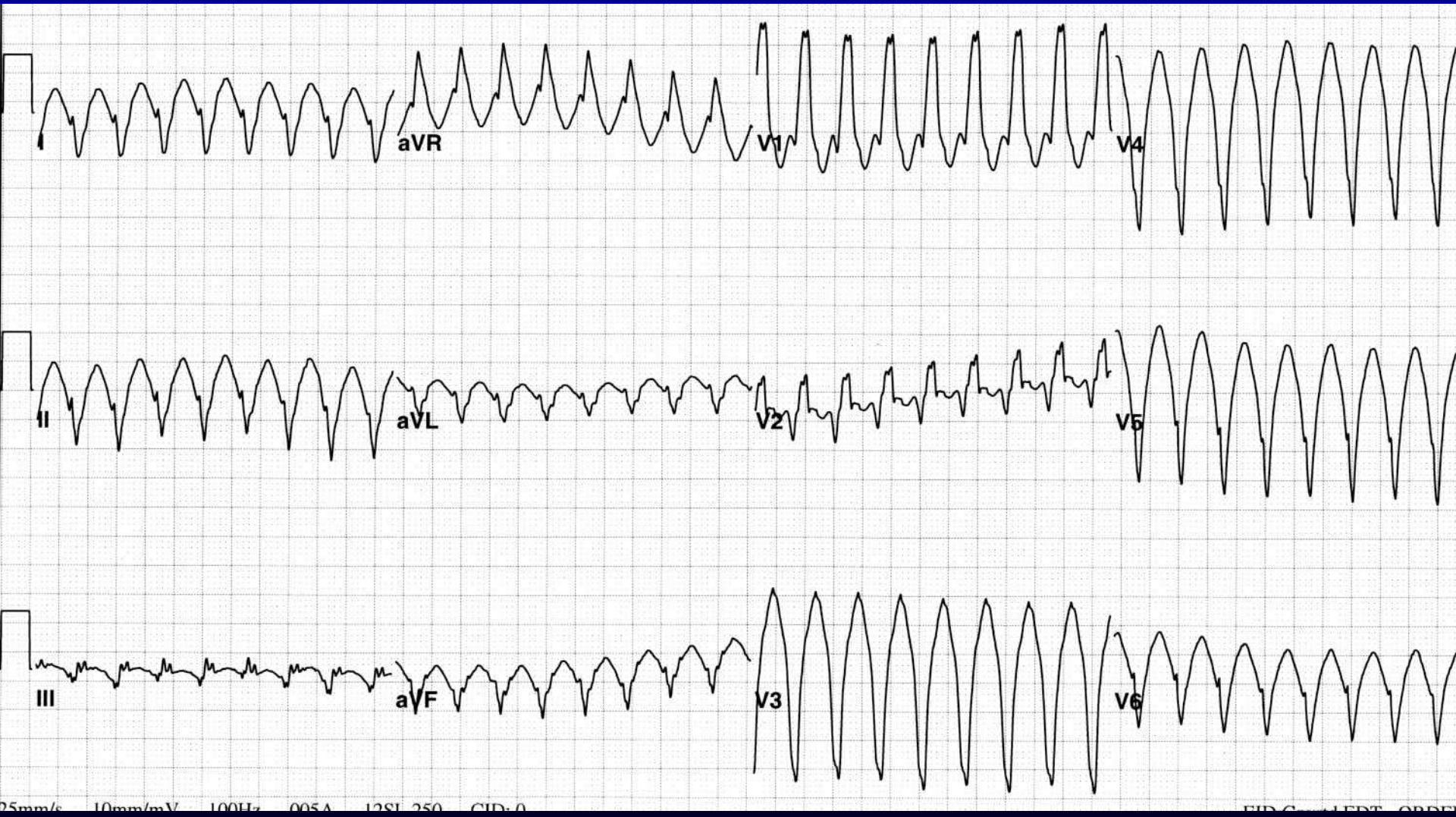


Baseline 6 mo prior

Case 11



Case 11



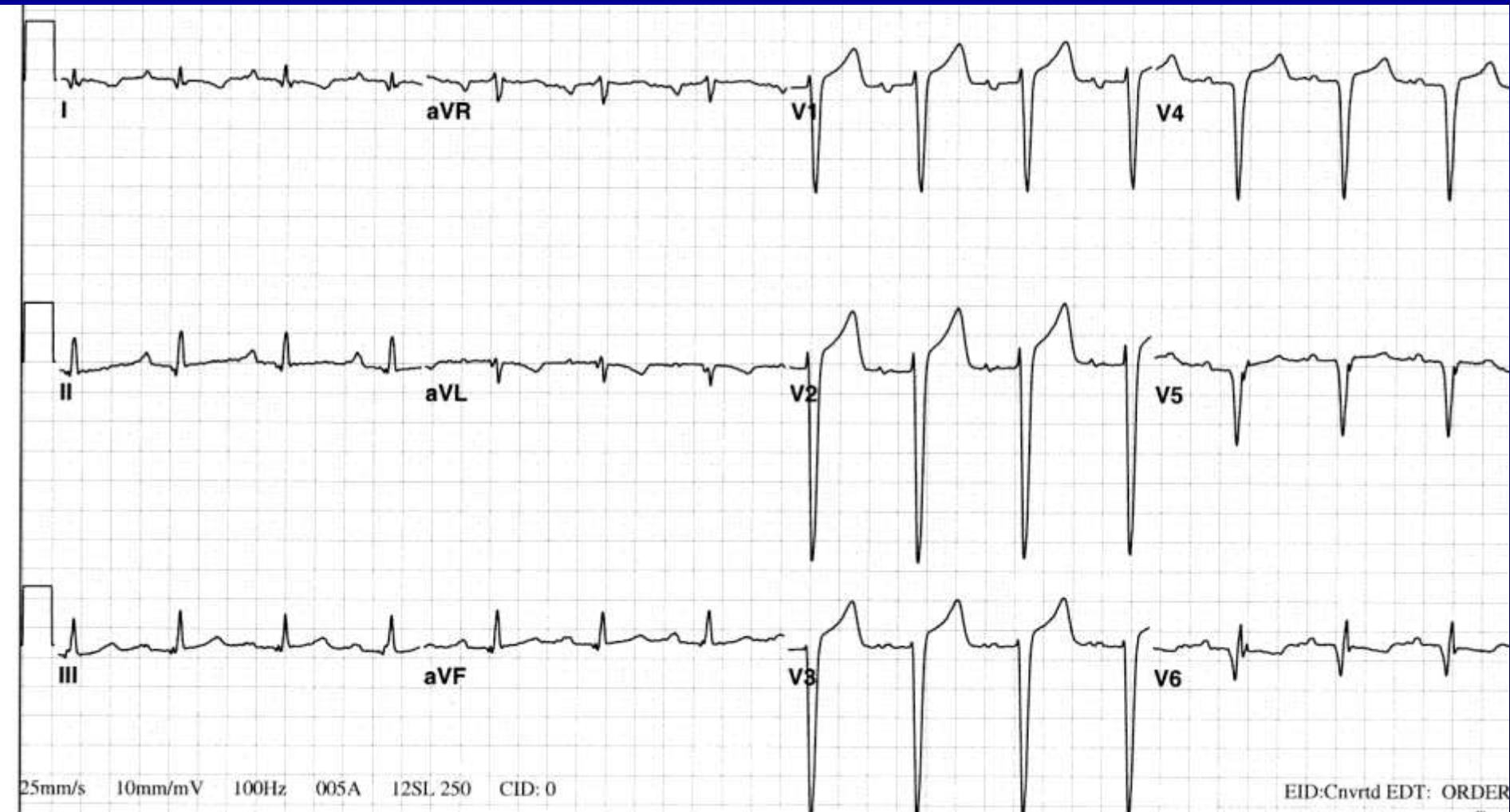
Sustained VT 23 Nov 1997, rate 202, QRS duration 0.17
Baseline ECG: inferolateral MI with QRS0.12 and LAE

Case 11



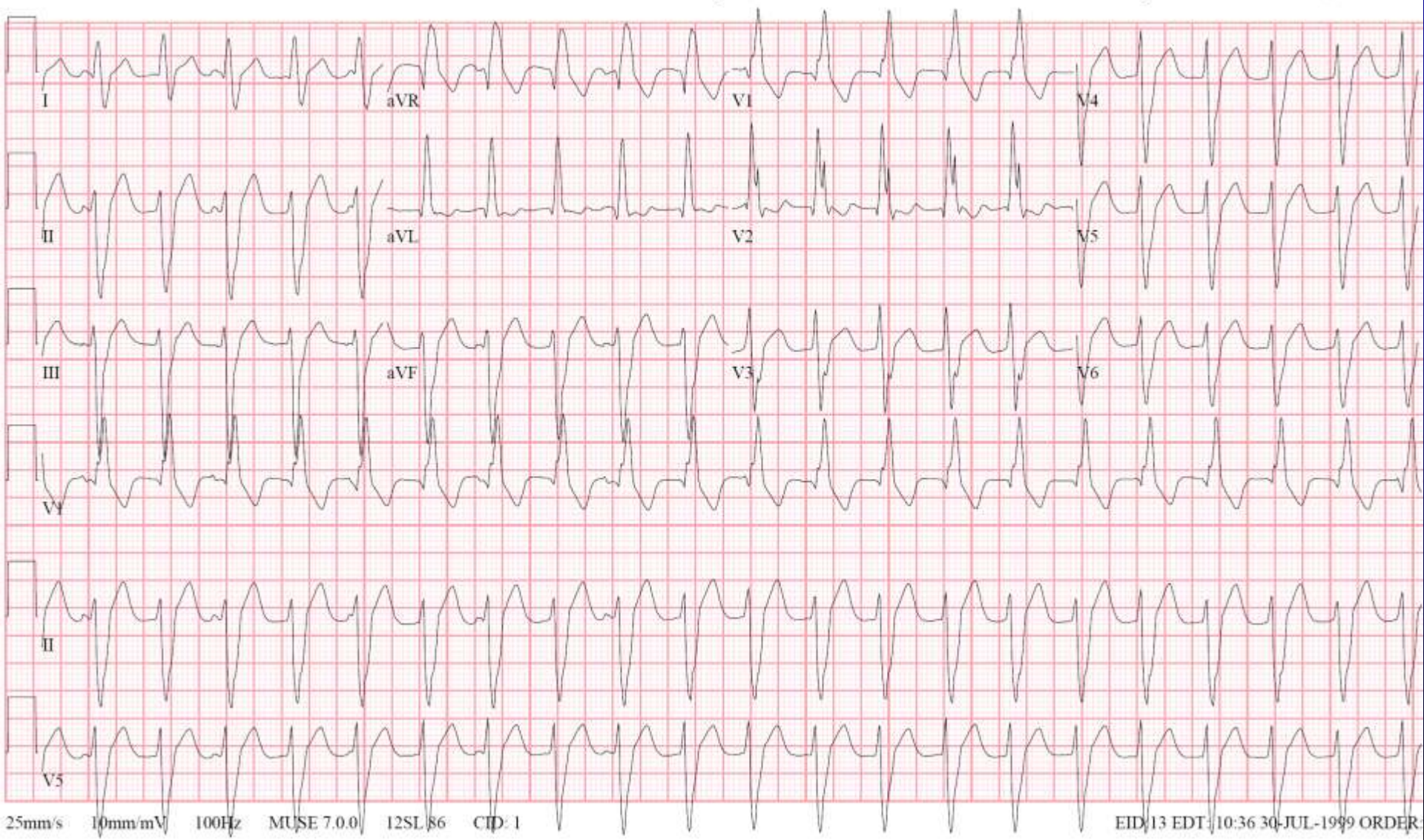
Sustained VT 1 Dec 1997, rate 164, QRS duration 0.20

Case 11



Baseline ECG with anterolateral MI, LAE, QRS 0.12

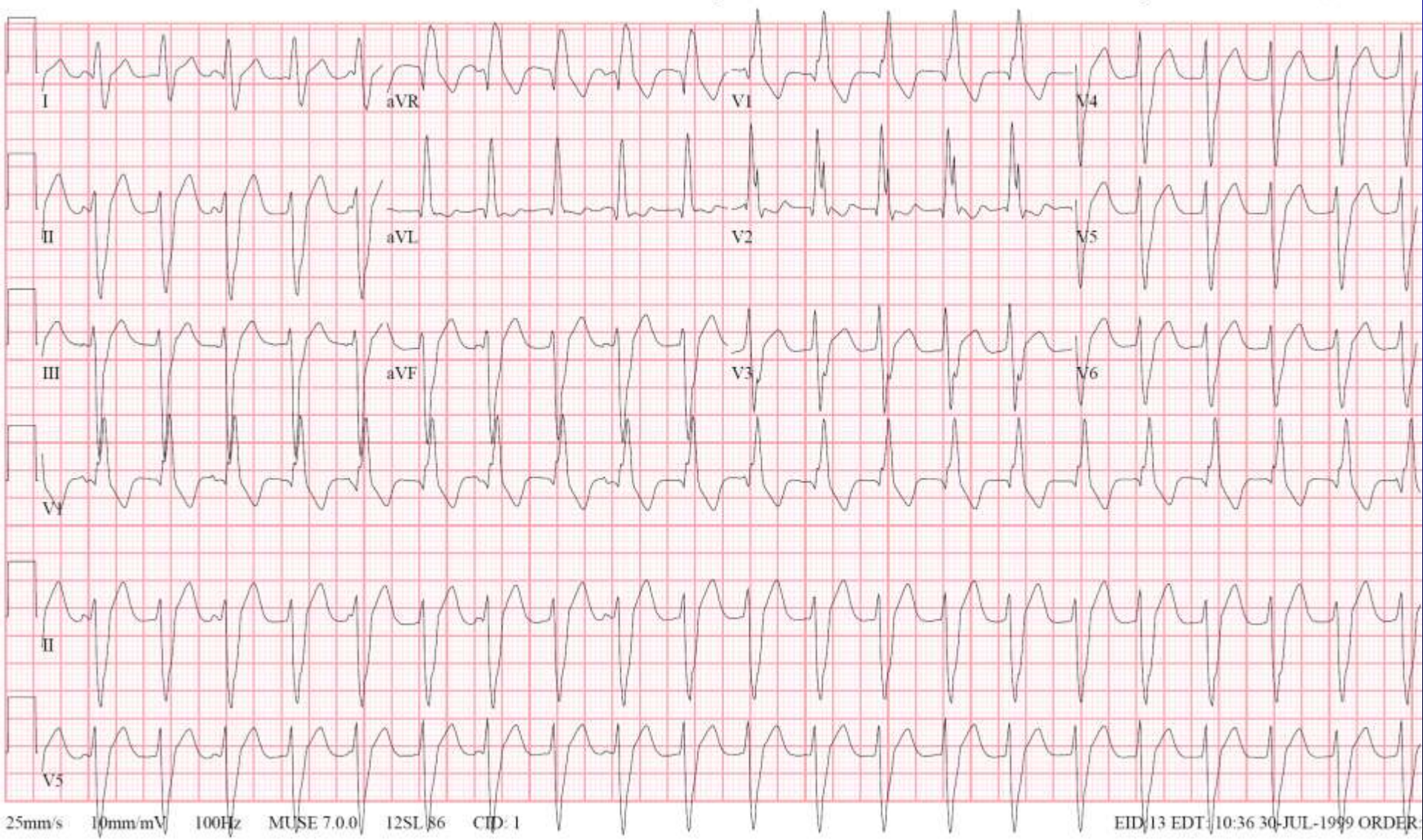
Case 12



21 year old man with clear AV dissociation

What is expected on physical examination?

Case 12



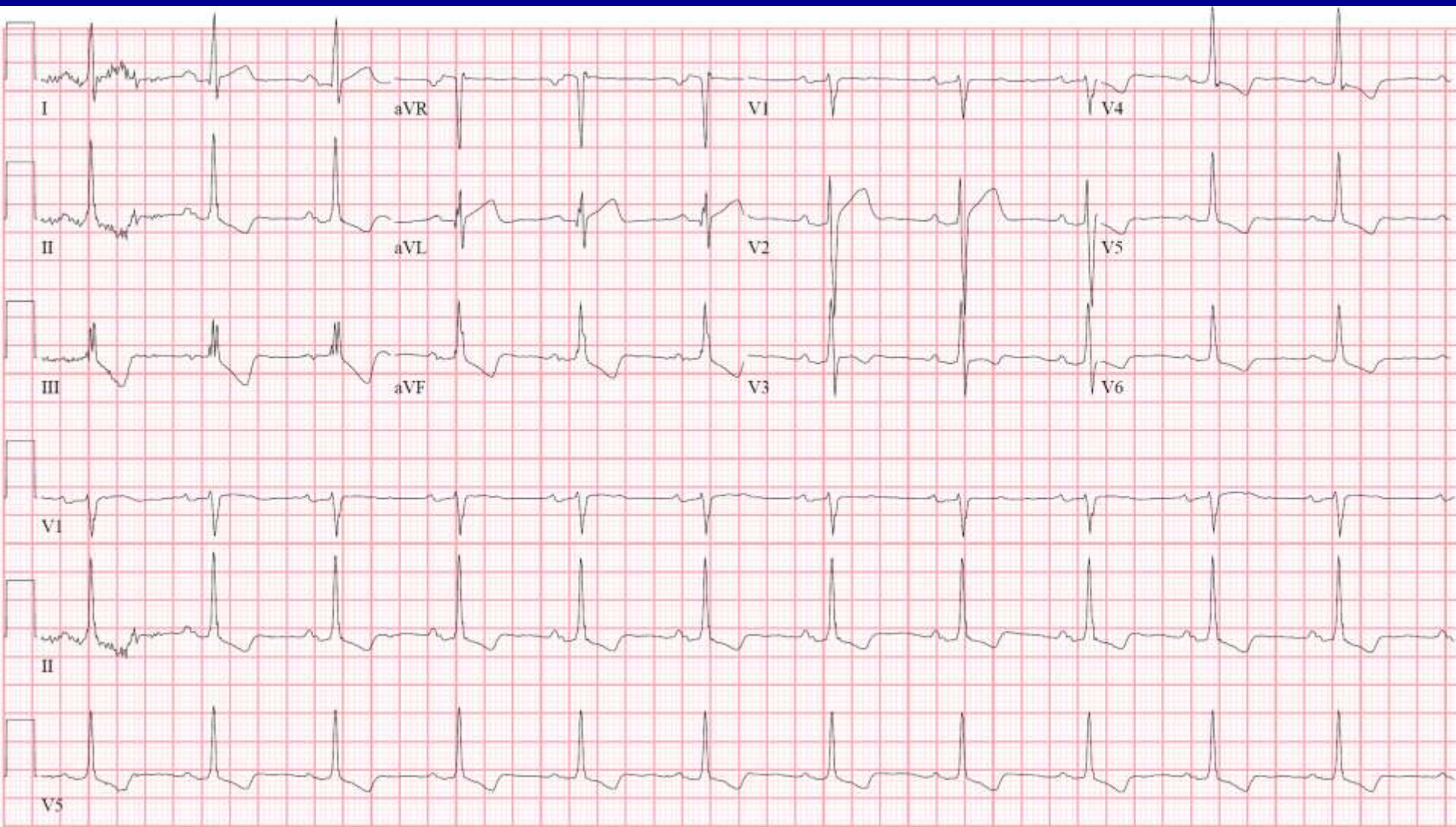
21 year old man – second episode

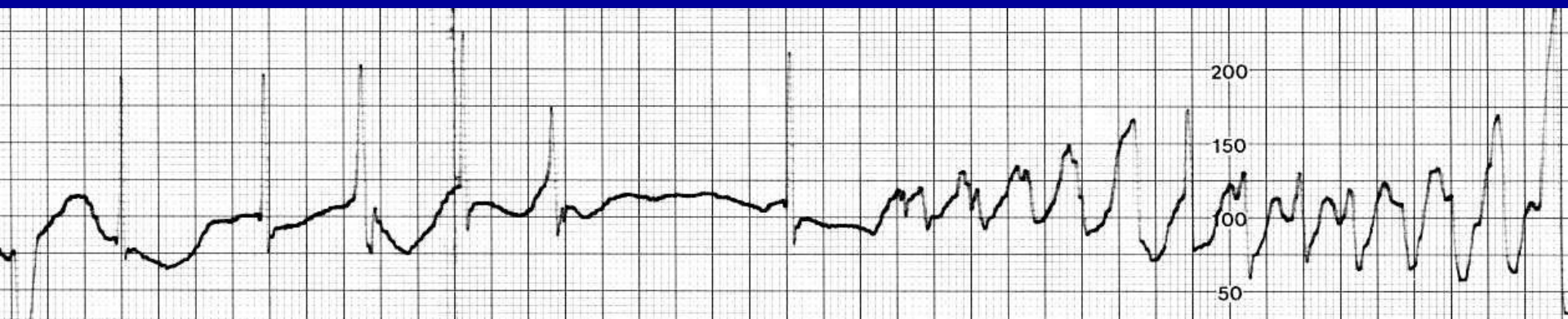
Case 12



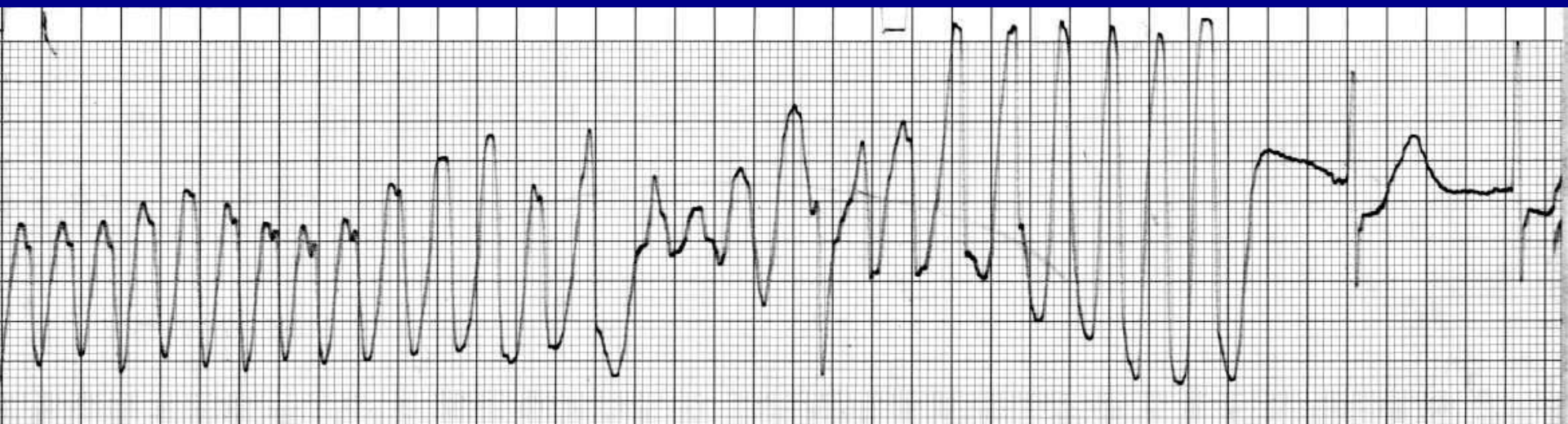
Baseline ECG from 21 year old man with VT, shows
repolarization abnormality

Case 12



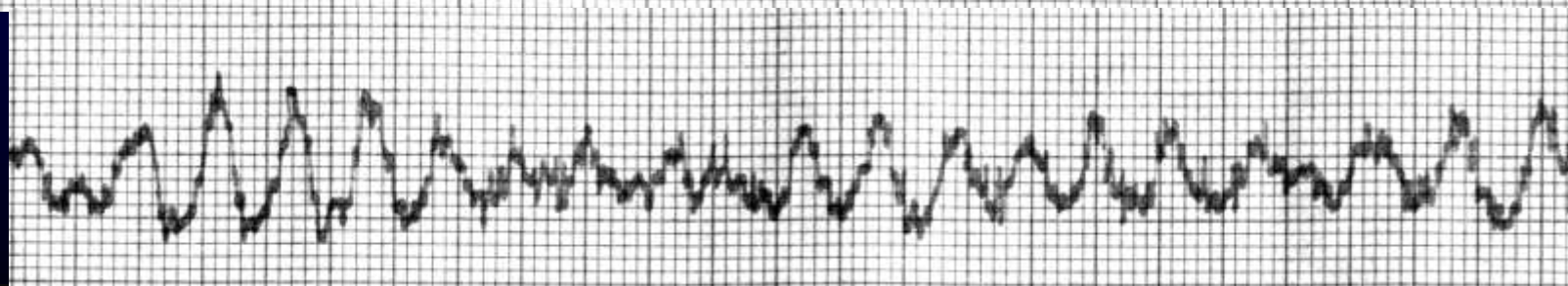
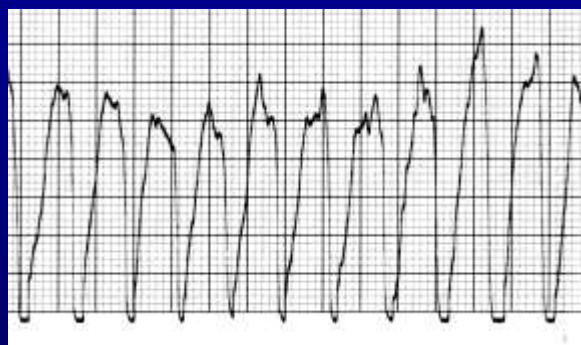
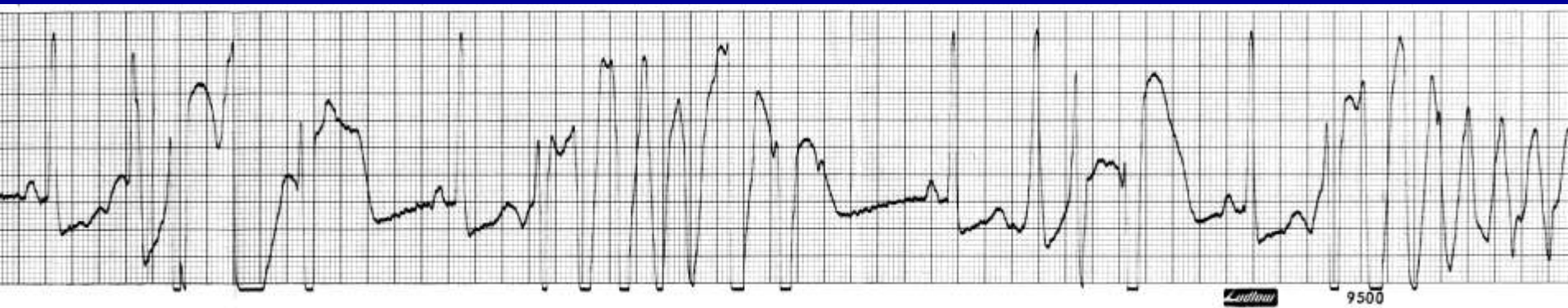


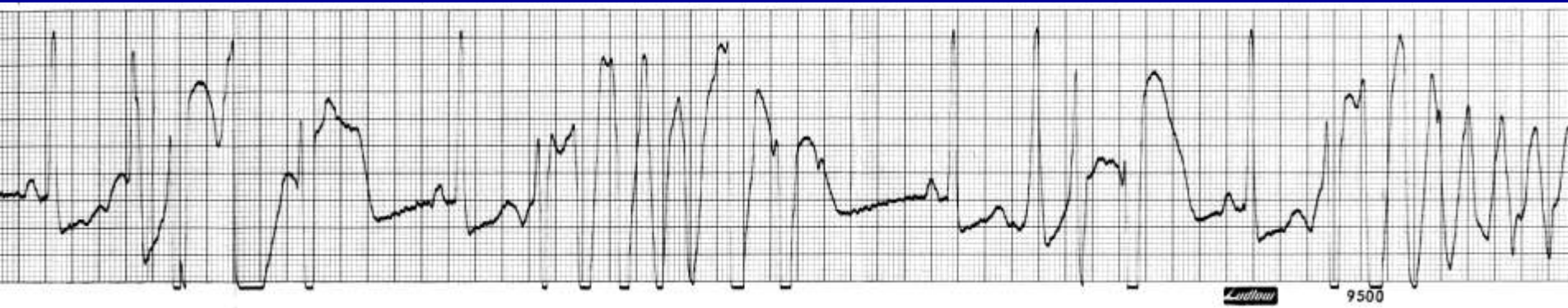
Case 13



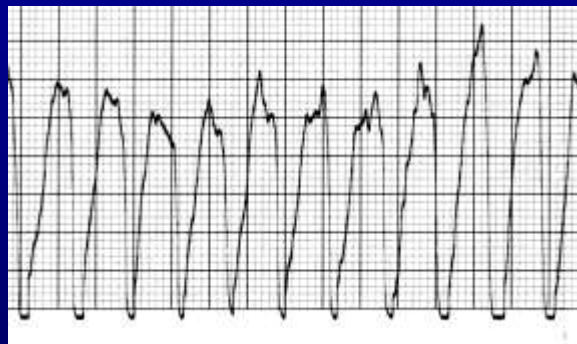
Case 13

Initiation and termination of Torsade

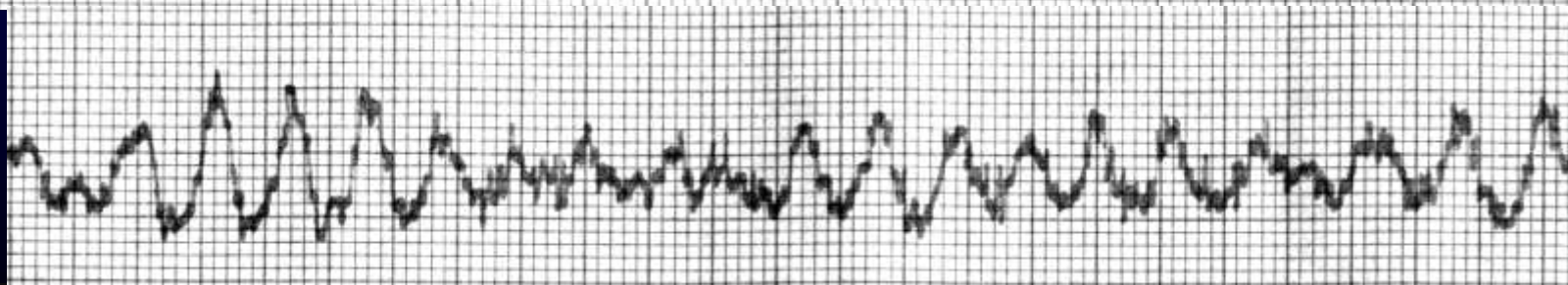


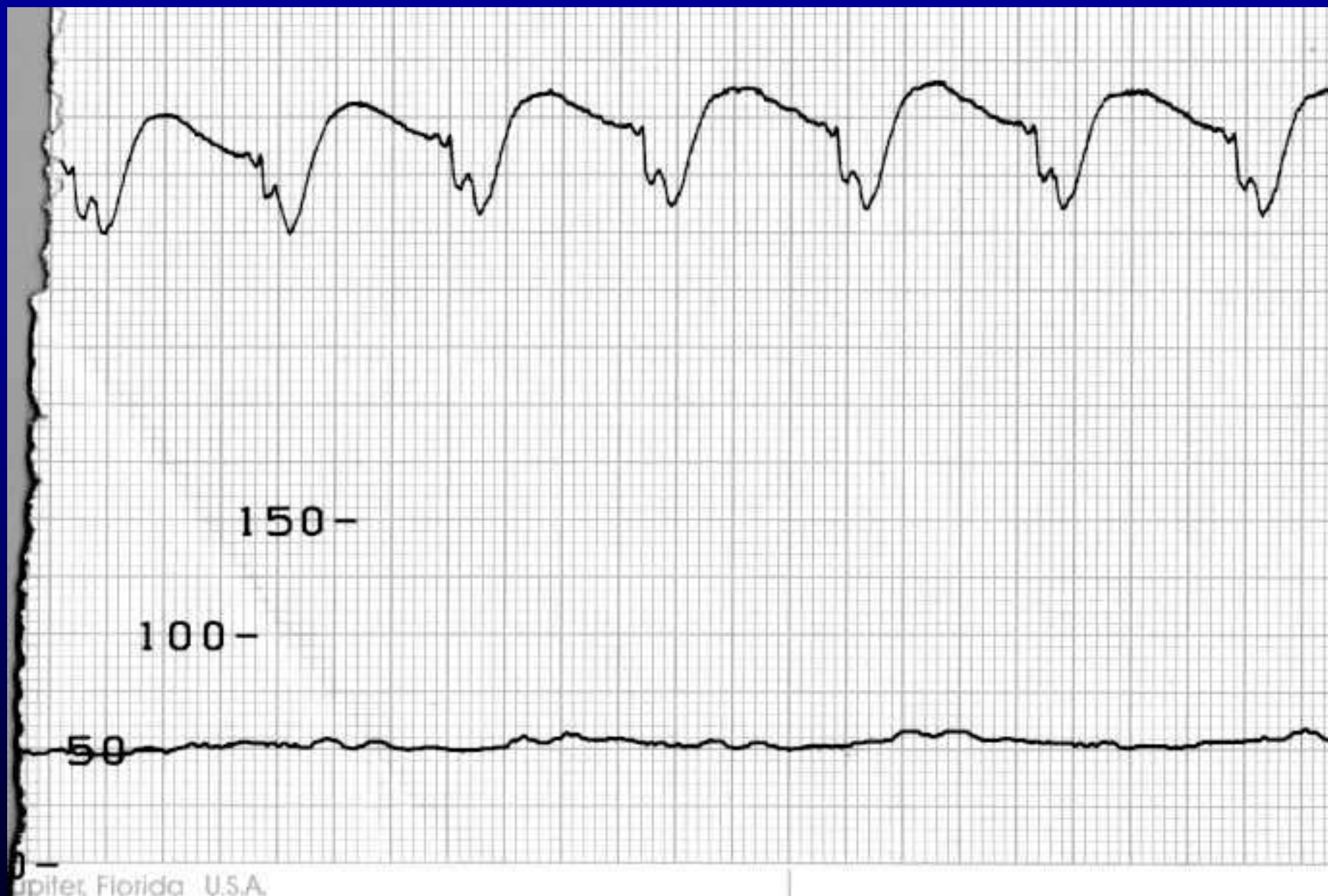


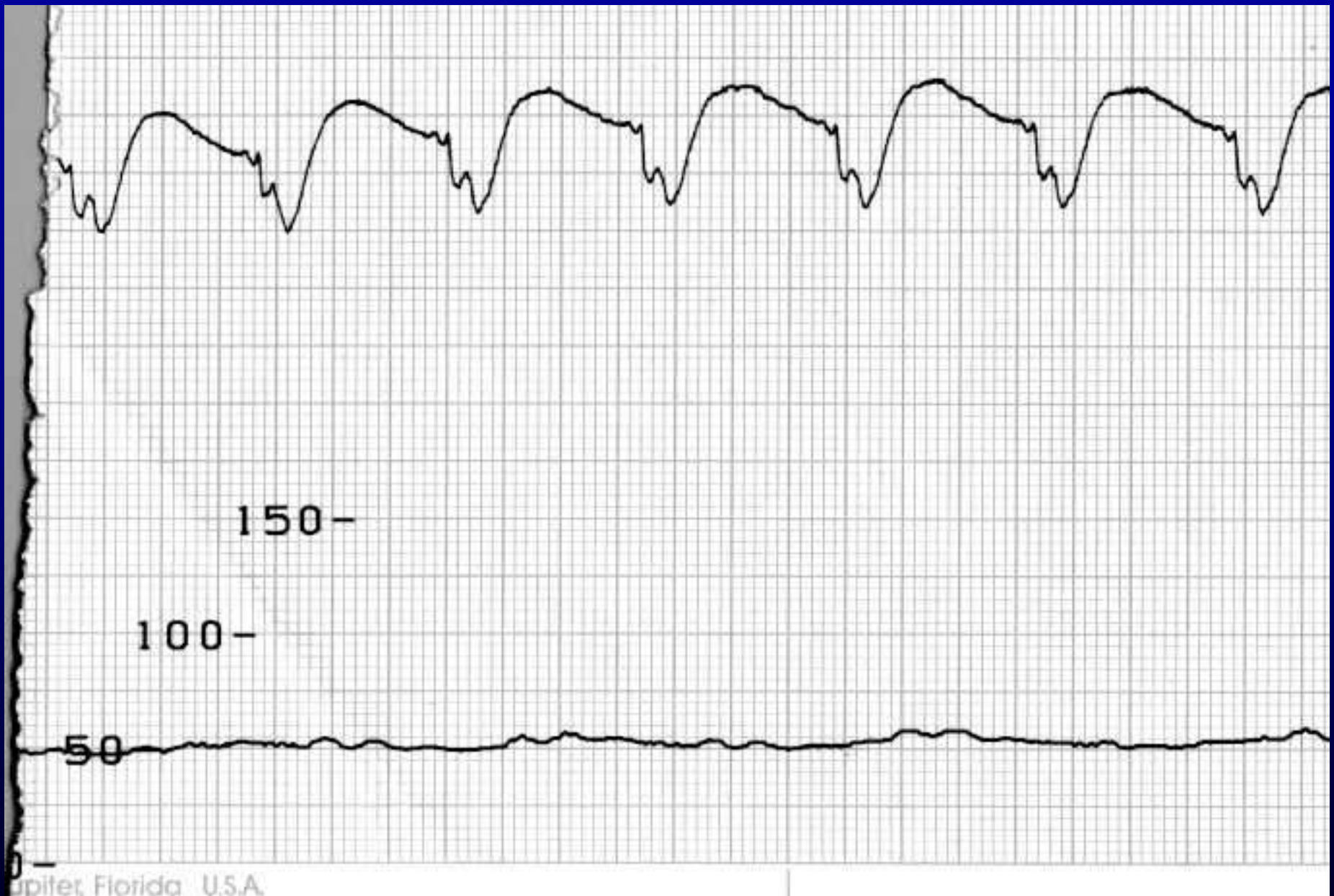
Torsades



VT/VF

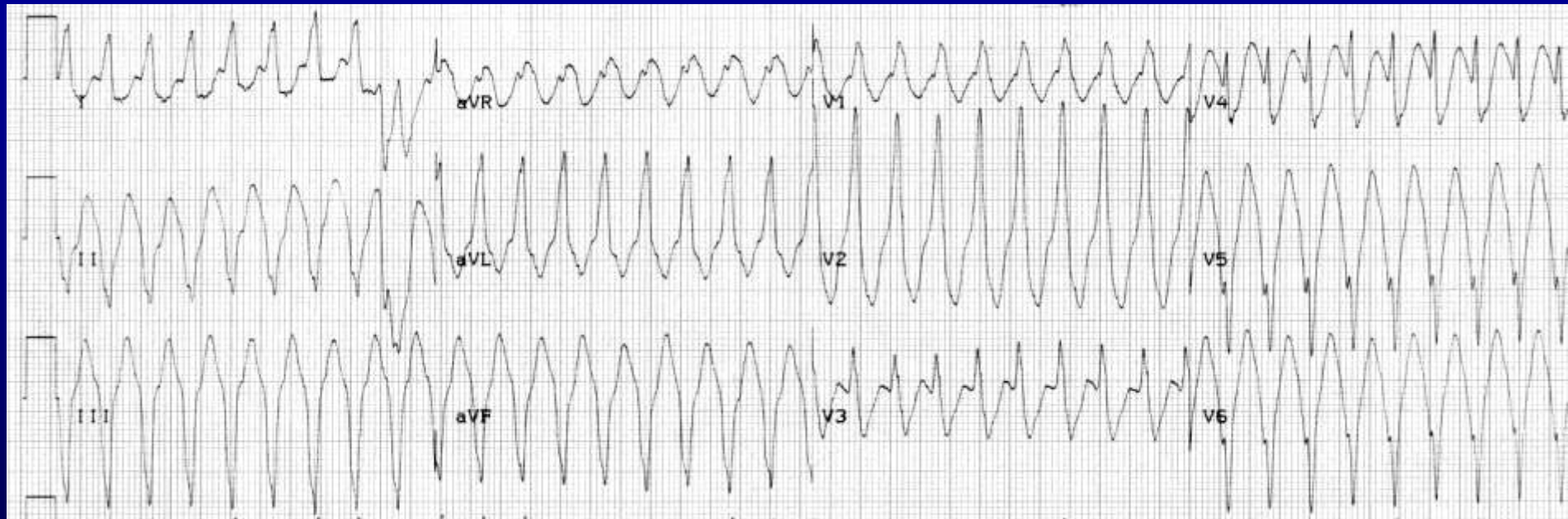




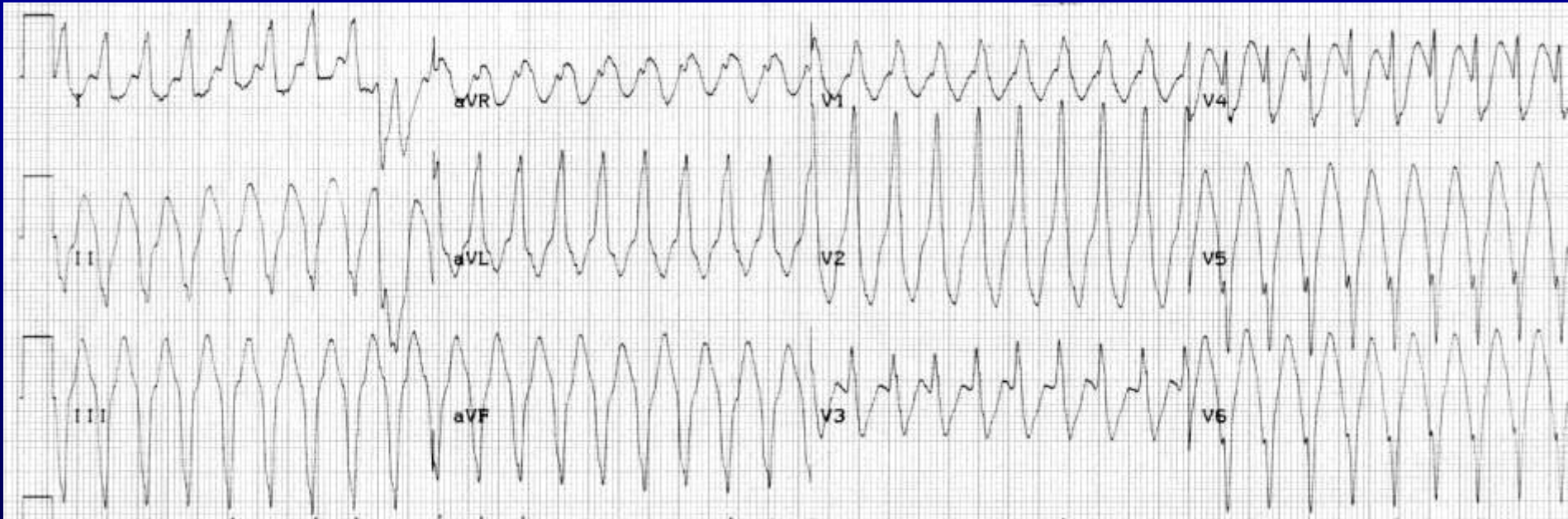


AIVR without significant pulse

Case 14



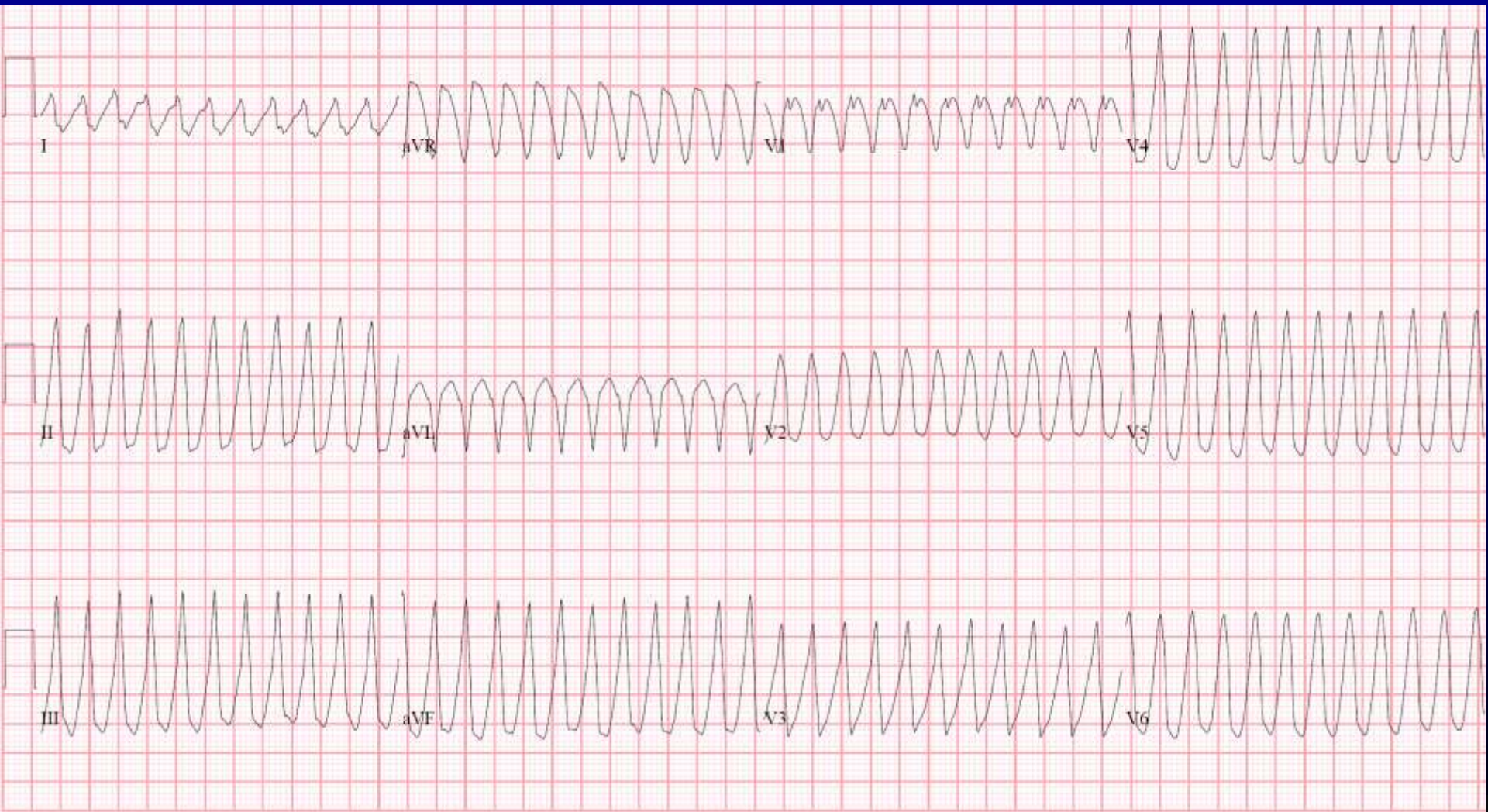
Case 14



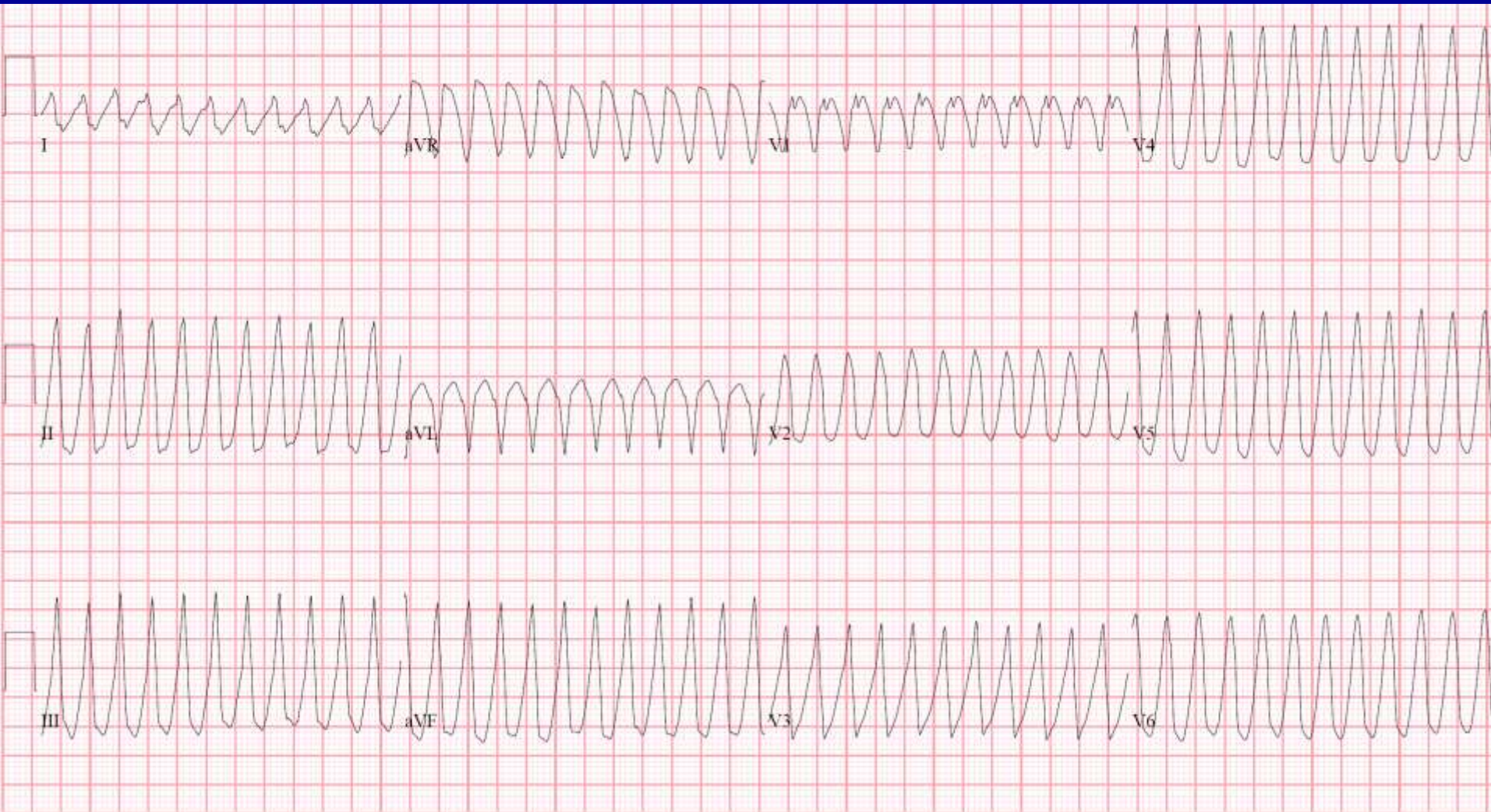
Rapid monomorphic sustained VT

Case 15

29 yo man post surgery for VSD and Tetralogy, seizure



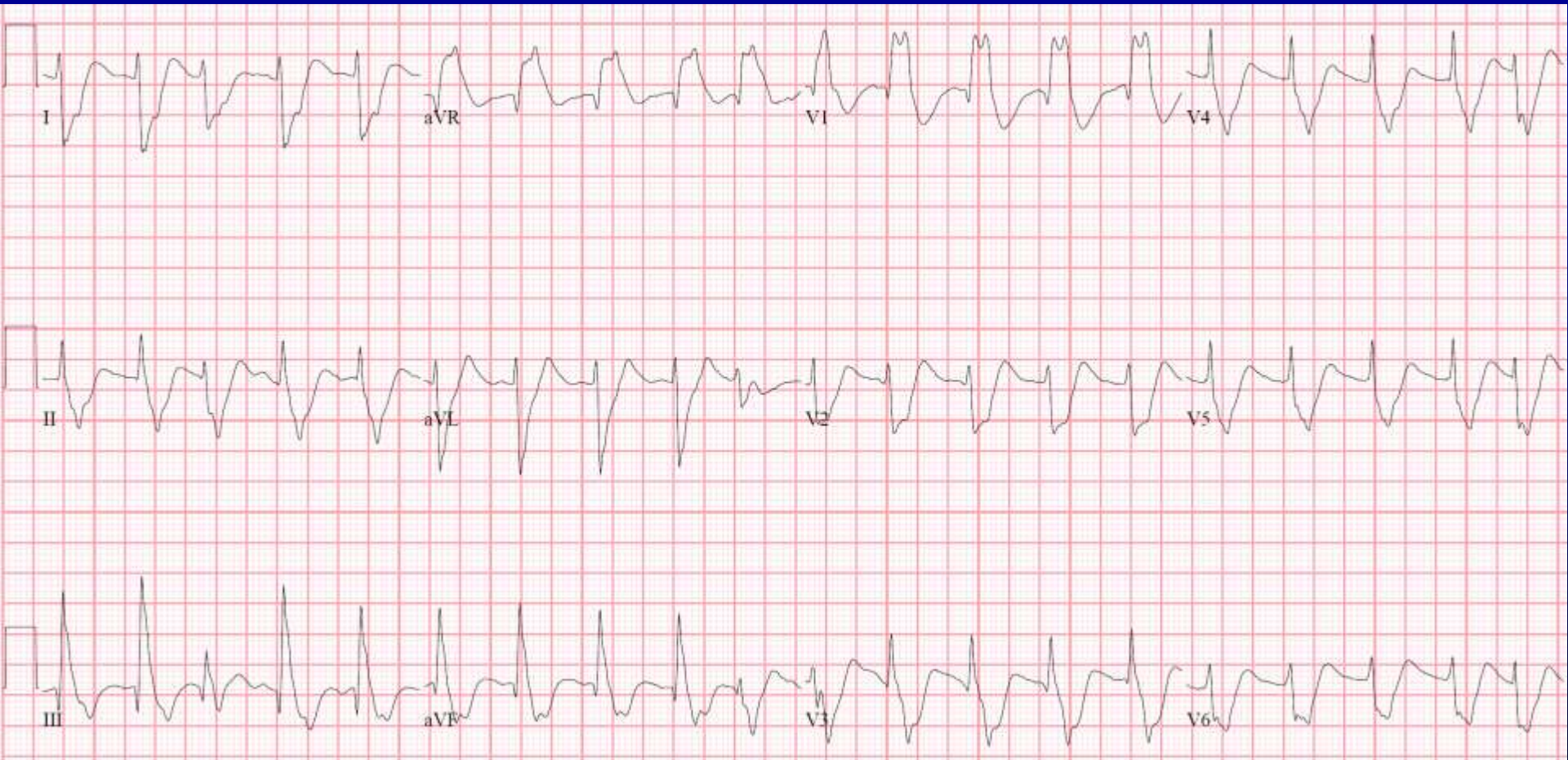
Case 15



Inducible on second EPS

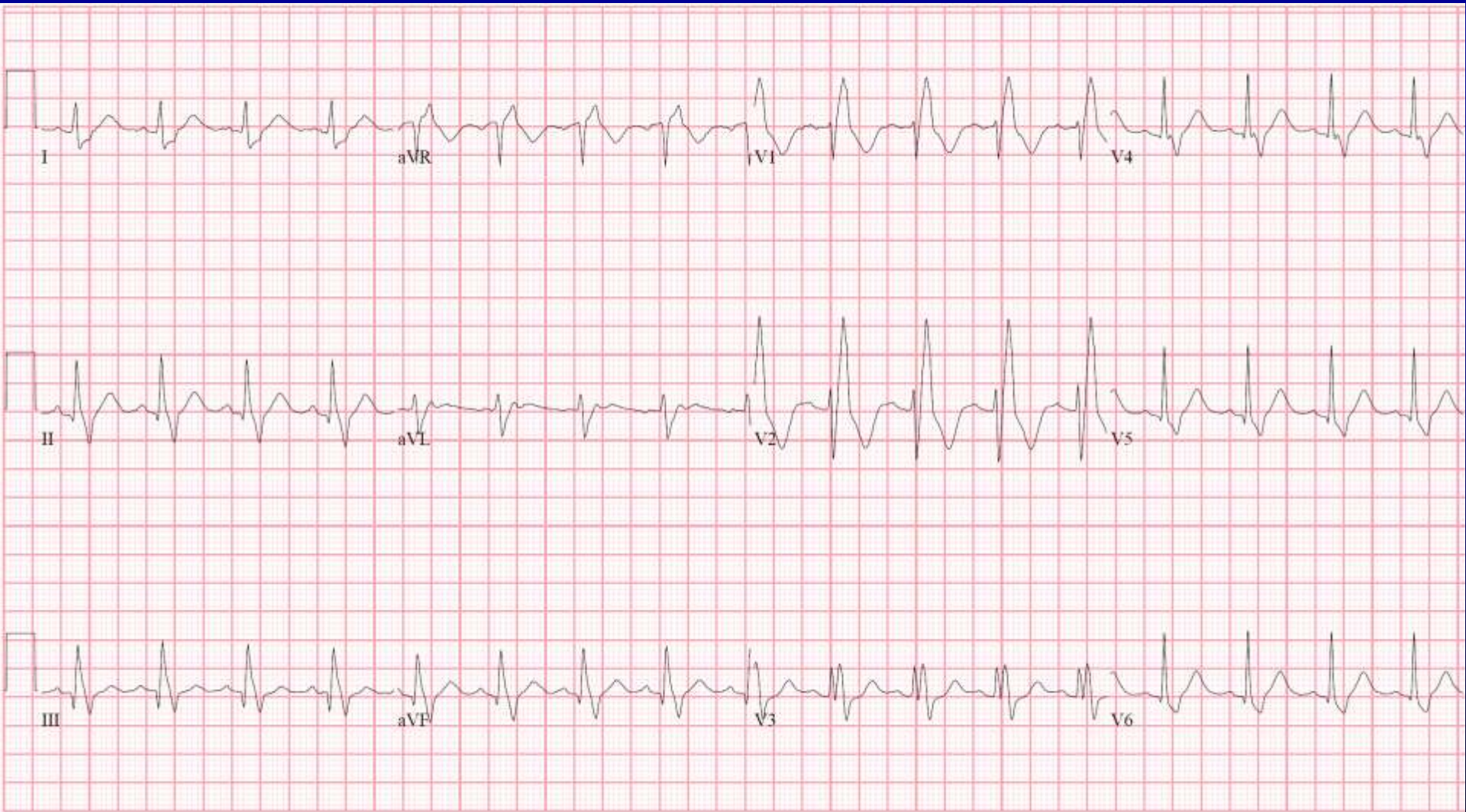
Rapid monomorphic Sustained VT - received ICD

Case 15



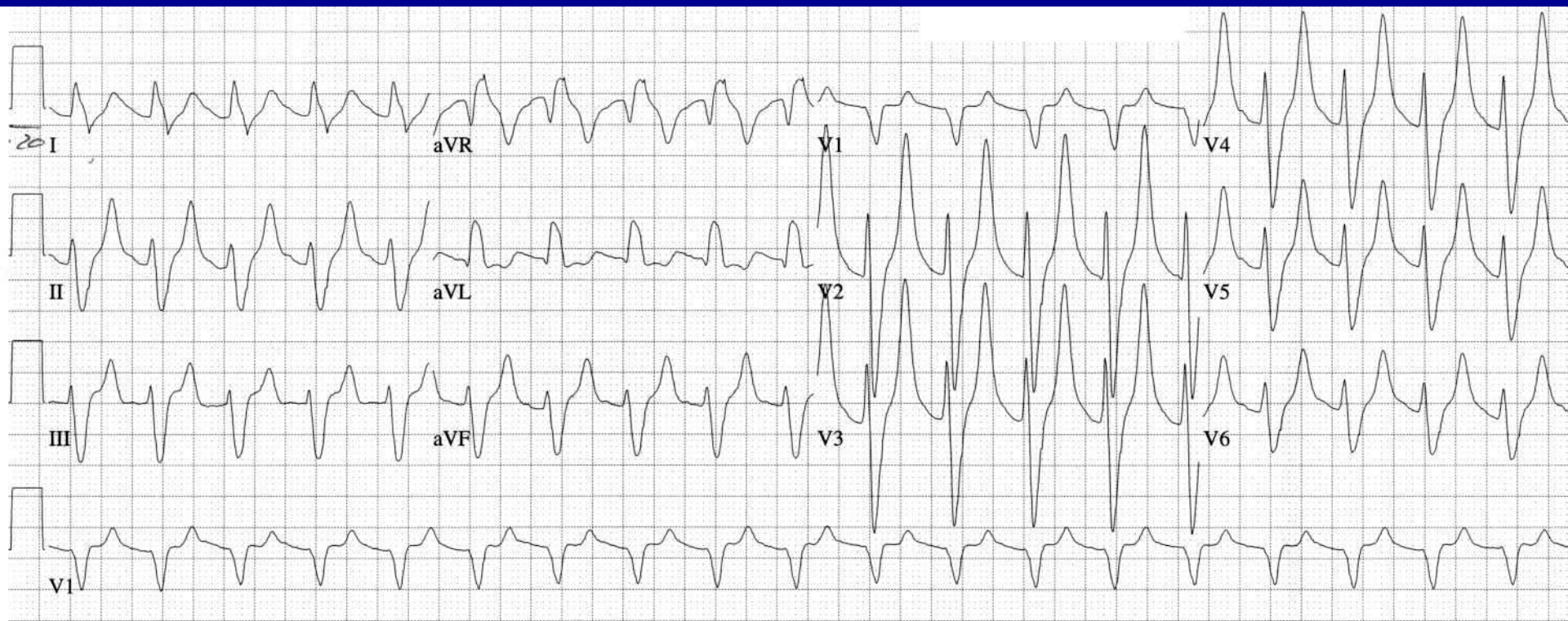
4 minutes after conversion: Injury pattern

Case 15

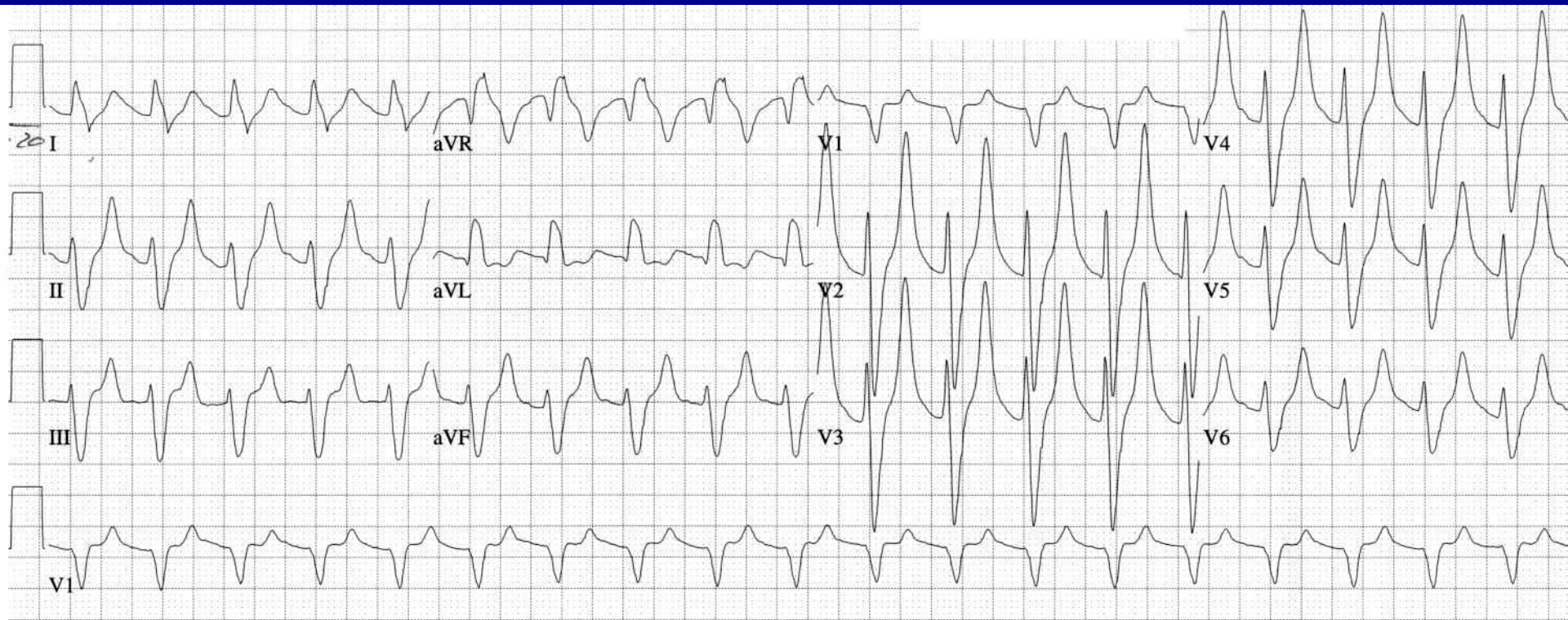


Several hours after conversion: sinus tachycardia

Case 16



Case 16

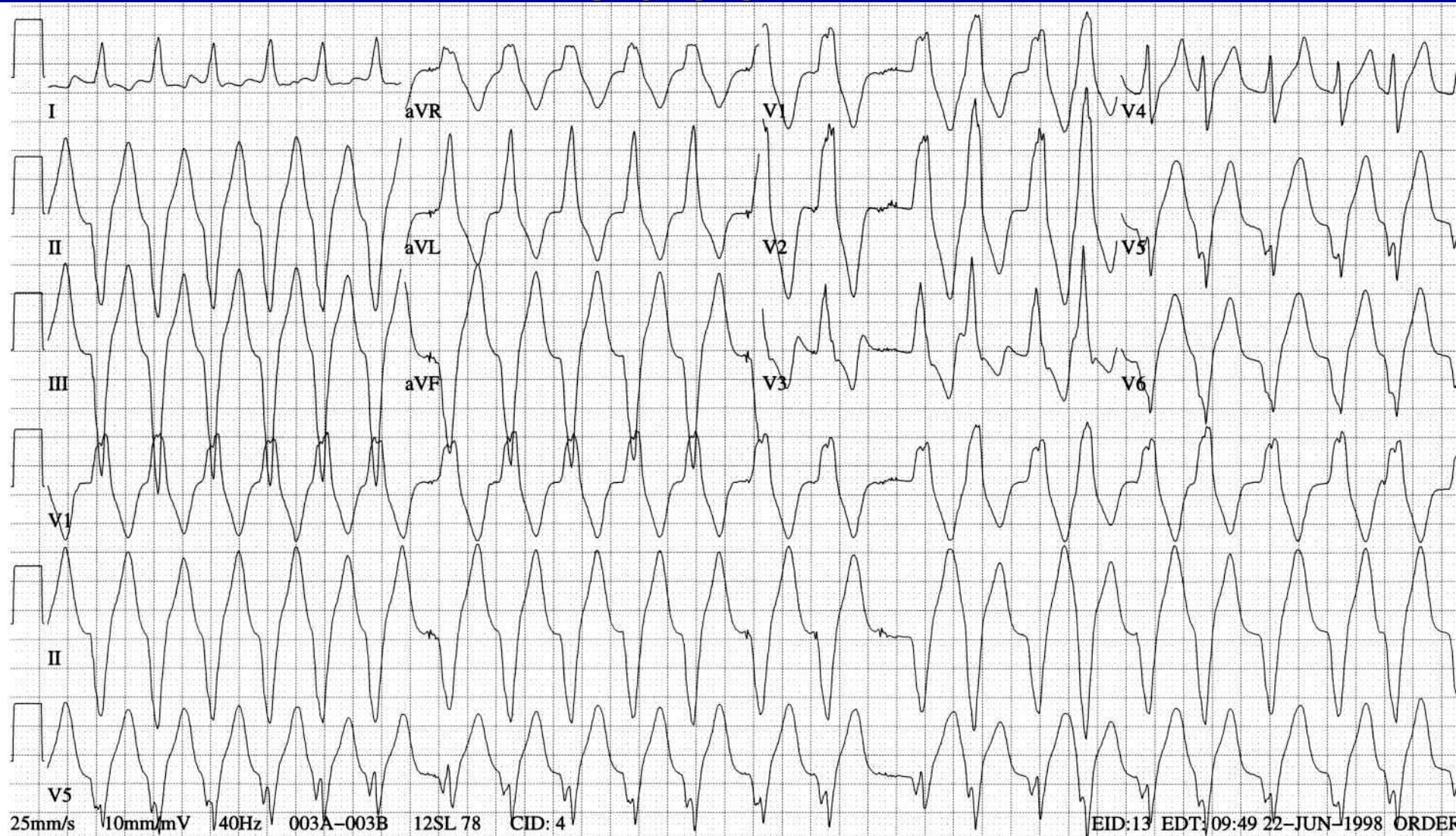


Sinus tachycardia and hyperkalemia
Hyperkalemia can also mimic ST elevation of acute MI

Case 17

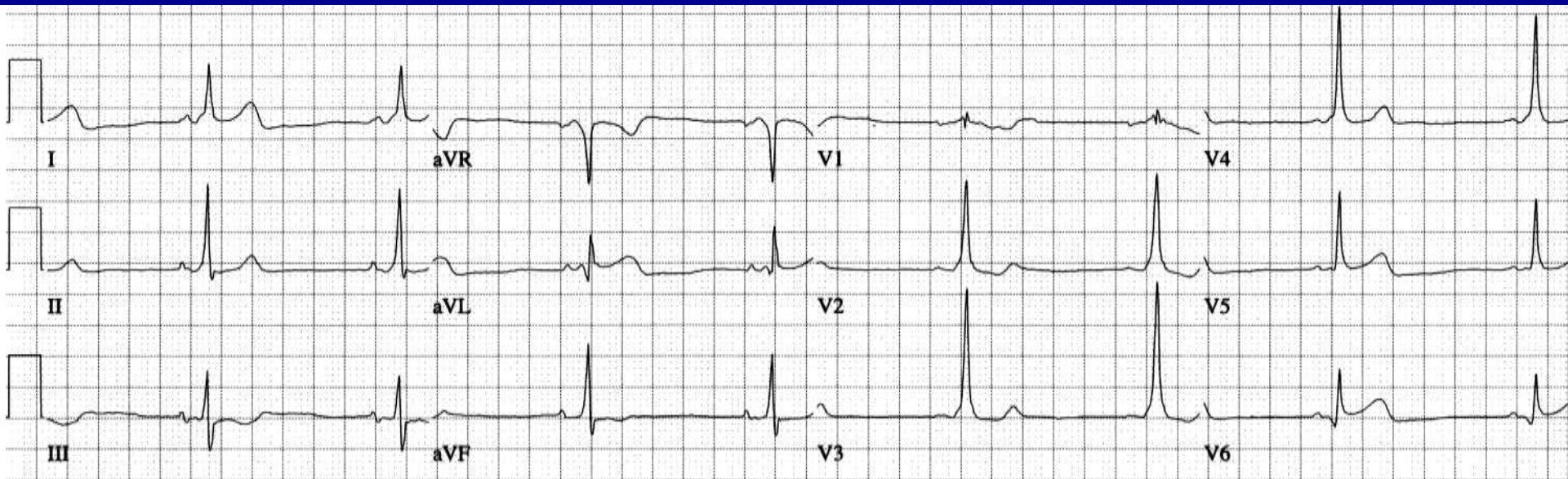


Case 17



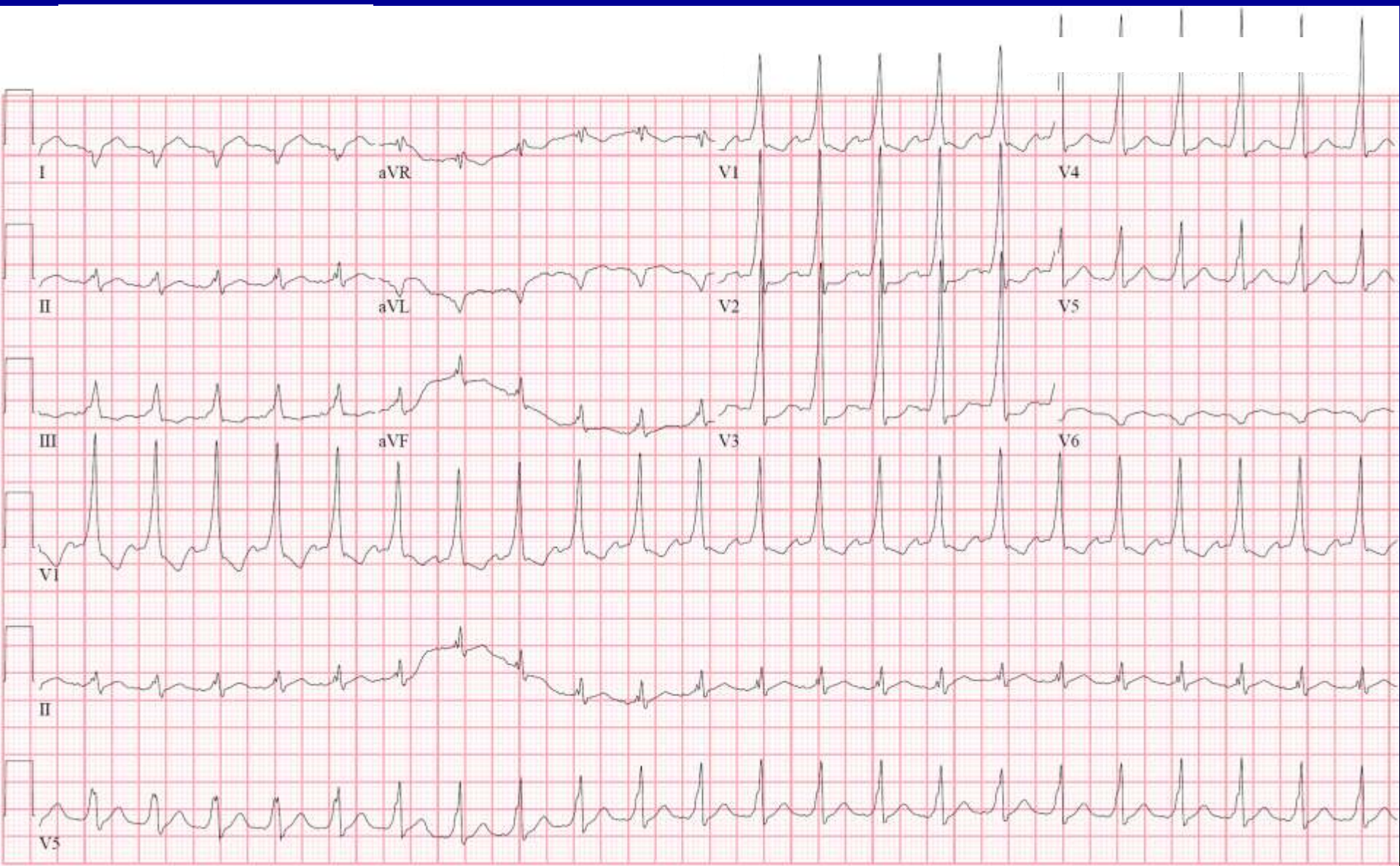
Very irregular WCT, looks like VT, but so irregular
Wonder about Afib but no fib waves

Case 17



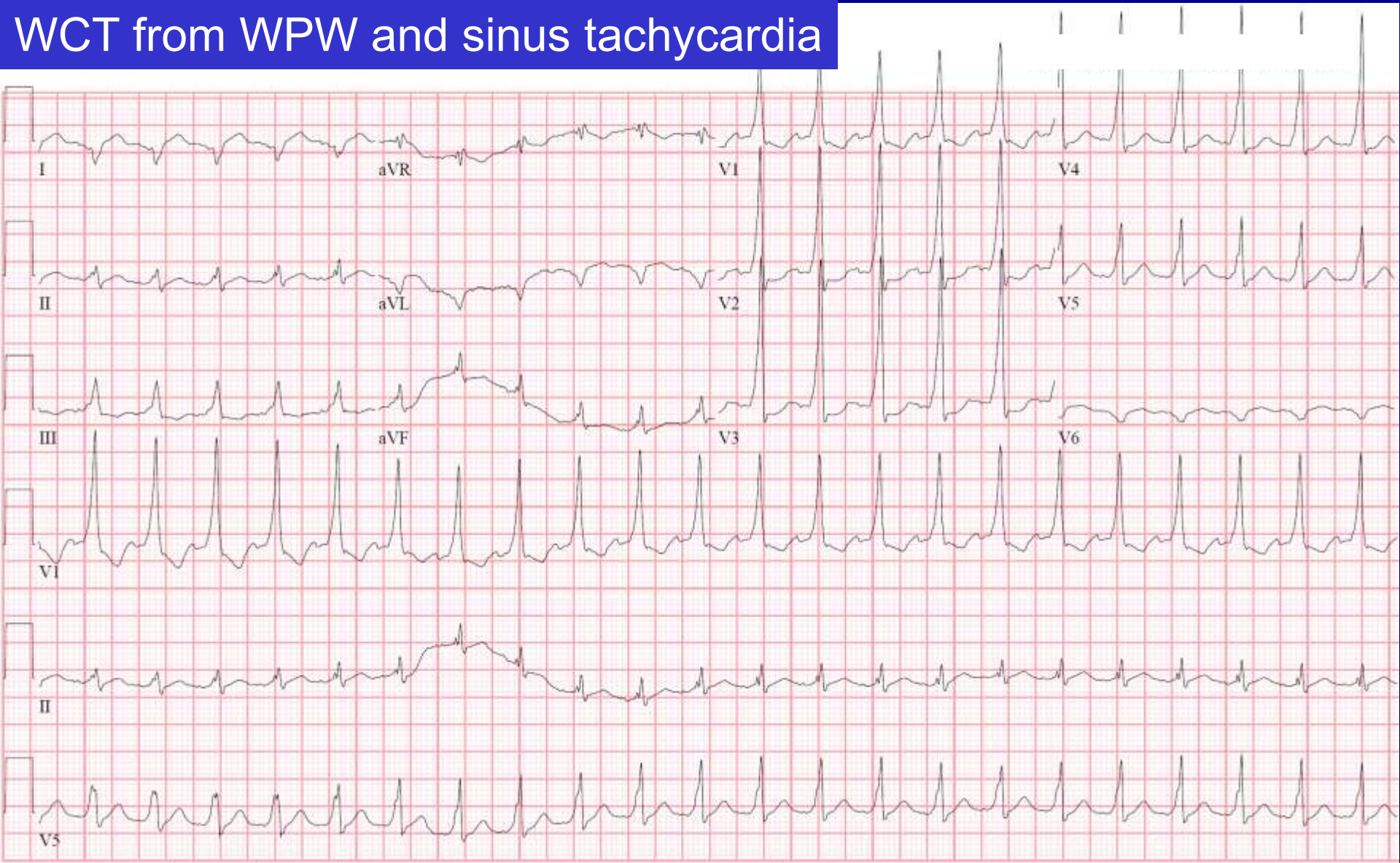
Baseline ECG shows WPW pattern, not on all tracings.

Case 18



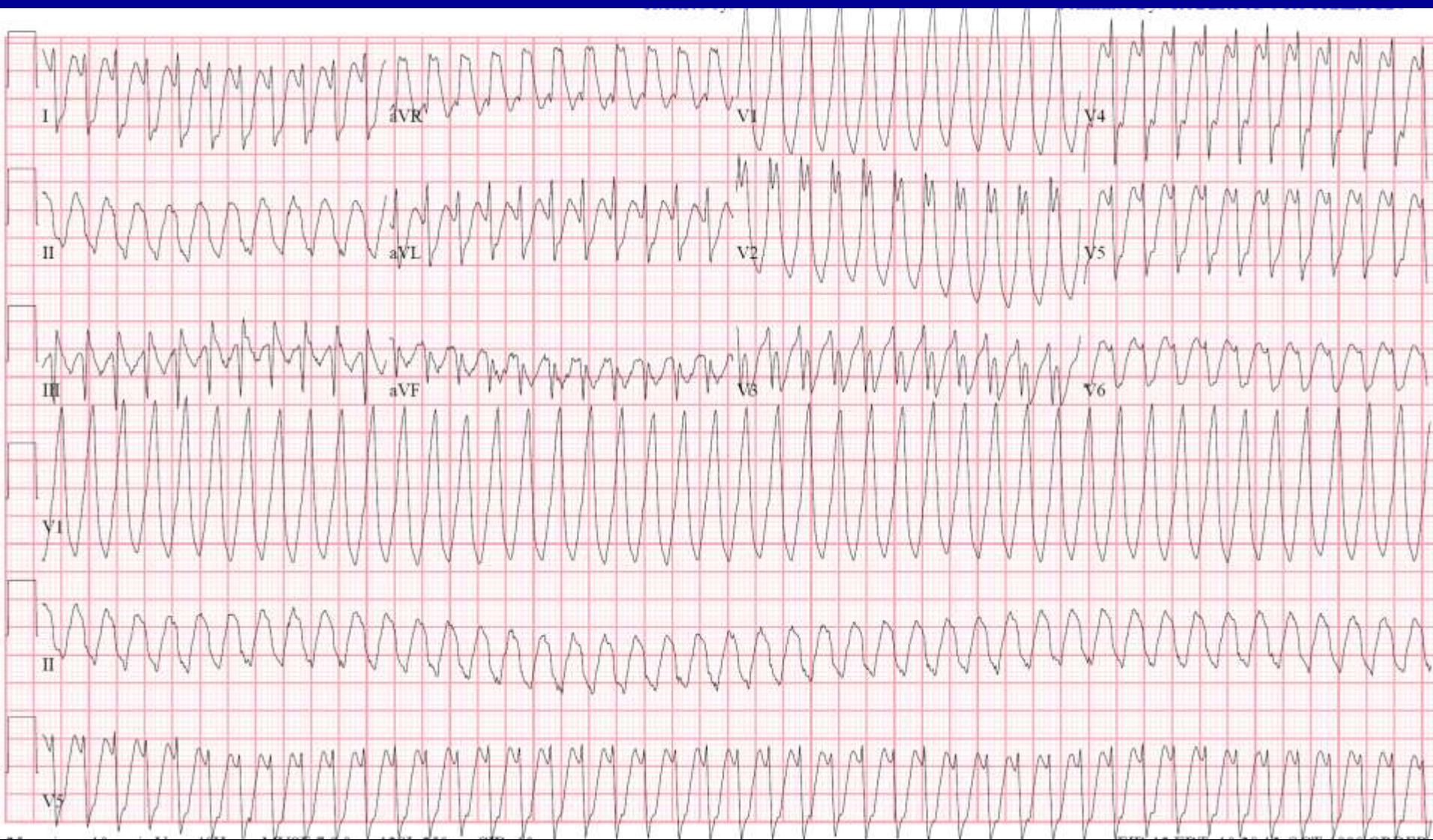
Case 18

WCT from WPW and sinus tachycardia



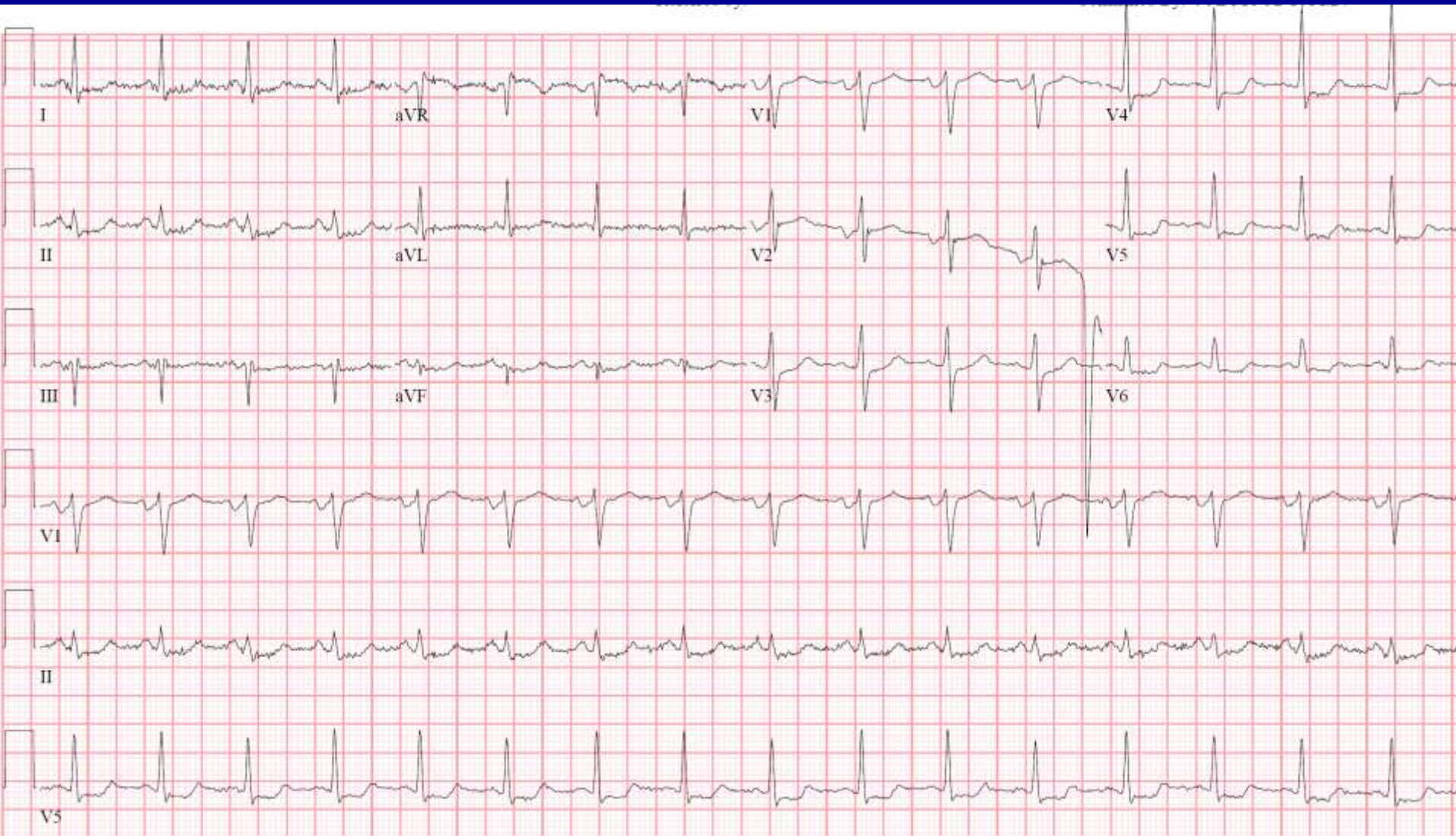
Sept 1998, rate 264

Case 19



Sept 1998, 50 minutes later

Case 19



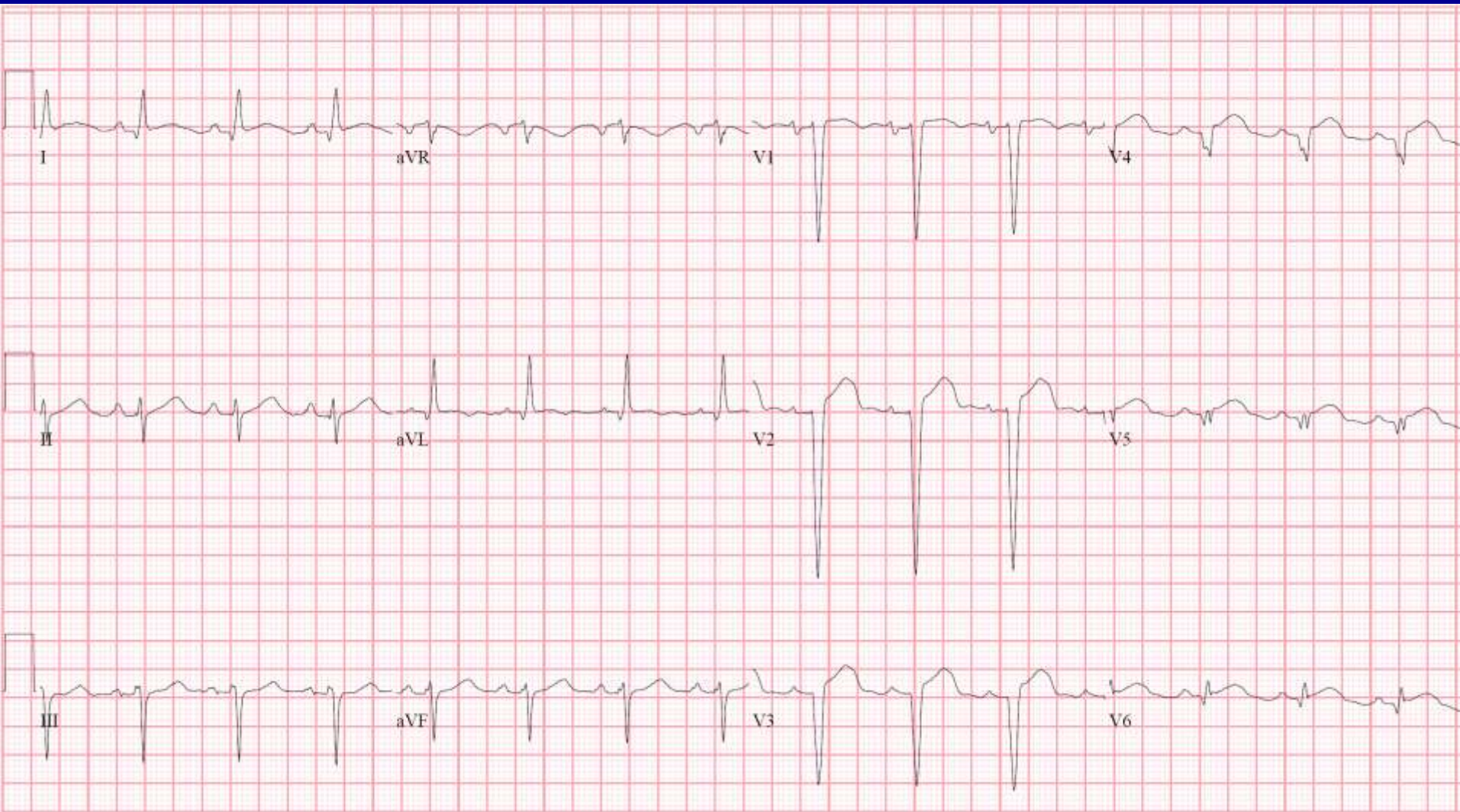
October 1987, rate 160

Case 20



October 1987, 2 hr later

Case 20



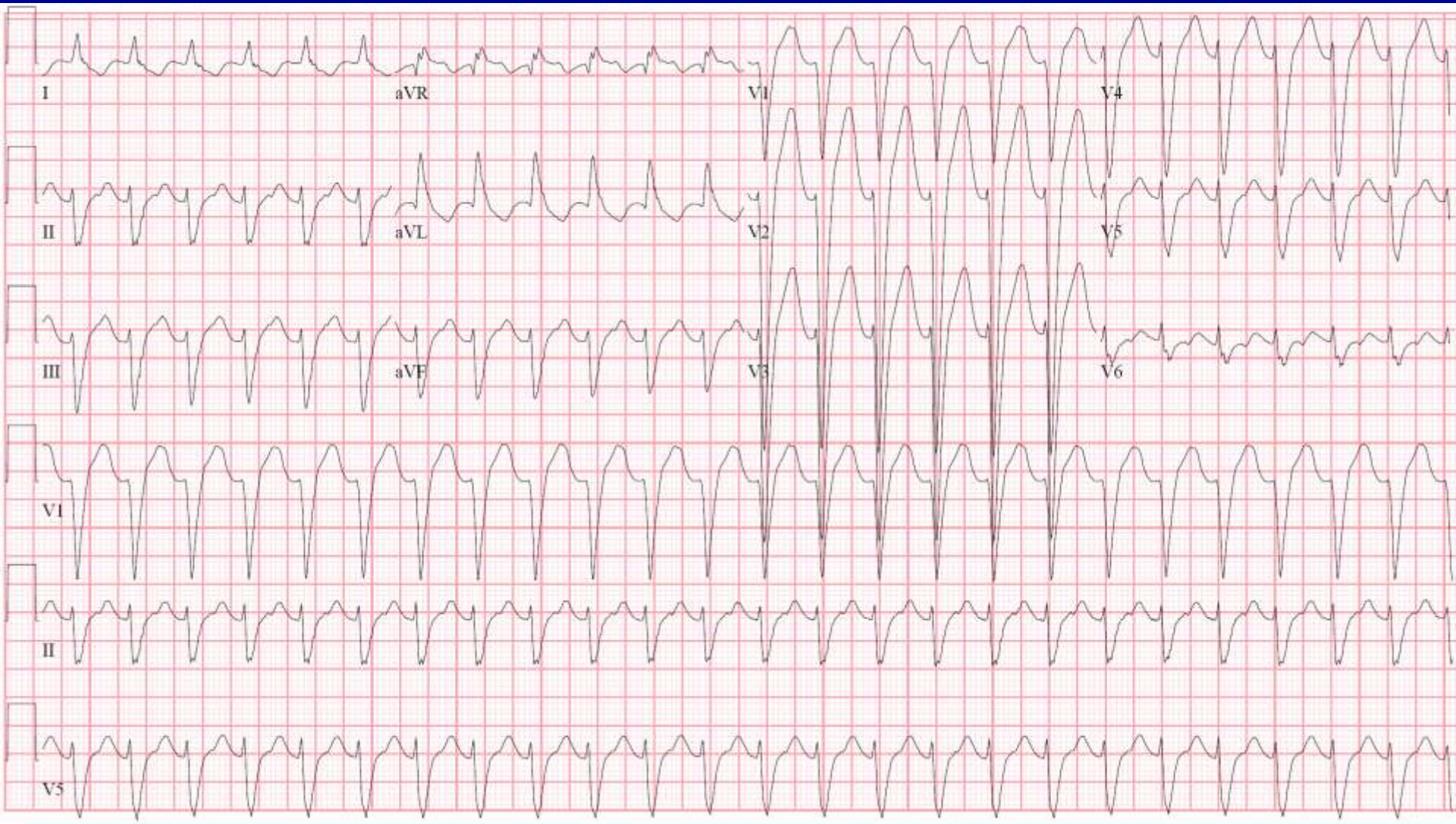
October 1987, 5 da prior

Case 20



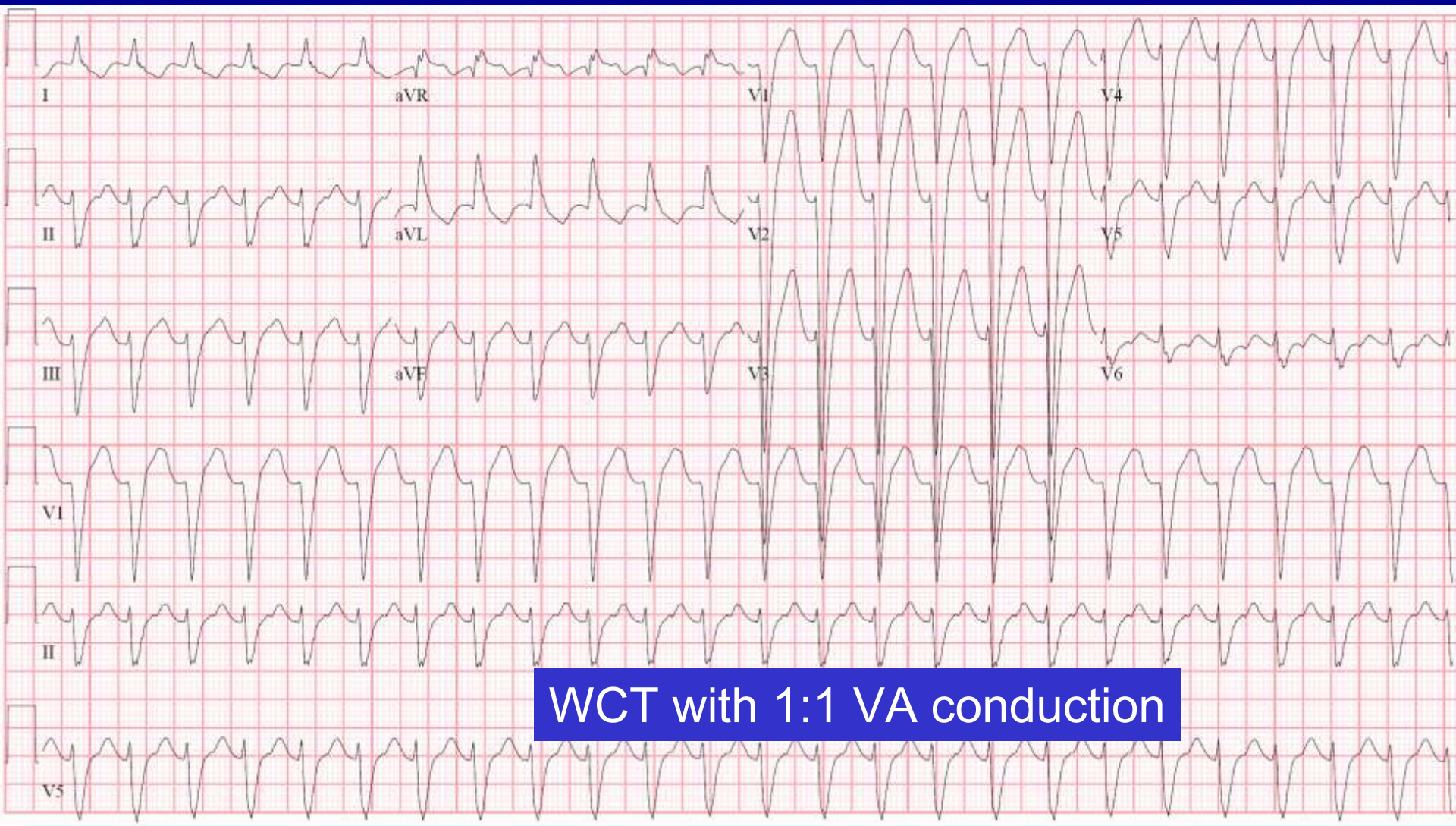
Sept 2005, rate 148

Case 21



Sept 2005

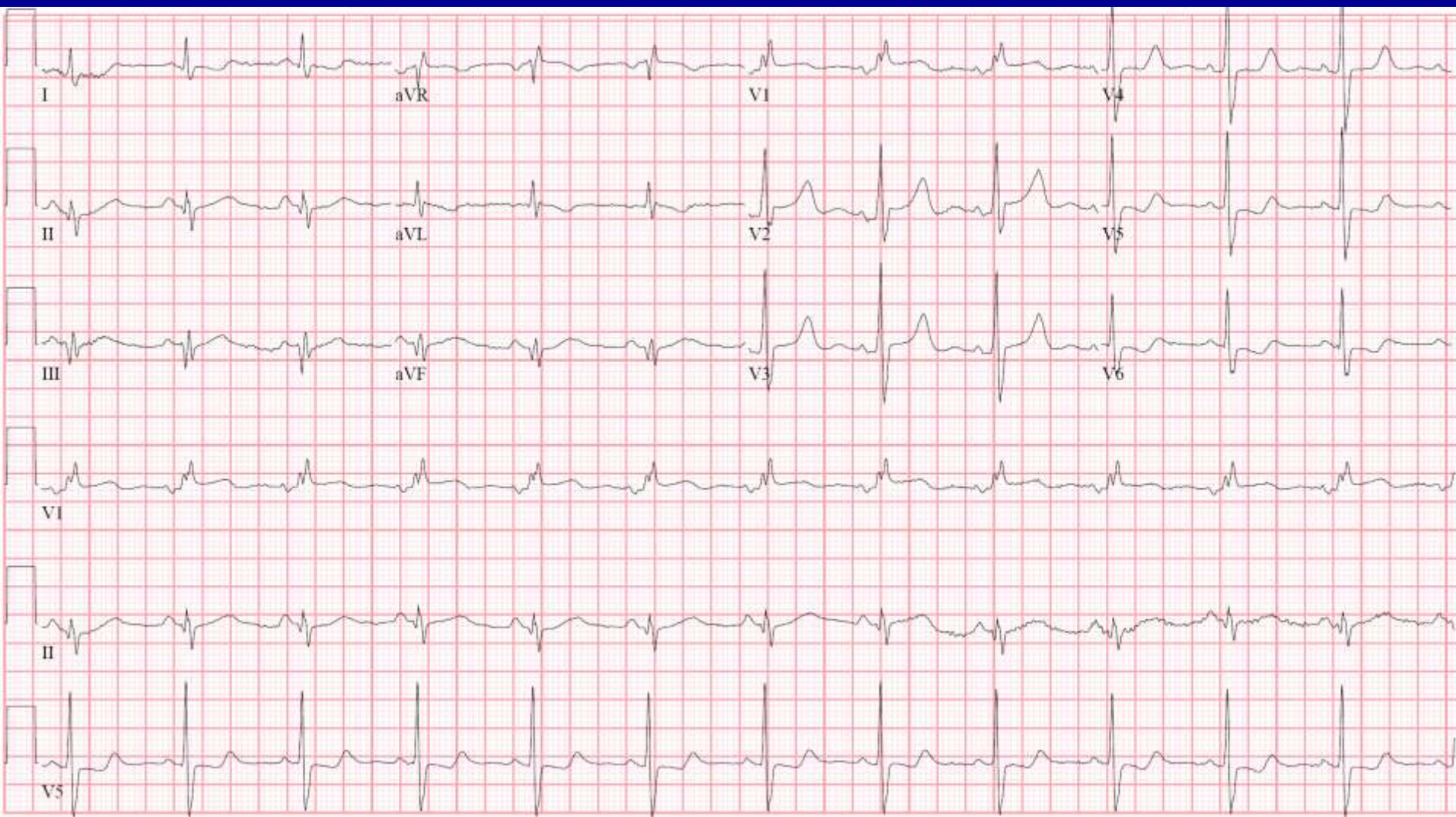
Case 21



WCT with 1:1 VA conduction

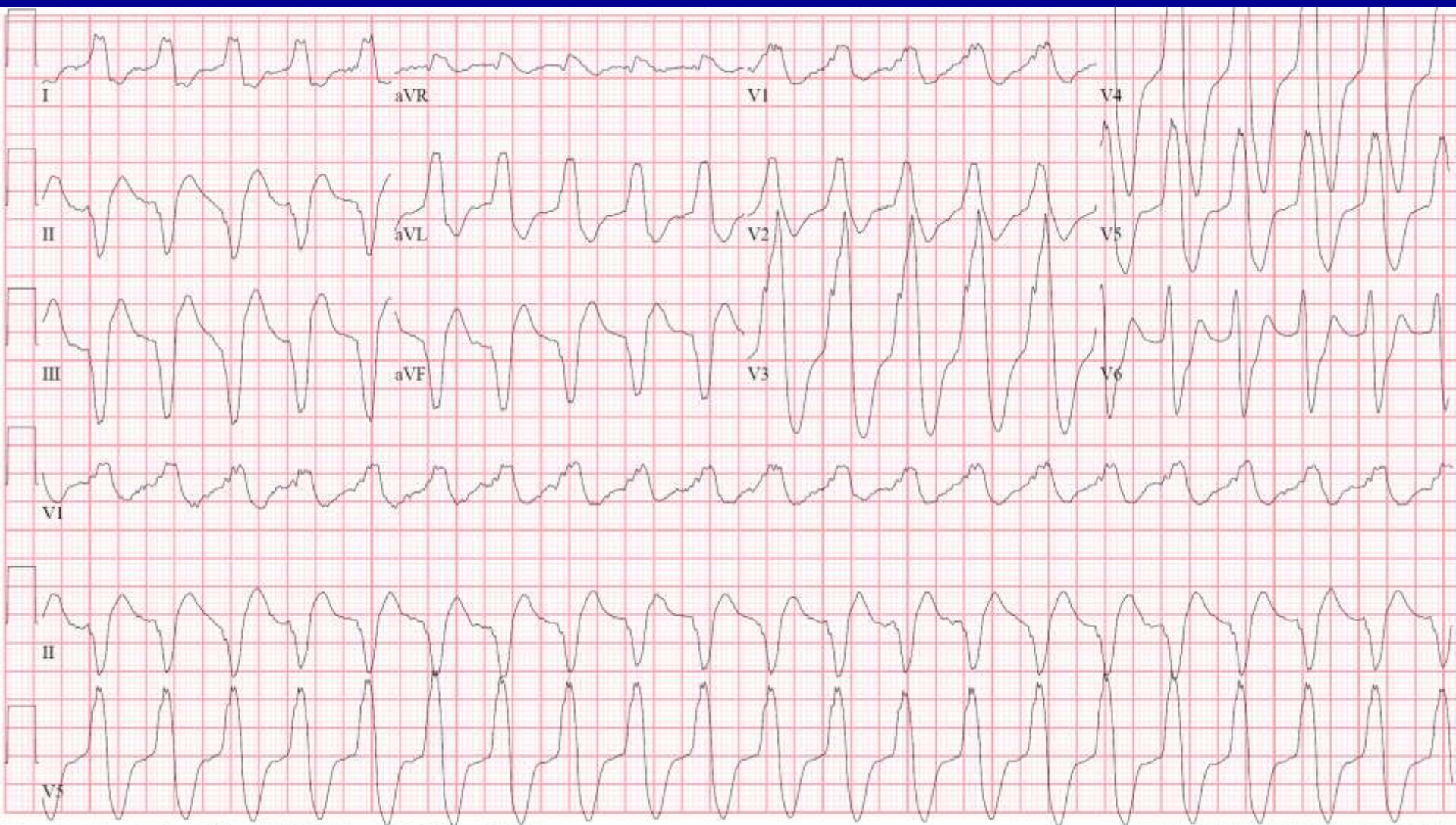
Sept 2005, 2 hr later

Case 21



June 1998

Case 22



June 1998, 35 minutes later

Case 22

