

Intermediate ECG Course - Part 5

2010

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Topics in Intermediate ECG

- Consolidation of prior information with additional details
- Not “advanced”, but feel free to ask advanced questions
- Causes of axis deviation and wide QRS (1)
- Infarction and causes of ST segment shifts (2)
- Electrolyte effects on the ECG (2)
- Flutter versus fib, and ventricular patterns (3)
- AV conduction and AV dissociation (4)
- Tachyarrhythmias, wide and narrow QRS (5, 6)
- Integrating ECG and clinical information (7,8)

Tachycardias, Wide and Narrow

Narrow

- Regular
 - Sinus tachycardia
 - Flutter 2:1
 - AVNRT
 - AVRT, orthodromic
 - Atrial tachycardia
- Irregular
 - MAT
 - Atrial fib or flutter
 - S Tach with PACs

Wide

- Regular
 - BBB and supraventricular
 - Rate related aberrancy
 - Ventricular tachycardia
 - AVRT, antidromic
 - WPW and tachycardia
- Irregular
 - BBB and MAT or fib or flutter or PACs
 - Rate-related BBB
 - WPW
 - Rarely, VT

Wide QRS Tachycardia

Definition: rate >120 and QRS >0.12 sec

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

Determining the type of WCT

- Primary diagnostic tool: ECG
- 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

ECG Diagnosis of Regular WCT

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

- Rate >120 , QRS duration >120
- AV relationships which favor VT (“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

ECG Diagnosis of Regular WCT

- QRS duration >0.14 favors VT and 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 and WPW and multiple tracts

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

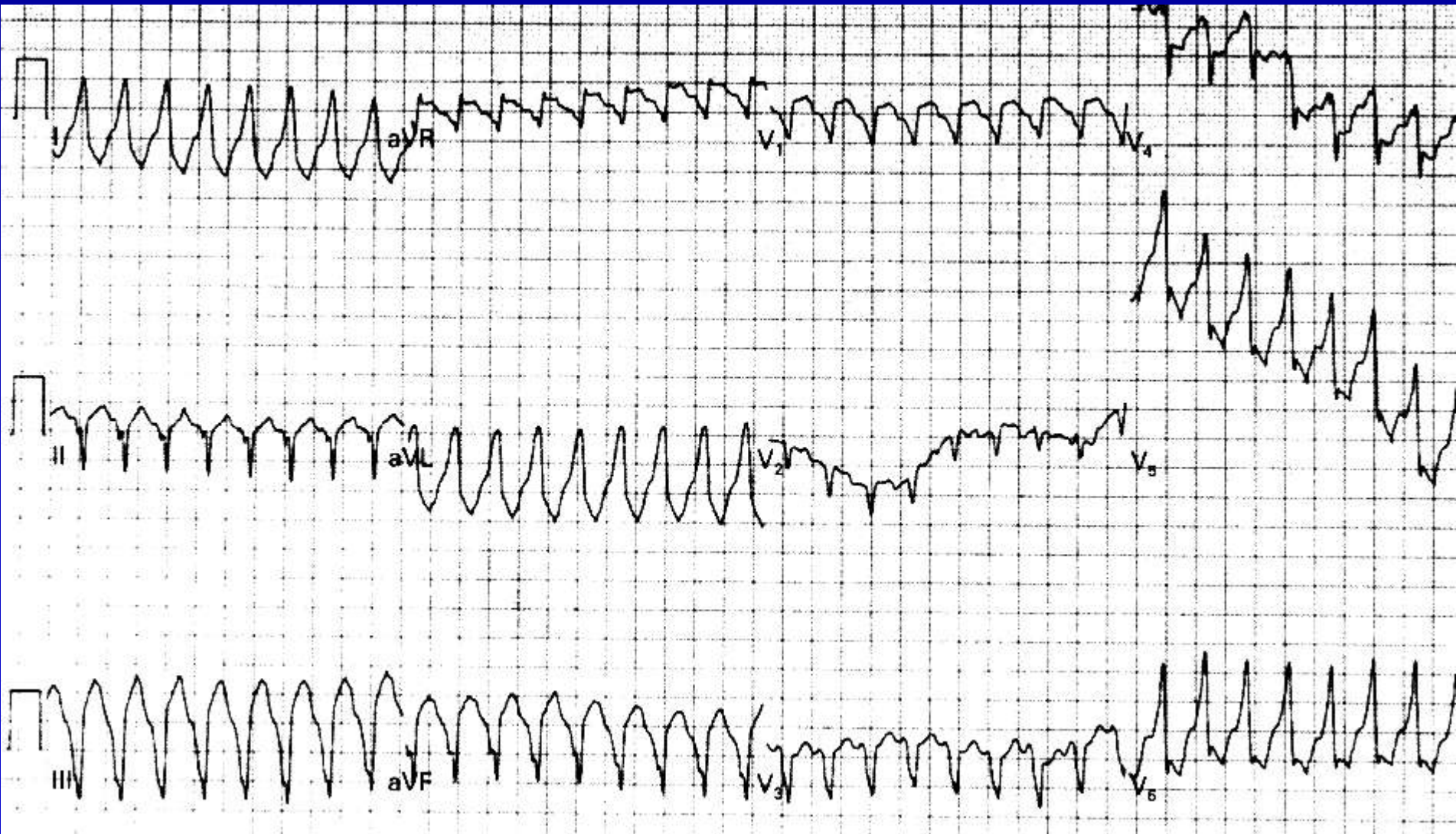
ECG Diagnosis of Regular WCT - 3

- 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, which may be 250-280

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



WCT Case 1

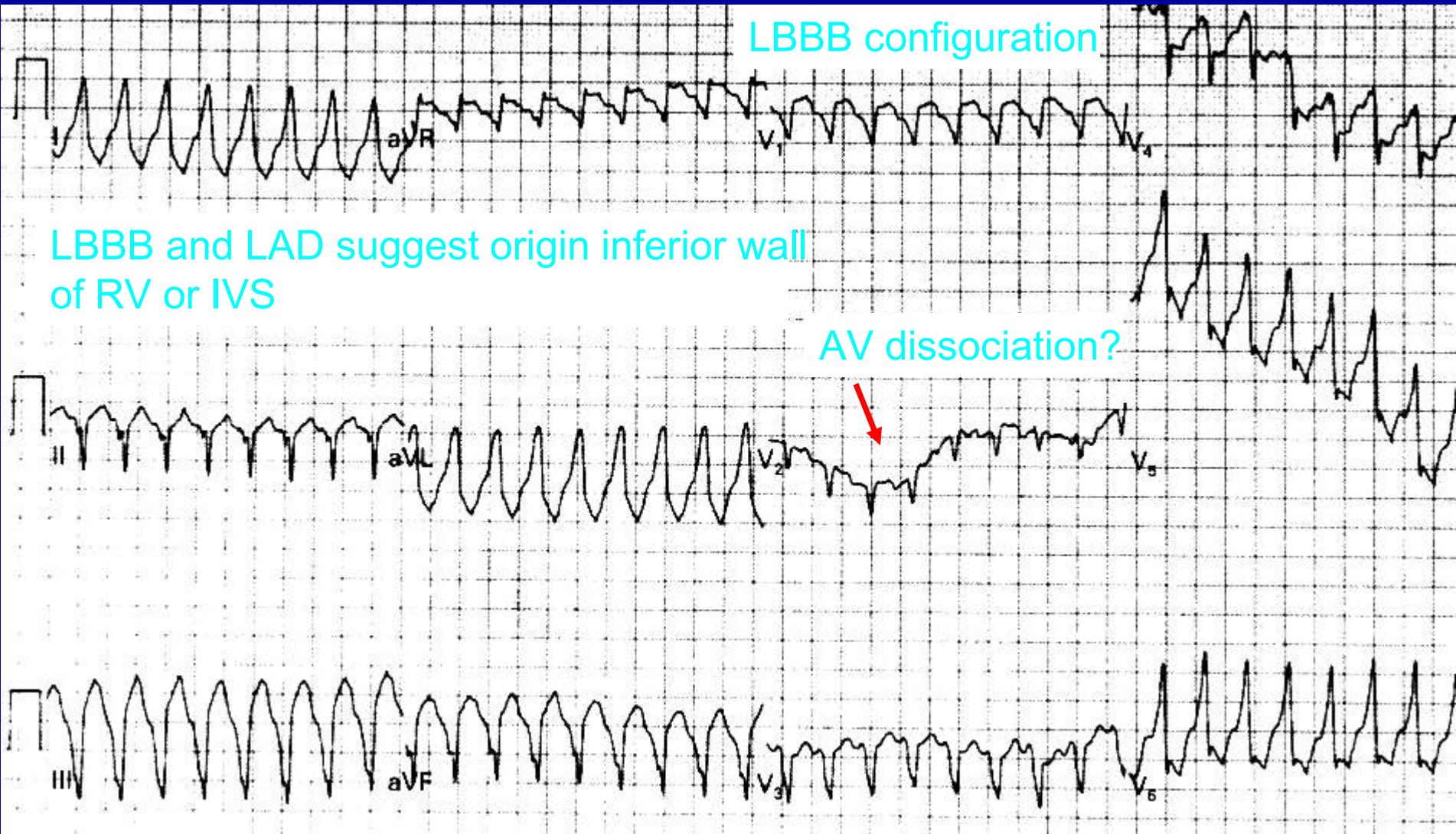
Echo: reduced EF

Native sinus QRS is narrow with LAD Onset R to nadir S $>100\text{ms}$

LBBB configuration

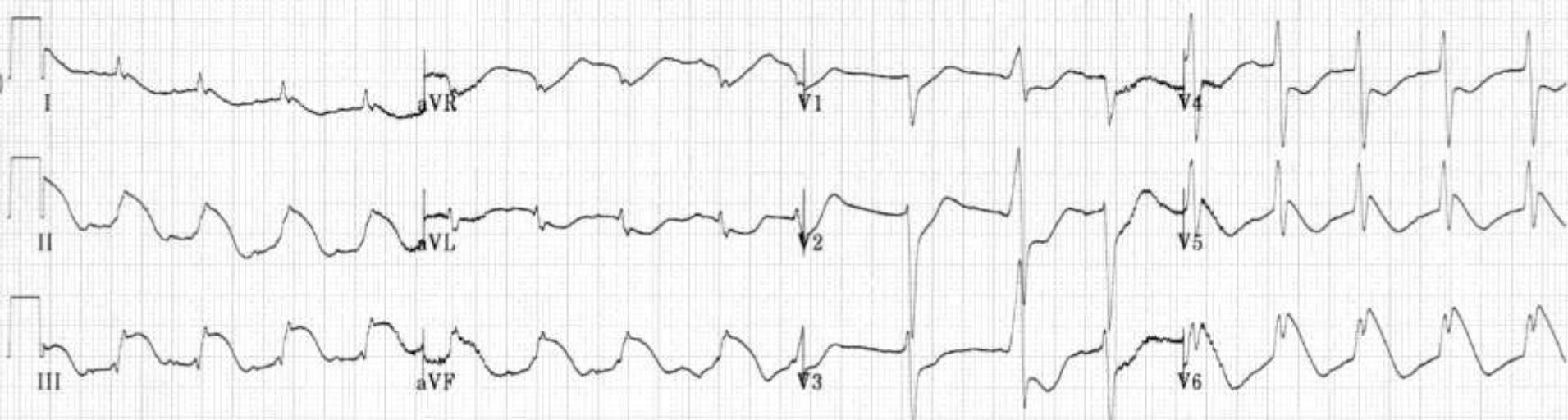
LBBB and LAD suggest origin inferior wall
of RV or IVS

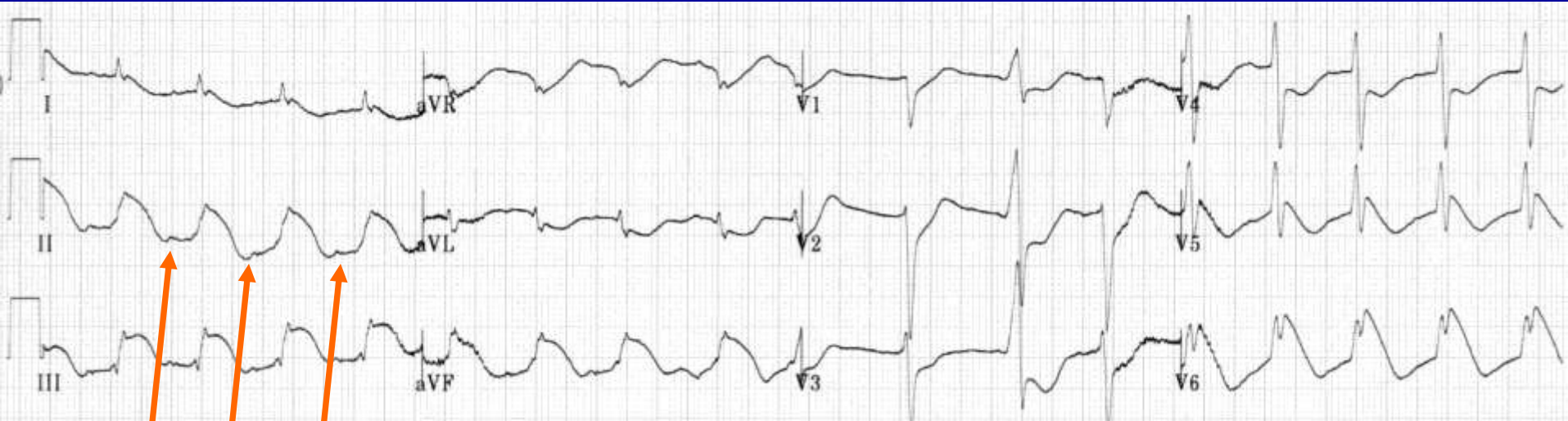
AV dissociation?



Monomorphic VT - 3 Types

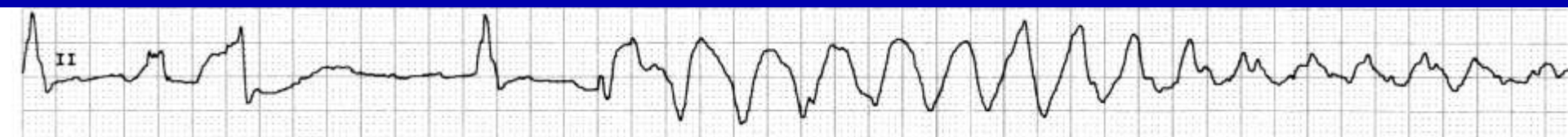
- Focal origin
 - RVOT VT
 - LVOT VT
 - LV VT verapamil sens
- Bundle-branch reentry
 - conduction system
 - cardiomyopathy
 - valvular disease
 - muscular dystrophy
 - CAD
- Scar-related reentry
 - healed MI
 - RV cardiomyopathy
 - DCM
 - Sarcoidosis
 - Scleroderma
 - Giant-cell myocarditis
 - Healed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



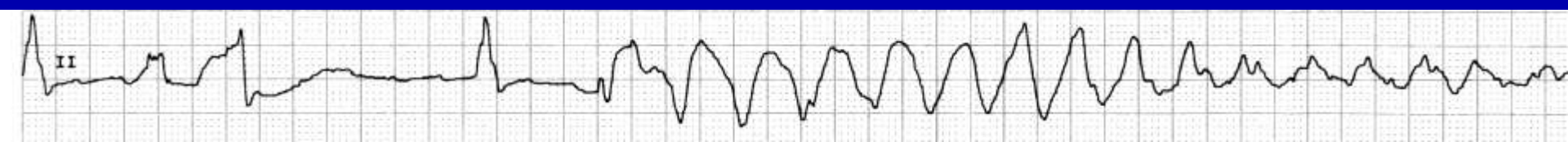


P waves

Sinus tachycardia, dramatic transmural injury



Torsade de Pointes



Baseline Atrial fibrillation

“Long-short”, provokes even more prolonged QT

Set up for VT/VF



Sinus rhythm after defibrillation

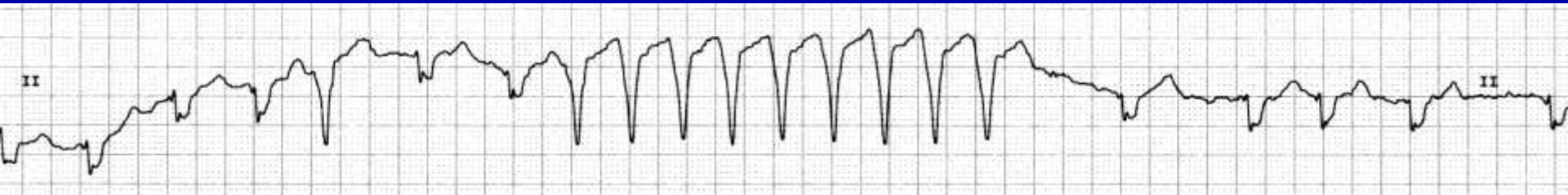
23:19:04>

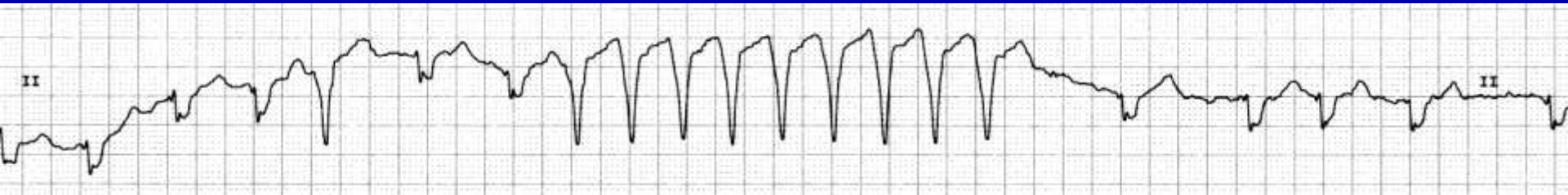


23:19:04>



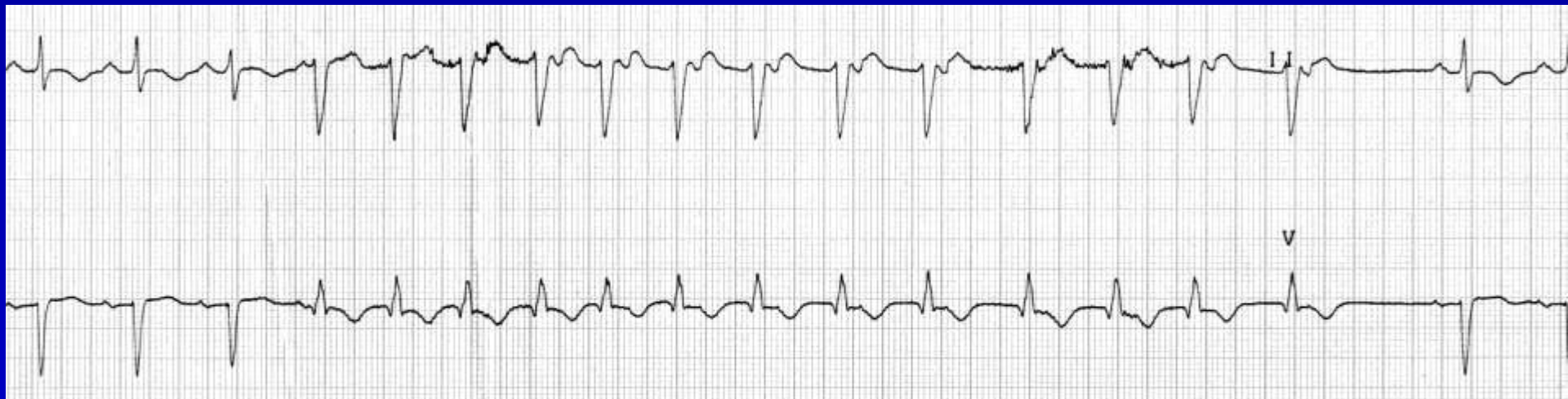
Frequently Torsade is preceded by bigeminy





Atrial fibrillation and nonsustained VT, wide QRS on native beats

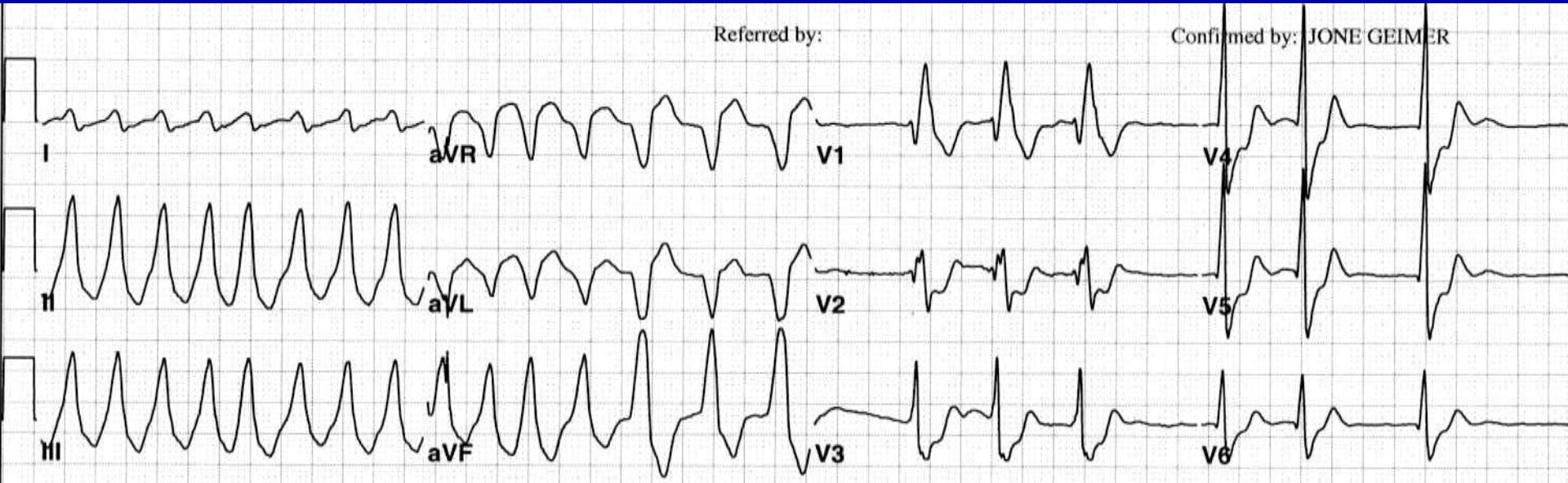


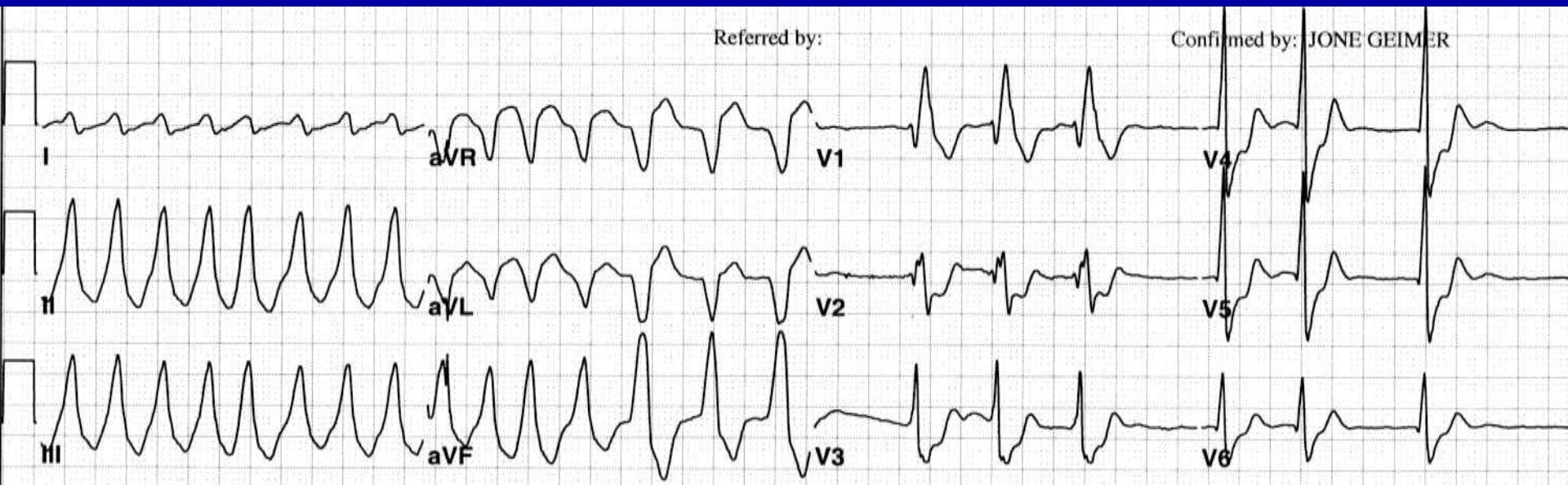


Sinus rhythm with narrow QRS, late PVC, with
NSVT with retrograde conduction

Referred by:

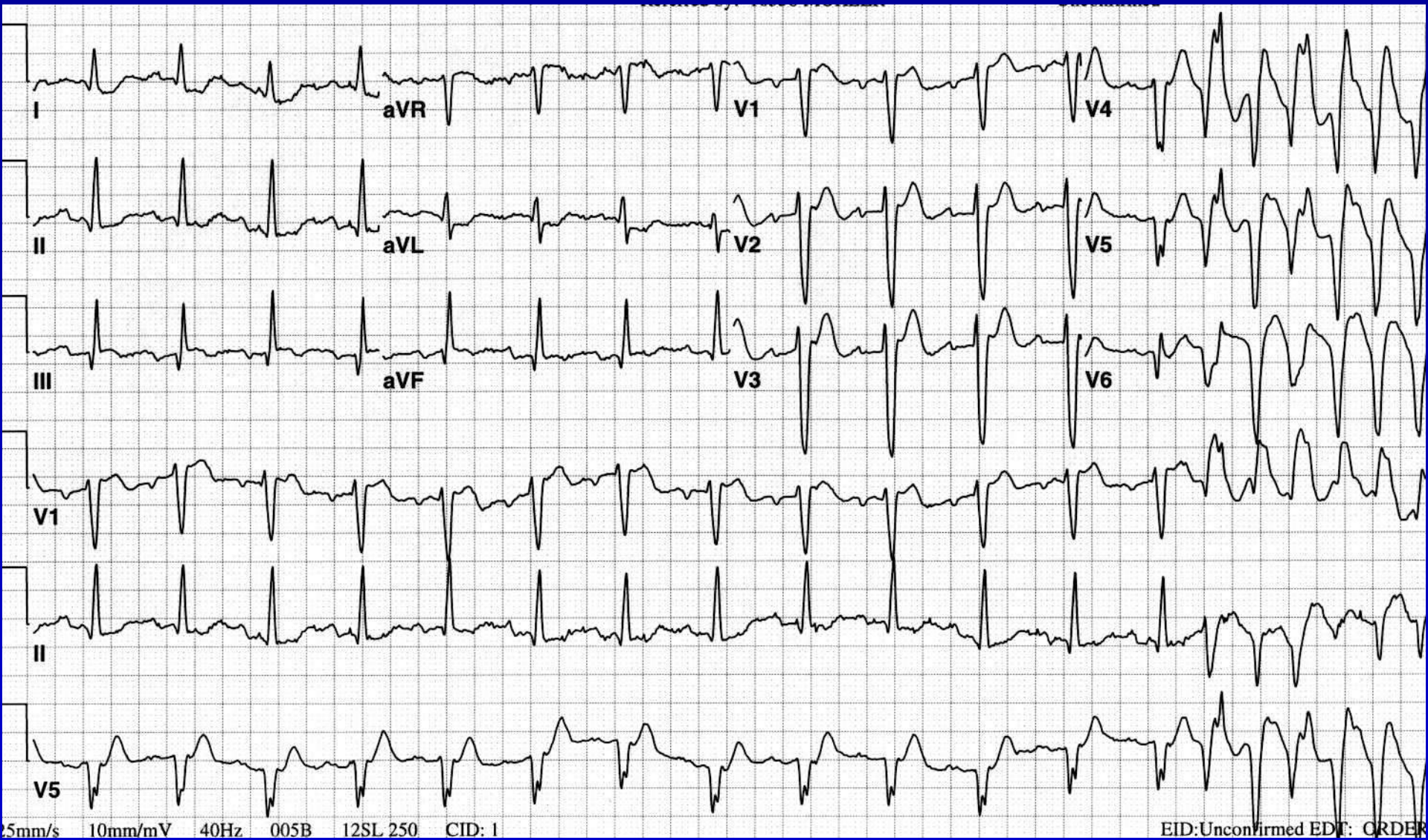
Confirmed by: JONE GEIMER





Nonsustained VT, not exactly monomorphic,
baseline atrial fibrillation

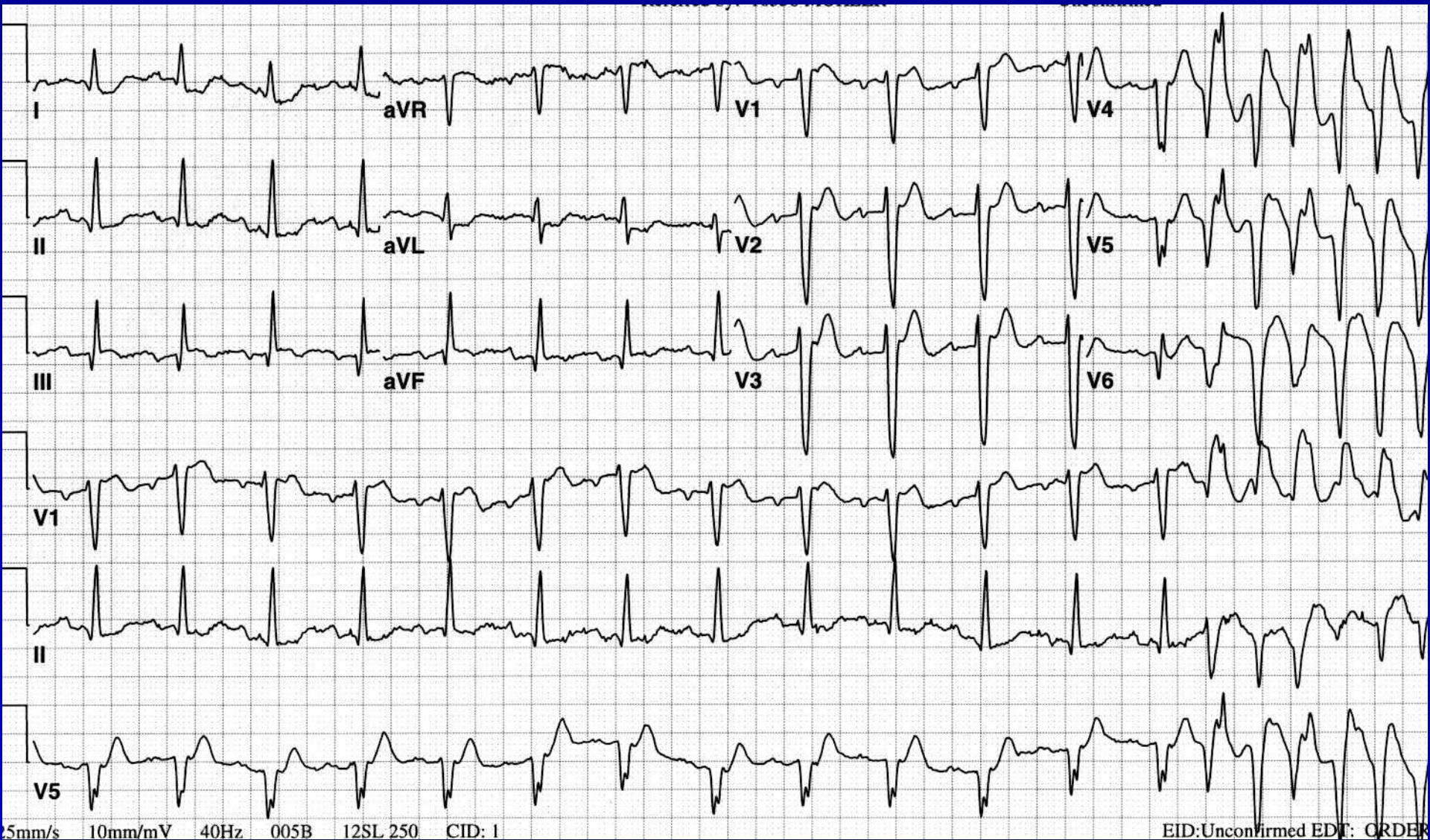
Patient Example



25mm/s 10mm/mV 40Hz 005B 12SL 250 CID: 1

EID:Unconfirmed EDT: ORDER

Patient Example



25mm/s 10mm/mV 40Hz 005B 12SL 250 CID: 1

EID:Unconfirmed EDT: ORDER

Baseline ECG shows inferior injury and then polymorphic VT

Patient Example

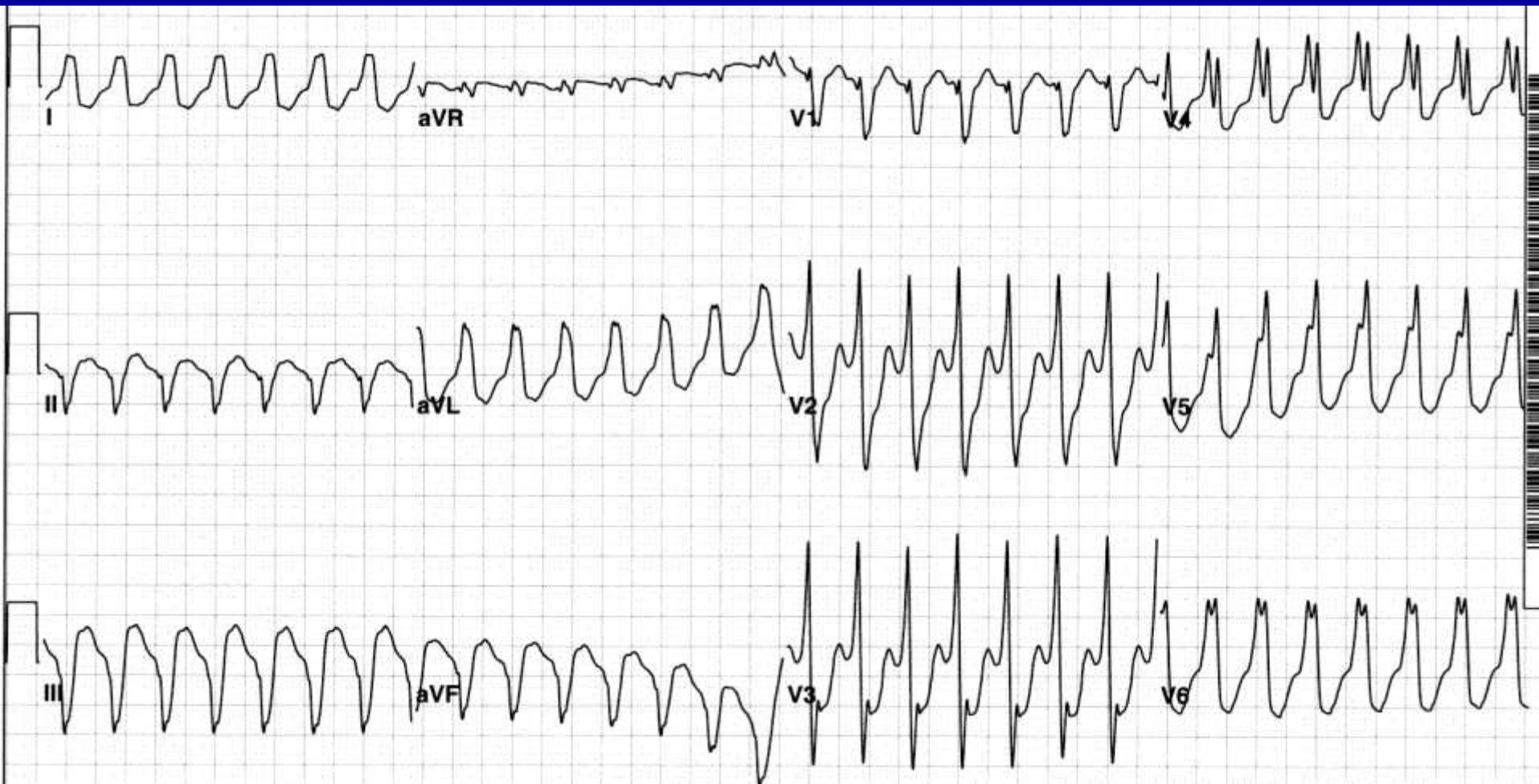


Patient Example

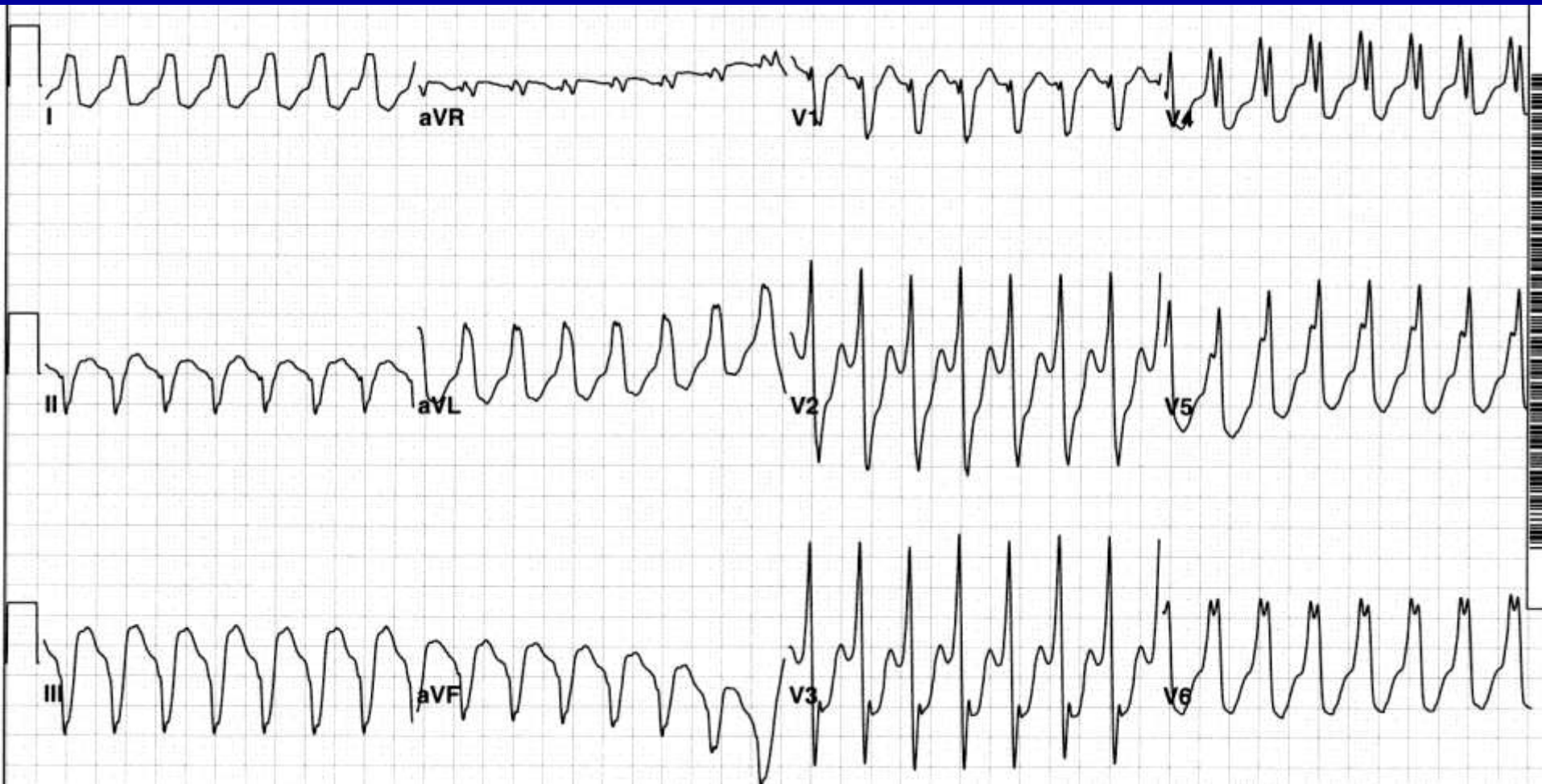


Same patient few seconds later, better polymorphic VT

Second Patient Example

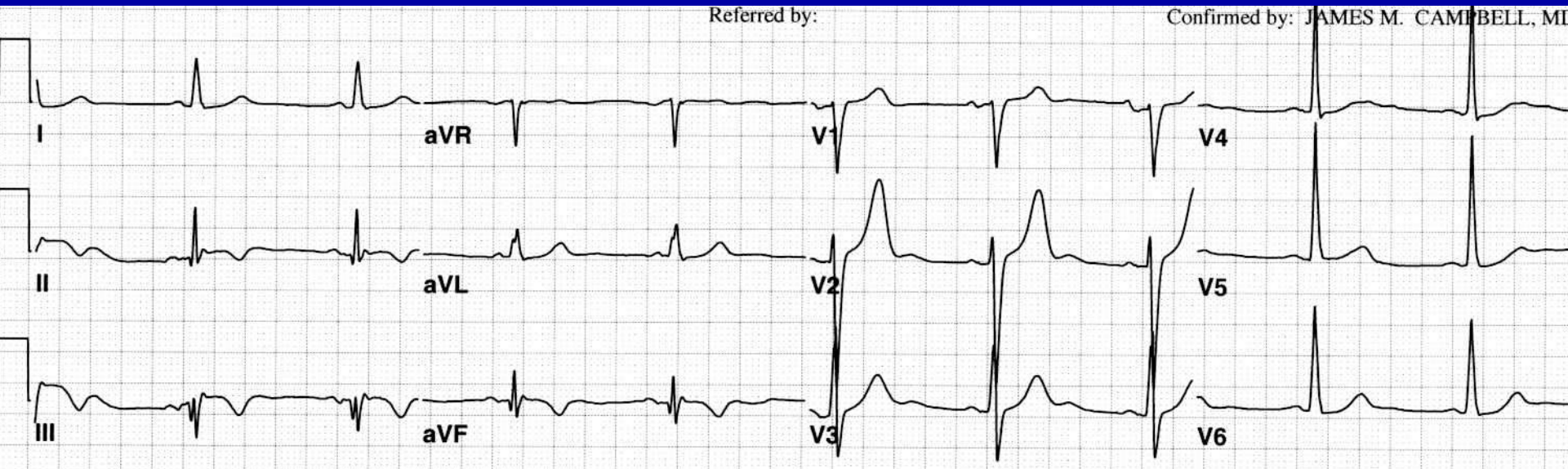


Second Patient Example



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

Second Patient Example



Same patient with inferior MI and normal QRS duration

Third Patient Example VM1049 10-28-86 12:16



Third Patient Example VM1049 10-28-86 12:16

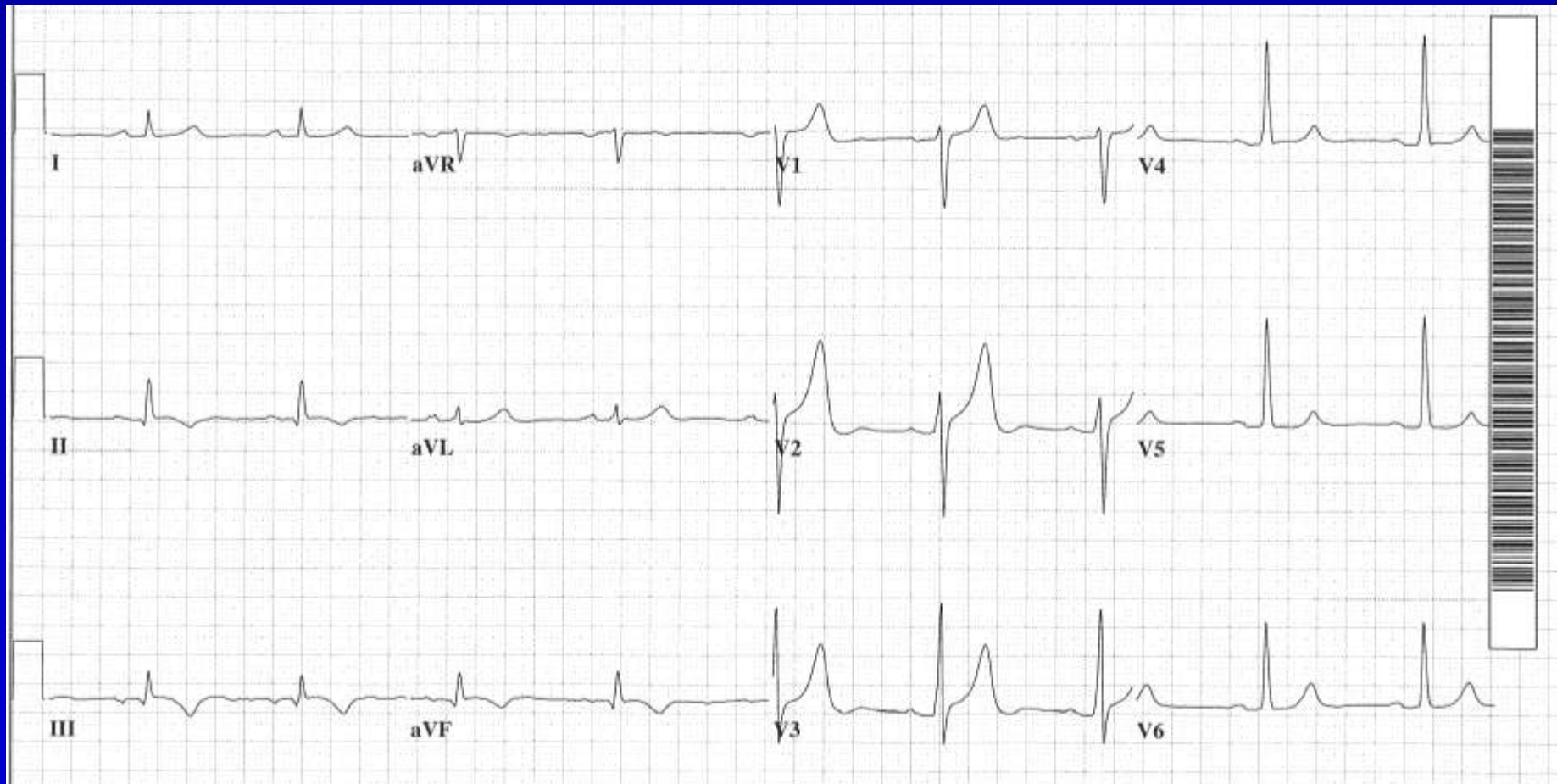


Sustained VT, with baseline ECG showing QRS duration of 0.11 sec and inferior MI, probably recent

Third Patient Example

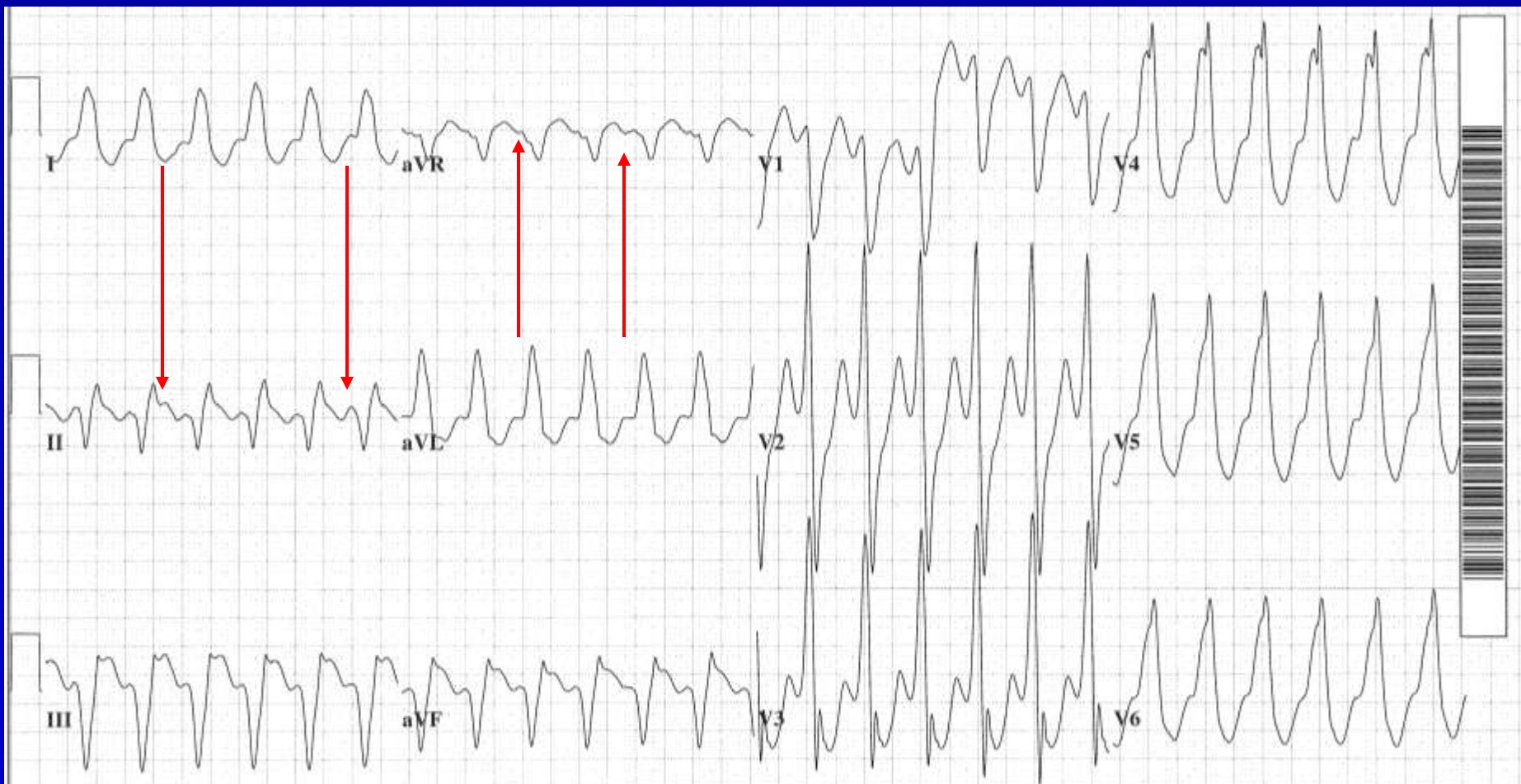
VM1049 10-21-86 09:34

Sinus bradycardia, inferoposterior ischemia,
possible recent inferior MI, first degree AV block

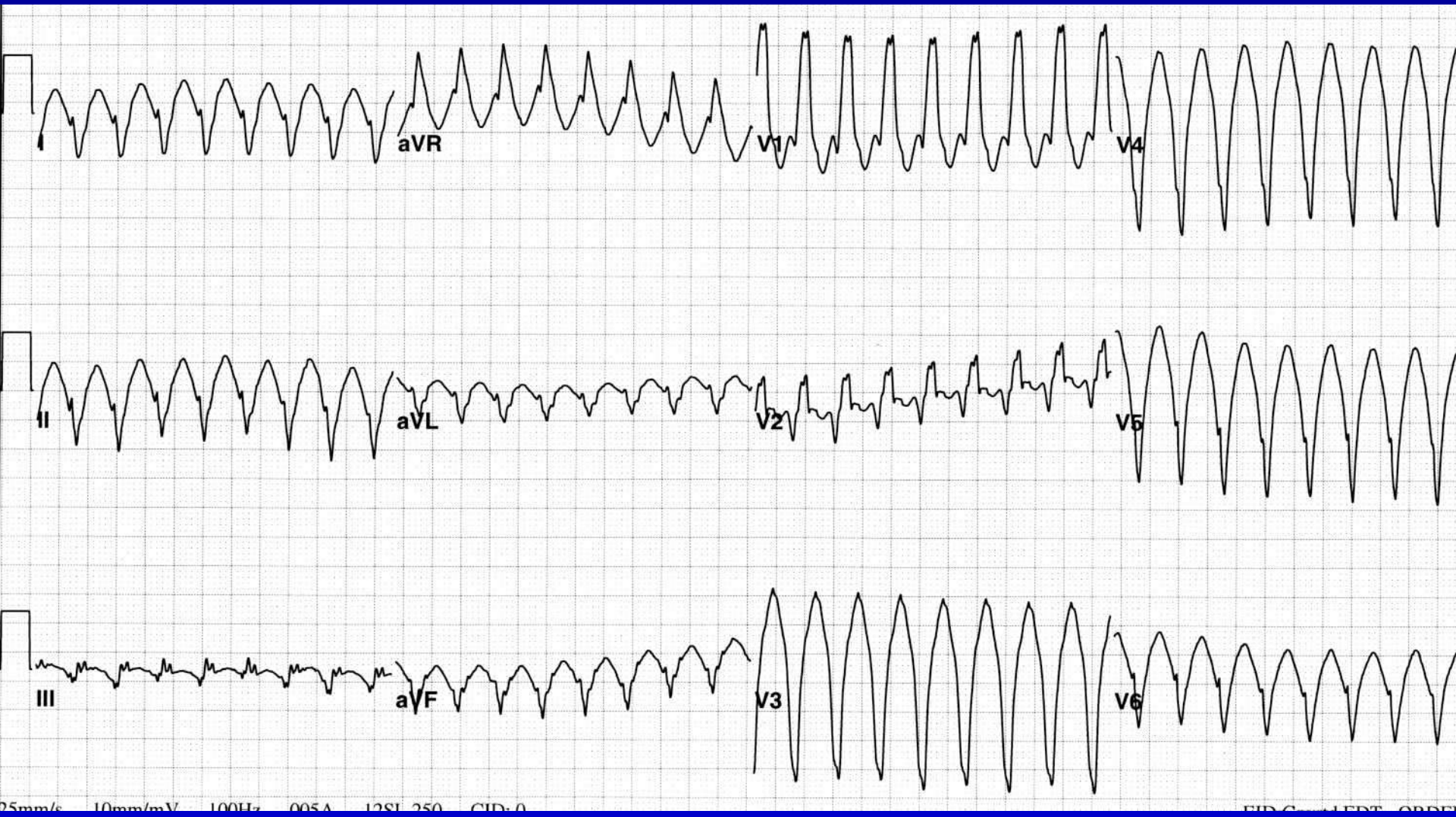


VM1049 10-28-86 12:16 2 of 2

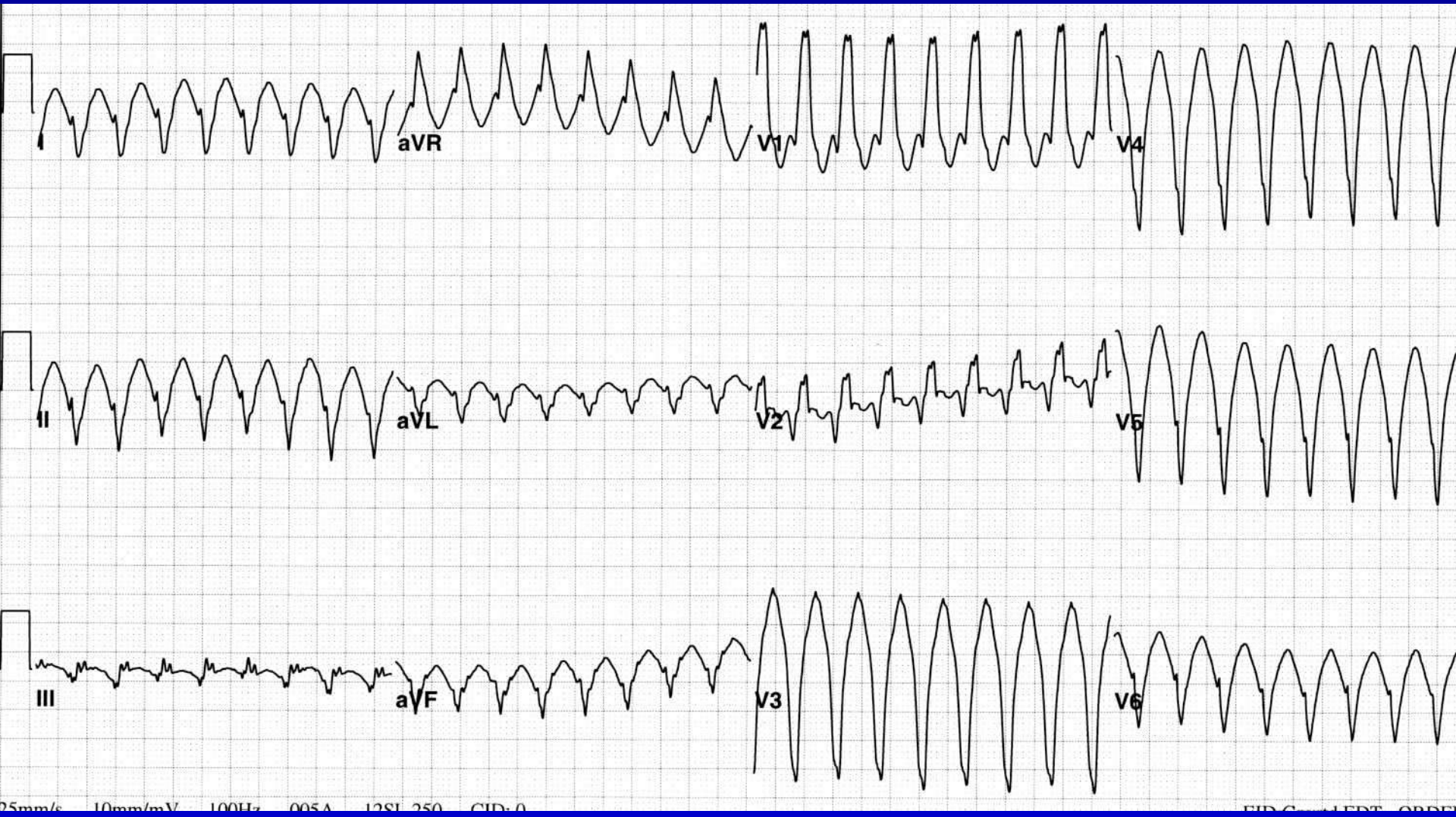
Wide QRS tachycardia, VTach (abnormal baseline ECG, V1time to nadir is long, lead 2 suggestive of AV dissociation)



Fourth Patient Example



Fourth Patient Example



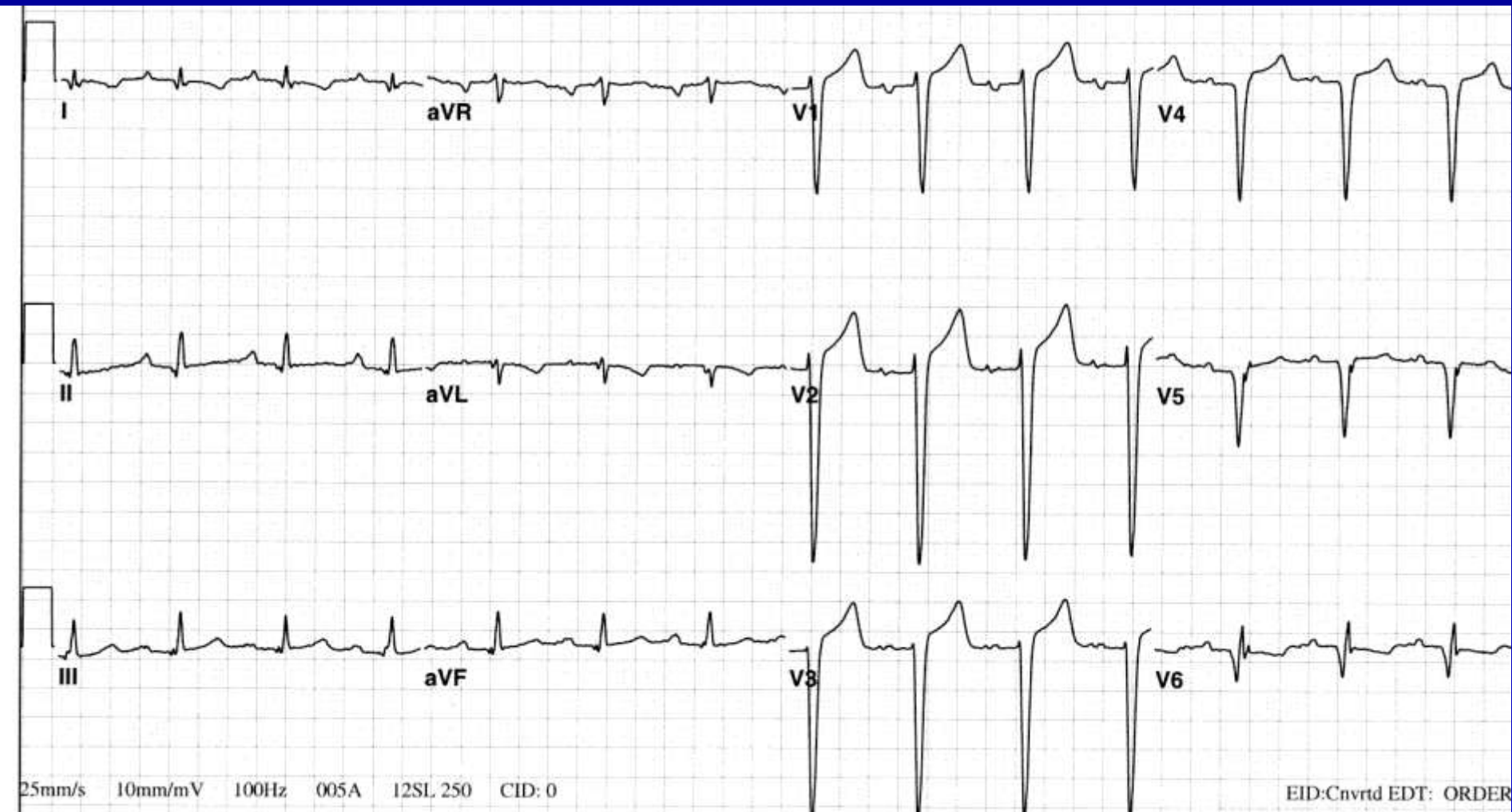
Sustained VT 23 Nov 1997, rate 202, QRS duration 0.17
Baseline ECG: inferolateral MI with QRS0.12 and LAE

Fourth Patient Example



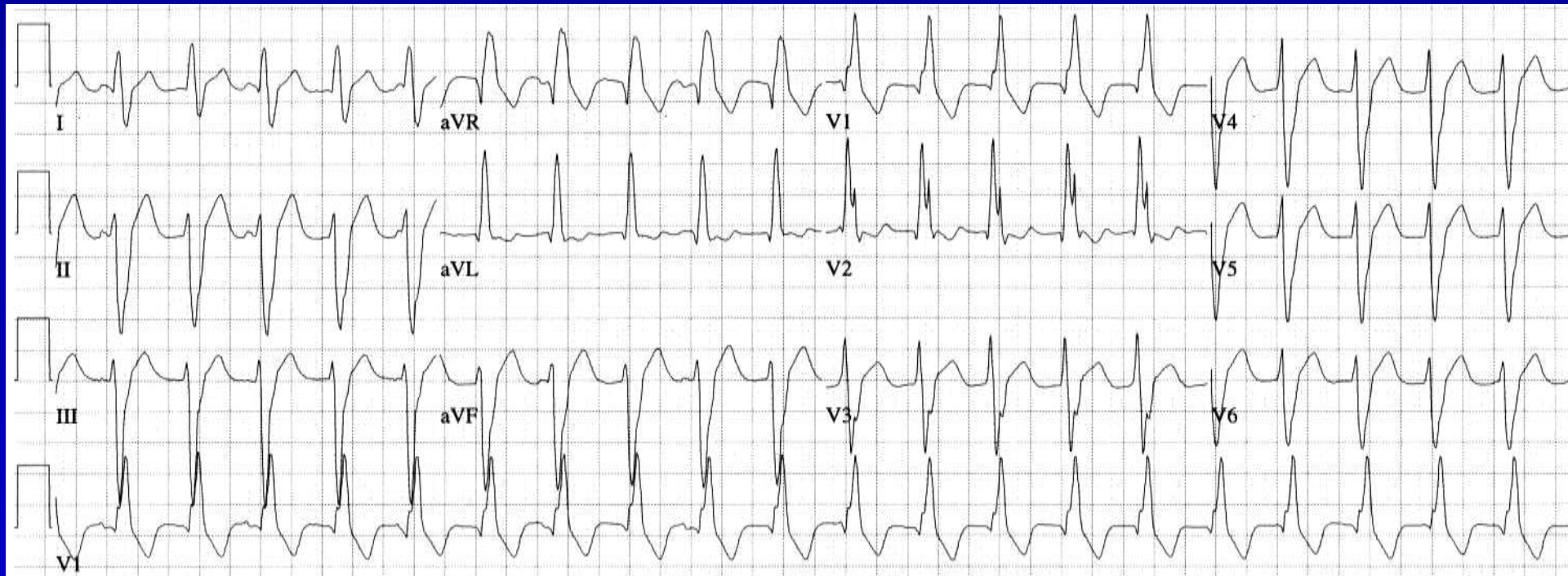
Sustained VT 1 Dec 1997, rate 164, QRS duration 0.20

Fourth Patient Example

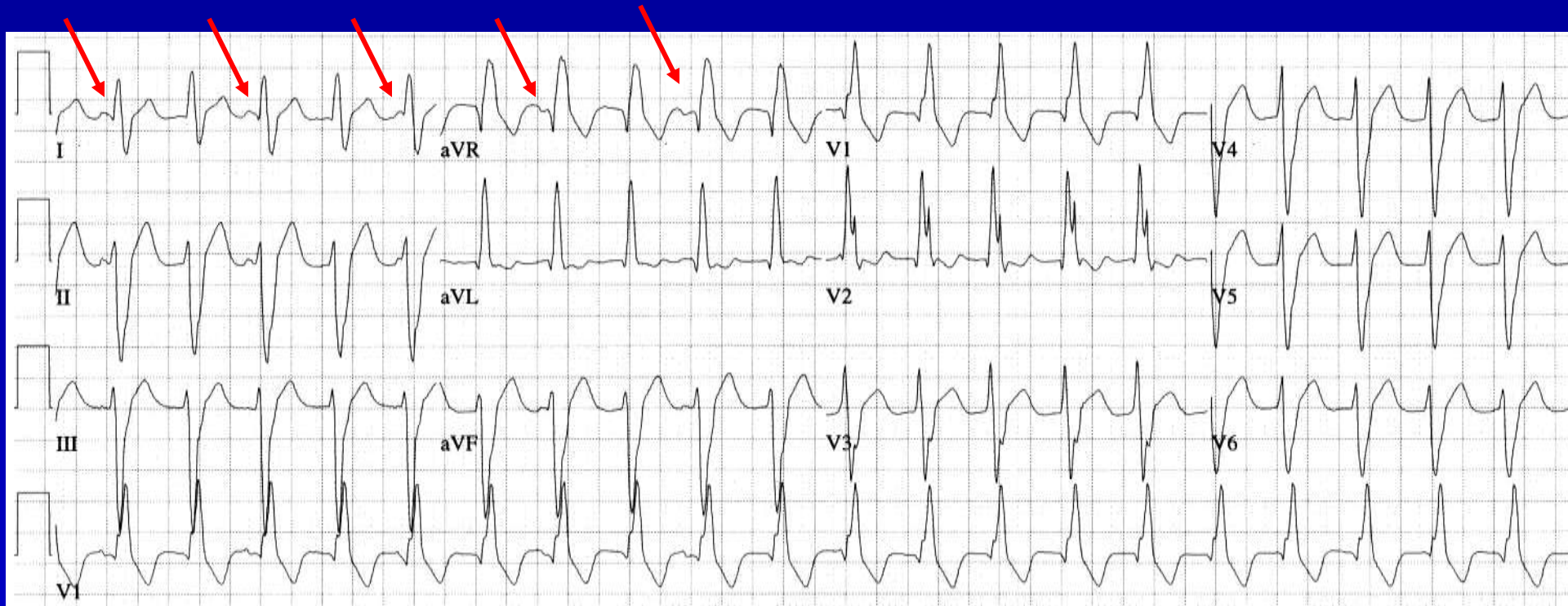


Baseline ECG with anterolateral MI, LAE, QRS 0.12

Fifth Patient Example



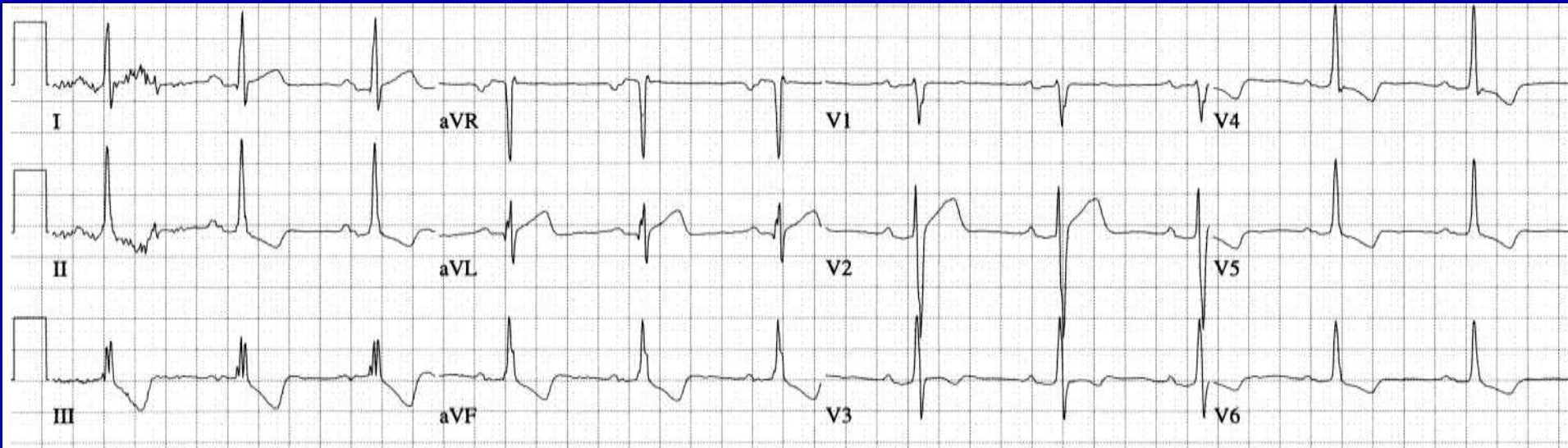
Fifth Patient Example



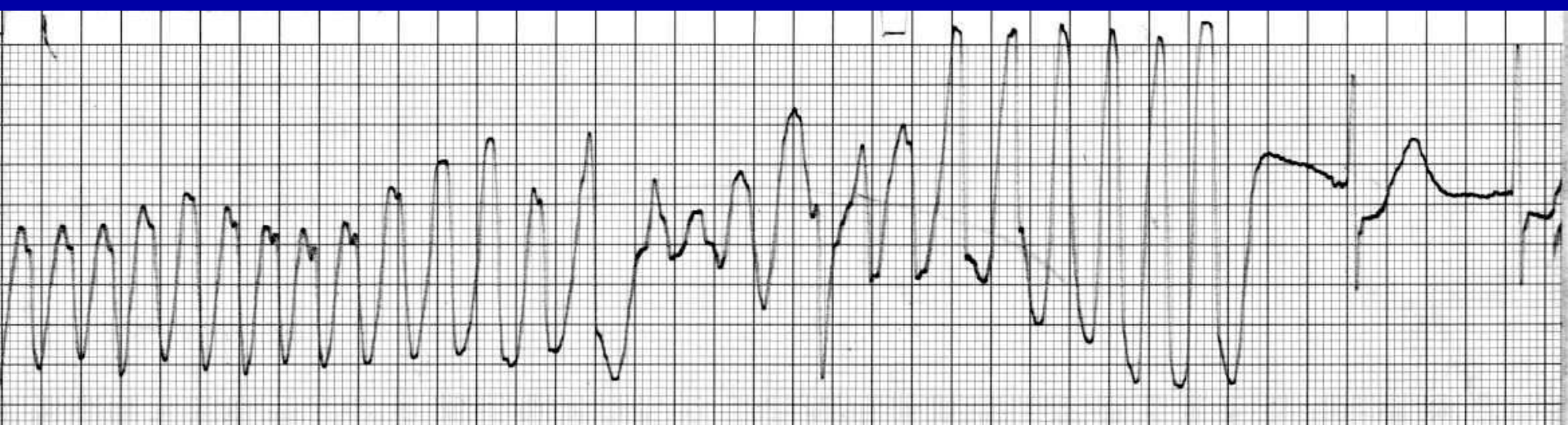
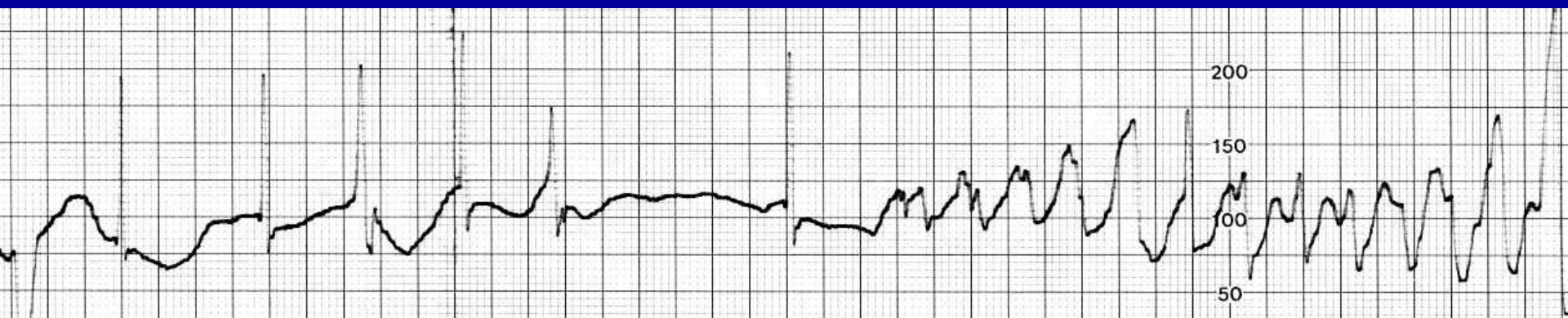
21 year old man with Ventricular Tachycardia
and clear AV dissociation

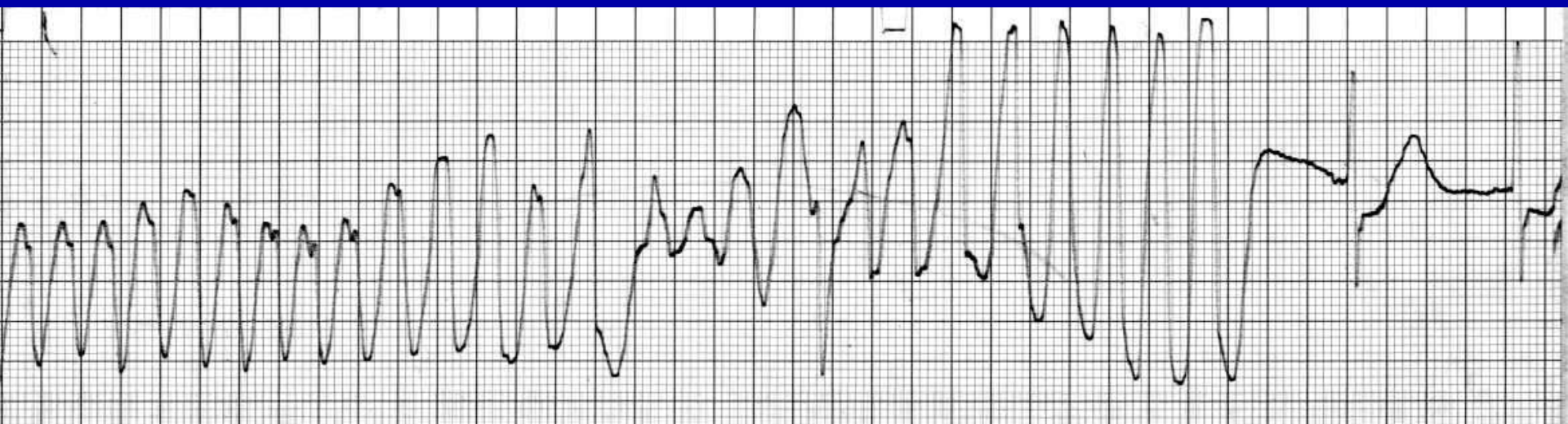
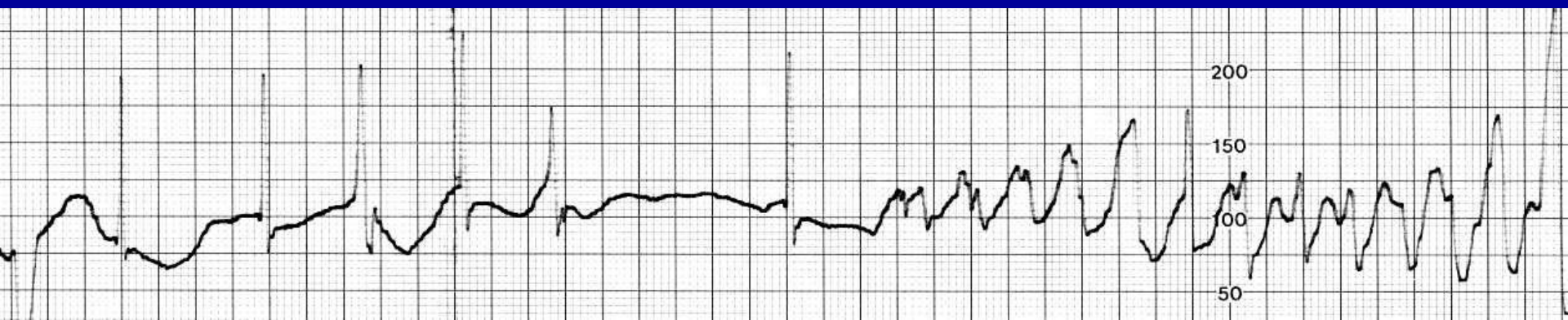
What is expected on physical examination?

Fifth Patient Example

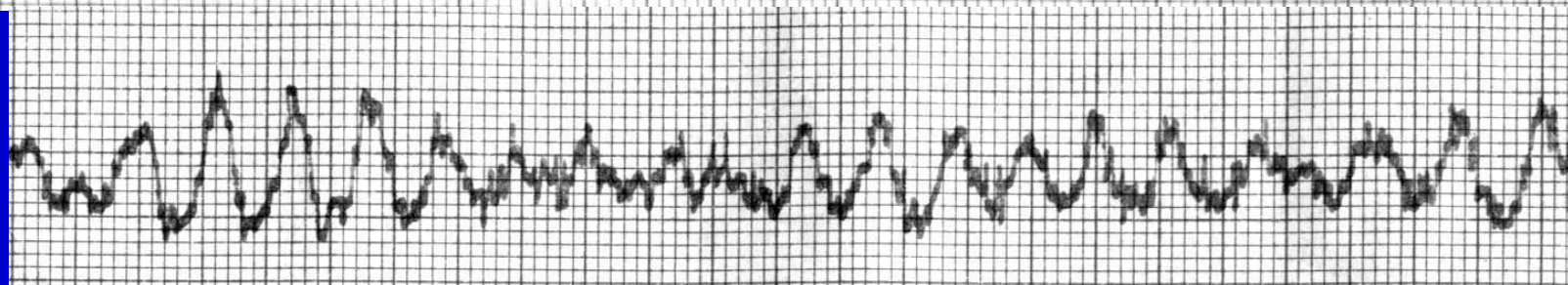
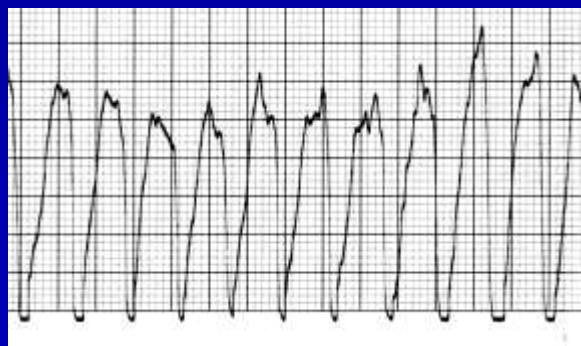
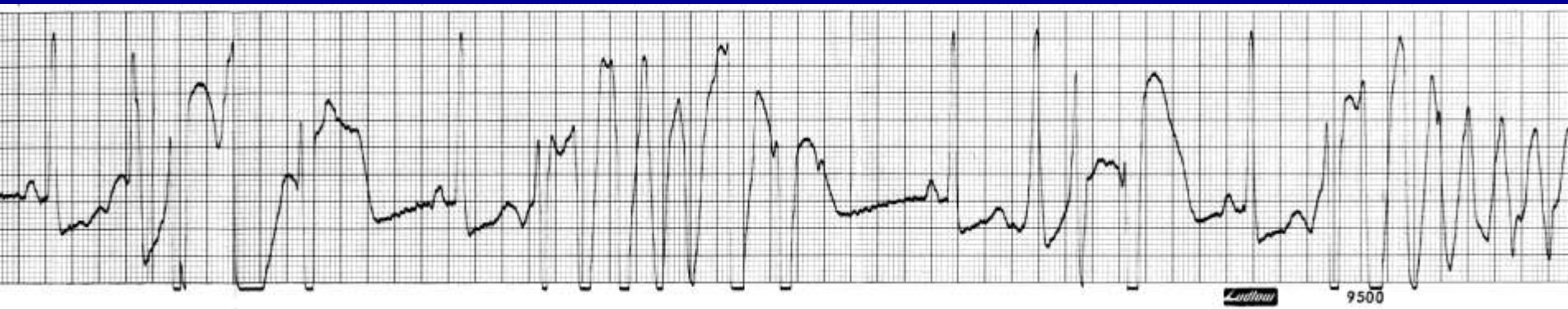


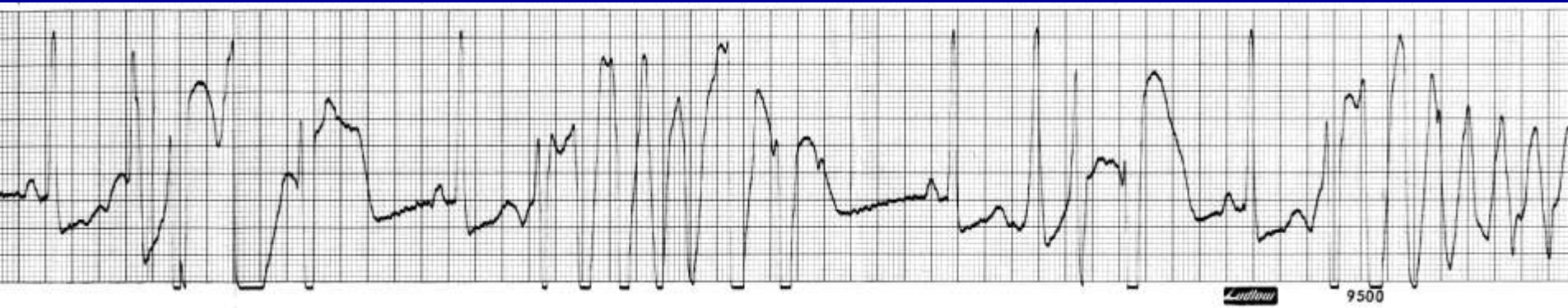
Baseline ECG from 21 year old man with VT, shows repolarization abnormality



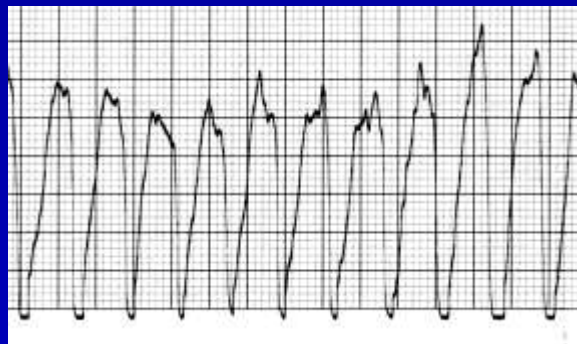


Initiation and termination of Torsade

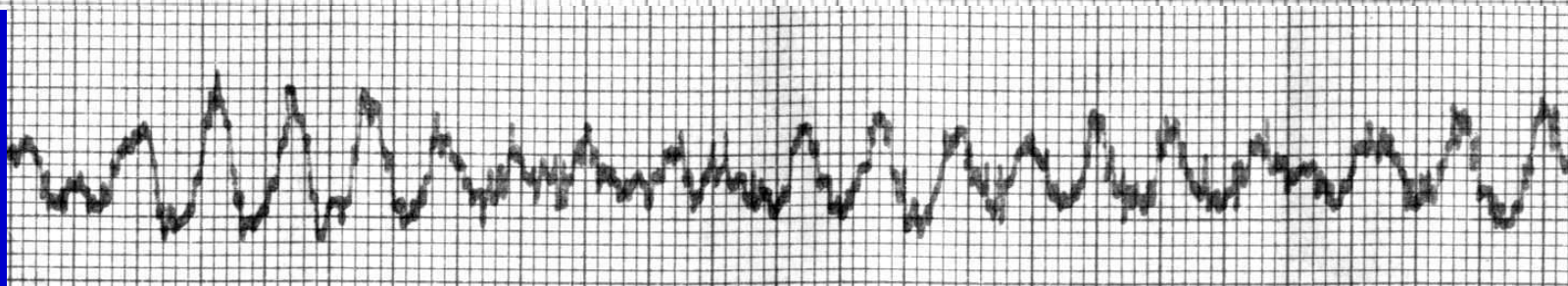


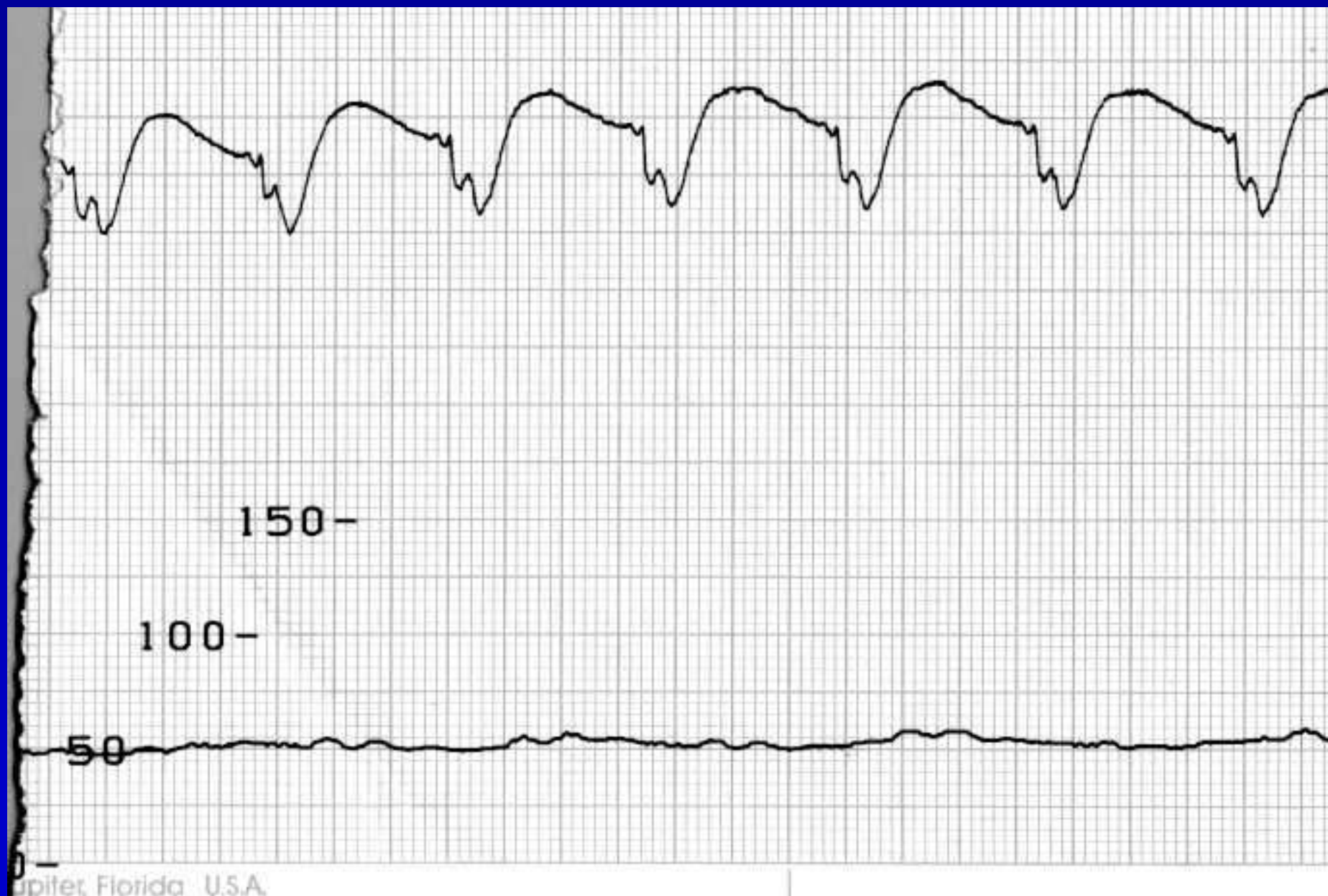


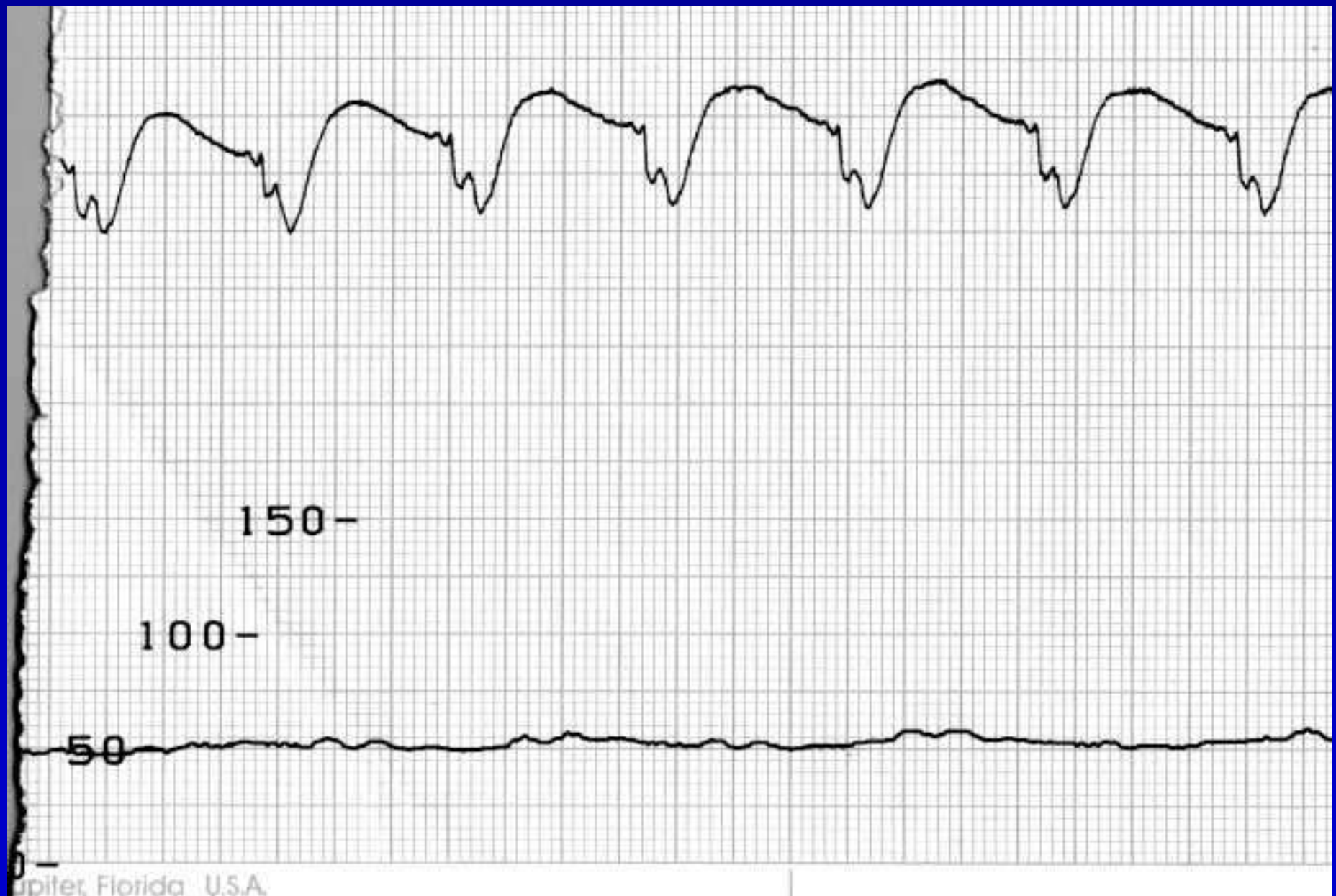
Torsades



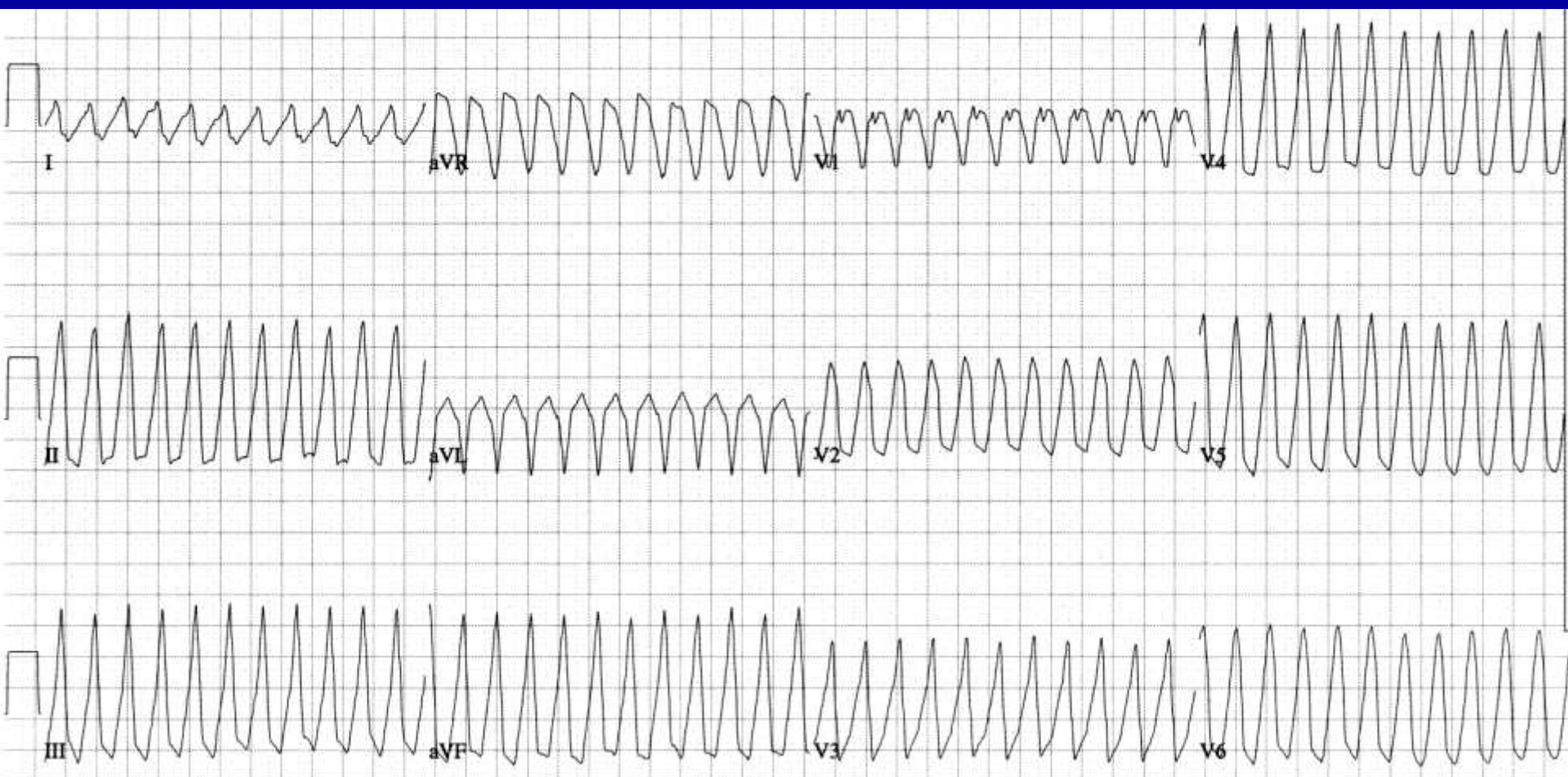
VT/VF

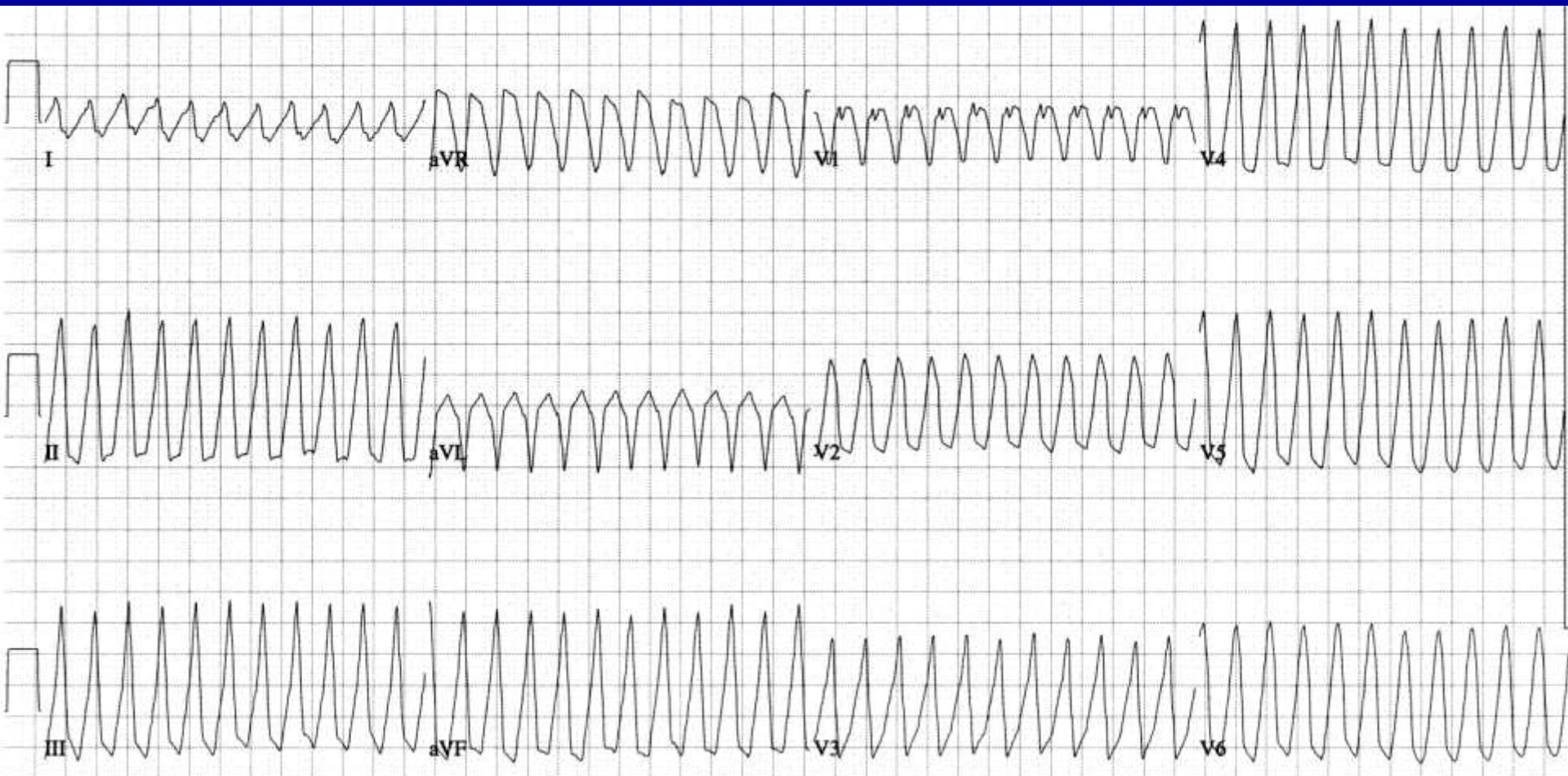




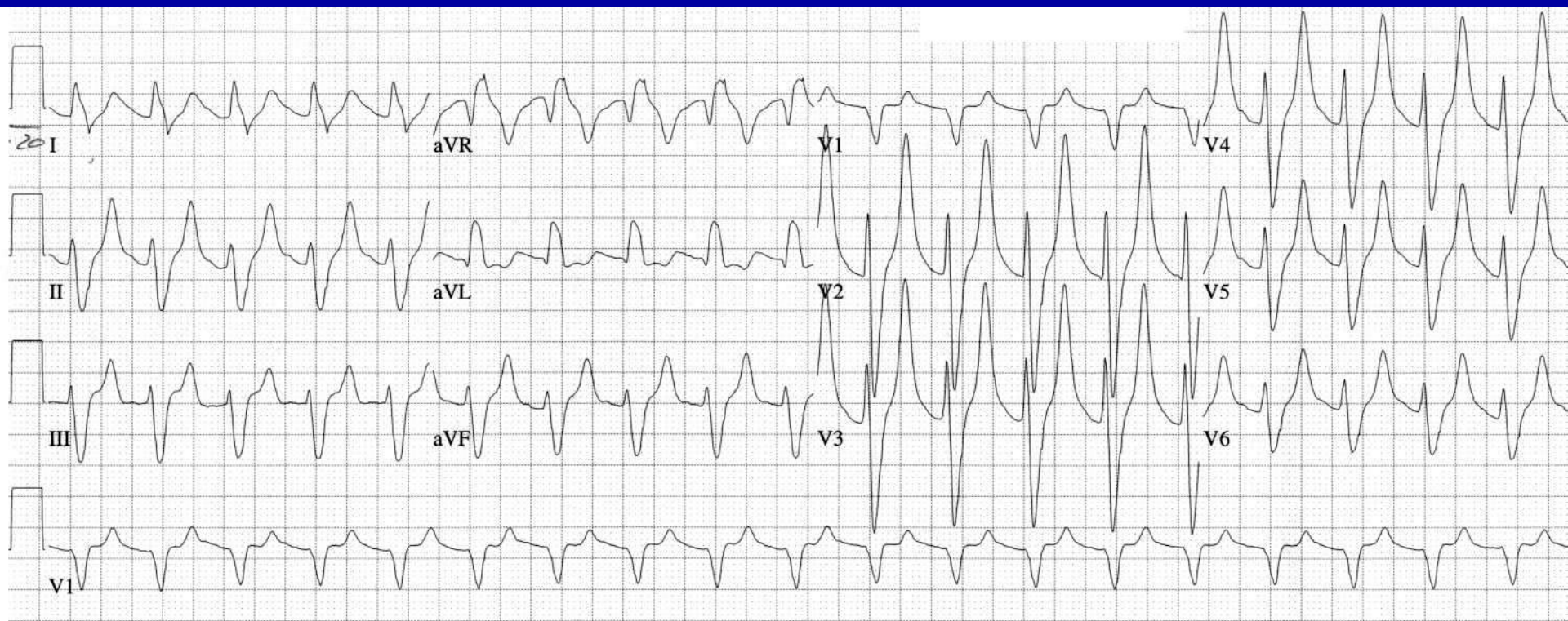


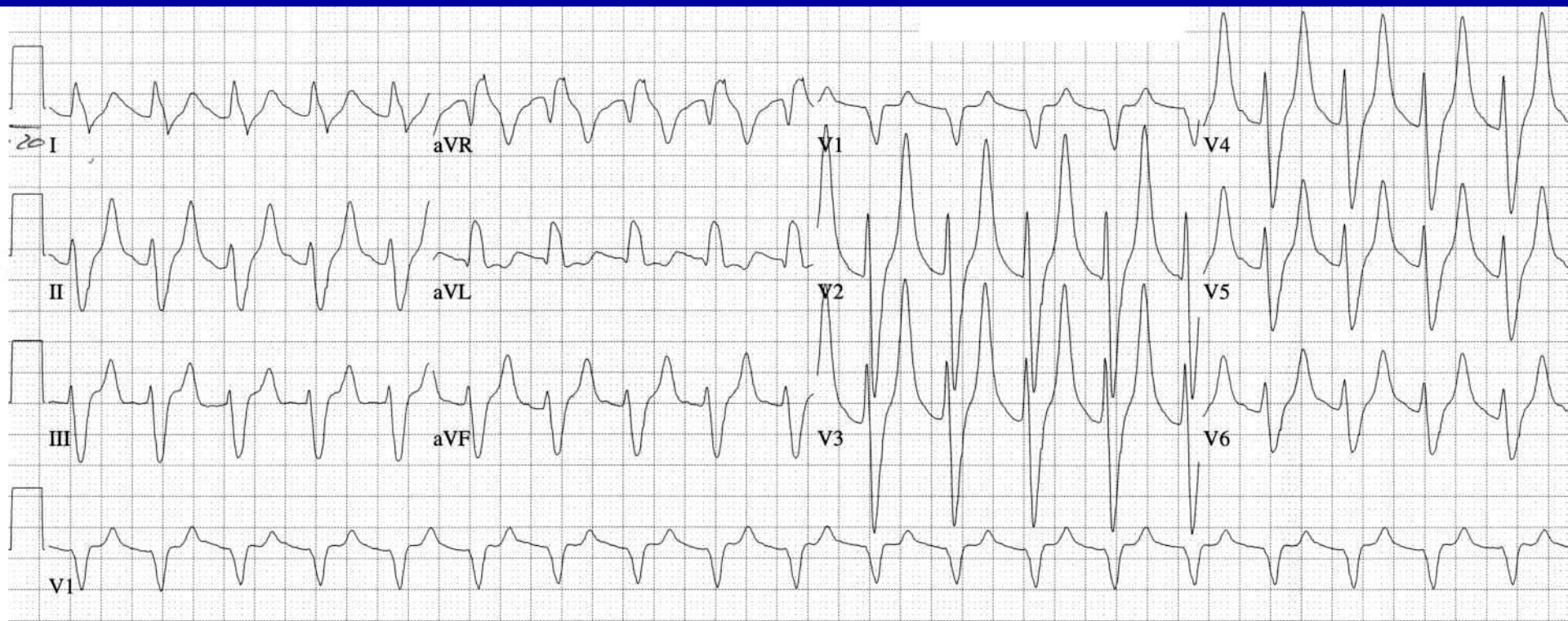
VT without significant pulse





Tetralogy, postoperative repair, inducible on second EPS
Rapid monomorphic Sustained VT - received ICD



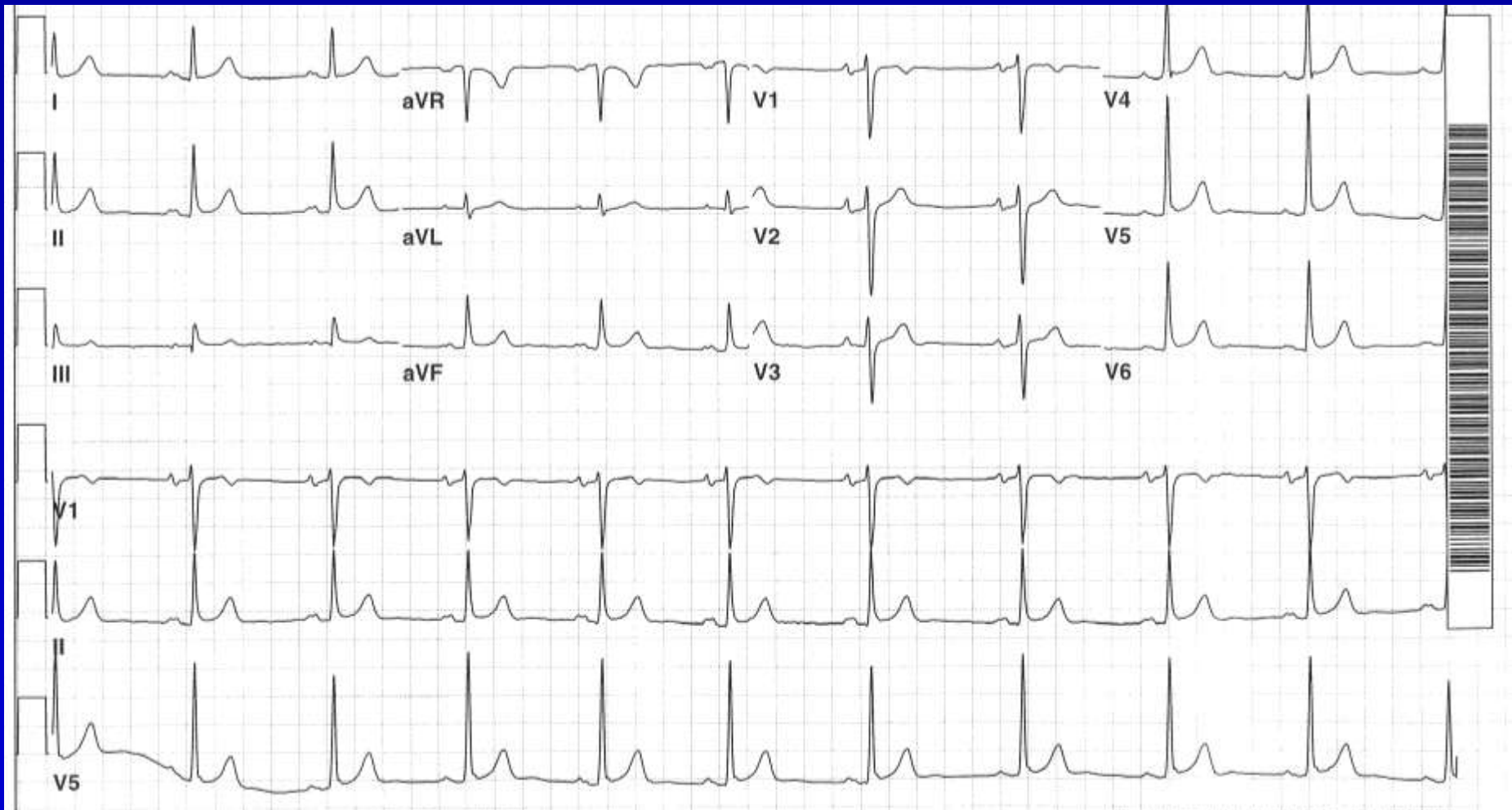


Sinus tachycardia and hyperkalemia

Hyperkalemia can also mimic ST elevation of acute MI

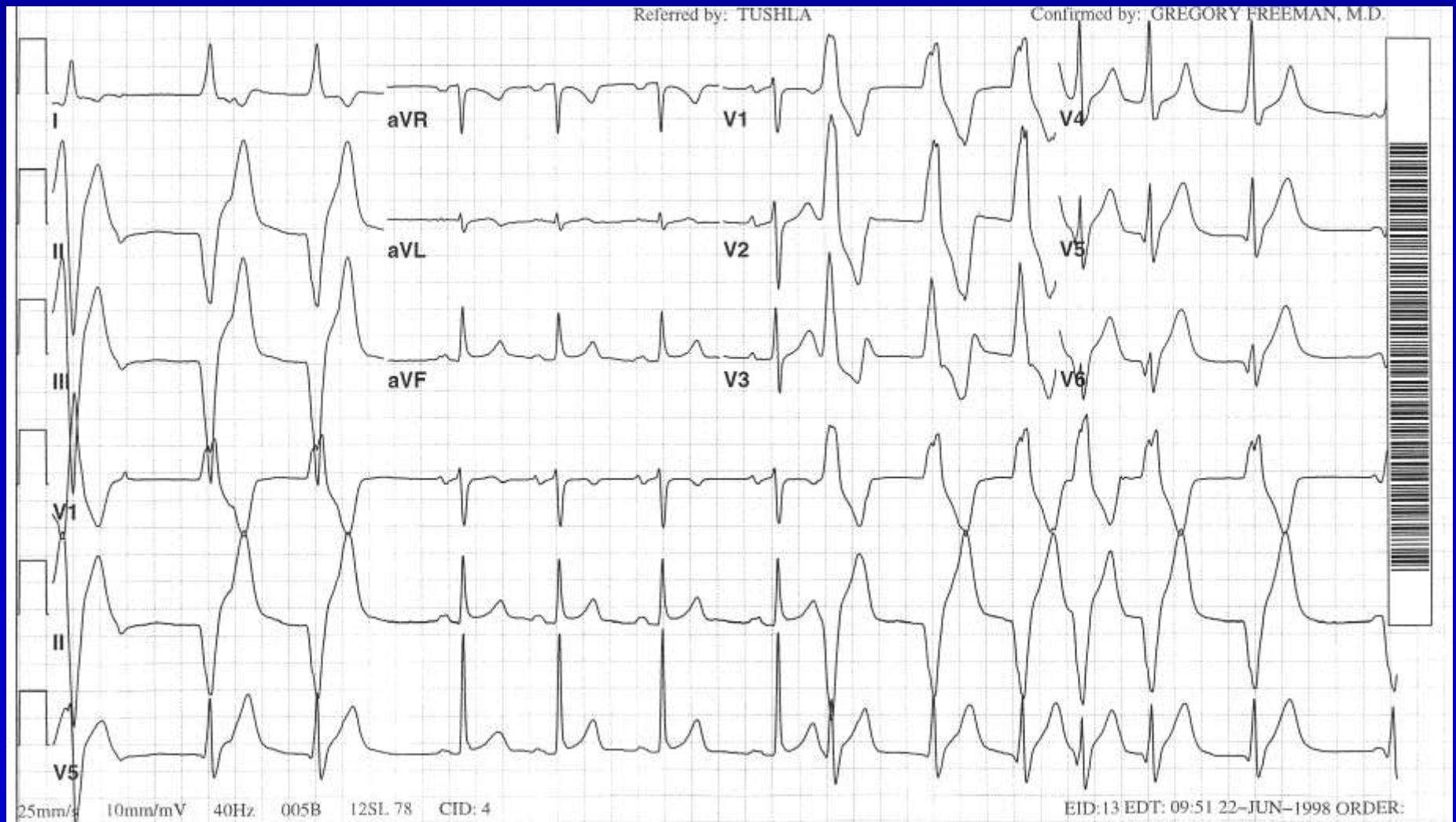
UE1967 5-23-98 19:53

1 of 3 baseline



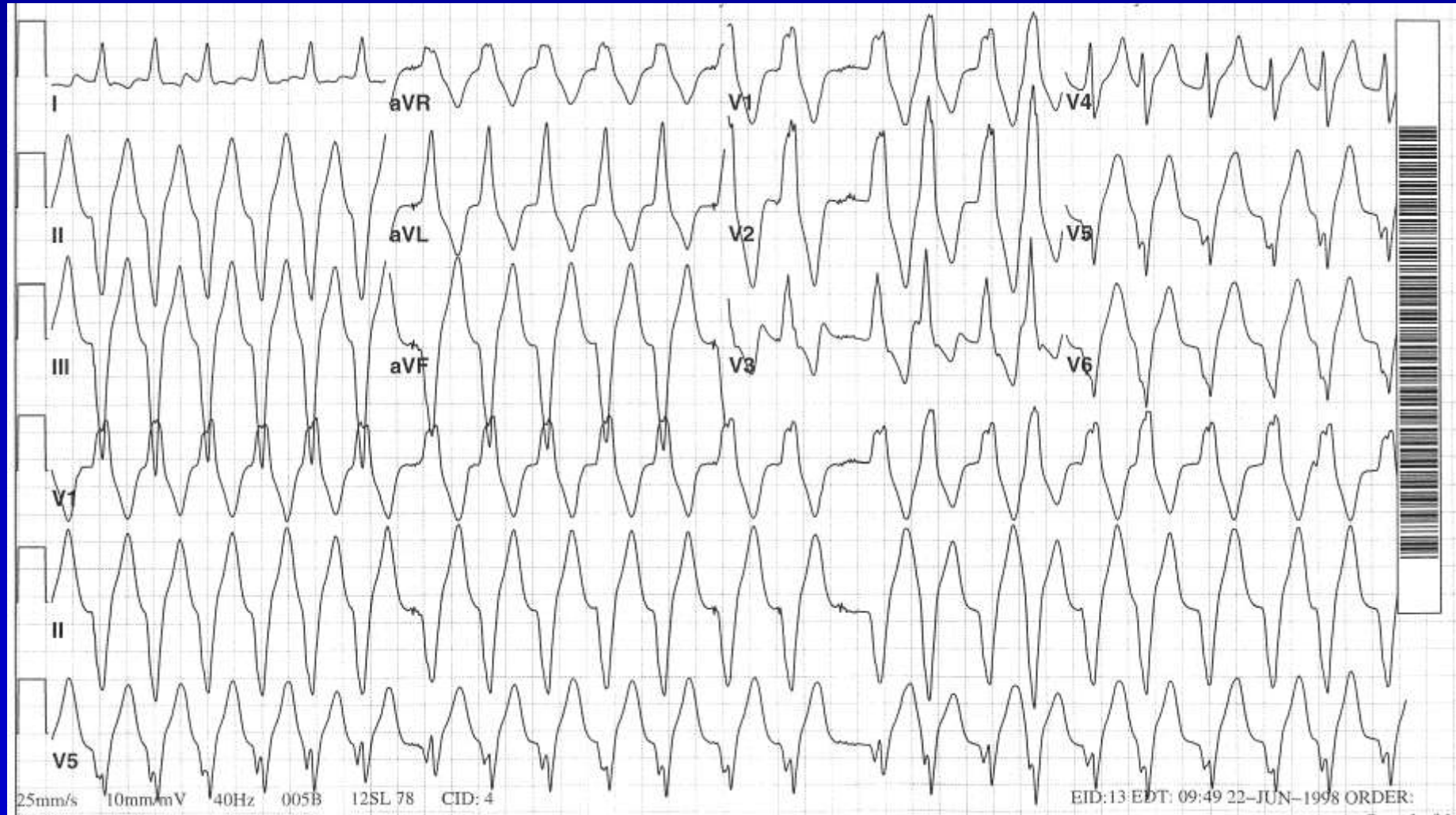
UE1967 5-27-98 13:44

2 of 3

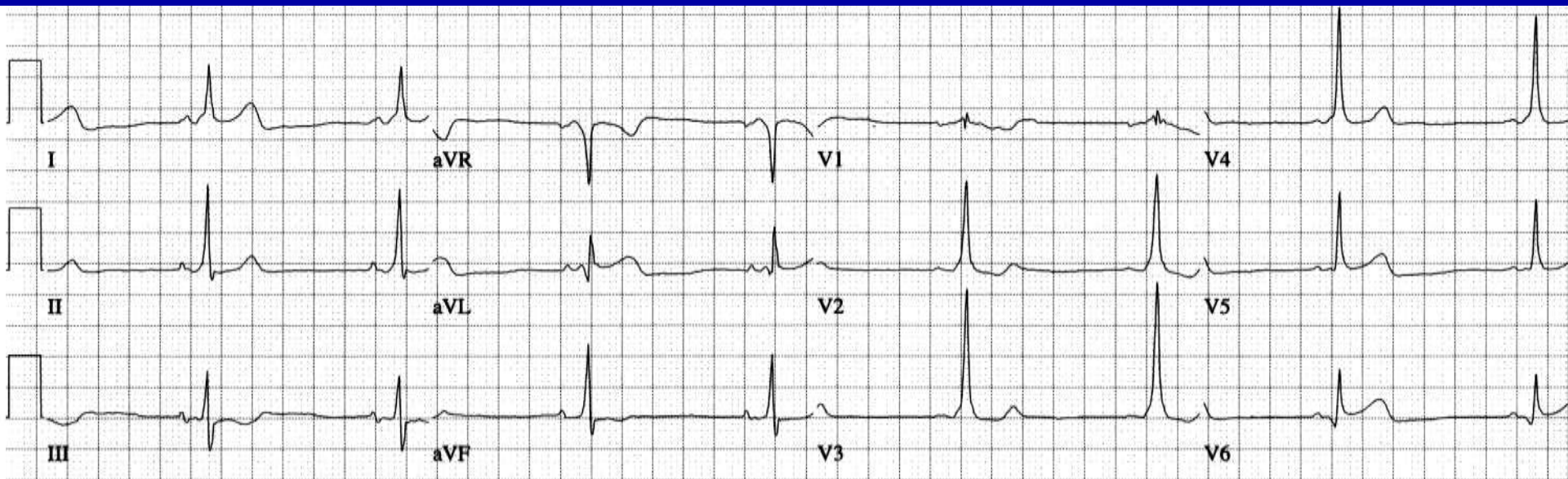


UE1967 5-27-98 13:54

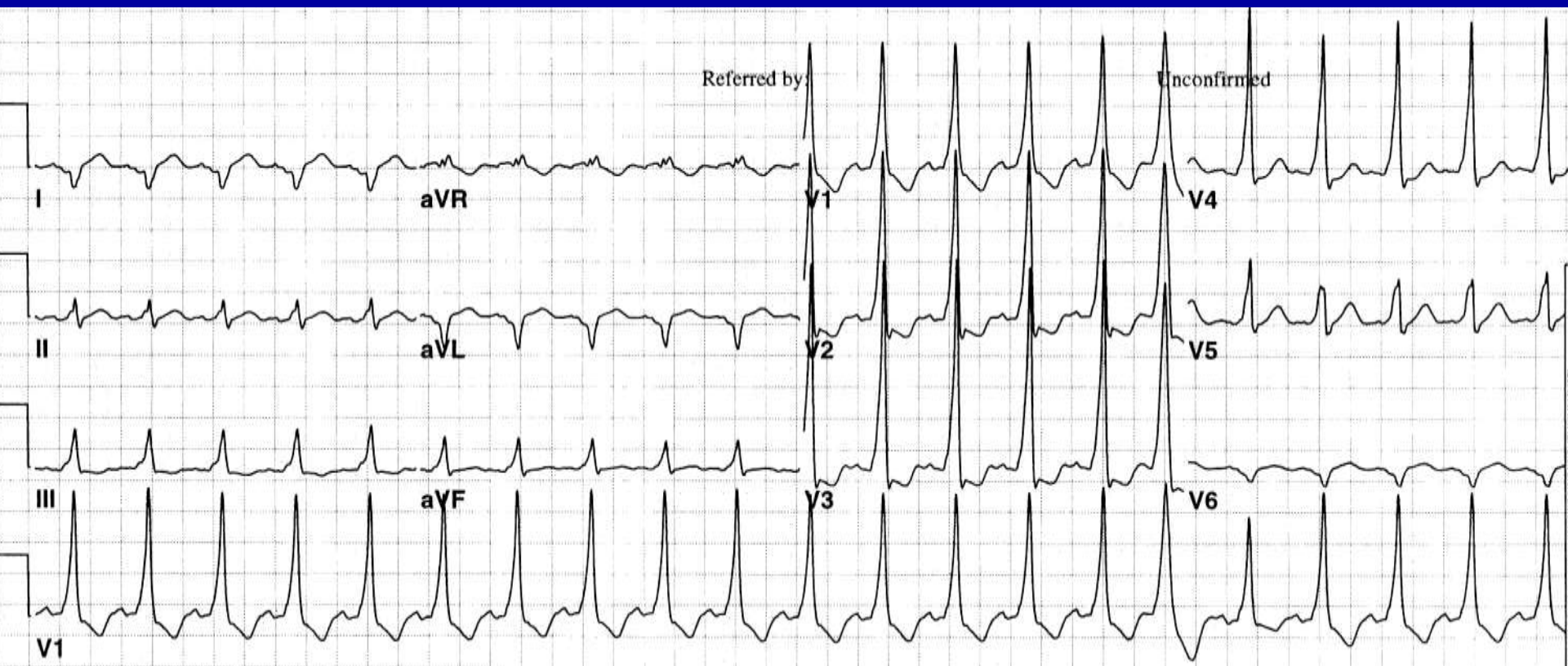
3 of 3

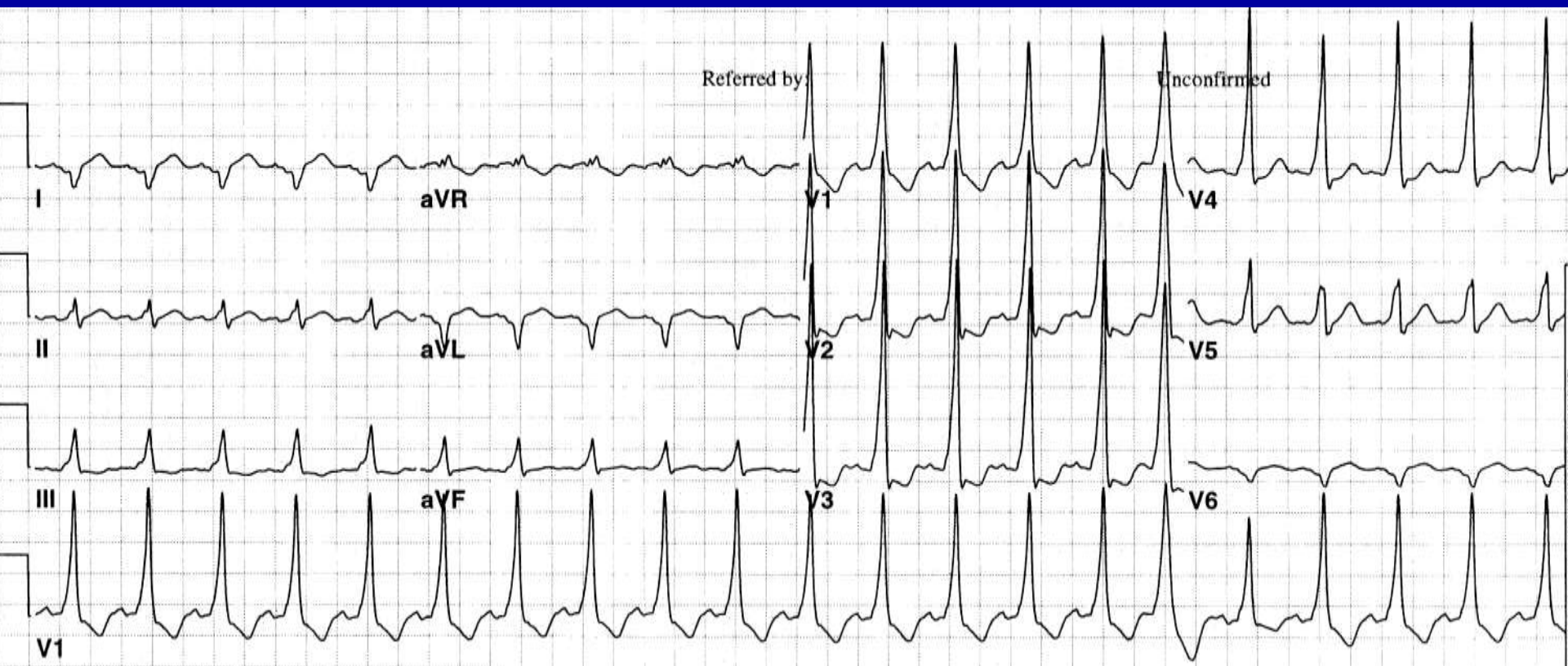


Very irregular WCT, looks like VT, but so irregular
Wonder about Afib but no fib waves



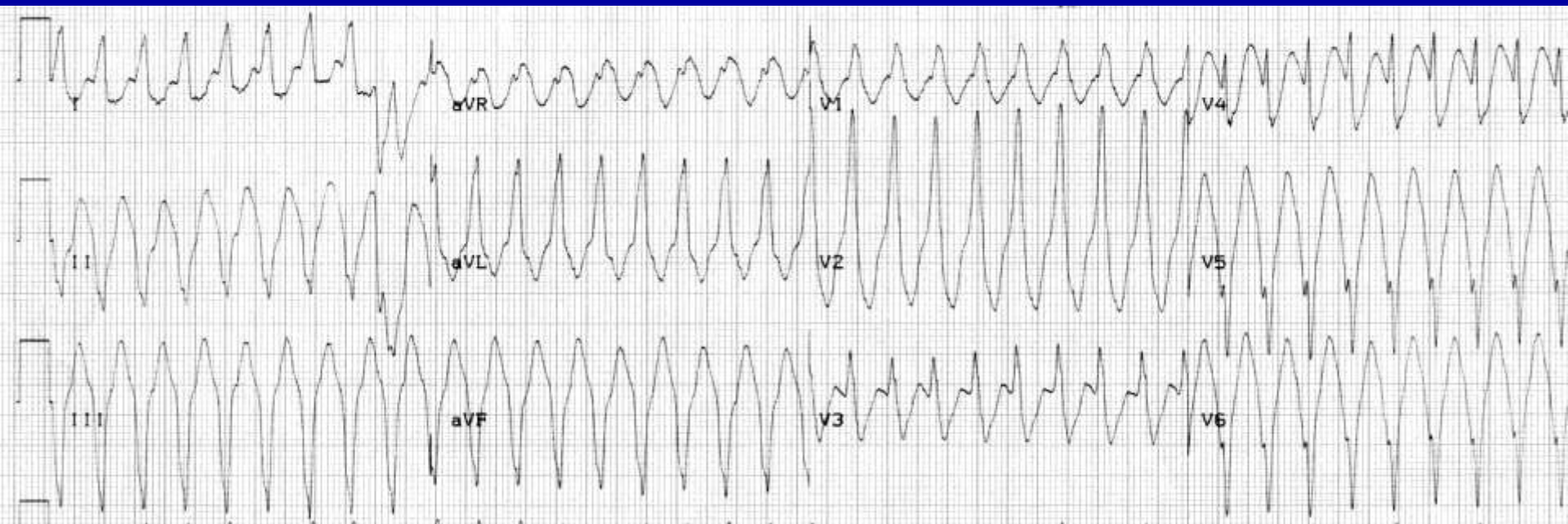
Baseline ECG shows WPW pattern, not on all tracings.





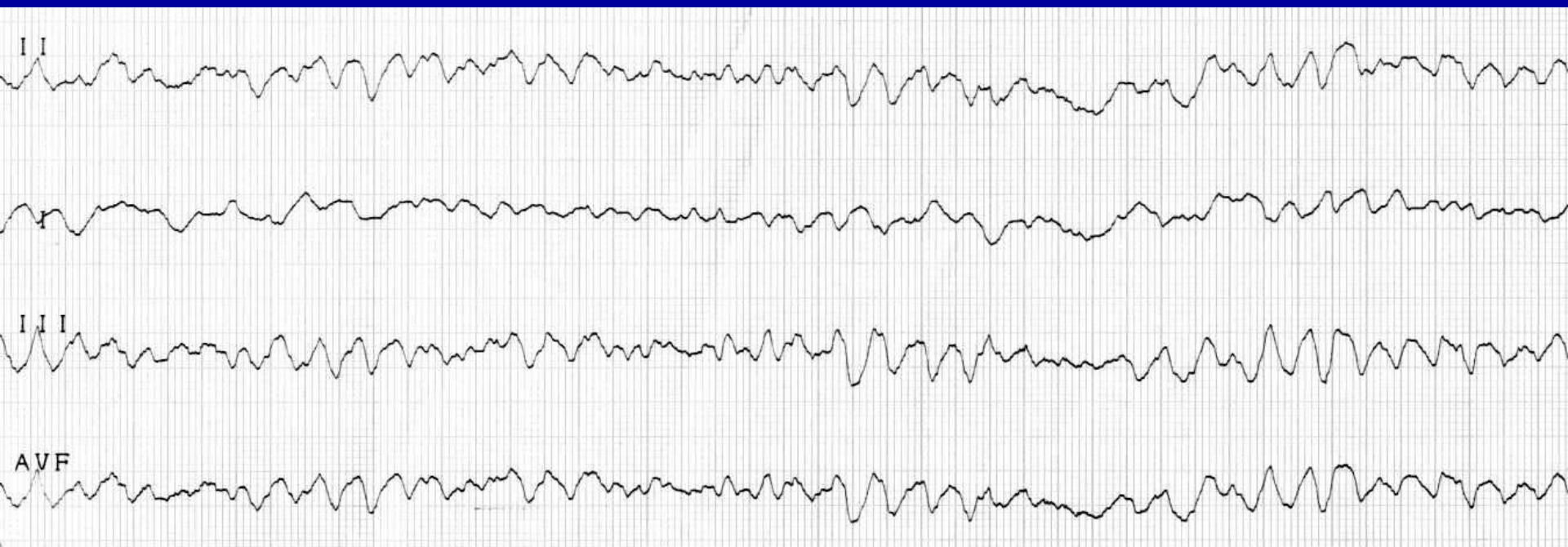
WCT from WPW and sinus tachycardia

Sustained Ventricular Tachycardia

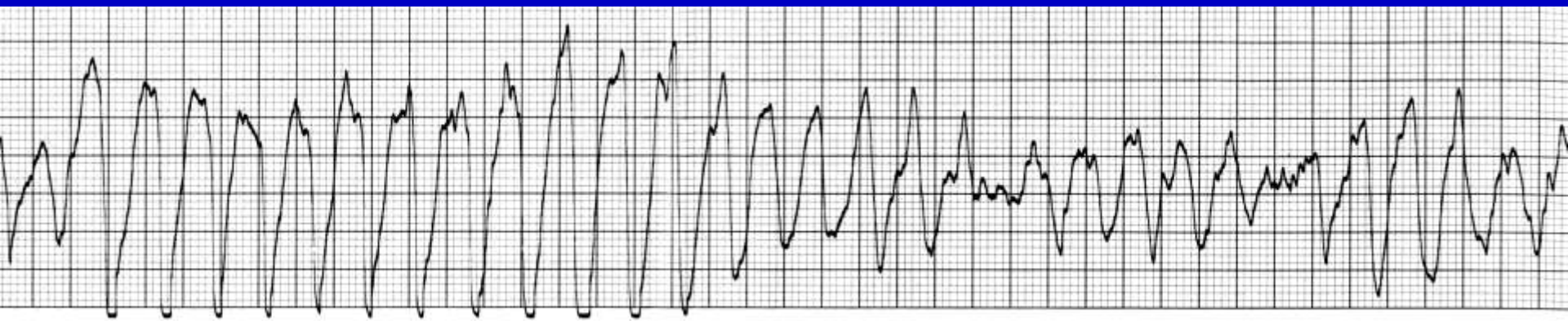


41 year-old man with DCM and normal coronary arteries

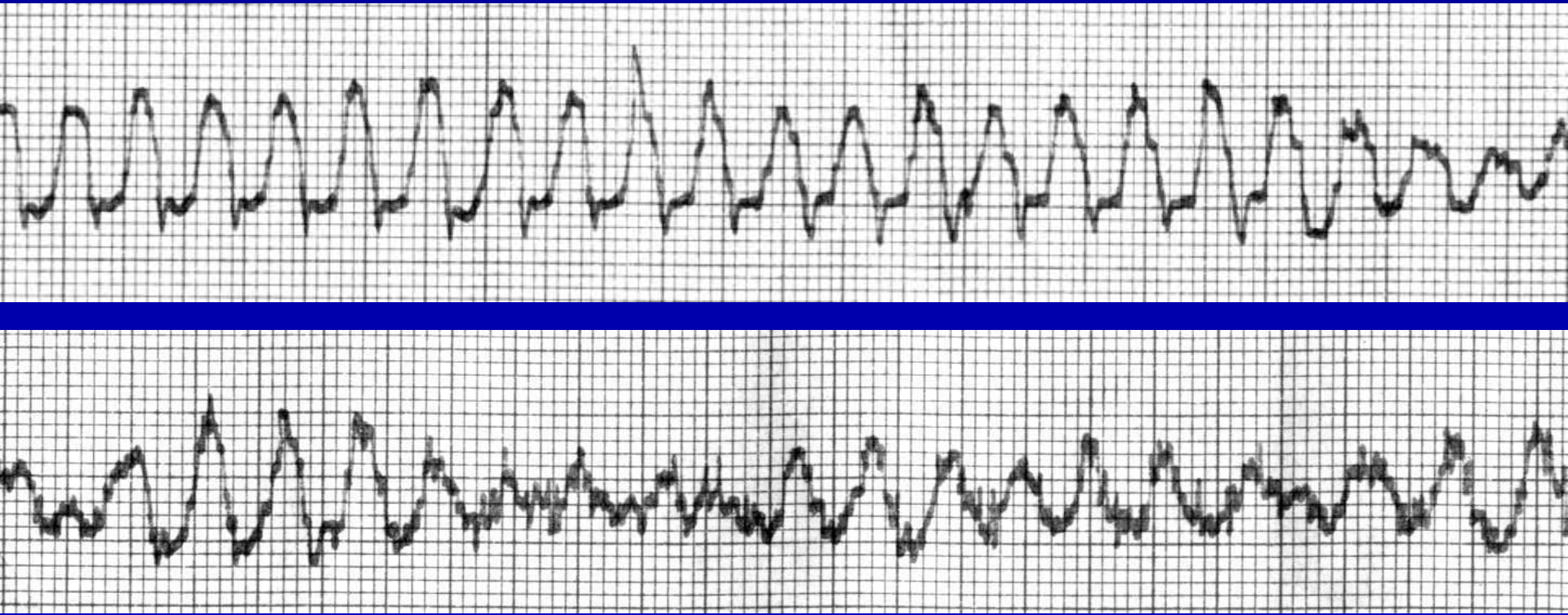
Ventricular Fibrillation



Torsades



Ventricular Fibrillation



Narrow complex tachycardias

- The P is the key
 - Finding the P may be a challenge
 - Determine if the P waves are regular or irregular
 - Determine if the relationship of the P to the QRS is constant or variable
 - Determine the PR (or RP) interval if the relationship is constant

Atrial activity in Supraventricular Tachycardias - 1

- Sinus tachycardia: one P wave preceding a QRS, upright in I and aVF, particularly in II
- Atrial tachycardia: like sinus tachycardia, but P wave is different from sinus P wave, often not upright in II or aVF (can be ectopic or reentrant)
- Definition: Retrograde P wave: P wave is inverted in II (retrograde P wave generally has an axis of about -75 degrees)
- AV Nodal reentrant tachycardia (AVNRT): P wave is retrograde
- Atrioventricular reentrant (or reciprocating) tachycardia (AVRT)

Atrial activity in Supraventricular Tachycardias - 2

- AV Nodal reentrant tachycardia (AVNRT): P wave is retrograde
 - Typical type (“slow-fast”, meaning antegrade conduction down the slow pathway, and retrograde conduction up the fast pathway): P wave occurs simultaneously or immediately on the heels of the QRS (R-P interval is less than the PR interval, and generally less than 0.07 sec, meaning the P wave has already started before the QRS is finished; in fact the P wave may be entirely buried in the QRS and not visible at all)
 - Atypical type (“fast-slow”, meaning antegrade conduction is down the fast pathway and retrograde conduction is up the slow pathway): P wave occurs shortly before the QRS complex (R-P interval is longer than the PR interval)

Atrial activity in Supraventricular Tachycardias - 3

- Atrioventricular reentrant (or reciprocating) tachycardia (AVRT):
 - Only occurs in presence of an accessory pathway, like that responsible for WPW Syndrome
 - In orthodromic AVRT the AV node conducts in the antegrade direction (and the bypass tract conducts in the retrograde direction), it is a narrow complex tachycardia: the P wave is abnormal in shape and axis, and occurs after the QRS, with an RP interval of more than 70 msec (slightly longer than in AVNRT)
 - In antidromic AVRT the ventricle is activated by the bypass tract (accessory pathway) resulting in a wide-complex tachycardia (the atrium activated retrogradely via the AVnode)

P Wave in SVT

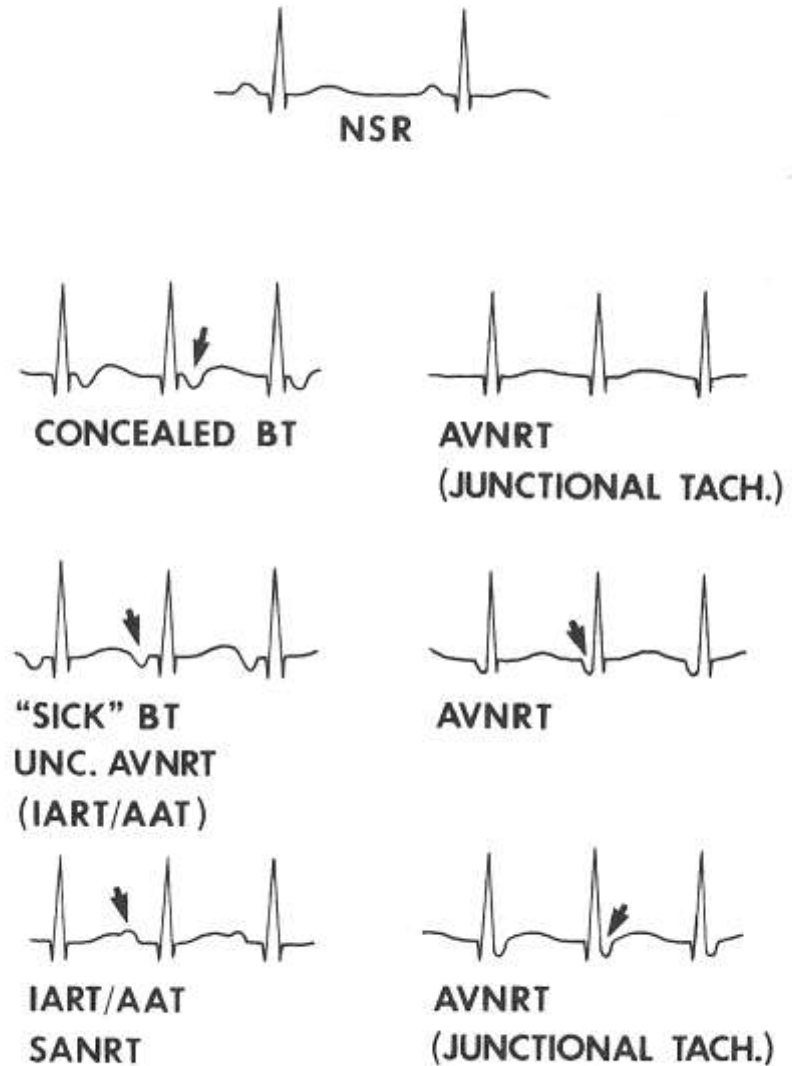


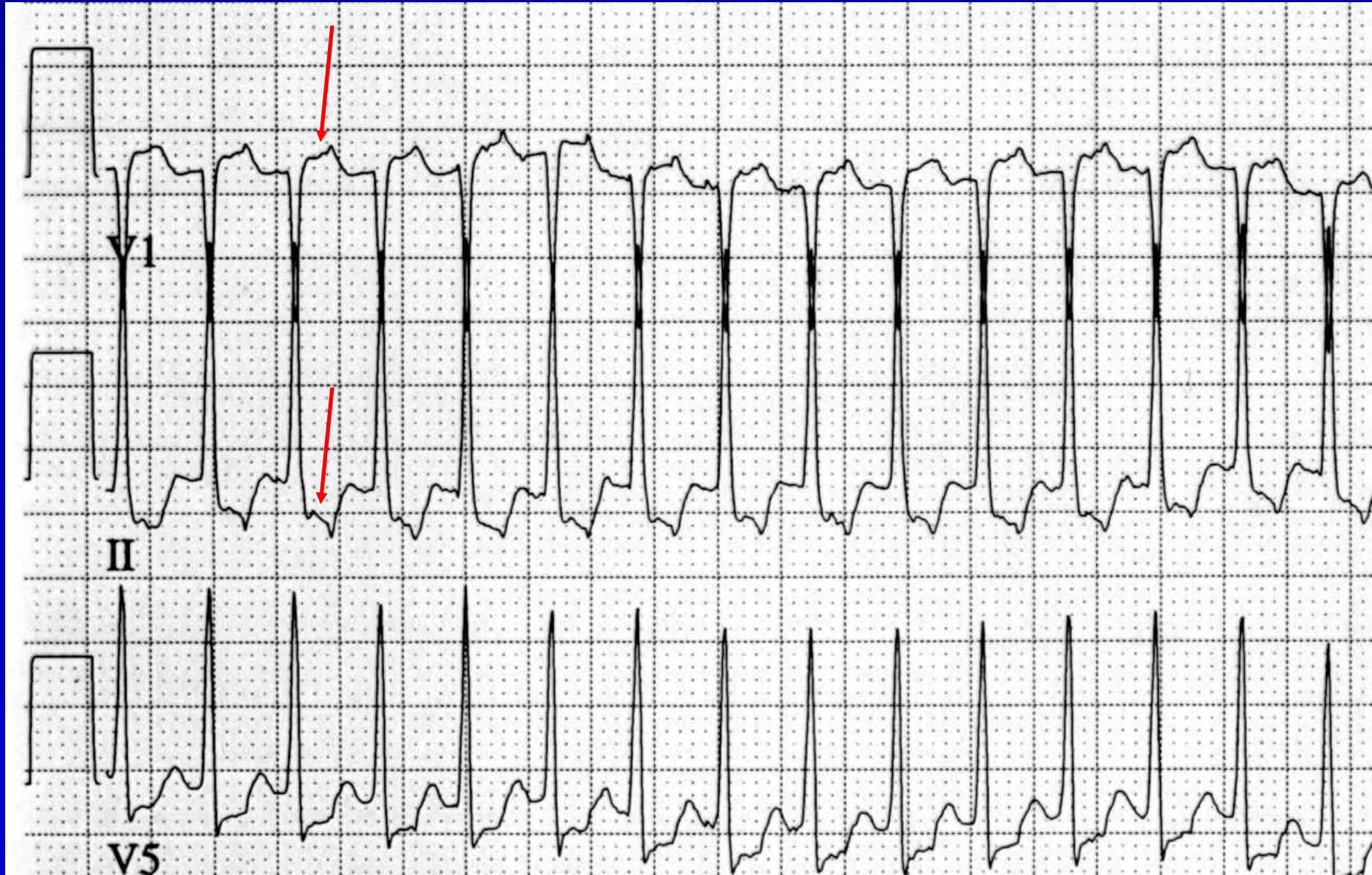
FIG. 8-150. *Differential diagnosis of tachycardias with different R-P/P-R relationships and P-wave configurations. See Figure 8-115 for abbreviations.*

Josephson ME. p. 266-7, Clinical Cardiac Electrophysiology, 3rd ed. 2002.

Differentiating Ectopic atrial tachycardia from Intraatrial reentrant Tachycardia

| | Ectopic atrial Tachycardia | Intraatrial reentrant Tachycardia |
|---|----------------------------|-----------------------------------|
| First beat of tachycardia is same as subsequent | Yes | No |
| Warm-up of rate at initiation | Yes | No |

Supraventricular Tachycardia



Paroxysmal Atrial Tachycardia with Block

- Abnormal P waves different from sinus P waves
- Atrial rate 150-250
- Isoelectric intervals between P waves in all leads
- AV block greater than first degree

Multifocal Atrial Tachycardia

- Variable P morphology and PR interval and P-P interval, not gradual or progressive
- Rate over 100 beats/min
- Often indicates severe end-stage cardiac or pulmonary disease

Multifocal Atrial Tachycardia



Tachycardias in WPW Syndrome

- Accessory pathway integral to circuit
 - Orthodromic AVRT (most common)
 - With or without functional bundle branch block (ipsilateral, slows rate)
 - Pre-excited reciprocating tachycardias
 - Antidromic AV reentrant tachycardias
 - AVRT with multiple pathways
- Accessory pathway passive, not essential
 - AVNRT
 - AVRT with second bystander accessory pathway
 - Aflutter or Fibrillation
 - VT

Tachycardias in WPW Syndrome

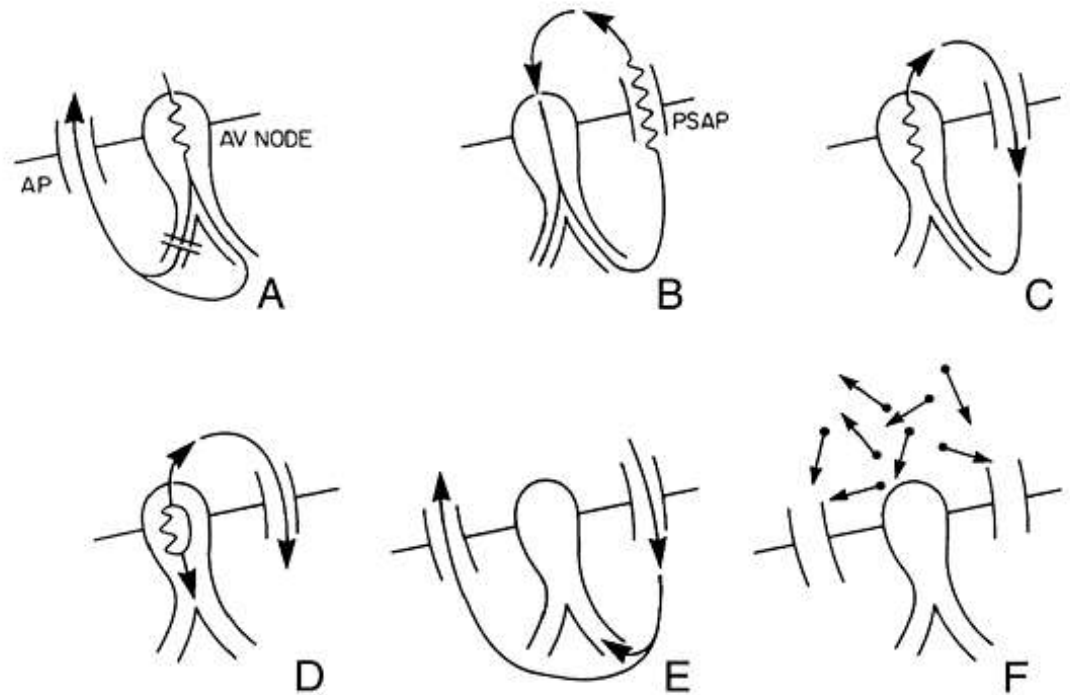


FIGURE 94-3 ■ The spectrum of tachycardias in the Wolff-Parkinson-White (WPW) syndrome. A, Orthodromic atrioventricular (AV) reciprocating tachycardia with or without functional bundle branch block. B, The permanent form of junctional reciprocating tachycardia. C, Antidromic AV reciprocating tachycardia. D, AV node reentrant tachycardia with bystander accessory pathway (AP) conduction. E, Pre-excited reciprocating tachycardia using multiple APs. F, Atrial fibrillation. PSAP, posteroseptal accessory pathway.

AVRT

- Most common tachycardia in WPW

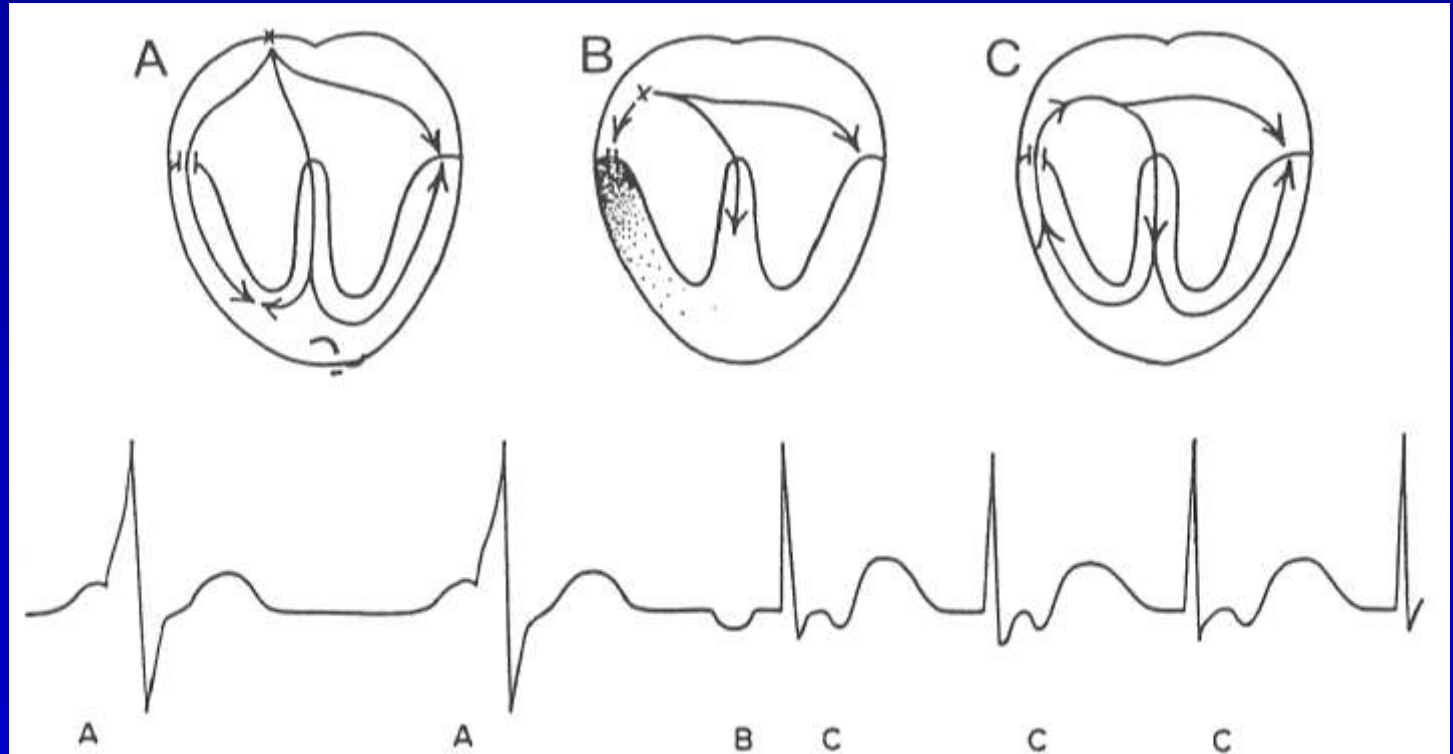


Figure 6.6. The schematic illustration from Figure 6.3 is repeated on the *left* (**A**). In **B**, an atrial premature beat occurs before the Kent bundle has completed its period of refractoriness following the previous sinus beat, preventing antegrade ventricular preexcitation. Normal ventricular activation is then followed by retrograde atrial excitation (**C**). The resultant macrore-entrant circuit forms the basis for the tachyarrhythmia. (From Wagner GS, Waugh RA, Ramo BW. Cardiac arrhythmias. New York: Churchill Livingstone, 1983:13.)

PJRT: Permanent Form of Junctional Reciprocating Tachycardia (Coumel)

- Incessant or nearly so, esp. seen in young
- Almost all cases due to retrograde conduction over accessory pathway, so better term is PAVRT, and accessory pathway has decremental retrograde conduction
- P waves are usually broad, inverted in 2, 3, and aVF
- RP longer than PR
- Initiation of arrhythmia is with sinus beat, not PAC
- Rate of arrhythmia is sensitive to autonomic tone and physical activity with modulation of both RP and PR intervals
- Transient termination of arrhythmia through block in retrograde limb (no P wave)
- Retrograde limb sensitive to β -blockade, vagal maneuvers and calcium blockade, but arrhythmia is often refractory to medication

PJRT, or PAVRT

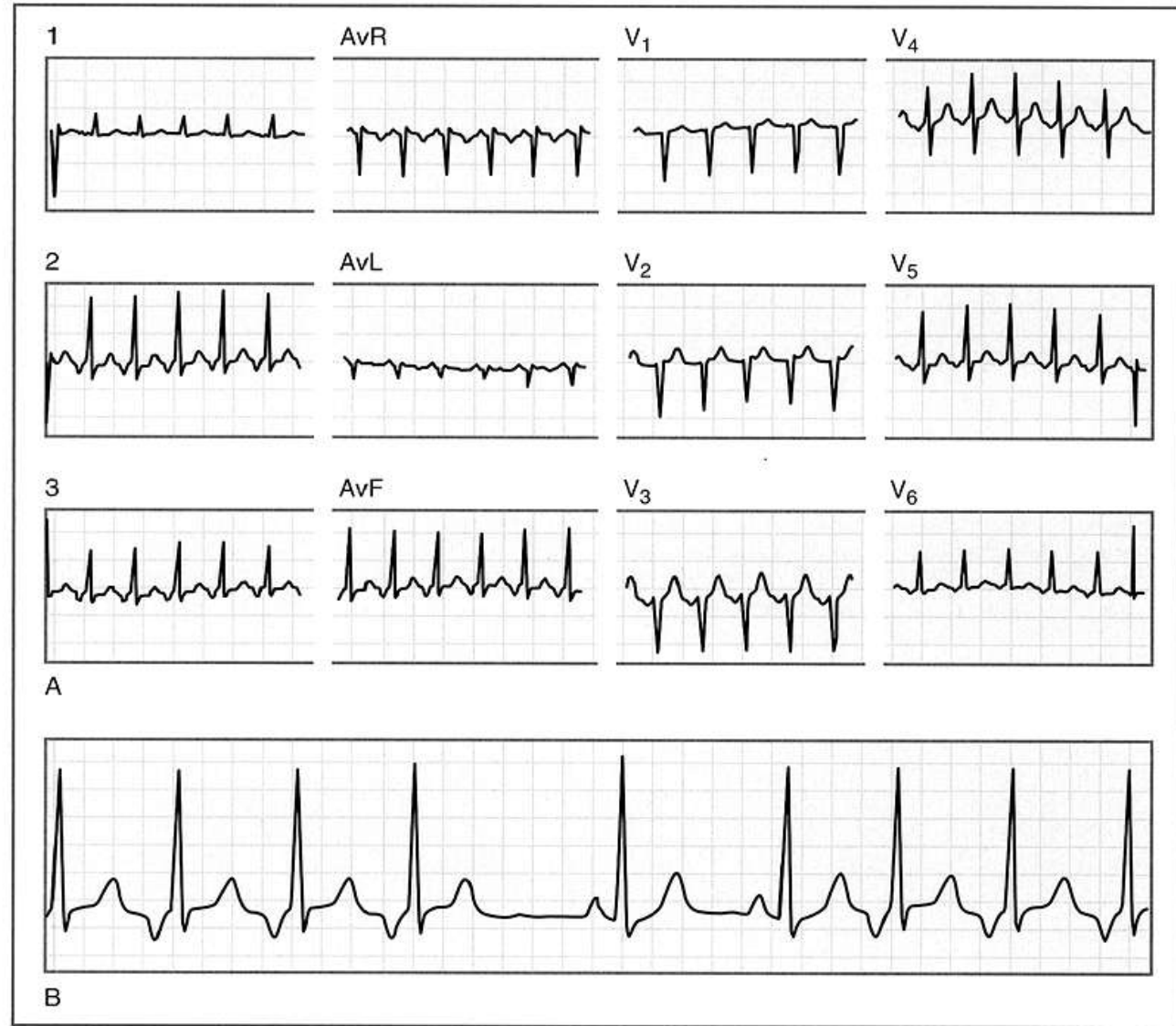
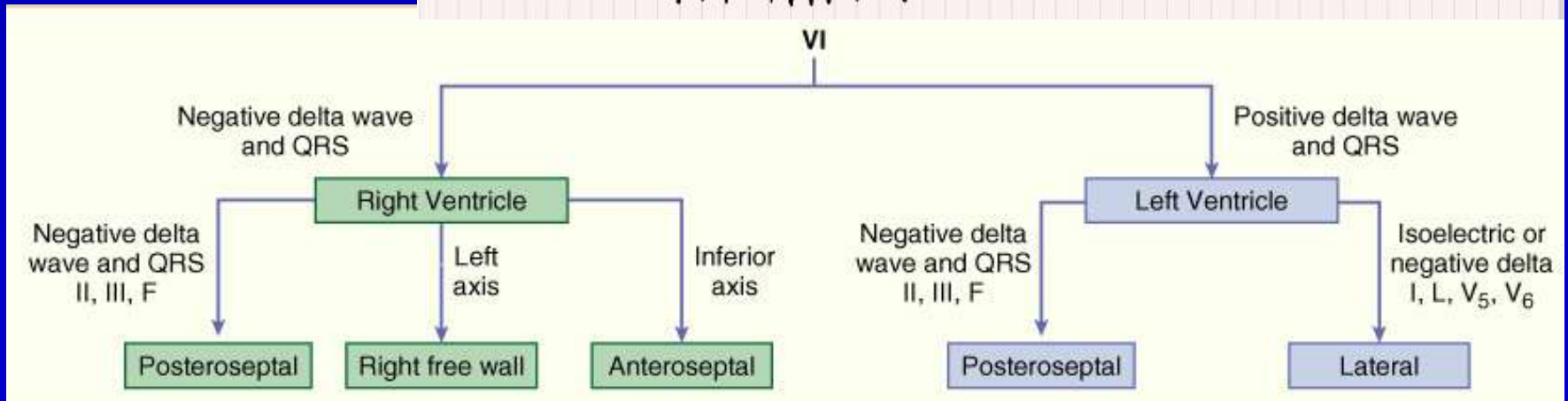
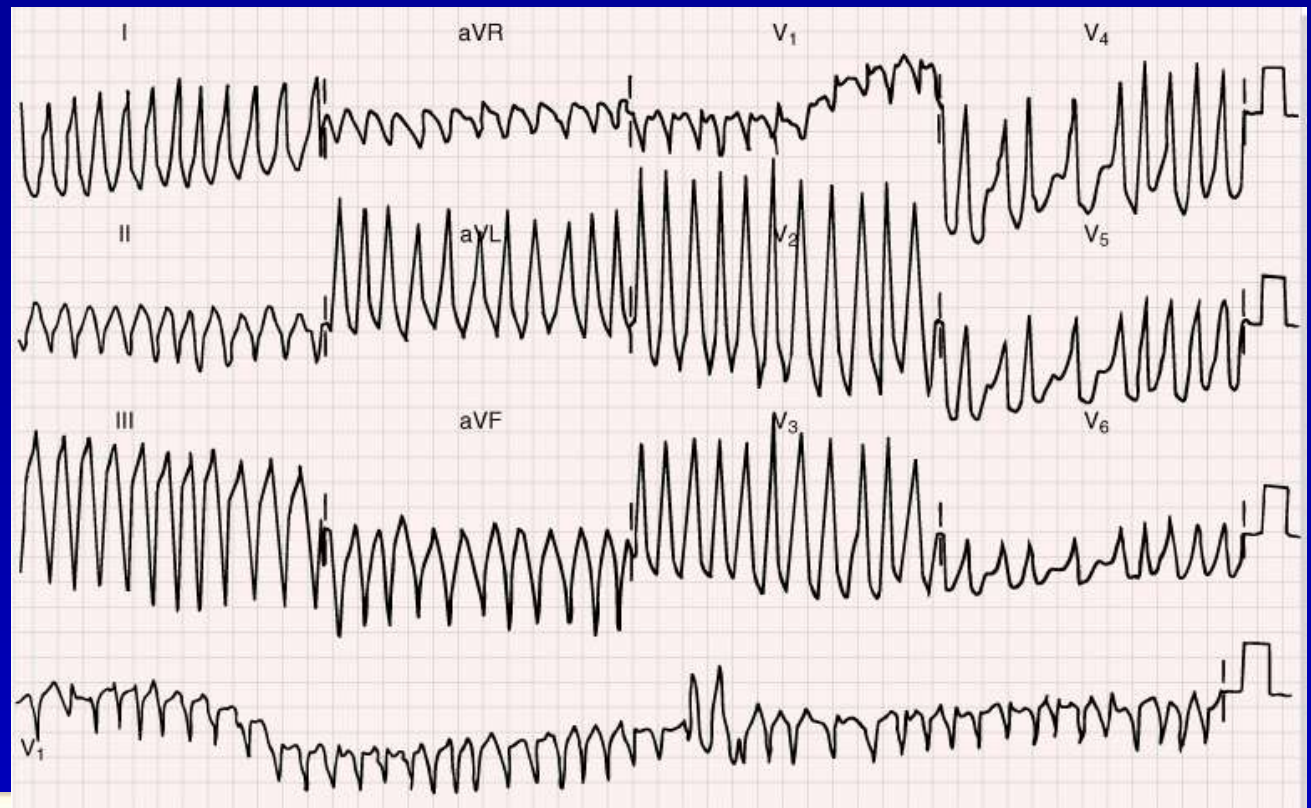


FIGURE 94-5 ■ Surface electrocardiogram of a patient with the permanent form of junctional reciprocating tachycardia. *A*, The 12-lead electrocardiogram illustrates the essential features of the tachycardia with typical negative P waves in leads II, III, and aVF and an R-P interval longer than the P-R interval. *B*, The tachycardia was transiently terminated by right carotid sinus massage. Termination without a retrograde P wave indicated block occurred in the retrograde limb and illustrated the atrioventricular node-like behavior of the accessory pathway. With acceleration of the sinus rate, there was spontaneous resumption of tachycardia.

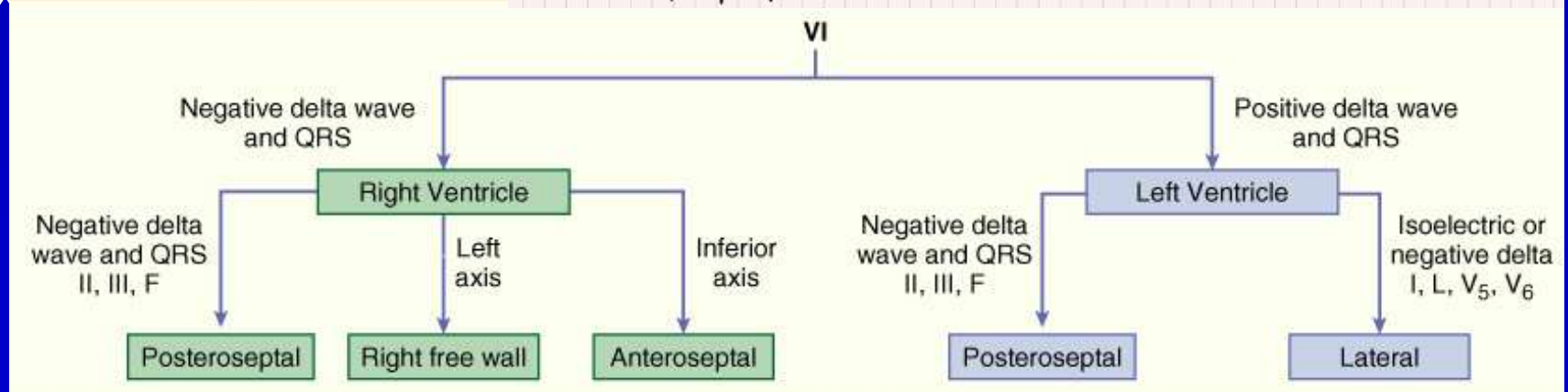
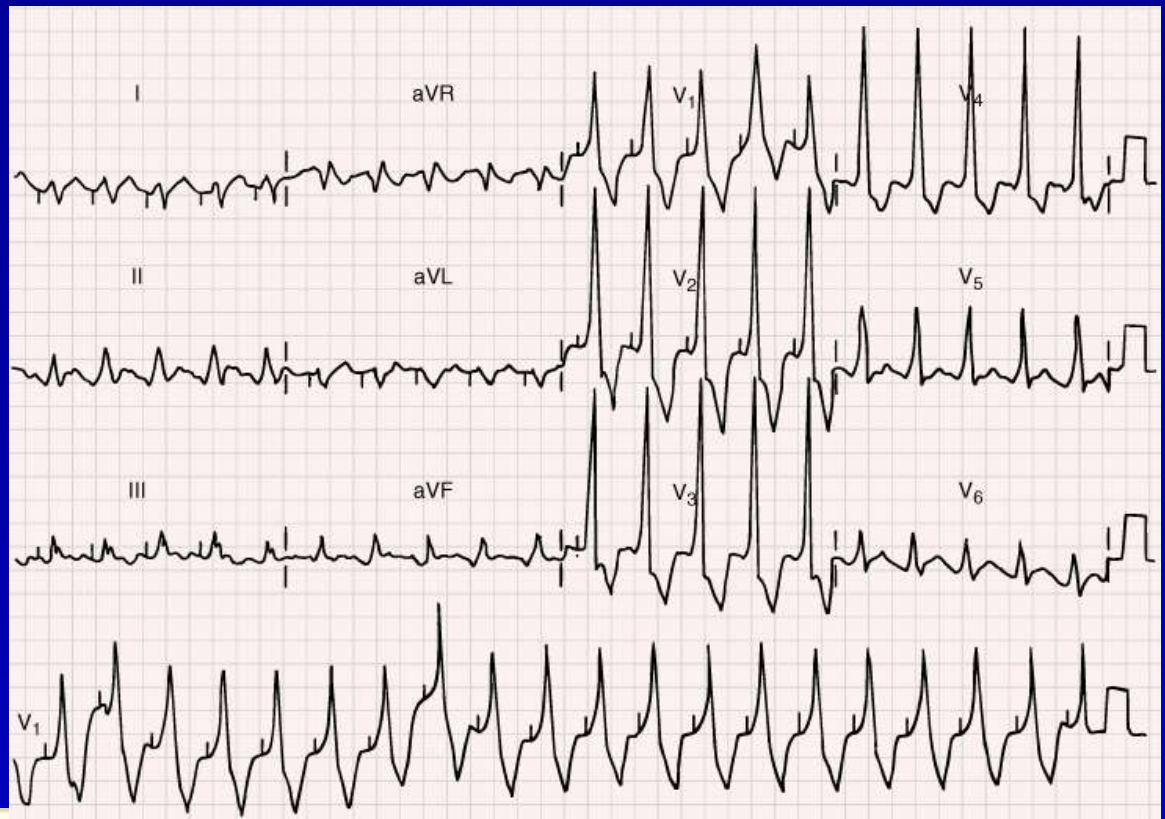
Orthodromic AVRT

- If P wave is visible
 - Inverted in I – left lateral accessory pathway
 - Unfortunately, frequently impossible to discern

Right posteroseptal accessory pathway.
negative delta in II, III, and aVF, upright in I and aVL localize the pathway to posteroseptal, and negative delta in V1 and rapid transition in V2 pinpoints to right posteroseptal; AFib



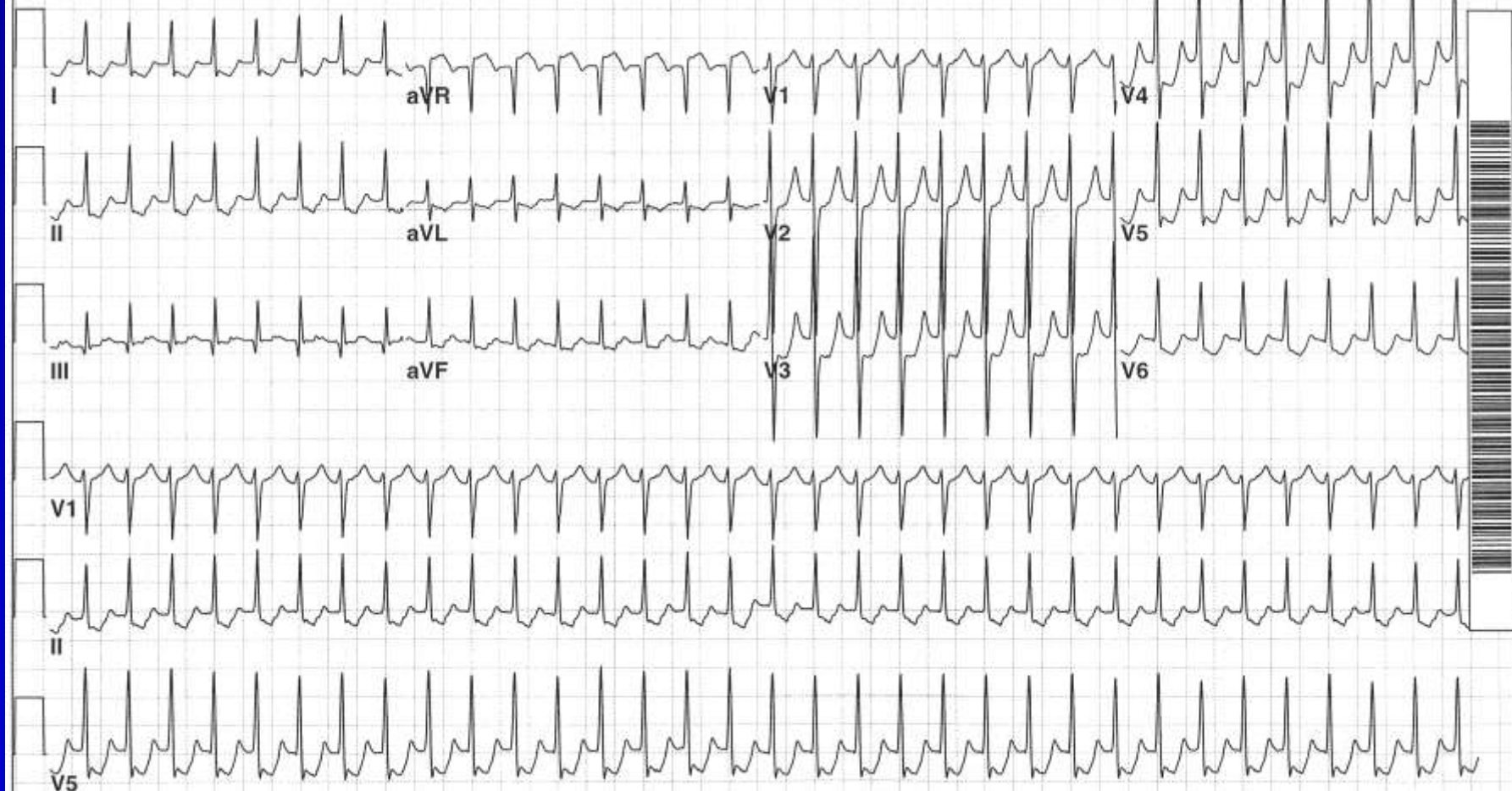
Left lateral accessory pathway – positive delta in anterior precordial leads and in II, III, and aVF, positive or isoelectric in leads I and aVL, and isoelectric or negative in V5 and V6 is typical of a left lateral accessory pathway. Coronary sinus pacing was used to enhance preexcitation



Test Ind: CP

Referred by: 13090 SMITH

Confirmed by: SUMANTH PRABHU, M.D.



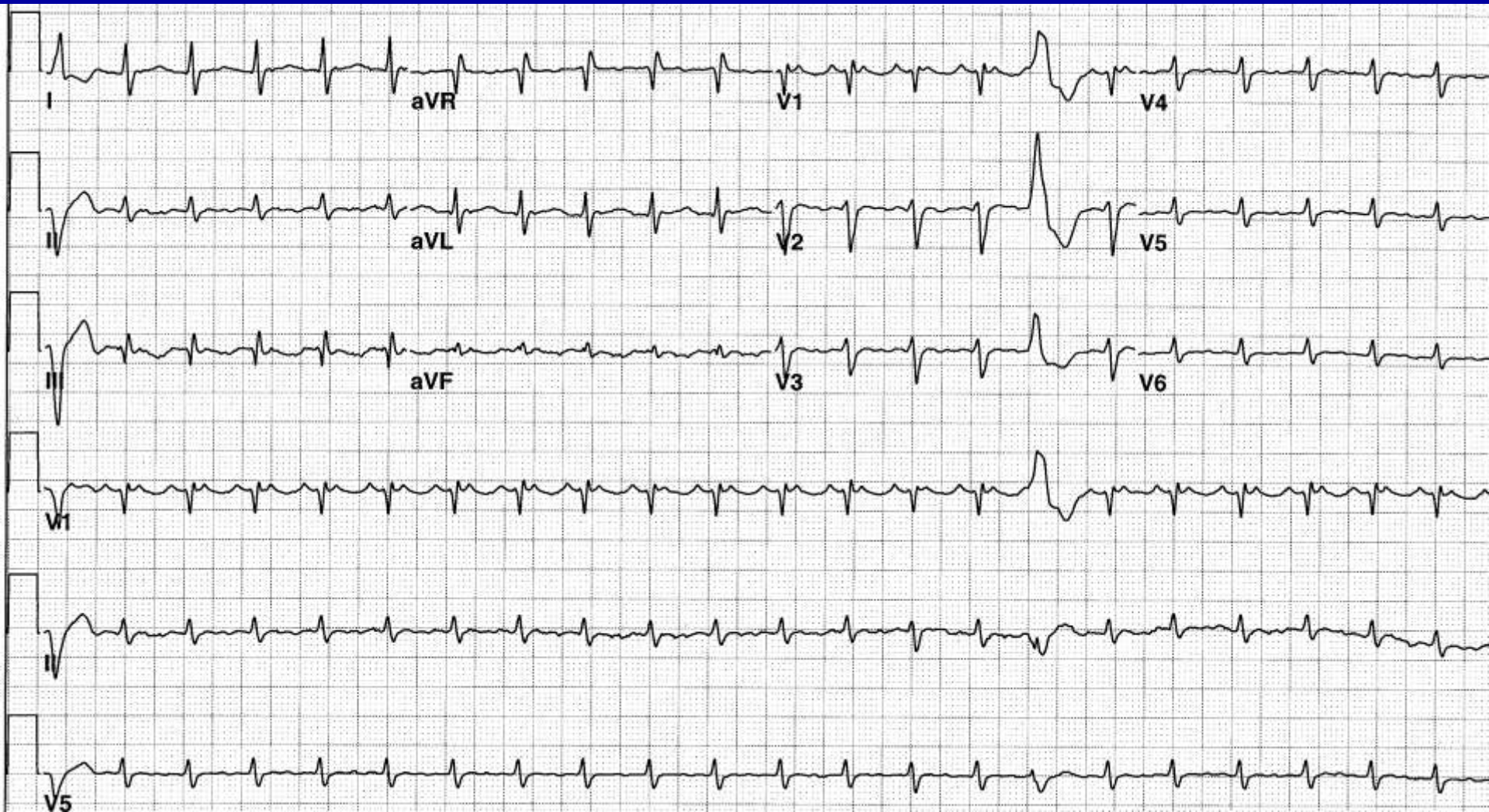
25mm/s 10mm/mV 40Hz 005B 12SL 250 CID: 10

EID:18 EDT: 12:58 20-MAY-1998 ORDER:

Page 1 of 1

UHS4666

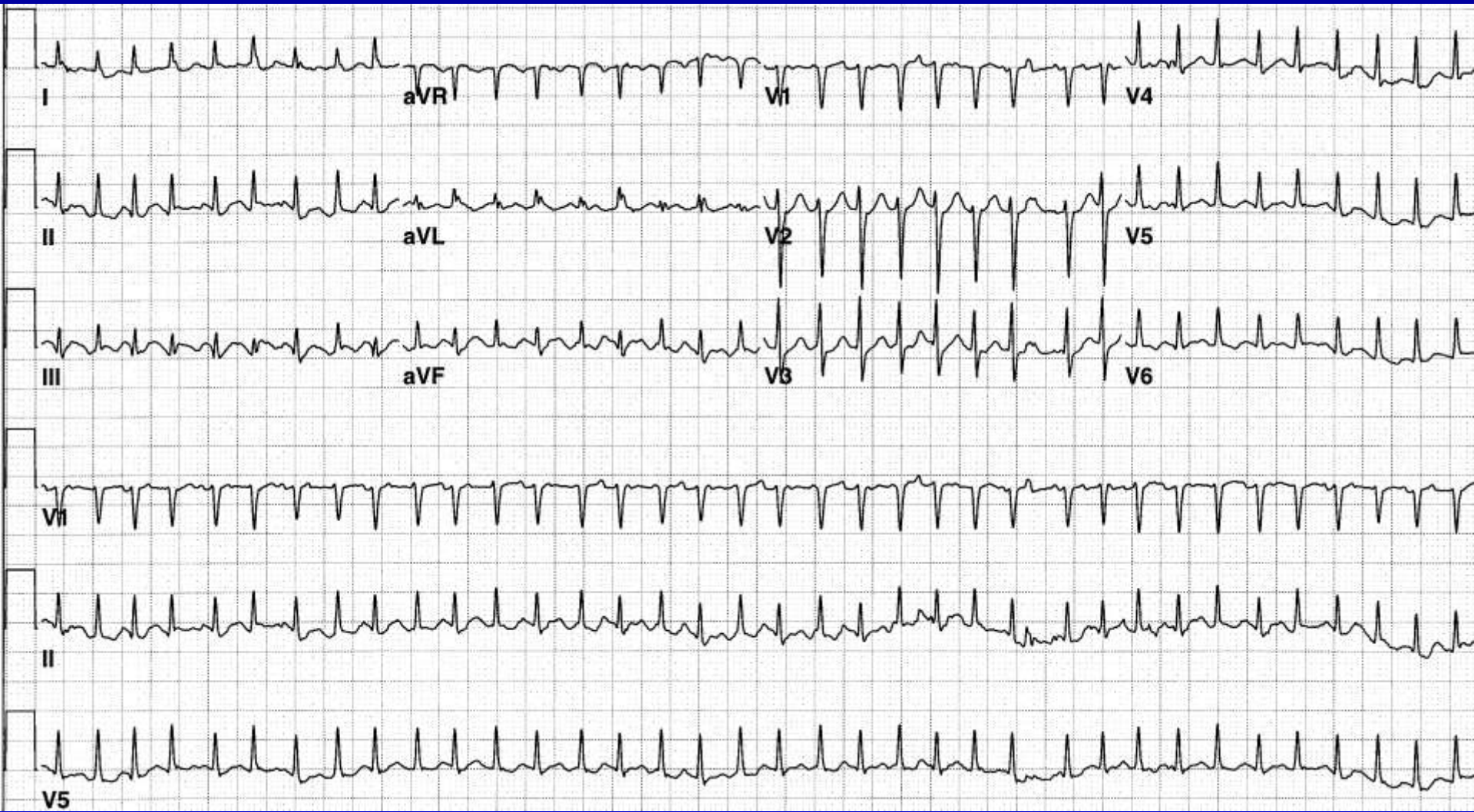
Case 4



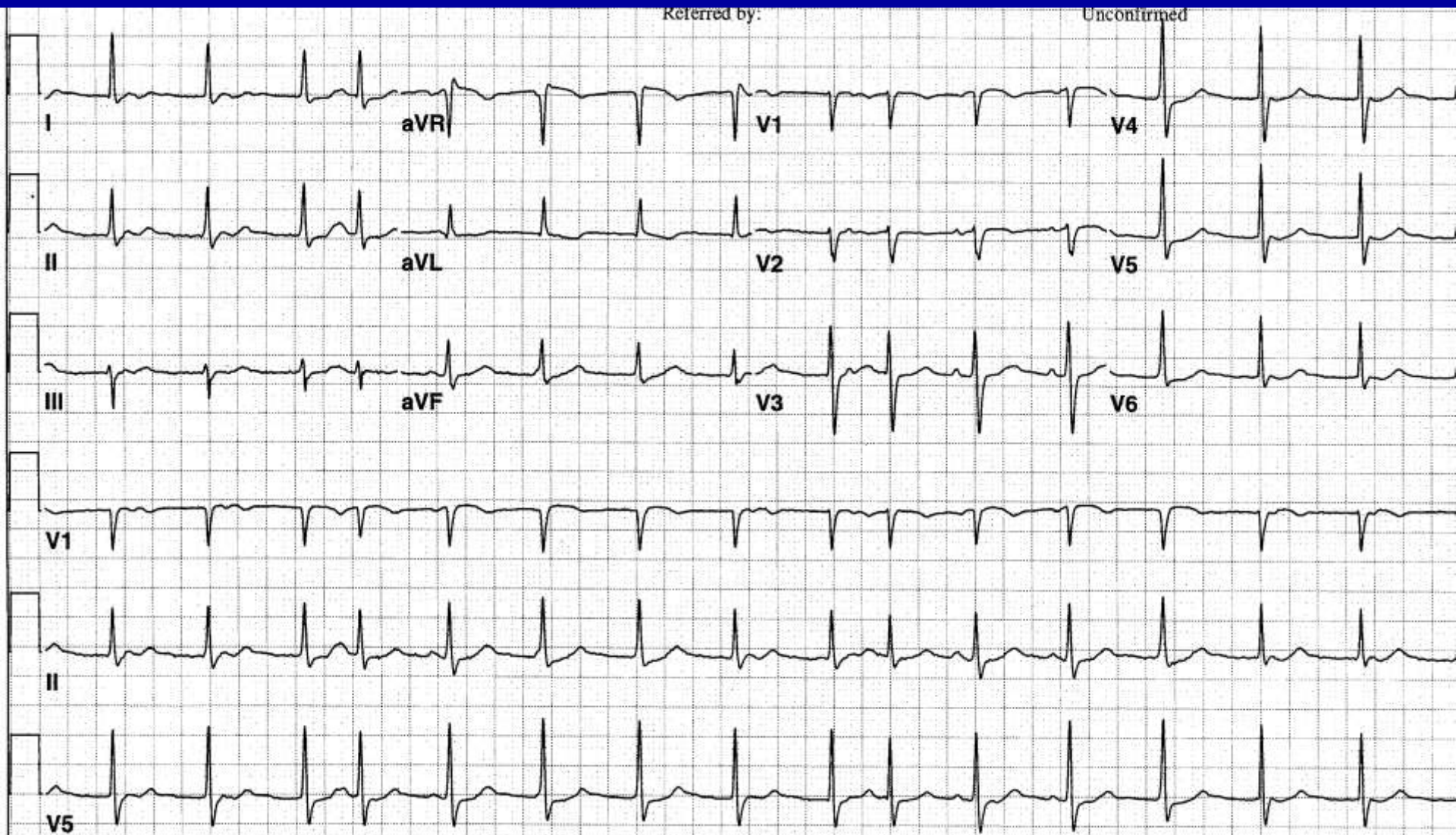
Case 11



Case 13

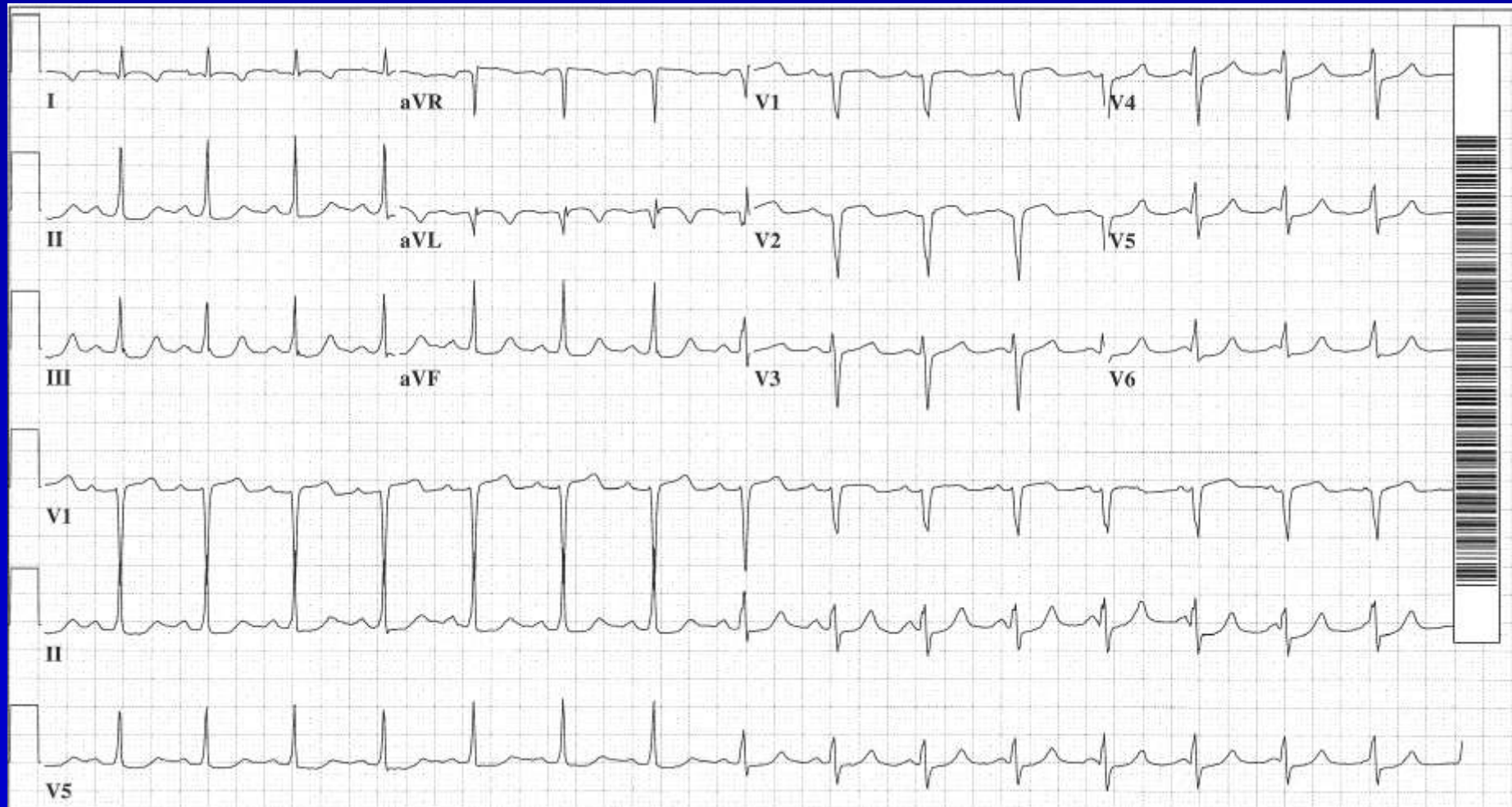


Case 18

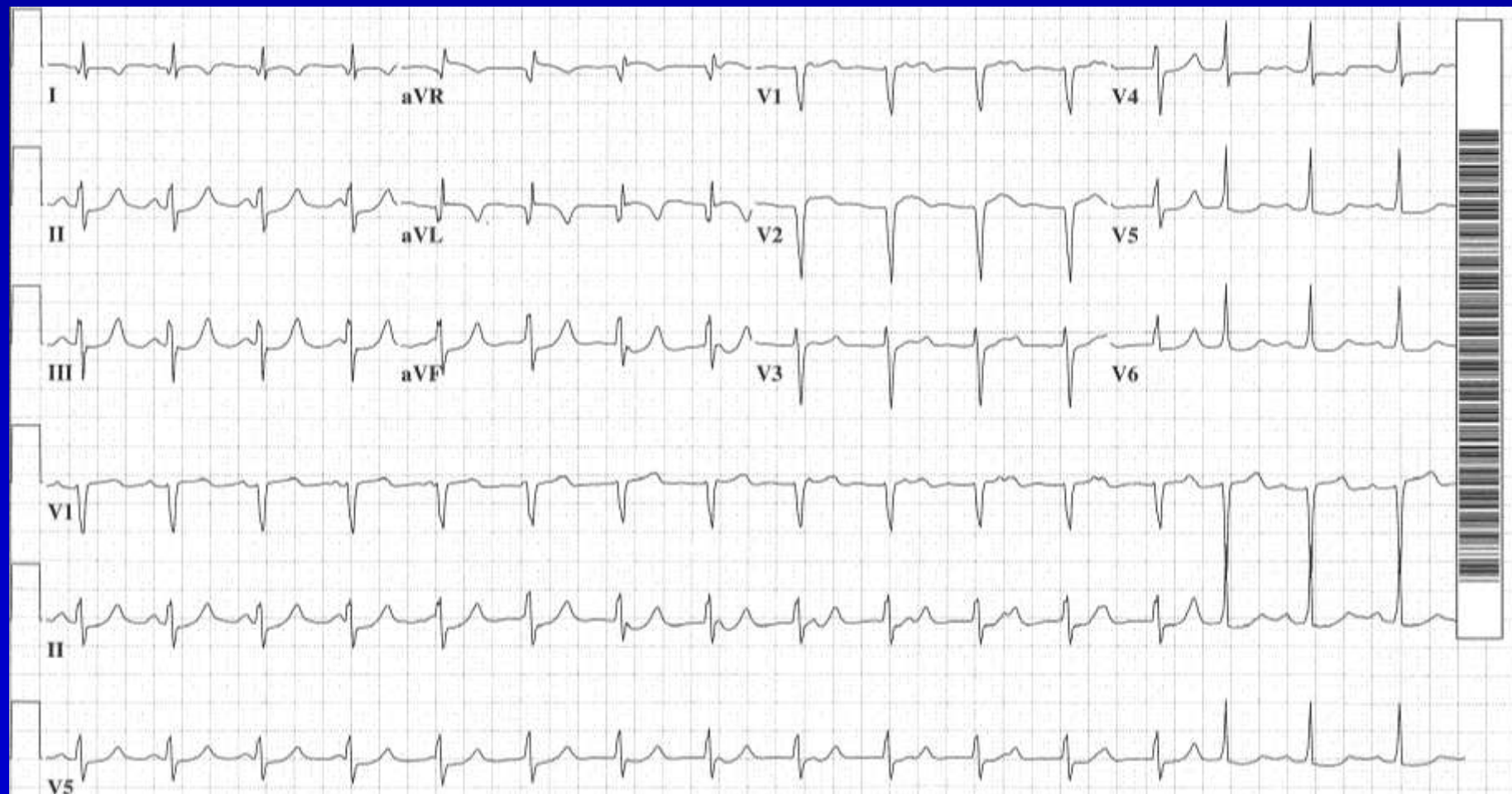


VP 0180 1-16-02, 14:37 1 of 2

Initial, sinus, rate about 95, NSST, lat MI
Later, accel ventric rhythm with AV diss

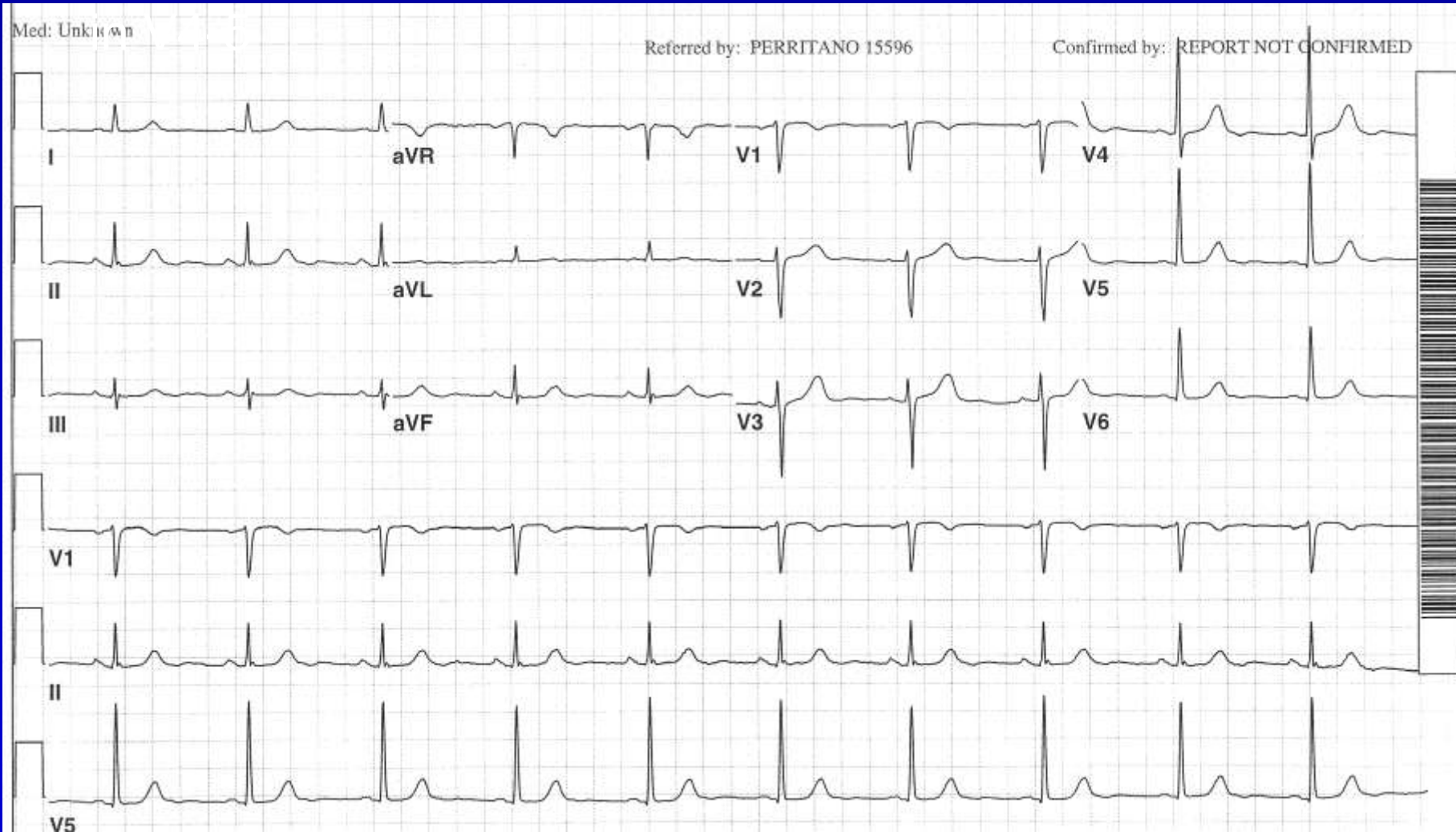


VP 0180 1-16-02, 14:45 2 of 2

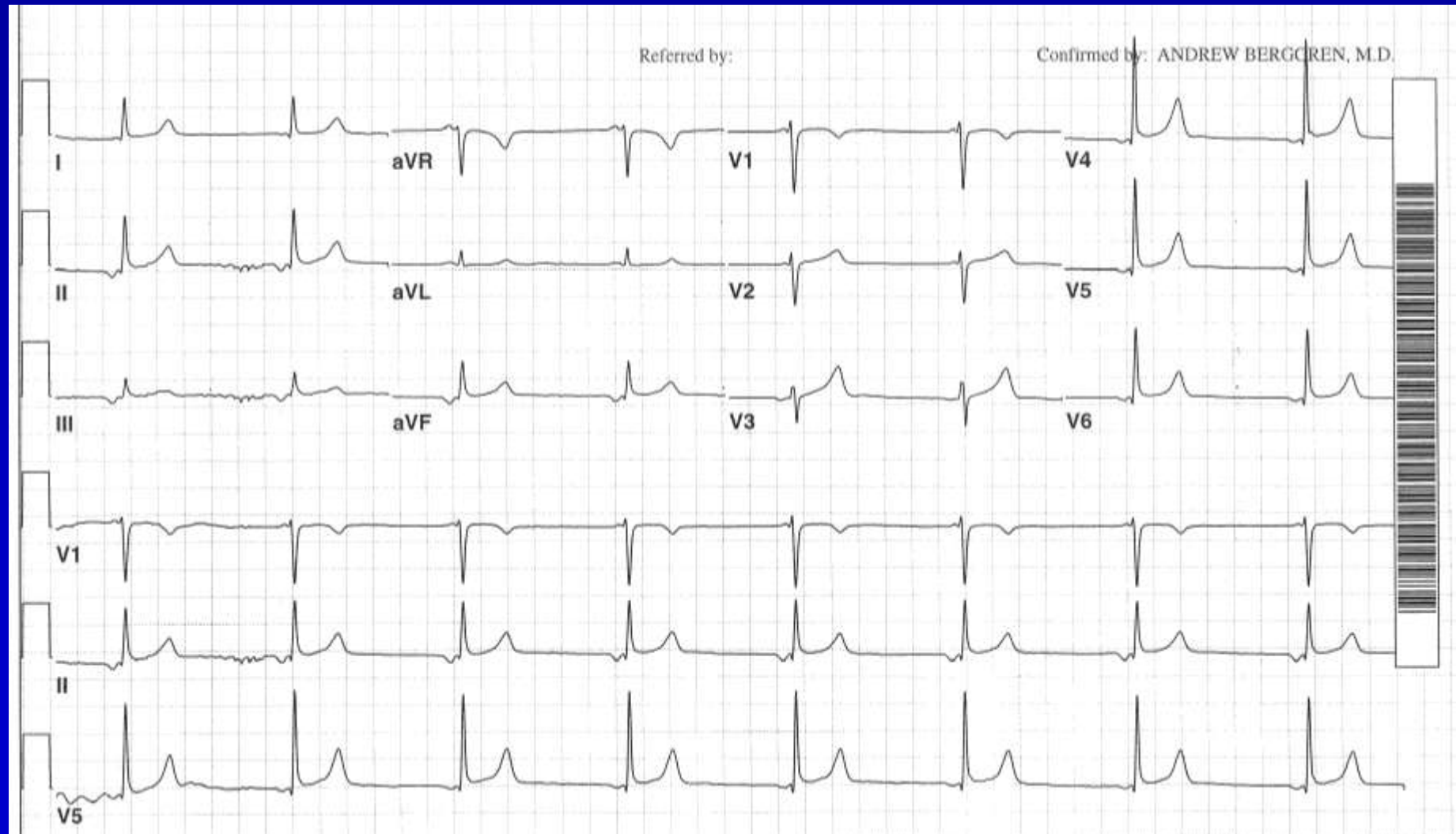


UE0561 10-15-99 08:54 1 of 2

Sinus rate about 62, normal axis, no hypertrophy or infarction, normal T wave, but abnormal U wave

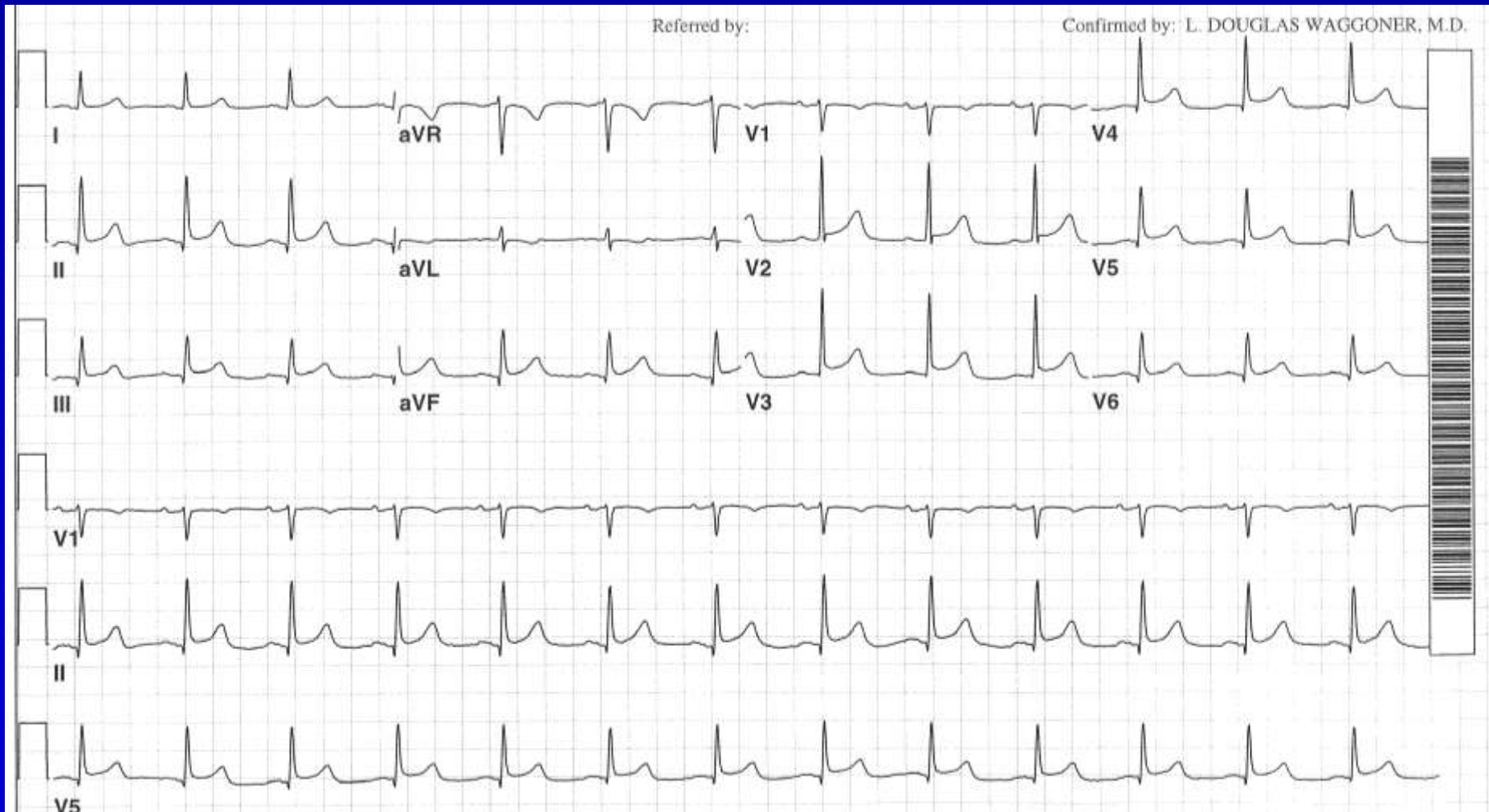


UQ5018 9-26-02 12:47 1 of 3



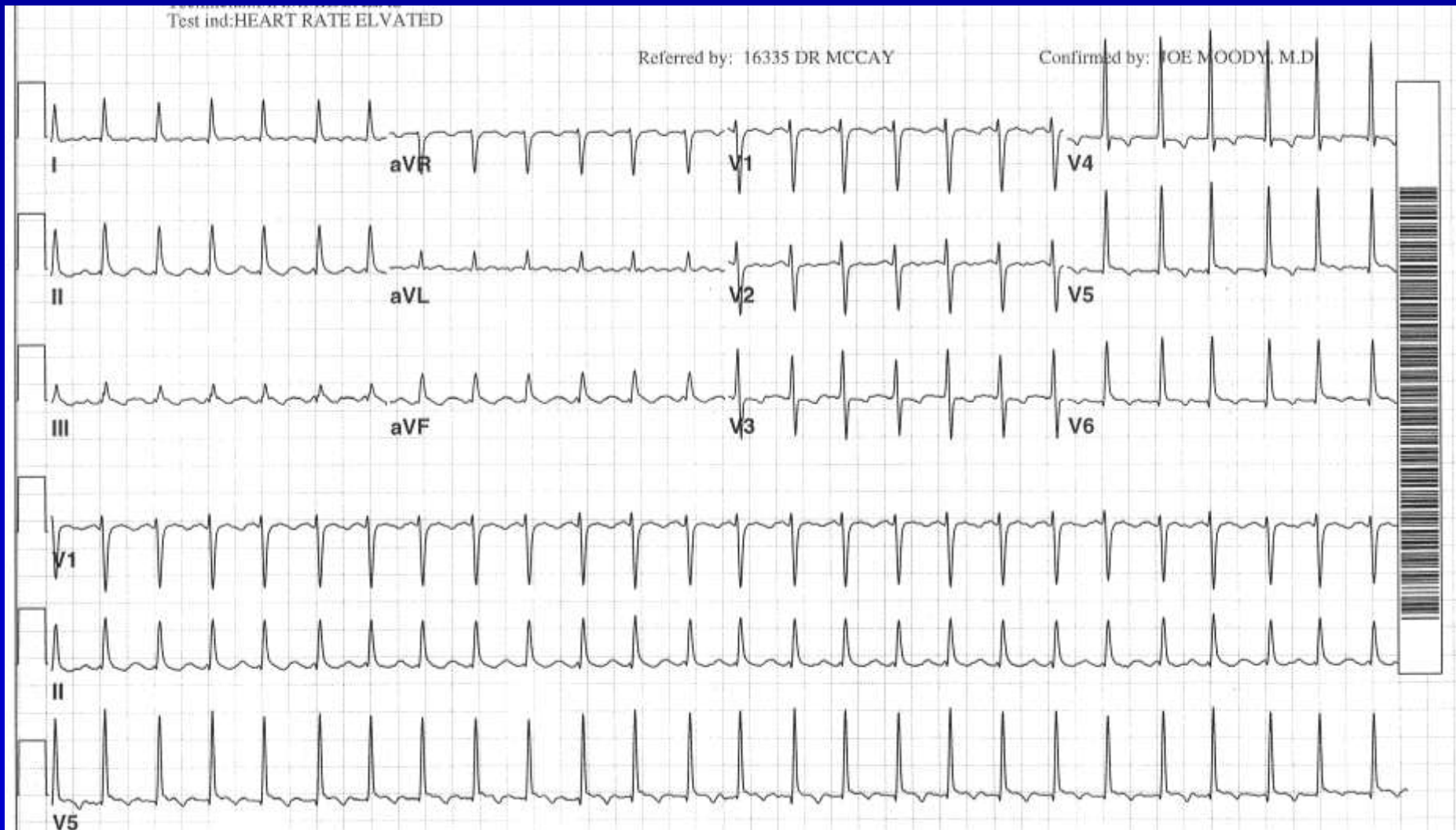
UQ5018 9-27-02 21:58

2 of 3

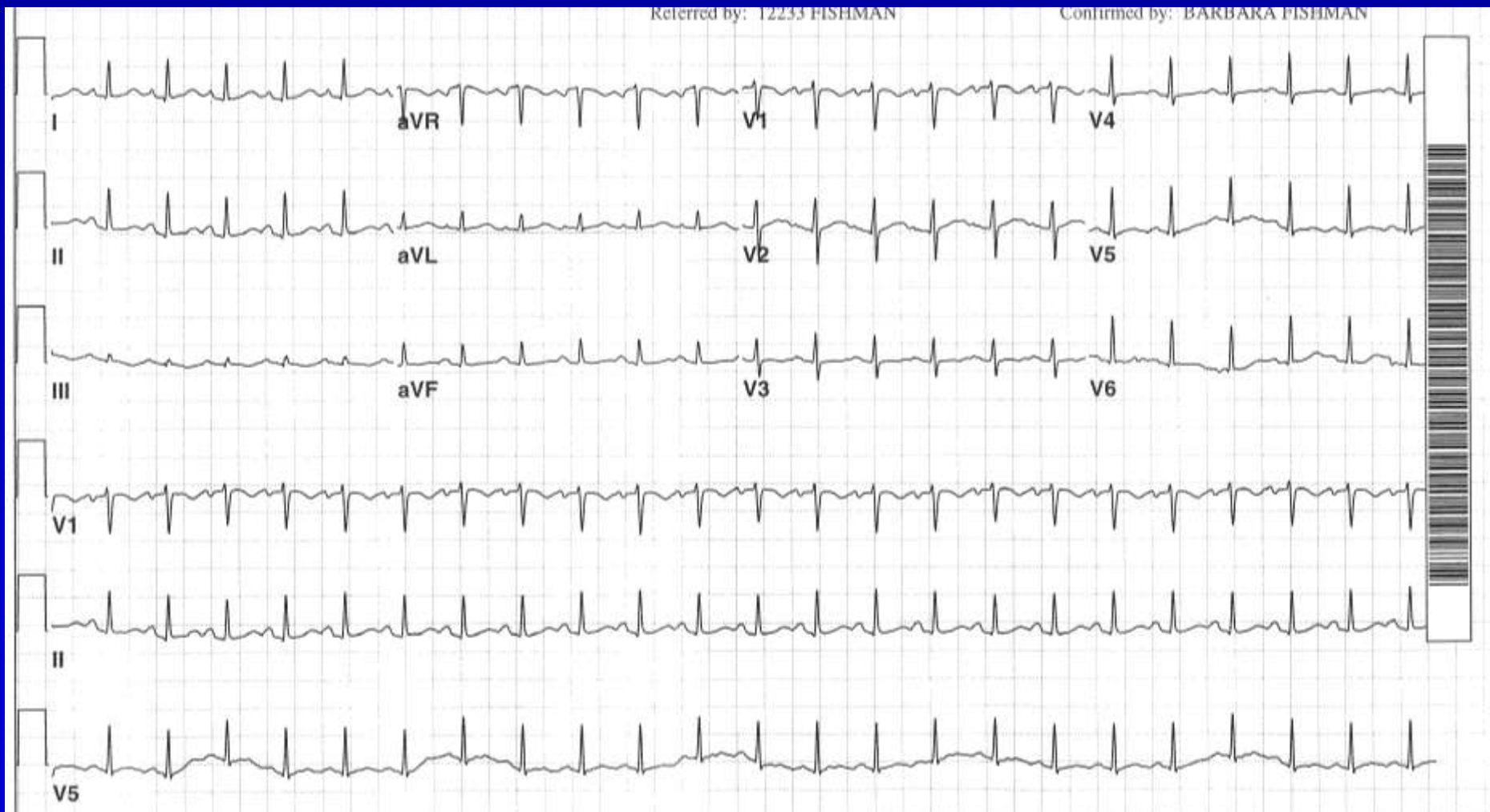


UQ5018 10-08-02 09:51 3 of 3

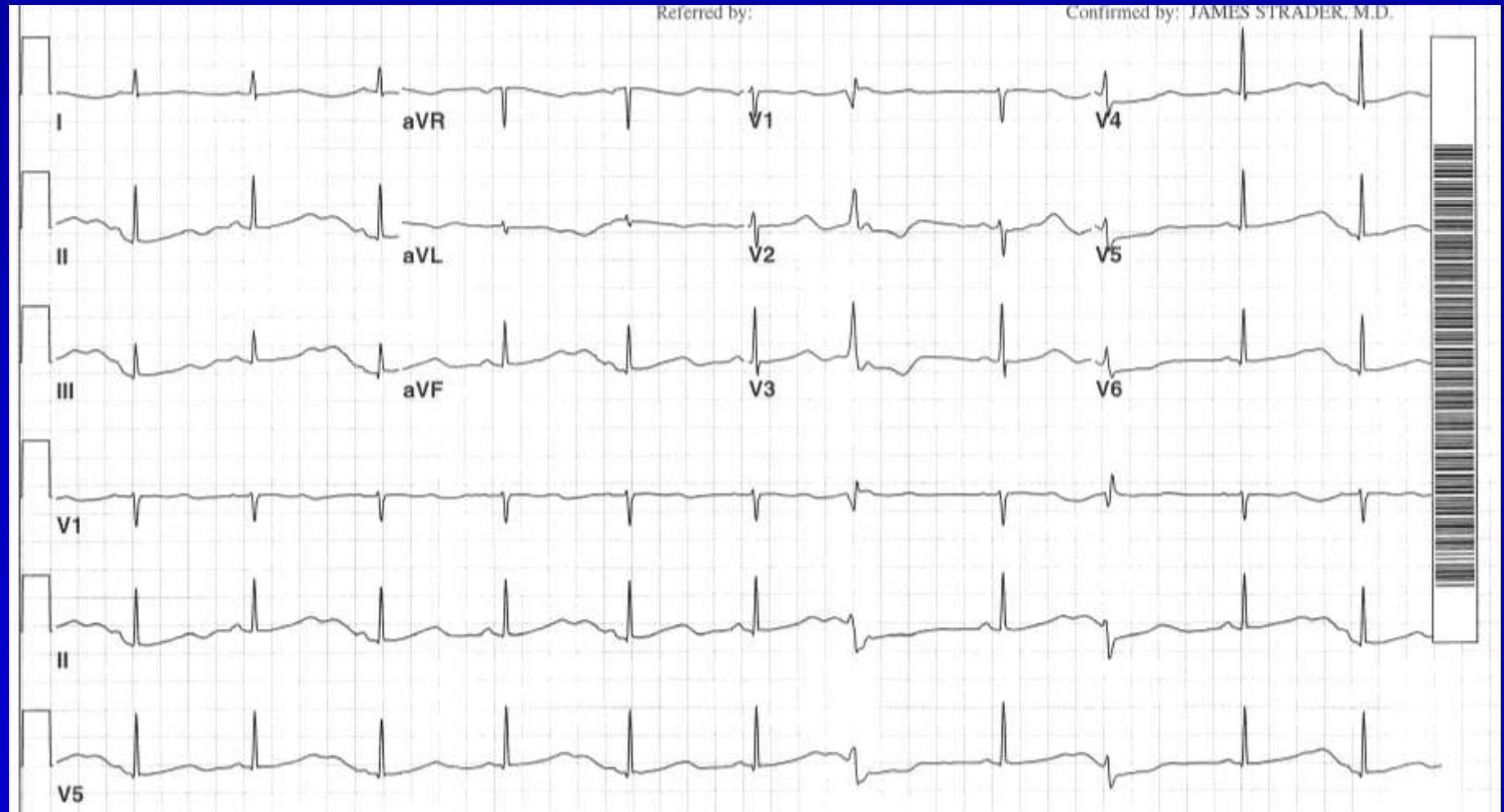
Atrial flutter with
variable AV block



US0149 10-03-02 21:16 1 of 7 baseline



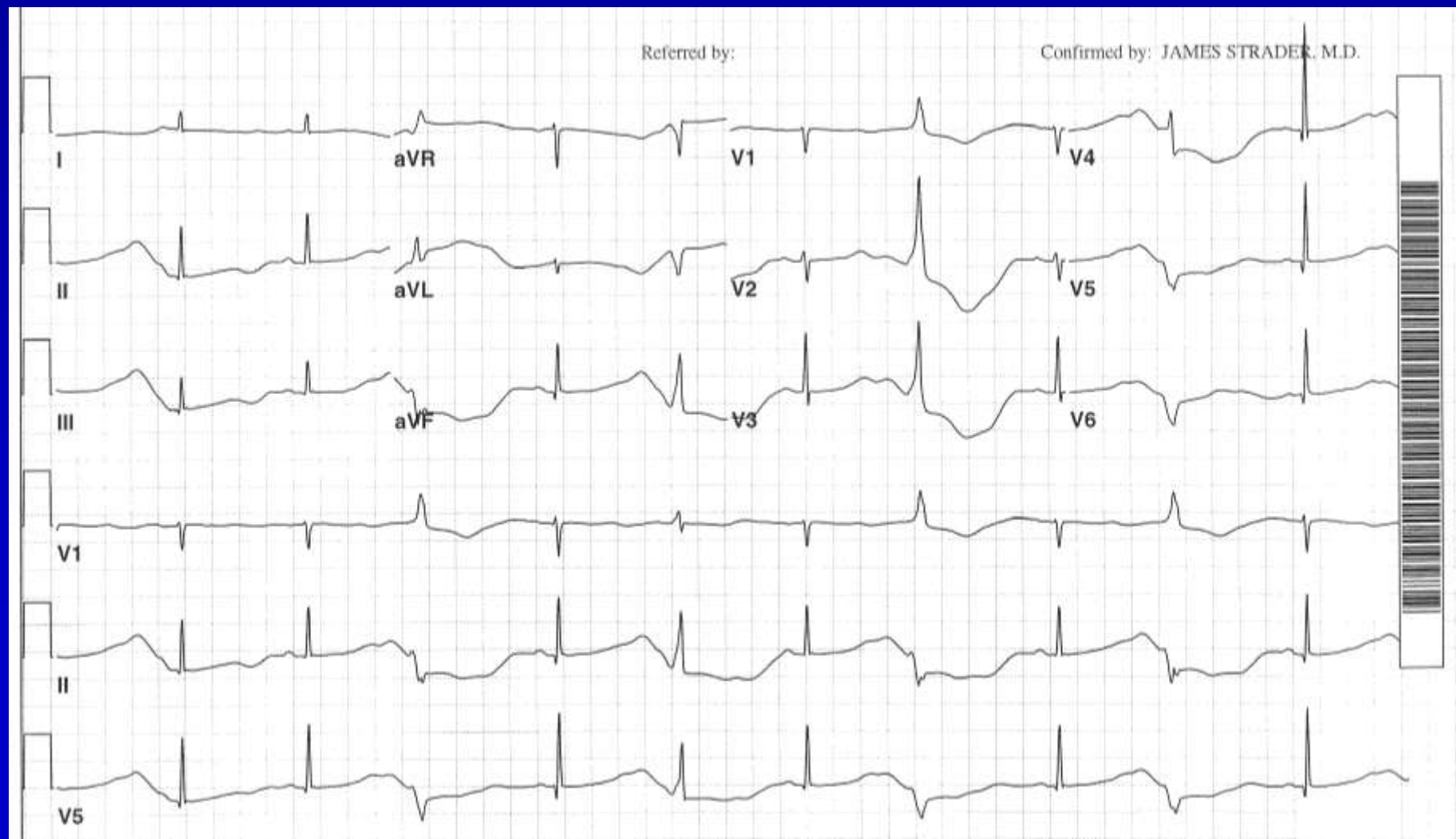
US0149 10-28-02 15:49 2 of 7



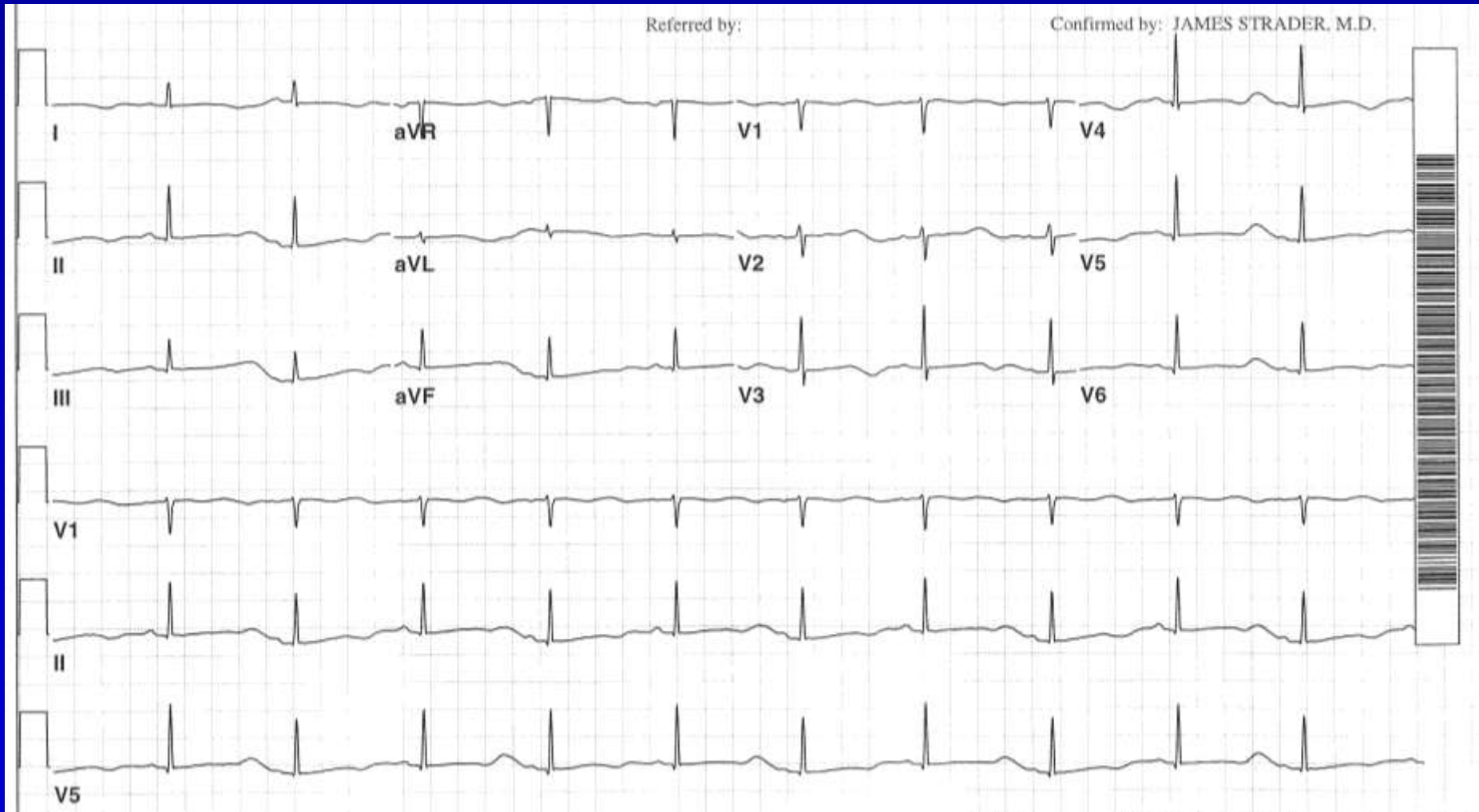
US0149 10-28-02 20:36 3 of 7



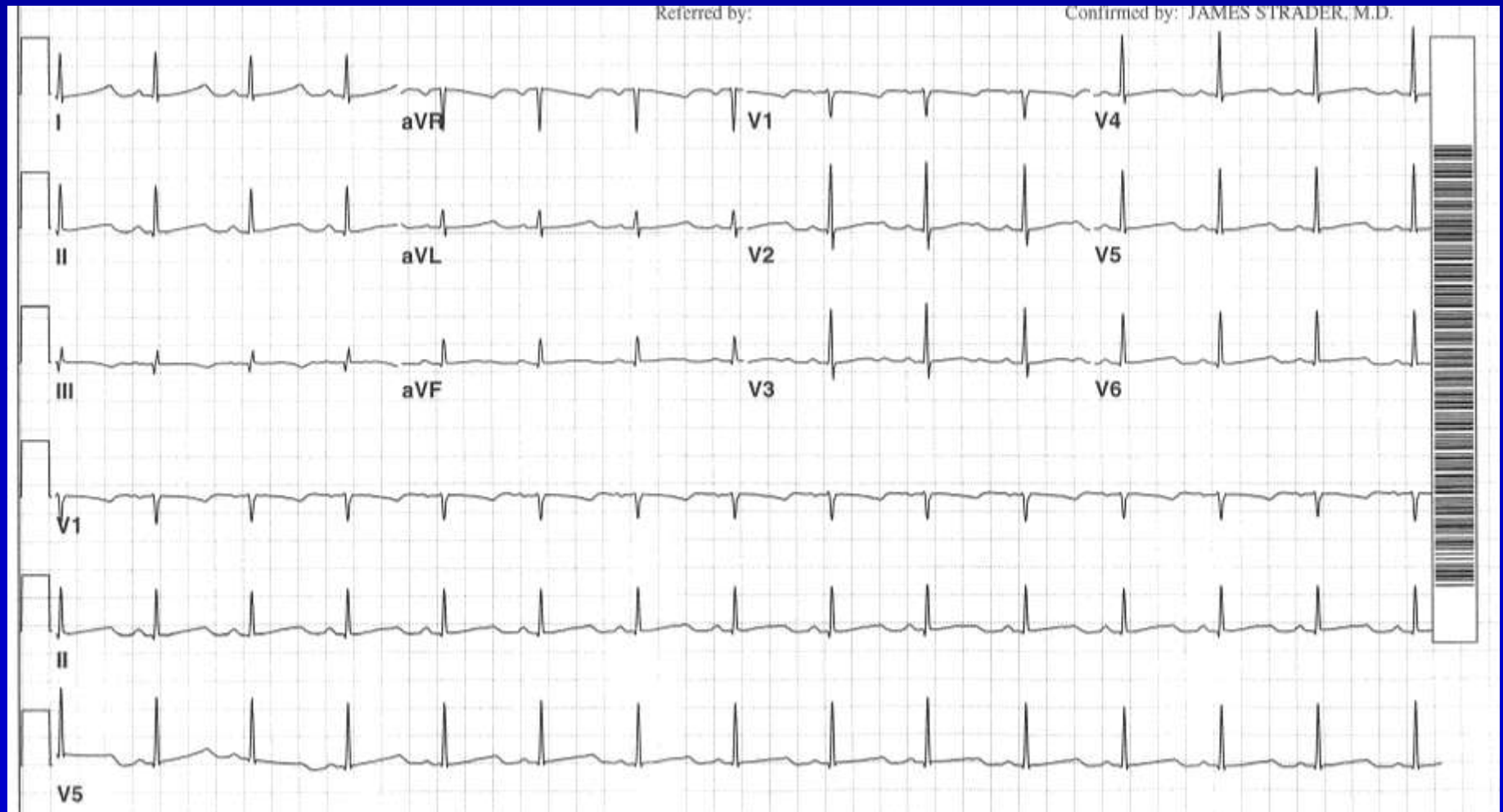
US0149 10-28-02 20:39 4 of 7



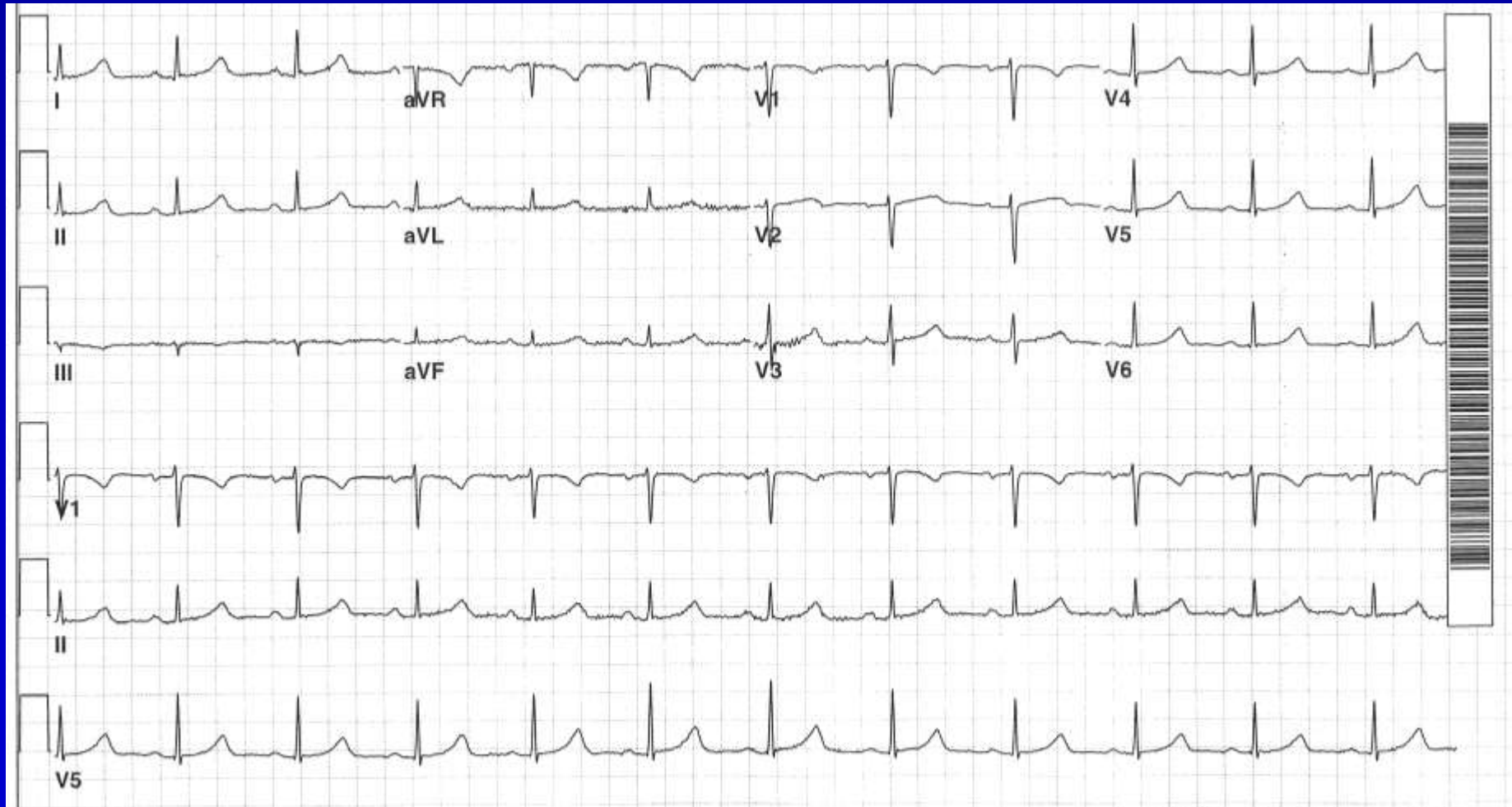
US0149 10-28-02 23:03 5 of 7



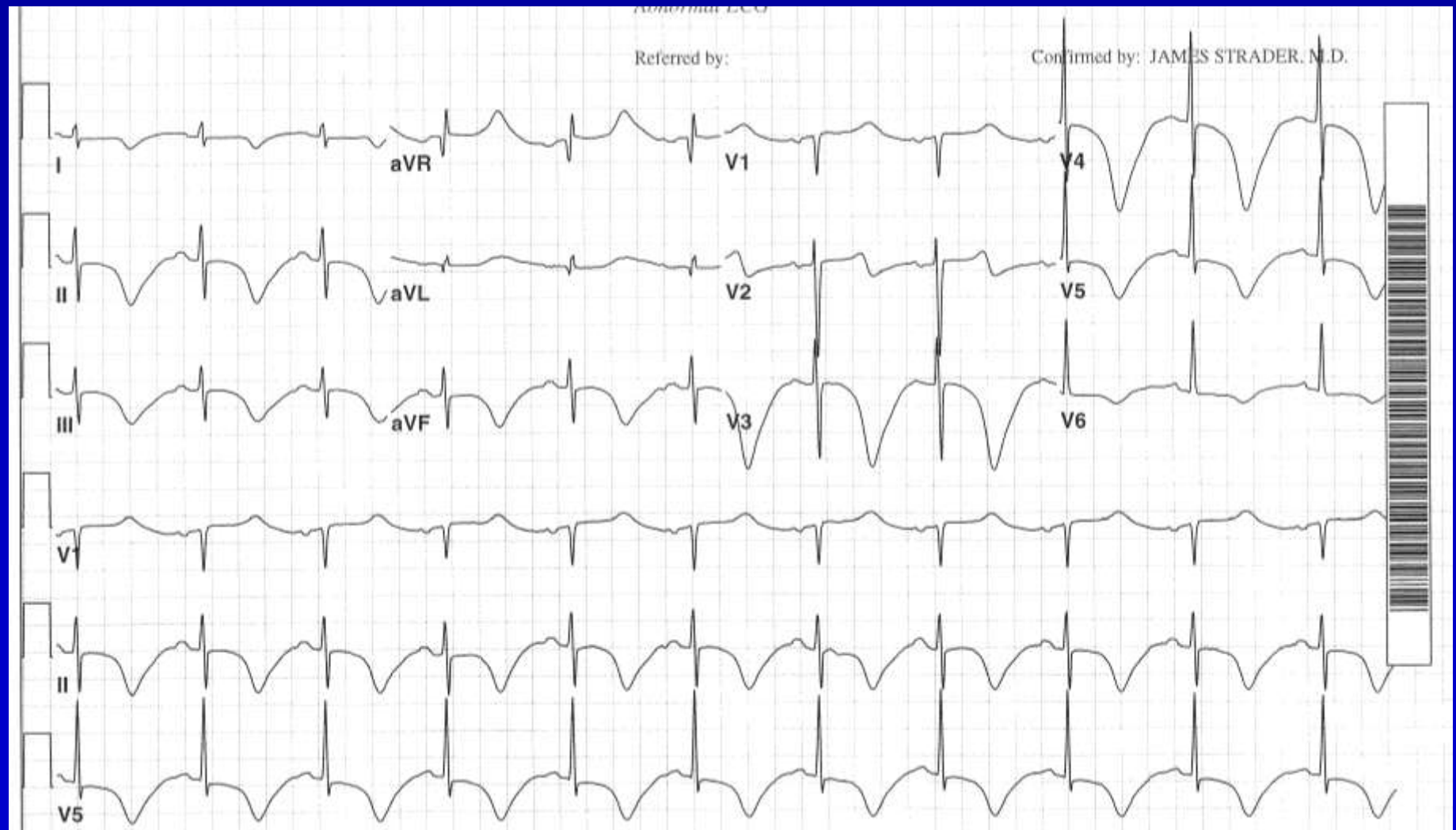
US0149 10-31-02 00:22 6 of 7



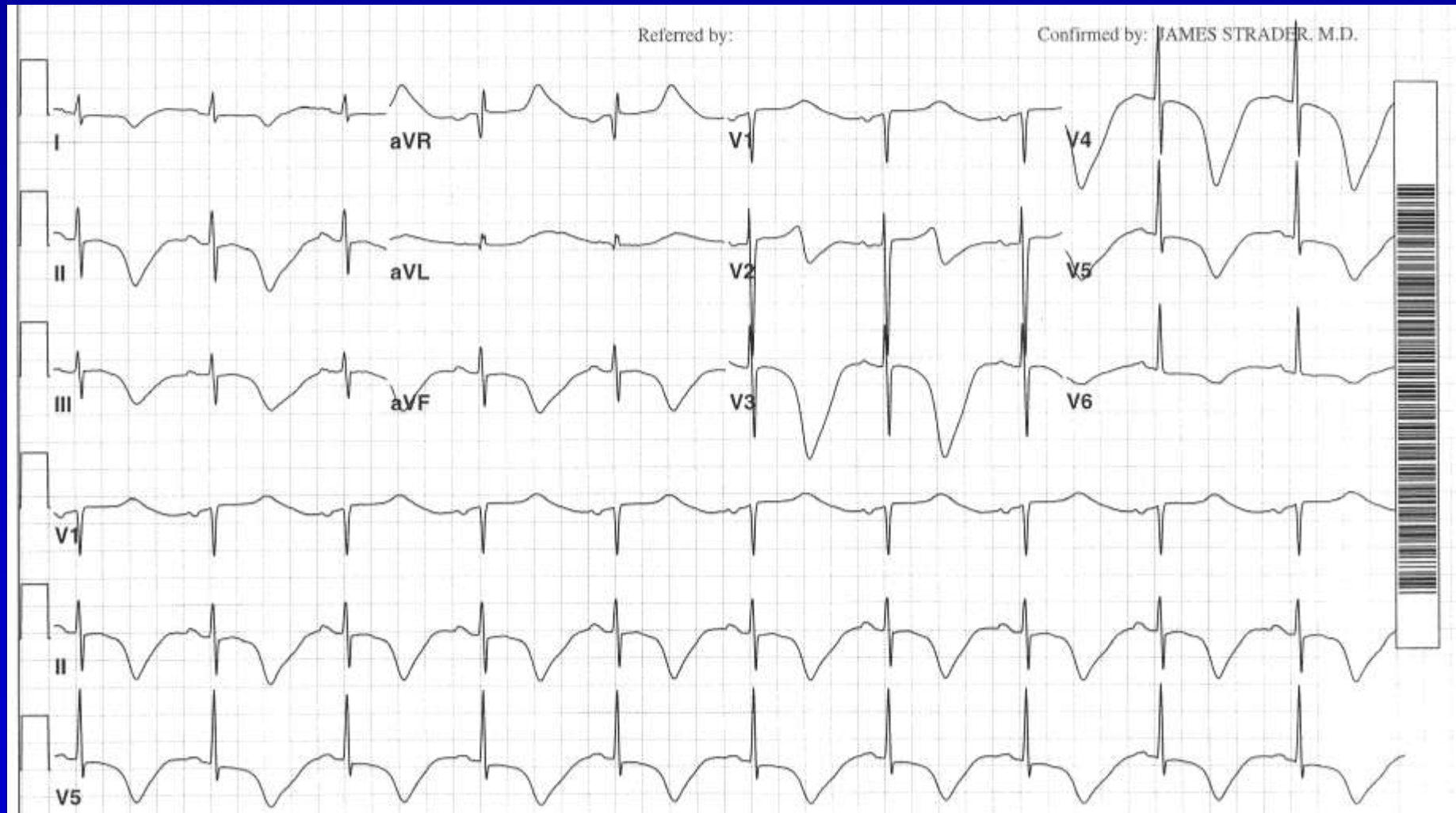
US0149 11-14-04 10:42 7 of 7



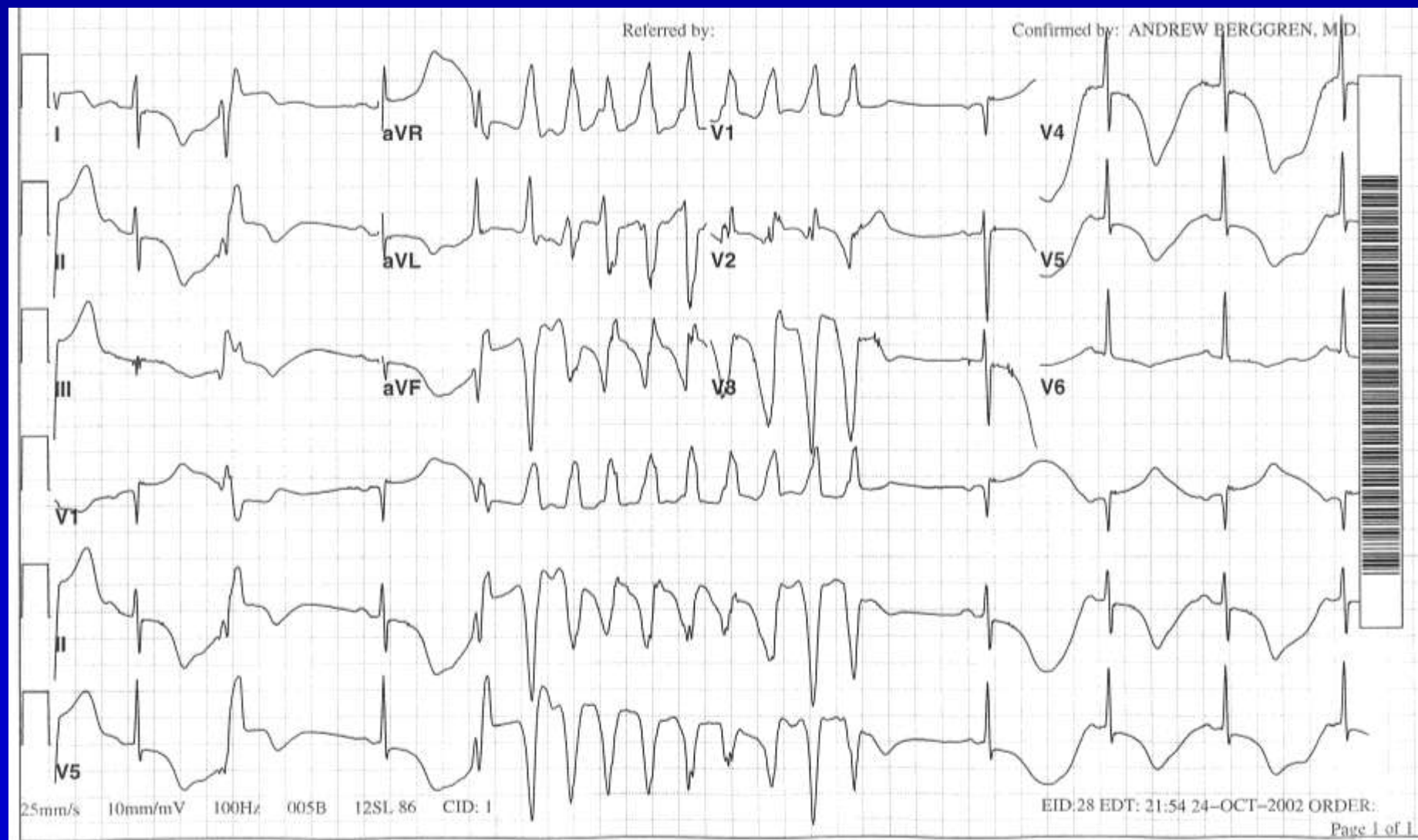
UR5578 10-16-02 06:58 1 of 4



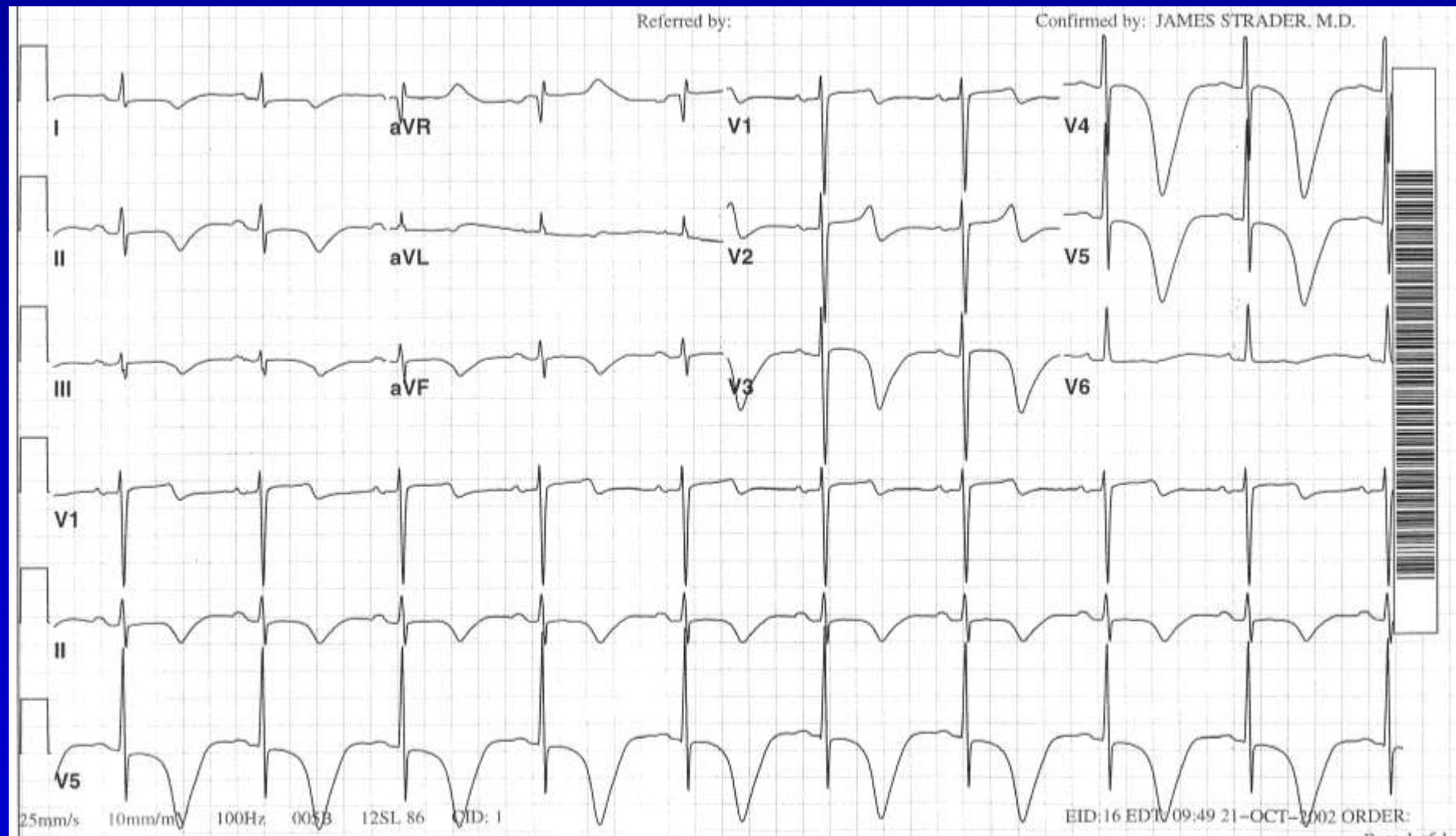
UR5578 10-16-02 09:17 2 of 4



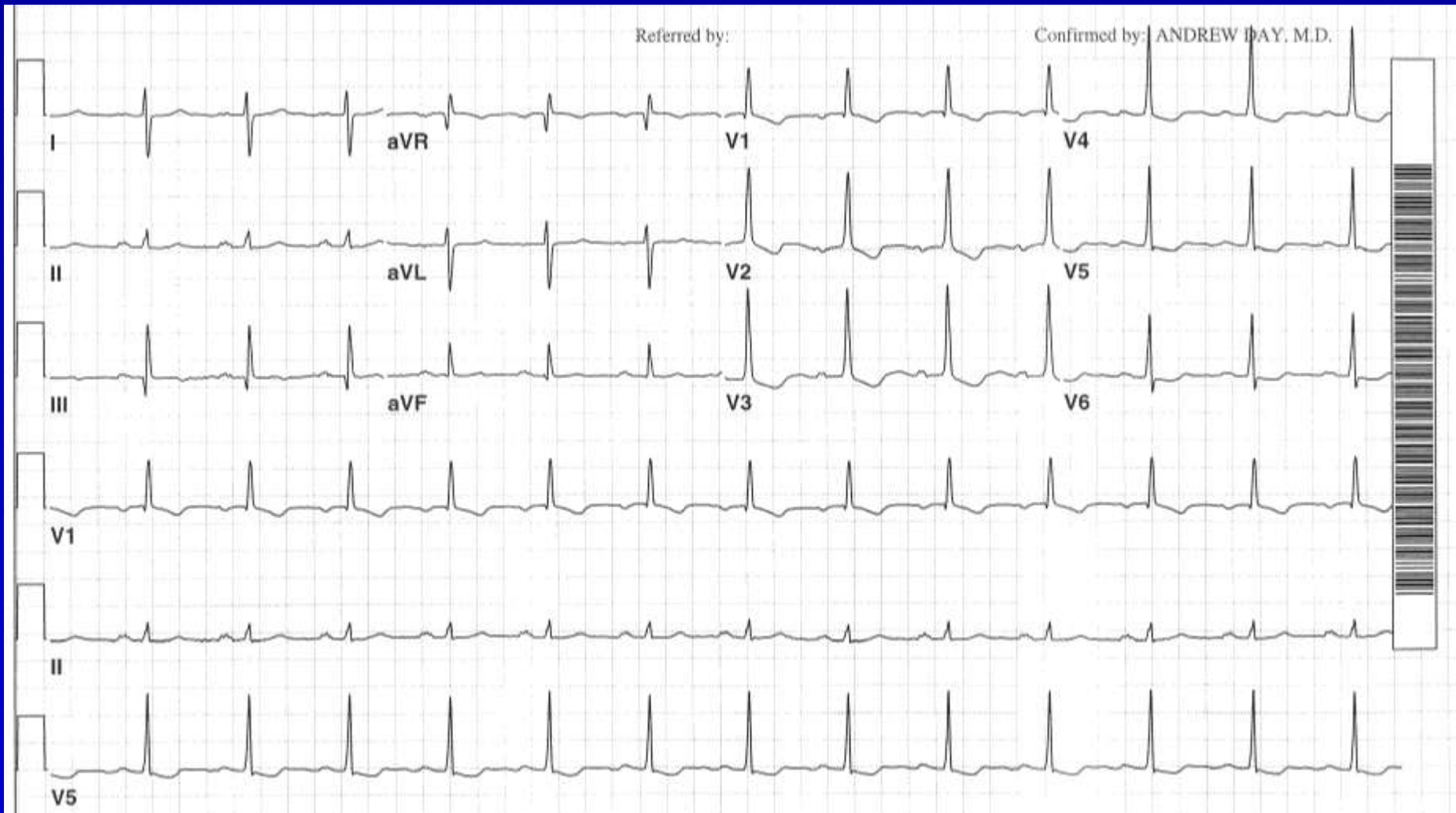
UR5578 10-16-02 11:03 3 of 4



UR5578 10-17-02 05:33 4 of 4



UD8387 12-15-01 10:37 1 of 3 baseline



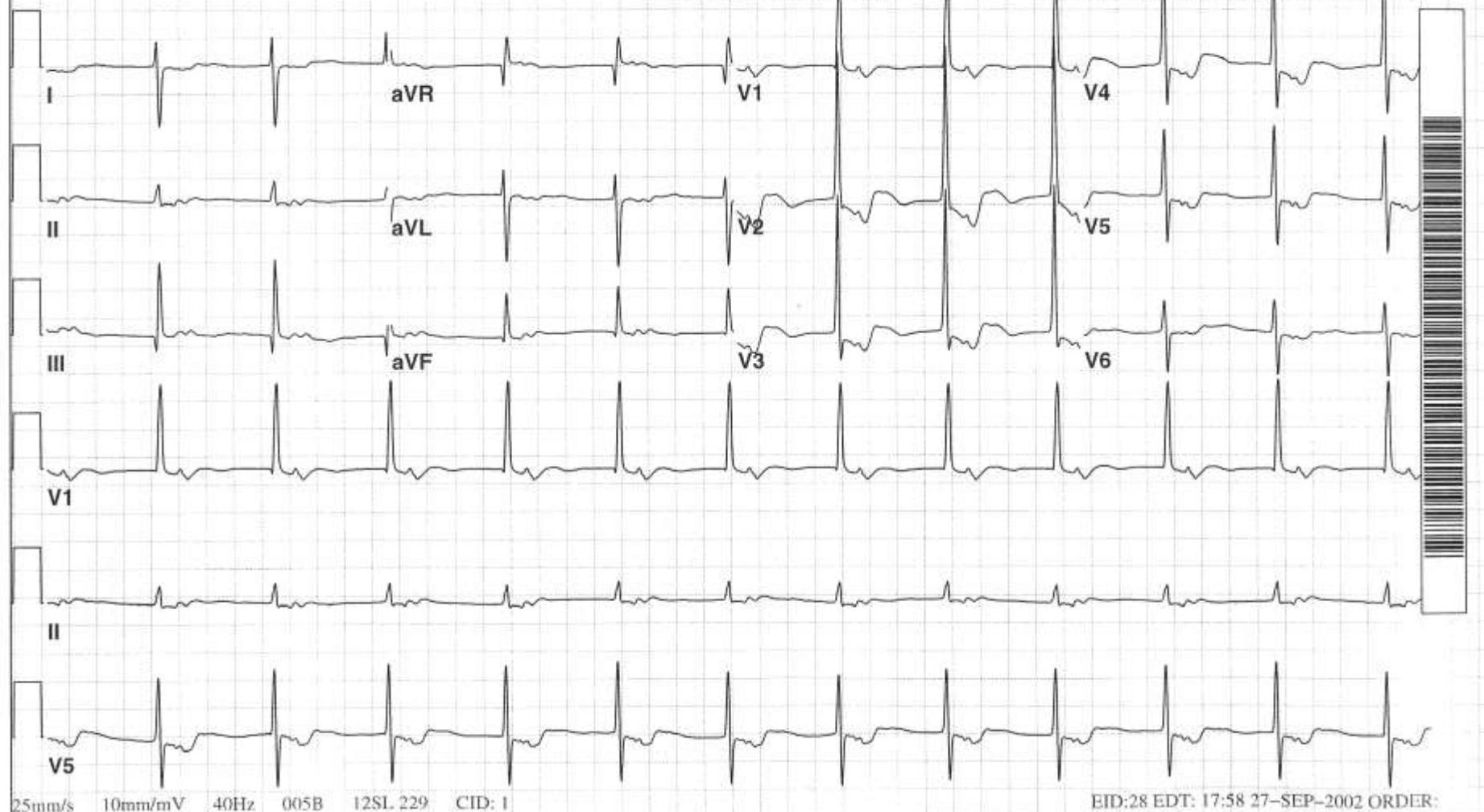
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2 of 3

Test ind: ATRIAL FLUTTER

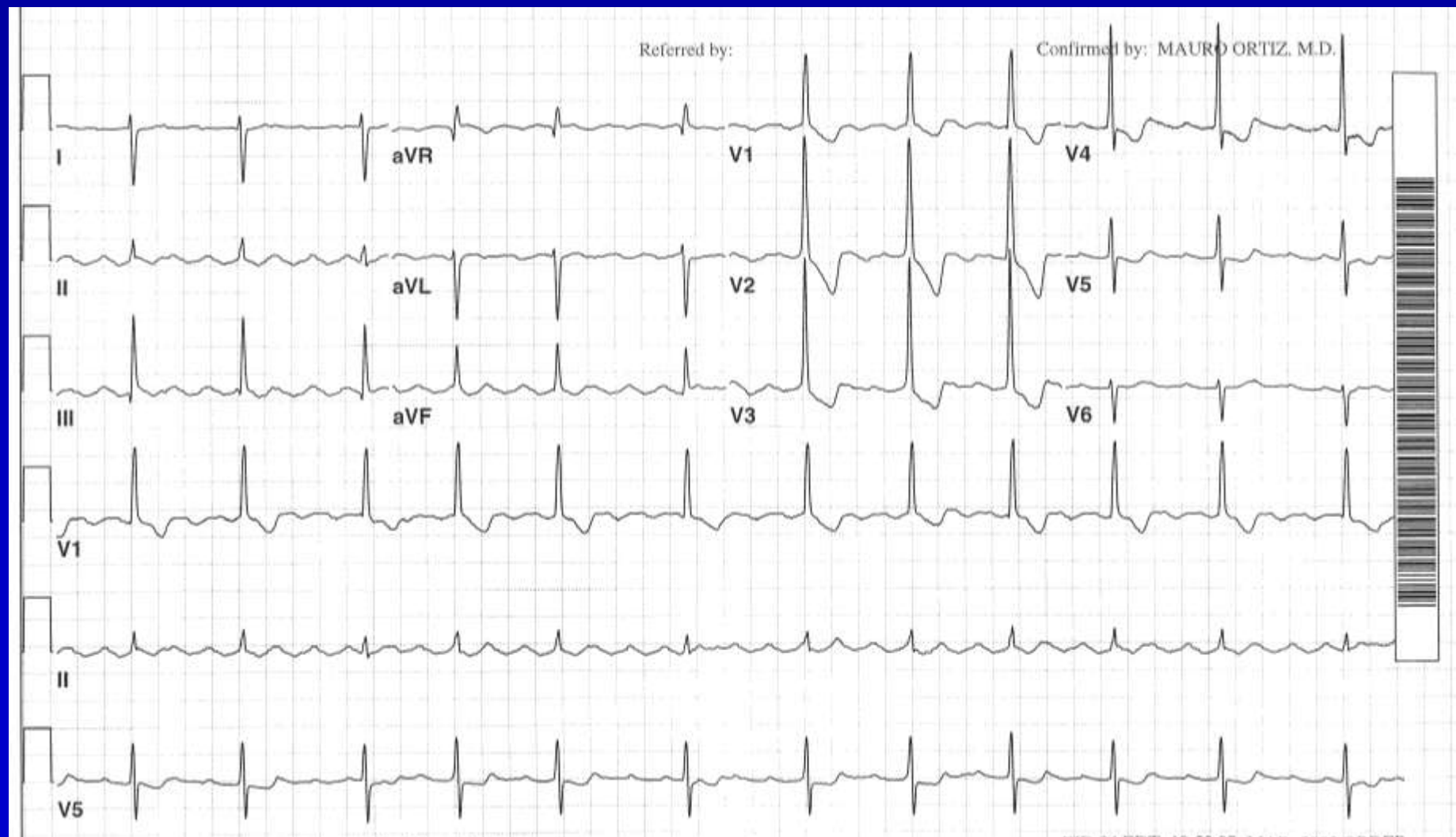
Referred by: 04578 ROGERS

Confirmed by: ANDREW BERGGREN, M.D.



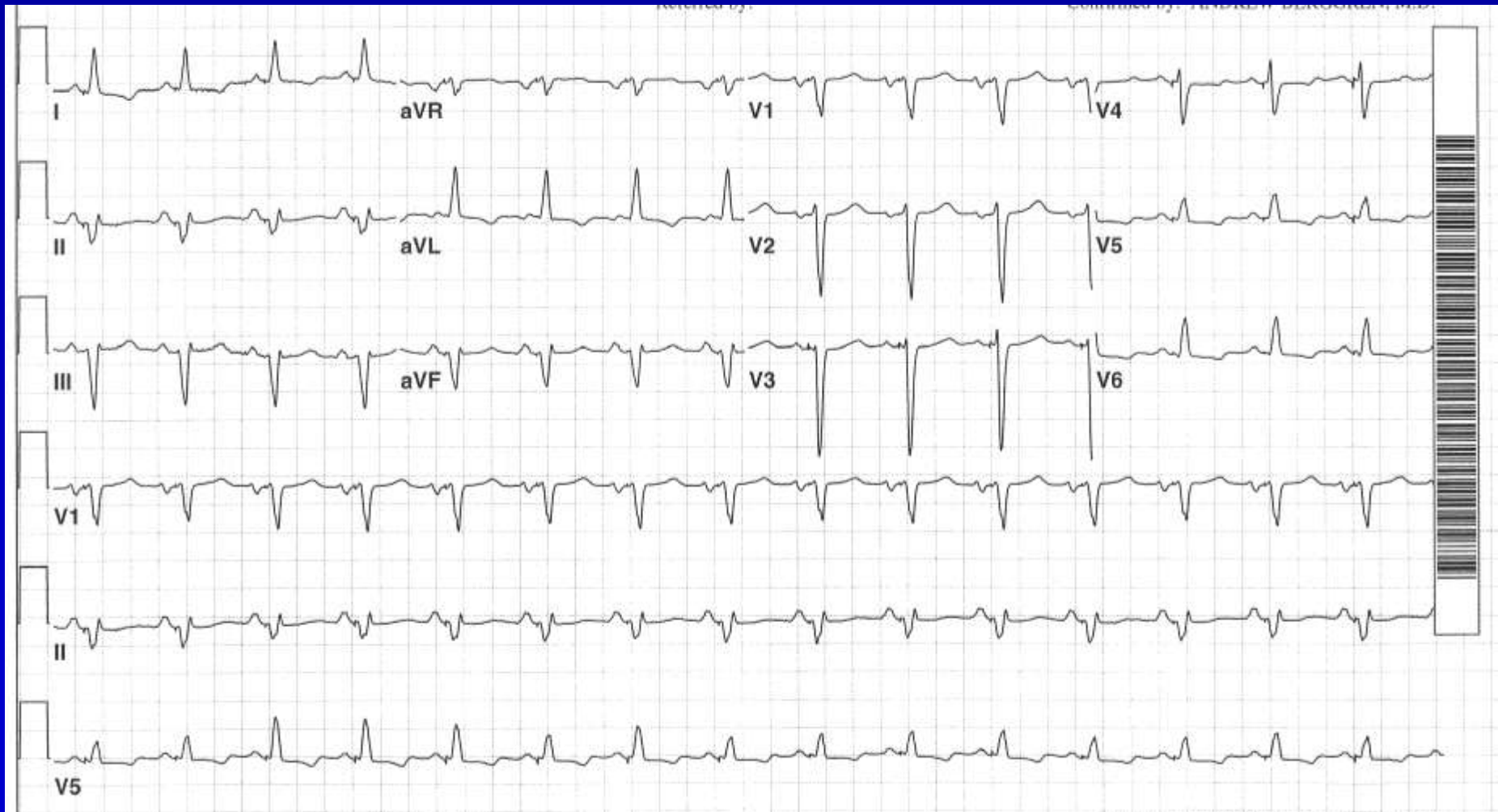
UD8387 3-17-03 06:02

3 of 3



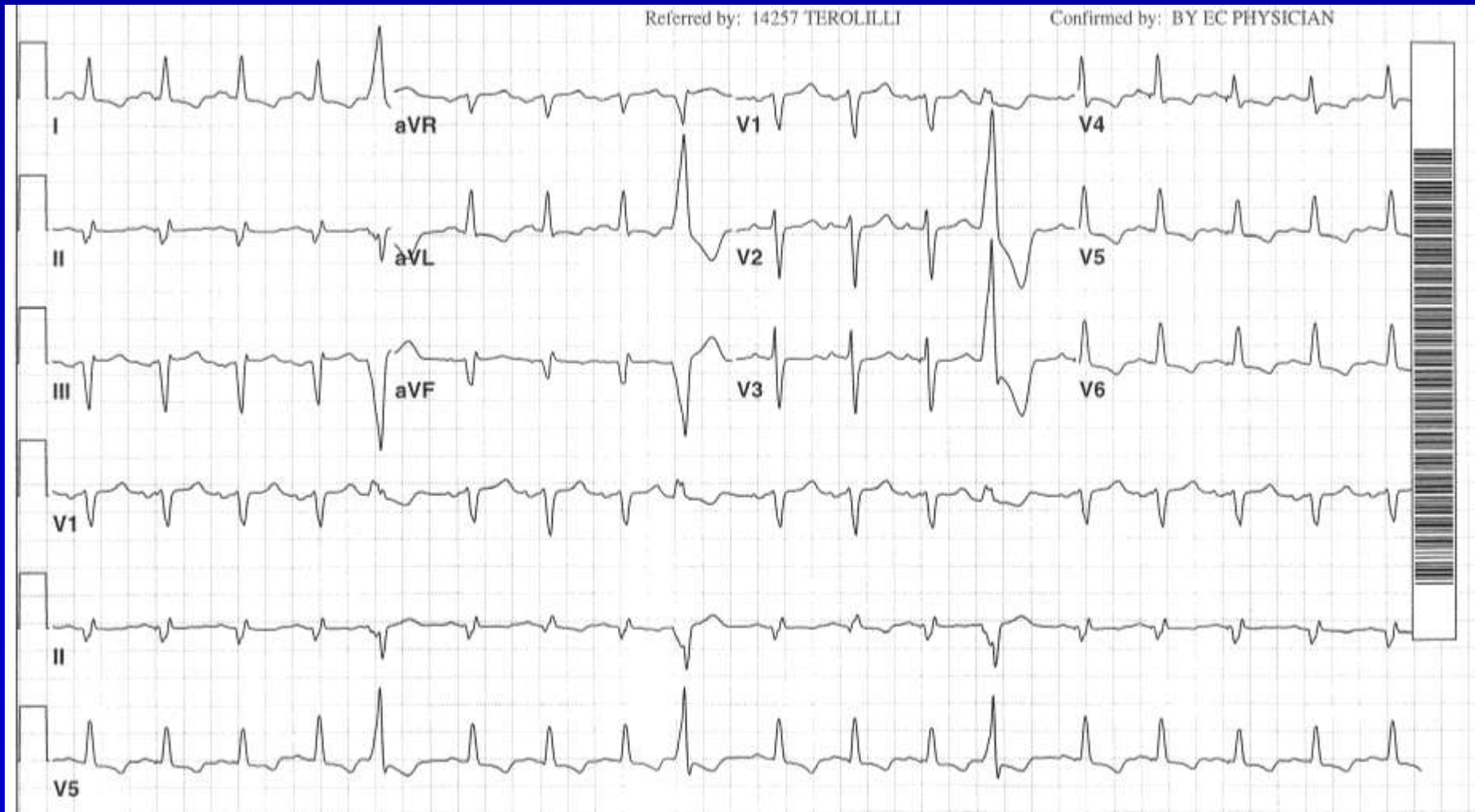
UL4768 7-13-02 05:22

1 of 5 baseline

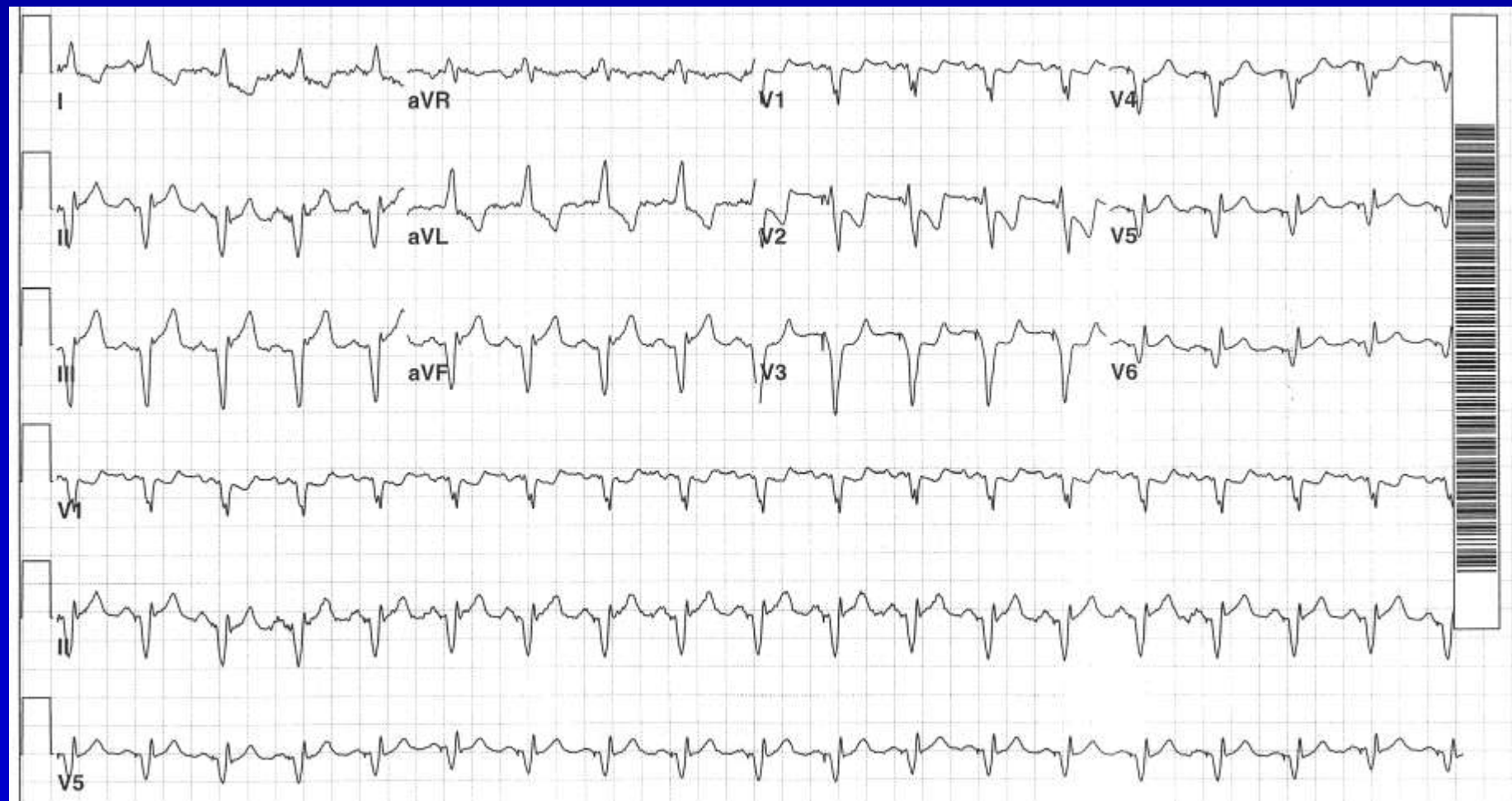


UL4768 8-02-02 19:46

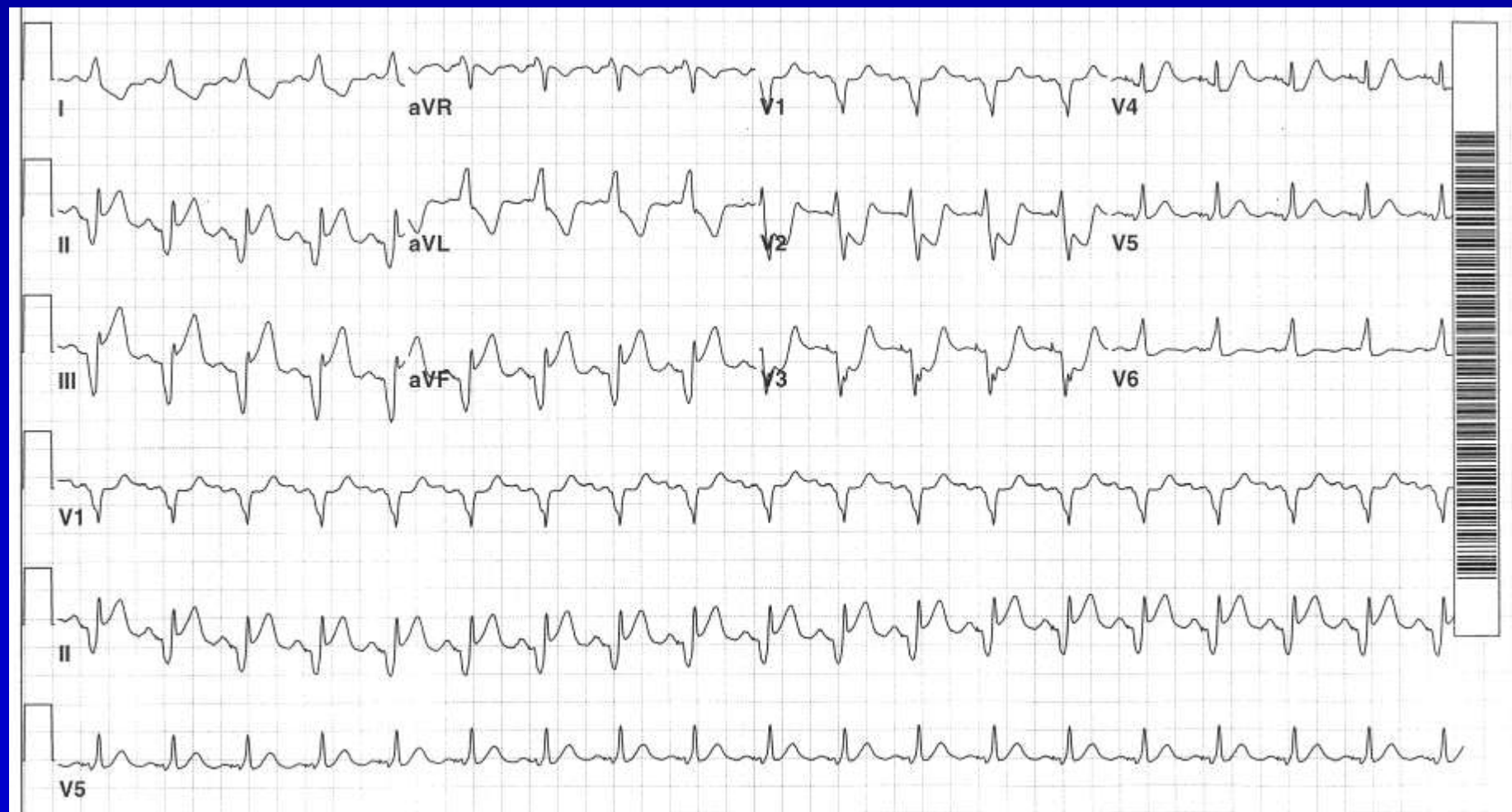
2 of 5



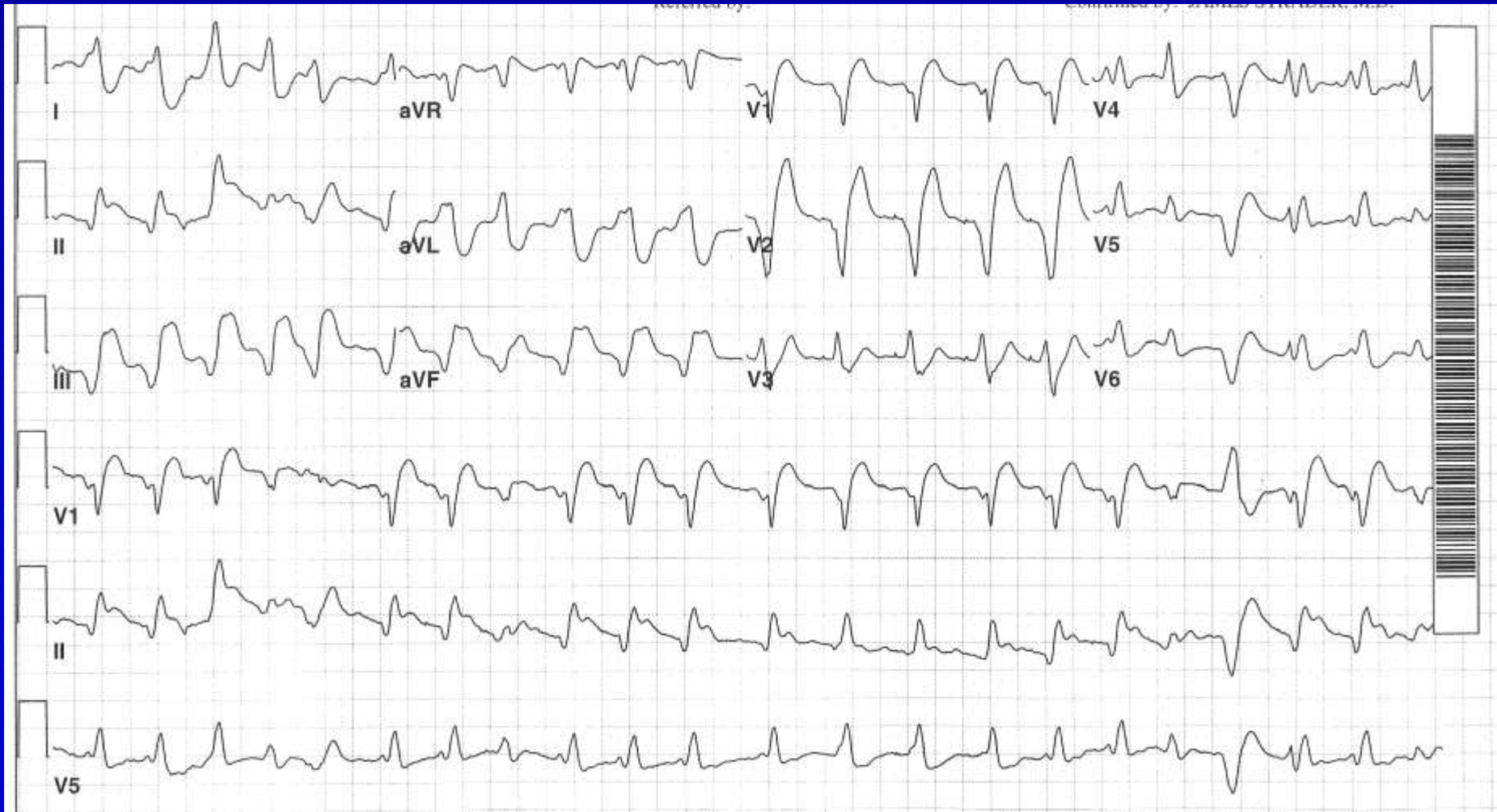
UL4768 11-02-02 05:14 3 of 5



UL4768 11-02-02 11:59 4 of 5

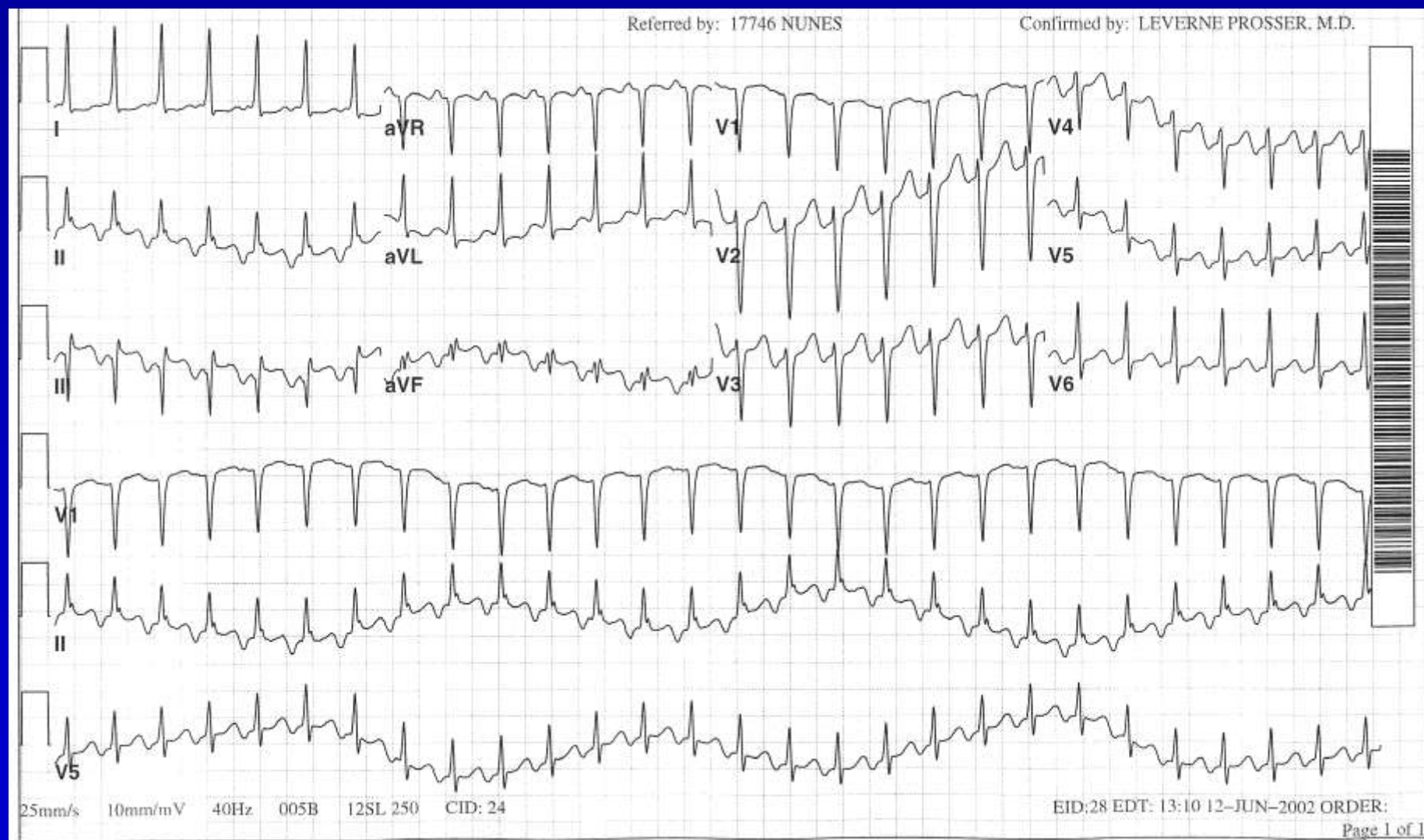


UL4768 11-02-02 20:46 5 of 5



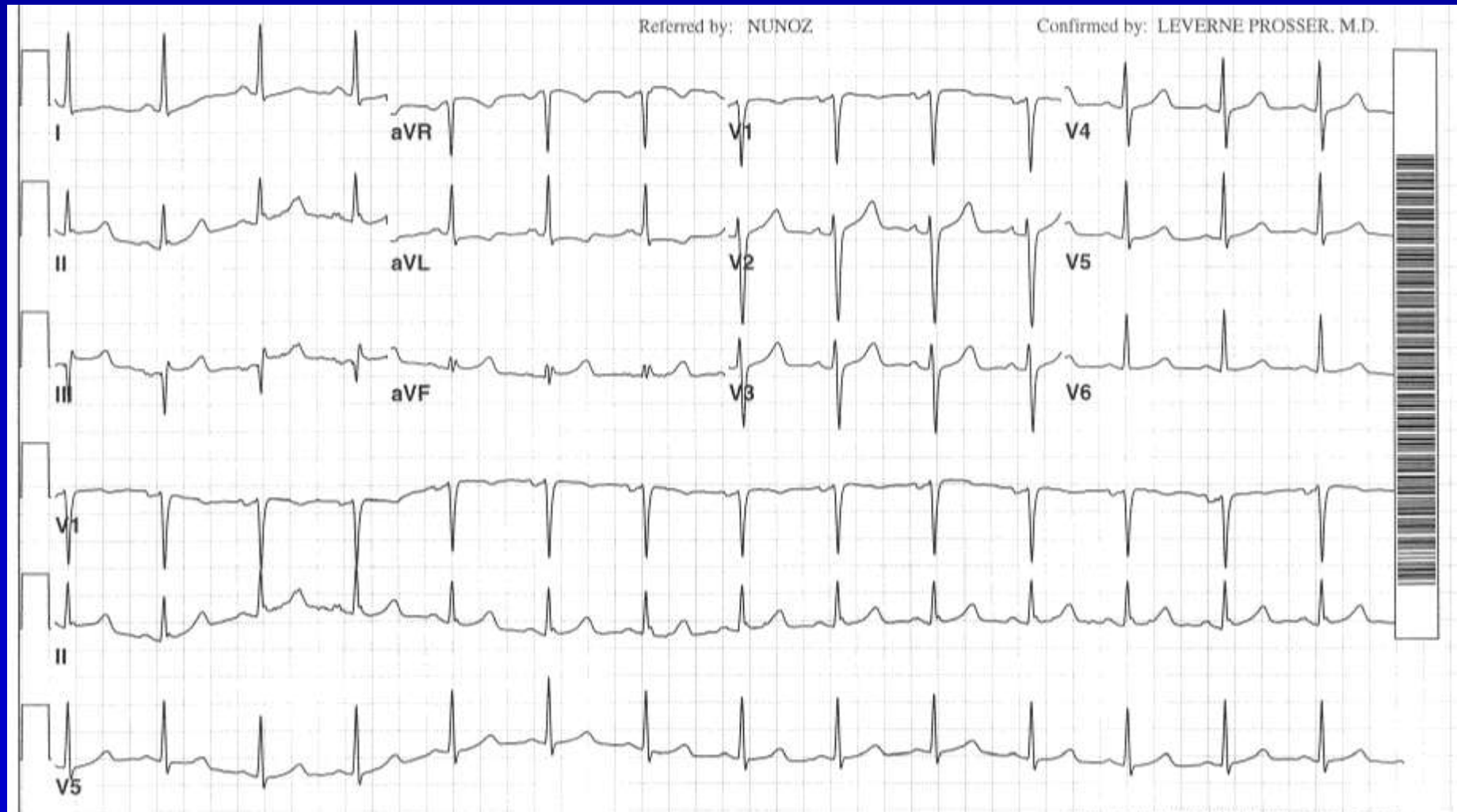
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1 of 4



UM8256 6-05-02 07:36

2 of 4

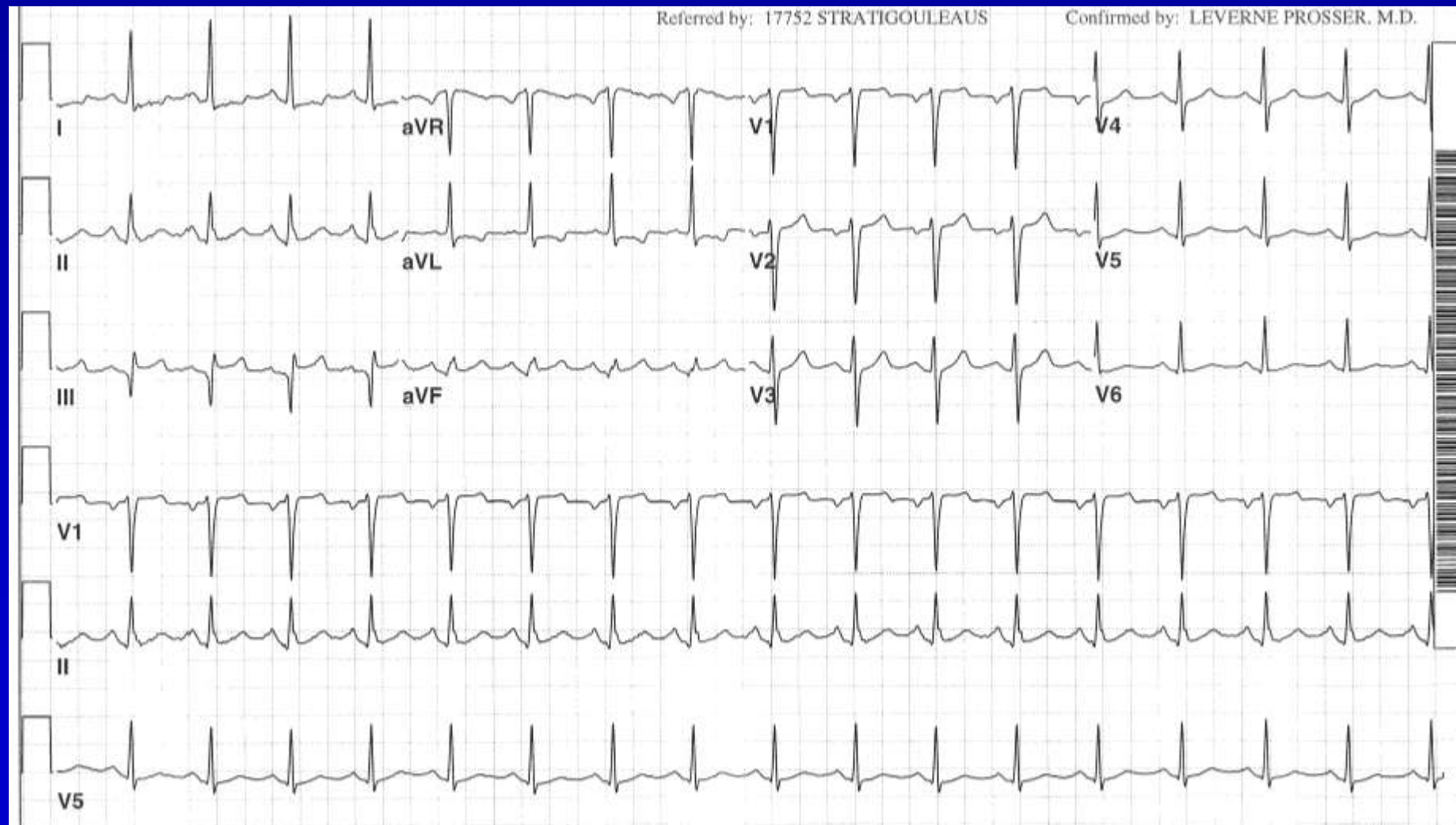


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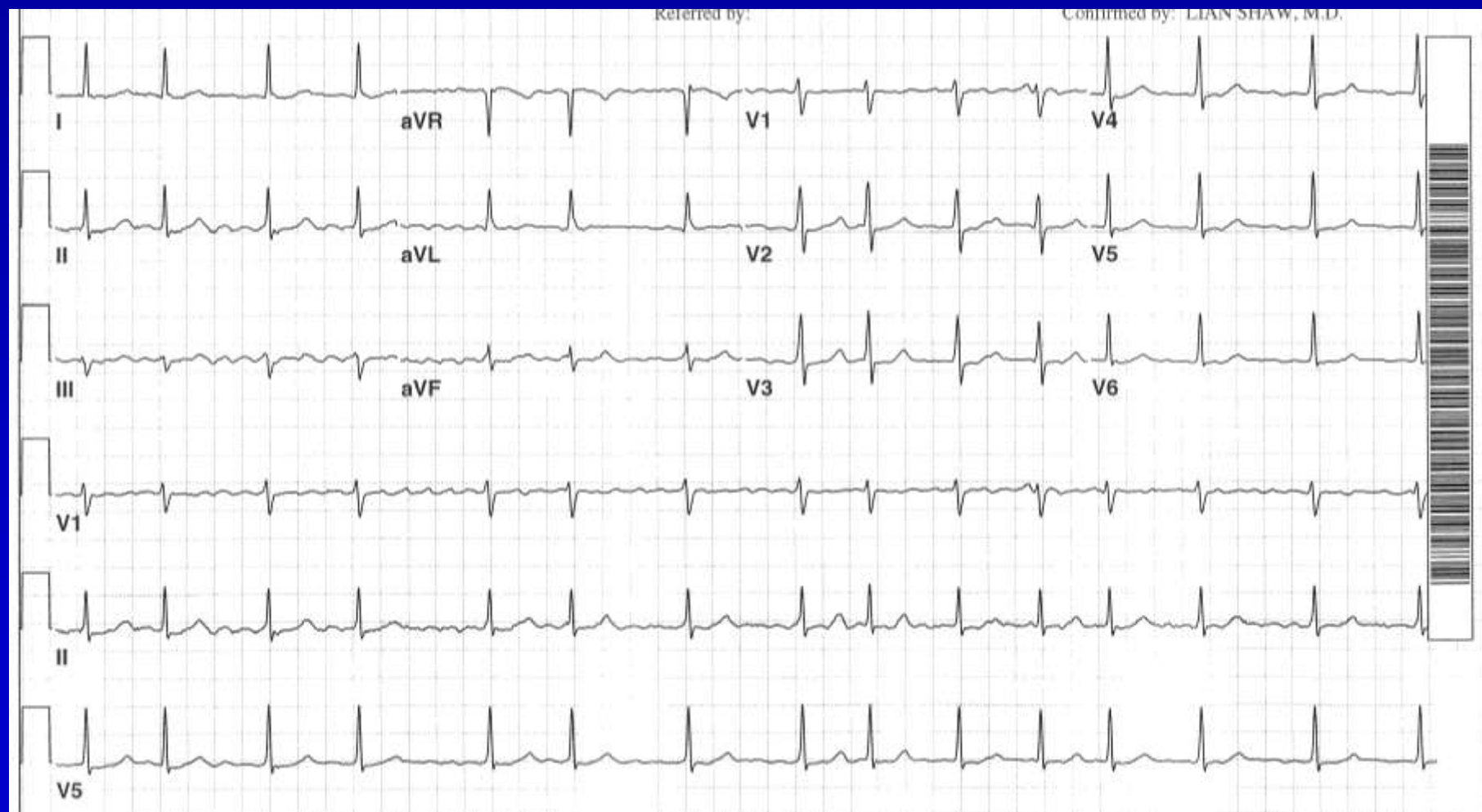
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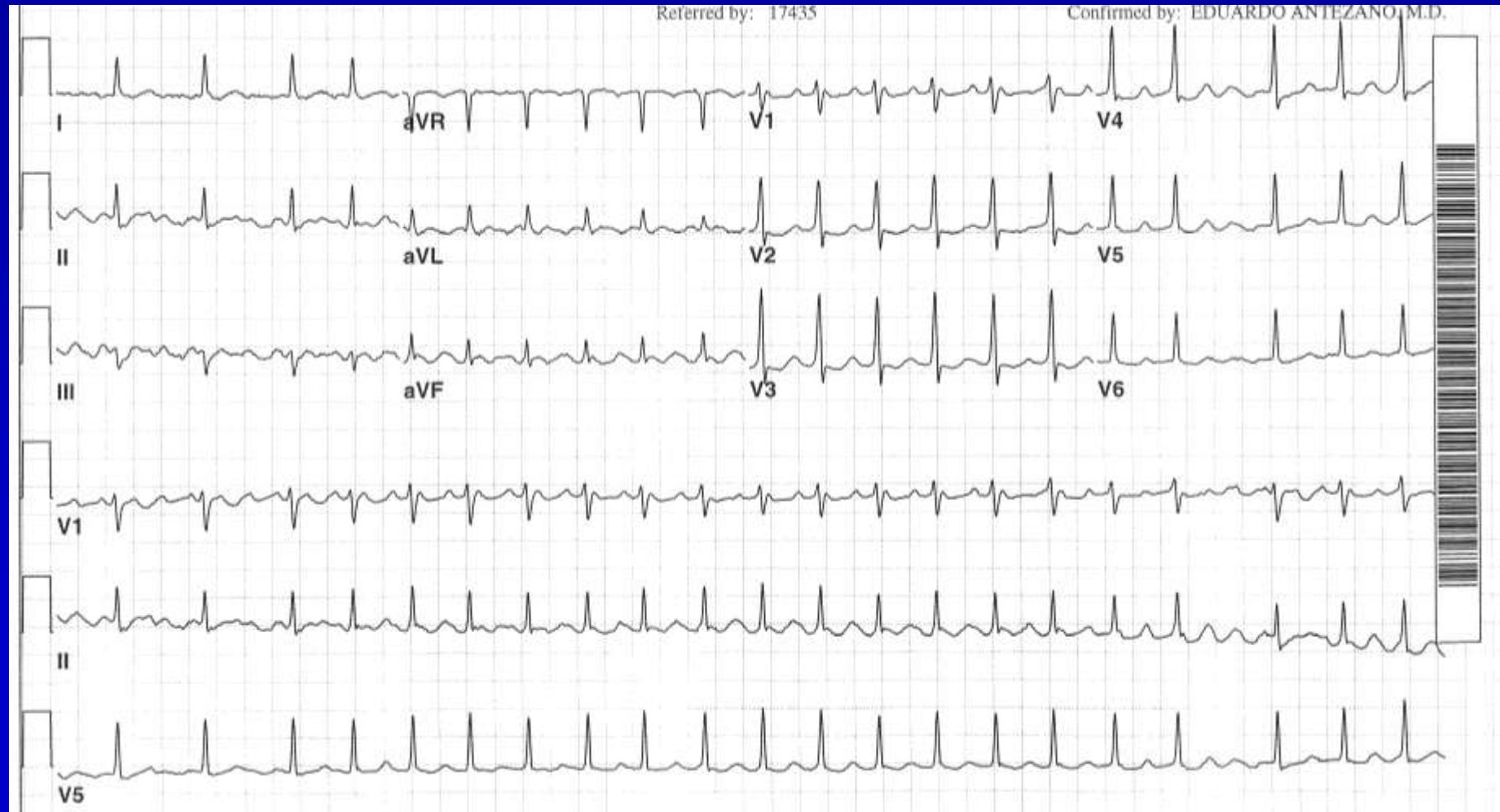


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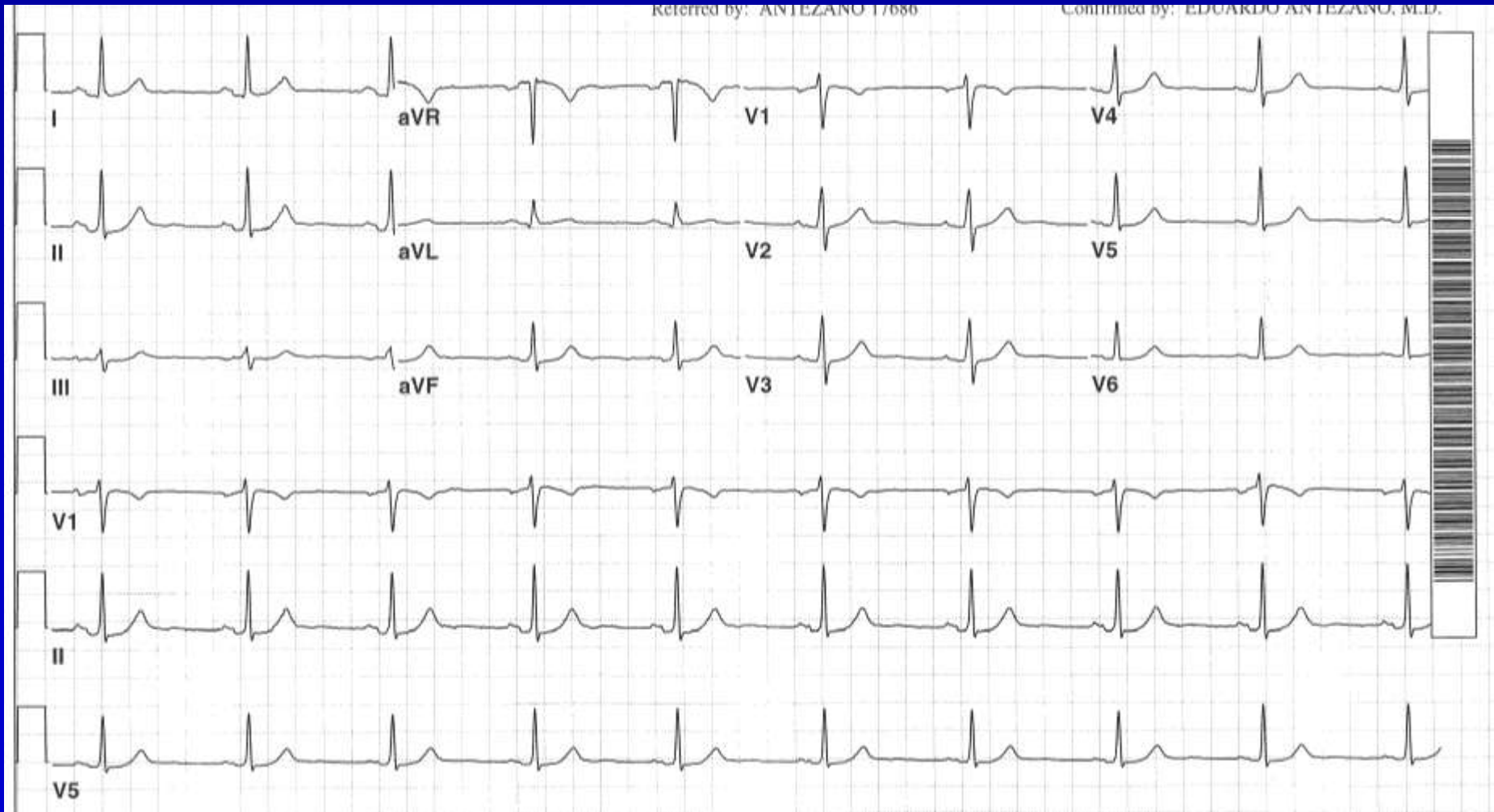
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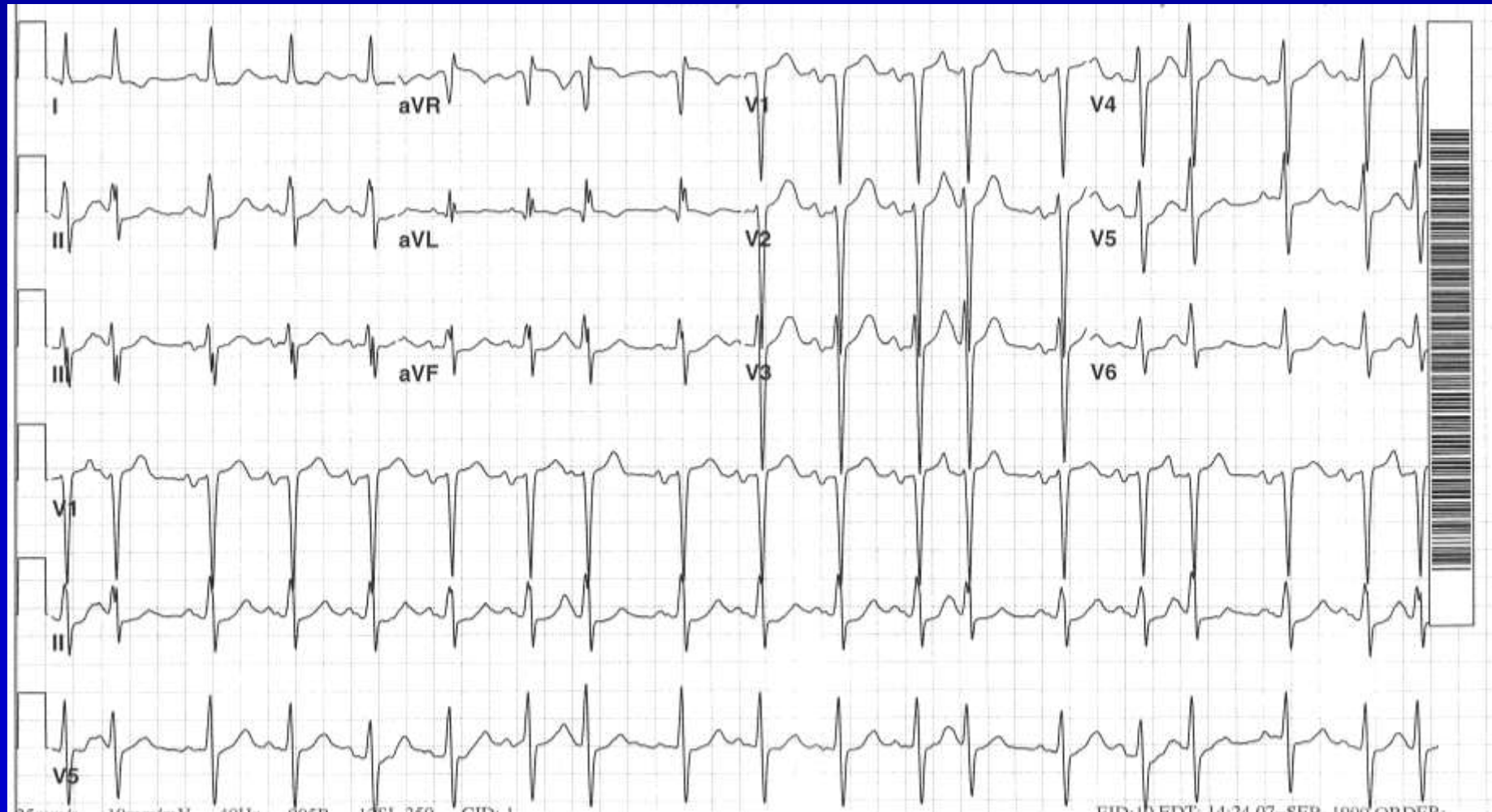
UD4175 9-28-01 18:45 2 of 3



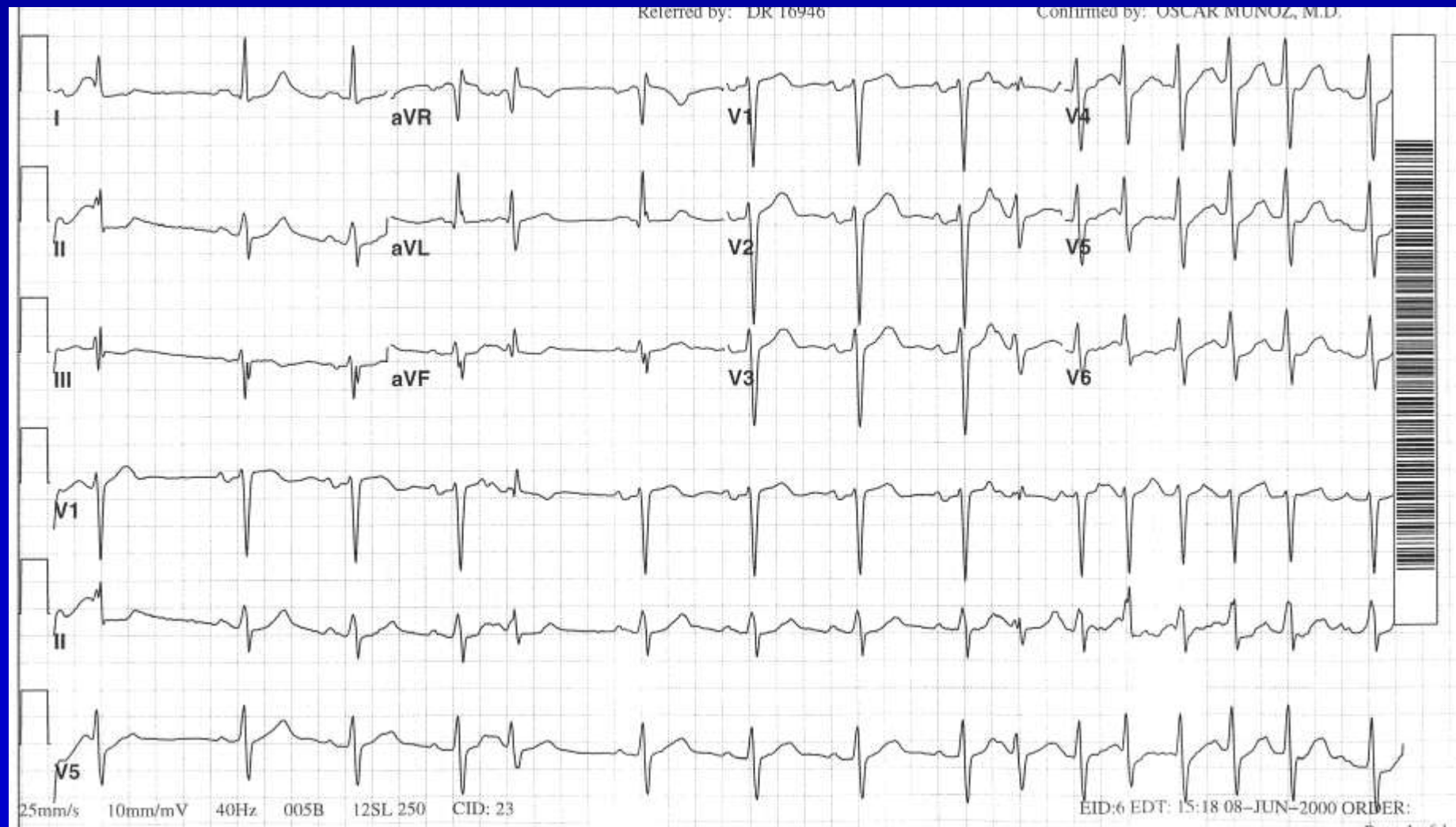
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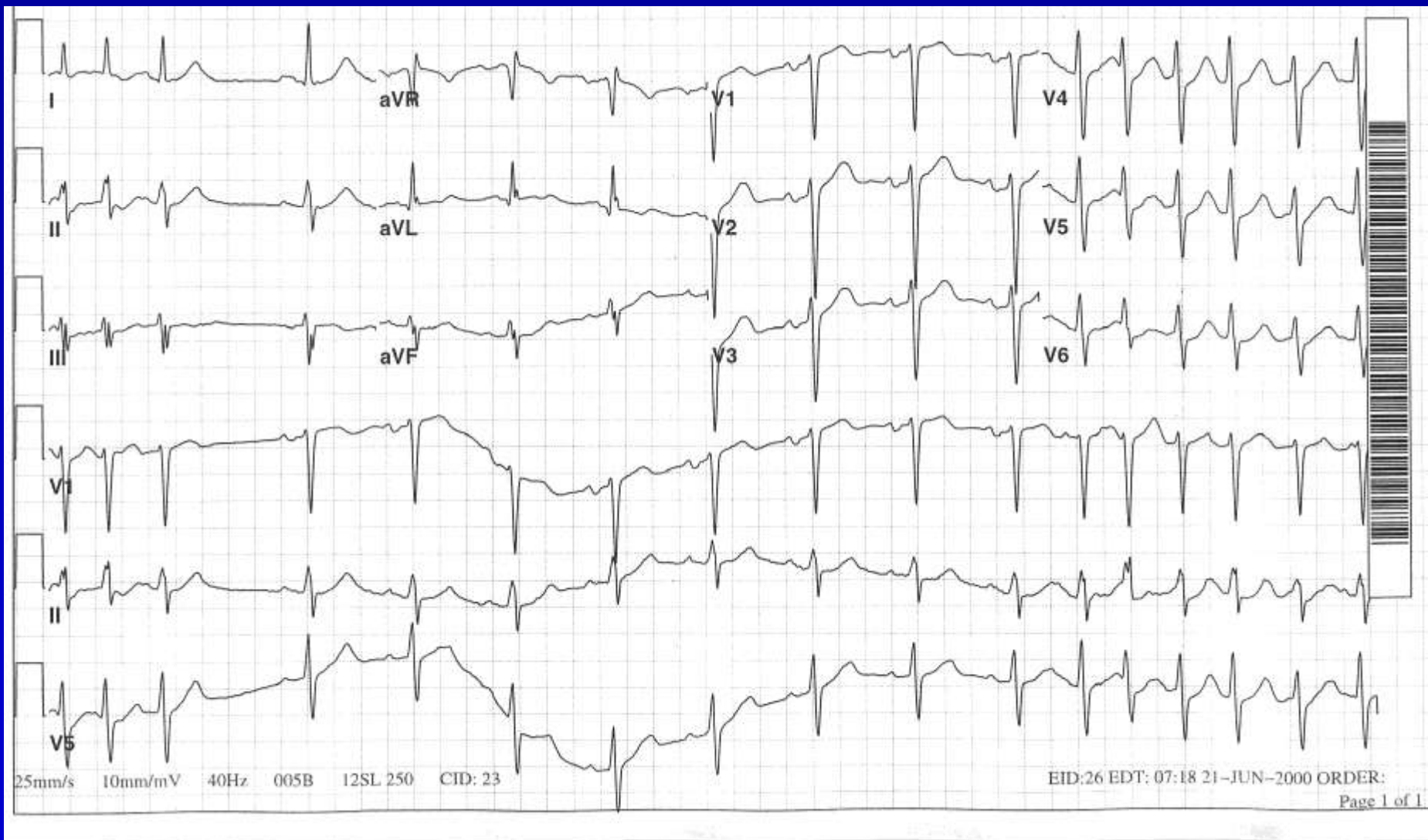
UG3760 9-01-99 11:12 1 of 3 baseline



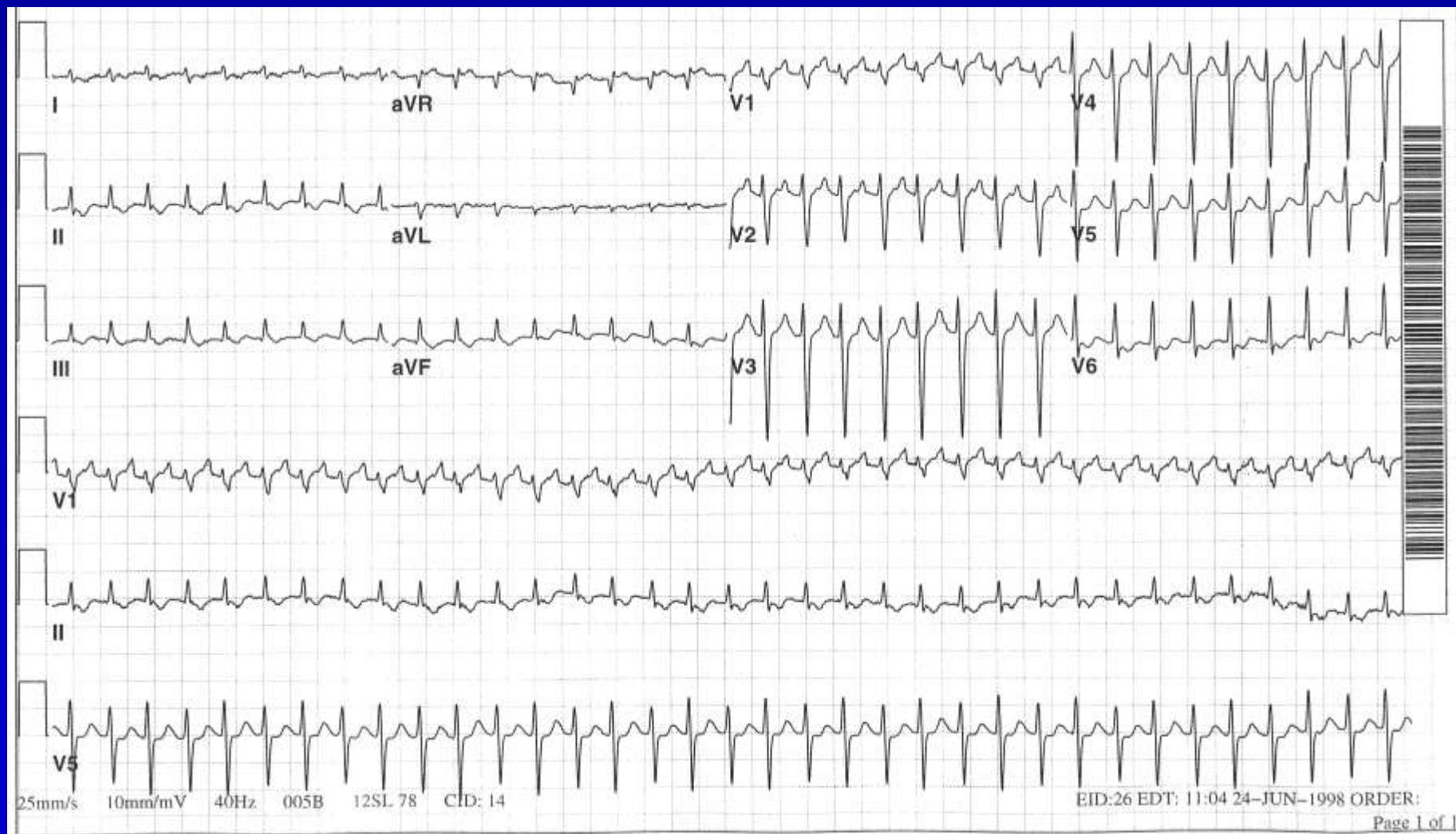
UG3760 6-05-00 12:20 2 of 3



UG3760 6-05-00 12:20 3 of 3

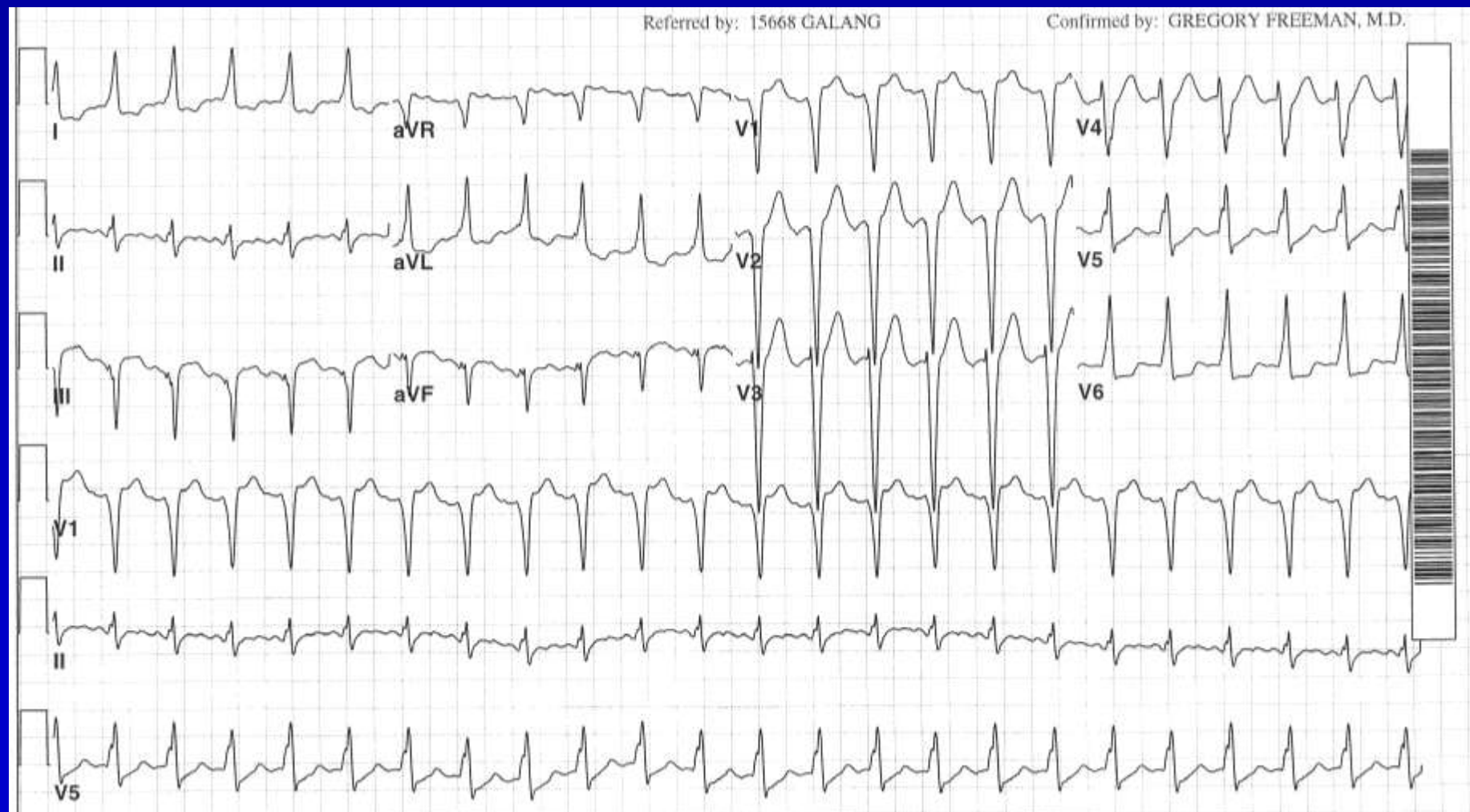


UF5373 3-30-98 16:51 1 of 1



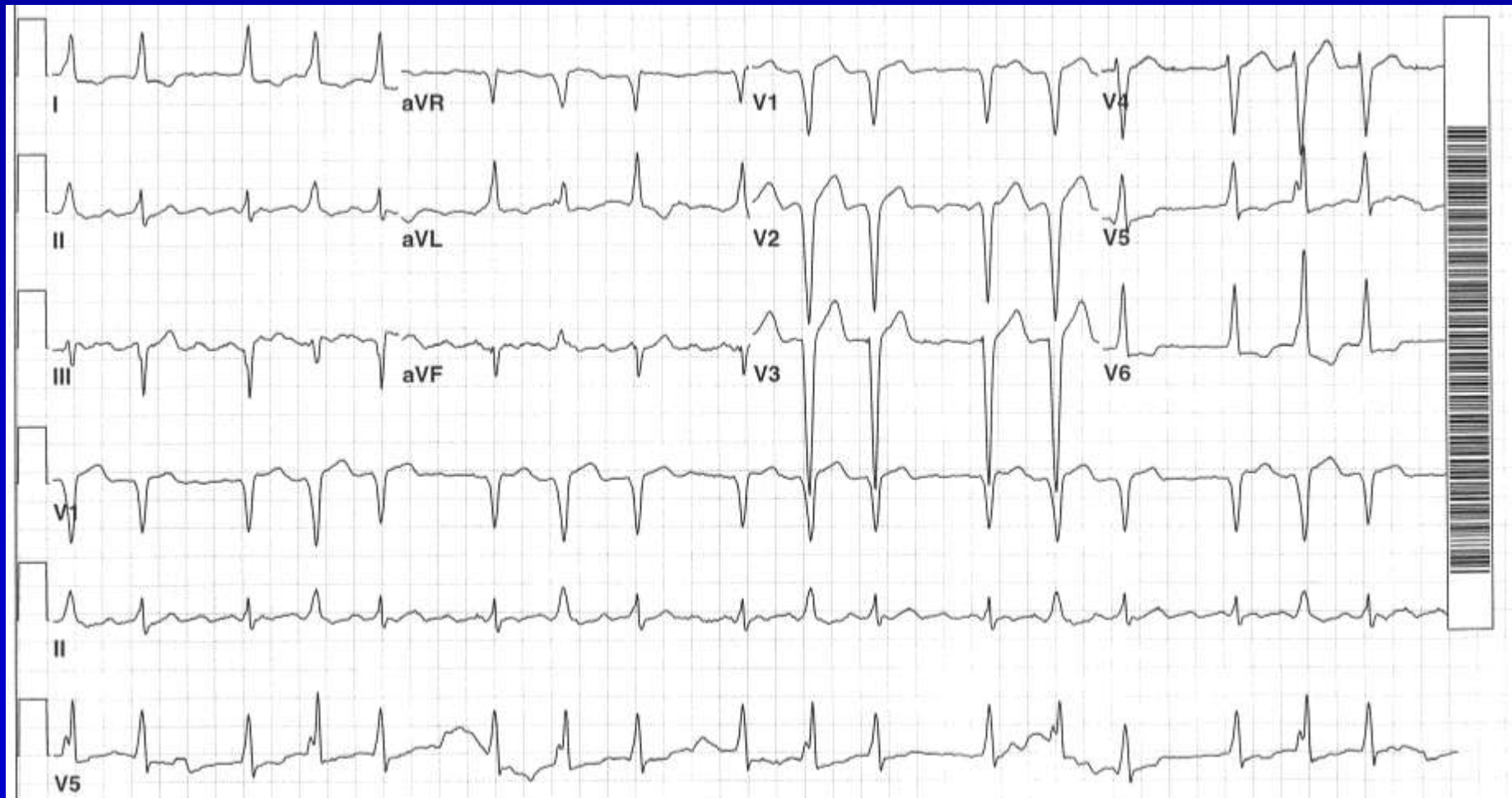
UB2765 6-24-98 07:03

1 of 4



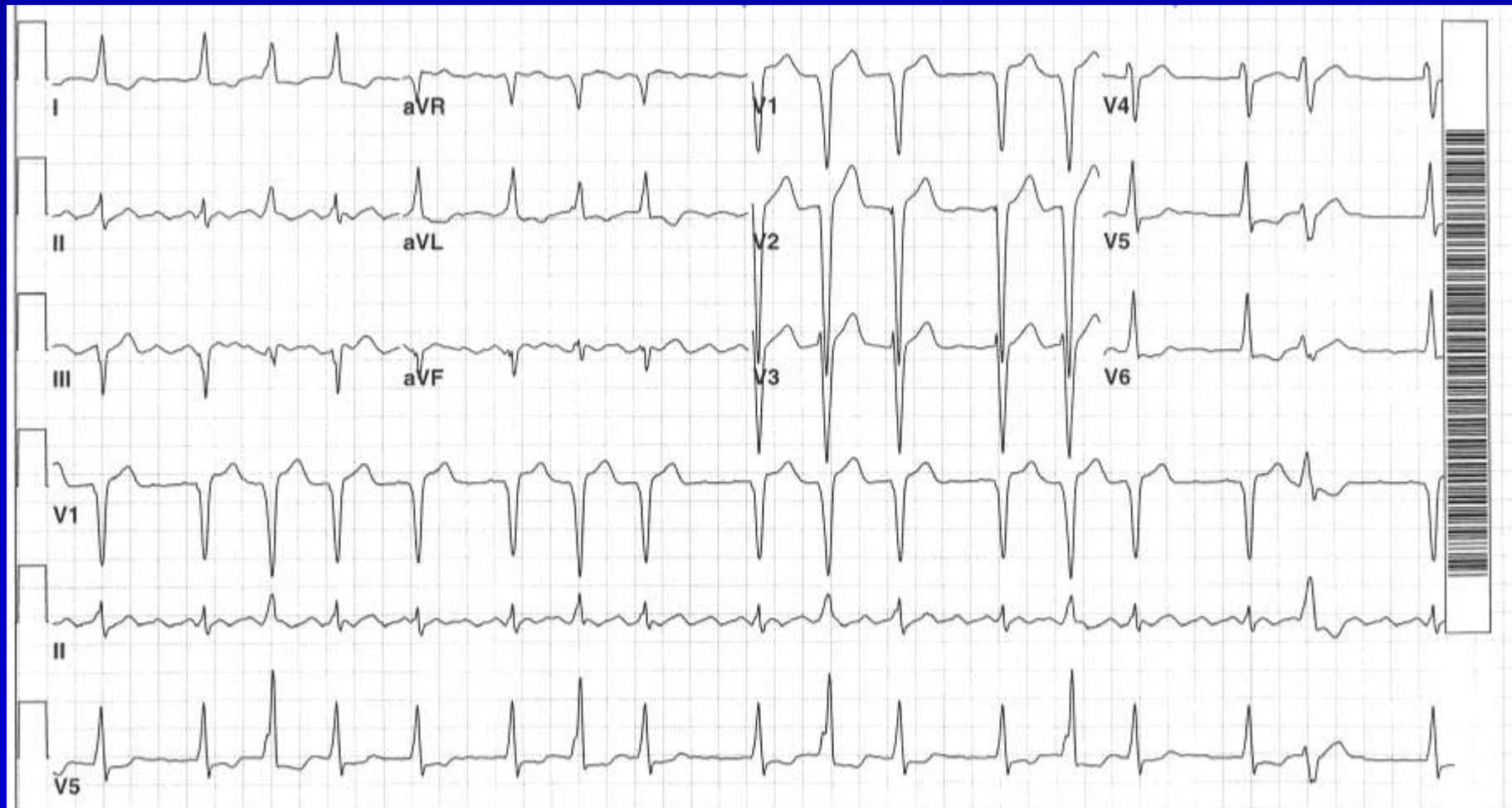
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2 of 4



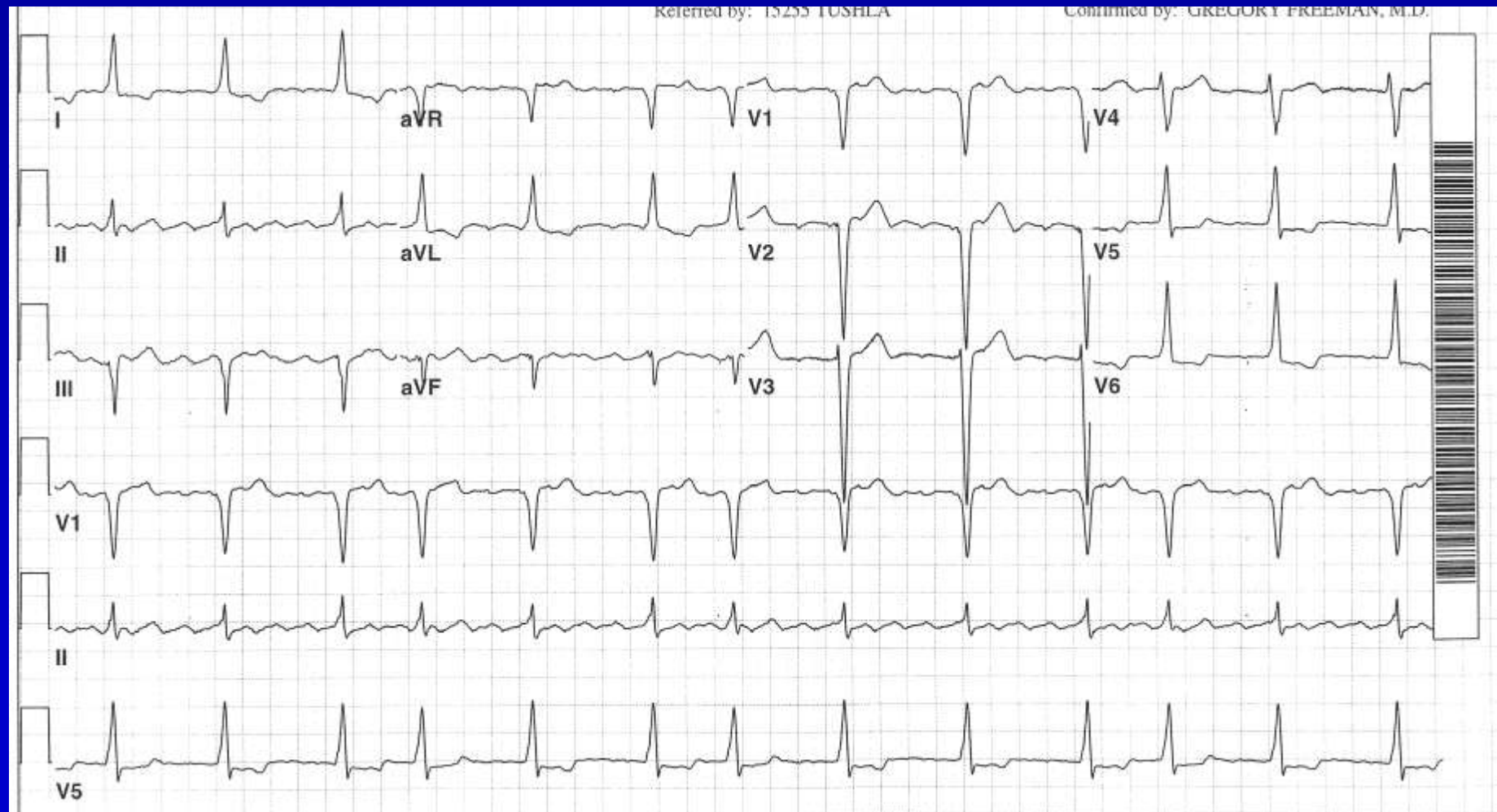
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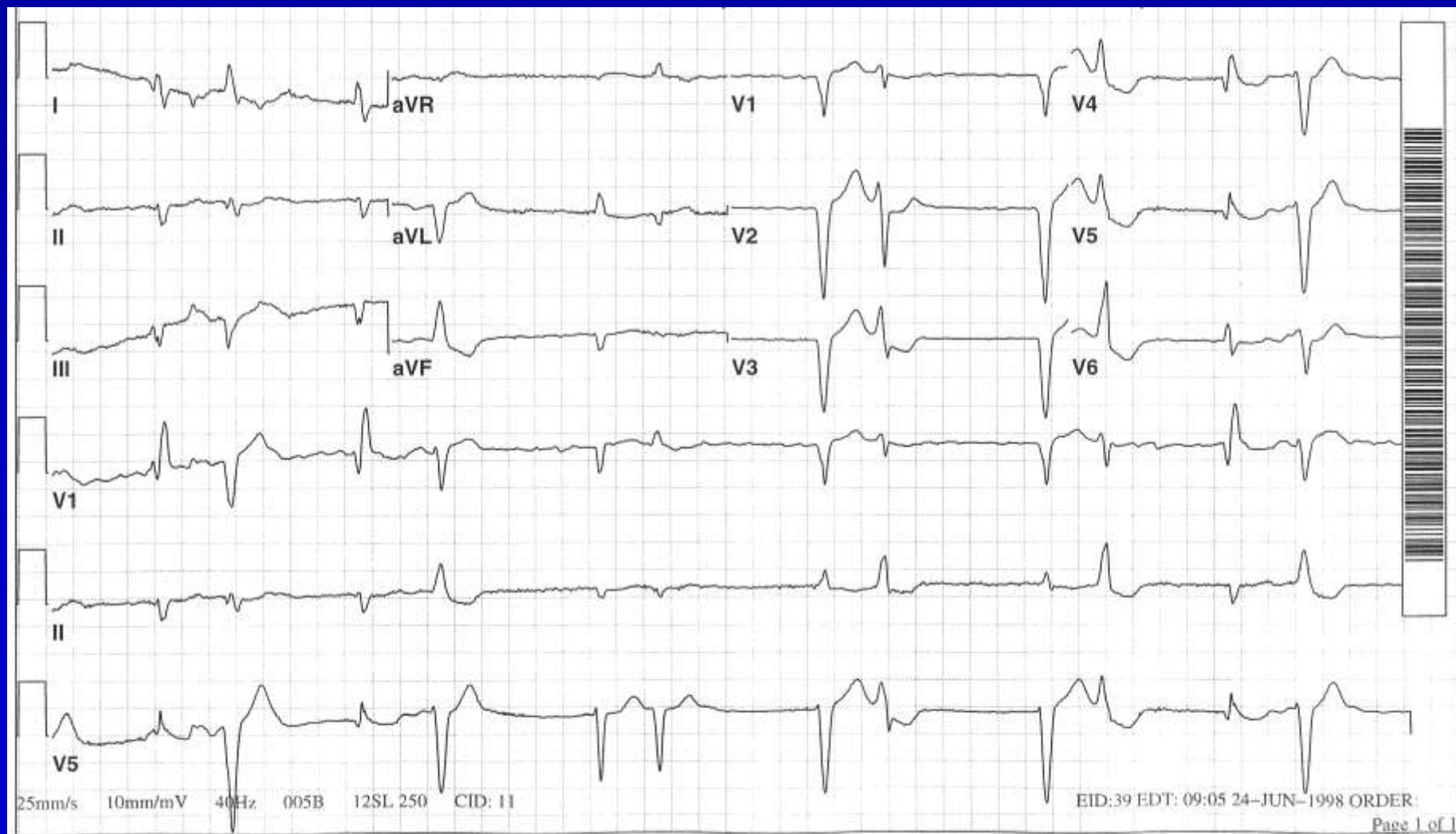


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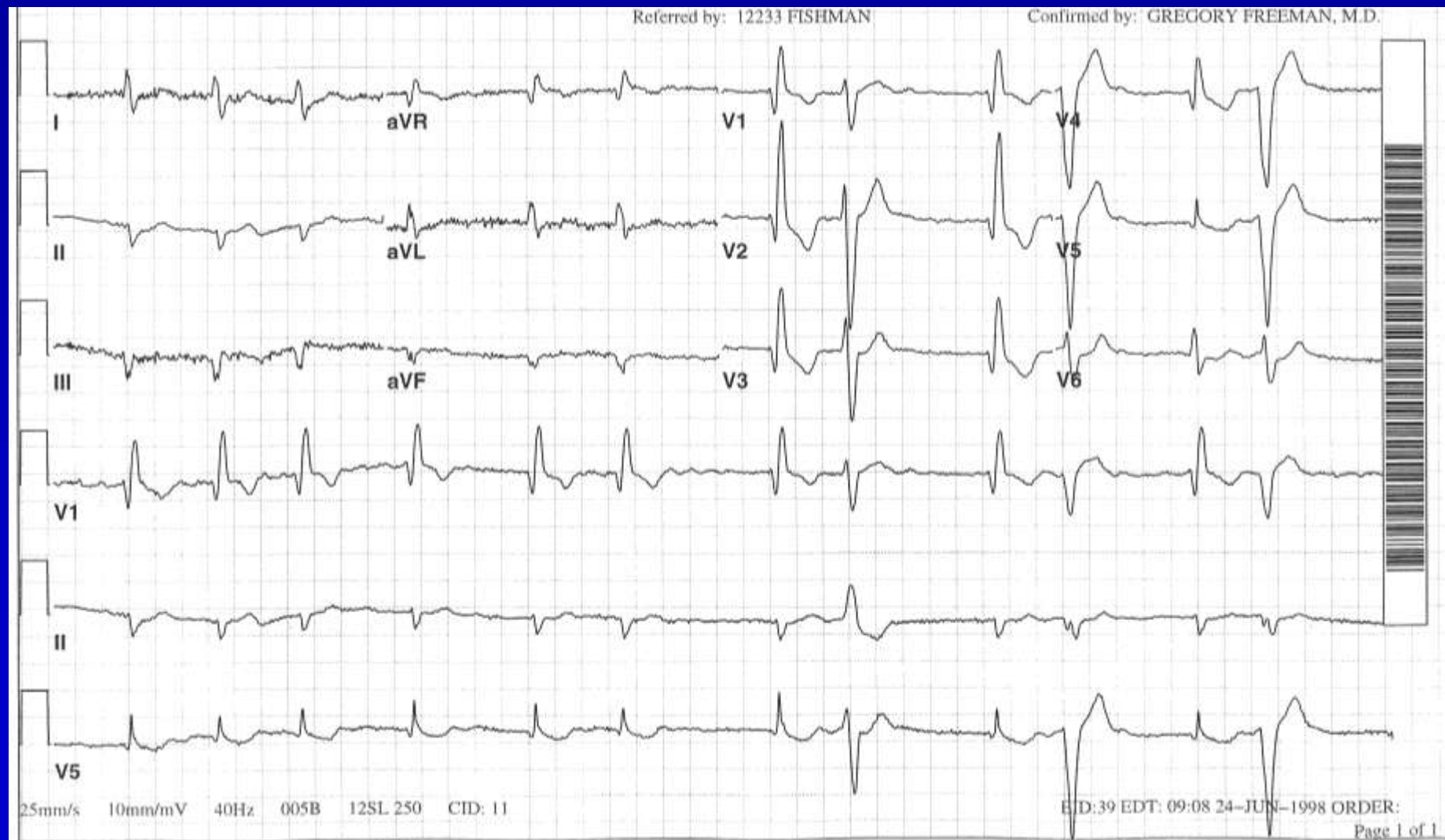
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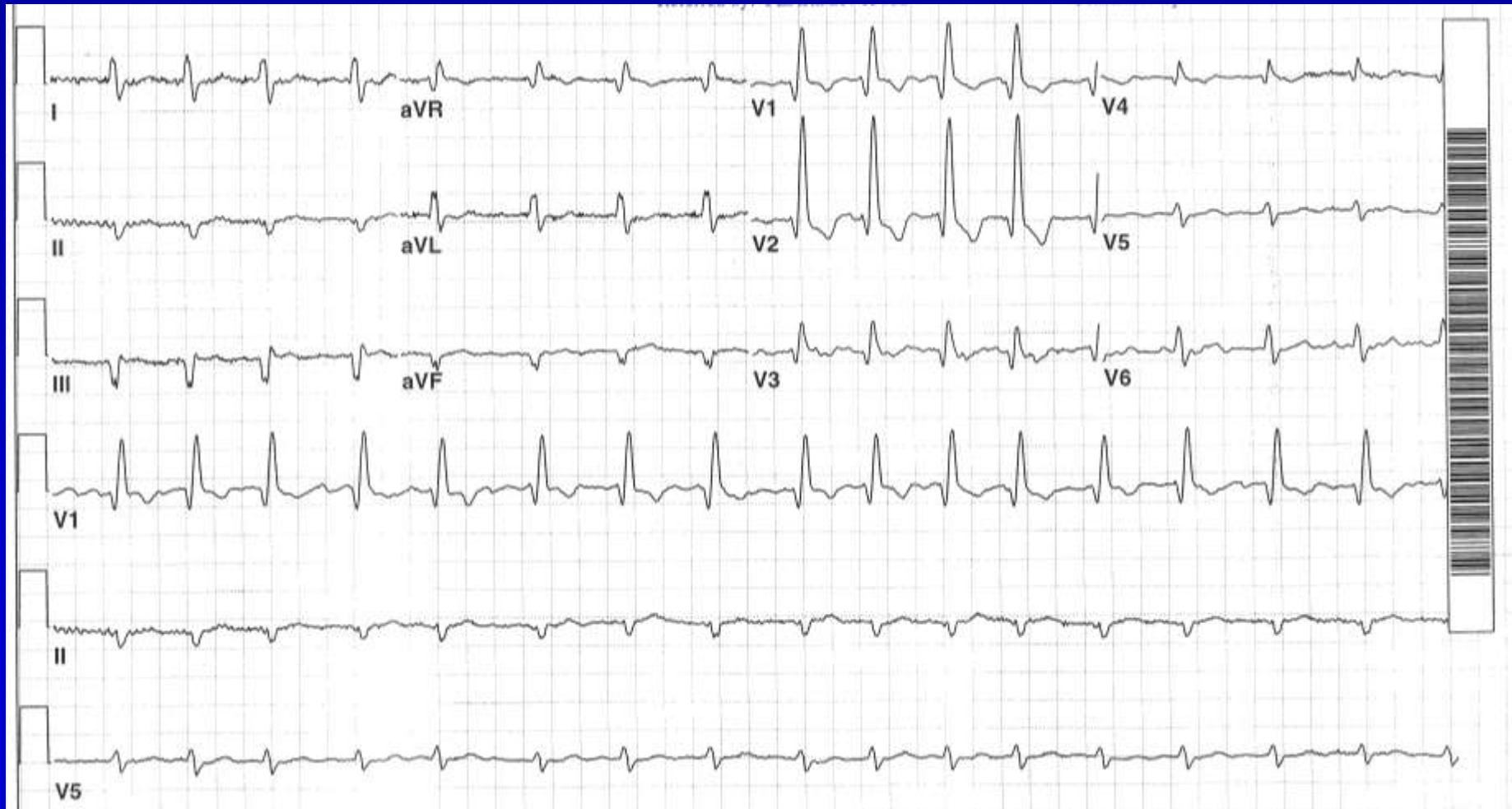
UM9270 6-05-98 17:12 1 of 3



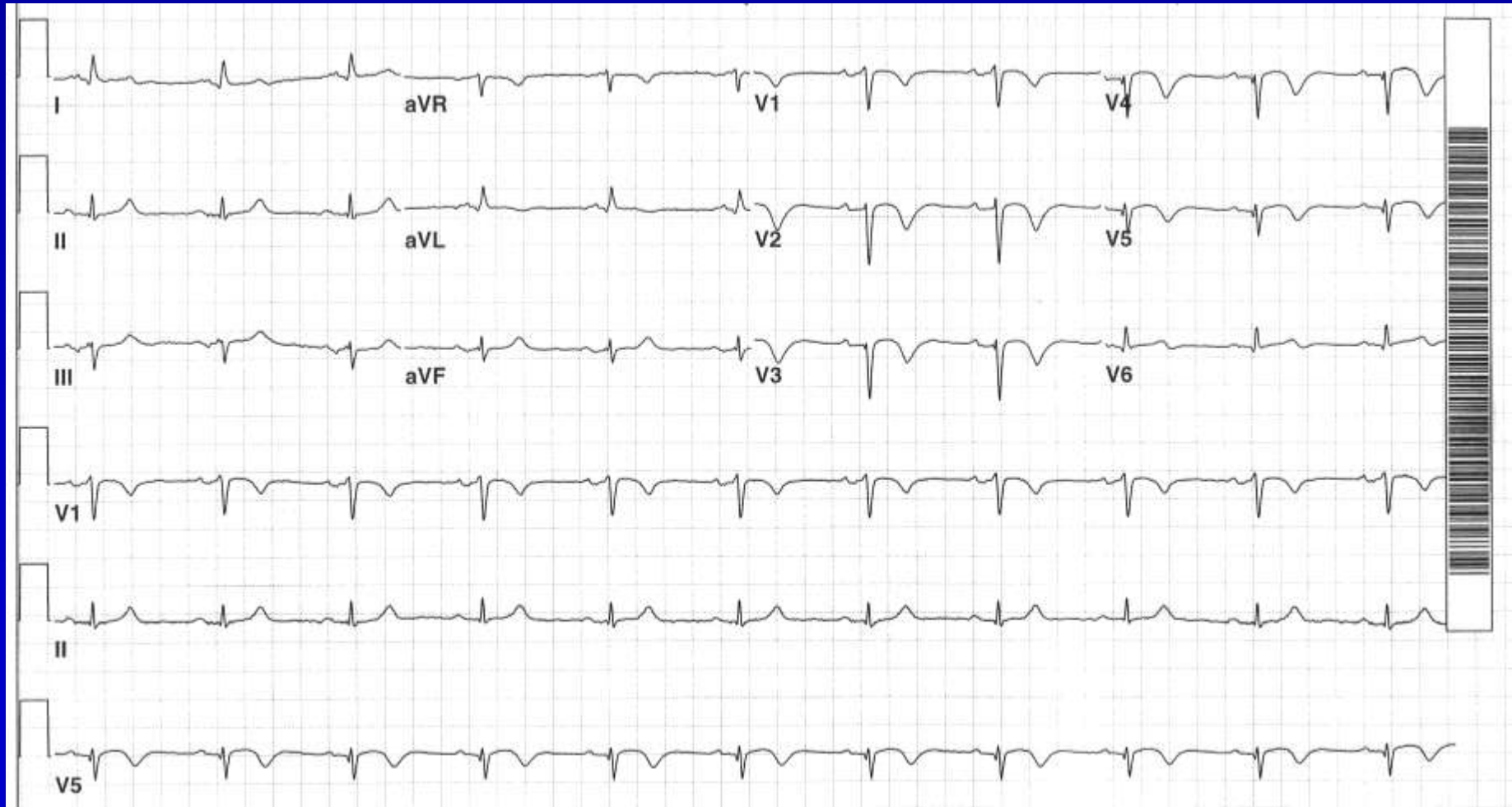
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UM9270 8-19-98 12:41 3 of 3

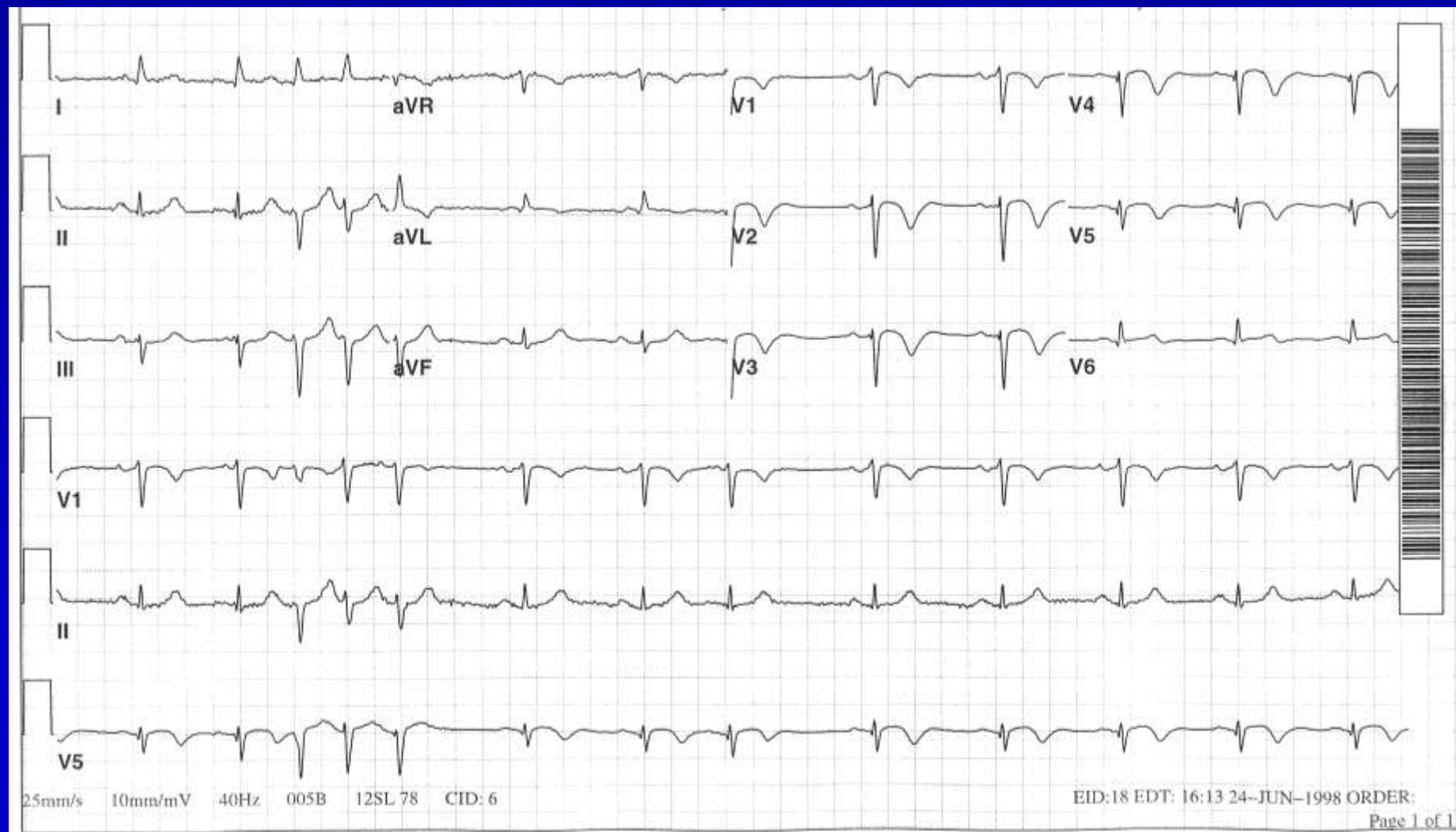


UC2211 6-23-98 20:58 1 of 2



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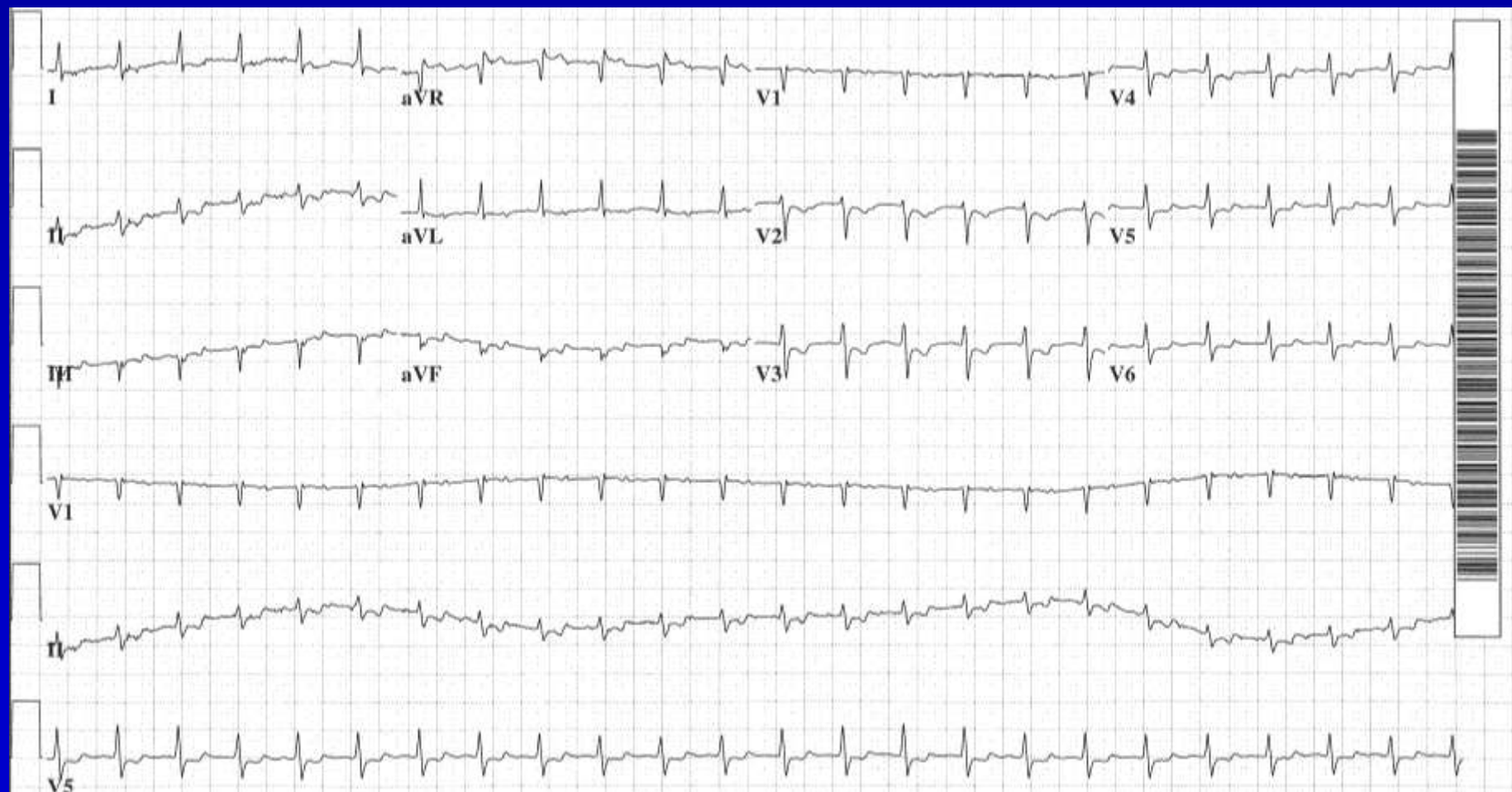
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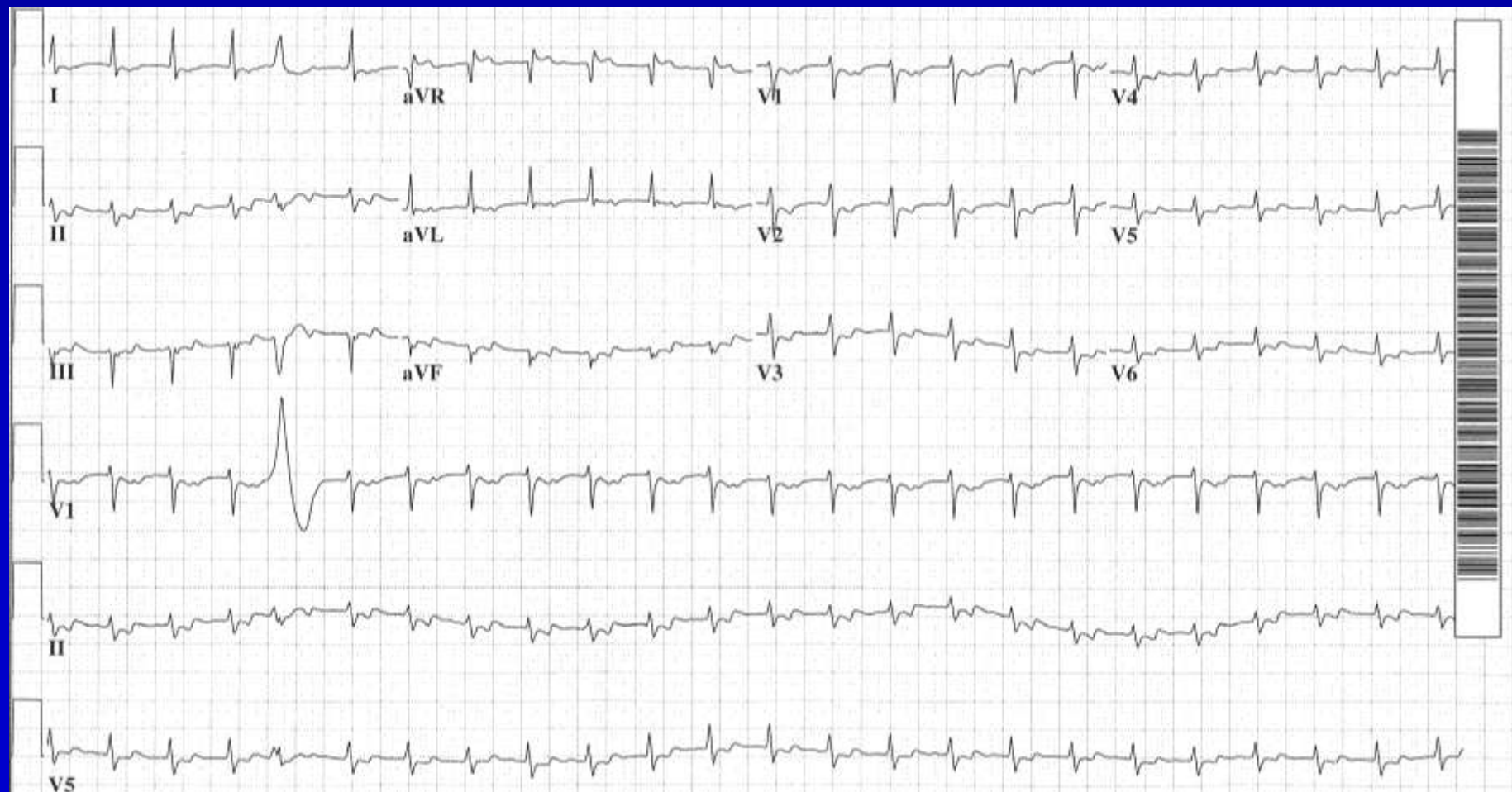
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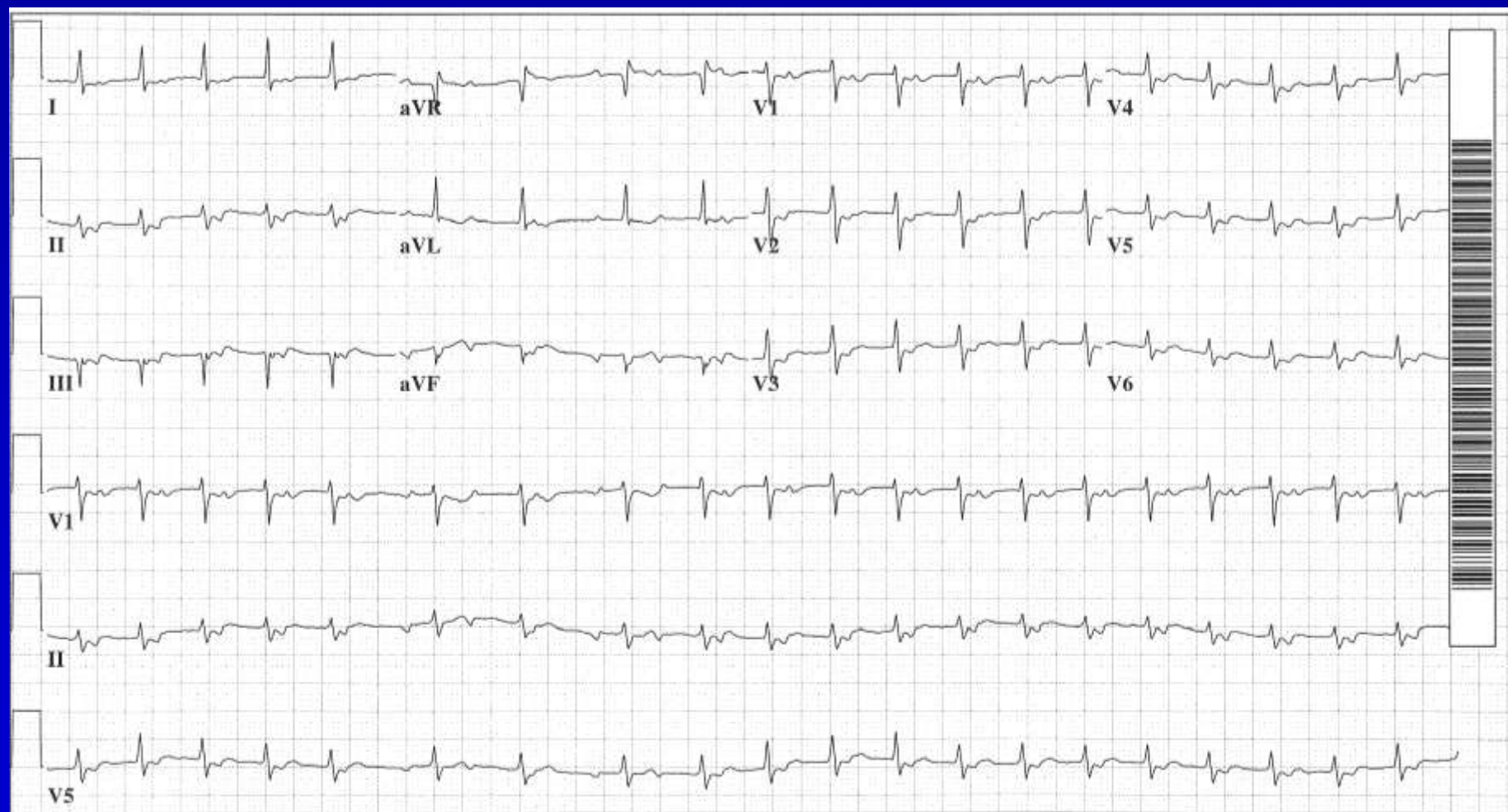
VJ2306 11-25-04 11:49 2 of 6



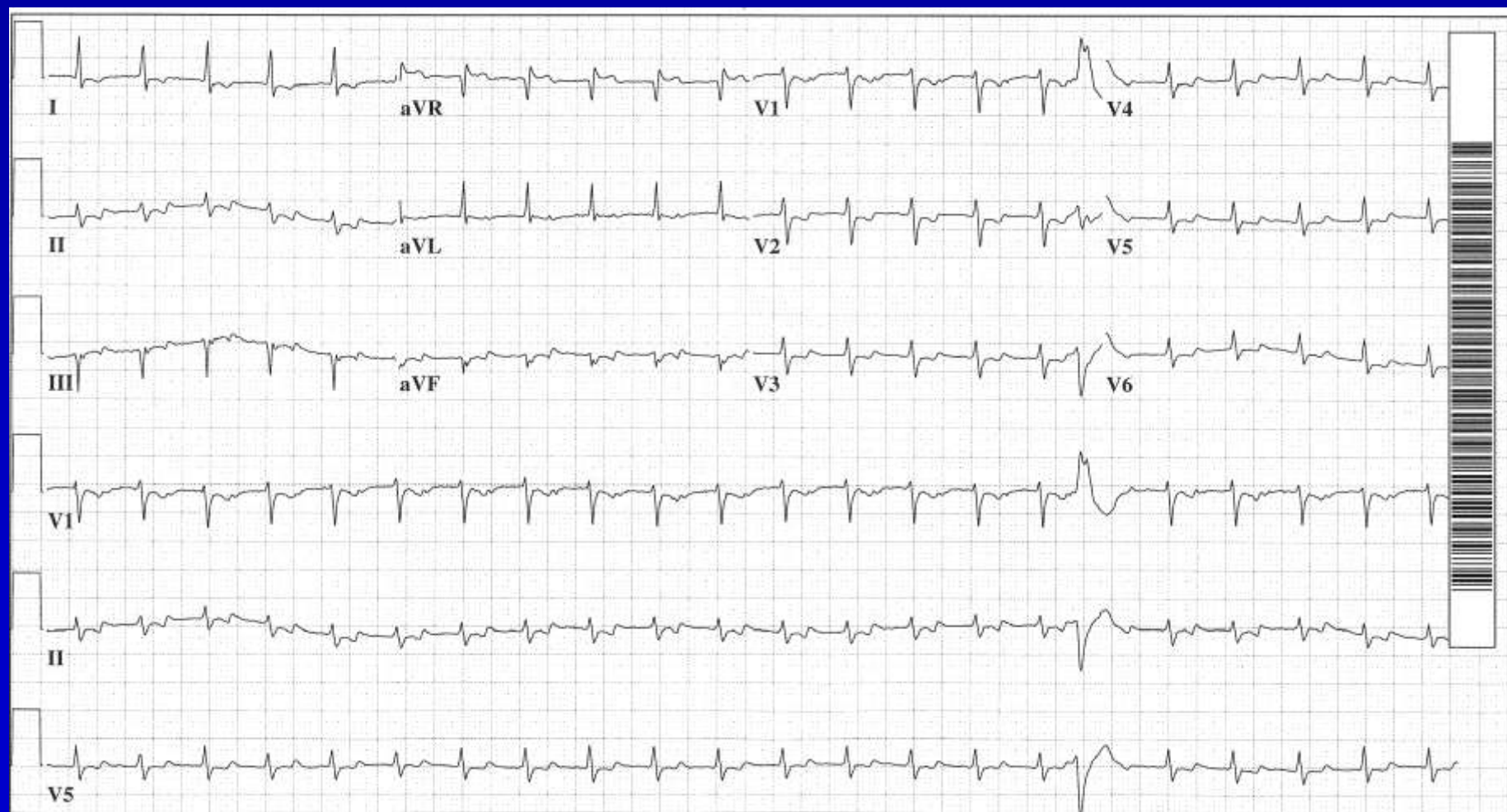
VJ2306 11-25-04 12:22 3 of 6



VJ2306 11-25-04 12:26 4 of 6



VJ2306 11-25-04 12:32 5 of 6



VJ2306 11-25-04 14:17 6 of 6

