Reading the ECG: Clues, Tips & Pearls

Maully Shah, MBBS,FACC FHRS

Director , Cardiac Electrophysiology

The Children's Hospital of Philadelphia

Professor of Pediatrics

Perelman School of Medicine, University of Pennsylvania

Scott Weinreb, MD

The Children's Hospital of Philadelphia

Perelman School of Medicine, University of Pennsylvania

Ivor Asztalos, MD

The Children's Hospital of Philadelphia

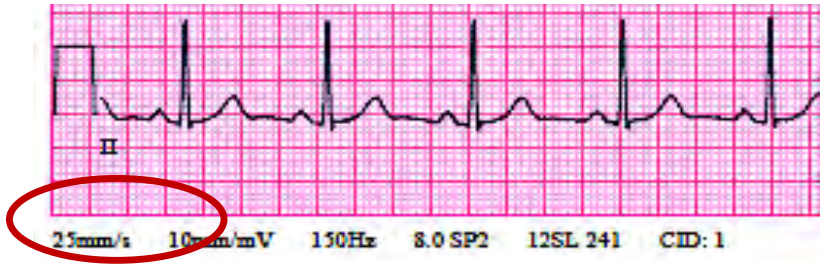
Perelman School of Medicine, University of Pennsylvania

Shah's 3 S's : Before Interpreting the ECG

1. Squares: to calculate heart rate

300/6=50 b.p.m.

2. Sweep Speed: Standard speed : 25mm/sec



Double speed (50 mm/sec)
-Double the calculated HR
-Halve measured durations (PR, QRS and QT)

3. Standard: Rectangle Height=2 big squares

Half standard (1 big square)
-Multiply voltages x2

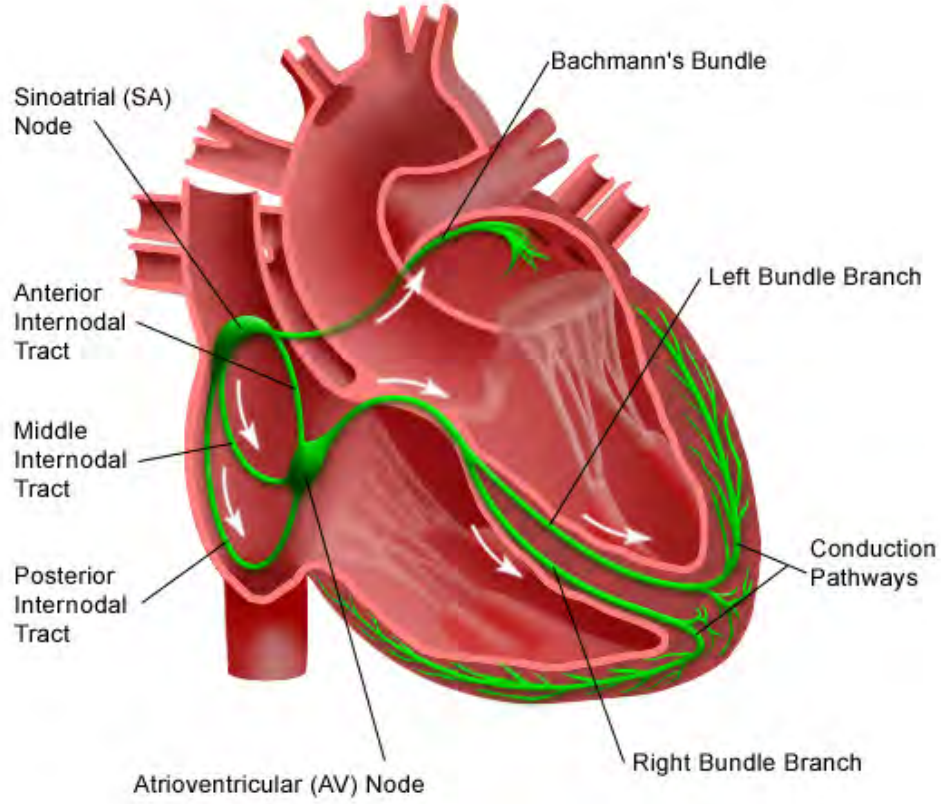
Sinus rhythm: p wave

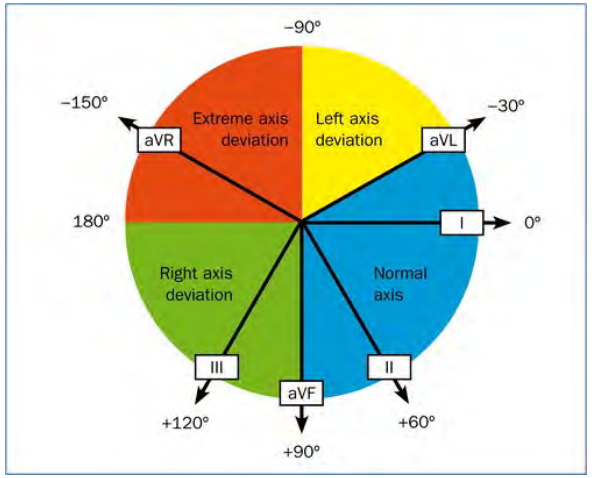
- **P wave:**

-represents the activation from the *sinus node* as it travels through the *right and left atria*.

-origin in the high right atrium and vector is towards the AV node, it assumes a positive configuration in ECG leads I and aVF.

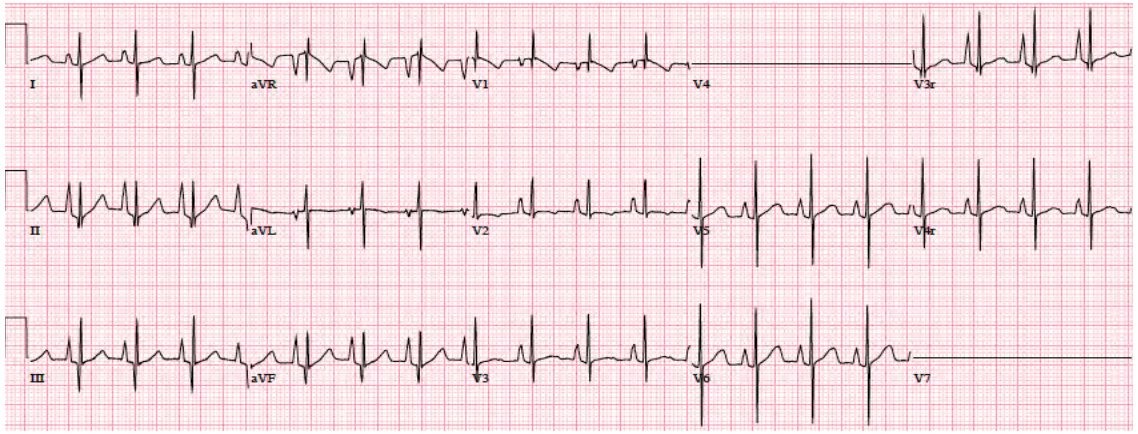
-P wave of an axis other than 15 to 110 is unlikely to be from the sinus and is most probably from an ectopic atrial focus acting as a pace maker.



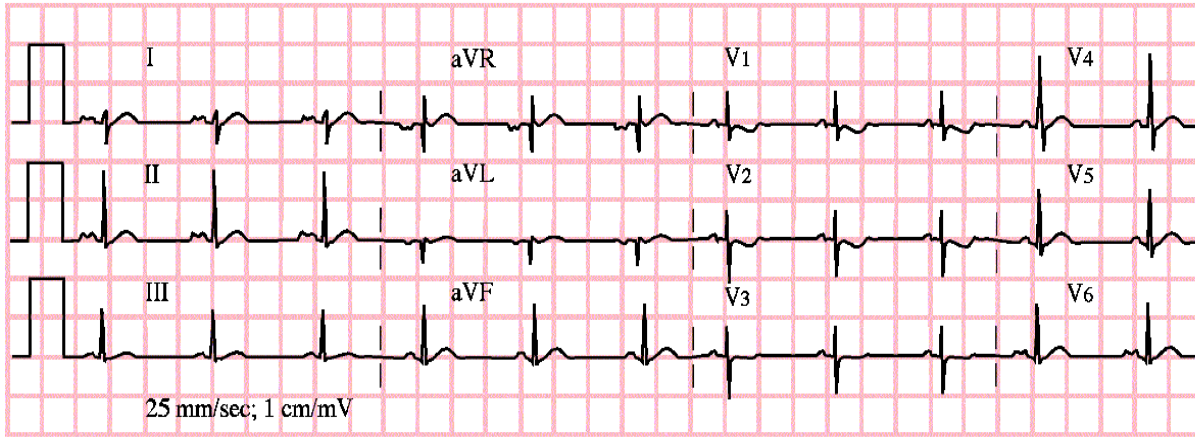


P Waves and Atrial Enlargement:

Right atrial enlargement : Tall P waves: > 3 small boxes (> 3mm)



Left atrial enlargement : wide P waves: > 3 small boxes (>0.12 ms)



Sinus Rhythm: Top →Bottom; R→ L activation

aVR P -

aVL P +

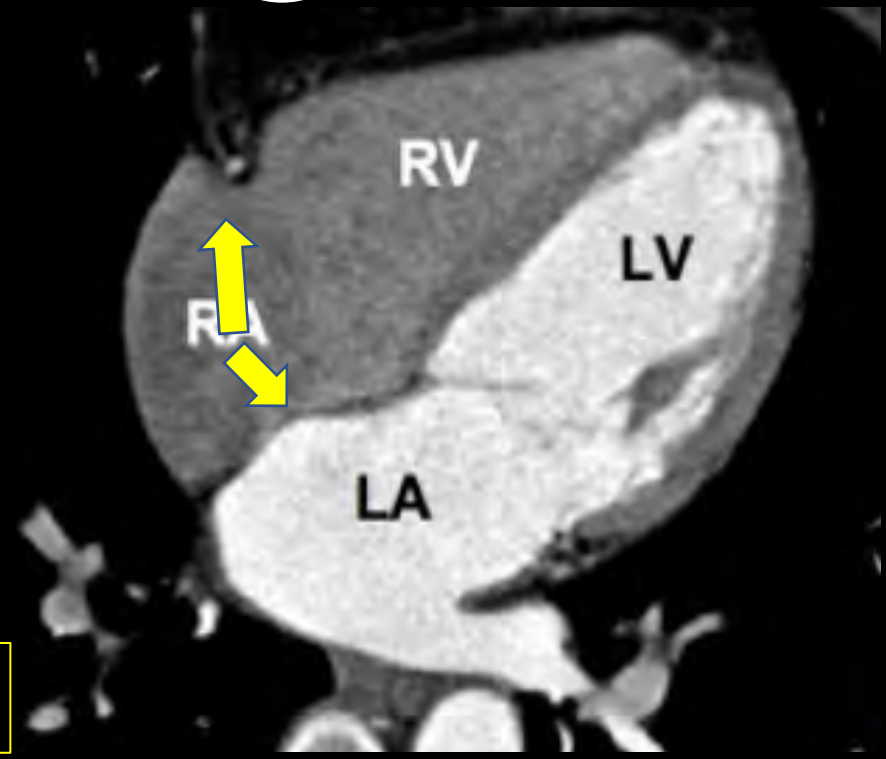
V1 P +/-

I P +

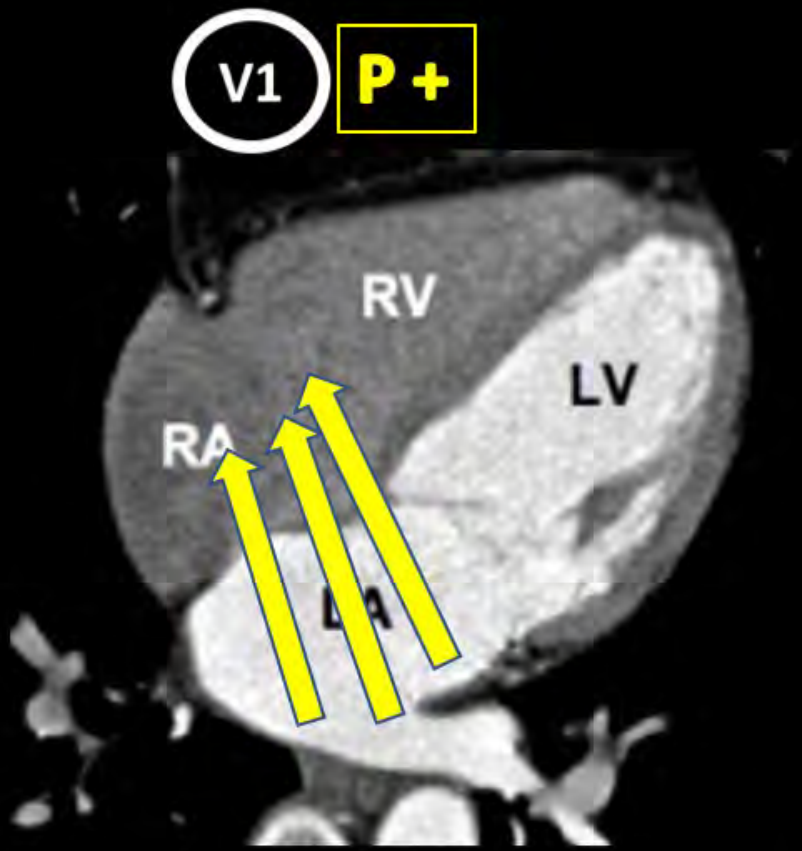
III P +

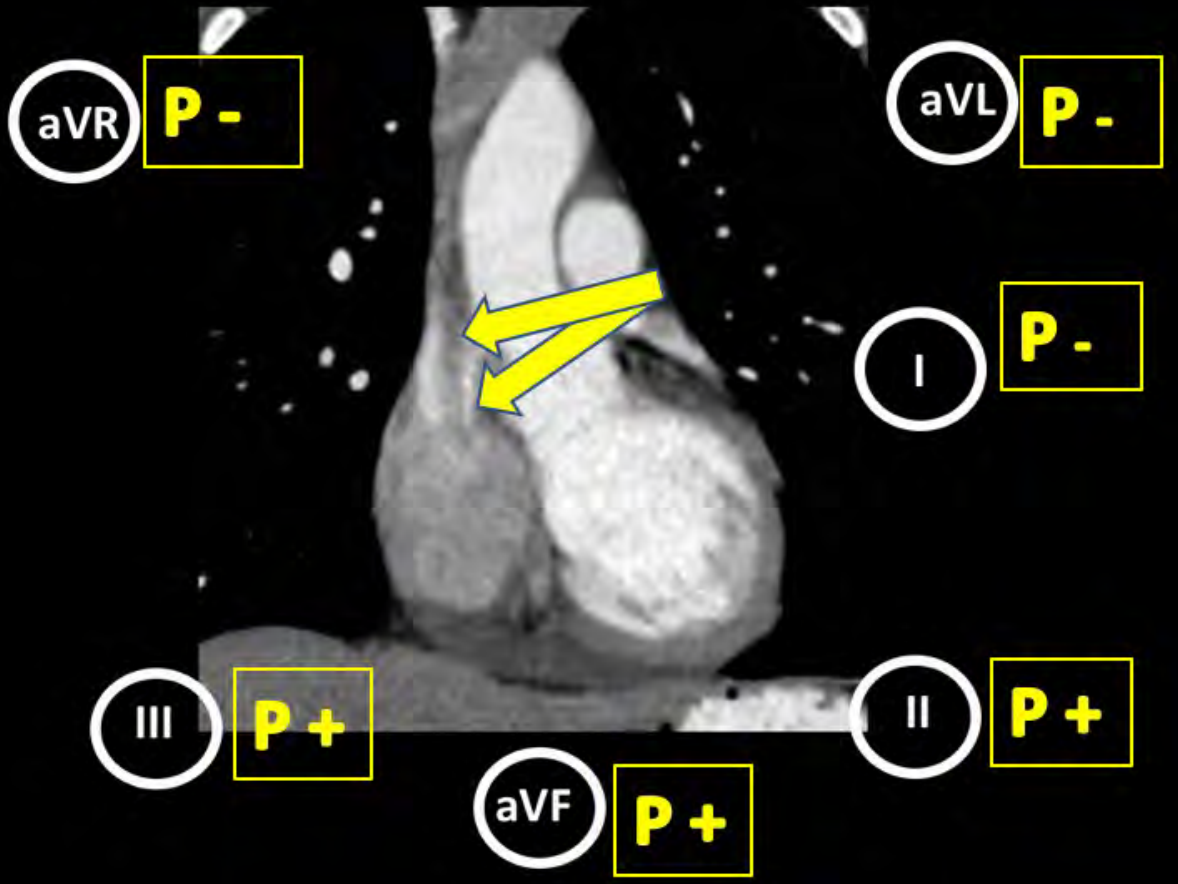
aVF P +

II P +



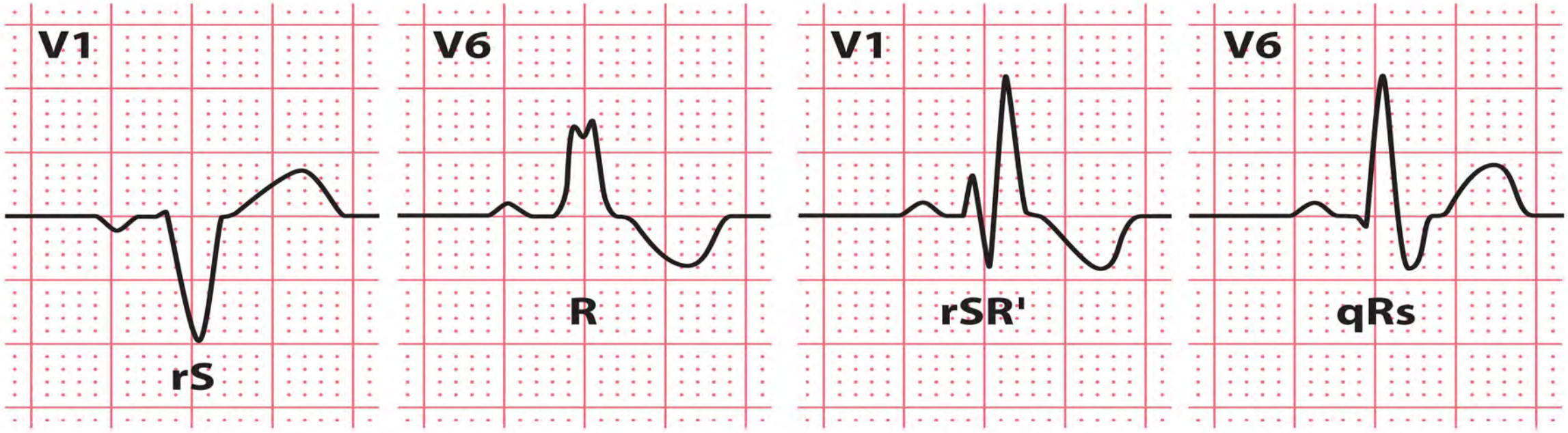
AT From Left Atrial Sites



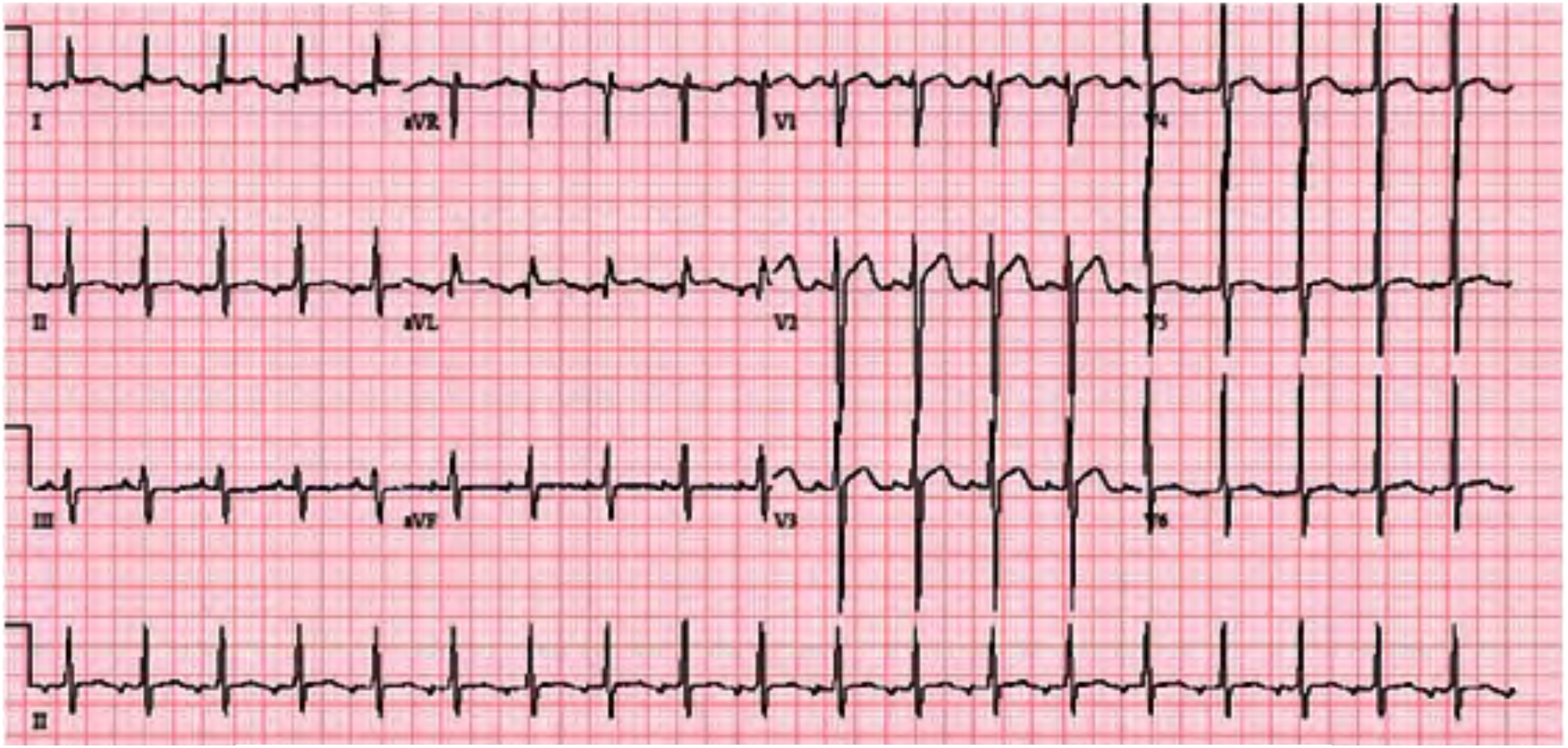


Bundle Branch Block Patterns

-Usually accompanied by axis deviation



8 year old with a screening ECG prior to starting ADHD medications

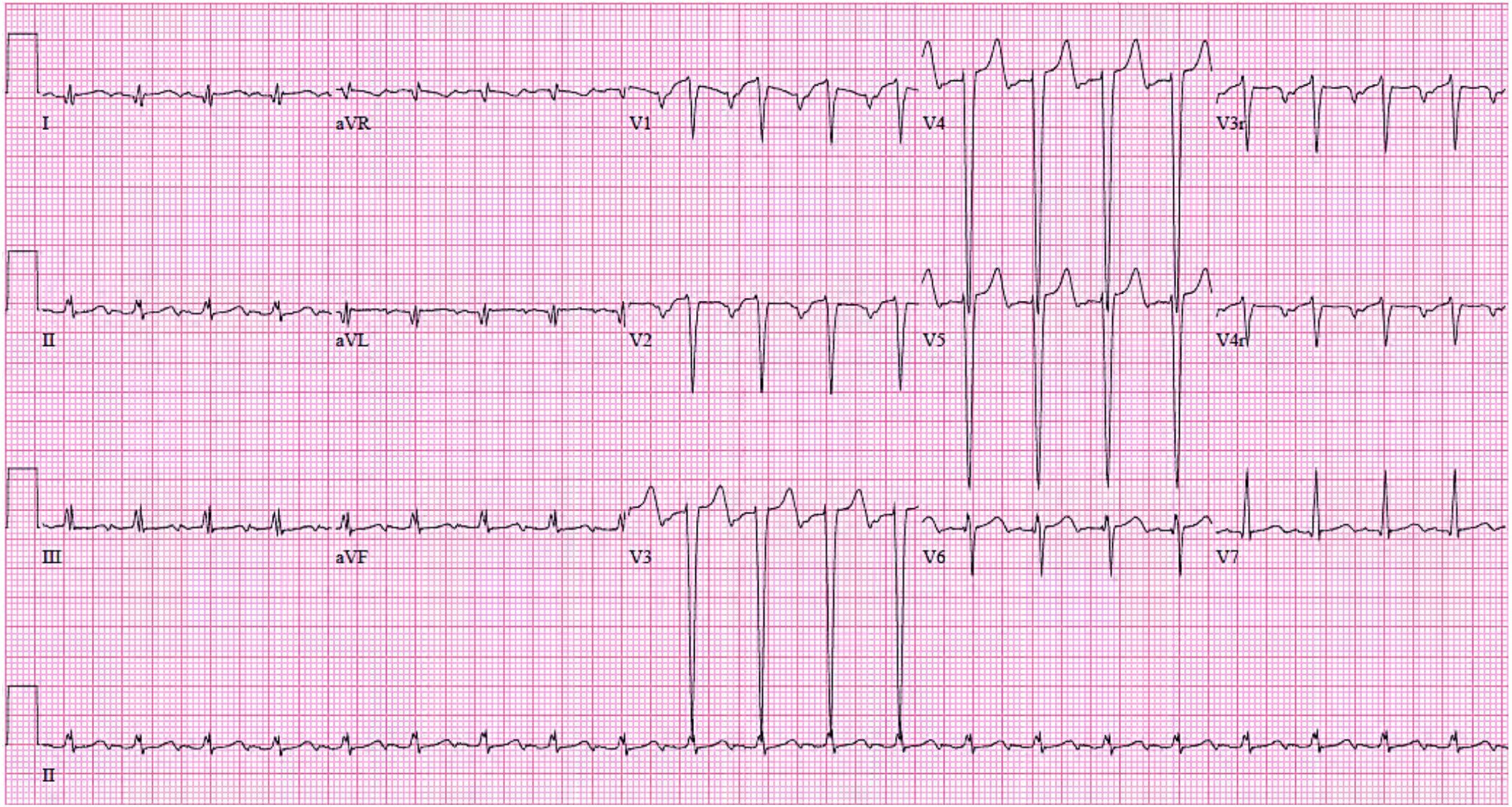


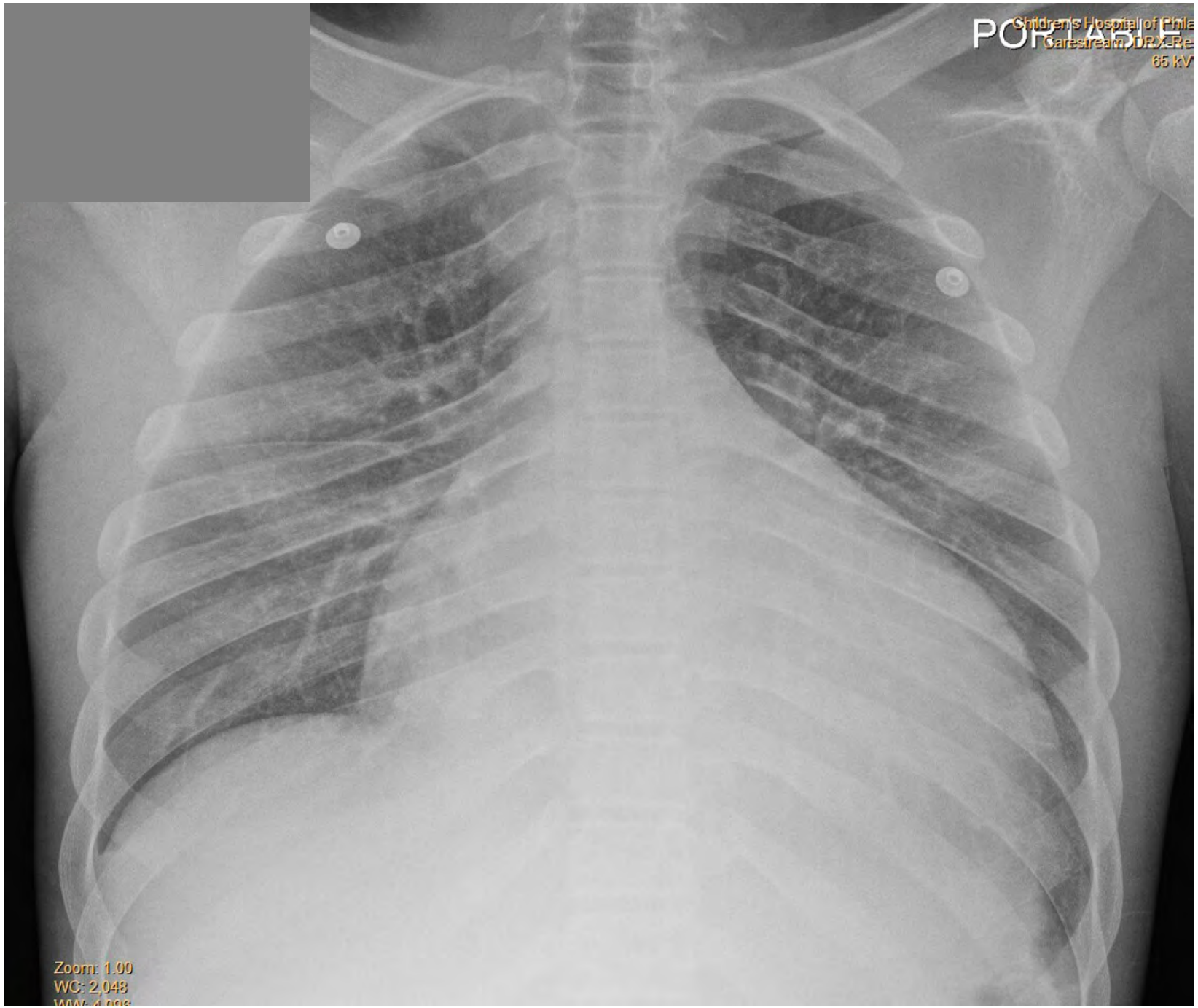
<u>Correct Answer:</u> Ectopic atrial rhythm (tachycardia) from left atrium

-P waves positive in Lead V1

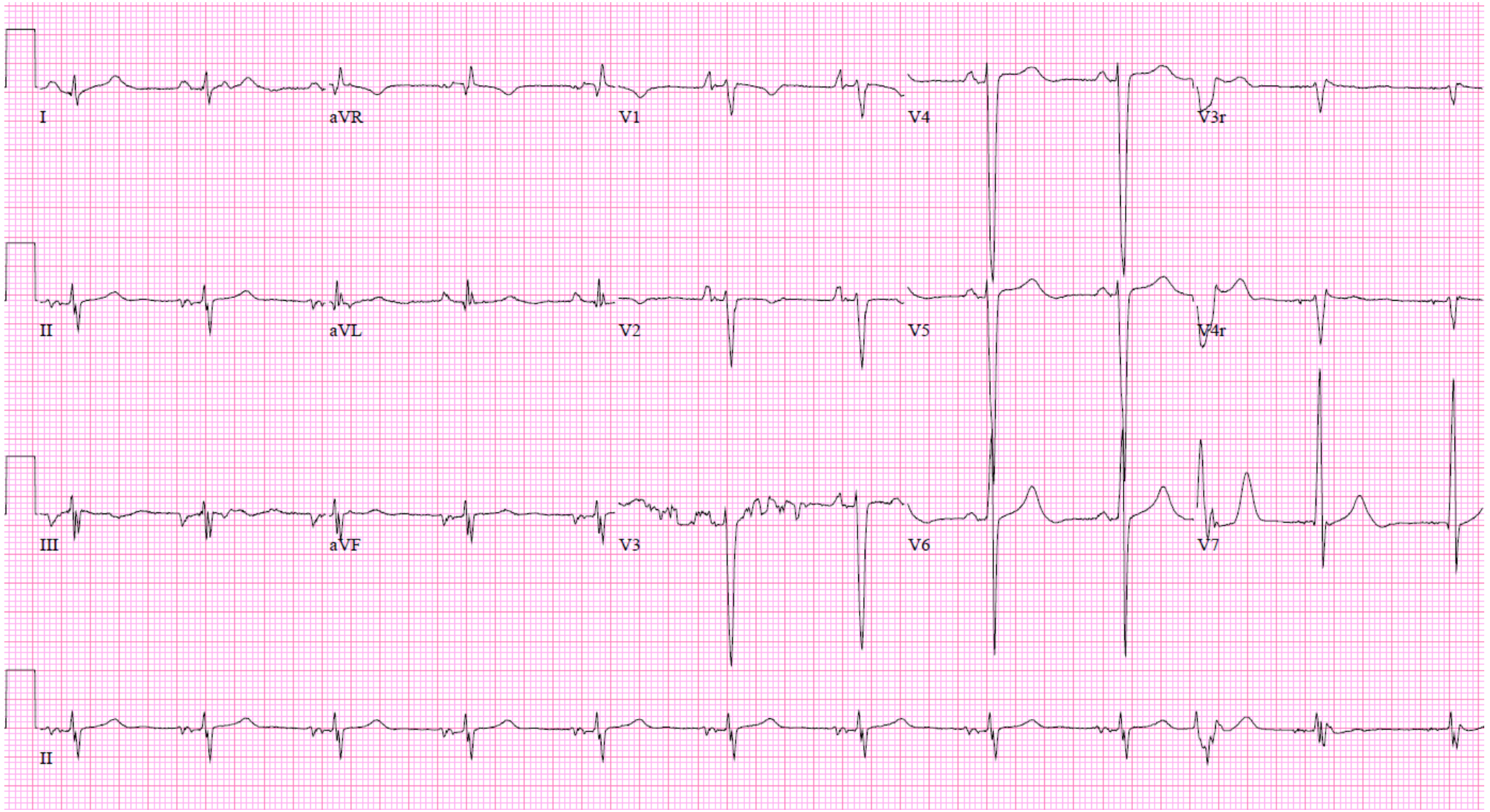
-P waves negative in I and aVL

14 year old with shortness of breath:
HR 127 bpm, PR 214 ms

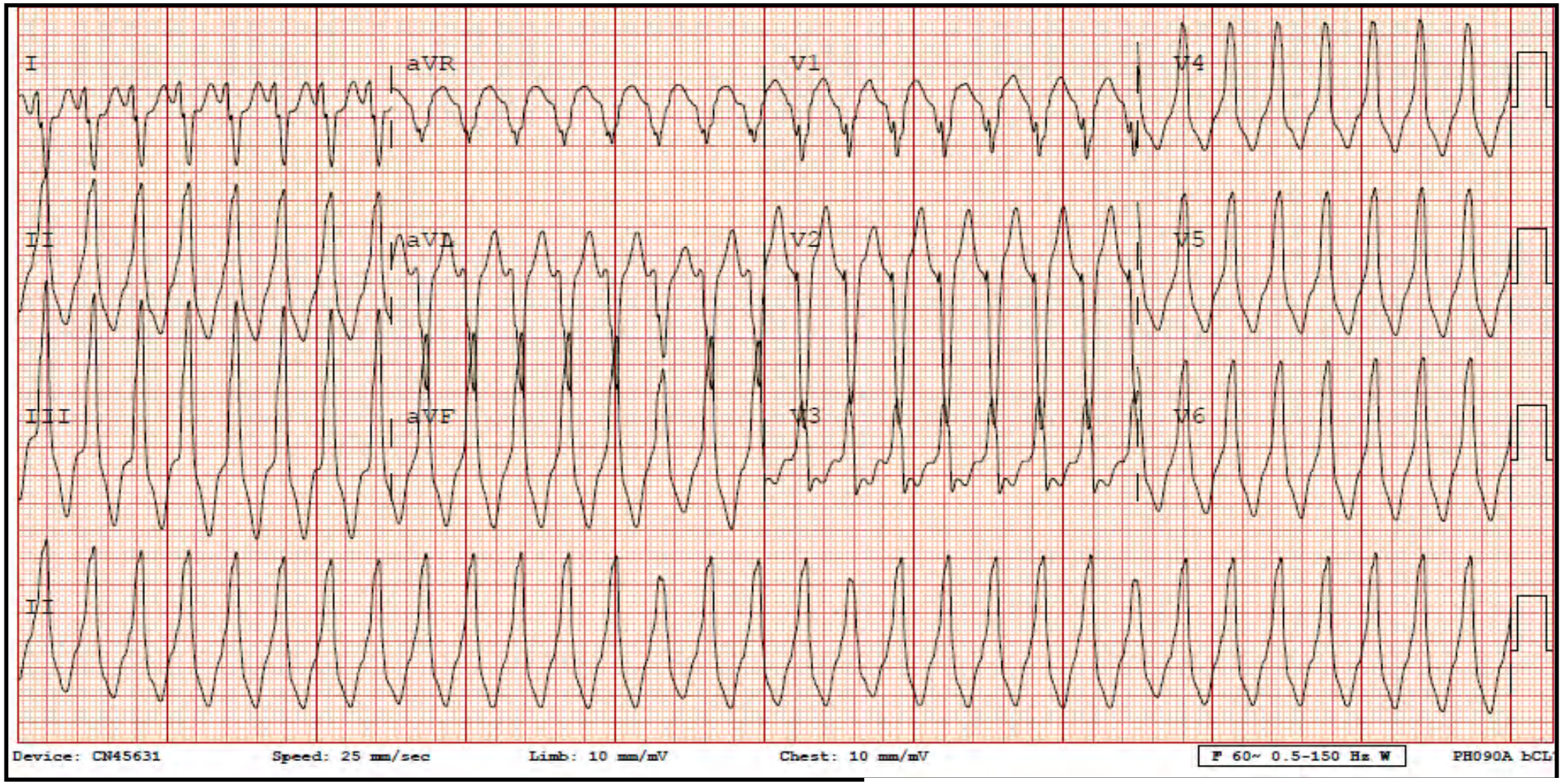



PORTABLE
Children's Hospital of Phila
Carestream DRX-Re
65 kV
Zoom: 1.00
WC: 2,048

Post Procedure:



15 year old male presents to the ER with palpitations



1. **Sinus tachycardia**
2. **Supraventricular tachycardia**
3. **Ventricular tachycardia**
4. **Junctional ectopic tachycardia**

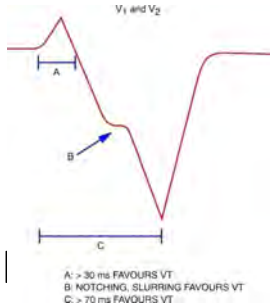
<u>Correct Answer:</u> Ventricular Tachycardia
Note LBBB pattern,
Inferior directed QRS axis
Substrate from RVOT

1 year old with poor feeding: Heart Rate: 280 b.p.m.

Wide Complex Tachycardia

- Conduction occurring *outside* of the His Purkinje system- VT, Antidromic AP conduction
- Slowed conduction *within* the His Purkinje system- Aberrancy

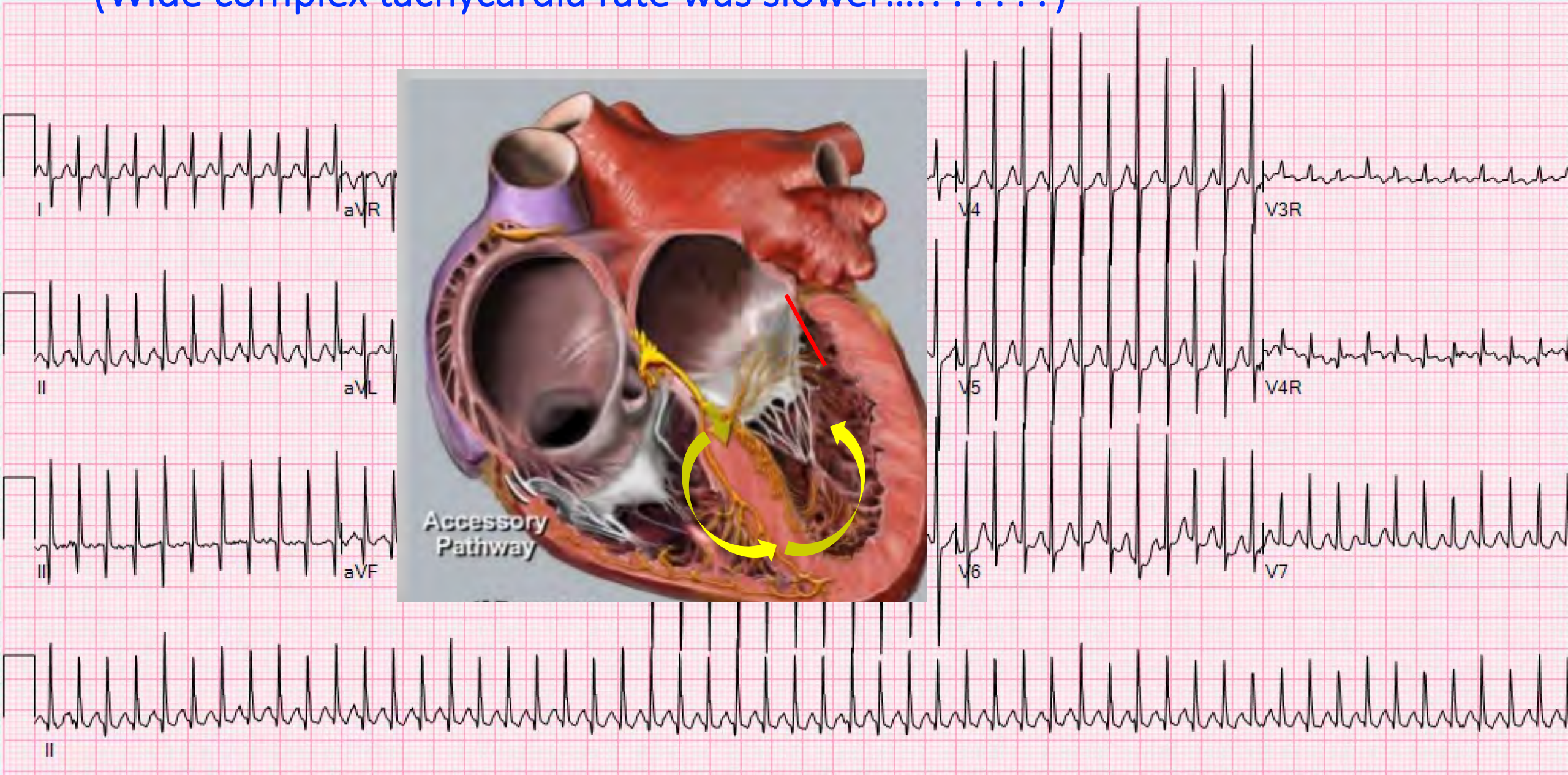
Clues to Differentiating VT from Aberrancy:



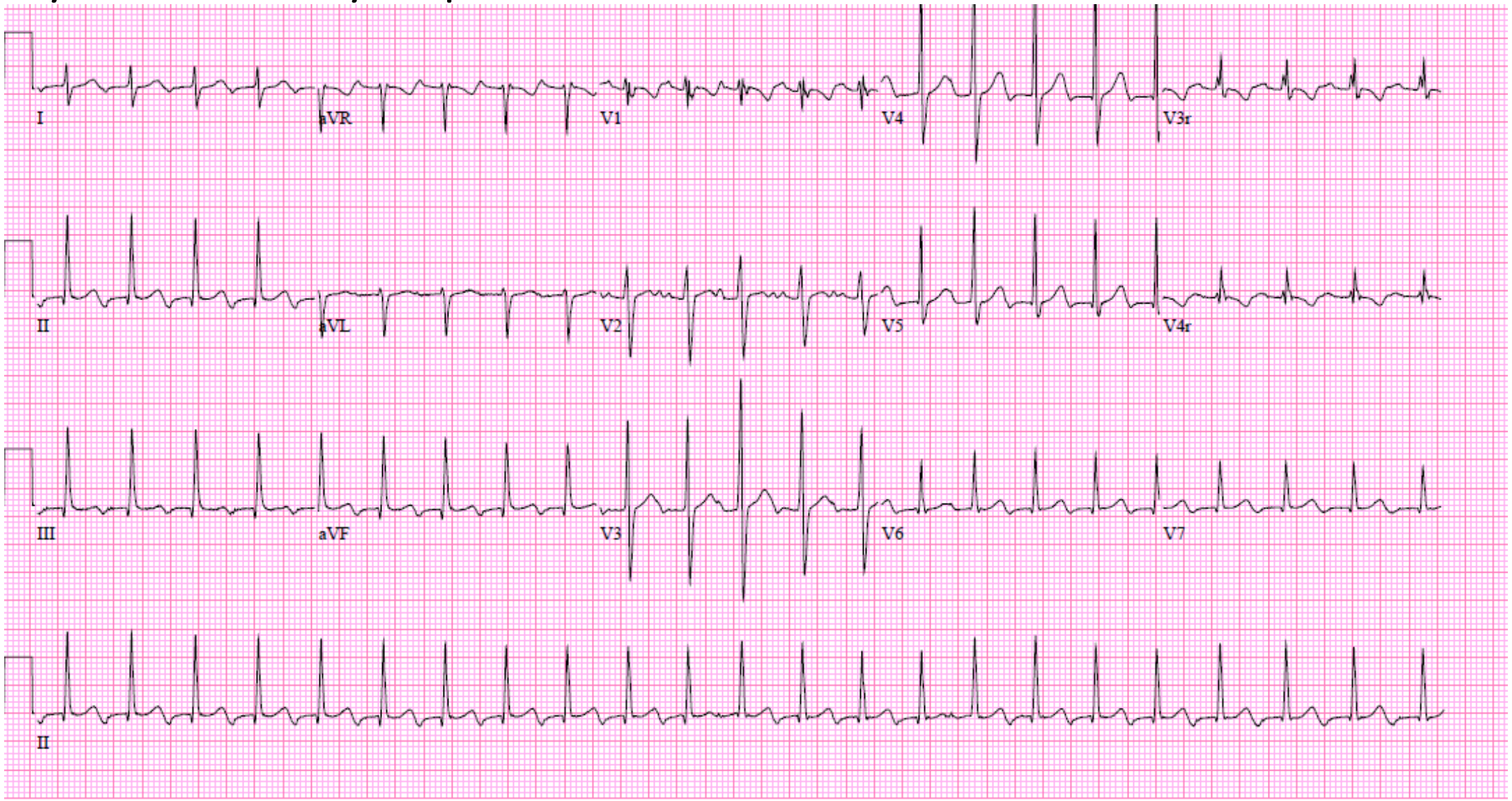
-Absence of typical RBBB or LBBB morphology
-Extreme QRS axis deviation
VA dissociation
Capture beats —transient ‘ normal capture’ of the ventricles- normal
Fusion beats —sinus + ventricular beat =a hybrid complex
Positive or negative concordance throughout the precordial (chest) leads,
Brugada sign – QRS complex to the nadir of the S-wave is > 100ms (V1,V2)
Josephson sign – Notching near the nadir of the S-wave (V1, V2)
RSR’ complexes with a taller left rabbit ear. *Note: This is in contrast to RBBB, where the right rabbit ear is taller.*

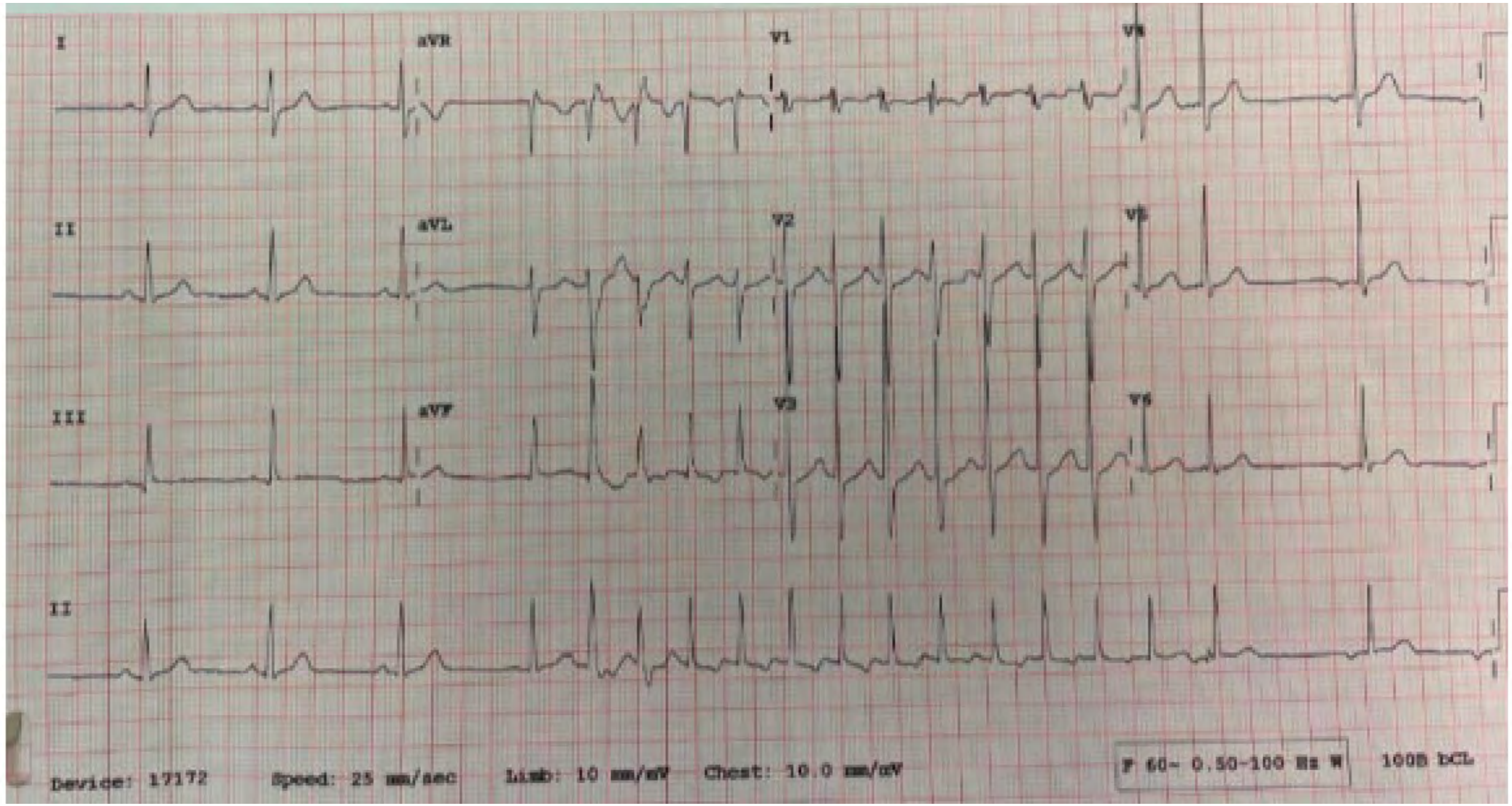
Same Patient: Narrow complex tachycardia : 310 b.p.m.

(Wide complex tachycardia rate was slower….??????)

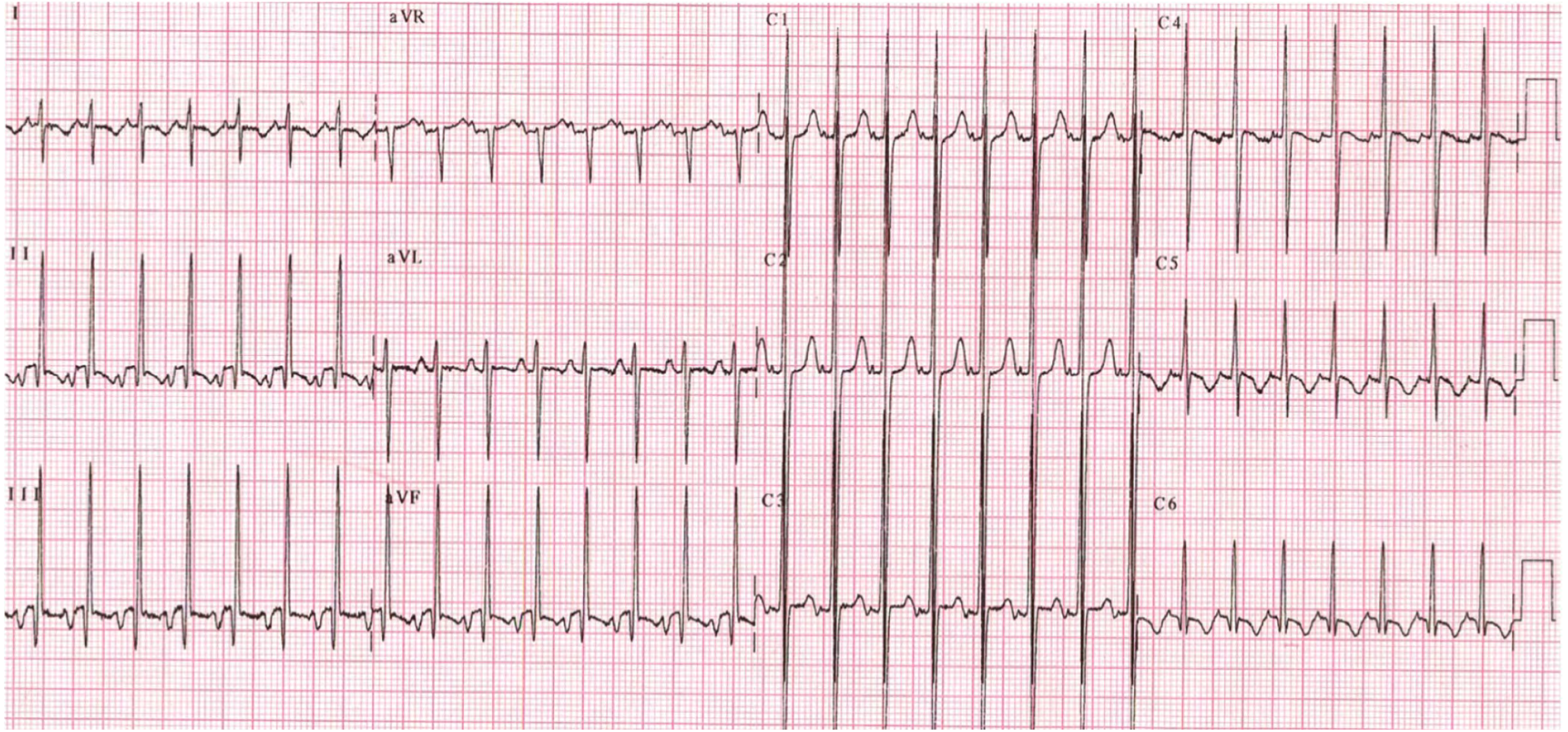


8 year old with syncope




I
aVR
V1
V4
II
aVL
V2
V5
III
aVF
V3
V6
II
Device: 17172
Speed: 25 mm/sec
Limb: 10 mm/mV
Chest: 10.0 mm/mV
F 60~ 0.50-100 Hz W
100B 5CL

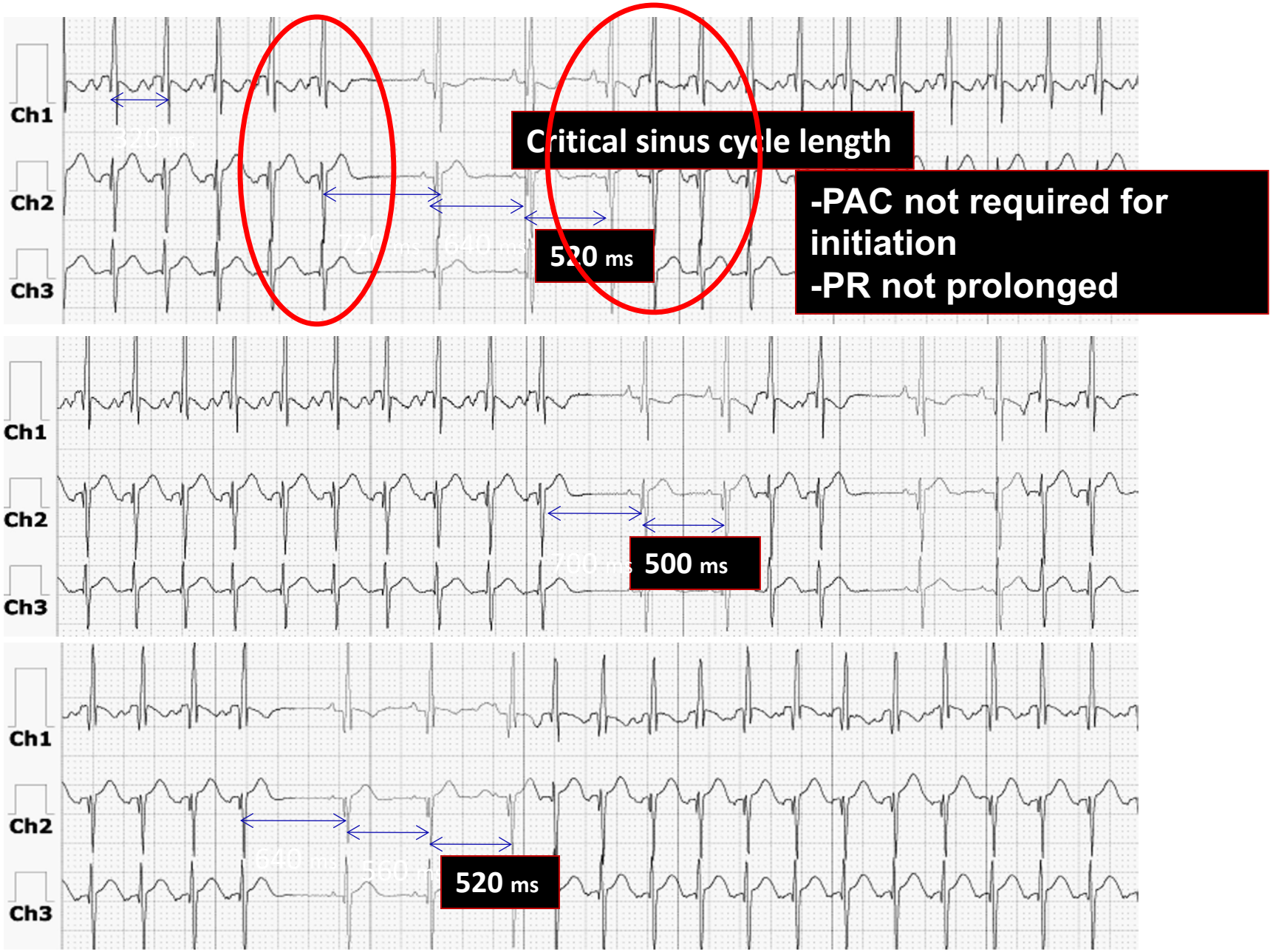
6 month old infant with failure to thrive



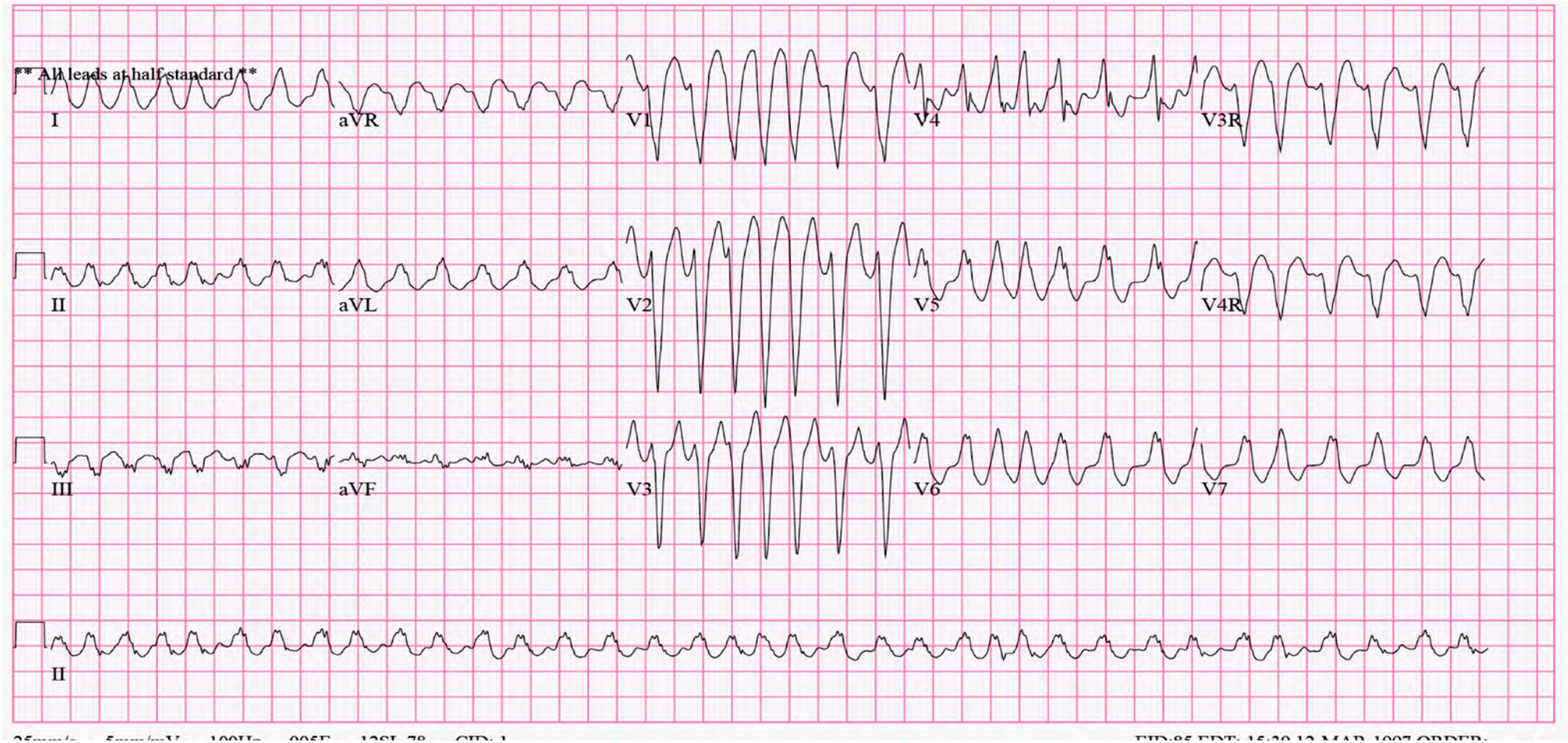
1. Supraventricular Tachycardia
2. Ventricular tachycardia
3. Junctional Ectopic Tachycardia
4. Sinus tachycardia with Rate Related Aberrancy

Correct Answer: SVT (PJRT)
-Note RP>PR
-negative P waves in II, III, avF

Ambulatory Monitoring:



15 year old with h/o palpitations and syncope while watching T.V.

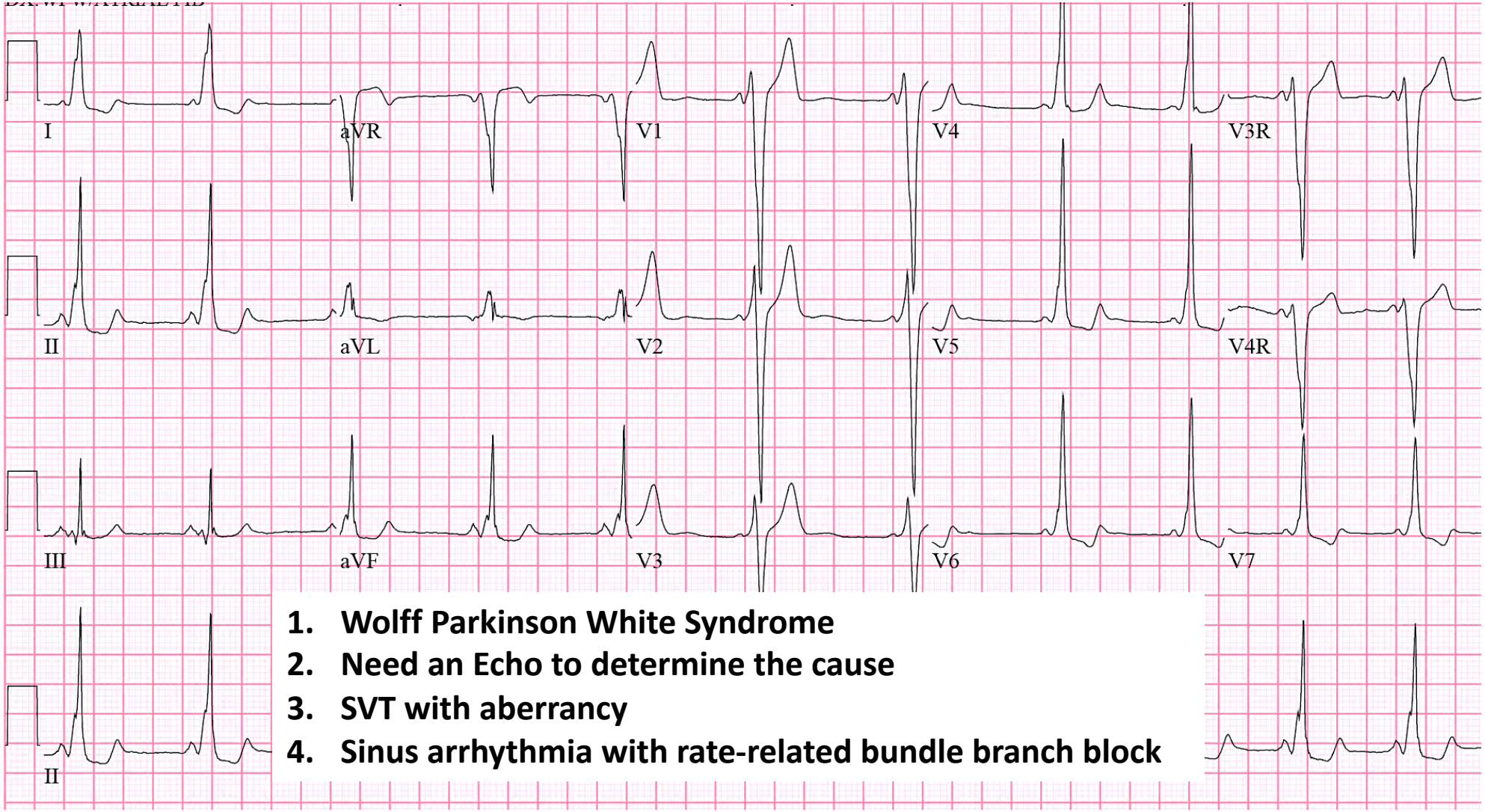


1.Ventricular tachycardia
2.Sinus tachycardia with Right Bundle Branch Block
3.Sinus tachycardia with Left Bundle Branch Block
4.Pre-excited Atrial Fibrillation

Based on this EKG what is the next most appropriate step?

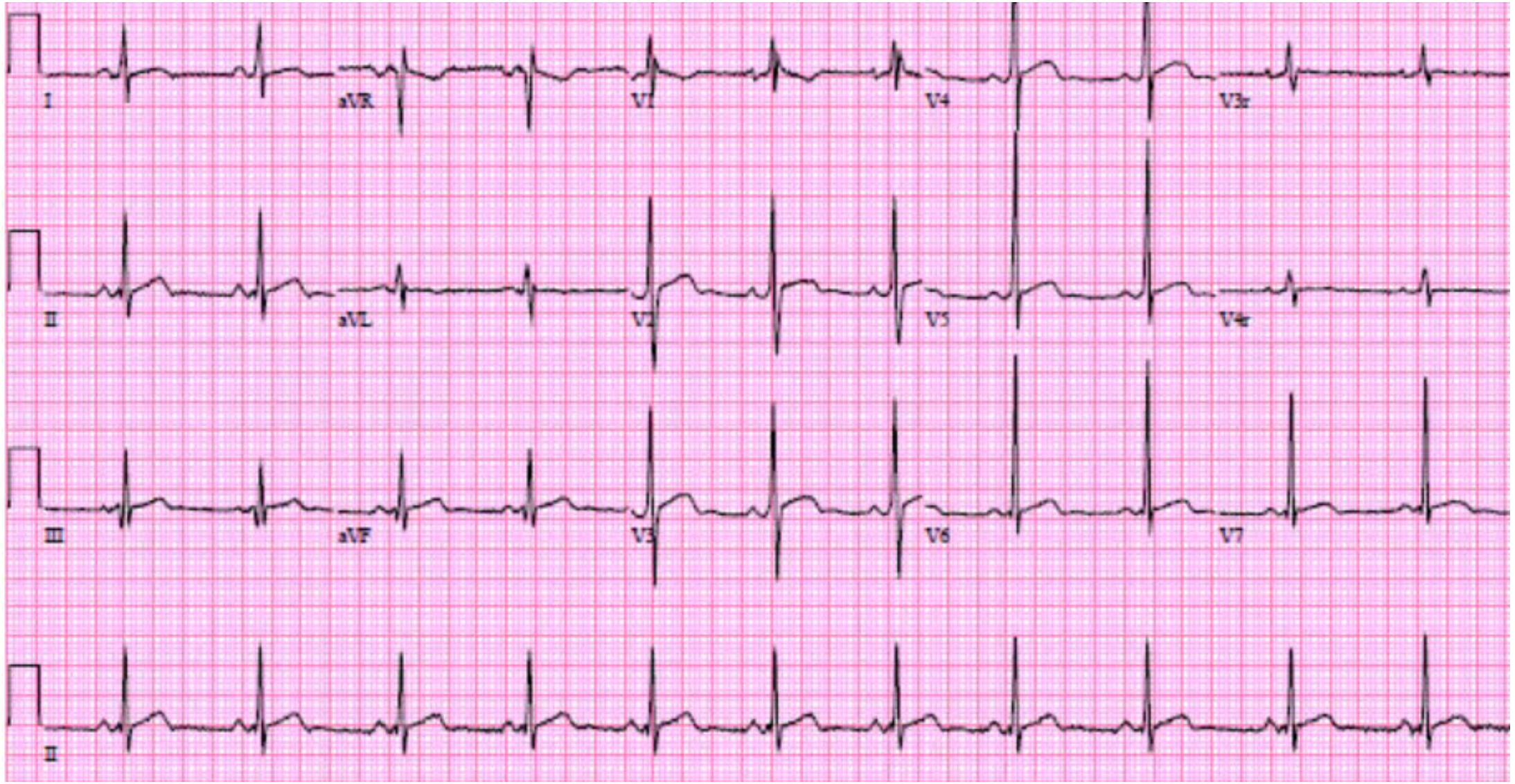
1. **Observation for spontaneous termination**
2. **I.V. Lidocaine**
3. **i.v. procainamide**
4. **DC Cardioversion**
5. **Check electrolytes**

What was the most likely cause for the patient's wide complex tachycardia?

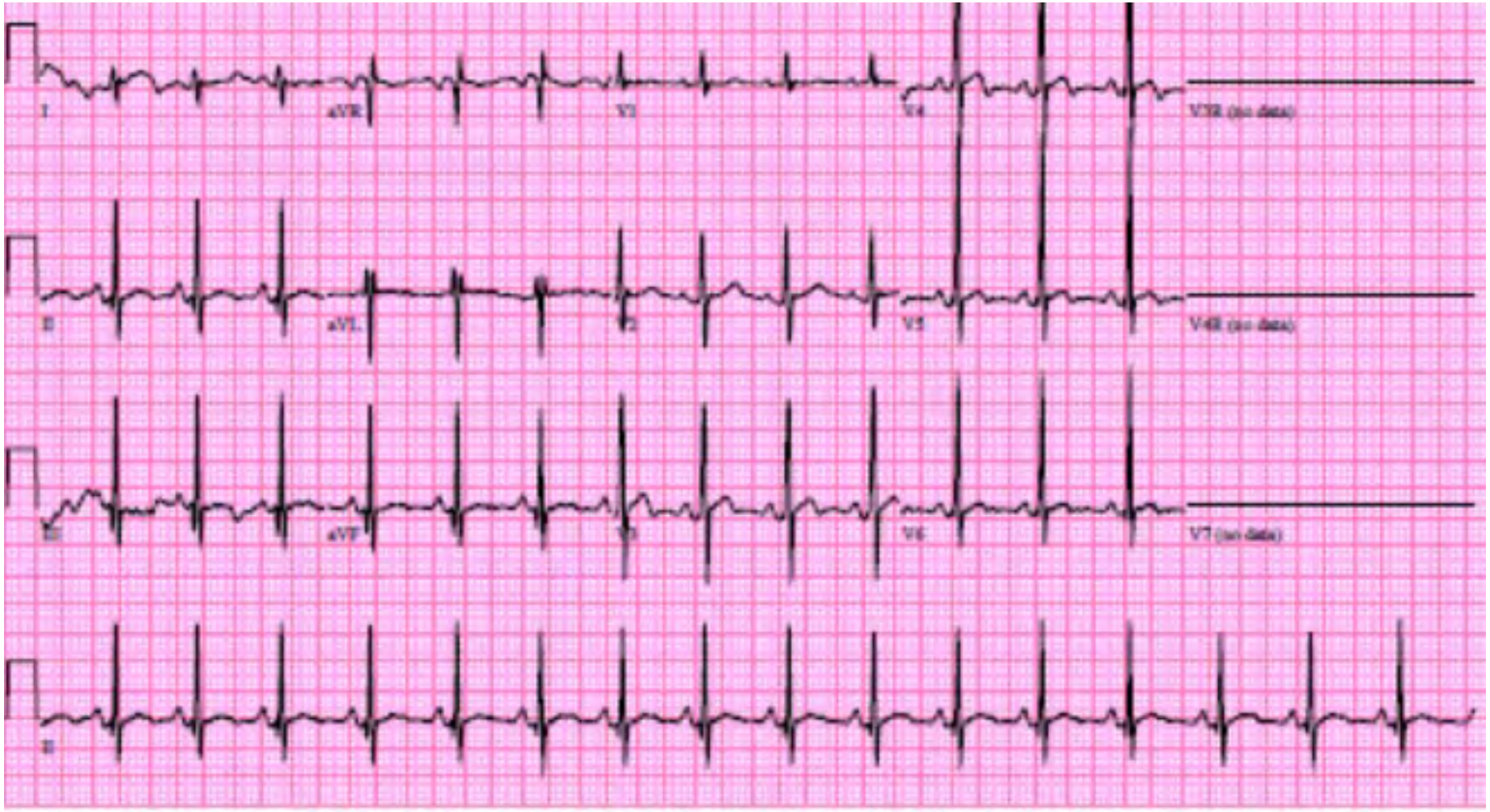


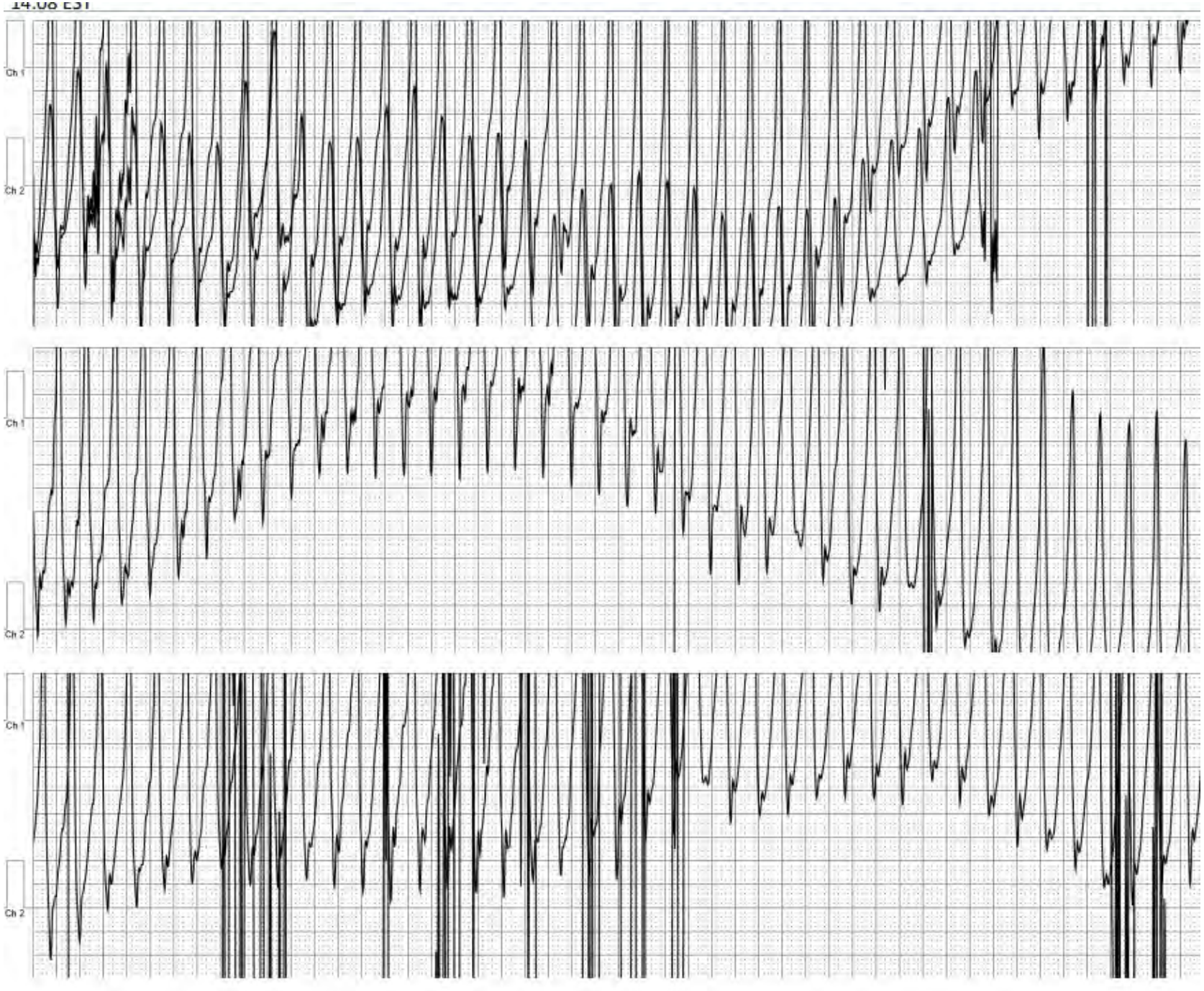
1. **Wolff Parkinson White Syndrome**
2. **Need an Echo to determine the cause**
3. **SVT with aberrancy**
4. **Sinus arrhythmia with rate-related bundle branch block**

14 year old with palpitations



Exercise Stress Test: HR 115 b.p.m

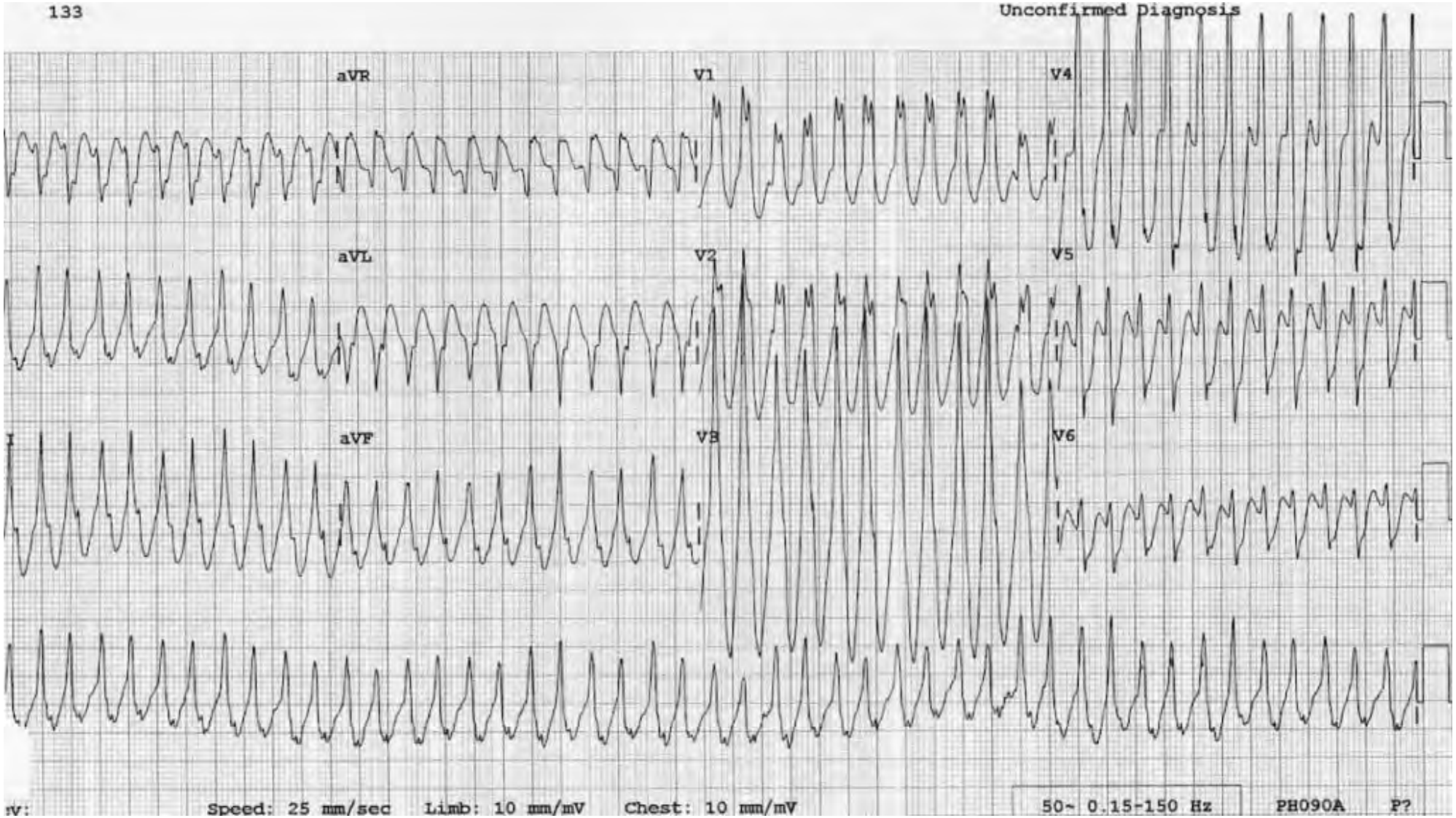




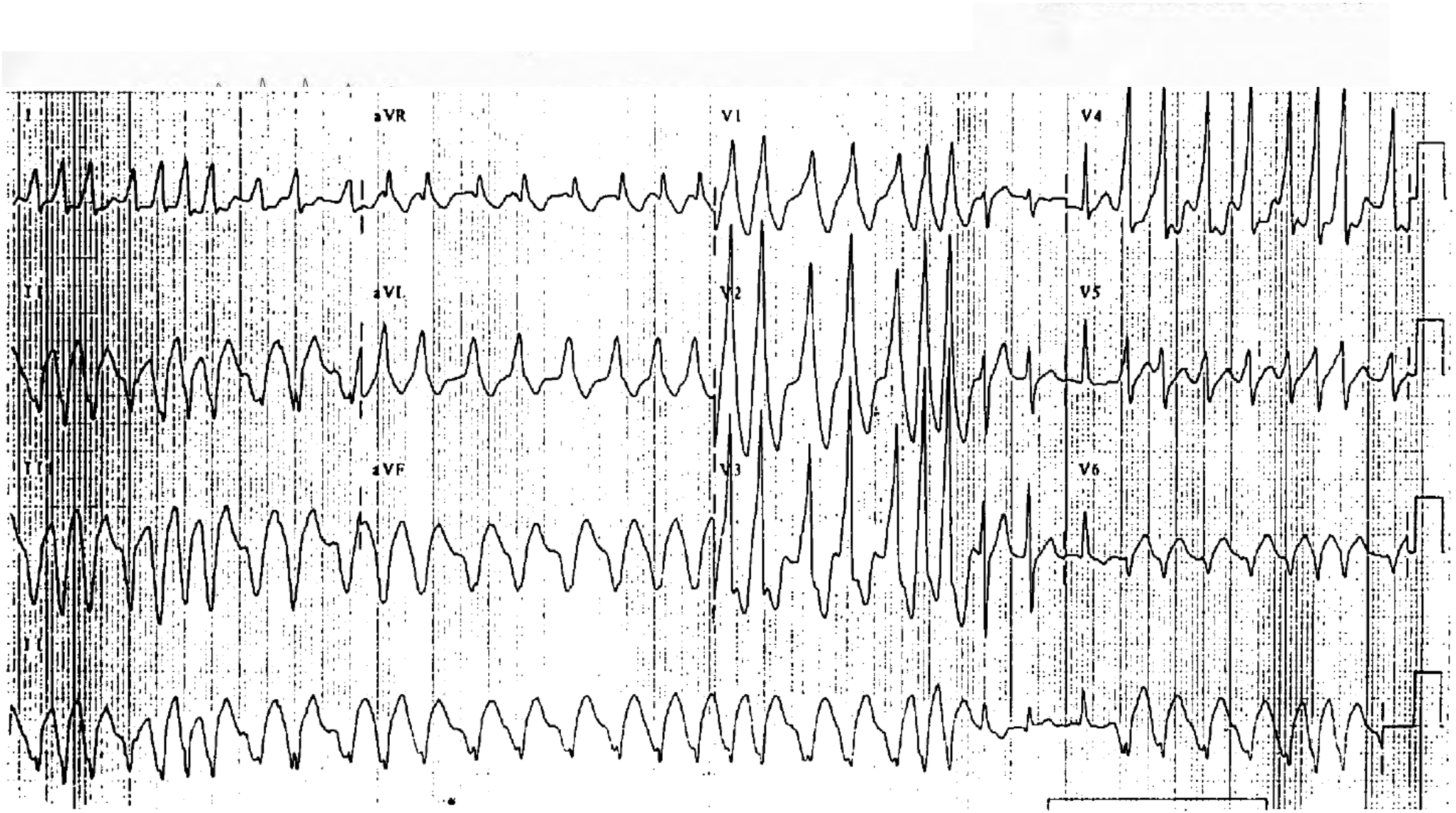
Same patient..

1. Artefact
2. Aberrancy
3. SVT
4. VT

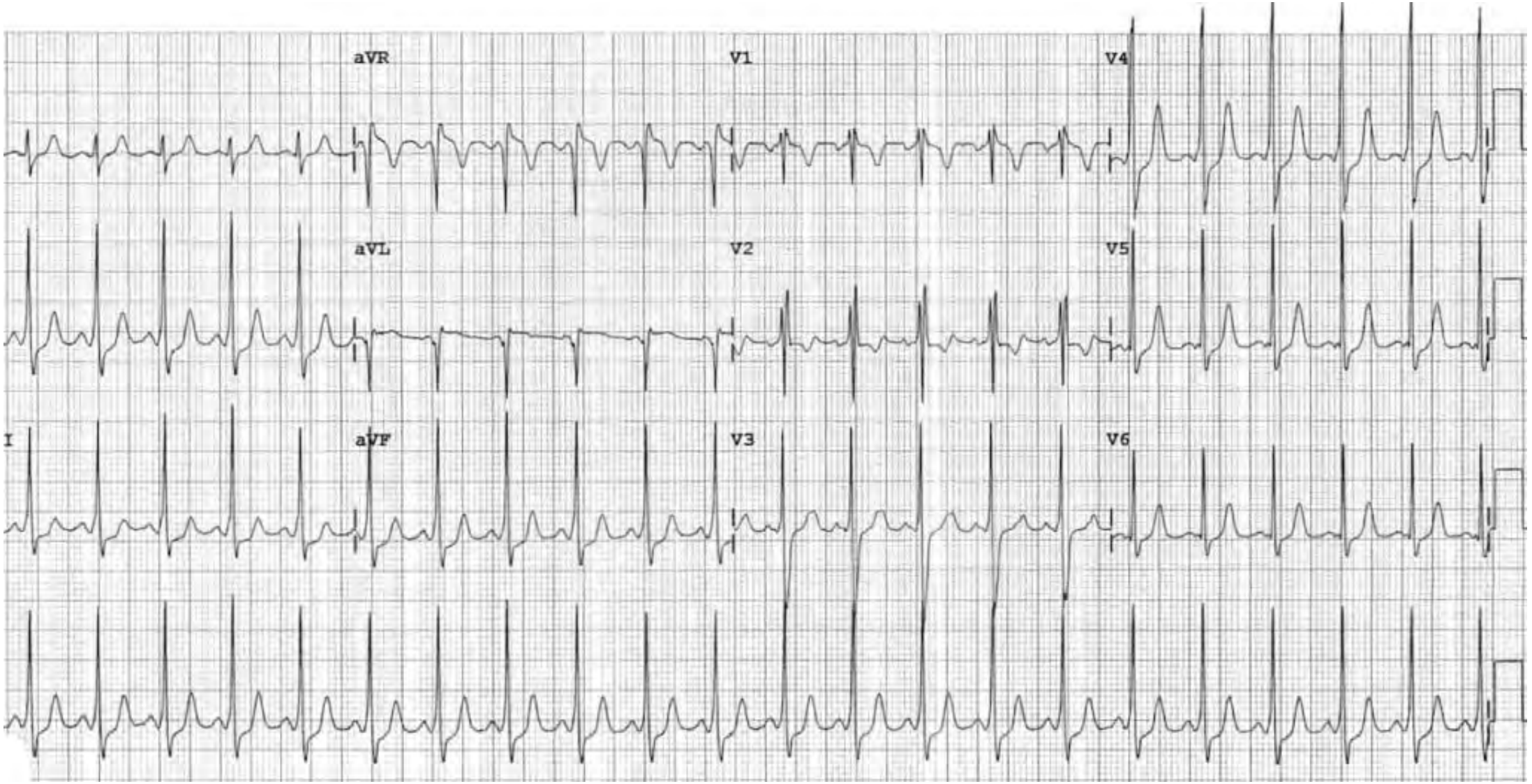
18 year old: SVT or VT ???



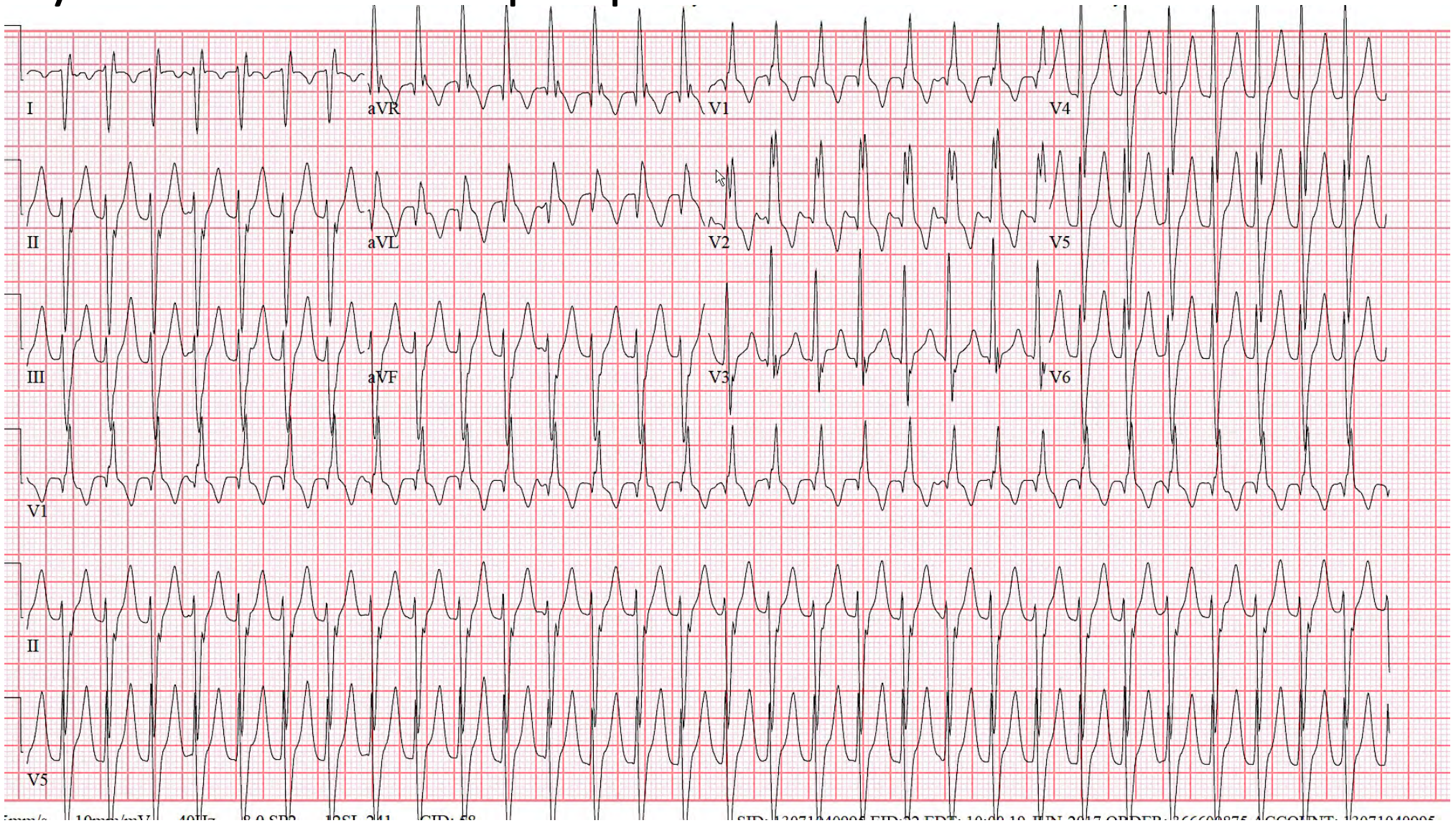
What's the worse that could happen?



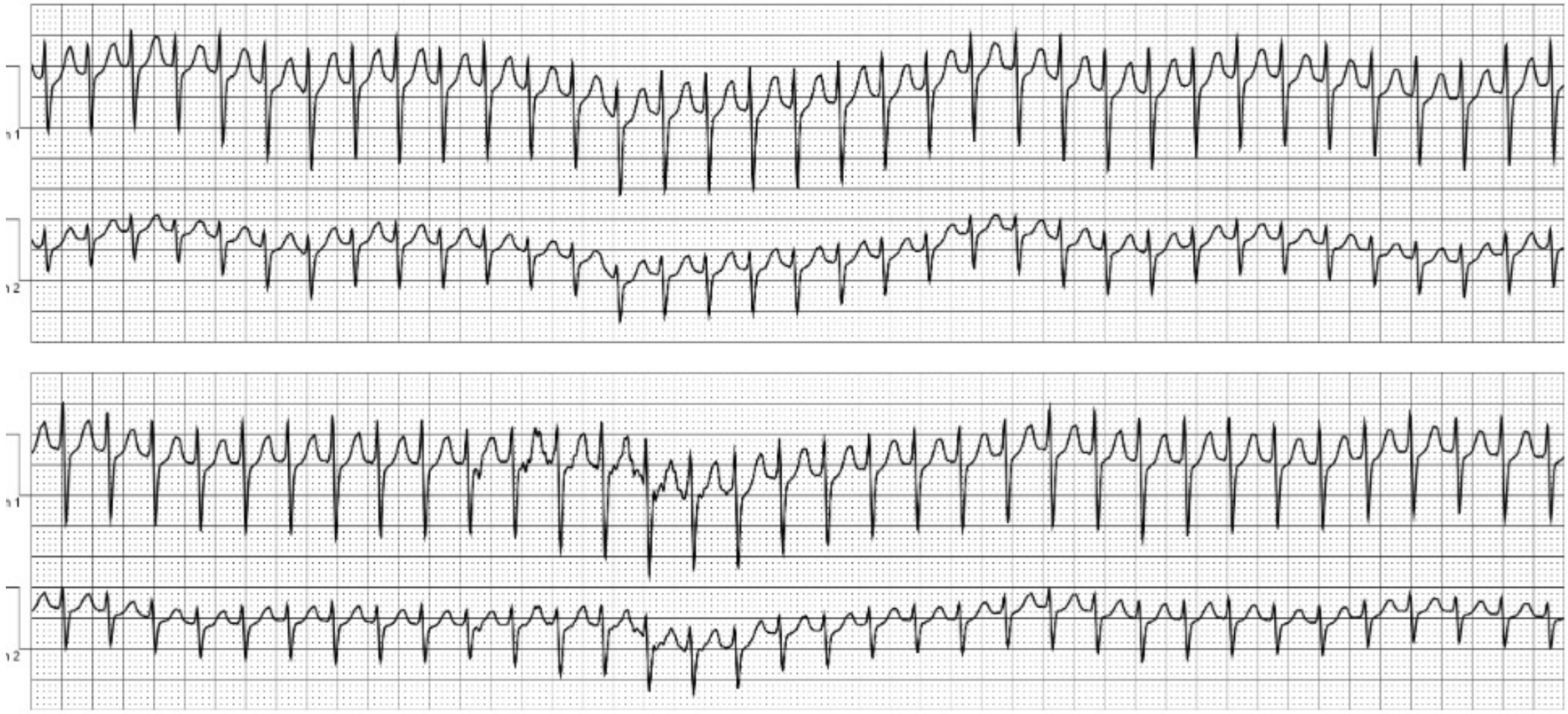
s/p DC defibrillation



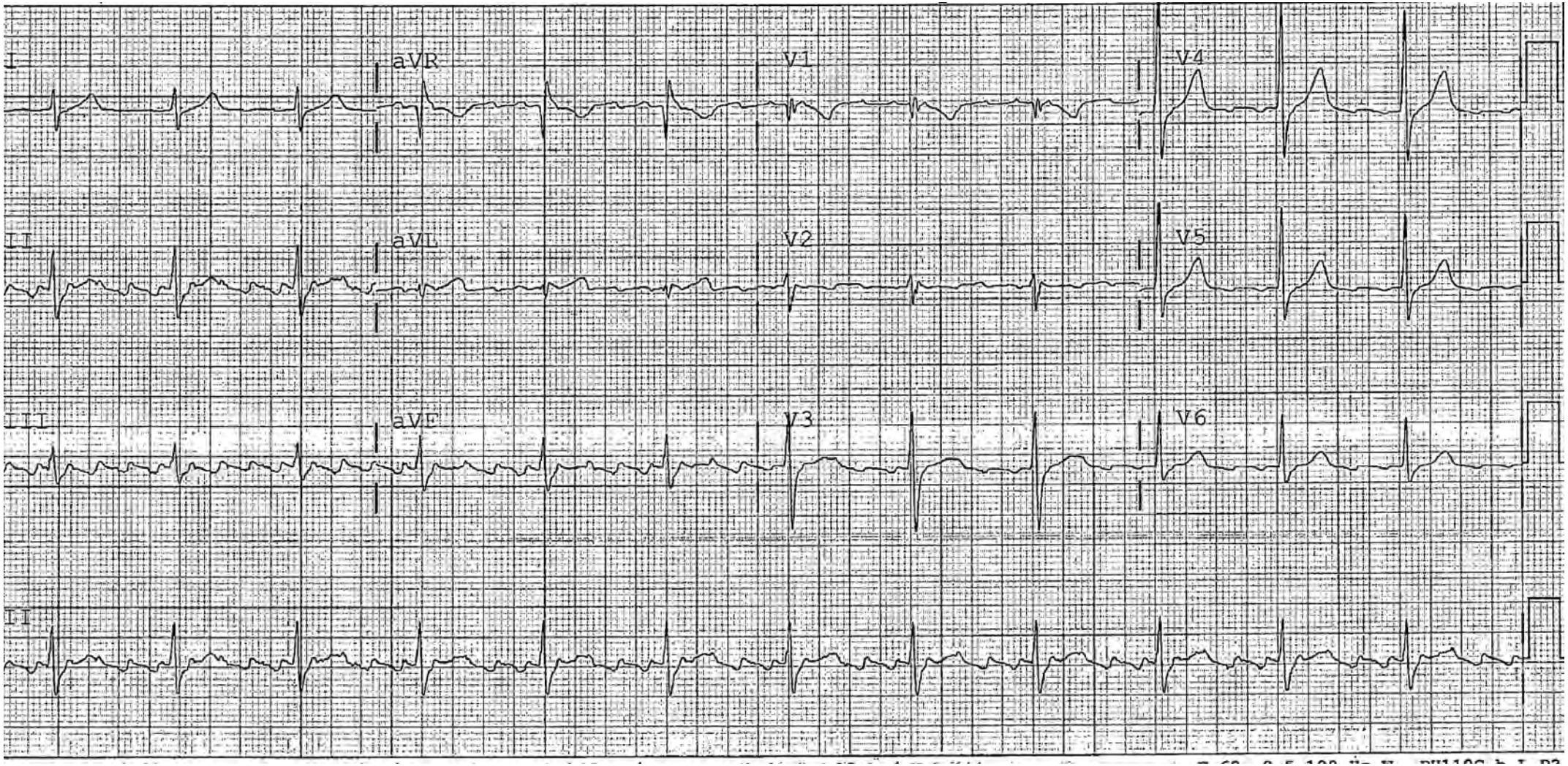
7 year old with palpitations:



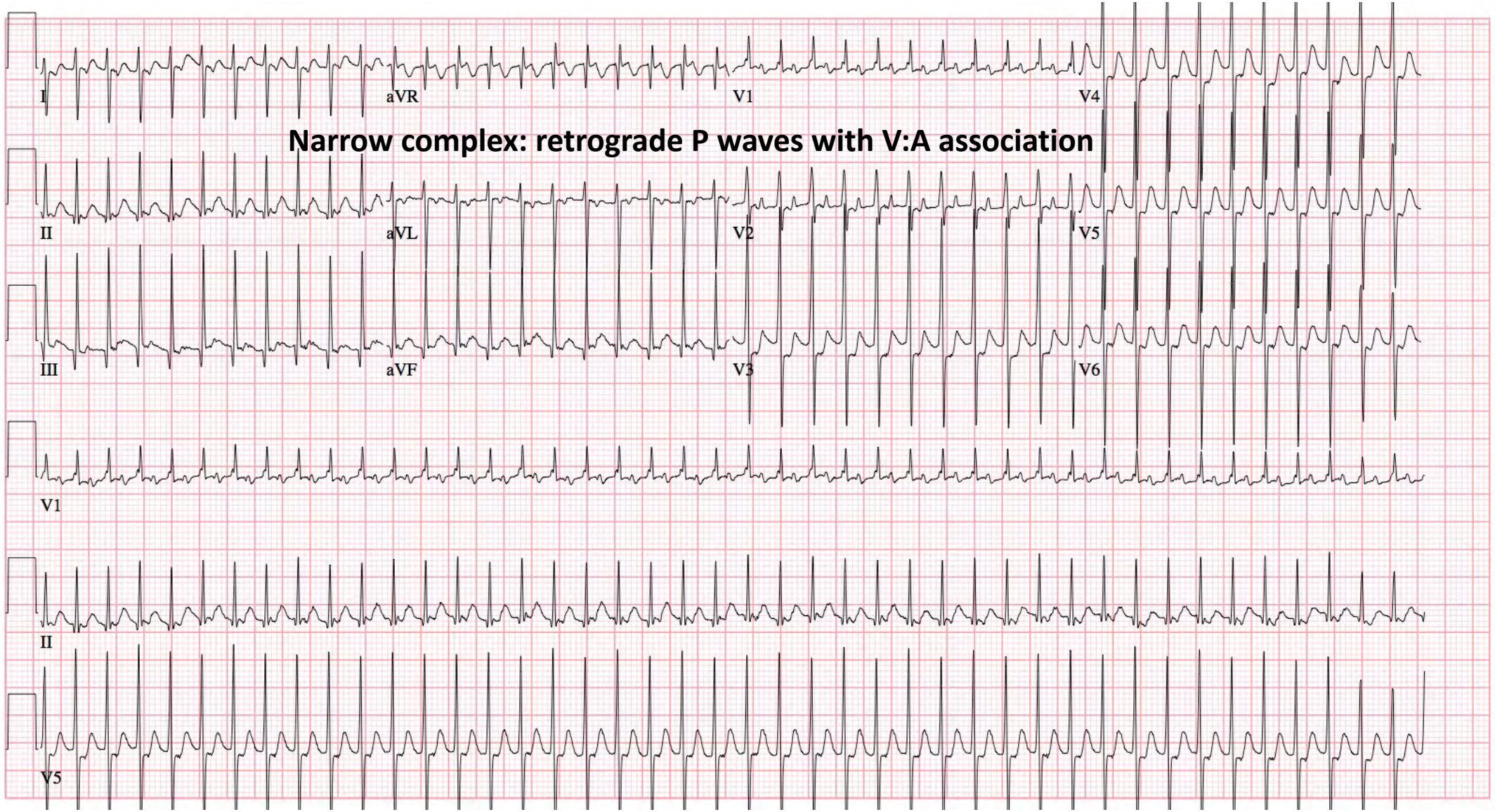
14 year old with palpitations



14 year old with palpitations – 15 minutes later the ER states that patient has “converted”!

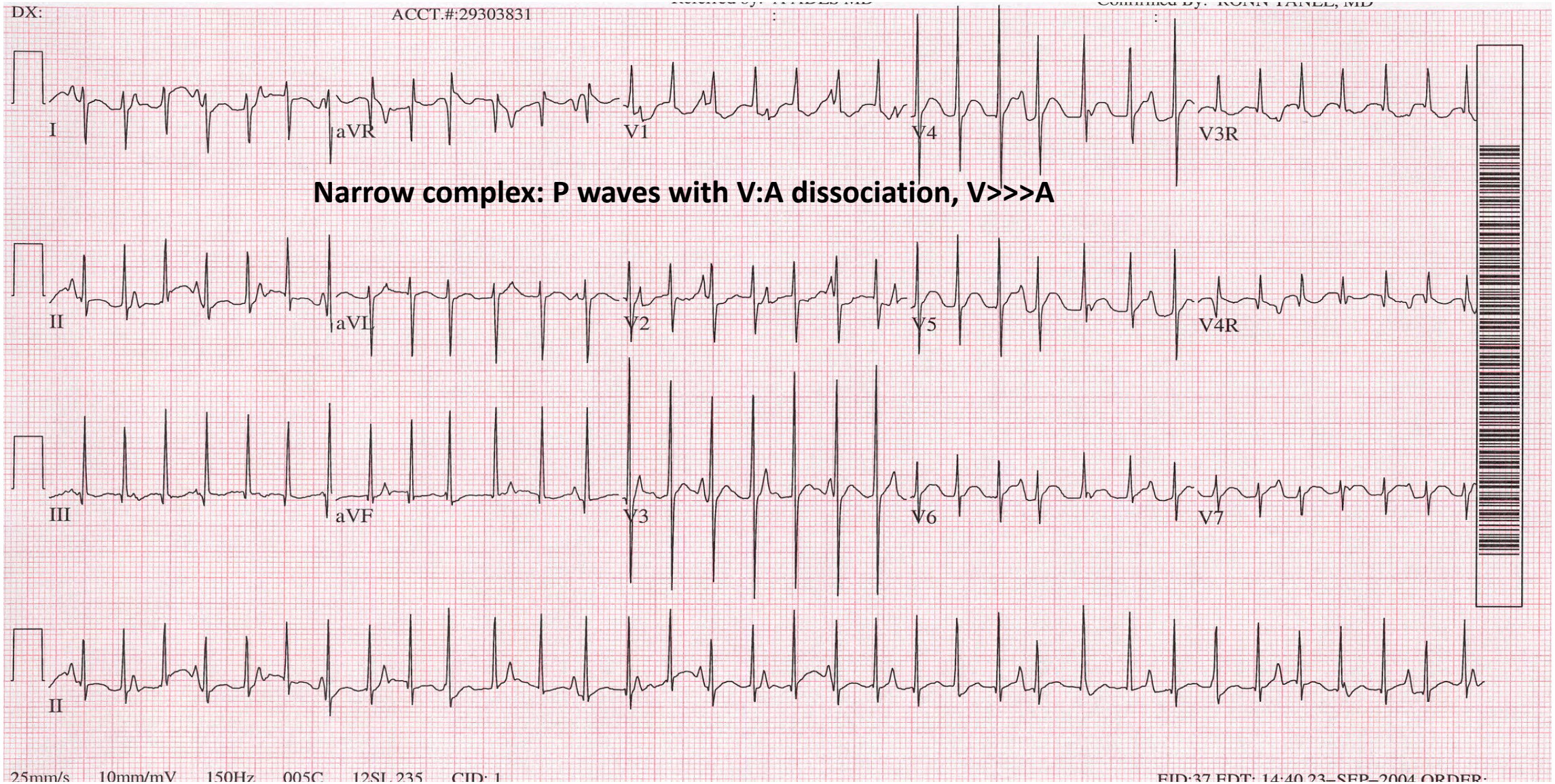


10 year old with palpitations in ER



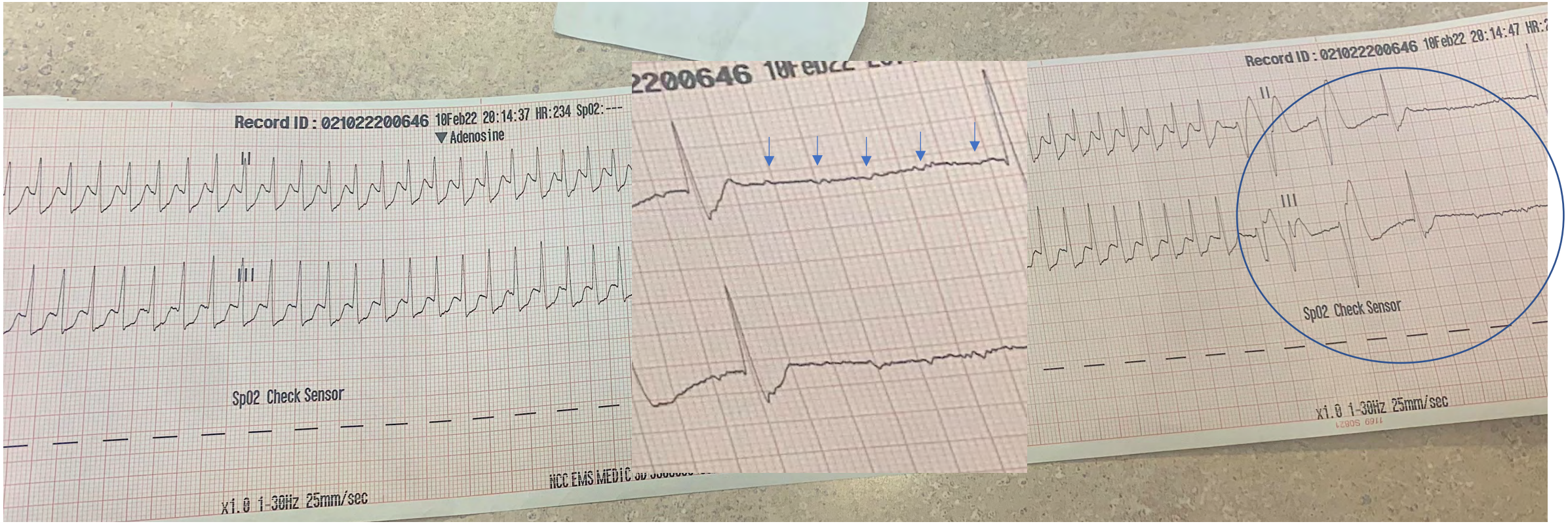
Narrow complex: retrograde P waves with V:A association

10 year old with tachycardia

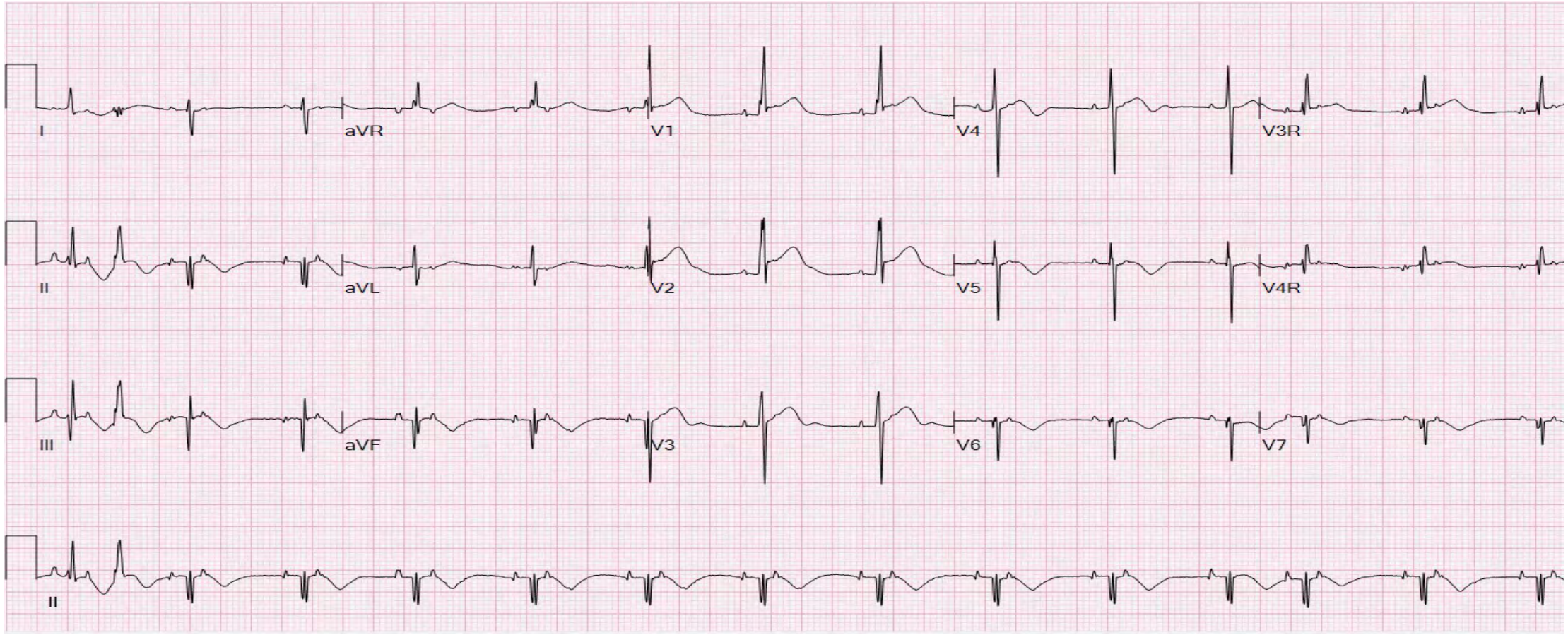


Narrow complex: P waves with V:A dissociation, V>>>A

16 year old with palpitations and syncope s/p adenosine



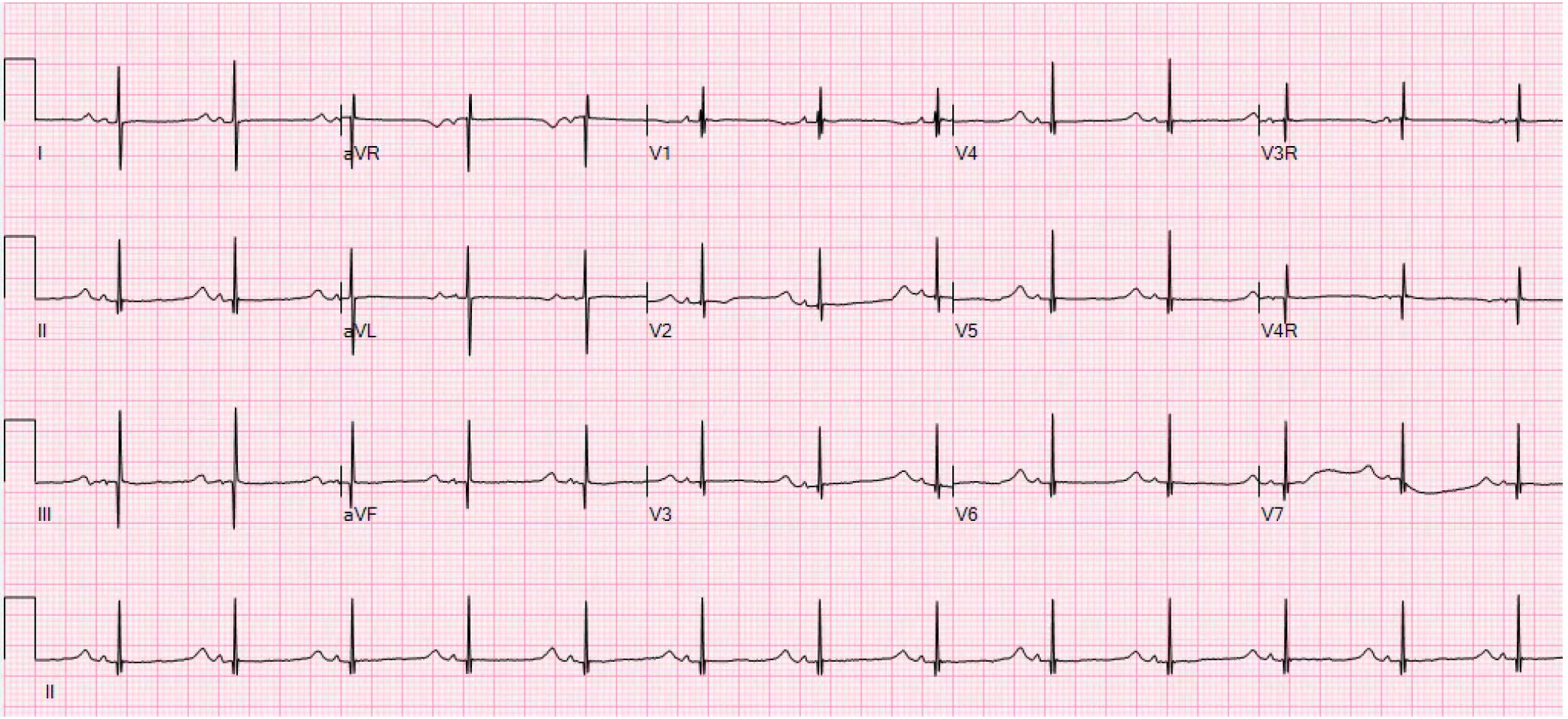
1 week old NICU baby: Bradycardia



1. **Sinus Rhythm**
2. **3rd Degree Atrioventricular Block**
3. **Non conducted premature atrial ectopic complexes**
4. **Prolonged QT syndrome**

Correct answer:
-Non conducted premature atrial ectopic complexes

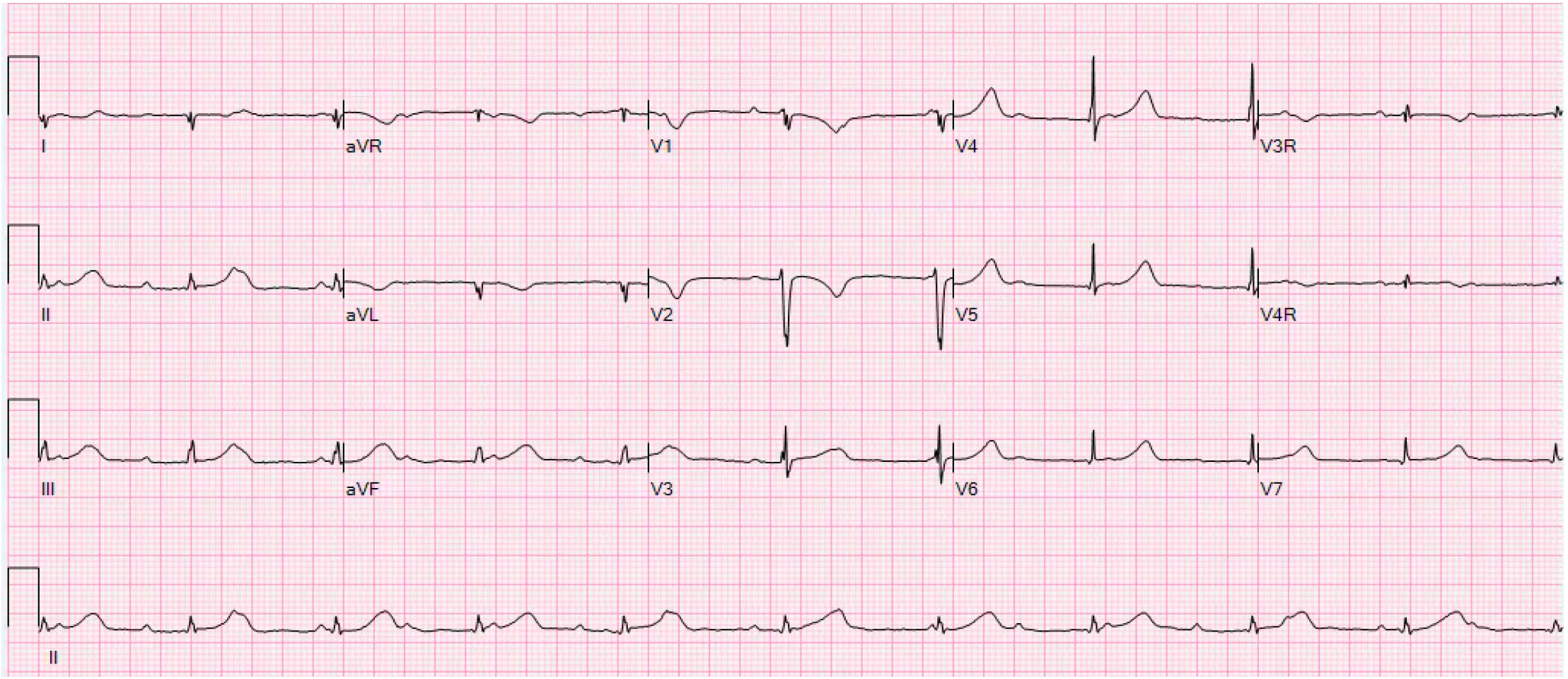
1 week old NICU baby: Bradycardia



1. **Sinus Rhythm**
2. **3rd Degree Atrioventricular Block**
3. **Non conducted premature atrial ectopic complexes**
4. **Prolonged QT syndrome**

Correct answer:
-Long QT Syndrome

1 week old NICU baby: Bradycardia



1. **Sinus Rhythm**
2. **3rd Degree Atrioventricular Block**
3. **Non conducted premature atrial ectopic complexes**
4. **Prolonged QT syndrome**

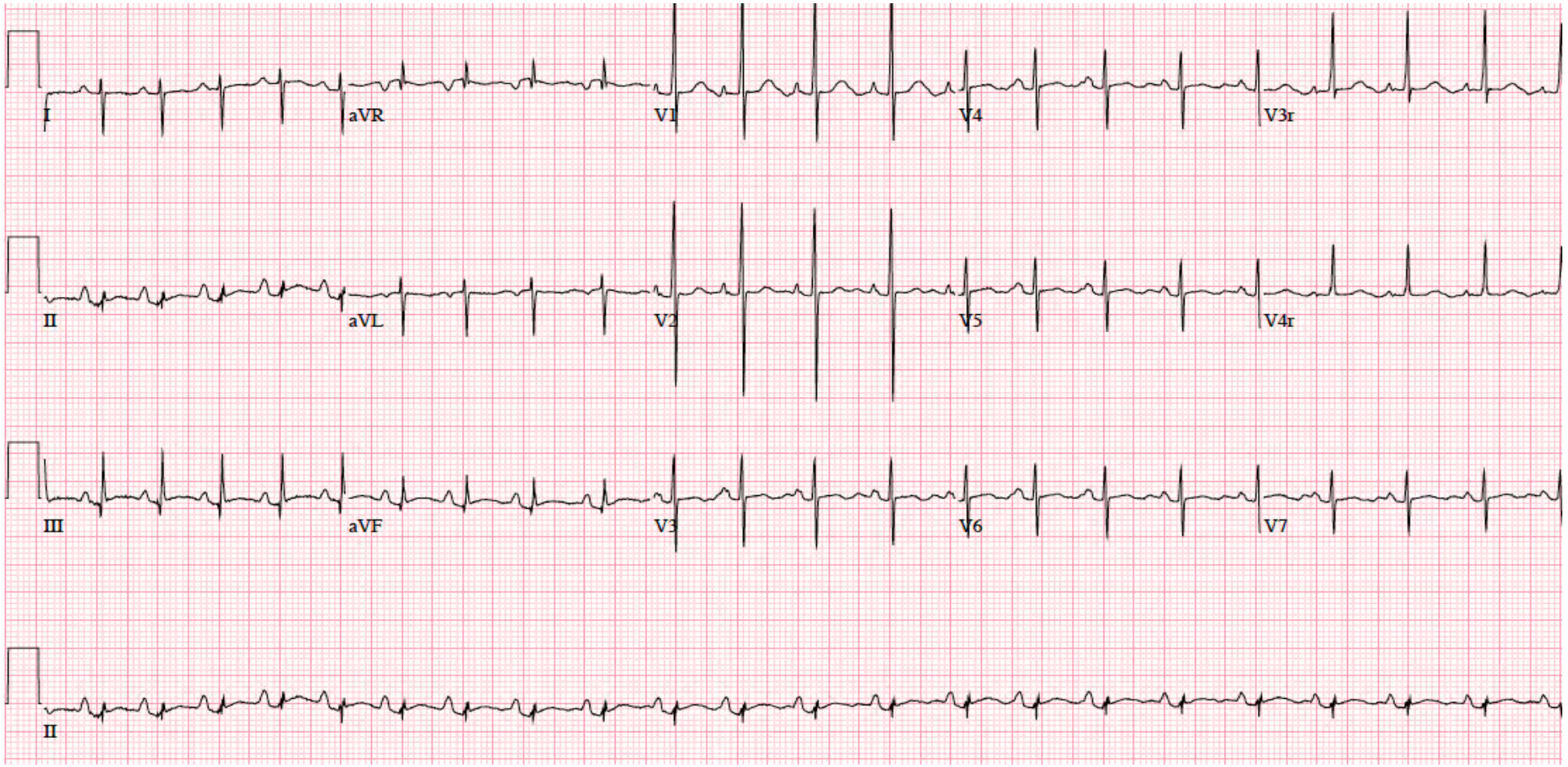
Correct answer:
-3rd degree AV block

Neonatal AV Block

- 2:1 AV block- most likely due to LQTS

- 3rd Degree AV block- most likely due to maternal antibodies

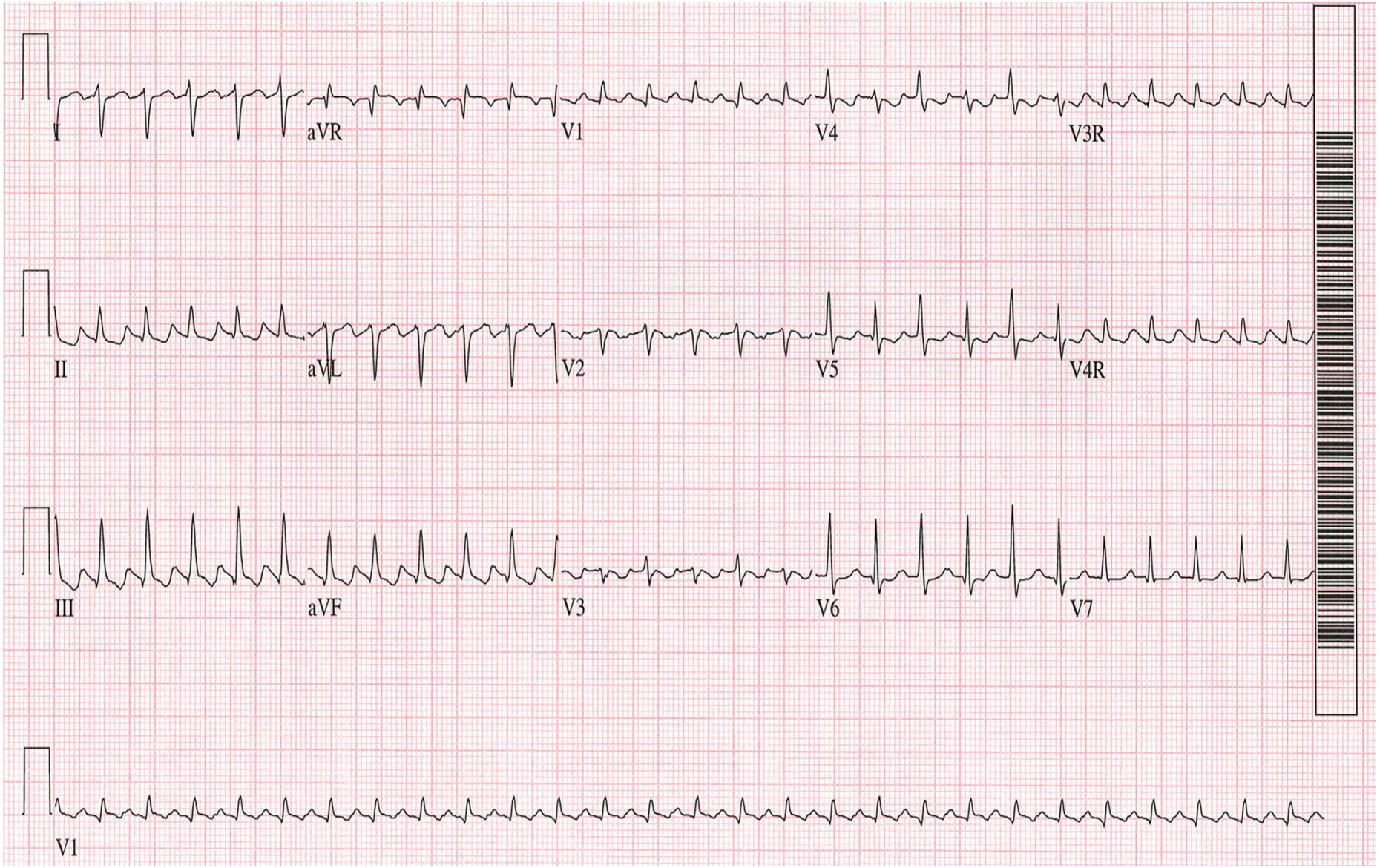
1 week old NICU baby



1. **Normal EKG for age**
2. **Brugada Syndrome**
3. **Wolff Parkinson White Syndrome**
4. **Right Ventricular Hypertrophy**

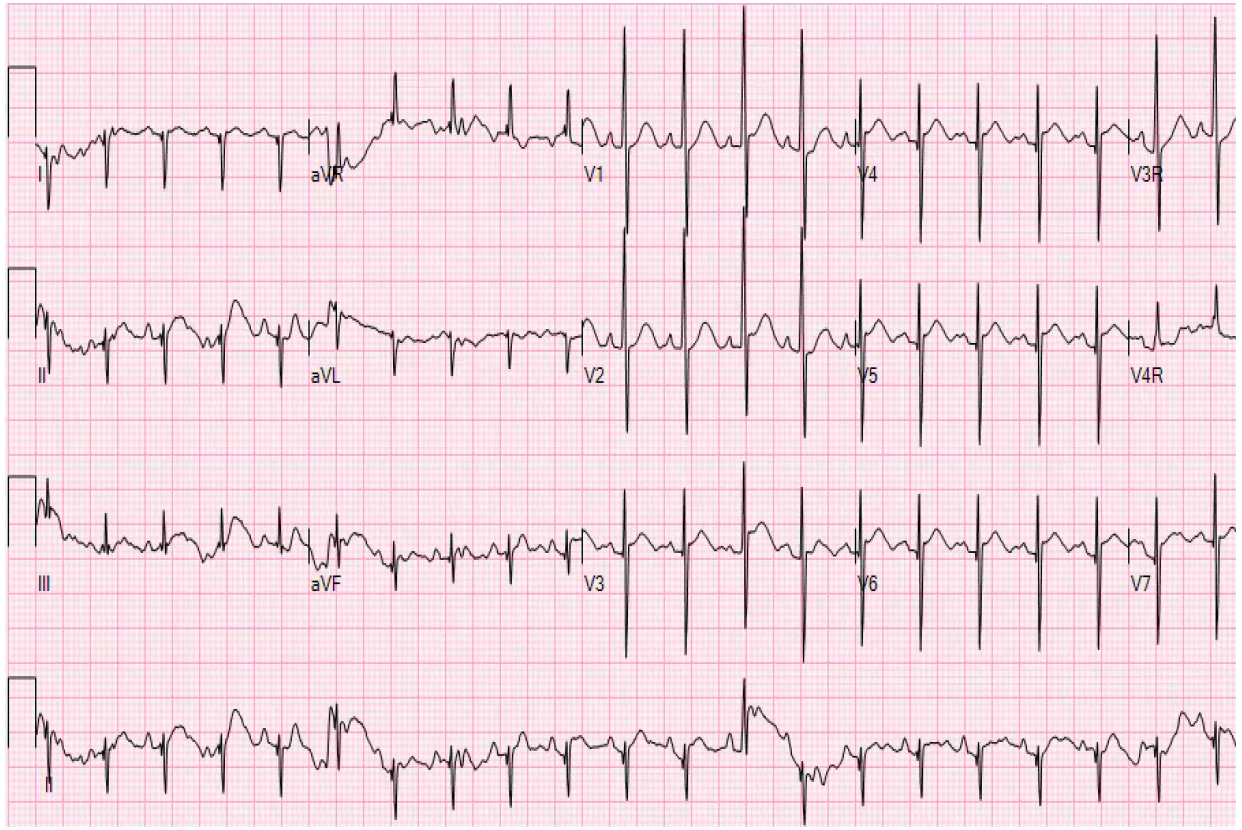
Correct answer:
-Right Ventricular Hypertrophy

1 day old baby in nursery with tachycardia

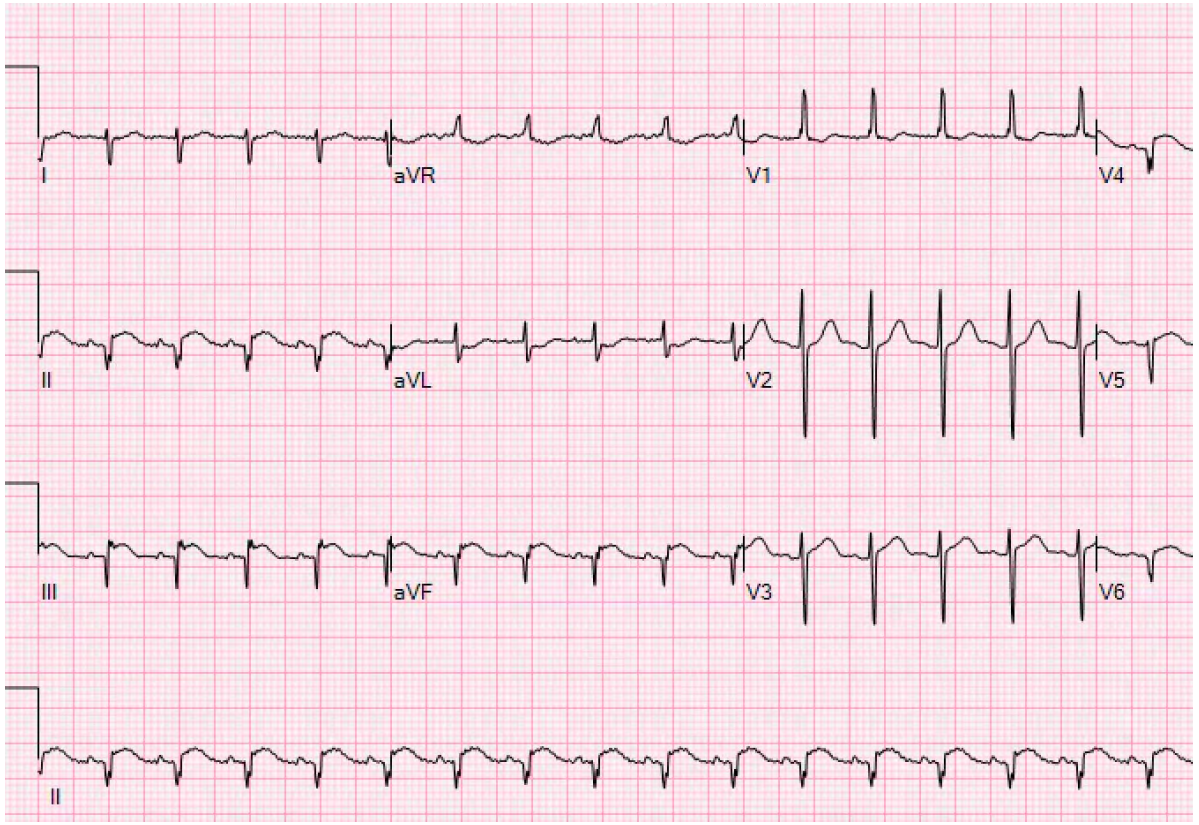


1 week old with TGA

Pre-op EKG



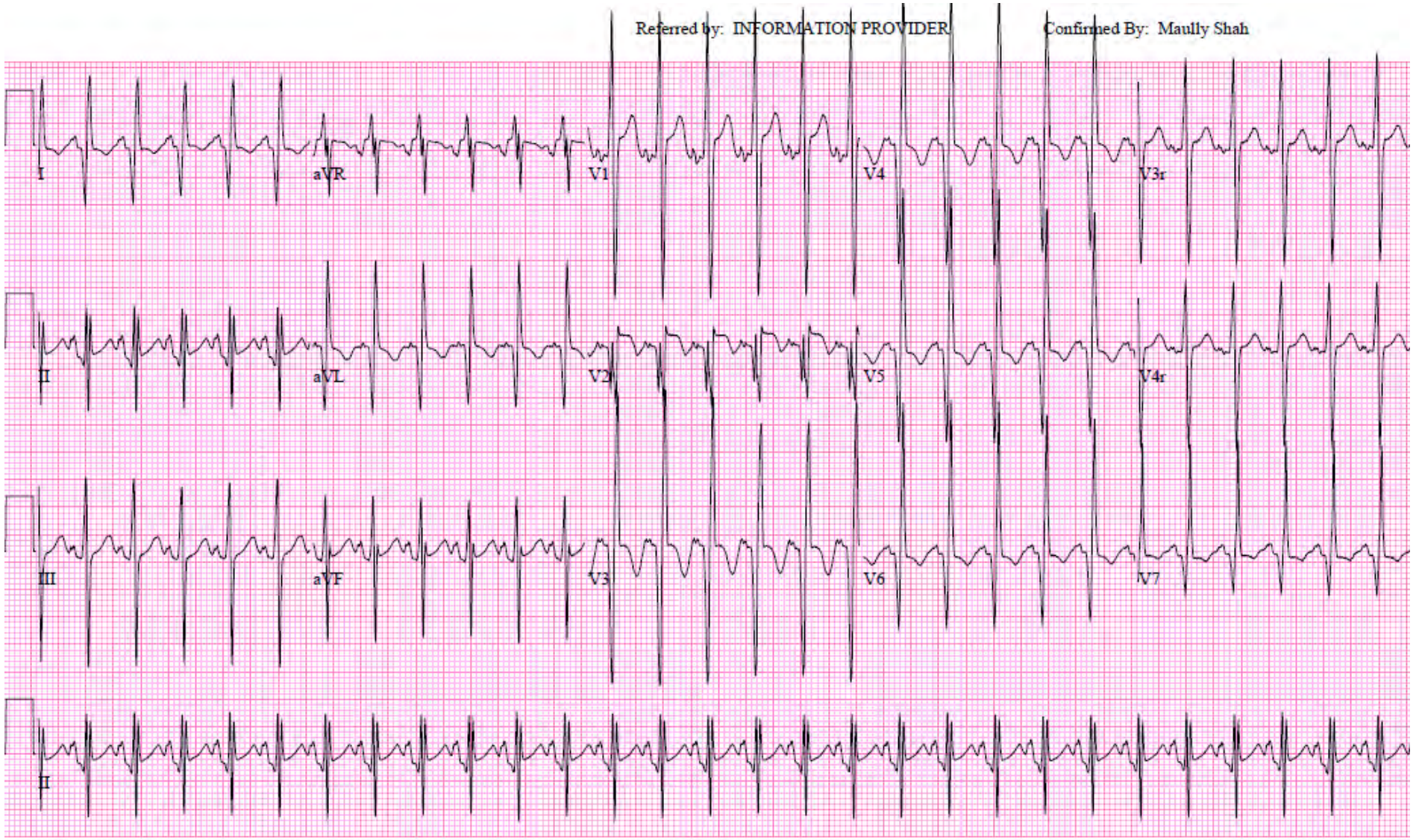
Post-op EKG



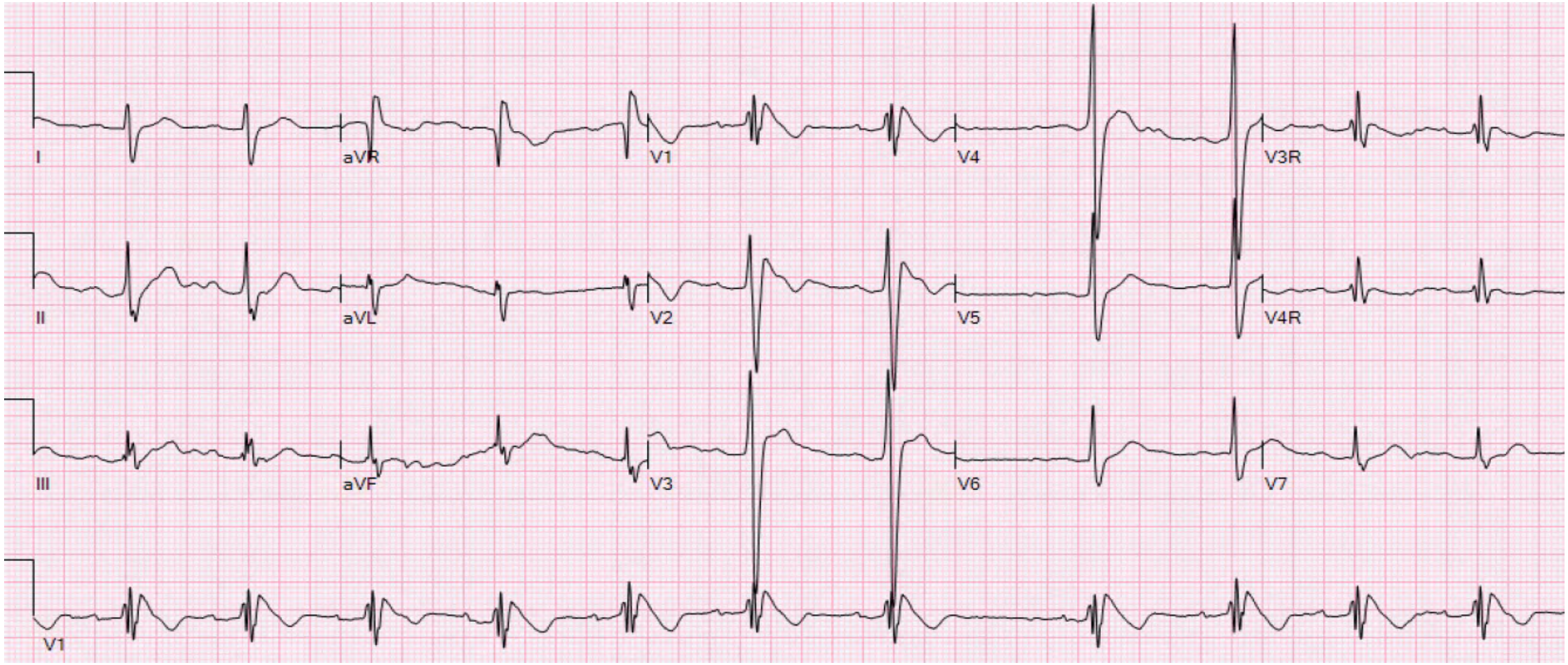
1. Normal EKG for age
2. Left Ventricular Hypertrophy
3. Wolff Parkinson White Syndrome
4. Myocardial infarction

Correct answer:
-Myocardial Infarction

6 month old with poor feeding

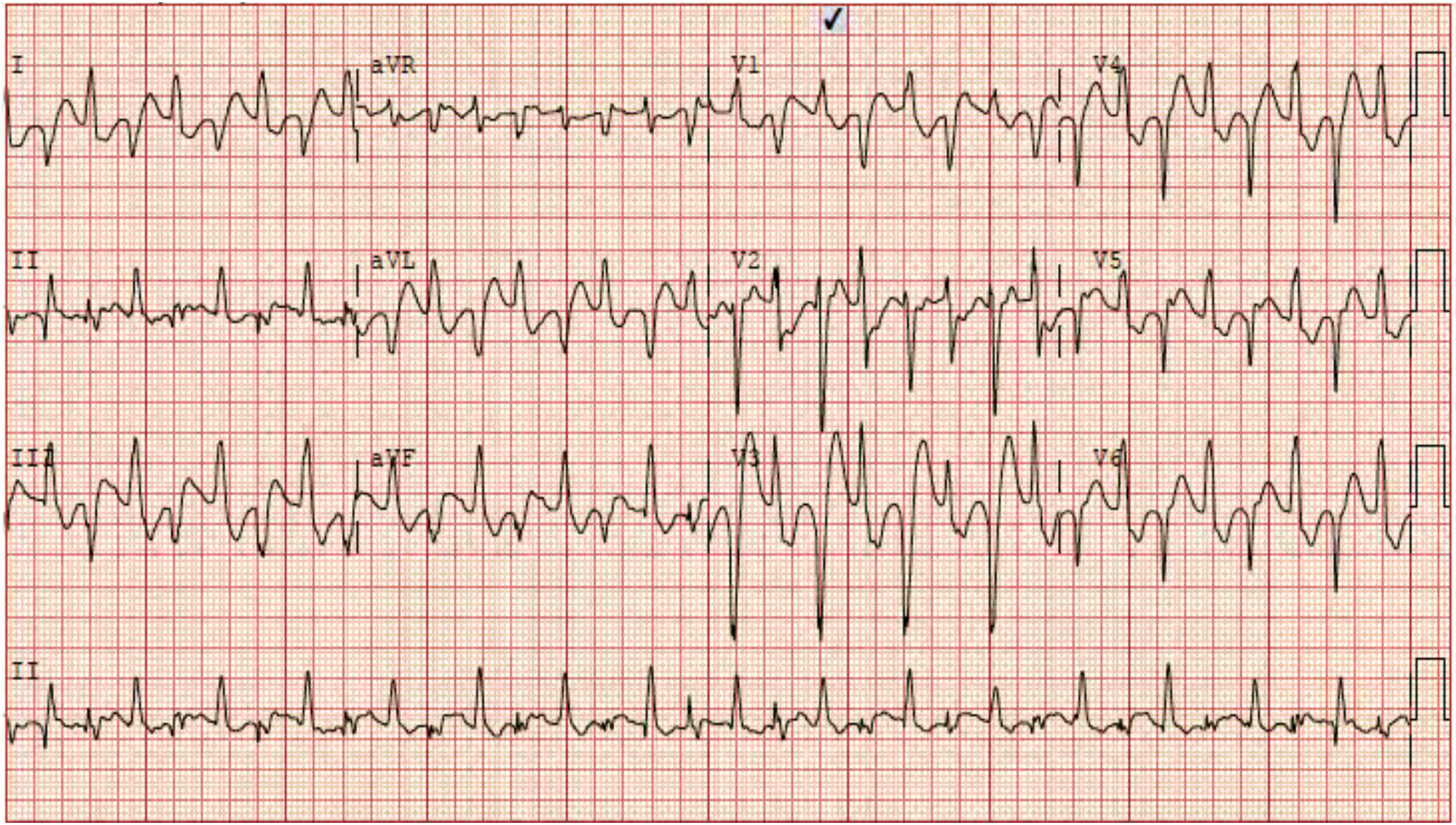


11 year old girl with Syncope

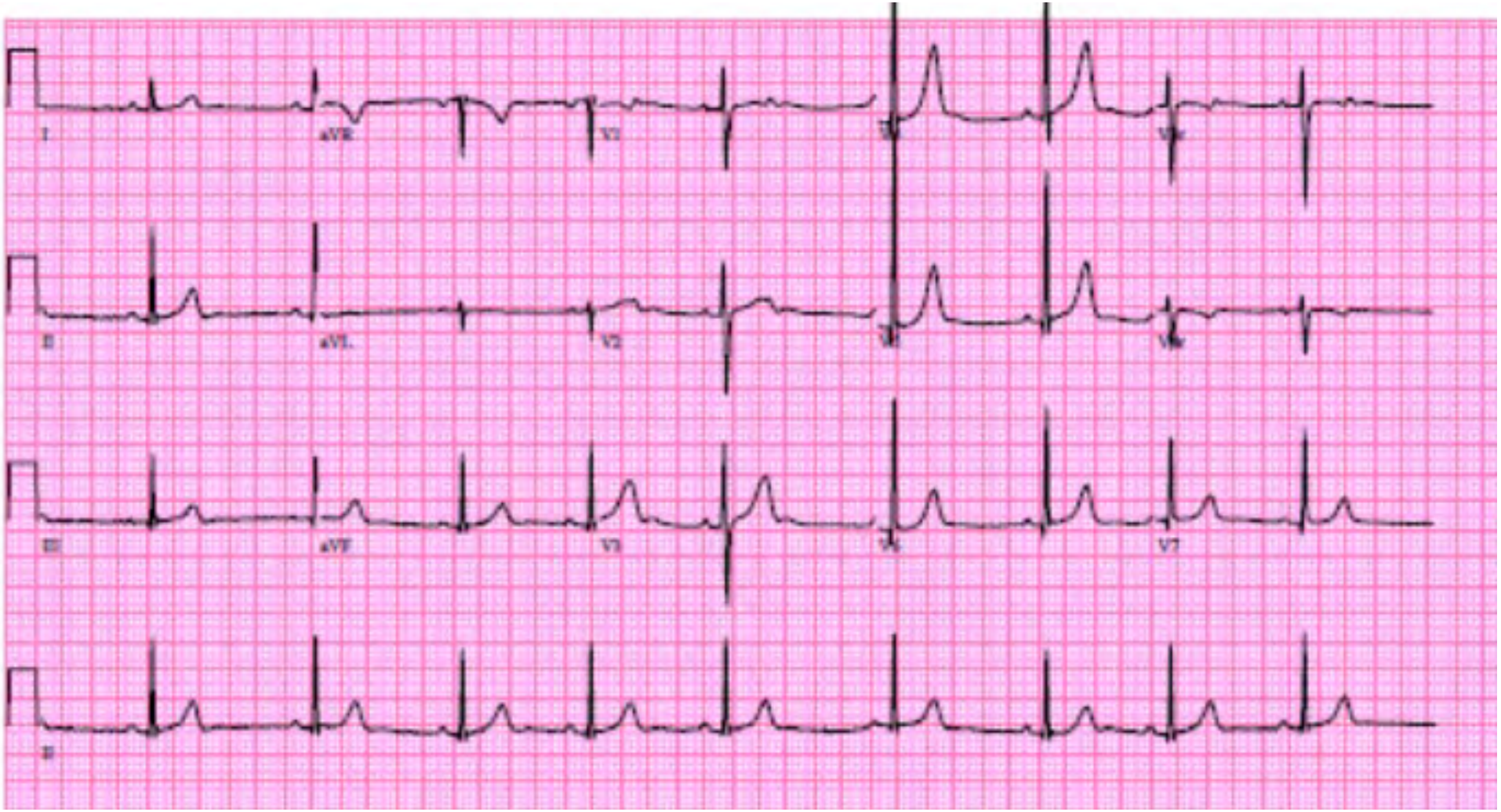


1.Sinus rhythm with right bundle branch block (RBBB)
2.Sinus rhythm with left bundle branch block (LBBB)
3.Normal EKG
4.Brugada Syndrome

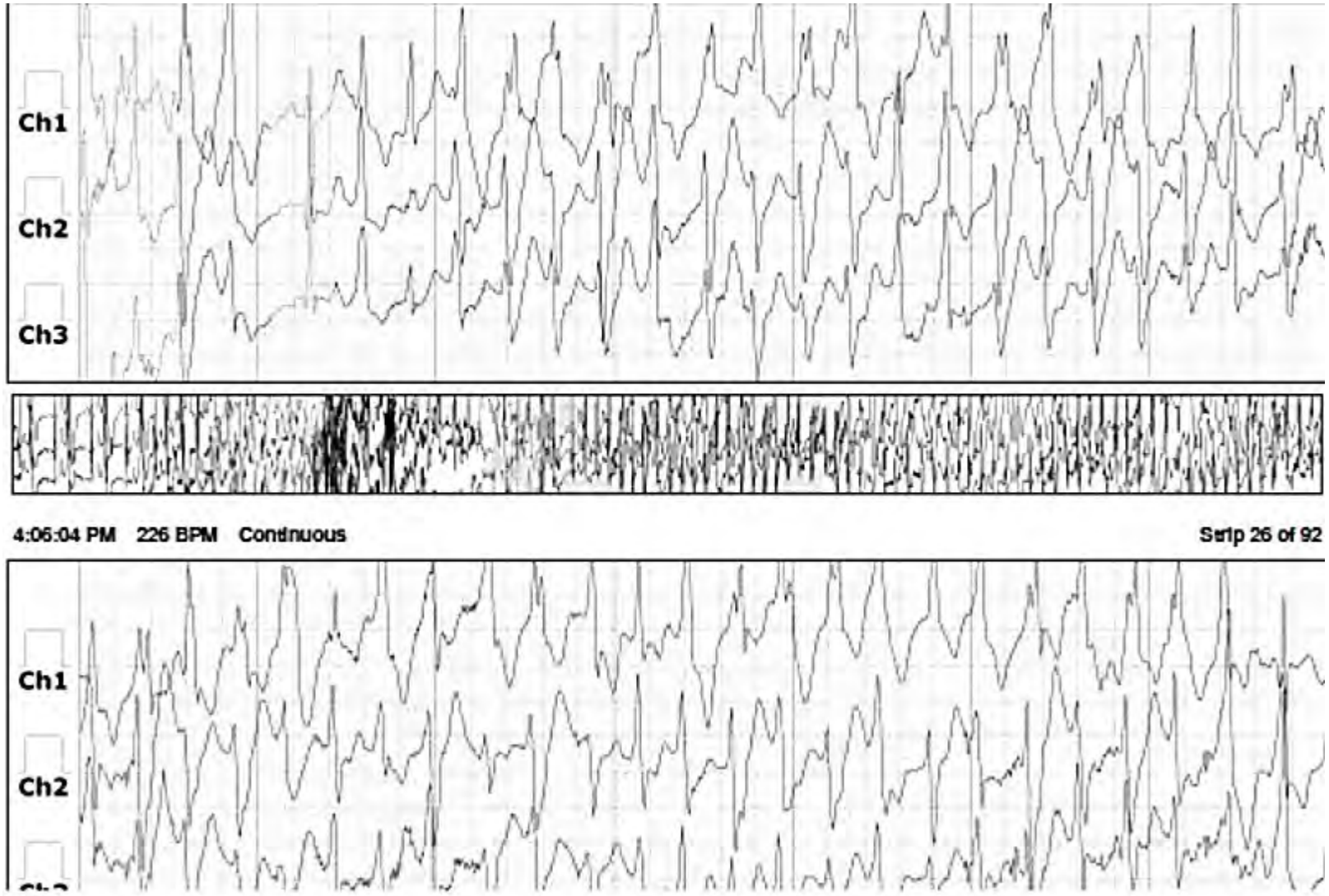
Correct Answer:
Brugada Syndrome: Note J point elevation in V1, V2
Prolonged PR interval


I
aVR
V1
V4
II
aVL
V2
V5
III
aVF
V3
V6
II

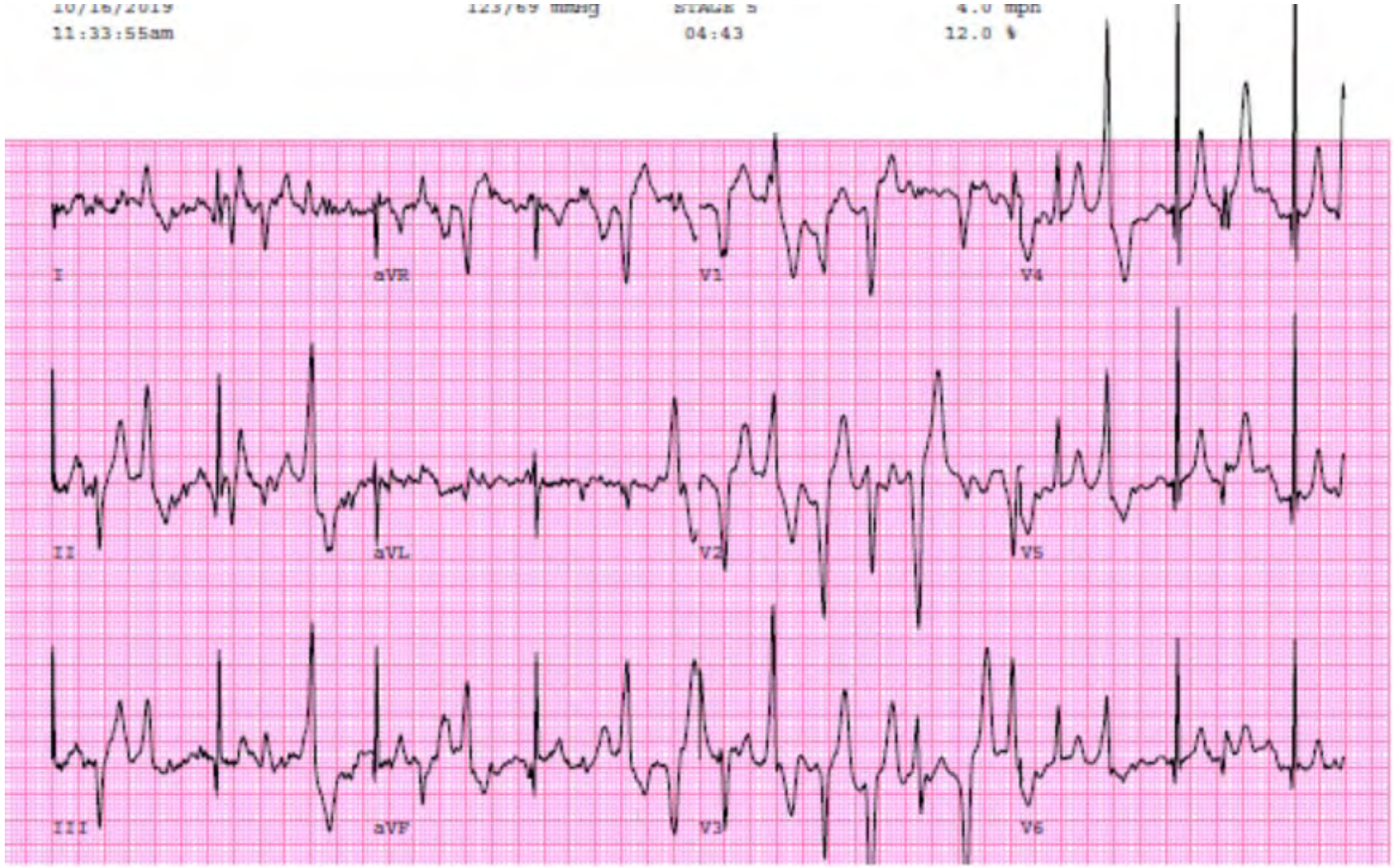
9 y.o with syncope while playing “Fortnite”



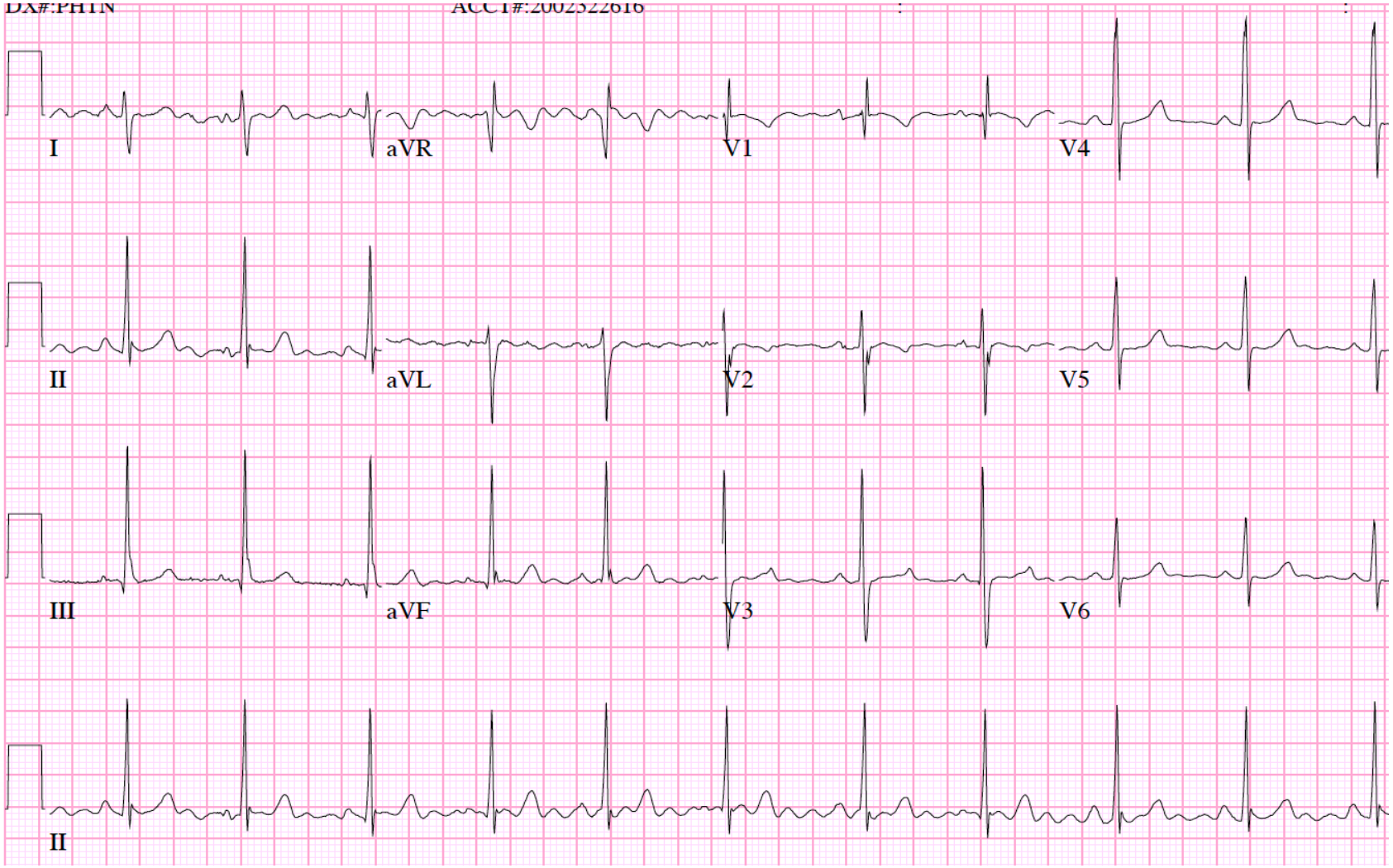
9 y.o with syncope while playing “Fortnite”



Exercise stress test



17 year old with palpitations after eating “brownies”



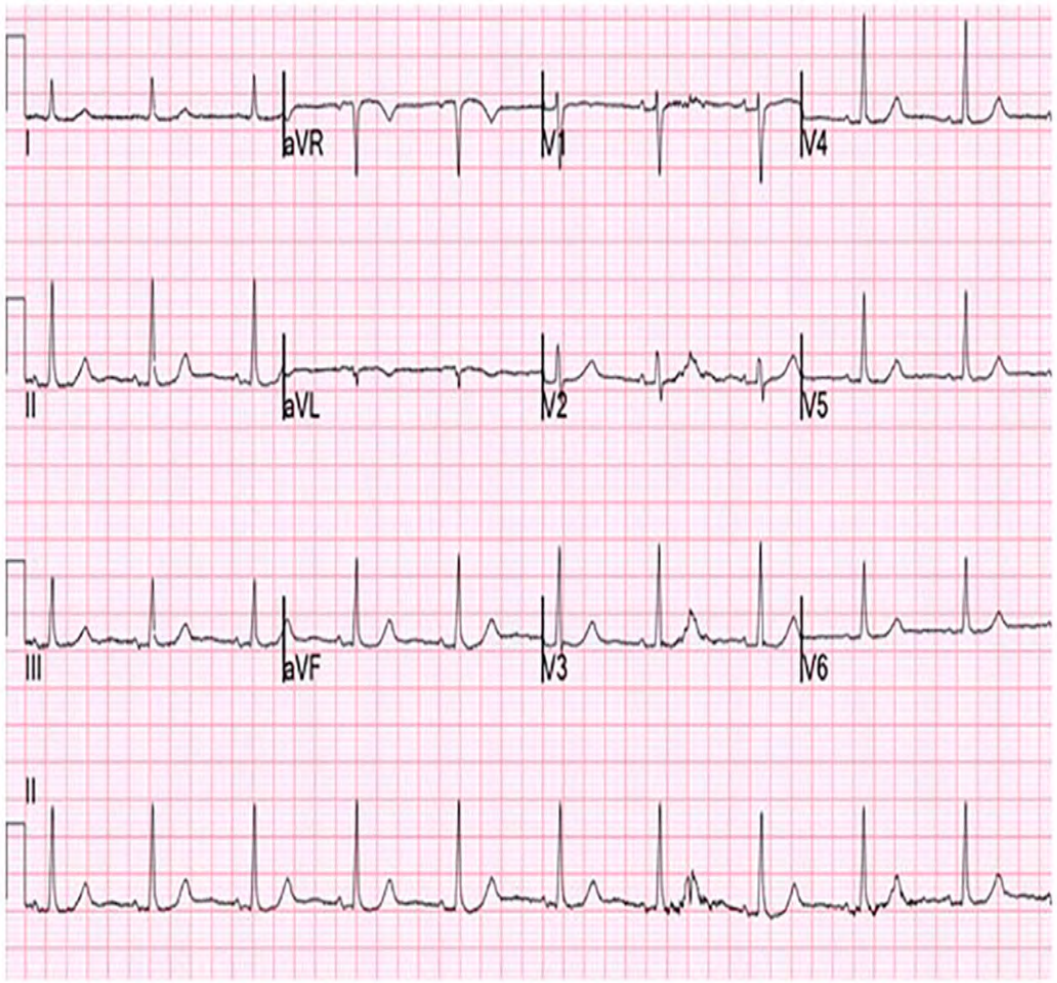
Ivor Asztalos : AsztalosI@chop.edu

Scott Weinreb: WeinrebS@chop.edu

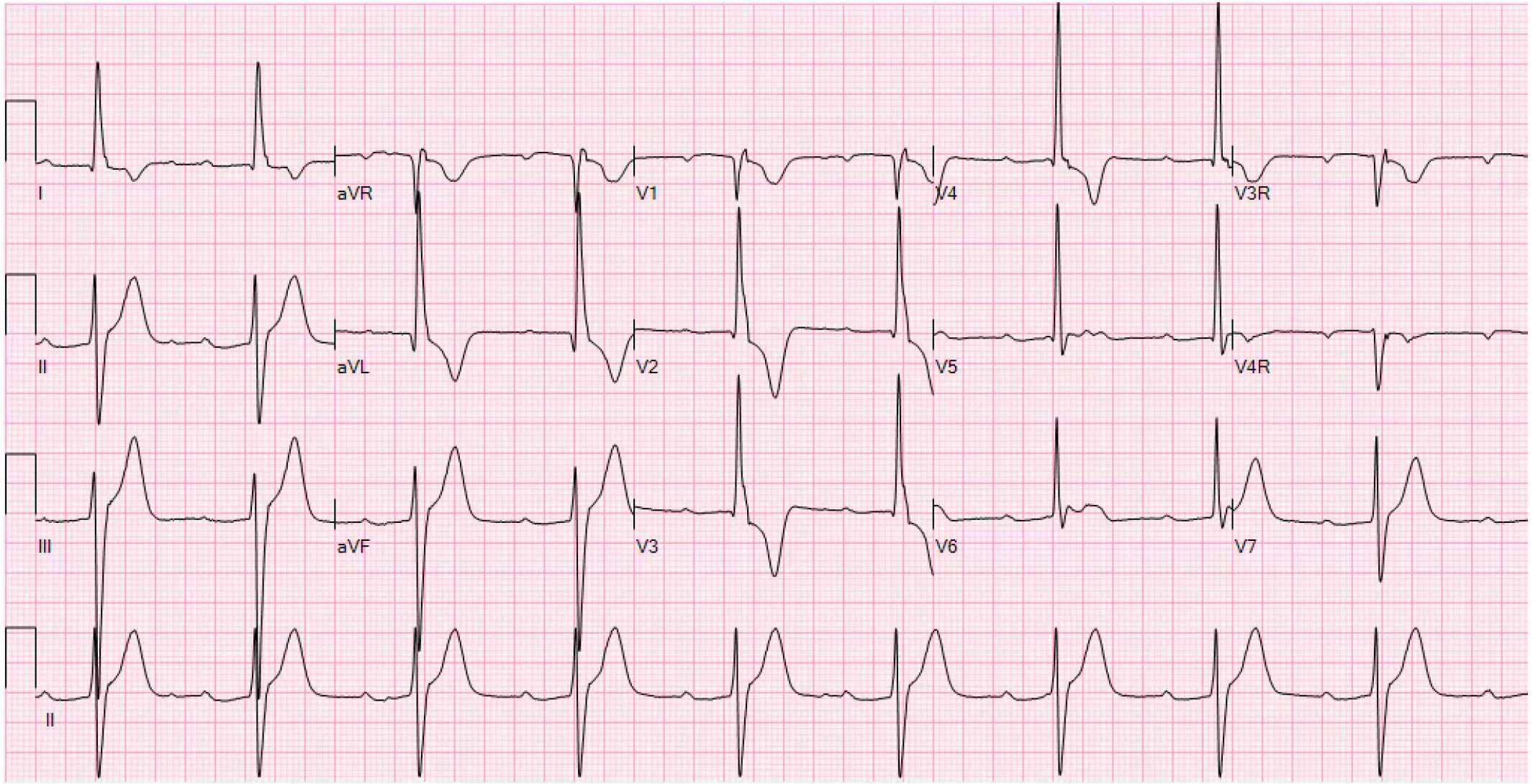
Maully Shah: Shahm@chop.edu

Review paper on WPW and athletes: Let sleeping dogs lie

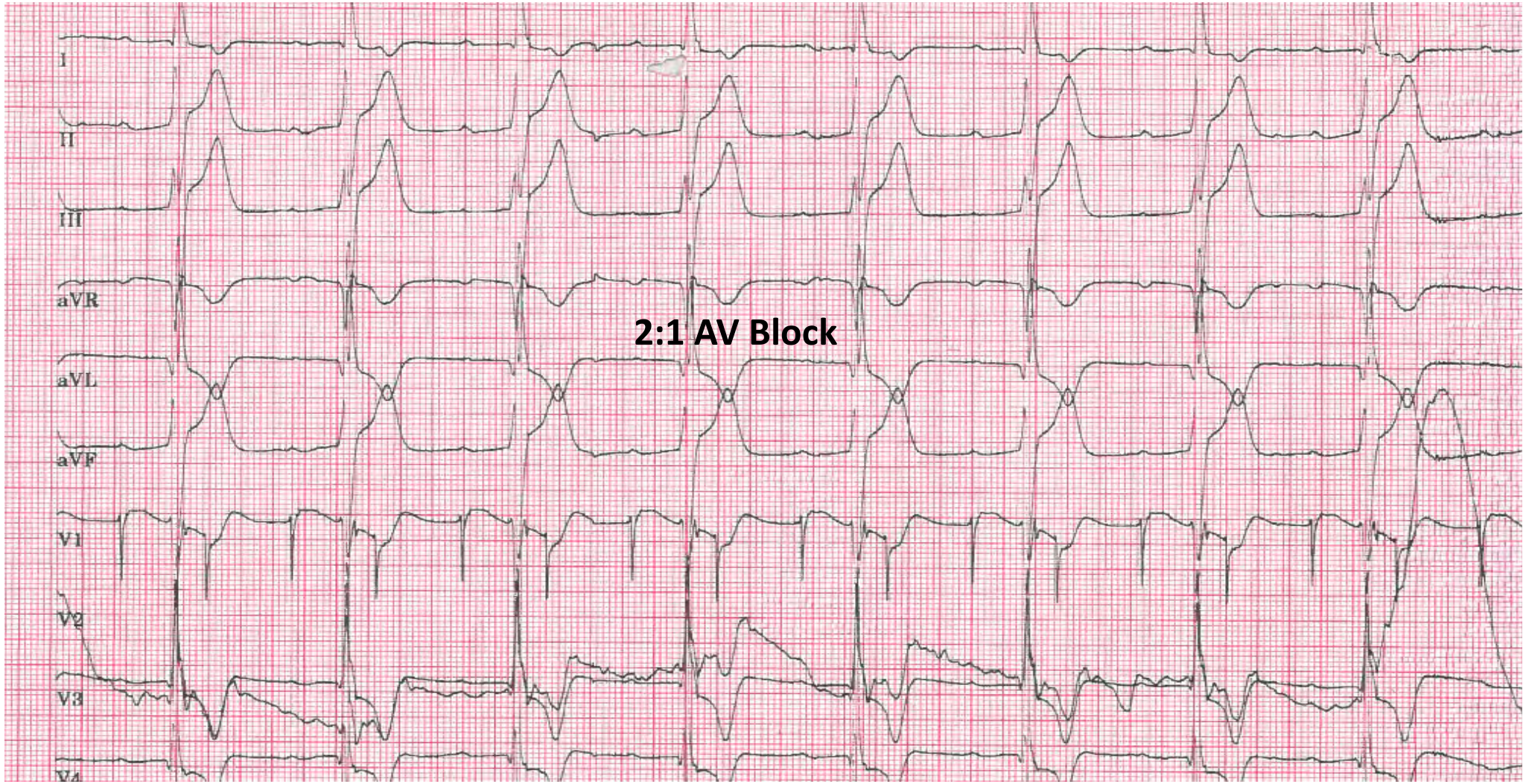
The picture can't be displayed.

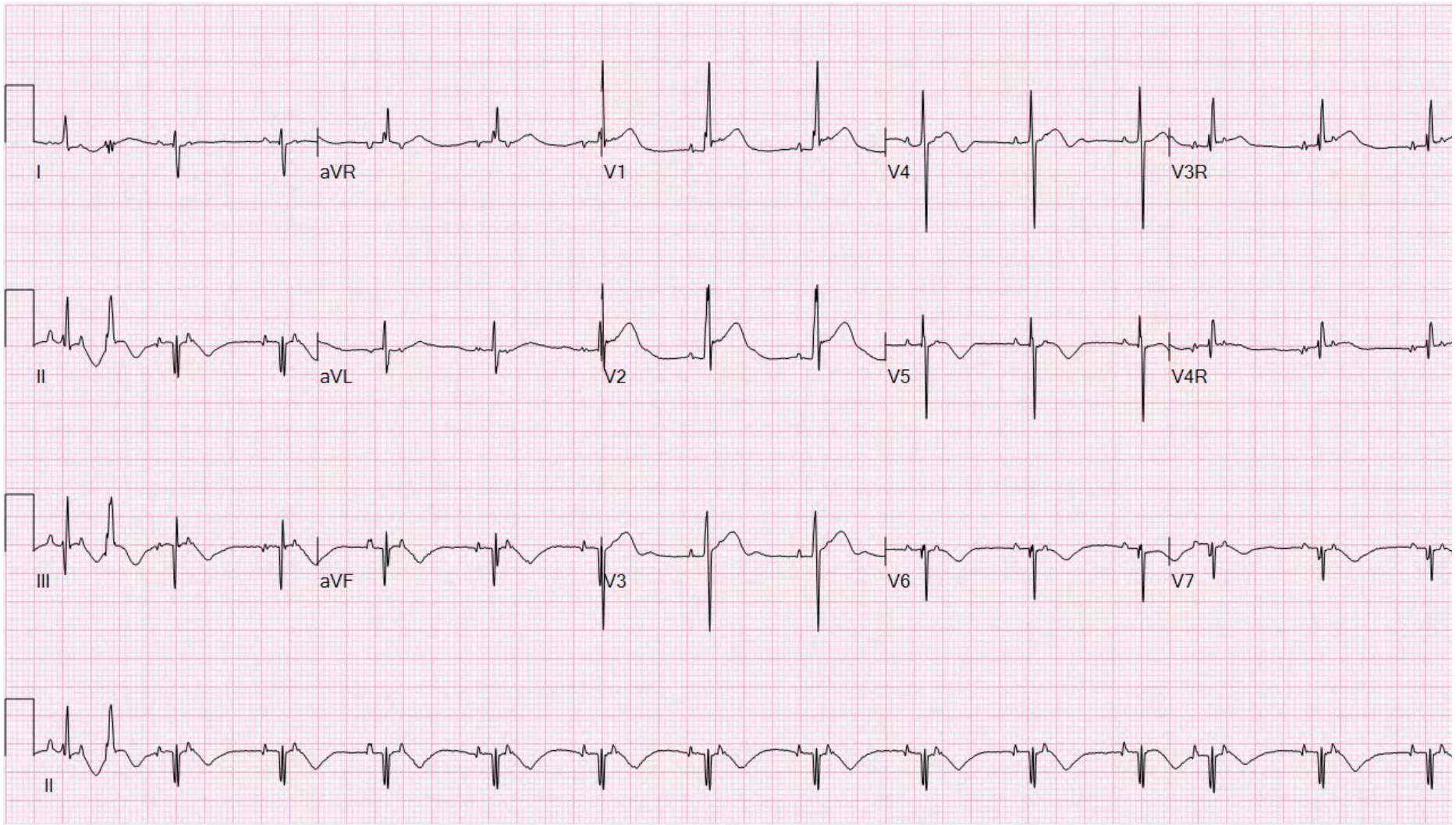


15 year old s/p Heart Transplant, bradycardia

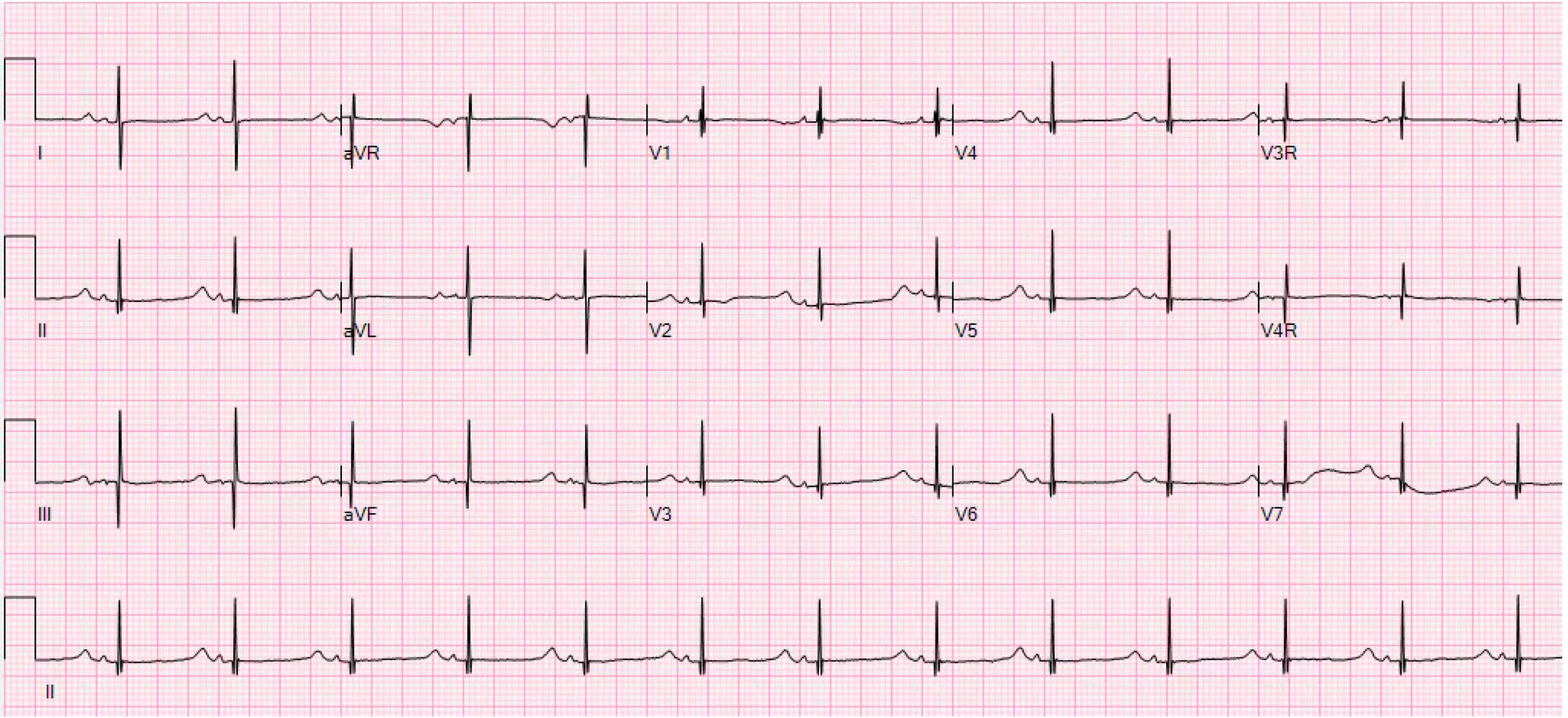


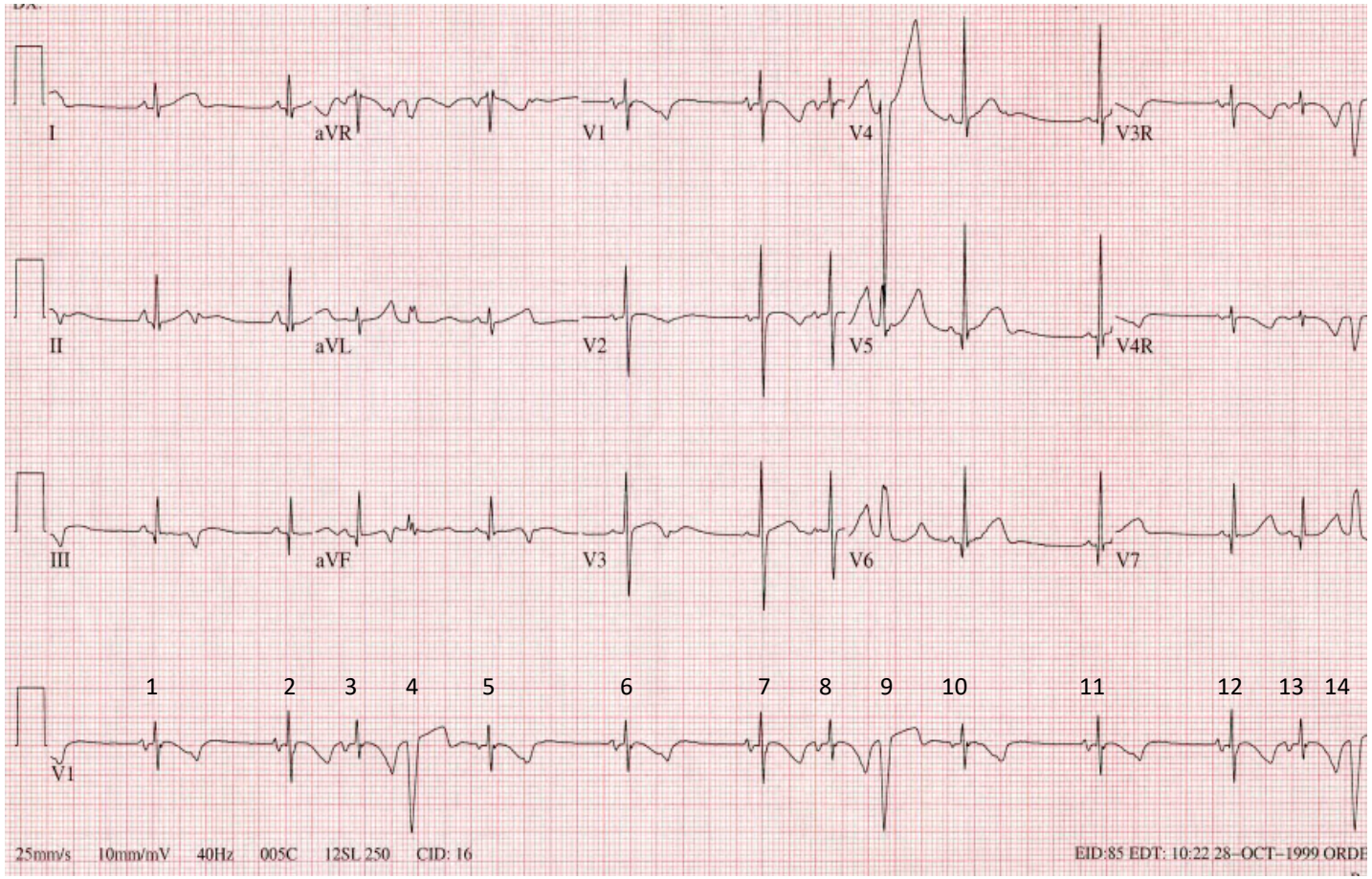
Same Patient: Atrial EGM

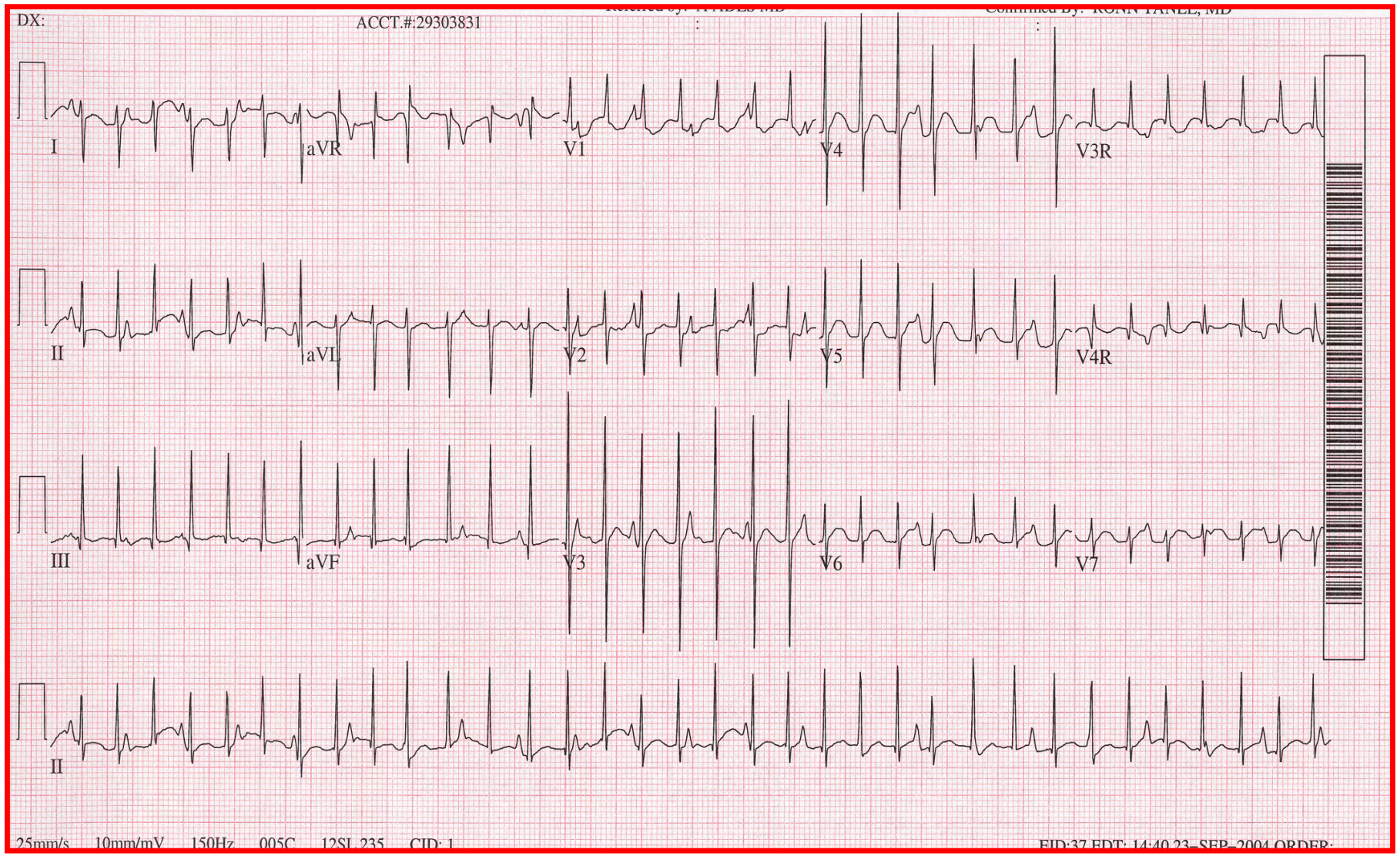


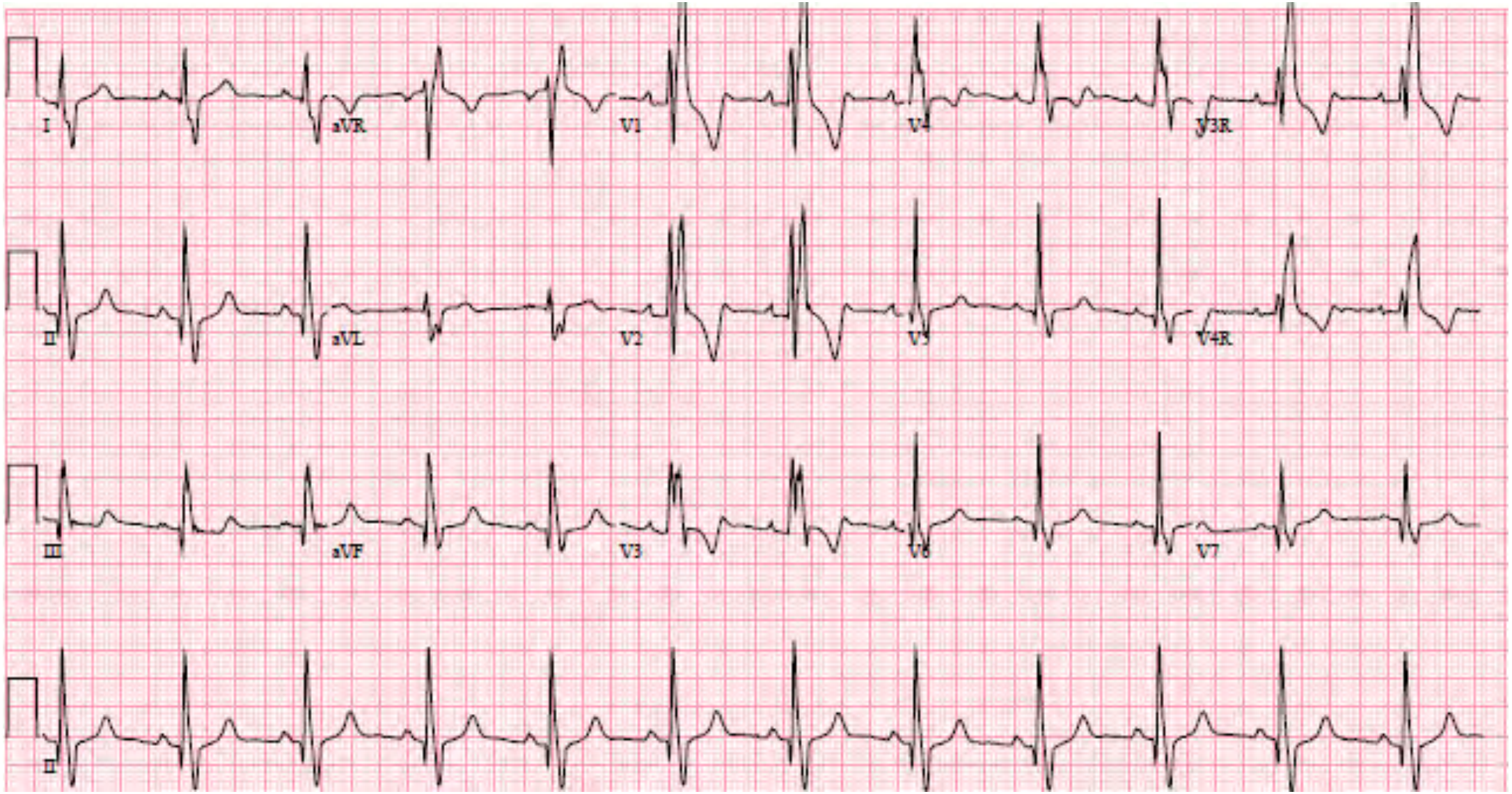

I
aVR
V1
V4
V3R
II
aVL
V2
V5
V4R
III
aVF
V3
V6
V7
II

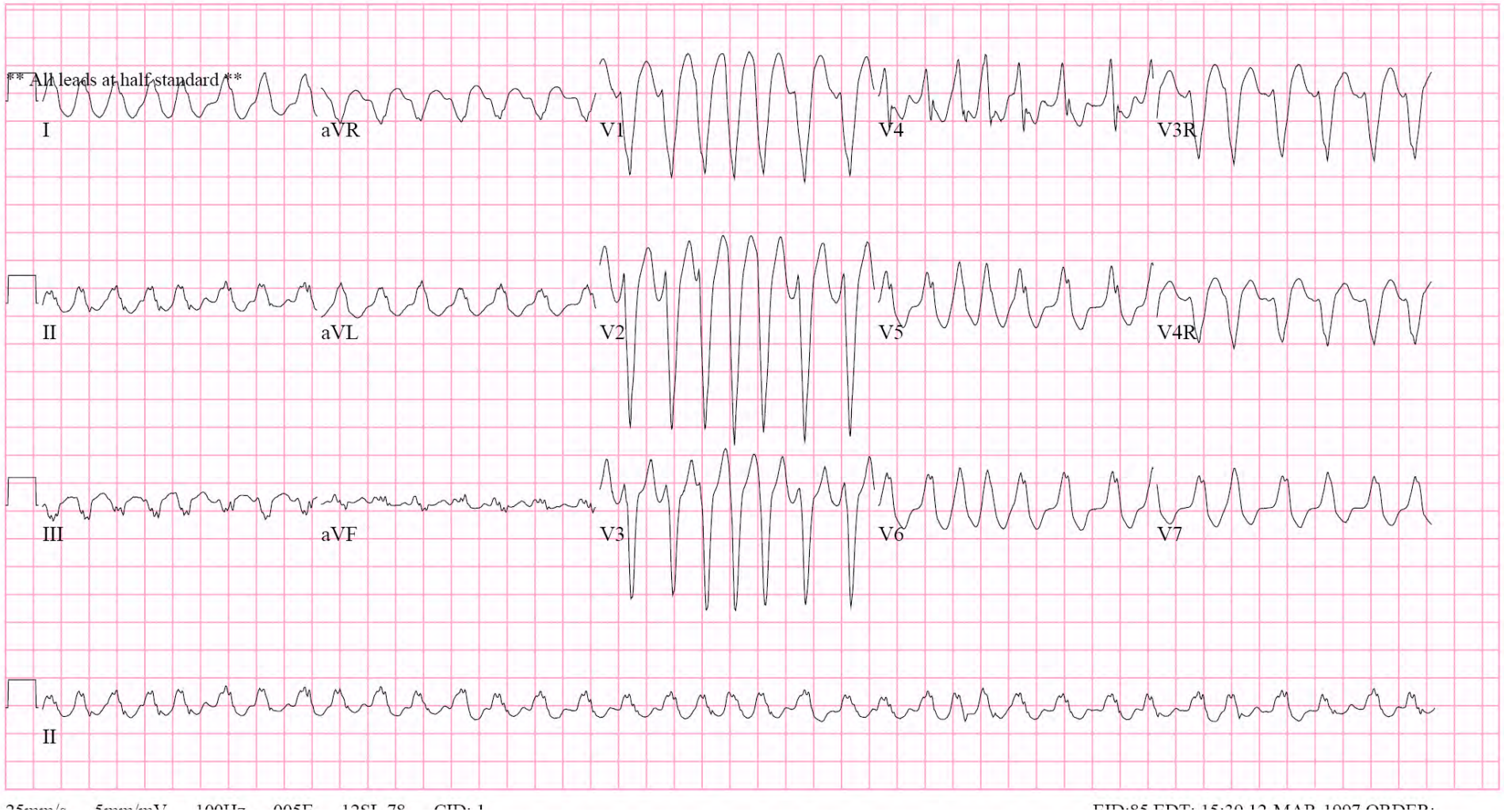
18 month old with ‘ALTE’

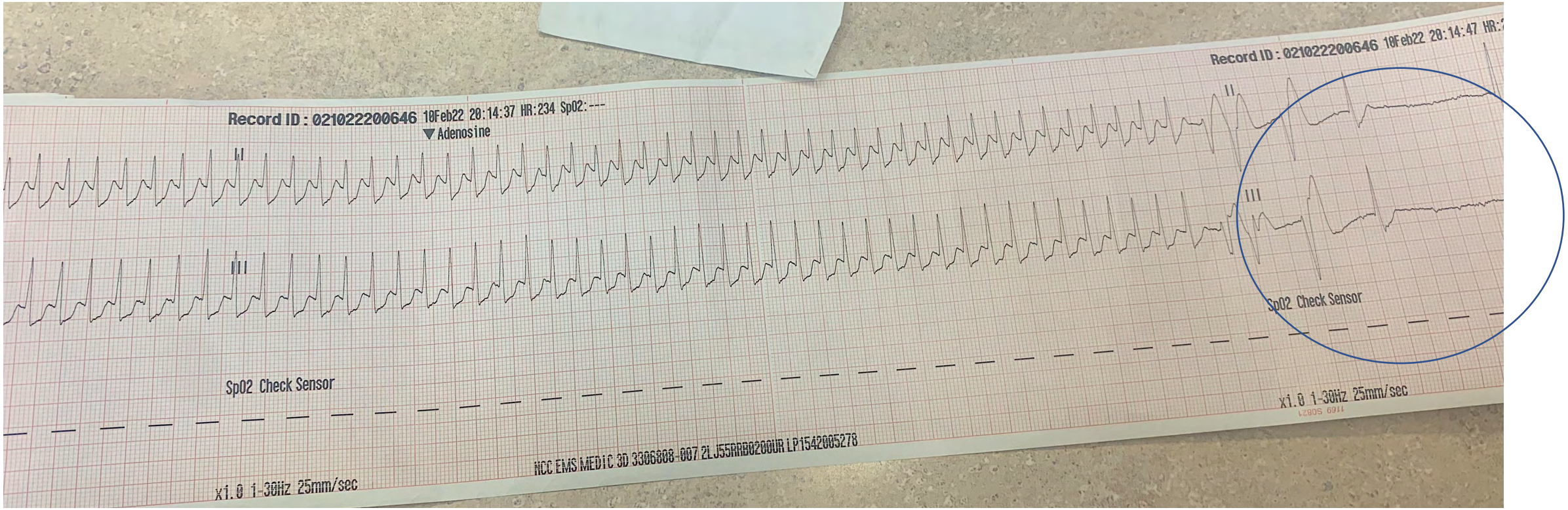


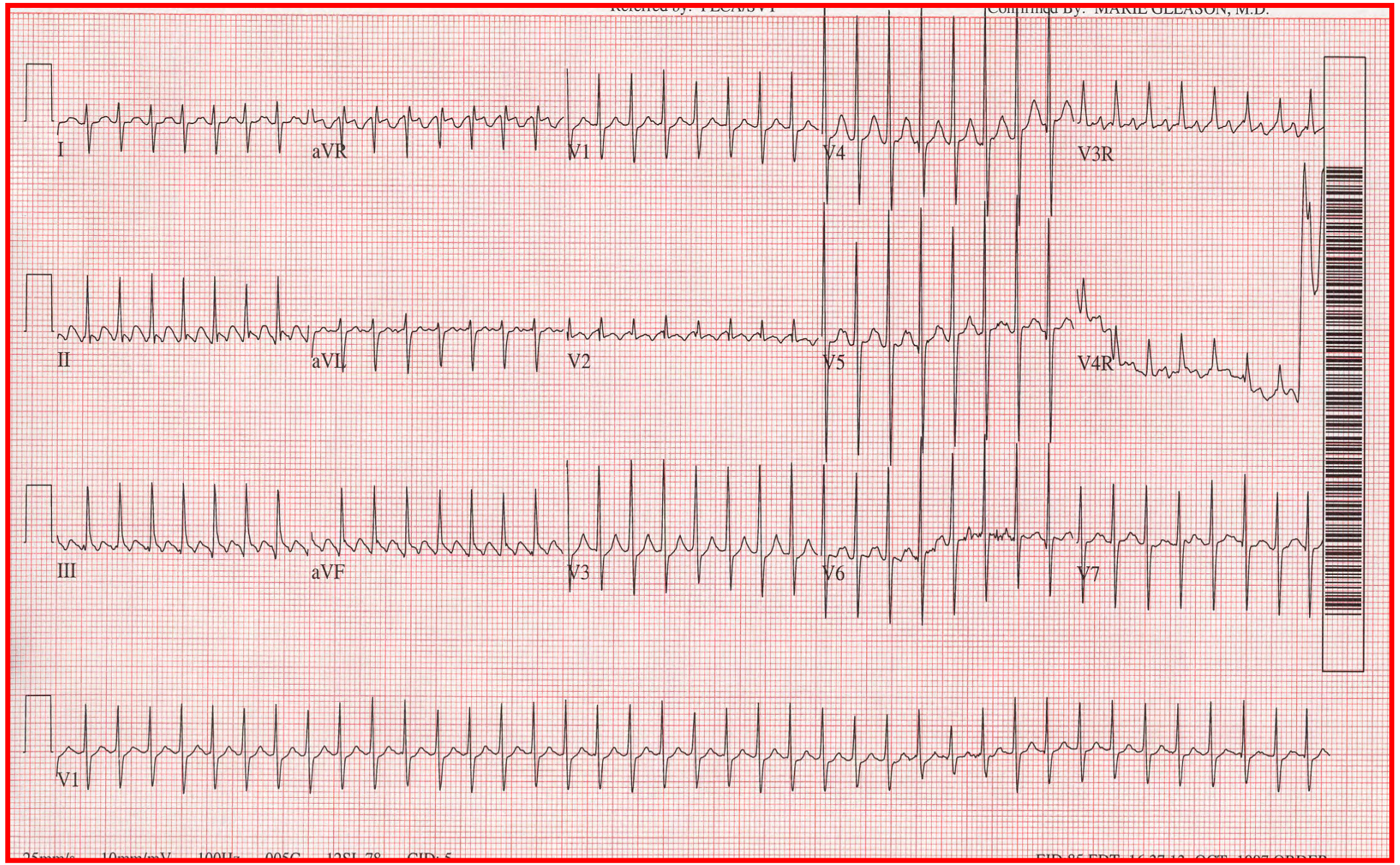

I
aVR
V1
V4
V3R
II
aVL
V2
V5
V4R
III
aVF
V3
V6
V7
1
2
3
4
5
6
7
8
9
10
11
12
13
14
V1
25mm/s
10mm/mV
40Hz
005C
12SL 250
CID: 16
EID:85 EDT: 10:22 28-OCT-1999 ORDE


DX:
ACCT.#:29303831
I
aVR
V1
V4
V3R
II
aVL
V2
V5
V4R
III
aVF
V3
V6
V7
II
25mm/s 10mm/mV 150Hz 005C 12SL 235 CID: 1
EID:37 EDT: 14:40 23-SEP-2004 ORDER:

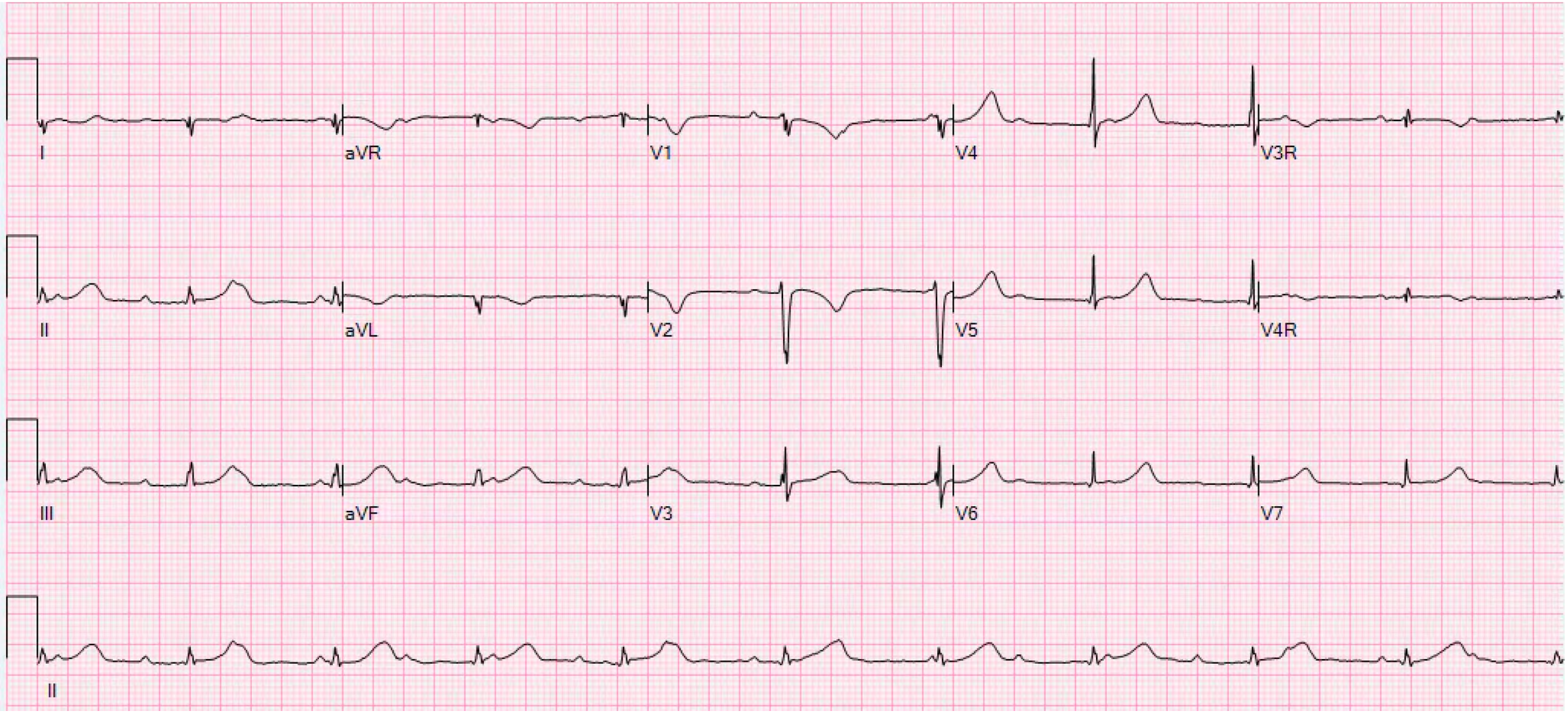

I
aVR
V1
V4
V3R
II
aVL
V2
V5
V4R
III
aVF
V3
V6
V7
II

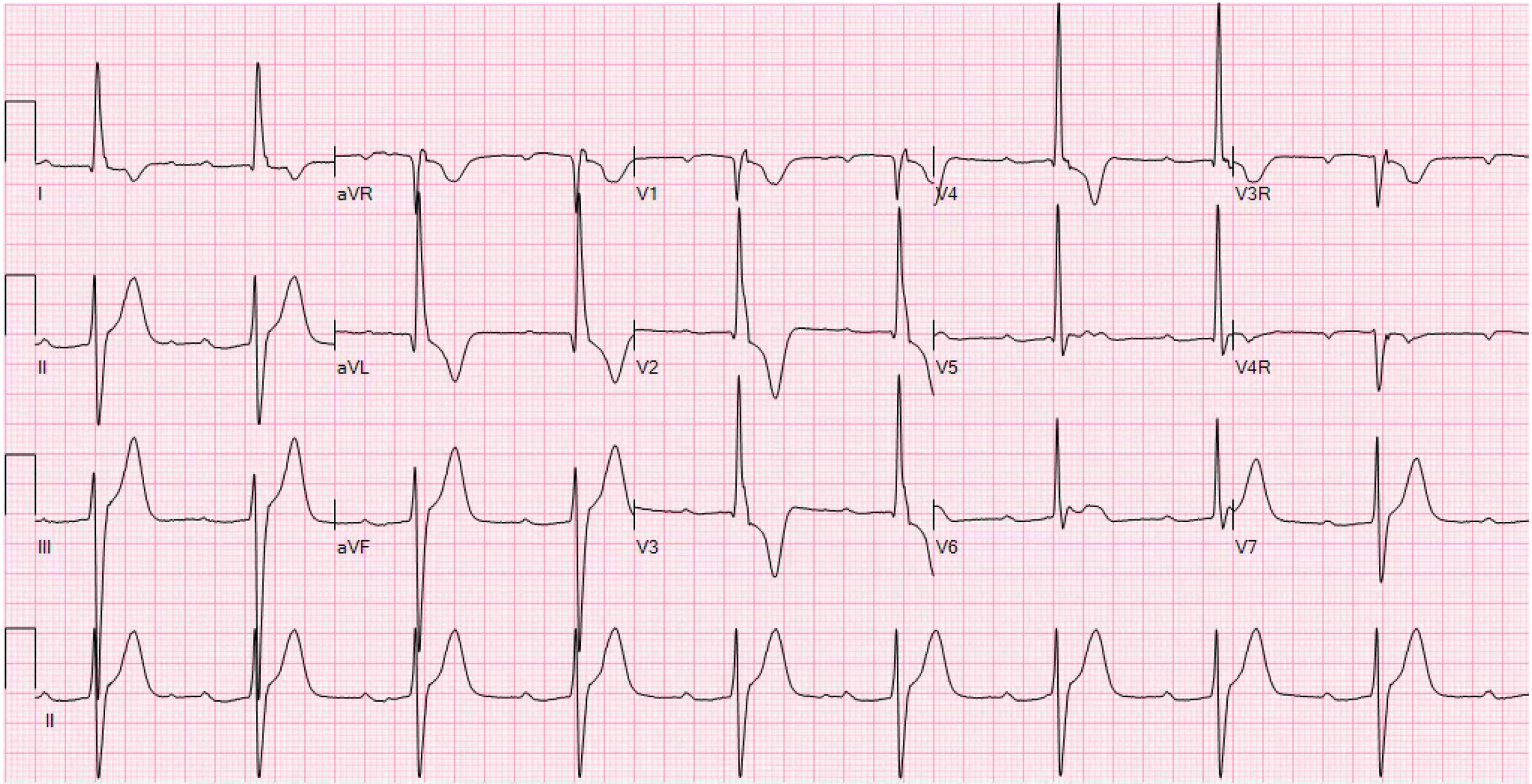

** All leads at half standard **
I
aVR
V1
V4
V3R
II
aVL
V2
V5
V4R
III
aVF
V3
V6
V7
II

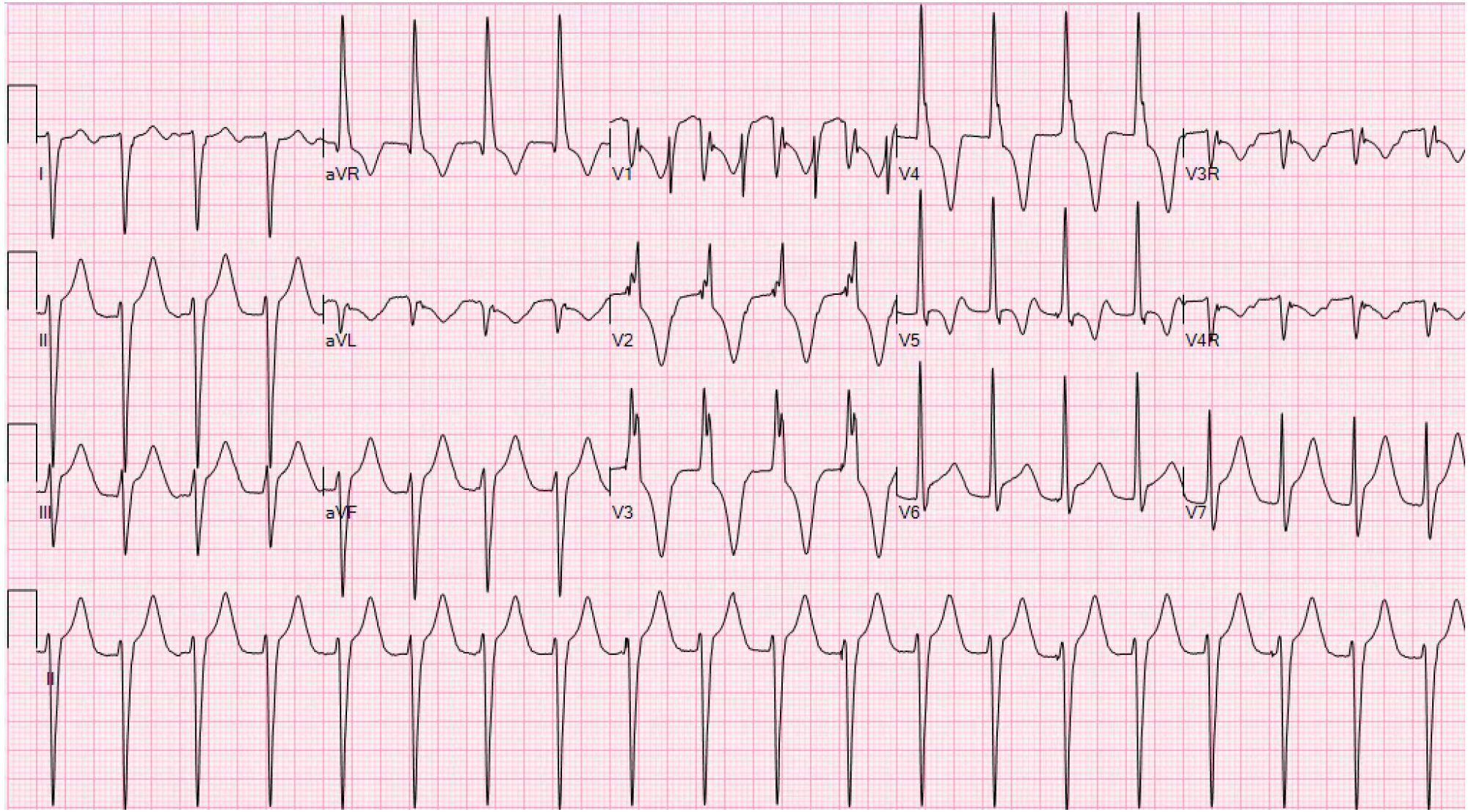

Record ID : 021022200646 10Feb22 20:14:37 HR:234 SpO2:---
Adenosine
II
III
SpO2 Check Sensor
x1.0 1-30Hz 25mm/sec
NCC EMS MEDIC 3D 3306808-007 2LJ55RRB0200UR LP1542005278
Record ID : 021022200646 10Feb22 20:14:47
II
III
SpO2 Check Sensor
x1.0 1-30Hz 25mm/sec

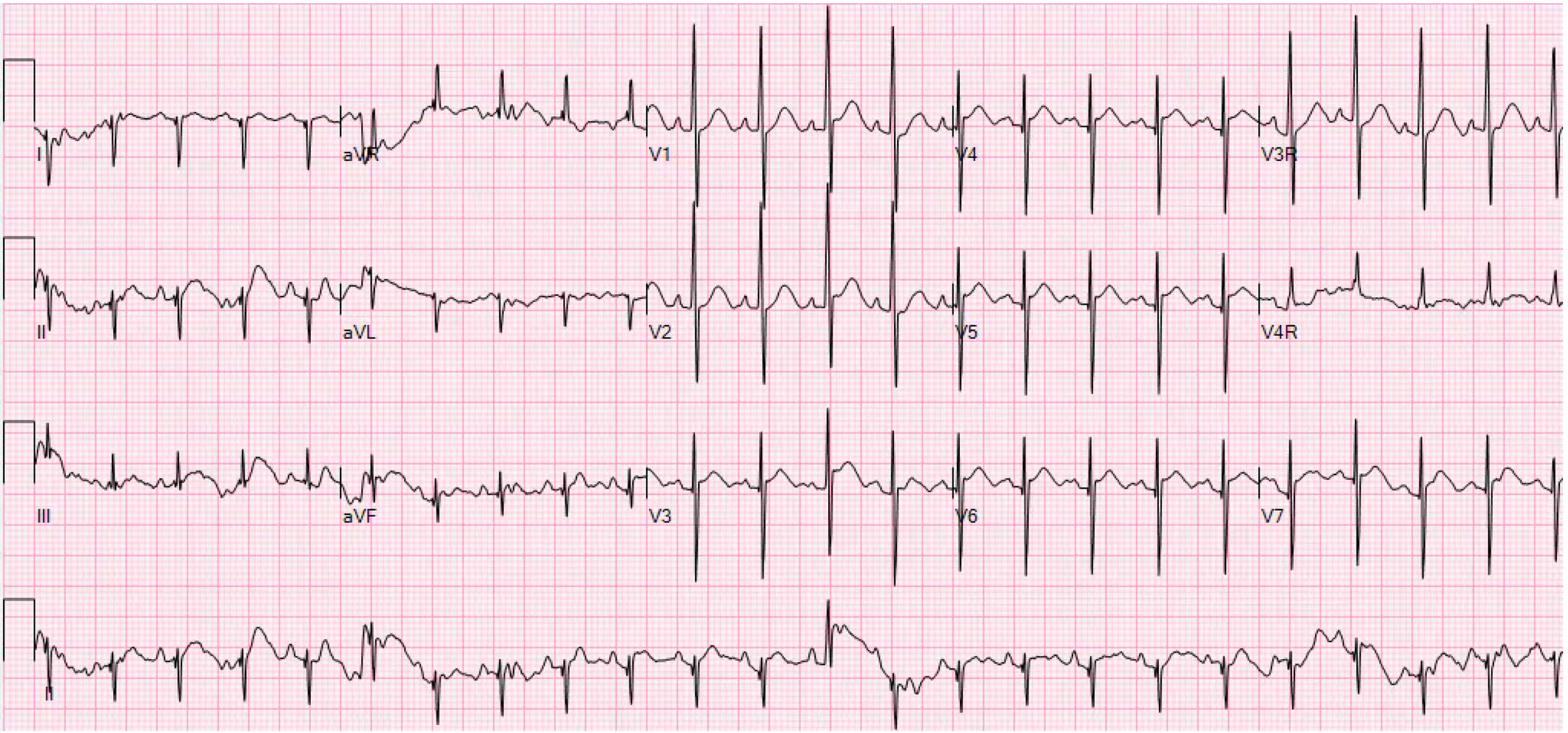

I
aVR
V1
V4
V3R
II
aVL
V2
V5
V4R
III
aVF
V3
V6
V7
V1

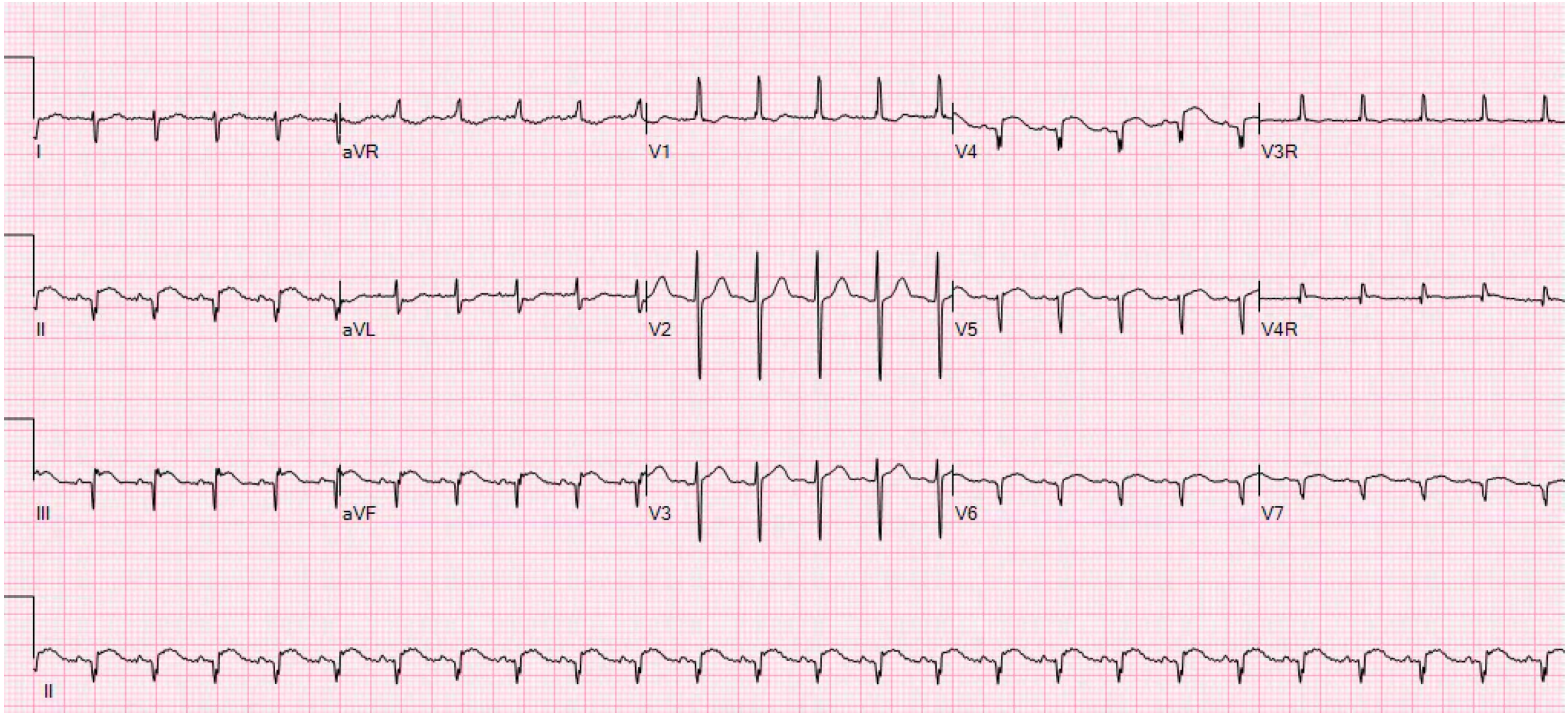
7 year old

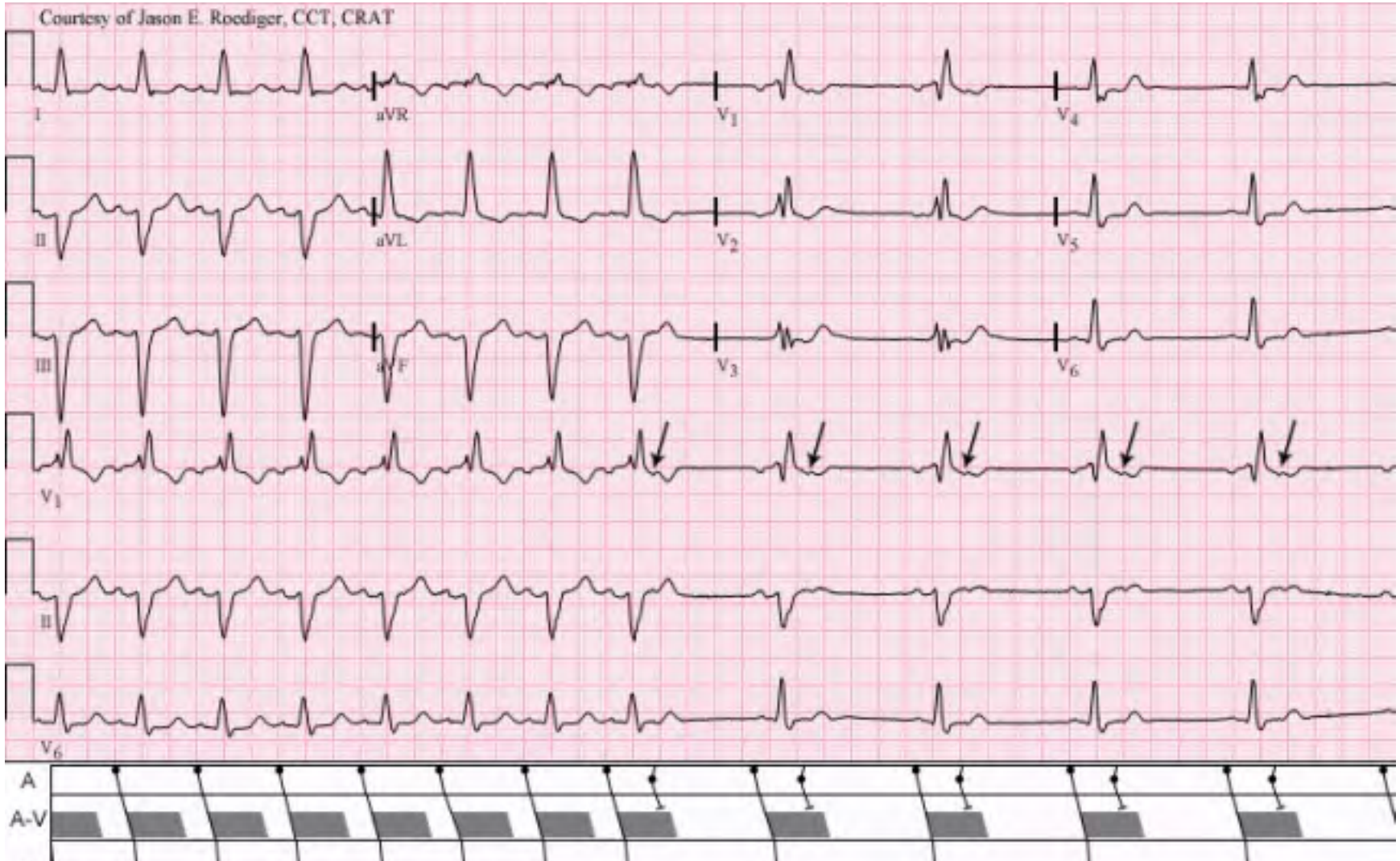



I
aVR
V1
V4
V3R
II
aVL
V2
V5
V4R
III
aVF
V3
V6
V7
II

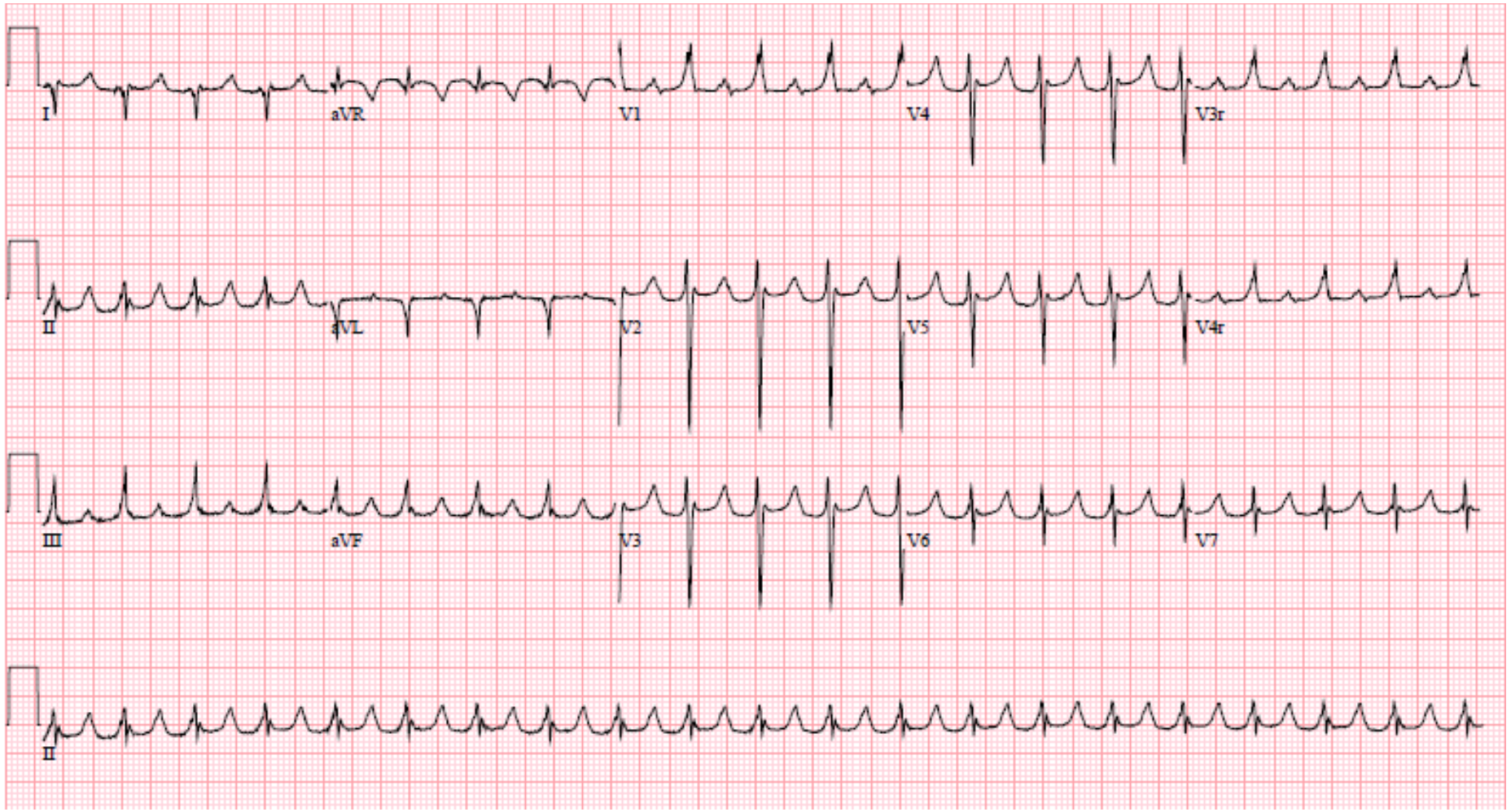

I
aVR
V1
V4
V3R
II
aVL
V2
V5
V4R
III
aVF
V3
V6
V7
II


I
aVR
V1
V4
V3R
II
aVL
V2
V5
V4R
III
aVF
V3
V6
V7
II

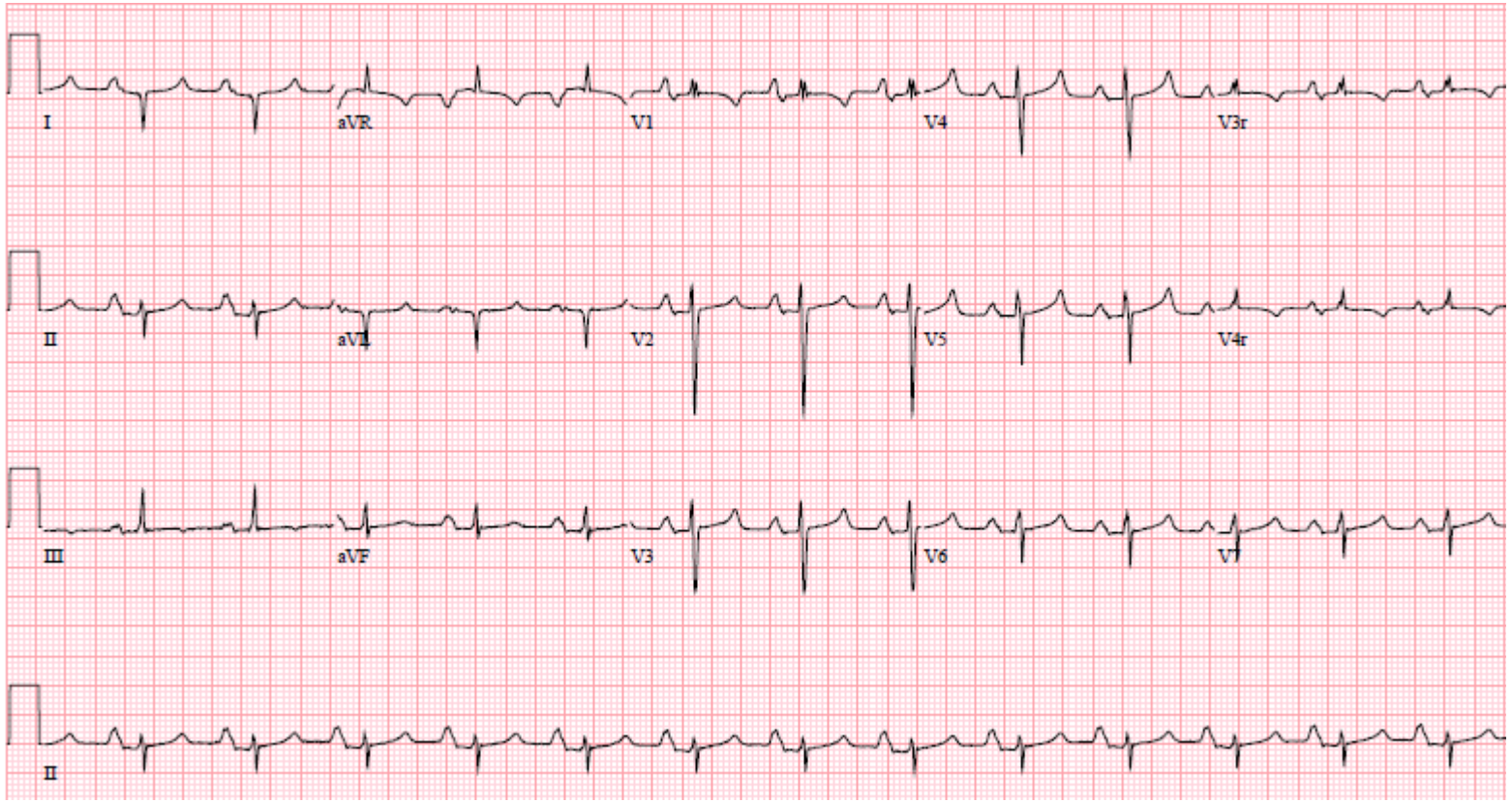

I
aVR
V1
V4
V3R
II
aVL
V2
V5
V4R
III
aVF
V3
V6
V7
II

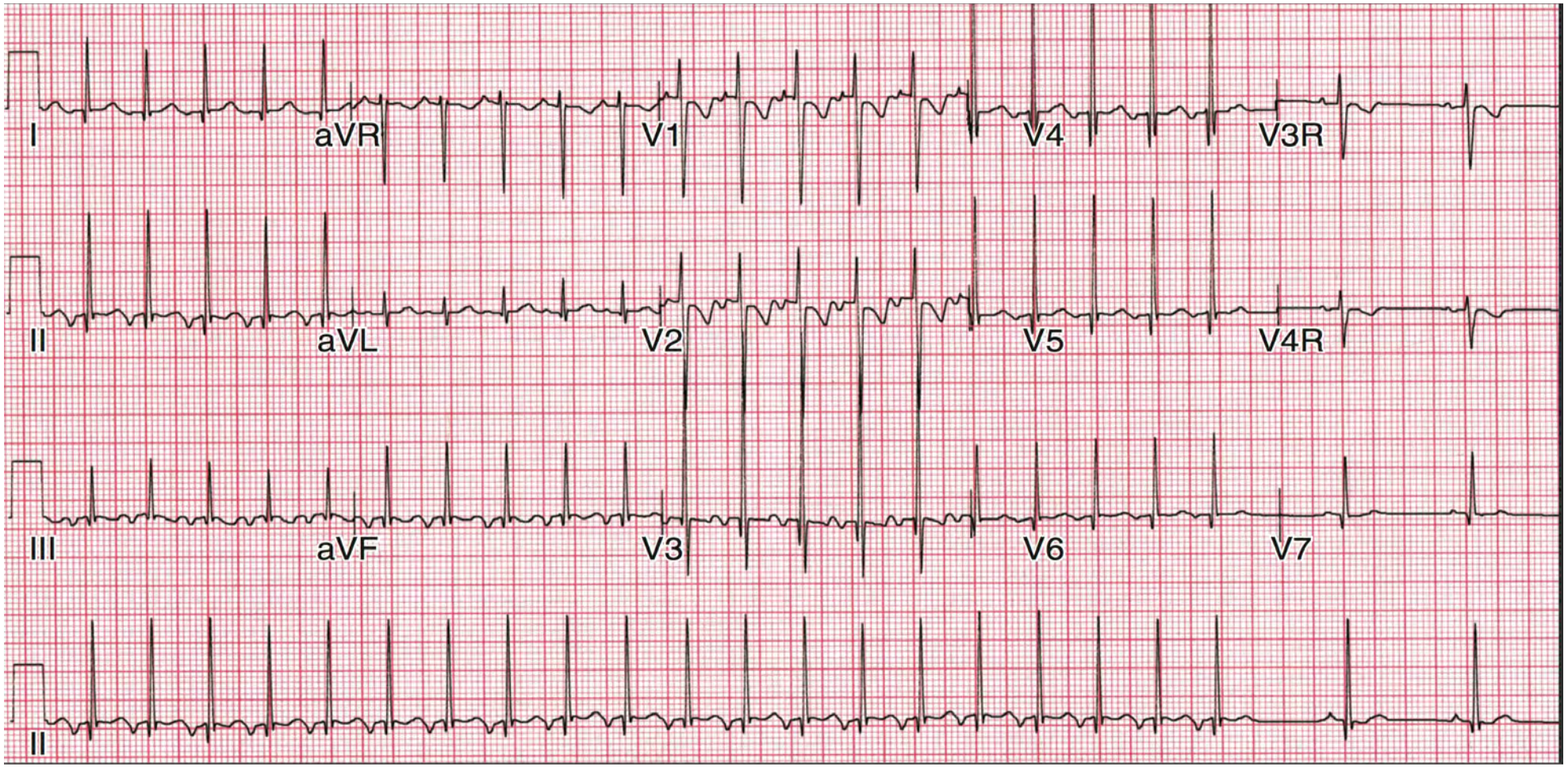

Courtesy of Jason E. Roediger, CCT, CRAT
I
aVR
V1
V4
II
aVL
V2
V5
III
aVF
V3
V6
V1
II
V6
A
A-V

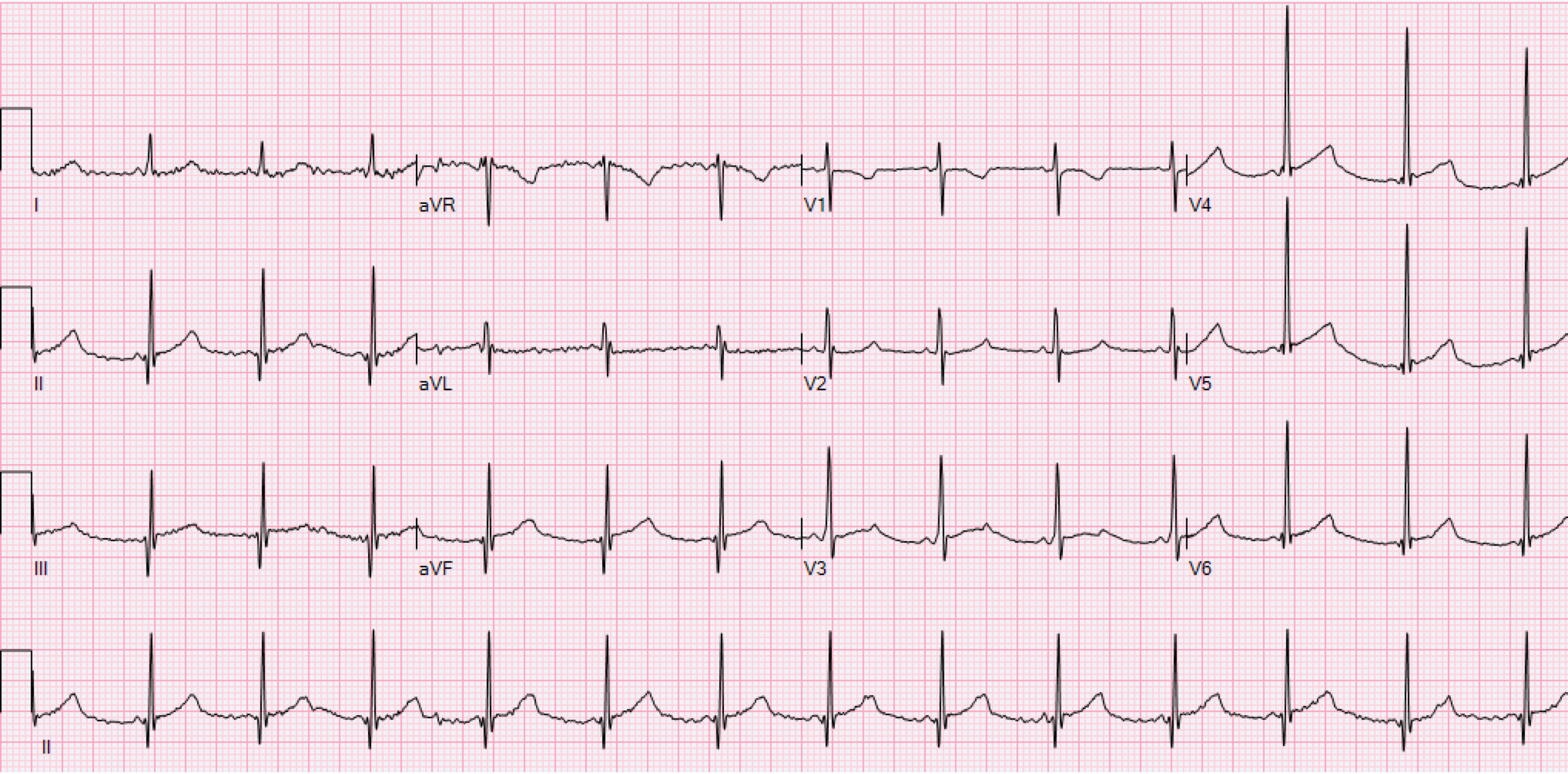
Recurrent Flutter s/p prosthetic MVR

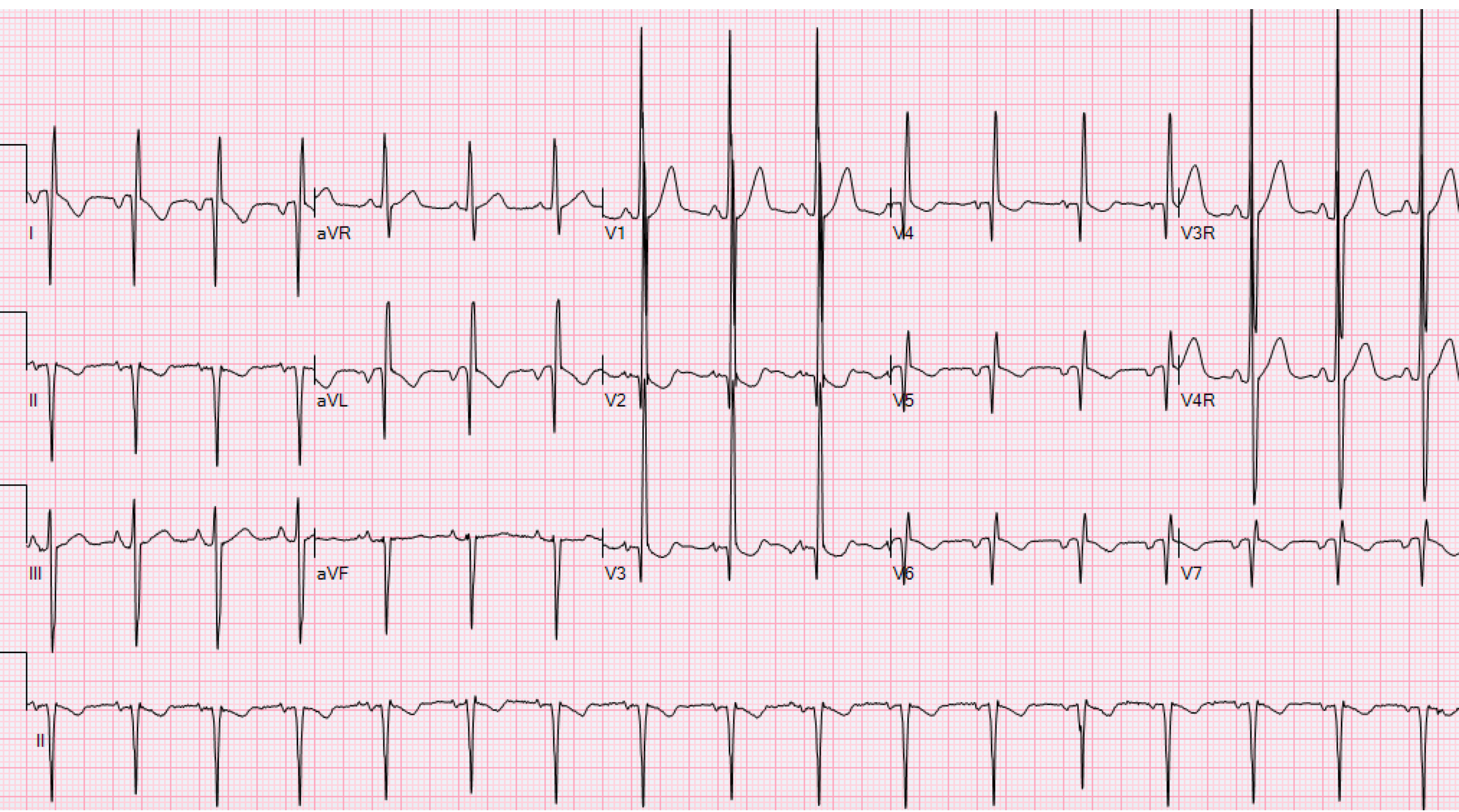


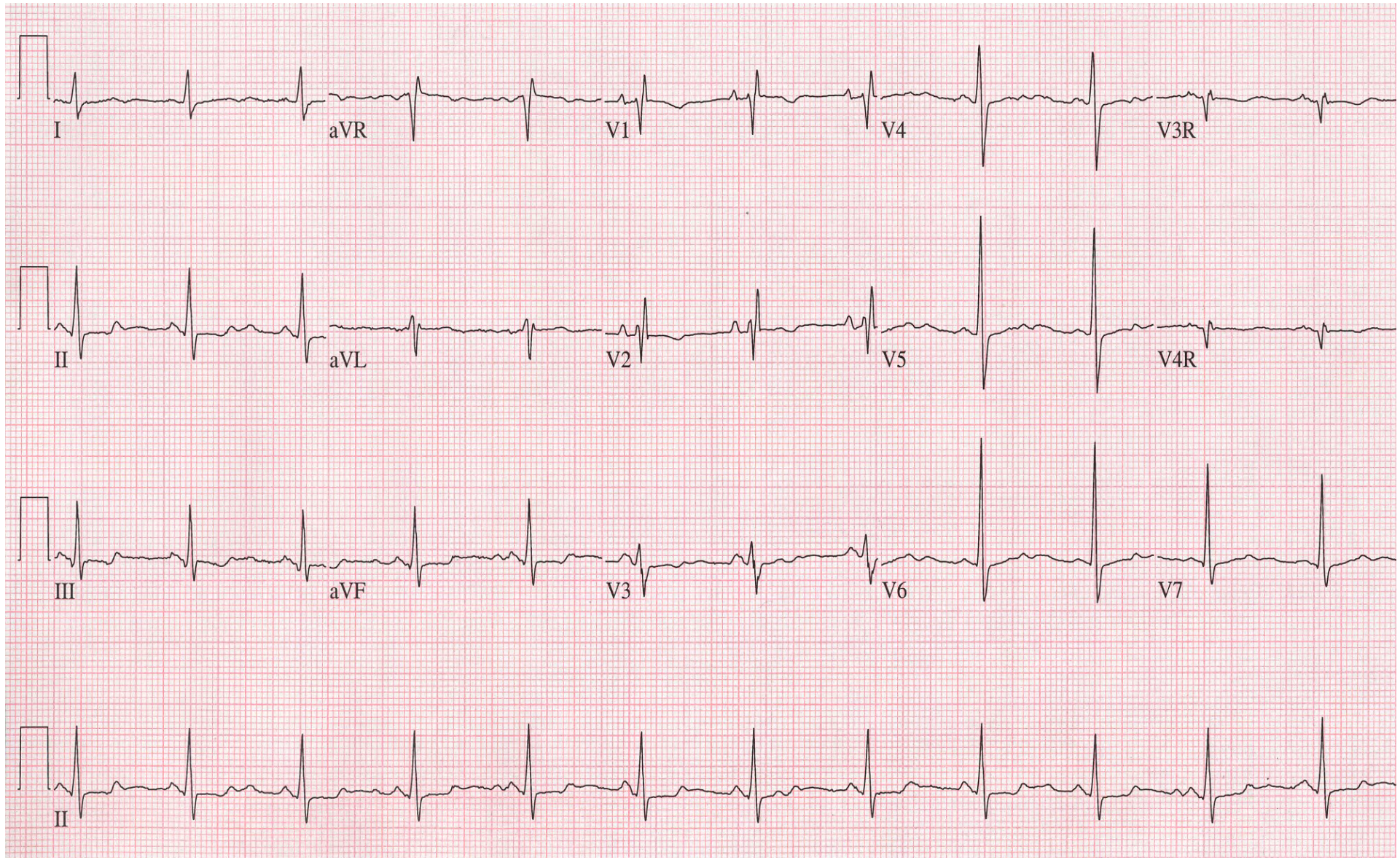
Same Patient- sinus rhythm



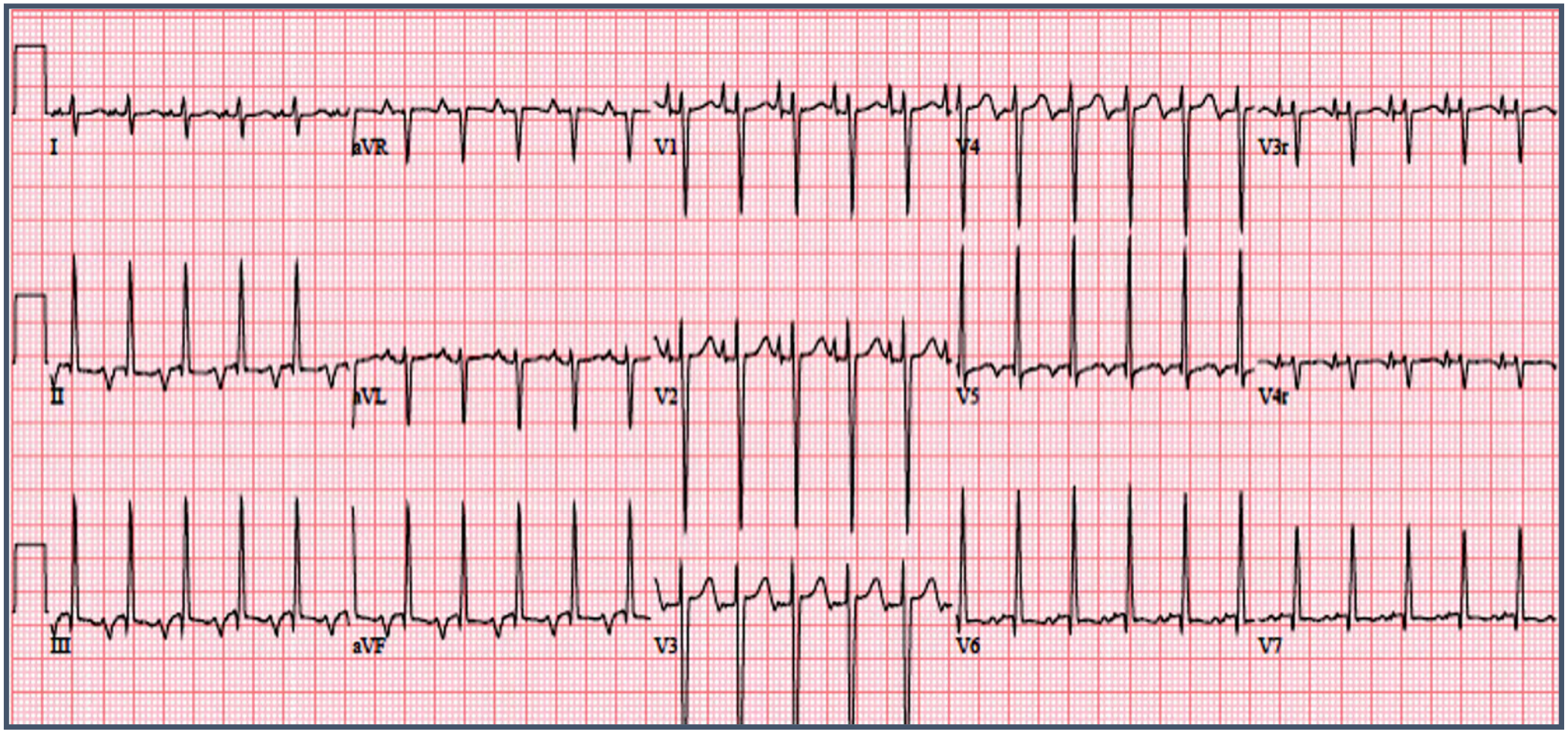

I
aVR
V1
V4
V3R
II
aVL
V2
V5
V4R
III
aVF
V3
V6
V7
II

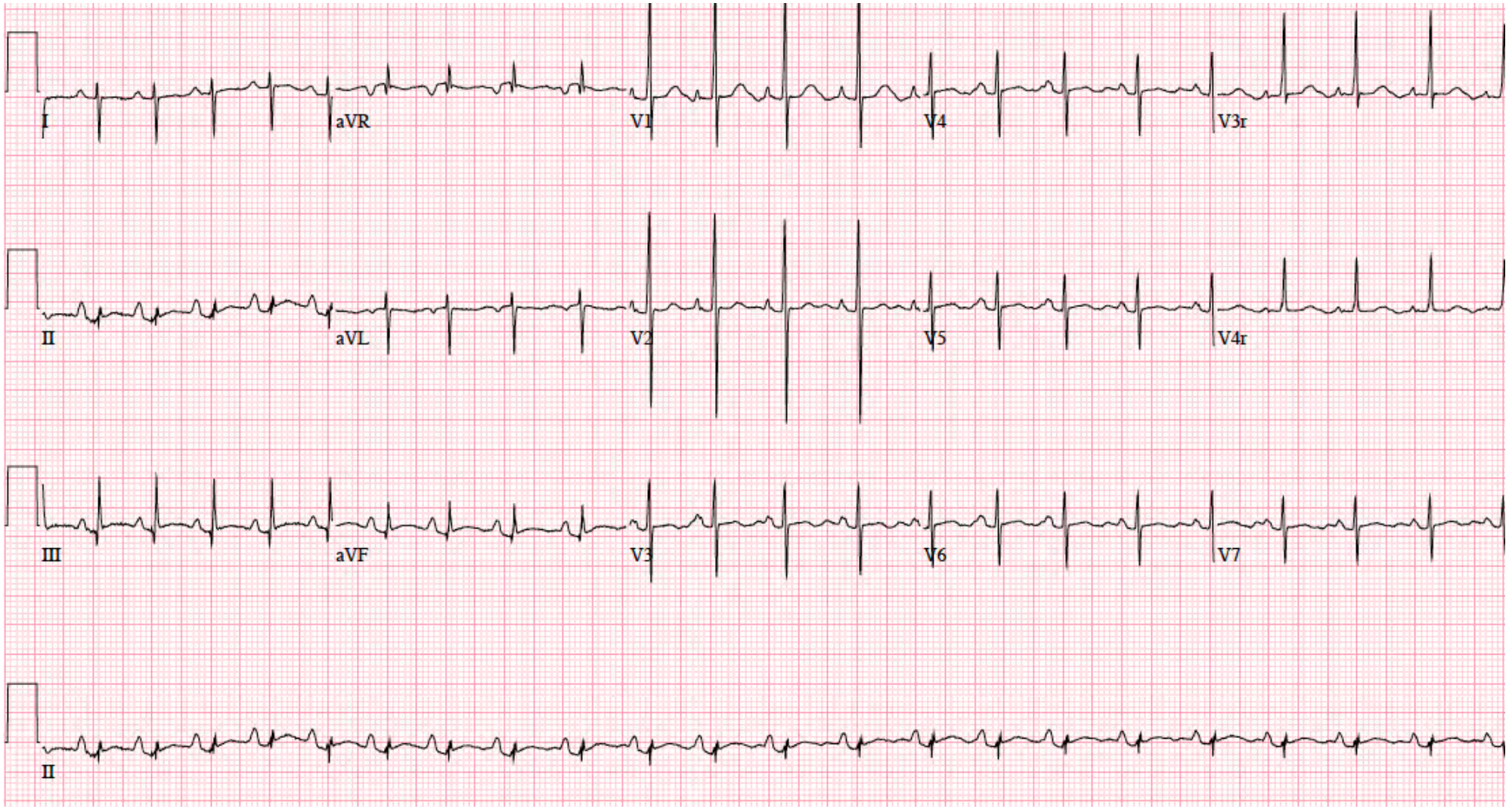

I
aVR
V1
V4
II
aVL
V2
V5
III
aVF
V3
V6
II

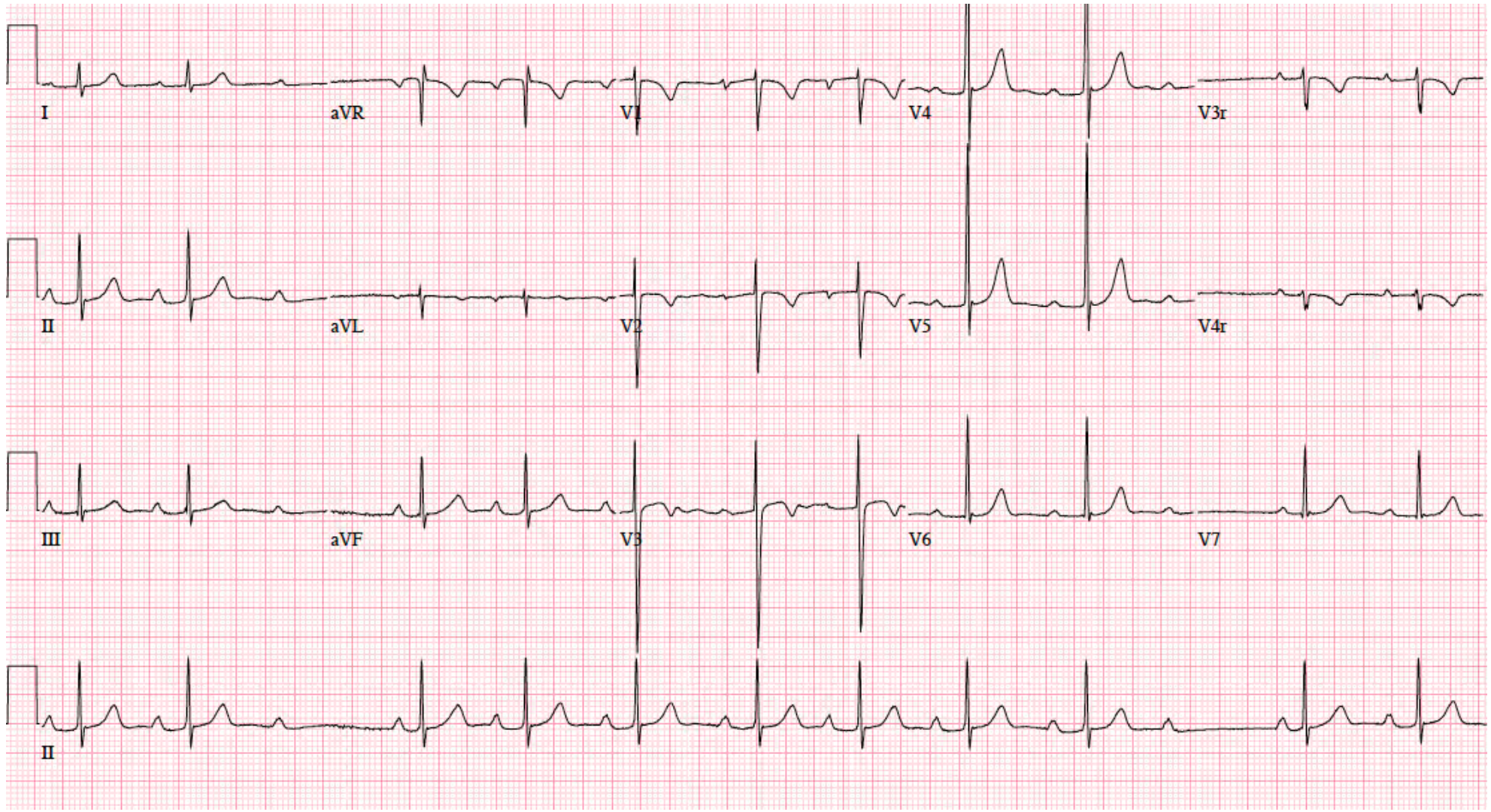

I
aVR
V1
V4
V3R
II
aVL
V2
V5
V4R
III
aVF
V3
V6
V7
II


I
aVR
V1
V4
V3R
II
aVL
V2
V5
V4R
III
aVF
V3
V6
V7
II

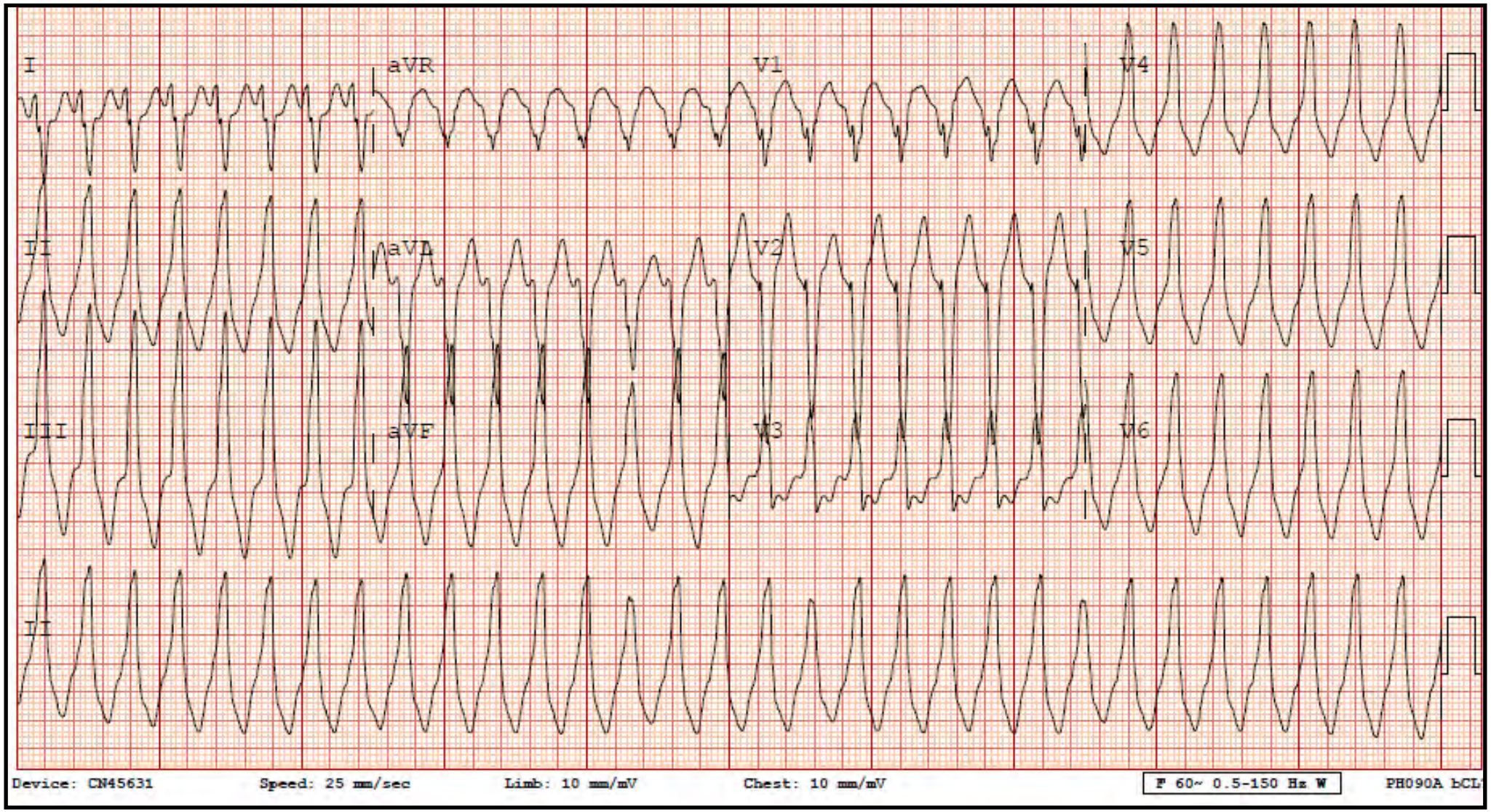
3 year old with Tachycardia

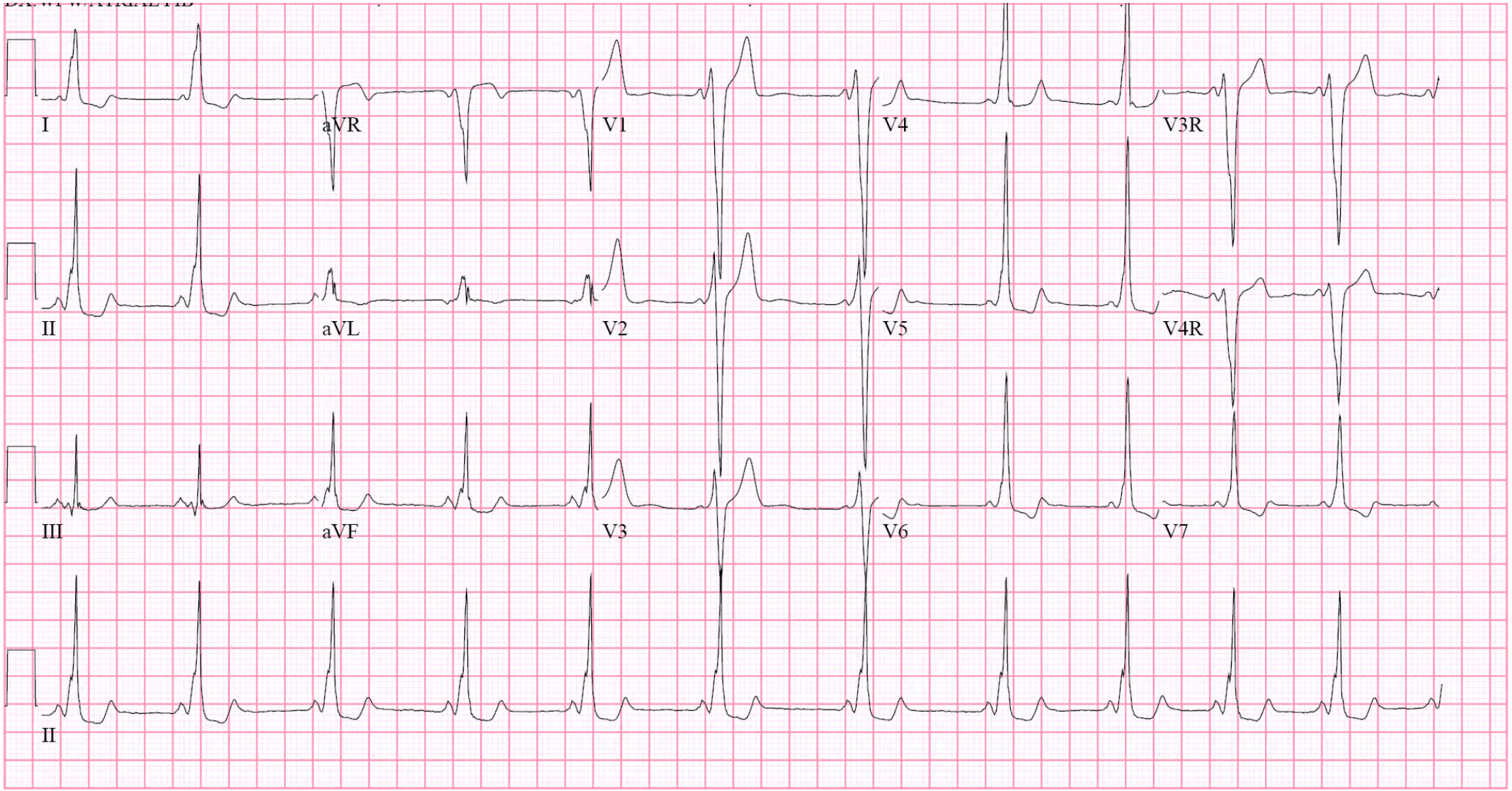



I
aVR
V1
V4
V3r
II
aVL
V2
V5
V4r
III
aVF
V3
V6
V7
II


I
aVR
V1
V4
V3r
II
aVL
V2
V5
V4r
III
aVF
V3
V6
V7
II

15 year old with palpitations while playing basketball





25mm/s 10mm/mV 150Hz 005E 12SL 250 CID: 1

EID:85 EDT: 15:40 12-MAR-1997 ORDER: