

# Day 1

# Homework

## General Introduction to ECG

Reading Assignment (p2-16 in PDF ‘*Outline*’)

### Objectives

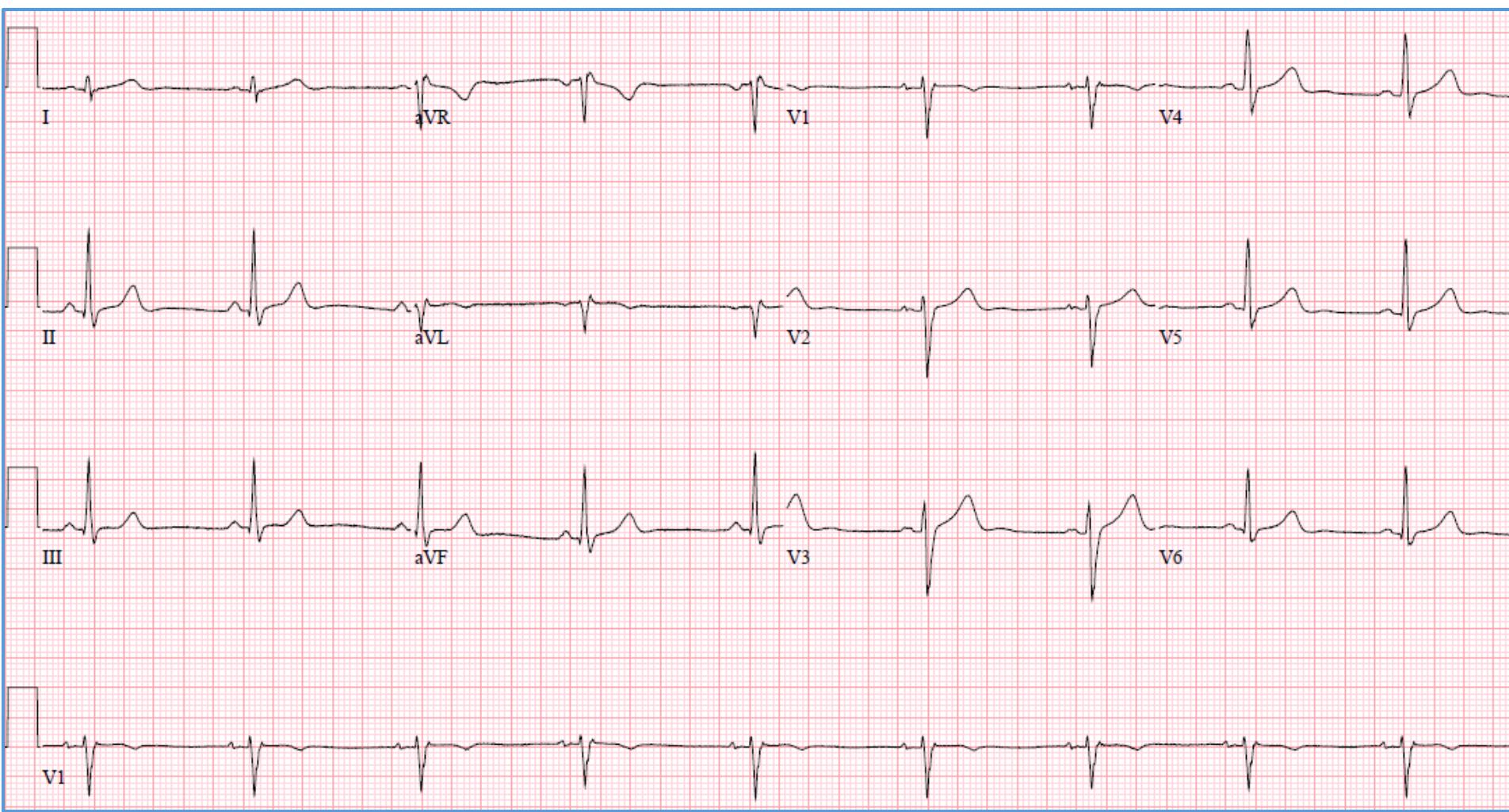
1. Practice the 5-step ‘Method’
2. Differential Diagnosis: R & L axis deviation
3. Differential Diagnosis: Poor R-wave progression
4. Differential Diagnosis: Prominent Anterior Forces

# Welcome to the “5-Step Method”

ECG #:

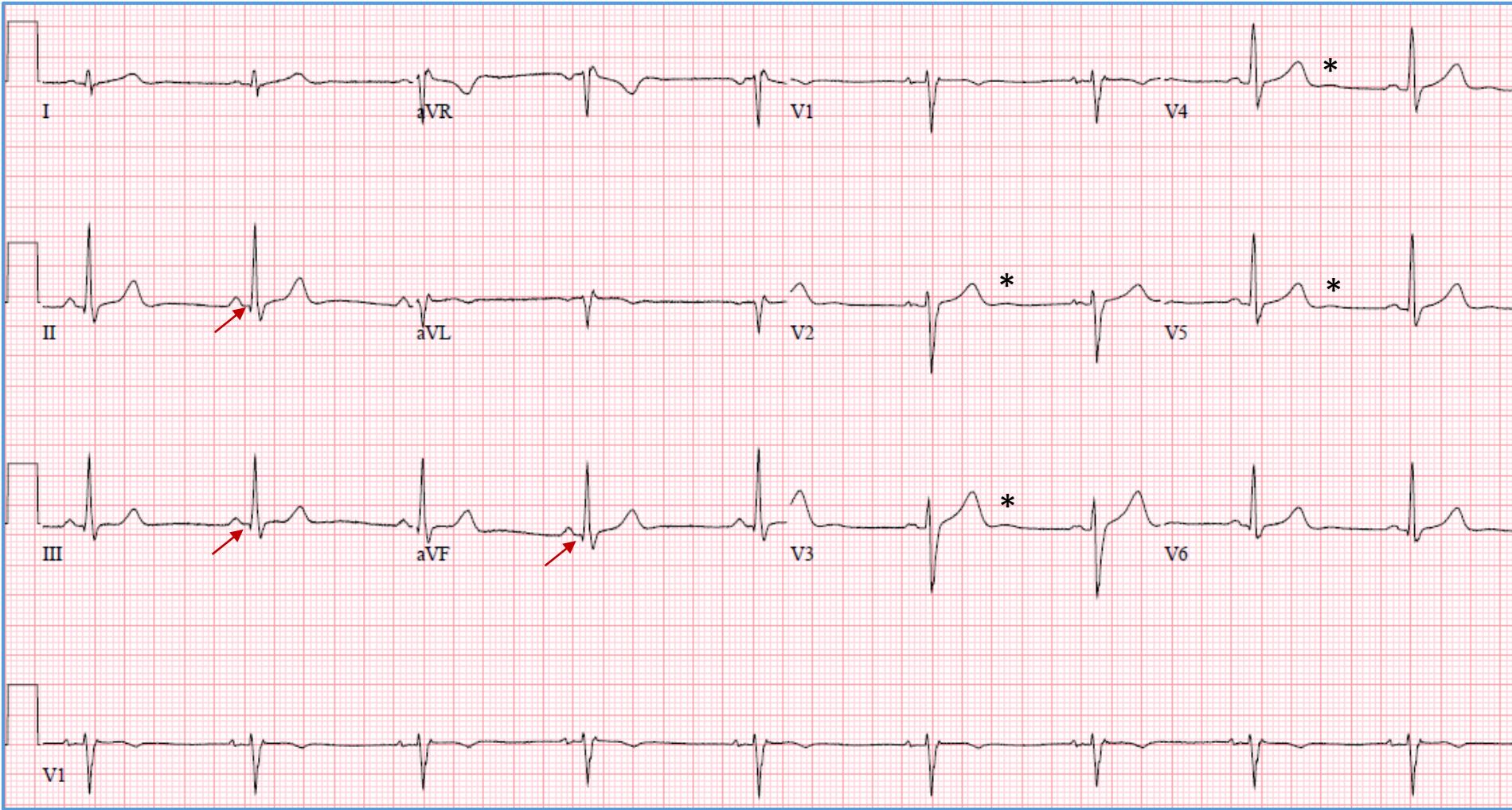
Mearurements:	Rhythm (s):	Conduction:	Waveform:	Interpretation:
A=      V=				
PR=				
QRS=				
QT=				
Axis=				

1. Compute the 5 basic measurements: HR, PR interval, QRS duration, QT interval, Axis
2. What's the basic rhythm and other rhythm statements (e.g., PACs and PVC's)
3. Any conduction abnormalities (SA blocks, AV blocks (Types I or II), and IV blocks
4. Waveform abnormalities beginning with P waves, QRS complexes, ST-T, and U waves
5. Final interpretations: Normal ECG or Borderline or Abnormal ECG (list final conclusions)

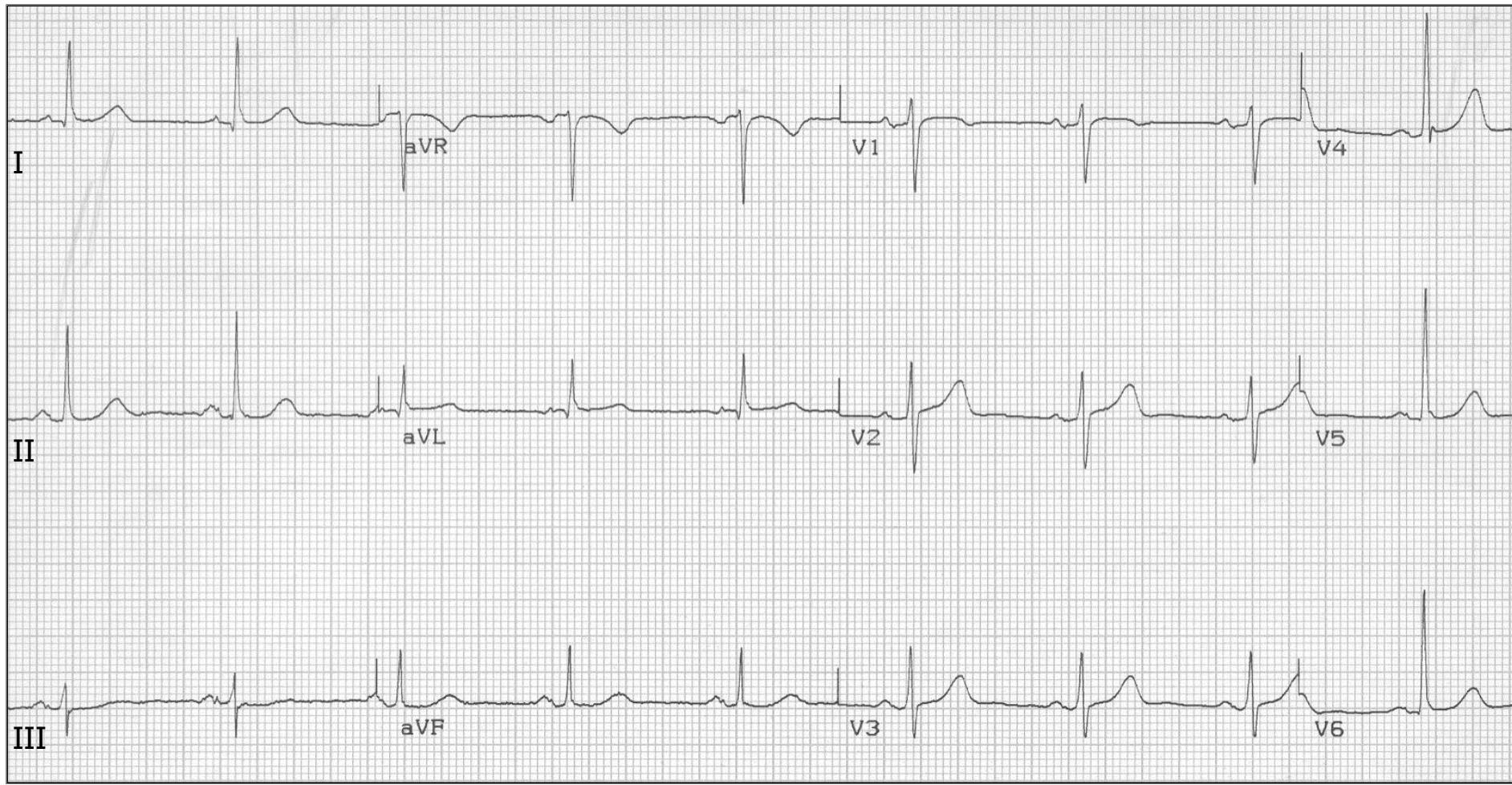


30 year old woman (explain the sequence of activation from sinus node to ventricular muscle)

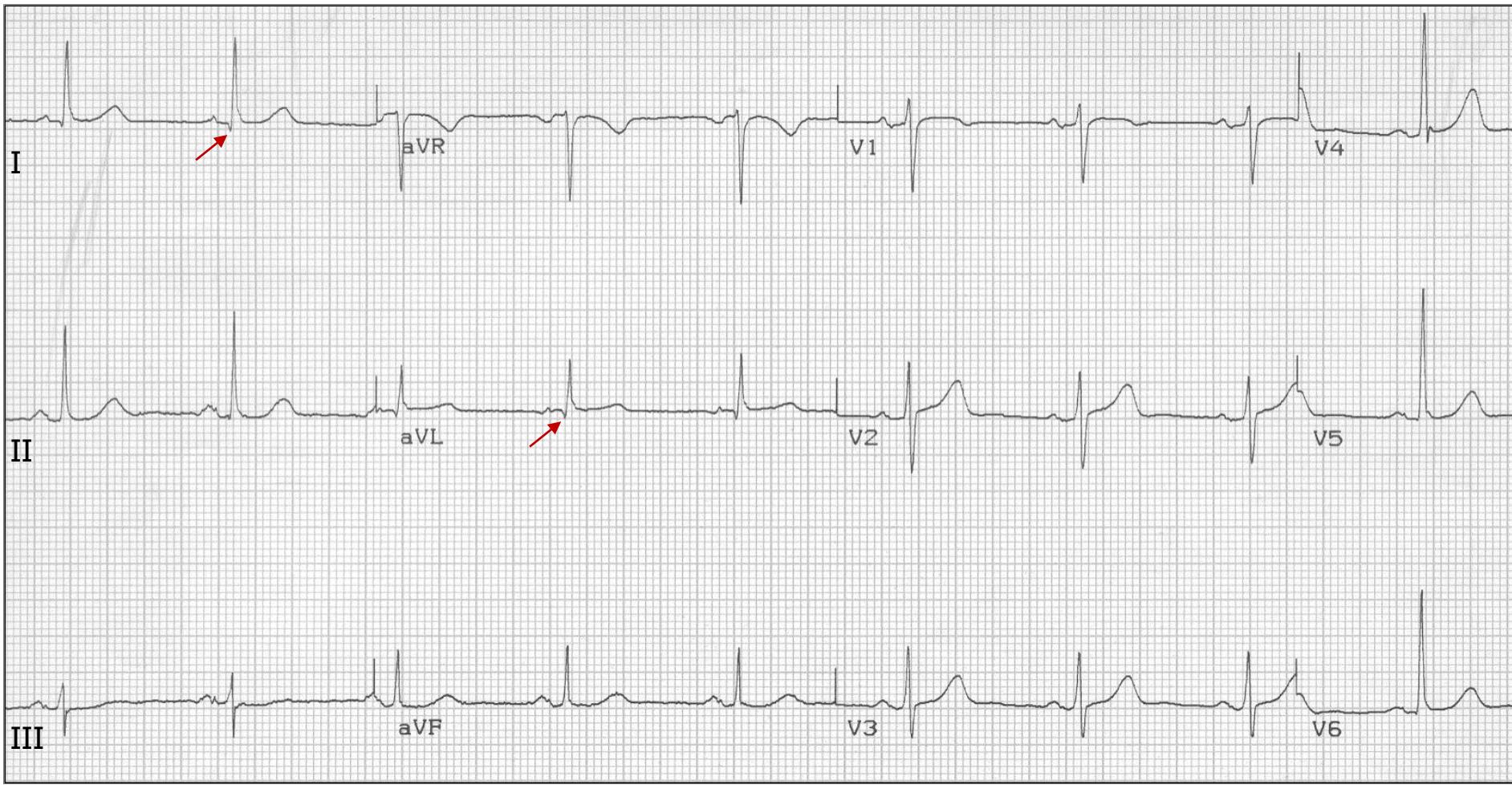
What are 'septal' q-waves?



Mearurements:	Rhythm (s):	Conduction:	Waveform:	Interpretation:
A=55    V=55	Normal Sinus rhythm	Normal SA, AV, IV conduction	<ul style="list-style-type: none"> <li>Normal P, QRS, ST, T; note normal U waves in precordial leads (*)</li> <li>Septal q's in II, III, aVF</li> </ul>	Normal ECG (septal q-waves normally seen in II, III, aVF in ECG's when the QRS axis is > +60°; see arrows)
PR=140				
QRS=100				
QT=430				
Axis= +80		<u>Sequence of conduction:</u> <ul style="list-style-type: none"> <li>SA node → (RA→LA) → AV node → His Bundle → RBB &amp; LBB → LAF &amp; LPF &amp; LSF → Purkinje network → left septal surface (onset of QRS)</li> </ul>	(onset of ventricular activation begins on the left ventricular septal surface resulting in small <i>septal</i> q-waves)	

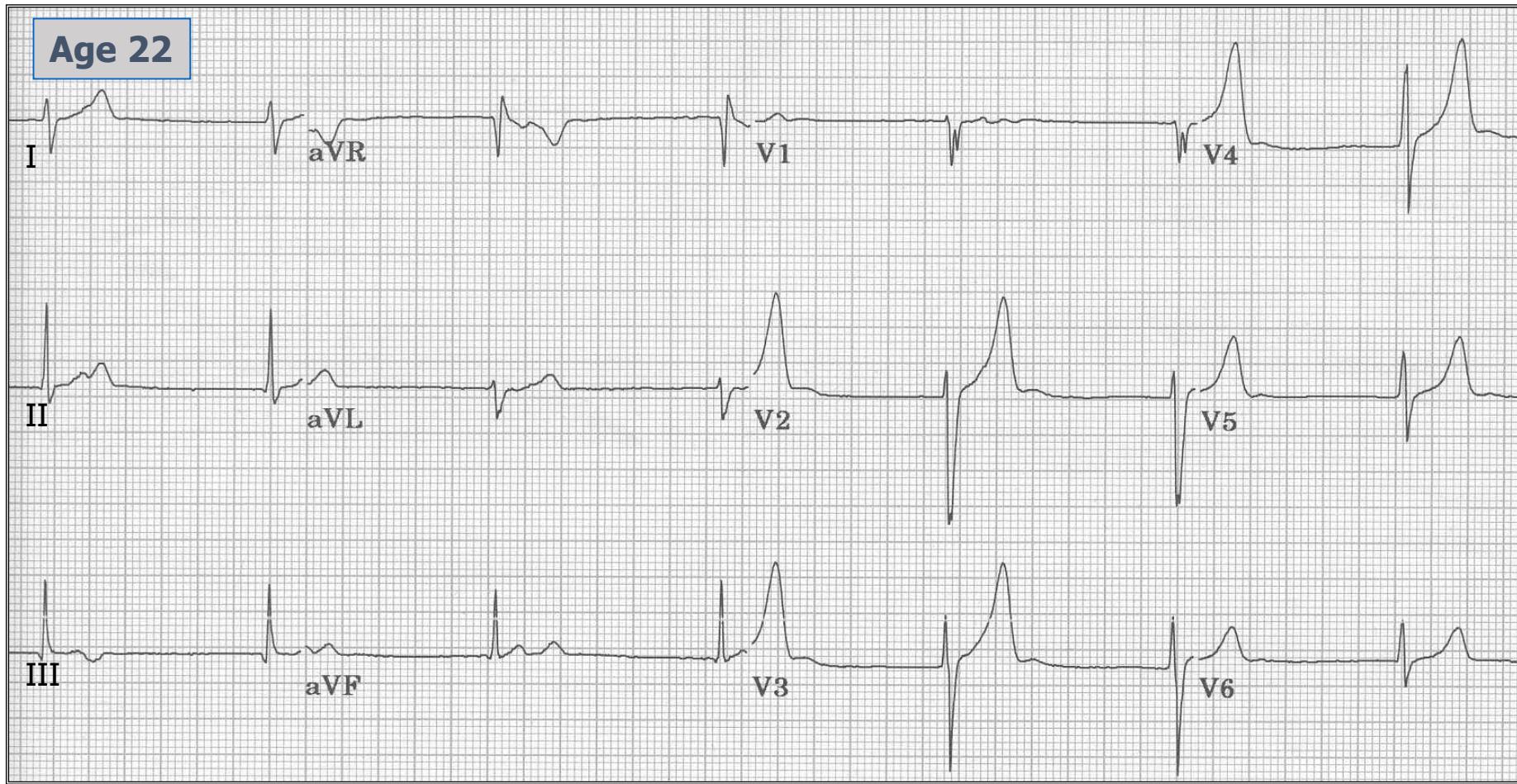


65 Year old woman  
Where are the 'septal' q-waves?



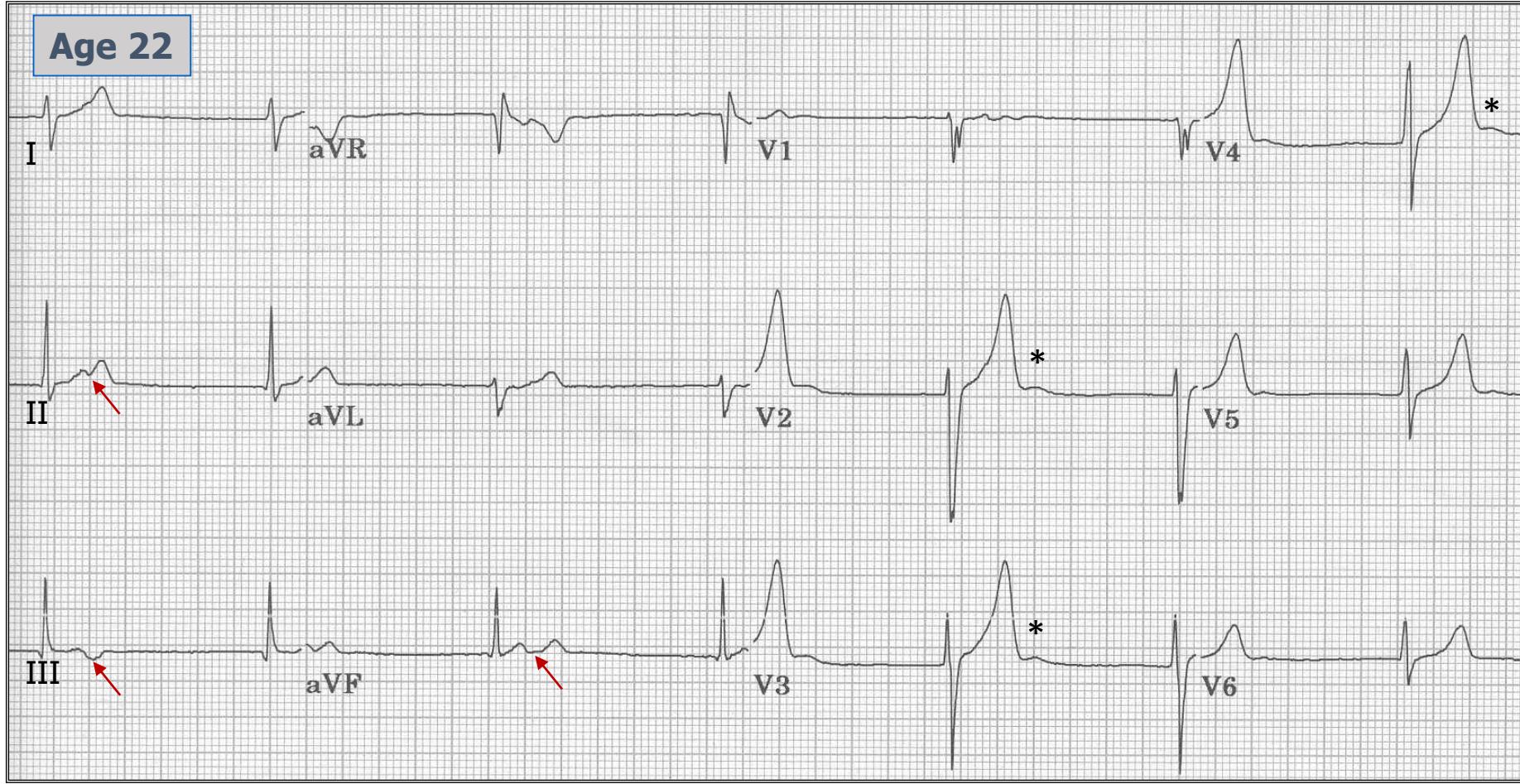
Mearurements:	Rhythm (s):	Conduction:	Waveform:	Interpretation:
A=65    V=65	Sinus Rhythm	Normal SA, AV, IV	<ul style="list-style-type: none"> <li>Normal P, QRS, ST-T</li> <li>Septal q-waves I, aVL (arrows)</li> </ul> <p>(onset of ventricular activation begins in the left ventricular septal surface)</p>	Normal ECG (septal q-waves are normally seen in leads I, and aVL when the QRS axis is < +60°)
PR=169				
QRS=70				
QT=380				
Axis= +30				

**Age 22**

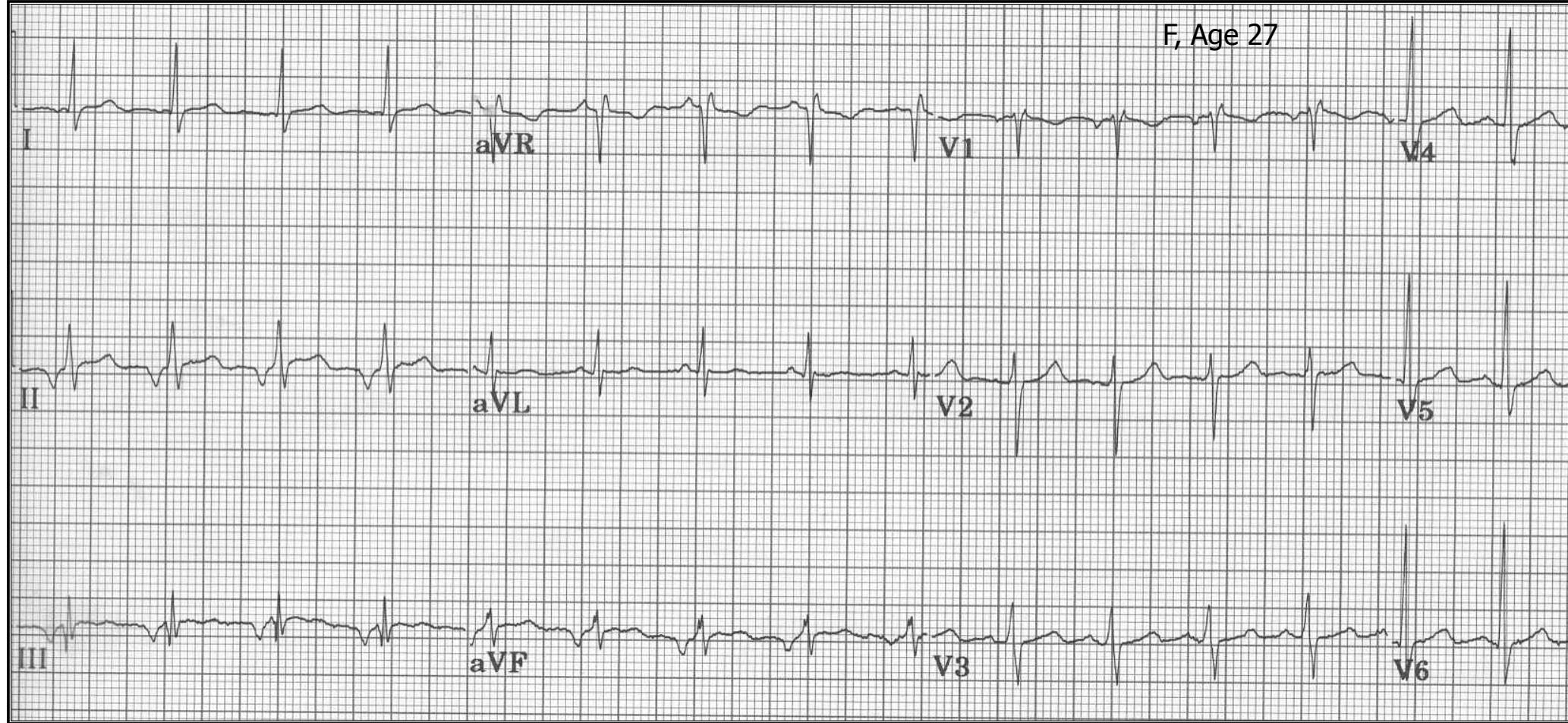


22 year old man; just waking up.

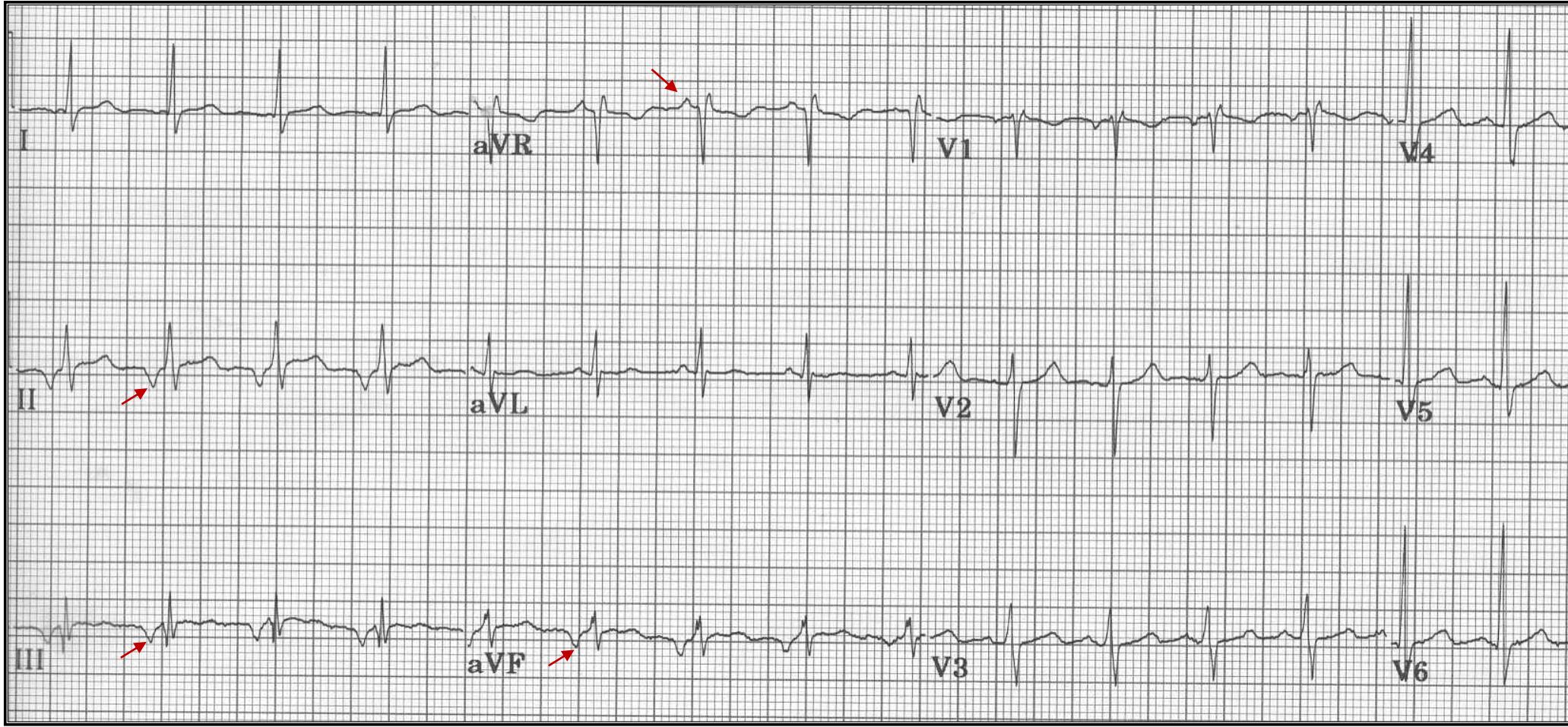
**Age 22**



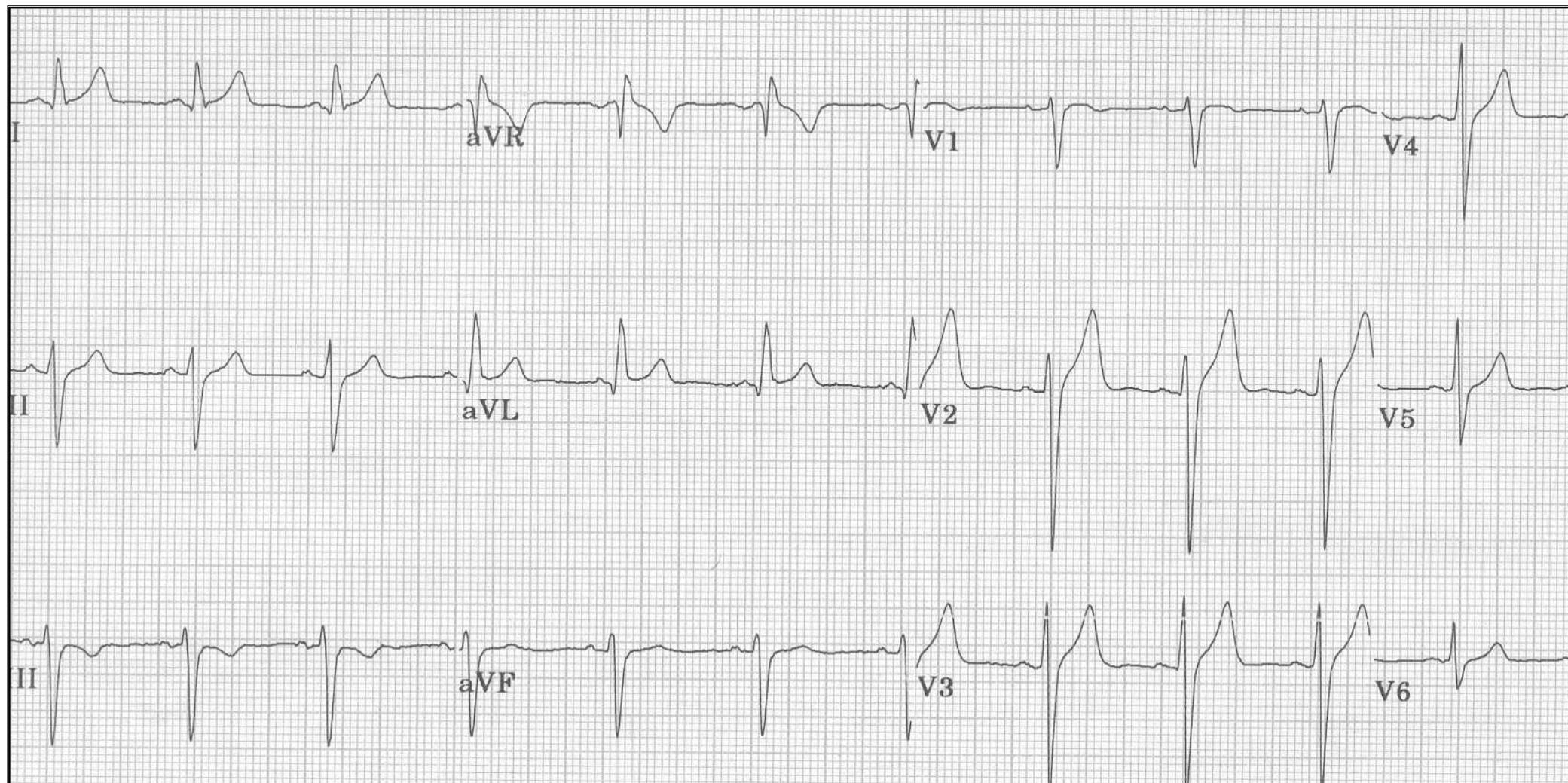
Mearurements:	Rhythm (s):	Conduction:	Waveform:	Interpretation:
A=48    V=48	Junctional escape rhythm	• Normal IV	• Normal QRS, ST, T, U (*) • Retrograde P waves after the QRS in the ST segment, best seen in II, III, aVF (arrows); it's like someone <i>took a bite out of the T wave!</i>	Abnormal ECG (likely a normal variant in an athlete) 1. Slight right axis deviation (can be normal in 22 year old man) 2. Junctional escape rhythm (probably due to vagal slowing of the sinus rate in a healthy athlete; sinus rhythm would reappear after light exercise)
PR= none	(Escape rhythms serve as backup pacemakers when the primary pacemaker gets too slow <u>or</u> when heart block prevents primary pacemaker from reaching the ventricles)			
QRS=90				
QT=400			<u>Note:</u> normal U waves are best seen in leads V2-5 (*); these are the best leads to see U waves especially at slow heart rates.	
Axis= +100				



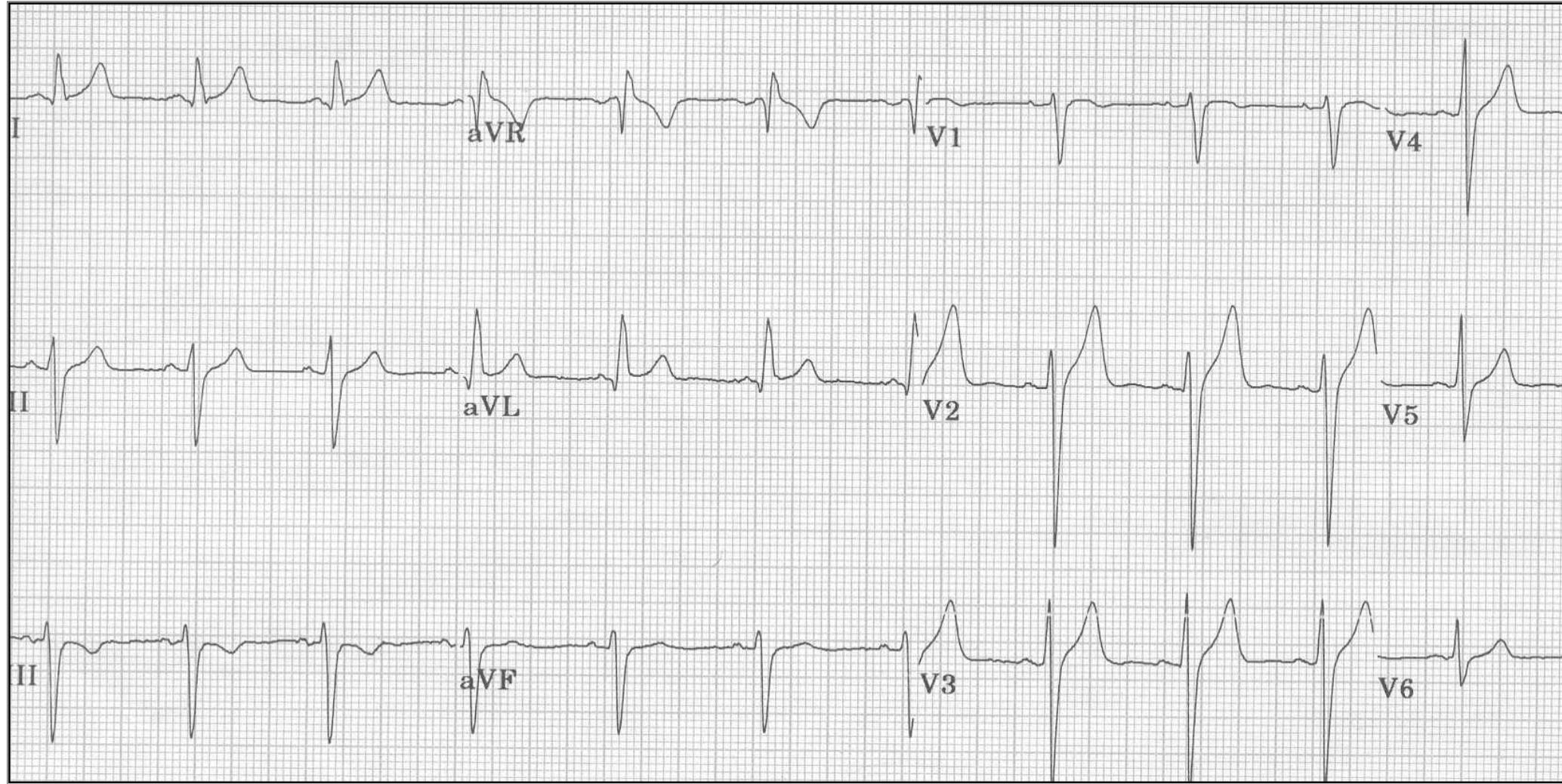
27 year old woman; feeling anxious.



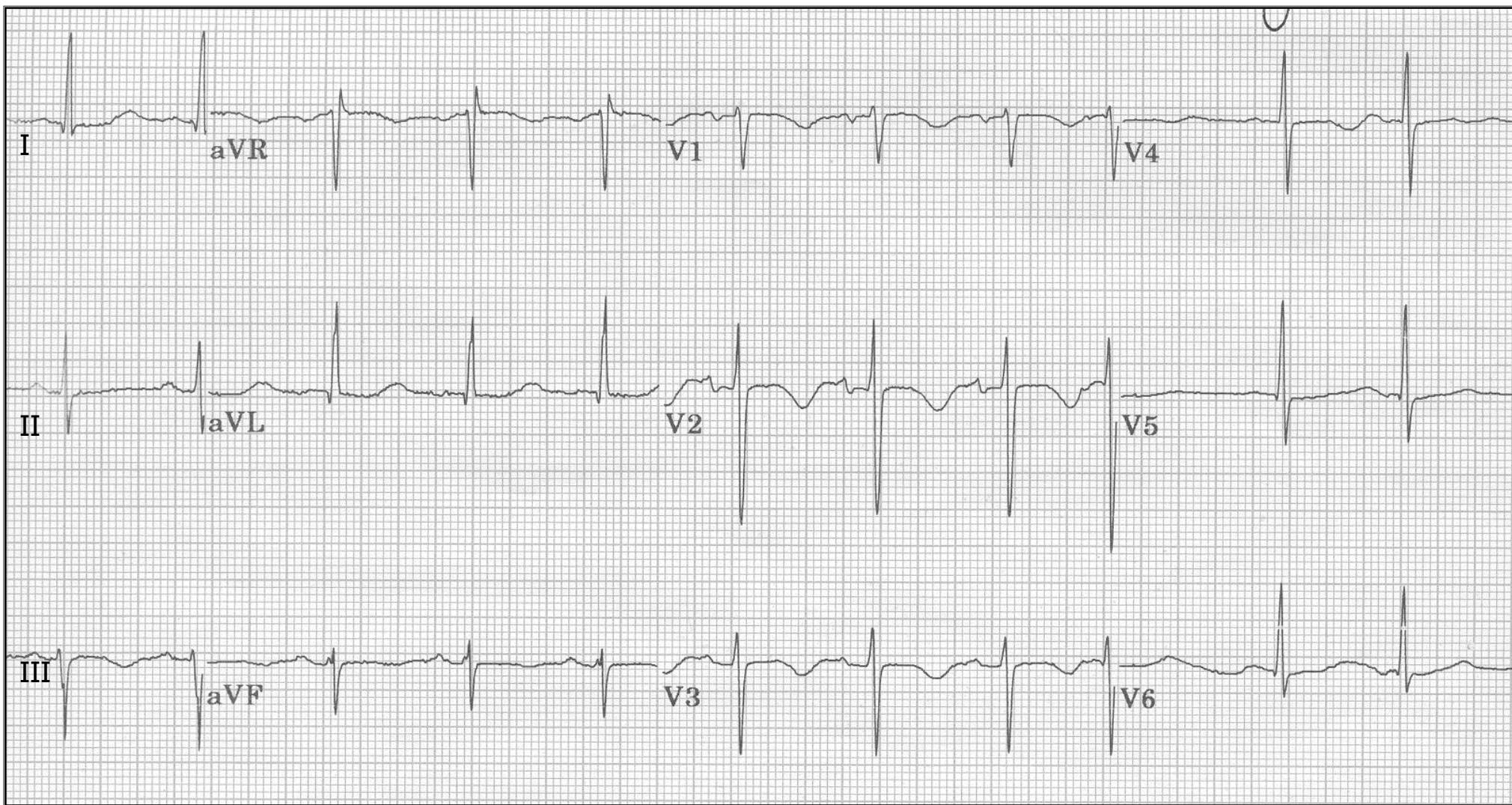
Mearurements:	Rhythm (s):	Conduction:	Waveform:	Interpretation:
A=110    V=110	Ectopic atrial tachycardia	Normal AV, IV	<ul style="list-style-type: none"> <li>Inverted P waves II, III, aVF; upright P waves in lead aVR; (low atrial ectopic pacemaker)</li> <li>Normal QRS, ST, T waves</li> </ul> <p><u>Note:</u> In the horizontal plane (V1-6) ectopic atrial P waves may look <i>normal</i> in morphology; i.e., upright in direction.</p>	<p>Abnormal ECG:</p> <ol style="list-style-type: none"> <li>Rhythm (this rhythm abnormality can be the result of various internal or external stress perturbations; e.g., hypoxia, stimulants, sepsis, et al.)</li> </ol> <p>Brief ectopic atrial rhythms (usually 3-6 beat runs) are common in otherwise healthy people (may also occur in sick individuals)</p>
PR=120				
QRS=80				
QT=300				
Axis= +10				



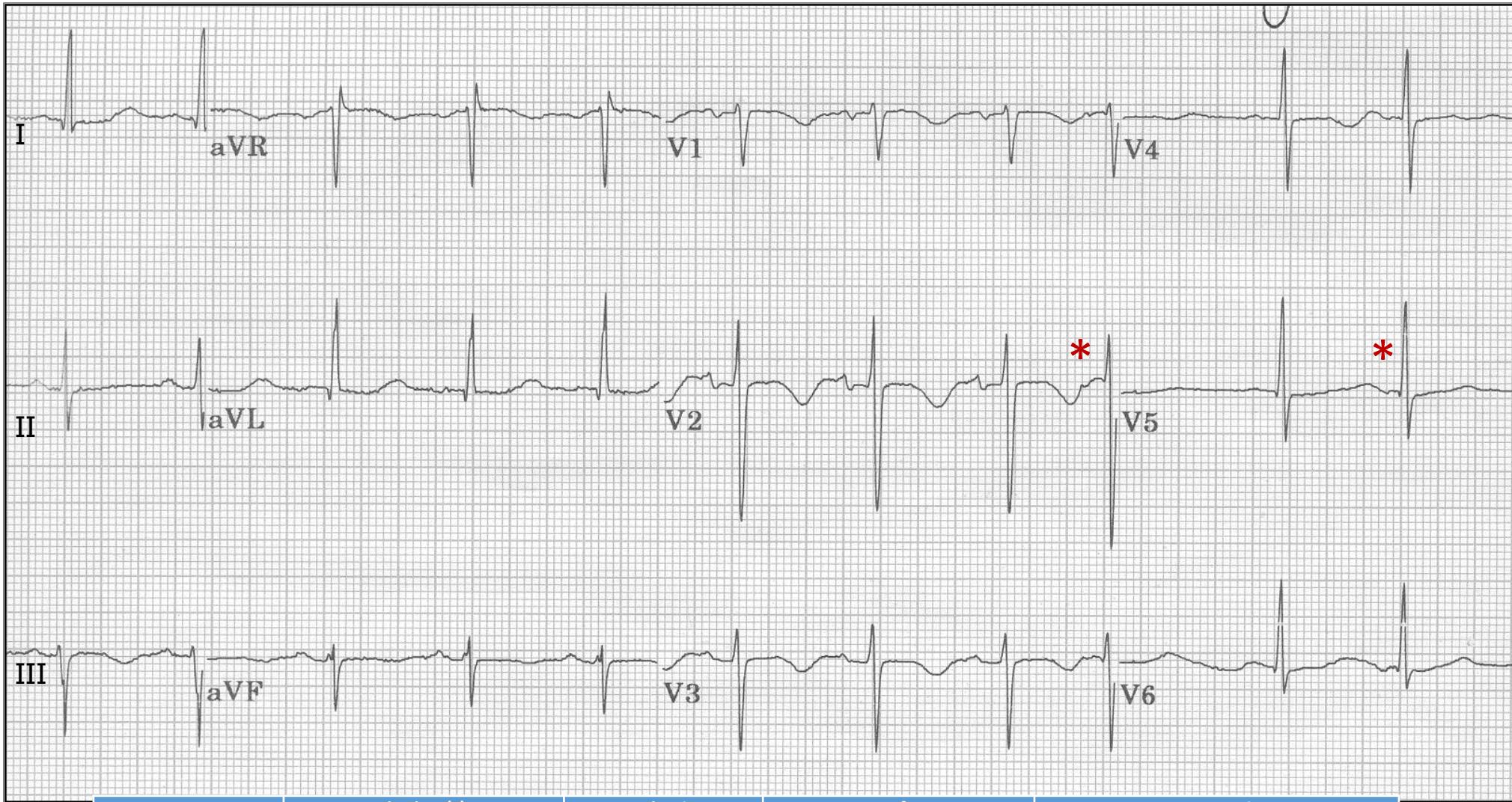
Just an ordinary guy getting an insurance physical.



Measurements:	Rhythm (s):	Conduction:	Waveform:	Interpretation:
A= 80    V=80	Sinus rhythm	Normal SA, AV, slight IV conduction delay	<ul style="list-style-type: none"> <li>Normal P</li> <li>rS in II, III, aVF (<math>S_{III} &gt; S_{II}</math>)</li> <li>Small q in I, aVL</li> <li>Delayed QRS transition in horizontal plane (V5); note persistent S waves in V5-6.</li> </ul>	<p>Abnormal ECG:</p> <ol style="list-style-type: none"> <li>Left anterior fascicular block (LAFB is the most common IV conduction disorder)</li> </ol> <p>The left bundle branches into two (sometimes three) fascicles: anterior, (septal), and posterior. (see pp 55-58 in the <i>Outline</i>)</p>
PR= 120				
QRS=110				
QT=360				
Axis= -60				



F, Age 87 (sick and dehydrated)

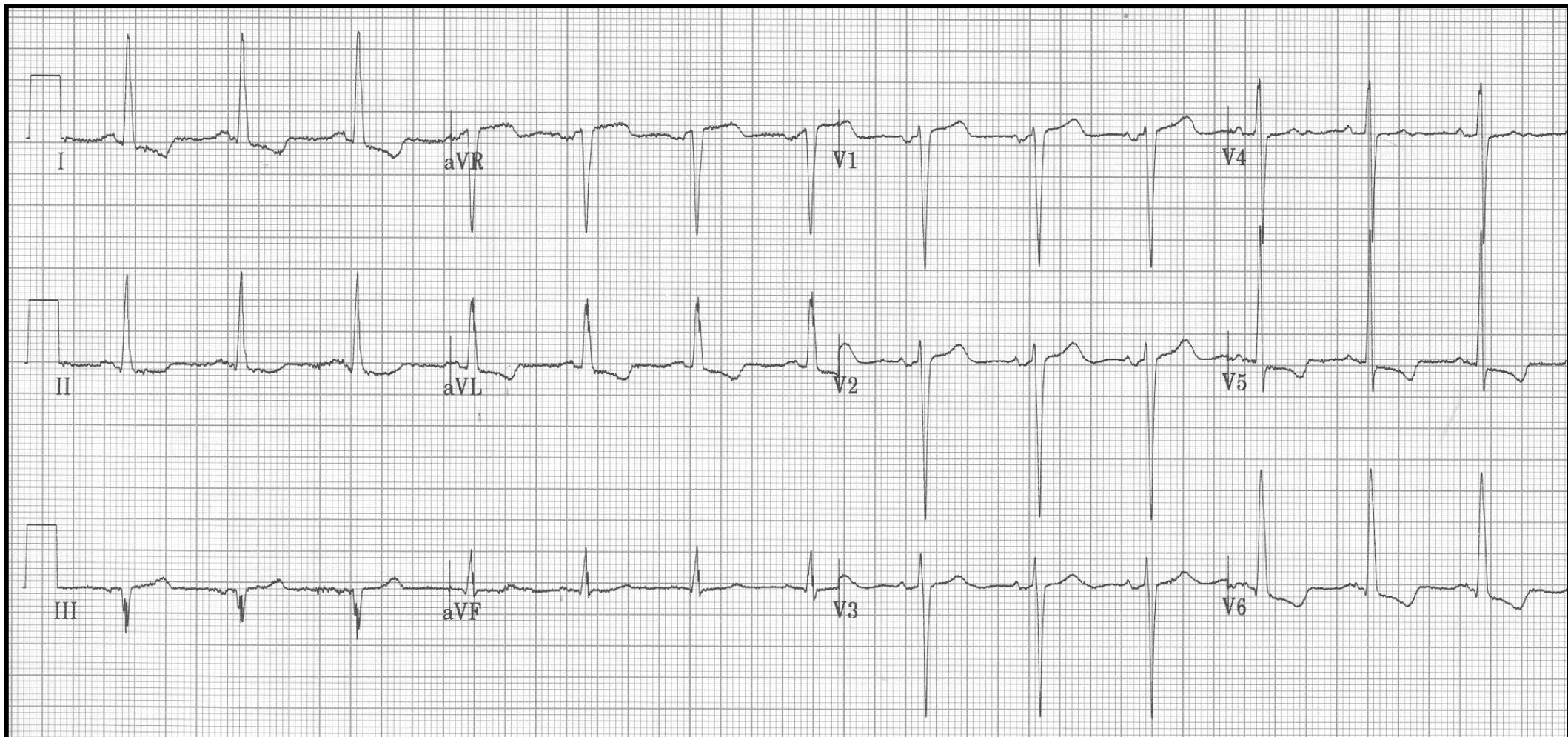


Mearurements:	Rhythm (s):	Conduction:	Waveform:	Interpretation:
A=80    V=80	Sinus rhythm with 2 PACs (*)	Normal SA, AV, IV	<ul style="list-style-type: none"> <li>Normal P, QRS</li> <li>Slight ST depression V5-6</li> <li>T inversion in III, V2-4</li> </ul>	Abnormal ECG: <ol style="list-style-type: none"> <li>Prolonged QT (upper limit @ 80 bpm is ~380 ms); many etiologies to consider!</li> <li><i>Nonspecific</i> ST-T abnormalities (consider abnormal electrolytes, drugs, various heart diseases, etc)</li> <li>Rhythm: 2 PACs</li> </ol>
PR=160	<u>Note:</u> The PAC's are early beats with different P wave morphology; the first PAC is followed by a pause (longer RR cycle)			
QRS=80				
QT=480				
Axis= -20				

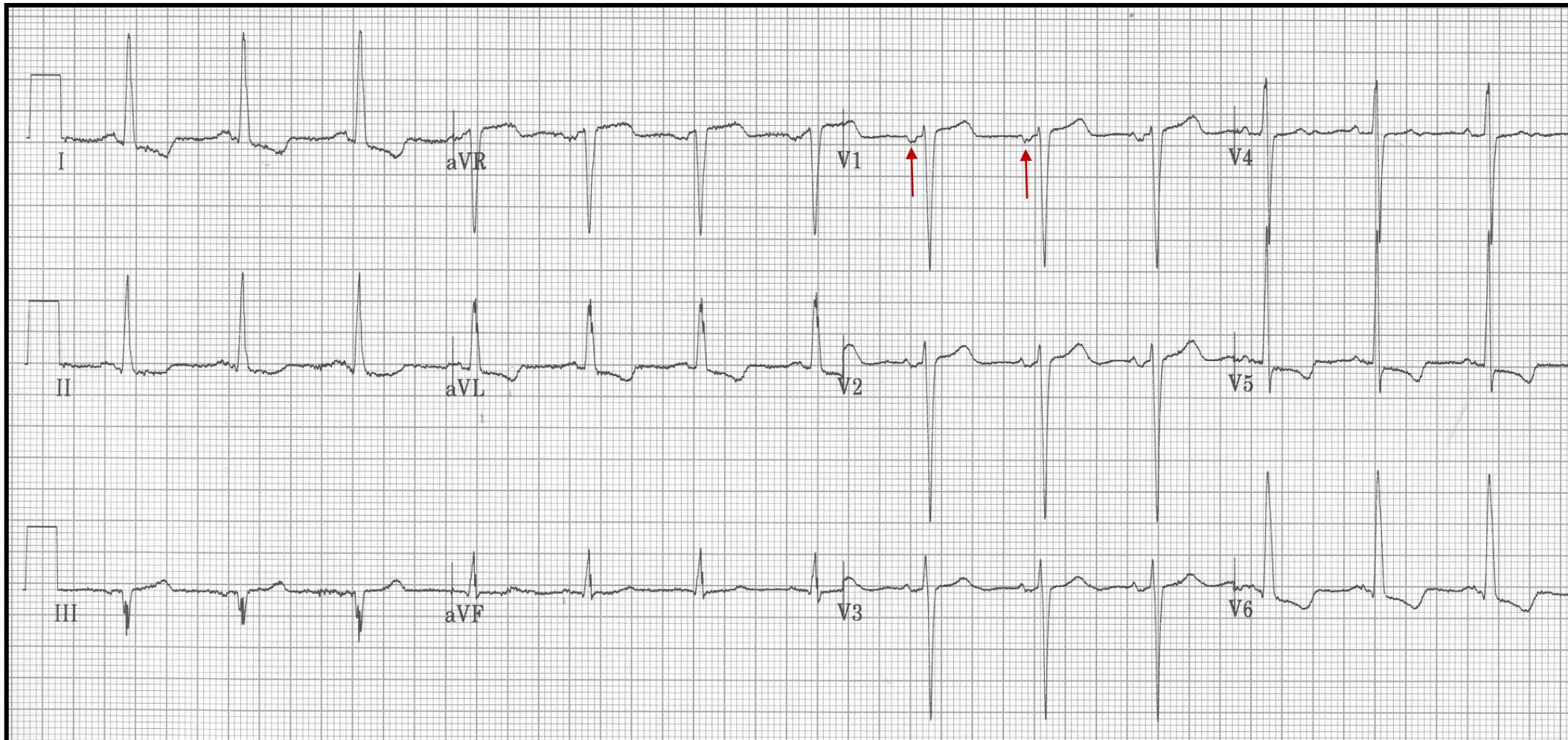
# $V_{1-6}$ : Differential Diagnoses

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- **Poor R-wave progression (small or no r-waves  $V_{1-3}$ , +  $R:S_{V4} < 1$ )**
  - Normal variant (esp. in women)
  - Misplaced precordial leads
  - Left ventricular hypertrophy
  - Anterior and anteroseptal MI
  - LBBB and incomplete LBBB
  - Left anterior fascicular block
  - Emphysema and COPD
  - Some cases of WPW
  - Diffuse infiltrative diseases
  - Dextrocardia
- **Prominent anterior forces (PAF:  $R:S V_{1-2} \geq 1$ )**
  - Normal variant
  - Misplaced precordial leads
  - Right ventricular hypertrophy
  - RBBB and incomplete RBBB
  - ‘True Posterior’ (now called Lateral) MI
  - Some cases of WPW
  - Left septal fascicular block
  - Muscular dystrophy

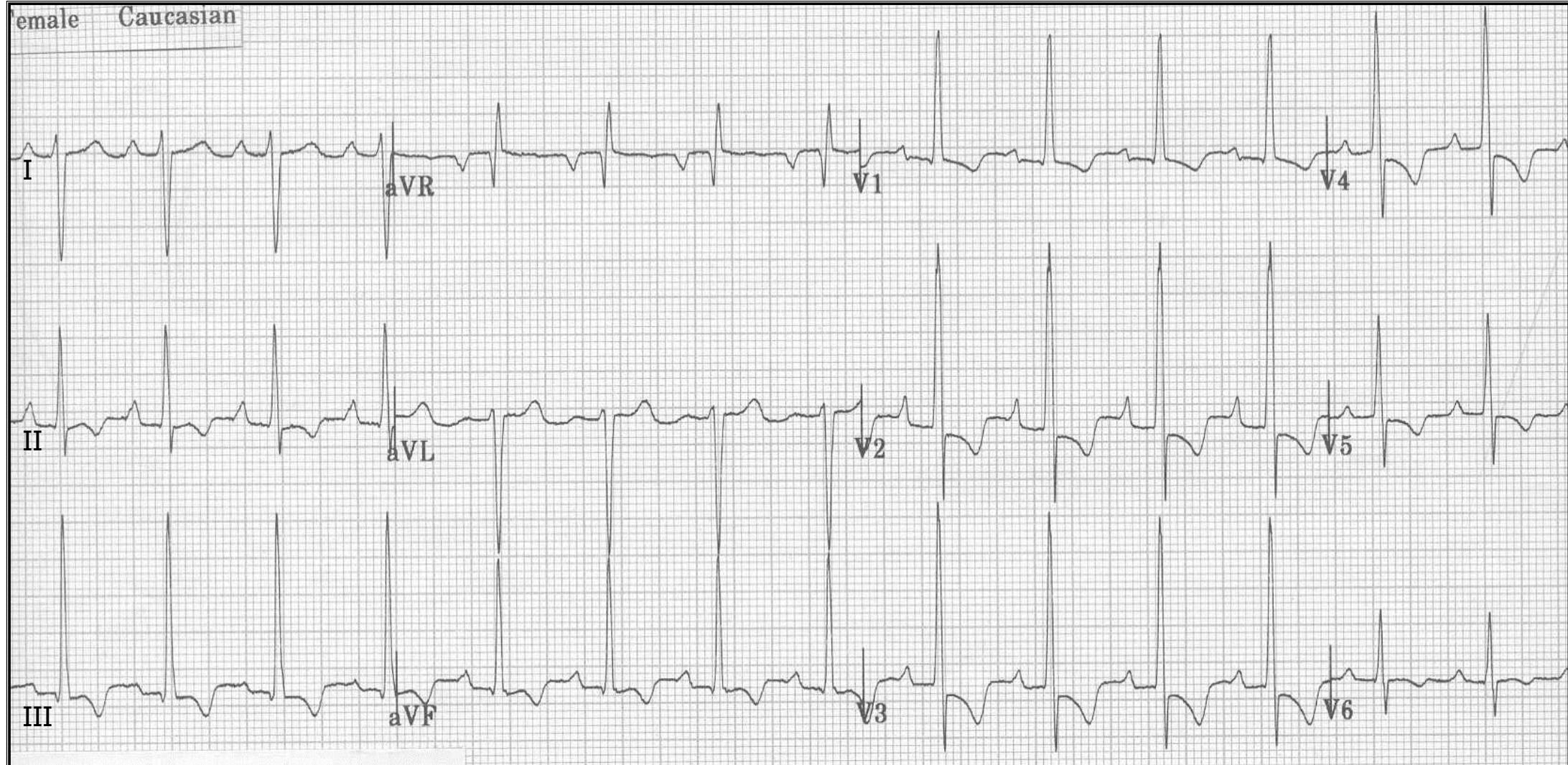


68 y.o. woman (History of hypertension on Rx)



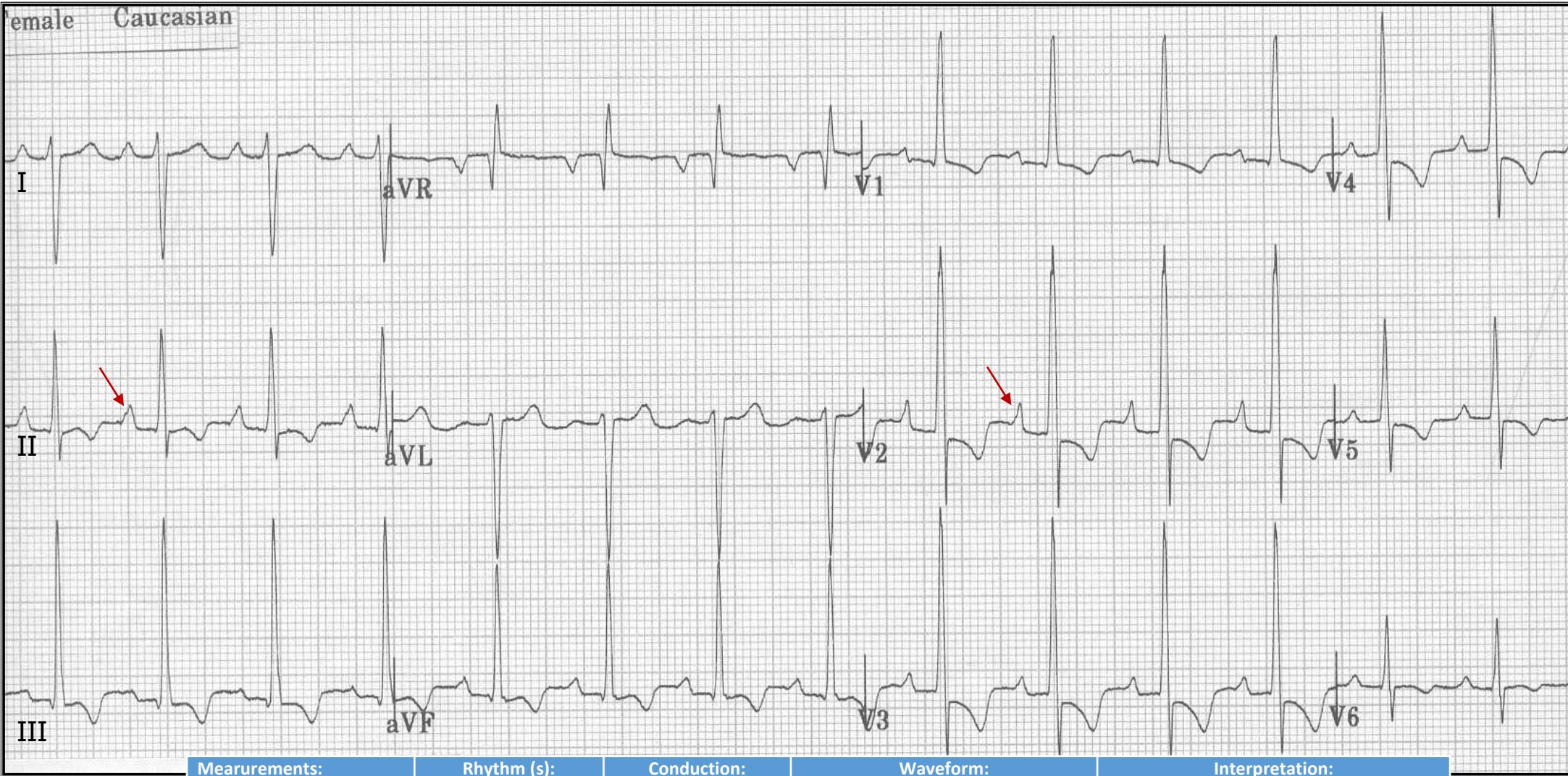
Mearurements:	Rhythm (s):	Conduction:	Waveform:	Interpretation:
A=85    V=85	Sinus rhythm	Normal SA, AV, IV	<ul style="list-style-type: none"> <li>• Increase P terminal force V1 (arrow)</li> <li>• Multiple voltage criteria for LVH</li> <li>• Poor R wave progression V1-4</li> <li>• ST depression, T inversion in I, aVL, V5-6</li> </ul>	Abnormal ECG 1. LAE 2. LVH with strain pattern (seen in LV pressure overload conditions like aortic stenosis, hypertensive heart disease, IHSS)  (See p61 in the 2018 pdf <i>Outline</i> for various LVH criteria; ECG criteria for LVH has very poor <i>sensitivity</i> <u>but</u> high <i>specificity</i> )
PR=140				
QRS=90				
QT=360				
Axis= +15				

Female Caucasian

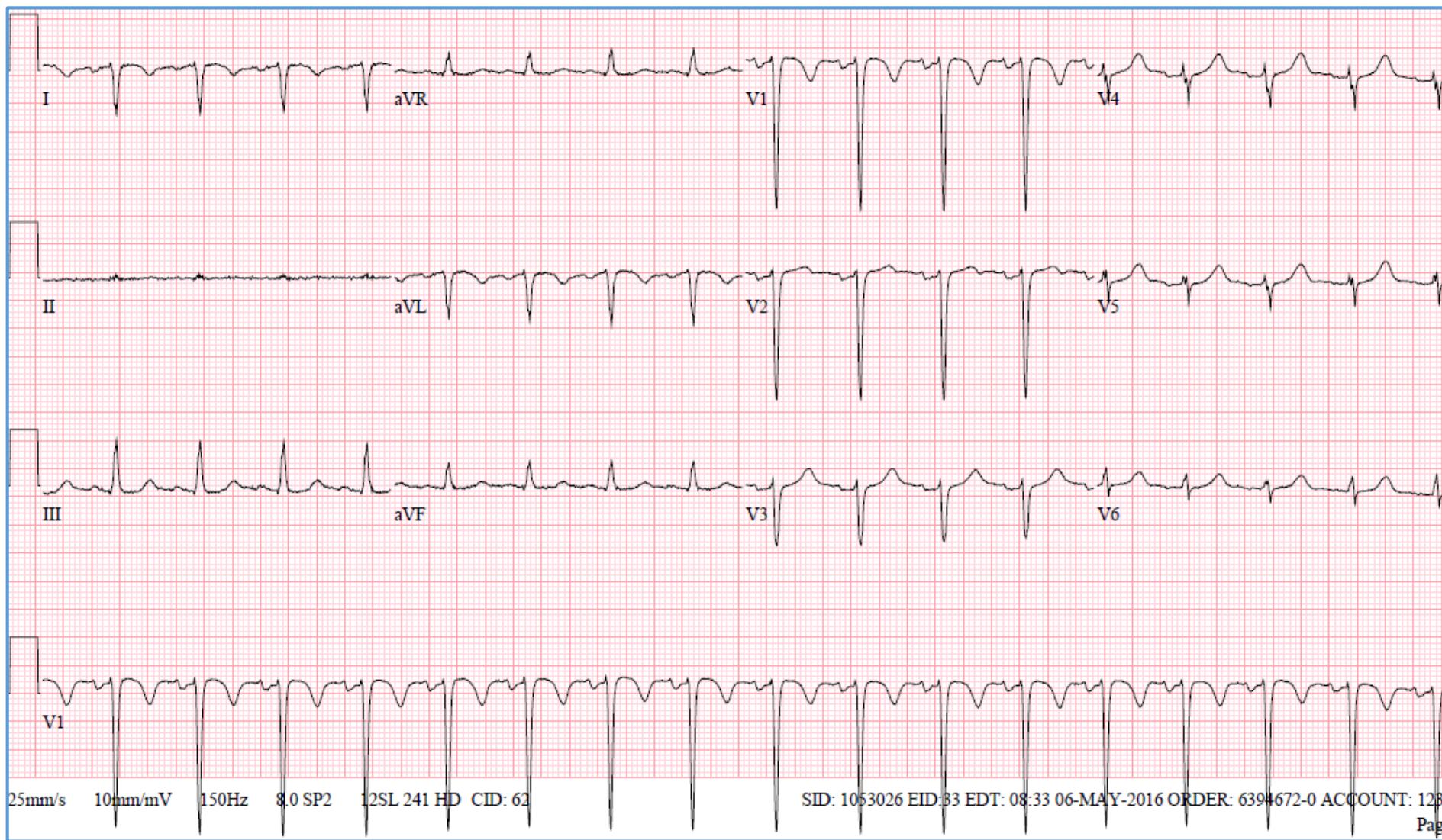


18 year old woman who is pretty sick!

Female Caucasian

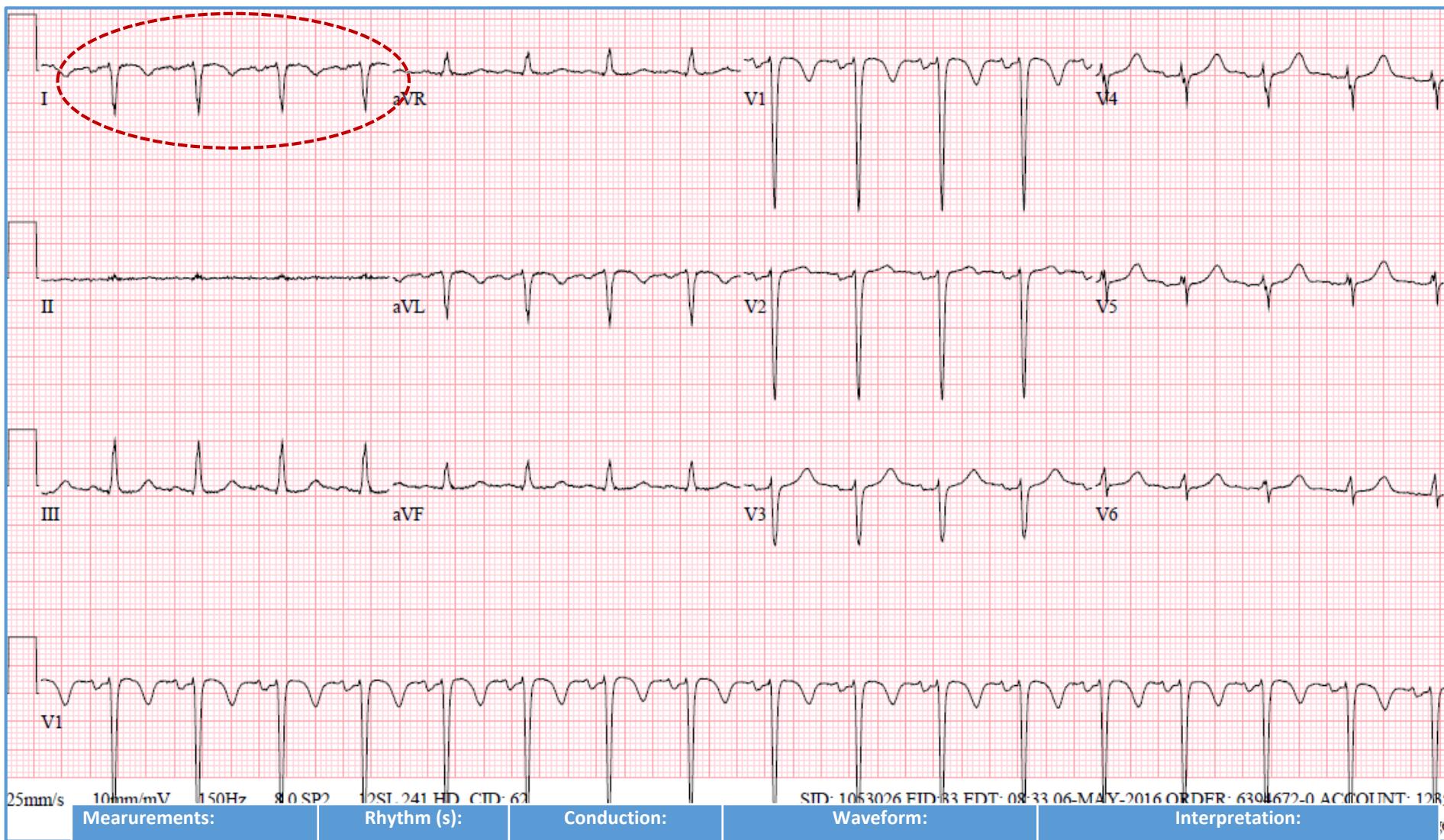


Mearurements:	Rhythm (s):	Conduction:	Waveform:	Interpretation:
A= 100 V=100	Sinus tachycardia	Normal SA, AV, IV	<ul style="list-style-type: none"> <li>P<sub>II, V2</sub> ≥ 2.5 mm (arrows)</li> <li>Prominent anterior forces (PAF) with qR pattern in V1</li> <li>ST depression, T wave inversion multiple leads</li> </ul>	Abnormal ECG:
PR=180				1. Right atrial enlargement (RAE)
QRS=80				2. RVH with strain pattern
QT=330				3. Heart rate (tachycardia)
Axis= +130				(This is a patient with primary pulmonary hypertension; severe right heart disease)



35 year old woman admitted for acute alcohol intoxication

What else went wrong?





Oh, oh.... What to do ?



Mearurements:	Rhythm (s):	Conduction:	Waveform:	Interpretation:
A=110    V=110	Sinus tachycardia	Normal SA, AV, IV	Much artifact (but you can still recognize aspects of the ECG waveform (see lead III))	Artifact precludes accurate ECG interpretation; sinus tachycardia is present.
PR=140				Artifact in this case is from a patient with Parkinson's disease (skeletal muscle).
QRS=70				
QT=300				
Axis=?				