

# 12 Lead ECG Workshop



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California Association of Nurse Practitioners

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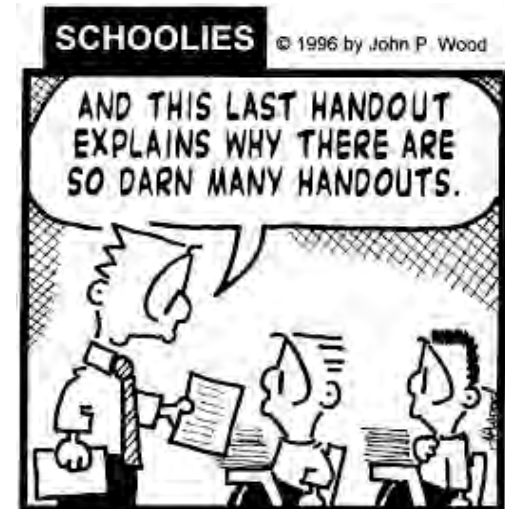
# Learning Objectives

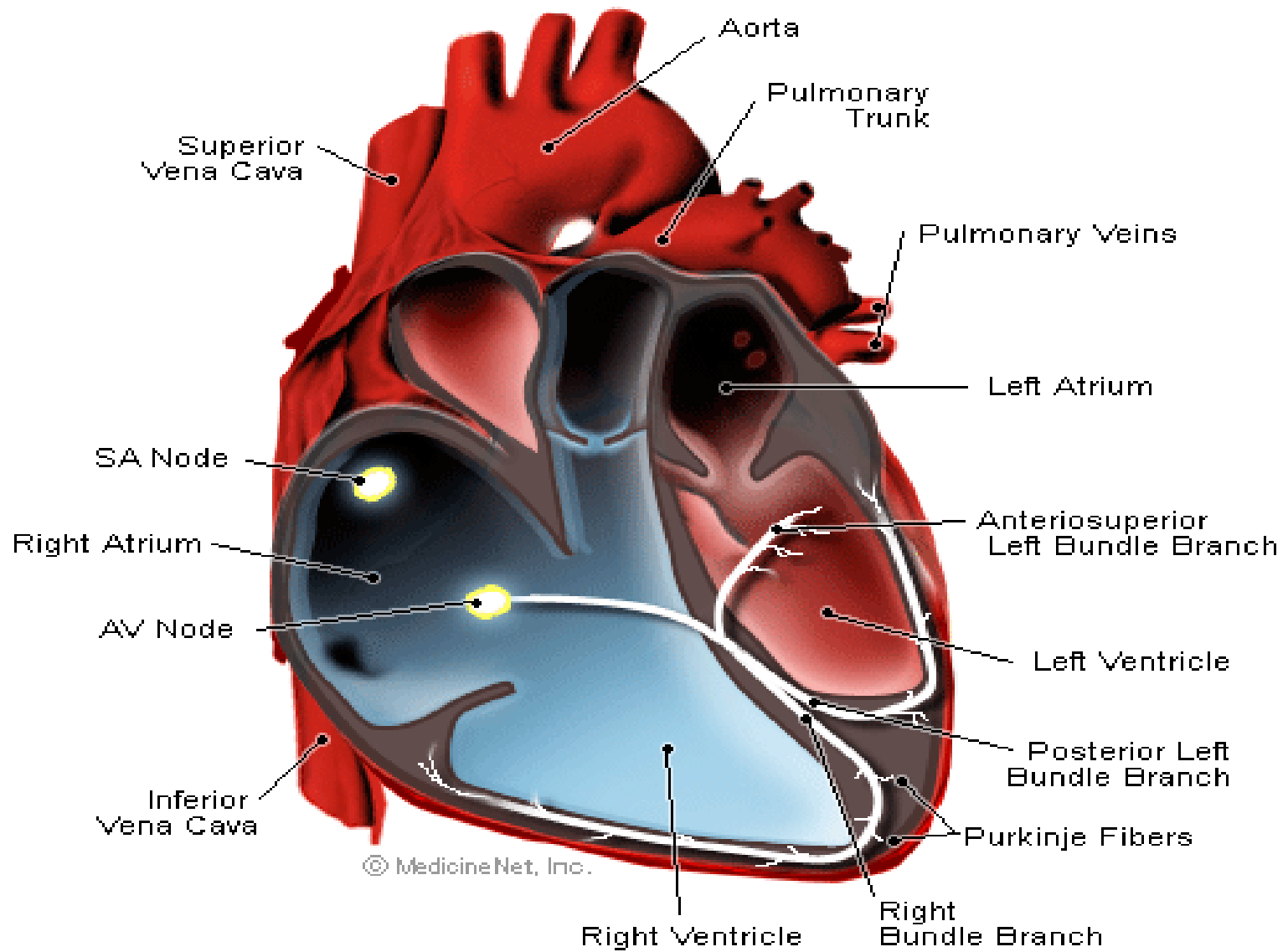


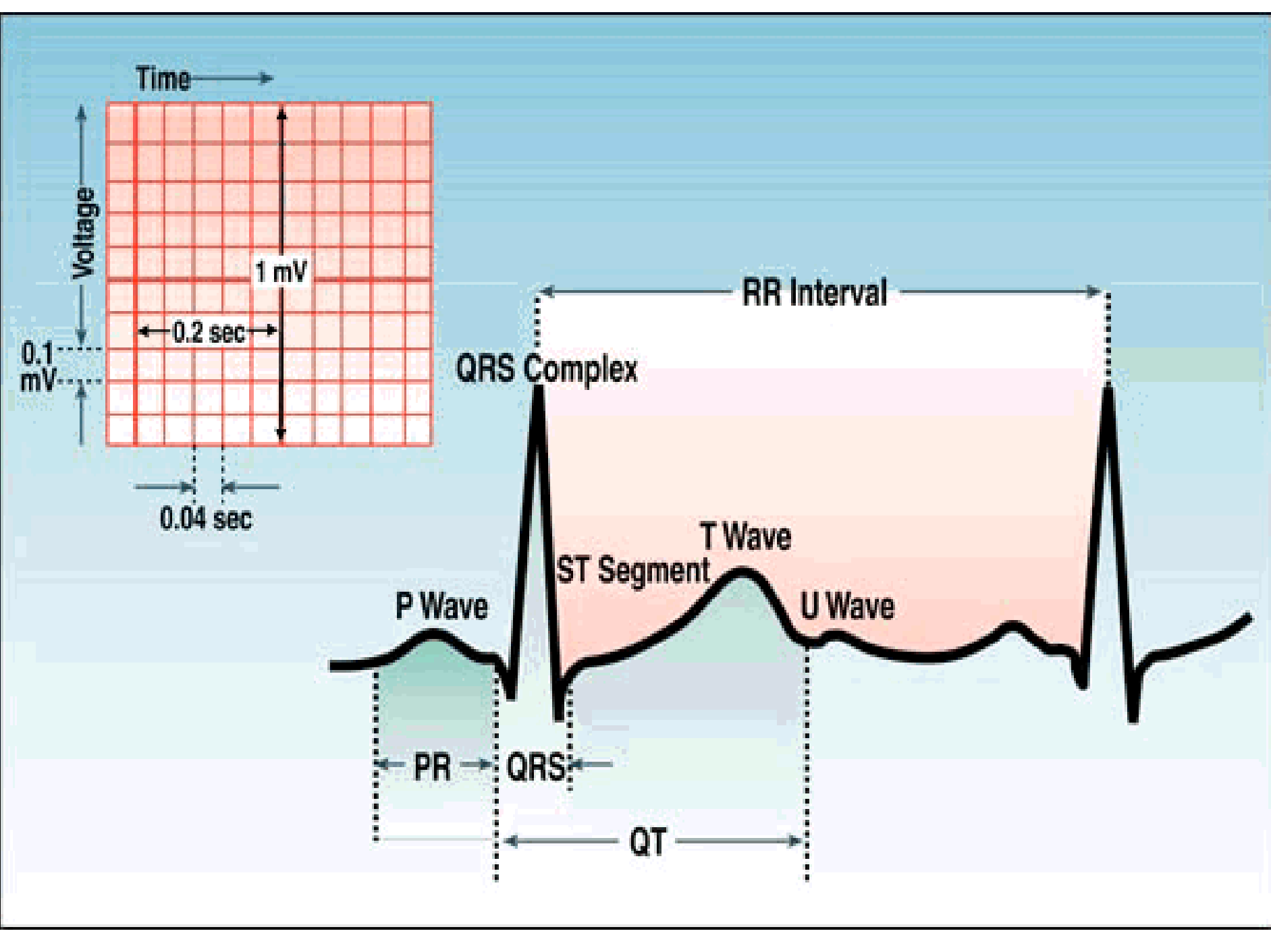
- Explain the purpose of a 12 lead ECG, the importance of proper lead placement and what the leads represent.
- Identify key characteristics of axis deviation, pericarditis, electrolyte disturbances, hypertrophy and bundle branch block.
- Analyze changes in the ECG which represent myocardial ischemia, infarct or injury.

# In This Handout.....

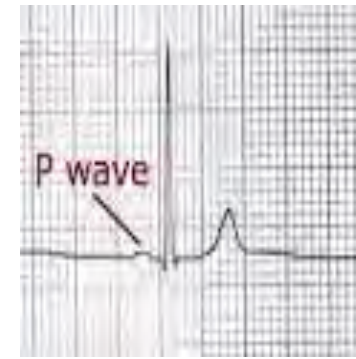
- Color Coded Map of Leads, ST Elevation and Reciprocal changes
- Review of components of waveforms
- Summary of 12 Lead ECG Features
- 12 Lead ECGs
- Calipers





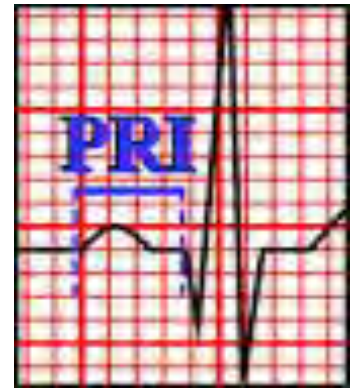


# P Wave



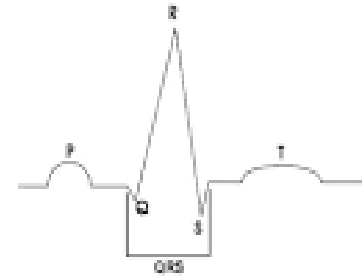
- Electrical
  - Atrial Depolarization- right and left sequential activation
  - Normally upright in I, II, aVF, V4-V6
  - Duration < 0.12 seconds
  - Amplitude < 2.5 mm
  - May see notched or biphasic P waves in frontal plane
- Mechanical
  - Blood is ejected from the atria through the Tricuspid Valve (RA) and the Mitral Valve (LA)

# PR Interval



- Electrical
  - The time it takes for the energy to spread through the atria and pass through the AV junction
- Mechanical
  - Ventricular filling time
  - S1 is the sound of the atrial valves closing in the cardiac cycle.
  - Normally .12-.20 seconds and isoelectric

# QRS Complex



- Electrical
  - Ventricular depolarization- simultaneous activation of both
  - Energy passing through the Bundle of His, down Bundle Branches and out through Purkinje Fibers.
- Mechanical
  - Blood is ejected out of the ventricles, through the semi lunar valves (Pulmonary RV and Aortic LV).
  - S2 is the sound of these two valves closing in the cardiac cycle.
- Normally .06-.10 seconds
- Small, narrow Q wave in I, aVL, aVF, V5 and V6 normal

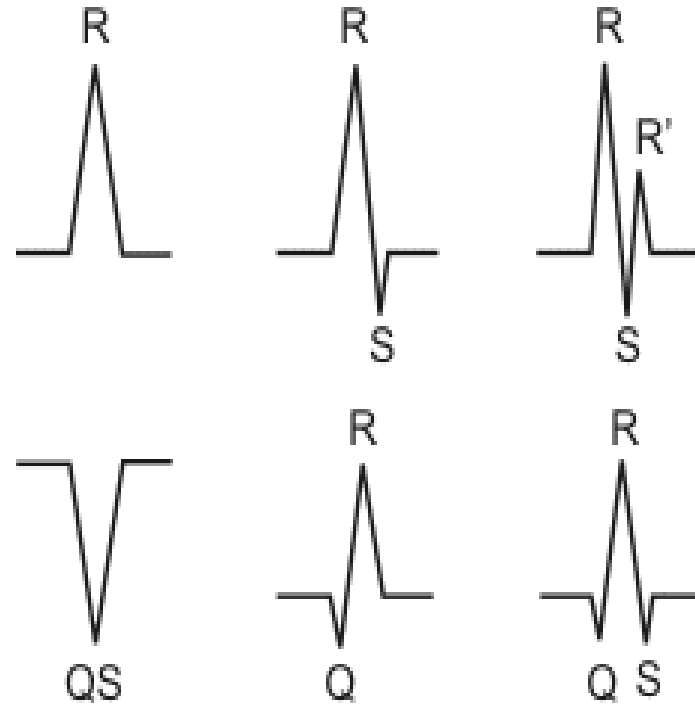


# QRS Complex

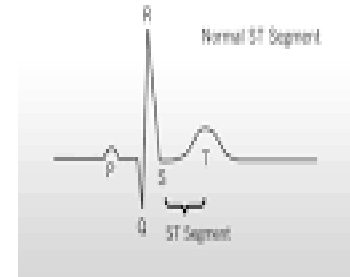
**Q WAVE:** The first negative deflection following the P wave, before the R wave.

**R WAVE:** first positive deflection following the P wave. A second positive deflection is R prime (R').

**S WAVE:** The second negative deflection following the P wave, or the first negative deflection after the R wave.

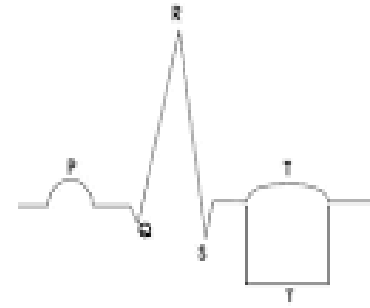


# ST Segment



- Electrical
  - Beginning of ventricular repolarization
  - Usually flat on the tracing
  - Refractory period for cells
- Mechanical
  - Passive filling of ventricle

# T wave



- Electrical
  - Part of the repolarization of the ventricles
  - Usually a positive deflection
  - Asymmetrical tent shape
- Mechanical
  - Passive refilling of the ventricles

# QT Interval



- Measured from onset of QRS complex to end of T wave: includes ventricular depolarization and repolarization
- Rule of thumb: QT is 1/2 of the preceding R-R for NSR
- QT interval length depends on rate, physiology and medications: normal is generally .36-.44
- QTc = QT Corrected
  - Males > .45 seconds is abnormal
  - Females > .47 seconds is abnormal

# Why Take a 12-LEAD ECG?

- Gold standard for the diagnosis of arrhythmias
- Guides therapy and risk stratification for patients with suspected myocardial infarction
- Helps detect electrolyte disturbances (e.g. hyperkalemia and hypokalemia)
- Allows for the detection of conduction abnormalities (e.g. right and left bundle branch block)
- Used as a screening tool for ischemic heart disease during a cardiac stress test
- Occasionally helpful with non-cardiac diseases (e.g. pulmonary embolism or hypothermia)

# What Does Each Lead “See”?

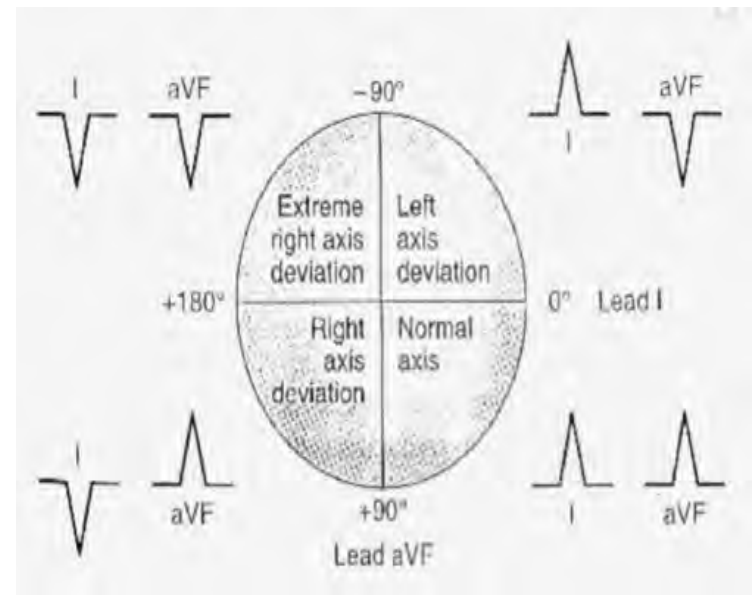
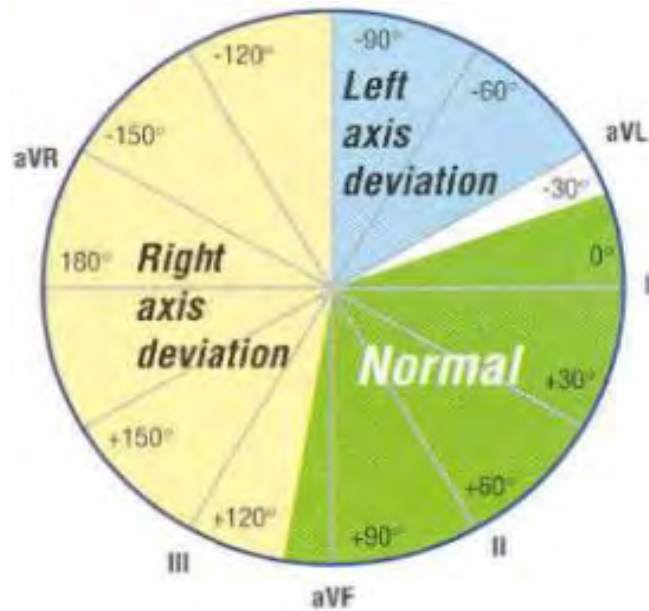
I Lateral	aVR	V1 Septal	V4 Anterior
II Inferior	aVL Lateral	V2 Septal	V5 Lateral
III Inferior	aVF Inferior	V3 Anterior	V6 Lateral

<http://www.ivline.org/2010/05/quick-guide-to-ecg.html>



<http://www.clinicaljunior.com/cardiologynecg.html>

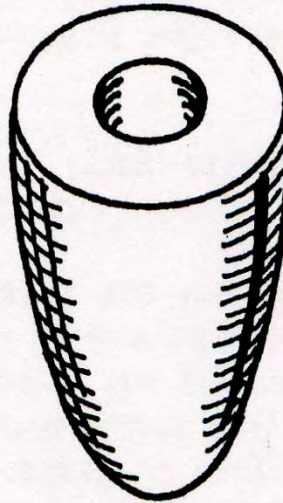
# Axis Deviation- Quick Check



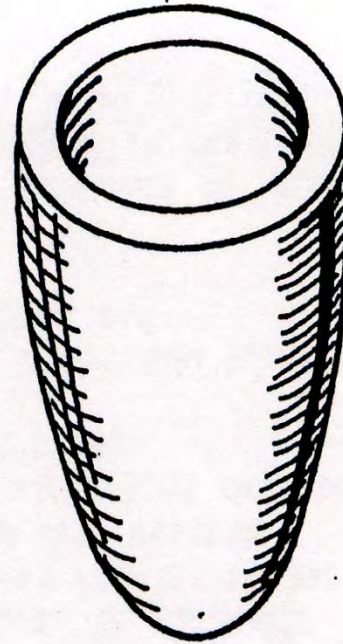
# Hypertrophy: Normal, Concentric & Eccentric



Normal



Pressure  
overload



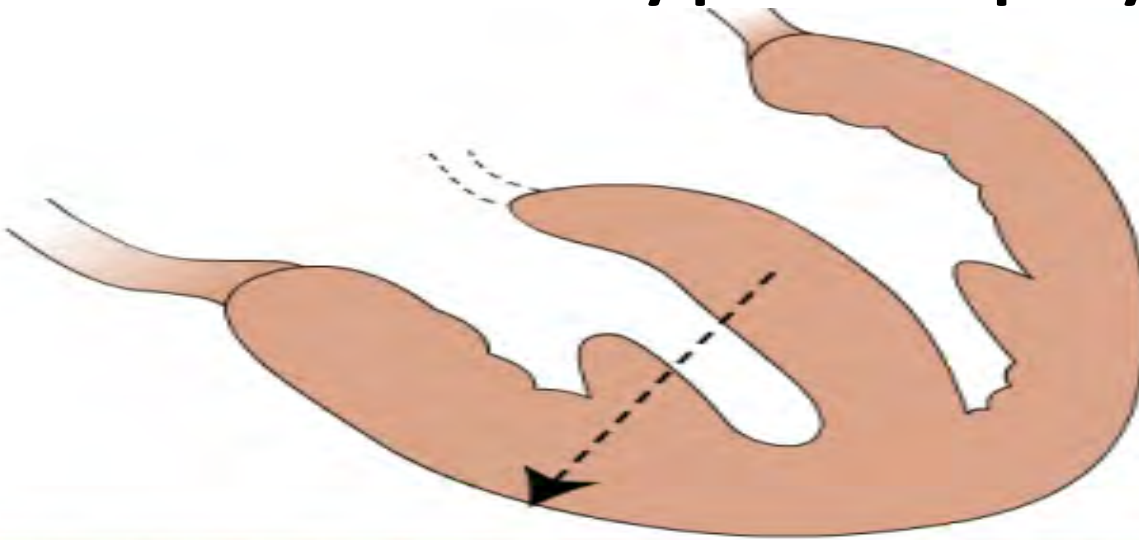
Volume  
overload



# Hypertrophy

- The ECG criteria for diagnosing hypertrophy are very insensitive: ~50% of those with hypertrophy will NOT have expected ECG changes.....
- **BUT** the criteria are very specific: >90% of patients with expected ECG changes are very likely to have hypertrophy

# Right Ventricular Hypertrophy (RVH)



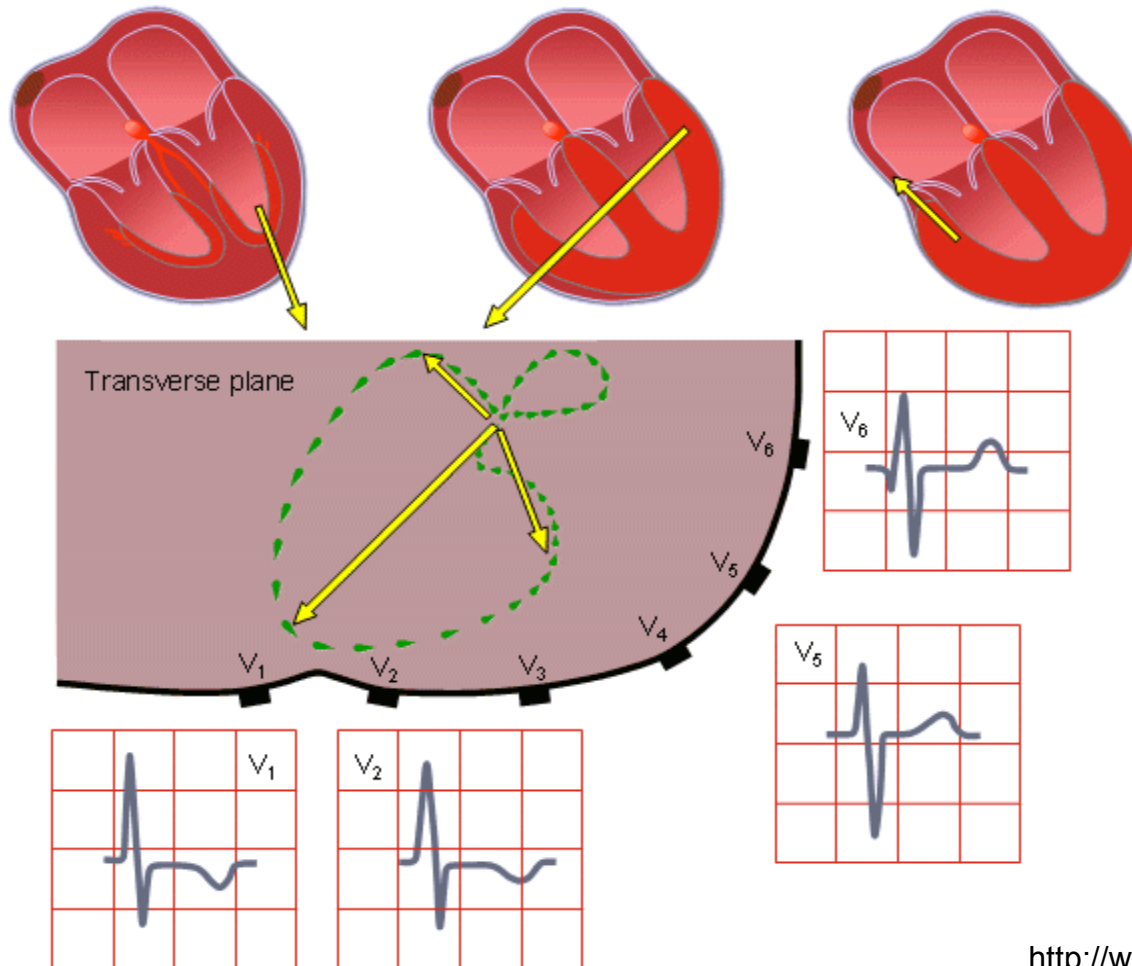
right ventricle hypertrophy

ECG-PEDIA.ORG

# Right Ventricular Hypertrophy (RVH)

## RIGHT VENTRICULAR HYPERTROPHY

Large R wave in leads V1 and V2,  
Wide S wave in leads V1 and V2, wide R wave in V5 and V6



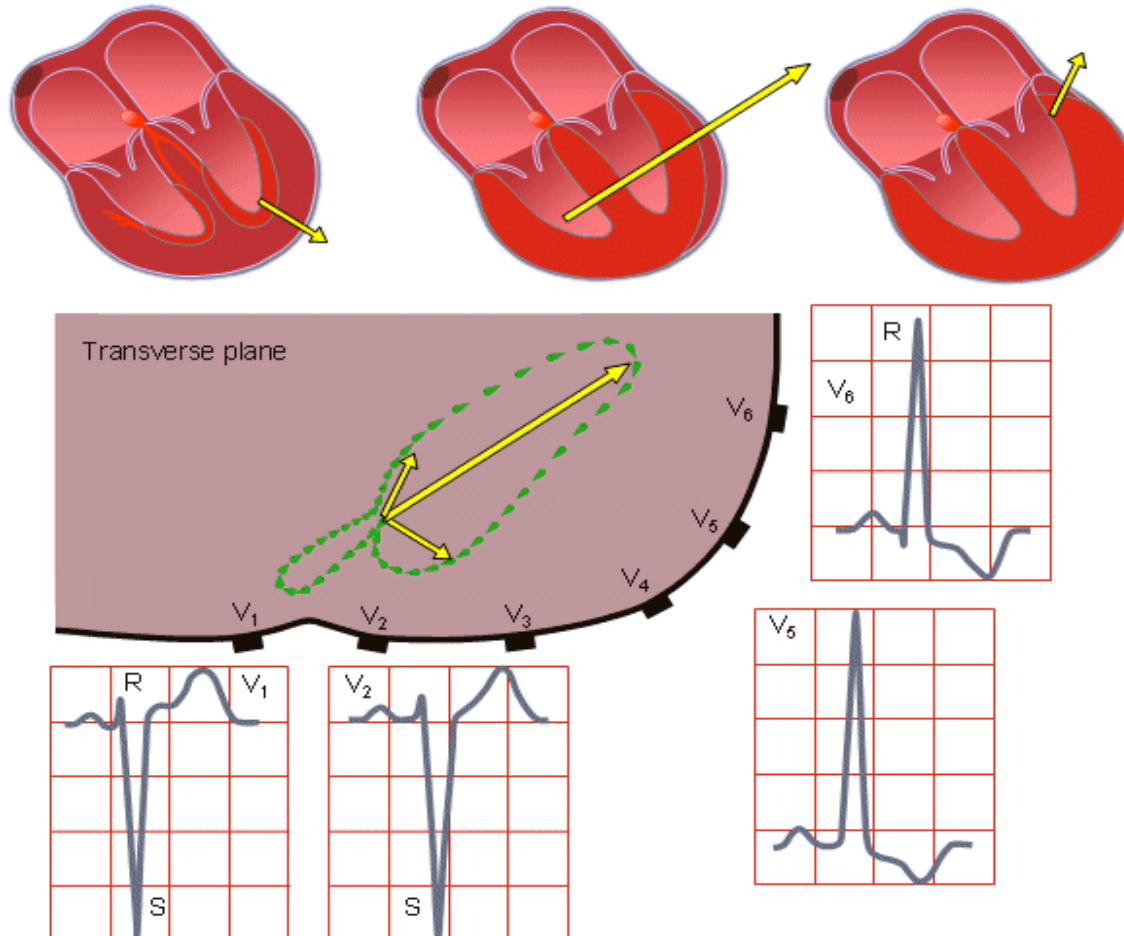
# Left Ventricular Hypertrophy (LVH)



# Left Ventricular Hypertrophy (LVH)

## LEFT VENTRICULAR HYPERTROPHY

Large S wave in leads V1 and V2, large R wave in V5 and V6

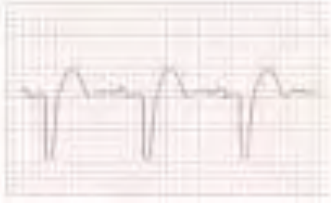


# Criteria for LVH

- Increased QRS amplitude
  - In lead facing the hypertrophied ventricle (V5 or V6) a tall R wave and in lead facing the negative side of the activation (V1 or V2) a deep S wave is present. When added together is  $\geq 35\text{mm}$ .
  - $R \text{ in I} + S \text{ in III} > 25 \text{ mm}$
  - $S \text{ in V1 or V2} \geq 30 \text{ mm}$
  - $R \text{ in lead V5 or V6} \geq 30 \text{ mm}$

# .....More Criteria for LVH

- Sokolow + Lyon (*Am Heart J, 1949;37:161*)
  - S V1+ R V5 or V6 > 35 mm
- Cornell criteria (*Circulation, 1987;3: 565-72*)
  - SV3 + R avl > 28 mm in men
  - SV3 + R avl > 20 mm in women
- Framingham criteria (*Circulation, 1990; 81:815-820*)
  - R avl > 11mm, R V4-6 > 25mm
  - S V1-3 > 25 mm, S V1 or V2 +
  - R V5 or V6 > 35 mm, R I + S III > 25 mm

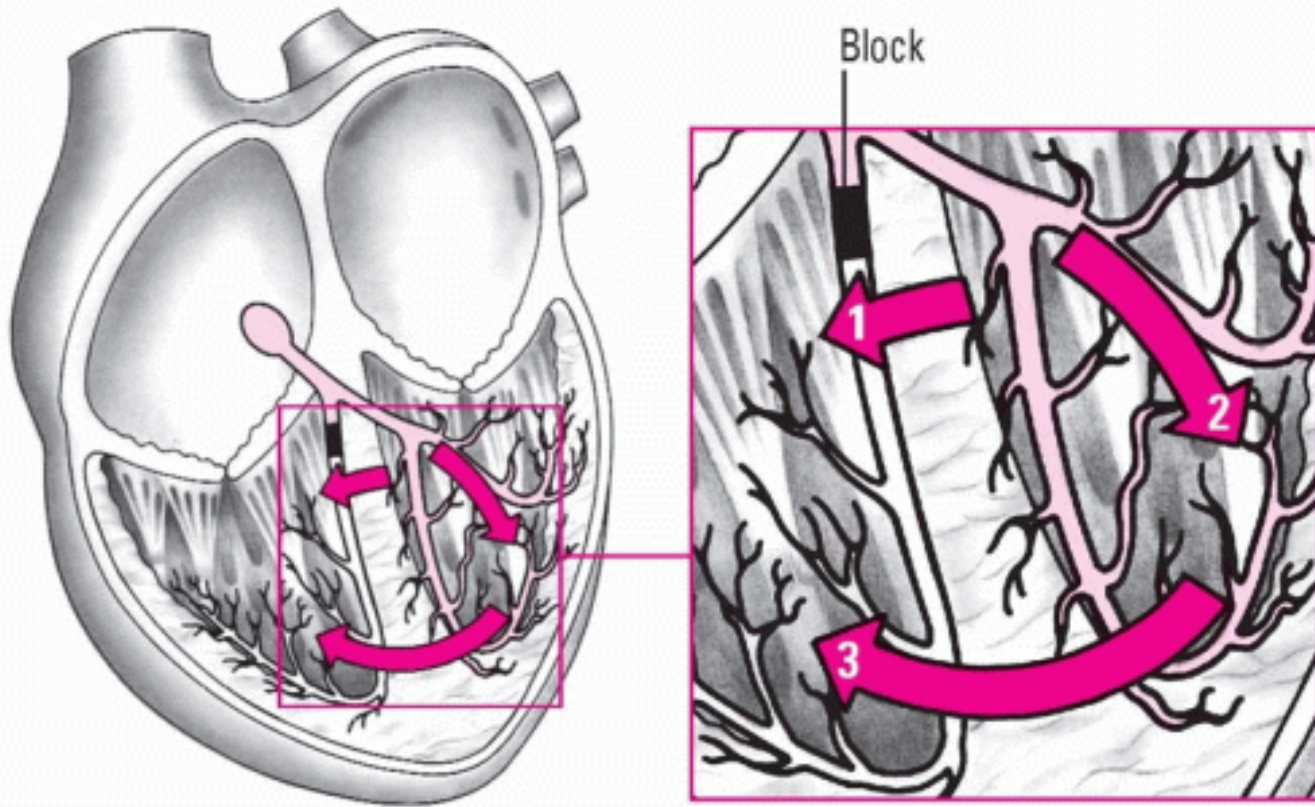


# Bundle Branch Block

- Anatomic or functional discontinuity in one of the bundle branches preventing or slowing conduction, resulting in ventricle on affected side becoming activated late.
- Transient bundle branch block may occur with tachycardia, bradycardia, pulmonary embolism, anemia, infection, myocardial ischemia or infarction, congestive heart failure, metabolic disorders/changes, hypoxia, and others.



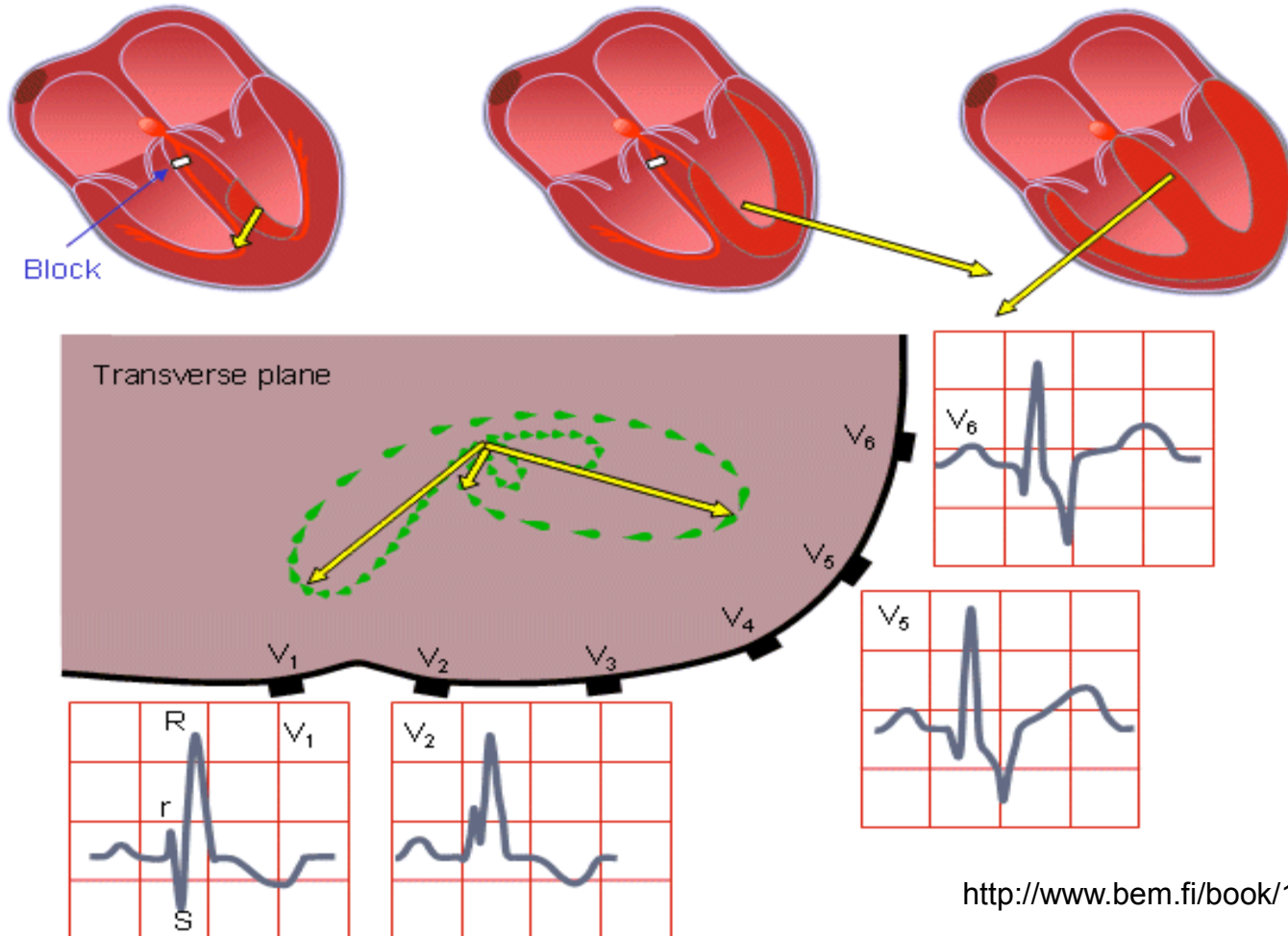
# Right Bundle Branch Block (RBBB)



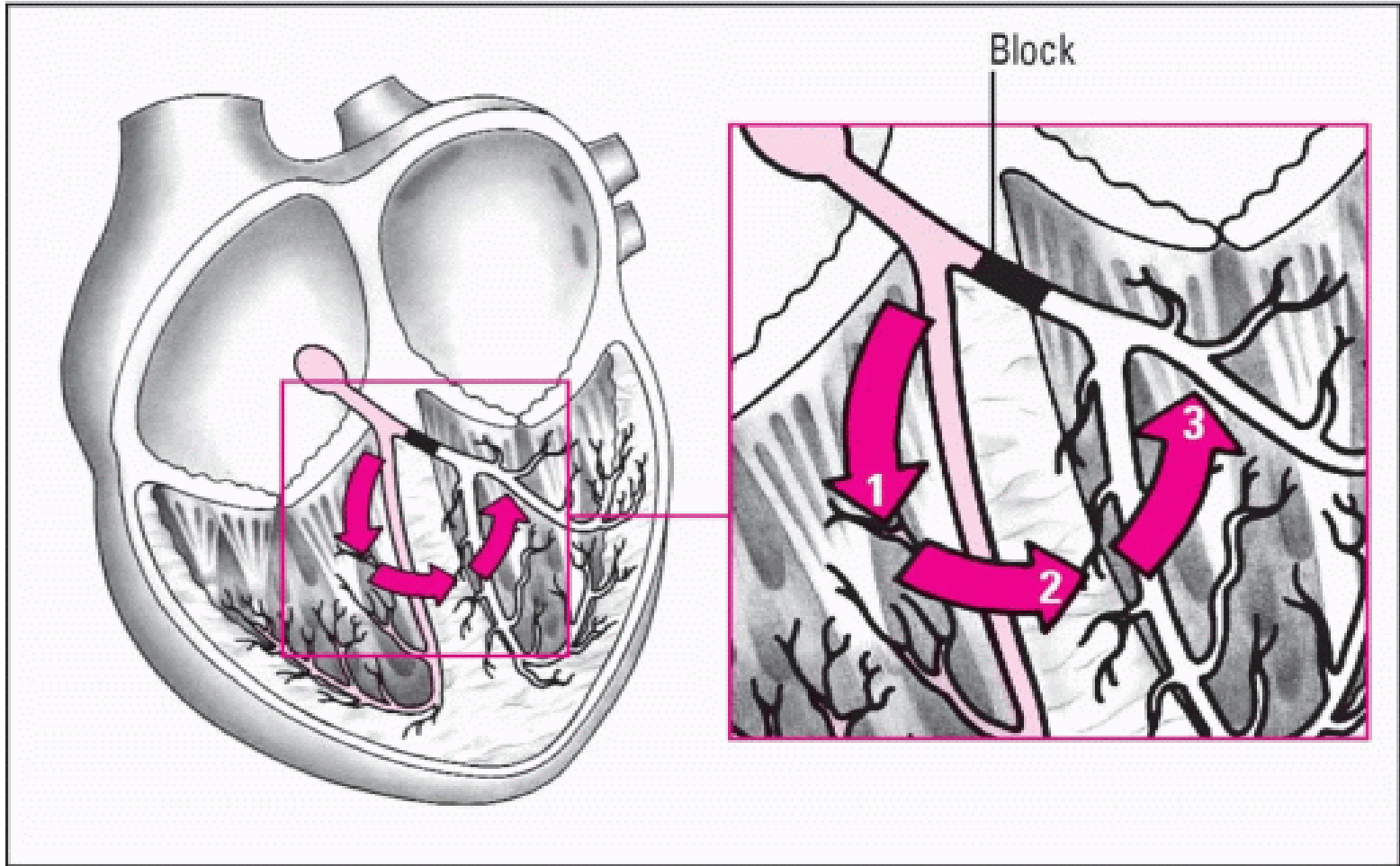
# Right Bundle Branch Block (RBBB)

## RIGHT BUNDLE-BRANCH BLOCK

QRS duration greater than 0.12 s  
Wide S wave in leads I, V5, and V6



# Left Bundle Branch Block (LBBB)

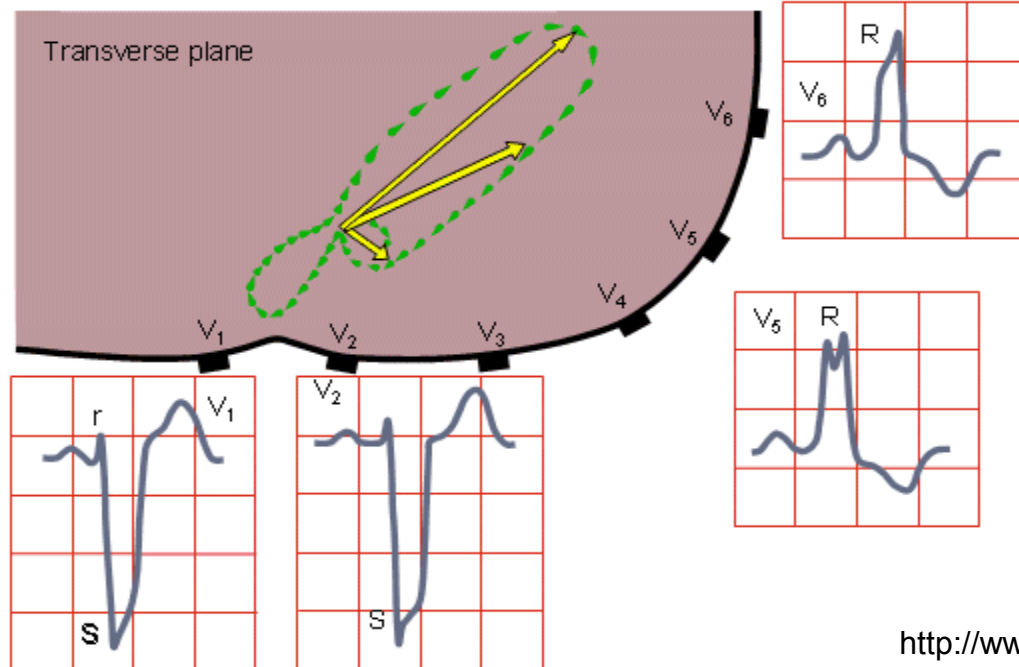
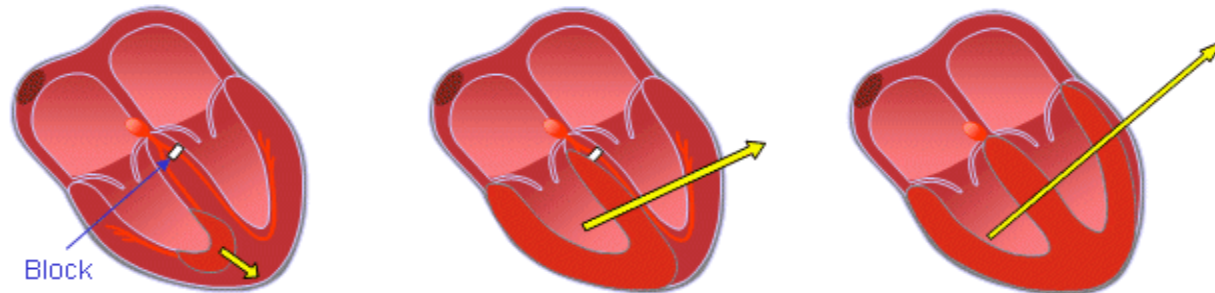


# Left Bundle Branch Block (LBBB)

## LEFT BUNDLE-BRANCH BLOCK

QRS duration greater than 0.12 s

Wide S wave in leads V1 and V2, wide R wave in V5 and V6



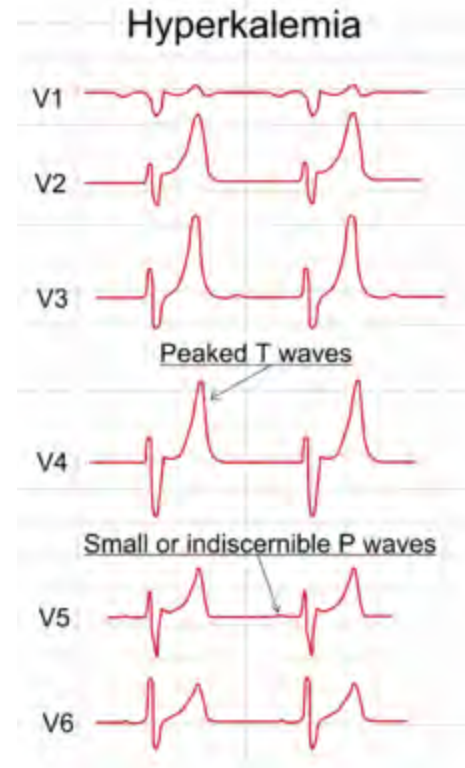
# Miscellaneous Changes

	Abnormality . . .	Suggestive of . . .
P Waves	<ul style="list-style-type: none"> <li>• wide, flat P waves</li> <li>• no P waves</li> </ul>	Hyperkalemia
QRS Complexes	<ul style="list-style-type: none"> <li>• widening of QRS</li> <li>• merging QRS and T</li> <li>• widening of QRS</li> <li>• prolonged QT interval</li> <li>• short QT interval</li> <li>• short QT interval</li> </ul>	Hyperkalemia  Hypokalemia Hypercalcemia Hypocalcemia Digitalis Toxicity
ST Segments	<ul style="list-style-type: none"> <li>• disappearing ST segments</li> <li>• ST depression</li> <li>• sloping ST segments</li> <li>• depressed, “scooped” ST segments</li> <li>• elevated, concave ST segments</li> </ul>	Hyperkalemia Hypokalemia Digitalis Toxicity  Pericarditis
T Waves	<ul style="list-style-type: none"> <li>• tall, peaked T waves</li> <li>• flattening of T wave</li> <li>• diphasic or inverted T waves</li> </ul>	Hyperkalemia Hypokalemia Digitalis Toxicity
U Waves	<ul style="list-style-type: none"> <li>• development of U waves</li> </ul>	Hypokalemia



# Miscellaneous Changes

Pericarditis:  
upsloping, elevated  
ST segments in  
many leads



# Myocardial Ischemia, Injury, & Infarct



Normal coronary artery



Atherosclerosis

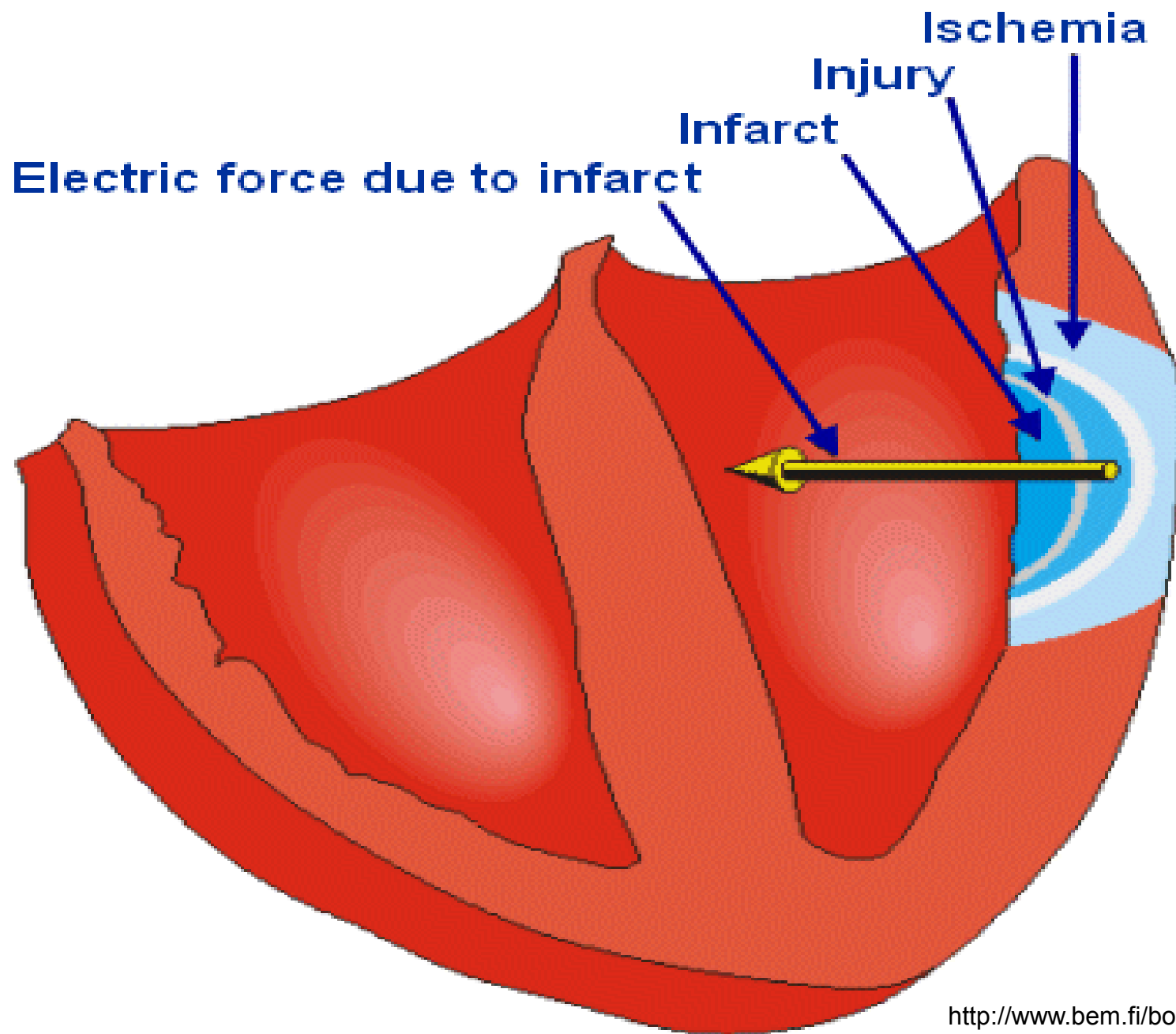


Atherosclerosis with blood clot

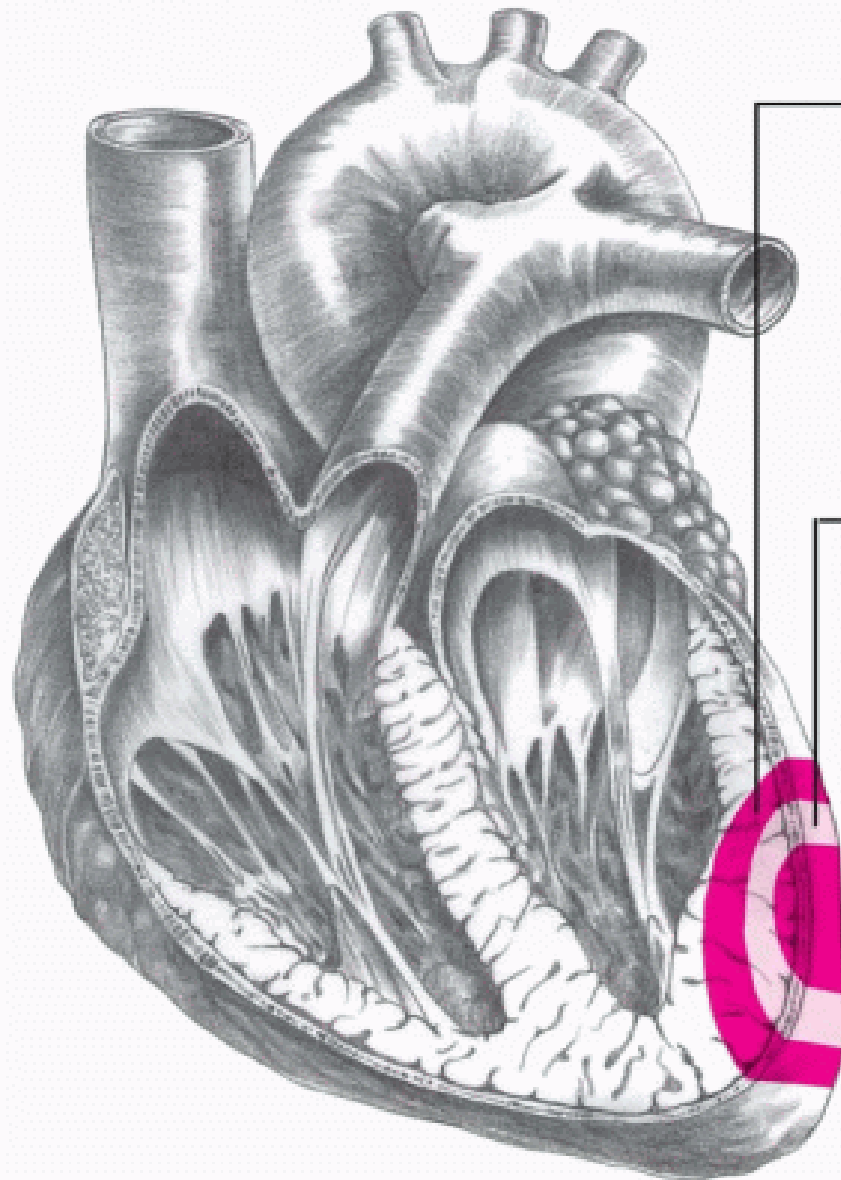


Coronary spasm



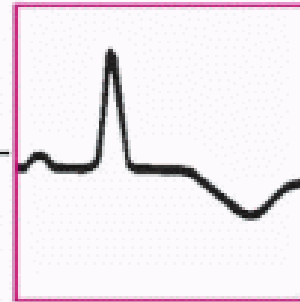






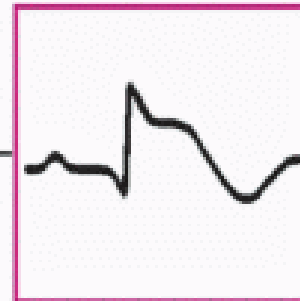
### **Myocardial ischemia**

- T-wave inversion
- ST-segment depression



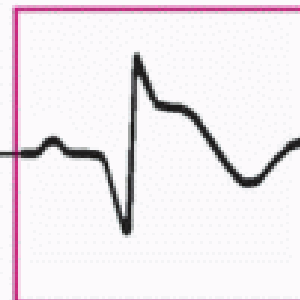
### **Myocardial injury**

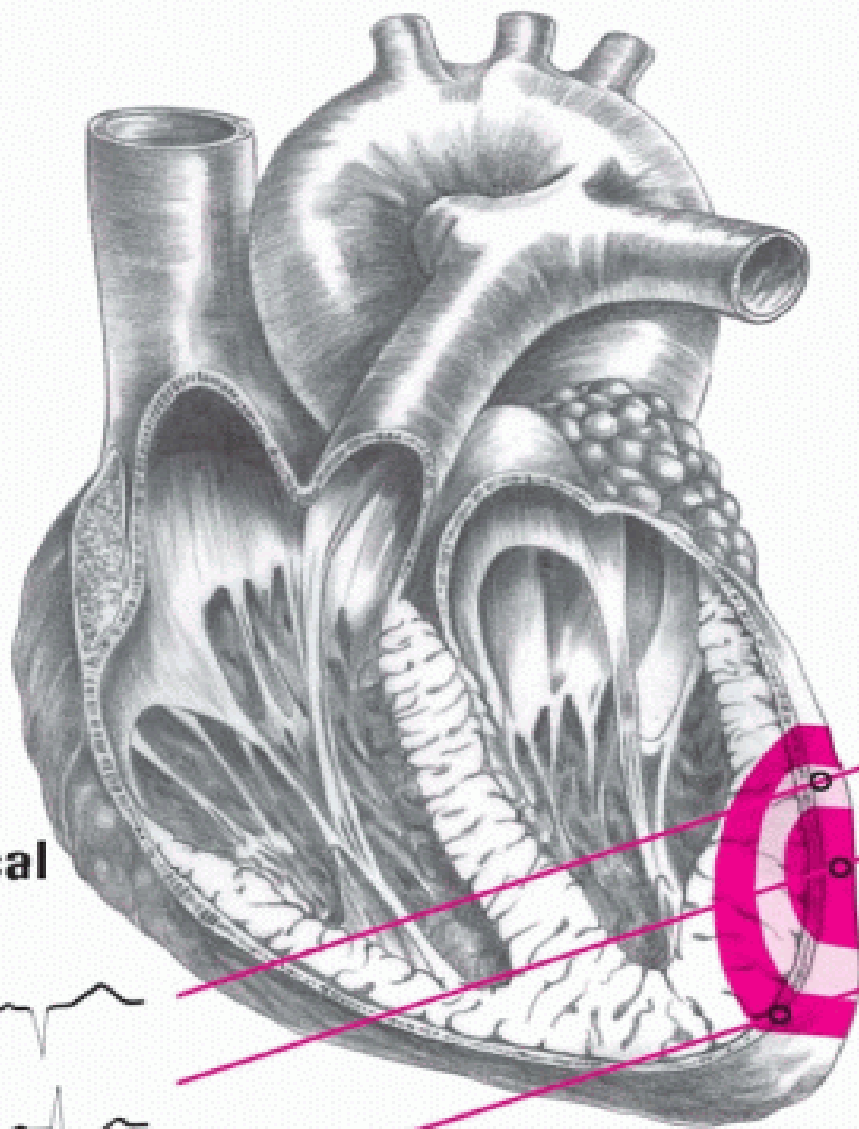
- ST-segment elevation
- T-wave inversion



### **Myocardial infarction**

- Q waves
- ST-segment elevation
- T-wave inversion





**Reciprocal changes**

Injury



Infarction



Ischemia



**Changes on damaged side**

Injury



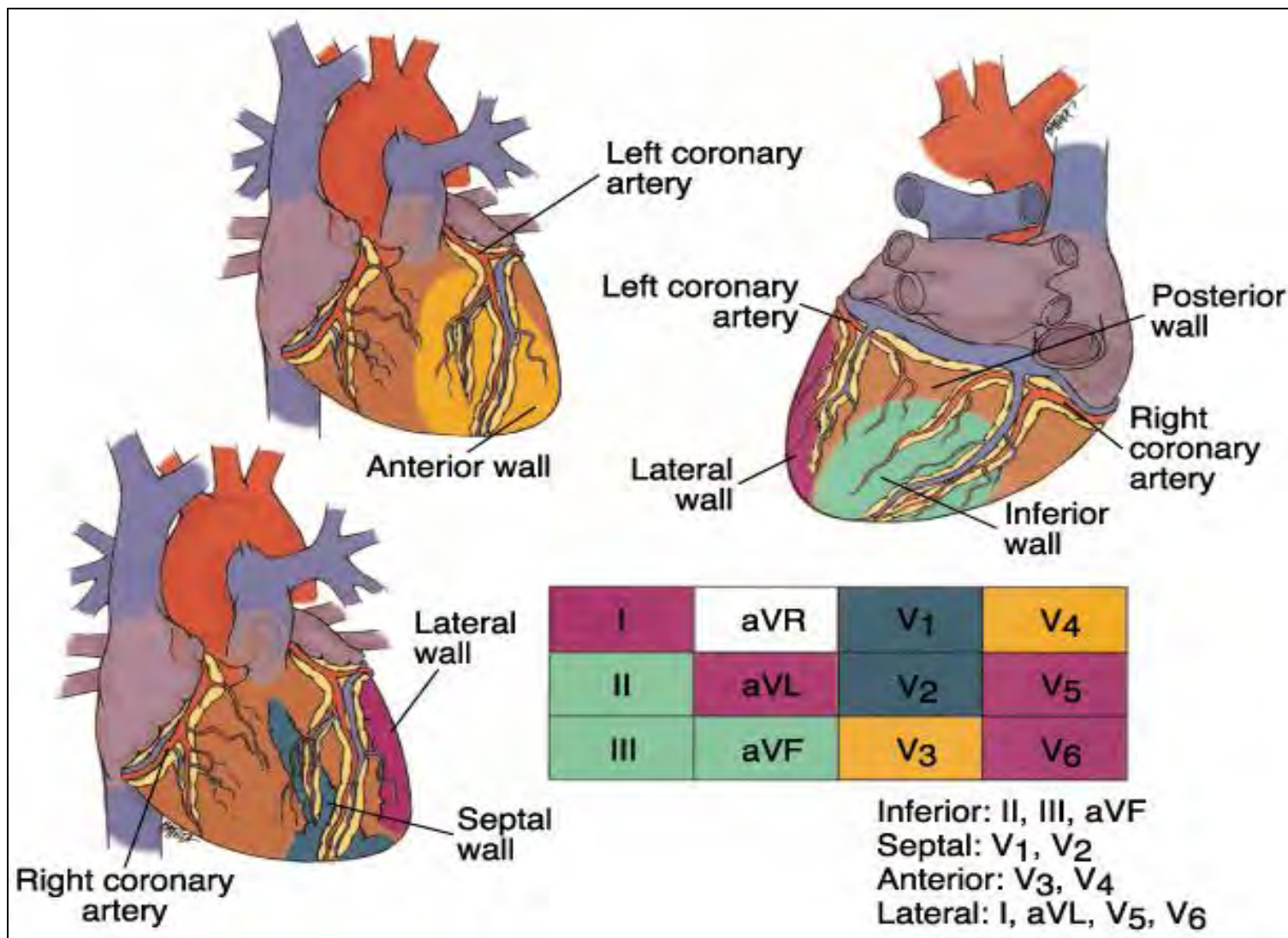
Infarction



Ischemia

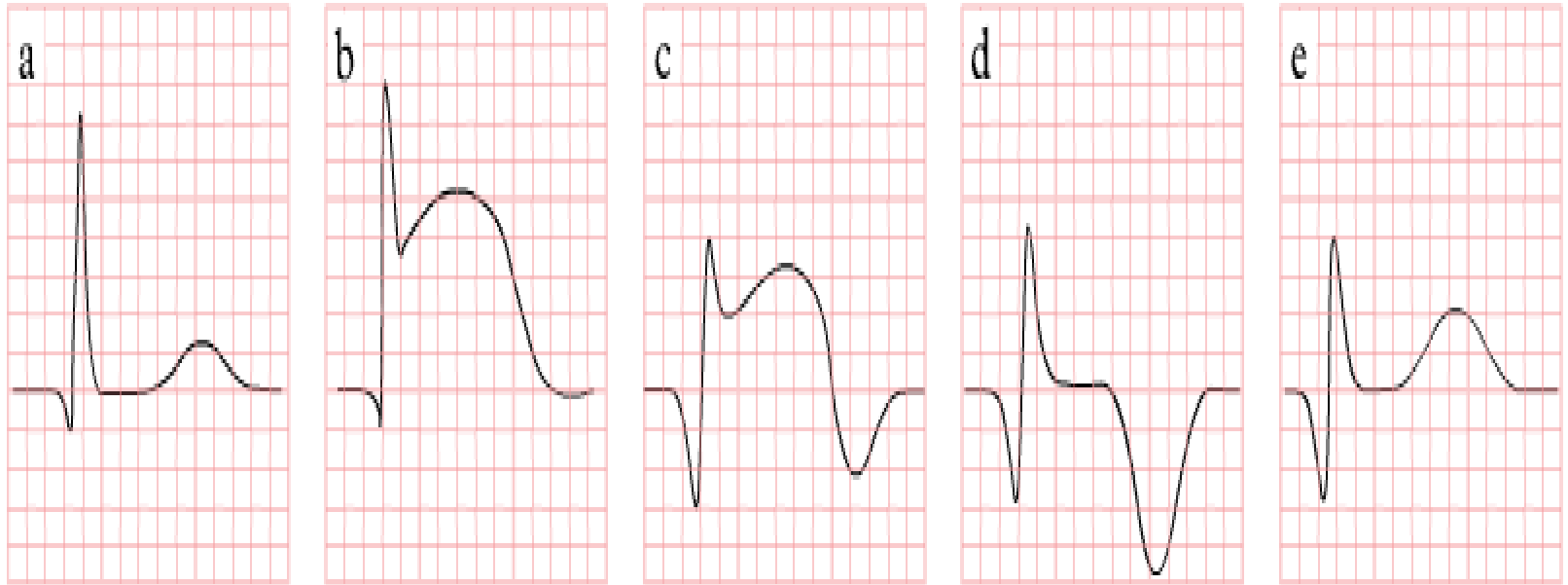


# Localization of Infarct



From Aehlert, *ECGs Made Easy*, 5<sup>th</sup> ed., 2013.

# Evolution of an Acute MI



evolutie acuut hartinfarct - [ECGPEDIA.ORG](http://ECGPEDIA.ORG)

The evolution of an infarct on the ECG. ST elevation, Q wave formation, T wave inversion, normalisation with a persistent Q wave

# 12 Lead ECGs

Let the Practice Begin.....

# Case #1: 47 y/o male

23-JAN-1963 (47 yr)

Male

Room:ER16

Loc:201

Vent. rate	61	BPM
PR interval	136	ms
QRS duration	98	ms
QT/QTc	390/392	ms
P-R-T axes	46 74	36

\*\*\*age and gender specific ECG analysis\*\*\*

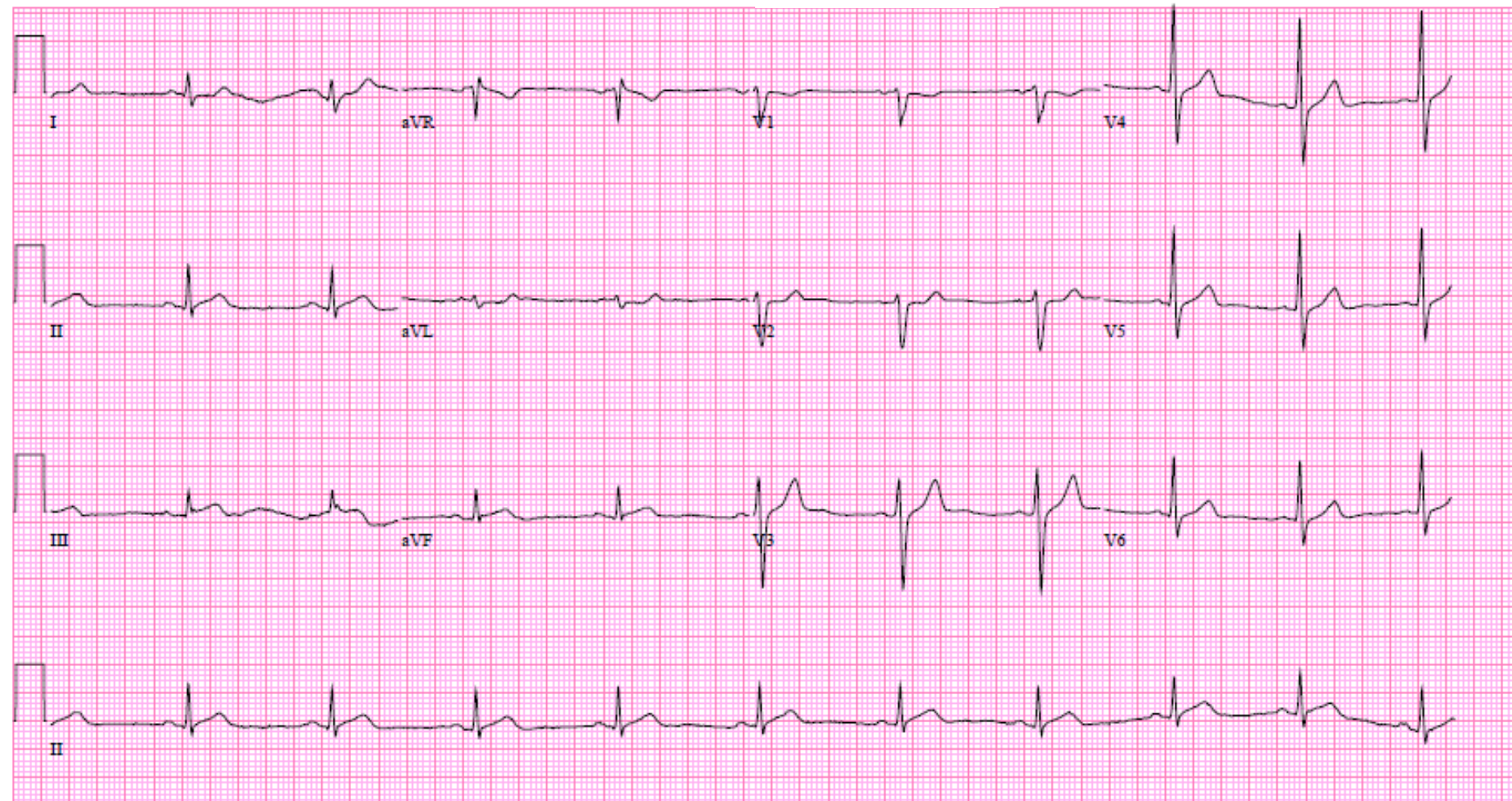
Normal sinus rhythm

Normal ECG

Technician:  
Test ind:STEMI

Referred by:

Unconfirmed  
NOTIFIED T:



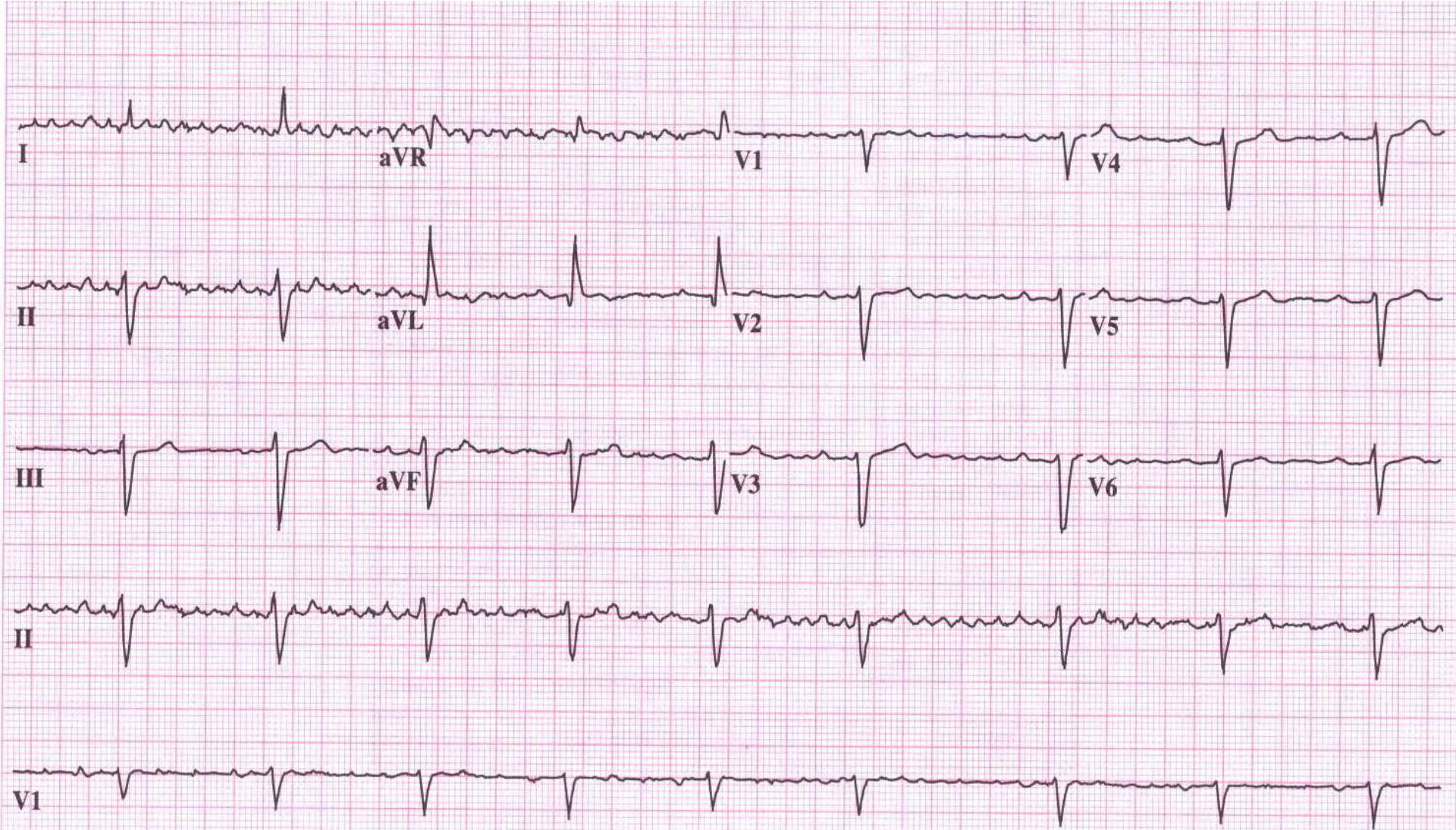


# Case #2: 86 y/o with dyspnea + Parkinson's

Rate: 60 bpm  
PRI: 280 ms

QRS: 100 ms  
QT/QTc: 440 ms/440 ms  
R Axis: -60

Sinus Arrhythmia  
Left Axis Deviation





# Case #3: 64 y/o man with COPD

Rate: 80 bpm

QRS: 80 ms

R Axis: +120

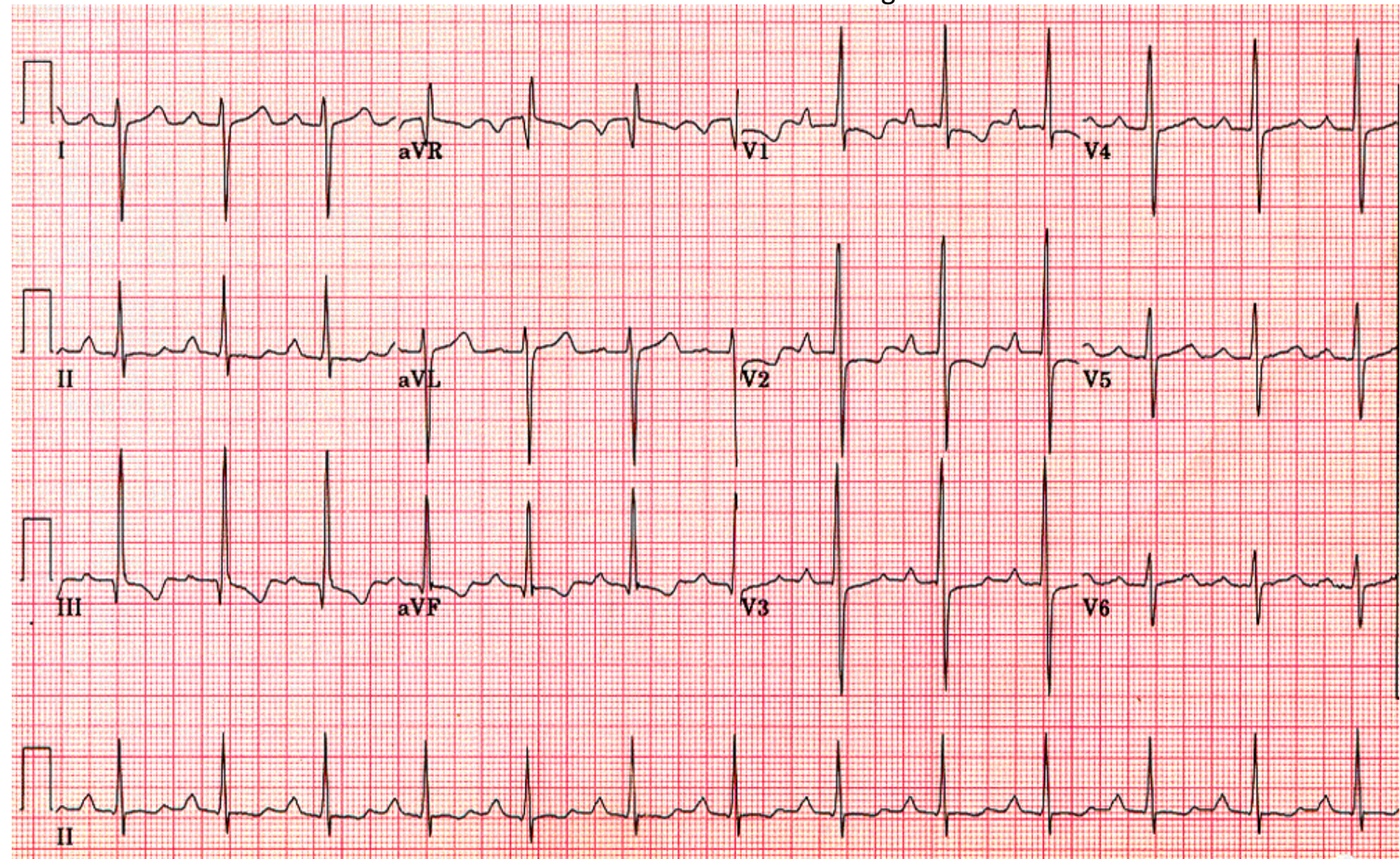
Normal Sinus Rhythm

PRI: 240 ms

QT/QTc: 380/439 ms

Right Ventricular Hypertrophy

Right Axis Deviation





# Case #4: 30 y/o male runner

Rate: 94 bpm

QRS: 110 ms

R Axis: +110

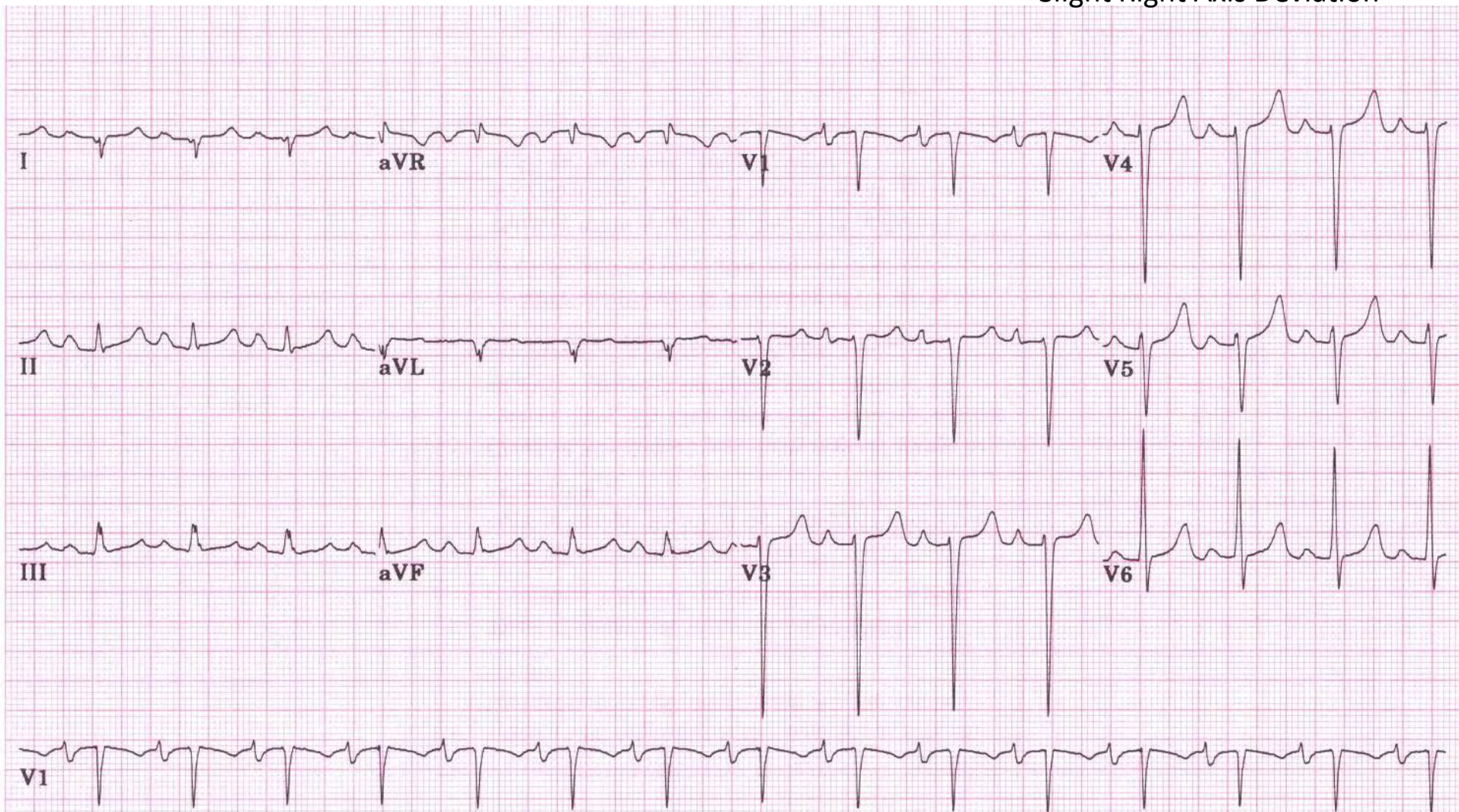
Normal SR

PRI: 210 ms

QT/QTc: 380 ms/478 ms

Left Ventricular Hypertrophy

Slight Right Axis Deviation





# Case #5: 61 y/o man with intermittent CP

21-JUL-1950 (61 yr)  
Male

Vent. rate	94	BPM
PR interval	158	ms
QRS duration	134	ms
QT/QTc	382/477	ms
P-R-T axes	61 -74	58

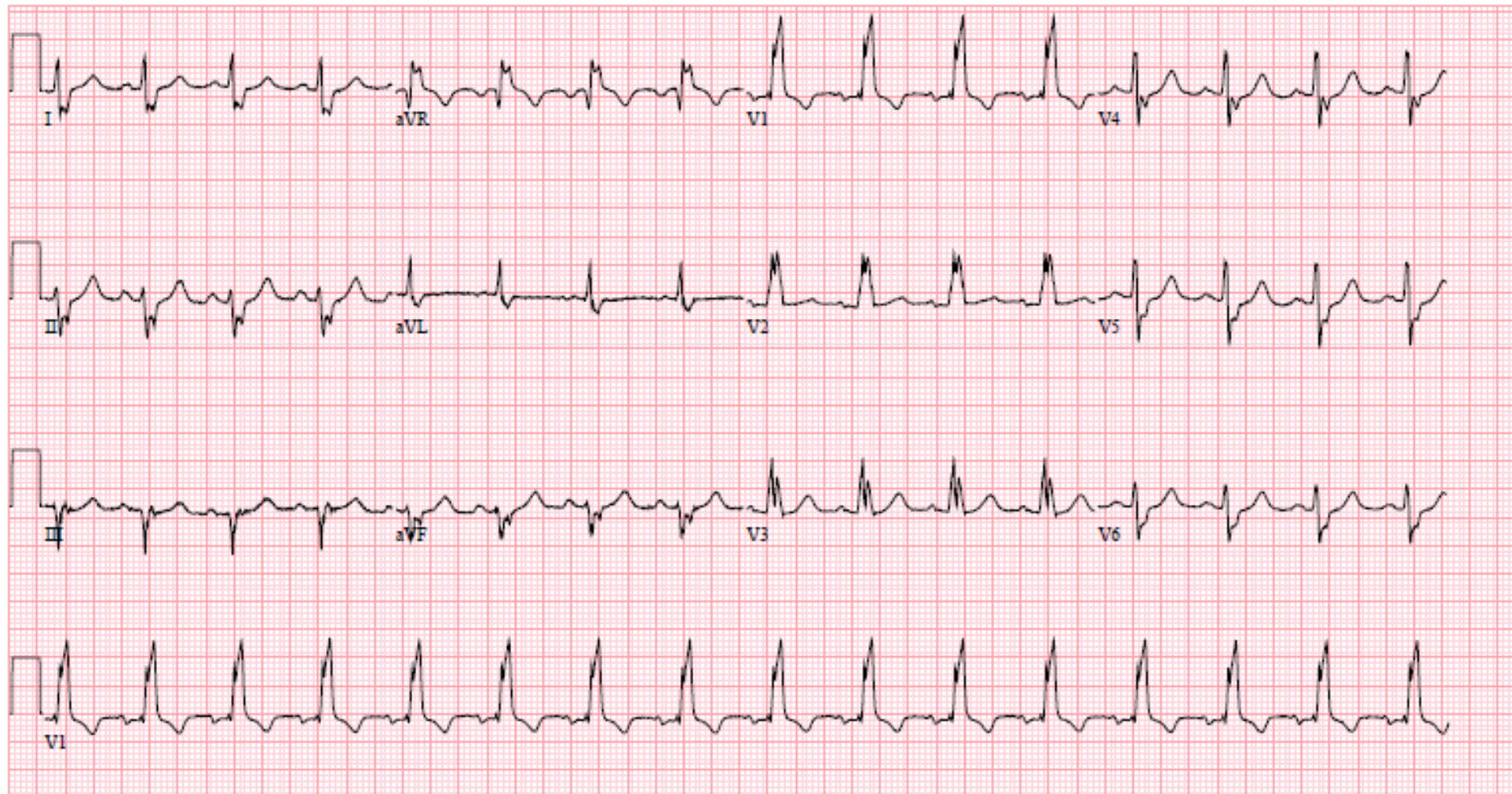
Normal sinus rhythm  
Left axis deviation  
Right bundle branch block  
Abnormal ECG

Room: ER17  
Loc: 201

Technician  
Test ind: CHEST PAIN

Referred by:  
CV-WHO ?:

Confirmed By:  
CV-TIME ?:



# Case #6: 82 y/o female with DM; pre-op exam

16-MAY-1929 (82 yr)  
Female

Room: ED 18  
Loc: 201

Vent. rate	52	BPM
PR interval	158	ms
QRS duration	164	ms
QT/QTc	472/438	ms
P-R-T axes	40 -45	95

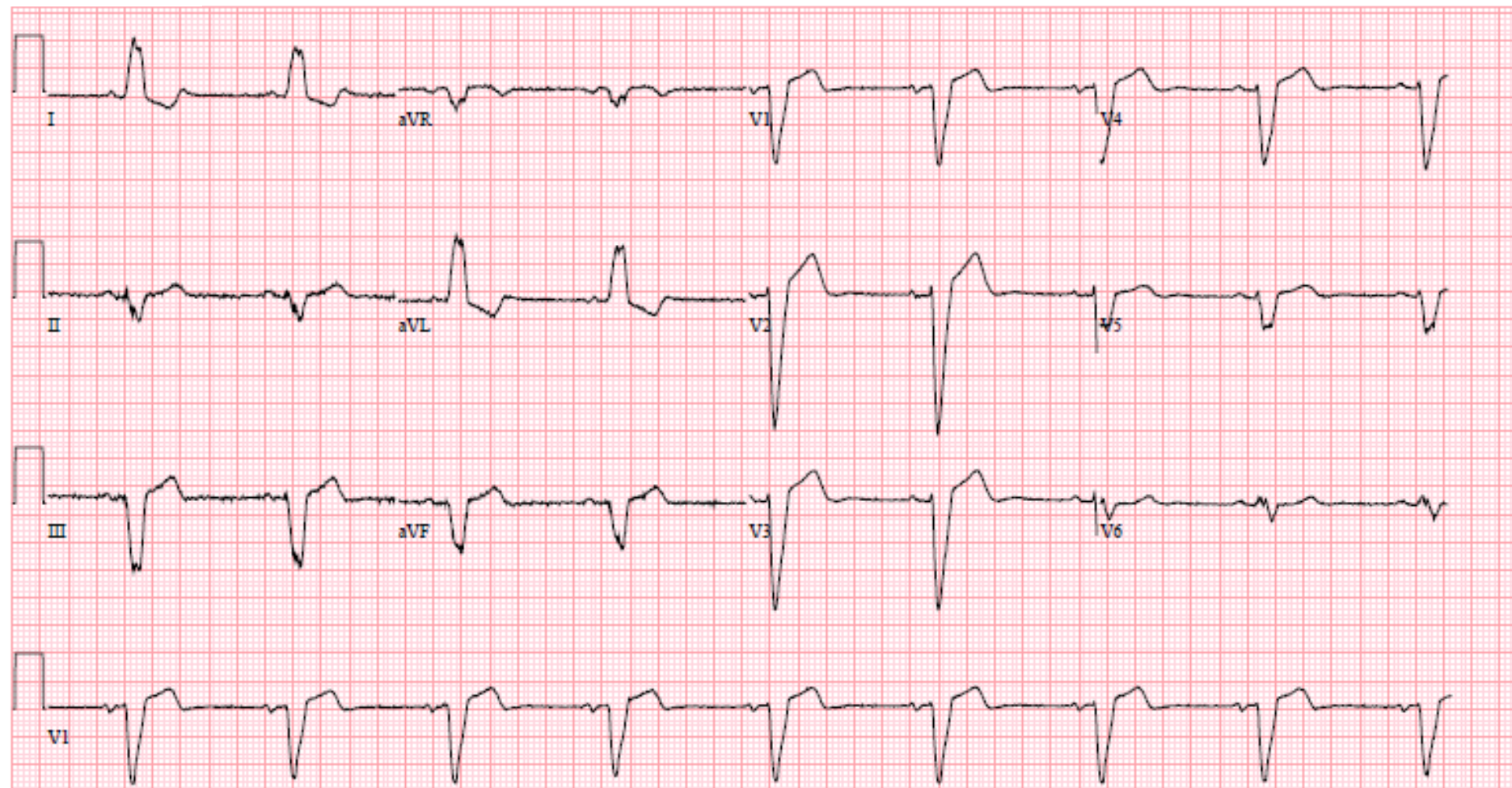
Sinus bradycardia  
Left axis deviation  
Left bundle branch block  
Abnormal ECG  
When compared with ECG of 19-NOV-2011 16:46,  
PREVIOUS ECG IS PRESENT

Technician:  
Test ind: CP

CV-WHO?:

Referred by: CV-TIME?:

Confirmed By: ER Doctor Read on Chart



# Case #7a: 48 y/o female with fatigue

20-OCT-1966 (48 yr)

Vent. rate	180	BPM
PR interval	*	ms
QRS duration	82	ms
QT/QTc	254/439	ms
P-R-T axes	* 42	-23

Atrial fibrillation with rapid ventricular response  
Nonspecific ST abnormality  
Abnormal QRS-T angle, consider primary T wave abnormality  
Abnormal ECG  
No previous ECGs available

Room: ED19  
Loc: 201

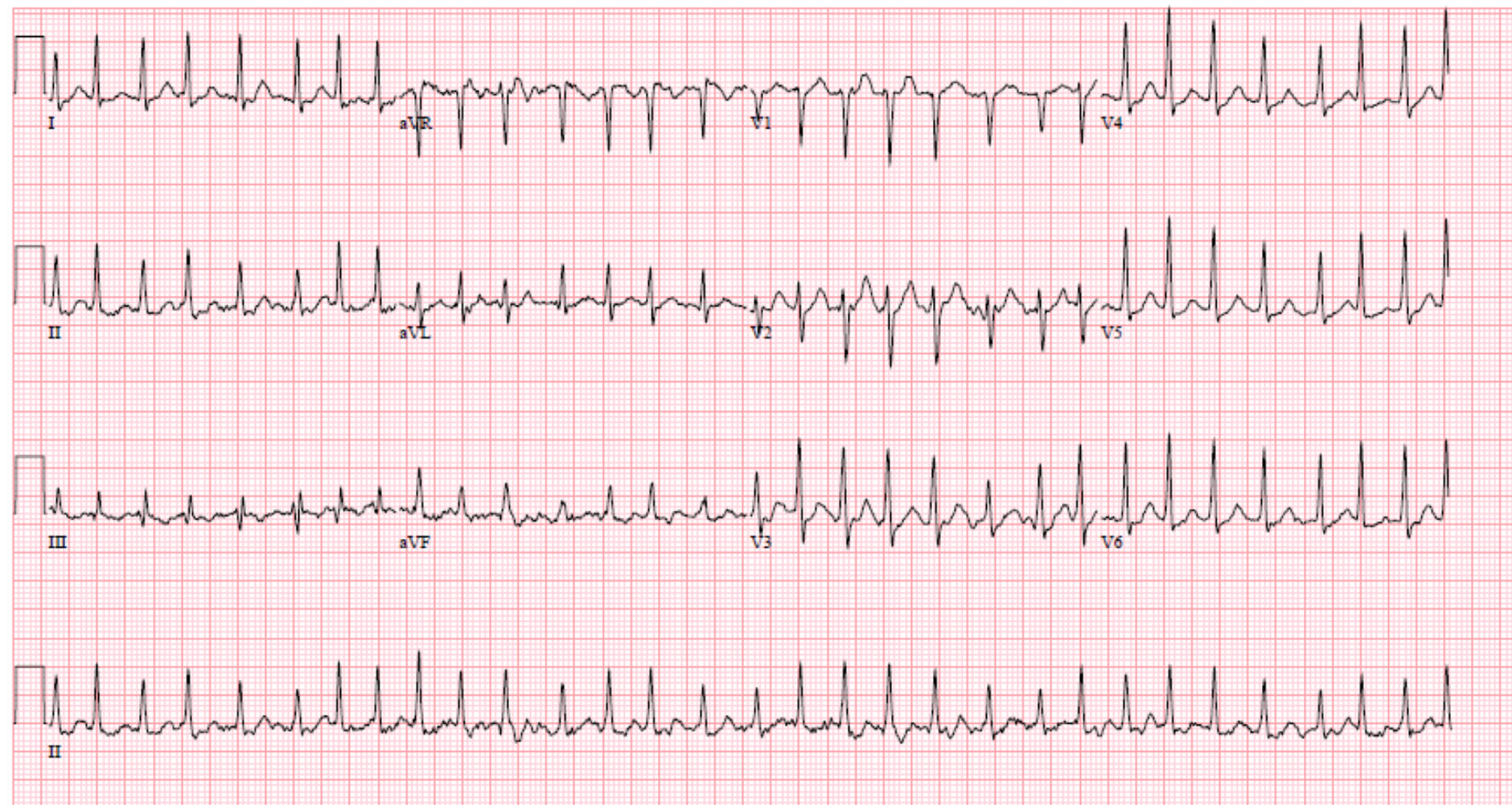
Technician:  
Test ind:

Referred by:

Confirmed By: ER Doctor Read on Chart

NOTIFIED W:

NOTIFIED T:





# Case #7b: 79 y/o with chest pain

Rate: 150 bpm

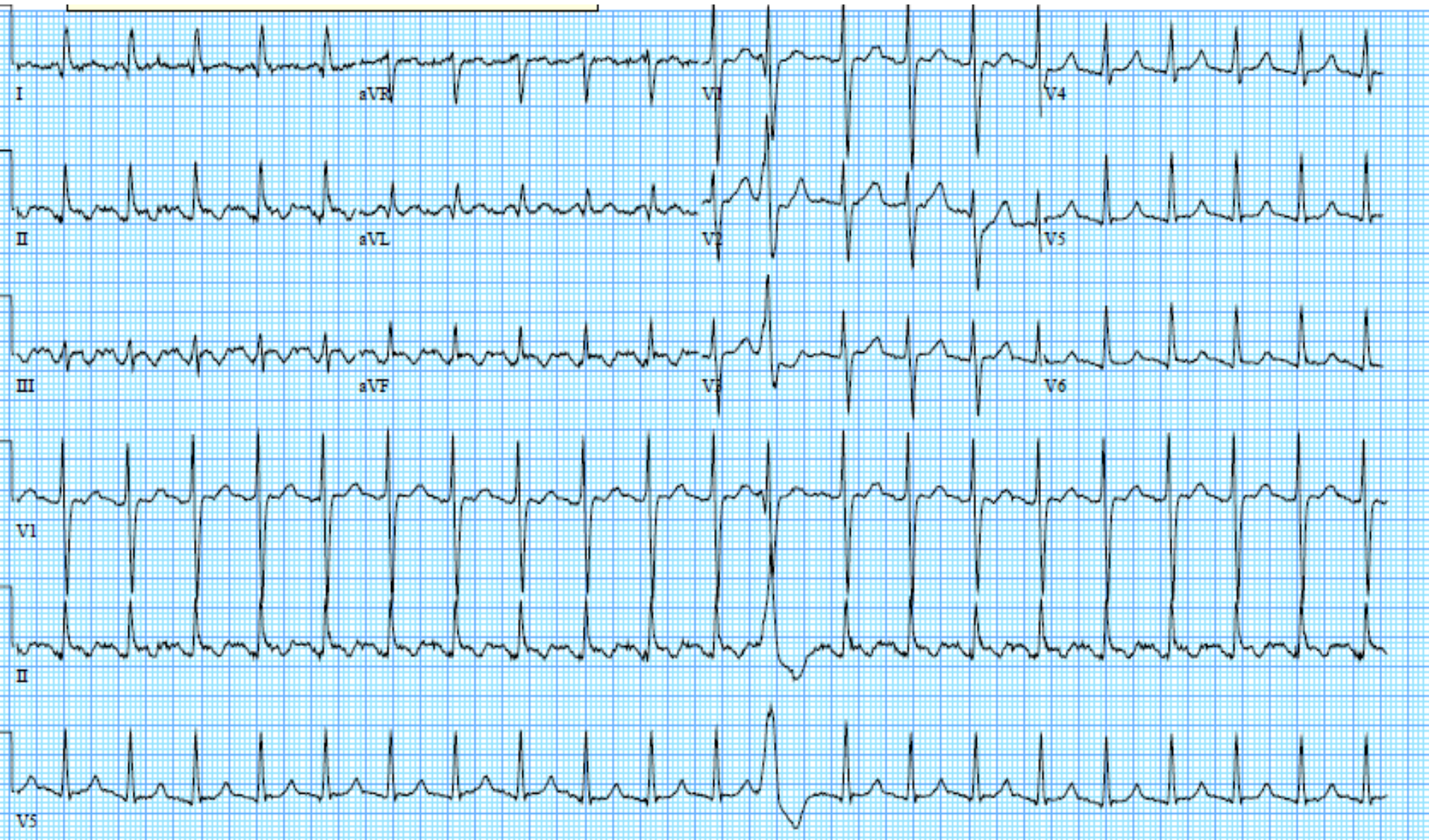
QRS: 80 ms

R Axis: +30

Atrial Flutter; 2:1 Conduction

PRI: N/A

QT/QTc: 300/474 ms





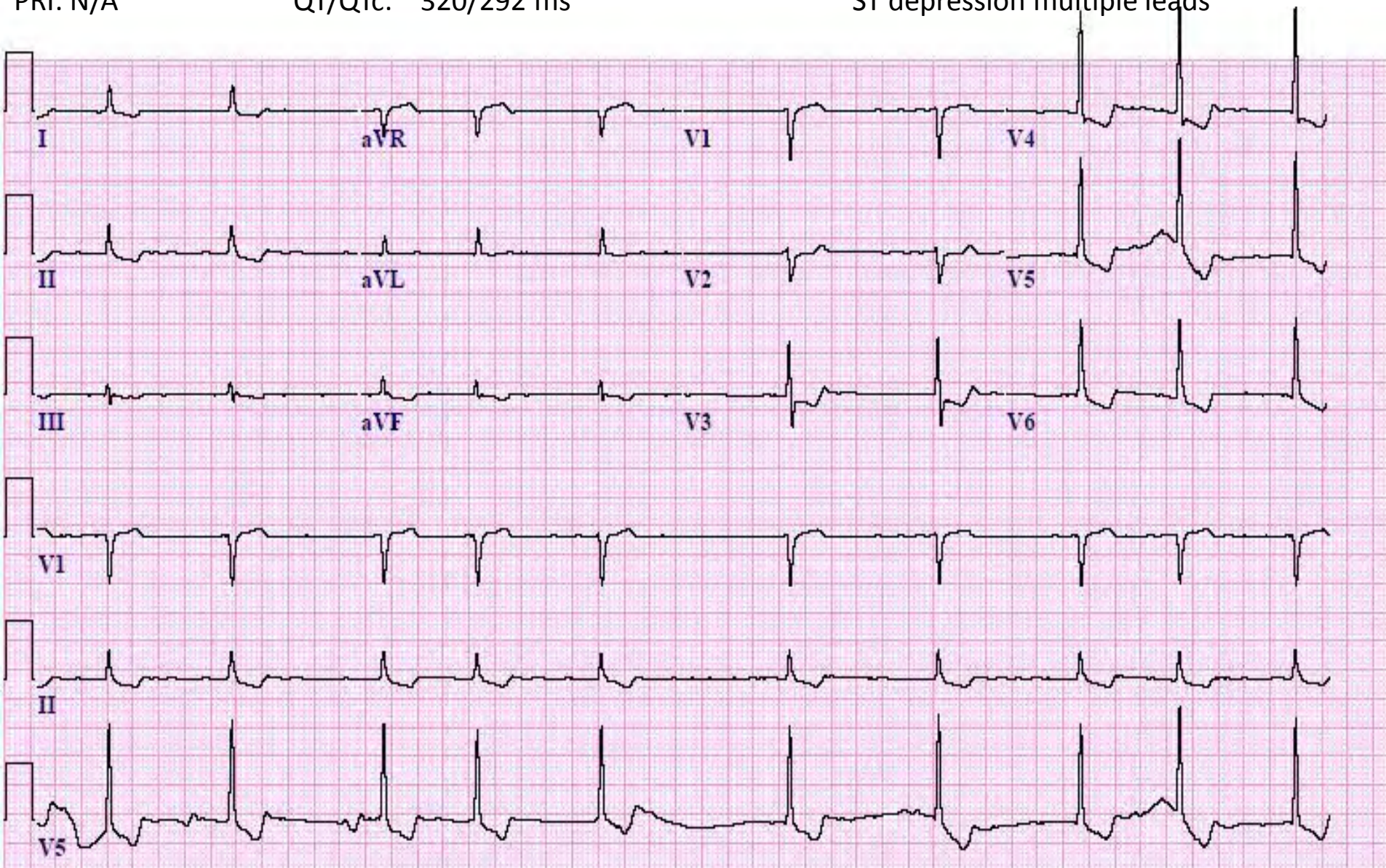
# Case #7c: 65 y/o on HF medications

Rate: 50bpm  
PRI: N/A

QRS: 60 ms  
QT/QTc: 320/292 ms

R Axis: +60

Atrial Fibrillation with slow rate  
ST depression multiple leads





# Case #8a: 22 y/o with palpitations

Rate: 220 bpm

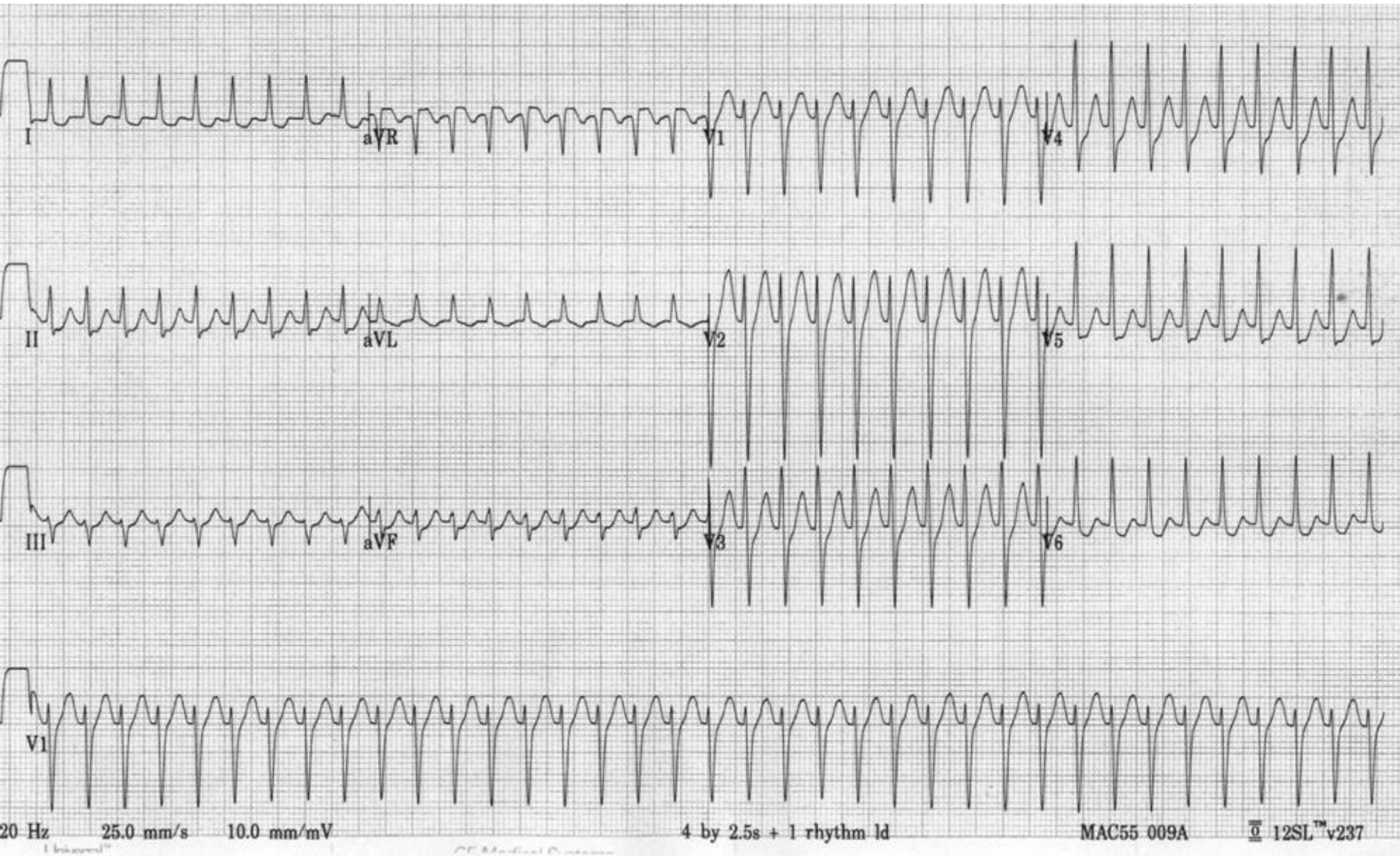
QRS: 60 ms

R Axis: 0

Supra Ventricular Tachycardia

PRI: N/A

QT: 250 ms



# Case #8b: 61 y/o with fast heart rate

19-SEP-1949 (61 yr)  
Male

Vent. rate	167	BPM
PR interval	*	ms
QRS duration	210	ms
QT/QTc	348/580	ms
P-R-T axes	* -78	101

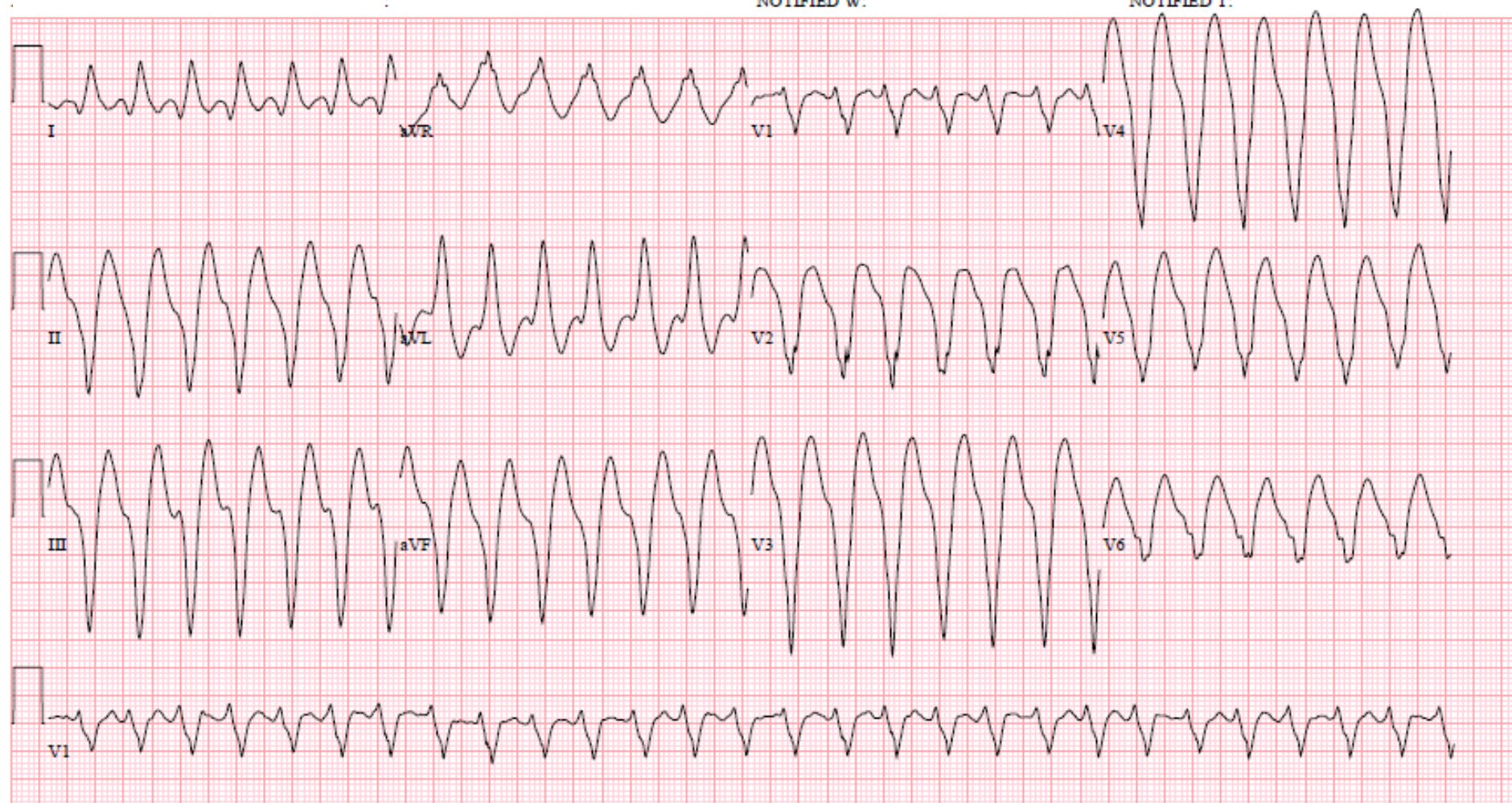
\*\*\*age and gender specific ECG analysis\*\*\*  
Left axis deviation  
Ventricular tachycardia (ventricular or supraventricular with aberration)  
Abnormal ECG

Room:ERT2  
Loc:201

Technician:  
Test ind:FEVER CHILLS

Referred by:  
NOTIFIED W:

Confirmed By:  
NOTIFIED T:





# Case #9: 33 y/o on hemodialysis

03-MAY-1977 (33 yr)  
Female

Vent. rate	72	BPM
PR interval	200	ms
QRS duration	18	ms
QT/QTc	398/435	ms
P-R-T axes	-69 0	66

\*\*\*age and gender specific ECG analysis\*\*\*

Unusual P axis, possible ectopic atrial rhythm with Possible Premature atrial complexes with Aberrant conduction

Indeterminate axis

Pulmonary disease pattern

ST elevation consider anterolateral injury or acute infarct

\*\*\*\*\* ACUTE MI \*\*\*\*\*

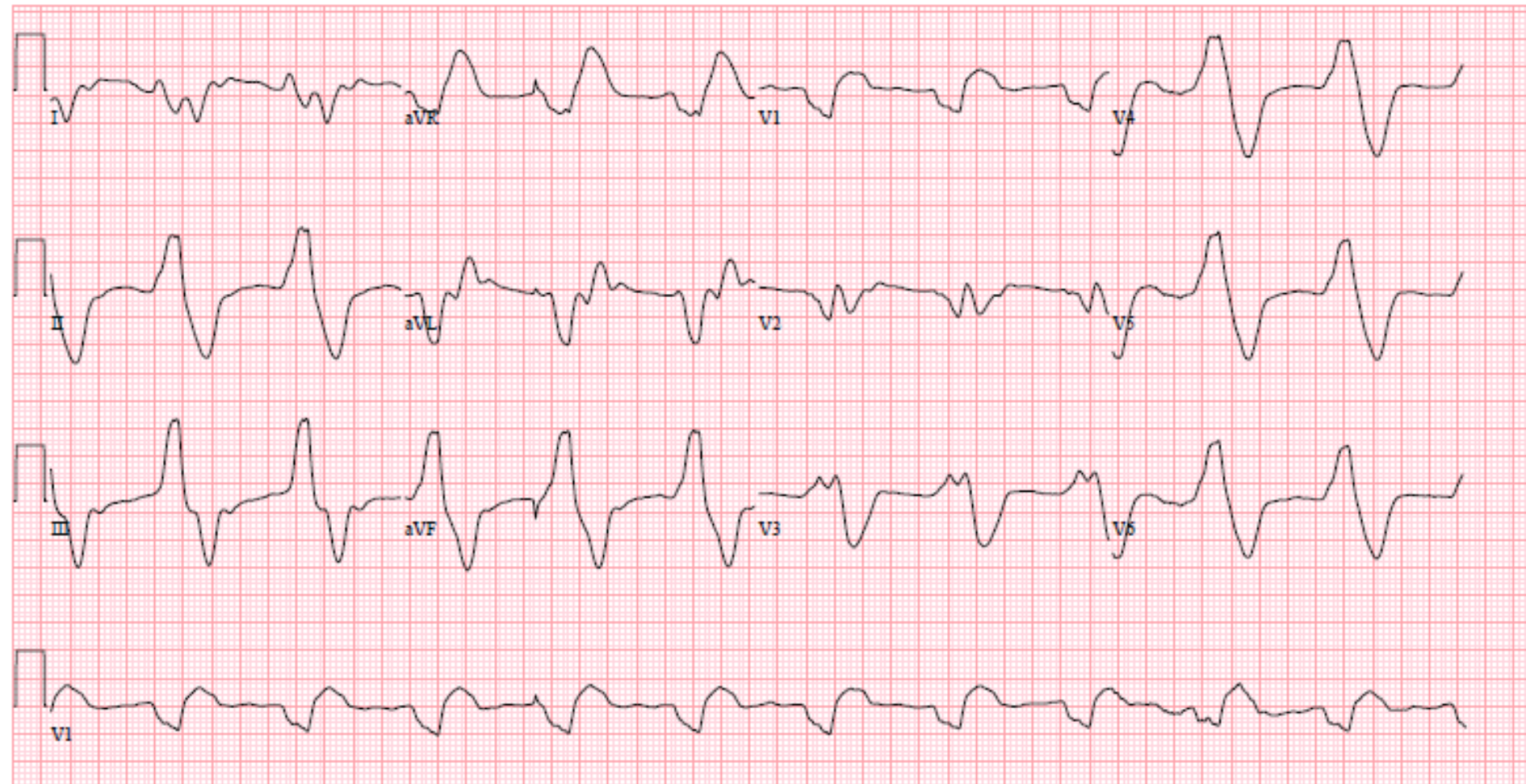
Abnormal ECG

Room:  
Loc:201

Technician:  
Test ind:

Referred by: MD  
NOTIFIED W:

Confirmed By:  
NOTIFIED T:0



# Case #10: 61 y/o with pneumonia

17-MAY-1950 (61 yr)  
Female

Vent. rate	76	BPM
PR interval	168	ms
QRS duration	84	ms
QT/QTc	436/490	ms
P-R-T axes	58 -19	53

Normal sinus rhythm with sinus arrhythmia  
Prolonged QT  
Abnormal ECG  
When compared with ECG of 09-AUG-2011 20:24,  
PREVIOUS ECG IS PRESENT

Room: ER 12  
Loc: 201

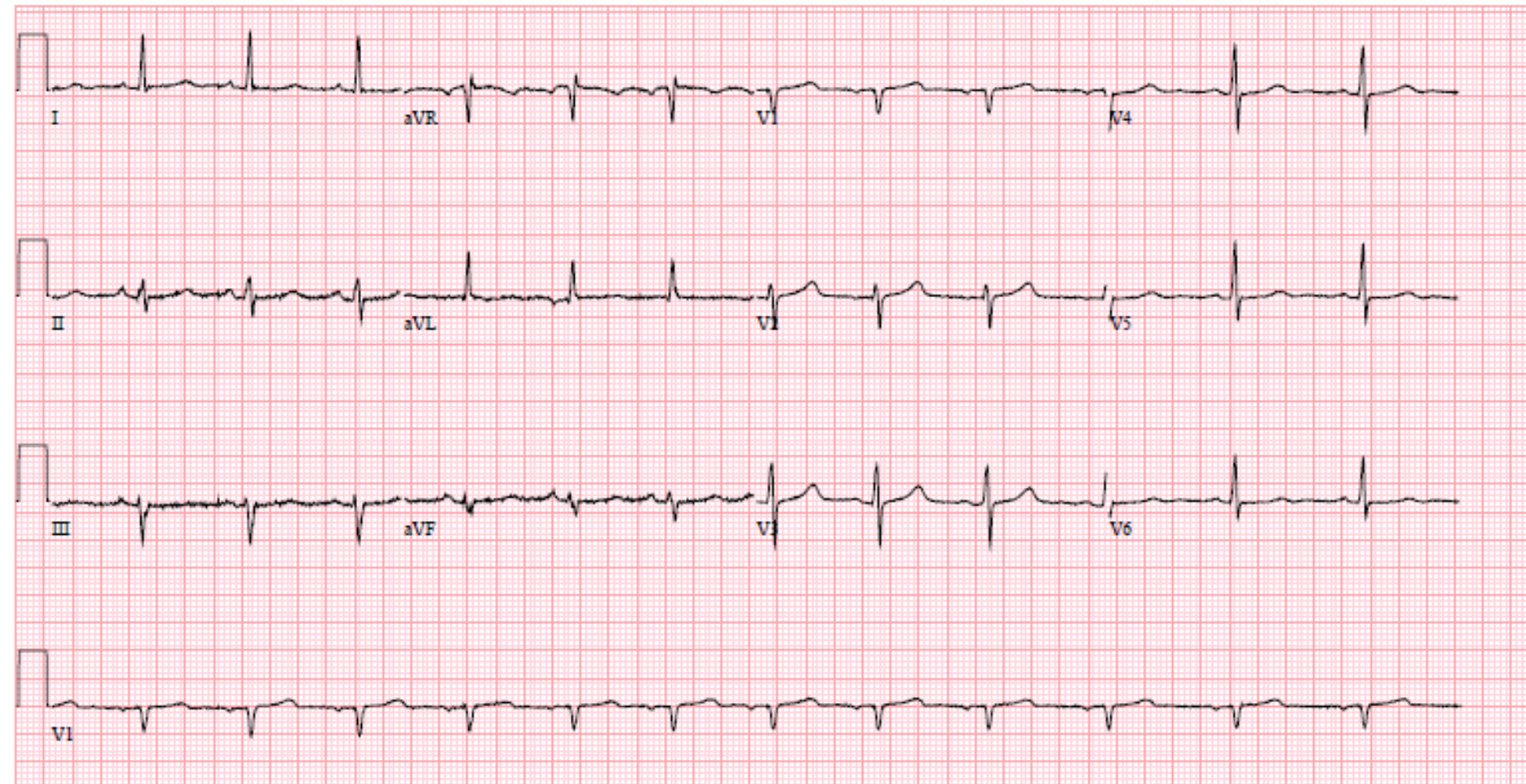
Technician: 9408  
Test ind: SYNCOPÉ

CV-WHO?:

Referred by:

CV-TIME?:

Confirmed By:



# Case # 11a: 84 y/o new patient

12-JAN-1927 (84 yr)  
Female

Room:157  
Loc:203

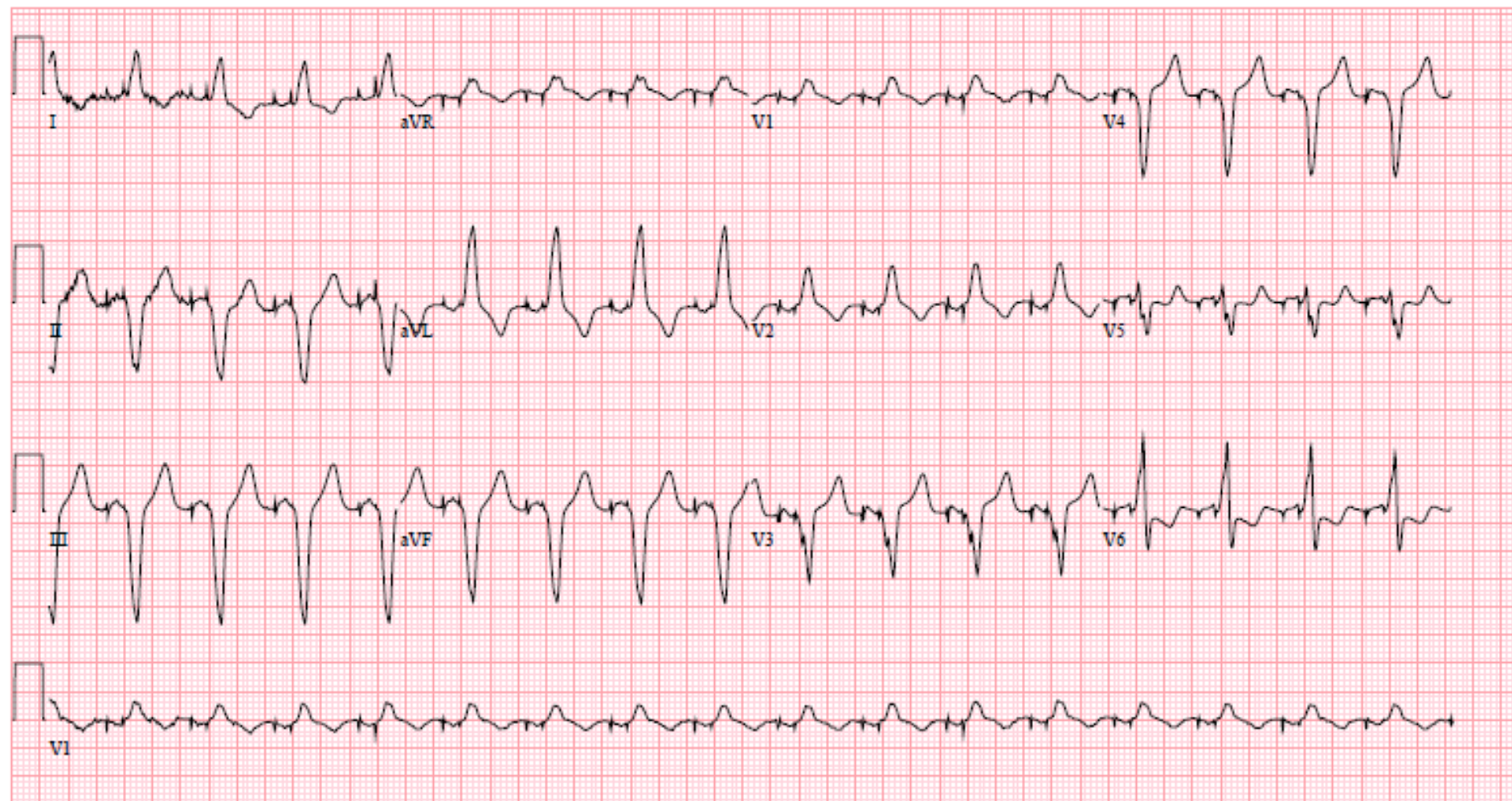
Vent. rate	100	BPM
PR interval	104	ms
QRS duration	172	ms
QT/QTc	380/490	ms
P-R-T axes	-82 -70	107

\*\*\*age and gender specific ECG analysis\*\*\*  
AV sequential or dual chamber electronic pacemaker  
When compared with ECG of 20-FEB-2011 04:09,  
PREVIOUS ECG IS PRESENT

Technician: EL  
Test ind: WITH MAGNET

Referred by:  
NOTIFIED W:

Confirmed By:  
NOTIFIED T:





# Case #12: 86 y/o new patient

15-AUG-1925 (86 yr)  
Female

Room:ICU2  
Loc:208

Vent. rate	83	BPM
PR interval	*	ms
QRS duration	88	ms
QT/QTc	420/493	ms
P-R-T axes	* -59	150

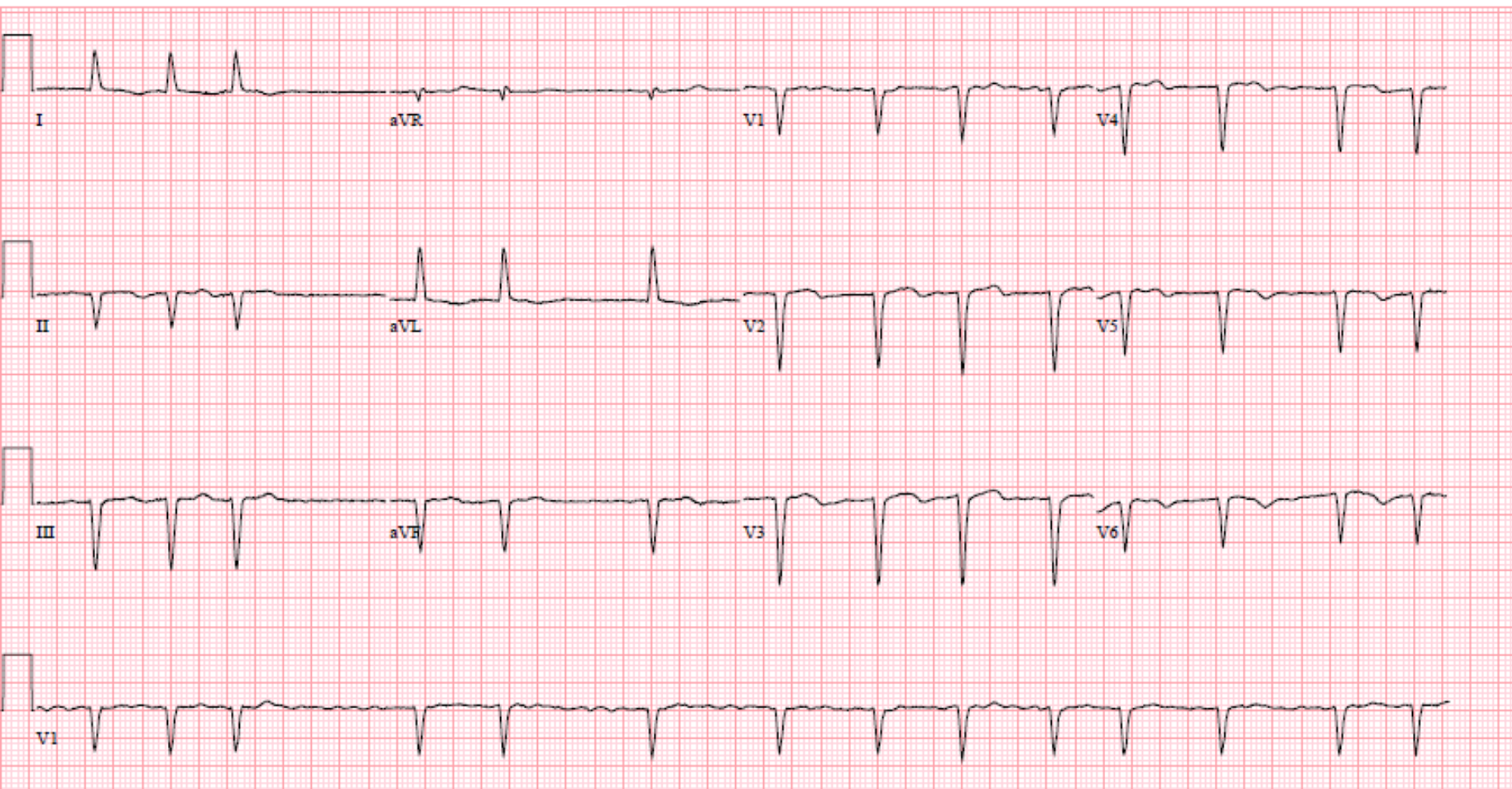
Atrial fibrillation  
Left axis deviation  
Inferior infarct , age undetermined  
Anterolateral infarct , age undetermined  
Abnormal ECG  
When compared with ECG of 08-NOV-2011 12:13,  
PREVIOUS ECG IS PRESENT

Technician: LB  
Test ind:ROUTINE

CV-WHO ?

Referred by:  
CV-TIME ?:0605

Confirmed By:



# Case #13a: 54 y/o female with SOB

30-NOV-1956 (54 yr)

Female

Room:

Loc:201

Vent. rate	97	BPM
PR interval	140	ms
QRS duration	90	ms
QT/QTc	358/454	ms
P-R-T axes	64 33	-69

\*\*\* Critical Test Result: STEMI  
Normal sinus rhythm  
Anteroseptal infarct, possibly acute  
T wave abnormality, consider inferolateral ischemia  
\*\*\* ACUTE MI / STEMI \*\*\*  
Abnormal ECG  
When compared with ECG of 17-JUL-2007 07:09,  
PREVIOUS ECG IS PRESENT

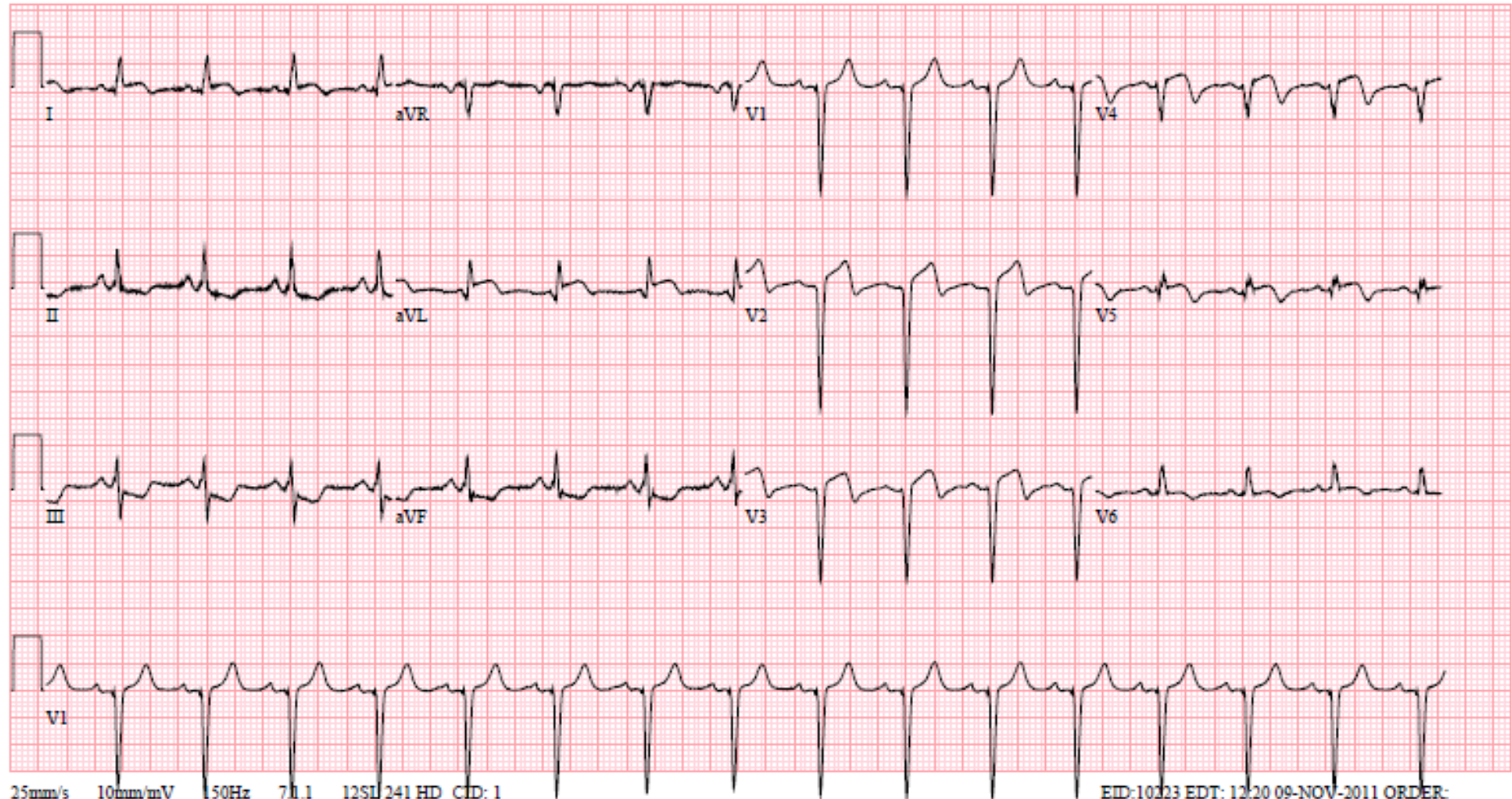
Technician:  
Test ind:CP

CV-WHO ?:

Referred by:

CV-TIME ?:

Confirmed By:





# Case #13b: 63 y/o with chest pain

Rate: 41 bpm

QRS: 100 ms

R Axis: -30

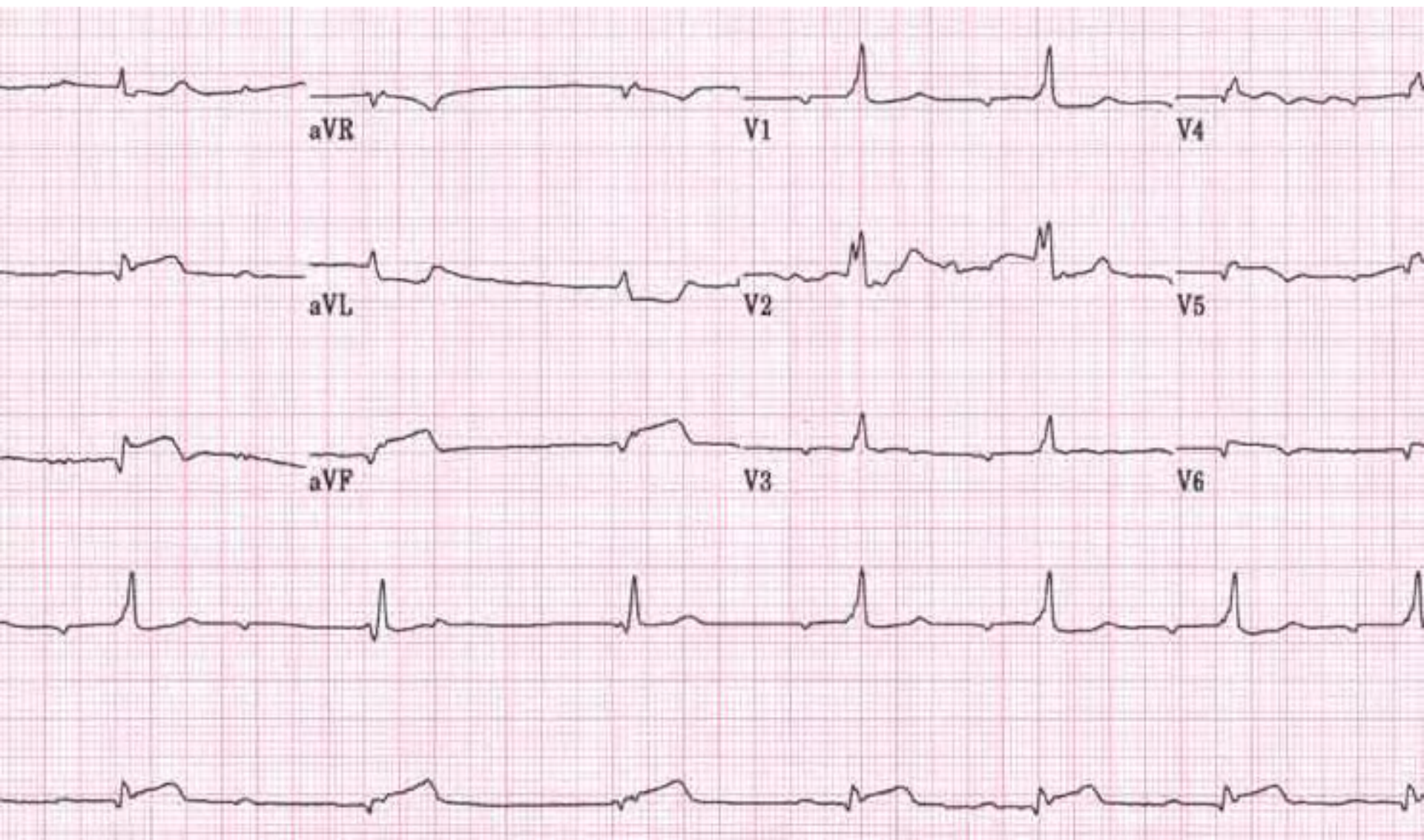
\*Acute Inferoposterolateral MI

PRI: N/A

QT/QTc: 400 ms/331 ms

Complete Heart Block

Slight Left Axis Deviation





# Case #13c: 23 y/o male with CP

Rate: 100 bpm

QRS: 80 ms

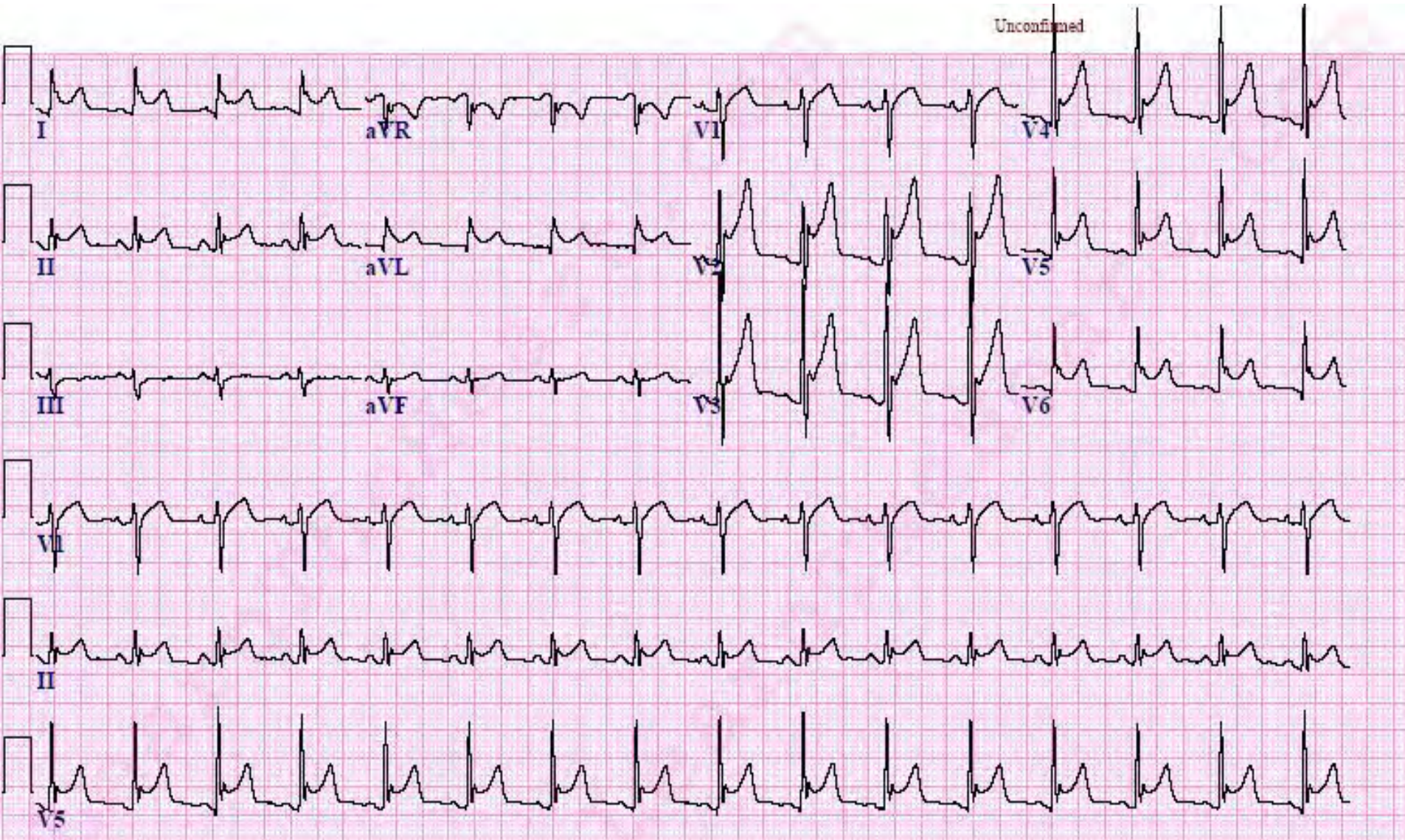
R Axis: 0

ST elevation in Multiple leads

PRI: 120 ms

QT/QTc: 360 ms/465 ms

Consider Pericarditis



# Extras



*"When is it time to want more?"*



# Case #4b: 56 year old with HTN (Extra LVH)

08-FEB-1955 (56 yr)  
Male

Vent. rate	103	BPM
PR interval	152	ms
QRS duration	110	ms
QT/QTc	380/497	ms
P-R-T axes	48 2	128

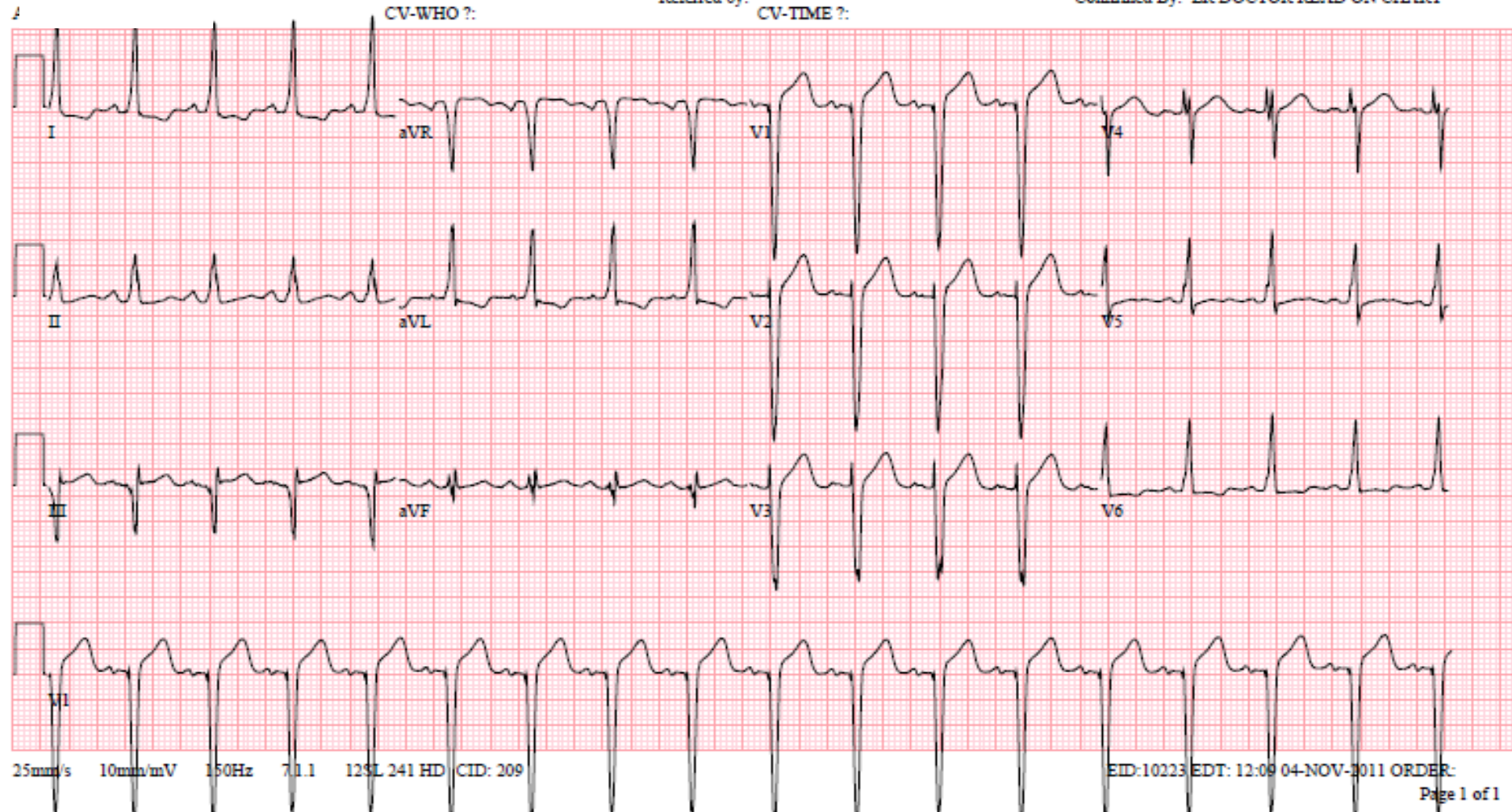
Sinus tachycardia  
Left ventricular hypertrophy with repolarization abnormality  
Abnormal ECG  
No previous ECGs available

Room: ER 24  
Loc: 201

Technician  
Test ind: ALOC

Referred by: CV-WHO ?  
CV-TIME ?

Confirmed By: ER DOCTOR READ ON CHART



# Case #5b: 81 y/o male (Extra RBBB)

12-MAY-1930 (81 yr)  
Male  
72in 183lb  
Room:ED 22  
Loc:201

Vent. rate	44	BPM
PR interval	230	ms
QRS duration	158	ms
QT/QTc	514/439	ms
P-R-T axes	96 -41 -4	

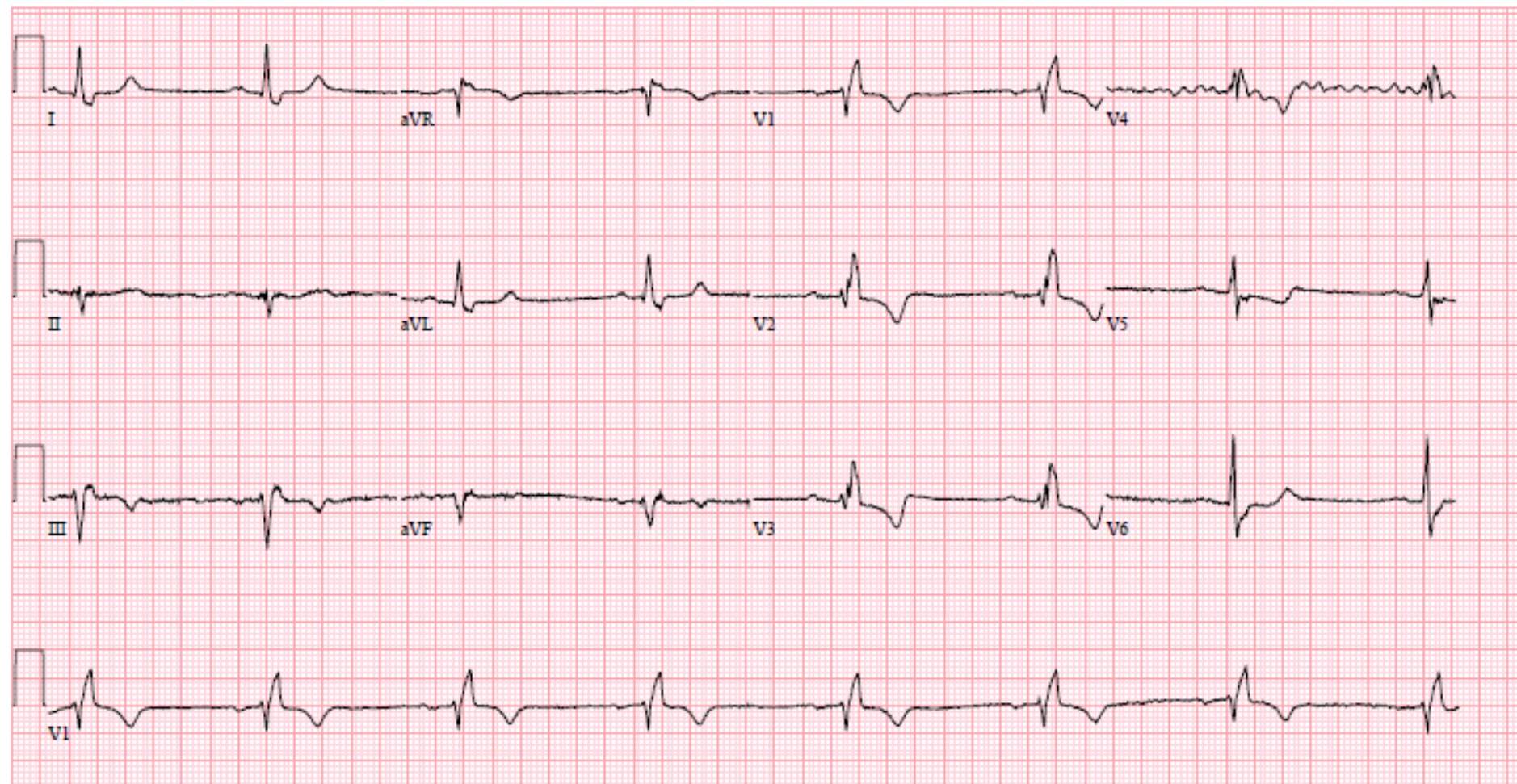
Marked sinus bradycardia with 1st degree A-V block  
Left axis deviation  
Right bundle branch block  
T wave abnormality, consider lateral ischemia  
Abnormal ECG  
When compared with ECG of 23-NOV-2010 12:56,  
PREVIOUS ECG IS PRESENT

Technician:  
Test ind:CF

CV-WHO ?:

Referred by: \_\_\_\_\_  
CV-TIME ?:

Newly Acquired





# Case #7d: 82 y/o smoker with dyspnea (MAT)

Rate: 145 bpm

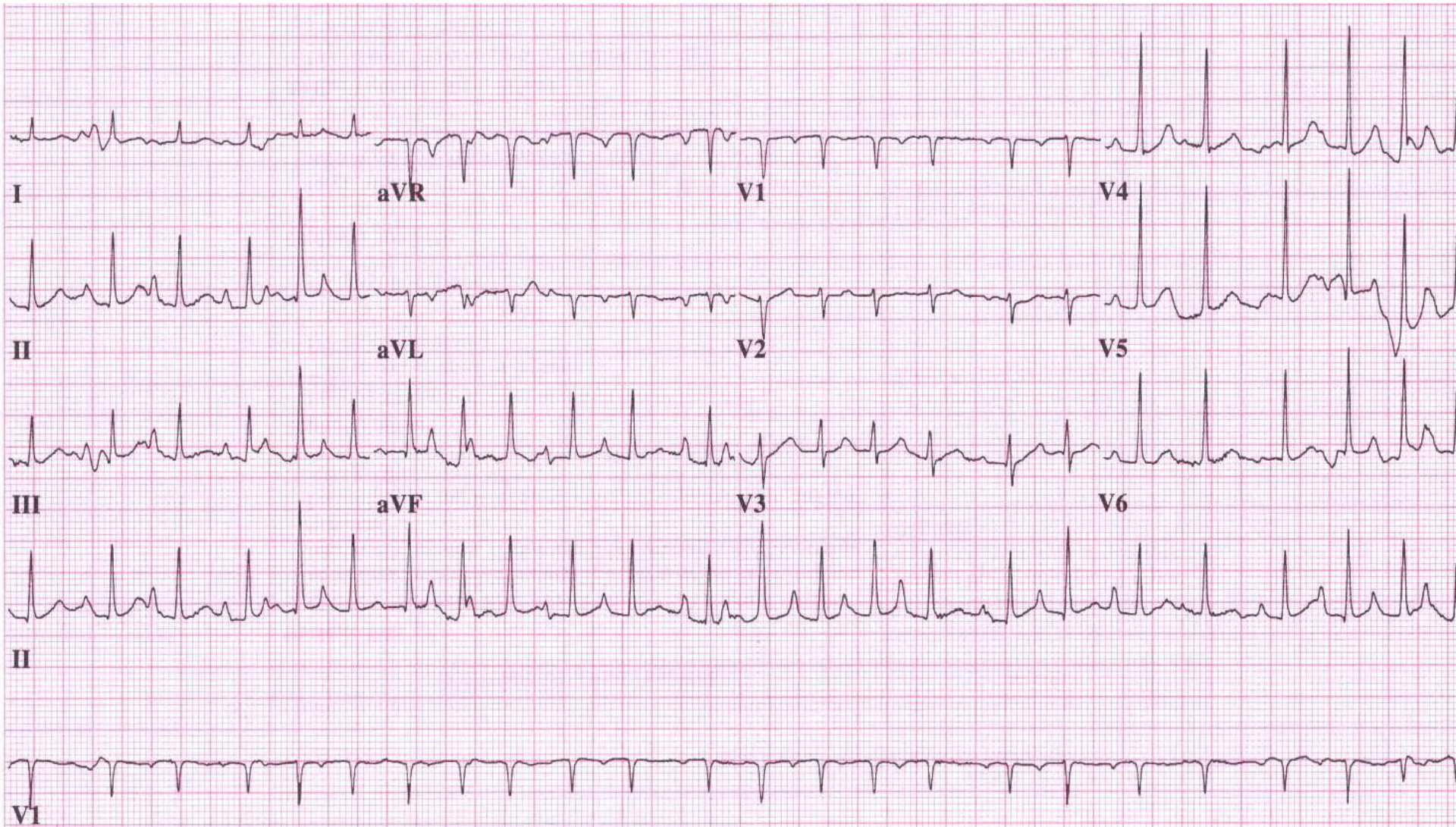
QRS: 60 ms

R Axis: +60

Multifocal Atrial Tachycardia

PRI: N/A

QT/QTc: 300ms/460 ms





# Case #8c: 18 y/o with dizziness (AVNRT)

Rate: 250 bpm

QRS: 50 ms

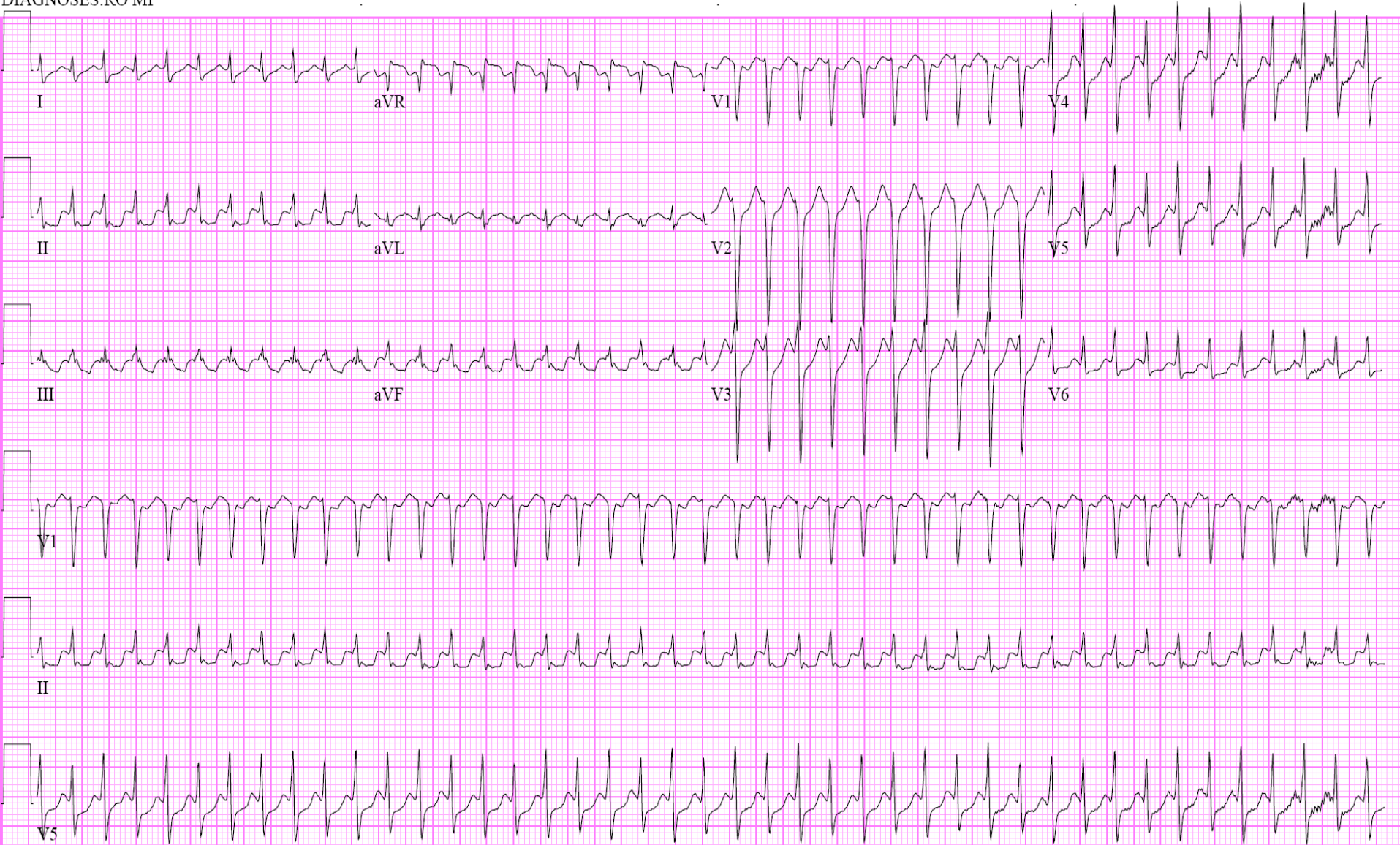
R Axis: +60

AV Nodal Rentry Tachycardia

PRI: N/A

QT: 260 ms

DIAGNOSES:RO MI



# Case #8c: Continued..... (Post Vagal SVT to SR)

Rate: 90 bpm

QRS: 50 ms

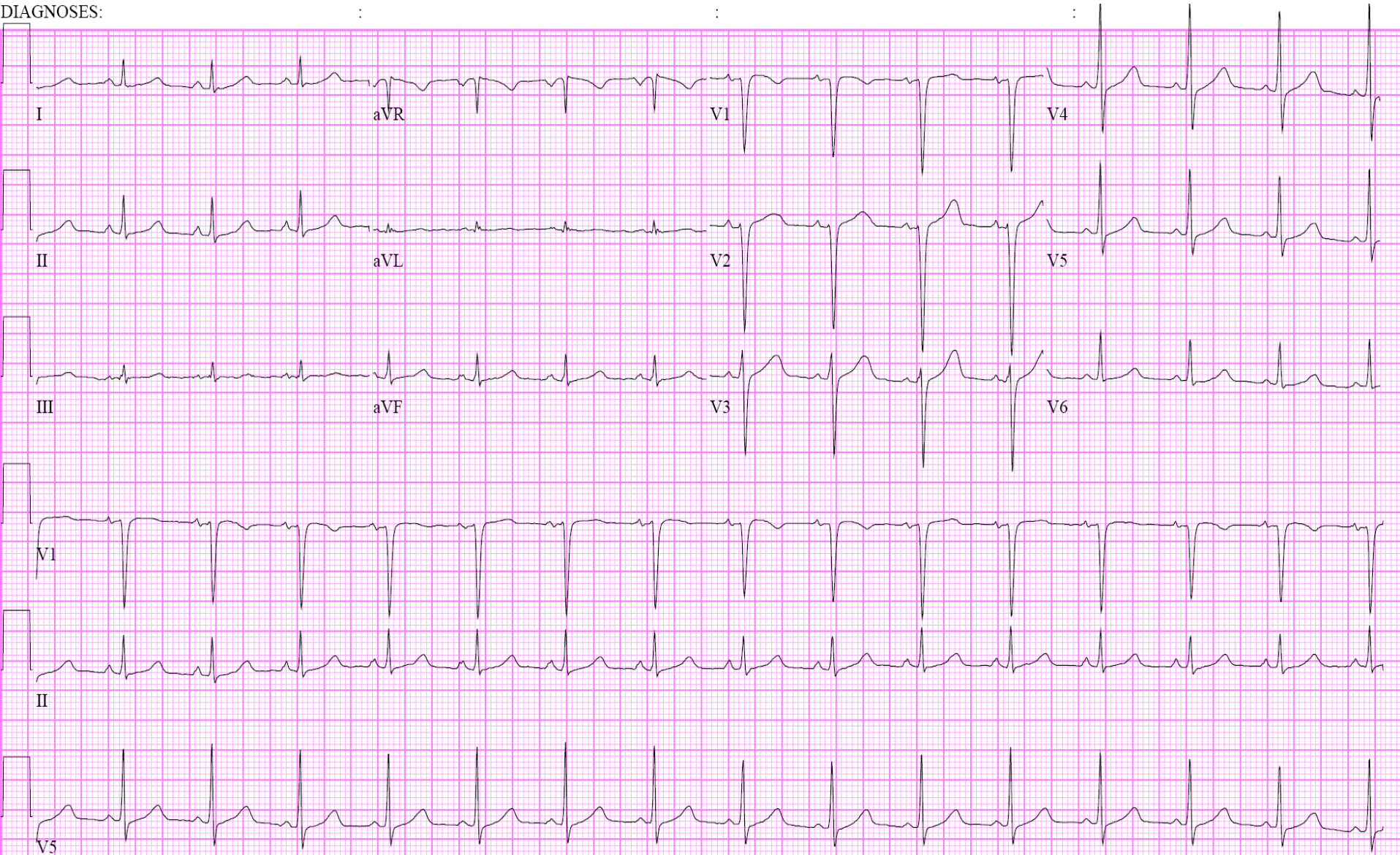
R Axis: +60

Sinus Rhythm

PRI: 160 ms

QT/QTc: 360 ms/441 ms

DIAGNOSES:





# Case #8d: 66 y/o with fast heart rate (VT)

Rate: 176 bpm

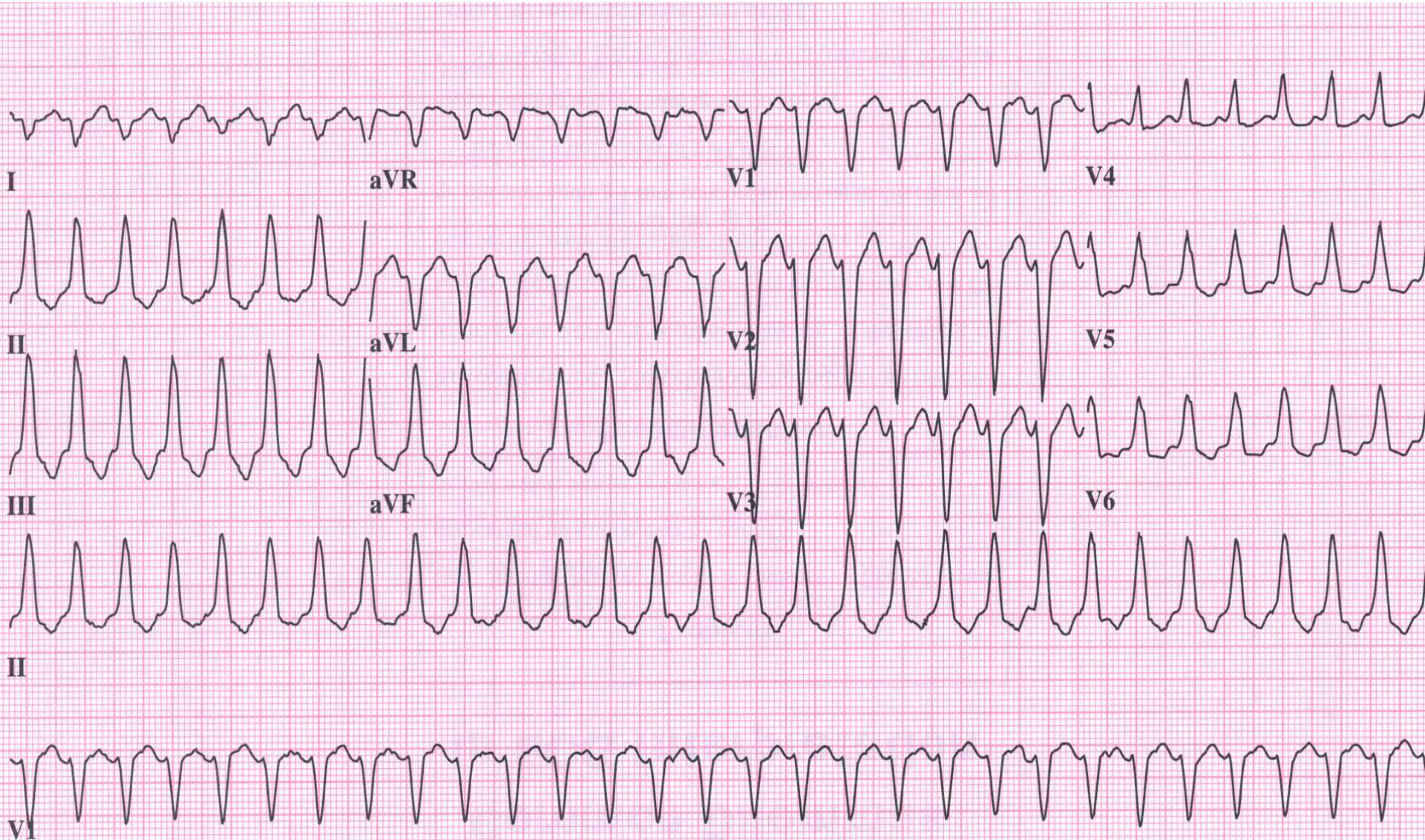
QRS: 120 ms

Ventricular Tachycardia

PRI: N/A

QT/QTc: 300 ms/ 510 ms

Right Axis Deviation





# Case #8e: 24 y/o with palpitations (WPW)

Rate: 80bpm

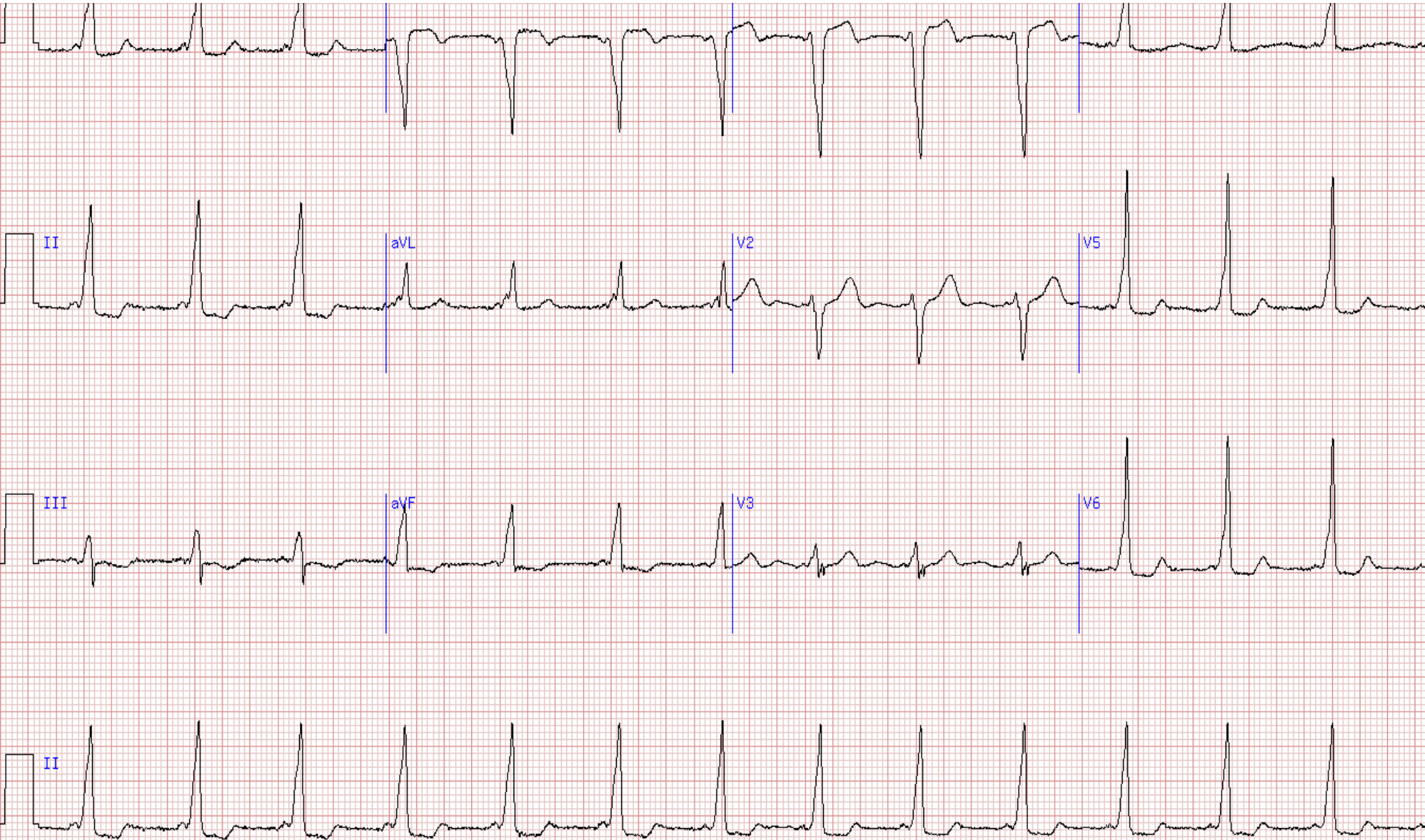
QRS: 100 ms

R Axis: +30

Wolff Parkinson White Syndrome

PRI: 80 ms

QT/QTc: 400 ms/462 ms

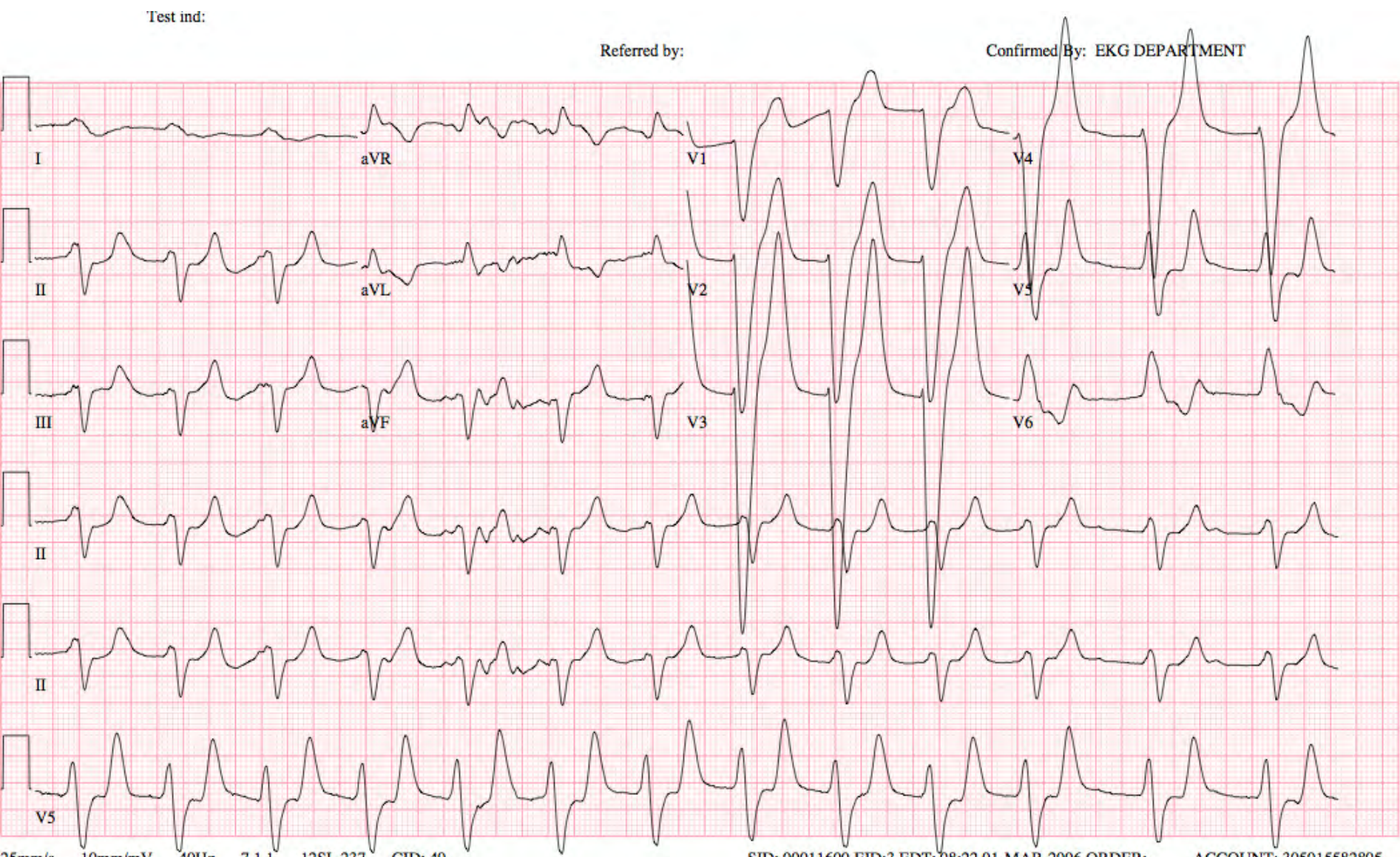


# Case #9b: 83 y/o female with HF

Rate: 80 bpm  
PRI: N/A

QRS: 200 ms  
QT: 540 ms

Hyperkalemia  
Right Axis Deviation





# Case #11b: 60 y/o f/u appt with HF

Rate: 75 bpm

QRS: 240 ms

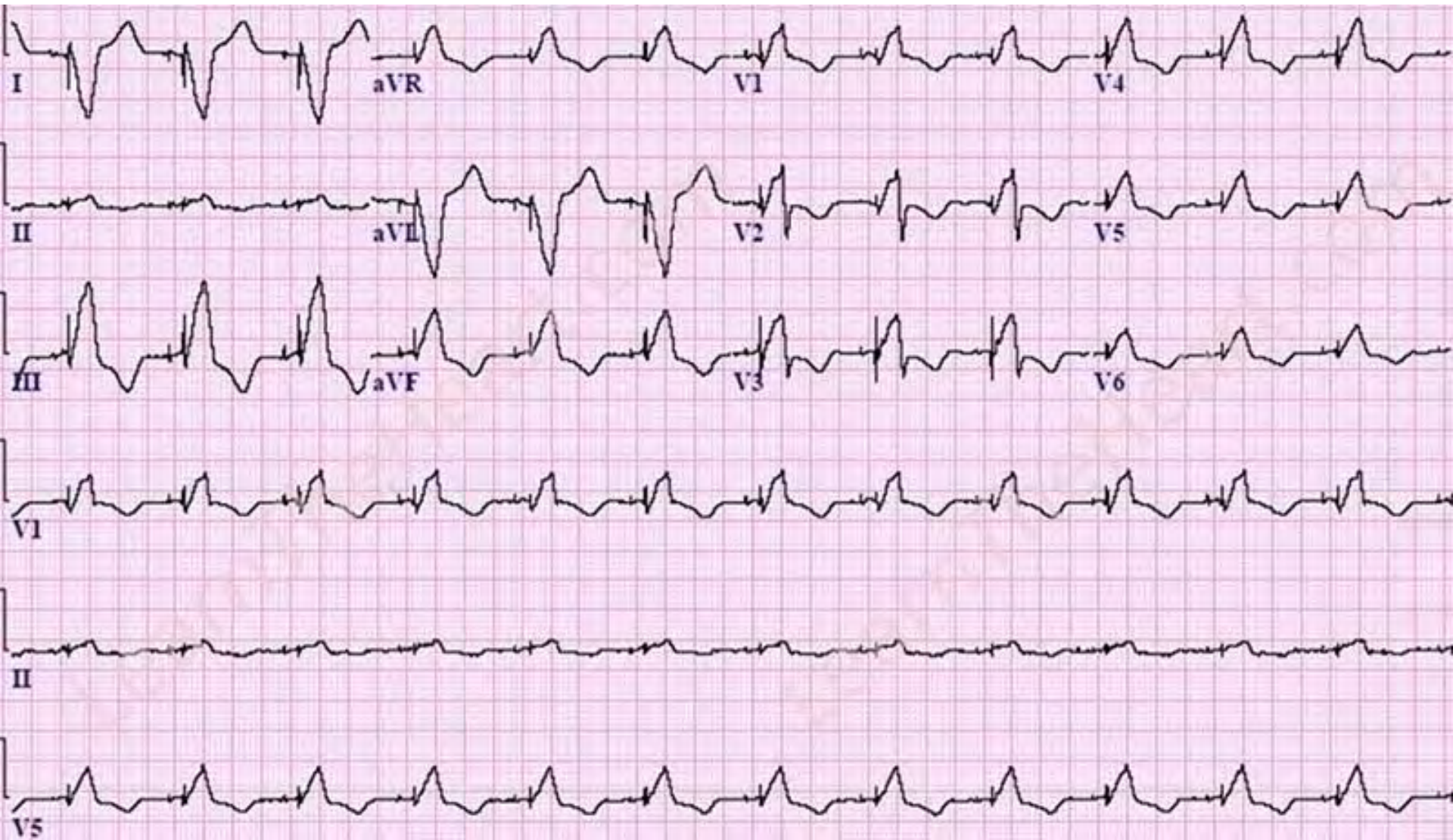
R Axis: +150

Bi-Ventricular Pacemaker

PRI: 120 ms

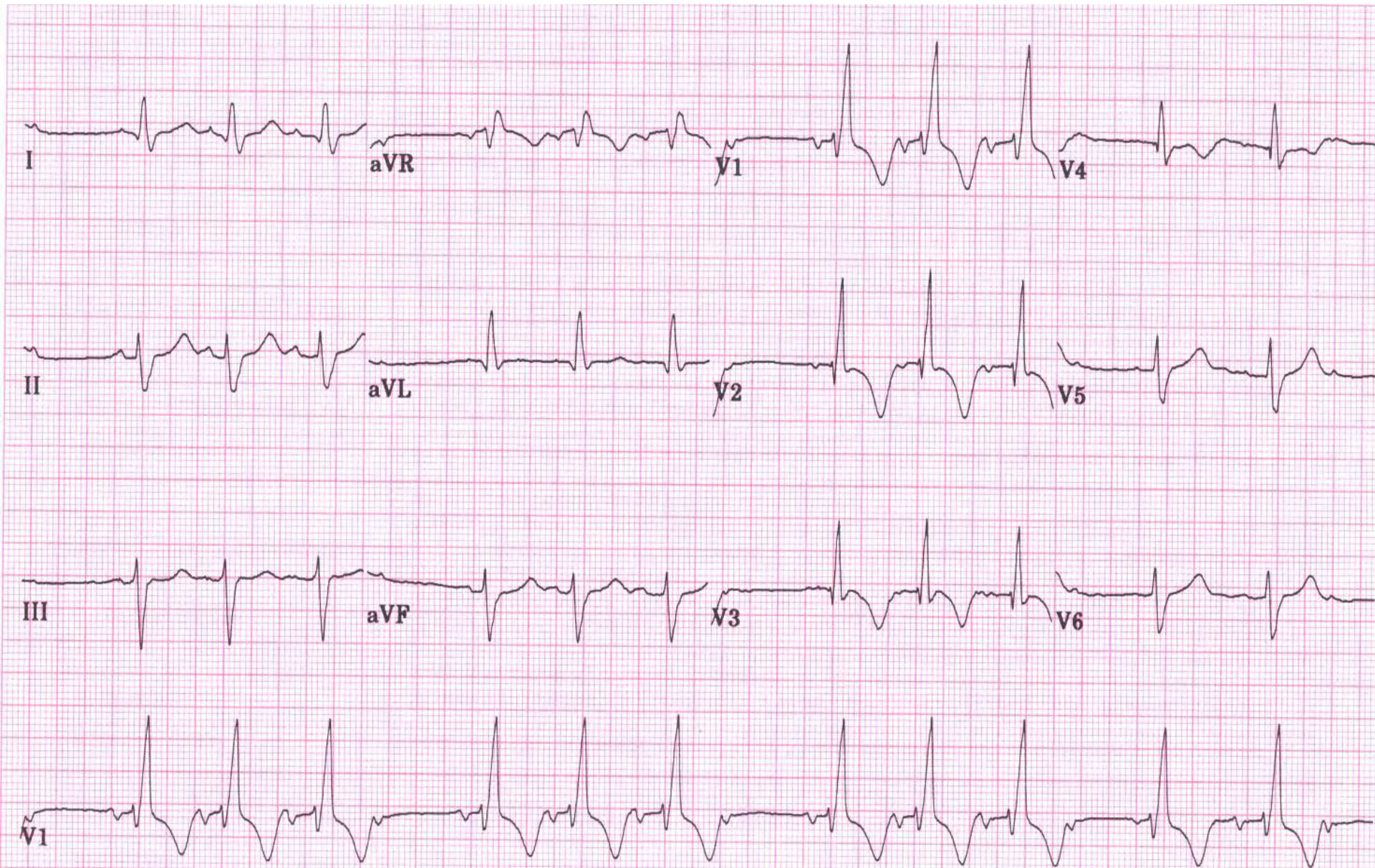
QT/QTc: 460 ms/514 ms

Right Axis Deviation



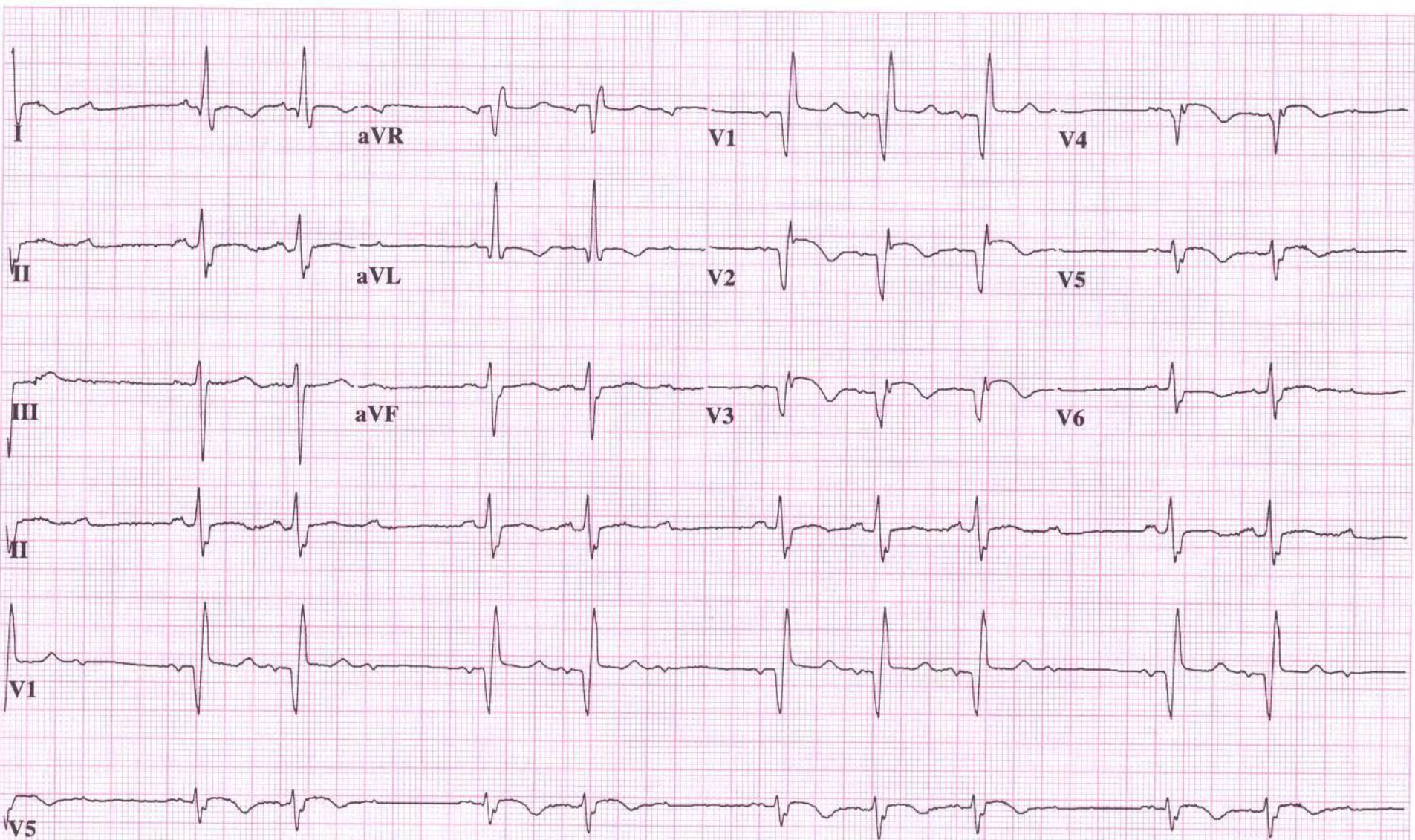


# 76 y/o post-op hip surgery (Mobitz I)

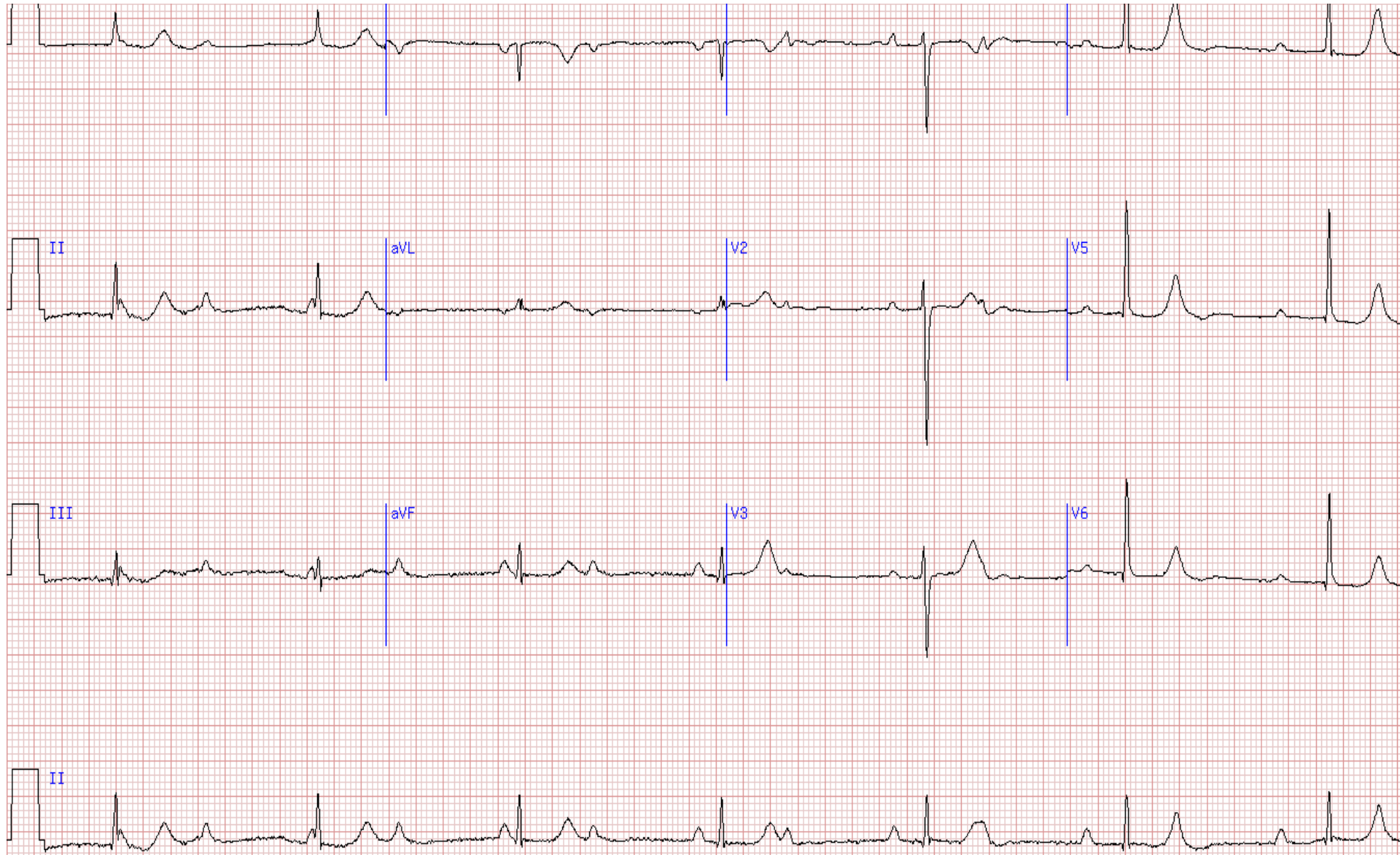




# 50 y/o with chest pain (Mobitz II)

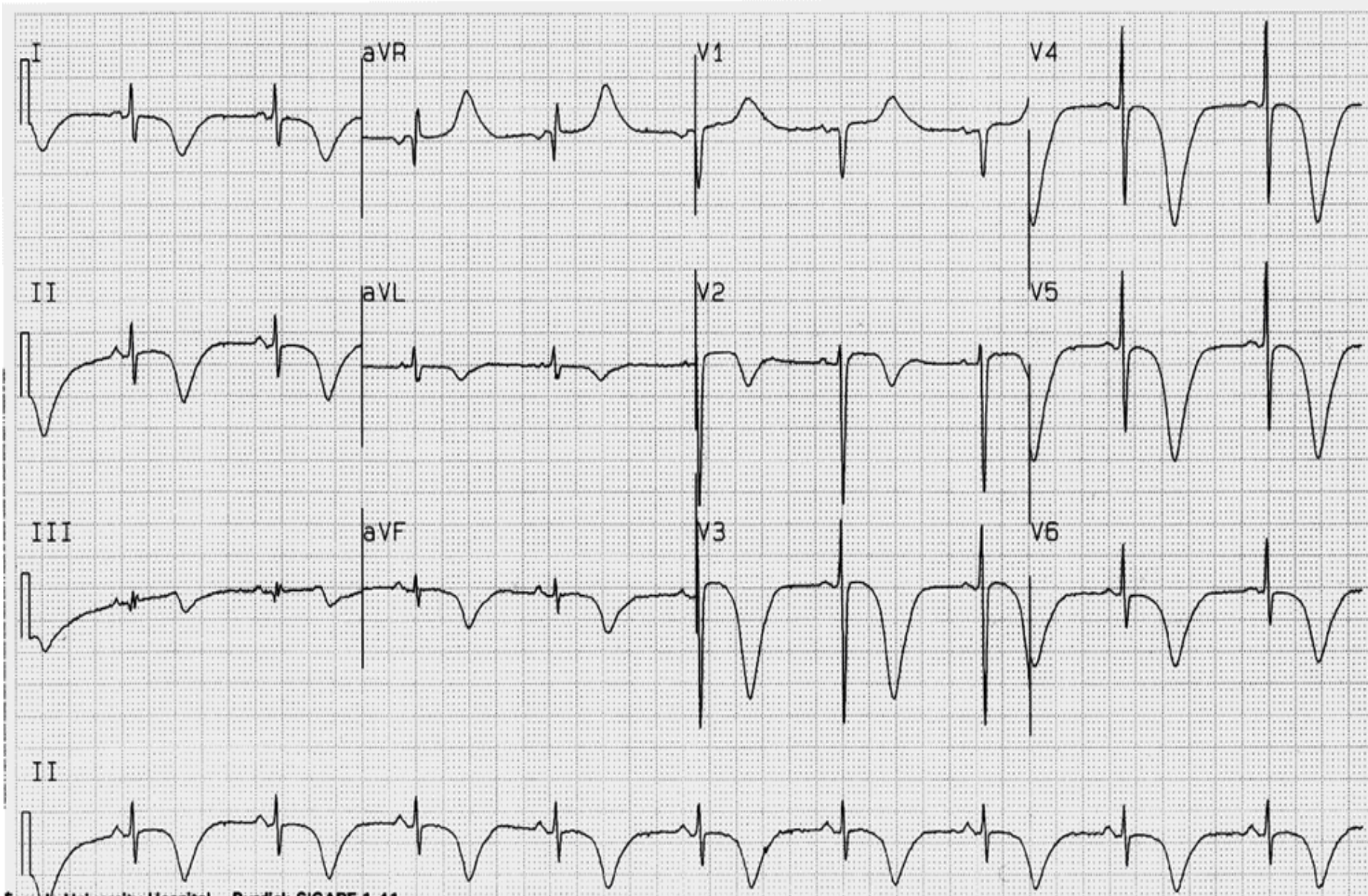


# 53yo with dizziness (CHB)



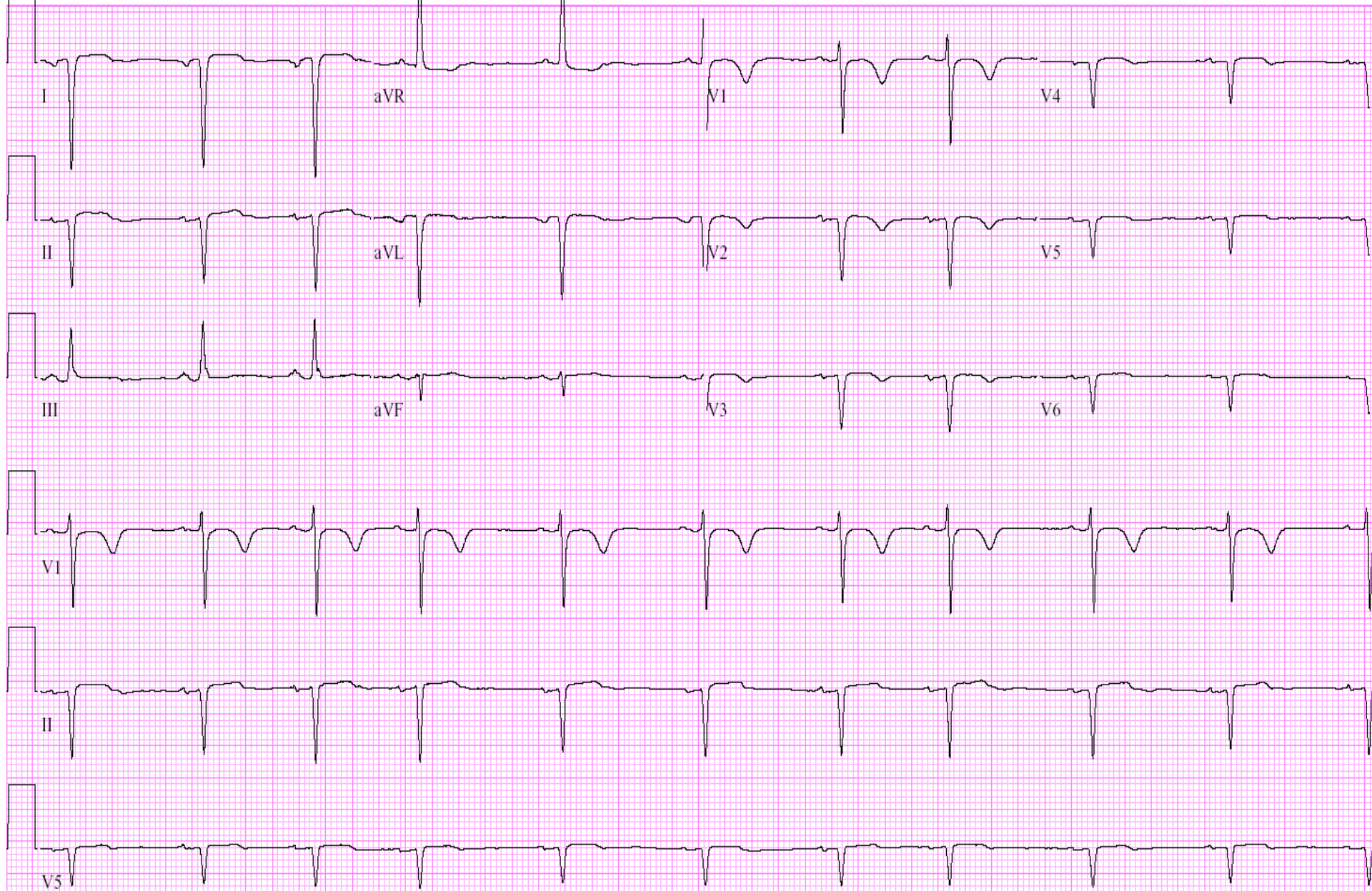


# 77 y/o with headache (TBI)



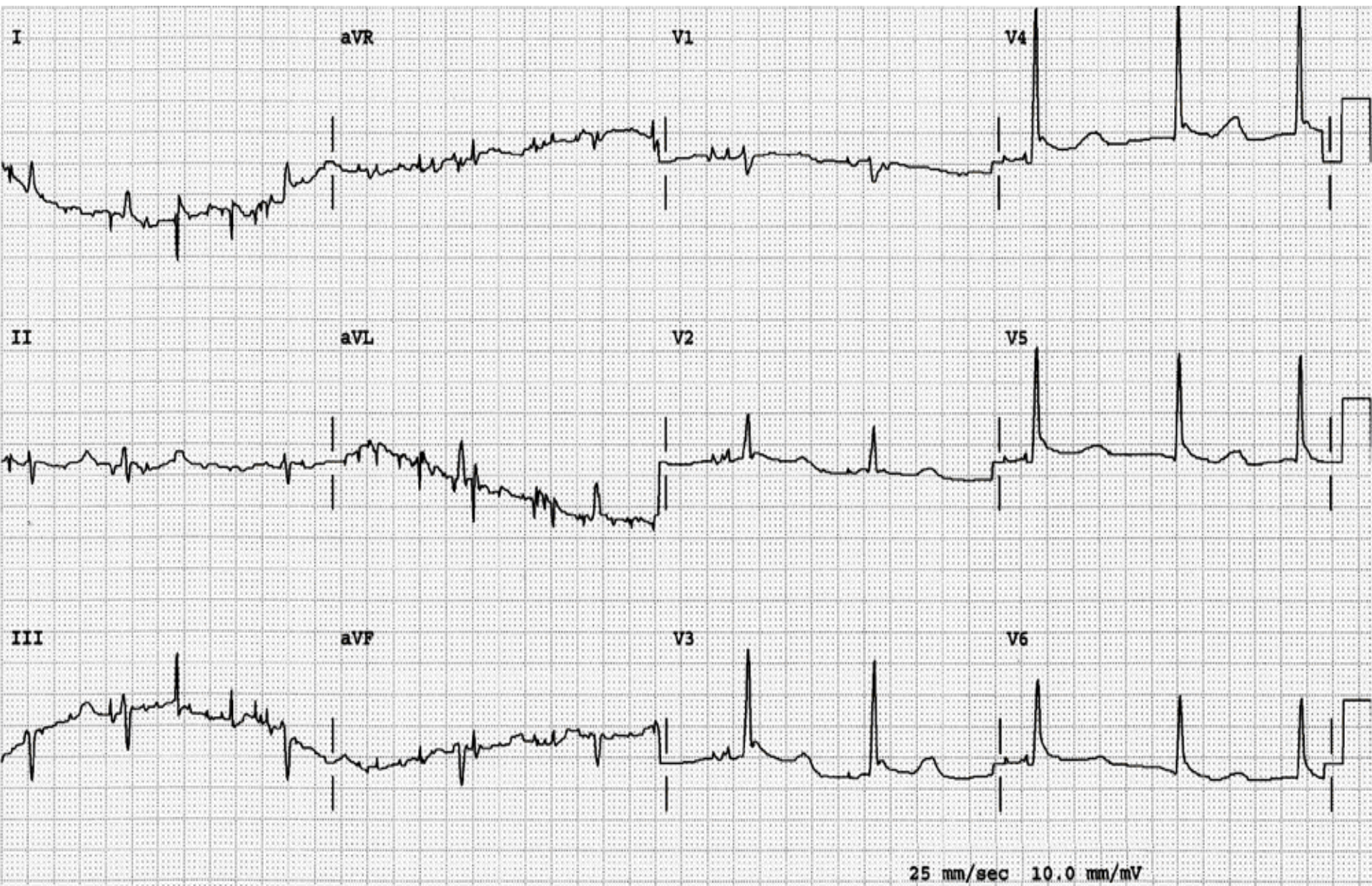
# 24 y/o for routine physical (Dextrocardia)

DIAGNOSIS: L SIDE LEADS





# 90 y/o unresponsive man (Hypothermia)





ASSESSMENT	LOOK AT	LOOK FOR
<b>Context</b>	Patient, Chart	<ul style="list-style-type: none"> <li>Clinical condition</li> <li>Changes over time</li> </ul>
<b>Rhythm and Rate</b>	Rhythm Strip (Lead II)	<ul style="list-style-type: none"> <li>Arrhythmias</li> <li>Threats to perfusion</li> </ul>
<b>Ischemia/Infarction</b>	All Leads <ul style="list-style-type: none"> <li>V<sub>1</sub>–V<sub>4</sub> (anterior)</li> <li>V<sub>5</sub>–V<sub>6</sub>, aVL, I (lateral)</li> <li>II, III, aVF (inferior)</li> </ul>	<ul style="list-style-type: none"> <li>ST changes</li> <li>T wave changes</li> <li>Q waves</li> <li>Loss of R waves</li> </ul>
<b>Axis</b>	Leads I and aVF	<ul style="list-style-type: none"> <li>QRS upright in I and aVF (normal axis)</li> <li>QRS up in I, down in aVF (LAD)</li> <li>QRS down in I, up in aVF (RAD)</li> <li>QRS down in I and aVF (ERAD)</li> </ul>
<b>Chamber Enlargement</b>	Atrial Enlargement V <sub>1</sub> —	<i>Diphasic P:</i> <ul style="list-style-type: none"> <li>Initial deflection is larger (RAE)</li> <li>Terminal deflection is larger (LAE)</li> </ul>
	II—	<i>Unusual P Morphology:</i> <ul style="list-style-type: none"> <li>Tall, peaked P wave (RAE)</li> <li>Notched P wave (LAE)</li> </ul>
	Ventricular Enlargement V <sub>1</sub> —	<i>High-Amplitude QRS Complexes:</i> <ul style="list-style-type: none"> <li>R wave longer than S (RVE)</li> <li>Extremely deep S (LVE)</li> </ul>
	V <sub>6</sub> —	<ul style="list-style-type: none"> <li>S wave larger than R (RVE)</li> <li>Extremely tall R (LVE)</li> </ul>
<b>Intraventricular Conduction Defects</b>	V <sub>1</sub> —	<i>Wide QRS:</i> <ul style="list-style-type: none"> <li>Notched R wave (RBBB)</li> <li>Deep, slurred S wave (LBBB)</li> </ul>
	V <sub>6</sub> —	<ul style="list-style-type: none"> <li>Broad S wave (RBBB)</li> <li>Broad notched R wave (LBBB)</li> </ul>
<b>Miscellaneous Abnormalities</b>	All Leads	<ul style="list-style-type: none"> <li>Tall, peaked T waves</li> <li>Wide, flat P waves</li> <li>Widening of QRS</li> <li>Disappearing ST segment</li> <li>Merging QRS and T</li> </ul>
	• Hypokalemia	<ul style="list-style-type: none"> <li>Flat T waves</li> <li>Increasingly prominent U waves</li> </ul>
	• Hypercalcemia	<ul style="list-style-type: none"> <li>Prolonged QT interval (for rate)</li> </ul>
	• Hypocalcemia	<ul style="list-style-type: none"> <li>Short QT interval (for rate)</li> </ul>
	• Digitalis Toxicity	<ul style="list-style-type: none"> <li>Sloping ST segment</li> <li>ST depression</li> <li>Diphasic or inverted T wave</li> <li>Short QT interval</li> </ul>
	• Pericarditis	<ul style="list-style-type: none"> <li>Elevated, concave ST segment</li> <li>Diffuse ST changes not correlated to coronary vessels</li> </ul>

# Websites/Videos

- <http://www.youtube.com/watch?v=URBREKIUALk>
- <http://www.youtube.com/watch?v=YsiNFaDtTYo>
- <http://www.youtube.com/watch?v=MU71NqijEu0>
  
- <http://ecg.utah.edu/>
- <http://www.ecglibrary.com/ecghome.html>
- <http://lifeinthefastlane.com/resources/ecg-database/>
- <http://www.12leadecg.com/full/ecgindex.aspx>

**THANK YOU!!!**

**QUESTIONS?**