Advanced 12 Lead

Subtle and High Risk Signs on 12 Lead EKG

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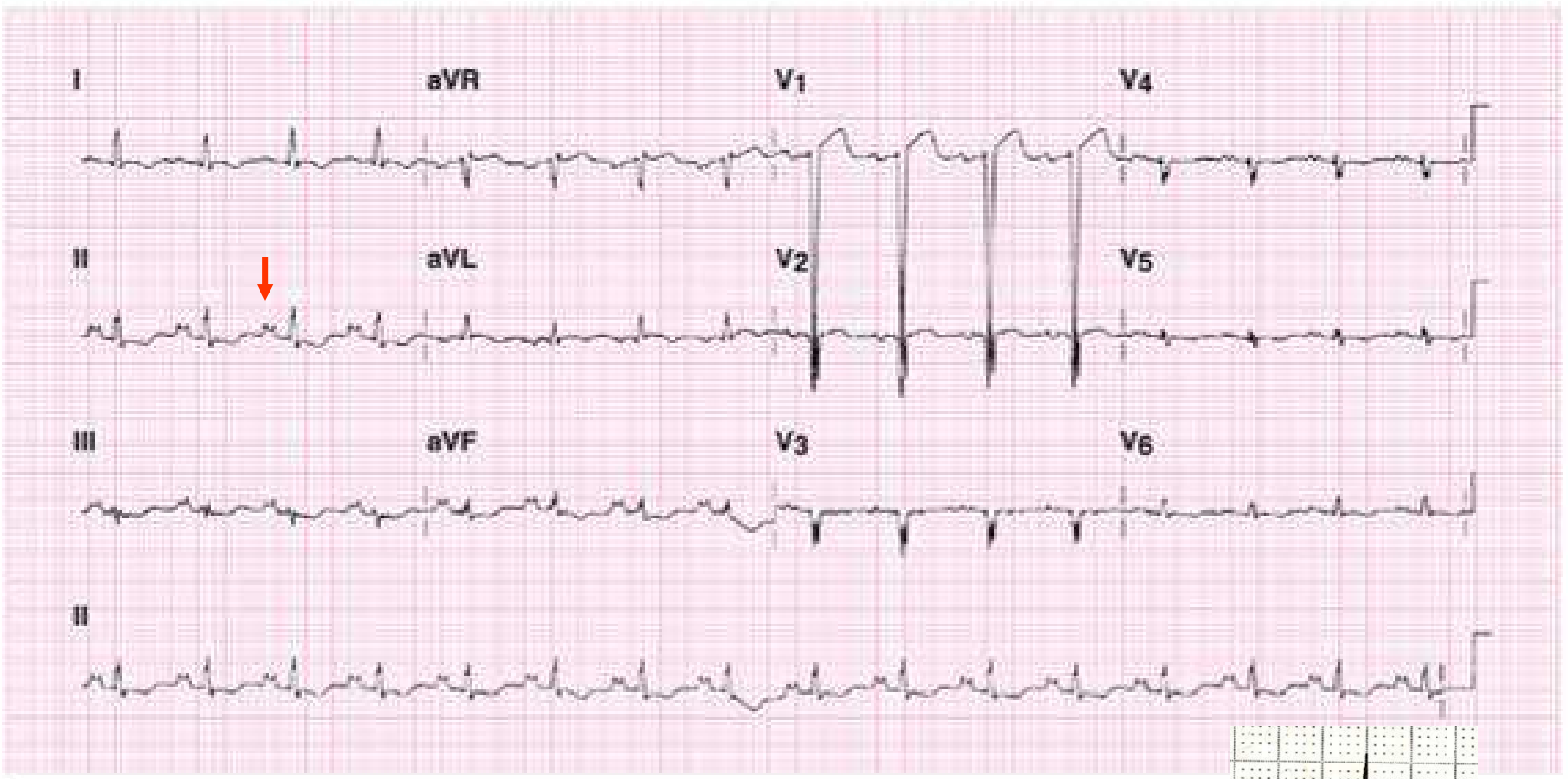
Acknowledgement

- Many ECGs from the Instructor's Toolkit to accompany:
- Garcia, T.B., & Holtz, N.E. (2001). *12 lead ECG: The art of interpretation*. Boston: Jones and Bartlett Publishers.

Hypertrophy

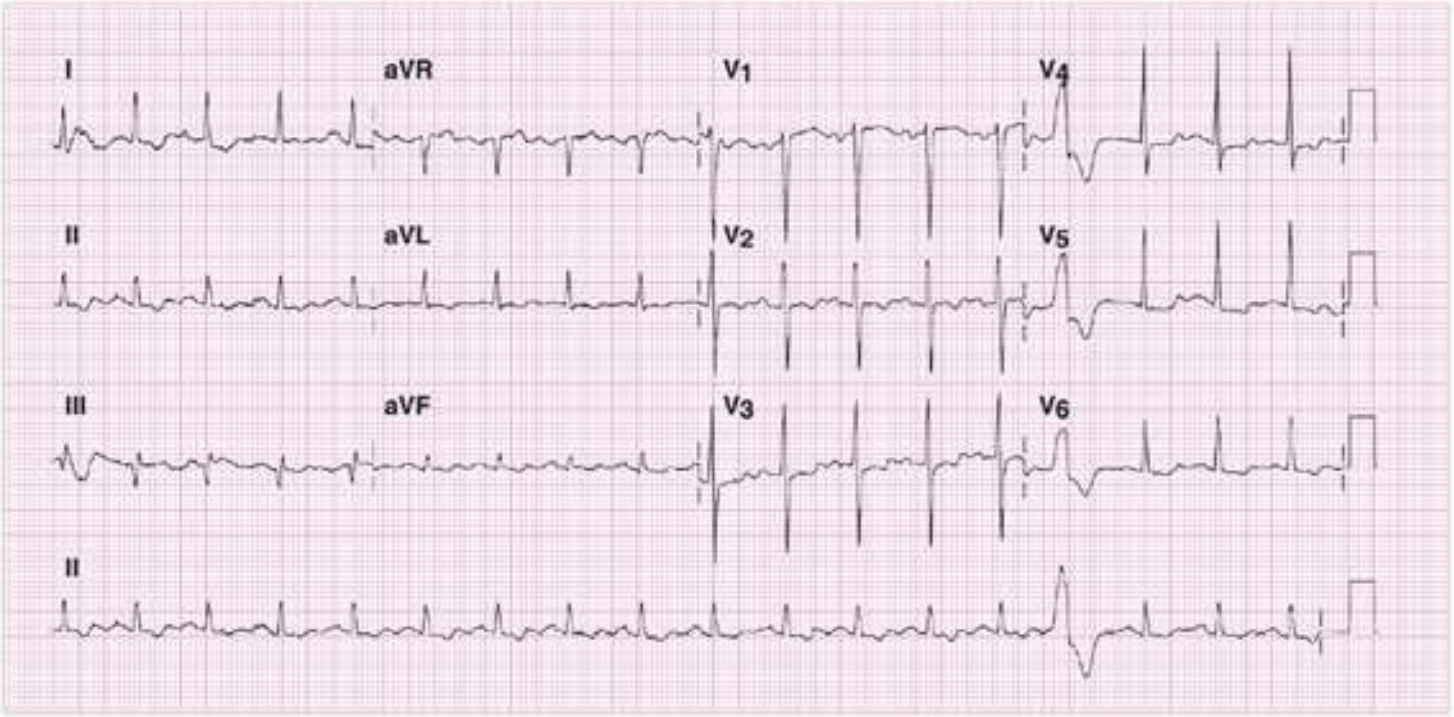
- Complexes larger because takes longer to get through atria or ventricles
- Atrial enlargement = Large p waves
- Ventricular enlargement = Tall R waves

ECG 9-5 P-mitrale



- Severe Left Atrial Enlargement
- Notched p wave > 0.12 second in limb leads
- Causes prolonged conduction times required to travel through enlarged LA
- Produces a double hump (camel hump)

ECG 9-7 P-mitrale

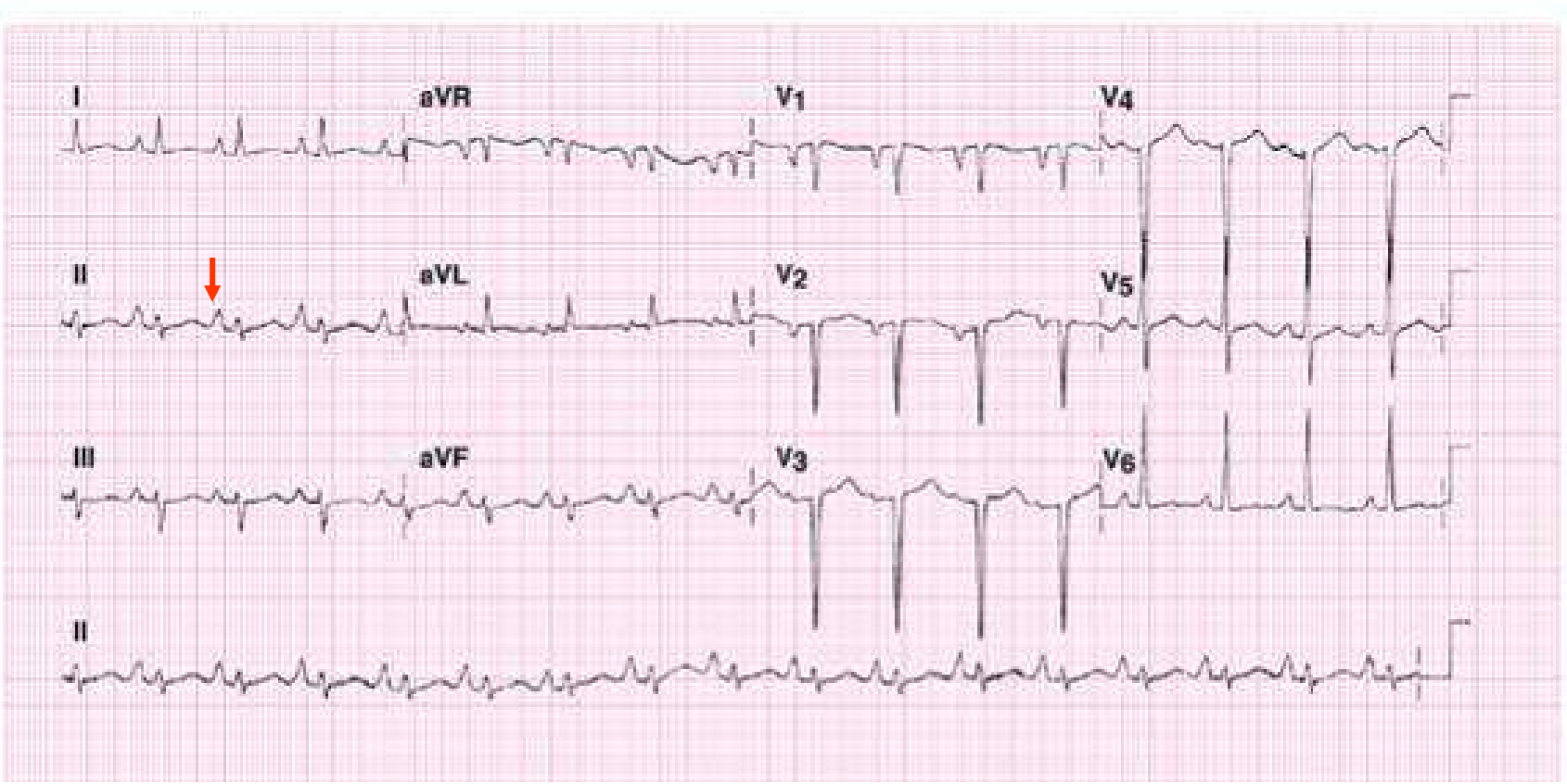


ECG 9-7 (Levels 2, 3)
P-mitrale

Clinical Implications
LA enlargement

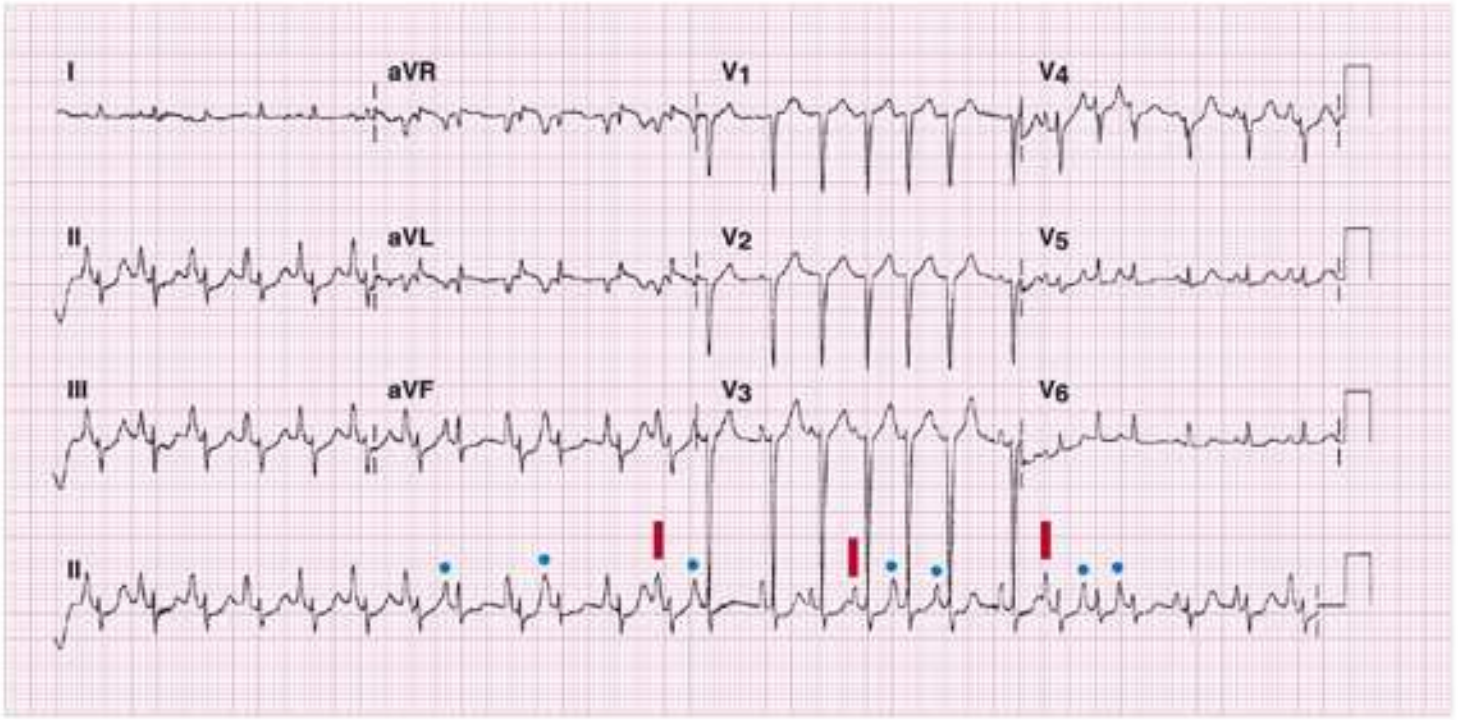
- Causes
  - Mitral stenosis
  - LV Dysfunction
  - Obstructive sleep apnea
  - Obesity
- Risk for new onset atrial fibrillation
- Risk for stroke

ECG 9-9 P-pulmonale



- Right Atrial Enlargement
- Peaked P wave taller than 2.5 mm in the limb leads
- P-pulmonale = teepee

ECG 9-8 P-pulmonale

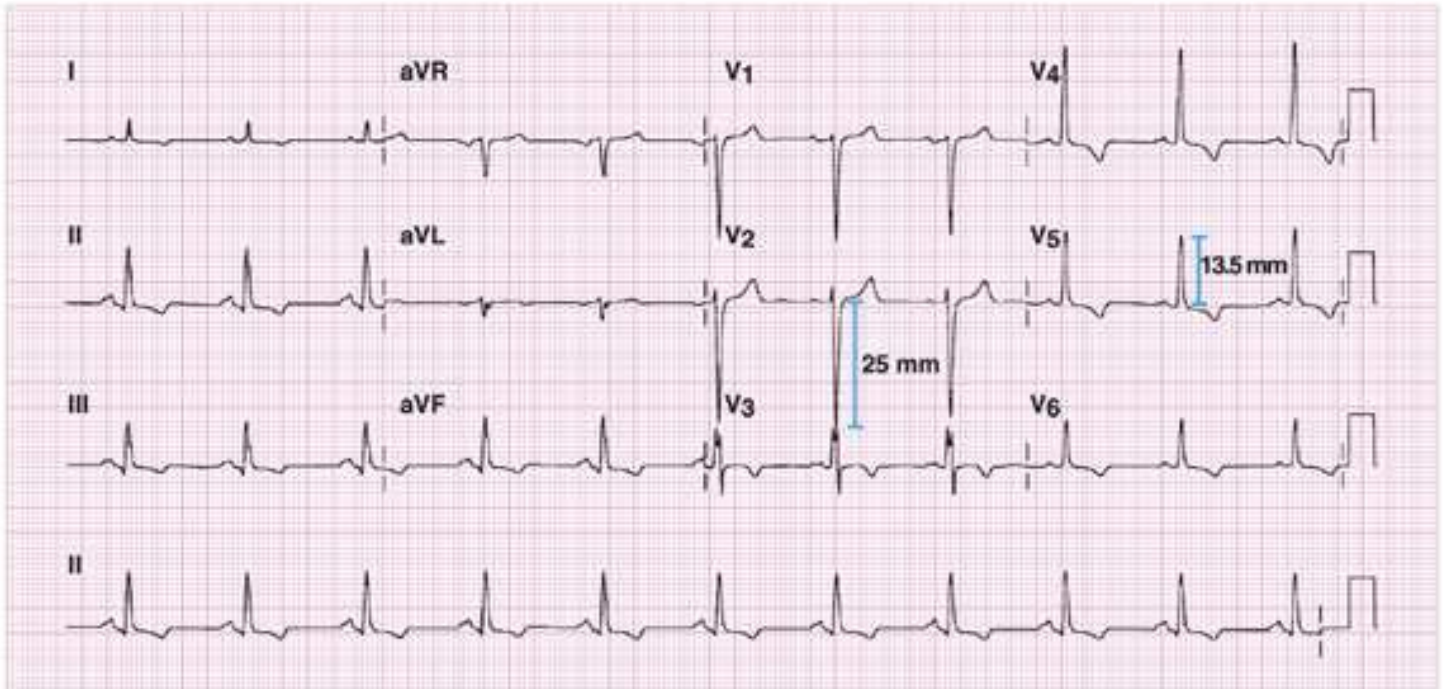


ECG 9-8 (Level 2)
P-pulmonale

Clinical Implications
RA enlargement

- Causes
  - Increased right ventricular pressures
    - Pulmonary arterial hypertension
    - Cor pulmonale
    - COPD
  - Valvular disease
    - Tricuspid regurgitation.
    - Tricuspid stenosis
  - Atrial septal defect (ASD)
  - Right Ventricular Failure

ECG 11-4 Left Ventricular Hypertrophy



- S in V1 or V2 + R in V5 or V6 ≥ 35 mm.

Or

- Any precordial lead is ≥ 45 mm
- The R wave in AVL is ≥ 11mm
- The R wave in Lead I is ≥ 12 mm
- The R wave in lead AVF is ≥ 20 mm

Identifying Left Ventricular Hypertrophy, Step by Step

Here's how to measure the distances needed to determine LVH. First, measure the deepest S wave in either V_1 or V_2 (distance A in Figure 11-9). Now transfer your calipers, without changing the distance, down to the top of the tallest R wave in either V_5 or V_6 (Figure 11-10, A). Next, without moving the top pin, move the bottom pin to the baseline of the R wave that you are measuring (Figure 11-10, B). That distance is the sum of the depth of the S wave in either V_1 or V_2, and the height of the R wave in V_5 or V_6. If it is greater than or equal to 35 mm, you've identified LVH. Easy, isn't it? Figure 11-11 illustrates the other LVH criteria.

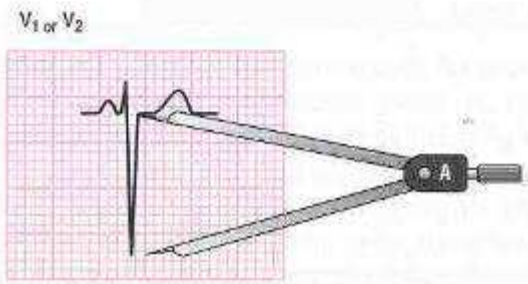


Figure 11-9: Measuring for LVH.

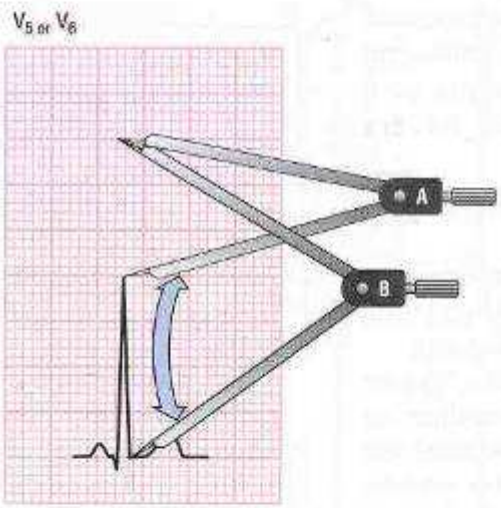


Figure 11-10: LVH criterion #1.

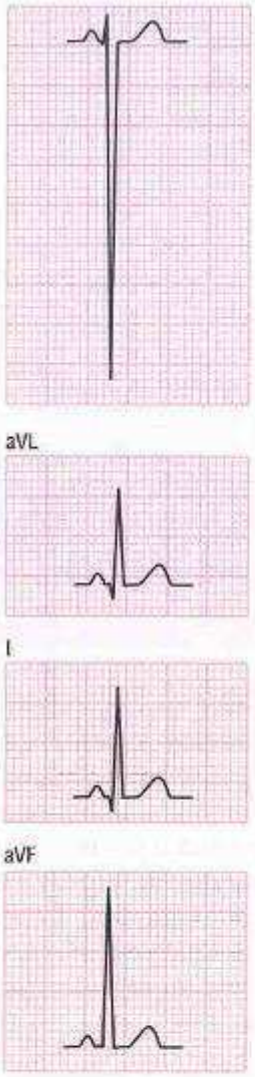
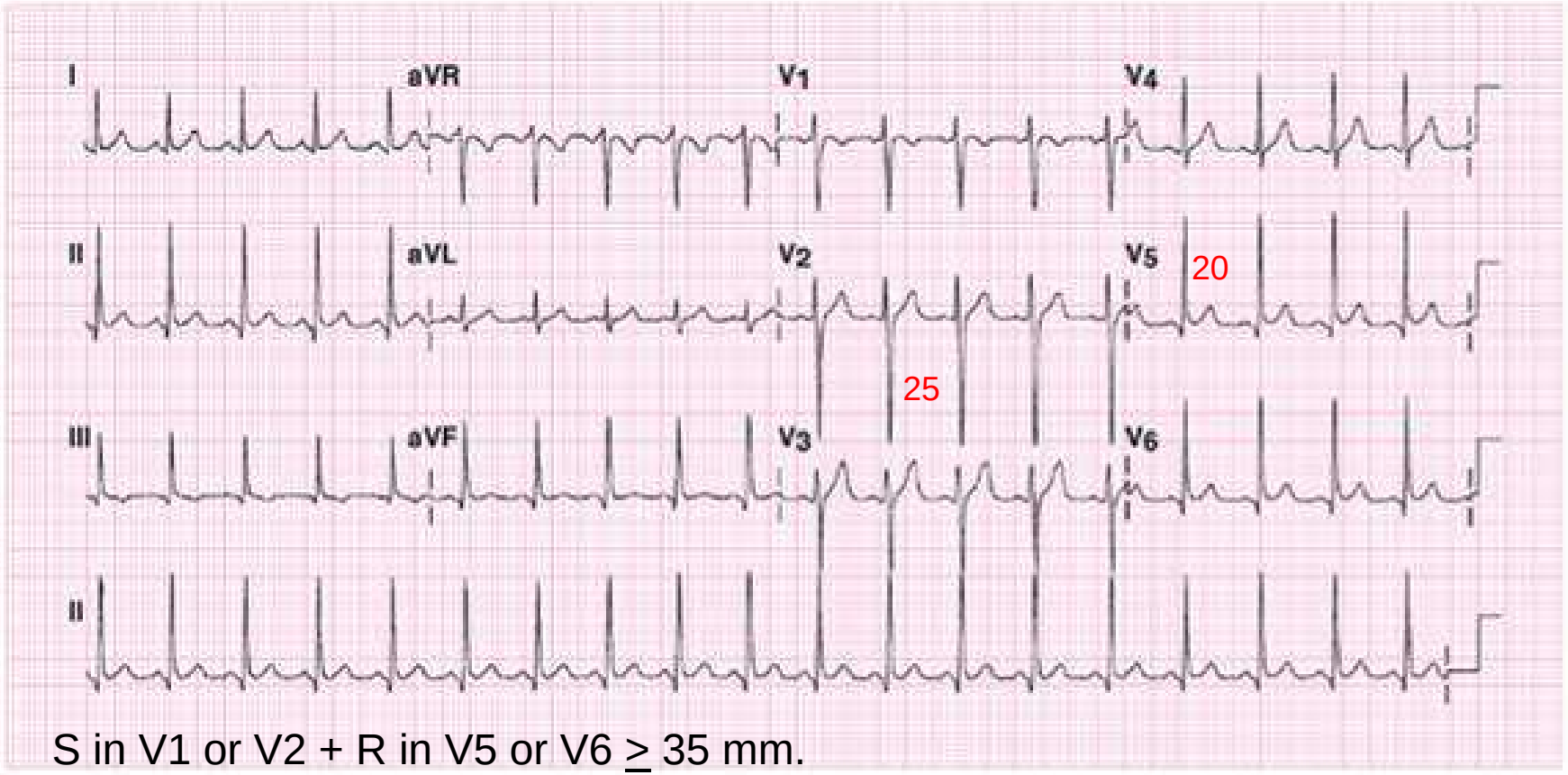


Figure 11-11: LVH criteria #2-5. Use your calipers!

ECG 11-5 Left Ventricular Hypertrophy



S in V1 or V2 + R in V5 or V6 ≥ 35 mm.

Or

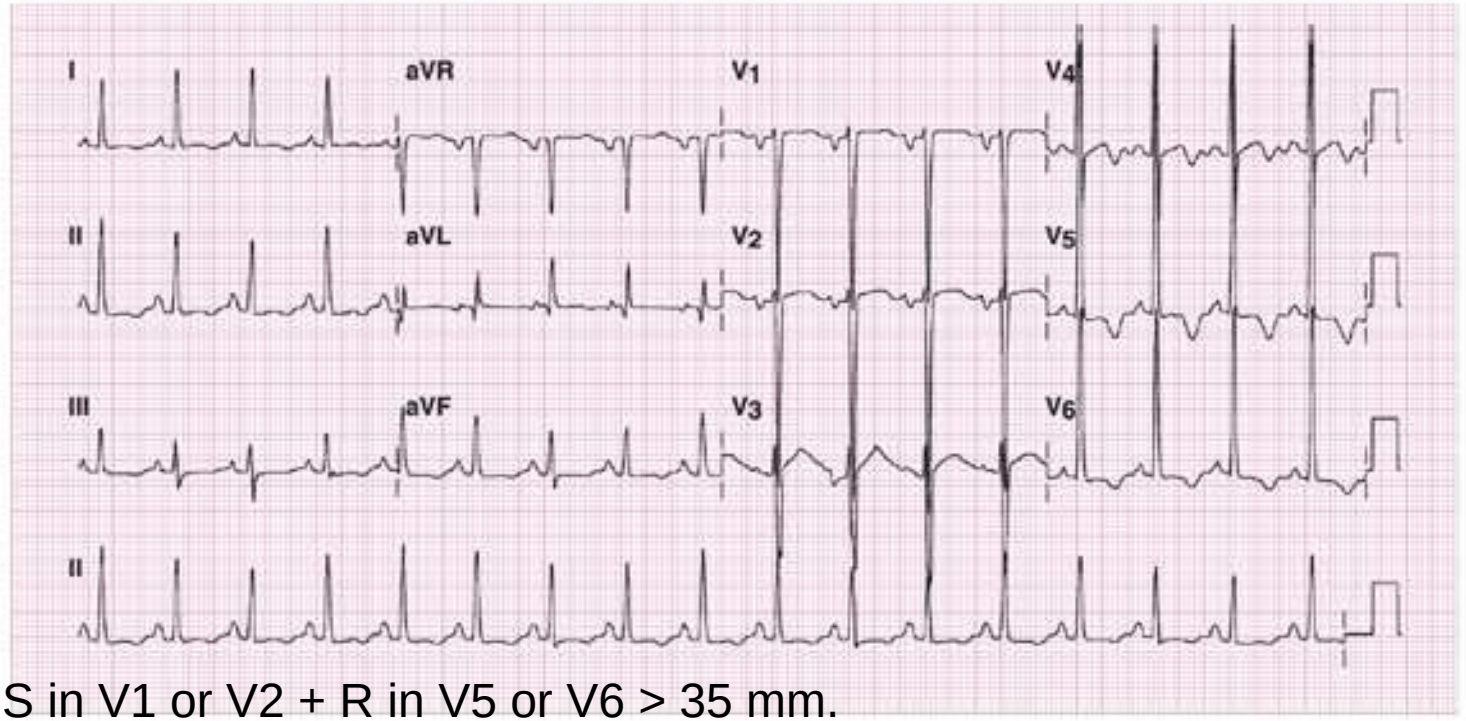
Any precordial lead is ≥ 45 mm

The R wave in AVL is ≥ 11mm

The R wave in Lead I is ≥ 12 mm

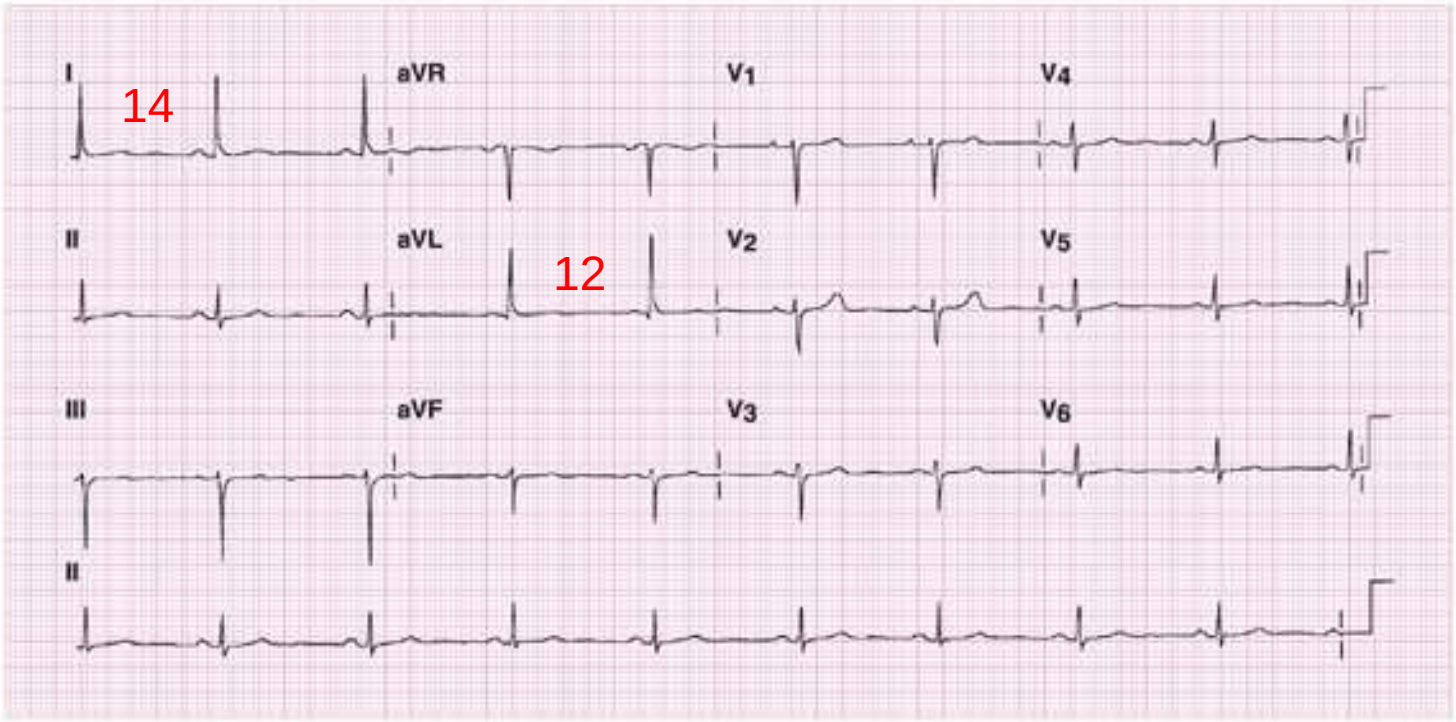
The R wave in lead AVF is ≥ 20 mm

ECG 11-11 Left Ventricular Hypertrophy



S in V1 or V2 + R in V5 or V6 ≥ 35 mm.
Or
Any precordial lead is ≥ 45 mm
The R wave in AVL is ≥ 11mm
The R wave in Lead I is ≥ 12 mm
The R wave in lead AVF is ≥ 20 mm

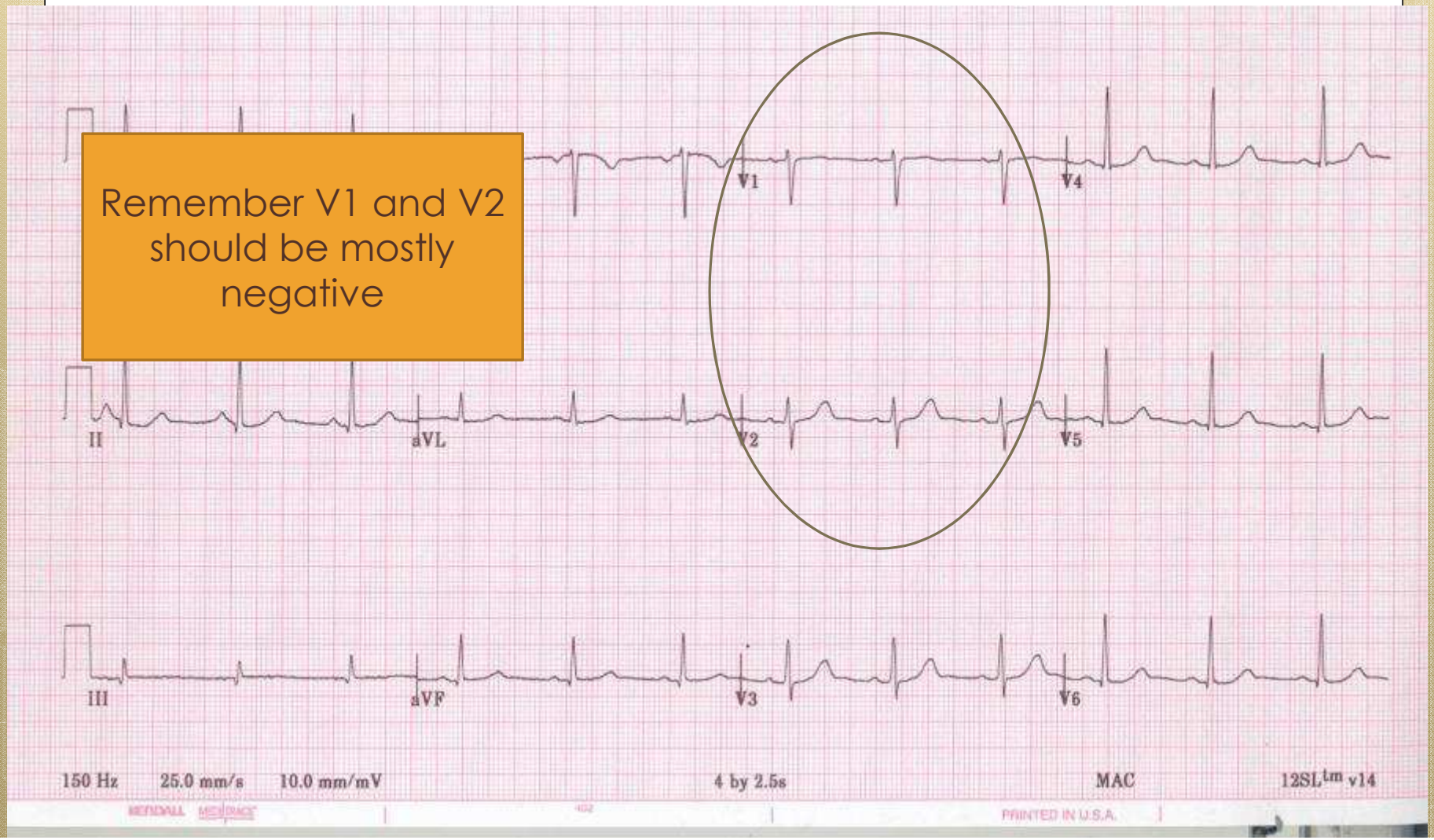
ECG 11-7 Left Ventricular Hypertrophy



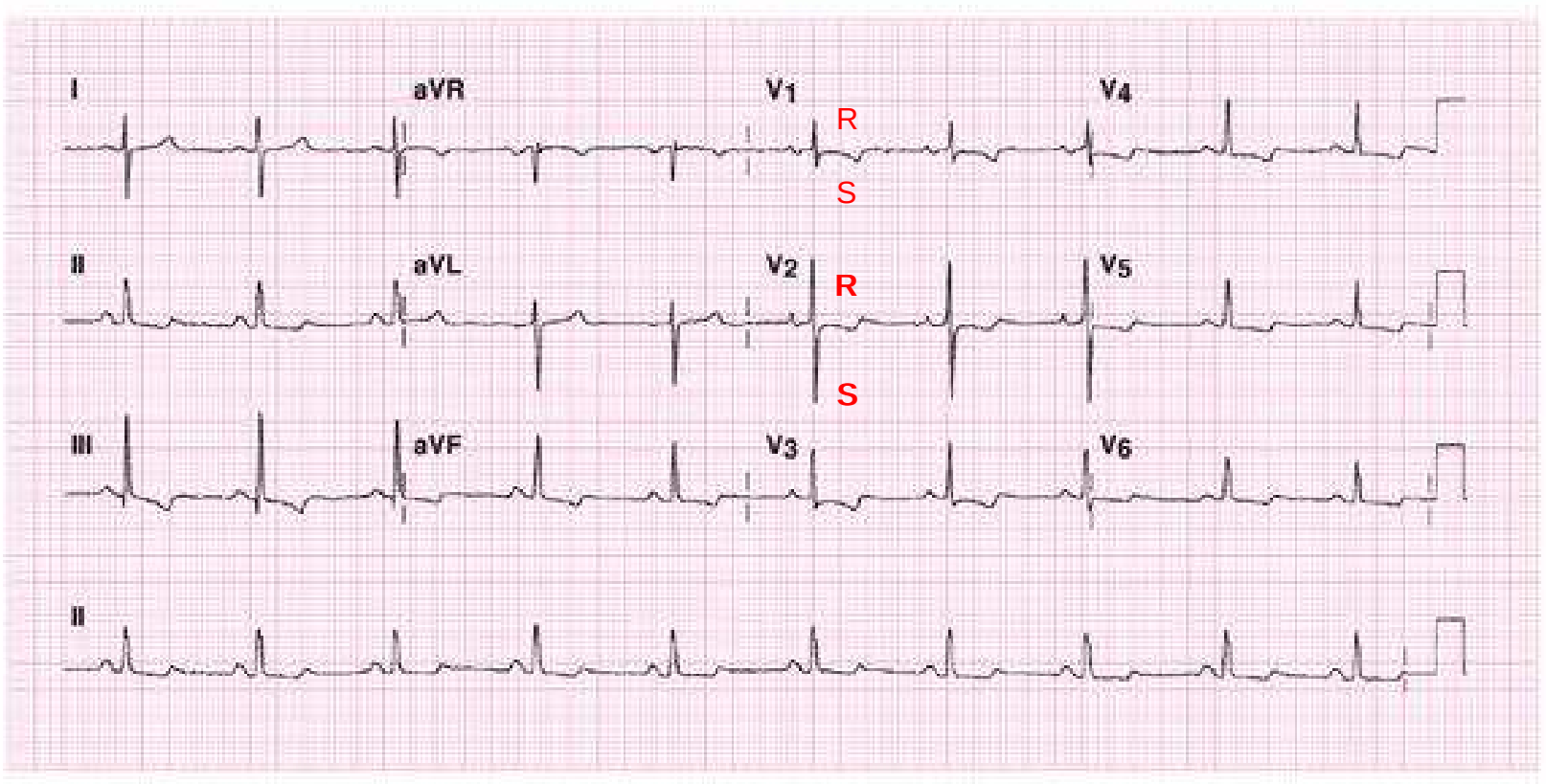
S in V1 or V2 + R in V5 or V6 ≥ 35 mm.
Or
Any precordial lead is ≥ 45 mm
The R wave in AVL is ≥ 11mm
The R wave in Lead I is ≥ 12 mm
The R wave in lead AVF is ≥ 20 mm

12 Lead EKG 101

Learn the *Normal* so you can detect the abnormal

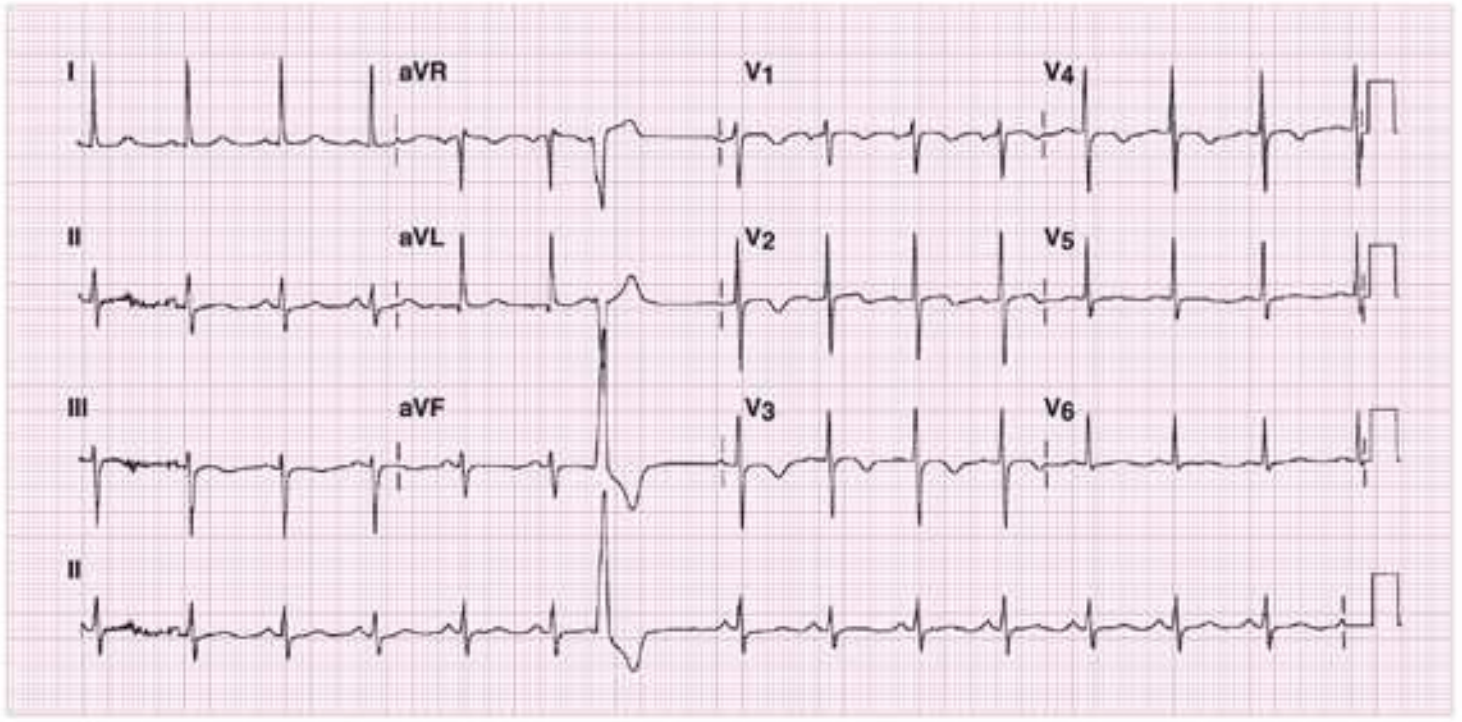


ECG 11-12 Right Ventricular Hypertrophy



- R:S ratio is ≥ 1 in leads V1 and/or V2
- R is bigger than S

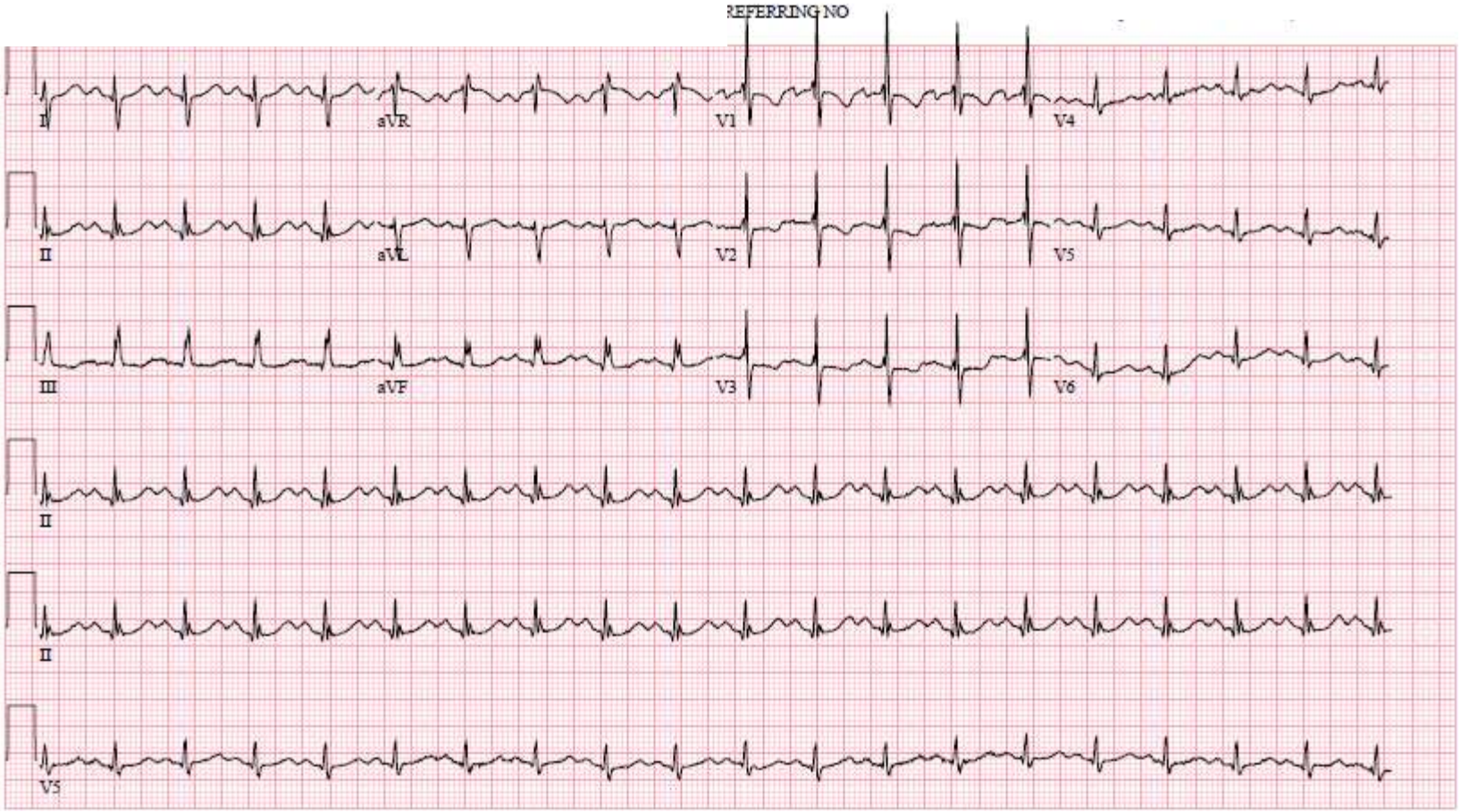
ECG 11-13 Right Ventricular Hypertrophy



R:S ratio is $\geq$ 1 in leads V1 and/or V2
R is bigger than S

Practice EKG #1

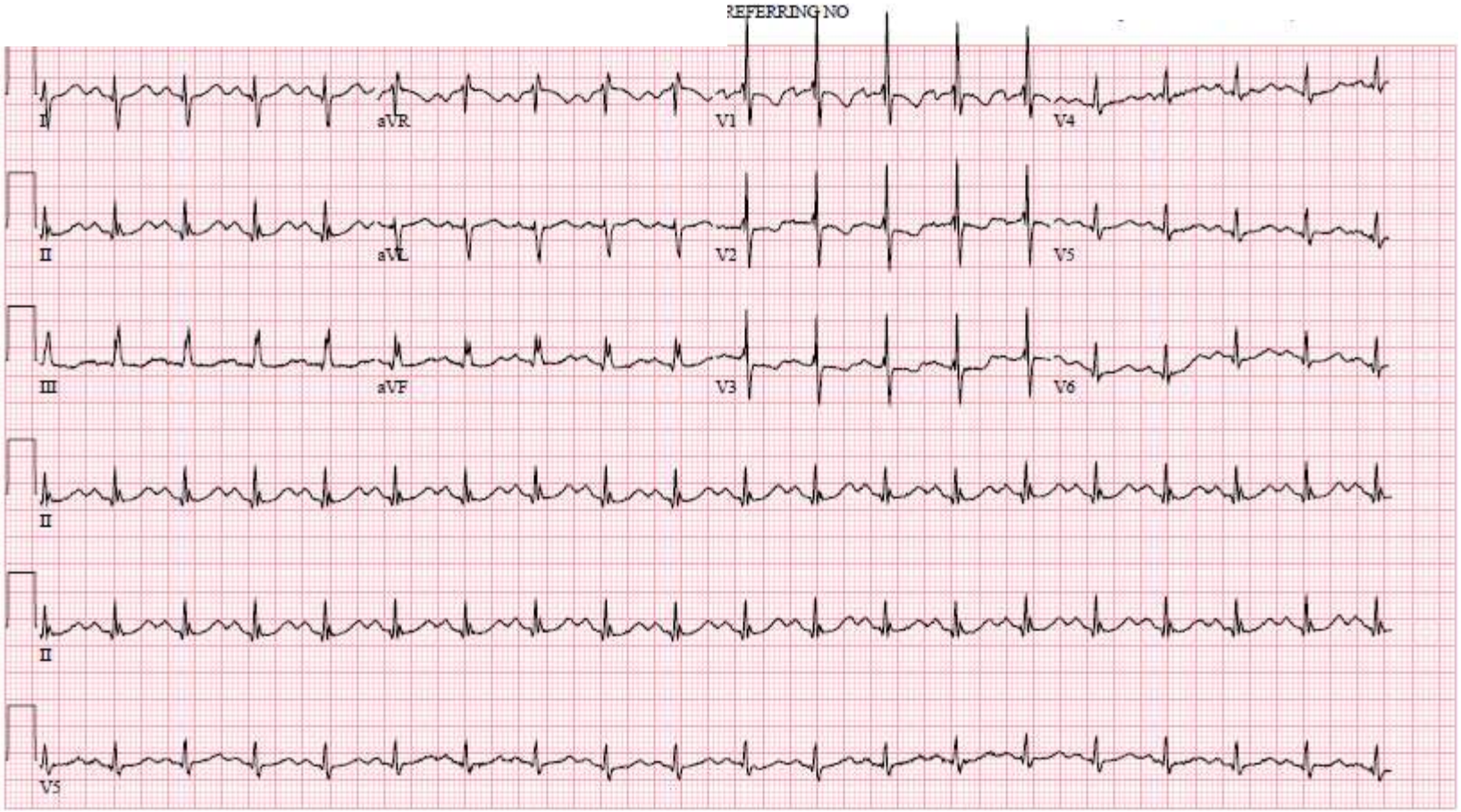
Vent. rate	116	BPM
PR interval	164	ms
QRS duration	98	ms
QT/QTc	336/467	ms
P-R-T axes	35 108	23



HX of Pulmonary Hypertension & spontaneous pneumothorax

Practice EKG #1 -- Answer

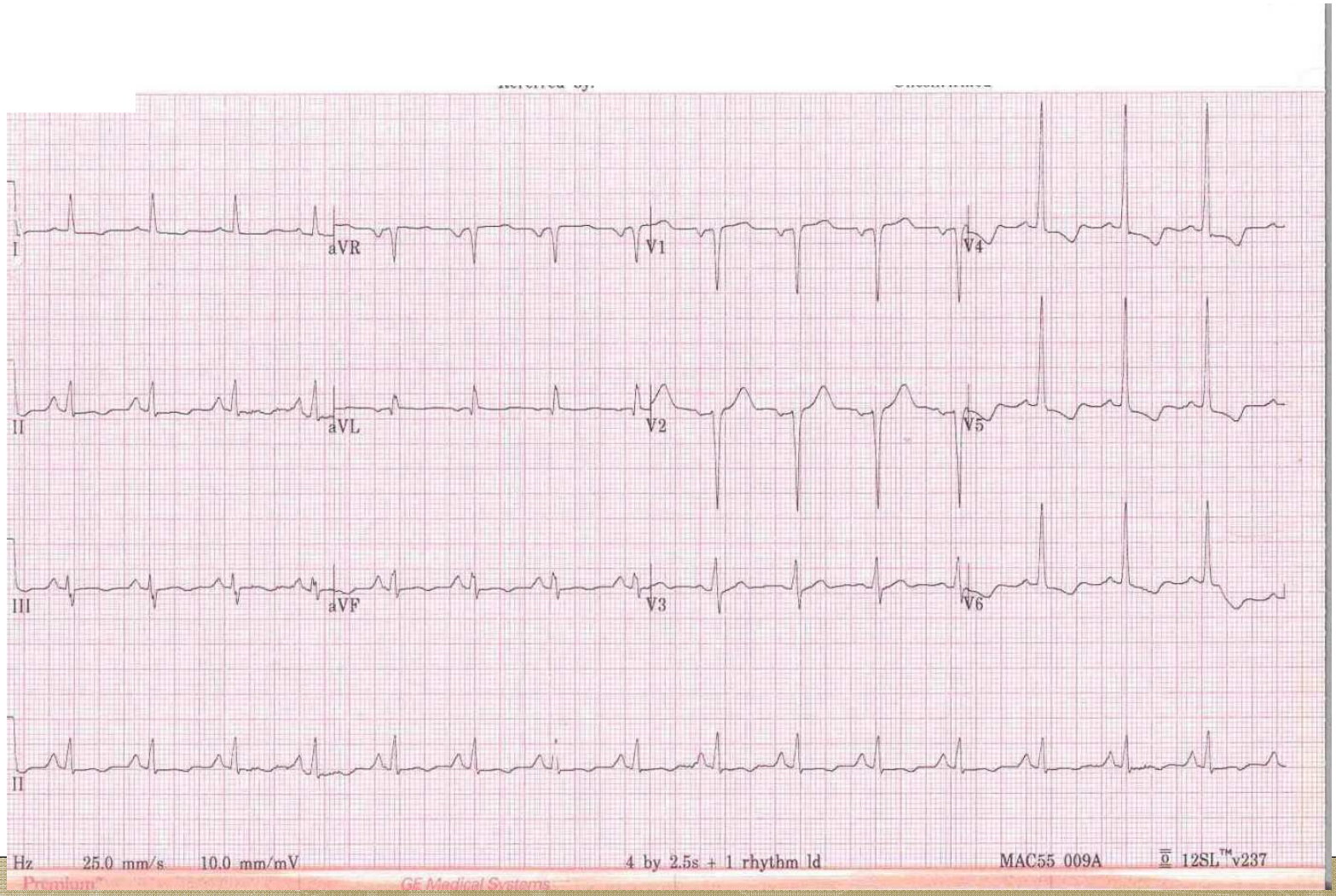
Vent. rate	116	BPM	Sinus tachycardia
PR interval	164	ms	Right ventricular hypertrophy with repolarization abnormality
QRS duration	98	ms	Abnormal ECG
QT/QTc	336/467	ms	When compared with ECG of 09-DEC-2009 05:50,
P-R-T axes	35 108	23	No significant change was found



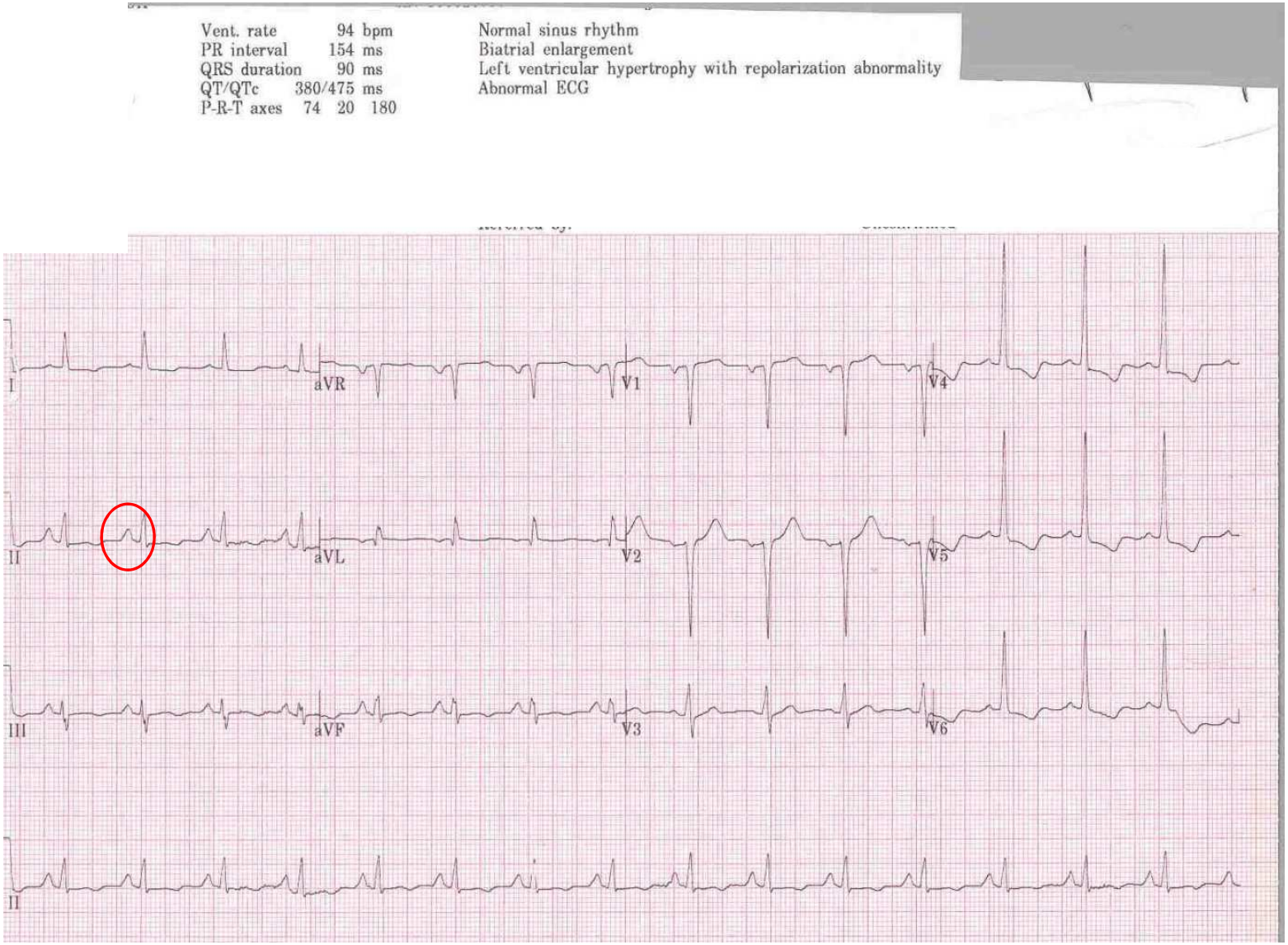
HX of Pulmonary Hypertension & spontaneous pneumothorax

Practice EKG #2

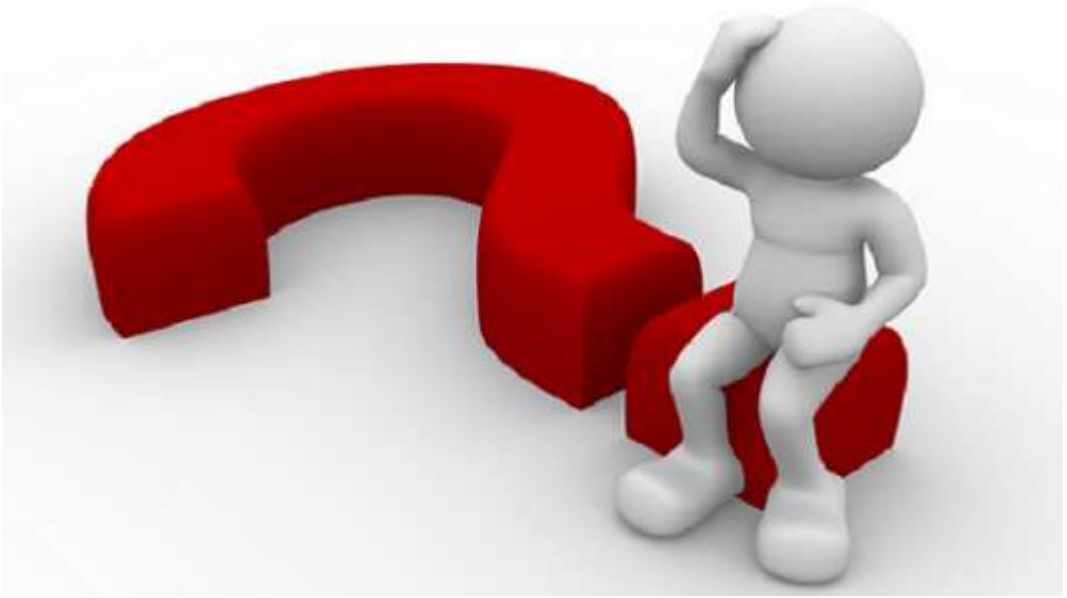
Vent. rate	94 bpm
PR interval	154 ms
QRS duration	90 ms
QT/QTc	380/475 ms
P-R-T axes	74 20 180



Practice EKG #2 Answer



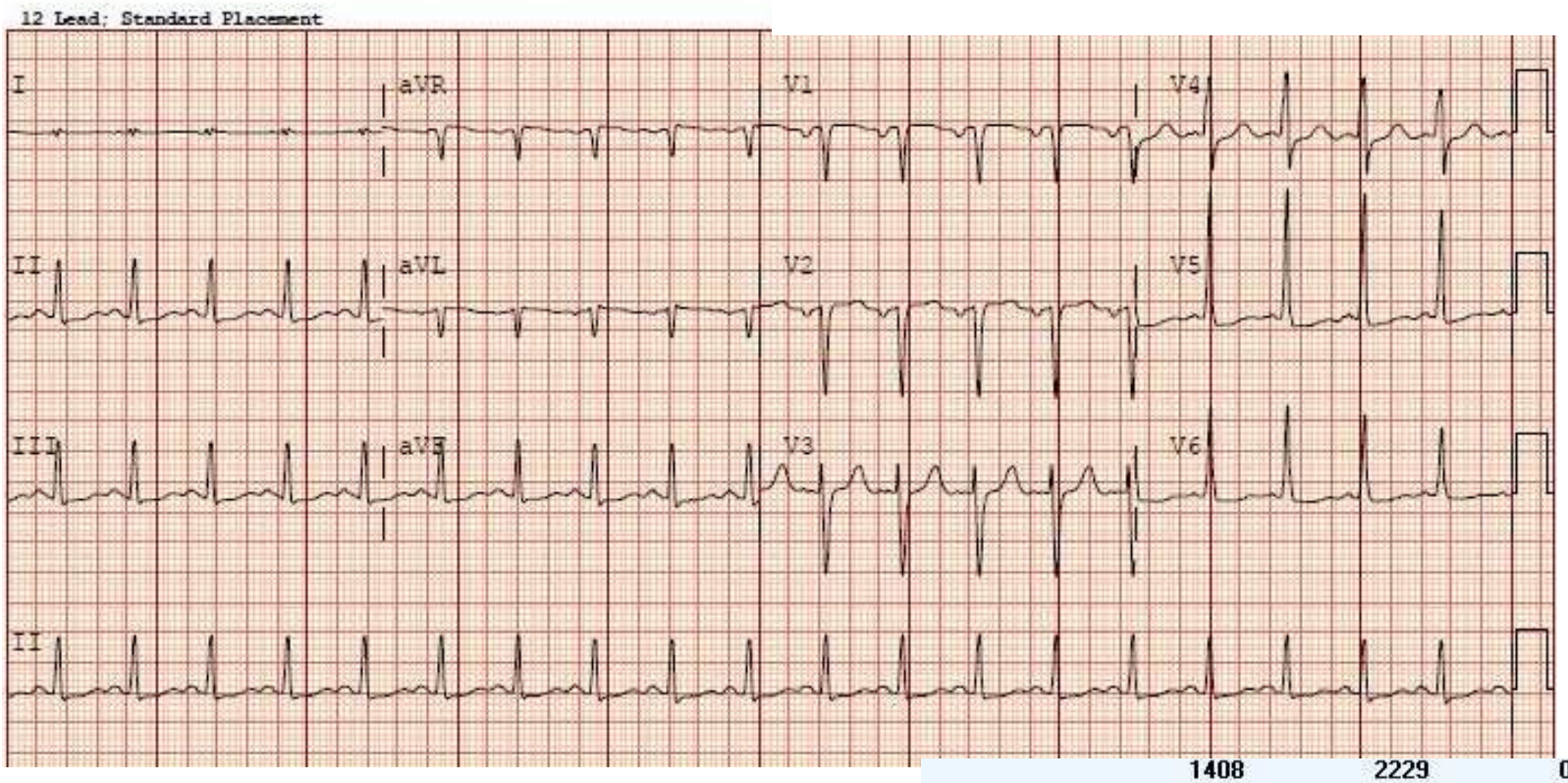
Would you be concerned about these ECGs?



Patient presents with Atypical Chest Pain

HR	117
PR	141
QRSD	95
QT	337
QTc	471

-- AXIS --	
P	90
QRS	87
T	242



	1408	2229	0617
CARDIAC PROFILE			
Troponin I	0.049 *	0.030 *	0.024 *
Pro-BNP	3,948 *		
LDH Total	375		

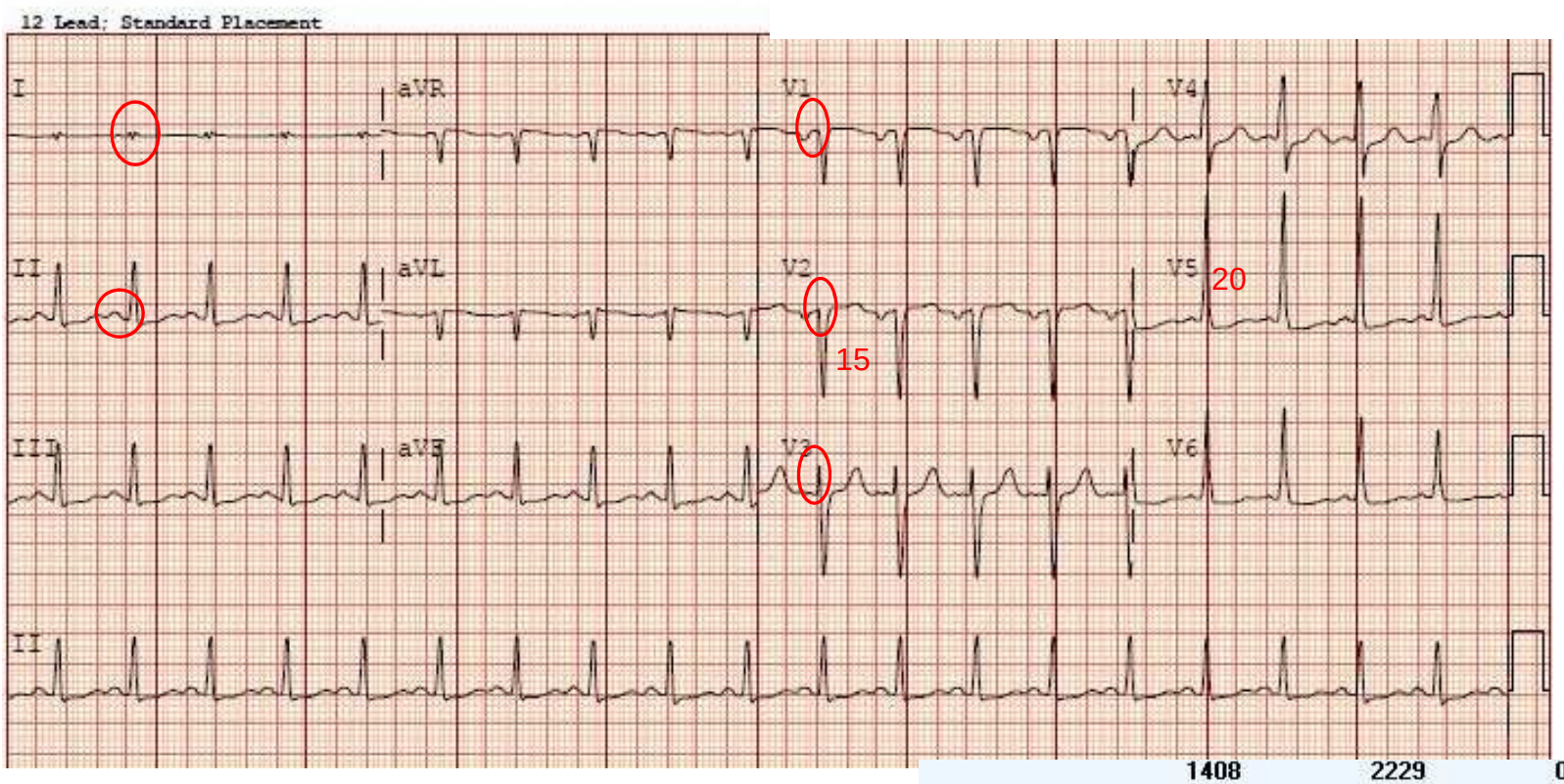
Patient presents with Atypical Chest Pain

HR	117	. Sinus tachycardia
		. Left atrial enlargement
PR	141	. LVH with secondary repolarization abnormality
QRSD	95	. No previous ECG available for comparison
QT	337	
QTc	471	

-- AXIS --

P	90
QRS	87
T	242

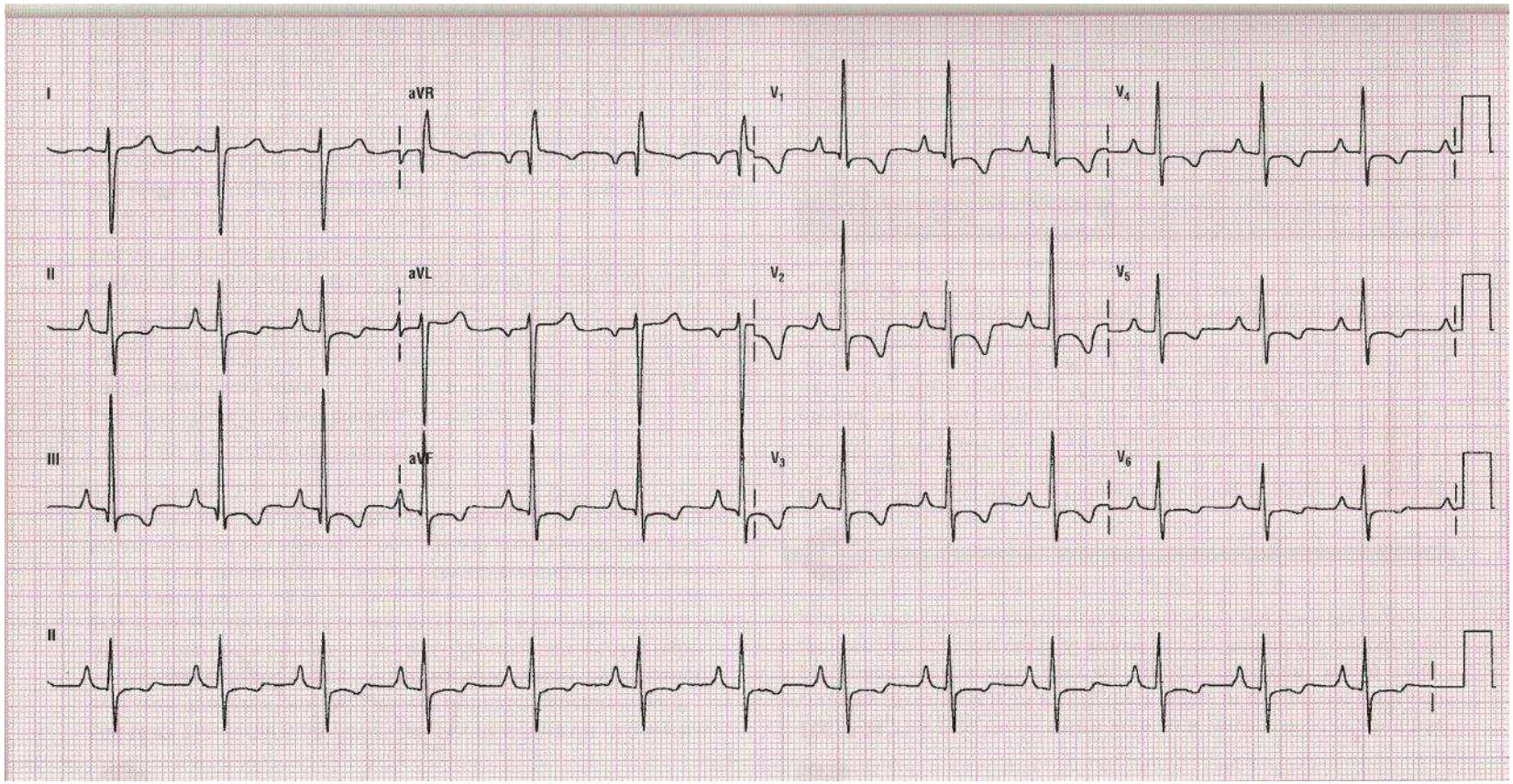
- ABNORMAL ECG -



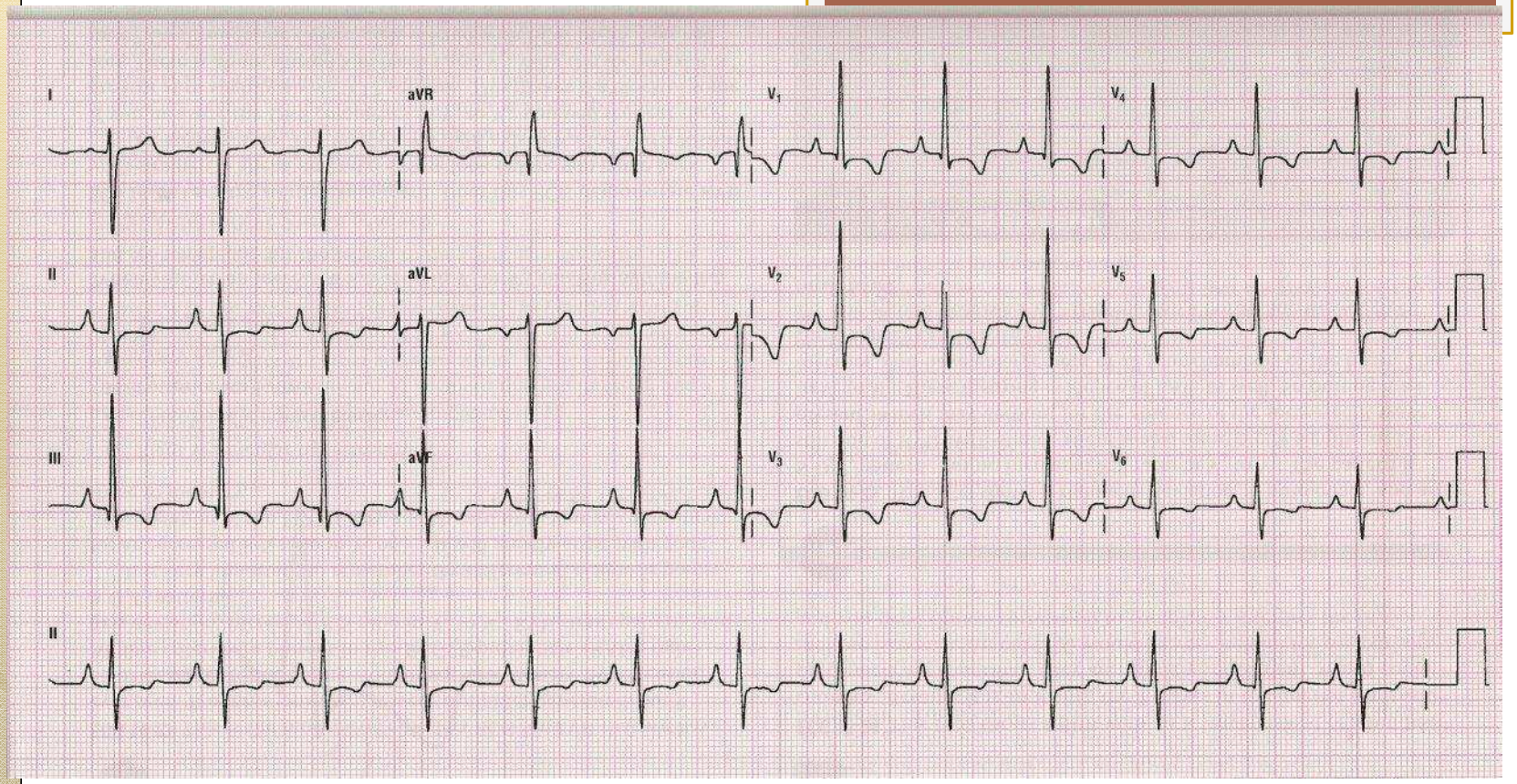
	1408	2229	0617
CARDIAC PROFILE			
Troponin I	0.049 *	0.030 *	0.024 *
Pro-BNP	3,948 *		
LDH Total	375		

Echocardiogram

- LVEF 19%
- Severely decreased RV systolic function
- Mild biatrial enlargement
- Moderate mitral regurgitation
- Mild tricuspid regurgitation
- Mild to moderate pulmonary hypertension



PH

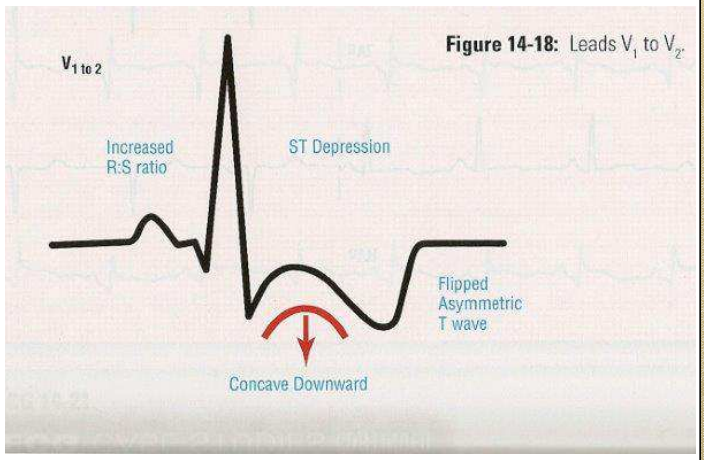


- Pulmonary Hypertension
  - P –Pulmonale (RAE)
  - Right axis deviation
  - Increased R:S ratio in V1 to V2
  - RVH strain pattern
  - S1, Q3, T3 pattern

PH

Right Ventricular Strain Pattern

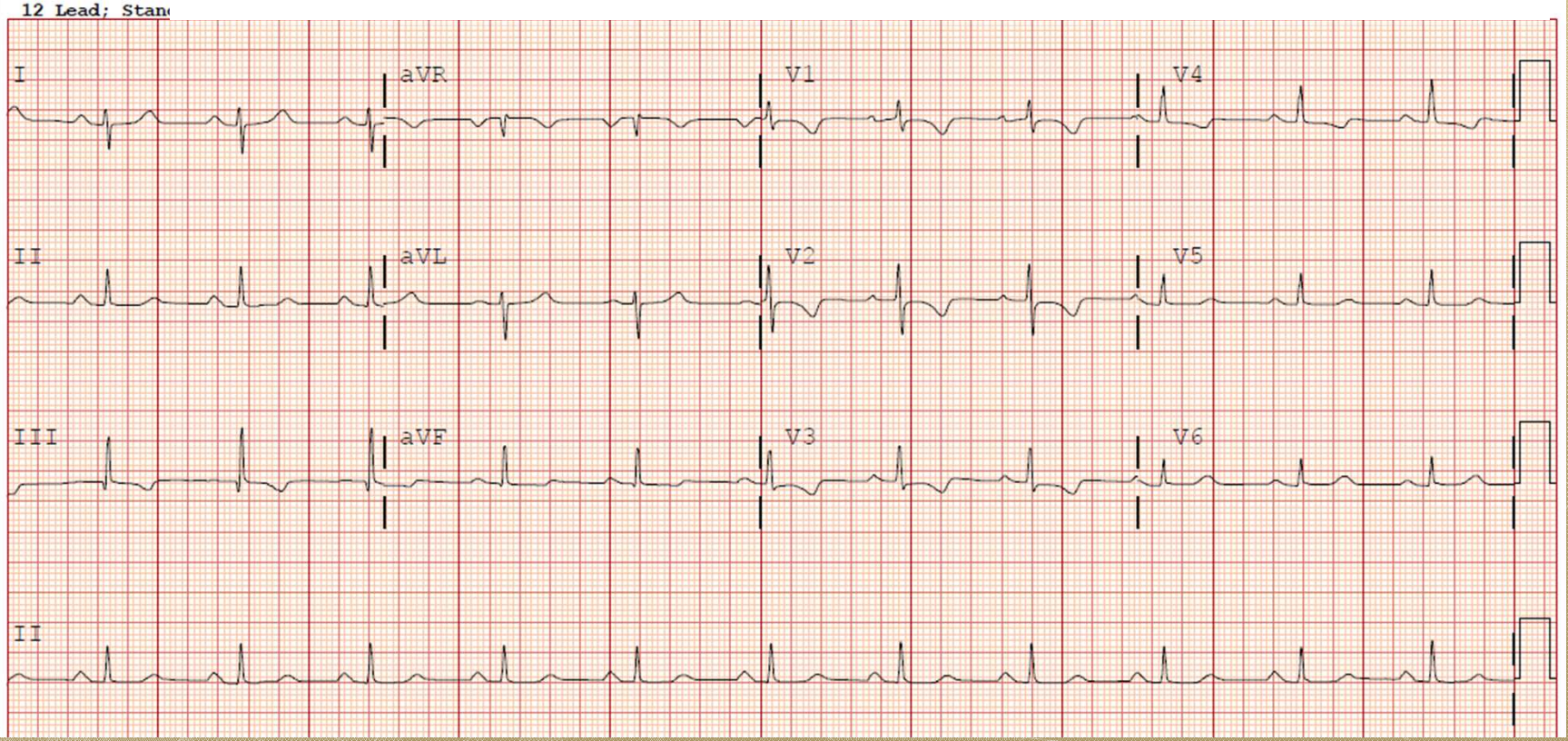
- Increased R:S ratio (RVH)
- Concave downward ST segment that is depressed
- Flipped symmetrical T wave



Pulmonary Hypertension

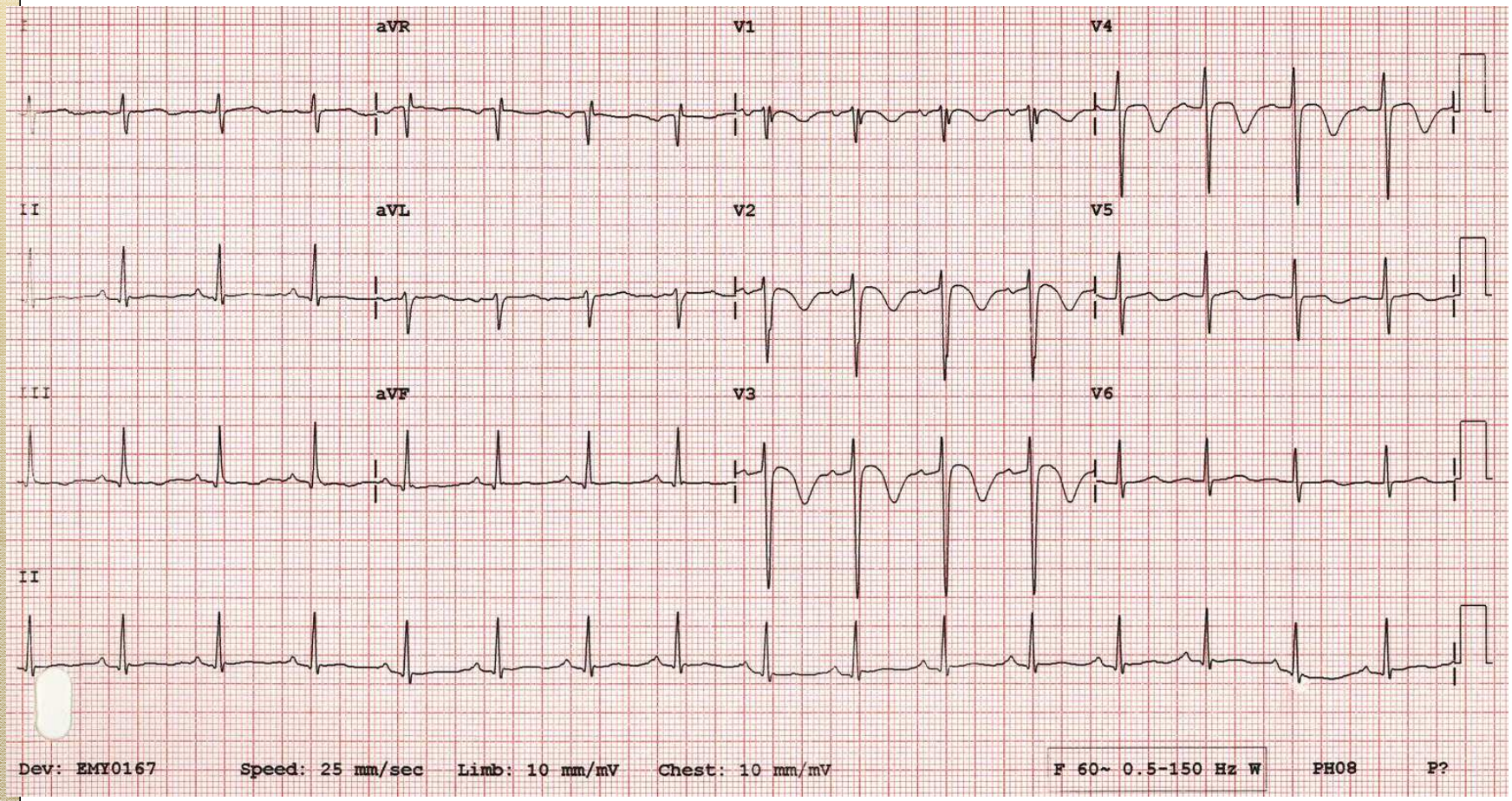
HR	68
PR	196
QRSD	72
QT	398
QTc	424
-- AXIS --	
P	36
QRS	90
T	-12

12 Lead; Stan



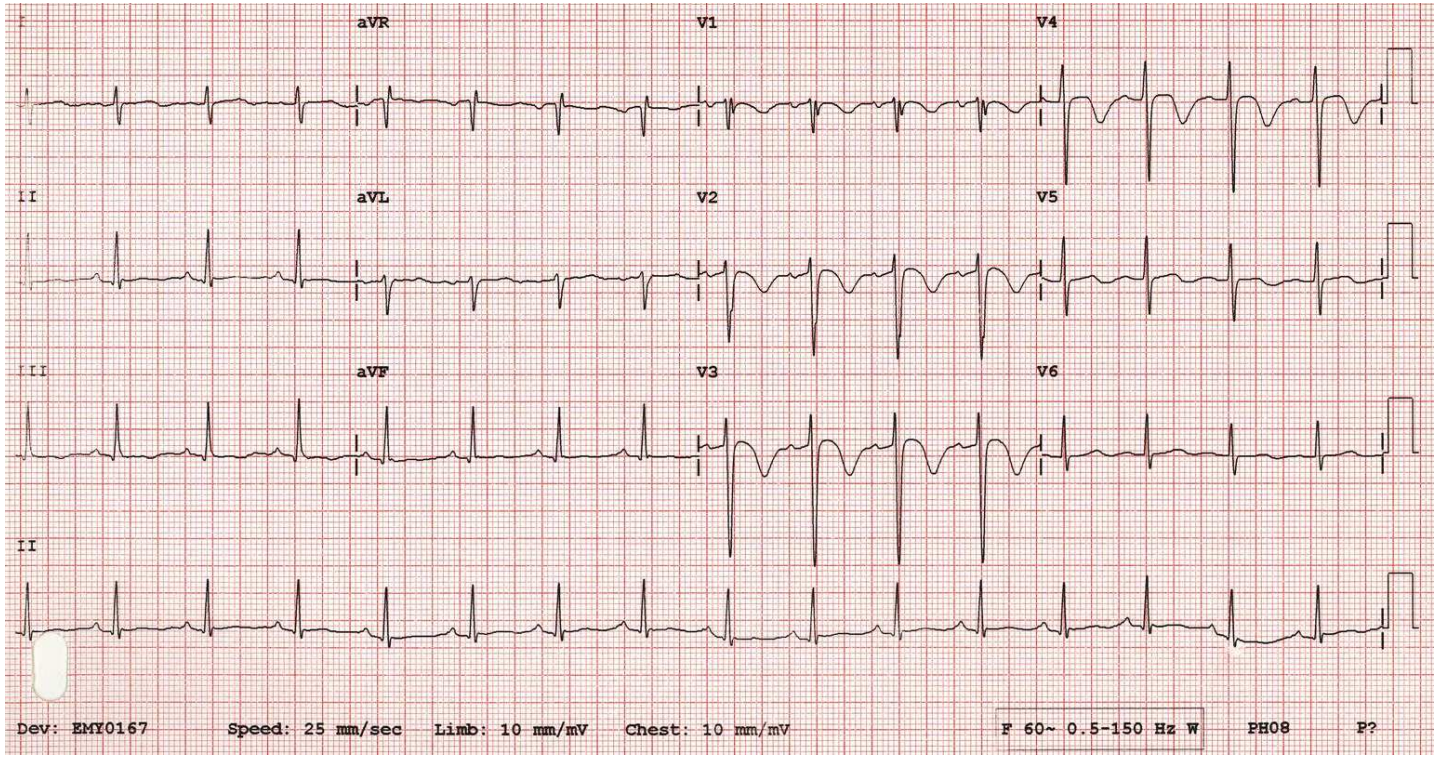
Warning signs – won't do well in surgery

- RBBB and RVH → think pulmonary hypertension
- Peaked p waves → think atrial enlargement
- Inverted t waves → think right ventricular strain


I
aVR
V1
V4
II
aVL
V2
V5
III
aVF
V3
V6
II
Dev: EMY0167
Speed: 25 mm/sec
Limb: 10 mm/mV
Chest: 10 mm/mV
F 60~ 0.5-150 Hz W
PH08
P?

W

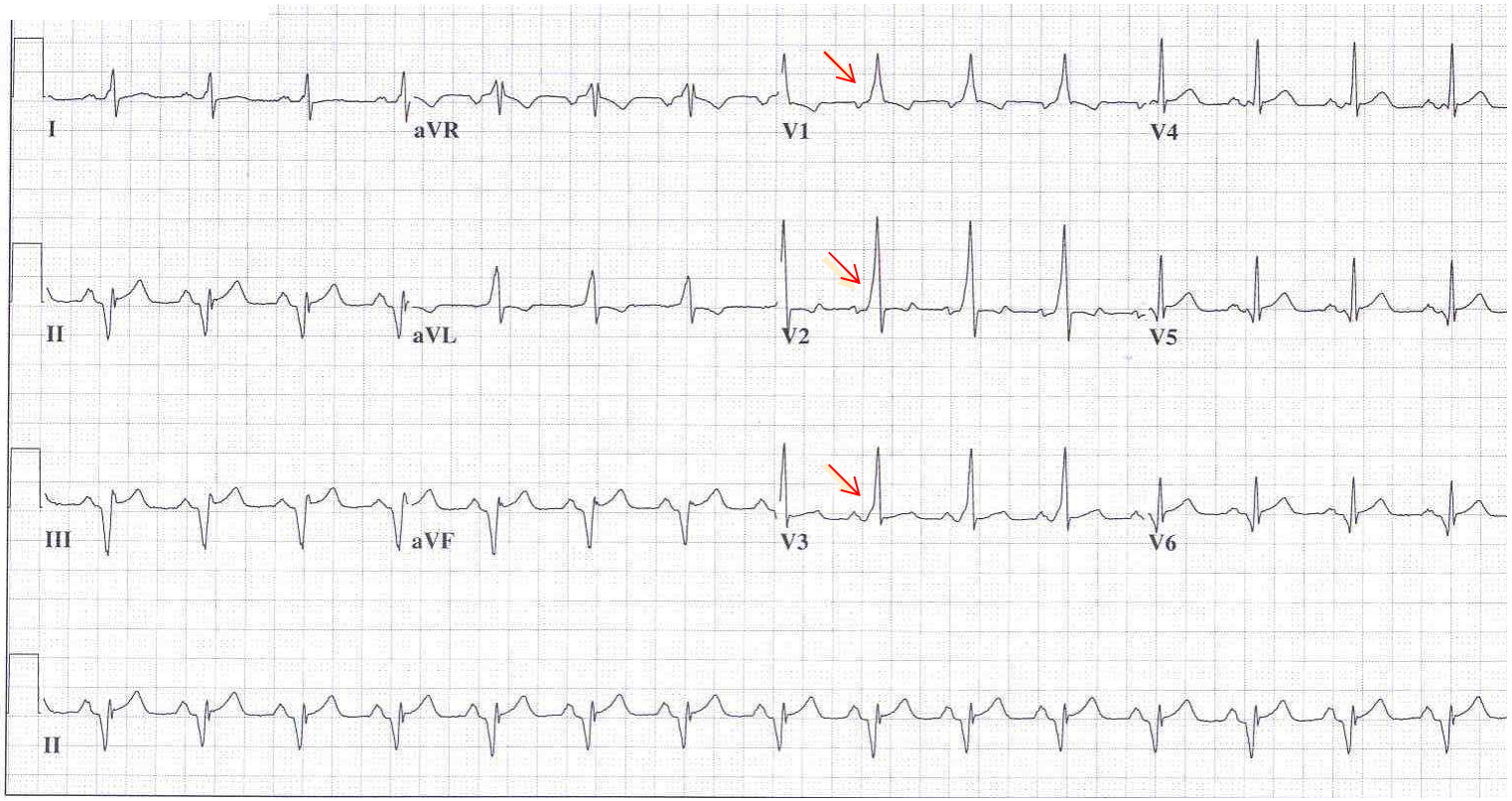
Wellens' Syndrome



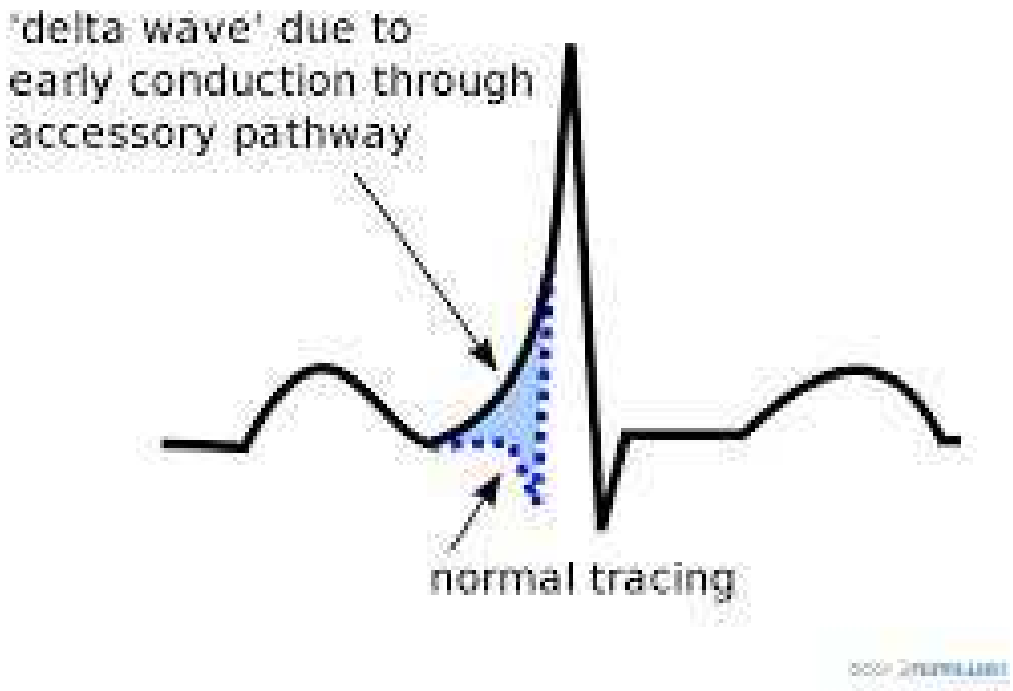
- Characterized by symmetrical, often deep (>2 mm), *T wave inversions* in the anterior precordial leads
- Warning of critical stenosis of LAD

W

Vent. rate	92	BPM
PR interval	122	ms
QRS duration	118	ms
QT/QTc	364/450	ms
P–R–T axes	64 –67	78

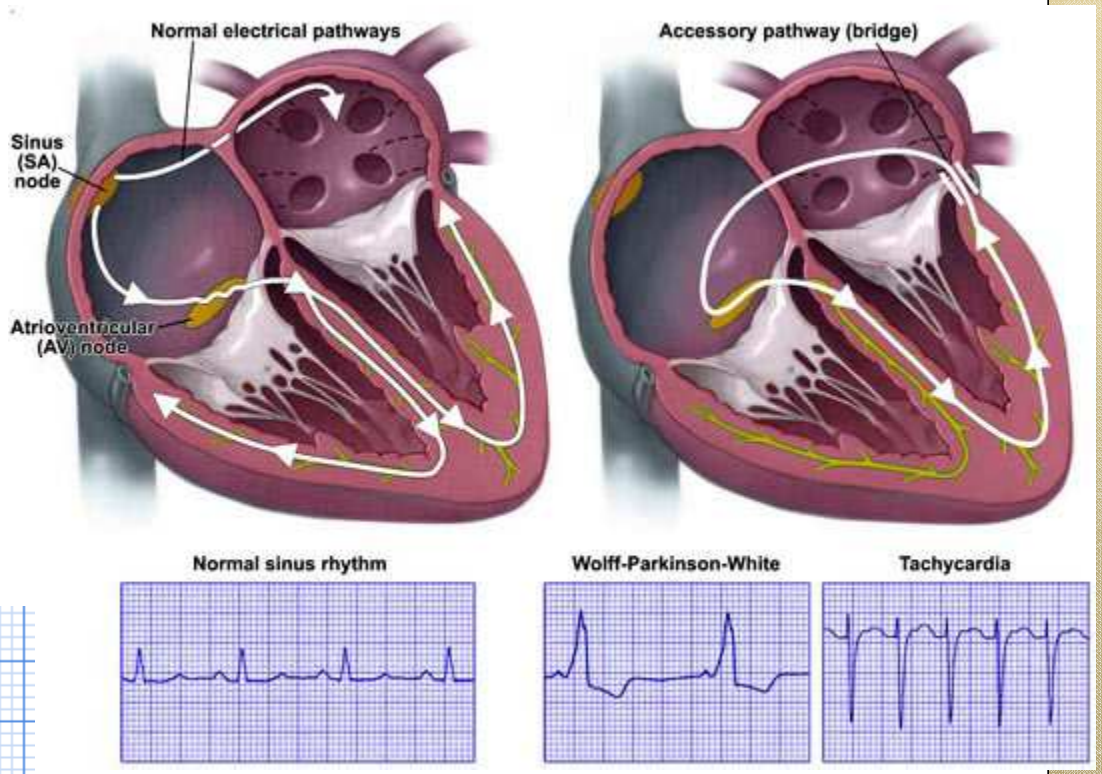


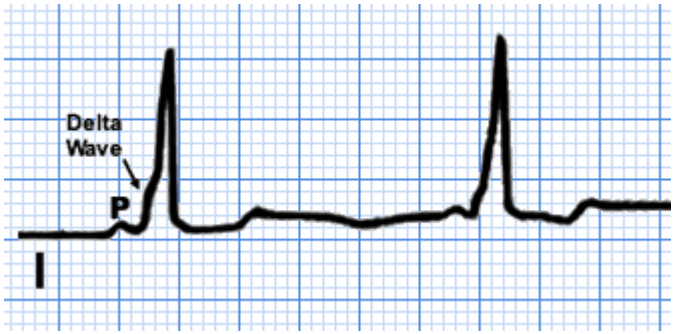
Wolff-Parkinson-White Syndrome



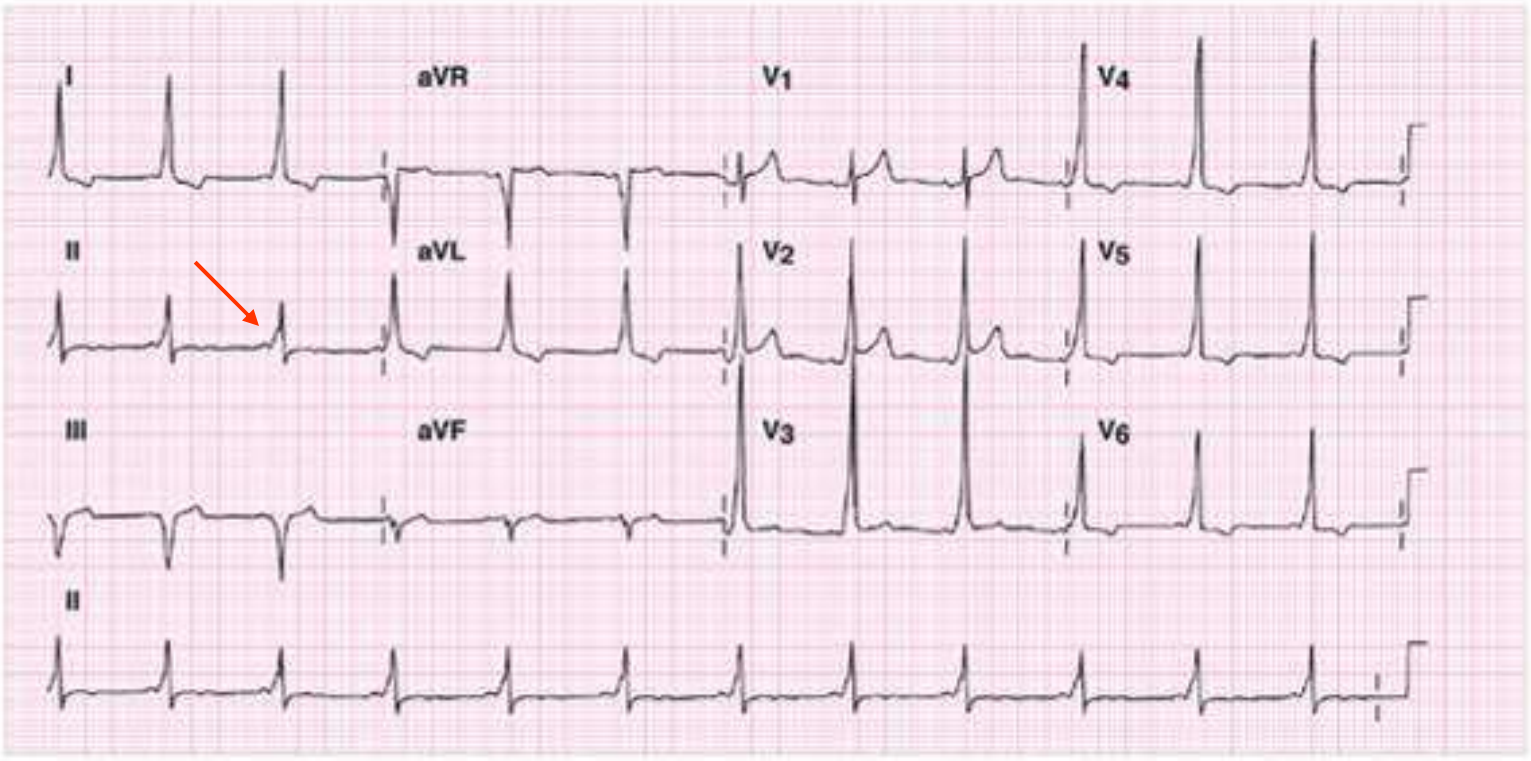
Wolff-Parkinson-White syndrome

- An extra electrical connection between the atria and the ventricles



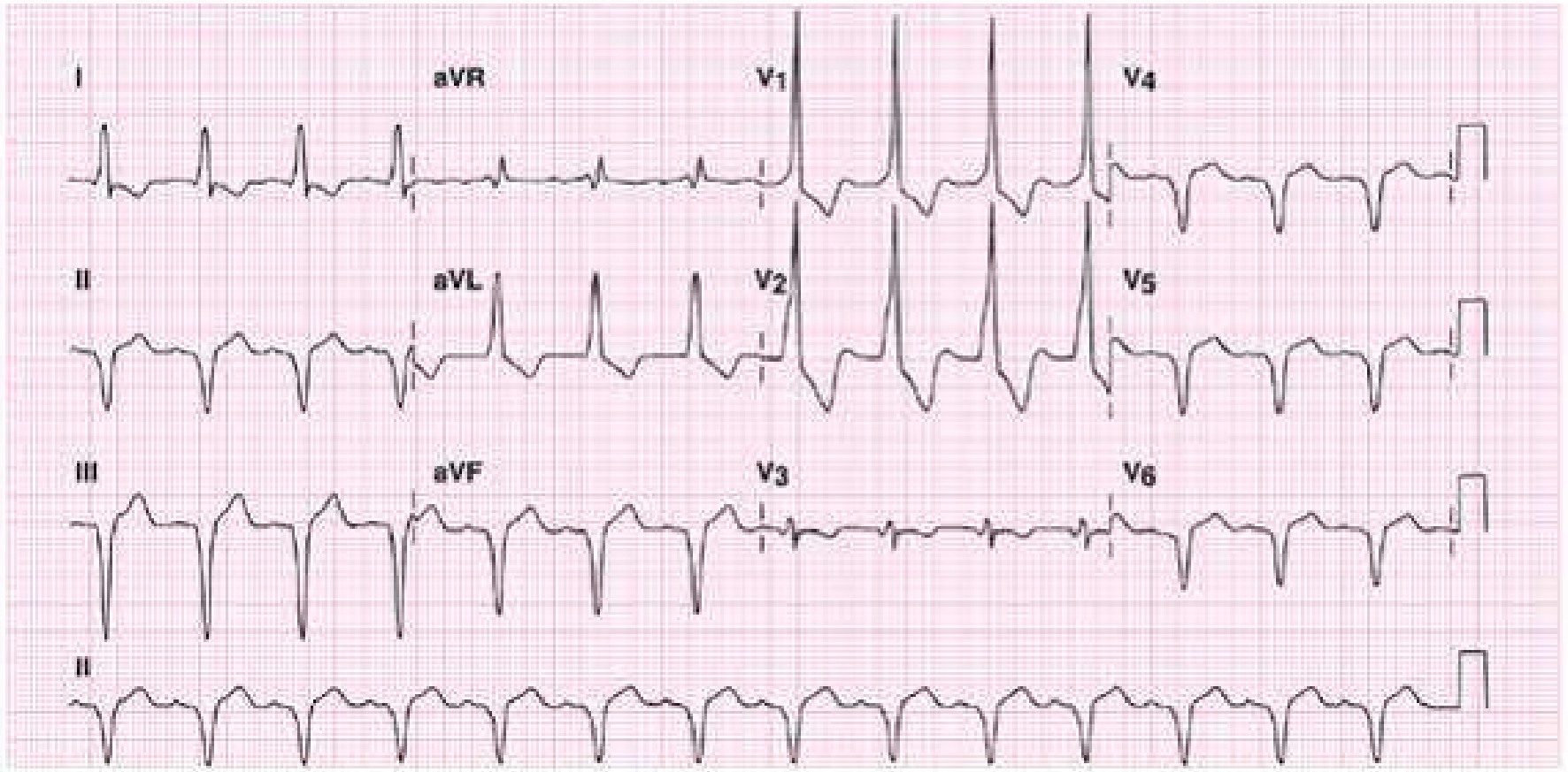


ECG 10-3 Wolff-Parkinson-White Syndrome



- Shortened PR interval < 0.12 sec with a normal p wave
- Wide QRS complex ≥ 0.11 sec
- The presence of a delta wave
- Association with paroxysmal tachycardias – can be fatal

ECG 10-6 Wolff-Parkinson-White Syndrome



Case Study – 37 y/o male

- Came to cardiologist office as he developed rapid palpations associated with some shortness of breath while exercising with weight lifting.

Family history positive for CAD

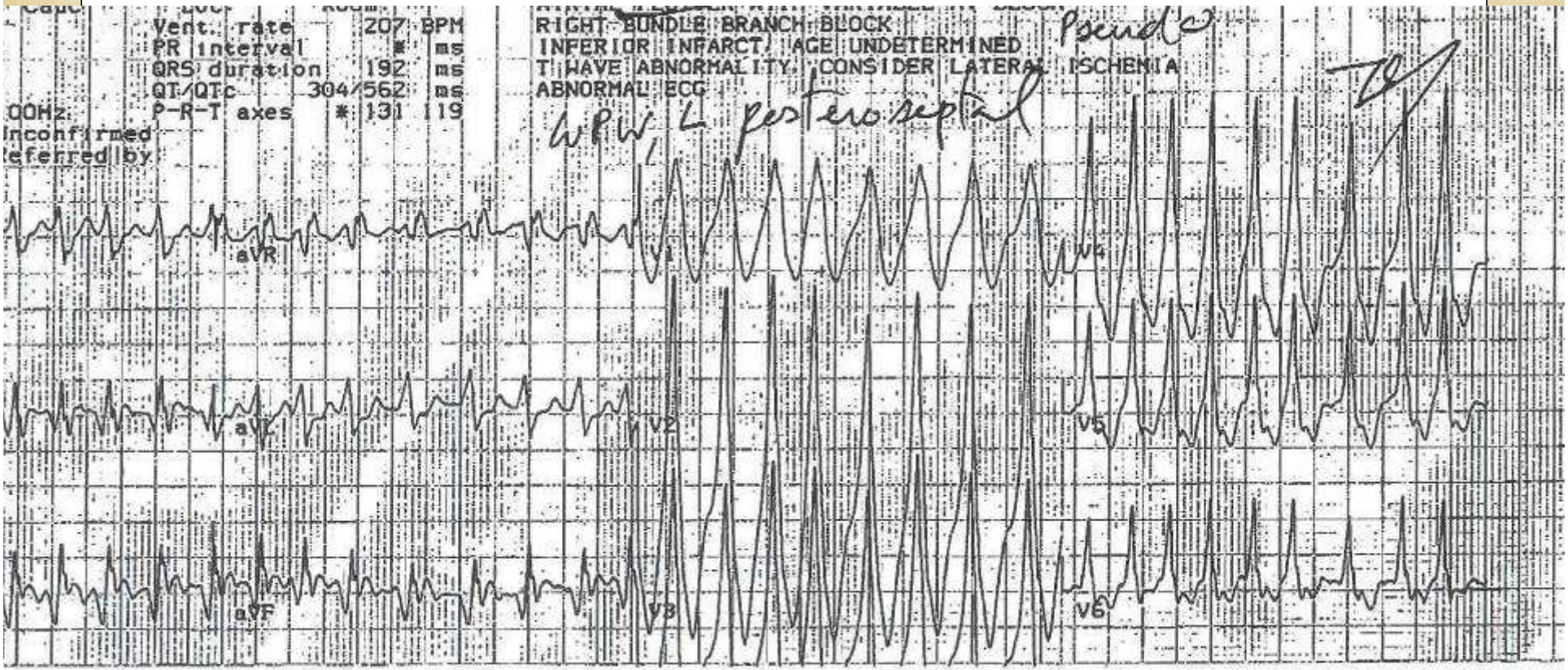
- One uncle died suddenly of AMI
- Three uncles -- CAD, AMI, CABG, and angioplasty
- Mother & all grandparents = hypertension
- Grandfather – stroke
- One aunt -- CAD, CABG, and stenting
- One cousin -- cardiac arrhythmia

PMH

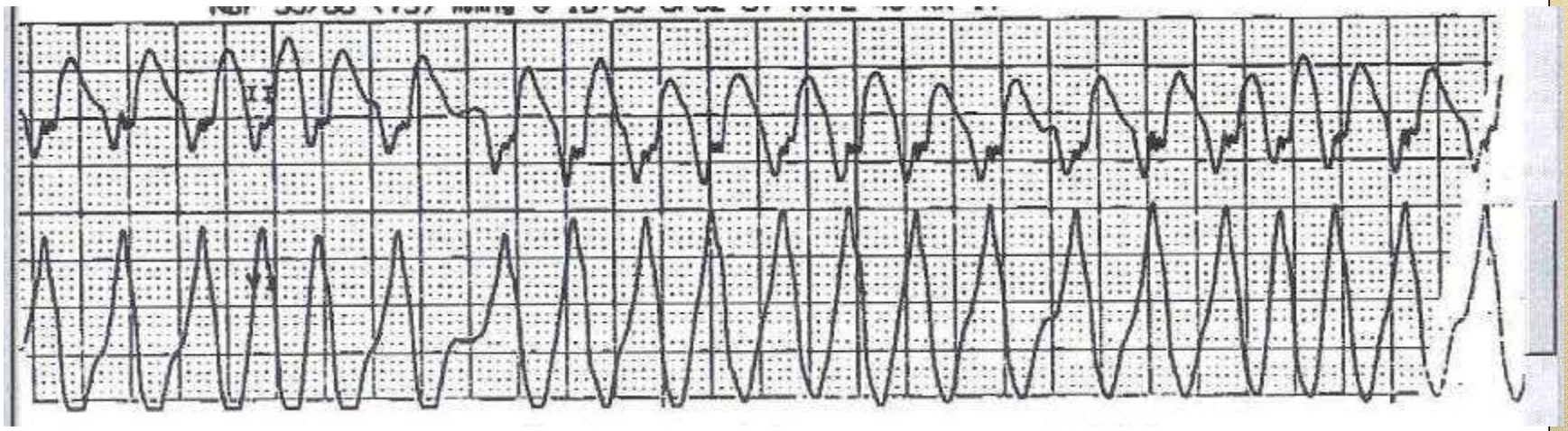
- Moderate drinker – 6 beers per week
- Does not smoke
- Average BMI
- 1st seen by cardiologist one year ago for three episodes of resting palpitations which resided spontaneously.
- 12 Lead at that time: Findings consistent with left posteroseptal WPW syndrome
- 24 hour holter – no arrhythmia
- Stress test: negative for ischemia
- ASA 81 mg daily

At cardiologist office

- BP 120/70
- Heart rate 160 irregular

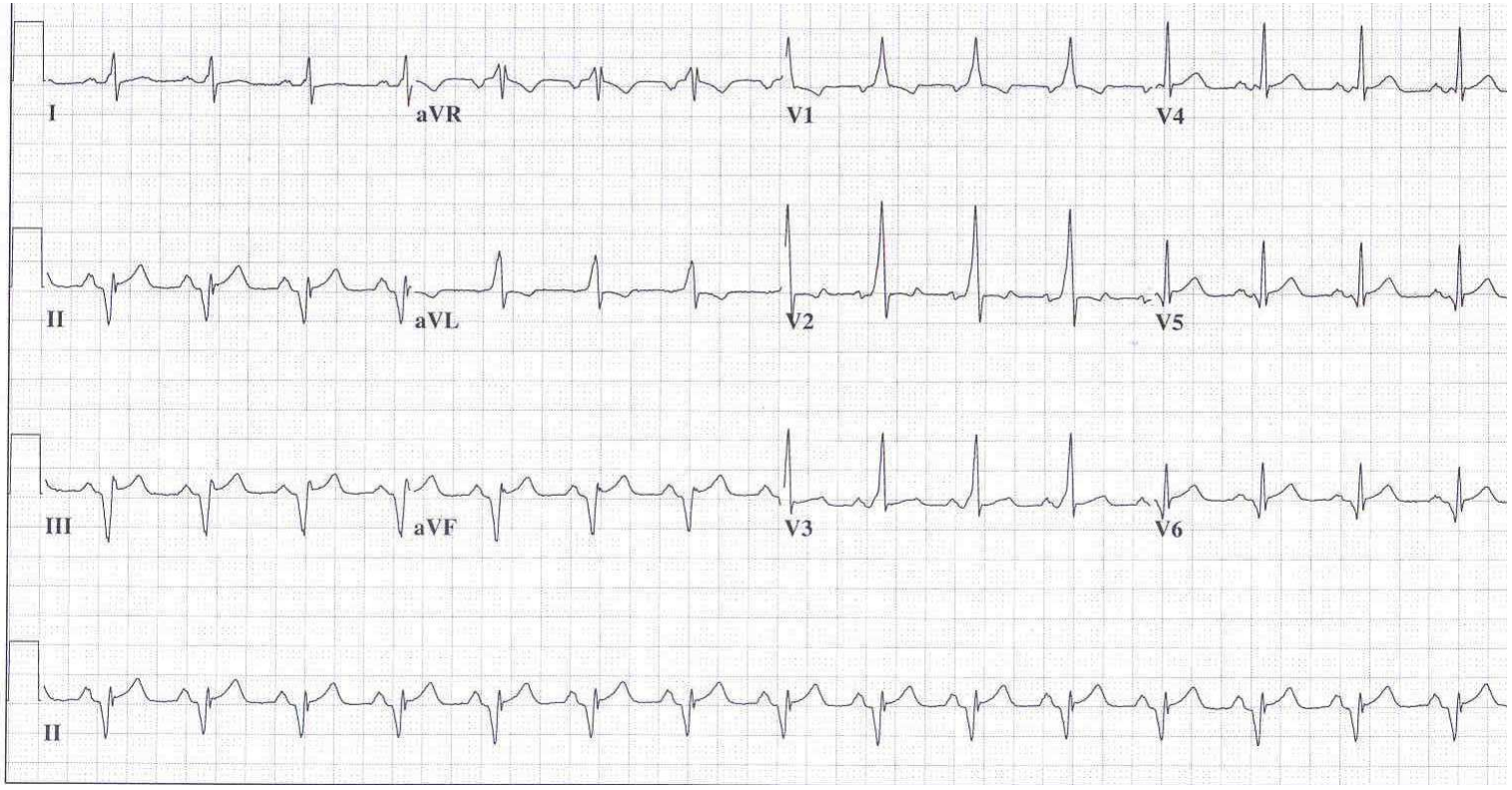

Vent. rate 207 BPM
PR interval * ms
QRS duration 192 ms
QT/QTc 304/562 ms
P-R-T axes * 131 119
RIGHT BUNDLE BRANCH BLOCK
INFERIOR INFARCT AGE UNDETERMINED
T WAVE ABNORMALITY, CONSIDER LATERAL ISCHEMIA
ABNORMAL ECG
WPW, L posteroseptal
Pseudo
aVR
V1
V4
aVL
V2
V5
aVF
V3
V6

Direct admit to CVICU



- Tambocor 150 mg given po
- Does not convert and BP dropped to 76/sys.
- Cardioverted (moderate sedation) with 100 joules.

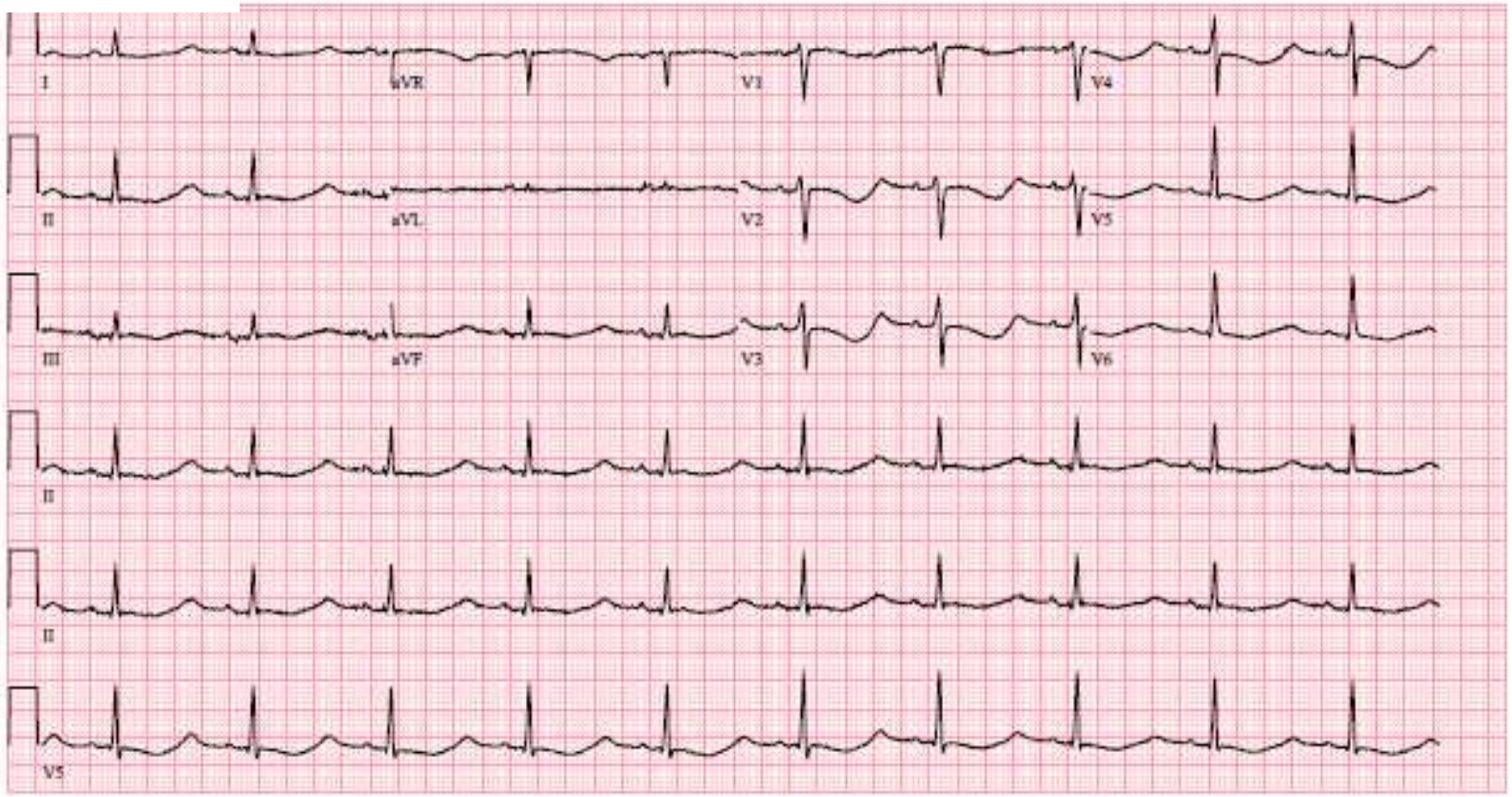
Vent. rate	92	BPM	Normal sinus rhythm
PR interval	122	ms	Ventricular pre–excitation, WPW pattern type A
QRS duration	118	ms	Abnormal ECG
QT/QTc	364/450	ms	No previous ECGs available
P–R–T axes	64 –67	78	



Discharge

- Tambocor 150 mg po bid
- Baby ASA 81 mg daily
- Follow up with electrophysiologist for catheter ablation of the left posteroseptal pathway

64 y/o EKG with dizziness and syncope



MEDICATIONS:
1. Advair Diskus 1 puff every 12 hours as needed.
2. Albuterol 2 puffs MDI every 4-6 hours as needed.
3. Baclofen 10 mg t.i.d.
4. Celexa 40 mg daily.
5. Coumadin 5 mg daily.
6. Colace 100 mg b.i.d.
7. Estradiol 0.05 mg daily.
8. Etodolac 400 mg b.i.d.
9. Flexeril 5 mg every 8 hours p.r.n.
10. Fosamax 70 mg weekly.
11. Glucophage 500 mg daily.
12. Lamictal 25 mg daily.
13. Lasix 40 mg b.i.d.
14. Levothyroxine 50 mcg daily.
15. Lipitor 80 mg daily.
16. Meclizine 25 mg every 8 hours as needed.
17. Metolazone 5 mg daily.
18. Neurontin 100 mg b.i.d.
19. Omeprazole 20 mg daily.
20. Potassium 20 mEq daily.
21. Prevacid 30 mg daily.
22. ProAir MDI every 4 hours as needed.
23. Seroquel 150 mg at bedtime.
24. Singulair 10 mg daily.
25. Symbicort 2 sprays b.i.d.
26. Topamax 75 mg b.i.d.

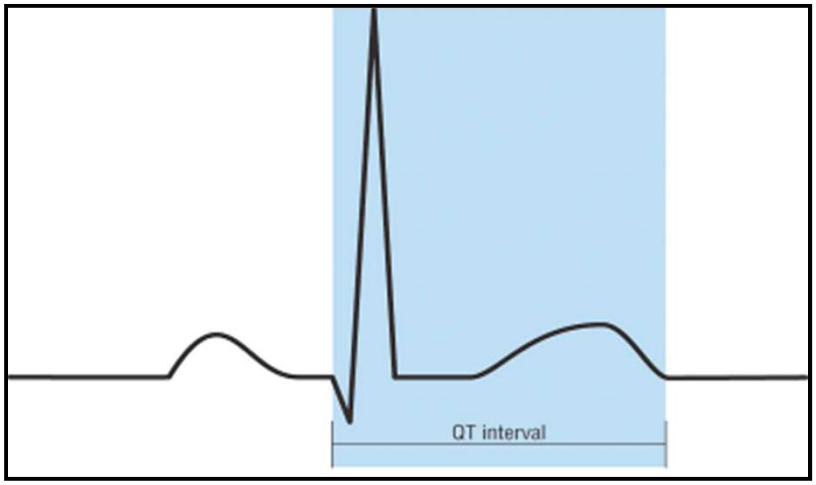
- Celexa
- Seroquel

- Potassium 2.2

Q-T Measurement

Q – T Interval

- Represents the time from when the electrical impulse leaves the AV node – travels through the Bundle of HIS, down the bundle branches, throughout the ventricles and ventricular REPOLARIZATION is complete.
- From the beginning of the "Q" to the end of the "T"

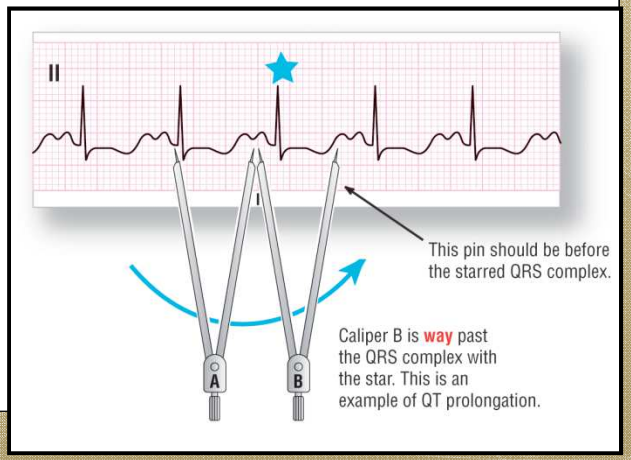


Upper limits of Q-T interval – Rate Based

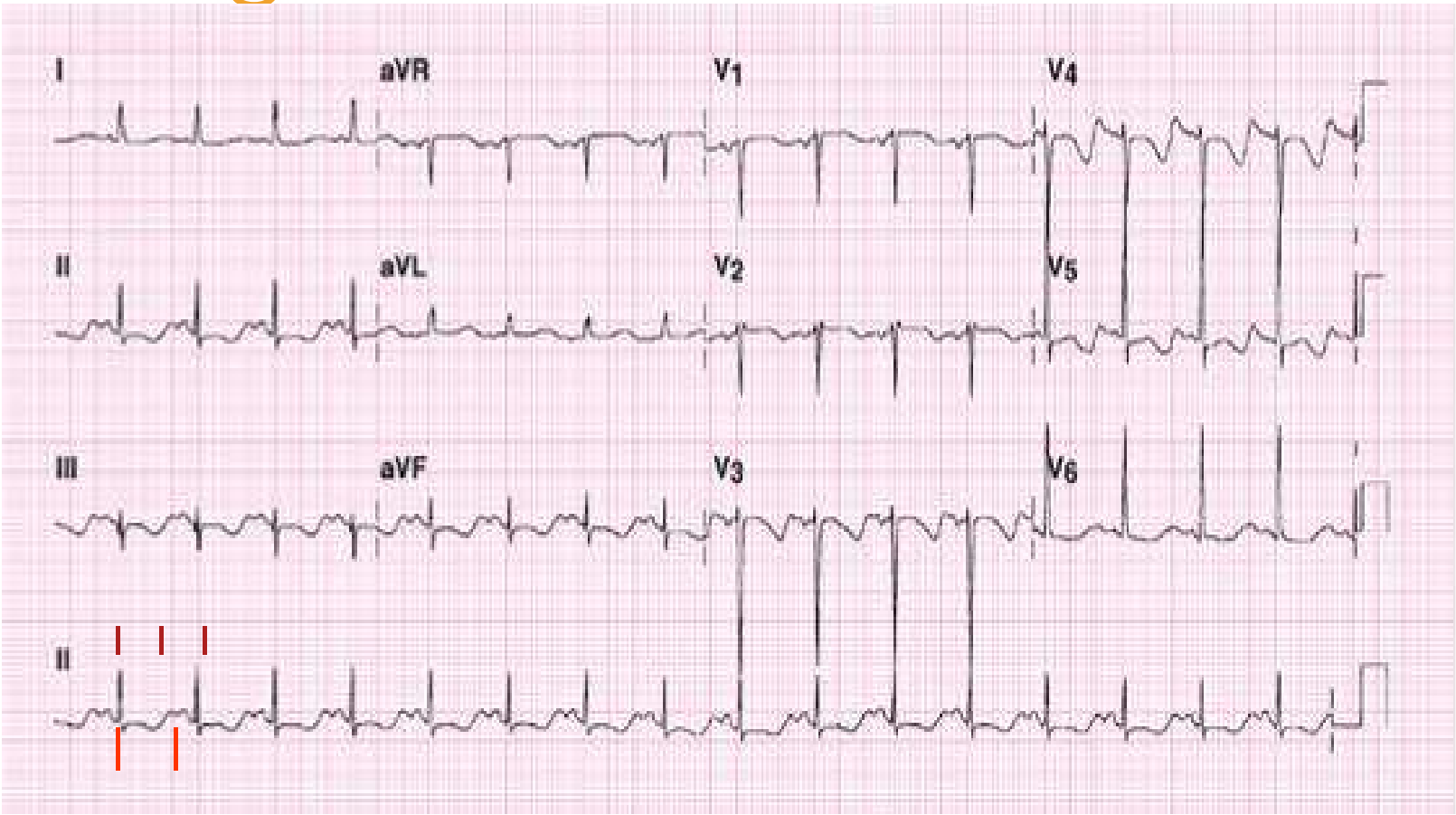
Rate	QT interval
40	0.49 – 0.50 sec.
50	0.45 – 0.46 sec.
60	0.42 – 0.43 sec.
70	0.39 – 0.40 sec.
80	0.37 – 0.38 sec.
90	0.35 – 0.36 sec.
100	0.33 – 0.34 sec.
110	0.32 – 0.33 sec.
120	0.31 – 0.32 sec.

Prolonged QT

- Rate-related value
- QTc represents the QT *corrected* for the rate.
  - Prolonged if over 0.419 sec
  - Markedly prolonged if over 0.440 sec
- Good rule of thumb:
  - If the patient is not tachycardic, the QT interval should not be more than half the R-R interval.



Prolonged QT



- Normal QT interval rate dependant
- QT should be < half R to R interval
- www.qtdrugs.org

Long QT Syndrome (LQTS)

- Congenital
- Acquired
  - Drugs
    - Certain antibiotics (Quinolines)
    - Antiarrhythmics
      - Quinidine, procainamide, disopyramide, amiodarone, sotalol
    - Antihistamines
    - Psychotropic agents
      - Tricyclic antidepressants and phenothiazine derivatives
    - Diuretics
  - Electrolytes imbalances
    - Hypokalemia, hypocalcemia, and hypomagnesemia

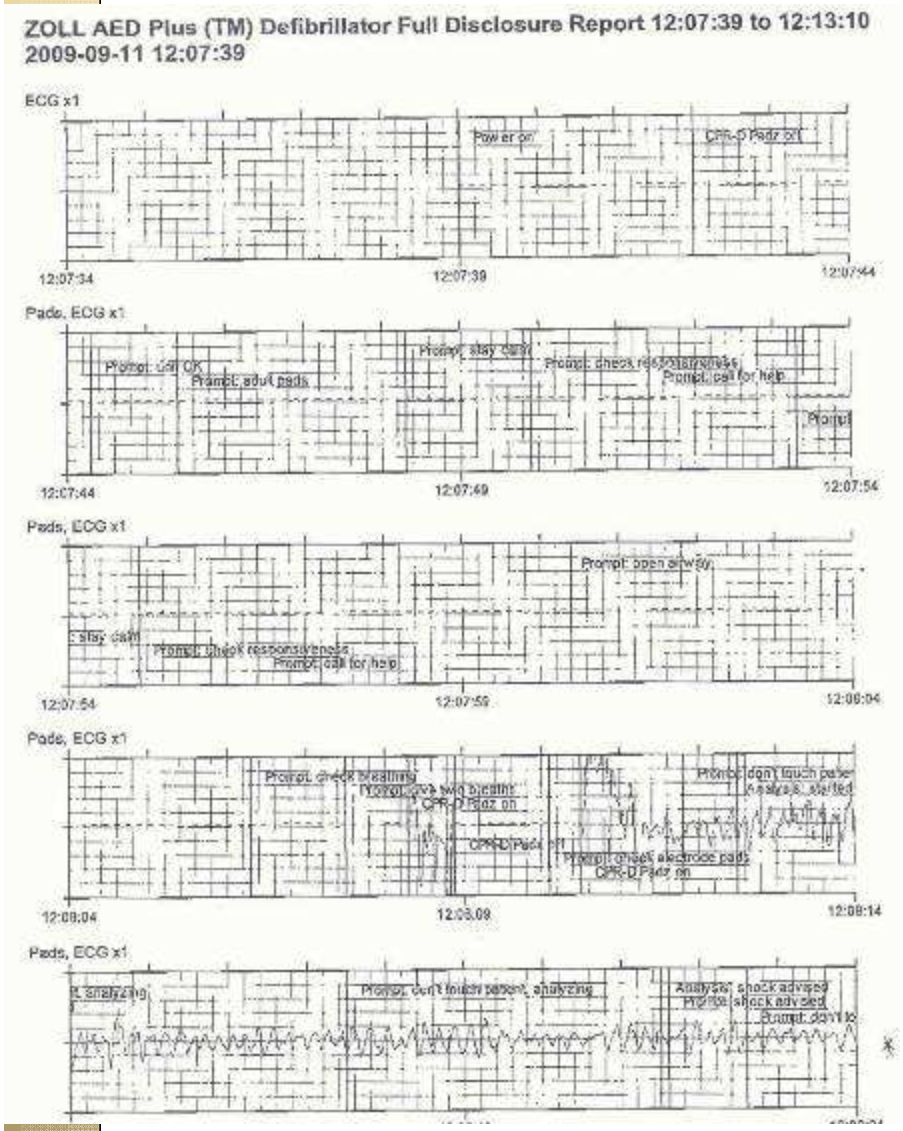
Table 1. Drugs implicated in drug-induced long QT syndrome.

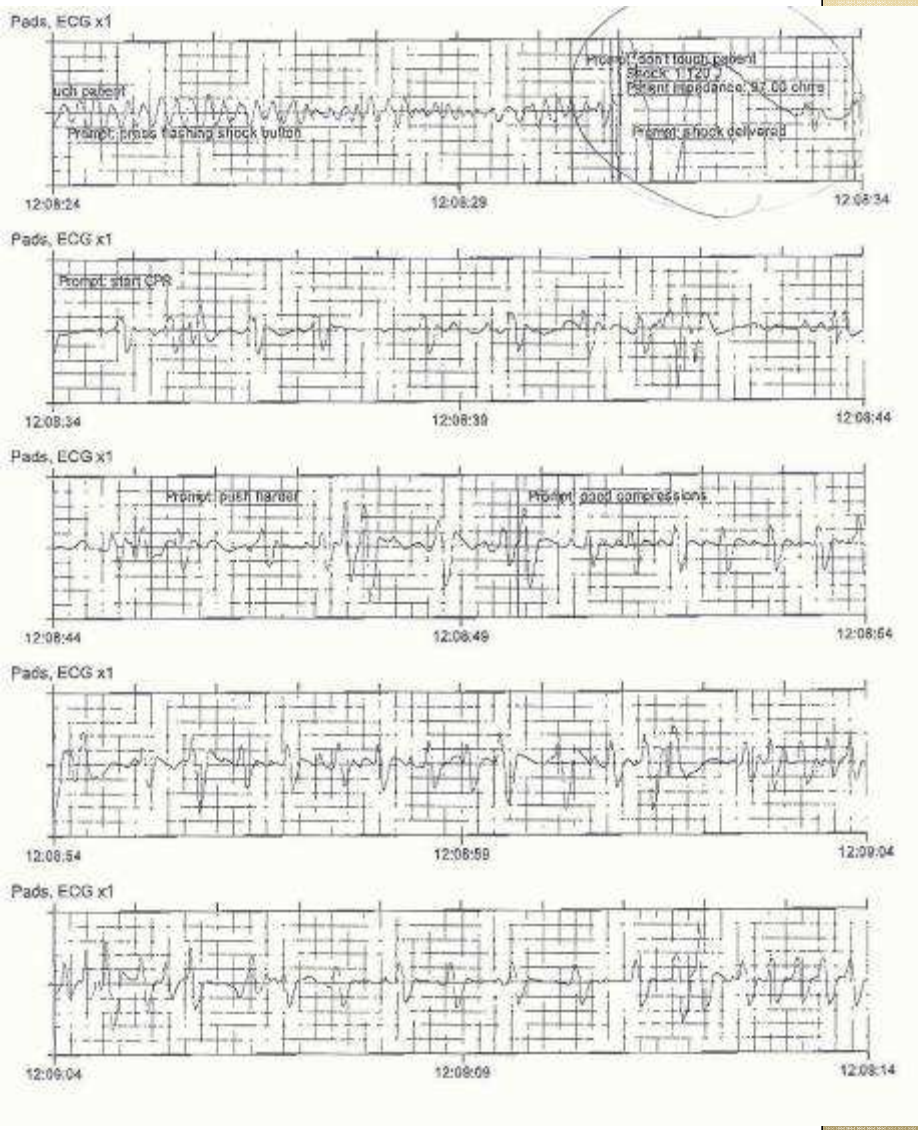
Category	Drugs
Antiarrhythmics	Disopyramide, procainamide, quinidine, mexiletine, propafenone, flecainide, d,l-sotalol, amiodarone, bretylium, dofetilide, ibutilide, azimilide, ajmaline
Antimicrobials	Erythromycin, clarithromycin, azithromycin, levofloxacin, moxifloxacin, sparfloxacin, gatifloxacin, grepafloxacin, trimethoprim-sulfamethoxazole, pentamidine, quinine, itraconazole, ketoconazole, fluconazole, chloroquine, halofantrine, mefloquine, amantadine, spiramycin
Antihistamines	Astemizole, diphenhydramine, ebastine, terfenadine, hydroxyzine
Antidepressants	Doxepin, venlafaxine,fluoxetine, desipramine, imipramine, clomipramine, paroxetine, sertraline, citalopram
Antipsychotics	Chlorpromazine, prochlorperazine, trifluoperazine, fluphenazine, felbamate, haloperidol, thioridazine, droperidol, mesoridazine, pimozide, risperidone, quetiapine, ziprasidone, lithium, chloral hydrate, pericycline, sertindole, sultopride, zimeldine, maprotiline
Anti-migraine	Naratriptan, sumatriptan, zolmitriptan
Bronchodilators	Albuterol, salmeterol
Diuretics	Indapamide, thiazide, furosemide
Gastrointestinal stimulants	Cisapride, metoclopramide, domperidone
Hormones	Octreotide, vasopressin
Immunosuppressives	Tacrolimus
Others	Arsenic trioxide, aconitine, veratridine, vincamine, terodiline, budipine, tizanidine tiapride, cocaine, organophosphorus compounds

Source: Konstantinos P. Drug Induced Long QT Syndrome. Hellenic J Cardio 48:296-299, 2007

45 y/o white female sudden syncope while teaching

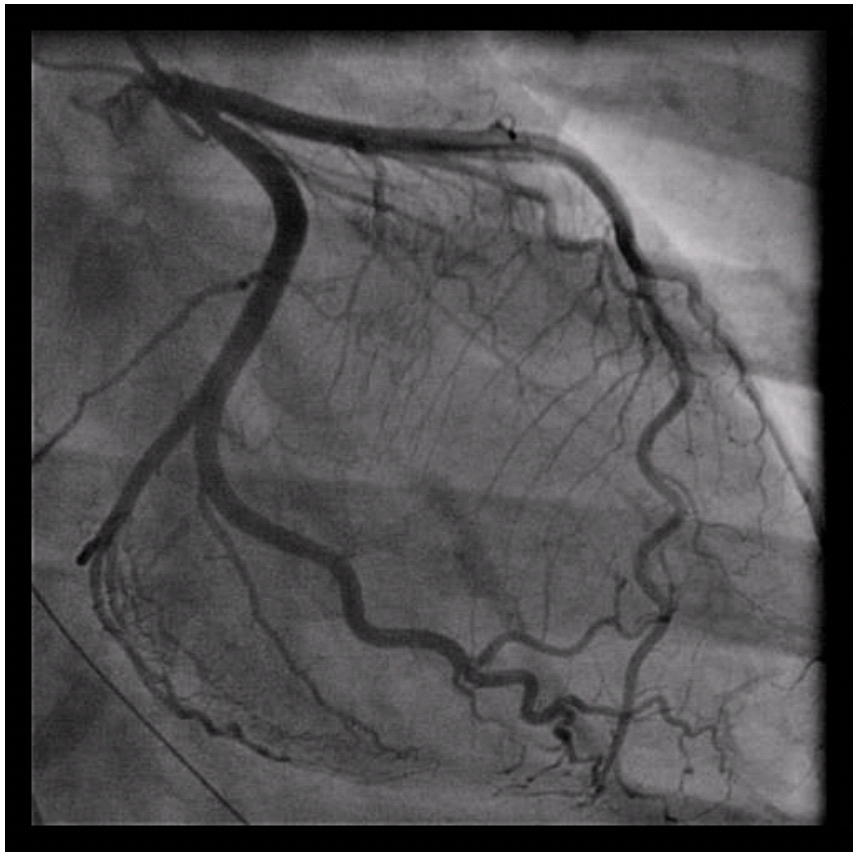
- CPR started, AED applied and delivered one shock

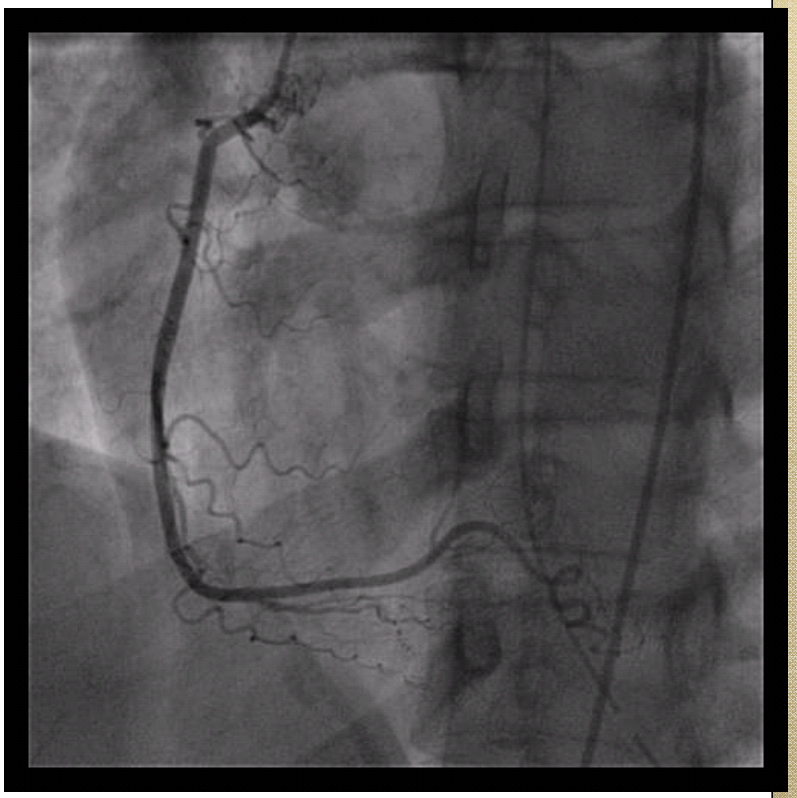

ZOLL AED Plus (TM) Defibrillator Full Disclosure Report 12:07:39 to 12:13:10
2009-09-11 12:07:39
ECG x1
Power on
CPR-D Padz on
12:07:34
12:07:39
12:07:44
Pads, ECG x1
Prompt: stay calm
Prompt: adult pads
Prompt: call for help
12:07:44
12:07:49
12:07:54
Pads, ECG x1
Prompt: open airway
Prompt: check responsiveness
Prompt: call for help
12:07:54
12:07:59
12:08:04
Pads, ECG x1
Prompt: check breathing
Prompt: don't touch patient, analyzing
12:08:04
12:08:09
12:08:14
Pads, ECG x1
Prompt: don't touch patient, analyzing
Prompt: shock advised
12:08:14


Pads, ECG x1
Prompt: don't touch patient
Shock: 1120 J
Patient impedance: 97.00 ohms
Prompt: shock delivered
12:08:24
12:08:29
12:08:34
Pads, ECG x1
Prompt: start CPR
12:08:34
12:08:39
12:08:44
Pads, ECG x1
Prompt: push harder
Prompt: good compressions
12:08:44
12:08:49
12:08:54
Pads, ECG x1
12:08:54
12:08:59
12:09:04
Pads, ECG x1
12:09:04
12:09:09
12:09:14

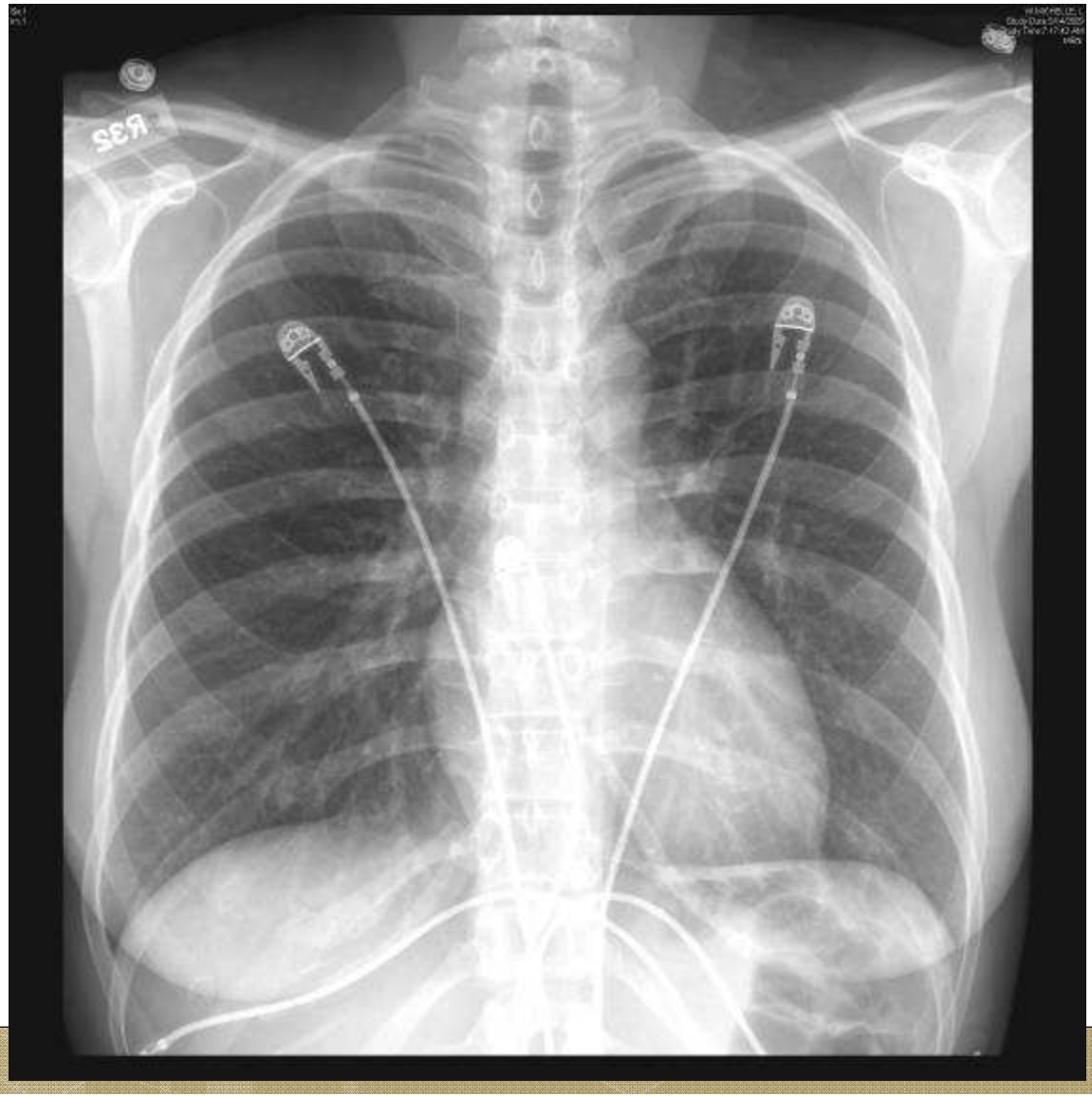
Admission EKG12:26

EF 40- 45%





45 y/o post cardiac arrest pre ICD



- PMH: Father fatal MI at age 57
- No smoking, alcohol, or illicit drug use
- Wt: 60 kg
- D-Dimer 2443, Potassium 3.3
- DX- Aborted sudden cardiac death etiology secondary to cardiomyopathy along with hypokalemia

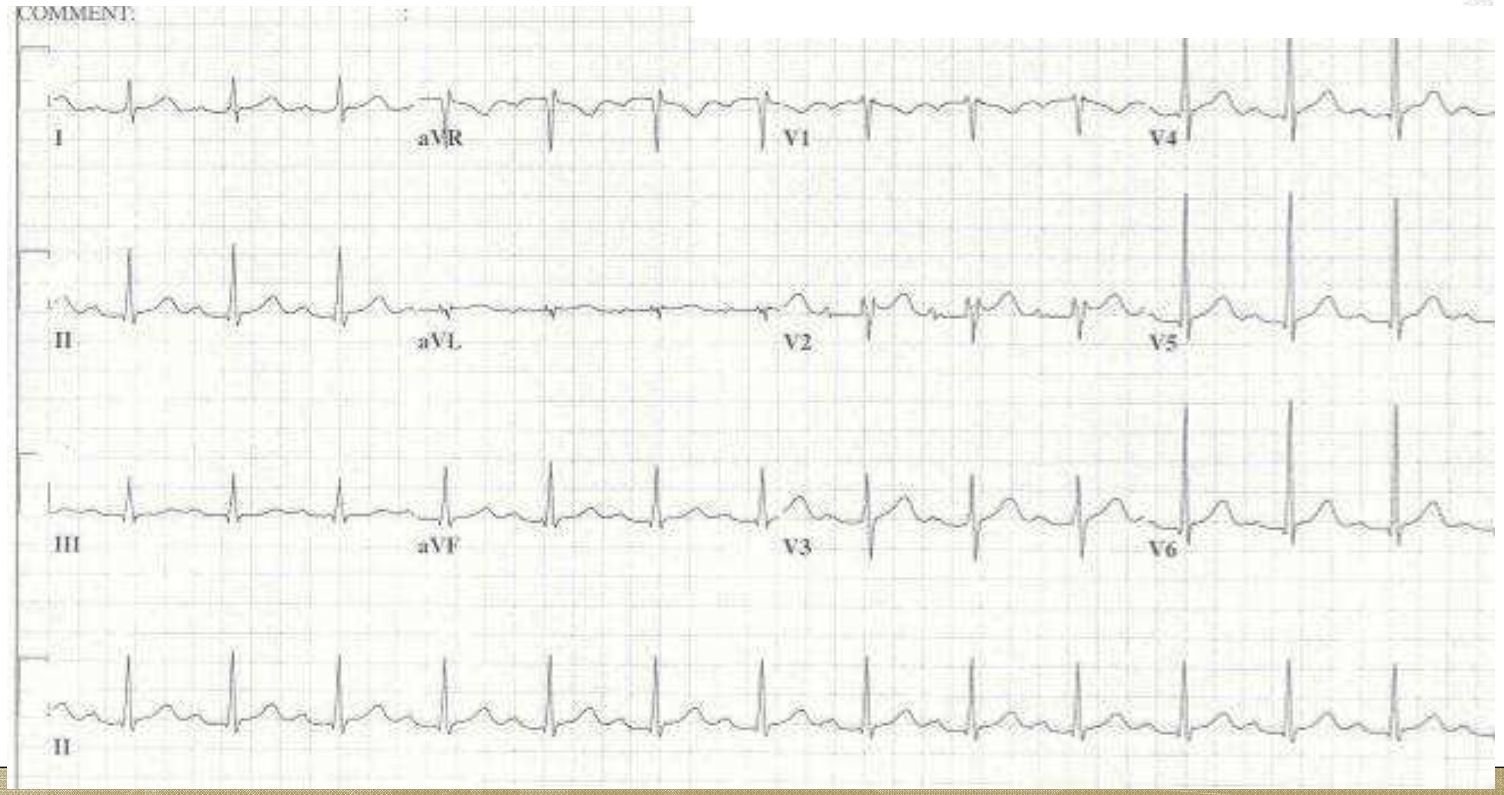
- **Thyroid Stimulating Hormone**
  - **TSH = 0.15 µIU/mL (0.4–4.0) ↓**
- **T3-FREE**
  - **FREE T-3 2.2 pg/ml (2.2-4.0)**
- **T4 FREE**
  - **FREE T4 1.16 ng/dl (0.80-1.50)**
- **THYROID PEROXIDASE AB**
  - **TPO AB <0.3 IU/mL (0.0-3.9)**

Discharge diagnosis

- Cardiomyopathy with EF 40 – 45% presumably related to thyrotoxicosis
- ICD implanted

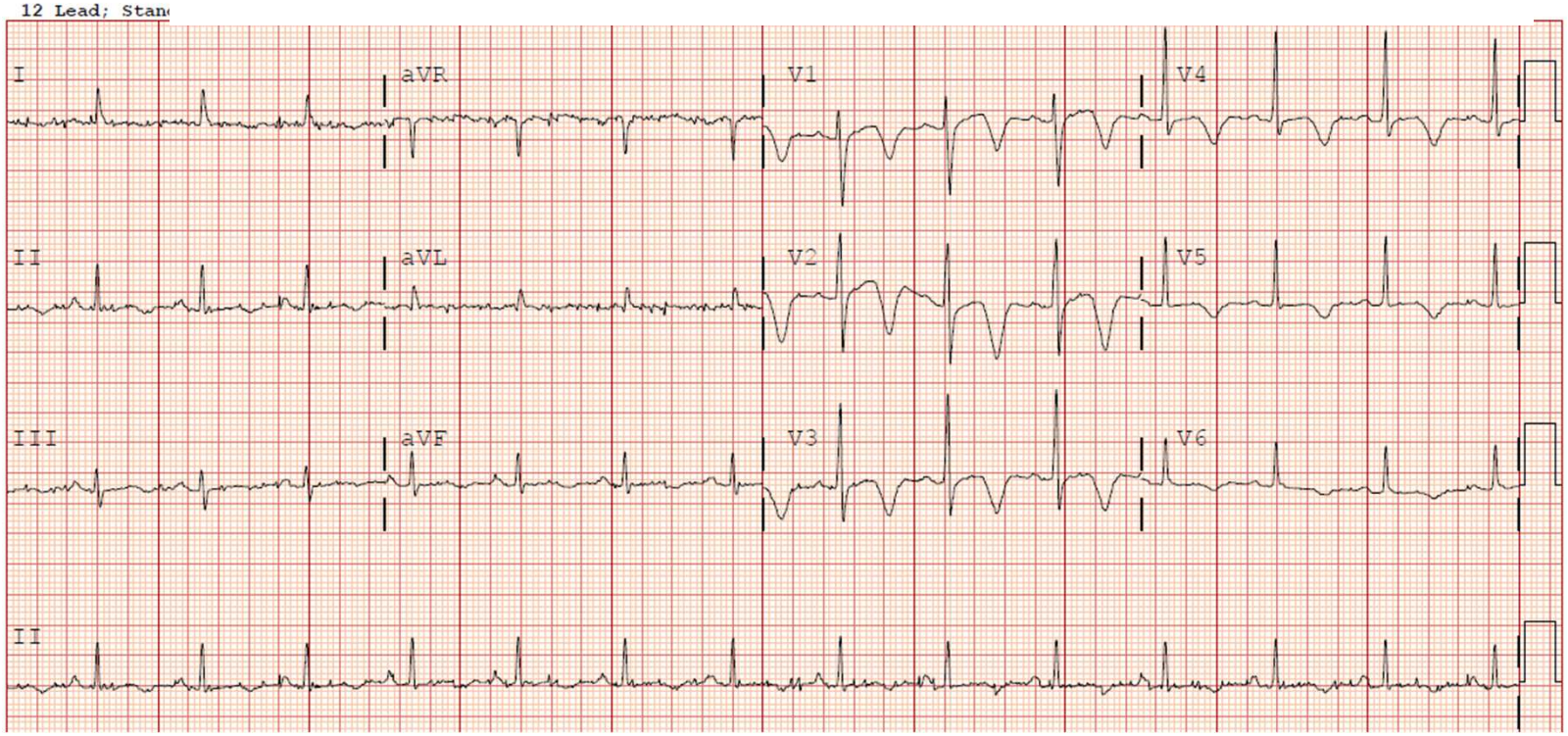
EKG 2 years prior to event

Vent. rate	83	BPM	Sinus rhythm with 1st degree A–V block
PR interval	268	ms	Prolonged QT
QRS duration	102	ms	Abnormal ECG
QT/QTc	424/498	ms	No previous ECGs available
P–R–T axes	63 66	47	



HR	84
PR	164
QRSD	95
QT	457
QTc	541
-- AXIS --	
P	72
QRS	35
T	223

12 Lead; Stan

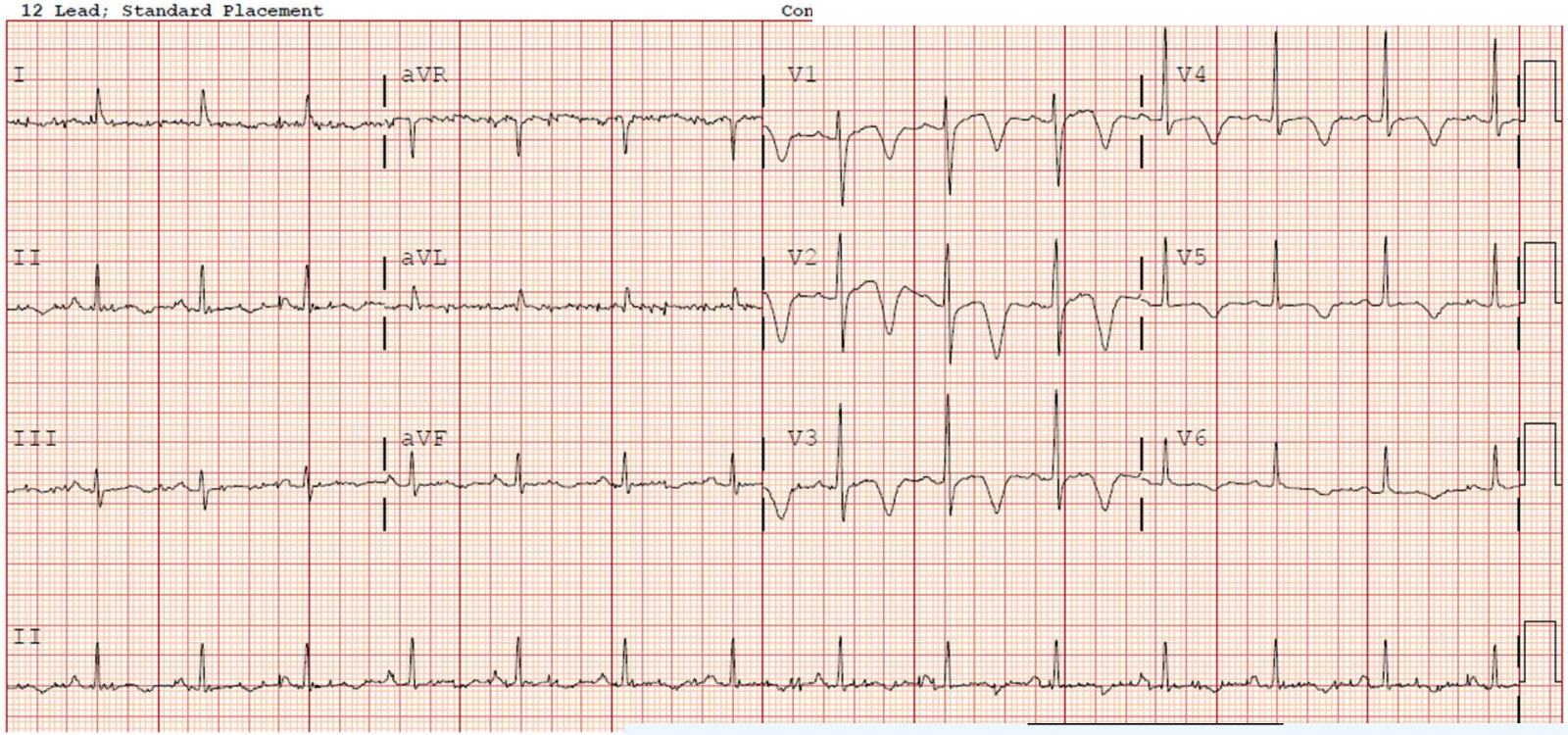


Takotsubo Cardiomyopathy Pattern EKG 12/4

HR	84	. Sinus rhythm
		. Abnormal R-wave progression, early transition
PR	164	. Abnrm T, probable ischemia, anterolateral lds
QRSD	95	. Prolonged QT interval
QT	457	. When compared with ECG of 01-Dec-2017 16:02:28,
QTc	541	. New or worsened ischemia or infarction
		. Significant repolarization change
-- AXIS --		. Change in clinical status
P	72	
QRS	35	
T	223	

- ABNORMAL ECG -

12 Lead; Standard Placement Con



EF 25 – 30%

Normal Coronary Arteries

	... 5 10/31/2016 1709	4 11/29/2017 0625	3 12/4/2017 1016	2 12/4/2017 1515	1 12/4/2017 2155
CARDIAC PROFILE					
Troponin I	<0.015 *		<0.015 *	<0.015 *	0.025 *
Pro-BNP	333 *	3,952 *			

- ACC/AHA Risk app

- Cardiac risk – low, intermediate, high for low, intermediate, high risk procedure
- Gives patient and surgeon info on the risk to proceed with procedure.