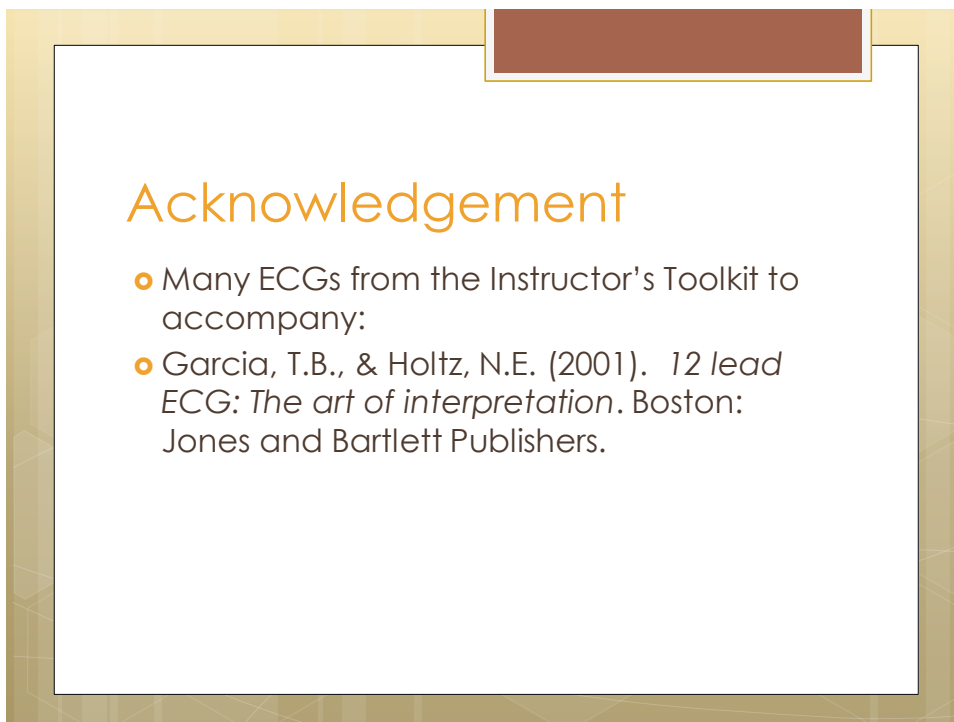




1



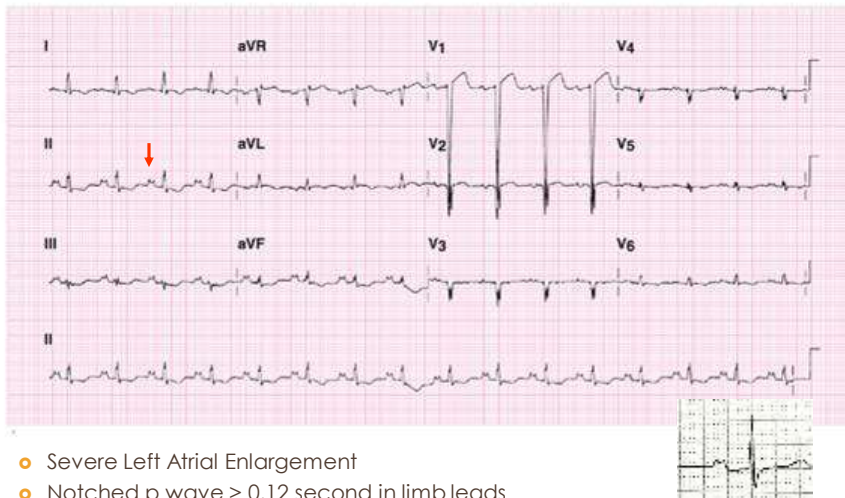
2

Hypertrophy

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

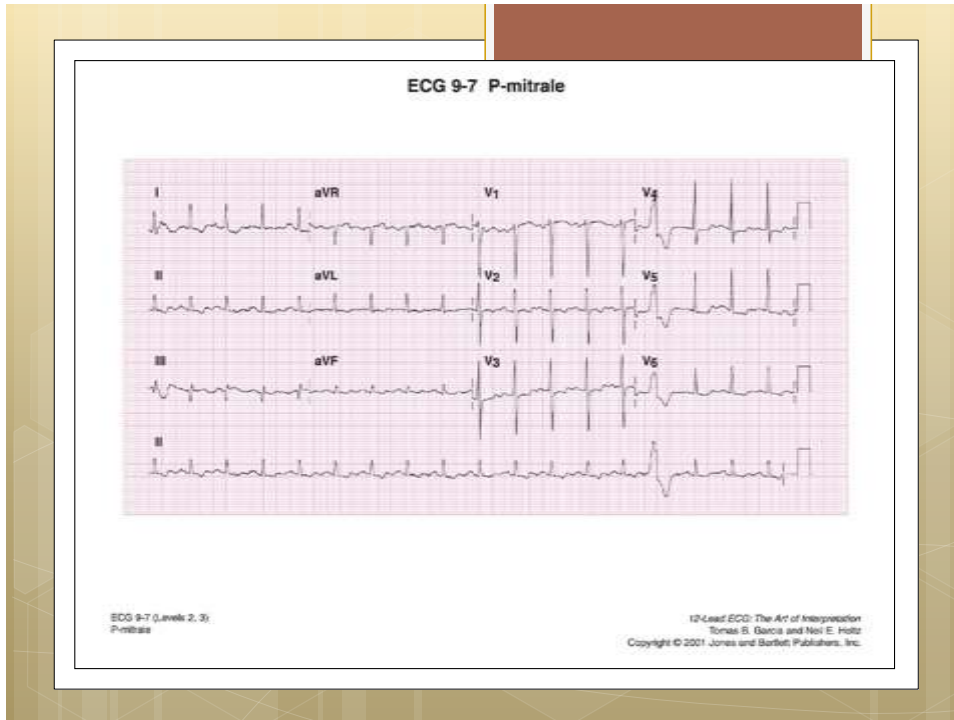
3

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)

4



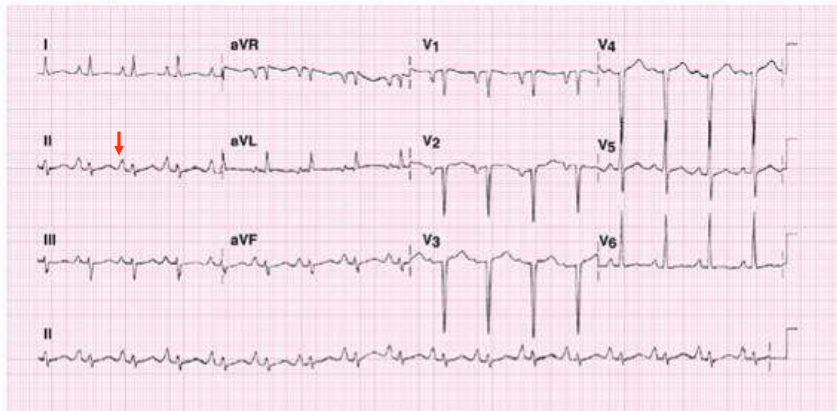
5

Clinical Implications LA enlargement

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

6

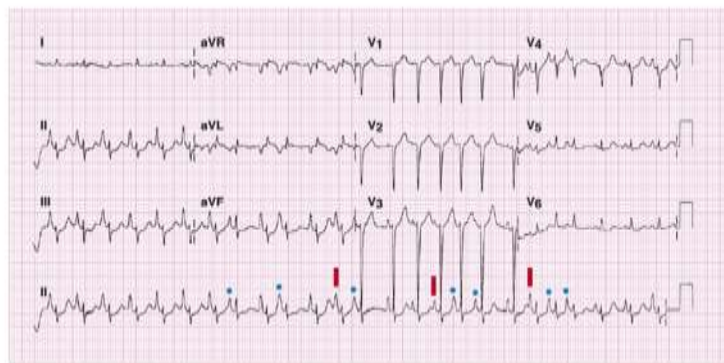
ECG 9-9 P-pulmonale



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

7

ECG 9-8 P-pulmonale



ECG 9-8 (Level 2)
P-pulmonale

12-Lead ECG: The Art of Interpretation
Thomas H. Garvin and Neil E. Holtz
Copyright © 2001 Jones and Bartlett Publishers, Inc.

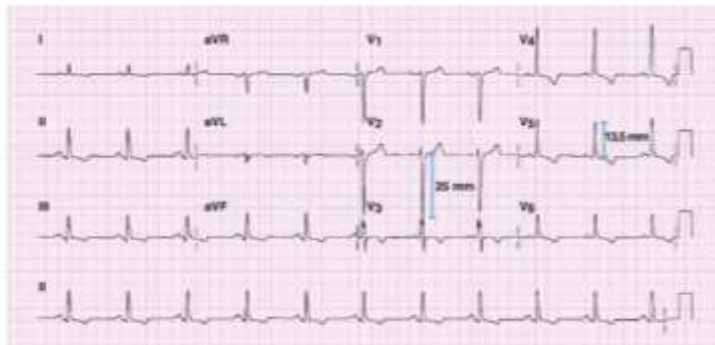
8

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

9

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 ≥ 11 mm
- The R wave in Lead I is ≥ 12 mm
- The R wave in lead aVF is ≥ 20 mm

10

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's greater than or equal to 35 mm, you've identified LVH. Easy, isn't it? Figure 11-11 illustrates the other LVH criteria.

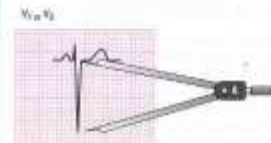


Figure 11-9: Measuring for LVH.

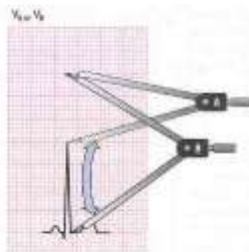


Figure 11-10: LVH criterion #1.

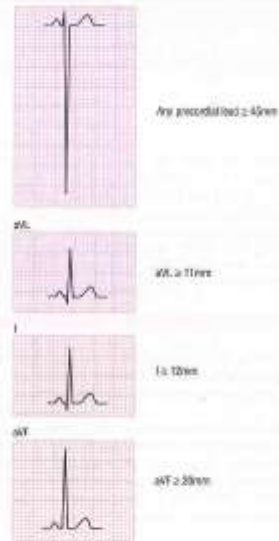
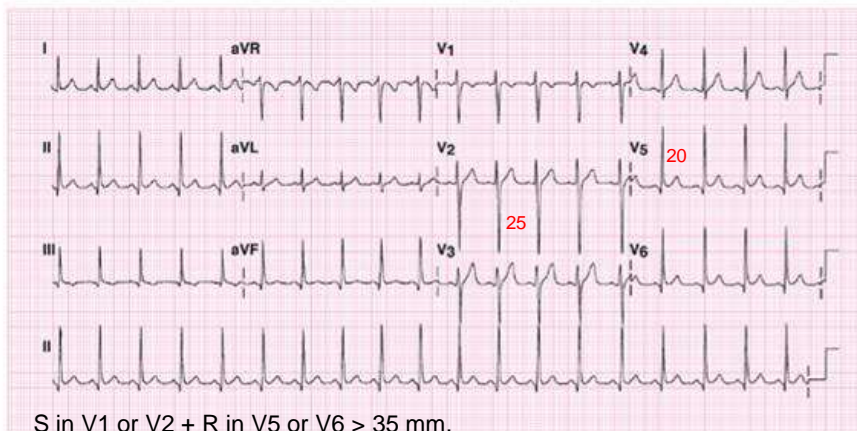


Figure 11-11: LVH criteria #2-5. Use your calipers!

11

ECG 11-5 Left Ventricular Hypertrophy



S in V_1 or V_2 + R in V_5 or V_6 \geq 35 mm.

Or

Any precordial lead is \geq 45 mm

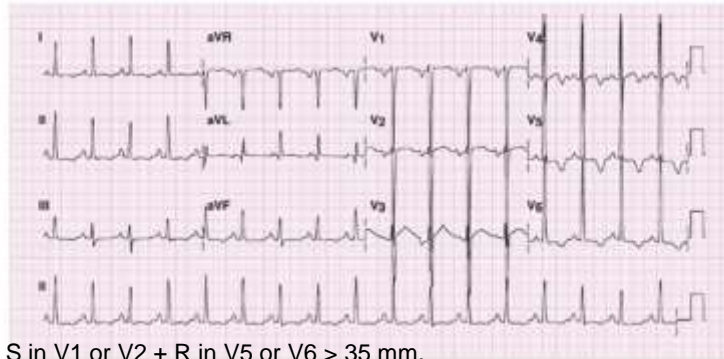
The R wave in aVL is \geq 11 mm

The R wave in Lead I is \geq 12 mm

The R wave in lead aVF is \geq 20 mm

12

ECG 11-11 Left Ventricular Hypertrophy



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

Or

Any precordial lead is \geq 45 mm

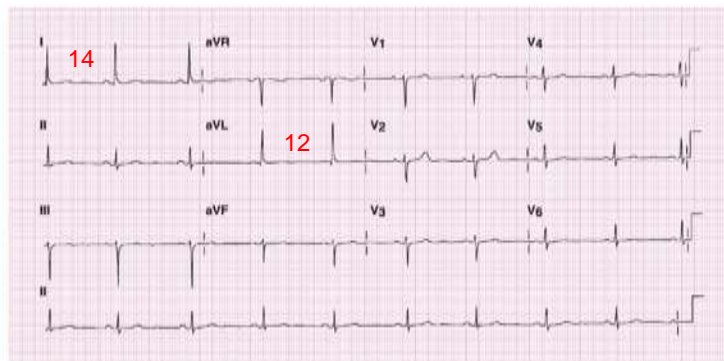
The R wave in aVL is \geq 11mm

The R wave in Lead I is \geq 12 mm

The R wave in lead aVF is \geq 20 mm

13

ECG 11-7 Left Ventricular Hypertrophy



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

Or

Any precordial lead is \geq 45 mm

The R wave in aVL is \geq 11mm

The R wave in Lead I is \geq 12 mm

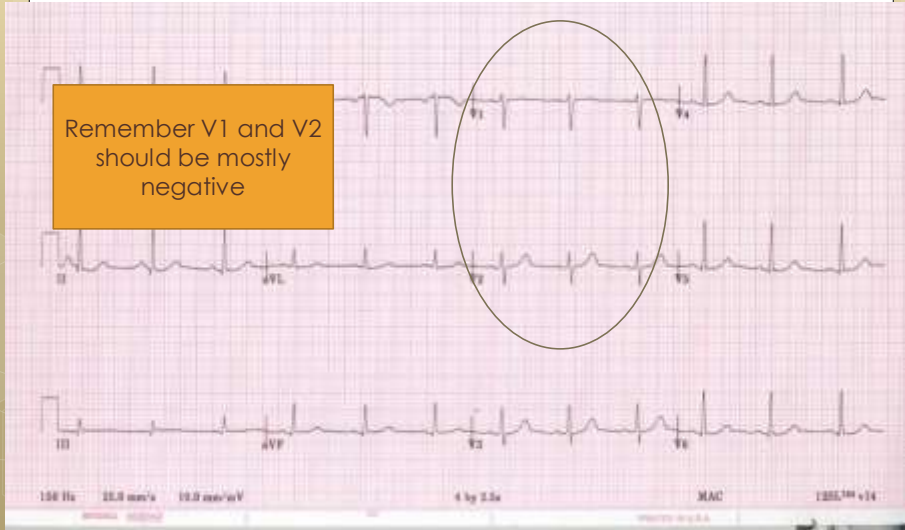
The R wave in lead aVF is \geq 20 mm

14

12 Lead EKG 101

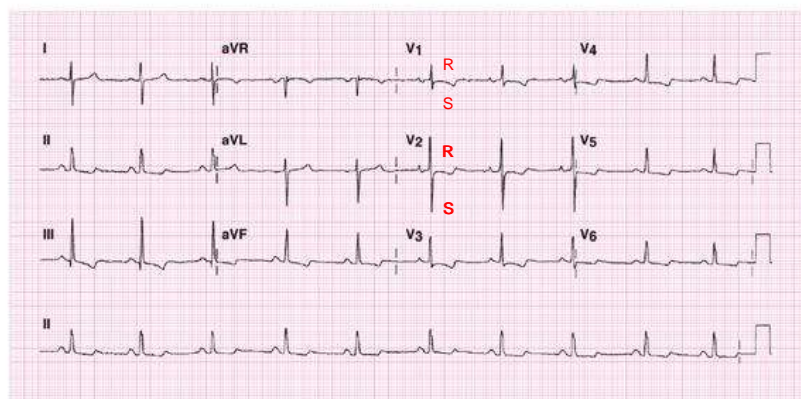
Learn the Normal so you can detect the abnormal

Remember V1 and V2 should be mostly negative



15

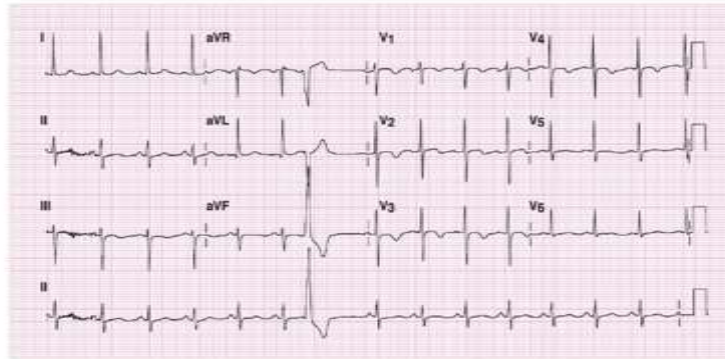
ECG 11-12 Right Ventricular Hypertrophy



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

16

ECG 11-13 Right Ventricular Hypertrophy

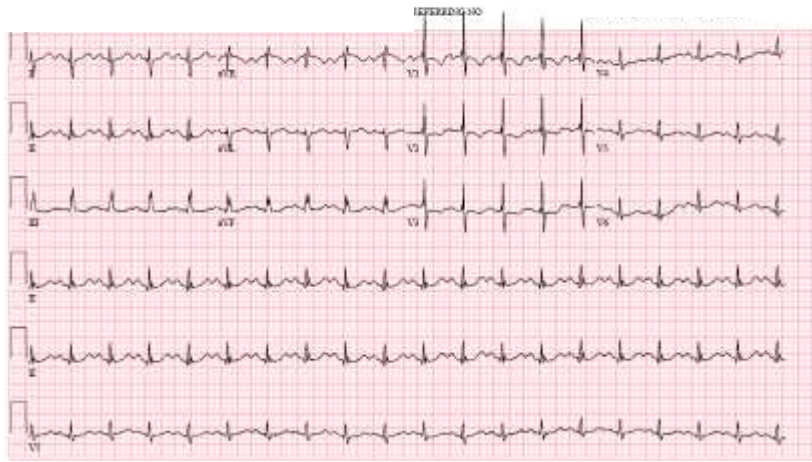


R:S ratio is ≥ 1 in leads V1 and/or V2
R is bigger than S

17

Practice EKG #1

Lead sets: 116 BPM
PR interval: 184 ms
QRS duration: 85 ms
QT/QTc: 335/457 ms
P-R-T axis: 27 188 33



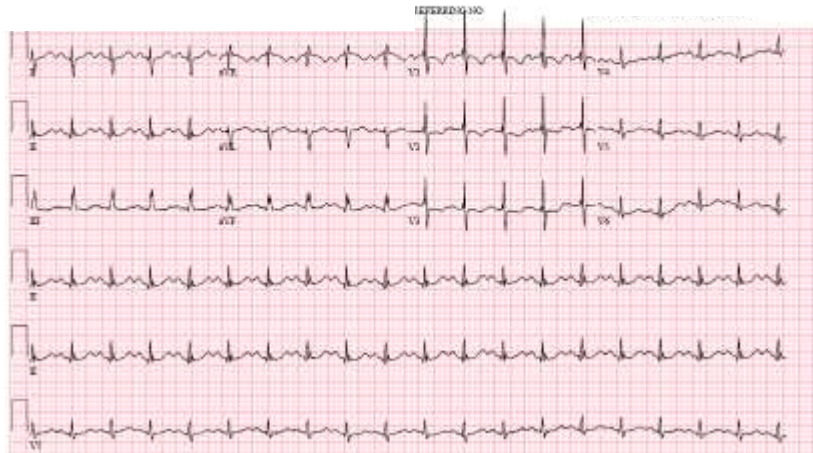
HX of Pulmonary Hypertension & spontaneous pneumothorax

18

Practice EKG #1 -- Answer

Vent rate 116 BPM
 PR interval 184 ms
 QRS duration 96 ms
 QT/QTc 356/447 ms
 P-R-T axis 21 148 23

Time to Specimen
 Right ventricular hypertrophy with repolarization abnormality
 Abnormal ECG
 When compared with ECG of 85-DEC-2009 09:10:
 No significant change was found

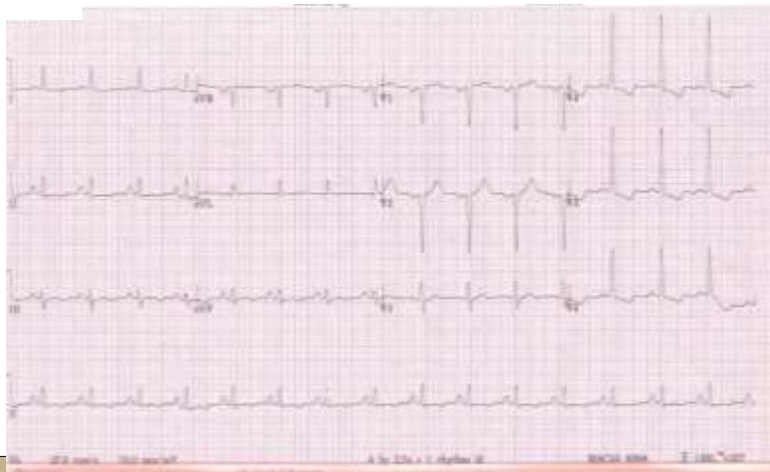


HX of Pulmonary Hypertension & spontaneous pneumothorax

19

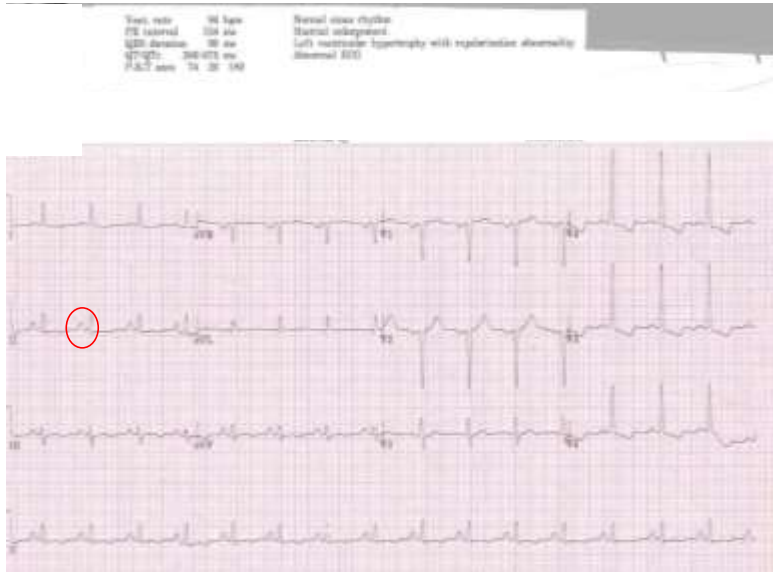
Practice EKG #2

Vent rate 101 bpm
 PR interval 158 ms
 QRS duration 96 ms
 QT/QTc 360/471 ms
 P-R-T axis 74 28 142



20

Practice EKG #2 Answer



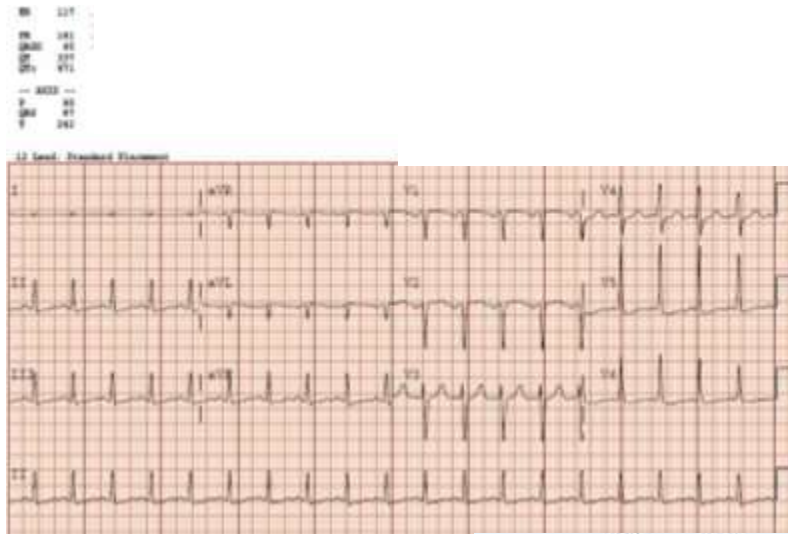
21

Would you be
concerned
about these
ECGs?



22

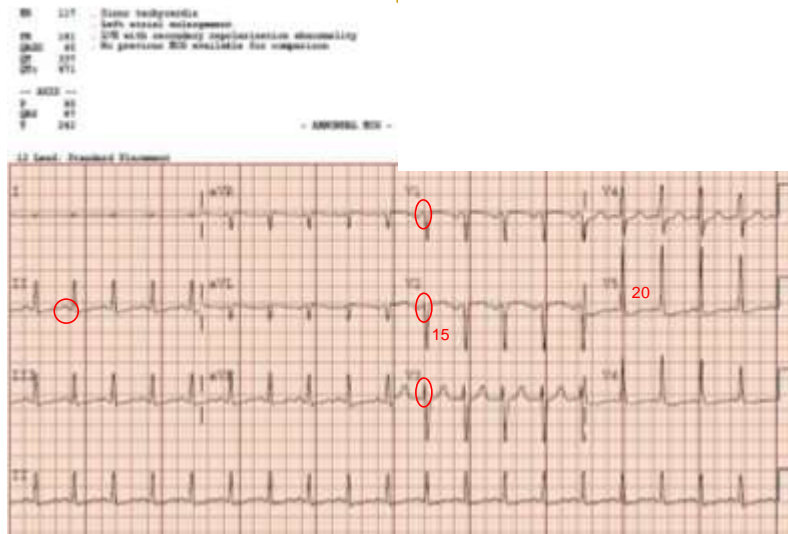
Patient presents with
Atypical Chest Pain



	1481	7724	1117
CARDIAC PROFILE			
Typical	0.049 *	0.070 *	0.024 *
ForbF	0.949 *		
ICI - d*	3.05		

23

Patient presents with
Atypical Chest Pain



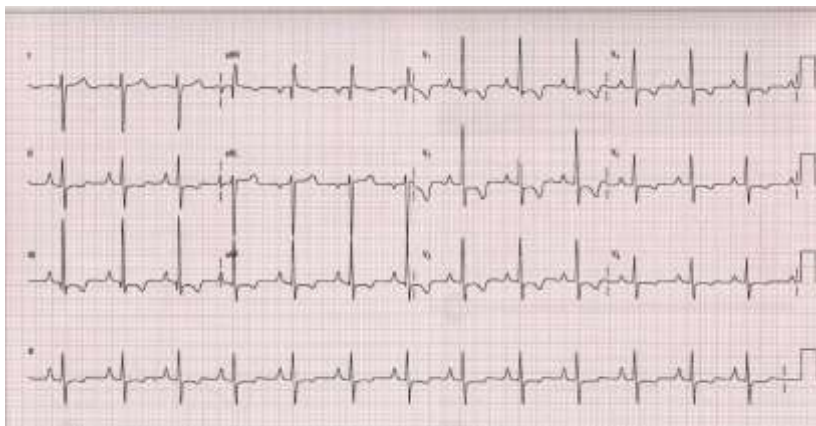
	1481	7724	1117
CARDIAC PROFILE			
Typical	0.049 *	0.070 *	0.024 *
ForbF	0.949 *		
ICI - d*	3.05		

24

Echocardiogram

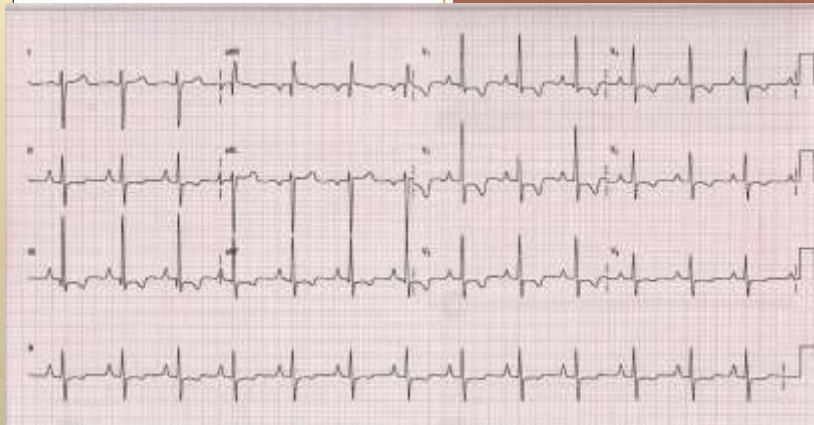
- LVEF 19%
- Severely decreased RV systolic function
- Mild biatrial enlargement
- Moderate mitral regurgitation
- Mild tricuspid regurgitation
- Mild to moderate pulmonary hypertension

25



PH

26



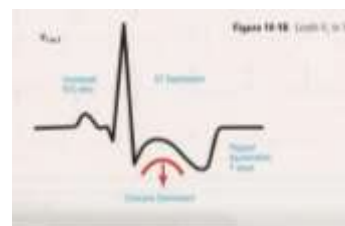
- Pulmonary Hypertension
 - P-Pulmonale (RAE)
 - Right axis deviation
 - Increased R:S ratio in V1 to V2
 - RVH strain pattern
 - S1, Q3, T3 pattern

PH

27

Right Ventricular Strain Pattern

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



28

Pulmonary Hypertension

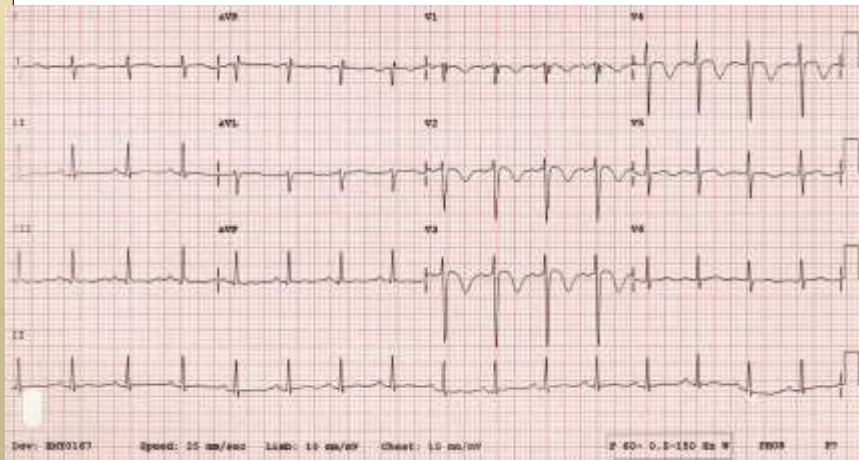


29

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

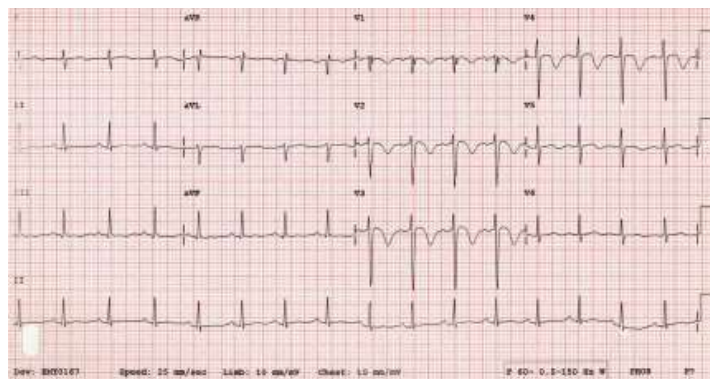
30



W

31

Wellens Syndrome



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

W

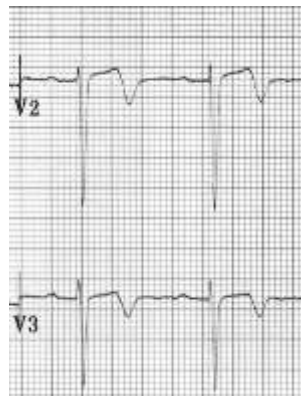
32

Two patterns of T-wave abnormality in Wellens syndrome

- **Type A** – Biphasic, with initial positivity and terminal negativity (25% of cases)
- **Type B** – Deeply and symmetrically inverted (75% of cases)

33

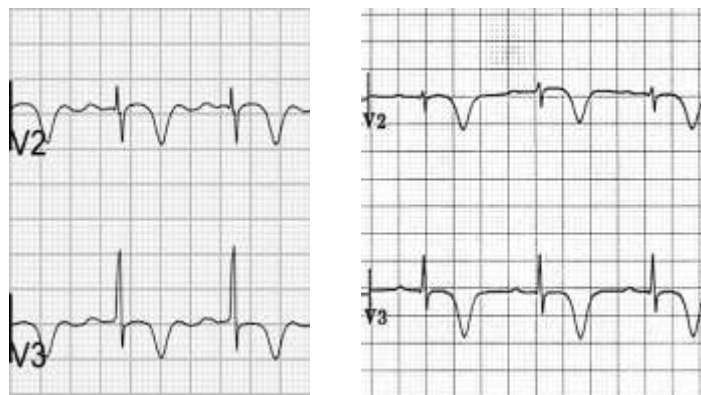
Type A Biphasic T Waves



Biphasic, with initial positivity and terminal negativity (25% of cases)

34

Type B Deeply Inverted T Waves



Deeply and symmetrically inverted (75% of cases)

35

Wellens Diagnostic Criteria

- Deeply-inverted or biphasic T waves in V2-3 may extend to V1-6
- Isoelectric or minimally-elevated ST segment (< 1mm)
- No precordial Q waves
- Preserved precordial R wave progression
- Recent history of angina
- ECG pattern present in pain-free state
- Normal or slightly elevated serum cardiac markers

Reference: Rhinehart et al. *Am J Emerg Med.* 2002 Nov;20(7):638-43.

36

Wellens T wave Evolution

T wave changes can evolve over time from Type A to Type B pattern ([Smith et al](#)).

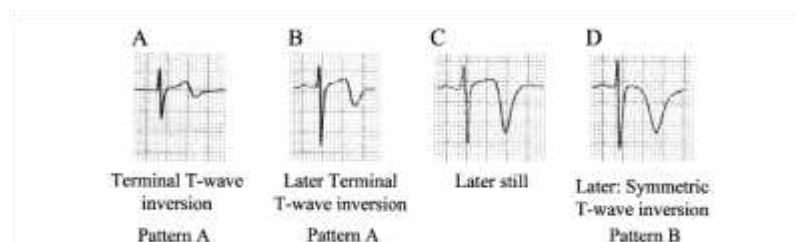


Fig. 19. Evolution of T-wave inversion (A–D) after coronary reperfusion in STEMI reperfusion and in Wellens syndrome (NSTEMI). Reprinted with permission from Smith SW, Zvosec DL, Sharkey SW, Henry TD. The ECG in acute MI: an evidence-based manual of reperfusion therapy. 1st edition. Philadelphia: Lippincott, Williams, and Wilkins; 2002. p. 358.

Reference: Smith et al. (N Engl J Med. 1980; 303:897–902.)

37

Possible sequence of events with Wellens syndrome

- A sudden occlusion of the LAD
 - causing a transient anterior STEMI.
 - The patient has chest pain & diaphoresis.
 - May not be successfully captured on an ECG recording.
- Re-perfusion of the LAD (e.g. due to spontaneous clot lysis or prehospital aspirin).
 - The chest pain resolves.
 - ST elevation improves and T waves become biphasic or inverted.
 - The T wave morphology is identical to patients who reperfuse after a successful PCI.
- If the artery remains open, the T waves evolve over time from biphasic to deeply inverted.

Reference: <https://litfl.com/wellens-syndrome-ecg-library/>

38

Possible sequence of events with Wellens syndrome (cont.)

- - The coronary perfusion is unstable
 - LAD can re-occlude at any time
 - If this happens, the first sign on the ECG is an apparent normalisation of the T waves — so-called “pseudo-normalisation”
 - The T waves switch from biphasic/inverted to upright and prominent.
 - This is a sign of hyperacute STEMI and is usually accompanied by recurrence of chest pain, although the ECG changes can precede the symptoms.
 - If the artery remains occluded, the patient now develops an evolving anterior STEMI.
 - Alternatively, a “stuttering” pattern may develop, with intermittent reperfusion and re-occlusion.
 - This would manifest as alternating ECGs demonstrating Wellens and pseudonormalisation/STEMI patterns.

Reference: <https://litfl.com/wellens-syndrome-ecg-library/>

39

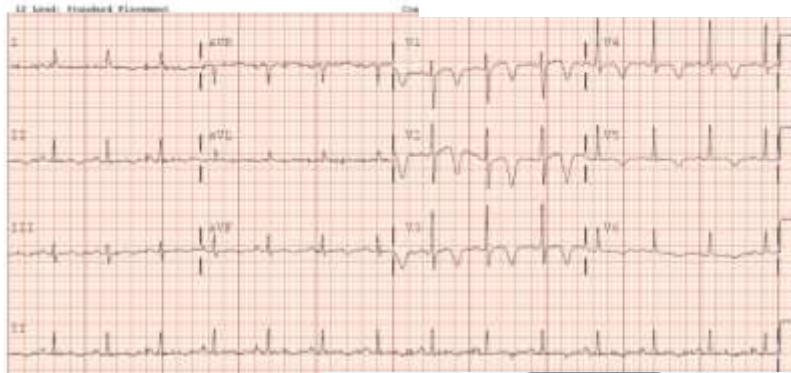


TC

40

Takotsubo Cardiomyopathy Pattern EKG 12/4

RR 88 -biv. rhythm
 PR 164 -Normal P-wave progression; early transition
 QRS 97 -Deep V, yentricular lead, anteriorly placed lead
 QT 407 -Prolonged QT interval
 QTc 447 -Was compared with ECG of 11-Dec-2017 10:02:28;
 STc 141 -Was no increased ischemic or infarction
 - ADIS - -Significant repolarization change
 - ADIS - -Change in sinus rate above
 P 72
 QRS 97
 T 123 -ABNORMAL ECG-

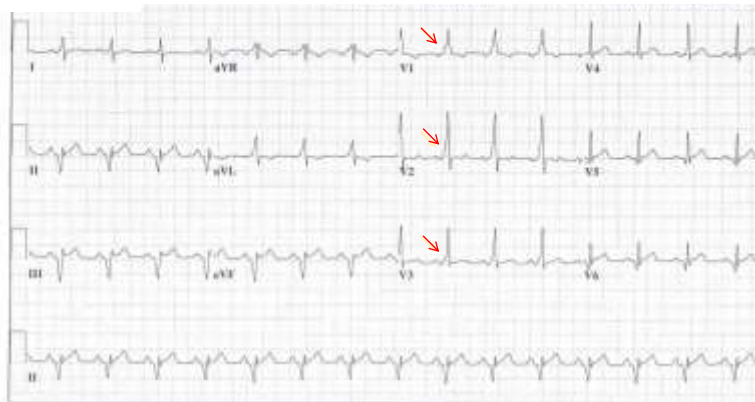


EF 25 – 30%
 Normal Coronary Arteries

	5 10/31/2016 1704	4 11/23/2017 8625	3 12/4/2017 1816	2 12/14/2017 1515	1 12/14/2017 2130
CARDIAC PROFILE					
Isoprene	-0.015 *	-0.015 *	-0.015 *	-0.015 *	-0.025 *
ReBNP	233 *	2,852 *			

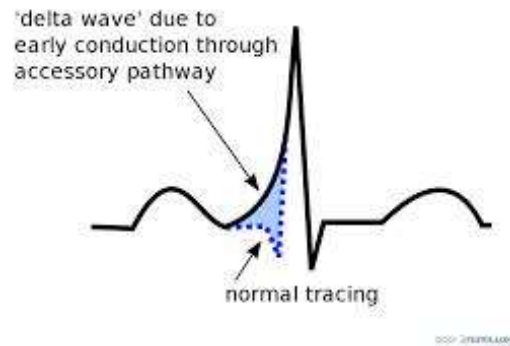
41

Vals. cm 90 BPM
 PR interval 122 ms
 QRS duration 118 ms
 QT/QTc 364/350 ms
 T-A-T axis 64 -97 78



42

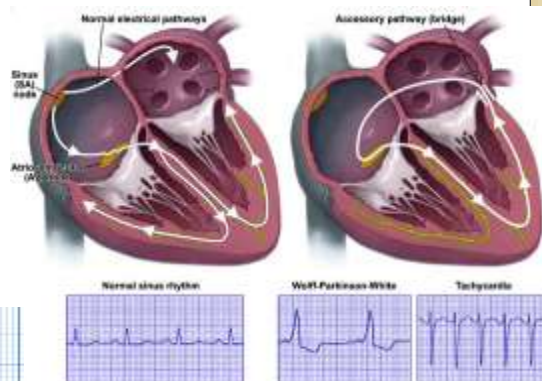
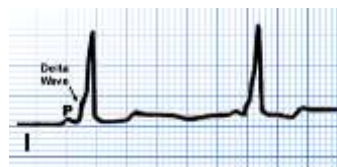
Wolff-Parkinson-White Syndrome



43

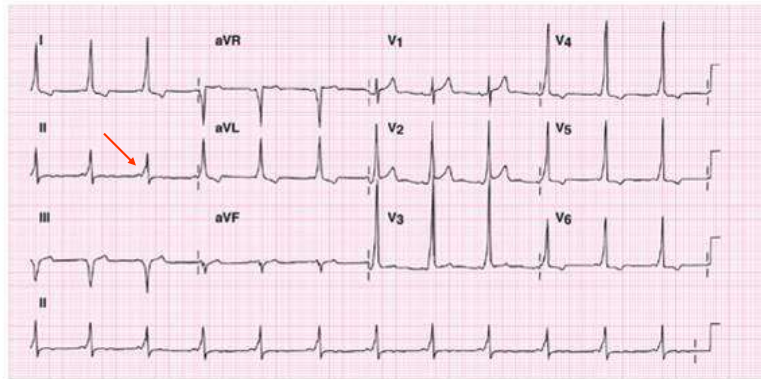
Wolff-Parkinson-White syndrome

- An extra electrical connection between the atria and the ventricles



44

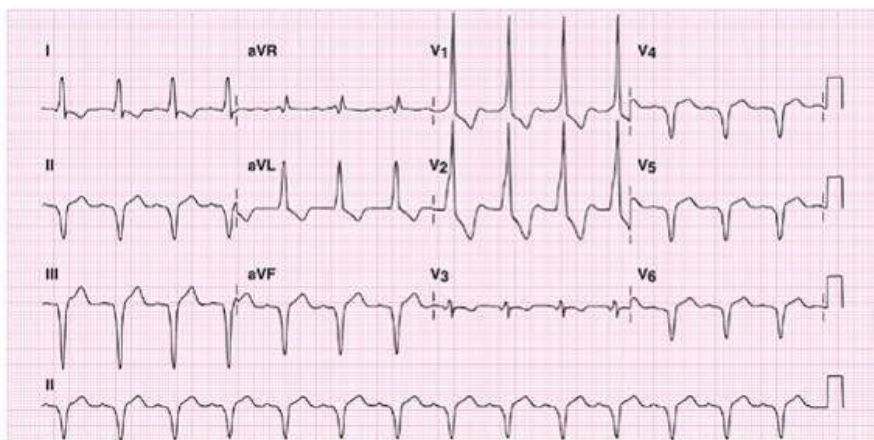
ECG 10-3 Wolff-Parkinson-White Syndrome



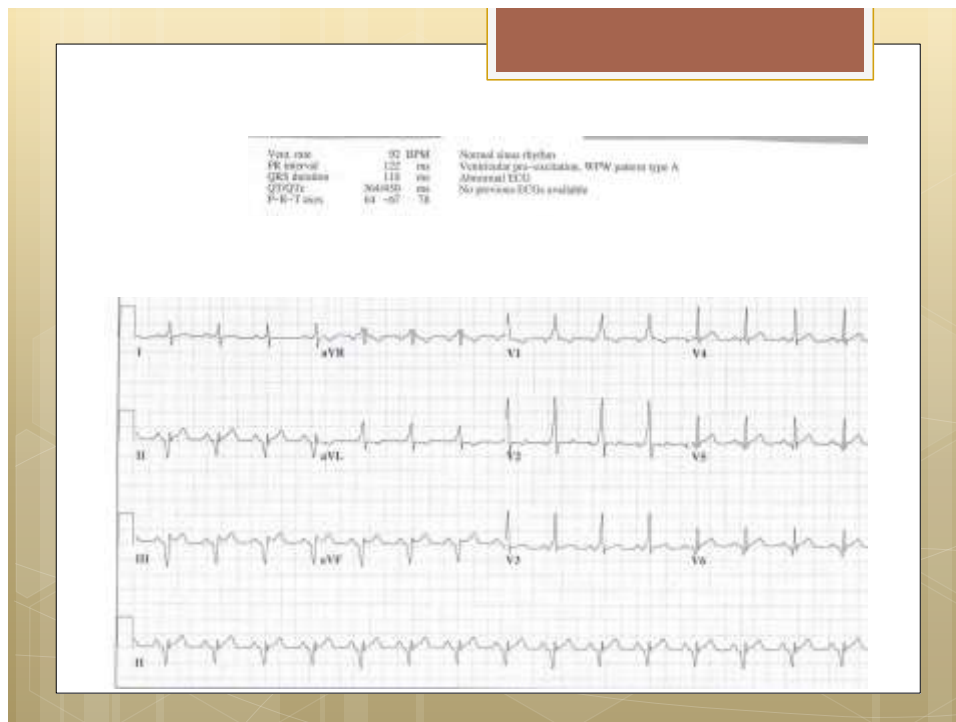
- Shortened PR interval < 0.12 sec with a normal p wave
- Wide QRS complex ≥ 0.11 sec
- The presence of a delta wave
- Association with paroxysmal tachycardias – can be fatal

45

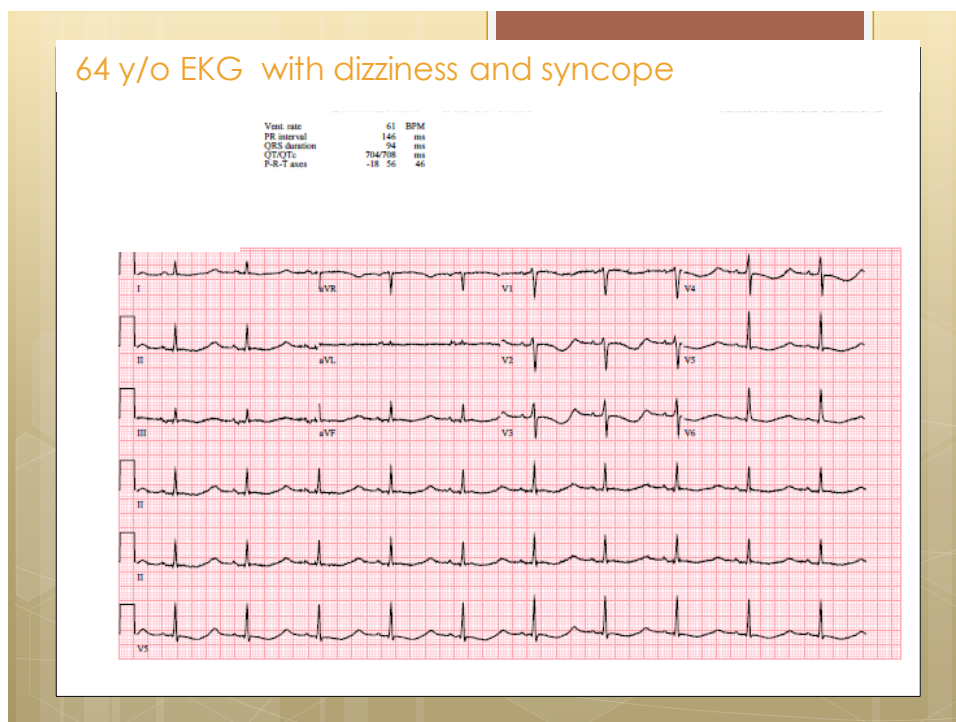
ECG 10-6 Wolff-Parkinson-White Syndrome



46



47



48

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

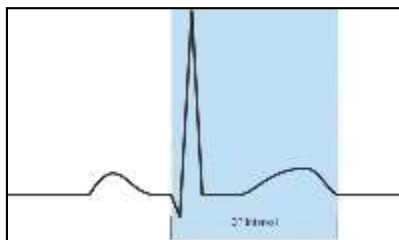
- Potassium 2.2

49

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”



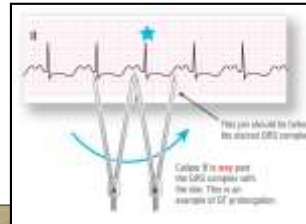
Upper limits of Q-T interval – Rate Based

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.

50

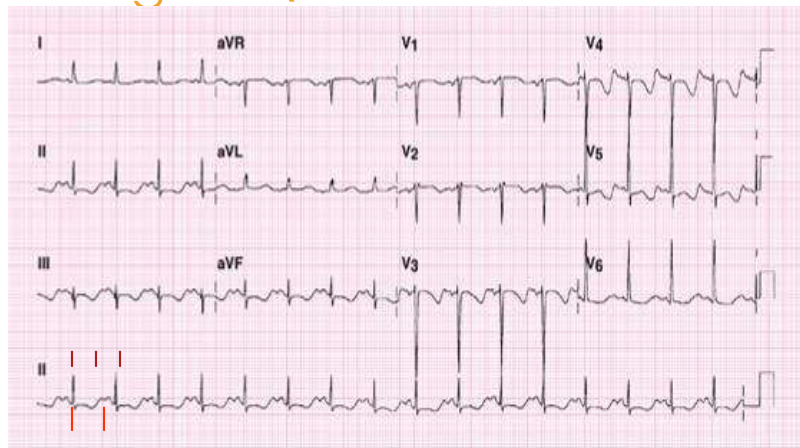
Prolonged QT

- 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.



51

Prolonged QT



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

52

Long QT Syndrome (LQTS)

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

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Drug-Induced Long QT Syndrome

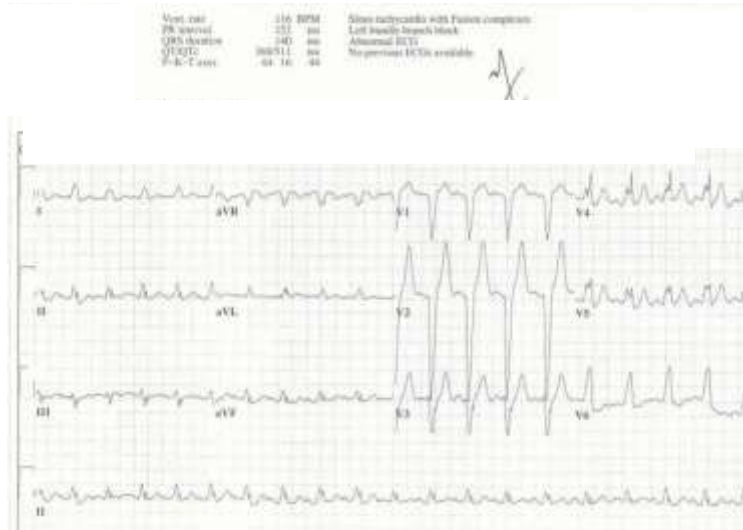
Table 1. Drugs implicated in drug-induced long QT syndrome.

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, grepulofacin, 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, perphenazine, trifluoperazine, fluphenazine, fenthazine, haloperidol, thioridazine, droperidol, meprobazine, pimozide, risperidone, quetiapine, ziprasidone, lithium, chloral hydrate, pericydine, sertindole, vortioxetine, zolmitriptan, mirtazapine
Anti-migraine	Naratriptan, sumatriptan, zolmitriptan
Bronchodilators	Albuterol, salmeterol
Diuretics	Furosemide, thiazide, furosemide
Gastrointestinal stimulants	Cisapride, metoclopramide, domperidone
Hormones	Oestrone, vasopressin
Immunosuppressives	Tacrolimus
Others	Arsenic trioxide, aconitine, veratridine, vincamine, terfenadine, budipine, tiranidine, tiapride, cocaine, organophosphorus compounds

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

54

Admission EKG 12:26



55

EKG 2 years prior to event



56