

Basic ECG interpretation

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- **NOTE:** This ECG interpretation approach to help to diagnose some most common disorders. It is important to note that there are many other helpful approaches to interpret ECG and there are many disorders **not** covered in this approach.

Recall the approach

- 1. Take a deep breath**
- 2. Analyze rate**
- 3. Analyze rhythm**
- 4. Look at axis**
- 5. Look for injury/strain/ischemic patterns**
- 6. Look for conduction deficits (RBBB, LBBB)**
- 7. Hypertrophy, meds, toxic effects**
- 8. Make your measurements (PR, QT/QTc, QRS)**

Another approach

* Like this*

- Look at :

- Rhythm → Irregular: AFB - Atrial flutter - 2nd degree block - Sinus Arrhythmia

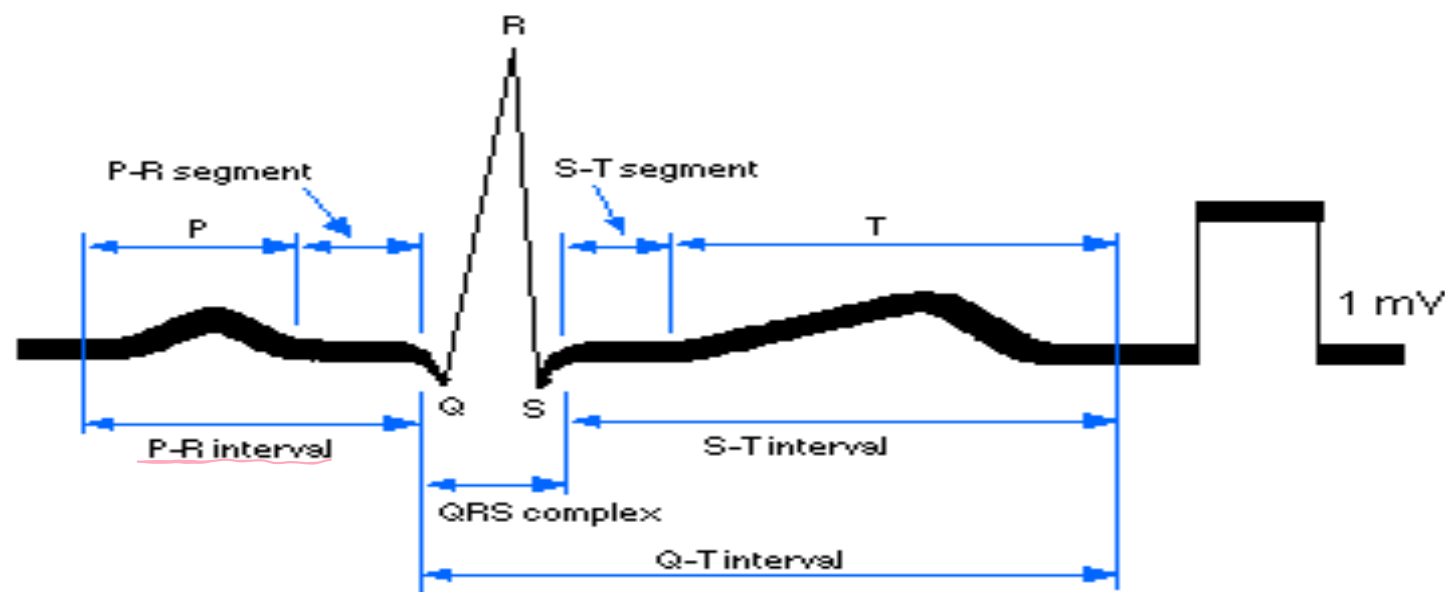
↳ from Lead 2

- Rate

- Axis

- P wave, P-R interval, Q wave, QT interval, QRS complex, ST segment, T-wave.

Normal ECG Waveform (Lead I)

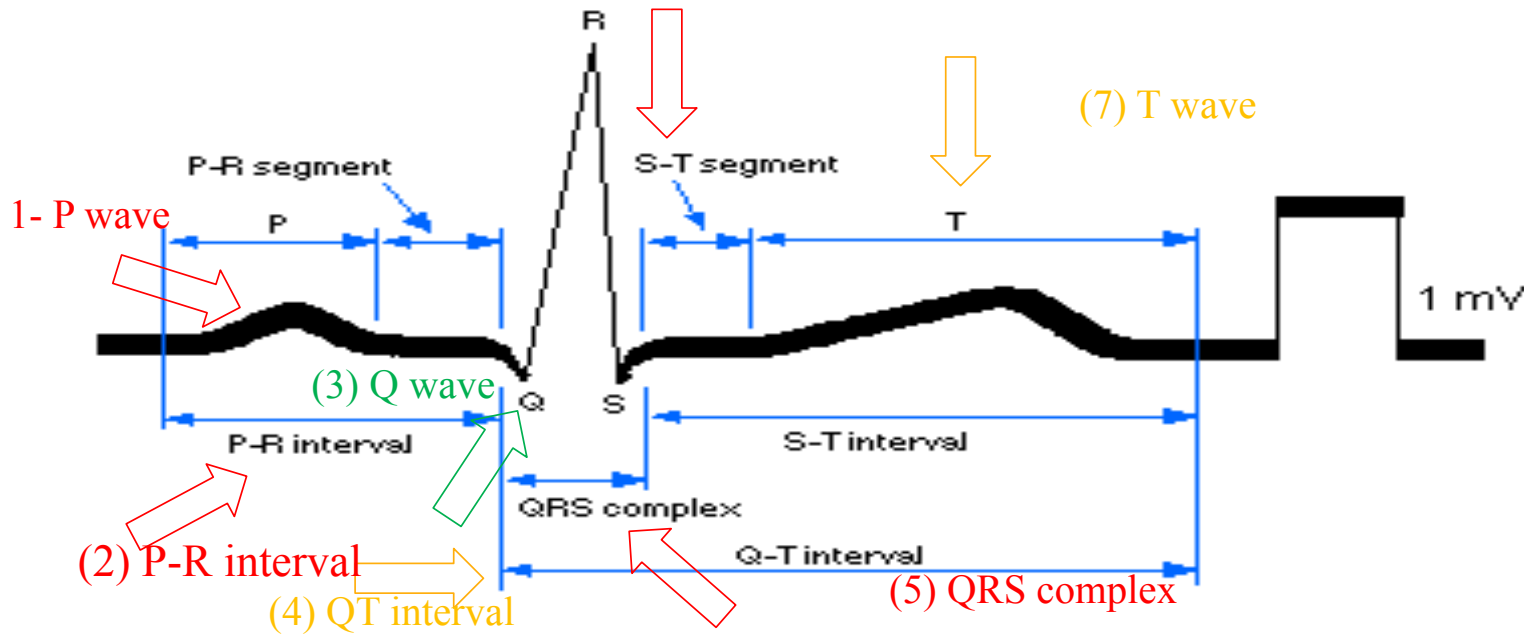


Normal Values for Amplitudes and Durations of ECG Parameters:

Amplitude:	P wave	0.25 mV	Atrial Depolarization
	R wave	1.60 mV	
	Q wave	25% of R wave	
	T wave	0.1 to 0.5 mV	Ventricular Repolarization
Duration:	P-R interval	0.12 to 0.20 sec	
	Q-T interval	0.35 to 0.44 sec	
	S-T segment	0.05 to 0.15 sec	
	P wave interval	0.11 sec	
	QRS interval	0.09 sec	Ventricular Depolarization

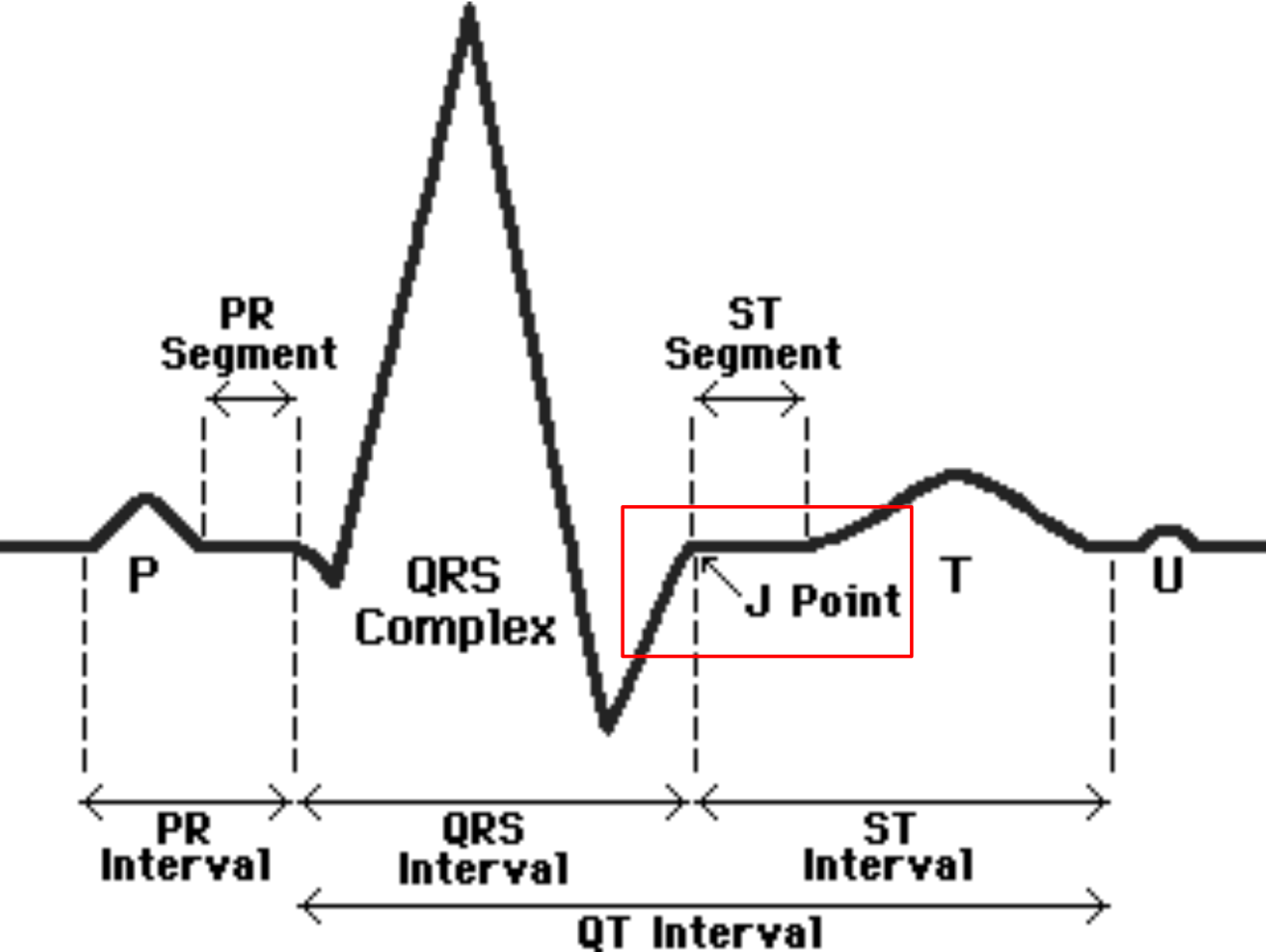
Normal ECG Waveform (Lead I)

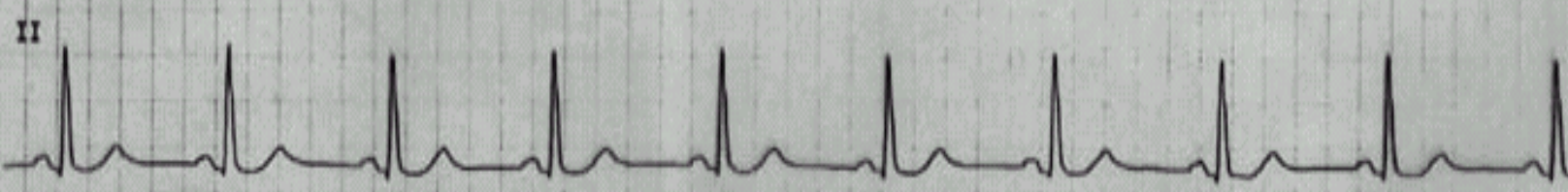
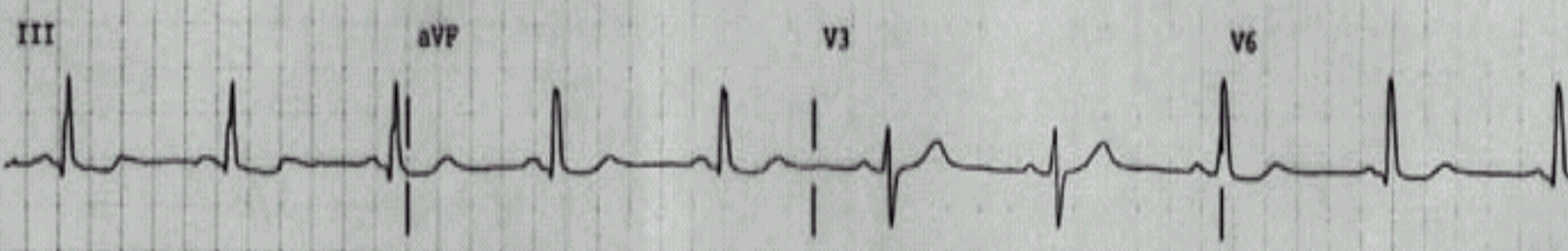
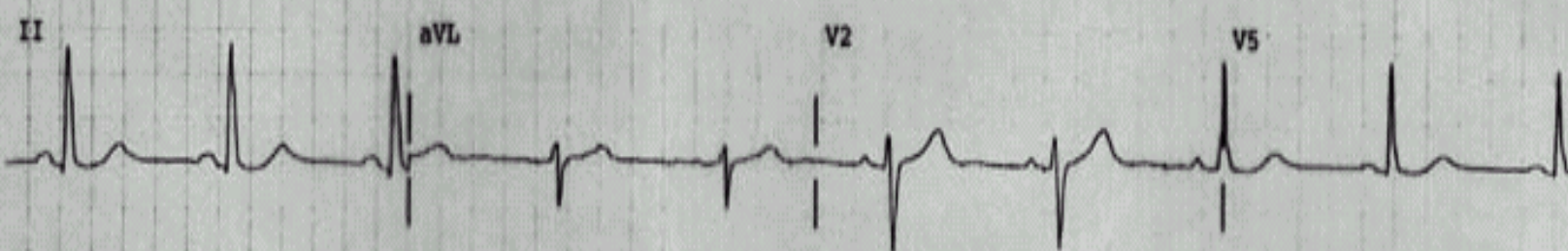
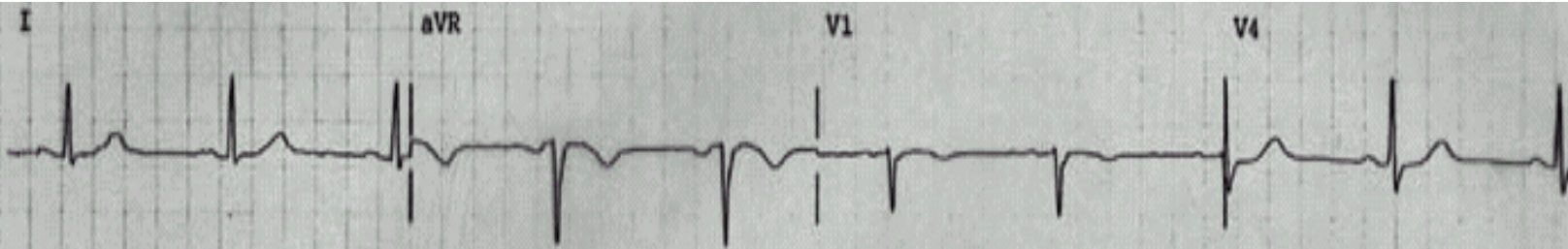
(6) S-T segment



Normal Values for Amplitudes and Durations of ECG Parameters:

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	P wave interval	0.11 sec	
	QRS interval	0.09 sec	Ventricular Depolarization





Irregular rhythm

- there are many causes but the most important and common are:
 1. Atrial Fibrillation
 2. Atrial flutter
 3. Second degree heart block Type1 (mobitz 1)
 4. Second degree heart block T2 (mobitz II)
 5. Sinus arrhythmia

Rate:

- if regular rhythm:

- > calculate big square between R-R:

- if > 5 big square (bradycardia)

- if < 3 big square (tachycardia)

- if between 3 and 5 big squares (normal heart rate)

- > calculate the big squares between R-R

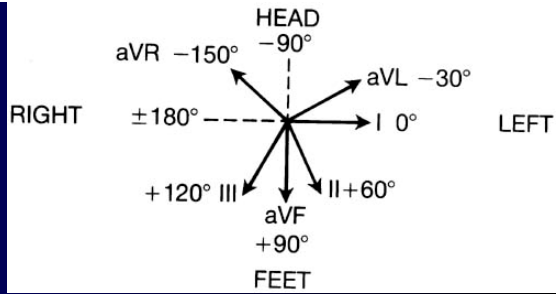
Number of squares	1 square	2 squares	3 squares	4 squares	5 squares	6 squares
Heart rate	300	150	100	75	60	40

- > in standard ECG: calculate the number of QRS complex in ECG and multiply by 6

- > Method working for regular and irregular rhythm:

- measure 30 big square on ECG strip, then calculate how many QRS complex within this 30 big square, then multiply the number of QRS complex by 10 then you will get the heart rate.

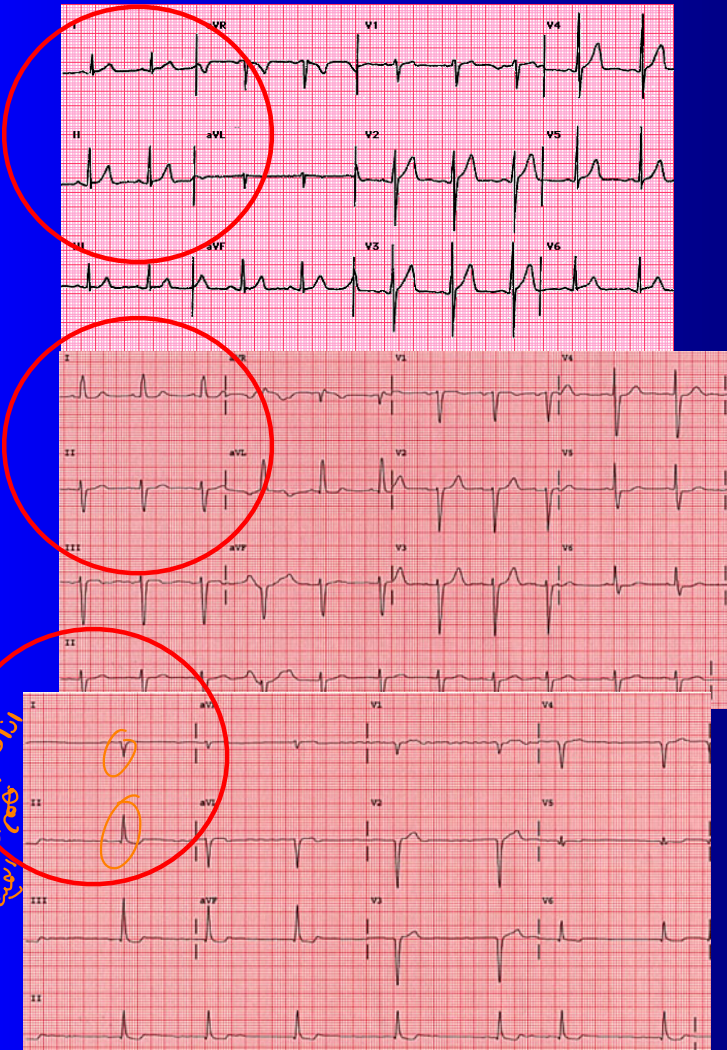
Axis trick



Positive in I and II = normal

Positive in I
Negative in II = LAD

Negative in I
Positive in II = RAD



انقلاب
موج

P-Wave

- **P wave**: better seen in lead II.
- **absent P wave** can be seen in many disorders, the most important and common causes are: DDX :
 - **Atrial Fibrillation**: (if absent P wave + irregular rhythm = consider it as Atrial Fibrillation)
 - **SVT (supraventricular tachycardia)**: regular narrow complex tachycardia with absent P wave
 - **VT (V tach) (Ventricular tachycardia)**: any wide QRS complex tachycardia is considered VT until proven otherwise.
 - **VF (V fib) (ventricular Fibrillation)**: An ECG finding of a rapid grossly irregular ventricular rhythm with marked variability in QRS cycle length, morphology, and amplitude.

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PR interval:

- Prolong PR interval >0.2 sec (> 200 ms) (>5 small boxes)
= AVB (1st, 2nd type1, 2nd type2 or 3rd degree heart block)
or hyperkalemia
- **Short PR interval** <0.120 sec (120 ms) (< 3 small squares)
= **most important** cause is WPW which is associated with
delta wave.
not necessarily

fx/1

Q- wave:

- Q waves: >1 small square in width and $>25\%$ height of R wave in ≥ 2 contiguous leads suggests old MI

FYI

Q-T interval:

- It is the time between the start of the **Q wave** and the end of the **T wave**
- normal value for the QTc in men is ≤ 0.44 sec (440 ms) and in women is ≤ 0.45 (450 ms)
- if QT interval $>$ half the RR interval; then consider prolonged QT interval
- Q-T interval is a marker for the potential of ventricular tachyarrhythmias like Torsades de pointes and a risk factor for sudden death.

IMPORTANT

QRS complex

- **Wide QRS** if more than 0.12 sec (120 ms) (more than 3 small squares)
- Most important causes of wide QRS complex:
 - Ventricular tachycardia *IMP*
 - Hyperkalemia
 - Bundle branch block (Rt or Lt)
 - WPW (not always wide QRS complex)
 - 3rd degree heart block (not always wide QRS complex)
 - Some drug toxicity "Tricyclic" =

←

IMPORTANT

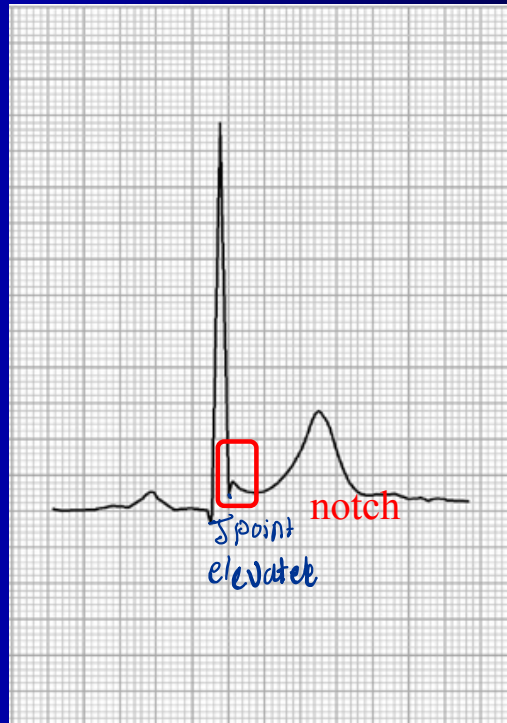
ST segment

- Either elevated or depressed.
- Better determined by J point.
- The best isoelectric line to measure the ST segment elevation or depression is TP.
- Most important and common causes of ST-elevation:
 - **MI** *
 - **Acute pericarditis** (Widespread ST elevation and PR depression in most leads, expect lead AVR will be ST depression and PR elevation)
 - LBBB
 - Benign early repolarization

✚ If you find a notch in ST-segment, then very less likely to be ischemia

IMP

Notch



- Most important cause of ST segment depression:
 - Ischemia (either as part of non STEMI or as a reciprocal changes)
 - LVH with repolarization abnormality

T wave abnormality:

- Peaked, Inverted, biphasic or flattened.
- may be ischemia / injury but
NONSPECIFIC

Bundle Branch Block

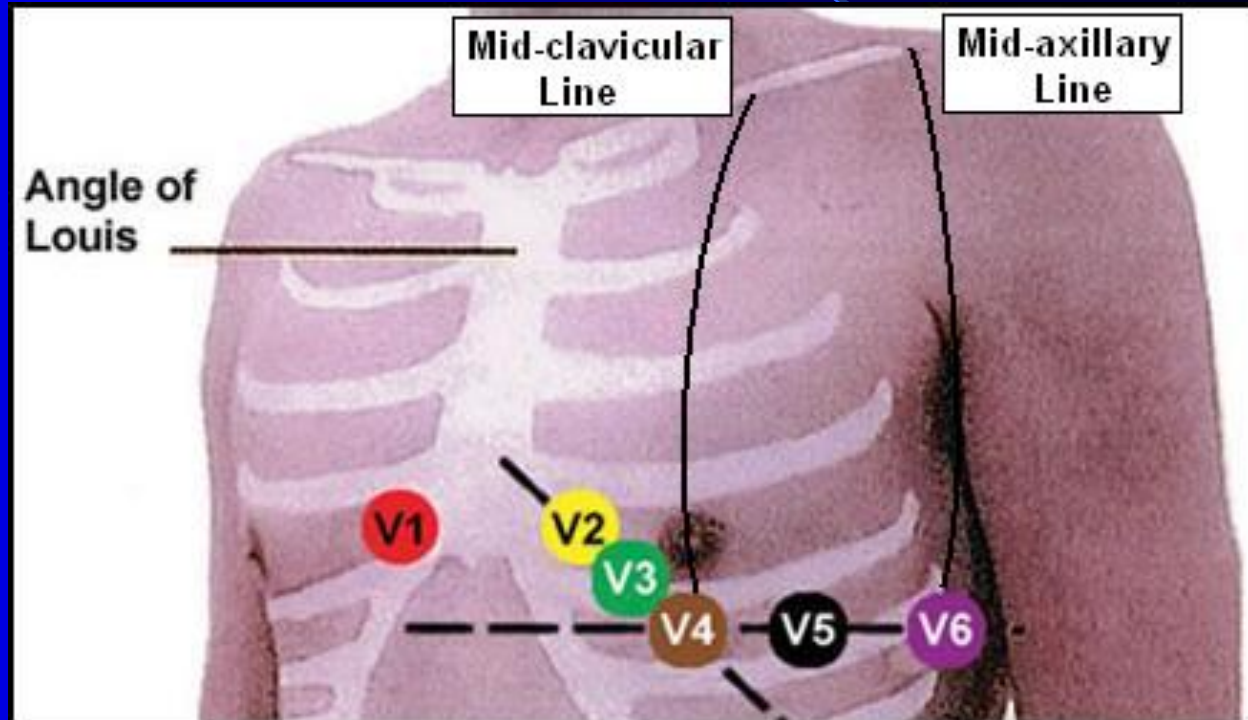
- - LBBB: terminal deflection in lead I (+); bunny ears in V5-V6
WiLLiaM
- - RBBB: terminal deflection in lead I (-); bunny ears in V1-V2
MaRRoW

i.e., with LBBB, there is a W in lead V1 and an M in lead V6, whereas, with RBBB, there is an M in V1 and a W in V6.

Left ventricular hypertrophy

- *VI. Hypertrophy (more muscle -> more voltage)*
 - a. $LVH = SV1 + RV5/6 > 35$ small squares (> 7 big boxes)

Precordial Leads



Adapted from: www.numed.co.uk/electrodepl.html

0123456

09/27/2006
55 Years

19:09:12
Male



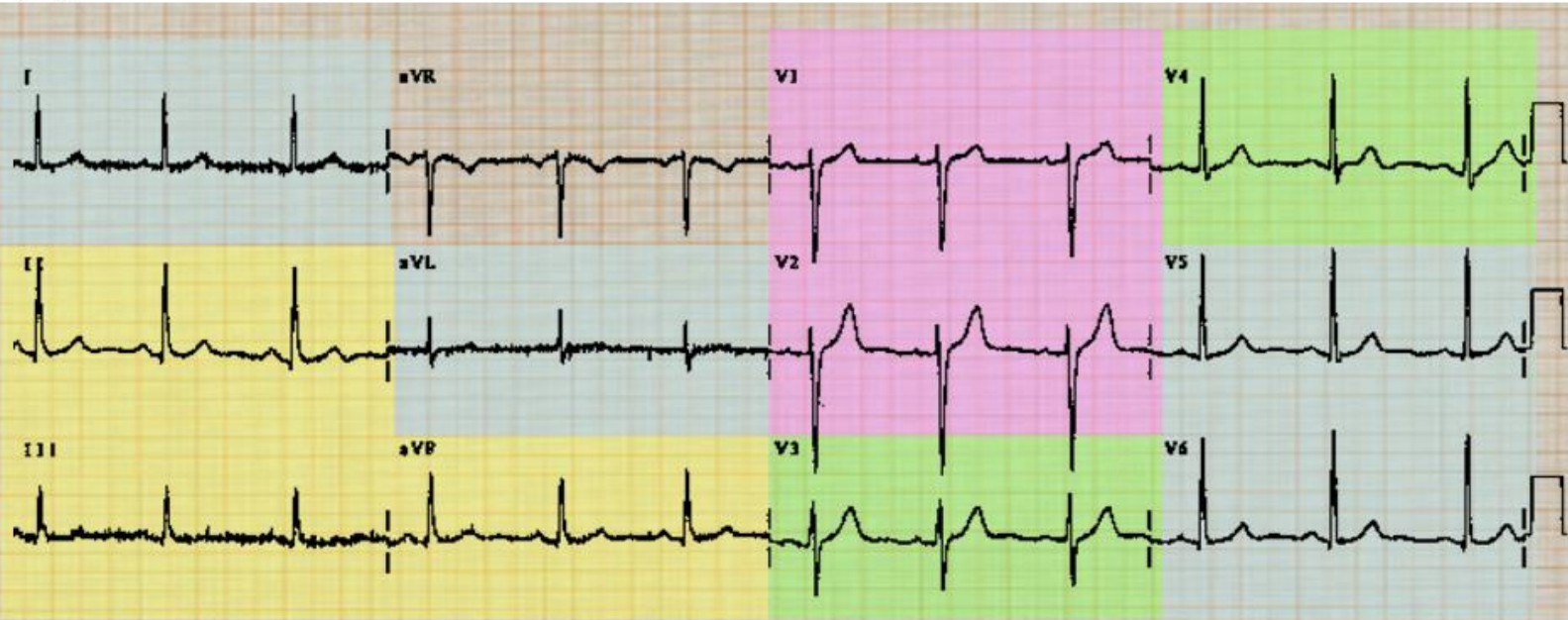
St. Elsewhere General Hospital
Dept: E.D.
Room: 215
Oper: JDM

Rate 71
PR 164
QRSD 102
QT 388
QTc 422

SINUS RHYTHM
BORDERLINE ST ELEVATION,

-- AXIS --
P 57
QRS 69
T 36

PRELIMINARY - MD MUST REVIEW



Inferior Wall



Lateral Wall



Anterior Wall



Septal Wall



Lead Groups

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

Limb Leads

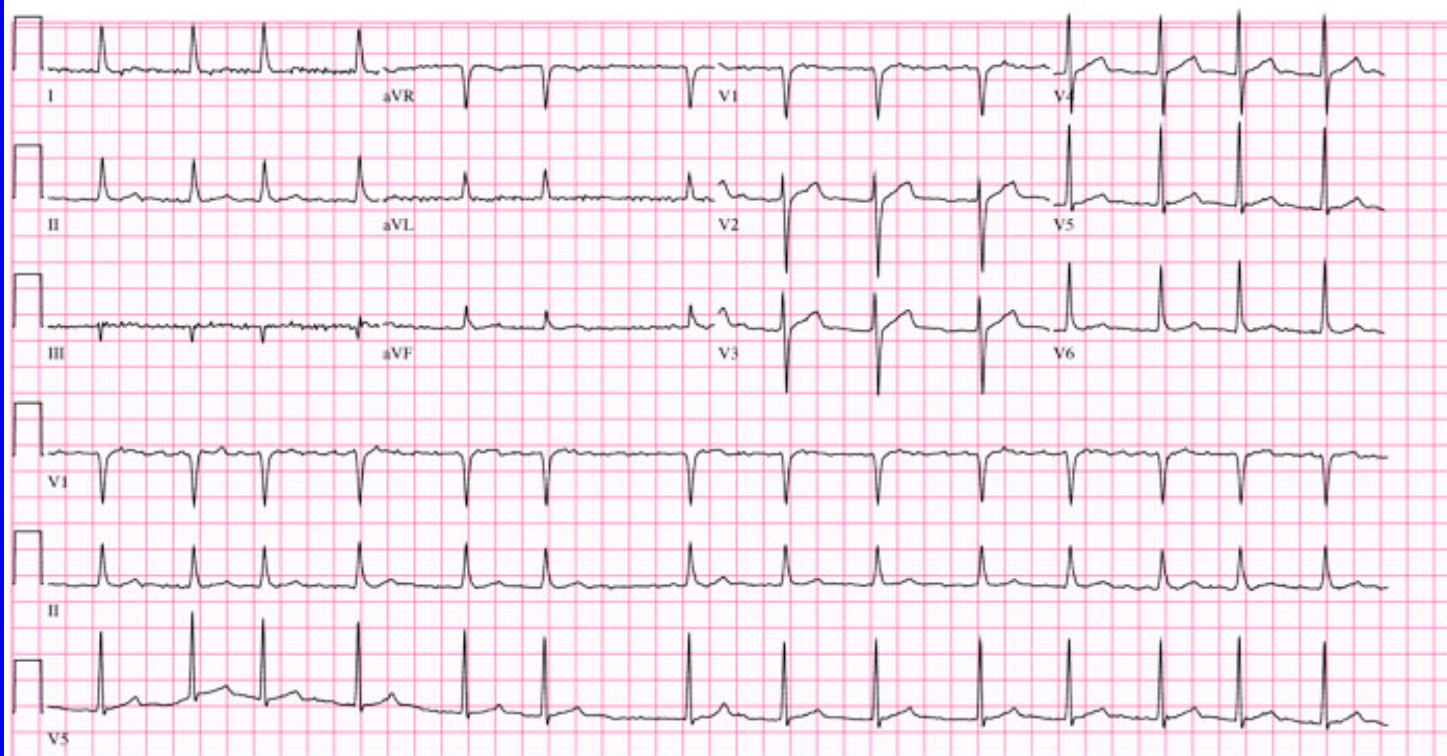
Chest Leads

Interpret the following ECGs



interpretation

- Important finding:
- Saw tooth appearance
- Diagnosis:
- Atrial Flutter



25mm/s 10mm/mV 100Hz 005E 12SL 233 CID: 1

interpretation

- Important findings:
 - Irregular rhythm
 - Absent P-wave
- Diagnosis :
 - Atrial Fibrillation



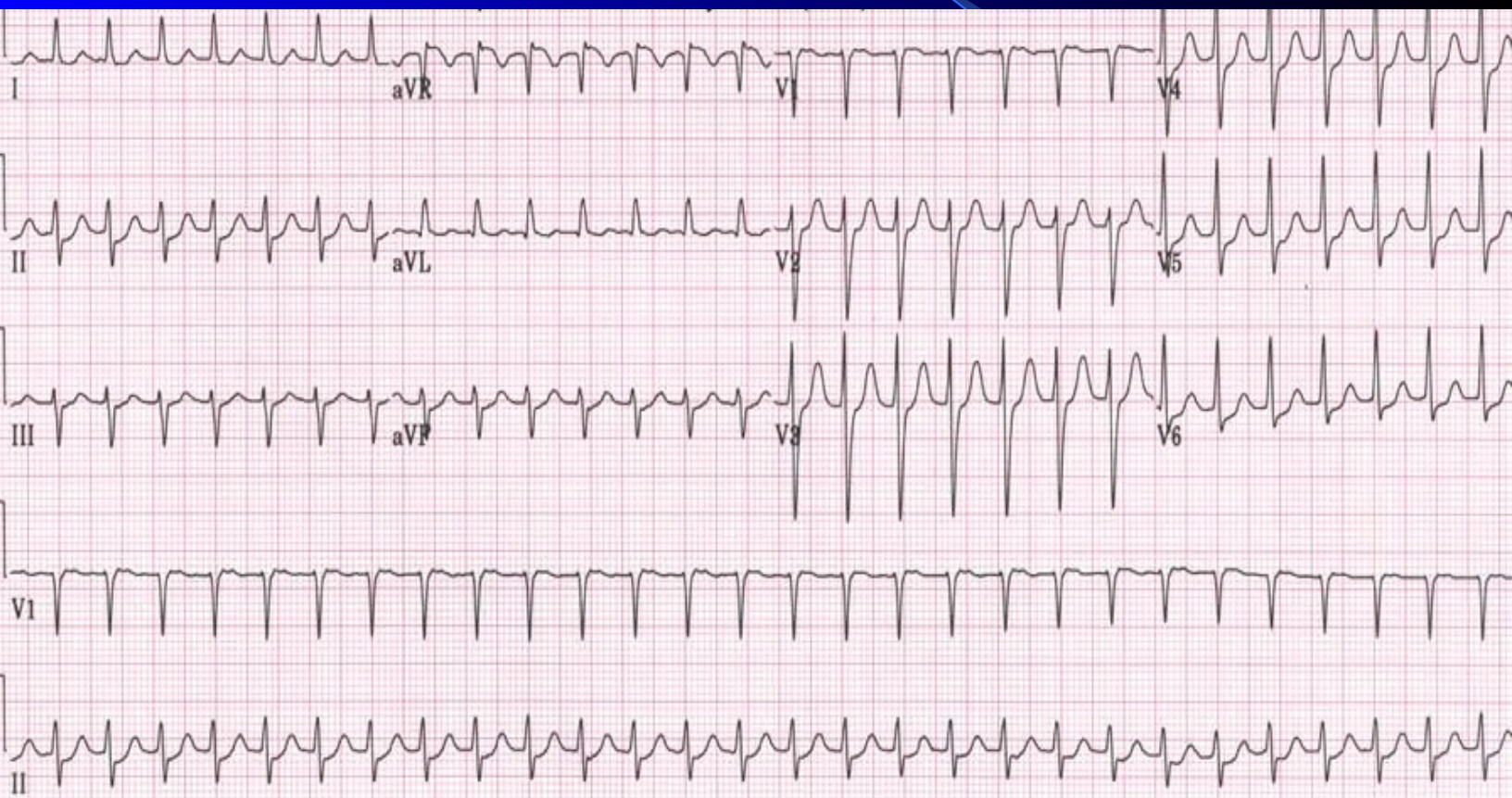
interpretation

Important findings:

- Irregular rhythm
- Present P-wave with normal PR interval

Diagnosis:

- Sinus arrhythmia



interpretation

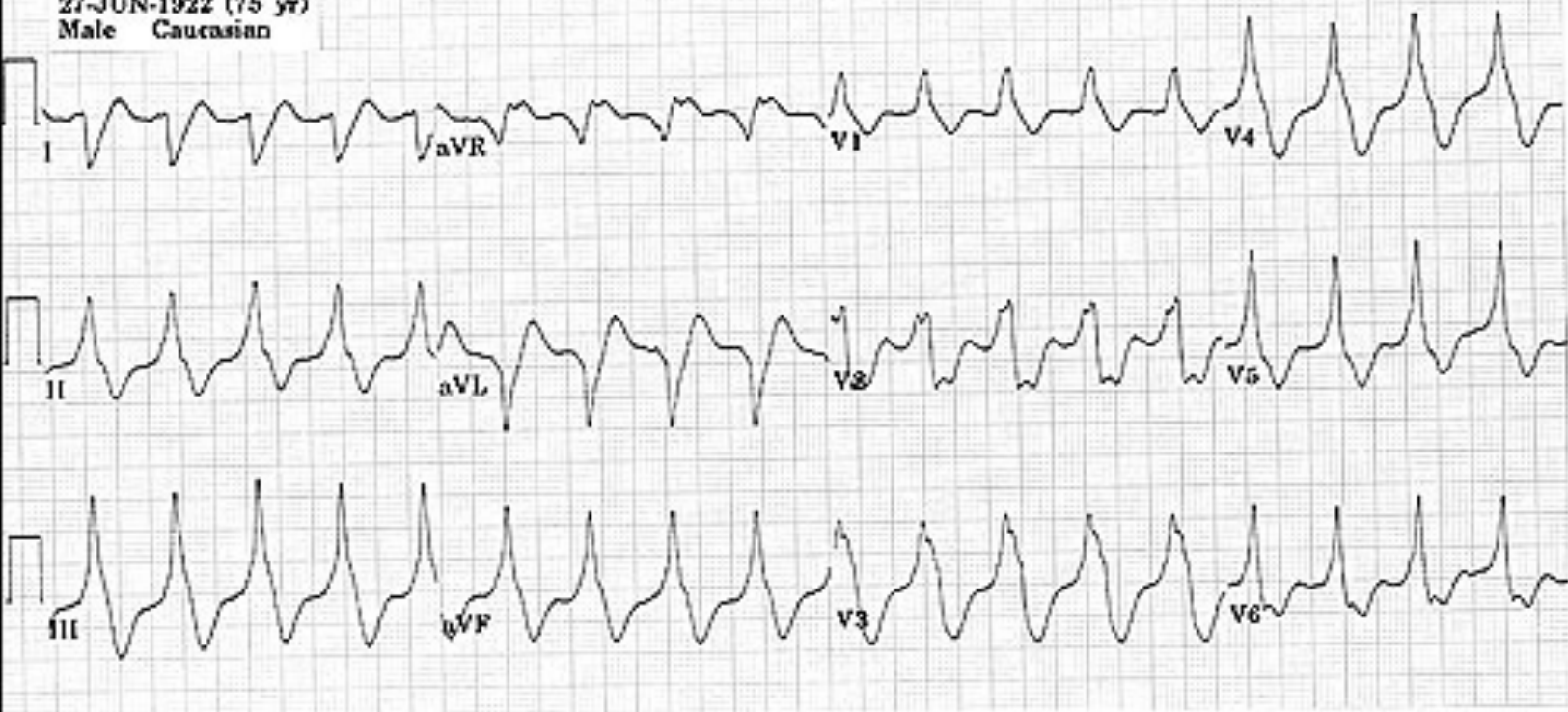
Important findings:

- Regular tachycardia
- Absent P wave
- Normal QRS complex

Diagnosis:

- SVT

27-JUN-1922 (75 yr)
Male Caucasian



interpretation

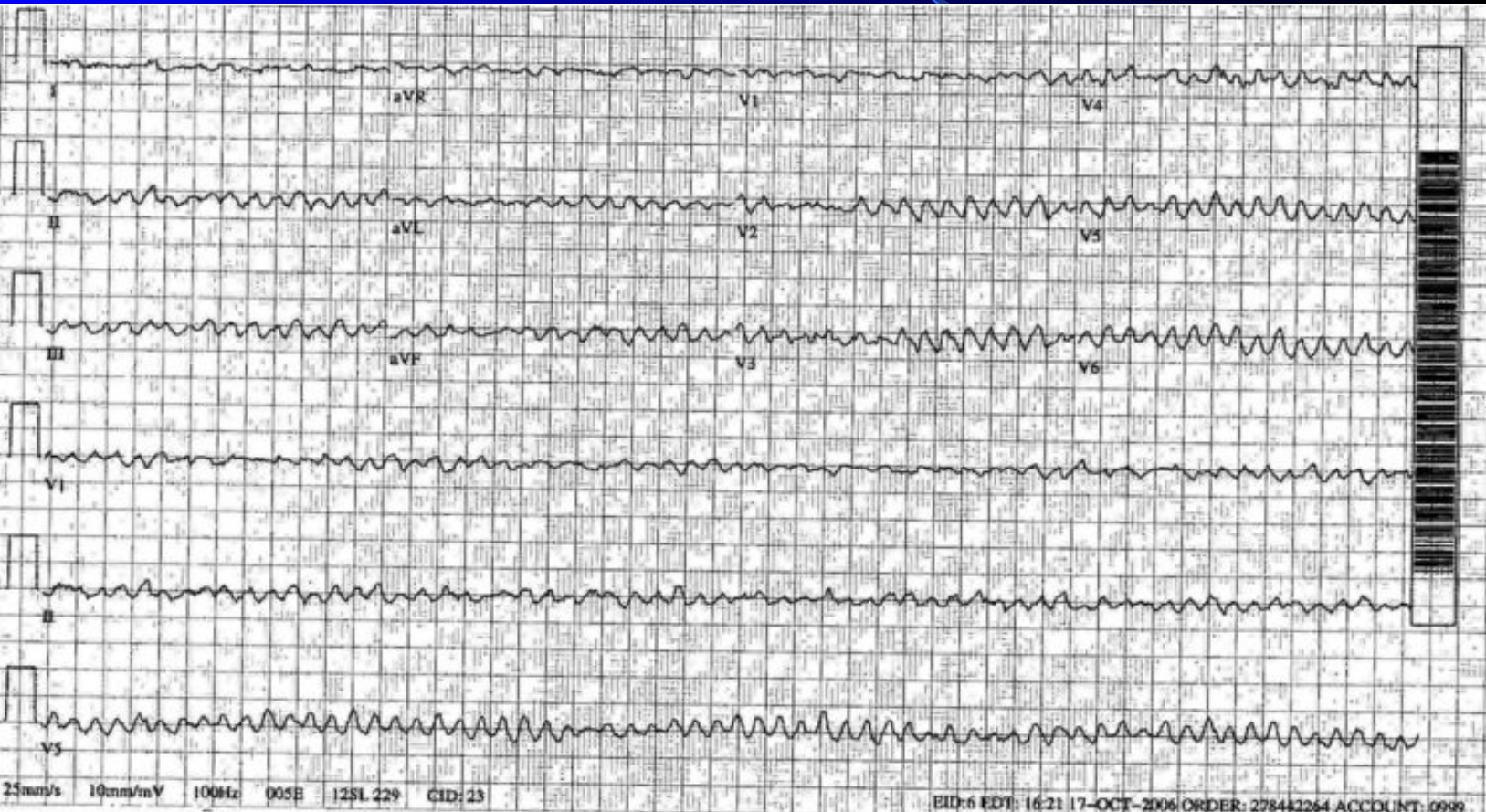
Important findings:

- Regular tachycardia
- Absent P- wave
- Wide QRS complex

Diagnosis:

- Wide QRS complex tachycardia most likely
Ventricular Tachycardia

Ventricular Fibrillation





interpretation

Important findings:

- Regular rhythm
- Fixed prolonged PR interval without QRS complex drop

Diagnosis:

- 1st degree heart block



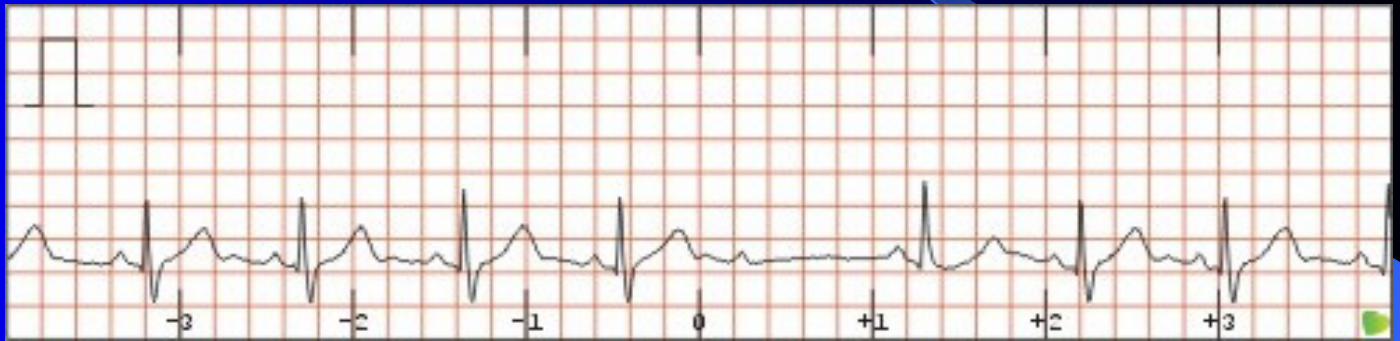
interpretation

Important findings:

- Irregular
- Progressive prolongation of PR interval followed by a drop in QRS complex

Diagnosis:

- 2nd degree heart block type 1 (mobitz 1)



interpretation

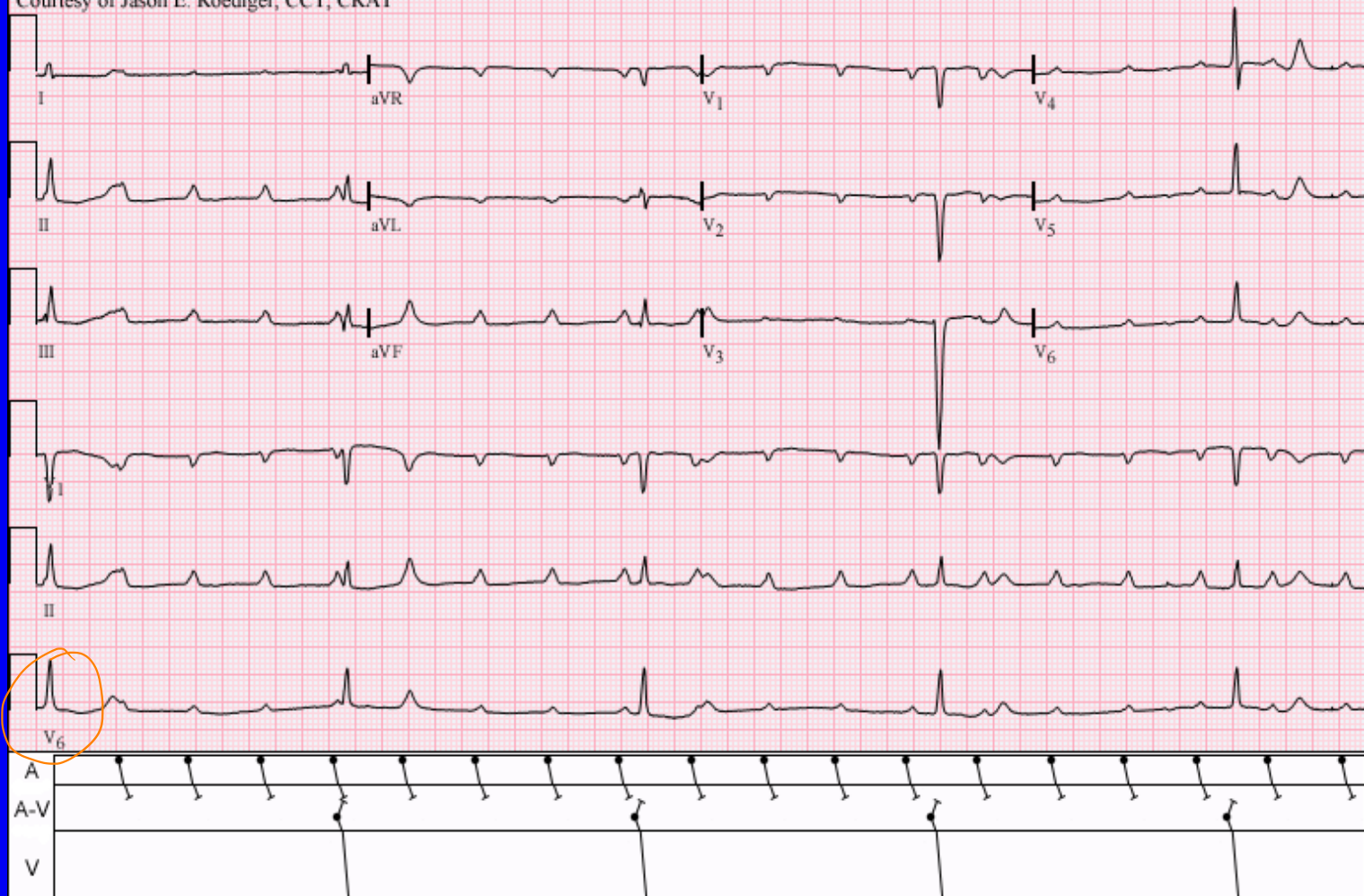
Important findings:

- Irregular rhythm
- Sixed prolonged PR interval followed by drop in QRS complex

Diagnosis:

- 2nd degree heart block type 2 (Mobitz 11)

Courtesy of Jason E. Roediger, CCT, CRAT



interpretation

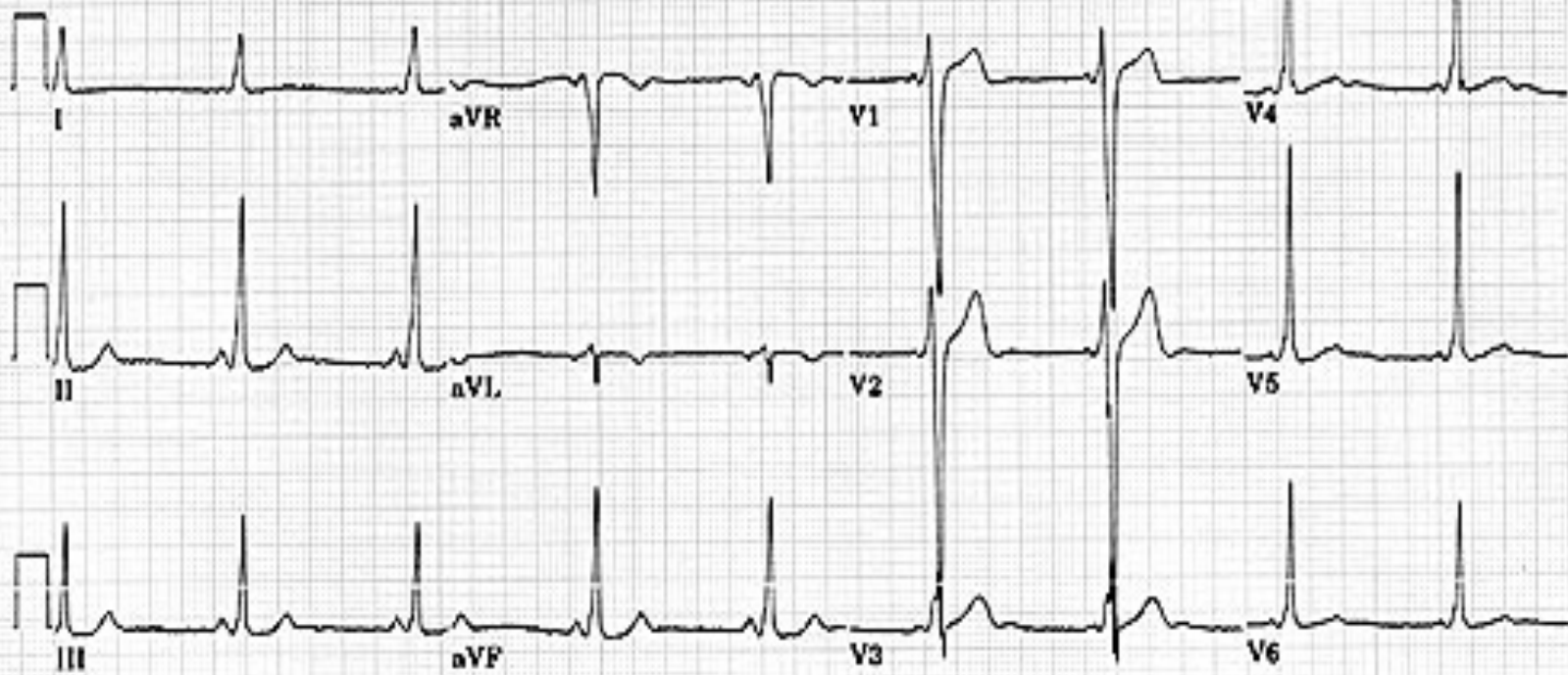
Important findings:

- Regular rhythm
- The P wave with a regular P-to-P interval
- The QRS complex with a regular R-to-R interval.
- The PR interval will be variable, as the hallmark of complete heart block is lack of any apparent relationship between P waves and QRS complexes.

Diagnosis:

- 3rd degree heart block (complete heart block)

30-MAY-1977 (17 yr)
Male Caucasian



07-FEB-1995 17:17

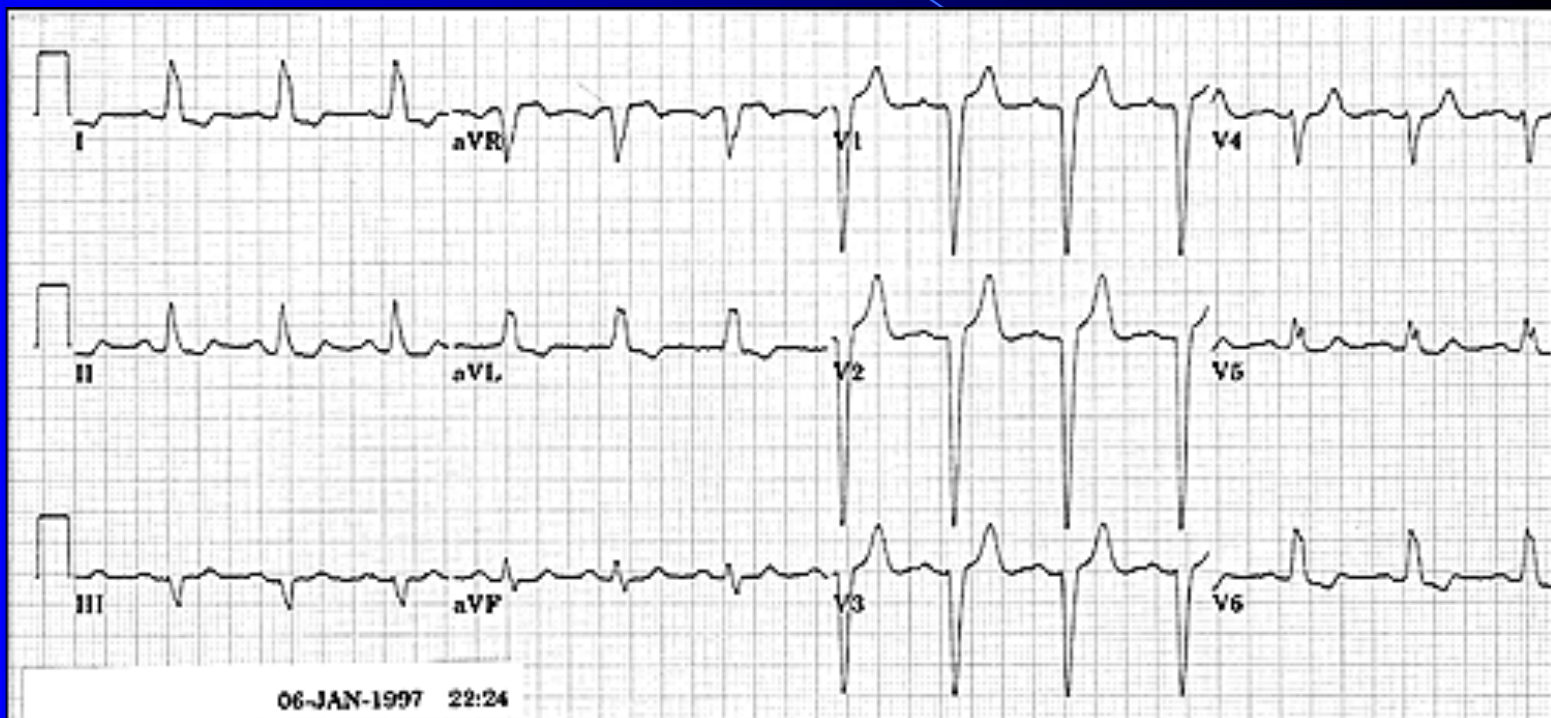
interpretation

Important findings:

- Short PR interval
- Delta wave

Diagnosis:

- WPW



interpretation

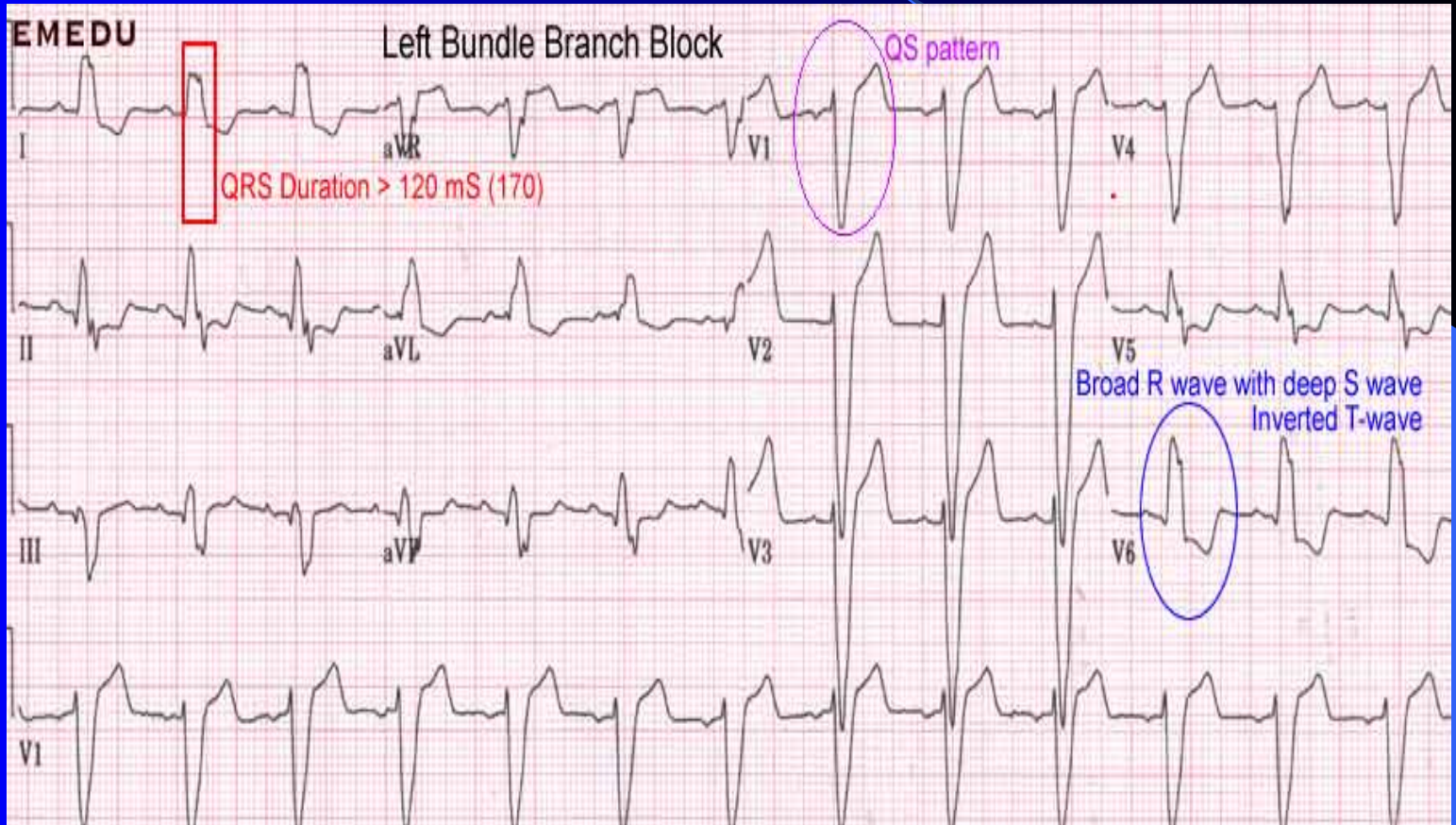
Important findings:

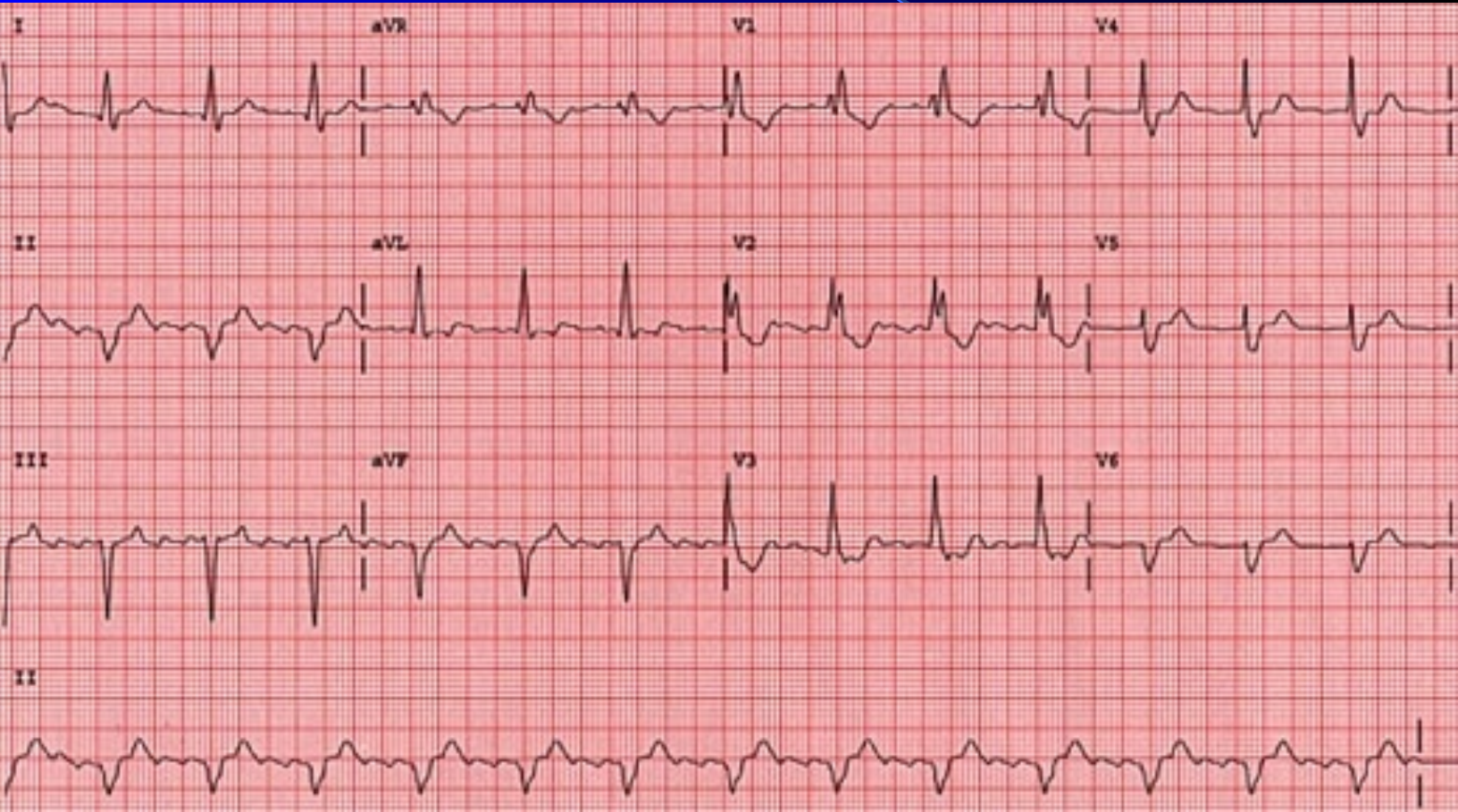
- Wide QRS complex
- ST elevation V1-V2
- notched ('M'-shaped) R wave in lead V6.

Diagnosis:

- Left Bundle Branch Block

Wide QRS (LBBB)





interpretation

Important findings:

- Wide QRS complex
- notched ('M'-shaped) RSR wave in lead V1.

Diagnosis:

- Right Bundle Branch Block

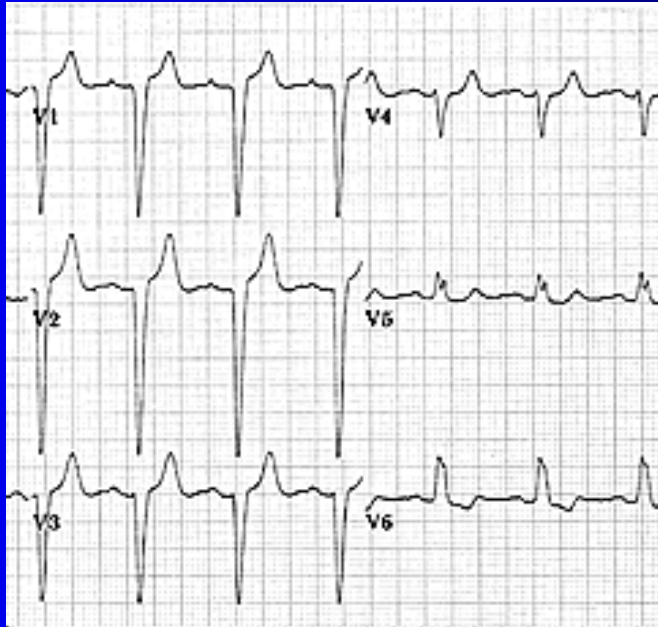
RSR' pattern



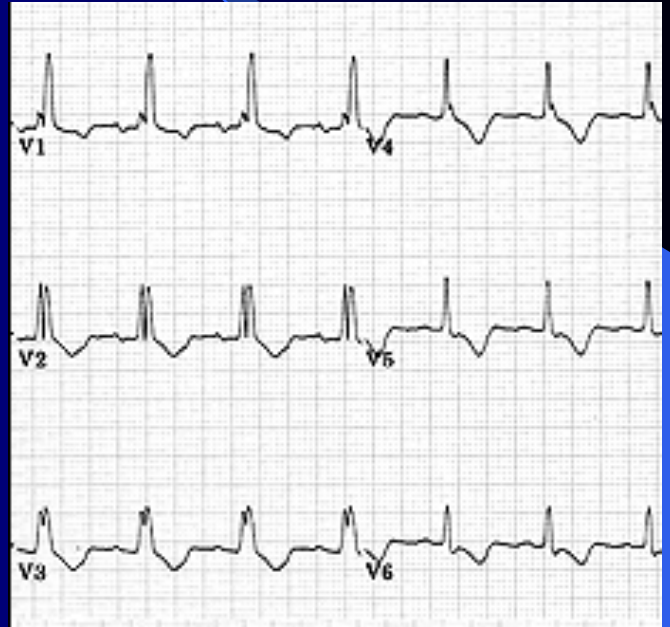
RBBB

19-SEP-1932 (64 yr)
Female Caucasian





LBBB



RBBB



interpretation

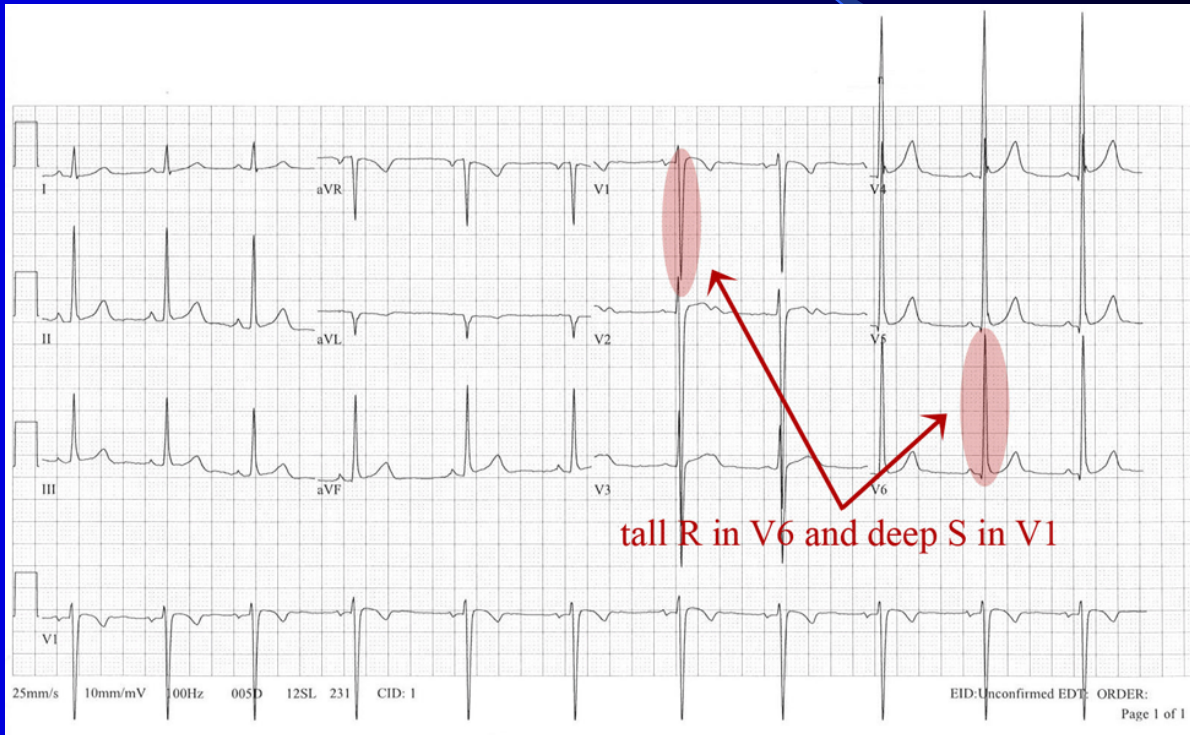
Important findings:

- $SV1 + RV5$ or $6 > 35$ small squares (> 7 big squares)
- ST segment depression in $V5-V6$ (not always present)

Diagnosis:

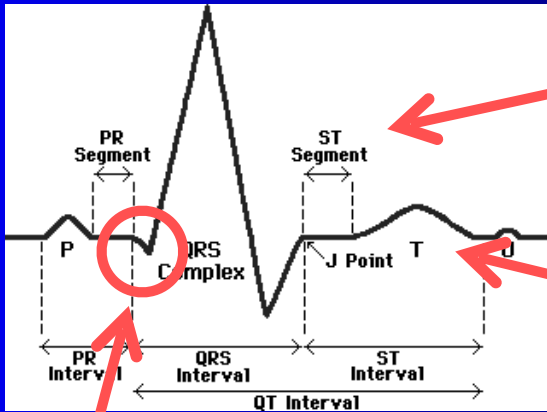
- Left Ventricular Hypertrophy (LVH)

LVH

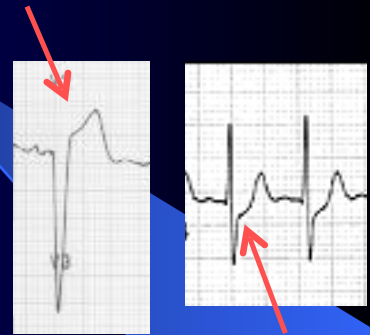


Ischemic ECG Changes

Ways the ECG can change include:



ST elevation & depression



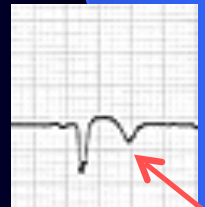
T-waves

peaked

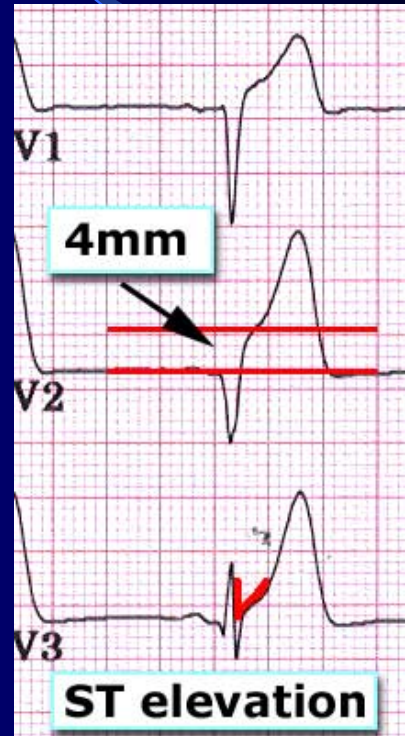
flattened

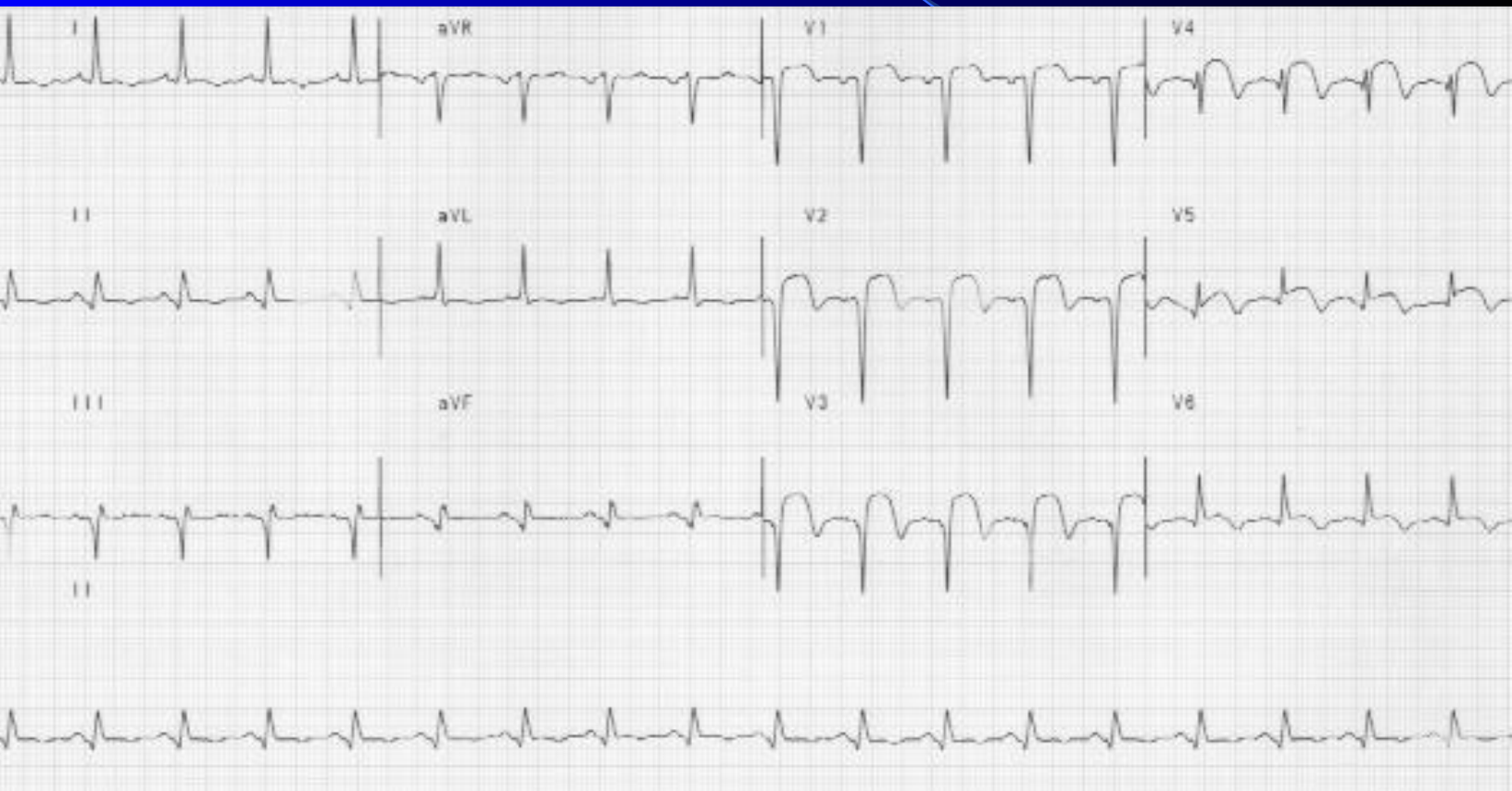
inverted

Appearance of pathologic Q-waves



ST-Segment Elevation





interpretation

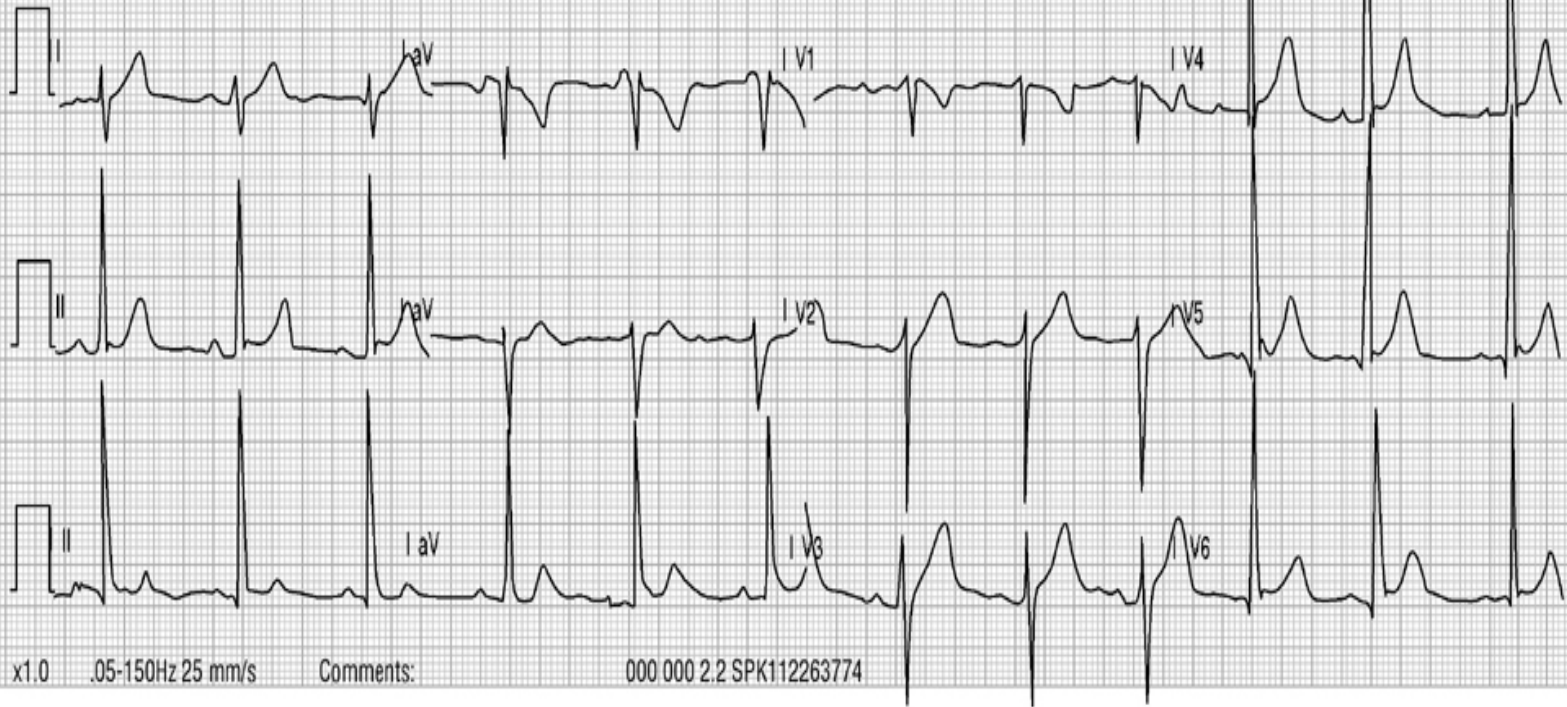
Important findings:

- ST segment elevation in V1-V6
- Flattened T wave in inferior Lead

Diagnosis:

- Most likely anterior MI (based on the Hx and complete picture)

Name: HR: 70 P-QRS-T axes 69 92 44
Age: Sex: PR Int: 176 ARS Dur: 92 QT/QTc: 388/409



x1.0 .05-150Hz 25 mm/s Comments: 000 000 2.2 SPK112263774

interpretation

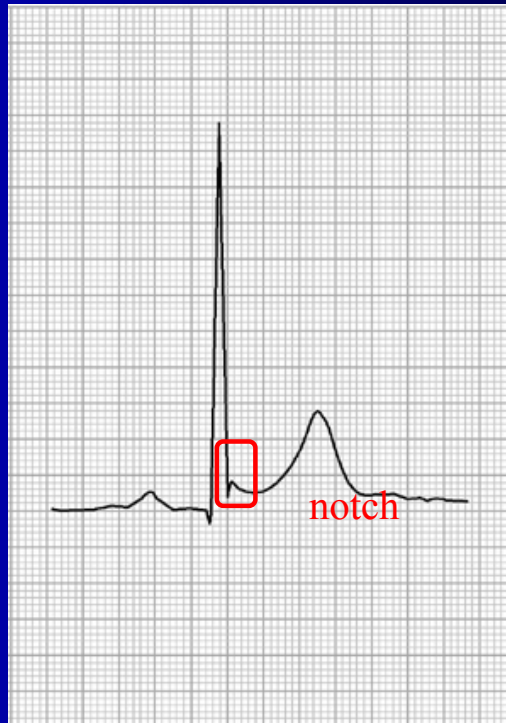
Important findings:

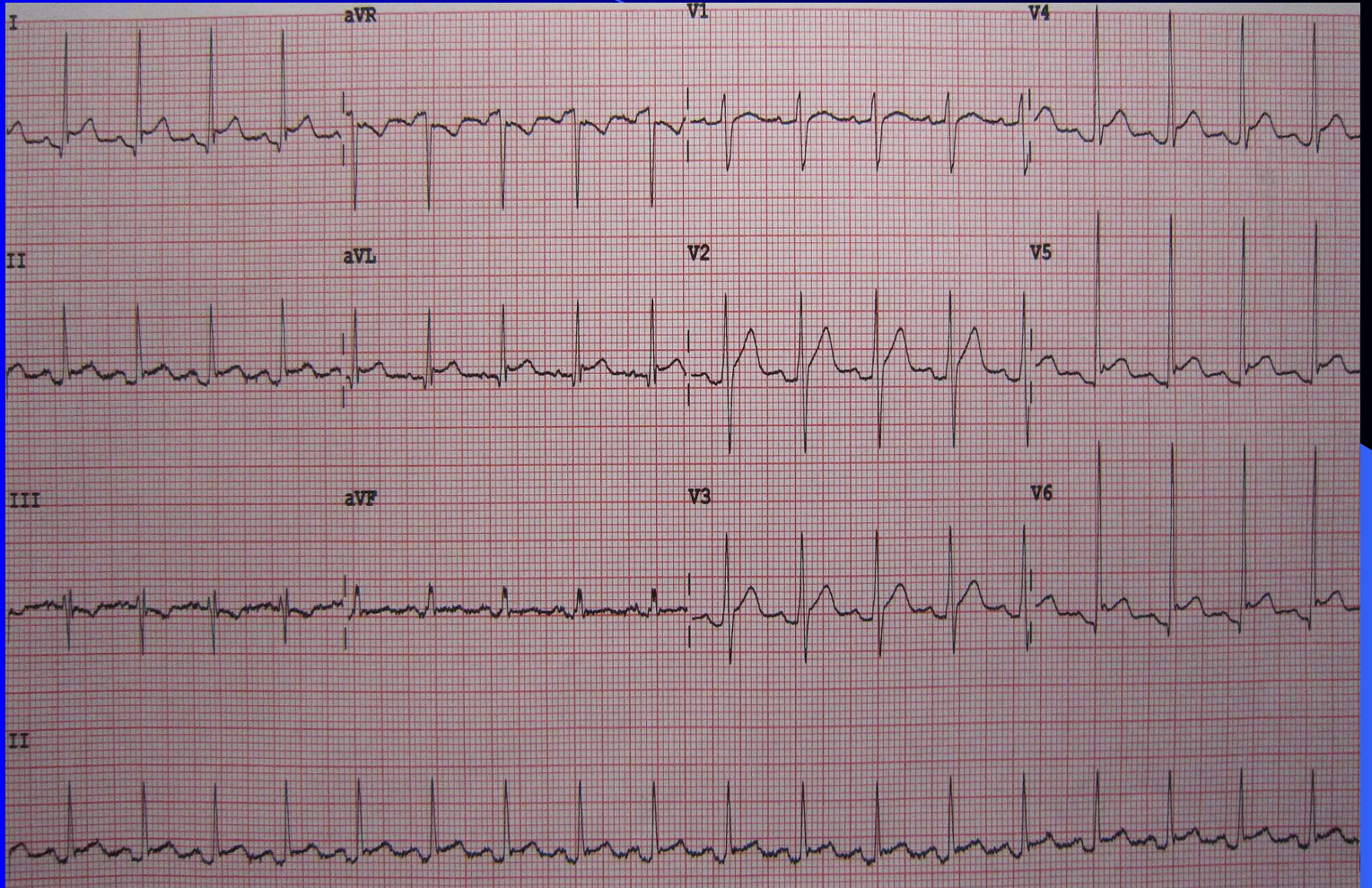
- Widespread ST elevation
- There is a notch in ST segment which make it less likely to be ischemia.

Diagnosis:

- Benign early repolarization

Benign Early Repolarization





interpretation

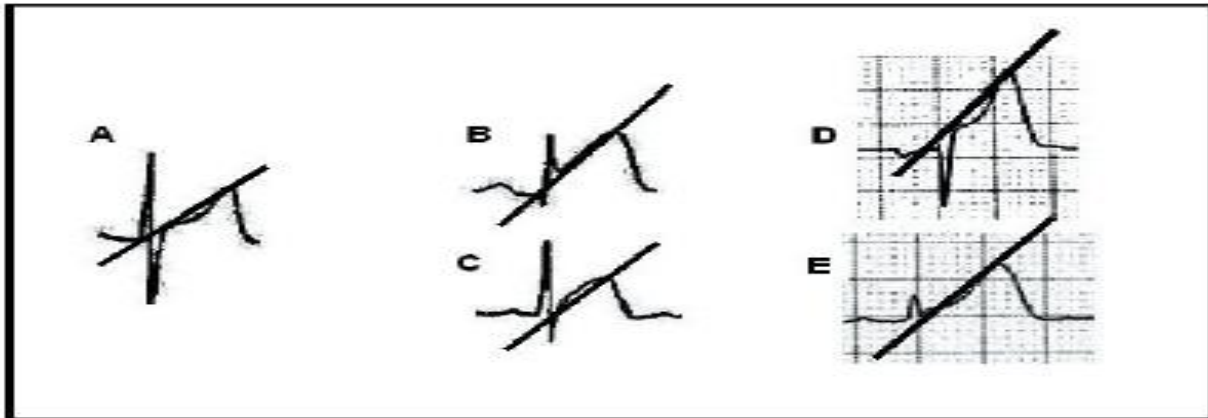
Important findings:

- Widespread ST elevation with
- In AVR lead there is reciprocal change(ST depression+ PR segment elevation)

Diagnosis:

- Acute pericarditis

Figure 5. ST-Segment Elevation — Concave Morphology.



A. Benign early repolarization with a concave form of ST-segment elevation. A line is “drawn” from the J point to the apex of the T wave. If the ECG waveform is below the drawn line (concave morphology), then a non-AMI cause of ST-segment elevation is suggested. B. & C. If the line is either superimposed on (B) or below (C) the ECG waveform, then AMI is suggested; in these scenarios, the waveform has a nonconcave morphology. D. & E. STEMI presentations with a concave morphology, illustrating the fallibility of this technique in all presentations.

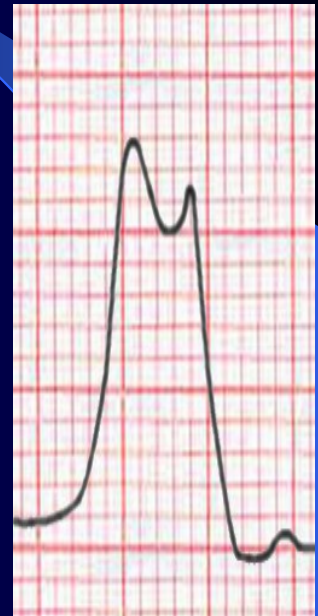
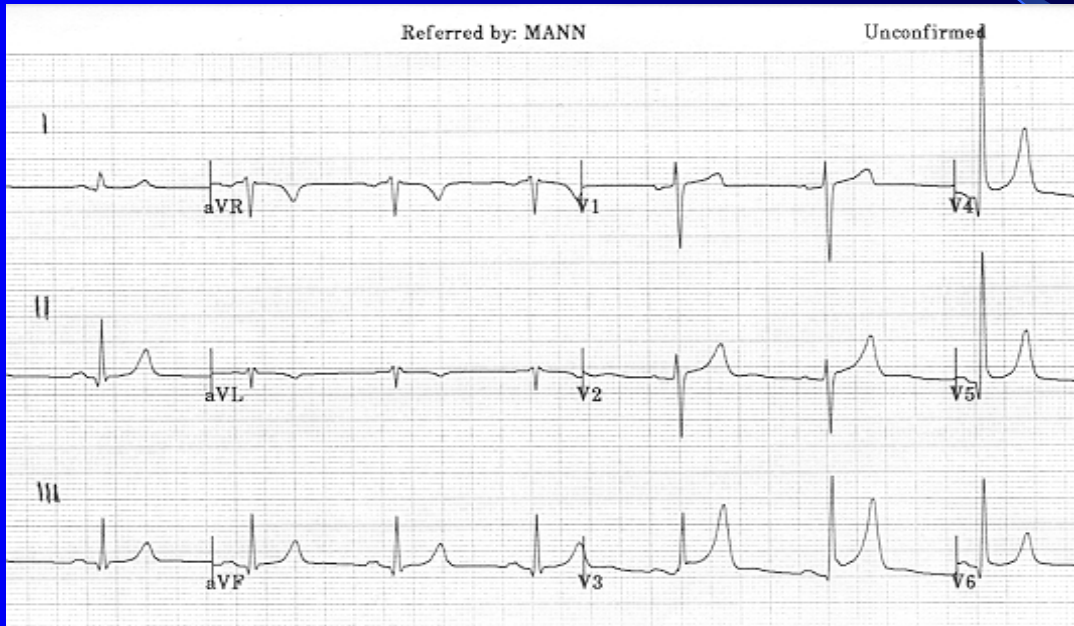
ST depression

Figure 23

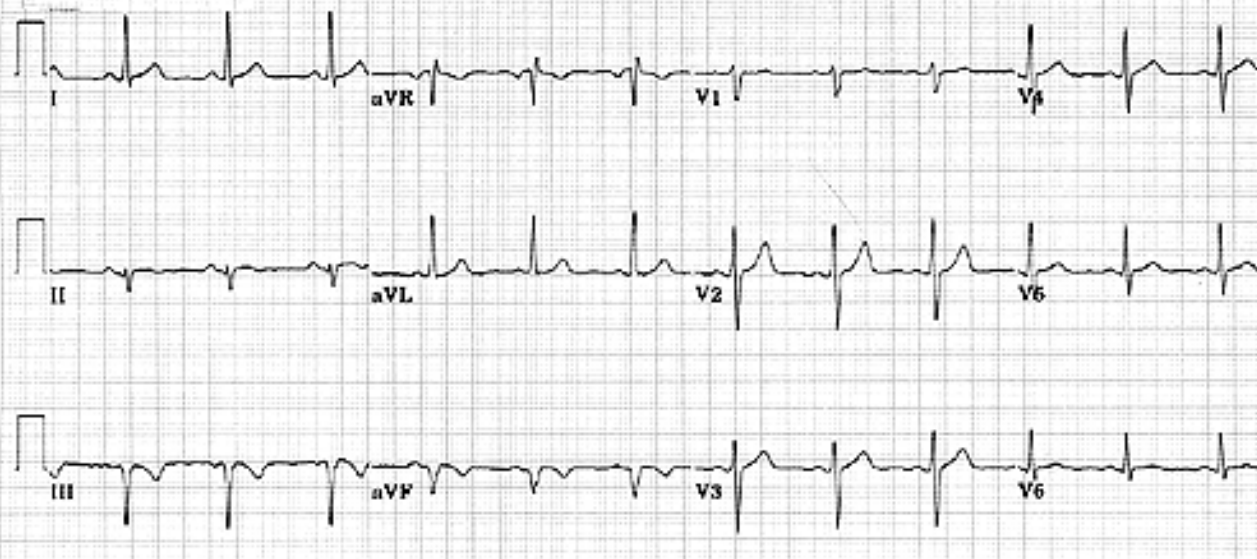


T wave

Hyperacute T waves



11-FEB-1942 (55 yr)
Male Caucasian



ID: 528527184 10-FEB-1997 07:55

© 1997 Frank G. Yanowitz, M.D.

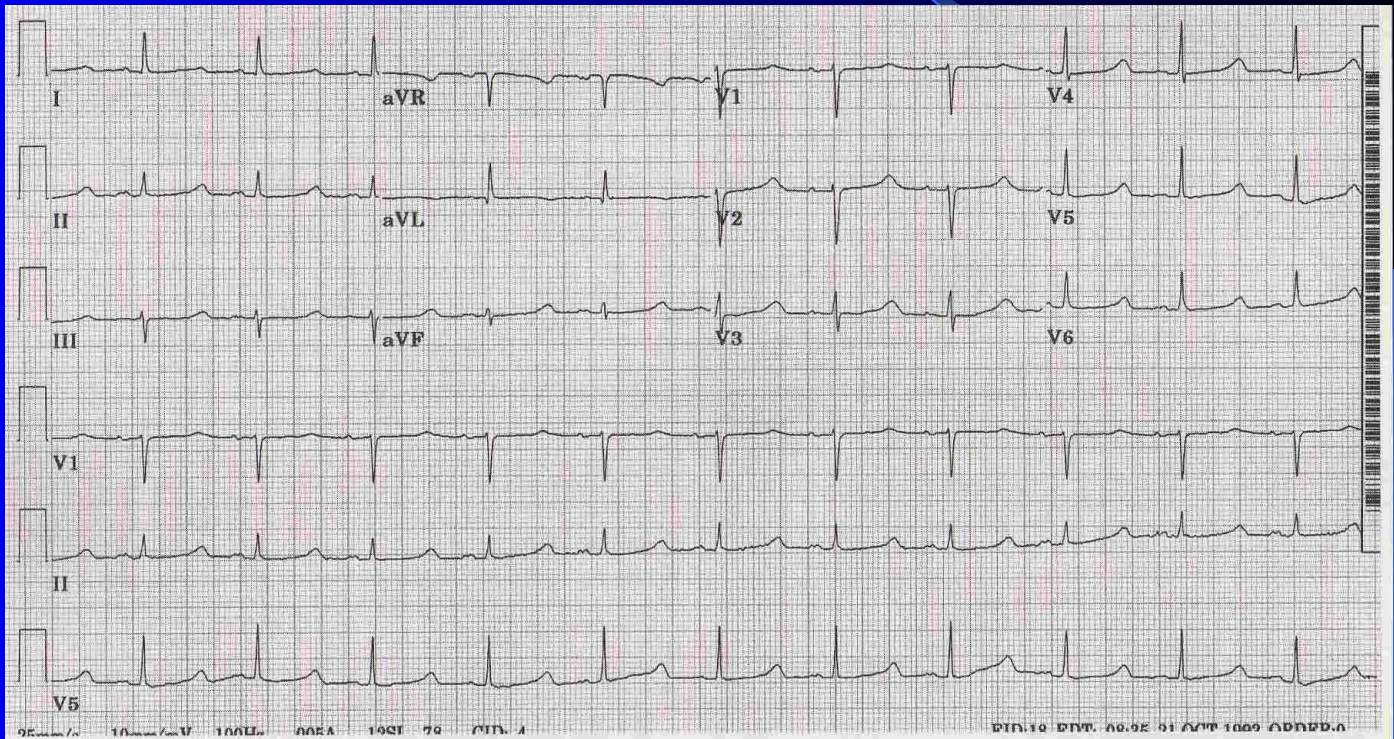
interpretation

Important findings:

- There is T wave inversion in inferior leads

Diagnosis:

- Ischemia (most likely NON STEMI which depend on Hx and complete picture)



25mm/s 10mm/mV 100L 005A 1001 70 010.1

010110 0005 0005 01 010110

interpretation

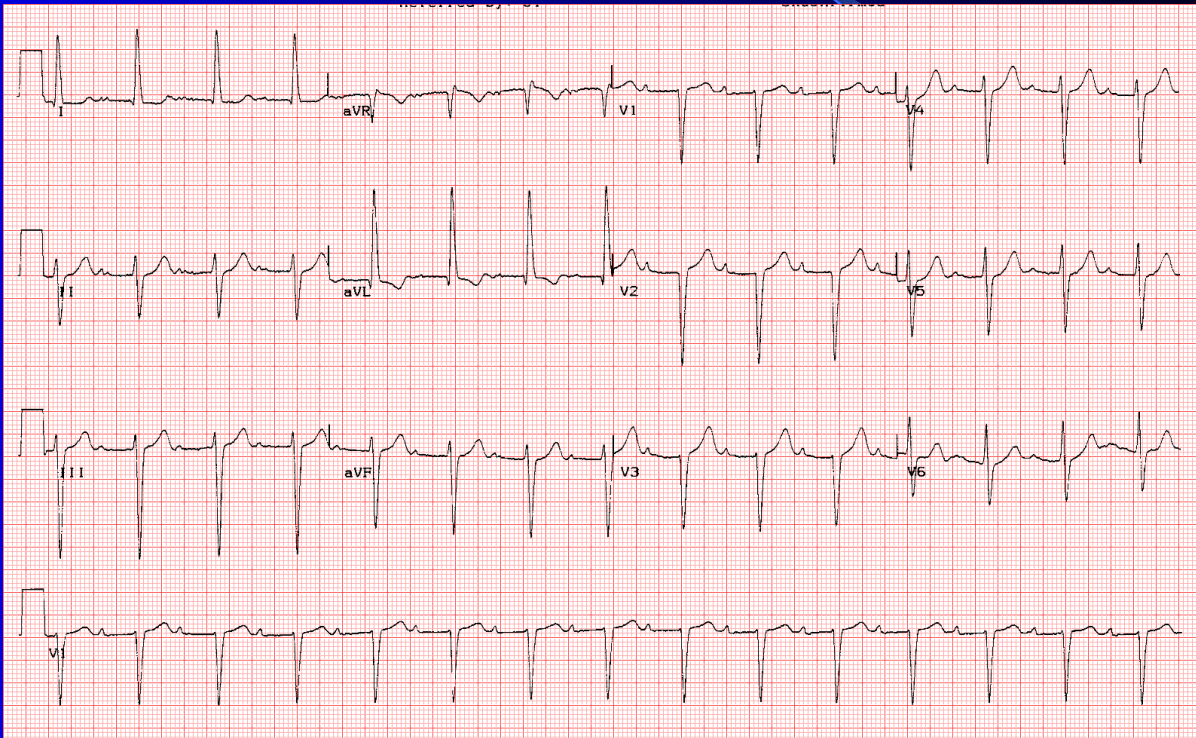
Important findings:

- QT interval in $> 50\%$ of R-R interval.

Diagnosis:

- Prolonged QT interval

ECG interpretation Test



interpretation

Important findings:

- Regular rhythm
- Fixed prolonged PR interval without QRS complex drop

Diagnosis:

- 1st degree heart block

WWW.LEARNABOUTECGS.COM



Courtesy of David Winter

interpretation

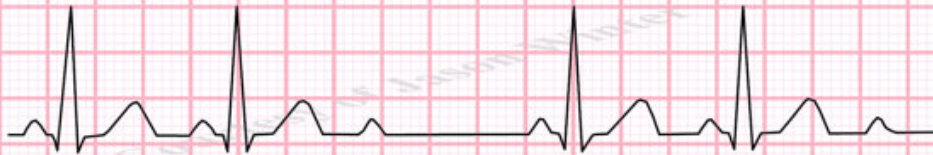
Important findings:

- Regular rhythm
- Fixed prolonged PR interval without QRS complex drop

Diagnosis:

- 1st degree heart block

WWW.LEARNABOUTECCS.COM



interpretation

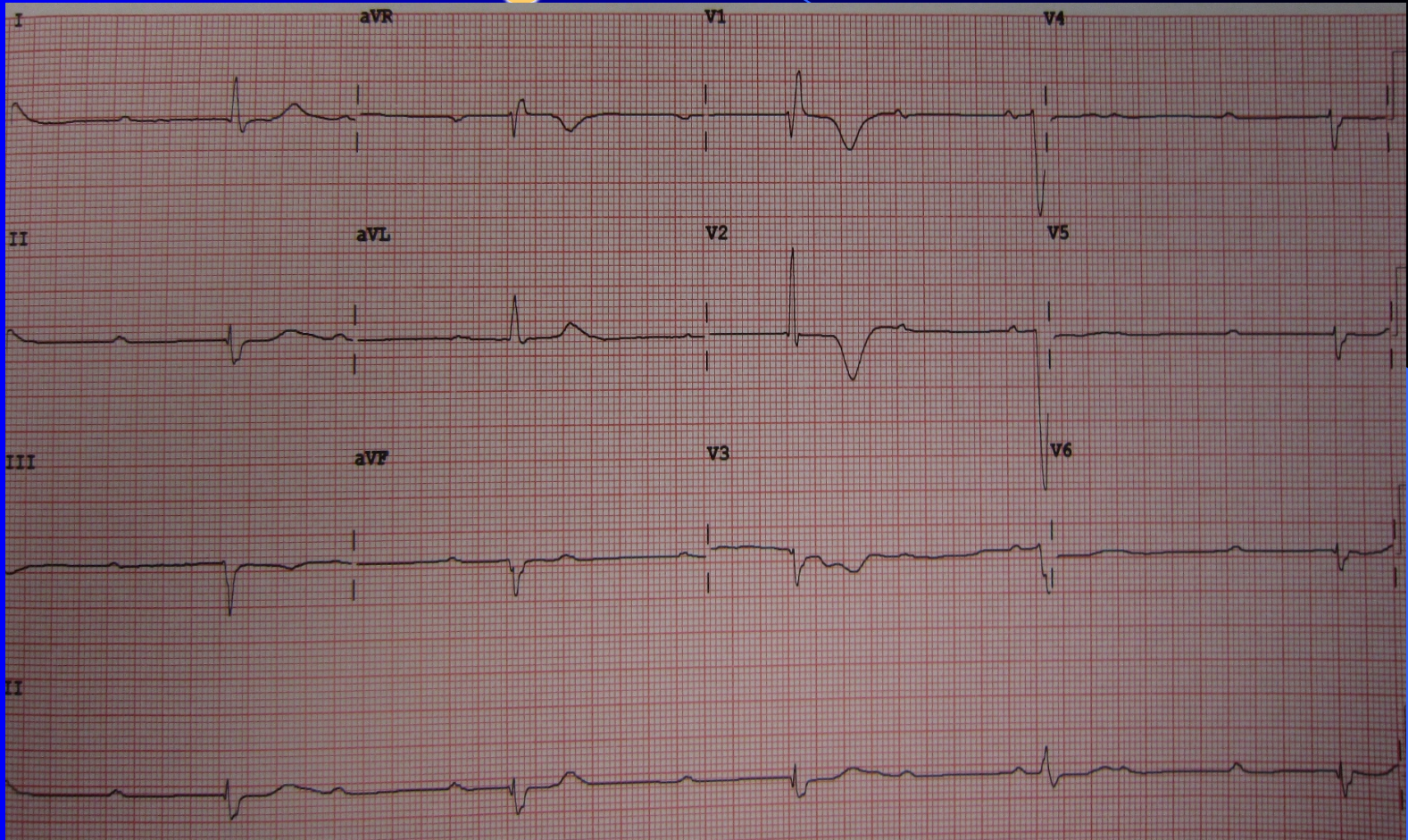
Important findings:

- Irregular
- Progressive prolongation of PR interval followed by a drop in QRS complex

Diagnosis:

- 2nd degree heart block type 1 (mobitz 1)

3rd degree heart block



interpretation

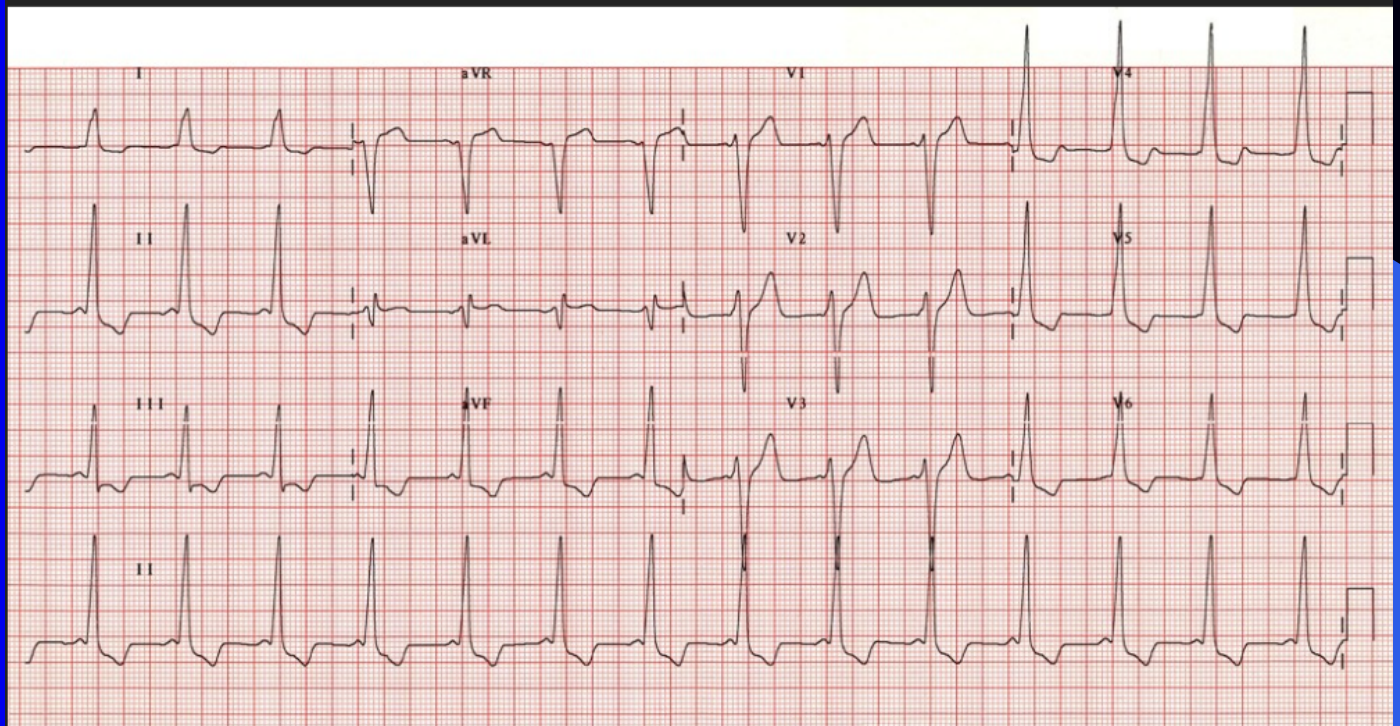
Important findings:

- Regular rhythm
- Bradycardia
- Wide QRS complex
- The P wave with a regular P-to-P interval
- The QRS complex with a regular R-to-R interval .
- The PR interval will be variable, as the hallmark of complete heart block is lack of any apparent relationship between P waves and QRS complexes.

Diagnosis:

- 3rd degree heart block (complete heart block)

WPW



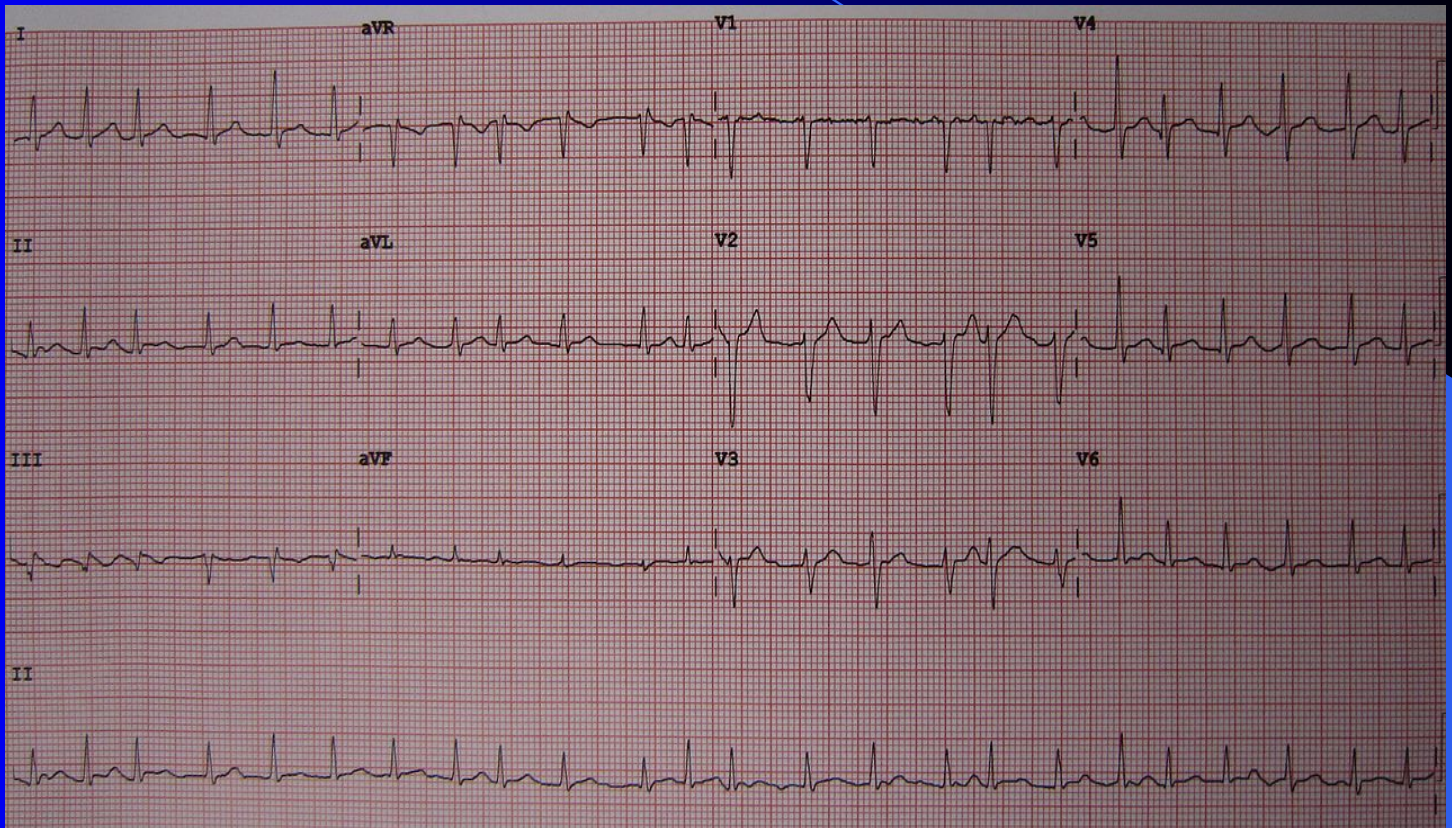
interpretation

Important findings:

- Short PR interval
- Delta wave

Diagnosis:

- WPW

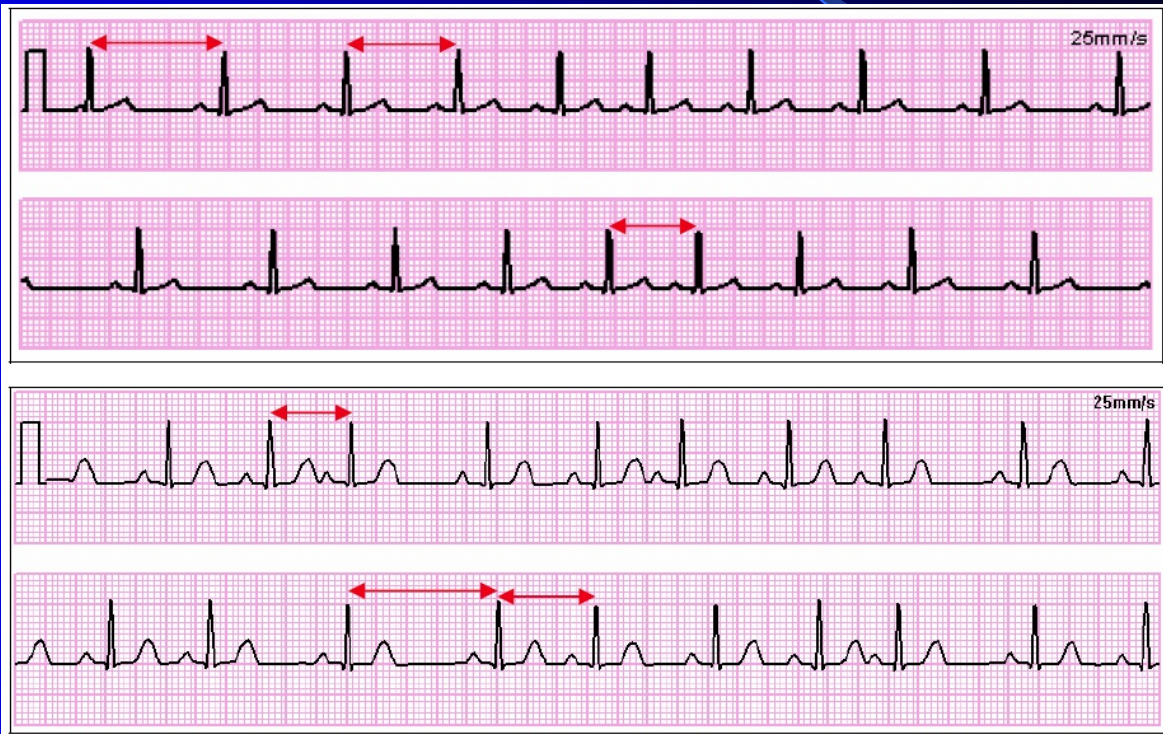


- Important findings:

- Irregular rhythm
- Absent P-wave

- Diagnosis :

- Atrial Fibrillation



interpretation

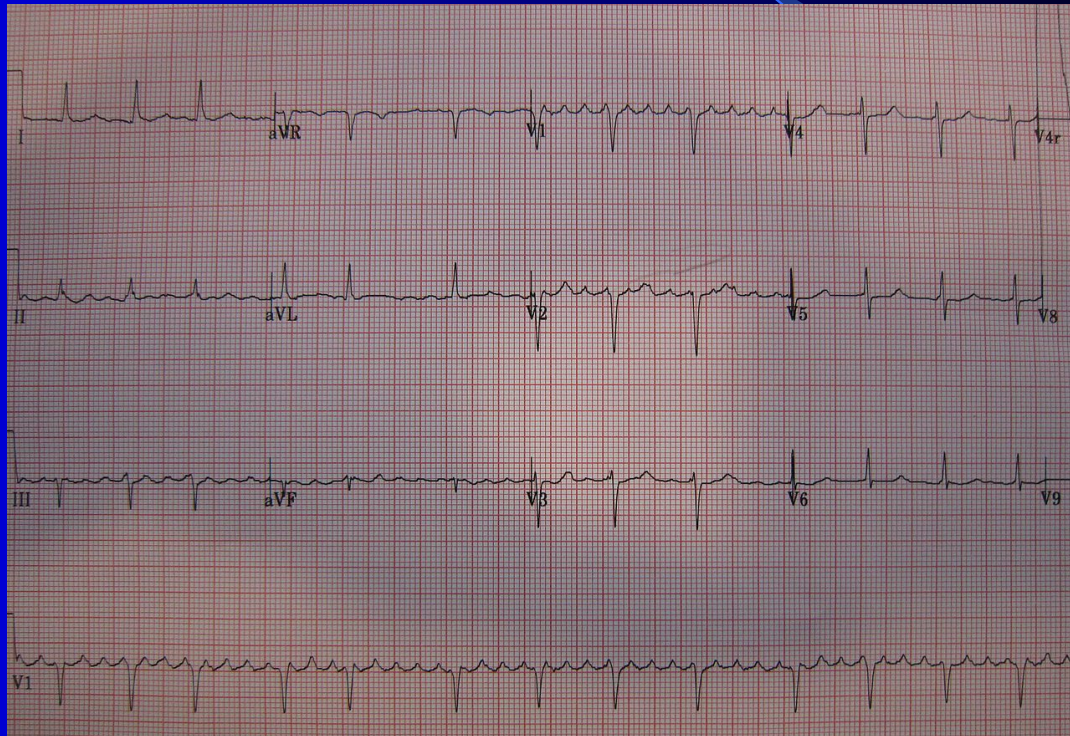
Important findings:

- Irregular rythem
- Present P-wave with normal PR interval

Diagnosis:

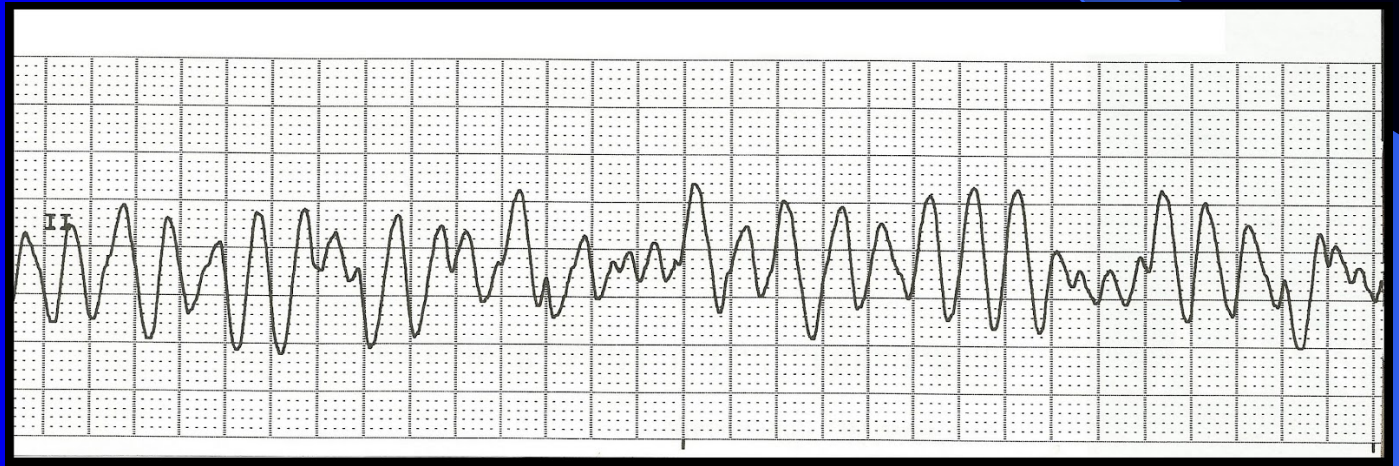
- Sinus arrhythmia

Atrial flutter



- Important finding:
- Saw tooth appearance
- Diagnosis:
- Atrial Flutter

VF



Sinus tachycardia

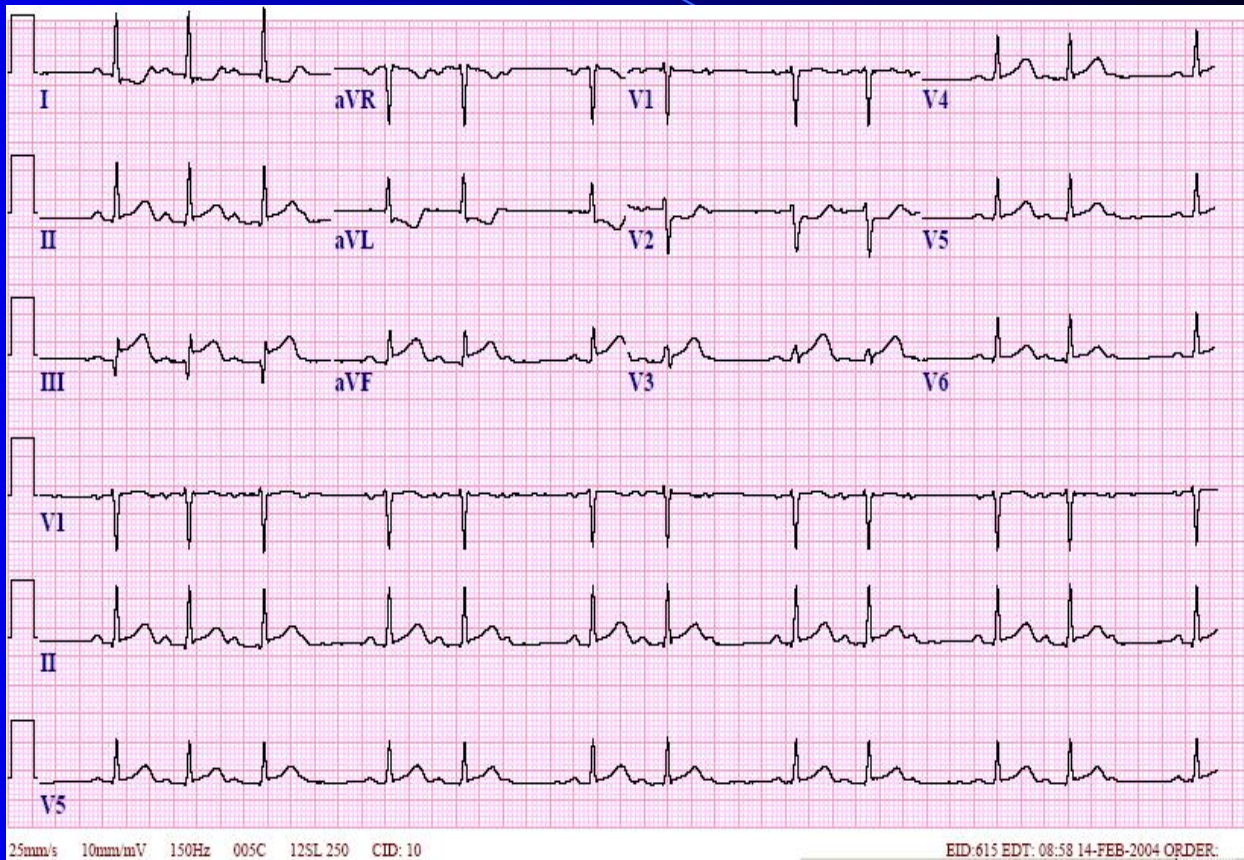


(From Goldberger, A. L. [2006]. Clinical electrocardiography: A simplified approach [7th ed., p. 158]. St. Louis: Mosby.)

- Important findings:
 - regular rhythm
 - Sinus rhythm (present P-wave)
 - Tachycardia
 - Normal QRS complex
- Diagnosis :
 - Sinus tachycardia

Case

- A 55 year old male presents with substernal chest pain radiating to his left arm.



interpretation?

Findings:

- 1) progressive prolongation of PR interval with a drop of QRS complex.
- 2) Inferior ST segment elevation MI (leads II, III, and aVF) with reciprocal ST depression (leads I and aVL)

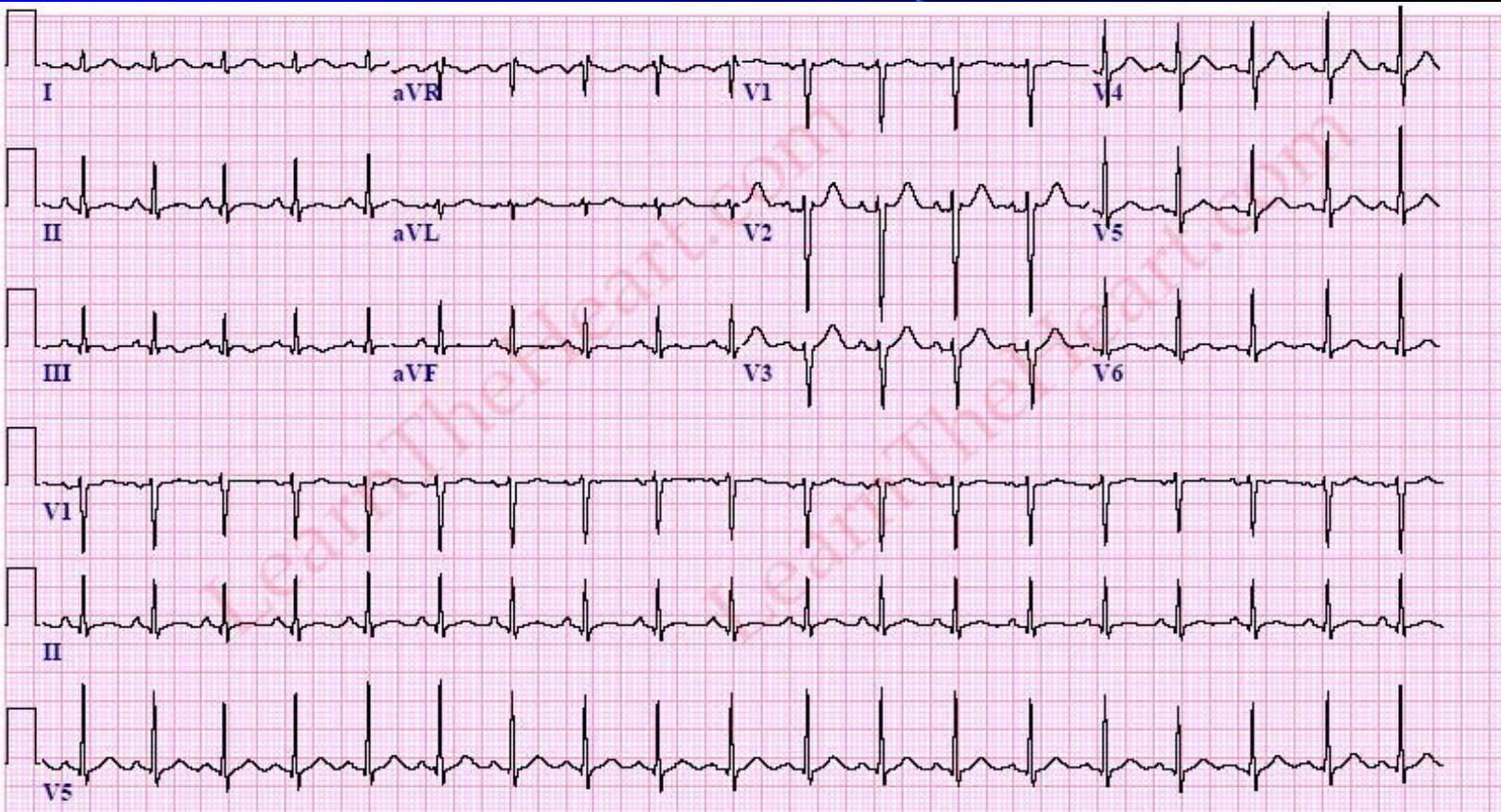
Diagnosis:

Acute inferior STEMI with 2nd degree type 1 heart block.

Case

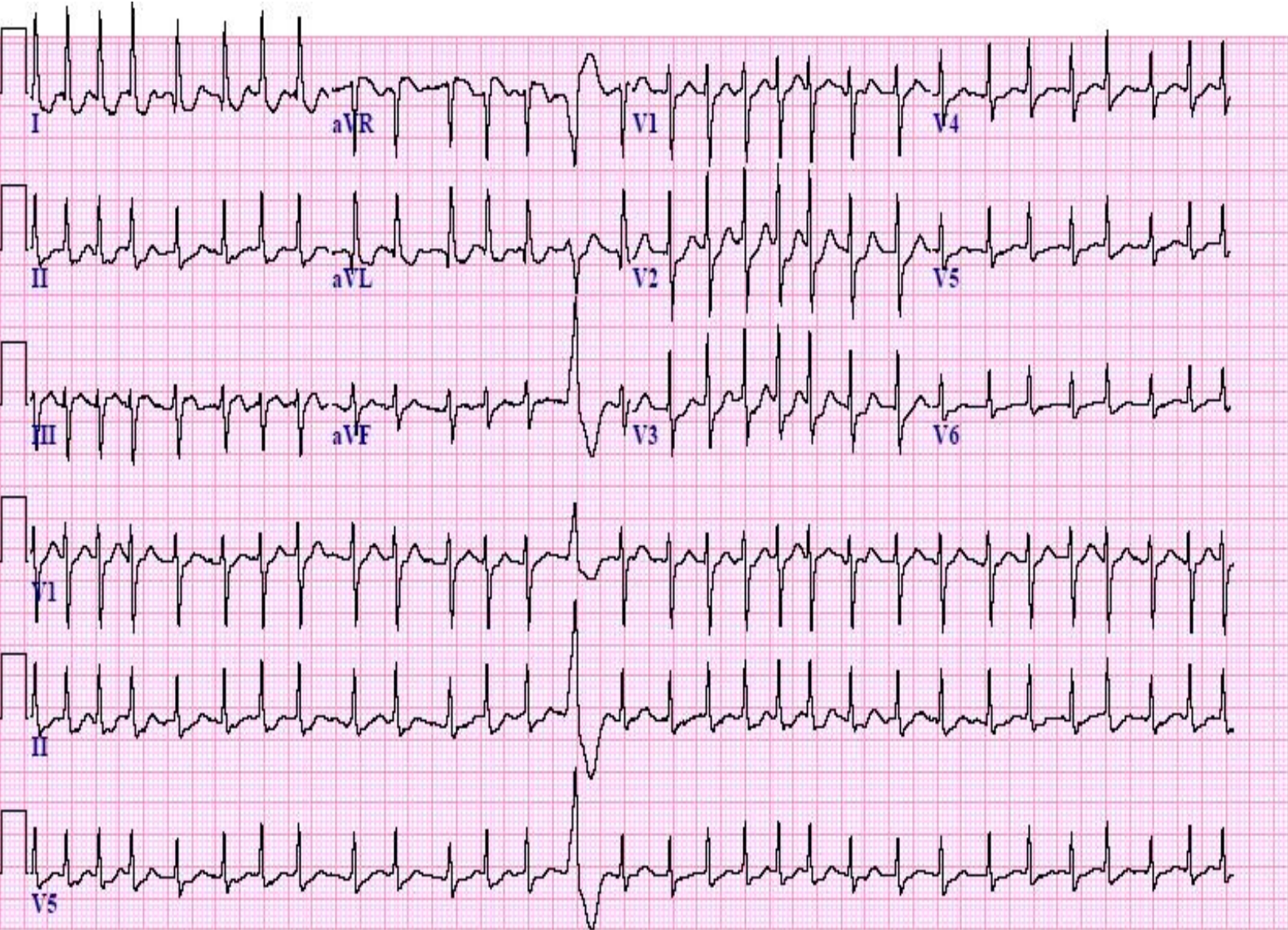
- 63 y old lady with SOB for 3 weeks.

Sinus tachycardia



Case

82 year old male with a history of HTN presents to the clinic with a complaint of generalized weakness for 3 days.

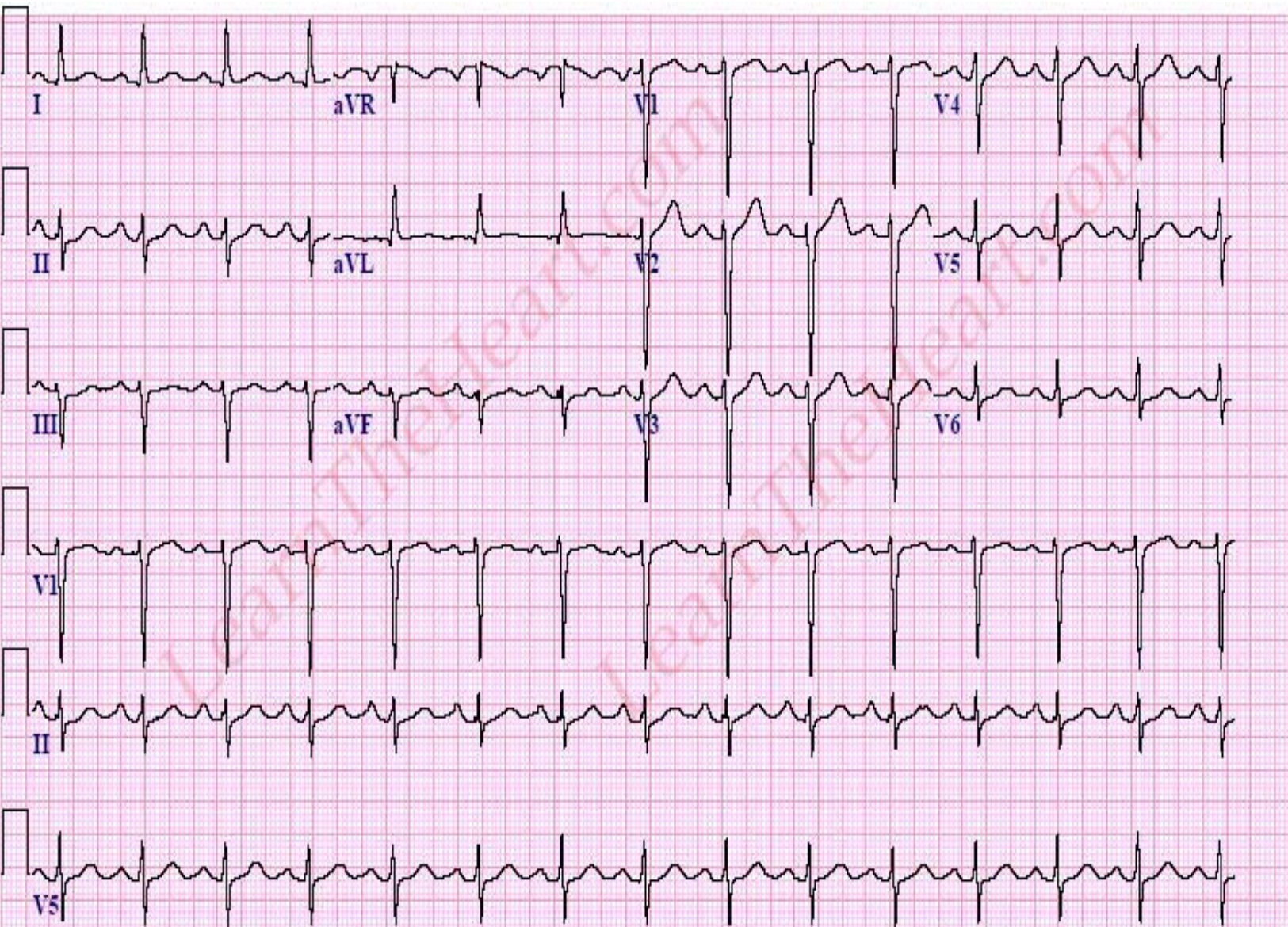


What are the findings?

- **1) Atrial fibrillation with rapid ventricular response**
2) PVC

Case

- 52 y old male pre-OP ECG.



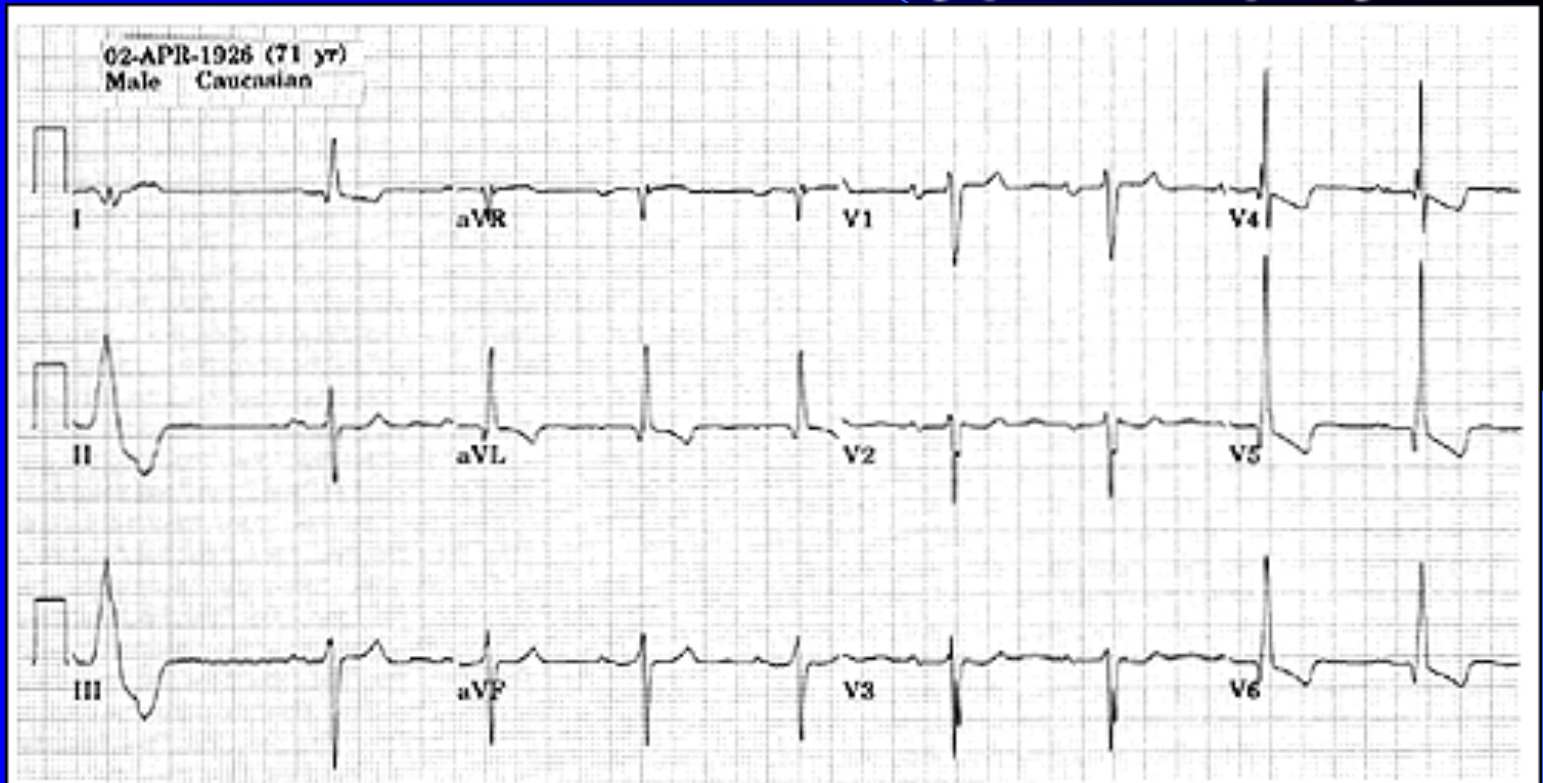
What are the findings?

- **Normal sinus rhythm with a first degree AV block**

case

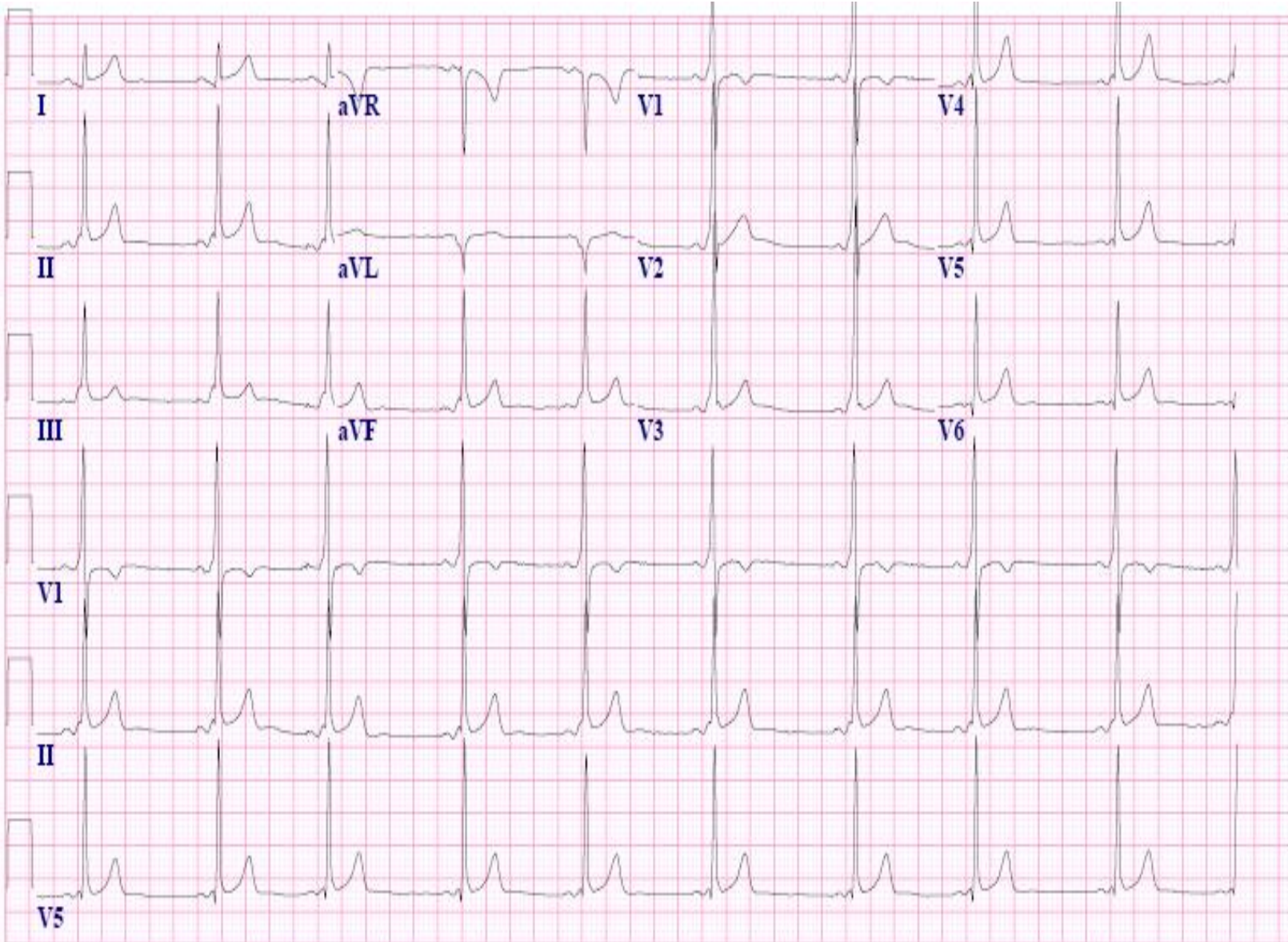
- 49 y old lady newly diagnosed HTN.

Left Ventricular Hypertrophy



Case

- 24 y old lady presented with Hx of syncope



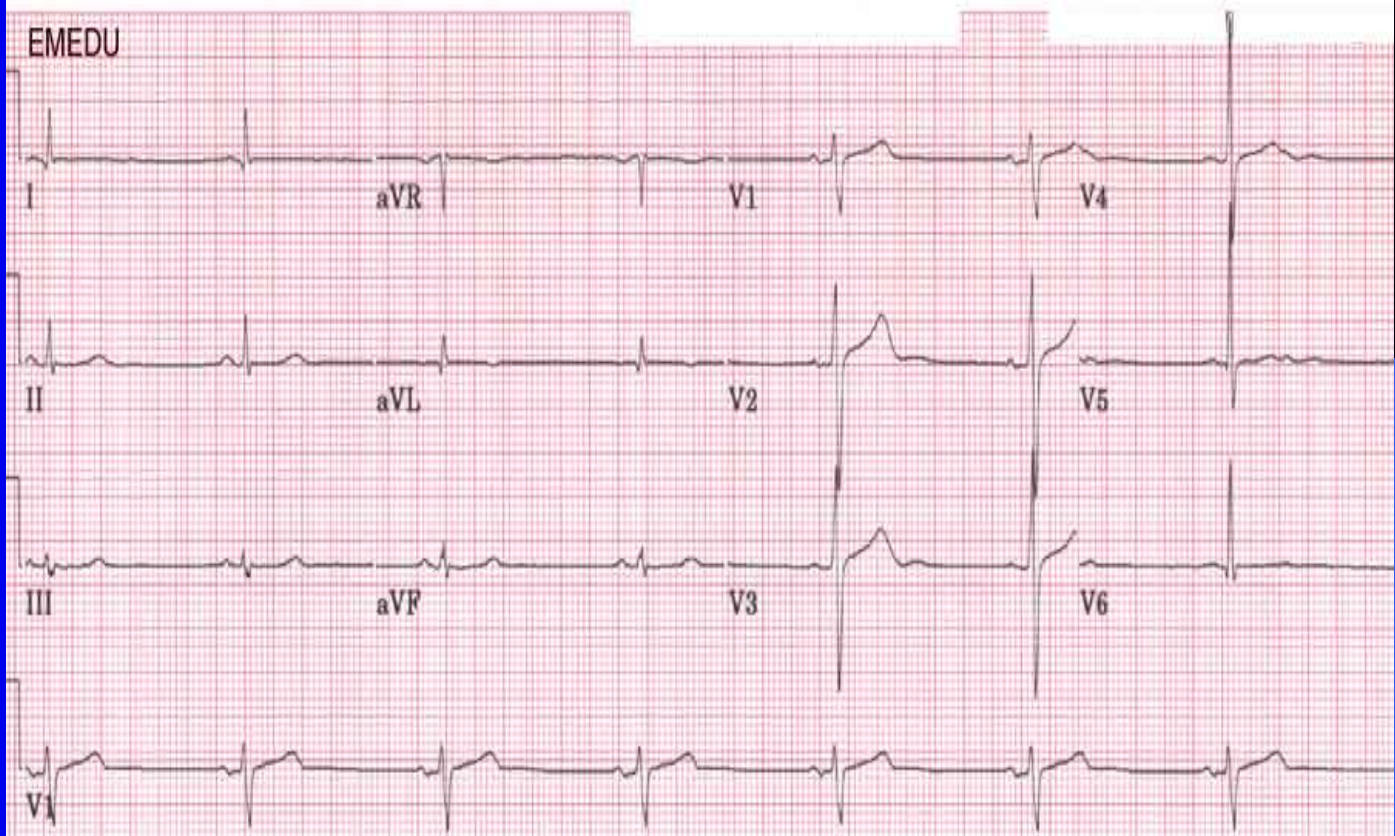
What are the findings?

- **Short PR interval and delta waves consistent with Wolff-Parkinson-White (WPW) syndrome**

Case

- 57 y old lady healthy with reproducible chest pain for 5 days.

EMEDU



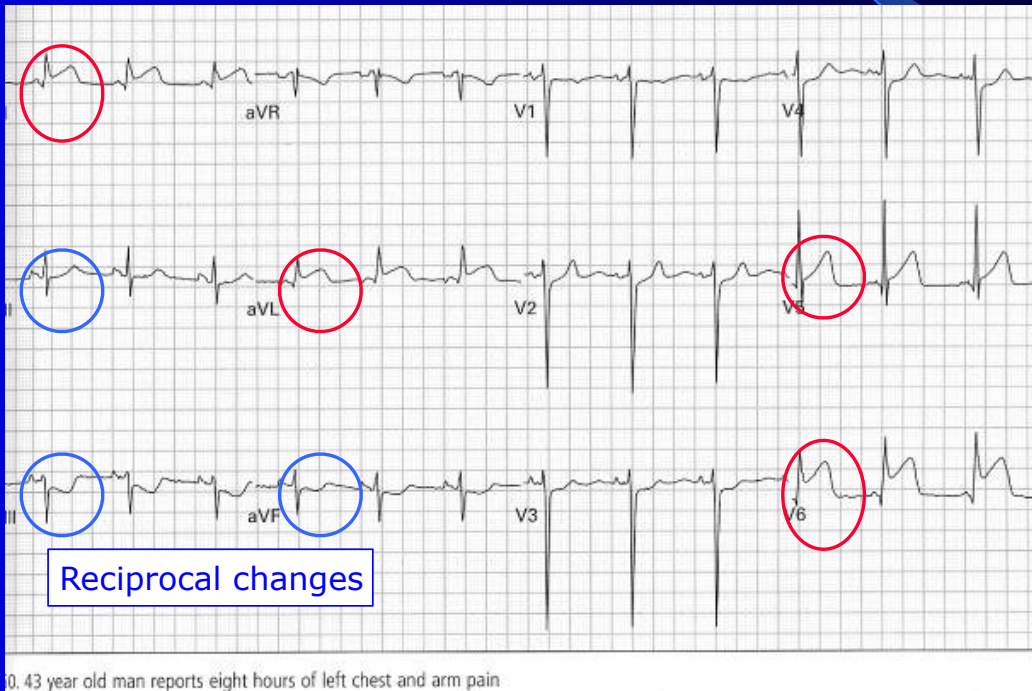
Diagnosis

- Sinus bradycardia

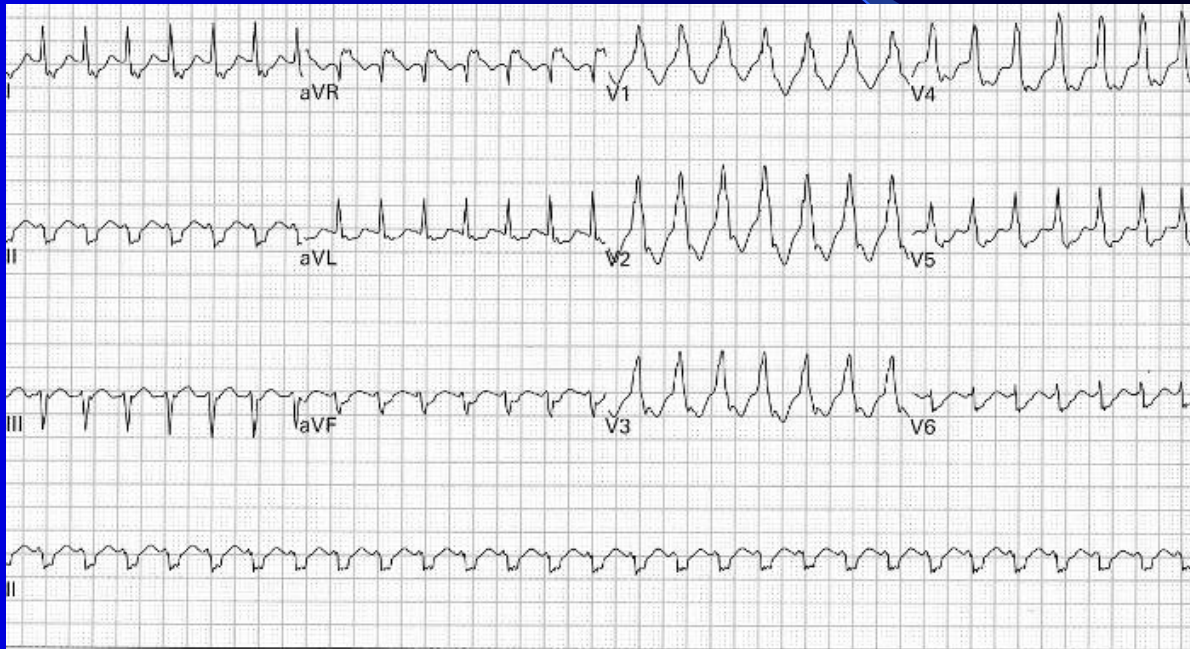
Case

- 63 y old male with chest pain for 8 h.

Lateral MI



Wide QRS complex tachycardia

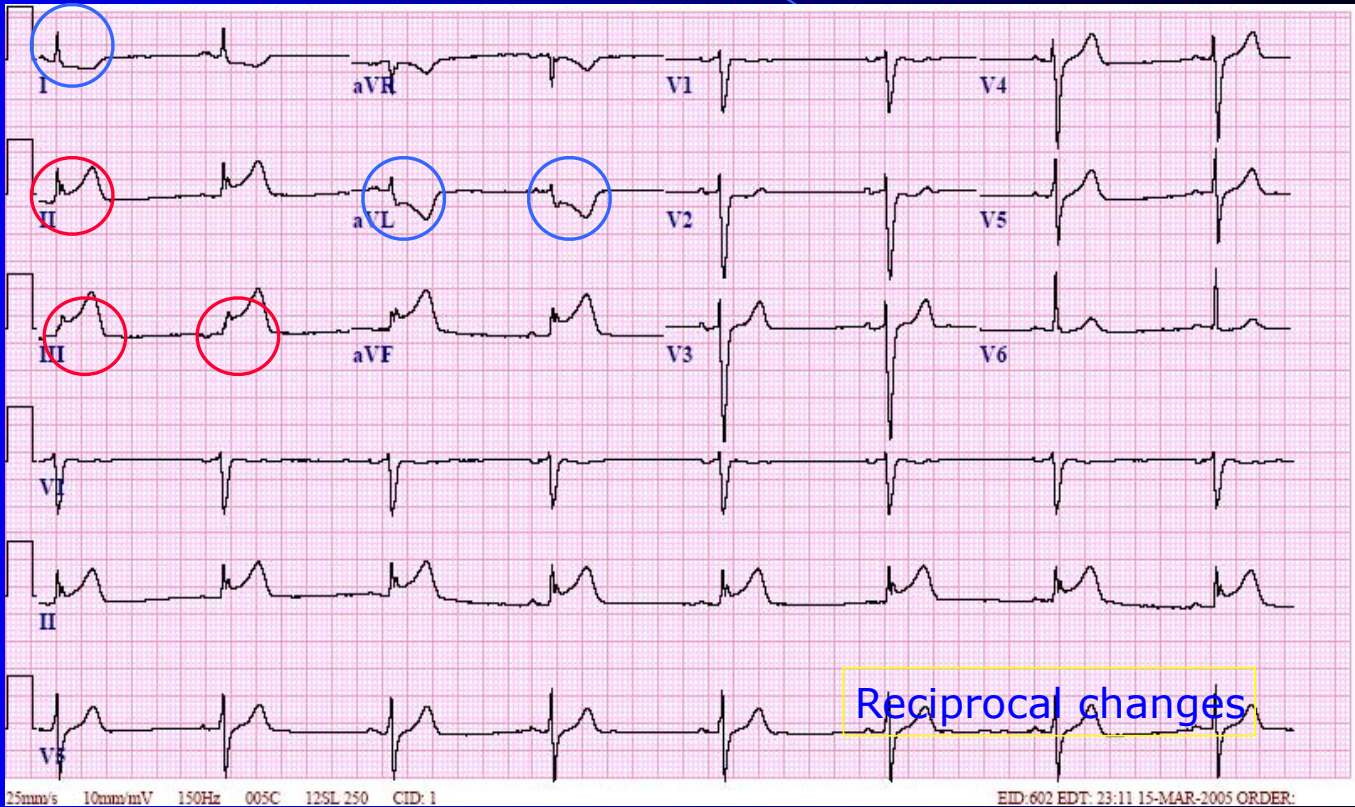


9. 74 year old man with chest pain and palpitations

Case

- 66 y old lady , diabetic presented with Hx of SOB for 3 h.
- HR 57
- Bp 90/60
- Other VS are stable

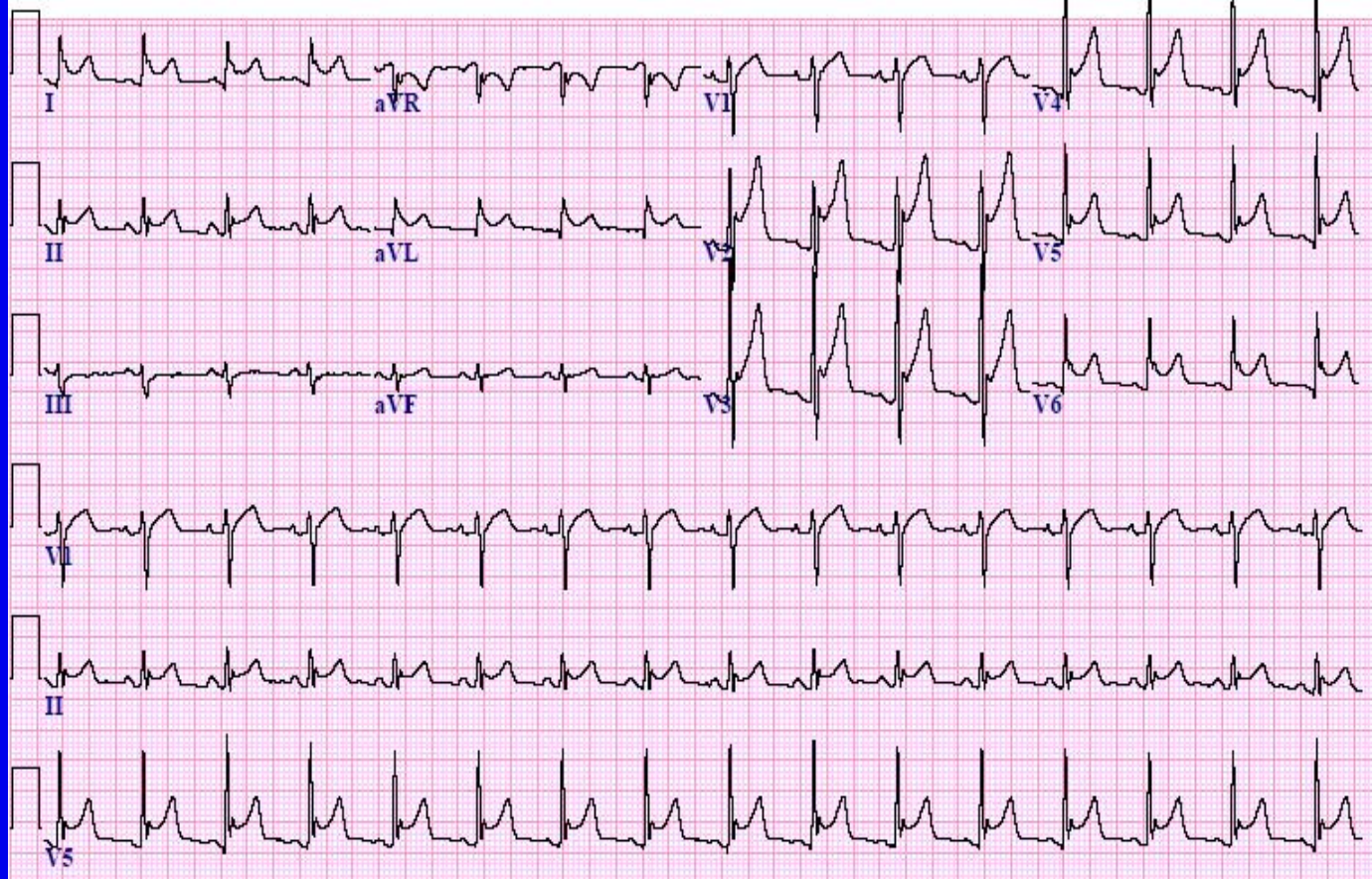
Inferior MI with reciprocal changes



Case

- 54 year old male with no significant past medical history presents to his Family physician with 2 days of chest pain.

Unconfirmed



interpretation

Important findings:

- Widespread ST elevation with PR segment depression.
- In AVR lead there is a reciprocal change (ST depression+ PR segment elevation)

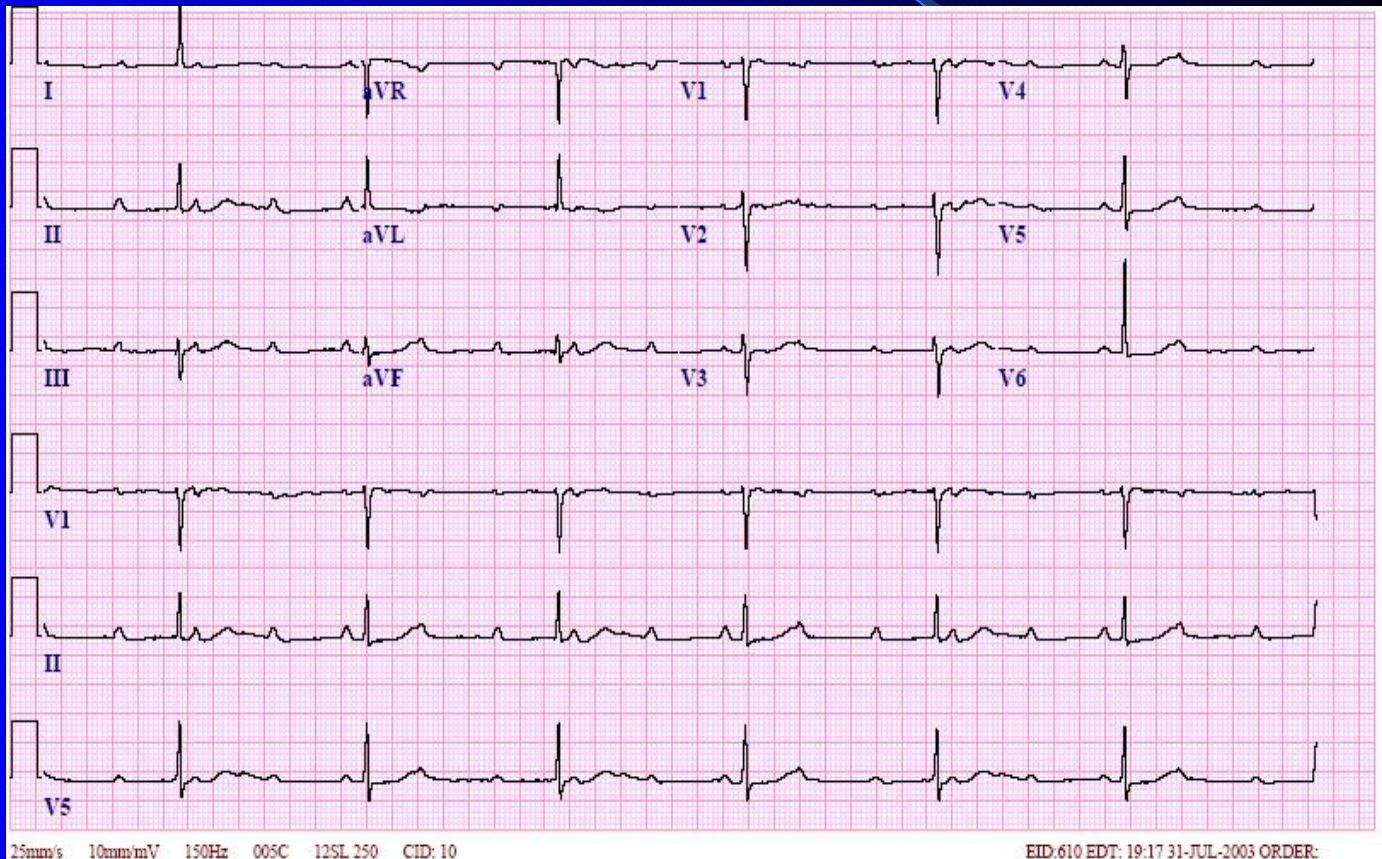
Diagnosis:

- Acute pericarditis

Case

- 7 y old with Hx of syncope

Third degree heart block



interpretation

Important findings:

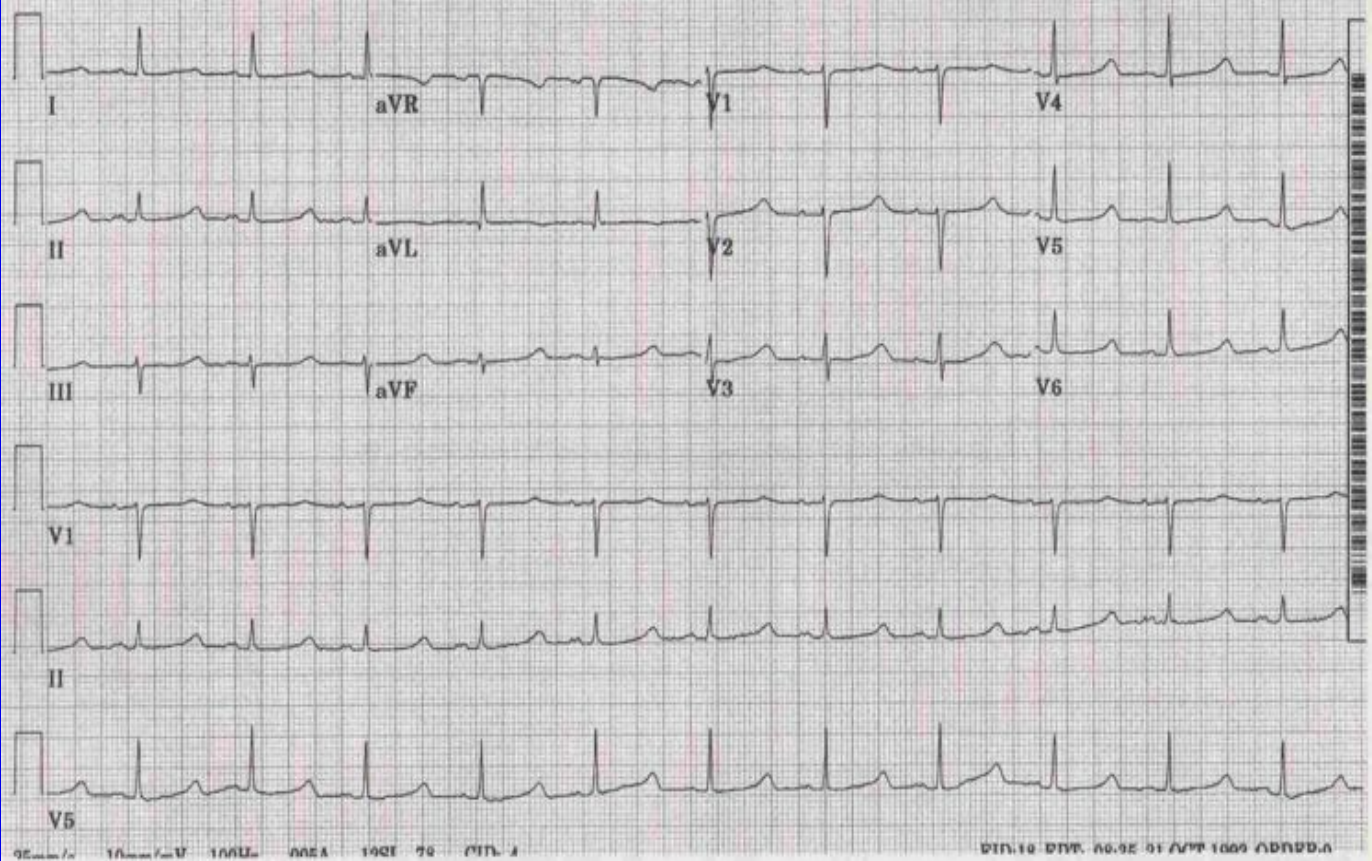
- Regular rhythm
- bradycardia
- The P wave with a regular P-to-P interval
- The QRS complex with a regular R-to-R interval .
- The PR interval will be variable, as the hallmark of complete heart block is lack of any apparent relationship between P waves and QRS complexes.

Diagnosis:

- 3rd degree heart block (complete heart block)

Case

- 29 y old male with Hx of syncope 4 days ago.



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What are the findings?

- Long QT Interval