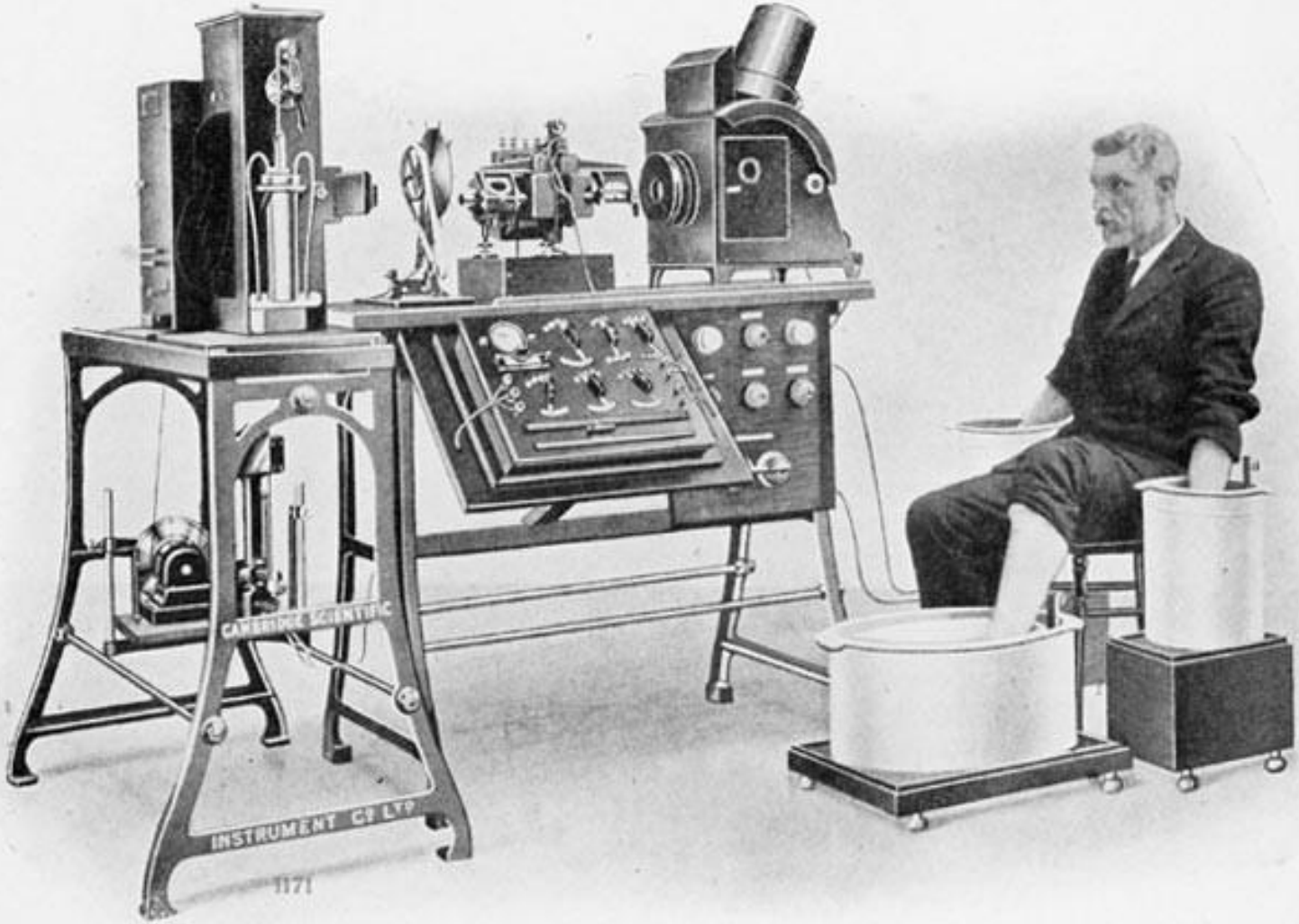
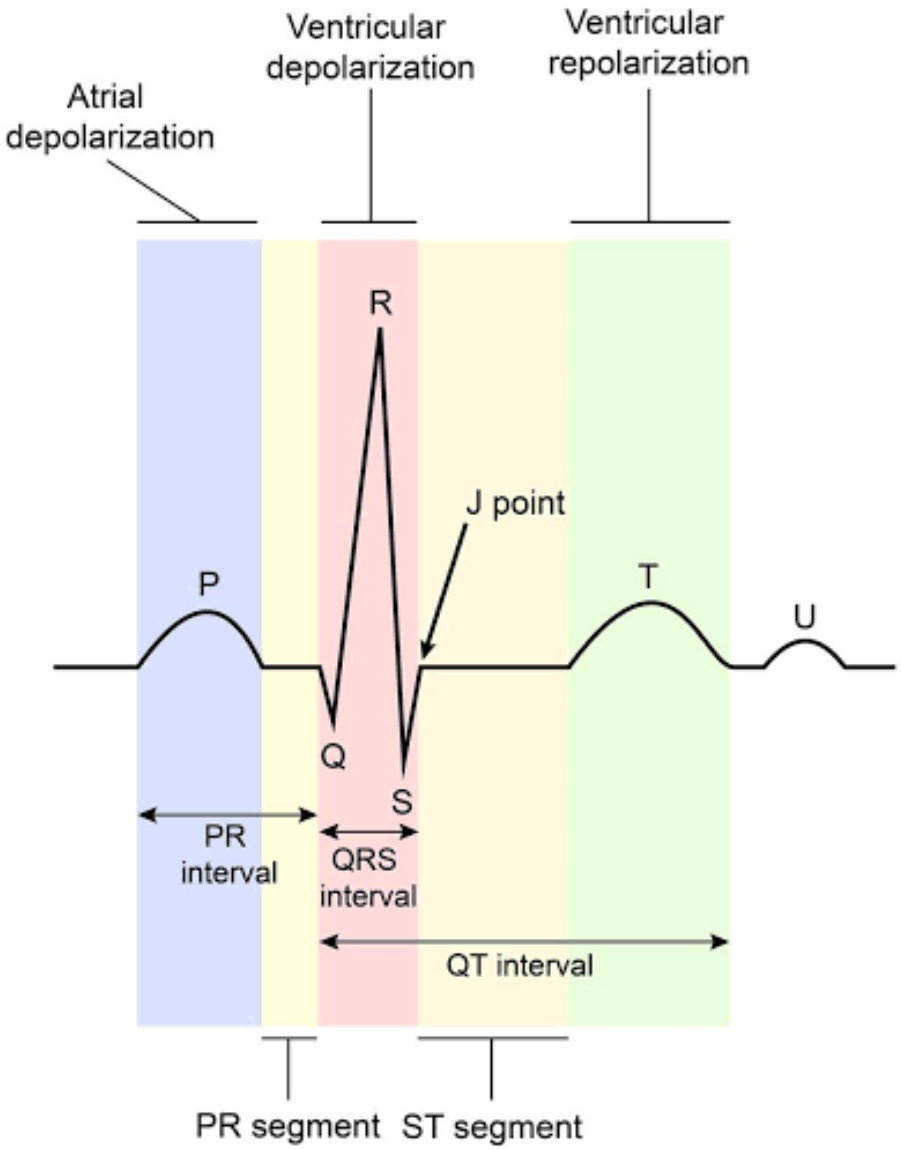
Basic Electrocardiography Prof Rheeder

Thanks to Prof. S. Ellemdin for sharing his slides

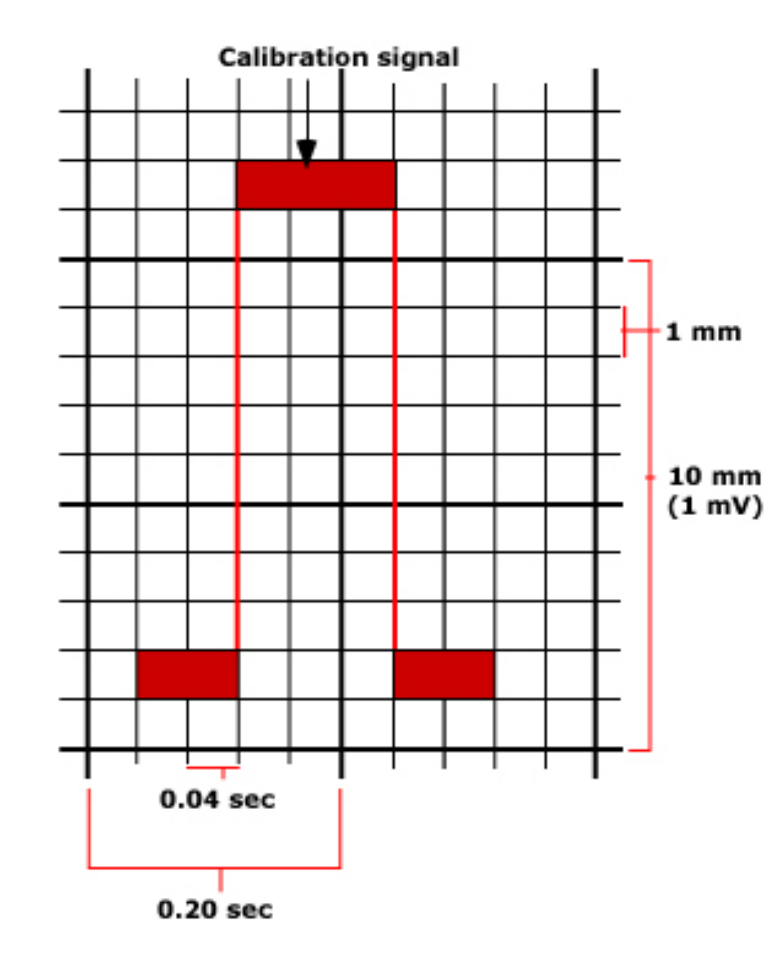


PHOTOGRAPH OF A COMPLETE ELECTROCARDIOGRAPH, SHOWING THE MANNER IN WHICH THE ELECTRODES ARE ATTACHED TO THE PATIENT, IN THIS CASE THE HANDS AND ONE FOOT BEING IMMERSED IN JARS OF SALT SOLUTION

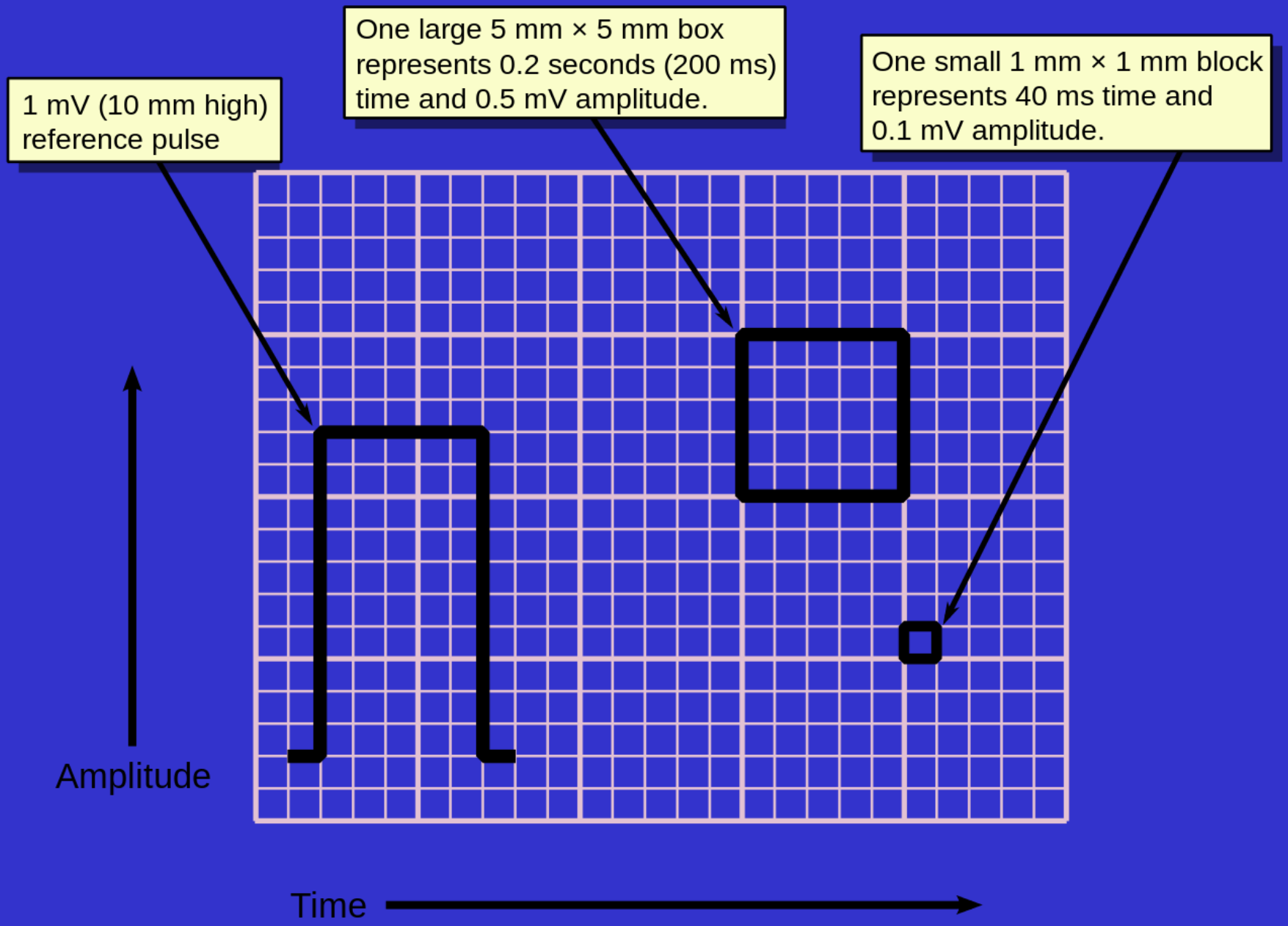
Electrocardiogram



The paper measurements of ECG : time and voltage



ECG:
“Standardized” at 10 mm/mV and 25 mm/second


1 mV (10 mm high) reference pulse
One large 5 mm × 5 mm box represents 0.2 seconds (200 ms) time and 0.5 mV amplitude.
One small 1 mm × 1 mm block represents 40 ms time and 0.1 mV amplitude.
Amplitude
Time

Basic facts and measurements:

Standard lead II

- P wave upright; in front of every QRS: constant relationship to QRS. (Sinus rhythm)

PR interval

- 0.12 – 0.20 sec (3-5 small blocks).

QRS complex width

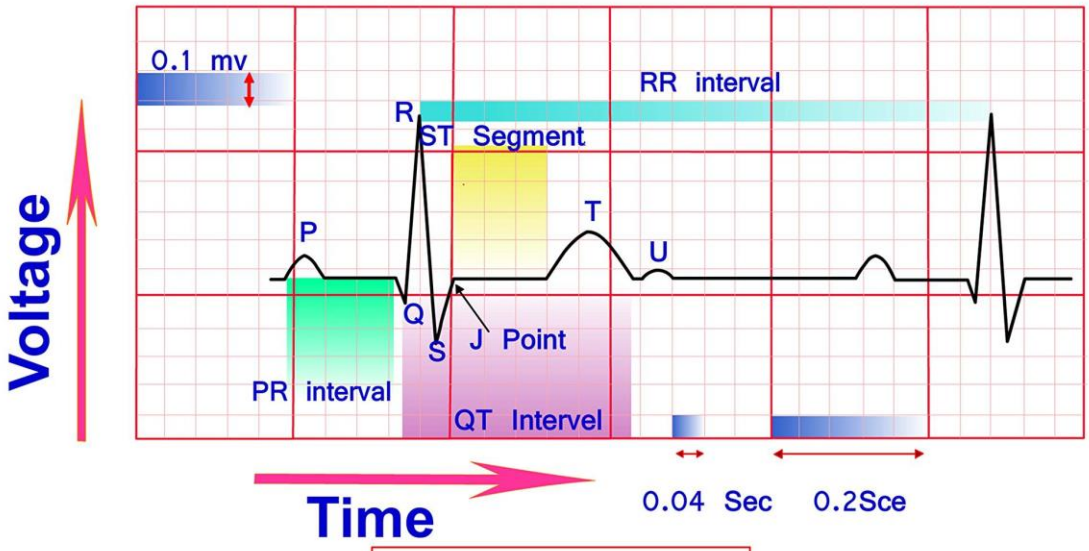
- 0.04 – 0.10 sec (1-2½ small blocks)(≥ 3 blocks: broad: B.B.B.)

Standard lead aVR

- QRS complex, and P-wave, and T-wave: always negative in aVR
- [if not: leads wrongly placed; Dextrocardia].

SIMPLIFIED APPROACH TO ECG

- RATE/RHYTHM
- Axis
- P wave MORPHOLOGY
- QRS MORPHOLOGY
- ST/T changes



PR intervel	0.12–0.20 sec
QRS duration	0.06 -0.10 sec
QT intervel	0.4–0.43 sec

Steps in EKG Interpretation

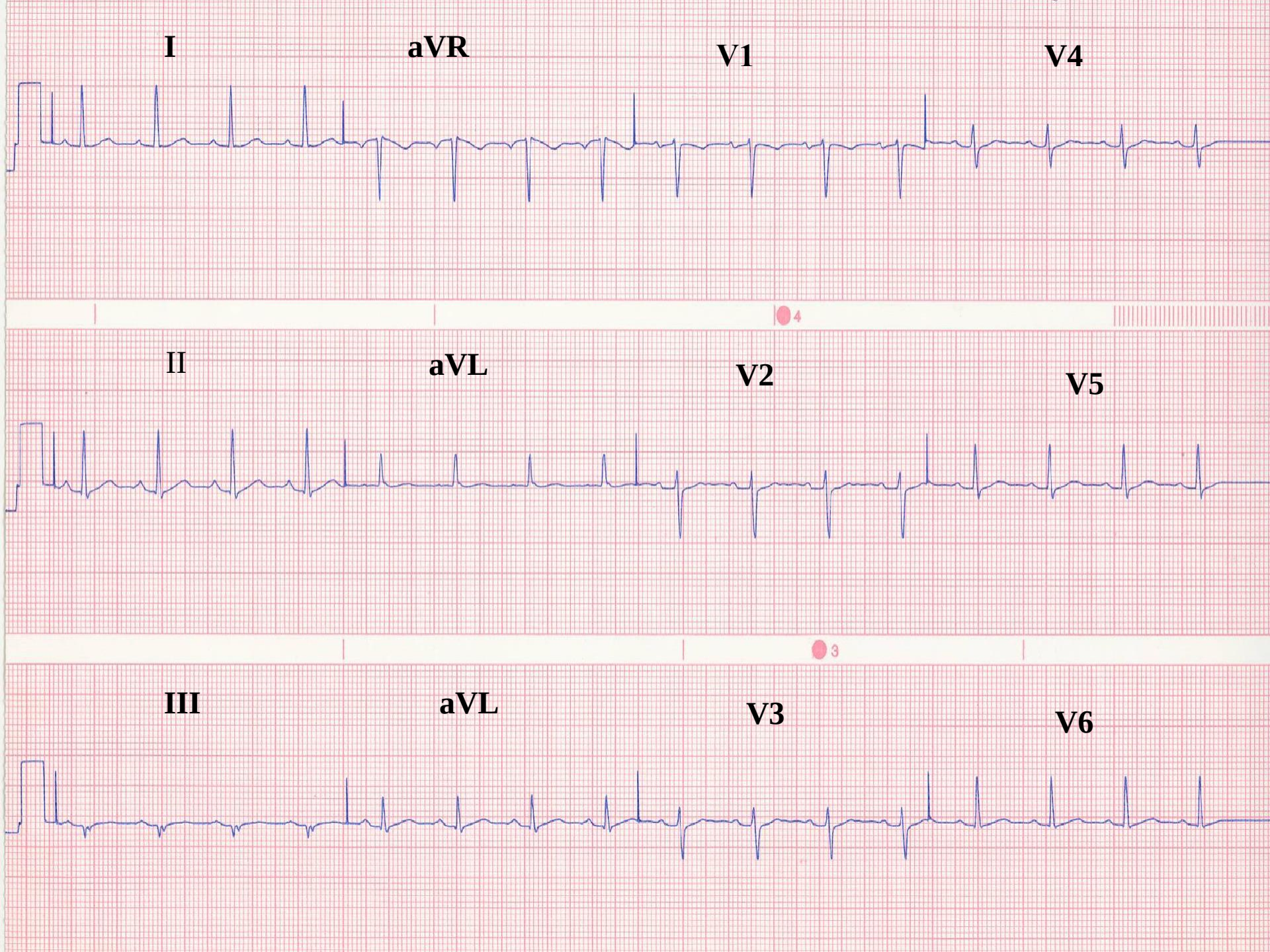
1. Determine the **rhythm** and **regularity**
2. Calculate the **rate**
3. Evaluate **P wave**
4. Calculate **PR interval**
5. Analyze **QRS complex**
6. Examine **T wave**
7. Calculate **QT interval**
8. Look for **other** characteristics

Steps in 12 lead EKG Interpretation

1. **R**hythm
2. **A**xis
3. **B**undle branch block
4. **E**nlargement of chamber
5. **I**schemia or infarction
6. **O**ther abnormalities

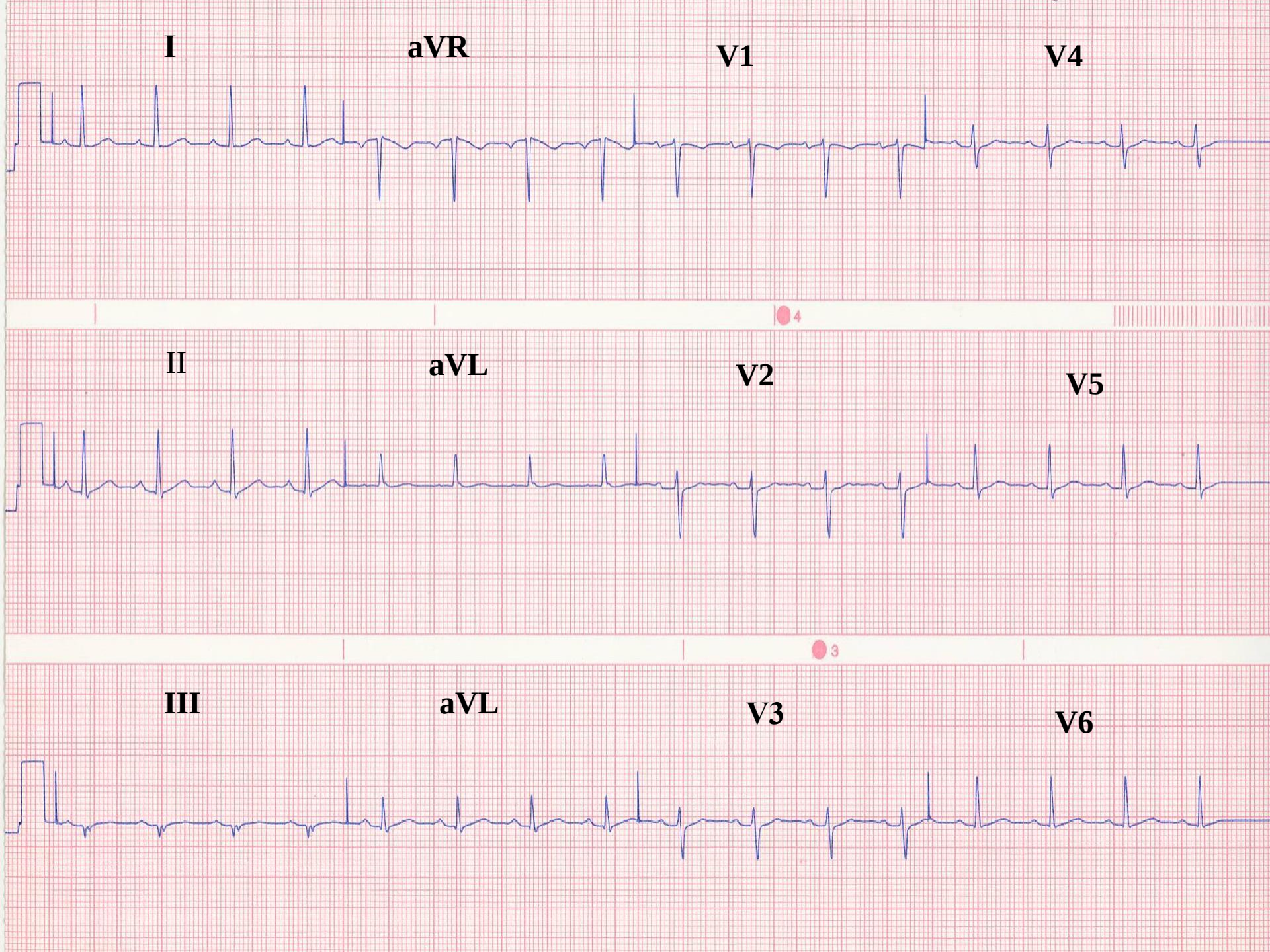
How to calculate HR on ECG

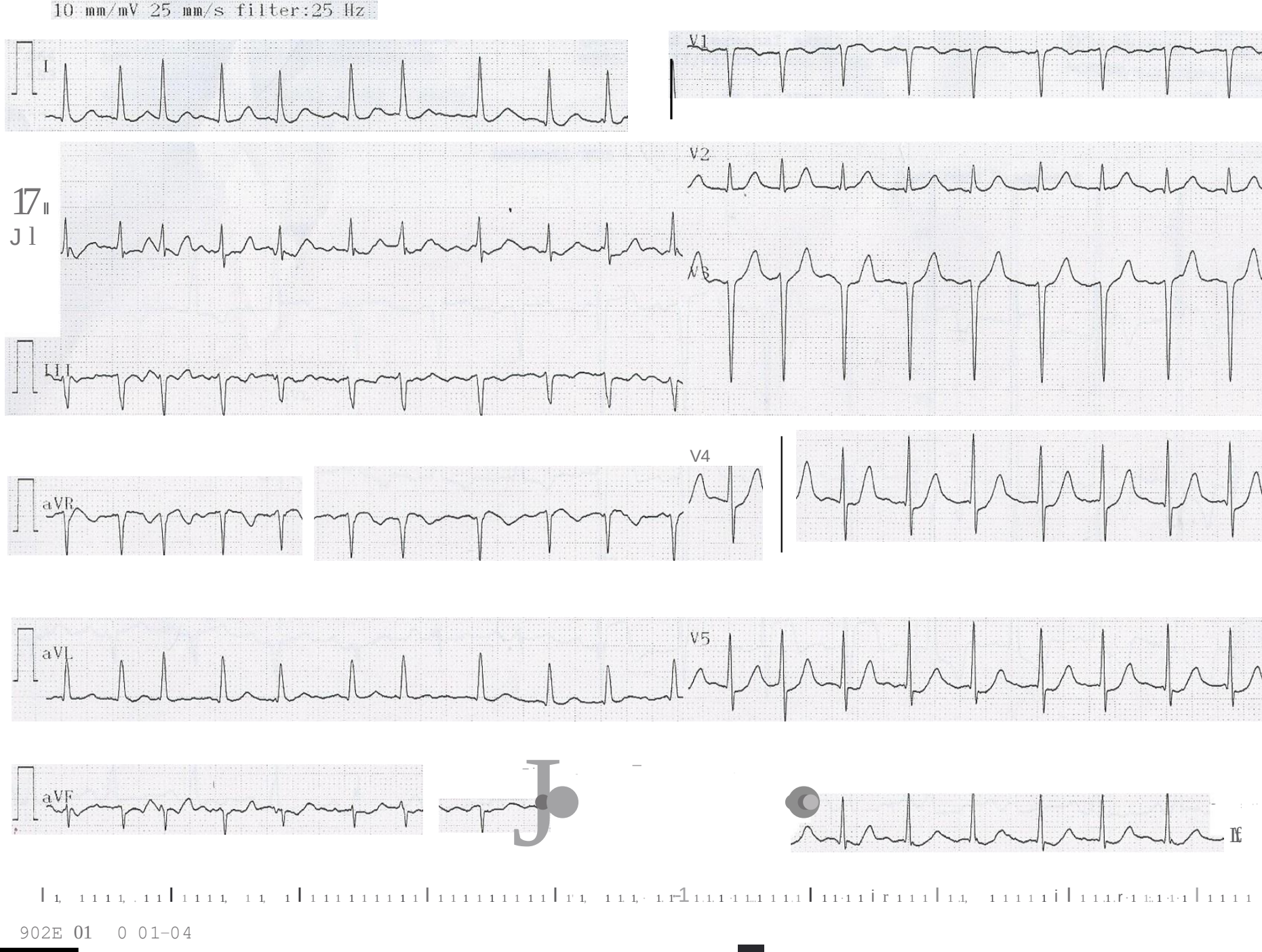
- 300 divided by the number of large blocks between RR interval


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

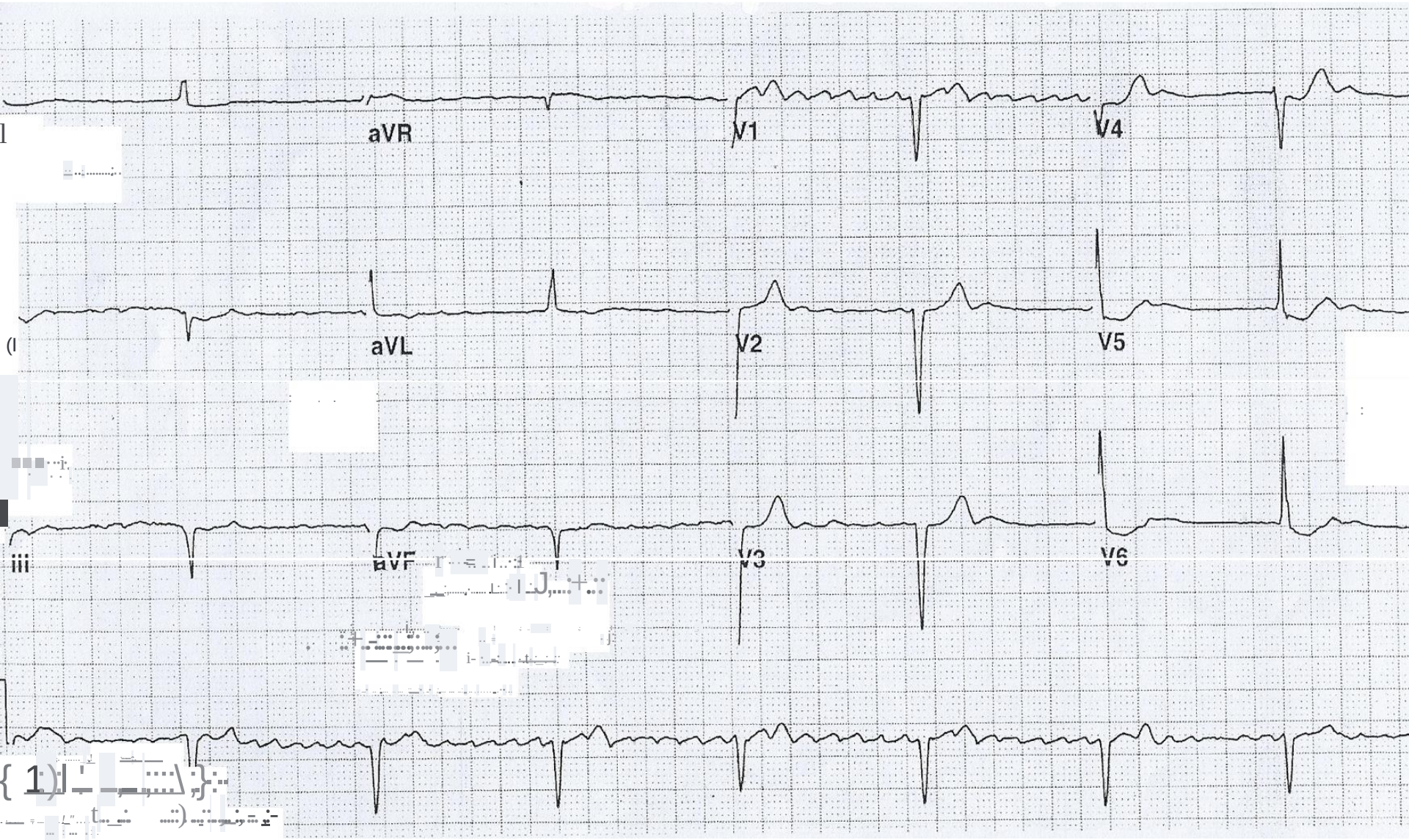
How to assess RHYTHM on ECG

- Sinus rhythm or not
- P wave before every QRS
- Can assess P wave rate and QRS rate – should be 1 to 1


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

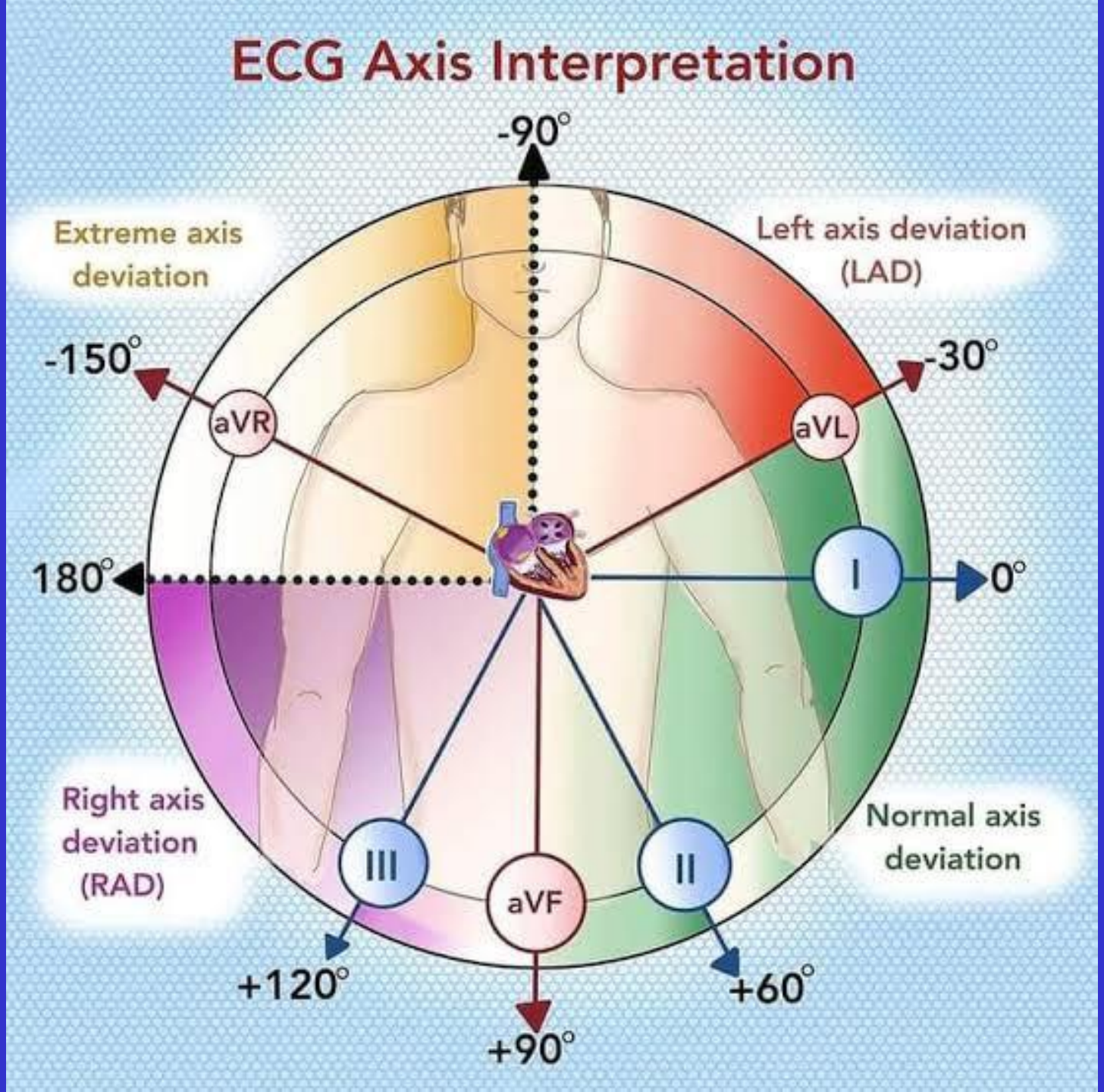

10 mm/mV 25 mm/s filter:25 Hz
I
V1
17
II
V2
III
V3
aVR
V4
aVL
V5
aVF
V6

ECG 6



Easy Peasy AXIS on the ECG

- Normal I and II positive
- I negative Right Axis
- II negative Left axis


ECG Axis Interpretation
-90°
Extreme axis deviation
Left axis deviation (LAD)
-150°
-30°
aVR
aVL
180°
I
0°
Right axis deviation (RAD)
Normal axis deviation
III
aVF
II
+120°
+60°
+90°

Right axis deviation

- Normal variation (vertical heart with an axis of 90º)
- Mechanical shifts, such as inspiration and emphysema
- **Right ventricular hypertrophy**
- **Right bundle branch block**
- Left posterior fascicular block
- Dextrocardia
- Ventricular ectopic rhythms
- Preexcitation syndromes
- Lateral wall myocardial infarction
- **Right ventricular load, for example Pulmonary Embolism or Cor Pulmonale (as in COPD)**

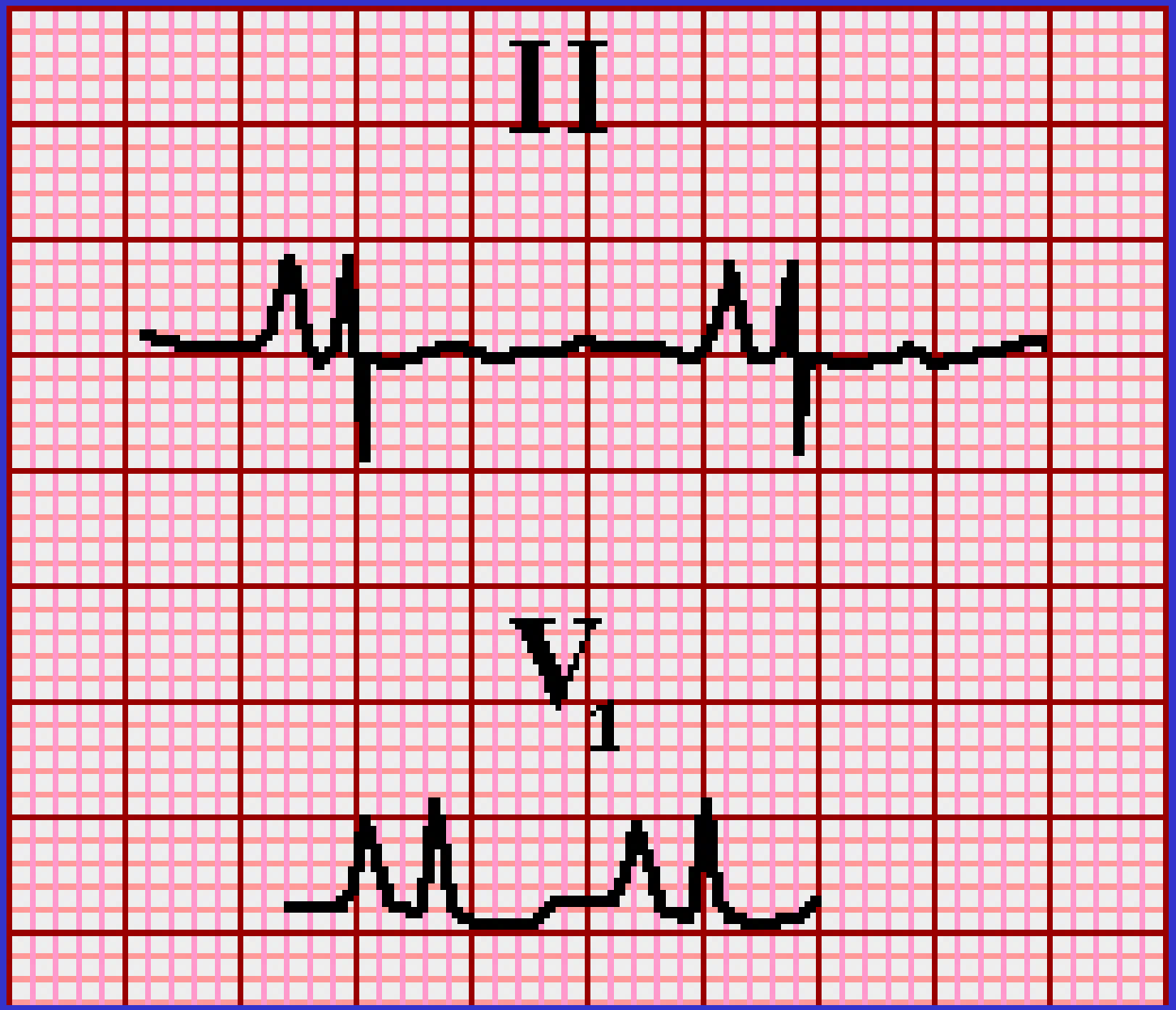
Left axis deviation

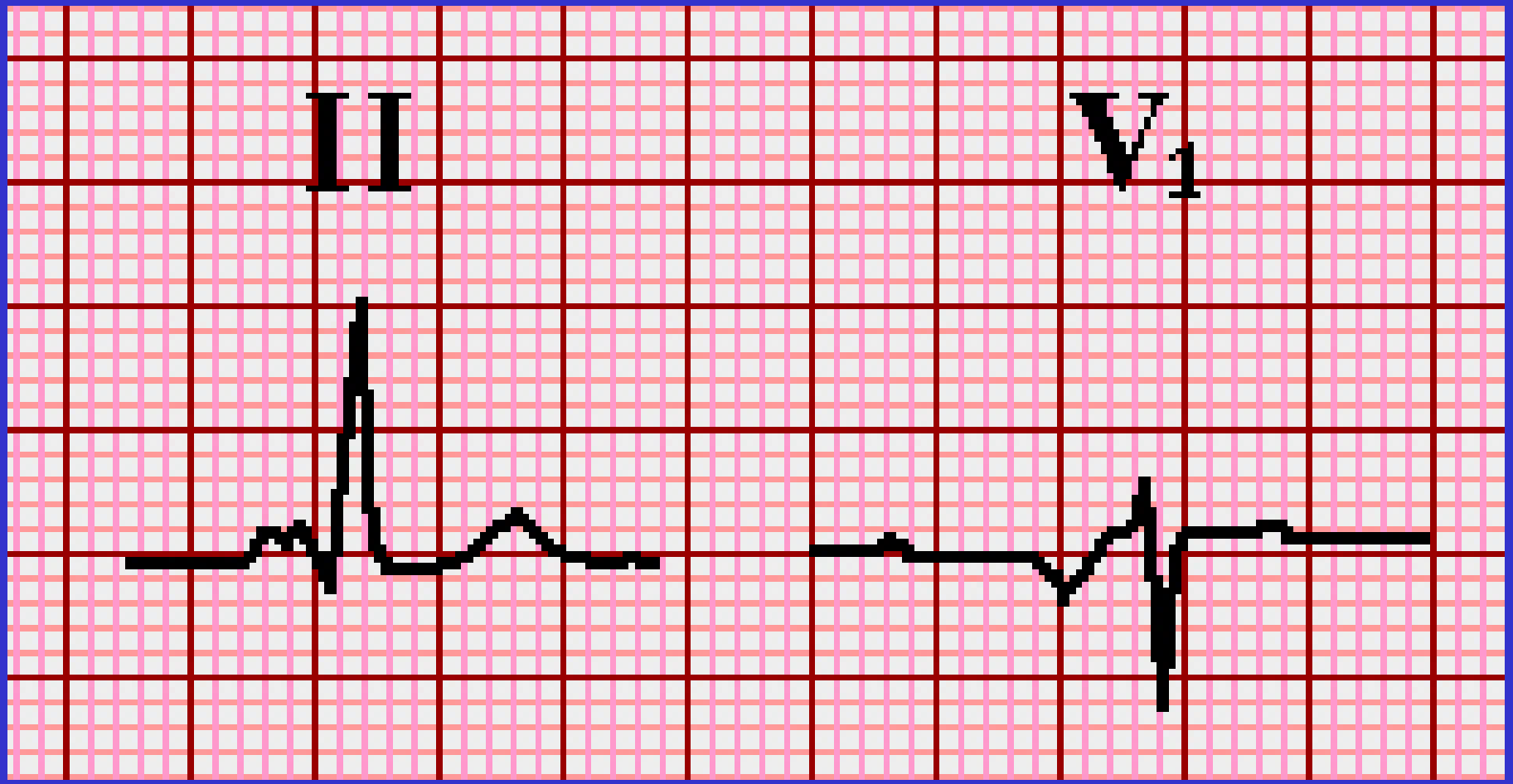
Normal variation (physiologic, often with age)
Mechanical shifts, such as expiration, high diaphragm (pregnancy, ascites, abdominal tumor)
Left ventricular hypertrophy
Left bundle branch block
left anterior fascicular block
Congenital heart disease (e.g. atrial septal defect)
Emphysema
Hyperkalemia
Ventricular ectopic rhythms
Preexciatation syndromes
Inferior MI
Pacemaker rhythm

CASE 3

P wave morphology

- Normal P wave should be less than 2 and ½ small blocks in height and width
- If greater than 2 and ½ in height = P pulmonale (RA enlargement)
- If greater than 2 and ½ in width or bifid = P mitrale (LA enlargement)
- Absent P waves = Atrial fibrillation


II
V1

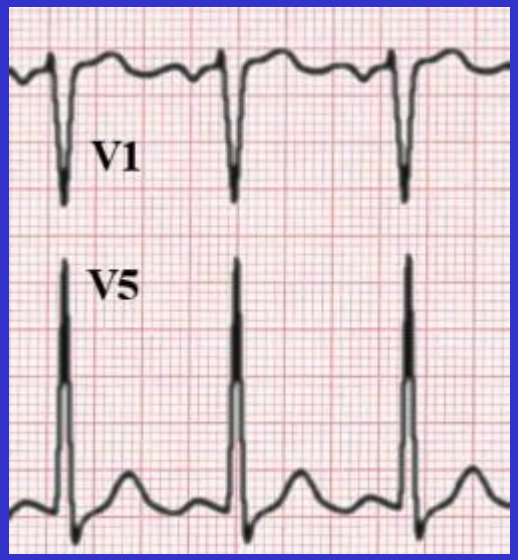

II
V1

QRS morphology

- Normal QRS less than 100 milliseconds
- If greater than 100 millseconds indicates a bundle branch block
- LBBB -> ‘M’ pattern in V6
- RBBB -> ‘rSR’ pattern in V1

Tall R-waves: Hypertrophy:

L.V.H



The **Sokolow-Lyon criterion**, this is most often used:

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

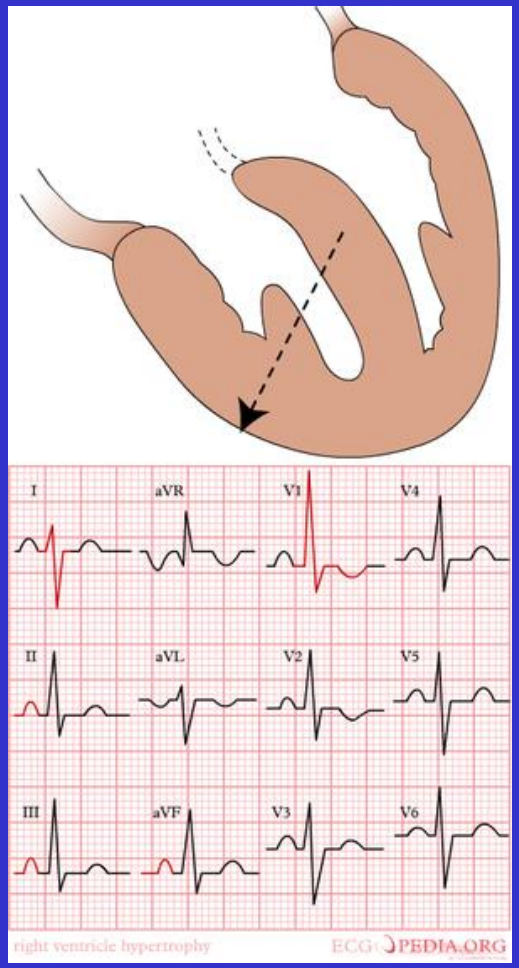
The **Cornell-criterion** has different values in men and women:

- R in aVL and S in V3 >28 mm in men
- R in aVL and S in V3 >20 mm in women

THE 35:28:20 rule!

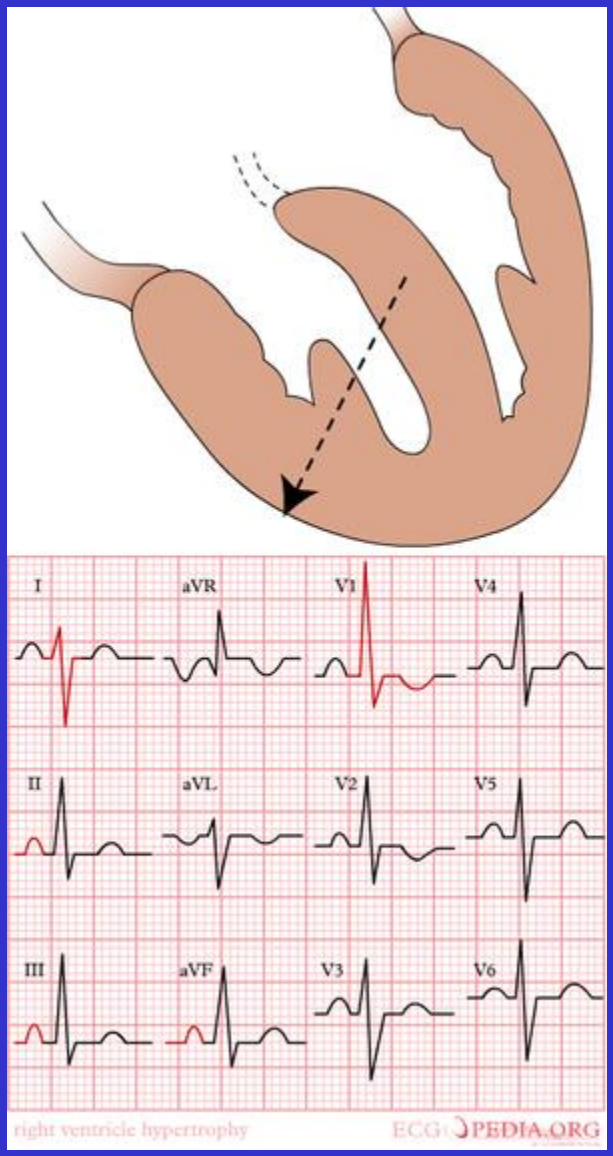
Tall R-waves: Hypertrophy:

R.V.H



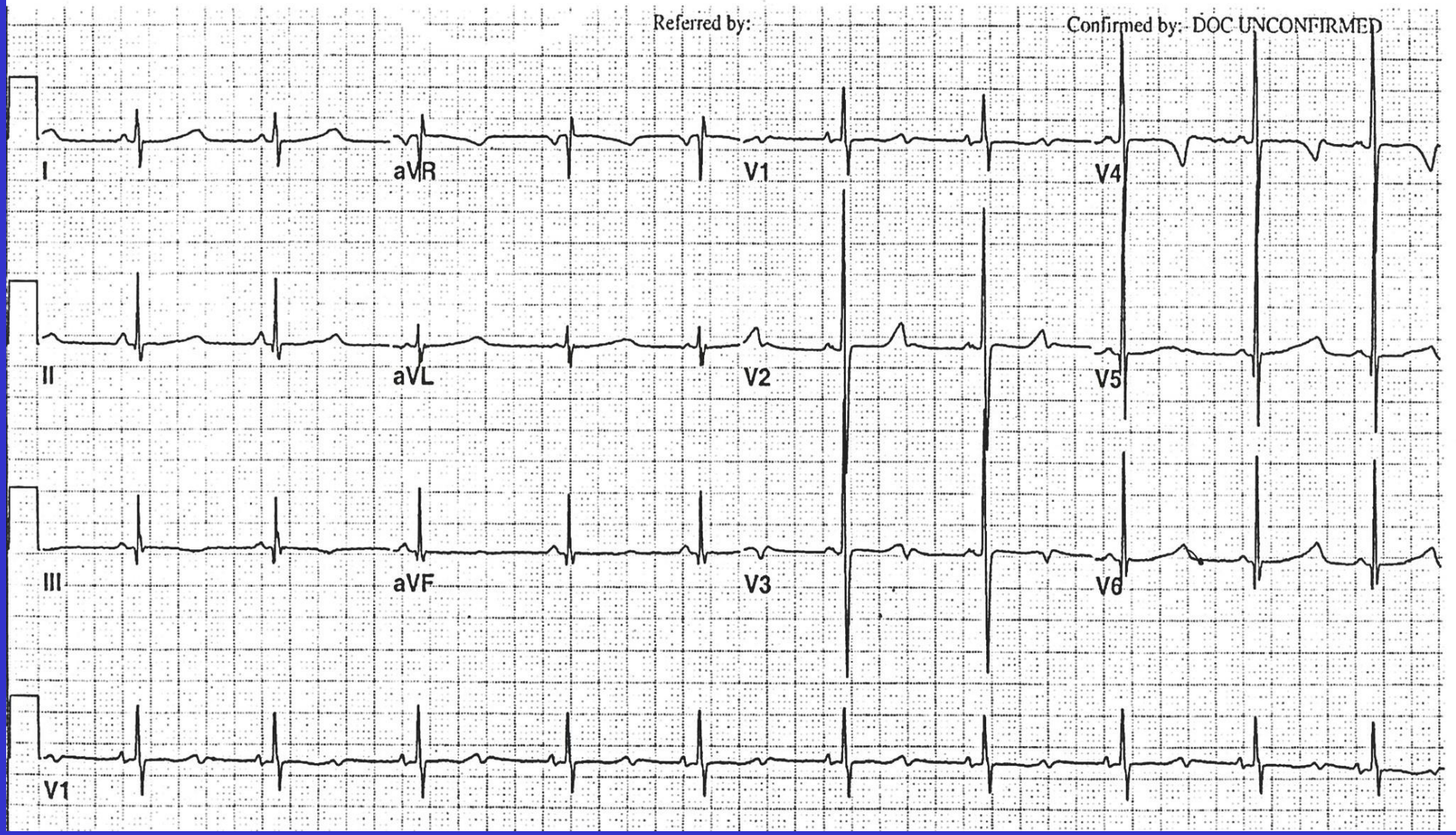
- QRS duration < 120ms
- Right heart axis (> 110 degrees)
- **Dominant R wave V1:**
  - R/S ratio in V1 or V3R > 1, or R/S ratio in V5 or V6 <= 1
  - R wave in V1 >= 7 mm
  - R wave in V1 + S wave in V5 or V6 > 10.5 mm
  - rSR= in V1 with R'= > 10 mm
  - qR complex in V1
- Secondary ST-T changes in right precordial leads
- Right atrial abnormality
- Onset of intrinsicoid deflection in V1 between 0.035 and 0.055 s

Tall R waves in V1



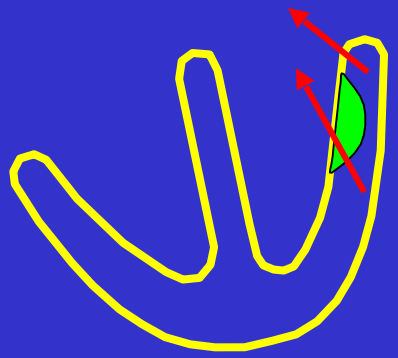
- Normal in children and young adults
- Right Ventricular Hypertrophy (RVH)
  - Pulmonary Embolus
  - Persistence of infantile pattern
  - Left to right shunt
- Right Bundle Branch Block (RBBB)
- Posterior Myocardial Infarction (ST elevation in Leads V7, V8, V9)
- Wolff-Parkinson-White (WPW) Type A
- Incorrect lead placement (e.g. V1 and V3 reversed)
- Dextrocardia
- HOCM
- Dystrophy
  - Myotonic dystrophy
  - Duchenne Muscular dystrophy

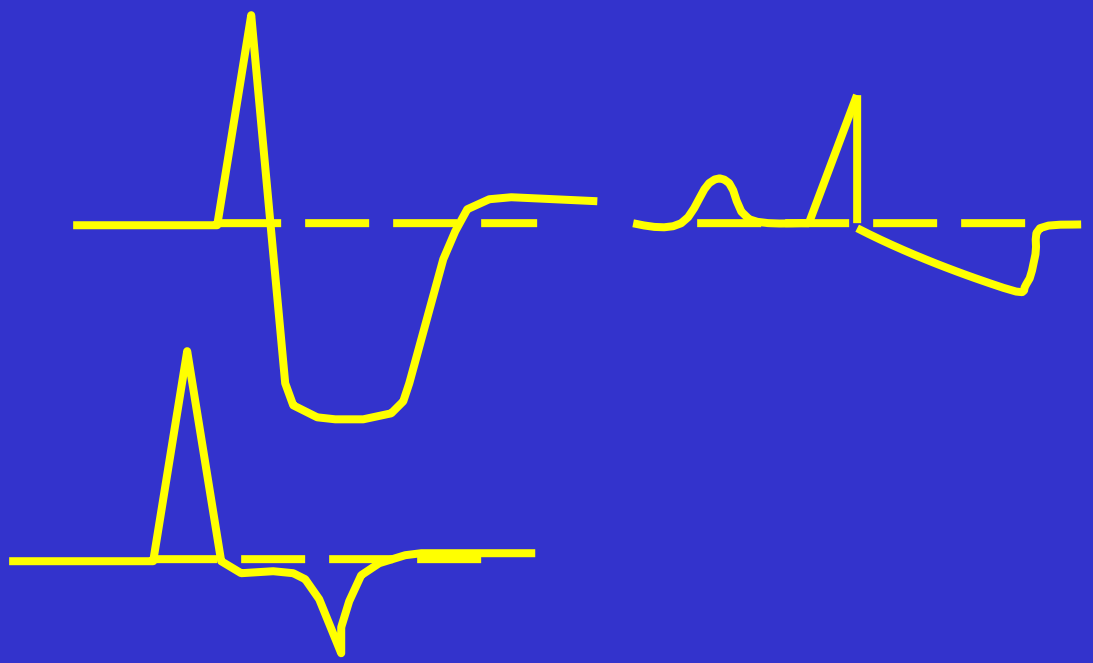
ECG 8:


Referred by:
Confirmed by: DOC UNCONFIRMED
I
aVR
V1
V4
II
aVL
V2
V5
III
aVF
V3
V6
V1

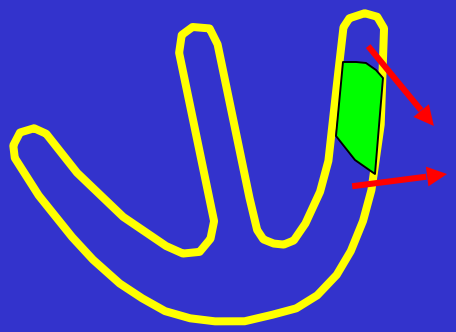
Concept of current-of-injury :

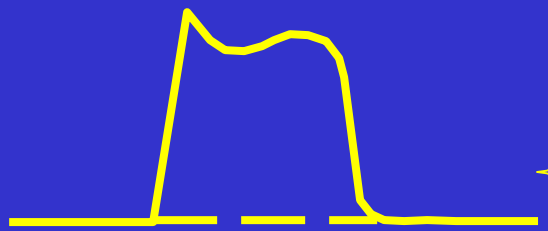
["Subendocardial"]





"Transmural"
"Epicardial"

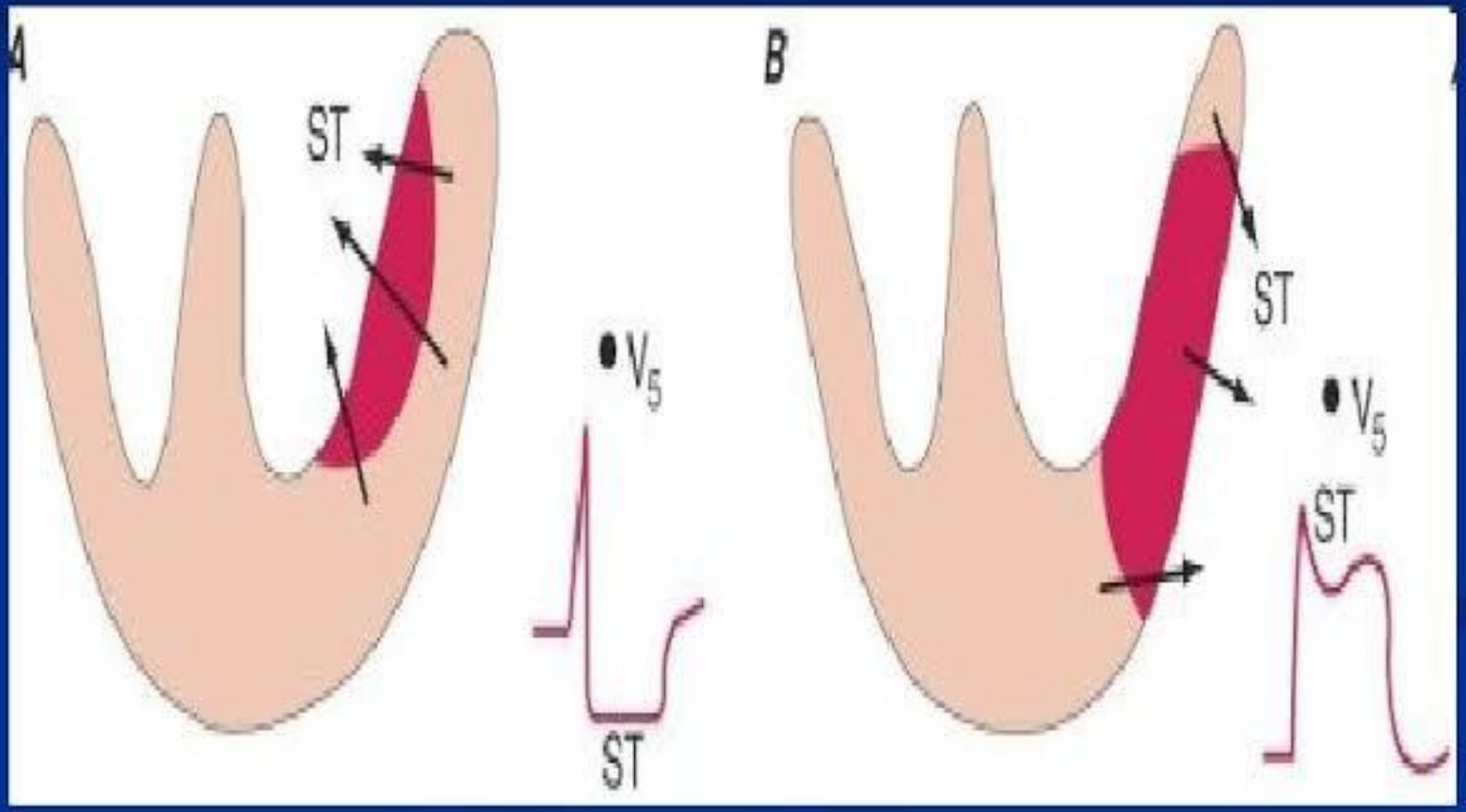




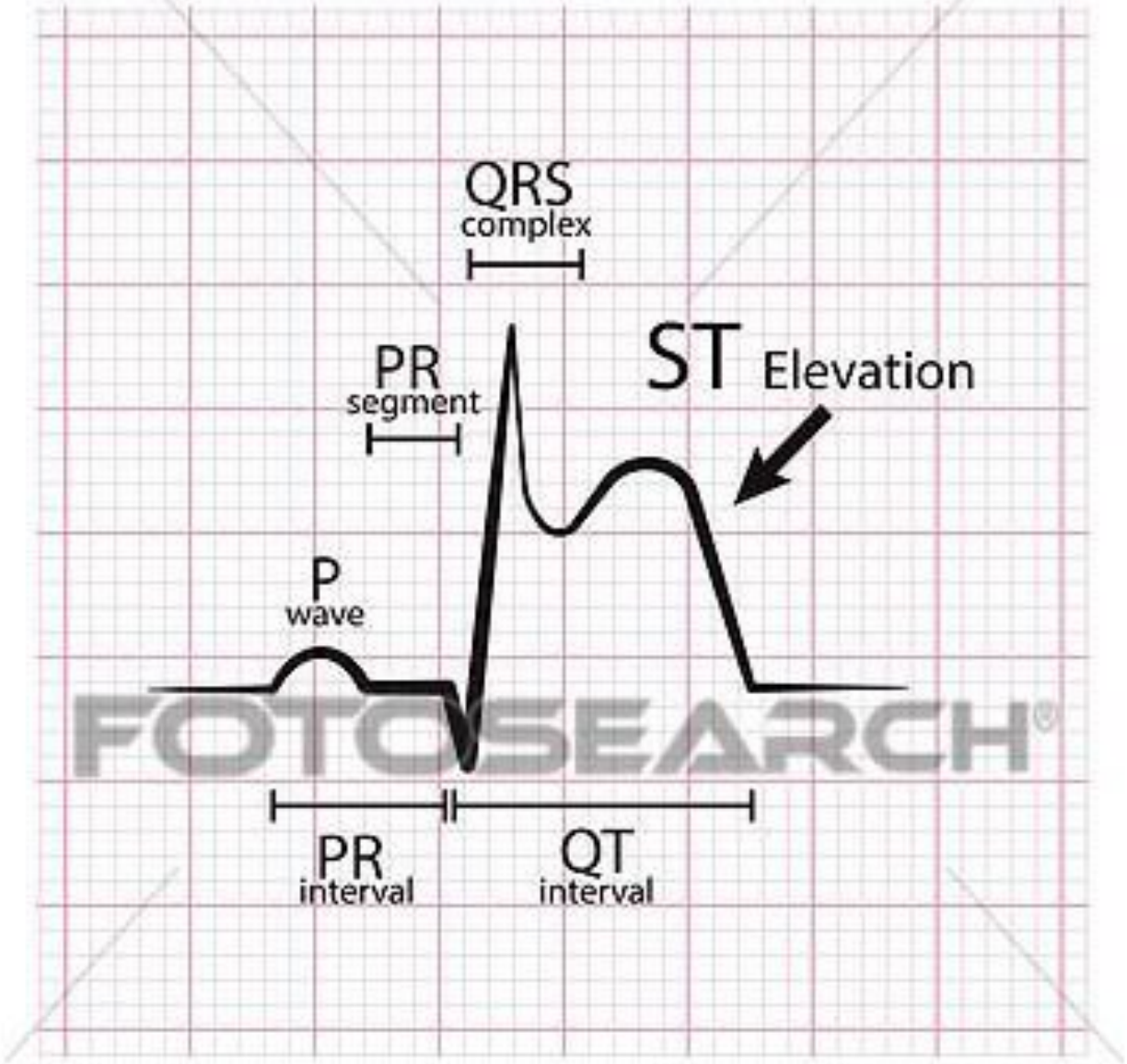
Causes of ST elevation:

- **Acute M.I. (stemi)**
- **Acute pericarditis.**
- **LBBB.**
- **Hyperkalemia.**
- **Pulmonary embolism.**

Acute ischemia causes a current of injury. With predominant subendocardial ischemia (A), the resultant ST vector will be directed toward the inner layer of the affected ventricle and the ventricular cavity. Overlying leads therefore will record ST depression. With ischemia involving the outer ventricular layer (B) (transmural or epicardial injury), the ST vector will be directed outward. Overlying leads will record ST elevation.



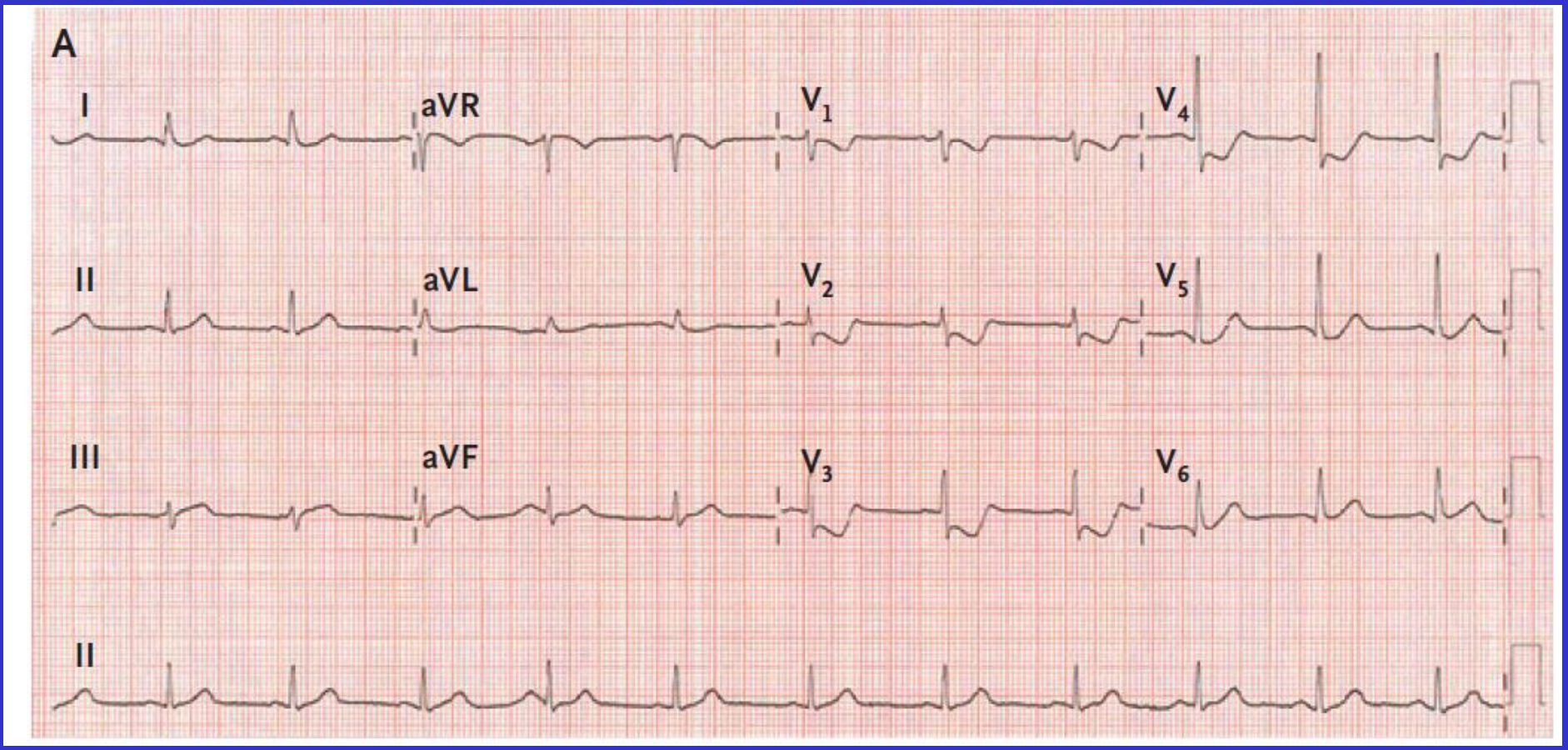
STEMI


QRS
complex
PR
segment
ST Elevation
P
wave
PR
interval
QT
interval

Localizing of myocardial infarction on ECG

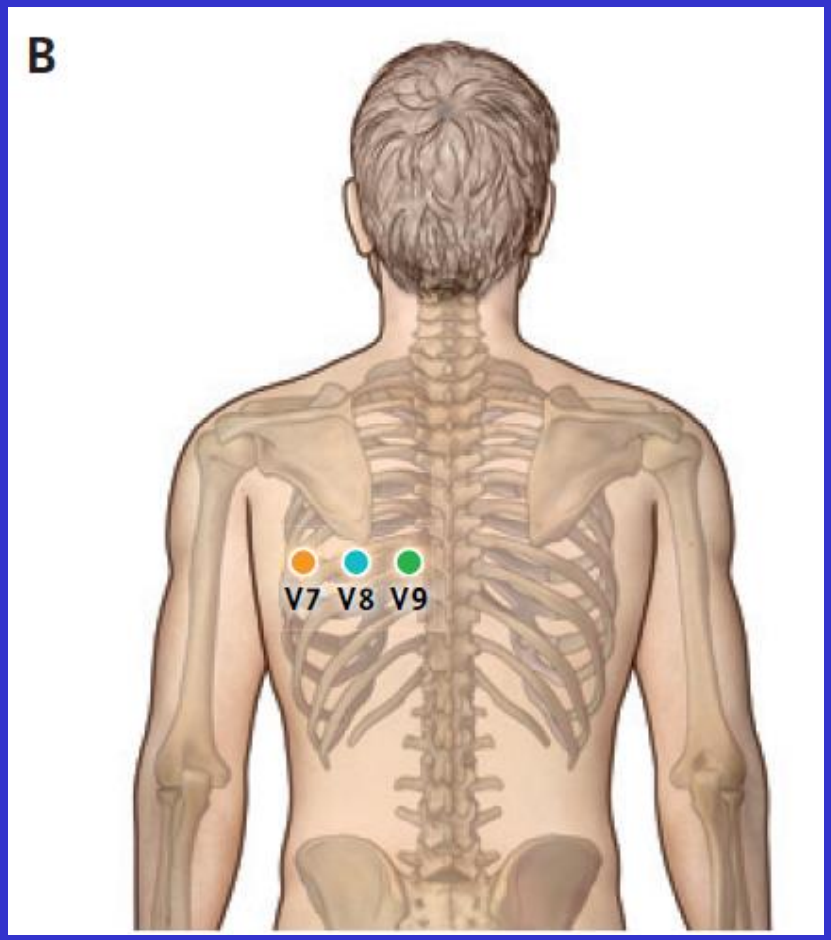
Infarct location	ECG changes	Affected coronary artery
Septal	V_1–V_2	Septal LAD
Anterior	V_3–V_4	LAD
Lateral	I, aVL, V_5, V_6	LCx, diagonals
Inferior	II, III, aVF	LCx (15%), RCA (85%)
Posterior	V_7, V_8, V_9 (posteriorly placed)	RCA

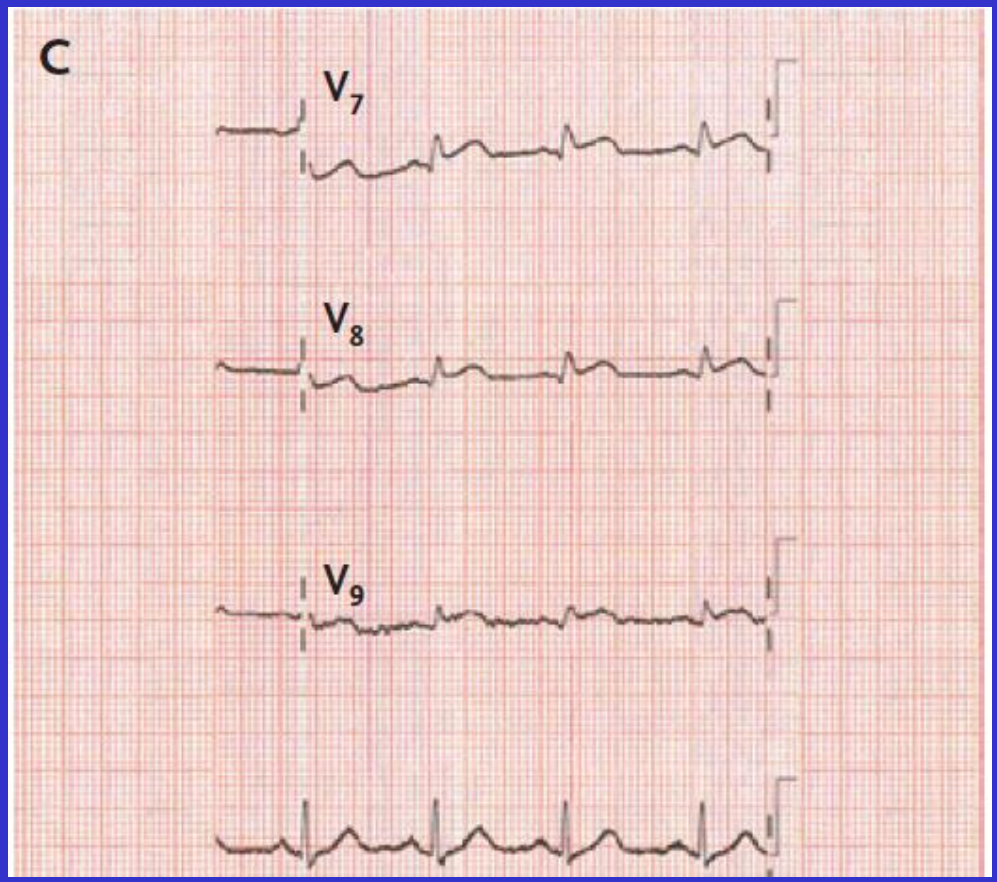
Posterior wall MI on ECG



Posterior wall MI on ECG

n engl j med 381;17 nejm.org October 24, 2019





Posterior wall MI on ECG

Can co exist with inferior MI

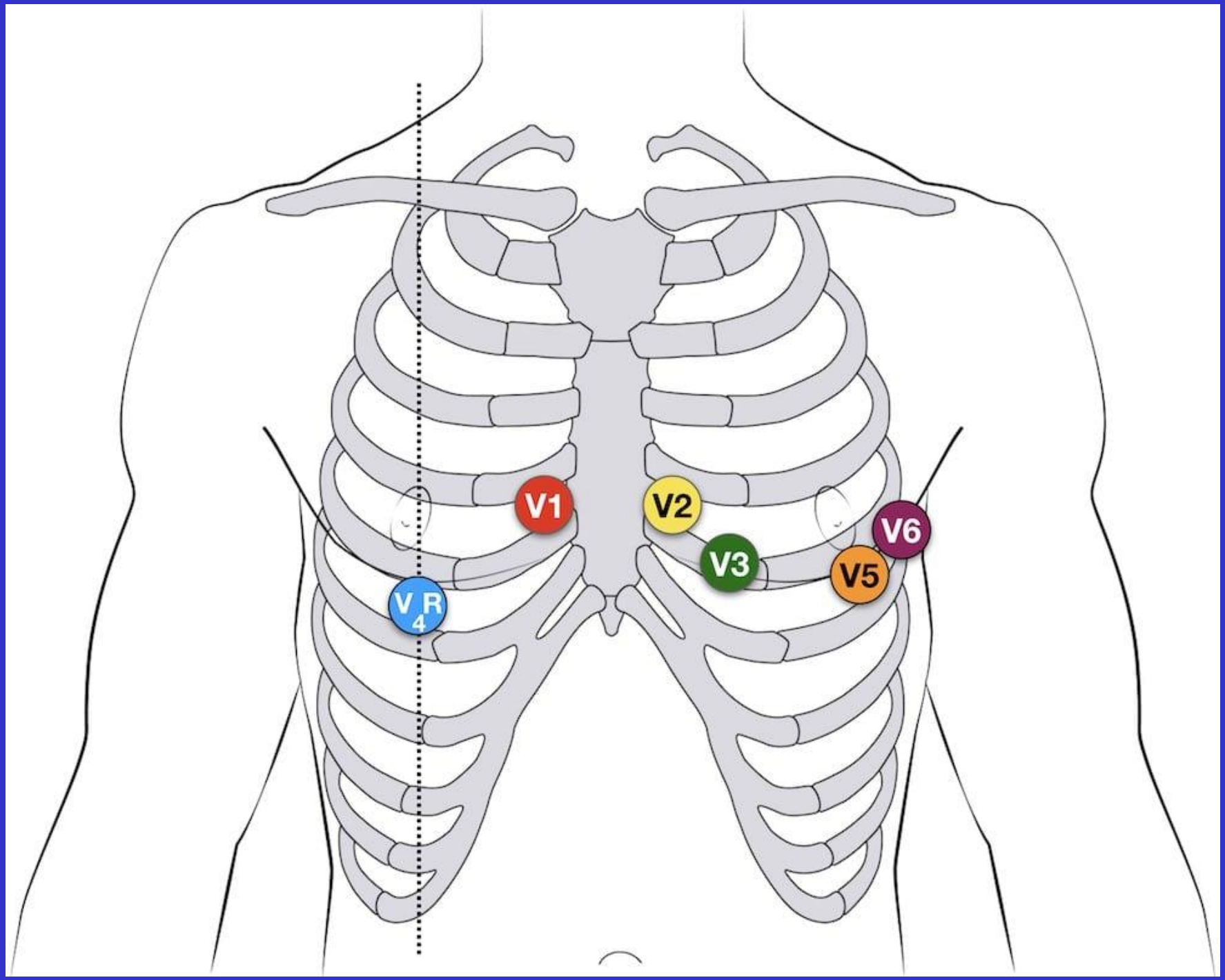
RV MI on ECG

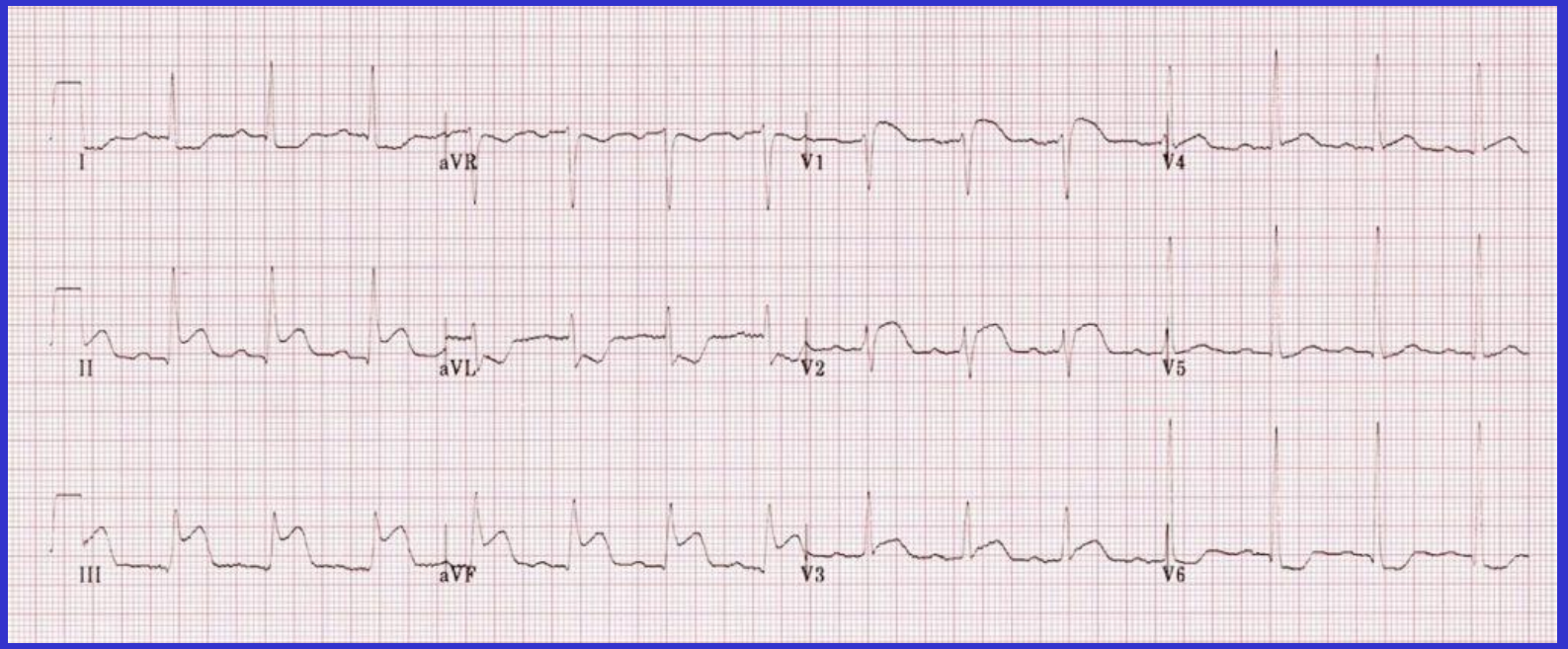
Can co exist with inferior MI

In patients with inferior STEMI, right ventricular infarction is suggested by:

- ST elevation in V1
- ST elevation in V1 and ST depression in V2 (highly specific for RV infarction)
- Isoelectric ST segment in V1 with marked ST depression in V2
- ST elevation in III > II

Diagnosis is confirmed by the presence of ST elevation in the right-sided leads (V3R-V6R)


V1
V2
V3
V4R
V5
V6



Inferior STEMI. Right ventricular infarction is suggested by:

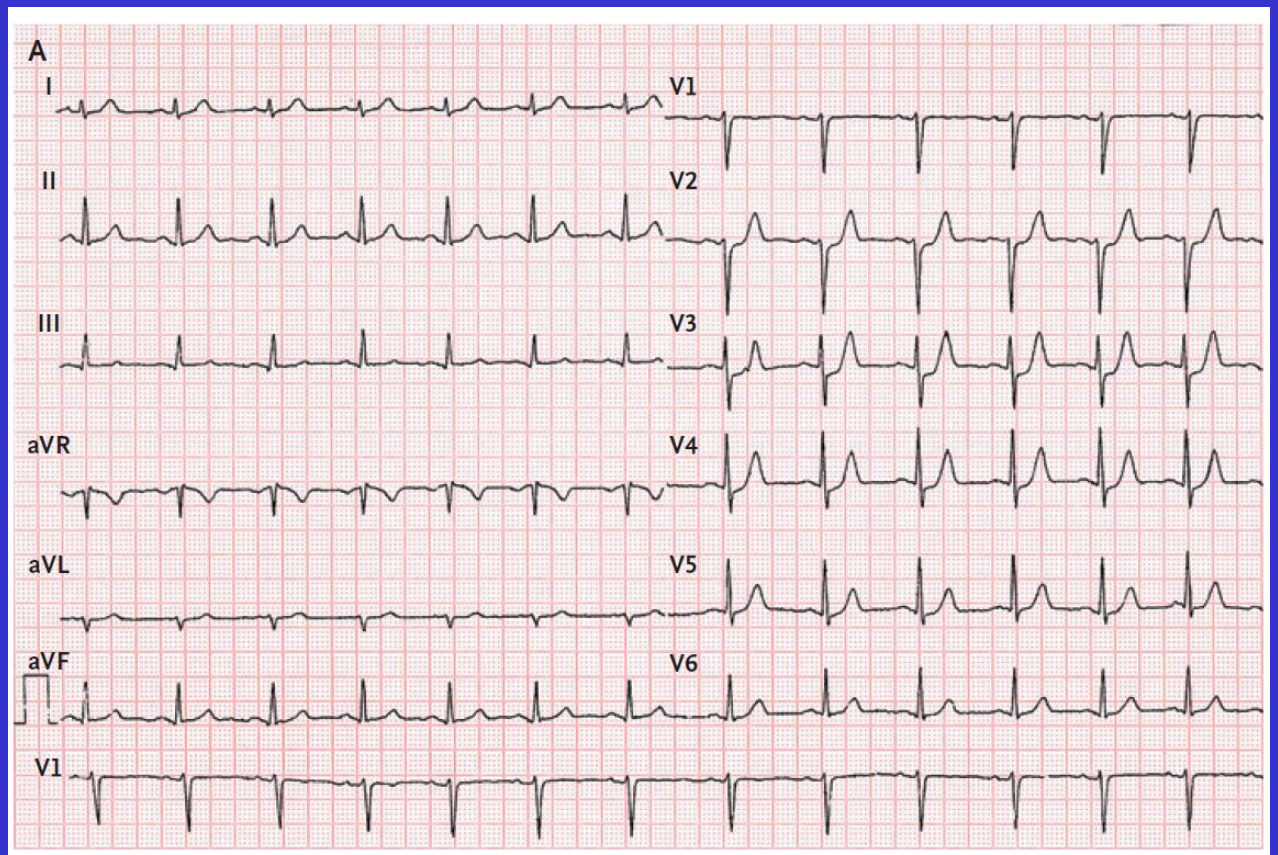
ST elevation in V1

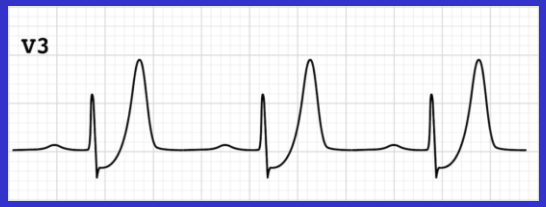
ST elevation in lead III > lead II

Dutch Names on ECG!

De Winter Pattern

upsloping ST-segment depression and tall, symmetric T waves in leads V2 through V5:**stenosis of the proximal LAD** coronary artery, seen in **~2% of acute LAD occlusions** and is often under-recognised by clinicians



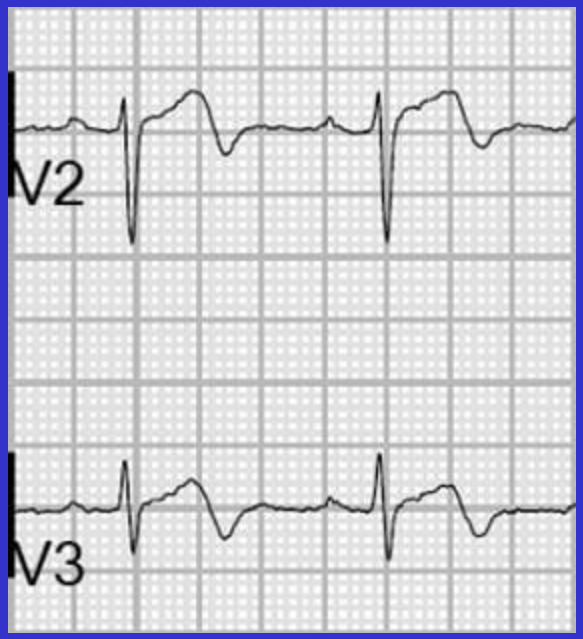


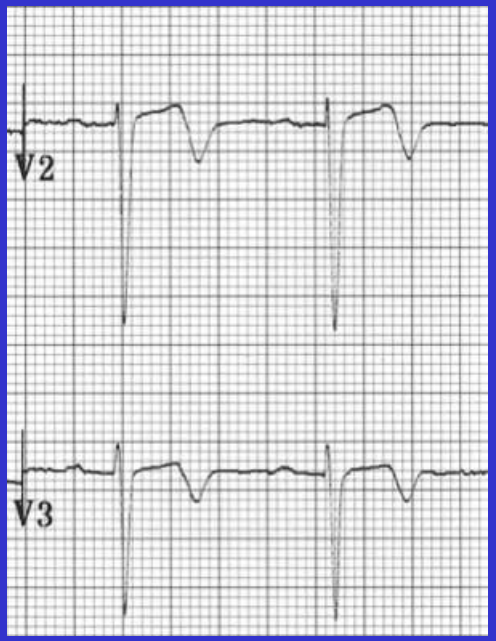
Dutch Names on ECG

n engl j med 372;1 nejm.org january 1, 2015

Wellens sign

anterior T-wave inversions with biphasic lateral T waves: critical stenosis LAD

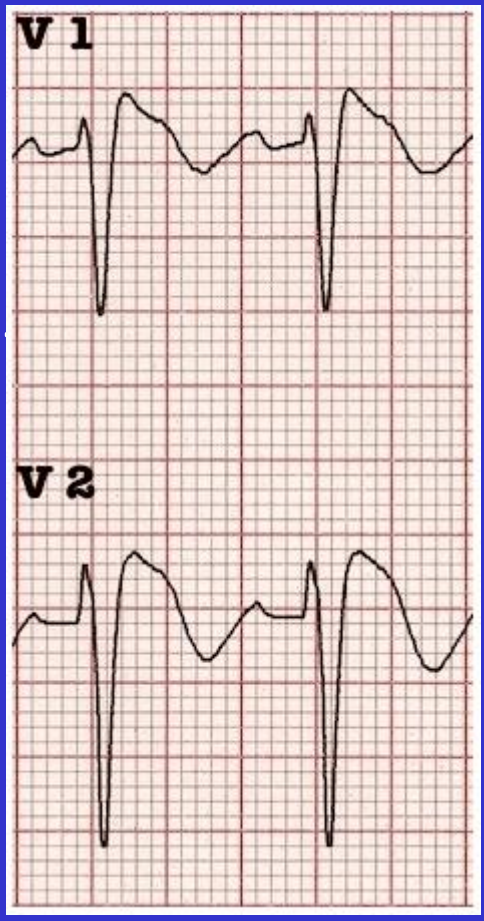


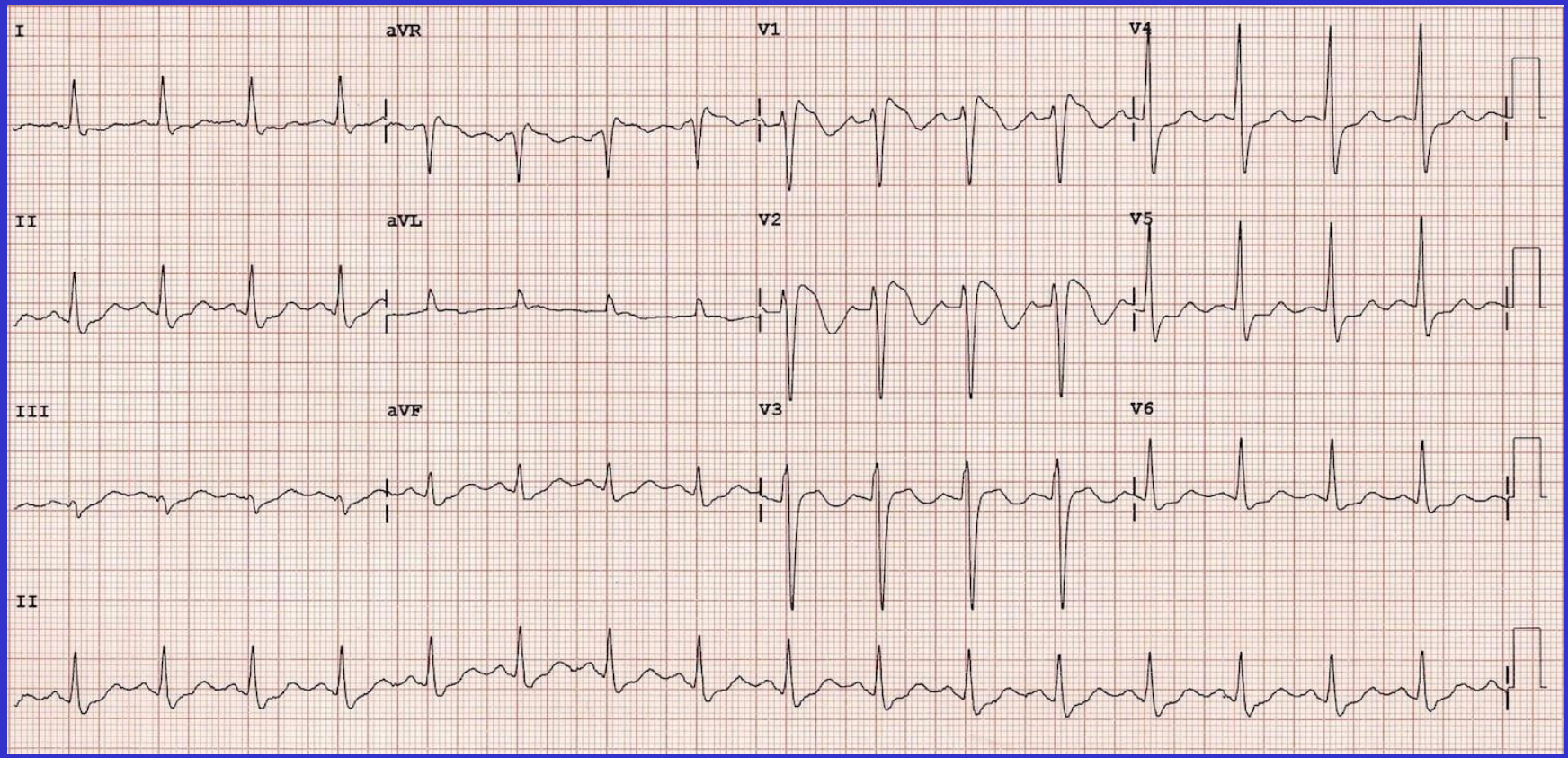


Names on ECG

Brugada Sign/Syndrome

Coved ST segment elevation >2mm in >1 of V1-
V3 followed by a
negative T wave.

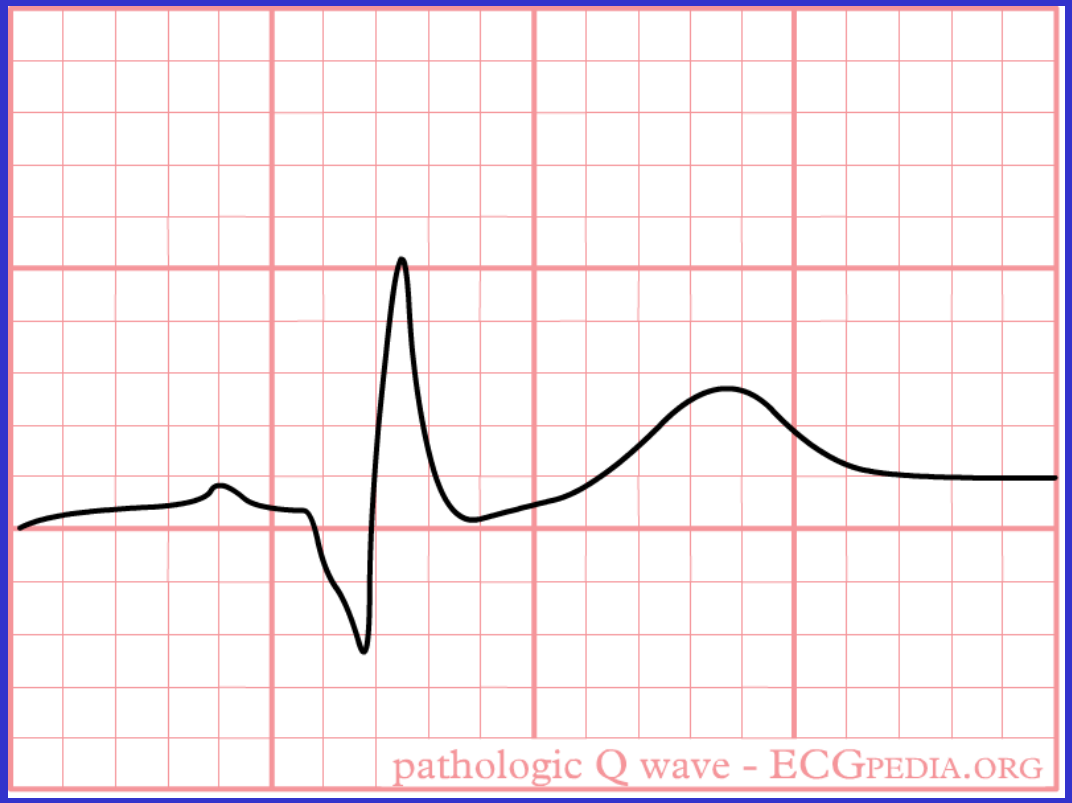



I
aVR
V1
V4
II
aVL
V2
V5
III
aVF
V3
V6
II

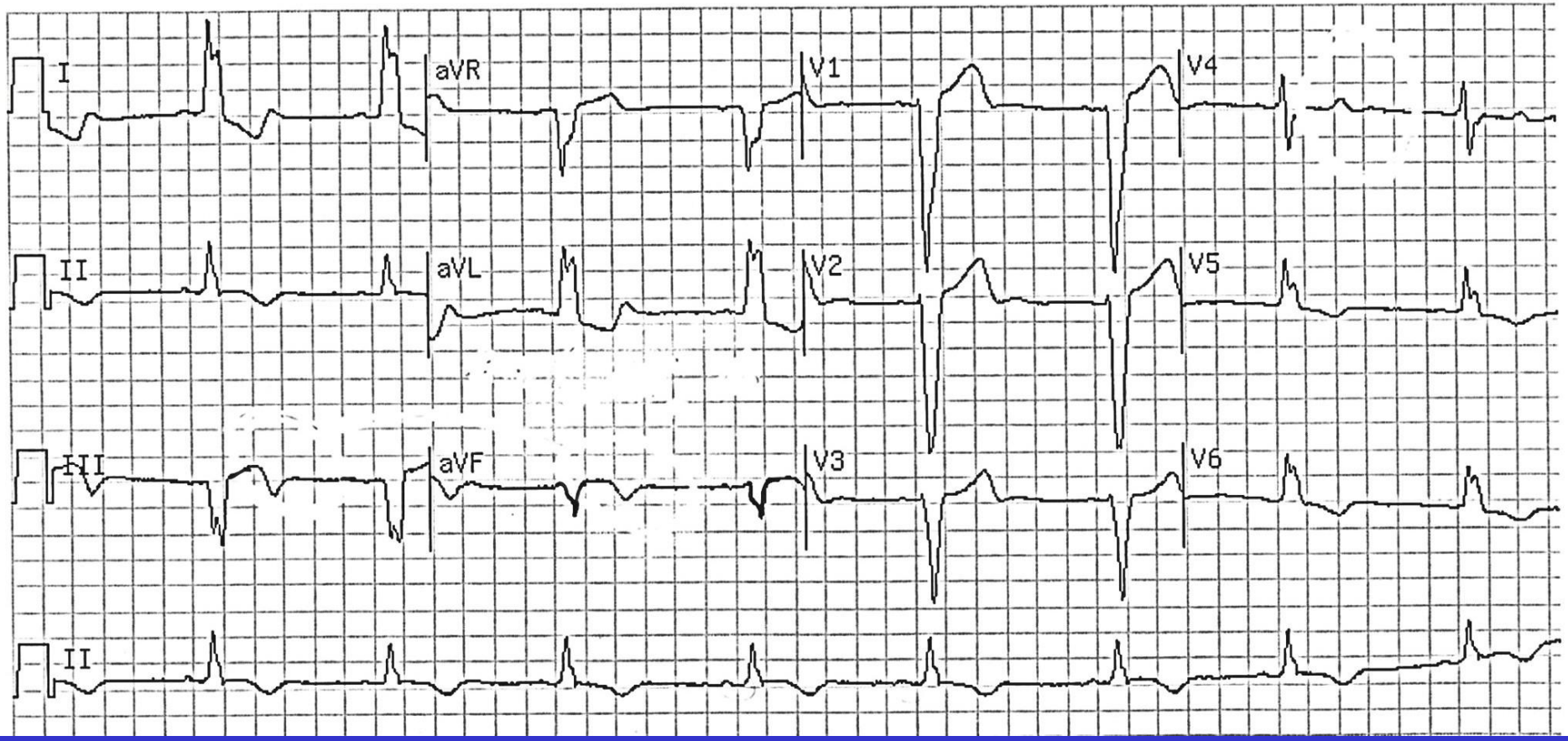
Pathological Q waves

- Any Q-wave in leads V2–V3 ≥ 0.02 s or QS complex in leads V2 and V3
- Q-wave ≥ 0.03 s and > 0.1 mV deep or QS complex in leads I, II, aVL, aVF, or V4–V6 in any two leads of a contiguous lead grouping (I, aVL,V6; V4–V6; II, III, and aVF)
- R-wave ≥ 0.04 s in V1–V2 and R/S ≥ 1 with a concordant positive T-wave in the absence of a conduction defect

Pathological Q waves



2



Resources

Life in the fast lane

ECGpedia https://en.ecgpedia.org/