ECG Interpretation

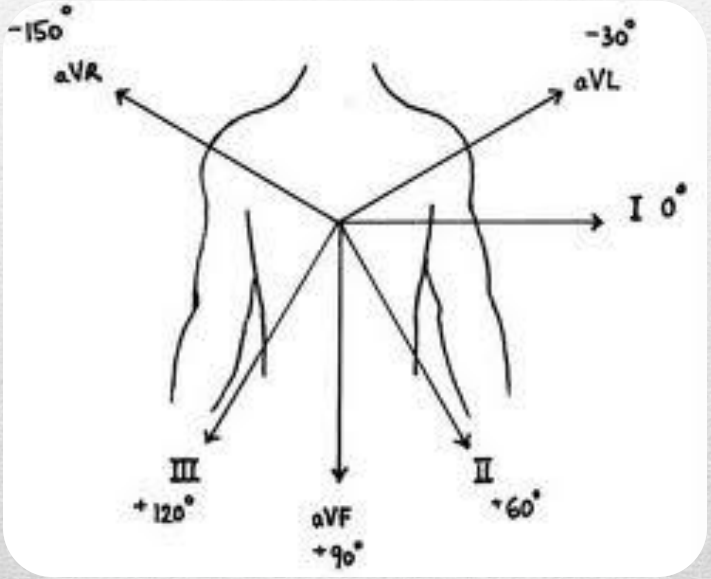
Outlines:

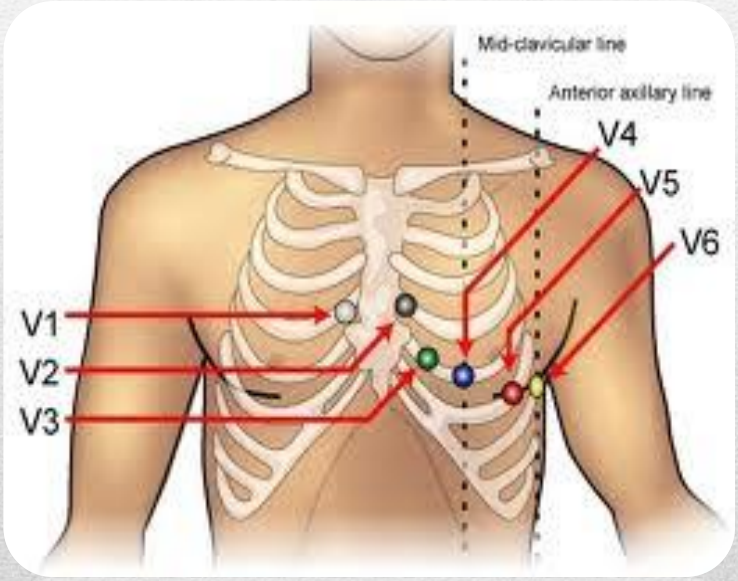
- ECG definition.
- Leads presentation.
- Electrical conduction.
- How to read an ECG paper.
- Cardiac dysrhythmias.

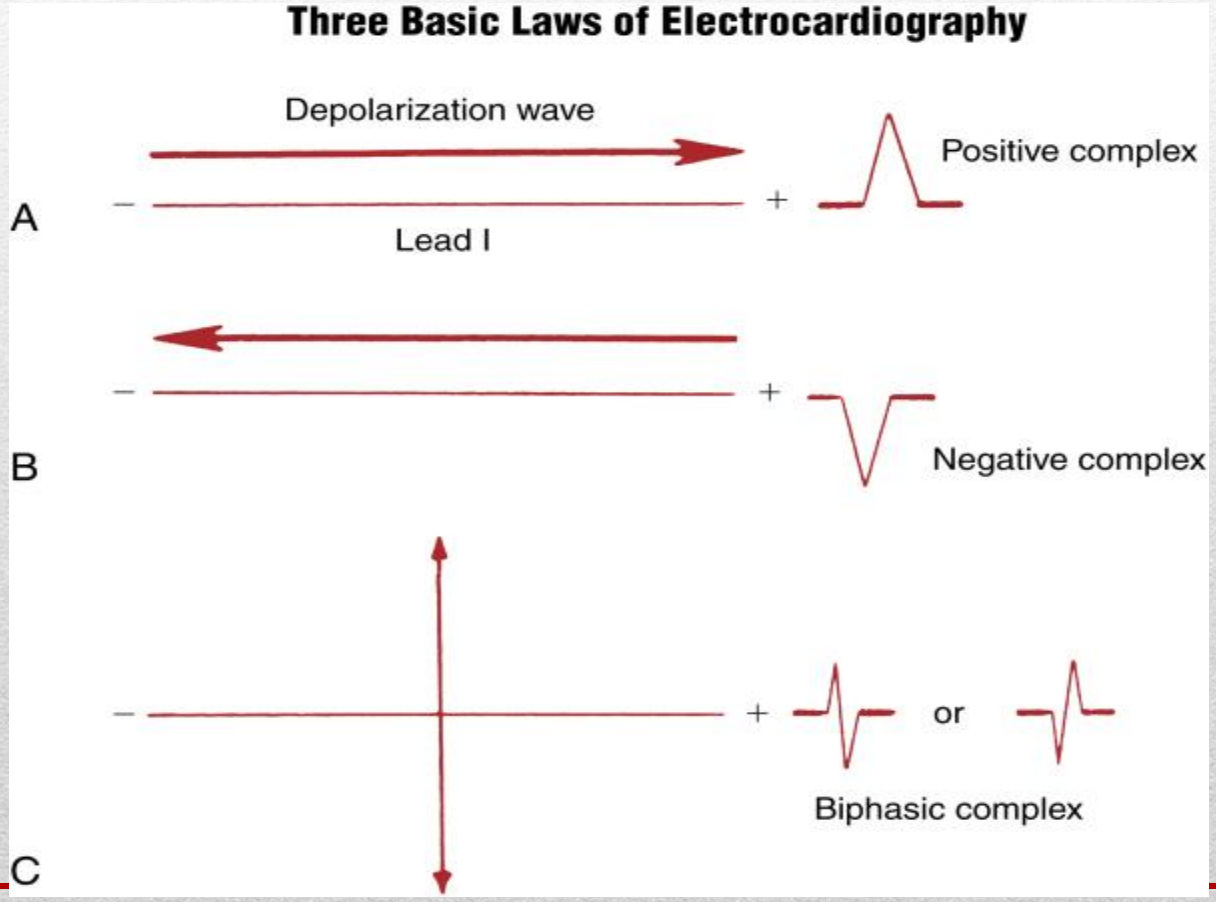
Part 1

- ECG definition.
- Leads presentation.
- Electrical conduction.
- How to read an ECG paper.

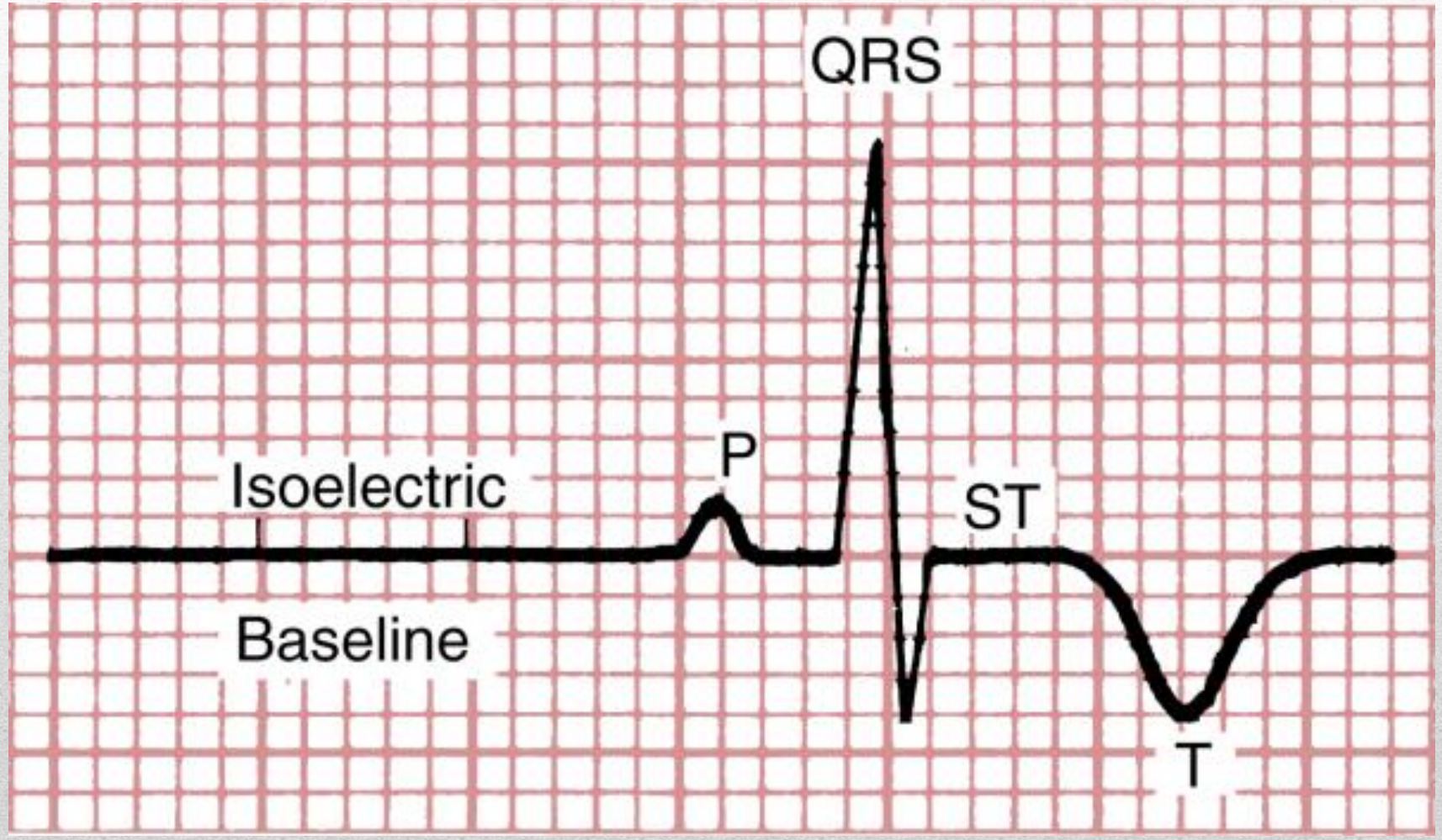
Leads Presentation



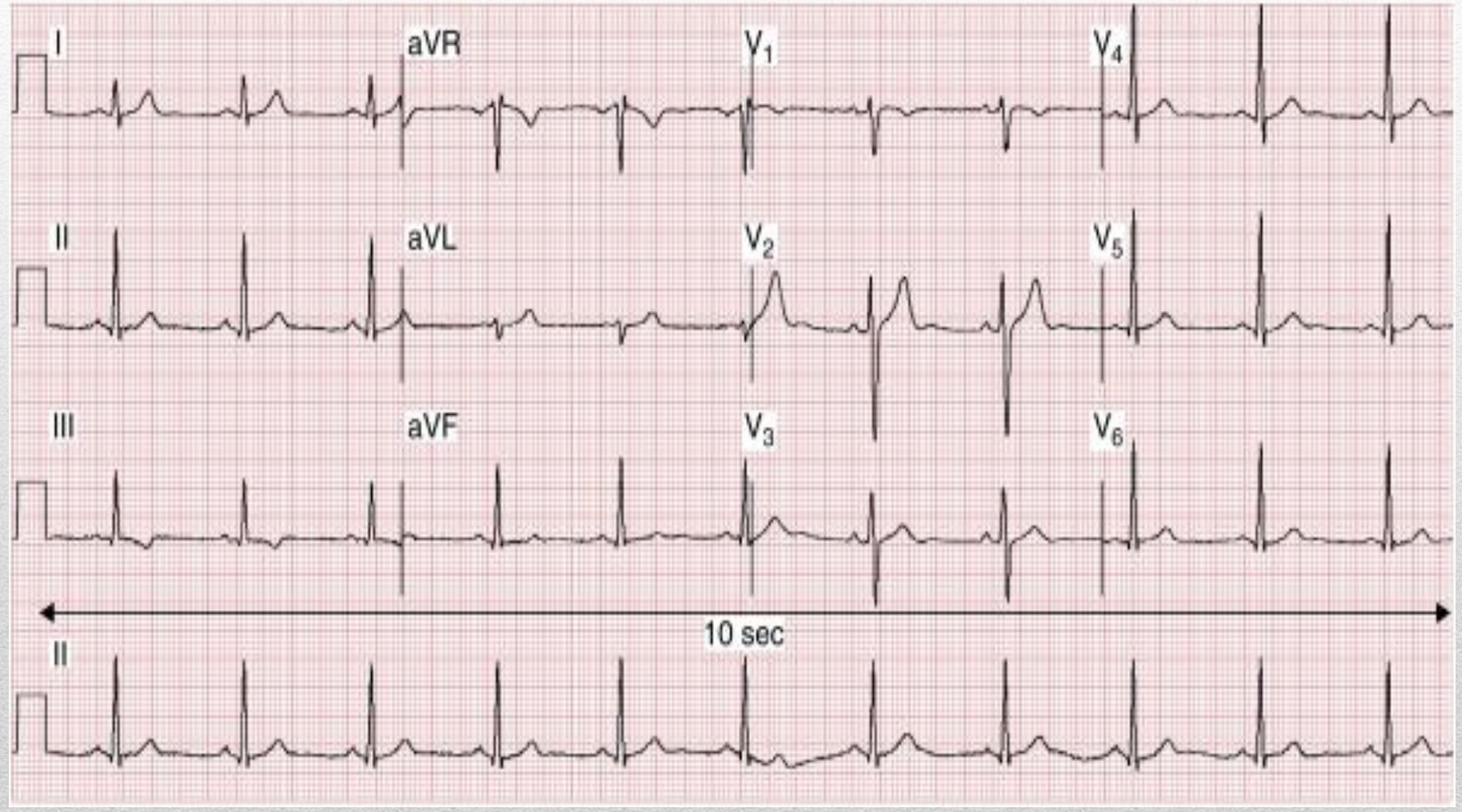



Three Basic Laws of Electrocardiography
Depolarization wave
Positive complex
A
–
+
Lead I
B
–
+
Negative complex
C
–
+
or
Biphasic complex

Waves



12 Leads EKG

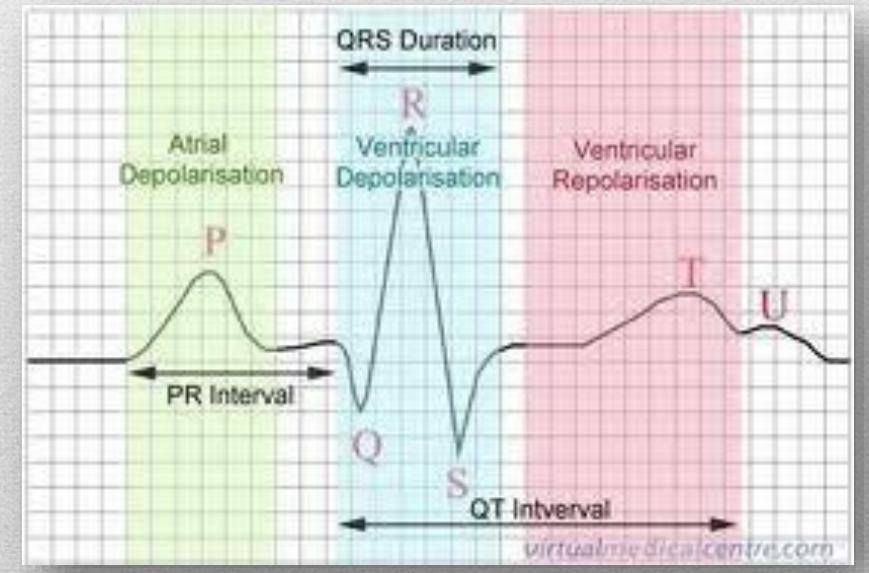


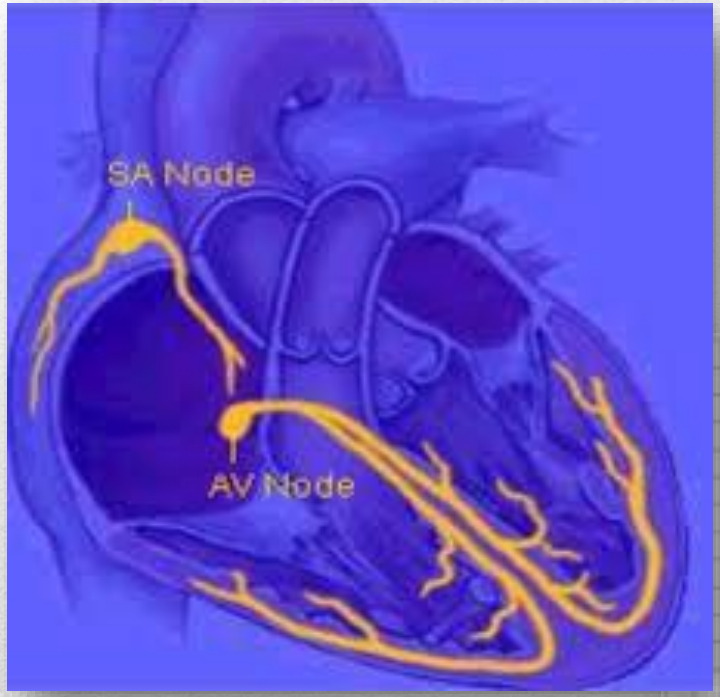
QRS Complex

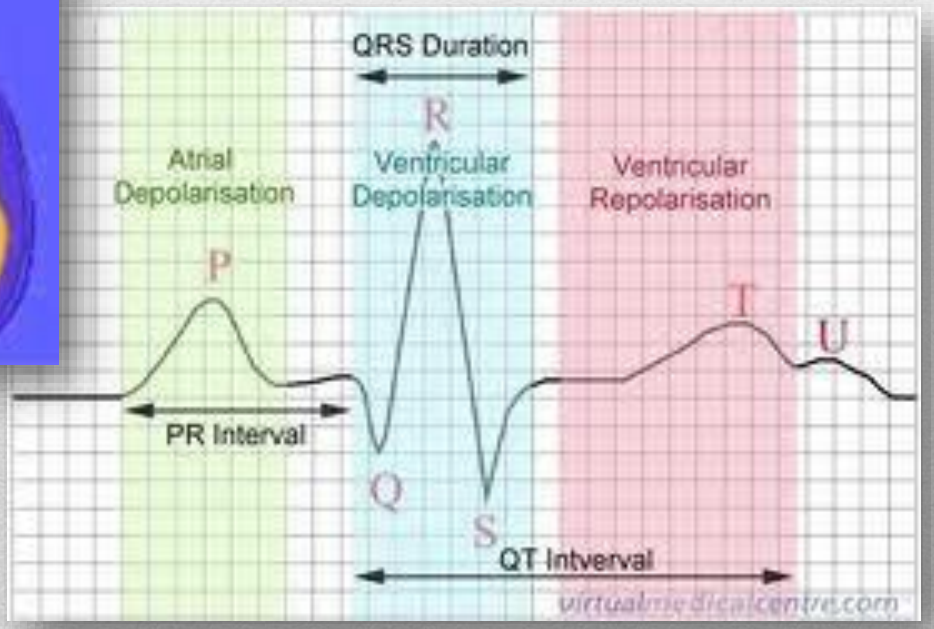
It represents ventricular depolarization.

Normal QRS duration

≤ 3 ss (≤ **120 seconds**)

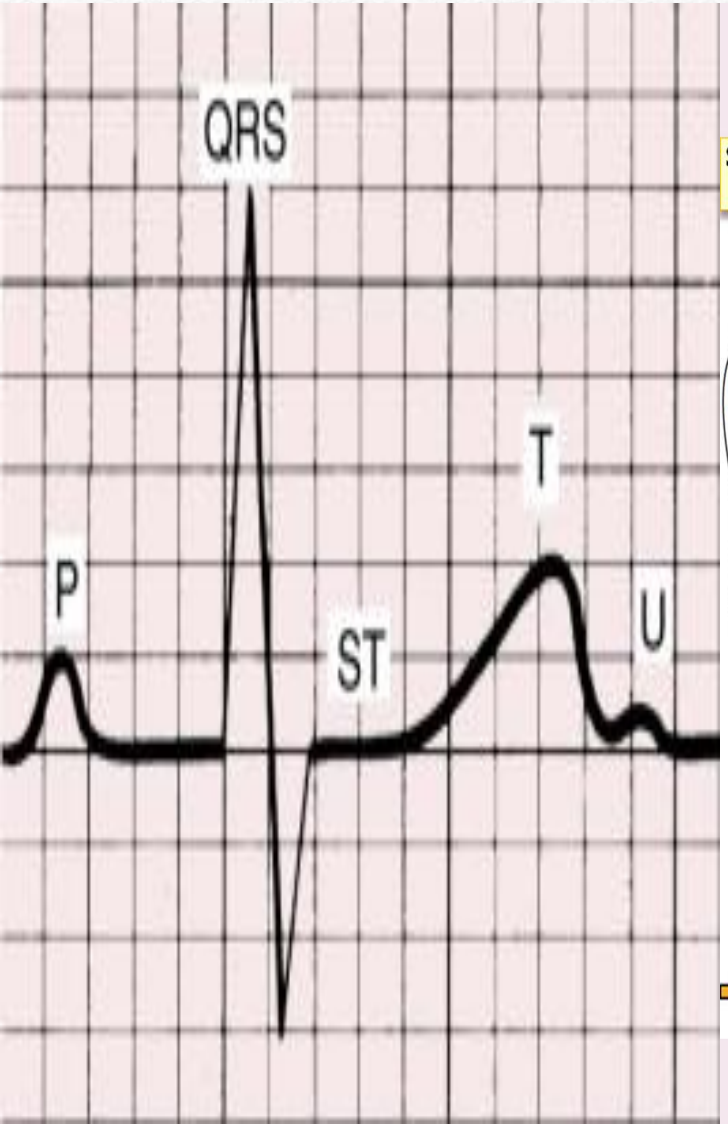


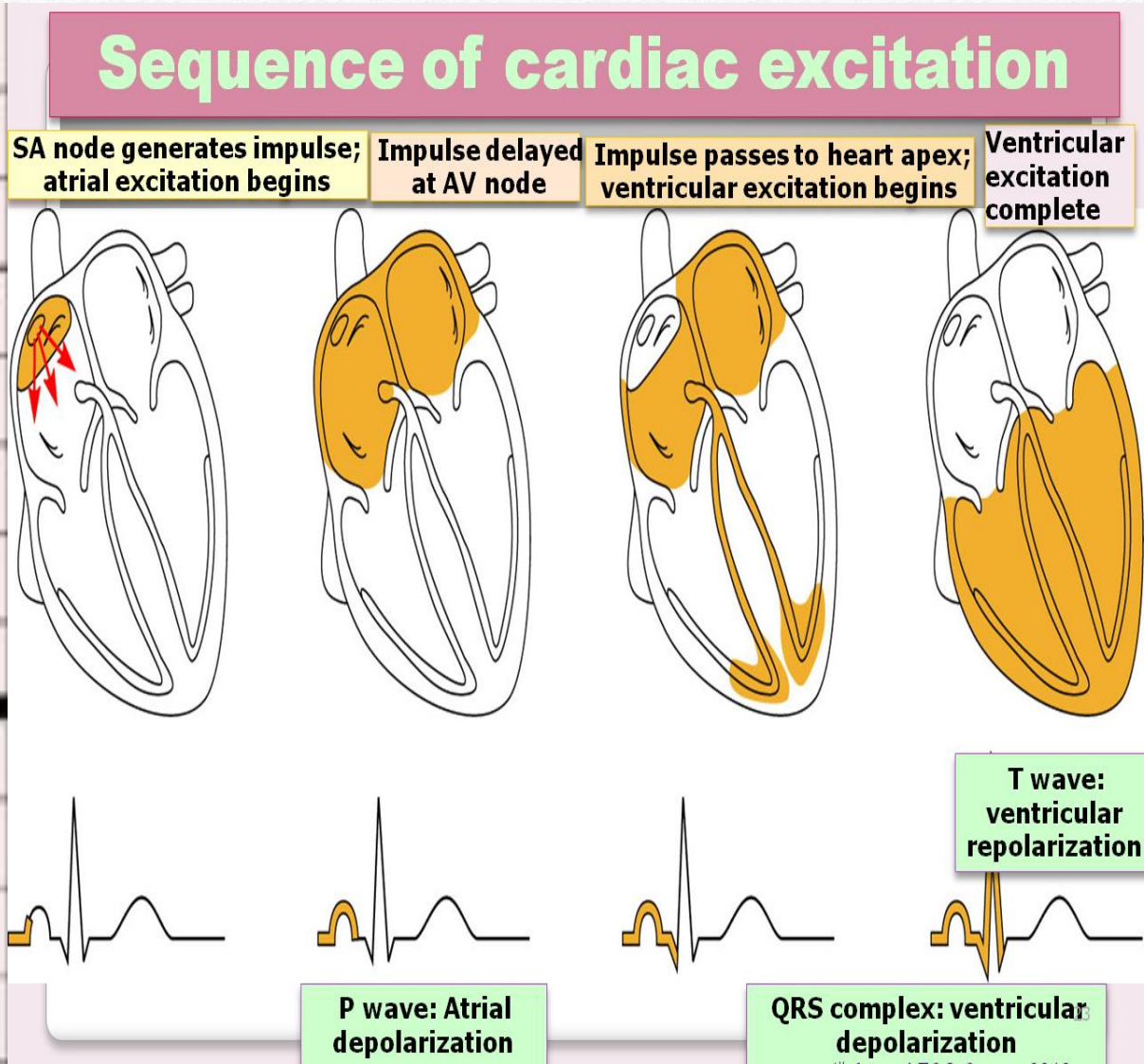




Electrical Conduction

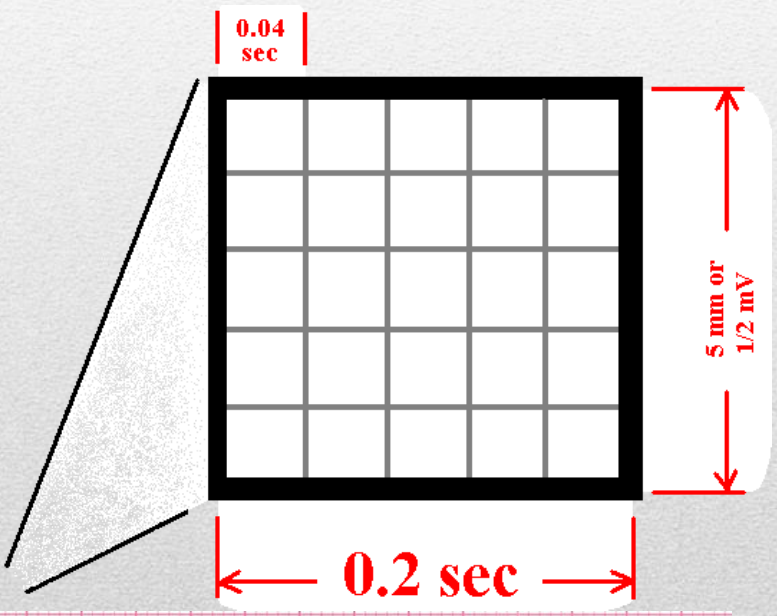
Waves

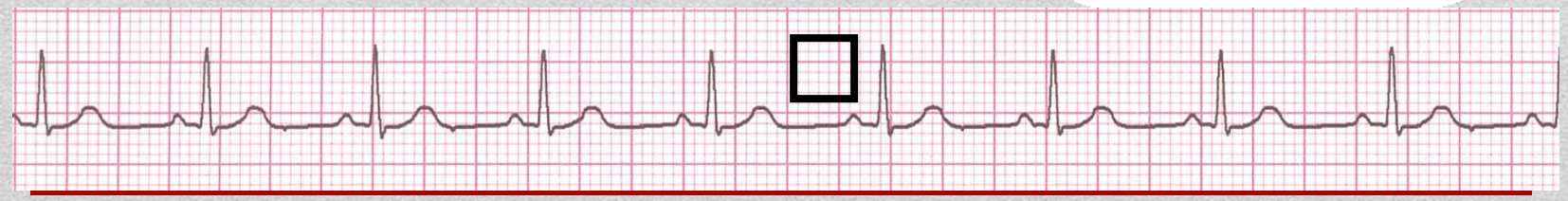

QRS
T
P
ST
U


Sequence of cardiac excitation
SA node generates impulse; atrial excitation begins
Impulse delayed at AV node
Impulse passes to heart apex; ventricular excitation begins
Ventricular excitation complete
T wave: ventricular repolarization
P wave: Atrial depolarization
QRS complex: ventricular depolarization

The ECG Paper

- Horizontally
  - One small box - 0.04 s
  - One large box - 0.20 s
- Vertically
  - One large box - 0.5 mV



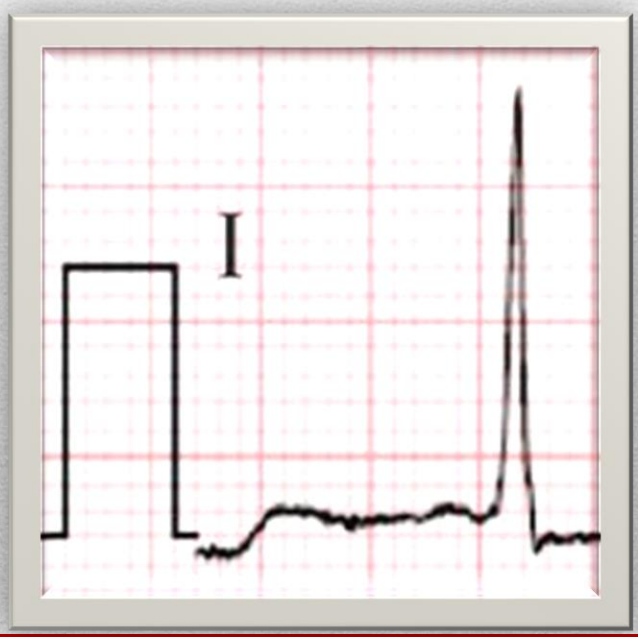


How to interpret ECG

- Caliber.
- Rhythm.
- Rate.
- Axis.
- Waves.

Caliber

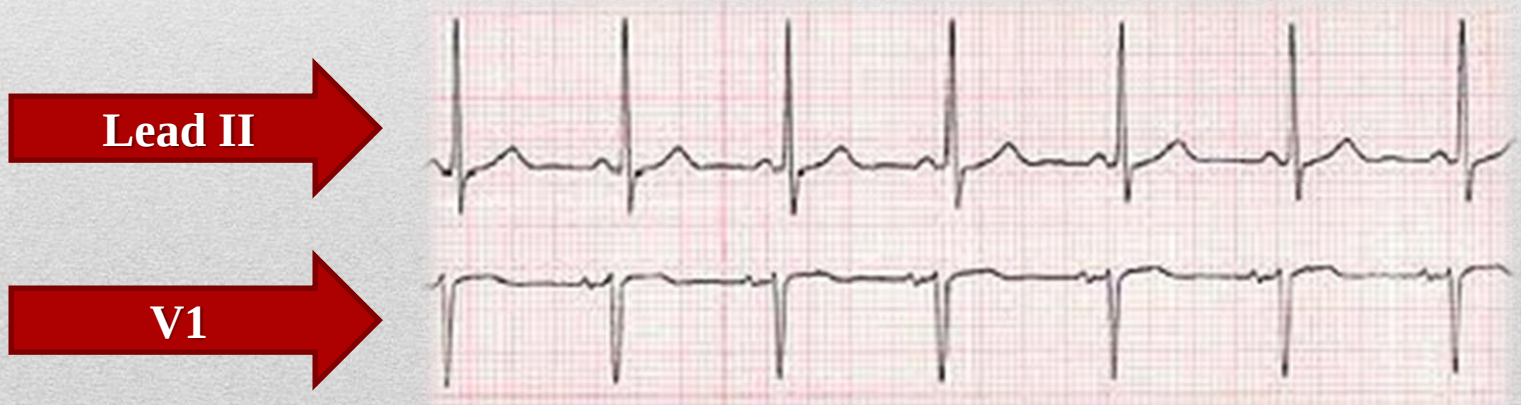
It should be ≤10 mm otherwise you have to repeat the ECG.



Normal Sinus Rhythm

Rhythm

- **LEDA II:** Positive P wave preceding each QRS.
- **V1:** Biphasic P wave.

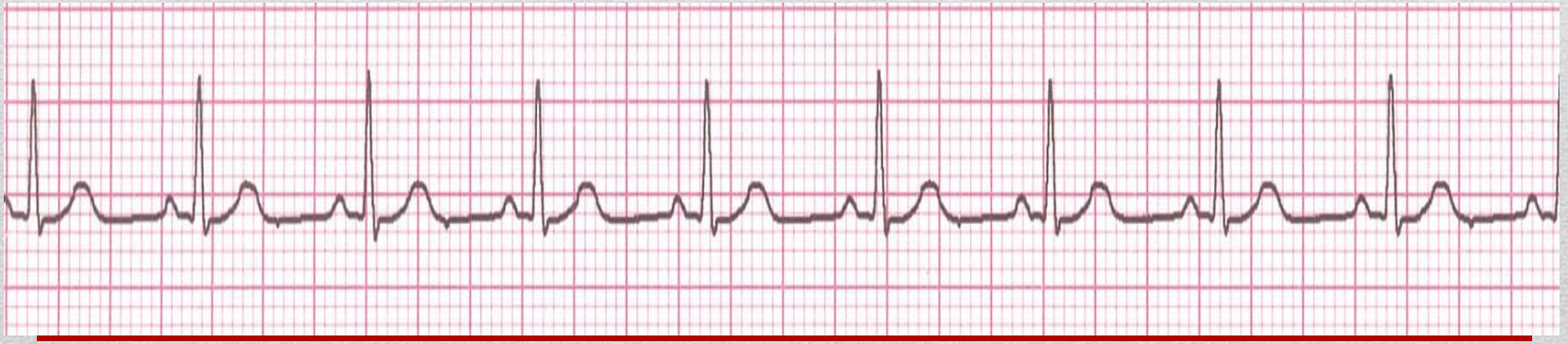


Rate

- **Normal sinus rate:** (60-100).
- **Tachycardia:** >100.
- **Bradycardia:** <60.

How to Calculate Rate

- 300/No. of large squares R-R.
- 1500/No. of small squares R-R.
- No. of (R) waves in the strip×6.
- 300›››150 ›››75 ›››60 ›››55

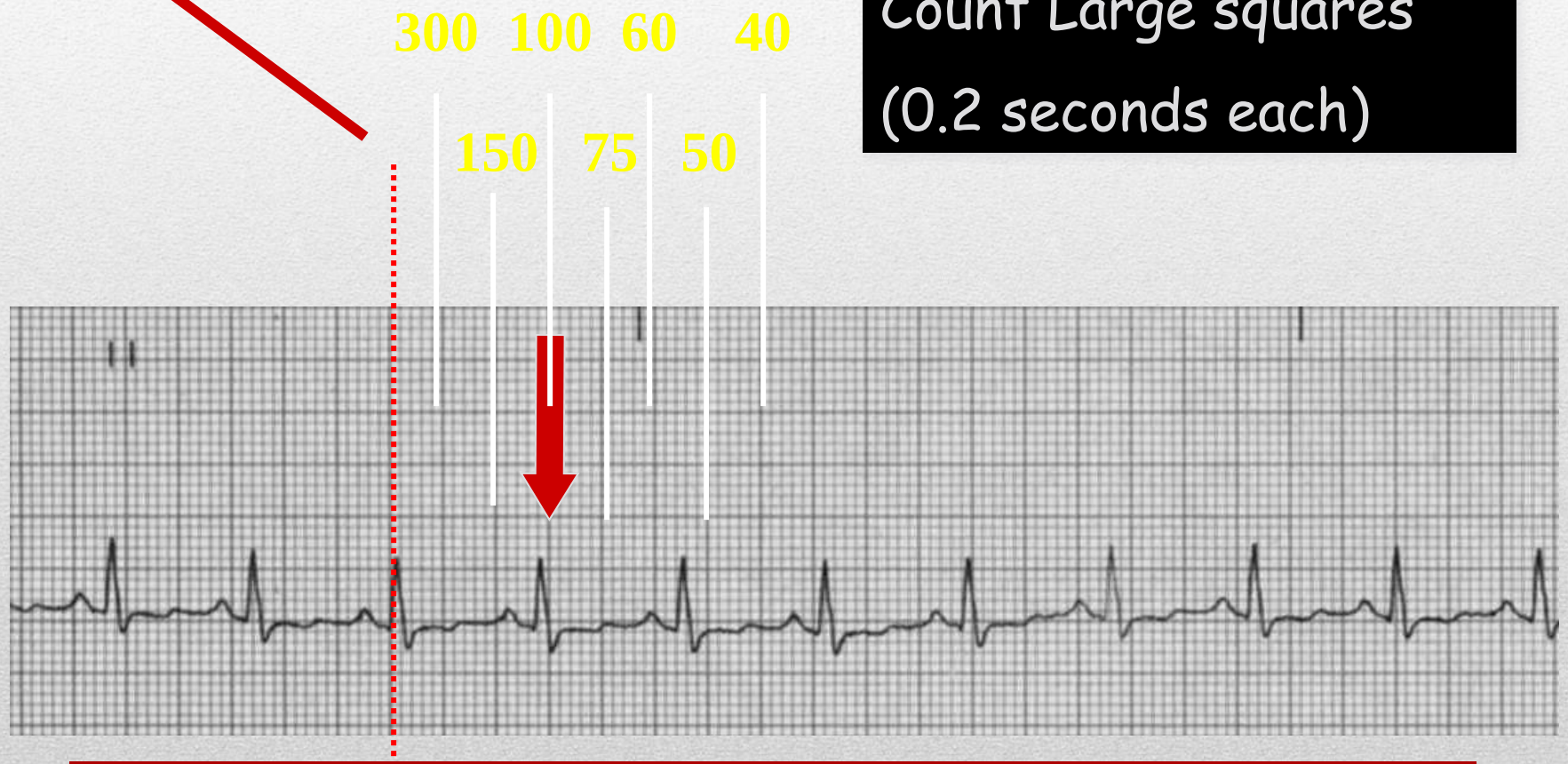


Rate

Start if possible on a beat whose QRS (usually R wave) is on the border of a large square

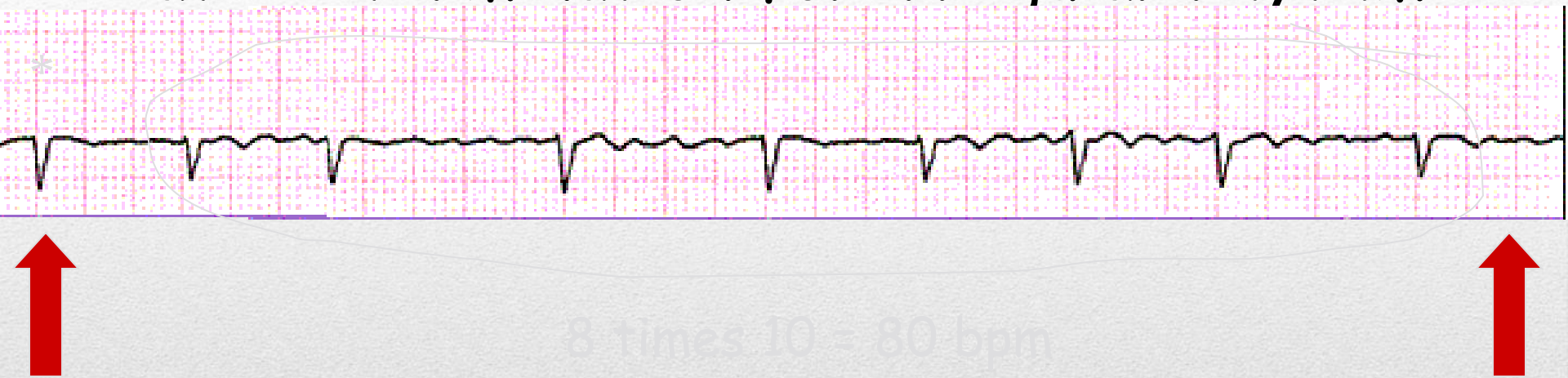
Count Large squares

(0.2 seconds each)



This tracing example shows a rate of 100 bpm

Rate determination for irregular rhythm



For irregular rhythm (such as atrial fibrillation), the method shown on the last slide may be inaccurate. Use this alternate method.

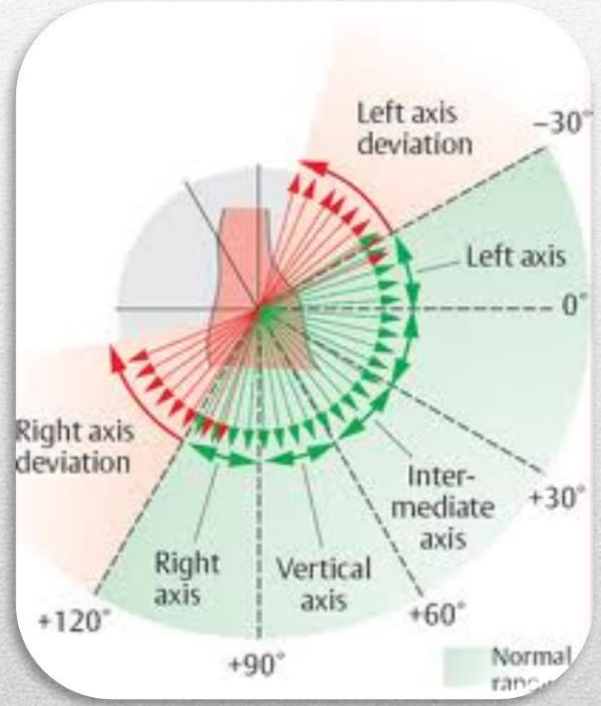
Start as before by finding a QRS that lands on the border of a large square (*).

Then count 30 large squares (= 0.2 X 30 = 6 seconds). Add up all beats (QRSs) that land within the interval (not counting that first beat (*) and multiple by 10.

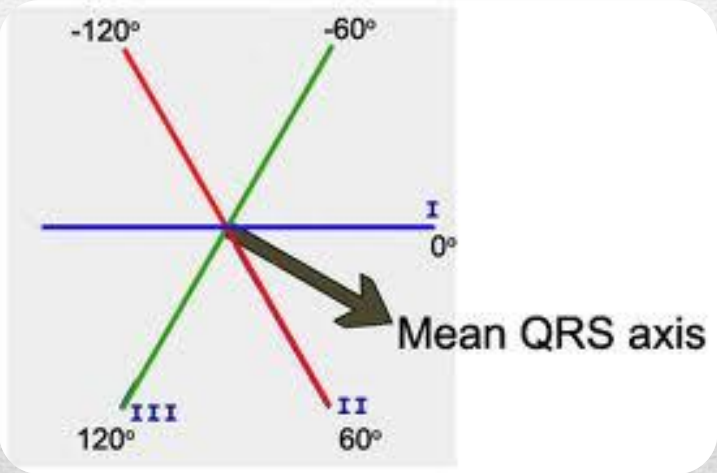
This equals the number of beats per minute.

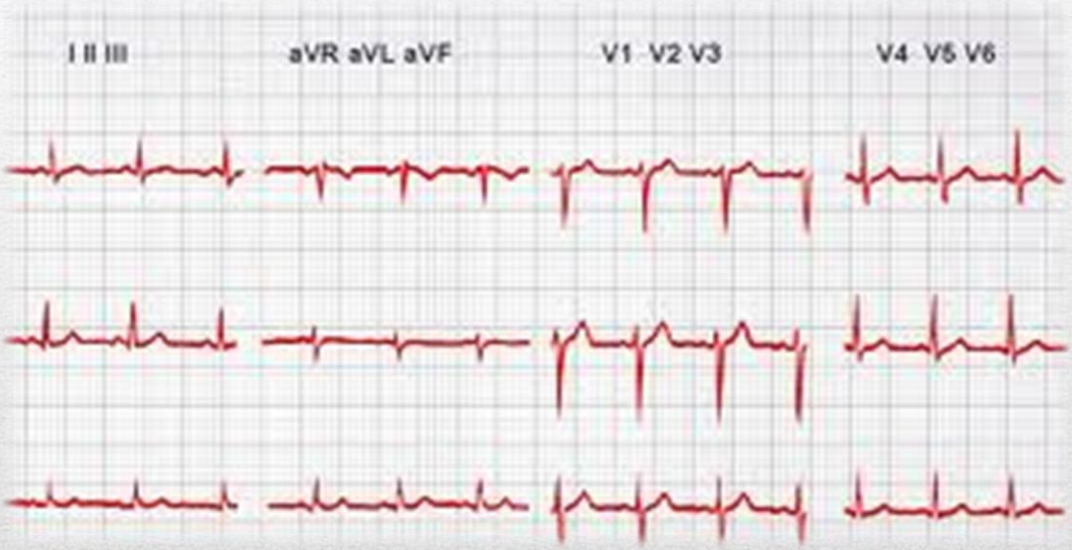
Axis

- Normal axis.
- Right axis deviation.
- Left axis deviation.
- Extreme axis deviation.



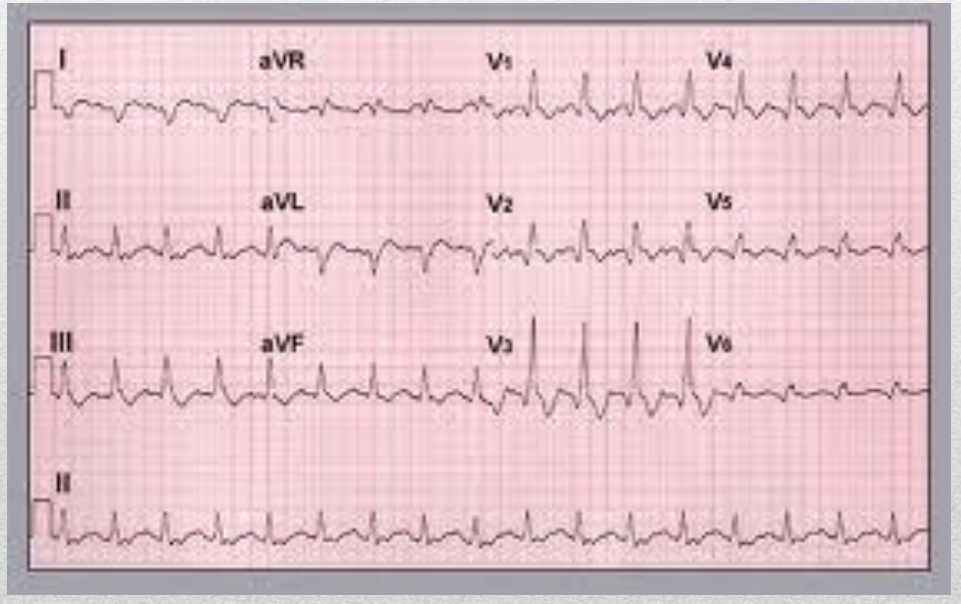
Normal Heart Axis



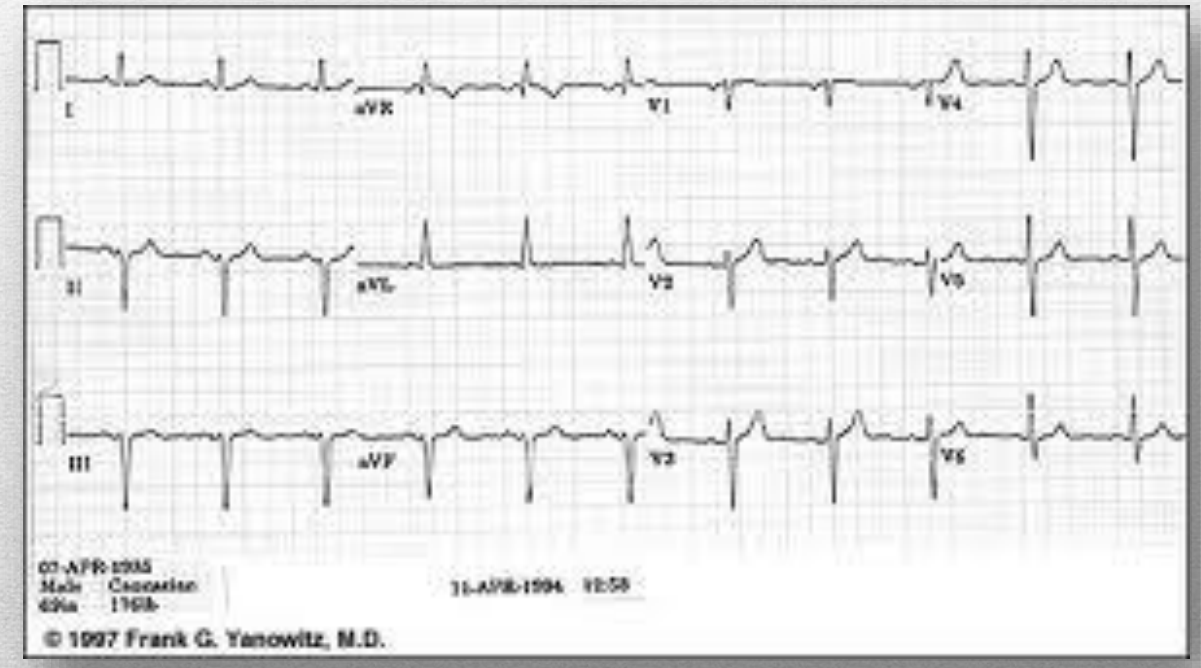


Normal Heart Axis Cont…

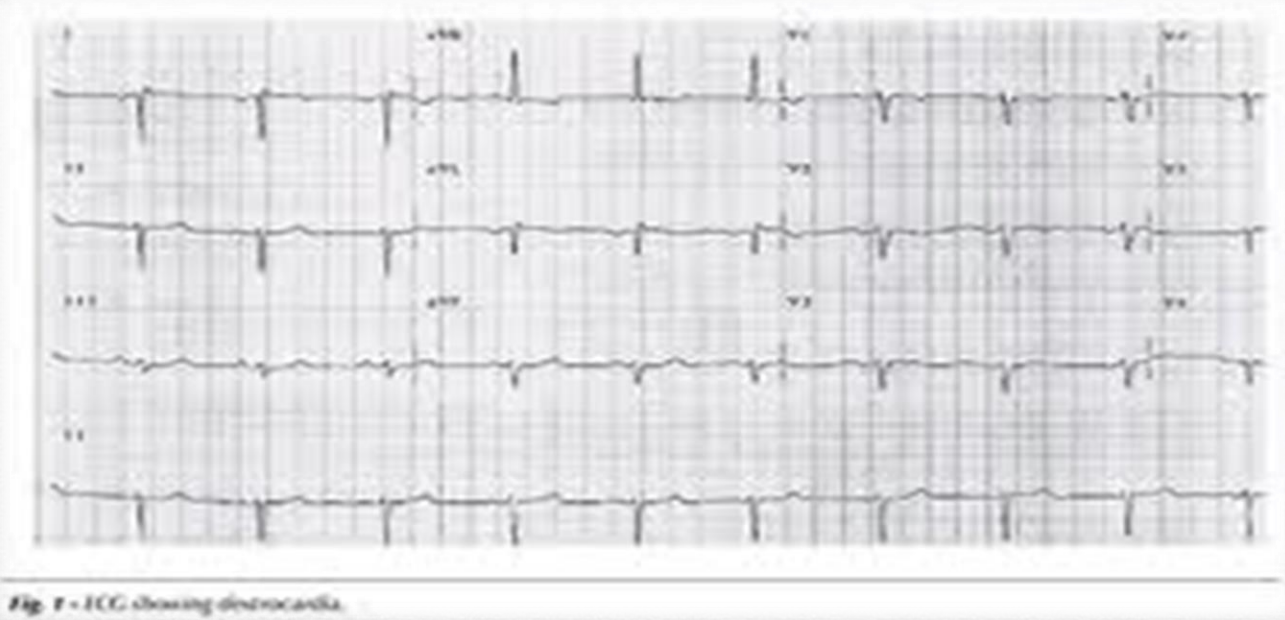
Right Axis Deviation



Left Axis Deviation

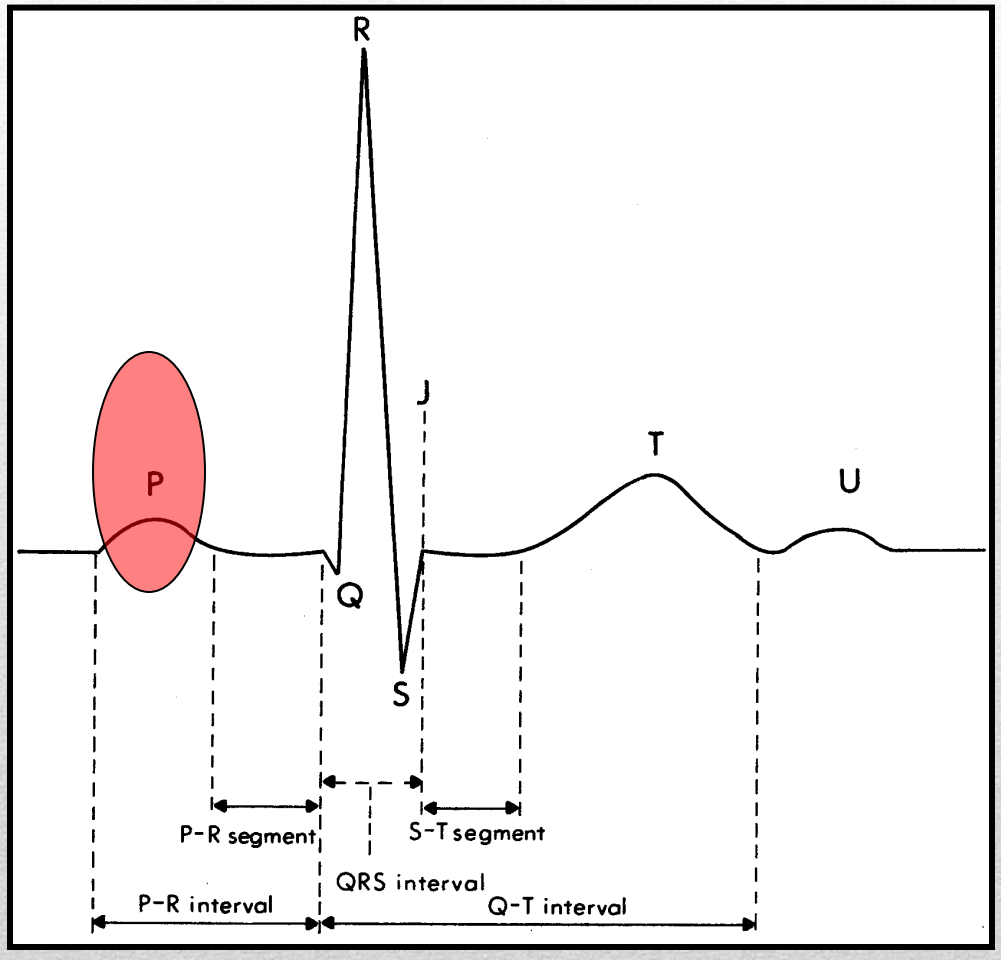


Extreme Axis Deviation



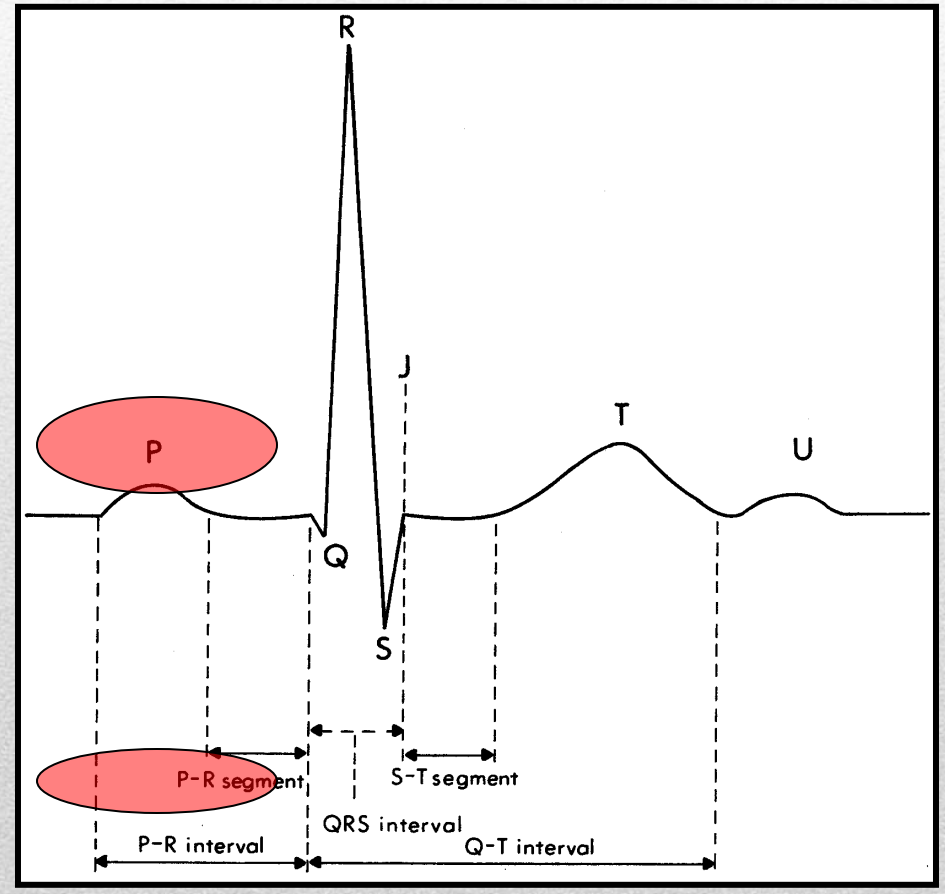
The P Wave

- **Normally from sinus node**
- **Upright in I, II, aVF, V4-V6**
- **Monophasic (except V1)**
- **Normal ranges:**
  - **< 0.12 sec wide**
  - **< 2.5 mm tall**

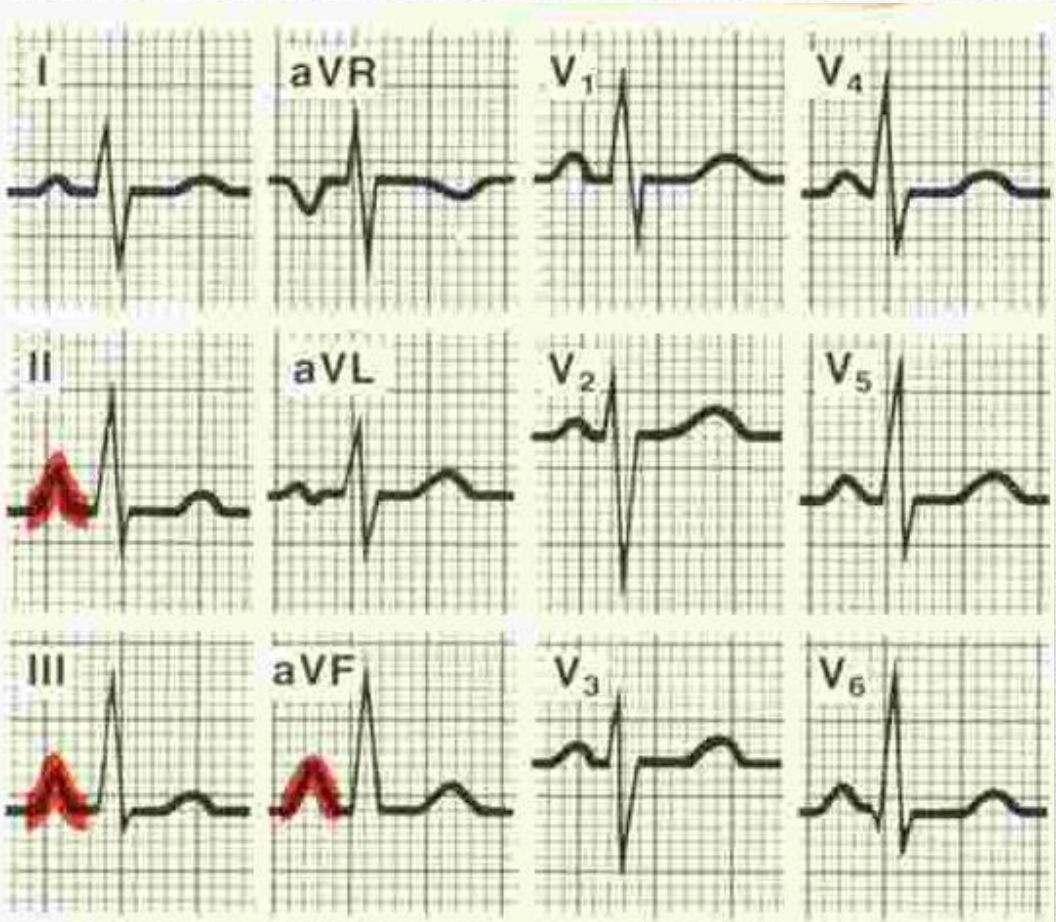


The PR Interval

- Measure from beginning of P wave to onset of QRS. Usually measure in Lead II
- Measure the longest PR interval in the limb leads
- Normal range 0.12-0.20 seconds
- < 0.12 = Accelerated conduction
- > 0.2 = Heart block

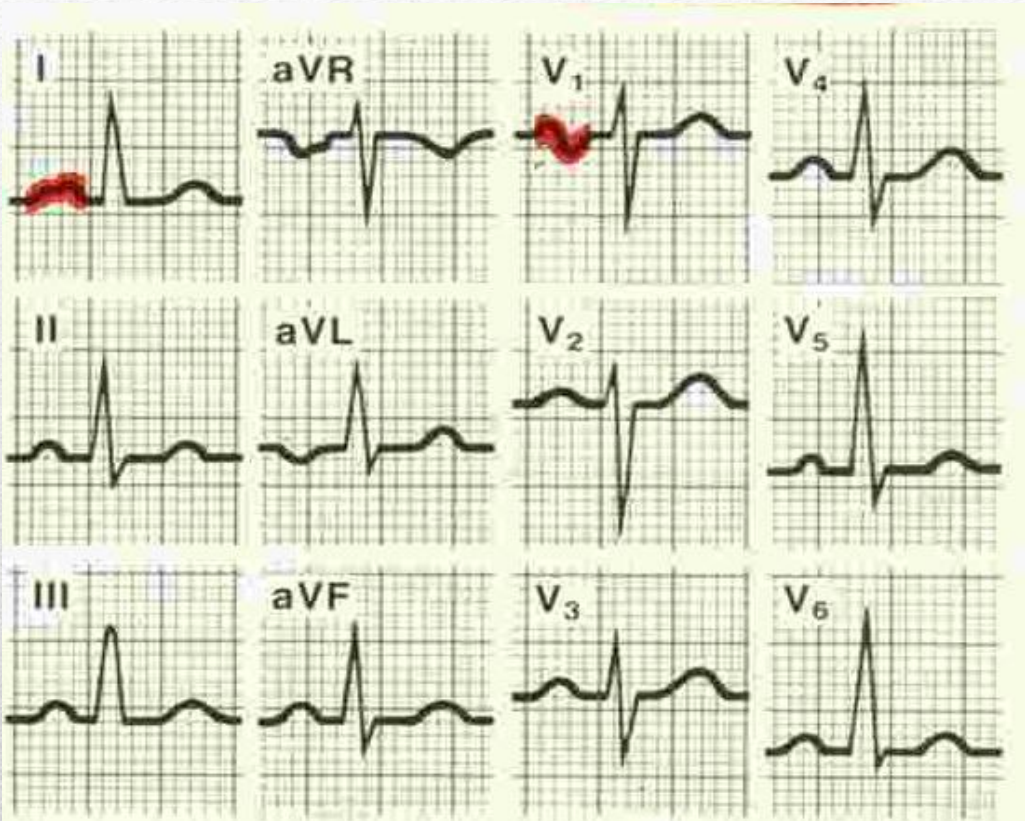


Right Atrial Enlargement



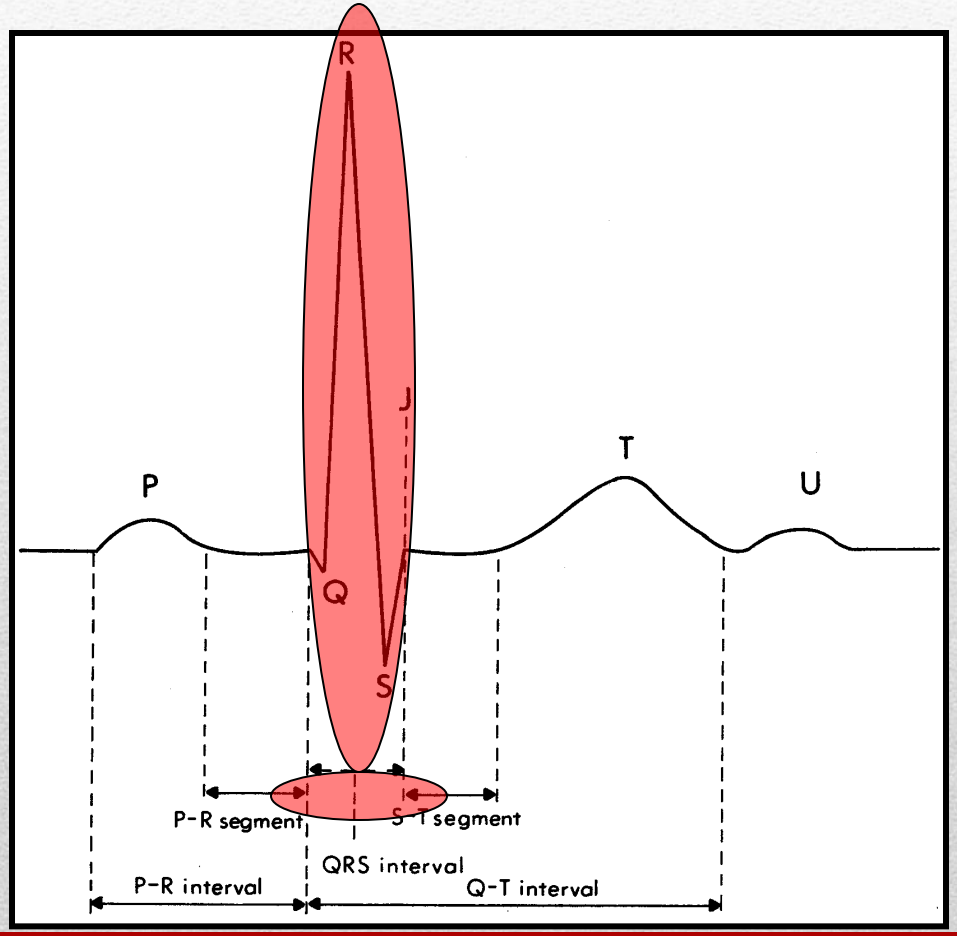
Tall P waves in leads II, III and aVF ≥2.5 mm
(P pulmonale)

Left Atrial Enlargement

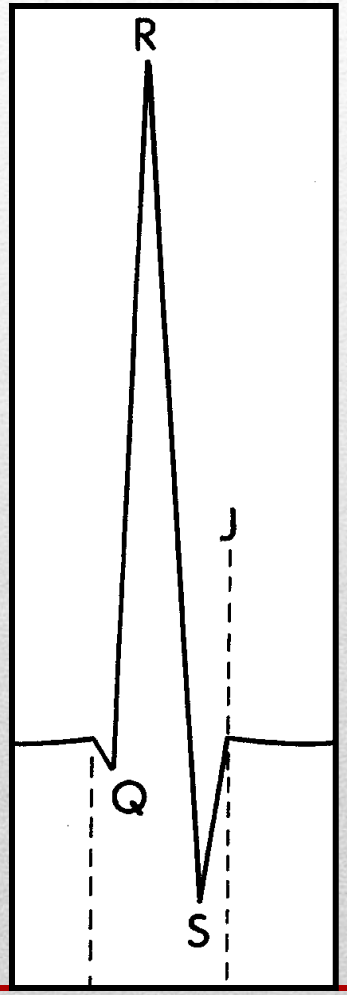


P wave in lead I ≥0.11 second. Terminal negativity of P wave in lead V_1 ≥1 mm^2 (P mitrale)

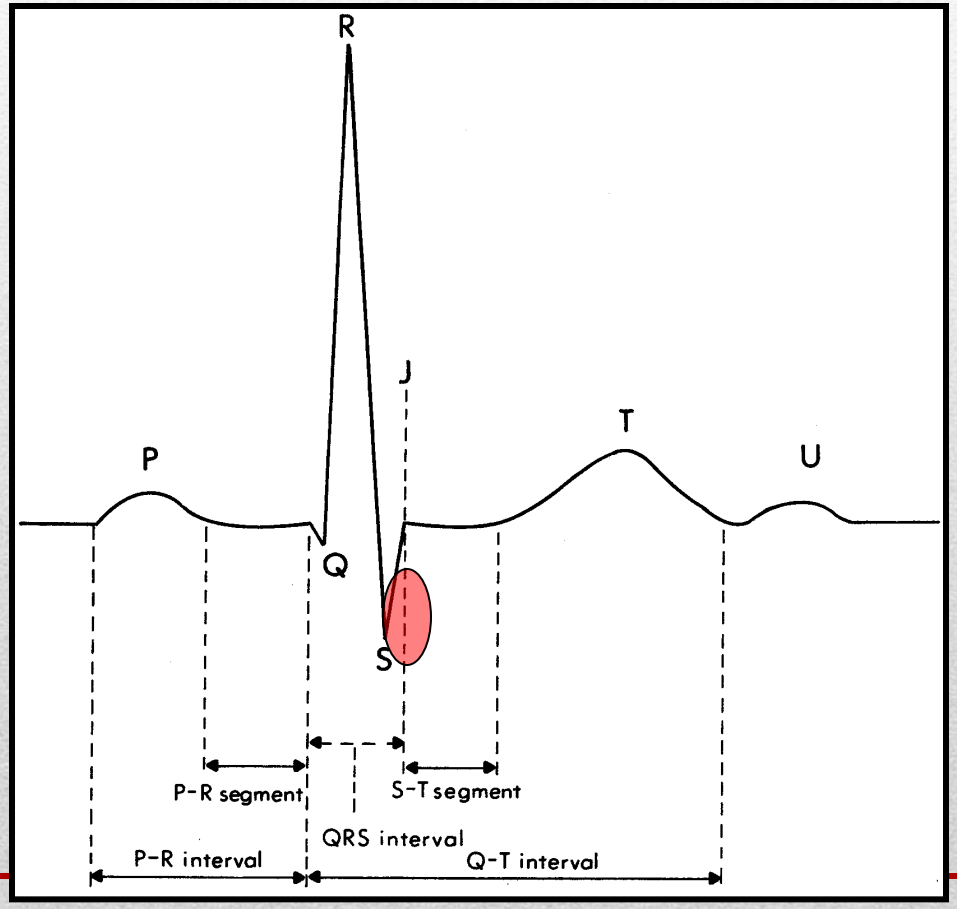
The QRS Complex



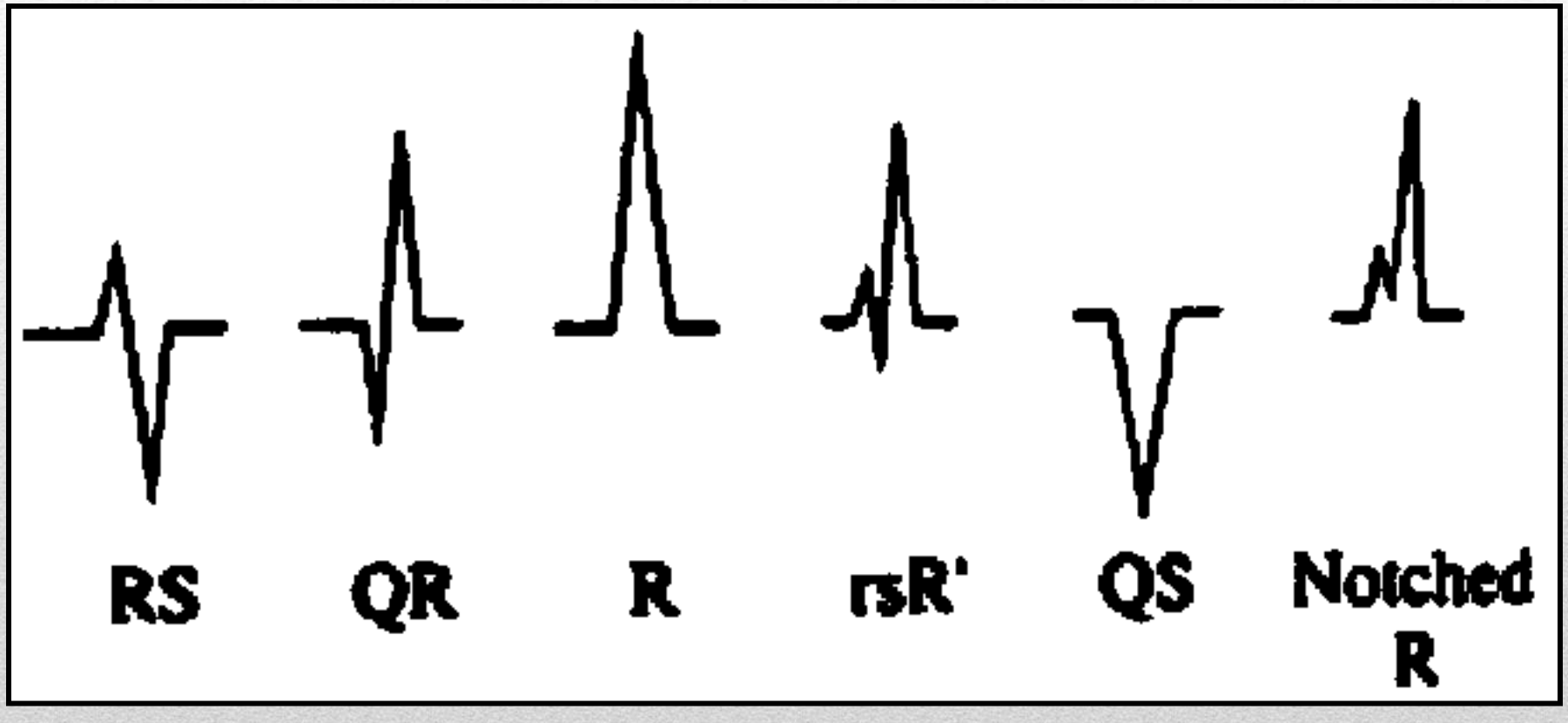
The Q Wave



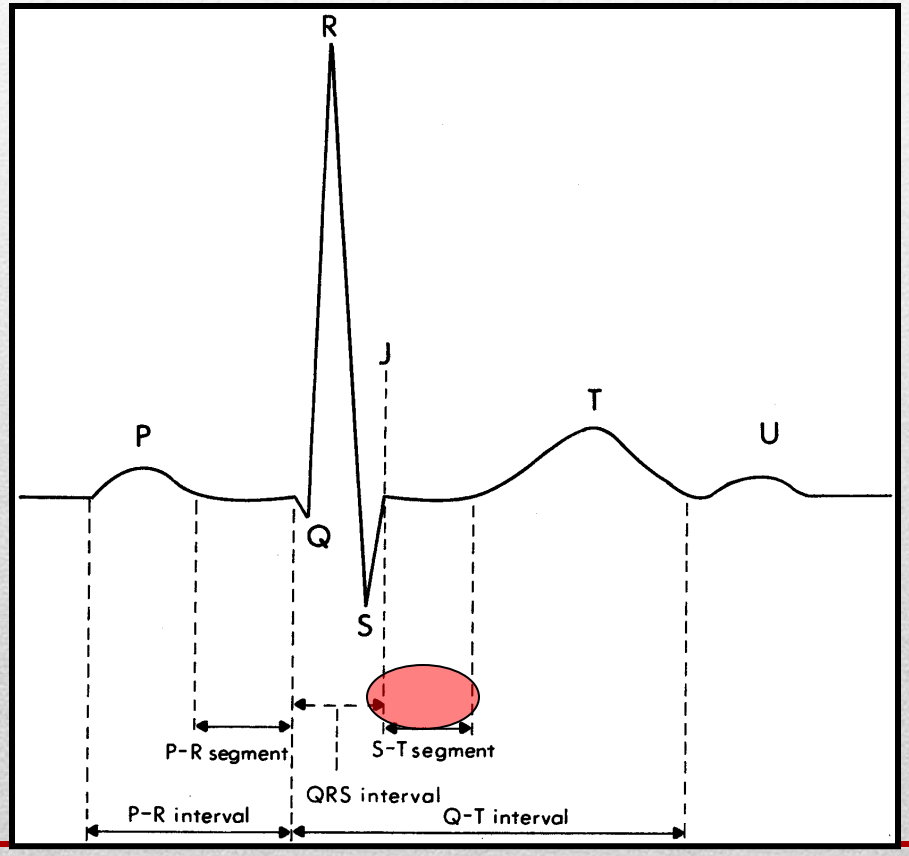
The J - Point


R
J
T
P
U
Q
S
P-R segment
S-T segment
QRS interval
P-R interval
Q-T interval

QRS Waveforms

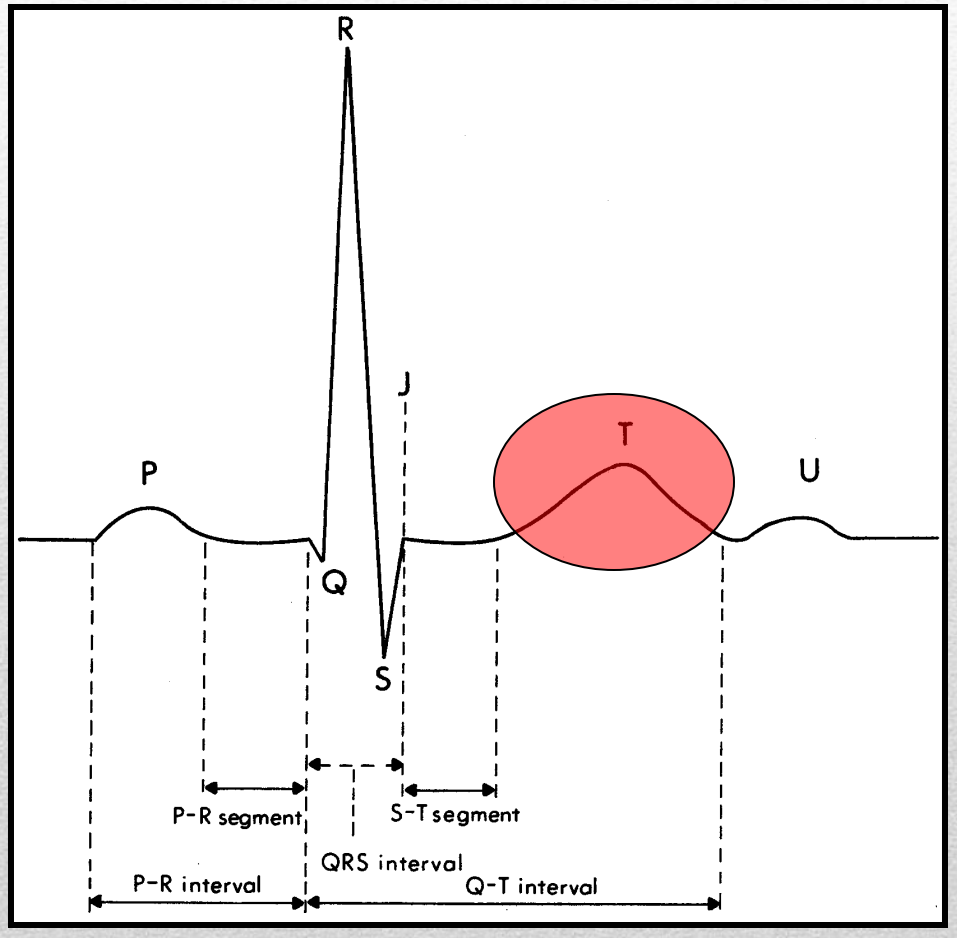


The ST Segment

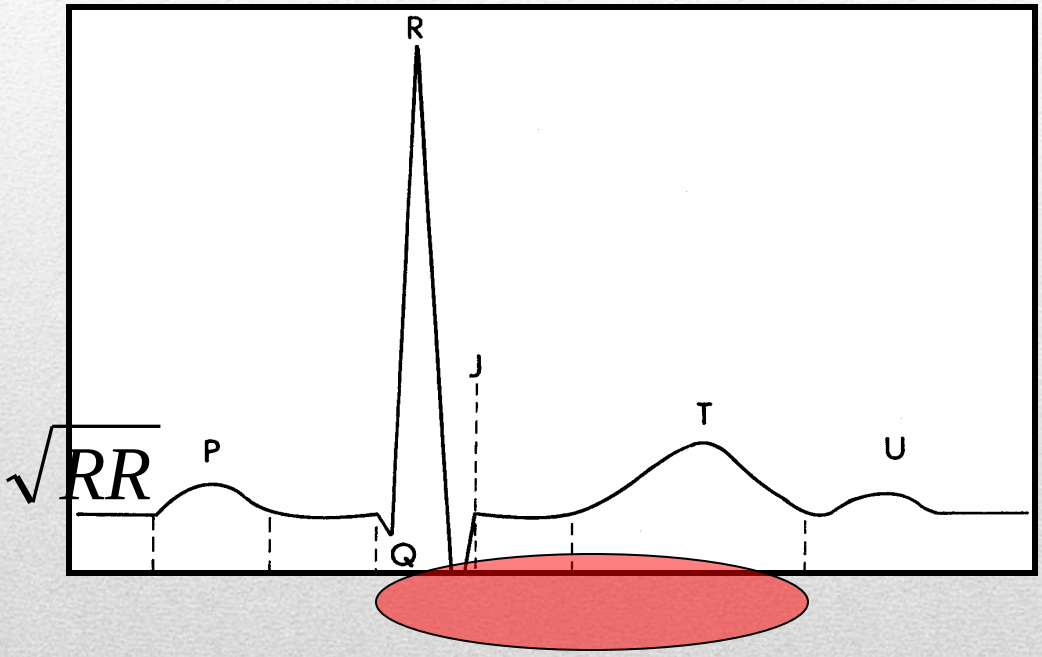


The T Wave

- T waves may be normally inverted in aVR (almost always), III (frequently), and V1 (sometimes).
- T waves are “tall” if their height is:
  - **> 50% QRS height**
  - **> 5mm in limb lead**
  - **> 10 mm in precordial lead**

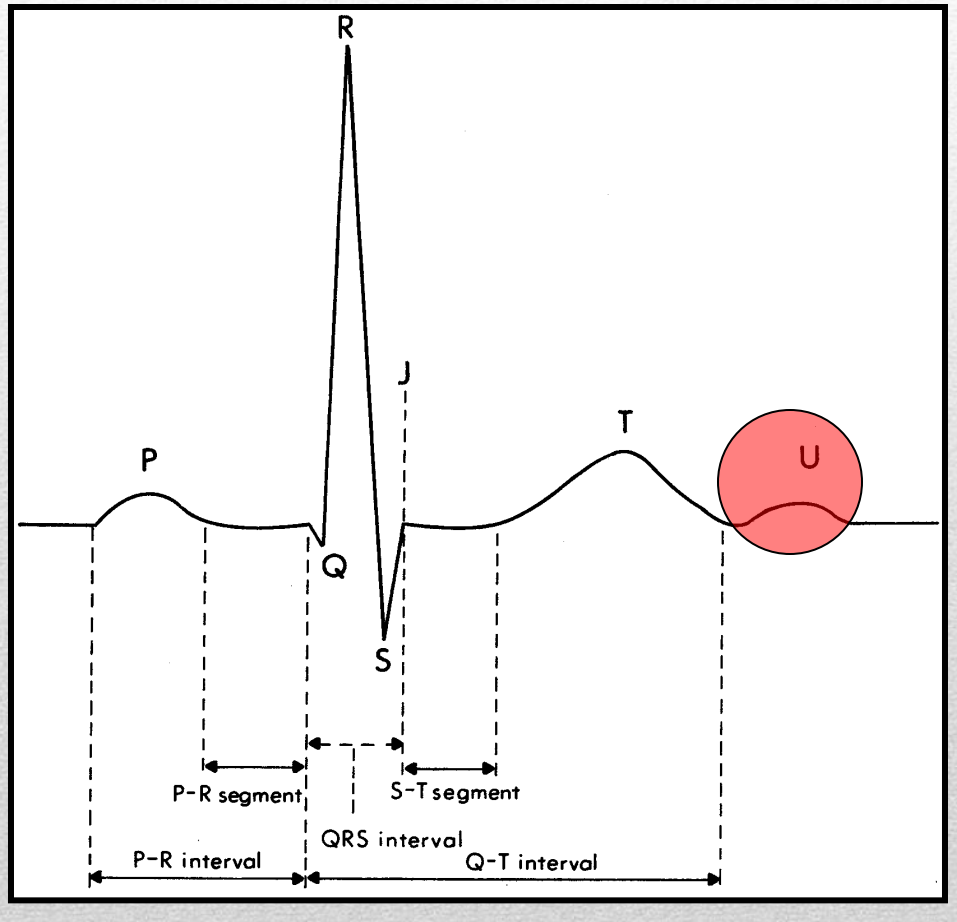


The QT Interval

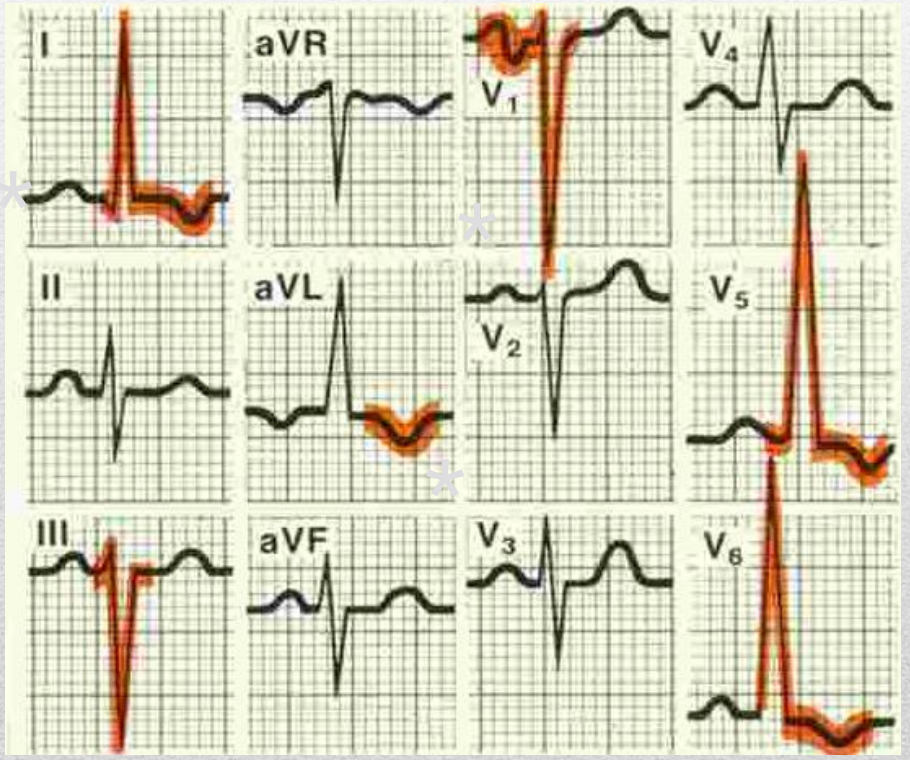


The U Wave

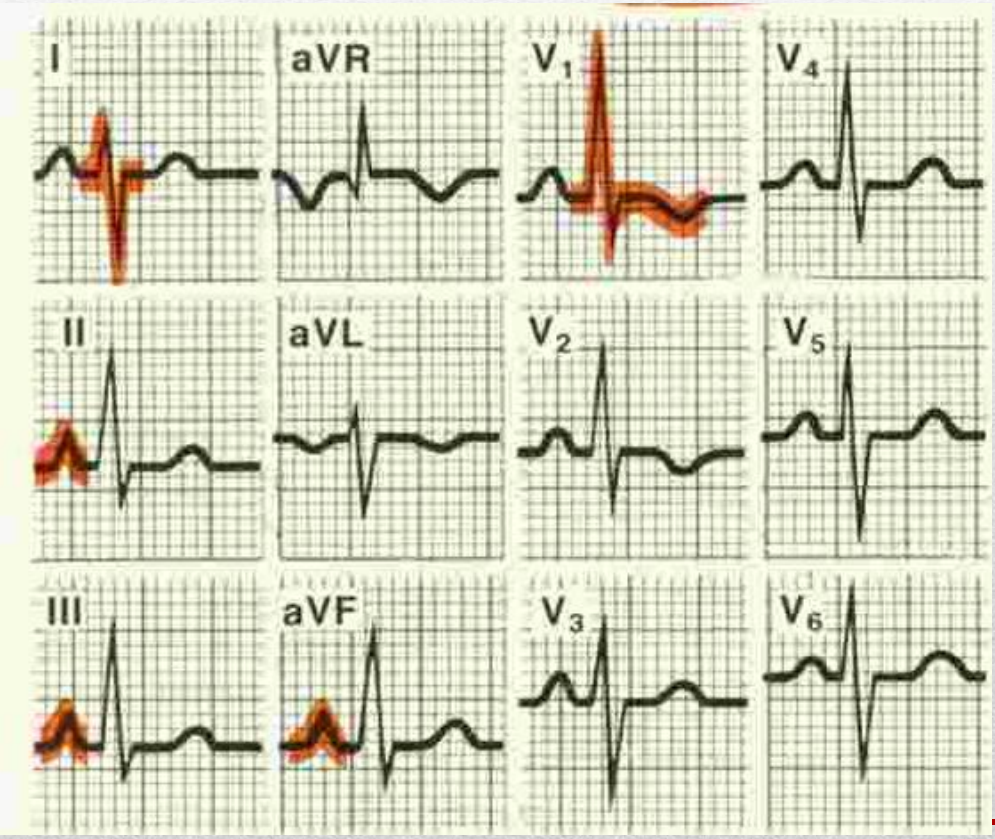
- Causes:
  - Normal
  - Bradycardia
  - CAD
  - Hypertension
  - Hypokalemia
  - Hypercalcemia



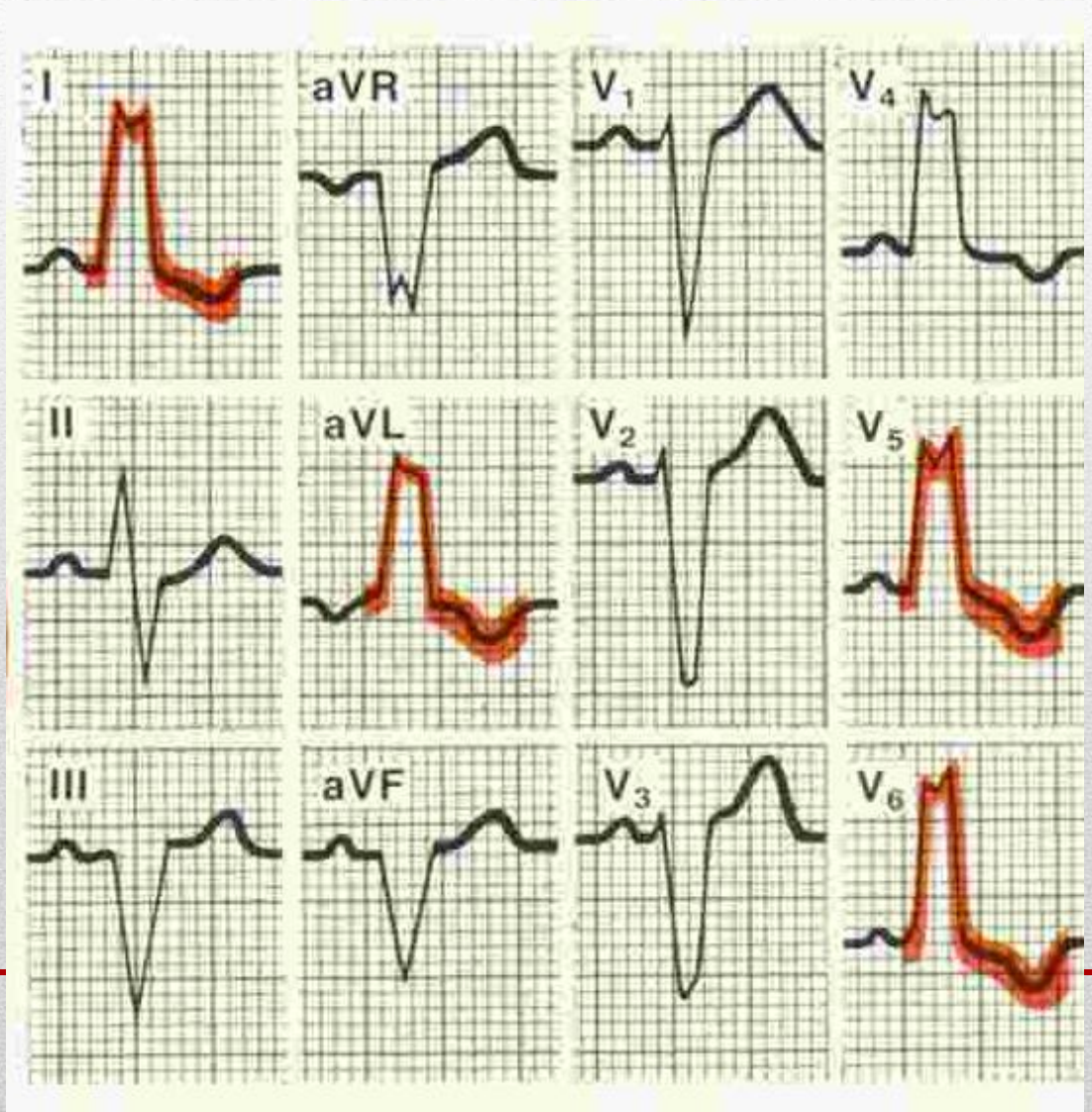
Left Ventricular Hypertrophy



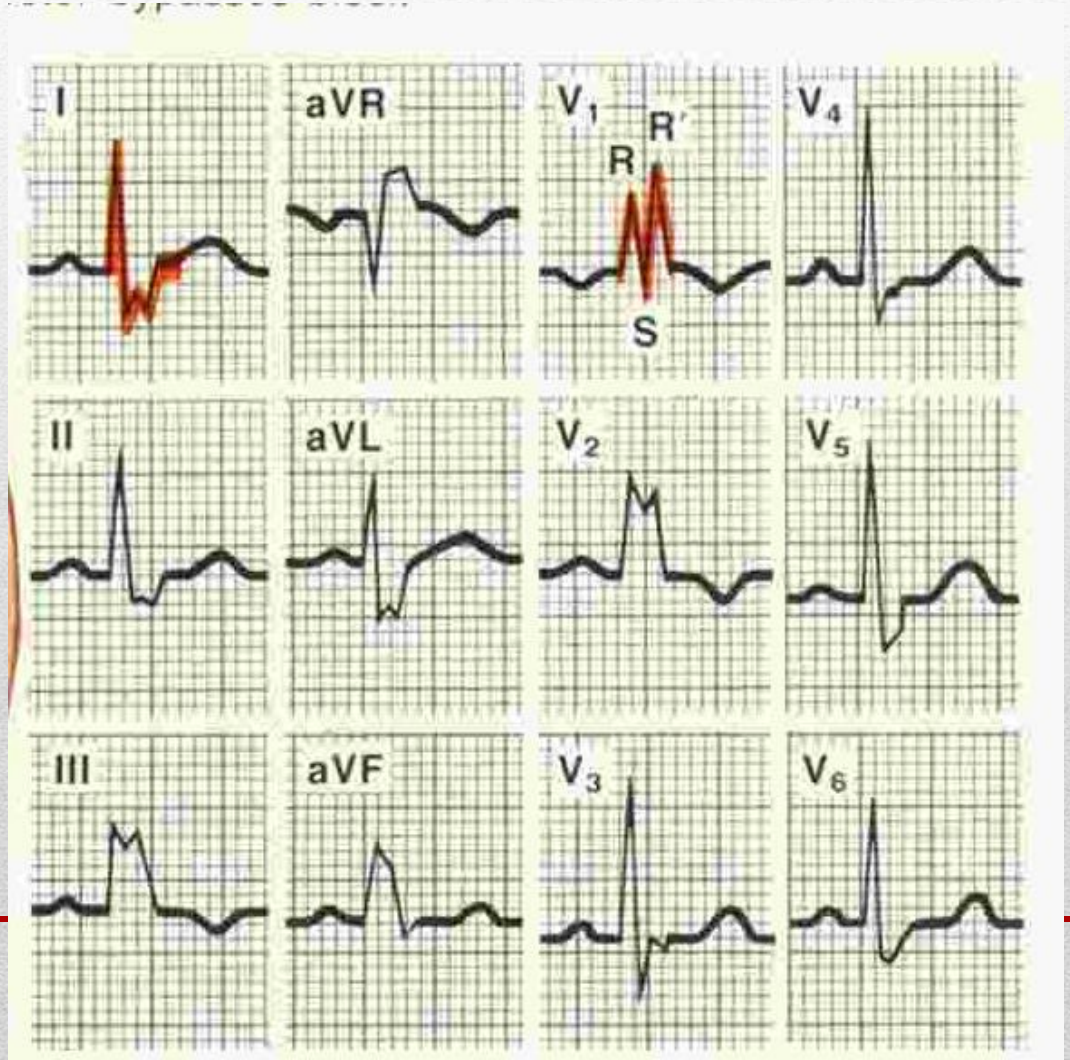
Right Ventricular Hypertrophy



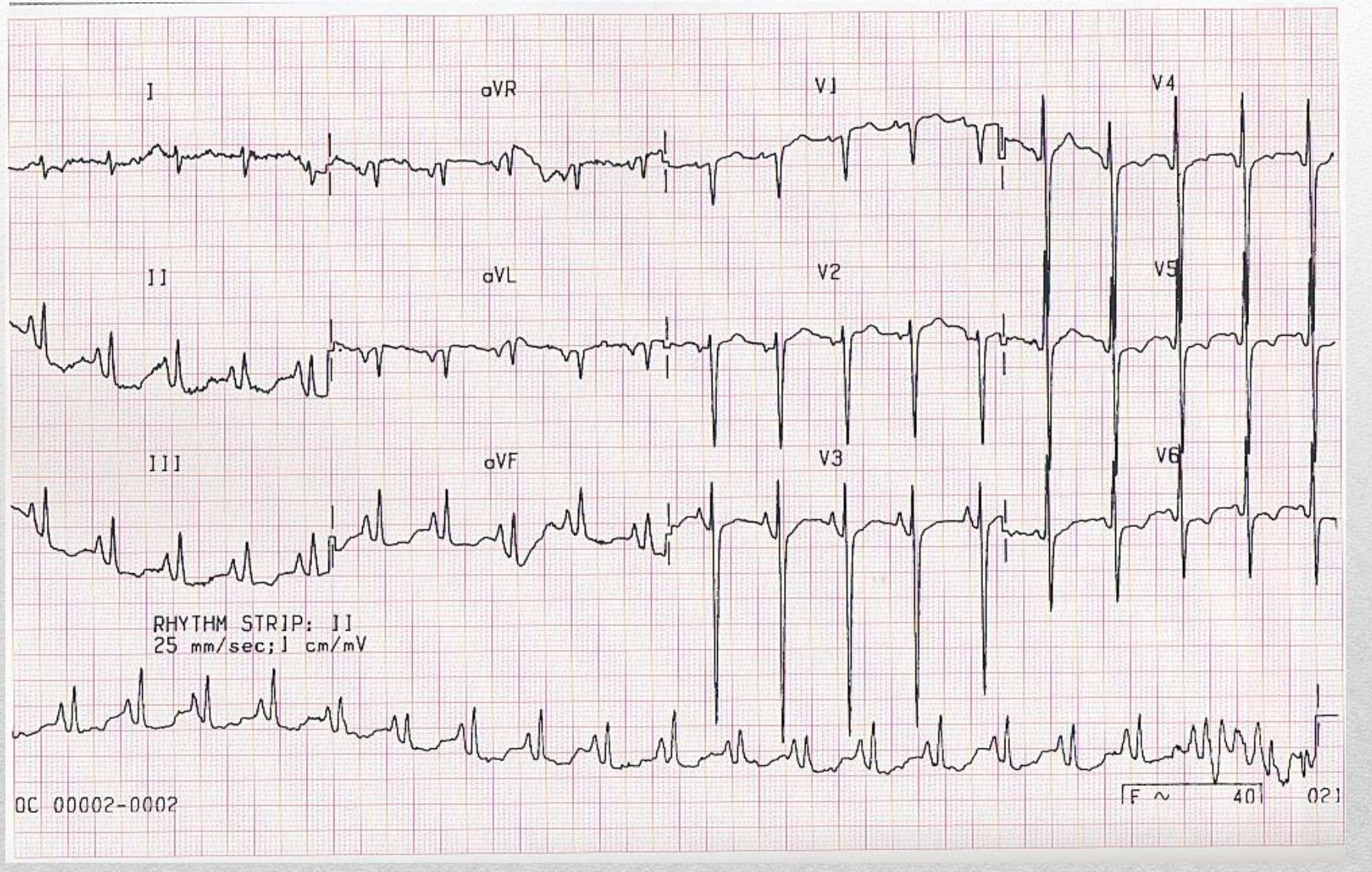
LBBB

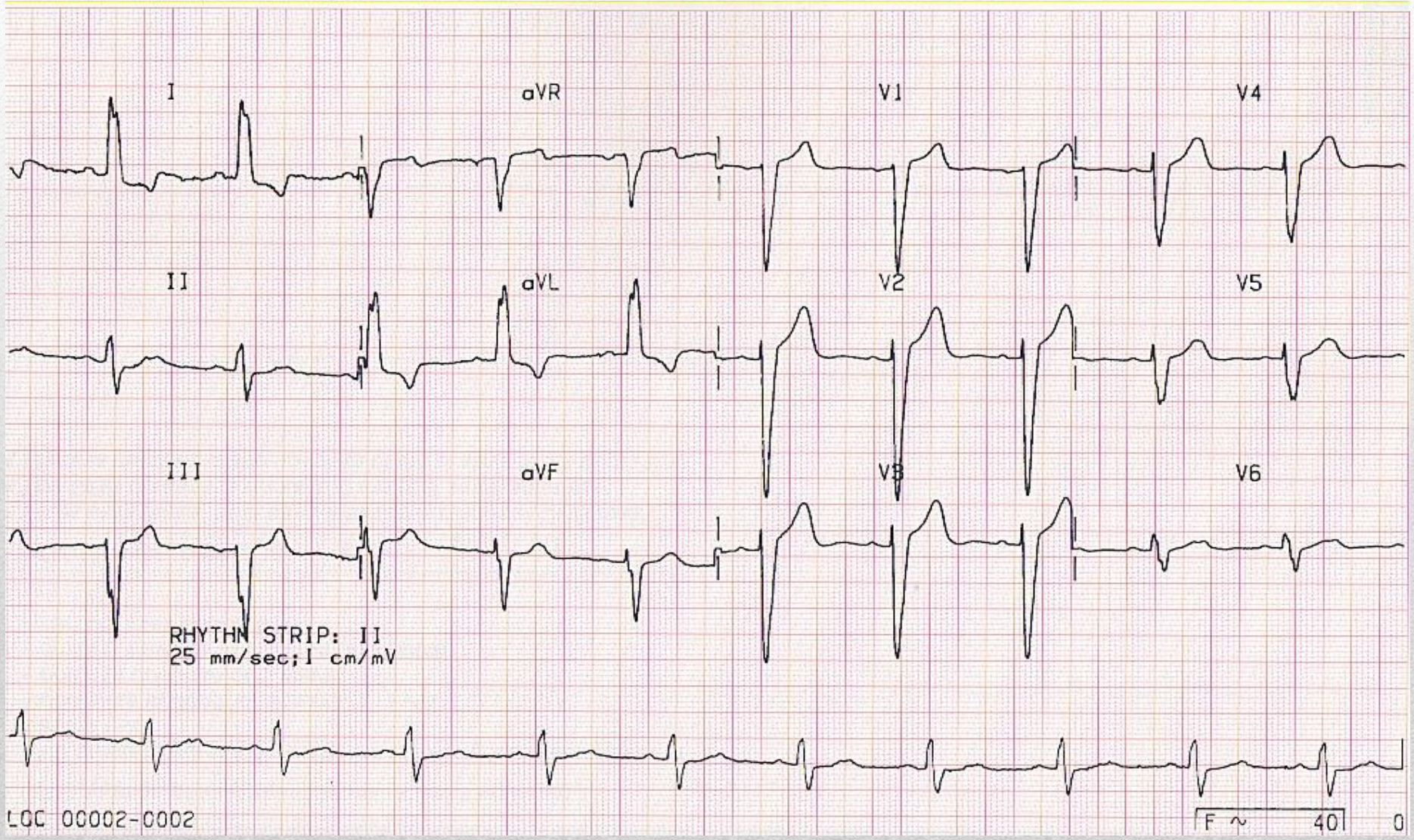


RBBB



Realty check




I
aVR
V1
V4
II
aVL
V2
V5
III
aVF
V3
V6
RHYTHM STRIP: II
25 mm/sec; 1 cm/mV
LOC 00002-0002
F ~ 40 0

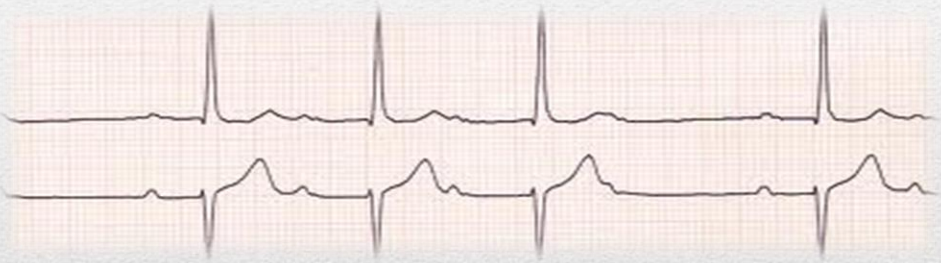
Heart Block

1st○	• Constant PR prolongation without drop beat.
2nd○	• **Mobitz1:** Progressive PR prolongation + drop beat. • **Mobits2:** Constant PR prolongation + drop beat.
3rd ○	• Complete dissociation between P and QRS.

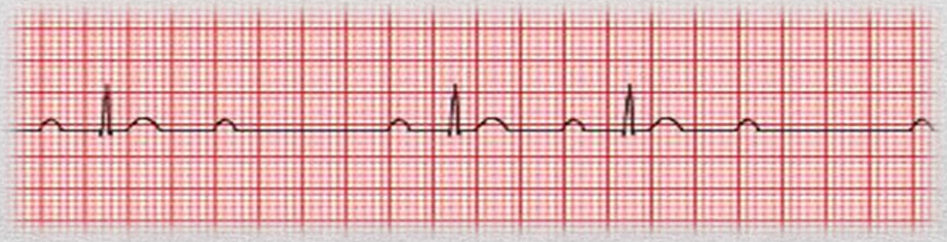
First Degree Heart Block

Second Degree Heart Block

- **Mobitz (I):**

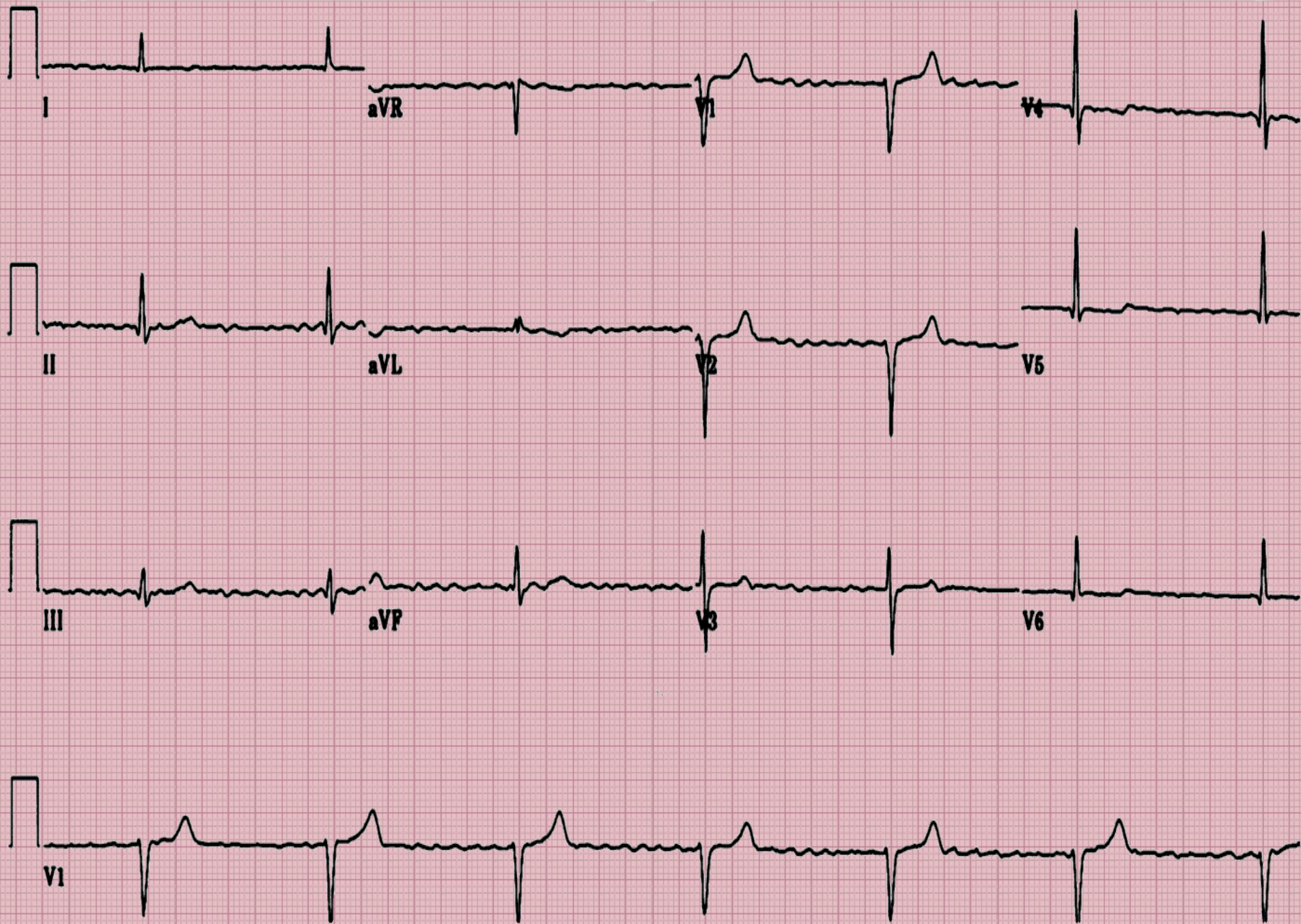


- **Mobitz (II):**

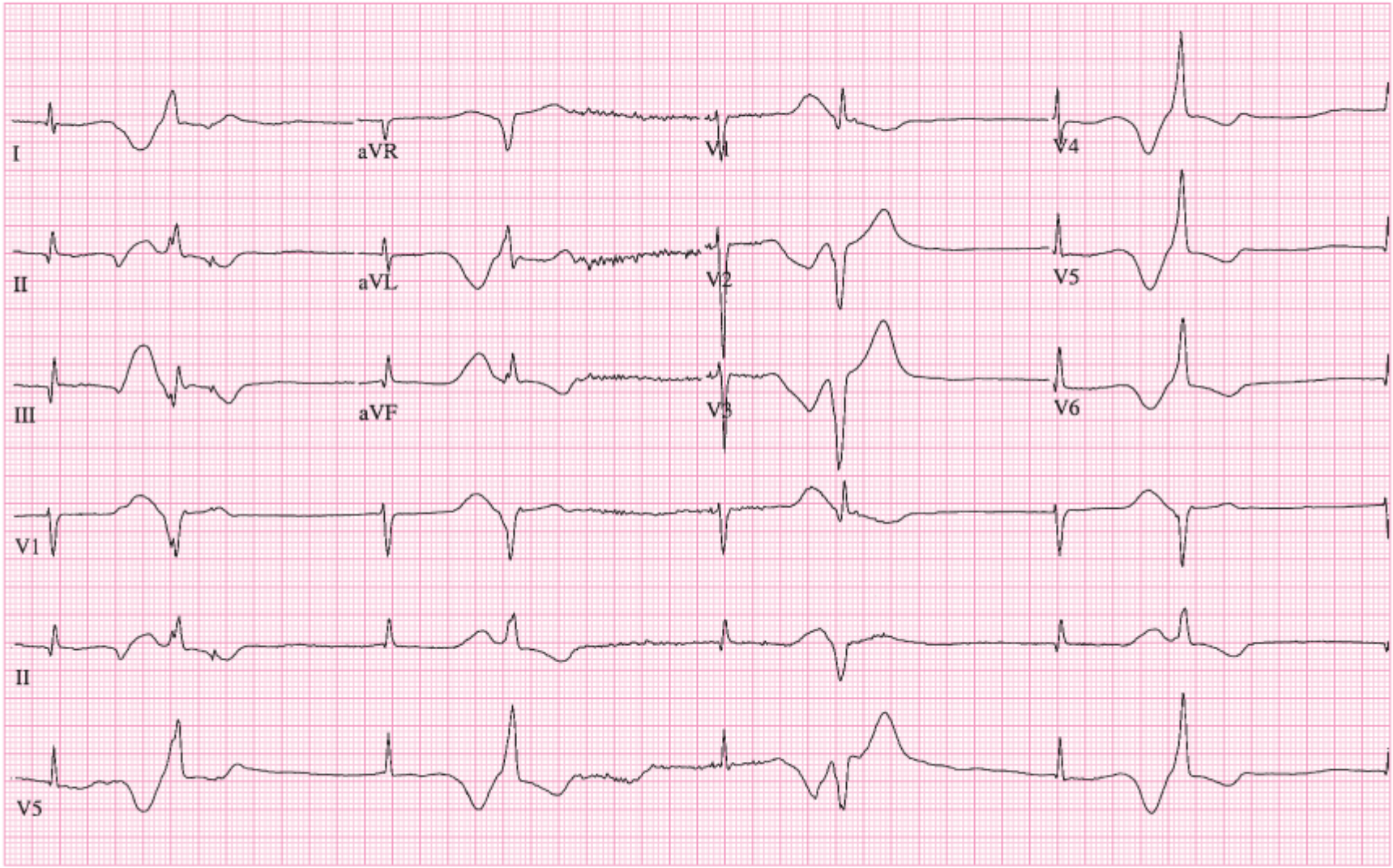


Third Degree Heart Block

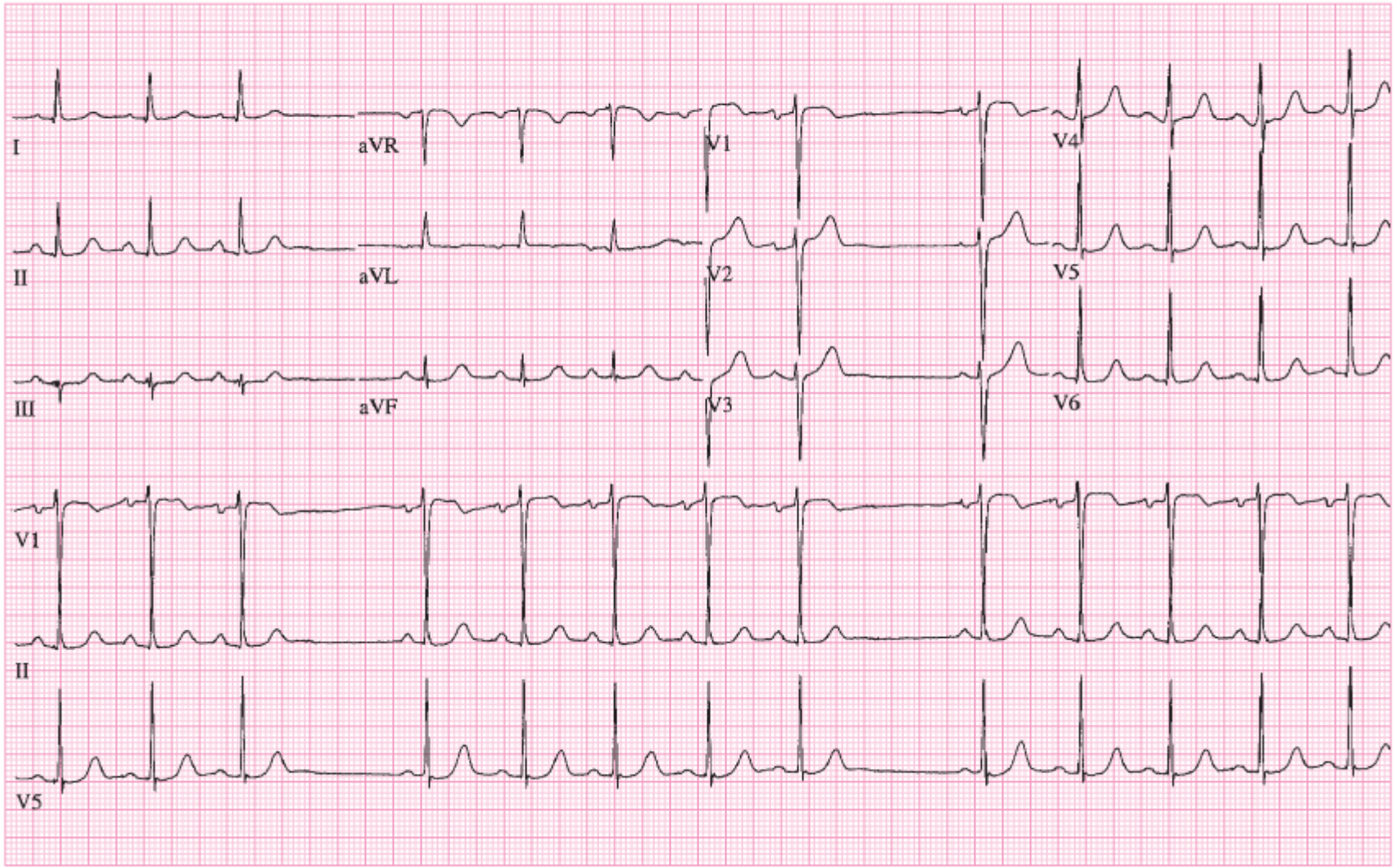
60 yrs old man with dilated CHF presented with nausea&vomating



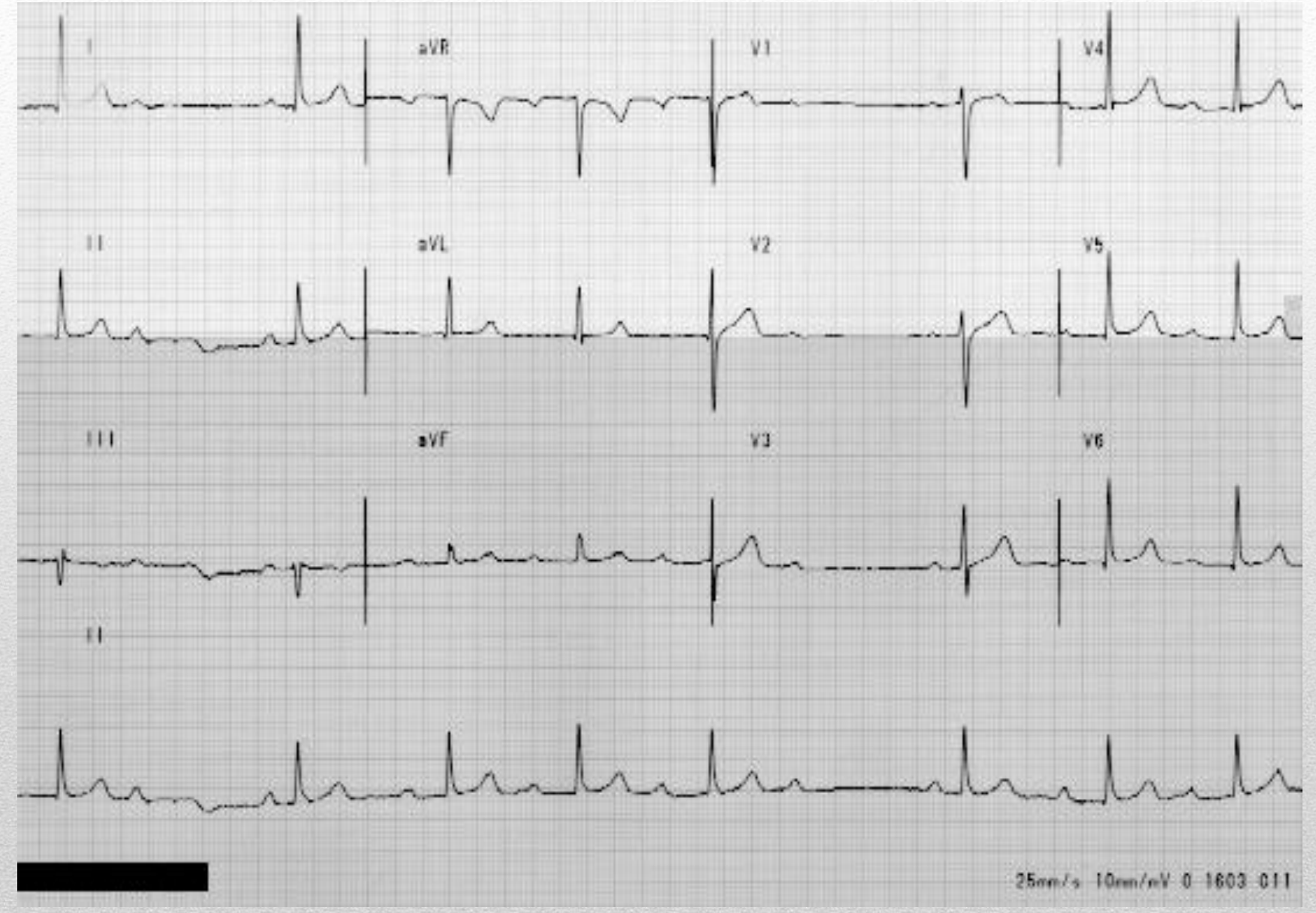
ECG 20. 62-year-old male with history of treated atrial fibrillation and recent weakness:



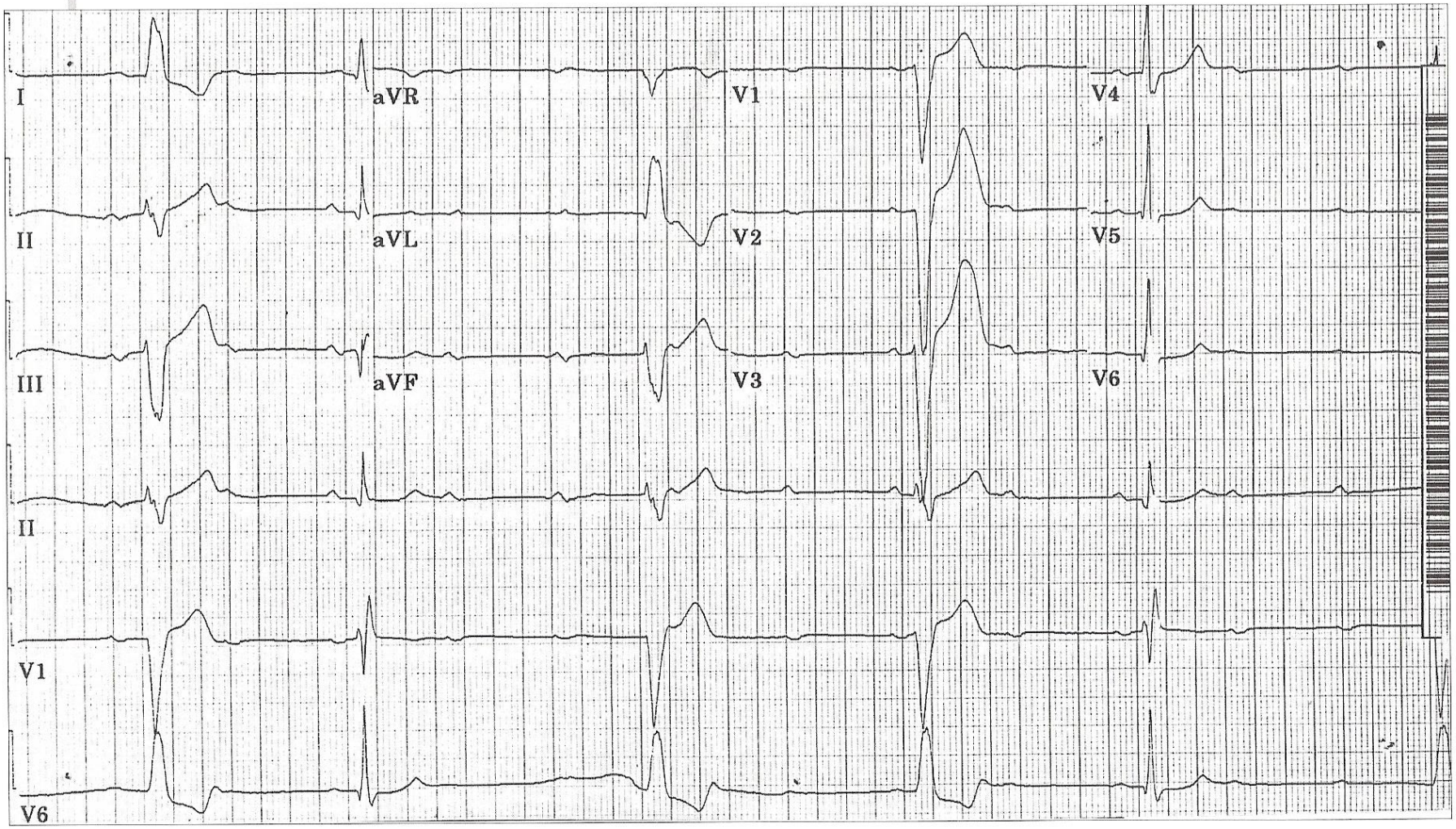
ECG 38. 87-year-old female with dizziness:



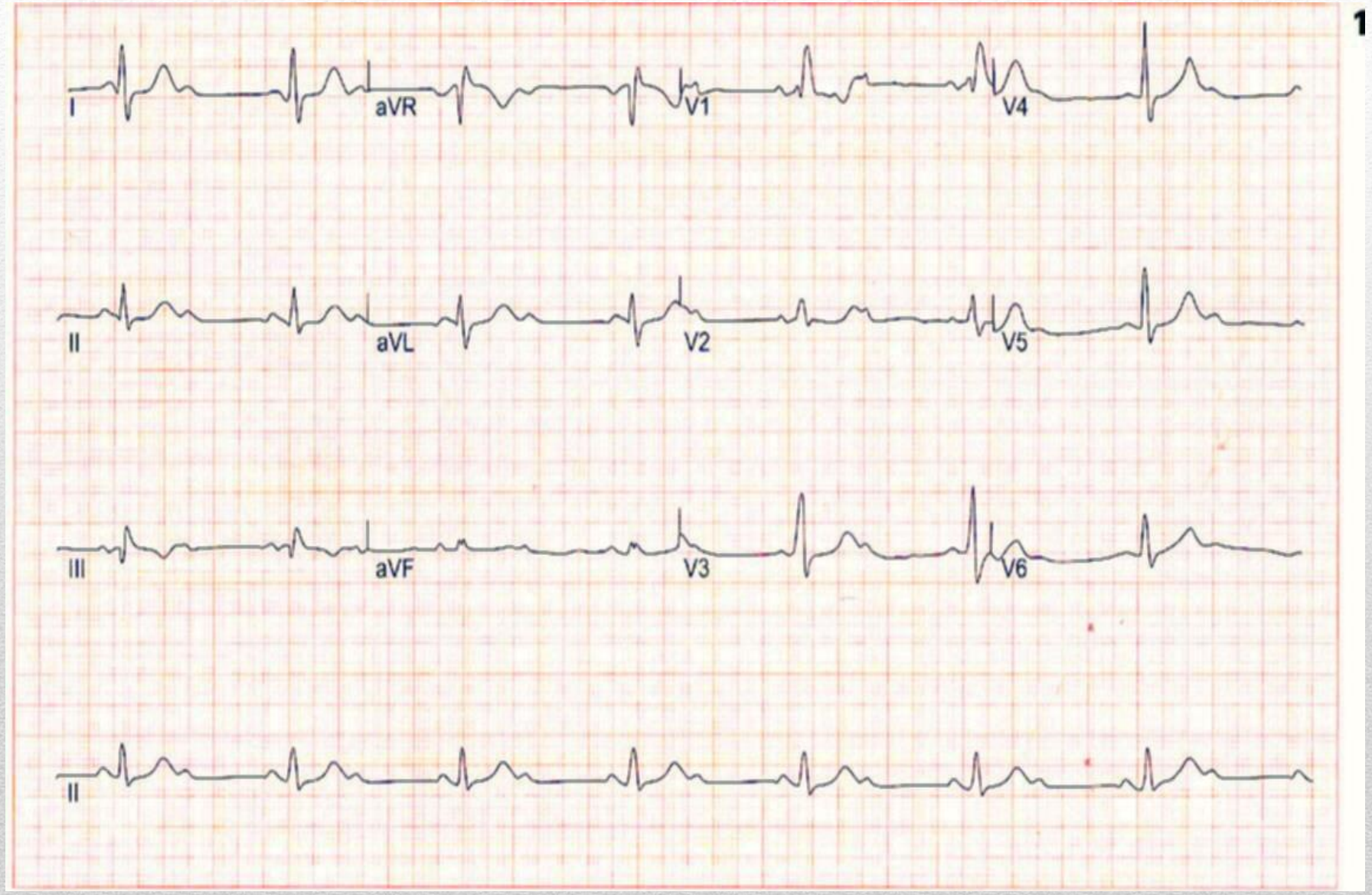
Realty check



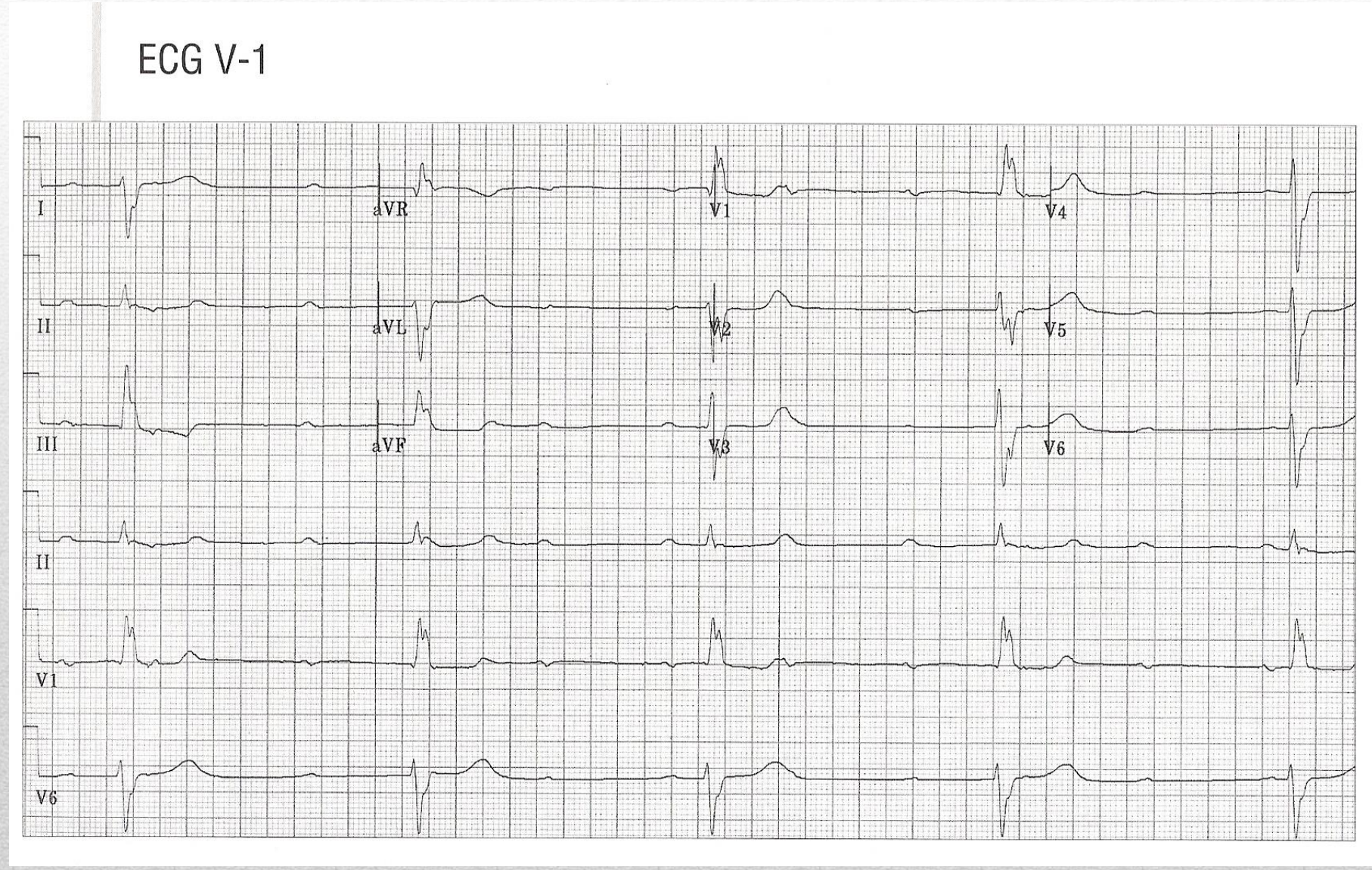
ECG V-24



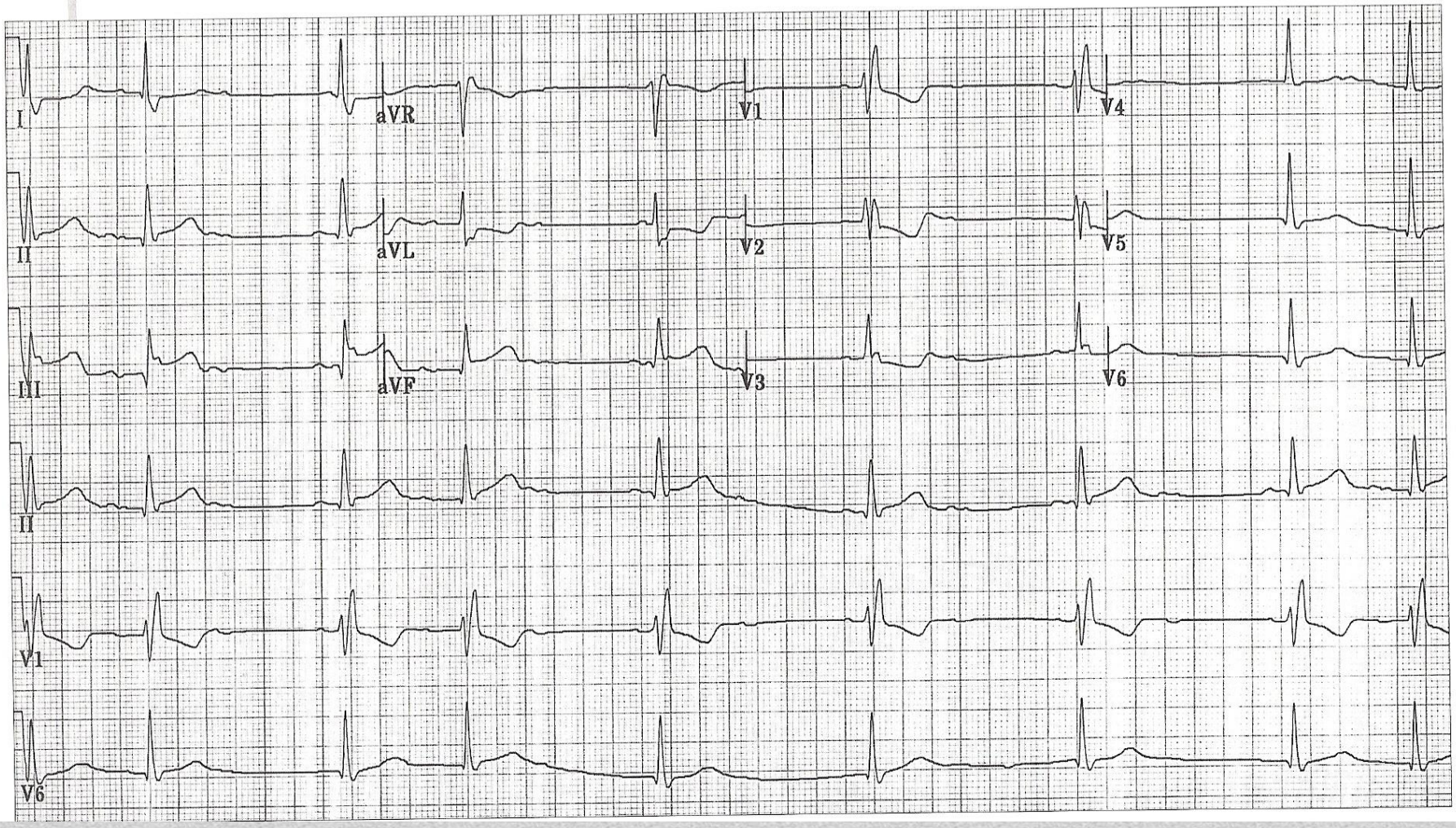
Realty check



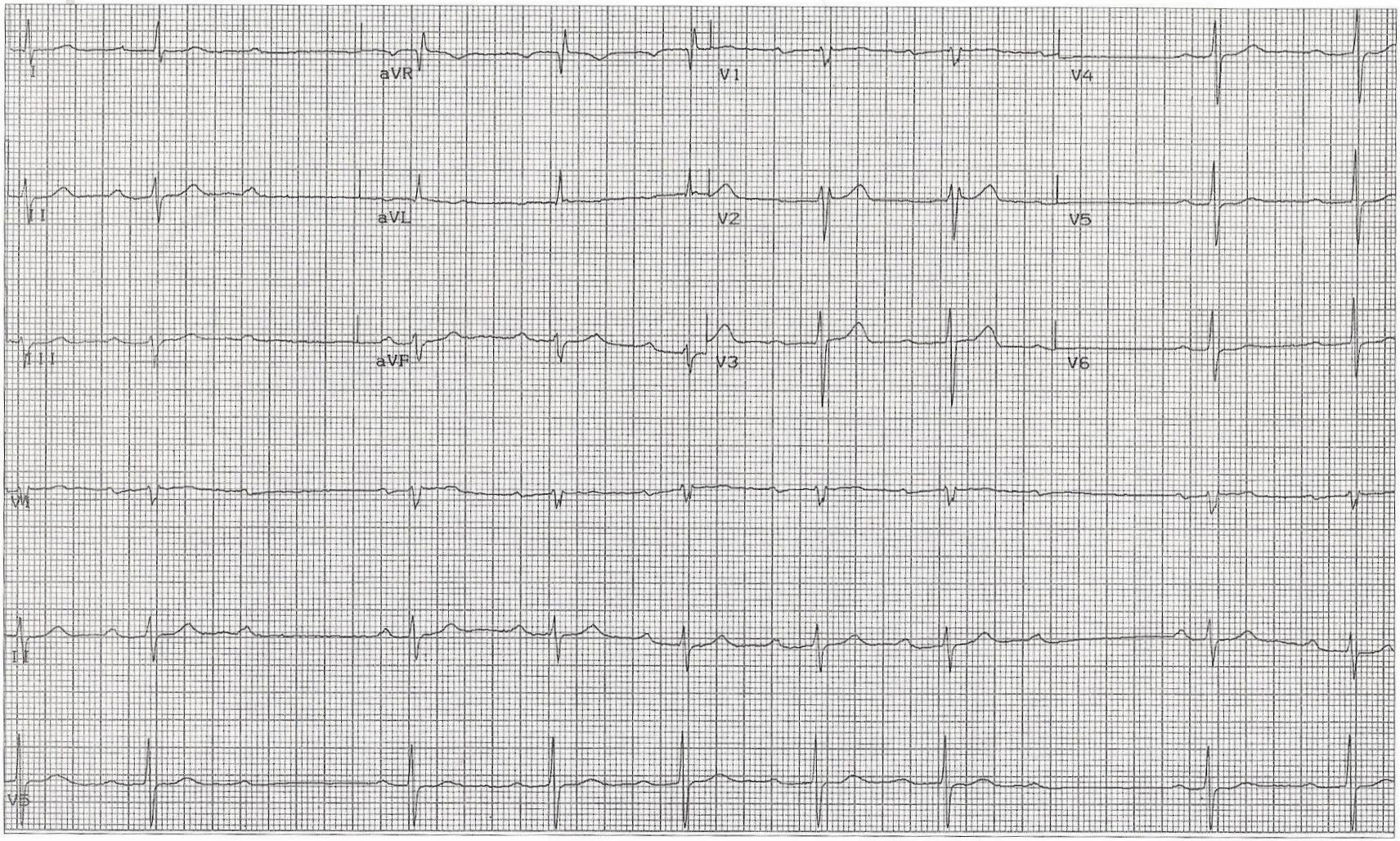
Realty check



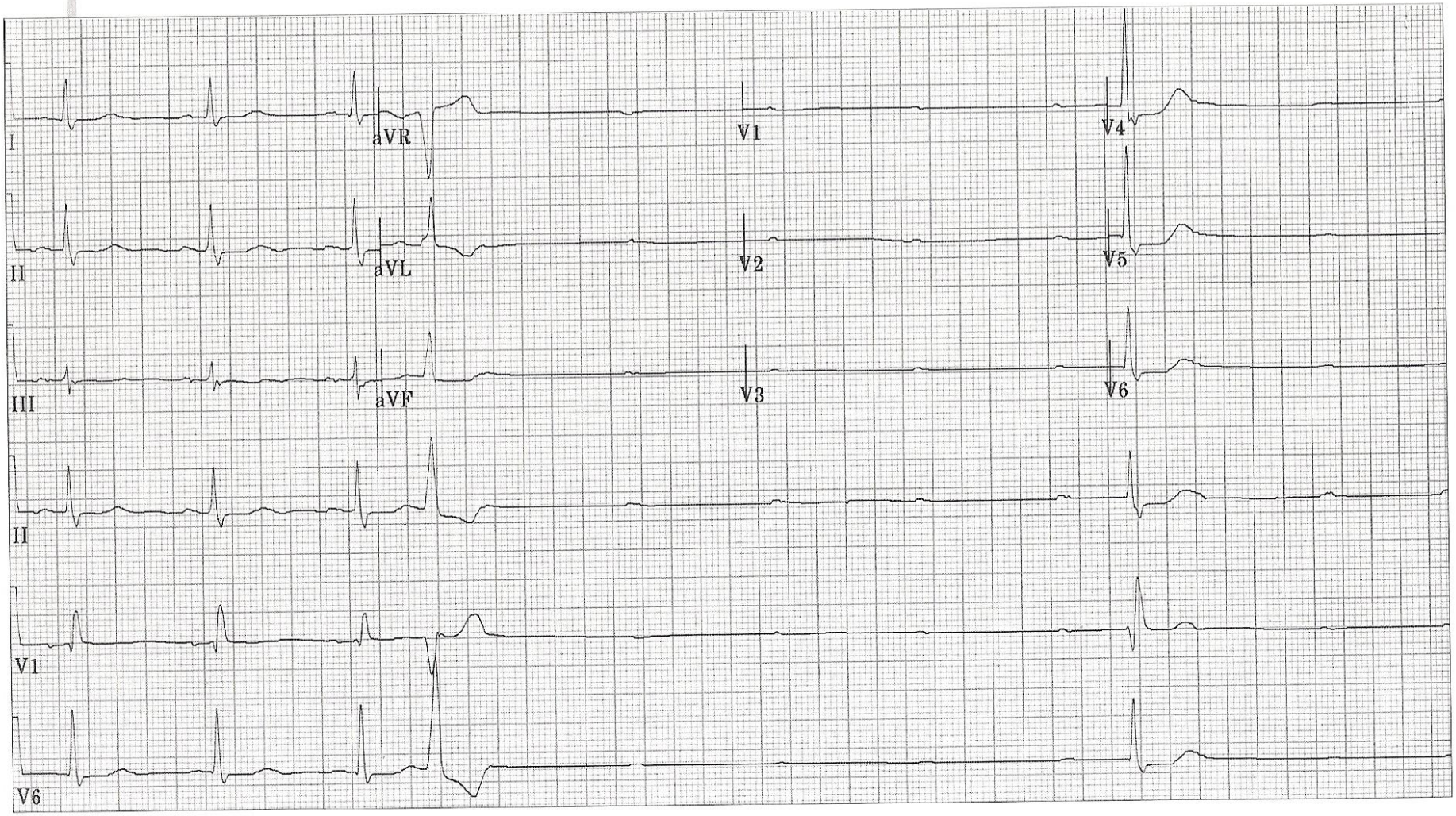
ECG V-6



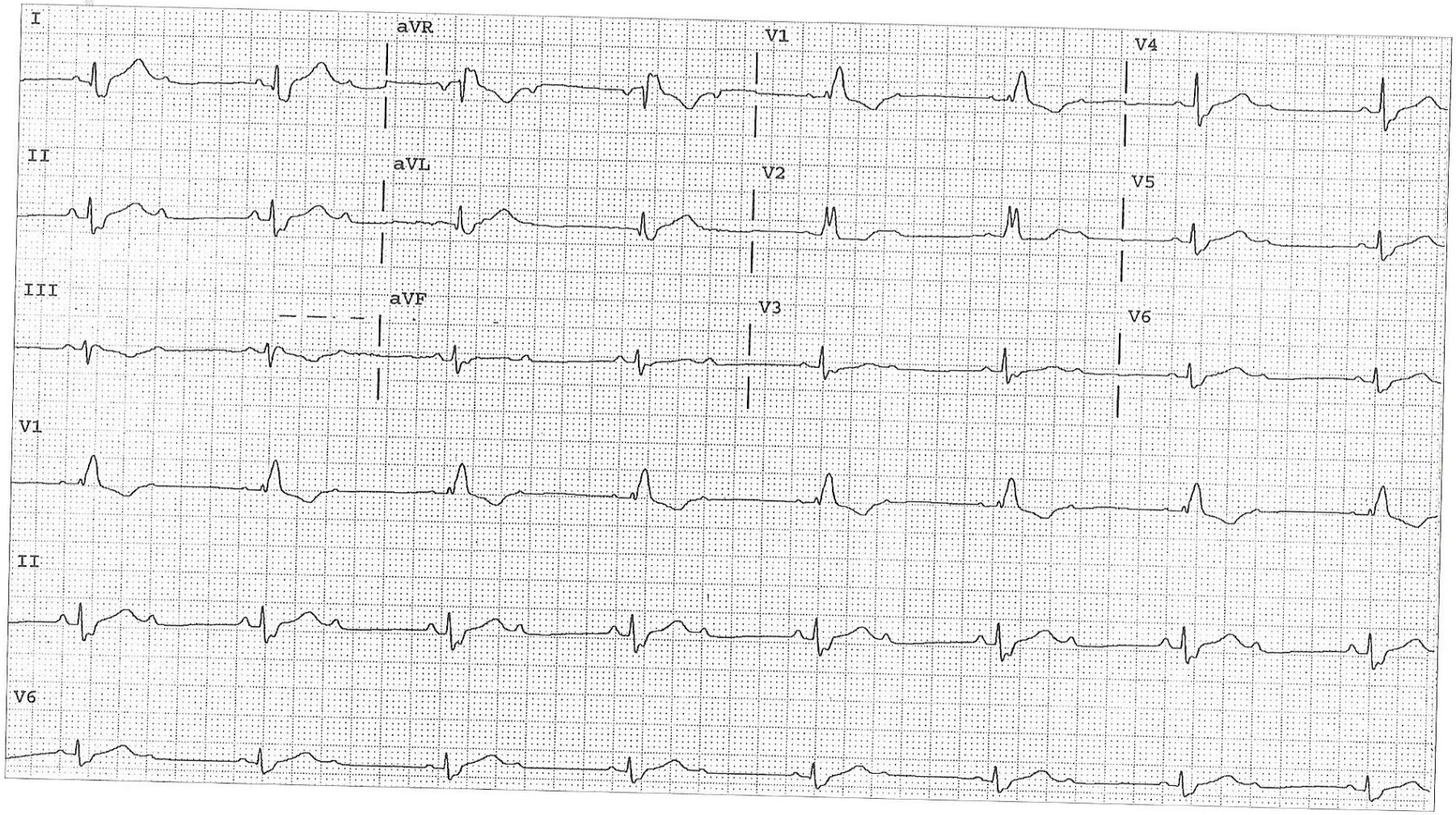
ECG V-15



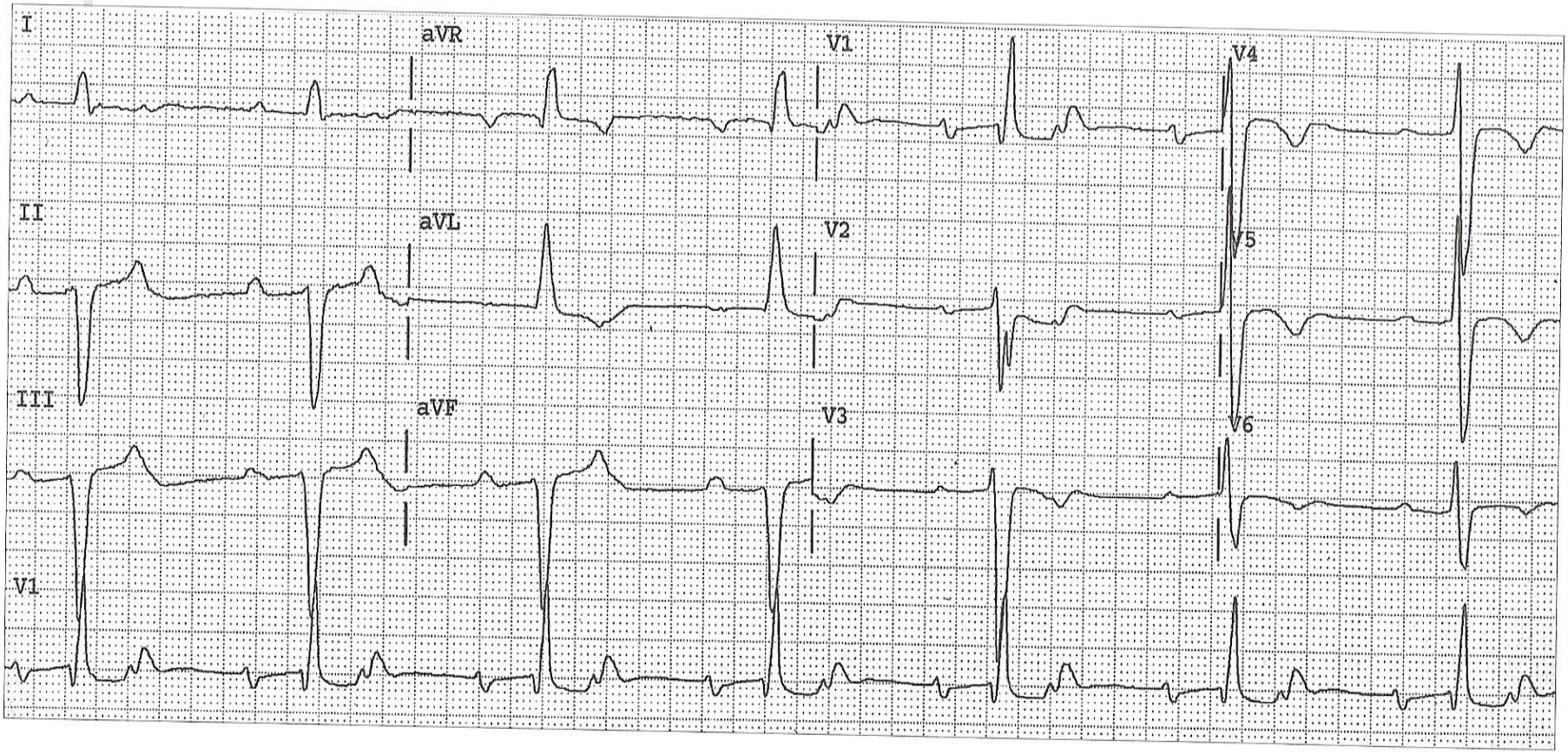
ECG V-22



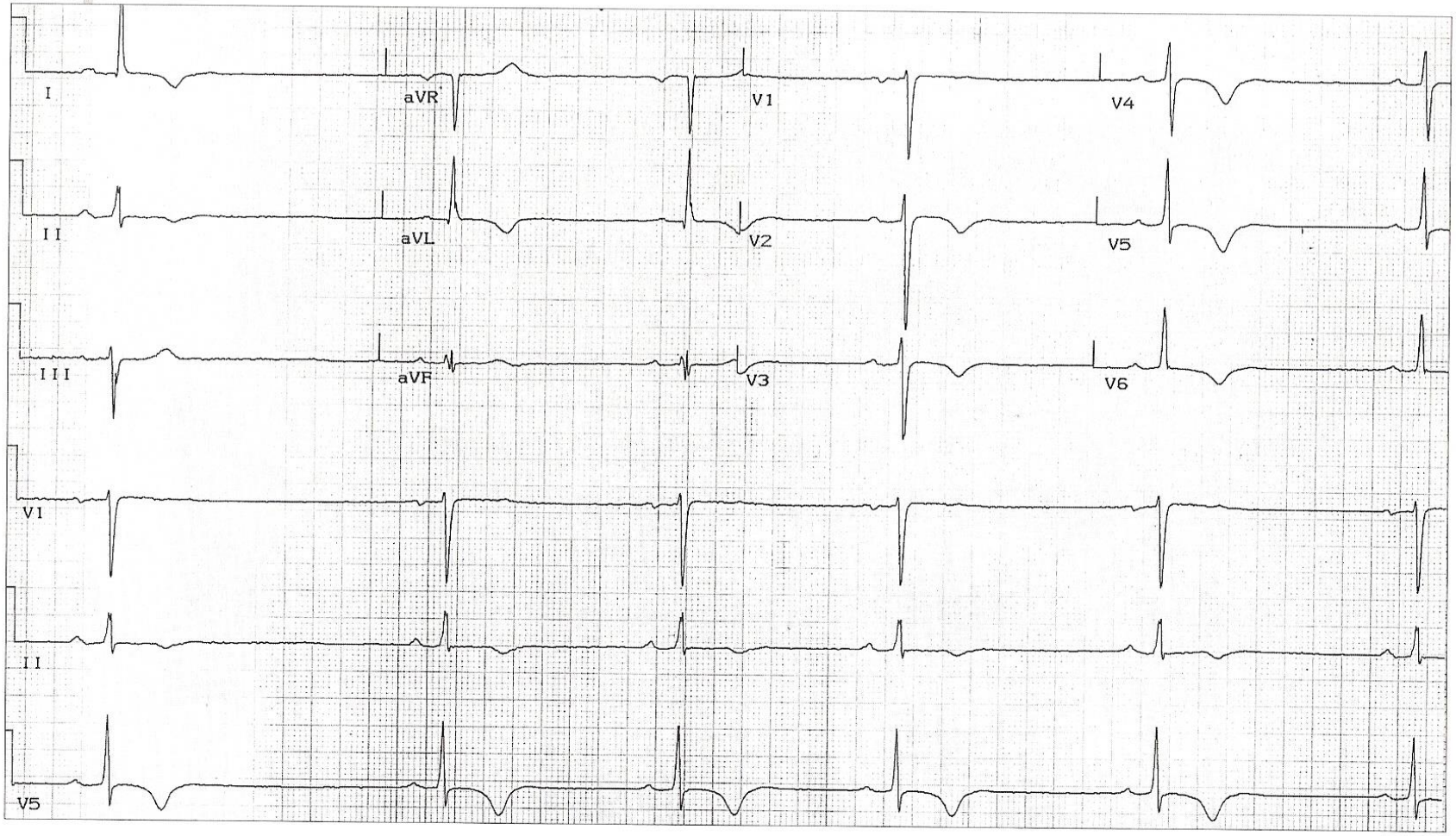
ECG V-26



ECG V-27

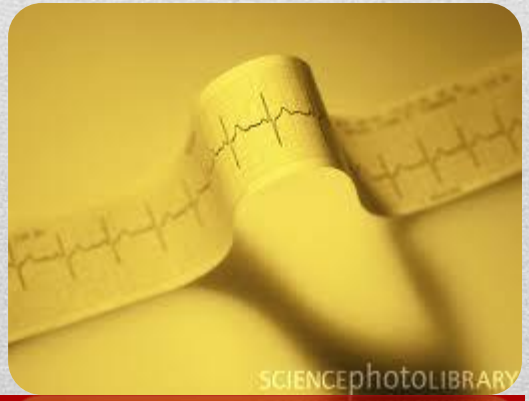


ECG VI-1



Part 2

Dysrhythmia

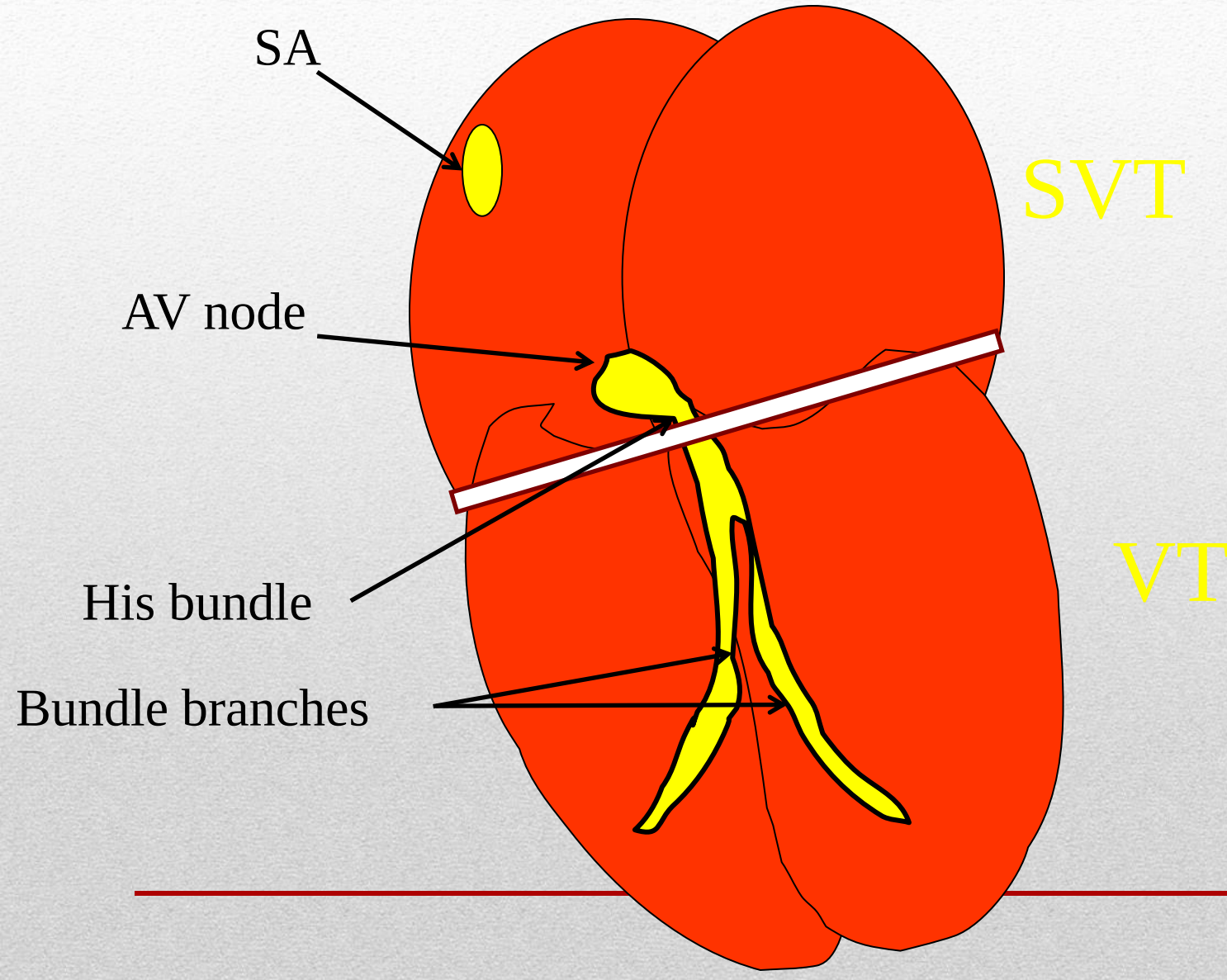


Outline

- Definition
- Mechanisms of tachyarrhythmia's
- Differential diagnosis
- Common examples
- Approach to diagnosis

What are NCT?

- Fast cardiac rhythms (>100bpm)
- QRS duration ≤120ms (less than 2.5 small squares).
- Originate from the atria or AV junction
- If aberrant conduction is present ,the QRS will be long even though the arrhythmia originates above the AV junction.


SA
AV node
His bundle
Bundle branches
SVT
VT

MECHANISMS OF TACHYARRHYTHMIA'S

Mechanism

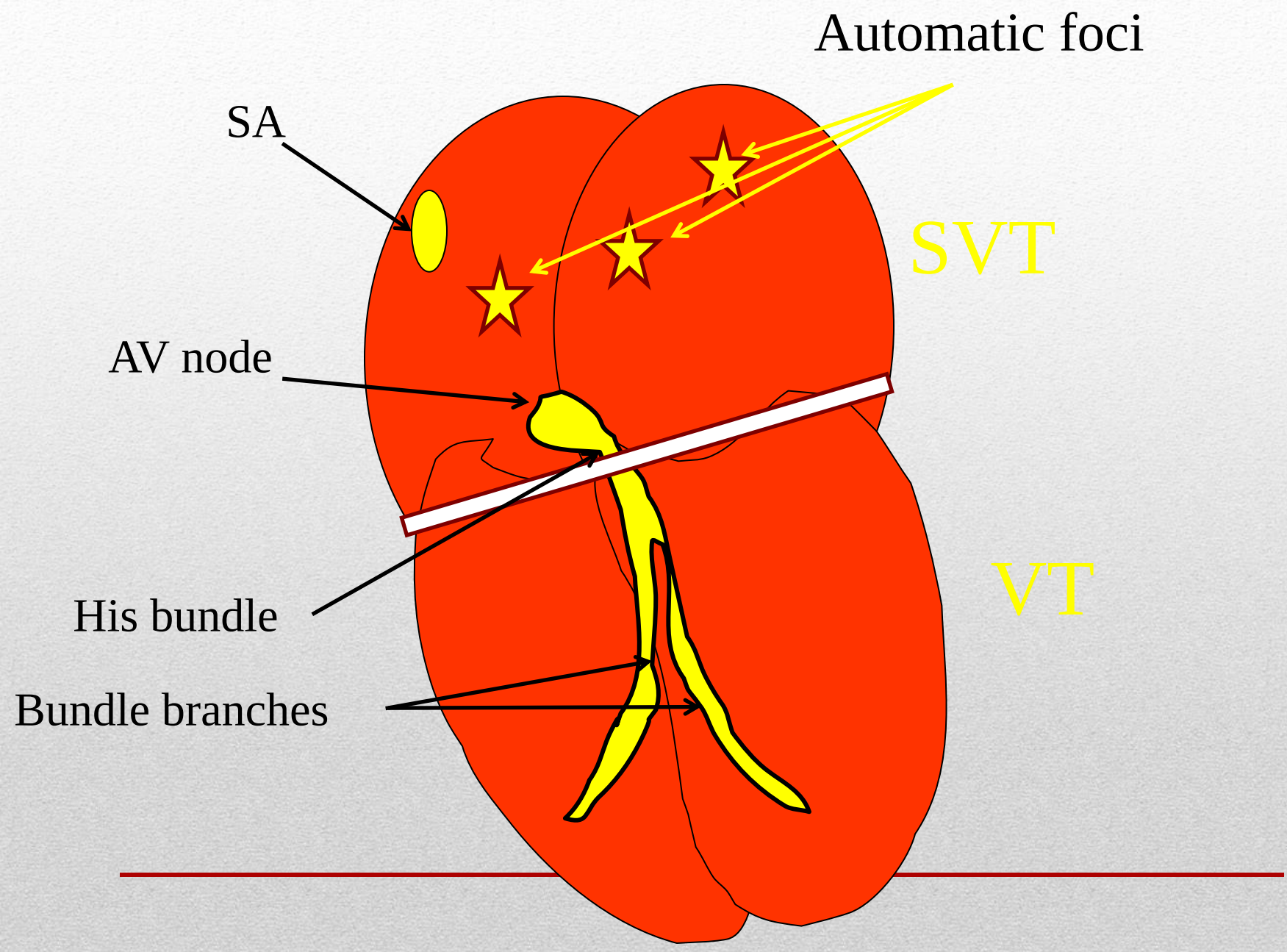
1) Accelerated automaticity

Automatic impulse generation from unusual site or overtakes sinus node.

2) Triggered activity

Secondary depolarization during or after repolarization

3) Reentry

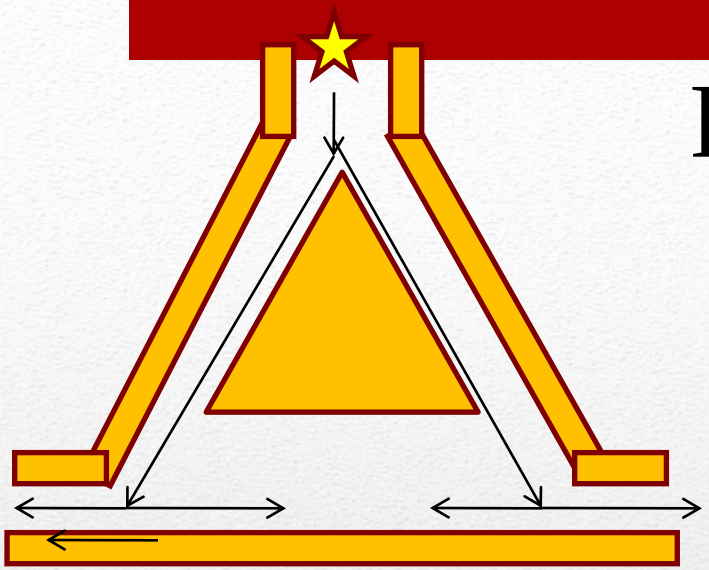

Automatic foci
SA
SVT
AV node
His bundle
VT
Bundle branches

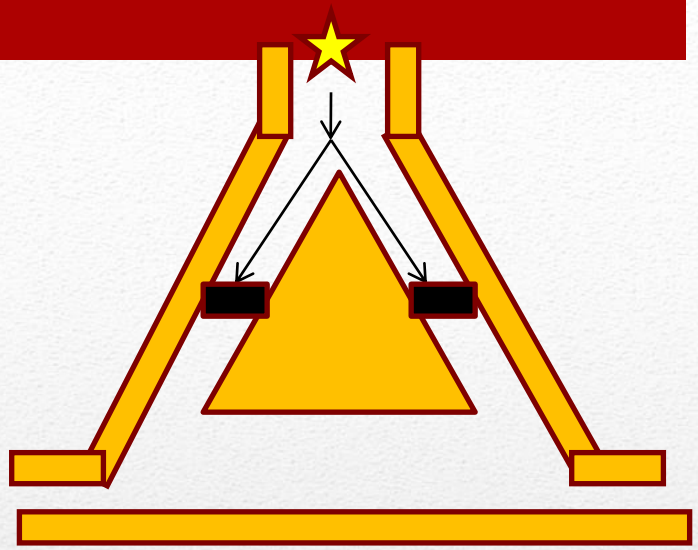
Reentry

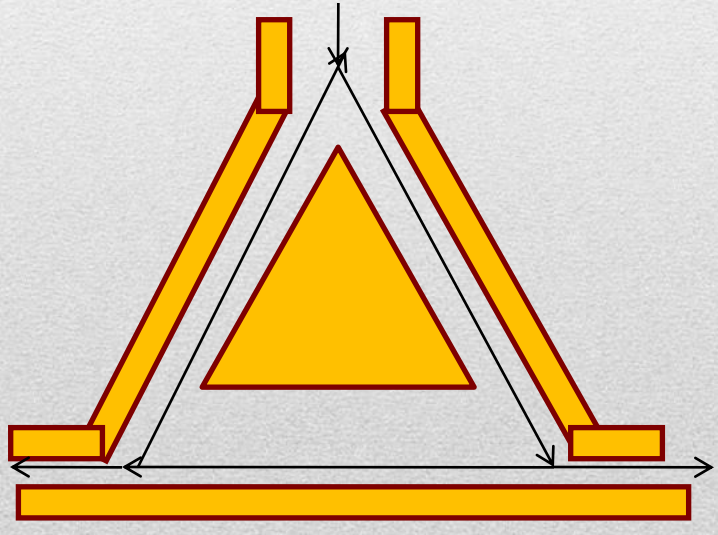
- Most common mechanism (around 90%)
- 3 prerequisites to develop reentry:

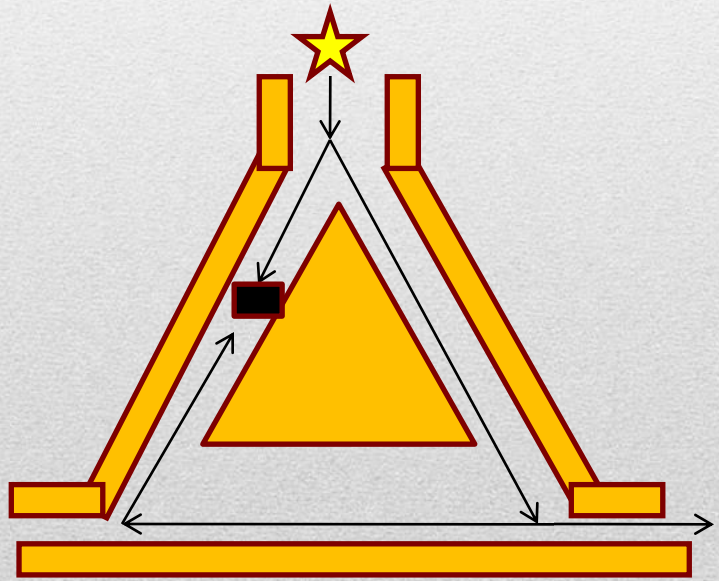
1. Available circuit
2. Difference in the refractory periods of the 2 limbs in the circuit
3. Slow enough conduction somewhere in the circuit

Reentry









reentry

Mechanisms….why know them?

- Each mechanism may have unique features on the surface ECG.

  Example: - Automaticity arrhythmias start & stop gradually.

  - Reentry starts & stops abruptly

- Impacts management

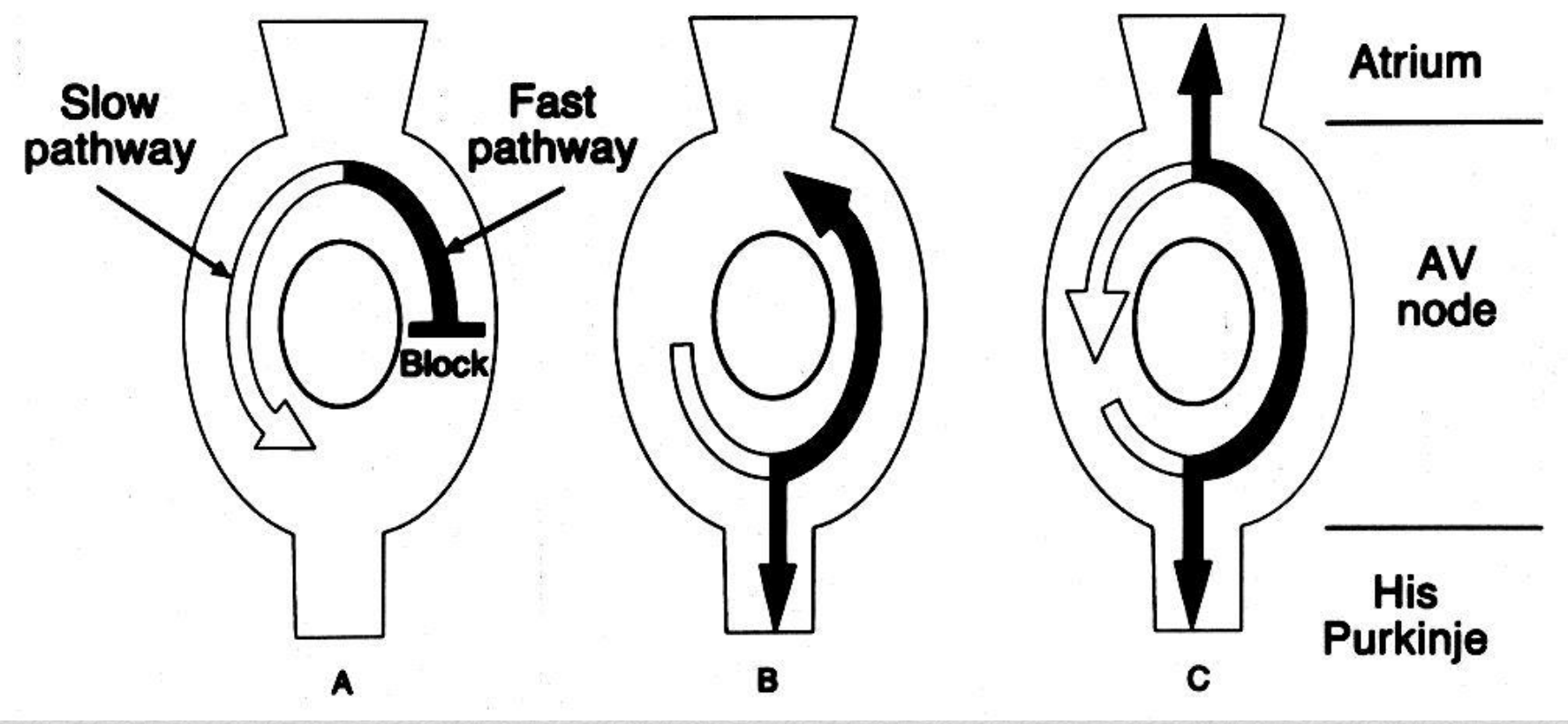
DIFFERENTIAL DIAGNOSIS

- Sinus tachycardia
- SA nodal reentry tachycardia
- Atrial tachycardia /PAT/MAT
- Atrial flutter
- Atrial fibrillation
- AVNRT (AV nodal reentrant tachycardia)
- AVRT (AV reentrant tachycardia)
- Junctional tachycardia

AV NODAL REENTRANT TACHYCARDIA (AVNRT)

AVNRT

- Most common SVT (AF/Aflutter excluded).
- Initiated by a PAC
- Reentry at the level of the AV node
- P waves are seen either immediately following the QRS or buried within it.
- Ventricular rate can reach 280 bpm

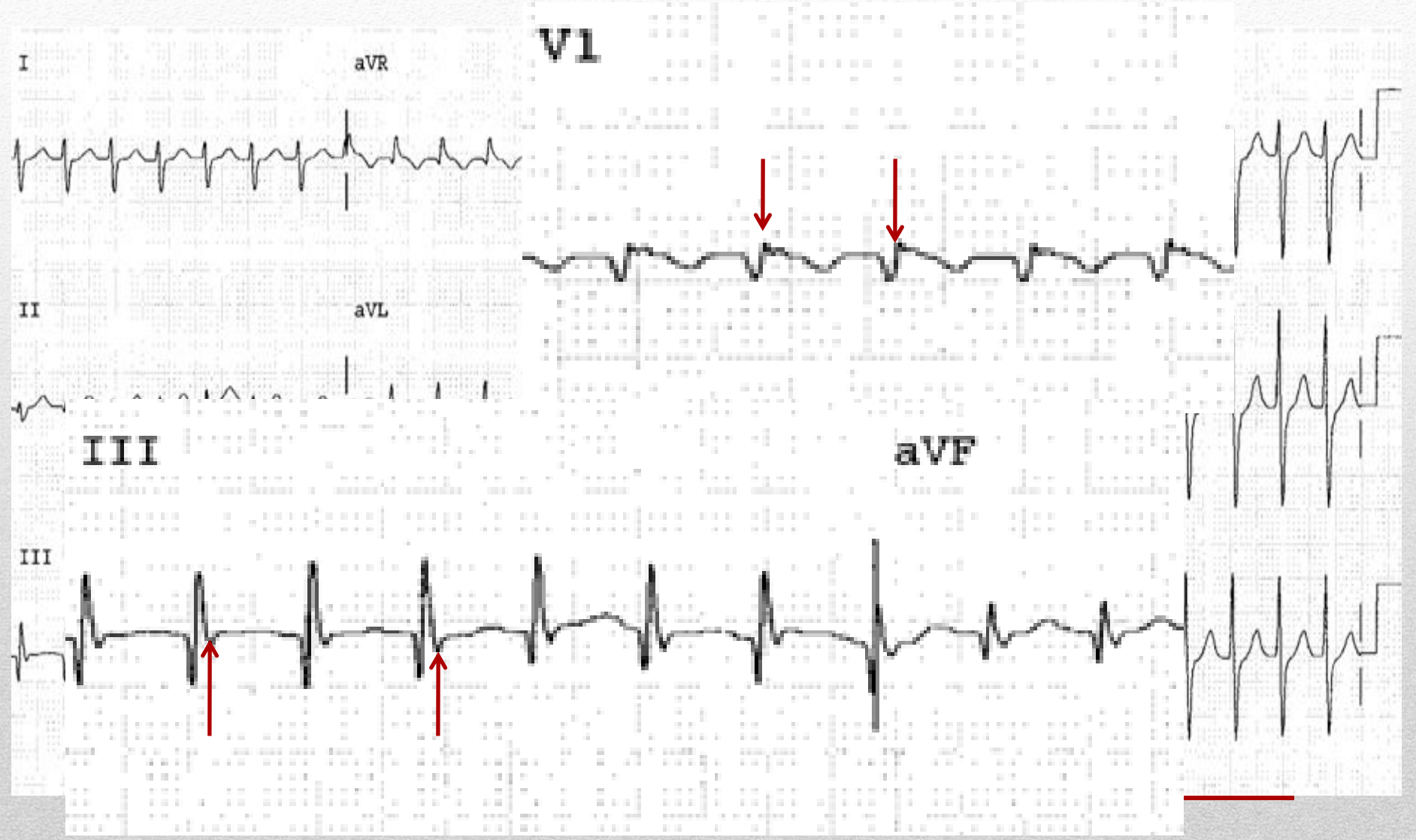


Mayo Clin Proc 1995; 70:371

AVNRT

- Slow-fast verity is the most common, but the reverse could happen i.e. fast-slow
- Slow-fast is mostly in adults
- Triggered by a PAC
- On ECG, a retrograde P wave (short RP) manifest as :

  - R’ in V1
  - Pseudo S in inferior leads (II,III, AVF)
  - 2/3 of cases no P wave seen


I
aVR
II
aVL
III
V1
aVF
III

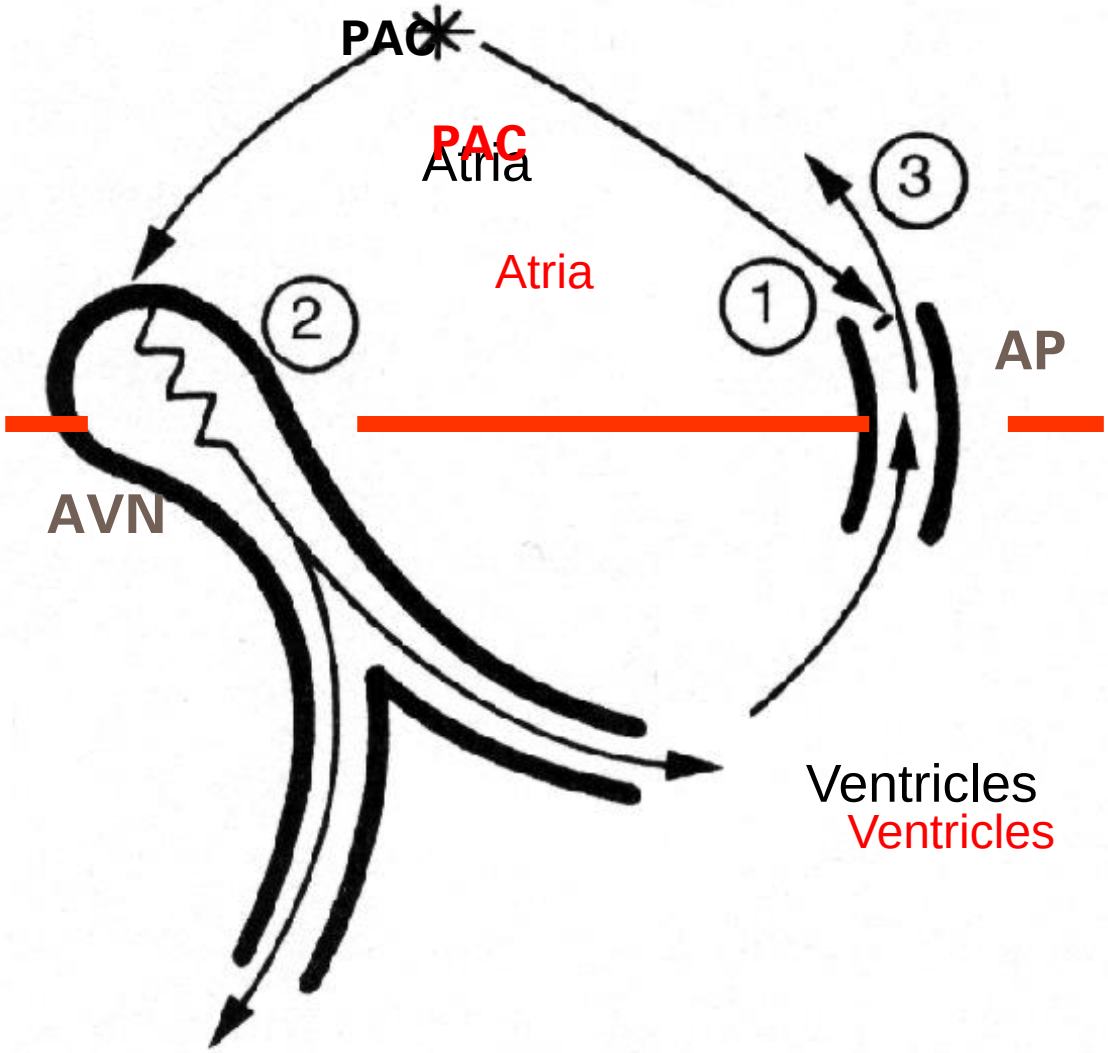
AVRT

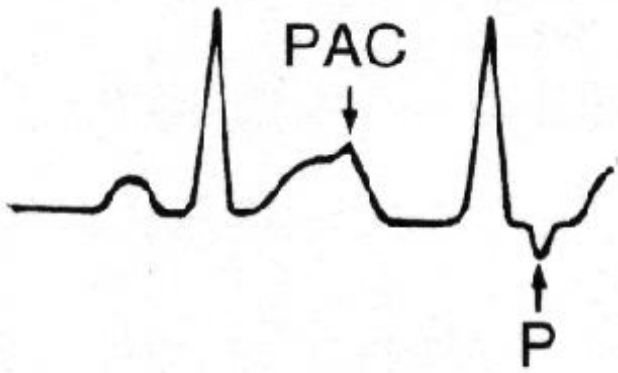
- 2nd most common SVT
- Involves reentry between the atrium and ventricle with use of the AV node as the antegrade, slow pathway and an accessory AV connection as the retrograde, fast pathway.
- Also known as “Orthodromic reciprocating tachycardia”

Terminology in use

- Orthdromic tachycardia= conduction occurs in an antegrade fashion down the AV node.
- Antidromic tachycardia= conduction occurs in a retrograde fashion up the AV node.

Initiation of Orthodromic AV Reentrant Tachycardia

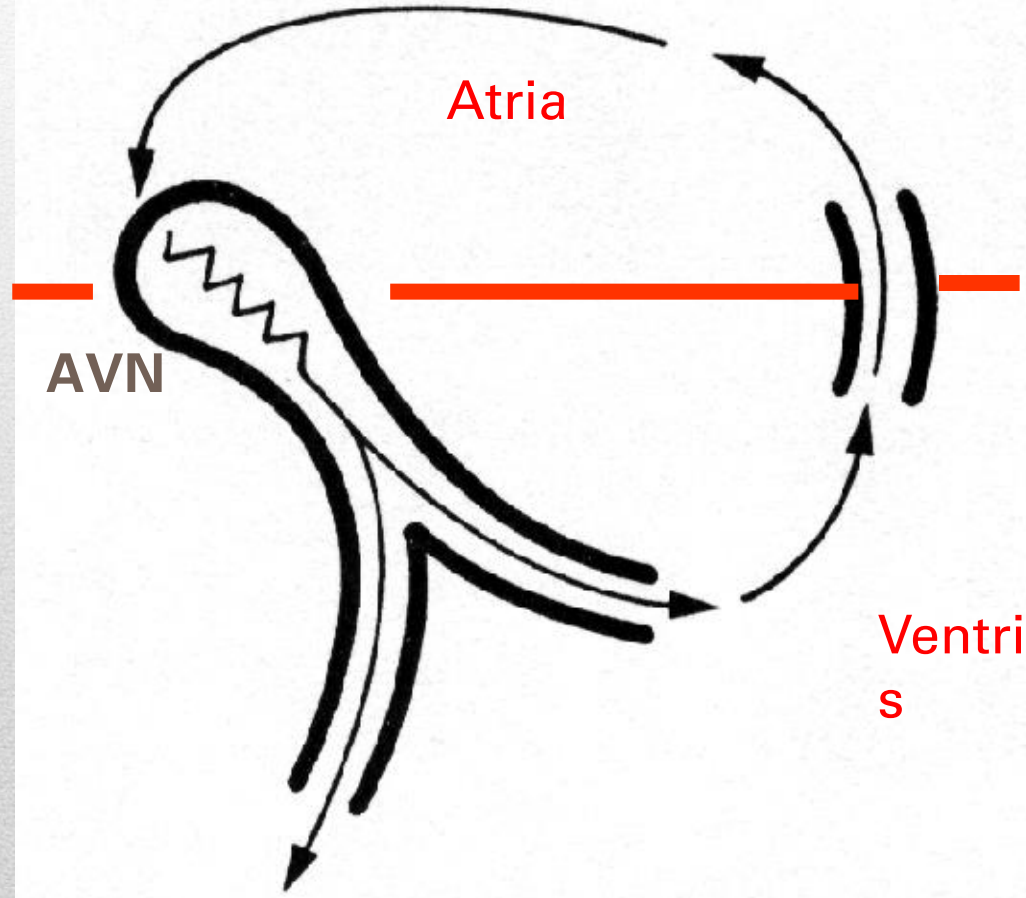




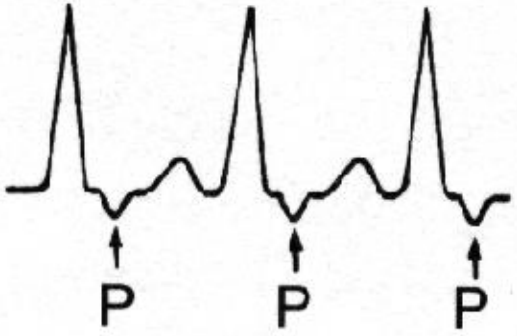
PAC = premature atrial complex (beat)

PAC = premature atrial complex (beat)

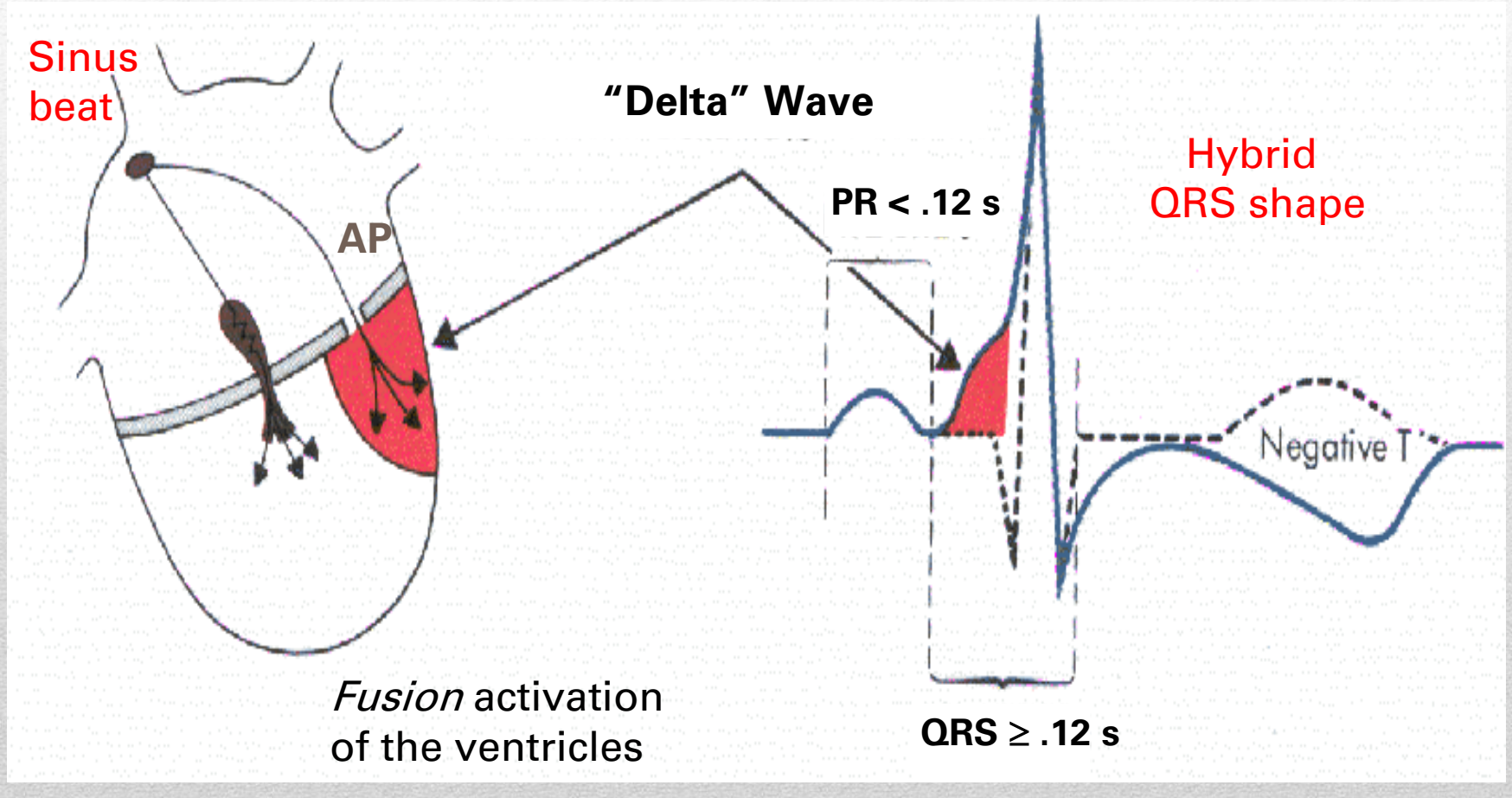
Sustainment of Orthodromic AV Reciprocating Tachycardia



Rate 150-250 beats per min

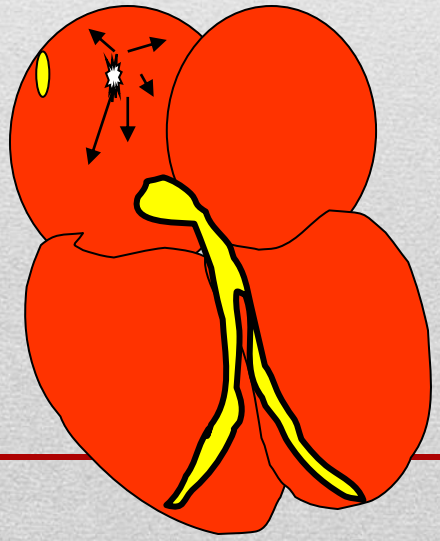


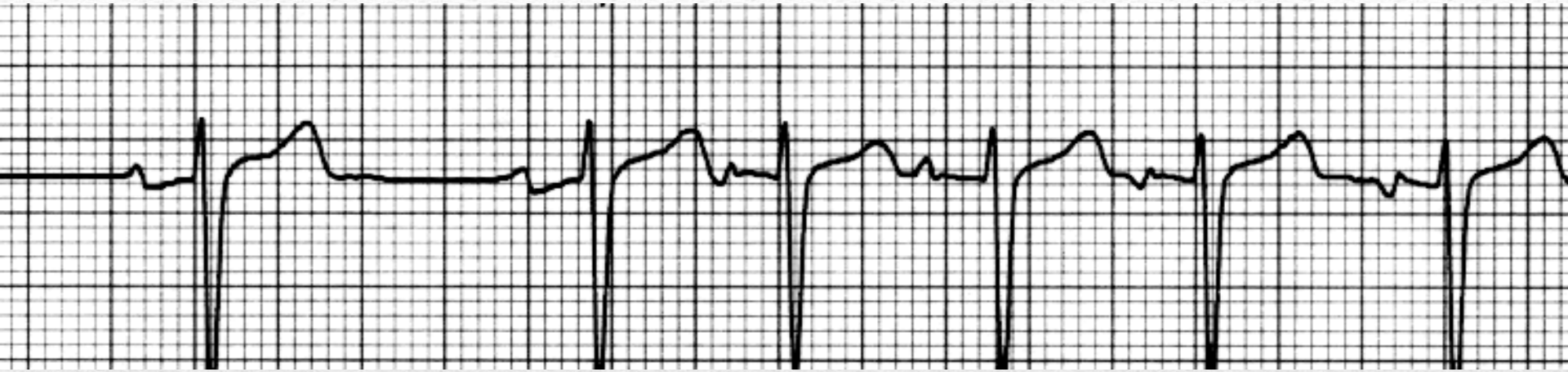
Retrograde P's fall in the ST segment with fixed, short RP


Sinus beat
AP
"Delta" Wave
PR < .12 s
Hybrid QRS shape
Negative T
Fusion activation of the ventricles
QRS ≥ .12 s

Atrial tachycardia

- Most common long RP tachycardia
- Rate 150-250 bpm
- An AV nodal independent tachycardia
- Can be associated with variable block



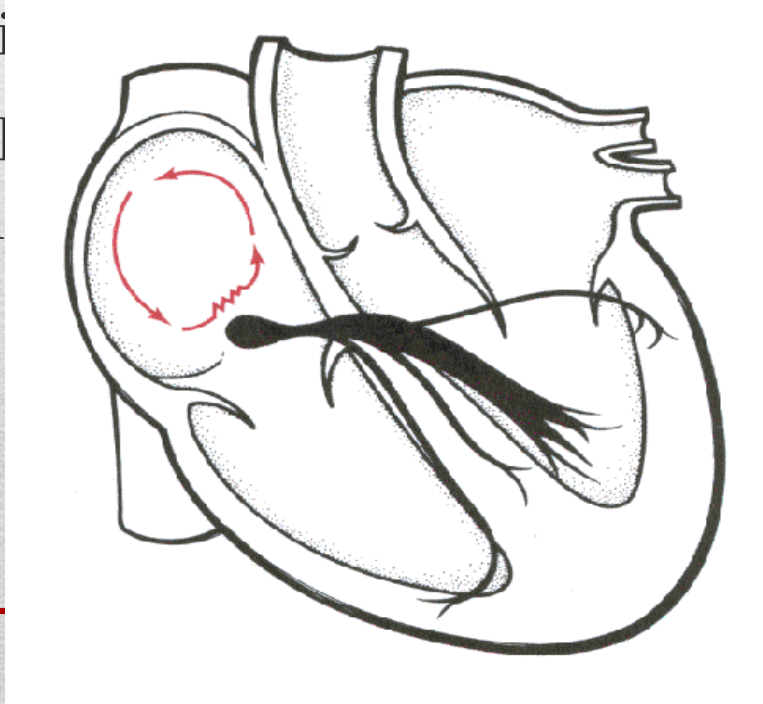


Differs from AV nodal or AV reentrant SVT

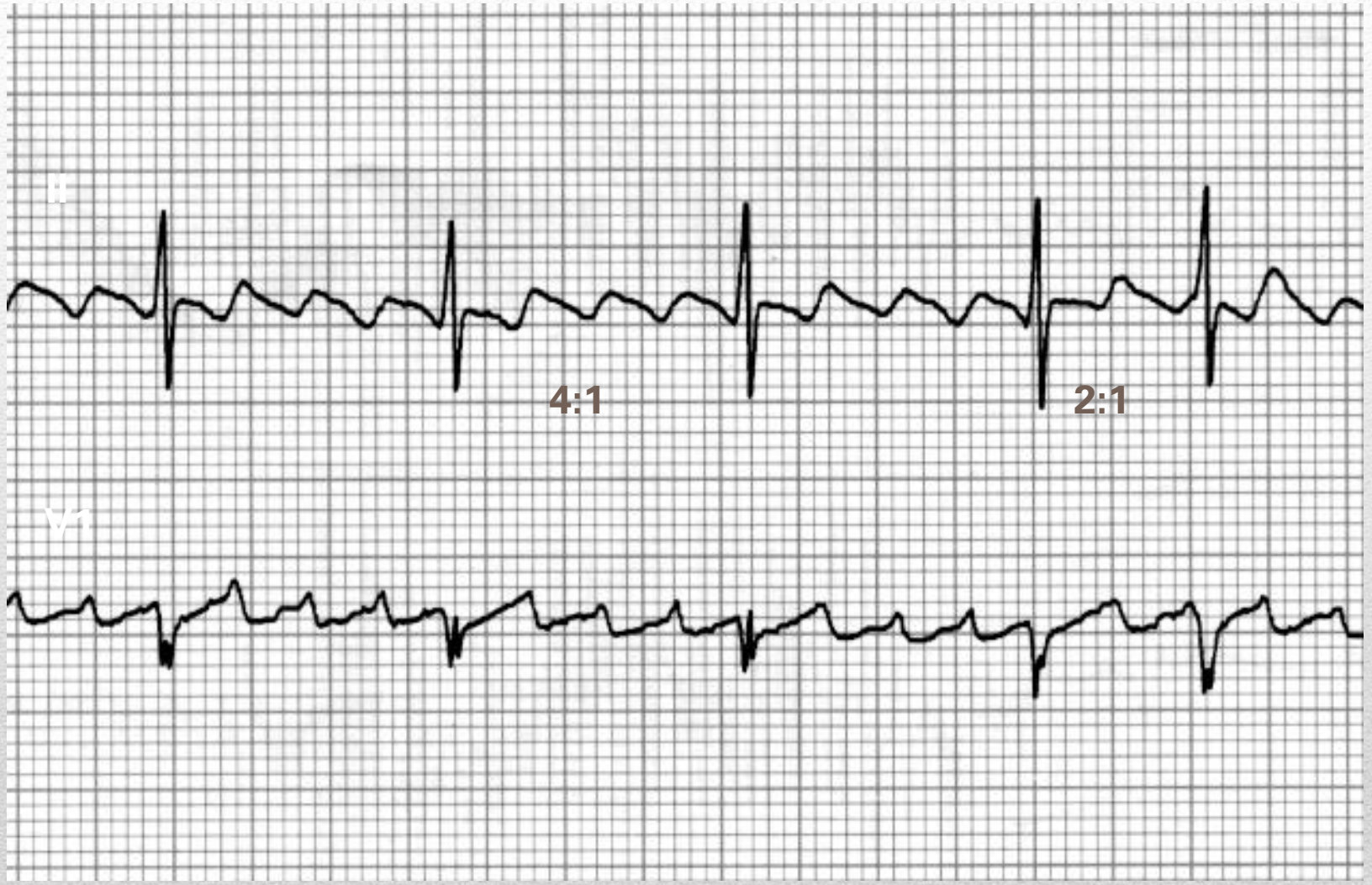
- **RP intervals can be variable**
- **RP often > PR**
- **(Example slower than more common rate mof 150-250 beats per min)**

Atrial

- Reentrant rhythm of the ri
- Typical atrial rate is 300b
- P waves have a characteri



Atrial Flutter

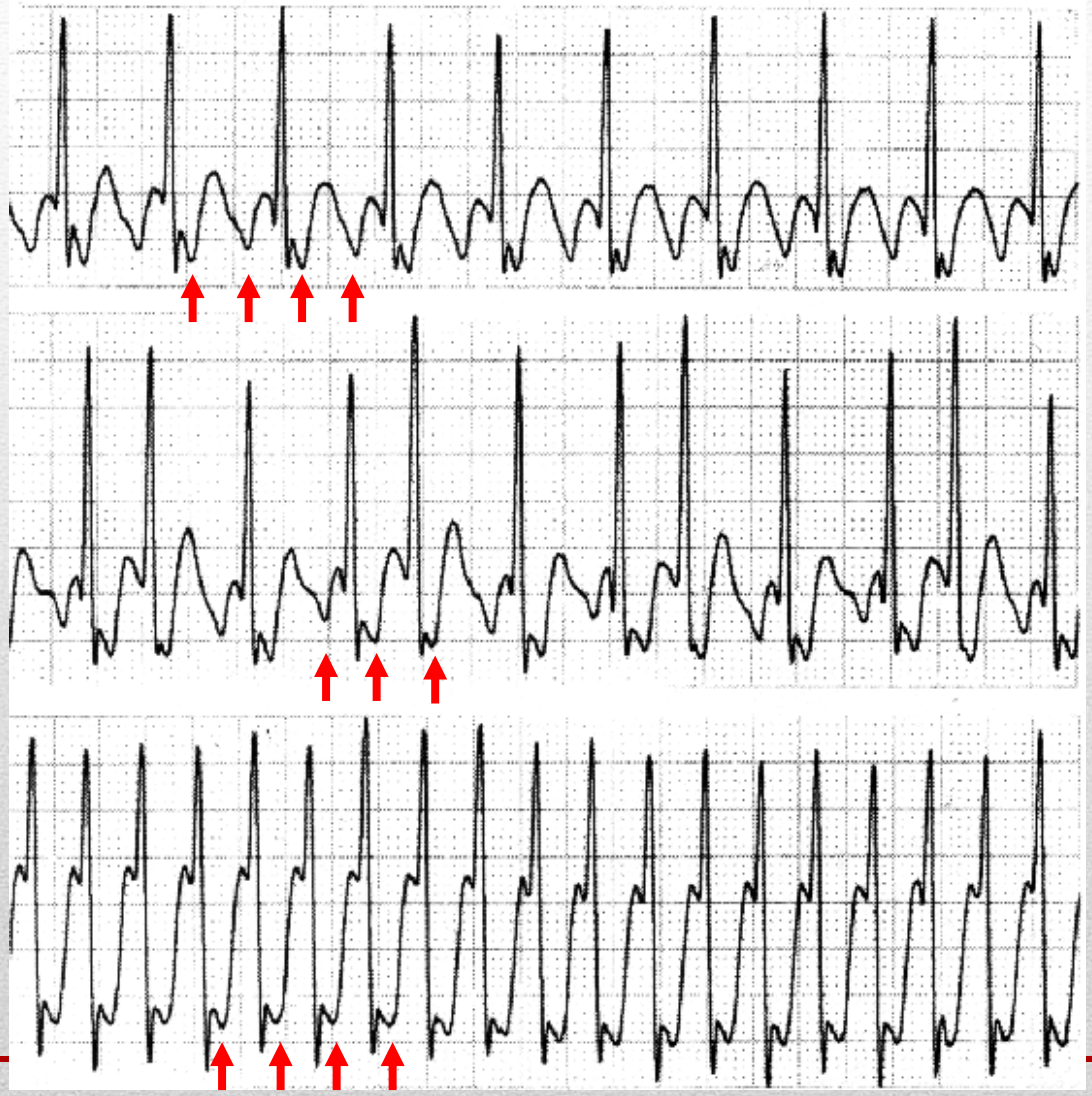


Atrial Flutter

2:1 Conduction

2:1 & 3:2 Conduction

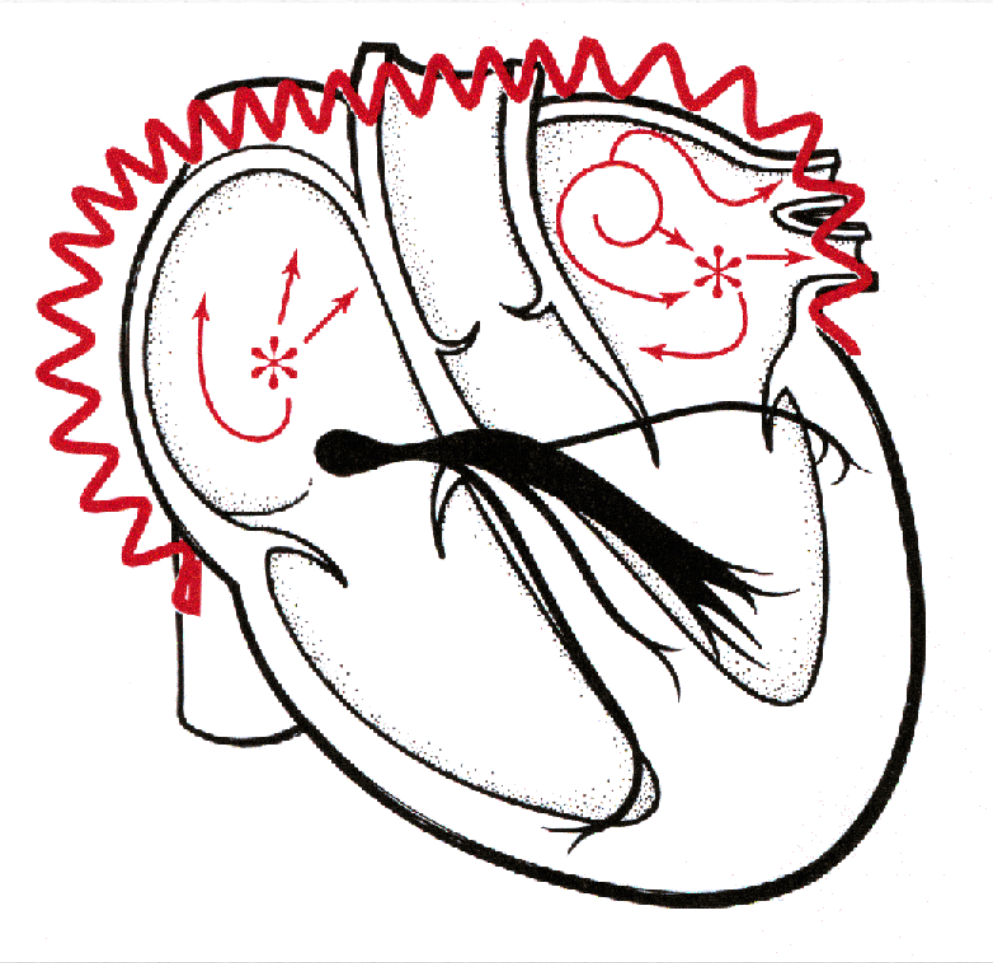
1:1 Conduction



V. rate 140-160 beats/min

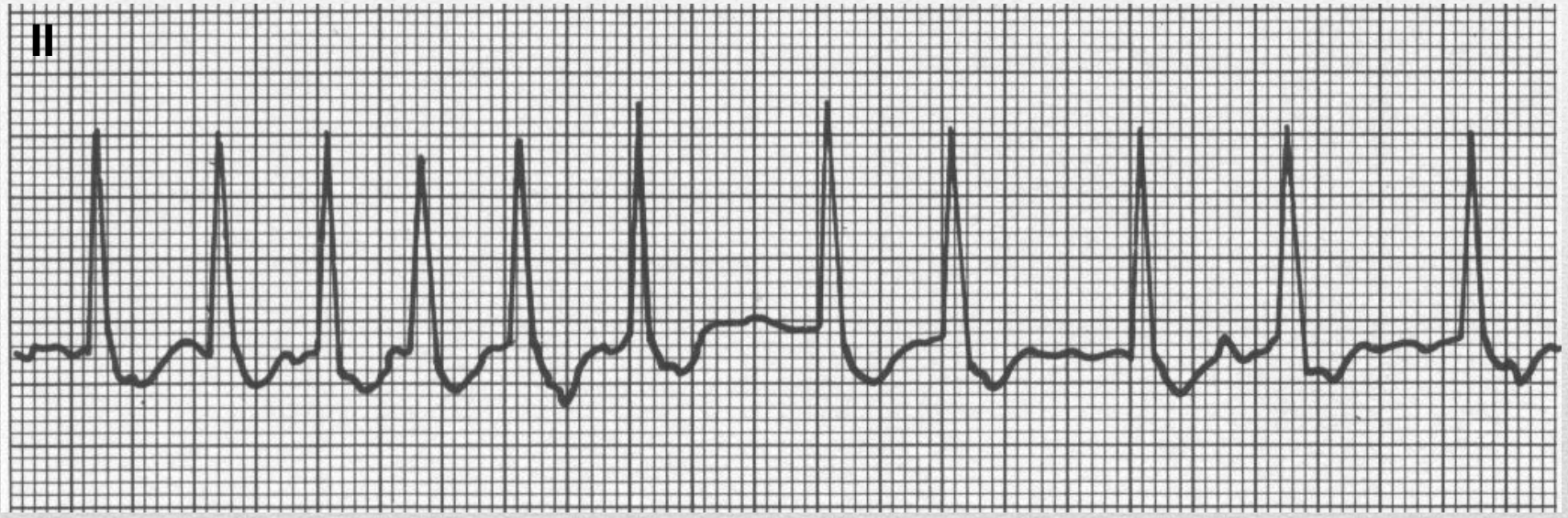
Atrial Fibrillation

Focal firing or multiple wavelets



Chaotic, rapid atrial rate at 400-600 beats per min

Atrial Fibrillation: Characteristic "Irregularly Irregular" Ventricular Response



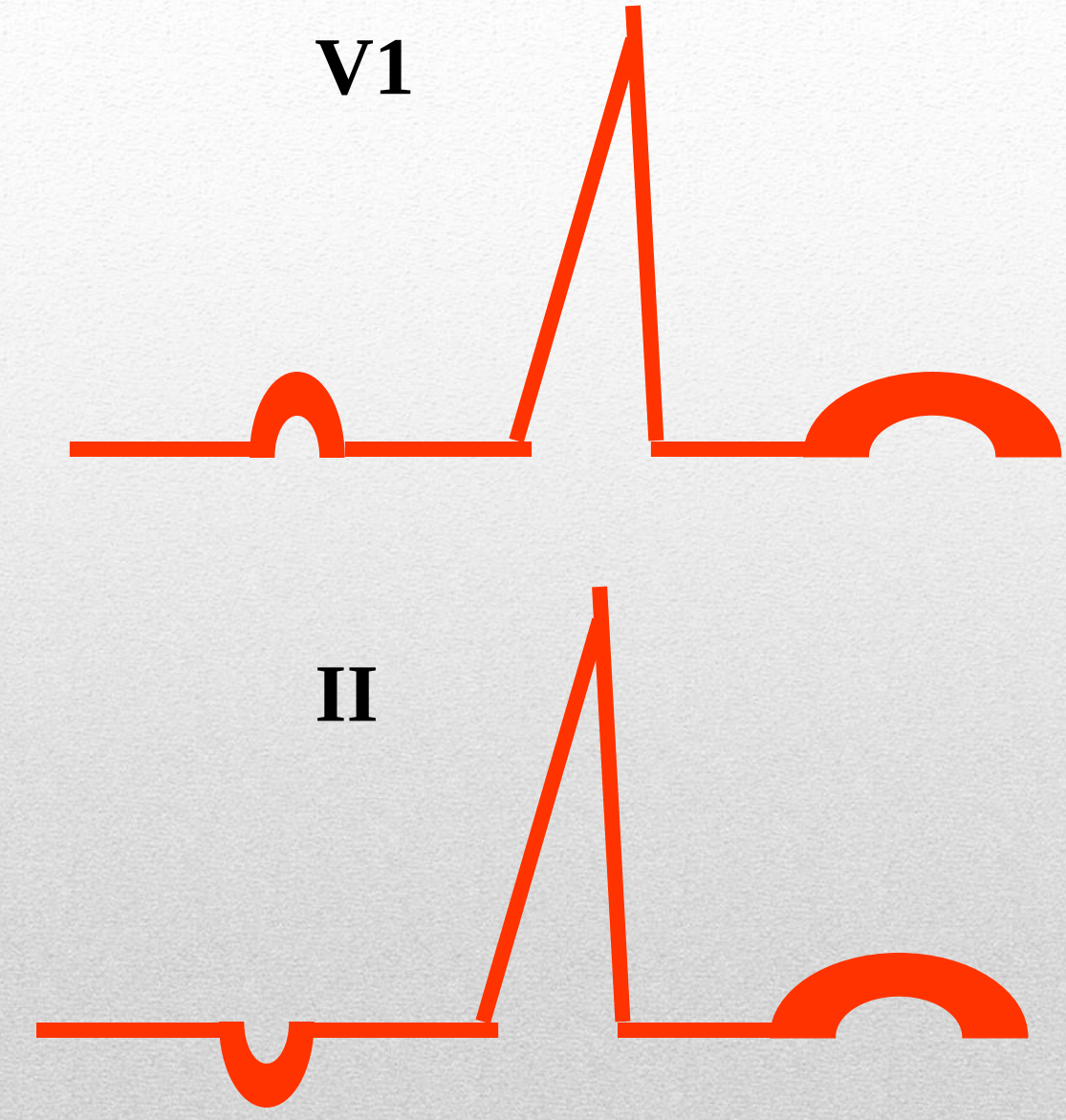
- **Rapid, undulating baseline (best seen in V1)**
- **Most impulses block in AV node → *Erratic* conduction**

HOW TO MAKE THE DIAGNOSIS?

- Is it a tachycardia?
- Is it narrow or wide complex?
- What is the shape/axis of the P wave?
- What is the relationship of the P wave to the QRS?

Shape/axis of the P wave

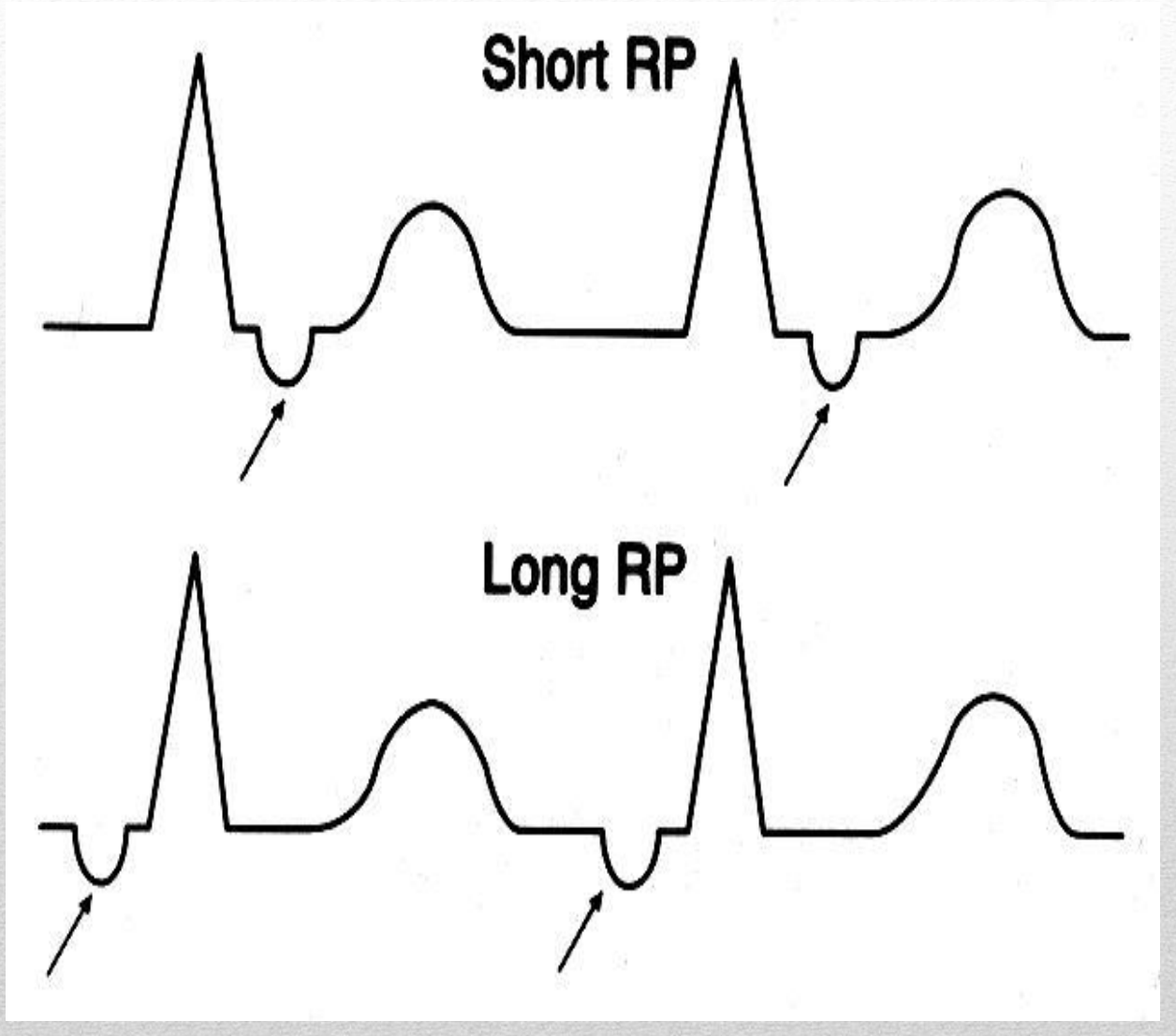
- Morphology of the p wave can aid in identifying the origin
- Look at leads II and V1 , if upright in II, and biphasic in V1, then it’s likely from the SN or near to it.
- If negative in II, and upright in V1 then it likely is from elsewhere (LA)


V1
II

Relationship to QRS

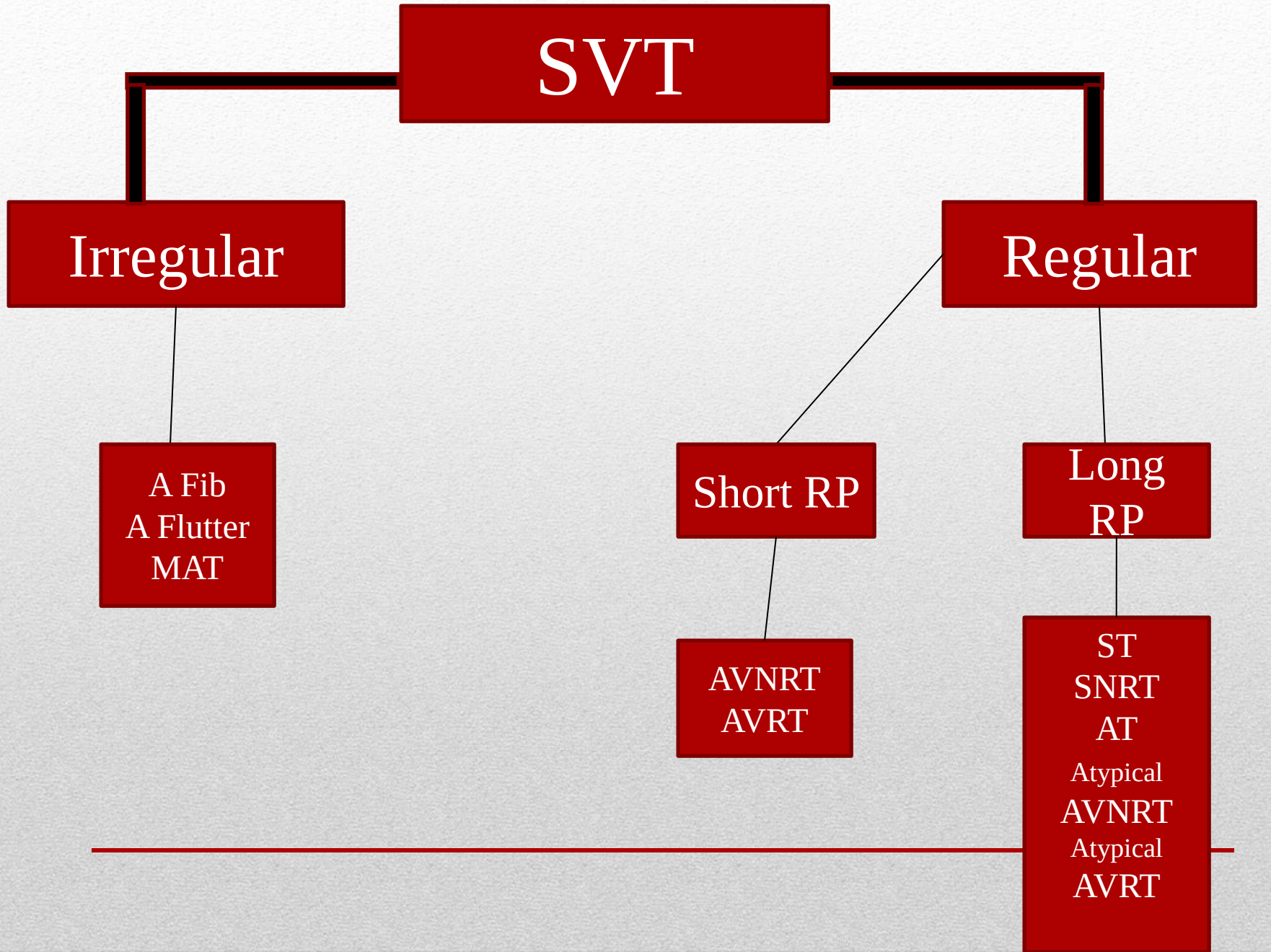
3 situations could be described:

1. P just precedes the QRS (Long RP)
2. P occurs simultaneously or immediately follows the QRS (Short RP)
3. No relation between P and QRS (AV dissociation)



RP < ½ RR

RP > ½ RR


SVT
Irregular
Regular
A Fib
A Flutter
MAT
Short RP
Long RP
AVNRT
AVRT
ST
SNRT
AT
Atypical
AVNRT
Atypical
AVRT

BROAD THERAPEUTIC APPROACH TO CLASSIFY (NCT)

Classification

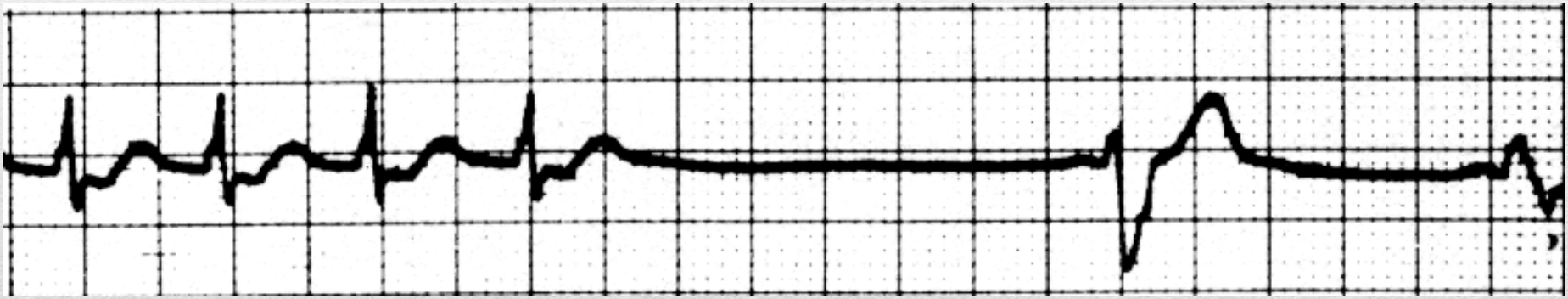
- AV nodal dependant NCT
  (AVNRT, AVRT)
- AV nodal independent NCT
  (AT, Flutter, ST)

Methods of increasing AV node stimulation

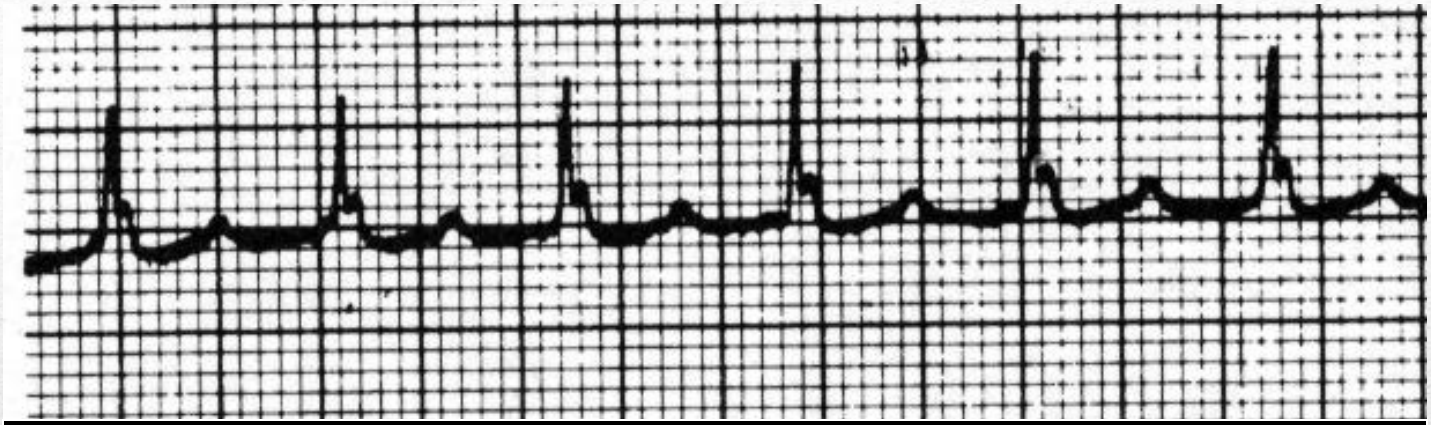
- Vagotonic Maneuvers
  - Carotid sinus massage
  - Valsalva maneuver (bearing down)
  - Facial ice pack ("diving reflex;" for kids)
- Adenosine (6-12 mg I.V.)
- If SVT "breaks," a reentrant mechanism involving the AV node is likely
- If atrial rate unchanged, but ventricular rate slows (#P's > #QRS's), SVT is atrial in origin

- SVT termination
  - AV nodal reentrant tachycardia
  - AV reentrant tachycardia
- No SVT termination (despite maximal attempts)
  - Sinus tachycardia
  - Atrial flutter or fibrillation
  - *Most* atrial tachycardias (a minority are “adenosine-sensitive”)

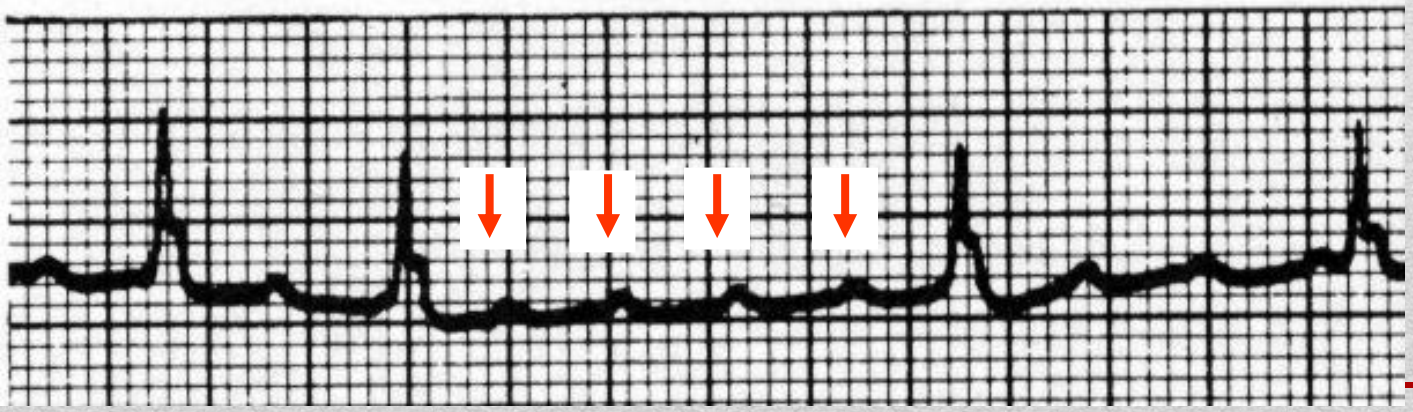
AVNRT / AVRT

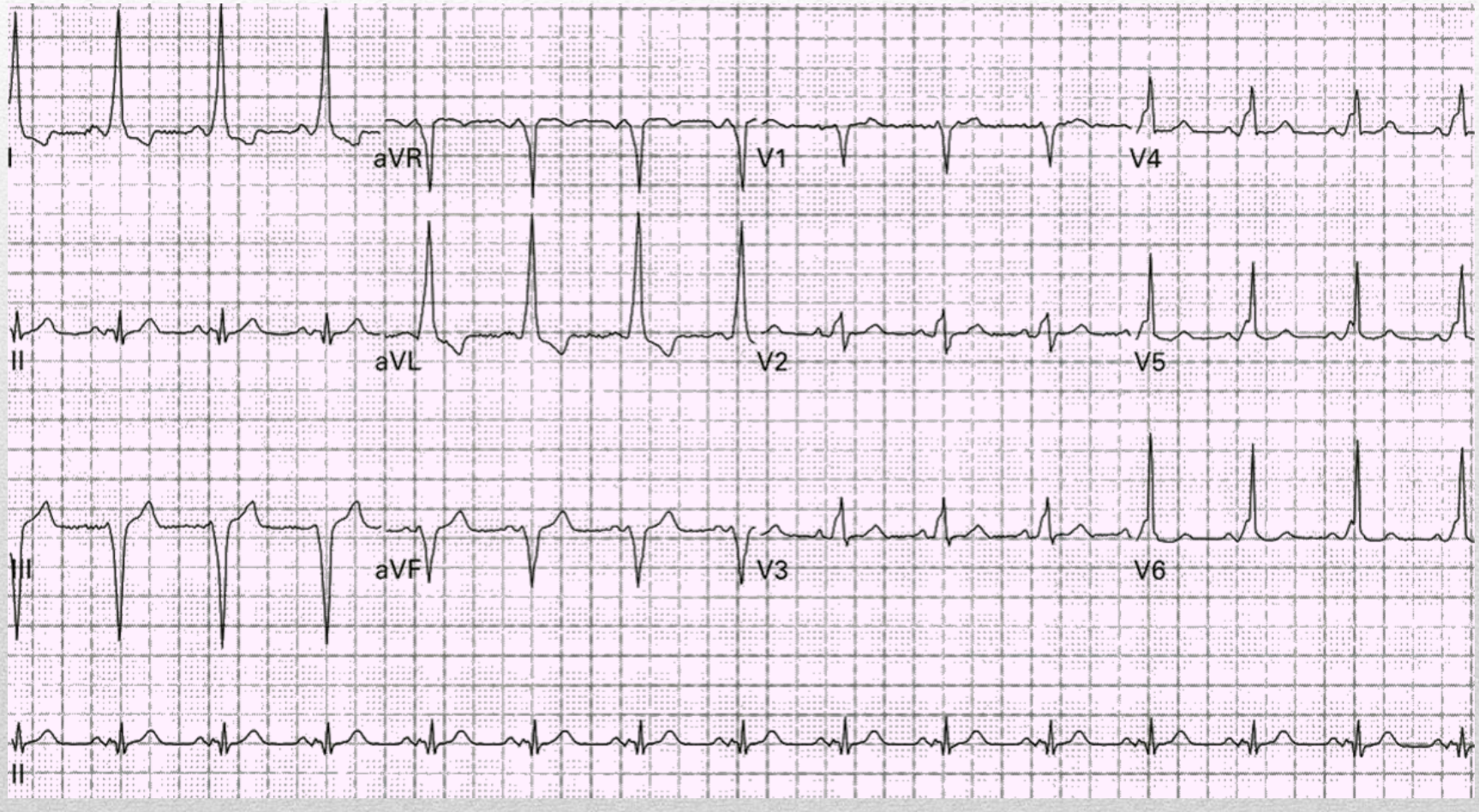


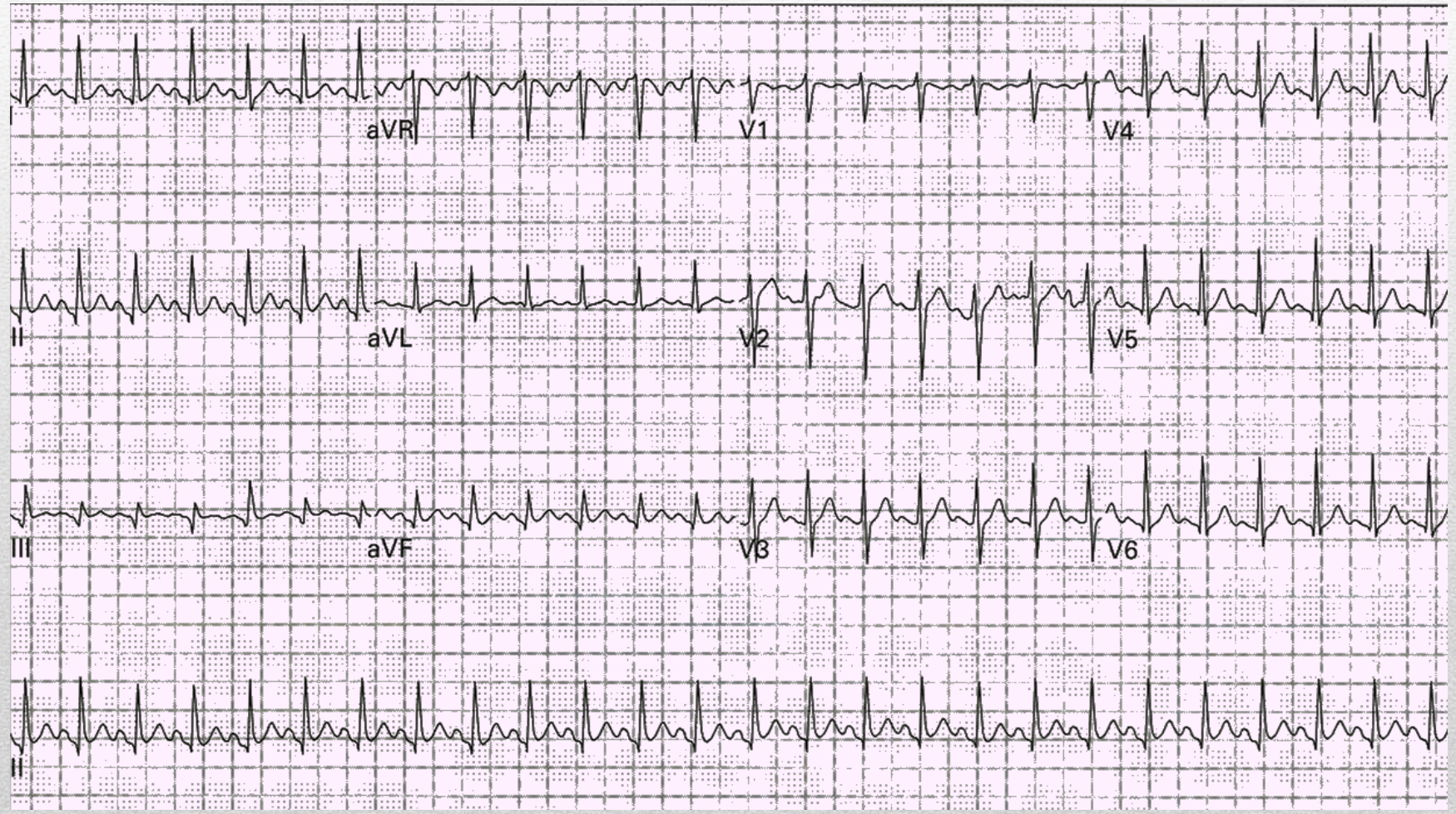
A. Flutter

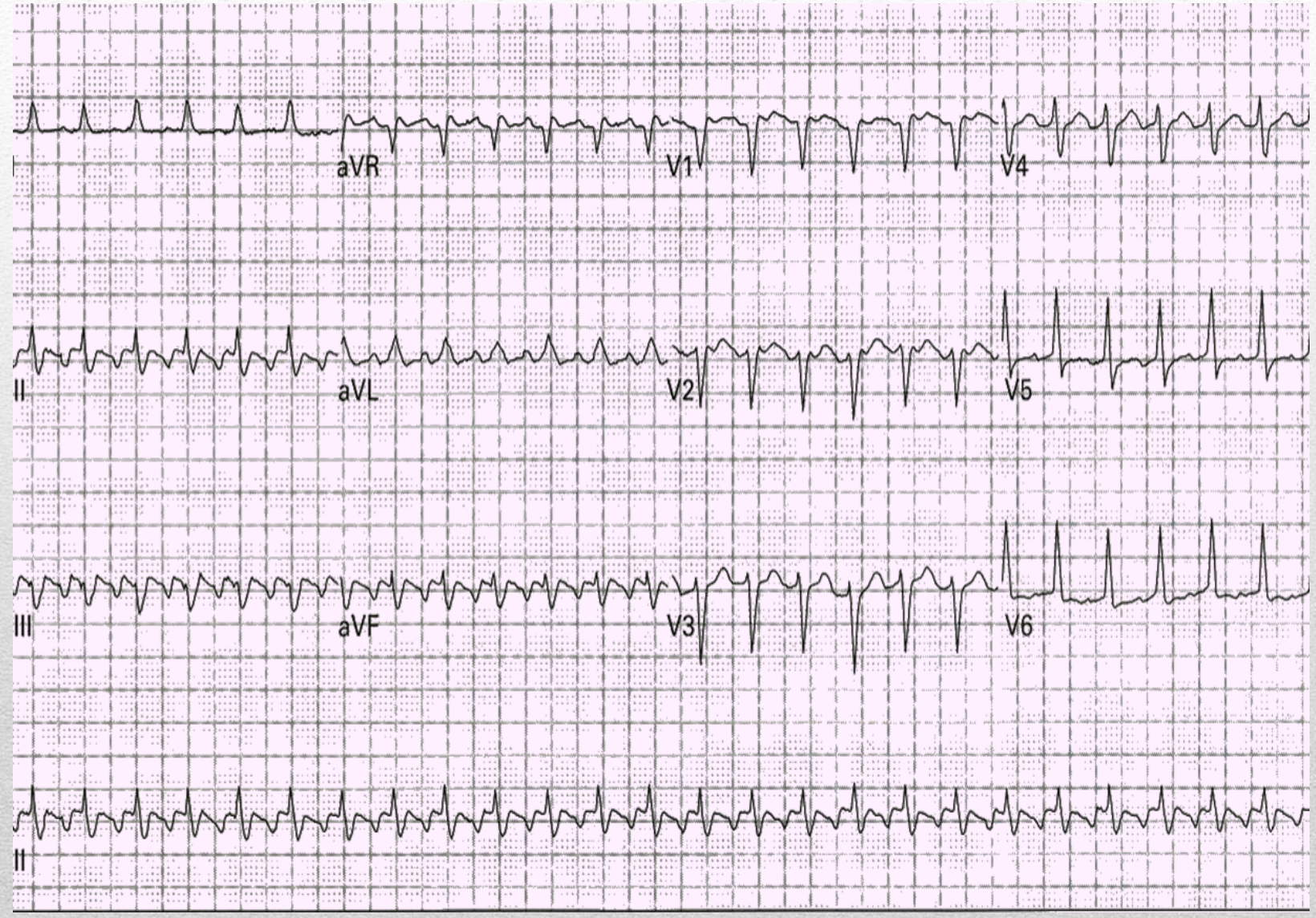


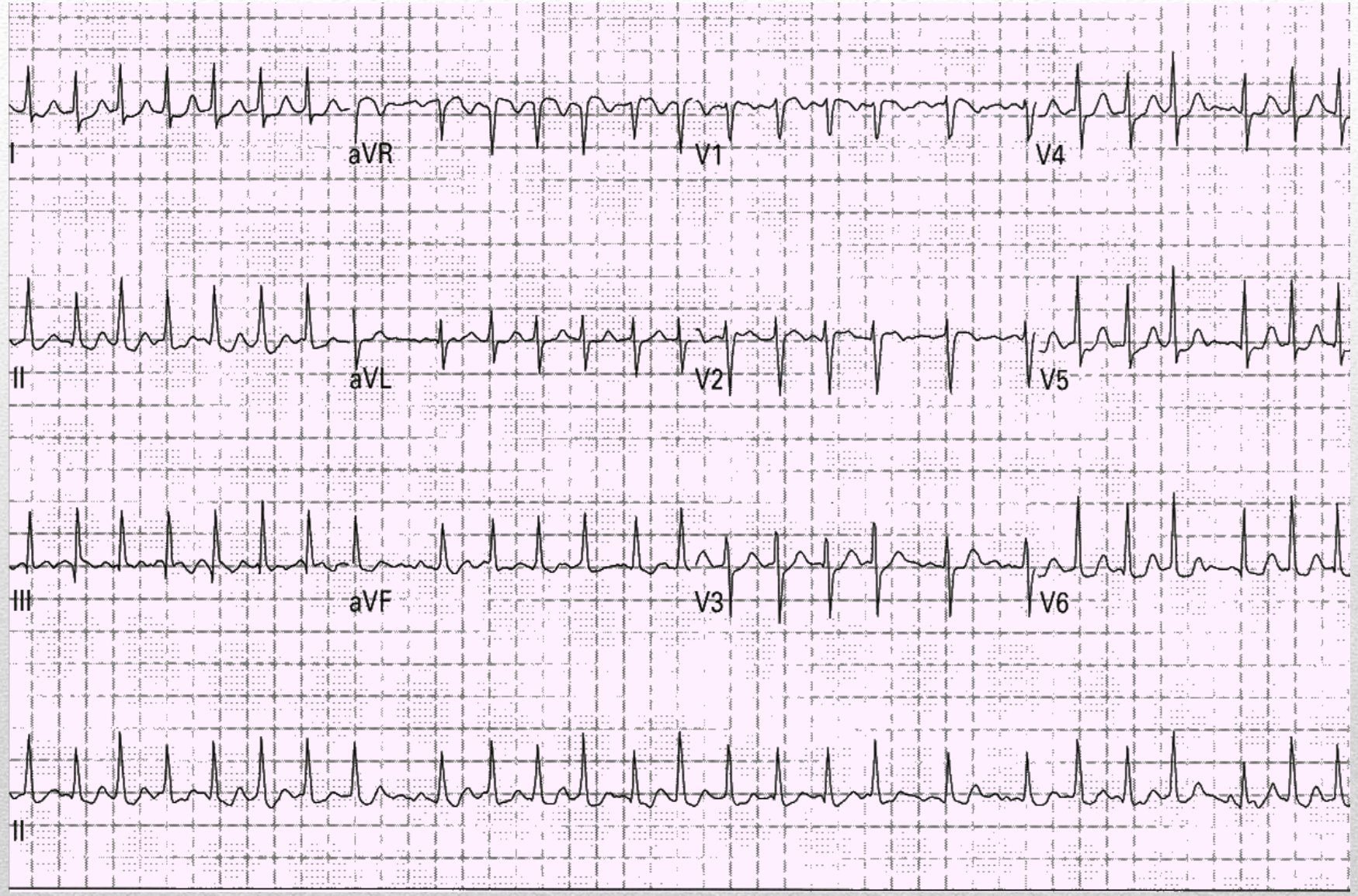
Carotid Sinus Massage




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


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

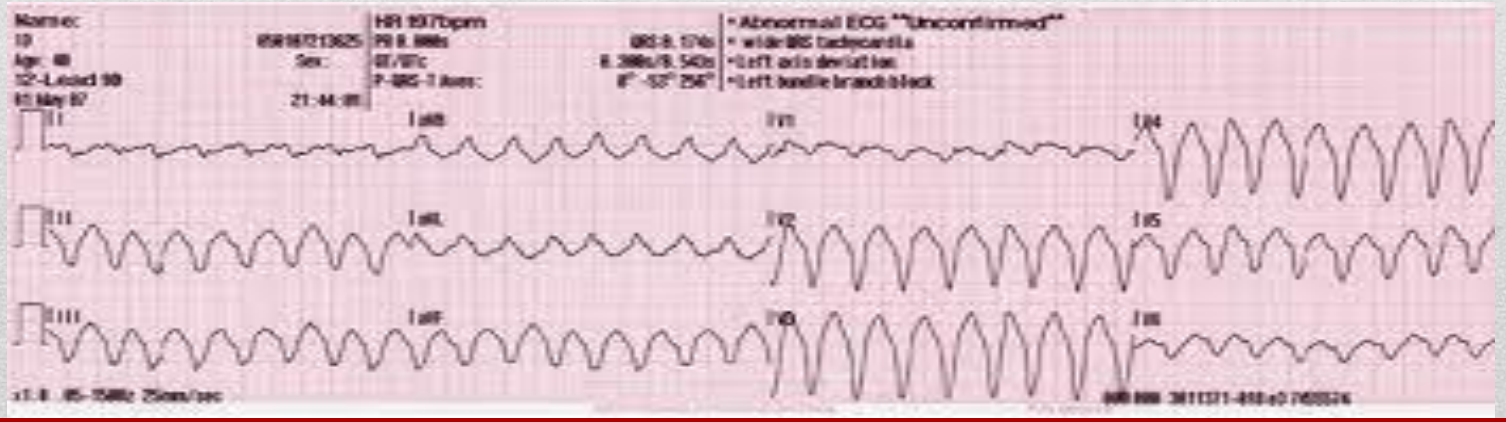

I
aVR
V1
V4
II
aVL
V2
V5
III
aVF
V3
V6
II


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


FunnyChill.com

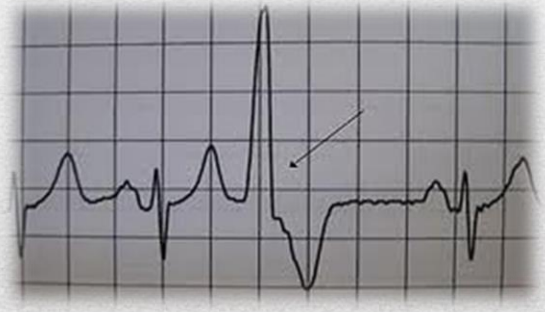
Ventricular Tachycardia

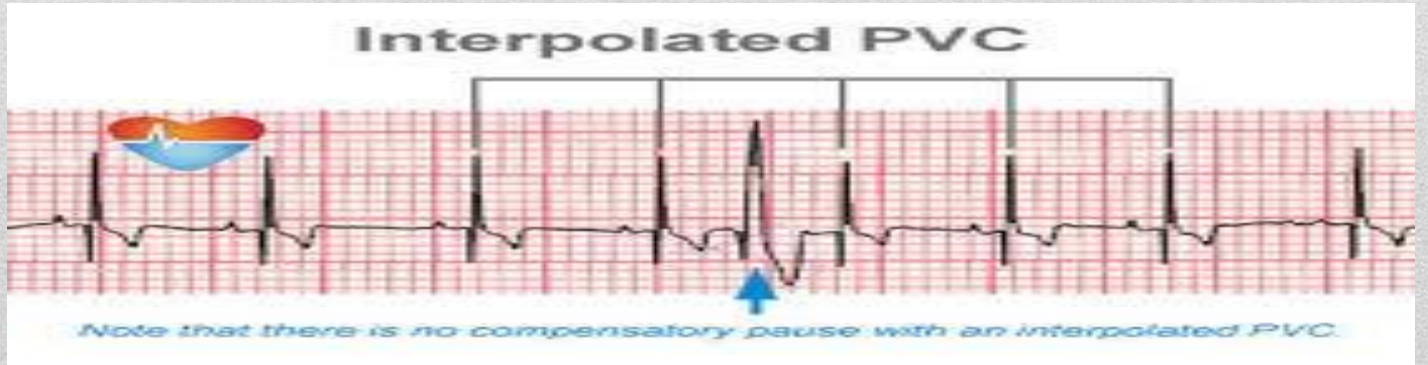
- Impulse is generated by the ventricle below bundle of His.
- **ECG findings:**
  1) Wide QRS complex with absent P wave.
  2) HR > 100 BPM **(REGULAR)**



Premature Ventricular Contractions

- The ventricles fire an early impulse which causes the heart to beat earlier causing irregularity in the heart rhythm.



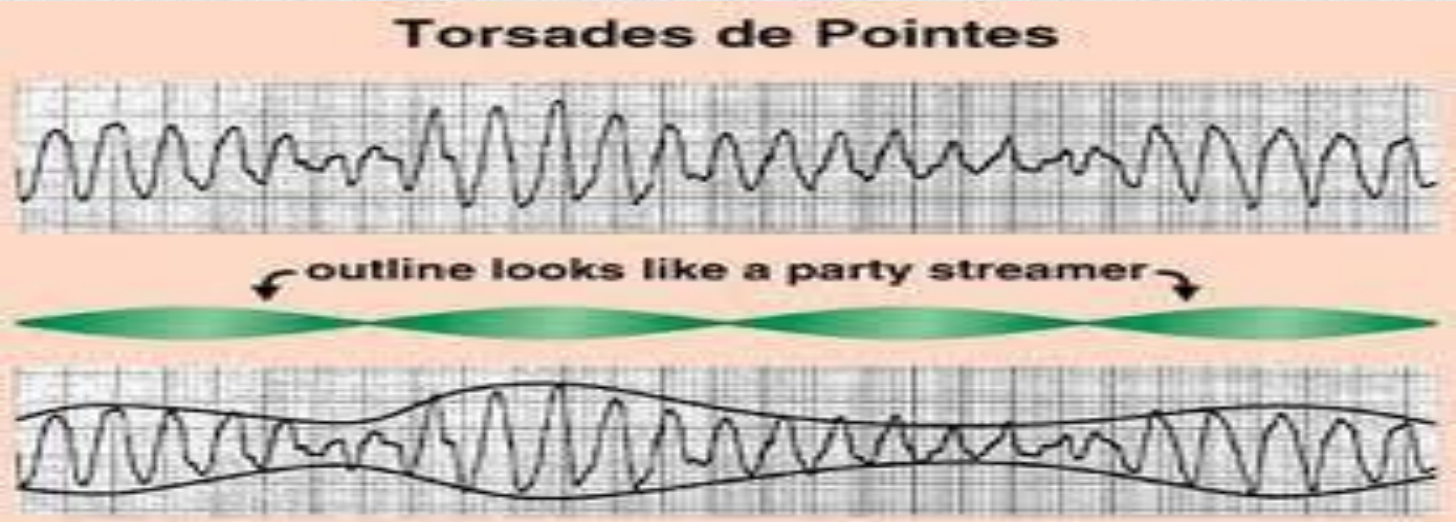


Torsade De point

- **ECG findings:**

  1) Polymorphic wide complex (ventricular) tachycardia.

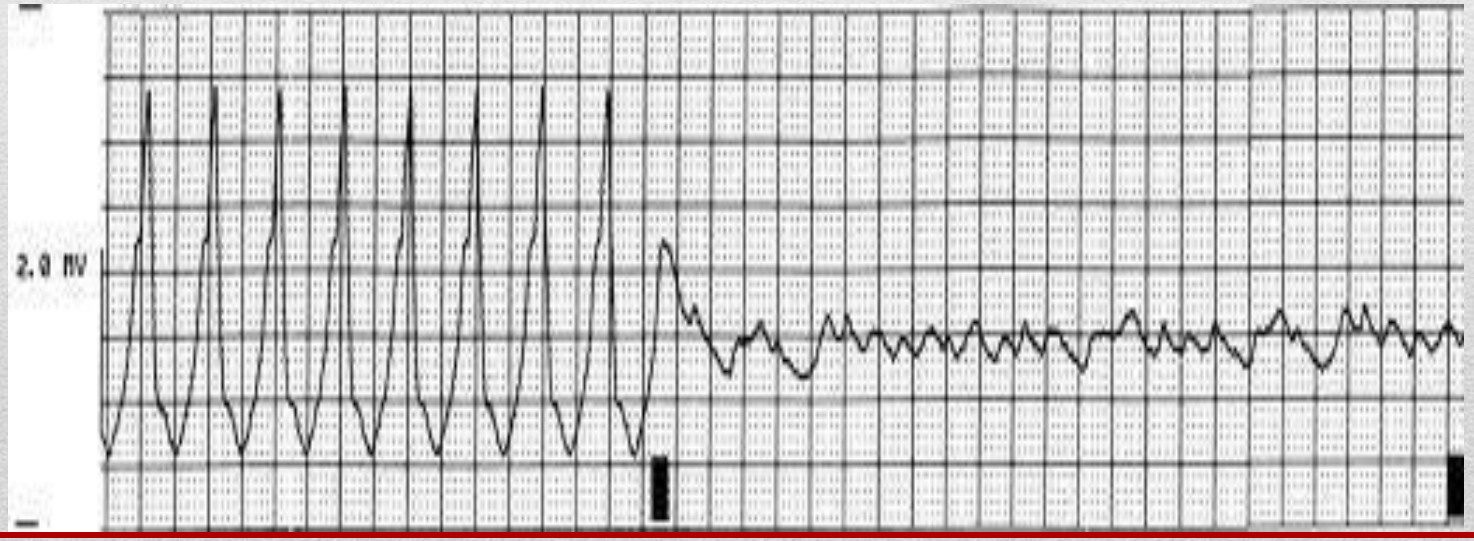
  2) Looks like if QRSs are twisted around the isoelectric line.

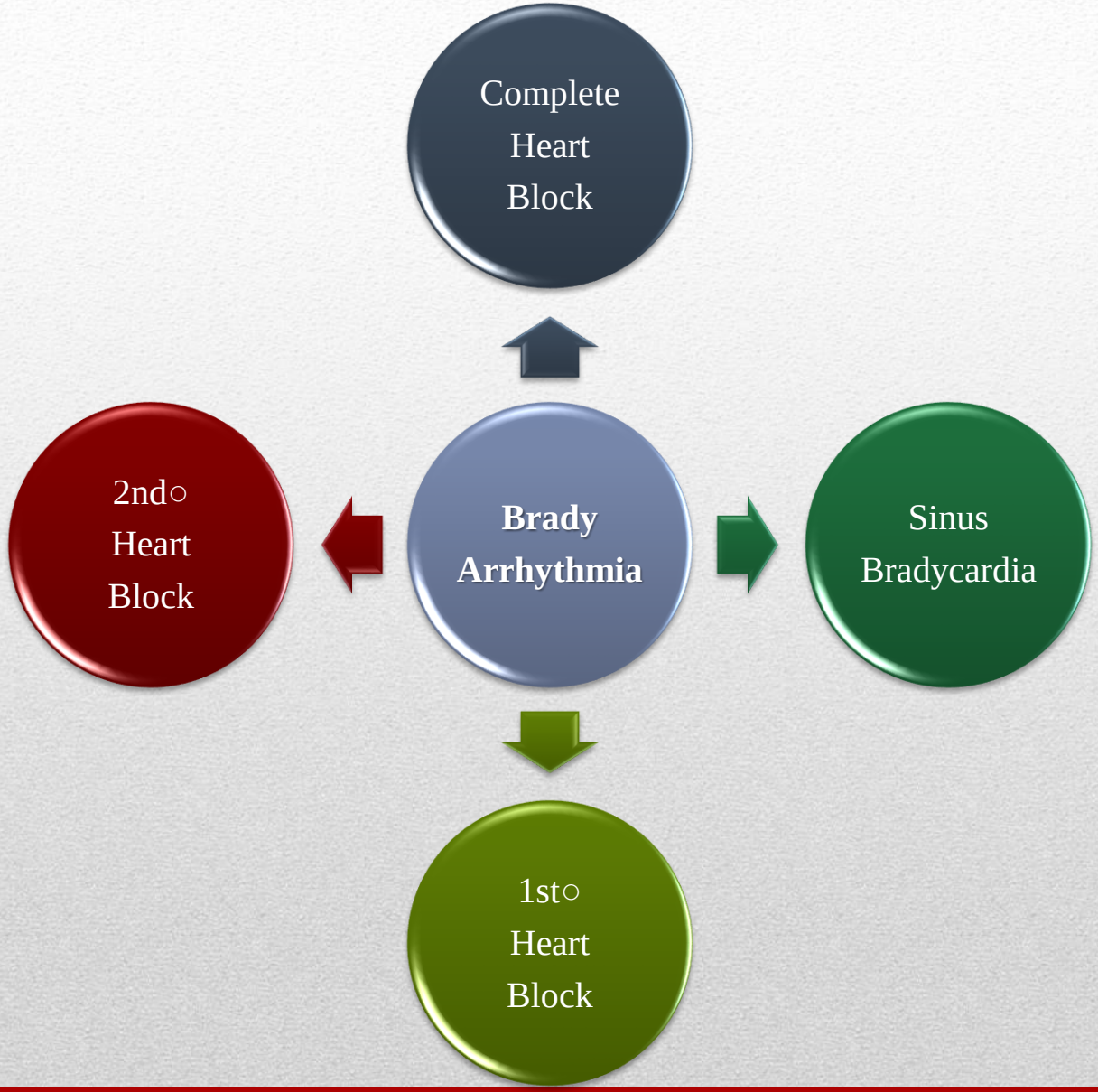


Ventricular Fibrillation

- **ECG findings:**

  Rapid, erratic electrical impulses.




Complete Heart Block
2nd○ Heart Block
Brady Arrhythmia
Sinus Bradycardia
1st○ Heart Block