ECG INTERPRETATION

I. Systematic Approach to ECG Interpretation

A. Stepwise approach

00:21

Stepwise Approach	Purpose of this Step	Clinical Correlation
Step 1	Rate	- Tachycardia or Bradycardia
Step 2	Rhythm	- Tachy / Bradyarrhythmias
Step 3	Axis	- Axis Deviation
Step 4	Intervals	- Heart Blocks or WPW
Step 5	P Wave	- Atrial Enlargement
Step 6	QRS Complex	- BBB and Ventricular Hypertrophy
Step 7	ST Segment & T Wave	- Myocardial Ischemia / Infarction

B. Approach to Heart Rate

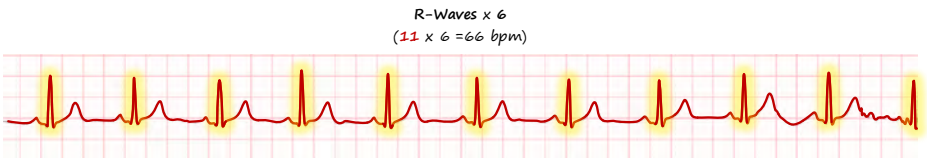
01:56

1. Methods Used to Determine Heart Rate

Heart Rate	Type of Rate
HR > 100 bpm	- Tachycardia
HR 60 - 100 bpm	- Normal
HR < 60 bpm	- Bradycardia

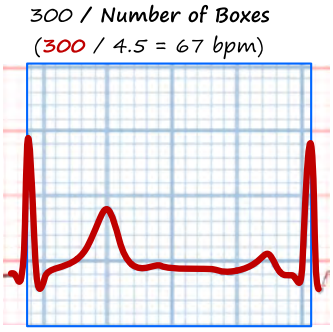
a) R-Wave Method

- **First:** Assess the number of R-waves in the rhythm strip
- **Second:** Take the number of R-waves and multiply by 6
- **Third:** # of R-waves x 6 = Heart rate



b) Box Method

- **First:** Assess the number of boxes between the R-R interval
  - 1 box distance = 300 bpm
- **Third:** 300/ Number of boxes between R-R interval = Heart rate



C. Approach to Rhythm

04:08

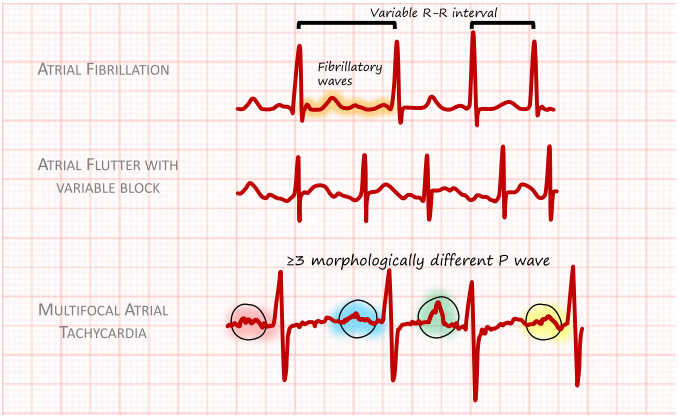
1. Approach to the Tachycardic Rhythm

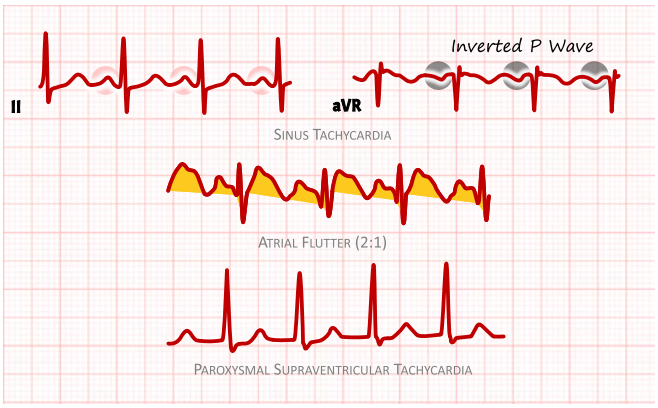
a) Obtain Characteristics of QRS Complex

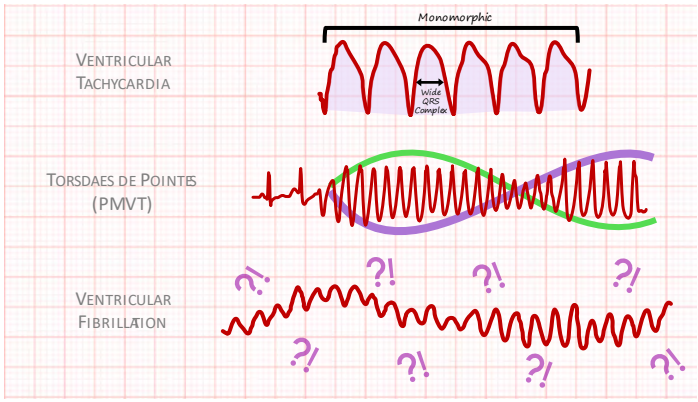
- **Narrow QRS →** < 120ms
- **Wide QRS →** > 120ms

b) Obtain Characteristics of RR Interval

- **Regular →** Same RR Interval throughout rhythm strip
- **Irregular →** Variable RR Interval throughout rhythm strip







QRS	RR Interval	Causes of Rhythm
Narrow	Regular	- Sinus Tachycardia - 2:1 Atrial Flutter - PSVT (AVRT or AVNRT)
Narrow	Irregular	-Atrial Fibrillation -Atrial Flutter with variable block -Multifocal Atrial Tachycardia (MAT)
Wide	Regular	-Monomorphic Ventricular Tachycardia
Wide	Irregular	-Polymorphic Ventricular Tachycardia (Tdp) -Ventricular Fibrillation

2. Approach to the Bradycardic Rhythm

09:34

a) Obtain Duration of PR Interval

- **Normal PR interval →** 160-200ms
- **Prolonged PR-Interval →** > 200ms

b) Obtain the Presence of QRS Complexes

- **Dropped QRS →** 2nd degree AV block and beyond

PR Interval	QRS	Causes of Rhythm
Normal	No drop in QRS	- Sinus Bradycardia
Prolonged		- 1st Degree AV Block
Progressively Prolonged	Drops QRS	- 2nd Degree AV Block (Mobitz I)
Constant		- 2nd Degree AV Block (Mobitz II)
AV Dissociation		- 3rd Degree AV Block

D. Approach to Axis

12:26

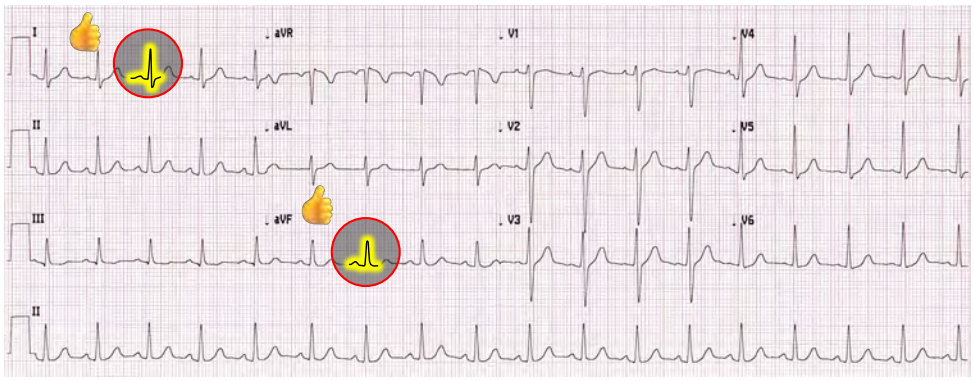
1. Method of Determining the Axis

a) Assess Lead I

- **If QRS is (+)** → (+) in Lead I
- **If QRS is (-)** → (-) in Lead I

b) Assess Lead aVF

- **If QRS is (+)** → (+) in Lead aVF
- **If QRS is (-)** → (-) in Lead aVF

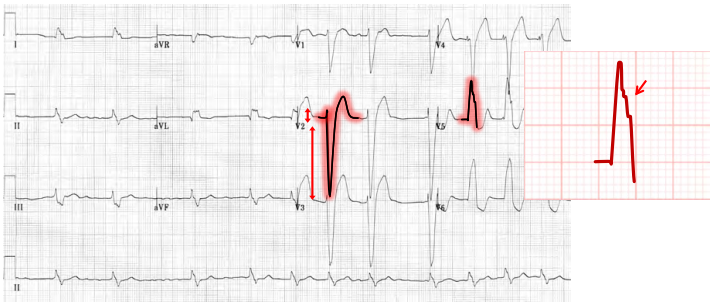


Normal Axis

2. Mechanism of Left Axis Deviation

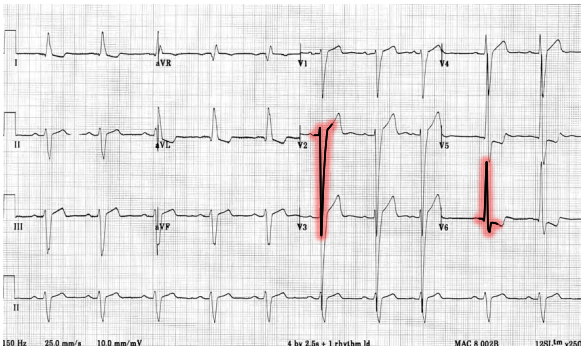
- **Delayed Depolarization of Left Ventricle** → Electrical activity from the Right bundle branches has to then move in the direction of the LV → This creates a vector pointing toward the left ventricle wall

Left Bundle Branch Block



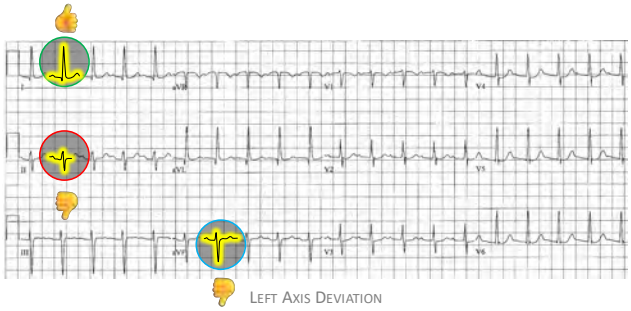
Left Bundle Branch Block (LBBB)

Left Ventricular Hypertrophy

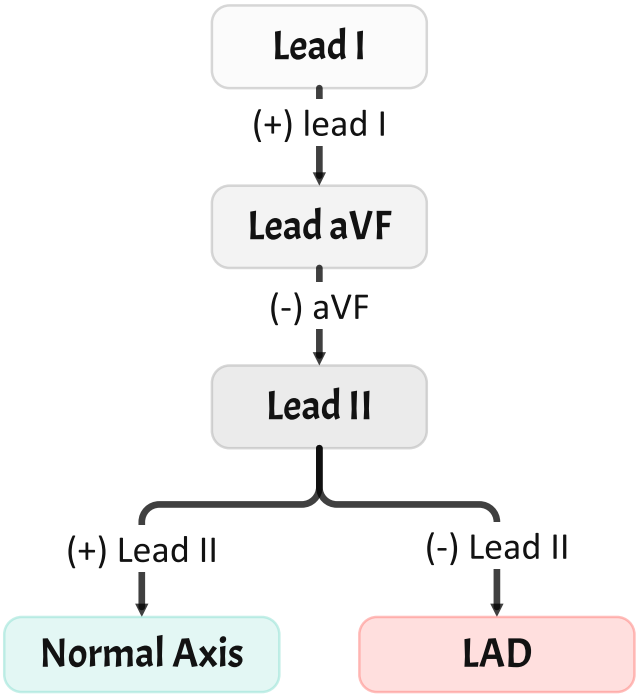


Left Ventricular Hypertrophy

Left Anterior Fascicular Block



Left Axis Deviation



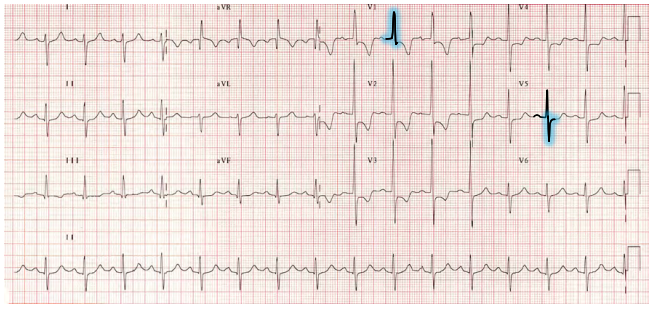
3. Mechanism of Right Axis Deviation

- **Delayed Depolarization of Right Ventricle** → Electrical activity from the Left bundle branches has to then move in the direction of the RV → This creates a vector pointing toward the right ventricle wall

Right Bundle Branch Block

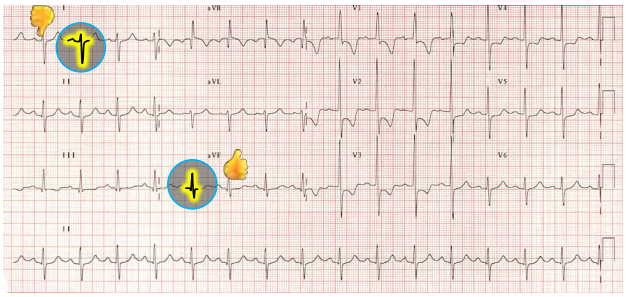
Right Bundle Branch Block (RBBB)

Right Ventricular Hypertrophy



Right Ventricular Hypertrophy

Left Posterior Fascicular Block

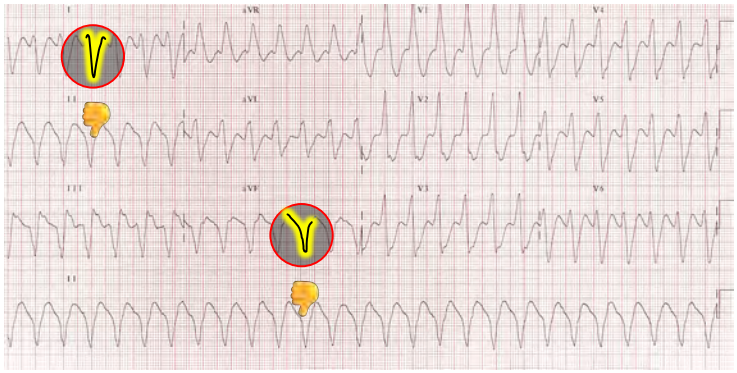


Right Axis Deviation

4. Mechanism of Extreme Right Axis Deviation

- **Depolarization of the ventricles first** → Electrical activity from the ventricles moves in the direction of the atria → This creates a vector pointing toward the right atrial/ventricular wall

Ventricular Tachycardia



Extreme Right Axis Deviation

Lead I	Lead aVF	Type of Axis	Cause of Axis Deviation
(+)	(+)	- Normal Axis	
(+)	(-)	- Left Axis Deviation	- LBBB - LVH - LAFB
(-)	(+)	- Right Axis Deviation	- RBBB - RVH - LPFB
(-)	(-)	-Extreme Right Axis Deviation	-VTach

E. Approach to Intervals

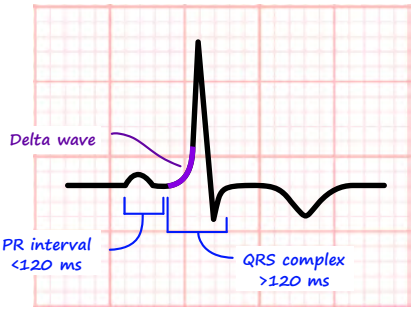
16:08

1. Obtain Duration of PR Interval

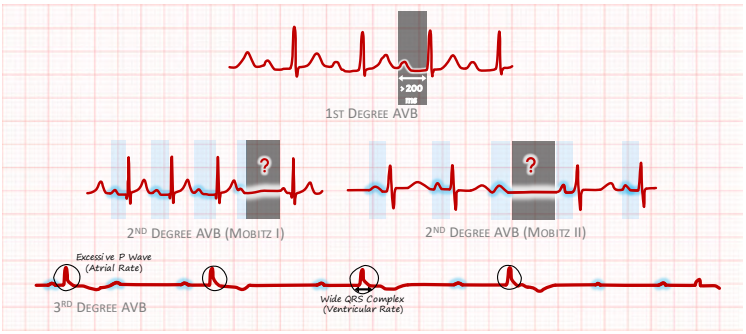
- **Normal PR interval →** 160-200ms
- **Short PR-Interval →** < 160ms
- **Prolonged PR-Interval →** > 200ms

Suspect WPW

- ↓PR interval
- Wide QRS
- Delta wave

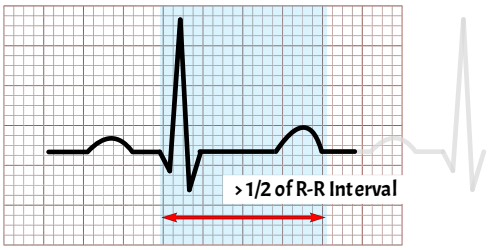


Suspect AV Blocks

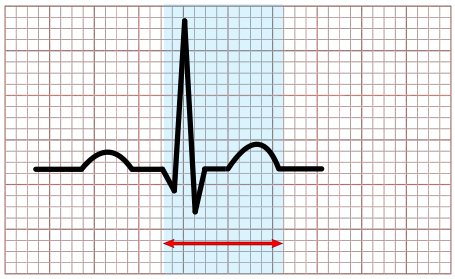


2. Obtain QT Interval

- **Normal QT-Interval →** 360-440ms for men and 360-460ms for women
- **Prolonged QT-Interval →** > 500ms
  - **High risk for Torsades de Pointes**
- **Short QT interval →** < 340ms



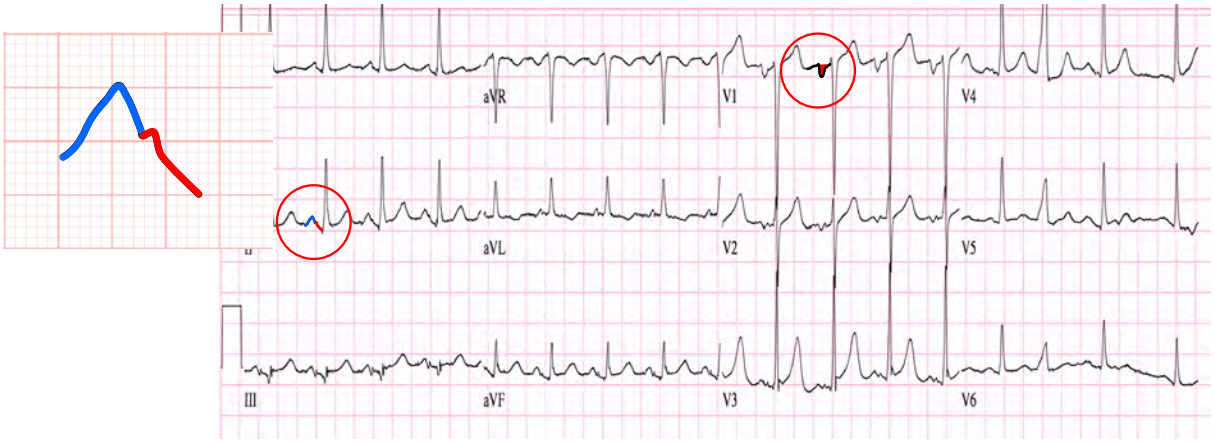
Long QT Interval



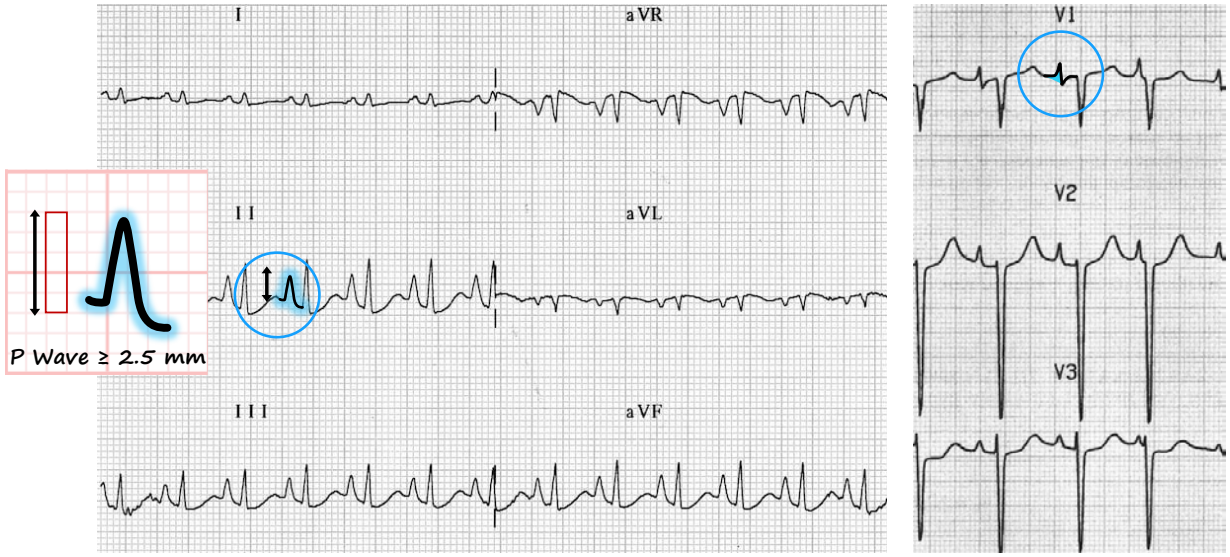
Short QT Interval

Intervals	Prolonged or Shortened	Causes of Abnormality
PR Interval	Prolonged	- AV Blocks
	Short	- WPW Syndrome
QT Interval	Prolonged	- Anti-Arrhythmics - Anti-Biotics - Anti-psyChotics - Anti-Depressants - Anti-Emetics - HypoK/HypoMg/HypoCa
	Short	- HyperCa/HyperK

Lead II	Lead V1	Type of Abnormality	Causes
Bifid P Wave	Biphasic P Wave with large terminal component	- Left Atrial Enlargement	- Left Heart Failure - Cardiomyopathy - Mitral Disease
P Wave ≥ 2.5 mm	Biphasic P Wave with large initial component	- Right Atrial Enlargement	- Pulmonary HTN - Tricuspid Disease

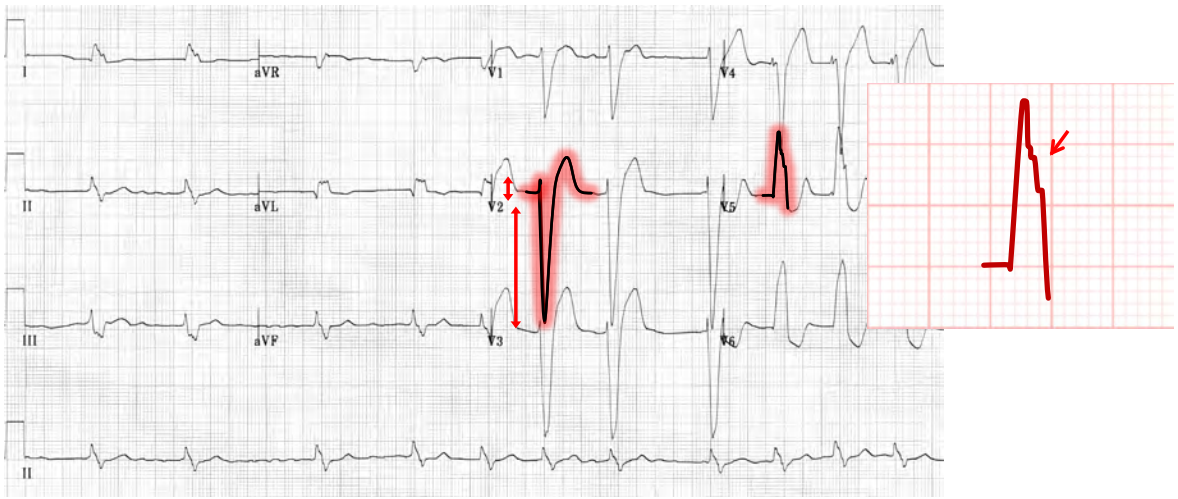


Left Atrial Enlargement



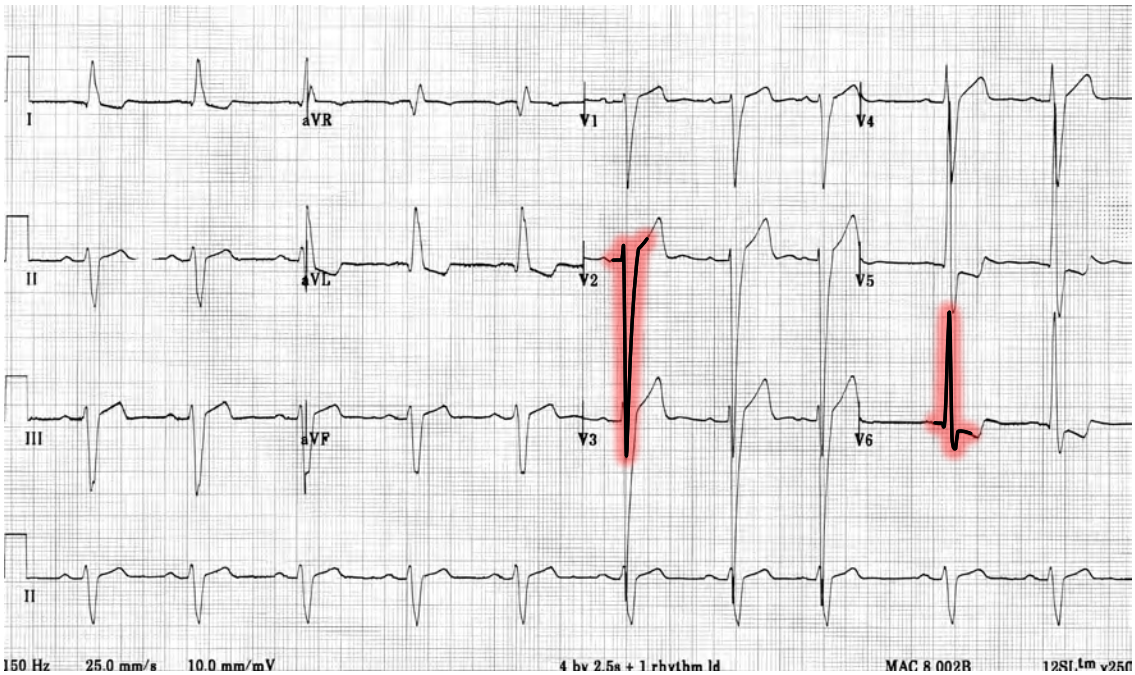
Right Atrial Enlargement

V1/V2	V5/V6	BBB or Hypertrophy	Cause of BBB or Hypertrophy
rS Wave	Notched R Wave	- LBBB	- Left Heart Failure - Myocardial infarction - LVH
rSR' Wave	Wide Slurred S Wave	- RBBB	- Pulmonary HTN - Myocardial Infarction
Deep S Wave	Tall R Wave	- LVH	- Aortic Stenosis - Hypertension
Tall R Wave	Deep S Wave	- RVH	- Pulmonary HTN

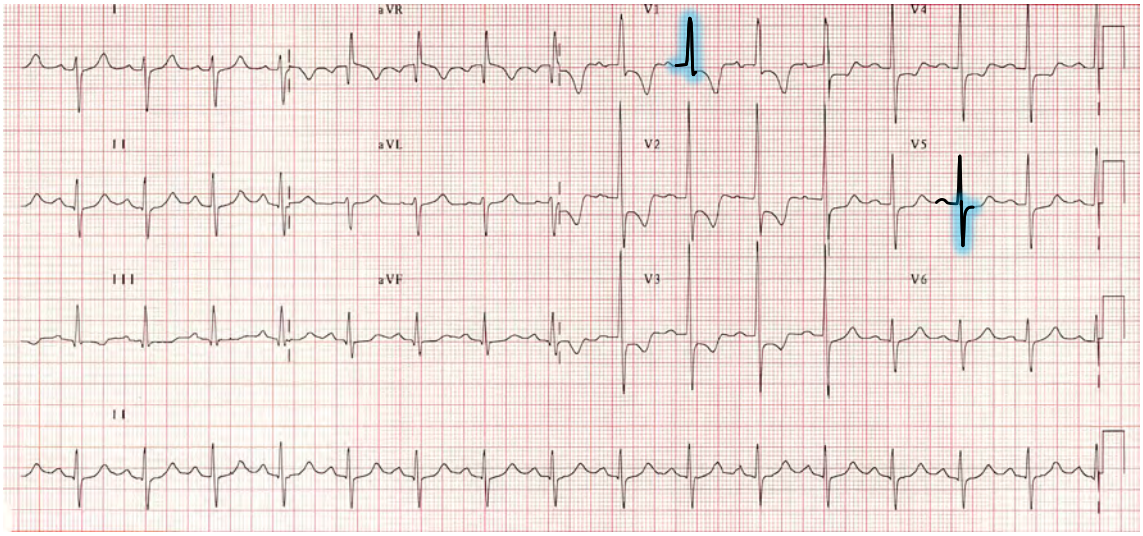


Left Bundle Branch Block (LBBB)

Right Bundle Branch Block (RBBB)



LEFT VENTRICULAR HYPERTROPHY

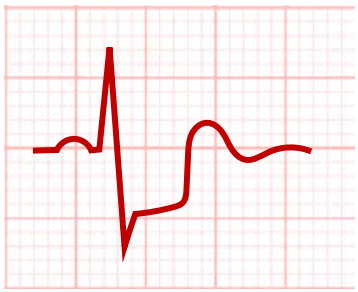


RIGHT VENTRICULAR HYPERTROPHY

ST Segment	T Waves	Cause of ST-T Changes
ST Depression	T Wave Inversion	- NSTE-ACS - Digoxin toxicity - Hypokalemia
ST Elevation	Hyperacute T Waves	- STEMI - Pericarditis - Hyperkalemia

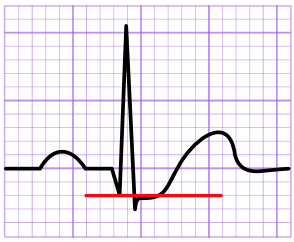
1. Approach to ST Segment

- **ST Depression →** > 0.5mm (½ a small box) below the J-point in 2 contiguous leads

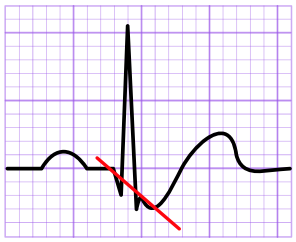


> 0.5 mm in V2/V3
> 1 mm in all other leads

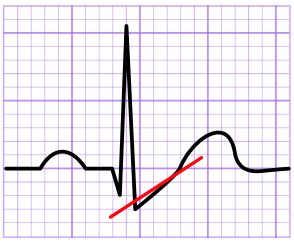
Horizontal



Down-Sloping

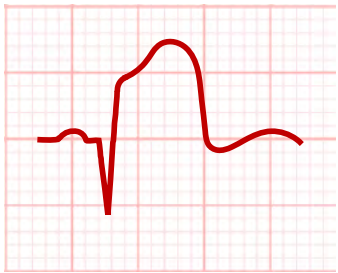


Up-Sloping



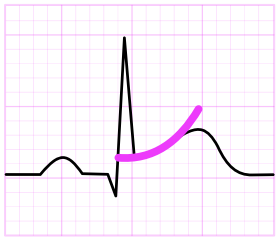
If in 2 contiguous leads, more likely to indicate Cardiac Ischemia

- **ST Elevation →** > 1mm (1 small box) elevation above the J-point in 2 contiguous leads except for V2-V3, where it needs to be > 2mm (2 small boxes) elevation above the J-point
  - o **Concave ST elevation →** Suggests Pericarditis
  - o **Convex ST elevation →** Suggests STEMI

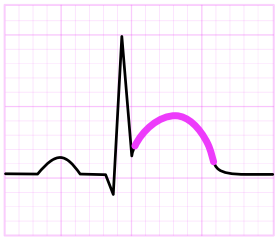


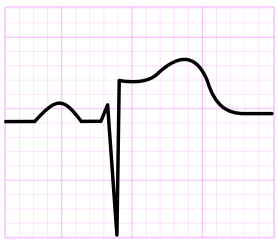
> 1 mm in Limb Leads
> 2 mm in Precordial Leads

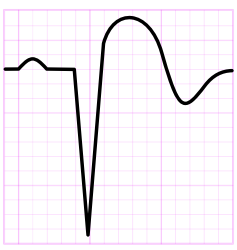
Concave



Convex

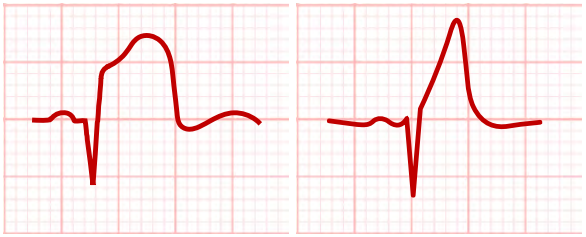






2. Approach to T-Waves

- **T-wave Inversion →** > 1mm (1 small box) depression below the isoelectric line in 2 contiguous leads
- **Hyperacute T-Waves →** > ⅔ the height of the QRS complex and a broad base



> 1 mm in Limb Leads

> 2 mm in Precordial Leads