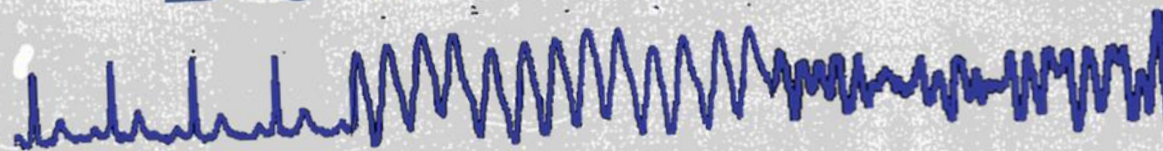




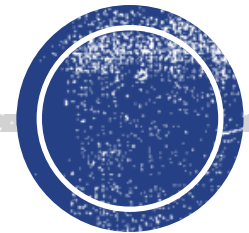
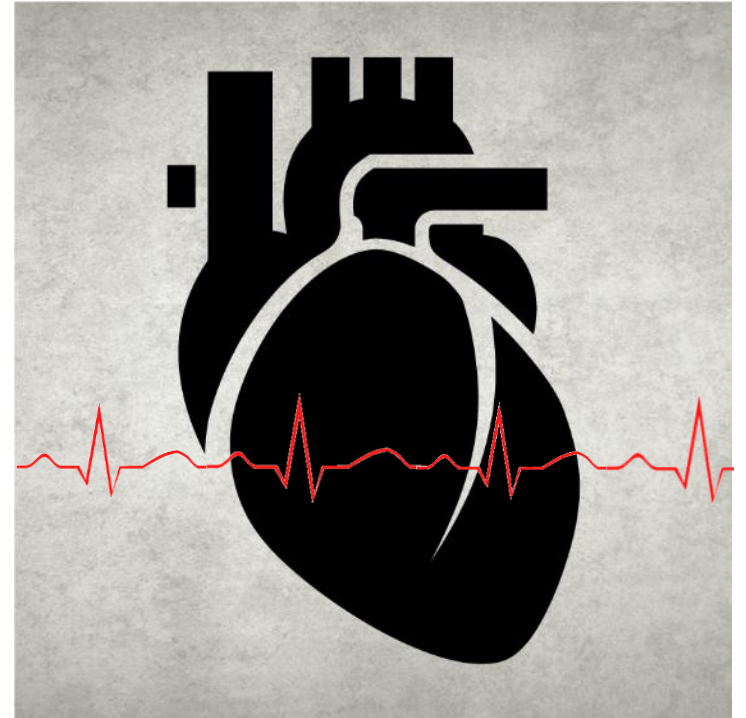
EMERGENCY MEDICINE

BOOT CAMP

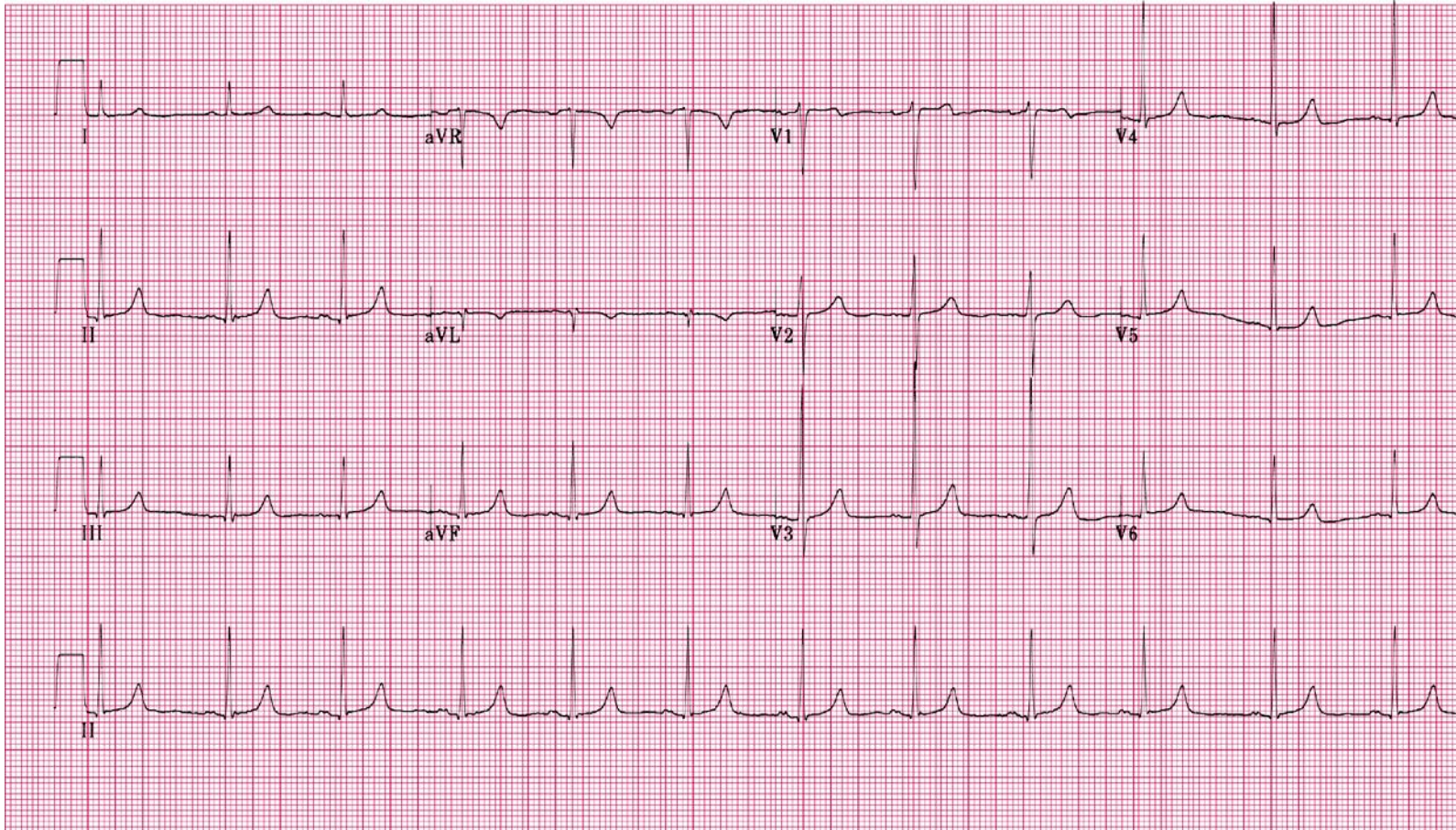


INTRODUCTION TO EKG

José A. Rubero, MD, FACEP, FAAEM
Professor in Emergency Medicine



THE NORMAL 12-LEAD



No abnormalities



1st degree AV block (1dAVb)



Right bundle branch block (RBBB)



Left bundle branch block (LBBB)



Sinus bradycardia (SB)



Atrial fibrillation (AF)

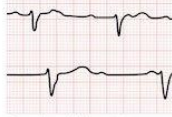
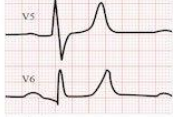
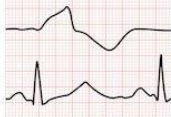
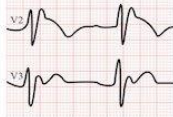
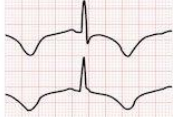
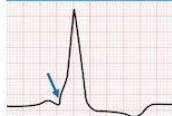
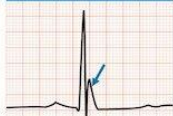
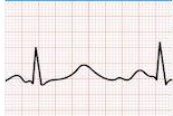


Sinus tachycardia (ST)



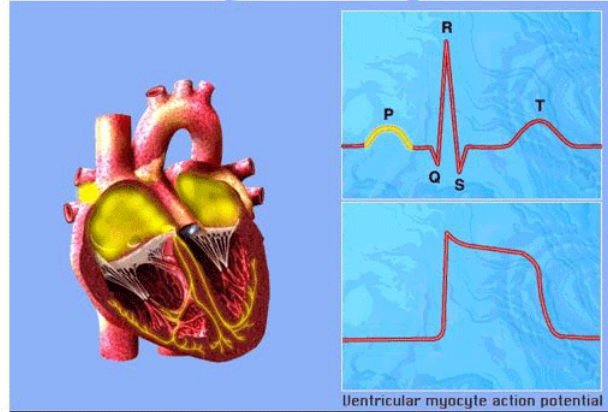
Can't Miss ECG Findings

Christian Rose, MD; Robert Goodnough, MD

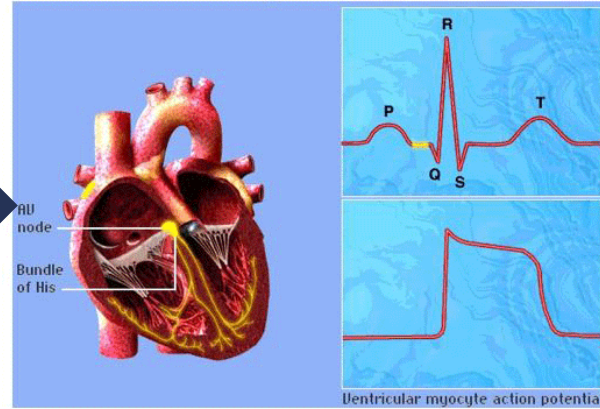
P Third Degree AV Block  Complete AV dissociation Common causes • Ischemia • Electrolyte abnormality • Toxins	QRS/QTc Pericardial Effusion  Low voltage ECG criteria • Precordial QRS: <10 mm • Limb QRS: <5 mm Electrical alternans • Alternating tall-short QRS Complication • Pericardial tamponade	ST ST Elevation MI  ACCF/AHA 2013 definition: STE in 2 contiguous leads STE height in lead V2 or V3 • Men ≥ 2 mm • Women ≥ 1.5 mm STE height in all other leads • Everyone ≥ 1 mm	T Peaked T Wave  High risk causes • Ischemia (early sign) • Hyperkalemia (does not predict K value) Other hyperkalemia findings • PR/QRS interval prolongation • AV block
Mobitz II  ECG criteria • Dropped QRS without progressive PR prolongation Complication • High grade AV block	Wide Interval  ECG criteria • QRS width ≥ 120 msec Common causes • Hyperkalemia (assume until proven otherwise) • Ischemia • Conduction disease • Medication and toxins	Brugada Sign  Type 1: Coved STE >2 mm in ≥ 1 lead of V1-V3, followed by negative T wave • This ECG finding + clinical criteria needed to diagnose Brugada syndrome, which is high risk for sudden death Type 2: Saddleback shaped STE >2 mm; less specific	Inverted T Wave  Normal in leads aVR and V1 Causes for precordial inverted Ts • Acute ischemia • Cardiomyopathy (CMP) • Conduction disease • RV strain (e.g. PE, ARVD) • CNS catastrophe
Mobitz I  ECG criteria • Dropped QRS with progressive PR prolongation Less risk than Mobitz II	HCM Hypertrophic cardiomyopathy  ECG criteria • Left ventricular hypertrophy • Narrow "dagger" Q waves in lateral / inferior leads • Deep T wave inversions High risk for syncope, atrial fibrillation (CVA risk), progressive heart failure, VT / VF arrest	ST Depression  If in anterior leads: • Consider posterior MI If in lateral leads: • Likely LVH with strain, if with high QRS voltage Consider ACS if ST depression in any lead with chest pain or shortness of breath	ARVD Arrhythmogenic RV dysplasia  ECG criteria • Variable • May see epsilon wave, a small positive deflection at QRS end (arrow) High risk for syncope, arrhythmia, heart failure, sudden cardiac death
WPW Wolff-Parkinson-White  ECG criteria • Short PR <120 msec • Delta wave (arrow) • Wide QRS ≥ 120 msec • Secondary ST repolarization High risk for arrhythmia and mimicking/masking ischemia	Q Wave  ECG criteria for pathologic Qs • Q wave in any V1-V3 lead • Any other lead when width ≥ 30 msec or depth ≥ 1 mm Common causes • Acute MI • Cardiomyopathy • WPW	J Wave Osborn Wave  ECG criteria • Positive deflection at J point most often seen in precordial leads May be seen in hypothermia Associated with higher risk for arrhythmia (bradycardia, VF) and STEMI	QTc Prolongation  High risk ECG criteria • QTc >500 msec Normal QTc interval • Men <440 msec • Women <460 msec Common causes • Electrolyte abnormality • Medication and toxins • Familial



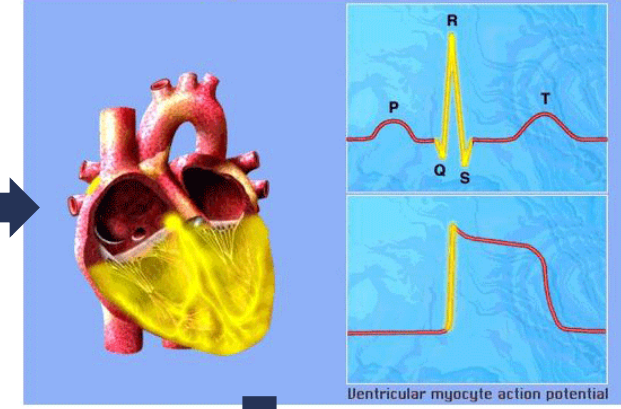
EKG Tracing-Atrial Depolarization



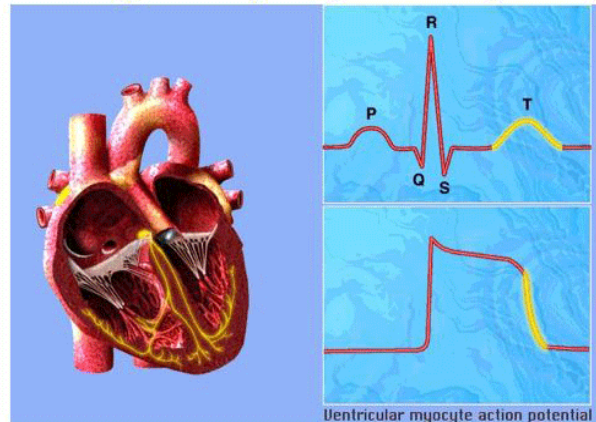
EKG Tracing-Delay at AV Node



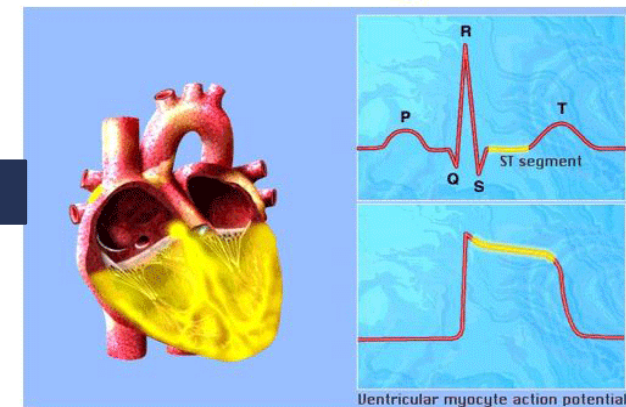
EKG Tracing-Ventricular Depolarization



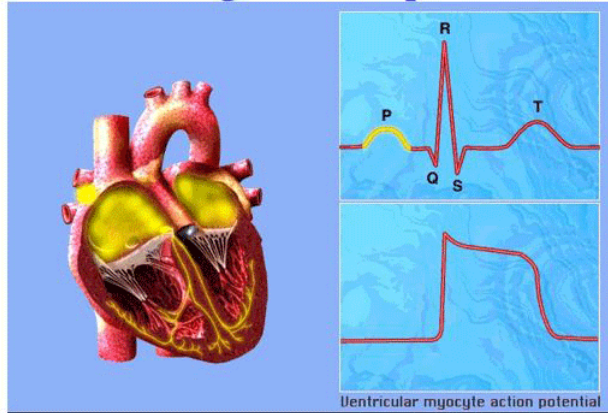
EKG Tracing-Final Rapid Repolarization (Phase 3)



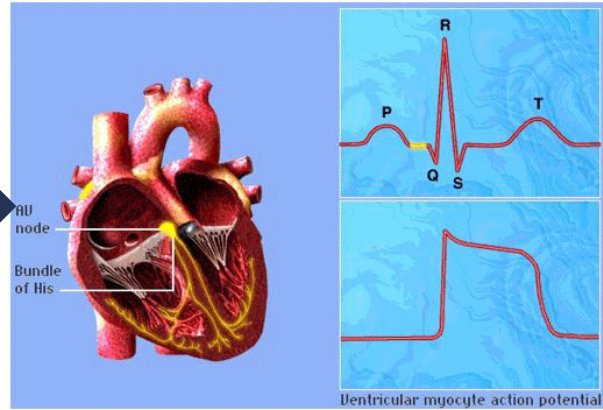
Plateau Phase of Repolarization



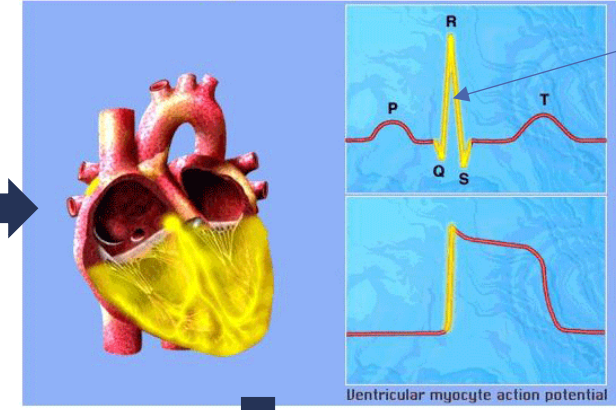
EKG Tracing-Atrial Depolarization



EKG Tracing-Delay at AV Node

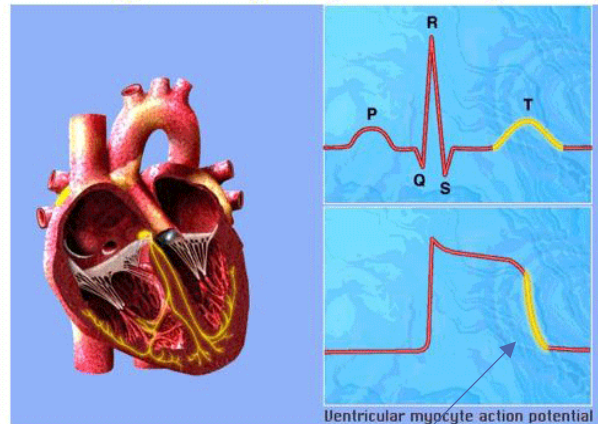


EKG Tracing-Ventricular Depolarization



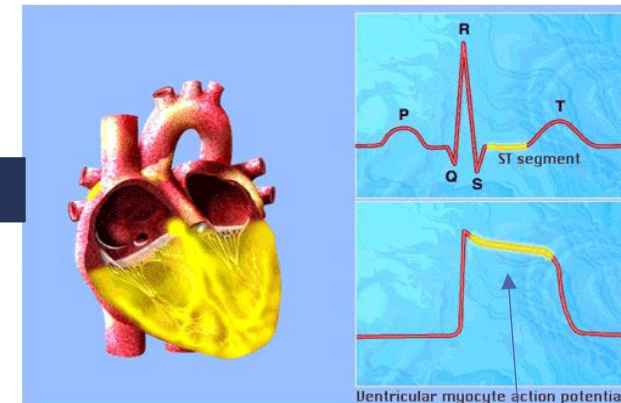
Na,
TCA

EKG Tracing-Final Rapid Repolarization (Phase 3)



K Disturbance

Plateau Phase of Repolarization



Ca Disturbance,
Digoxin

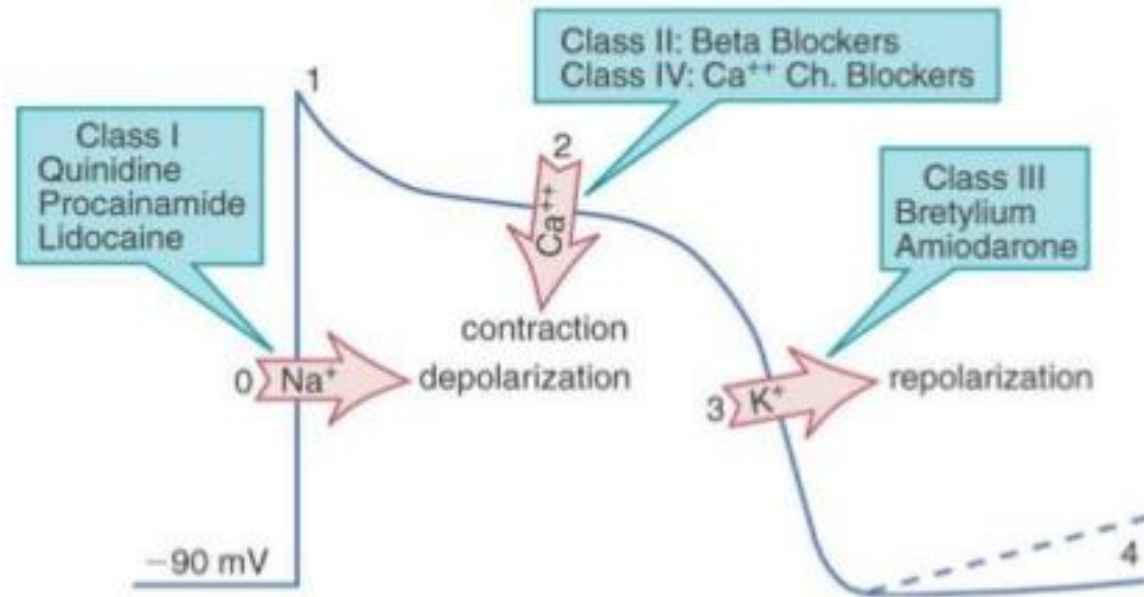


Physiology of the Nerve Impulse

Action potential

- All or none response

A Myocardium and His-Purkinje System



Adrian Kyle M. Jacinto, RPh (Confidential File)

ANTIARRHYTHMICS

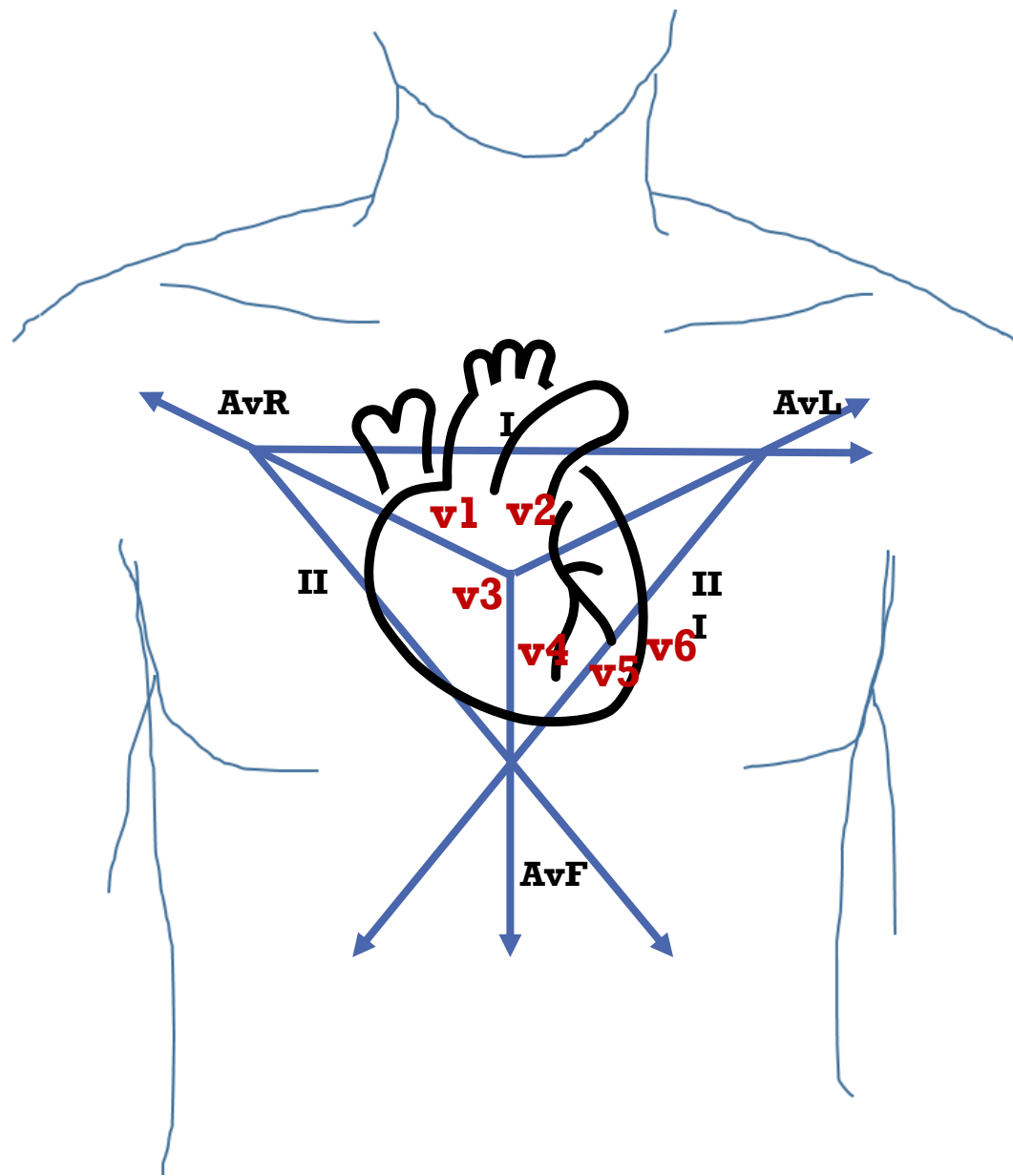
- Mnemonic for Class I-IV agents: SoBe PoCa (SOBE as in South Beach or the drink, POCA as in Polka)
- Also - remembering that of all anti-arrhythmics "some block potassium channels" can help you:
- Class I "Some" = S = Sodium
- Class II "Block" = B = Beta blockers
- Class III "Potassium" = Potassium channel blockers
- Class IV "Channels" = C = Calcium channel blockers

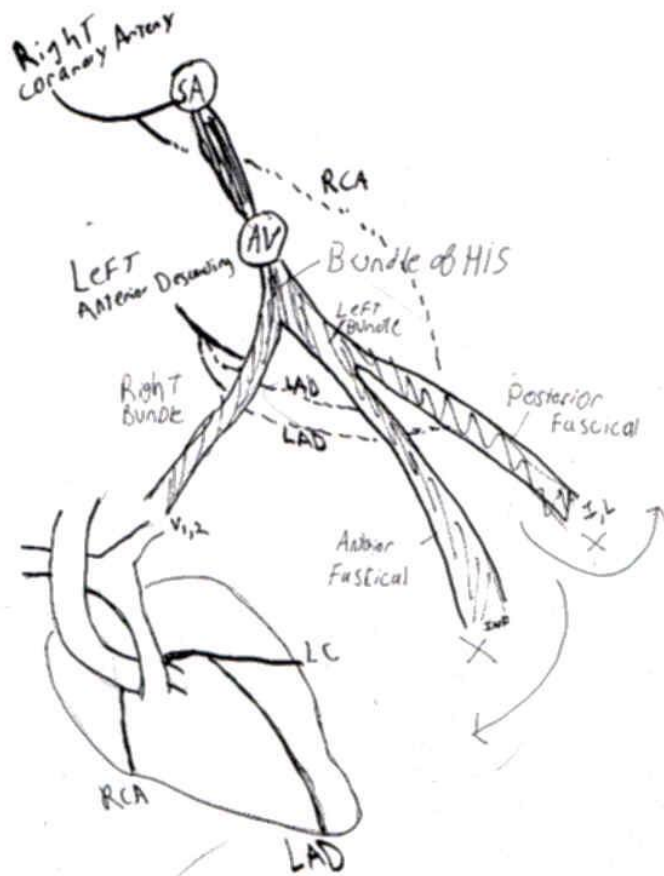


EKG INTERPRETATION

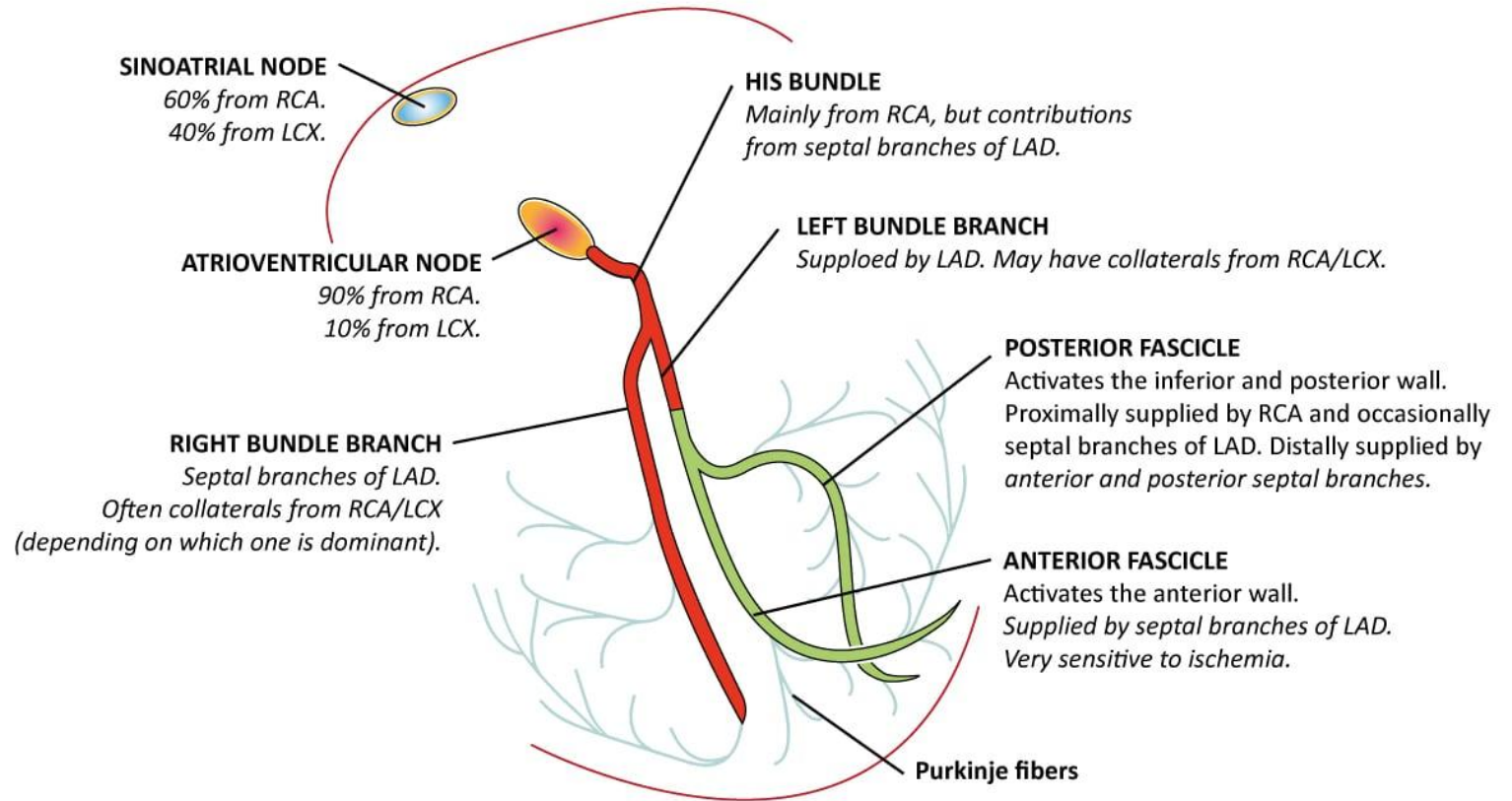
- Rhythm?
- Rate?
- Axis?
- PR?
- QRS?
- QTc?
- Δ 's?



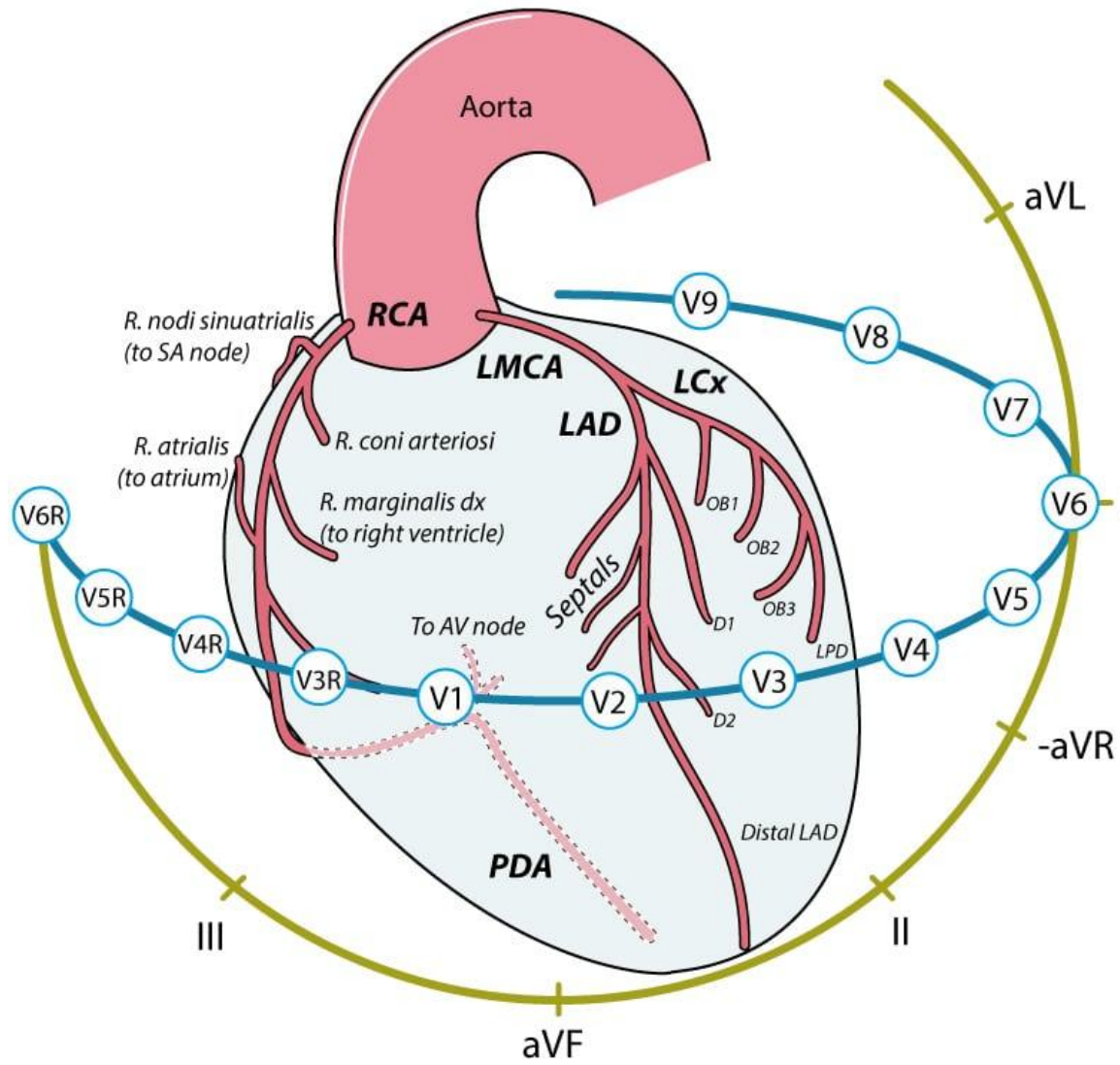




The components of the conduction system and their vascular supply

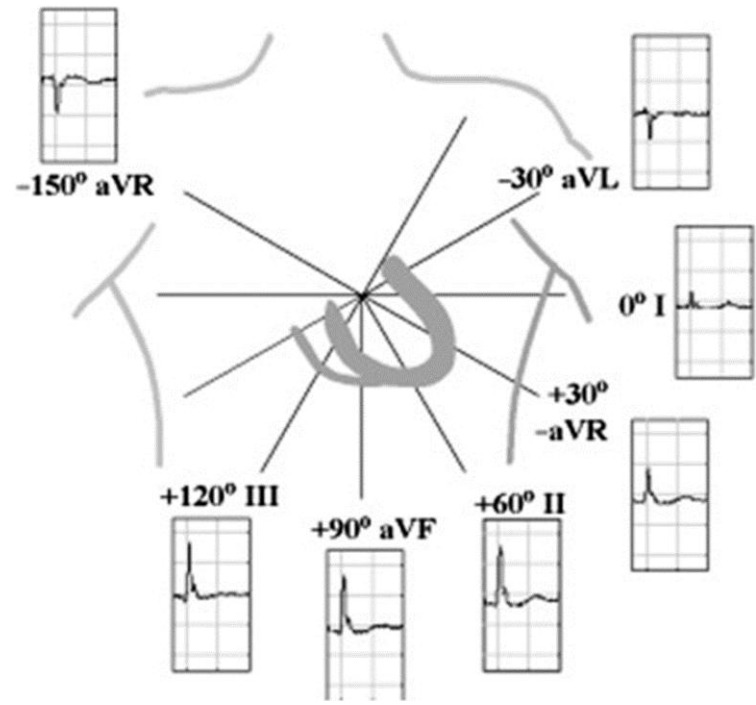


Schematic overview of the coronary arteries and their relation to the ECG leads

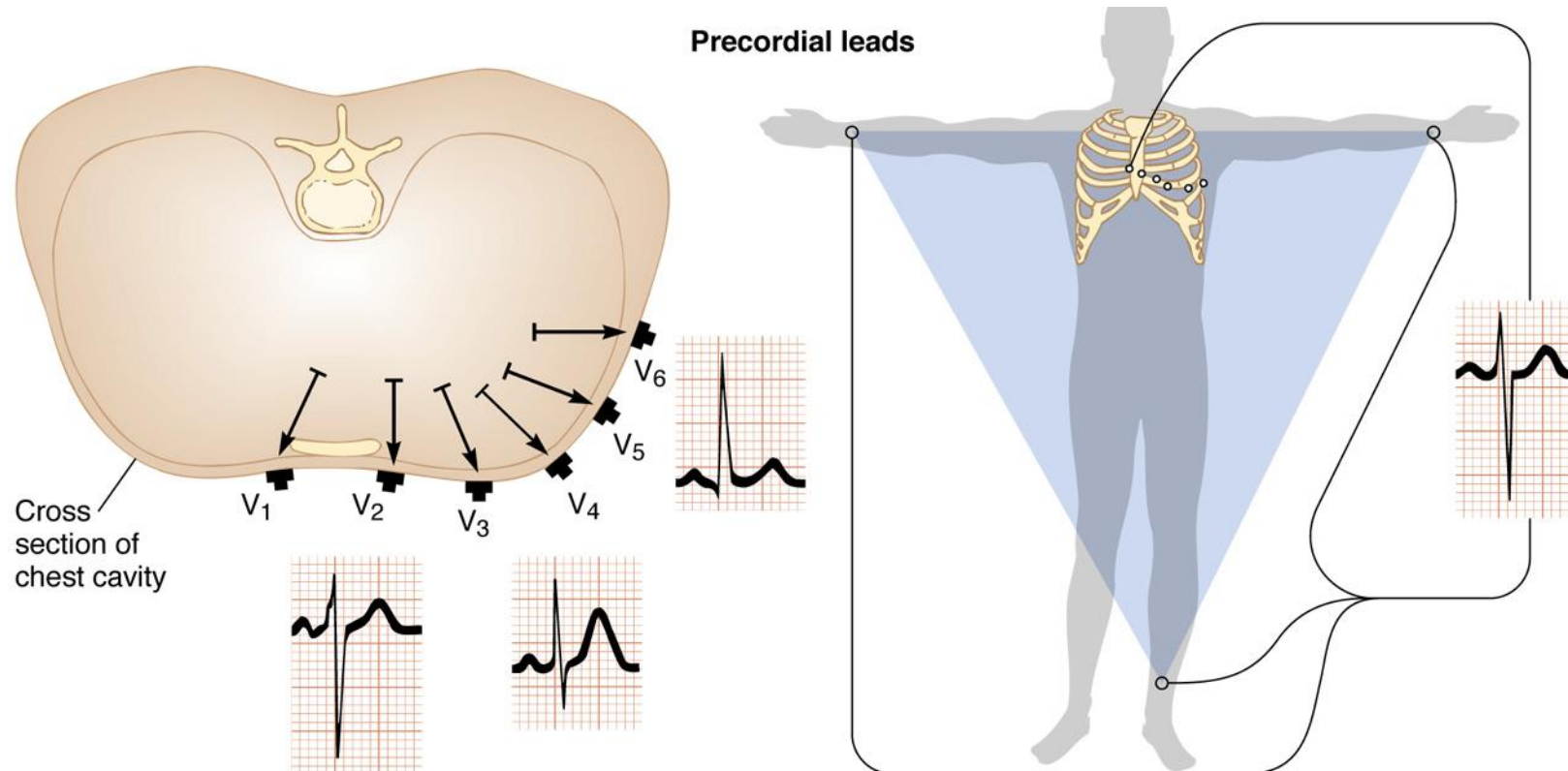


RCA = Right coronary artery
PDA = Posterior descending artery

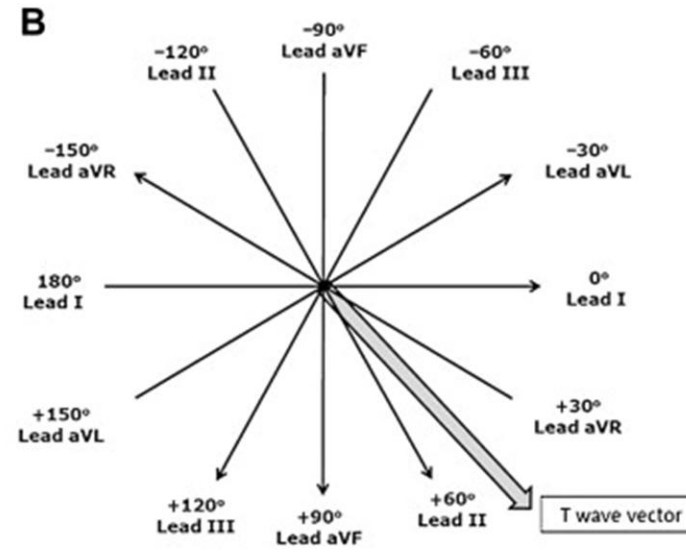
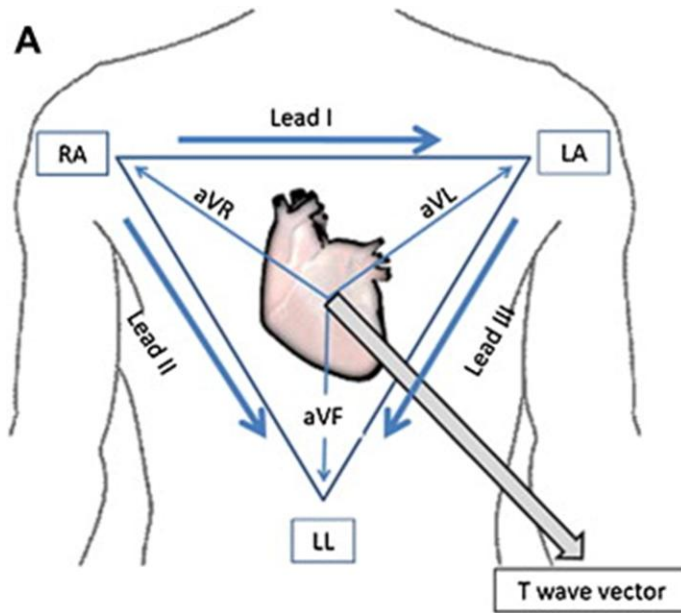
LMCA = Left main coronary artery
LAD = Left anterior descending artery
D = Diagonal branches (D1, D2)
Septals = Septal branches
LCx = left circumflex artery
OB = Obtuse marginals (OB1, OB2, OB3)
LPD = Left posterior descending artery



ECG LEADS



When current flows toward arrowheads (axes), upward deflection occurs in ECG
When current flows away from arrowheads (axes), downward deflection occurs in ECG
When current flows perpendicular to arrows (axes), no deflection occurs

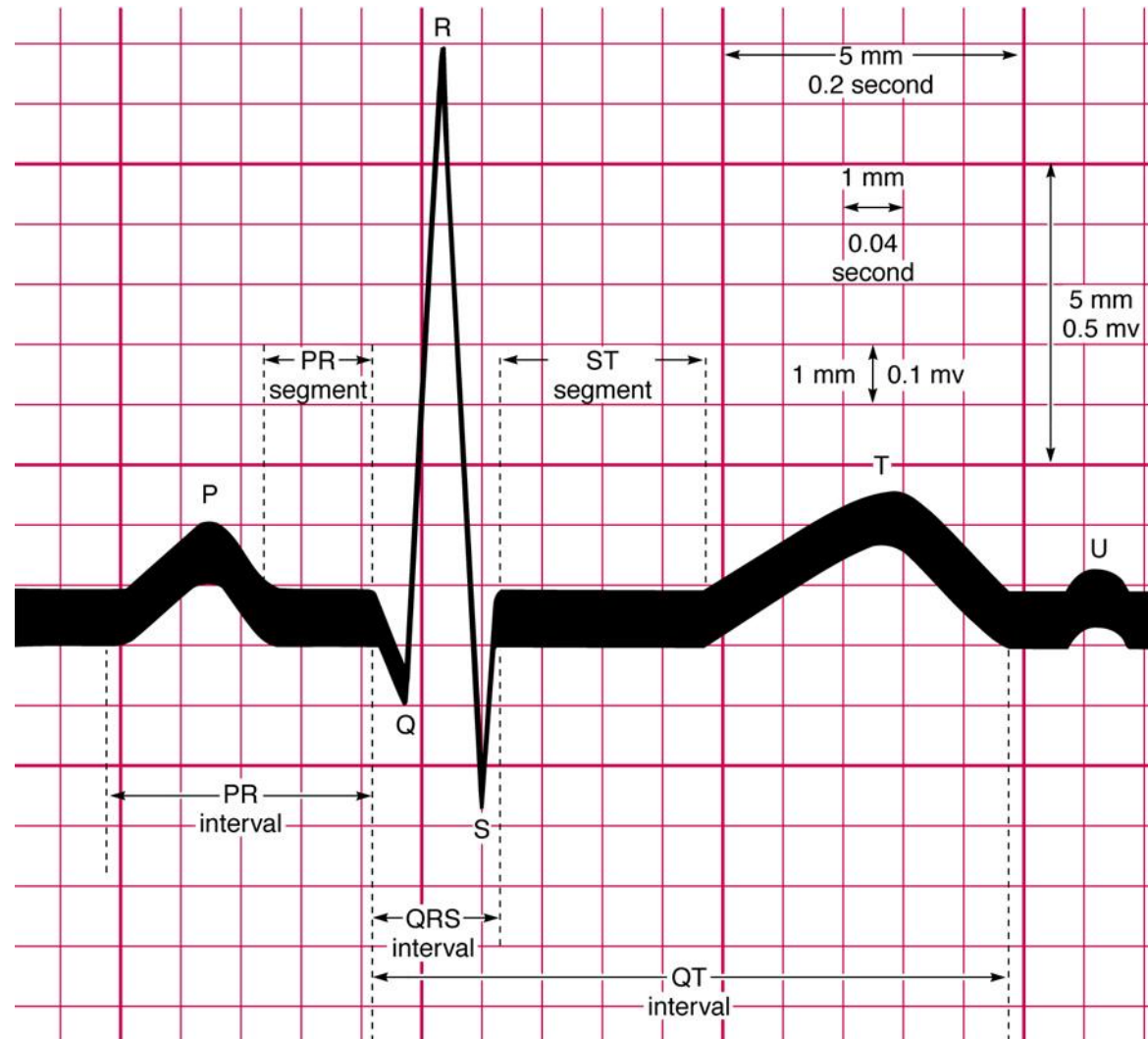


THE ELECTROCARDIOGRAM: LEAD SYSTEMS AND HEART SURFACES

Leads with STE	Affected myocardial area	Occluded coronary artery
v1 – v2	Septal	Proximal LAD
v3 – v4	Anterior	LAD
v5 – v6	Apical	Distal LAD, LCx or RCA
I, aVL	Lateral	LCx
II, III, aVF	Inferior	90% RCA 10% LCx
v7, v8, v9 (reciprocal ST depressions are evident in v1 – v3)	Posterolateral (inferobasal or posterior)	RCA or LCx



ECG RECORDING



RHYTHM?

- Is there is a P-QRS-T complex in most of the rhythm?
- If yes, then
 - Sinus
- If no,
 - Regular?
 - Irregular?
 - Any arrhythmia
 - i.e. afib, aflutter, PAT,etc



HOW FAST OR RATE?

- Normal

- 60-100
- 75 BPM



- Tachycardia

- >100



- Bradycardia

- <60



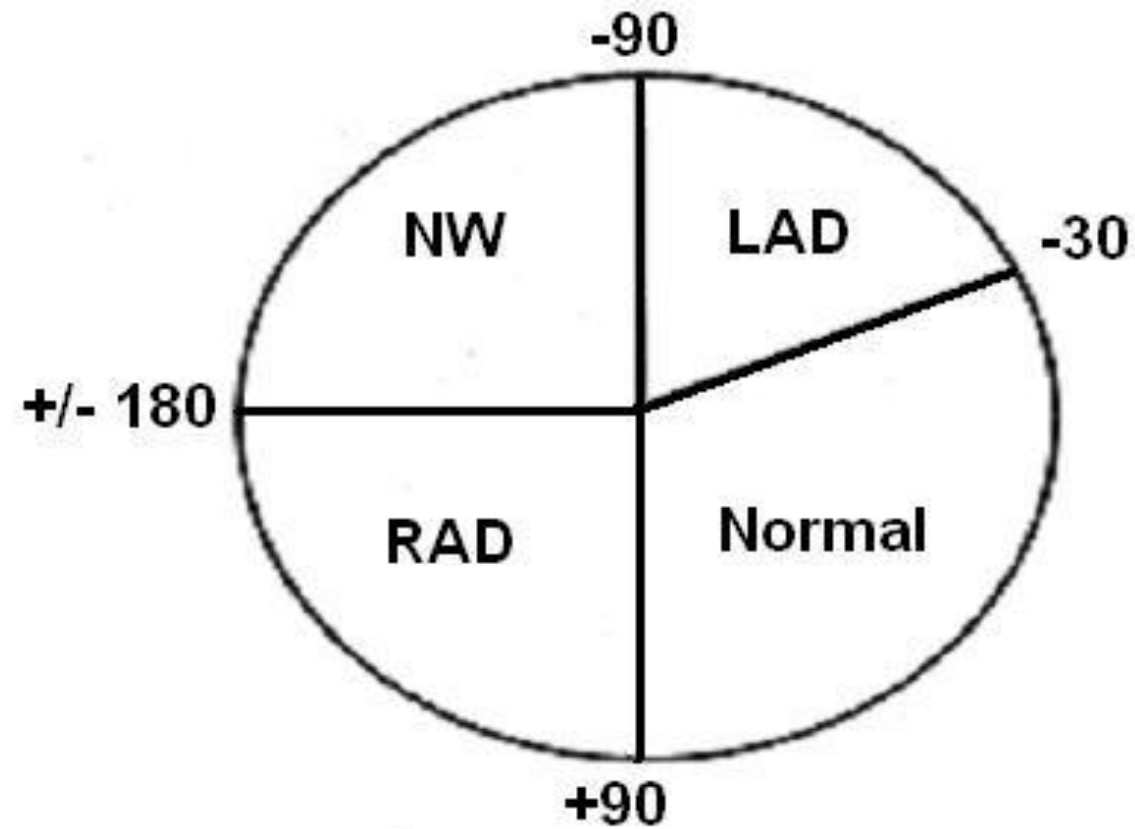
- Sinus arrhythmia



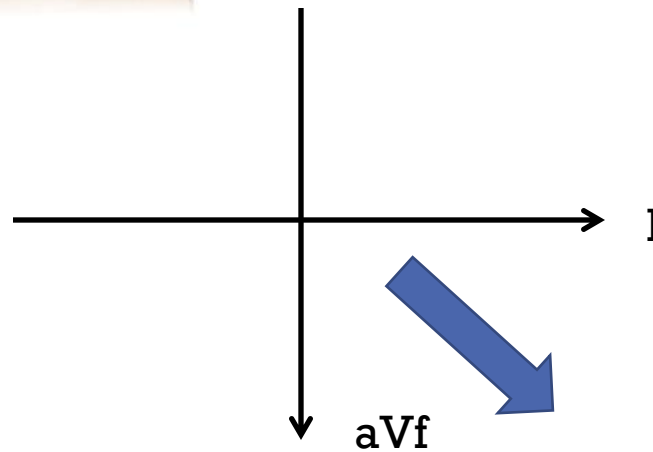
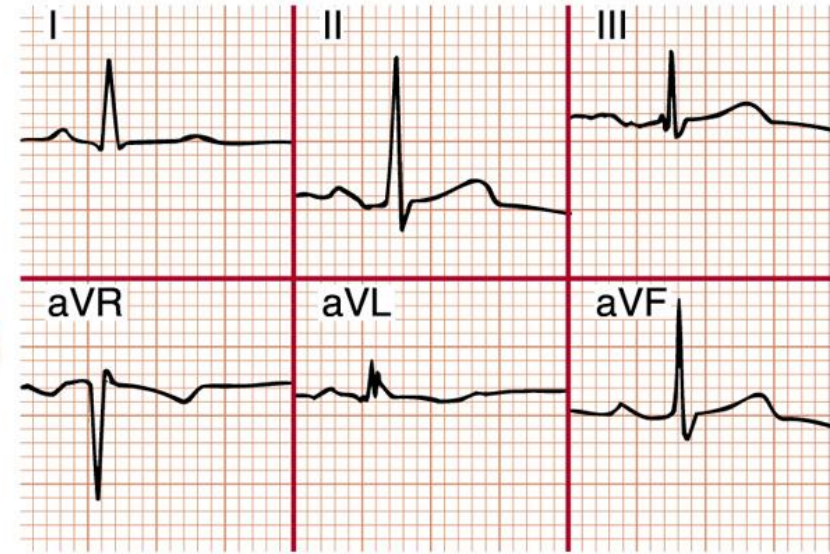
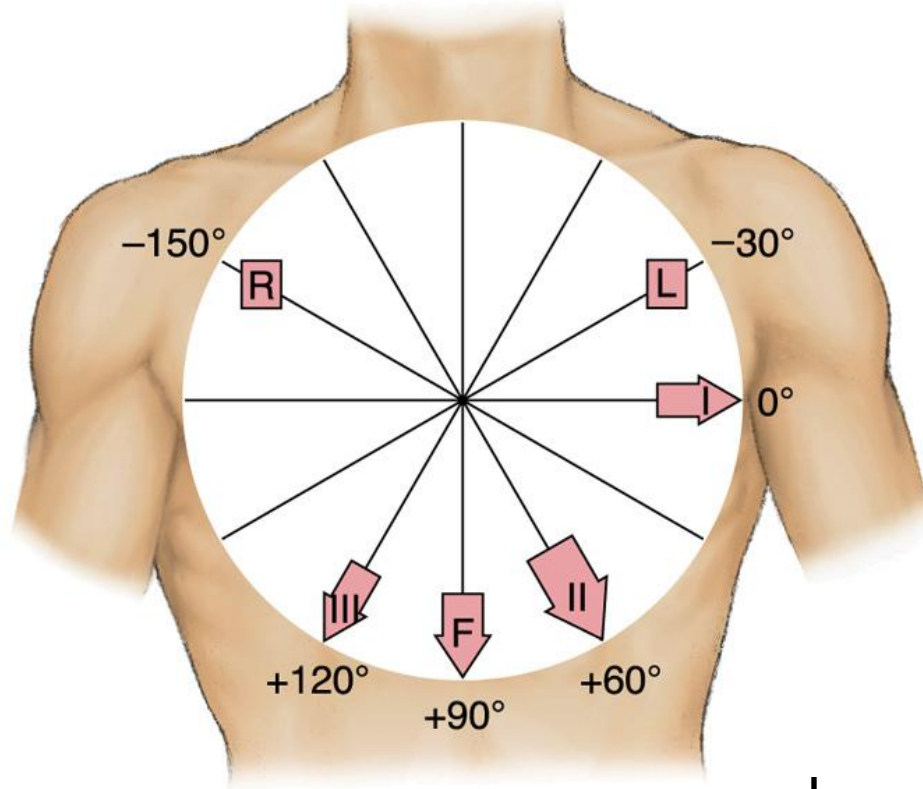
- Sinus arrest



Axis?

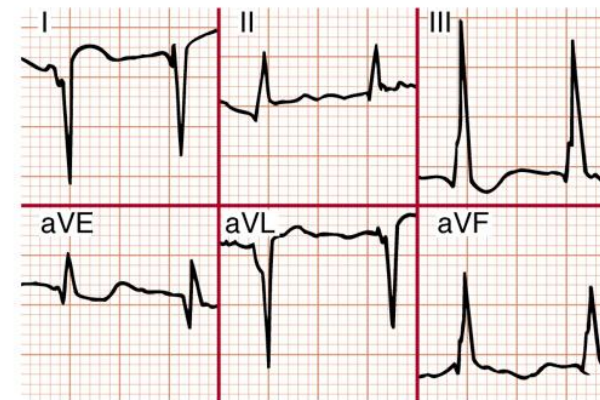
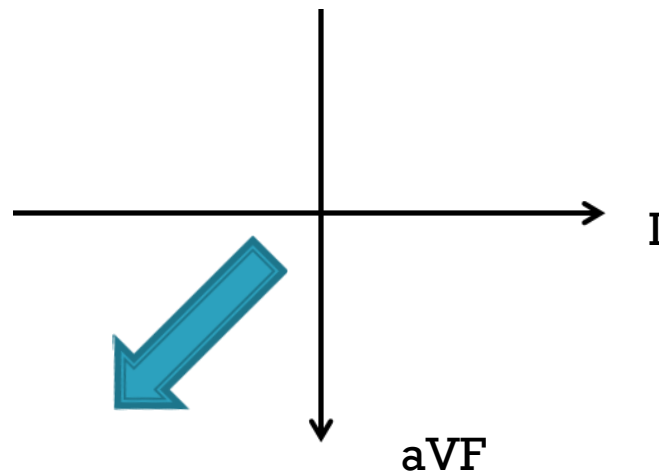
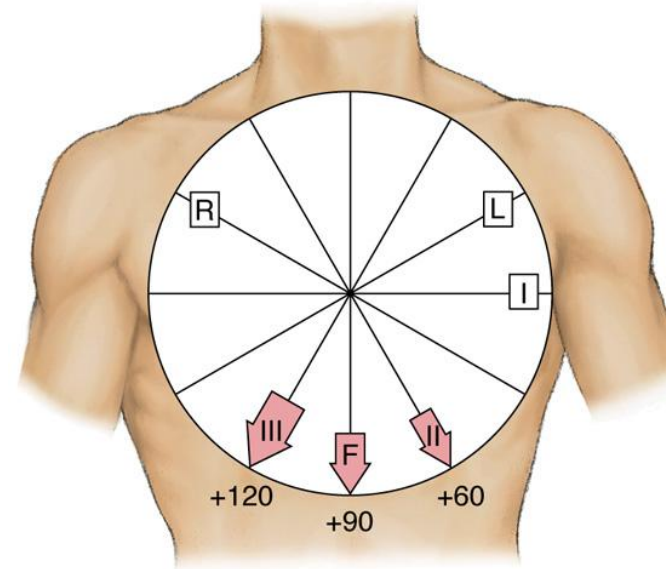


ECG LEADS



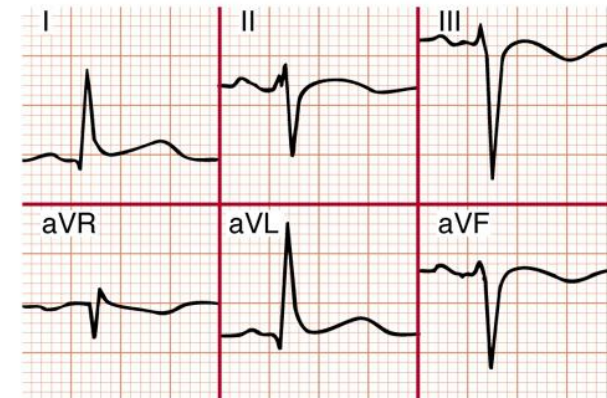
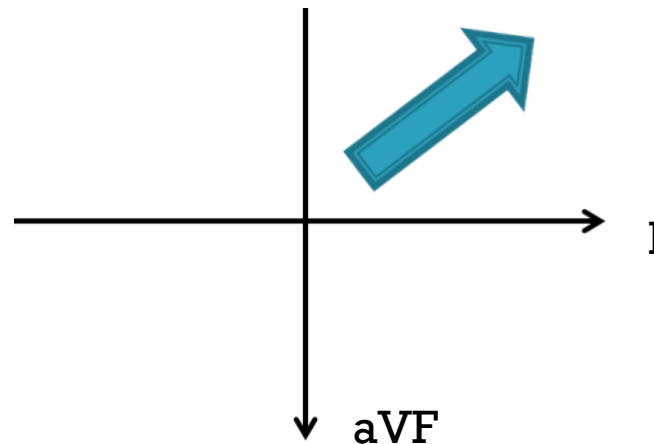
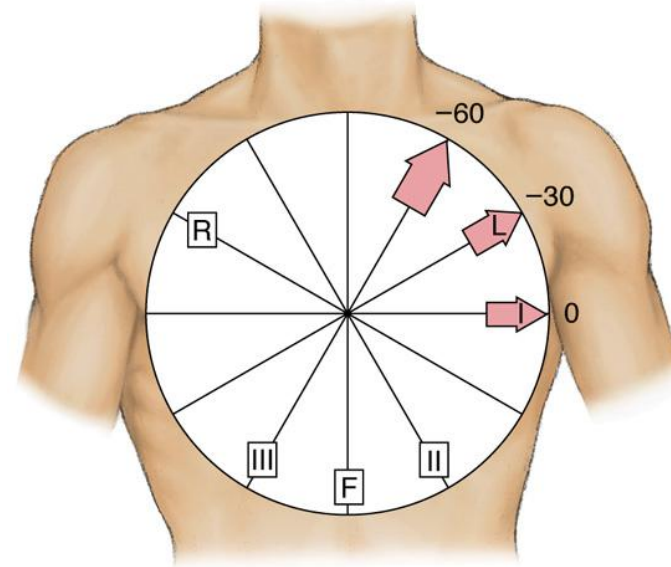
AXIS DEVIATION

- Right Axis Deviation
 - Abnormal finding.
 - Often associated with COPD, PE, PS, and pulmonary hypertension.



AXIS DEVIATION

- Left Axis Deviation
 - Abnormal finding.
 - Often associated with hypertension, valvular heart disease, and other disease processes.
- Indeterminate Axis



AXIS DEVIATION

- Rapid Axis Determination
 - Utilizes Leads I and aVf
 - $I \uparrow$ AND $aVf \uparrow$ = NAD
 - $I \uparrow$ AND $aVf \downarrow$ = LAD
 - $I \downarrow$ AND $aVf \uparrow$ = RAD



PR INTERVAL?

- Normal
 - 0.12-0.20 sec



- <0.12 sec
 - WPW
 - LGL (Lown-Ganong-Levine Syndrome)



PR INTERVAL?

- >0.20 sec
 - 1st degree
 - 2nd degree
 - Mobitz 1
 - Mobitz 2
 - 3rd degree

Four Types of AV-block (PQ interval > 0.2 s)

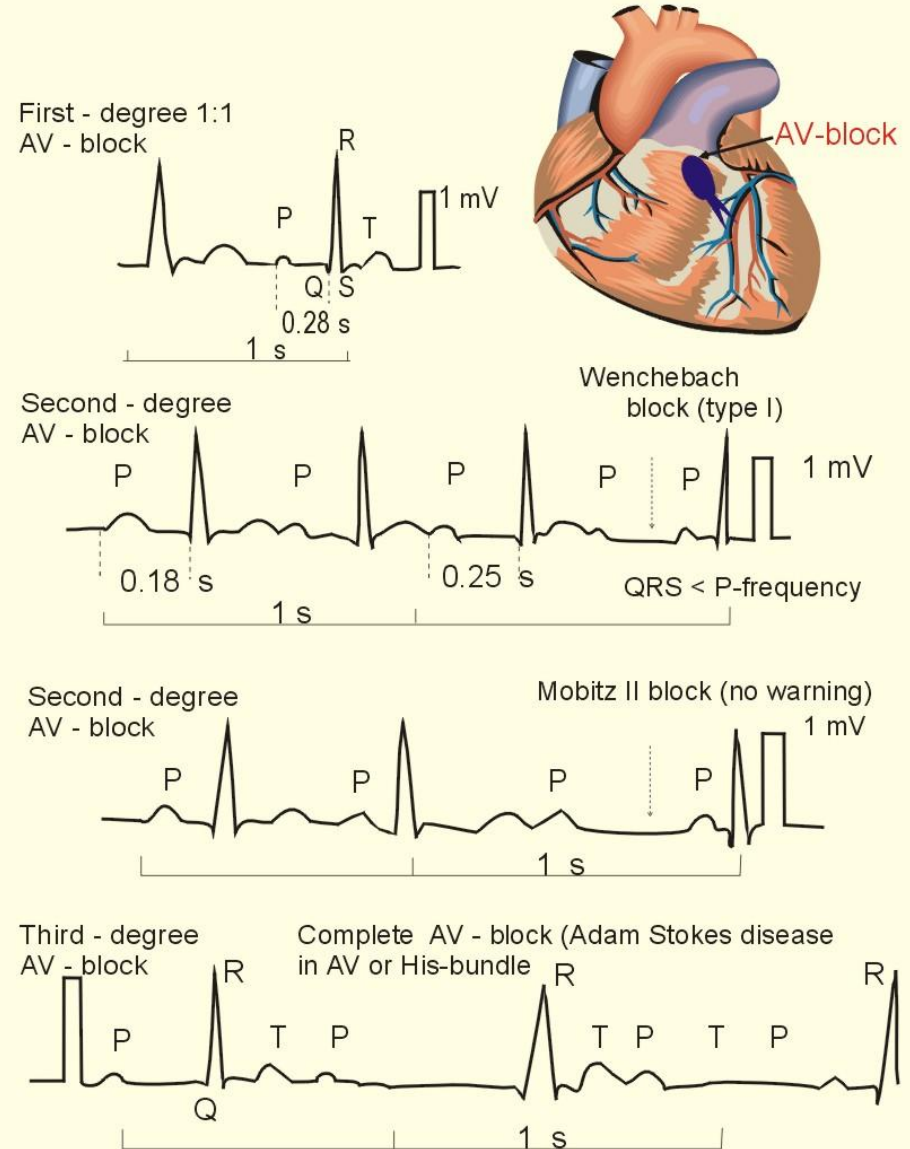


Fig. 11-12

KMc



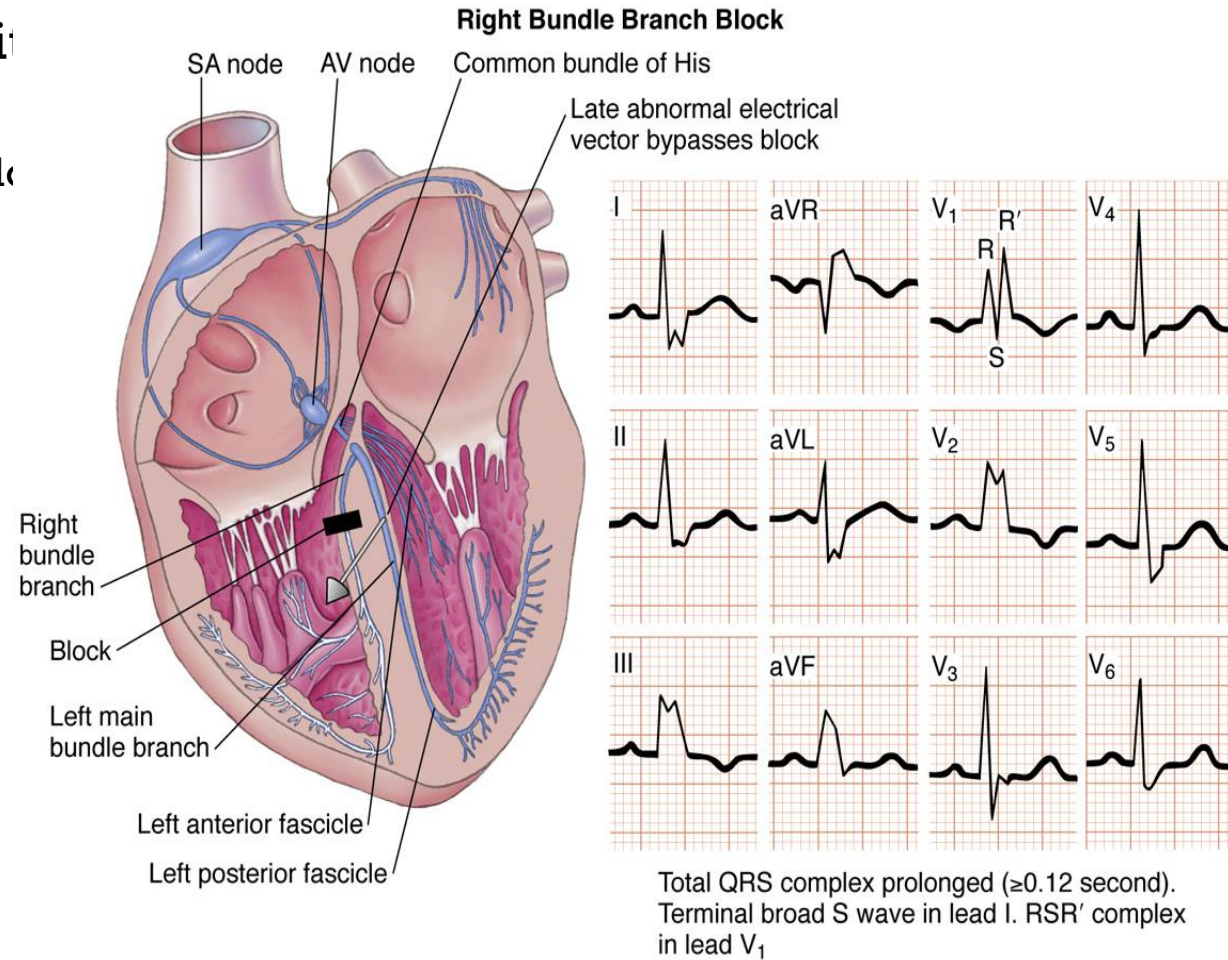
QRS?

- Normal
 - <0.12 sec
- Block
 - >0.12 sec



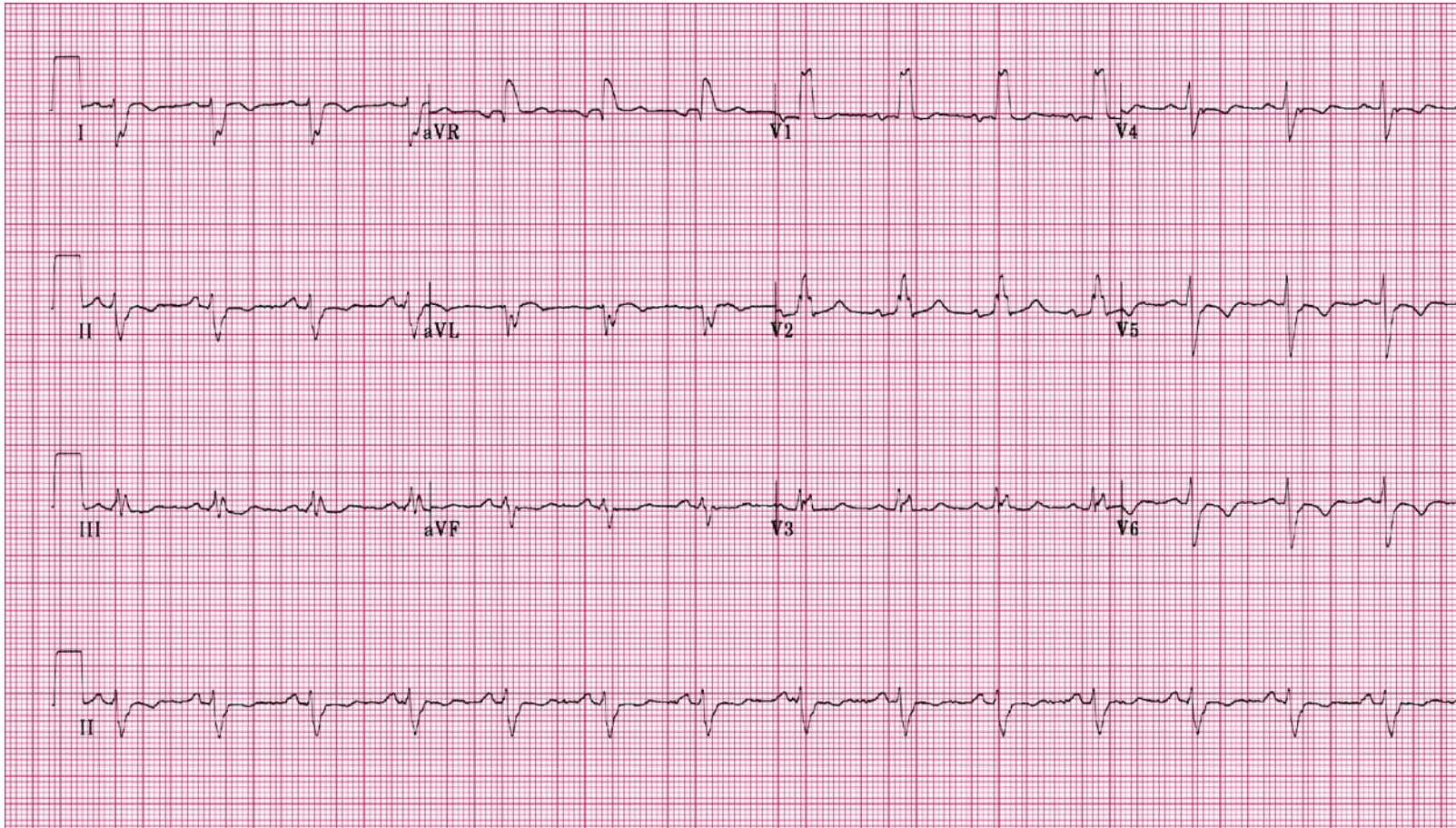
DISEASE FINDINGS

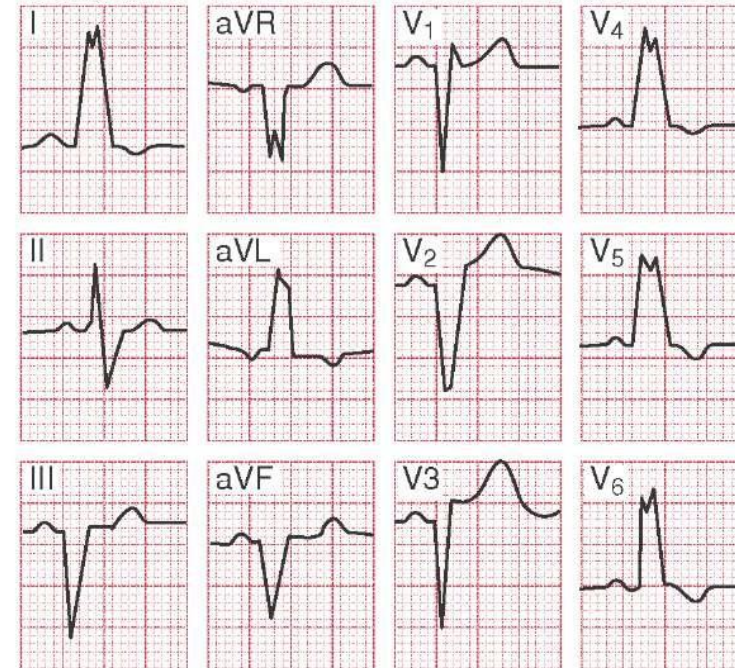
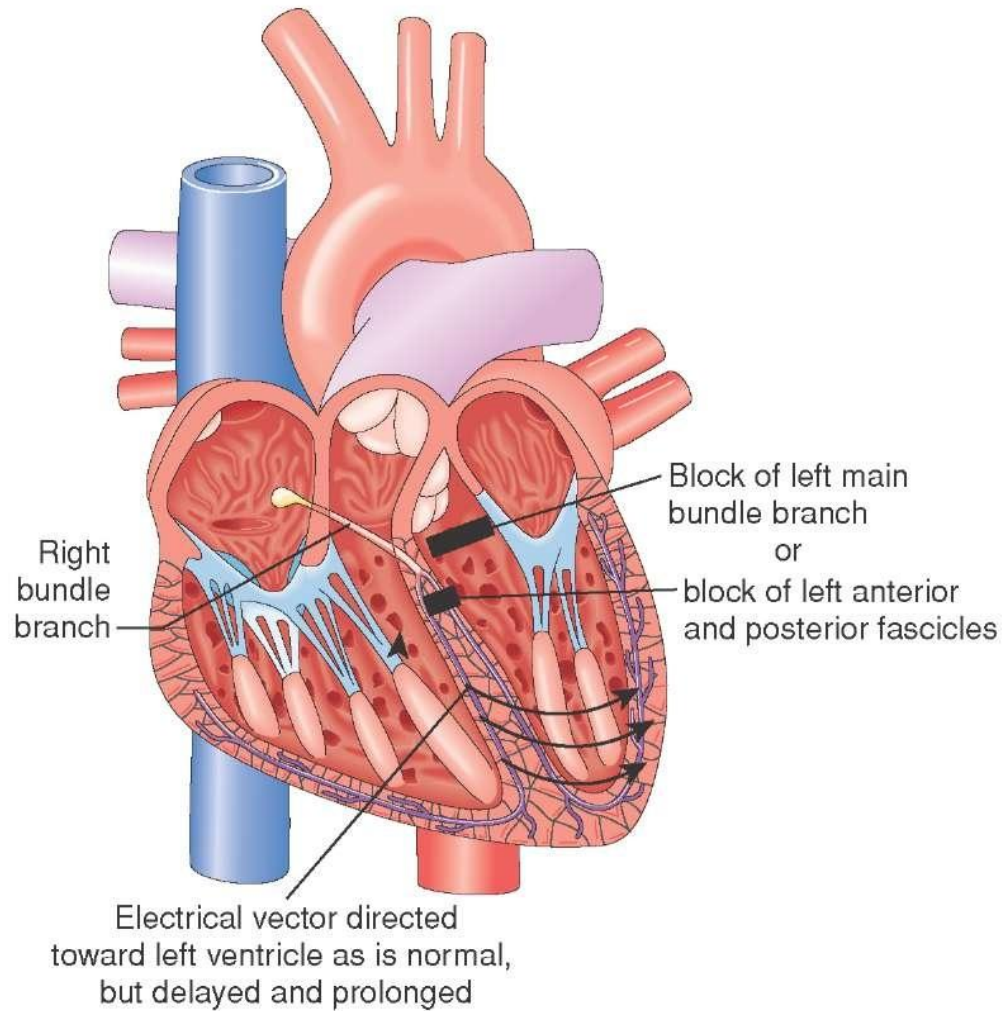
- Conduction Abnormalities
 - Bundle Branch Blocks
 - Right Bundle Branch Block



DISEASE FINDINGS

RIGHT BUNDLE BRANCH BLOCK

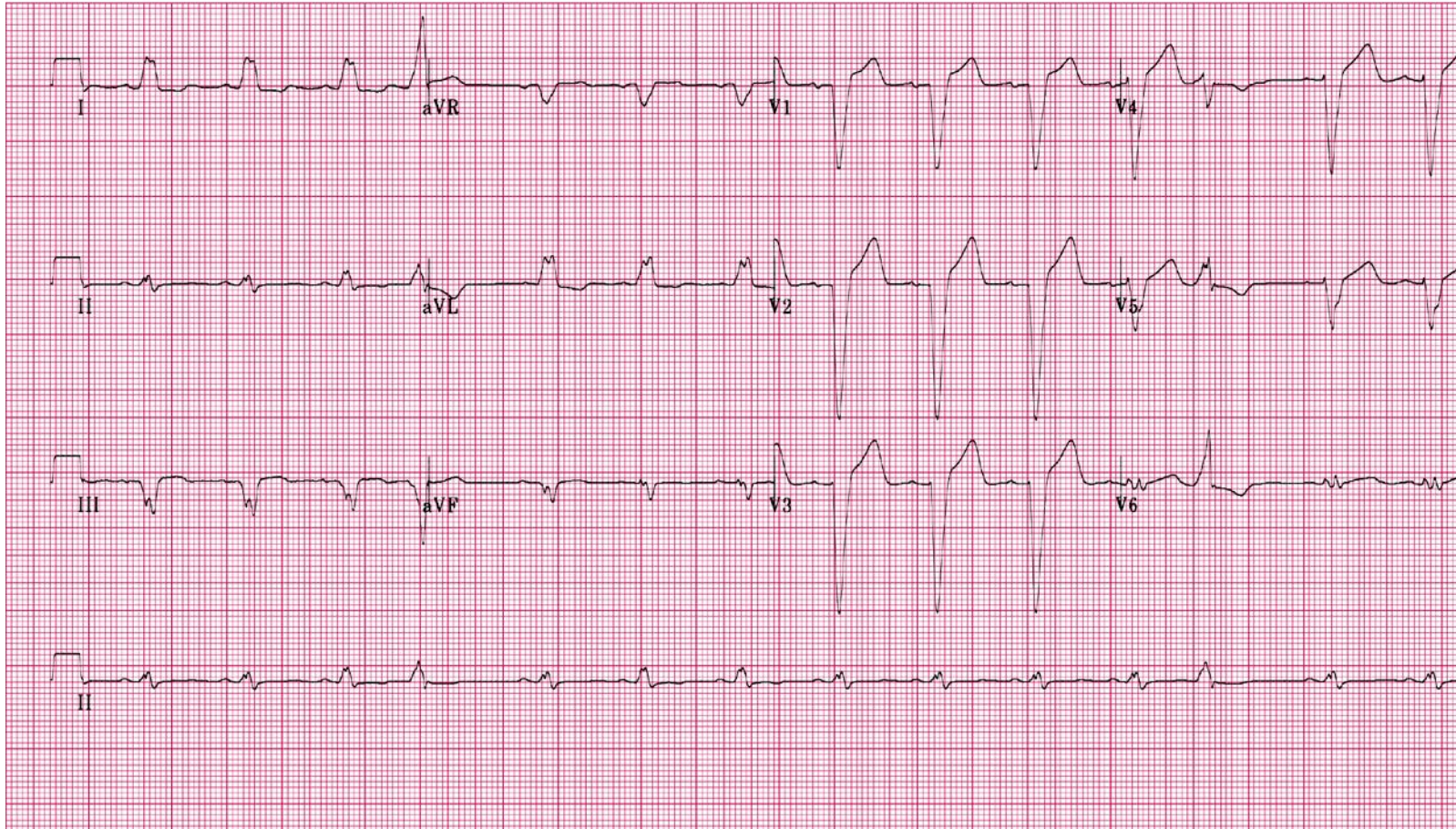




Wide QRS complex prolonged (≥ 0.12 second).
with ST depressions and inverted T waves,
particularly in leads I, aVL, V₅ and V₆

DISEASE FINDINGS

LEFT BUNDLE BRANCH BLOCK



QTc?

$$QTc = QT / \sqrt{RR}$$

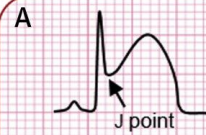
- Male
 - ~0.46 sec
- Female
 - ~0.48 sec
- Prolonged
 - Hypocalcemia
 - TCA overdose
 - QTc syndrome
 - Antiarrhythmic medications with...
 - Quinolones
 - Macrolides
 - Hypokalemia
 - Hypomagnesemia
- Shortened
 - Hypercalcemia
 - Hyperkalemia



ANY OTHER CHANGES?

STEMI Equivalents

Conventional STEMI



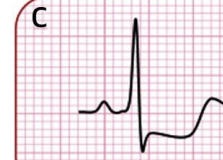
Elevation of ST segment at (or 40-60 ms after) the J point

De Winter syndrome



J-point depression and upsloping ST depression in V1-V6 that continues into tall, positive symmetrical T-waves, often with 1-2 mm ST elevation in aVR

Posterior STEMI



ST depression ≥ 0.05 mV (horizontal or downsloping and concave) in V1-V3 (or V4) especially if there is a tall R in V1/V2 with R/S ratio > 1 in V2

Wellens sign A



Biphasic anterior T waves, not always accompanied by chest pain

Wellens sign B



Deeply inverted anterior T waves, not always accompanied by chest pain

Hyperacute T wave



Tall, often asymmetrical, broad-based anterior T-waves often associated with reciprocal ST depression

Sgarbossa criterion 1



ST elevation ≥ 0.1 mV concordant to the QRS in any of the leads I, aVL, V4 to V6.

Sgarbossa criterion 2



ST depression ≥ 0.1 mV concordant to the QRS in any of the leads V1 to V3.

Sgarbossa criterion 3^{modified}



ST elevation with amplitude $> 25\%$ of the depth of the preceding S-wave with discordant QRS complex (leads V1 to V3)

"Shark fin"



J-point transitioning in a convex ST-segment (T wave indistinguishable from ST-segment due to extreme ST deviation)

Acute ischemia in LVH



ST elevation $> 25\%$ of QRS amplitude AND (ST elevation in 3 contiguous leads, or T-wave inversions in the anterior leads)

