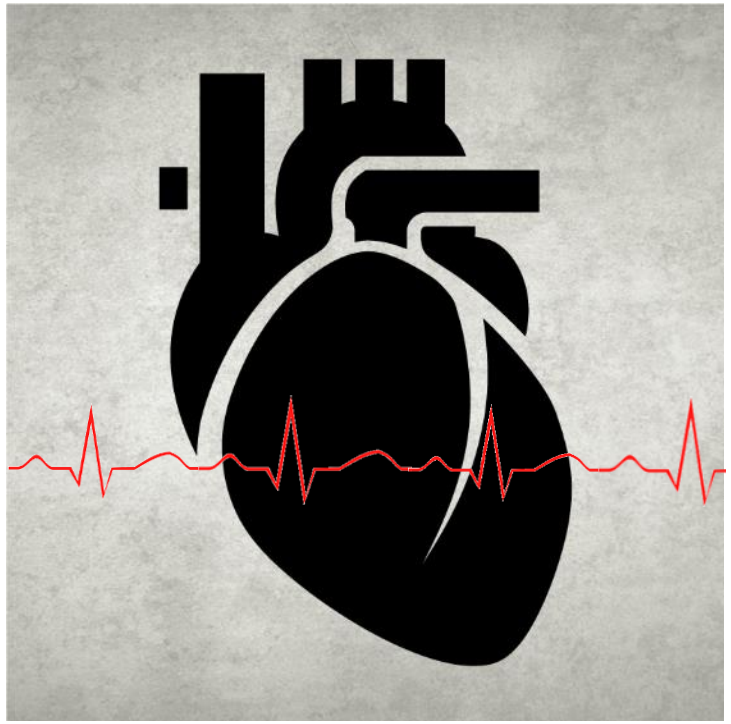
EMERGENCY MEDICINE

BOOT CAMP

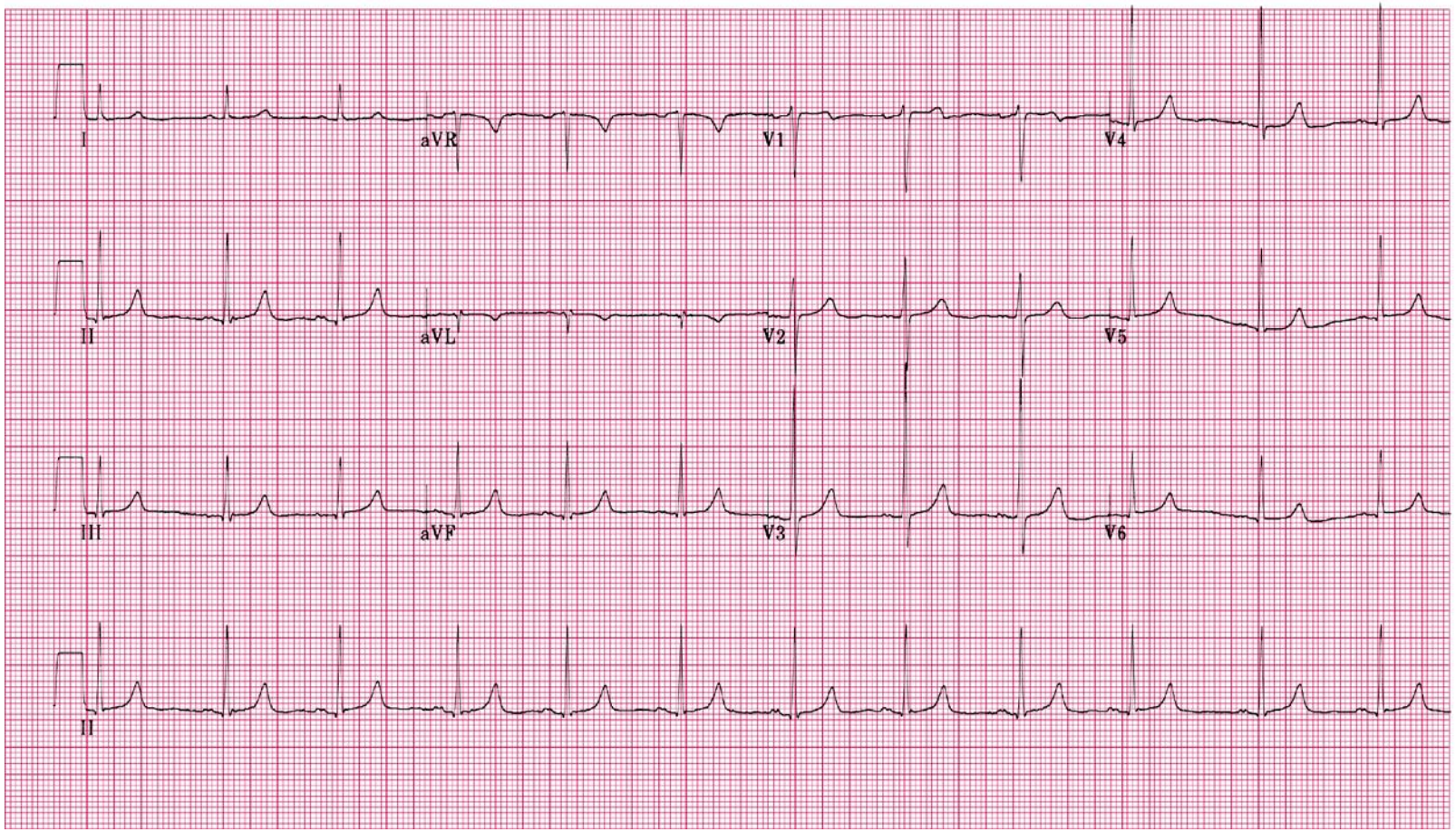
INTRODUCTION TO EKG

José A. Rubero, MD, FACEP, FAAEM

Professor in Emergency Medicine



THE NORMAL 12-LEAD



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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)

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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

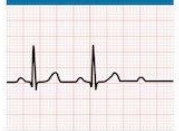
T

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

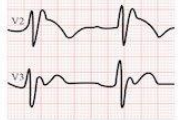
Complication
- High grade AV block

Wide Interval

ECG criteria
- QRS width ≥120 msec

Common causes
- Hyperkalemia (assume until proven otherwise)
- Ischemia
- Conduction disease
- Medication and toxins

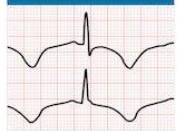
Brugada Sign



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

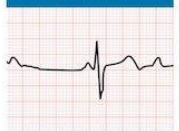
Inverted T Wave



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

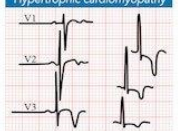
Mobitz I



ECG criteria
- Dropped QRS **with** progressive PR prolongation

Less risk than Mobitz II

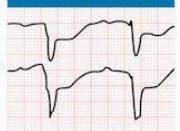
HCM
Hypertrophic cardiomyopathy



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 deflction 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

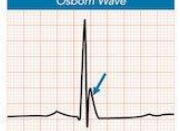
High risk for arrhythmia and mimicking/masking ischemia

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

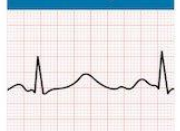


ECG criteria
- Positive deflection at J point most often seen in precordial leads

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

ALiEM
Updated 7-21-18
v2

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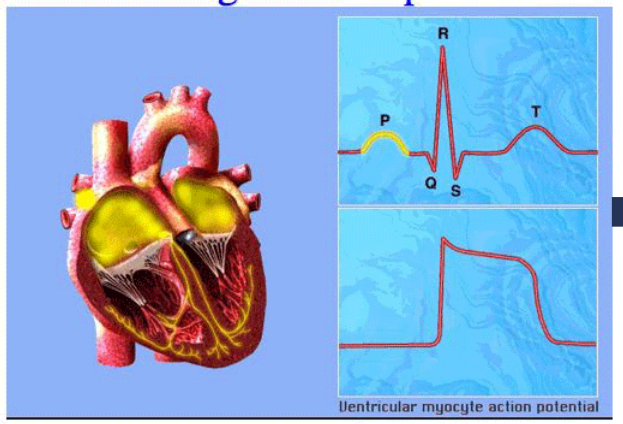
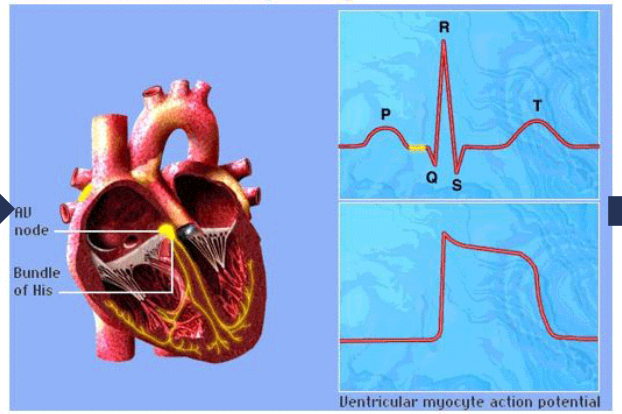
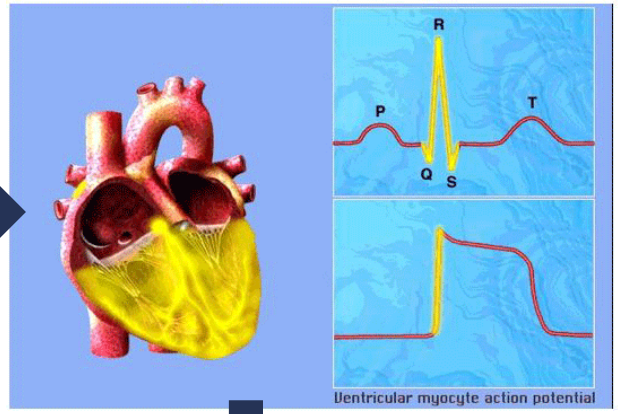
EKG Tracing-Atrial Depolarization



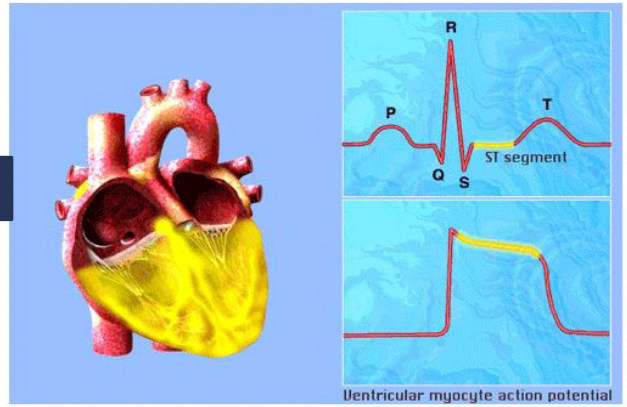
EKG Tracing-Delay at AV Node



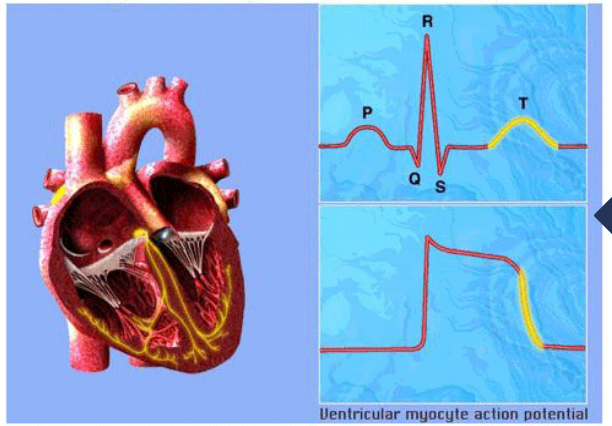
EKG Tracing-Ventricular Depolarization



Plateau Phase of Repolarization



EKG Tracing-Final Rapid Repolarization (Phase 3)



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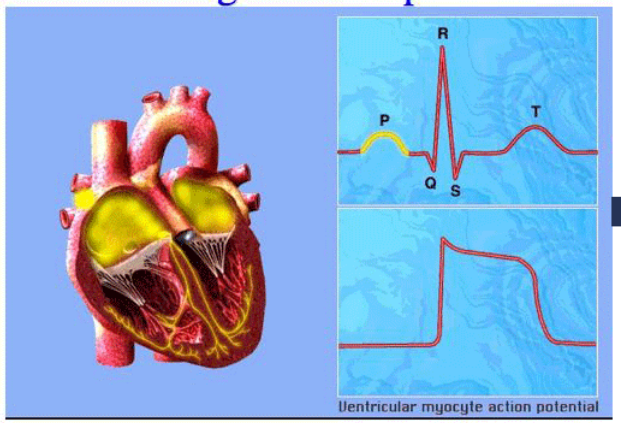
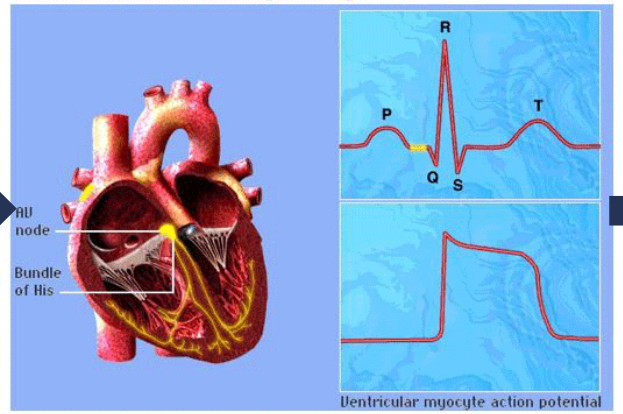
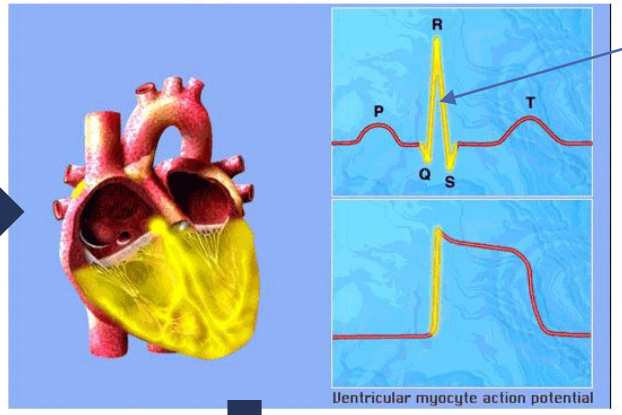
EKG Tracing-Atrial Depolarization



EKG Tracing-Delay at AV Node

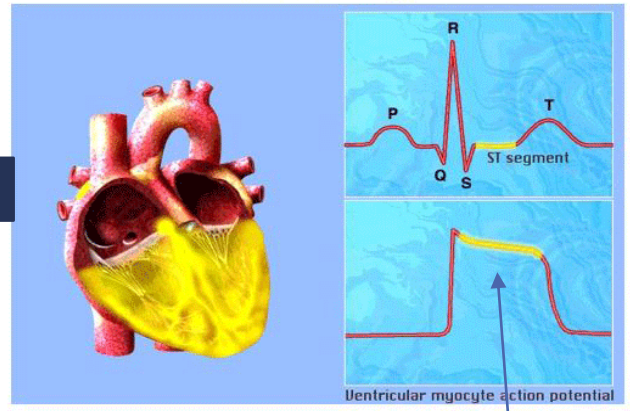


EKG Tracing-Ventricular Depolarization



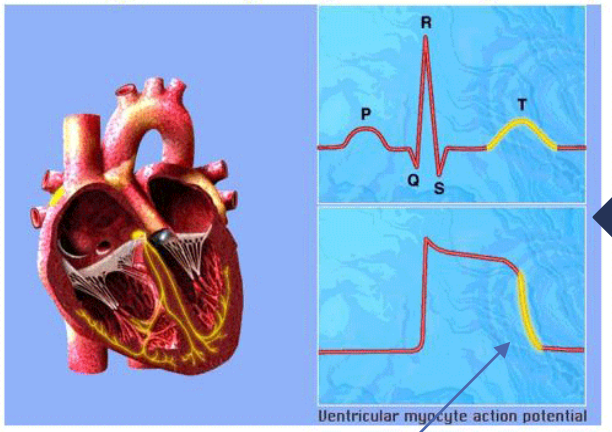
Na,
TCA

Plateau Phase of Repolarization



Ca Disturbance,
Digoxin

EKG Tracing-Final Rapid Repolarization (Phase 3)



K Disturbance

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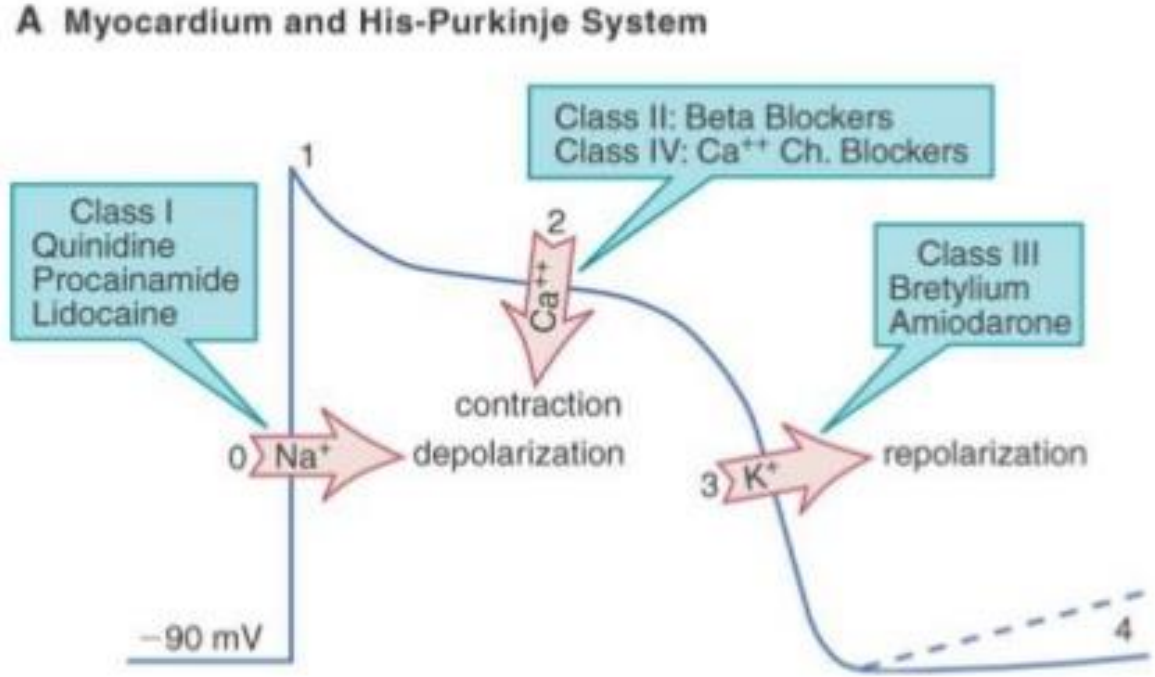
Physiology of the Nerve Impulse

Action potential

- All or none response



Adrian Kyle M. Jacinto, RPh (Confidential File)

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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?

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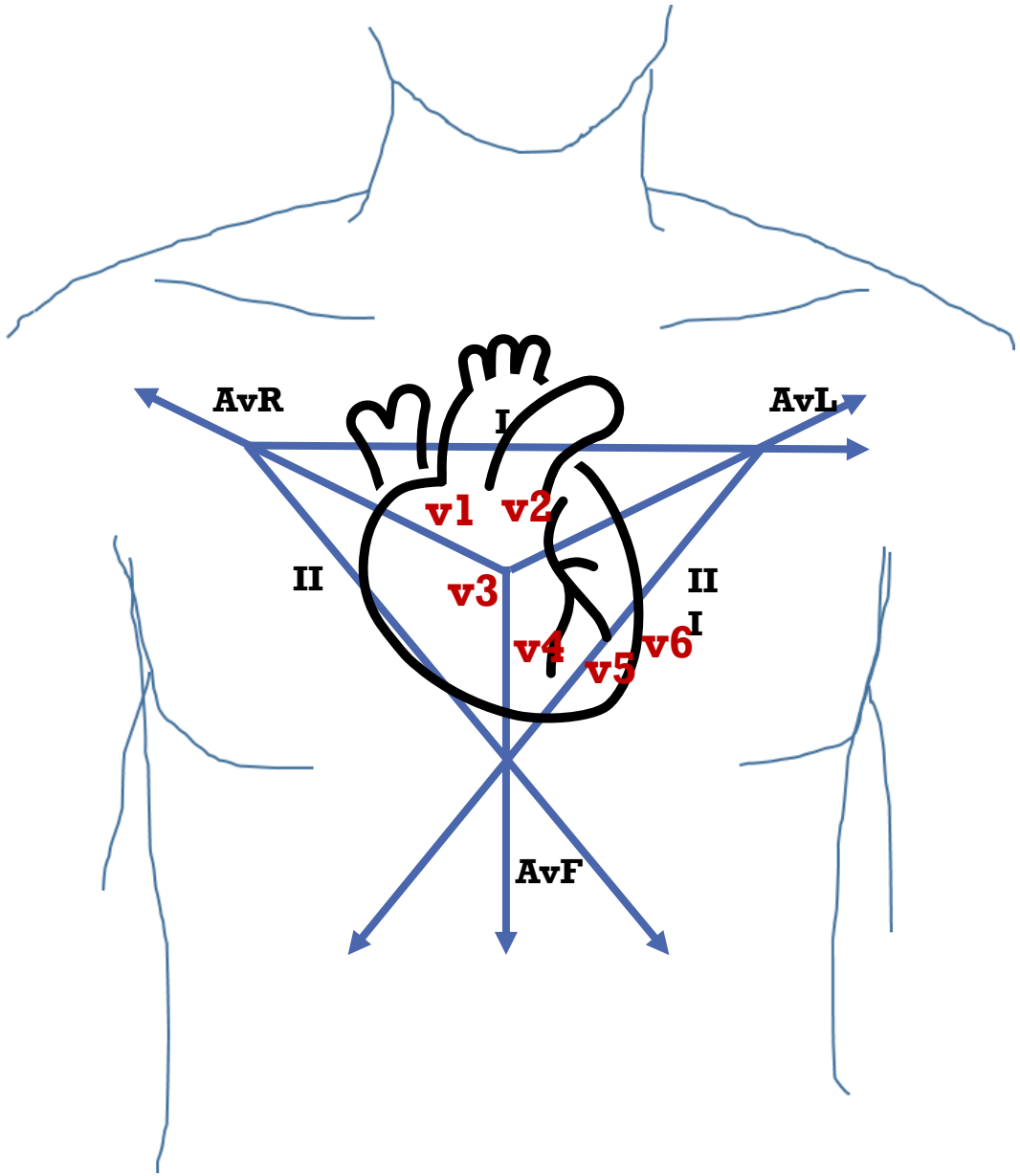

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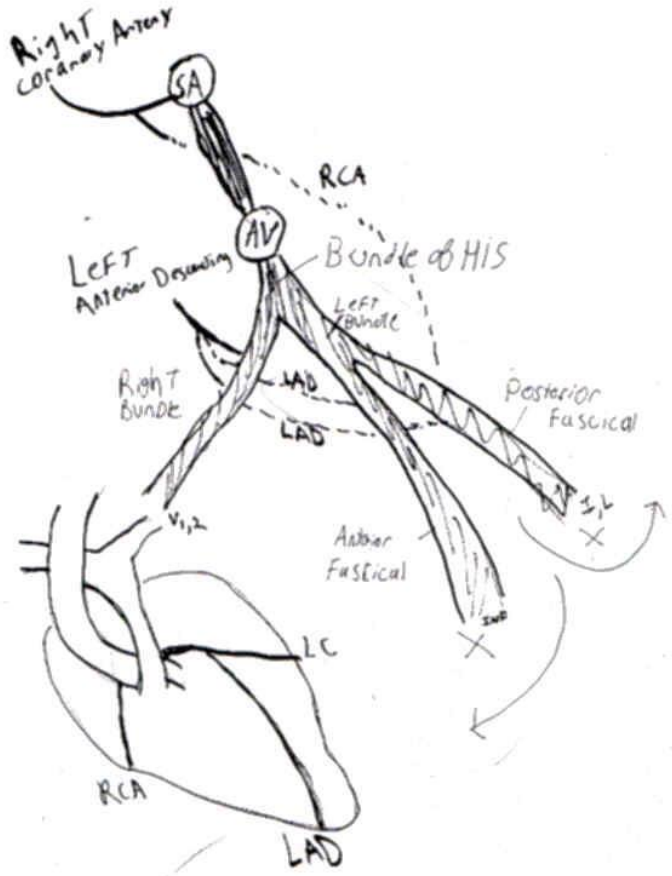
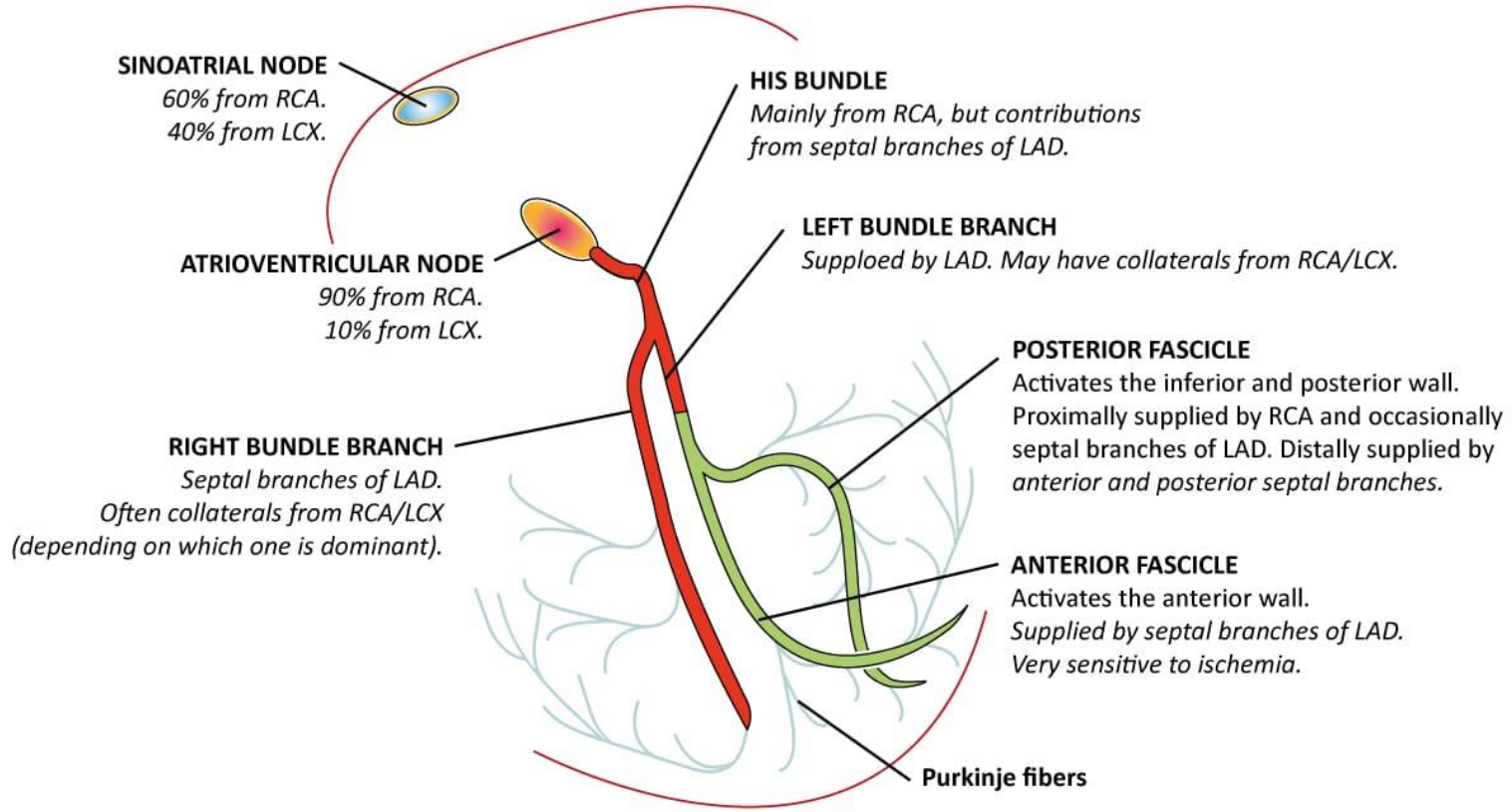


The components of the conduction system and their vascular supply



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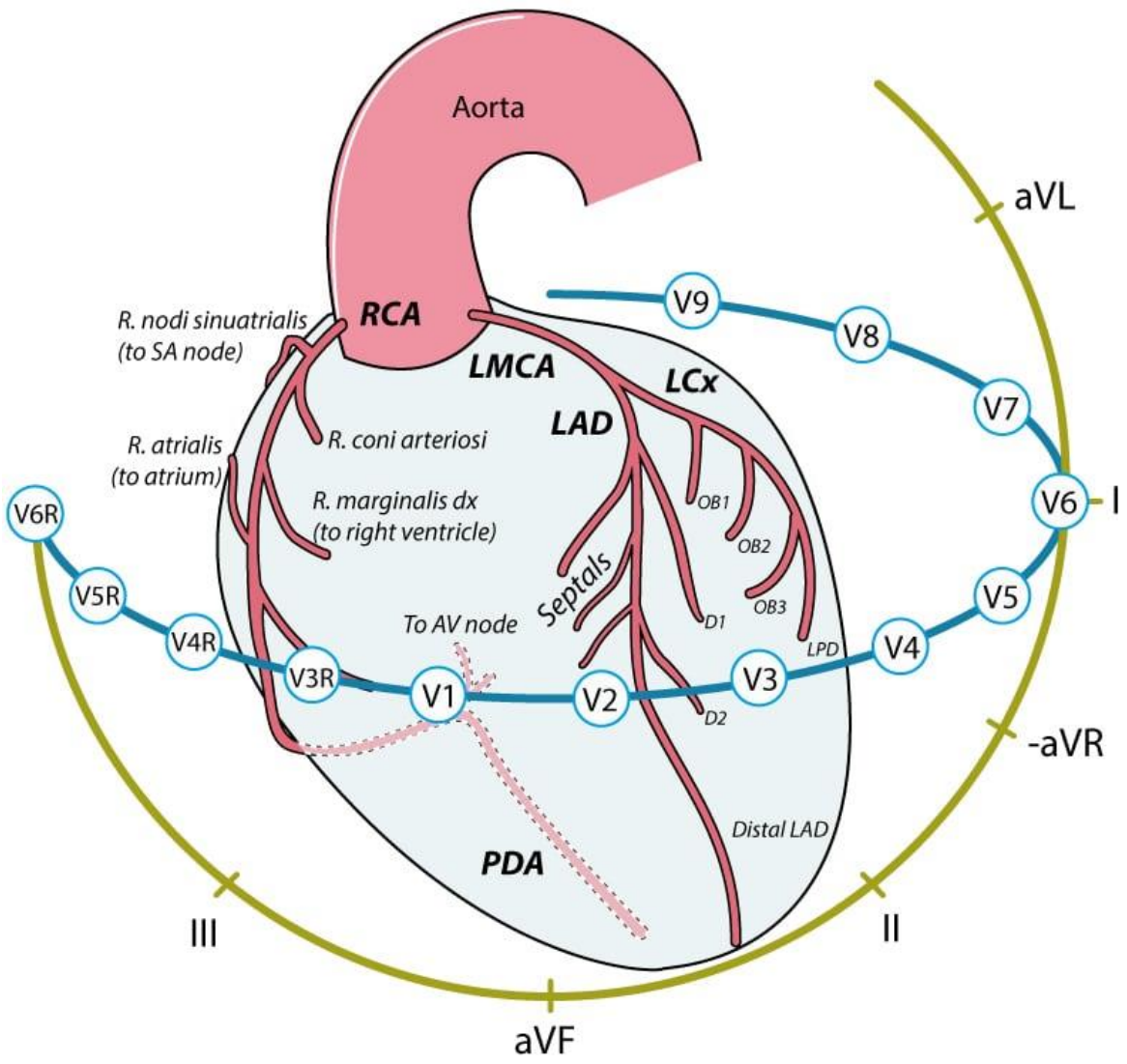
Schematic overview of the coronary arteries and their relation to the ECG leads



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

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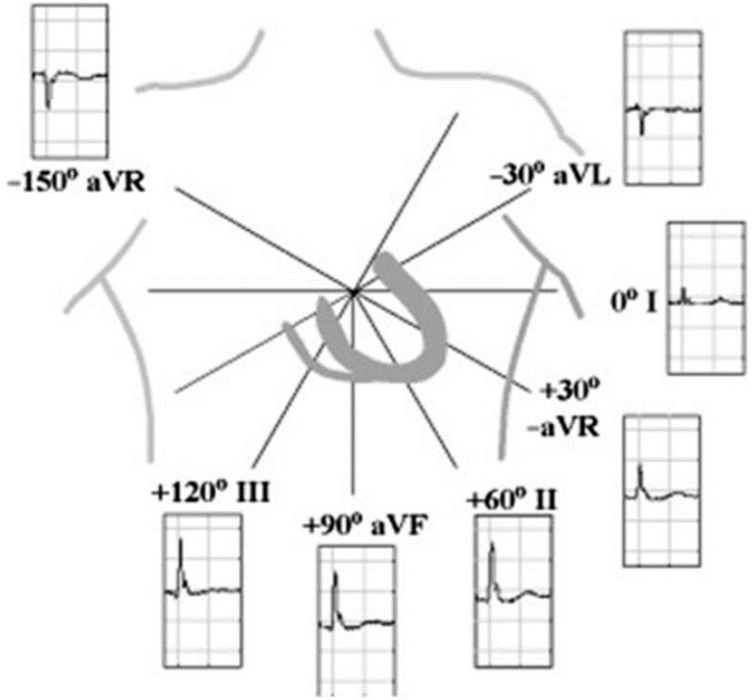
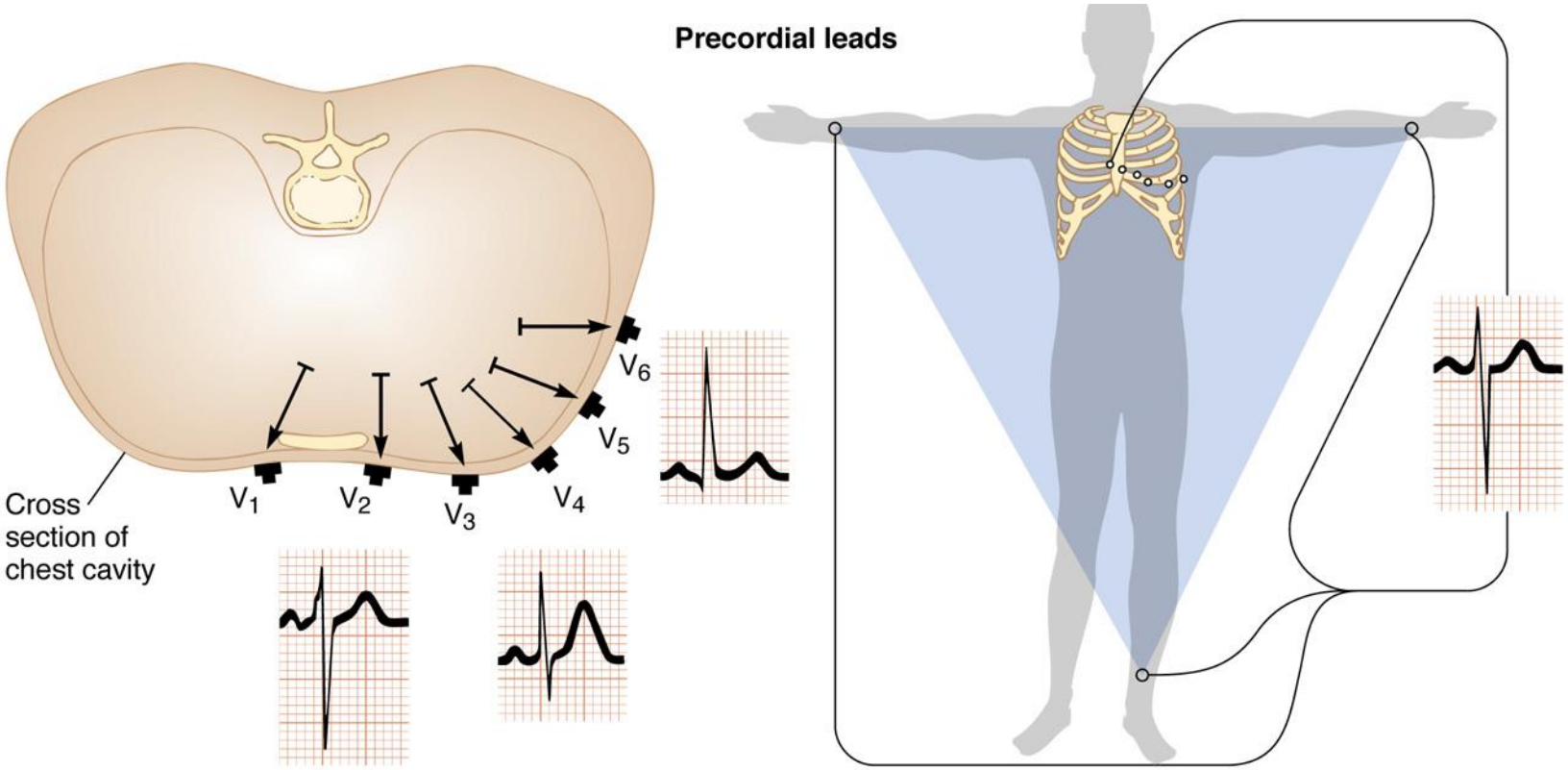

-150° aVR
-30° aVL
0° I
+30°
-aVR
+120° III
+90° aVF
+60° II

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

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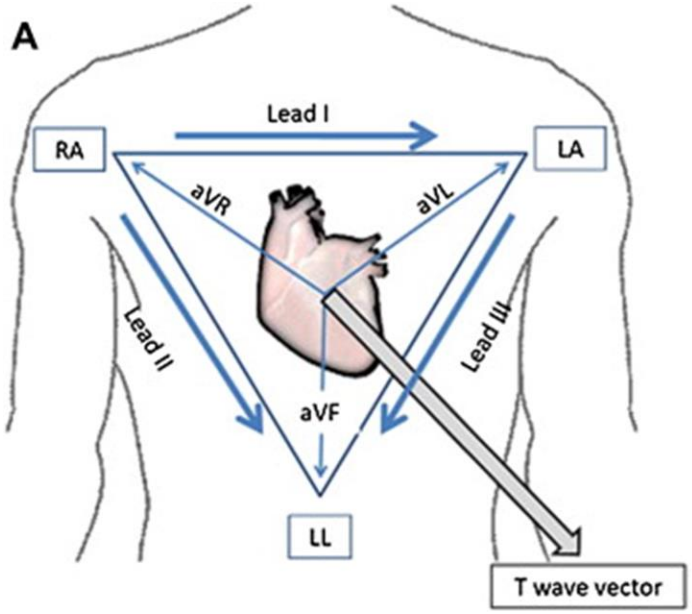

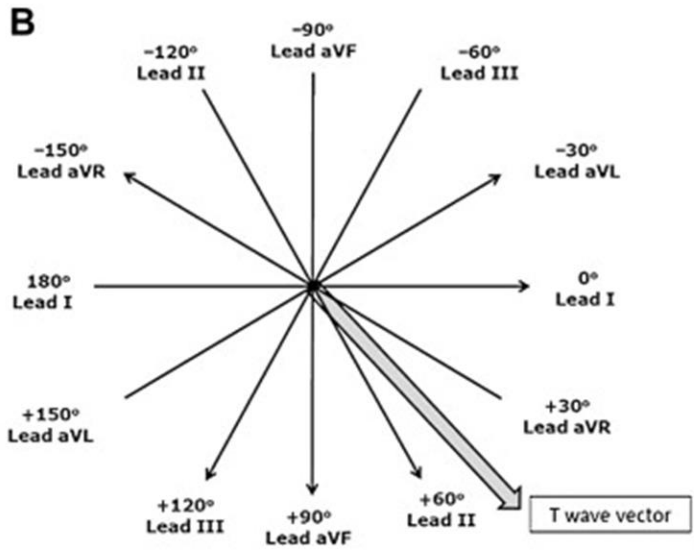

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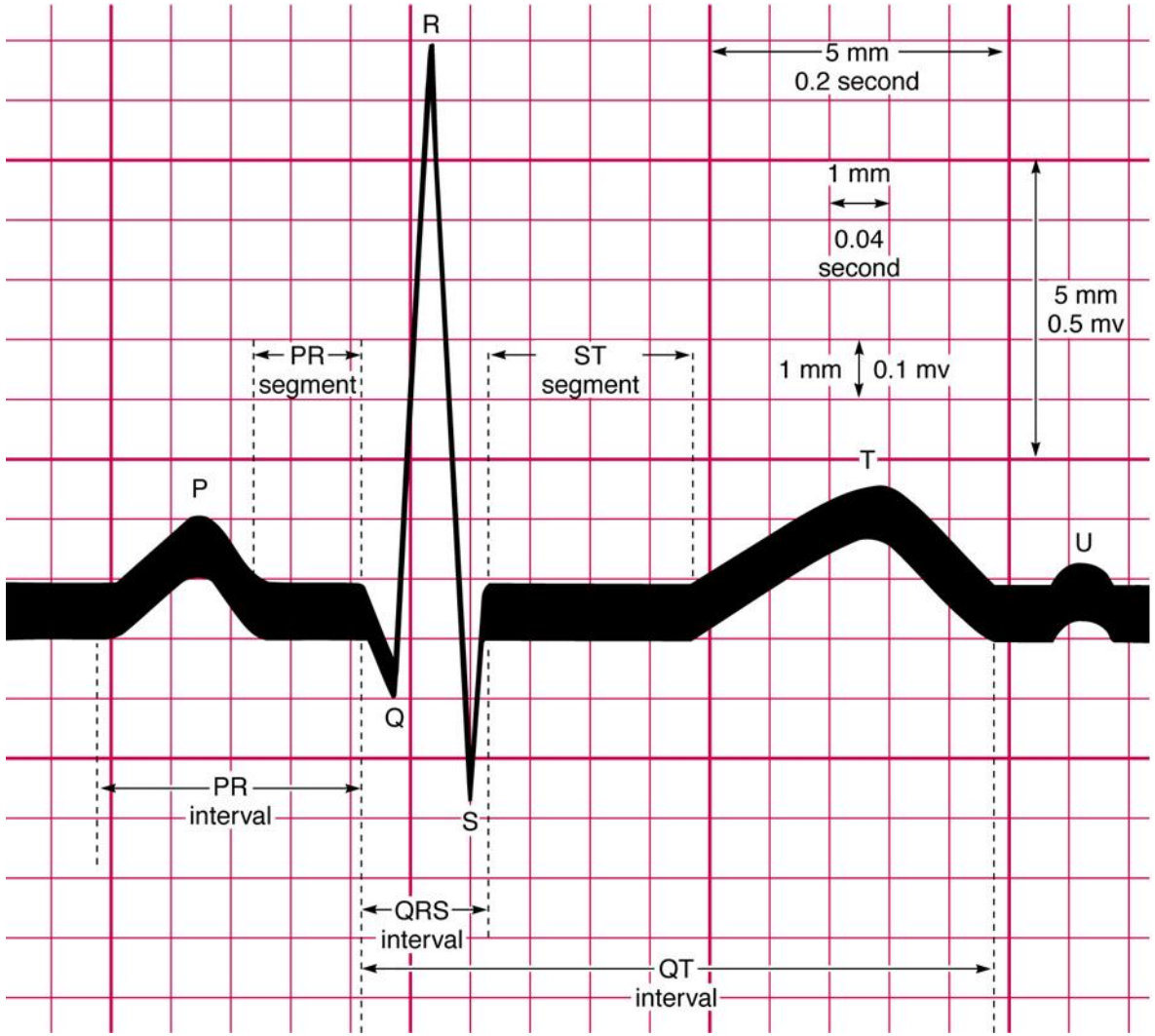
THE ELECTROCARDIOGRAM: LEAD SYSTEMS AND HEART SURFACES

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 evidentin v1 – v3	Posterolateral (inferobasal or posterior)	RCA or LCx

ECG RECORDING



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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

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HOW FAST OR RATE?

- Normal
  - 60-100
  - 75 BPM

- Tachycardia
  - >100

- Bradycardia
  - <60

- Sinus arrythmia

- Sinus arrest

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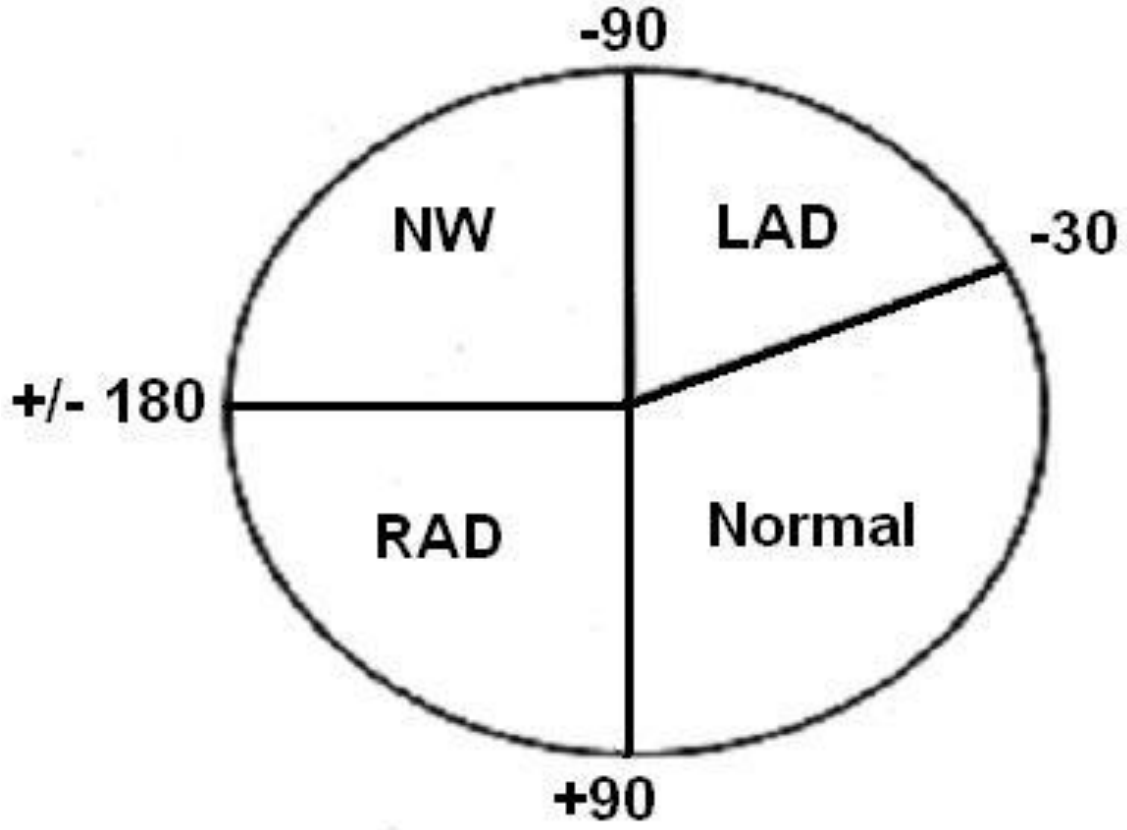
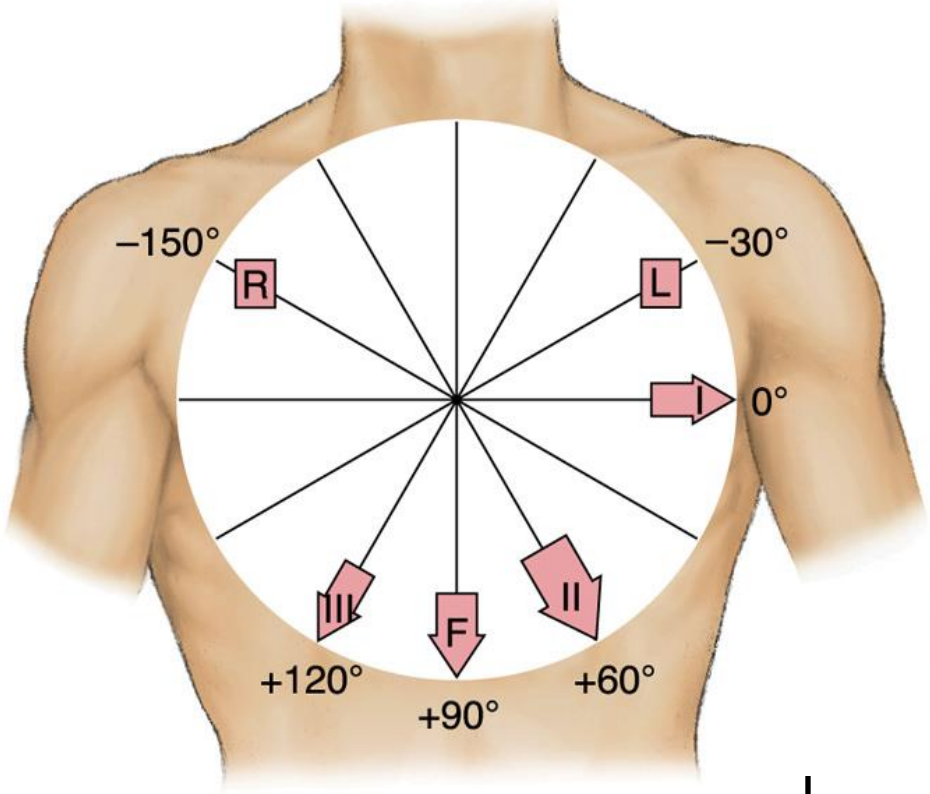
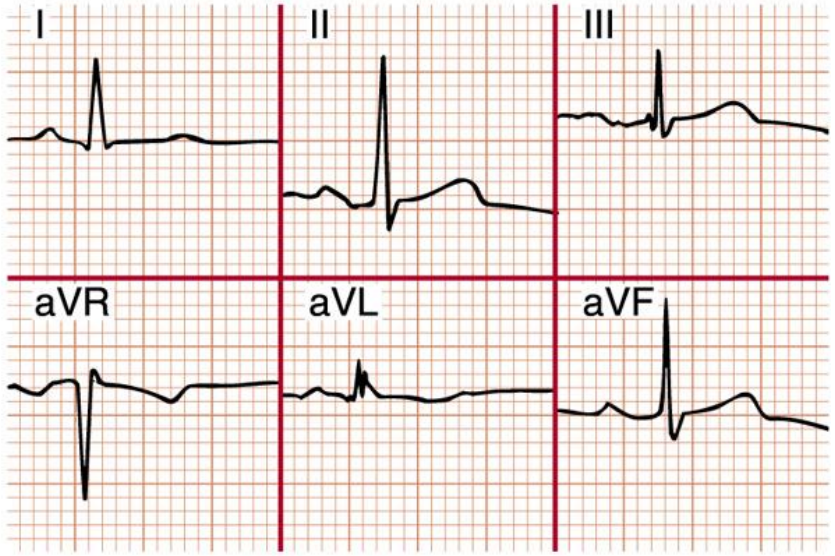
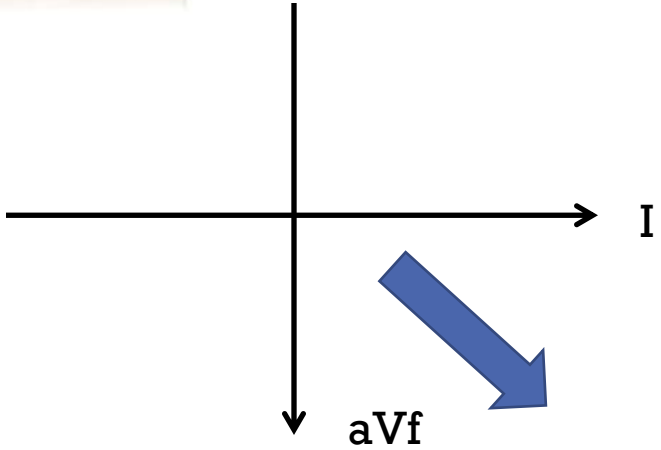
Axis?



ECG LEADS







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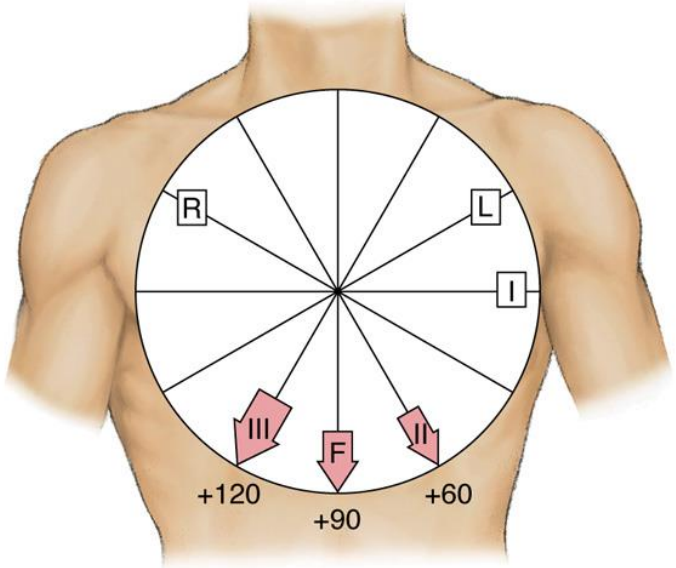
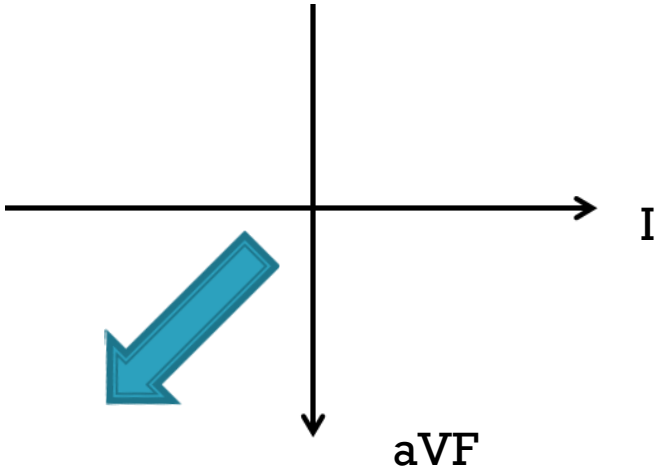
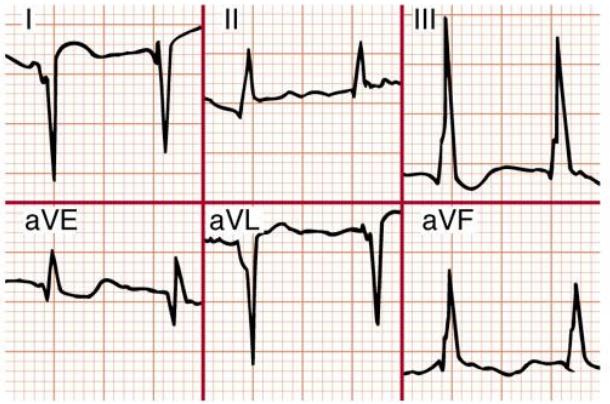
AXIS DEVIATION

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







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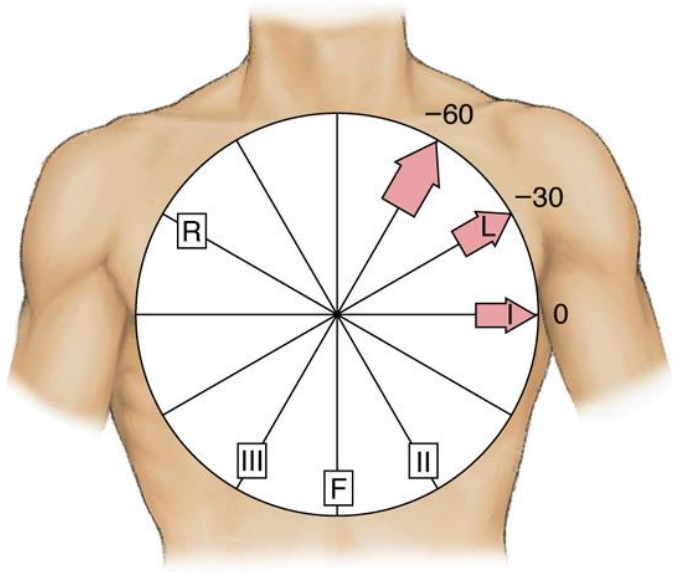
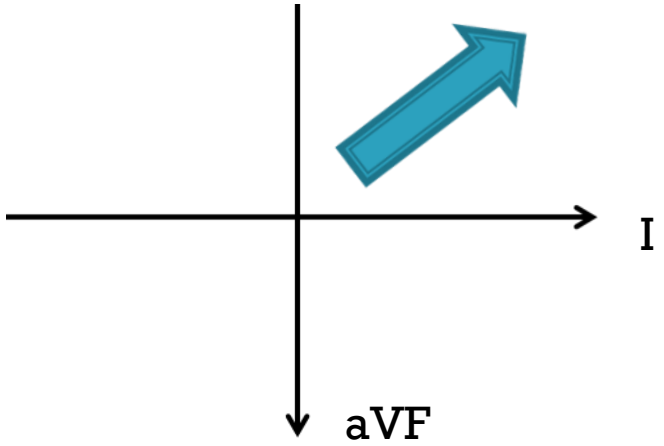
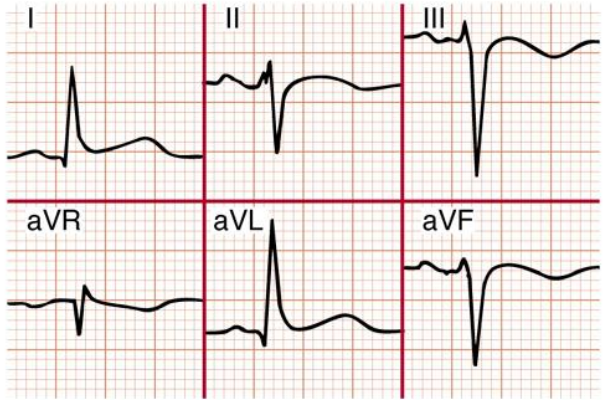
AXIS DEVIATION

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







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AXIS DEVIATION

- Rapid Axis Determination
  - Utilizes Leads I and aVf
  - I ↑ AND aVf ↑ = NAD
  - I ↑ AND aVf ↓ = LAD
  - I ↓ AND aVf ↑ = RAD

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PR INTERVAL?

- Normal
  - 0.12-0.20 sec

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

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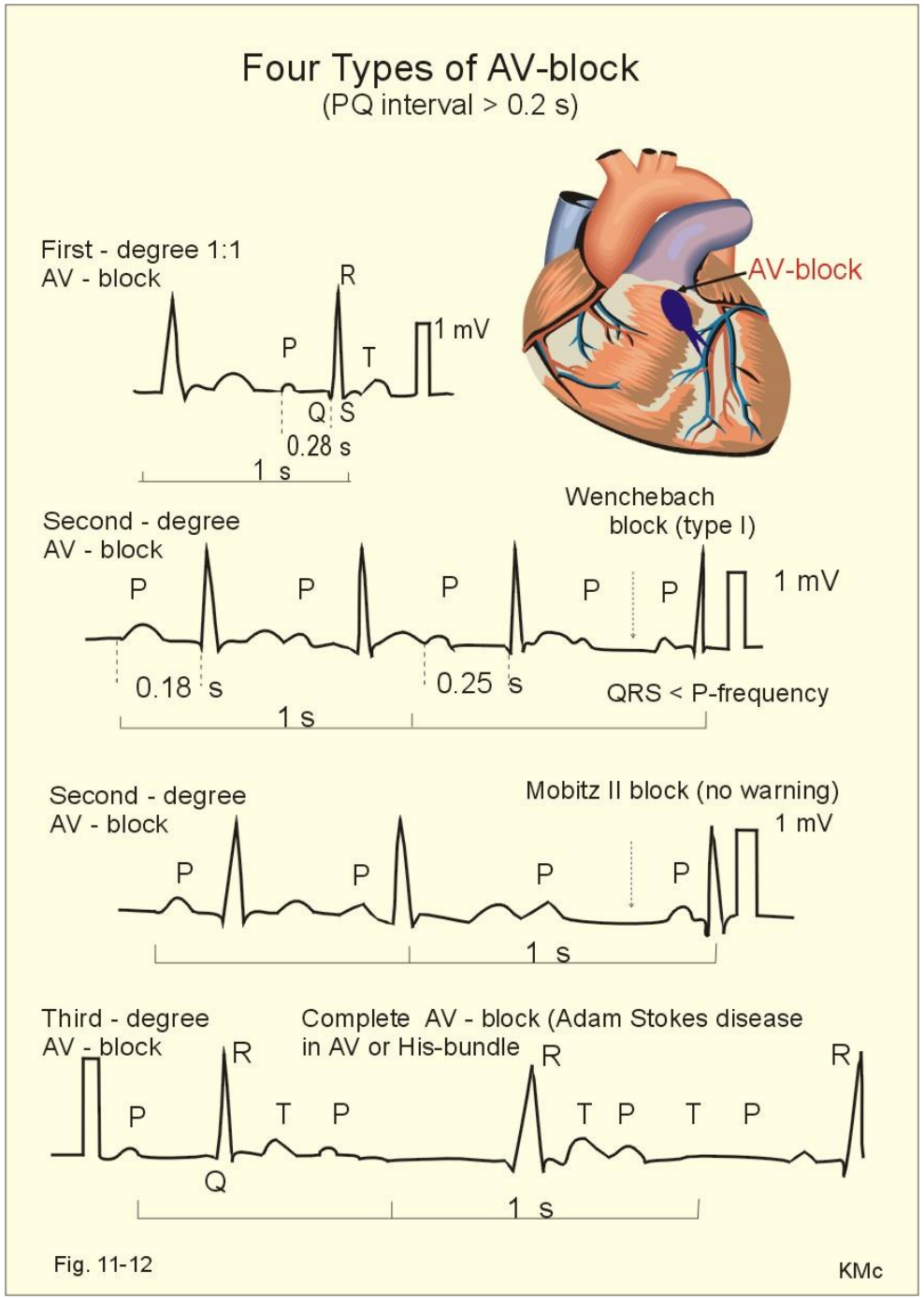
PR INTERVAL?

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



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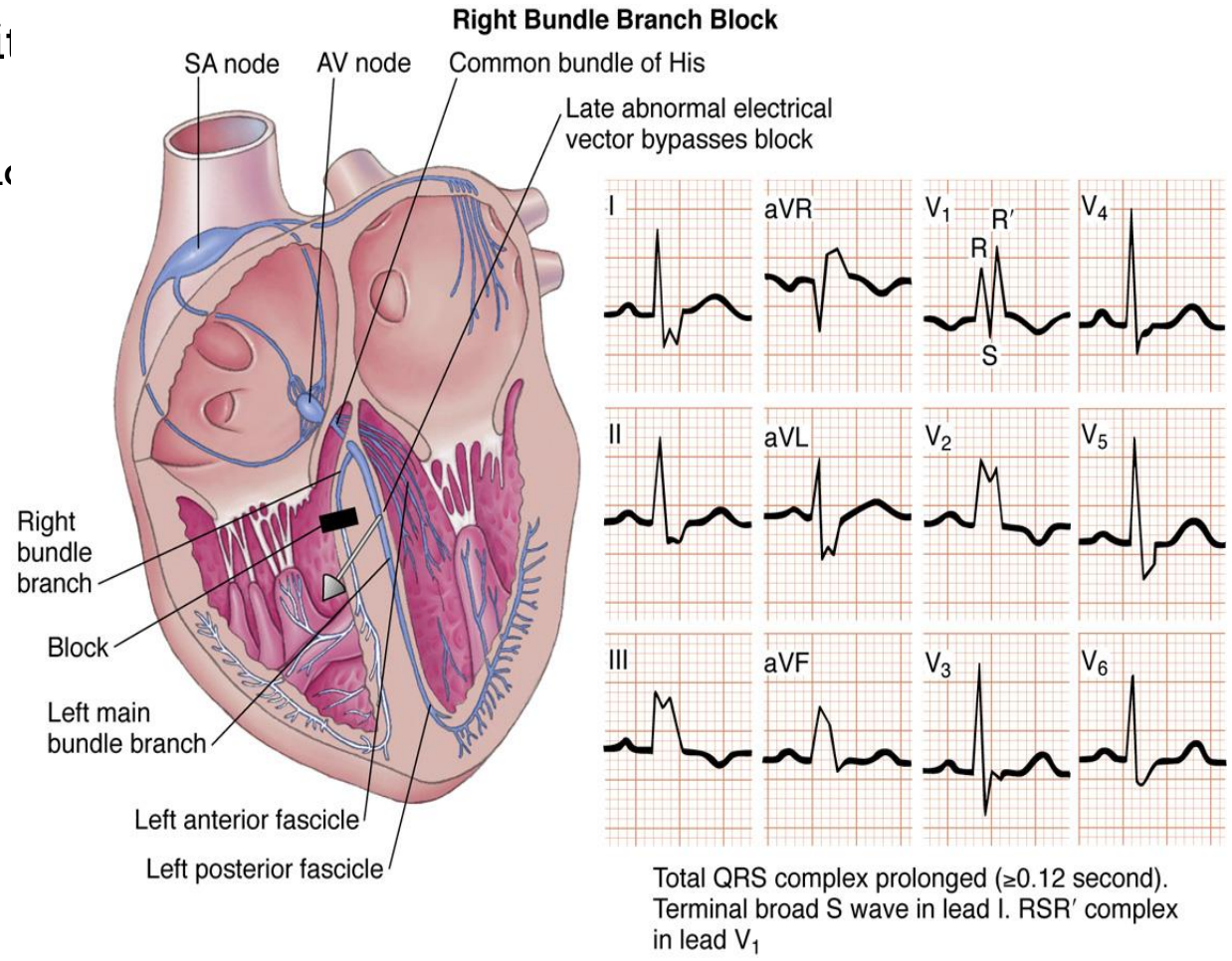
QRS?

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

DISEASE FINDINGS

- Conduction Abnormaliti
  - Bundle Branch Blocks
    - Right Bundle Branch Bl



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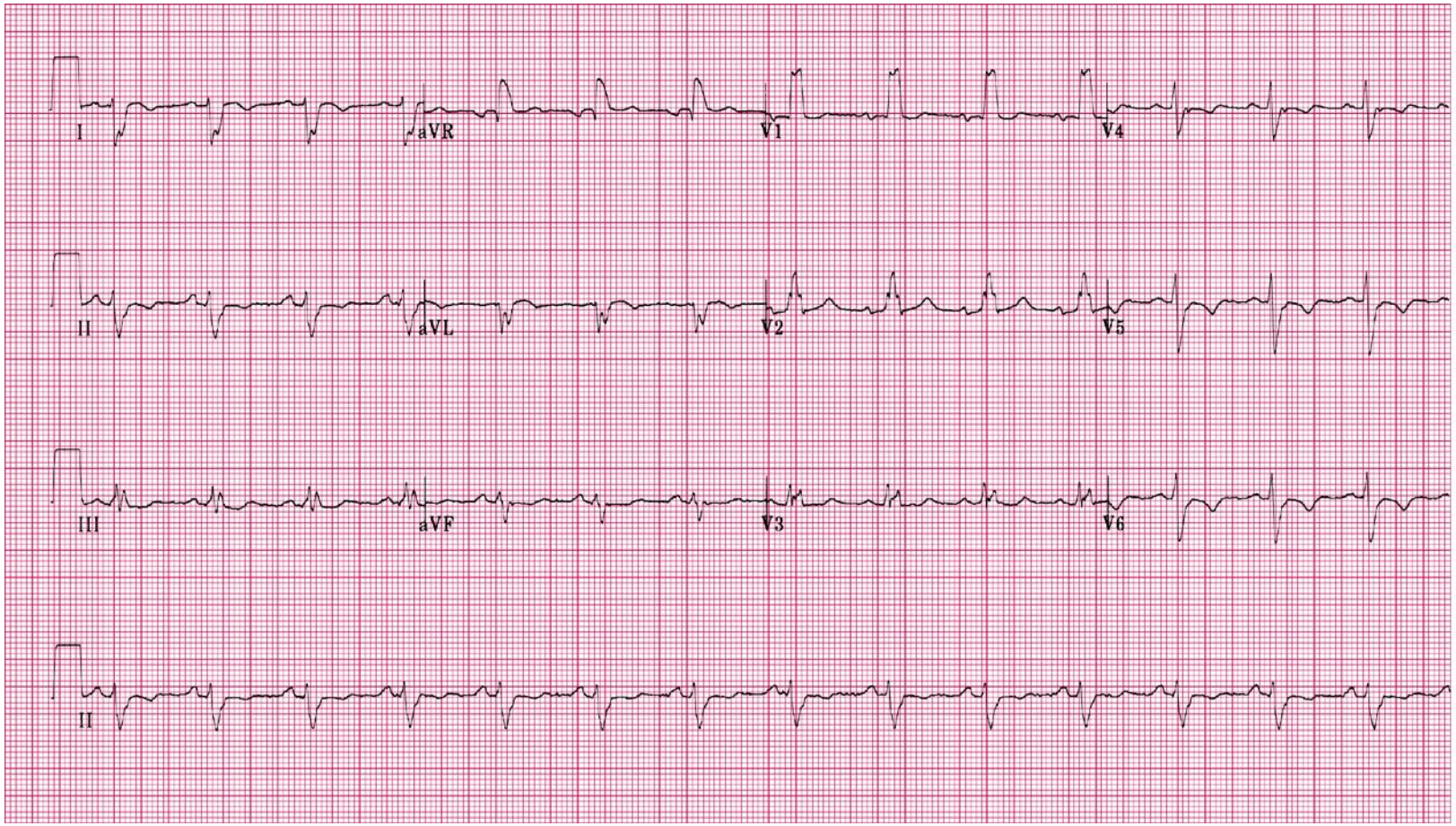
DISEASE FINDINGS

RIGHT BUNDLE BRANCH BLOCK



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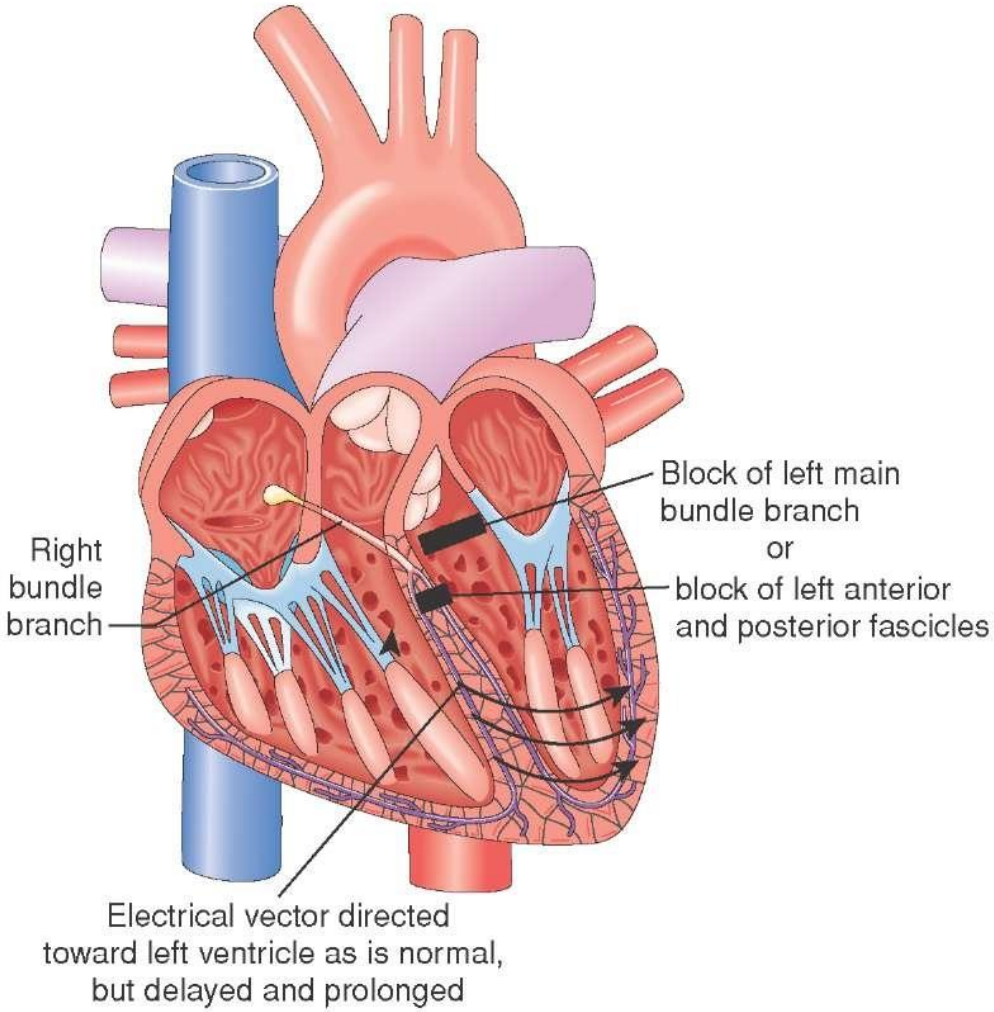

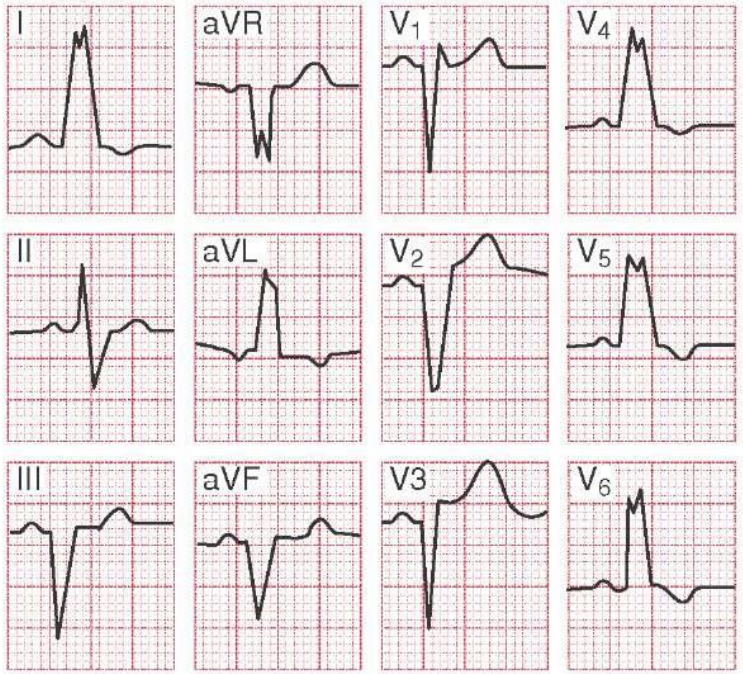

Wide QRS complex prolonged (≥ 0.12 second). with ST depressions and inverted T waves, particularly in leads I, aVL, V_5 and V_6

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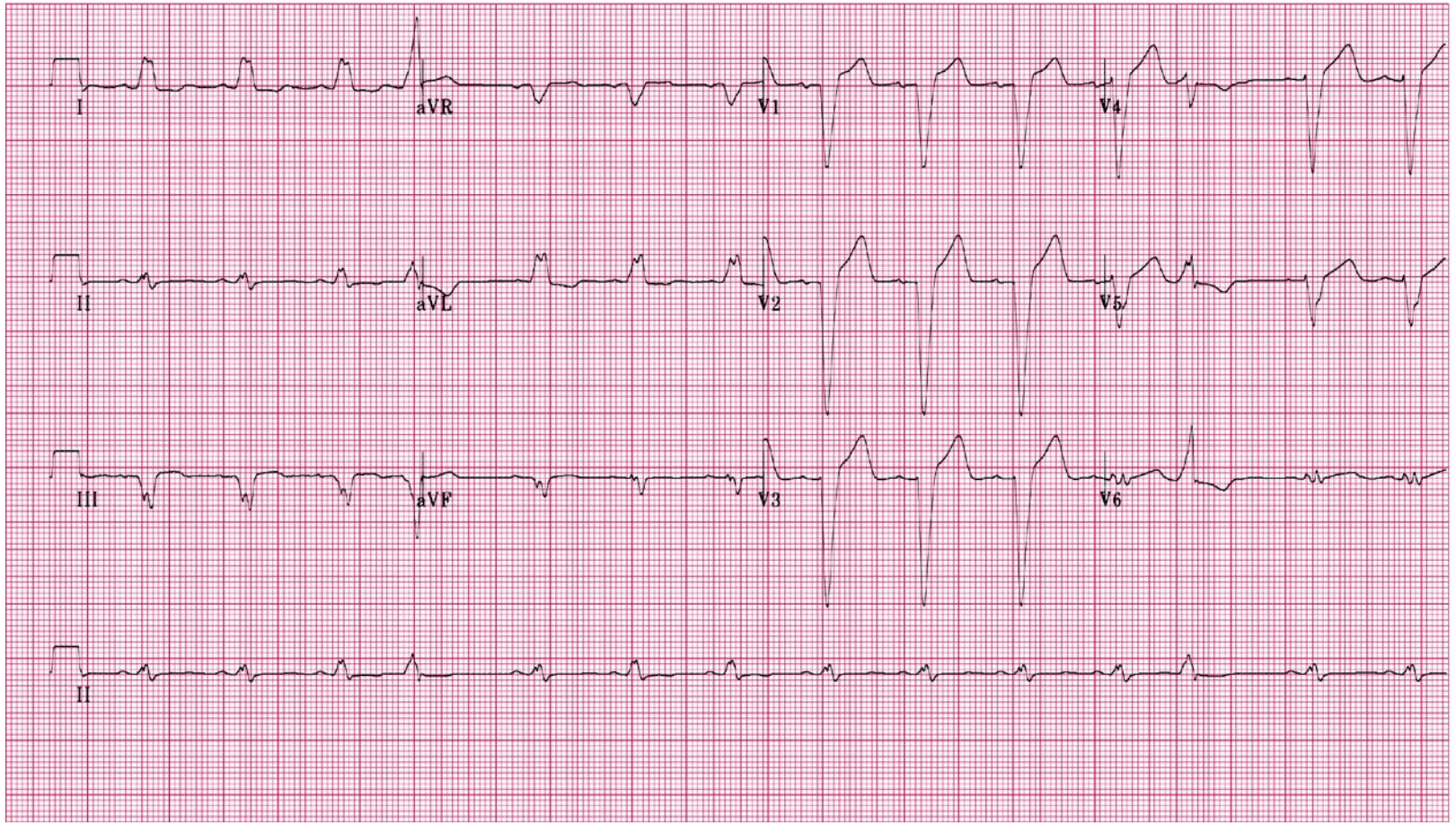
DISEASE FINDINGS

LEFT BUNDLE BRANCH BLOCK



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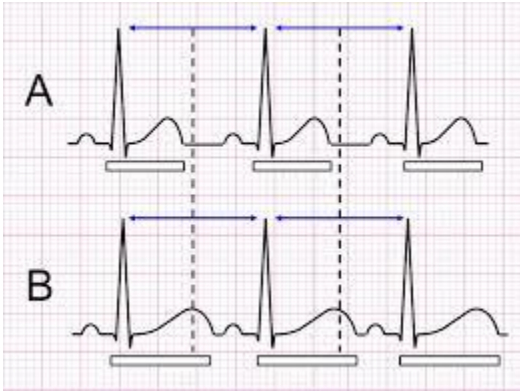
QTC?

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

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



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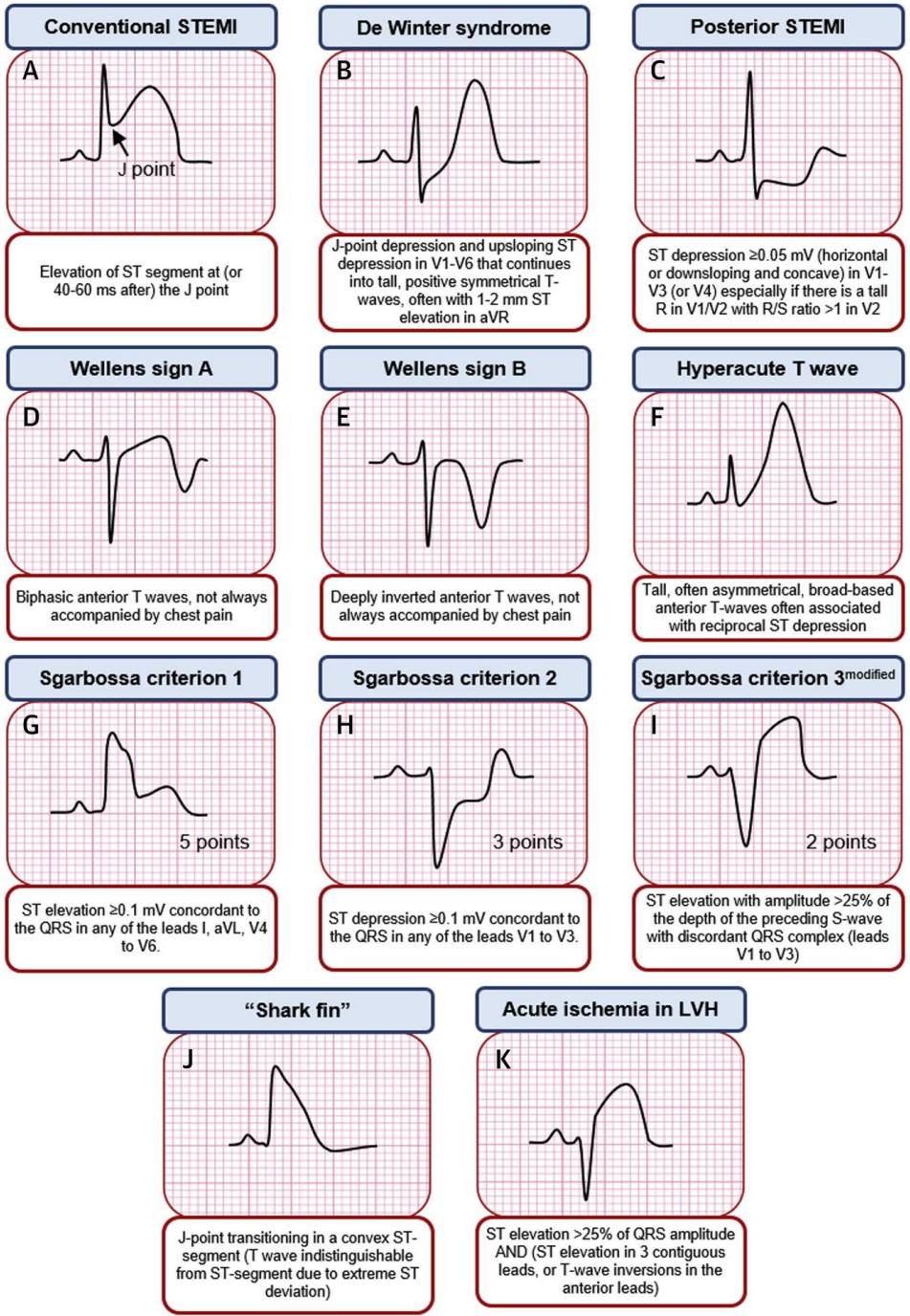
ANY OTHER CHANGES?

STEMI Equivalents



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