Questions?

- True or False: ST segment depression in the presence of LV hypertrophy is always secondary to ischemia.
- True or false: A normal variant will not produce J point elevation.
- Name 2 clinical conditions (excluding ACS) that can produce both chest pain and ECG changes.
Normal Variants

Early Repolarization

- Precordial ST elevation in most adults
  - Up to 90%
- Early repolarization most common normal variant
  - African American men < 50 years of age

? Increased Risk of Sudden Death
ST Elevation of Early Repolarization

- ST segments highest in V2-V3
- ST elevation up to 5 mm
- J point elevation
- Concavity, not convexity
- Tall peaked asymmetric T waves
- T waves are tall (not too tall) but not wide
- ST elevation < 0.5 m in lead V5 and V6
- T wave amplitude in V6 > V1
- No reciprocal ST depression
- Less common after age 55
ST Elevation of Early Repolarization

- Rarely seen in limb leads alone
- Right precordial early repolarization ("humpback")
- J wave (fishhook)

ECGs over time with early repolarization.

May be confused with or concurrent with LVH.
Persistent Juvenile T Waves

- Negative (inverted) T waves in V1-V3 (right precordial leads)
- Not “deep” inversions
- Usually in young, healthy women
- More common in African Americans

Note: Infants > 48 hours through childhood have inverted right precordial T waves. Progressive change to upright through late childhood.
rSr’ Pattern

- V1 and V2
- r’ amplitude < r
- QRS interval < 0.11 seconds

When r’ changes to R’, consider incomplete RBBB

? Fragmented QRS and non STEMI

ECG Mimics
ST Changes with RBBB

- Normal direction of T wave (discordant)
  - In V₁ – V₃
  - T wave inverted in leads with rSR' pattern
  - T wave upright in leads with S wave
- ST elevation is usually due to injury
- Measure QRS in easiest identified lead
- Determine the end of the QRS in any lead
ST Changes with LBBB

- Discordant ST and T waves in precordial leads
- LBBB typically manifest ST elevation certain leads in the absence of injury so assessment of STEMI is challenging
- Left BBB is common reason for delayed or withheld reperfusion
- New LBBB and clinical signs of AMI are indication for reperfusion therapy
- Old LBBB with increased ST elevation or specific indicators should also receive reperfusion

Diagnostic Strategies for AMI with LBBB

- √ Concordant ST elevation > 1 mm in leads where QRS is predominantly positive
  - V5, V6, I, aVL, II
- √ Concordant ST depression > 1 mm in one or more leads in leads where QRS is predominantly negative
  - V1 – V4
- √ Discordant ST elevation > 5 mm and disproportionate with the QRS voltage.
Left Anterior Hemiblock

Causes
- Ischemia
- Valvular disease
- Cardiomyopathy
- Congenital heart disease
- Rarely normal

- Blood supply received from septal branch of LAD (or AV nodal artery of RCA)

Left Anterior Hemiblock

- Block of anterior – superior fascicle of the LBB
- Left axis deviation
  - - 30° to –75°
  - Become suspicious at - 30°
  - Definitive at – 40 to 45°
  - Common at -60°
  
  Key for recognizing -60° Axis
  - aVR most equiphase limb lead

- Commonly seen in anterior wall MI
  - Low mortality if isolated

- Left anterior hemiblock in association with RBBB during AMI
  - Associated with left main occlusion and high mortality
**Left Anterior Hemiblock**

- Lead 2, Lead 3 and aVF
  - rS pattern
  - Small r waves
  - Slightly wide / deep S waves
  - Increased limb lead voltage
- Lead 1 and aVL
  - qR pattern
- Normal QRS duration

**LVH**

- Common reason for false positive ST elevation
- Anatomic LVH may be present in absence of ECG criteria
  - To ascribe ST elevation to LVH the ECG must meet the voltage criteria
Left Ventricular Hypertrophy

- V1 and V2
  - Deeper than normal S waves
  - Small r waves
- V5 and V6
  - Taller than normal R waves
  - Small S waves

LVH Voltage Criteria

- One or more voltage criteria
- Only applicable if QRS is < 120 ms

- Precordial lead voltage criteria
  - R-wave in V5 or V6 > 26 mm
  - R-wave in V5 or V6 + S-wave in V1 > 35 mm
  - Largest R-wave + largest S-wave in precordial leads > 45 mm
ST – T Wave Changes Secondary to LVH

- ST elevation is generally discordant
  - ST elevation in V2 - V3
  - ST elevation in lead III
  - ST depression in V4-V6
    - Previously called strain pattern
    - Down sloping – not horizontal

Not due to LVH
- ST elevation in lateral leads
- ST depression in V2-V3
Right Ventricular Hypertrophy

- RV Hypertrophy
  - Right Axis deviation is one of earliest signs
  - Reverse R wave progression
  - Dominant R wave in V1 and V2
  - Deep S wave in V5 and V6

Digitalis Effect

- Sagging depression of ST segment in leads with positive QRS
- Reduced T wave amplitude
- Increased U wave amplitude

- Difficult to evaluate if hypertrophy or BBB
Pericarditis: ECG Findings

- Mimics: anteroinferior; inferolateral; antero-infero-lateral MI
- ST Elevation
  - ST elevation typically greatest in II and V5 (also I and V6)
  - ST elevation may also be in V1 –V4; aVF, III and aVL (least)
  - Upwardly concave ST segments
  - ST elevation usually ≤ 5 mm
Pericarditis: ECG Findings

- Other ST changes
  - ST depression in aVR
  - Minimal depression V1, III, aVL may exist
- PR Segment depression
  - PR depression most common in II, aVF and V4 – V6
  - PR elevation > 0.5 mm in aVR
- Electrical Alternans
- Voltage changes with pericardial effusion or tamponade

Stages of Pericarditis

- Stage I
  - ST elevation
  - More concave
  - Lasts up to 2 weeks
- Stage II
  - ST to baseline
  - Decrease T wave amplitude
  - Lasts from days to several weeks
- Stage III
  - T wave inversion
  - Starts at end of second to third week
- Stage IV
  - Gradual resolution
  - T wave may stay inverted up to 3 months
Pericarditis

- Diffuse Pericarditis
  - Easiest to differentiate with both pain and ECG assessment

- Localized Pericarditis
  - May have reciprocal changes

Perimyocarditis
- Troponin
- Wall motion abnormalities

Classic Pericarditis
Pericarditis

Acute Cor Pulmonale

- Transient ECG changes
- ST or atrial tachycardia (or fib / flutter)
- T wave inversion (or other ECG signs of ischemia, injury, infarction) in both inferior and anteroseptal leads
- Elevated ST segments aVR and V1-V2
- Prominent S waves in I and aVL
- RAD or incomplete or complete RBBB
- Widespread S waves
- Prominent P waves in inferior leads (right atrial strain)
Acute Cor Pulmonale
Pain Mimics

Clinical Presentation of Aortic Dissection

- Chest or back pain with variation in upper extremity blood pressure is key assessment finding
  - Recurrent chest or back pain can indicate extension or rupture.

- Hypertension most important risk factor
Clinical Presentation of Aortic Dissection

- The presence of murmur of aortic regurgitation in the setting of chest pain is also suspicious for aortic dissection.

- ECG may be normal or show MI secondary to retrograde dissection.

Additional Mimics with Deep Symmetrical T Wave Inversion

- Adams – Stokes attack
- Hypertrophic cardiomyopathy
- Central nervous system disease
- Post extrasystolic T wave change
Additional Mimics of ST Elevation

- Hyperkalemia
- Intracranial bleed
  - Prolonged QT
  - Prominent U wave

Non MI Causes of Q Waves

- LVH
- RVH
- Cor Pulmonale
- Cardiomyopathy
- LBBB
- LAHB
- WPW
- Pulmonary Embolism
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