STUDENT ECG: ISCHEMIA, INJURY INFARCTION
ISCHEMIA

- Represents diminished blood flow to the myocardium and is a reversible phenomenon. ECG changes are due to altered repolarization (affecting ST segment and T waves).
- The subendocardium is the most susceptible due to coronary anatomy and high pressure in the ventricular cavity.
ISCHEMIA

ST&T waves

ECG changes include:

- T wave inversion, especially in transmural ischemia
- ST segment depression in subendocardial ischemia.
- These are not typically distinguished clinically.
ISCHEMIA

ST&T waves

- Clinically in an acute decrease in coronary blood flow, ST depression or T wave inversion is usually seen.

- In conditions where myocardial demand outstrips supply (e.g., exercise), ST depression is typically seen.

- ST and T wave changes are seen immediately, and typically resolve with treatment.
ISCHEMIA
ST&T waves

- Measure ST depression 0.08 sec. after the J point. Downsloping ST depression is the most specific for ischemia; upsloping is least specific, and horizontal is intermediate.

- T wave inversion and ST depression may be indicative of ischemia, but they can also be caused by a variety of conditions, including repolarization change from BBB, hypertrophy, or CNS events.
Ischemic T waves
69 year old with chest pain

Notice the symmetric T wave inversion in the anterolateral leads indicating ischemia.
Patient during stress test--

ST depression
INJURY

- A current of injury occurs if diminished perfusion or occlusion of a coronary artery persists beyond the ischemic phase. It may still be reversible.

- Usual ECG changes are ST segment elevation; ST segment depression can be seen in an evolving Non-ST elevation MI.
ST Elevation

- ST elevation should be present in 2 or more consecutive leads with at least 1mm ST elevation in limb leads and 2mm in precordial leads to be significant.

- With sensitive troponin assays, many MIs don't have associated ST elevation and are termed "non-ST elevation MI."
ST Segment Changes

- Horizontal ST depression
- Downsloping ST depression
- Upsloping ST depression
- Downsloping ST depression
ST elevation in an acute inferior MI
ST Elevation in an evolving Acute Anterolateral MI

The ST segment and T wave may become one.
Other Causes of ST Elevation

1-2 mm of ST elevation in leads V1-V3 may be a normal variant, but you must be very careful to interpret this in light of the clinical situation, and if it is new, it may be significant for an evolving MI.
ST ELEVATION-upsloping
Early Repolarization

- Seen mainly in young individuals, often males
- T wave starts early, during ST segment, giving the appearance of ST elevation. J point is elevated also.
- Common in individuals less than 30.
Early Repolarization

Notice the J point is elevated, and the ST segment begins early, slurring into the T wave.
35 year-old complaining of chest pain, worse lying down
The previous ECG shows diffuse mild ST elevation.

Taken together with the patients age and symptoms not typical for cardiac ischemia, pericarditis is a likely diagnosis.

Depression of the PR segment is also seen in pericarditis.
Infarction represents irreversible myocardial necrosis. Dead tissue is electrically silent so forces from opposite wall of heart predominate. Hence loss of R wave, or Q wave appears.

Q waves generally correlate with myocardial death, but not always. Some MIs do not have associated Q waves.

Q waves appear several hours to a day into an MI.
Q WAVES

- Should be present in 2 or more leads.
- Ignore them in aVR, and if present in isolation in V1 or III.
- Depth should be at least 25% of R wave height.
- Should be 0.04 sec. or longer.
- Generally ignore in LBBB, but they are significant in RBBB.
- Note that septal depolarization typically causes small Q waves in I, aVL, V4-V6.
Septal vs Pathologic Qs
Septal or Pathologic Q Waves?
Typical MI Progression

1. Initially T waves peak (often early, transient and may not be seen).
2. ST segments elevate within hours
3. Q waves (or loss of R wave) develop within 1-2 days.
4. ST segment elevation gradually resolve over several days. Inverted T waves may then develop.
5. Q waves or loss or R wave remain permanently.
6. Inverted T waves may or may not resolve.
MI Sequence

(The T wave may remain inverted indefinitely)
Acuity of MIs

- Generally ST elevation resolves over days to weeks and is an indicator of the acuity of an MI.

- Q waves without ST elevation would be termed an “age indeterminant” MI and could be weeks to years old.

- Post MI, T waves are often inverted, and may remain inverted permanently; therefore they don’t necessarily tell us about acuity.
Localization of MIs

(doesn’t always correlate anatomically)

- Anteroseptal: V1-V3 (may be more apical)
- Anterior: V1-V4 (V3-V4)
- Anterolateral: I, aVL, and V4-V6
- High lateral: I, aVL
- Lateral: V5, V6
- Inferior: II, III, aVF (need 2 of 3)
Localization of MIs

- Inferolateral: II, III, aVF, V5-V6, occ. I, aVL;
- Posterior: Tall R in V1, V2
  - Usually seen with an inferior MI
Acute Anterior MI
Inferior and Anteroseptal MI, age indeterminate
Posterior MI

- Often difficult to diagnose as changes may not be apparent in the standard 12 leads.
- Most common pattern is tall R waves in V1 and V2 with ST depression and/or T wave inversion.
- Usually are seen with inferior or occasionally lateral infarctions.
Posterior MI

Occlusion of the posterior descending coronary artery (usually a branch of the RCA)
Infero-Posterior MI-Tall R waves in V1 and V2
Reciprocal Changes

- Usually ST depression (opposite of ST elevation) in leads opposite MI.

<table>
<thead>
<tr>
<th>MI</th>
<th>Reciprocal Change</th>
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<tbody>
<tr>
<td>Anterior</td>
<td>Inferior</td>
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<tr>
<td>Inferior</td>
<td>I, aVL, occ. anterior</td>
</tr>
<tr>
<td>Lateral</td>
<td>V1, sometimes inferior</td>
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Anterior MI with inferior reciprocal change

notice inferior ST depression (reciprocal change)
Acute inferior MI with lateral and anterior reciprocal changes
T wave inversion

- Myocardial ischemia
- Repolarization from BBB or hypertrophy
- Normal variant
- Myocardial disease (cardiomyopathy, etc)
- Cerebral T waves (subarachnoid hemorrhage, etc)
- Chronic pericarditis
ST elevation

- Acute injury pattern leading to MI
- Acute pericarditis
- Early repolarization
- Ventricular aneurysm (persists after MI)
- Normal variant (esp V1-V3; 1-2 mm)
Q waves

- Myocardial Infarction
- From LBBB
- Fascicular blocks
- WPW
- Cardiomyopathy
- Normal if isolated in III, V1
- Septal Q waves (small)
Inverted T waves or ST depression--Ischemia

ST elevation without Q waves: Evolving Acute MI

ST elevation with pathologic Q waves: Acute MI, hours to days into event.

Q Waves without ST elevation: Age indeterminate MI
When Assessing an ECG for Ischemia/Infarct

- Look for T wave inversion, ST depression or ST elevation.
- Assess for pathologic Q waves.
- Look at R wave progression across precordial leads.
- You can do this via territories (inferior, etc) or by looking at individual leads sequentially.