ST Segment Elevation – When is it not an MI?

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Waves & Intervals = Electrical Information

- Electricity moving towards/away from electrode create downward/upward directions of waves

Leads = Spatial Information

- Frontal view — Limb leads: I, II, III, avL, avF, (avR)
- Horizontal view — Chest/precordial leads: V1-V6
- Lead Grouping — leads look at heart from same viewpoint (‘camera’)

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First three questions to ask with every EKG:

- Is it fast or slow?
- Is it regular or irregular?
- Are there P-waves – yes or no?

Then look at QRS complex, ST segments and T-wave

Look in ALL leads for

- P-waves
- Pacer spikes

Whenever possible, compare to old tracings
Period between ventricular depolarization and repolarization
- In normal state, isoelectric relative to PR interval
- Starts at junction of J-point and ends at beginning of T-Wave
- Often difficult to define as it is pulled imperceptibly into the ascending limb of T-Wave
- Gives T-Wave an asymmetrical appearance
- To establish true ST elevation, measured 0.08 msec (2 small boxes) out from J-Point
  - Same with ST depression!

ST Segment Morphology
- Upward concave → 'smiley face'
- Upward convex → 'sad face'
Common Causes of ST Elevation

- LVH
- Conduction defect (e.g. LBBB)
- Early repolarization
- Normal variant of ST elevation
- Concave ST elevation
- Spontaneously reperfused STEMI
- Aneurysm/old myocardial infarction
- Pericarditis/myocarditis
- Wolf-Parkinson-White syndrome (pre-excitation)
- Brugada pattern
- Takotsubo (apical ballooning) syndrome
- Hyperkalemia
- Hypercalcemia

Differential Diagnosis of ST Elevation

- “Doesn’t hurt and isn’t dangerous”
  - Early Repolarization
  - LBBB, (Ventricular Pacing, LVH)
- “Hurts and is dangerous”
  - MI, pericarditis, (coronary artery spasms = Prinzmetal’s Angina)
- “Doesn’t hurt, but is dangerous”
  - Ventricular aneurysm
  - (Hyperkalemia)

Early Repolarization

- Normal Variant commonly seen in young people, but can persist
  - concave upwards with tall upright Twaves
  - usually seen in the middle precordial leads
  - J-point elevation (where QRS joins the concave ST elevation)
    → “J-wave”
  - no reciprocal changes
  - “Fish-hook”, “Smiley Face”
ST-segment elevation (long arrow) in all leads without reciprocal depression.

Peaked T waves (short arrow) in the middle precordial leads - no Q waves present.
Broad monophasic R ('big ugly bizarre')
- QRS complex >0.12 sec
- V1-2: rS or qS with ST elevation, T wave upright → QRS negative V1
  - Discordance of QRS and T wave
- V5-6: Slurred notched monophasic R or rsR
- Cannot easily diagnose acute MI or ischemia in presence of LBBB
Associated with classic STT wave changes and taller/wider QRS → 'strain pattern'
- Twave oriented opposite to QRS direction
- Discordance of QRS and T waves
- "Hockey sticks"
- Causes ST elevation in the right precordial leads (V1-3) with deep Swaves

Many different criteria, most commonly used:
- Limb leads: R in I >14mm, or R in avF >21mm, or R in avL >12mm
- Precedial leads: R in V5-6 + S in V1 >35mm, or any precedial R + S >45mm
Pericardial fluid
- 50cc normal
- >100cc = effusion
- >250cc = enlarged silhouette on CXR

Signs:
- Diffuse ST elevation, PR depression (hallmark of pericarditis), Sinus tachycardia
- Low voltage and electrical alternans (QRS tall-short-tall-short...) \(\rightarrow\) late signs with large effusions

Causes:
- Trauma, infection, cancer, autoimmune, renal, post-MI (Dressler’s syndrome), idiopathic, ...
ST segment (long arrow) elevated in all leads (universal elevation in contrast to focal elevation in acute MI) without reciprocal change.

Elevation = upward concavity ("smiling face"). PR interval (short arrow) depressed due to inflammatory changes.

Pericarditis
Myocardial Infarction

What sets STEMI apart from other types of ST elevation?
- Magnitude of elevation
- Morphology
  - ‘sad face’ vs ‘smiley face’, upward convex, rounded ST segment
- Distribution
  - Coronary perfusion territory, such as RCA/LAD/LCx territory
  - Lead grouping correspond to perfusion territory and allow localization of MI

STEMI Evolution

Hyperacute phase (very early - minutes)
- ST elevation with tall/upright Twaves, “tombstones”, “fireman’s hats”, no Qwaves

Acute to fully evolved phase (early – minutes to hours)
- ST begins to drop, Qwaves form, T begins to invert

Recent – resolution phase (days to weeks)
- ST segments almost back to baseline with Twaves inverted, Qwaves more pronounced

Old/remote – stabilized phase (months to years)
- Permanent Qwaves, isoelectric ST segments, Twaves typically back to baseline

Early evolving MI
Complication of MI
Thinning and ballooning of ventricular wall
Can lead to thrombus, lethal arrhythmia or rupture
Hyperkalemia

- Series of changes based on K+ levels
  - P wave flattening, peaked T Wave ("tenting"), widening of QRS
  - EKG changes usually seen with K+ >7
  - With K+ >9, sine wave develops
- Heart blocks and ventricular arrhythmia
  - Sinus bradycardia, sinus arrest, AV Blocks, Vtach/Vfib
- Death by arrhythmia
  - Rapid and unpredictable progression to malignant arrhythmia and cardiac arrest

Hyperkalemia (K+ 8.6)
LBBB

STEMI

Sgarbossa/Modified Sgarbossa’s Criteria: LBBB versus STEMI

Sgarbossa’s criteria
- Three criteria are included in Sgarbossa’s criteria
  - ST elevations ≥ 2 mm at V1–V2 or at the J point in leads I, aVL, or V5–V6
  - ST depression ≥ 1 mm in the inferior leads (II, III, aVF)
  - ST depression ≥ 2 mm in the anterior leads (V1–V3)
- A score of 3 or more = highly suggestive of STEMI

ST Segment Depression
- Most commonly a sign of ischemia
- Other causes
  - Normal variant or artifact
  - Physiologic J-point depression with tachycardia
  - LVH
  - Hypokalemia
  - Digoxin
  - BBB
  - WPW
  - Neurogenic/CNS disease
**NSTE MI**

- Diagnosis by cardiac enzymes
  - Levels of enzymes usually lower than with STEMI
  - Good history taking important to raise suspicion for NSTEMI
- Localization by STTwave changes in specific leads not valid
- Evolving STTwave changes may include:
  - Downward ST depression (common)
  - Twave inversion (common)
  - No Qwave development (submural vs transmural)

**ST Depression**

- Evolving STTwave changes may include:
  - Downward ST depression (common)
  - Twave inversion (common)
  - No Qwave development (submural vs transmural)

**Resolution of STTwave changes post-PCI**

- Resolution of STTwave changes post-PCI
Resources

- [healio.com/cardiology/learn-the-heart](healio.com/cardiology/learn-the-heart)
- [lifeinthefastlane.com/ecg-library/](lifeinthefastlane.com/ecg-library/)
- [ecgguru.com/](ecgguru.com/)
- [ecgcours.com](ecgcours.com)
- [hqmeded-ecg.blogspot.com](hqmeded-ecg.blogspot.com)
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