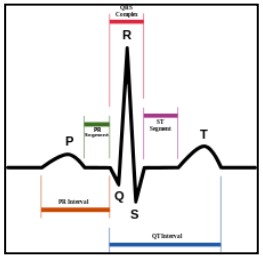
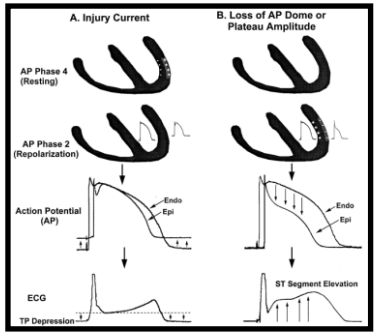
ST-Segment Elevation on ECG



Introduction

- Normally, the ST segment is a flat, isoelectric section between the end of the QRS complex (ie. J point) to the beginning of the T wave.
- Represents the transitional time during ventricular depo to repolarization.
- Measure in relation to the end of PR segment or T-P segment.
- 50-80% of patients with STE had diagnoses other than MI.
- 5-10% of patients underwent PCI or thrombolysis did not have MI. (NEJM 2003;349:2128-35).

Mechanism Underlying ST segment elevation



A. "Injury current": The"injury zone" is in the epicardium, with a reduction in resting membrane potential, produces an injury current during resting phase → TQ depression (instead of ST-segment elevation)

B."loss of AP dome or plateau amplitude": A difference in the AP plateau amplitude generates a transmural voltage gradient → ST-segment displacement.(True ST-segment elevation)

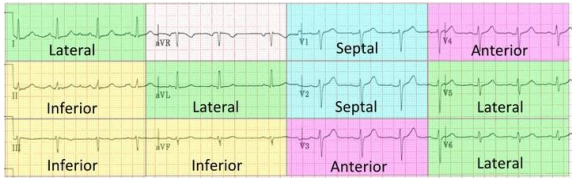
(JACC 2003;42:401–9)

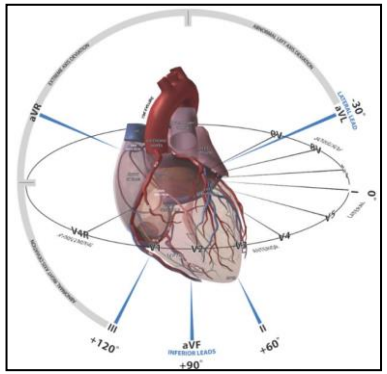
Clinical Note:

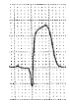
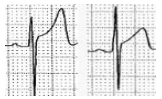
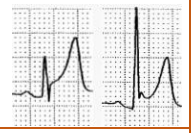
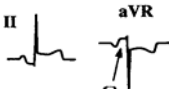
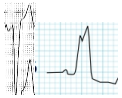
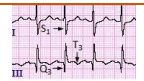
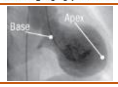
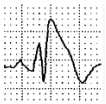
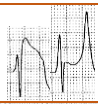
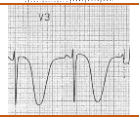
- Always start with H&P not the ECG.
- See table for common causes of STE on ECG.
- Other causes of STE may include myocarditis, post DC cardioversion (15%, last a few minutes, memory T wave?), ARVD, DCM, WPW (pseudo Q), pancreatitis, cholecystitis, external heart compression (tumor), too high chest lead, Tricyclic antidepressants or phenothiazines, scorpion bite.
- Recommend reading Wang K. NEJM 2003;.22: 2128-35, 3rd universal definition of MI JACC 2012.

Acute MI (STEMI)

- ECG diagnosis of STEMI (3rd universal definition of MI JACC 2012):
  - New ST elevation at the J point in 2 contiguous leads
  - In V2, V3 > 0.2 mV in men > 40 yo,
    > 0.25 mV in men <40 yo,
    > 0.15 mV in women
  - In other leads; > 0.1 mV
- Other causes of STE may meet the criterion for STEMI according to guideline, and thrombolytic or PCI may be harmful.
- Understand axis (in vertical and horizontal plane is crucial for thinking of coronary representation on ECG.





Condition	Note	STE features	ECG Example
STEMI JACC2012;60:1581-98	• Clinical + ECG + cardiac marker • usually described as plateau, shoulder, upsloping, tombstone • Dynamic changes	Convex STE Q, Loss of R wave TWI Reciprocal changes	
Normal (so-call male pattern) JACC2002;40:1870-6	• seen in healthy young men • ↓ Prev. with ↑age. (90% in 20s, 30% in 70 yo men. • The deeper the S the greater the STE	Concave, 1-3 mm STE Mostly in V2	
Early repolarization	• Normal variant? • Young black athlete male. • Early repolarize = short QT, high QRS voltage, where as it is not in AMI or pericarditis.	Concave STE Most in V4 notch J -"fish-hook" Large not inverted T May see PR depression	
Acute Pericarditis Circ2006;113:1622-1632	• Sub-epicedial involvement causing STE • Elevation seldom >5 mm • STE axis usually at 45 degree	Diffused, concave STE Depressed PR Reciprocal ST/PR segment in aVR	
Left ventricular hypertrophy	• Most common cause of STE in ED patient with chest pain	Concave, V1-V3 See LVH criteria	
Left bundle branch block	• abnormal depolarize sequence → abnormal repolarization •Sgarbossa criteria for dx MI in patient with baseline LBBB (NEJM 1996;334:481-7)	Concave STE, V1-V3 ST-QRS discordant (the opposite direction between ST & QRS)	
Pulmonary embolism	• RV pressure overload, dilate, and ischemia • Mild ↑ troponin	STE in inf, antˢseptal S1Q3T3 (~20%) Sinus tachycardia	 The $S_1Q_3T_3$ pattern
Takotsubo	• Transient left ventricular apical ballooning, stress induced CM. • DDx: occlusion of wrapping LAD.	ECG indistinguishable from STEMI	
Brugada syndrome JACC 1992;20:1391-6 Europace 2014;16: 1257–1283	• loss function of Na channel (SCN5A gene) → loss of AP dome in the RV epicardium (Circ 1999;100:1660-1666) • Unmasked by class 1C.	rSR' in V1,V2 Downsloping STE Begin at top of R' wave TWI	V2 
Hyperkalemia	• Tall T/ P หาย / wide QRS/ sine wave • DDX with hyperactue T in AMI	Downsloping Bizarre- looking STE	
Subarachnoid hemorrhage	• Catecholamine flooding • May have the same patho with Phaeochromocytoma • +/- RWMA	Deep, symmetrically TWI QT prolong ↓HR (cushing reflex)	
Hypothermia Circ2008;118:977-978	• Osborn wave • DDx : HyperCa (short QT)	Prominent J wave "slurred" downstroke QRS complex	
Left ventricular aneurysm	• Same patient setting as STEMI w/o acute chest pain • the Taller T, smaller QRS amplitude, the more like AMI than aneurysm. Tw/QRS ratio > 0.36 = AMI (sens.90%)	Concave/convex Well-form Q wave No reciprocal ST segment change