EKG Boot Camp: Ischemia and Infarction
Systematic Approach

- Heart Rate
- Rhythm
- Intervals
- Axis
- Voltage
- R Wave Progression
- Q Wave
- ST segments
- T waves
- Device Involvement
QRS complex

- Q wave – may or may not be present, always negative
- R – first positive deflection
- R’ second positive deflection
- S – negative deflection following R
- S’ – second negative deflection
ST Segment

• In limb leads, the ST segment is isoelectric, may be slightly elevated or depressed by less than 1 mm
• In precordial leads, the ST segment may be elevated 1-2 mm
• The J point is where the QRS complex and the ST segment meet
ST Depression

Parameter Values:
- Age: 69 years
- Height: 179lb
- Vent. rate: 60 BPM
- PR interval: 160 ms
- QRS duration: 96 ms
- QT/Qtc: 484/484 ms
- P-R-T axes: 27 -13 124

Technician: LOURDES CRUZ
Test ind: CHEST/PAIN

[ECG waveform image]
ST Depression
T waves

- Ventricular repolarization
- Usually oriented in the same direction as the QRS
- Slightly asymmetrical
- Height less than 5mm in the limb leads
- Height less than 10mm in precordial leads
T Wave Inversion

- T wave inversion suggestive of ischemia or injury
- T waves should be pos I, II
- Inversion is common in V1, may occur III, aVL aVF and be normal
- Inv in V2-V6 suggestive of ischemia/injury
- Symmetrical T wave inversion develops after terminal TWI, common in NSTEMI
- Post STEMI, TWI is a sign of reperfusion
TWI
Always compare to the patient’s prior EKG
Ischemia

• Usually indicated by ST changes
  – Elevation = Acute infarction
  – Depression = Ischemia
• Can manifest as T wave changes
• Remote ischemia shown by q waves
ST Segment Elevation Patterns

- Hyperacute T wave – may occur as early as 2 mins post myocardial occlusion
- J Point Elevation
- Subtle ST elevation forming broad T wave
- *If there is elevation in limb leads, I, II, III, then worry*
- *If there is depression in the V leads, then worry*
ST Elevation

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
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<tbody>
<tr>
<td>Age</td>
<td>34 yr</td>
</tr>
<tr>
<td>Sex</td>
<td>Male</td>
</tr>
<tr>
<td>Weight (lb)</td>
<td>210</td>
</tr>
<tr>
<td>PR interval (ms)</td>
<td>172</td>
</tr>
<tr>
<td>QRS duration (ms)</td>
<td>106</td>
</tr>
<tr>
<td>QT/QTc (ms)</td>
<td>412/414</td>
</tr>
<tr>
<td>P-R-T axes</td>
<td>81/92</td>
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</table>
ST Elevation
ST Elevation
Ischemia and Infarction

- ST segment depression
  - Ischemia/Subendocardial
- T Wave Inversion
  - Ischemia/Injury
- ST segment elevation
  - Injury/Transmural
- Q Wave
  - Old MI
EKG Distributions

- Septal V1–V2
- Anterior: V3–V4
- Anteroseptal: V1–V4
- Lateral: V4–V6, I, aVL
- Inferior: II, III, and aVF
- Inferolateral: II, III, aVF, and V5 and V6
# Lead Representation of the Heart

<table>
<thead>
<tr>
<th>I</th>
<th>Lateral</th>
<th>aVR</th>
<th>V1</th>
<th>Septal</th>
<th>V4</th>
<th>Anterior</th>
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</thead>
<tbody>
<tr>
<td>II</td>
<td>Inferior</td>
<td>aVL</td>
<td>V2</td>
<td>Septal</td>
<td>V5</td>
<td>Lateral</td>
</tr>
<tr>
<td>III</td>
<td>Inferior</td>
<td>aVF</td>
<td>V3</td>
<td>Anterior</td>
<td>V6</td>
<td>Lateral</td>
</tr>
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</table>
Evolution of MI
Evolution of MI
Evolution of MI
Pathologic Q Waves

• A Q wave is the first negative deflection after the P wave.
• A pathologic Q wave is greater than .04 seconds wide (1 little box on the EKG paper) in 2 contiguous leads excluding V1, III.
• Depth is 1/3 the height of the R wave.
• 50% of adults have non-diagnostic Q wave
You are asked to review an ECG from an asymptomatic 73yo male scheduled for prostate surgery – is there an inferior MI?
Inferior Q wave inconsistency

Asymptomatic 73-Year-Old Male (7/10)
Coronary Arteries Supply to the Myocardium

- Anterior LV – LAD
- Lateral LV – LCx (OM)
- Posterior LV – RCA (PDA), LCx (OM)
- Inferior LV – RCA (marginal)
- Septum – LAD, RCA (PDA)
- RV - RCA (marginal/PDA)
## Reciprocal Leads

<table>
<thead>
<tr>
<th>SITE</th>
<th>FACING</th>
<th>RECIPROCAL</th>
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<tbody>
<tr>
<td>SEPTAL</td>
<td>V1, V2</td>
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</tr>
<tr>
<td>ANTERIOR</td>
<td>V3, V4</td>
<td>NONE</td>
</tr>
<tr>
<td>ANTEROSEPTAL</td>
<td>V1, V2, V3, V4</td>
<td>NONE</td>
</tr>
<tr>
<td>LATERAL</td>
<td>I, aVL, V5, V6</td>
<td>II, III, aVF</td>
</tr>
<tr>
<td>ANTEROLATERAL</td>
<td>I, aVL, V3, V4, V5, V6</td>
<td>II, III, aVF</td>
</tr>
<tr>
<td>INFERIOR</td>
<td>II, III, aVF</td>
<td>I, aVL</td>
</tr>
<tr>
<td>POSTERIOR</td>
<td>NONE</td>
<td>V1, V2, V3, V4</td>
</tr>
</tbody>
</table>
Reciprocal ST Depression

ST Elevation
aVR Elevation
Posterior MI Criteria

- ST depression in V1-V3
- Prominent R>S in V1-V3
- Upright T waves in V1-V3
- Often coexisting with inferior-lateral MI
- True posterior MI involves the left Cx artery
R>S, ST Depression, Upright T Waves

ST Elevation
Now compare with a normal ECG
Right Ventricular Infarct

- RVI should be considered in all pts who have an inferior MI (found in 1/3 of pts)
- Right-sided ECG, echo, and invasive hemodynamic monitoring also be helpful in diagnosis
- Elevated JVD, Hypotension and clear lung fields suggests RVI
- Treatment: volume load with NS
Right Ventricular Infarct Criteria

- ST elevation > 1mm in V4R-V6R
- Concurrent Inferior and Infero-posterior MI
- V5 and V6 are reciprocal to RV MI

*Treatment: fluid loading*
Right Ventricular Myocardial Infarction
Coronary Arteries Supply to the Conduction System

- SA node: RCA (LCx)
- AV node: RCA (LCx)
- His Bundle: RCA
- Bundle Branches: LAD

*Bradyarrhythmias/conduction disturbances are well recognized complications of acute MI*
Bradyarrhythmias that occur early in the setting of an inferior MI within the first 24 hours may respond to atropine
Conduction Disturbances and Infarct Location

• Inferior MI
  – Sinus brady most common arrhythmia, but Mobitz I and CHB also seen
  – High degree AV block located **above** the His
  – Usually resolves

• Anterior MI
  – Mobitz II, BBB, CHB
  – High degree AV block located **below** the AVN
  – Ppm for pts at high risk for CHB (2 or more: PR prolongation, 2nd degree AVB, left ant or post fascicular block, LBBB, RBBB)
84 yo woman with syncope

Mobitz II

ST Elevation
72 year old man with nausea and dyspnea

ST Elevation with Reciprocal Changes

Mobitz Type I: Wenckebach PR Prolongation
44 year old man with dyspnea

CHB

Anteroseptal MI
“It's not looking good. His pulse is up to 202 just from getting out of the chair and stepping on to the treadmill.”

A few others
65 year old female with acute subarachnoid hemorrhage

T wave inversion in precordial leads
A 36yo male presents with severe CP – EKG is consistent with: a) early repolarization b) ant MI
c) pericarditis d) inf ischemia
A 36yo male presents with severe CP – EKG is consistent with: a) early repolarization b) ant MI c) **pericarditis** d) inf ischemia
Chest Pain Status: Chief complaint

Rate  84  . NORMAL SINUS RHYTHM, RATE 84  . normal P axis, PR, rate & rhythm
PR   159  . ST ELEV, PROBABLE NORMAL EARLY REPOL PATTERN  . ST elevation, age 16-55
QRS  73
QT   342
QTc  404

---Axis---
P  54
QRS  90
T   49

- OTHERWISE NORMAL ECG -

Unconfirmed diagnosis.
51 yo female with pericardial effusion

Diagram:
- Low voltage
- Electrical alternans

Electrocardiogram leads:
- I
- aVR
- V1
- V4
- II
- aVL
- V2
- V5
- III
- aVF
- V3
- V6
Case Studies
89yo female presents with dyspnea and back pain
46 year old man with chest pain

Acute Pericarditis:
Diffuse ST elevation
PR depression
71yo female with nausea, dyspnea and general malaise. ECG changes in V2 are due to: Ant ischemia or Post injury
71yo female with nausea, dyspnea and general malaise. ECG changes in V2 are due to: Ant ischemia or Post injury
In 2011
The Eastern Cougar, a subspecies of the North American Cougar,
went extinct.
Remember hearing about it?
Me neither.

In 2012, Twinkies
were threatened with extinction and the entire country
lost its shit.