12 Lead ECGs: Ischemia, Injury & Infarction

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STEMI Coordinator
Flight Paramedic
Disclosures

- None
Objectives

- Upon completion of this program the learner will be able to
- Describe the conduction system of the heart.
- Discuss the sites of action potential generation and propagation through the cardiac conduction system.
- Choose proper placement of electrodes based on ECG mechanics.
- Calculate a heart rate from an ECG strip
- List injury locations and coronary arteries involved.
- Analyze how the following 12 lead EKGs would look.
  - Ischemia
  - Injury
  - Infract
- List nursing interventions associated with common 12 leads
- Describe the nursing interventions intended to correct the effects of insufficient tissue perfusion associated with ischemia, injury, infarcts seen on 12 lead.
Ischemia, Injury & Infarction

• Definitions
• Injury/Infarct Recognition
• Localization & Evolution
• Reciprocal Changes
• The High Acuity Patient
The Three I’s

• Ischemia
  • lack of oxygenation
  • ST segment depression or T wave inversion

• Injury
  • prolonged ischemia
  • ST segment elevation

• Infarct
  • death of tissue
  • may or may not show a Q wave
Injury/Infarct Recognition

Well Perfused Myocardium

- Epicardial Coronary Artery
- Lateral Wall of LV
- Septum
- Interior Wall of LV
- Positive Electrode
Injury/Infarct Recognition

Normal ECG
Injury/Infarct Recognition

Ischemia

- Epicardial Coronary Artery
- Lateral Wall of LV
- Septum
- Left Ventricular Cavity
- Inferior Wall of LV
- Positive Electrode
Injury/Infarct Recognition

• **Ischemia**
  - Inadequate oxygen to tissue
  - Represented by ST depression or T inversion
  - May or may not result in infarct or Q waves
Injury/Infarct Recognition

ST Segment Depression
Injury/Infarct Recognition

Injury

Thrombus

Ischemia
Injury/Infarct Recognition

- Injury
  - Prolonged ischemia
  - Represented by ST elevation
    - referred to as an “injury pattern”
  - Usually results in infarct
    - may or may not develop Q wave
Injury/Infarct Recognition

ST Segment Elevation
Injury/Infarct Recognition

Infarct

Infarcted Area Electrically Silent

Depolarization
Injury/Infarct Recognition

- Infarct
  - Death of tissue
  - Represented by Q wave
  - Not all infarcts develop Q waves
Injury/Infarct Recognition

Q Waves
Injury/Infarct Recognition

- Infarcted Area
- Electrically Silent
- Thrombus
- Ischemia
- Depolarization

Diagram: Depiction of injury and infarct recognition with labeled components.
Injury/Infarct Recognition

• What to Look for:
  • ST segment elevation (≥1mm)
  • Present in two or more anatomically contiguous leads
Injury/Infarct Recognition: Practice
Localization

Inferior: II, III, AVF
Septal: V1, V2
Anterior: V3, V4
Lateral: I, AVL, V5, V6
Localization

Which coronary arteries are most likely associated with each group of contiguous leads?

<table>
<thead>
<tr>
<th>I Lateral</th>
<th>aVR</th>
<th>V1 Septal</th>
<th>V4 Anterior</th>
</tr>
</thead>
<tbody>
<tr>
<td>Il Inferior</td>
<td>aVL Lateral</td>
<td>V2 Septal</td>
<td>V5 Lateral</td>
</tr>
<tr>
<td>III Inferior</td>
<td>aVF Inferior</td>
<td>V3 Anterior</td>
<td>V6 Lateral</td>
</tr>
</tbody>
</table>
Localization: Left Coronary Artery

- Right Coronary Artery
- Right Ventricle
- Septal Wall
- Anterior Descending Artery
- Anterior Wall of Left Ventricle
- Lateral Wall
- Left Main
- Left Circumflex
Localization: Left Coronary Artery (LCA)

- Left Main (proximal LCA) occlusion
  - Extensive Anterior injury
- Left Circumflex (LCX) occlusion
  - Lateral injury
- Left Anterior Descending (LAD) occlusion
  - Anteroseptal injury
Localization Practice ECG
Localization Practice ECG
Localization Practice ECG
Localization: Extensive Anterior MI

- Evidence in septal, anterior, and lateral leads
- Often from proximal LCA lesion
- “Widow Maker”
- Complications common
  - Left ventricular failure
  - CHF / Pulmonary Edema
  - Cardiogenic Shock
Localization: Definitive Therapy for Extensive AWMI

- Normal blood pressure
  - Thrombolysis may be indicated
- Signs of shock
  - PTCA
  - CABG
Localization: LCA Occlusions

- Other considerations
  - Bundle branches supplied by LCA
  - Serious infranodal heart block may occur
Localization: Right Coronary Artery

- Left Coronary Artery
- Lateral Wall
- Left Ventricle
- Right Coronary Artery
- Posterior Descending Artery
- Posterior Wall
- Inferior Wall of left ventricle
Localization: Right Coronary Artery (RCA)

- Proximal RCA occlusion
  - Right Ventricle injured
  - Posterior wall of left ventricle injured
  - Inferior wall of left ventricle injured
- Posterior descending artery (PDA) occlusion
  - Inferior wall of right ventricle injured
Localization Practice ECG
Localization: Proximal RCA Occlusion

• Right Ventricular Infarct (RVI)
  • 12-lead ECG does not view right ventricle
  • Use additional leads
    • V3R - V6R
    • V4R
  • Right precordial leads
    • same anatomical landmarks as on left for V3 - V6 but placed on the right side
Localization Practice ECG

Note: “R” designation manually placed on this ECG for teaching purposes
Localization: ECG Evidence of RVI

- Inferior MI (always suspect RVI)
- Look for ST elevation in right-sided V leads (V3-V6)
Localization: Physical Evidence of RVI

- Dyspnea with clear lungs
- Jugular vein distension
- Hypotension
  - Relative or absolute
Localization: Treatment for RVI

• Use caution with vasodilators
  • Small incremental doses of MS
  • NTG by drip
• Treat hypotension with fluid
  • One to two liters may be required
  • Large bore IV lines
Localization: Posterior Wall MI (PWMI)

• Usually extension of an inferior or lateral MI
  • Posterior wall receives blood from RCA & LCA
• Common with proximal RCA occlusions
• Occurs with LCX occlusions
• Identified by reciprocal changes in V1-V4
  • May also use Posterior leads to identify
    • V7: posterior axillary line level with V6
    • V8: mid-scapular line level with V6
    • V9: left para-vertebral level with V6
Localization Practice ECG
Localization: Left Coronary Dominance

• Approximately 10% of population
  • LCX connects to posterior descending artery and dominates inferior wall perfusion

• In these cases when LCX is occluded, lateral and inferior walls infarct
  • Inferolateral MI
Localization Practice ECG
Localization Summary

• Left Coronary Artery
  • Septal
  • Anterior
  • Lateral
  • Possibly Inferior

• Right Coronary Artery
  • Inferior
  • Right Ventricular Infarct
  • Posterior
Evolution of AMI

- **Hyperacute**
  - Early change *suggestive* of AMI
  - Tall & Peaked
  - May precede clinical symptoms
  - Only seen in leads looking at infarcting area
  - Not used as a diagnostic finding
Evolution of AMI

• **Acute**
  - ST segment elevation
  - Implies myocardial injury occurring
  - Elevated ST segment presumed acute rather than old
Evolution of AMI

- Acute
  - ST segment Elevated
  - Q wave at least 40 ms wide = pathologic
  - Q wave associated with some cellular necrosis
Evolution of AMI

- **Age Undetermined**
  - Wide (pathologic) Q wave
  - No ST segment elevation
  - Old or “age undetermined” MI
AMI Recognition

A normal 12-lead ECG **DOES NOT** mean the patient is not having acute ischemia, injury or infarction!!!
Practice
Practice
Reciprocal Changes
Reciprocal Changes

II, III, aVF  \[\text{△}\]  I, aVL, V leads
Reciprocal Changes: Practice
Reciprocal Changes: Practice
AMI Recognition

• Reciprocal changes
  • Not necessary to presume infarction
  • Strong confirming evidence when present
  • Not all AMIs result in reciprocal changes
Summary

• ST segment elevation is presumptive evidence for AMI

• Other conditions may also cause ST elevation
  • Known as Imposters
Practice Case 1

• 48 year old male
  • Dull central CP 2/10, began at rest

• Pale and wet

• Overweight, smoker

• Vital signs: RR 18, P 80, BP 180/110, Sao₂ 94% on room air
Practice Case 1
Practice Case 2

- 68 year old female
  - Sudden onset of anxiety and restlessness,
  - States she “can’t catch her breath”
  - Denies chest pain or other discomfort

- History of IDDM and hypertension

- RR 22, P 110, BP 190/90, SaO₂ 88% on NC at 4 lpm
Practice Case 2
Practice Case Summary

• Must take into Account
  • Story
  • Risk factors
  • ECG
  • Treatment
ZOLL® X Series® Defibrillator 12-Lead Report

Patient Name: Male
Patient ID: PATIENT 1106
Patient Age: 64
Patient Sex: Male
Device ID: age undetermined
Device Serial: N/A

Acquired By: Med-Trans/Mercy Air Care

PATIENT NAME: 64 Male
PATIENT ID: PATIENT 1106
PATIENT AGE: 64
PATIENT SEX: MALE
aVF/V1/V3
DEVICE ID: age undetermined
RECORDED: 2015-04-24 17:32:30

*** STEMI ***
Abnormal finding for 40+ male
Supraventricular bradycardia
Acute ST elevation inferior infarct w/ posterior extension [marked STE in II/aVF/III/V6, ST dep in

25 mm/s 10 mm/mV 0.5-40 Hz, ECG x1

Grid size is 0.2 s x 0.5 mV

STJ aVR aVL aVF V1 V2 V3 V4 V5 V6
-0.88 -2.4 -3.71 -2.94 -4.22 -5.57 -0.89 2.28 4.78

Validate rendering fidelity by referencing the 1 mV ECG calibration signals.

Page 1 of 1
ZOLL ResNet 12-Lead
Questions?
References

• AHA 2015 guidelines
• 2018 MAC-1 treatment guidelines for STEMI care
• 2016 Iowa AHA Mission Life Line guidelines