ISCHEMIC CHANGES IN ECG AND MYOCARDIAL INFARCTION

LEARNING OBJECTIVES

- List the principal early and late ECG manifestations of myocardial infarction and explain the early changes in terms of the underlying ionic events that produce them.

GENERAL CONSIDERATIONS

- Ischemic Heart disease may be divided into:
  - CAD
  - Angina
  - Myocardial infarction
- The branches of coronary arteries arising from the aortic root are distributed on the epicardial surface of the heart.
- These in turn provide intramural branches that supply the cardiac muscle.
- Myocardial ischemia (IHD) generally appears first and is more extensive in the sub-endocardial region since these deeper myocardial layers are farthest from the blood supply, with greater intramural tension and need for oxygen.

ECG IN IHD

- A person with all the risk factors for heart disease, e.g., obesity, diabetes, smoking, hyperlipidemia, still may have a normal ECG at rest.
- Exercise tolerance test, with continuous ECG monitoring required to detect changes
- In ANGINA, with temporary heart block, the changes are also temporary
- In MI, with ischemia and subsequent death of heart muscle, the changes are permanent

Coronary Artery Disease and M.I.

- Atherosclerosis of the larger coronary arteries is the most common anatomic condition to diminish coronary blood flow.
- Coronary Artery Disease (CAD) is the result of Atherosclerosis
- A heart attack or Myocardial Infarction (M.I.) is when blood vessels that supply blood to the heart are blocked, preventing enough oxygen from getting to the heart.
- The heart muscle dies or becomes permanently damaged.

SIGNIFICANCE OF PERFORMING ECG FOR IHD

Advantages

- Ischemic ECG changes are best evidence of acute MI
  - Applies if symptom onset within last 3 hours
- Normal/ Nondiagnostic initial ECG predicts low risk

Disadvantages

- Poor sensitivity for Myocardial Infarction (40-50%)
  - 3-10% of MI patients have initial normal ECG
  - 25% of patients with missed MI had misread ECG
Precautions
• The computer over-reads abnormal ECG s
• Compare with prior ECG s (Increases Specificity)

ECG waves and intervals as well as standard time and voltage measures on the ECG paper

ST Segment
One way to diagnose an acute MI is to look for elevation of the ST segment.

Current of Injury
Injury

Injury to the myocardial cells results when the ischemic process is more severe.

Summary of the Three Major Abnormalities of Membrane Polarization Associated with Acute Myocardial Infarction

<table>
<thead>
<tr>
<th>Defect in Infarcted Cells</th>
<th>Current Flow</th>
<th>Resultant ECG Change in Leads Over Infarct</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rapid repolarization</td>
<td>Out of infarct</td>
<td>ST segment elevation</td>
</tr>
<tr>
<td>Decreased resting membrane potential</td>
<td>Into infarct</td>
<td>QT segment depression (manifested as ST segment elevation)</td>
</tr>
<tr>
<td>Delayed depolarization</td>
<td>Out of infarct</td>
<td>ST segment elevation</td>
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</tbody>
</table>

Findings
ECG Markers of underlying CAD
The classic changes of necrosis (Q waves), injury (ST elevation), and ischemia (T wave inversion) may all be seen during acute infarction.
In recovery, the ST segment is the earliest change that normalizes, then the T wave; the Q wave usually persists for years after infarction

Primary vs Secondary Changes In ECG

General ECG Changes suggestive of acute MI

Evolving Pattern
- Hyperacute T Waves (over 50% of preceding R)
  - Must have 2 or more leads with changes
- ST-T elevation (>1mm in limb or precordial leads)
  - Must have >=2 concordant leads with changes
  - ST depression in Lead V1, Lead V2 (Posterior MI)
- T Wave inversion
  - Unless isolated to Lead III or Lead V1
- Q Waves (.04 sec and 1/3 height of R Wave)
  - Unless isolated in Lead III
- New left ventricular strain pattern
- New Left Bundle Branch Block

Sequence of ECG Changes
Coronary Anatomy Revisited

ECG Changes in M.I.

Anterior wall MI

- ECG Changes
  - Lead II, Lead III, and Lead aVF
- Distribution
  - Right Coronary Artery: Posterior descending branch

Inferior wall MI
**Lateral Wall MI**

- **ECG Changes**
  - ST segment elevation in leads V5, V6, I, AVL
  - ST segment depression in leads V1, V2, V3
- **Distribution**
  - Left Coronary Artery: Circumflex branch

**RV Infarction**

- **EKG Changes**
  - Lead V4R (Lead V4 placed on Right chest)
- **Distribution**
  - Right Coronary Artery: Proximal branches
- **Complications**
  - Diagnosis >1mm ST Elevation in V4R
  - Suspect in Inferior MI

**Posterior Wall Infarction**

- **EKG Changes**
  - Lead V1 to Lead V4 ST depression
- **Distribution**
  - Left Coronary Artery: Circumflex
  - Right Coronary Artery: Posterior descending
- **Complications**
  - Left Ventricular Dysfunction

**Site of infarction**
Leads that best detect changes in commonly described locations are classified as follows:

**Sequence of ECG Changes**

- **Hyperacute Phase**
  - Begins immediately or a few hours after MI.
  - EKG characteristics in leads facing the injury:
    - ST segment elevation
    - Tall, upright T wave

- **Fully Evolved Phase**
  - Starts hours to days after MI onset, depending on the extent of the injury.
  - EKG characteristics in leads facing the injury:
    - Deep T wave inversion
    - Pathologic Q wave

**ST elevation**

**Deep Q wave**
Sequence of changes in evolving AMI

Anterior infarction

Inferior infarction
### Injury vs Infarction

<table>
<thead>
<tr>
<th>Injury</th>
<th>Infarction</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Mainly sub-endocardial</td>
<td>1. Sub-endocardial and trans-mural</td>
</tr>
<tr>
<td>2. ST and T wave abnormalities</td>
<td>2. QRS, ST and T wave abnormalities</td>
</tr>
<tr>
<td>3. Affects recovery mainly</td>
<td>3. Affects activation + recovery both</td>
</tr>
<tr>
<td>4. ST depression+ TWI</td>
<td>4. ST elevation+ Distortion of QRS</td>
</tr>
</tbody>
</table>

### REFERENCES
- Familypracticenotebook [http://www.fpnotebook.com](http://www.fpnotebook.com)
- American Heart Association [http://www.americanheart.org](http://www.americanheart.org)
- Guyton and Hall text book of physiology
- Ganong's review of physiology

**THANKS**