Myocardial Infarction

Reading Assignment (p66-78 in ‘Outline’)

Objectives
1. Why do ST segments go up or down in ischemia?
2. STEMI locations and culprit vessels
   3. Why 15-lead ECGs?
   4. What’s up with aVR?
Simple 2-Cell Model

Depolarization

Repolarization

Genesis Of Normal ECG

V₅ Normal ECG
ECG in Injury/Ischemia

**Subendocardial**

Ischemic

Nonischemic

V5

Systolic Injury

Diastolic Injury

**Transmural**

Nonischemic

Ischemic

Systolic & Diastolic Injury

ST elevation (with TQ segment depression) is the direct ECG manifestation of transmural ischemia/injury
The “5-Step Method”

1. Compute the 5 basic measurements: HR, PR interval, QRS duration, QT interval, Axis
2. What’s the basic rhythm and other rhythm statements (e.g., PACs and PVC’s)
3. Any conduction abnormalities (SA blocks, AV blocks (Types I or II), and IV blocks
4. Waveform abnormalities beginning with P waves, QRS complexes, ST-T, and U waves
5. Final interpretations: Normal ECG or Borderline or Abnormal ECG (list final conclusions)
KB, 58 y.o. man with c-pain in E.R.; Hx hypertension, hyperlipidemia, smoking 20-Sept-2013, 12:45 hrs.
Measurements:  
- Rhythm (s): Sinus rhythm  
- Conduction: Normal SA, AV, IV  
- Waveform:  
  - ST elevation II, III, aVF  
  - ST<sub>III</sub> > ST<sub>II</sub>  
  - ST depression I, aVL, V4-6  
  - T inversion I, aVL  
  - Q’s in II, III, aVF  
  - R<sub>V2</sub> > S<sub>V3</sub> (prominent anterior forces, PAF)  
- Interpretation:  
  Abnormal ECG:  
  1. Acute inferior wall STEMI (RCA is culprit artery)
KB, 58 y.o. man with chest pain; Hx hypertension, hyperlipidemia, smoking.

20-Sept-2013, 15:19 hrs (after an intervention).

- Origin of the rhythm?
- What treatment did the patient receive?
- Why is this a good ECG finding?
Measurements: | Rhythm (s): | Conduction: | Waveform: | Interpretation: |
---|---|---|---|---|
A= V=85 | Accelerated ventricular rhythm | Wide QRS is the result of a likely ectopic pacemaker located in the left posterior fascicle (based on QRS morphology of RBBB-like and left axis deviation) | Concordant ST-T waveform due to LV ectopic rhythm | Abnormal ECG: 1. Accelerated ventricular rhythm (this is a transient reperfusion arrhythmia originating in the area of infarction and indicates the rescue of dying pacemaker cells in that region.... An expression of thanks to the interventional cardiologist!) |
KB, 58 y.o. man with c-pain; Hx hypertension, hyperlipidemia, smoking
21-Sept-2013, 06:11 hrs.

22-Sept-2013: Time to go home!
Measurements: | Rhythm (s): | Conduction: | Waveform: | Interpretation: |
---|---|---|---|---|
A=55 V=55 | Sinus rhythm | Normal SA, AV, IV | • Q's II, III, aVF • Inverted T waves II, III, aVF • Flat T waves V4-6 • Slight ST depression aVL, V2-4 • Rv2 > Sv2 (prominent anterior forces, PAF) | Abnormal ECG: 1. Fully evolved inferior MI Time to go home (...and refer to cardiac rehabilitation) |
PM (male, age 18): 22-Feb-2016, 07:05 hrs
Measurements: | Rhythm(s): | Conduction: | Waveform: | Interpretation: |
---|---|---|---|---|
A=70 | Sinus rhythm | Normal SA, AV, IV | • ST elevation V1-6, I, aVL  
• ST depression II, III, aVF | Abnormal ECG:  
1. Extensive anterior and lateral myocardial STEMI (young man with acute dissection of his LAD following a fall). Coronary artery dissection is an unusual cause of acute MI.  
He was quickly treated with LAD stent! |
Measurements:  | Rhythm (s):  | Conduction:  | Waveform:  | Interpretation:  
--- | --- | --- | --- | --- 
A=85 V=85 | Sinus rhythm | Normal SA, AV, IV | • Pathologic Q waves V1-4 • Persistent ST elevation V1-4 | Abnormal ECG: Evolving anterior MI (post reperfusion and stent) 
Unfortunately this young man subsequently developed an ischemic cardiomyopathy due to the large infarction size. 

PR=140 
QRS=70 
QT=360 
Axis= indeterminate
Unknown person, but someone must know him!
What is meant by “prominent anterior forces” (PAF)?
Measurements:  
- A=75  V=75
- PR=160
- QRS=90
- QT=320
- Axis= -75

Rhythm (s):  
- Sinus rhythm

Conduction:  
- Normal SA, AV, IV

Waveform:  
- Q’s II, III, aVF (ignore tiny r-waves)
- ST elevation II, III, aVF
- Prominent anterior forces (PAF)
- ST depression V1-3, aVL

Interpretation:  
- Abnormal ECG:
  1. Evolving infero-lateral MI (old terminology would be infero-posterior MI)
  2. Left axis deviation (LAD) due to large Q’s in inferior leads (this is not left anterior fascicular block)
69 year old woman; ER visit for chest pain. Where do the bundle branches get their blood supply?)
Measurements:  
- A= 95  V=95
- PR=120
- QRS=120
- QT=360
- Axis= -40

Rhythm(s):  
- Sinus rhythm

Conduction:  
- Normal SA, AV
- IVCD

Waveform:  
- ST elevation V1-5, I, aVL
- ST depression III, aVF
- qR V1-4 with late S in I, aVL, V5,6 (due to RBBB + MI)

Interpretation:  
- Abnormal ECG:
  1. Acute anterior and lateral STEMI
  2. RBBB with possible LAFB

Bundle branches get their blood form LAD (anterior two-thirds of septum, and posterior descending branch of RCA (posterior third of septum). BBB's are complications of LAD related Ml's.
M, Age 69 (asymptomatic man, history of MI)  Pre-op ECG before elective TURP
**Measurements:**
- **Rhythm (s):**
  - Sinus rhythm
- **Conduction:**
  - Normal SA, AV
  - IVCD
- **Waveform:**
  - Q waves II, III, aVF, V1-5
  - ST elevation III, aVF, V2-3
  - qsR' in V1; late S I, aVL, V6
  - qrS in lead II; S III > S II
  - Notched P in II; borderline increased P terminal force in V1)
- **Interpretation:**
  - Abnormal ECG:
    1. Inferior and Anterior q-wave myocardial infarctions (age undetermined)
    2. RBBB + LAFB (bifascicular block)
    3. Left atrial enlargement

Note: small q plus deep S in II, III, aVF with left axis deviation: combination of inferior MI + LAFB)
55 year old man with chest pain
<table>
<thead>
<tr>
<th>Measurements</th>
<th>Rhythm(s)</th>
<th>Conduction</th>
<th>Waveform</th>
<th>Interpretation</th>
</tr>
</thead>
<tbody>
<tr>
<td>A=80 V=80</td>
<td>Sinus rhythm</td>
<td>Normal SA, AV, IVCD</td>
<td>rSR V1, late S in I, aVL, V6, Q waves II, III, aVF, rS in II; S_{III} &gt; S_{II} Note: merger of Q with S in III and aVF (combined LAFB with Inferior MI)</td>
<td>Abnormal ECG: 1. RBBB + LAFB (bifascicular block) 2. Inferior MI (age uncertain but not acute)</td>
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<tr>
<td>PR=140</td>
<td></td>
<td></td>
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<td></td>
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<tr>
<td>QRS=130</td>
<td></td>
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<tr>
<td>QT=380</td>
<td></td>
<td></td>
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<td></td>
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<tr>
<td>Axis=-40</td>
<td></td>
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</tbody>
</table>
Follow up ECG in a patient with chronic coronary heart disease
M, Age 76

Measurements: | Rhythm (s): | Conduction: | Waveform: | Interpretation:
---|---|---|---|---
A=100 V=100 | Sinus tachycardia and a PVC couplet | • Normal SA | • Q waves I, aVL, V5-6 (arrows) | Abnormal ECG:
PR=220 | 1st degree AVB | • Poor R wave progression V1-4 | 1. Rhythm (PVC’s)
QRS=140 | IVCD | • Mid QRS notching | 2. Conduction (1st degree AVB, LBBB)
QT=360 | | • ↑ P terminal force V1 | 3. Septal infarct (Q’s I, aVL, V5-6 are due to early RV free wall rightward activation unopposed by the infarcted IV septum)
Axis= -10 | | | 4. Probable left atrial enlargement
65 y old man in the ER with acute dyspnea
**Measurements:**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>95</td>
</tr>
<tr>
<td>V</td>
<td>95</td>
</tr>
<tr>
<td>PR</td>
<td>200</td>
</tr>
<tr>
<td>QRS</td>
<td>80</td>
</tr>
<tr>
<td>QT</td>
<td>360</td>
</tr>
<tr>
<td>Axis</td>
<td>+70</td>
</tr>
</tbody>
</table>

**Rhythm:**
Sinus rhythm

**Conduction:**
Normal SA, AV, IV

**Waveform:**
- ST↑ in II, III, aVF and V4r
- ST↓ in I, aVL, V2-6, V8 with T inversion
- Small q’s in II, III, aVF (probable septal q’s with QRS axis > +60)

**Interpretation:**

Abnormal ECG:

1. Acute inferior wall STEMI with RV infarction (note ST↑ in V4r)

RV infarcts occur in the setting of acute inferior STEMI’s due to proximal RCA occlusion.
77 year old man; chest pain
<table>
<thead>
<tr>
<th>Measurements:</th>
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<th>Waveform:</th>
<th>Interpretation:</th>
</tr>
</thead>
<tbody>
<tr>
<td>A= 70</td>
<td>Sinus rhythm</td>
<td>Normal SA, AV</td>
<td>ST ↑ II, III, aVF</td>
<td>Abnormal ECG:</td>
</tr>
<tr>
<td>V=70</td>
<td></td>
<td>IVCD</td>
<td>ST ↓ I, aVL, V1-3</td>
<td>1. Acute inferior STEMI (RCA origin)</td>
</tr>
<tr>
<td>PR=160</td>
<td></td>
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<td>rsR' in V1, late S in I, aVL, V4-6</td>
<td>2. RBBB</td>
</tr>
<tr>
<td>QRS=140</td>
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<td>Small q's II, III, aVF (these are septal q's seen when QRS axis &gt; +60)</td>
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<tr>
<td>QT=380</td>
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<tr>
<td>Axis= +90</td>
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</tbody>
</table>
82 year old woman; ER visit for confusion
Measurements: | Rhythm(s): | Conduction: | Waveform: | Interpretation: \\
---|---|---|---|---
A= 80 V= 80 | Sinus rhythm | Normal SA, AV, IVCD | QS V1-3, Late R in V1, late S in I, aVL, V5-6 (due to the RBBB), Slight ST↑ V1-3 | Abnormal ECG 
1. Antero septal MI, uncertain age 
2. RBBB 
Note: the atypical RBBB is due to loss of initial ‘r’ of the typical rsR’ in V1, replaced by infarct Q-waves (V1-3)
75 y.o. woman in E.R. with chest pain
Measurements: | Rhythm(s): | Conduction: | Waveform: | Interpretation:
---|---|---|---|---
A=72 V=72 | Sinus rhythm | * Normal SA * 1st degree AV block * IVCD | * ST ↓ I, II, aVL, III, V2-6 * ST ↑ aVR | Abnormal ECG: 1. High probably of subtotal left-main coronary obstruction (ST elevation in aVR with ≥7 leads of ST depression; indicates circumferential subendocardial ischemia; considered as a STEMI equivalent, requires urgent coronary intervention) 2. 1st degree AV block 3. Nonspecific IVCD
75 y.o. man in E.R. with Chest Pain

Who is Sgarbossa and what did he say?
Measurements:

- PR = 200
- QRS = 150
- QT = 400
- Axis = -30

Mearurements:

- A = 80
- V = 80

Rhythm (s):

- Sinus rhythm

Conduction:

- Normal SA, AV
- IVCD
- Hyperacute ST↑ V1-4
- ST↑ also in I, aVL
- Wide QRS with late posterior and leftward forces
- Small q in I, aVL, V6 (arrows)

Waveform:

Interpretation:

- Abnormal ECG:
  1. Acute anterior STEMI
  2. Complete LBBB (atypical due to small q in I and aVL (? septal MI)

  Sgarbossa criteria (acute MI in LBBB)
  - ST↓ in LBBB leads usually having ST↑
  - ST↑ in leads usually having ST↓
  - >5mm ST↑ in leads with expected ST↑ (i.e., V1-3)
75 y.o. man in E.R. with Chest Pain

Who is Sgarbossa and what did he say?
**Measurements:**

- Rhythm (s):
  - Ectopic atrial tachycardia (arrows) with one PAC (*)

- Conduction:
  - Short AV
  - IVCD

- Waveform:
  - ST↑ II, III, aVF, V6 (expect ST↓ those leads in LBBB; + Sgarbossa criteria)
  - Unusual P (-/+ shape in II, aVF)

- Interpretation:
  - Abnormal ECG:
    1. Rhythm (ectopic atrial tachycardia with one PAC)
    2. Acute inferolateral STEMI
    3. LBBB

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</thead>
</table>
| A=115, V=115 | Ectopic atrial tachycardia (arrows) with one PAC (*) | Short AV, IVCD | ST↑ II, III, aVF, V6 (expect ST↓ those leads in LBBB; + Sgarbossa criteria), Unusual P (-/+ shape in II, aVF) | Abnormal ECG:
  1. Rhythm (ectopic atrial tachycardia with one PAC)
  2. Acute inferolateral STEMI
  3. LBBB |
62 year old man

Computer diagnosis:

Normal sinus rhythm
ST elevation consider inferolateral injury or acute infarct
*** *** *** * ACUTE MI * *** *** **
Abnormal ECG
Measurements: | Rhythm (s): | Conduction: | Waveform: | Interpretation: |
---|---|---|---|---|
A=70 V=70 | Sinus rhythm | Normal SA, AV, IV | • ST↑ II, III, aVF, V3-6 (upward concavity)  
• ST↓ aVR | Normal ECG with early repolarization ST segment elevation  
False+ computer interpretation; this ECG is from an asymptomatic man undergoing a routine executive health exam; ECG interpretation always needs a clinical context – something the computer doesn’t know |
48 y.o. man with chest pain
<table>
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<th>Interpretation:</th>
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</table>
| A=130        | Sinus tachycardia | Normal SA, AV, IV | • ST ↑ I, II, III, aVF, V1-6  
• ST ↓ aVR  
• PR segment ↓ in multiple leads indicating atrial injury (arrow) | Abnormal ECG:  
1. Acute pericarditis (look for multiple leads with ST elevation and only one lead, aVR, with ST depression); also look for PR segment depression. ST segments are usually concave up. |
36 y.o. woman with intermittent dyspnea
Measurements:
- Rhythm(s):
- Conduction:
- Waveform:
- Interpretation:

Sinus
- Normal SA
- Short AV
- IVCD

- Delta waves
- Prominent anterior forces V1-2 (PAF)
- Pseudo q-waves II, III, aVF (not really q-waves but negative delta waves)

Abnormal ECG
1. WPW type preexcitation

Note: Negative delta waves in some leads mimic infarct Q-waves. PAF in anterior precordial leads also due to positive delta waves; in this case there is also early transition of the QRS in the precordial leads. The IVCD is due to the fusion of 2 wave fronts during ventricular excitation.

- A=52
- V=52
- PR=90
- QRS=110
- QT=380
- Axis=-10

- Pseudo q-waves II, III, aVF