EKG Conferences – 2013 - 2014
Steven R. Lowenstein, MD, MPH

ECG TRACINGS
Don’t-Miss Electrocardiograms for Emergency Physicians

“I do not imagine that electrocardiography is likely to find any very extensive use in the hospital...it can at most be of rare and occasional use.”

Augustus Waller (1919)

Introduction to ECG TRACINGS

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PREVIOUSLY

- Inferior STEMI
- Anterior STEMI
- Posterior STEMI
- Shortness of breath
- Coronary anatomy
- Classic patterns
- Early warnings
- Complications
ST-T Depressions: *Is there acute disease?*

- “Non-specific ST-changes”
- Acute Coronary Syndrome
  - Ischemia or non-STEMI
  - Reciprocal to STEMI
- LVH with “strain”
- Digitalis effect
- Pulmonary embolism
- Electrolyte disturbances

**Miscellaneous:** Pneumothorax, cholecystitis, pancreatitis, food impaction
65 year-old female; presented after a mechanical fall
Digitalis Effect
65 year-old female; presented after a mechanical fall
64 year-old man with chest pain
Signs of digitalis

“Effect”
- Sagging ST-segment
- Shortening of QT
- Prominent u-waves
- PR-segment prolongation

Toxicity
- Inhibitory signs
  - Sinus bradycardia
  - Heart block
  - Junctional escape (NPJT)
- Excitatory signs
  - Atrial tachycardia + block
  - Ventricular ectopy
- Toxicity in atrial fibrillation
  - Slow and regular
  - Junctional escape (NPJT)
  - Ventricular ectopy
    - Bi-directional VT
68 year-old male – fatigue, SOB
Left Ventricular Hypertrophy

- Reflects chronic volume or pressure overload
  - Pressure - Chronic hypertension or aortic stenosis
  - Volume - Mitral insufficiency, dilated cardiomyopathy
- "Strain:" LVH w/ repolarization abnormality
- Major reason for confusion, misdiagnosis
  - 30 percent of ED chest pain patients have LVH
  - LVH on ECG alone is risk factor for symptomatic CAD, CHF, premature death
    - Framingham: confers 2-9 – fold higher risk
  - LVH can mimic antero-septal MI (acute or old)
  - LVH can mimic Wellens + other “warnings”
EKG signs of LVH

**Voltage Signs**
- Increased voltage over left chest or limb leads
- Voltage sum ≥ 45 mm
  - Deepest S (V1 or V2)
  - Tallest R (V5 or V6)
- S (V1) + R (V5 or 6) > 35
- R-wave ≥ 12 mm I or aVL
- R-wave V6 > V5
- Poor R-wave progression

**Other Signs**
- Repolarization Δ (strain)
- QRS widening to upper limits of normal (.10 - .11)
- Delayed intrinsicoid deflection (≥ 50 msec)
- ST-elevation V1-2-3
  - Often marked
  - Opposite to ST↓ V5-6
  - Mimics AS MI or Wellens
- Left atrial enlargement
- Left axis deviation
“Strain Pattern”

**Ischemia**
- Symmetric T-inversion
- Flat or downsloping ST-segment depression (not shown)

**Strain**

**Hallmark:** *Inverted t-wave with asymmetric limbs*
- Gradual descent of ST-segment
- Blends imperceptibly into inverted T-wave
- T-wave ~ *always* inverted
- Sharp upstroke at end of T-wave
LVH with “Strain Pattern”

- LVH by voltage is present (I, aVL, precordial leads)
- Gradual descent of ST-segment
  - Blends into *inverted T-wave*
  - *In LVH T-wave always inverted* (vs. ischemia)
  - Ascent of ST-segment is rapid, sharp
  - Often overshoots as it returns to baseline
- Stable pattern
- Best seen in left-sided leads with large voltage
  - V5-V6 and leads I, aVL
- Often accompanied by: LAE, LAD, QRS widening, poor r-wave progression
57 year old female with SOB
71 year old man with near-syncope
54 year-old female at the zoo. Sudden onset squeezing chest pain and near syncope, SOB, N/V
Same patient

20-MAY-1945 (54 yr)
Female Caucasian

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vent. rate</td>
<td>66 BPM</td>
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<tr>
<td>PR interval</td>
<td>166 ms</td>
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<tr>
<td>QRS duration</td>
<td>128 ms</td>
</tr>
<tr>
<td>QT/QTc</td>
<td>390/408 ms</td>
</tr>
<tr>
<td>P-R-T axes</td>
<td>61 2 149</td>
</tr>
</tbody>
</table>

Normal sinus rhythm
Left ventricular enlargement with repolarization abnormality
Non-specific intraventricular block
Abnormal ECG
No previous ECGs available

Technician: 380

Referred by: D STILLMAN
Confirmed by: LANE CRADDOCK M.D.
Unknown: 73 yo female weakness, altered mental status
75 year old female presented after a syncopal episode at DIA; sustained forehead laceration. No chest pain.
LVH can resemble Antero-Septal MI
55 yo female with chest wall pain (History hypertension, diabetes, CHF)
47 yo man with hypertension + poor compliance. Tobacco use and hyperlipidemia. Presented with 2 weeks epigastric burning, often exertional, relieved after ice cream.
LVH vs. Evolving Anterior MI
NON-SPECIFIC ST-T CHANGES

- Minimal (< 0.5 mm) ST depression
- T-wave flattening or slight inversion
- These patients may have CAD
- Not associated with initial complications unless the troponin is positive.
ISCHEMIC ST-T CHANGES
UA/NSTEMI

• **ST-segment depressions**
  – Flat or down-sloping
  – **THRESHOLD**: > 0.5 mm in V2-V3 (> 1 mm in other leads)

• **T-wave inversions**
  – Symmetric
  – Often disproportionate to QRS
  – Especially useful if no LVH is present

• **Regional** (anatomic): 2+ contiguous leads
• **Dynamic**
ACS: Risk Stratification

• Patient admitted for rule-out MI and risk stratification

• Risk stratification of patients with ACS begins upon presentation and is then a continuous process to predict those who are at high risk for adverse outcomes
Risk stratification of ACS patients in the E.D.

- Dynamic ECG changes (with pain)
- Transient hypotension, MR, PVCs, CHF
- “Unstable” pattern of pain (*Tempo*)
- **ST depressions ≥ 2 mm in 3+ leads**
  - Marker for positive troponin, complications
- Elevated troponin
- UA/Non-STEMI patients are HIGH-RISK:
  - Good candidate for heparin
  - Prognosis improved with IIB/IIIA agents, early invasive therapy
- **Always:** Be sure ST segment depressions are not reciprocal to STEMI
35 yo man with 1 week increasing effort-related chest pain, radiation to neck, throat. Pain recurred at rest, despite IV NTG. Initial trop = .22
15-Jun-1923
Male Caucasian
Loc: 0

Vent. rate 94 bpm
PR interval 160 ms
QRS duration 98 ms
QT/QTc 336/420 ms
P-R-T axes 52 - 6 94

Normal sinus rhythm
Septal infarct, age undetermined
Possible inferior infarct, age undetermined
Marked ST abnormality, possible anterior subendocardial injury
Abnormal ECG

Technician: 116

Referred by: ABBOTT, JEAN
Unconfirmed
57 y.o. male presented with 3 hours substernal chest pain, radiated to jaw. No prior visits or ECGs. Initial Trop elevated at 0.44.
Another case of “ST-T changes”

• 42 year old female with recurrent episodes of chest pain. History of alcohol abuse, severe erosive esophagitis/gastritis. Presented with “atypical chest and epigastric pain.”
• CP resolved in E.D. after nitroglycerin, ASA, morphine and beta-blockers.
• Report of normal coronary angiogram 3 years earlier at Memorial Hospital in Colorado Springs.
ST-T Depressions
“Non-specific” … or something else

• LVH with repolarization abnormality
• Digitalis effect

• Acute Coronary Syndrome
  – **Ischemia or Non-STEMI**
    • Flat or down-sloping
    • Regional
    • ≥ 2 mm in 3+ contiguous leads
    • Dynamic
  – **Could be reciprocal to STEMI**

• Right ventricular pressure overload (V1 – V3)
• Electrolyte abnormality
T-wave inversions: Acute Disease

- **Myocardial ischemia or infarction**
  - Regional, narrow, symmetric
  - ST-segment may be depressed – or not
  - “Coronary T-waves” (Wellens B) can warn of anterior STEMI

- **Pulmonary embolism**
  - In V1-V3, T-inversions may reflect RV overload
  - Often with concomitant T↓ in anterior and inferior leads
  - RAD, RsR’, S1Q3T3
T-wave inversions in ischemia

- A. Wellens Type A
- B. Wellens type B (coronary t-waves)
T-wave inversions: Acute Disease

- Intra-cerebral hemorrhage
  - Widely splayed *(grotesque)* T-inversions in V1 – V4
  - QT prolongation
  - Bradycardia
  - U-waves

- Cardiomyopathy
  - Takotsubo syndrome
    - Apical myocardial ballooning on echocardiogram
    - Maybe stress-induced, anxiety, loss ("broken heart syndrome")
    - ECG: Marked ST-segment elevations or T-inversions
  - Apical version of HCM
    - Yamaguchi syndrome
70 y.o. female with dizziness + SOB
SBP = 60

ABNORMAL ECG

Previous ECG:23-Jul-2008 18:42:42 - Abnormal Confirmed

Edited

Confirm by: Long, Carlin, MD 24-Jul-2008 02:40:00
REVIEW TRACINGS
47 y.o. Hispanic man, with hypertension and angina for 1 month. Presented after prolonged episode of chest pain.
Normal sinus rhythm
T wave abnormality, consider anterior ischemia
Abnormal ECG
No previous ECGs available

Technician: JESSICA HOFFMAN

Referred by: KRISTEN NORDENHOLZ
Reviewed and Interpreted by: LAWRENCE HORWITZ M.D.
52 yo female with chest tightness, nausea and dyspnea.
Normal sinus rhythm
Left axis deviation
Left ventricular hypertrophy with repolarization abnormality
Prolonged QT
Abnormal ECG
No previous ECGs available

Technician: MELANIE PUGH
Test ind: CP

Reviewed and Interpreted by: PETER BUT
64 yo female: COPD, no hx CAD. Had 5 days stuttering, 8/10 chest pain, radiated to both arms.
51 year old man with a history of hypertension. Presented with diffuse occipital headache. Denied chest pain. Had not been compliant with his labetolol for past month.
49 year old female with several days of nausea, vomiting, diarrhea and abdominal pain. In moderate distress in the ED. BP elevated, otherwise stable VS.
ECG TRACINGS

Don't-Miss Electrocardiograms for Emergency Physicians

"I do not imagine that electrocardiography is likely to find any very extensive use in the hospital...it can at most be of rare and occasional use."

Augustus Waller (1919)

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