ECG Patterns That Confound the Diagnosis of AMI

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Diagnosis of Myocardial Infarction

• History
• Examination
• ECG
• Biomarkers
ST Segment Elevation
*Electrocardiographic Cause of ST Elevation*

Multiple causes of ST segment elevation
--- Adult patients
--- Chest pain (or equivalent)
--- ST elevation in 2 leads

....Same criteria for fibrinolysis & PCI

ECG Limitations

- Non-diagnostic ECG
- Evolving event
- **Confounding patterns**
- Anatomical issues
Diagnosis of Myocardial Infarction

Confounding ECG Patterns

- History
- Examination
- ECG
- Biomarkers

What are the Confounding Patterns?

- Left bundle branch block pattern
- Left ventricular paced pattern (from a permanent pacemaker)
- Left ventricular hypertrophy pattern
What does it mean to confound?

• These patterns.....
  – reduce the ability of the ECG (and you) to detect ACS-related changes
  – make the evaluation of potential ACS much more difficult
  – and also mimic the appearance of STEMI (and other ACS presentations)

The ECG Cycle
Electrocardiographic Diagnosis of ACS

Much information is contained in ECG regarding ACS

High-yield portions of ECG -- ST segment & T wave
ST Segment & T Wave

ST Segment & T Wave (& QRS Complex)
**ST Segment & T Wave (& QRS Complex)**

**QUESTION:** Why is the QRS complex important when considering the ST segment?

**ANSWER:** If BBB, paced rhythm, or LVH pattern is present, interpretation of ST segment / T wave will be altered.

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**Normal**

**LBBB**

**LVH**

**Paced**
ECG ST Elevation

- BBB / LVH / Paced
  - Appropriate Discordance
- Normal Intraventricular Conduction
  - ST Segment / T Wave

Image: Fire rescue vehicles and helicopter
Left Bundle Branch Block

- LBBB reduces diagnostic power of ECG
- Changes mask ischemic change
  - or can be misinterpreted as injury/infarct
- Most frequently misinterpreted pseudoinfarct pattern in practice today, responsible for:
  - Delayed diagnosis & RX of AMI
Left Bundle Branch Block

- Patients with LBBB pattern:
  - If new
    - Candidates for thrombolysis
    - At high risk for CHB, cardiogenic shock, & death
  - If old
    - Have significant, pre-existing LV dysfunction
    - High risk for death
- May benefit significantly from acute revascularization therapies
  - More so than “typical” AMI patients
- Yet are diagnosed early much less often

Left Bundle Branch Block

- Characteristics
  - QRS complex > 0.12 sec
  - Mainly negative QS or rS complex in lead V₁
  - Monophasic R wave in leads V₆, I & aVl
- Secondary repolarization findings:
  - QS or rS complexes -- ST elevation
  - Large monophasic R wave -- ST depression
- Explained by the Concept of Appropriate Discordance

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-- ST segment / T wave complex is directed opposite from the major, terminal portion of the QRS complex
Left Bundle Branch Block
Normal ST Segment & T Wave

Appropriate Discordance
“Normal” ST Segment & T Wave Configurations in LBBB
Abnormal Findings in LBBB
“Sgarbossa’s Criteria”

**ST Segment & T Wave Configurations Suggestive of AMI in LBBB**

- **Concordant ST Segment Elevation** (> 1 mm)
- **Concordant ST Segment Depression** (in leads V1, V2, or V3)
- **“Excessive” Discordant ST Segment Elevation** (> 5 mm)

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**Sgarbossa’s Criteria**

**Clinical Decision Tool**

1. Patient with chest pain and LBBB
2. Is there ST-segment elevation > 1 mm that is concordant with the QRS complex?
   - Yes
   - No
3. Is there ST-segment depression > 1 mm in at least V1, V2, or V3?
   - Yes
   - No
4. Is there ST-segment elevation > 5 mm that is discordant with the QRS complex?
   - Yes
   - No

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**Table**

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NEJM 1996;334:481
Concordant ST Segment Elevation
Strongly Suggestive of AMI

LBBB with AMI
Concordant ST Segment Elevation
LBBB with AMI
Concordant ST Segment Elevation

LBBB with AMI
Concordant ST Segment Elevation
LBBB with AMI

Concordant ST Segment Elevation

Concordant ST Segment Depression
(Limited to Leads V1, V2, or V3)

Strongly Suggestive of AMI
LBBB with AMI

Concordant ST Segment Depression
LBBB with AMI

Concordant ST Segment Depression
LBBB with AMI
Concordant ST Segment Depression

LBBB with AMI
Concordant ST Segment Depression
“Excessive” Discordant ST Segment Elevation (> 5 mm)
Somewhat Strongly Suggestive of AMI

LBBB with AMI
Excessive Discordant ST Segment Elevation
LBBB with AMI

Excessive Discordant ST Segment Elevation
LBBB with AMI

Excessive Discordant ST Segment Elevation
LBBB with AMI

*Excessive Discordant ST Segment Elevation*

“Excessive” Discordance or Proportional ST Segment Elevation?

> 5 mm
“Excessive” Discordant ST Segment Elevation
(> 5 mm)
Somewhat Strongly Suggestive of AMI

ST Segment Elevation is Proportional to Size of QRS Complex
NOT INDICATIVE OF ELECTROCARDIOGRAPHIC AMI
Serial ECGs: 1 of 2
“Concerning” Chest Pain Presentation

Serial ECGs: 2 of 2
Evolution of AMI with LBBB
Serial ECGs: 2 of 2
Evolution of AMI with LBBB
Ventricular Paced Rhythm

- Elderly population w/ pre-existing heart disease
- ECG characteristics
  - Broad, mainly negative QS complexes (leads V₁ to V₆)
  - QS complexes may also seen in leads II, III & aVf
  - Large monophasic R wave -- leads I & aVL
Ventricular Paced Rhythm

Normal Findings

Ventricular Paced Pattern
Normal ST Segment & T Wave
“Sgarbossa’s Criteria”
ST Segment & T Wave Configurations Suggestive of AMI with Ventricular Paced Rhythms

Concordant ST Segment Elevation (≥ 1 mm)

Concordant ST Segment Depression (in leads V1, V2, or V3)

“Excessive” Discordant ST Segment Elevation (≥ 5 mm)

Ventricular Paced Pattern with AMI
Concordant ST Segment Elevation
Ventricular Paced Pattern with AMI
Concordant ST Segment Elevation

Serial ECGs: 1 of 2
Ventricular Paced Pattern with Chest Pain
Serial ECGs: 1 of 2
Ventricular Paced Pattern with Chest Pain
*Excessive Discordant ST Segment Elevation*
Left Ventricular Hypertrophy Pattern
Left Ventricular Hypertrophy with Strain Pattern

- LVH pattern reduces diagnostic power of ECG
- Like LBBB, changes mask & mimic ACS-related findings
- LVH by voltage criteria
  - Many
  - S (Q) wave V1 + R wave V6 > 35 mm
- “Strain” pattern
  - ST segment & T wave changes
  - Seen in 75% of LVH pattern presentation

LVH with Strain Pattern

- LVH seen frequently in adult chest pain patients suspected of ACS
- Final hospital Dx
  - 26% ultimately ACS
  - 74% non-ACS
- ECG *incorrectly* interpreted > 70% of cases
  - Frequently did not identify LVH pattern
  - Attributed ST / T changes to ischemia or infarction
  - Observed changes resulted from
- Stress importance of correct ECG interpretation
  - Directly impacts therapeutic & diagnostic decisions

Larsen et al, J Gen Intern Med 1994
QRS Complex Size?

The LVH Pattern

The QRS Complex Size?

Determination of QRS Complex Size

V1 / V2 + V5 / V6 > 35 mm *

Q wave + R wave

*In a patient > age 35 years
QRS Complex Size?

- ST segment & T wave changes in LVH
- 80% of patients with this ECG pattern
- Not indicative of ACS
- Mimic & mask ACS

LVH with Strain Pattern

- V2
- V3
- V6
- aVL
Left Ventricular Hypertrophy

with Strain Pattern
Left Ventricular Hypertrophy with Strain Pattern
Left Ventricular Hypertrophy with Strain Pattern Evolving AMI
Left Ventricular Hypertrophy with Strain Pattern Evolving AMI
Right Bundle Branch Block
Right Bundle Branch Block

• Does not obscure ECG DX of AMI
• May confuse ECG Dx of ACS

• Lack of knowledge of anticipated ST segment & T wave patterns
  – “Hide” ACS
  – Incorrectly “suggest” ACS

Right bundle branch block is a high risk pattern in the ACS patient
Right Bundle Branch Block

- May also hinder ECG diagnosis
  - Not due to electrophysiologic issues
  - Resulting from interpretative errors

- Age of RBBB
  - Chronicity not an issue for fibrinolysis
  - ECG can be interpreted – consider ST segments
  - Marker for poor outcome

- NRMI-2 registry
  - RBBB pattern in approximately 6% of AMI patients
  - Less often received fibrinolysis
  - Increased poor outcome [64% increased odds ratio of death]
    - Worse than LBBB!

Right Bundle Branch Block

- Characteristics of RBBB
  - QRS complex > 0.12 sec
  - Broad, monophasic R or RSR’ wave in lead V₁
  - Wide S or RS wave in lead V₆

- Marked ST segment changes are seen
  - Right precordial leads -- ST depression
  - Inferior & left precordial leads -- upright T wave & ST elevation
Right Bundle Branch Block

RBBB with Anterior Wall STEMI
RBBB with Anterior Wall STEMI

V4
0037

V4
0129

RBBB with Anterior Wall STEMI

V4
0037

V4
0129
RBBB with Anterior Wall STEMI

Many Thanks
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Cases

Case History
(for all cases today)

• 58 year-old male / female
• Chest pain
• Dyspnea with diaphoresis
• Exam – anxious & diaphoretic
• ECG...........
Case #1

Case #2
Case #3

Case #4
Case #5

Case #6
Case #7

Case #8
Case #9

Case #10
Case #13