Diagnosis of Myocardial Infarction/Ischemia with Bundle Branch Blocks

Mark I. Langdorf, MD, MHPE, FACEP, FAAEM, RDMS
Professor and Chair
Associate Residency Director
Department of Emergency Medicine
University of California, Irvine
Objectives

- Interpretation of 12 lead ECGs with:
  - Infarction or
  - Ischemia

In the presence of:
- Right bundle branch block
- Left bundle branch block
- Ventricular paced rhythms

- To understand and use decision rules
Take-home Messages:

- You **can** diagnose acute MI or ischemia in patients with bundle branch blocks or pacers.
- Secondary ST-T wave changes are normal, and go in the **opposite** direction of the last part of the QRS complex.
- Primary ST-T wave changes mean ischemia or infarction, and go in the **same** direction as the last part of the QRS complex.
Take-home Messages:

- One half to two-thirds of patients with chest pain and LBBB that is new or not known to be old will have an AMI.
- Reperfusion therapy is recommended.
- Serial ECGs may clarify the situation.
- Immediate angiogram is preferred.
Truth?

“The diagnosis of myocardial infarction in the presence of left bundle branch block is impossible.”
Partially true…

- True: Diagnosis of **completed** MI with LBBB is more difficult
  - Q waves present in precordial leads without anterior infarction.
  - ST segment elevation hides in repolarization changes.

- Do we care much about completed MI?
You Can Diagnose MI…

- “ongoing ischemia and injury can be detected in the presence of LBBB, and may be seen as often as they are in the presence of normal cardiac conduction.”

Dr. Braunwald says:

- “Some findings are highly specific and predictive (90-100%) for MI with left bundle branch block.”
- Acute MI: Primary ST-T wave changes in two or more contiguous leads
ST-T Wave Changes with Bundle Branch Blocks:

- Changes are same with both right and left
- “Secondary” means normal, expected
- “Primary” means abnormal: ischemia or infarction
J point
ST segment
Last deflection of QRS
ST-T Wave Changes

- Even with bundle branch blocks
- ST segment elevation still means infarction
- ST segment depression/T wave inversion still means ischemia
No, no! I hate needles!
Secondary ST-T Wave Changes

- These are **normal**, expected
- Last deflection of QRS complex is key
- J point displaced **away** from the last portion of the QRS complex
- T wave oriented **away** from the last portion of the QRS complex
Primary ST-T Wave Changes

- “Primary” = abnormal, not a result of BBB
- ST segment displaced toward last portion of QRS complex
- T wave points toward last portion of QRS complex
Primary ST-T Wave Changes

- Must be in two contiguous leads
  - Inferior: II, III and aVF
  - Septal: V₁ and V₂
  - Anterior: V₃ and V₄
  - Lateral: V₅, V₆, I and aVL (high lateral)

- Don’t call ischemia/infarction if only one lead in transition from positive to negative QRS
Concept of Dis/Concordance

- Refers to whether the last portion of the QRS complex goes in the same or different direction as the T wave
- Discordance=good=secondary
- Concordance=bad=primary
Right BBB in $V_1$

“up down”

Secondary (normal, discordant) ST-T Wave changes
Right BBB in $V_6$

“down up”

Secondary (normal, discordant) ST-T Wave Changes
Left BBB in $V_1$

“down up”

Secondary (normal, discordant) ST-T Wave changes
Left BBB in V₆

“up down”

Secondary (normal, discordant)
ST-T Wave changes
Secondary=Discordant=Good

- “Down up” pattern
- “Up down” pattern
Right BBB in $V_1$

Primary Infarction (concordant) ST-T Wave changes

“up up”
Right BBB in V₆

“down down”

Primary Ischemic (concordant) ST-T Wave Changes
Left BBB in $V_1$

Primary Ischemic (concordant) ST-T Wave Changes

“down down”
Left BBB in $V_6$

“up up”

Primary Infarction (concordant) ST-T Wave Changes
Primary = Concordant = Bad

- “Up up” pattern
- “Down down” pattern
ECG of Evolving MI with Left BBB

- Review of 26,003 GUSTO patients (1993)
- Derivation set: 131 (0.5%) patients with LBBB
- Average time from onset of symptoms to ECG: 120 minutes
- Validation set: 45 patients from GUSTO-2A with AMI and LBBB

Sgarbossa et al., *NEJM*, 334:481, 1996
ECG of Evolving MI with Left BBB

Identified three predictive criteria:

- ST segment elevation ≥ 1 mm **concordant** with QRS
- ST segment depression ≥ 1 mm **concordant** with QRS
- ST segment elevation ≥ 5mm **discordant** with QRS
Left BBB in $V_1$

Primary Infarction ST-T Wave change

Exaggerated ST Segment Elevation

- Normal: 2-3 mm
- Exaggerated: $\geq 5$ mm

“too far up”
ECG of Evolving MI with LBBB

- How did these factors perform on the validation set?
  - ST elevation ≥ 1 mm concordant (bad) with QRS
    - Sensitivity: 73%
    - Specificity: 92%
    - Odds ratio: 25.2 (95% CI 11.6-54.7)
  - ST depression ≥ 1 mm concordant (bad) with QRS
    - Sensitivity: 25%
    - Specificity: 92%
    - Odds ratio: 6.0 (95% CI 1.9-19.3)
ECG of Evolving MI with Left BBBB

- ST elevation $\geq 5$ mm discordant with QRS
  - Sensitivity: 26%
  - Specificity: 92%
  - Odds ratio: 4.3 (95% CI 1.8-10.6)

- Decision tree incorporates all three factors in order of predictive power
ECG of Evolving MI with LBBB

- Does the T wave go the wrong way up?
- Does the T wave go the wrong way down?
- Does the T wave/ST segment go the right way, but too far?
- Three “yes” answers = 100% MI
- Three “no” answers = 16% MI
Probability of MI

100  92  93  88  100  66  50  16

Wrong way up?

Wrong way down?

Right way, but too far?
Are These Criteria Valid?

- **Poor performance**
  - 190 patients/13% with AMI
  - Sensitivity: 0-16%
  - Specificity: 93-100%
  - Treat all LBBB not known to be old as acute MI

- **Good performance**
  - 224 patients/45% with AMI
  - Sensitivity: 73% (cardiologist) vs. 67% (EP)
  - Specificity: 98% (both)

RBBB with Secondary ST-T Wave Changes
LBBB with Secondary ST-T Wave Changes
RBBB with Anteroseptal Infarction
LBBB with Exaggerated ST Elevation: Anteroseptal/lateral Infarction

≥ 5 mm
LBBB with Lateral Infarction
Left BBB with Anteroseptal Ischemia
Left BBB

Primary STT Wave elevation

Exaggerated ST segment elevation

Primary ST T Wave depression
Should We Treat All LBBB Patients with Lytics?

- American Heart Association 2005: **Yes!**
- Treat “new or presumably new LBBB”
- Literature: not necessarily
  - 35% with new LBBB and chest pain did *not* have an MI (Kontos)
  - 48% with LBBB not known to be old did *not* have an MI (Edhouse)


Treating all LBBB as if AMI risks unnecessary thrombolytics in 1/3 to 1/2
Reasonable if low risk of complications
Sgarbossa criteria are helpful
  - If present, thrombolytics indicated
If criteria absent
  - serial ECGs for dynamic changes
  - Transfer for cath if < 90 mins
Take-Home Messages:

- You can diagnose acute MI or ischemia with BBB
- Secondary (normal) ST-T changes are opposite the last part of the QRS
- Primary (abnormal) ST-T changes mean ischemic or infarction, and go in the same direction as the last part of the QRS
Take-Home Messages:

- One-half to two-thirds of patients with chest pain and new LBBB (or not known to be old) have AMI
- Reperfusion therapy is recommended
- Serial ECGs may clarify
- Immediate angiogram is preferred
“Why, your fever’s way down.”
Next two slides good but no time in Buenos Aires
LBBB with Evolving MI

- 182 patients with LBBB and acute MI
- New LBBB: Sens = 46%, Spec = 65%
- Concordant ST-segment elevation or depression (Sgarbossa criteria)
  - Specificity = 100%
  - Positive predictive values = 100%
  - Sensitivity for ST elevation = 8%
  - Sensitivity for ST depression = 17%

ECG of Evolving MI with LBBB

- Of patients with acute MI and LBBB, the LBBB was *NEW* (from their MI) in only 46%.
- If we only treated *NEW* LBBB, we’d miss treating 54% of patients who needed it.
- Conversely, only 65% of patients with *NEW* LBBB actually had MI.
- So, if we treated everyone with *new* LBBB and chest pain we’d treat 35% unnecessarily.
ECG of LBBB without MI

- 124 patients with LBBB and no MI
- Only 1 had primary ST segment depression anteriorly
- Only 1 had primary ST segment elevation
- 9 had exaggerated ST segment elevation ≥ 5 mm
- Sgarbossa criteria are sufficiently specific (few false positives)

ECG of LBBB \textit{with} Evolving MI

- 414 LBBB patients \textit{with} AMI vs. 85 \textit{without} AMI:
  - Concordant ST-segment elevation: 6%
  - Concordant ST-segment depression: 3%
  - Discordant ST-segment elevation: 19%

- Concordant ST elevation (LR 5.3) and ST depression in $V_1$-$V_3$ highly specific for AMI, but not sensitive
ECG criteria in diagnosis of acute myocardial infarction in the presence of left bundle branch block

Gunnar Gunnarsson*, Peter Eriksson, Mikael Dellborg

Clinical Experimental Research Laboratory, Department of Medicine, Sahlgrenska University Hospital /Östra, 416 85 Gothenburg, Sweden

Received 24 October 2000; received in revised form 30 December 2000; accepted 10 January 2001

Abstract

Background: The diagnosis of acute myocardial infarction in the presence of left bundle branch block is difficult. Recently a diagnostic ECG scoring system was suggested, showing good diagnostic abilities. This scoring system has never been tested in a prospective manner; we have done so and investigated if it might bear prognostic information.


Results: One hundred and fifty-eight patients were included, mean age 74.9 years. Seventy-six patients (48%) had an acute myocardial infarction. The proposed cut-off total score of $3$ of the ECG scoring system for the diagnosis of acute myocardial infarction had a sensitivity of 17.1% (95% CI 8.6–25.6%) and specificity of 94.0% (95% CI 88.9–99.1%). Clinical judgement of acute myocardial infarction resulted in a sensitivity of 15.8% (95% CI 7.6–24%) and specificity of 96.0% (CI 92.3–100%). No difference was seen in 3-month or 1-year survival between those with total ECG score $\geq 3$ versus total score $<3$.

Conclusion: The diagnostic abilities of the proposed ECG criteria are low and not better than the clinical judgement. The criteria are therefore not suitable for screening patients with suspicion of acute myocardial infarction in the presence of left bundle branch block, nor do they seem to identify high risk patients. Ó 2001 Elsevier Science Ireland Ltd. All rights reserved.
"It's tax season all right – that's the third calculator I've extracted today."
“Second Floor Please”
RBBB with Anteroseptal Ischemia
“One of these is a prescription and one is a receipt from a Chinese restaurant.”