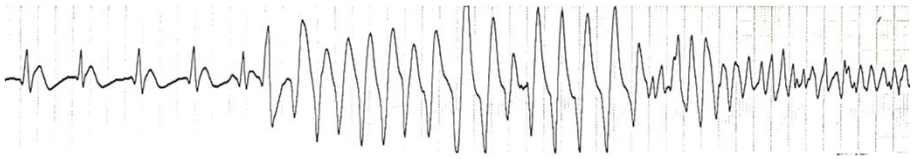
ECG Patterns That Confound the Diagnosis of AMI



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Diagnosis of Myocardial Infarction

- History
- Examination
- ECG
- Biomarkers

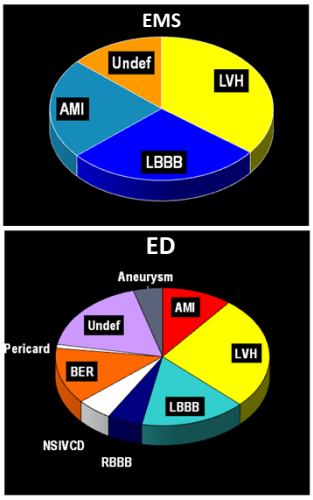
ST Segment Elevation

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~~ X
- Biomarkers

- History
- Examination
- Biomarkers

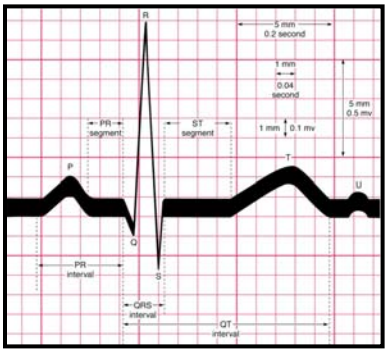
What are the Confounding Patterns?

- 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)

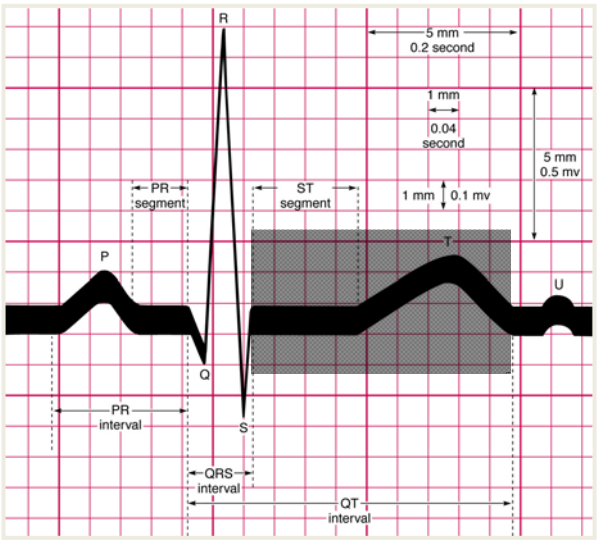
The ECG Cycle
Electrocardiographic Diagnosis of ACS



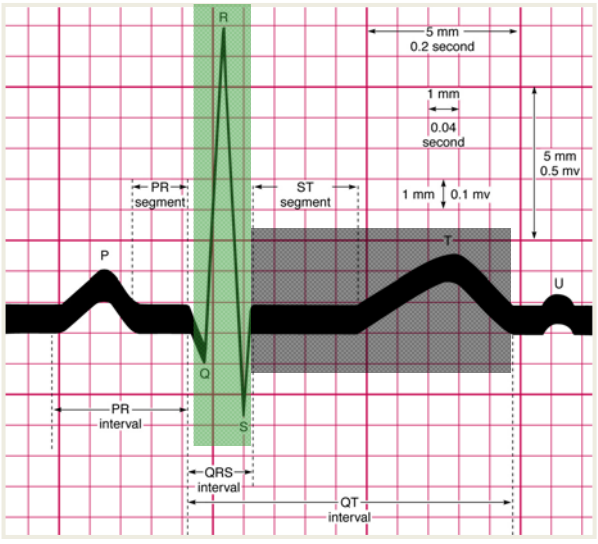
Much information is contained in ECG regarding ACS

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

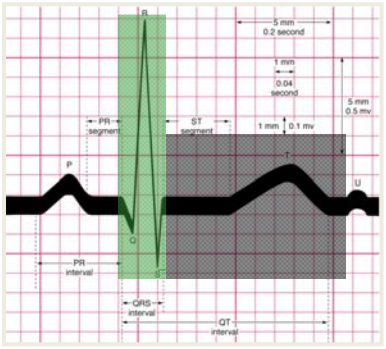
ST Segment & T Wave



ST Segment & T Wave (& QRS Complex)



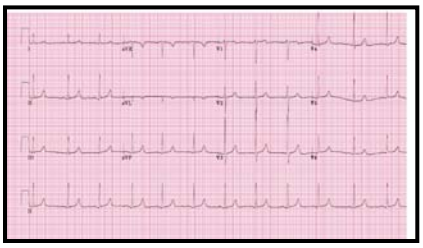
ST Segment & T Wave (& QRS Complex)



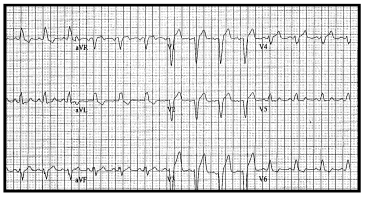
QUESTION: **Why is the QRS complex Important when considering the ST segment?**

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

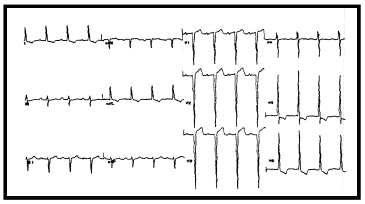
Normal



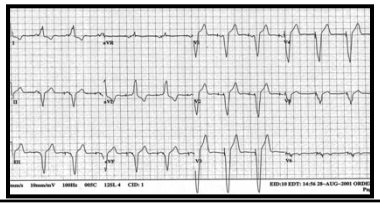
LBBB

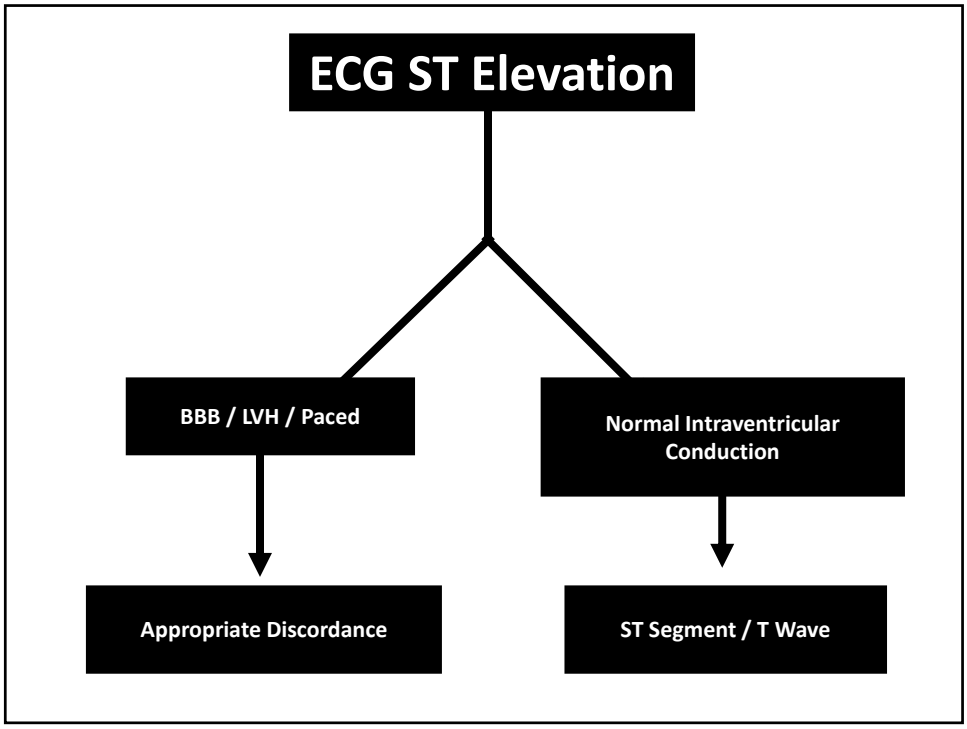


LVH



Paced



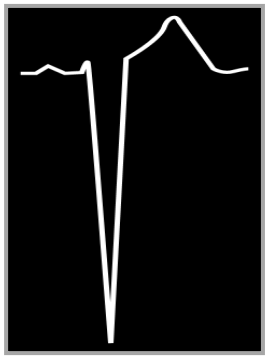

ECG ST Elevation
BBB / LVH / Paced
Normal Intraventricular Conduction
Appropriate Discordance
ST Segment / T Wave


FIRE RESCUE
ALBEMARLE COUNTY

Left Bundle Branch Block

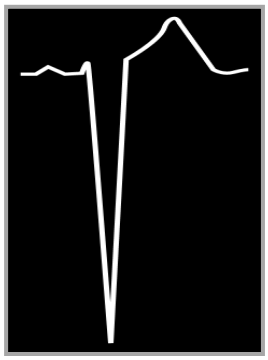
Left Bundle Branch Block

- **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**



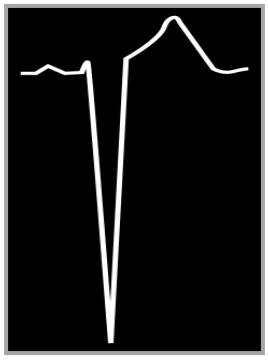
Left Bundle Branch Block

- **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**



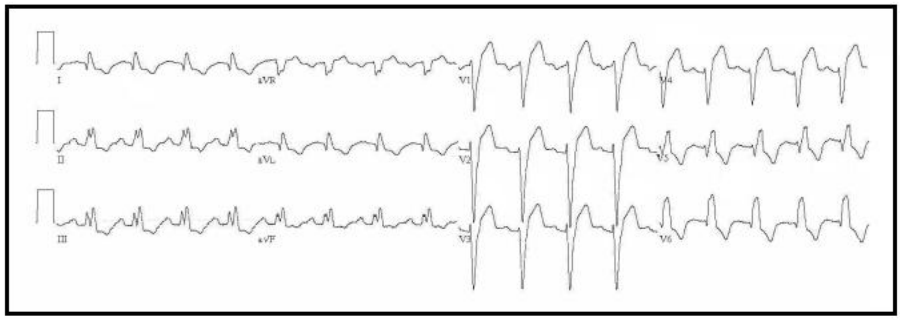
Left Bundle Branch Block

- **Characteristics**
  - **QRS complex > 0.12 sec**
  - **Mainly negative QS or rS complex in lead V_1**
  - **Monophasic R wave in leads V_6, I & aVl**
- **Secondary repolarization findings:**
  - **QS or rS complexes -- ST elevation**
  - **Large monophasic R wave -- ST depression**
- **Explained by the *Concept of Appropriate Discordance***



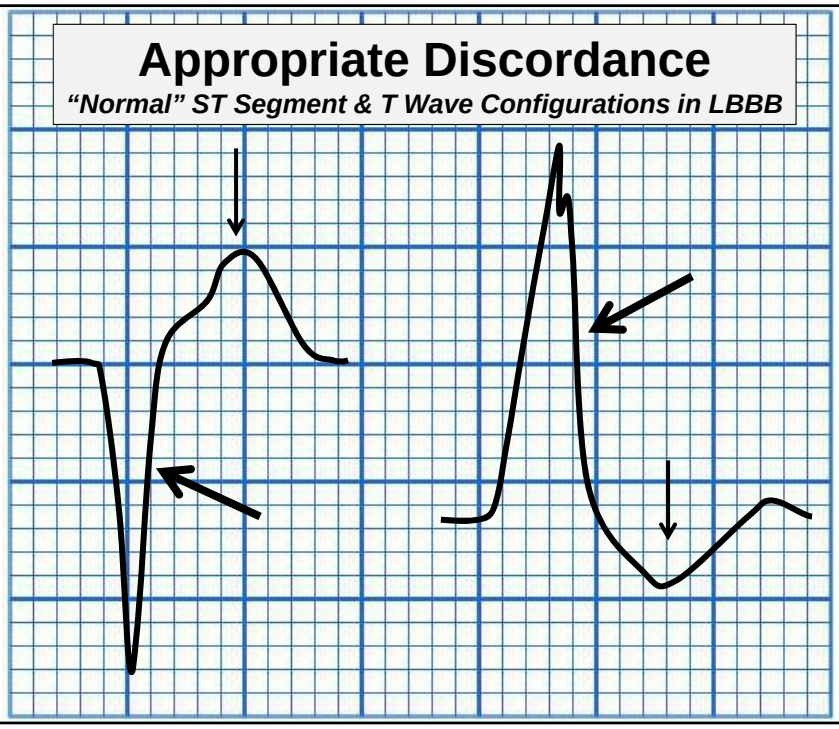
-- ST segment / T wave complex is directed opposite from the major, terminal portion of the QRS complex

Left Bundle Branch Block
Normal ST Segment & T Wave

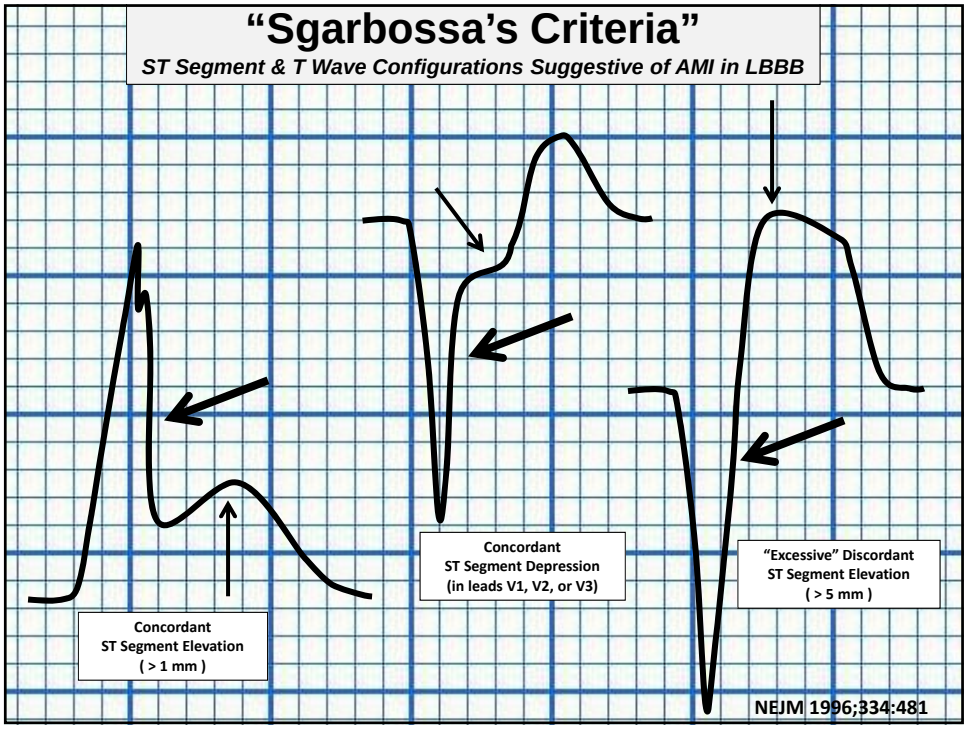


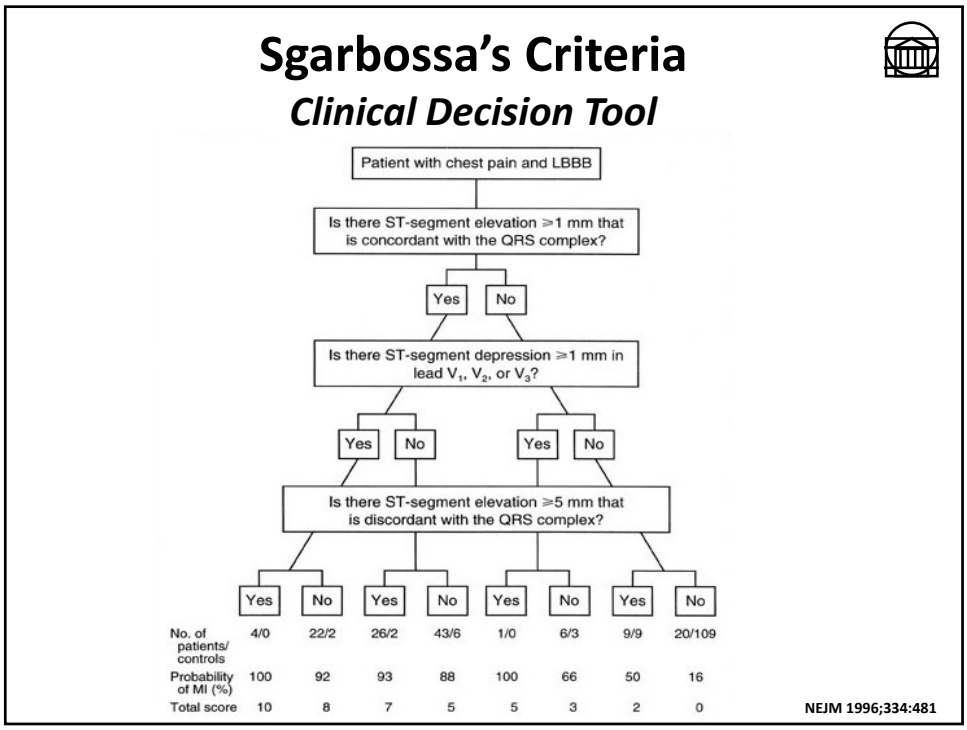
Appropriate Discordance

"Normal" ST Segment & T Wave Configurations in LBBB

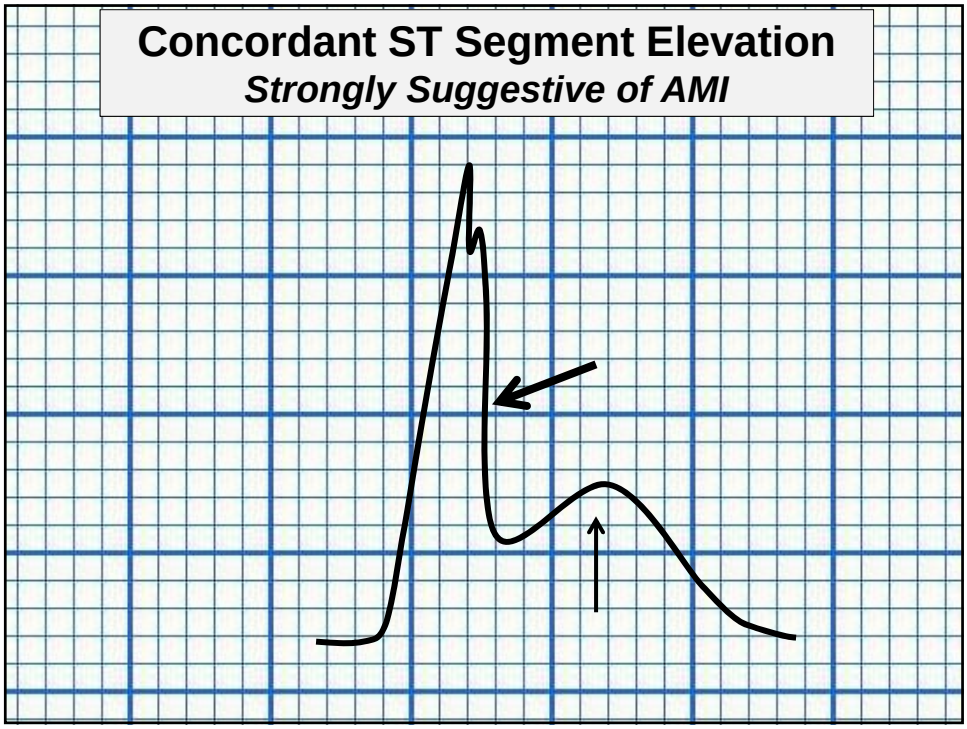


Abnormal Findings in LBBB

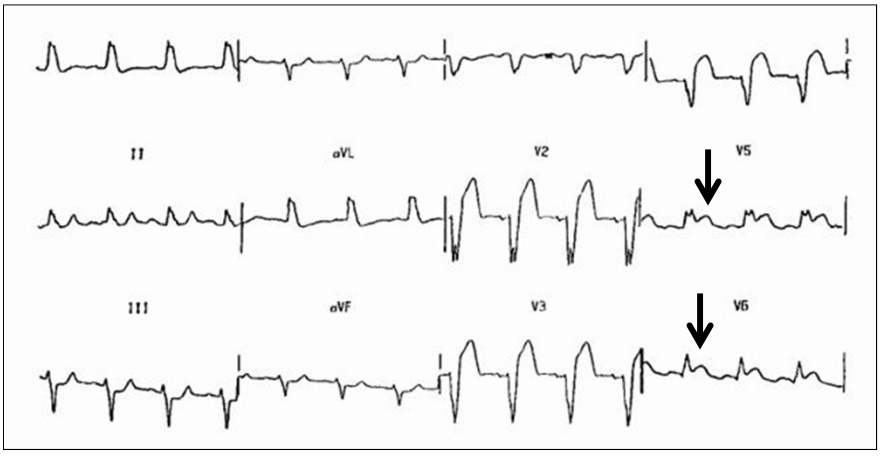

"Sgarbossa's Criteria"
ST Segment & T Wave Configurations Suggestive of AMI in LBBB
Concordant
ST Segment Elevation
(> 1 mm)
Concordant
ST Segment Depression
(in leads V1, V2, or V3)
"Excessive" Discordant
ST Segment Elevation
(> 5 mm)
NEJM 1996;334:481


Sgarbossa's Criteria
Clinical Decision Tool
Patient with chest pain and LBBB
Is there ST-segment elevation ≥1 mm that is concordant with the QRS complex?
Yes
No
Is there ST-segment depression ≥1 mm in lead V1, V2, or V3?
Yes
No
Yes
No
Is there ST-segment elevation ≥5 mm that is discordant with the QRS complex?
Yes
No
Yes
No
Yes
No
Yes
No
No. of patients/ controls 4/0 22/2 26/2 43/6 1/0 6/3 9/9 20/109
Probability of MI (%) 100 92 93 88 100 66 50 16
Total score 10 8 7 5 5 3 2 0
NEJM 1996;334:481

Concordant ST Segment Elevation
Strongly Suggestive of AMI

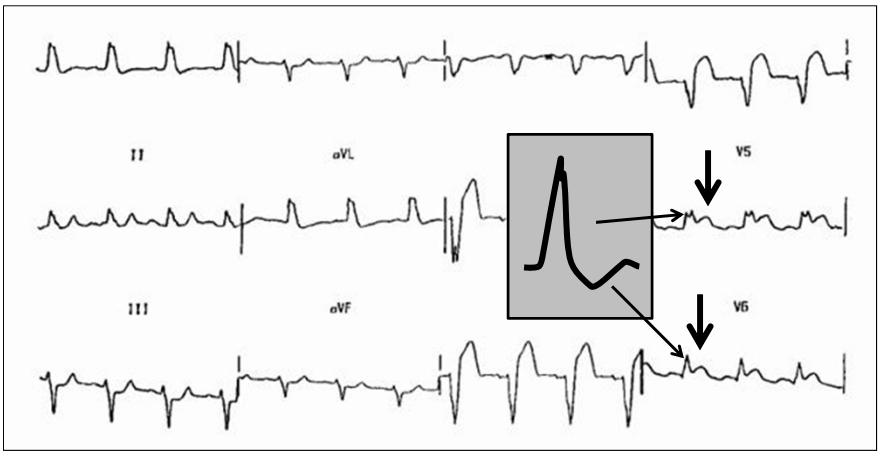


LBBB with AMI
Concordant ST Segment Elevation



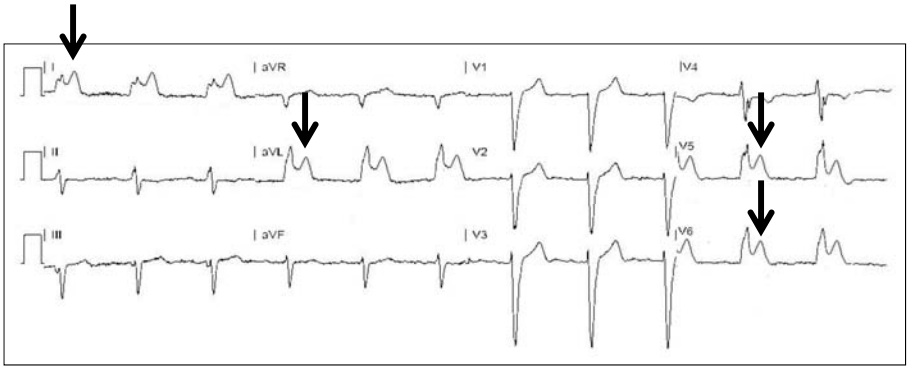
LBBB with AMI

Concordant ST Segment Elevation



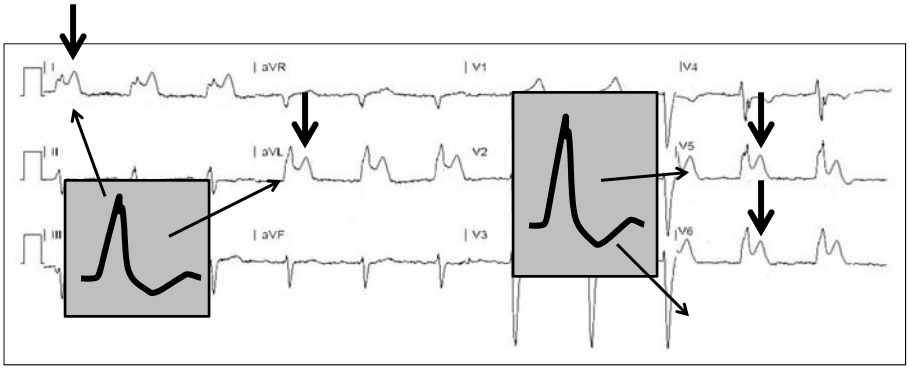
LBBB with AMI

Concordant ST Segment Elevation



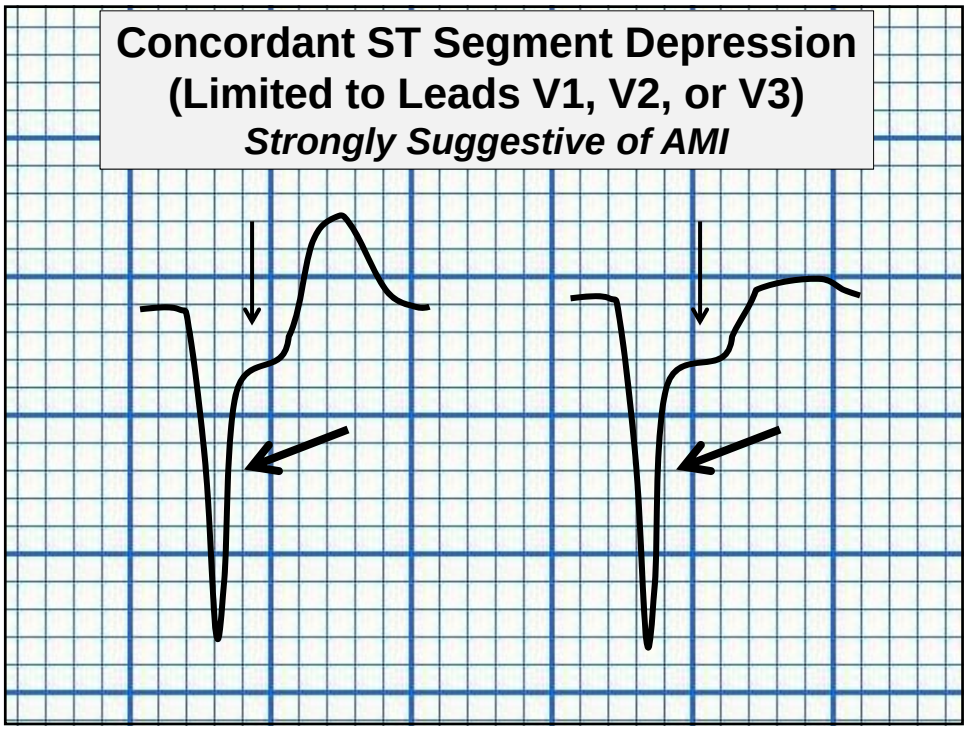
LBBB with AMI

Concordant ST Segment Elevation



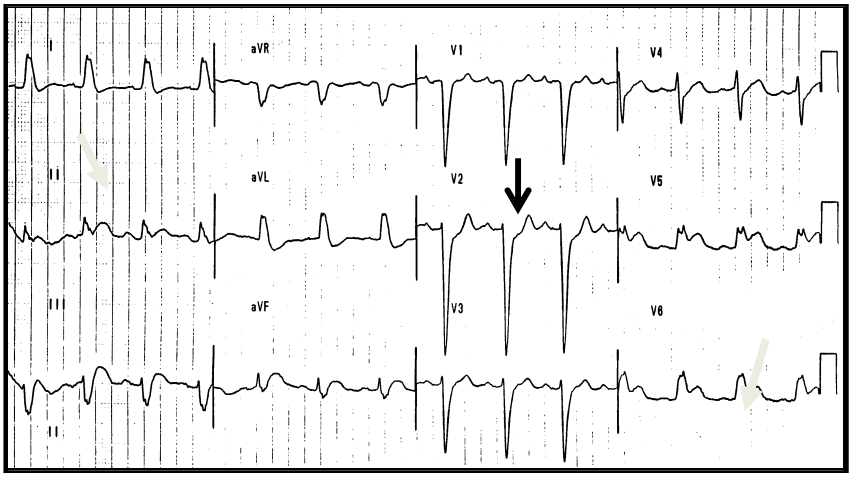
Concordant ST Segment Depression (Limited to Leads V1, V2, or V3)

Strongly Suggestive of AMI



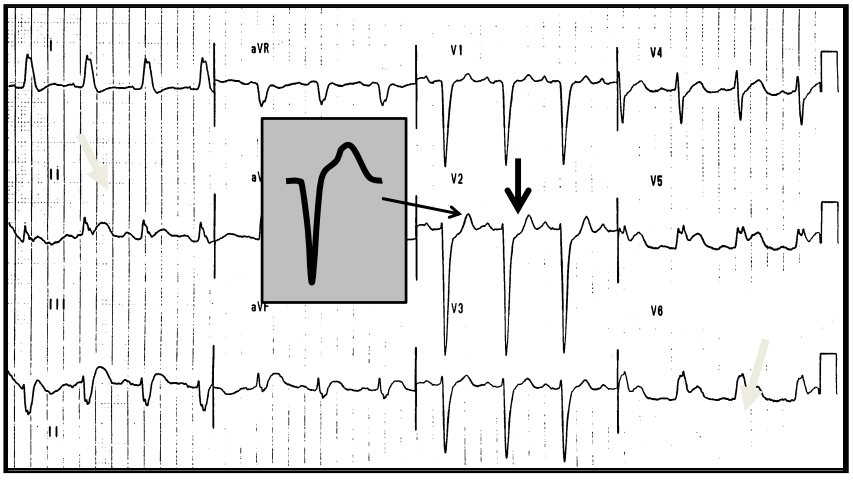
LBBB with AMI

Concordant ST Segment Depression



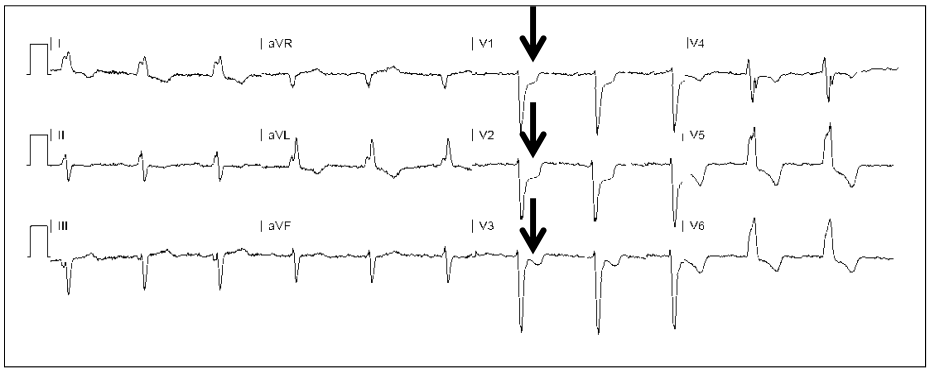
LBBB with AMI

Concordant ST Segment Depression



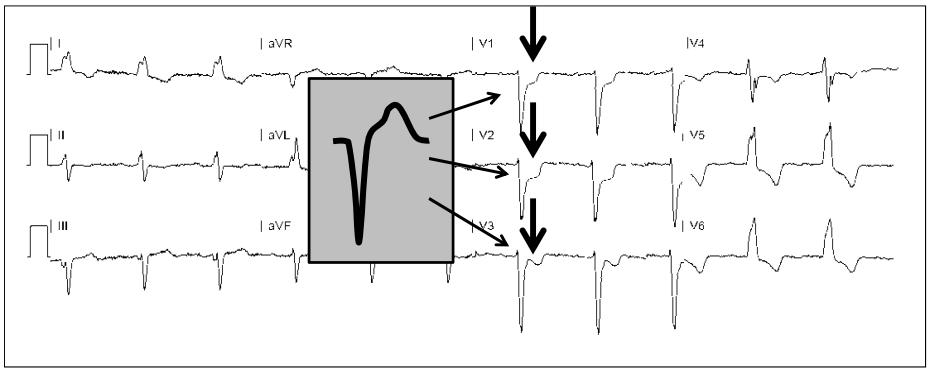
LBBB with AMI

Concordant ST Segment Depression



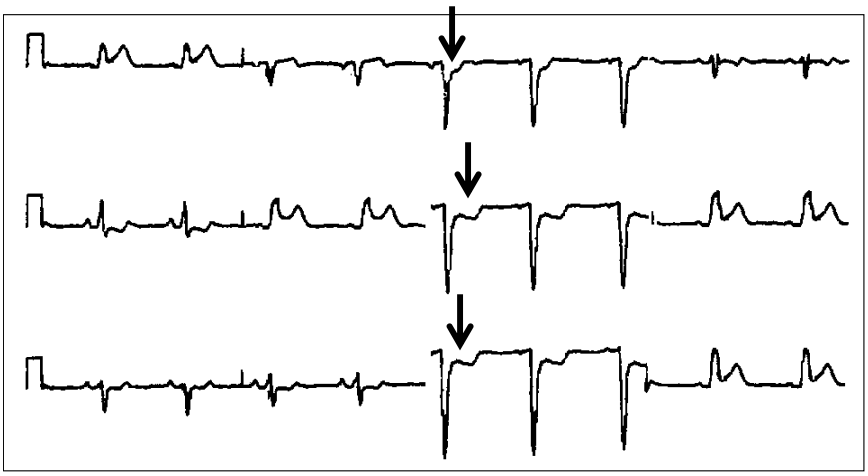
LBBB with AMI

Concordant ST Segment Depression



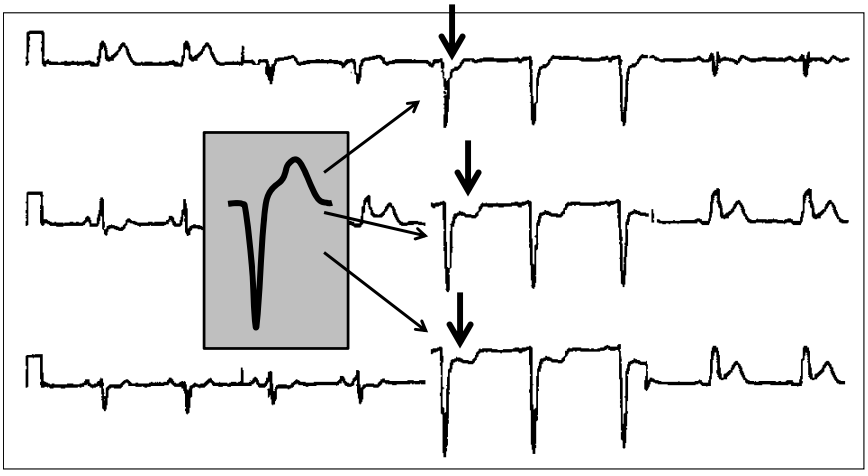
LBBB with AMI

Concordant ST Segment Depression



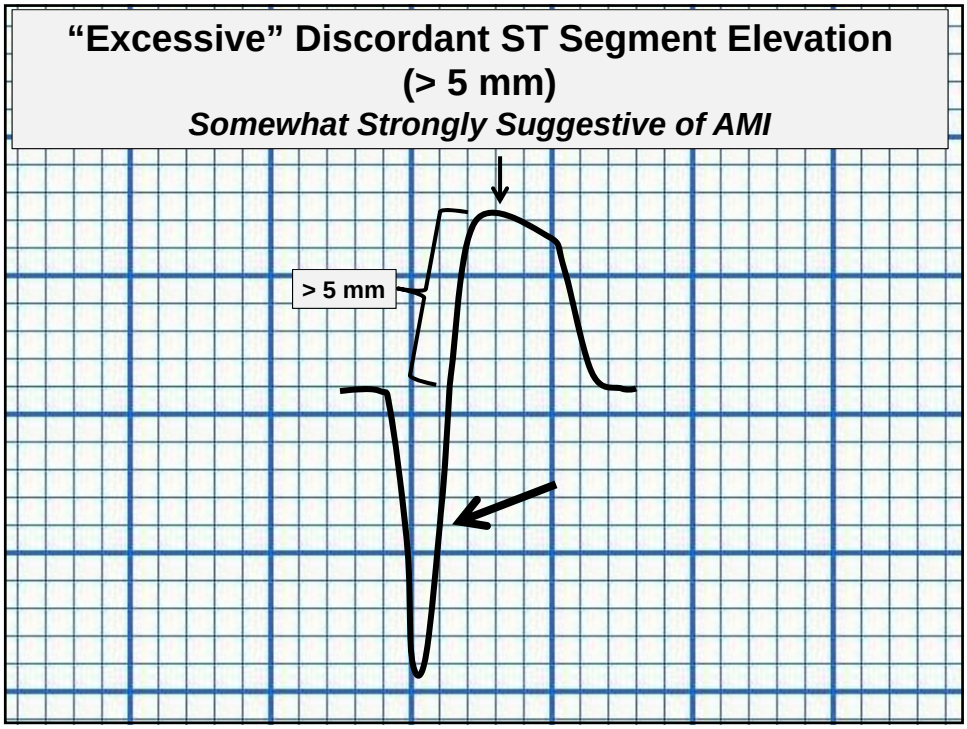
LBBB with AMI

Concordant ST Segment Depression



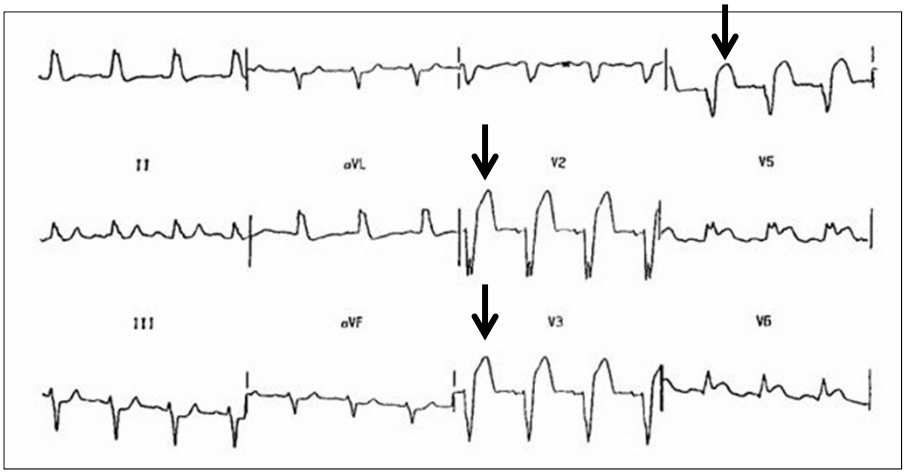
"Excessive" Discordant ST Segment Elevation (> 5 mm)

Somewhat Strongly Suggestive of AMI



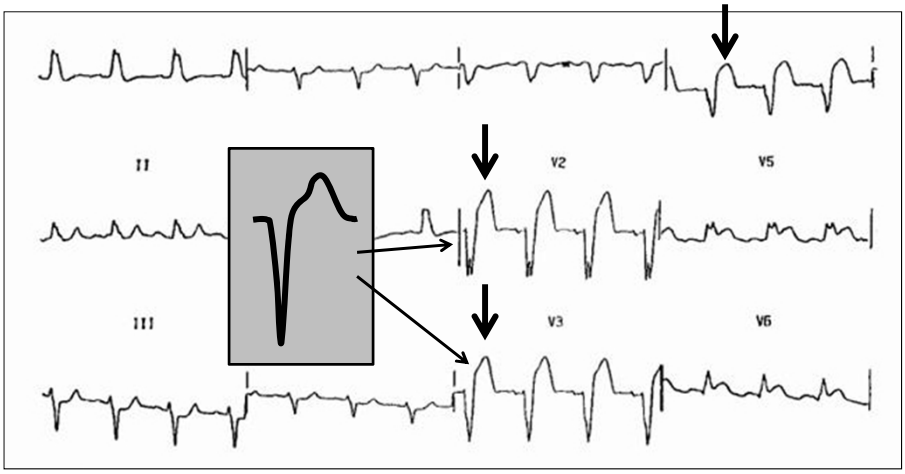
LBBB with AMI

Excessive Discordant ST Segment Elevation



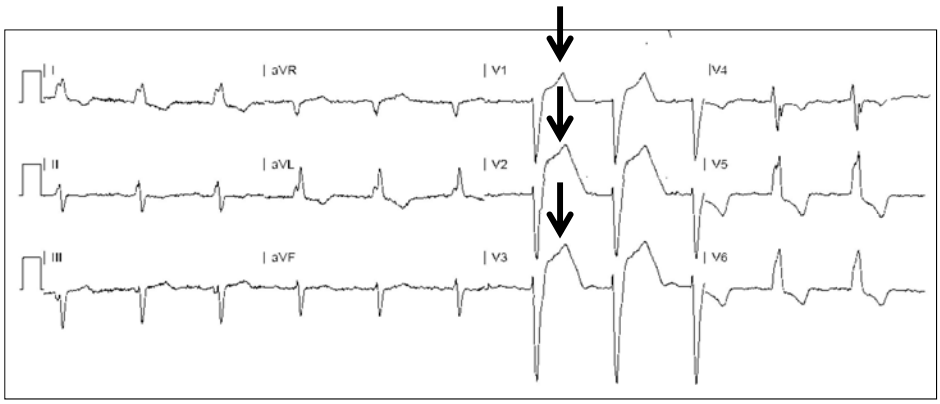
LBBB with AMI

Excessive Discordant ST Segment Elevation



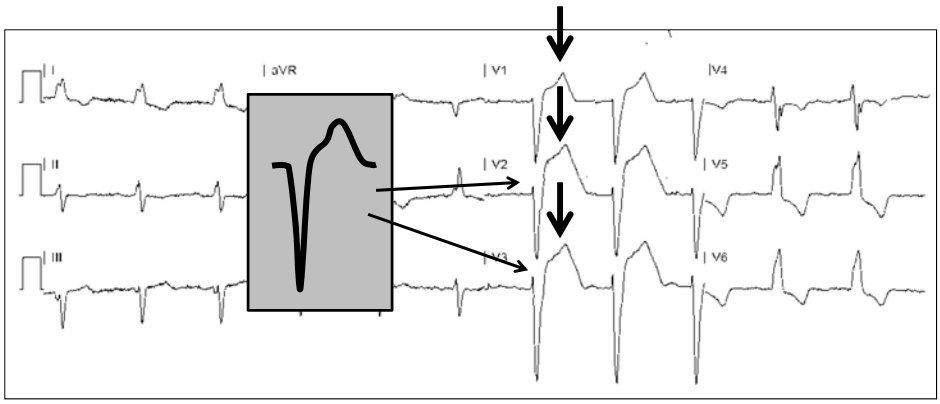
LBBB with AMI

Excessive Discordant ST Segment Elevation



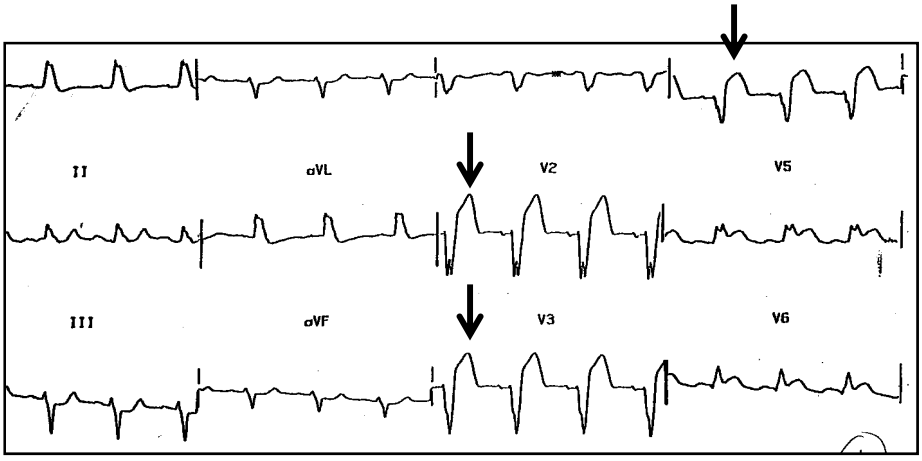
LBBB with AMI

Excessive Discordant ST Segment Elevation



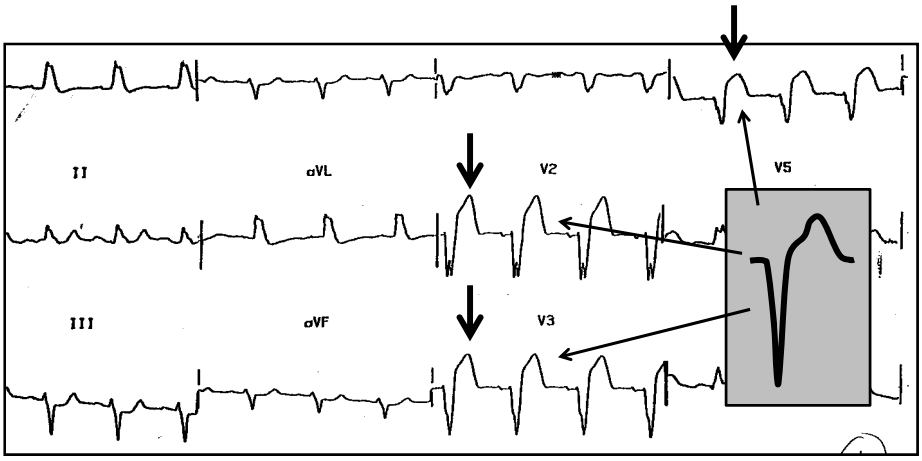
LBBB with AMI

Excessive Discordant ST Segment Elevation

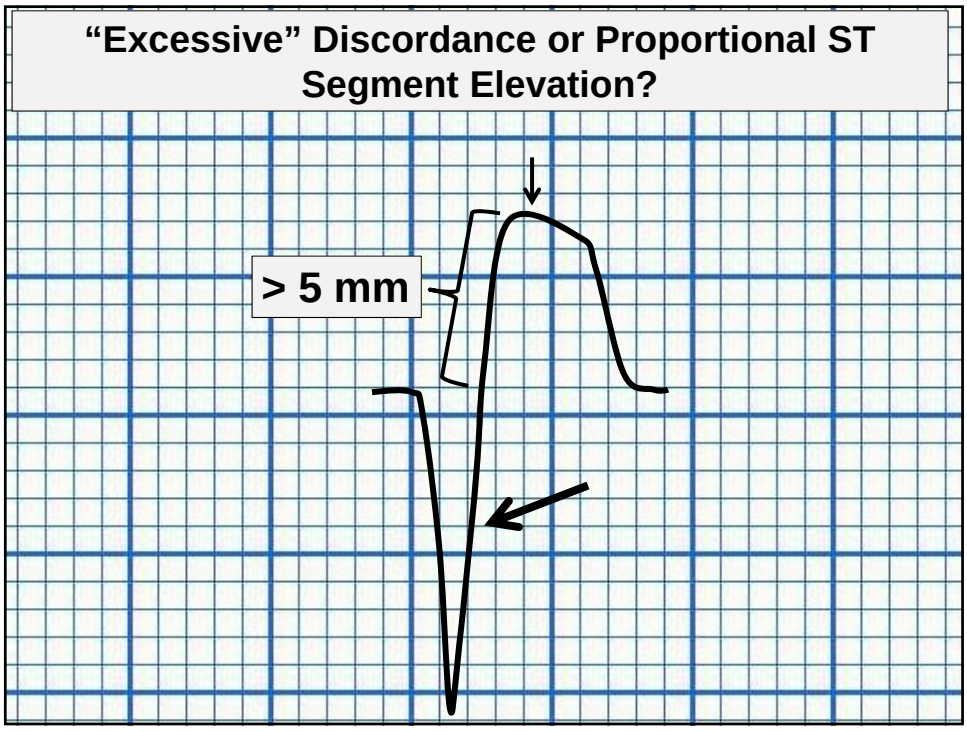


LBBB with AMI

Excessive Discordant ST Segment Elevation

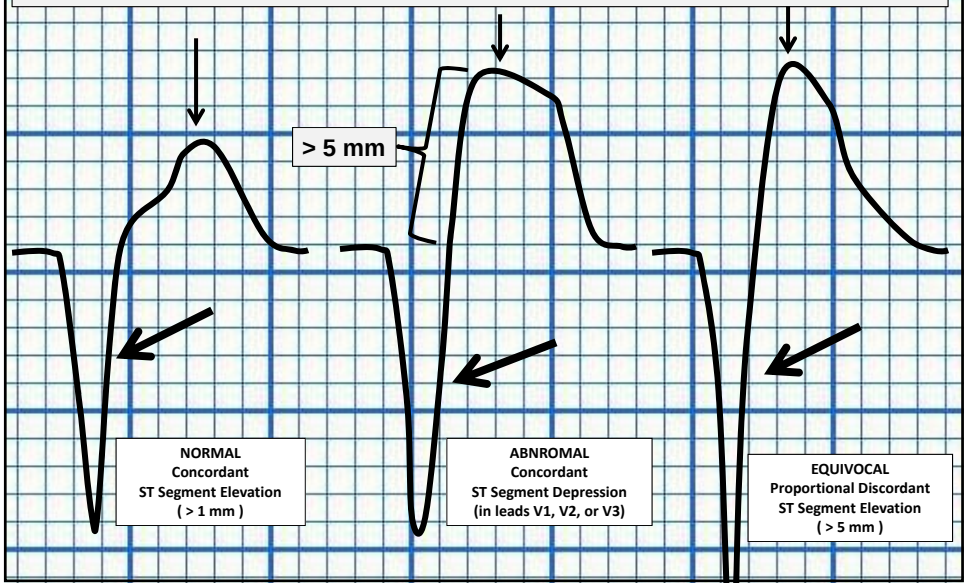


"Excessive" Discordance or Proportional ST Segment Elevation?



"Excessive" Discordant ST Segment Elevation (> 5 mm)

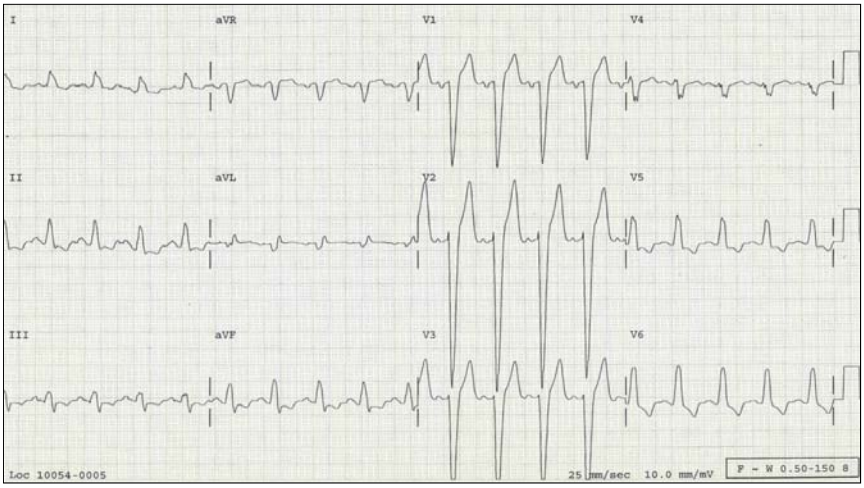
Somewhat Strongly Suggestive of AMI



Excessive Discordant ST Segment Elevation

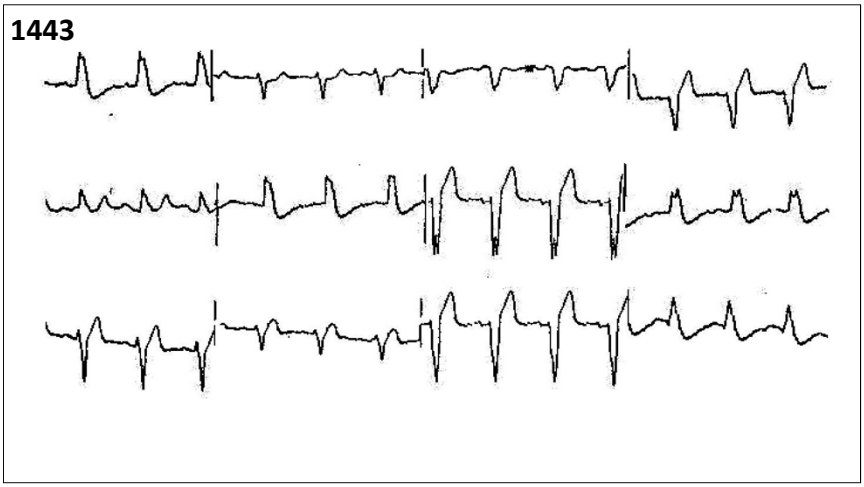
ST Segment Elevation is Proportional to Size of QRS Complex

NOT INDICATIVE OF ELECTROCARDIOGRAPHIC AMI



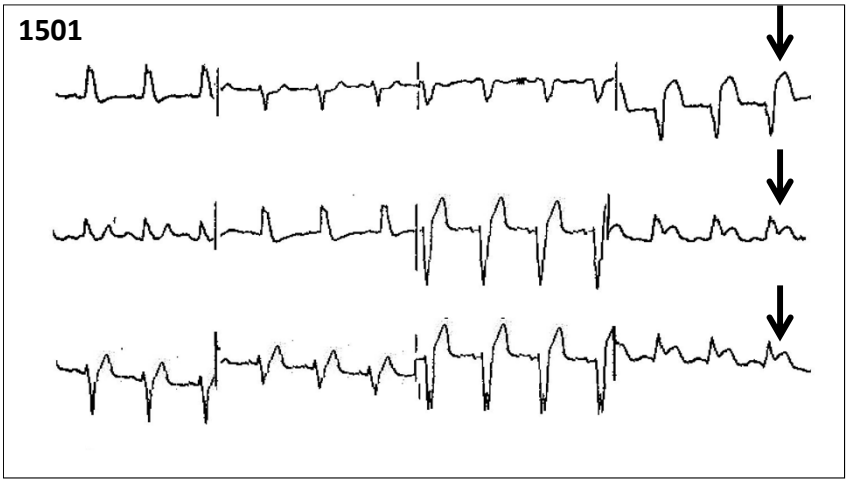
Serial ECGs: 1 of 2

"Concerning" Chest Pain Presentation

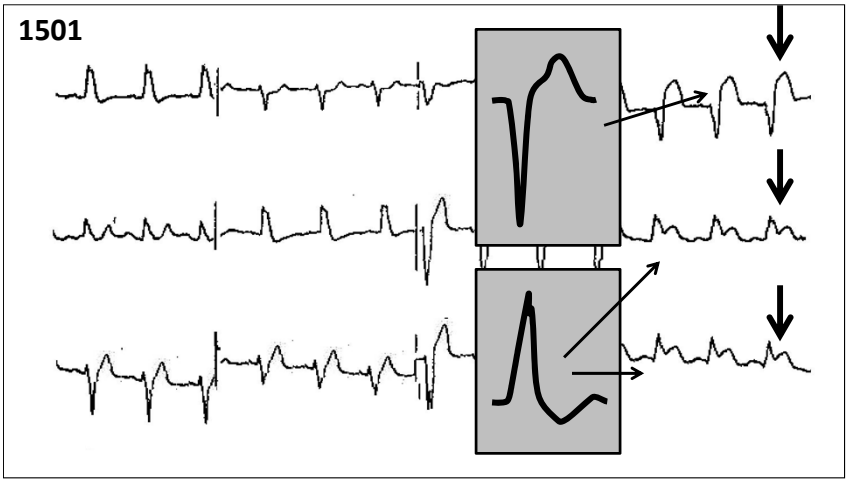


Serial ECGs: 2 of 2

Evolution of AMI with LBBB



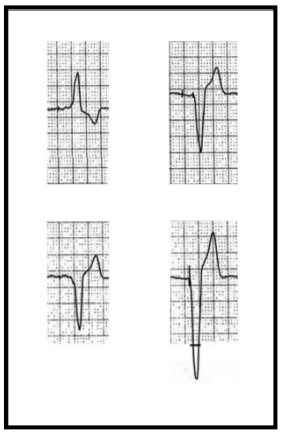
Serial ECGs: 2 of 2
Evolution of AMI with LBBB



Ventricular Paced Rhythm

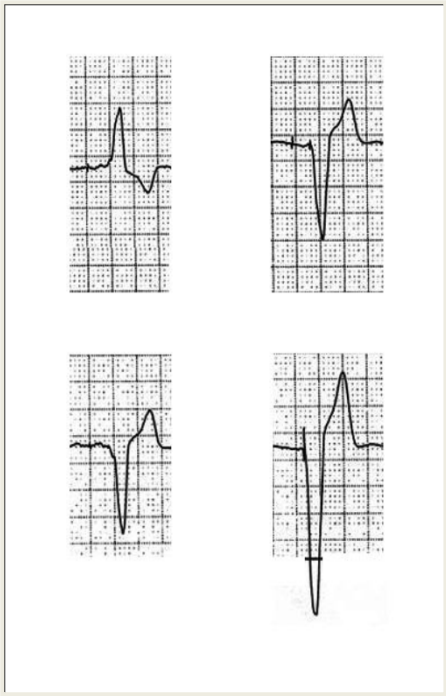
Ventricular Paced Rhythm

- Elderly population w/ pre-existing heart disease
- ECG characteristics
  - Broad, mainly negative QS complexes (leads V_1 to V_6)
  - QS complexes may also seen in leads II, III & aVf
  - Large monophasic R wave -- leads I & aVL

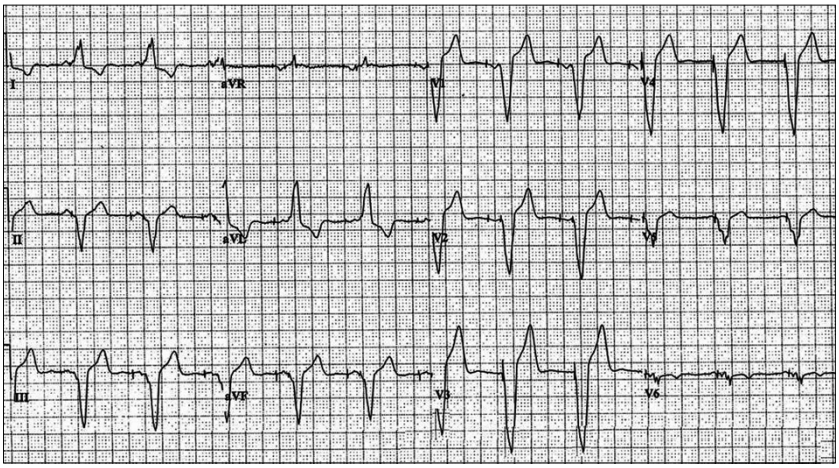


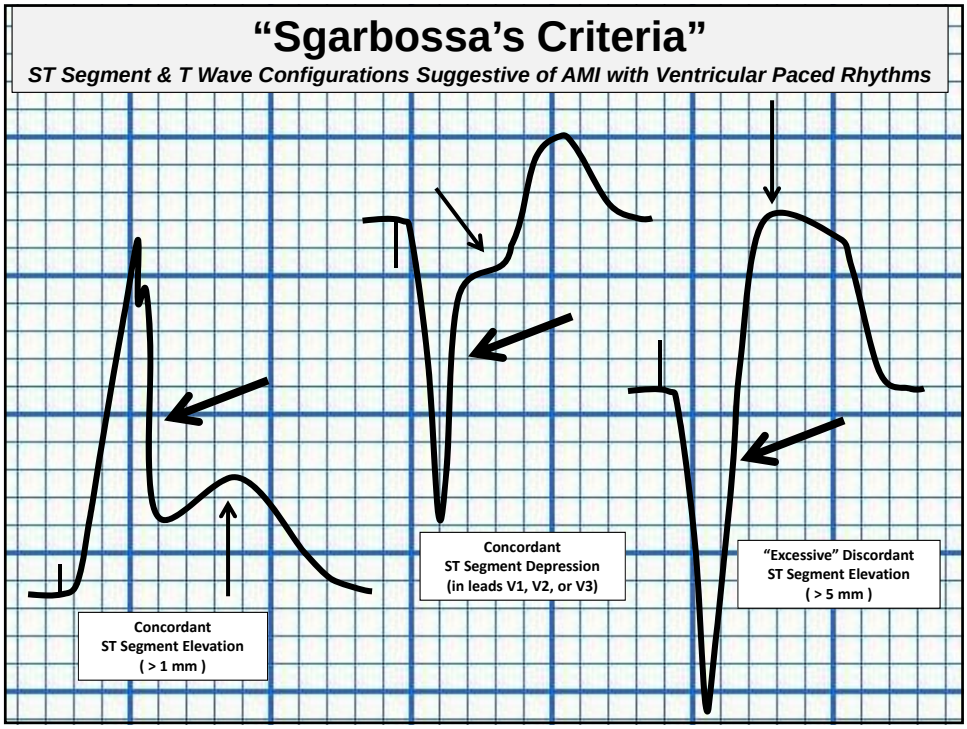
Ventricular Paced Rhythm

Normal Findings



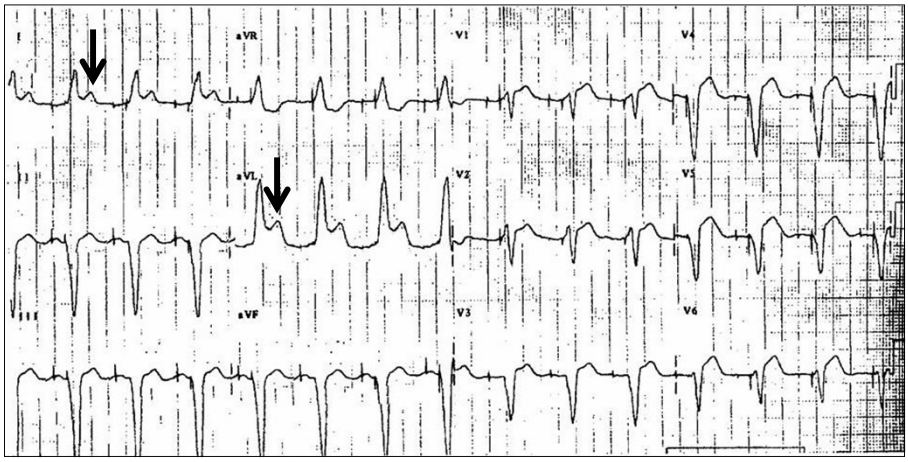
Ventricular Paced Pattern Normal ST Segment & T Wave





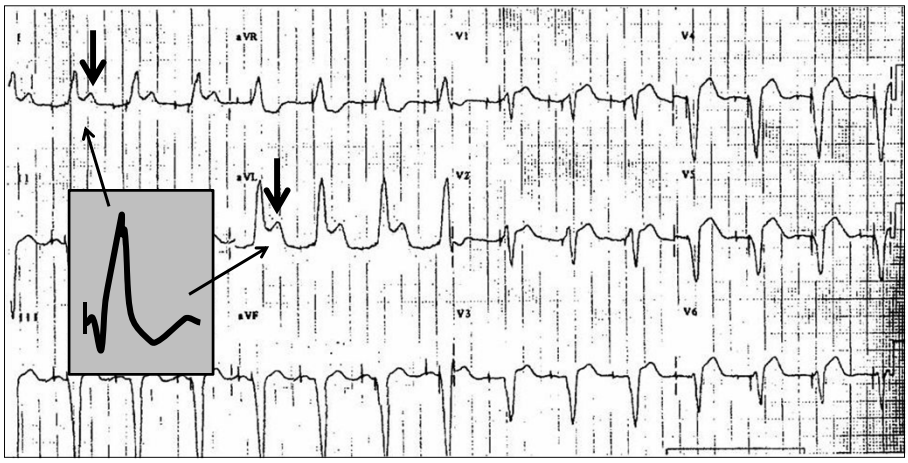
Ventricular Paced Pattern with AMI

Concordant ST Segment Elevation



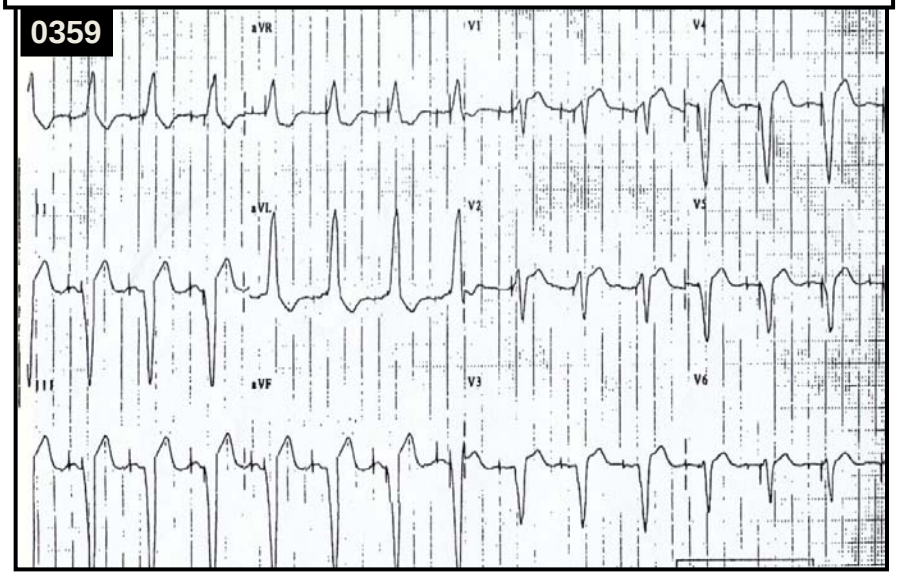
Ventricular Paced Pattern with AMI

Concordant ST Segment Elevation



Serial ECGs: 1 of 2

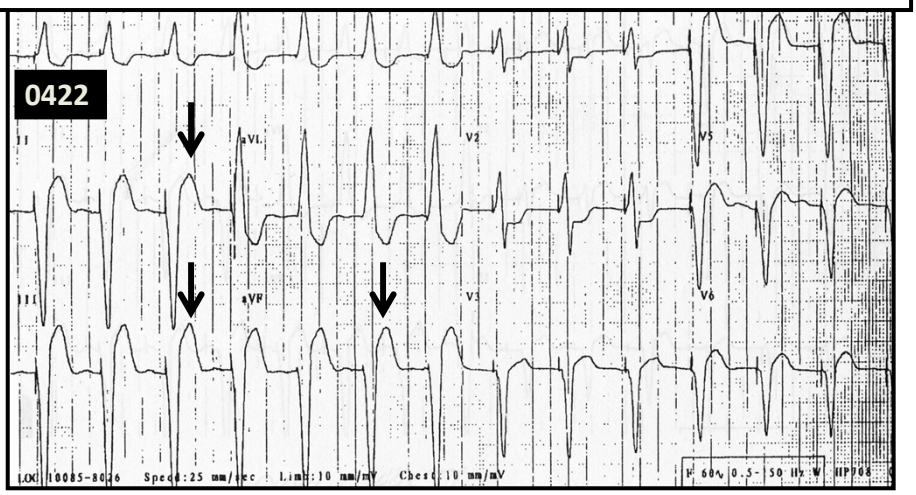
Ventricular Paced Pattern with Chest Pain



Serial ECGs: 1 of 2

Ventricular Paced Pattern with Chest Pain

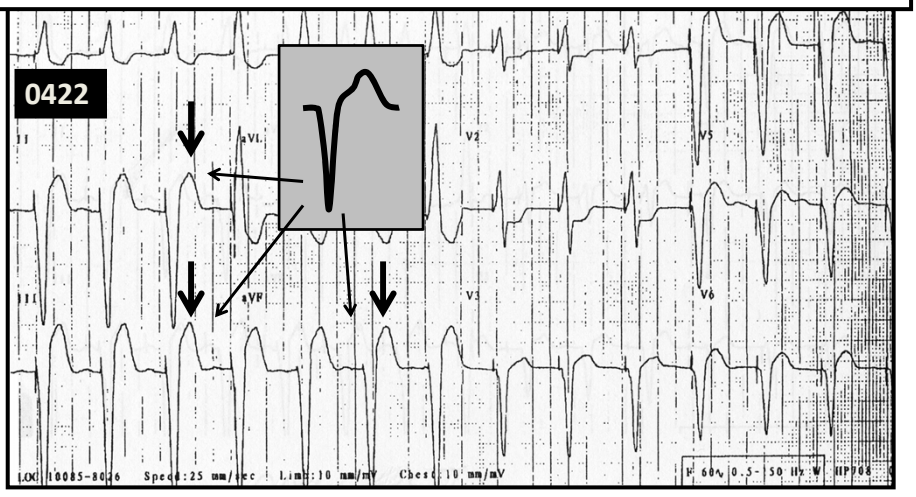
Excessive Discordant ST Segment Elevation



Serial ECGs: 1 of 2

Ventricular Paced Pattern with Chest Pain

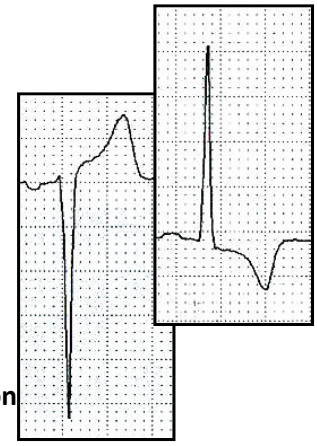
Excessive Discordant ST Segment Elevation



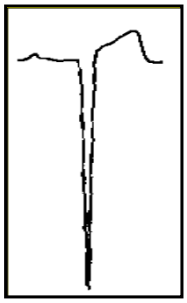
Left Ventricular Hypertrophy Pattern

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

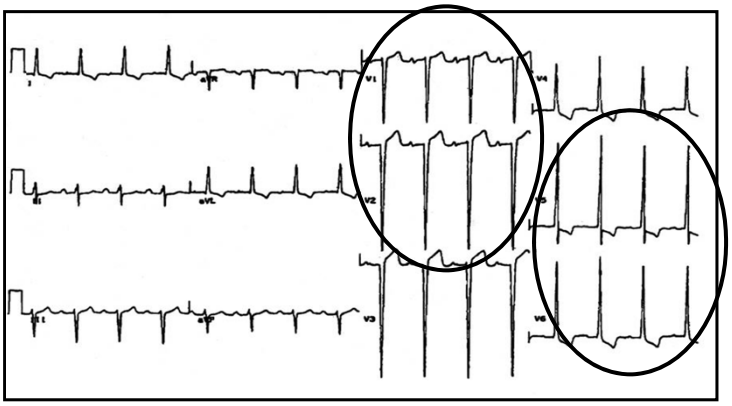


- LVH seen frequently in adult chest pain patients suspected of ACS
- Final hospital Dx
  - 26% ultimately ACS
  - 74% non-ACS
- ECG ***incorrectly*** interpreted > 70% of cases
  - Frequently did not identify LVH pattern
  - Attributed ST / T changes to ischemia or infarction
  - Observed changes resulted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

Larsen et al, J Gen Intern Med 1994

QRS Complex Size?

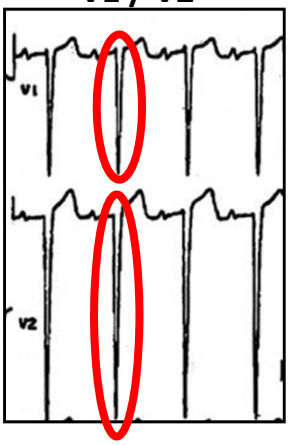
The LVH Pattern



QRS Complex Size?

Determination of QRS Complex Size

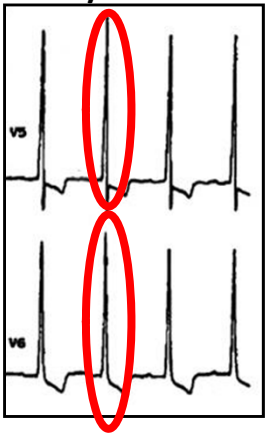
V1 / V2



Q wave

+

V5 / V6



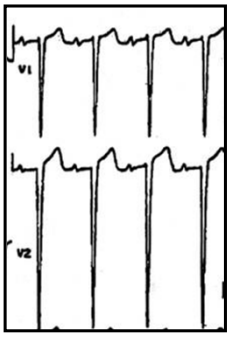
R Wave

> 35 mm *

*In a patient > age 35 years

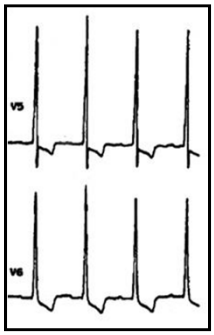
QRS Complex Size?

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

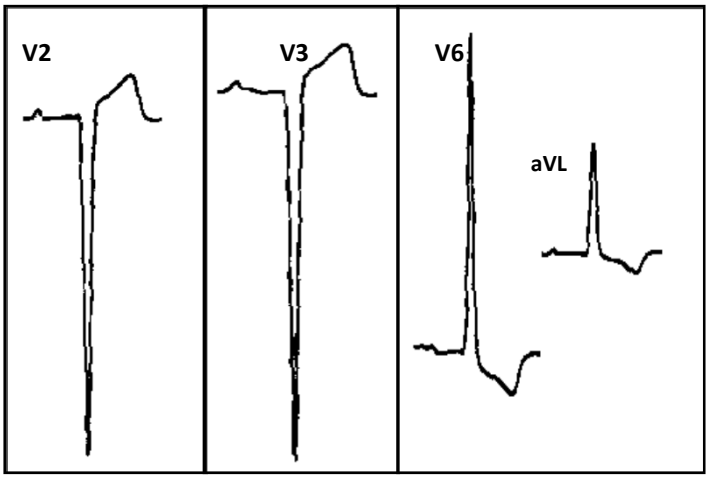


ST Segment Elevation

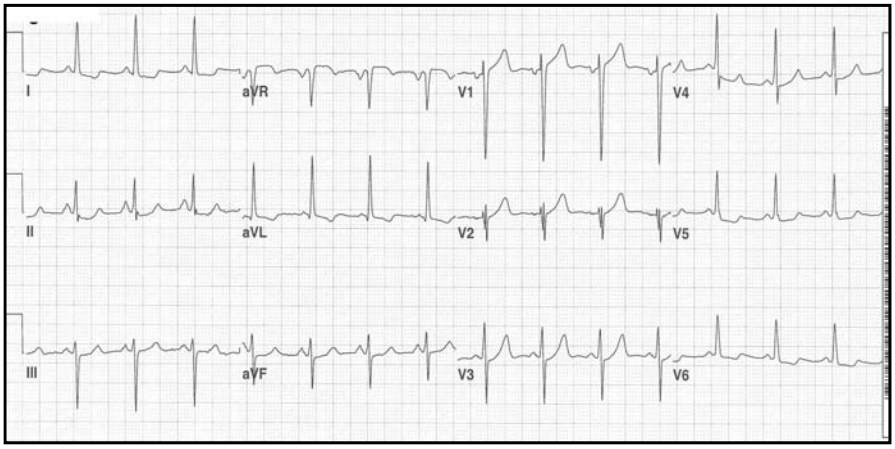
ST Segment Depression & T Wave Inversion



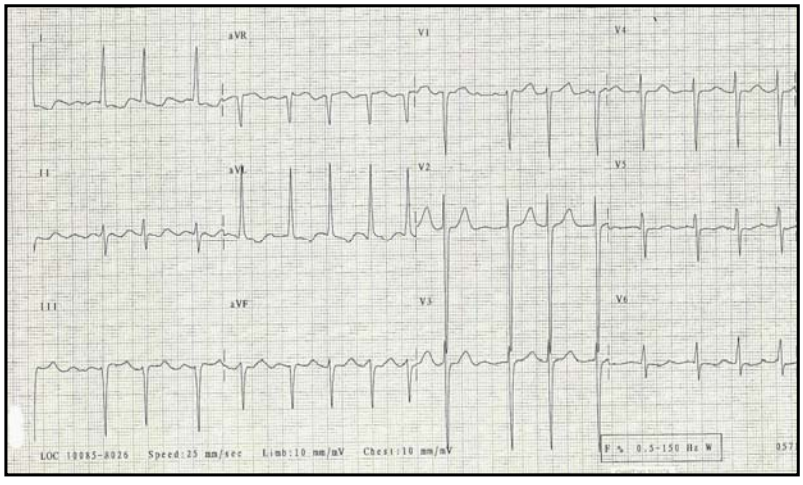
LVH with Strain Pattern



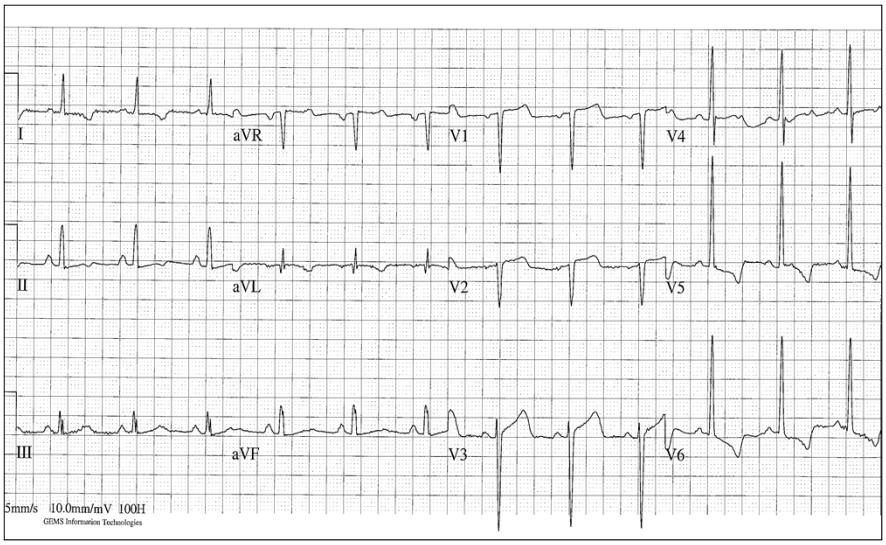
Left Ventricular Hypertrophy



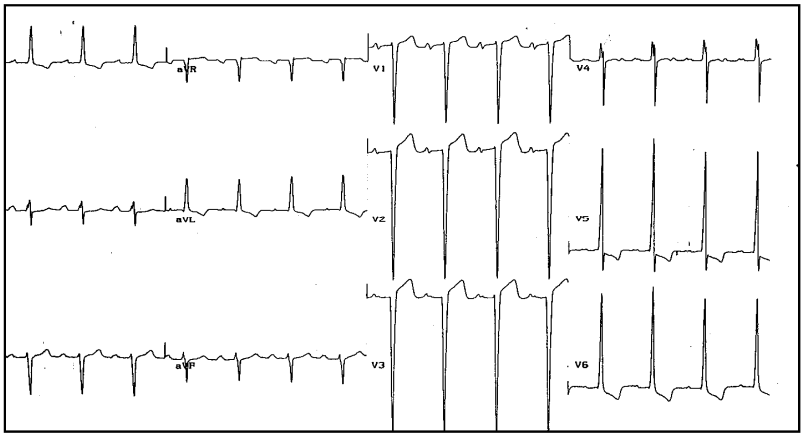
Left Ventricular Hypertrophy with Strain Pattern



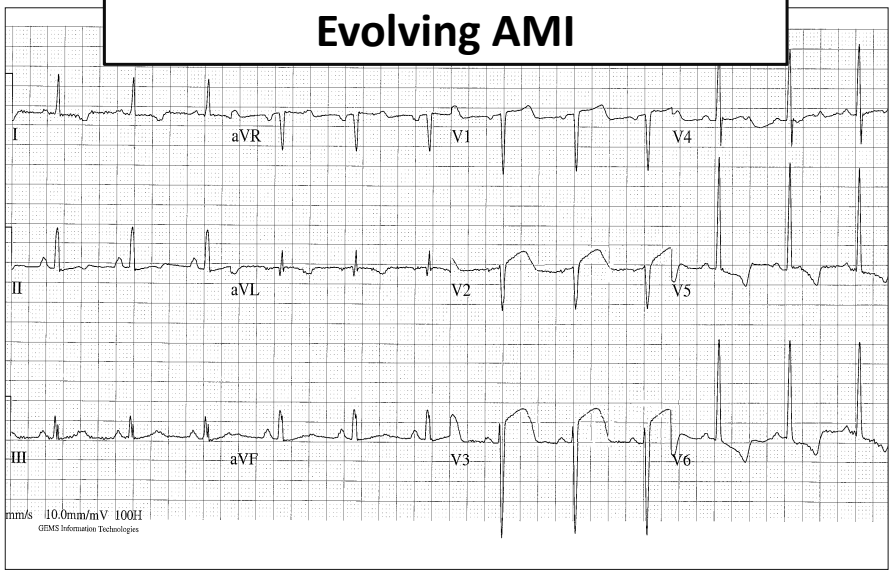
Left Ventricular Hypertrophy with Strain Pattern



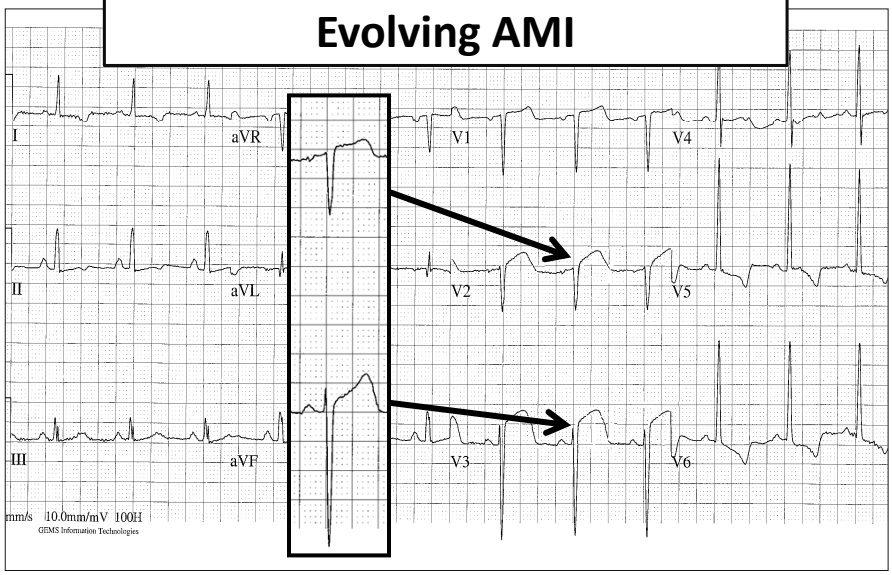
Left Ventricular Hypertrophy with Strain Pattern



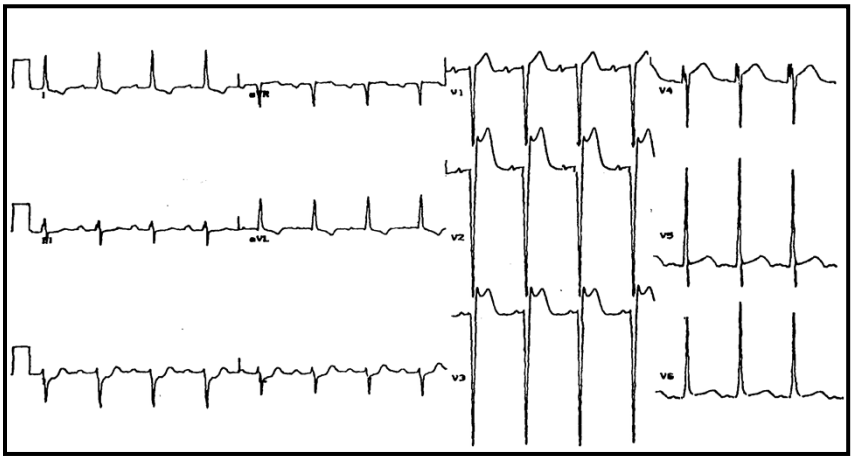
Left Ventricular Hypertrophy with Strain Pattern Evolving AMI



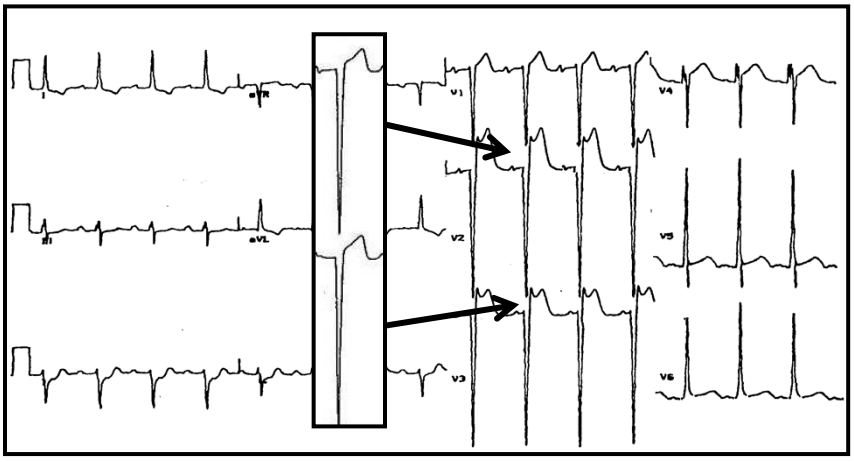
Left Ventricular Hypertrophy with Strain Pattern Evolving AMI

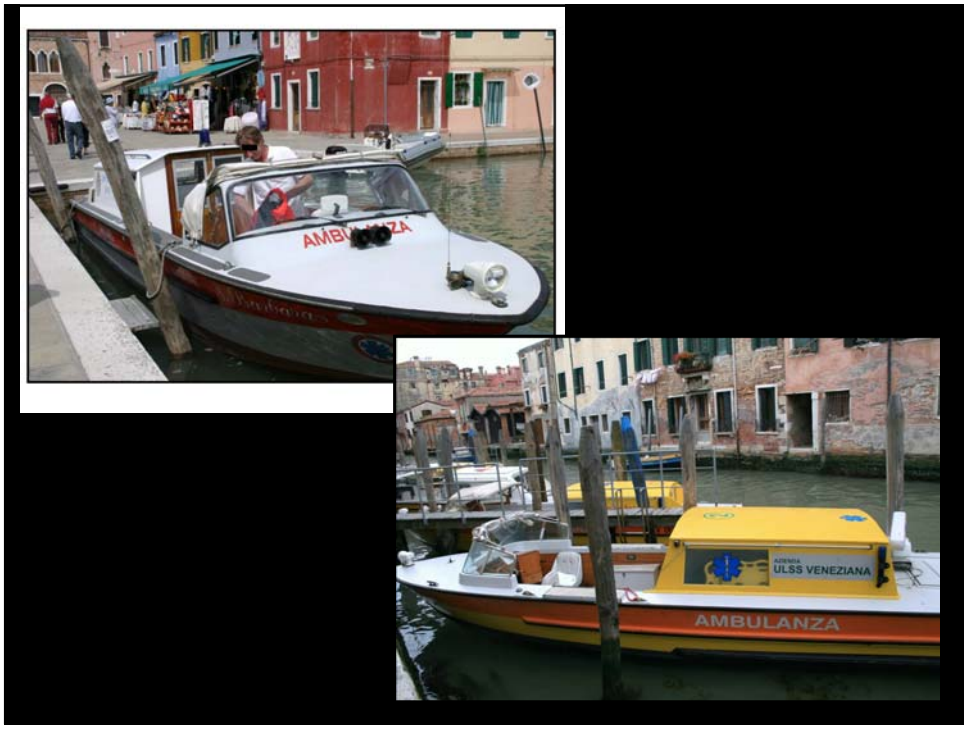


Left Ventricular Hypertrophy with Strain Pattern Evolving AMI



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

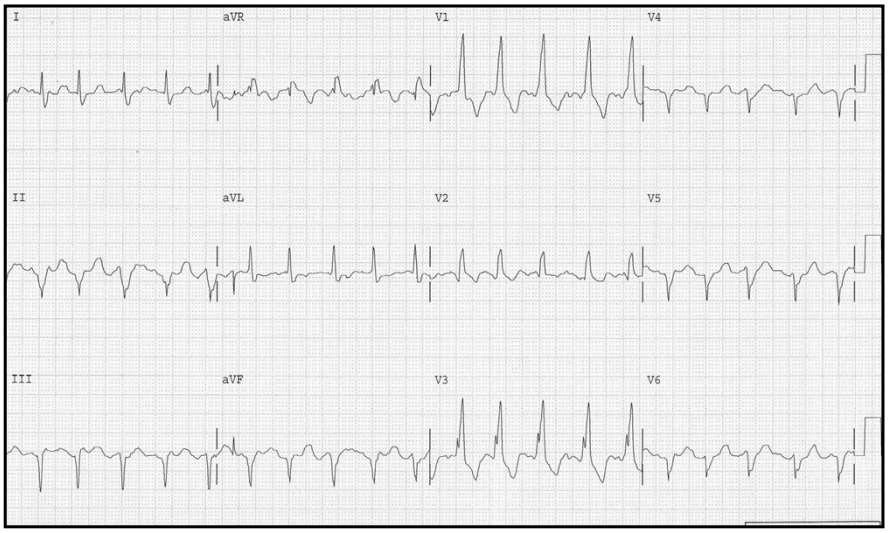
- **May also hinder ECG diagnosis**
  - **Not due to electrophysiologic issues**
  - **Resulting from interpretative errors**
- **Age of RBBB**
  - **Chronicity not an issue for fibrinolysis**
  - **ECG can be interpreted – consider ST segments**
  - **Marker for poor outcome**
- **NRMI-2 registry**
  - **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 V_1
  - Wide S or RS wave in lead V_6

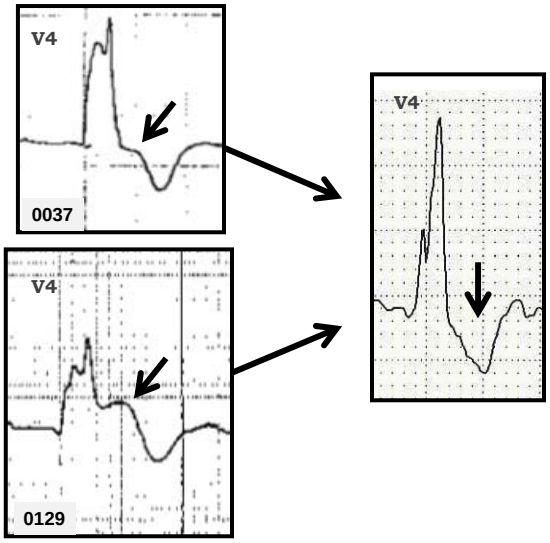
- Marked ST segment changes are seen
  - Right precordial leads -- ST depression
  - Inferior & left precordial leads -- upright T wave & ST elevation

Right Bundle Branch Block

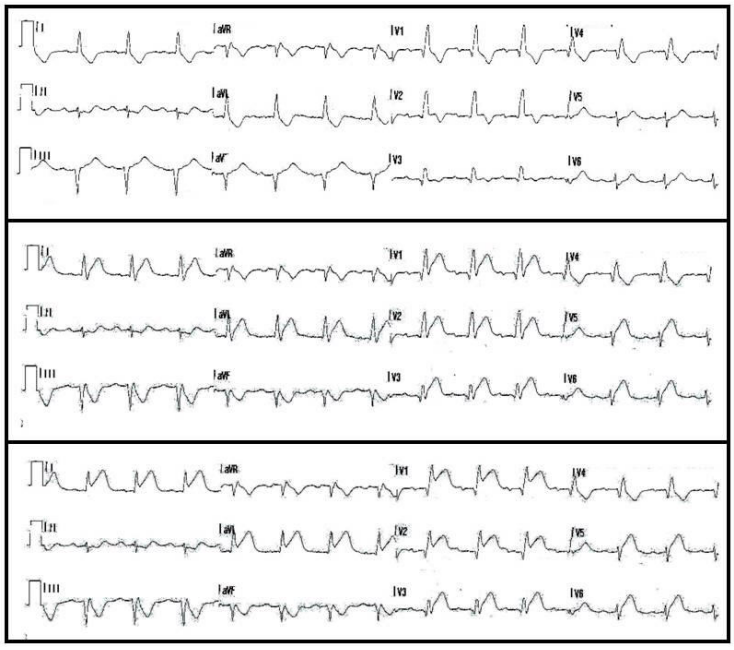


RBBB with Anterior Wall STEMI

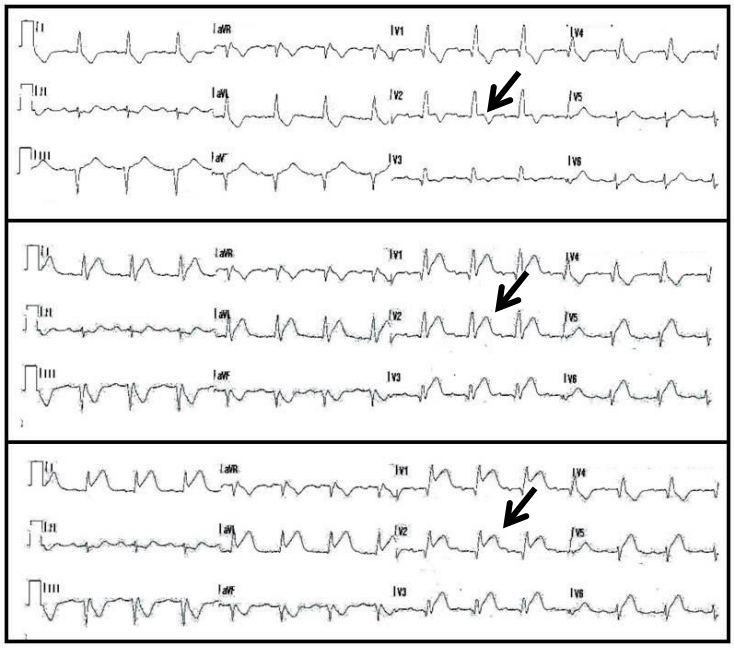
RBBB with Anterior Wall STEMI



RBBB with Anterior Wall STEMI



RBBB with Anterior Wall STEMI



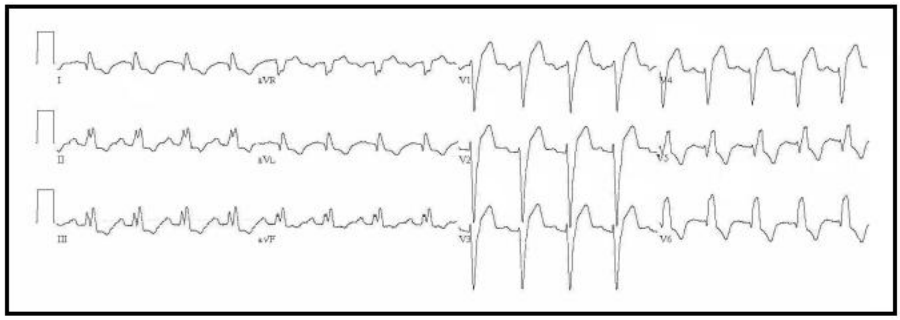
Cases

Case History

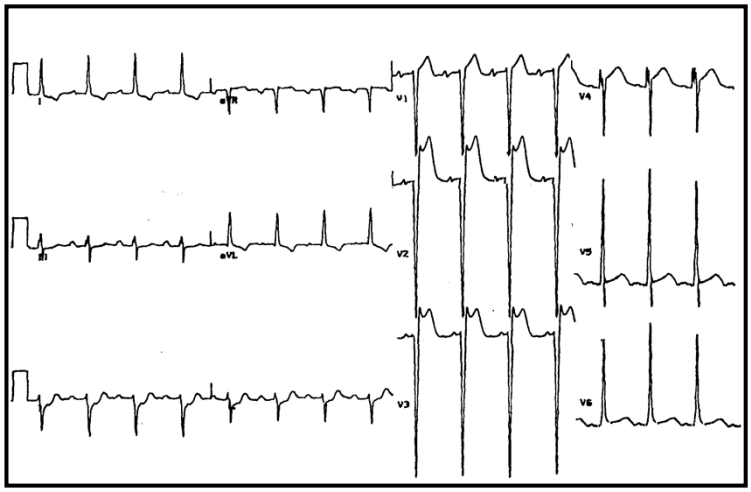
(for all cases today)

- **58 year-old male / female**
- **Chest pain**
- **Dyspnea with diaphoresis**
- **Exam – anxious & diaphoretic**
- **ECG…….**

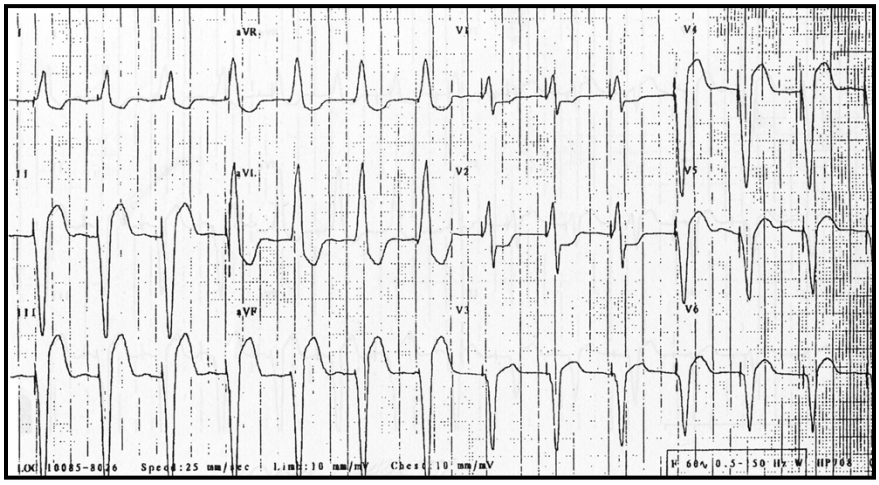
Case #1



Case #2



Case #3



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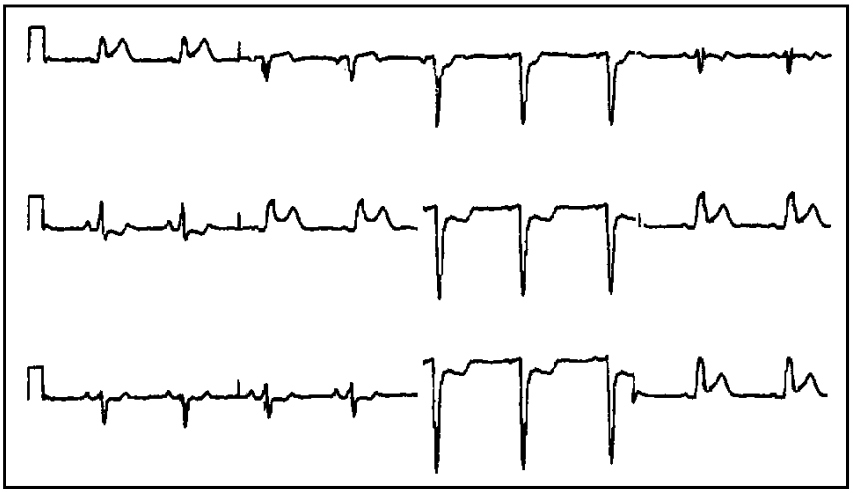
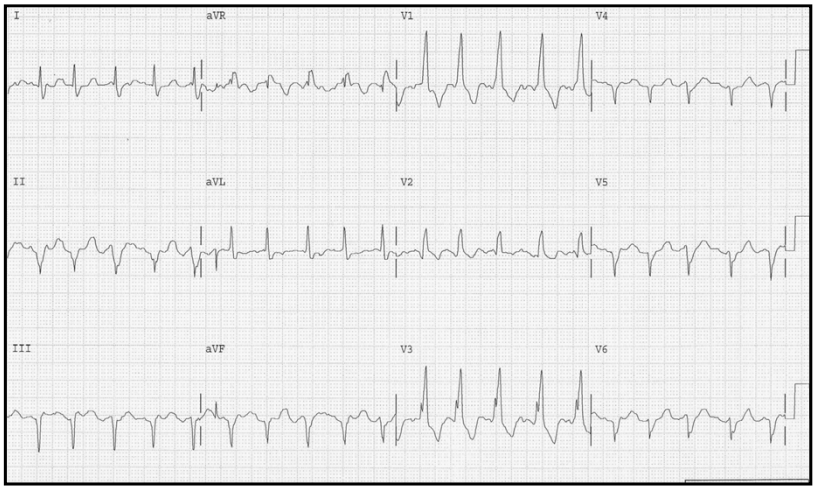
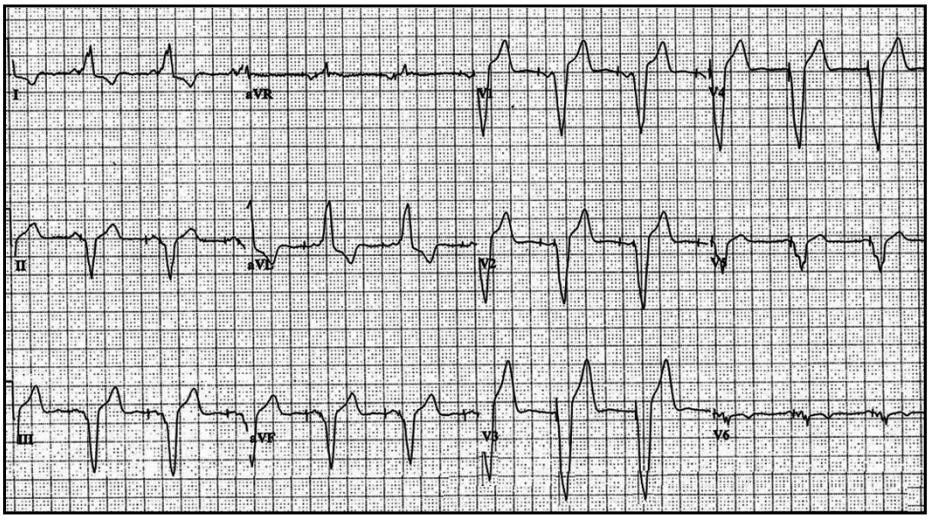


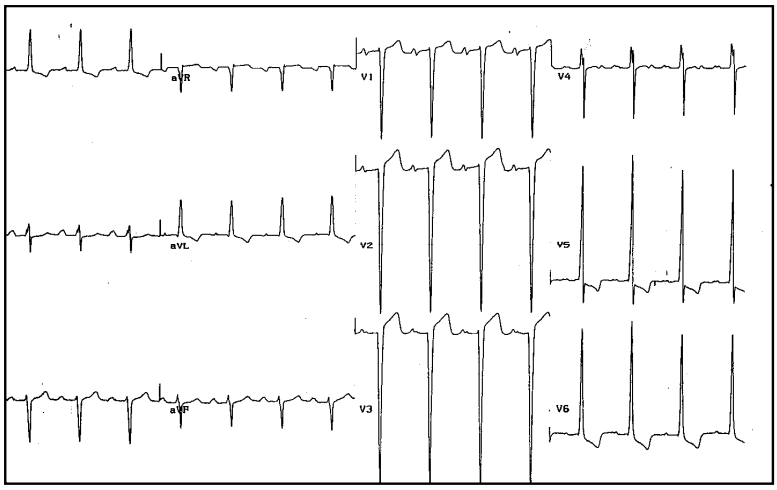
Case #5


I
aVR
V1
V4
II
aVL
V2
V5
III
aVF
V3
V6

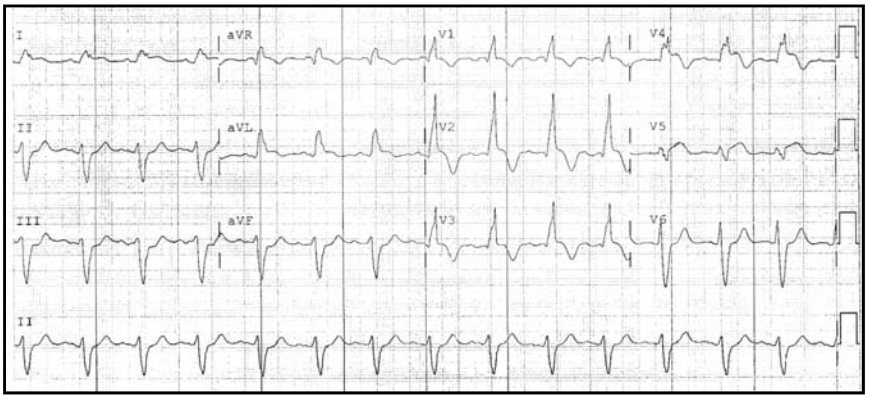
Case #6


I
aVR
V1
V4
II
aVL
V2
V5
III
aVF
V3
V6

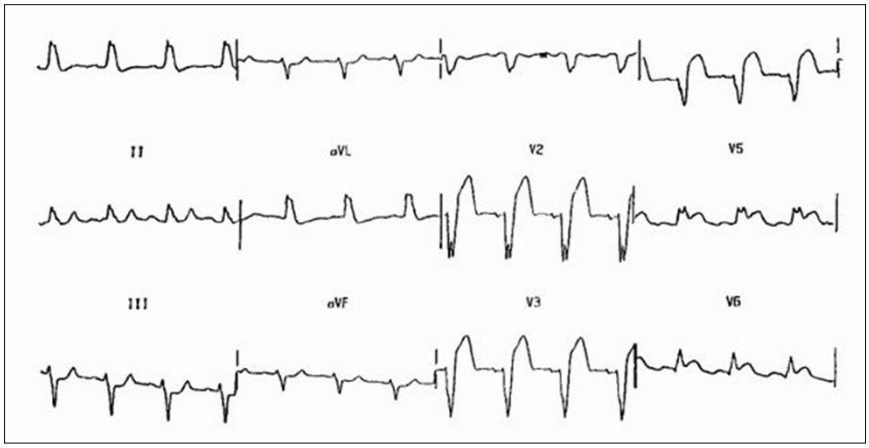
Case #7


aVR
V1
V4
aVL
V2
V5
aVR
V3
V6

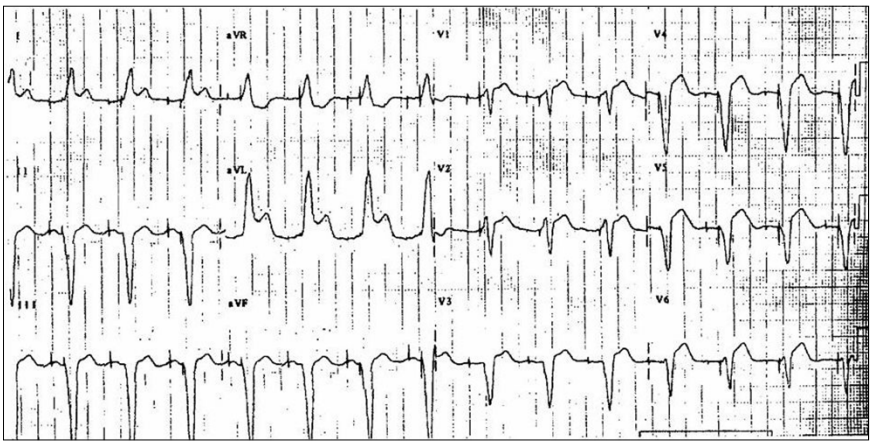
Case #8


I
aVR
V1
V4
II
aVL
V2
V5
III
aVF
V3
V6
II

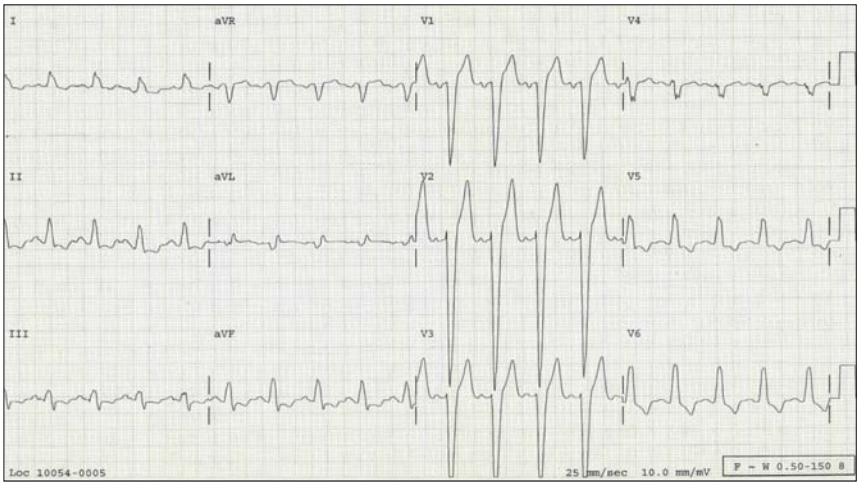
Case #9



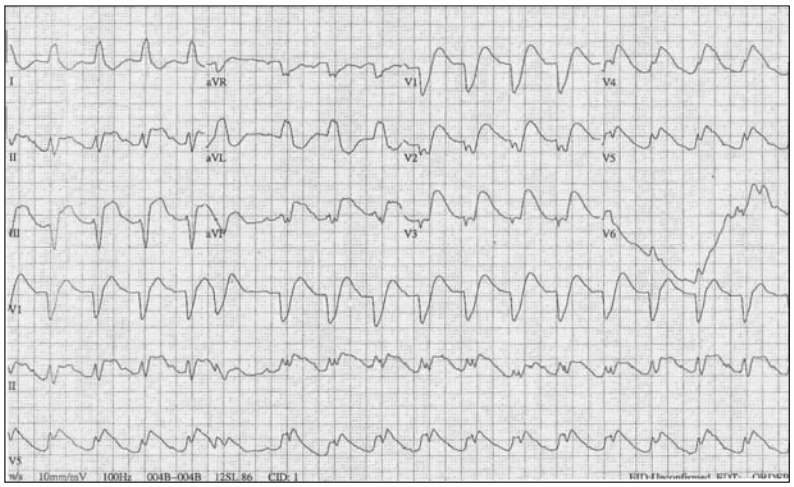
Case #10



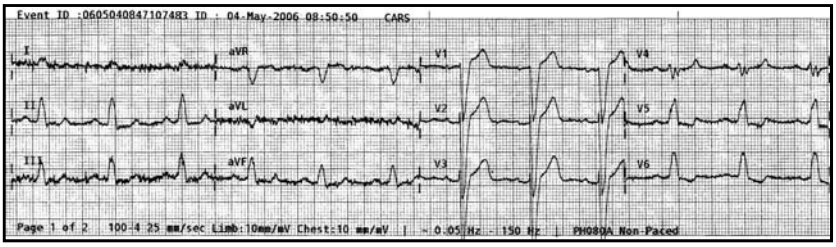
Case #11

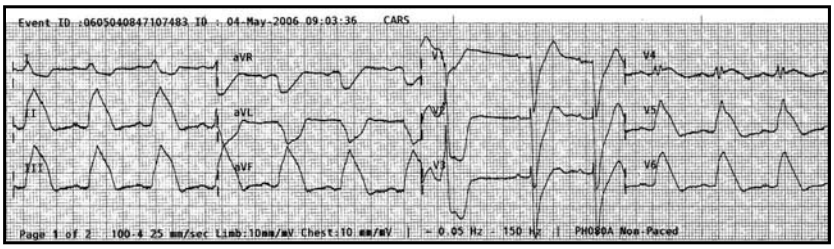


Case #12



Case #13


Event ID :0605040847107483 ID : 04-May-2006 08:50:50 CARS
I
II
III
aVR
aVL
aVF
V1
V2
V3
V4
V5
V6
Page 1 of 2 100 4 25 mm/sec Limb:10mm/mV Chest:10 mm/mV | ~ 0.05 Hz - 150 Hz | PH080A Non-Paced


Event ID :0605040847107483 ID : 04-May-2006 09:03:36 CARS
I
II
III
aVR
aVL
aVF
V1
V2
V3
V4
V5
V6
Page 1 of 2 100 4 25 mm/sec Limb:10mm/mV Chest:10 mm/mV | ~ 0.05 Hz - 150 Hz | PH080A Non-Paced