

STAT 12 Lead ECG Workshop: Basics & ACS

Part 2: Acute Coronary Syndrome

WAYNE W RUPPERT, CVT, CCCC, NREMT-P

**Cardiovascular Coordinator
Bayfront Health Seven Rivers
Crystal River, Florida**

**Interventional Cardiovascular
& Electrophysiology
Technologist**

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Your patient arrives.....

Initial Assessment:

- ABCs (rule out – or treat – cardiac arrest)
- SHOCK Assessment

SHOCK ASSESSMENT



SECONDS

SHOCK =

INADEQUATE TISSUE
PERFUSION

- STARTS THE INSTANT YOU SEE PATIENT
- ENDS WHEN YOU REACH THE PATIENT'S SIDE

SHOCK ASSESSMENT

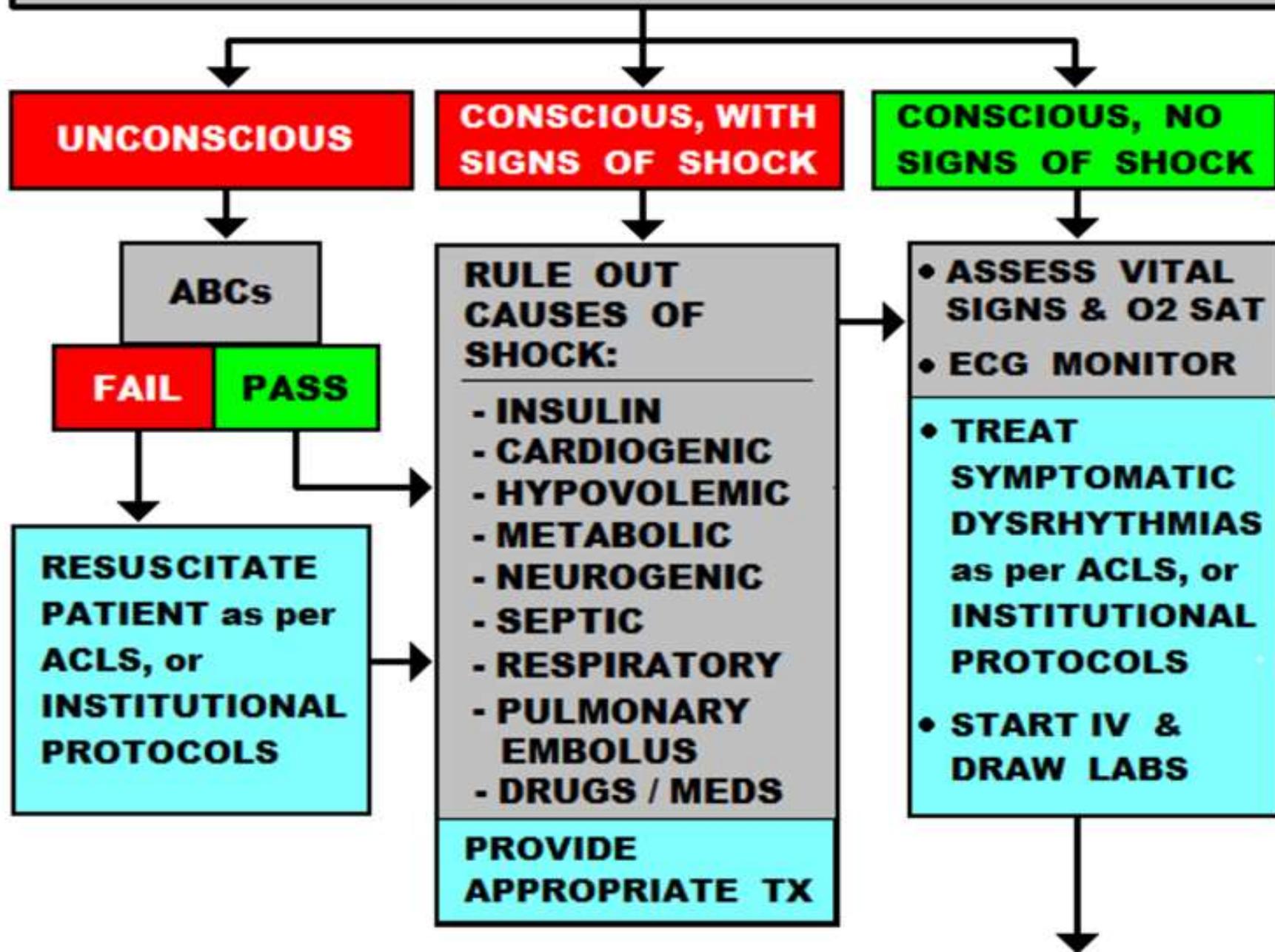
LOC:	ANXIOUS RESTLESS LETHARGIC UNCONSCIOUS	AWAKE ALERT & ORIENTED
SKIN:	PALE / ASHEN CYANOTIC COOL DIAPHORETIC	NORMAL HUE WARM DRY
BREATHING:	TACHYPNEA	NORMAL
PULSE:	WEAK / THREADY TOO FAST or SLOW	STRONG
STATUS:	 SHOCK 	NORMAL

FAIL the SHOCK SURVEY ?



**RAPIDLY FIND *AND TREAT*
THE ROOT CAUSE . . .**

- ABCs
- SHOCK ASSESSMENT



ACLS criteria for Oxygen:

- SAO₂ less than 90 And/ or
- Signs of Hypoxia (shock) are present.

Some agency protocols are more aggressive about when O₂ is given

If the patient has TWO or more of the following, ACS should be RULED OUT:

- **ACS Symptoms**
- **Risk Factors for Heart Disease (3 or more, or KNOWN history of heart disease)**
- **ECG abnormalities (ST- T wave changes)**
- **Cardiac Markers (Troponin) elevated.**

If the patient has TWO or more of the following, ACS should be RULED OUT:

- _____
- _____ for Heart Disease (3 or more, or KNOWN history of heart disease)
- _____ (ST- T wave changes)
- _____ (Troponin) elevated.

The QUADRAD of ACS



PRESENTING SYMPTOMS



RISK FACTOR PROFILE



ECG ABNORMALITIES



CARDIAC MARKERS

A POSITIVE finding in TWO or MORE of the above categories indicates it is EXTREMELY LIKELY that ACS is present steps must be **AGGRESSIVELY TAKEN** to definitively **RULE OUT** the **PRESENCE** of ACS !

CHIEF COMPLAINT

KEY WORDS:

“CHEST: PAIN / HEAVINESS / PRESSURE/
FUNNY FEELING IN,” etc.

SHORTNESS BREATH

DIZZINESS / LIGHTHEADEDNESS

ETC. ETC. ETC.



TYPICAL SYPTOMS of **ACUTE CORNARY SYNDROME:**

- ✓ **CHEST PAIN - DESCRIBED AS . . .**
 - "HEAVINESS, PRESSURE, DULL PAIN, TIGHTNESS"
 - CENTERED IN CHEST, SUBSTERNAL
 - MAY RADIATE TO SHOULDERS, JAW, NECK, LEFT or RIGHT ARM
 - NOT EFFECTED by:
 - MOVEMENT
 - POSITION
 - DEEP INSPIRATION

- ✓ **SHORTNESS OF BREATH**
 - MAY or MAY NOT BE PRESENT

- ✓ **NAUSEA / VOMITING**
 - MAY or MAY NOT BE PRESENT

“Classic” cardiac chest pain:

- Location: Substernal
- Dull or Pressure-like in nature
- Does not change with deep inspiration

“Classic” cardiac chest pain:

- Location: _____
- _____ or _____ in nature
- Does not change with _____

INFARCTION

- - - "*Classic Symptoms*" - - -



QUICK ASSESSMENT "SHORT FORM"

- SUBSTERNAL CHEST PAIN**
(HAVE PATIENT POINT TO WORST PAIN)
- DESCRIBED AS "DULL PAIN,"
"PRESSURE," or "HEAVINESS"**
- DOES NOT CHANGE WITH
DEEP BREATH**

stable angina

1. SYMPTOMS START DURING PHYSICAL EXERTION.
2. SYMPTOMS ARE "PREDICTABLE"

VS.

unstable angina

1. SYMPTOMS MAY START AT ANY TIME, EVEN DURING REST
2. SYMPTOMS ARE NEW, DIFFERENT, or WORSE THAN PREVIOUS EPISODES

BEWARE of the patient with

“INTERMITTENT CHEST PAIN”



ATYPICAL SYMPTOMS of ACS

???

Acute MI patients who present without chest pain* are SHREWD:

Sroke (previous history of)

Heart failure (previous history of)

Race (non-white)

Elderly (age 75+)

Women

Diabetes mellitus

* The information listed in the table to the immediate left resulted from a study conducted by John G. Canto, MD, MSPH, et. al., of the University of Alabama. The study consisted of 434,877 patients diagnosed with AMI between 1994 and 1998 in 1,674 US hospitals. Study results were published in the Journal of the American Medical Association (JAMA) on June 28, 2000, Vol. 283, No. 24, pages 3223-3229

Common atypical complaints associated with AMI without chest pain include:

Malaise (weakness)

Fatigue

Indigestion

Abdominal pain

Nausea

Cold sweats

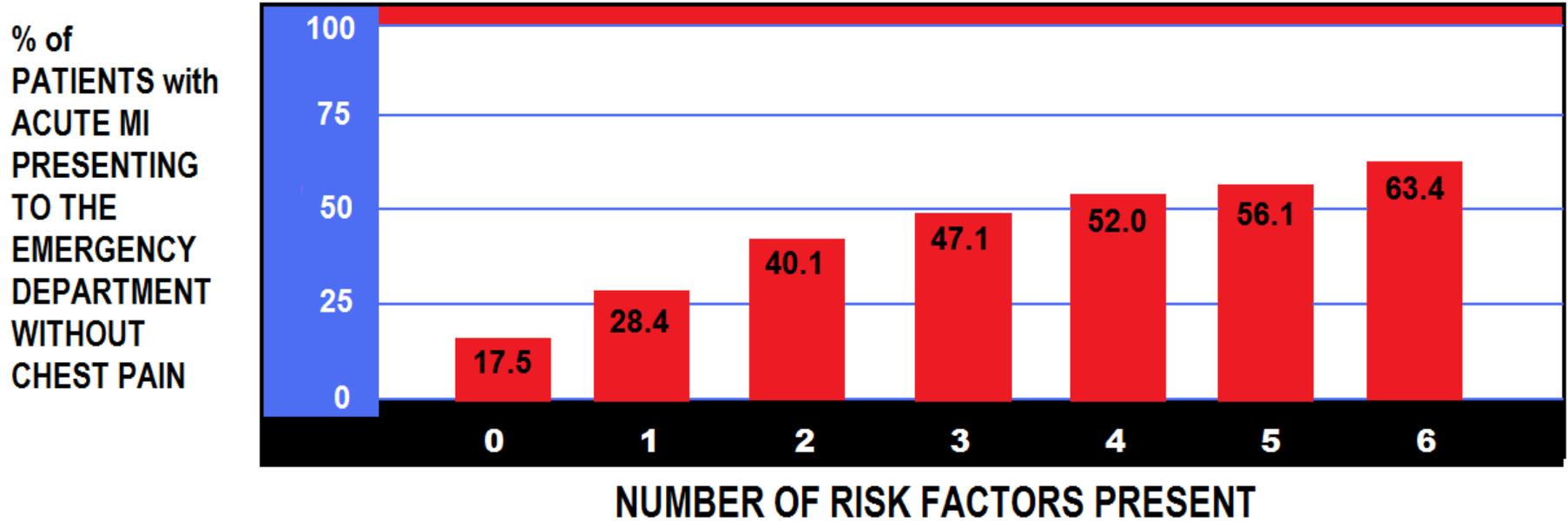
Dizziness

Elevated heart rate

Syncope

Dyspnea

Effect of Having Multiple Risk Factors for AMI Without Chest Pain



RISK FACTORS INCLUDE: **S**roke (previous), **H**ear failure (previous), **R**ace (non-white), **E**lderly (age 75+), **W**omen, **D**iabetes

DATA SOURCE: J. CANTO, MD, MSPH, et al, JAMA 2000 ; 283 : 3223 - 3229

**WOMEN'S MAJOR SYMPTOMS
PRIOR TO THEIR HEART ATTACK:**

- UNUSUAL FATIGUE 71 %
- SLEEP DISTURBANCE 48 %
- SOB 42 %
- INDIGESTION 39 %
- ANXIETY 36 %

APPROXIMATELY 78 % OF WOMEN REPORTED EXPERIENCING AT LEAST ONE OF THESE SYMPTOMS FOR MORE THAN ONE MONTH EITHER DAILY OR SEVERAL TIMES PER WEEK PRIOR TO THEIR MI.

**WOMEN'S MAJOR SYMPTOMS
DURING THEIR HEART ATTACK:**

- SHORTNESS OF BREATH 58 %
- WEAKNESS 55 %
- UNUSUAL FATIGUE 43 %
- COLD SWEAT 39 %
- DIZZINESS 39 %



43 % HAD NO CHEST PAIN AT ANY TIME DURING THEIR MI!

Circulation, 2003;108;2619-2623

Physical Exam – Clues of MI:

- Skin may be PALE, CLAMMY
- **SWEATING !** (Diaphoresis)
- Clutching /Rubbing chest
- BP can be high, normal or low
- Anxiety / “look of impending doom.”

The QUADRAD of ACS



PRESENTING SYMPTOMS



RISK FACTOR PROFILE



ECG ABNORMALITIES



CARDIAC MARKERS

A POSITIVE finding in TWO or MORE of the above categories indicates it is EXTREMELY LIKELY that ACS is present steps must be **AGGRESSIVELY TAKEN** to definitively **RULE OUT** the **PRESENCE** of ACS !

The QUADRAD of ACS

- PRESENTING SYMPTOMS**
- RISK FACTOR PROFILE**
- ECG ABNORMALITIES**
- CARDIAC MARKERS**

A POSITIVE finding in TWO or MORE of the above categories indicates it is EXTREMELY LIKELY that ACS is present steps must be **AGGRESSIVELY TAKEN to definitively **RULE OUT** the **PRESENCE** of ACS !**

Risk Factors for Heart Disease:

One of the following gets a “checkmark” in the box for Risk Factors:

- KNOWN HISTORY of cardiovascular disease

--or--

- 3 or more Risk Factors (listed on the next page):

RISK FACTORS

for the development of

CORONARY ARTERY DISEASE:

-  **HEREDITY**
-  **↑ LDL and ↓ HDL CHOLESTEROL PROFILES**
-  **SMOKING**
-  **DIABETES MELLITUS**
-  **OBESITY**
-  **PHYSICAL INACTIVITY**
-  **HYPERTENSION**
-  **AGE - OVER 65**
-  **MALE**
-  **HIGH STRESS**

The QUADRAD of ACS

- PRESENTING SYMPTOMS**
- RISK FACTOR PROFILE**
- ECG ABNORMALITIES**
- CARDIAC MARKERS**

A POSITIVE finding in TWO or MORE of the above categories indicates it is EXTREMELY LIKELY that ACS is present steps must be **AGGRESSIVELY TAKEN to definitively **RULE OUT** the **PRESENCE** of ACS !**

Elevated Troponin:

A Troponin value that is HIGHER than your institution's "normal" range.

At Bayfront Seven Rivers:

- **"normal" range is anything < 0.017**
- **"borderline" range is: 0.017-0.056**
- **"high" range is: >0.056**

The QUADRAD of ACS

- PRESENTING SYMPTOMS**
- RISK FACTOR PROFILE**
- ECG ABNORMALITIES**
- CARDIAC MARKERS**

A POSITIVE finding in TWO or MORE of the above categories indicates it is EXTREMELY LIKELY that ACS is present steps must be **AGGRESSIVELY TAKEN** to definitively **RULE OUT** the **PRESENCE** of ACS !

All patients with ACS symptoms . . .

***STAT 12 Lead ECG; obtain and have
read within 10 minutes !!!***

ACC/AHA Guideline!

The 12 Lead ECG to Rule out ACS:

- **Acute Coronary Syndrome (ACS)** is made up of the following cardiac conditions:
 - Unstable Angina
 - Non-ST Segment Elevation Myocardial Infarction (NSTEMI)
 - ST Segment Elevation Myocardial Infarction (STEMI)
- Low Risk Chest Pain

Unstable Angina

stable angina

1. SYMPTOMS START DURING PHYSICAL EXERTION.
2. SYMPTOMS ARE "PREDICTABLE"

VS.

unstable angina

1. SYMPTOMS MAY START AT ANY TIME, EVEN DURING REST
2. SYMPTOMS ARE NEW, DIFFERENT, or WORSE THAN PREVIOUS EPISODES

Unstable Angina - ECG:

The 12 Lead ECG may show:

The 12 Lead ECG may show:

- ST Depression
- Other ST Segment changes
- Inverted T waves
- **THE ECG MAY BE COMPLETELY NORMAL.**

CASE STUDY 17 - UNSTABLE ANGINA

CHIEF COMPLAINT and SIGNIFICANT HISTORY:

45 y/o MALE c/o EXERTIONAL CHEST PRESSURE x past 2 months, getting worse. In last week, CHEST PRESSURE has come on at rest. DYSPNEA sometimes present. Pain is relieved when patient rests, however now takes longer than 20 minutes to subside.

RISK FACTOR PROFILE:

- 🔥 FAMILY HISTORY: father died of AMI age 50, brother had CABG age 44
- 🔥 CIGARETTE SMOKER x 20 YEARS
- 🔥 HYPERTENSION
- 🔥 ELEVATED LDL, TRIGLYCERIDES, LOW HDL CHOLESTEROL

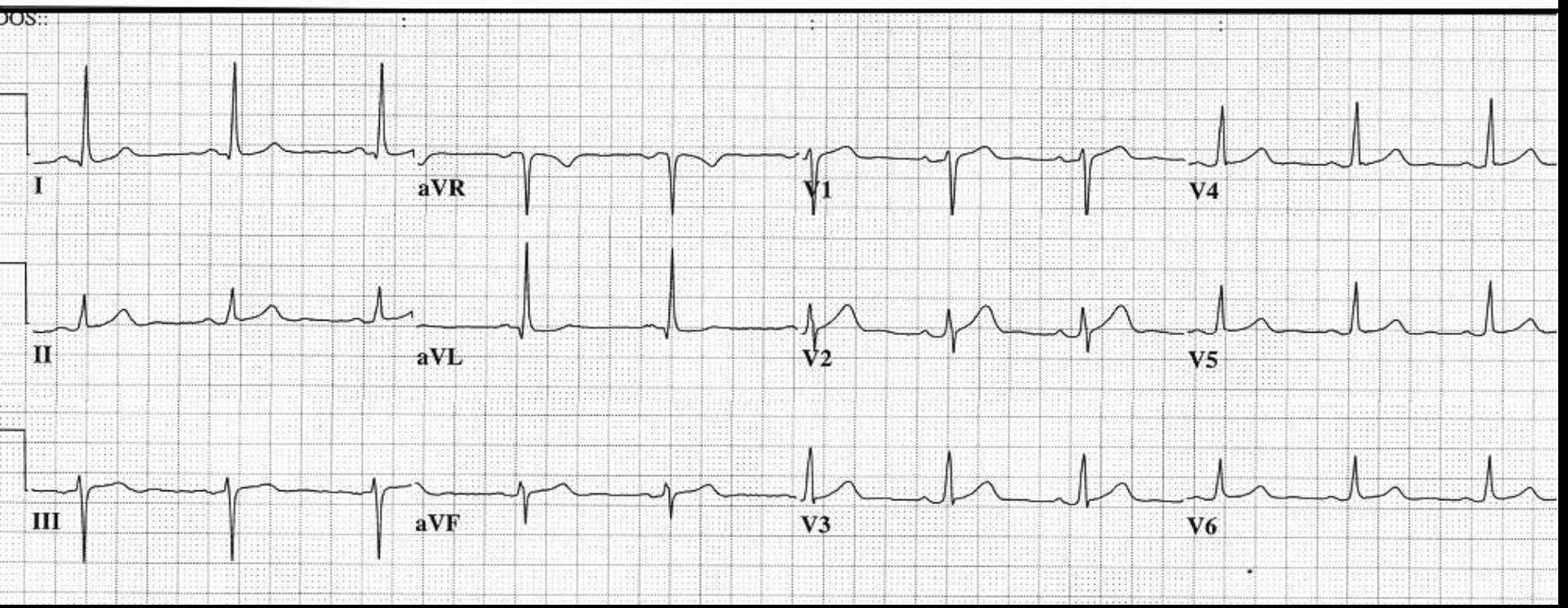
PHYSICAL EXAM: Pt. asymptomatic at time of exam, skin warm, dry, color normal, pupils PERLA, no JVD, lungs = clear, heart sounds normal S1, S2. Abd. soft, non-tender, No ankle edema

VITAL SIGNS: BP: 177/96 P: 64 R: 16 SAO2: 99 % on room air

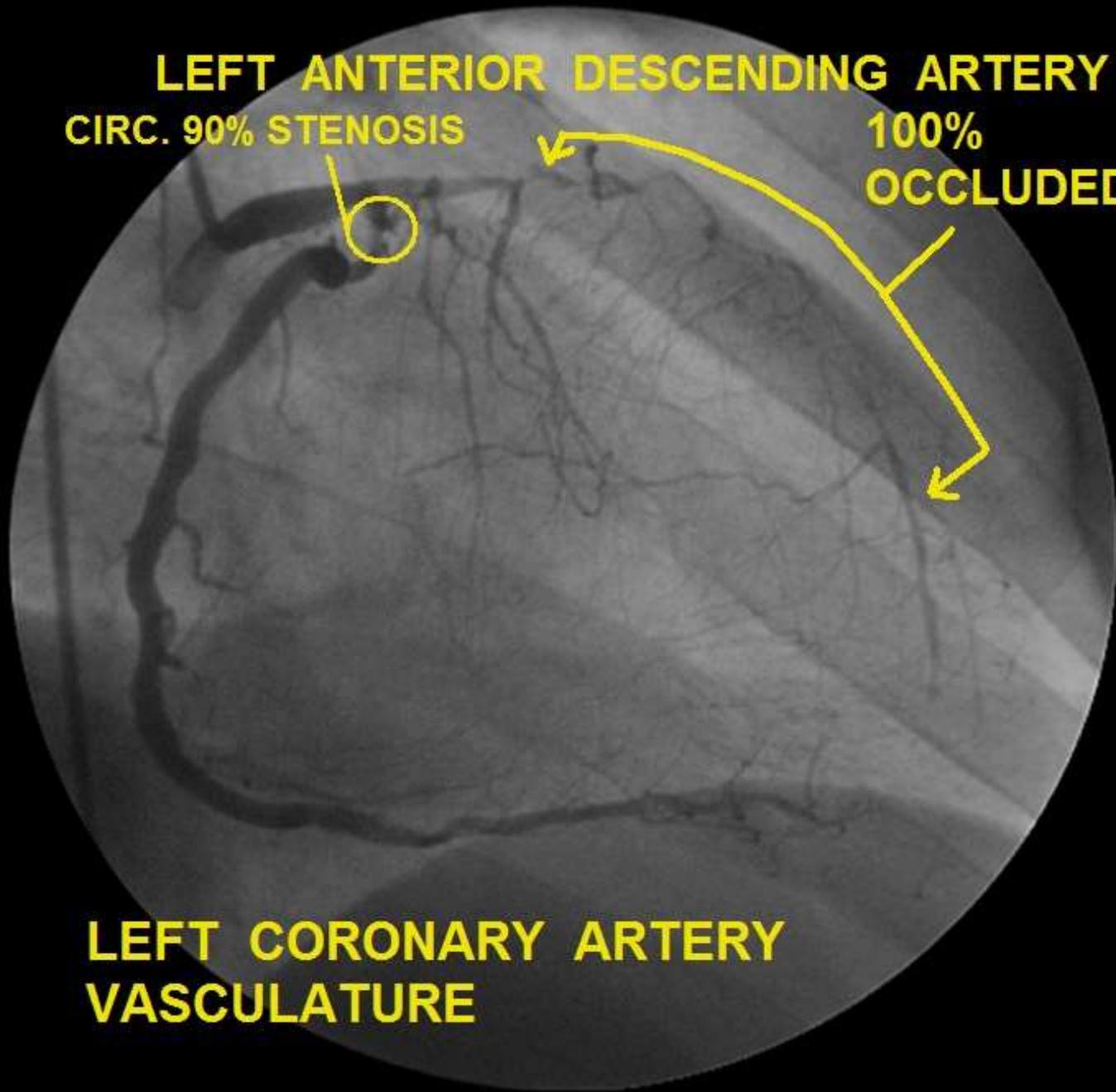
LABS: TROPONIN: < .04

45 yr
Male Caucasian
Loc:7 Option:35

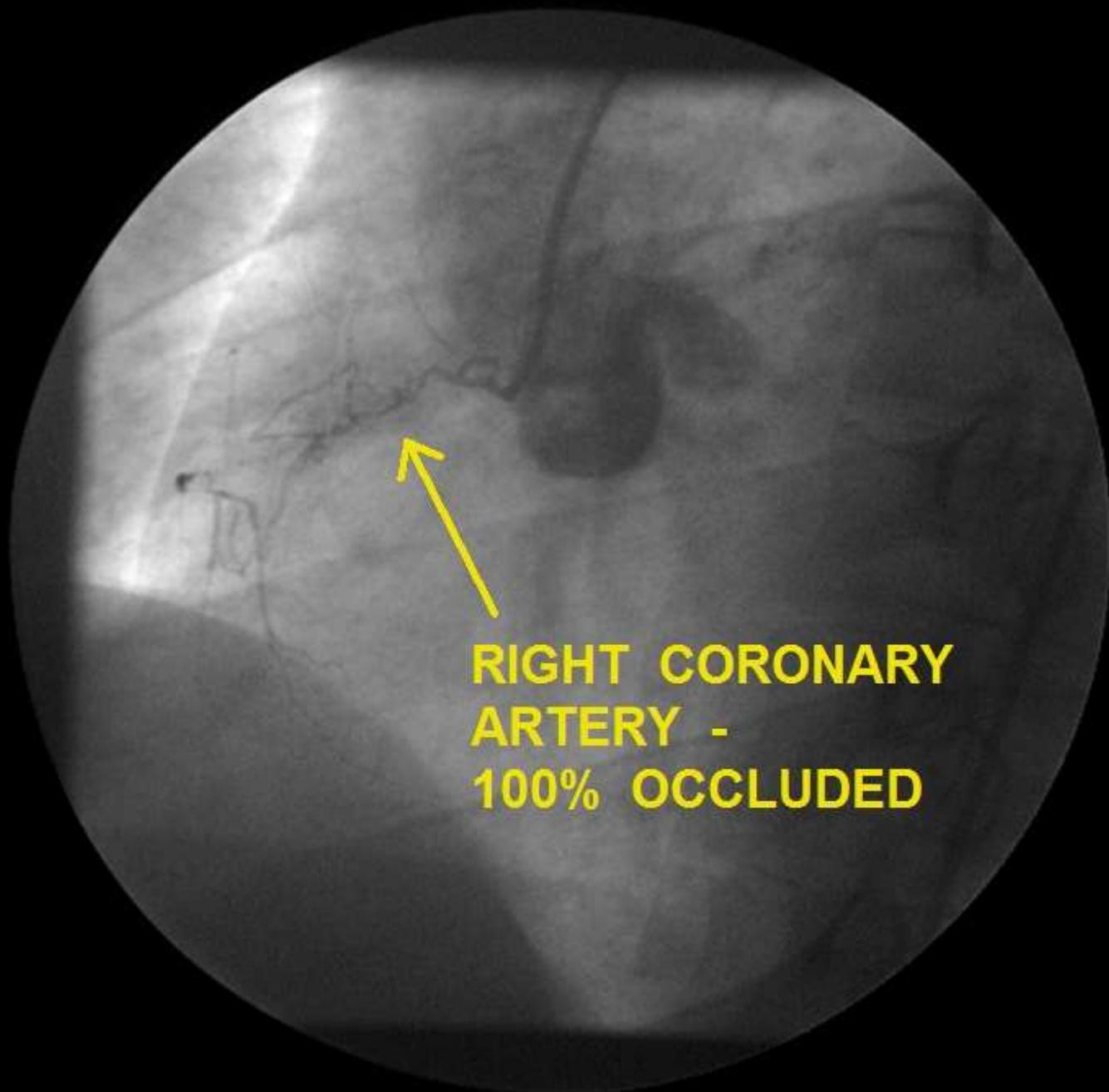
Vent. rate 65 BPM
PR interval 160 ms
QRS duration 86 ms
QT/QTc 384/399 ms
P-R-T axes 11 -8 55



LEFT ANTERIOR DESCENDING ARTERY
CIRC. 90% STENOSIS **100%**
OCCLUDED



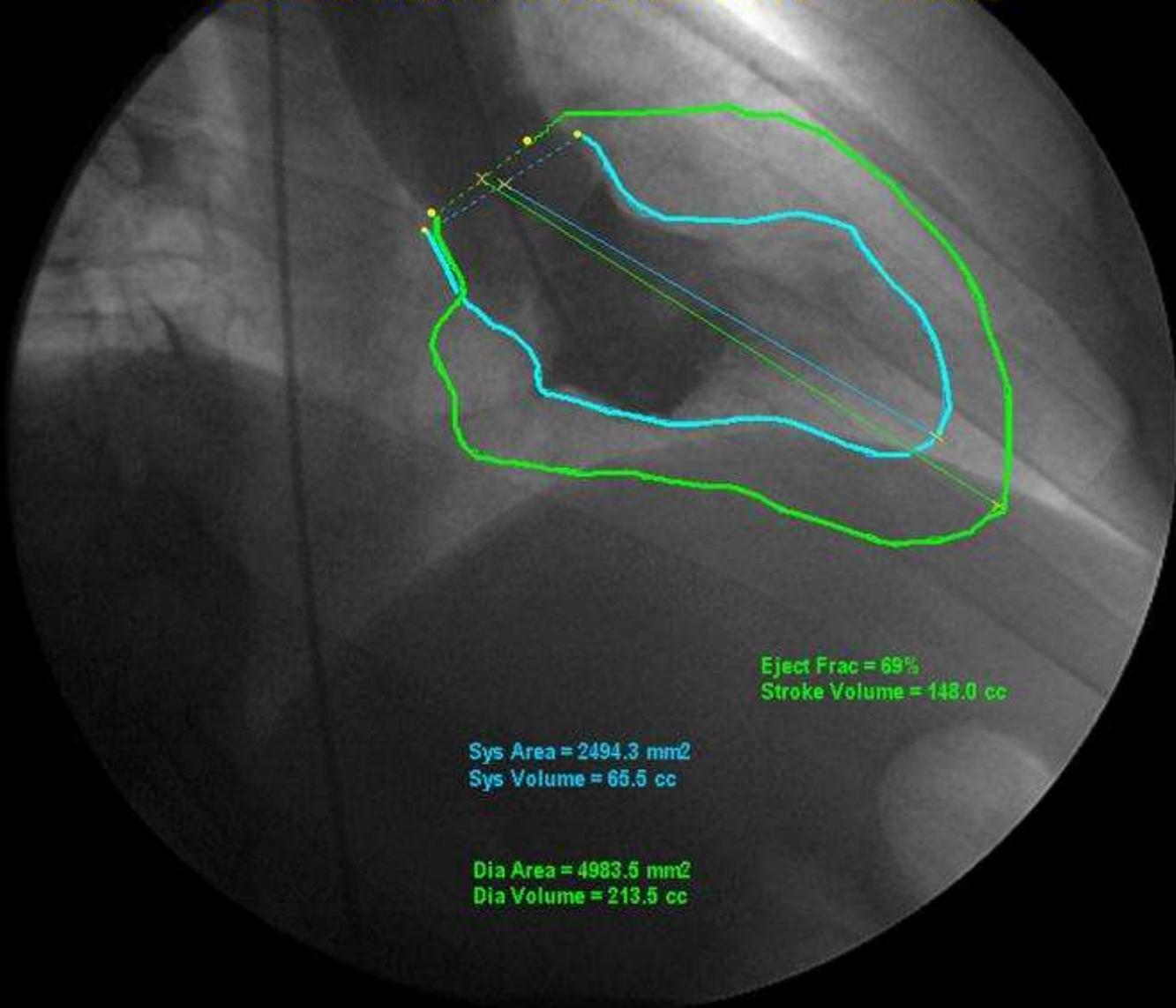
LEFT CORONARY ARTERY
VASCULATURE



**RIGHT CORONARY
ARTERY -
100% OCCLUDED**

LEFT VENTRICULAR ANGIOGRAPHY

EJECTION FRACTION = 69%



CASE STUDY 15 - UNSTABLE ANGINA

CHIEF COMPLAINT and SIGNIFICANT HISTORY:

42 y/o FEMALE c/o INTERMITTENT CHEST PRESSURE which has been WORSENING during the past week. Also c/o mild DIB. Symptoms previously provoked by exertion, now comes on at rest.

RISK FACTOR PROFILE:

- 🔥 HYPERTENSION
- 🔥 CIGARETTE SMOKER x 15 YEARS
- 🔥 FAMILY HISTORY - FATHER Dx WITH CAD, HAD CABG AT 52

PHYSICAL EXAM: Pt. ASYMPTOMATIC at time of exam. SKIN WARM, DRY, COLOR NORMAL, PERLA, LUNGS= CLEAR, HS NORMAL S1, S2, NO ANKLE EDEMA.

VITAL SIGNS: BP: 148/92 P: 64 R: 20 SAO2: 97 % on 2 LPM O2

LABS: TROPONIN: < .04

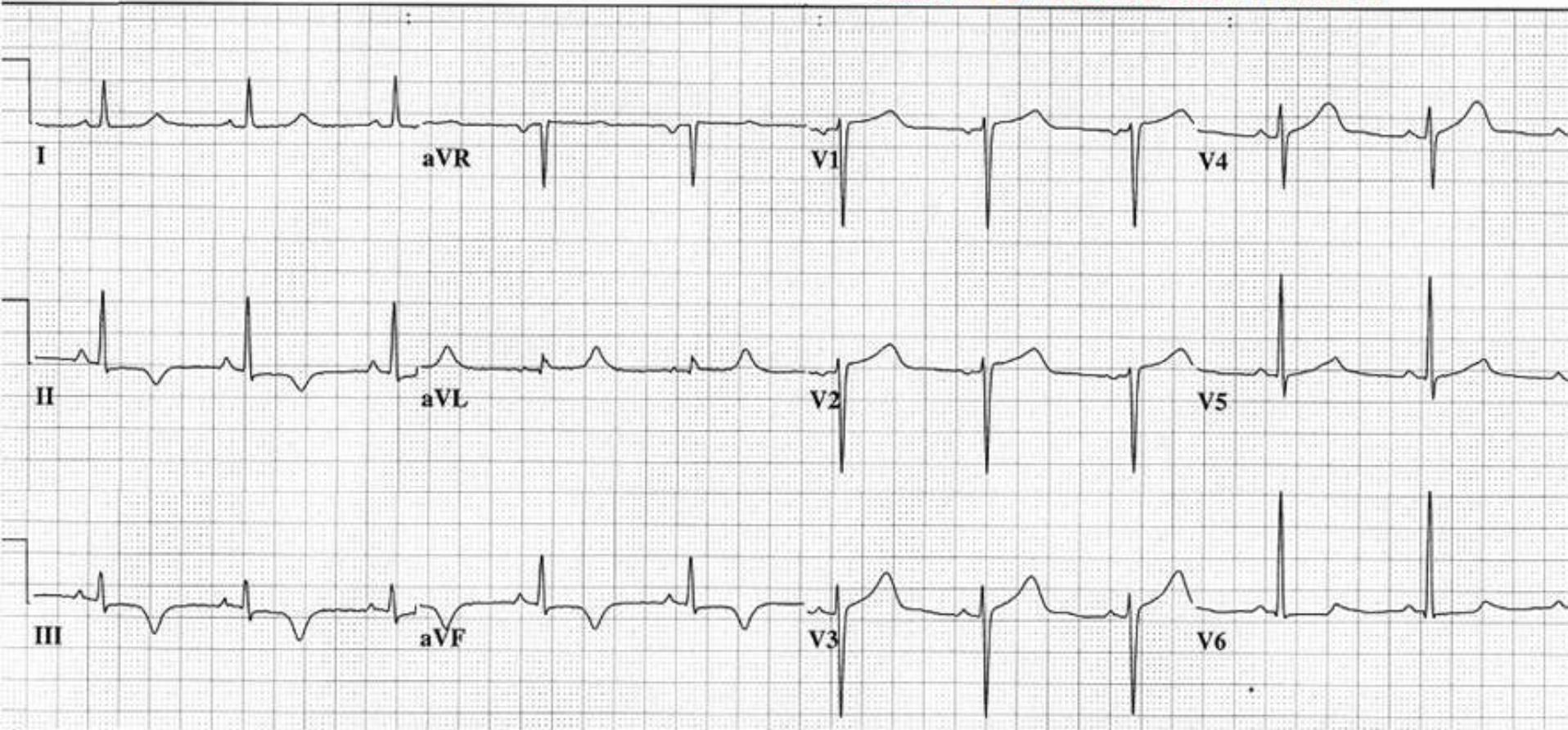
42 yr
Female Caucasian
Room:S5
Loc:3 Option:23

Vent. rate	63	BPM
PR interval	142	ms
QRS duration	74	ms
QT/QTc	462/472	ms
P-R-T axes	65 42 -72	



EVALUATE THE EKG FOR:

- ST SEGMENT ELEVATION / DEPRESSION
- HYPERACUTE T WAVES
- FLAT / CONVEX J-T APEX SEGMENTS
- OTHER ST-T WAVE ABNORMALITIES
- ABNORMAL R WAVE PROGRESSION / TRANSITION



42 yr
Female Caucasian
Room:S5
Loc:3 Option:23

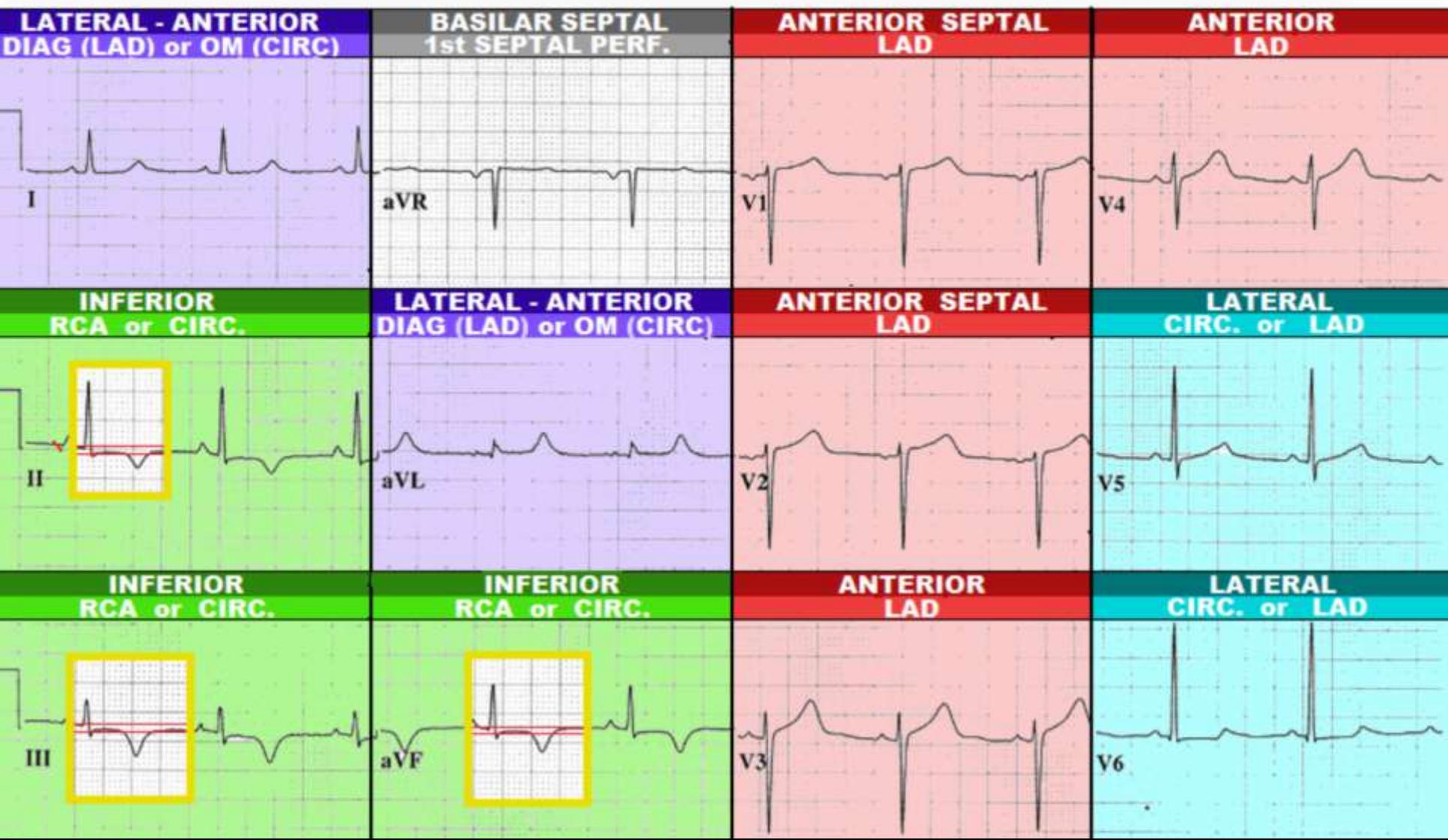
Vent. rate 63 BPM
PR interval 142 ms
QRS duration 74 ms
QT/QTc 462/472 ms
P-R-T axes 65 42 -72

Normal sinus rhythm

ST & T wave abnormality, consider inferior ischemia

Abnormal ECG

ST SEGMENT DEPRESSION



Unstable Angina Findings:

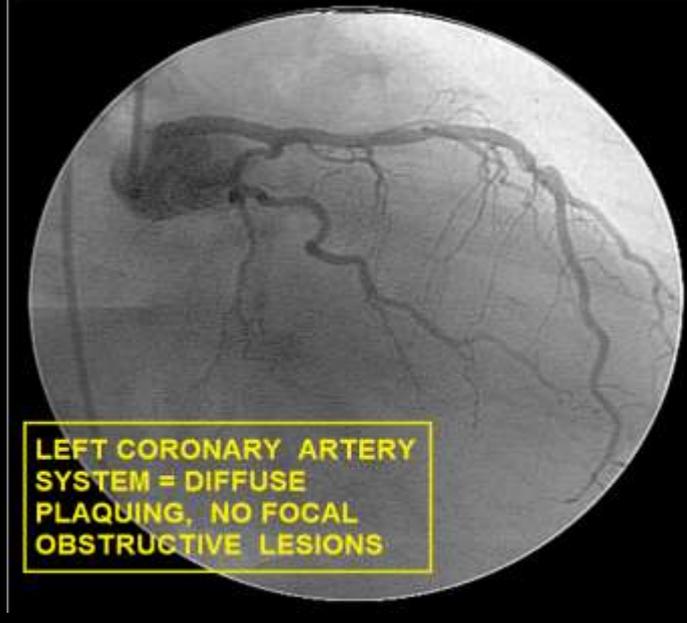
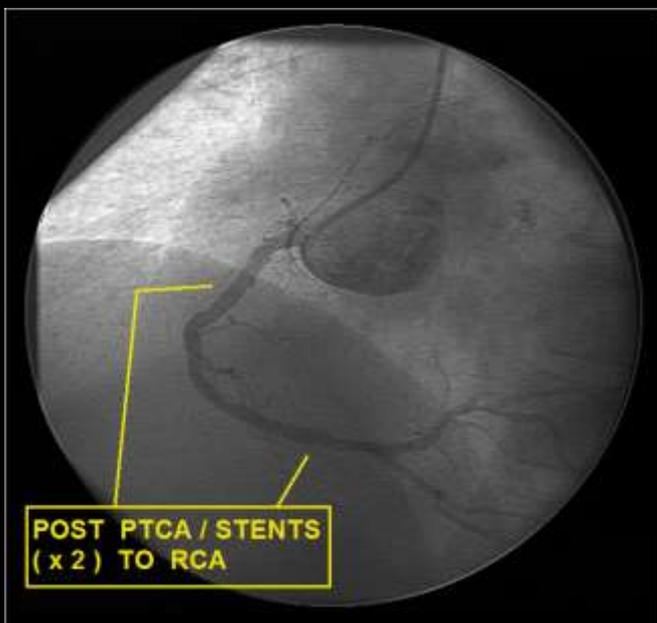
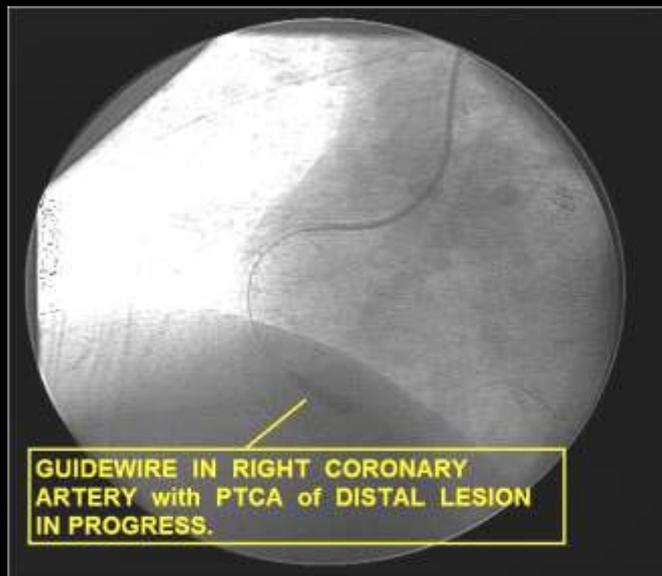
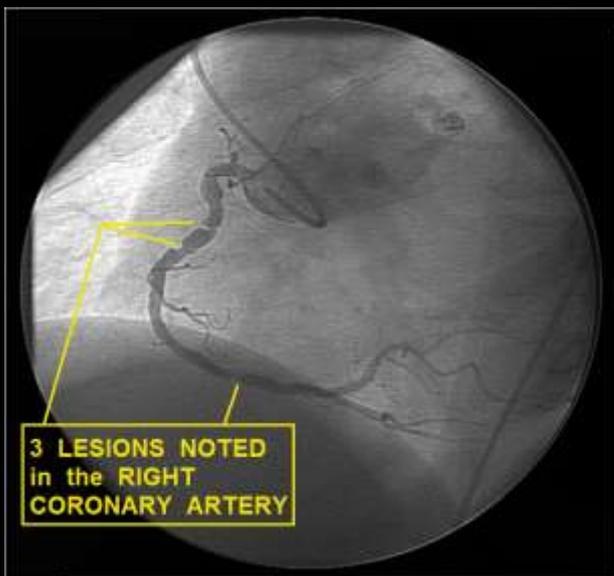
The 12 Lead ECG may exhibit:

- ST-T Wave changes in leads that view the ischemic region
 - ST Depression
 - T Wave Inversion
 - Other “non-specific” ST-T changes
- The ECG may be TOTALLY NORMAL.
- Troponin is NEGATIVE.

Unstable Angina Findings:

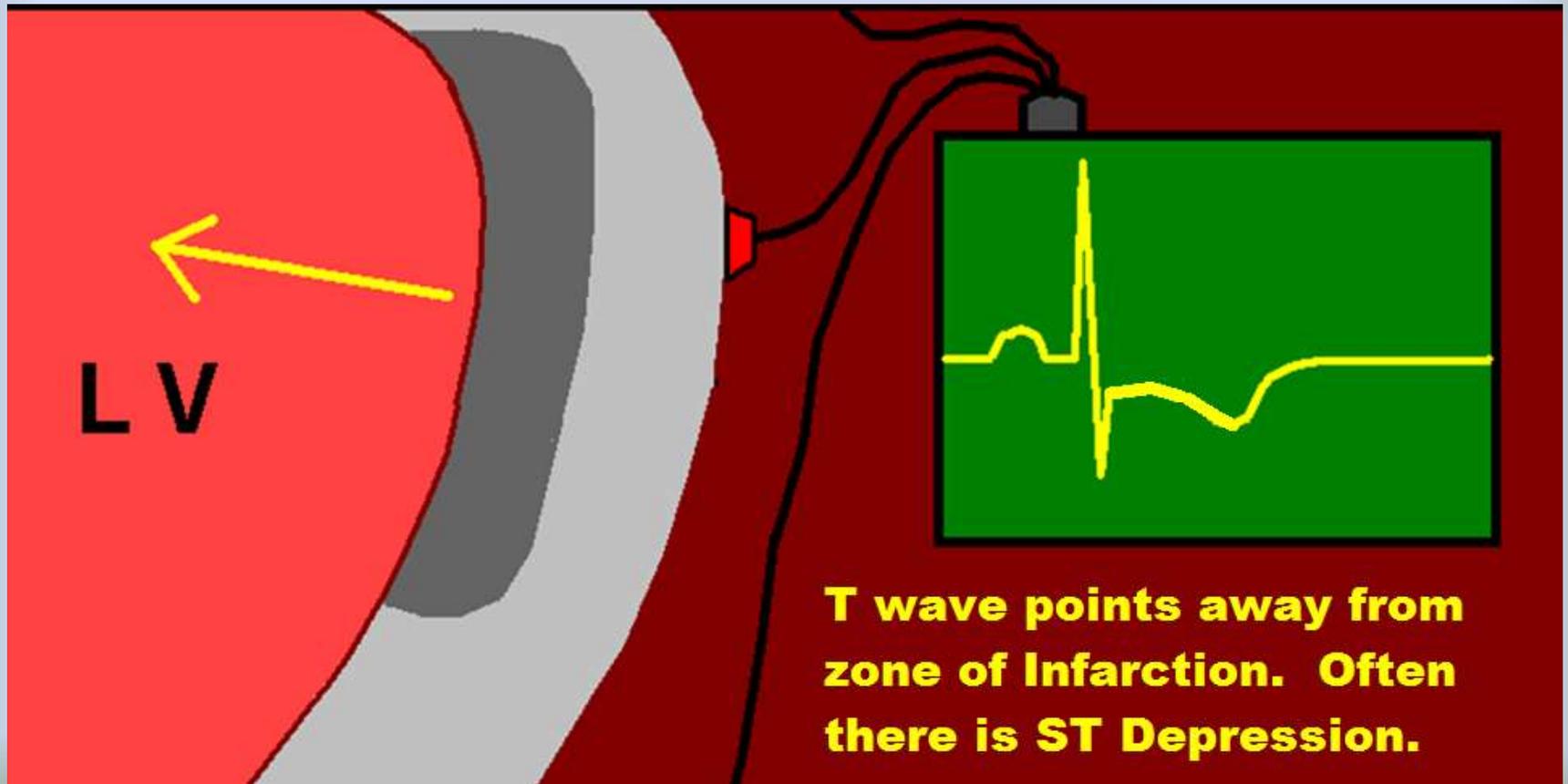
The 12 Lead ECG may exhibit:

- _____ in leads that view the ischemic region
 - ST Depression
 - T Wave Inversion
 - Other “non-specific” ST-T changes
- The ECG may be _____.
- Troponin is _____.



Non-STEMI (NSTEMI)

Non-ST Segment Elevation Myocardial Infarction.
“sub-endocardial MI” . . . “partial wall thickness”



NSTEMI Findings:

The 12 Lead ECG may exhibit:

- ST-T Wave changes in leads that view the ischemic region
 - ST Depression
 - T Wave Inversion
 - Other “non-specific” ST-T changes
- The ECG may be COMPLETELY NORMAL.
- Troponin is POSITIVE.

NSTEMI Findings:

The 12 Lead ECG may exhibit:

- _____ in leads that view the ischemic region
 - ST Depression
 - T Wave Inversion
 - Other “non-specific” ST-T changes
- The ECG may be _____.
- Troponin is _____.

CHIEF COMPLAINT and SIGNIFICANT HISTORY:

42 y/o MALE in ED c/o INTERMITTENT SUBSTERNAL CHEST PAIN x 9 HOURS, "8" on 1-10 scale, pain does not radiate, not effected by position/deep inspiration. Denies DIB. Pt. given NTG 0.4mg SL without releif of CHEST PAIN.

RISK FACTOR PROFILE:

-  ELEVATED LDL CHOLESTEROL, LOW HDL CHOLESTEROL
- ✓ PATIENT DENIES SMOKING, FAMILY HISTORY, HYPERTENSION

PHYSICAL EXAM: CAOx4, SKIN WARM, DRY, COLOR NORMAL, NON-ANXIOUS, LUNGS CLEAR, HEART SOUNDS NORMAL S1, S2, NO JVD, NO ANKLE EDEMA

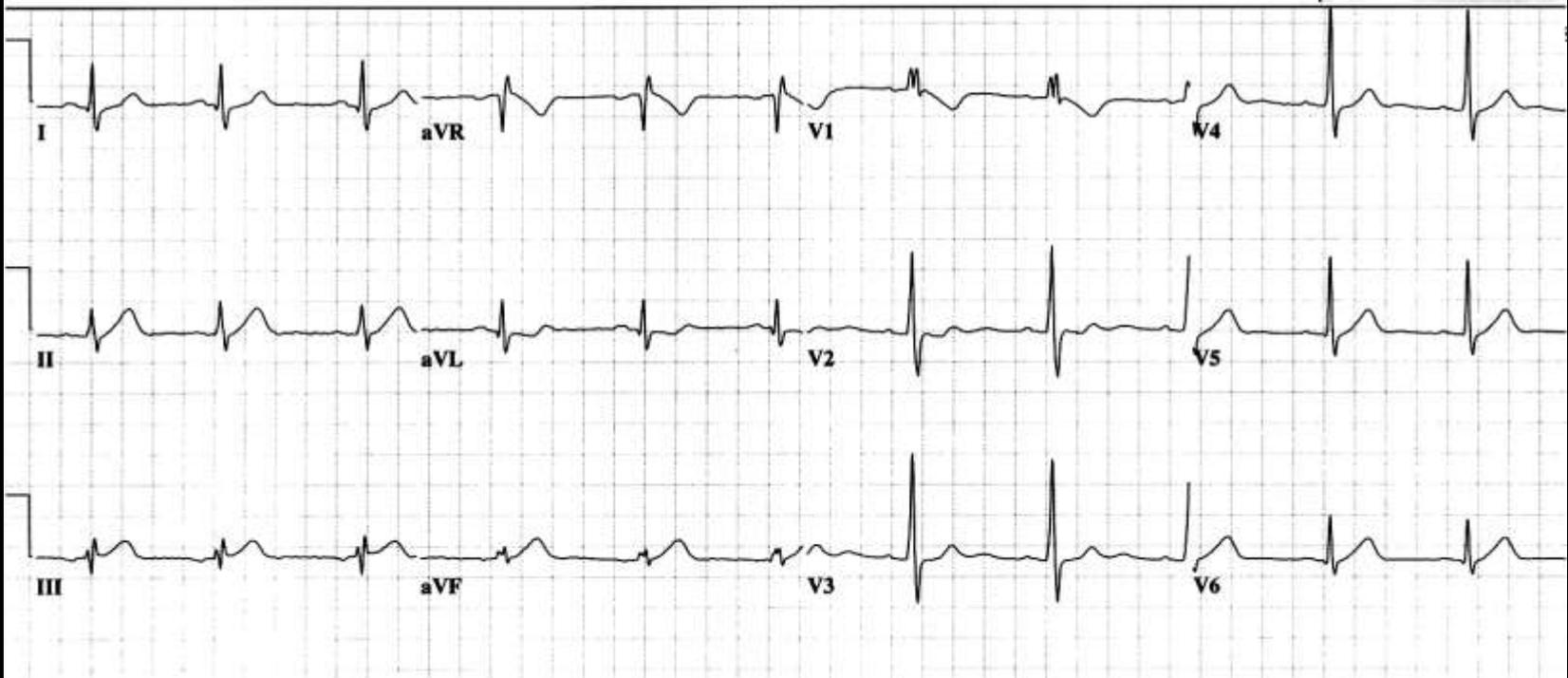
VITAL SIGNS: BP: 122/76 P: 86 R: 16 SAO2: 98% on 2 LPM O2

LABS: TROPONIN: >500 CK: 4,410 CK MB: 224.1 CK INDEX: 5.1

42 yr
Male Hispanic
Room:ED
Loc:3 Option:23

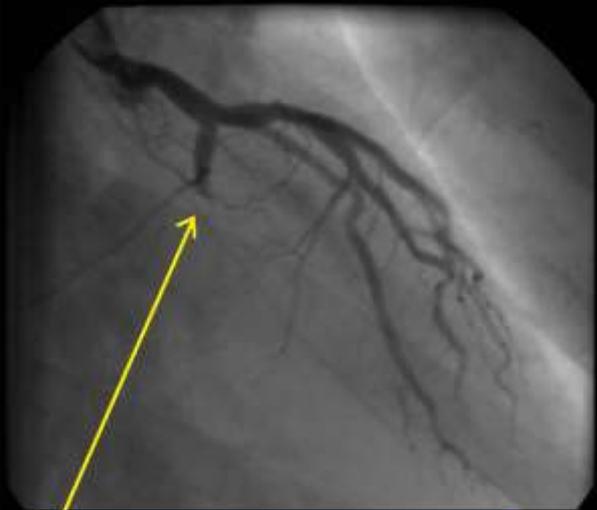
Vent. rate 67 BPM
PR interval 148 ms
QRS duration 94 ms
QT/QTc 400/422 ms
P-R-T axes -5 34 59

***unedited copy: report is computer generated only, without physician interpretation**.
Normal sinus rhythm
Nonspecific ST abnormality
Abnormal ECG
No previous ECGs available



CASE STUDY QUESTIONS:

NOTE LEADS WITH ST ELEVATION:	NOTE LEADS WITH ST DEPRESSION:
WHAT IS THE SUSPECTED DIAGNOSIS ?	
WHAT IS THE "CULPRIT ARTERY" -- if applicable ?	
LIST ANY CRITICAL STRUCTURES COMPROMISED:	LIST ANY POTENTIAL COMPLICATIONS:



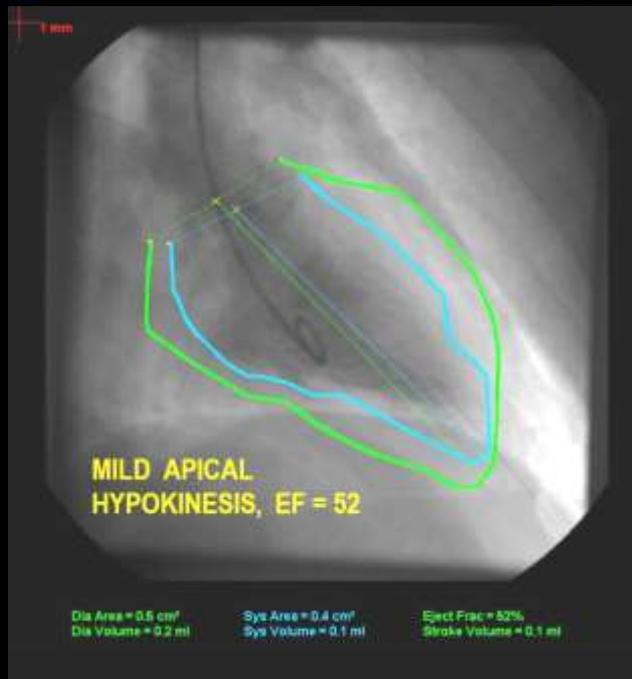
TOTAL OBSTRUCTION - PROXIMAL CIRCUMFLEX ARTERY



DOMINANT RIGHT CORONARY ARTERY OPEN



POST PTCA / STENT TO CIRCUMFLEX ARTERY



MILD APICAL HYPOKINESIS, EF = 52

Dia Area = 0.6 cm²
Dia Volume = 0.2 ml

Sys Area = 0.4 cm²
Sys Volume = 0.1 ml

Eject Frac = 52%
Stroke Volume = 0.1 ml

Non-STEMI (NSTEMI)

Non-ST Segment Elevation Myocardial Infarction.

“sub-endocardial MI” . . . “partial wall thickness”

This is a “Partial Wall Thickness” MI, heart cells are dying, and the Troponin becomes detectable in the patient’s bloodstream.

Usually “less severe” than a STEMI, patient needs blood thinners and to get to the cath lab in 24-48 hours.

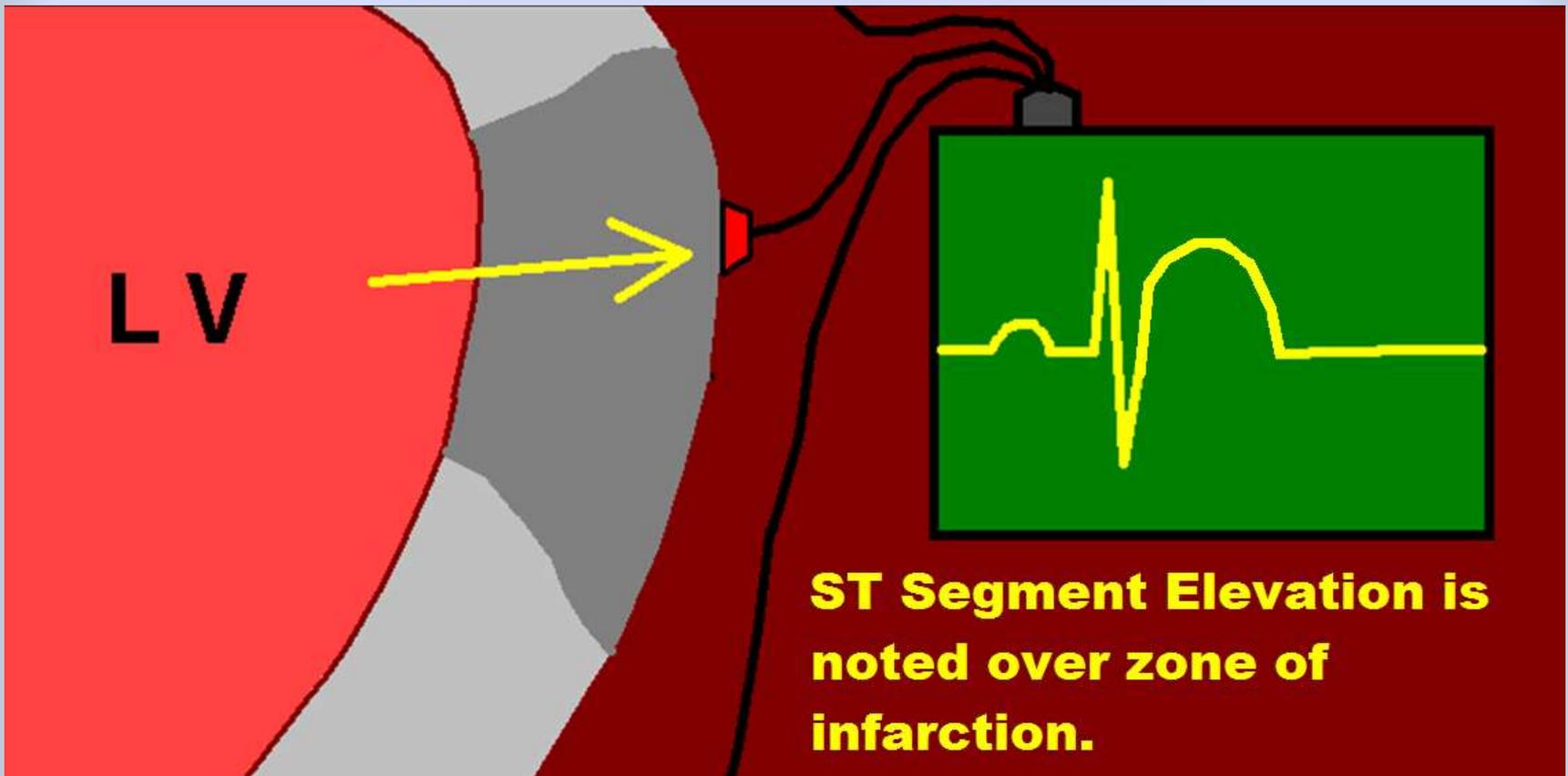
NSTEMI ECG Findings:

The 12 Lead ECG may exhibit:

- ST-T Wave changes in leads that view the ischemic region
 - ST Depression
 - T Wave Inversion
 - Other “non-specific” ST-T changes
- The ECG may be TOTALLY NORMAL.

STEMI

- ST Segment Elevation Myocardial Infarction.



STEMI

ST Segment Elevation Myocardial Infarction.
(“full-wall thickness,” Transmural event)

This is a life-threatening emergency. Part of the patient’s heart is dying. Blood flow must be restored within 90 minutes or less in order to preserve heart muscle. Based on the region of the heart affected, critical and often lethal complications rapidly develop.

Ischemia and Infarction = Acute Coronary Syndrome

The conditions associated with Acute Coronary Syndrome (ACS) include:

- Unstable Angina (**ischemia**)
- Non-ST Segment Elevation Myocardial Infarction (NSTEMI) (**infarction**)
- ST Segment Elevation Myocardial Infarction (STEMI) (**Infarction**)

Q: To evaluate the patient for ischemia or infarction, what part of the ECG do we look at?

Q: To evaluate the patient for ischemia or infarction, what part of the ECG do we look at?

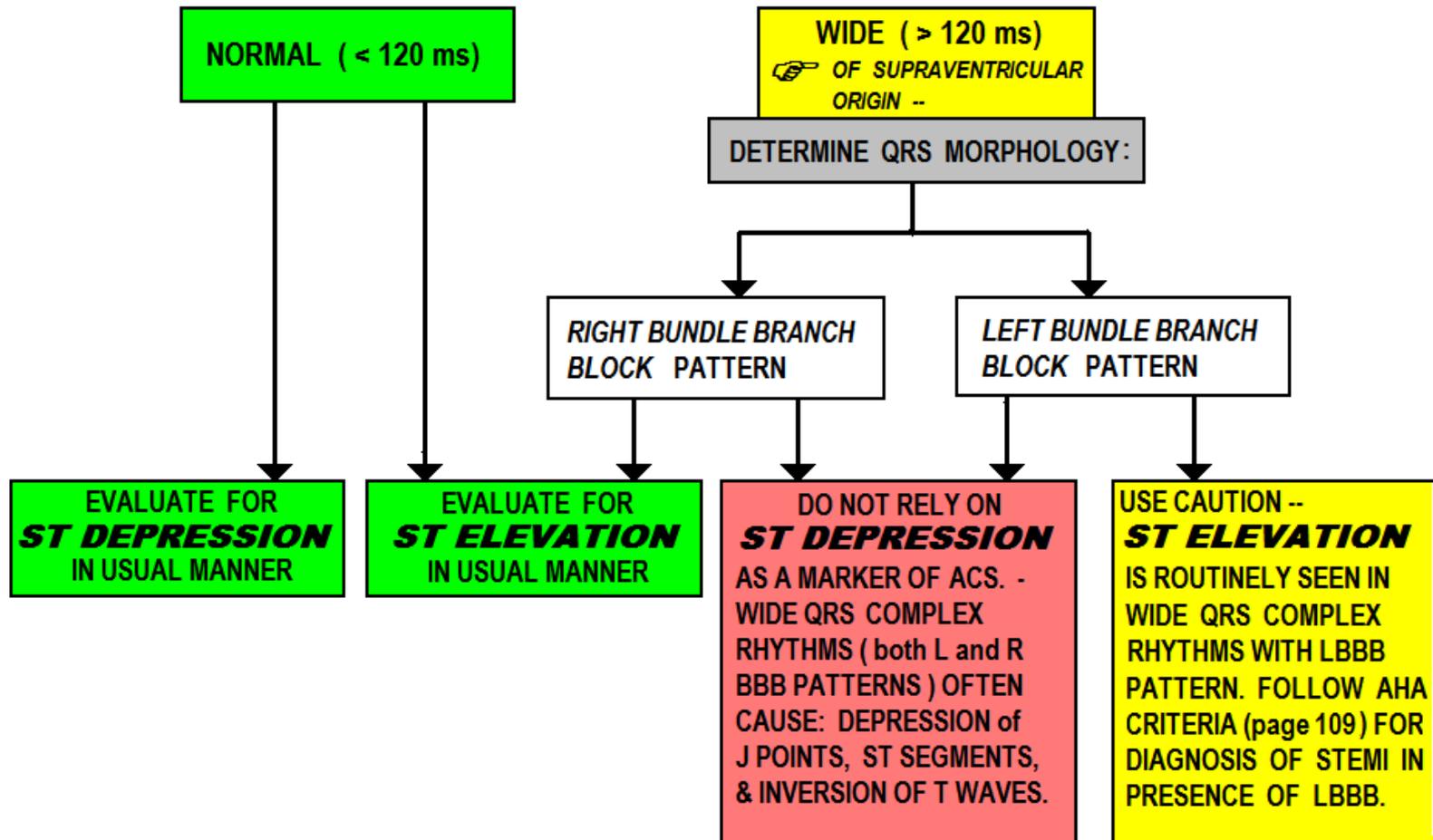
A: We evaluate the

- J Points**
- ST Segments &**
- T Waves**

..... in each lead !

Evaluating the ECG for ACS:

STEP 1 - EVALUATE WIDTH OF QRS:



Evaluating the ECG for ACS:

Patients with Normal Width QRS (QRSd < 120ms)

STEP 2 - EVALUATE the EKG for ACS

THE EKG MARKERS USED FOR DETERMINING THE PRESENCE OF ACUTE CORONARY SYNDROME INCLUDE:

- J POINTS
- ST SEGMENTS
- T WAVES

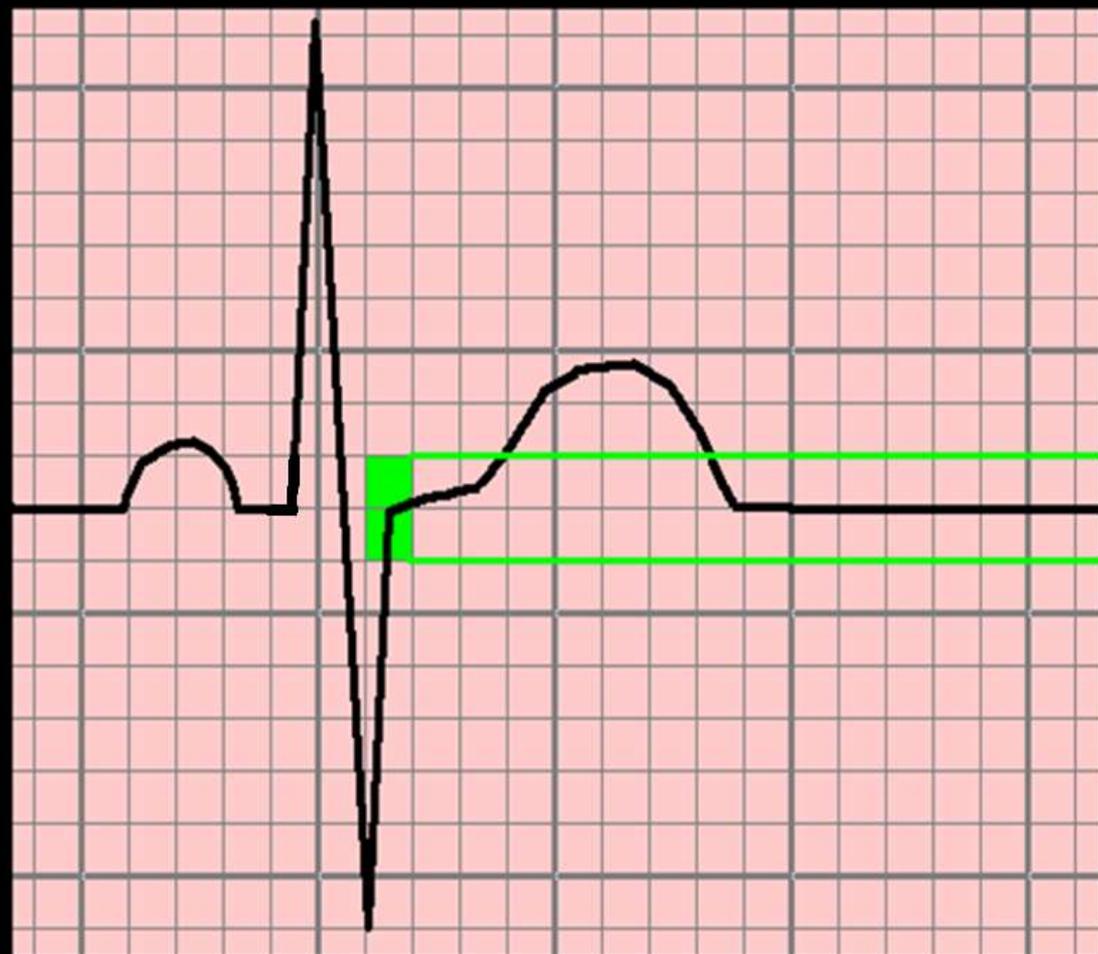
CAREFULLY SCRUTINIZE THESE MARKERS IN EVERY LEAD OF THE 12 LEAD EKG, TO DETERMINE IF THEY ARE *NORMAL* or *ABNORMAL*.

Q: Why is QRS width an issue when we look at J Points, ST Segments and T Waves??

Q: Why is QRS width an issue when we look at J Points, ST Segments and T Waves??

A: When the QRS is abnormally wide ($> 120\text{ms}$), it ALTERS the J Points, ST Segments and T Waves.

THE J POINT SHOULD BE ..

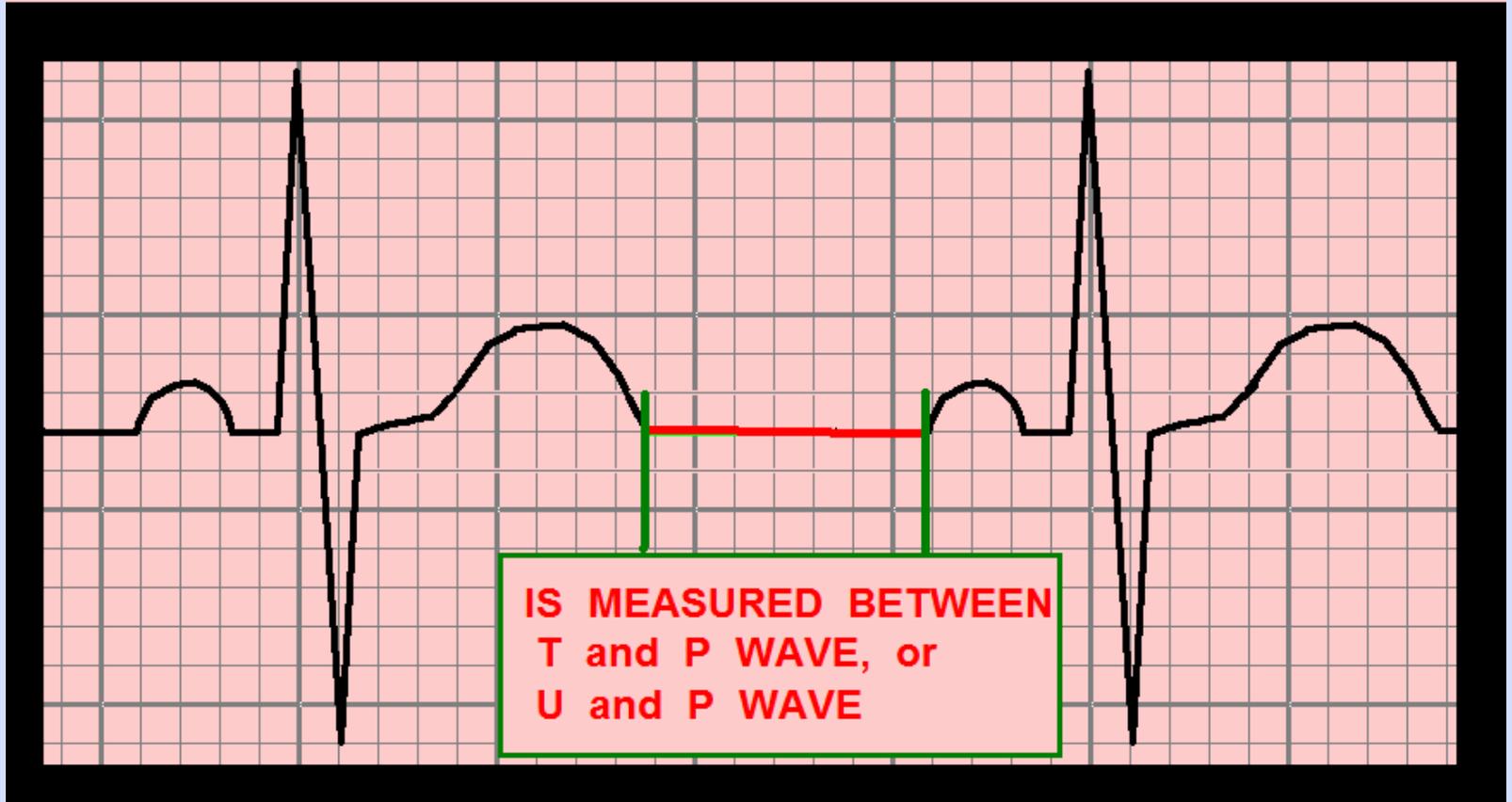


WITHIN
1 mm
ABOVE

OR

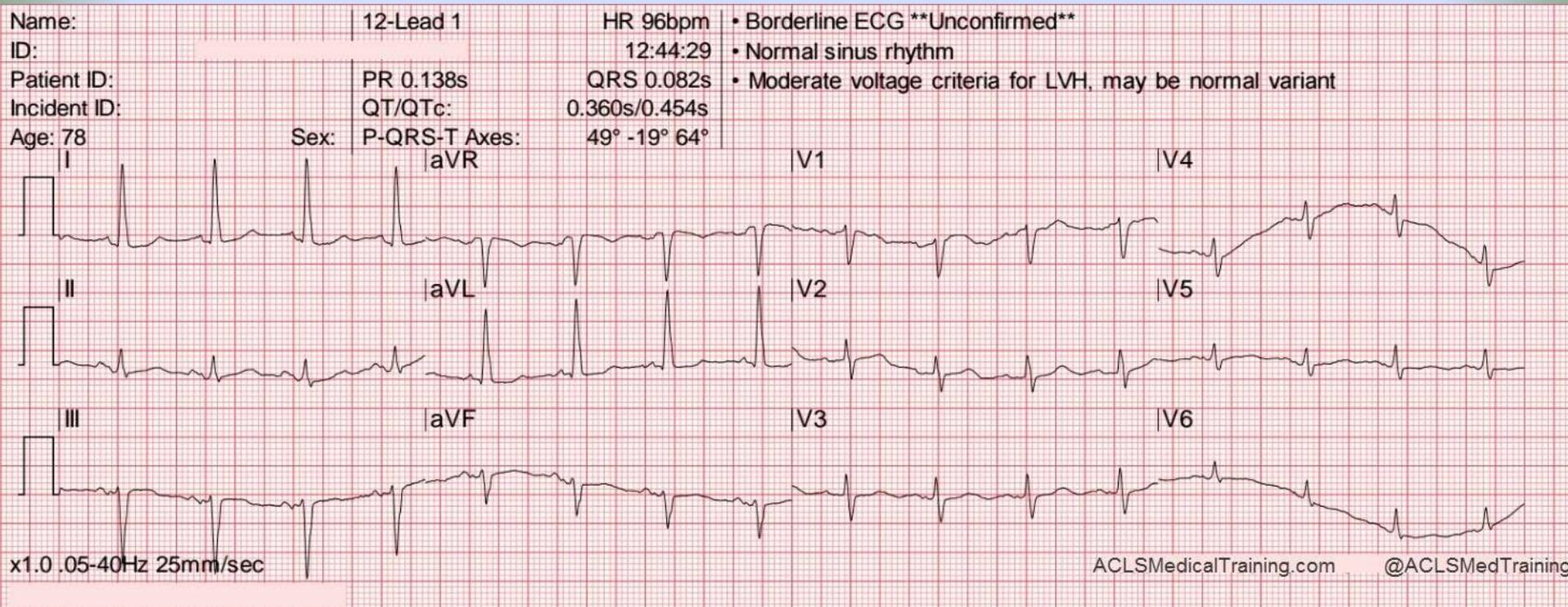
BELOW
the
ISOELECTRIC
LINE

THE ISOELECTRIC LINE



...the “flat line” between ECG complexes,
when there is no detectable electrical
activity ...

The Isoelectric Line - *it's not always isoelectric !*



THE P-Q JUNCTION

. . . is the POINT where the P-R SEGMENT ends and the QRS COMPLEX BEGINS. Used for POINT OF REFERENCE for measurement of the J-POINT and the S-T SEGMENT –



— as per the A.H.A., A.C.C., and WANG, ASINGER, and MARRIOTT, N.E.J.M. vol. 349:2128-2135 Nov. 27, 2003

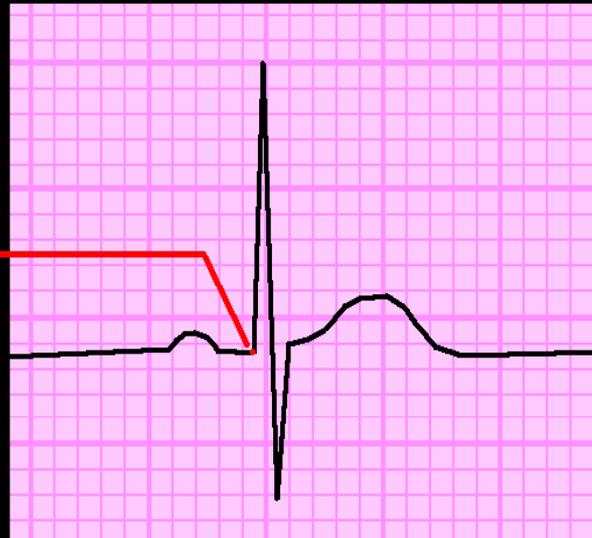
Use the P-Q junction as a reference point for measuring the J Point and ST-Segment when “iso-electric line is

THE P-Q JUNCTION

not iso-
electric !”

. . . is the POINT where the P-R SEGMENT ends and the QRS COMPLEX BEGINS.

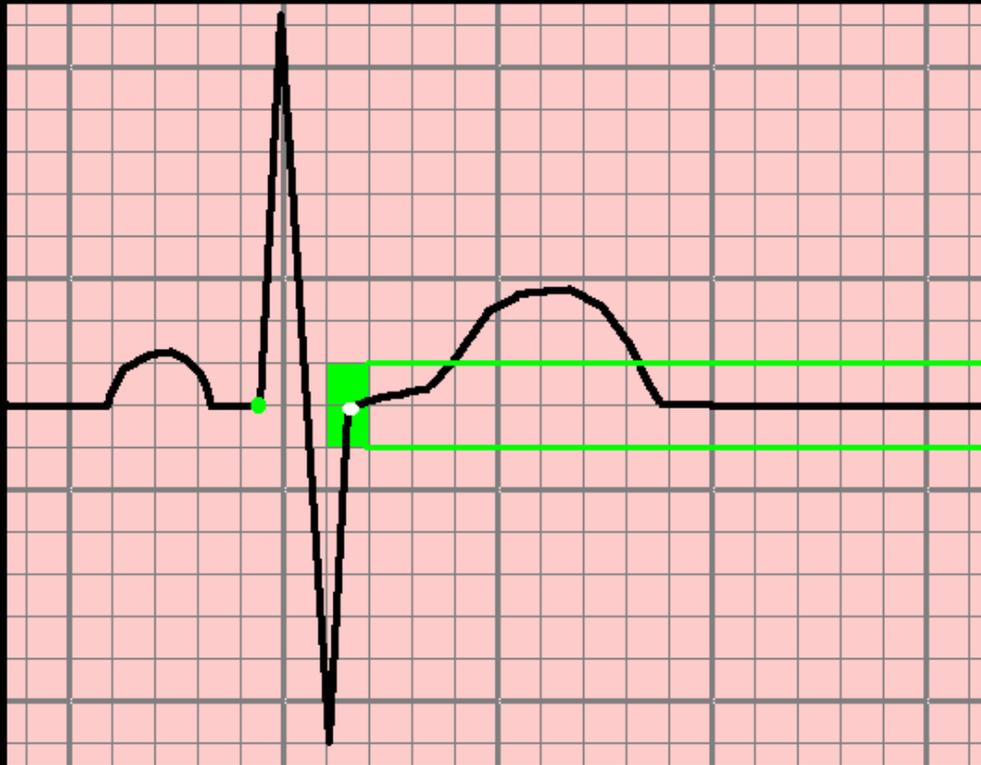
Used for POINT OF REFERENCE for measurement of the J-POINT and the S-T SEGMENT -



— as per the A.H.A., A.C.C., and WANG, ASINGER, and MARRIOTT, N.E.J.M. vol. 349:2128-2135 Nov. 27, 2003

Defining NORMAL:

THE J POINT SHOULD BE ..



**WITHIN
1 mm
ABOVE**

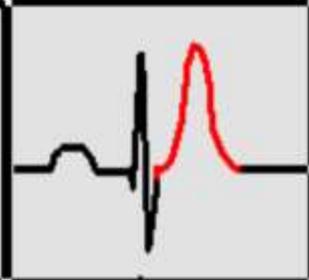
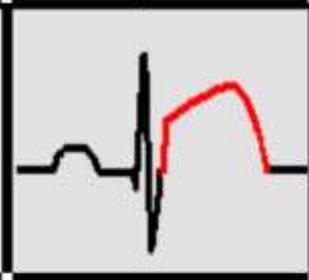
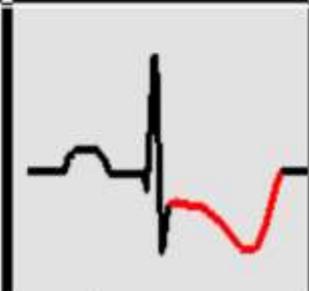
OR

**BELOW
THE
P-Q
JUNCTION**

**ECG Indicators of
ABNORMAL PERFUSION
(possible ischemia / infarction)
in Patients with
Normal Width QRS Complexes
(QRS duration < 120 ms)**

PATTERNS of ACS & ISCHEMIA

-- J POINT, ST SEGMENT, and T WAVE ABNORMALITIES --

<p>! FLAT or CONVEX J-T APEX SEGMENT</p>			<p><i>ACUTE MI</i> <i>EARLY PHASE</i></p>
<p>! HYPER-ACUTE T WAVE</p>			<p><i>ACUTE MI</i> <i>EARLY PHASE</i></p>
<p>! S-T SEGMENT ELEVATION at J POINT</p>			<p><i>ACUTE MI</i></p>
<p>! DEPRESSED J pt. DOWNSLOPING ST and INVERTED T</p>			<p>- ACUTE (NON-Q WAVE) MI - ACUTE MI - (RECIPROCAL CHANGES) - ISCHEMIA</p>

INVERTED
T WAVE



- **MYOCARDITIS**
- **ELECTROLYTE IMBAL.**
- **ISCHEMIA**

SHARP S-T
T ANGLE



- **ACUTE MI (NOT COMMON)**
- **ISCHEMIA**

BI-PHASIC
T WAVE
(WELLEN'S)



- **SUB-TOTAL LAD LESION**
- **VASOSPASM**
- **HYPERTROPHY**

DEPRESSED J
POINT with
UPSLOPING ST



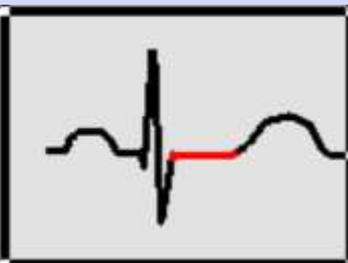
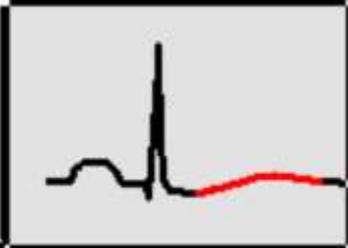
- **ISCHEMIA**

DOWNSLOPING
S-T SEGMENT



- **ISCHEMIA**

Some less common, less reliable possible indicators of ACS:

? FLAT S-T SEGMENT > 120 ms		- ISCHEMIA
? LOW VOLTAGE T WAVE WITH NORMAL QRS		- ISCHEMIA
? U WAVE POLARITY OPPOSITE THAT OF T WAVE		- ISCHEMIA

LET'S START HERE

PATTERNS of ACS & ISCHEMIA

-- J POINT, ST SEGMENT, and T WAVE ABNORMALITIES --



! FLAT or CONVEX J-T APEX SEGMENT			<i>ACUTE MI</i> <i>EARLY PHASE</i>
! HYPER-ACUTE T WAVE		<i>ACUTE MI</i> <i>EARLY PHASE</i>	
! S-T SEGMENT ELEVATION at J POINT		<i>ACUTE MI</i>	
! DEPRESSED J pt. DOWNSLOPING ST and INVERTED T		- ACUTE (NON-Q WAVE) MI - ACUTE MI - (RECIPROCAL CHANGES) - ISCHEMIA	

J-T Apex Segment

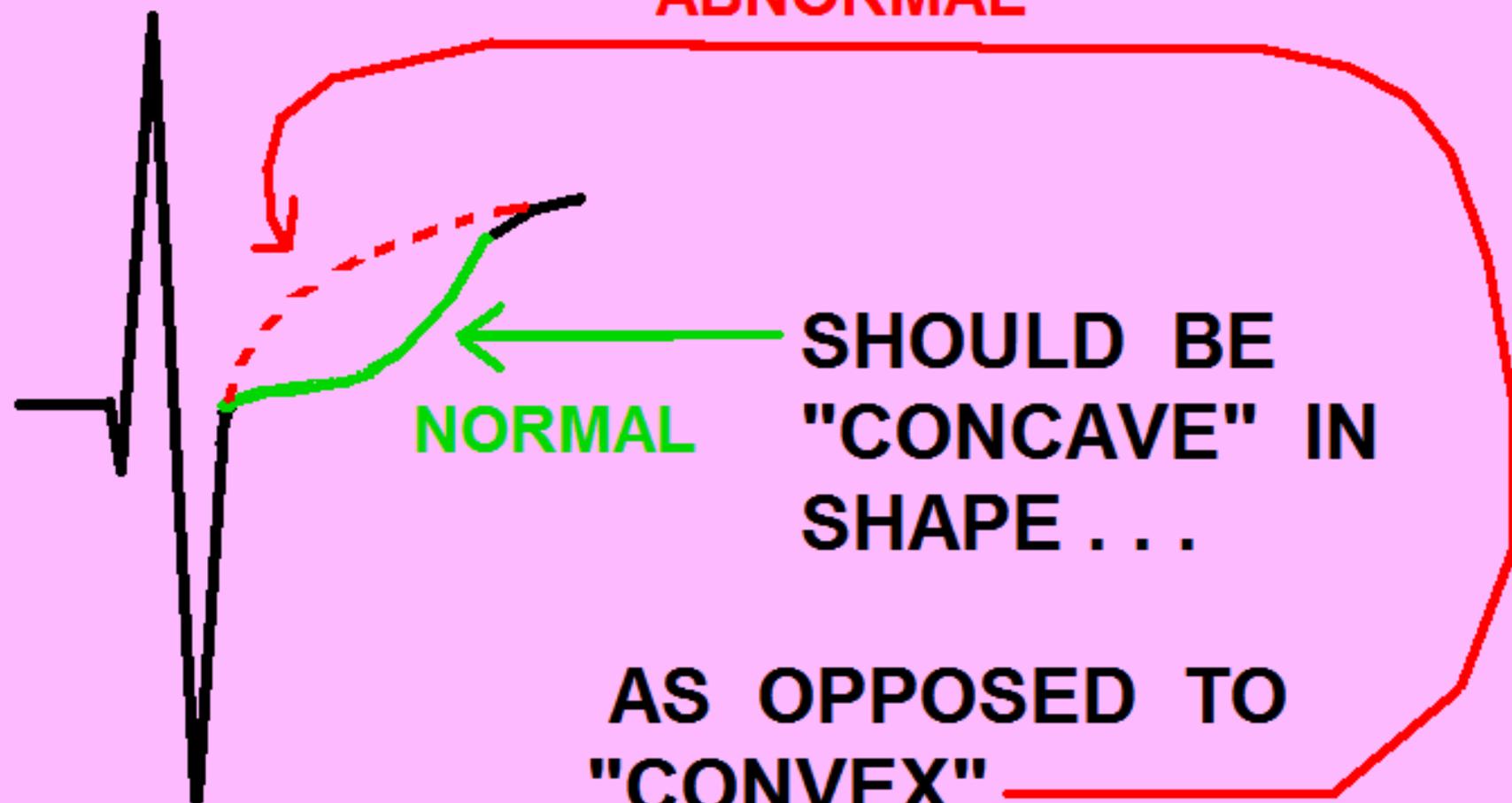


ST-Segment

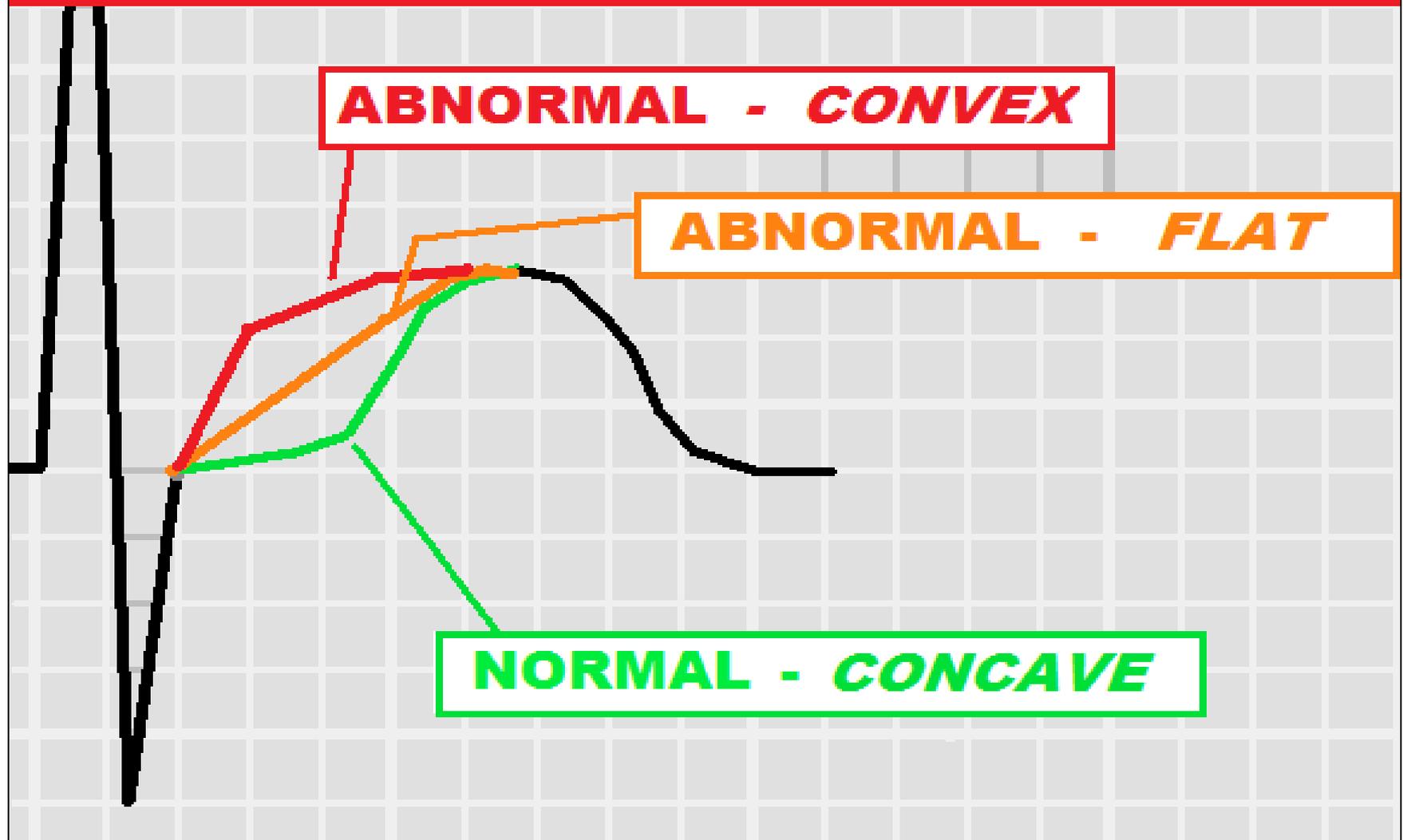
T wave: origin to apex

THE S-T SEGMENT

ABNORMAL



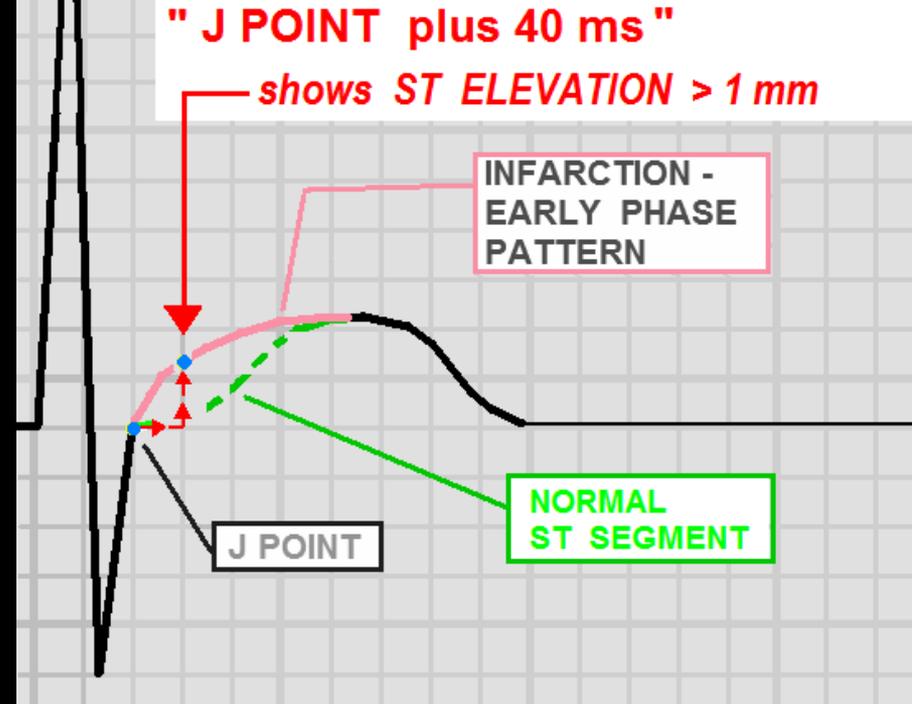
J - T APEX SEGMENT VARIATIONS



PATTERNS of EARLY INFARCTION
-- FLAT and CONVEX J-T APEX SEGMENTS

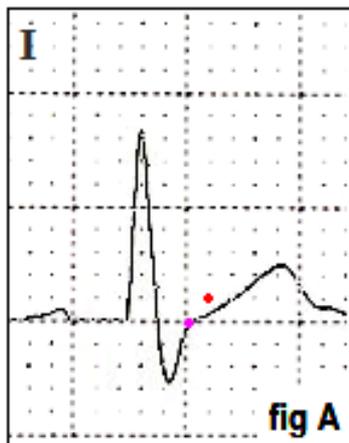
WHEN EVALUATING for ST SEGMENT ELEVATION

From:
AMERICAN HEART ASSOCIATION
ACLS 2005 REVISIONS

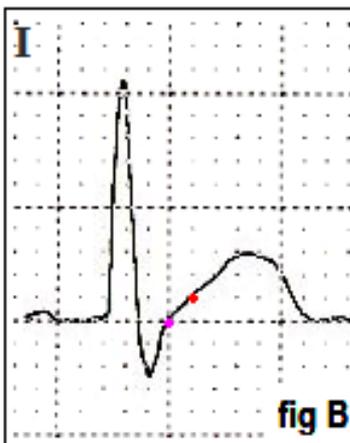


During **NORMAL STATES** of **PERFUSION**, the **J POINT** is **ISOELECTRIC** and the **ST SEGMENT** has a **CONCAVE** appearance. When measured 40 ms beyond the **J POINT** (noted by the **RED DOT**), the **ST SEGMENT** elevation is less than 1mm.

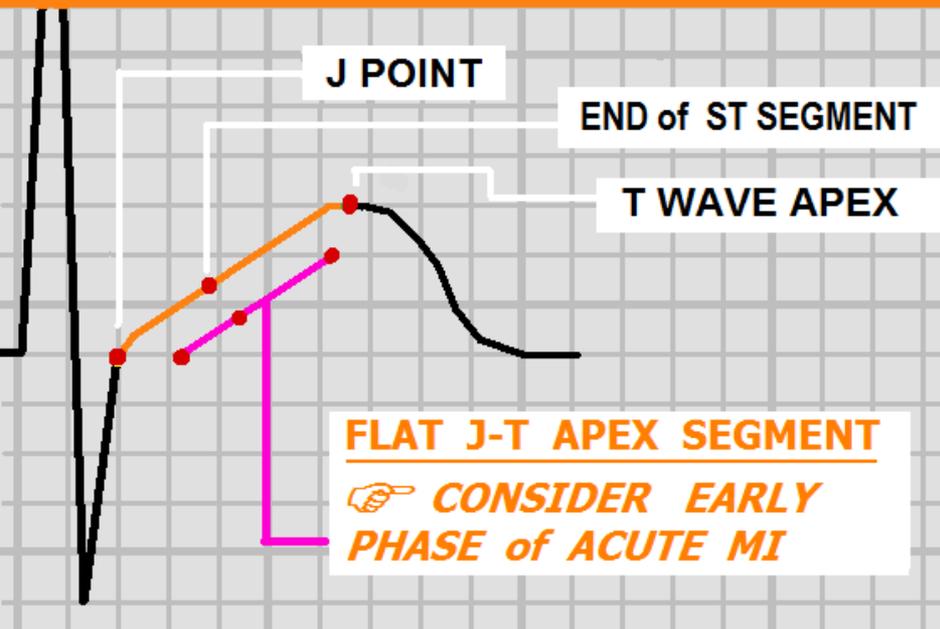
Both figures were recorded from a 54 year old male while resting (figure A), and during PTCA of the Left Anterior Descending artery (figure B).



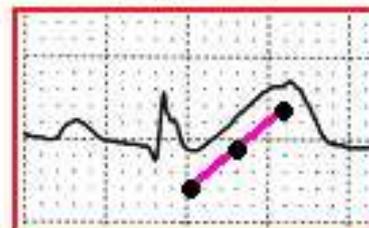
During a 20 second **BALLOON OCCLUSION** of the patient's LAD during routine PTCA, the ST segment assumes a **CONVEX** shape. When measured 40 ms beyond the **J POINT**, the ST segment is elevated > 1 mm. This phenomenon is seen routinely in the cath lab prior to the occurrence of **ST ELEVATION** at the **J POINT** during PTCA and **STENTING**.



ABNORMAL J-T APEX SEGMENT



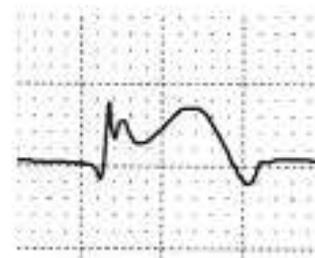
LEAD II



41 y/o FEMALE

In ER C/O CHEST PAIN
x 30 minutes.

- **FLAT J-T APEX SEGMENT**
- **NO ST ELEVATION at J POINT!**

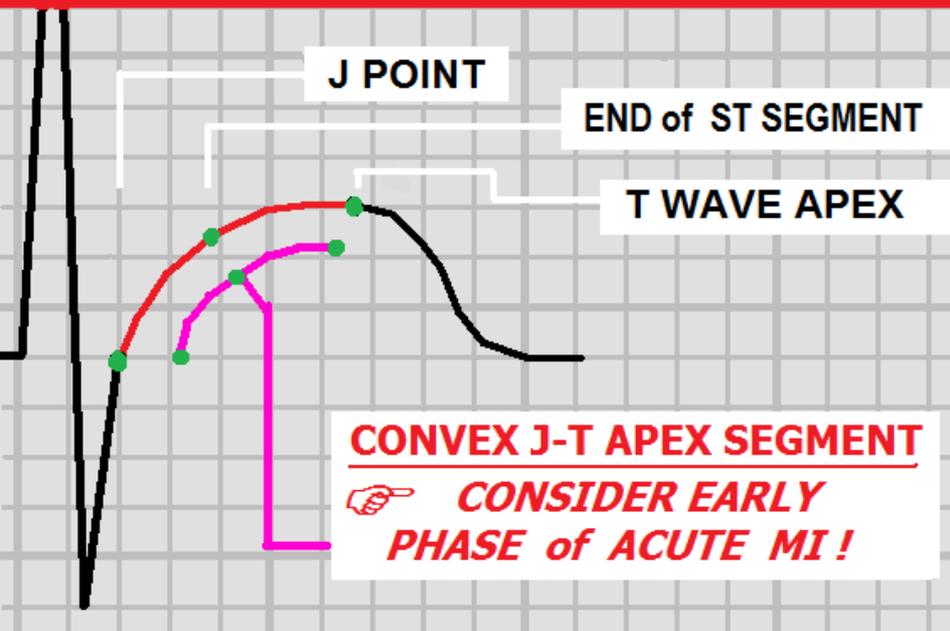


STEMI - INFERIOR WALL

11 MINUTES LATER, S-T
ELEVATION at the J POINT
IS NOTED.

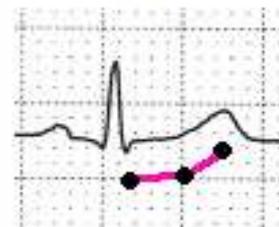
- **CATH LAB FINDINGS:**
**TOTAL OCCLUSION of the
RIGHT CORONARY ARTERY**

ABNORMAL J-T APEX SEGMENT



LEAD I

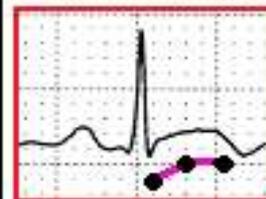
53 y/o MALE



1 yr. PRIOR TO MI

NORMAL EKG

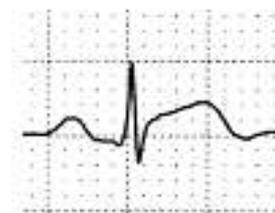
CONCAVE J - T APEX SEGMENT



0732 hrs

STEMI LATERAL WALL

- **CONVEX J-T APEX SEGMENT**
- **MINIMAL ST ELEVATION at J POINT**



0747 hrs

15 MINUTES LATER, S-T ELEVATION at the J POINT IS NOTED.

- **CATH LAB FINDINGS: TOTAL OCCLUSION OF CIRCUMFLEX ARTERY**

CASE STUDY: ABNORMAL J-T APEX SEGMENTS

CHIEF COMPLAINT and SIGNIFICANT HISTORY:

56 y/o MALE presents to ED with complaint of "INTERMITTENT SUBSTERNAL & SUB-EPIGASTRIC PRESSURE" x 3 HOURS. PMHx of ESOPHAGEAL REFLUX. NO other significant past medical history.

RISK FACTOR PROFILE:

-  FAMILY HISTORY - father died of MI at age 62
- PREVIOUS CIGARETTE SMOKER - quit 15 years ago.
- CHOLESTEROL - DOES NOT KNOW; "never had it checked."
- OBESITY

PHYSICAL EXAM: Patient supine on exam table, mildly anxious, currently complaining of "mild indigestion," skin is warm, pale, dry; REST OF EXAM is UNREMARKABLE.

VITAL SIGNS: BP 142/94, P 80, R 20, SAO2 98%

LABS: JUST OBTAINED, RESULTS NOT AVAILABLE YET.

36 yr
Male Caucasian
Room:A9
Loc:3 Option:23

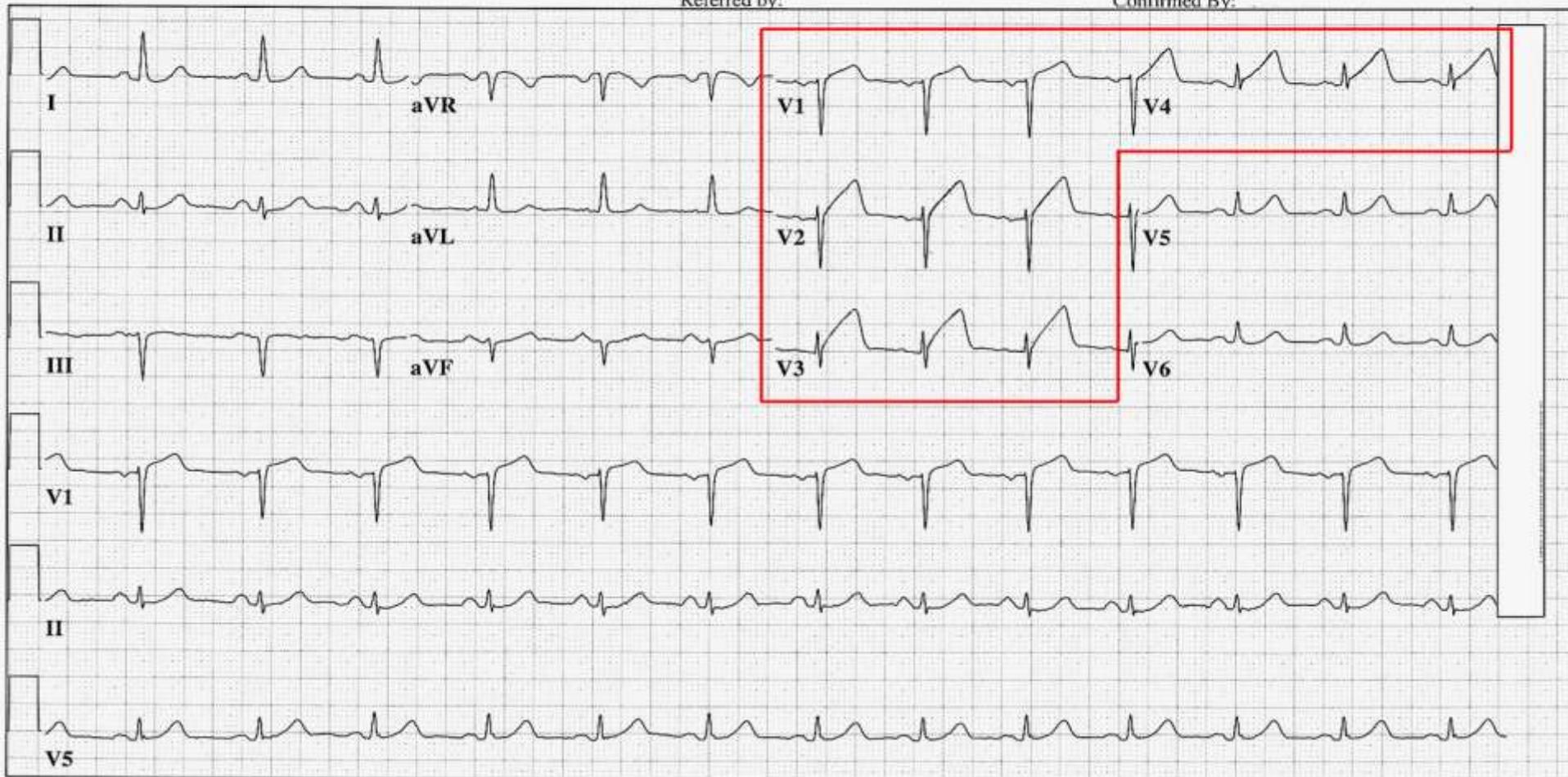
Vent. rate 80 BPM
PR interval 154 ms
QRS duration 78 ms
QT/QTc 380/438 ms
P-R-T axes 51 -24 38

****UNEDITED COPY – REPORT IS COMPUTER GENERATED ONLY, WITHOUT
PHYSICIAN INTERPRETATION**
Normal sinus rhythm
Normal ECG
No previous ECGs available

Technician: W Ruppert

Referred by:

Confirmed By:

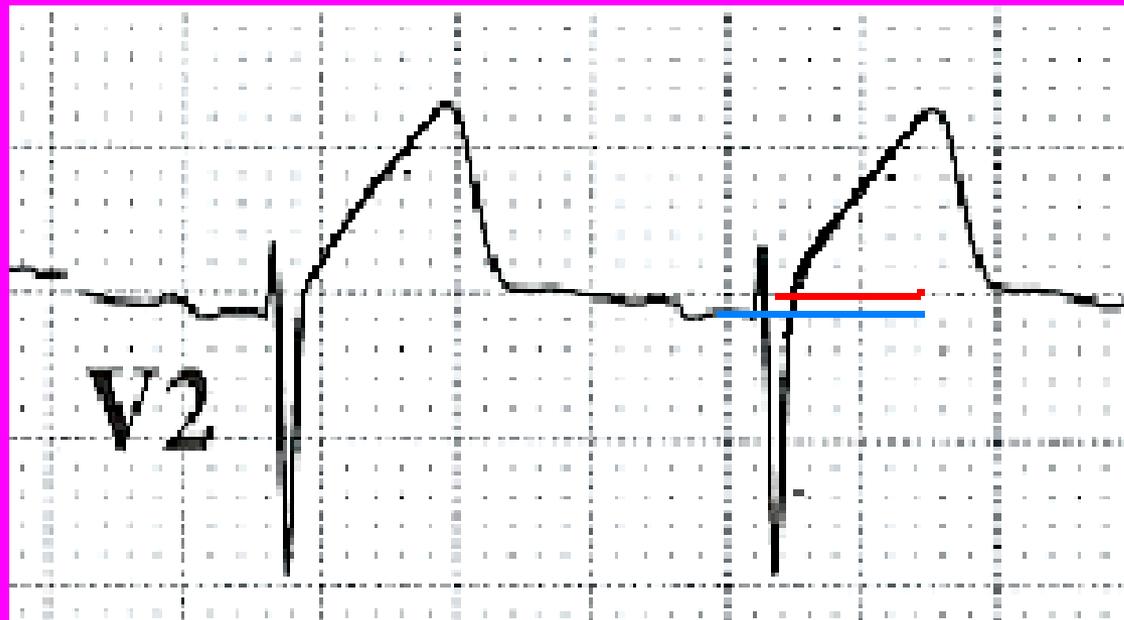


25mm/s 10mm/mV 40Hz 005C 12SL 235 CID: 3

EID:10 EDT:

ECG COMPUTER DOES NOT NOTICE THE CONVEX J-T APEX SEGMENTS !

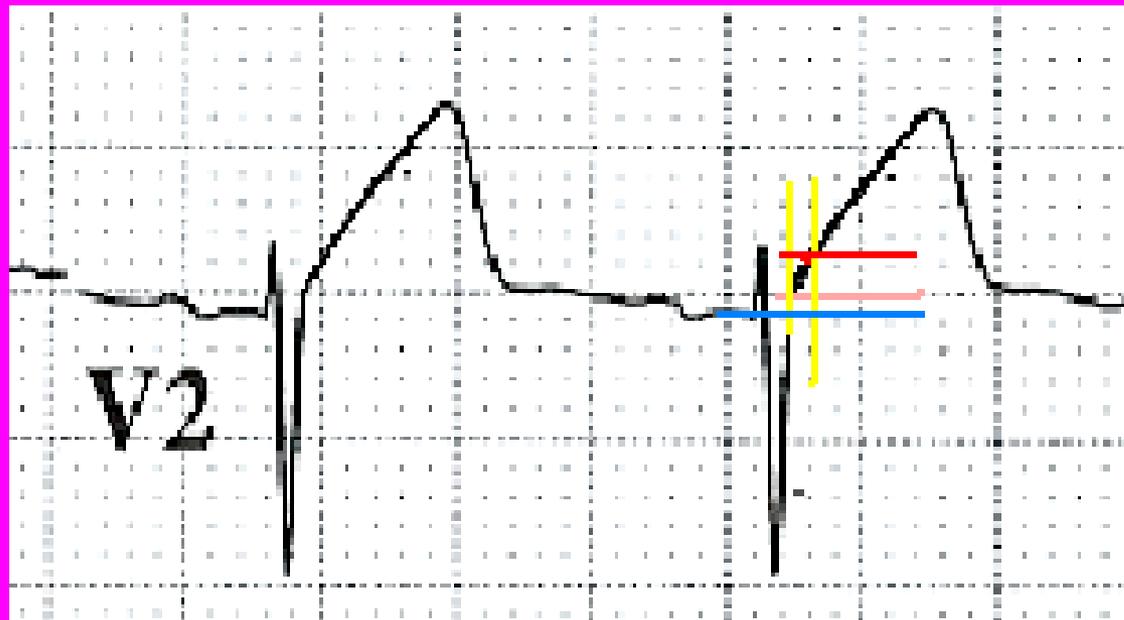
measurement of S-T elevation



S-T elevation at J point = 0.5 mm

ACUTE MI = S-T elev. > 1.0 mm

measurement of S-T elevation by "J point + .04" method

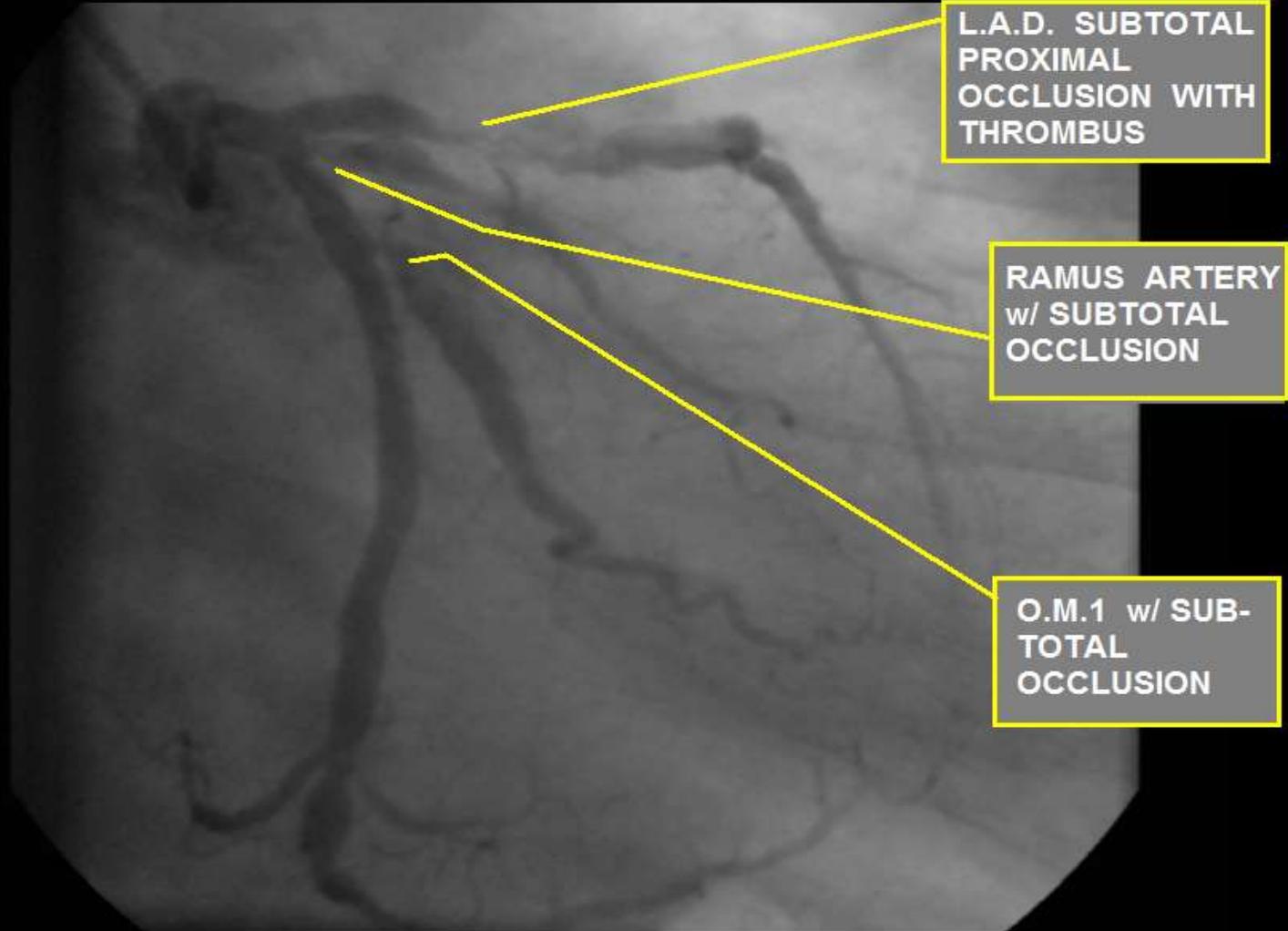


S-T elevation at J point = 0.5 mm

S-T elevation at J + .04 = 2.0 mm

ACUTE MI = S-T elev. > 1.0 mm

CASE STUDY: 56 y/o male with INTERMITTENT "CHEST HEAVINESS"



TREATMENT PLAN : EMERGENCY CORONARY ARTERY BYPASS SURGERY (4 VESSEL)

ECG Patterns associated with “EARLY PHASE MI:”

- ***J-T Apex abnormalities***
- ***Dynamic ST-T Wave
Changes on Serial ECGs***

Rate 75 . SINUS RHYTHM.....normal P axis, V-rate 50- 99
 . CONSIDER ANTEROSEPTAL INFARCT.....Q >30ms, V1 V2
 PR 140 . BORDERLINE REPOLARIZATION ABNORMALITY.....ST dep & abnormal T
 QRSD 90 . BASELINE WANDER IN LEAD(S) V1,V2
 QT 376
 QTc 420

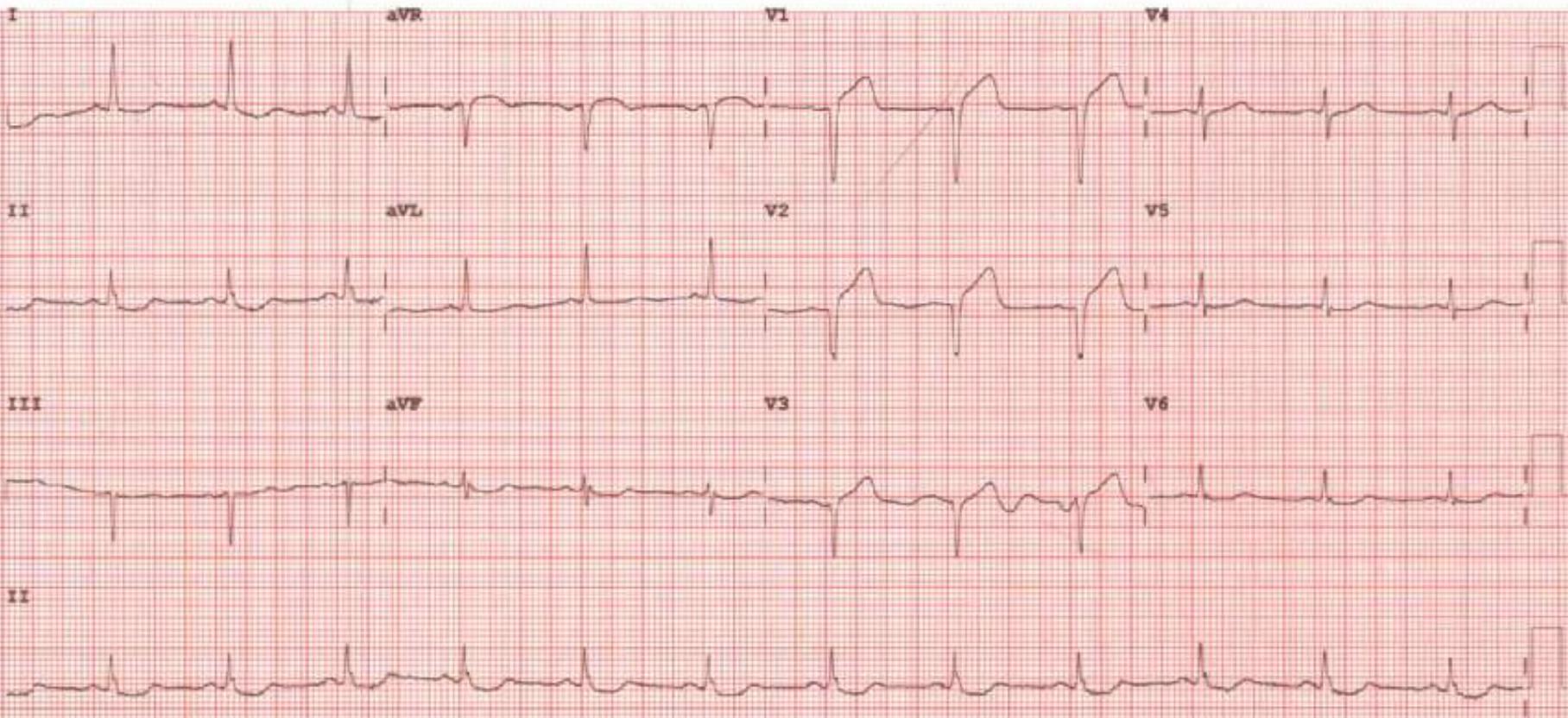
SEVEN RIVERS REGIONAL MED CTR

--AXIS--

P 35
 QRS 6
 T 193

- ABNORMAL ECG -

Unconfirmed Diagnosis



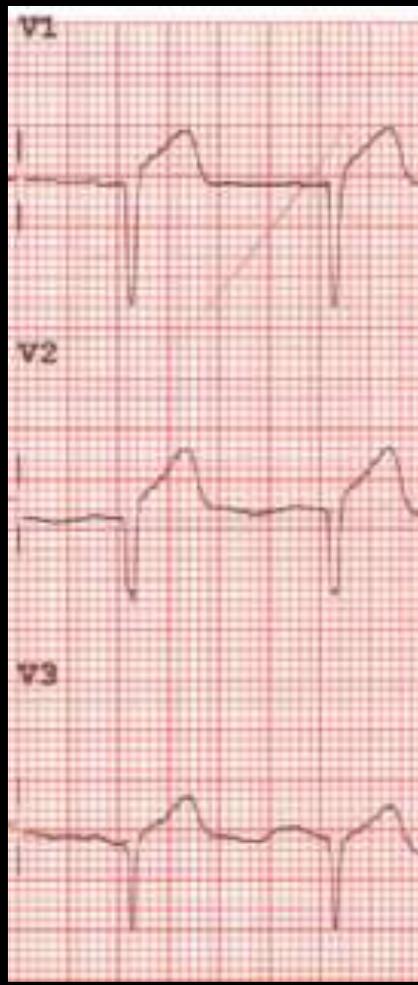
3. Dynamic ST-T Wave Changes in Serial ECGs. Recorded at SRRMC

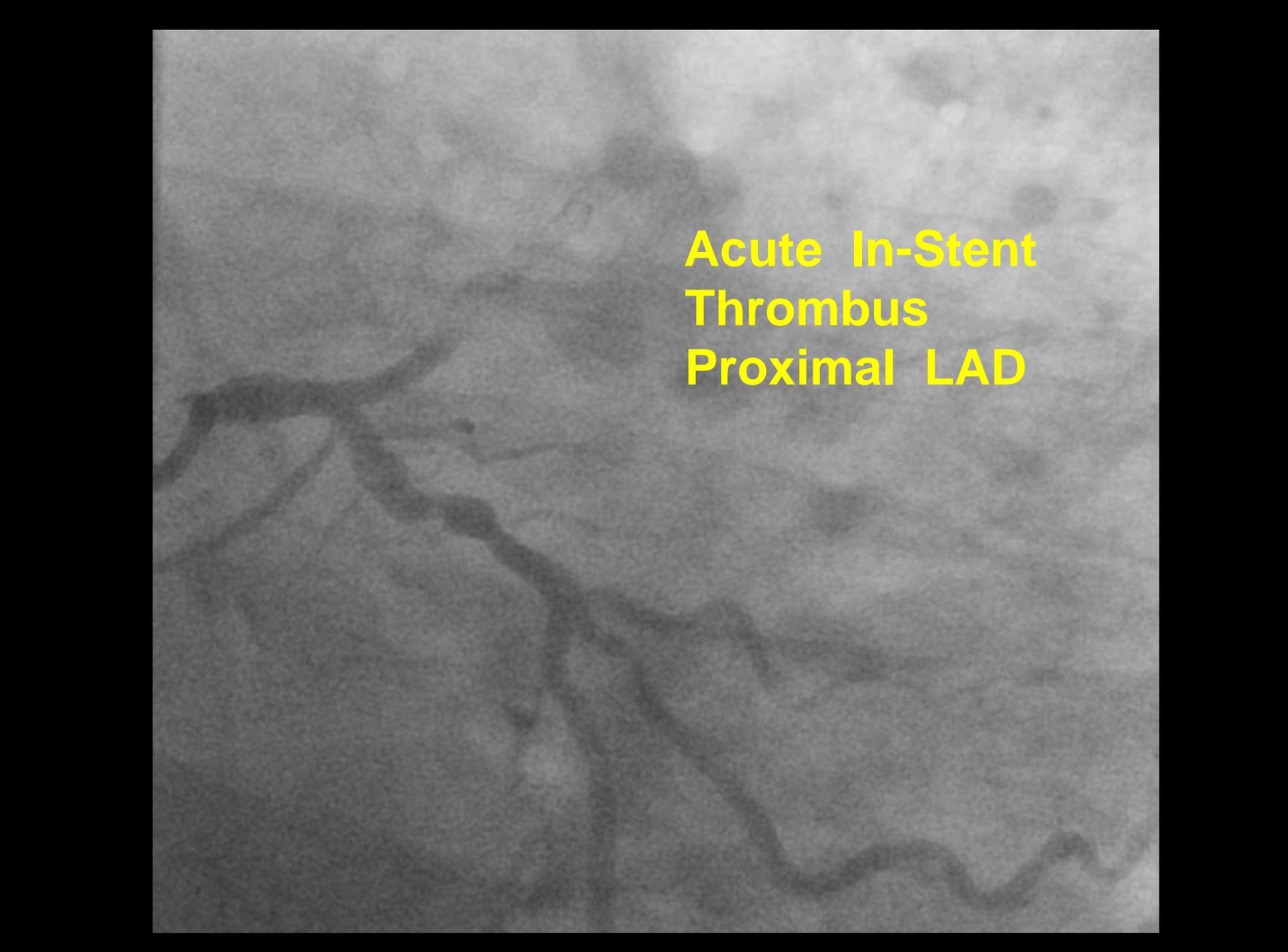
1st ECG

2nd ECG

1st ECG

2nd ECG

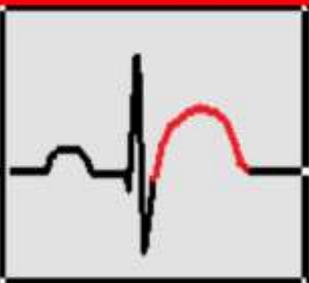
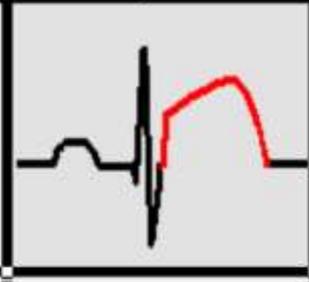


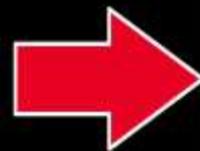
An angiogram of the proximal left anterior descending artery (LAD) showing acute in-stent thrombosis. The image displays a dark, irregular filling defect within the lumen of the artery, indicating a blood clot. The surrounding vessel walls and branches are visible, with some contrast enhancement. The text "Acute In-Stent Thrombus Proximal LAD" is overlaid in yellow on the right side of the image.

**Acute In-Stent
Thrombus
Proximal LAD**

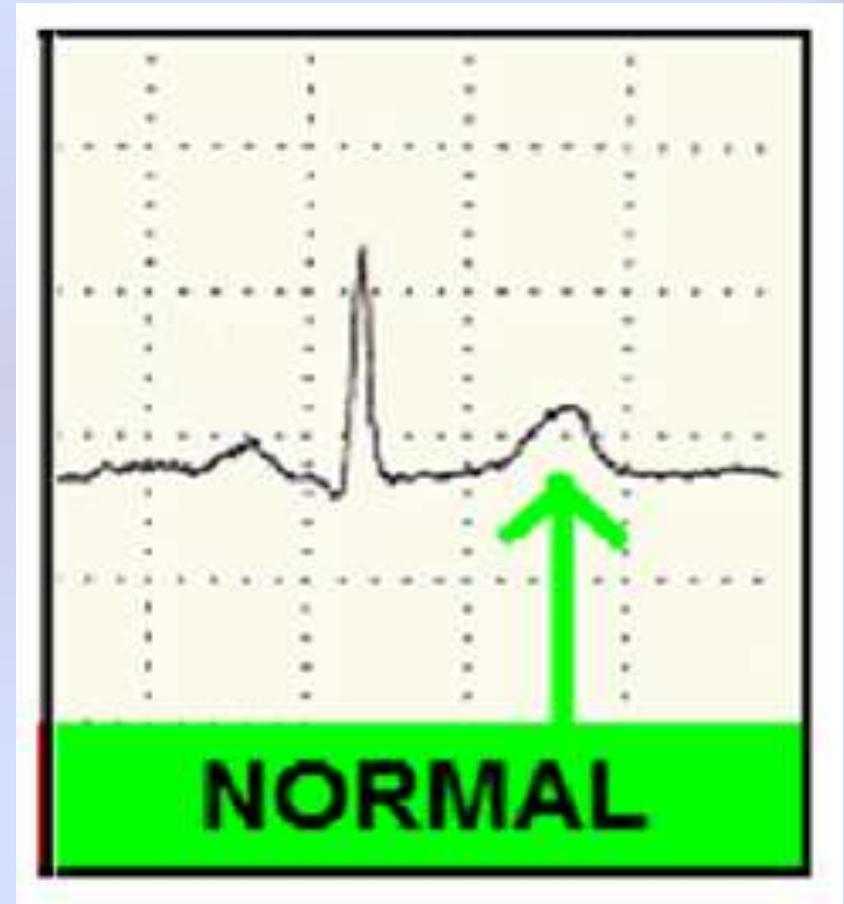
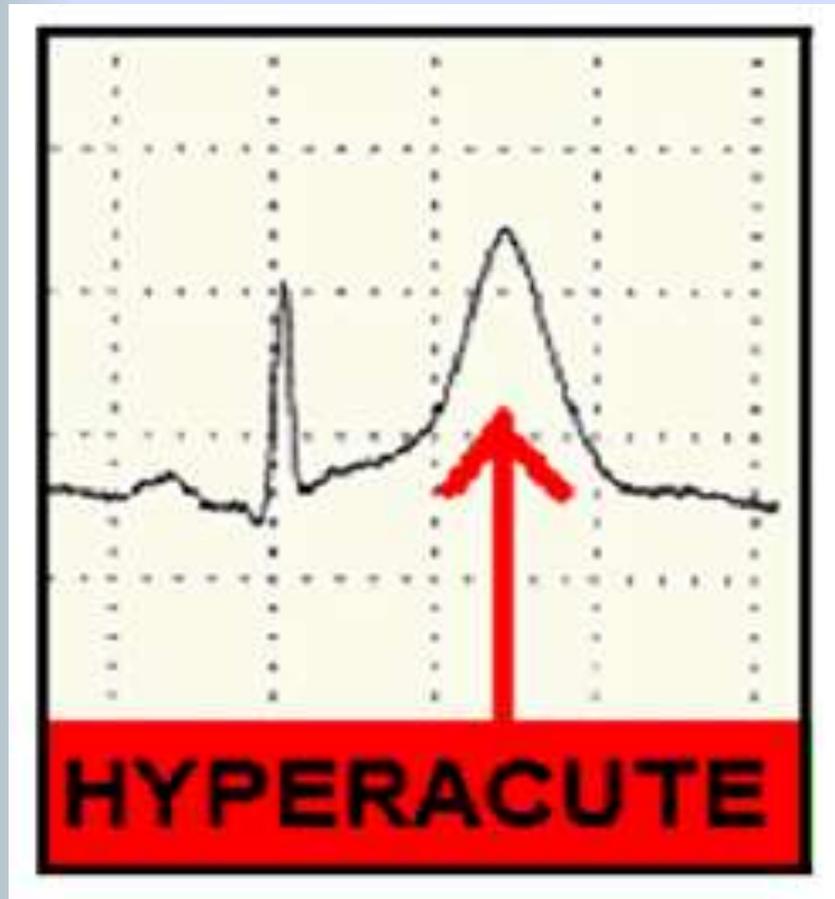
PATTERNS of ACS & ISCHEMIA

-- J POINT, ST SEGMENT, and T WAVE ABNORMALITIES --

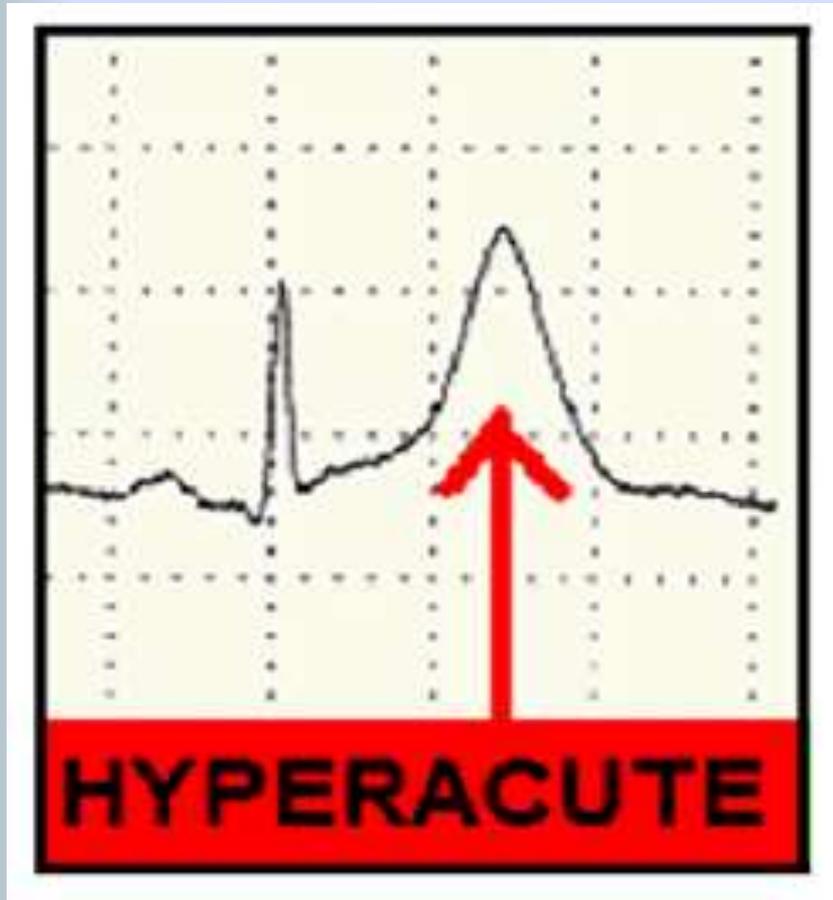
! FLAT or CONVEX J-T APEX SEGMENT			<i>ACUTE MI</i> <i>EARLY PHASE</i>
! HYPER-ACUTE T WAVE			<i>ACUTE MI</i> <i>EARLY PHASE</i>
! S-T SEGMENT ELEVATION at J POINT			<i>ACUTE MI</i>
! DEPRESSED J pt. DOWNSLOPING ST and INVERTED T			- ACUTE (NON-Q WAVE) MI - ACUTE MI - (RECIPROCAL CHANGES) - ISCHEMIA



T waves should not be HYPERACUTE

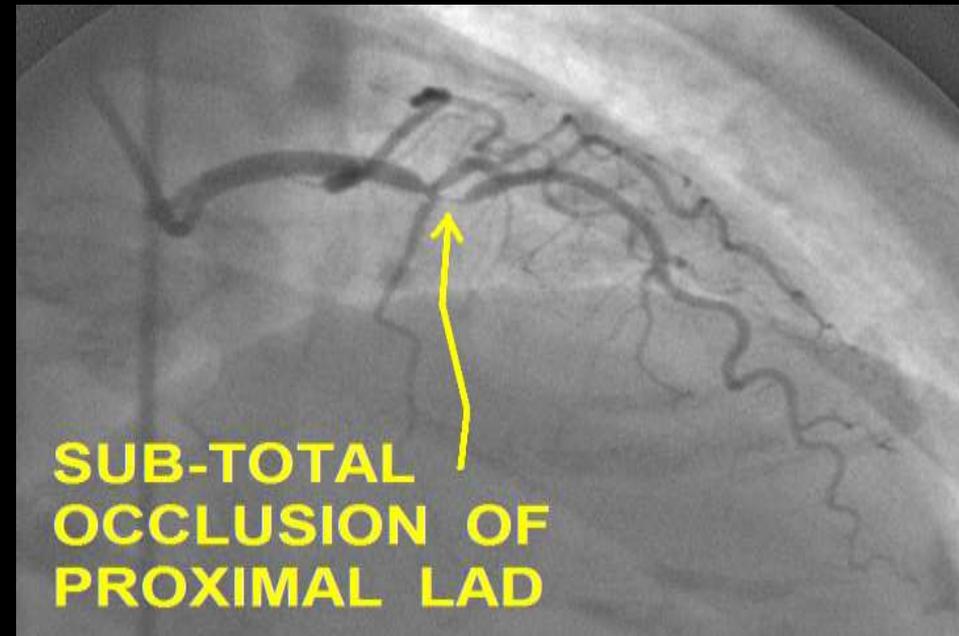
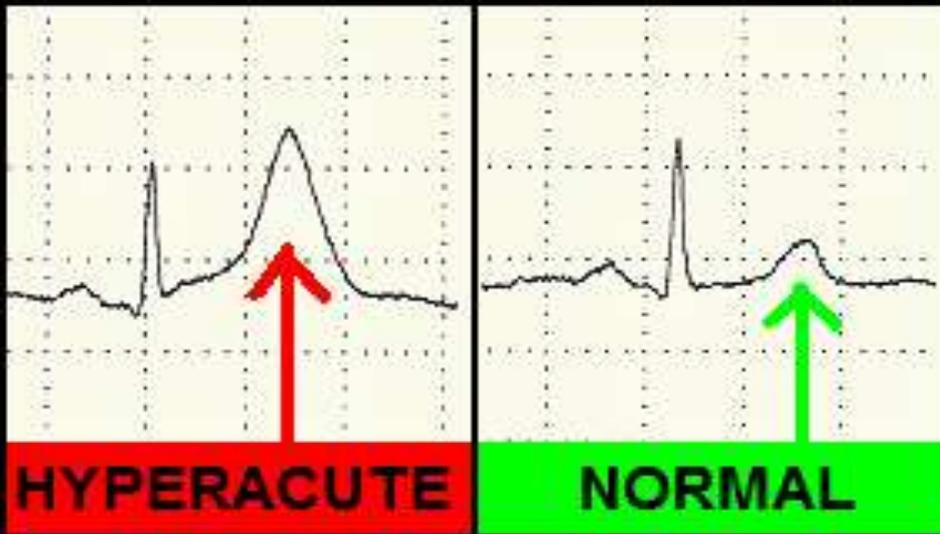


HYPERACUTE T Waves may indicate:



- **Early phase Acute MI**
- **Transmural ischemia** (usually seen in one region of the ECG)
- **Hyperkalemia** (seen globally across ECG)
- **Hypertrophy**

HYPERACUTE T WAVES



ECG waveforms obtained just before (hyperacute) and just after (normal) the critical blockage was stented in this patient's Proximal Left Anterior Descending (LAD) artery.

Helpful Clue: Hyper-Acute T Waves

- **GLOBAL Hyper-acute T Waves** (in leads viewing multiple myocardial regions / arterial distributions) **favours HYPERKALEMIA**

ID:

23-Nov-

REGIONAL MEDICAL CENTER

55years

Female

Caucasian

Vent. rate 57 bpm

PR interval 150 ms

QRS duration 102 ms

QT/QTc 472/459 ms

P-R-T axes 76 70 58

Sinus bradyc a

Possible Left atrial enlargement

Borderline ECG

Room:

Technician:

Test ind:

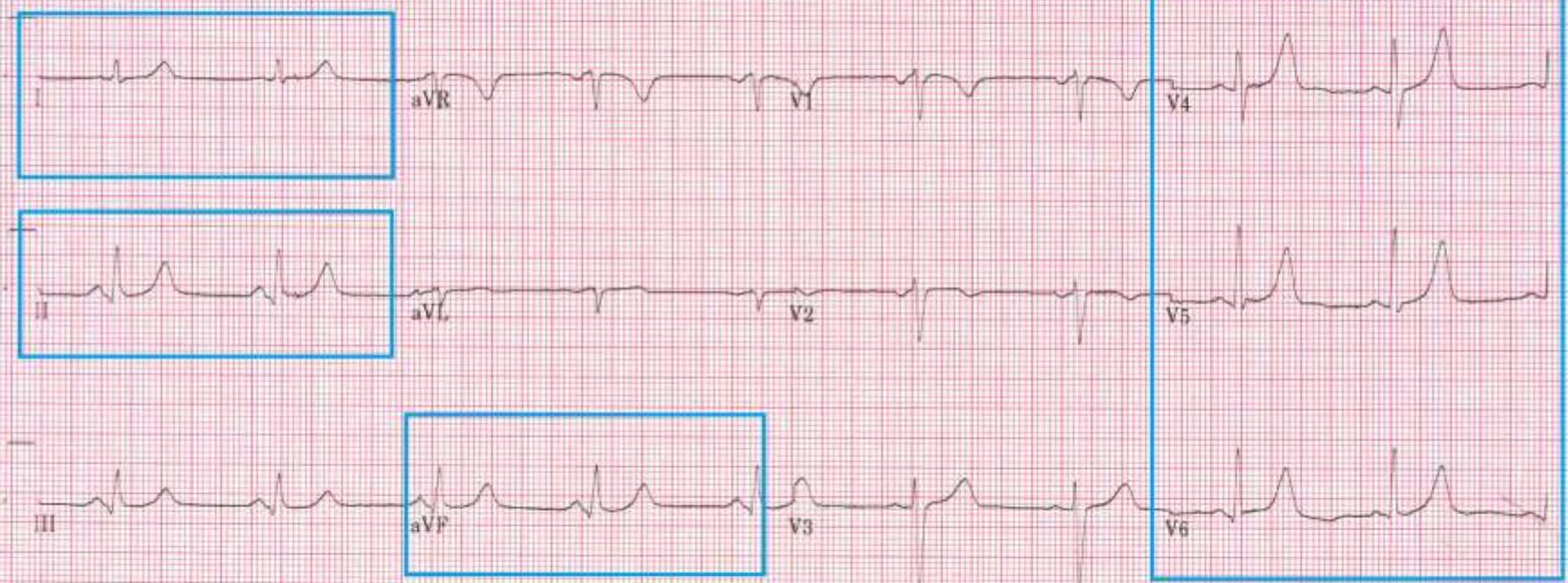
ER ATTENDING REVIEW
NO STEMI
TIME 1:51

K+ = 6.7

Referred by:

Unconfirmed

LOCATION:



100 Hz 25.0 mm/s 10.0 mm/mV

4 by 2.5s + 1 rhythm ld

MAC55 009A

12SL™ v237

Helpful Clue: Hyper-Acute T Waves

- **GLOBAL Hyper-acute T Waves** (in leads viewing multiple myocardial regions / arterial distributions) **favours HYPERKALEMIA**
- **Hyper-acute T Wave noted in ONE ARTERIAL DISTRIBUTION** (Anterior / Lateral / Inferior) **favours TRANSMURAL ISCHEMIA / Early Phase Acute MI**

CASE STUDY: HYPERACUTE T WAVES

CHIEF COMPLAINT and SIGNIFICANT HISTORY:

30 y/o male presents to ER via EMS, c/o sudden onset of dull chest pain x 40 min. Pain level varies, not effected by position, movement or deep inspiration. No associated symptoms.

RISK FACTOR PROFILE: NONE. CHOLESTEROL UNKNOWN.

PHYSICAL EXAM: Patient is supine on exam table, CAO x 4, anxious, restless, skin pale, cool, dry. Patient c/o chest pressure, "7" on 1 - 10 scale, uneffected by position, movement, deep inspiration. Lungs clear. HS: NL S1, S2, no rubs, murmurs, gallops

VITAL SIGNS: BP 136/88 P 90 R 20 SAO2 98%

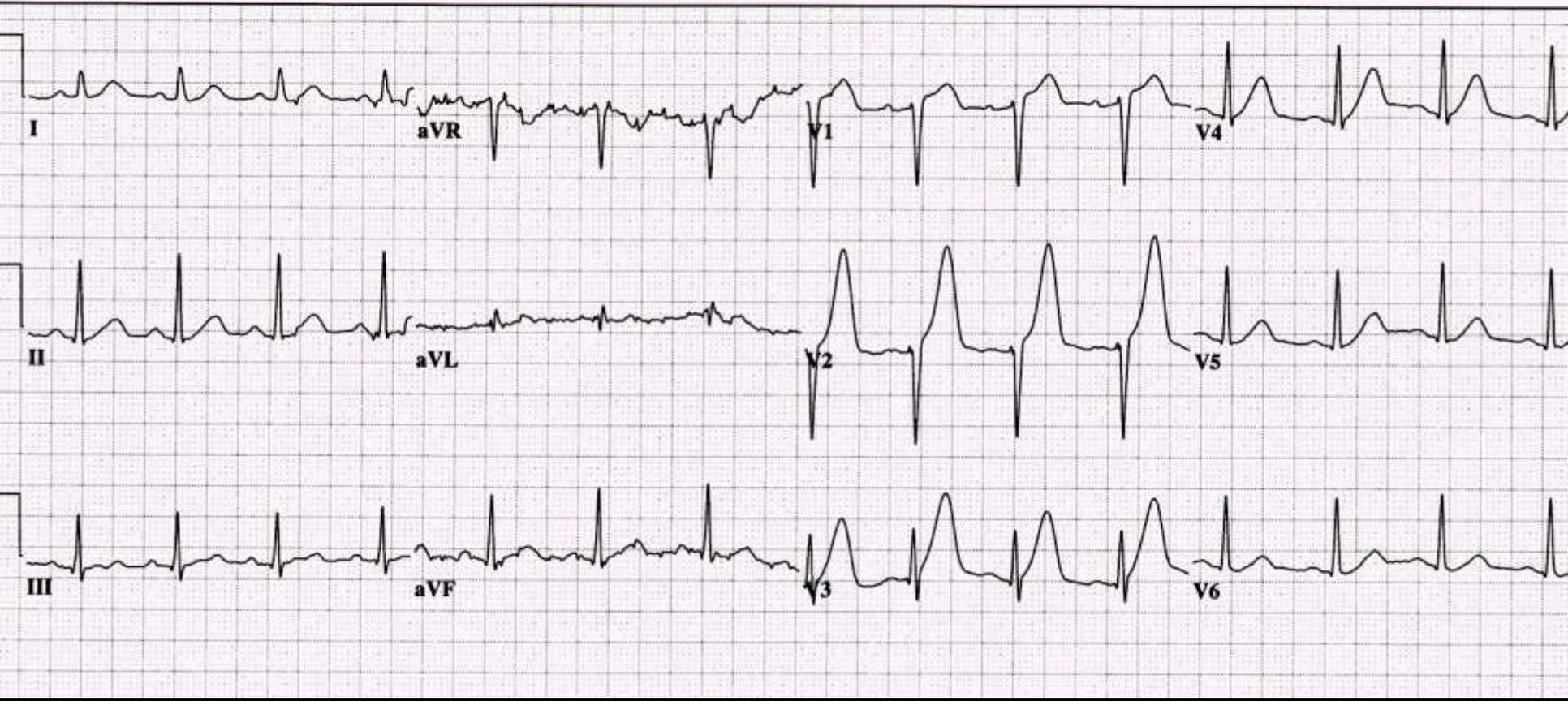
DIAGNOSTIC TESTING: 1st TROPONIN I - ultra: <0.07

30 yr
Male Black
Room: ER
Loc: Option:

Vent. rate 88 BPM
PR interval 164 ms
QRS duration 90 ms
QT/QTc 370/447 ms
P-R-T axes 61 62 53

Normal sinus rhythm
Normal ECG
No previous ECGs available

← NOTE COMPUTER INTERPRETATION



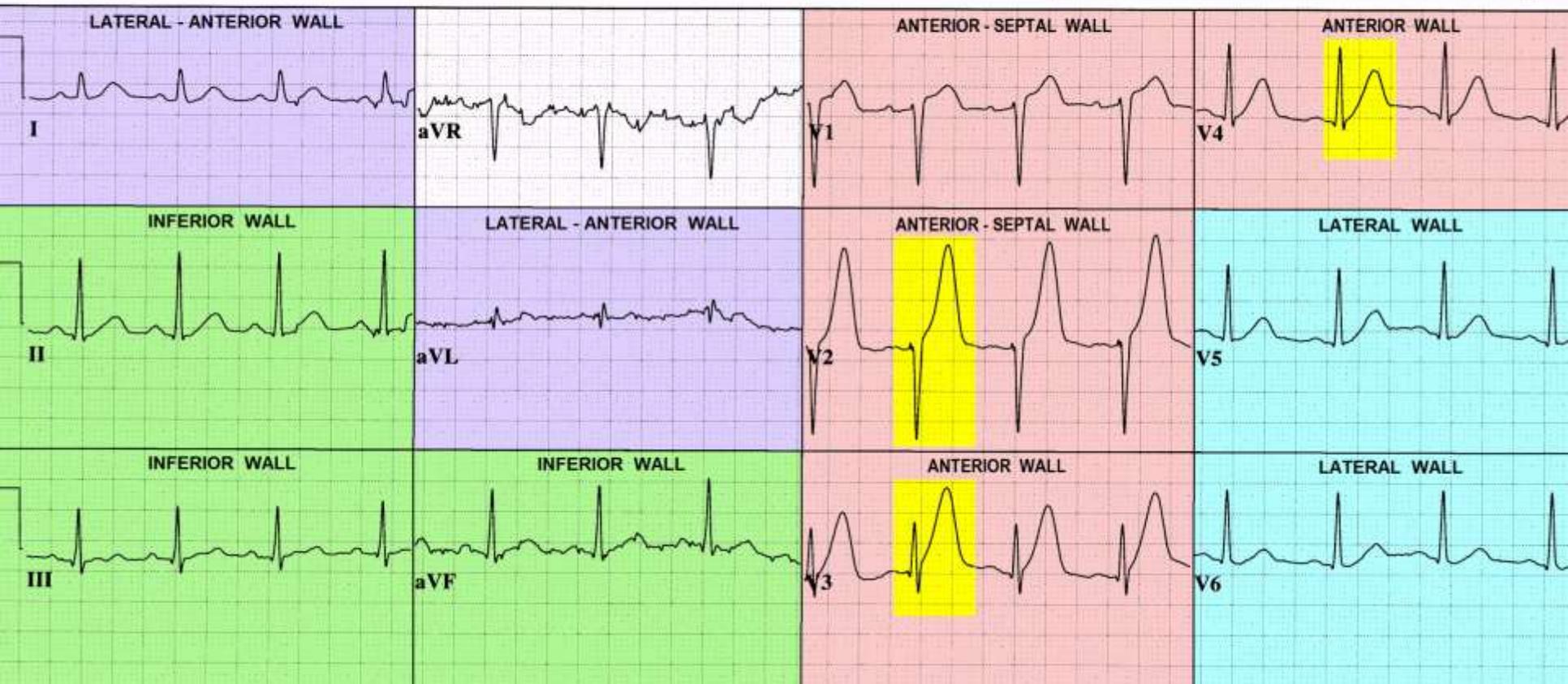
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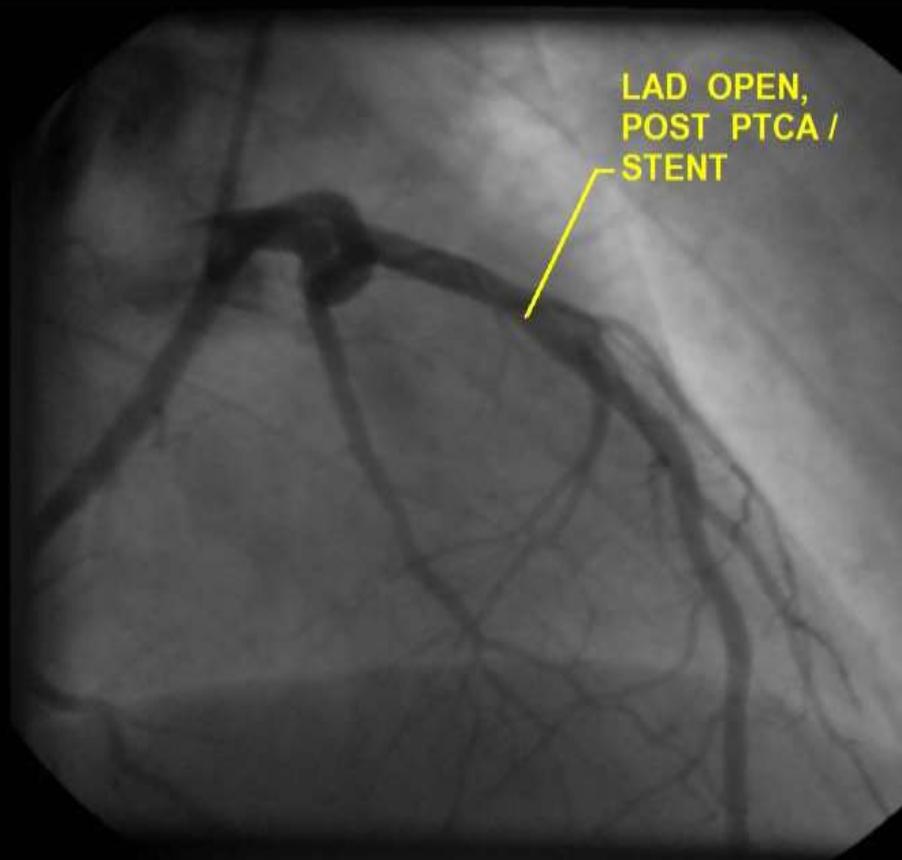
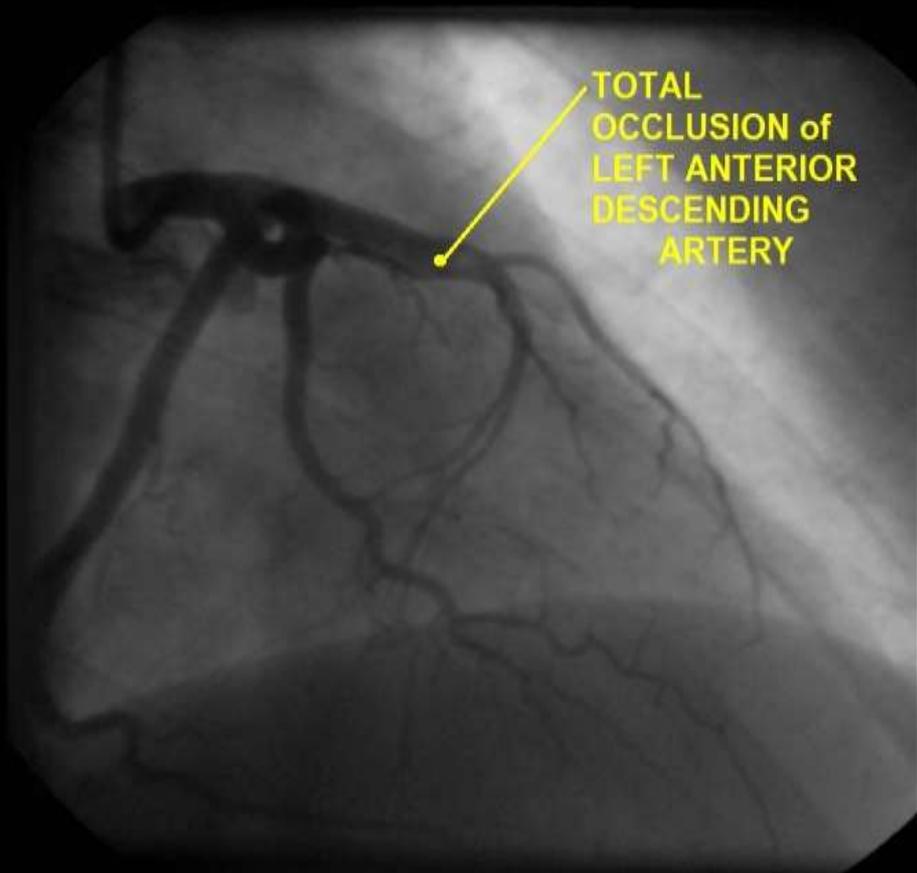
Normal sinus rhythm
 Normal ECG
 No previous ECGs available

**HIGHLIGHTED AREAS =
 HYPERACUTE T WAVES**

CORONARY ARTERIAL DISTRIBUTIONS:
 V1 - V4 = LEFT ANTERIOR DESCENDING (LAD)
 I, AVL = DIAGONAL (DIAG) off the LAD or
 OBTUSE MARGINAL (OM) off CIRCUMFLEX (CX)
 V5, V6 = CIRCUMFLEX
 II, III, AVF = RIGHT CORONARY ARTERY or CX



Cath Lab findings:



Dynamic ST-T Wave Changes:

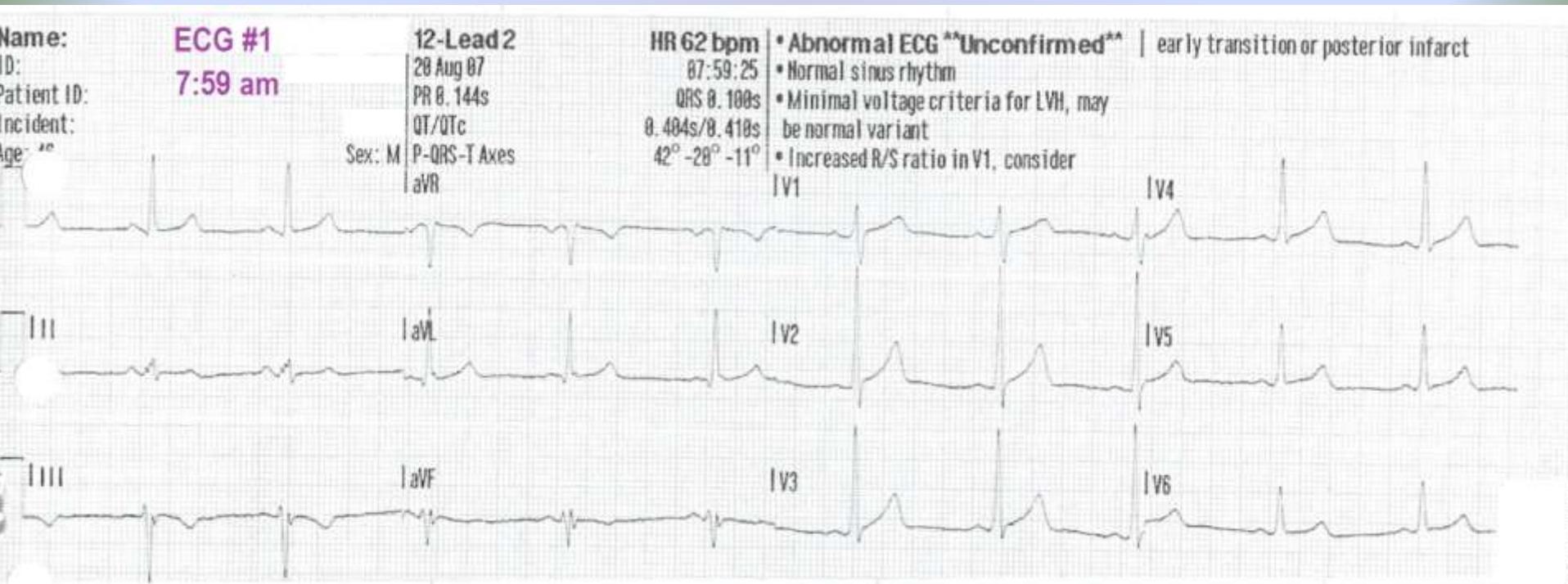
- Other than HEART RATE related variations (which affect intervals), ***J Points, ST-Segments and T Waves SHOULD NOT CHANGE.***

Dynamic ST-T Wave Changes:

- Other than HEART RATE related variations (which affect intervals), ***J Points, ST-Segments and T Waves SHOULD NOT CHANGE.***
- **When changes to J Points, ST-Segments and/or T waves are NOTED, consider EVOLVING MYOCARDIAL ISCHEMIA and/or EARLY PHASE MI, until proven otherwise.**

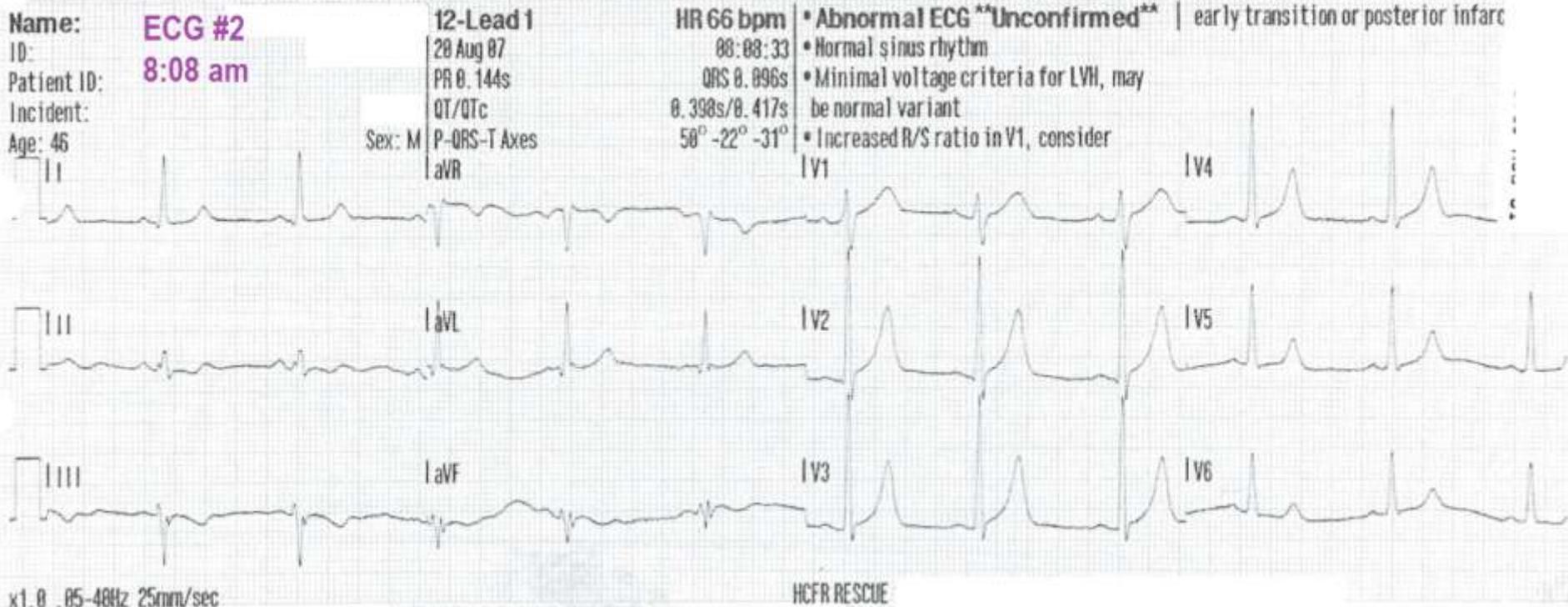
46 year old male

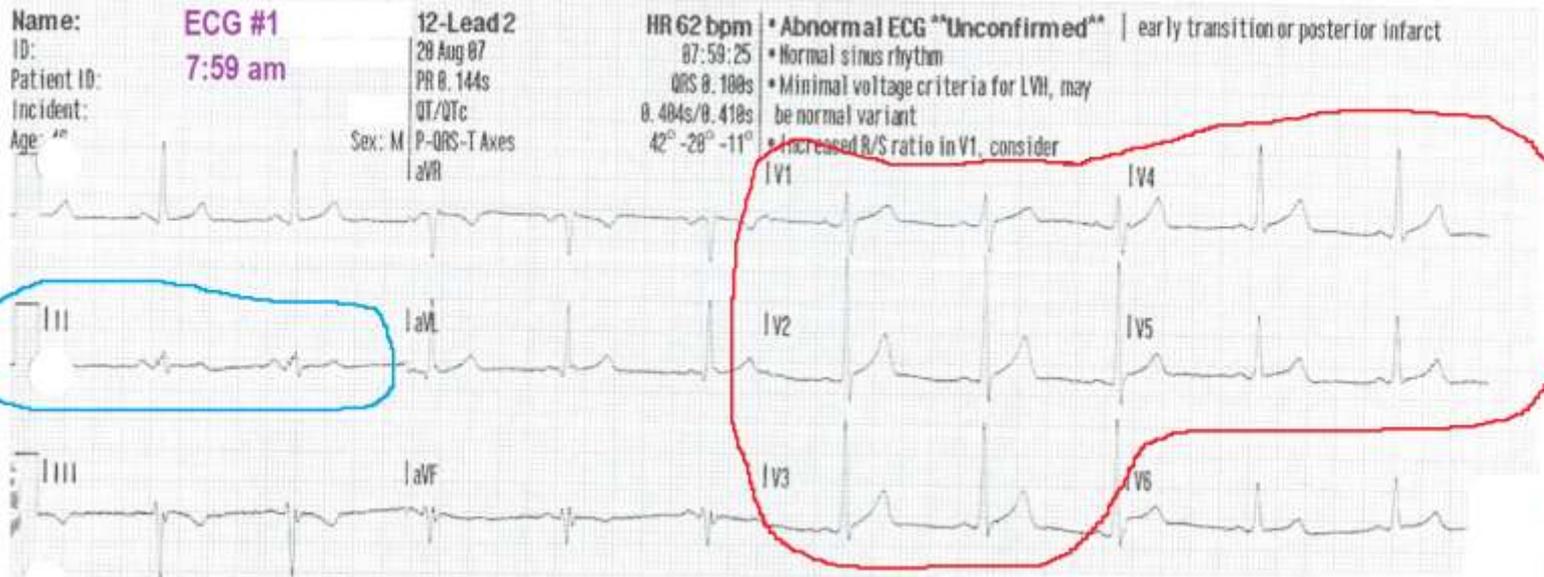
- Exertional dyspnea X “several weeks”
- Intermittent chest pressure X last 3 hours. Currently pain free.



46 year old male: ECG 1

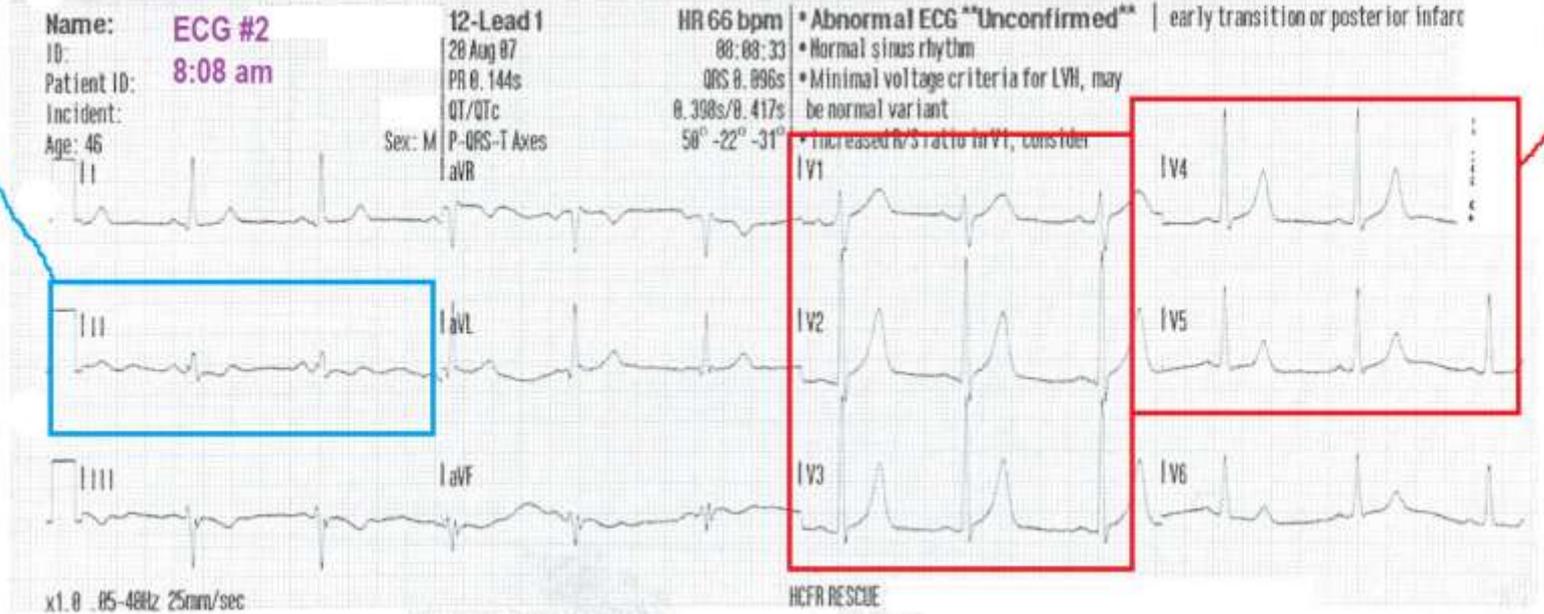
- Chest pressure has returned, “5” on 1-10 scale. 2nd ECG obtained due to “change in symptoms”:





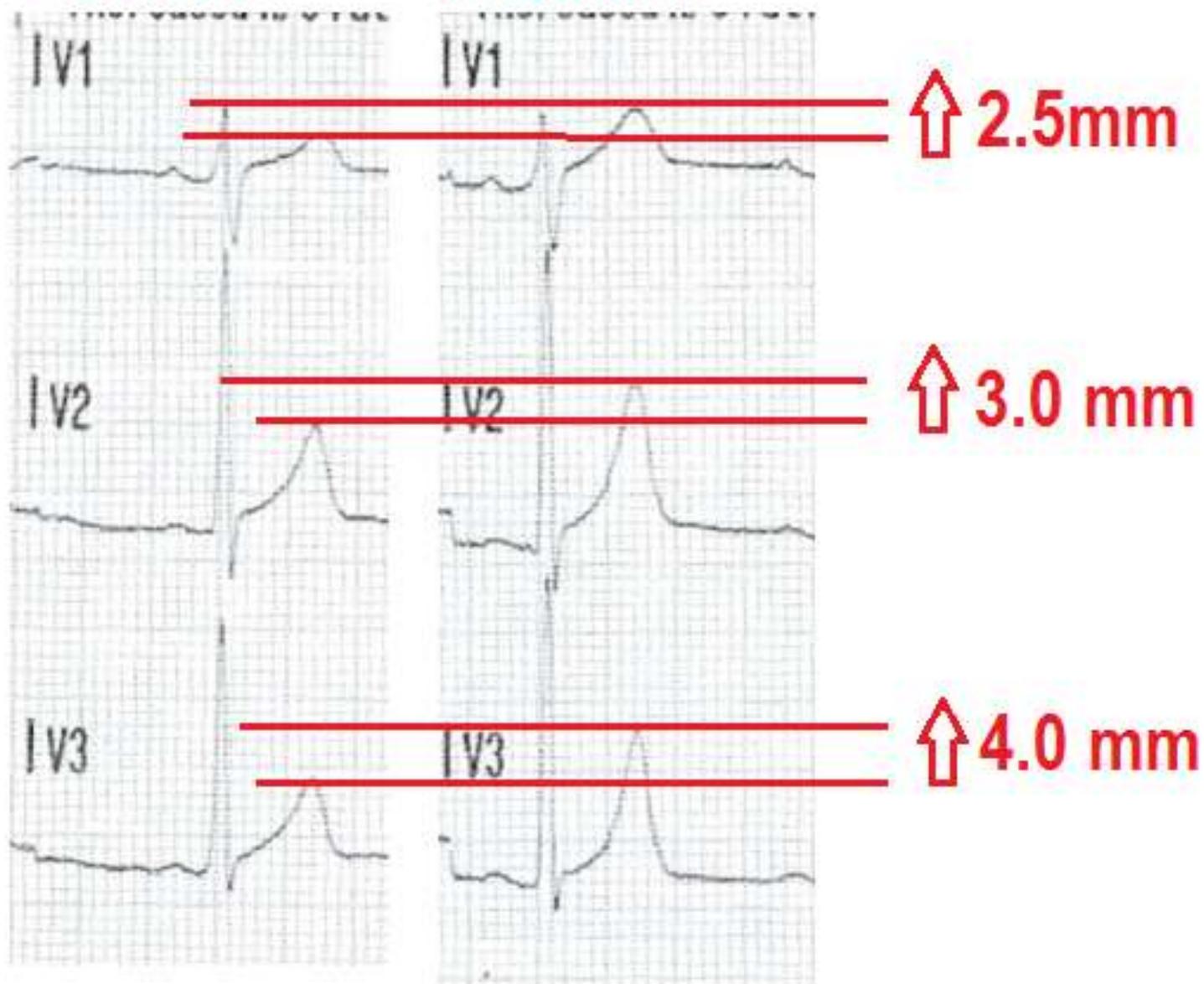
ST-segments have dropped in Lead II

T waves have gained amplitude in Leads V1-V5



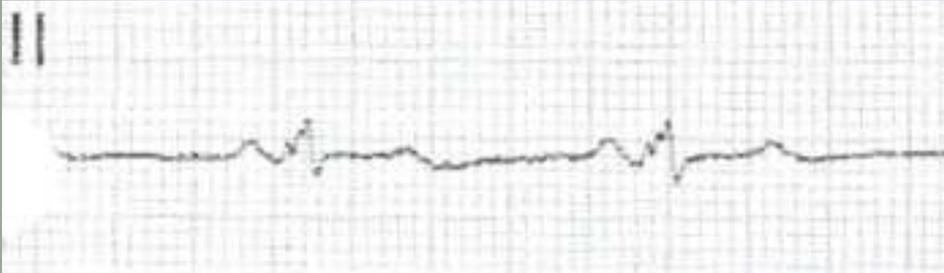
7:59 am

8:08 am

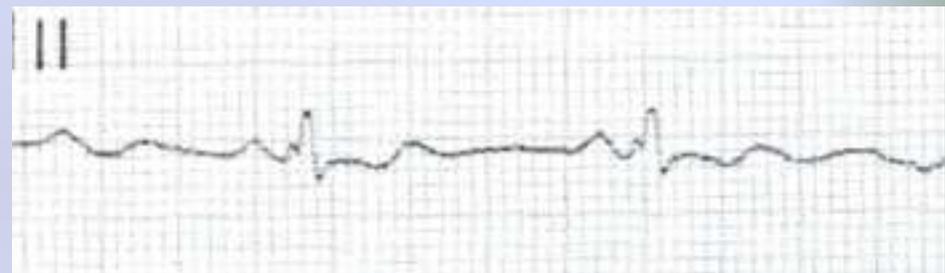


ST-Segment Depression

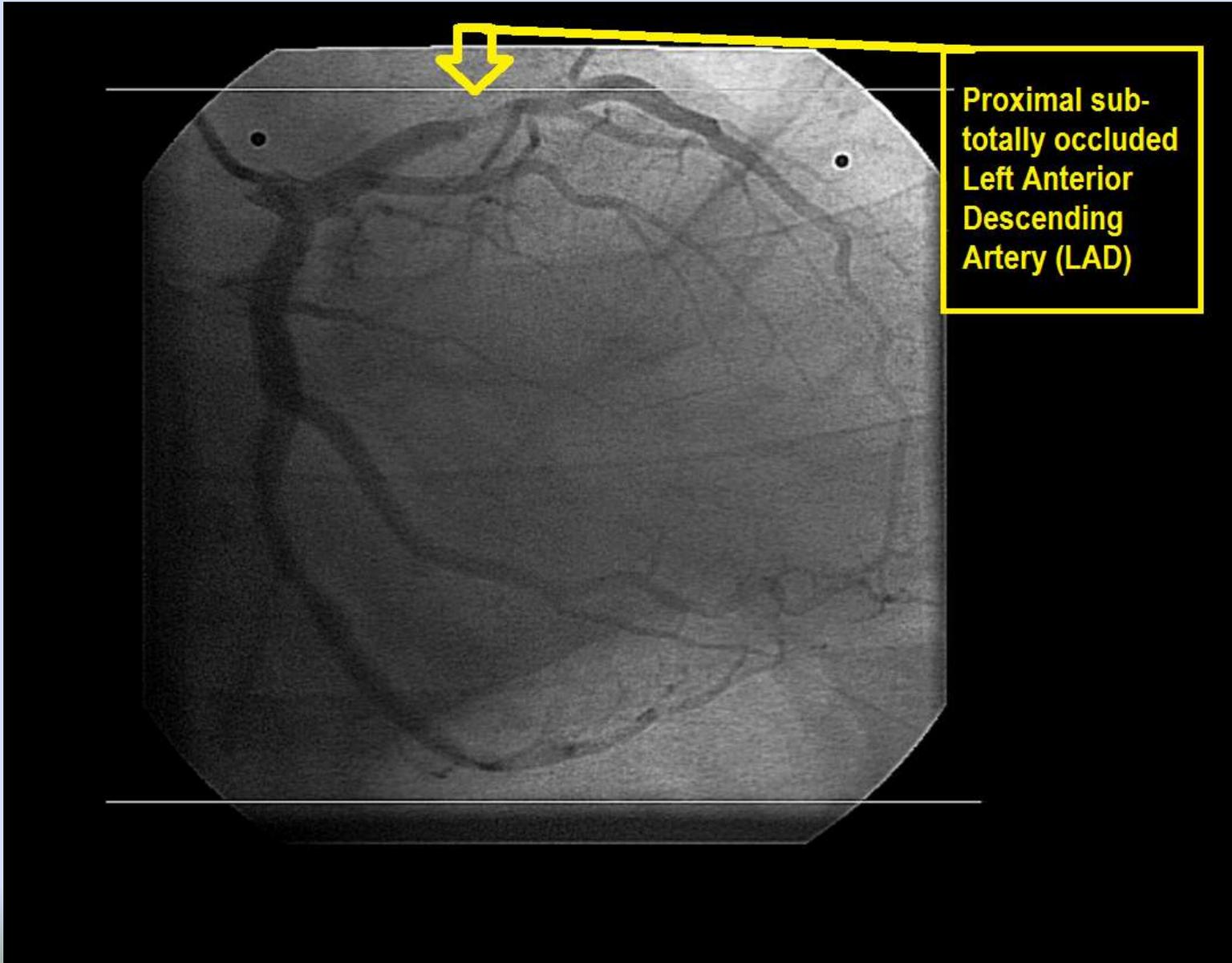
7:59 am



8:08 am



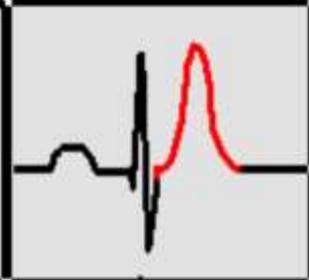
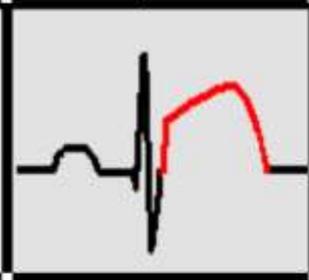
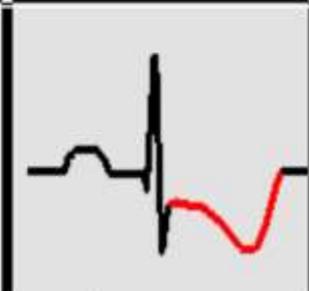
Cath Lab Angiography:

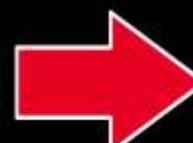


Proximal sub-totally occluded Left Anterior Descending Artery (LAD)

PATTERNS of ACS & ISCHEMIA

-- J POINT, ST SEGMENT, and T WAVE ABNORMALITIES --

! FLAT or CONVEX J-T APEX SEGMENT			<i>ACUTE MI</i> <i>EARLY PHASE</i>
! HYPER-ACUTE T WAVE			<i>ACUTE MI</i> <i>EARLY PHASE</i>
! S-T SEGMENT ELEVATION at J POINT			<i>ACUTE MI</i>
! DEPRESSED J pt. DOWNSLOPING ST and INVERTED T			- ACUTE (NON-Q WAVE) MI - ACUTE MI - (RECIPROCAL CHANGES) - ISCHEMIA



STEMI Criteria for 18 Lead ECGs:

Right-Sided Chest Leads

(V3R – V6R): 0.5 mm

Posterior Chest Leads

(V7 – V9): 0.5 mm

* P. Rautaharju et al, “Standardization and Interpretation of the ECG,” JACC 2009;(53)No.11:982-991

STEMI Criteria for 18 Lead ECGs:

Right-Sided Chest Leads

(V3R – V6R): _____ mm

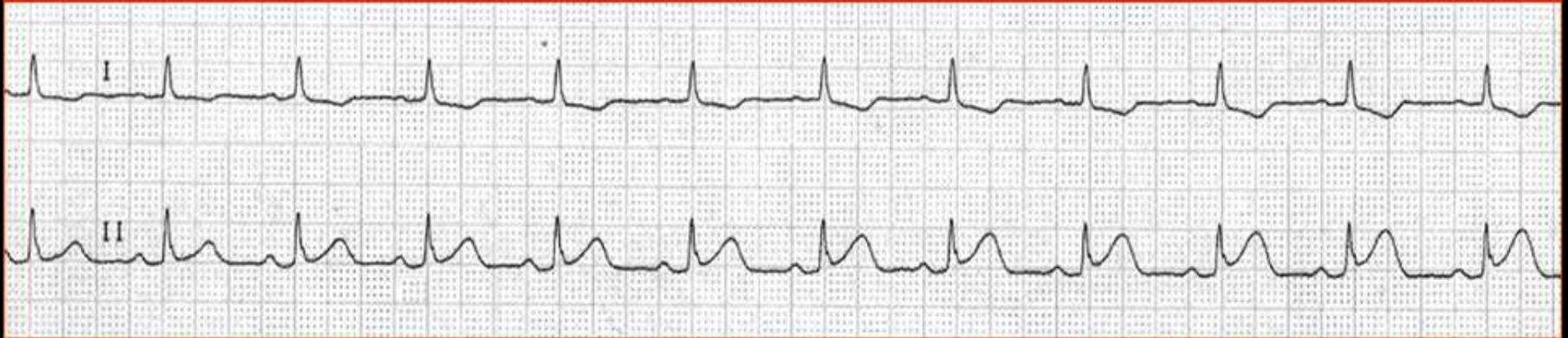
Posterior Chest Leads

(V7 – V9): _____ mm

* P. Rautaharju et al, "Standardization and Interpretation of the ECG," JACC 2009;(53)No.11:982-991

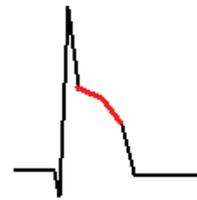
ST SEGMENT ELEVATION:

S-T SEGMENTS ELEVATE WITHIN SECONDS OF CORONARY ARTERY OCCLUSION:



IN THIS CASE, a normal response to balloon occlusion of the RIGHT CORONARY ARTERY during PTCA in the CARDIAC CATH LAB

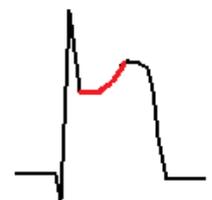
**3 COMMON PATTERNS of
ST SEGMENT ELEVATION
From ACUTE MI:**



**DOWNSLOPING
S-T SEGMENT**



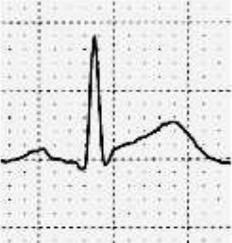
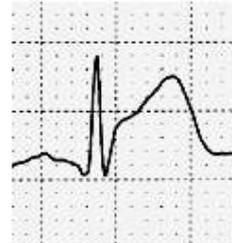
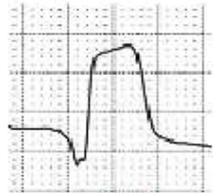
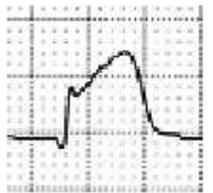
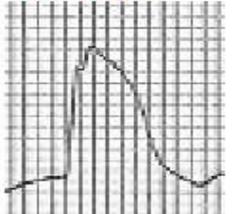
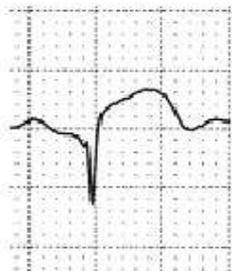
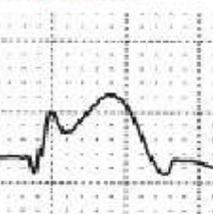
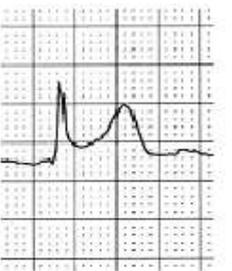
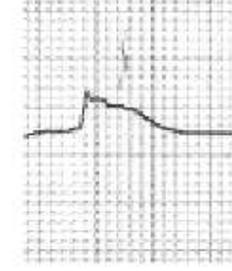
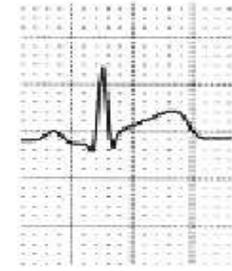
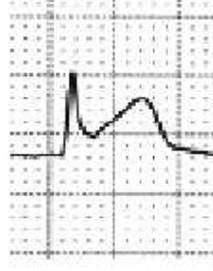
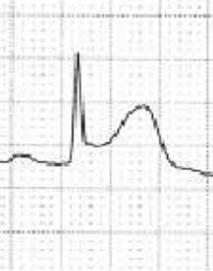
**FLAT
S-T SEGMENT**



**UPSLOPING
S-T SEGMENT**

ST SEGMENT ELEVATION in ACUTE MI:

The following samples are from patients with ACUTE MI, as confirmed by discovery of total arterial occlusion in the Cardiac Cath Lab:

 <p>V5 - ANTERIOR LATERAL MI</p>	 <p>V4 - ANTERIOR LATERAL MI</p>	 <p>aVL - ANTERIOR LATERAL MI</p>	<p>"TOOMBSTONE" PATTERN</p>  <p>V2 - ANTERIOR LATERAL MI</p>	<p>"FIREMAN'S HAT" PATTERN</p>  <p>V3 - ANTERIOR LATERAL MI</p>
<p>"TOOMBSTONE" PATTERN</p>  <p>V4 - ANTERIOR LATERAL MI</p>	 <p>V5 - ANTERIOR LATERAL MI</p>	 <p>V5 - ANTERIOR LATERAL MI</p>	 <p>II - INFERIOR POSTERIOR MI</p>	<p>"FIREMAN'S HAT" PATTERN</p>  <p>aVF - INFERIOR POSTERIOR MI</p>
 <p>III - INFERIOR MI</p>	 <p>III - INFERIOR POSTERIOR MI</p>	 <p>III - INFERIOR MI</p>	 <p>III - INFERIOR MI</p>	 <p>II - INFERIOR POSTERIOR MI</p>

Reciprocal S-T Segment Depression *may* or *may not* be present during AMI.

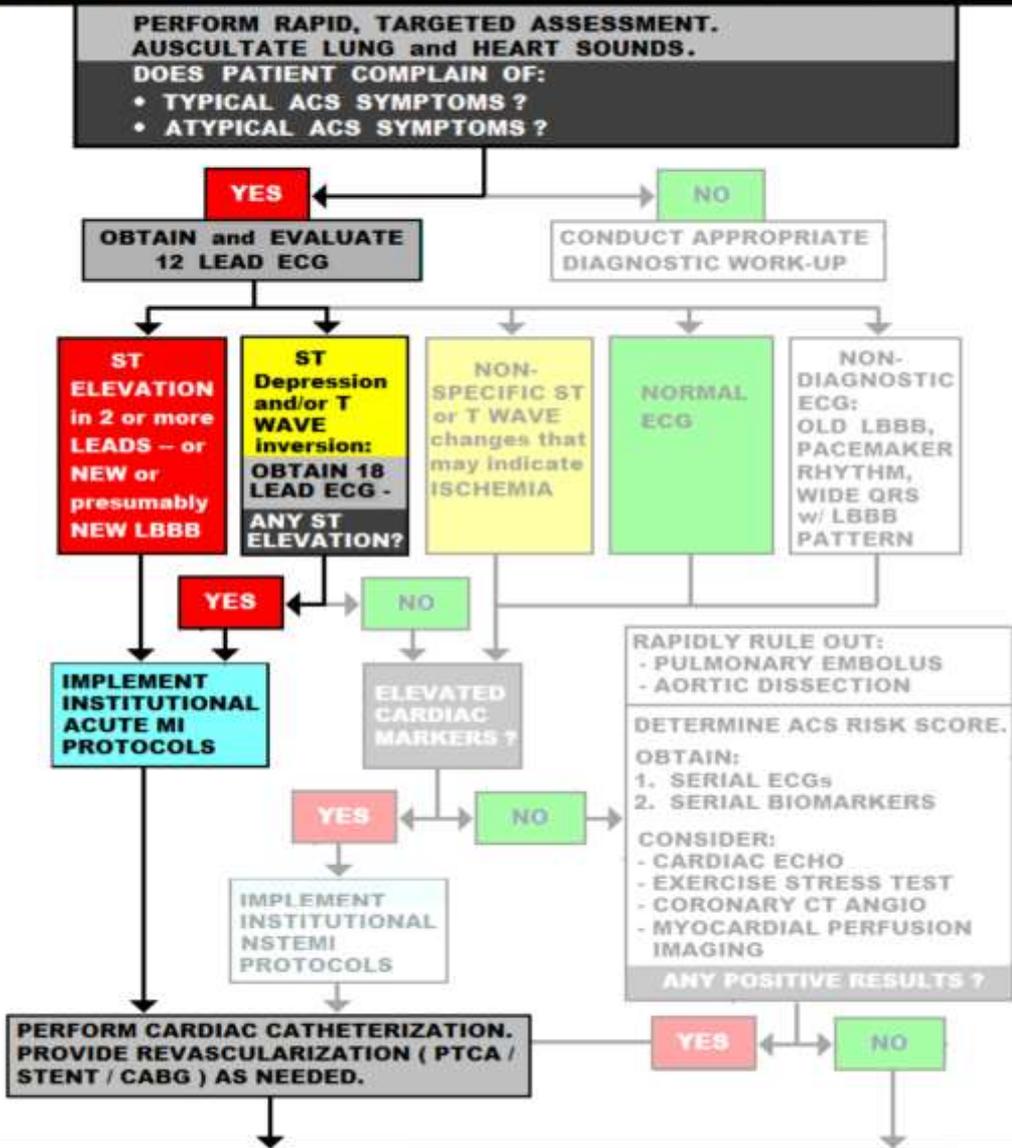
The presence of S-T Depression on an EKG which exhibits significant S-T elevation is a fairly reliable indicator that AMI is the diagnosis.

However the *lack of Reciprocal S-T Depression* DOES NOT rule out AMI.

STEMI CASE STUDIES

PHASE 1: RULE OUT LIFE-THREATENING CONDITIONS

PHASE 2: RULE OUT ACUTE CORONARY SYNDROME



PHASE 3: RULE OUT OTHER LETHAL CARDIAC and NON-CARDIAC CONDITIONS.

ACUTE MI

COMPLICATIONS TO ANTICIPATE FOR ALL MI PATIENTS :



LETHAL DYSRHYTHMIAS



CARDIAC ARREST



**FAILURE OF STRUCTURE(S)
SERVED BY THE BLOCKED ARTERY**

INTERPRET THE EKG, THEN:

- KEY IDENTIFY THE AREA OF THE HEART WITH A PROBLEM ...
- KEY RECALL THE ARTERY WHICH SERVES THAT REGION ...
- KEY RECALL OTHER STRUCTURES SERVED BY THAT ARTERY ...
- KEY ANTICIPATE FAILURE OF THOSE STRUCTURES ...
- KEY INTERVENE APPROPRIATELY!



“NOWHERE”, NEW MEXICO, 1994

***STEMI CASE
STUDIES***

STEMI Case Studies,
excerpts from “12 Lead
ECG Interpretation in ACS
with Case Studies from
the Cardiac Cath Lab.”

CASE STUDY 1 - STEMI

CHIEF COMPLAINT and SIGNIFICANT HISTORY:

72 y/o male, c/o CHEST "HEAVINESS," started 20 minutes before calling 911. Pain is "8" on 1-10 scale, also c/o mild shortness of breath. Has had same pain "intermittently" x 2 weeks.

RISK FACTOR PROFILE:

-  FAMILY HISTORY - father died of MI at age 77
-  FORMER CIGARETTE SMOKER - smoked for 30 year - quit 27 years ago
-  DIABETES - oral meds and diet controlled
-  HIGH CHOLESTEROL - controlled with STATIN meds
-  AGE: OVER 65

PHYSICAL EXAM: Patient calm, alert, oriented X 4, skin cool, dry, pale. No JVD, Lungs clear bilaterally. Heart sounds normal S1, S2. No peripheral edema.

VITAL SIGNS: BP: 100/64, P: 75, R: 20, SAO2: 94%

LABS: FIRST TROPONIN: 6.4

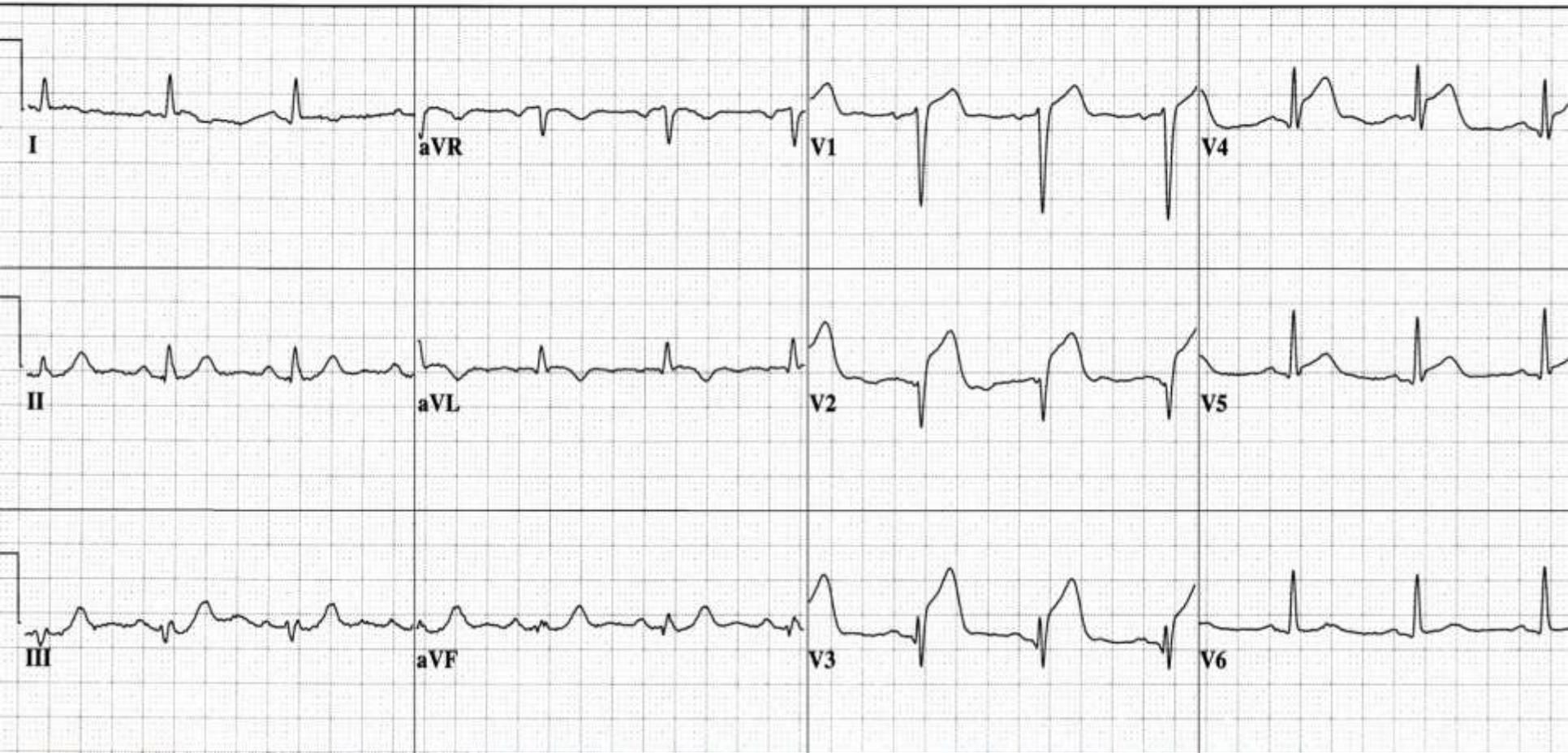
72 yr
Male Caucasian
Loc:3 Option:23

Vent. rate	75	BPM
PR interval	162	ms
QRS duration	98	ms
QT/QTc	382/426	ms
P-R-T axes	72 13	83



EVALUATE EKG for indicators of ACS:

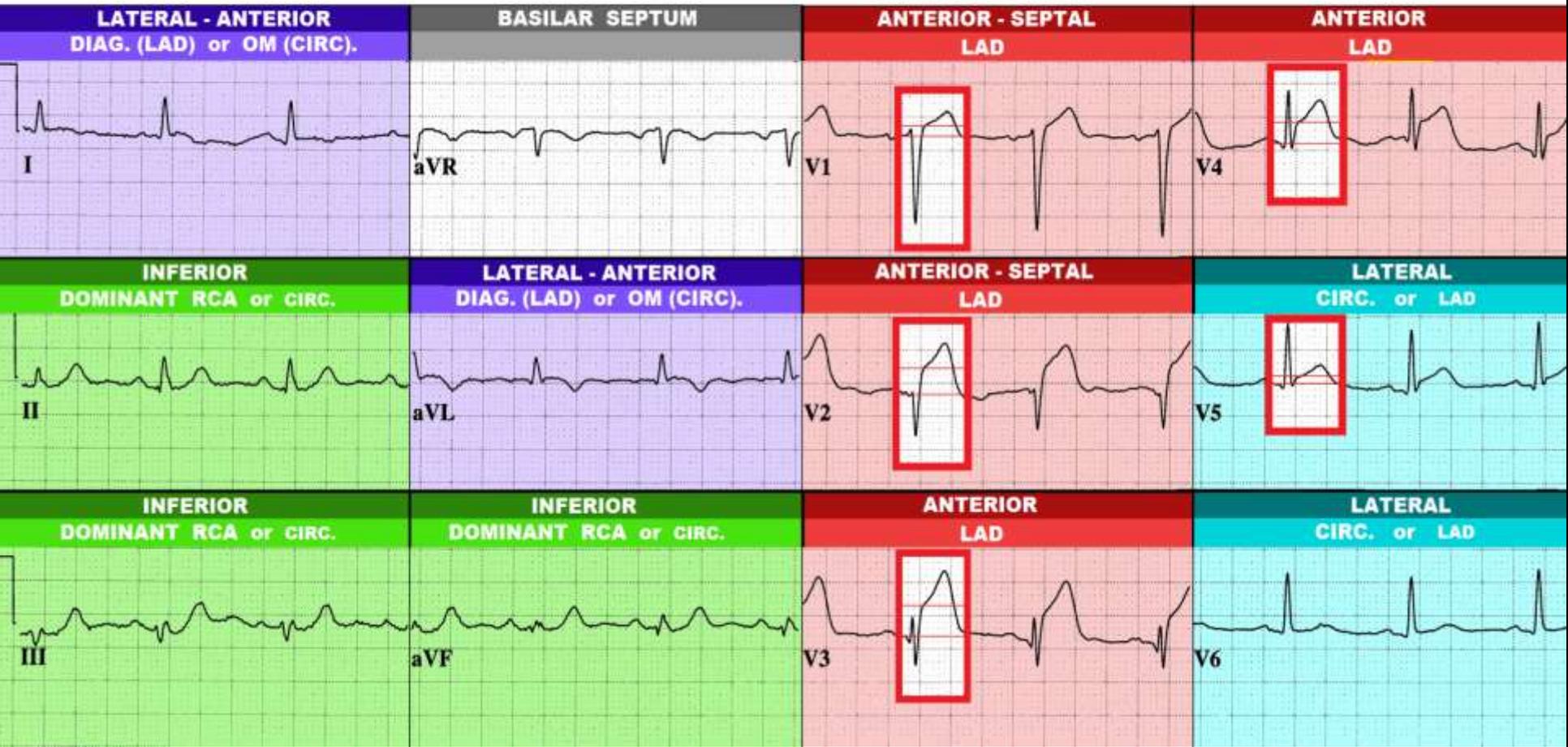
- ST SEGMENT ELEVATION / DEPRESSION
- HYPERACUTE T WAVES
- CONVEX ST SEGMENTS
- OTHER ST SEGMENT / T WAVE ABNORMALITIES



72 yr Male
 Caucasian
 Loc: Option:2
 Vent. rate 75 BPM
 PR interval 162 ms
 QRS duration 98 ms
 QT/QTc 382/426 ms
 P-R-T axes 72 13 83

Normal sinus rhythm
 Anteroseptal infarct, possibly acute
 ***** ACUTE MI *****
 Abnormal ECG

ST SEGMENT ELEVATION

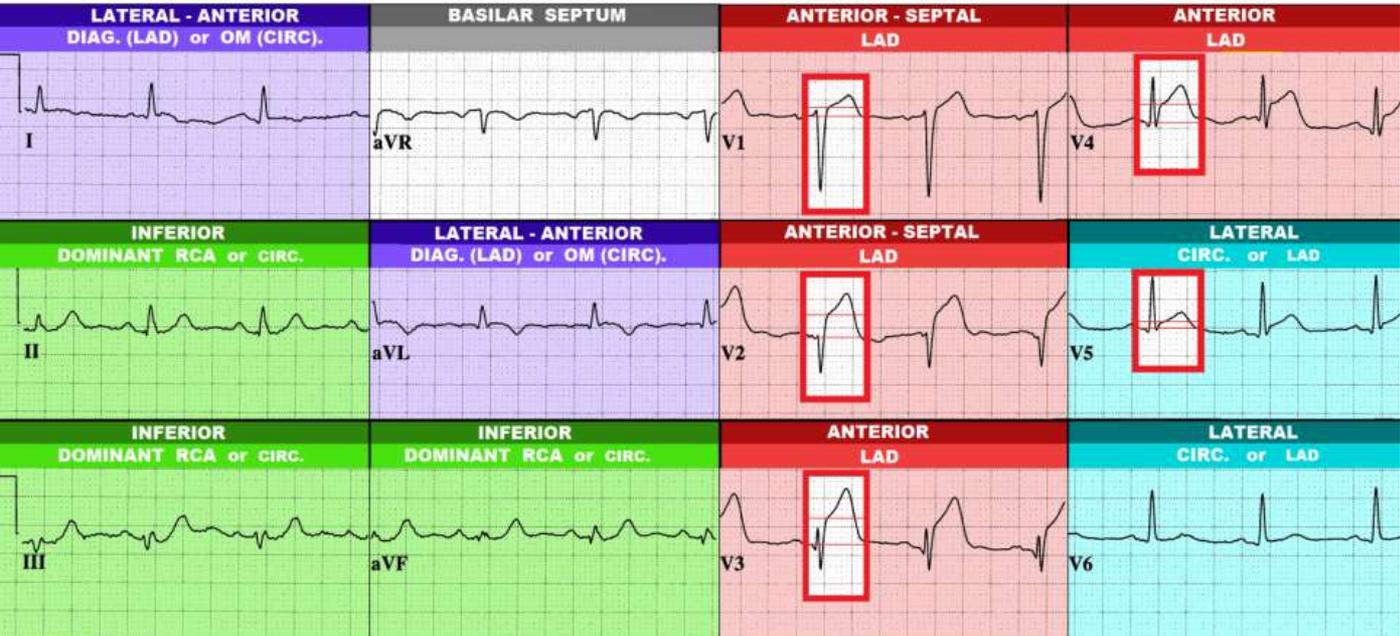


Note: There is NO Reciprocal ST Depression on this STEMI ECG !

72 yr Male Caucasian
 Vent. rate 75 BPM
 PR interval 162 ms
 QRS duration 98 ms
 QT/QTc 382/426 ms
 P-R-T axes 72 13 83

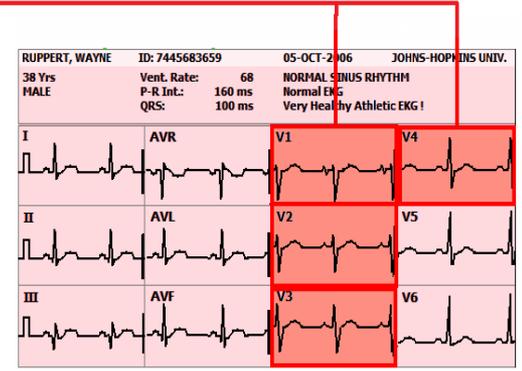
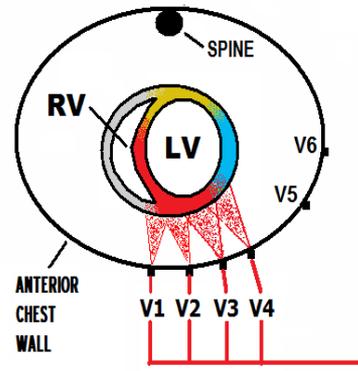
Normal sinus rhythm
 Anteroseptal infarct, possibly acute
 ***** ACUTE MI *****
 Abnormal ECG

ST SEGMENT ELEVATION



V1 - V4 VIEW THE ANTERIOR-SEPTAL WALL of the LEFT VENTRICLE

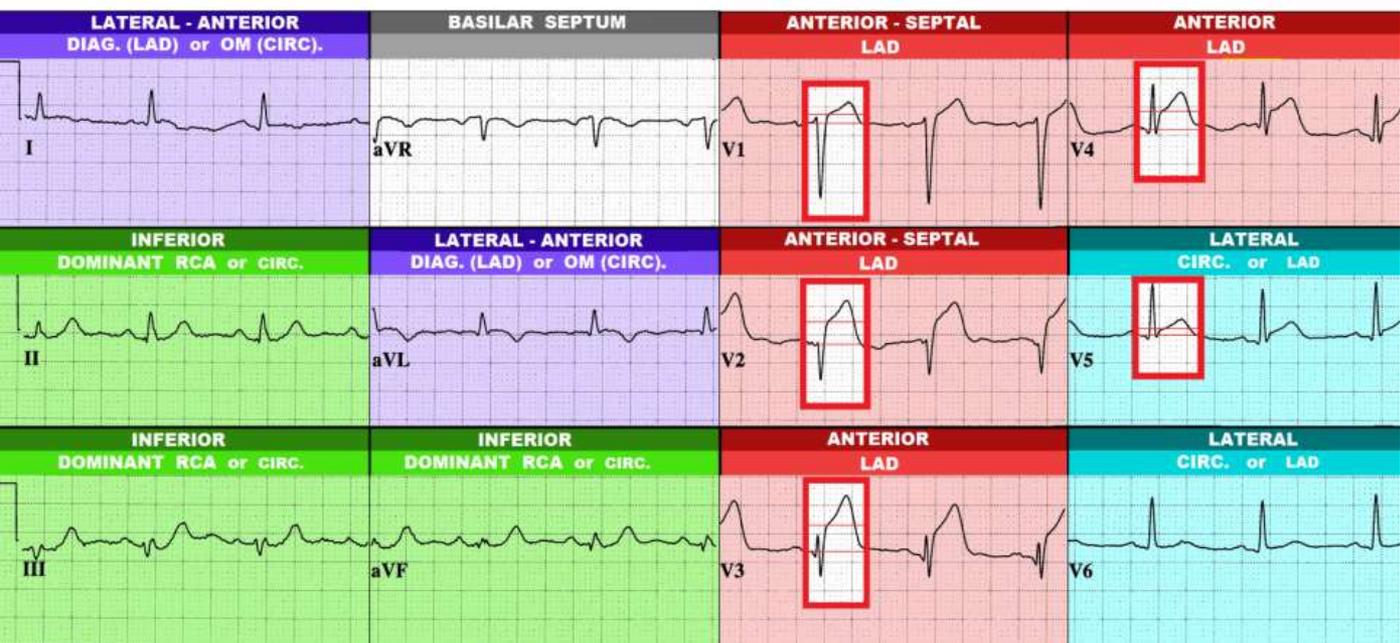
V1, V2 - ANTERIOR / SEPTAL
 V3, V4 - ANTERIOR



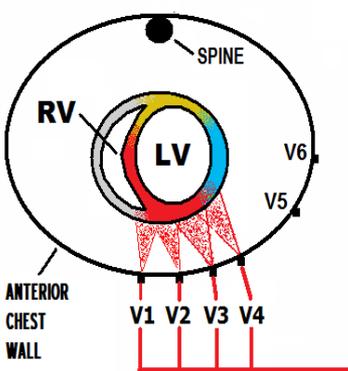
72 yr Male Caucasian
 Vent. rate 75 BPM
 PR interval 162 ms
 QRS duration 98 ms
 QT/QTc 382/426 ms
 P-R-T axes 72 13 83

Normal sinus rhythm
 Anteroseptal infarct, possibly acute
 ***** ACUTE MI *****
 Abnormal ECG

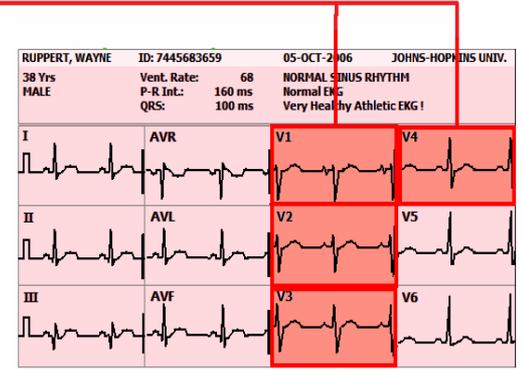
ST SEGMENT ELEVATION



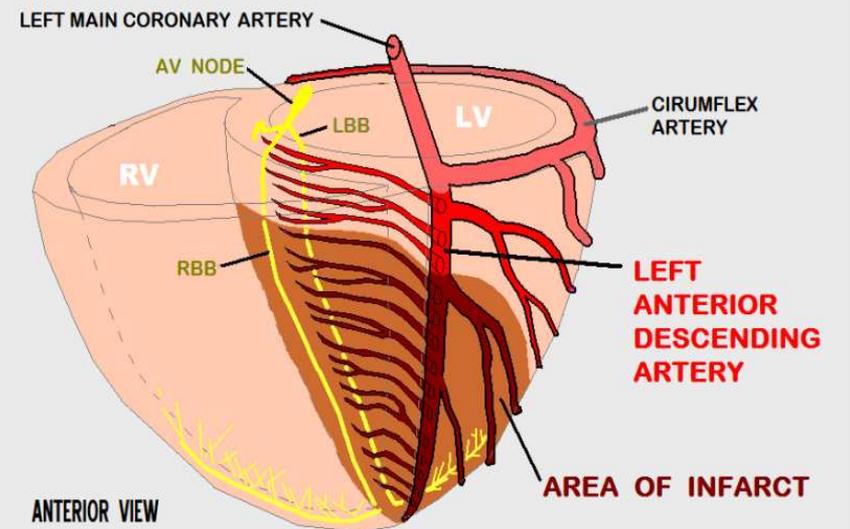
V1 - V4 VIEW THE ANTERIOR-SEPTAL WALL of the LEFT VENTRICLE



V1, V2 - ANTERIOR / SEPTAL
V3, V4 - ANTERIOR



OCCCLUSION of MID - LEFT ANTERIOR DESCENDING ARTERY



OCCLUSION of MID - LEFT ANTERIOR DESCENDING ARTERY

LEFT MAIN CORONARY ARTERY

AV NODE

LBB

LV

CIRUMFLEX ARTERY

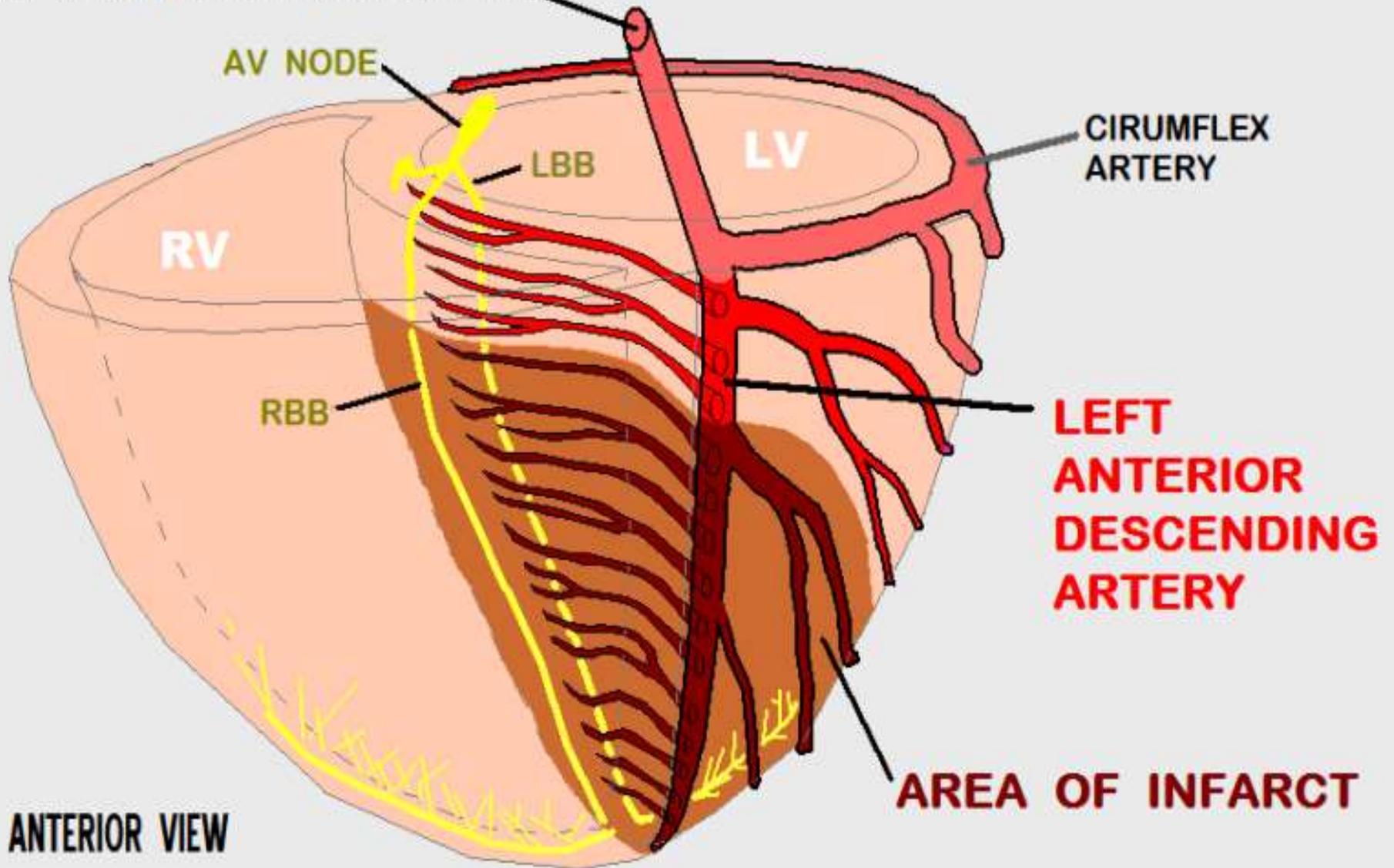
RV

RBB

LEFT ANTERIOR DESCENDING ARTERY

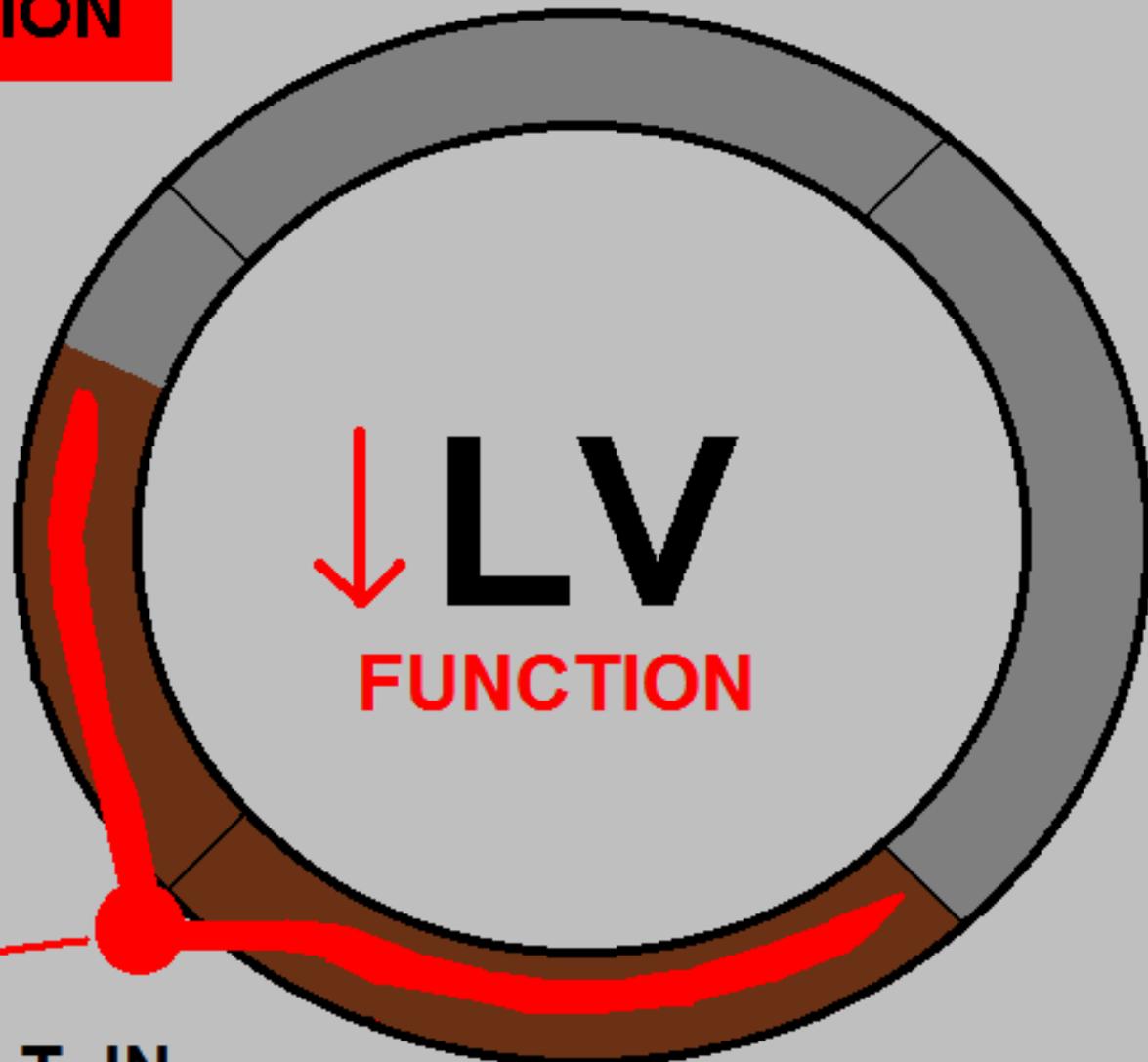
AREA OF INFARCT

ANTERIOR VIEW



LAD DISTRIBUTION

35 - 45 % of LV MUSCLE MASS



A
BLOCKAGE
OF THE
LAD

CAN RESULT IN
LV PUMP FAILURE --



CARDIOGENIC SHOCK
PULMONARY EDEMA



Do not remove this flap until you are ready to use.
Do not use if overwrap has been damaged or
damaged. The overwrap is a barrier and overwrap failure
The inner bag maintains the sterility of the solution.

400 mg Dopamine

(1600 mcg/mL)
Dopamine Hydrochloride
and 5% Dextrose Injection USP

250 mL

Each 100 mL contains 160 mg Dopamine Hydrochloride
USP & 5 g Dextrose Hydrochloride USP, pH adjusted with hydrochloric acid
buffered as a stabilizer. Osmolality 269 mOsmol/L, NaCl
pH 3.5 (2.5 to 4.5). Sterile, nonpyrogenic, single dose container. Dopamine
should not be made to this solution. Dosage instructions
should be made to this solution. Caution: Break
leakage may occur by squeezing the inner bag firmly.
Use only for intravenous solution. A leaky
inner bag may be found. A leaky inner bag
may be found. A leaky inner bag may be found.
Do not use if this solution is clear
and is not darker than slightly yellow.
Rx Only. Recommended storage
Room temperature (25°C). Avoid
excessive heat. Protect from
freezing.

Baxter

Baxter Healthcare Corporation
Deerfield, IL 60015 USA

Made in USA
© Baxter Healthcare Corporation
All rights reserved.

28862
NDC 5228-102-02



500 mg Total
DOBUTamine

Hydrochloride
&
5% Dextrose
(2000 mcg/mL)

250 mL

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LEFT ANTERIOR DESCENDING ARTERY (LAD)

- ANTERIOR WALL OF LEFT VENTRICLE



35 - 45 % OF LEFT VENTRICLE MUSCLE MASS

- SEPTUM, ANTERIOR 2/3

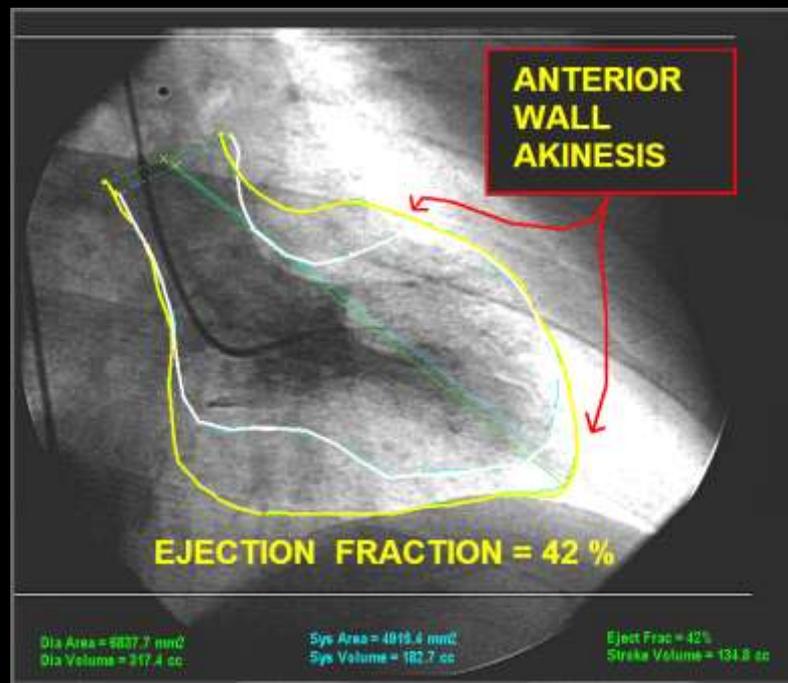
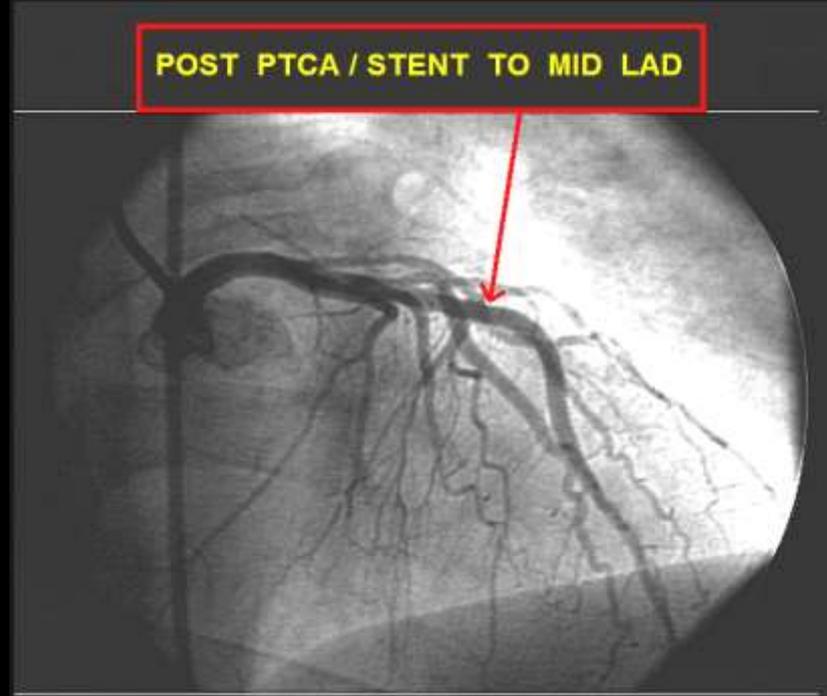
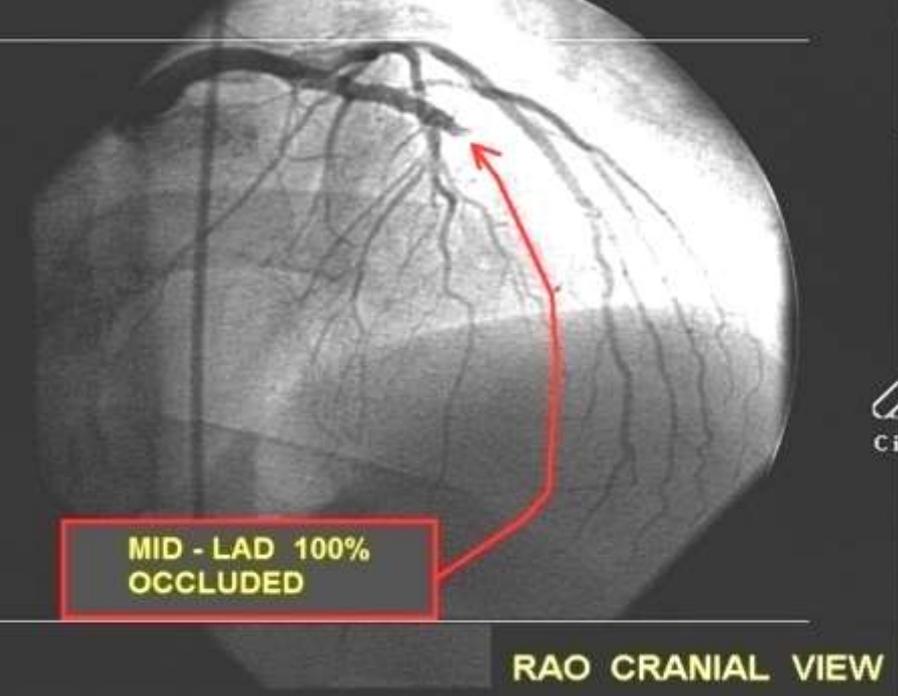


BUNDLE BRANCHES

- ANTERIOR-MEDIAL PAPILLARY MUSCLE

ANTICIPATED COMPLICATIONS of ANTERIOR-SEPTAL WALL STEMI & POSSIBLE INDICATED INTERVENTIONS:

- CARDIAC ARREST	BCLS / ACLS
- CARDIAC DYSRHYTHMIAS (VT / VF)	ACLS (antiarrhythmics)
- PUMP FAILURE with CARDIOGENIC SHOCK	INOTROPE THERAPY: -DOPAMINE / DOBUTAMINE / LEVOPHED - INTRA-AORTIC BALLOON PUMP (use caution with fluid challenges due to PULMONARY EDEMA)
- PULMONARY EDEMA	- CPAP - ET INTUBATION (use caution with diuretics due to pump failure and hypotension)
- 3rd DEGREE HEART BLOCK - NOT RESPONSIVE TO ATROPINE	TRANSCUTANEOUS or TRANSVENOUS PACING



CASE STUDY 2: STEMI

CHIEF COMPLAINT and SIGNIFICANT HISTORY:

46 y/o Female walks into ED TRIAGE, with chief complaint of EPIGASTRIC PAIN, NAUSEA and WEAKNESS. Symptoms have been intermittent for last two days. She was awakened early this morning with the above symptoms, which are now PERSISTENT.

RISK FACTOR PROFILE:

-  FAMILY HISTORY - father died of CAD, older brother had CABG, age 39
-  DIABETES - diet controlled
-  HYPERTENSION

PHYSICAL EXAM: Pt. CAOx4, anxious, SKIN cold, clammy, diaphoretic. No JVD.
Lungs: clear, bilaterally. Heart Sounds: Normal S1, S2.

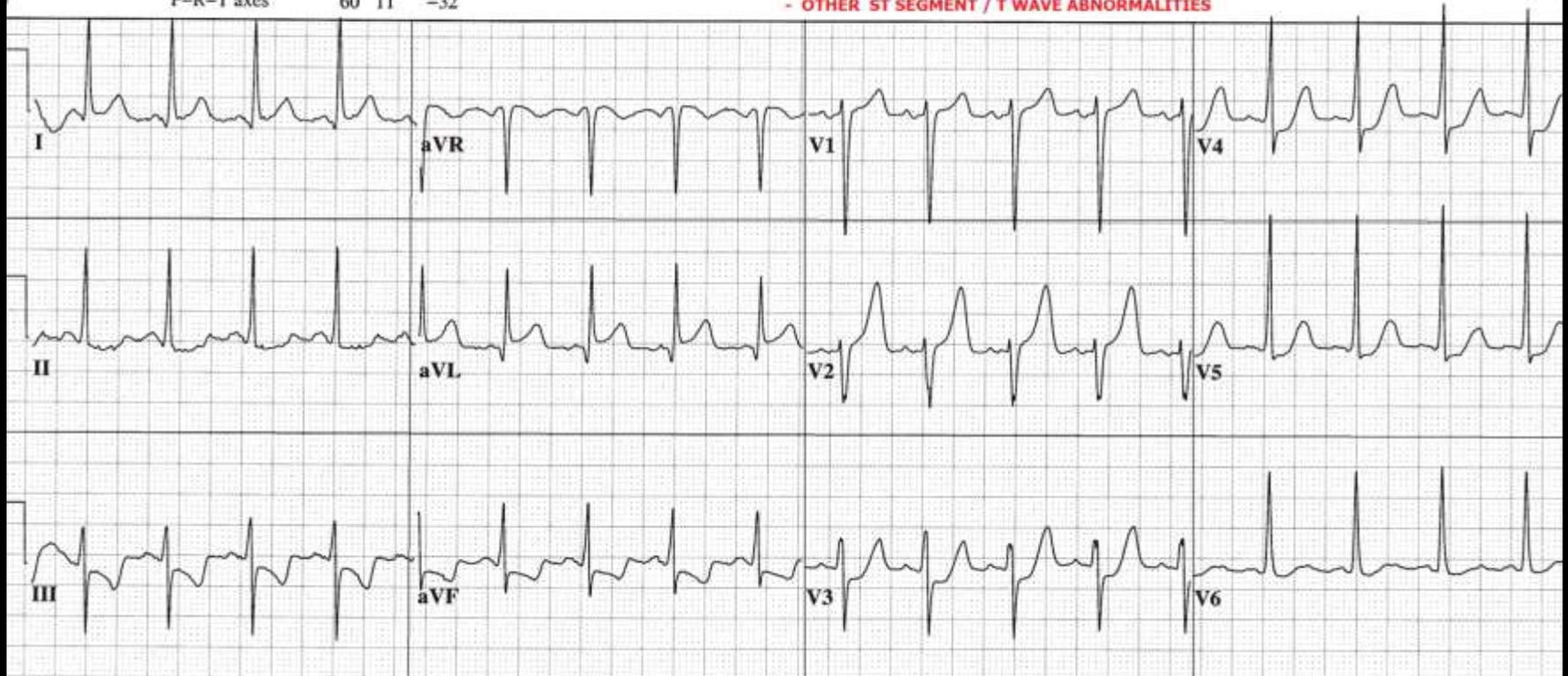
VITAL SIGNS: BP: 168/98, P: 110, R: 24, SAO2: 97% on O2 4 LPM via nasal canula

LABS: TROPONIN ultra = 2.8

46 yr Vent. rate 109 BPM
Female PR interval 132 ms
 QRS duration 82 ms
Room:ER QT/QTc 346/465 ms
 P-R-T axes 60 11 -32

 **EVALUATE EKG for indicators of ACS:**

- ST SEGMENT ELEVATION / DEPRESSION
- HYPERACUTE T WAVES
- CONVEX ST SEGMENTS
- OTHER ST SEGMENT / T WAVE ABNORMALITIES



CASE STUDY QUESTIONS:

NOTE LEADS WITH ST ELEVATION:

NOTE LEADS WITH ST DEPRESSION:

WHAT IS THE SUSPECTED DIAGNOSIS ?

WHAT IS THE "CULPRIT ARTERY" -- if applicable ?

LIST ANY CRITICAL STRUCTURES COMPROMISED:

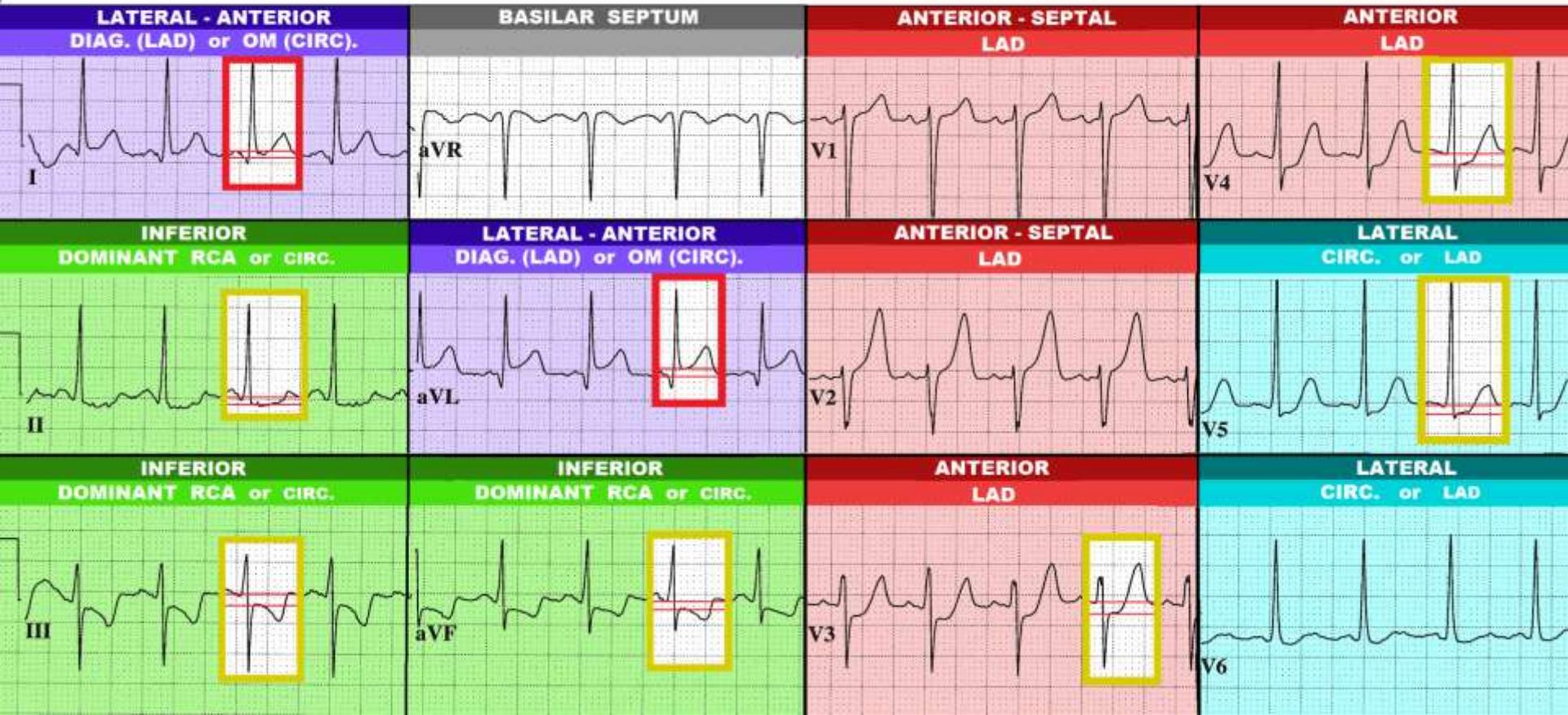
LIST ANY POTENTIAL COMPLICATIONS:

46 yr Female
 Room:ER
 Vent. rate 109 BPM
 PR interval 132 ms
 QRS duration 82 ms
 QT/QTc 346/465 ms
 P-R-T axes 60 11 -32

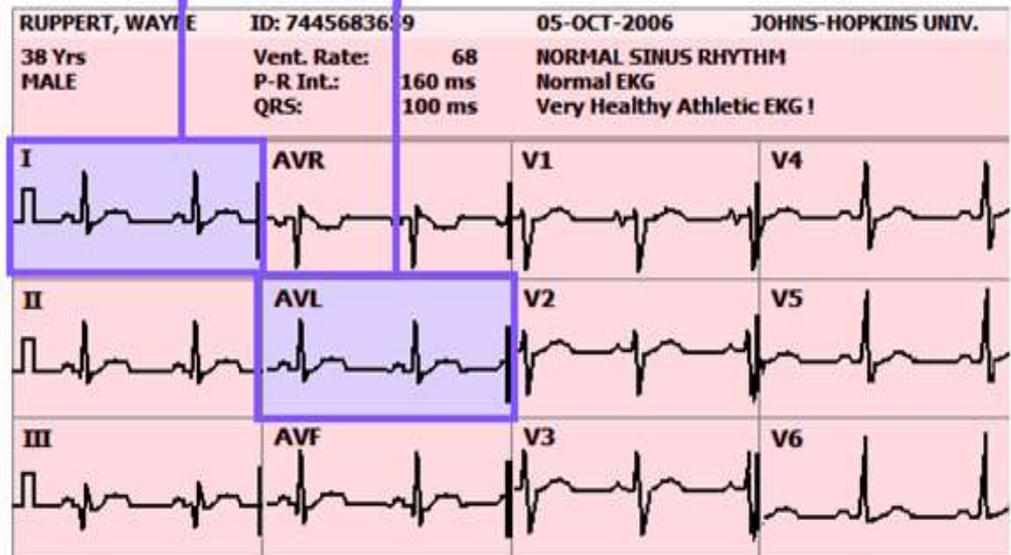
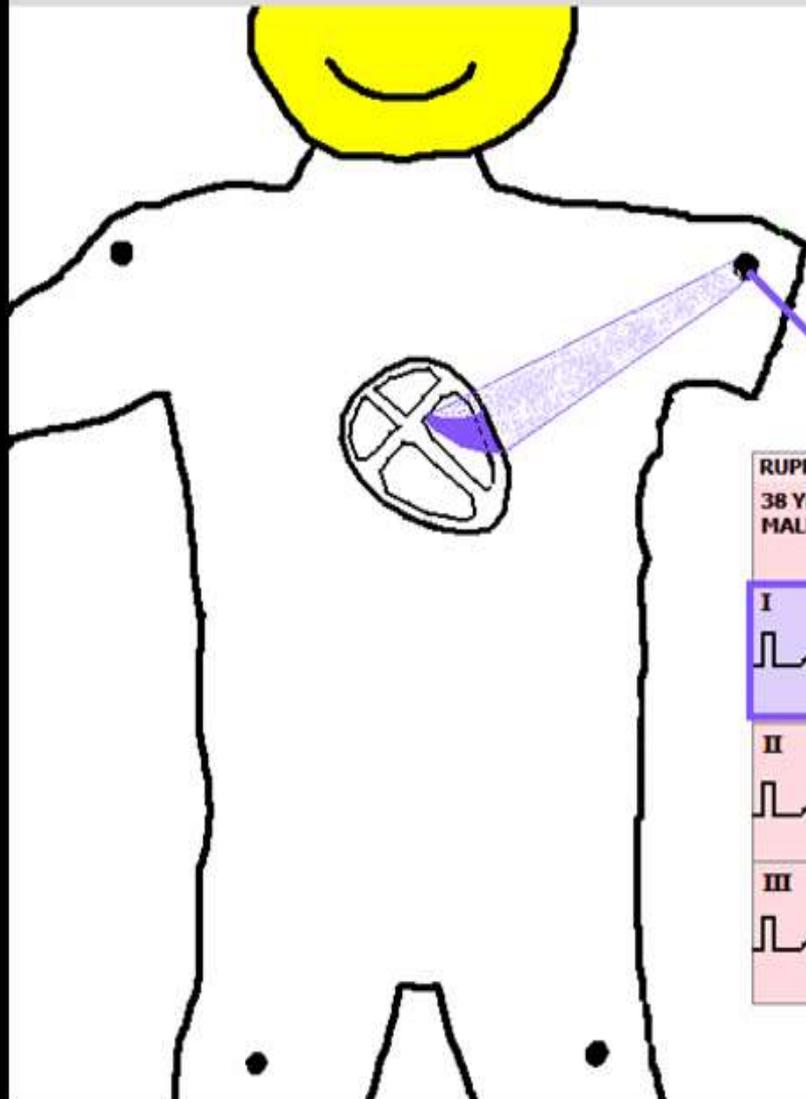
Sinus tachycardia
 Left ventricular hypertrophy with repolarization abnormality
 ST elevation consider lateral injury or acute infarct
 ***** ACUTE MI *****

ST SEGMENT ELEVATION

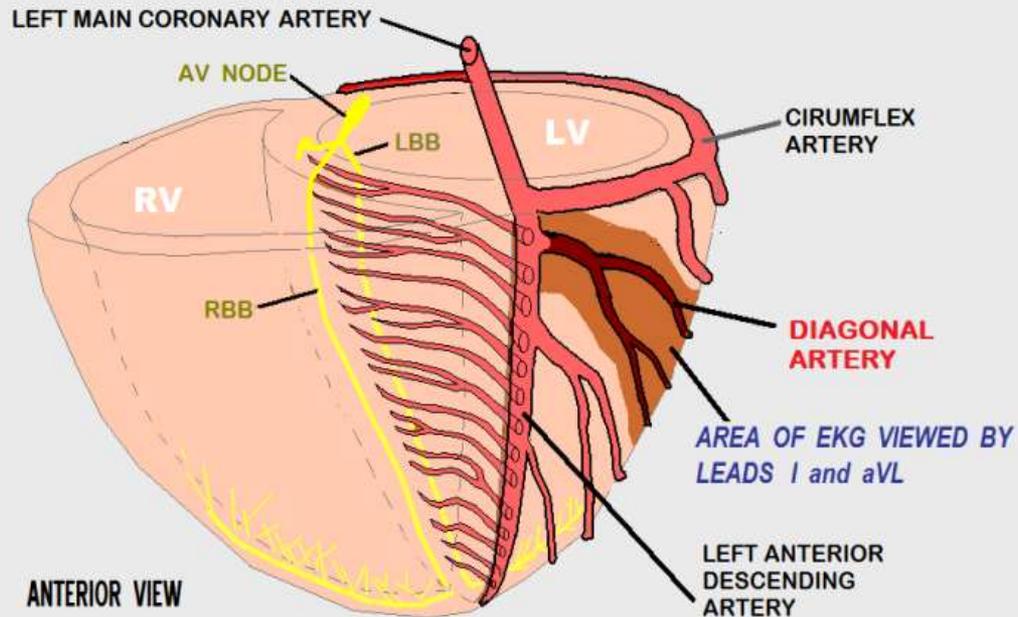
ST SEGMENT DEPRESSION



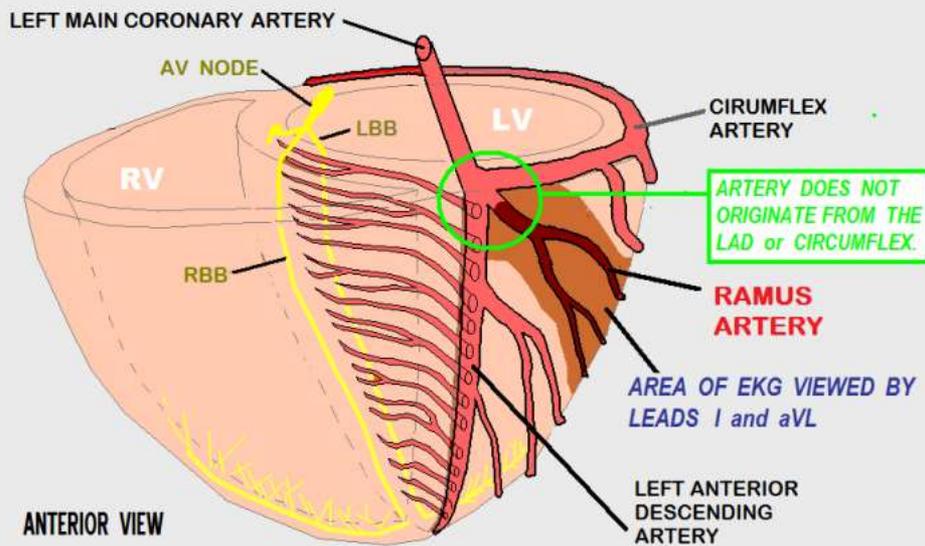
LEADS I and aVL view the ANTERIOR-LATERAL JUNCTION



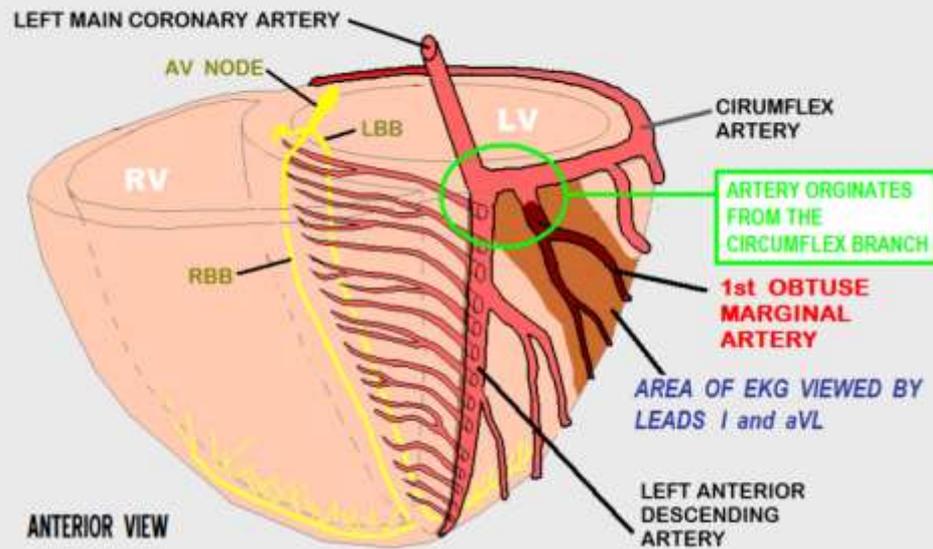
OCCUSION of DIAGONAL ARTERY



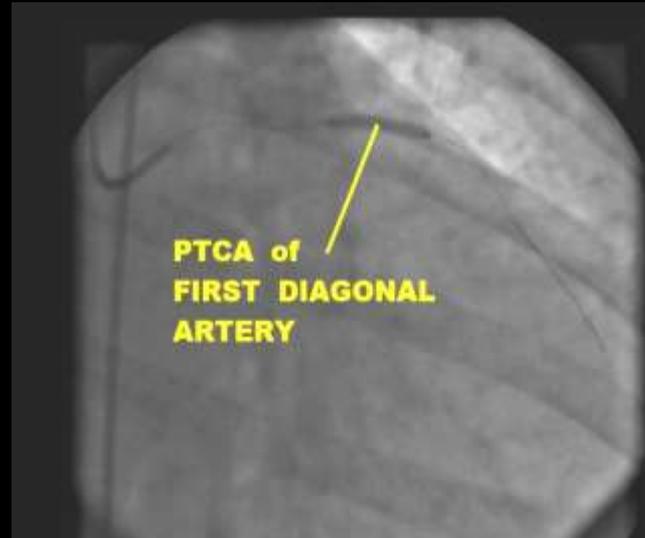
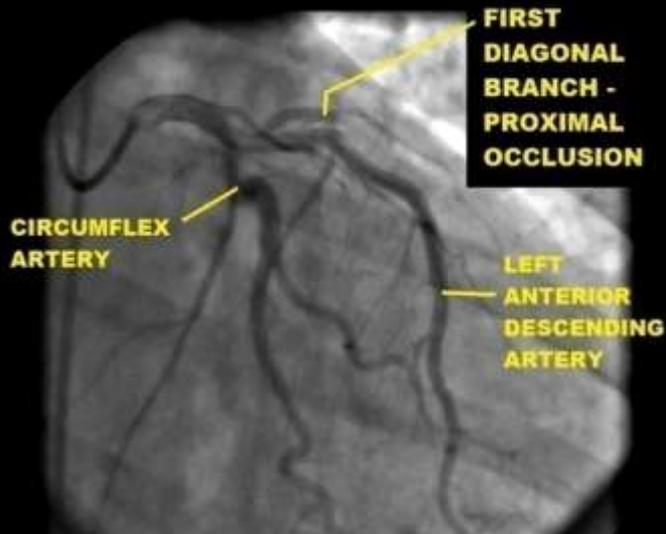
OCCUSION of RAMUS ARTERY



OCCUSION of OBTUSE MARGINAL ARTERY



CASE PROGRESSION: As the patient was being prepared for transport to the Cardiac Cath Lab, she experienced an episode of Ventricular Fibrillation.



11111111
Born 1/ 1941 77 Years

Acct# [REDACTED] MR# [REDACTED]
ONIER VILLARREAL
Adm: [REDACTED] 2018 DOB: [REDACTED]
SEVEN RIVERS RMC

3/16/2018 1:31:57 PM
Seven Rivers Reg al

Rate 69 . SINUS RHYTHMnormal P axis, V-rate 50- 99 Room: er11
LEFT ATRIAL ABNORMALITY.....P,P' >60mS, <-0.15mV V1
PR 180 . LEFT ANTERIOR FASCICULAR BLOCK.....axis(240,-40), init forces inf
QRS 94
QT 436
QTc 467

--AXIS--

P 56
QRS -51
T -7

- ABNORMAL ECG -

12 Lead; Standard Placement

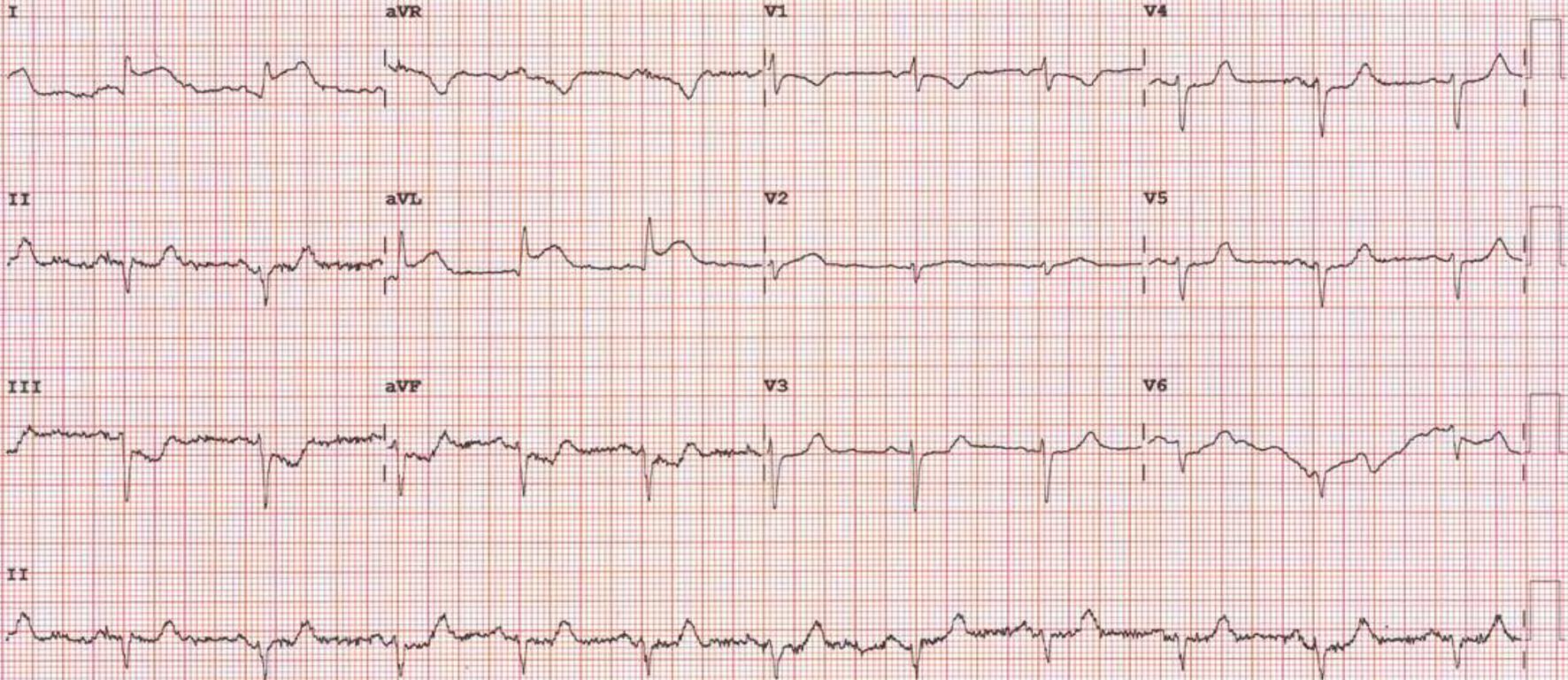
Unconfirmed Diagnosis

Physician
Date
Time
STEMI

1331

YES

NO



Device: Speed: 25 mm/sec Limb: 10 mm/mV Chest: 10.0 mm/mV

F 60~ 0.15-100 Hz PH090A L P?

11111111
Born 1/ 1941 77 Years

Acct# [REDACTED] MR# [REDACTED]
ONIER VILLARREAL
Adm: [REDACTED] 2018 DOB: [REDACTED]
SEVEN RIVERS RMC

3/16/2018 1:31:57 PM
Seven Rivers Reg al

Rate 69 . SINUS RHYTHMnormal P axis, V-rate 50- 99 Room: er11
LEFT ATRIAL ABNORMALITY.....P, P' >60ms, <-0.15mV V1
PR 180 . LEFT ANTERIOR FASCICULAR BLOCK.....axis(240,-40), init forces inf
QRSD 94 . LATERAL INJURY, PROBABLE EARLY ACUTE INFARCT.....ST >0.10mV, I aVL V5 V6
QT 436
QTc 467

--AXIS--

P 56
QRS -51
T -7

12 Lead; Standard Placement

ST Elevation Leads I & AVL

- ABNORMAL ECG -

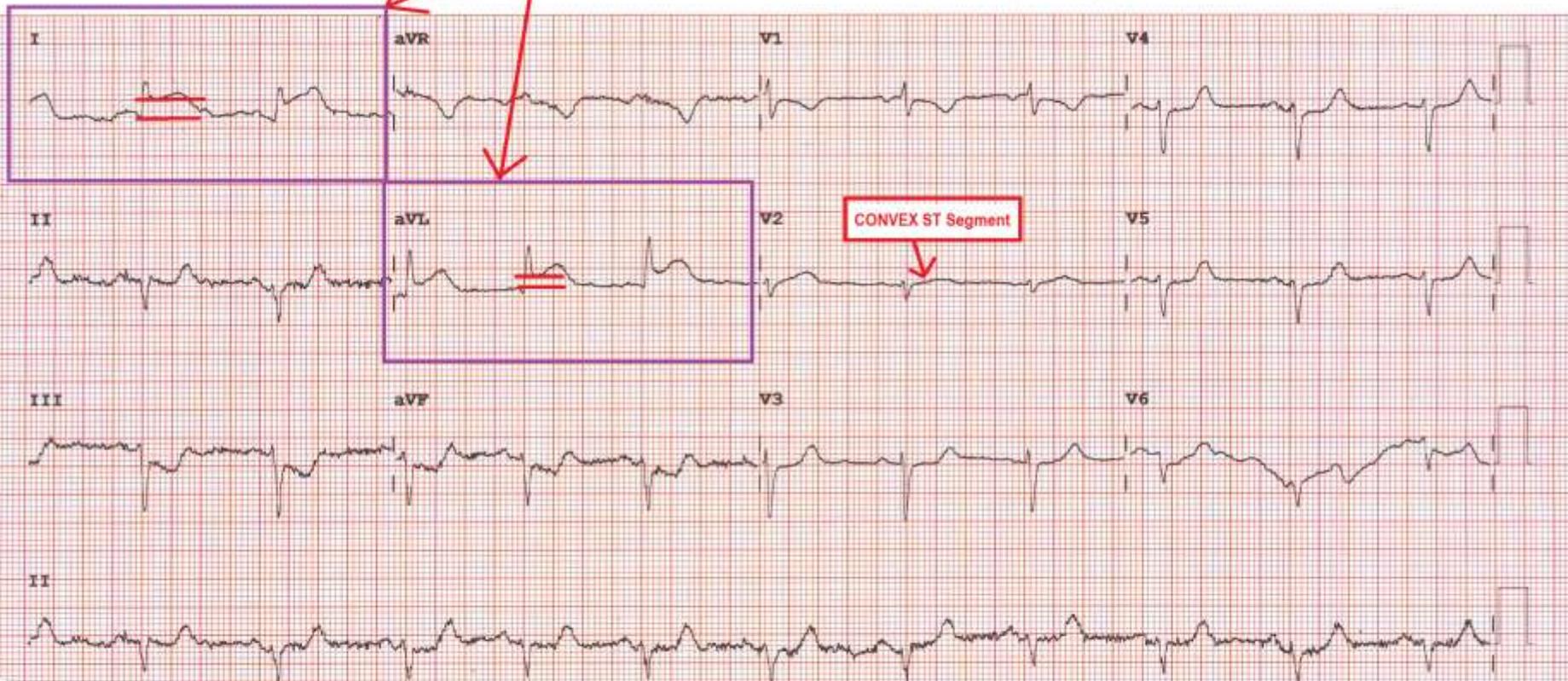
Unconfirmed Diagnosis

Physician
Date
Time
STEMI

1331

YES

NO



Device: Speed: 25 mm/sec Limb: 10 mm/mV Chest: 10.0 mm/mV

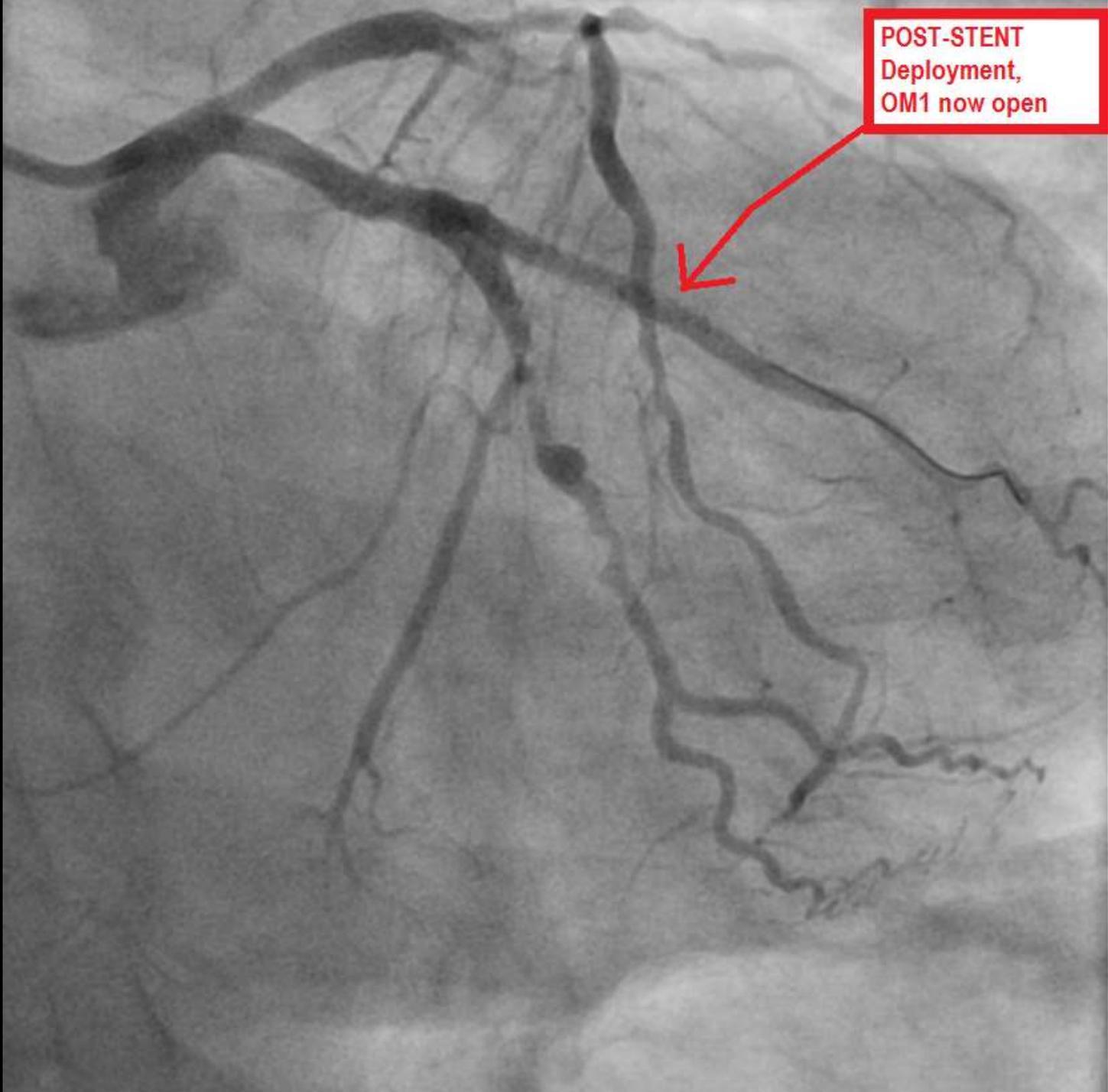
F 60~ 0.15-100 Hz PH090A L P2

OM 1 100%
occluded proximally





POST-STENT
Deployment,
OM1 now open



CASE STUDY SUMMARY

ST ELEVATION:

I, aVL

ST DEPRESSION:

II, III, aVF, V3 - V5

SUSPECTED DIAGNOSIS:

ACUTE LATERAL WALL M.I.

SUSPECTED "CULPRIT ARTERY" (if applicable):

USUALLY ONE OF THE SMALLER SIDE-BRANCH ARTERIES:

1. **DIAGONAL ARTERY.** (This is a side-branch artery off of the **LEFT ANTERIOR DESCENDING (LAD)** artery.)
2. **OBTUSE MARGINAL ARTERY.** (This is a side-branch artery off of the **CIRCUMFLEX** artery)
3. **RAMUS ARTERY.**

IMMEDIATE CONCERNS FOR ALL STEMI PATIENTS:

- **BE PREPARED TO MANAGE SUDDEN CARDIAC ARREST (PRIMARY V-FIB / V-TACH, BRADYCARDIAS / HEART BLOCKS)**
- **STAT REPERFUSION THERAPY: THROMBOLYTICS vs. CARDIAC CATHETERIZATION and PCI**
- **CONSIDER NEEDS FOR ANTI-PLATELET and ANTI-COAGULATION THERAPY**

CRITICAL STRUCTURES COMPROMISED:



**15-30% of the LV
MUSCLE MASS**

POTENTIAL COMPLICATIONS:

**POSSIBLE MODERATE
LV PUMP FAILURE**

POSSIBLE CRITICAL INTERVENTIONS:

**INOTROPIC AGENTS
ET INTUBATION
I.A.B.P. INSERTION**

CASE STUDY 3: STEMI

CHIEF COMPLAINT and SIGNIFICANT HISTORY:

29 y/o male presents to the ER c/o "HEAVY CHEST PRESSURE" x 30 minutes. The patient states he was playing football with friends after eating a large meal. Pt. also c/o nausea. Denies DIB.

RISK FACTOR PROFILE:

-  FAMILY HISTORY - father died of MI age 46
-  CURRENT CIGARETTE SMOKER
-  "MILD" HYPERTENSION - untreated
- CHOLESTEROL - unknown - "never had it checked."

PHYSICAL EXAM: Patient alert, oriented X 4, skin cool, dry, pale. Patient restless. No JVD, Lungs clear bilaterally. Heart sounds normal S1, S2. No peripheral edema.

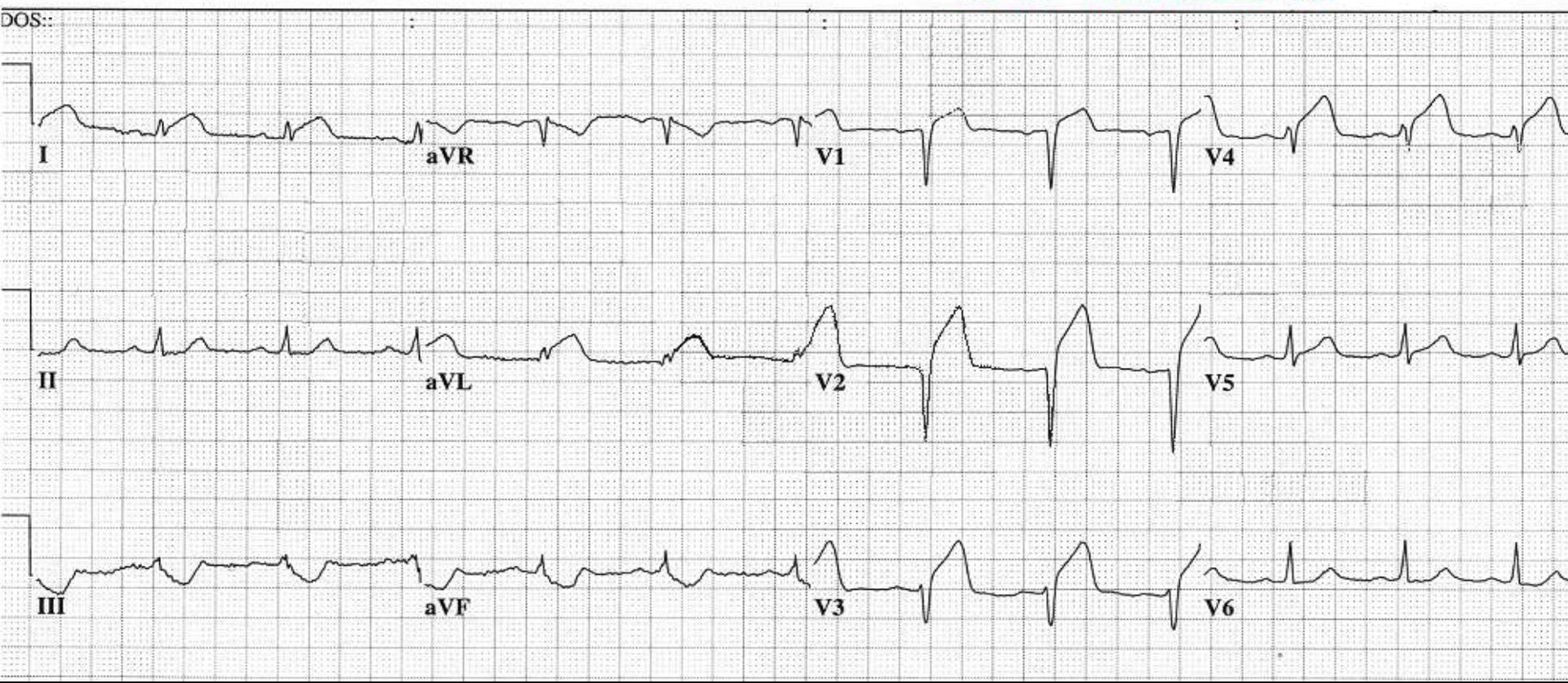
VITAL SIGNS: BP: 104/78, P: 76, R: 20, SAO2: 96%

LABS: INITIAL CARDIAC MARKERS - NEGATIVE

29 yr
Male Caucasian
Loc:3 Option:20

Vent. rate 75 BPM
PR interval 176 ms
QRS duration 90 ms
QT/QTc 362/404 ms
P-R-T axes 70 50 -11 14:07 Hours

EVALUATE the EKG for signs of ACS:
- ST SEGMENT ELEVATION / DEPRESSION
- HYPERACUTE T WAVES
- CONVEX / FLAT ST SEGMENTS
- OTHER ST - T WAVE ABNORMALITIES



29 yr
Male

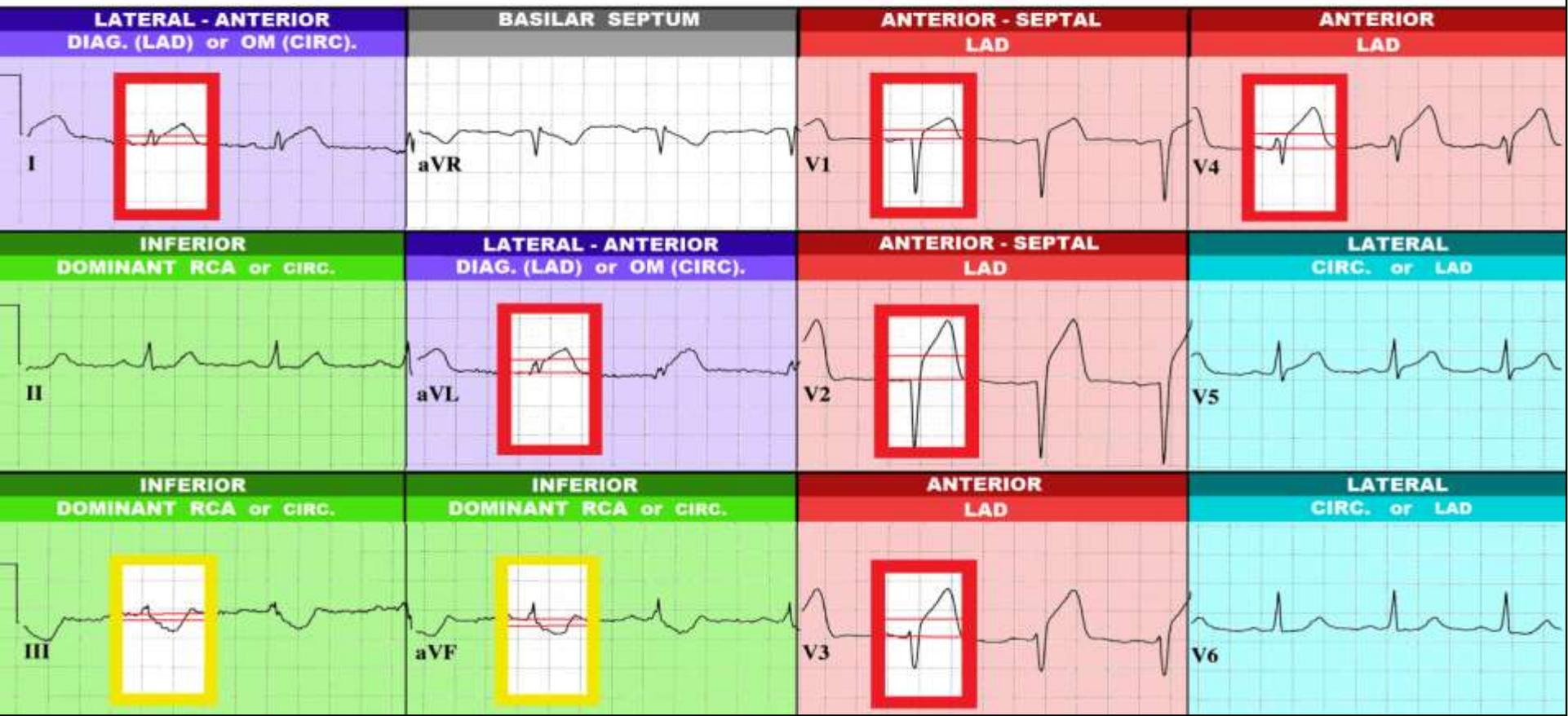
Caucasian

Vent. rate	75	BPM
PR interval	176	ms
QRS duration	90	ms
QT/QTc	362/404	ms
P-R-T axes	70 50	-11

Normal sinus rhythm
 Septal infarct, possibly acute
 Anterolateral injury pattern
 ***** ACUTE MI *****
 Abnormal ECG

ST SEGMENT ELEVATION

ST SEGMENT DEPRESSION



The difference between the current and previous ANTERIOR WALL STEMI case studies is that in THIS case study, RECIPROCAL ST DEPRESSION is present in the Inferior Leads, II, III and AVF.

In the PREVIOUS case study, there was NO RECIPROCAL ST DEPRESSION.

Here is the reason

When Reciprocal S-T Segment Depression is noted on the 12 Lead ECG during STEMI, it is a fairly reliable indicator that the lesion is located in the PROXIMAL aspect of the affected CORONARY ARTERY.

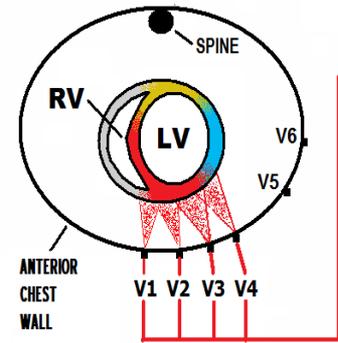
When Reciprocal S-T Segment Depression is noted on the 12 Lead ECG during STEMI, it is a fairly reliable indicator that the lesion is located in the PROXIMAL aspect of the affected CORONARY ARTERY.

In general terms, when the lesion is located more proximally, the zone of infarction is more extensive, and the complications (pump failure, cardiogenic shock) are often more profound.

- **Reciprocal ST Depression is NOW PRESENT**
- **Additional ST Elevation is present in Leads I, AVL**

V1 - V4 VIEW THE ANTERIOR-SEPTAL WALL of the LEFT VENTRICLE

V1, V2 - ANTERIOR / SEPTAL
V3, V4 - ANTERIOR



RUPPERT, WAYNE		ID: 7445683659	05-OCT-2006	JOHNS-HOPKINS UNIV.
38 Yrs	MALE	Vent. Rate: 68	P-R Int.: 160 ms	QRS: 100 ms
		NORMAL SINUS RHYTHM Normal EKG Very Healthy Athletic EKG!		
I	AVR	V1	V4	
II	AVL	V2	V5	
III	AVF	V3	V6	

+

Leads I & AVL view the ANTERIOR-LATERAL JUNCTION

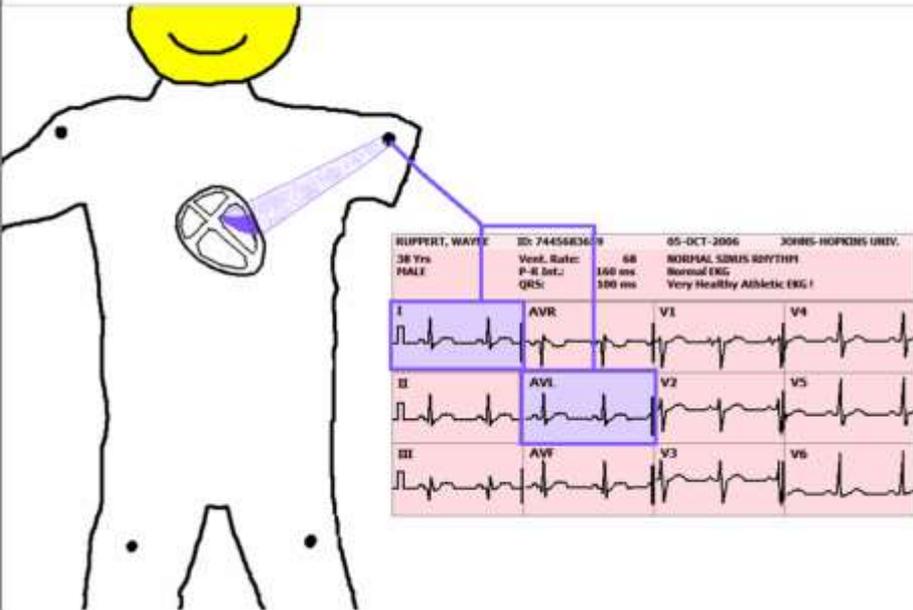


RUPPERT, WAYNE		ID: 7445683659	05-OCT-2006	JOHNS-HOPKINS UNIV.
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III	AVF	V3	V6	

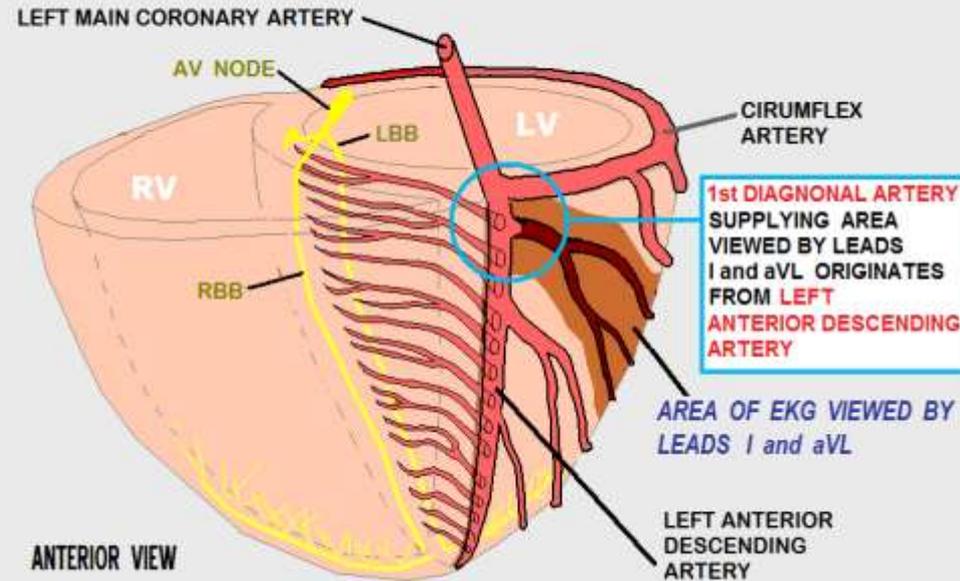
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29 yr Male	Caucasian	Vent. rate PR interval QRS duration QT/QTc P-R-T axes	75 176 90 362/404 70 50 -11	BPM ms ms ms ms	Normal sinus rhythm Septal infarct, possibly acute Anterolateral injury pattern ***** ACUTE MI ***** Abnormal ECG	ST SEGMENT ELEVATION	ST SEGMENT DEPRESSION
LATERAL - ANTERIOR DIAG. (LAD) or OM (CIRC).	BASILAR SEPTUM	ANTERIOR - SEPTAL LAD	ANTERIOR LAD	I	aVR	V1	V4
INFERIOR DOMINANT RCA or CIRC.	LATERAL - ANTERIOR DIAG. (LAD) or OM (CIRC).	ANTERIOR - SEPTAL LAD	LATERAL CIRC. or LAD	II	aVL	V2	V5
INFERIOR DOMINANT RCA or CIRC.	INFERIOR DOMINANT RCA or CIRC.	ANTERIOR LAD	LATERAL CIRC. or LAD	III	aVF	V3	V6

Leads I & aVL view the ANTERIOR-LATERAL JUNCTION

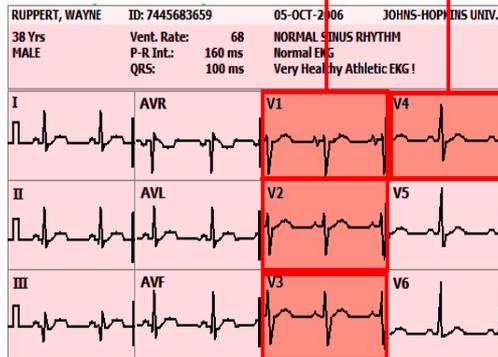
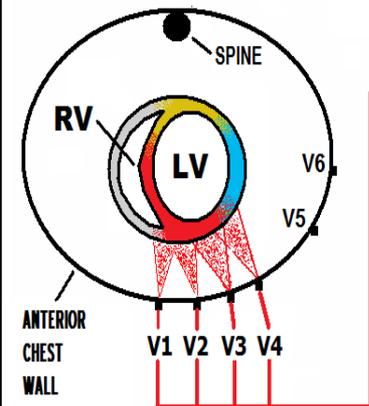


OCCUSION of DIAGONAL ARTERY

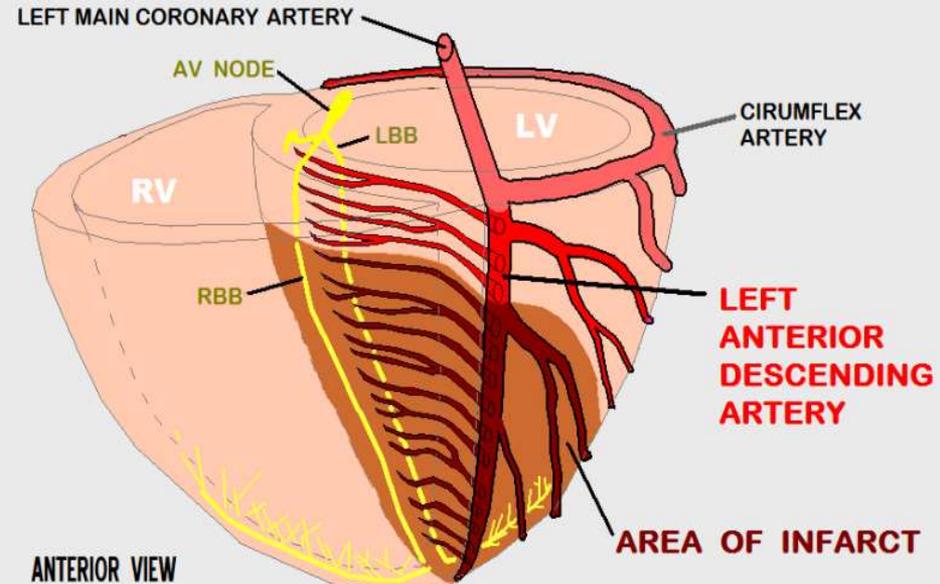


V1 - V4 VIEW THE ANTERIOR-SEPTAL WALL of the LEFT VENTRICLE

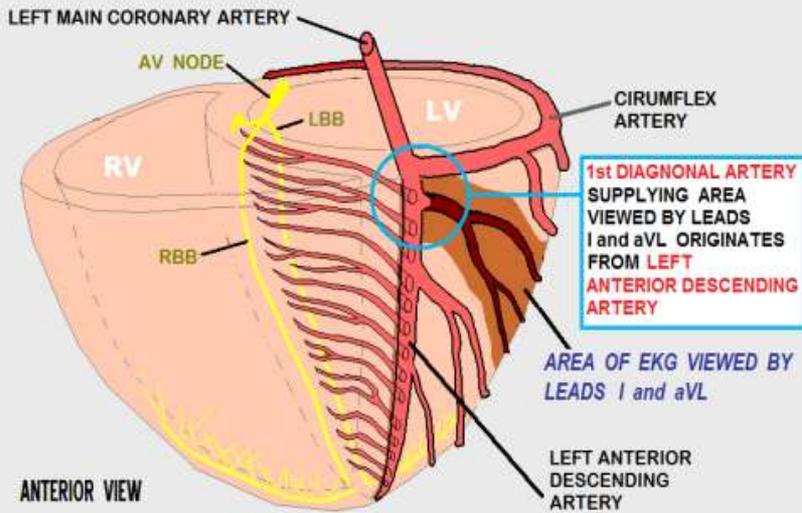
V1, V2 - ANTERIOR / SEPTAL
V3, V4 - ANTERIOR



OCCUSION of MID - LEFT ANTERIOR DESCENDING ARTERY

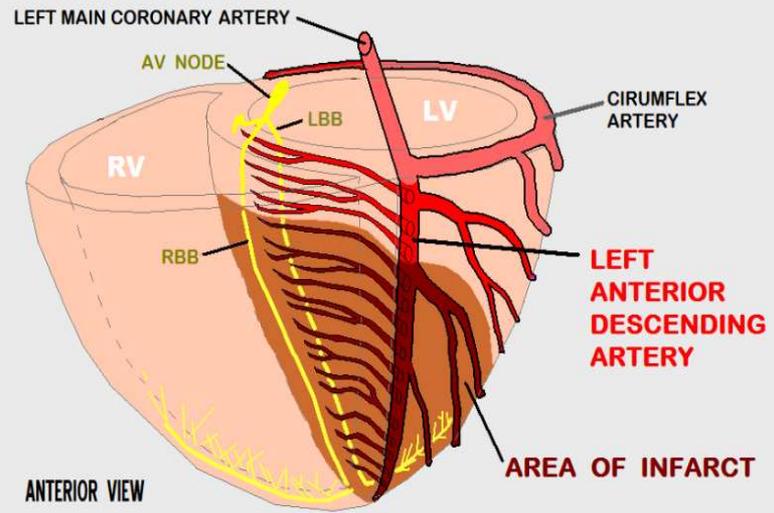


OCCLUSION of DIAGONAL ARTERY



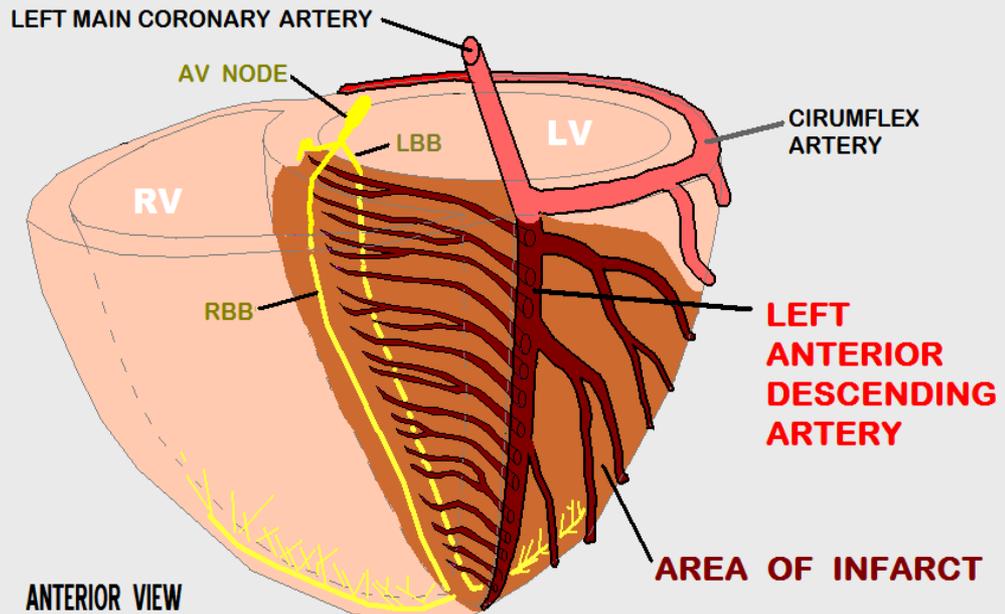
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OCCLUSION of MID - LEFT ANTERIOR DESCENDING ARTERY



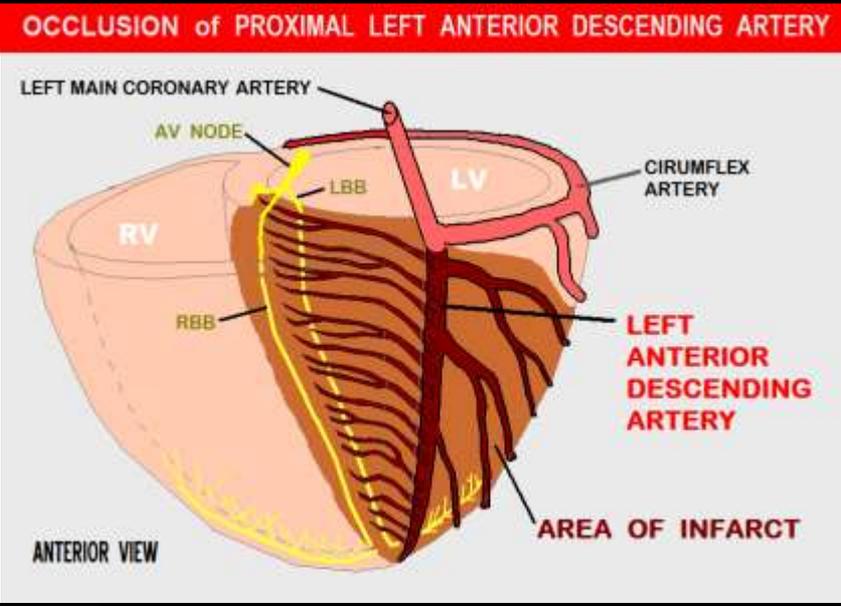
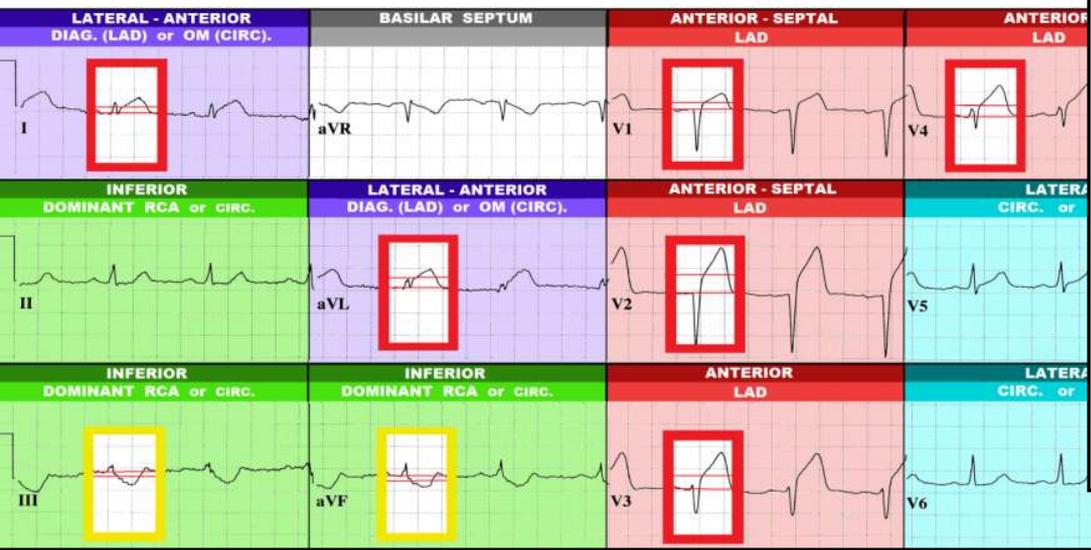
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OCCLUSION of PROXIMAL LEFT ANTERIOR DESCENDING ARTERY



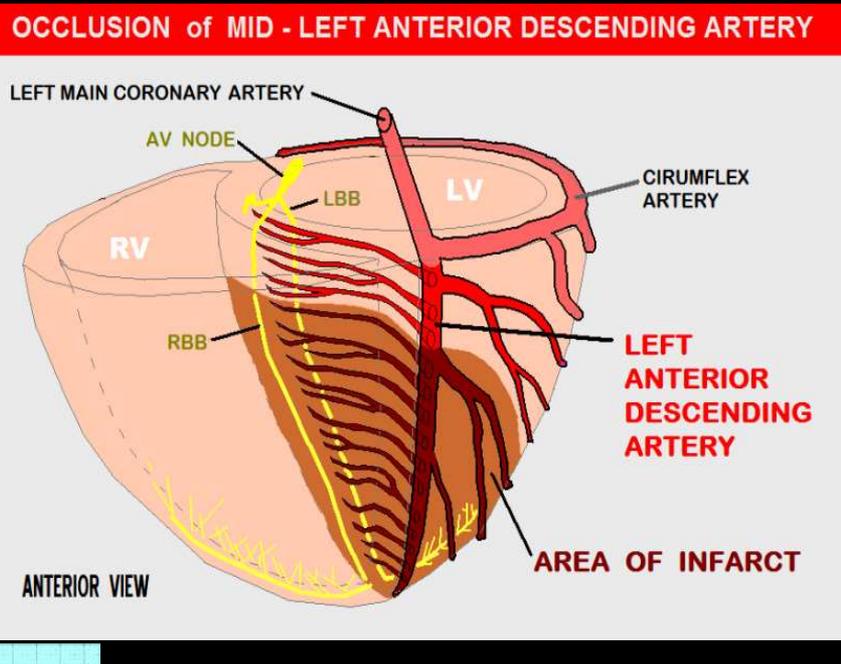
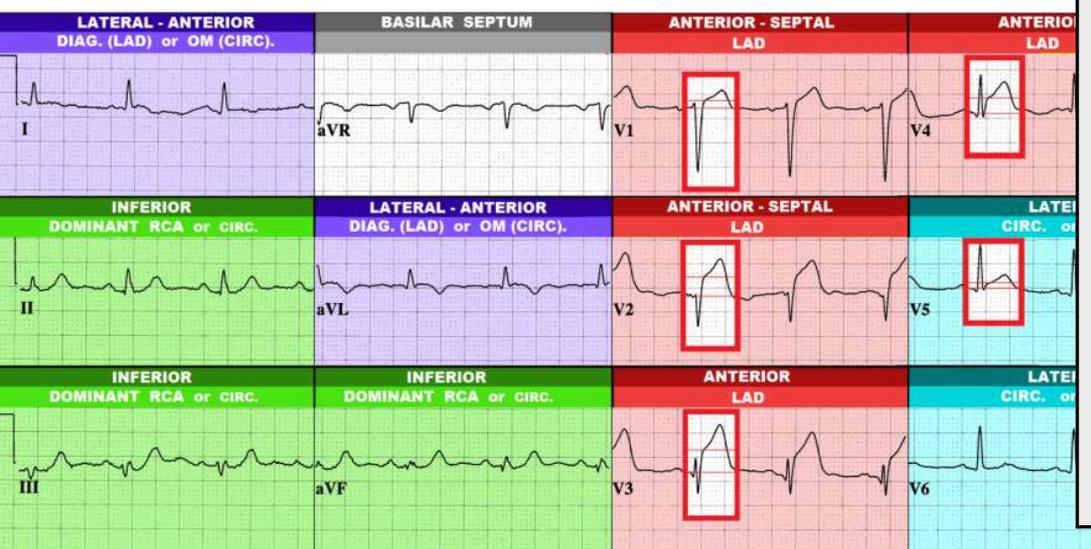
29 yr Male Caucasian Vent. rate 75 BPM Normal sinus rhythm
 PR interval 176 ms Septal infarct, possibly acute
 QRS duration 90 ms Anterolateral injury pattern
 QT/QTc 362/404 ms ***** ACUTE MI *****
 P-R-T axes 70 50 -11 Abnormal ECG

ST SEGMENT ELEVATION
 ST SEGMENT DEPRESSION



72 yr Male Caucasian Vent. rate 75 BPM Normal sinus rhythm
 PR interval 162 ms Anteroseptal infarct, possibly acute
 QRS duration 98 ms ***** ACUTE MI *****
 QT/QTc 382/426 ms Abnormal ECG
 P-R-T axes 72 13 83

ST SEGMENT ELEVATION



OCCLUSION of PROXIMAL LEFT ANTERIOR DESCENDING ARTERY

LEFT MAIN CORONARY ARTERY

AV NODE

LBB

LV

CIRUMFLEX ARTERY

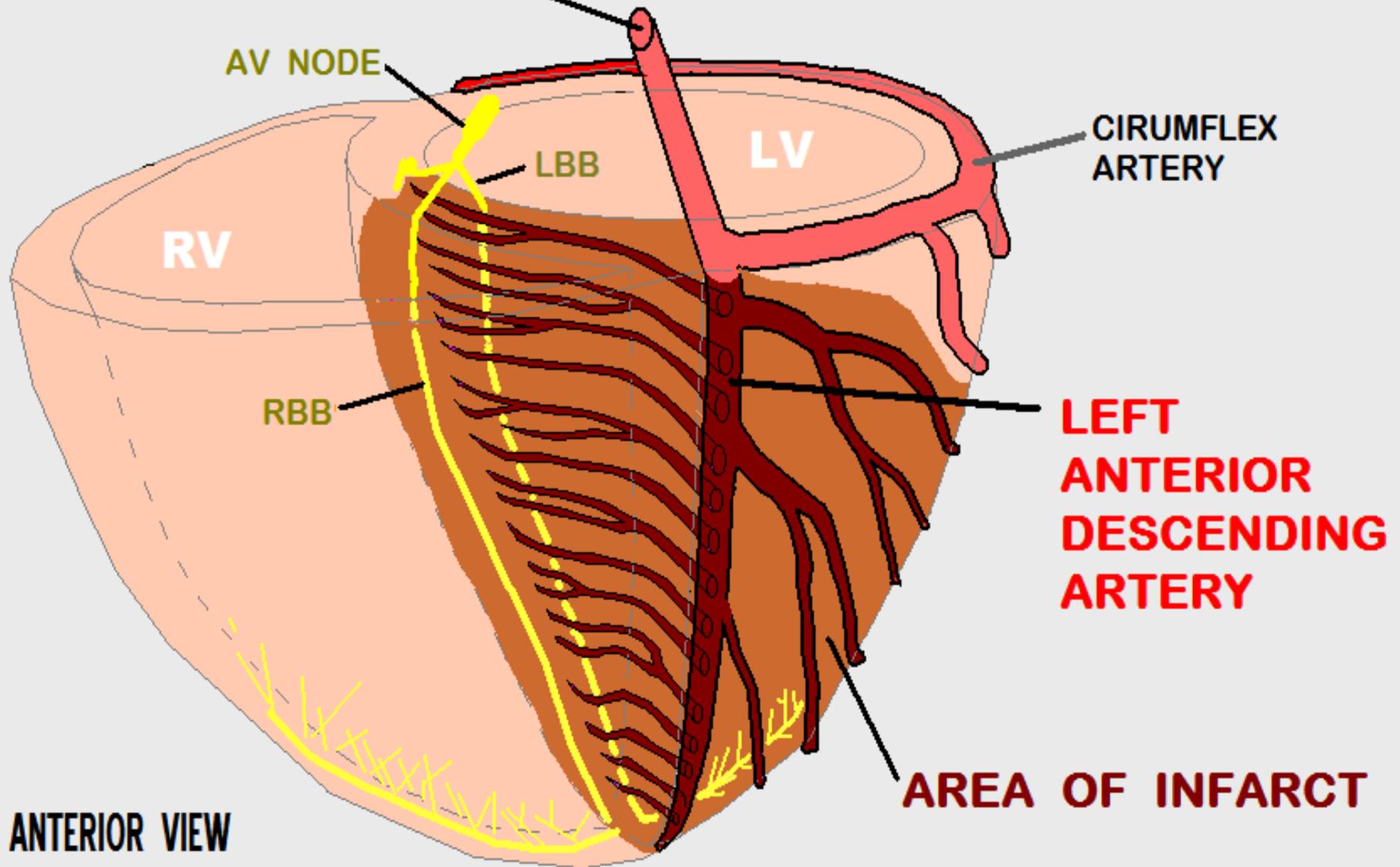
RV

RBB

LEFT ANTERIOR DESCENDING ARTERY

AREA OF INFARCT

ANTERIOR VIEW

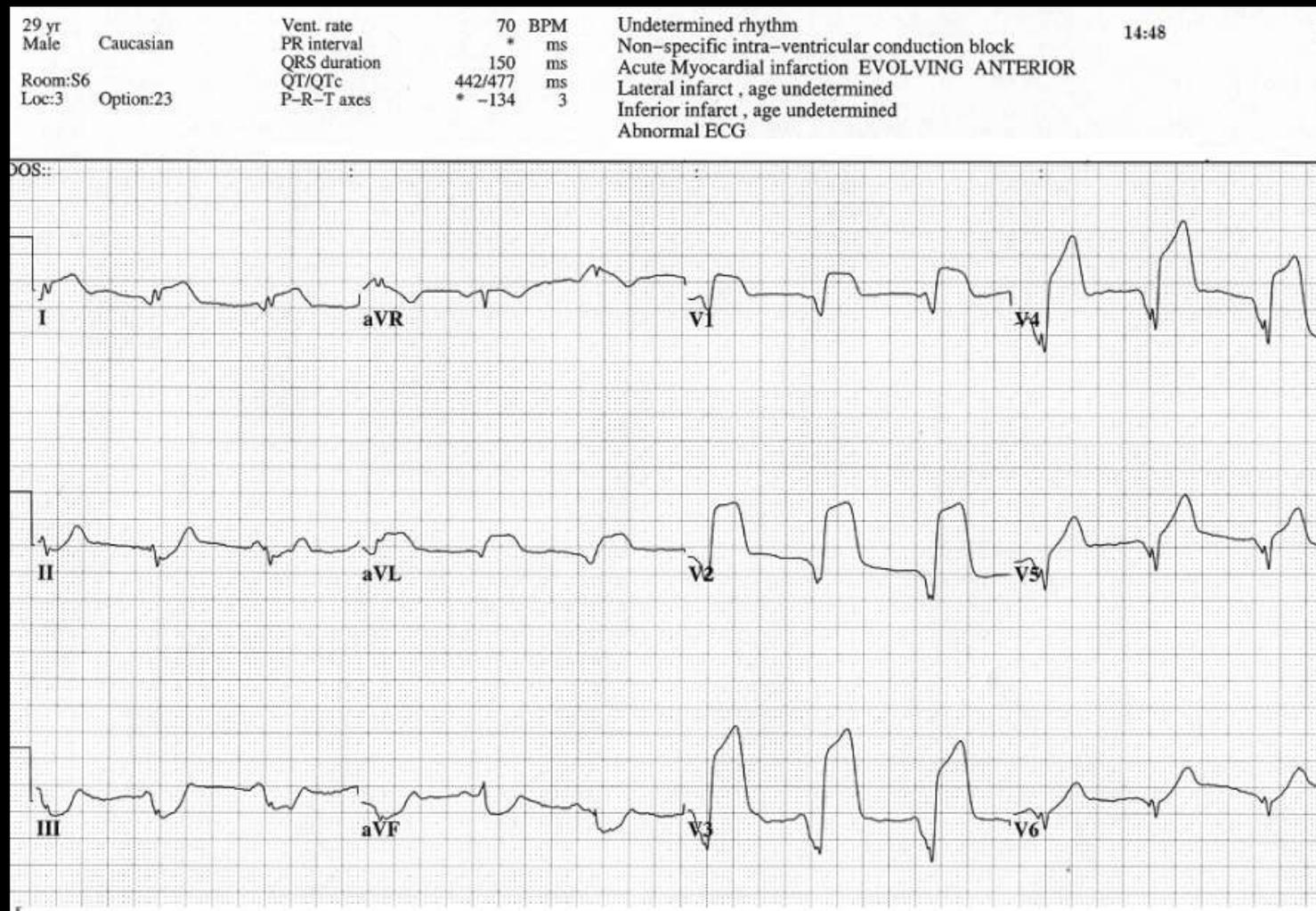


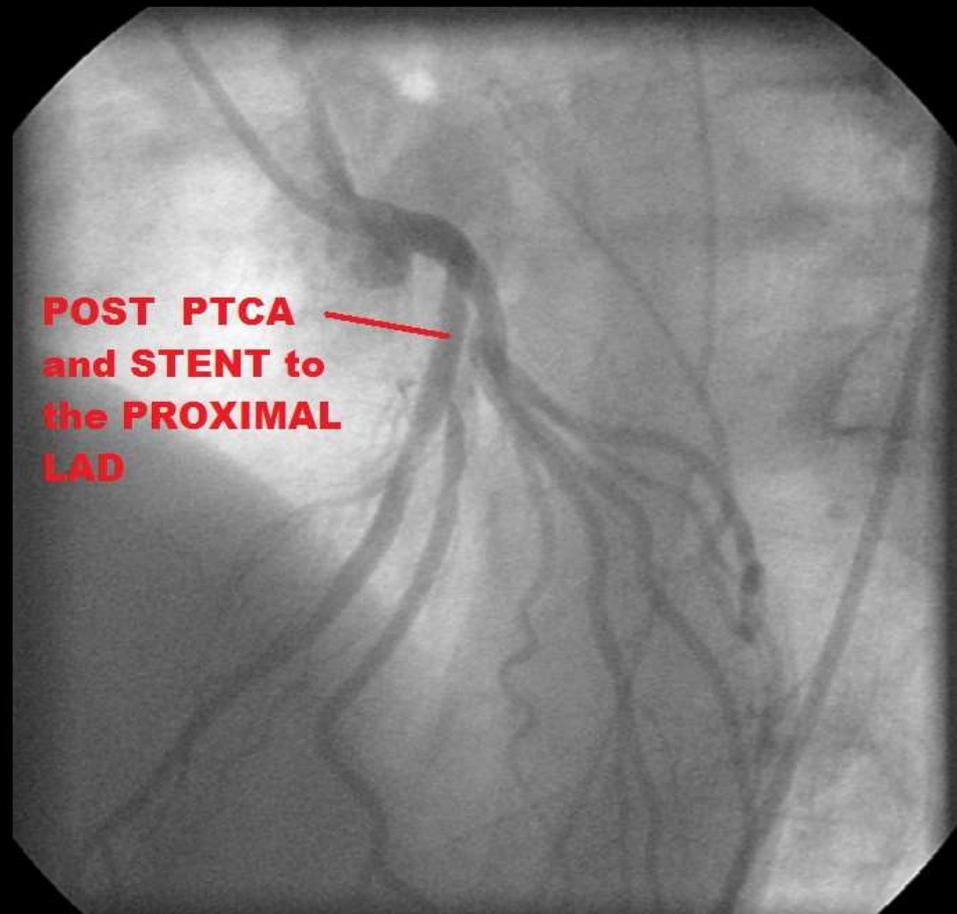
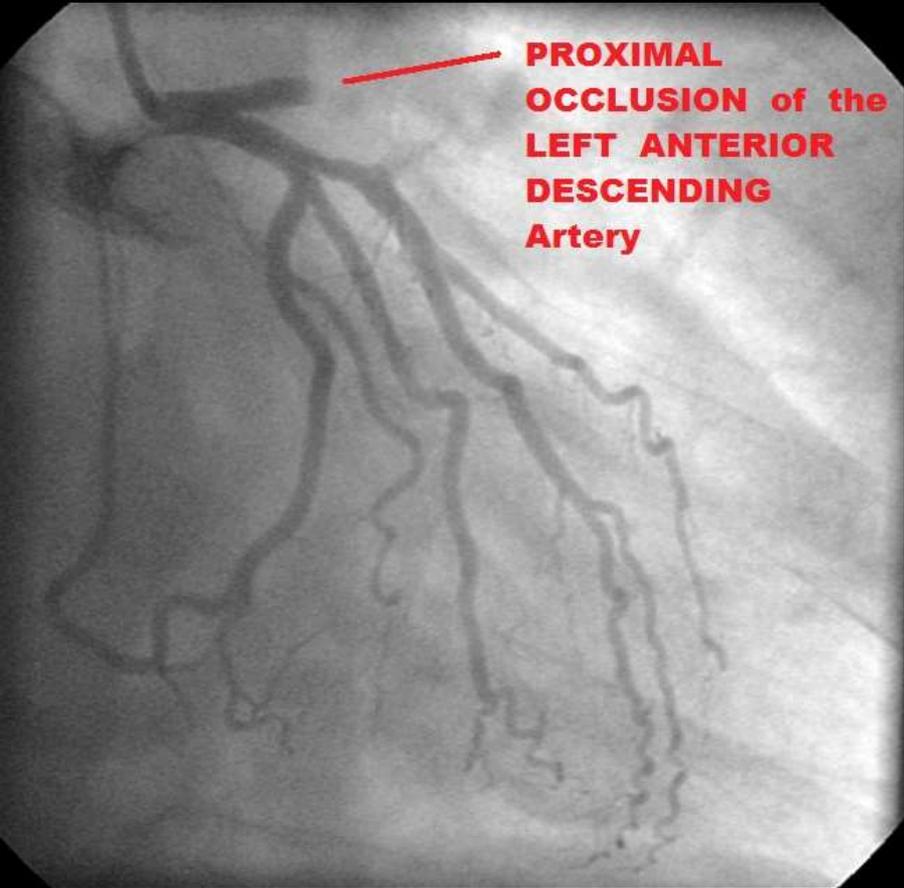
ANTICIPATED COMPLICATIONS of ANTERIOR-SEPTAL WALL STEMI & POSSIBLE INDICATED INTERVENTIONS:

- CARDIAC ARREST	BCLS / ACLS
- CARDIAC DYSRHYTHMIAS (VT / VF)	ACLS (antiarrhythmics)
- PUMP FAILURE with CARDIOGENIC SHOCK	INOTROPE THERAPY: -DOPAMINE / DOBUTAMINE / LEVOPHED - INTRA-AORTIC BALLOON PUMP (use caution with fluid challenges due to PULMONARY EDEMA)
- PULMONARY EDEMA	- CPAP - ET INTUBATION (use caution with diuretics due to pump failure and hypotension)
- 3rd DEGREE HEART BLOCK - NOT RESPONSIVE TO ATROPINE	TRANSCUTANEOUS or TRANSVENOUS PACING

WHILE AWAITING THE CATH TEAM, THE PATIENT BEGAN VOMITING. SKIN BECAME ASHEN & DIAPHORETIC. REPEAT BP = 50/30.

-WHAT THERAPEUTIC INTERVENTIONS SHOULD BE IMPLEMENTED AT THIS POINT ?





CASE STUDY 4: CRITICAL DECISIONS SCENARIO

As per current AHA recommendations, your hospital's policy is to send every STEMI patient to the Cardiac Catheterization Lab for emergency PCI.

You are the ranking medical officer on duty in the ED when two acute STEMI patients arrive, ten minutes apart. The Cath Lab has one lab open, and can take ONE patient immediately. Both patients duration of symptoms and state of hemodynamic stability are similar.

PATIENT A:

44 y/o MALE, CHEST PAIN x 1 HOUR,
BP: 78/46, P: 70, R: 28. CARDIAC MARKERS: NEGATIVE

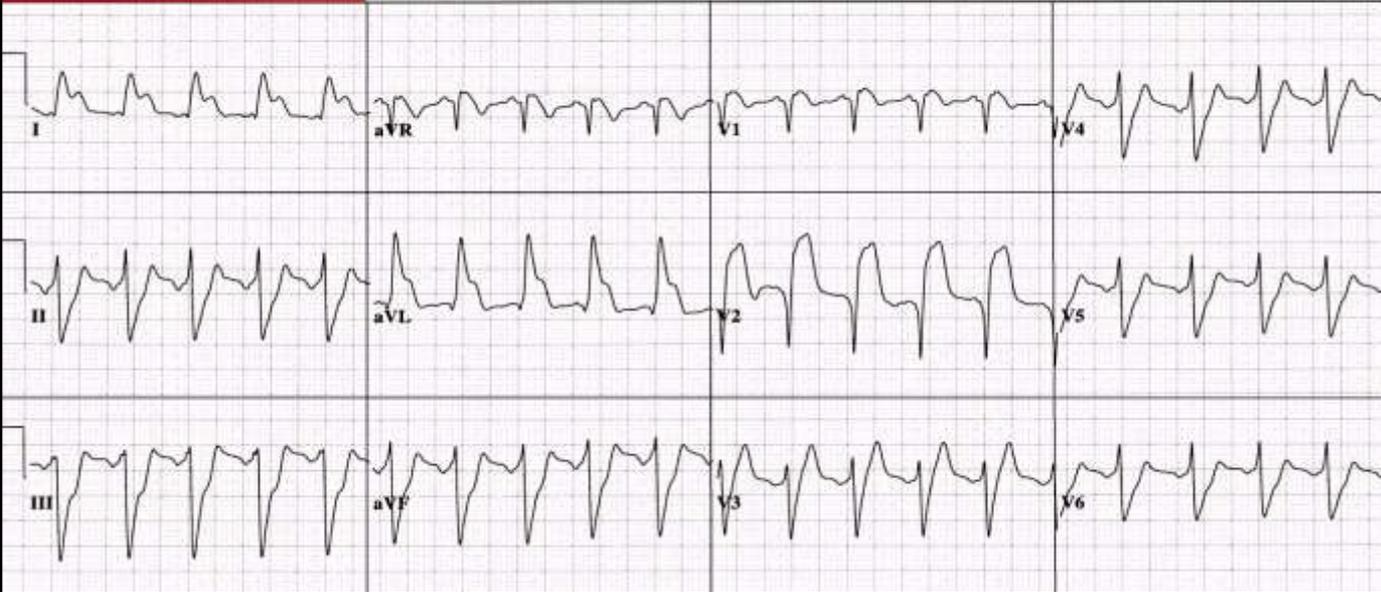


WHO SHOULD GO TO THE CATH LAB FIRST ?

And

PATIENT B:

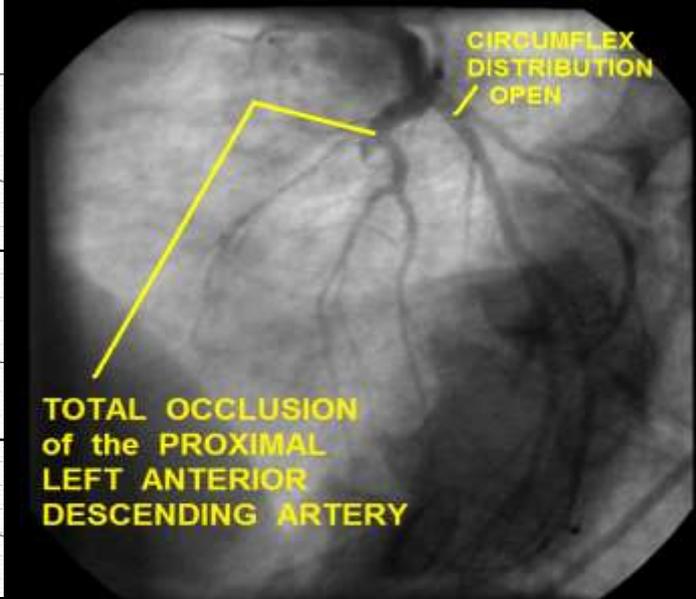
36 y/o MALE, CHEST PAIN x 1 HOUR,
BP: 80/48, P: 120, R: 28 CARDIAC MARKERS: NEGATIVE



WHAT WOULD YOU DO WITH THE PATIENT WHO DID NOT GO TO THE CATH LAB ?

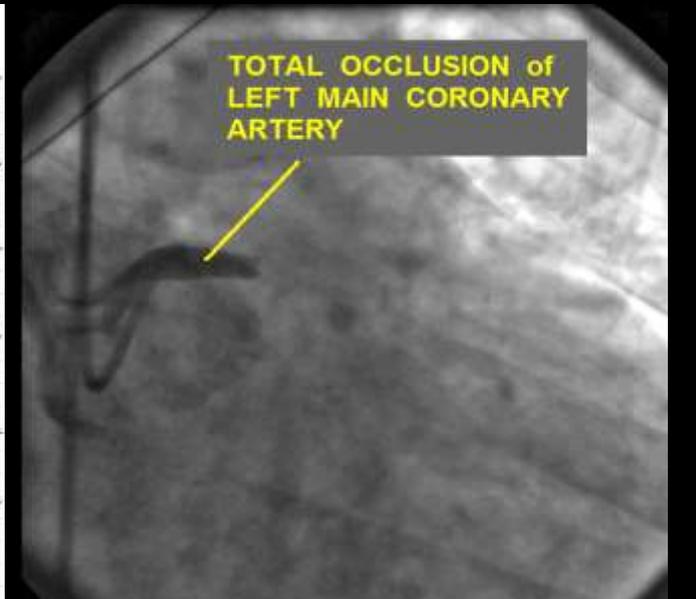
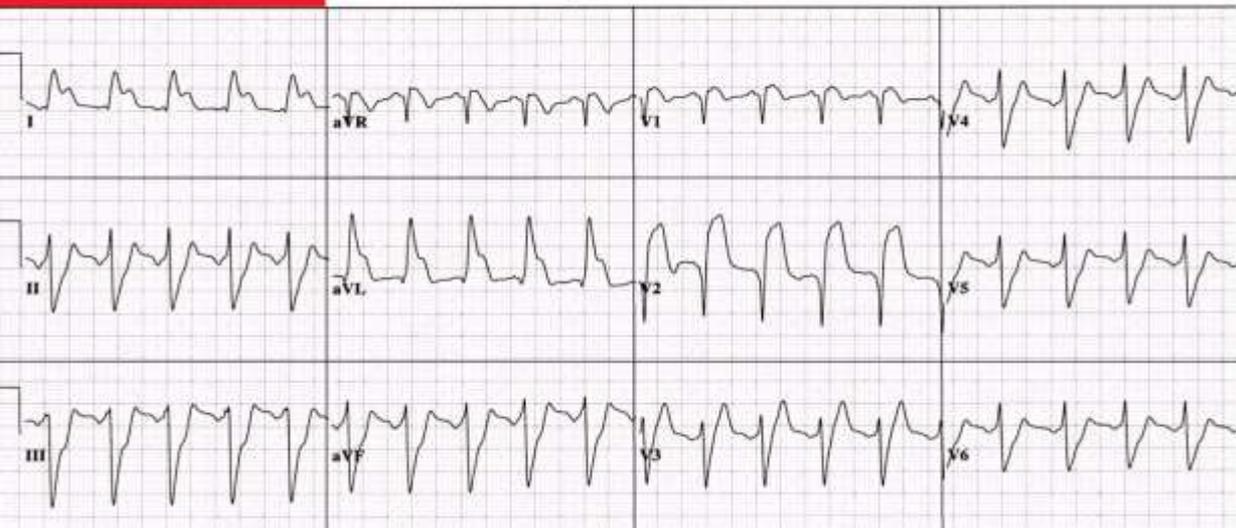
PATIENT A:

44 y/o MALE, CHEST PAIN x 1 HOUR,
BP: 78/46, P: 70, R: 28. CARDIAC MARKERS: NEGATIVE



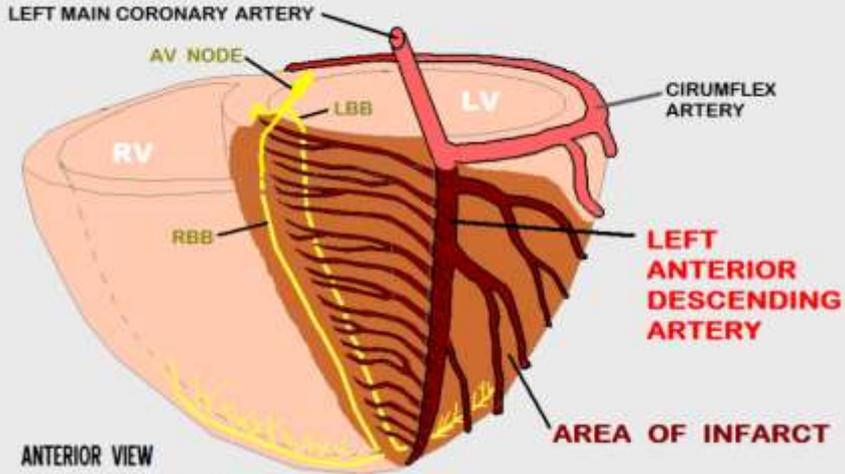
PATIENT B:

36 y/o MALE, CHEST PAIN x 1 HOUR,
BP: 80/48, P: 120, R: 28. CARDIAC MARKERS: NEGATIVE



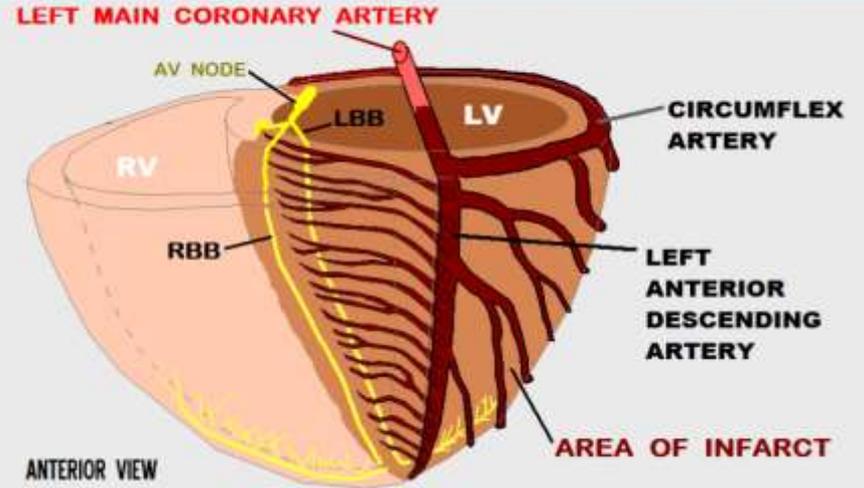
PATIENT A:

OCCLUSION of PROXIMAL LEFT ANTERIOR DESCENDING ARTERY



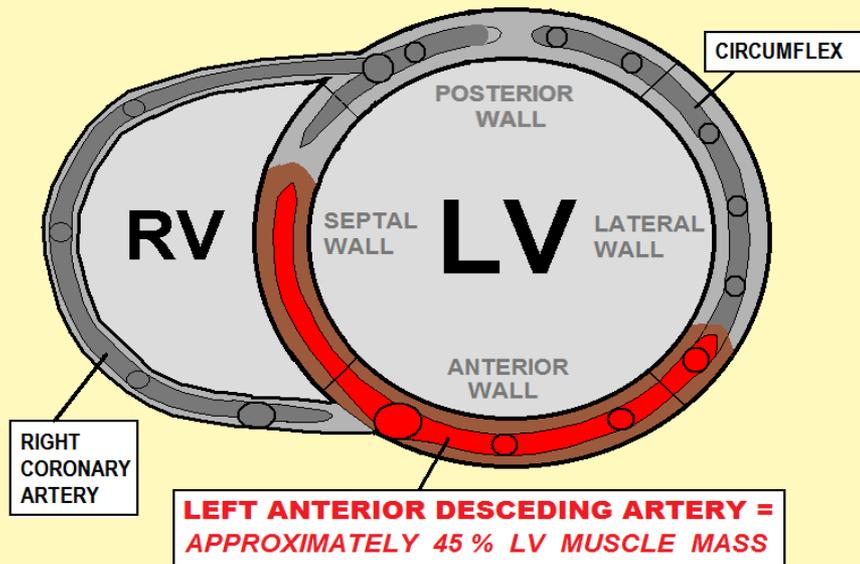
PATIENT B:

OCCLUSION of the LEFT MAIN CORONARY ARTERY



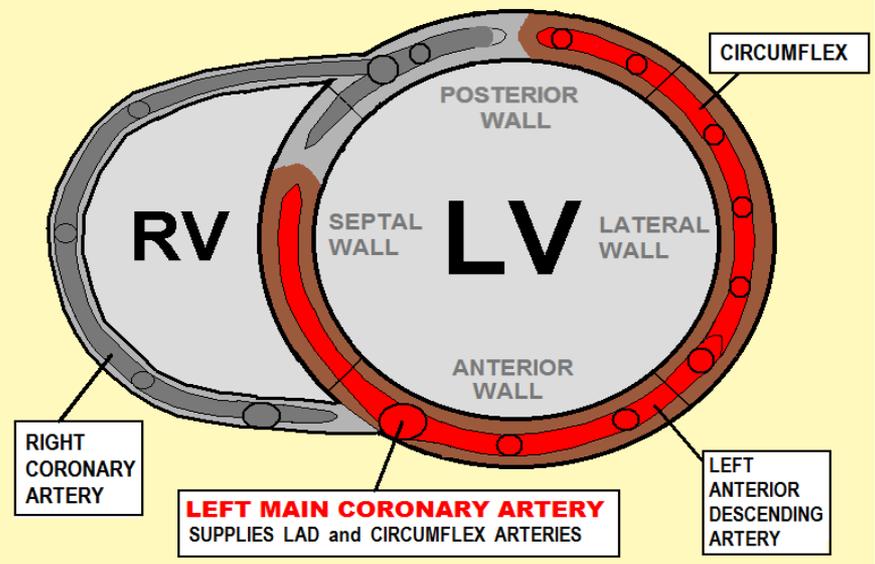
The LEFT ANTERIOR DESCENDING ARTERY

SUPPLIES 40-50% OF THE LEFT VENTRICULAR MUSCLE MASS



The LEFT MAIN CORONARY ARTERY

SUPPLIES 75-100% of the LEFT VENTRICULAR MUSCLE MASS

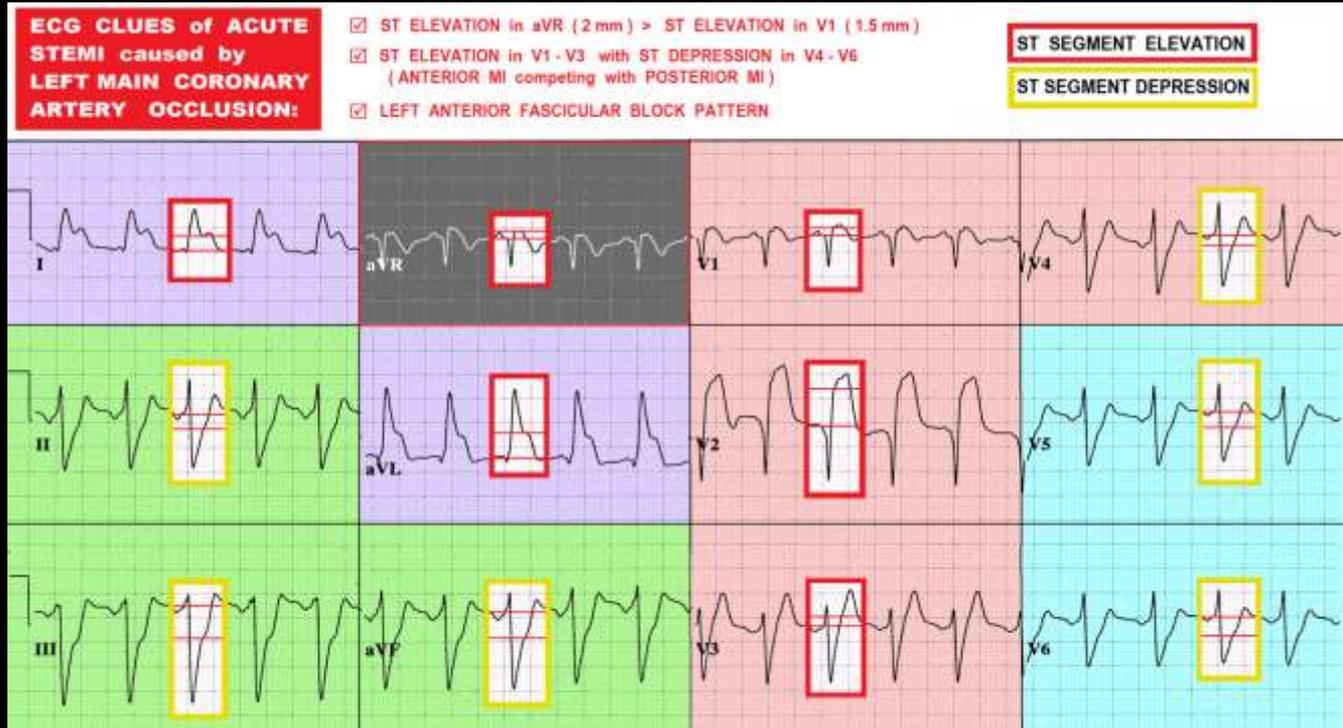


ECG Clues... for IDENTIFYING STEMI CAUSED BY LEFT MAIN CORONARY ARTERY occlusion:

- ☑ ST ELEVATION in ANTERIOR LEADS (V1 - V4) and LATERAL LEADS (V5 & V6)
- ☑ ST DEPRESSION or ISOELECTRIC J POINTS may be seen in V LEADS... mainly V2 and/or V3 caused by *COMPETING FORCES* of ANTERIOR vs. POSTERIOR WALL MI *+
 - NOTE: it is very unusual to see ST DEPRESSION in V LEADS with isolated ANTERIOR WALL MI when caused by occluded LAD.
- ☑ ST ELEVATION in AVR is GREATER THAN ST ELEVATION in V1 *+
- ☑ ST ELEVATION in AVR GREATER THAN 0.5 mm
- ☑ ST ELEVATION in LEAD I and AVL (caused by NO FLOW to DIAGONAL / OBTUSE MARGINAL BRANCHES) *
- ☑ ST DEPRESSION in LEADS II, III, and AVF (in cases of LMCA occlusion of DOMINANT CIRCUMFLEX, leads II, III, and AVF may show ST ELEVATION or ISOELECTRIC J POINTS) *+
- ☑ NEW / PRESUMABLY NEW RBBB, and/or LEFT ANTERIOR FASCICULAR BLOCK *+

* Kurisu et al, HEART 2004, SEPTEMBER: 90 (9): 1059-1060

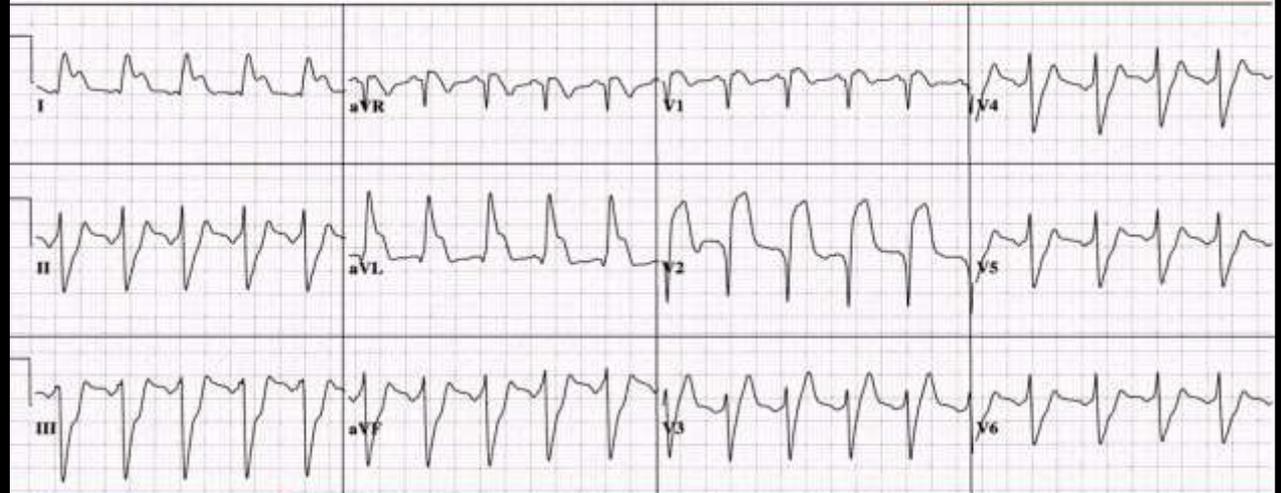
+ Yamaji et al, JACC vol. 38, No. 5, 2001, November 1, 2001:1348-54



36 yr Male Caucasian Vent. rate 123 BPM PR interval 96 ms QRS duration 130 ms QT/QTc 310/443 ms P-R-T axes * -53 43

Sinus tachycardia with short PR
Left ventricular hypertrophy with QRS widening
Cannot rule out Septal infarct, age undetermined
Lateral injury pattern
***** ACUTE MI *****

ACUTE STEMI caused by LEFT MAIN CORONARY ARTERY OCCLUSION



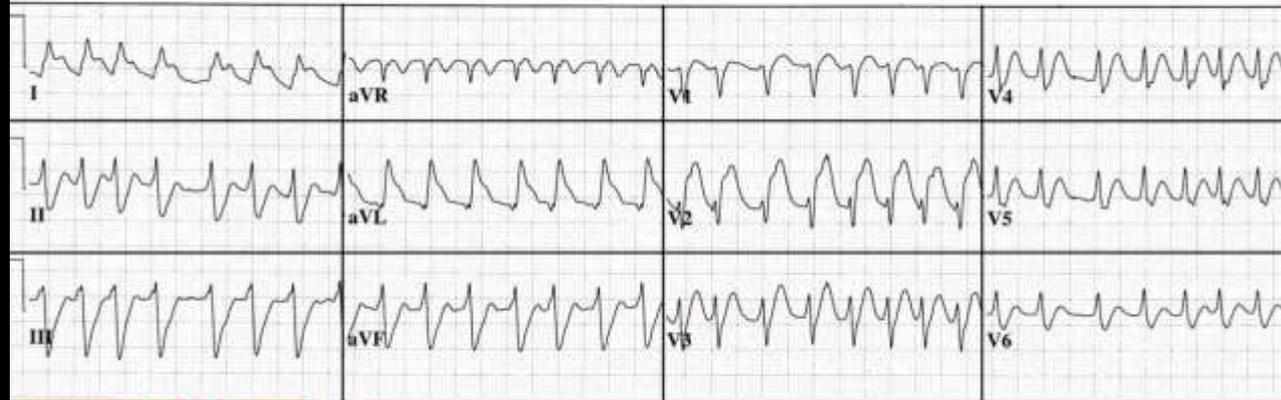
ECG CLUES of ACUTE STEMI caused by LEFT MAIN CORONARY ARTERY OCCLUSION:

- ST ELEVATION in leads I and aVL
- INCONSISTENCY of ST SEGMENT in leads V1-V6: V1-V3 ST ELEVATION, V4-V6 ST DEPRESSION (COMPETING FORCES of ANTERIOR vs. POSTERIOR M.I.)
- PATTERN of LEFT ANTERIOR FASCICULAR BLOCK (POS. QRS lead I; NEG rS leads II, III)
- ST ELEVATION in lead aVR > 0.5 mm

43 yr Male Vent. rate 183 BPM PR interval * ms QRS duration 106 ms QT/QTc 240/418 ms P-R-T axes * -34 -18

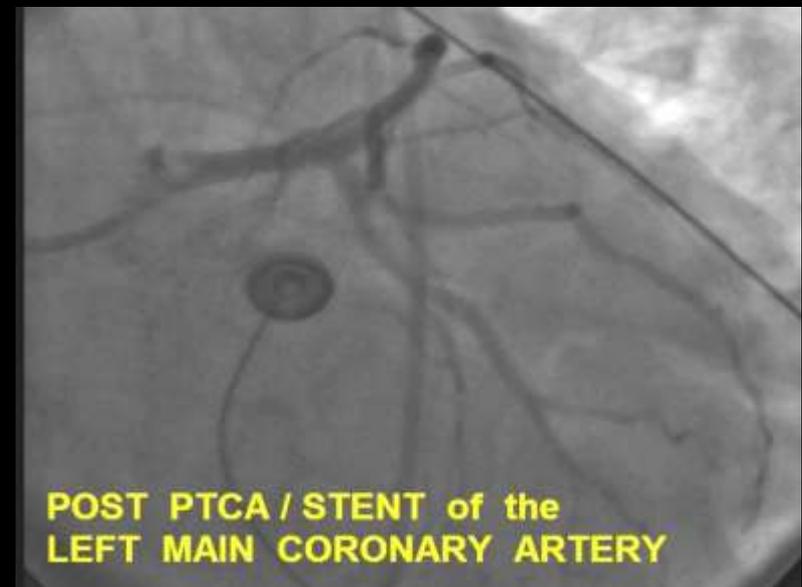
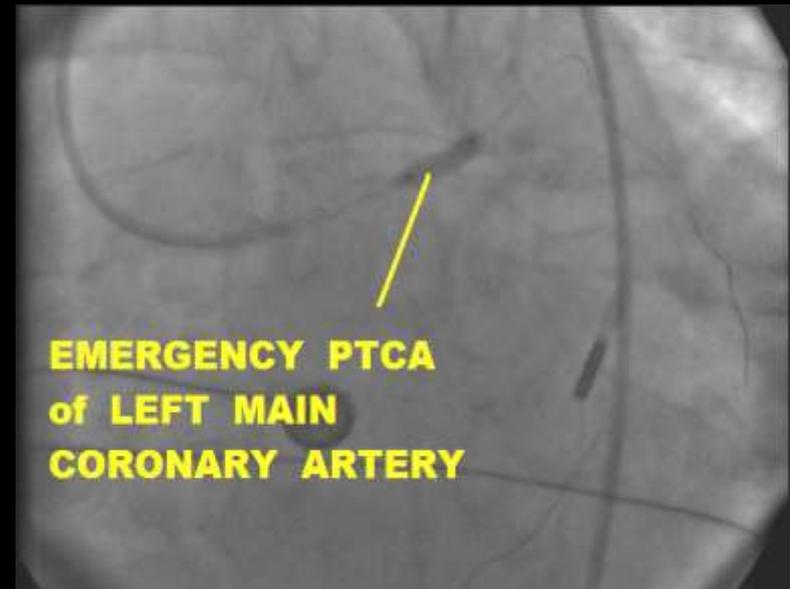
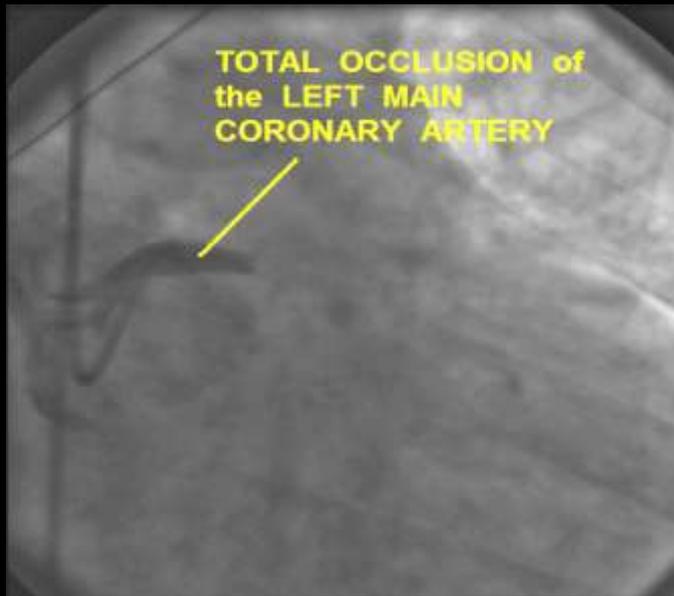
Atrial fibrillation with rapid ventricular response with premature ventricular or aberrantly conducted complexes
Left axis deviation
ST elevation consider anterolateral injury or acute infarct
***** ACUTE MI *****

ACUTE STEMI caused by LEFT MAIN CORONARY ARTERY OCCLUSION



ECG CLUES of ACUTE STEMI caused by LEFT MAIN CORONARY ARTERY OCCLUSION:

- ST ELEVATION in leads I and aVL
- INCONSISTENCY of ST SEGMENT in leads V1-V6: V1-V2 ST ELEVATION, V3-V6 ST DEPRESSION (COMPETING FORCES of ANTERIOR vs. POSTERIOR M.I.)
- PATTERN of LEFT ANTERIOR FASCICULAR BLOCK (POS. QRS lead I; NEG rS leads II, III)



Despite the dismal mortality rate associated with STEMI from total LMCA occlusion, this patient survived and was later discharged. His EF is estimated at approximately 30%. He received an ICD, and is currently stable.

CASE STUDY 4: CRITICAL DECISIONS SCENARIO

CONCLUSIONS:

QUESTION 1: WHICH PATIENT SHOULD BE TAKEN FIRST FOR IMMEDIATE CARDIAC CATHETERIZATION for EMERGENCY PCI ?

ANSWER: PATIENT B was taken emergently to the Cardiac Cath Lab - both the ED physician and the Interventional Cardiologist correctly identified the EKG patterns of LMCA occlusion.

QUESTION 2: WHAT COURSE OF ACTION SHOULD BE TAKEN WITH THE PATIENT NOT CHOSEN TO BE SENT TO THE CATH LAB FIRST?

ANSWER: PATIENT A received thrombolytic therapy in the ED. It was determined that THROMBOLYTIC THERAPY would achieve the FASTEST ROUTE to REPERFUSION --
-- *by at least 60 minutes.*

CASE STUDY 7 - STEMI

CHIEF COMPLAINT and SIGNIFICANT HISTORY:

46 yr. old MALE arrives in ER, C/O SUDDEN ONSET OF CHEST PRESSURE 45 MINUTES AGO. PAIN IS CONSTANT, PRESSURE-LIKE, AND NOT EFFECTED BY POSITION, MOVEMENT or DEEP INSPIRATION. ALSO C/O D.I.B.

RISK FACTOR PROFILE:

-  CURRENT CIGARTE SMOKER x 18 YEARS
-  HYPERTENSION
-  HIGH LDL CHOLESTEROL

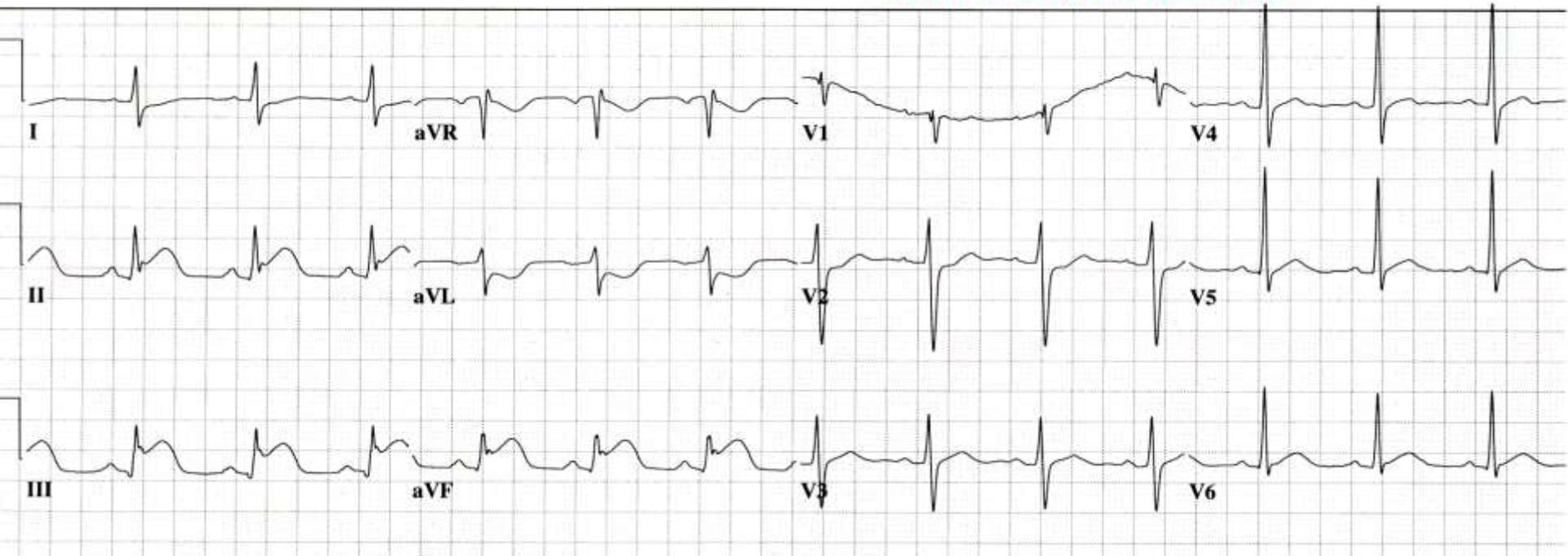
PHYSICAL EXAM: Patient is alert & oriented x 4, skin warm, dry, color normal. Non-anxious
Lungs clear, normal S1, S2. No JVD, No ankle edema.

VITAL SIGNS: BP: 136/88 P: 88 R: 20 SAO2: 100% on 4 LPM O2

LABS: TROPONIN: < .04

46 yr Male Caucasian Vent. rate 82 BPM
PR interval 168 ms
QRS duration 96 ms
QT/QTc 384/448 ms
Loc:3 Option:23 P-R-T axes 76 81 88

- EVALUATE EKG for indicators of ACS:**
- ST SEGMENT ELEVATION / DEPRESSION
 - HYPERACUTE T WAVES
 - CONVEX ST SEGMENTS
 - OTHER ST SEGMENT / T WAVE ABNORMALITIES



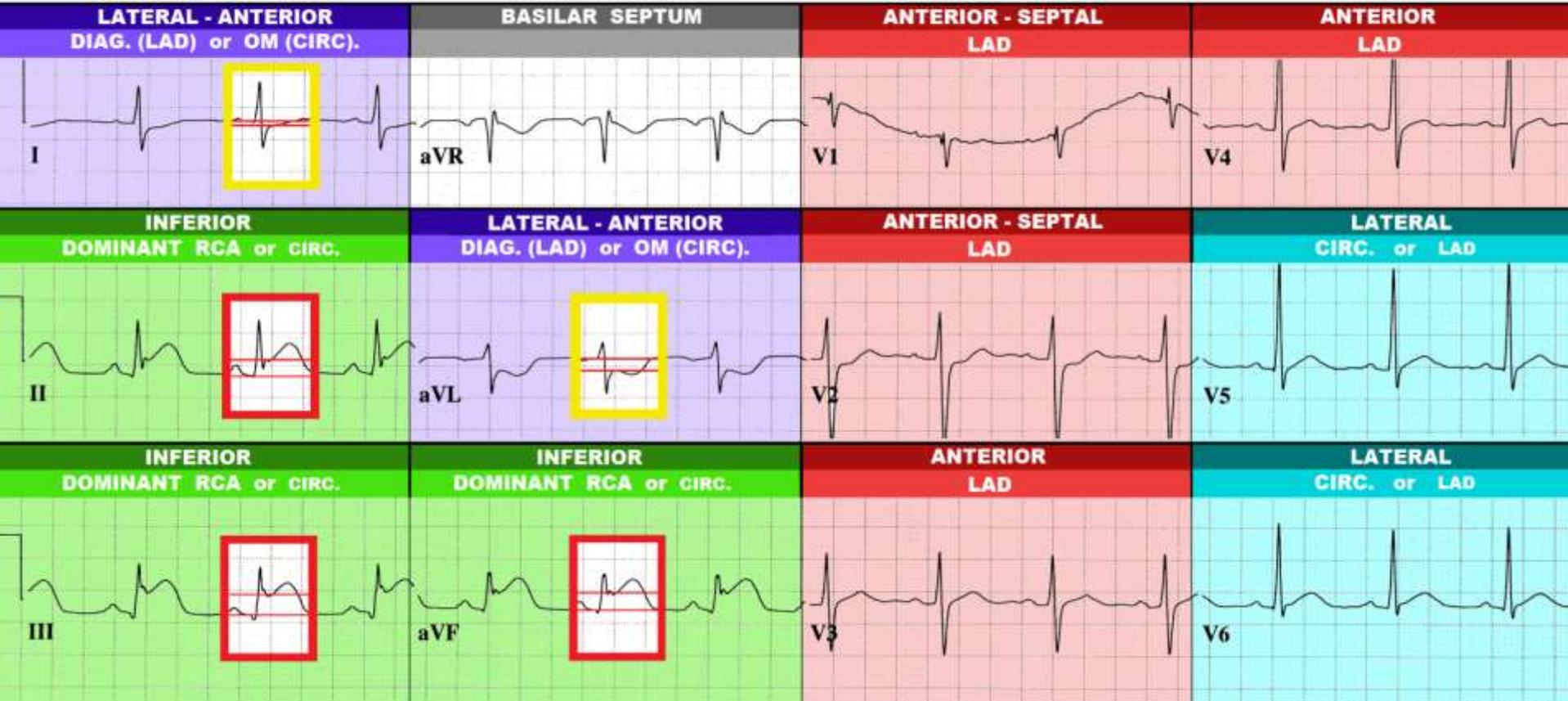
46 yr
Male Caucasian

Vent. rate 82 BPM
PR interval 168 ms
QRS duration 96 ms
QT/QTc 384/448 ms
P-R-T axes 76 81 88

Normal sinus rhythm
ST elevation consider inferior injury or acute infarct
***** ACUTE MI *****
Abnormal ECG

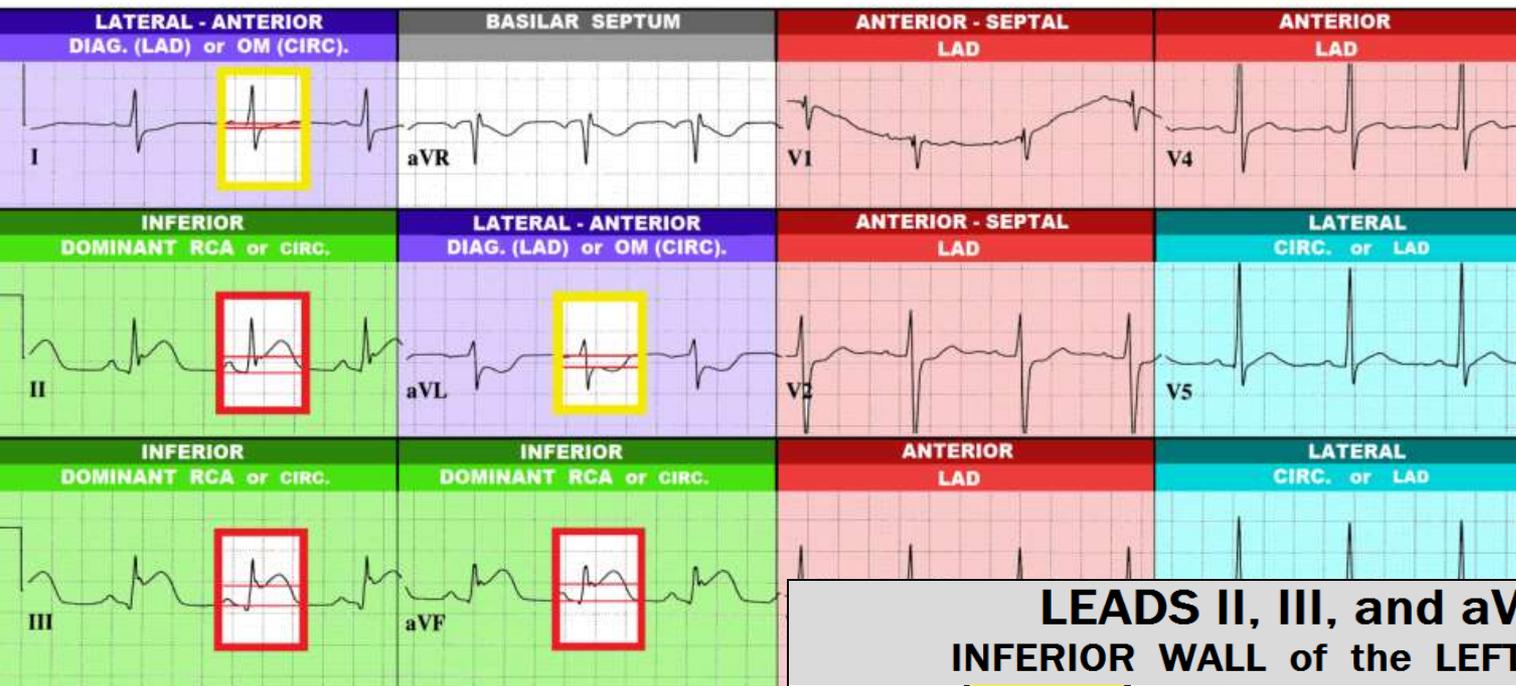
ST SEGMENT ELEVATION

ST SEGMENT DEPRESSION

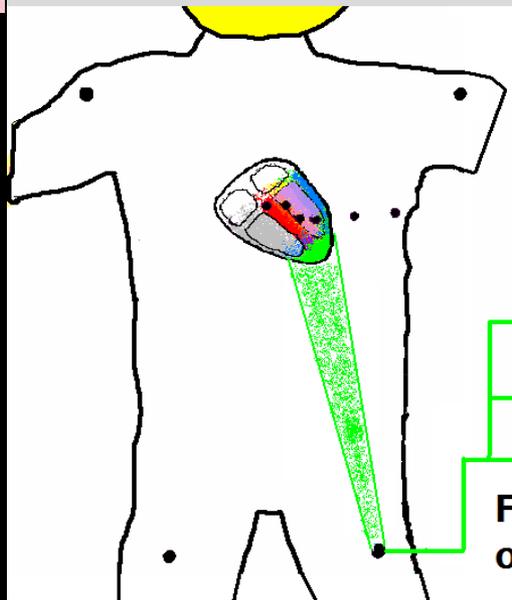


46 yr Male Caucasian Vent. rate 82 BPM Normal sinus rhythm
 PR interval 168 ms ST elevation consider inferior injury or acute infarct
 QRS duration 96 ms ***** ACUTE MI *****
 QT/QTc 384/448 ms Abnormal ECG
 P-R-T axes 76 81 88

ST SEGMENT ELEVATION
ST SEGMENT DEPRESSION



**LEADS II, III, and aVF VIEW
 INFERIOR WALL of the LEFT VENTRICLE**

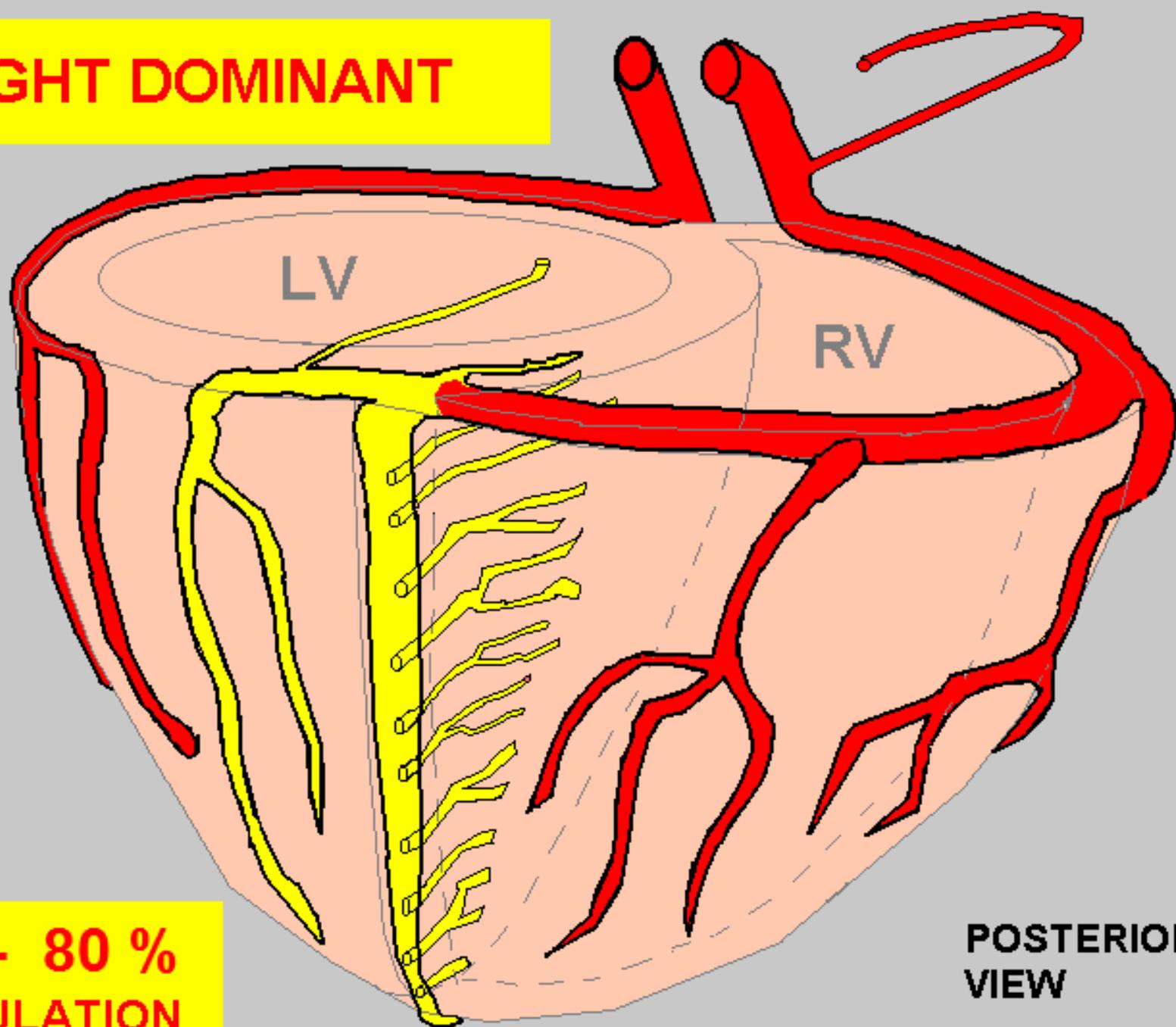


RUPPERT, WAYNE ID: 7445683659 05-OCT-2006 JOHNS-HOPKINS UNIV.
 38 Yrs Vent. Rate: 68 NORMAL SINUS RHYTHM
 MALE P-R Int.: 160 ms Normal EKG
 QRS: 100 ms Very Healthy Athletic EKG!

I	AVR	V1	V4
II	AVL	V2	V5
III	AVF	V3	V6

**FED by the RCA (75 - 80 % pop)
 or the CIRCUMFLEX (10 - 15 %)**

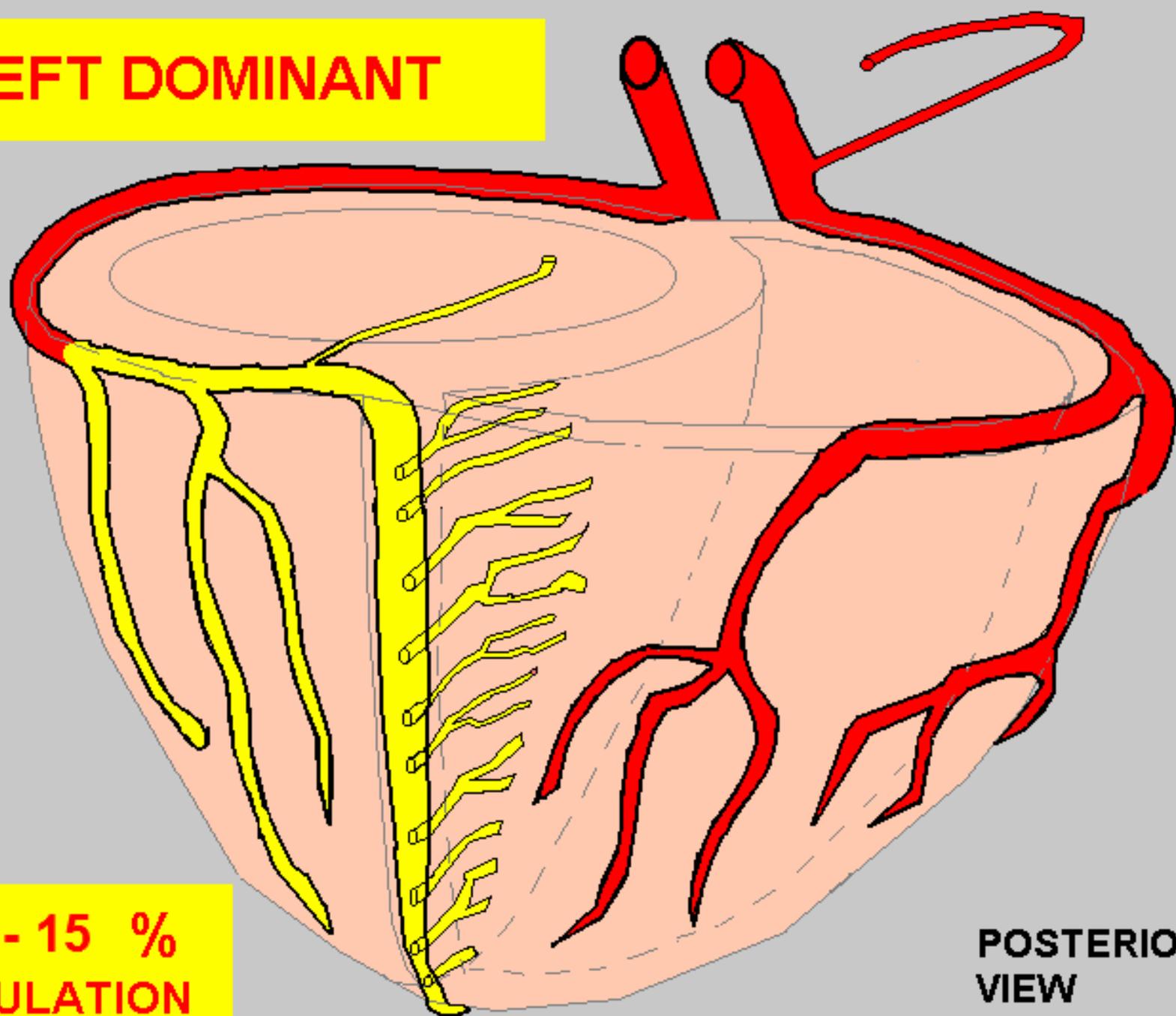
RIGHT DOMINANT



**75 - 80 %
POPULATION**

**POSTERIOR
VIEW**

LEFT DOMINANT



**10 - 15 %
POPULATION**

**POSTERIOR
VIEW**



HELPFUL HINT . . . *MEMORIZE THIS !*



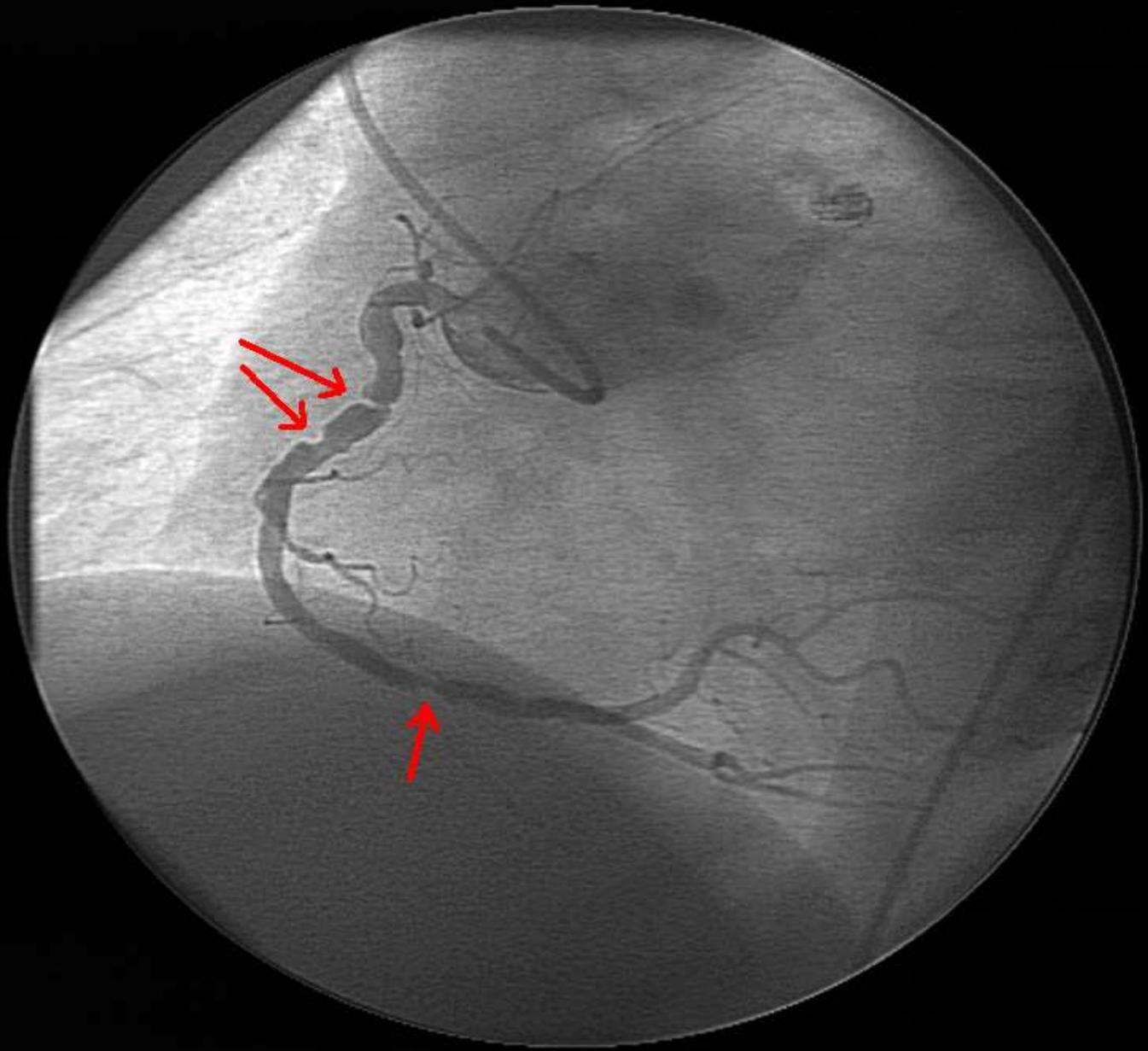
RIGHT CORONARY ARTERY (RCA)

RIGHT DOMINANT
SYSTEMS

- ▶ **RIGHT ATRIUM**
- ▶ **SINUS NODE** (55% of the population)
- ▶ **RIGHT VENTRICLE** - 100 % of muscle mass
- ▶ **LEFT VENTRICLE:** 15 - 25 % of muscle mass
 - **INFERIOR WALL**
 - approx. 1/2 of **POSTERIOR WALL**
- ▶ **AV NODE**

ANTICIPATED COMPLICATIONS of INFERIOR WALL STEMI secondary to RCA Occlusion & POSSIBLE INDICATED INTERVENTIONS:

- CARDIAC ARREST	BCLS / ACLS
- CARDIAC DYSRHYTHMIAS (VT / VF)	ACLS (antiarrhythmics)
- SINUS BRADYCARDIA	ATROPINE 0.5mg, REPEAT as needed UP TO 3mg. (follow ACLS and/or UNIT protocols)
- HEART BLOCKS (1st, 2nd & 3rd Degree HB)	ATROPINE 0.5mg, REPEAT as needed UP TO 3mg, Transcutaneous Pacing, (follow ACLS and/or UNIT protocols)
- RIGHT VENTRICULAR MYOCARDIAL INFARCTION	<ul style="list-style-type: none">- The standard 12 Lead ECG does NOT view the Right Ventricle.- You must do a RIGHT-SIDED ECG to see if RV MI is present.- Do NOT give any Inferior Wall STEMI patient NITRATES or DIURETICS until RV MI has been RULED OUT.
- POSTERIOR WALL INFARCTION	<ul style="list-style-type: none">- POSTERIOR WALL MI presents on the 12 Lead ECG as ST DEPRESSION in Leads V1 - V3.- POSTERIOR WALL MI is NOT PRESENT ON THIS ECG.



2
2

A standard

12 LEAD EKG

Does NOT show the

RIGHT VENTRICLE

To see the
RIGHT VENTRICLE . . .

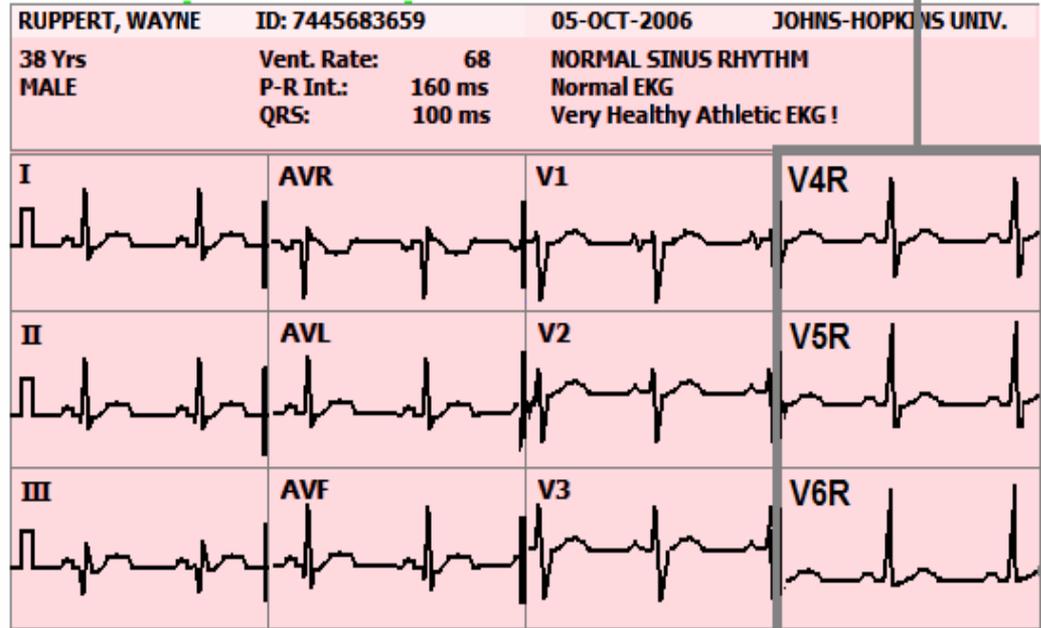
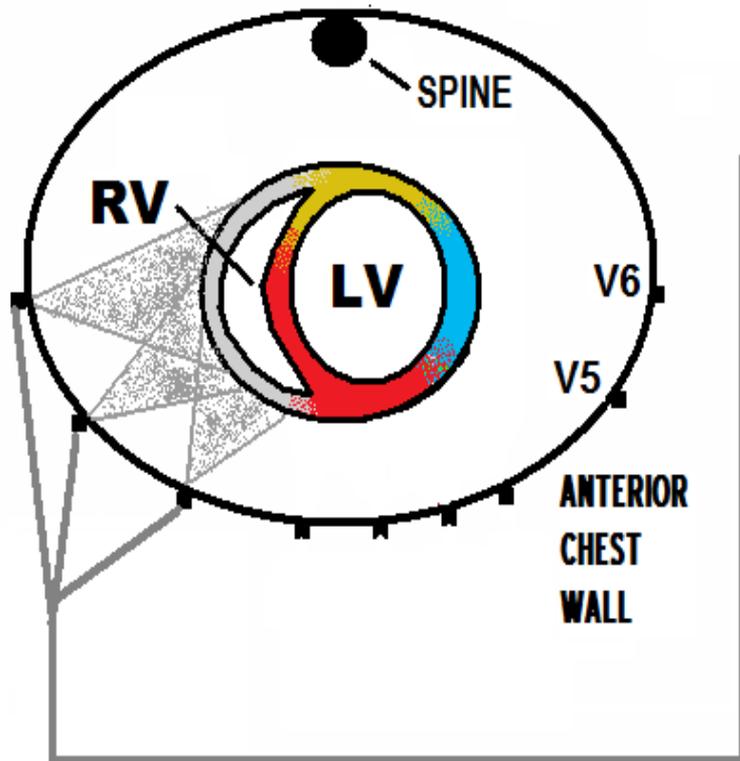
. . . such as in cases of
INFERIOR WALL M.I.



You must do a

RIGHT - SIDED EKG !!

V4R - V6R VIEW THE RIGHT VENTRICLE



RV MI STEMI Criteria:

- ST Elevation of 0.5mm (0.5mv) or more in Leads V3R, V4R, V5R or V6R

RV MI STEMI Criteria:

- ST Elevation of ___mm (0.5mv) or more in Leads V3R, V4R, V5R or V6R

ID:

46 yo
Male Caucasian
Room: Opt:

Vent. rate 87 bpm
PR interval 176 ms
QRS duration 94 ms
QT/QTc 330/397 ms
P-R-T axes 79 81 102

Normal sinus rhythm
~~Anterolateral infarct, possibly acute~~
Inferior injury pattern
***** Acute MI *****
Abnormal ECG

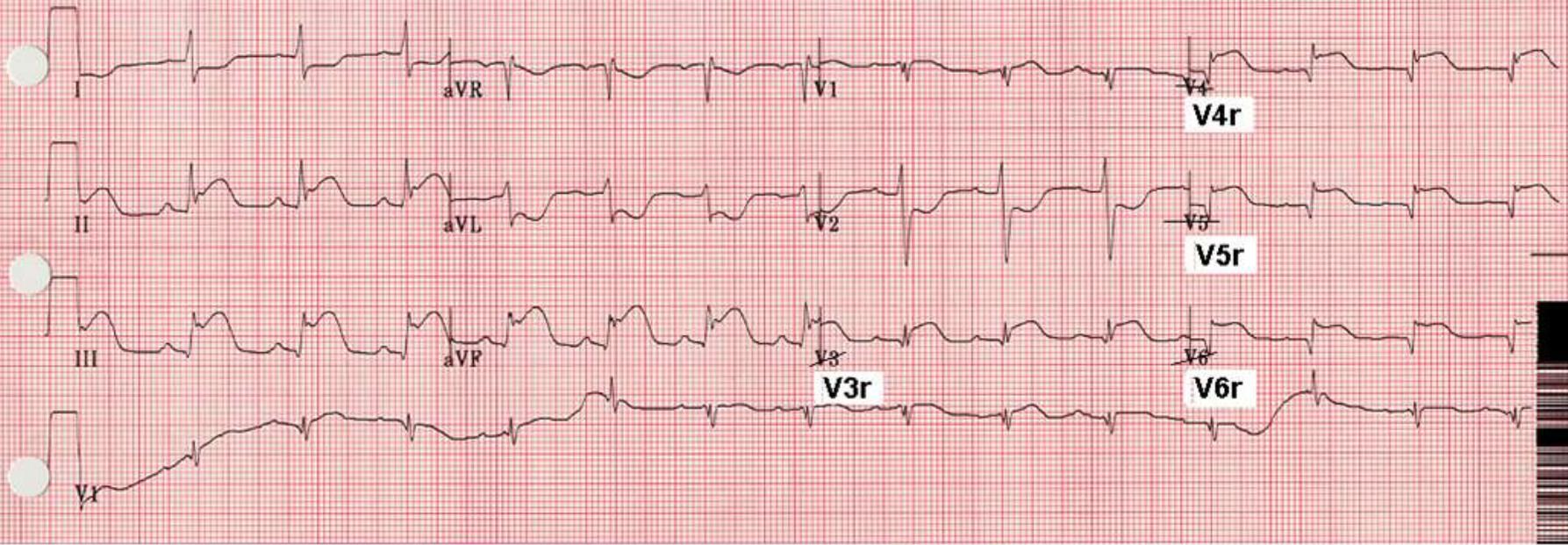
Right Ventricular Infarct

V LEADS
R SIDE

Technician:

Referred by:

Unconfirmed



RIGHT VENTRICULAR STEMI is indicated when ST Segment Elevation of 0.5mv is present.

IN *EVERY* CASE of

INFERIOR WALL STEMI

You must first *RULE OUT*

RIGHT VENTRICULAR MI

BEFORE giving any:

- NITROGLYCERIN
- Diuretics

**Nitroglycerin & Diuretics
are
CLASS III CONTRINDICATED
in
RIGHT VENTRICULAR MI !!***

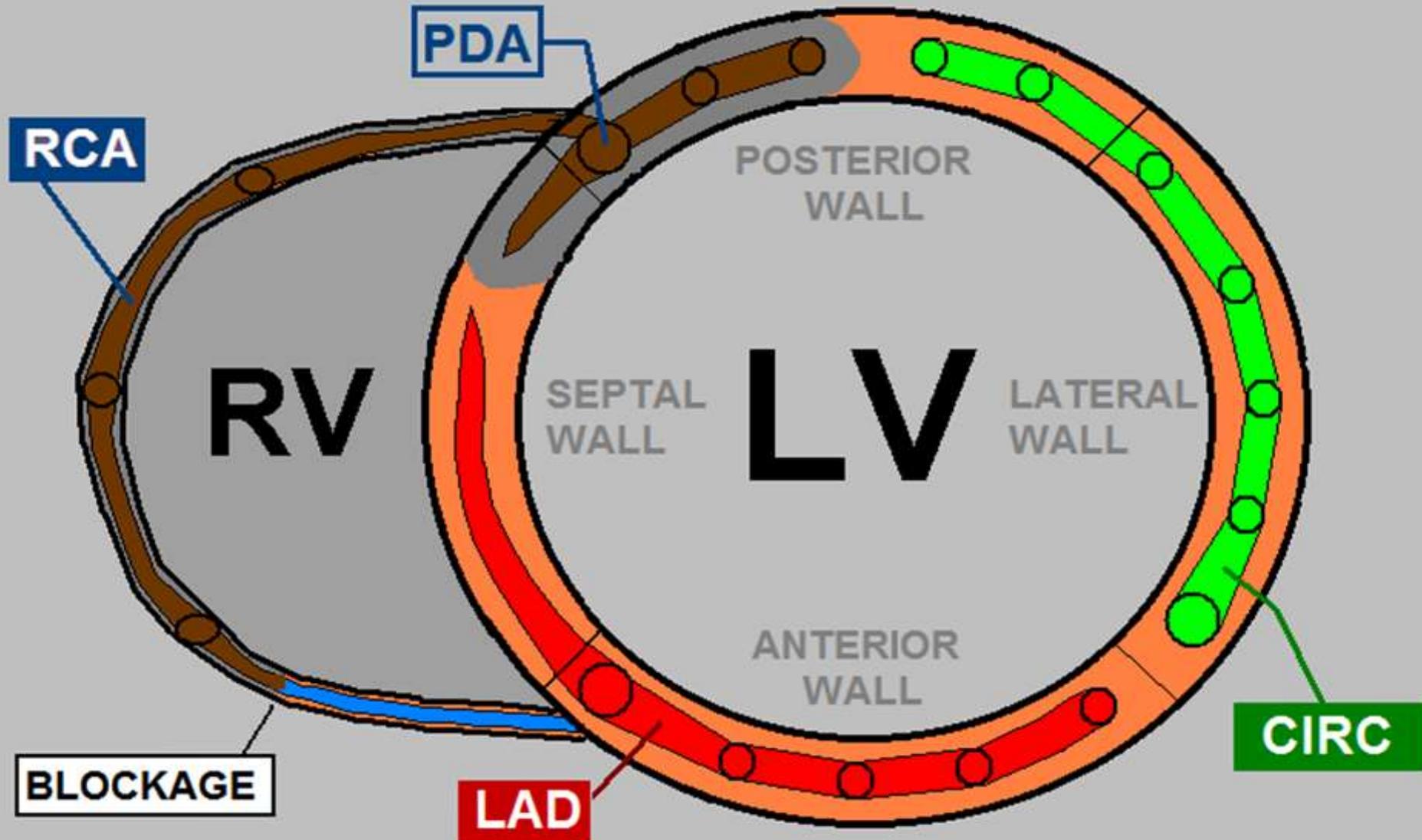
**They precipitate SEVERE
HYPOTENSION**

*** A.H.A. ACLS 2010 / 2015**

INFERIOR - RIGHT VENTRICULAR MI

DOMINANT RCA

75-80 % of POPULATION



ANTICIPATED COMPLICATIONS of INFERIOR - RIGHT VENTRICULAR WALL STEMI secondary to PROXIMAL RCA Occlusion & POSSIBLE INDICATED INTERVENTIONS:

- CARDIAC ARREST	BCLS / ACLS
- CARDIAC DYSRHYTHMIAS (VT / VF)	ACLS (antiarrhythmics)
- SINUS BRADYCARDIA	ATROPINE 0.5mg, REPEAT as needed UP TO 3mg. (follow ACLS and/or UNIT protocols)
- HEART BLOCKS (1st, 2nd & 3rd Degree HB)	ATROPINE 0.5mg, REPEAT as needed UP TO 3mg, Transcutaneous Pacing, (follow ACLS and/or UNIT protocols)
- RIGHT VENTRICULAR MYOCARDIAL INFARCTION	<ul style="list-style-type: none"> - NITRATES and DIURETICS are CONTRA-INDICATED. - TREAT HYPOTENSION WITH FLUIDS. (It is Not uncommon to give 500-2000ml of NORMAL SALINE to stabilize BP.
- POSTERIOR WALL INFARCTION	<ul style="list-style-type: none"> - POSTERIOR WALL MI presents on the 12 Lead ECG as ST DEPRESSION in Leads V1 - V3. - POSTERIOR WALL MI is NOT PRESENT ON THIS ECG.

If this patient becomes
HYPOTENSIVE

MI with HYPOTENSION ??

WET LUNG
SOUNDS ??

NO

YES

RIGHT VENTRICULAR MI ?

YES

NO

POSTERIOR / LATERAL
INVOLVEMENT ?

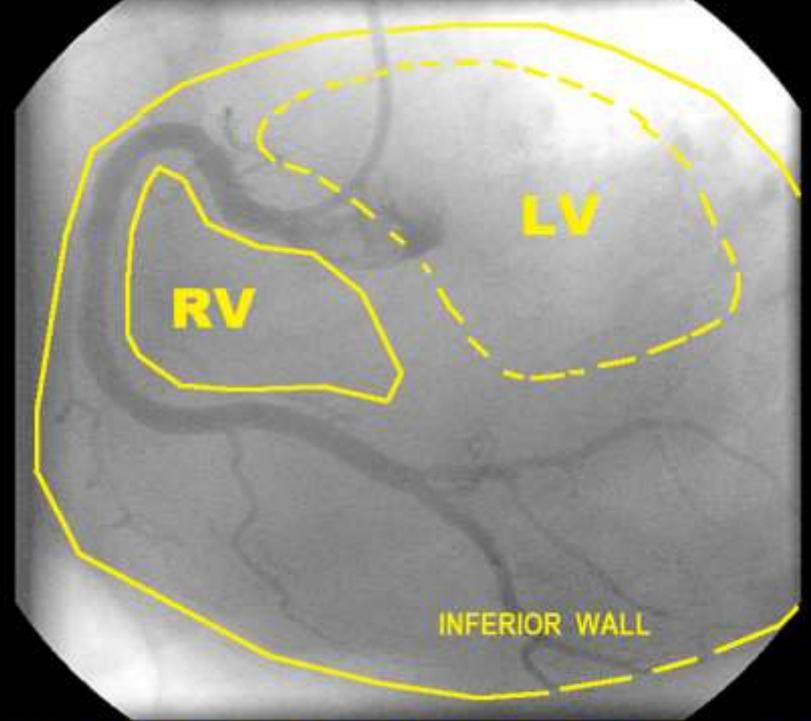
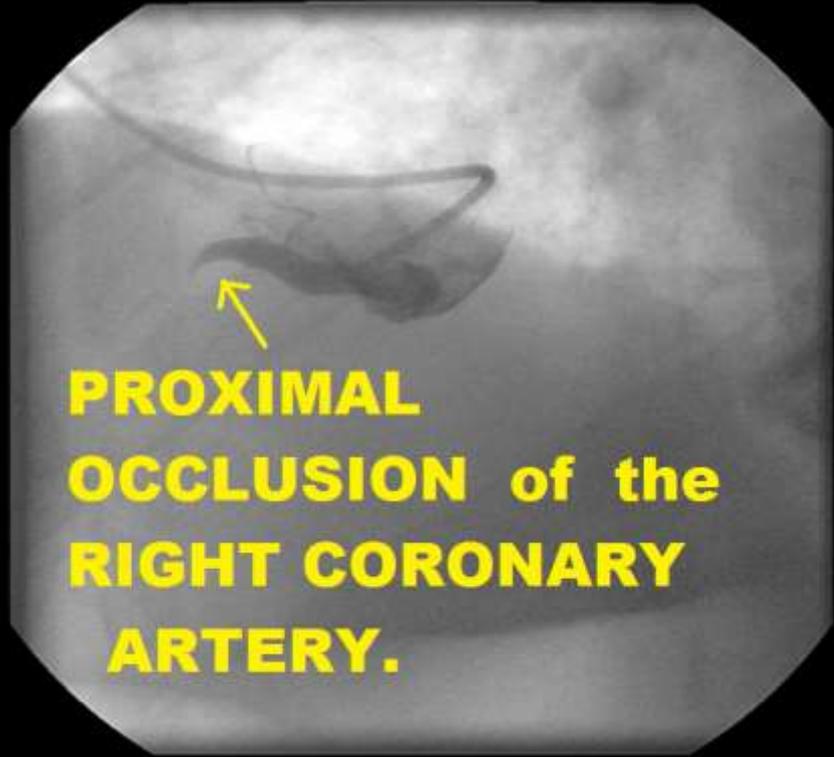
NO

YES

IV
FLUIDS !

- FLUID CHALLENGE
- INOTROPES
- CONSIDER I.A.B.P

- INOTROPES
- CONSIDER ET INTUBATION
- CONSIDER I.A.B.P.



POST PTCA / STENT DEPLOYMENT TO PROXIMAL RCA

CHIEF COMPLAINT and SIGNIFICANT HISTORY:

42 y/o MALE arrived via EMS, c/o "HEAVY CHEST PRESSURE," SHORTNESS of BREATH X 40 min. He has experienced V-FIB and been DEFIBRILLATED multiple times

RISK FACTOR PROFILE:

-  CIGARETTE SMOKER
-  HYPERTENSION
-  HIGH LDL CHOLESTEROL

PHYSICAL EXAM: Patient is alert & oriented x 4, ANXIOUS, with COOL, PALE, DIAPHORETIC SKIN. C/O NAUSEA, and is VOMITING. LUNG SOUNDS: COARSE CRACKLES, BASES, bilaterally

VITAL SIGNS: BP: 80/40 P: 70 R: 32 SAO2: 92% on 15 LPM O2

LABS: TROPONIN: < .04

SHOCK ASSESSMENT

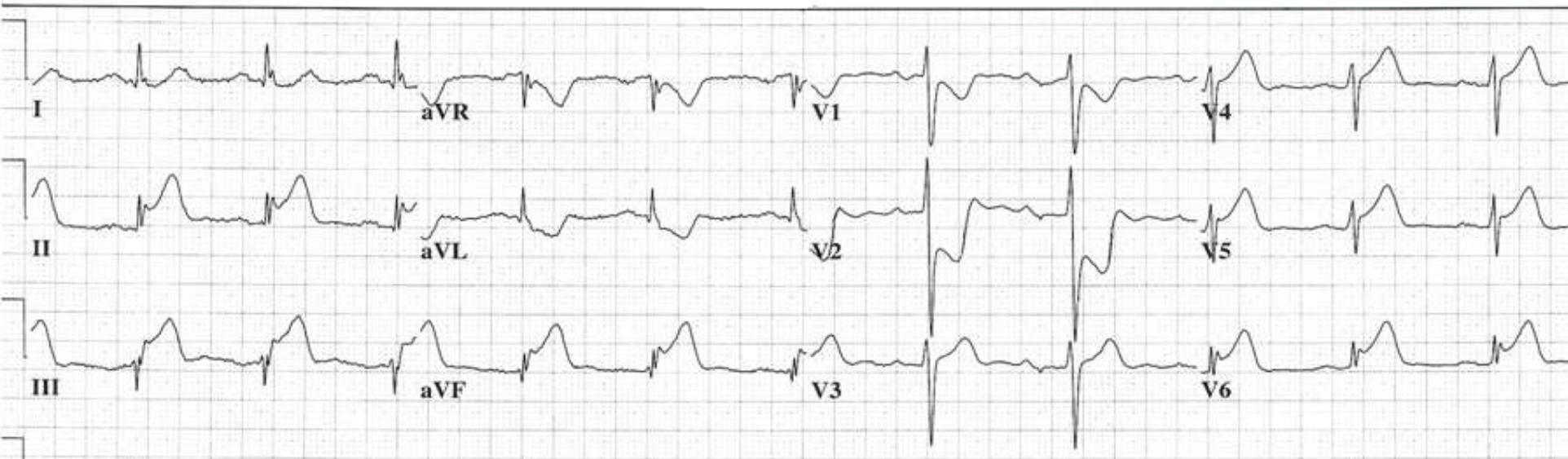
LOC:	ANXIOUS RESTLESS LETHARGIC UNCONSCIOUS	AWAKE ALERT & ORIENTED
SKIN:	PALE / ASHEN CYANOTIC COOL DIAPHORETIC	NORMAL HUE WARM DRY
BREATHING:	TACHYPNEA	NORMAL
PULSE:	WEAK / THREADY TOO FAST or SLOW	STRONG
STATUS:	 SHOCK 	NORMAL

42 yr		Vent. rate	69	BPM
Male	Caucasian	PR interval	196	ms
		QRS duration	98	ms
		QT/QTc	388/415	ms
Loc:3	Option:23	P-R-T axes	14 28	81



EVALUATE EKG for indicators of ACS:

- ST SEGMENT ELEVATION / DEPRESSION
- HYPERACUTE T WAVES
- CONVEX ST SEGMENTS
- OTHER ST SEGMENT / T WAVE ABNORMALITIES



CASE STUDY QUESTIONS:

NOTE LEADS WITH ST ELEVATION:

NOTE LEADS WITH ST DEPRESSION:

WHAT IS THE SUSPECTED DIAGNOSIS ?

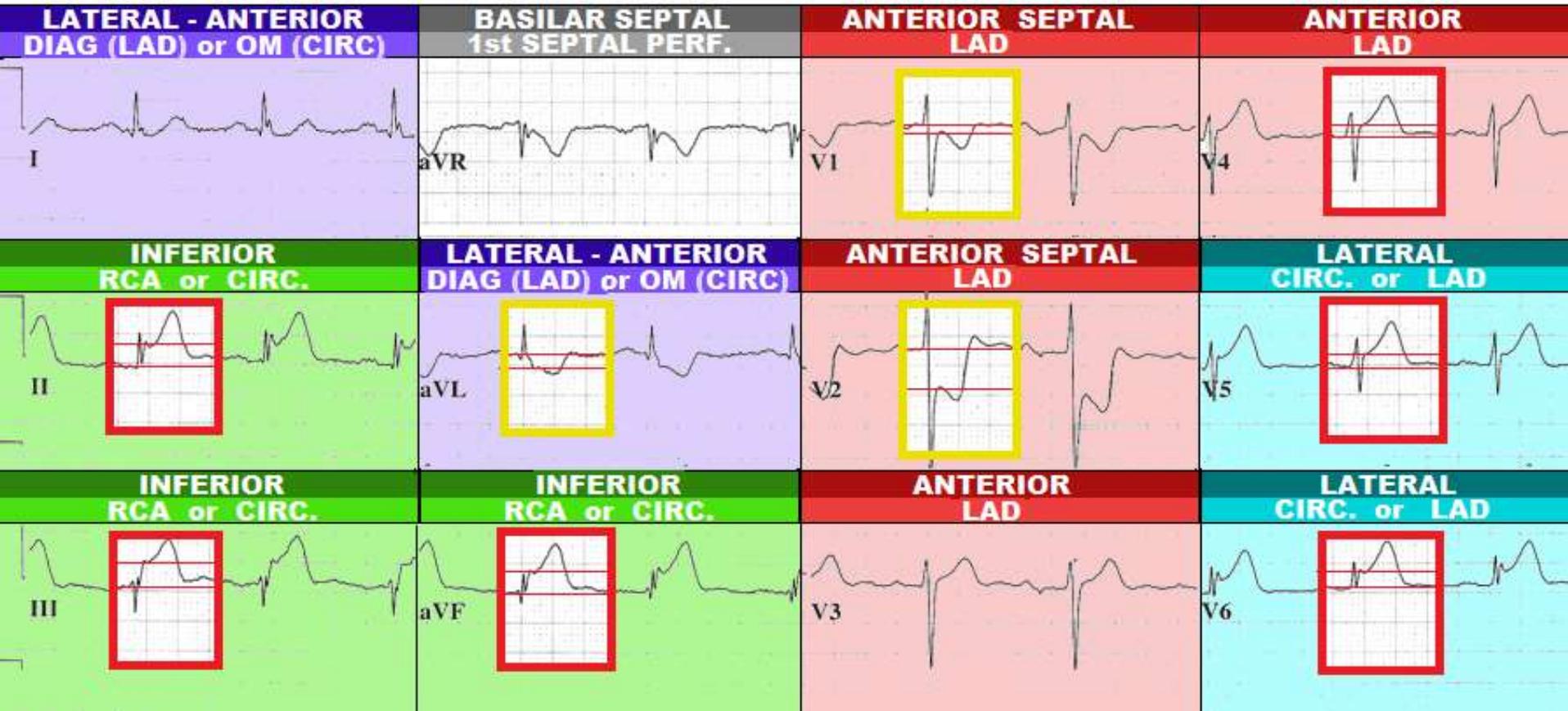
WHAT IS THE "CULPRIT ARTERY" -- if applicable ?

LIST ANY CRITICAL STRUCTURES COMPROMISED:

LIST ANY POTENTIAL COMPLICATIONS:

42 yr Male Caucasian Vent. rate 69 BPM *** Acute MI ***
 PR interval 196 ms Inferior-Posterior-Lateral Injury Pattern
 QRS duration 98 ms
 QT/QTc 388/415 ms
 Loc:3 Option:23 P-R-T axes 14 28 81

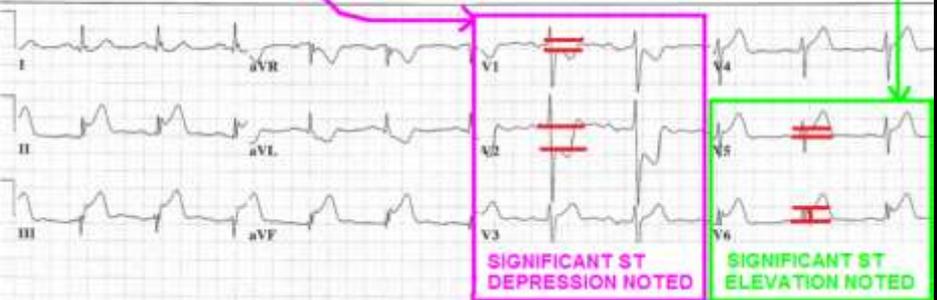
ST SEGMENT ELEVATION
ST SEGMENT DEPRESSION



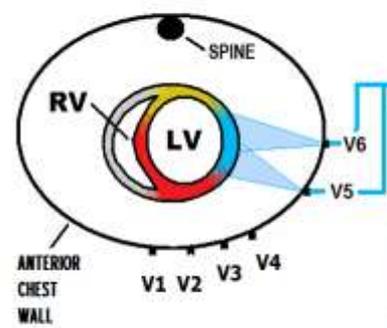
42 yr 60 BPM
 Male Caucasian
 Vent. rate: 190 ms
 PR interval: 50 ms
 QRS duration: 380/415 ms
 QT/QTc: 14 28 81
 Loc: 3 Option: 23 P-R-T axis

INDICATOR	COMPLICATION
1. S-T DEPRESSION IN THE V-LEADS (PREDOMINANTLY V1 - V3)	→ POSTERIOR WALL MI
2. S-T ELEVATION IN LEADS V5, V6, LEAD I, and AVL	→ LATERAL WALL MI
3. S-T ELEVATION in LEADS V3r - V6r (RIGHT-SIDED EKG)	→ R. VENTRICULAR MI

R SIDED ECG
 was obtained, NO
 ST ELEVATION was
 noted in RV Leads

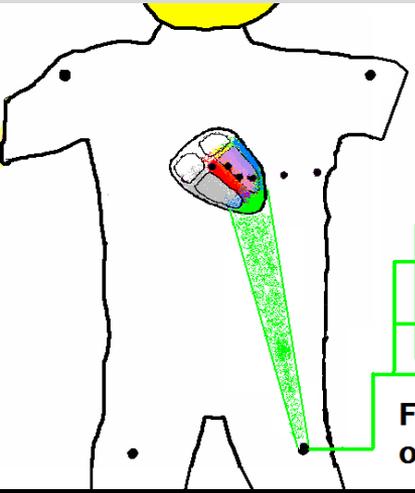


V5 - V6 VIEW THE LATERAL WALL of the LEFT VENTRICLE



RUPPERT, WAYNE		ID: 7445683659	05-OCT-2006	JOHNS-HOPKINS UNIV.
38 Yrs	MALE	Vent. Rate: 68	160 ms	NORMAL SINUS RHYTHM
		P-R Int.: 160 ms	100 ms	Normal EKG
		QRS:		Very Healthy Athletic EKG!
I	AVR	V1	V4	
II	AVL	V2	V5	
III	AVF	V3	V6	

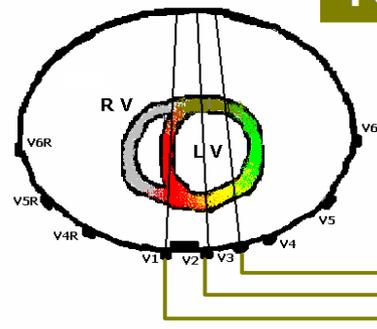
LEADS II, III, and aVF VIEW THE INFERIOR WALL of the LEFT VENTRICLE



RUPPERT, WAYNE		ID: 7445683659	05-OCT-2006	JOHNS-HOPKINS UNIV.
38 Yrs	MALE	Vent. Rate: 68	160 ms	NORMAL SINUS RHYTHM
		P-R Int.: 160 ms	100 ms	Normal EKG
		QRS:		Very Healthy Athletic EKG!
I	AVR	V1	V4	
II	AVL	V2	V5	
III	AVF	V3	V6	

FED by the **RCA** (75 - 80 % pop)
 or the **CIRCUMFLEX** (10 - 15 %)

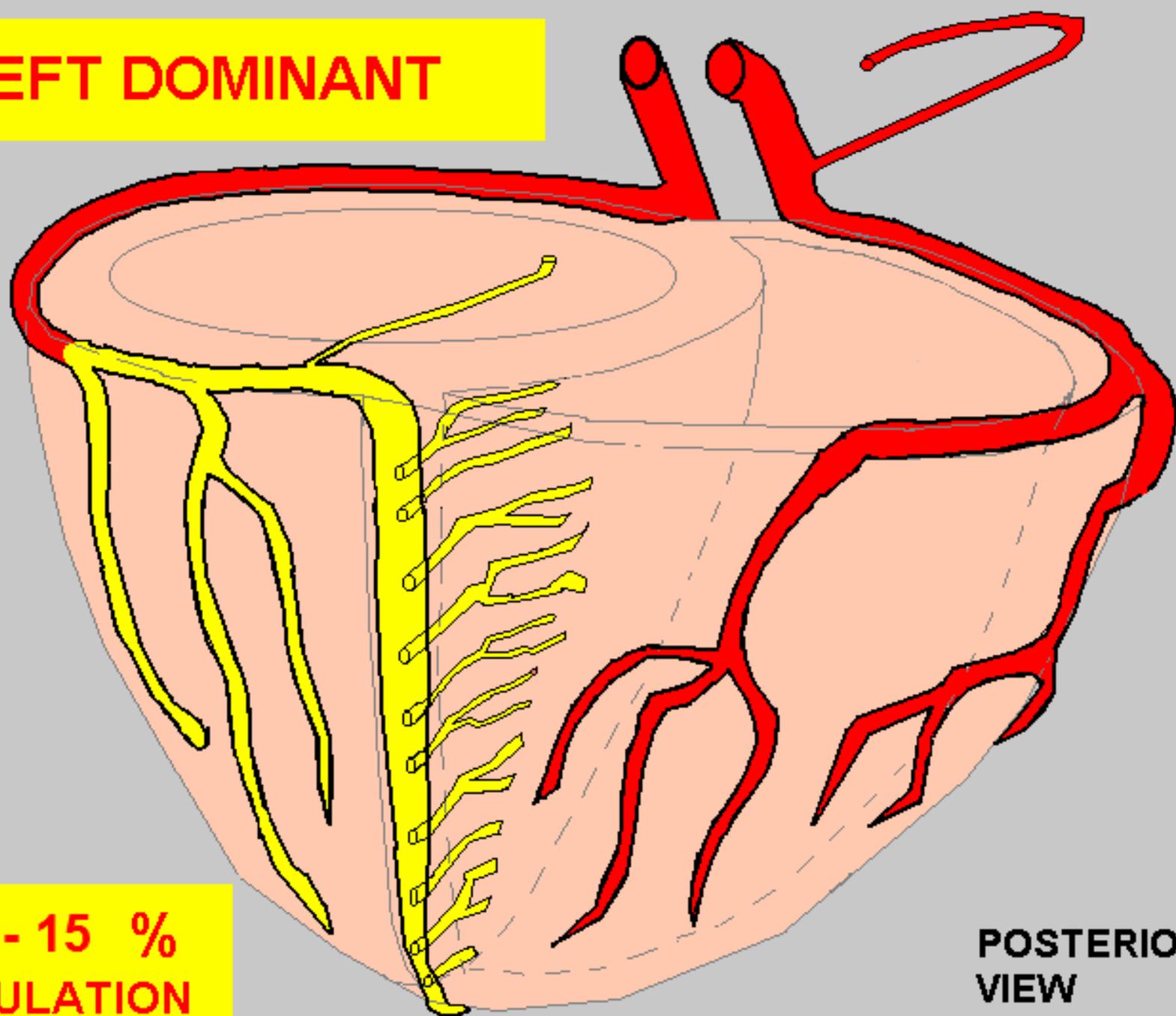
LEADS V1 - V3 view the POSTERIOR WALL



RUPPERT, WAYNE		ID: 7445683659	05-OCT-2006	JOHNS-HOPKINS UNIV.
38 Yrs	MALE	Vent. Rate: 68	160 ms	NORMAL SINUS RHYTHM
		P-R Int.: 160 ms	100 ms	Normal EKG
		QRS:		Very Healthy Athletic EKG!
I	AVR	V1	V4	
II	AVL	V2	V5	
III	AVF	V3	V6	

via **RECIPROCAL CHANGES.**

LEFT DOMINANT



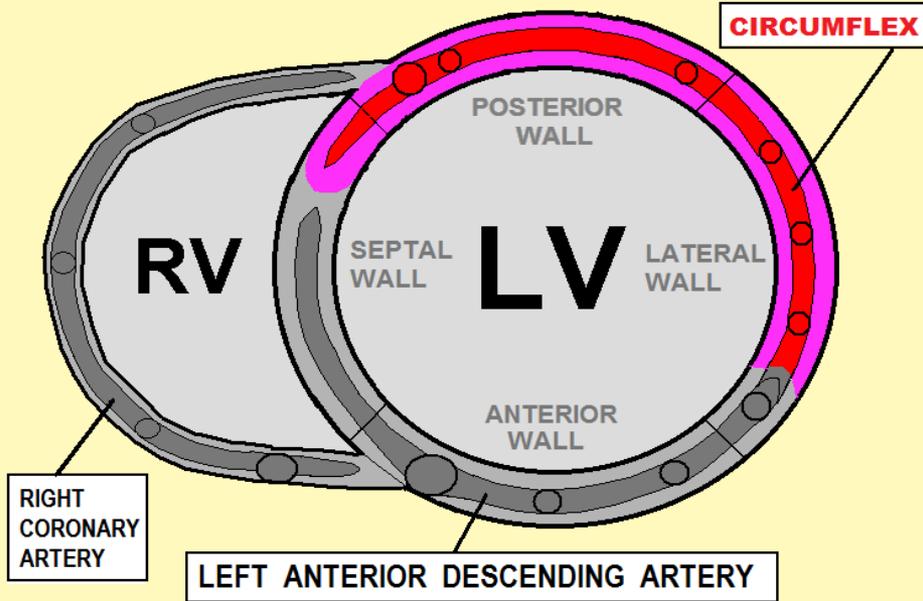
**10 - 15 %
POPULATION**

**POSTERIOR
VIEW**

Both patients will present with INFERIOR WALL STEMI (ST elevation leads II, III and AVF):

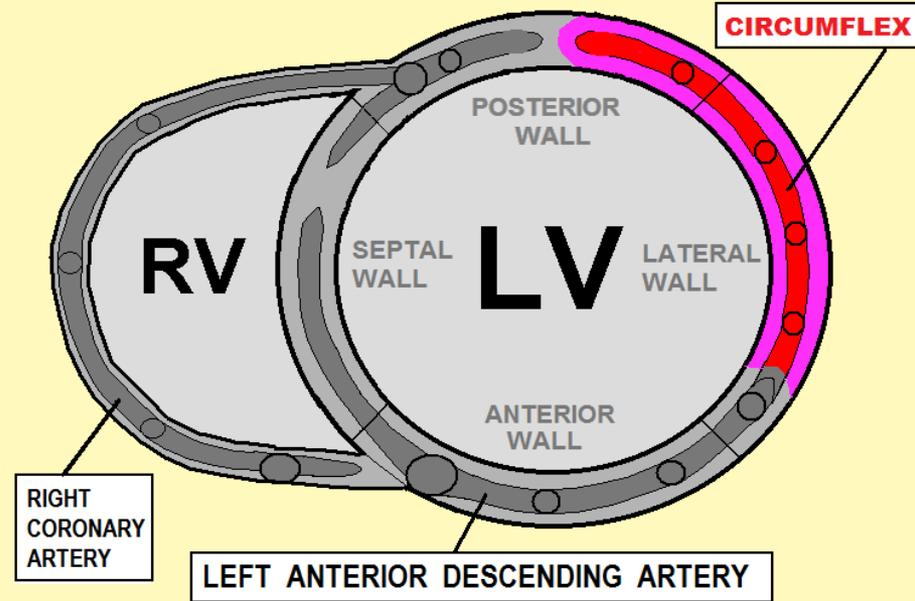
The **DOMINANT CIRCUMFLEX ARTERY** ...

SUPPLIES 35-55% OF THE LEFT VENTRICULAR MUSCLE MASS



The **NON - DOMINANT CIRCUMFLEX ARTERY**

SUPPLIES 25-30% OF THE LEFT VENTRICULAR MUSCLE MASS



Occlusion of **DOMINANT Circumflex** typically presents with more:

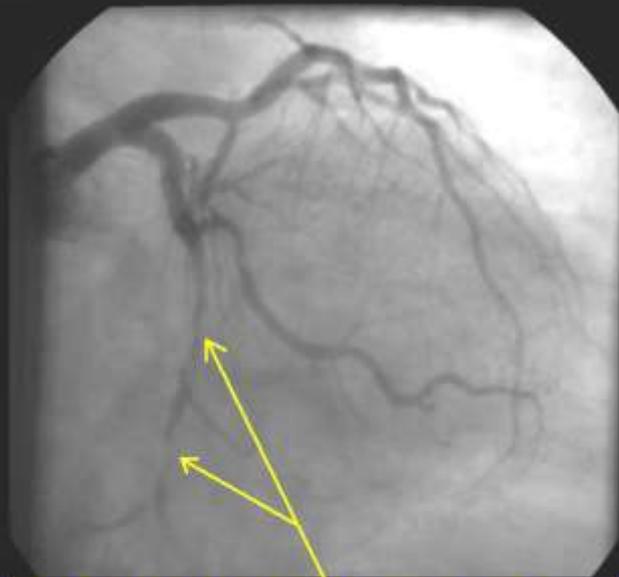
- ST Depression Leads V1 – V3 (Posterior MI)
- ST Elevation Leads V5, V6 (Lateral MI)

Usually has **PROFOUND** Cardiogenic Shock
ALMOST NEVER has Right Ventricular MI

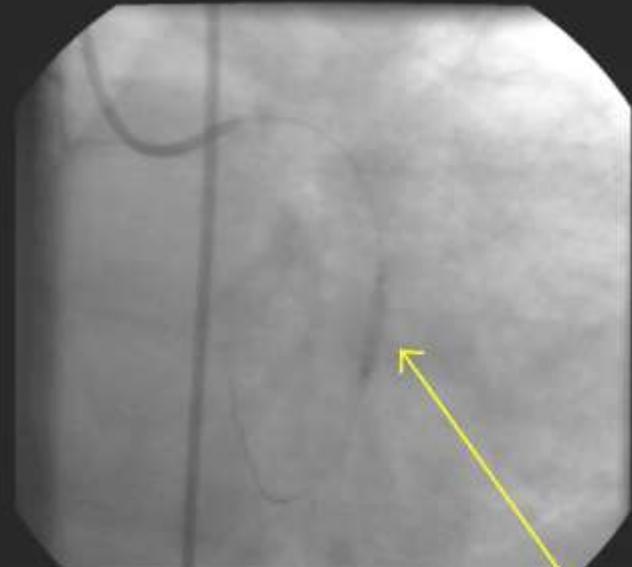
Occlusion of **DOMINANT RCA** typically presents with **VERY LITTLE** or **NO**:

- ST Depression Leads V1-V3
- ST Elevation Leads V5, V6

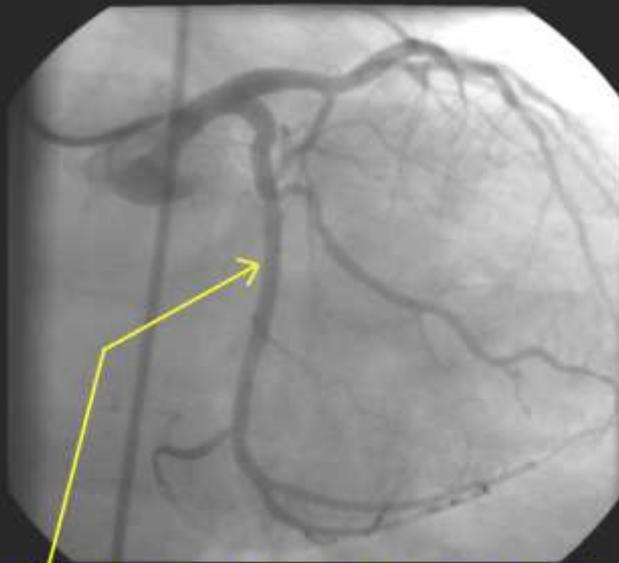
Usually **NO** Cardiogenic Shock, good BP
OFTEN has Right Ventricular MI



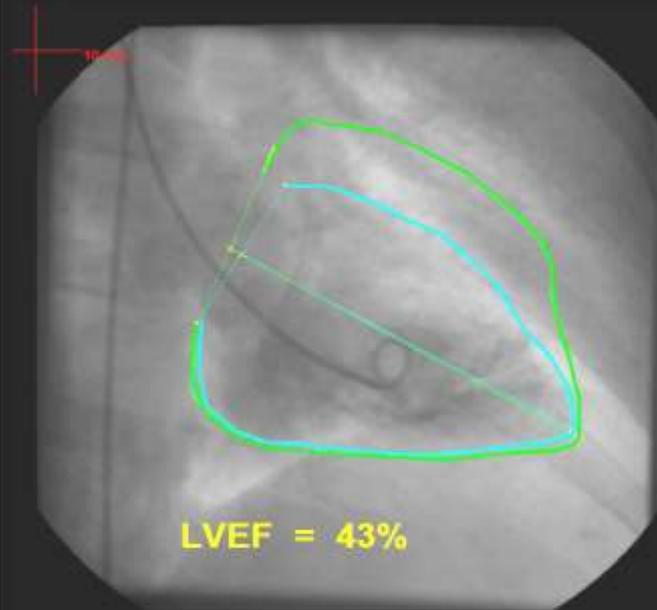
CIRCUMFLEX ARTERY OCCLUDED with significant THROMBUS.



PTCA of CIRCUMFLEX ARTERY.



DOMINANT CIRCUMFLEX ARTERY OPEN POST THROMBECTOMY with STENT DEPLOYMENT.



LVEF = 43%

Diast Area = 11.8 cm²
Diast Volume = 27.7 ml

Syst Area = 8.7 cm²
Syst Volume = 15.8 ml

Eject Frac = 43%
Stroke Volume = 11.9 ml

CASE STUDY SUMMARY

ST ELEVATION: II, III, aVF, V5, V6

ST DEPRESSION: V1 - V3, POSSIBLY I and aVL

SUSPECTED DIAGNOSIS: **ACUTE INFERIOR - POSTERIOR - LATERAL MI**

SUSPECTED "CULPRIT ARTERY" (if applicable):

OCCLUSION of DOMINANT CIRCUMFLEX ARTERY

IMMEDIATE CONCERNS FOR ALL STEMI PATIENTS:

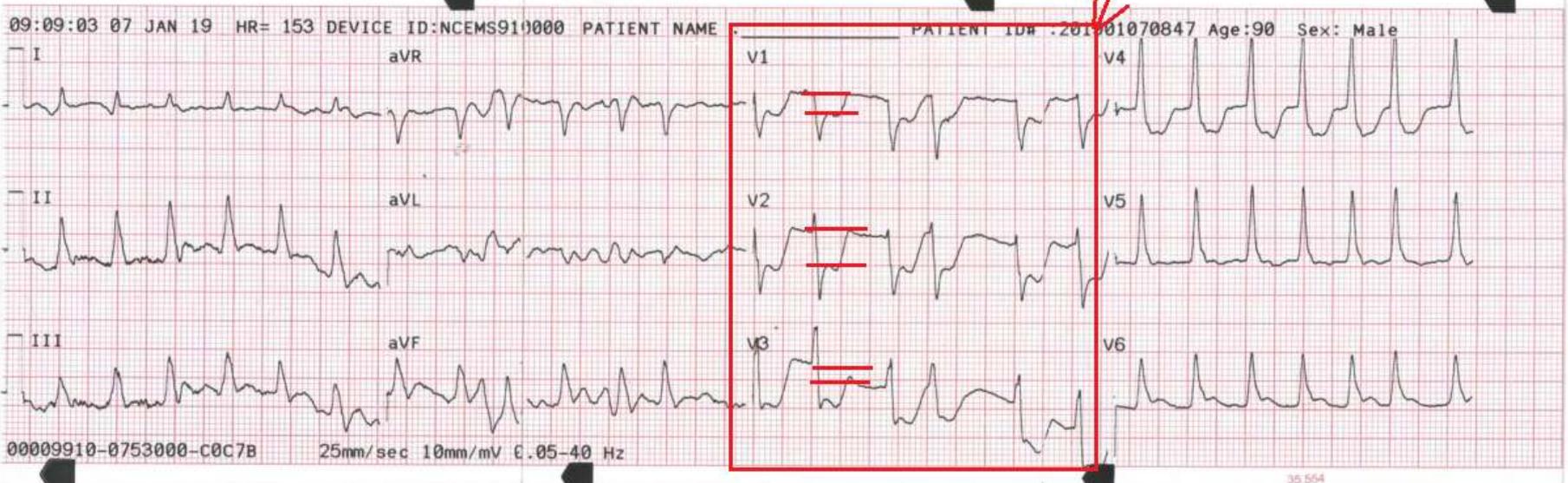
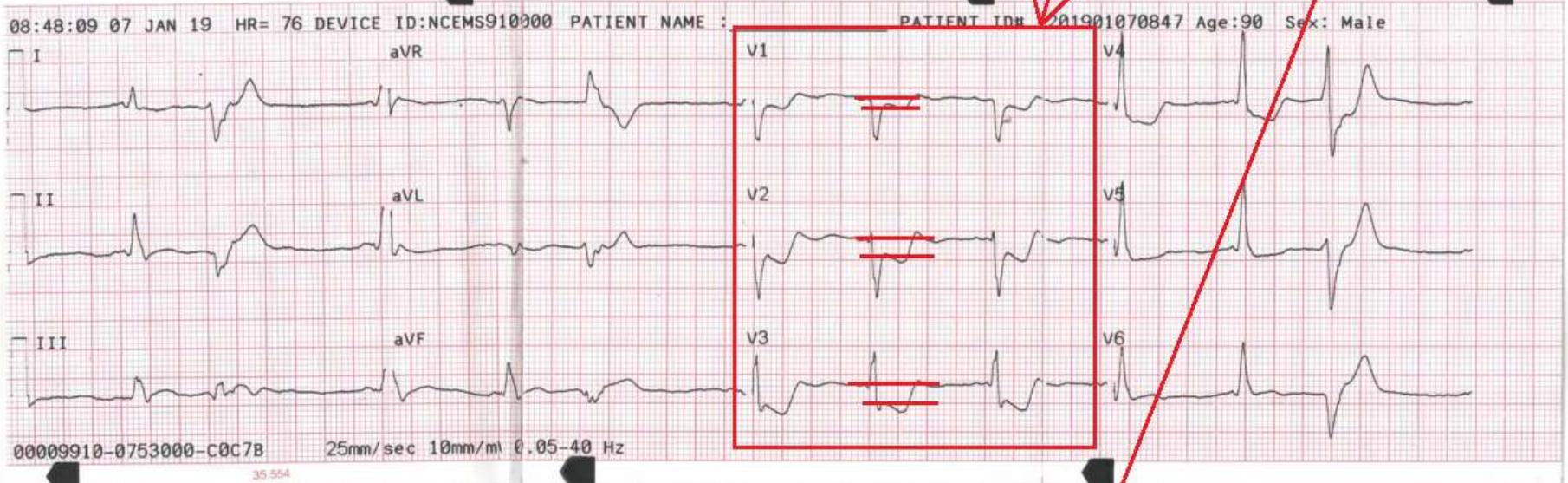
- BE PREPARED TO MANAGE SUDDEN CARDIAC ARREST (PRIMARY V - FIB / V- TACH, BRADYCARDIAS / HEART BLOCKS)
- STAT REPERFUSION THERAPY: THROMBOLYTICS vs. CARDIAC CATHETERIZATION and PCI
- CONSIDER NEEDS FOR ANTI-PLATELET and ANTI-COAGULATION THERAPY

CRITICAL STRUCTURES COMPROMISED:	POTENTIAL COMPLICATIONS:	POSSIBLE CRITICAL INTERVENTIONS:
 30 - 55% of LV MUSCLE MASS	 POSSIBLE SEVERE LV PUMP FAILURE	 INOTROPIC AGENTS ET INTUBATION I.A.B.P. INSERTION
 SA NODE	 SINUS BRADYCARDIA / SINUS ARREST	 ATROPINE TRANSCUTANEOUS PACING
 AV NODE	 HEART BLOCKS	 ATROPINE TRANSCUTANEOUS PACING
 SIGNIFICANT AMOUNT of PAPILLARY MUSCLE INSERTION to BASE of LV	 ACUTE PAPILLARY MUSCLE TEAR and MITRAL VALVE REGURGITATION (7 - 10 DAYS)	 INOTROPIC AGENTS DIEURETICS EMERGENCY SURGERY

Case Study- January 2019

- 79 y/o female complaining of “L arm pain, and minimal chest pain”
- EMS 12 Lead ECGs show ST Depression in Anterior Leads V1-V4. There is NO ST Elevation.....

Two EMS 12 Lead ECGs: none show ST Elevation, but both show significant ST depression in Anterior Leads V1-V3.



Initial Exam in ED

- Upon arrival in ED, 12 Lead ECG confirmed EMS findings: ST Depression in Leads V1-V4.

Pat ID [REDACTED]

01/07/2019 09:19:35
[REDACTED] 79 yrs

[REDACTED]
Caucasian Female
Account # [REDACTED]

Bayfront Health Seven Rivers ED
Dept ED
Room ED01
Tech gp

RX
DX

Rate 153 Atrial fibrillation with rapid V-rate
PR Nonspecific intraventricular conduction delay
QRSd 117 NO PREVIOUS ECG AVAILABLE FOR COMPARISON
QT 260
QTc 415

Req Provider:

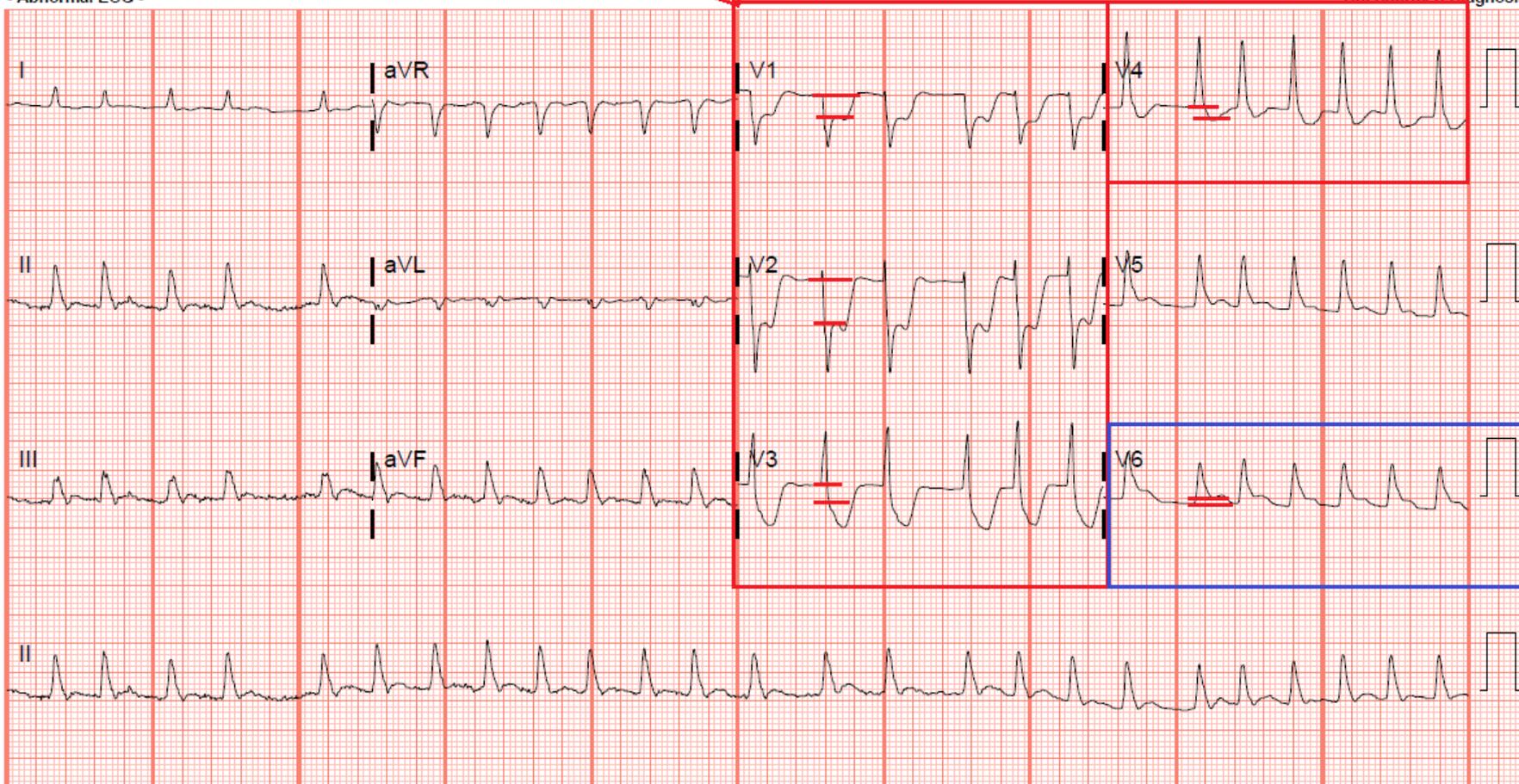
--Axis--

P
QRS 73
T 78

ST Depression Leads V1 - V4

**Minimal ST Elevation in Lead V6.
(Does not meet STEMI Criteria)**

- Abnormal ECG -



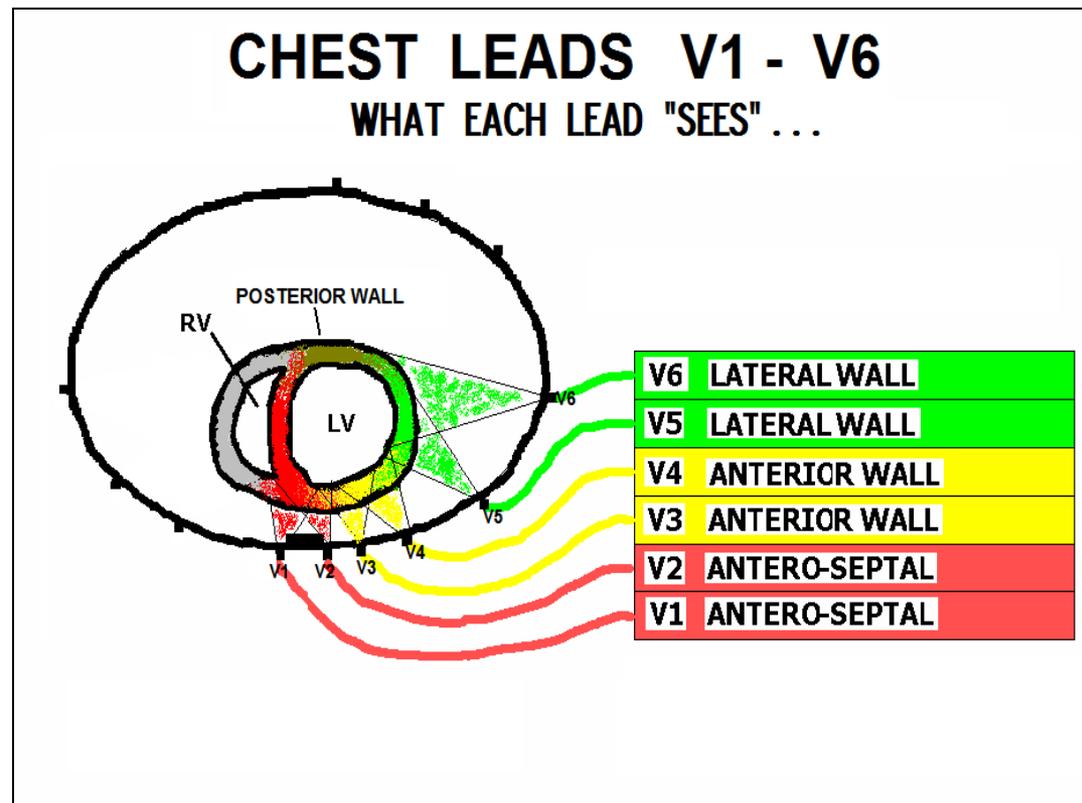
Unconfirmed Diagnosis

Causes of ST Depression V1-V4

- Anterior Wall ischemia
- Anterior Wall NSTEMI (partial wall thickness myocardial infarction)
- **Posterior Wall STEMI**

Posterior Wall STEMI....

- **Does not show ST elevation on standard 12 lead ECG** because NONE of the 12 leads view the Posterior Wall directly....

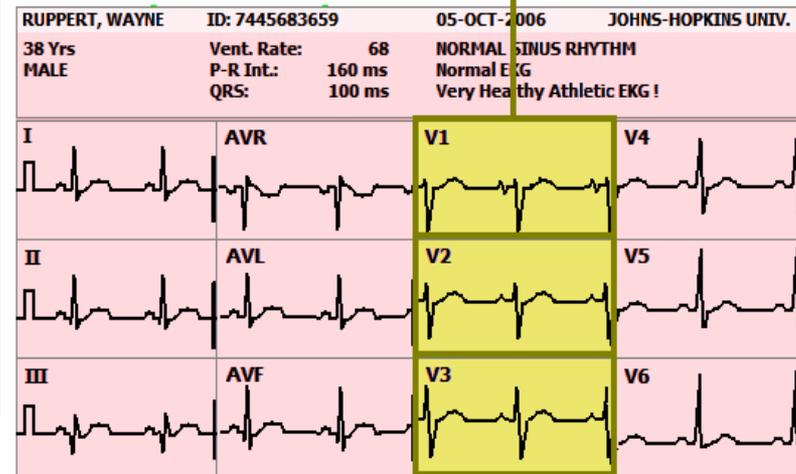
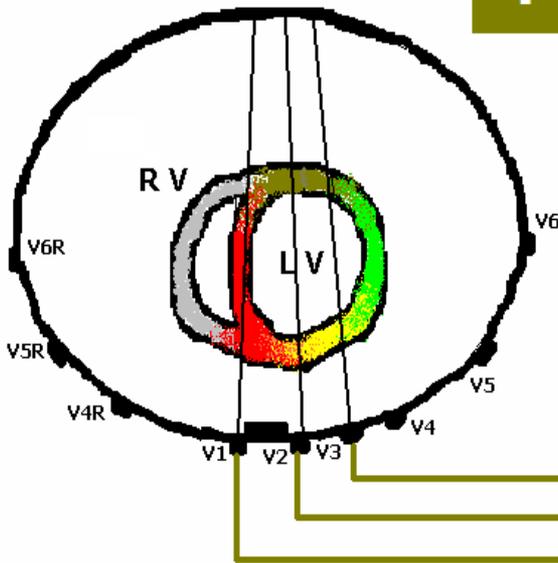


Posterior Wall STEMI....

- Often shows NO ST Elevation on the standard 12 Lead ECG.
- Will show up on standard 12 Lead ECG as “ST Depression” (Reciprocal) in Leads V1-V3 (sometimes V4-V6, too).

V1-V3 see the Posterior Wall ONLY through RECIPROCAL changes (ST Depression)

**LEADS V1 - V3 view the
POSTERIOR WALL**

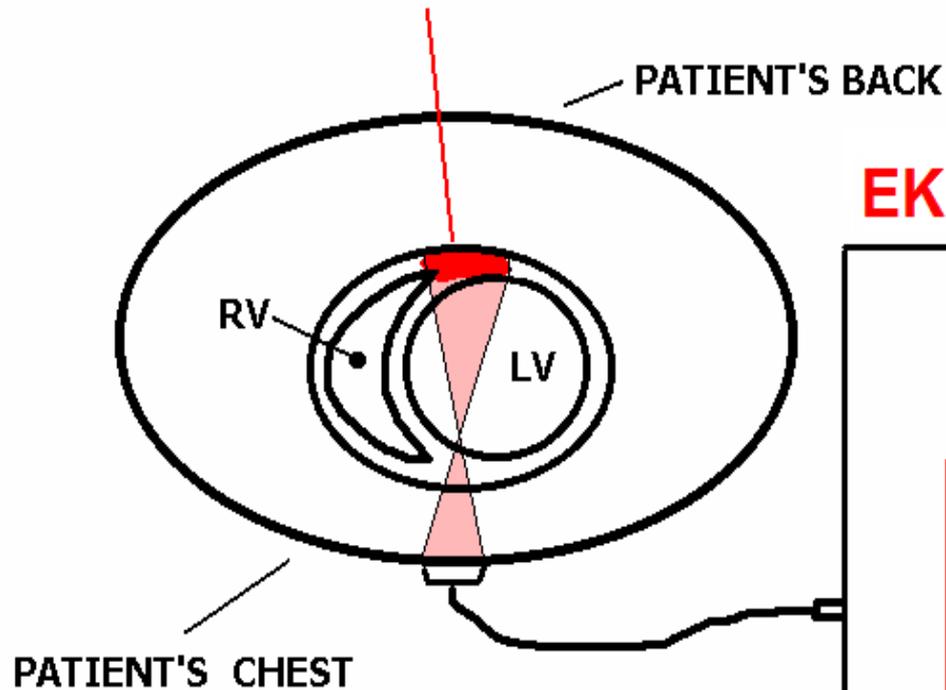


via RECIPROCAL CHANGES.

HOW EKG VIEWS RECIPROCAL CHANGES

EXAMPLE:

AREA OF ACUTE INFARCTION - POSTERIOR WALL



EKG sees S-T DEPRESSION

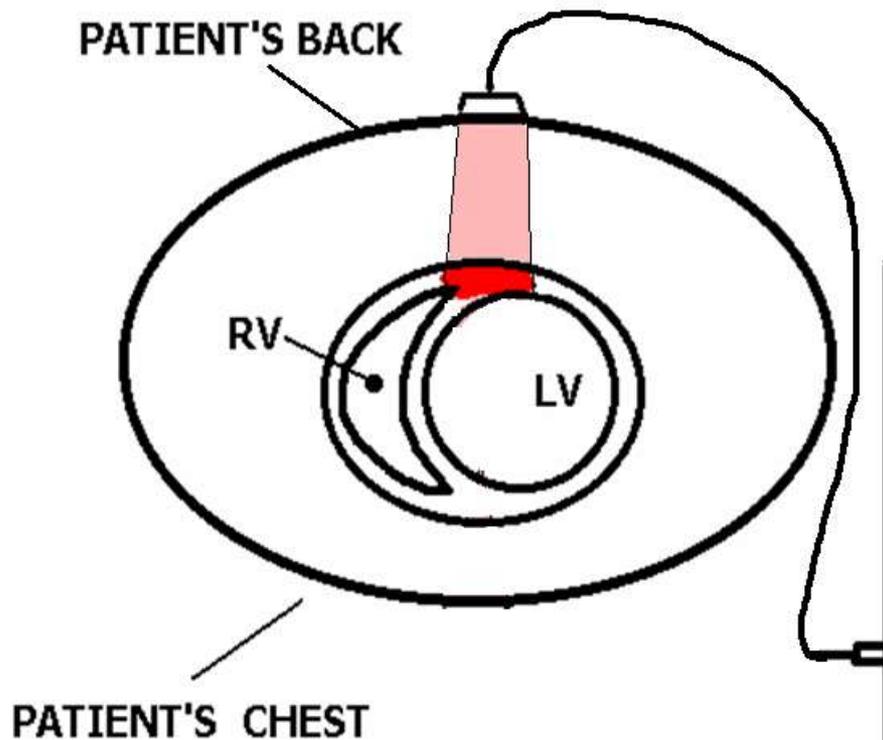
ECG LEAD V2



Posterior Wall STEMI....

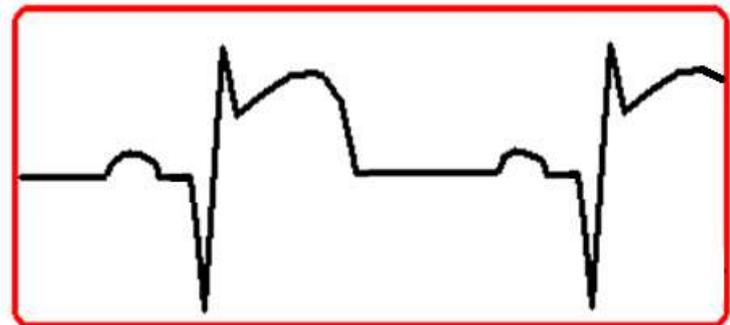
- To see **ST Elevation** from a Posterior Wall STEMI, *you must place ECG leads **on the patient's back...***

If we put ECG leads on the BACK of a PATIENT who is having an **ACUTE POSTERIOR WALL MI**



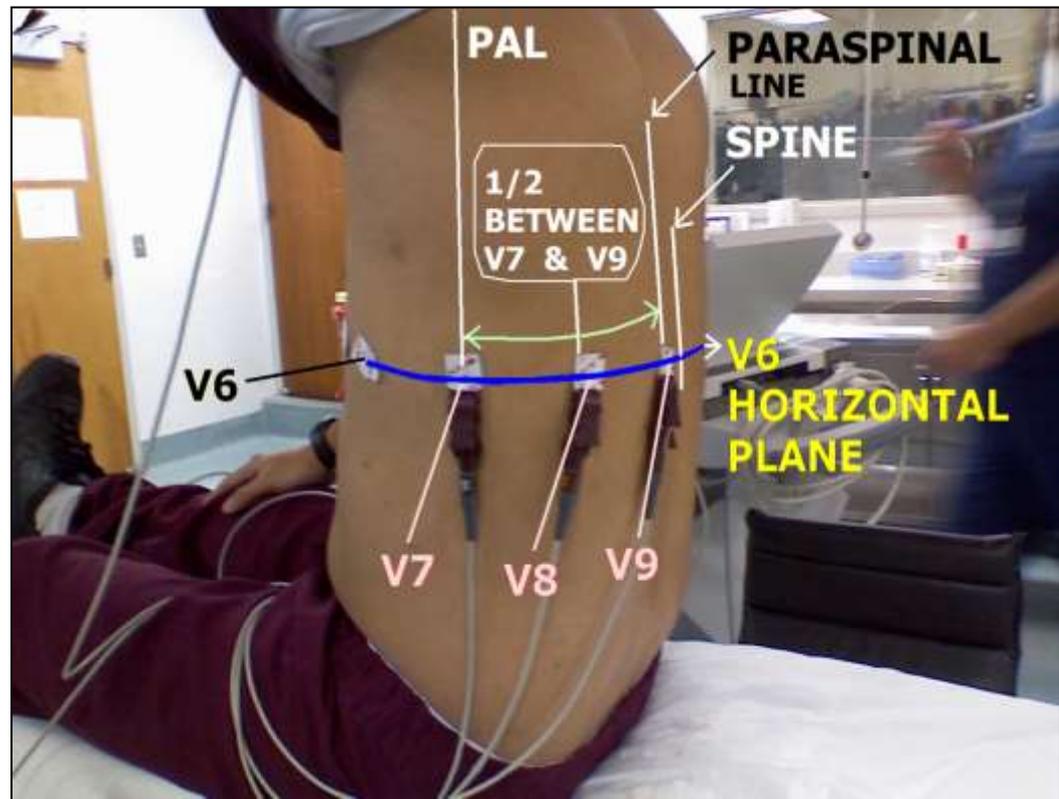
EKG sees S-T ELEVATION

ECG LEADS: V7, V8 or V9



Continued Exam in the ED....

- Upon noting ST Depression in Anterior Leads V1-V4, ED Paramedic Gary Polizzi place three leads on the patient's back. Gary used the lead wires for V4, V5 and V6, with placement as shown here:
- The "Posterior Lead ECG" is seen on the next slide.....



Posterior STEMI Criteria:

- ST Elevation of 0.5mm (0.5mv) or more in Leads V7, V8 and/or V9

Posterior STEMI Criteria:

- ST Elevation of ___mm (0.5mv) or more in Leads V7, V8 and/or V9

Pat ID [REDACTED]

01/07/2019 09:23:29

[REDACTED] 79 yrs

Caucasian Female

Account [REDACTED]

Bayfront Health Seven Rivers ED

Dept EDHD

Room EDH

Tech gp

RX
DX

Req Provider: ONIER VILLARREAL

Rate	133	Atrial fibrillation
PR		Anterolateral infarct, acute
QRSd	114	Prolonged QT interval
QT	337	COMPARED TO ECG 01/07/2019 09:21:04
QTc	502	PROLONGED QT INTERVAL NOW PRESENT

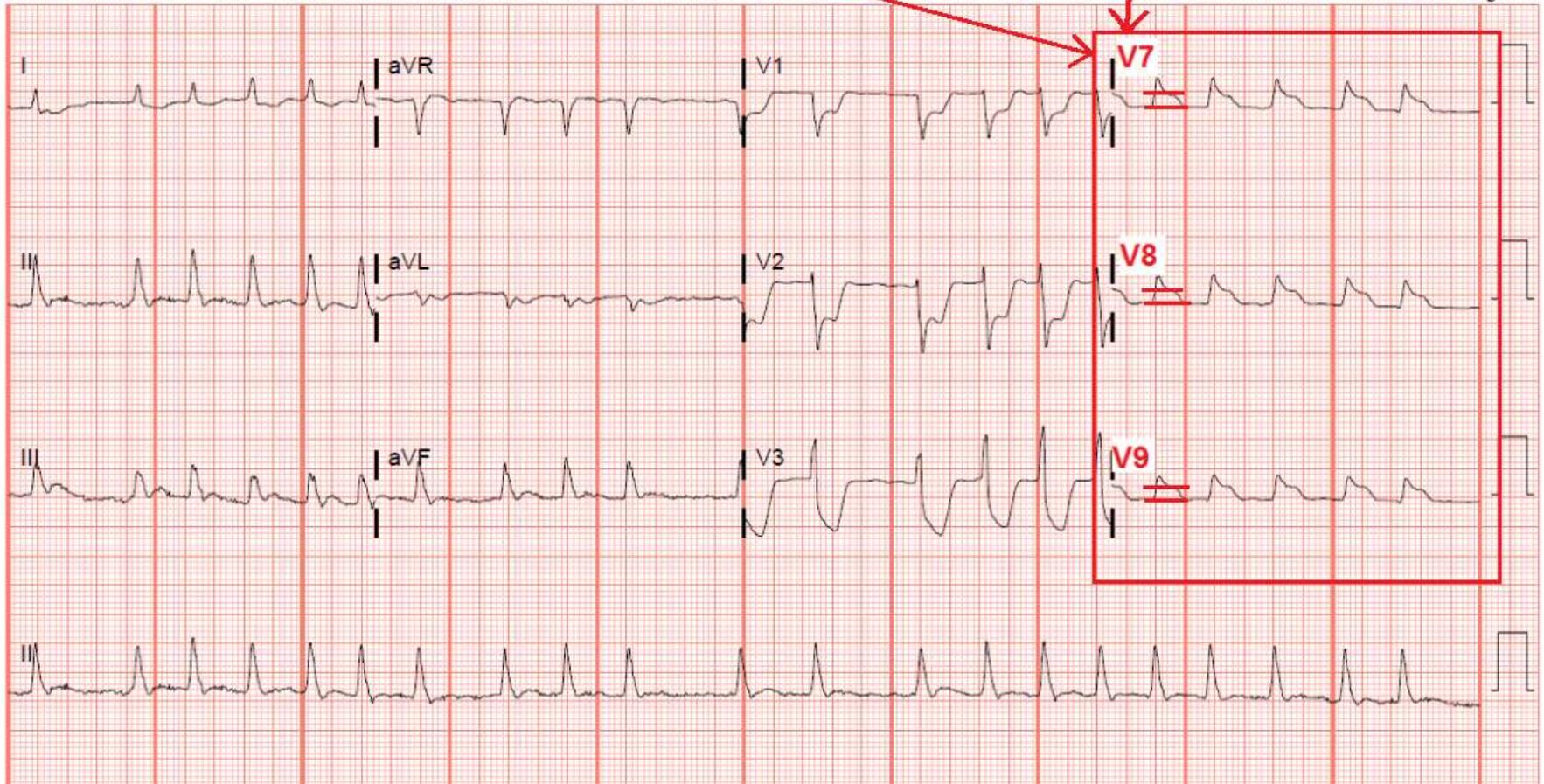
**** Posterior Infarct - Acute ****

ACUTE POSTERIOR WALL STEMI

Chest leads V4-V6 repositioned to patient's back (Posterior Leads V7, V8 and V9) reveal ST Segment Elevation. Patient diagnosis changes from "possible NSTEMI" to "Acute STEMI."

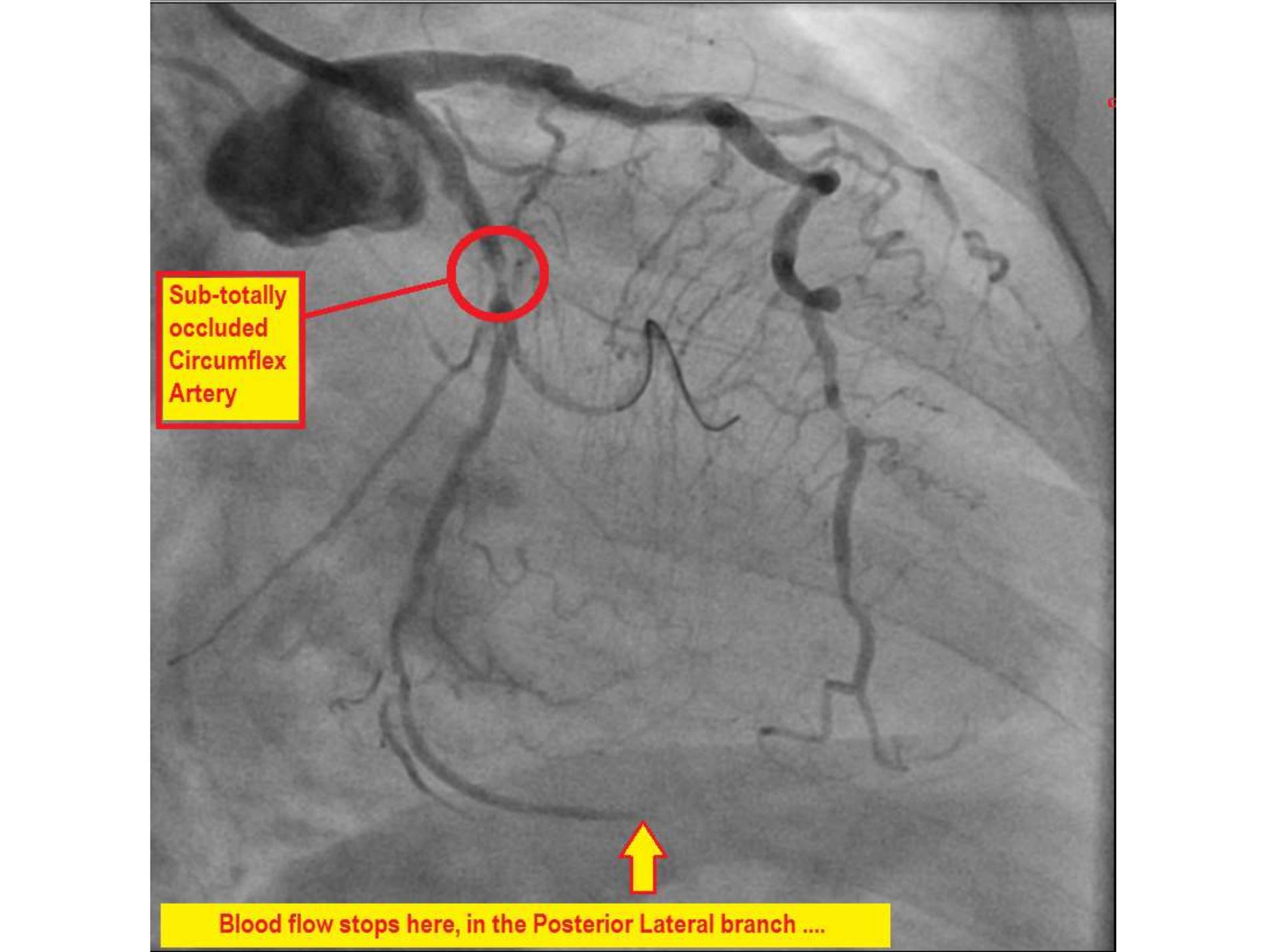
- Abnormal ECG -

Unconfirmed Diagnosis



STEMI Alert !

Upon seeing “Significant ST Elevation in TWO or more CONTIGUOUS LEADS, the ED physician diagnosed “Posterior Wall STEMI,” a STEMI Alert was issued, and the patient was taken immediately to the cardiac cath lab, where the following images were obtained.....

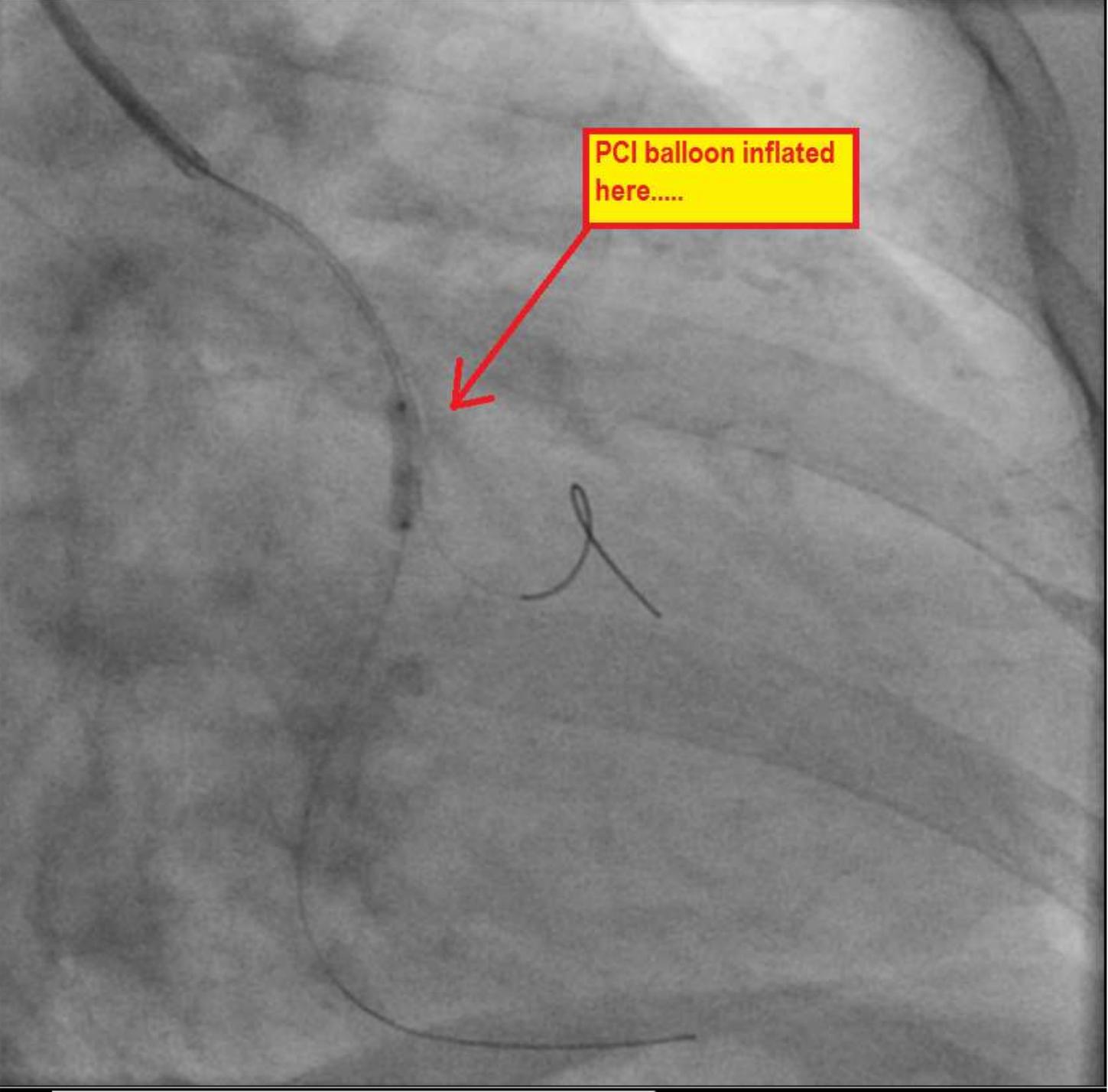


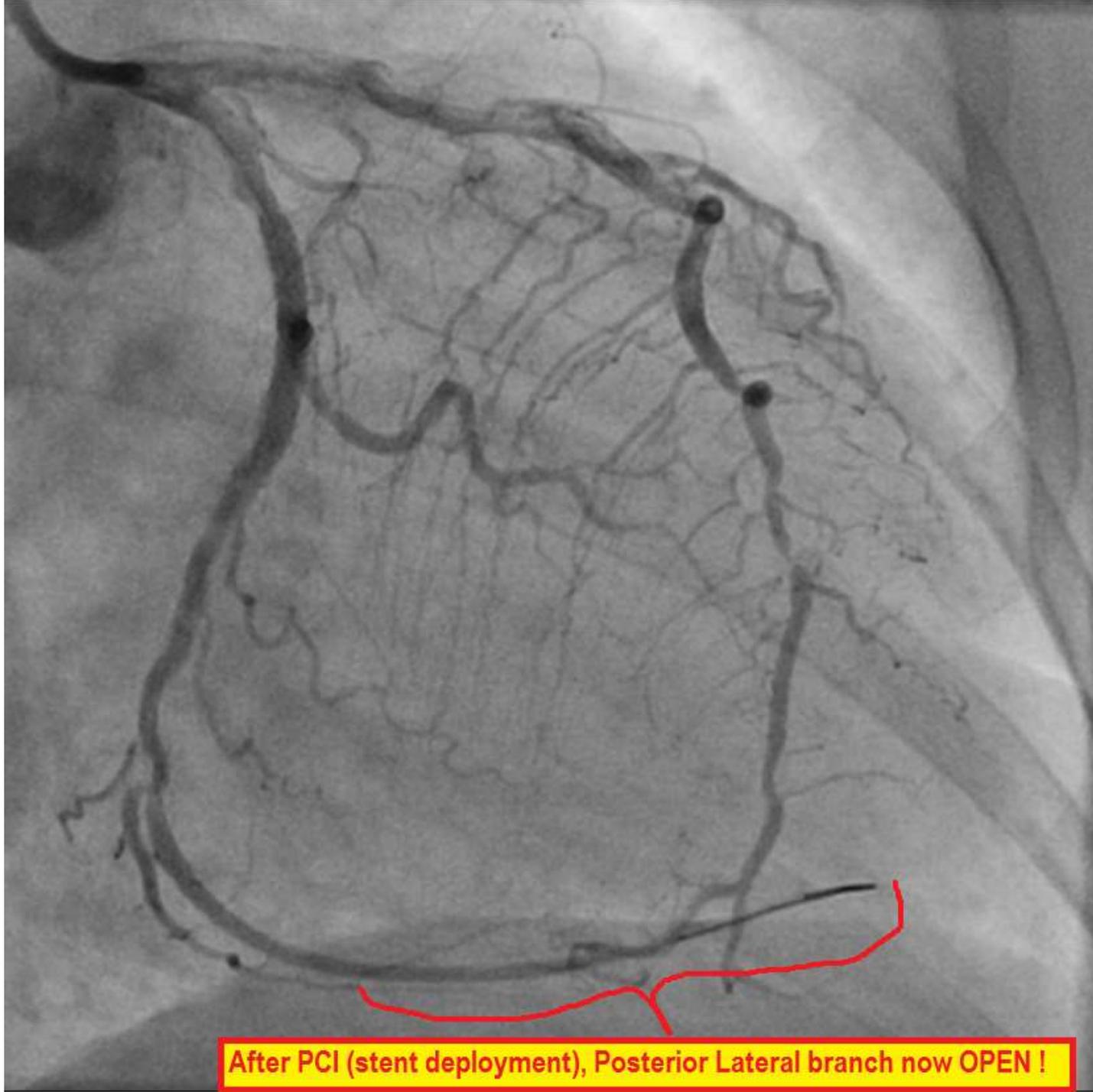
Sub-totally
occluded
Circumflex
Artery

This is a grayscale coronary angiogram showing the coronary artery system. A red circle highlights a narrowing in the Circumflex Artery. A yellow arrow points to a blockage in the Posterior Lateral branch. The rest of the coronary tree is visible with varying degrees of contrast.

Blood flow stops here, in the Posterior Lateral branch

PCI balloon inflated here.....





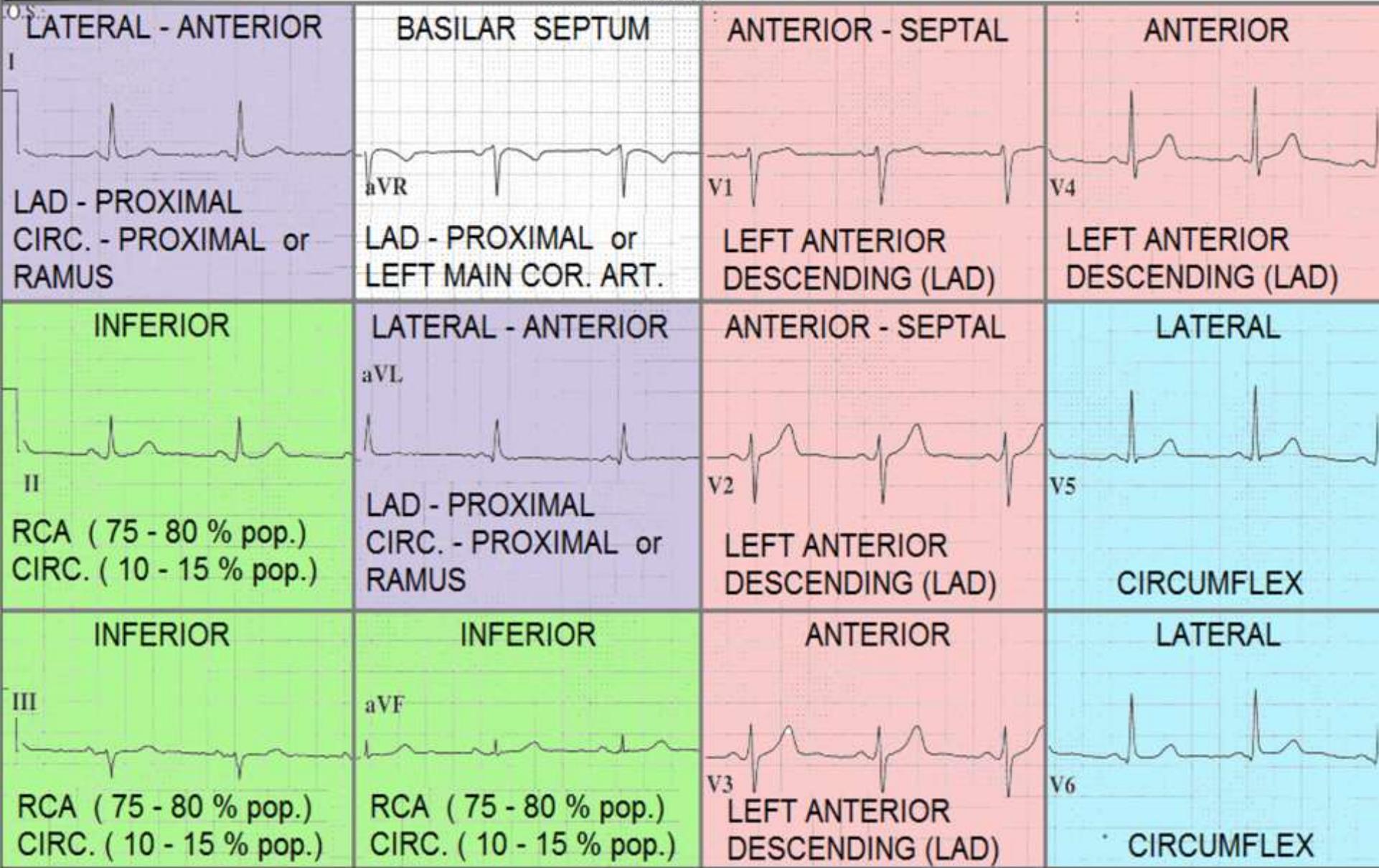
After PCI (stent deployment), Posterior Lateral branch now OPEN !

SUMMARY

- Whenever ST Depression is noted in Anterior Leads (V1-V4), it could indicate that Acute Posterior Wall STEMI is present.
- To rule-out Posterior Wall STEMI, a “posterior lead ECG” (V7 – V9) must be obtained.
- In THIS CASE, **Posterior Wall STEMI** was diagnosed via Posterior Lead ECG.
- **STEMI Alert was issued, with a Door-to-PCI time of 53 minutes.**

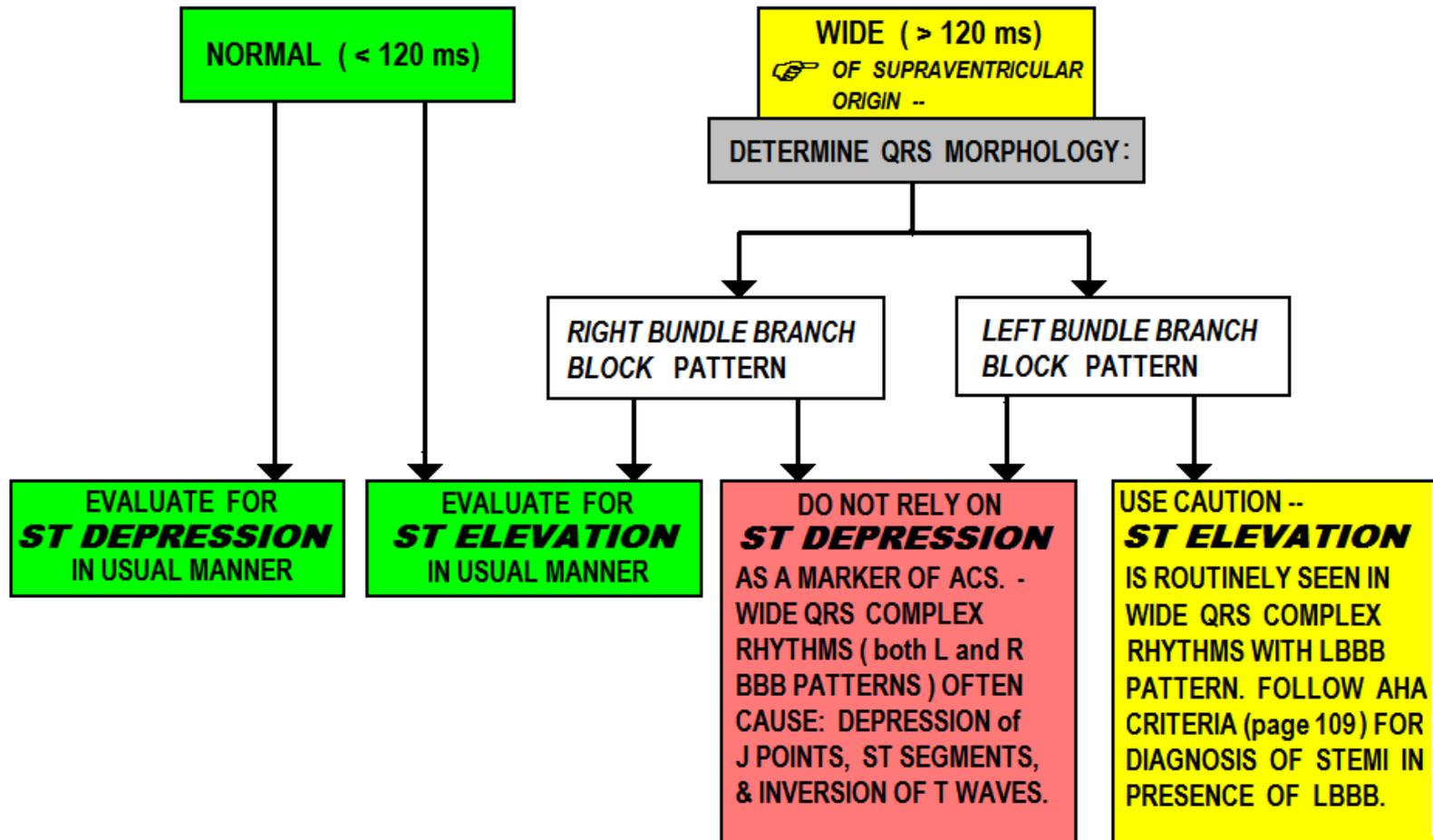
Vent. rate 64 BPM Normal sinus rhythm
 PR interval 130 ms Normal ECG
 QRS duration 96 ms No previous ECGs available
 QT/QTc 396/408 ms
 P-R-T axes 40 11 61

Referred by:



Evaluating the ECG for ACS:

STEP 1 - EVALUATE WIDTH OF QRS:



**Wide QRS present:
QRSd > 120ms**

- **Determine RIGHT vs. LEFT Bundle Branch Block Pattern**

Simple "Turn Signal Method" . . .

THE "TURN SIGNAL METHOD" for identifying BUNDLE BRANCH BLOCK

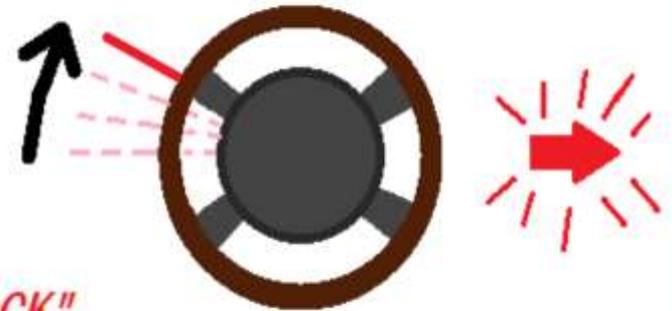
V1

USE LEAD V1 for this technique

To make a **RIGHT TURN**
you push the turn signal lever **UP**

THINK:

"QRS points UP = RIGHT BUNDLE BRANCH BLOCK"

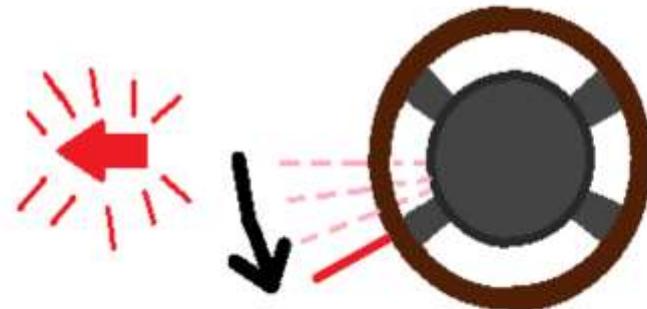


V1

To make a **LEFT TURN**
you push the turn signal lever **DOWN**

THINK:

"QRS points DOWN = LEFT BUNDLE BRANCH BLOCK"



“Terminal Phase of QRS Method”...

DIAGNOSING BUNDLE BRANCH BLOCK

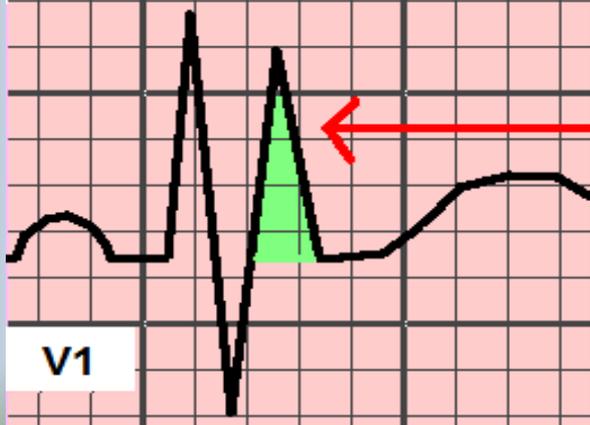
L.B.B.B.



USING LEAD V1

- QRS WIDER THAN 120 ms
- BEAT IS SUPRAVENTRICULAR IN ORIGIN
- TERMINAL PHASE OF QRS COMPLEX (LAST DEFLECTION)

R.B.B.B.



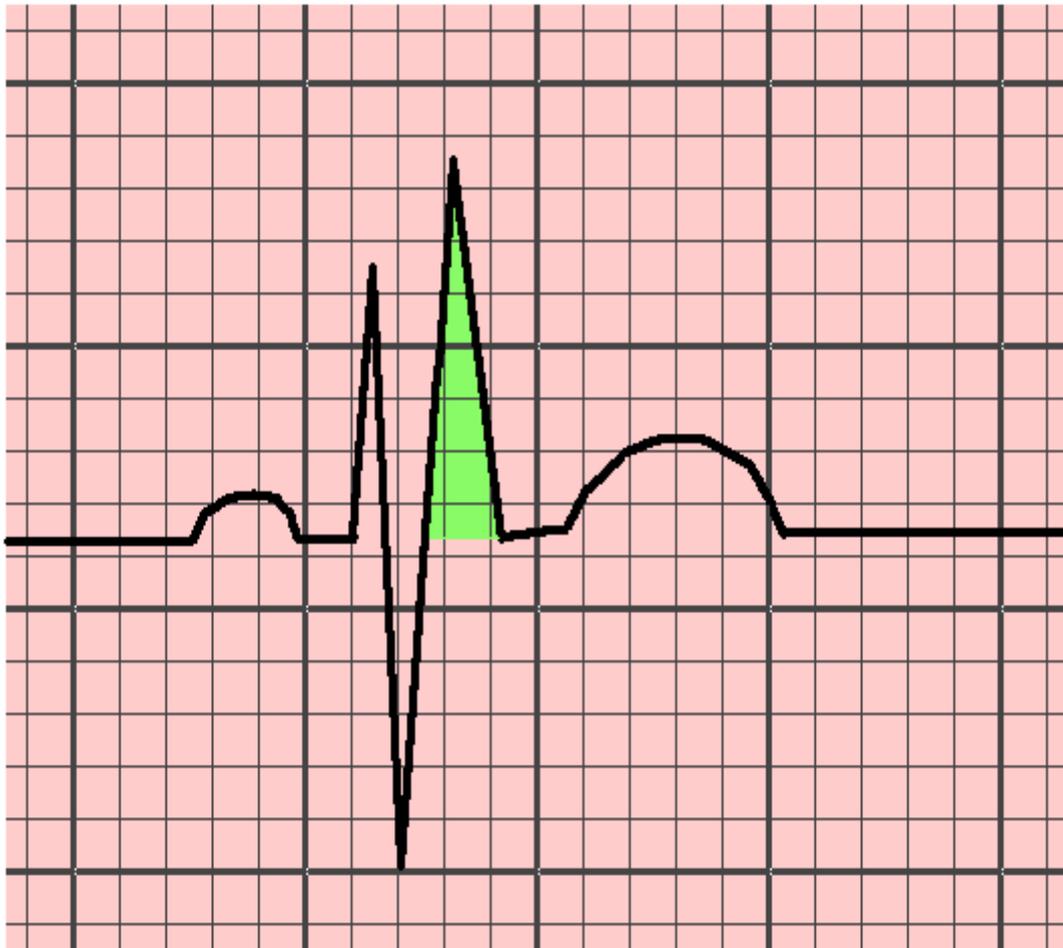
- NEGATIVE = LEFT BUNDLE BRANCH BLOCK
- POSITIVE = RIGHT BUNDLE BRANCH BLOCK

DIAGNOSING LBBB IN LEAD V1:



- QRS GREATER THAN 120 ms (.12)
- EVIDENCE THAT THIS IS NOT VENTRICULAR BEAT
- TERMINAL PHASE (LAST PART) OF QRS COMPLEX IS NEGATIVE DEFLECTION
- S-T SEGMENTS ARE NORMALLY ALWAYS ELEVATED !

DIAGNOSING RBBB IN LEAD V1:



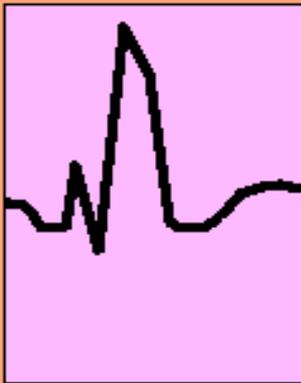
- **WIDER THAN 120 ms (.12)**
(or 3 little boxes)
- **TERMINAL PHASE (LAST PART) OF QRS COMPLEX IS POSITIVE DEFLECTION**

DIAGNOSING BUNDLE BRANCH BLOCK

USING LEADS V1, V2, and V5, V6:

LOCATING R_sR' or RR' COMPLEXES:

V1



V2



**RIGHT BUNDLE
BRANCH BLOCK**

V5



V6



**LEFT BUNDLE
BRANCH BLOCK**

74years
Male Caucasian
Room:
Loc: 0 Opt:

Vent. rate 72 bpm
PR interval 186 ms
QRS duration 166 ms
QT/QTc 436/477 ms
P-R-T axes 57 -32 32

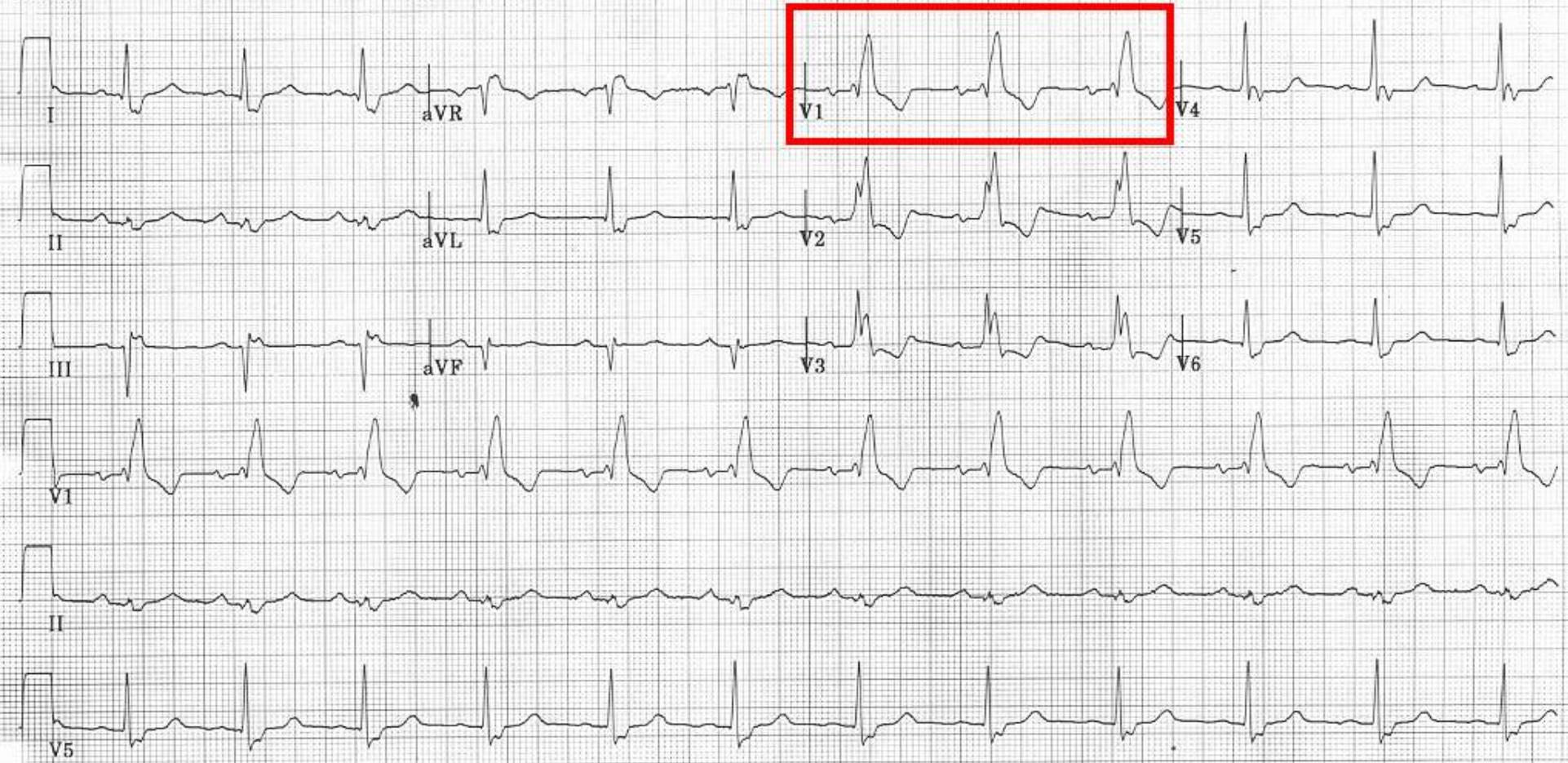
Normal sinus rhythm
Left axis deviation
Right bundle branch block
Inferior infarct, age undetermined
Abnormal ECG

Technician: WR

Referred by:

Unconfirmed

D.O.S.:



TERMINAL PHASE OF QRS IS
POSITIVE



**= RIGHT BUNDLE
BRANCH BLOCK**

09:16:40

74 yr
Female Caucasian

Vent. rate 64 BPM
PR interval 188 ms
QRS duration 152 ms
QT/QTc 472/486 ms
P-R-T axes 78 3 106

Normal sinus rhythm
Left bundle branch block
Abnormal ECG
When compared with ECG of 28-MAY-2003 06:36,

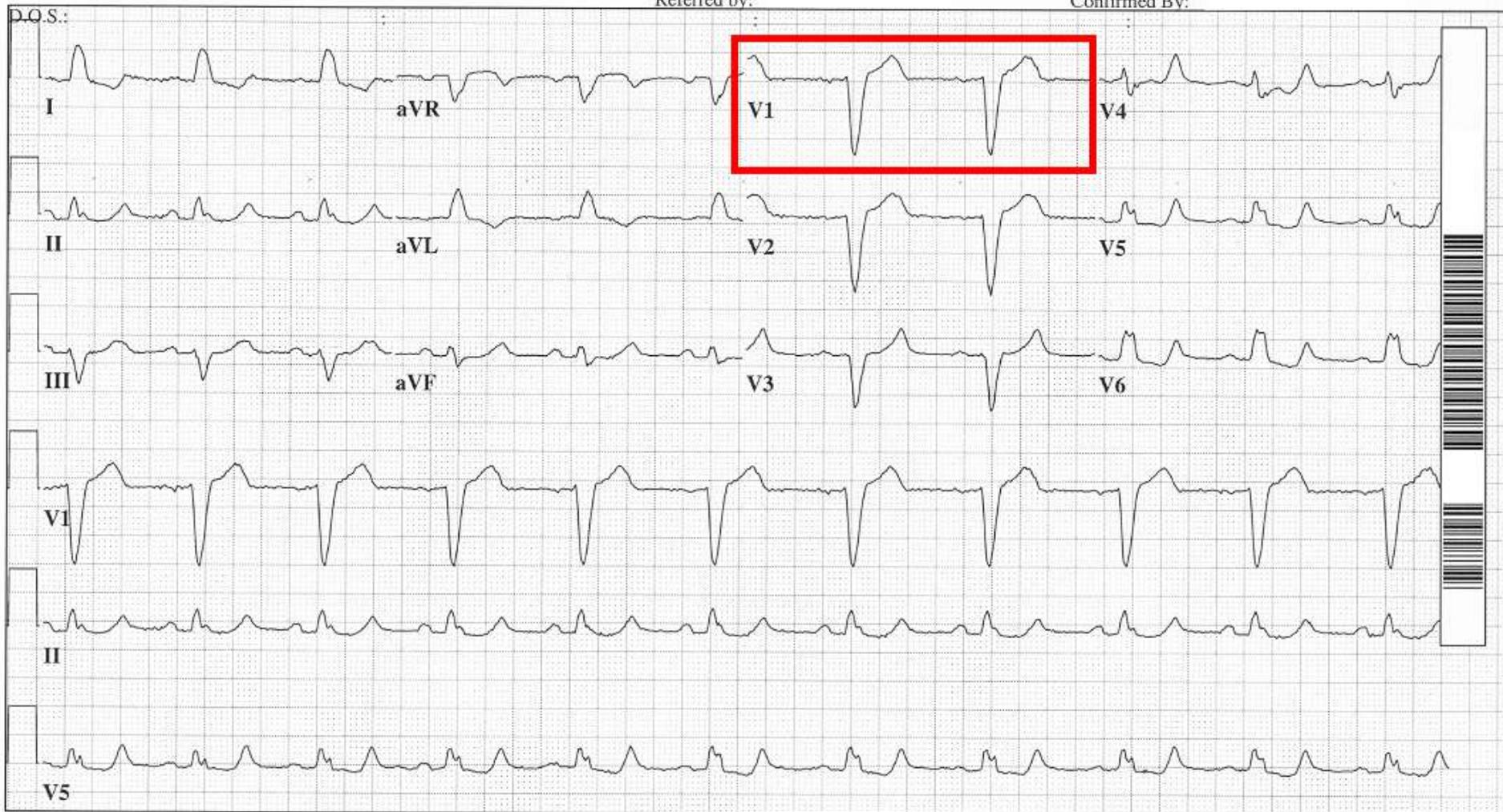
Loc:7 Option:35

EKG #WR03029959

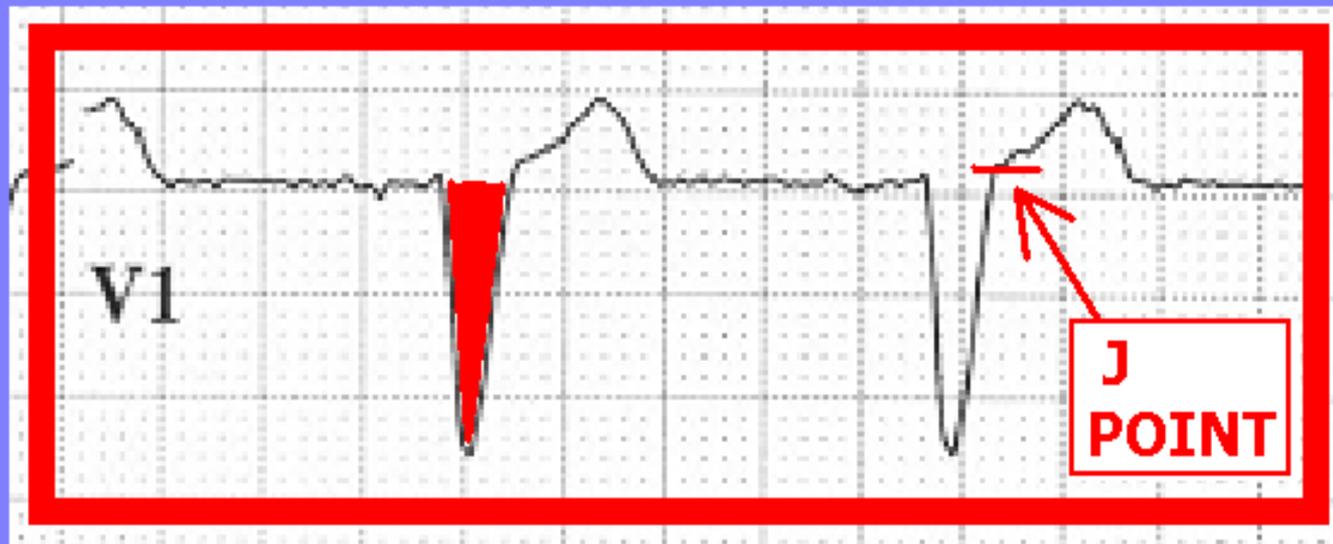
Technician: WW

Referred by:

Confirmed By:



**TERMINAL PHASE OF QRS IS
NEGATIVE**



**= LEFT BUNDLE
BRANCH BLOCK**

Wide QRS present: (QRSd > 120ms)

- **When RIGHT Bundle Branch Block pattern is present:**
 - **Precordial Leads typically demonstrate ST Depression and T wave Inversion**

74 years		Vent. rate	72 bpm	Normal sinus rhythm
Male	Caucasian	PR interval	186 ms	Left axis deviation
		QRS duration	166 ms	Right bundle branch block
Room:		QT/QTc	436/477 ms	Inferior infarct, age undetermined
Loc: 0	Opt:	P-R-T axes	57 -32 32	Abnormal ECG

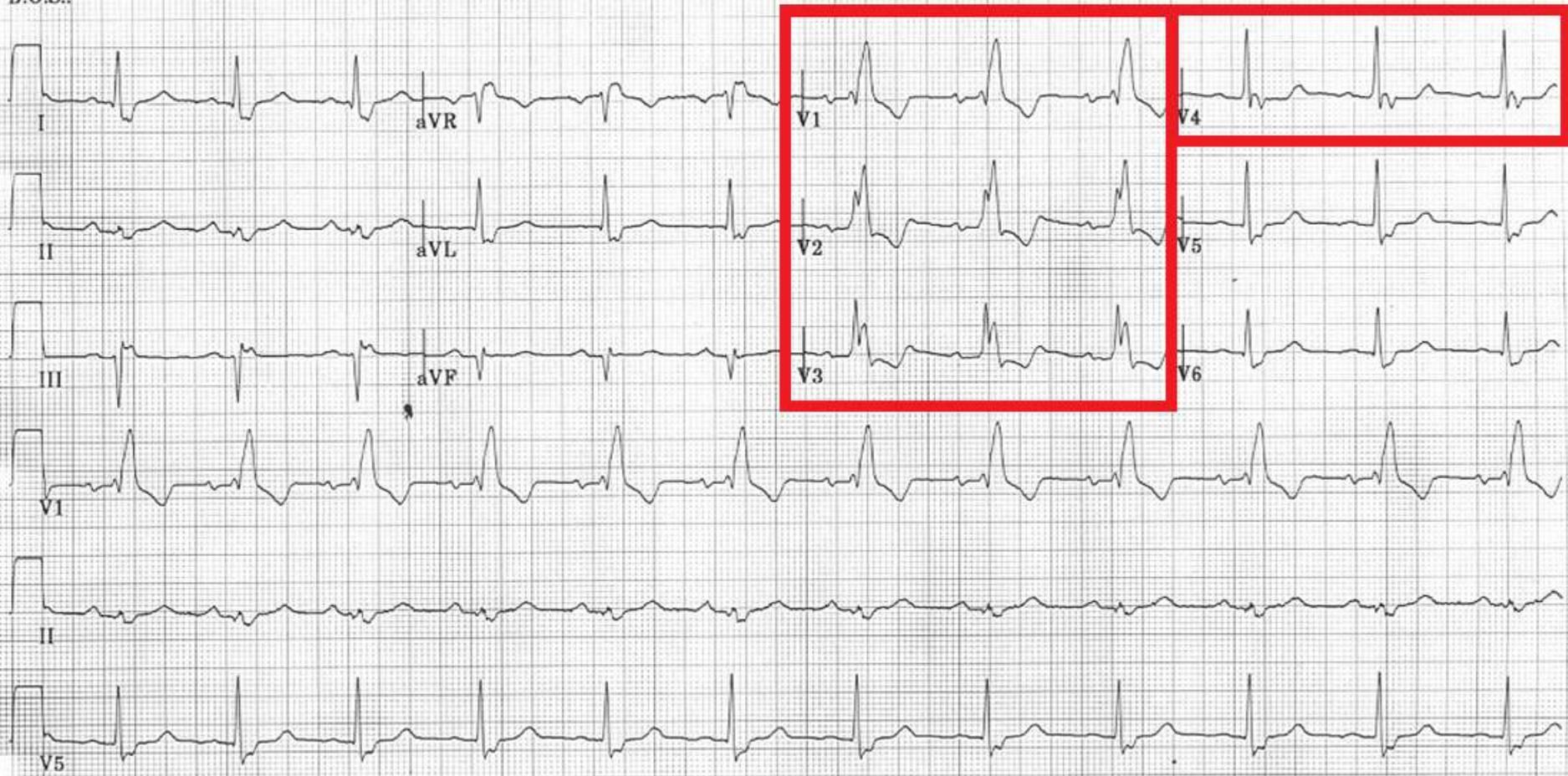
RBBB causes ST Depression, T Wave Inversion, ANTERIOR Leads (V1 - V4).

Technician: WR

Referred by:

Unconfirmed

D.O.S.:



Wide QRS present: (QRSd > 120ms)

- **When RIGHT Bundle Branch Block pattern is present:**
 - Precordial Leads typically demonstrate ST Depression and T wave Inversion
 - **DOES NOT MASK STEMI; *when ST Elevation is noted, CONSIDER STEMI !!***

RBBB with CHEST PAIN - CASE 1: ST ELEVATION IN LEADS V1 - V4

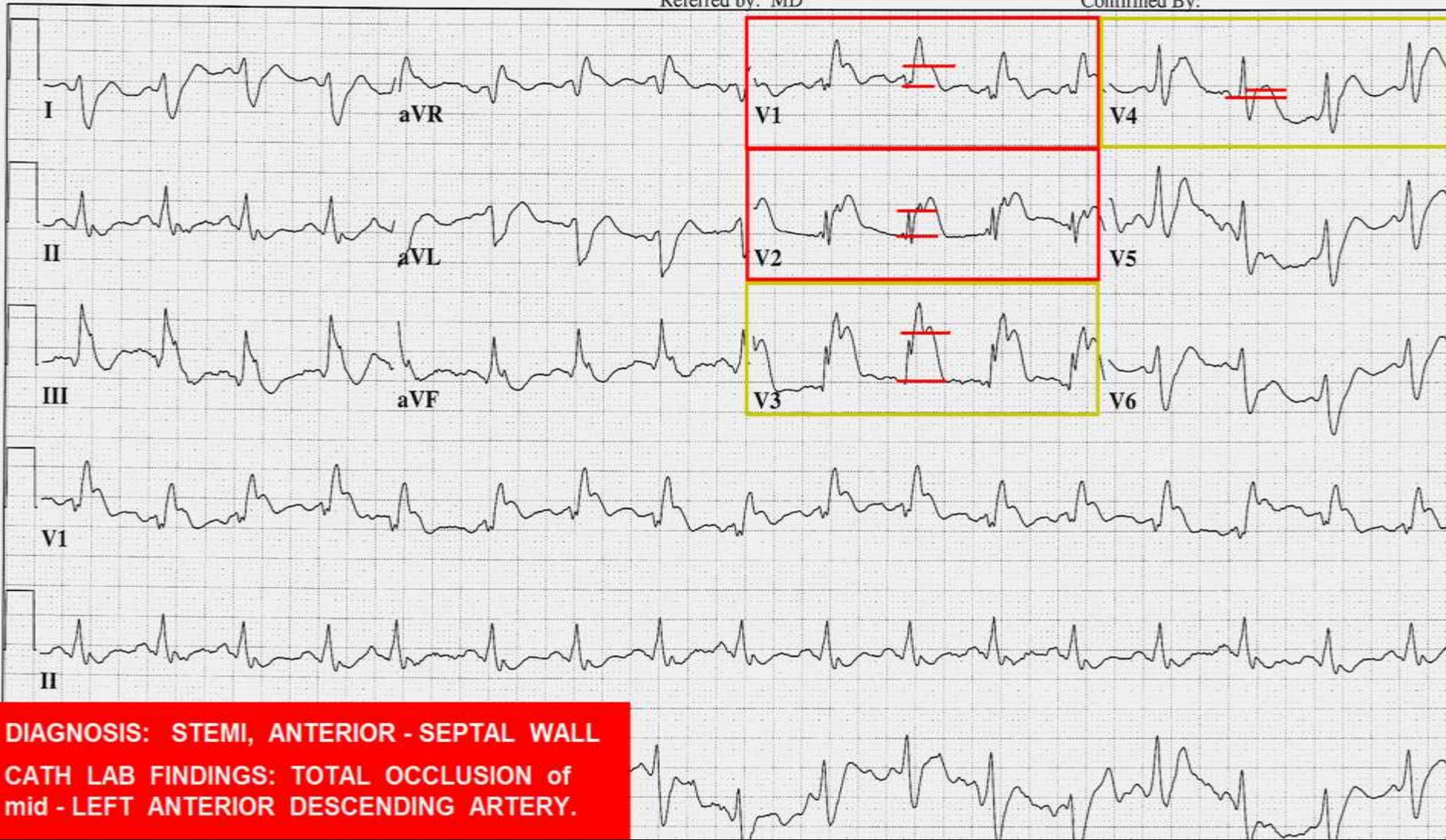
48 yr
Male Caucasian
Room:ATL
Loc:3 Option:23
Vent. rate 102 BPM
PR interval 130 ms
QRS duration 168 ms
QT/QTc 400/521 ms
P-R-T axes 60 114 -19

Sinus tachycardia with Premature supraventricular complexes and Fusion complexes
Right bundle branch block
ST elevation consider anterior injury or acute infarct
***** ACUTE MI *****
Abnormal ECG ...

Technician: W Ruppert

Referred by: MD

Confirmed By:



DIAGNOSIS: STEMI, ANTERIOR - SEPTAL WALL
CATH LAB FINDINGS: TOTAL OCCLUSION of mid - LEFT ANTERIOR DESCENDING ARTERY.

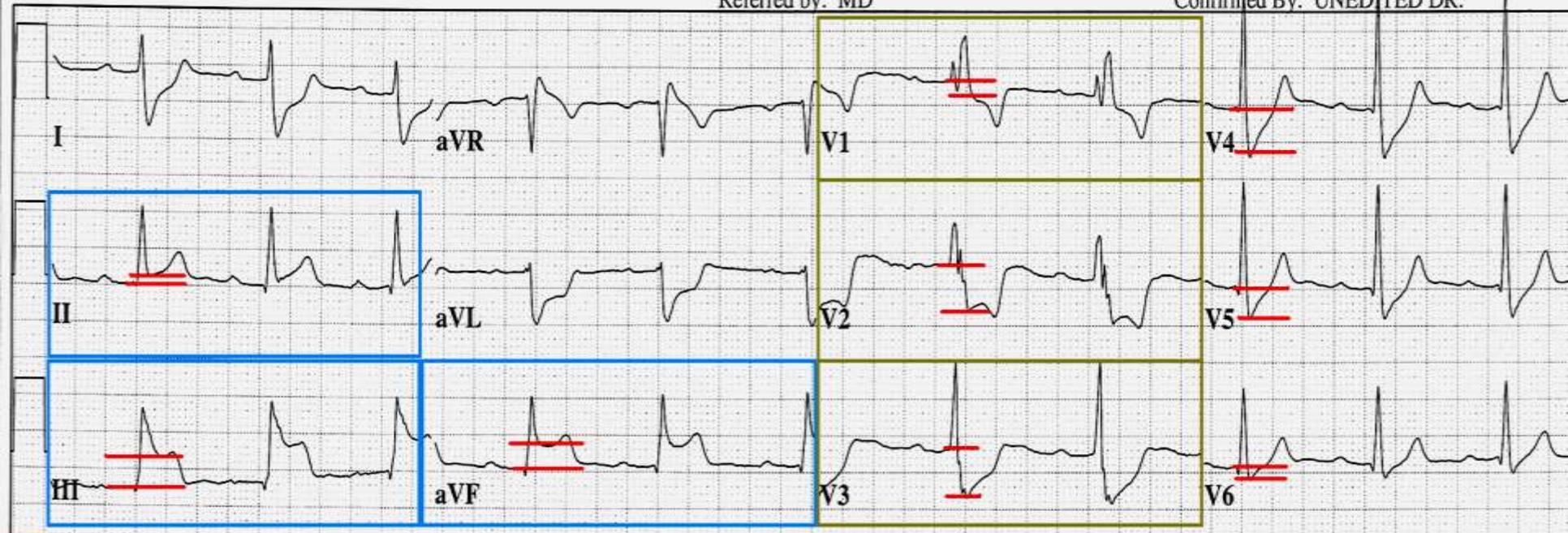
RBBB with CHEST PAIN - CASE 2: ST ELEVATION LEADS II, III, aVF - WITH RECIPROCAL ST DEPRESSION in LEADS V1 - V6

25 yr Male Caucasian
Loc:3 Option:23
Vent. rate 67 BPM
PR interval 258 ms
QRS duration 136 ms
QT/QTc 398/420 ms
P-R-T axes 44 94 82

Sinus rhythm with 1st degree A-V block
Right bundle branch block
ST elevation consider inferior injury or acute infarct
***** ACUTE MI *****
Abnormal ECG

Referred by: MD

Confirmed By: UNEDITED DR.



DIAGNOSIS: STEMI - INFERIOR-POSTERIOR WALL
CATH LAB FINDINGS: TOTAL OCCLUSION of DOMINANT RIGHT CORONARY ARTERY



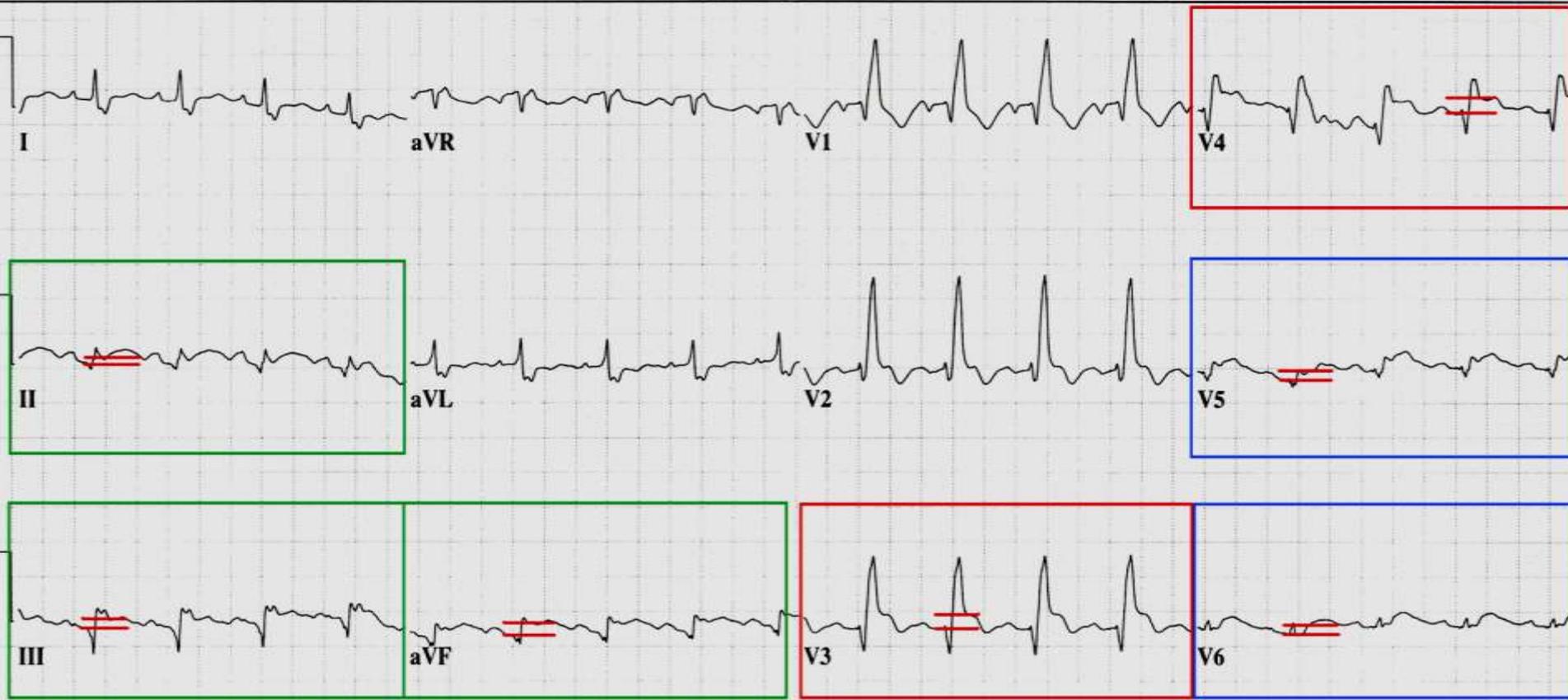
RBBB with CHEST PAIN - CASE 3: ST ELEVATION V3 - V6, II, III, aVF

75 yr
 Male Caucasian
 Room:CS-19
 Loc:6 Option:41

Vent. rate 110 BPM
 PR interval 170 ms
 QRS duration 148 ms
 QT/QTc 366/495 ms
 P-R-T axes 57 19 69

Sinus tachycardia
 Right bundle branch block
 Lateral infarct, possibly acute
 Inferior infarct, possibly acute
 Anterior injury pattern
 Abnormal ECG

ACUTE LATERAL - INFERIOR - ANTERIOR AMI
 CATH LAB FINDINGS: OCCLUDED VEIN GRAFT TO THE CIRCUMFLEX DISTRIBUTION (DOMINANT CIRCUMFLEX)



Wide QRS present:

(QRSd > 120ms)

- **When LBBB QRS pattern is present:**

Wide QRS present:

(QRSd > 120ms)

- **When LBBB QRS pattern is present:**
 - **ST-Segment Elevation is typically noted in Preordial Leads**

Wide QRS present:

(QRSd > 120ms)

- **When LBBB QRS pattern is present:**
 - ST-Segment Elevation is typically noted in Precordial Leads
 - *Can cause up to 5mm of J Point Elevation in normally calibrated ECG (1mm=10mv)*

Wide QRS present:

(QRSd > 120ms)

- **When LBBB QRS pattern is present:**
 - ST-Segment Elevation is typically noted in Precordial Leads
 - *Can cause up to 5mm of J Point Elevation in normally calibrated ECG (1mm=10mv)*
 - *Does NOT typically cause ST elevation in INFERIOR Leads (II, III and AVF).*

78 yr
Female Black
Room:ICU5
Loc:6 Option:19

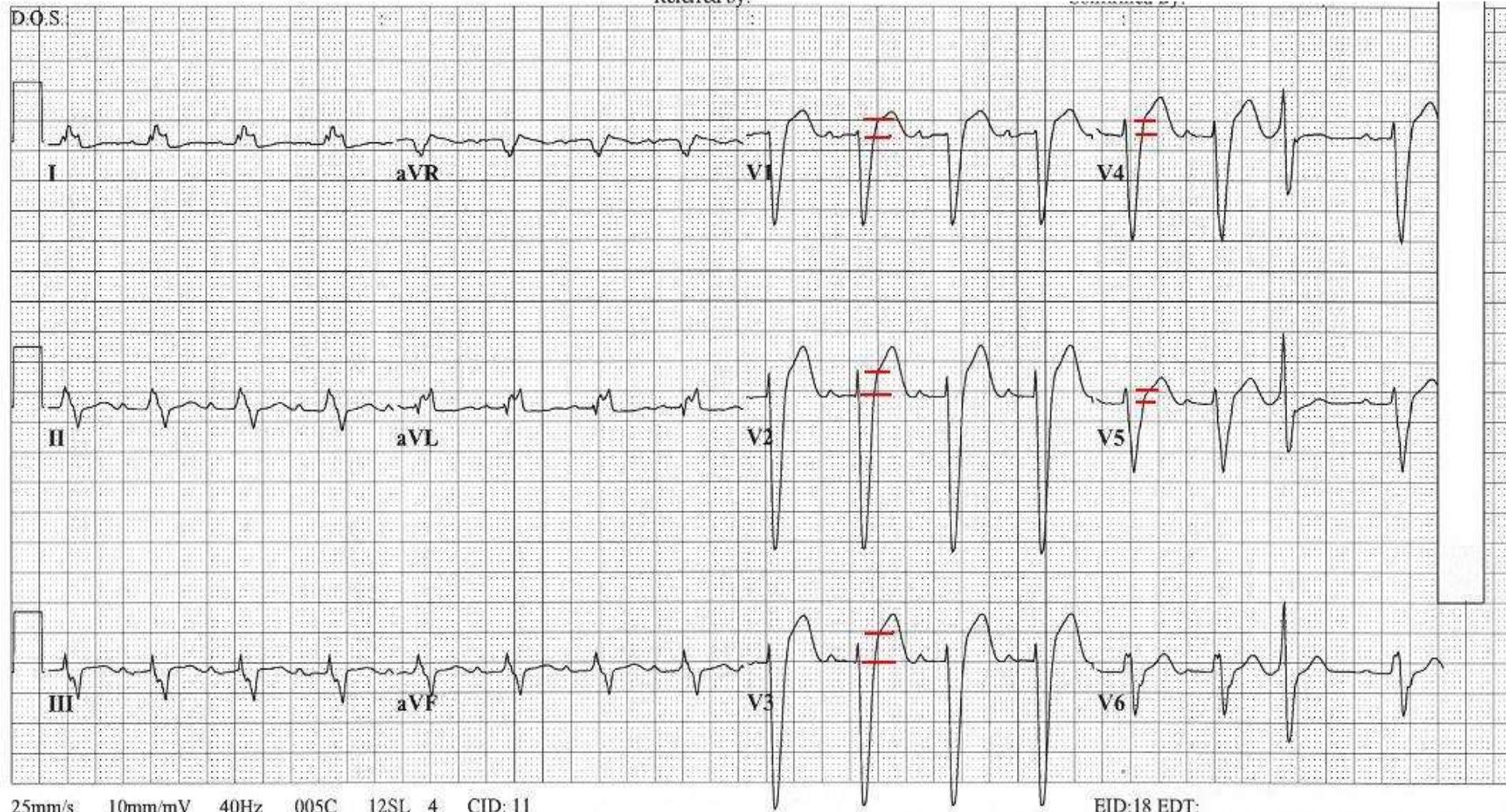
Vent. rate	94	BPM
PR interval	202	ms
QRS duration	160	ms
QT/QTc	388/485	ms
P-R-T axes	91 -23	87

Normal sinus rhythm with occasional Premature ventricular complexes
Left bundle branch block
Abnormal ECG

- Normal arteries
- Normal LV Function
- No hypertrophy

Technician: EKG CLASS #WR03602718

Referred by:



Diagnosis of STEMI with LBBB pattern:

2013 ACC/AHA Guideline for Management of STEMI

- *ST Elevation of 0.1mv (1mm) or more in leads with Positive Deflection QRS complexes*

Diagnosis of STEMI with LBBB pattern:

2013 ACC/AHA Guideline for Management of STEMI

- *ST Elevation of 0.1mv (1mm) or more in leads with Positive Deflection QRS complexes*
- *ST Elevation of 0.5mv (5mm) or more in leads with Negative Deflection QRS complexes*

Diagnosis of STEMI with LBBB pattern:

2013 ACC/AHA Guideline for Management of STEMI

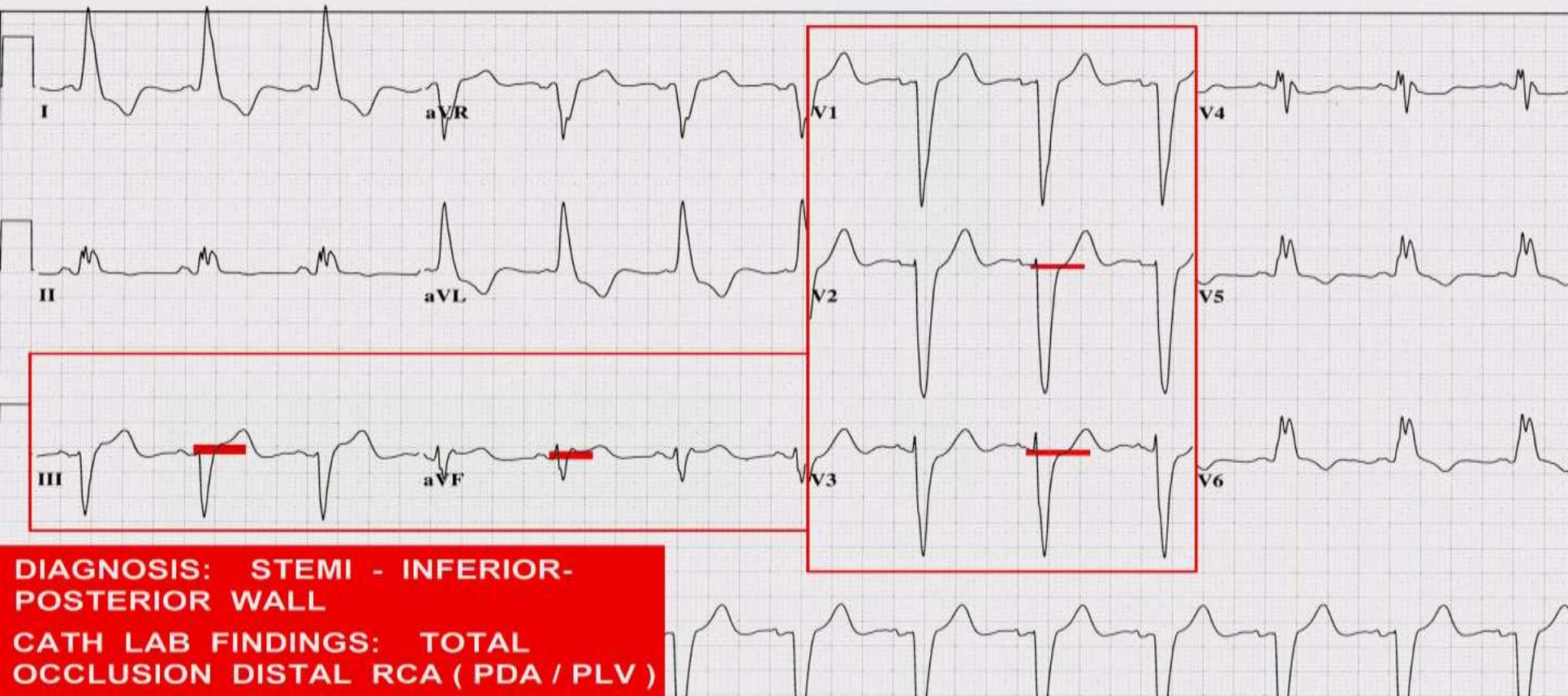
- *ST Elevation of 0.1mv (1mm) or more in leads with Positive Deflection QRS complexes*
- *ST Elevation of 0.5mv (5mm) or more in leads with Negative Deflection QRS complexes*
- *ST Segment Changes as compared with those of older ECGs with LBBB*

LBBB with CHEST PAIN - CASE 1 : PRESENTING EKG

58 yr
Female Hispanic
Room: ER
Loc:3 Option:23

Vent. rate 77 BPM
PR interval 128 ms
QRS duration 158 ms
QT/QTc 454/513 ms
P-R-T axes 43 -11 150

Normal sinus rhythm
Left bundle branch block
Abnormal ECG

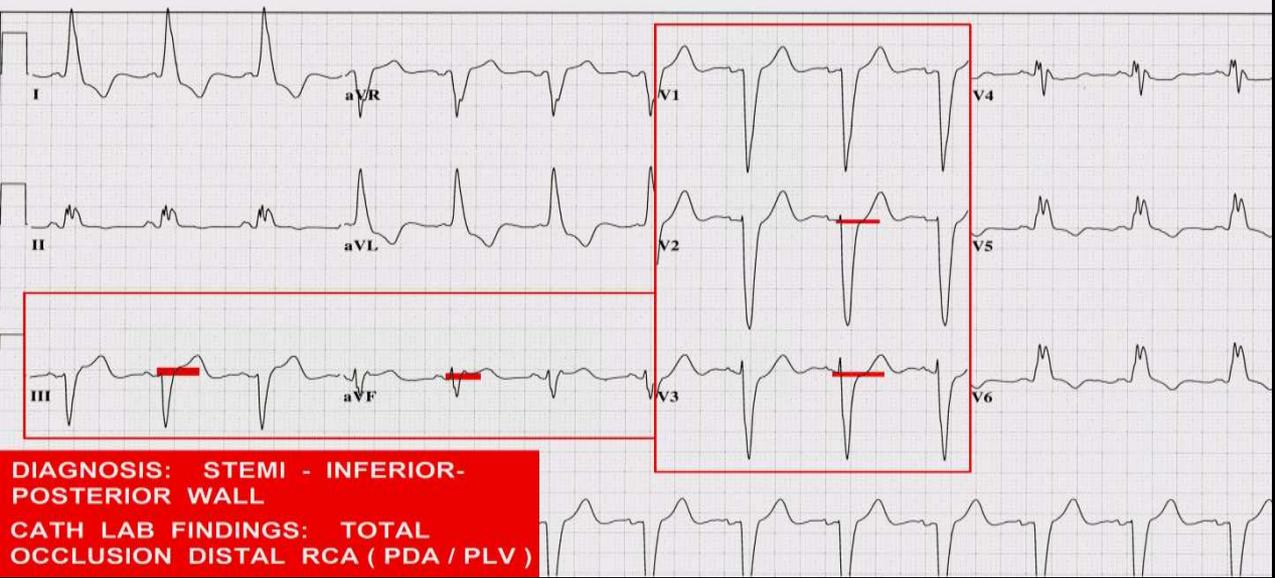


LBBB with CHEST PAIN - CASE 1 : PRESENTING EKG

58 yr Female Hispanic
 Room: ER Loc:3
 Option:23

Vent. rate 77 BPM
 PR interval 128 ms
 QRS duration 158 ms
 QT/QTc 454/513 ms
 P-R-T axes 43 -11 150

Normal sinus rhythm
 Left bundle branch block
 Abnormal ECG



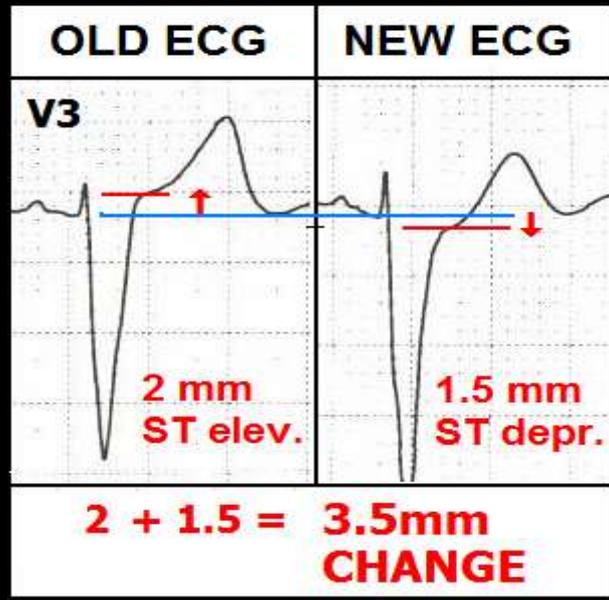
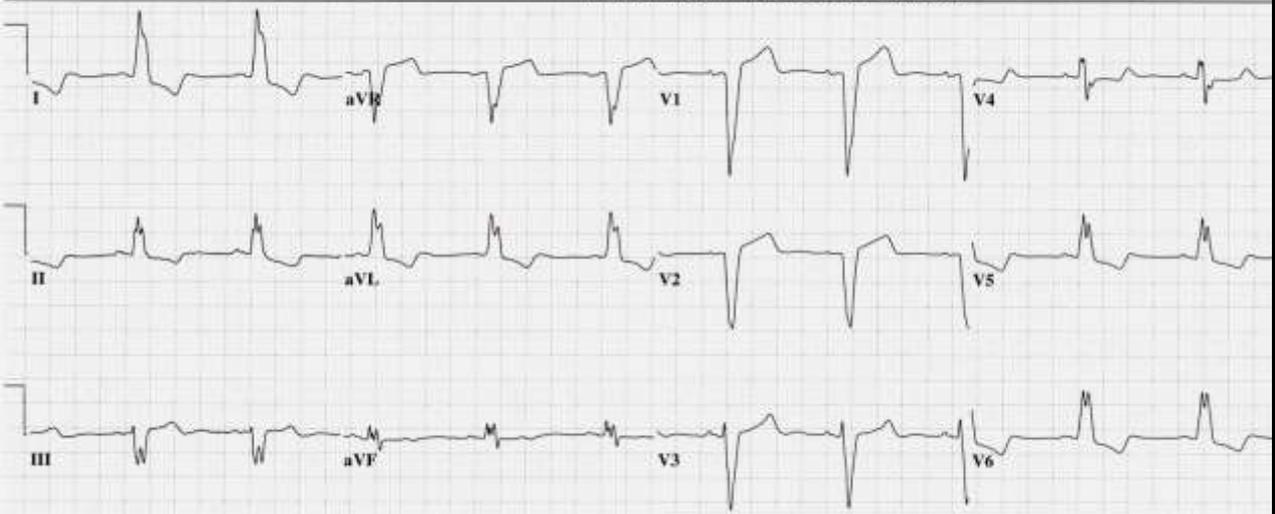
DIAGNOSIS: STEMI - INFERIOR-POSTERIOR WALL
CATH LAB FINDINGS: TOTAL OCCLUSION DISTAL RCA (PDA / PLV)

LBBB with CHEST PAIN - CASE 1 : EKG RECORDED 7 MONTHS AGO

57 yr Female Hispanic
 Room: 416B Loc:6
 Option:39

Vent. rate 63 BPM
 PR interval 140 ms
 QRS duration 142 ms
 QT/QTc 462/472 ms
 P-R-T axes 48 10 191

*** AGE AND GENDER SPECIFIC ECG ANALYSIS ***
 Normal sinus rhythm
 Left bundle branch block
 Abnormal ECG
 When compared with ECG of 22-JAN-2005 11:15.



Diagnosis of STEMI with LBBB pattern:

2013 ACC/AHA Guideline for Management of STEMI

- *ST Elevation of 0.1mv (1mm) or more in leads with Positive Deflection QRS complexes*
- *ST Elevation of 0.5mv (5mm) or more in leads with Negative Deflection QRS complexes*
- *ST Segment Changes as compared with those of older ECGs with LBBB*
- *Convex ST Segment*

Diagnosis of STEMI with LBBB pattern:

2013 ACC/AHA Guideline for Management of STEMI

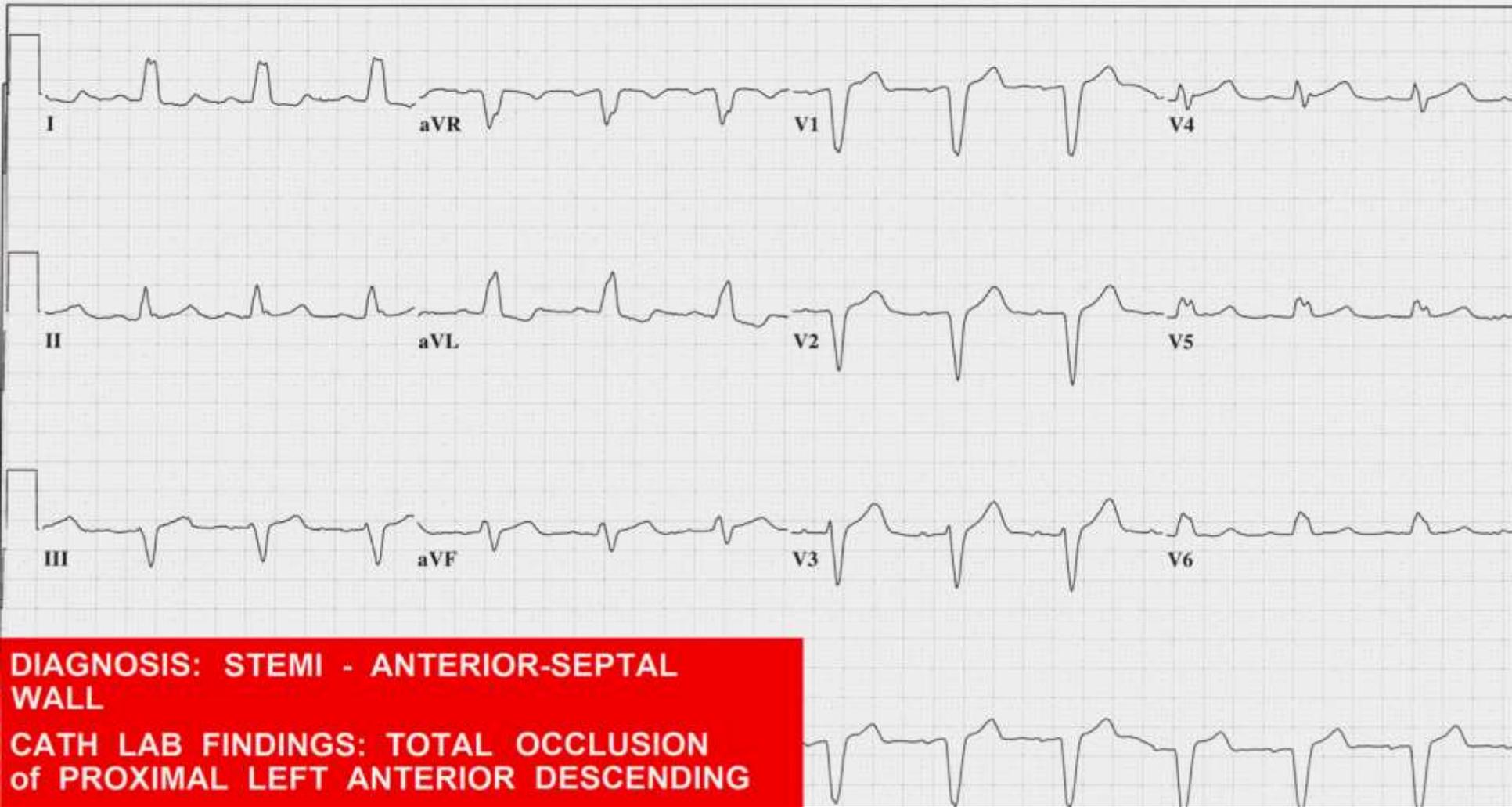
- *ST Elevation of 0.1mv (1mm) or more in leads with Positive Deflection QRS complexes*
- *ST Elevation of 0.5mv (5mm) or more in leads with Negative Deflection QRS complexes*
- *ST Segment Changes as compared with those of older ECGs with LBBB*
- *Convex ST Segment*
- *New Onset LBBB with ACS symptoms . . .*

LBBB with CHEST PAIN - CASE 2 : NEW ONSET of LBBB

46 yr
Male Caucasian
Room:ER
Loc:3 Option:23

Vent. rate 77 BPM
PR interval 172 ms
QRS duration 142 ms
QT/QTc 446/504 ms
P-R-T axes 38 0 92

Normal sinus rhythm
Left bundle branch block
Abnormal ECG



DIAGNOSIS: STEMI - ANTERIOR-SEPTAL WALL
CATH LAB FINDINGS: TOTAL OCCLUSION of PROXIMAL LEFT ANTERIOR DESCENDING

A.H.A. ACLS GUIDELINES

1. If patient has a **CONFIRMED HISTORY** of LBBB, rely on:

- **CARDIAC MARKERS**
- **SYMPTOMS**
- **RISK FACTOR PROFILE**
- **HIGH INDEX OF SUSPICION**

for diagnosis of STEMI

2. If patient has:

a) **previously NORMAL ECGs (no LBBB)**

-- OR --

b) **no old ECGs available for comparison**

consider diagnosis as STEMI until proven otherwise.



HELPFUL INDICATORS FOR ECG DIAGNOSIS OF STEMI in the presence of LBBB:

- ST ELEVATION $>$ 5 mm
- COMPARE J POINT, ST SEGMENTS and T WAVES of previous ECG with LBBB to NEW ECG.
- CONVEX ST SEGMENT = poss. MI
CONCAVE ST SEGMENT = normal
- CONCORDANT ST changes (1 mm or $>$ ST DEPRESSION V1 - V3 or ST ELEVATION LEADS II, III, AVF)
- ST ELEVATION in LEADS II, III, and/or AVF

“Electrocardiographic Diagnosis of Evolving Acute Myocardial Infarction in the Presence of Left Bundle-Branch Block” Birnbaum et al, N Engl J Med 1996; 334:481-487

In patients with

**Left Bundle Branch Block
Combined with
Ventricular Hypertrophy,**

*The J Point elevation can exceed 0.5 mv
(5mm) above the iso-electric line in patients
without ACS.*

Rate 75 . Sinus rhythm.....normal P axis V-rate 50- 99
 . Left bundle branch block.....QRSD 120, broad/notched R

ED

TECH

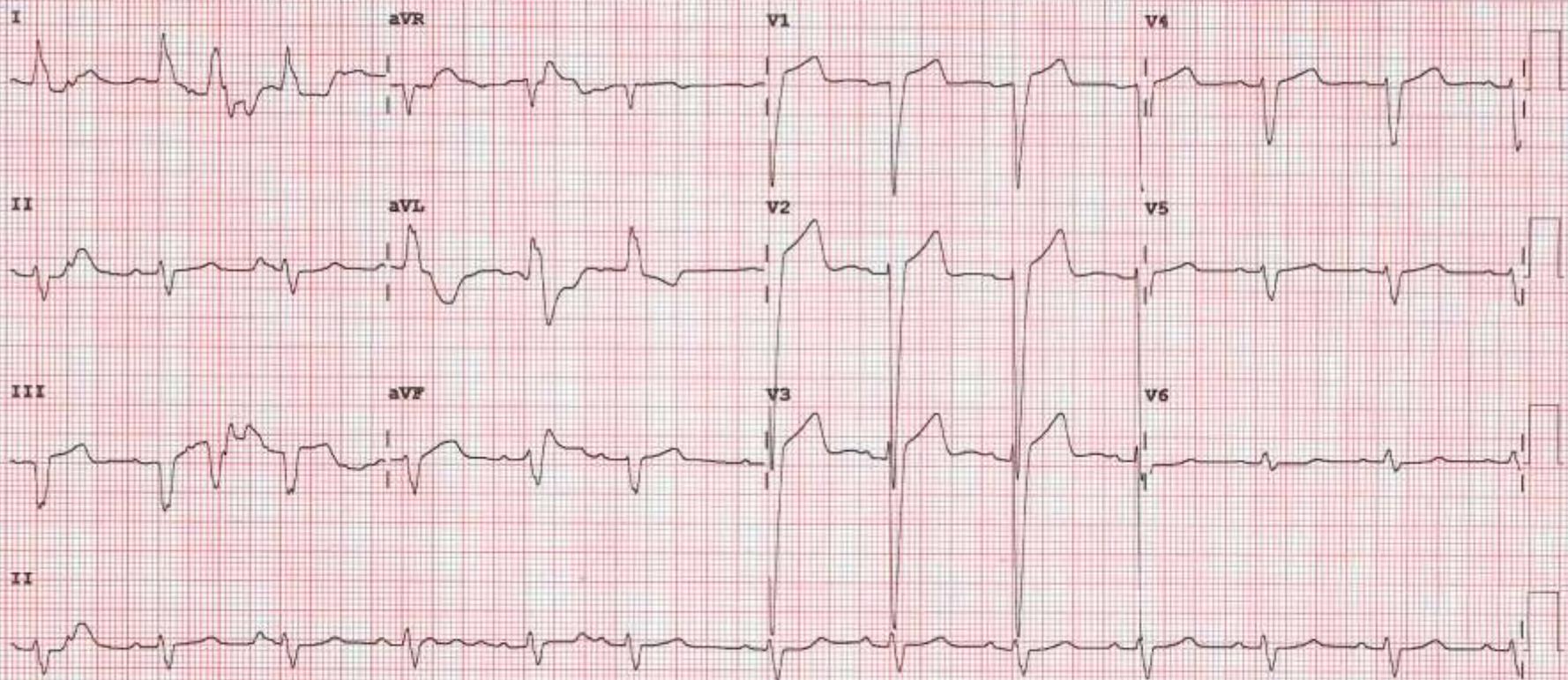
dcoull

FR 178
 QRSD 133
 QT 420
 QTc 470

Hypertrophy Clue: QRS Complexes "spearing through" QRS of other leads.

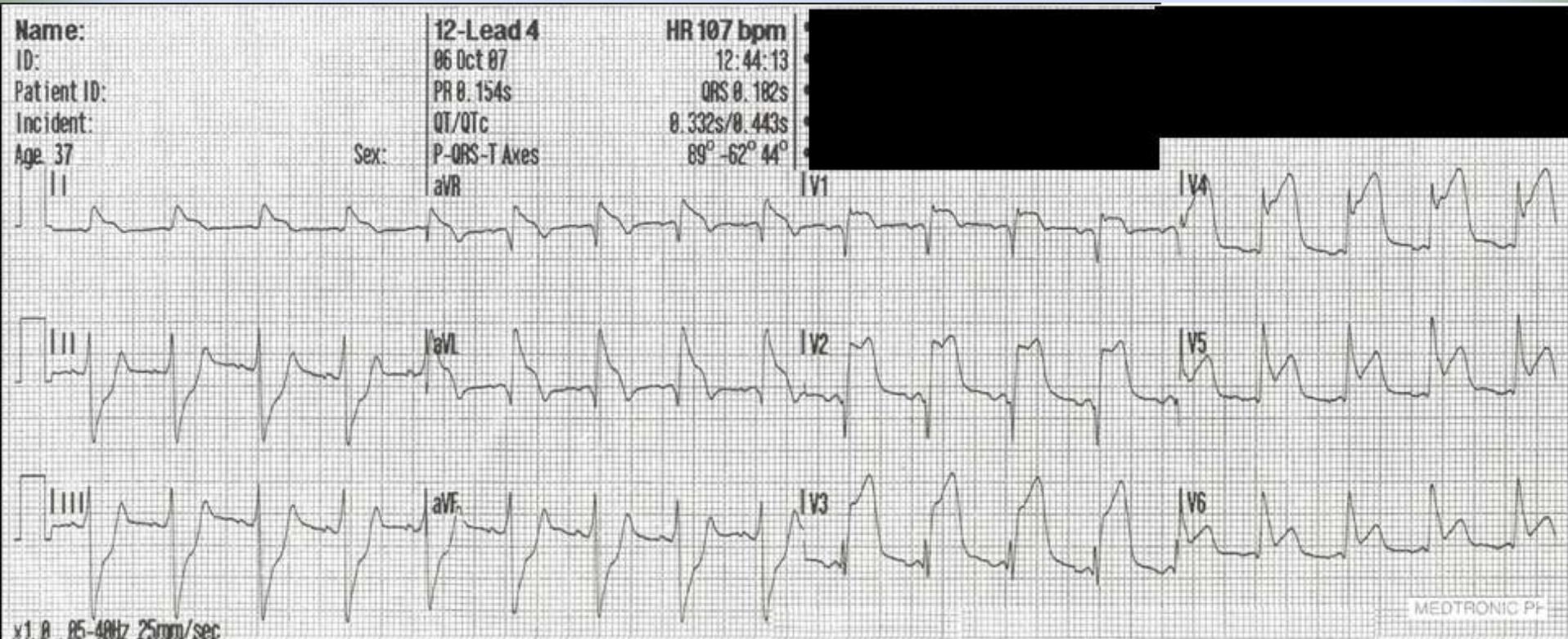
--AXIS--
 P 27
 QRS -43
 T 127
 12 Lead; Standard Placement

Unconfirmed Diagnosis

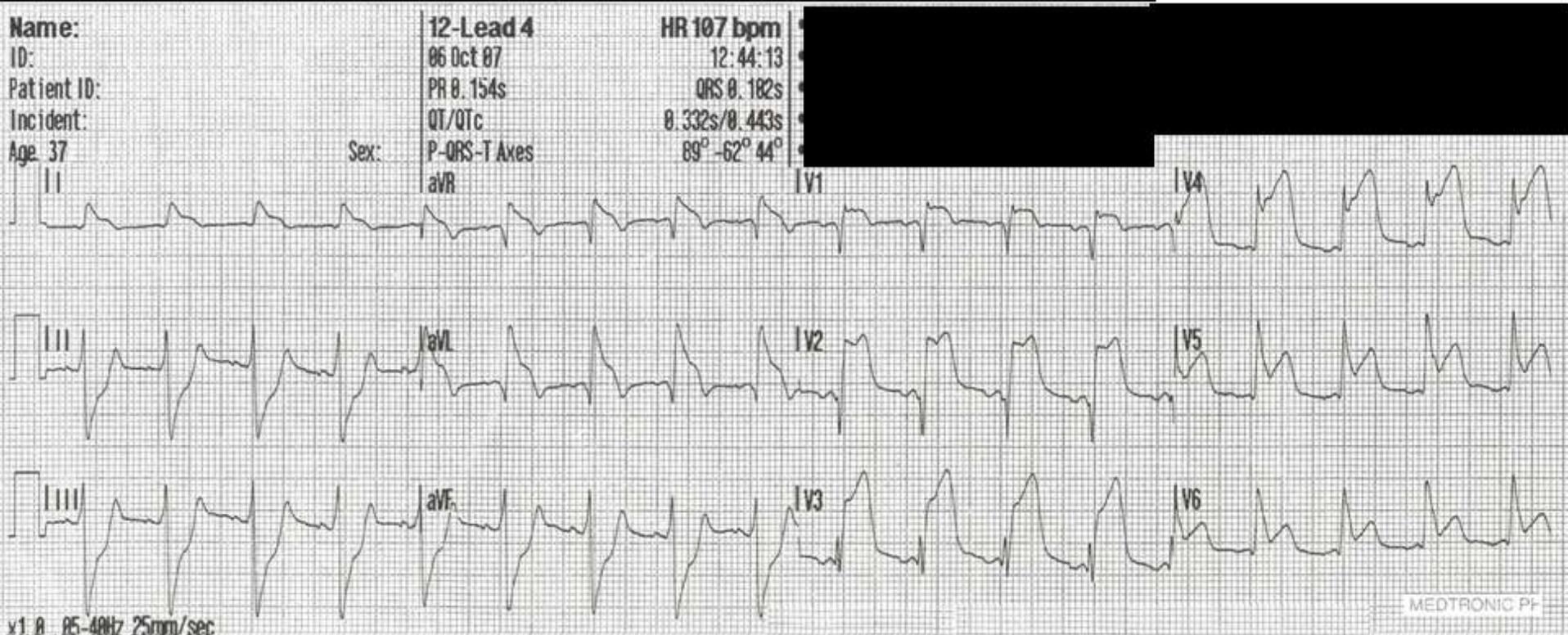


Practice ECGs . . .

Let's review

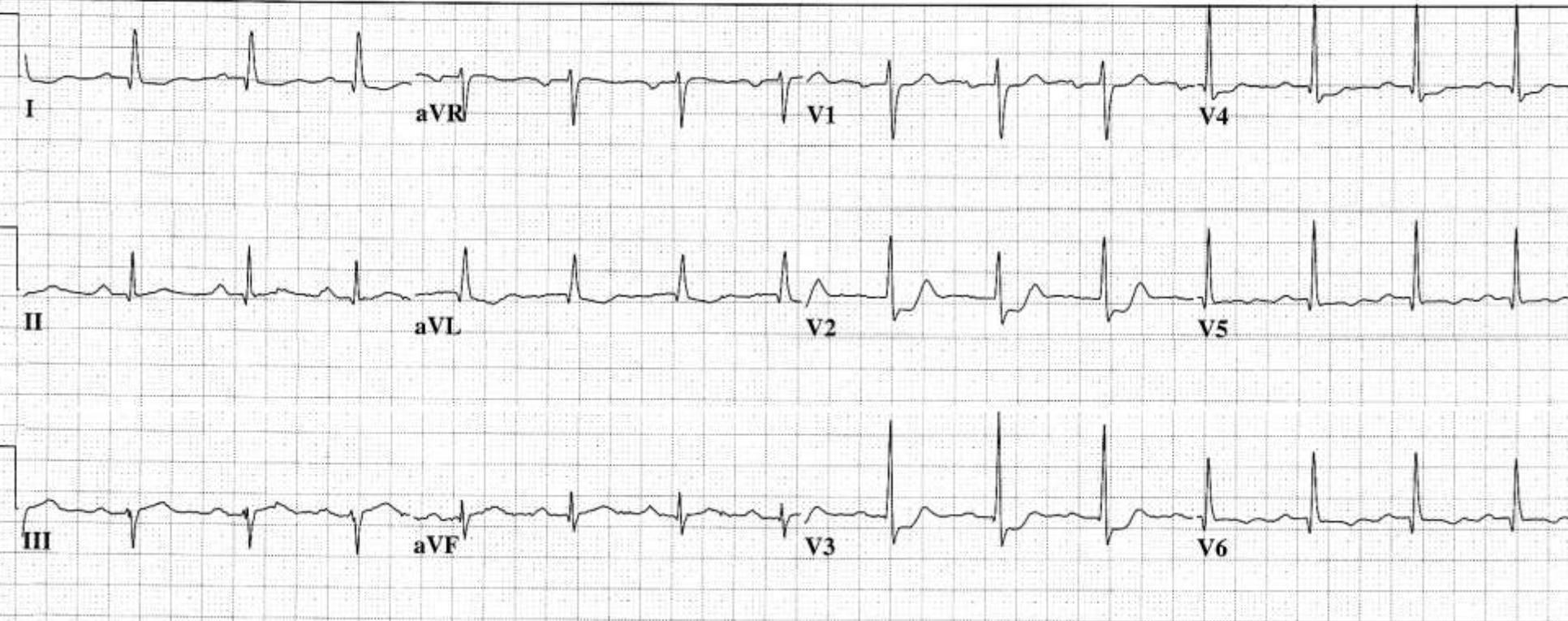


1. ECG abnormality(ies)?
2. Possible diagnosis?
3. Action / Intervention?



- 1. ECG abnormality(ies)? ST Elevation Leads I, AVR AVL, V1, V2, V3, V4, V5 & V6. ST Depression II, III and AVF**
- 2. Possible diagnosis? Acute Anterolateral Wall STEMI secondary to Left Main Coronary Artery occlusion (widow-maker MI).**
- 3. Action / Intervention? STAT CATH LAB vs STAT Thrombolytics. Prepare for Cardiac Arrest**

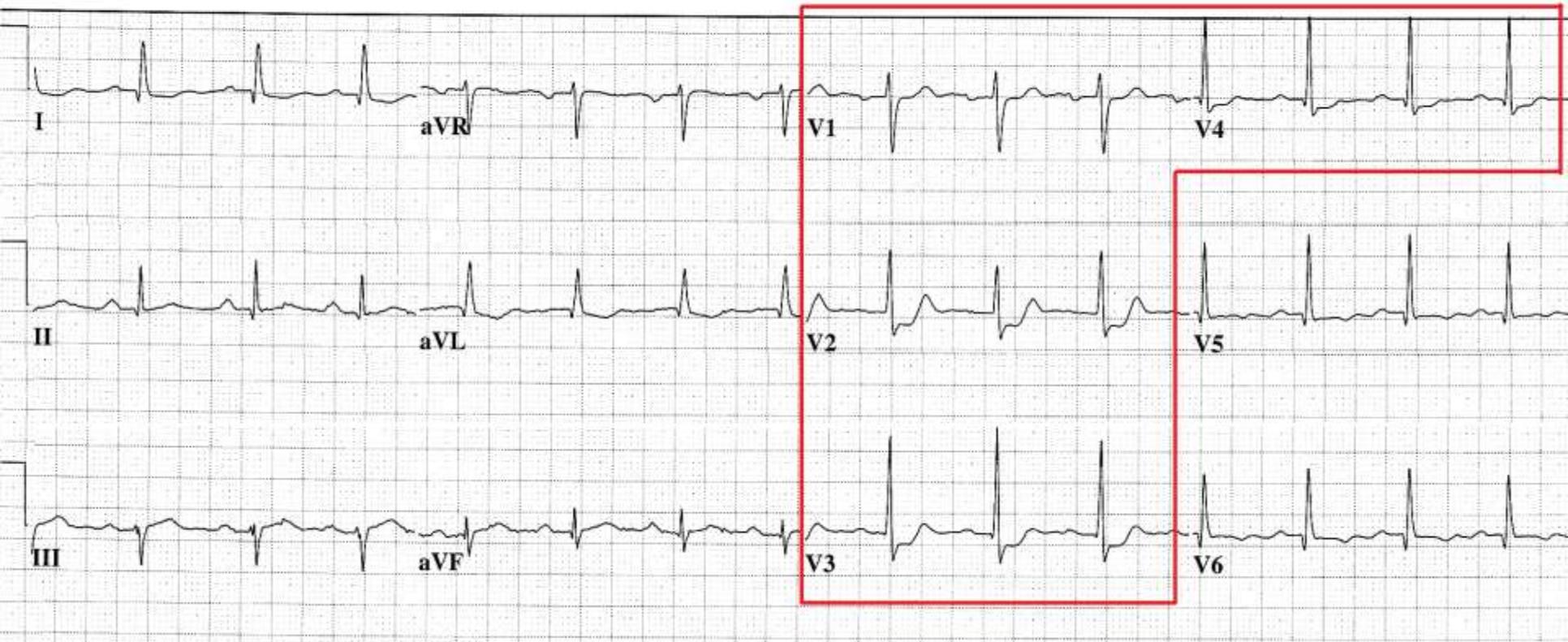
63 yr		Vent. rate	88	BPM
Male	Hispanic	PR interval	200	ms
		QRS duration	94	ms
Room: VAM		QT/QTc	352/425	ms
Loc: 3	Option: 23	P-R-T axes	63 2	118



1. ECG abnormality(ies)?
2. Possible diagnosis?
3. Action / Intervention?

63 yr
Male Hispanic
Room: VAM
Loc: 3 Option: 23

Vent. rate 88 BPM
PR interval 200 ms
QRS duration 94 ms
QT/QTc 352/425 ms
P-R-T axes 63 2 118

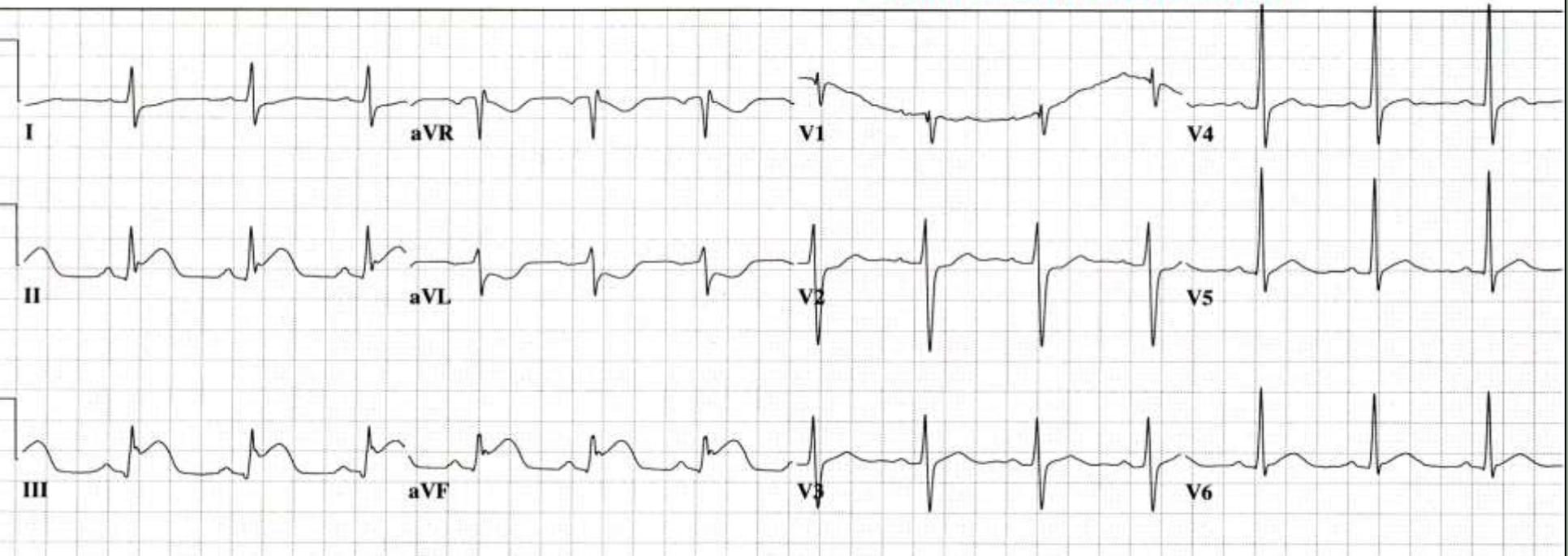


1. ECG abnormality(ies)? **ST Depression V1-V4**
2. Possible diagnosis? **Anterior ischemia vs. Posterior wall STEMI**
3. Action / Intervention? **Posterior ECG (V7-V9)**

46 yr		Vent. rate	82	BPM
Male	Caucasian	PR interval	168	ms
		QRS duration	96	ms
		QT/QTc	384/448	ms
Loc:3	Option:23	P-R-T axes	76 81	88

EVALUATE EKG for indicators of ACS:

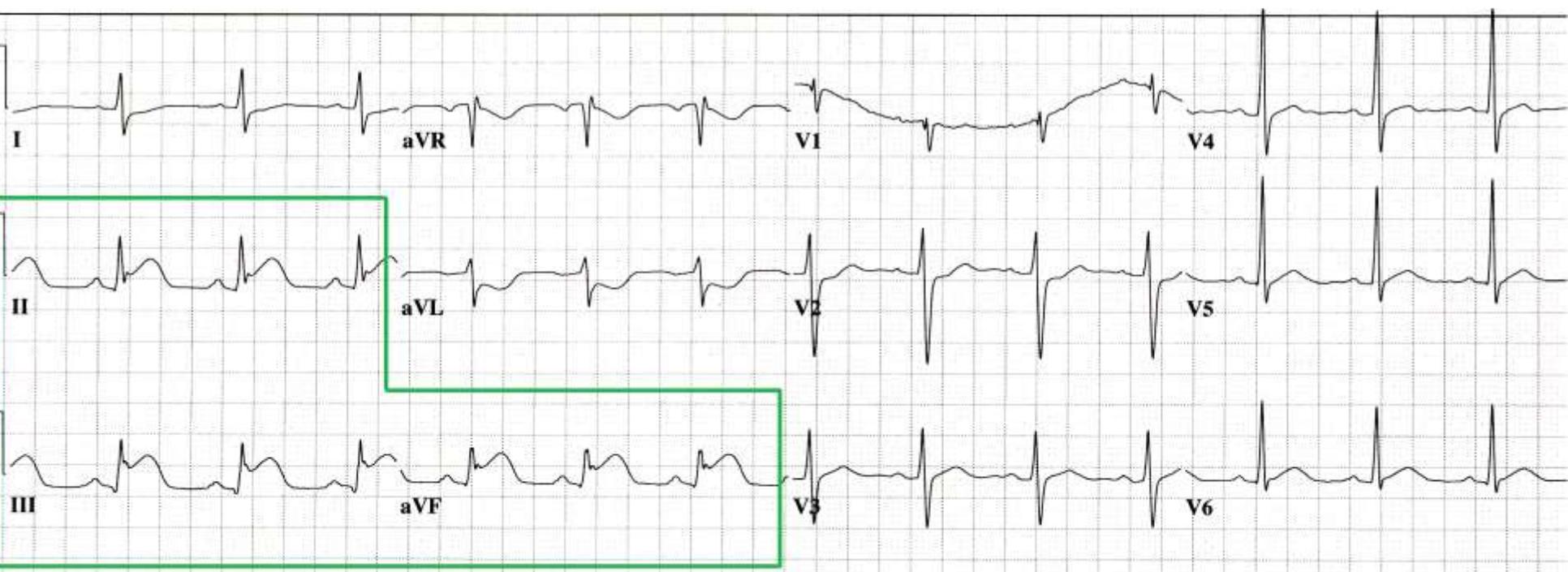
- ST SEGMENT ELEVATION / DEPRESSION
- HYPERACUTE T WAVES
- CONVEX ST SEGMENTS
- OTHER ST SEGMENT / T WAVE ABNORMALITIES



1. ECG abnormality(ies)?
2. Possible diagnosis?
3. Action / Intervention?

46 yr Male
Caucasian
Loc:3 Option:23
Vent. rate 82 BPM
PR interval 168 ms
QRS duration 96 ms
QT/QTc 384/448 ms
P-R-T axes 76 81 88

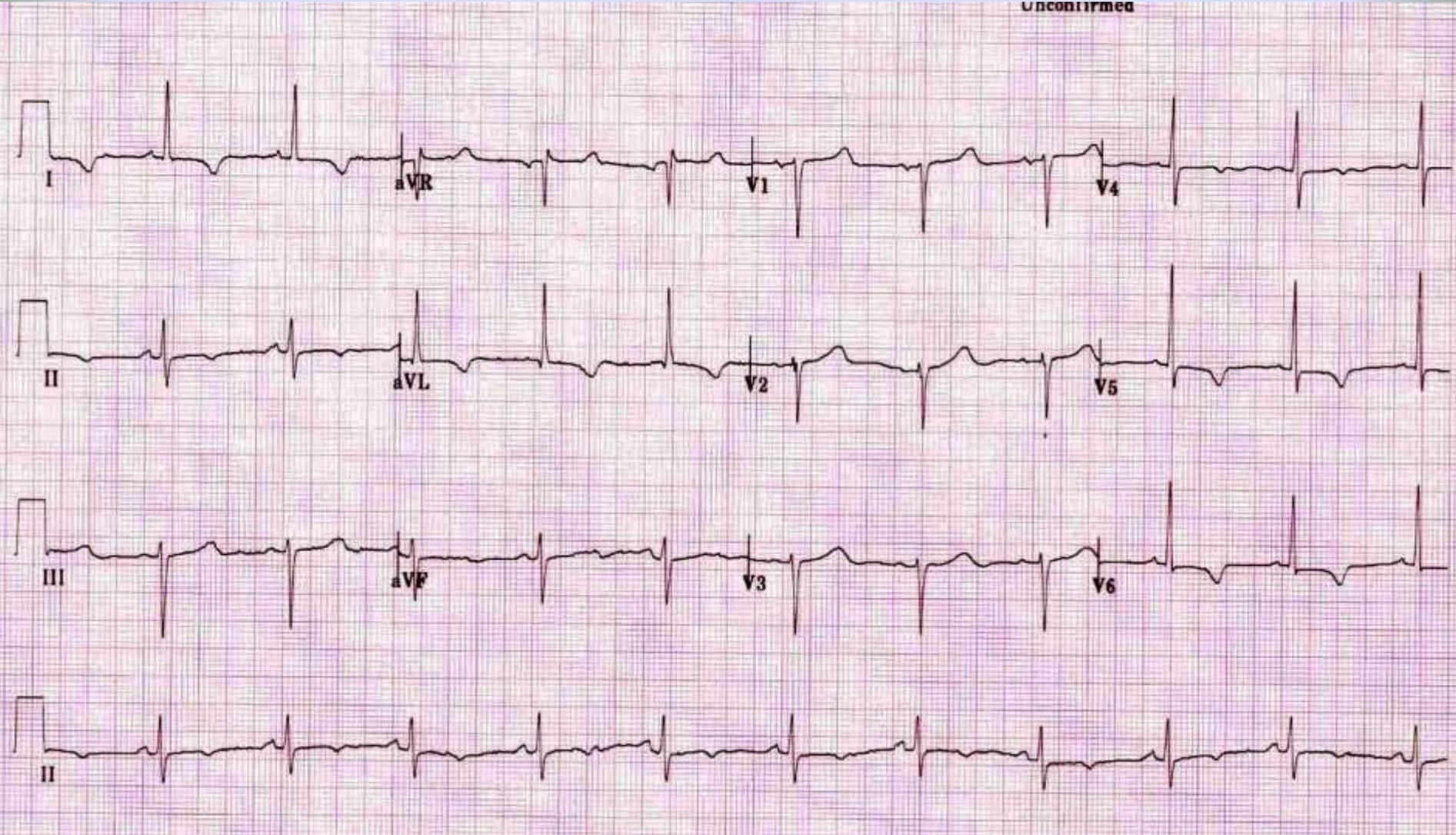
**ST-Segment Elevation in Leads II, III and AVF
Consistent with: INFERIOR STEMI**



- 1. ECG abnormality(ies)?** ST Elevation, Leads II,III & AVF
- 2. Possible diagnosis?** Inferior Wall STEMI
- 3. Action / Intervention?** 1. Do R-sided ECG, *prepare for Atropine administration, external pacing, cardiac arrest, STAT cath lab visit !*

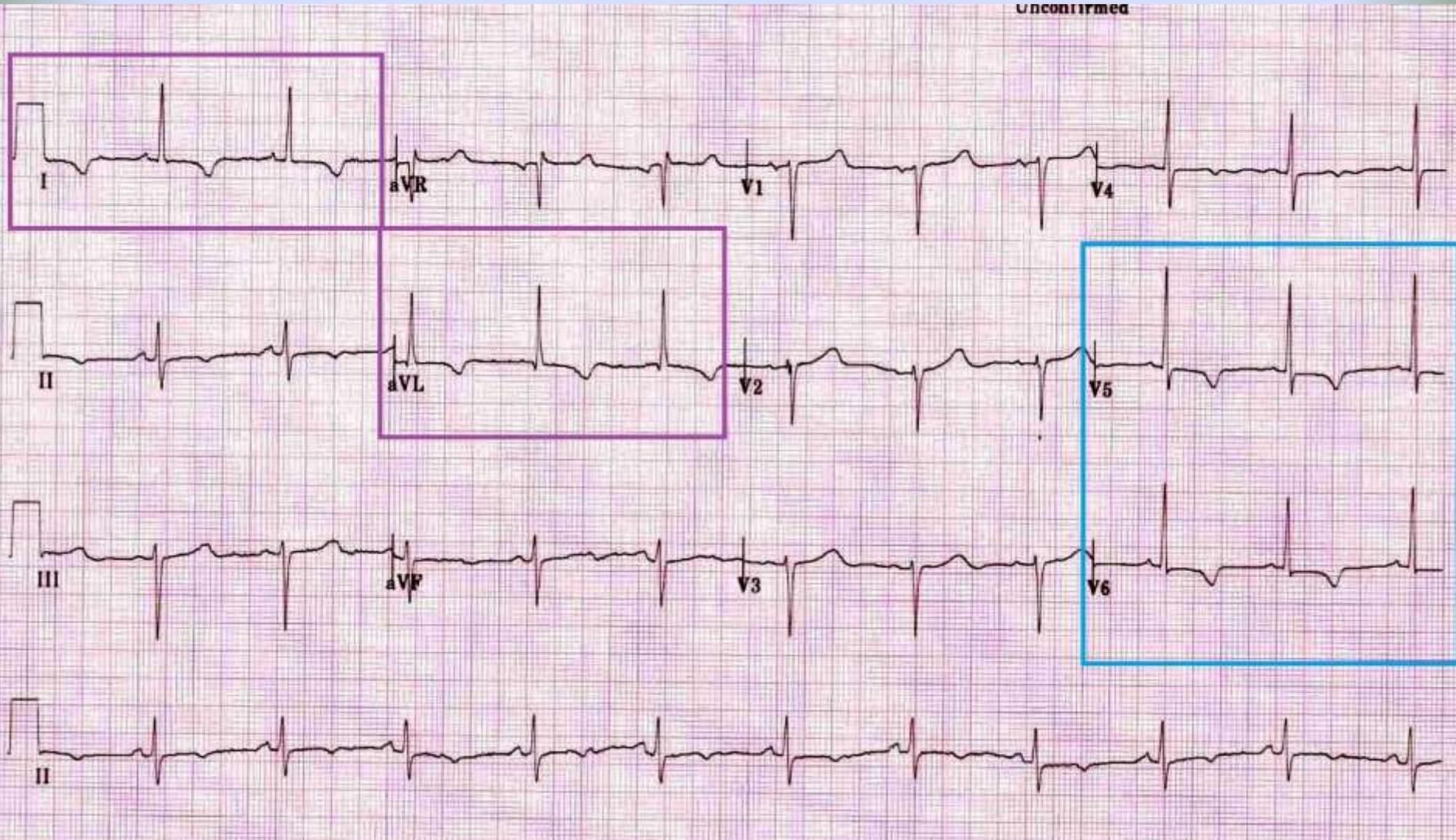
What leads show signs of possible ACS?

Unconfirmed



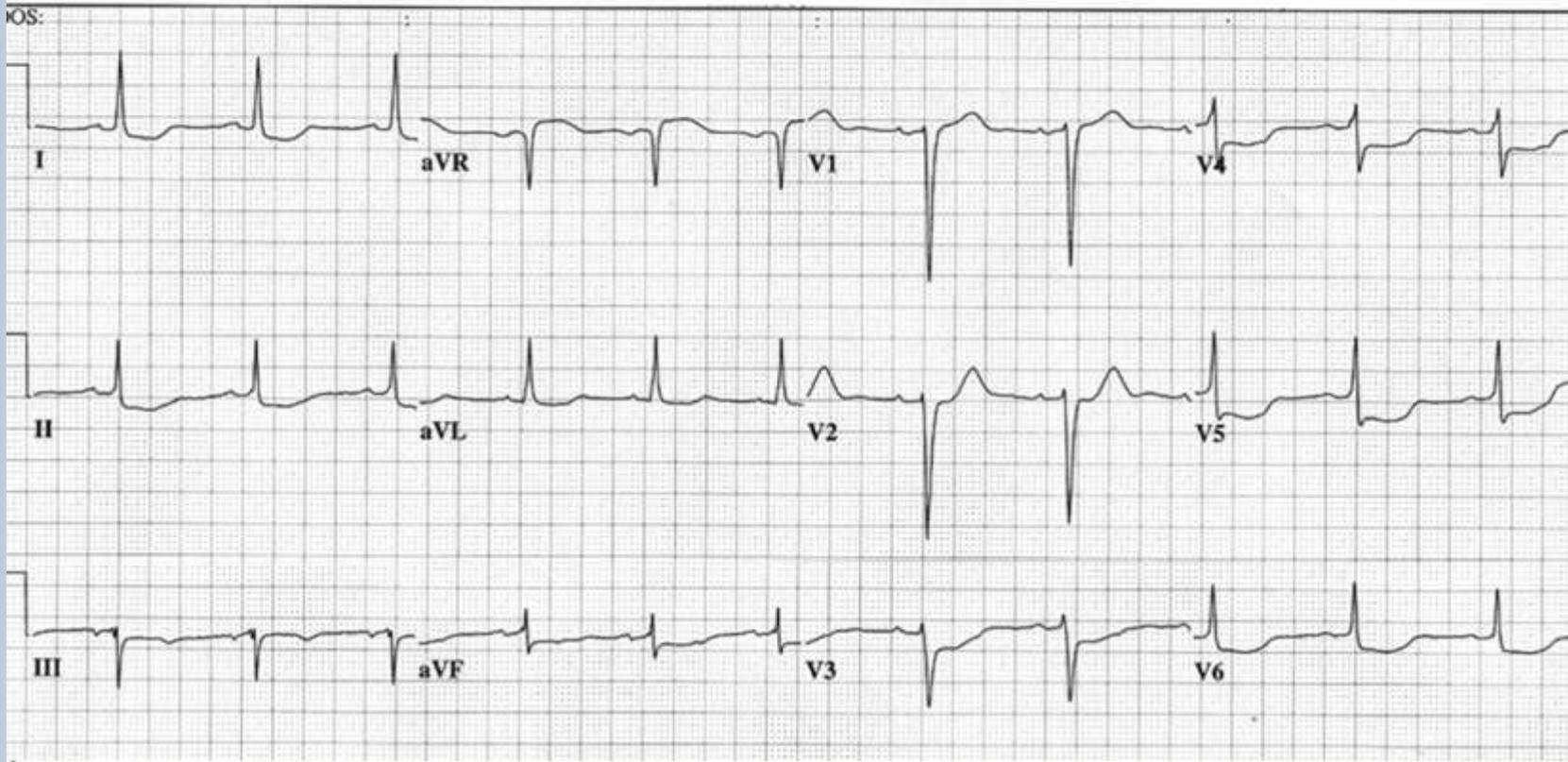
12 Lead ECG

shows ISCHEMIC CHANGES Lateral Wall:



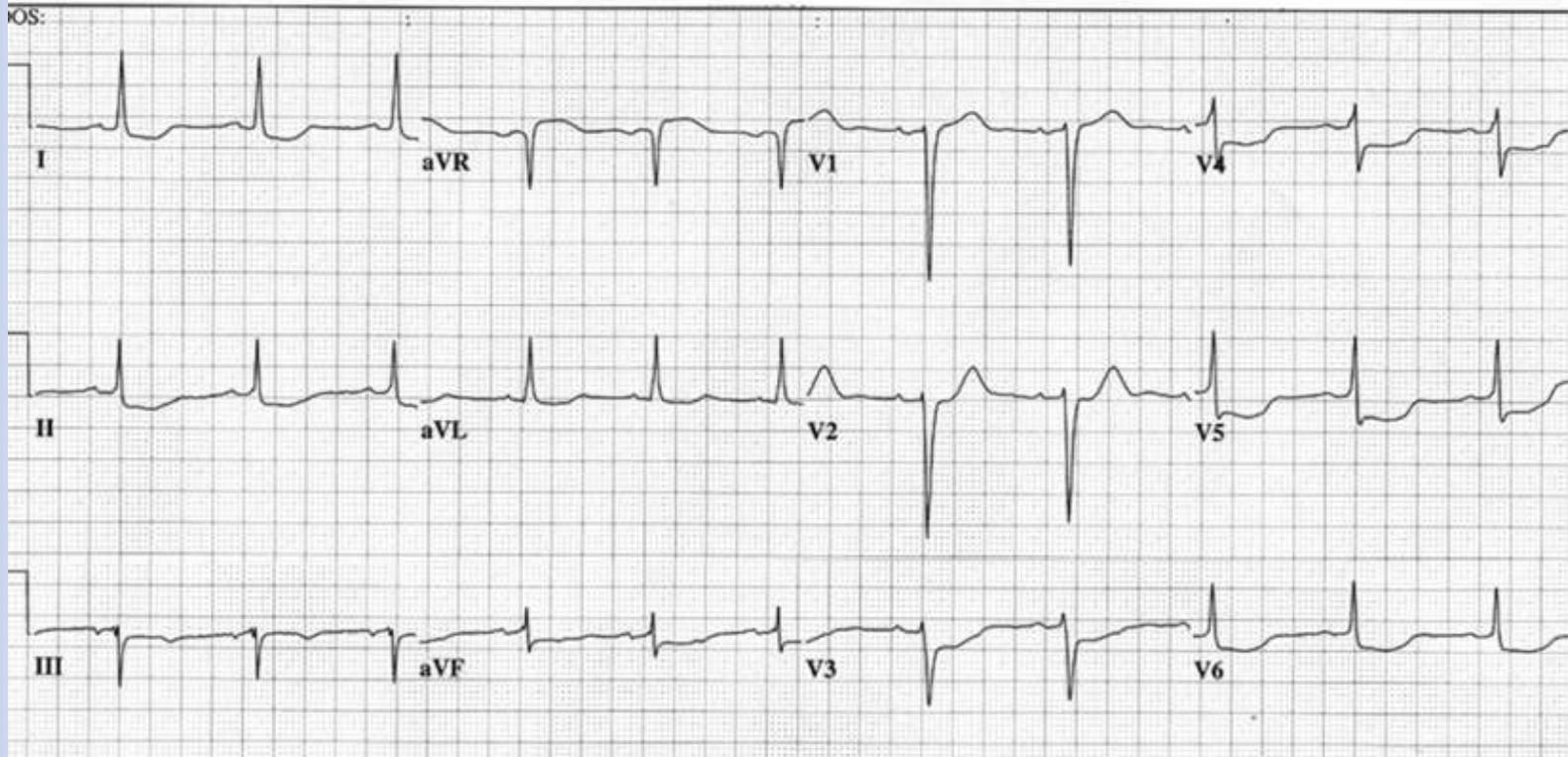
67 yr
Female Hispanic
Room:S7
Loc:3 Option:23

Vent. rate 67 BPM
PR interval 188 ms
QRS duration 106 ms
QT/QTc 458/483 ms
P-R-T axes 27 -3 -111



- 1. ECG abnormality(ies)?
- 2. Possible diagnosis?
- 3. Action / Intervention?

67 yr		Vent. rate	67	BPM
Female	Hispanic	PR interval	188	ms
		QRS duration	106	ms
Room:S7		QT/QTc	458/483	ms
Loc:3	Option:23	P-R-T axes	27 -3 -111	



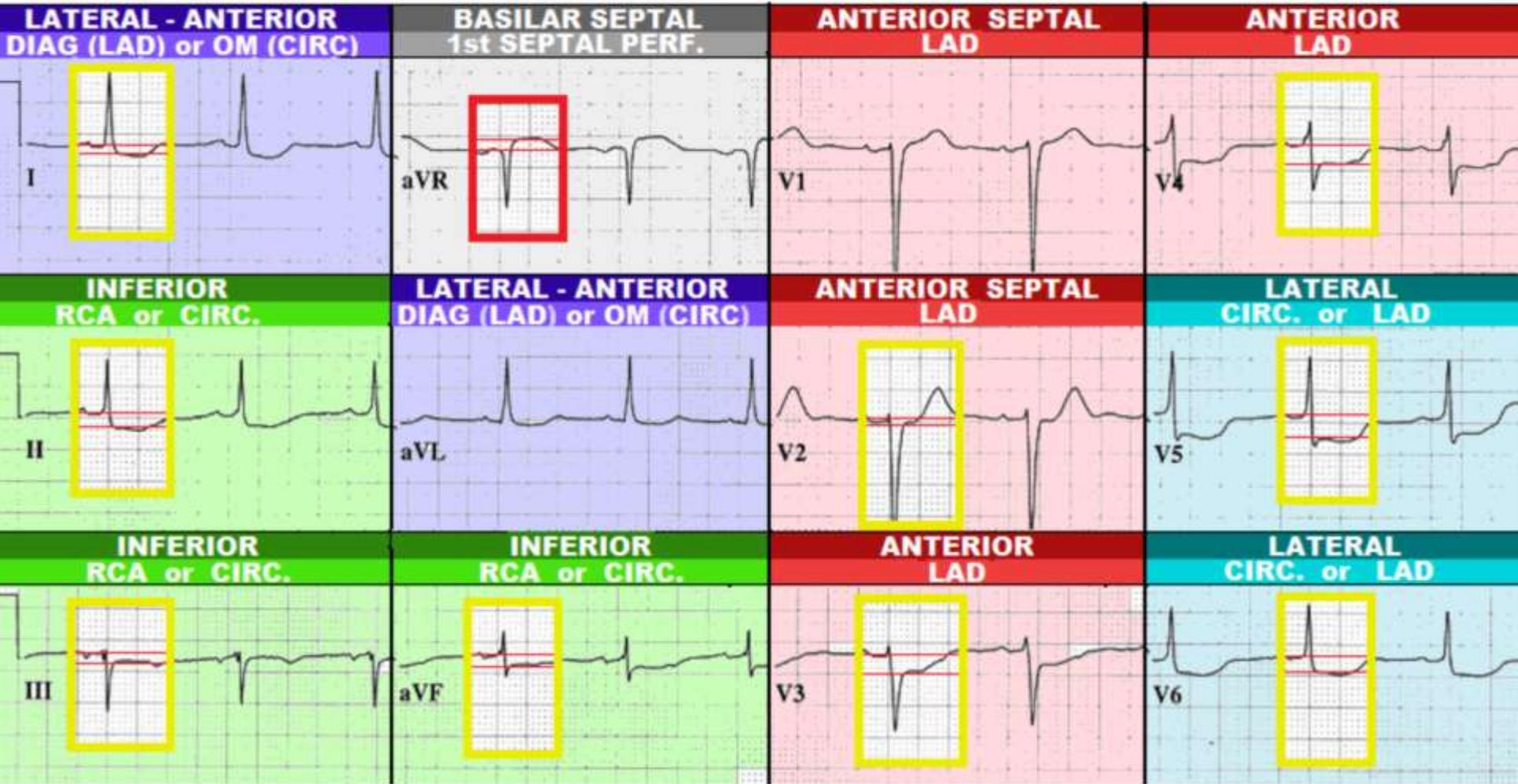
1. ECG abnormality(ies)? **ST Elevation Lead AVR, Global ST Depression (I, II, III, AVL, AVF, V2, V3, V4, V5, V6)**
2. Possible diagnosis? **possible LMCA or 3x vessel disease.**
3. Action / Intervention? **Troponins, Continuous ST monitoring, cath lab visit STAT or ASAP (based on sympt.)**

67 yr
Female Hispanic
Room:S7
Loc:3 Option:23

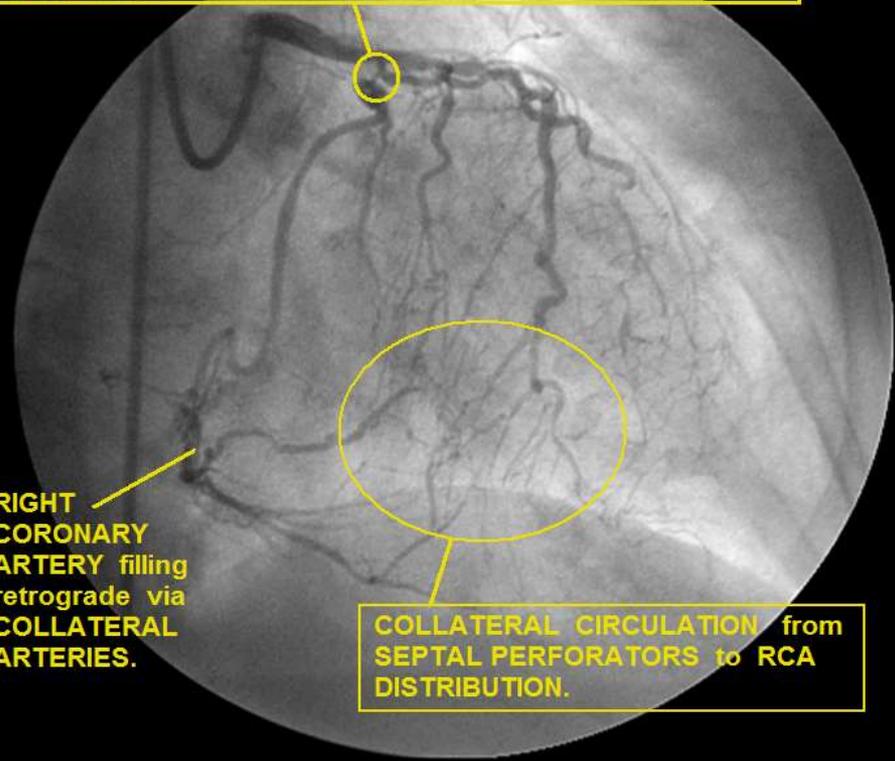
Vent. rate 67 BPM
PR interval 188 ms
QRS duration 106 ms
QT/QTc 458/483 ms
P-R-T axes 27 -3 -111

ST SEGMENT ELEVATION

ST SEGMENT DEPRESSION



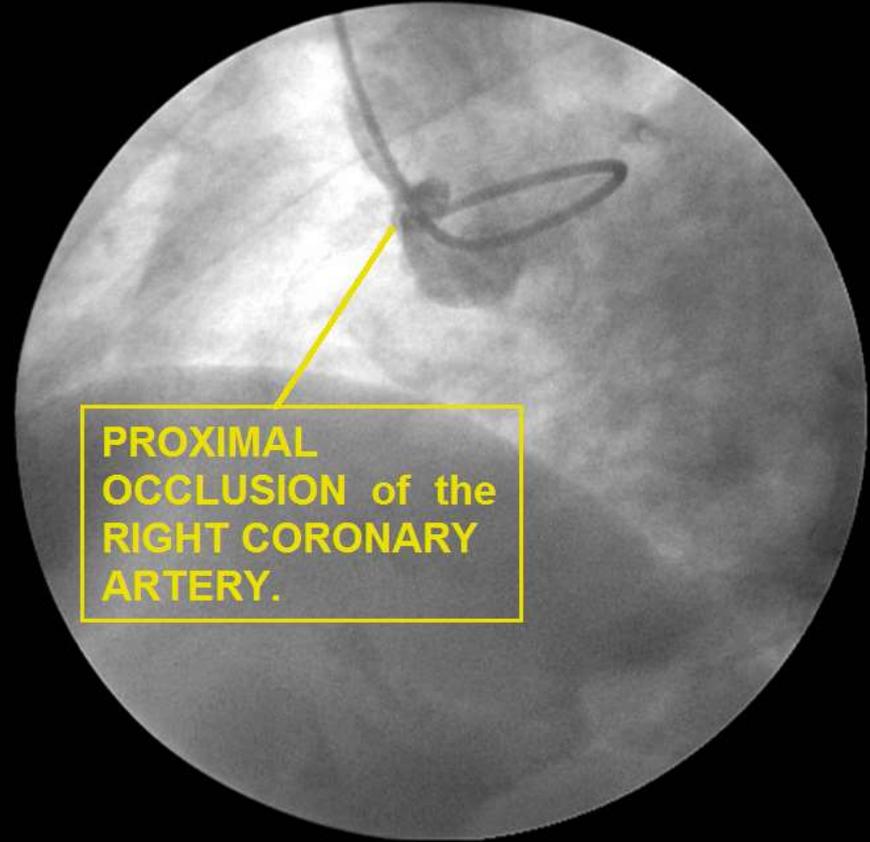
SUB-TOTAL OCCLUSION of CIRCUMFLEX ARTERY.



RIGHT CORONARY ARTERY filling retrograde via COLLATERAL ARTERIES.

COLLATERAL CIRCULATION from SEPTAL PERFORATORS to RCA DISTRIBUTION.

PROXIMAL OCCLUSION of the RIGHT CORONARY ARTERY.





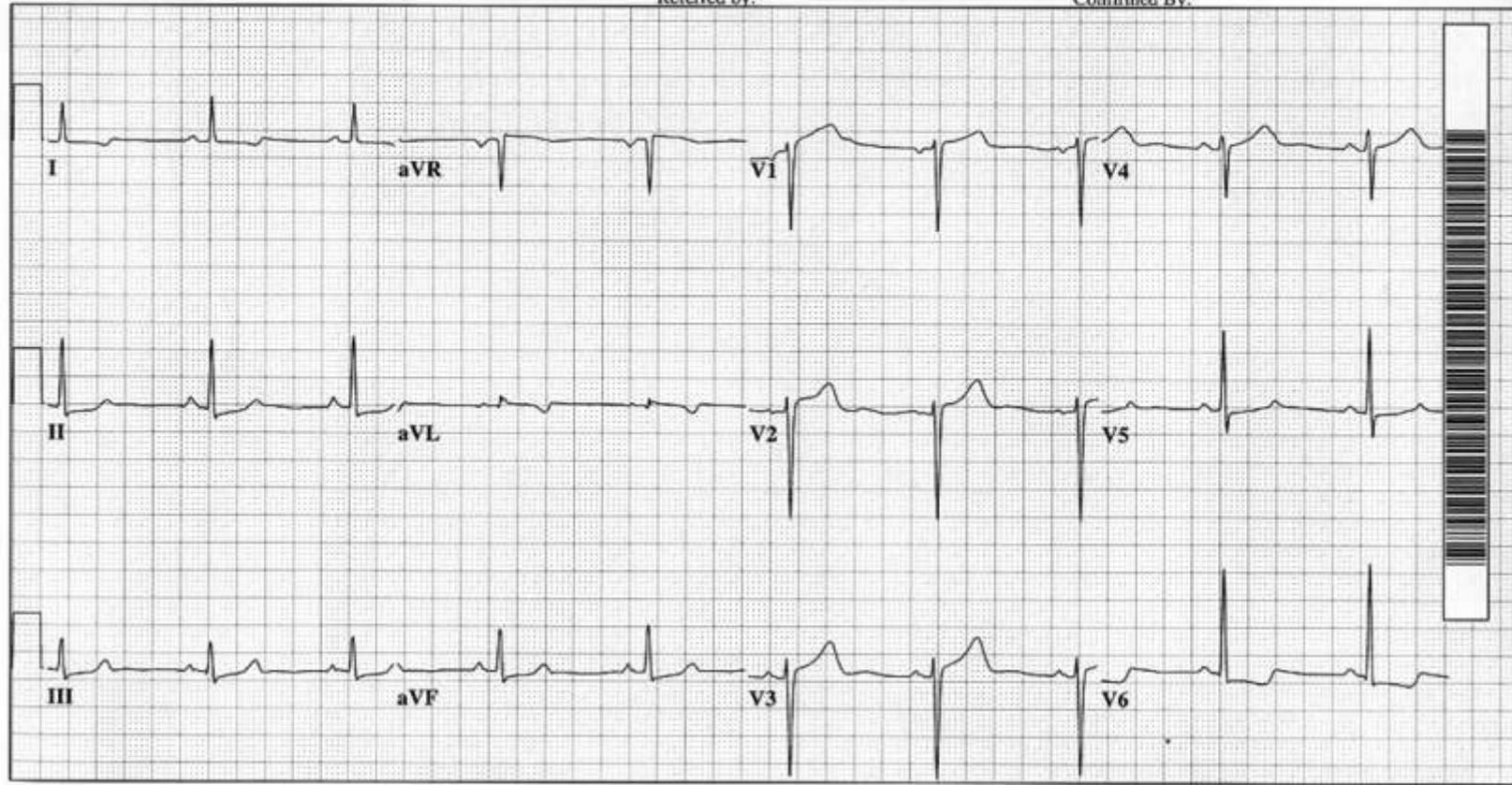
45 yr
Female Caucasian

Vent. rate 58 BPM
PR interval 148 ms
QRS duration 80 ms
QT/QTc 448/440 ms
P-R-T axes 57 48 105

Loc:1 Option:1

Referred by:

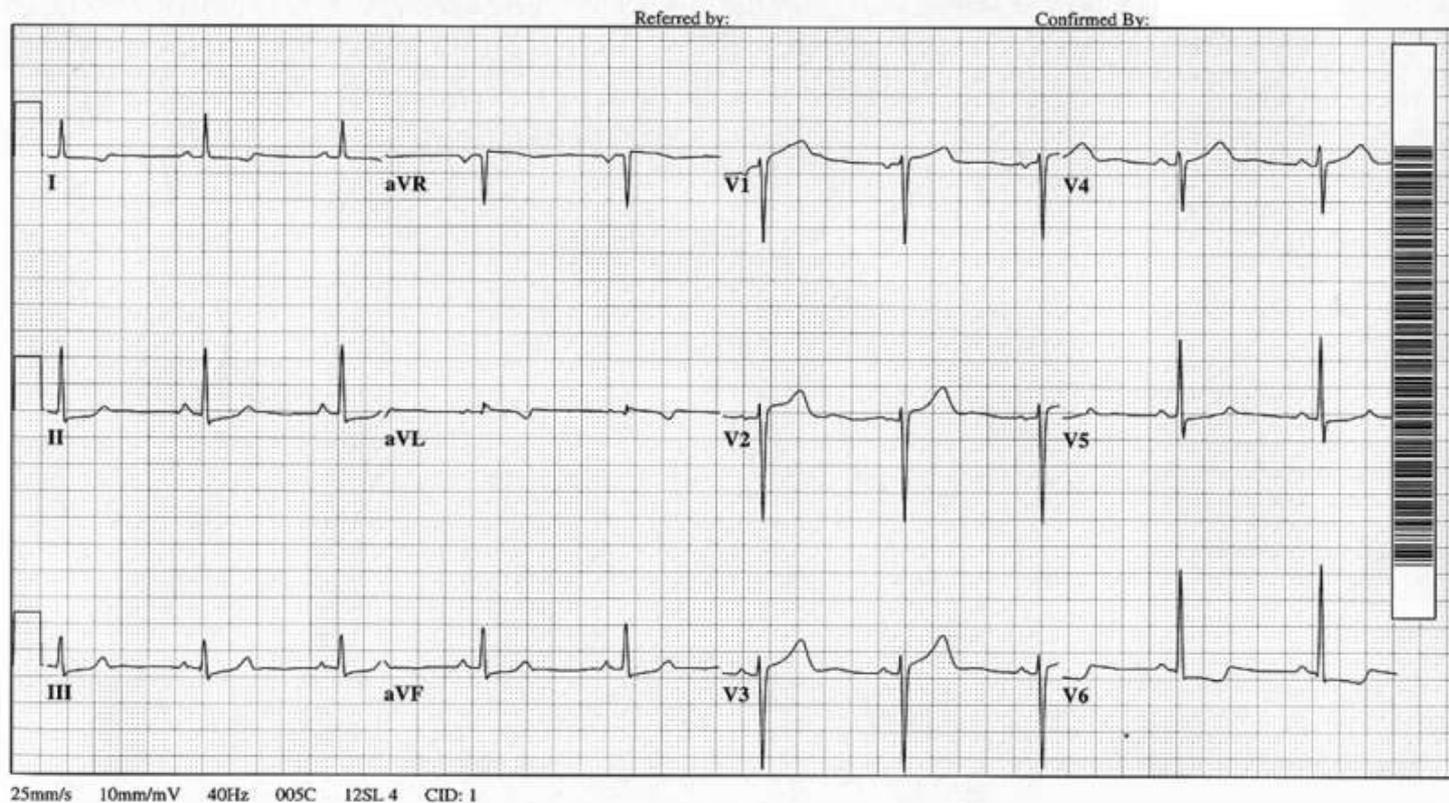
Confirmed By:



25mm/s 10mm/mV 40Hz 005C 12SL 4 CID: 1

1. ECG abnormality(ies)?
2. Possible diagnosis?
3. Action / Intervention?

45 yr
Female Caucasian
Vent. rate 58 BPM
PR interval 148 ms
QRS duration 80 ms
QT/QTc 448/440 ms
P-R-T axes 57 48 105



1. ECG abnormality(ies)? **Inferior (II, III, AVF) ST Depr (ischemia?), I & AVL T wave inversion, V5 ST Depr**
2. Possible diagnosis? **Inferior / Lateral ischemia**
3. Action / Intervention? **Serial ECGs / Troponins, additional diagnostic testing, cath lab**

INVERTED
T WAVE



- **MYOCARDITIS**
- **ELECTROLYTE IMBAL.**
- **ISCHEMIA**

SHARP S-T
T ANGLE



- **ACUTE MI (NOT COMMON)**
- **ISCHEMIA**

BI-PHASIC
T WAVE
(WELLEN'S)



- **SUB-TOTAL LAD LESION**
- **VASOSPASM**
- **HYPERTROPHY**

DEPRESSED J
POINT with
UPSLOPING ST



- **ISCHEMIA**

DOWNSLOPING
S-T SEGMENT



- **ISCHEMIA**

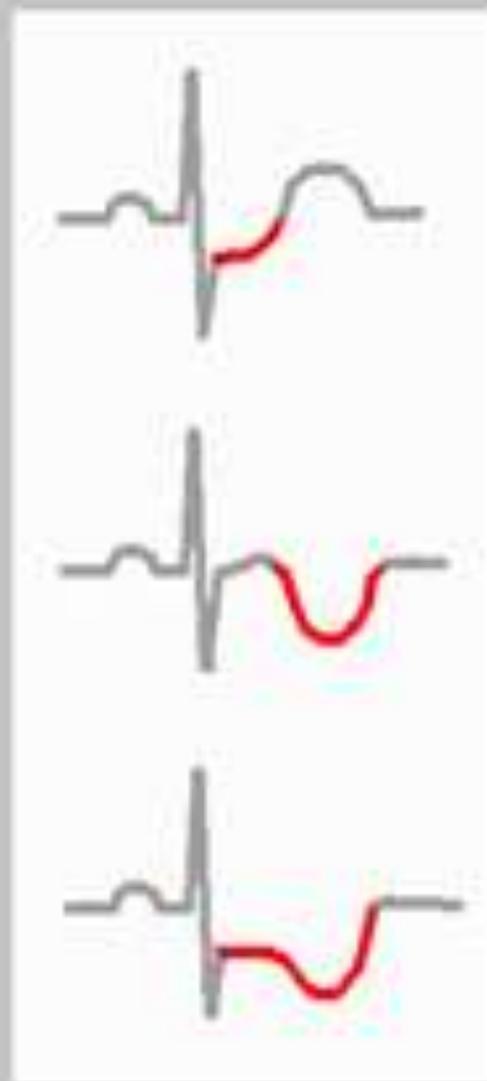
ISCHEMIA

HELPFUL PATTERNS . . .

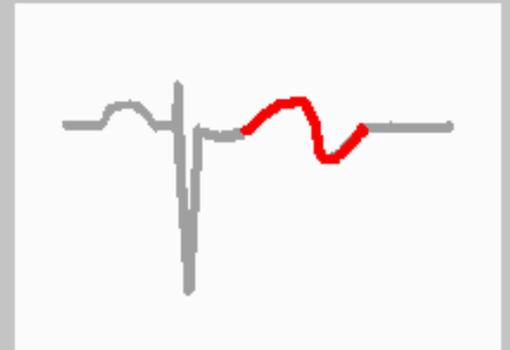
**J POINT DEPRESSION
(> 1 mm)**

INVERTED T WAVES

**J POINT DEPRESSION
+ INVERTED T WAVES**



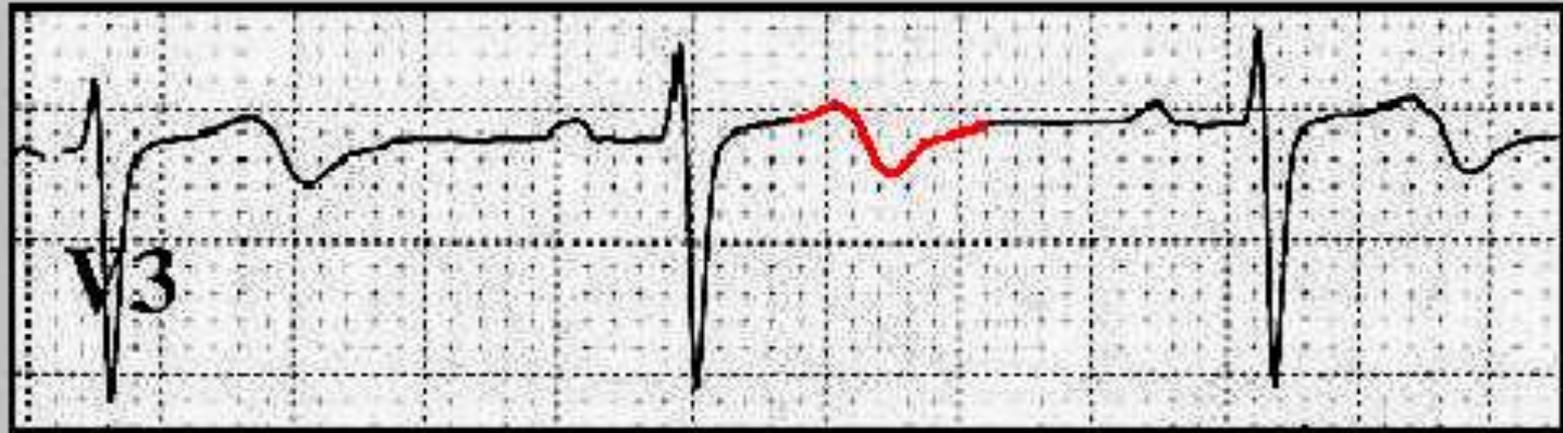
ISCHEMIA



BI-PHASIC T WAVE

- **SUB-TOTAL OCCLUSION of LEFT ANTERIOR DESCENDING ARTERY (when noted in V1-V4)**
- **LEFT VENTRICULAR HYPERTROPHY**
- **COCAINE INDUCED VASOSPASM**

BI-PHASIC T WAVES



**58 y/o MALE WITH SUB-TOTAL
OCCLUSIONS OF THE LEFT
ANTERIOR DESCENDING ARTERY**



**58 y/o MALE WITH "WELLEN'S
WARNING." PT HAS SUB-TOTALLY
OCCLUDED LAD X 2**

Classic “Wellen’s Syndrome:”

- **Characteristic T wave changes**
 - Biphasic T waves
 - Inverted T waves
- **History of anginal chest pain**
- **Normal or minimally elevated cardiac markers**
- **ECG without Q waves, without significant ST-segment elevation, and with normal precordial R-wave progression**

Wellen's Syndrome ETIOLOGY:

- **Critical Lesion, Proximal LAD**
- **Coronary Artery Vasospasm**
- **Cocaine use (vasospasm)**
- **Increased myocardial oxygen demand**
- **Generalized Hypoxia / anemia / low H&H**

Wellen's Syndrome EPIDEMIOLOGY & PROGNOSIS:

- Present in 14-18% of patients admitted with unstable angina
- 75% patients not treated developed extensive Anterior MI within 3 weeks.
- *Median Average time from presentation to Acute Myocardial Infarction – 8 days*

Sources: [H Wellens et. Al, Am Heart J 1982; v103\(4\) 730-736](#)

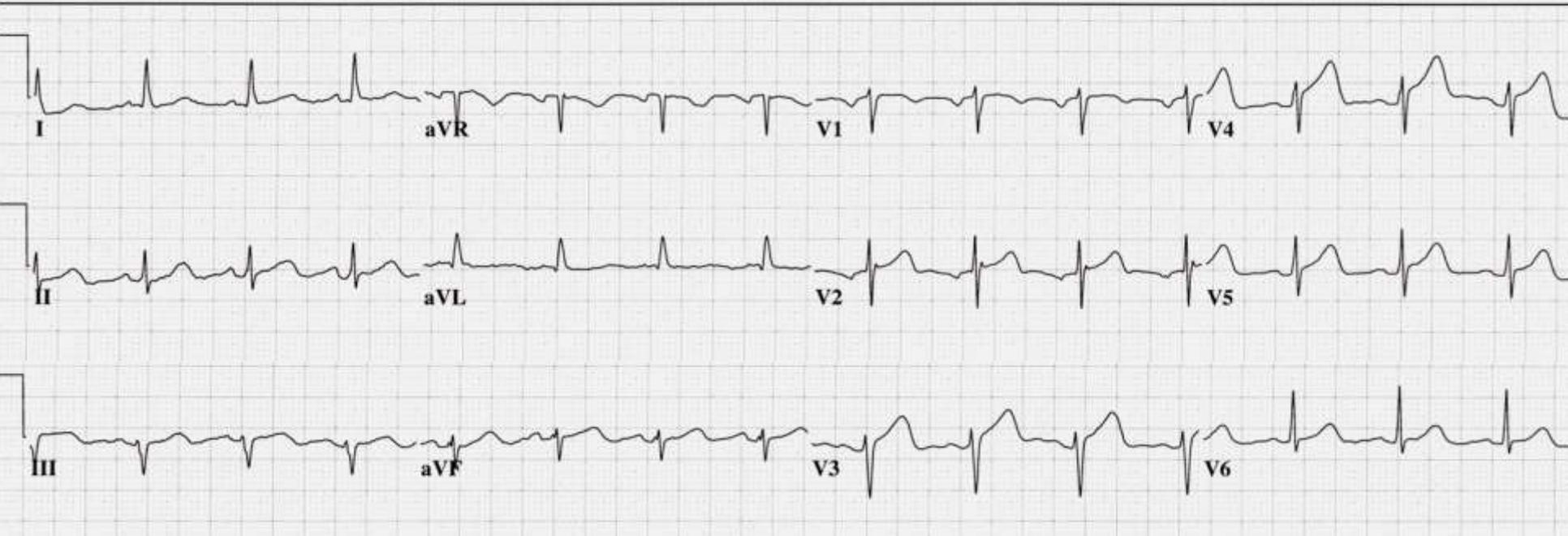
Wellen's Syndrome Case Study

- 33 y/o male
- Chief complaint “sharp, pleuritic quality chest pain, intermittent, recent history lower respiratory infection with productive cough.”
- ED physician attributed the ST elevation in precordial leads to “early repolarization,” due to patient age, gender, race (African American) and concave nature of ST-segments.

Wellen's Syndrome Case Study

SERIAL EKG CASE STUDY 1 - EKG # 1 @ 06:22 HOURS

33 yr		Vent. rate	89	BPM	Normal sinus rhythm
Male	Black	PR interval	158	ms	Possible Left atrial enlargement
		QRS duration	80	ms	Borderline ECG
		QT/QTc	366/445	ms	No previous ECGs available
Loc:3	Option:23	P-R-T axes	60 -5	65	



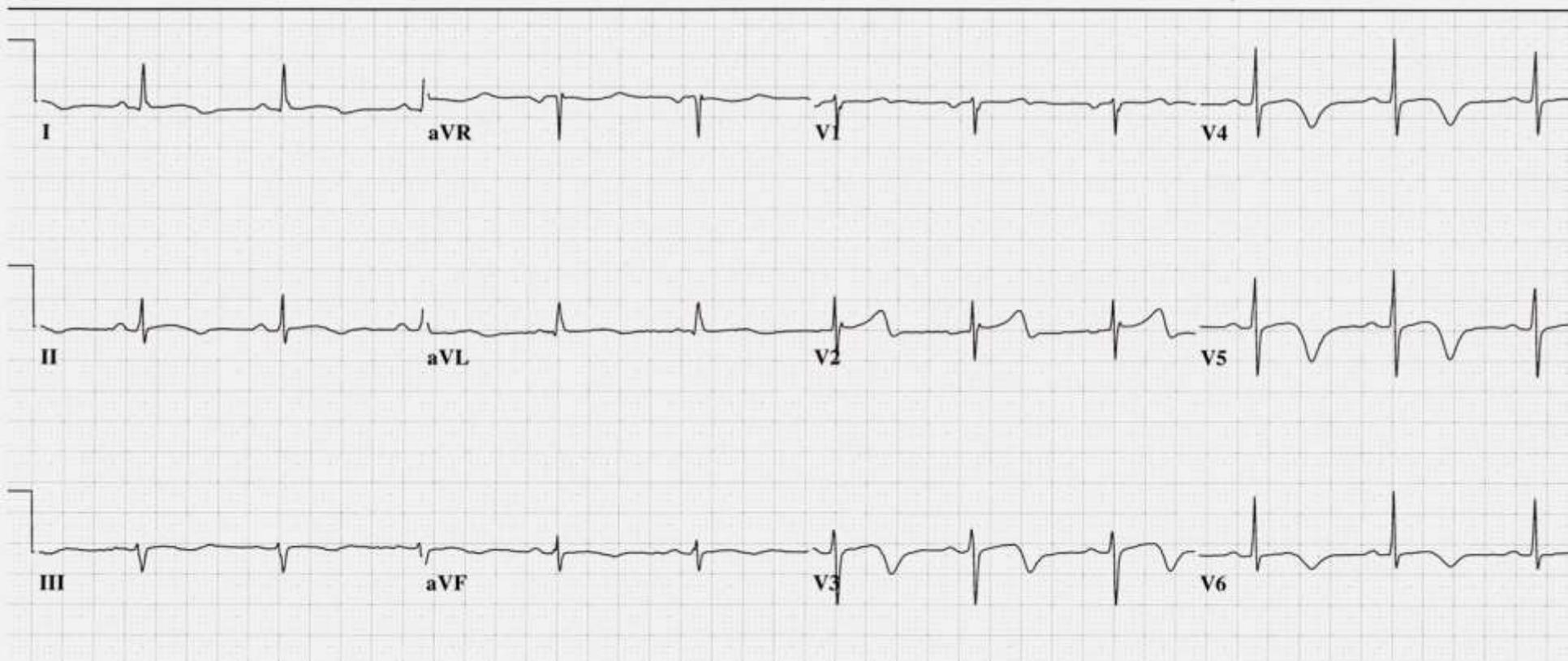
Wellen's Syndrome Case Study

SERIAL EKG CASE STUDY 1 - EKG # 2 @ 09:42 HOURS

33 yr
Male Black
Room:A13
Loc:3 Option:23

Vent. rate 67 BPM
PR interval 160 ms
QRS duration 82 ms
QT/QTc 512/541 ms
P-R-T axes 44 0 54

***UNEDITED COPY: REPORT IS COMPUTER GENERATED ONLY, WITHOUT PHYSICIAN INTERPRETATION**
Normal sinus rhythm
T wave abnormality, consider anterolateral ischemia
Prolonged QT
Abnormal ECG



***DYNAMIC ST-T Wave Changes
ARE PRESENT !!***

NOW

is the time for the

STAT CALL

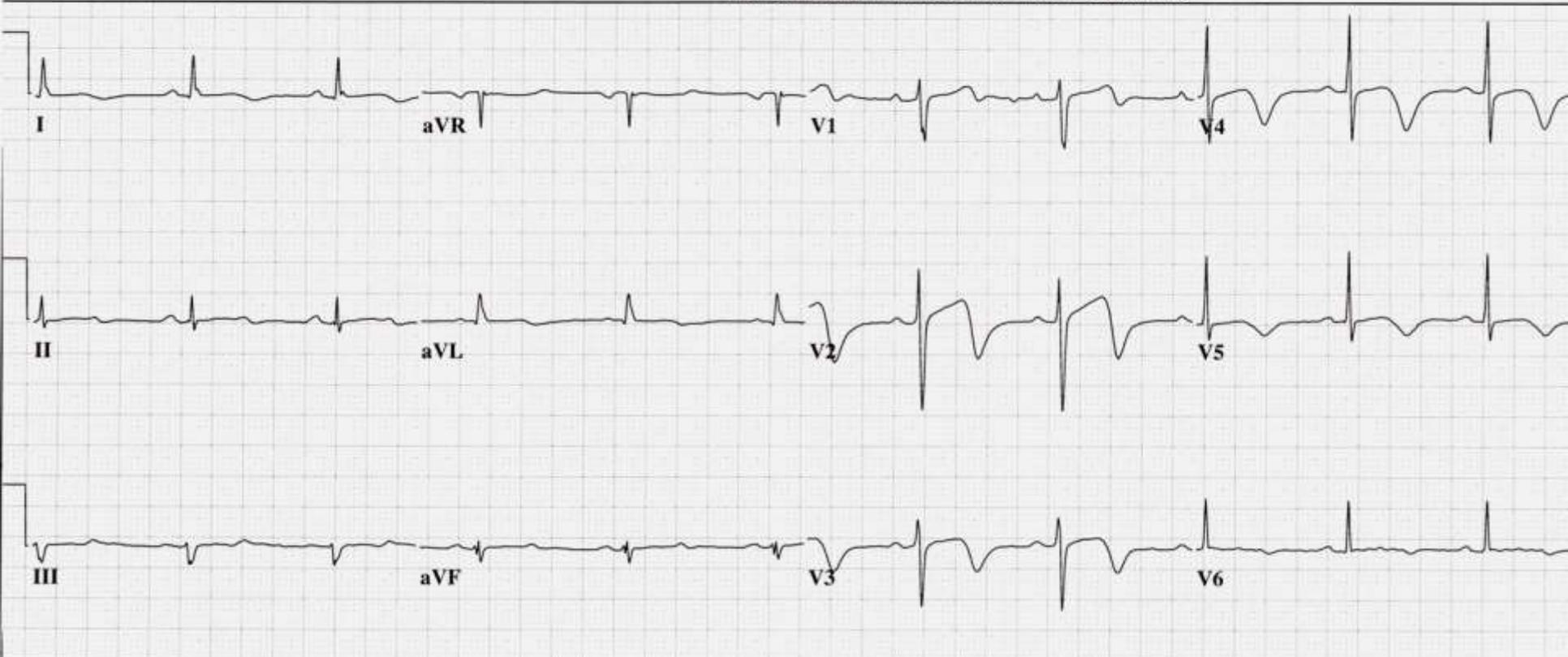
to the

CARDIOLOGIST !!!!

Wellen's Syndrome Case Study

SERIAL EKG CASE STUDY 1 - EKG # 3 @ 12:12 HOURS

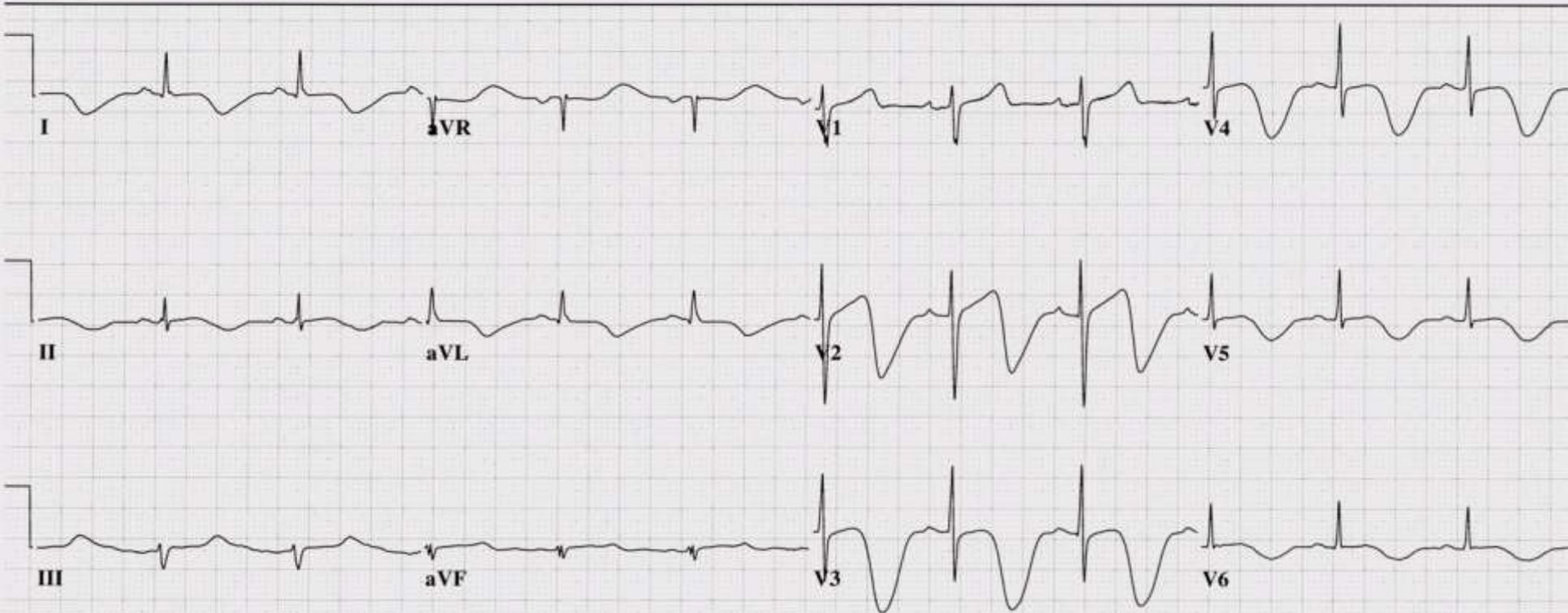
33 yr Male	Black	Vent. rate	64	BPM	Normal sinus rhythm
		PR interval	160	ms	Marked T wave abnormality, consider anterolateral ischemia
		QRS duration	84	ms	Prolonged QT
		QT/QTc	514/530	ms	Abnormal ECG
Loc:7	Option:35	P-R-T axes	45 3	91	When compared with ECG of 05-NOV-2008 05:12.



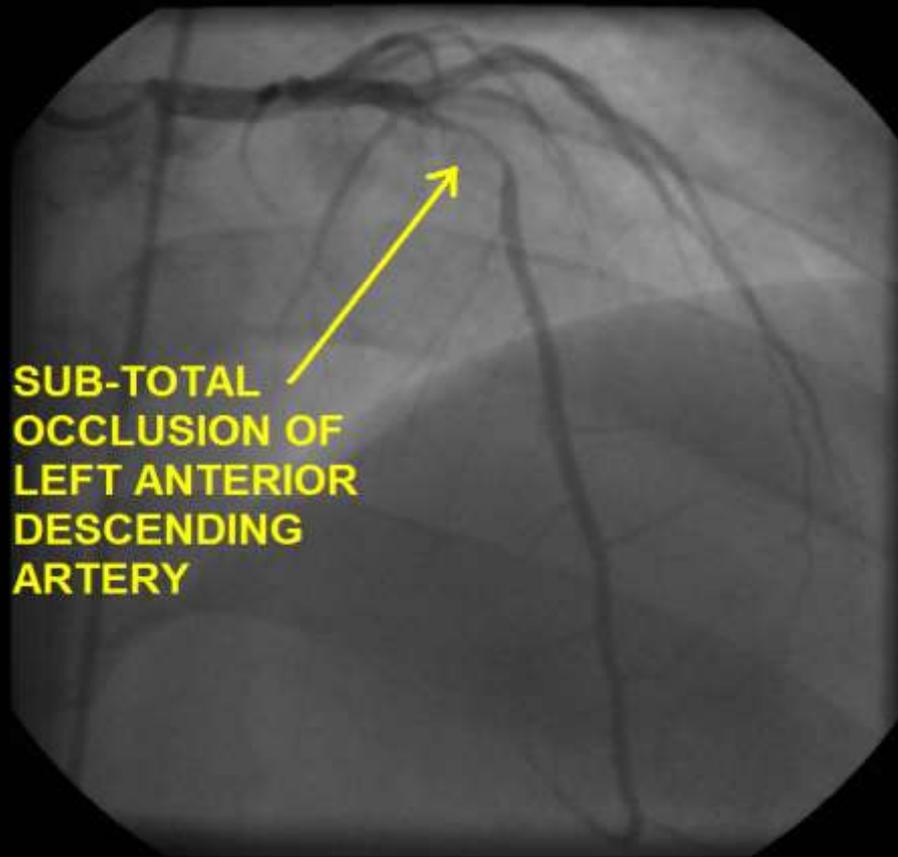
Wellen's Syndrome Case Study

SERIAL EKG CASE STUDY 1 - EKG # 4 @ 15:37 HOURS

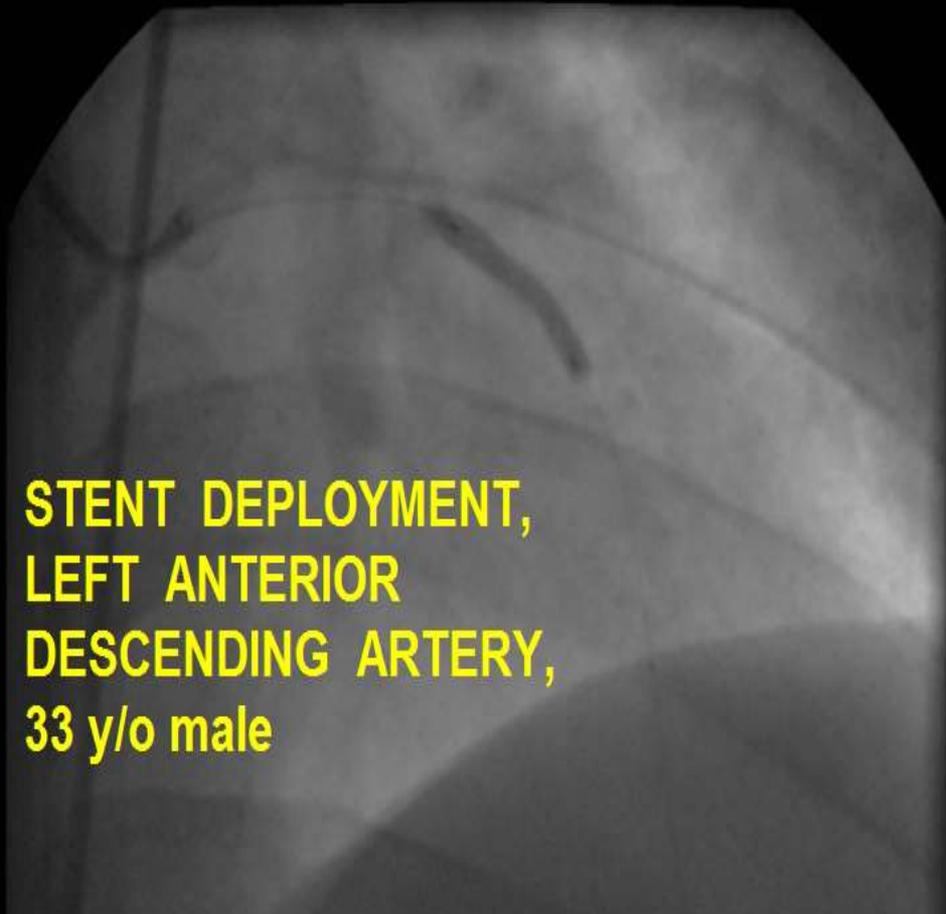
33 yr		Vent. rate	71	BPM	Normal sinus rhythm
Male	Black	PR interval	144	ms	Marked T wave abnormality, consider anterolateral ischemia
		QRS duration	74	ms	Prolonged QT
Room:405A		QT/QTc	600/652	ms	Abnormal ECG
Loc:5	Option:39	P-R-T axes	20 1	160	



Wellen's Syndrome Case Study

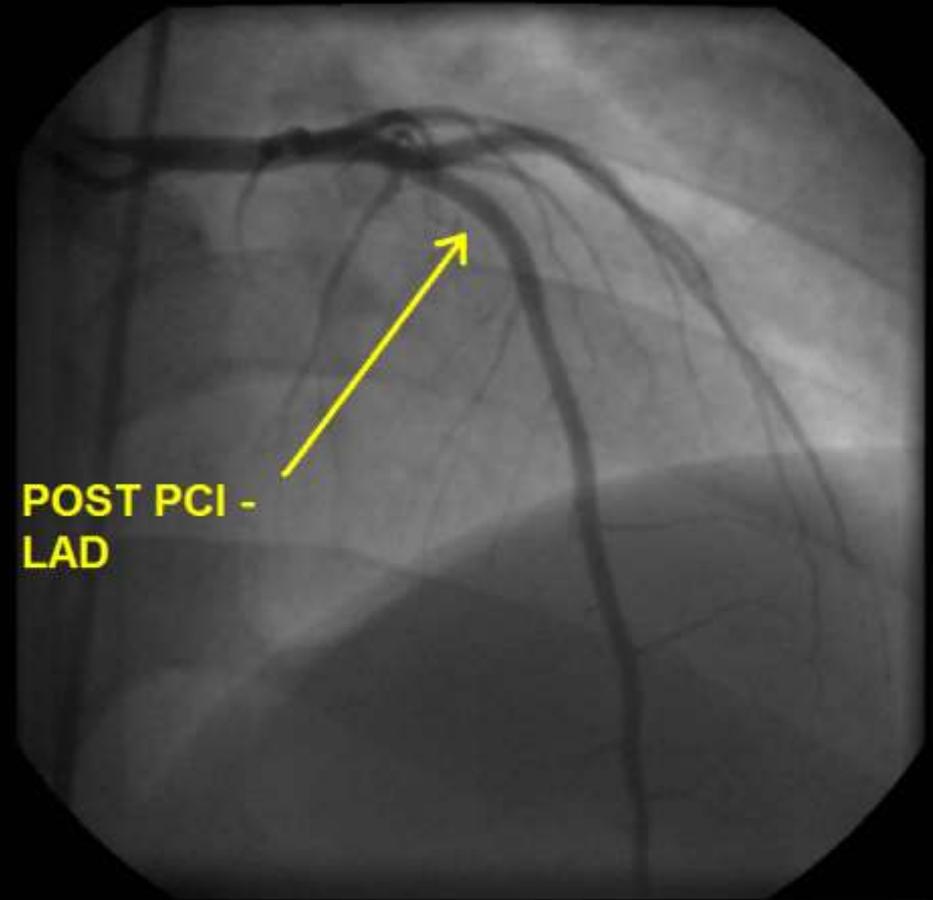
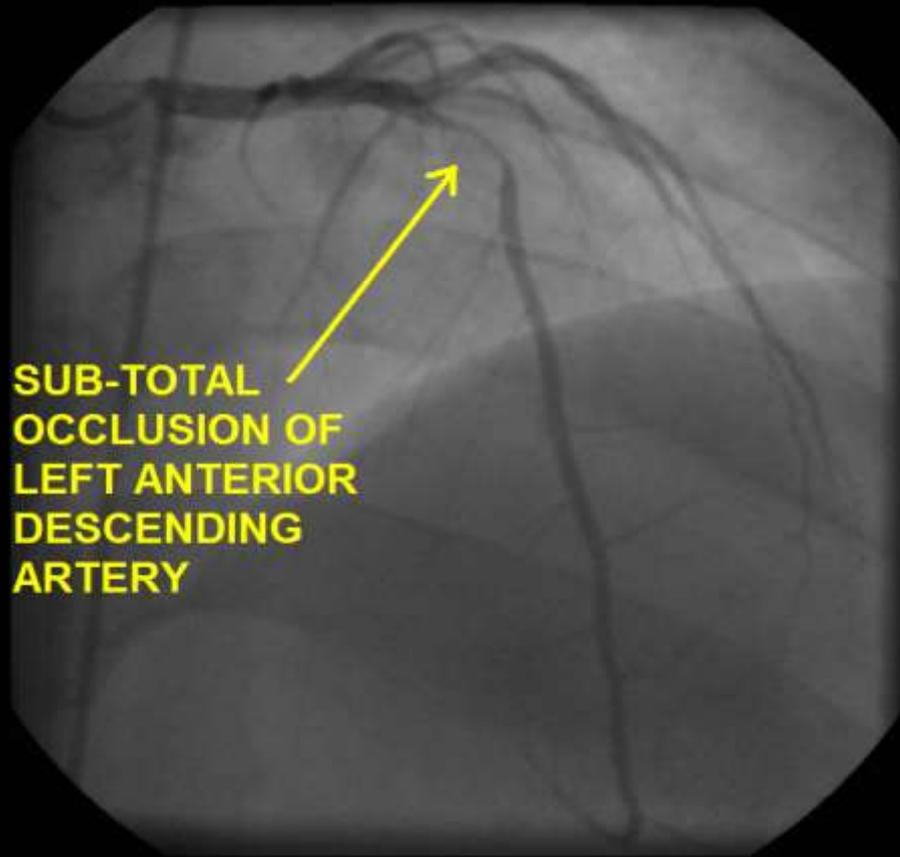


**SUB-TOTAL
OCCLUSION OF
LEFT ANTERIOR
DESCENDING
ARTERY**



**STENT DEPLOYMENT,
LEFT ANTERIOR
DESCENDING ARTERY,
33 y/o male**

Wellen's Syndrome Case Study



Additional Resources:

- [Wellen's Syndrome, NEJM case study](#)

S-T SEGMENT DEPRESSION - COMMON ETIOLOGIES:



CONDITION:

- **RECIPROCAL CHANGES of ACUTE MI**
- **NON-Q WAVE M.I. (NON-STEMI)**
- **ISCHEMIA**
- **POSITIVE STRESS TEST**
- **VENTRICULAR HYPERTROPHY (STRAIN PATTERN)**
- **WOLFF-PARKINSON-WHITE**
- **OLD MI (NECROSIS vs. ISCHEMIA)**
- **DIGITALIS**
- **R. BUNDLE BRANCH BLOCK**

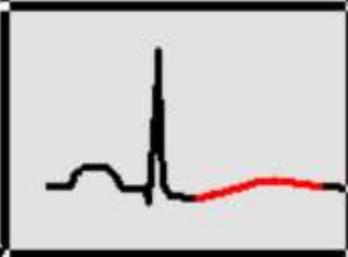
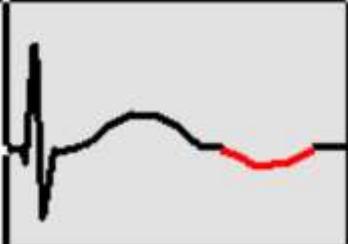
T WAVE INVERSION - COMMON ETIOLOGIES:



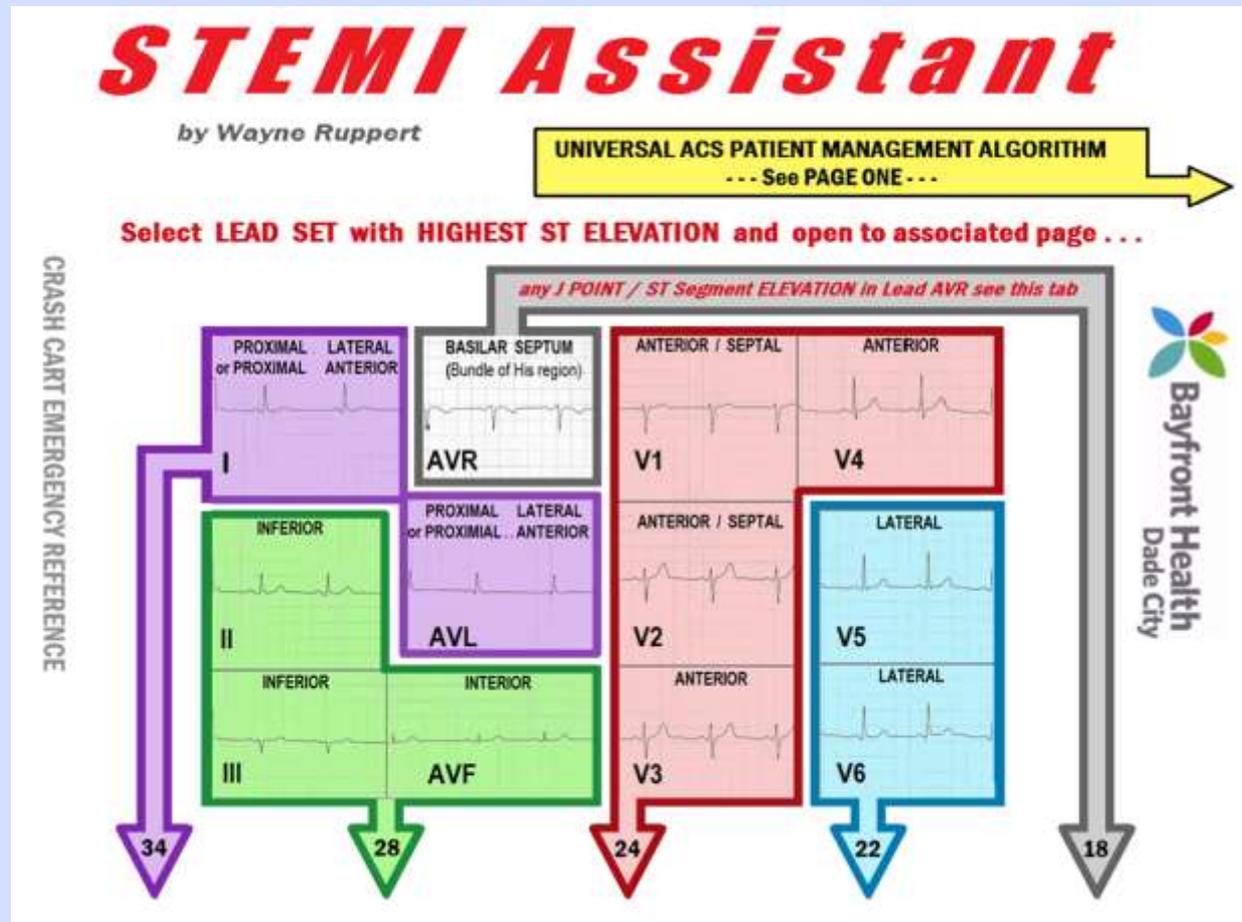
CONDITION:

- **MYOCARDITIS**
- **ELECTROLYTE IMBALANCE**
- **ISCHEMIA**
- **POSITIVE STRESS TEST**
- **CEREBRAL DISORDER**
- **MITRAL VALVE PROLAPSE**
- **VENTRICULAR HYPERTROPHY**
- **WOLFF-PARKINSON-WHITE**
- **HYPERVENTILATION**
- **CARDIOACTIVE DRUGS**
- **OLD MI (NECROSIS vs. ISCHEMIA)**
- **DIGITALIS**
- **R. BUNDLE BRANCH BLOCK**
- **NO OBVIOUS CAUSE**

Some less common, less reliable possible indicators of ACS:

? FLAT S-T SEGMENT > 120 ms		- ISCHEMIA
? LOW VOLTAGE T WAVE WITH NORMAL QRS		- ISCHEMIA
? U WAVE POLARITY OPPOSITE THAT OF T WAVE		- ISCHEMIA

STEMI Assistant: an Emergency Crash Cart Interactive Reference Manual - free Download



STEMI Assistant – Information Video

Helpful STEMI ECG Resources

[1] [“Use of the Electrocardiogram in Acute Myocardial Infarction,” Zimetbaum, et al, NEJM 348:933-940](#)

[Abnormal ST Elevation Criteria: ACC/AHA 2009 “Standardization and Interpretation of the ECG, Part VI Acute Ischemia and Infarction,” Galen Wagner, et al](#)

[ECG in STEMI – excellent powerpoint – quick reference, in-depth material](#)

***Your thoughts, ideas, comments
and feedback are welcome . . .***

Author's correspondence information:

Wayne W Ruppert

Wayneruppert@bayfronthealth.com

Office: 352-795-8558

Cell: 813-230-4747



My top two reasons for giving everything in life the best I have to offer.

Helpful STEMI ECG Resources

[Download Non-ED STEMI Protocol - example](#)

[Download STEMI Alert ED Physicians Order Set](#)

Correlation of Leads with ST Elevation and Cardiac Structures at Risk, based on STEMI in patients with Common Coronary Arterial Anatomy

	ECG Leads:	Associated Region:	Coronary Artery:	Structures at Risk:
All Patients	V1 - V4	Anterior and Septal walls of LV	Left Anterior Descending (LAD) Atery	<ul style="list-style-type: none"> - 35 - 45% of LV muscle mass - Bundle of HIS - Bundle Branches
RCA Dominant	V5 - V6	Lateral wall LV, approx. 50% Posterior wall	Circumflex (Cx) (non - dominant)	<ul style="list-style-type: none"> - 20 - 30% LV muscle mass - Sinus Node (rare)
	II, III, AVF	Inferior Wall, approx. 50% Posterior wall	Right Coronary Artery (RCA)	<ul style="list-style-type: none"> - SA Node - Right Ventricle - AV Node
Cx Dominant	V5 - V6 + II, III, AVF	Lateral wall of LV Posterior Wall (all) Inferior Wall	Circumflex (Dominant)	<ul style="list-style-type: none"> - 45-55% LV muscle mass - SA Node (rare) - AV Node

Evolving MI & “Old MI”

• Q WAVES •

Normal Q Waves

caused by depolarization of
the intraventricular septum

Abnormal Q Waves -

caused by:

- necrosis (old infarction)
- hypertrophy

• Q WAVES •

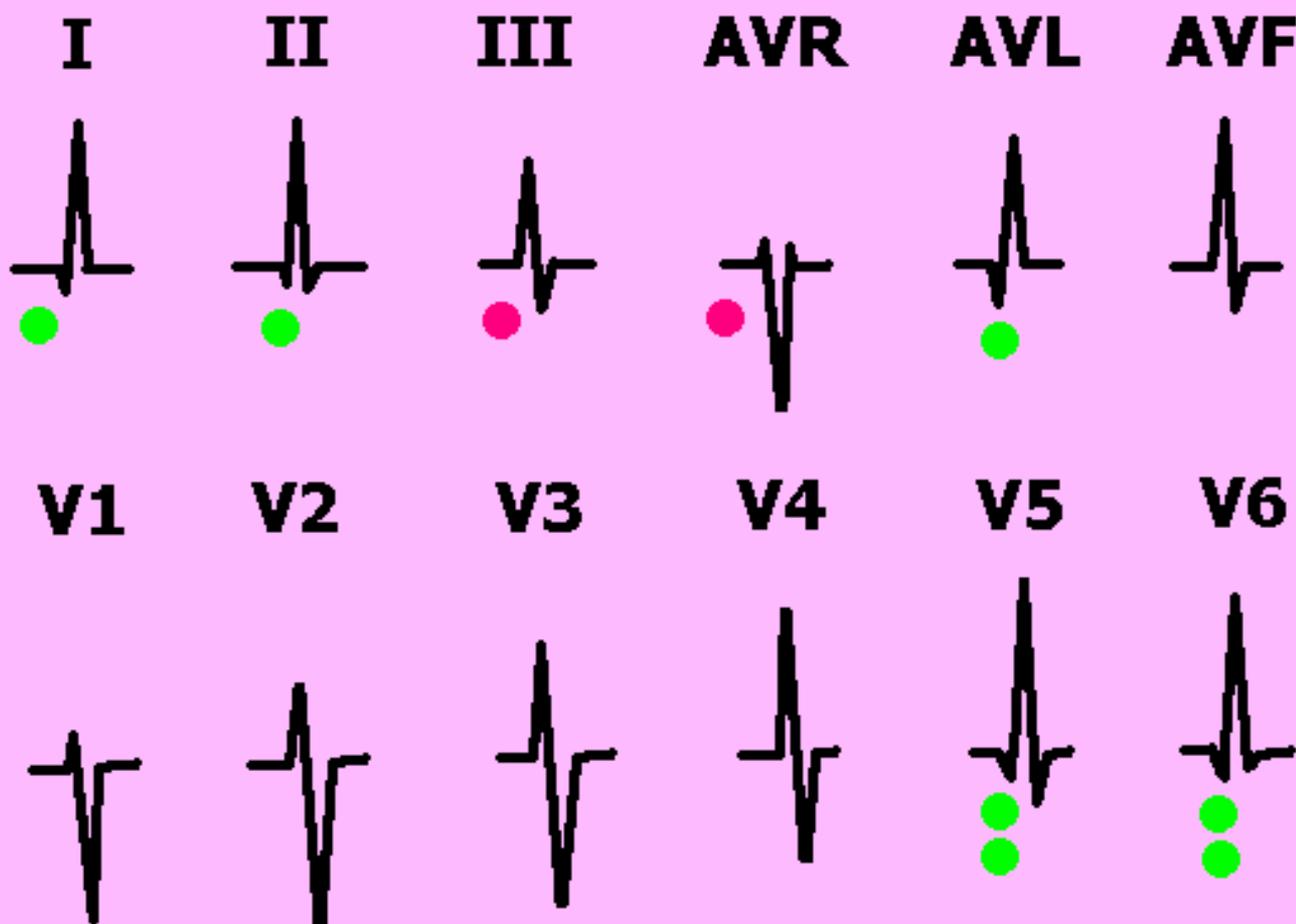
SIZE

DOES

COUNT!!!

LEADS WHERE Q WAVES ARE NORMAL

- Normal Q WAVES caused by SEPTAL DEPOLARIZATION



● Q WAVES NORMAL AND FREQUENTLY SEEN

● Q WAVES EXPECTED

● Q WAVES, IF PRESENT, CAN NORMALLY BE ANY SIZE

THE QRS COMPLEX

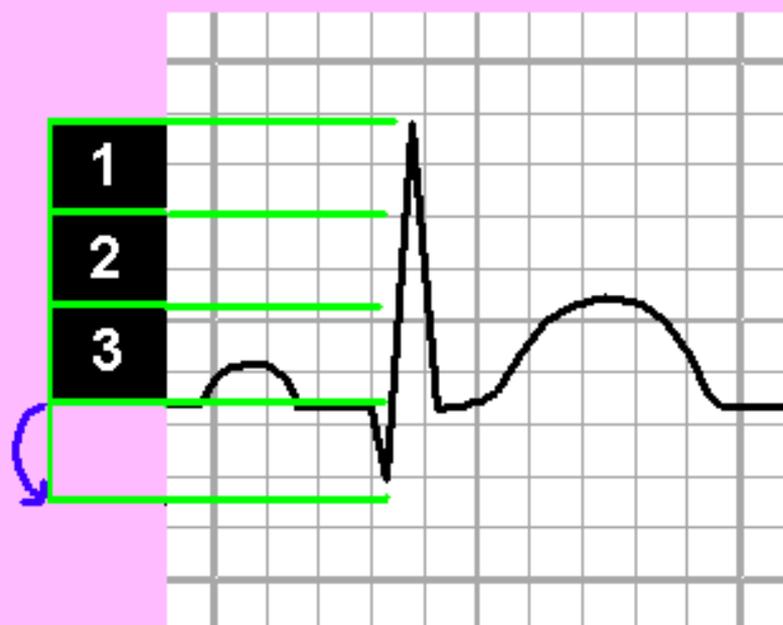
GENERAL RULES FOR NORMAL Q WAVES - WIDTH



**LESS THAN .40
(1 mm) WIDE**

THE QRS COMPLEX

GENERAL RULES FOR NORMAL Q WAVES - HEIGHT

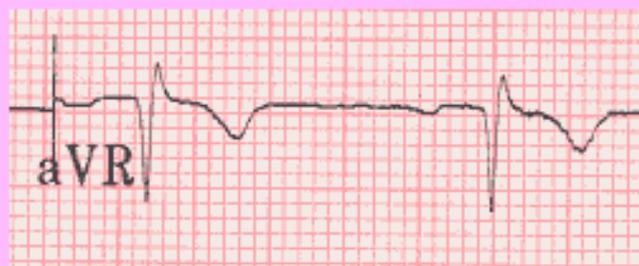


LESS THAN $\frac{1}{3}$ THE
HEIGHT OF THE R WAVE

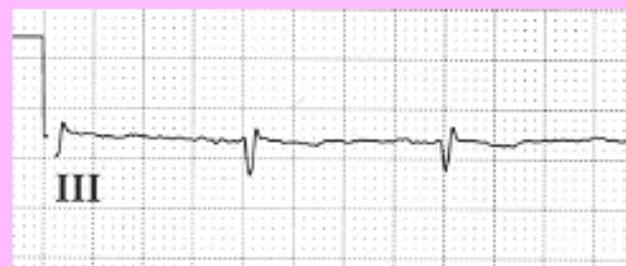
THE QRS COMPLEX

NORMAL Q WAVES

EXCEPTIONS TO THE RULES



LEAD AVR



LEAD III



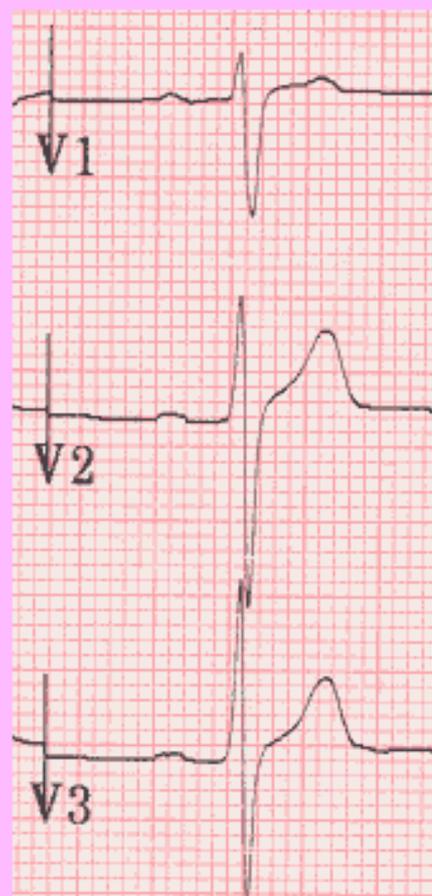
THE Q WAVE CAN BE ANY SIZE

THE QRS COMPLEX

NORMAL Q WAVES EXCEPTIONS TO THE RULES



THERE
SHOULD BE NO Q
WAVES PRESENT
IN LEADS: V1
V2
V3



THE QRS COMPLEX

Q WAVE RULES - SUMMARY:

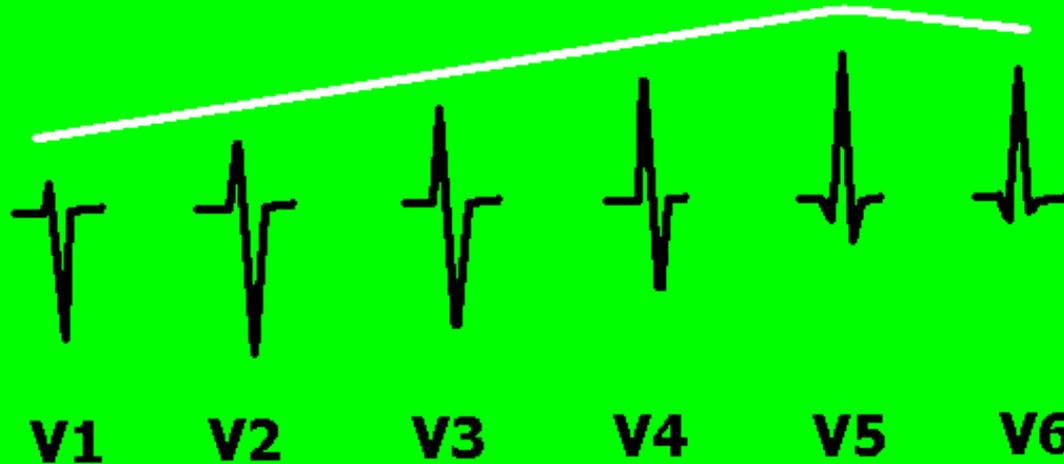
- Q WAVES SHOULD BE LESS THAN .40 WIDE (1 mm)
- Q WAVES SHOULD BE LESS THAN 1/3 THE HEIGHT OF THE R WAVE
- Q WAVES CAN BE ANY SIZE IN LEADS III and AVR
- THERE SHOULD BE NO Q WAVES IN LEADS V1, V2, or V3

The NORMAL ECG

ASSESSING AXIS ROTATION

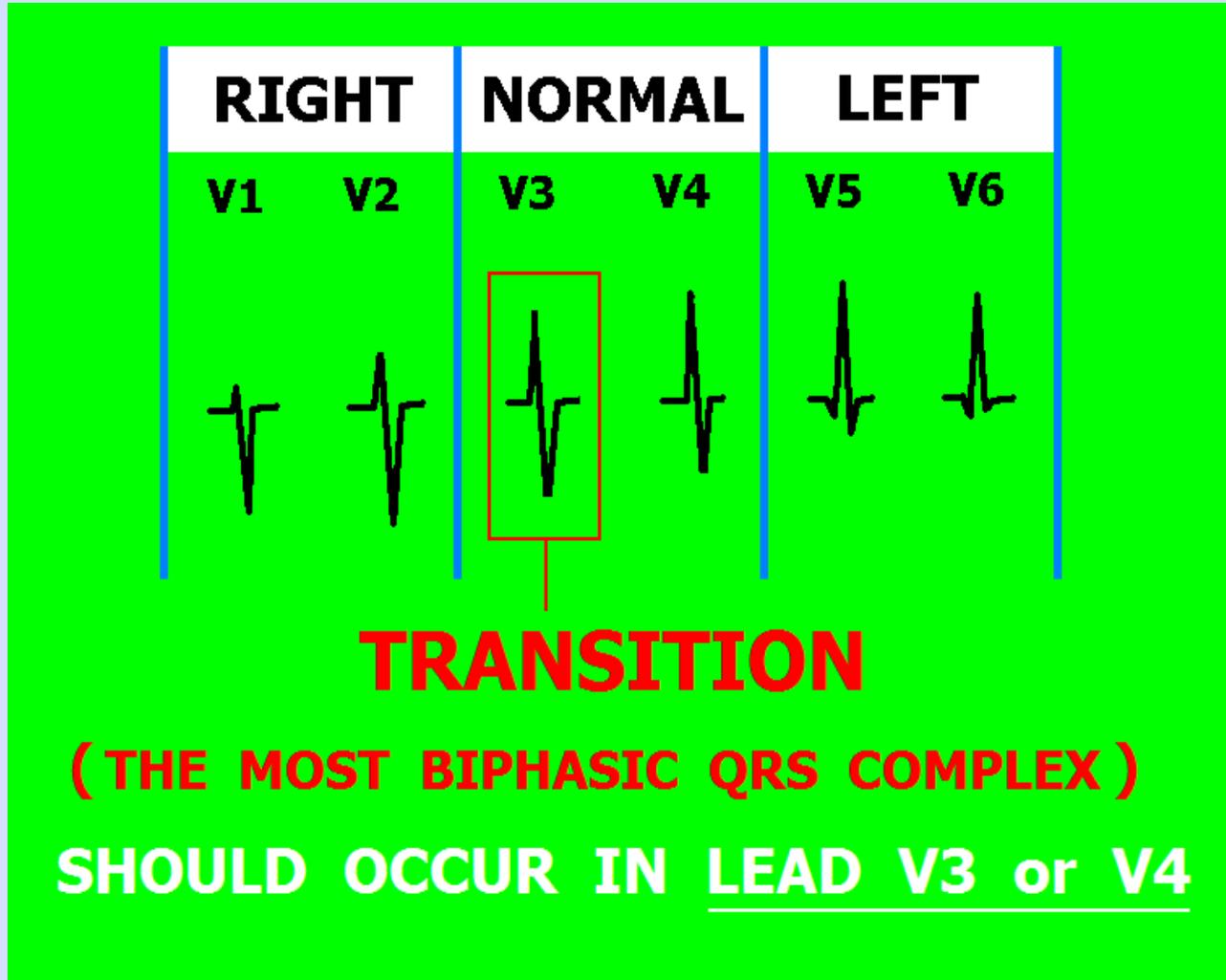
NORMAL

R - WAVE PROGRESSION



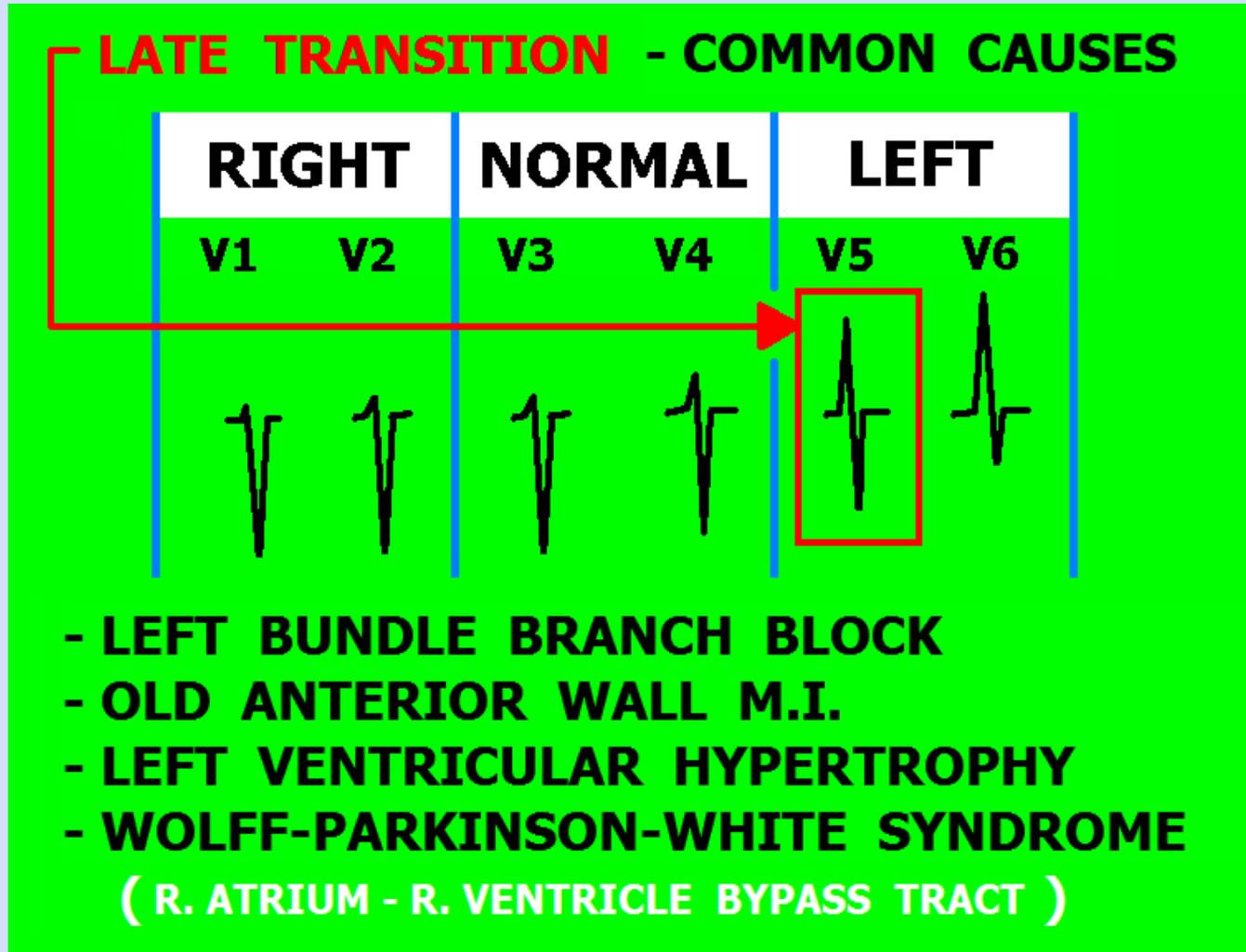
R wave amplitude (size) gradually increases from V1 through V6

The NORMAL ECG



In V3 or V4, the QRS complex becomes Biphasic.

“Poor R Wave Progression”



Anterior Wall necrosis (“old MI”) is a common cause of “Poor R Wave Progression”.

EVOLVING STEMI:

-ST SEGMENTS DROP

-Q WAVES FORM

-R WAVE PROGRESSION CHANGES

**IN PRECORDIAL
LEADS.**

Q WAVE RULES - SUMMARY:

- Q WAVES SHOULD BE LESS THAN .40 WIDE (1 mm)
- Q WAVES SHOULD BE LESS THAN $\frac{1}{3}$ THE HEIGHT OF THE R WAVE
- Q WAVES CAN BE ANY SIZE IN LEADS III and AVR
- THERE SHOULD BE NO Q WAVES IN LEADS V1, V2, or V3

EVOLVING STEMI:

-ST SEGMENTS DROP

-Q WAVES FORM

-R WAVE PROGRESSION CHANGES
IN PRECORDIAL
LEADS.

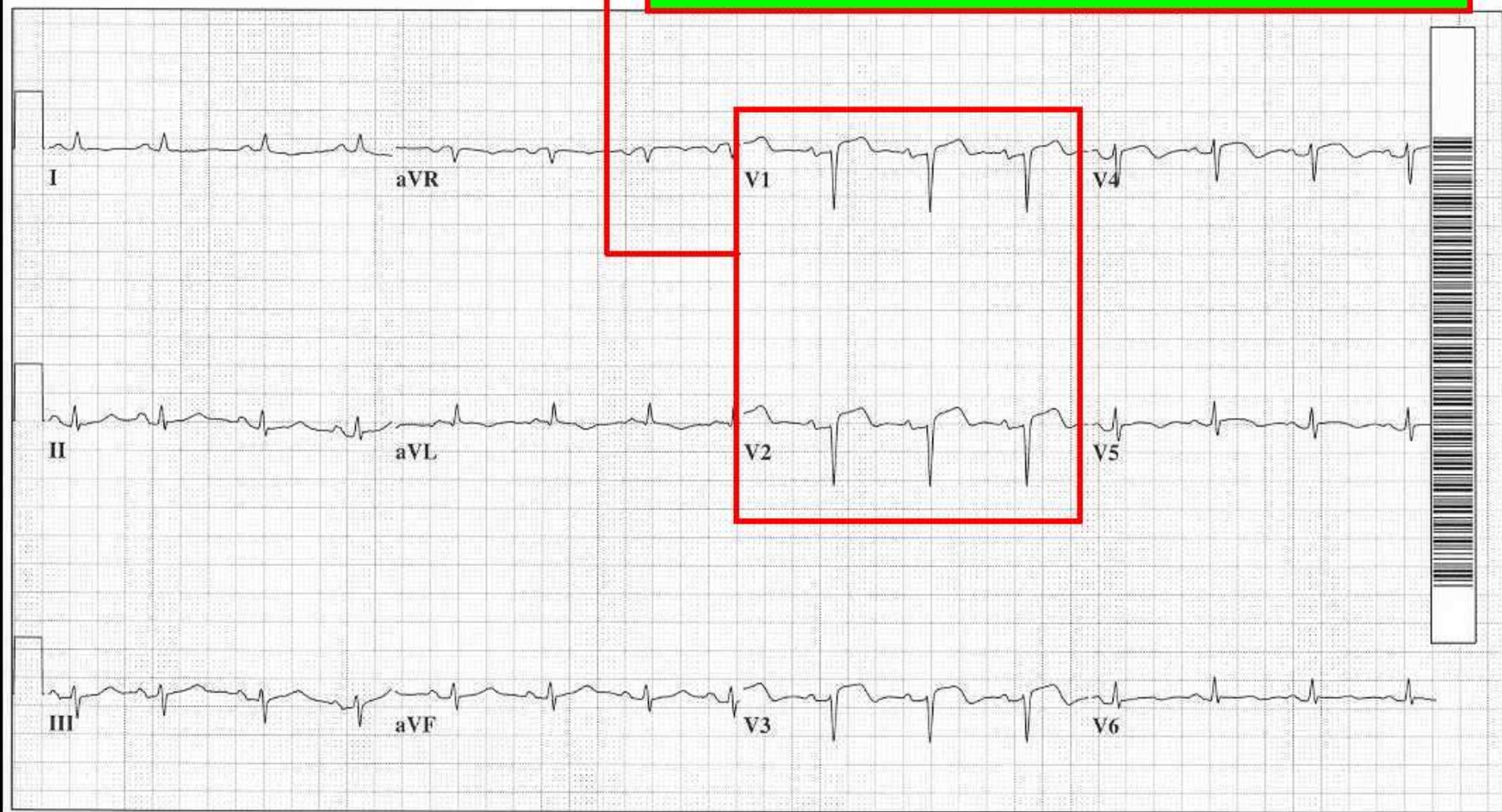
91 yr
Female Caucasian
Room:3
Loc:1 Option:1

Vent. rate 87 BPM
PR interval 156 ms
QRS duration 80 ms
QT/QTc 332/399 ms
P-R-T axes 45 4 96

Normal sinus rhythm
Possible Anterior infarct
Abnormal ECG

Technician ID: EKG CLASS # WR03110848

2. OLD ANTERIOR WALL M.I.
- Q waves in V1, V2, V3 and/or V4
- other causes of LATE TRANSITION ruled out



ACUTE ANTERIOR WALL STEMI

EKG # 1 UPON ARRIVAL IN E.D. - CHEST PAIN x 40 MINUTES

APRIL 6, 2009 01:14 HOURS

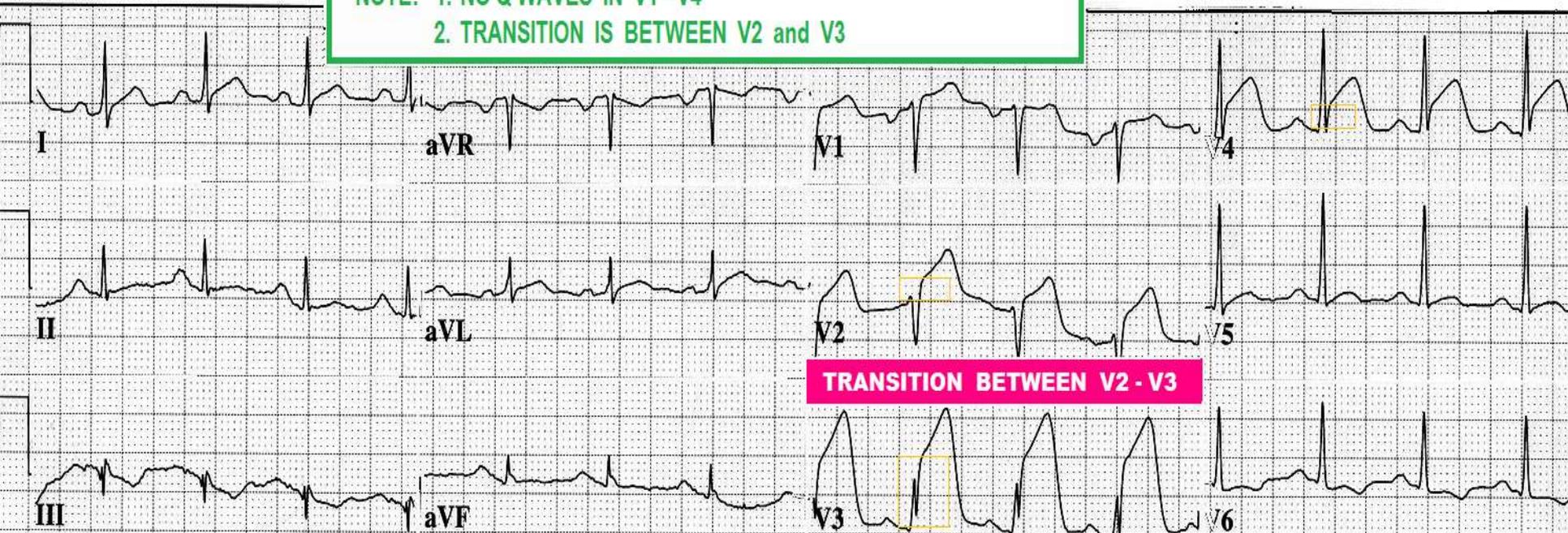
49 yr
Male
Caucasian
Loc:3
Option:23

Vent. rate 91 BPM
PR interval 172 ms
QRS duration 86 ms
QT/QTc 350/430 ms
P-R-T axes 41 17 -15

Normal sinus rhythm
Left atrial enlargement
Cannot rule out Inferior infarct, new
Anterior injury pattern
***** ACUTE MI *****

EKG TAKEN UPON ARRIVAL IN
EMERGENCY DEPARTMENT.
- CHEST PAIN x 40 MINUTES
- ST ELEVATION V1 - V4

NOTE: 1. NO Q WAVES IN V1 - V4
2. TRANSITION IS BETWEEN V2 and V3



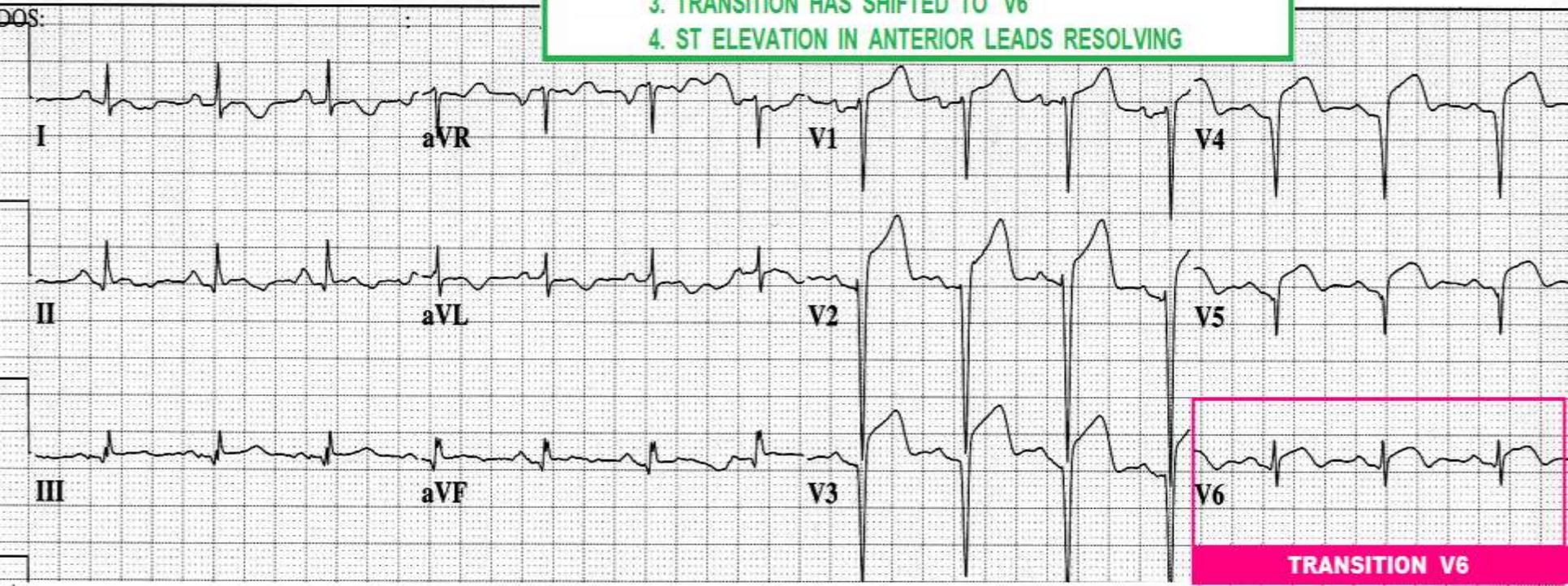
TRANSITION BETWEEN V2 - V3

EVOLVING ANTERIOR WALL STEMI

EKG # 4 APPROXIMATELY 19 HOURS FROM ONSET OF SYMPTOMS APRIL 6, 2009 19:36 HOURS

49 yr	Vent. rate	86	BPM	Normal sinus rhythm	
Male	Caucasian	PR interval	174	ms	Anterior infarct , possibly acute
		QRS duration	78	ms	Lateral injury pattern
Room:CS1		QT/QTc	360/430	ms	***** ACUTE MI *****
Loc:5	Option:28	P-R-T axes			

NOTE: 1. Q WAVES IN LEADS V2 - V5
2. ST ELEVATION NOW IN V5
3. TRANSITION HAS SHIFTED TO V6
4. ST ELEVATION IN ANTERIOR LEADS RESOLVING



FULLY EVOLVED ANTERIOR WALL MI

POST - INFARCTION EKG

TAKEN 1 YEAR AFTER ANTERIOR WALL MI

50 yr
Male Caucasian
Room:
Loc: Option:

Vent. rate 57 BPM
PR interval 216 ms
QRS duration 96 ms
QT/QTc 392/381 ms
P-R-T axes 40 58 -120

Sinus bradycardia with 1st degree A-V block
Anterolateral infarct
T wave abnormality, consider inferior ischemia
Abnormal ECG

NOTE: 1. QS COMPLEXES NOW SEEN IN V1 - V4
2. TRANSITION NOW BETWEEN V5 and V6
3. ST ELEVATION RESOLVED

