STAT 12 Lead ECG Workshop: Basics & ACS

Citrus County Fire Rescue – Session 2

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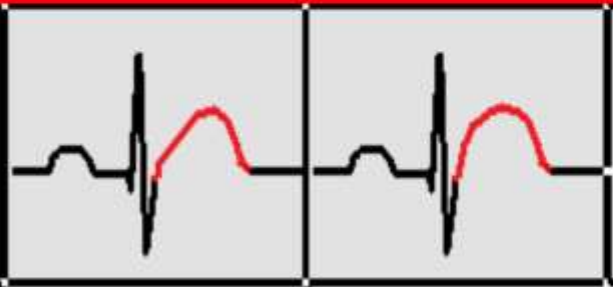
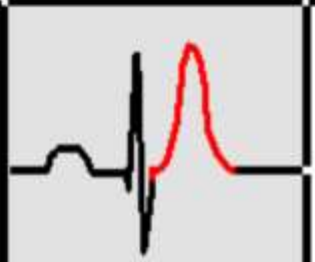
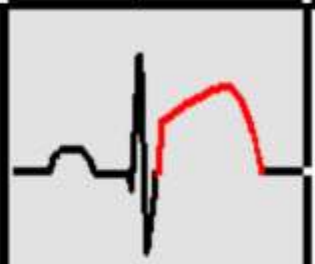
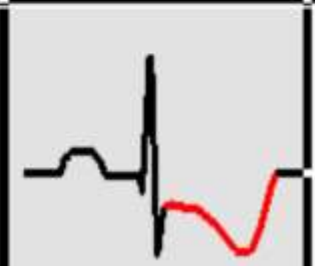
PATTERNS of ACS & ISCHEMIA

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

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

ECG CRITERIA for DIAGNOSIS of STEMI:

(ST ELEVATION @ J POINT)

*LEADS V2 and V3:

MALES AGE 40 and up ------ 2.0 mm

(MALES LESS THAN 40------- 2.5 mm)

FEMALES ---------- 1.5 mm

ALL OTHER LEADS: 1.0 mm or more,
in TWO or more
CONTIGUOUS LEADS

* **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): 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**

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Posterior Chest Leads

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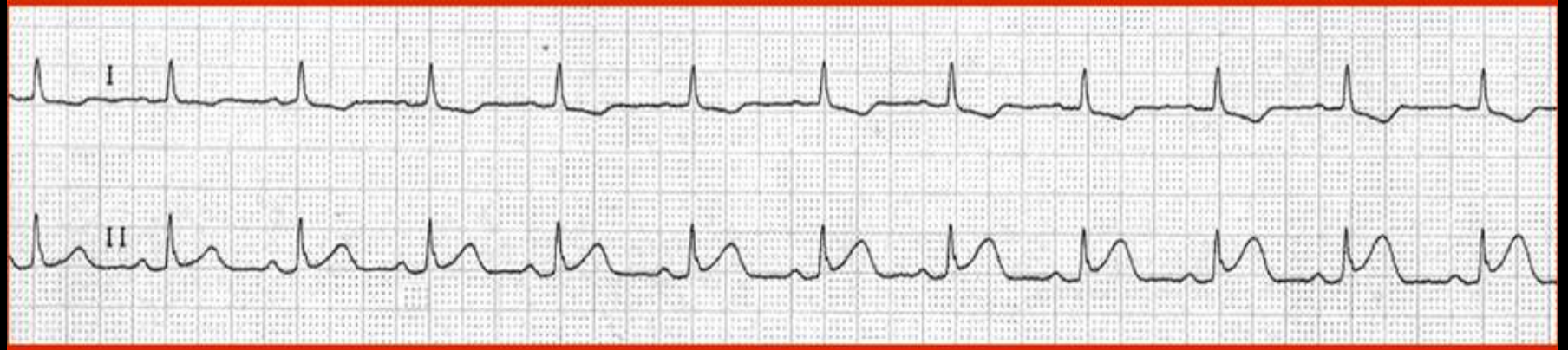
* **P. Rautaharju et al, "Standardization and Interpretation of the ECG," JACC 2009;(53)No.11:982-991**

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:

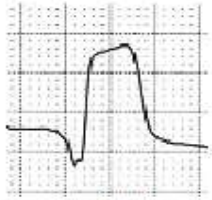
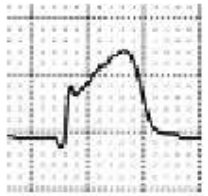
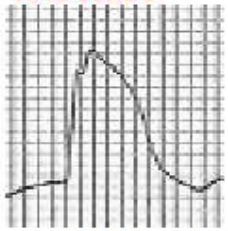
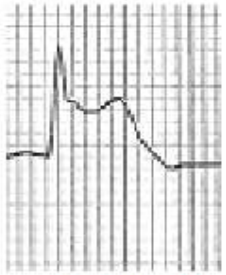
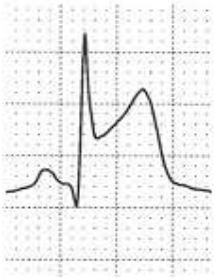
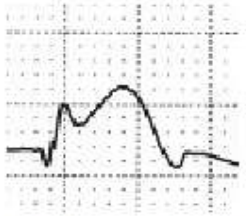
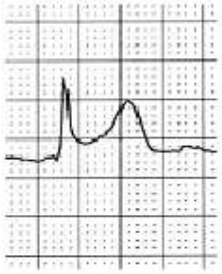
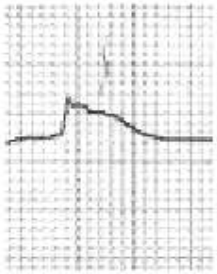
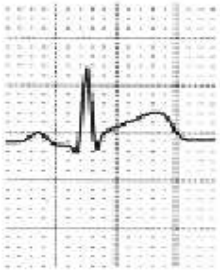
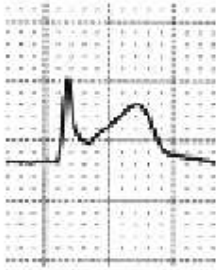
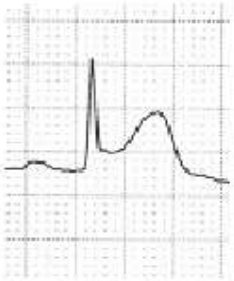
DOWNSLOPING S-T SEGMENT

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:

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

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.

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:

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

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.

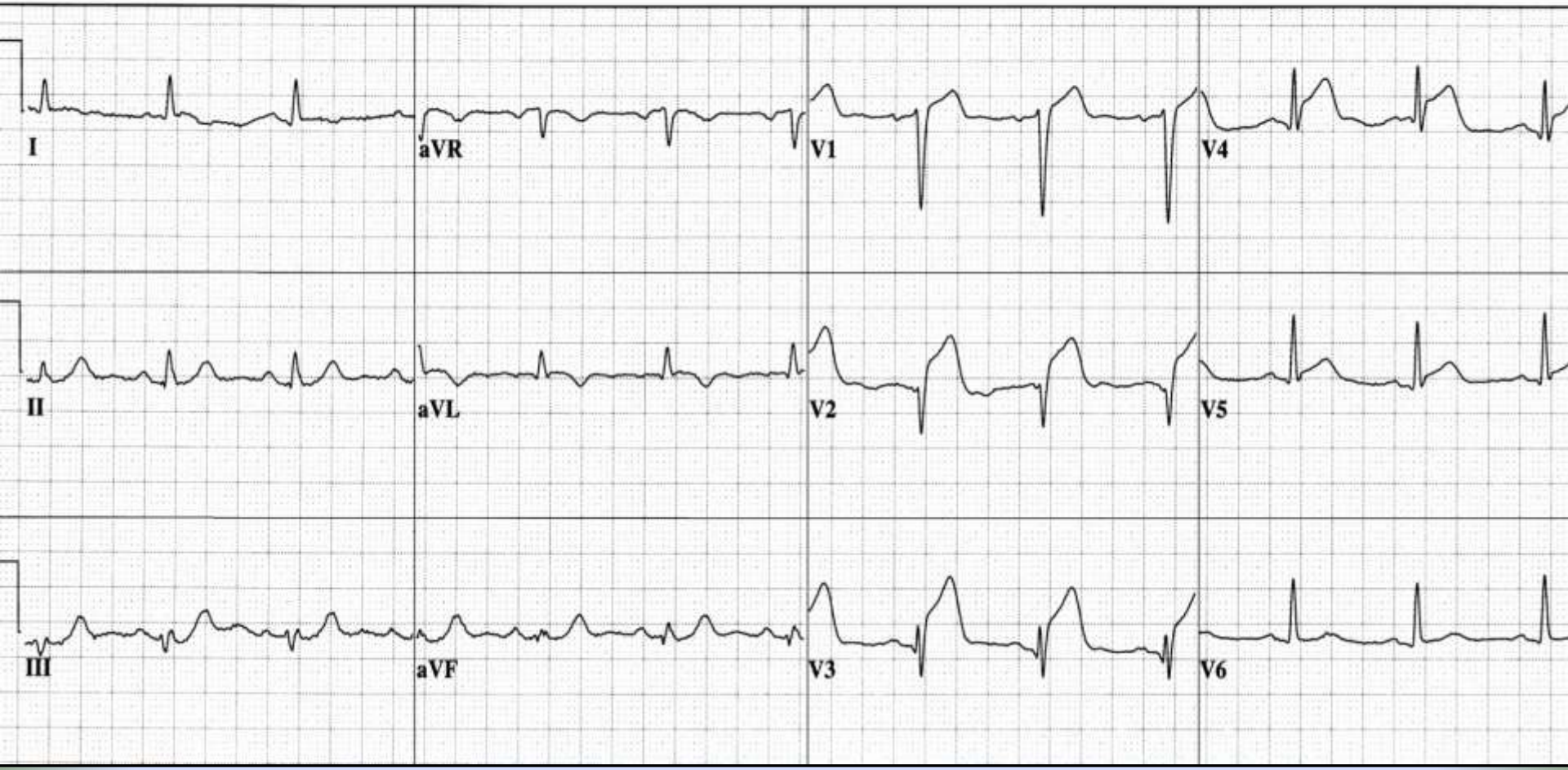
VITAL SIGNS: BP: 100/64, P: 75, R: 20, SAO2: 94%

LABS: FIRST TROPONIN: 6.4

72 yr		Vent. rate	75	BPM
Male	Caucasian	PR interval	162	ms
		QRS duration	98	ms
		QT/QTc	382/426	ms
Loc:3	Option:23	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



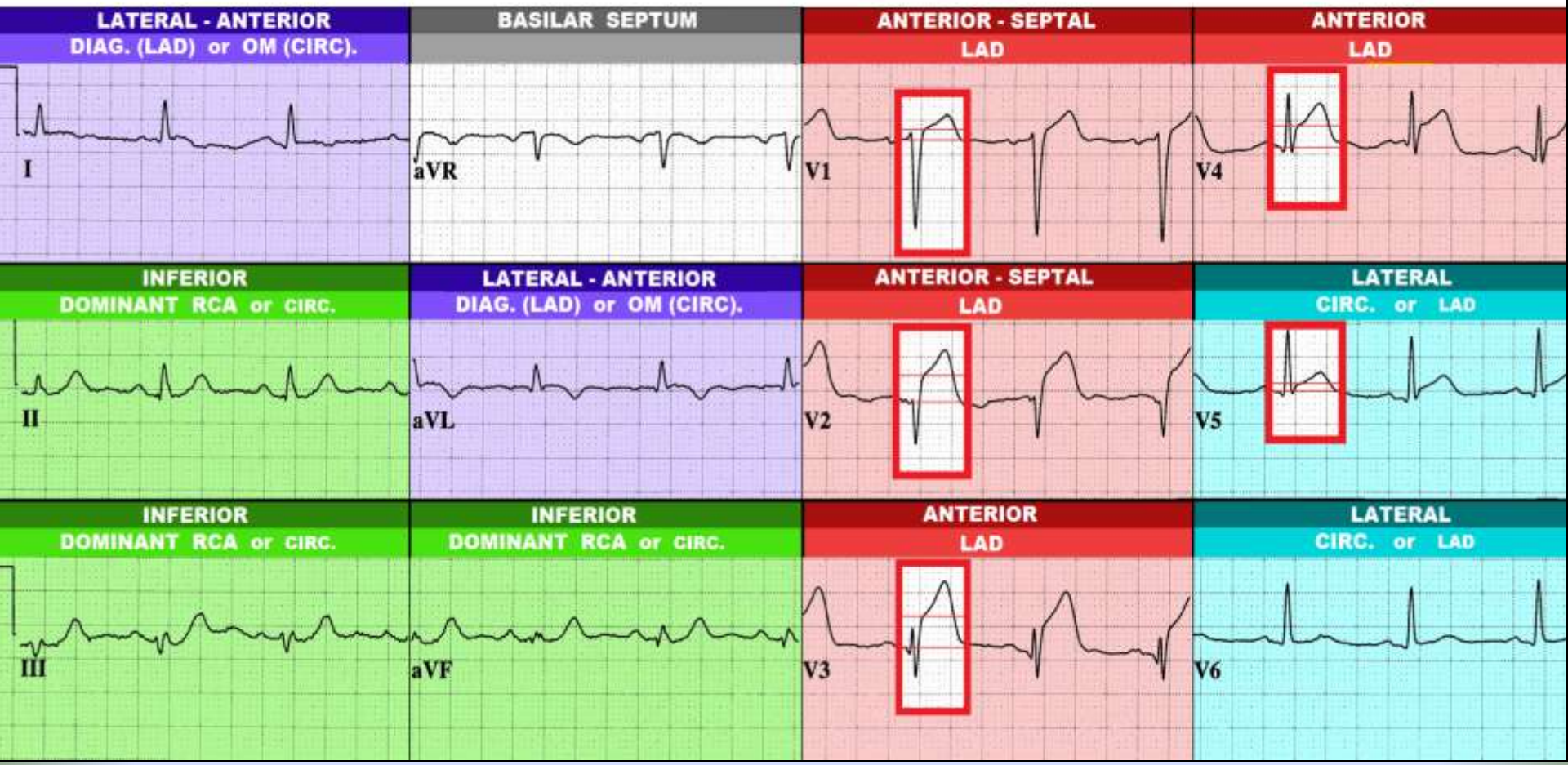
72 yr
Male Caucasian

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

Loc: Option:2

Vent. rate	75	BPM
PR interval	162	ms
QRS duration	98	ms
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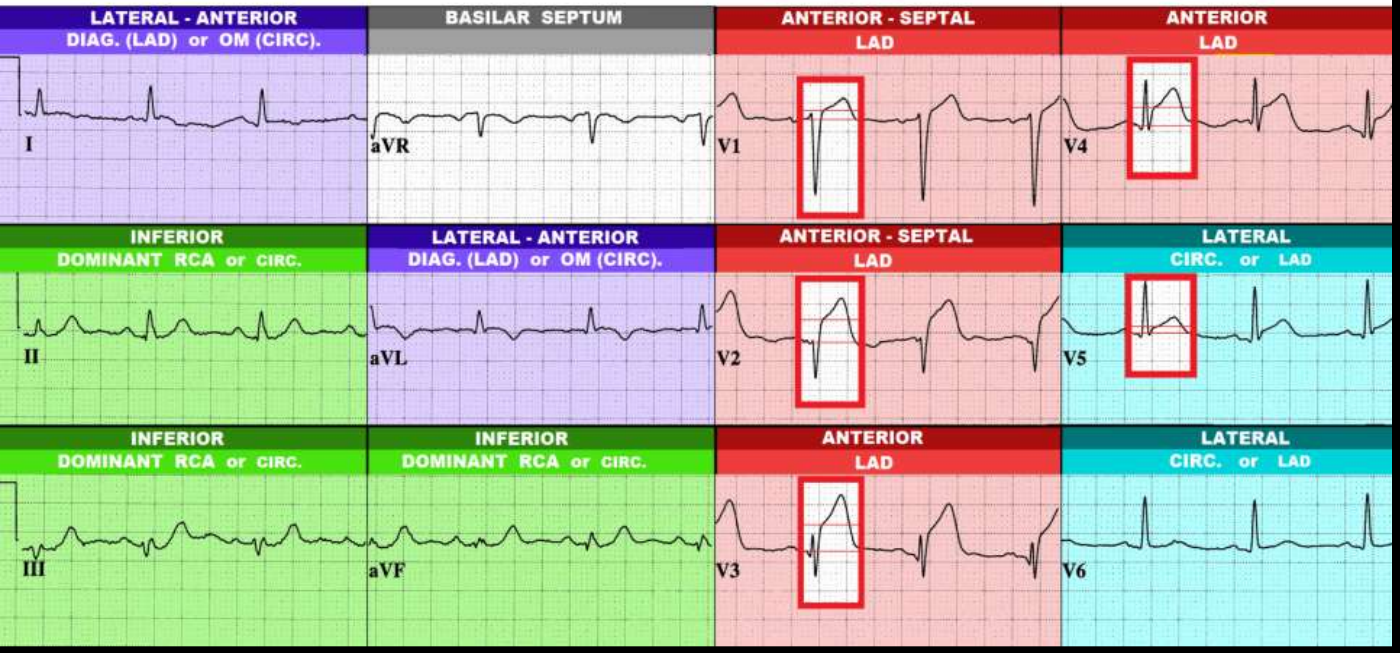
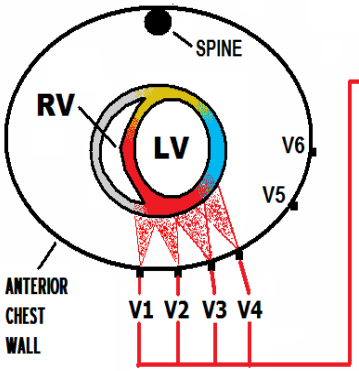
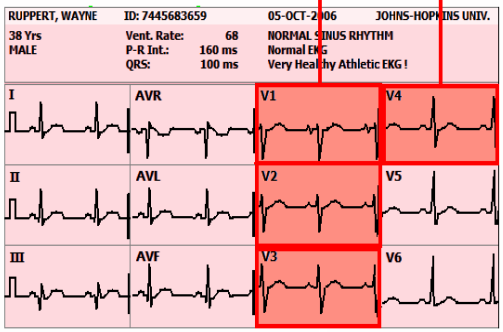


V1 - V4 VIEW THE ANTERIOR-SEPTAL WALL

of the LEFT VENTRICLE



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



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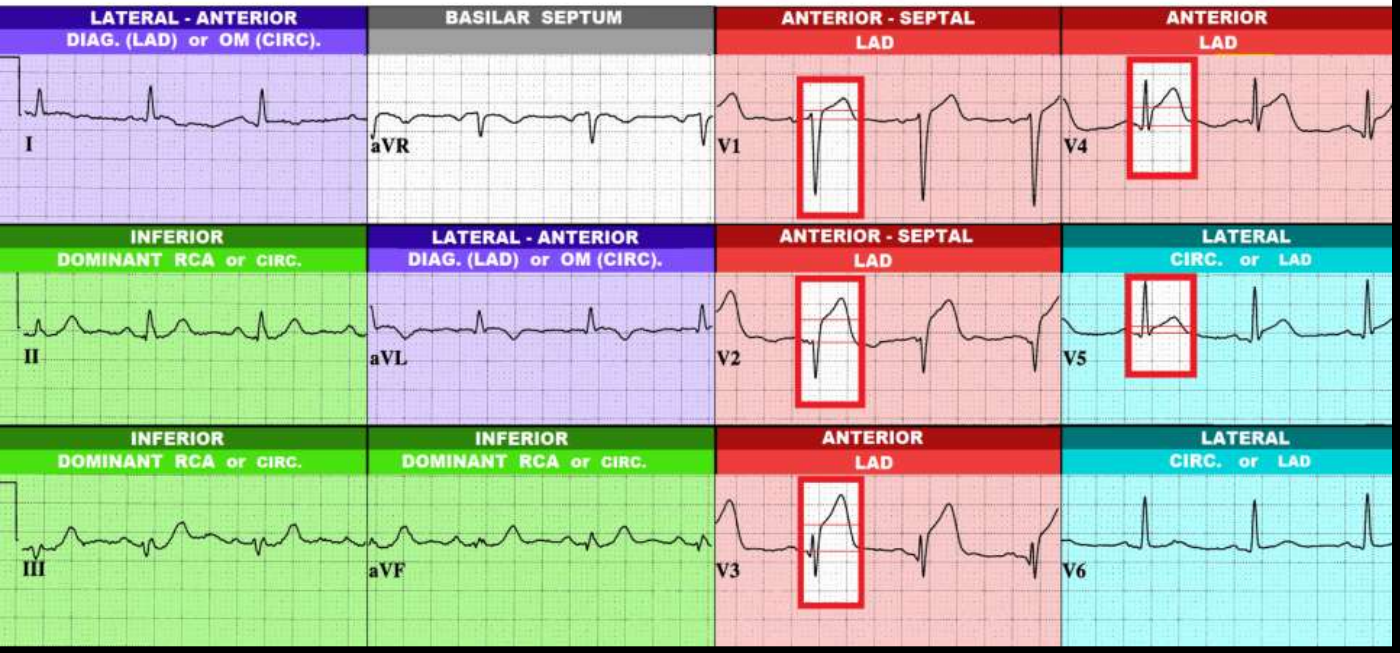

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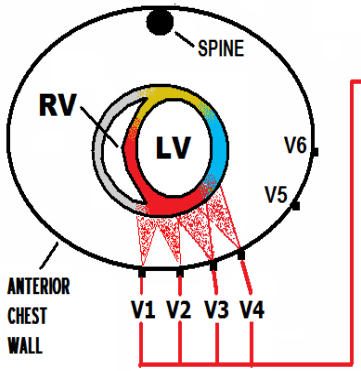
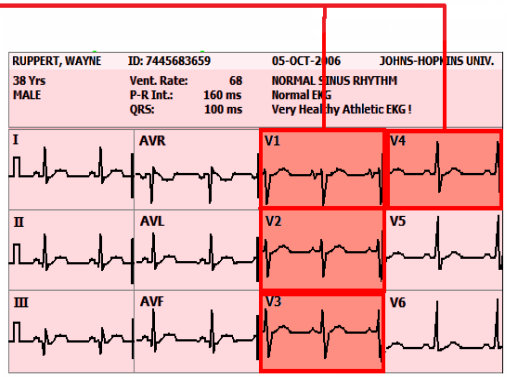
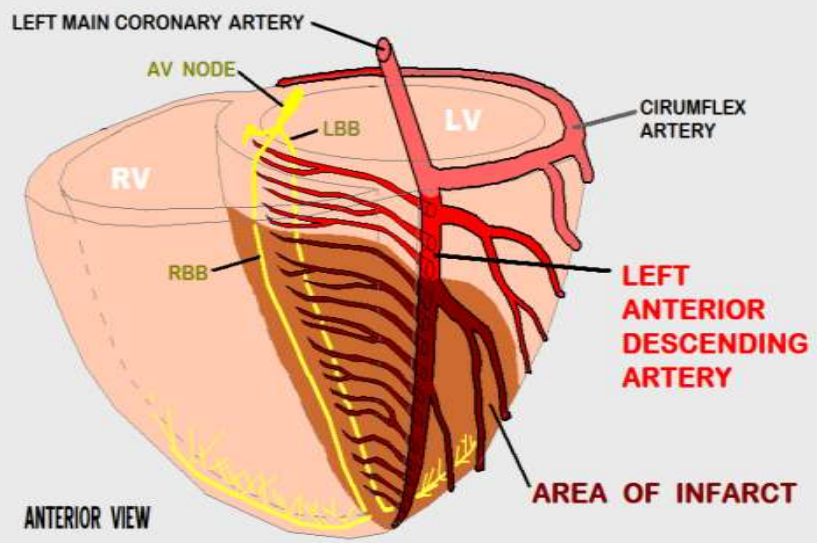


V1, V2 - ANTERIOR / SEPTAL
V3, V4 - ANTERIOR



OCCLUSION of MID - LEFT ANTERIOR DESCENDING ARTERY



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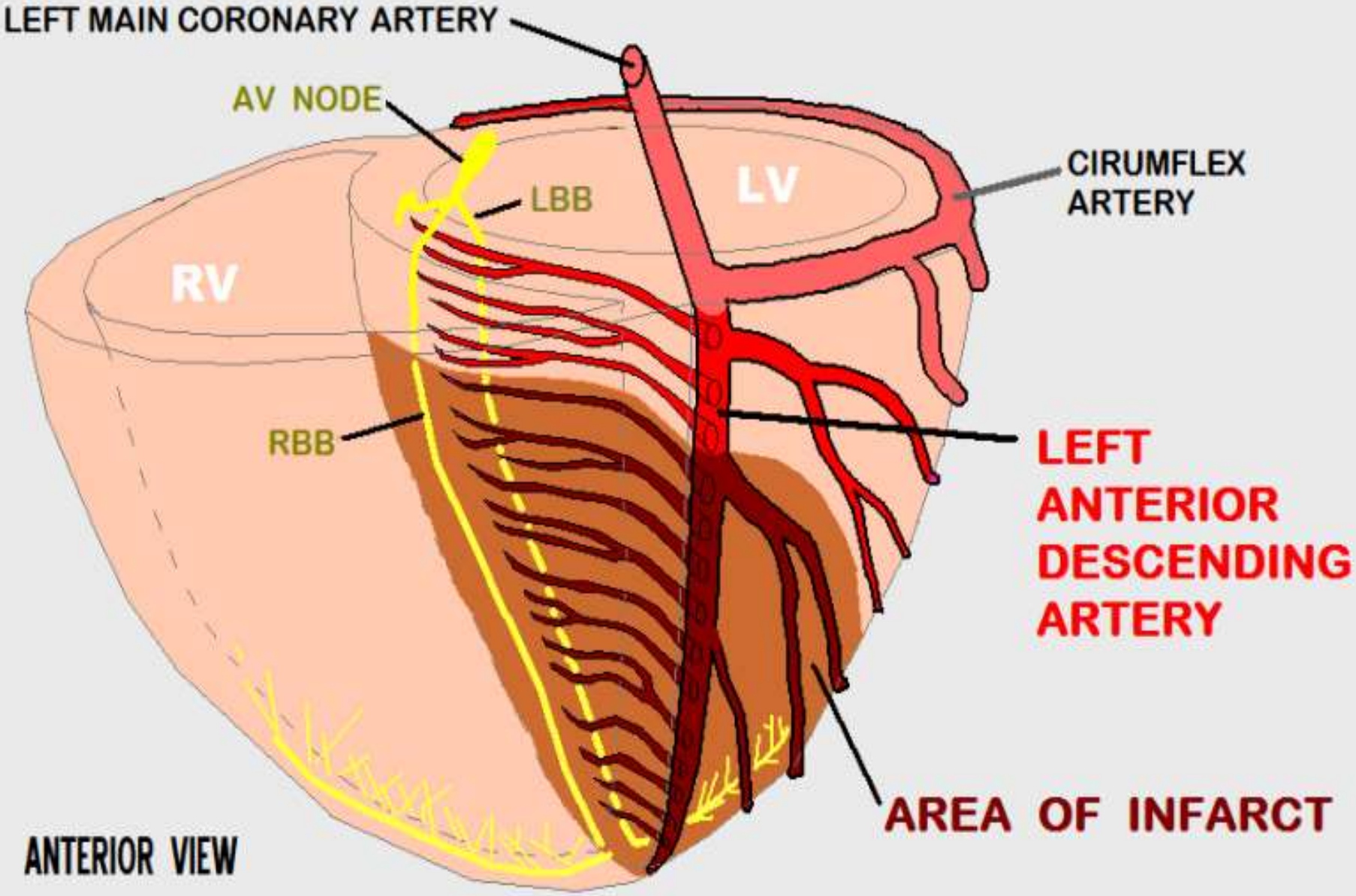
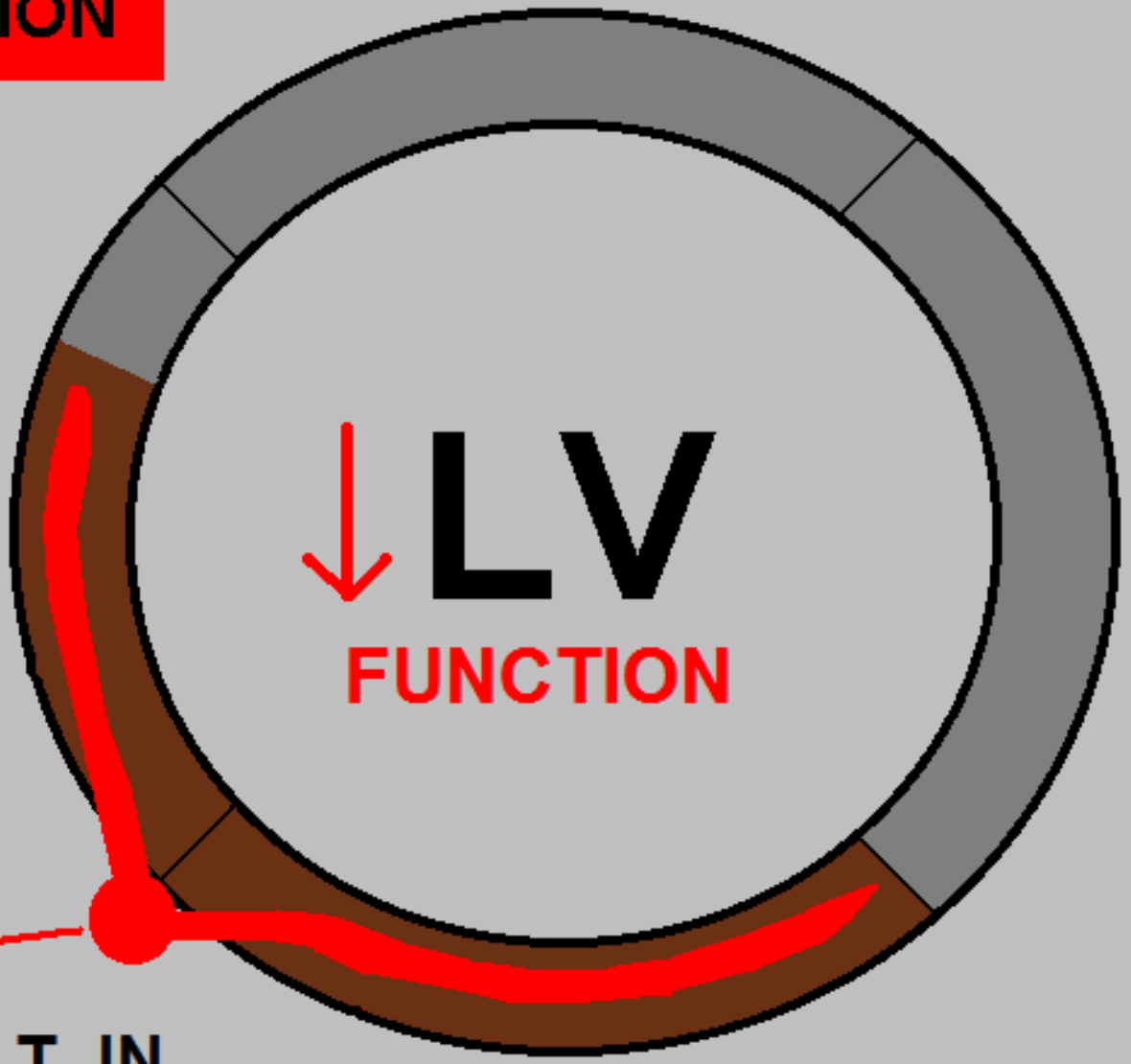


LAD DISTRIBUTION

35 - 45 % of LV MUSCLE MASS



A BLOCKAGE OF THE LAD

CAN RESULT IN LV PUMP FAILURE --

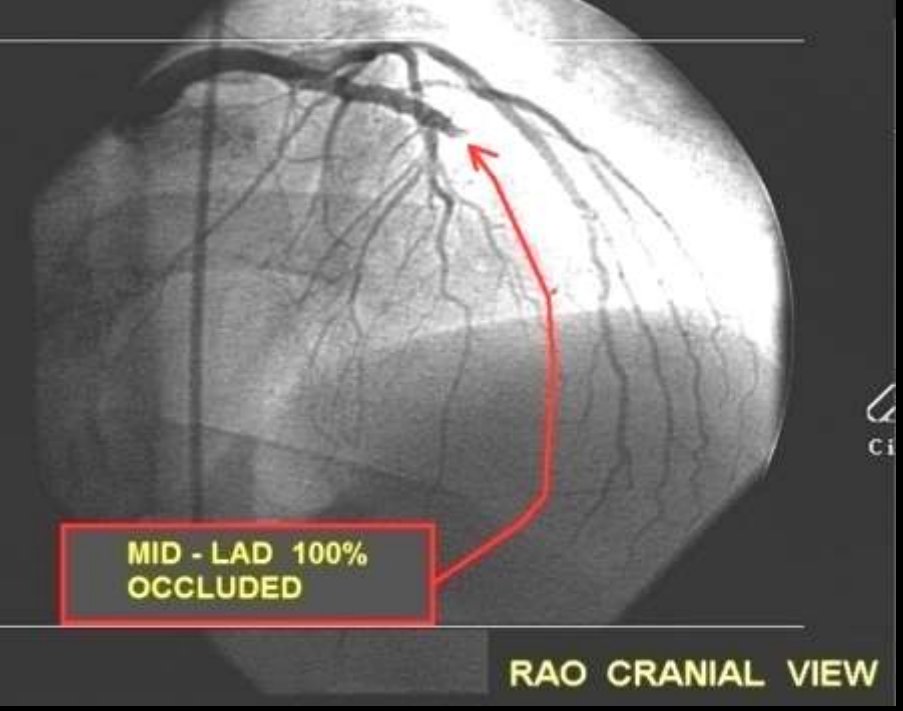
- CARDIOGENIC SHOCK
- PULMONARY EDEMA

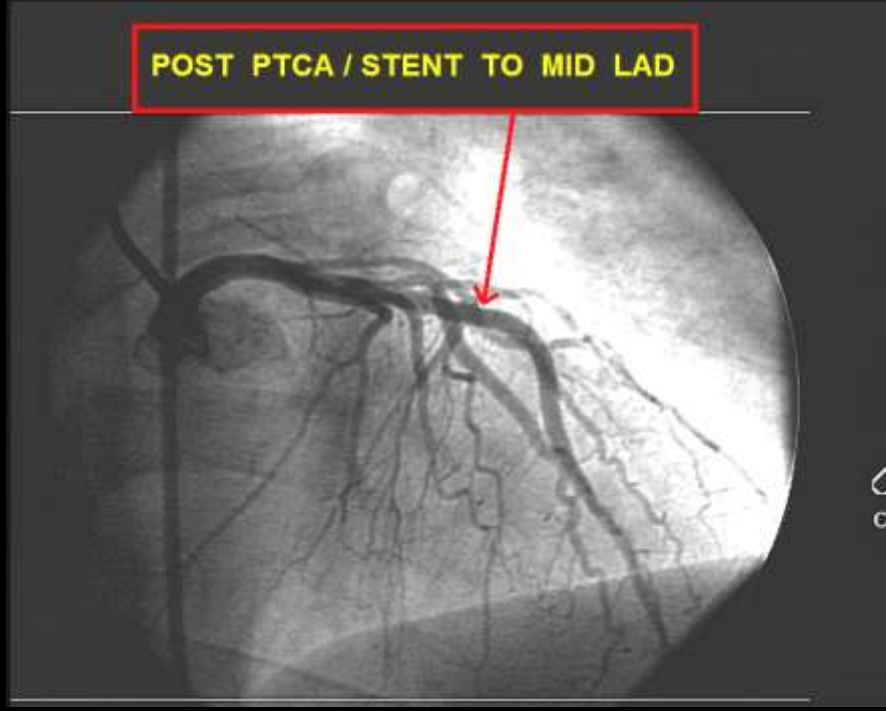

400 mg
Dopamine
(1600 mcg/mL)
Dopamine Hydrochloride
and 5% Dextrose Injection USP
250 mL
Baxter
500 mg Total
DOBUTamine
Hydrochloride in
5% Dextrose
250 mL
Baxter

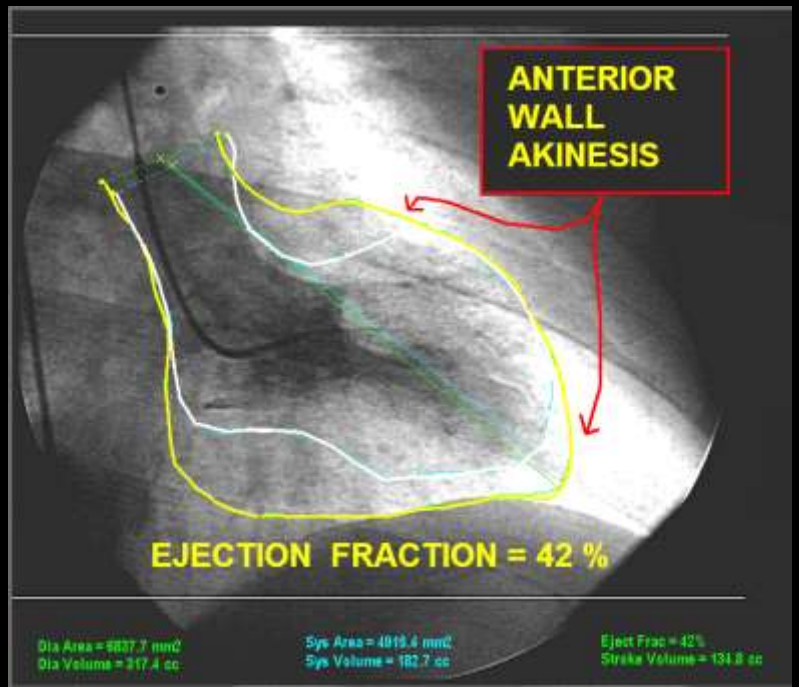
LEFT ANTERIOR DESCENDING ARTERY (LAD)

- 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 dieuretics due to pump failure and hypotension)
- 3rd DEGREE HEART BLOCK - NOT RESPONSIVE TO ATROPINE	TRANSCUTANEOUS or TRANSVENOUS PACING


MID - LAD 100%
OCCLUDED
RAO CRANIAL VIEW


POST PTCA / STENT TO MID LAD


ANTERIOR
WALL
AKINESIS
EJECTION FRACTION = 42 %
Dia Area = 6687.7 mm2
Dia Volume = 317.4 cc
Sys Area = 4819.4 mm2
Sys Volume = 182.7 cc
Eject Frac = 42%
Stroke Volume = 134.8 cc

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.

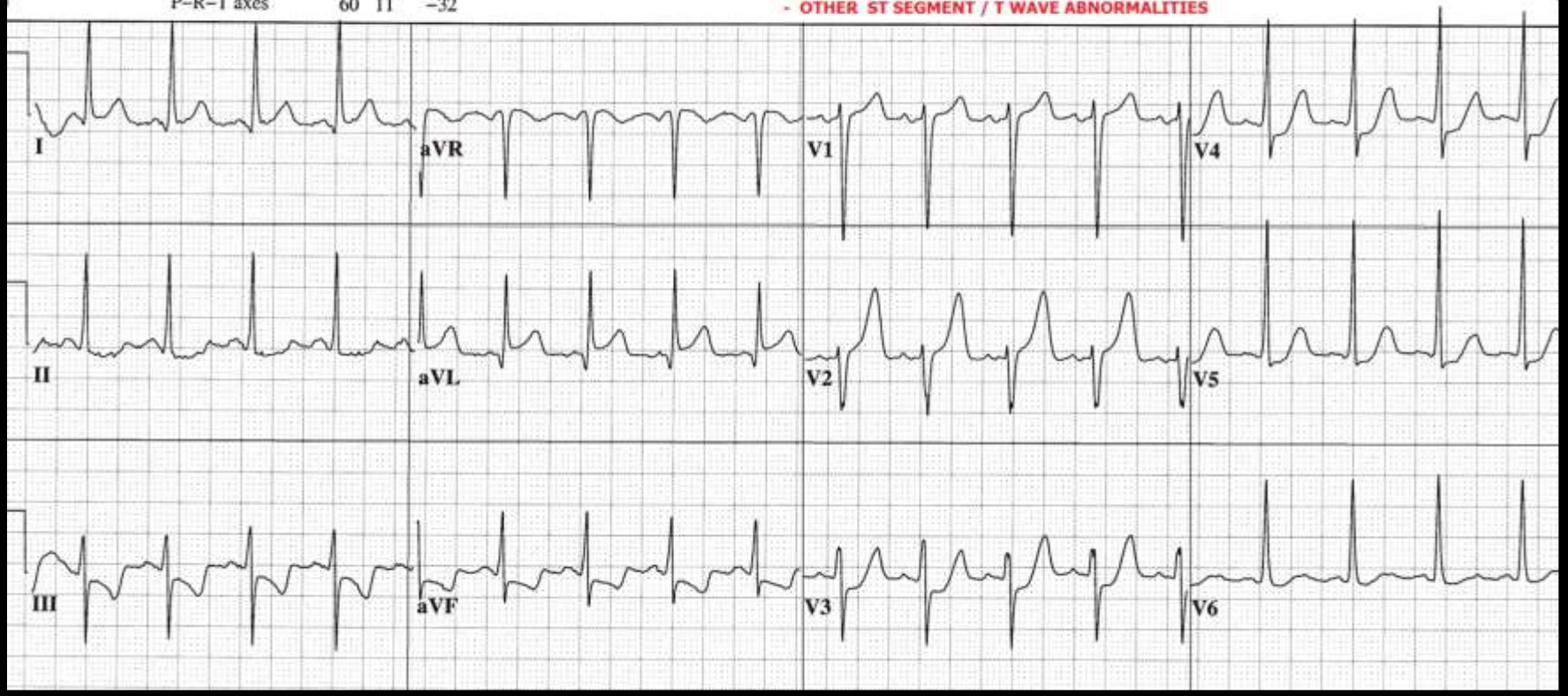
VITAL SIGNS: BP: 168/98, P: 110, R: 24, SAO2: 97% on O2 4 LPM via nasal canula

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

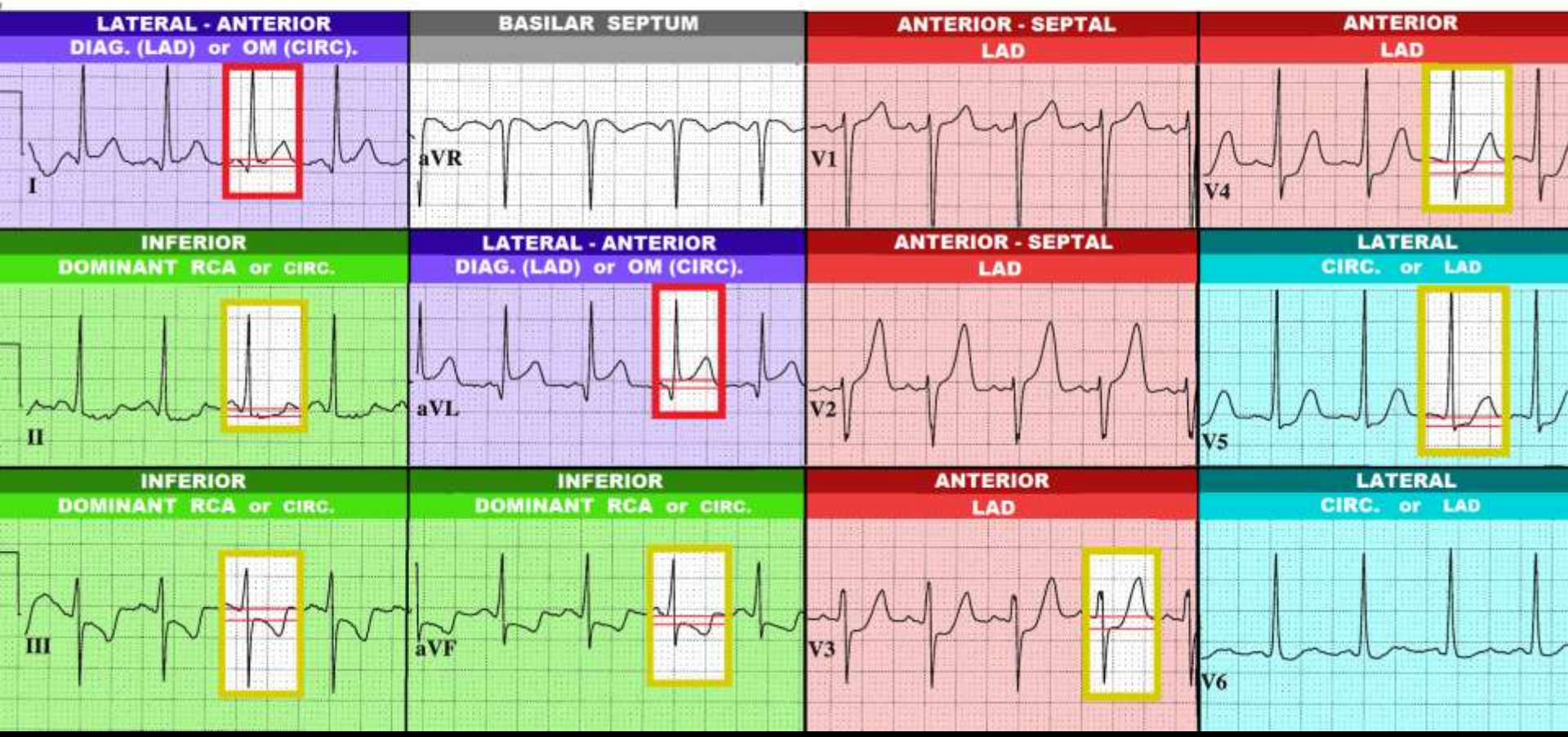
Room:ER

Vent. rate	109	BPM
PR interval	132	ms
QRS duration	82	ms
QT/QTc	346/465	ms
P–R–T axes	60 11	–32

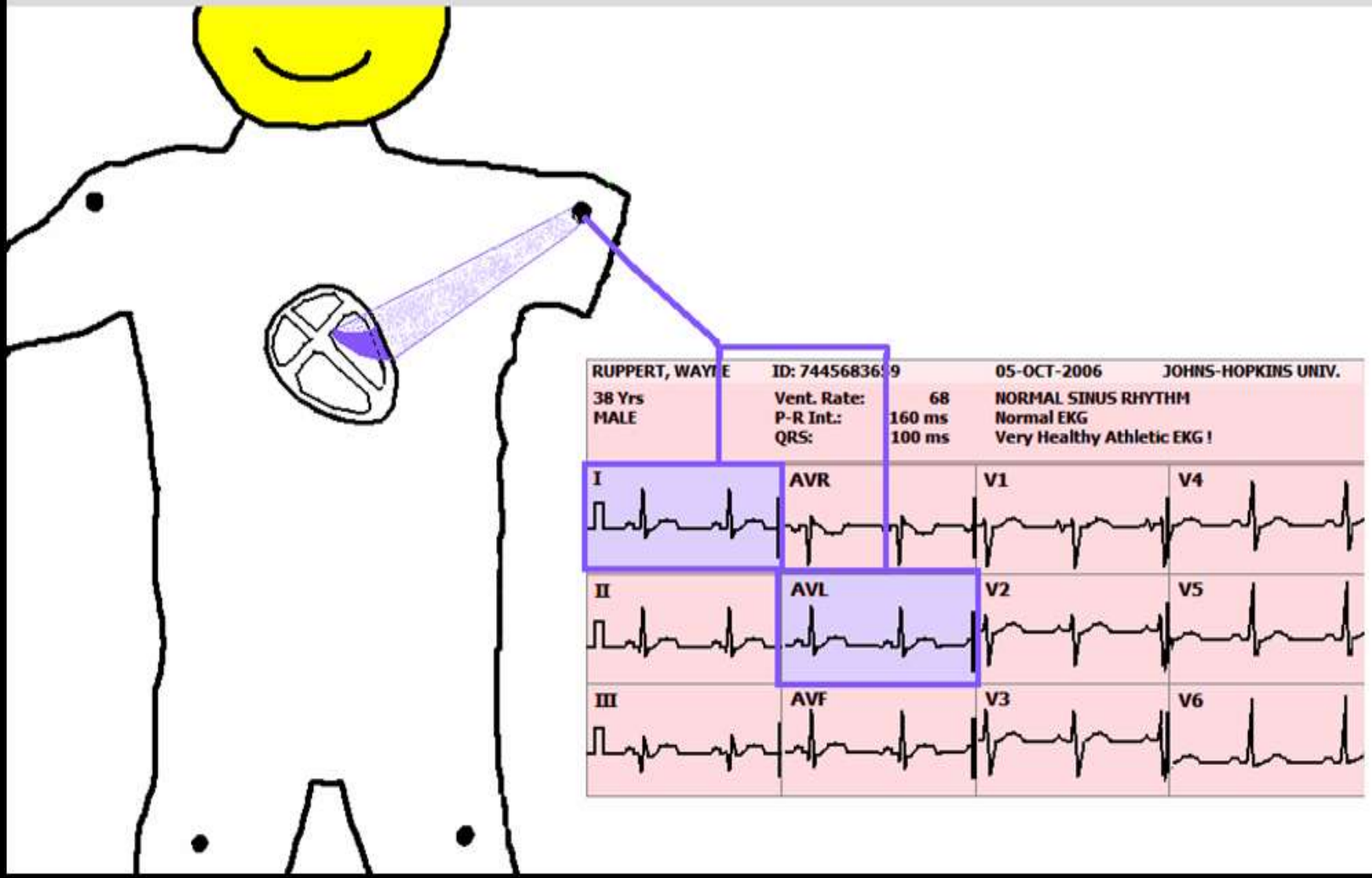
Sinus tachycardia
Left ventricular hypertrophy with repolarization abnormality
ST elevation consider lateral injury or acute infarct
*** ** ** ** * ACUTE MI ** ** ** **

ST SEGMENT ELEVATION

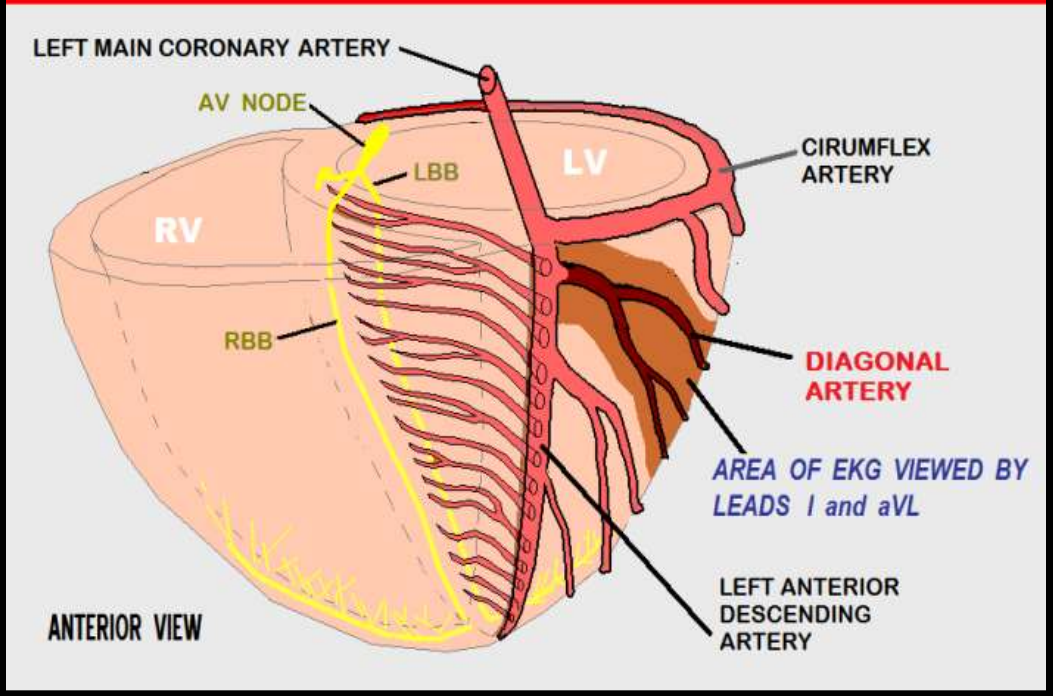
ST SEGMENT DEPRESSION



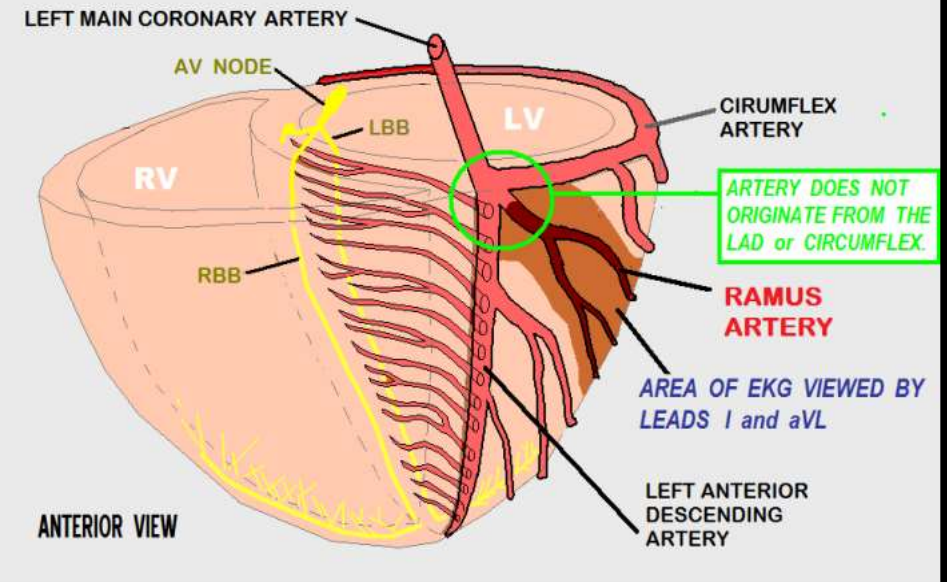
LEADS I and aVL view the ANTERIOR-LATERAL JUNCTION



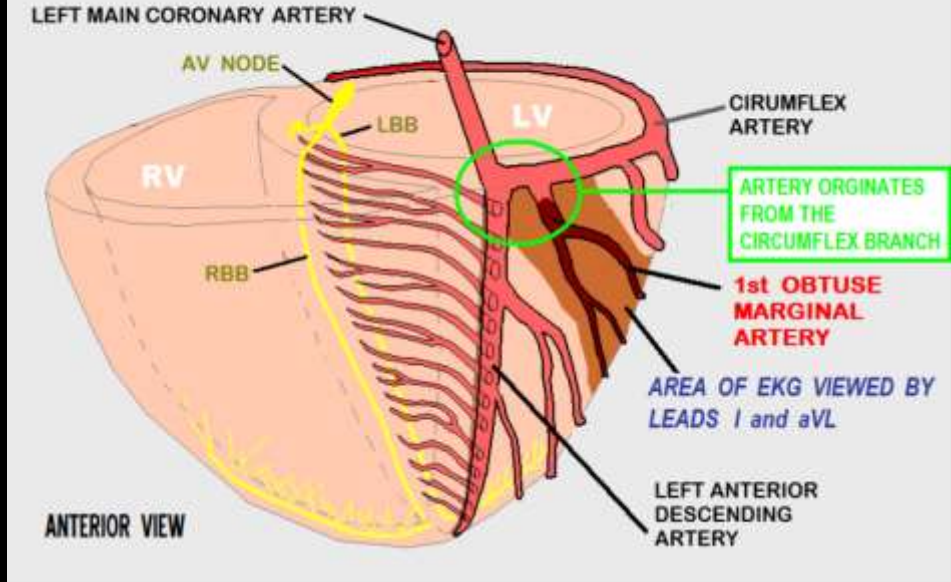
OCCLUSION of DIAGONAL ARTERY



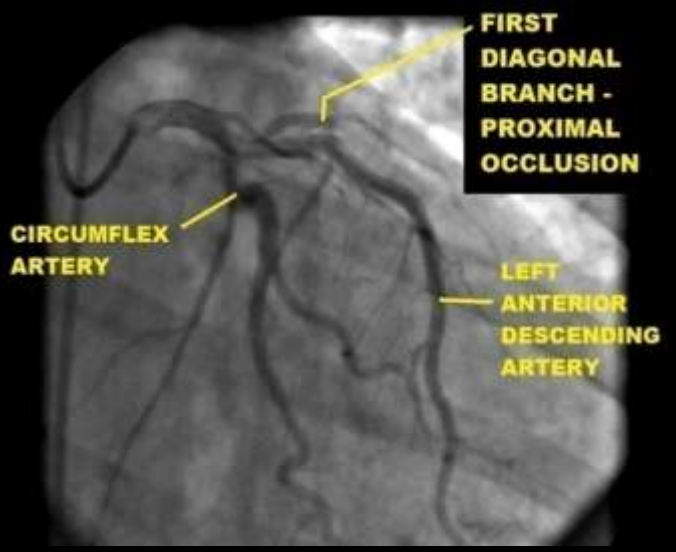
OCCLUSION of RAMUS ARTERY

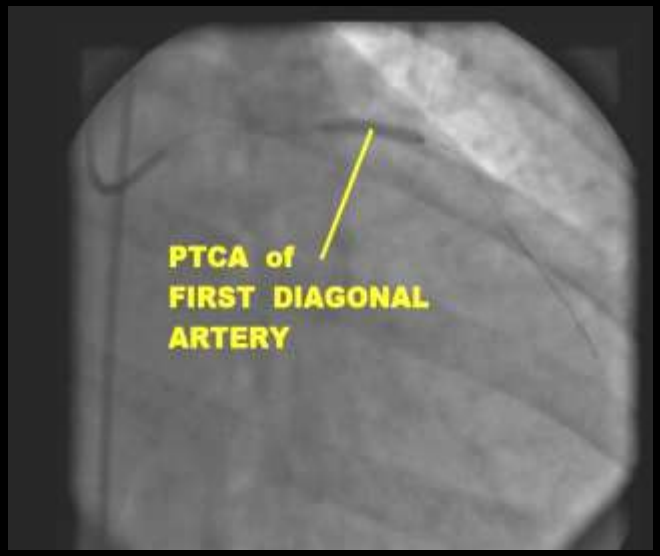


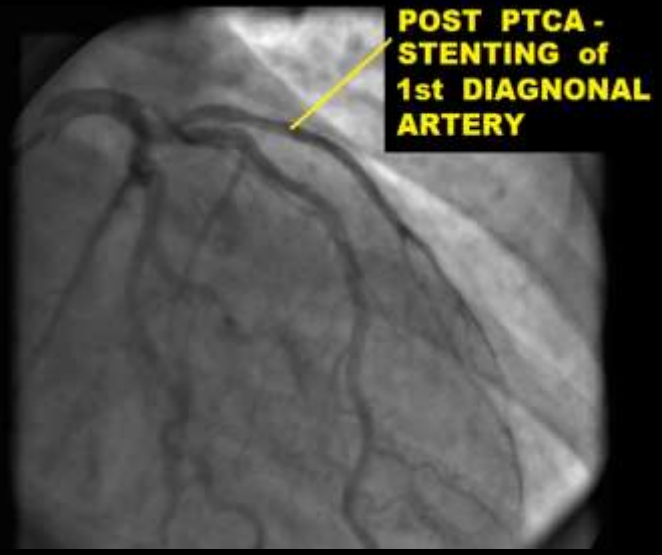
OCCLUSION of OBTUSE MARGINAL ARTERY

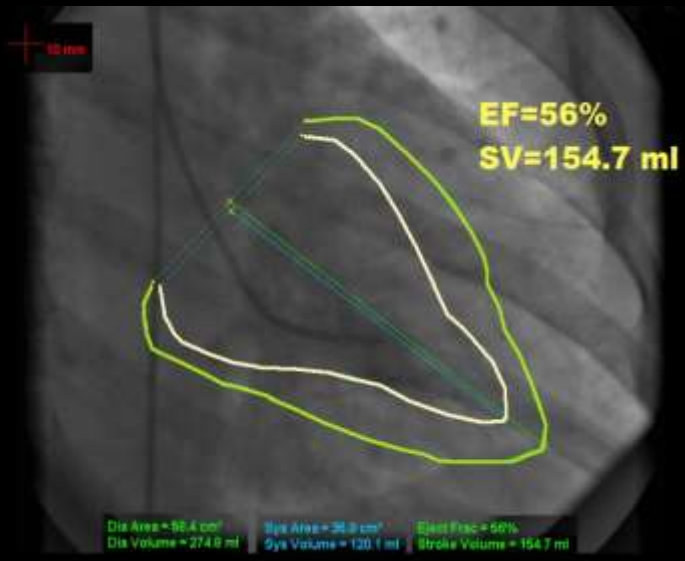


CASE PROGRESSION: As the patient was being prepared for transport to the Cardiac Cath Lab, she experienced an episode of Ventricular Fibrillation.









[redacted]

11111[redacted]11
Born 1/[redacted]1941 77 Years

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

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

Rate 69 . SINUS RHYT[redacted].....normal P axis, V-rate 50- 99
. LEFT ATRIAL ABNORMALITY.....P,P'>60mS, <-0.15mV V1
PR 180 . LEFT ANTERIOR FASCICULAR BLOCK.....axis(240,-40), init forces inf
QRSD 94 . [redacted]
QT 436
QTc 467

--AXIS--
P 56
QRS -51
T -7

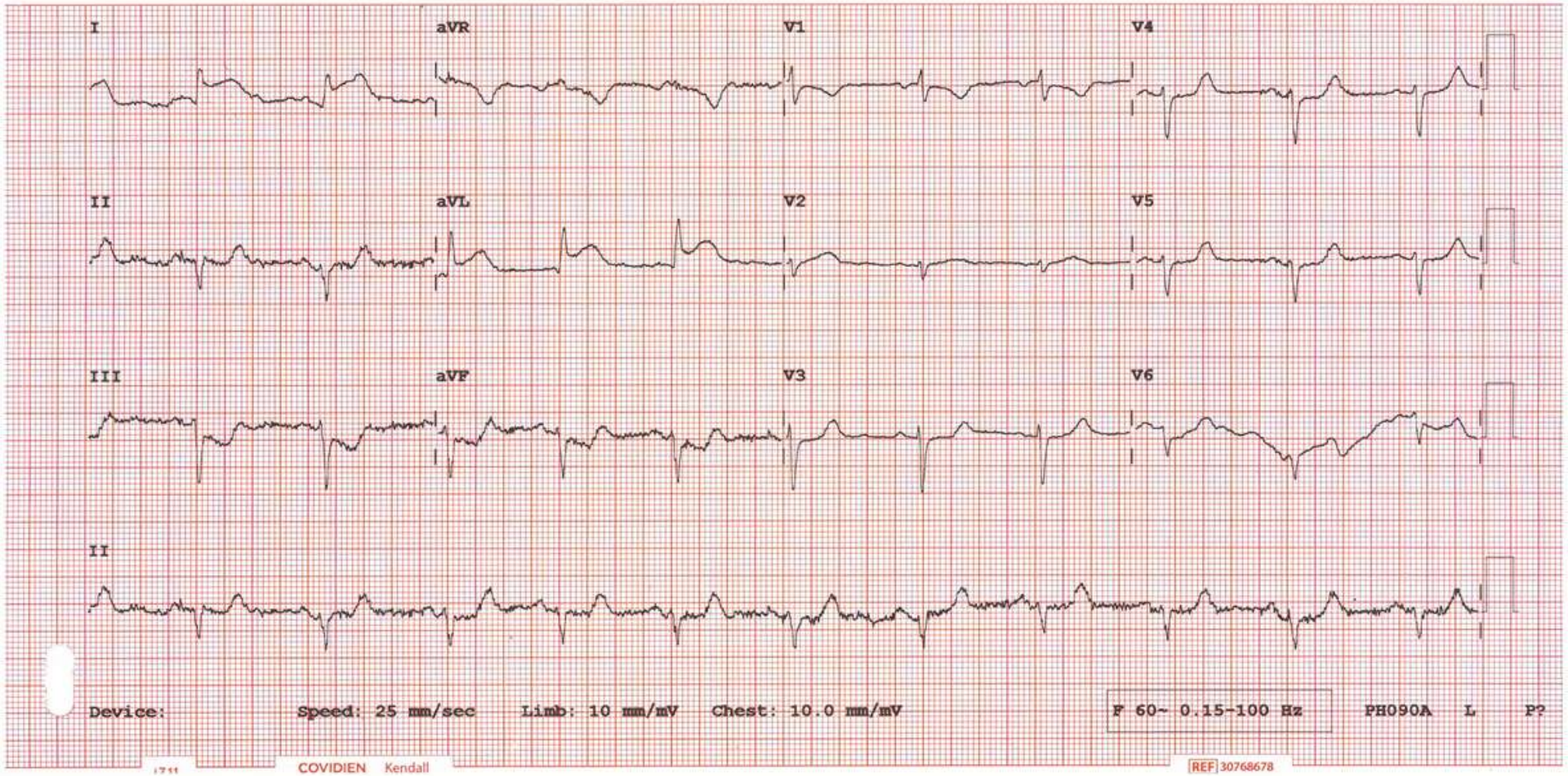
Room: er11

Physician [redacted]
Date
Time 1331
STEMI YES NO

- ABNORMAL ECG -

12 Lead; Standard Placement

Unconfirmed Diagnosis



COVIDIEN Kendall

REF 30768678

[redacted]

11111[redacted]11
Born 1/[redacted]1941 77 Years

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

3/16/2018 1:31:57 PM
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Rate 69 . SINUS RHYT[redacted] .....normal P axis, V-rate 50- 99
. 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

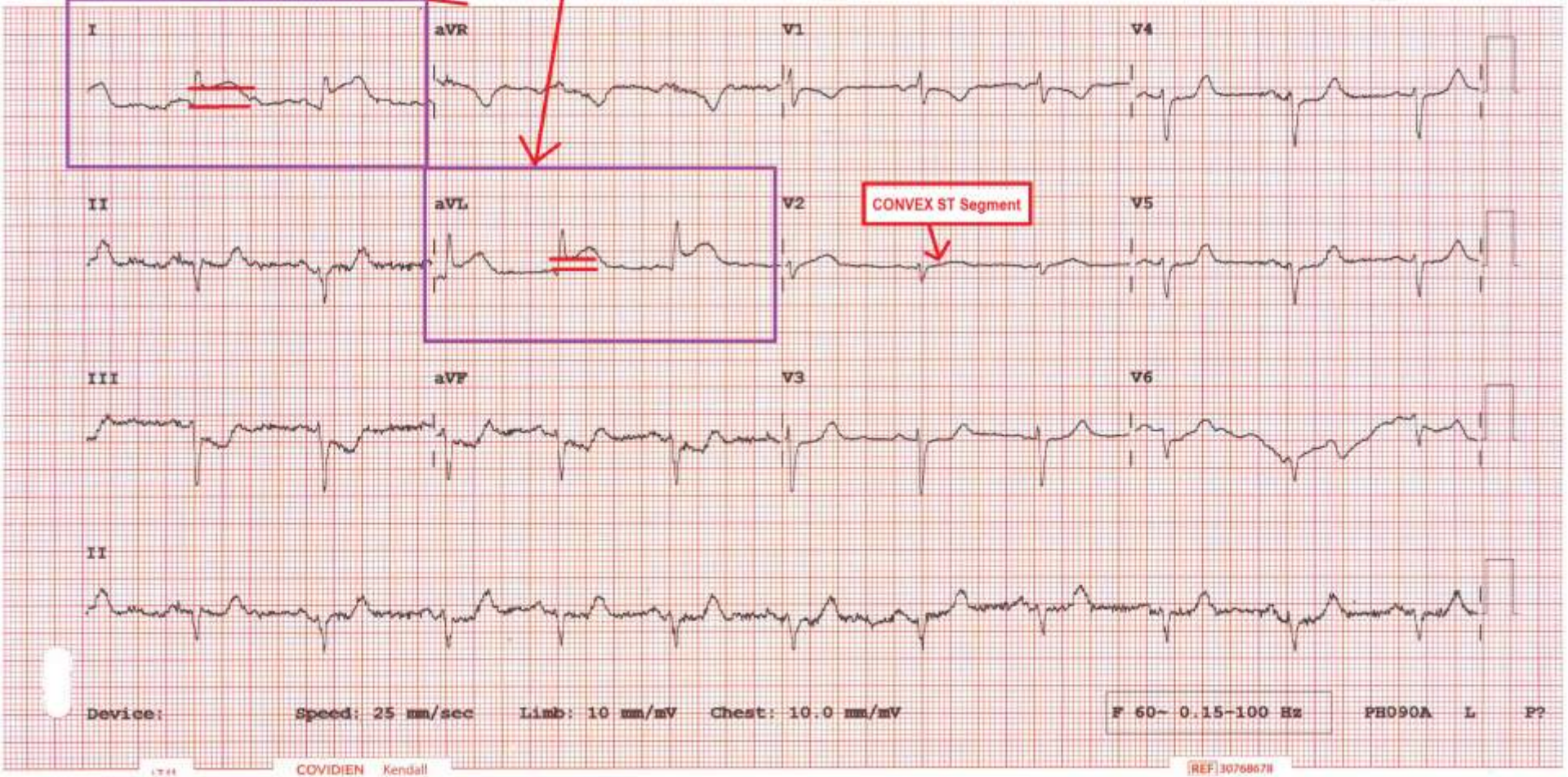
Room: er11

Physician [redacted]
Date
Time 1331
STEMI YES NO

ST Elevation Leads I & AVL

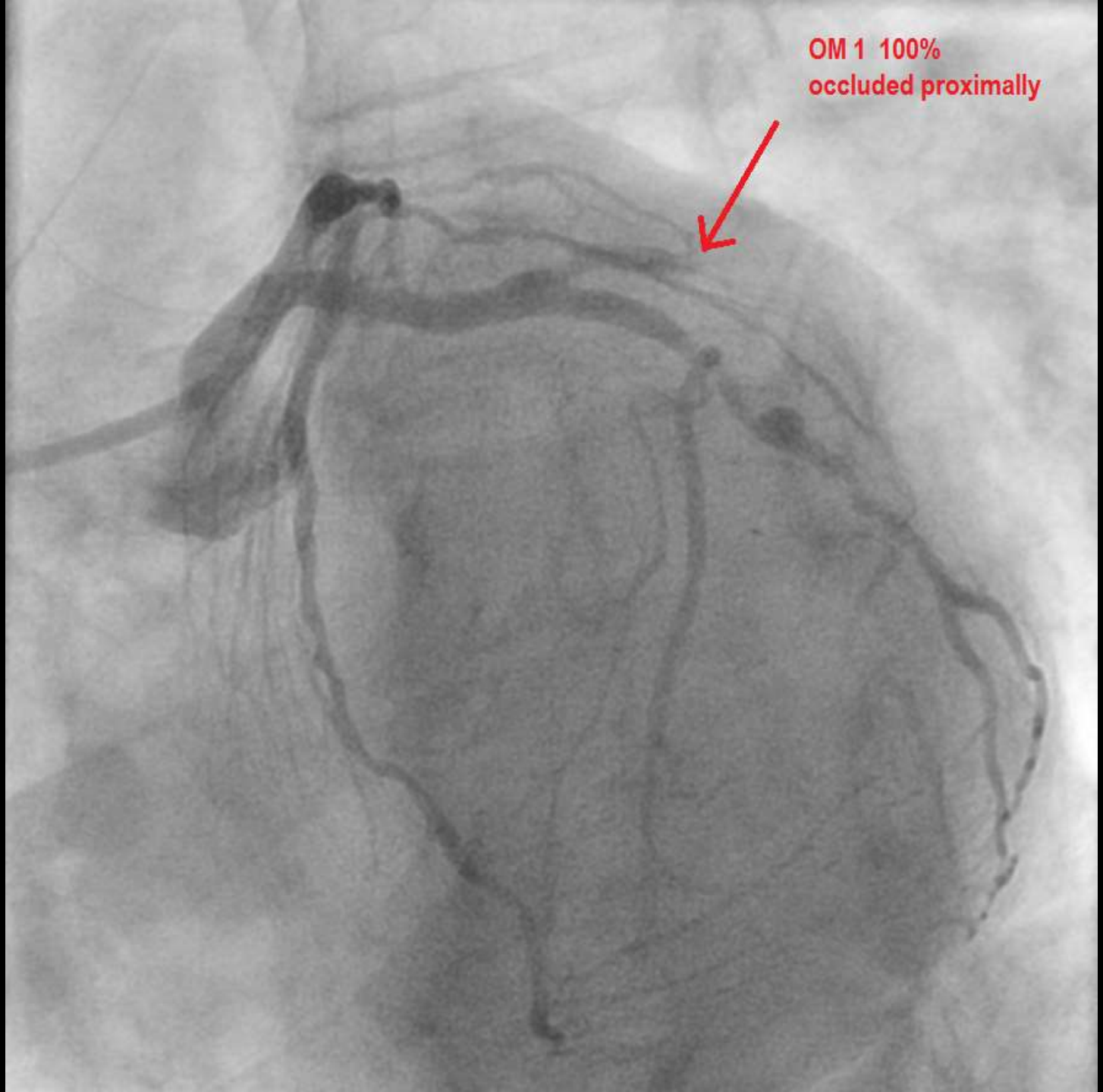
- ABNORMAL ECG -

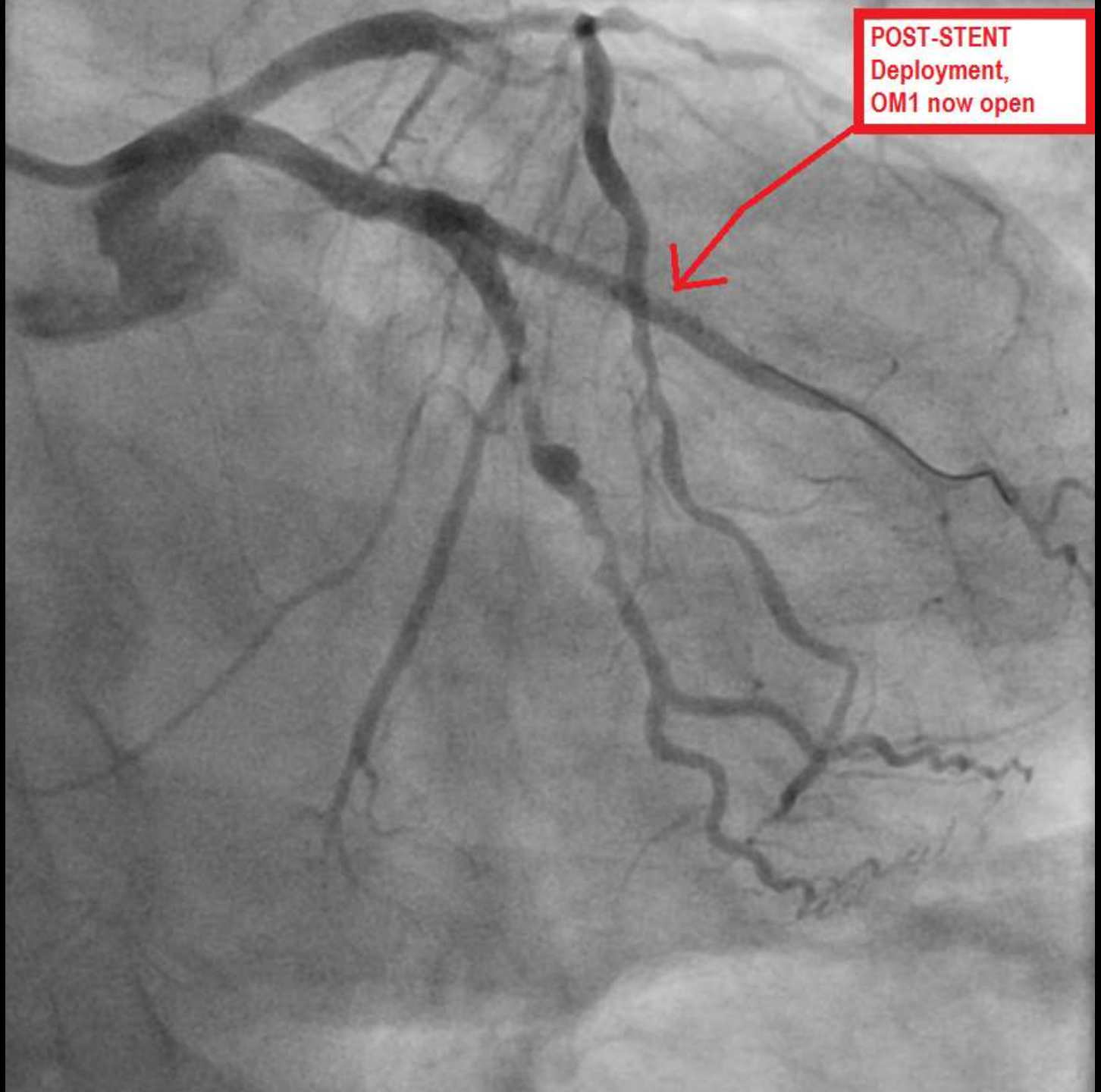
Unconfirmed Diagnosis



Device: Speed: 25 mm/sec Limb: 10 mm/mV Chest: 10.0 mm/mV F 60~ 0.15-100 Hz PH090A L P?

COVIDIEN Kendall REF 30768678


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:	POTENTIAL COMPLICATIONS:	POSSIBLE CRITICAL INTERVENTIONS:
15-30% of the LV MUSCLE MASS →	POSSIBLE MODERATE LV PUMP FAILURE →	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.

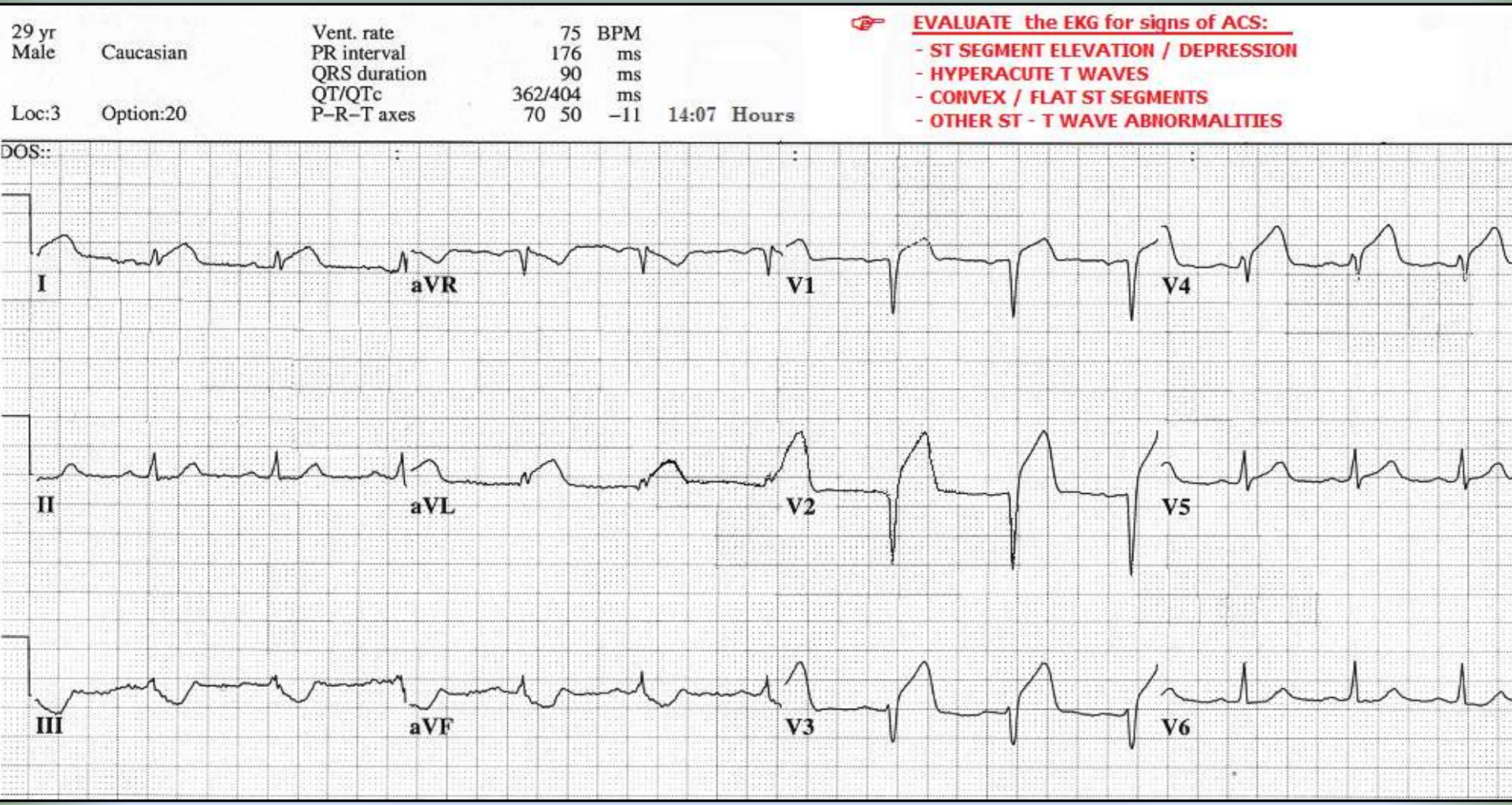
RISK FACTOR PROFILE:

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

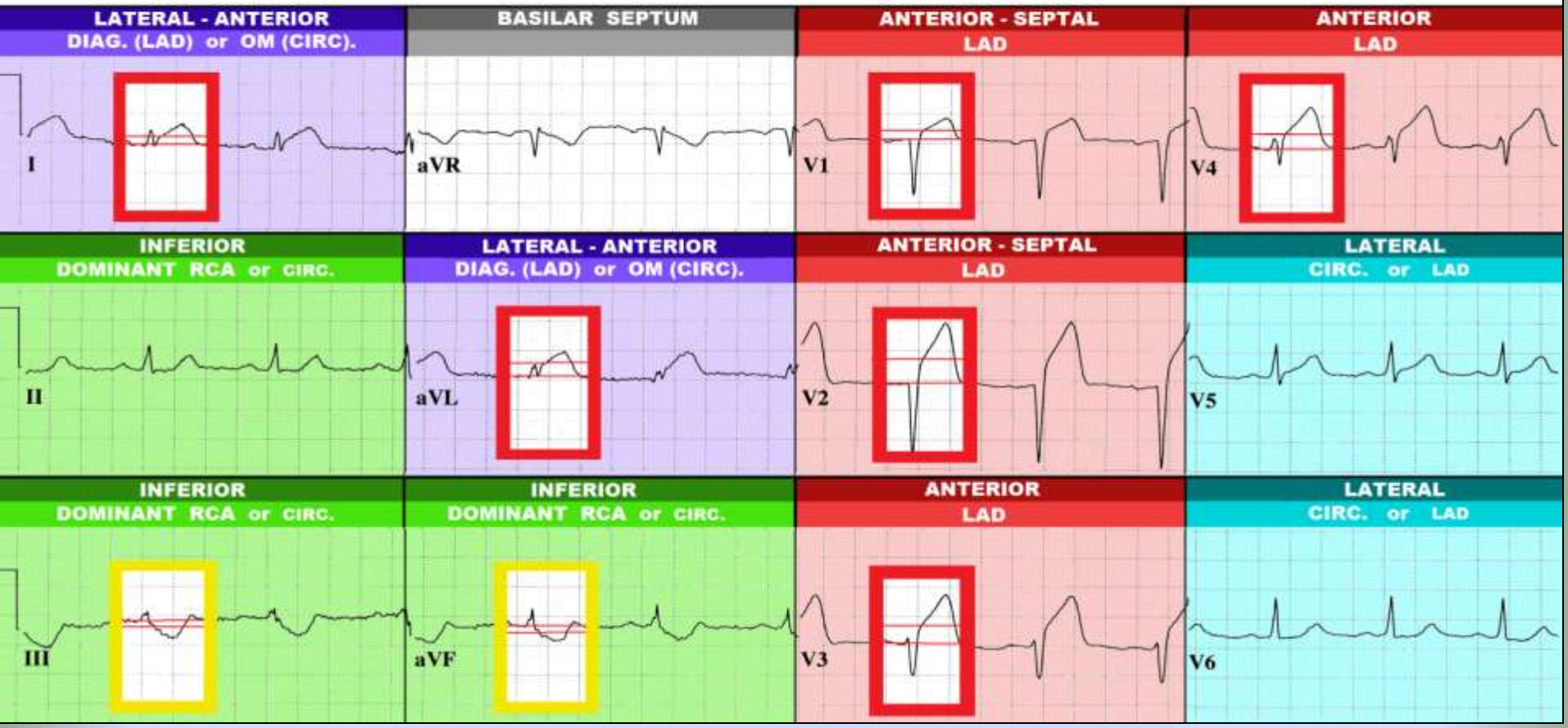
29 yr
Male
Caucasian

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.

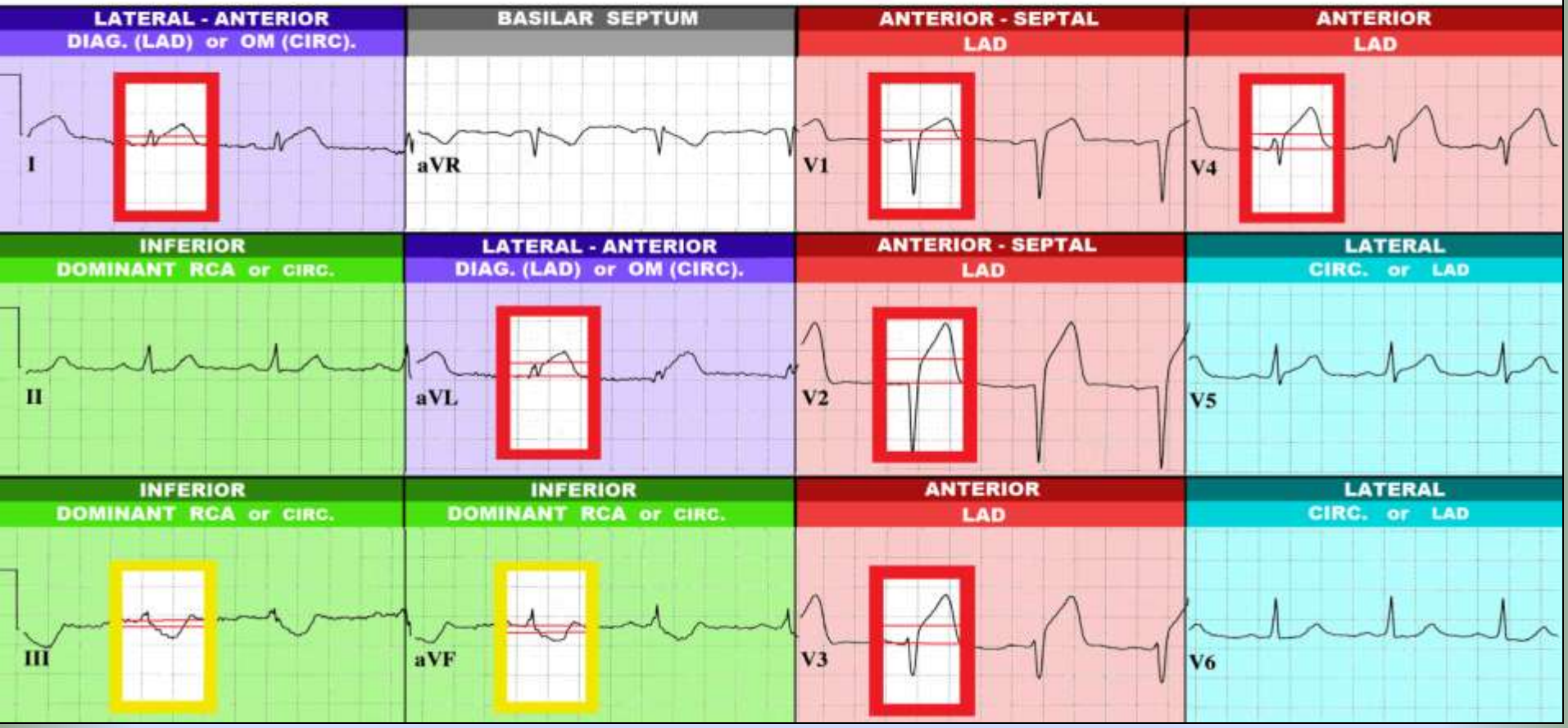
29 yr
Male
Caucasian

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

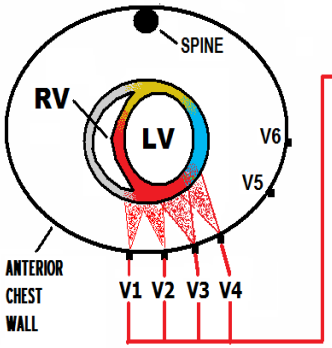
ST SEGMENT ELEVATION

ST SEGMENT DEPRESSION

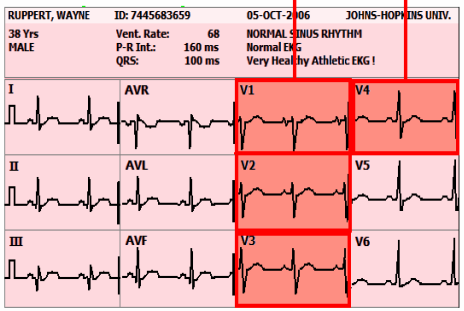


- Reciprocal ST Depression is NOW PRESENT
- Additional ST Elevation is present in Leads I, AVL

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



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



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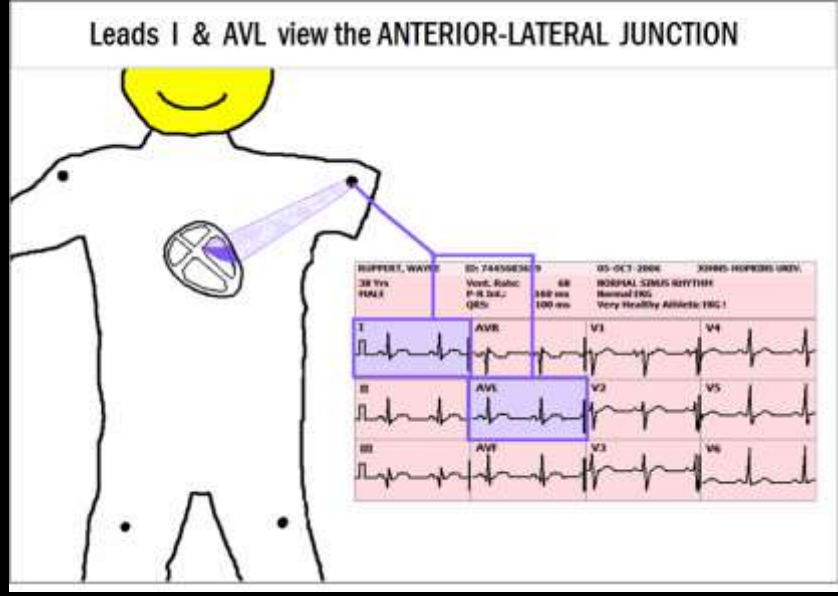
Leads I & AVL view the ANTERIOR-LATERAL JUNCTION



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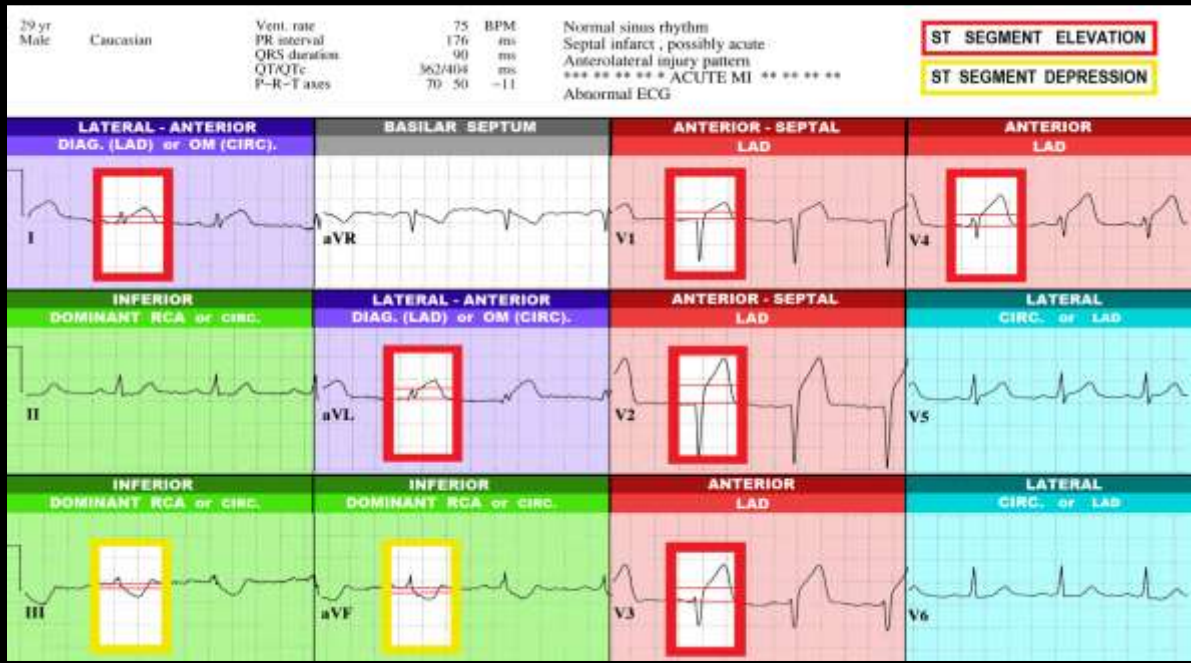
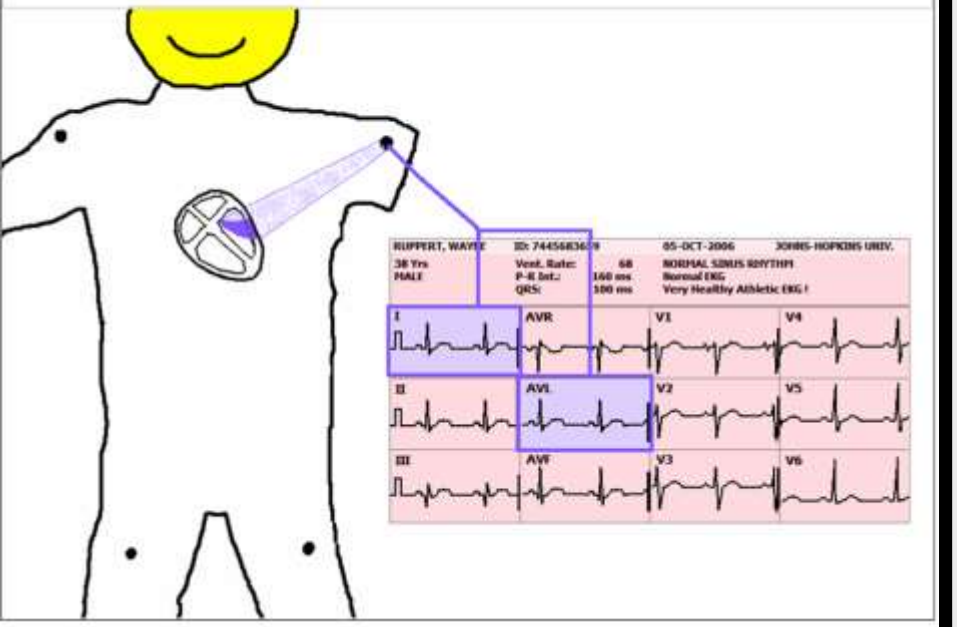
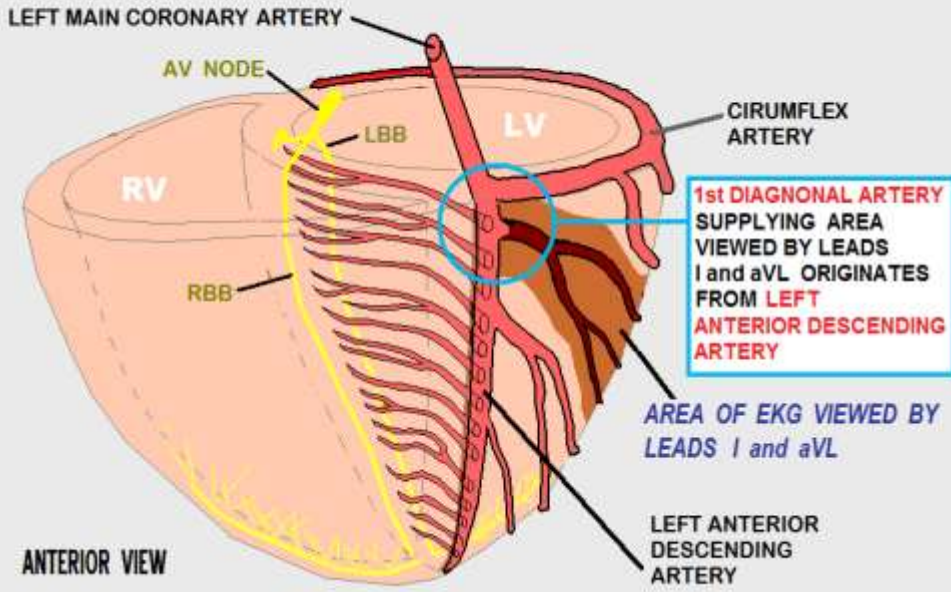


Leads I & AVL view the ANTERIOR-LATERAL JUNCTION

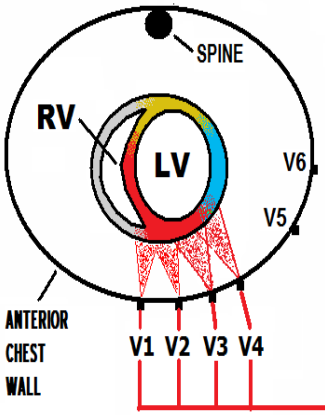


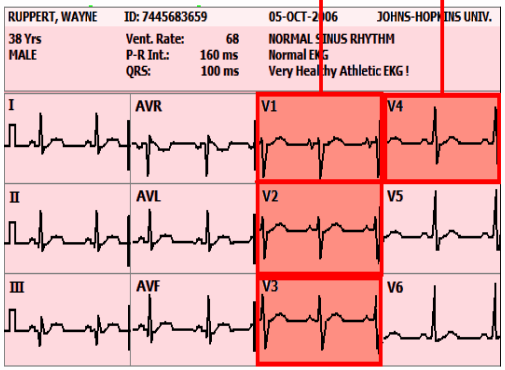
OCCLUSION of DIAGONAL ARTERY



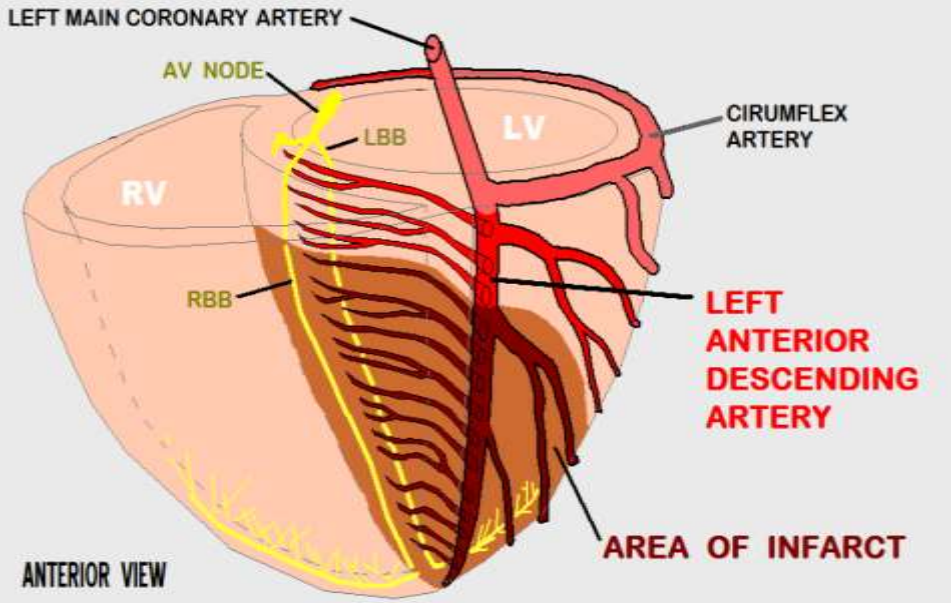
V1 - V4 VIEW THE ANTERIOR-SEPTAL WALL of the LEFT VENTRICLE

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

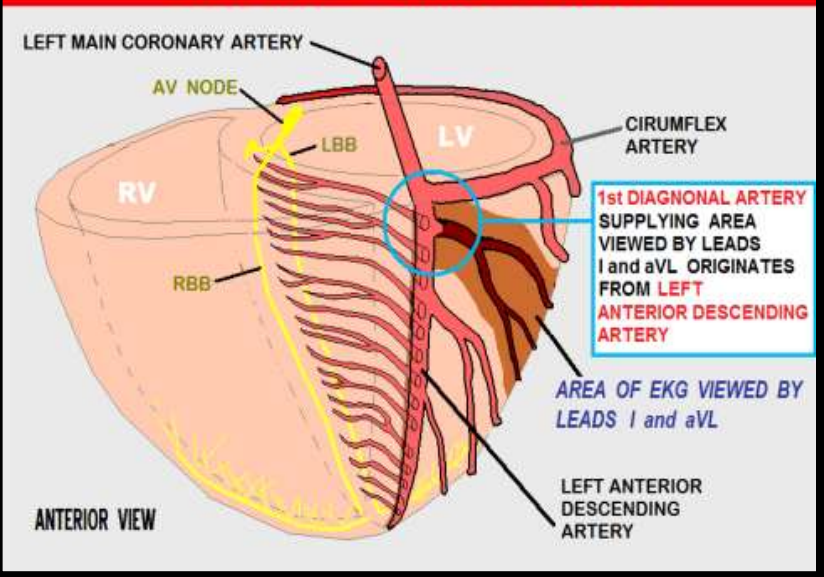




OCCLUSION of MID - LEFT ANTERIOR DESCENDING ARTERY



OCCLUSION of DIAGONAL ARTERY



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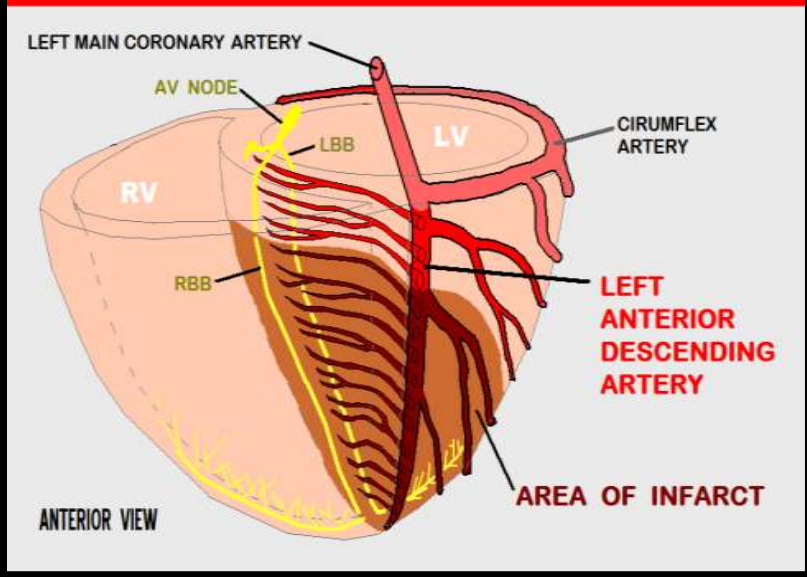
OCCLUSION of MID - LEFT ANTERIOR DESCENDING ARTERY



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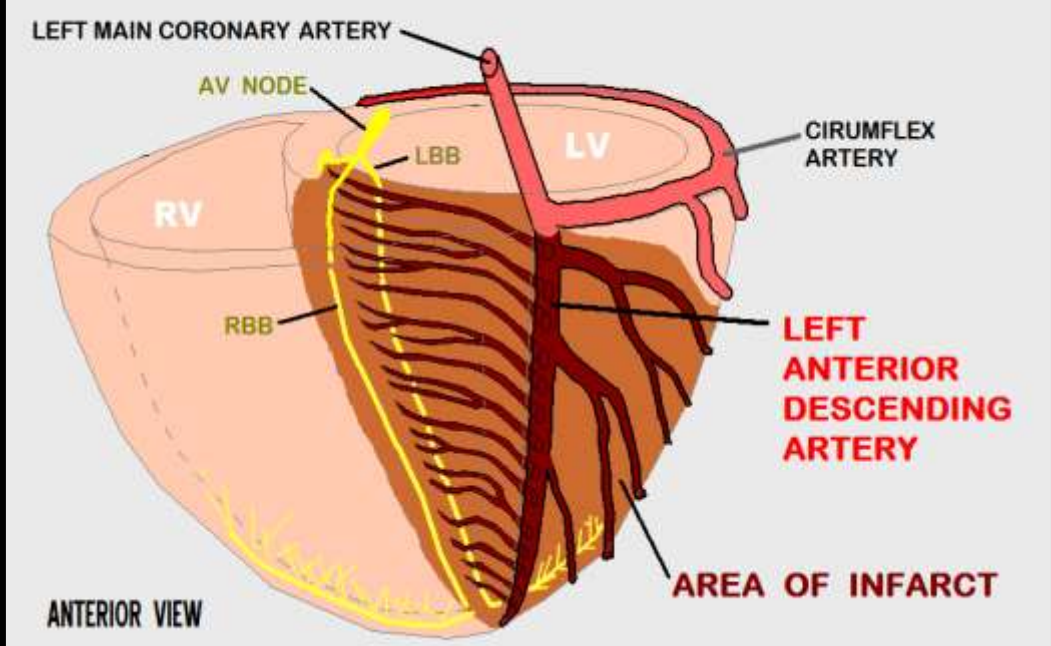
OCCLUSION of PROXIMAL LEFT ANTERIOR DESCENDING ARTERY

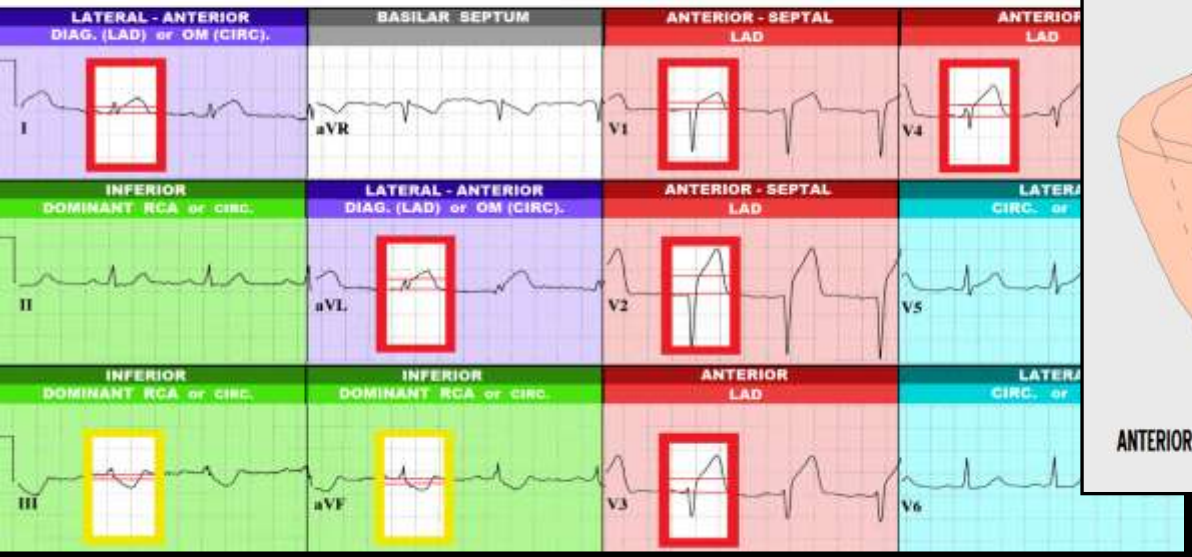


29 yr
Male
Caucasian

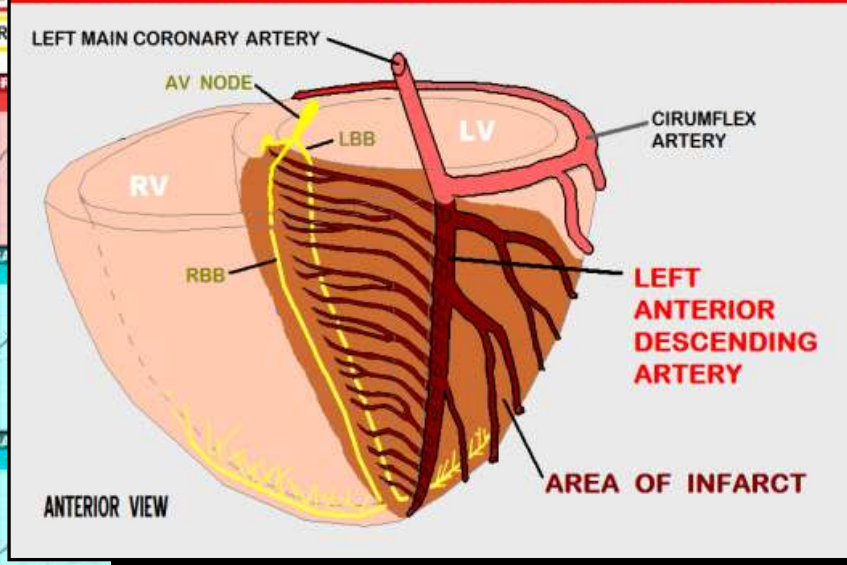
Vent. rate	75	BPM
PR interval	176	ms
QRS duration	90	ms
QT/QTc	362/404	ms
P–R–T axes	70 50	–11

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

ST SEGMENT ELE
ST SEGMENT DEPR



OCCLUSION of PROXIMAL LEFT ANTERIOR DESCENDING ARTERY

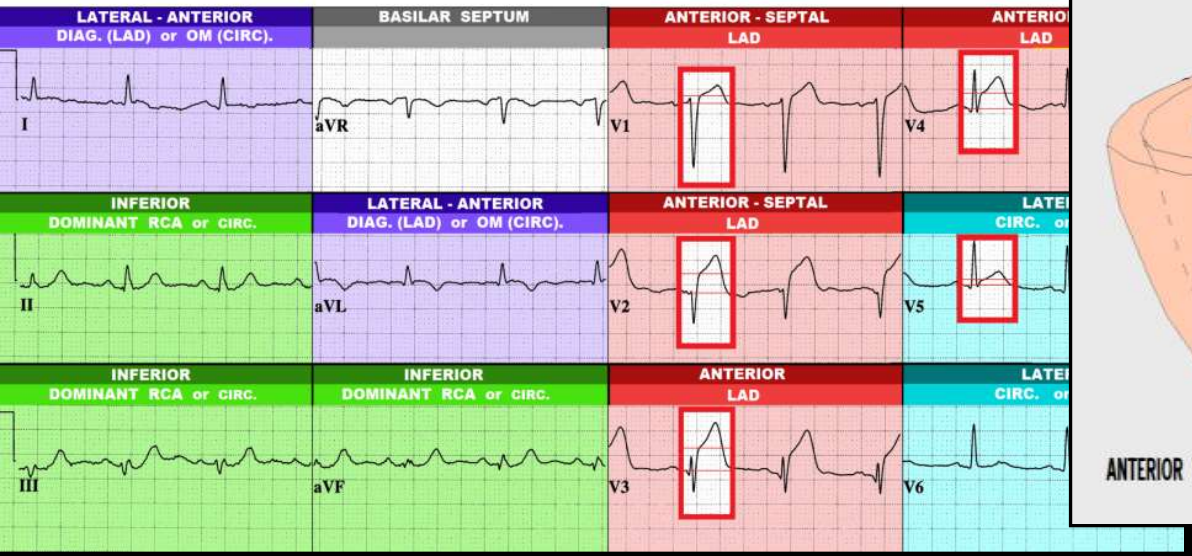


72 yr
Male
Caucasian
Loc:
Option:2

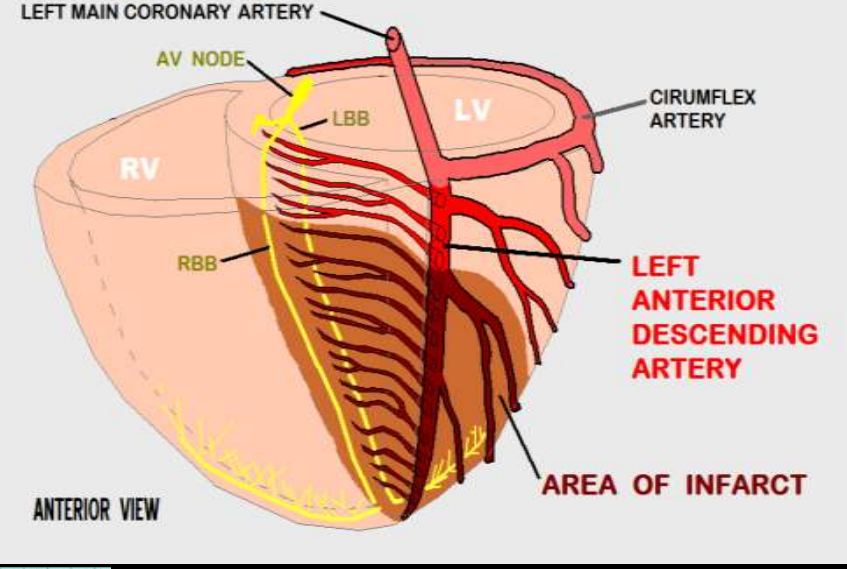
Vent. rate	75	BPM
PR interval	162	ms
QRS duration	98	ms
QT/QTc	382/426	ms
P–R–T axes	72 13	83

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

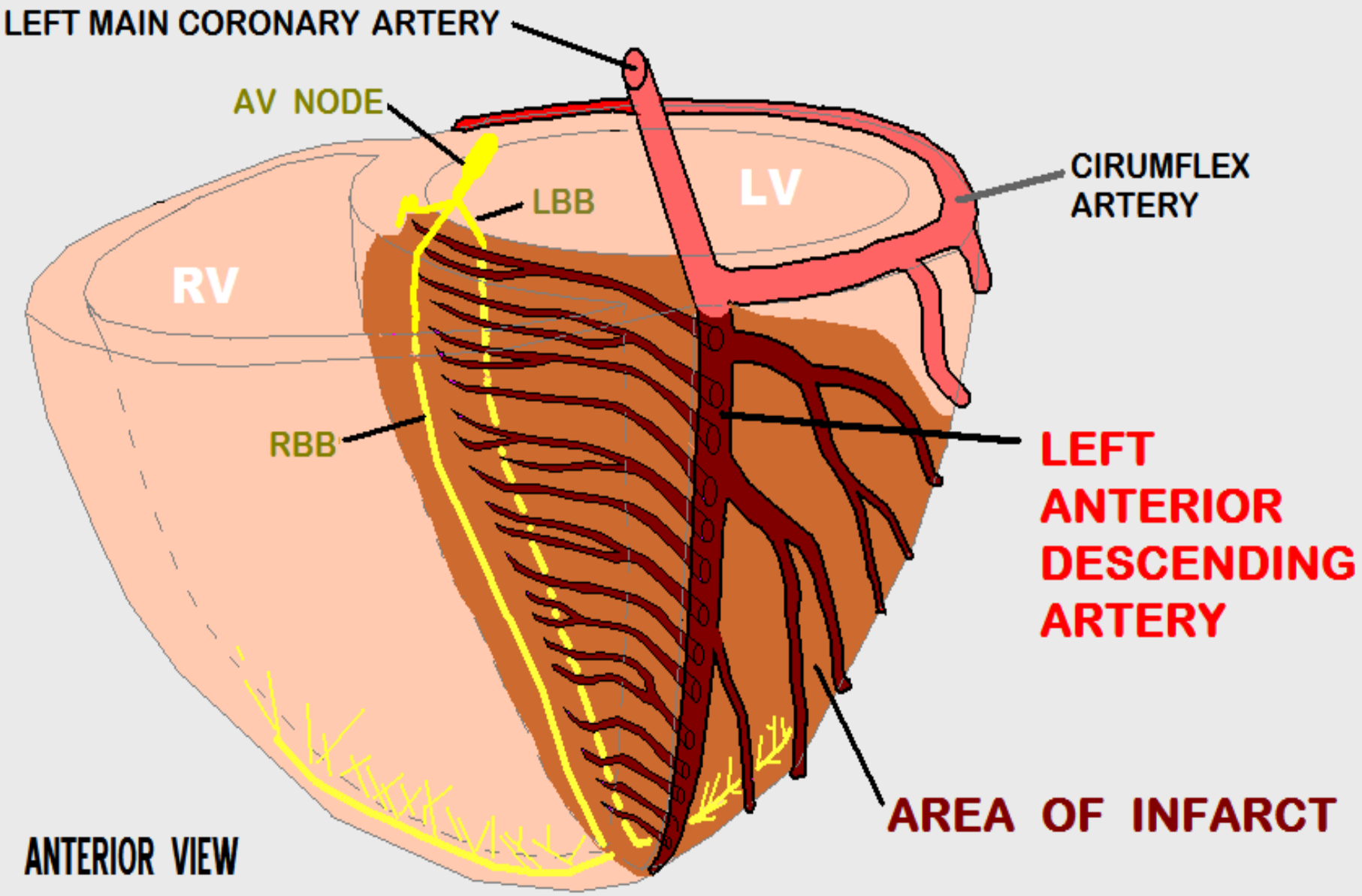
ST SEGMENT ELEVATIO



OCCLUSION of MID - LEFT ANTERIOR DESCENDING ARTERY



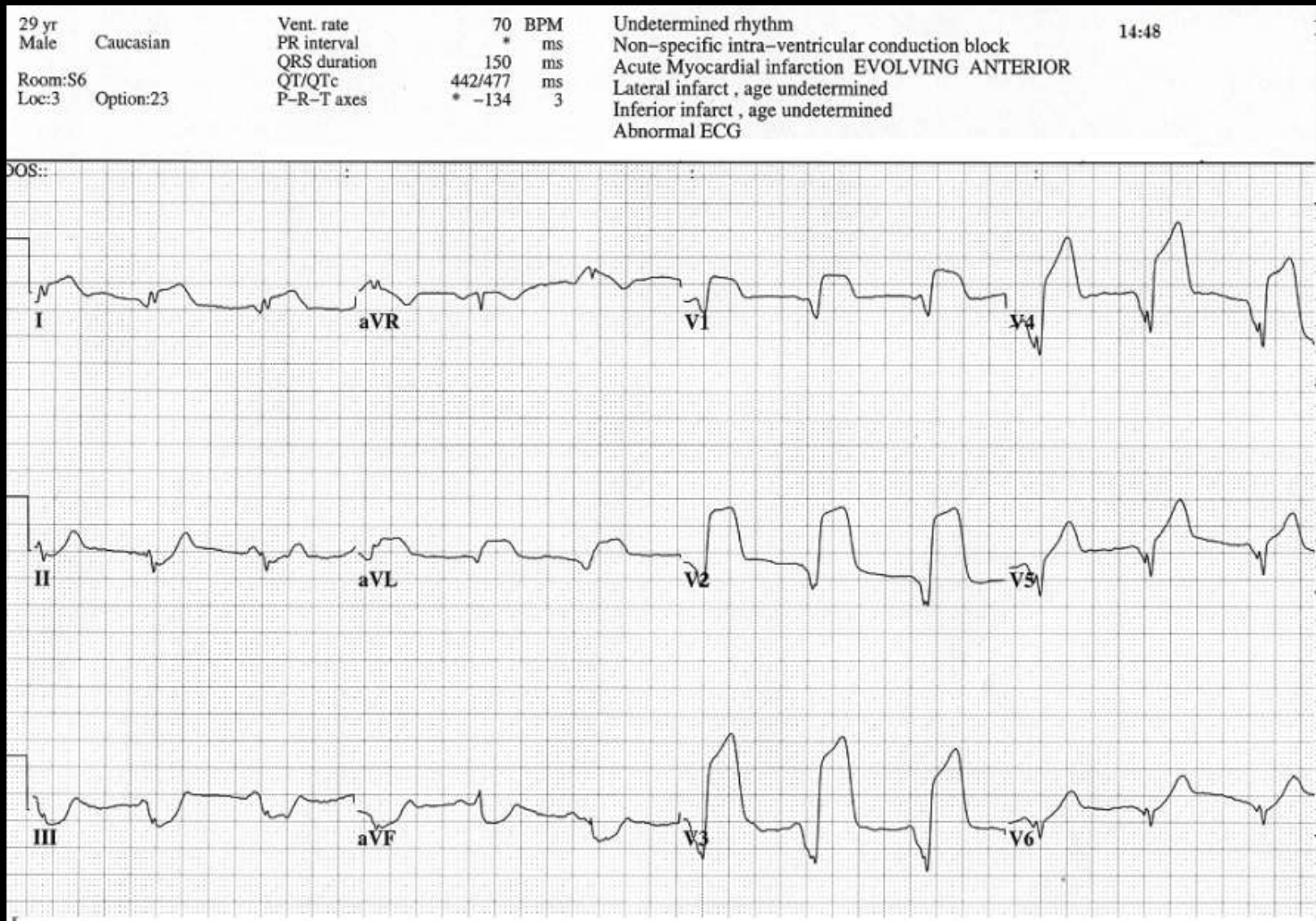
OCCLUSION of PROXIMAL LEFT ANTERIOR DESCENDING ARTERY

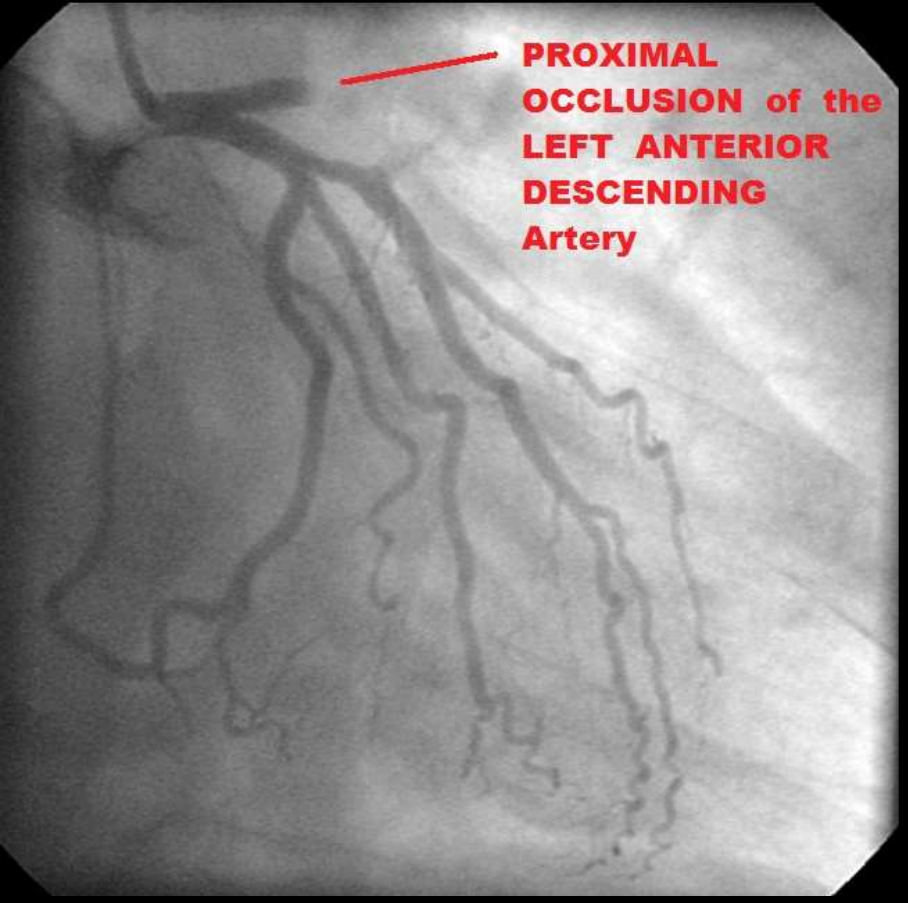


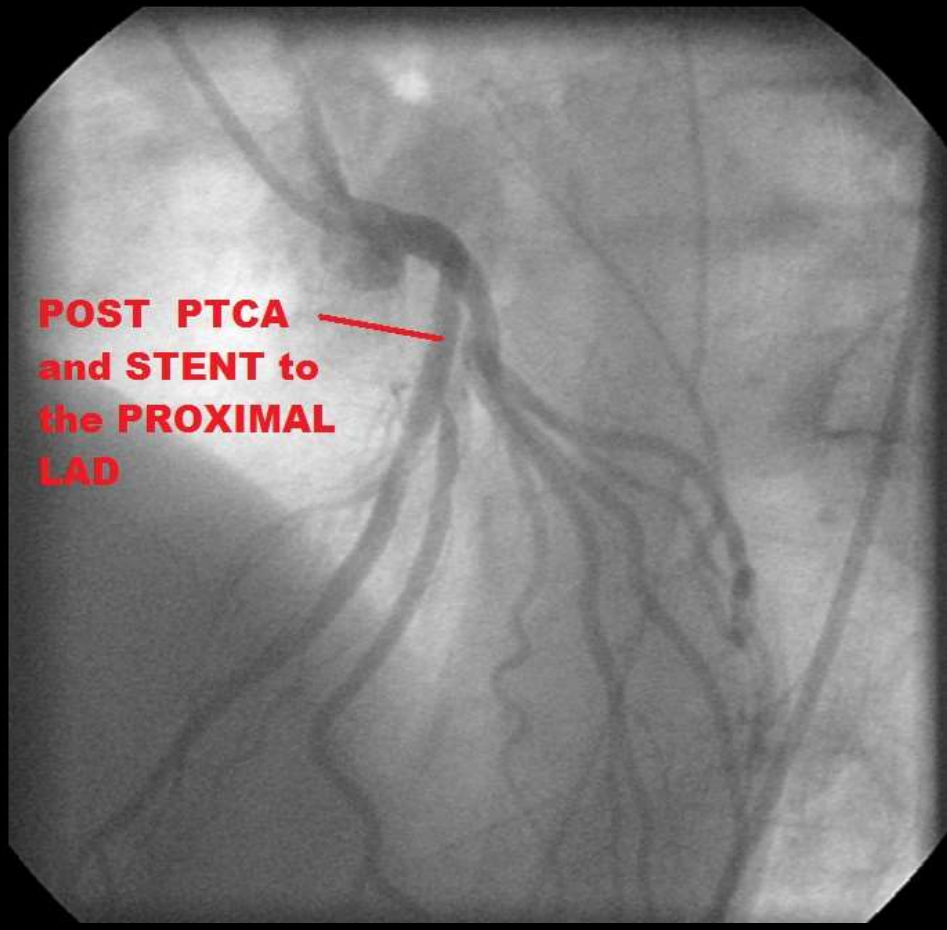
ANTICIPATED COMPLICATIONS of ANTERIOR-SEPTAL WALL STEMI & POSSIBLE INDICATED INTERVENTIONS:	
- CARDIAC ARREST	BCLS / ACLS
- CARDIAC DYSRHYTHMIAS (VT / VF)	ACLS (antiarrhythmics)
- PUMP FAILURE with CARDIOGENIC SHOCK	INOTROPE THERAPY: -DOPAMINE / DOBUTAMINE / LEVOPHED - INTRA-AORTIC BALLOON PUMP (use caution with fluid challenges due to PULMONARY EDEMA)
- PULMONARY EDEMA	- CPAP - ET INTUBATION (use caution with dieuretics 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 IMPLMENTED AT THIS POINT ?



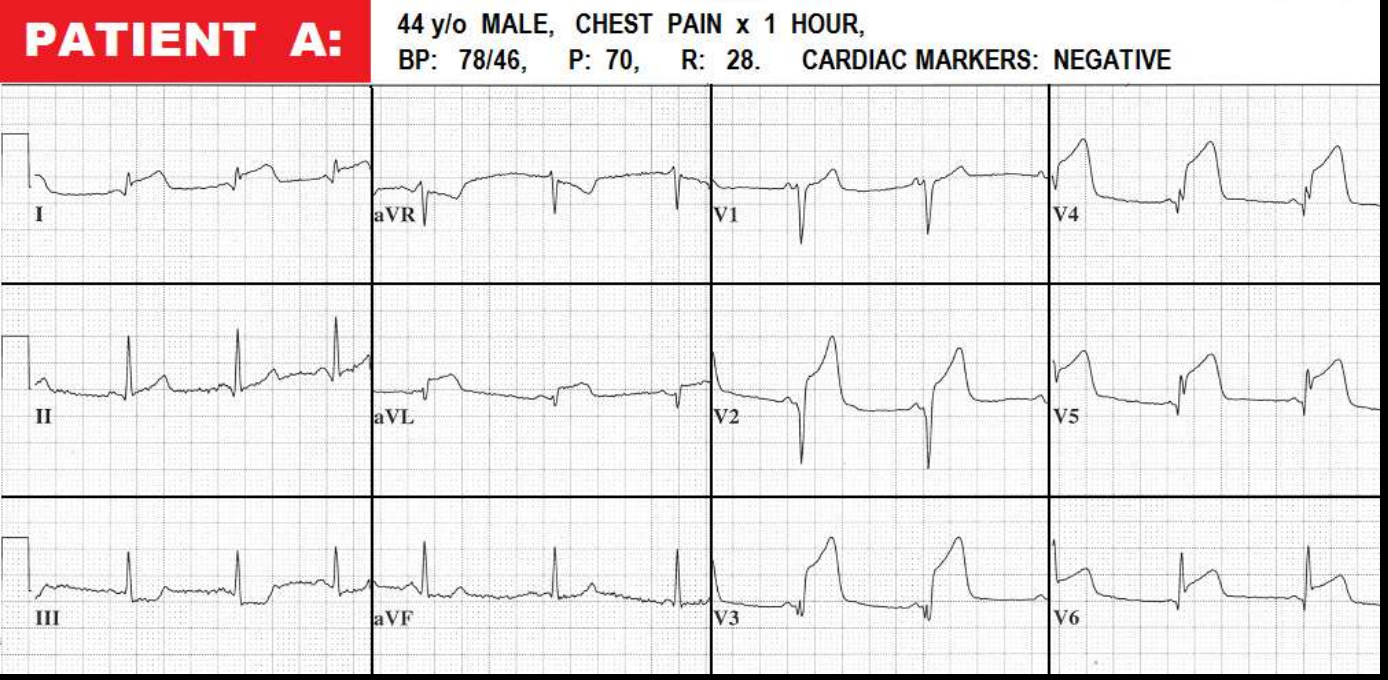

PROXIMAL
OCCLUSION of the
LEFT ANTERIOR
DESCENDING
Artery


POST PTCA
and STENT to
the PROXIMAL
LAD

CASE STUDY 4: CRITICAL DECISIONS SCENARIO

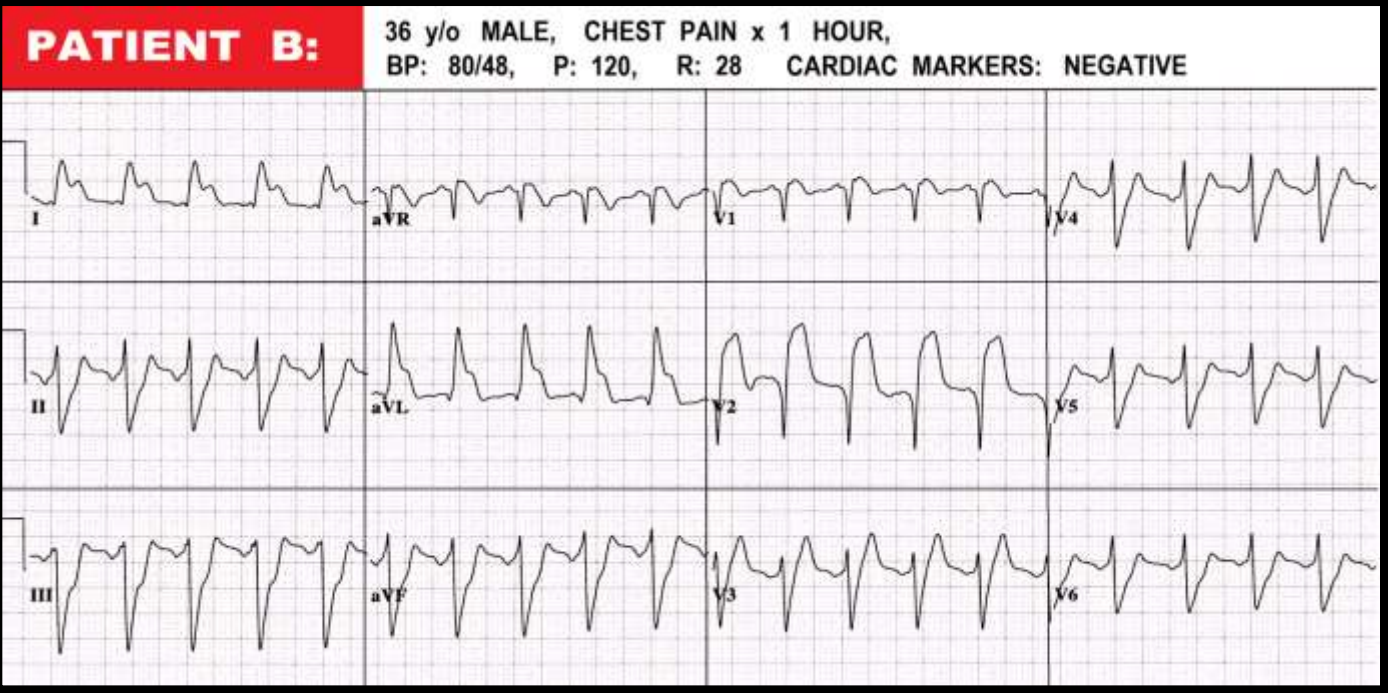
As per current AHA recommendations, your hospital's policy is to send every STEMI patient to the Cardiac Catheterization Lab for emergency PCI.

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.



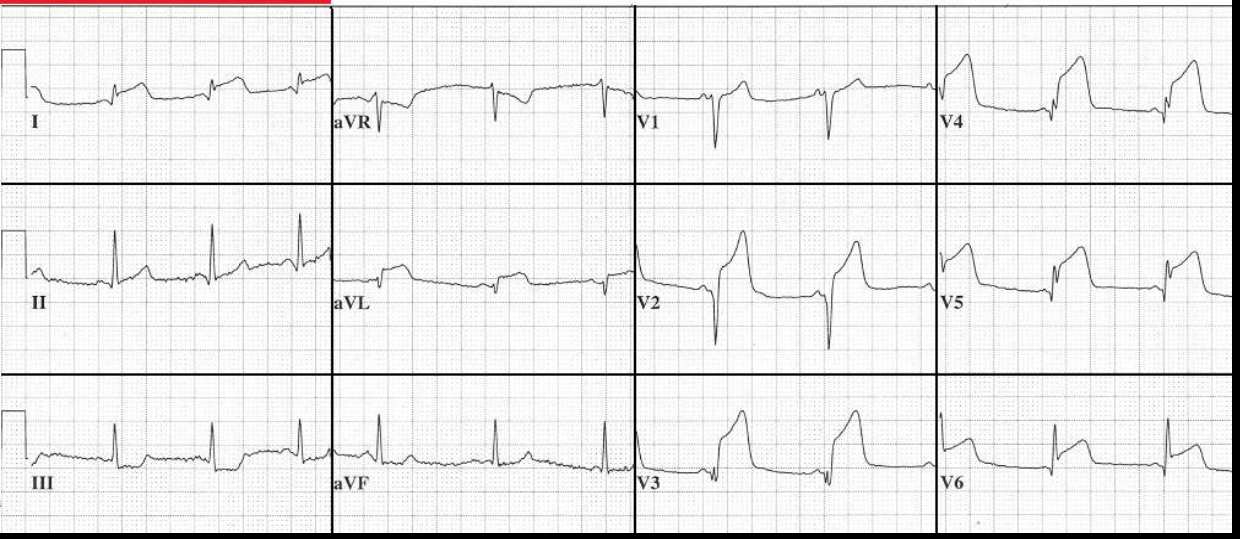
WHO SHOULD GO TO THE CATH LAB FIRST ?

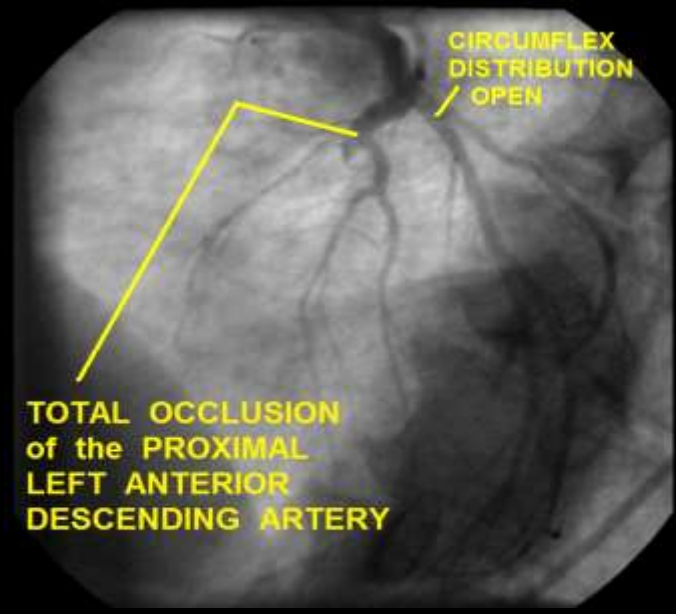
And . . . .



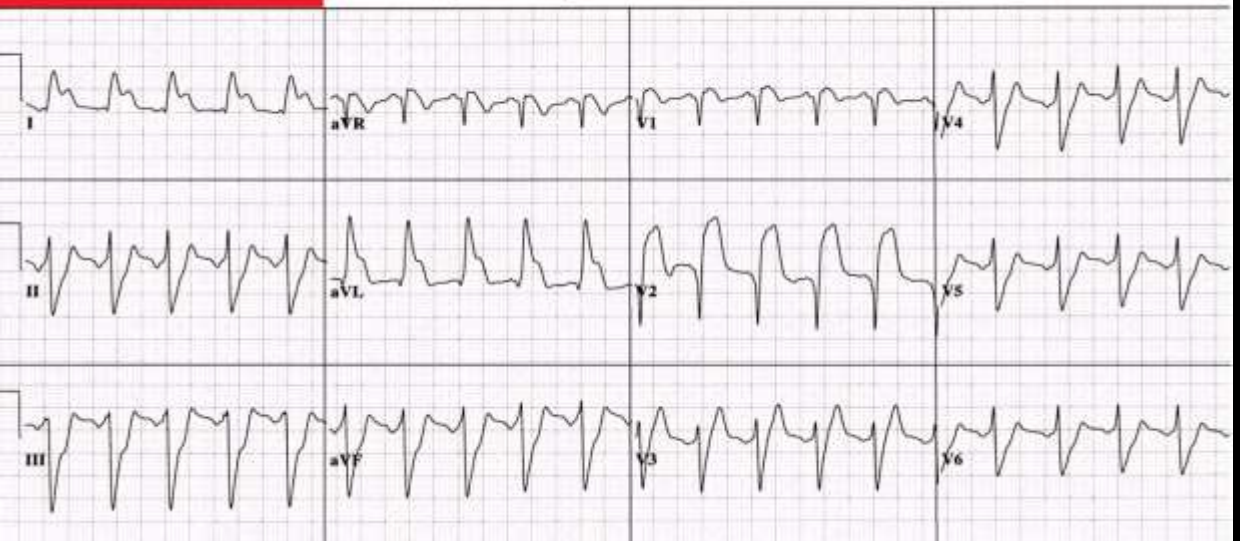
WHAT WOULD YOU DO WITH THE PATIENT WHO DID NOT GO TO THE CATH LAB ?

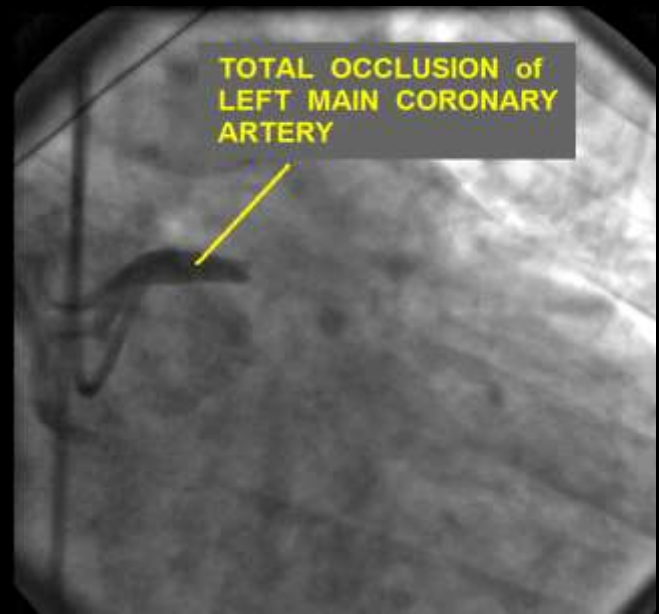
PATIENT A: 44 y/o MALE, CHEST PAIN x 1 HOUR,
BP: 78/46, P: 70, R: 28. CARDIAC MARKERS: NEGATIVE



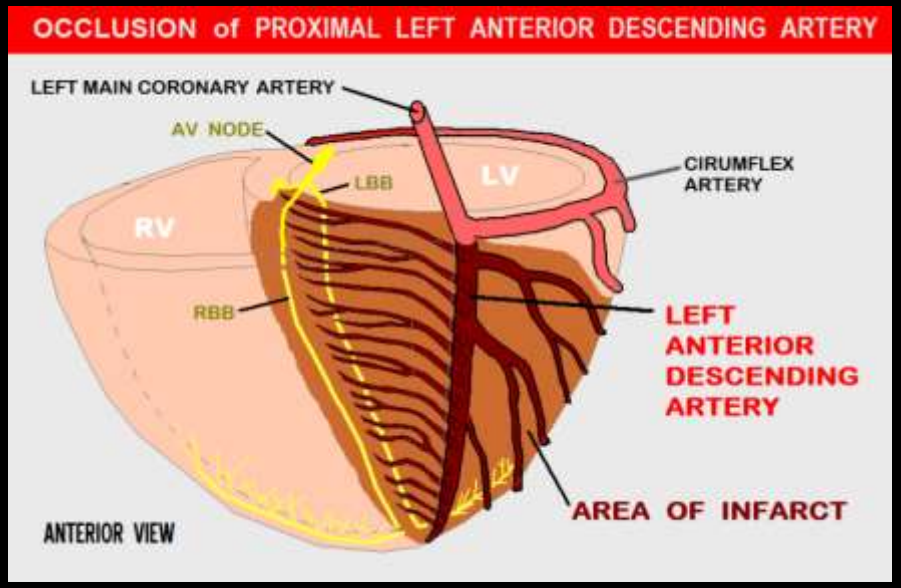


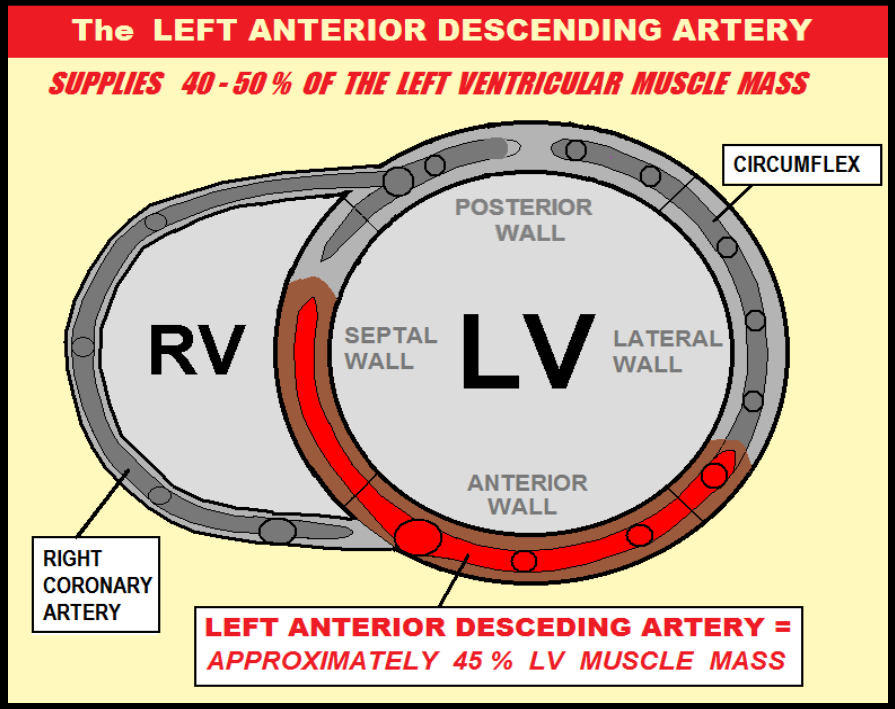
PATIENT B: 36 y/o MALE, CHEST PAIN x 1 HOUR,
BP: 80/48, P: 120, R: 28 CARDIAC MARKERS: NEGATIVE



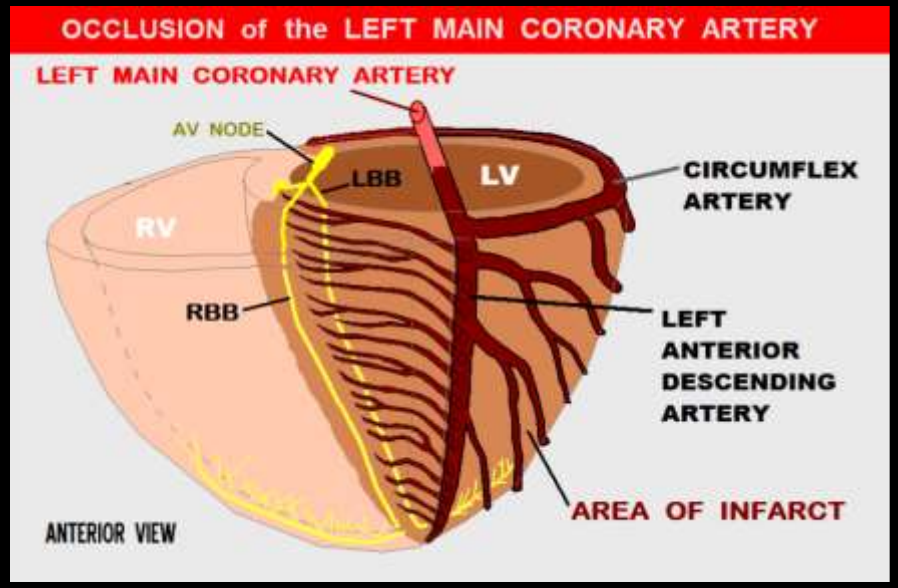


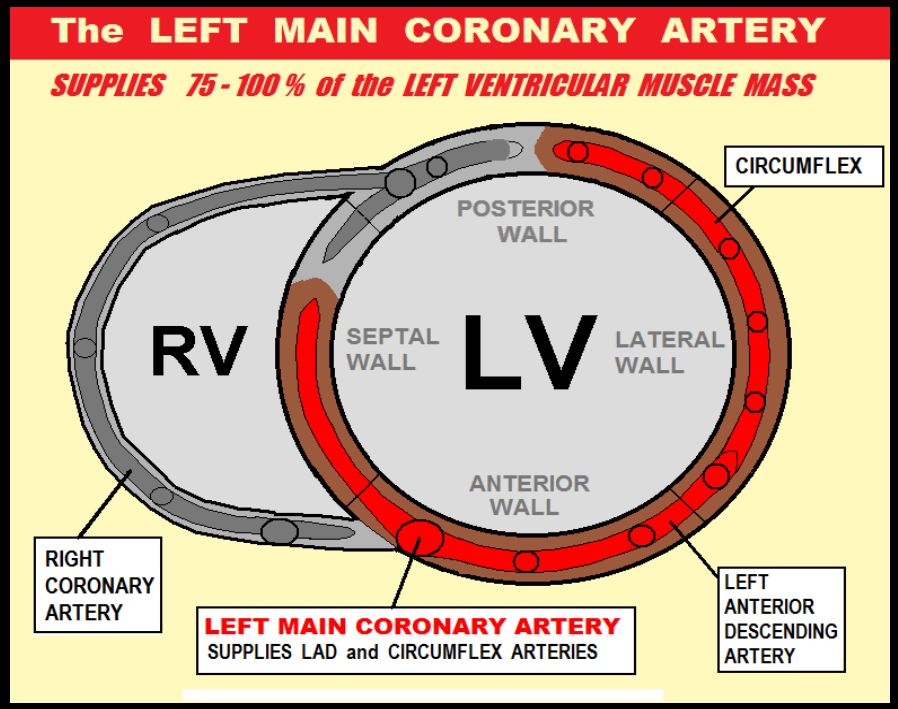
PATIENT A:





PATIENT B:





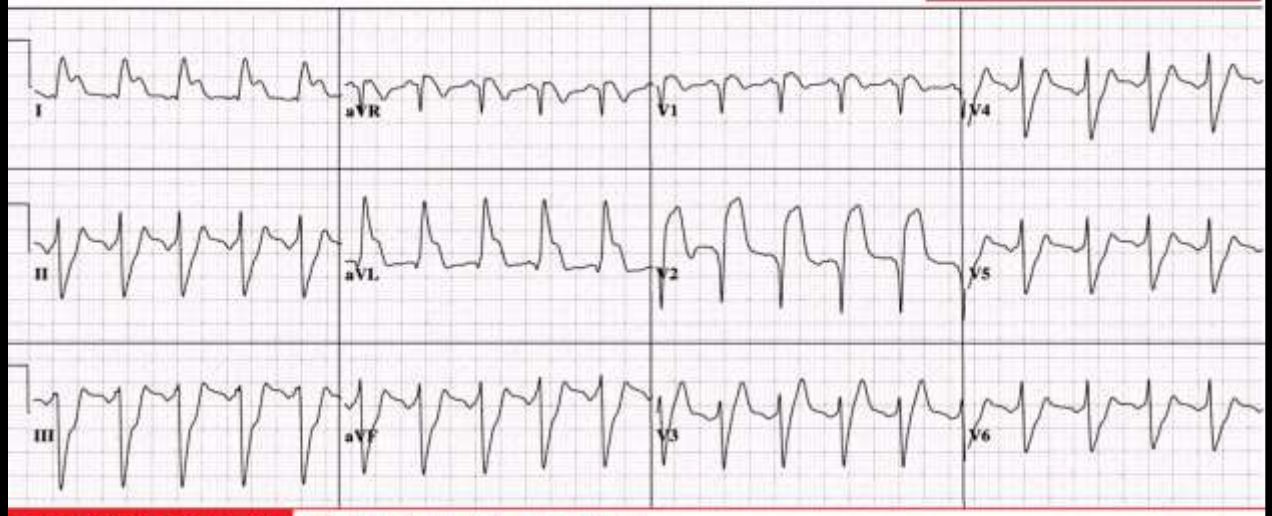
36 yr
Male
Caucasian

Room:C-
Loc:3

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:

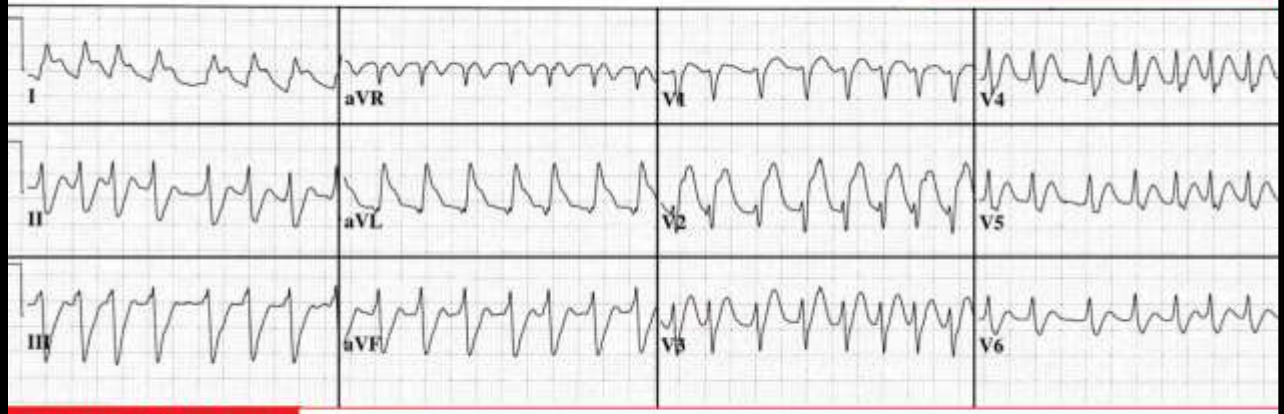
- ☑ ST ELEVATION in leads I and aVL
- ☑ INCONSISTENCY of ST SEGEMENT in leads V1 - V6 : V1 - V3 ST ELEVATION, V4 - V6 ST DEPRESSION (COMPETING FORCES of ANTERIOR vs. POSTERIOR M.I.)
- ☑ PATTERN of LEFT ANTERIOR FASCICULAR BLOCK (POS. QRS lead I; NEG rS leads II, III)
- ☑ ST ELEVATION in lead aVR > 0.5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

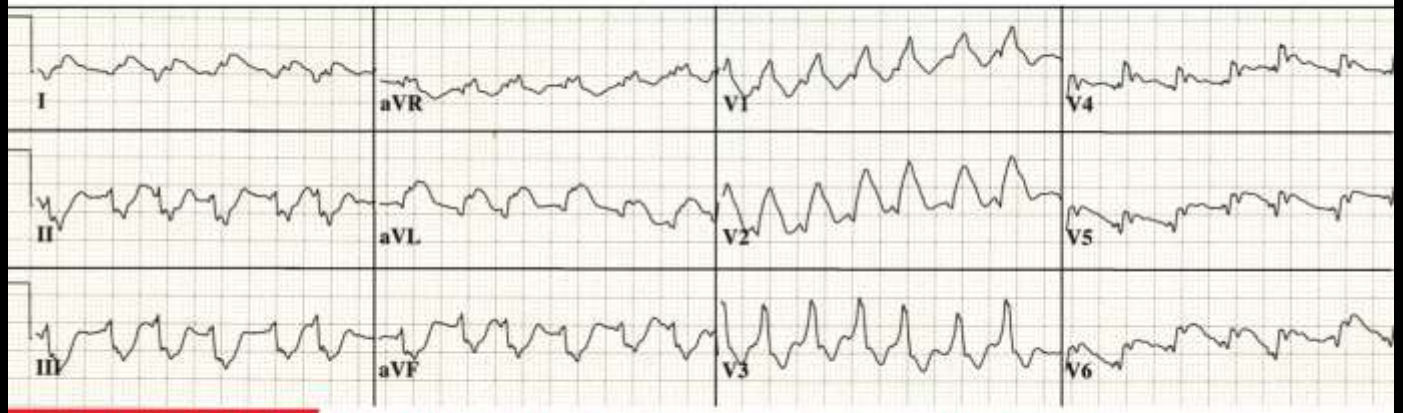
- ☑ ST ELEVATION in leads I and aVL
- ☑ INCONSISTENCY of ST SEGEMENT in leads V1 - V6 : V1 - V2 ST ELEVATION, V3 - V6 ST DEPRESSION (COMPETING FORCES of ANTERIOR vs. POSTERIOR M.I.)
- ☑ PATTERN of LEFT ANTERIOR FASCICULAR BLOCK (POS. QRS lead I; NEG rS leads II, III)

48 yr
Male Caucasian

Loc: Option:

Vent. rate	155	BPM
PR interval	*	ms
QRS duration	110	ms
QT/QTc	300/482	ms
P-R-T axes	* –83	–34

ACUTE STEMI caused by LEFT MAIN CORONARY ARTERY OCCLUSION



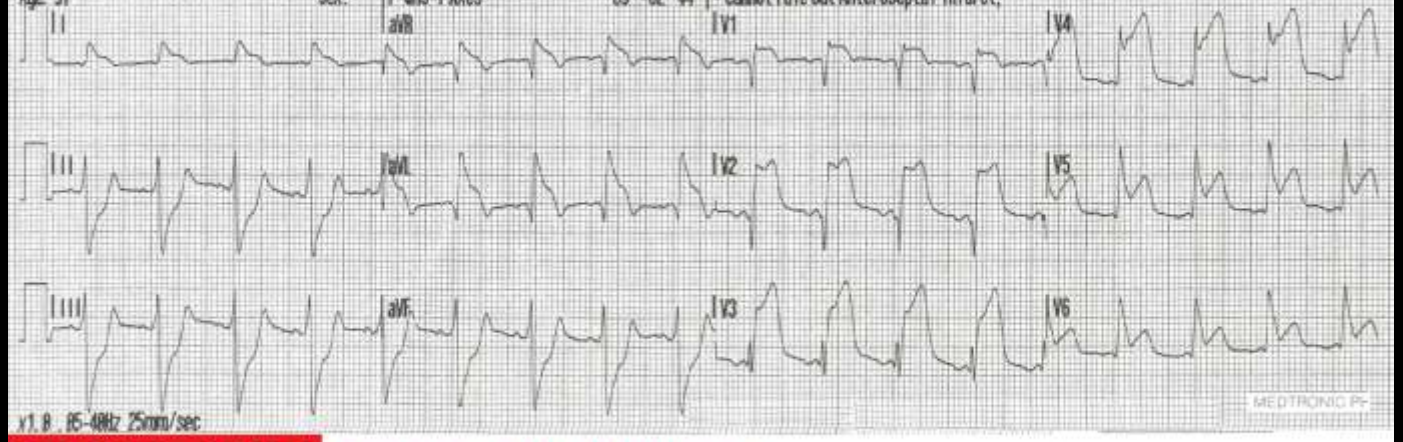
ECG CLUES of ACUTE STEMI caused by LEFT MAIN CORONARY ARTERY OCCLUSION:

- ☑ ST ELEVATION in LEADS I, aVL, V1 - V2, V4 - V6 with ST DEPRESSION in V3: (COMPETING FORCES of ANTERIOR vs. POSTERIOR M.I.)
- ☑ RIGHT BUNDLE BRANCH BLOCK PATTERN, with
- ☑ LEFT ANTERIOR FASCICULAR BLOCK PATTERN

Name:
ID:
Patient ID:
Incident:
Age: 37 Sex:

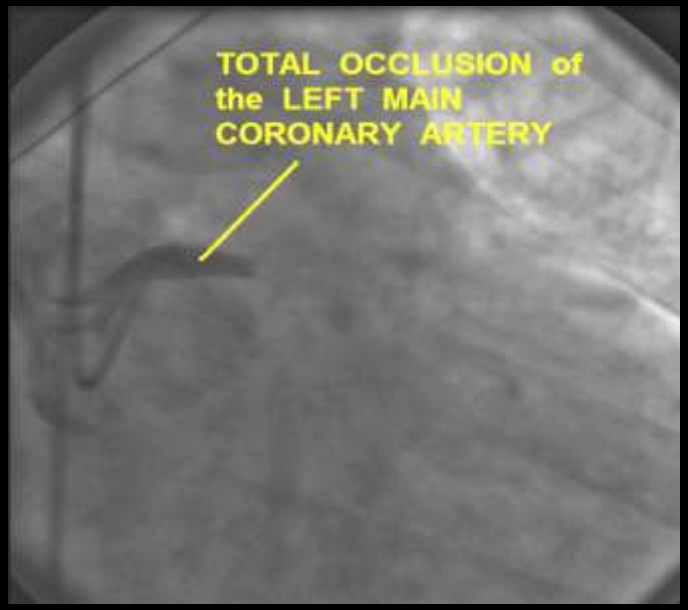
12-Lead 4	HR 107 bpm	*** ACUTE MI SUSPECTED ***
06 Oct 87	12:44:13	* Abnormal ECG **Unconfirmed**
PR 0.154s	QRS 0.102s	* Sinus tachycardia
QT/QTc	0.332s/0.443s	* Left anterior fascicular block
P-QRS-T Axes	89° -62° 44°	* Cannot rule out Anteroseptal infarct,

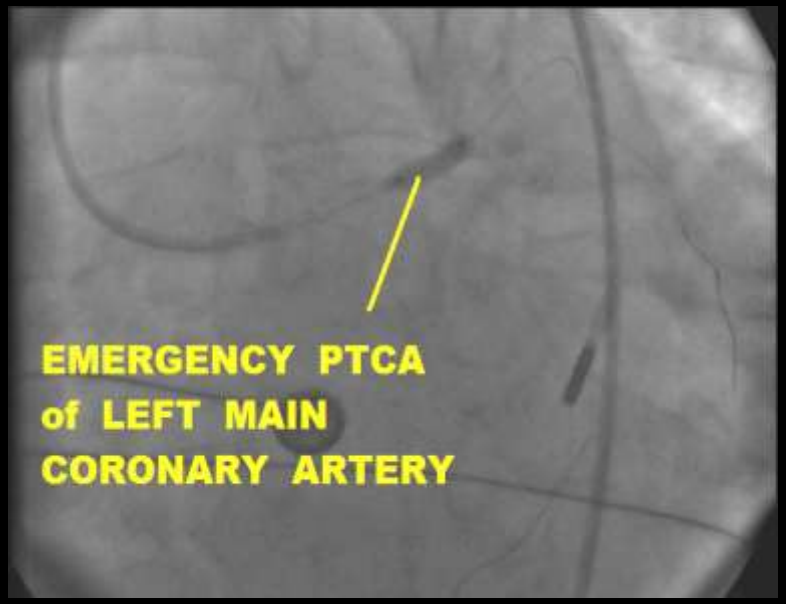
ACUTE STEMI caused by LEFT MAIN CORONARY ARTERY OCCLUSION



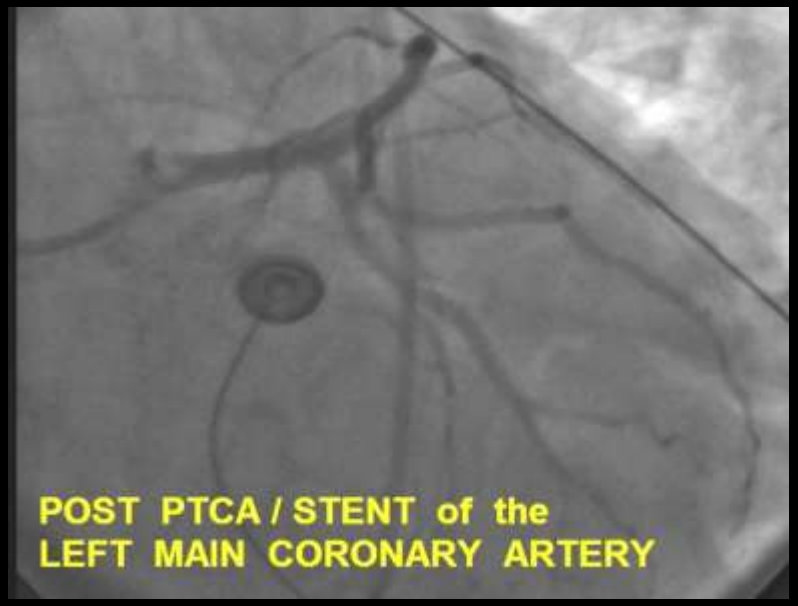
ECG CLUES of ACUTE STEMI caused by LEFT MAIN CORONARY ARTERY OCCLUSION:

- ☑ ST ELEVATION in LEADS I, aVL, V1 - V6
- ☑ ST ELEVATION in aVR GREATER THAN 0.5 mm
- ☑ ST ELEVATION in aVR GREATER THAN LEAD V1
- ☑ LEFT ANTERIOR FASCICULAR BLOCK PATTERN





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.

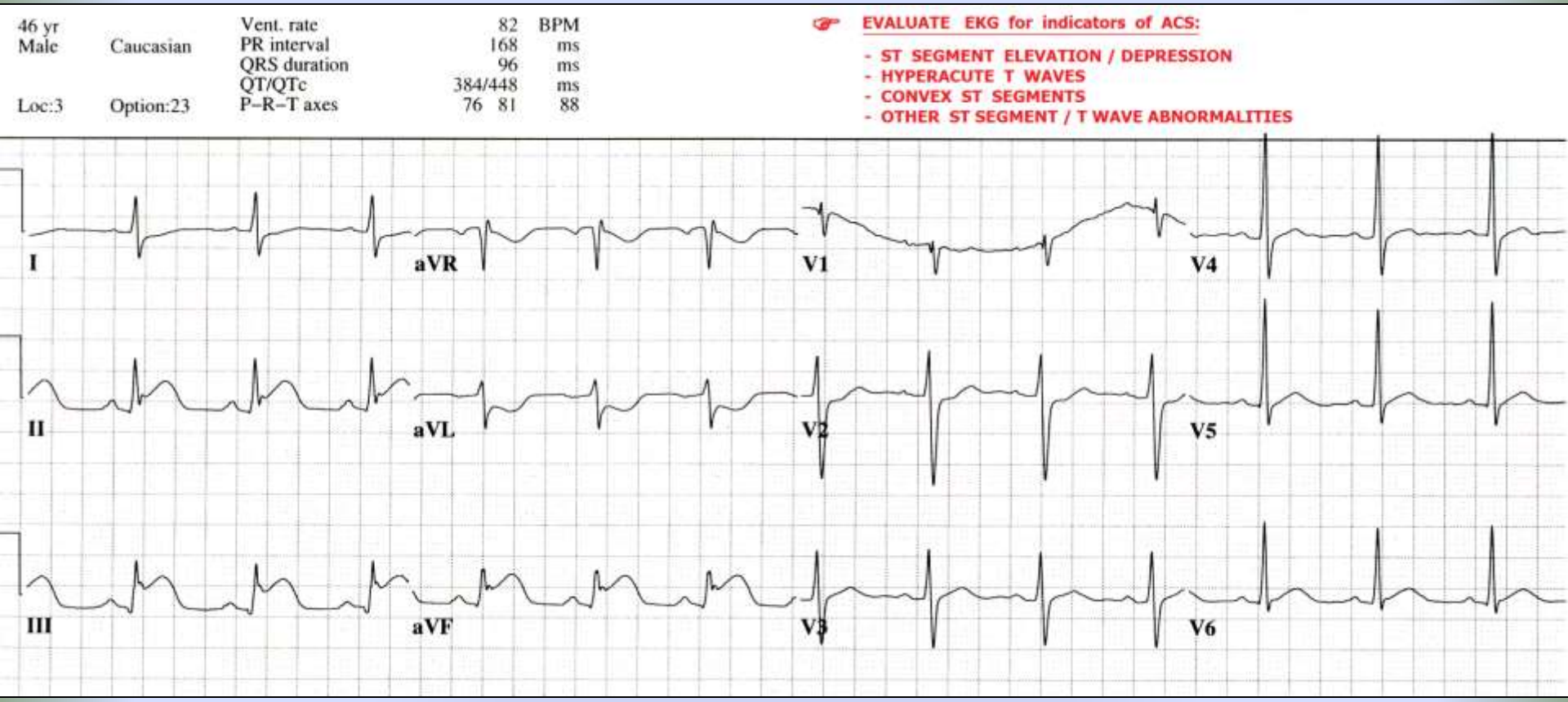
RISK FACTOR PROFILE:

- CURRENT CIGARTTE 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
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
EVALUATE EKG for indicators of ACS:
- ST SEGMENT ELEVATION / DEPRESSION
- HYPERACUTE T WAVES
- CONVEX ST SEGMENTS
- OTHER ST SEGMENT / T WAVE ABNORMALITIES
I
aVR
V1
V4
II
aVL
V2
V5
III
aVF
V3
V6

46 yr
Male

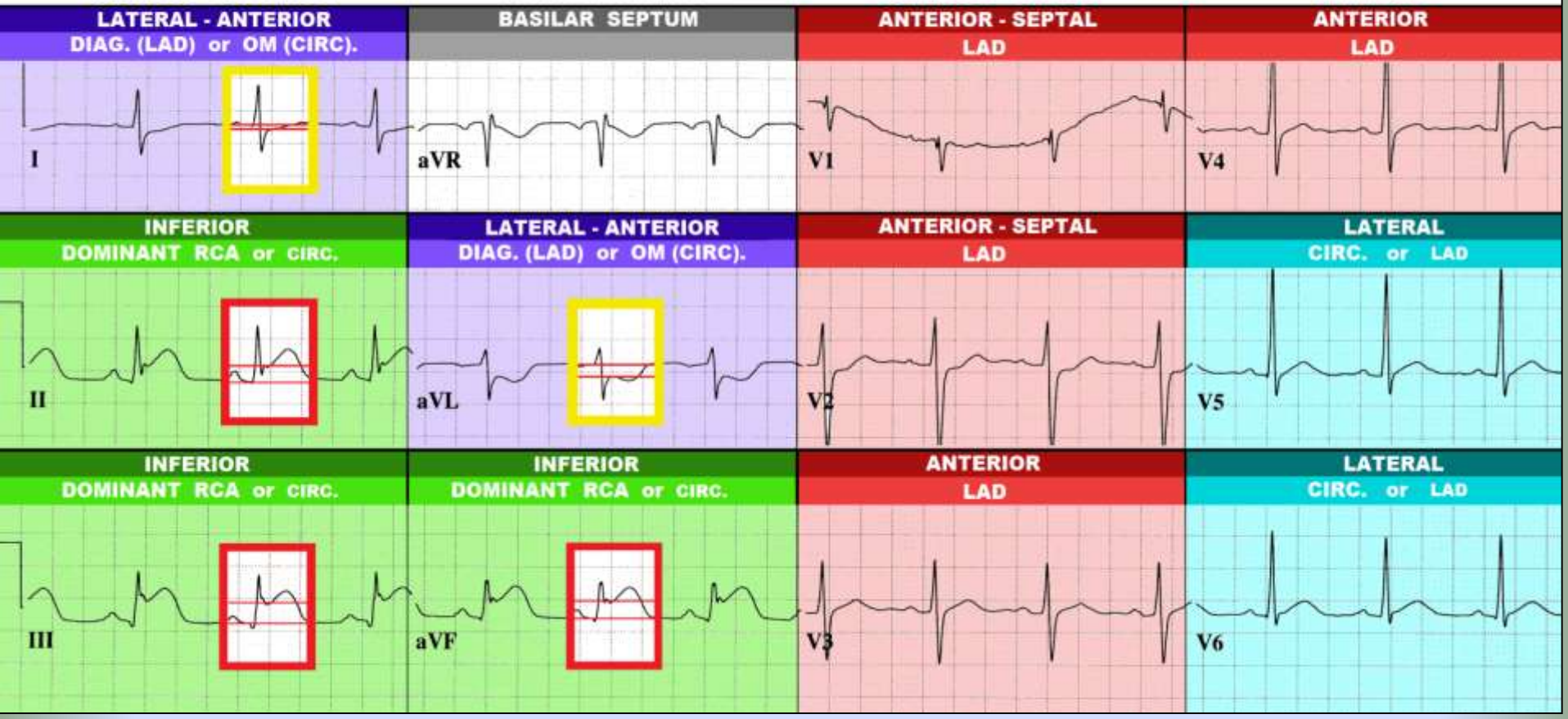
Caucasian

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

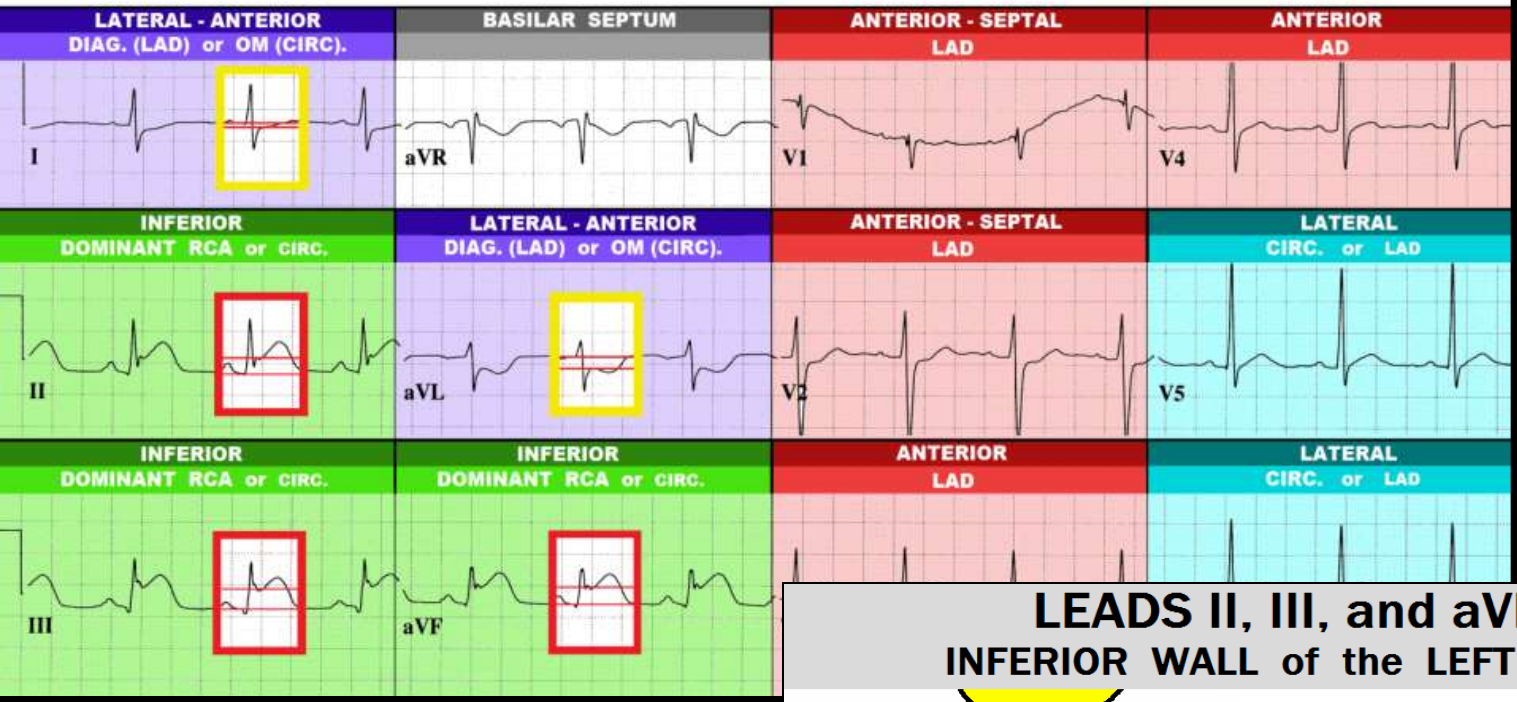
Caucasian

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

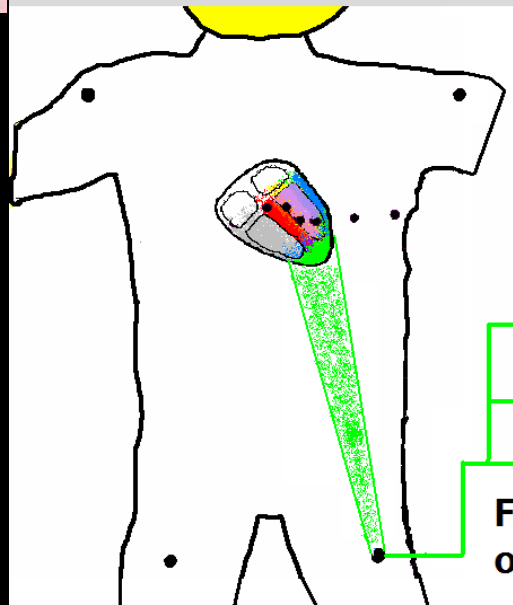
Normal sinus rhythm
ST elevation consider inferior injury or acute infarct
*** ** ** ** * ACUTE MI ** ** ** **
Abnormal ECG

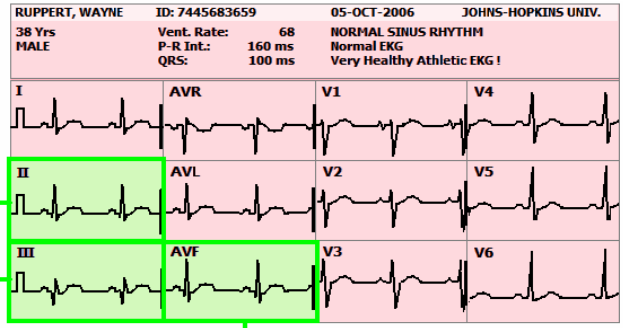
ST SEGMENT ELEVATION

ST SEGMENT DEPRESSION



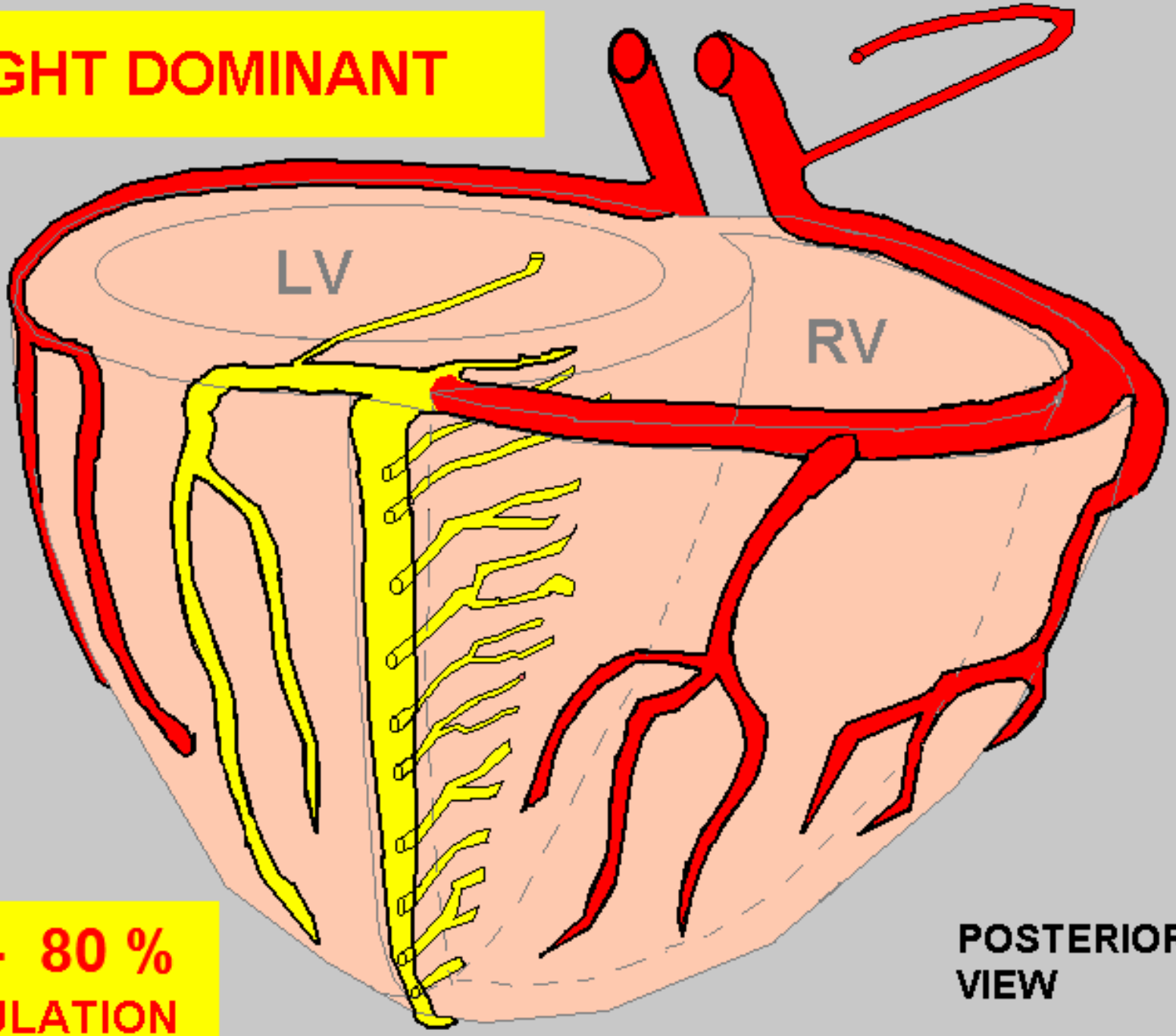
LEADS II, III, and aVF VIEW
INFERIOR WALL of the LEFT VENTRICLE





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

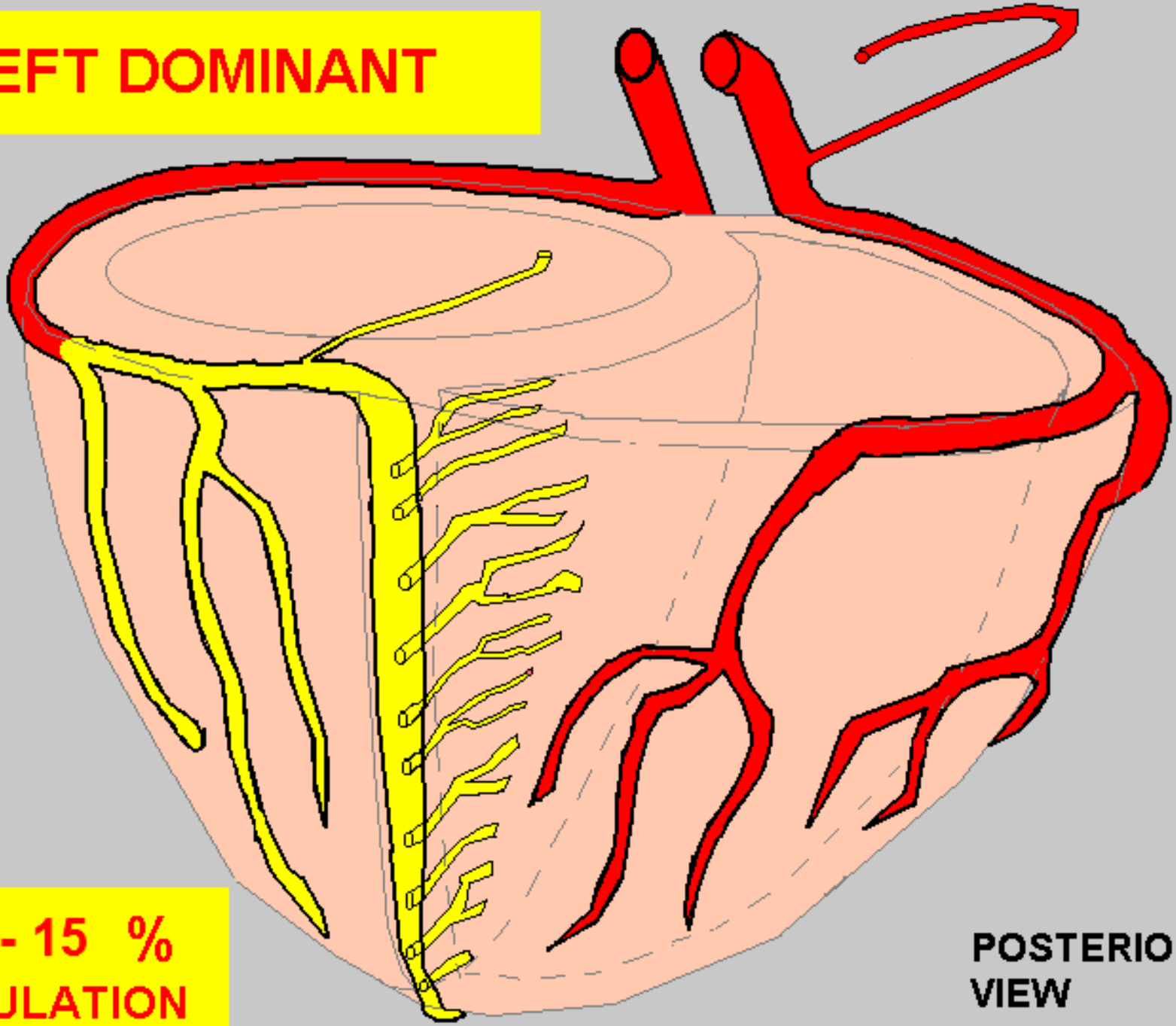
RIGHT DOMINANT



75 - 80 %
POPULATION

POSTERIOR VIEW

LEFT DOMINANT



10 - 15 %
POPULATION

POSTERIOR
VIEW

HELPFUL HINT . . . MEMORIZE THIS !

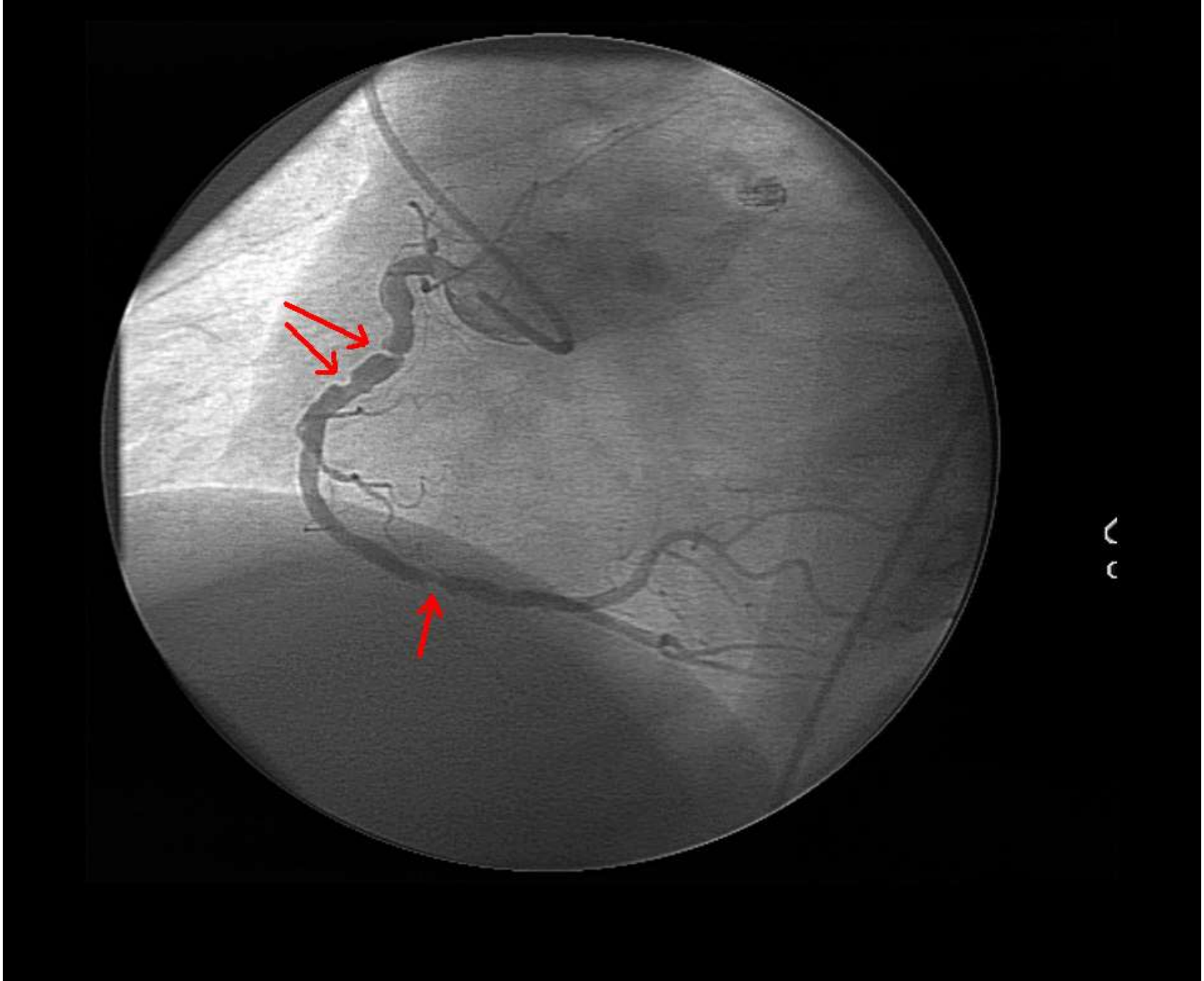
RIGHT CORONARY ARTERY (RCA)

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	- 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	- 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.



A standard

12 LEAD EKG

Does NOT show the

RIGHT VENTRICLE

To see the

RIGHT VENTRICLE . . .

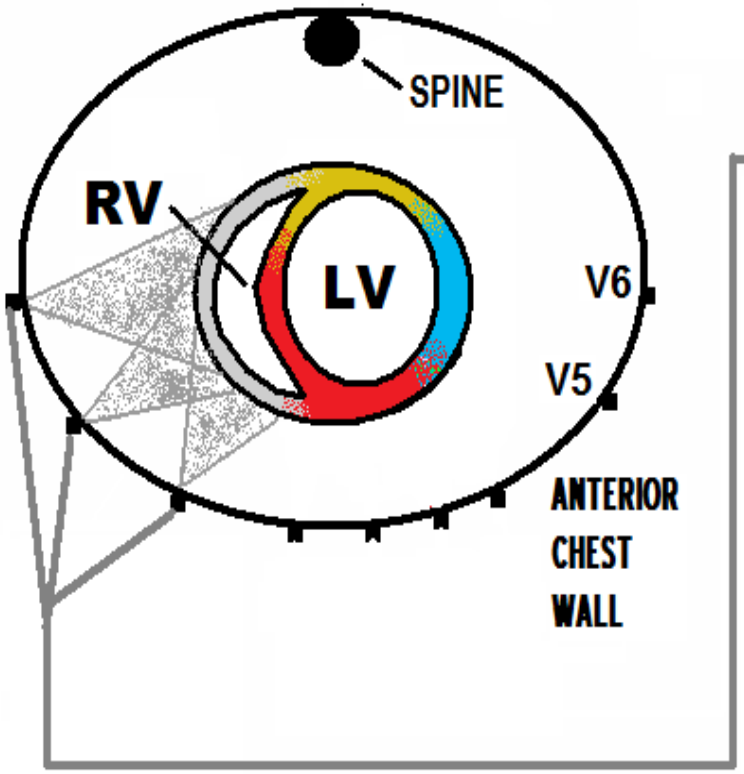
. . . such as in cases of

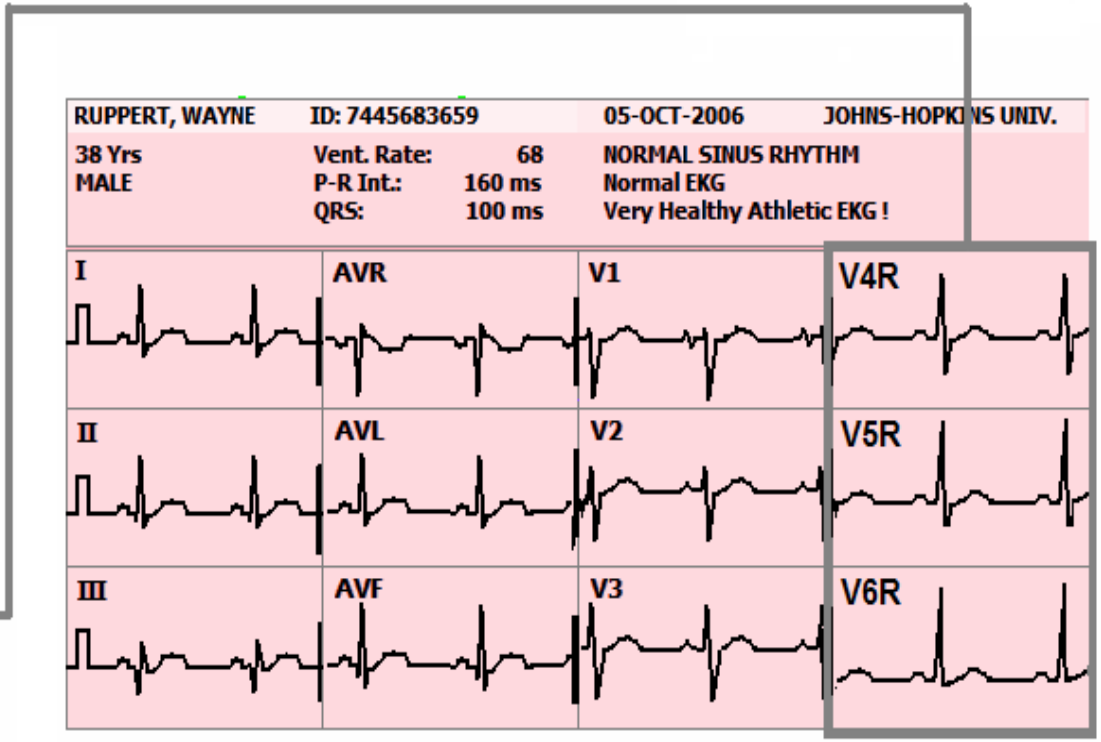
INFERIOR WALL M.I.

☞ You must do a

RIGHT - SIDED EKG ! !

V4R - V6R VIEW THE RIGHT VENTRICLE



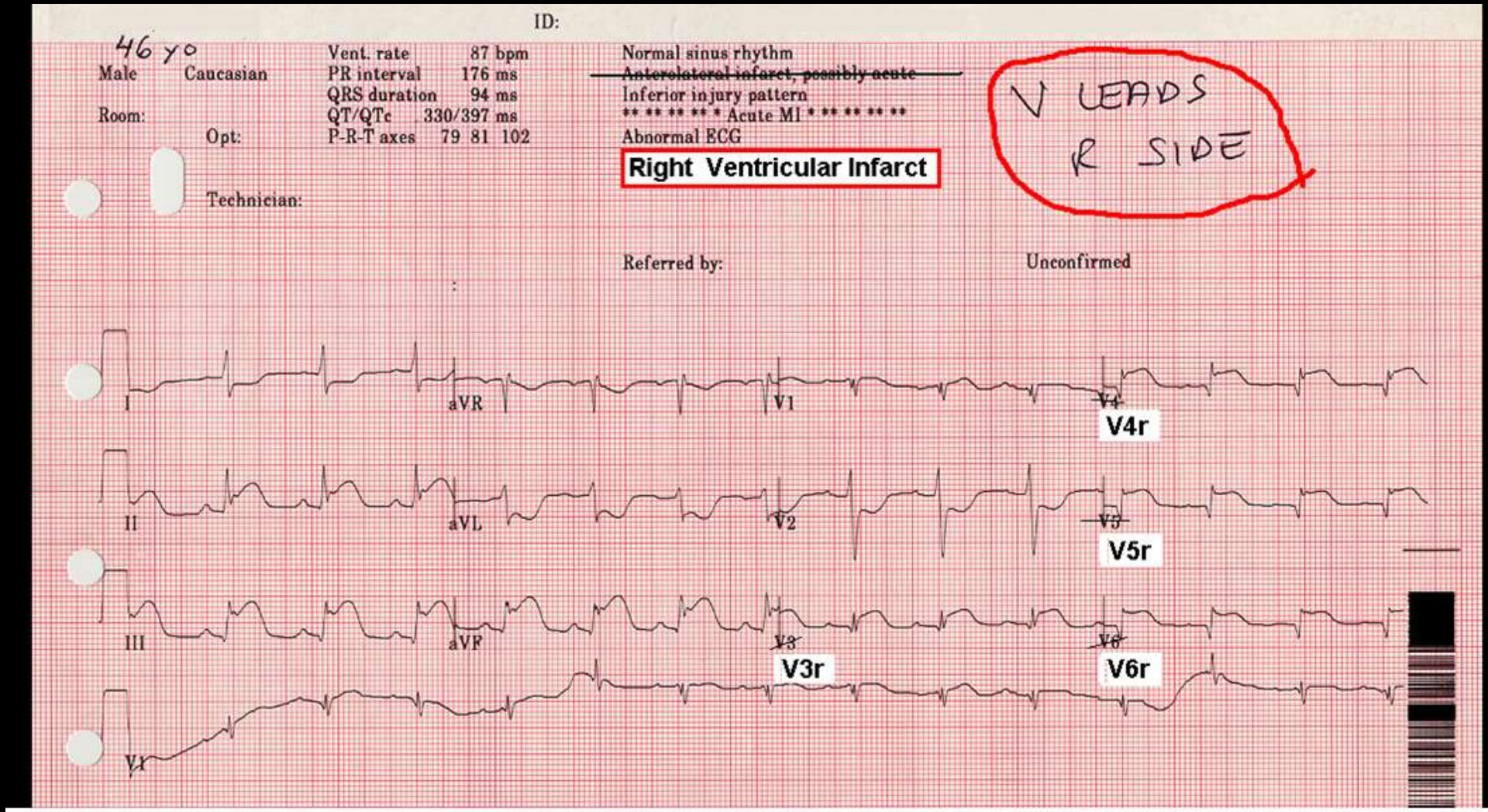


RV MI STEMI Criteria:

- 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



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 ! !*

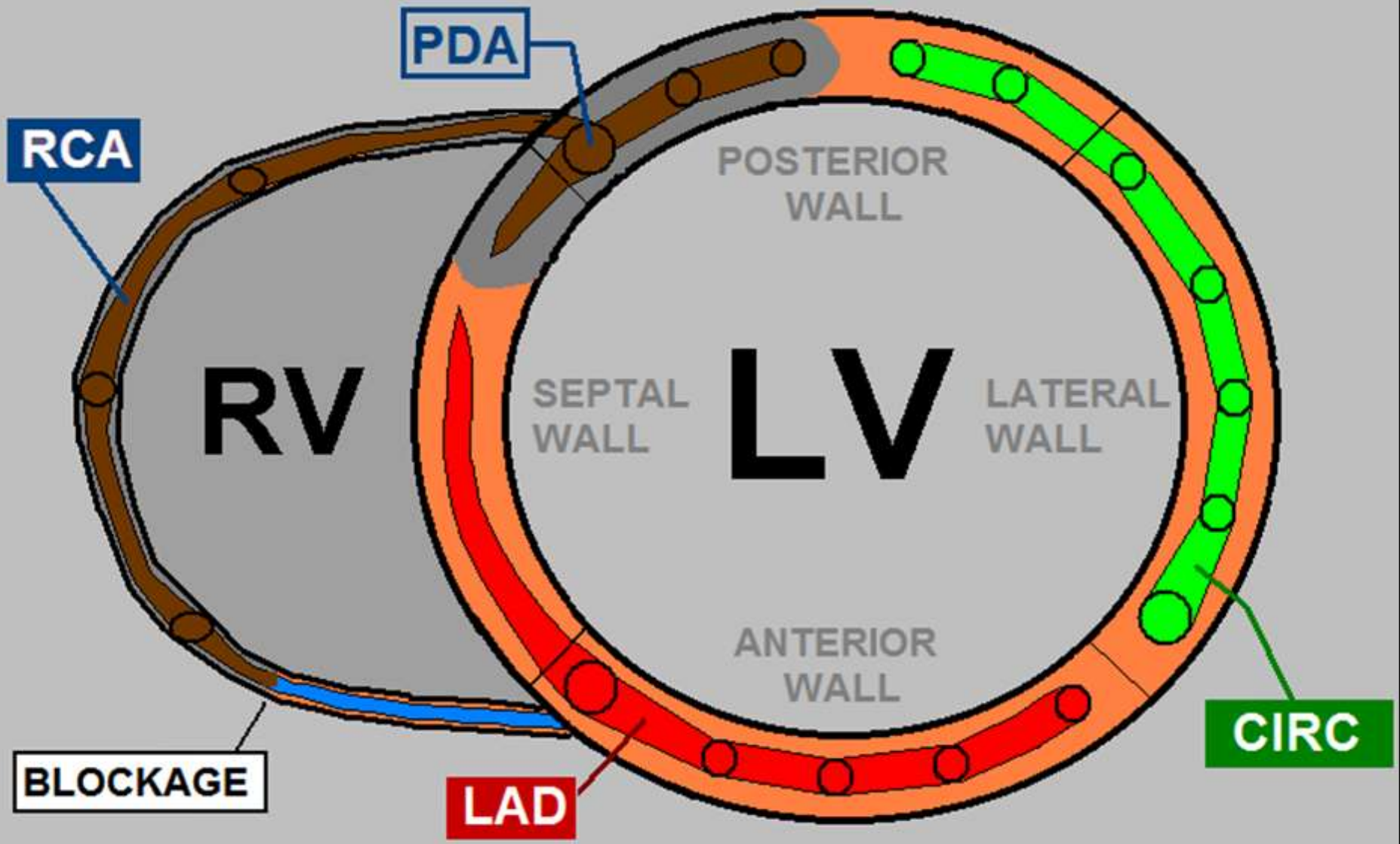
They precipitate SEVERE HYPOTENSION

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

INFERIOR - RIGHT VENTRICULAR MI

DOMINANT RCA

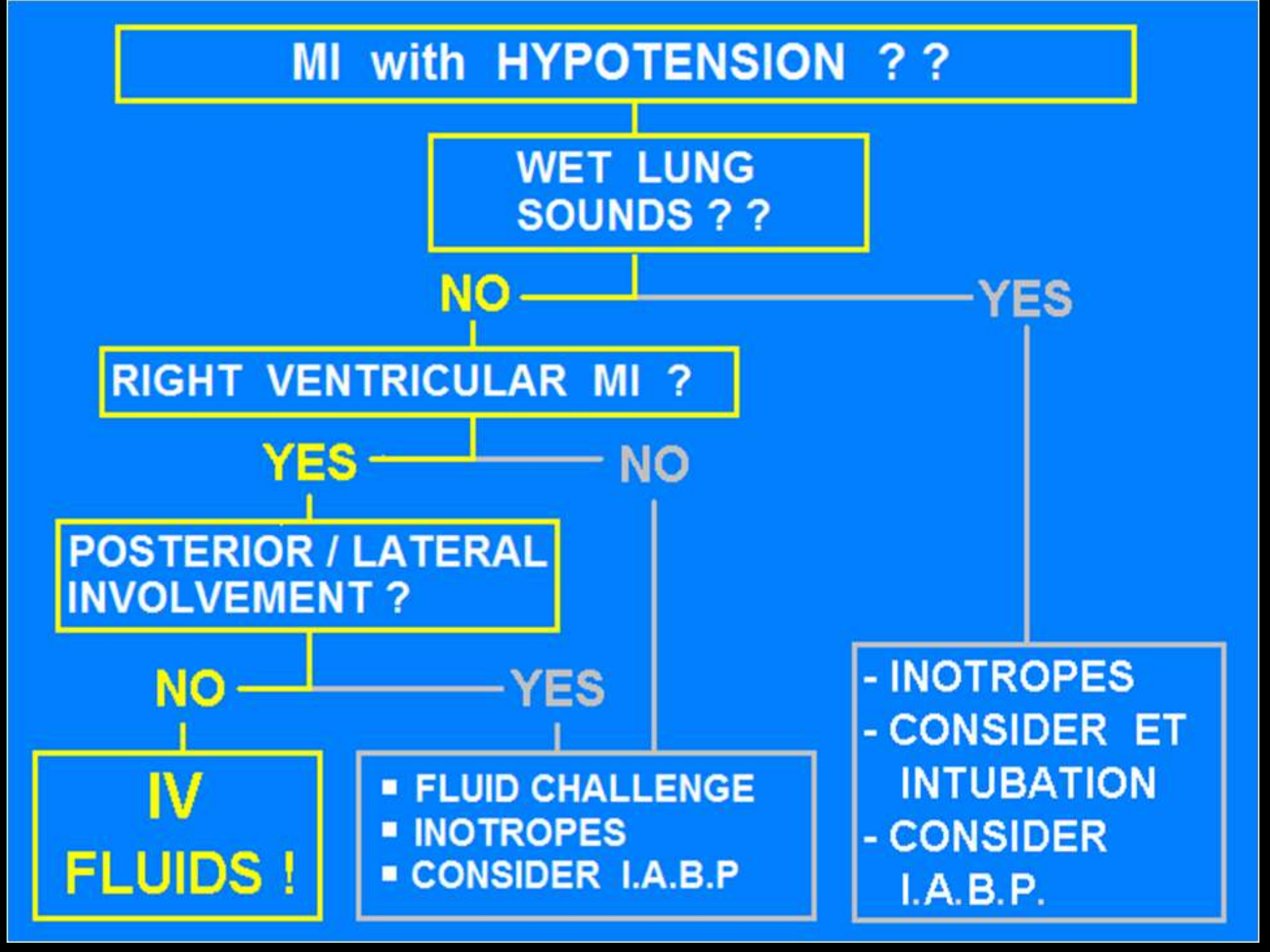
75-80 % of POPULATION

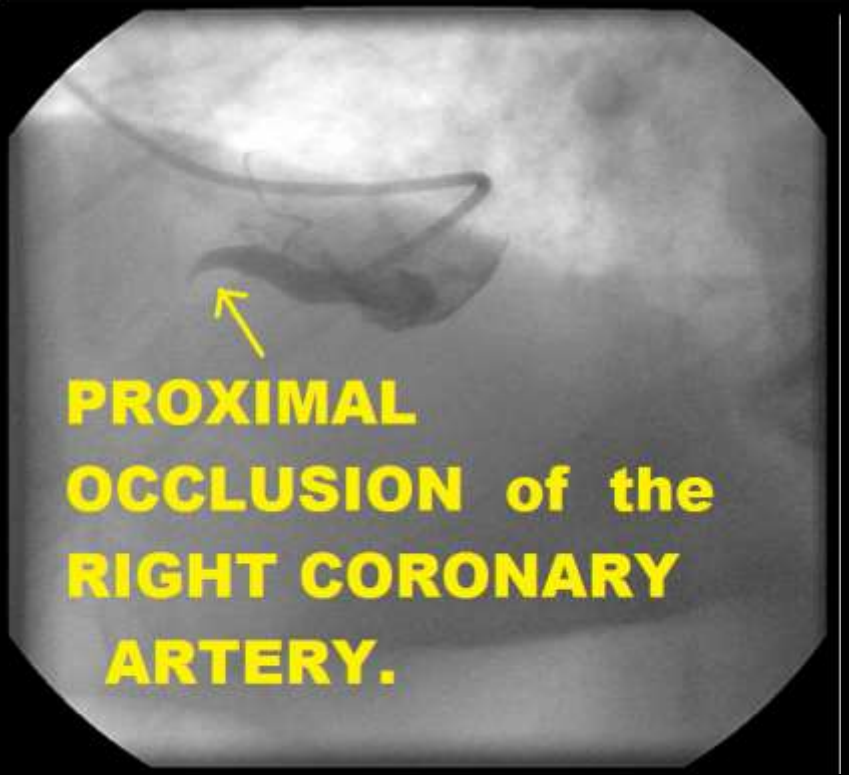


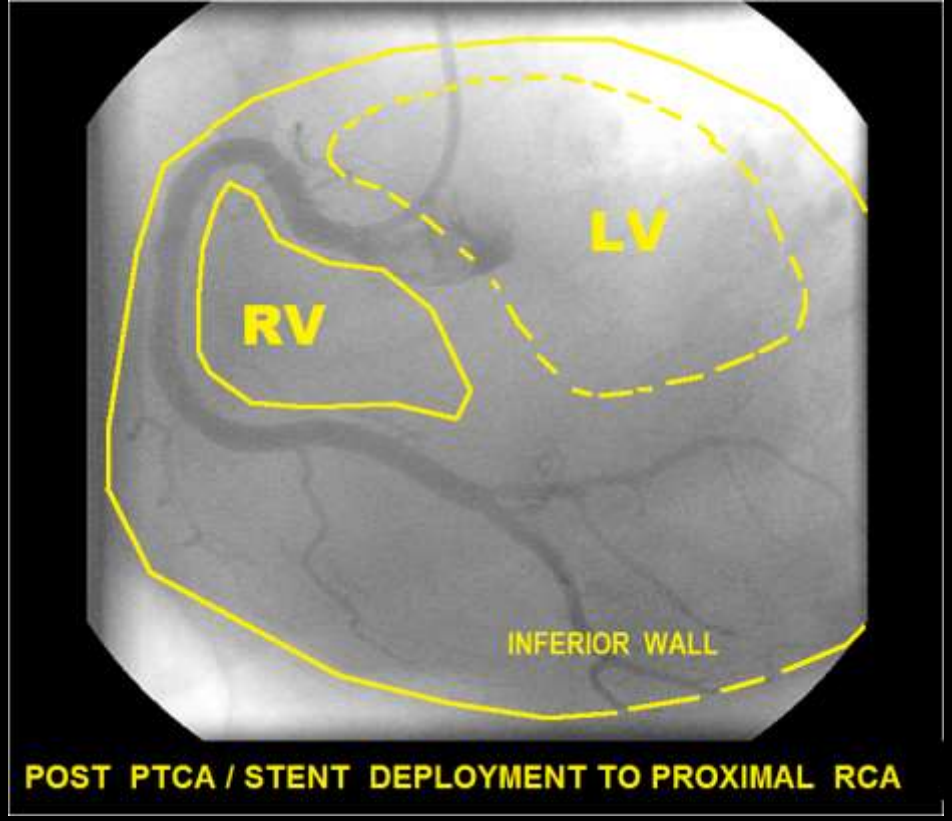
ANTICIPATED COMPLICATIONS of INFERIOR - RIGHT VENRICULAR WALL STEMI secondary to PROXIMAL RCA Occlusion & POSSIBLE INDICATED INTERVENTIONS:

- 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	- 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	- 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.


PROXIMAL
OCCLUSION of the
RIGHT CORONARY
ARTERY.


LV
RV
INFERIOR WALL
POST PTCA / STENT DEPLOYMENT TO PROXIMAL RCA

CASE STUDY 9 - STEMI

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

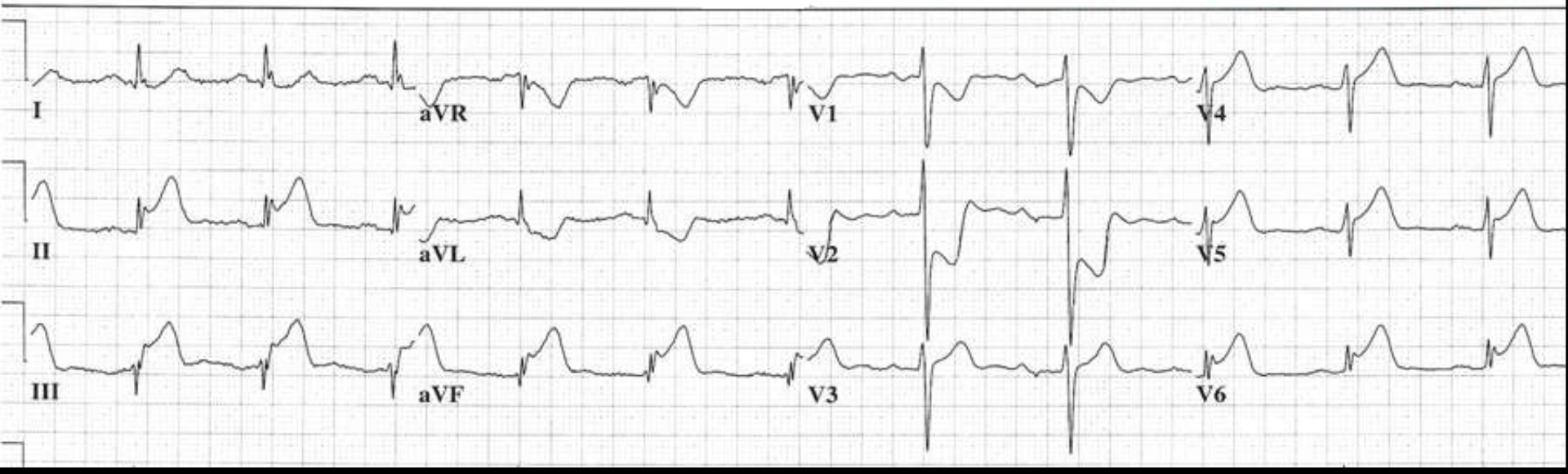
SHOCK ASSESSMENT

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:**

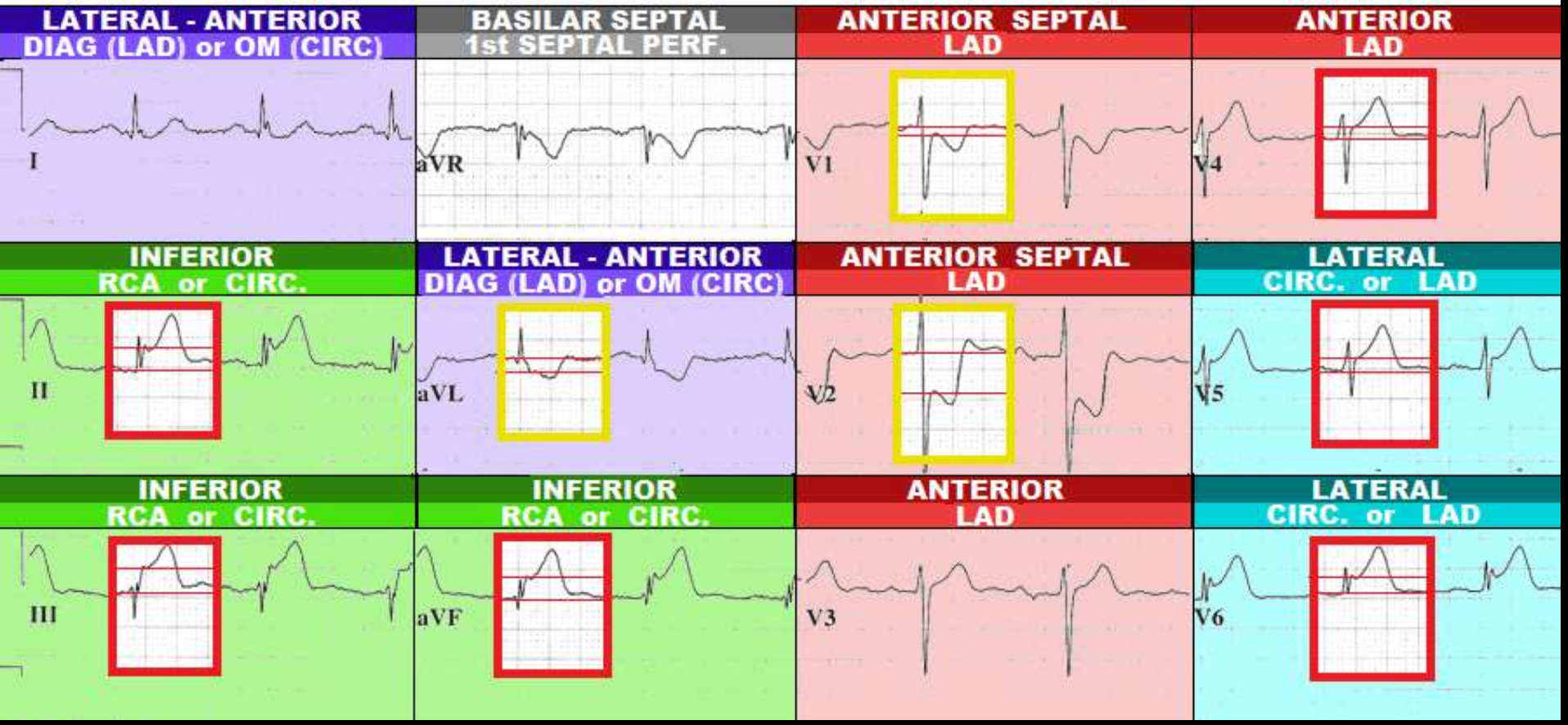
42 yr
Male
Caucasian

Loc:3
Option:23

Vent. rate	69	BPM
PR interval	196	ms
QRS duration	98	ms
QT/QTc	388/415	ms
P-R-T axes	14 28	81

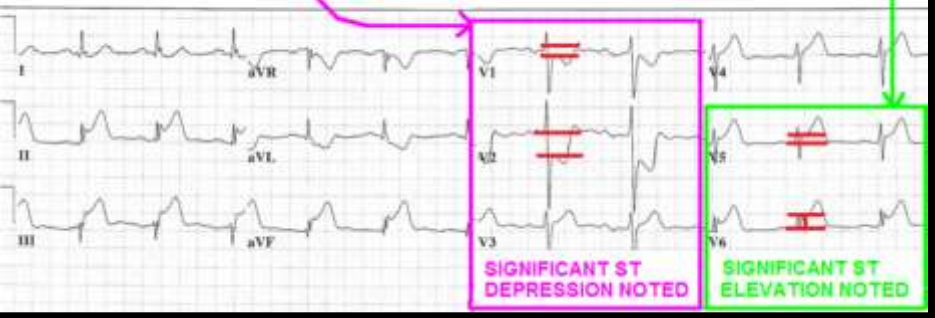
*** Acute MI ***
Inferior-Posterior-Lateral Injury Pattern

ST SEGMENT ELEVATION
ST SEGMENT DEPRESSION



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

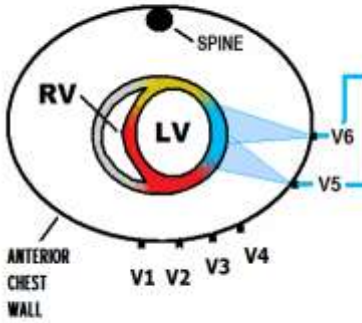
INDICATOR		COMPLICATION
1. S-T DEPRESSION IN THE V-LEADS (PREDOMINANTLY V1 - V3)	→	POSTERIOR WALL MI
2. S-T ELEVATION IN LEADS V5, V6, LEAD I, and AVL	→	LATERAL WALL MI
3. S-T ELEVATION in LEADS V3r - V6r (RIGHT-SIDED EKG)	→	R. VENTRICULAR MI

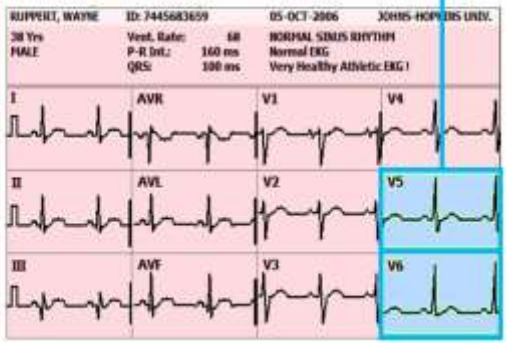


SIGNIFICANT ST DEPRESSION NOTED

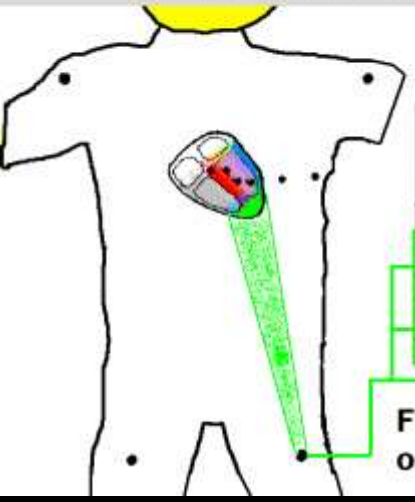
SIGNIFICANT ST ELEVATION NOTED

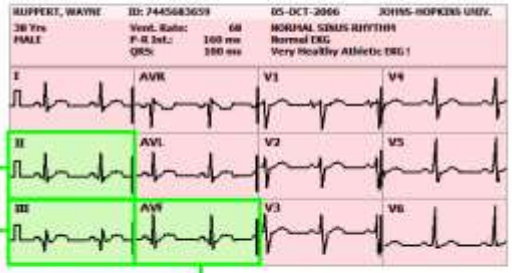
V5 - V6 VIEW THE LATERAL WALL of the LEFT VENTRICLE





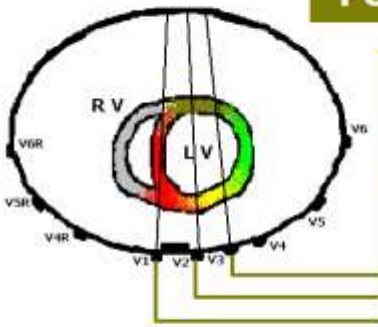
LEADS II, III, and aVF VIEW INFERIOR WALL of the LEFT VENTRICLE

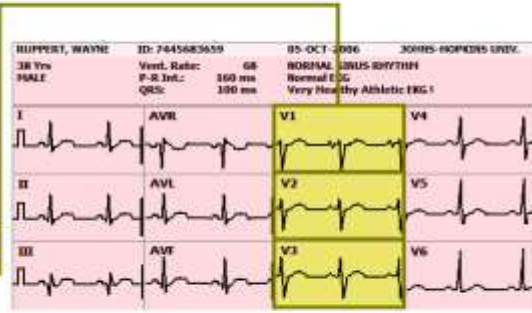




FED by the RCA (75 - 80 % pop) or the CIRCUMFLEX (10 - 15 %)

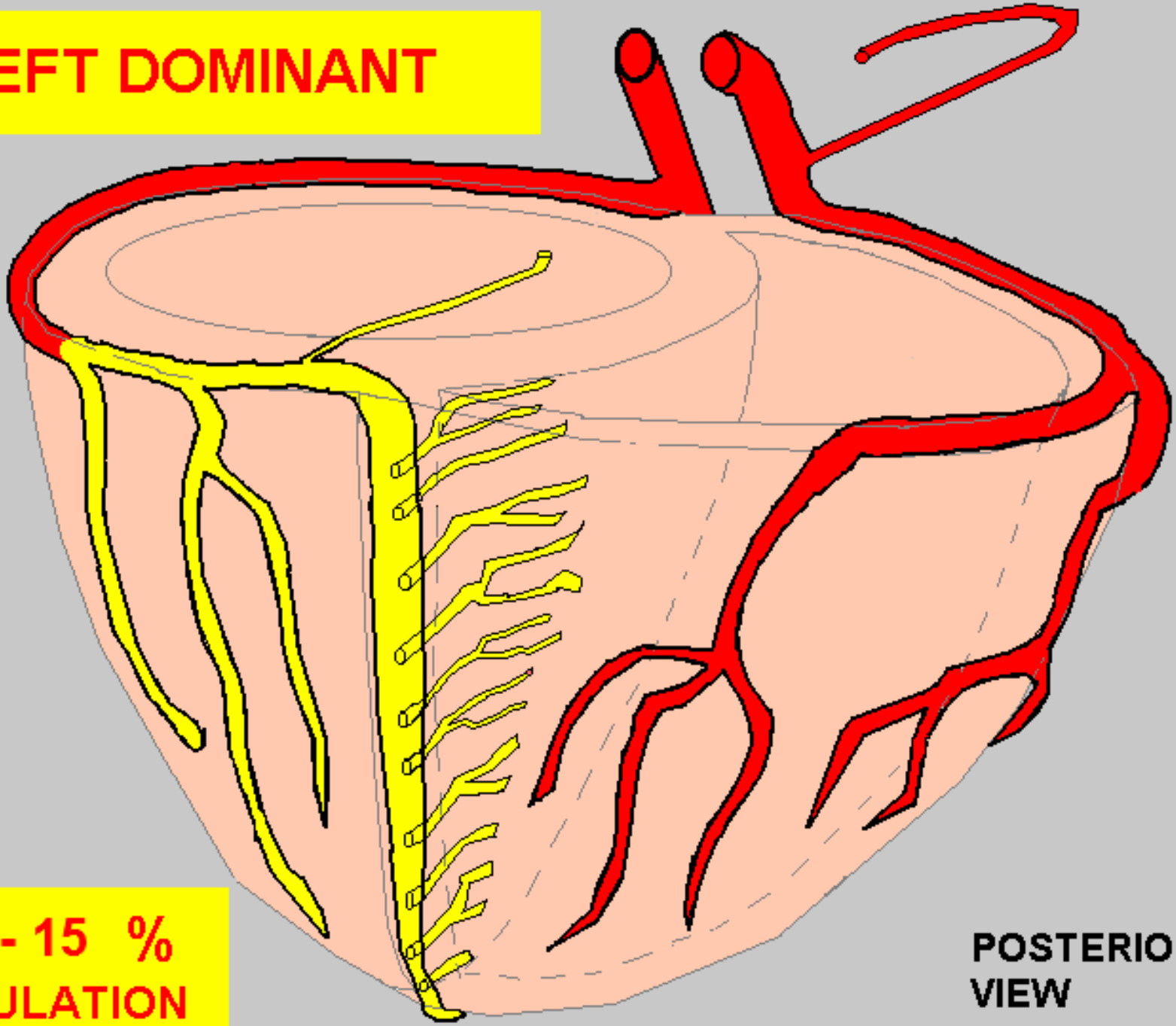
LEADS V1 - V3 *view the* POSTERIOR WALL





via RECIPROCAL CHANGES.

LEFT DOMINANT



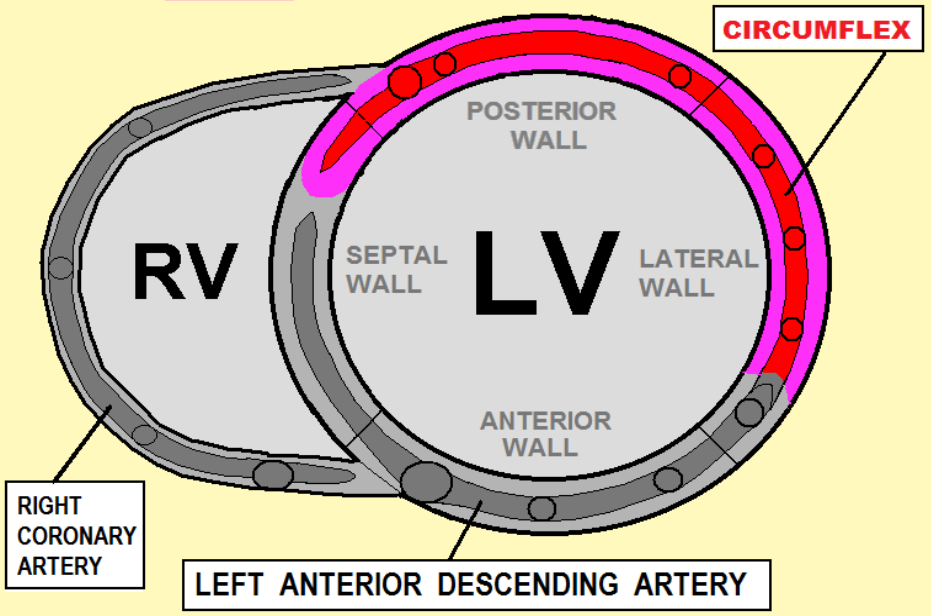
10 - 15 %
POPULATION

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



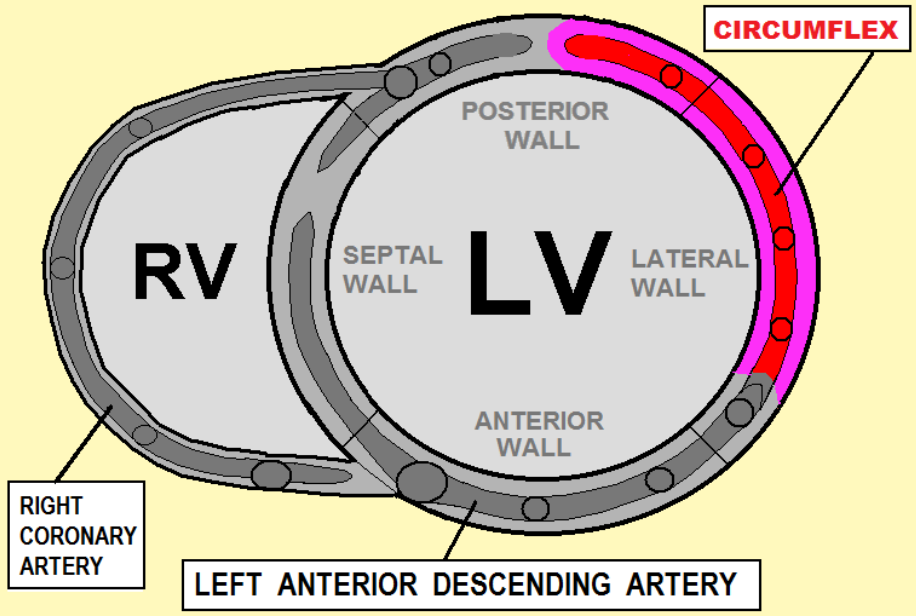
Occlusion of DOMINANT Circumflex typically presents with more:

- 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

The NON - DOMINANT CIRCUMFLEX ARTERY

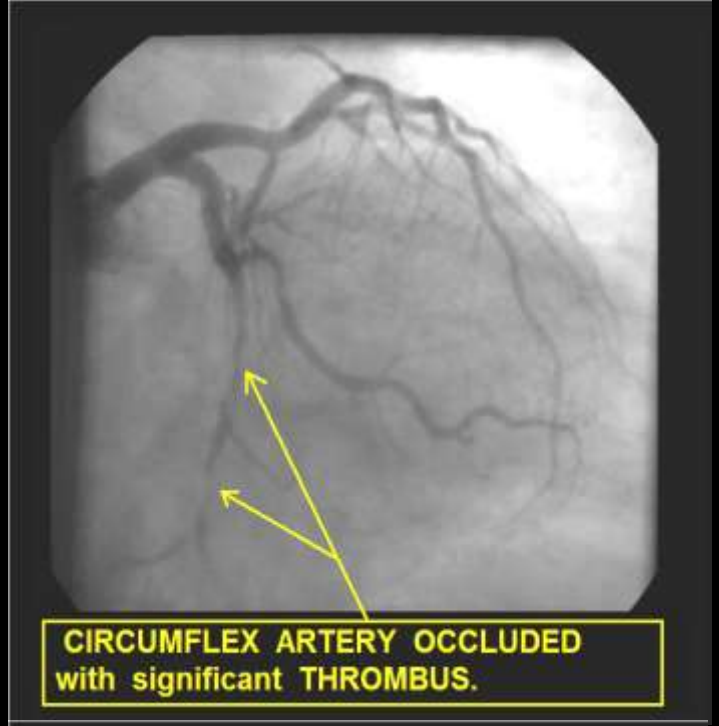
SUPPLIES 25-30 % OF THE LEFT VENTRICULAR MUSCLE MASS

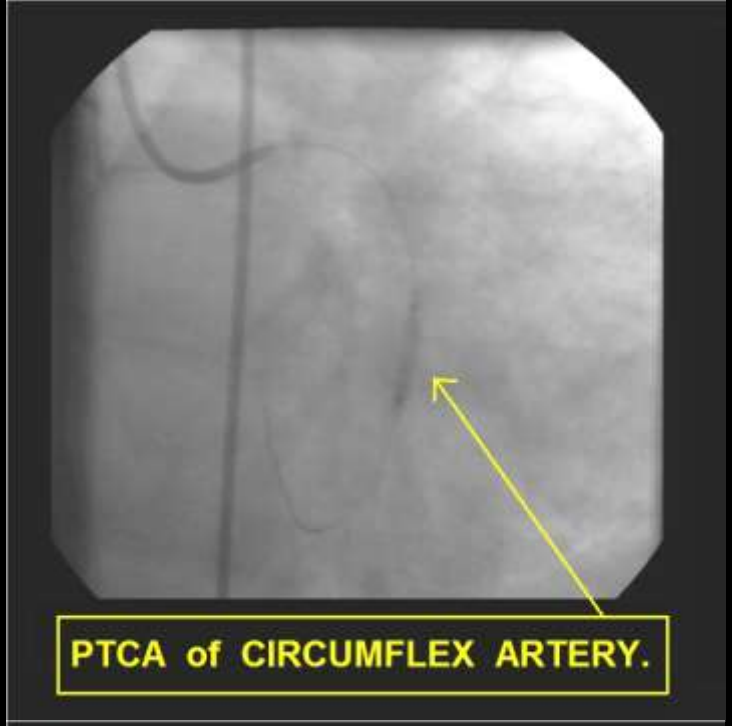


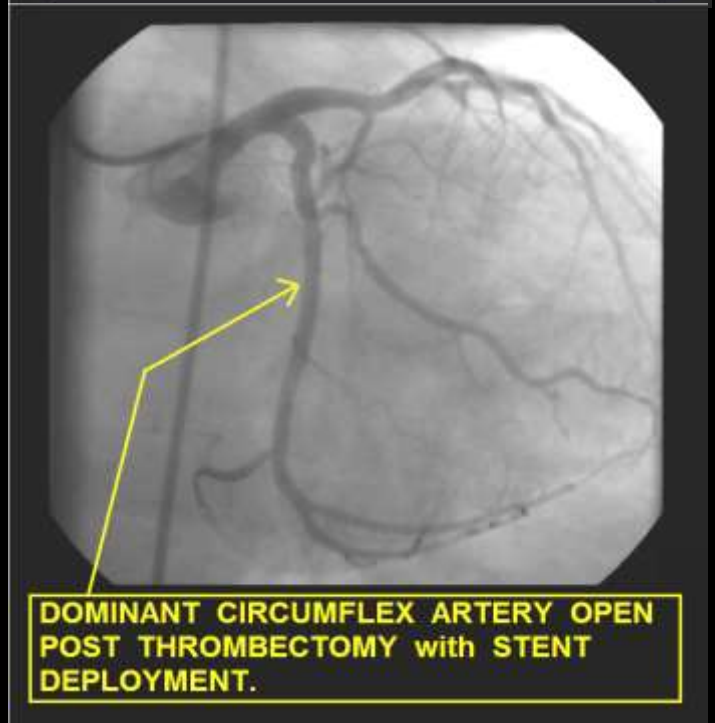
Occlusion of DOMINANT RCA typically presents with VERY LITTLE or NO:

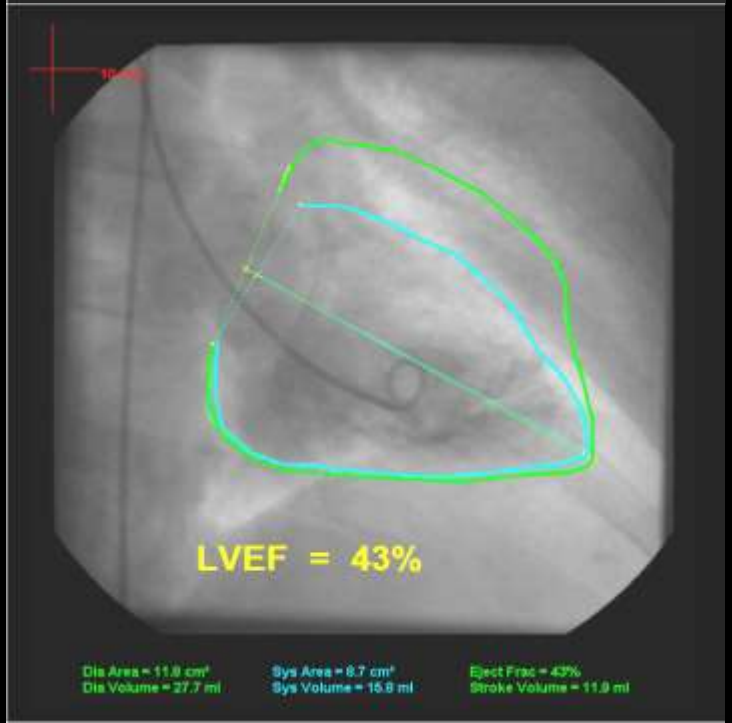
- ST Depression Leads V1-V3
- ST Elevation Leads V5, V6

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%
Dia Area = 11.8 cm²
Dia Volume = 27.7 ml
Sys Area = 6.7 cm²
Sys 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

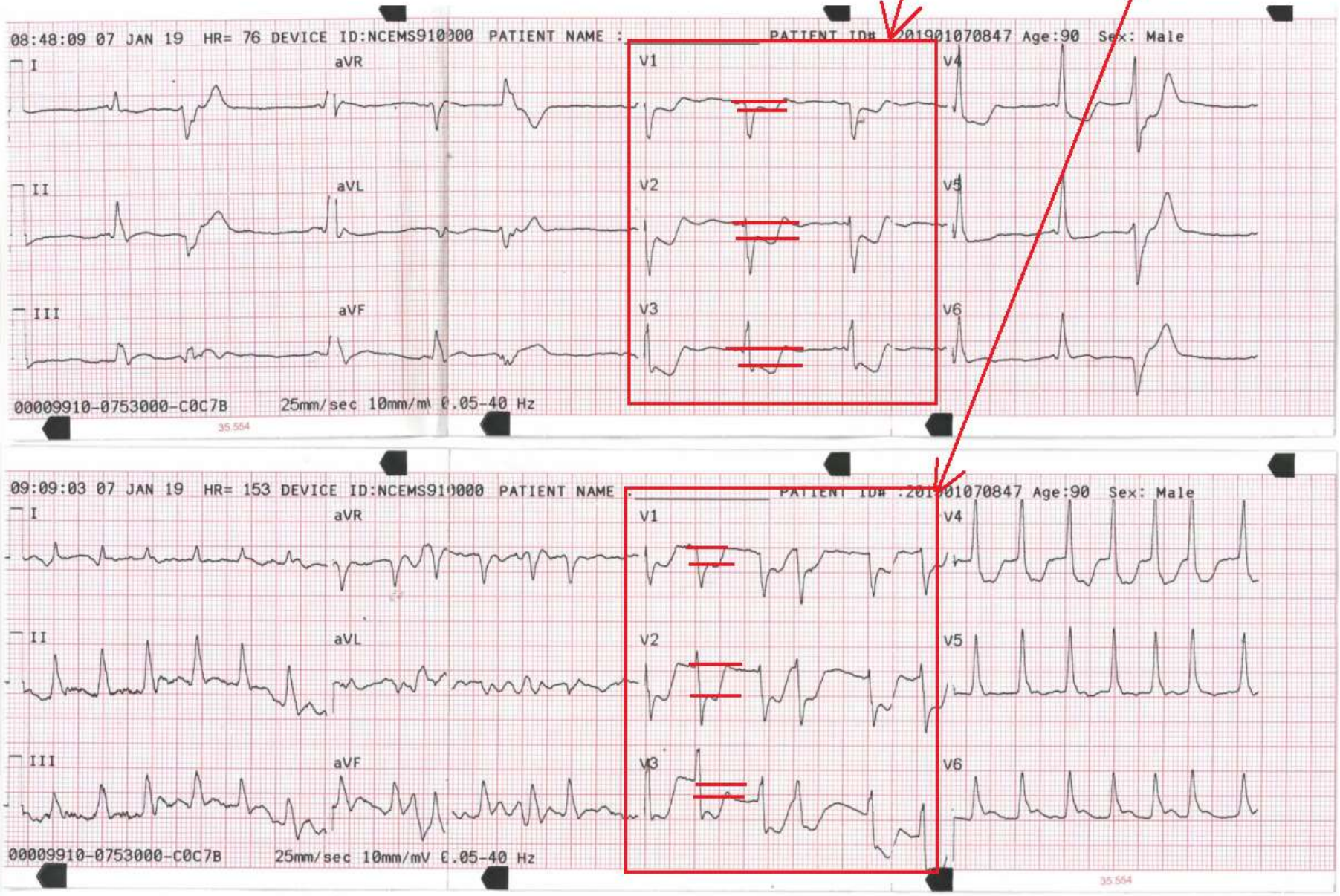
CRITICAL STRUCTURES COMPROMISED:	POTENTIAL COMPLICATIONS:	POSSIBLE CRITICAL INTERVENTIONS:
30 - 55% of LV MUSCLE MASS	POSSIBLE SEVERE LV PUMP FAILURE	INOTROPIC AGENTS ET INTUBATION I.A.B.P. INSERTION
SA NODE	SINUS BRADYCARDIA / SINUS ARREST	ATROPINE TRANSCUTANEOUS PACING
AV NODE	HEART BLOCKS	ATROPINE 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

“NOWHERE”, NEW MEXICO, 1994

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
PR	
QRSd	117
QT	260
QTc	415
--Axis--	
P	
QRS	73
T	78

Atrial fibrillation with rapid V-rate
Nonspecific intraventricular conduction delay
NO PREVIOUS ECG AVAILABLE FOR COMPARISON

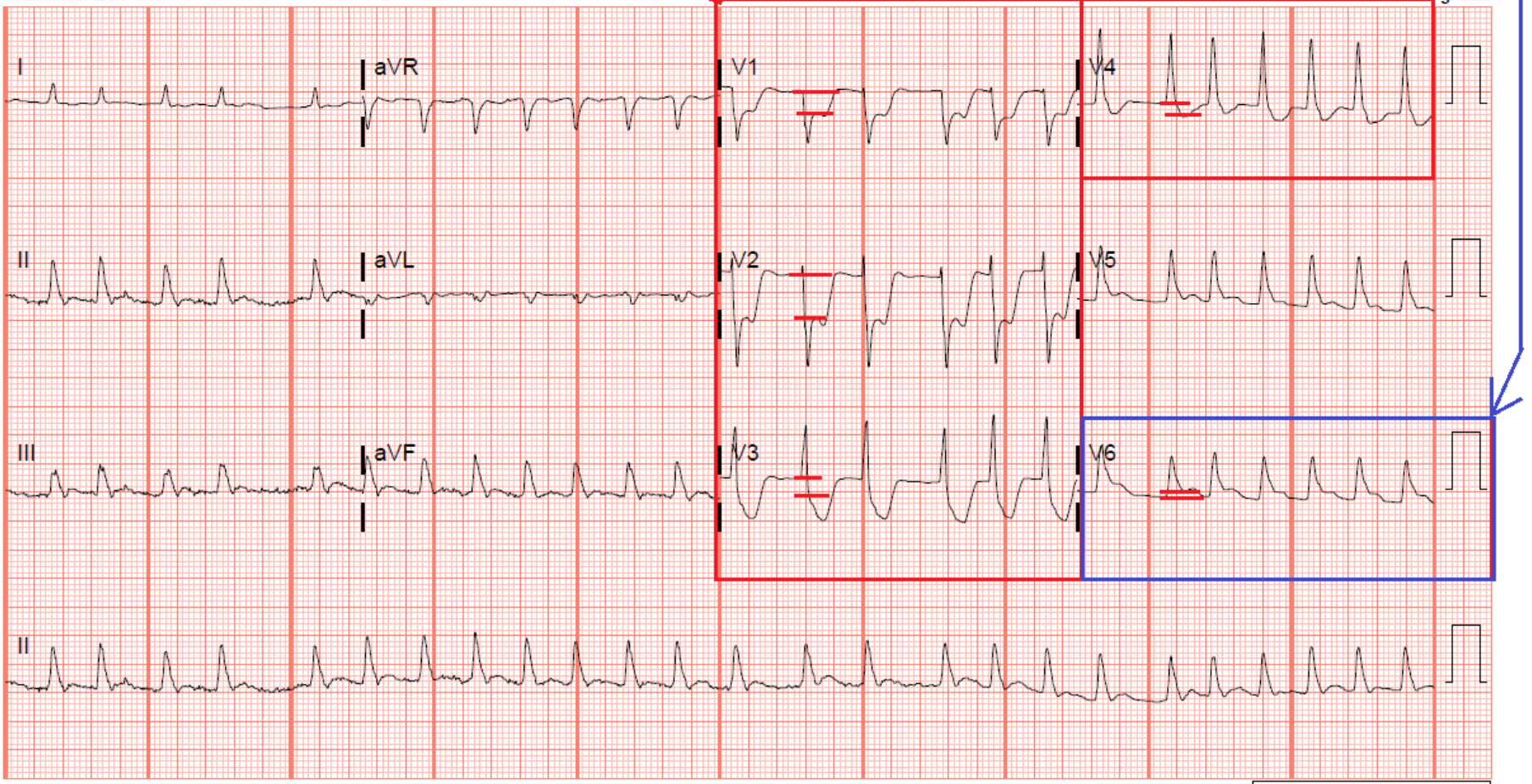
Req Provider:

ST Depression Leads V1 - V4

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

- Abnormal ECG -

Unconfirmed Diagnosis



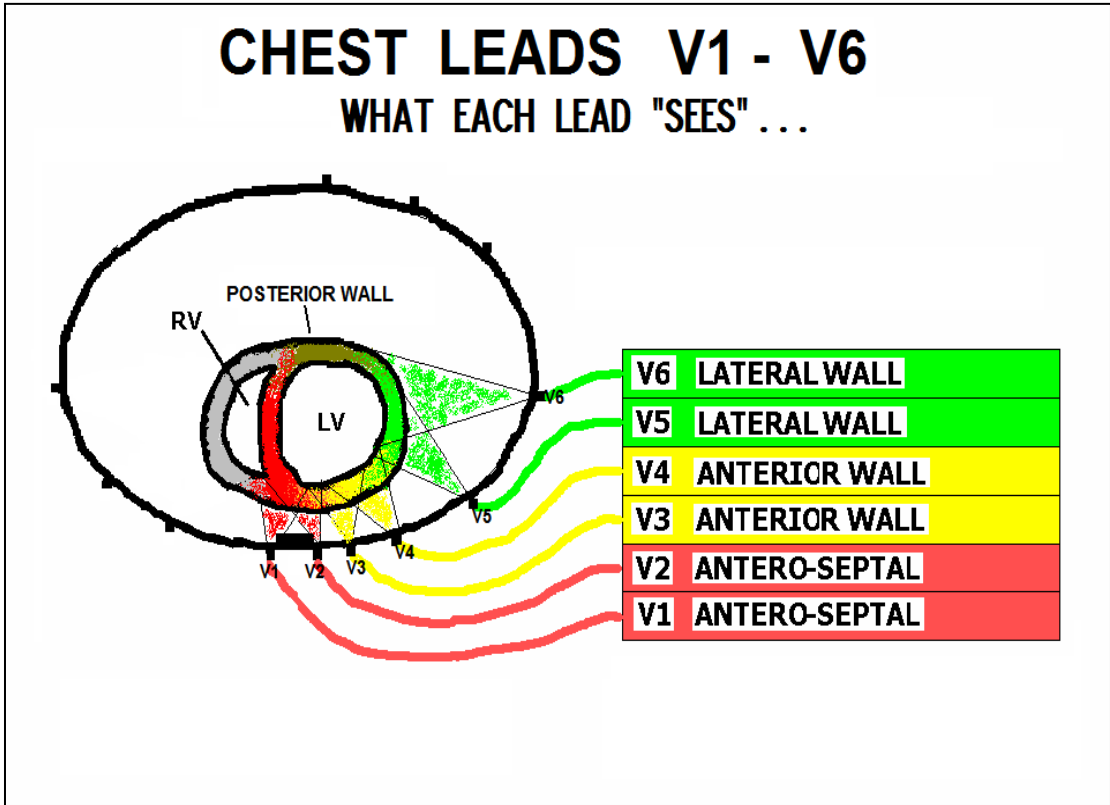
Philips PageWriter TC | 25 mm/sec | 10.00 mm/mV | F 60~ 0.15 - 100 Hz

Causes of ST Depression V1-V4

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

Posterior Wall STEMI….

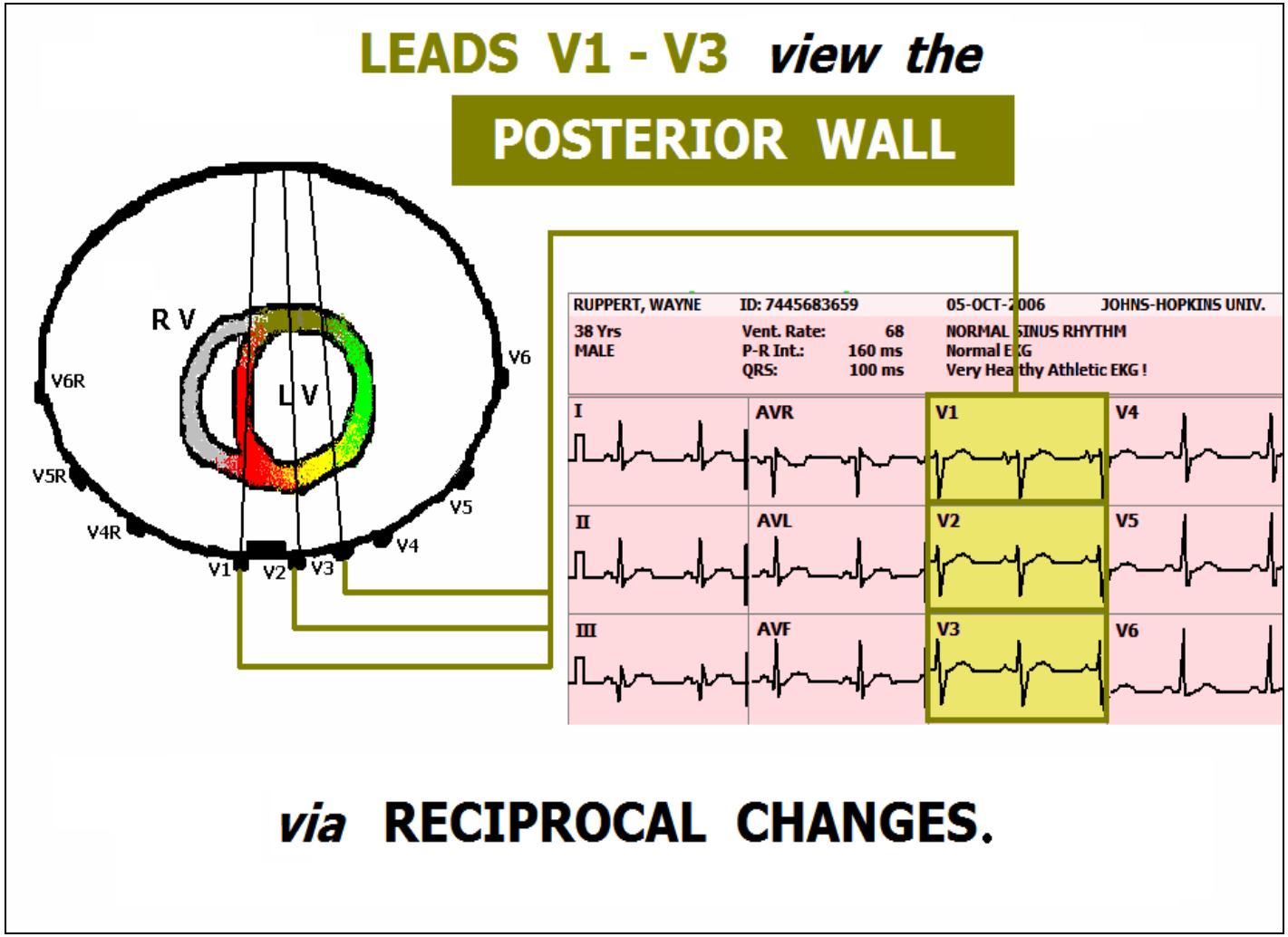
- **Does not show ST elevation on standard 12 lead ECG** because NONE of the 12 leads view the Posterior Wall directly….



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).

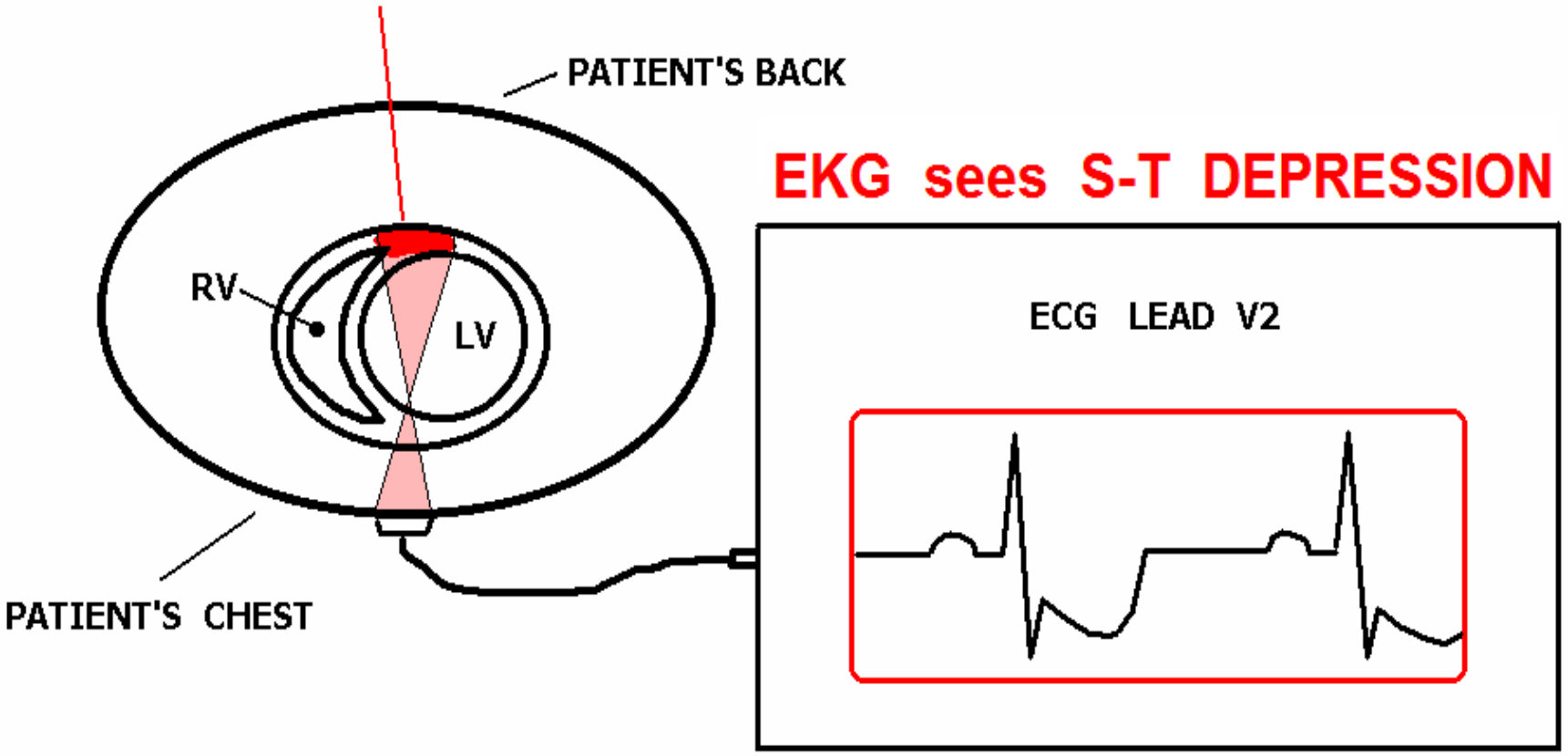
V1-V3 see the Posterior Wall ONLY through RECIPROCAL changes (ST Depression)



HOW EKG VIEWS RECIPROCAL CHANGES

EXAMPLE:

AREA OF ACUTE INFARCTION - POSTERIOR WALL

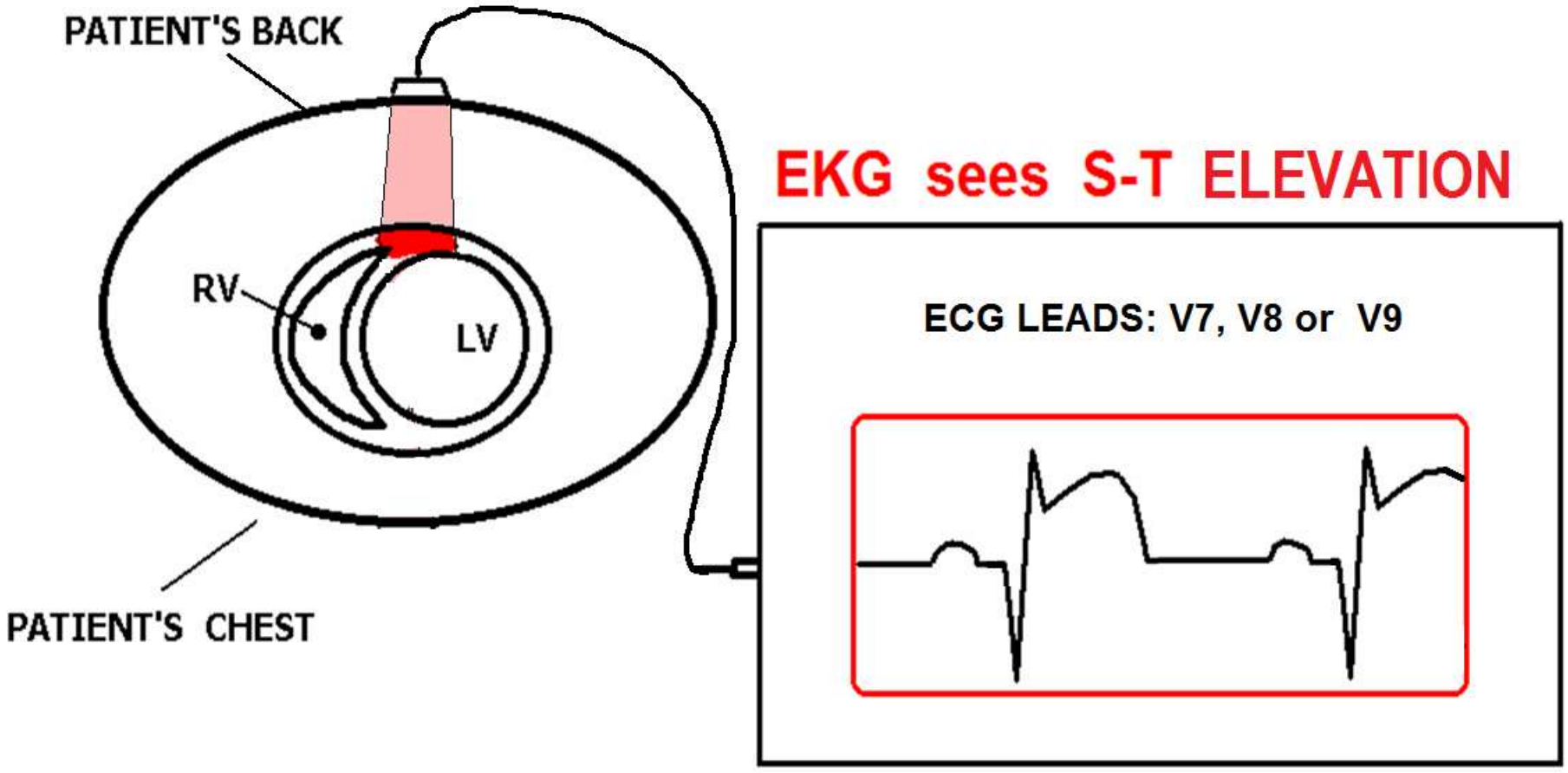


Posterior Wall STEMI….

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

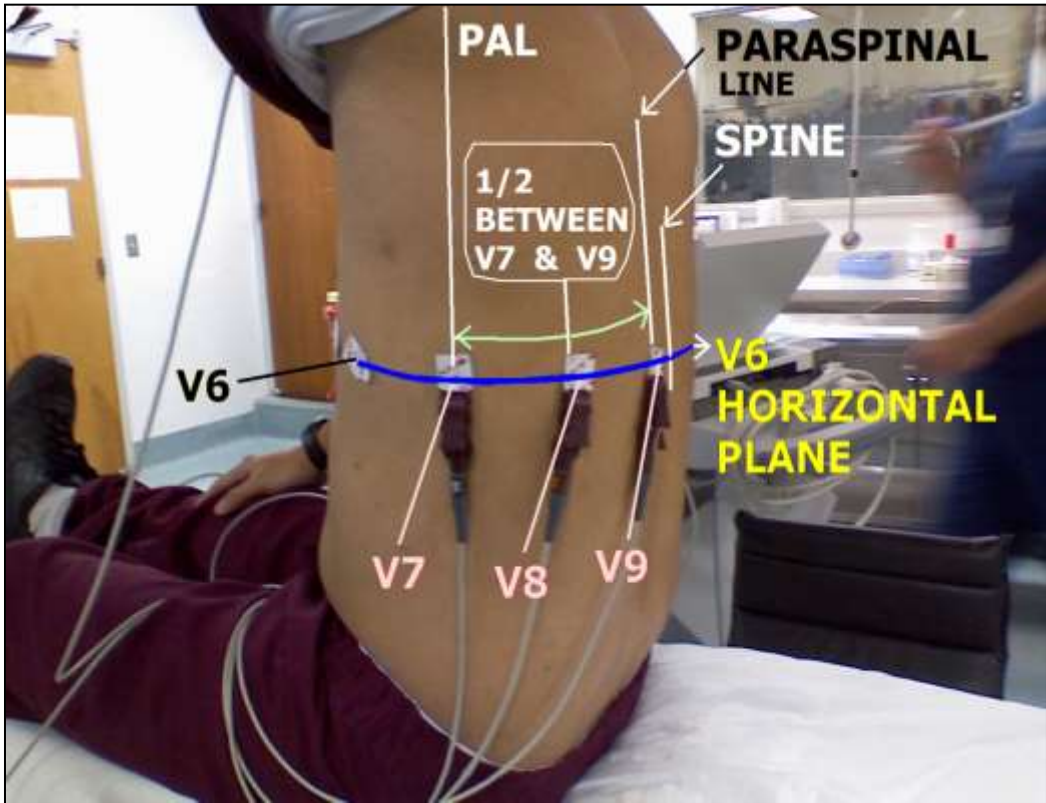
If we put ECG leads on the BACK of a PATIENT who is having an

ACUTE POSTERIOR WALL MI . . . . .



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

[redacted]
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
--Axis--		
P		
QRS	77	
T	121	

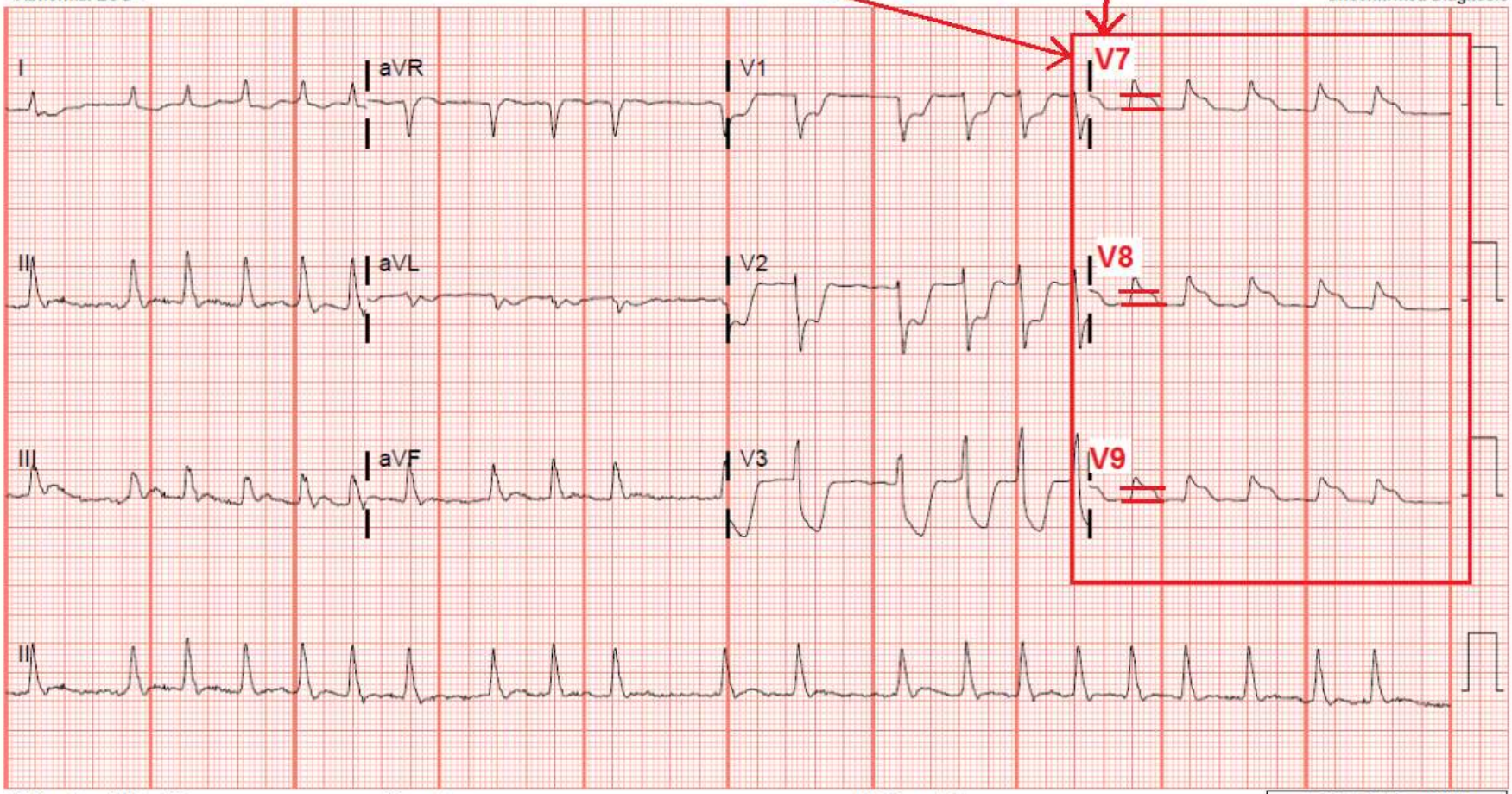
**** Posterior Infarct - Acute ****

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

ACUTE POSTERIOR WALL STEMI

- Abnormal ECG -

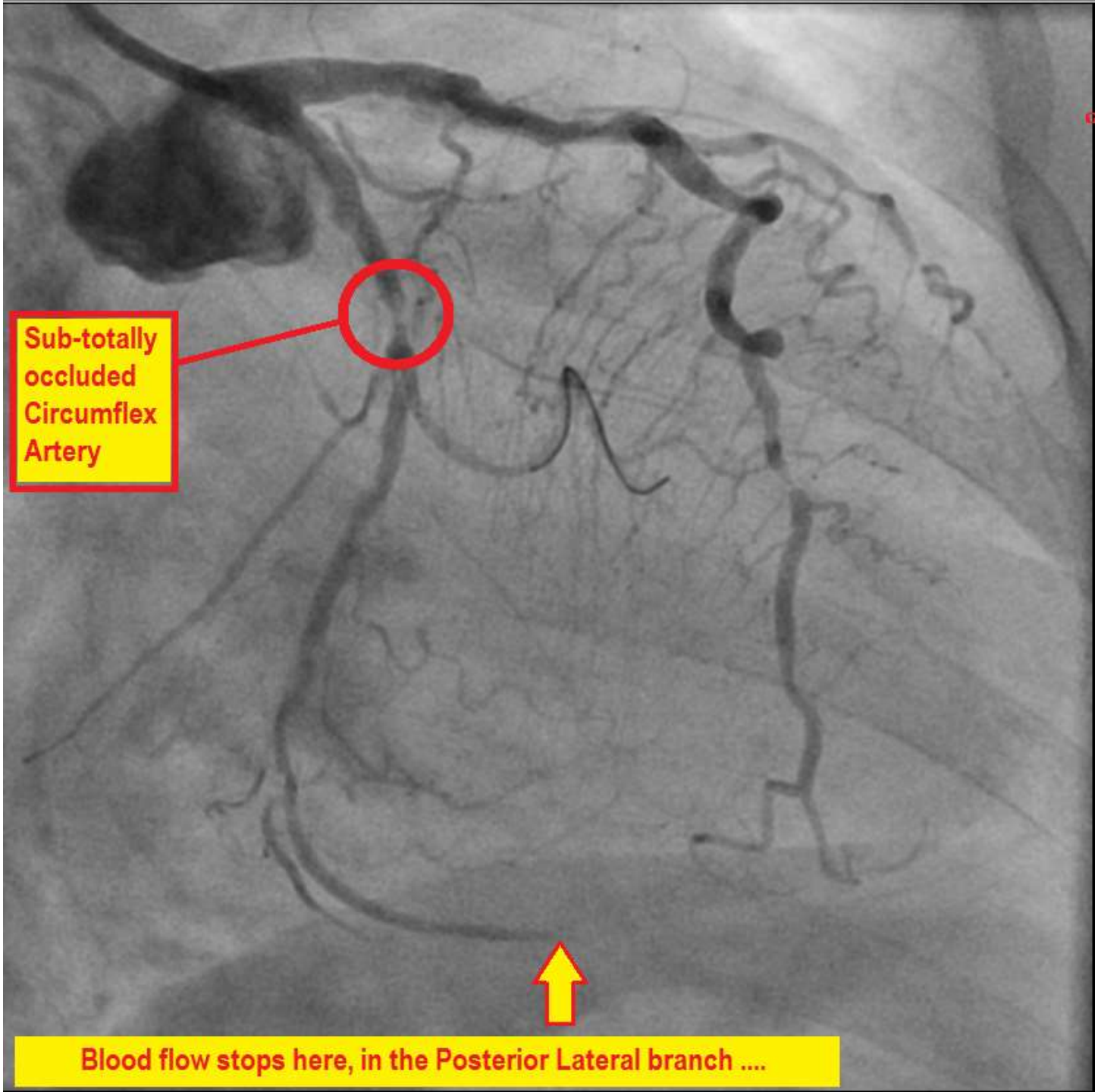
Unconfirmed Diagnosis

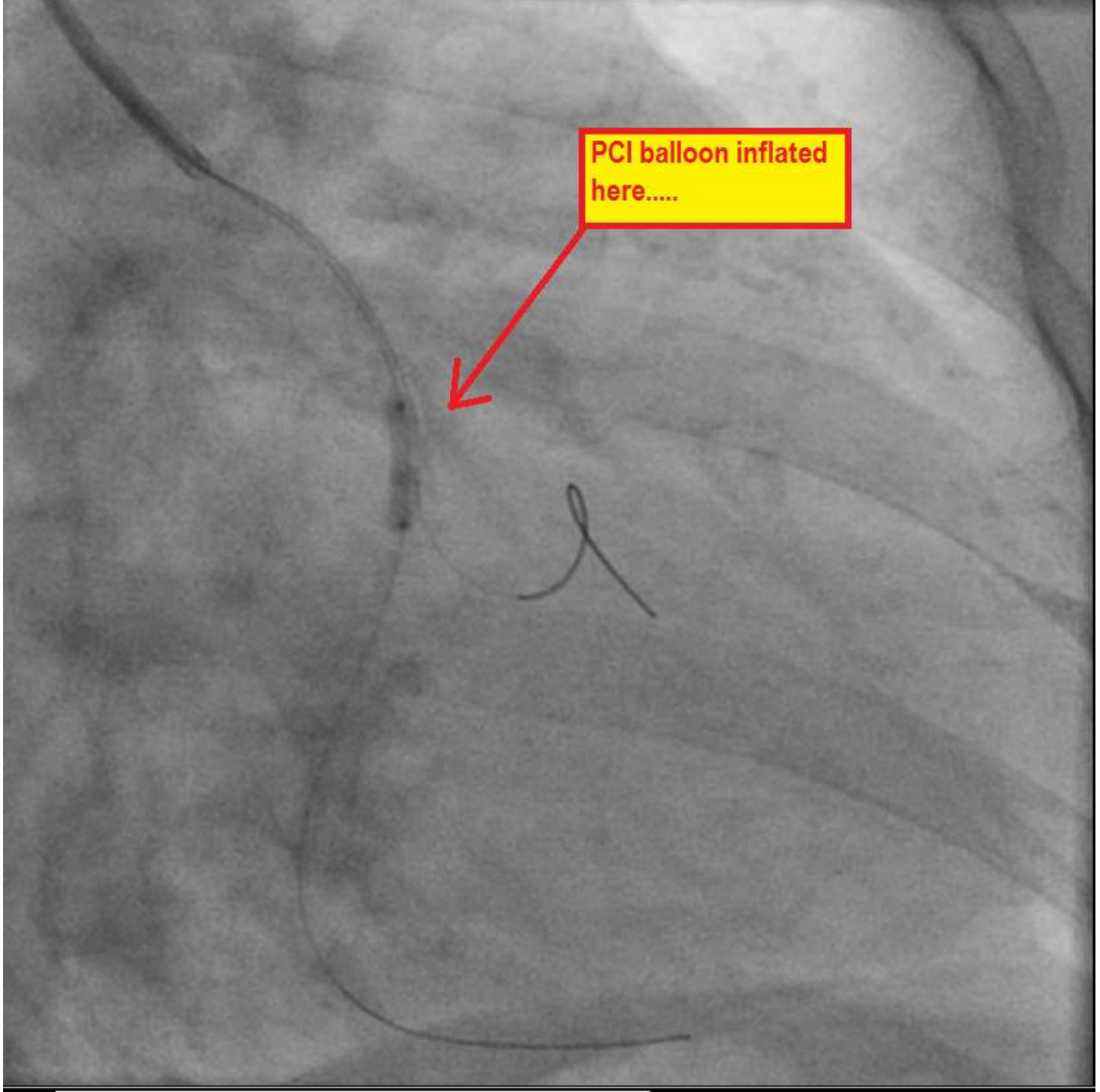


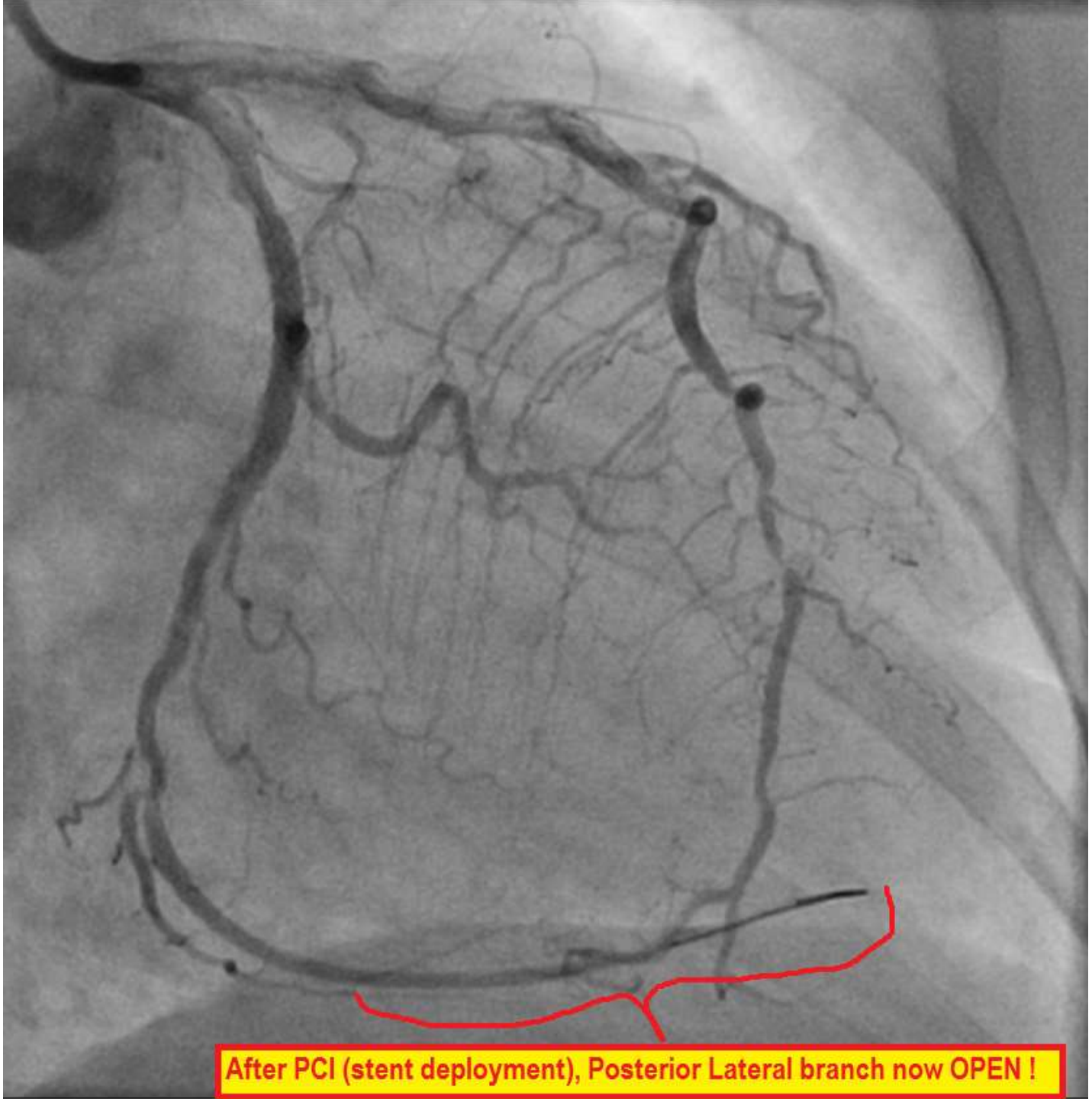
Philips PageWriter TC | 25 mm/sec | 10.00 mm/mV | F 60~ 0.15 - 100 Hz

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
Blood flow stops here, in the Posterior Lateral branch ....


PCI balloon inflated here.....


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

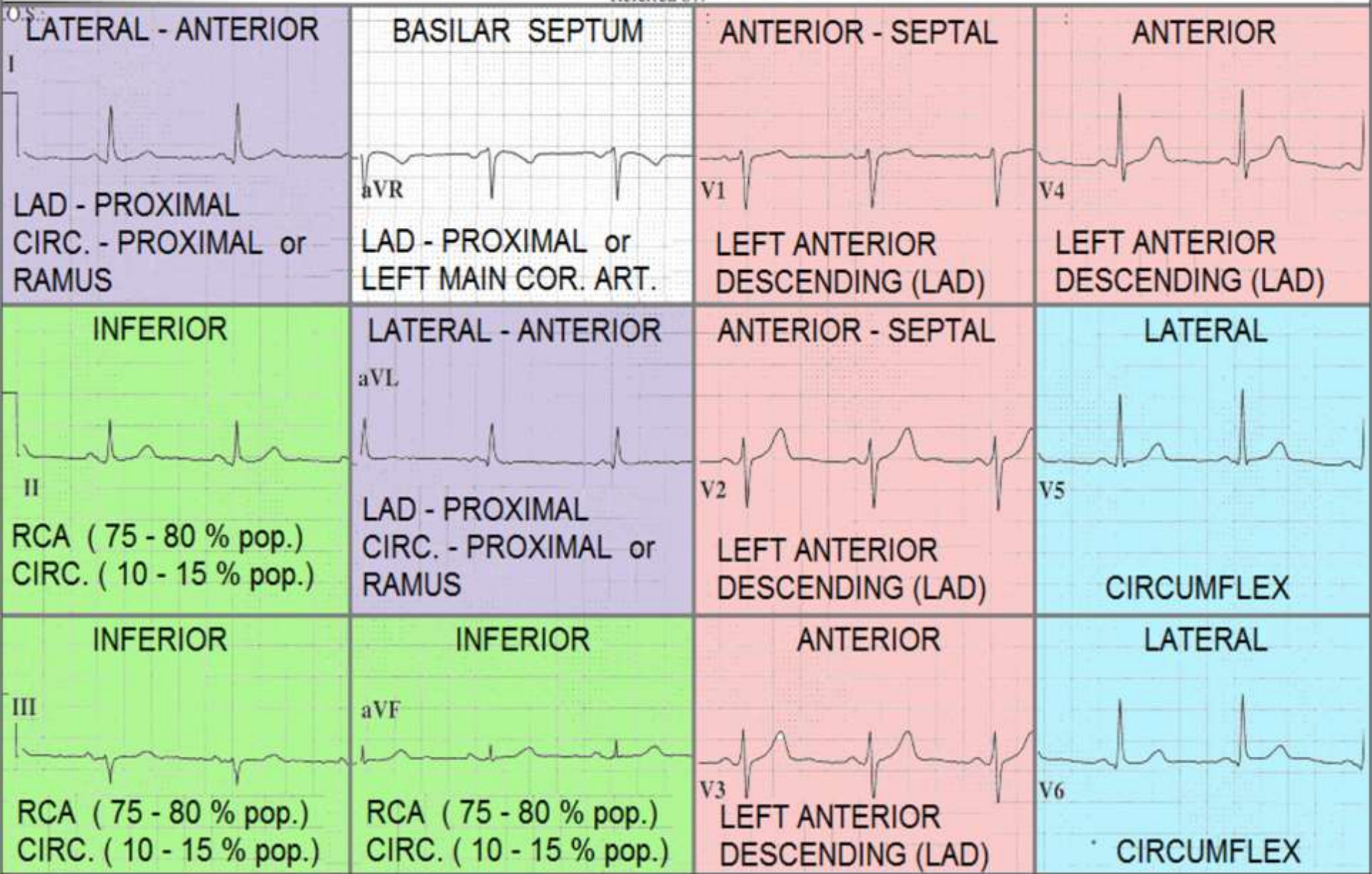
SUMMARY

- 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.**

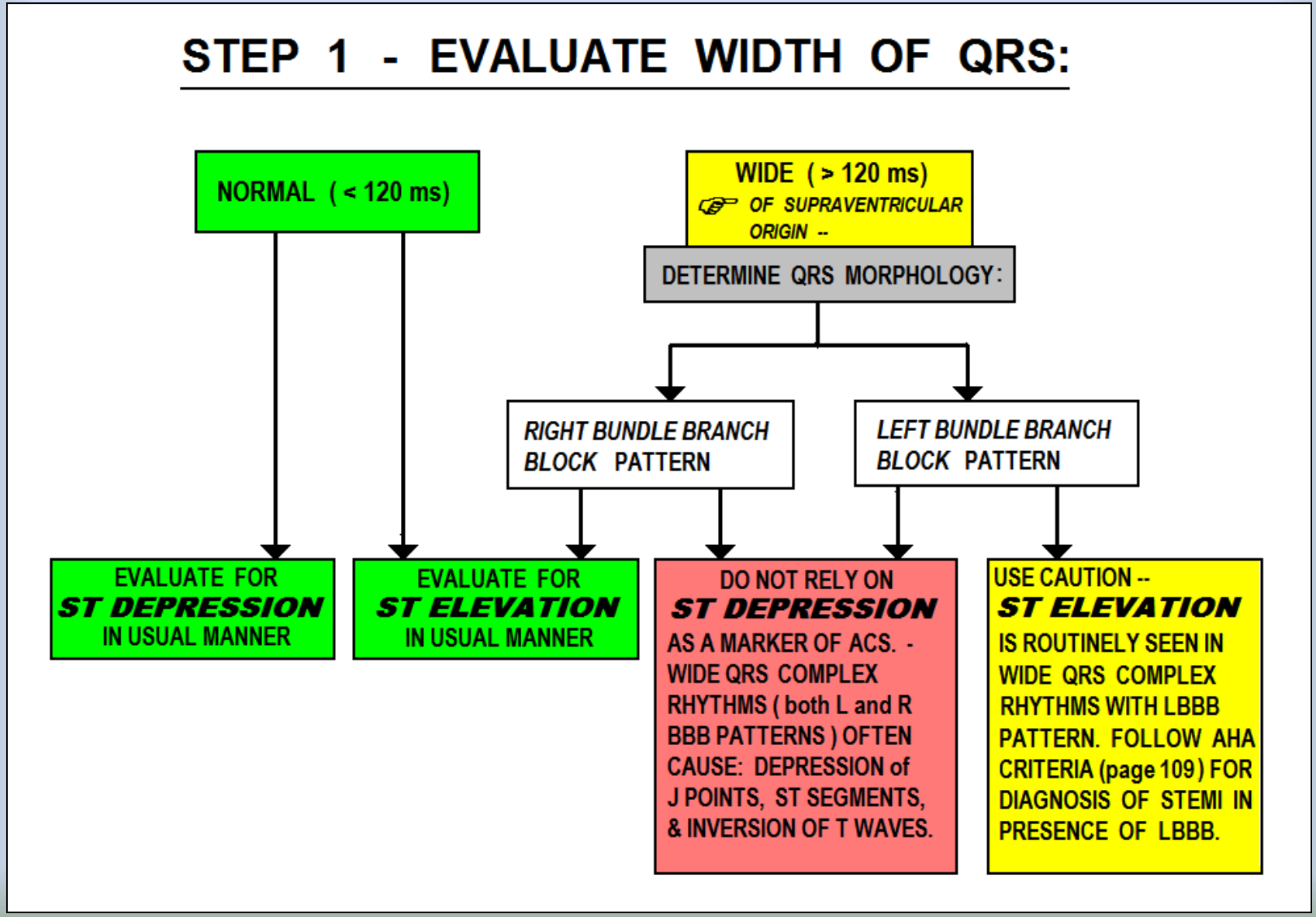
Vent. rate	64	BPM
PR interval	130	ms
QRS duration	96	ms
QT/QTc	396/408	ms
P–R–T axes	40 11	61

Normal sinus rhythm
Normal ECG
No previous ECGs available

Referred by:



Evaluating the ECG for ACS:



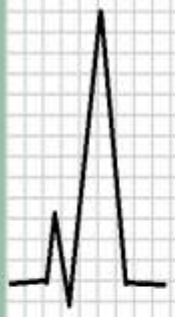
Wide QRS present:
QRSd > 120ms

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

Simple “Turn Signal Method” . . .

THE "TURN SIGNAL METHOD" for identifying BUNDLE BRANCH BLOCK

V1



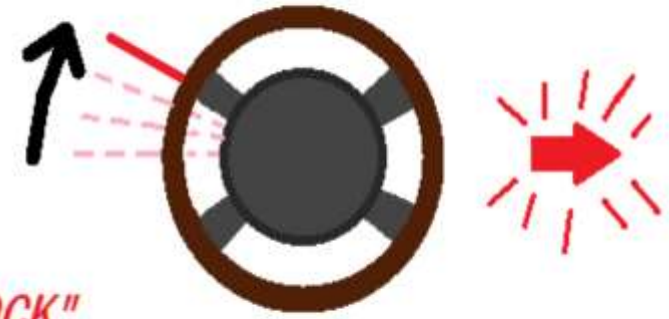
USE LEAD V1 for this technique

To make a **RIGHT TURN**

you push the turn signal lever **UP**. . . . .

THINK:

"QRS points UP = RIGHT BUNDLE BRANCH BLOCK"



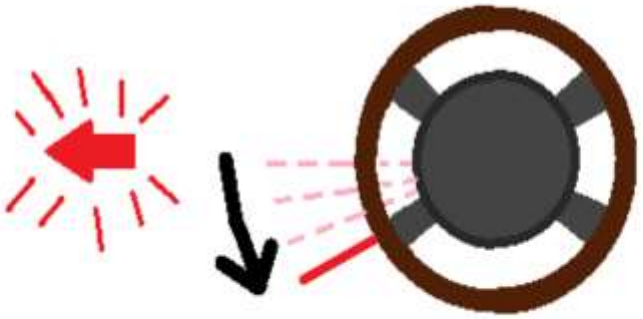
V1

To make a **LEFT TURN**

you push the turn signal lever **DOWN** . . . .

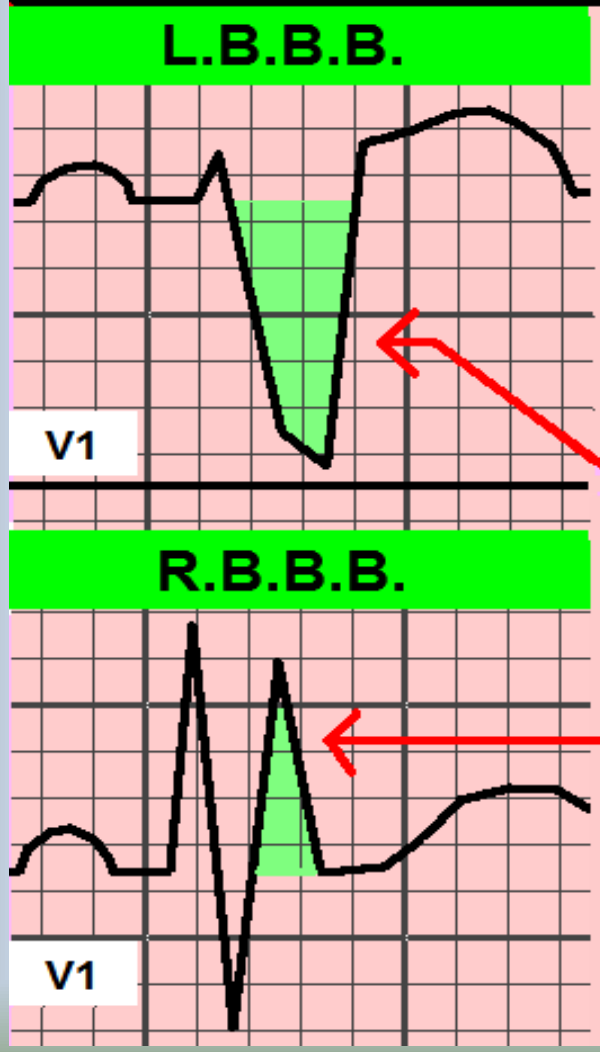
THINK:

"QRS points DOWN = LEFT BUNDLE BRANCH BLOCK"



“Terminal Phase of QRS Method”. . .

DIAGNOSING BUNDLE BRANCH BLOCK



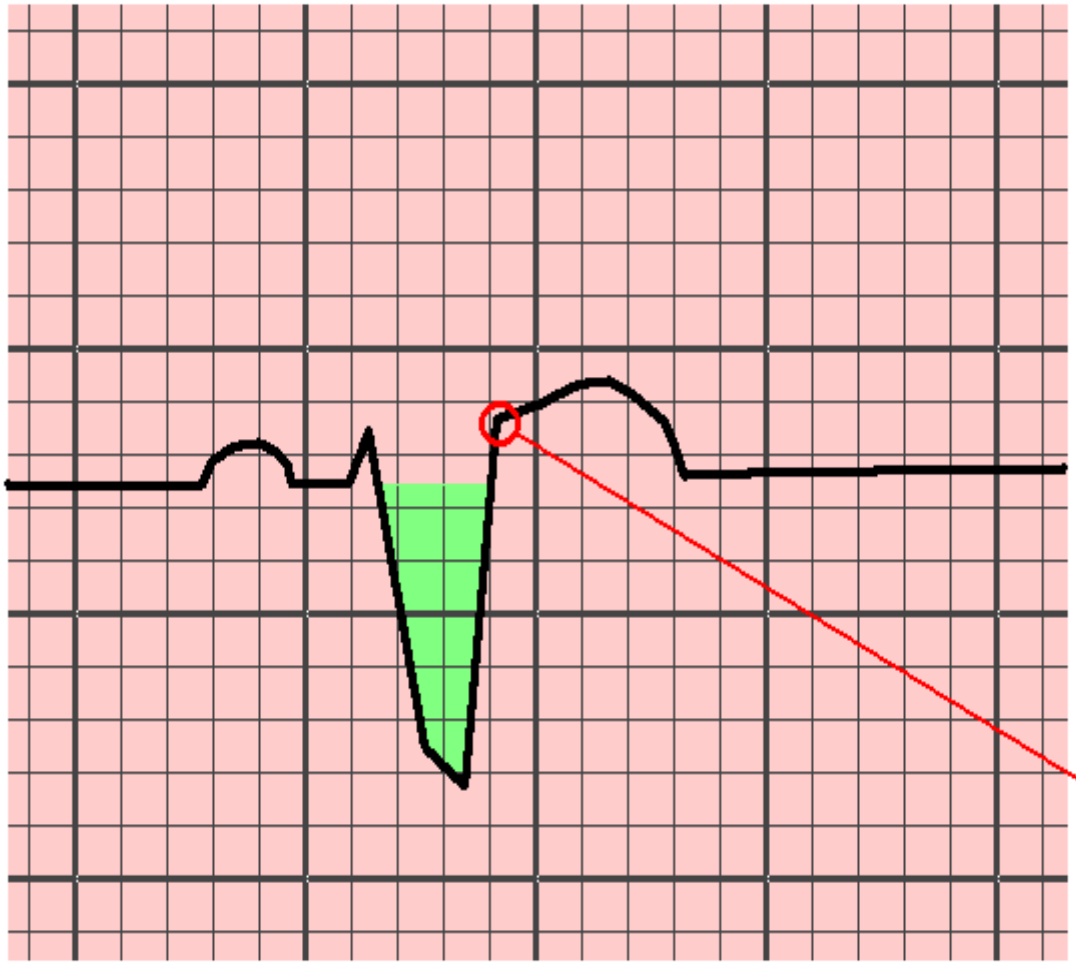
USING LEAD V1

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

NEGATIVE = LEFT BUNDLE BRANCH BLOCK

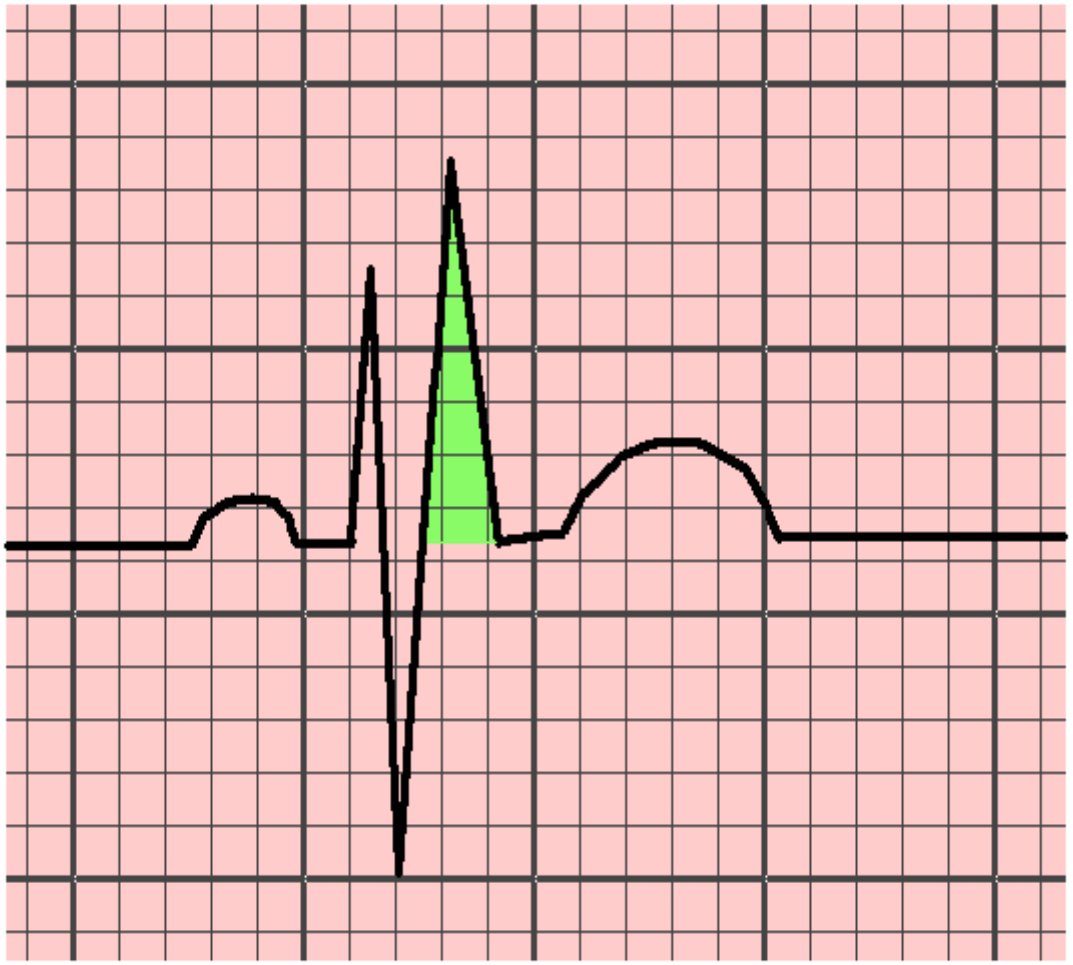
POSITIVE = RIGHT BUNDLE BRANCH BLOCK

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)

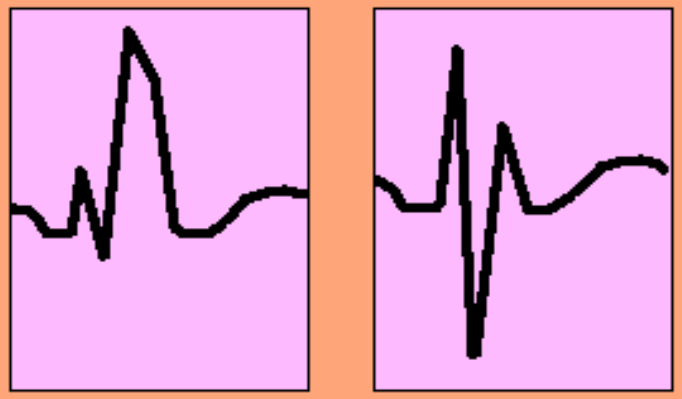
- **TERMINAL PHASE (LAST PART) OF QRS COMPLEX IS POSITIVE DEFLECTION**

DIAGNOSING BUNDLE BRANCH BLOCK

USING LEADS V1, V2, and V5, V6:

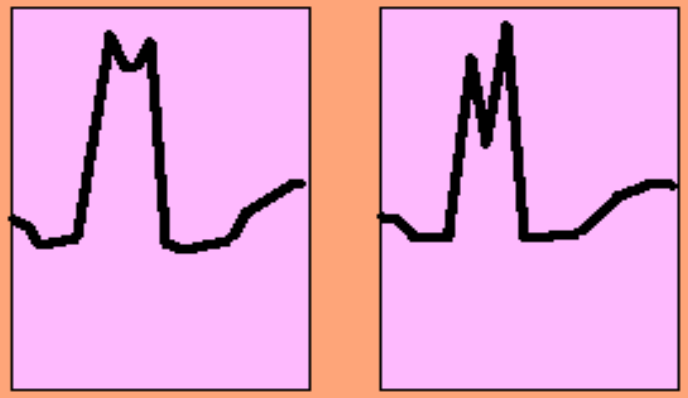
LOCATING RsR' or RR' COMPLEXES:

V1 V2



RIGHT BUNDLE BRANCH BLOCK

V5 V6



LEFT BUNDLE BRANCH BLOCK

From: “Rapid Interpretation of ECGs” by Dale Dubin, MD

RUPPERT, WAYNE ID: 099999999 4-Mar-2001

74years
Male Caucasian

Room:
Loc: 0 Opt:

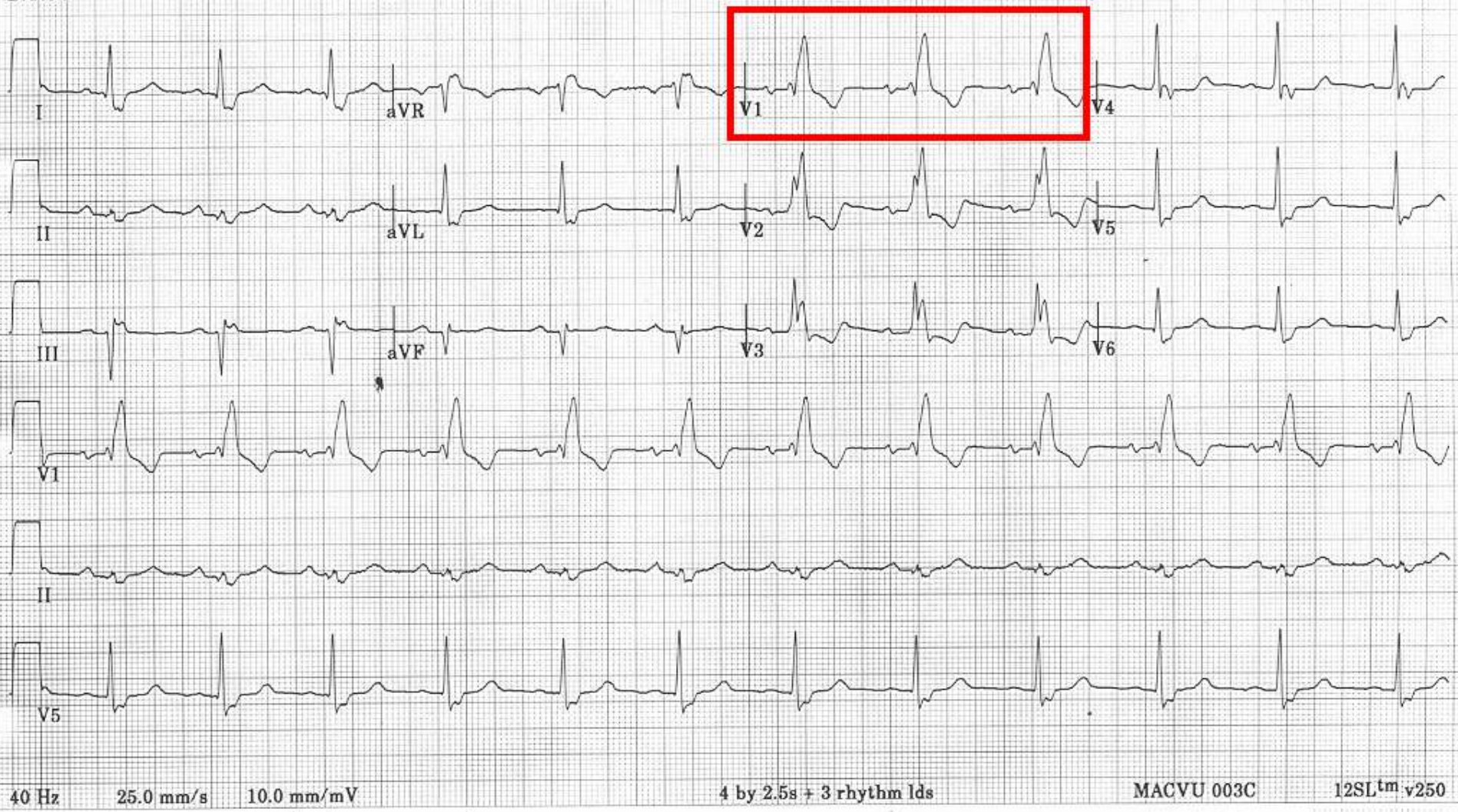
Technician: WR

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

Referred by: Unconfirmed

D.O.S.:



40 Hz 25.0 mm/s 10.0 mm/mV 4 by 2.5s + 3 rhythm lds MACVU 003C 12SL^{tm} v250

TERMINAL PHASE OF QRS IS

POSITIVE

= RIGHT BUNDLE BRANCH BLOCK

09:16:40

74 yr
Female Caucasian

Loc:7 Option:35

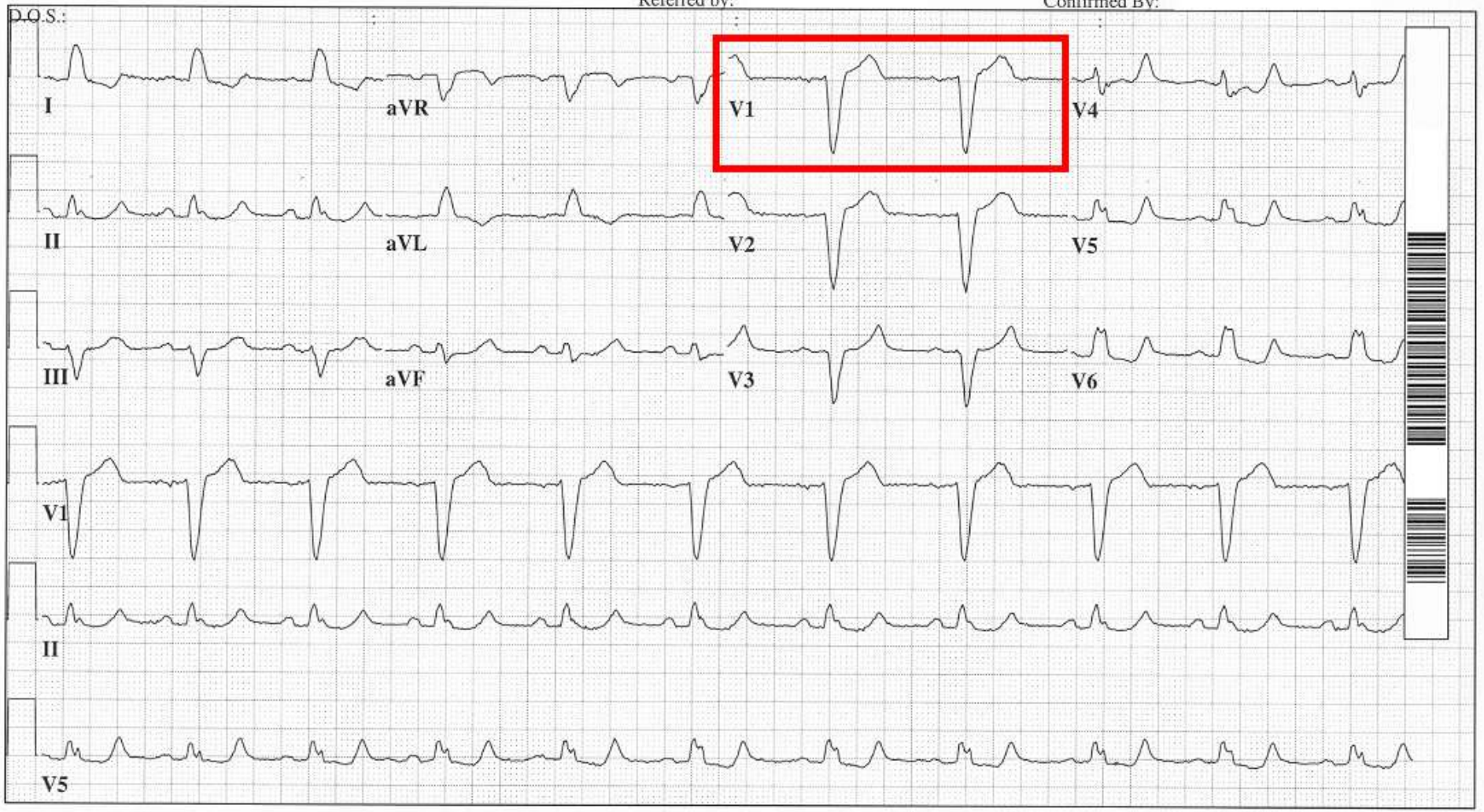
Vent. rate	64	BPM
PR interval	188	ms
QRS duration	152	ms
QT/QTc	472/486	ms
P-R-T axes	78 3	106

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

EKG #WR03029959

Technician: WW

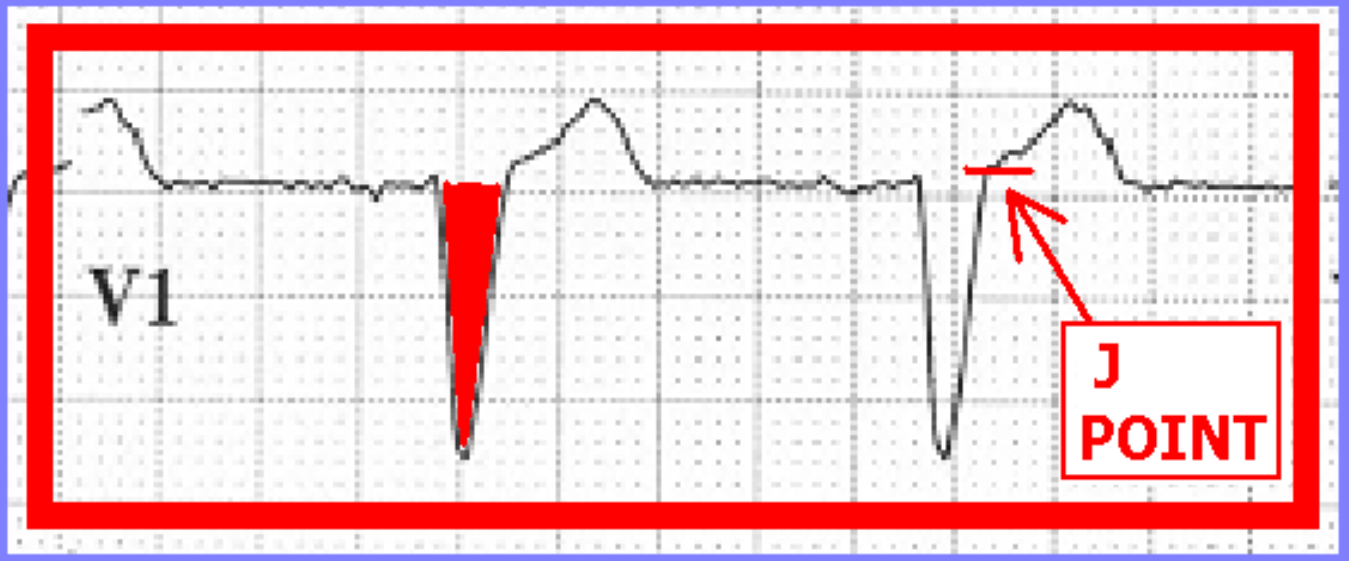
Referred by: Confirmed By:



25mm/s 10mm/mV 40Hz 005C 12SL 229 CID: 0

EID:5 EDT:

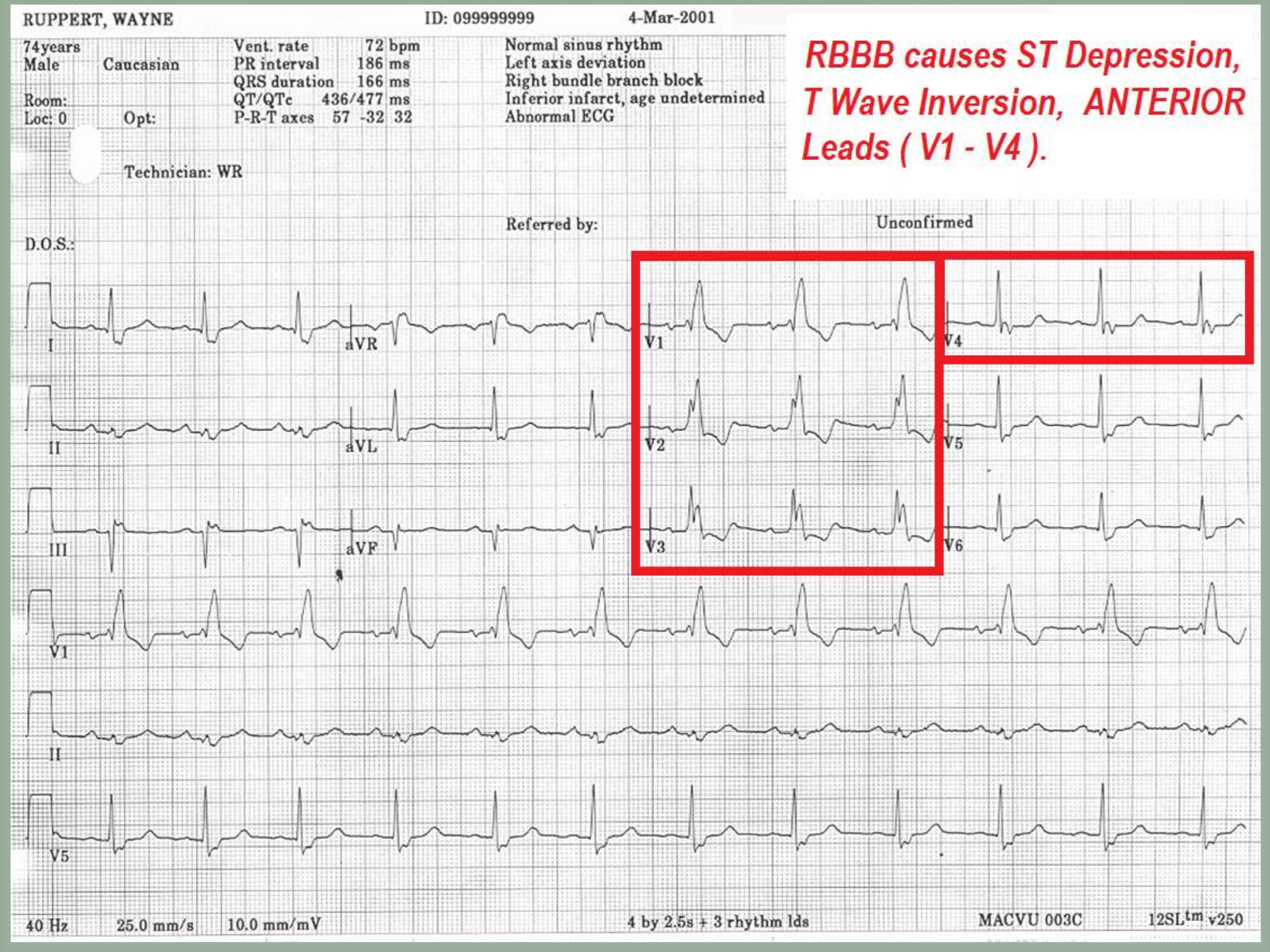
TERMINAL PHASE OF QRS IS NEGATIVE



= 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**



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

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

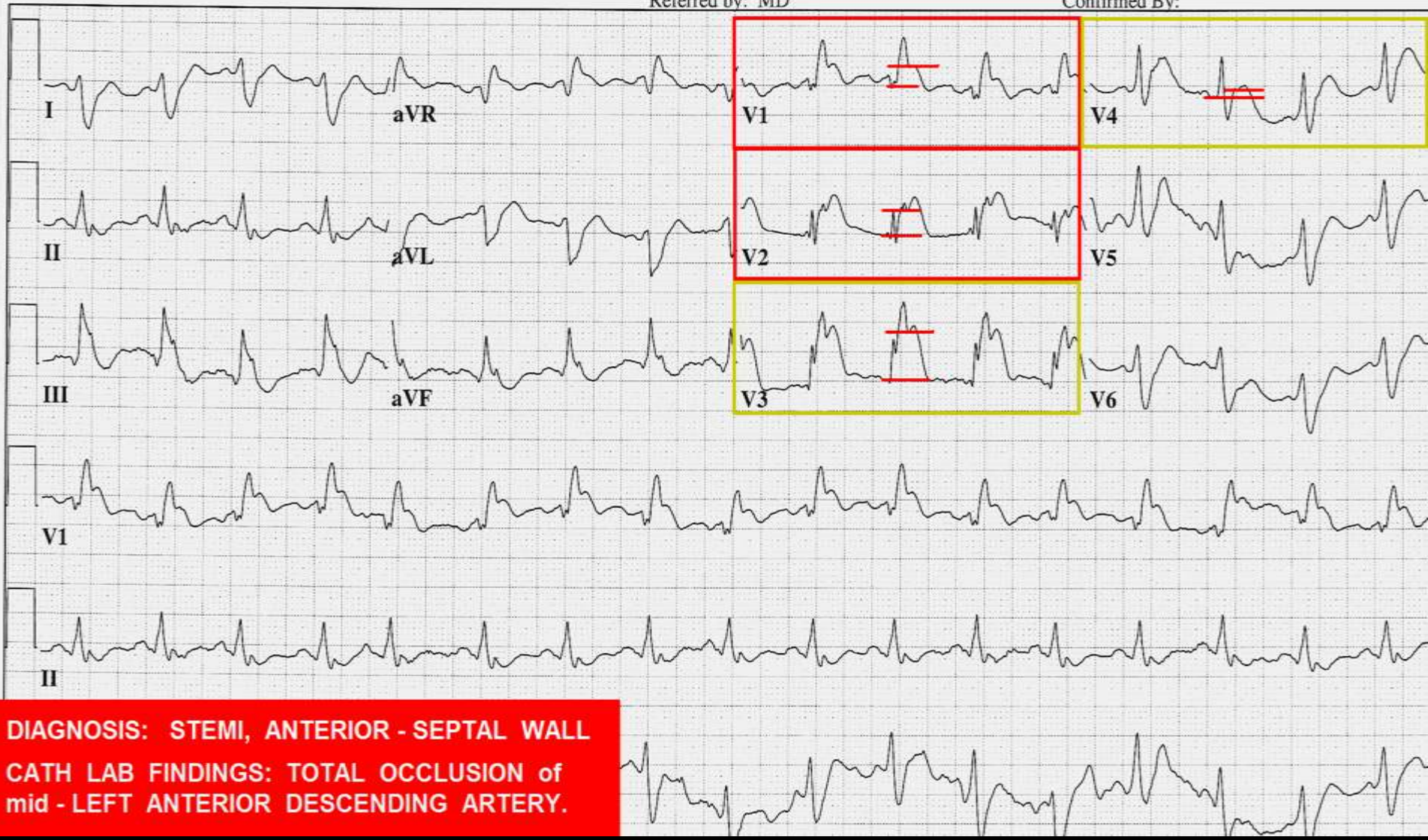
Vent. rate	102	BPM
PR interval	130	ms
QRS duration	168	ms
QT/QTc	400/521	ms
P–R–T axes	60 114	–19

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

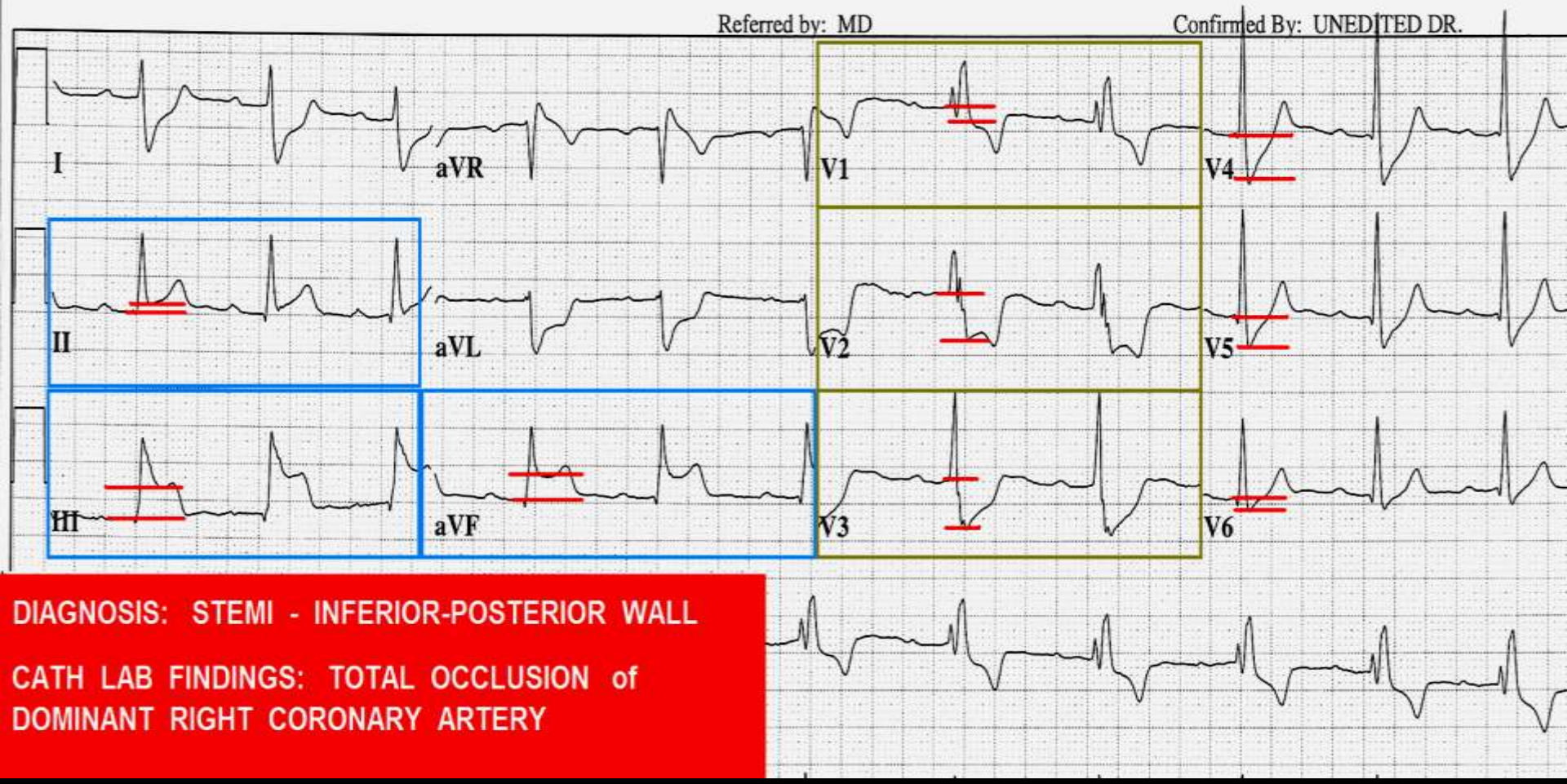
Loc:3 Option:23

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

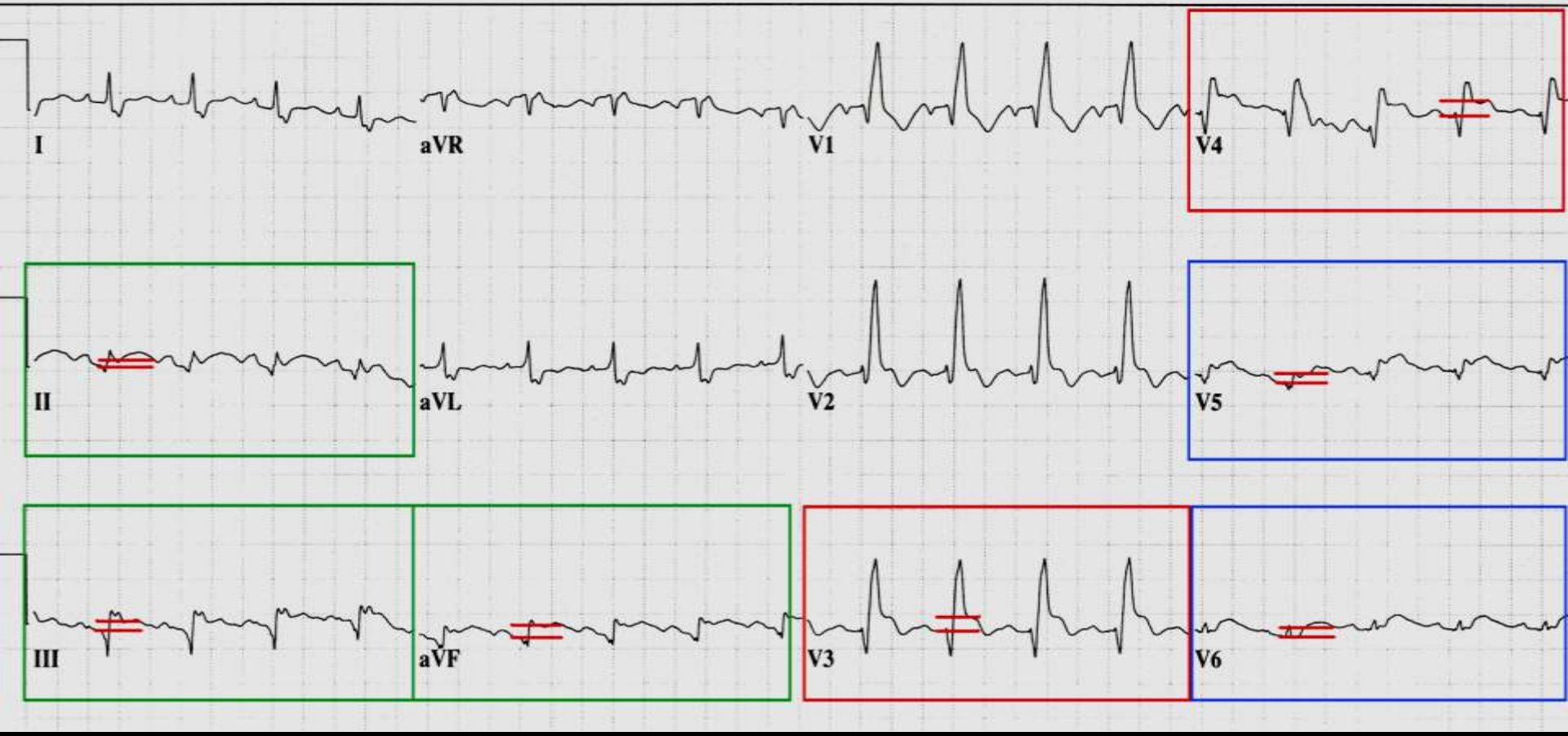
Room:CS-19
Loc:6 Option:41

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 Precordial 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:

D.O.S.

25mm/s 10mm/mV 40Hz 005C 12SL 4 CID: 11

EID:18 EDT:

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:

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- ***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***

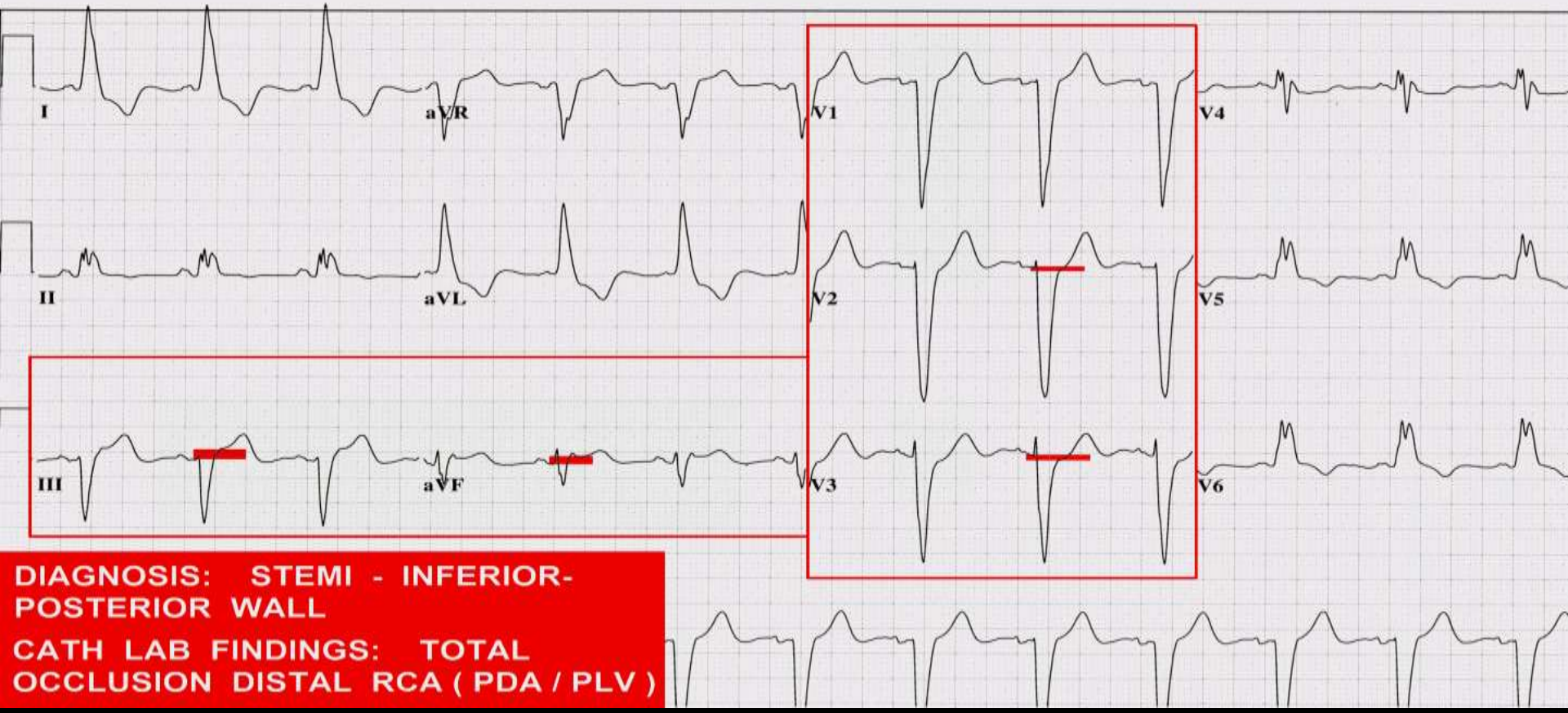
LBBB with CHEST PAIN - CASE 1 : PRESENTING EKG

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

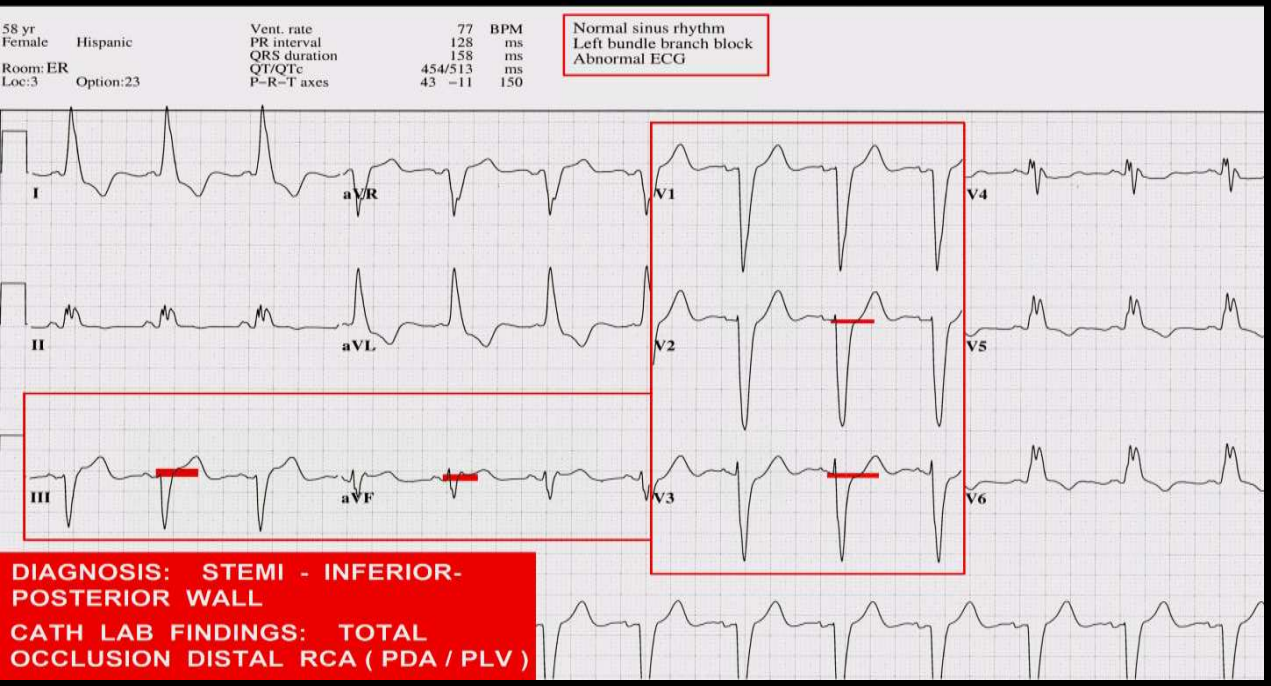
Normal sinus rhythm
Left bundle branch block
Abnormal ECG



DIAGNOSIS: STEMI - INFERIOR-POSTERIOR WALL

CATH LAB FINDINGS: TOTAL OCCLUSION DISTAL RCA (PDA / PLV)

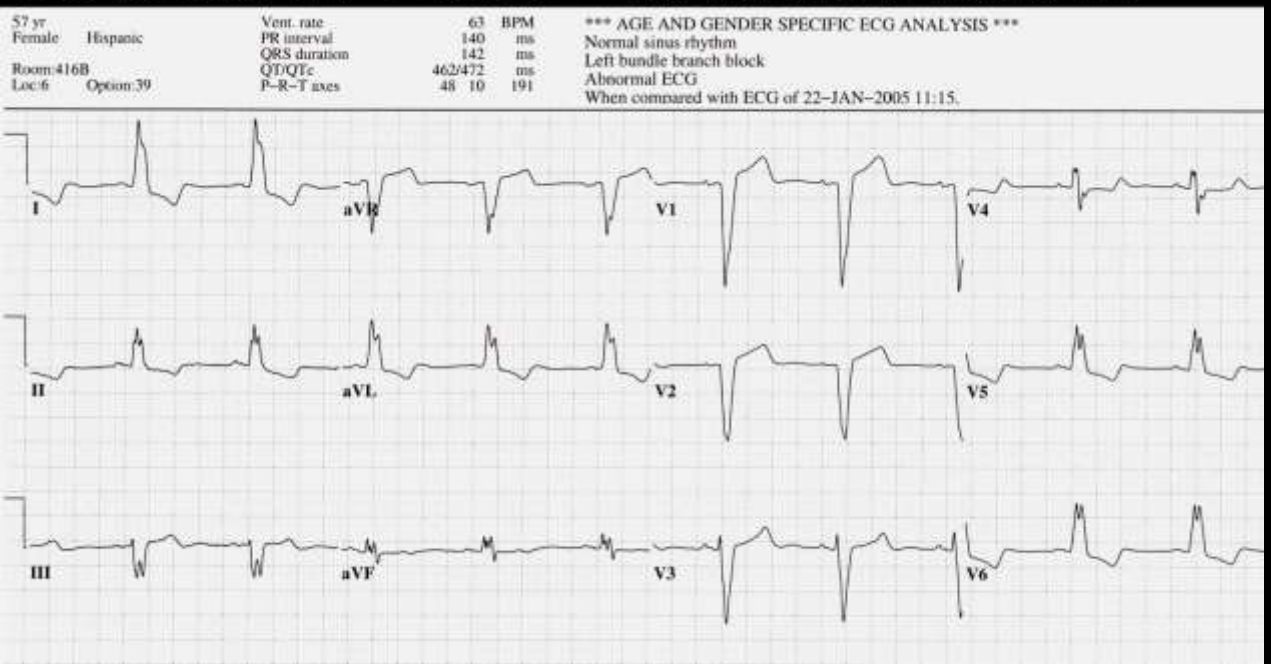
LBBB with CHEST PAIN - CASE 1: PRESENTING EKG

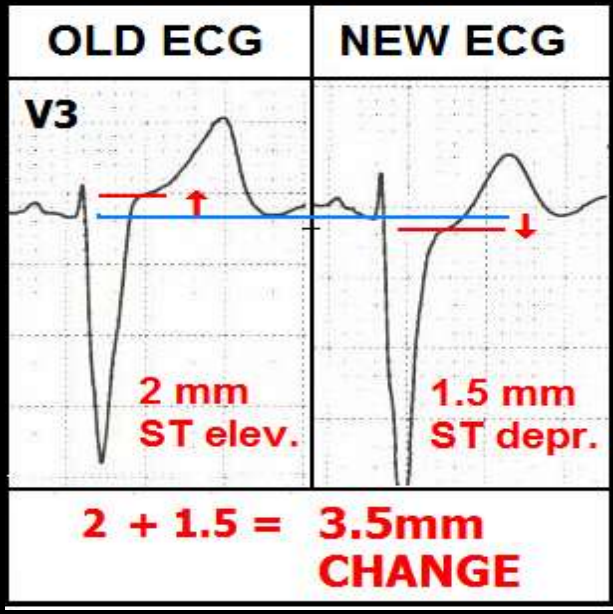


DIAGNOSIS: STEMI - INFERIOR-POSTERIOR WALL

CATH LAB FINDINGS: TOTAL OCCLUSION DISTAL RCA (PDA / PLV)

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





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 . . .***

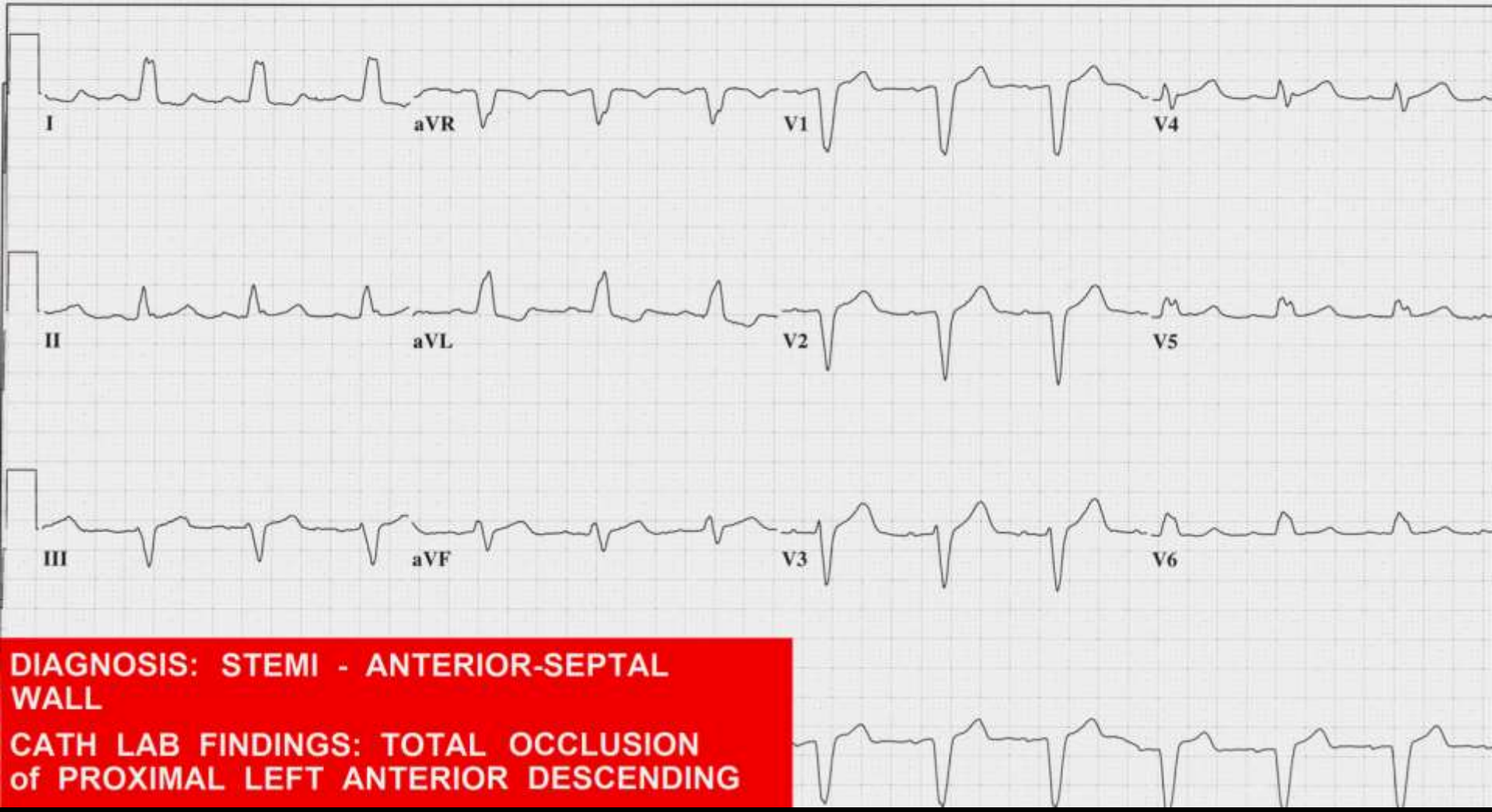
LBBB with CHEST PAIN - CASE 2: *NEW ONSET of LBBB*

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

N. ENGL. J. MED v 348; p933 - 940 - Zimetbaum, et. al.

“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.

[redacted]

[redacted]

(2)

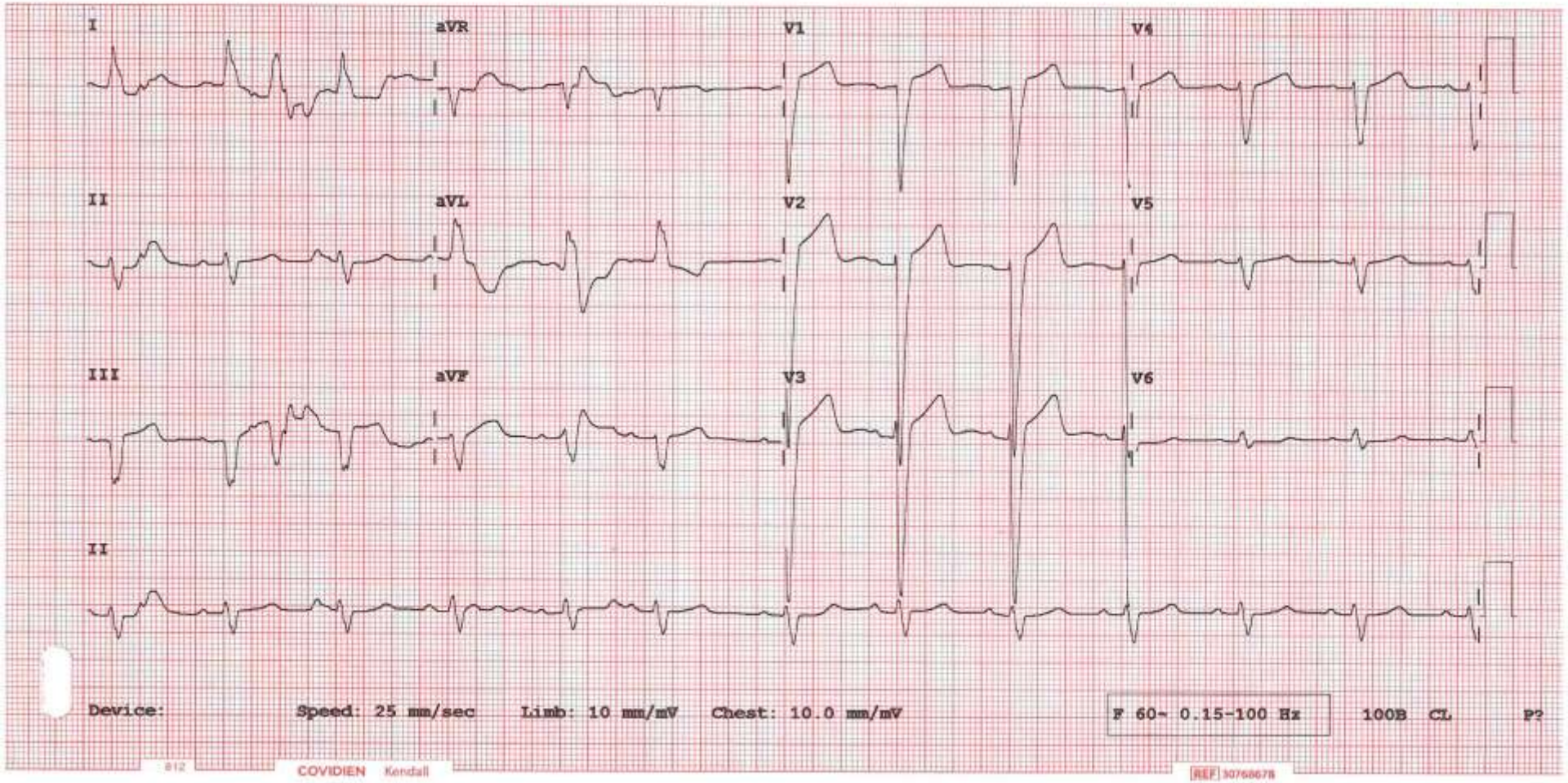
ED

Rate	75	. Sinus rhythm.....normal P axis V-rate 50- 99	
		. Left bundle branch block.....QRSd>120, broad/notched R	
PR	178		TECH dcoull
QRSD	133		
QT	420		
QTc	470		
--AXIS--			
P	27		
QRS	-43		
T	127		

12 Lead; Standard Placement

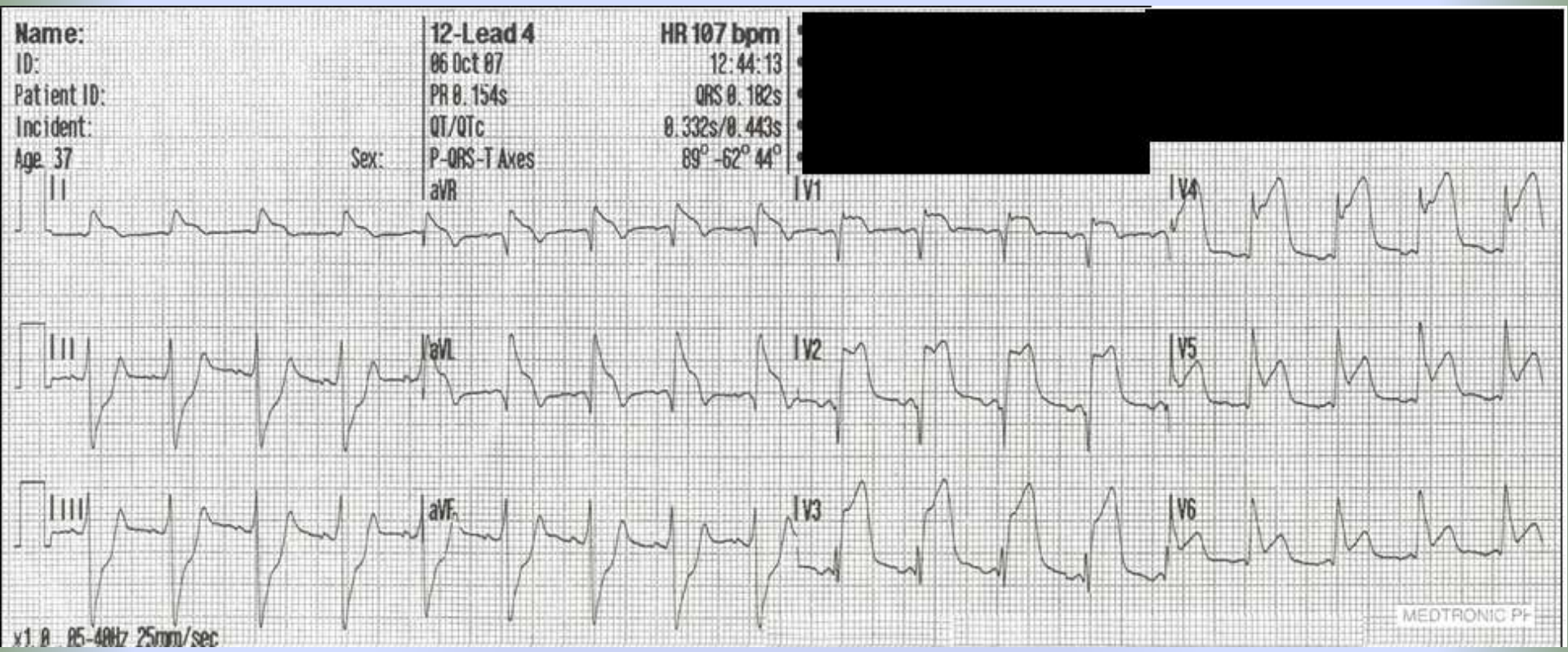
Unconfirmed Diagnosis

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

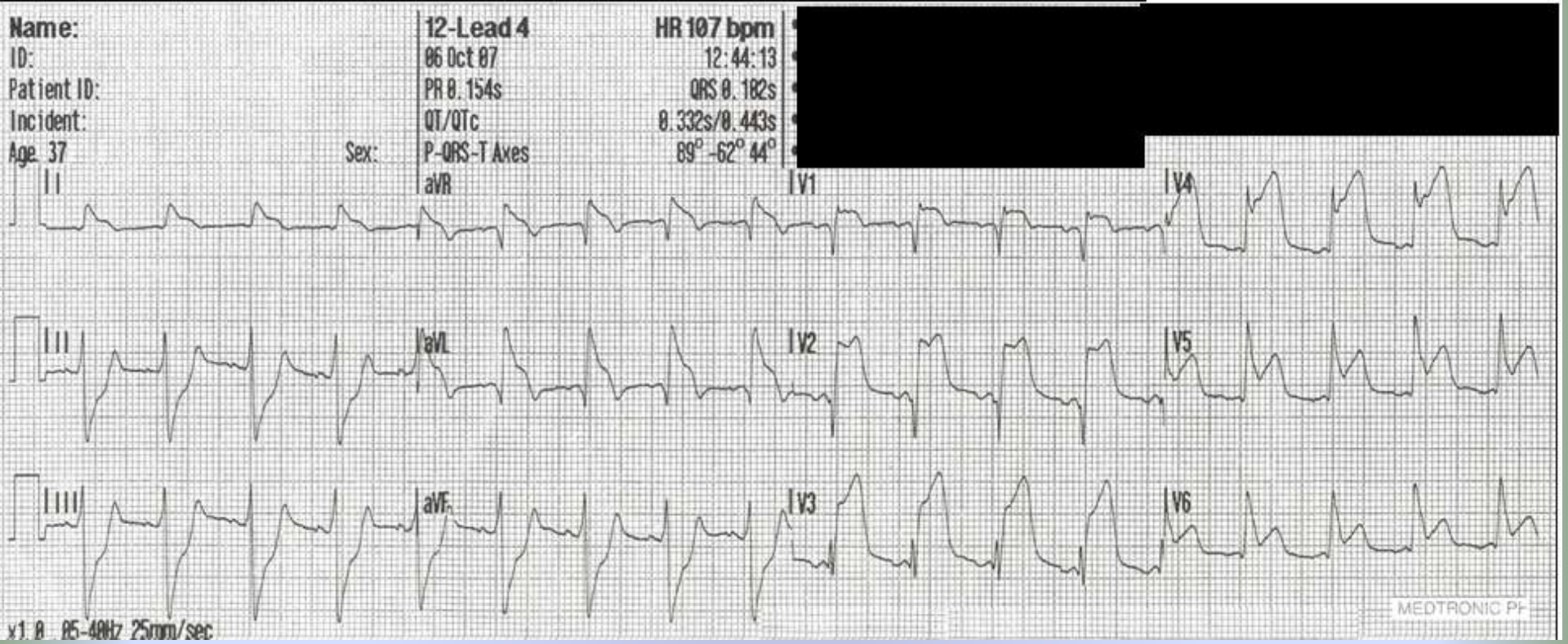


Practice ECGs . . .

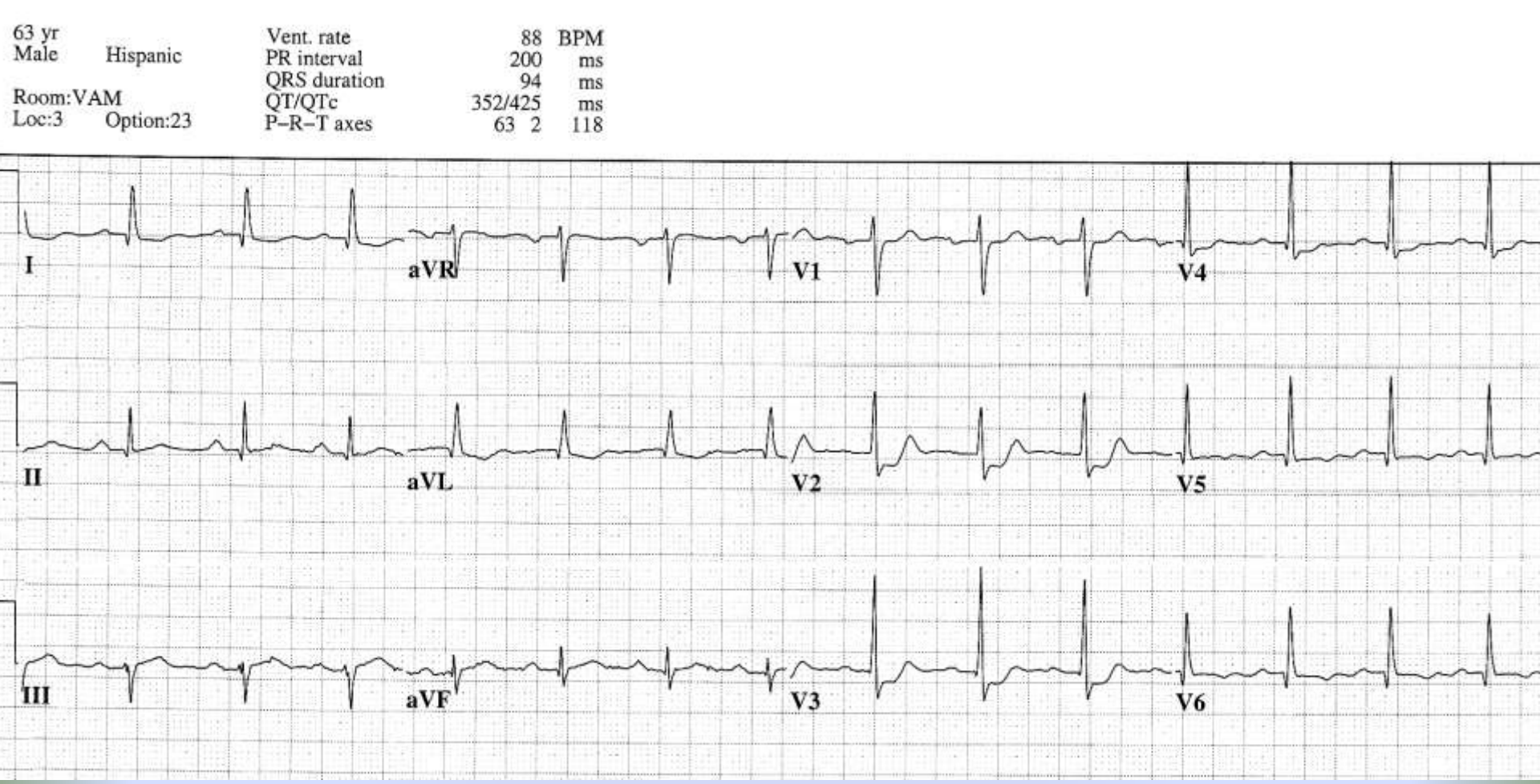
Let's review . . . .



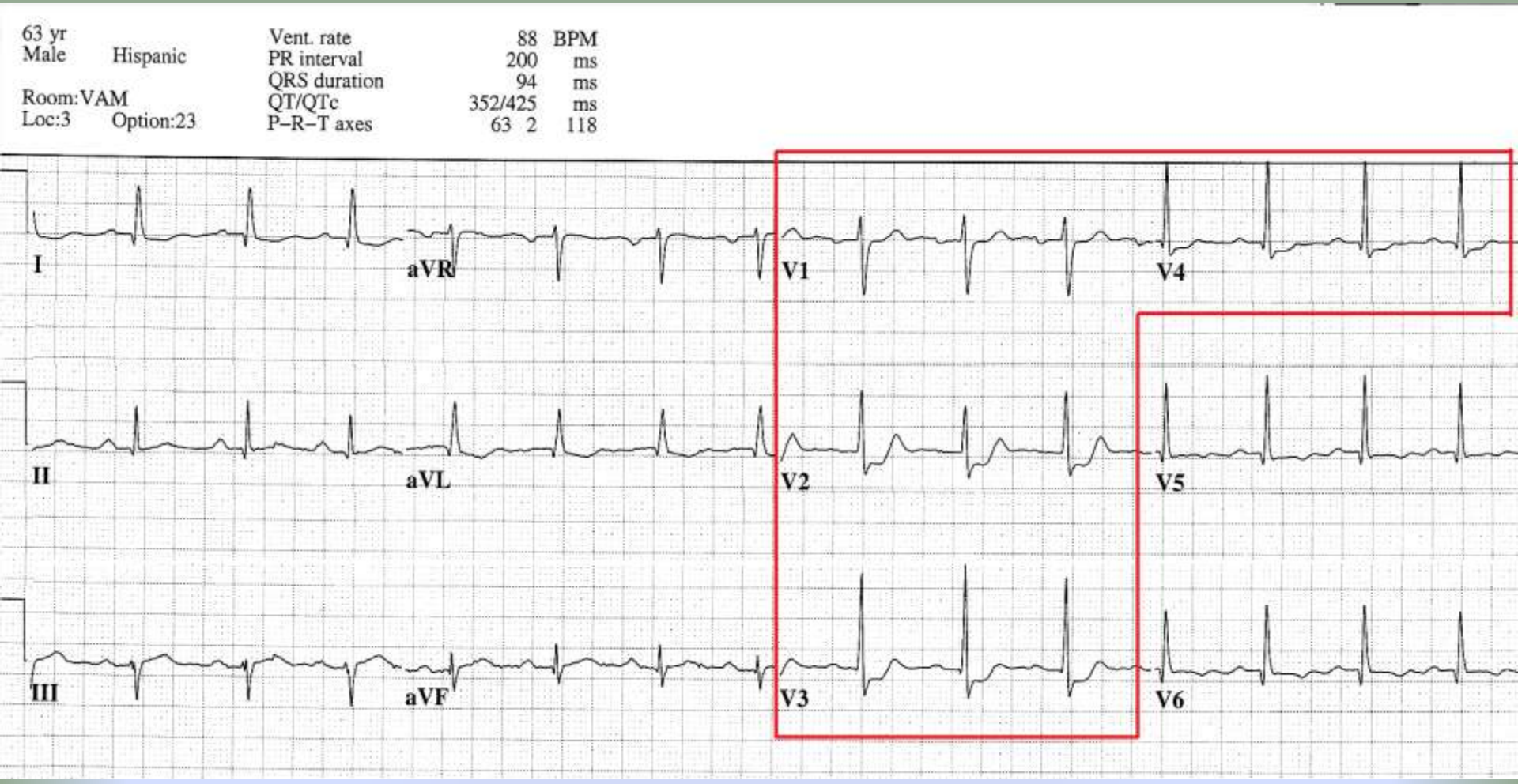
1. ECG abnormality(ies)?
2. Possible diagnosis?
3. Action / Intervention?



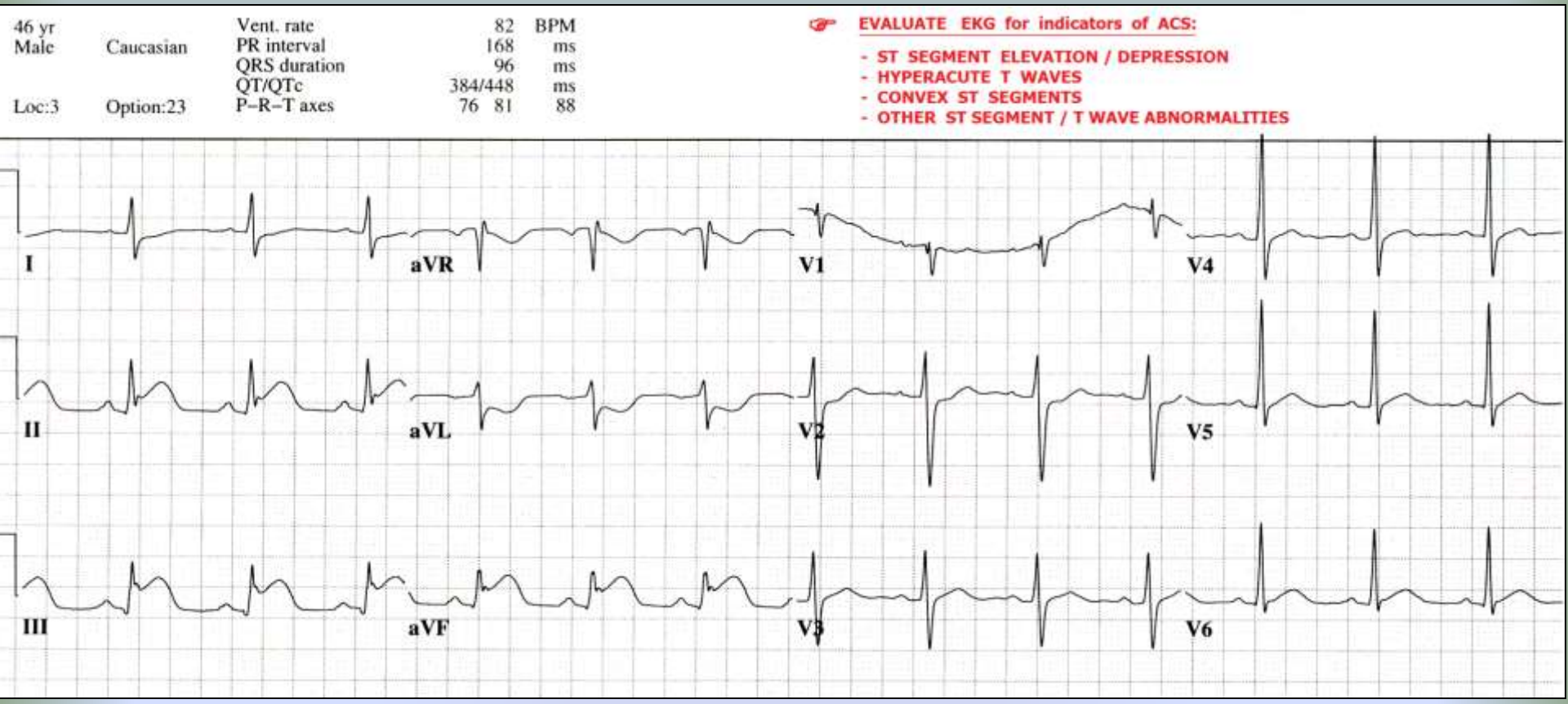
1. ECG abnormality(ies)? ST Elevation Leads I, AVR AVL, V1, V2, V3, V4, V5 & V6. ST Depression II, III and AVF
2. Possible diagnosis? Acute Anterolateral Wall STEMI secondary to Left Main Coronary Artery occlusion (widow-maker MI).
3. Action / Intervention? STAT CATH LAB vs STAT Thrombolytics. Prepare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



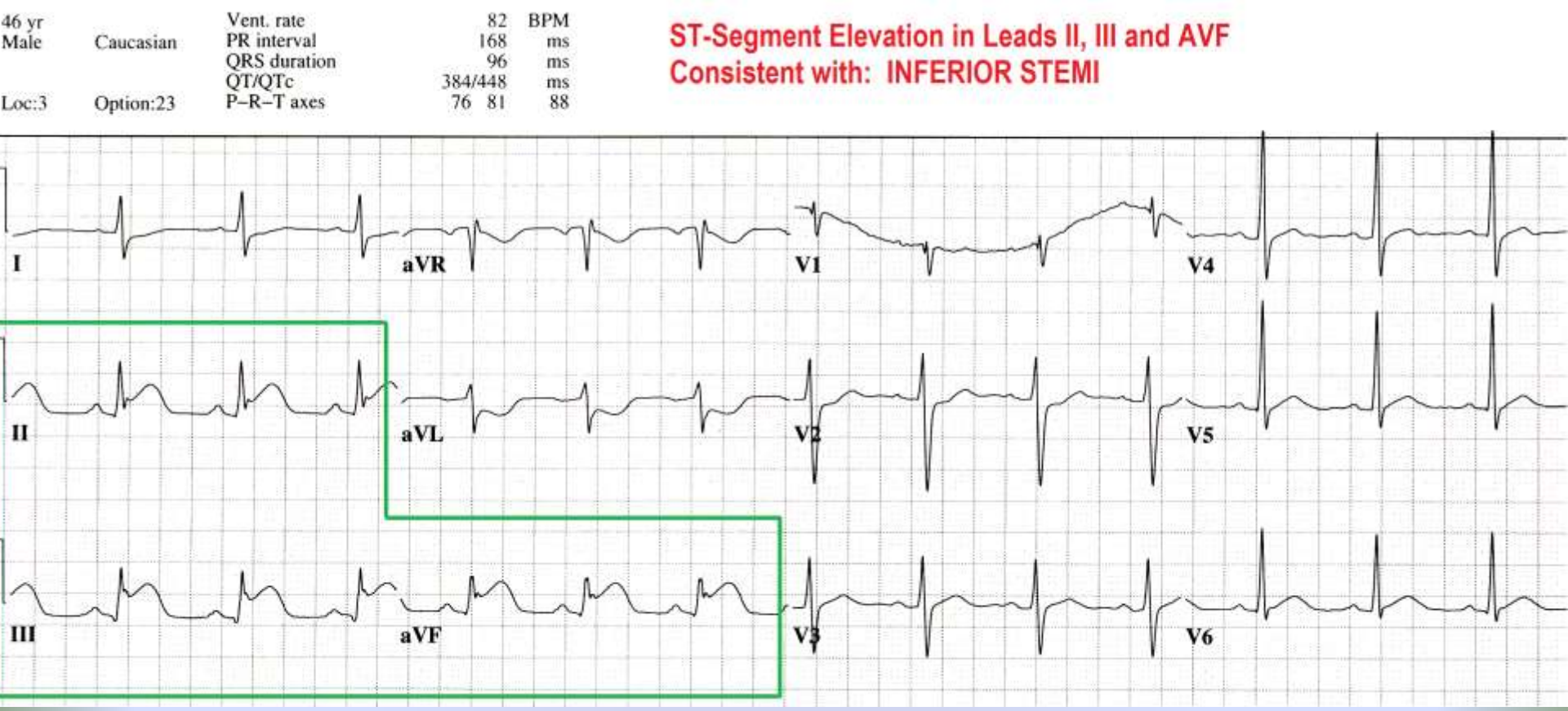
1. ECG abnormality(ies)?
2. Possible diagnosis?
3. Action / Intervention?



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

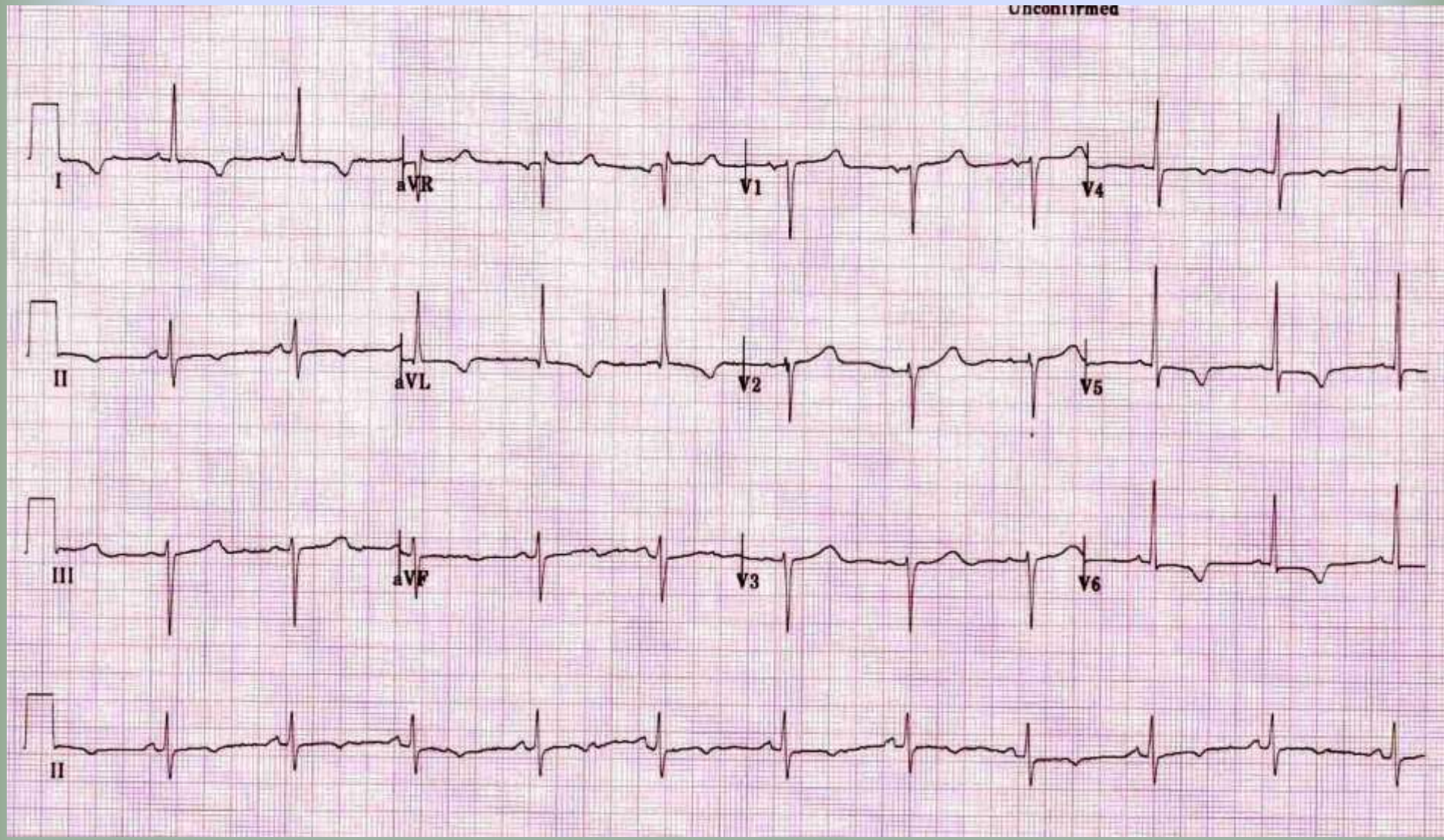


1. ECG abnormality(ies)?
2. Possible diagnosis?
3. Action / Intervention?

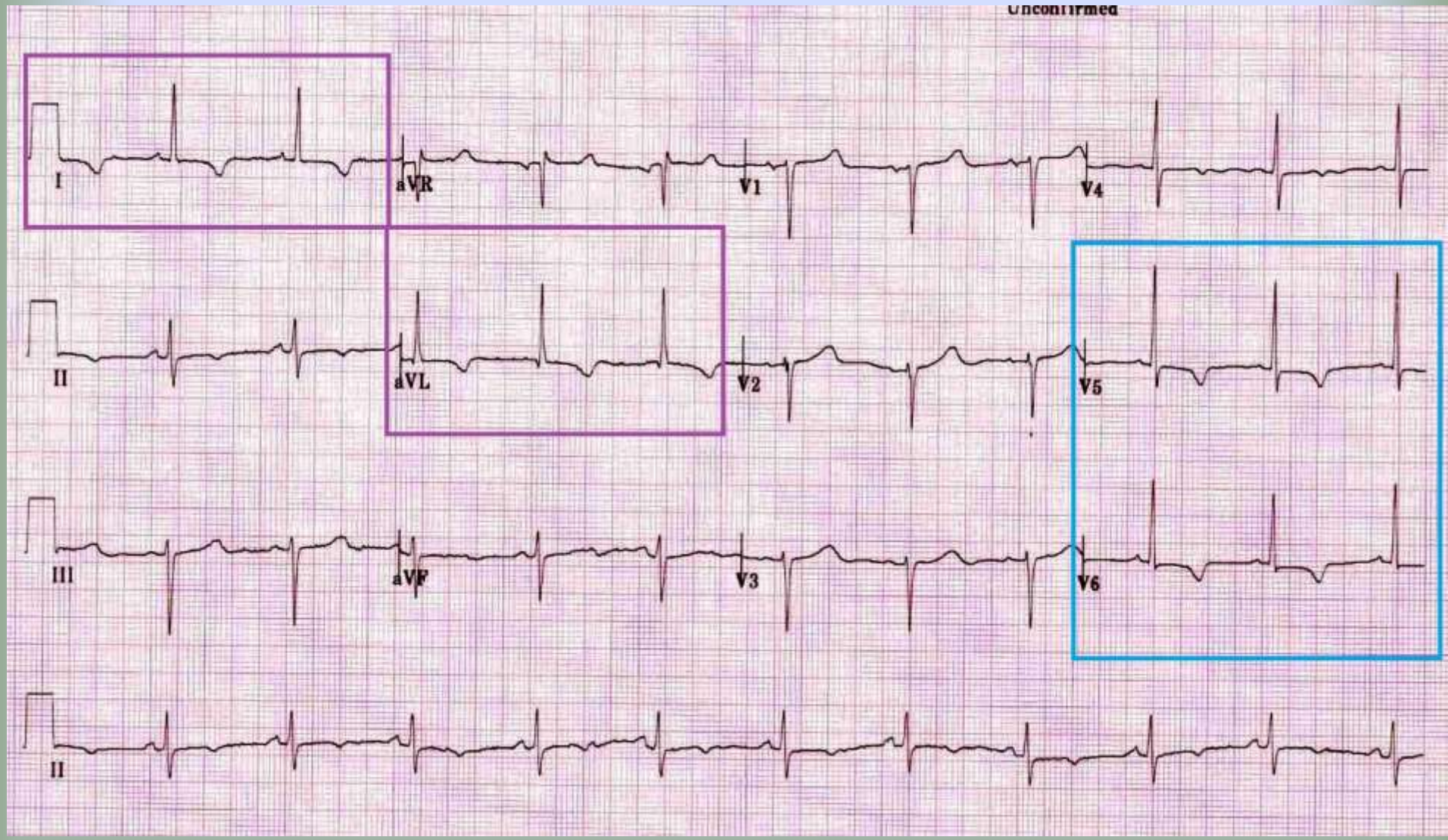


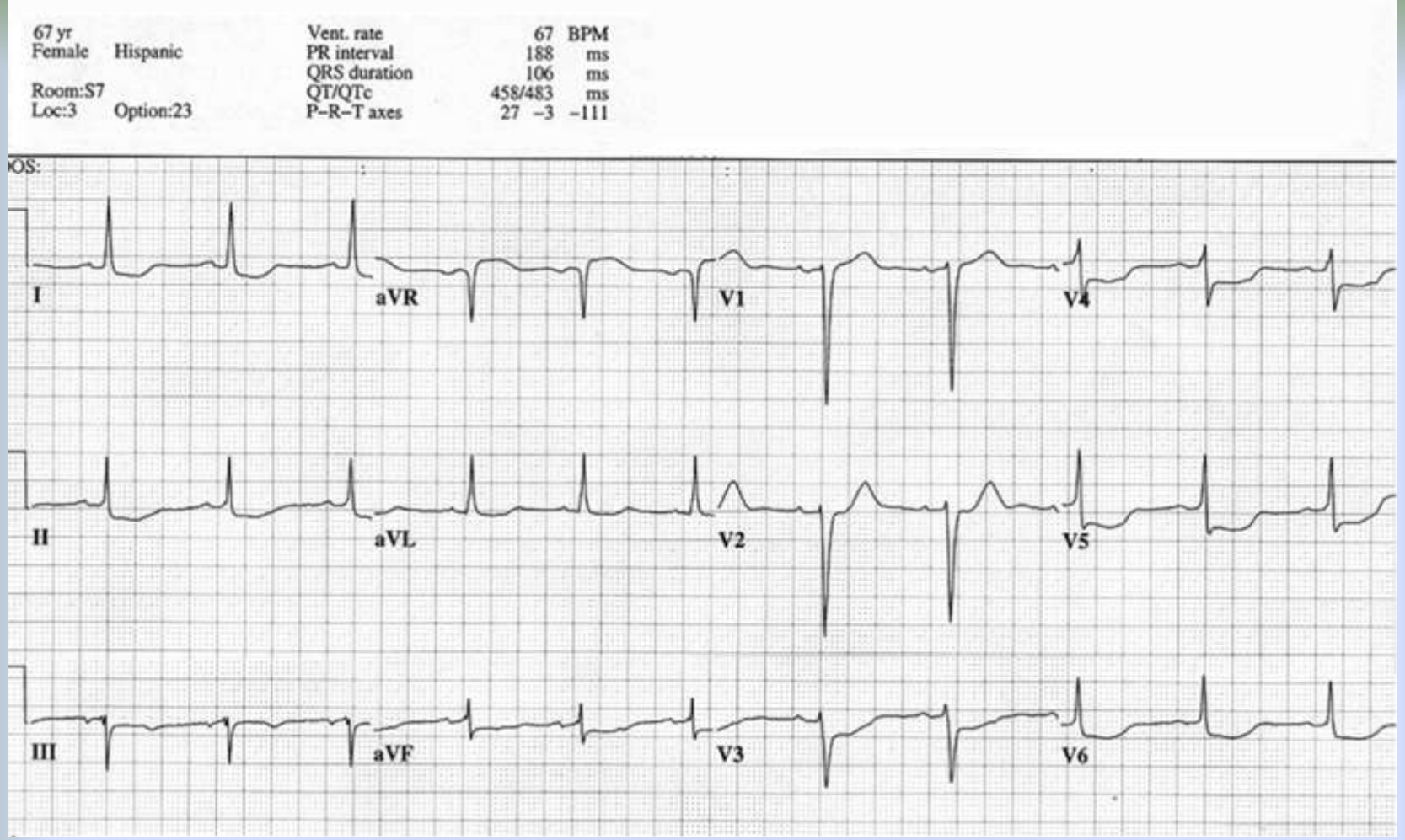
1. ECG abnormality(ies)? ST Elevation, Leads II,III & AVF
2. Possible diagnosis? Inferior Wall STEMI
3. Action / Intervention? 1. Do R-sided ECG, *prepare for* Atropine administration, external pacing, cardiac arrest, STAT cath lab visit !

What leads show signs of possible ACS?

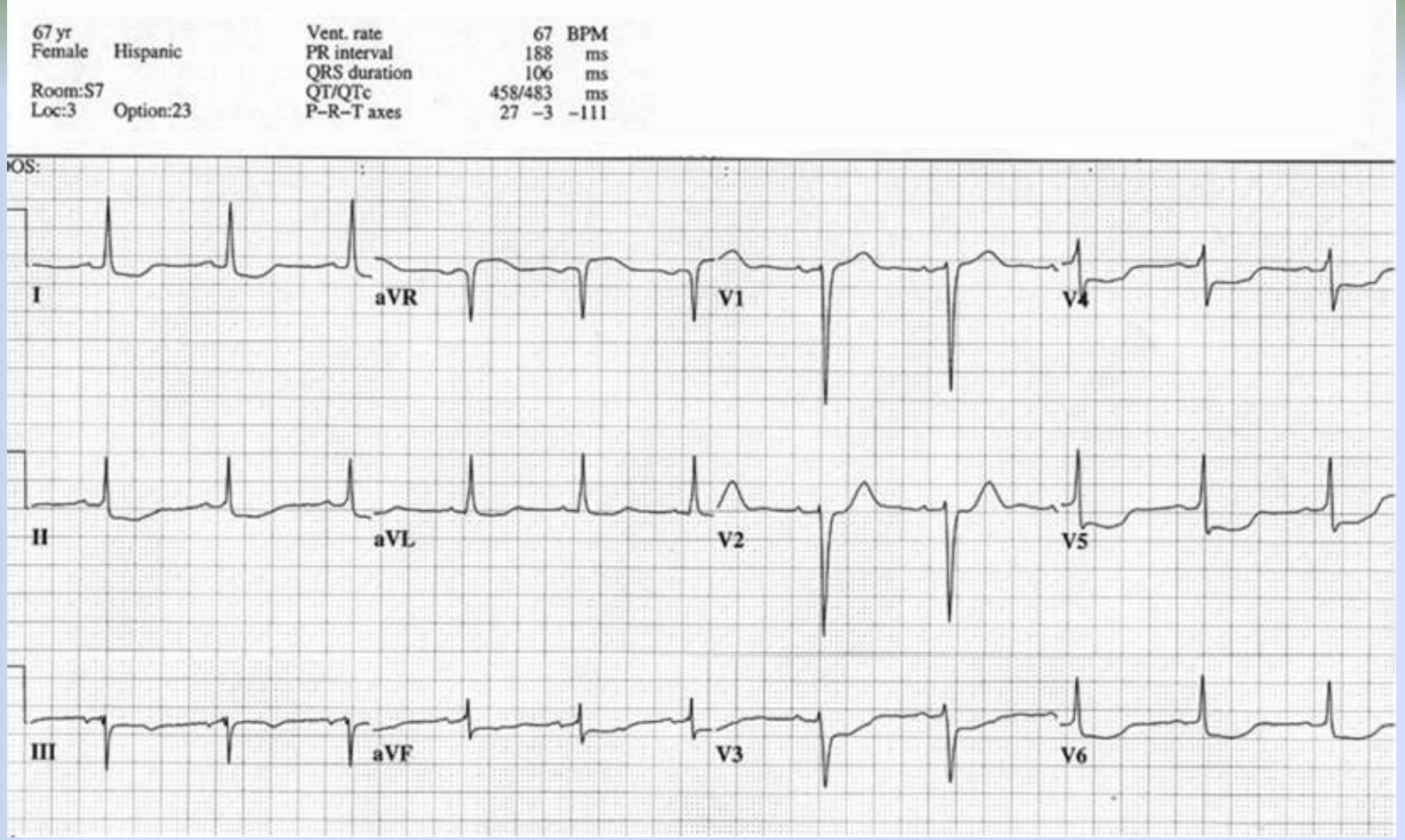


12 Lead ECG
shows ISCHEMIC CHANGES Lateral Wall:





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



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.)

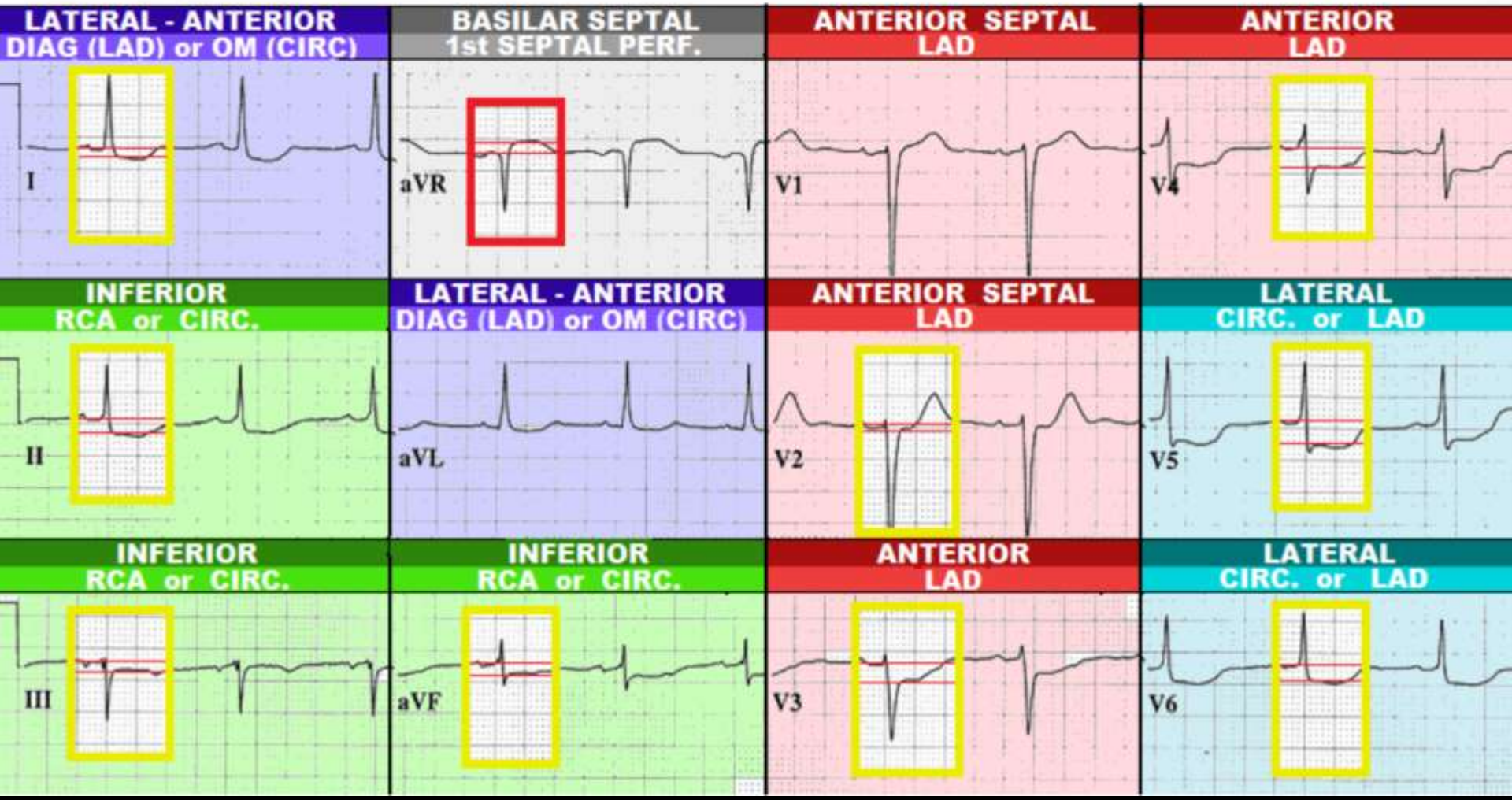
67 yr
Female Hispanic

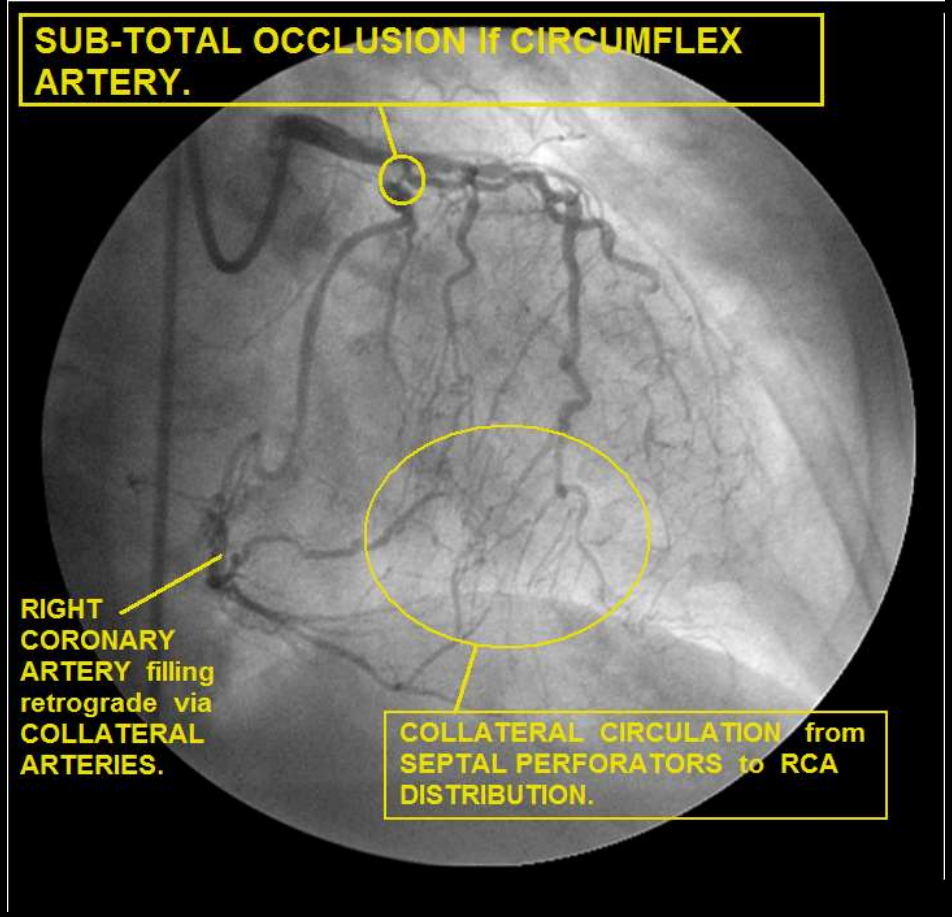
Room:S7
Loc:3 Option:23

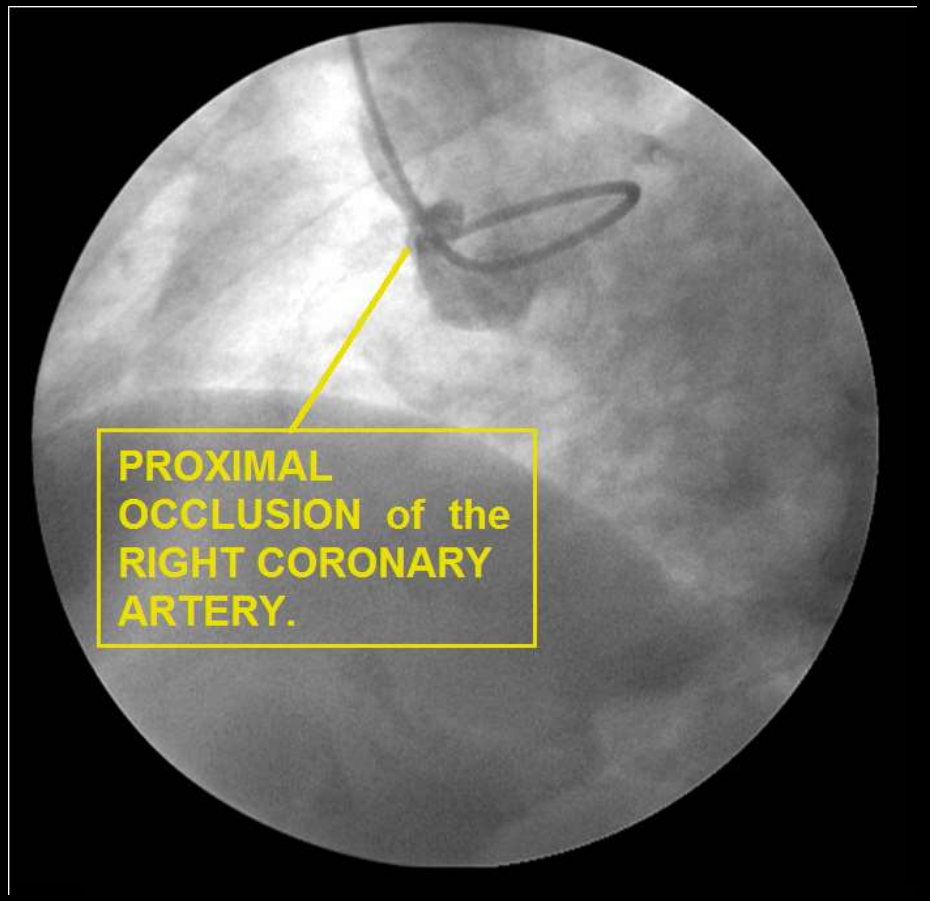
Vent. rate	67	BPM
PR interval	188	ms
QRS duration	106	ms
QT/QTc	458/483	ms
P-R-T axes	27 -3	-111

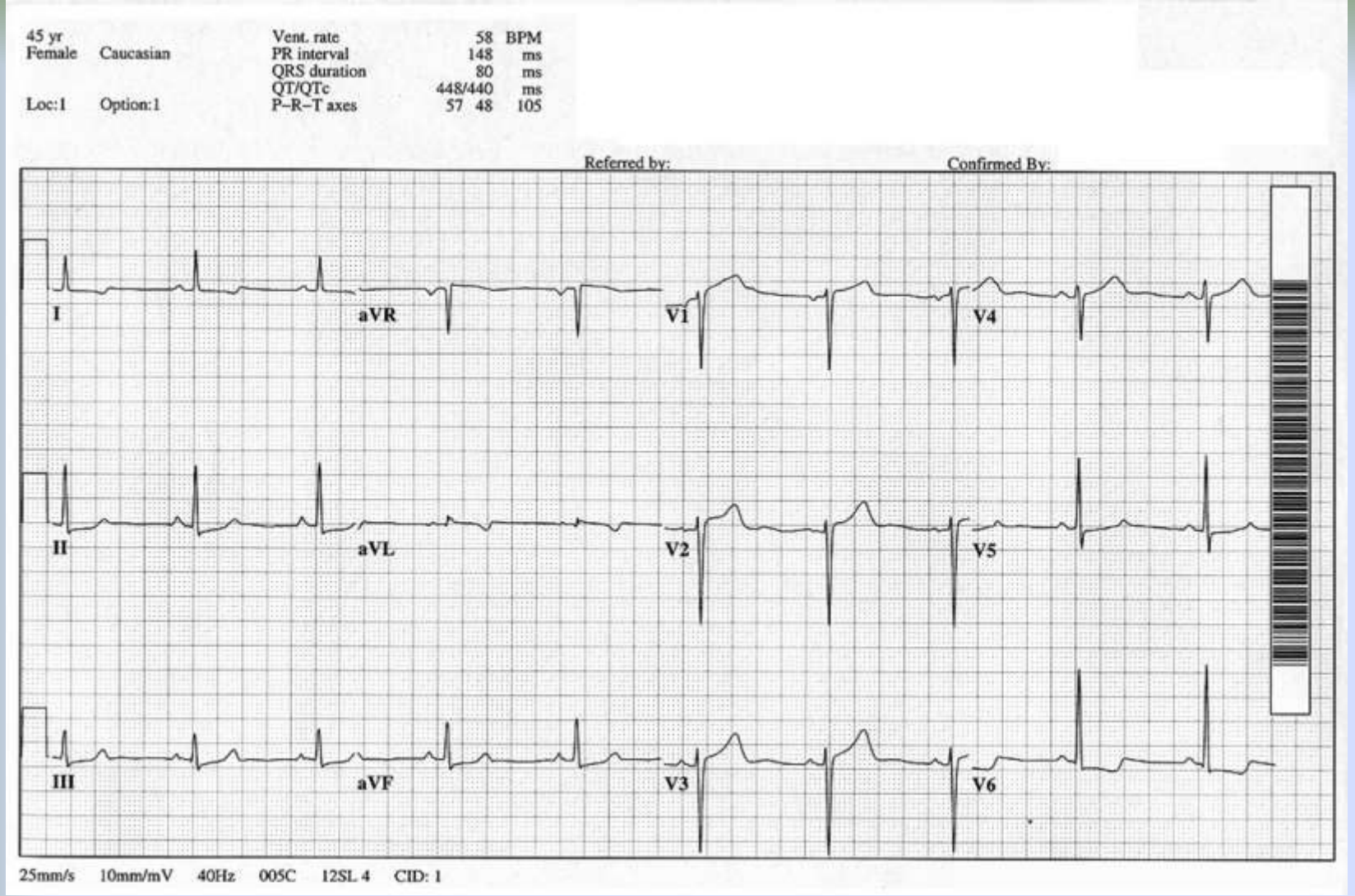
ST SEGMENT ELEVATION

ST SEGMENT DEPRESSION

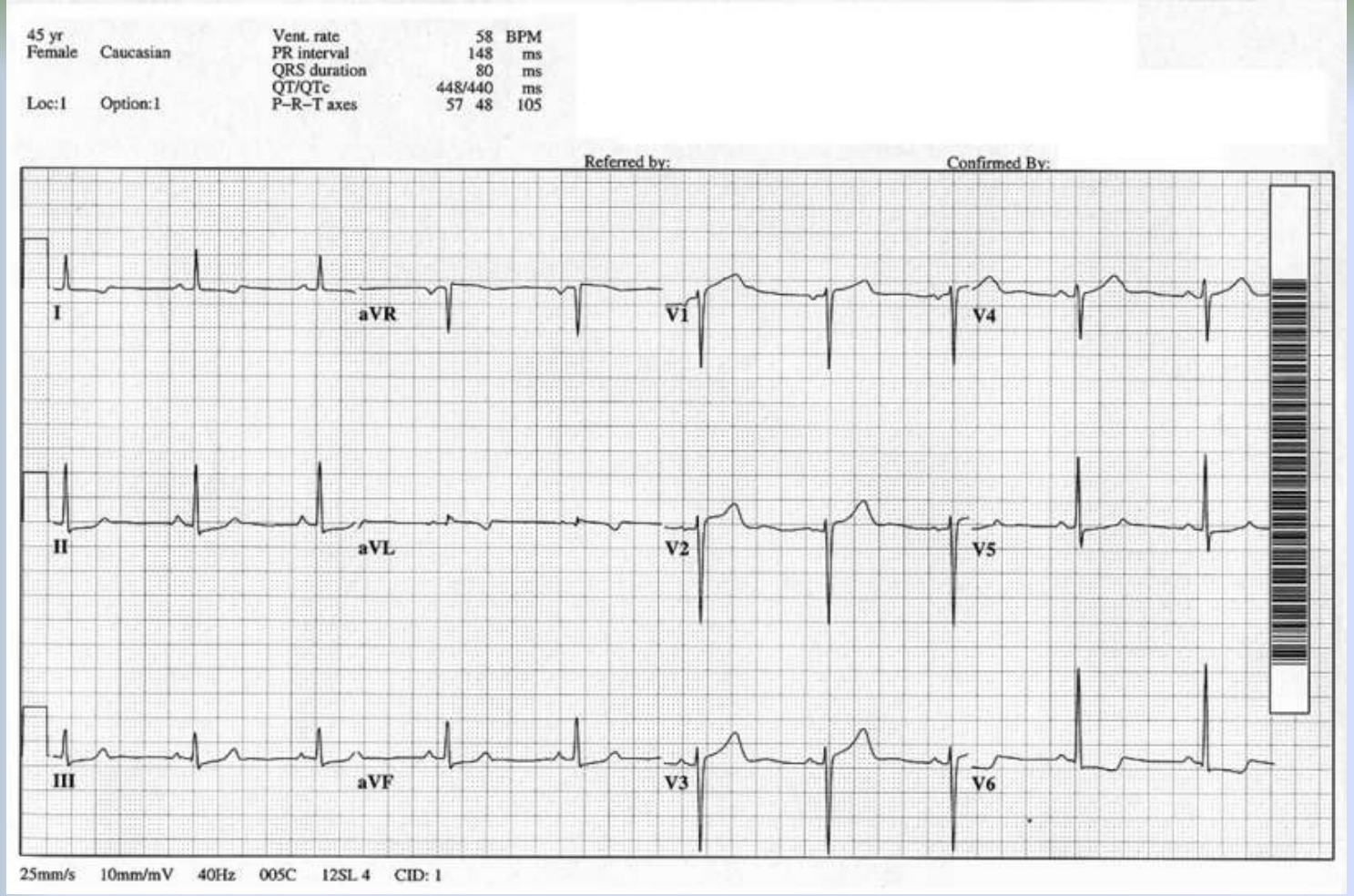



SUB-TOTAL OCCLUSION If CIRCUMFLEX ARTERY.
RIGHT CORONARY ARTERY filling retrograde via COLLATERAL ARTERIES.
COLLATERAL CIRCULATION from SEPTAL PERFORATORS to RCA DISTRIBUTION.

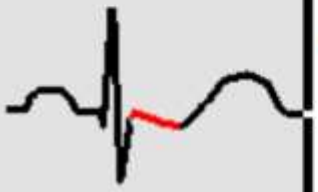

PROXIMAL OCCLUSION of the RIGHT CORONARY ARTERY.



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



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

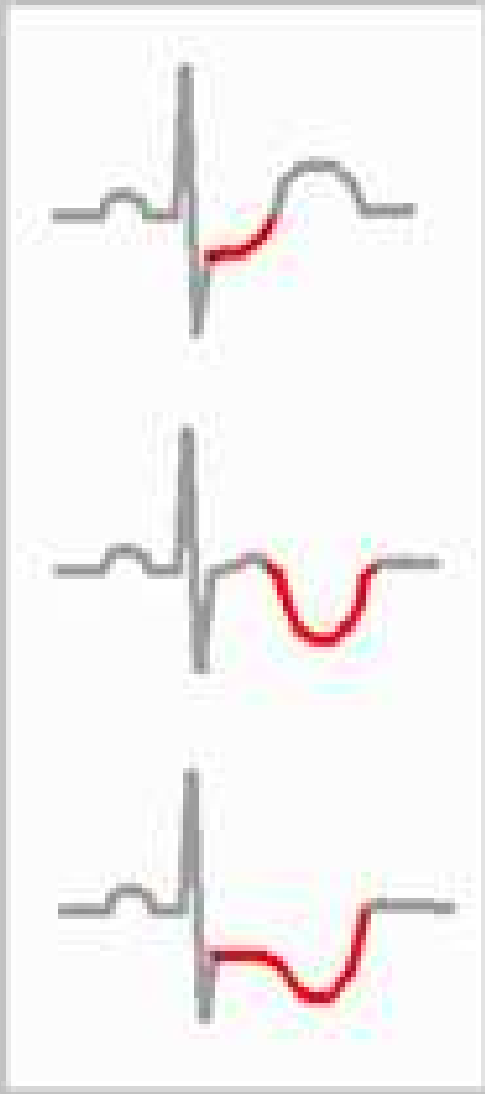
ISCHEMIA

HELPFUL PATTERNS . . .

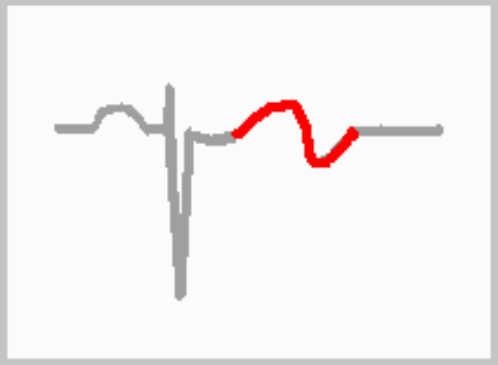
J POINT DEPRESSION
(> 1 mm)

INVERTED T WAVES

J POINT DEPRESSION
+ INVERTED T WAVES



ISCHEMIA

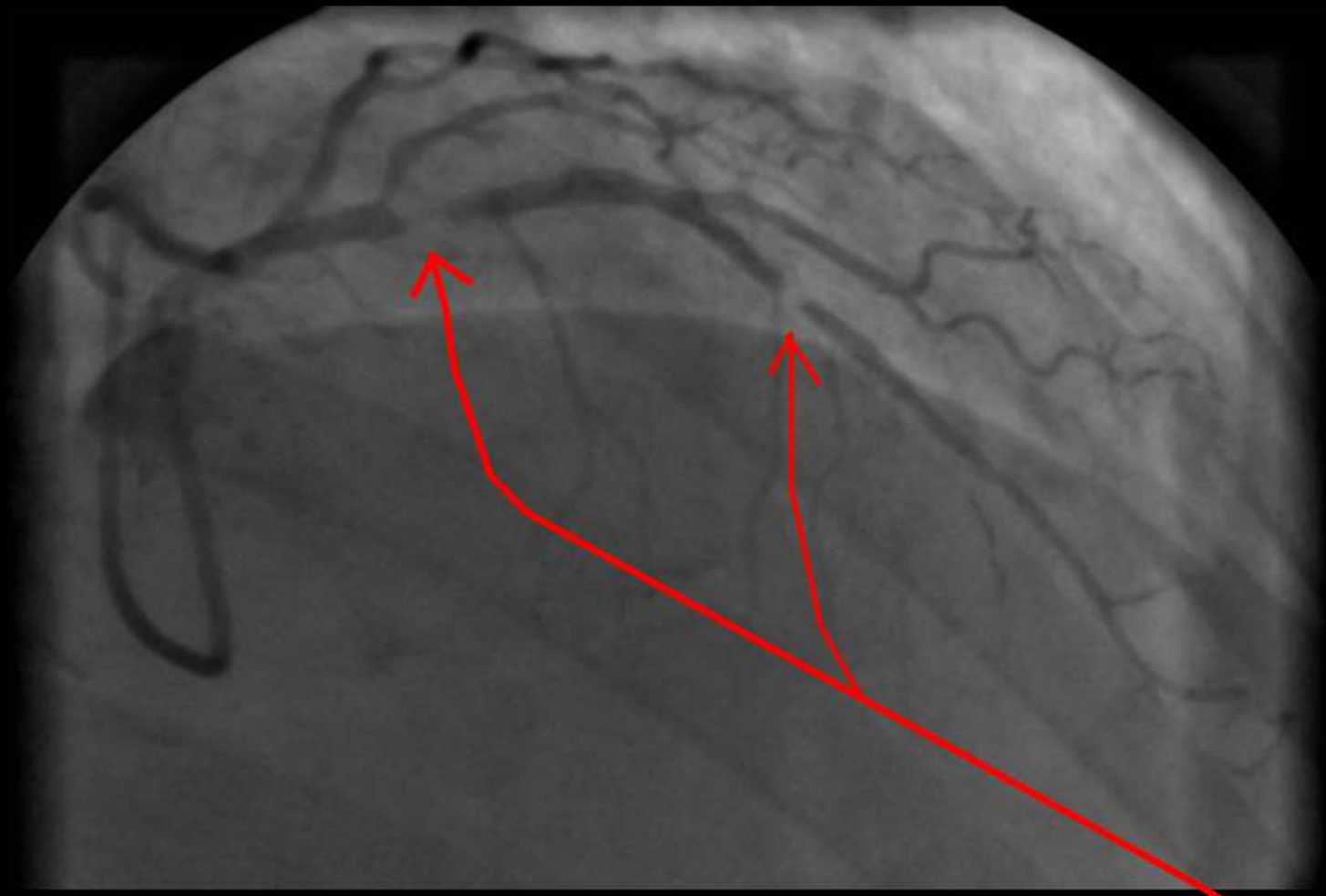


BI-PHASIC T WAVE

- 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:

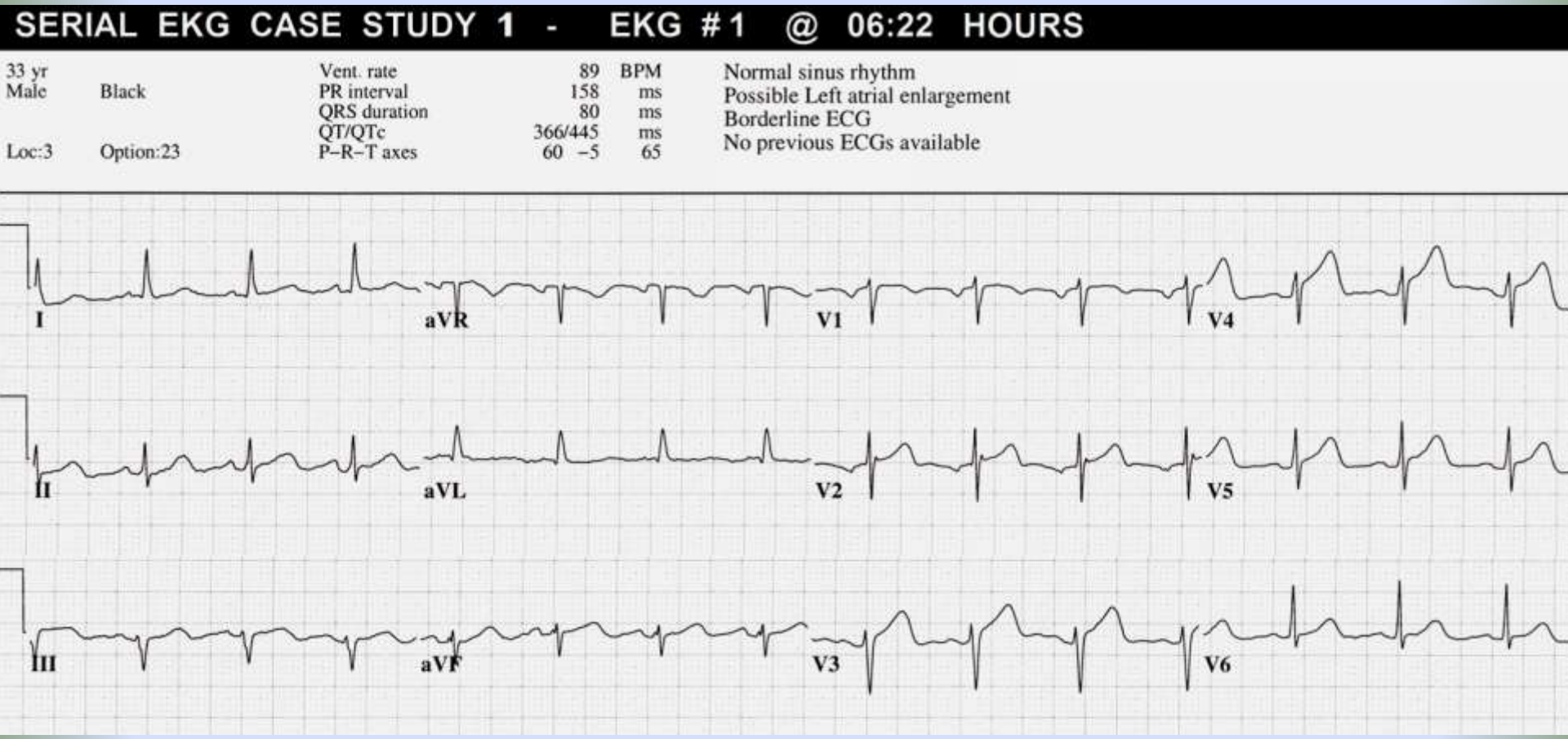
- **Present in 14-18% of patients admitted with unstable angina**
- **75% patients not treated developed extensive Anterior MI within 3 weeks.**
- ***Median Average time from presentation to Acute Myocardial Infarction – 8 days***

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

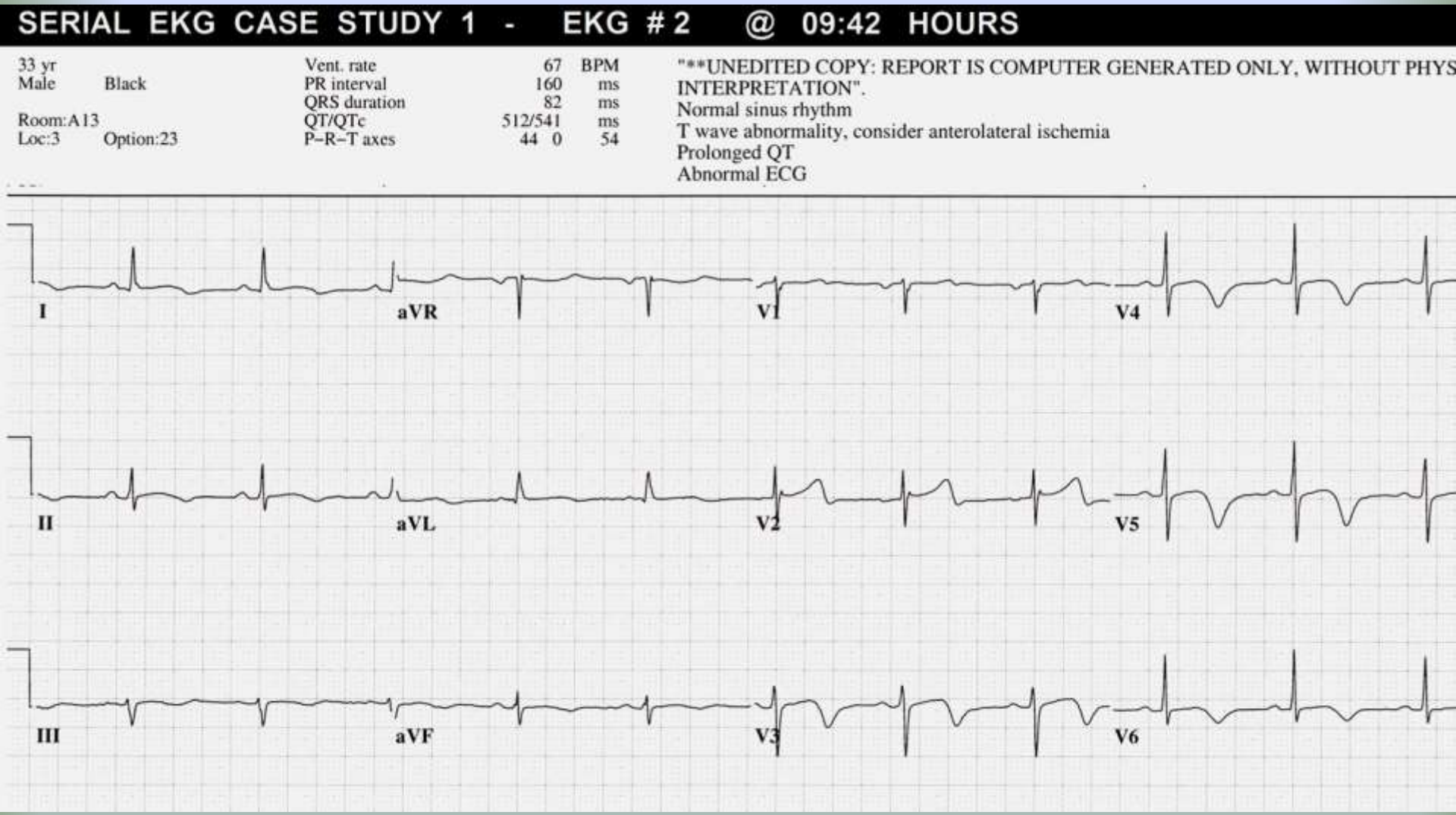
Wellen's Syndrome Case Study

- 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



Wellen's Syndrome Case Study

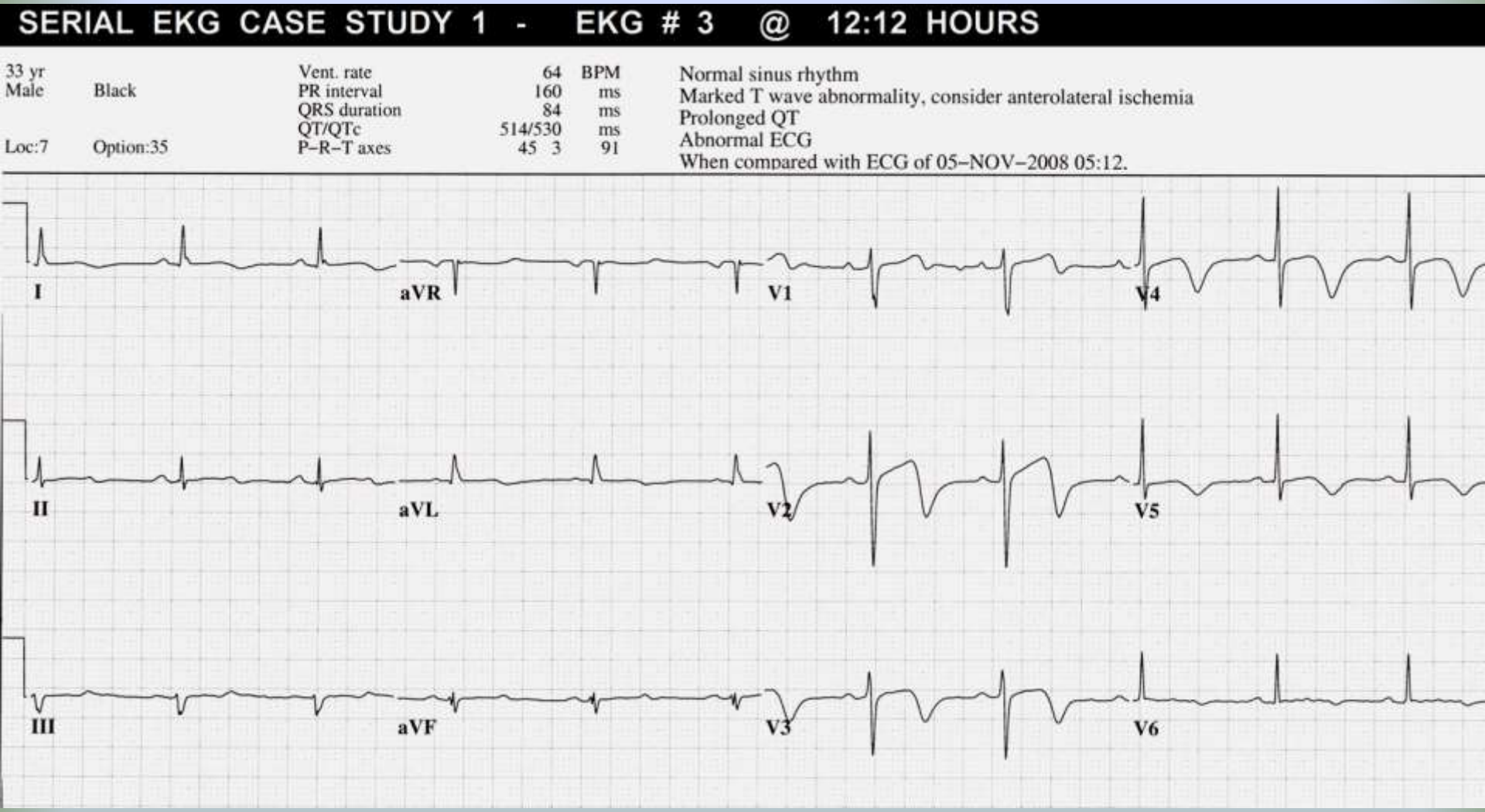


DYNAMIC ST-T Wave Changes ARE PRESENT !!

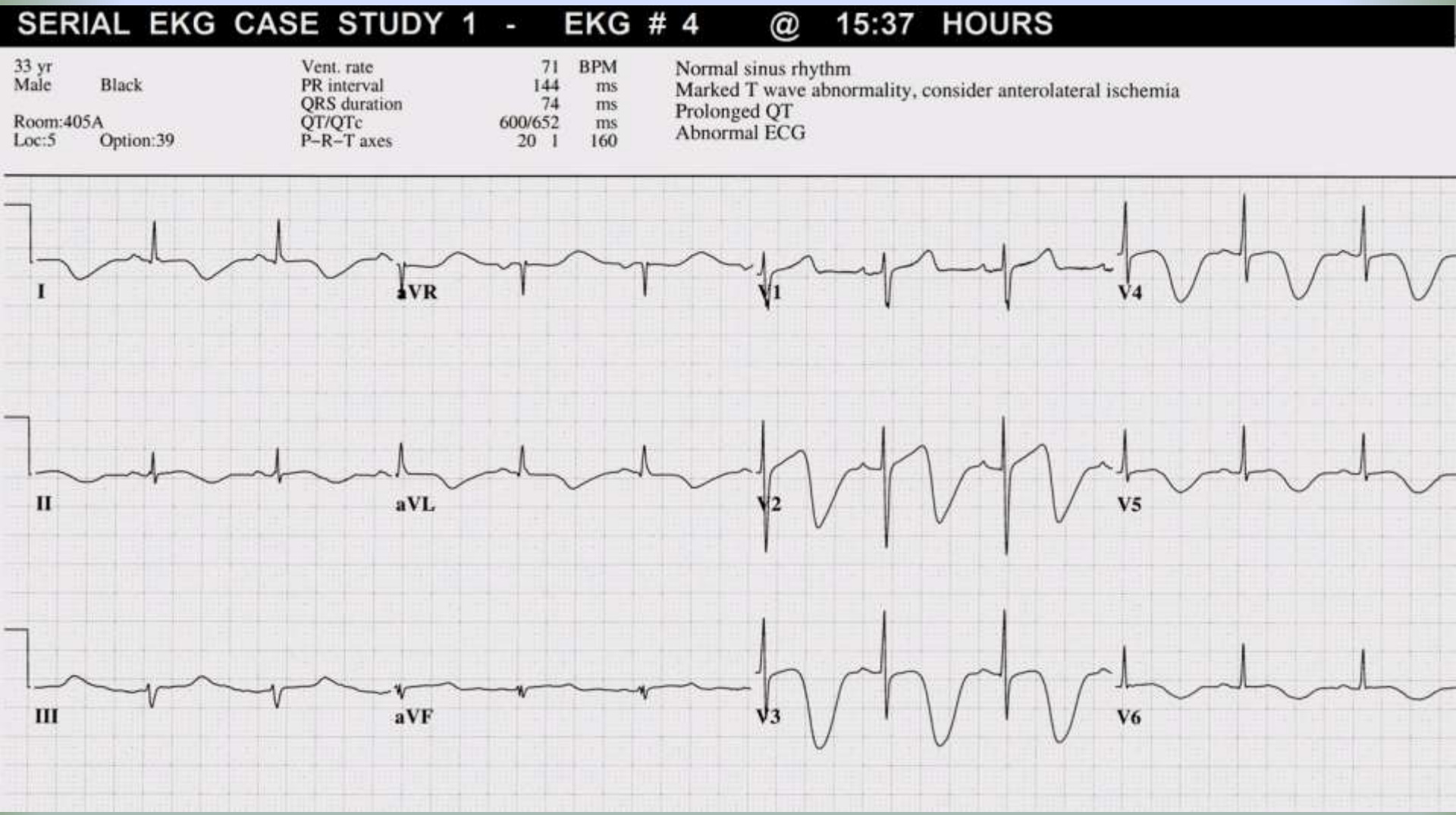
NOW

is the time for the STAT CALL to the CARDIOLOGIST !!!!

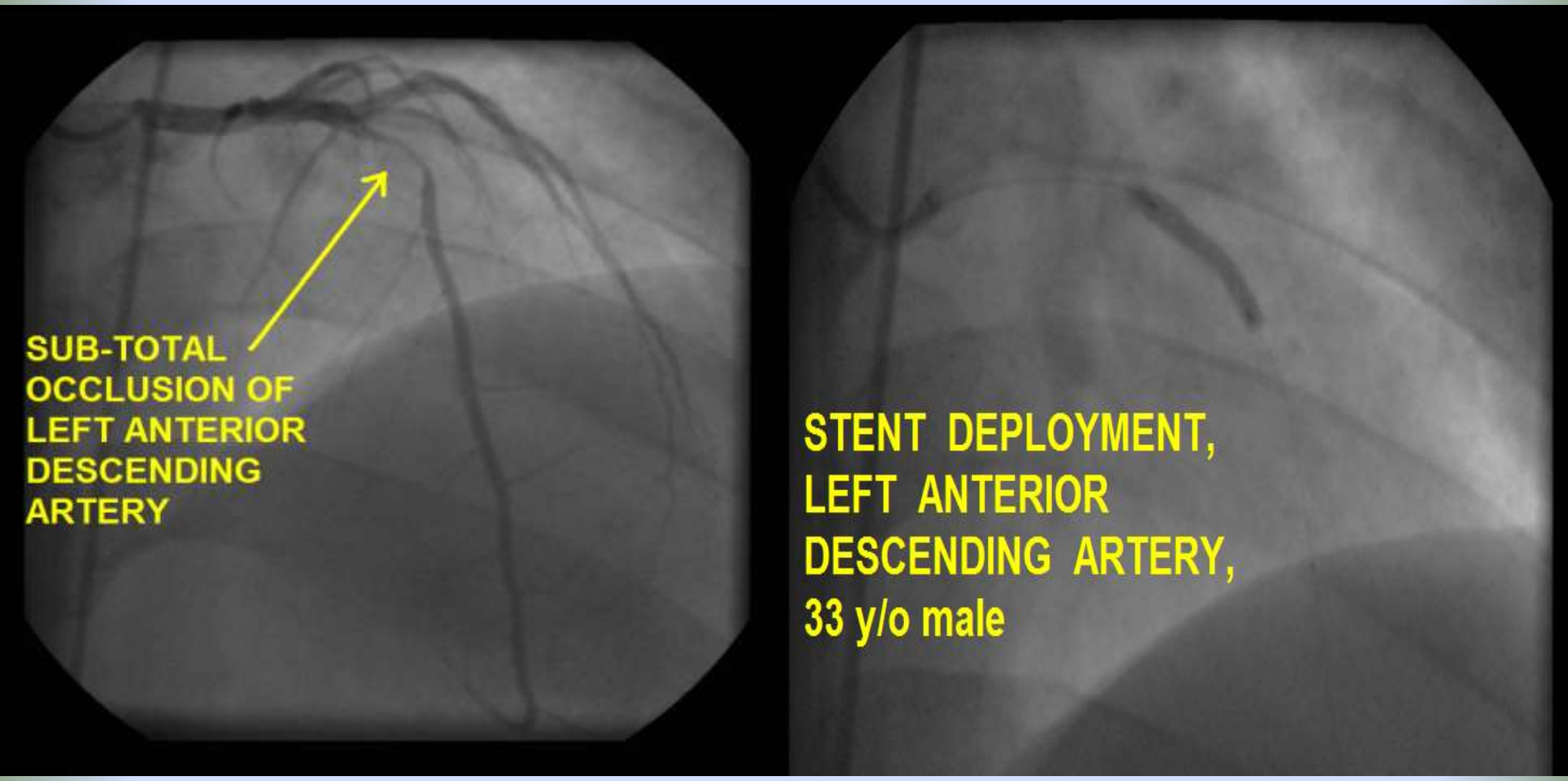
Wellen's Syndrome Case Study



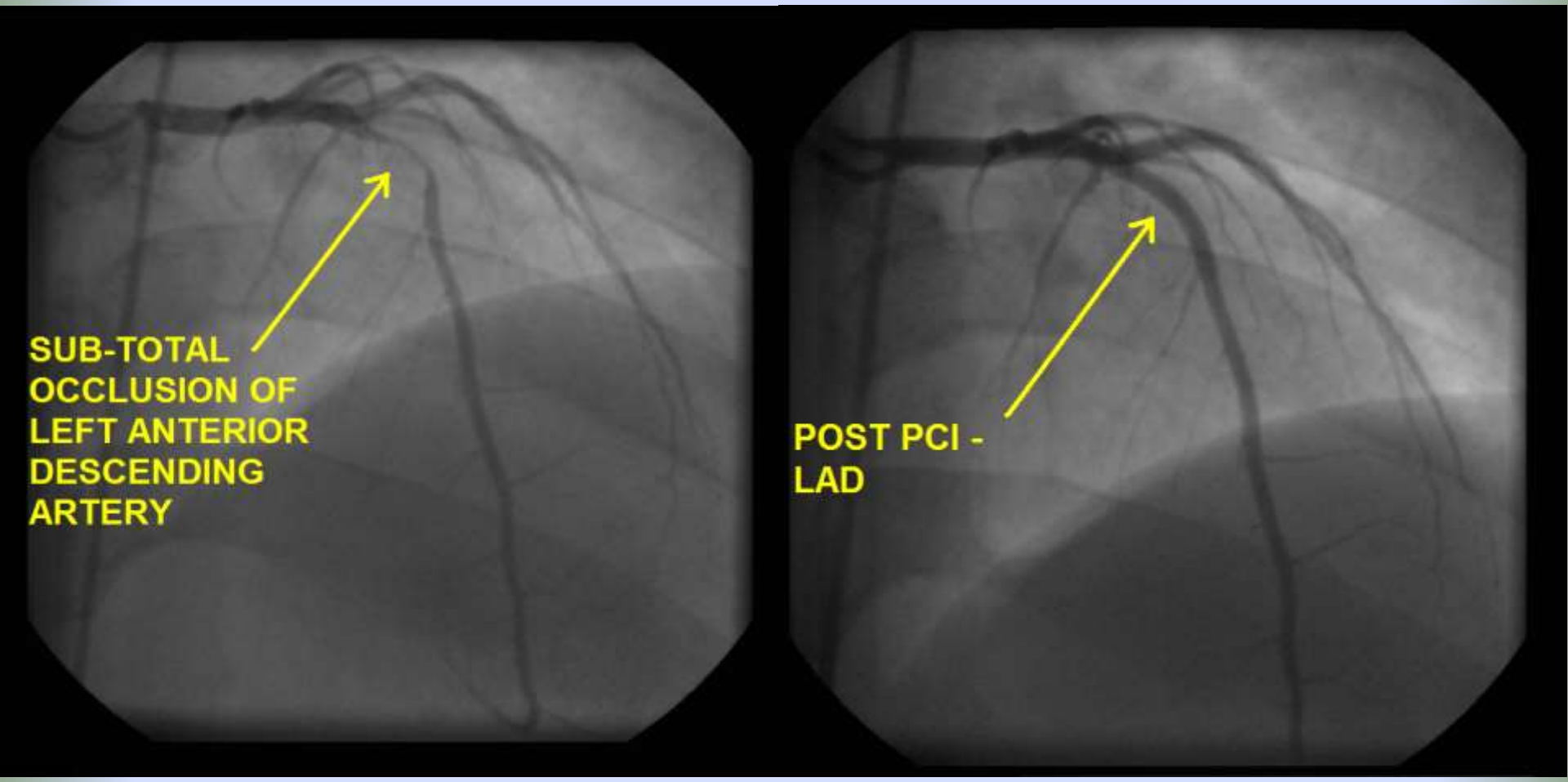
Wellen's Syndrome Case Study



Wellen's Syndrome Case Study



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

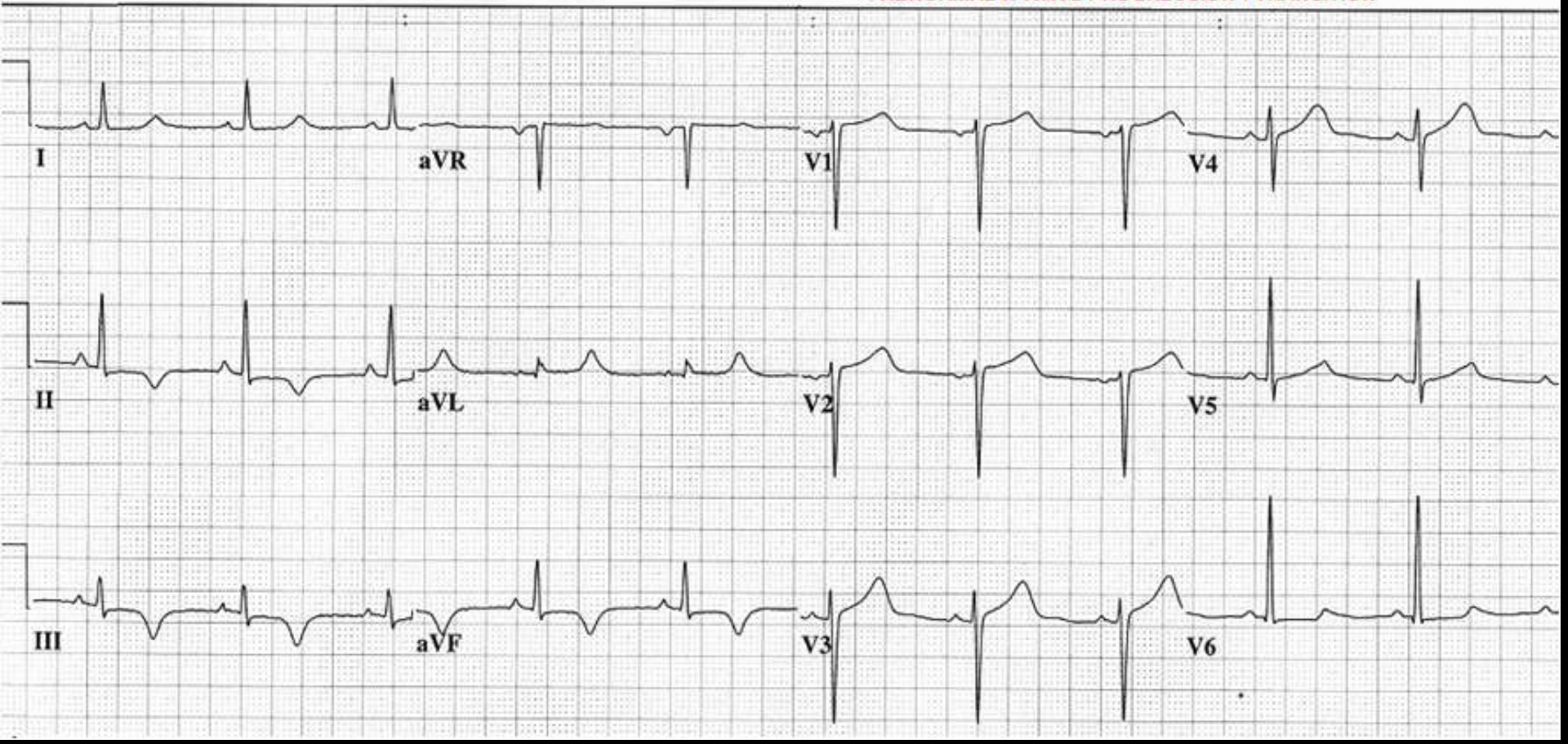
42 yr
Female Caucasian

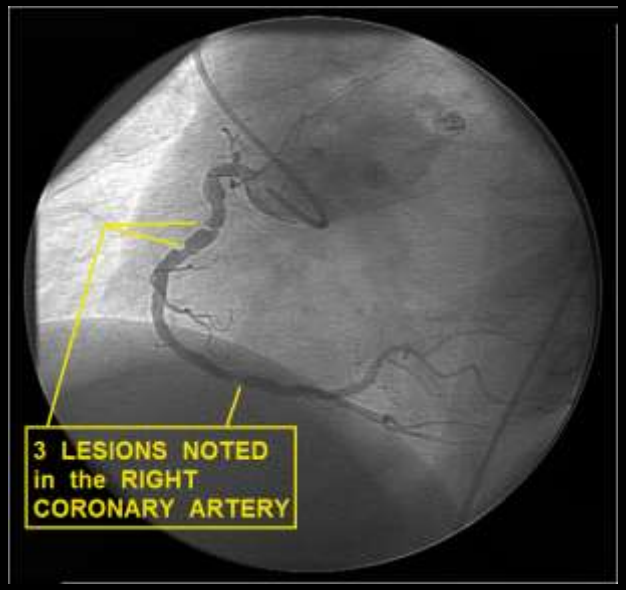
Room:S5
Loc:3 Option:23

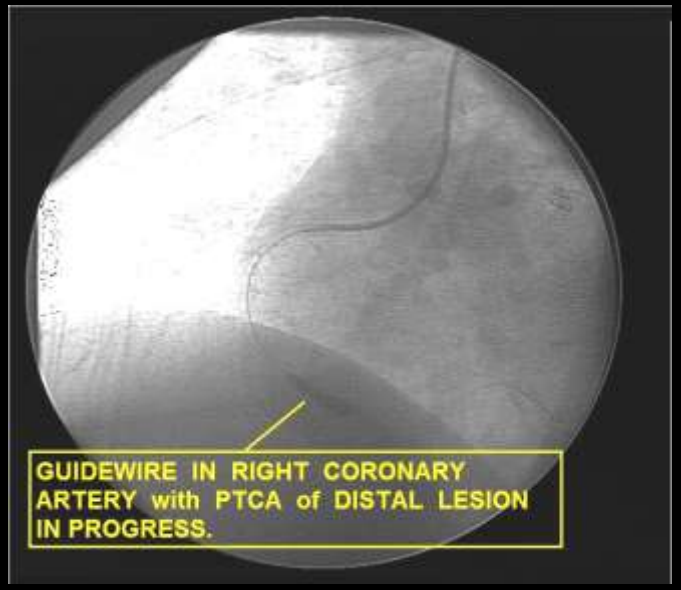
Vent. rate	63	BPM
PR interval	142	ms
QRS duration	74	ms
QT/QTc	462/472	ms
P–R–T axes	65 42	–72

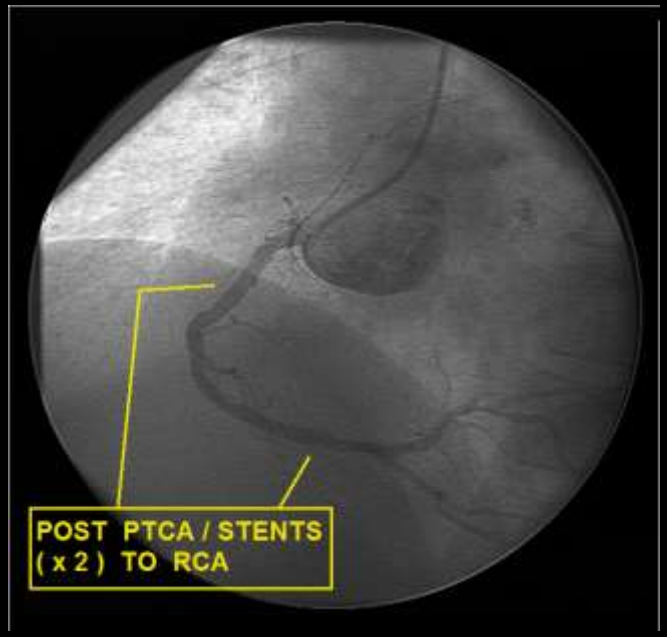
EVALUATE THE EKG FOR:

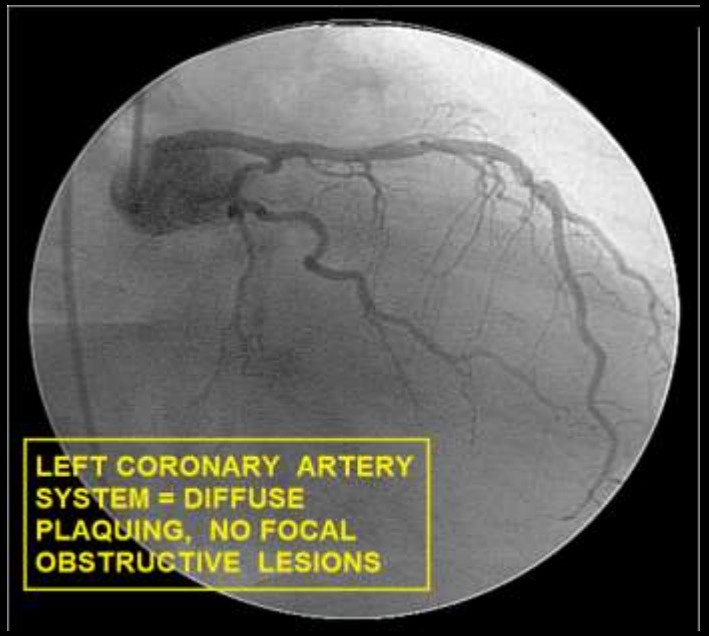
- ST SEGMENT ELEVATION / DEPRESSION
- HYPERACUTE T WAVES
- FLAT / CONVEX J-T APEX SEGMENTS
- OTHER ST-T WAVE ABNORMALITIES
- ABNORMAL R WAVE PROGRESSION / TRANSITION



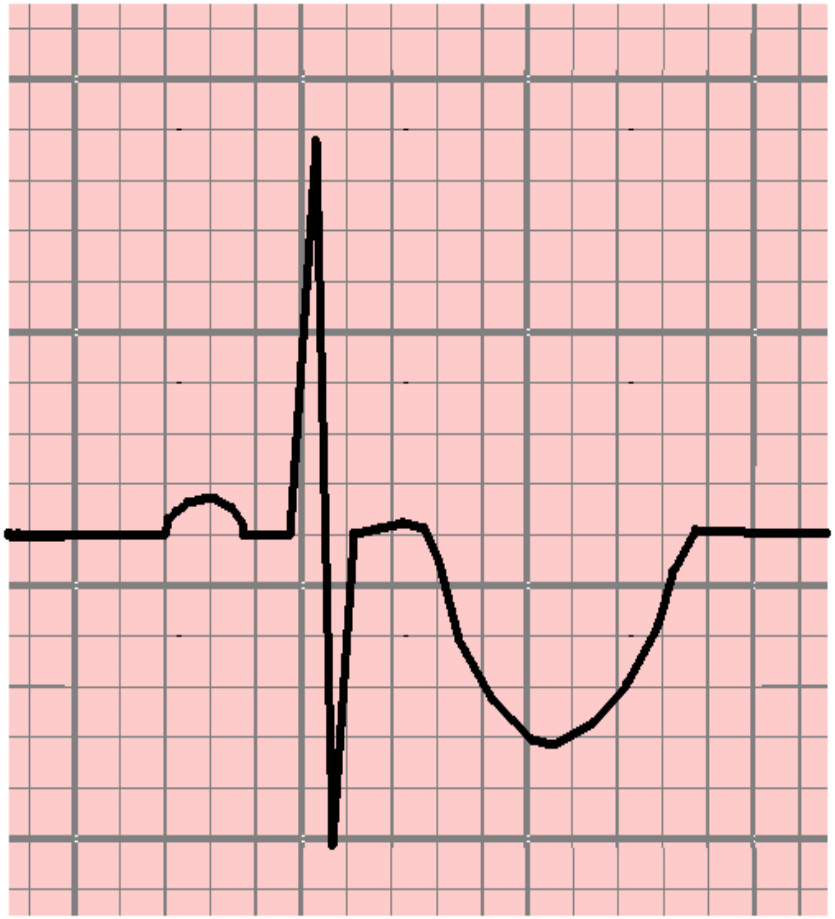

3 LESIONS NOTED
in the RIGHT
CORONARY ARTERY


GUIDEWIRE IN RIGHT CORONARY
ARTERY with PTCA of DISTAL LESION
IN PROGRESS.


POST PTCA / STENTS
(x 2) TO RCA


LEFT CORONARY ARTERY
SYSTEM = DIFFUSE
PLAQUING, NO FOCAL
OBSTRUCTIVE LESIONS

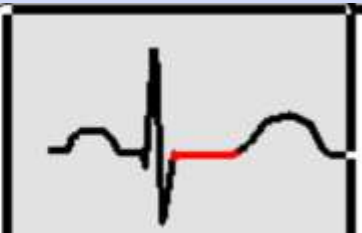
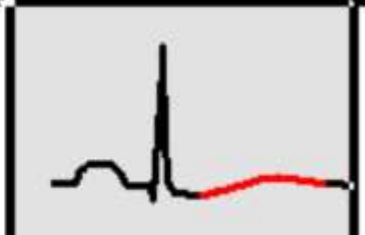
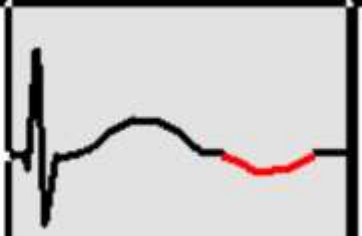
T WAVE INVERSION - COMMON ETIOLOGIES:



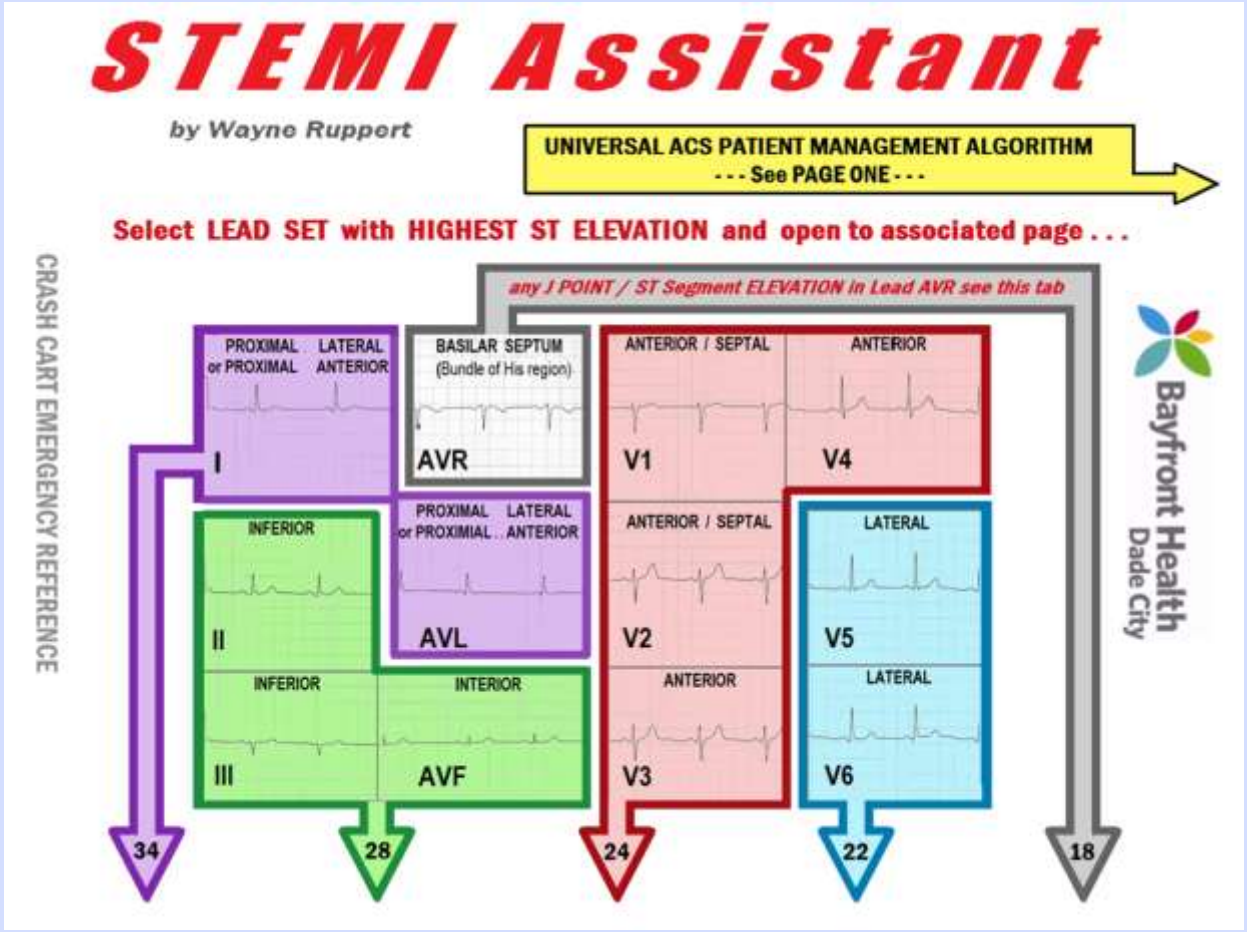
CONDITION:

- 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 . . .

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