BRAVERA HEALTH

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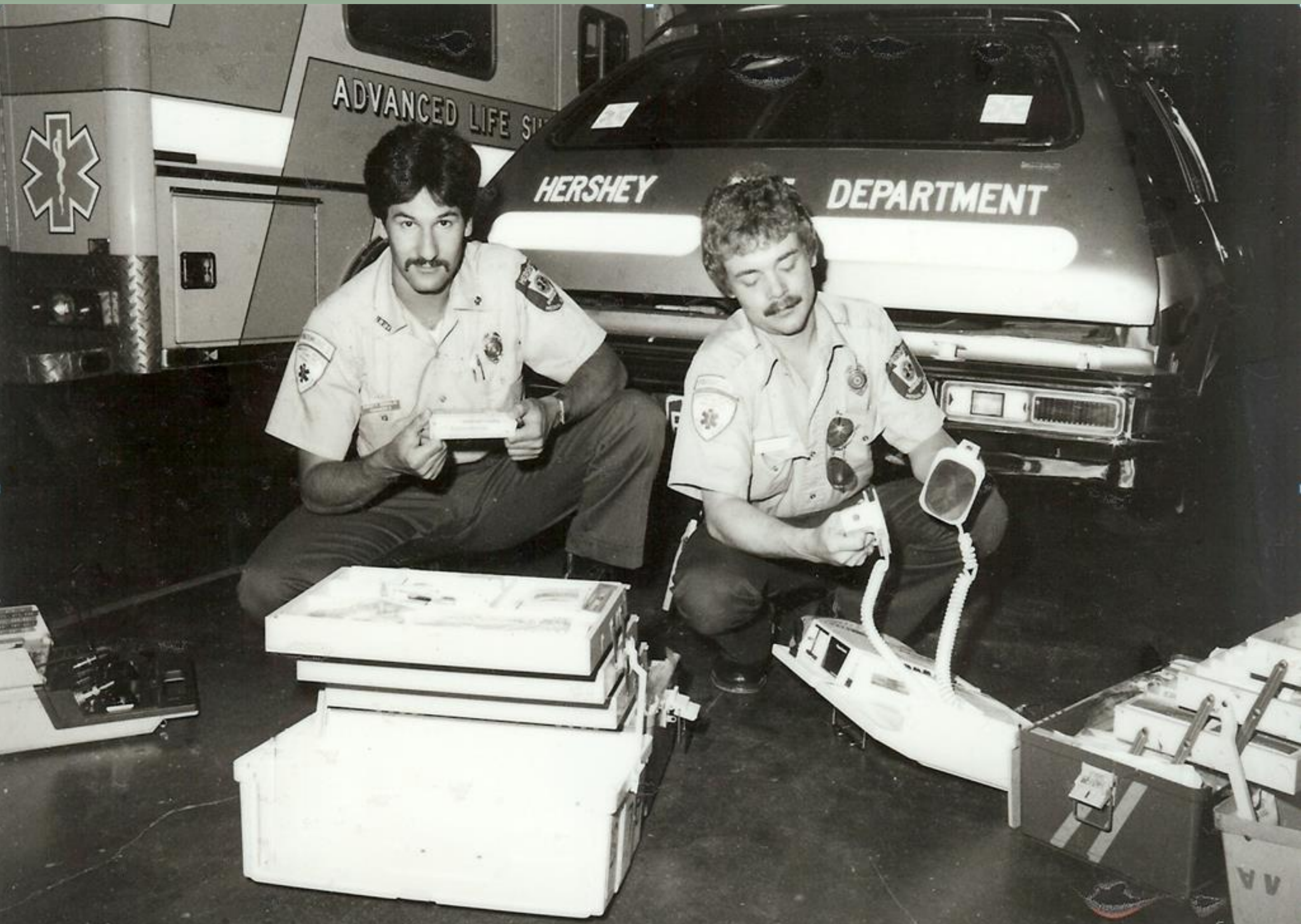
The INTEGRATED ECG

Wayne W Ruppert, CVT, CCCC, NREMT-P
Director of Clinical Outreach

Welcome !

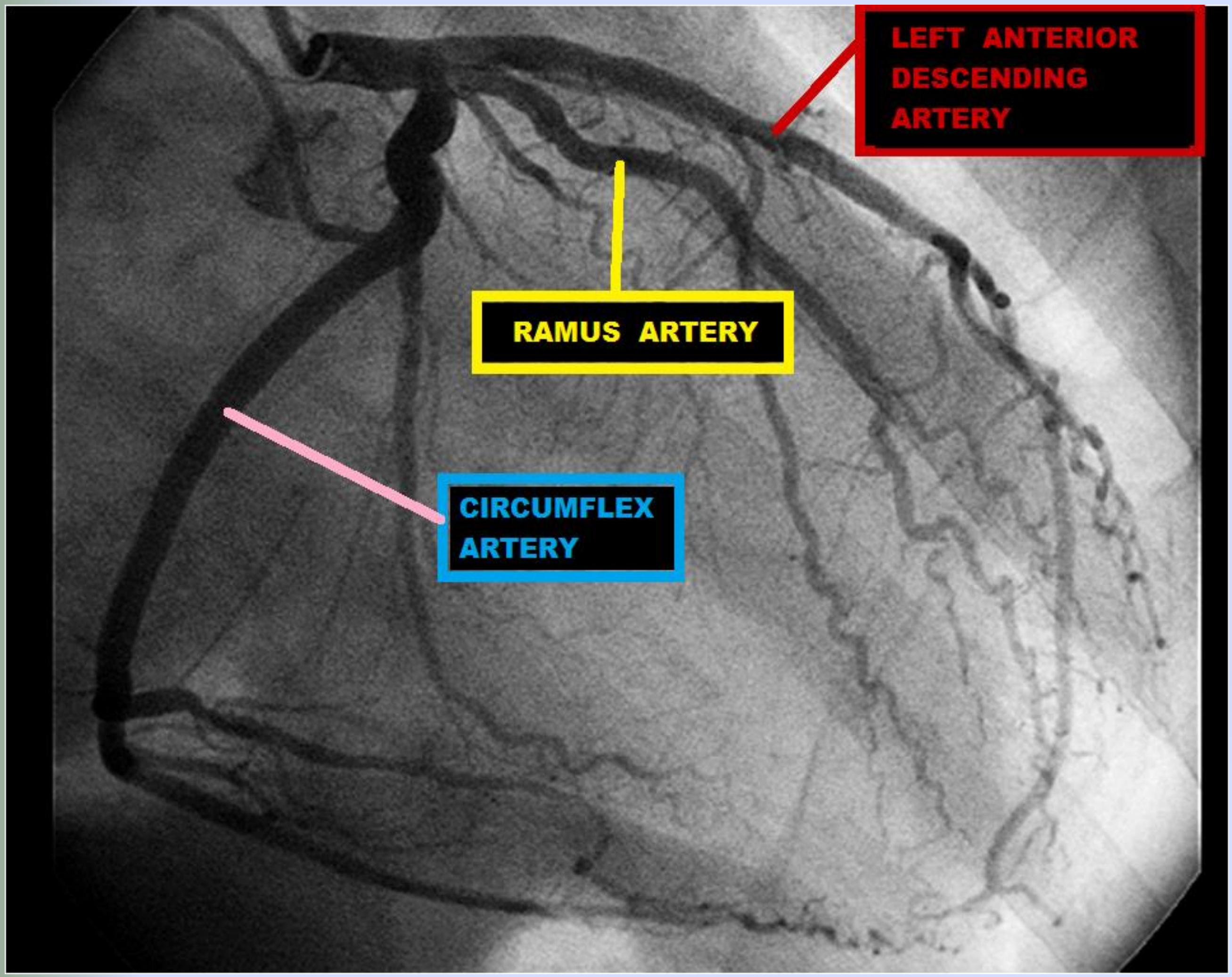


Paramedics Christ Megoulas and Wayne Ruppert, Hershey, PA Fire Department, 1982

13,000 – 15,000 EP and Cath Lab cases between 1996 - Today

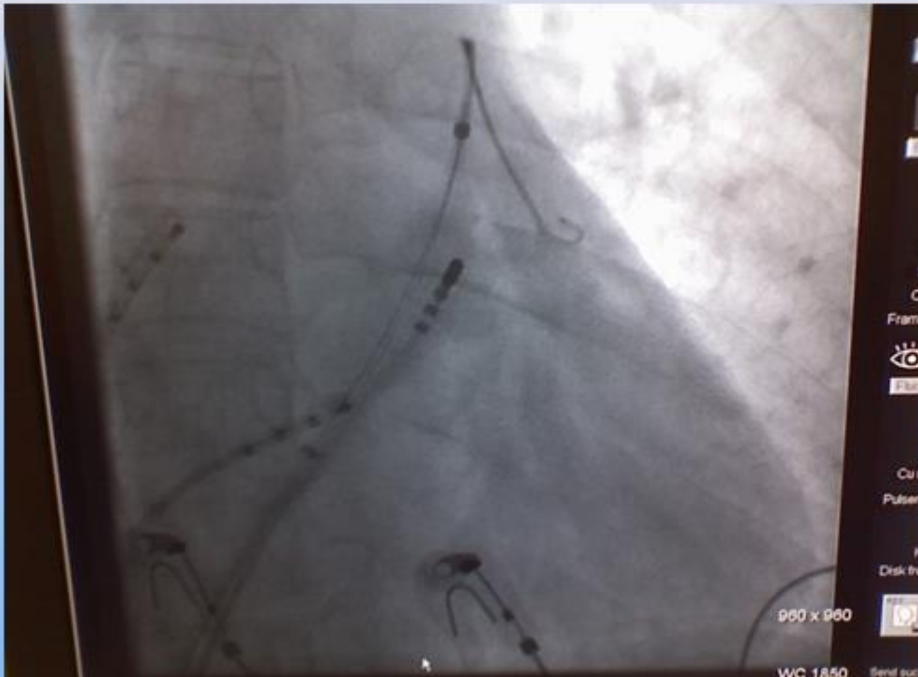
Wayne Ruppert and Dr. James Irwin, St Joseph’s Hospital, Tampa, 7/29/2004

Cardiac Cath Lab Advantage:



Correlation of ECG leads with SPECIFIC cardiac anatomic structures.

Electrophysiology Lab Case Studies



EP Catheters within the heart used for obtaining the Electrogram (the "internal ECG") Tracing and for Pace-mapping, an integral component of an EP study

Author Wayne Ruppert conducting Pace-mapping during EP study at the St Joseph's Hospital Heart Institute, Pediatric Electrophysiology Program, Tampa, FL in 2004

EP Lab Advantage:

Correlation of ECG derived diagnosis with true intra-cardiac electrogram acquired diagnosis.

Wayne Ruppert – Bio:

- 1978 – 1996   EMT-Paramedic
- 1996 – 2012 Interventional Cardiovascular Technologist Cardiac Cath Lab and Electrophysiology Labs
- 2012 – Present   Cardiovascular Programs Director / Coordinator

Wayne Ruppert - Bio:

- Cardiovascular Coordinator 2012-present (coordinated 7 successful accreditations)
- Interventional Cardiovascular / Electrophysiology Technologist, 1995-Present. (Approx 13,000 patients)
- Author of: "**12 Lead ECG Interpretation in Acute Coronary Syndrome with Case Studies from the Cardiac Cath Lab**," 2010, TriGen publishing / Ingram Books
- Author of: "**STEMI Assistant**," 2014, TriGen publishing / Ingram Books
- Florida Nursing CE Provider # 50-12998
- 12 Lead ECG Instructor, 1994-present (multiple hospitals, USF College of Medicine 1994)
- ACLS Instructor: 1982 - 2022
- Website: www.ECGtraining.org

Source of Curriculum:

- Case Studies from Cardiac Catheterization and Electrophysiology Labs, 1996 – Present

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- Current Evidence-based Research
  - Journal of the American College of Cardiology (JACC)
  - American Heart Association (AHA) Circulation
  - ACC/AHA Guidelines
  - New England Journal of Medicine

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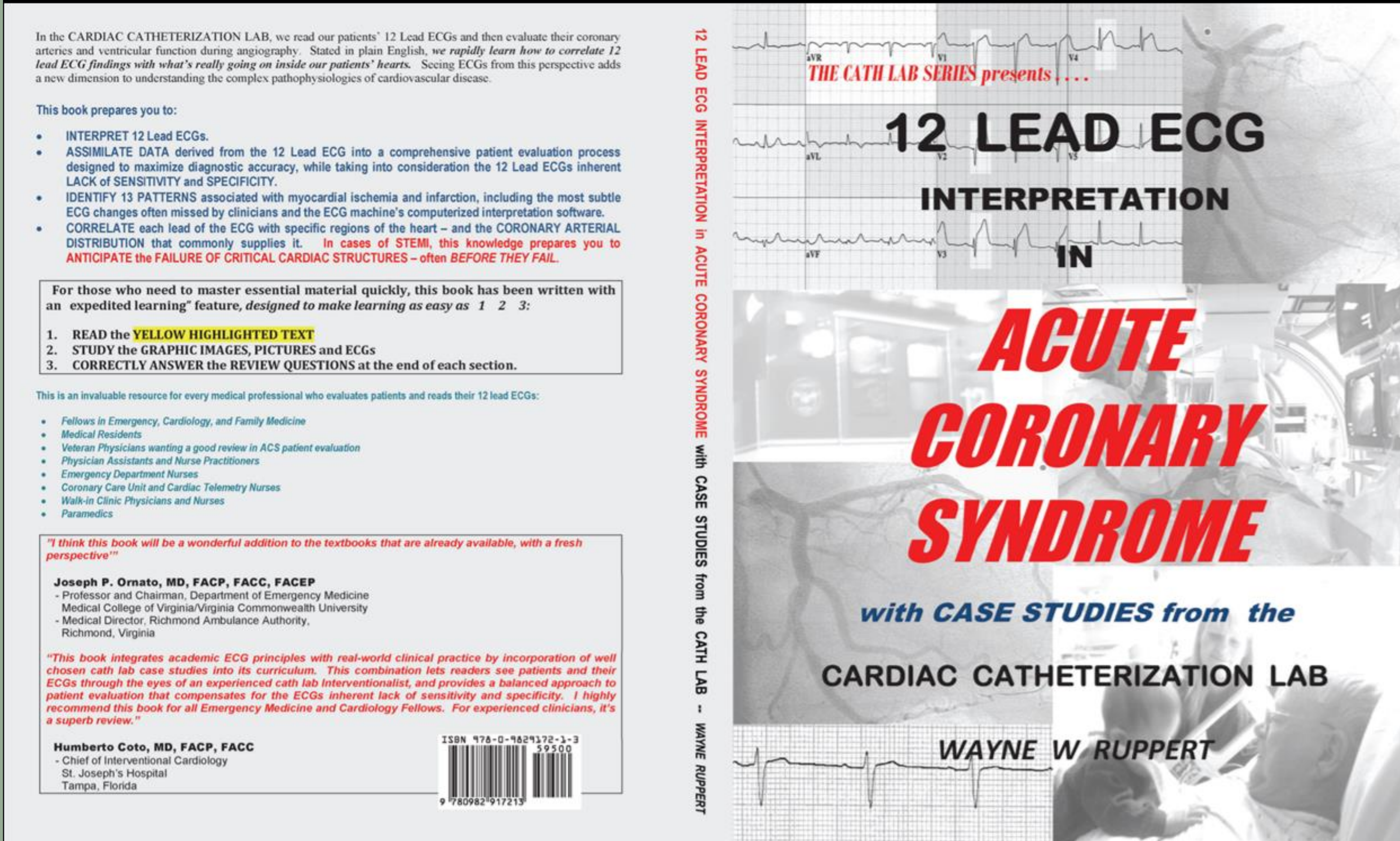
  - American Heart Association (AHA) Circulation
  - ACC/AHA Guidelines
  - New England Journal of Medicine
- Two peer reviewed, published textbooks



www.TriGenPress.com

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www.ECGtraining.org

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TEXTBOOK REVIEWED BY:

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2010 - Current

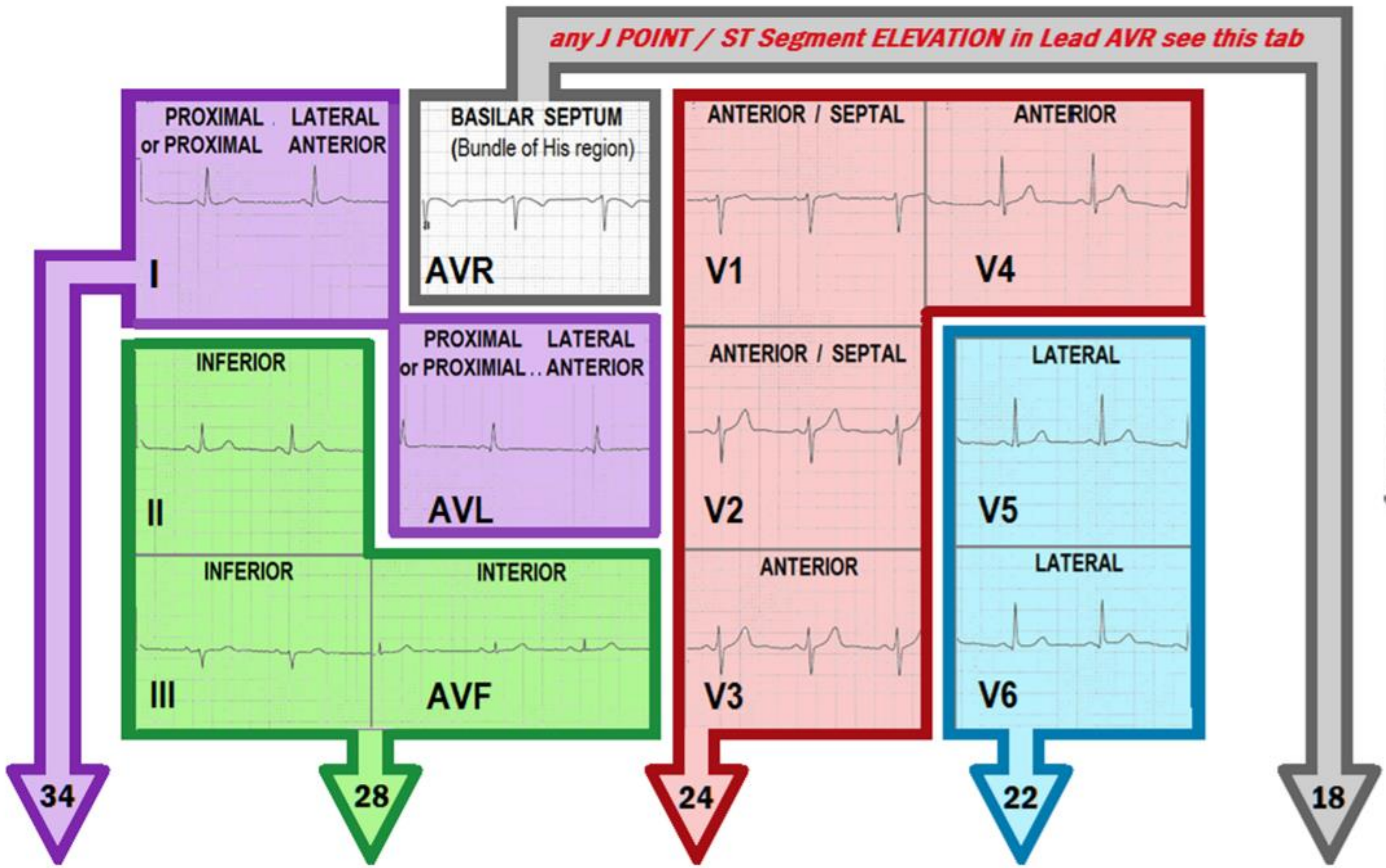
STEMI Assistant

by Wayne Ruppert

UNIVERSAL ACS PATIENT MANAGEMENT ALGORITHM
- - - See PAGE ONE - - -

Select LEAD SET with HIGHEST ST ELEVATION and open to associated page . . .

CRASH CART EMERGENCY REFERENCE



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William Parker, PharmD, CGP, Director of Pharmacy, Bayfront Dade City

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2010 - Current

STEMI Assistant

Tutorial Video

Free download – electronic copy (PDF file)

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www.practicalclinicalskills.com

www.skillstat.com/tools/ecg-simulator

www.ECGtraining.org

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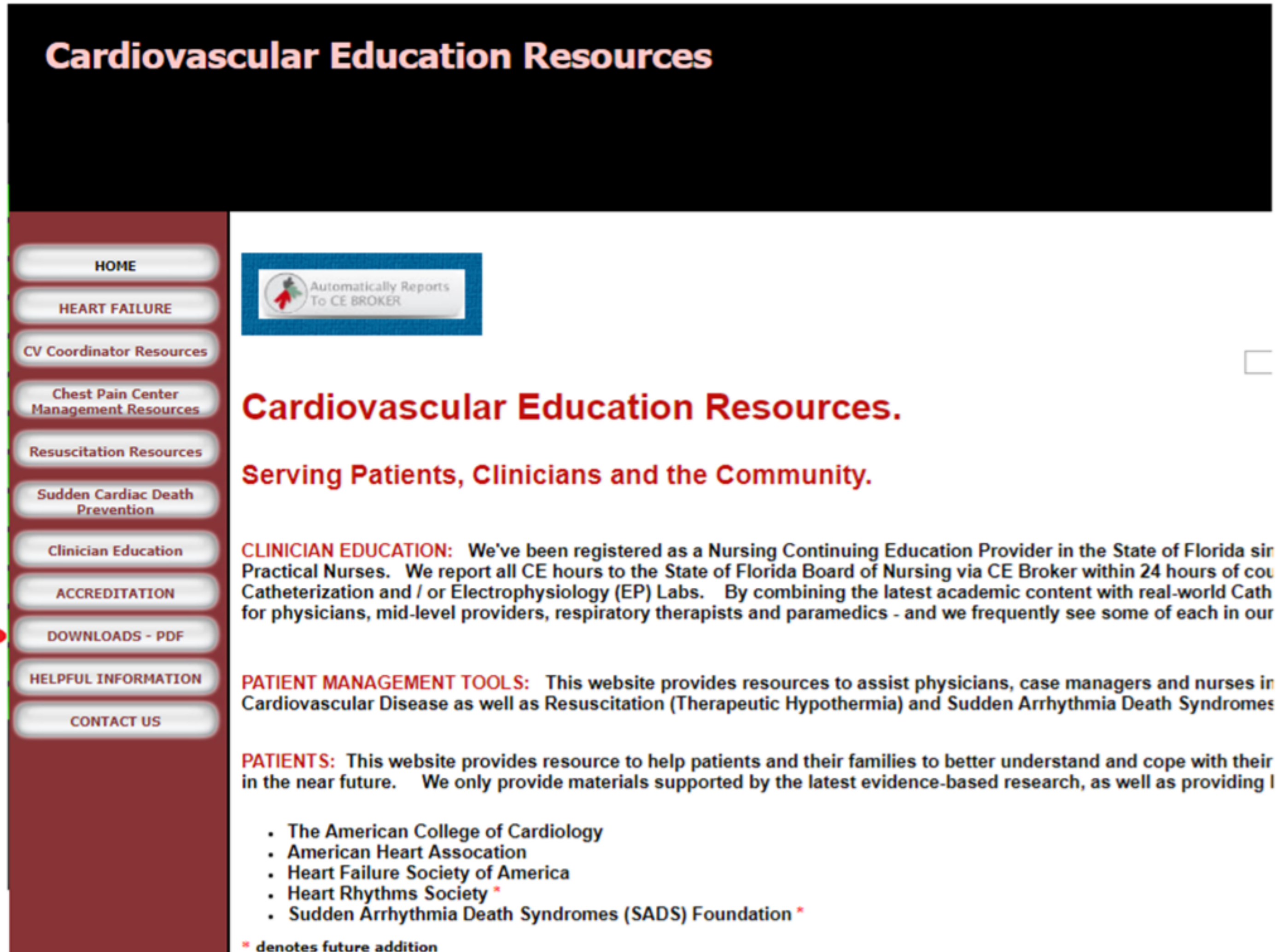

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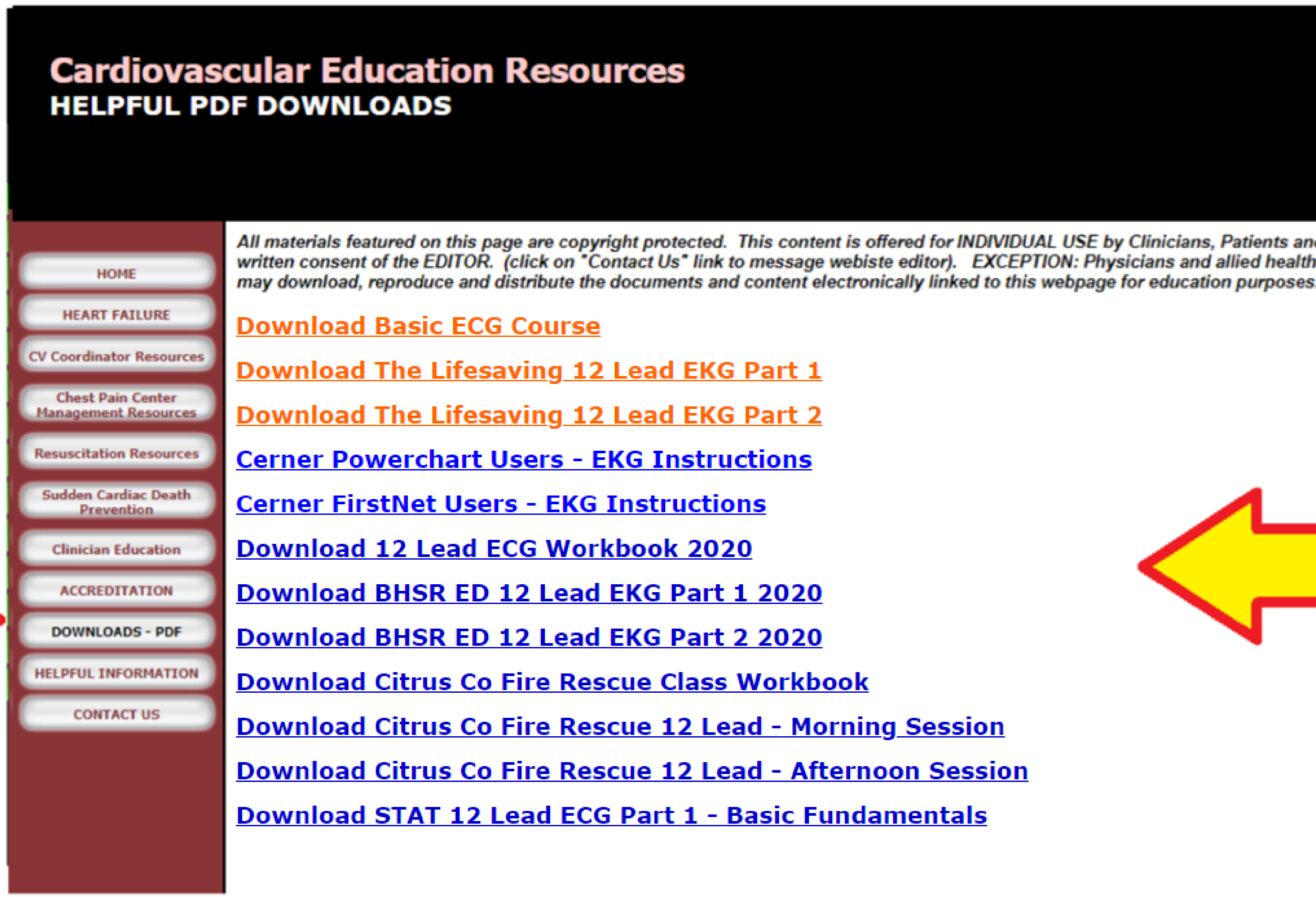

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Cerner Powerchart Users - EKG Instructions

Cerner FirstNet Users - EKG Instructions

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Download Citrus Co Fire Rescue Class Workbook

Download Citrus Co Fire Rescue 12 Lead - Morning Session

Download Citrus Co Fire Rescue 12 Lead - Afternoon Session

Download STAT 12 Lead ECG Part 1 - Basic Fundamentals

Integrated ECG:

PATIENT'S HEMODYNAMIC STATUS

+

SYMPTOMS

+

ECG

Integrated ECG:

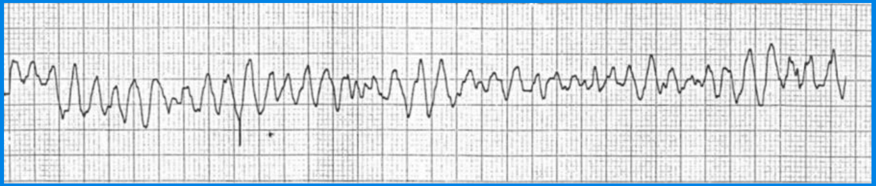
- HEMODYNAMIC STATUS
  - ABCs
  - Shock
- SYMPTOMS
  - Chest Pain / Pressure
  - Other ACS Symptoms
- ECG
  - 12 Lead
  - Single Lead “rhythm strip”

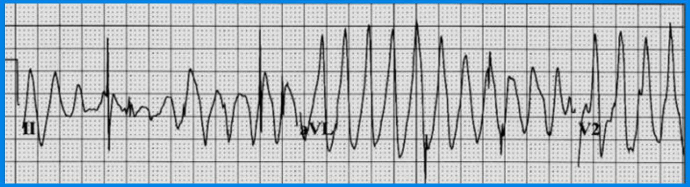
Integrated ECG:

- HEMODYNAMIC STATUS
  - ABCs (Airway open? + Breathing? + Pulse?)

If there is **NO PULSE** . . . .

- **Start CPR**
- **Apply ECG** – determine rhythm- shockable?
  - **SHOCKABLE:** V-fib / V-tach / Torsades





Defib 120-200 BiPhasic
- IV Access
- Advanced Airway

Defib 120-200 or HIGHER
- Epinephrine 1mg IV

Defib 120-200 or HIGHER
- Amiodarone 300mg - OR – Lidocaine 1.0 -1.5 mg/kg

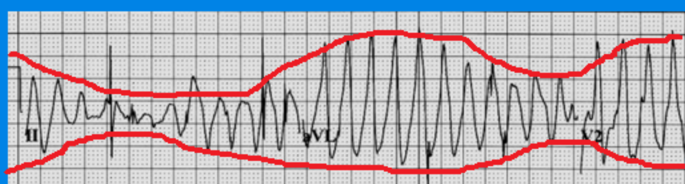
Defib 120-200 or HIGHER
- Epinephrine 1mg IV

Defib 120-200 or HIGHER
- CONTINUE as per ACLS....

If there is **NO PULSE** . . . .

- **Start CPR**
- **Apply ECG** – determine rhythm- shockable?
  - **SHOCKABLE:** V-fib / V-tach / Torsades

Torsades de Pointes . . . the QRS pattern resembles a "TWISTED RIBBON" . . . .



CONSIDER using Lidocaine in place of Amiodarone due to the increased possibility of QT PROLONGATION . . .

Defib 120-200 BiPhasic
- IV Access
- Advanced Airway

Defib 120-200 or HIGHER
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- ~~Amiodarone 300mg~~ – OR –
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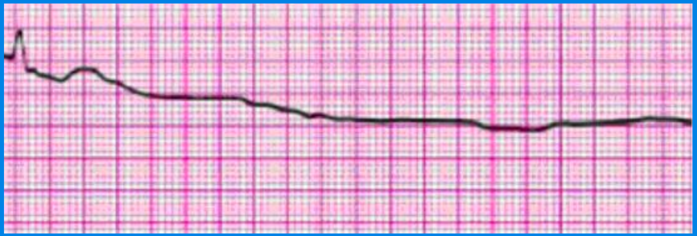
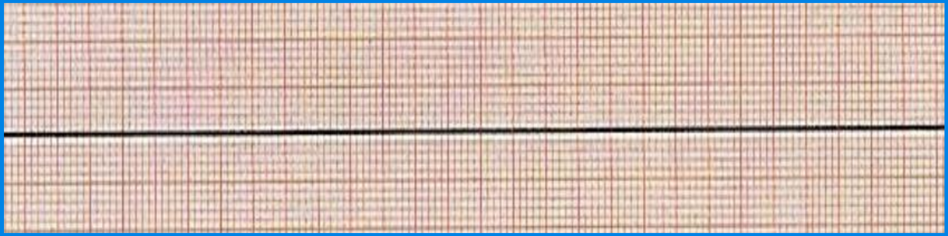
If there is **NO PULSE** . . . .

- **Start CPR**
- **Apply ECG** – determine rhythm- shockable?
  - **NOT SHOCKABLE:** Agonal Rhythm / Asystole / PEA

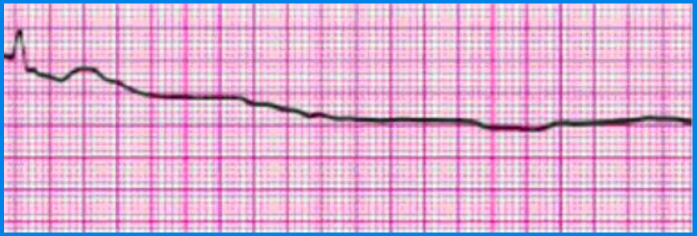




- Continue CPR
- IV/IO Access
- Advanced Airway
- Epinephrine 1mg IV
- Rule out reversible causes
- CONTINUE as per ACLS….

If there is **NO PULSE** . . . .

- **Start CPR**
- **Apply ECG** – determine rhythm- shockable?
  - **NOT SHOCKABLE:** Agonal Rhythm / Asystole / PEA



if the patient
HAS A PULSE with
AGONAL COMPLEXES . . . .
IMMEDIATELY BEGIN TRANSCUTANEOUS
PACING -
you will probably save the patient's life !

- Continue CPR
- IV/IO Access
- Advanced Airway
- Epinephrine 1mg IV
- Rule out reversible causes
- CONTINUE as per ACLS....

Integrated ECG:

- HEMODYNAMIC STATUS
  - ABCs
  - Shock Assessment

SHOCK ASSESSMENT

SHOCK =

INADEQUTE TISSUE PERFUSION

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

SHOCK ASSESSMENT

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

SHOCK

is

THE

CORRIDOR

TO

DEATH

SHOCK – FIND CAUSE . . .

- HYPOVOLEMIC (internal or external bleeding)
- OBSTRUCTIVE (PE / tamponade)
- PSYCHOGENIC (sudden fear – self-correcting)
- NEUROLOGICAL (spinal injury)
- INSULIN (hypoglycemia)
- SEPTIC (systemic infection)
- CARDIOGENIC (abnormal heart rate or contractility)

Actions at the Scene:

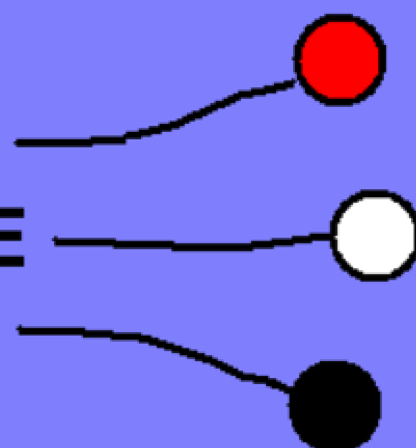
- Vital signs
- ECG
- Verbal history
- O2 (if indicated)
- IV (if indicated)

THE EKG MACHINE

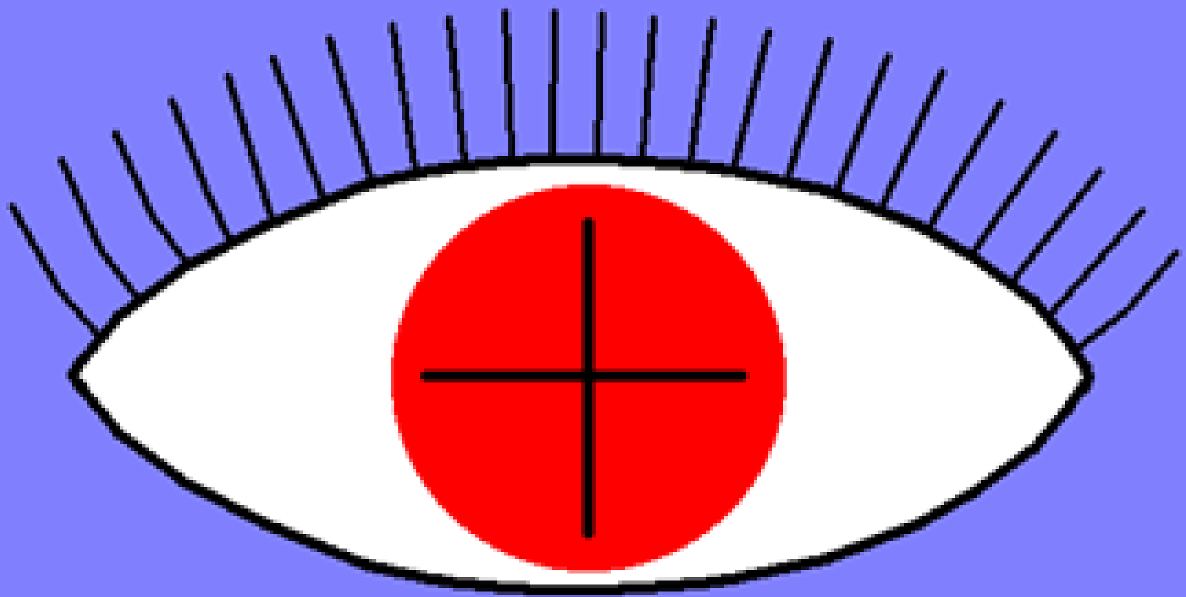
STANDARD 12 LEADS - USES 10 WIRES
(6 CHEST and 4 LIMB)

- I, II, III, and V1, V2, V3, V4, V5, V6
EACH CONSIST OF:

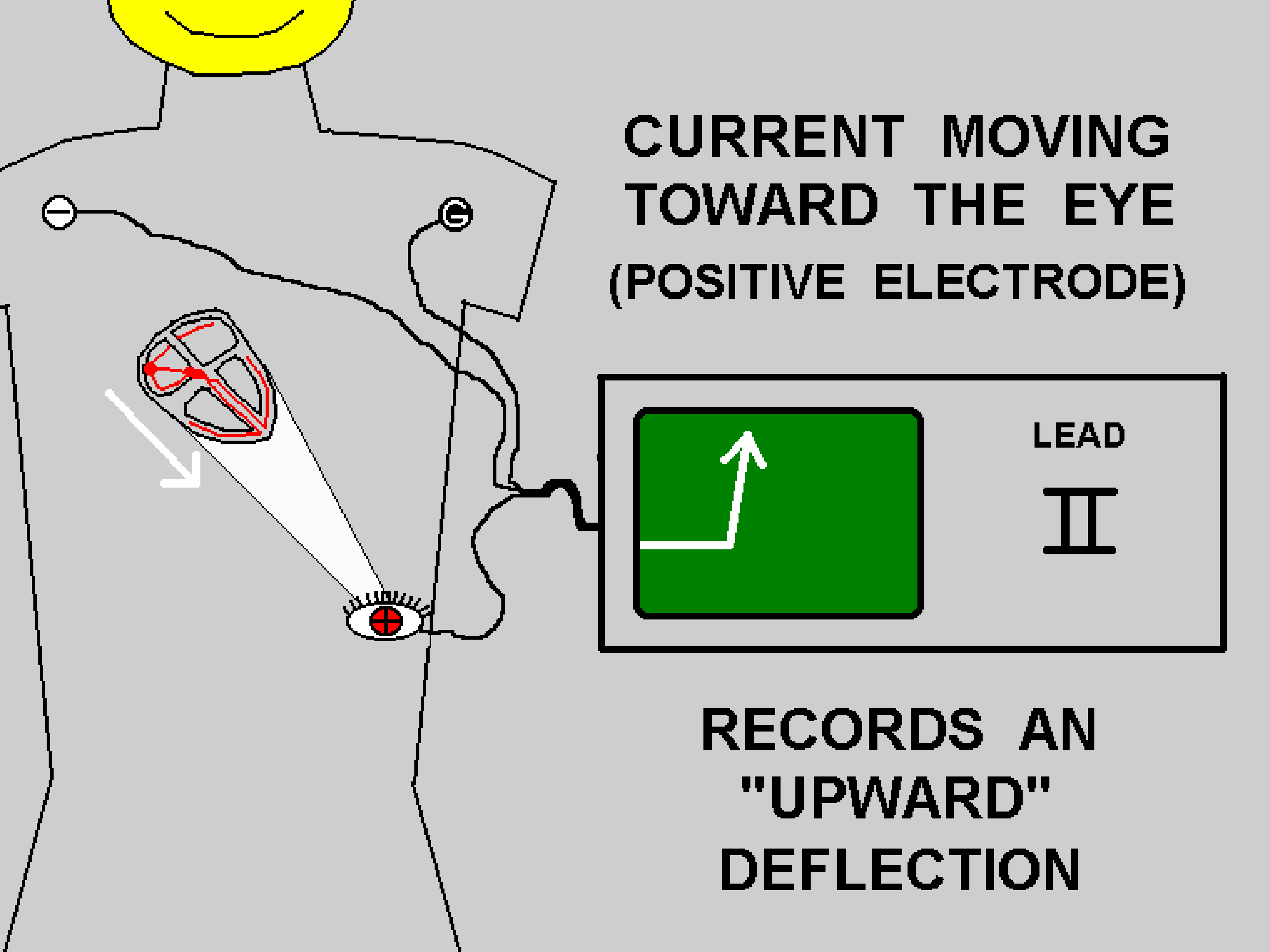
1 POSITIVE ELECTRODE
1 NEGATIVE ELECTRODE
1 GROUND ELECTRODE

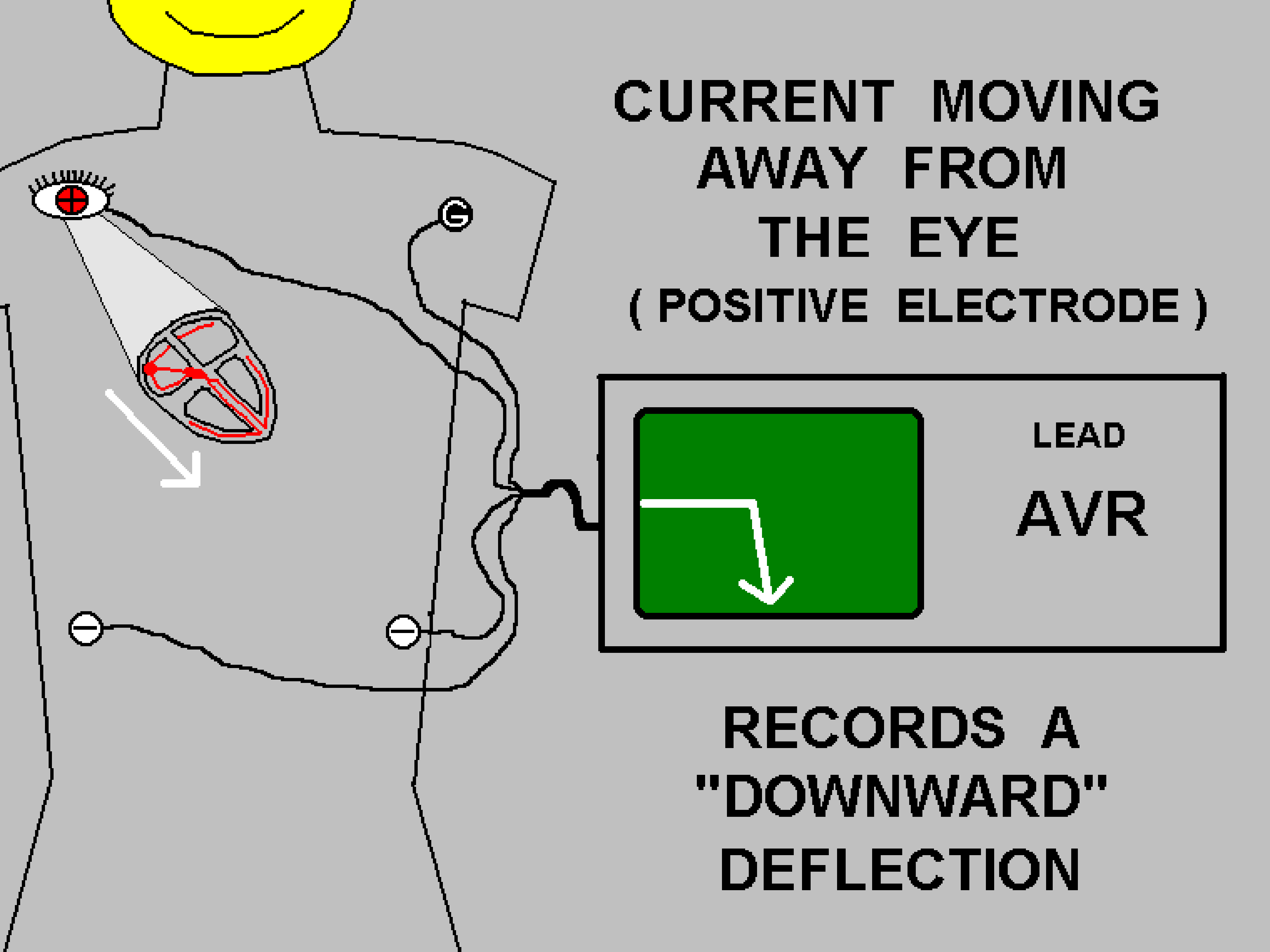


THE POSITIVE ELECTRODE



IS THE "EYE" . . .


CURRENT MOVING
TOWARD THE EYE
(POSITIVE ELECTRODE)
LEAD
II
RECORDS AN
"UPWARD"
DEFLECTION


CURRENT MOVING
AWAY FROM
THE EYE
(POSITIVE ELECTRODE)
G
LEAD
AVR
RECORDS A
"DOWNWARD"
DEFLECTION

CARDIOGENIC SHOCK

- **Heart Rate:**
  - **Should be between 50 – 150**

CARDIOGENIC SHOCK

- **Heart Rate:**
  - **Should be between 50 – 150**

DECREASED CARDIAC OUTPUT may be present when heart rate is:

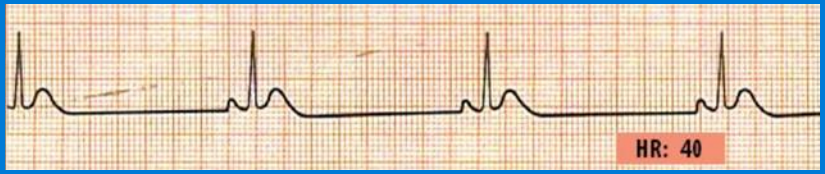
- **LESS THAN 50**
- **GREATER THAN 150**

CARDIOGENIC SHOCK

- **Heart Rate**
  - **TOO SLOW (less than 50) with signs of shock:**

☞ ***SPEED UP THE HEART RATE***

(follow ACLS and Protocols)

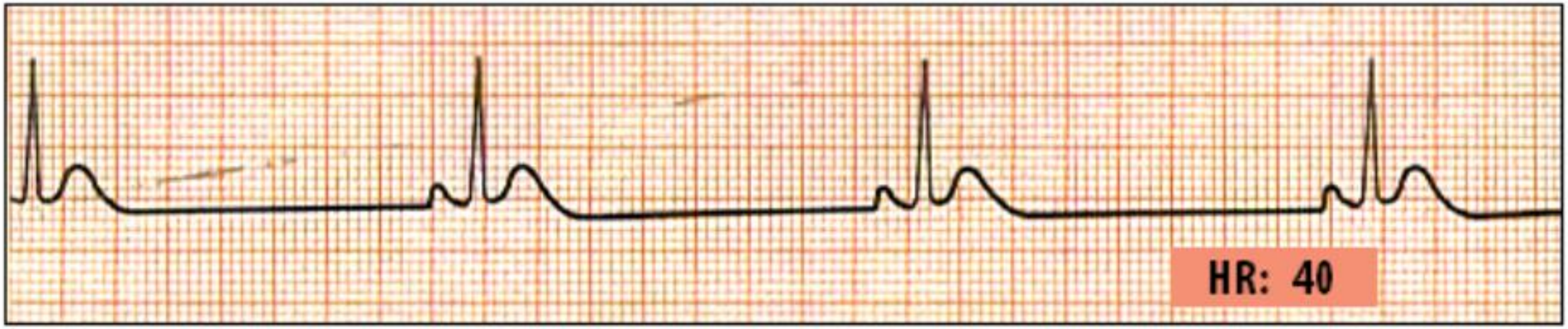


Usual treatment:
- Atropine
- Pacemaker

Bradycardias & Heart Block

- There are several ECG Rhythms seen with “BRADYCARDIA”
- While you should be able to distinguish each rhythm, what is MORE IMPORTANT is that you simply “identify when the heart rate being TOO SLOW is causing the patient to be symptomatic (SHOCK) . . . .and that you. . .
- KNOW how to treat it.

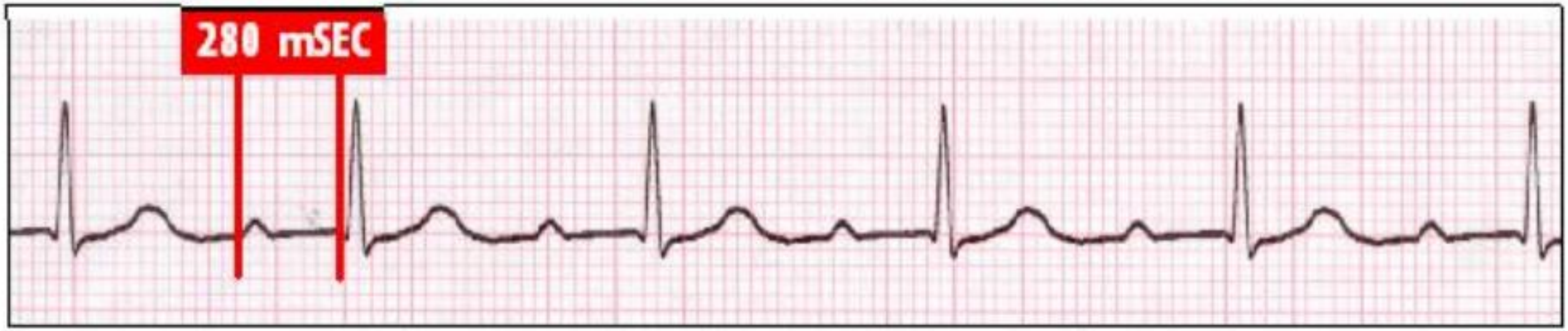
THIS RHYTHM IS: SINUS BRADYCARDIA



WE MUST CONSIDER UNDERLYING CAUSES: AND TREAT THEM:

WE MUST CONSIDER UNDERLYING CAUSES:		AND TREAT THEM:
INCREASED VAGAL TONE	→	ATROPINE
BLOCKED SA NODAL ARTERY (INFERIOR WALL MI)	→	CARDIAC CATH - PTCA / STENT THROMBOLYTICS
ELECTROLYTE IMBAL. (K+)	→	CORRECT ELECTROLYTES
HYPOTHERMIA	→	WARM PATIENT
ORGANOPHOSPHATE POISONING	→	ATROPINE
ATHLETIC METABOLISM (excellent health!)	→	COMPLIMENT PATIENT!

THIS RHYTHM IS: FIRST DEGREE HEART BLOCK



MAIN IDENTIFICATION CHARACTERISTIC(S): P-R INTERVAL TOO LONG - (GREATER THAN 200 mSEC.)

RATE ----------------	NORMAL
RHYTHM ------------	REGULAR
P-R INTERVAL -----	> 200 mSEC.
P:QRS RATIO ------	1:1
QRS INTERVAL ----	NORMAL

P : QRS RATIO

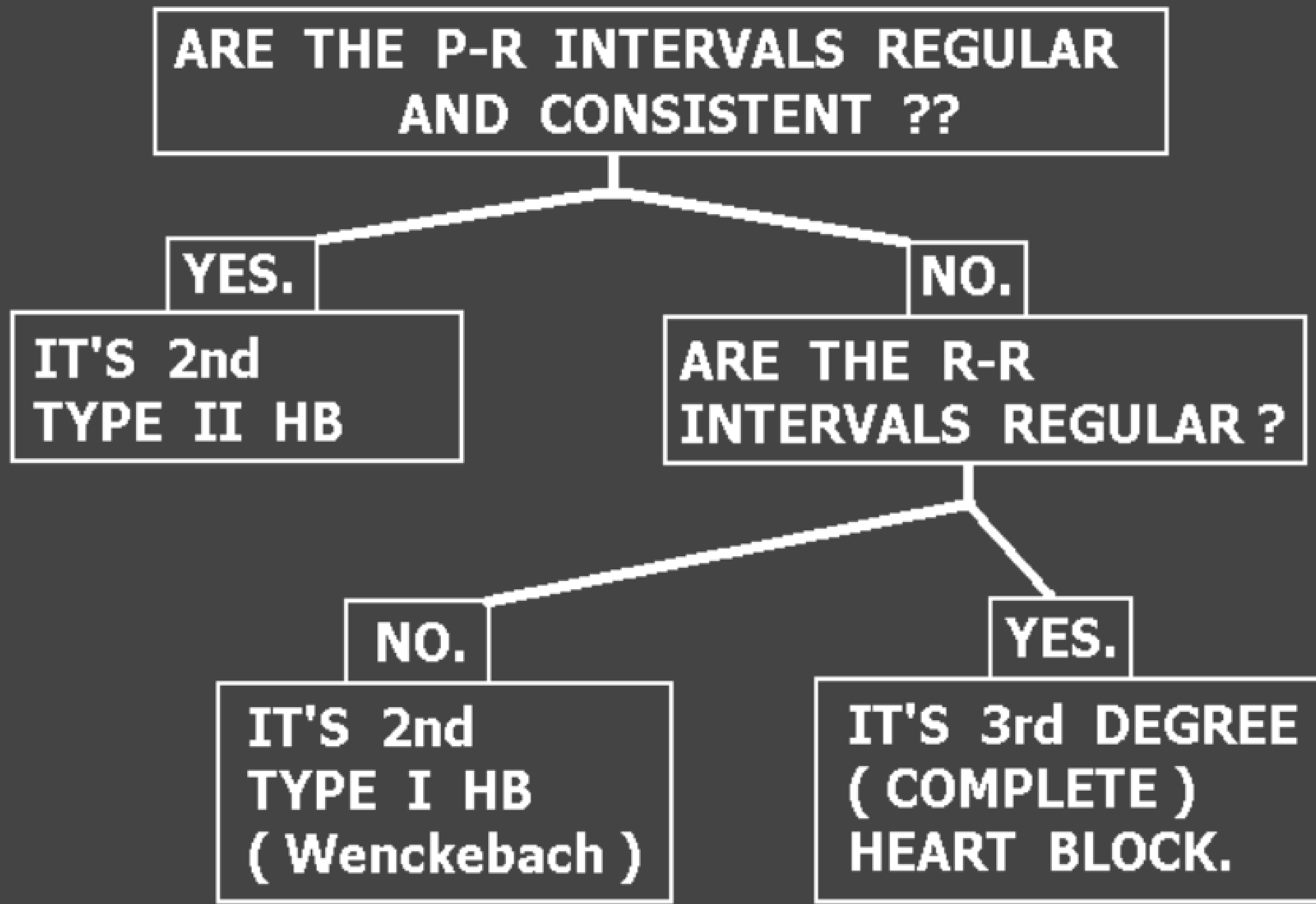
IF GREATER THAN 1 : 1

THINK:

- 2° HEART BLOCK
  (TYPE 1 or 2)
- 3° HEART BLOCK

DIAGNOSING 2nd and 3rd DEGREE HEART BLOCK

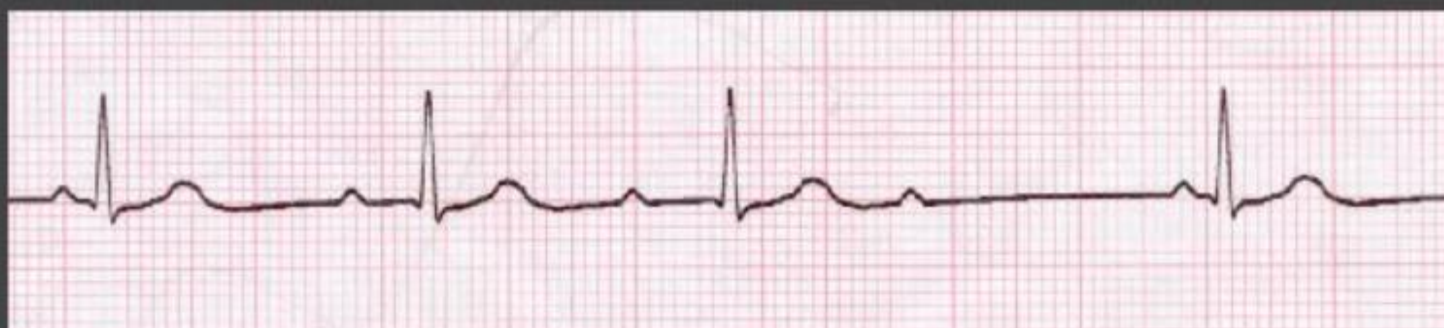
MORE P-WAVES THAN QRS COMPLEXES PRESENT.



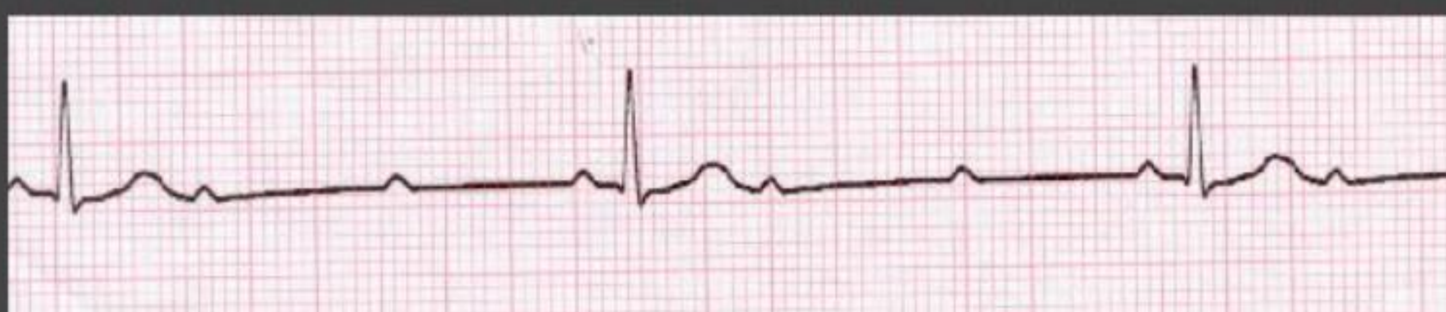
LET'S TEST THE PROCEDURE . . .

1

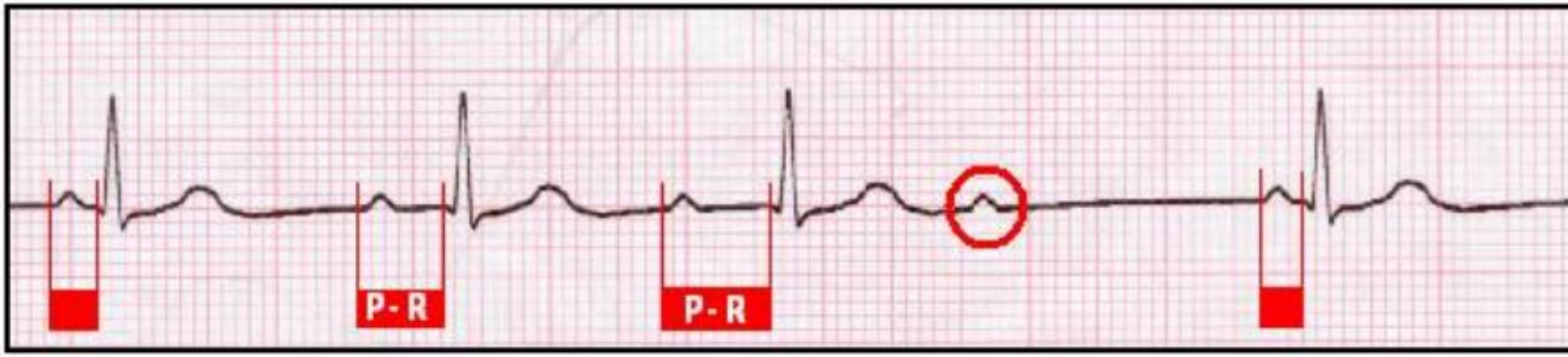
2



3



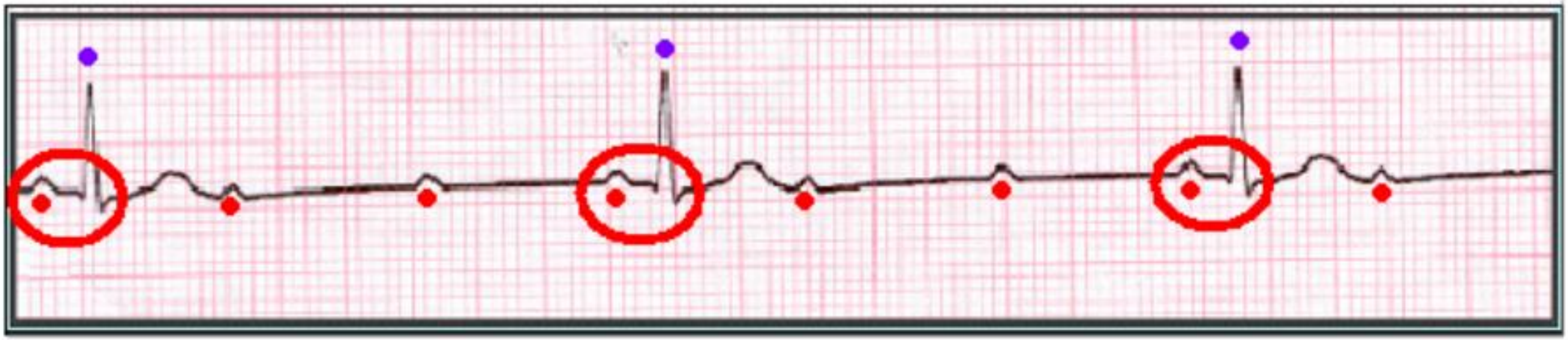
THIS RHYTHM IS: 2nd ° TYPE I HB (Wenckebach)



MAIN IDENTIFICATION CHARACTERISTIC(S): P-R INTERVAL GETS PROGRESSIVELY LONGER UNTIL IT DROPS A QRS -- THEN CYCLE REPEATS

RATE ---------------- NORMAL or BRADYCARDIC
RHYTHM ----------- REGULARLY IRREGULAR
P-R INTERVAL ----- VARIES (regularly irregular)
P: QRS RATIO ------ VAIRES (usually 1:1 and 2:1)
QRS INTERVAL ---- NORMAL

THIS RHYTHM IS: 2nd° TYPE II HEART BLOCK



MAIN IDENTIFICATION CHARACTERISTIC(S): MORE THAN ONE P WAVE FOR EACH QRS -- <u>BUT EVERY QRS HAS A NORMAL, CONSISTENT P-R INTERVAL</u>

RATE ------------------ USUALLY BRADYCARDIC
RHYTHM ------------- USUALLY REGULAR (can be irregular)
P-R INTERVAL ----- NORMAL and CONSISTENT
P:QRS RATIO ------ ≥ 2:1
QRS INTERVAL ---- NORMAL

THIS RHYTHM IS: 3rd° HB $\bar{c}$ JUNCTIONAL ESCAPE

MAIN IDENTIFICATION CHARACTERISTIC(S): P - R INTERVAL INCOSISTENT, P - P INTERVALS REGULAR, R - R INTERVALS REGULAR -- NO RELATIONSHIP BETWEEN P WAVES AND QRS COMPLEXES.

RATE ------------------	USUALLY BRADYCARDIC (40 - 60 JUNCTIONAL RATE)
RHYTHM -------------	REGULAR
P-R INTERVAL -----	INCONSISTENT (irregularly irregular)
P: QRS RATIO -----	VARIES - USUALLY > 2 : 1
QRS INTERVAL ----	NORMAL (< 120 ms) UNLESS PT HAS BUNDLE BRANCH BLOCK

THIS RHYTHM IS: 3rd$^{\circ}$ HB $\bar{c}$ IDIOVENTRICULAR ESCAPE

MAIN IDENTIFICATION CHARACTERISTIC(S): P - R INTERVALS INCONSISTENT P - P INTERVALS REGULAR, R - R INTERVALS REGULAR. NO RELATIONSHIP BETWEEN P WAVES AND QRS COMPLEXES. QRS COMPLEXES are WIDER THAN 120ms, AND OF SLOW VENTRICULAR RATE (usually < 40)

RATE ---------------- USUALLY BRADYCARDIC (< 40 VENTRICULAR RATE)
RHYTHM ------------ REGULAR
P-R INTERVAL ----- INCONSISTENT (irregularly irregular)
P: QRS RATIO ------ VARIES - USUALLY > 2 : 1
QRS INTERVAL ---- WIDER THAN 120 ms


II

???

THIS RHYTHM IS: JUNCTIONAL RHYTHM

MAIN IDENTIFICATION CHARACTERISTIC(S): P WAVES ABSENT, or LOCATED JUST AFTER QRS (in S-T seg) or JUST BEFORE QRS (short P-R). WHEN P wave seen, it is INVERTED (upside-down).

- HR USUALLY 40 - 60

RATE ---------------- 40 - 60
RHYTHM ------------ REGULAR
P-R INTERVAL ----- ABSENT or SHORT
P: QRS RATIO ------ 1 : 1
QRS INTERVAL ---- NORMAL

CARDIOGENIC SHOCK

- **Heart Rate**
  - **TOO FAST (greater than 150) with signs of shock:**

☞ ***SLOW the heart rate***

(follow ACLS and Protocols)

Usual treatment:
- Synchronized Cardioversion

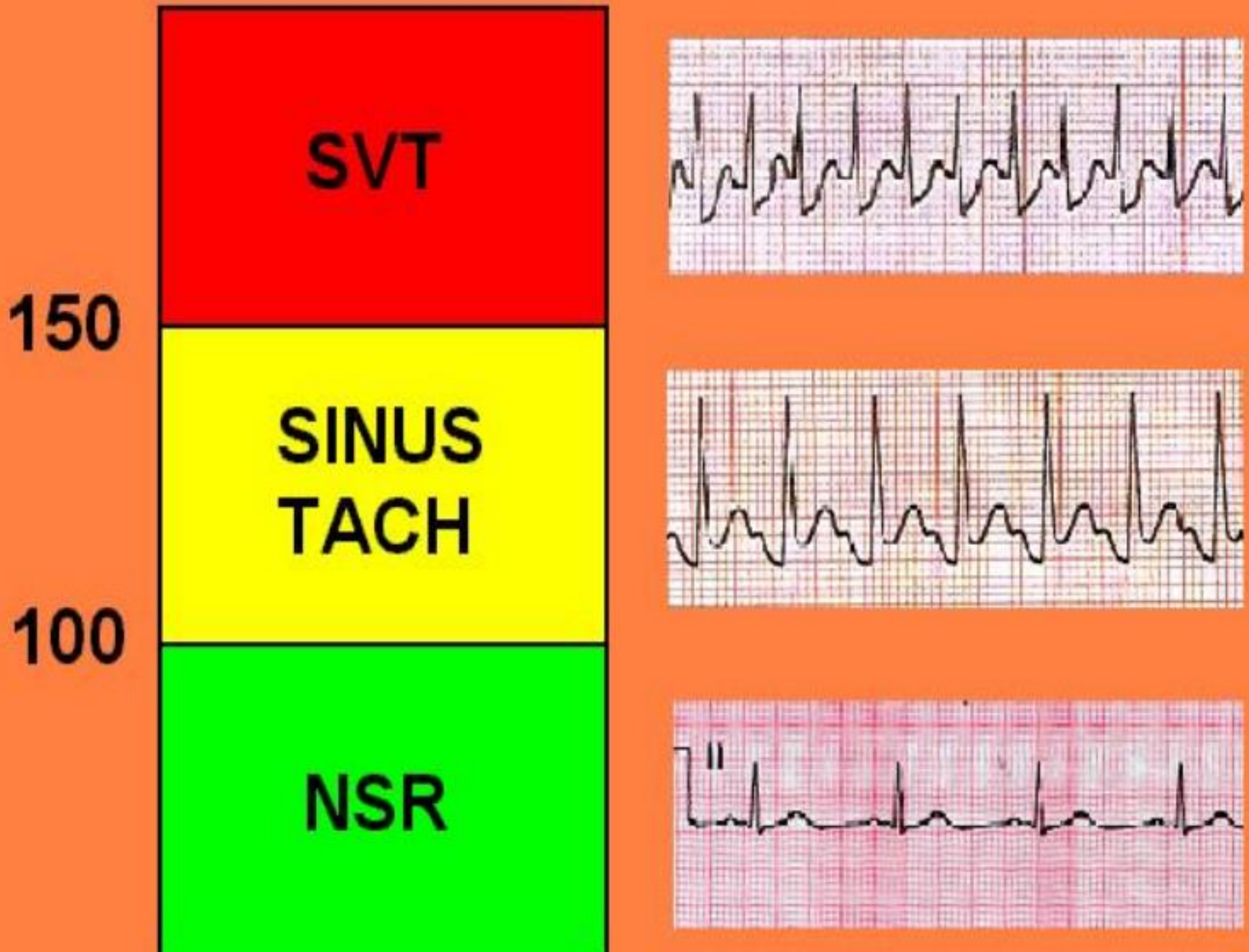
Tachycardias

- Is the patient STABLE or UNSTABLE?
- QRS narrow or wide ???
  - Narrow = "not greater than 120 ms" (3 mm)
  - Wide = "greater than 120 ms (3 mm)

ALL UNSTABLE TACHYCARDIAS:

- SYNCHRONIZED CARDIOVERSION
  - As per agency PROTOCOL and/or ACLS
  - NARROW tachycardias = less initial energy
  - WIDE QRS tachycardias AND A-fib RVR = higher initial energy

ACLS TACHYCARDIA GUIDELINES



THIS RHYTHM IS: SINUS TACHYCARDIA

MAIN IDENTIFICATION CHARACTERISTIC(S): SINUS RHYTHM, RATE HIGHER THAN 100. (ACLS guidelines: heart rate 100 - 150)

RATE ---------------- 100 - 150 (can be > 150)
RHYTHM ------------ REGULAR
P-R INTERVAL ----- NORMAL (120 - 200 ms)
P: QRS RATIO ------ 1 : 1
QRS INTERVAL ---- NORMAL (< 120 ms), (unless Bundle Branch Block present)

THIS RHYTHM IS: SINUS TACHYCARDIA

WE MUST CONSIDER UNDERLYING CAUSES:	AND TREAT THEM:
ANXIETY / FEAR →	CALM PATIENT
HYPOVOLEMIA	
DEHYDRATION →	FLUIDS
BLOOD LOSS →	STOP BLEEDING
MEDICATION EFFECTS →	CONSIDER MEDICAL Tx
OTHER ILLNESS →	IDENTIFY & Tx DISORDER

RHTHYM CLUES . . . .

SUPRAVENTRICULAR TACHYCARDIA

SVT is usually PAROXSYMAL -- ie: has a SUDDEN ONSET.

SINUS TACHYCARDIA usually has a " ramp - up " and " ramp - down " period -- a gradual change in HEART RATE.

THIS RHYTHM IS: SUPRAVENTRICULAR TACHYCARDIA (SVT)

MAIN IDENTIFICATION CHARACTERISTIC(S): HEART RATE TOO FAST, USUALLY > 150. P WAVES MAY BE "BURIED" IN THE PRECEDING T WAVES. Pt USUALLY C/O "SUDDEN ONSET of HEART RACING," or "PALPITATIONS."

RATE ---------------- TACHYCARDIC (usually > 150)
RHYTHM ------------ REGULAR
P-R INTERVAL ----- NORMAL or ABNORMAL. MAY BE IMPOSSIBLE TO SEE DUE TO P WAVE BURIED IN T WAVES
P:QRS RATIO ------- 1:1
QRS INTERVAL ----- NORMAL

THIS RHYTHM IS: SUPRAVENTRICULAR TACHYCARDIA (SVT)

MAIN IDENTIFICATION CHARACTERISTIC(S): HEART RATE TOO FAST, USUALLY > 150. P WAVES MAY BE "BURIED" IN THE PRECEDING T WAVES. Pt USUALLY C/O "SUDDEN ONSET of HEART RACING," or "PALPITATIONS."

TREATMENT / INTERVENTIONS:

BASED ON WHETHER PATIENT IS
STABLE or UNSTABLE . . .

THIS RHYTHM IS:

MAIN IDENTIFICATION CHARACTERISTIC(S):

RATE -----------------
RHYTHM ------------
P-R INTERVAL ------
P: QRS RATIO -------
QRS INTERVAL -----

THIS RHYTHM IS: MONOMORPHIC V-TACH

MAIN IDENTIFICATION CHARACTERISTIC(S): WIDE QRS COMPLEXES (> 120 ms) HR USUALLY BETWEEN 150 - 200; ALL QRS COMPLEXES APPEAR SAME IN SHAPE and DEFELCTION; IF P WAVES SEEN, DISASSOTIATED w/ QRS

RATE ------------------ > 100 (usually 150 - 200)
RHYTHM ------------ REGULAR
P-R INTERVAL ----- N / A
P: QRS RATIO ------ N / A
QRS INTERVAL ----- > 120 ms

V-Tach

- NO PULSE – Follow Protocols / ACLS for "V-Fib / V-Tach"
- PULSE – but UNSTABLE – Synchronized Cardioversion
- STABLE - Give MEDS as per Protocols / ACLS

THIS RHYTHM IS: POLYMORPHIC V - TACH

MAIN IDENTIFICATION CHARACTERISTIC(S): WIDE QRS COMPLEXES, MULTIPLE SHAPES AND FORMS, POSITVE AND NEGATIVE DEFLECTIONS, APPEARS TO ROTATE BETWEEN NEGATIVE AND POSITIVE (TWISTING OF POINTS)

RATE ------------------ 200 - 300
RHYTHM ------------- VARIES
P-R INTERVAL ------ N/A
P: QRS RATIO ------- N/A
QRS INTERVAL ----- VARIES

ECG Characteristics of TdP: The QRS Pattern of *Torsades de Pointes*

resembles . . . . .

a piece of Twisted Ribbon !

ABC s

NO PULSE

GO TO
V - FIB
ALGORITHM !

PULSE - UNSTABLE

- IMMEDIATE DEFIBRILLATION

START IV
CONSIDER
SEDATION

PULSE - STABLE

- O2 / IV / EKG
- MAGNESIUM INFUSION
  1 - 2 gm OVER
  5 - 60 min,

DO NOT give PROCAINAMIDE, AMIODARONE, or SOTALOL to patients with TORSADES or POLYMORPHIC VT !!!

QTc Values:

Too Short:	**< 390 ms**
Normal	
-Males:	**390 - 450 ms**
-Females:	**390 - 460 ms**
Borderline High	
-Males:	**450 - 500 ms**
-Females:	**460 - 500 ms**
High (All Genders):	**500 - 600 ms**
Critical High	
(associated with TdP):	**600 + ms**

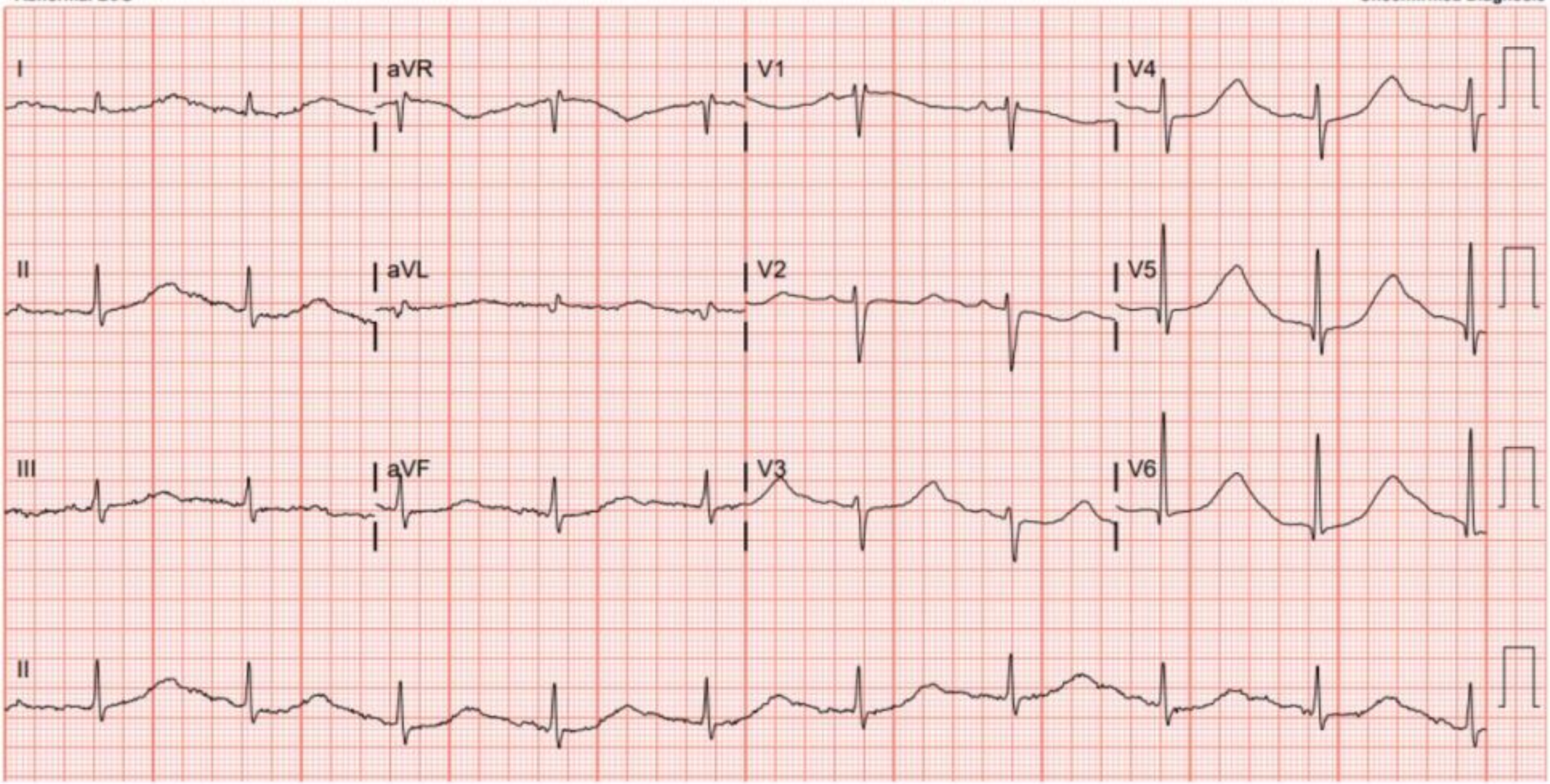
Rate	58
PR	185
QRSd	126
QT	668
QTc	657
--Axis--	
P	107
QRS	61
T	45

Sinus rhythm
IVCD, consider atypical RBBB
Baseline wander in lead(s) V2,V3,V4,V6
COMPARED TO ECG 07/22/2020 16:56:59
SINUS RHYTHM NOW PRESENT

Req Provider: Rafael Santiago-Ap

- Abnormal ECG -

Unconfirmed Diagnosis

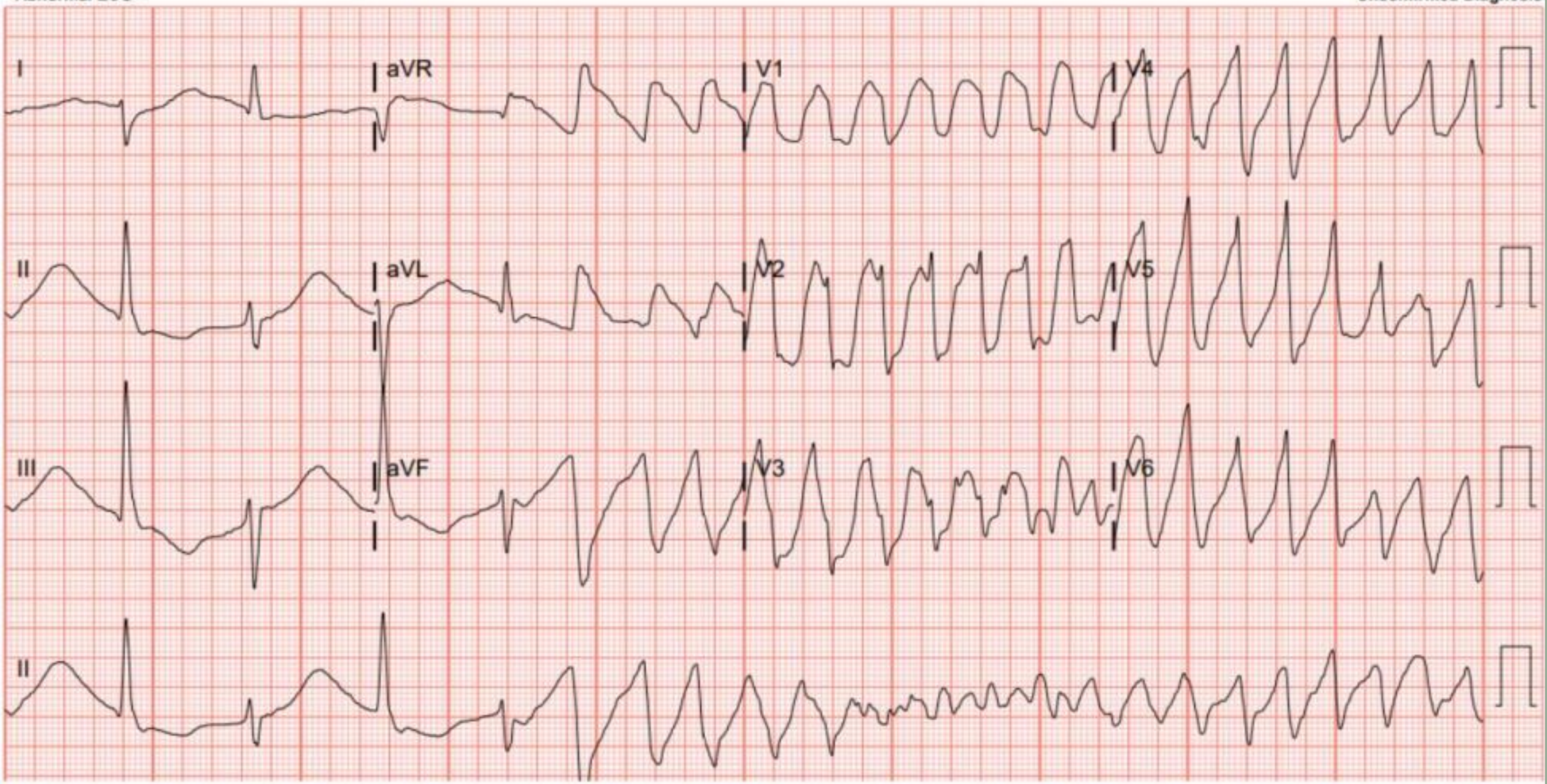


Rate	156	Atrial fibrillation
PR		Ventricular tachycardia, unsustained
QRSd	138	RBBB and LPFB
QT	456	Repol abnrm suggests ischemia, diffuse leads
QTc	735	Baseline wander in lead(s) II,III,aVR,aVF,V1,V2,V3,V4
--Axis--		COMPARED TO ECG 07/22/2020 15:32:52
P		ATRIAL FIBRILLATION NOW PRESENT
QRS	102	VENTRICULAR TACHYCARDIA NOW PRESENT
T	185	LEFT POSTERIOR FASCICULAR BLOCK NOW PRESENT
		RIGHT BUNDLE-BRANCH BLOCK NOW PRESENT
		POSSIBLE ISCHEMIA NOW PRESENT
		PROLONGED QT INTERVAL NO LONGER PRESENT

Req Provider: Rafael Santiago-A

- Abnormal ECG -

Unconfirmed Diagnosis



CARDIOGENIC SHOCK

- **Heart Rate:**
  - **Should be between 50 – 150**

CARDIOGENIC SHOCK

- Heart Rate:
  - Should be between 50 – 150
- Decreased Contractility:
  - STEMI / Acute Coronary Syndrome (vascular)

CARDIOGENIC SHOCK

- Heart Rate:
  - Should be between 50 – 150
- Decreased Contractility:
  - STEMI / Acute Coronary Syndrome (vascular)
  - Myocarditis (muscle dysfunction)

CARDIOGENIC SHOCK

- Heart Rate:
  - Should be between 50 – 150
- Decreased Contractility:
  - STEMI / Acute Coronary Syndrome (vascular)
  - Myocarditis (muscle dysfunction)

    Often mimics STEMI on the ECG. Often "challenging" for advanced practitioners to diagnose.

Integrated ECG:

- HEMODYNAMIC STATUS
  - ABCs
  - Shock
- SYMPTOMS
  - Chest Pain / Pressure

Integrated ECG:

- HEMODYNAMIC STATUS
  - ABCs
  - Shock
- SYMPTOMS
  - Chest Pain / Pressure = ***STAT 12 LEAD ECG !!!***

    (within 10 minutes) !!

CHIEF COMPLAINT

KEY WORDS:

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

SHORTNESS BREATH

DIZZINESS / LIGHTHEADEDNESS

ETC. ETC. ETC.

INFARCTION

SYMTOMS OF MYOCARDIAL INFARCTION:

1. CHEST PAIN:
   - Substernal - can radiate to neck, shoulders, jaw, L or R arm
   - Pain described as "Dull Pain" or "Pressure" or "Heaviness" - but can be sharp
   - Usually NOT effected by DEEP INSPIRATION, POSITION, or MOVEMENT

INFARCTION

SYMTOMS OF MYOCARDIAL INFARCTION:

1. CHEST PAIN
2. SHORTNESS OF BREATH
   May or may not be present.

INFARCTION

SYMTOMS OF MYOCARDIAL INFARCTION:

1. CHEST PAIN
2. SHORTNESS OF BREATH
3. NAUSEA
   May or may not be present

INFARCTION

SYMTOMS OF MYOCARDIAL INFARCTION:

1. CHEST PAIN
2. SHORTNESS OF BREATH
3. NAUSEA
4. COLD, CLAMMY, PALE SKIN
   and other signs of hypoperfusion
   may be present

INFARCTION

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

QUICK ASSESSMENT "SHORT FORM"

☑ SUBSTERNAL CHEST PAIN
(HAVE PATIENT POINT TO WORST PAIN)

☑ DESCRIBED AS "DULL PAIN," "PRESSURE," or "HEAVINESS"

☑ DOES NOT CHANGE WITH DEEP BREATH

Integrated ECG:

- HEMODYNAMIC STATUS
  - ABCs
  - Shock
- SYMPTOMS
  - Chest Pain / Pressure
  - Other ACS Symptoms

Integrated ECG:

- HEMODYNAMIC STATUS
  - ABCs
  - Shock
- SYMPTOMS
  - Chest Pain / Pressure
  - Other ACS Symptoms = ***STAT 12 LEAD ECG !!!***

    (within 10 minutes) !!

ATYPICAL SYMPTOMS of ACS

? ? ?

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

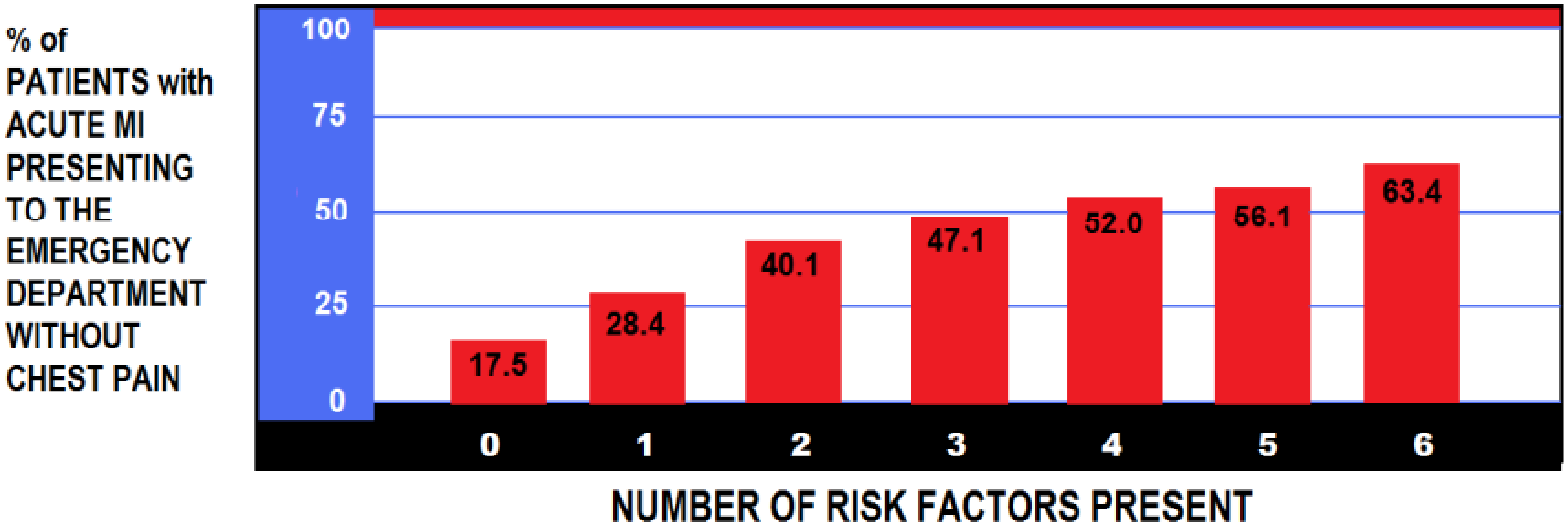
Stroke (previous history of)
Heart failure (previous history of)
Race (non-white)
Elderly (age 75+)
Women
Diabetes mellitus

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

Common atypical complaints associated with AMI without chest pain include:

Malaise (weakness)	**F**atigue
Indigestion	**A**bdominal pain
Nausea	**C**old sweats
Dizziness	**E**levated heart rate
Syncope	**D**sypnea

Effect of Having Multiple Risk Factors for AMI Without Chest Pain



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

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

Integrated ECG:

- HEMODYNAMIC STATUS
  - ABCs
  - Shock
- SYMPTOMS
  - Chest Pain / Pressure
  - Other ACS Symptoms
- ECG
  - 12 Lead
  - Single Lead “rhythm strip”

Actions at the Scene

- If patient has ANY symptoms of ACS, get a

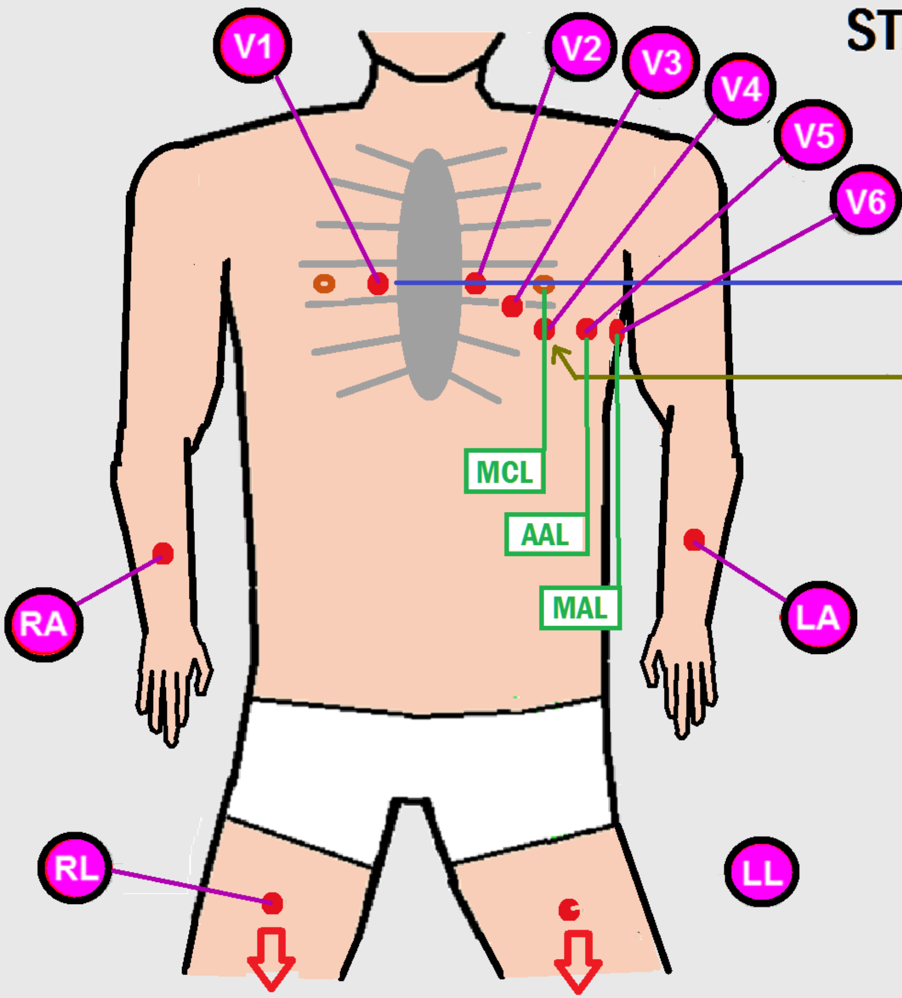
STAT 12 Lead ECG

EMS 12 Lead ECG

10 wires . . .

- 4 limb leads
- 6 chest (“V”) leads

Obtaining the 12 Lead ECG



STANDARD LEAD PLACEMENT ---
12 LEAD ECG

4 th INTERCOSTAL SPACE

V4 is at 5th INTERCOSTAL SPACE. V5 & V6 are on the SAME HORIZONTAL PLANE.

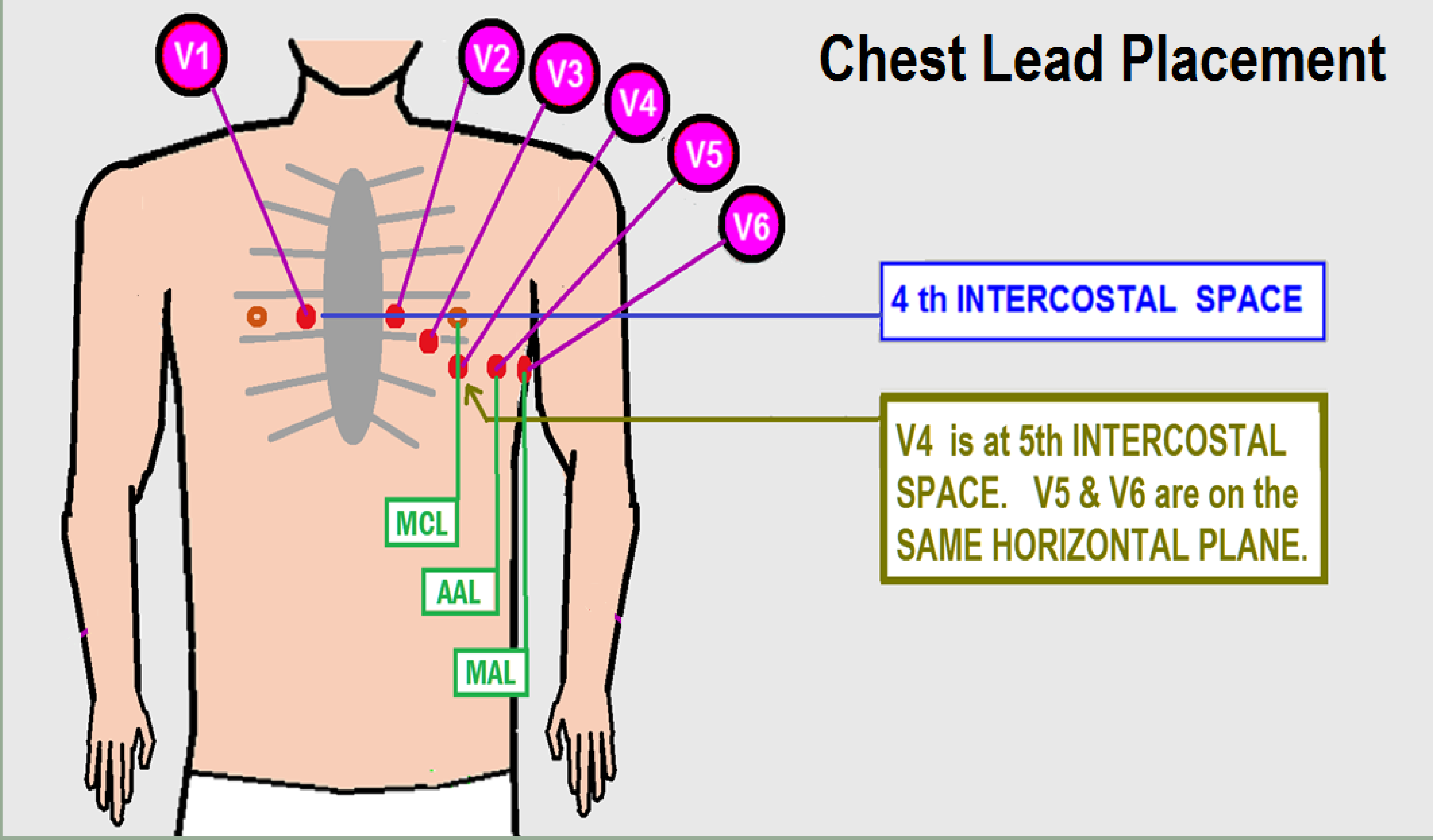
- PATIENT SHOULD LAY AS FLAT AS POSSILVE

- LIMB LEADS SHOULD BE PLACED AS DISTALLY AS POSSIBLE

Leads V1 & V2 on 12 Lead ECG:

- Proper lead placement of precordial Leads V1 and V2 are 4th intercostal space on opposite sides of the sternum.
- Incorrect placement of Leads V1 and V2 will result in: reduction of R wave amplitude (resulting in poor R wave progression) leading to misdiagnosis of previous anterior / septal infarction.

CORRECT Lead placement:



[redacted] [redacted] [redacted]

DOB [redacted] 75 Years Female (2)

Rate 76 . Sinus rhythm.......................................normal P axis, V-rate 50- 99

PR 161
QRSD 90
QT 350
QTc 394

[redacted]

TECH SD

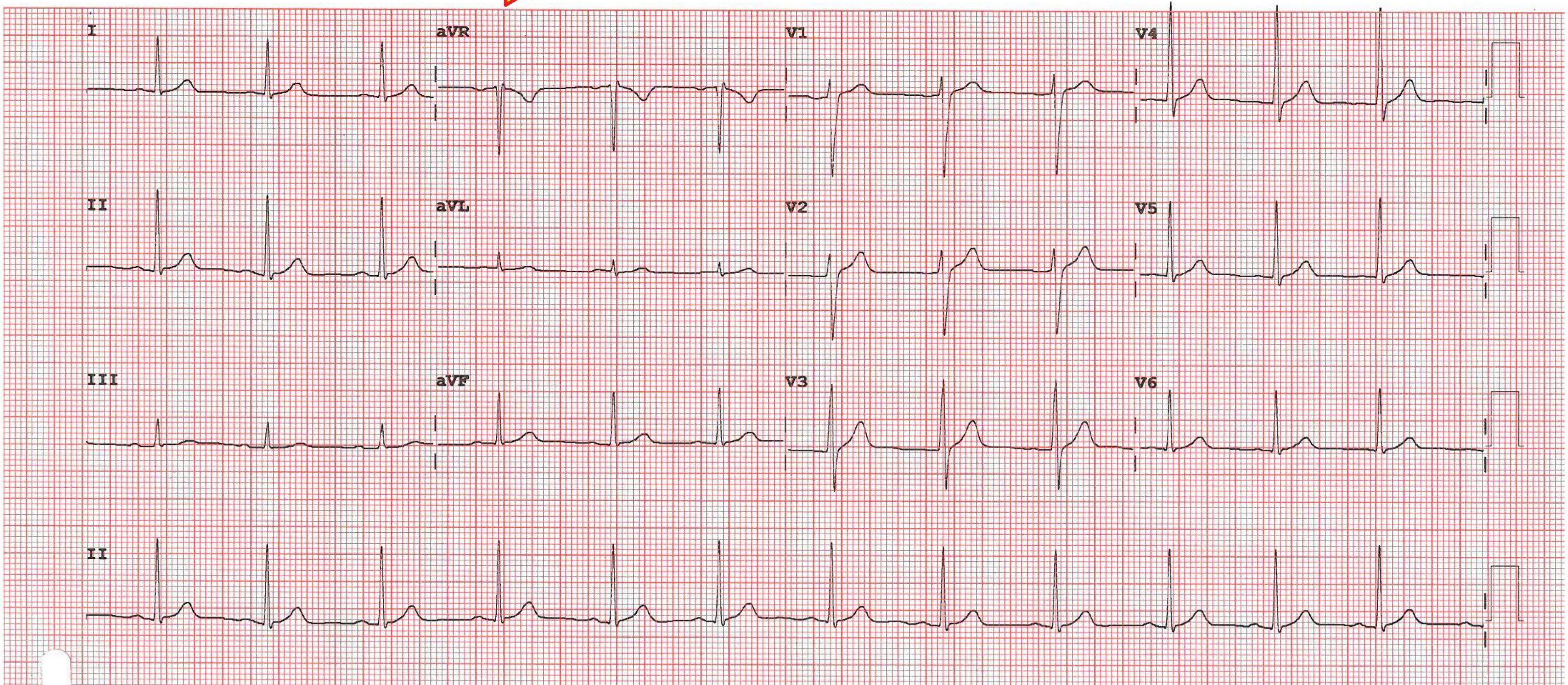
[redacted] [redacted]

--AXIS--
P 50
QRS 51
T 44

- NORMAL ECG -

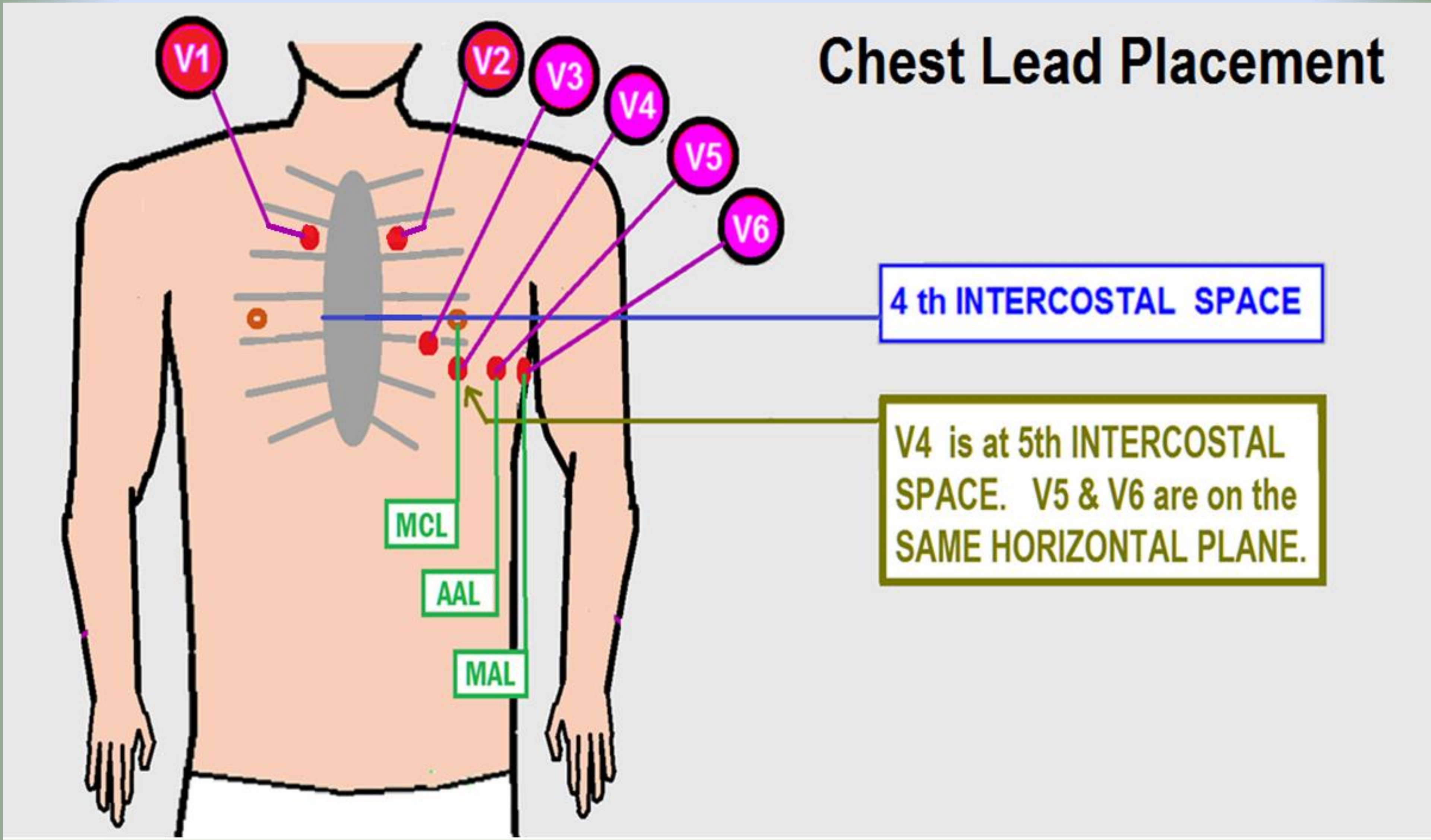
12 Lead; Standard Placement

Unconfirmed Diagnosi



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

INCORRECT Lead placement:



[redacted] [redacted] [redacted] 5:20:58 AM

DOB [redacted]1988 30 Years Female (1)

3NE

Rate 89 . Sinus rhythm.......................................normal P axis, V-rate 50- 99

. Anteroseptal infarct, age indeterminate...................Q >35mS

TEC

PR 157

QRSD 96

QT 365

QTc 445

[redacted]

--AXIS--

P 46

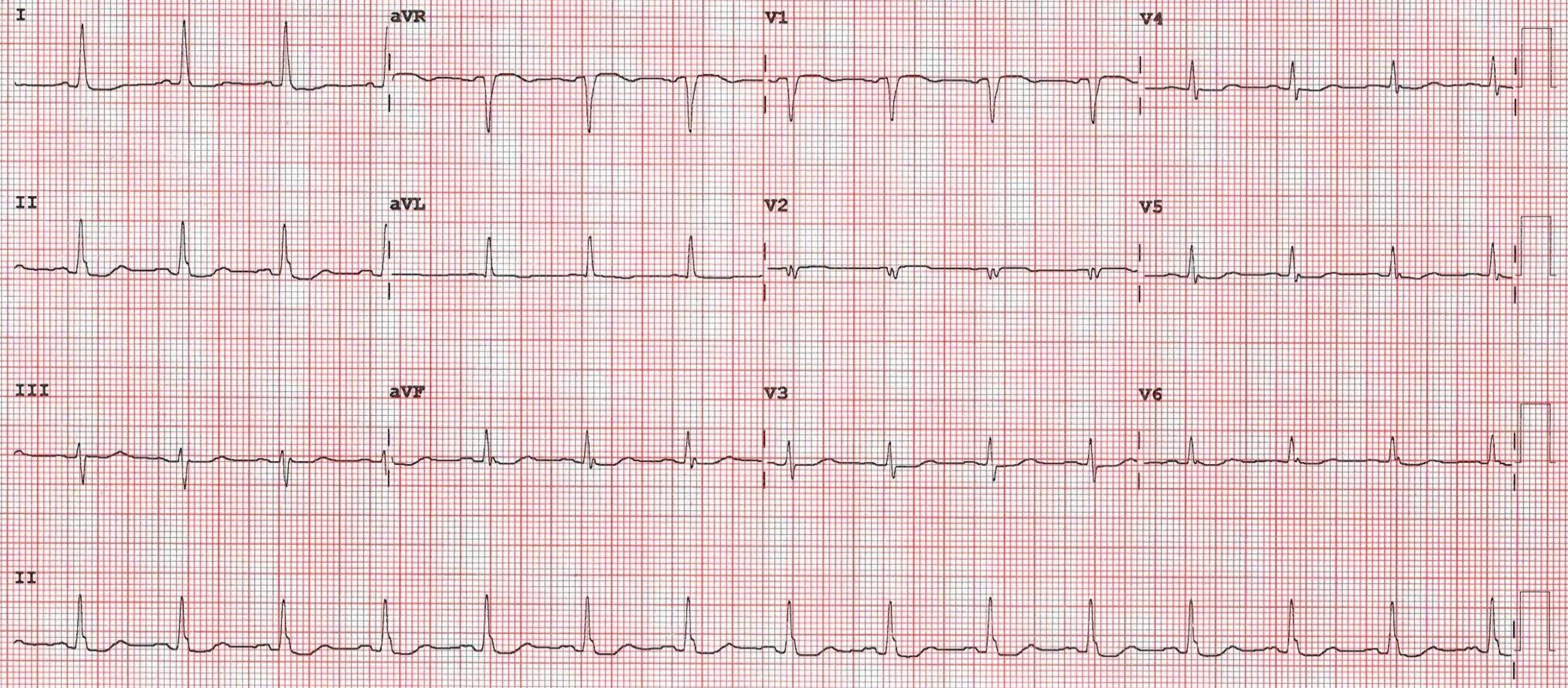
QRS 24

T 86

- ABNORMAL ECG -

12 Lead; Standard Placement

Unconfirmed Diagnosis



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

COVIDIEN Kendall REF 30768678

AHA/ACC/HRS Scientific Statement

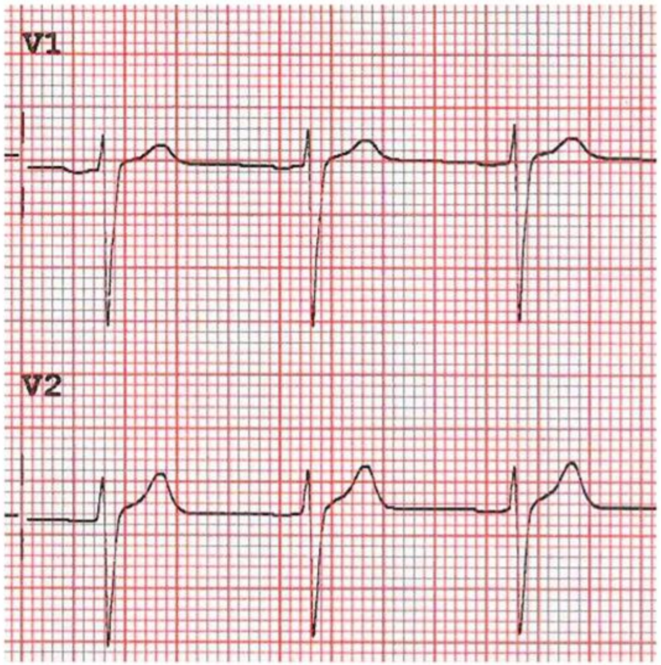
Recommendations for the Standardization and Interpretation of the Electrocardiogram

Part I: The Electrocardiogram and Its Technology

the often profound alterations in waveforms that can result from precordial electrode misplacement.[85,86] A common error is superior misplacement of V_1 and V_2 in the second or third intercostal space. This can result in reduction of initial R-wave amplitude in these leads, approximating 0.1 mV per interspace, which can cause poor R-wave progression or erroneous signs of anterior infarction.[87] Superior displacement of the V_1 and V_2 electrodes will often result in rSr′ complexes with T-wave inversion, resembling the complex in lead aVR. It also has been shown that in patients with low diaphragm position, as in obstructive pulmonary disease,[88,89]

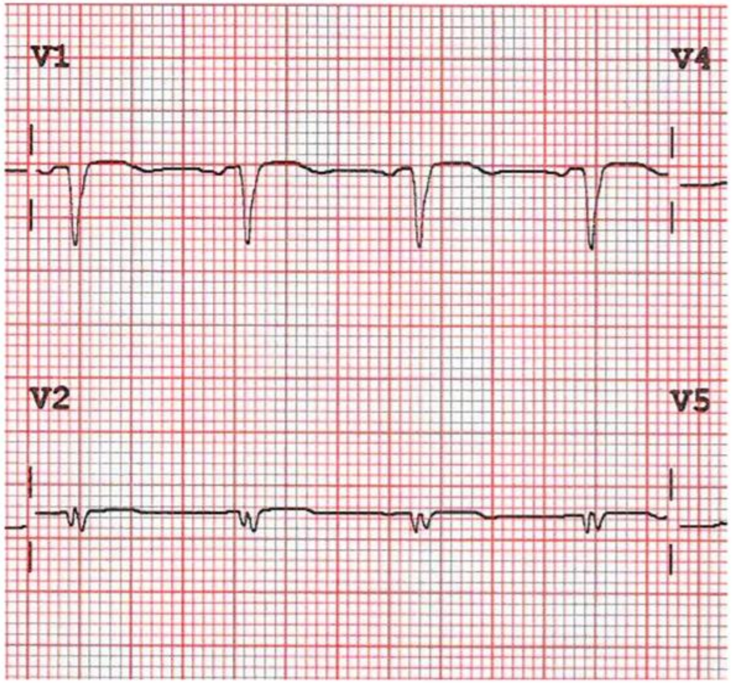
Kligfield et al Standardization and Interpretation of the ECG, Part I

Correct Lead Placement



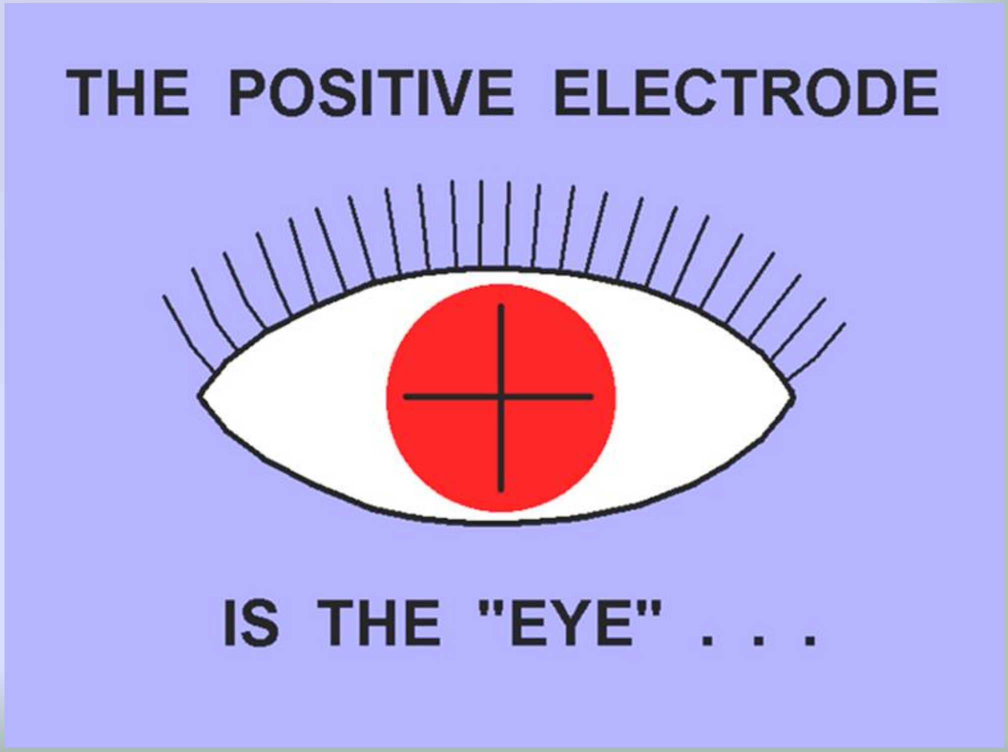
RS = NO old MI

Incorrect Lead Placement



QS = old MI

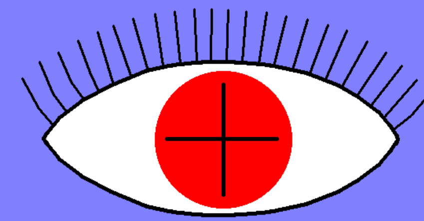
What part of the HEART does each lead SEE ?



AREAS VIEWED by 12 LEAD ECG

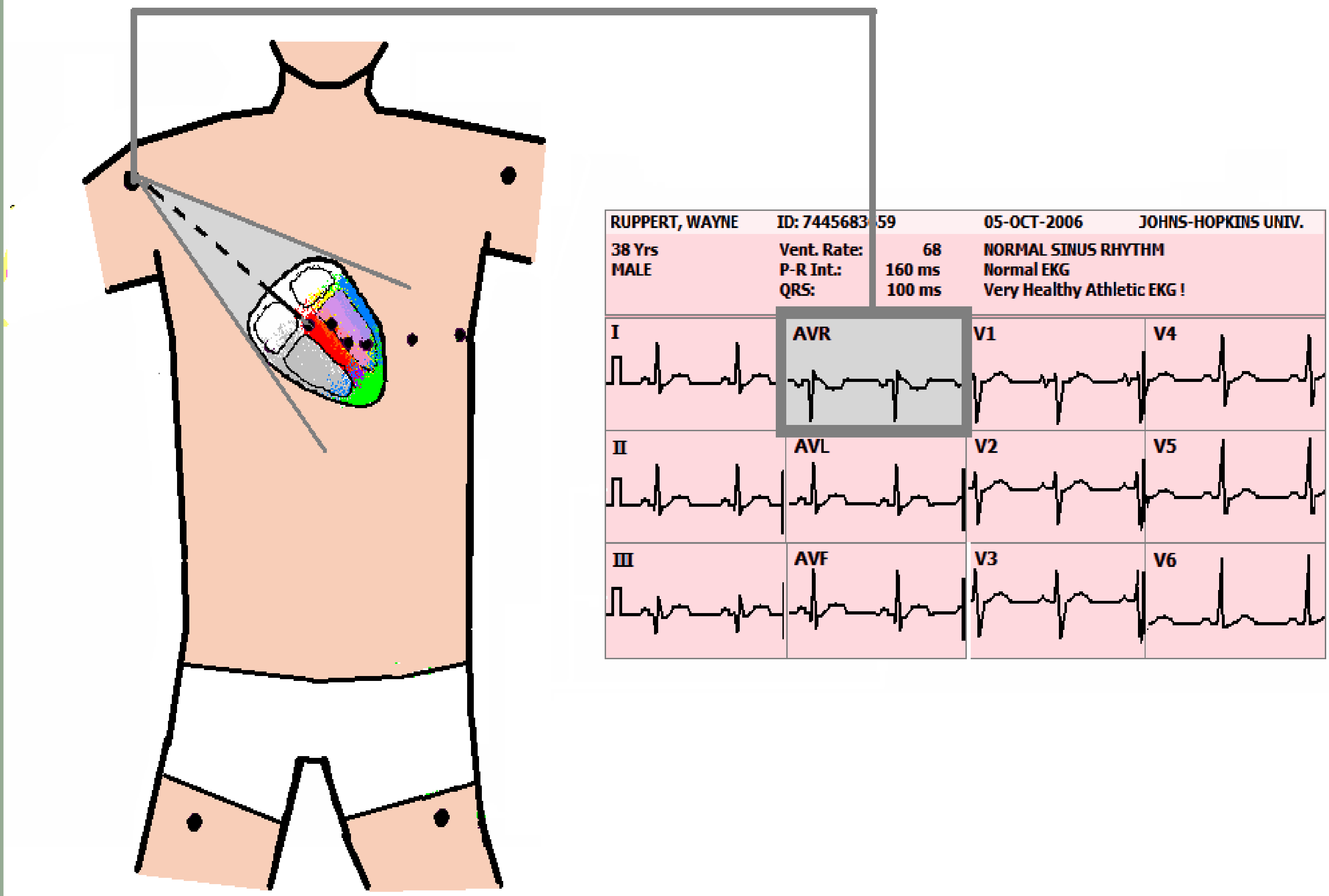
- AVR
- AVL, I
- V1, V2
- V3, V4
- V5, V6
- II, III, AVF

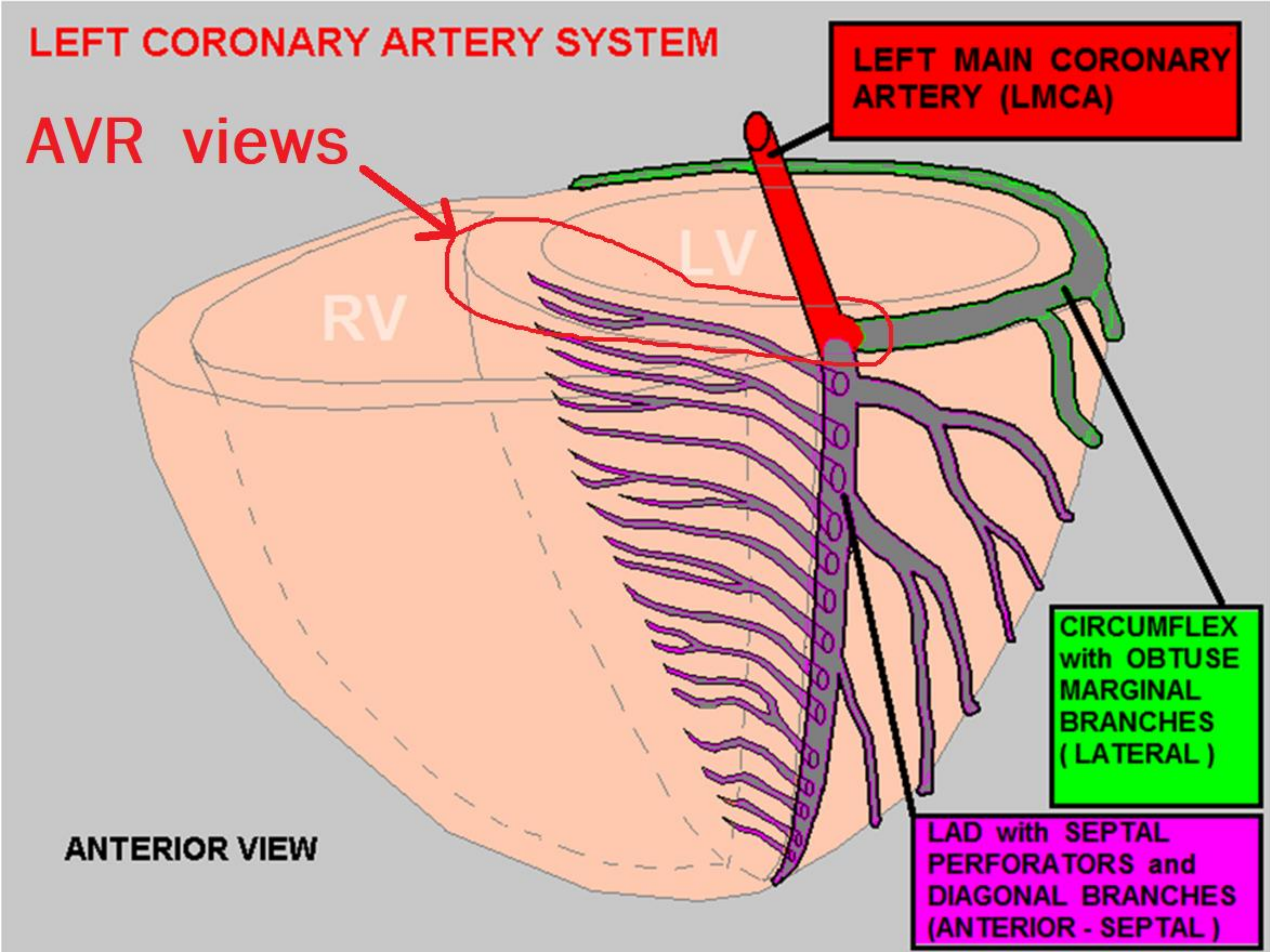
THE POSITIVE ELECTRODE



IS THE "EYE" . . .

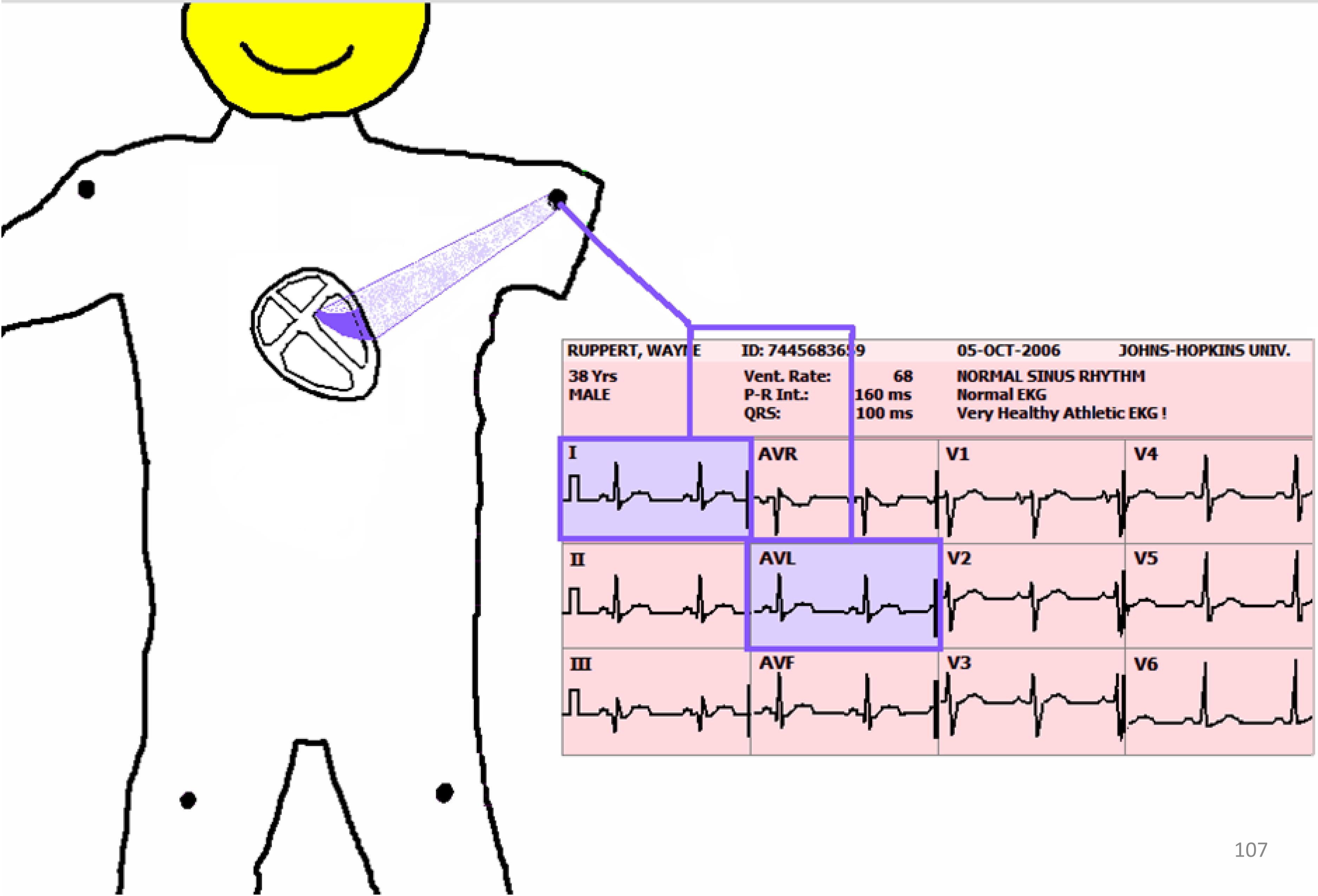
Lead AVR Views the BASILAR SEPTUM (region of the Bundle of His)





LEFT CORONARY ARTERY SYSTEM
LEFT MAIN CORONARY ARTERY (LMCA)
AVR views
LV
RV
CIRCUMFLEX with OBTUSE MARGINAL BRANCHES (LATERAL)
LAD with SEPTAL PERFORATORS and DIAGONAL BRANCHES (ANTERIOR - SEPTAL)
ANTERIOR VIEW

LEADS I and aVL VIEW the LATERAL - ANTERIOR WALL

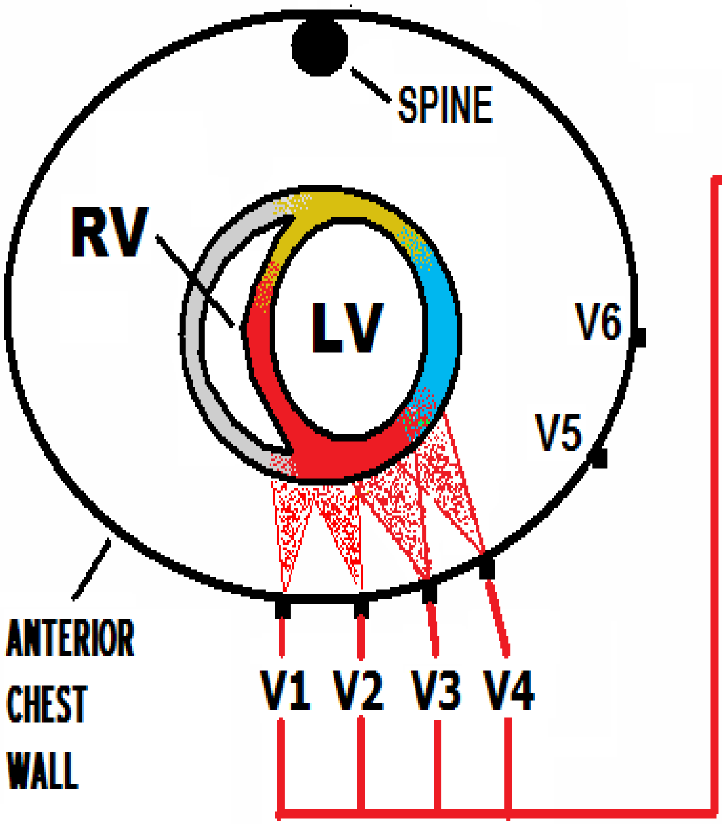


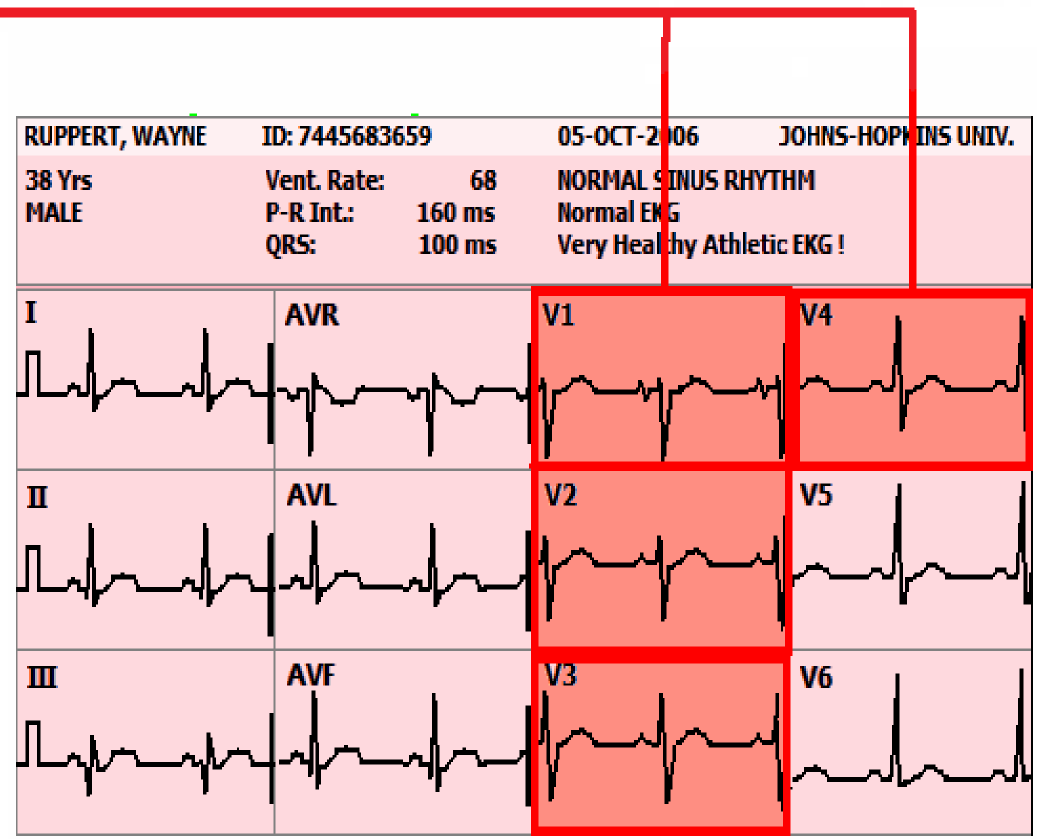
V1 - V4 VIEW THE ANTERIOR-SEPTAL WALL

of the LEFT VENTRICLE

V1, V2 - ANTERIOR / SEPTAL

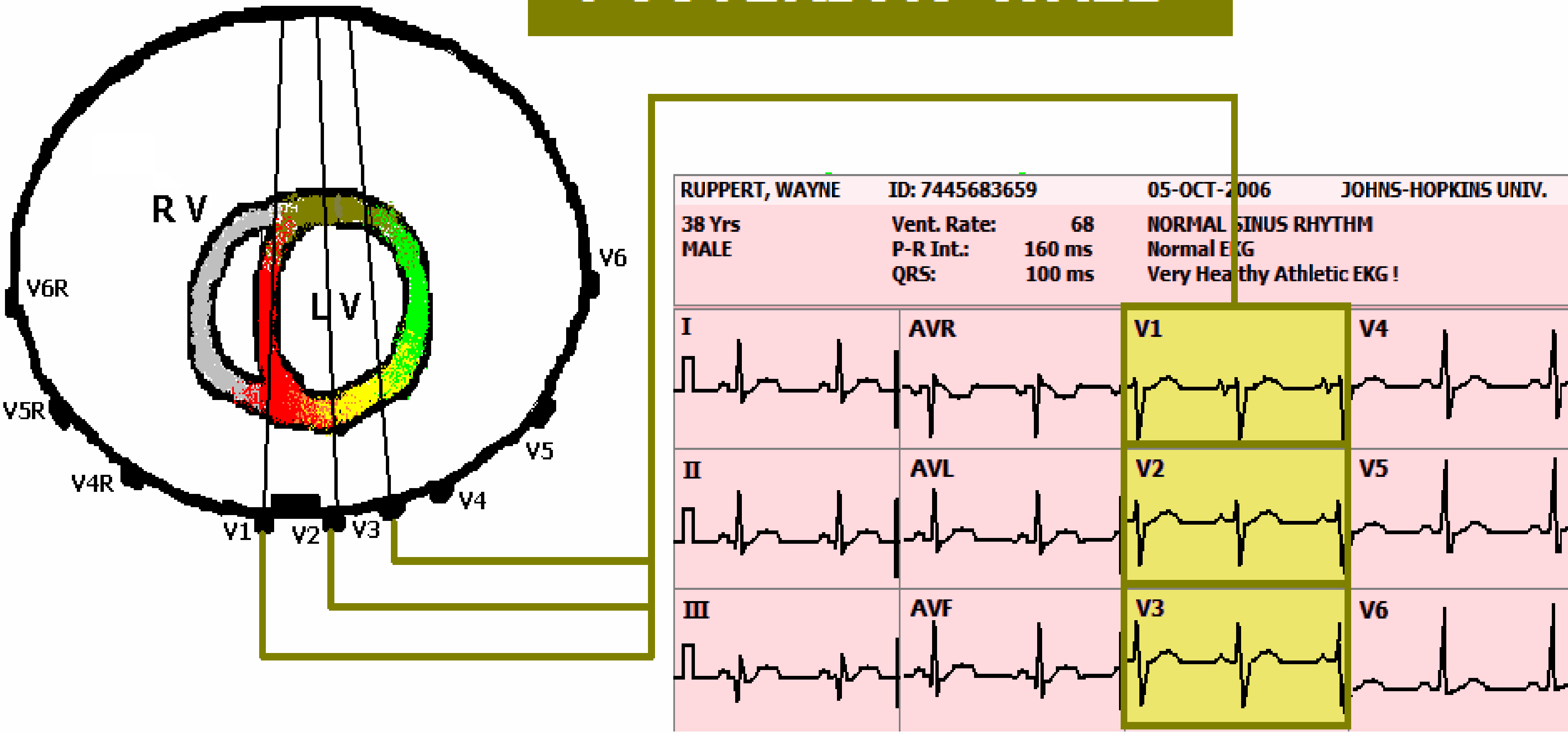
V3, V4 - ANTERIOR





LEADS V1 - V3 *view the*

POSTERIOR WALL

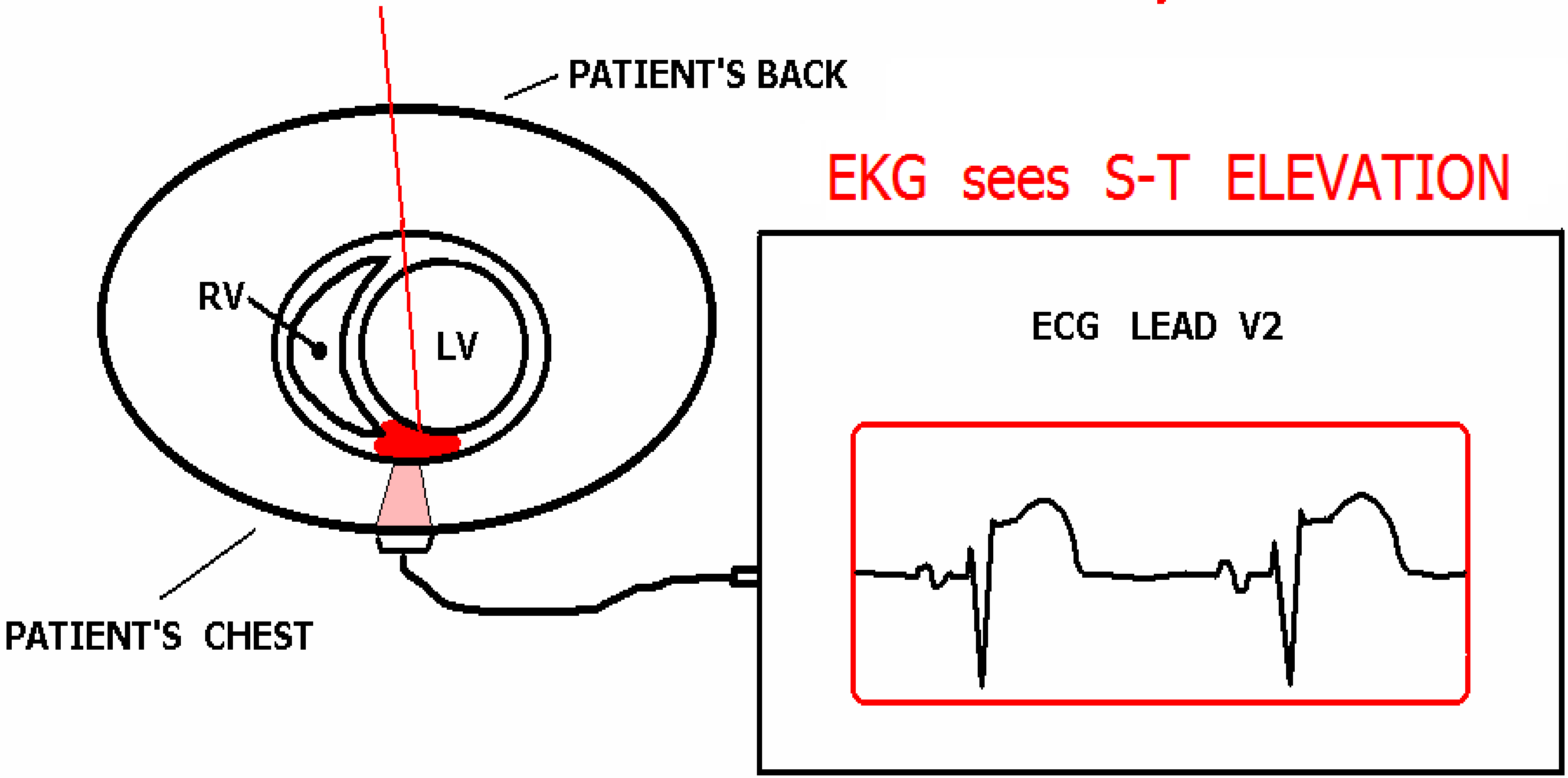


via RECIPROCAL CHANGES.

HOW EKG VIEWS INDICATIVE CHANGES

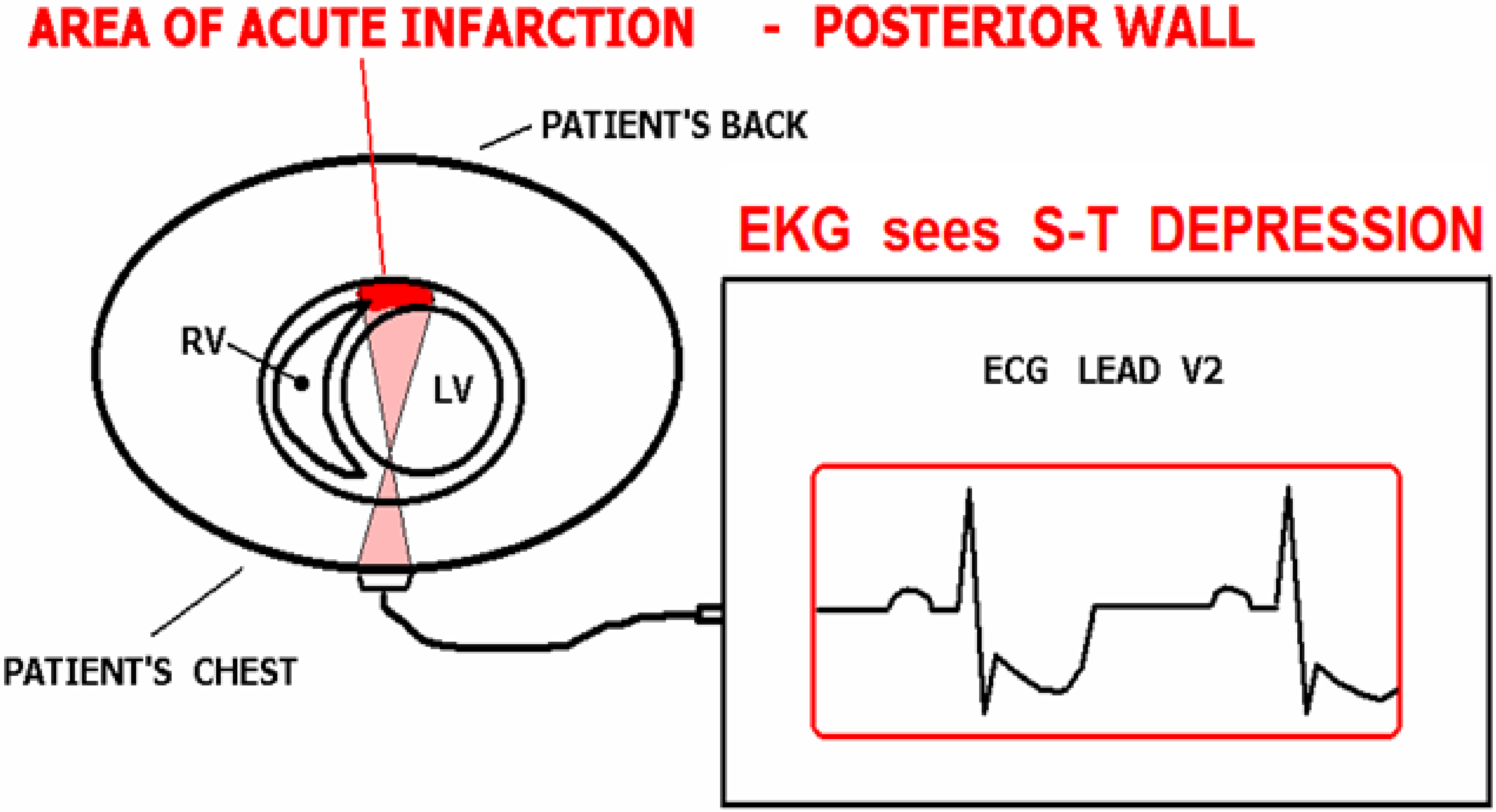
EXAMPLE:

AREA OF ACUTE INFARCTION - ANTERIOR/SEPTAL

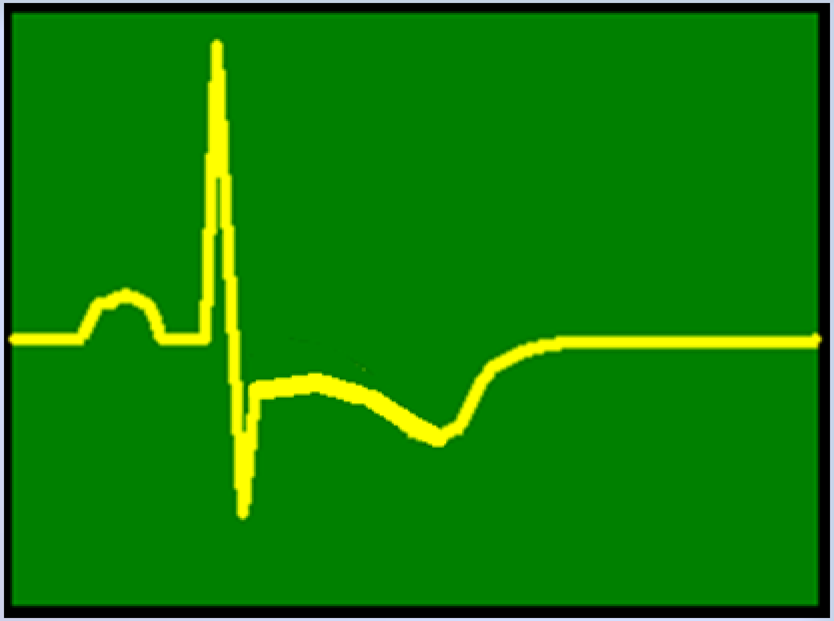


HOW EKG VIEWS RECIPROCAL CHANGES

EXAMPLE:



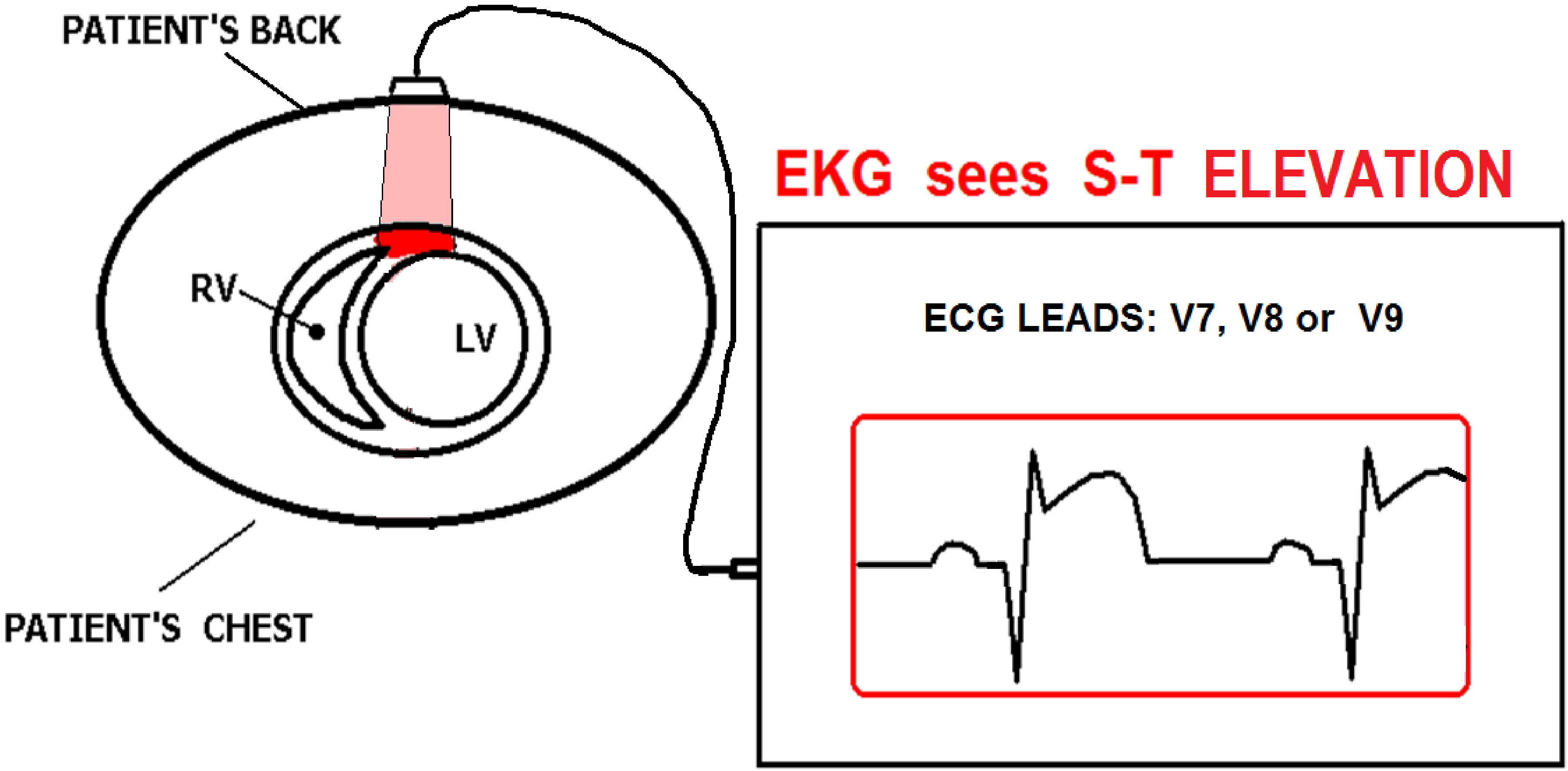
ST Depression can indicate:



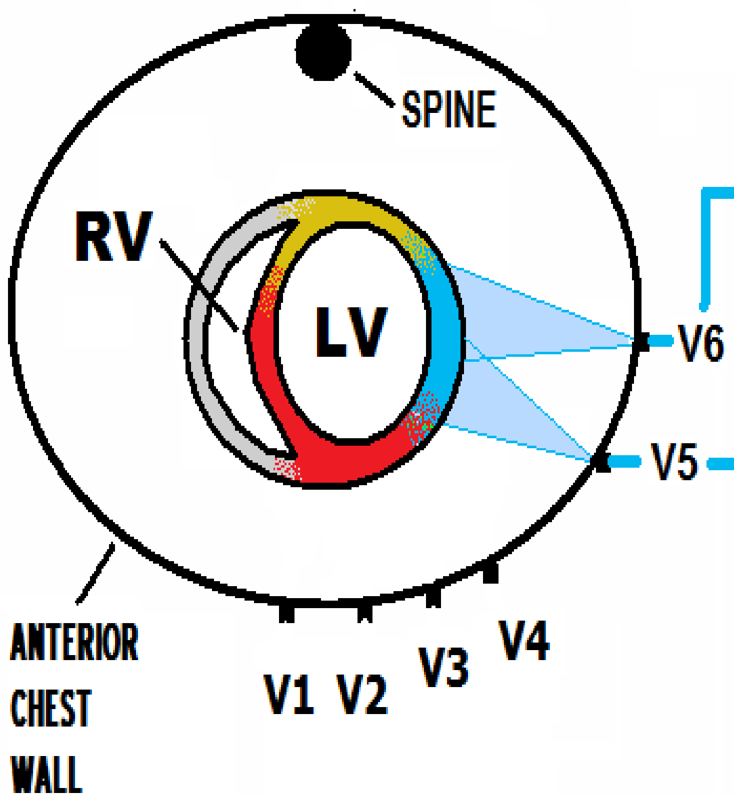
- ISCHEMIA
- “Partial-wall thickness” MI (NSTEMI)
- STEMI (in the opposite side of the heart)
- Other things (like RBBB, certain medications, etc).

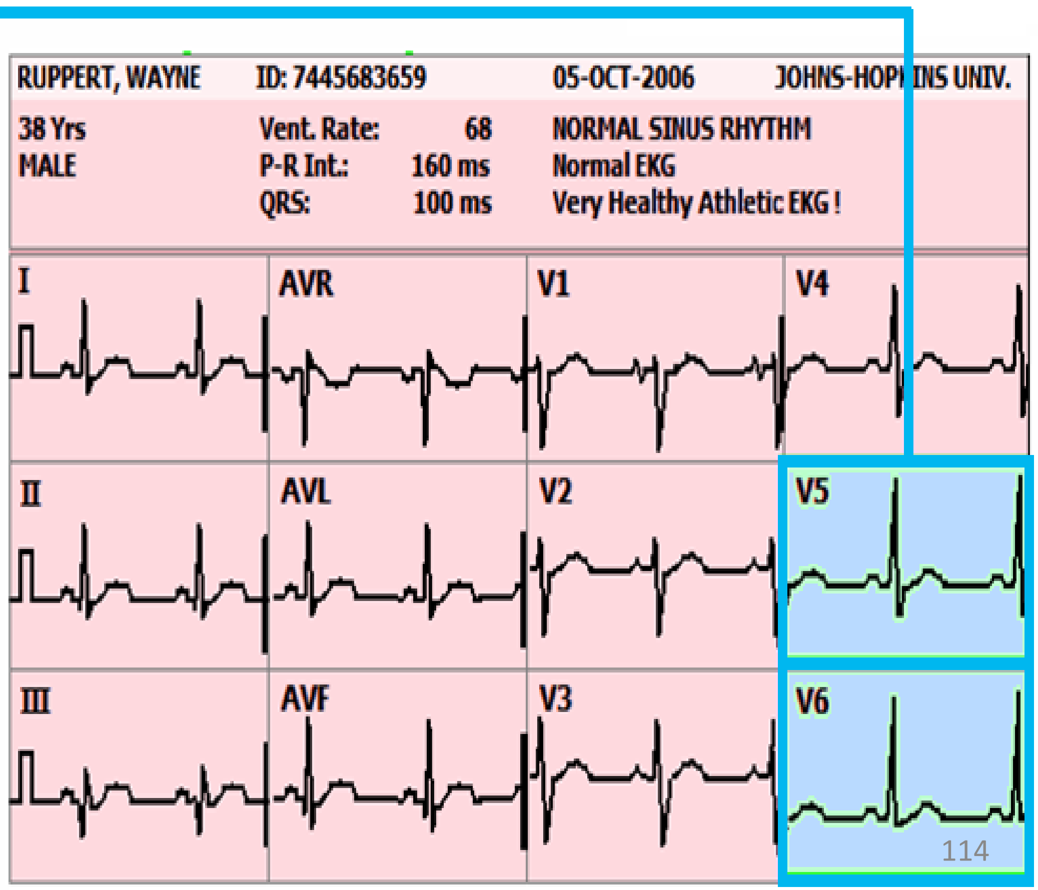
If we put ECG leads on the BACK of a PATIENT who is having an

ACUTE POSTERIOR WALL MI . . . . .

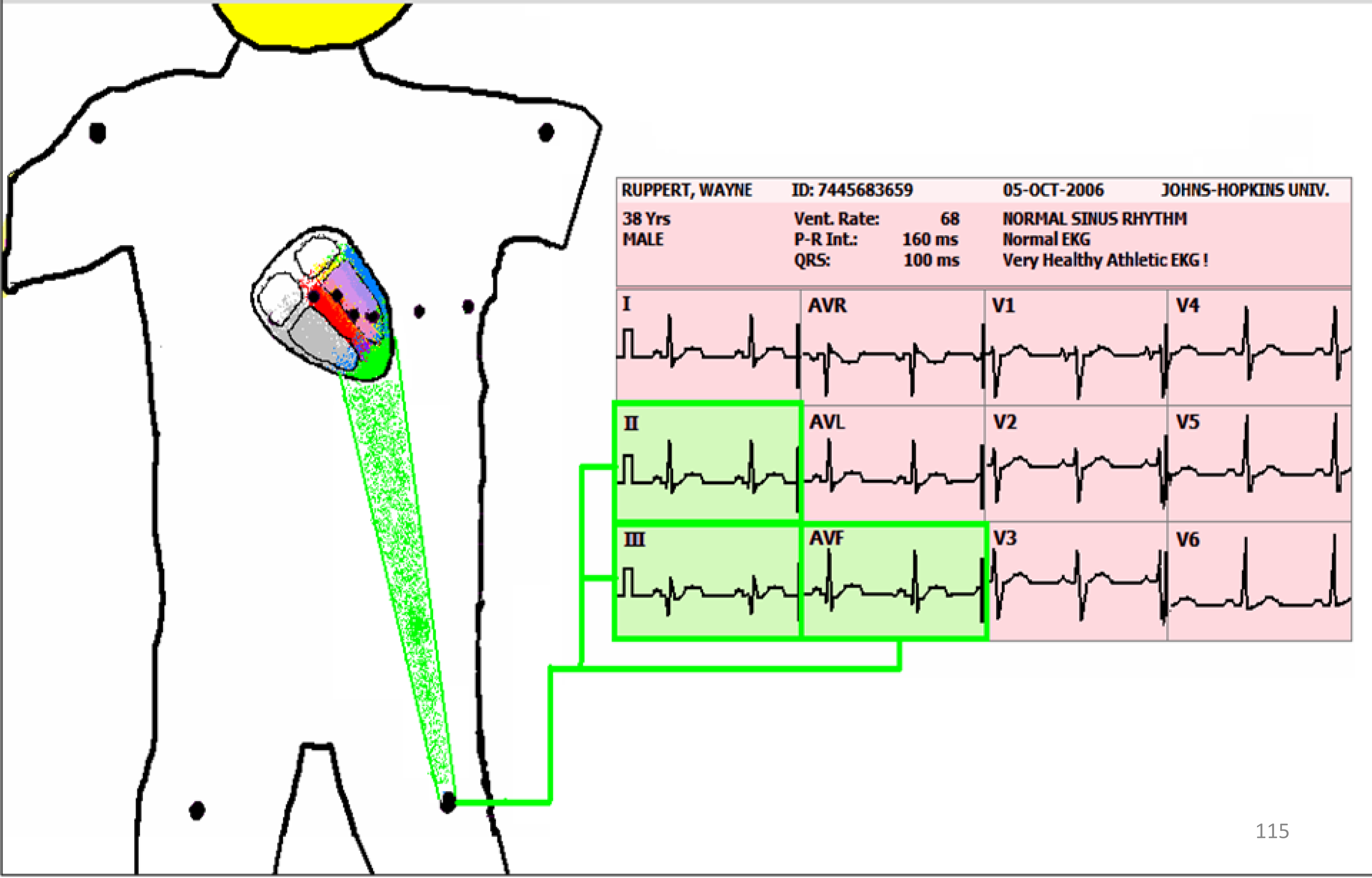


V5 - V6 VIEW THE LATERAL WALL
of the LEFT VENTRICLE



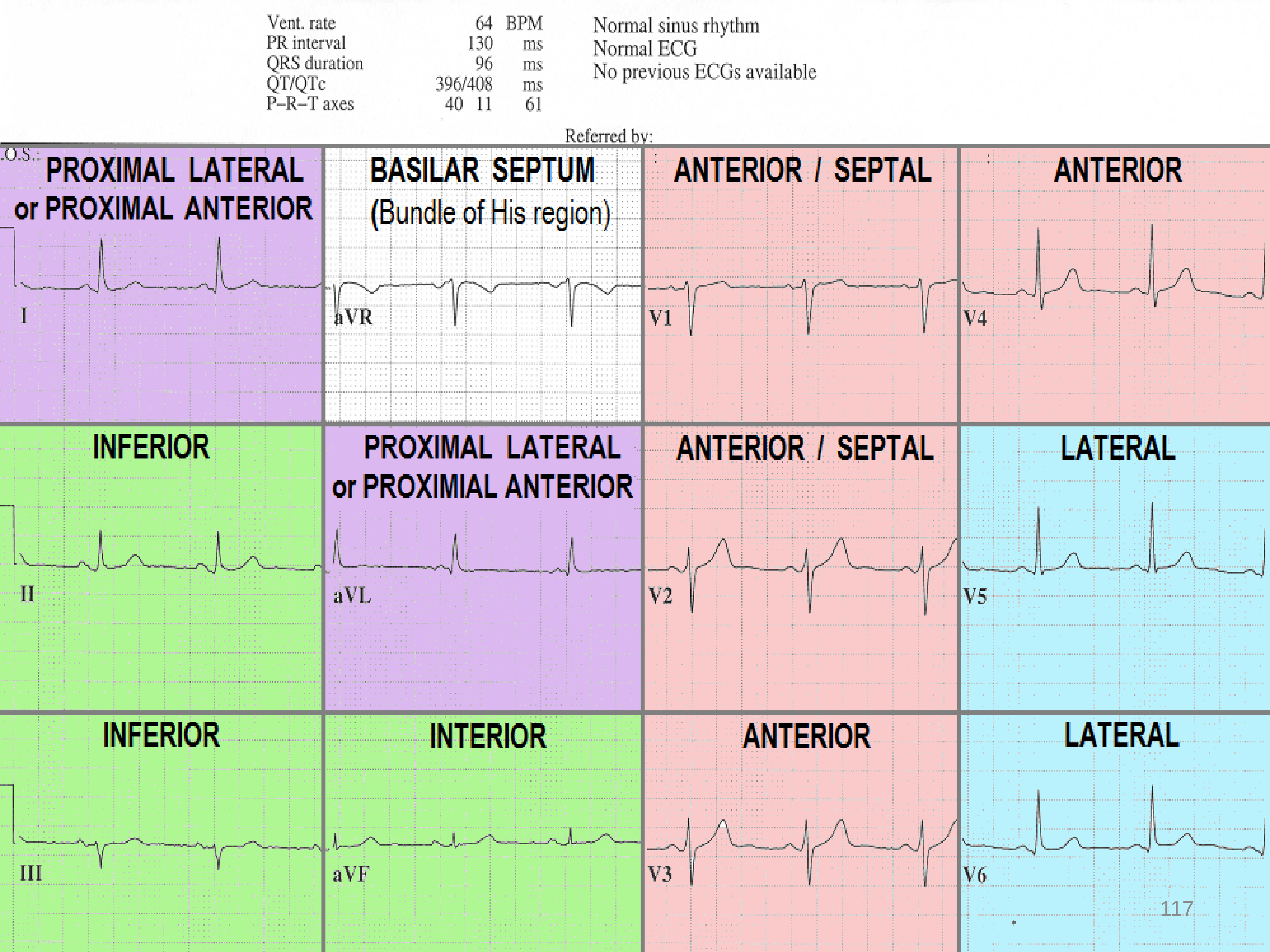


LEADS II, III, and aVF VIEW
INFERIOR WALL of the LEFT VENTRICLE



AREAS VIEWED by 12 LEAD ECG

AVR	*BASILAR SEPTAL*
AVL, I	LATERAL ANTERIOR
V1, V2	ANTERIOR
	SEPTAL
	POSTERIOR (recip.)
V3, V4	ANTERIOR
V5, V6	LATERAL
II, III, AVF	INFERIOR

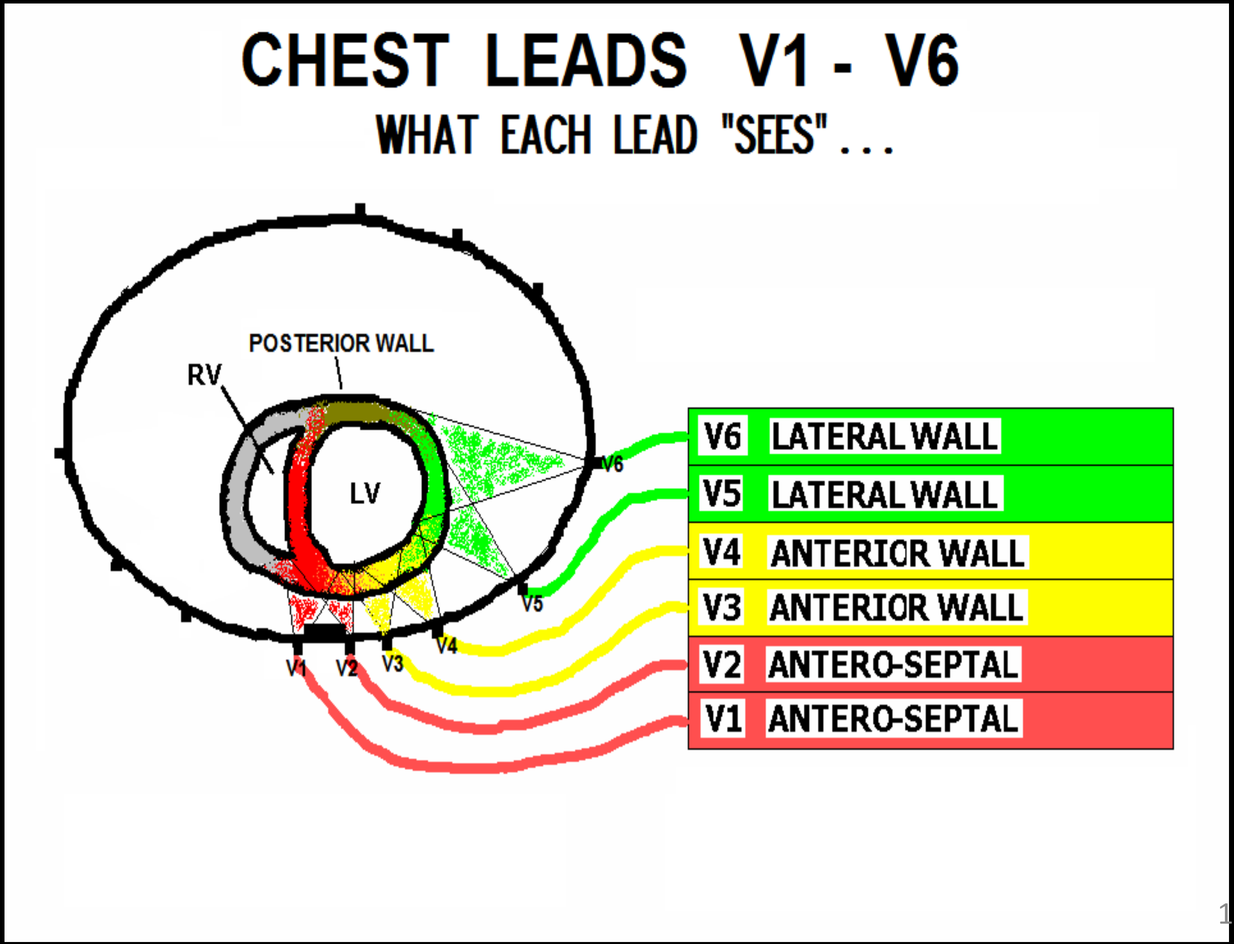

Vent. rate 64 BPM
PR interval 130 ms
QRS duration 96 ms
QT/QTc 396/408 ms
P–R–T axes 40 11 61
Normal sinus rhythm
Normal ECG
No previous ECGs available
Referred by:
PROXIMAL LATERAL or PROXIMAL ANTERIOR
I
BASILAR SEPTUM (Bundle of His region)
aVR
ANTERIOR / SEPTAL
V1
ANTERIOR
V4
INFERIOR
II
PROXIMAL LATERAL or PROXIMIAL ANTERIOR
aVL
ANTERIOR / SEPTAL
V2
LATERAL
V5
INFERIOR
III
INTERIOR
aVF
ANTERIOR
V3
LATERAL
V6

The 12 Lead ECG
Has TWO major BLIND SPOTS . . . . .

The POSTERIOR WALL

&

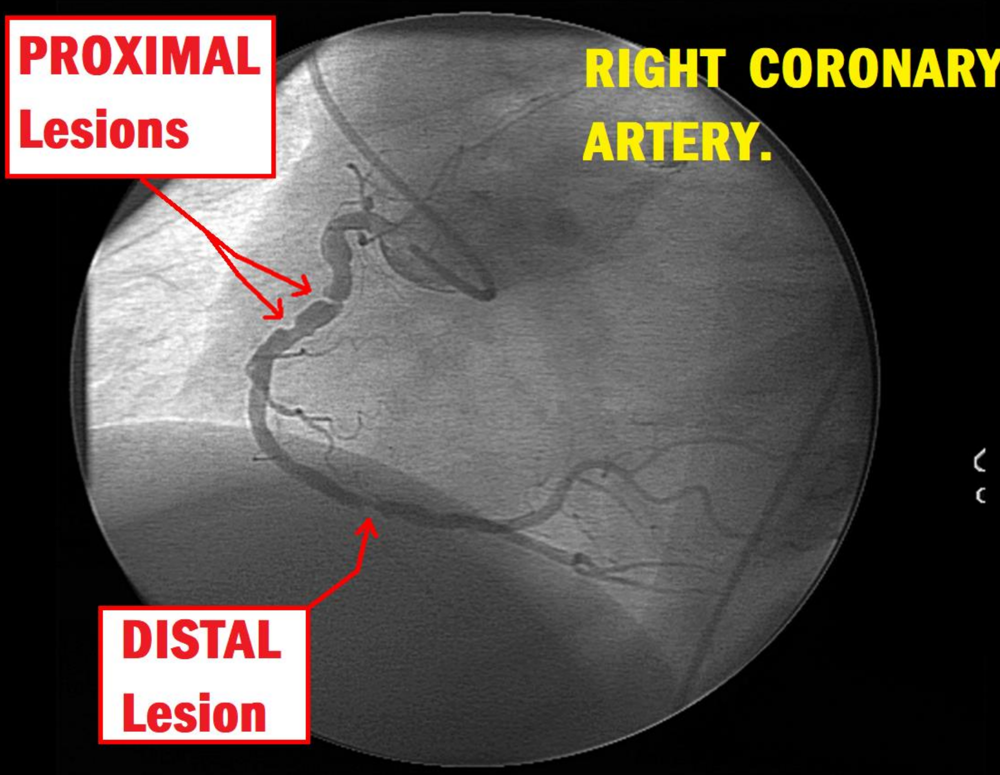
RIGHT VENTRICLE

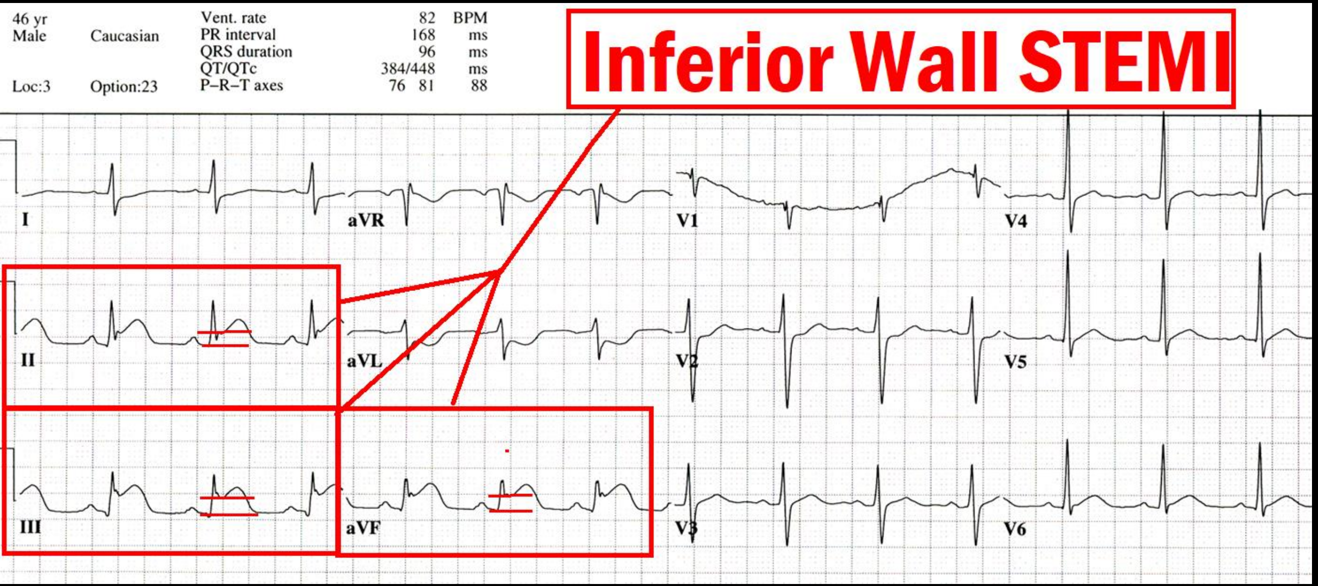


When do we need to see the Right Ventricle?

- All Patient with INFERIOR WALL STEMI (ST Elevation in Leads II, III, aVF).

When you see an EKG with **ST Elevation in Leads II, III and AVF** (Inferior Wall STEMI) – you cannot tell if the blockage is in the PROXIMAL RCA – or the DISTAL RCA.





To see the

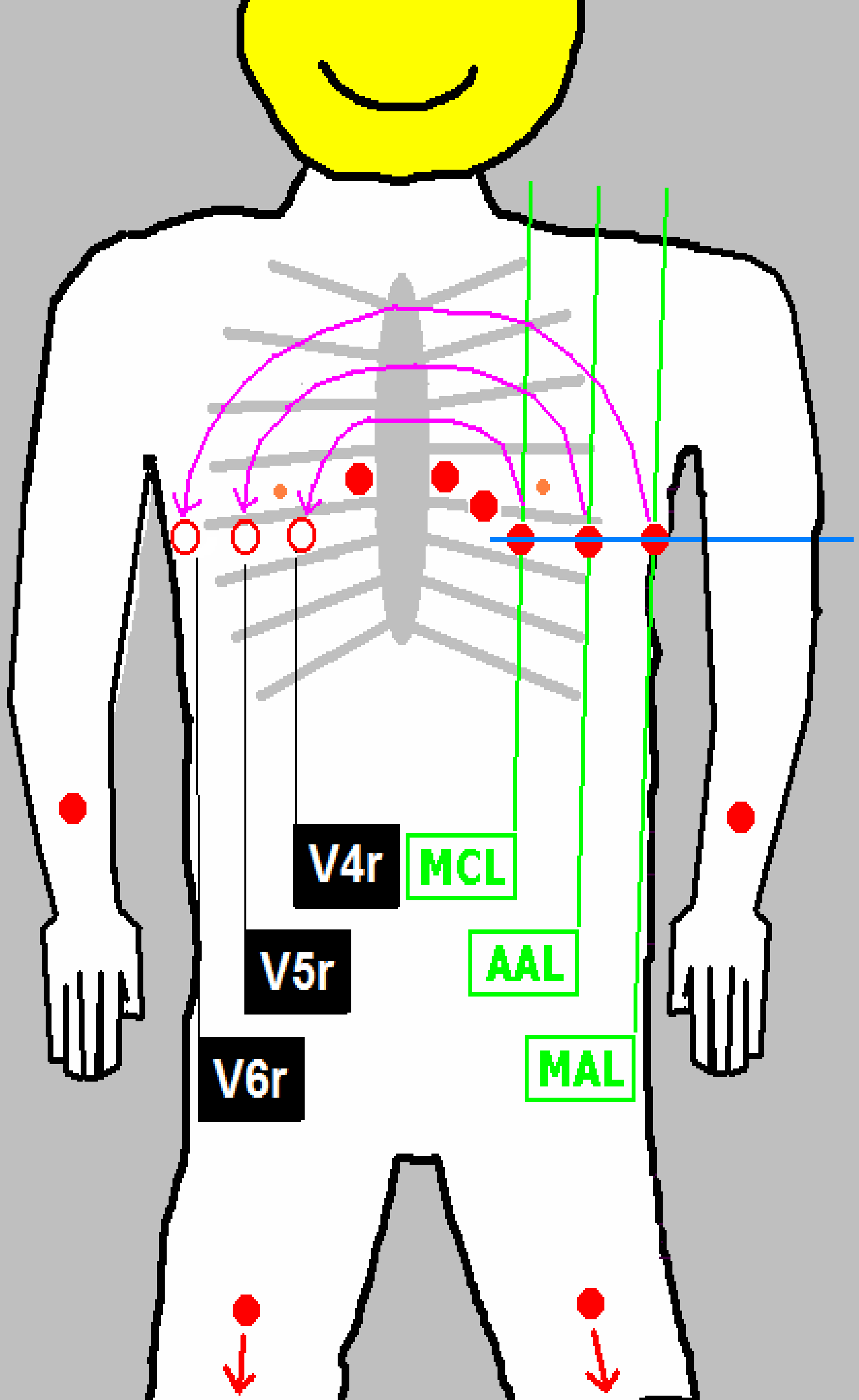
RIGHT VENTRICLE . . .

. . . such as in cases of

INFERIOR WALL M.I.

☞ You must do a

RIGHT - SIDED EKG ! !

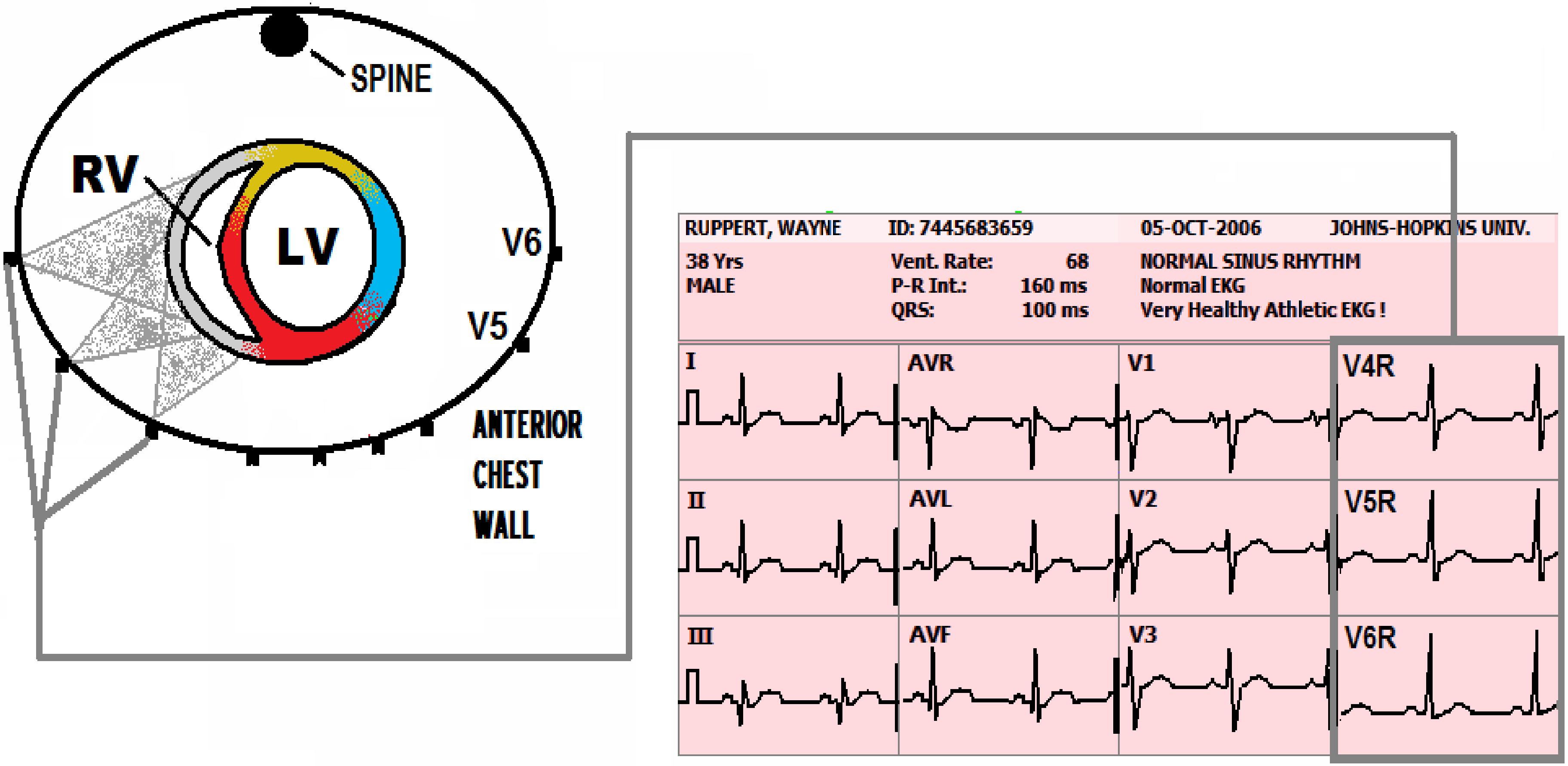


To do a
RIGHT - SIDED EKG . .

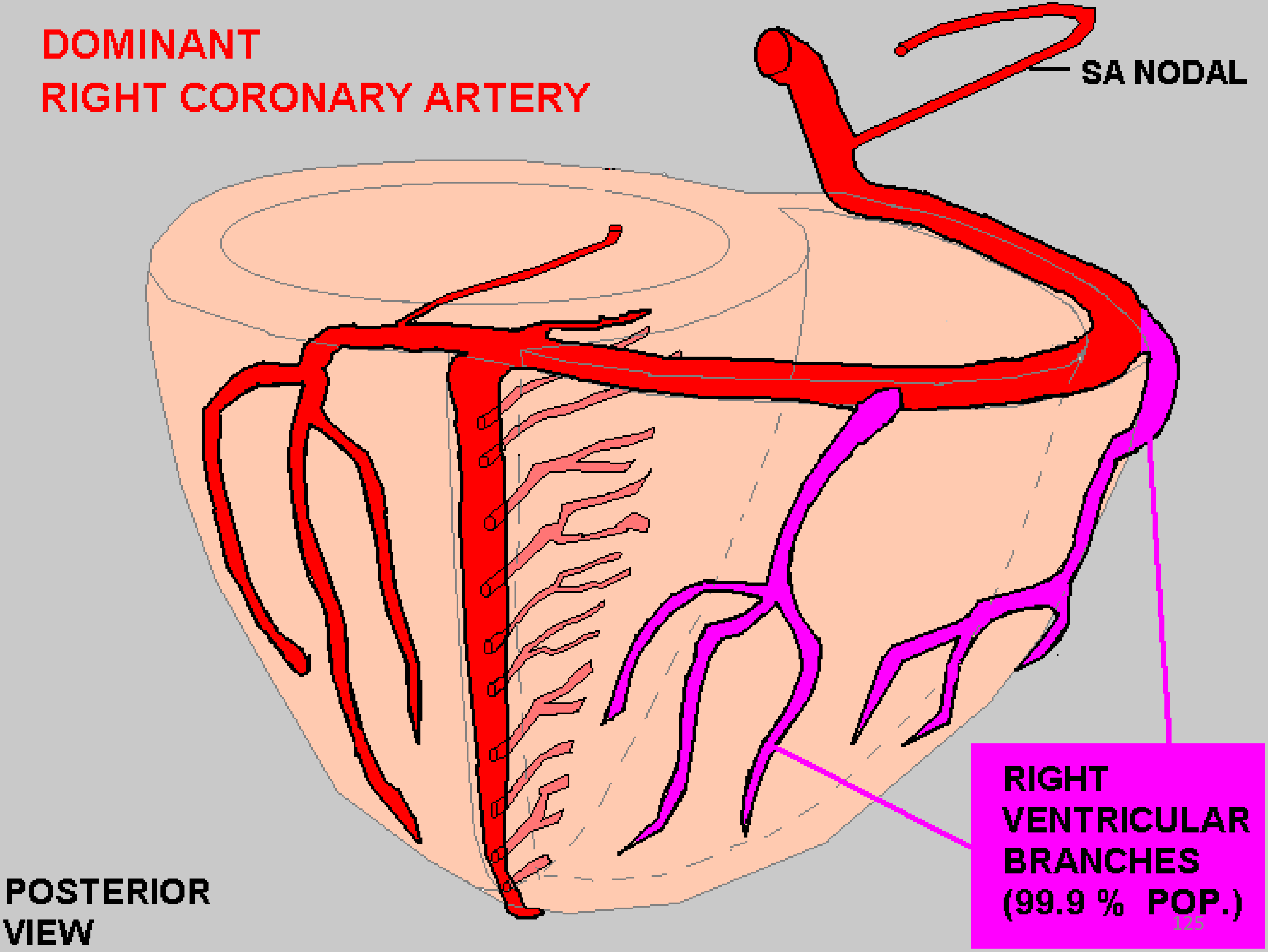
MOVE leads
V4, V5, and V6

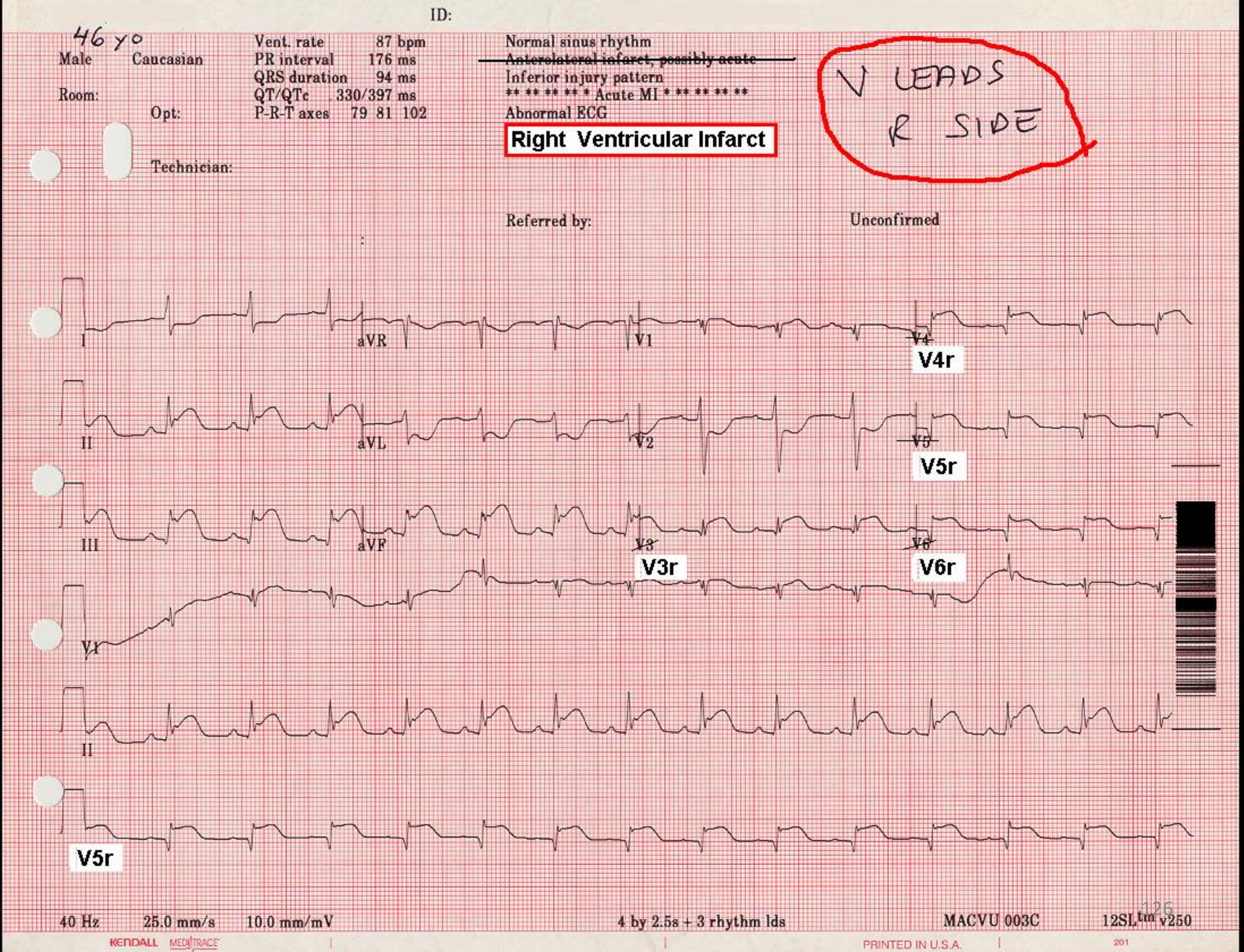
to the corresponding
placement on the
RIGHT SIDE of patient's
chest . . .

V4R - V6R VIEW THE RIGHT VENTRICLE



DOMINANT
RIGHT CORONARY ARTERY




ID:
46 yo
Male Caucasian
Room:
Opt:
Technician:
Vent. rate 87 bpm
PR interval 176 ms
QRS duration 94 ms
QT/QTc 330/397 ms
P-R-T axes 79 81 102
Normal sinus rhythm
~~Anterolateral infarct, possibly acute~~
Inferior injury pattern
** ** ** ** * Acute MI * ** ** ** **
Abnormal ECG
Right Ventricular Infarct
V LEADS R SIDE
Referred by:
Unconfirmed
I
aVR
V1
V4
V4r
II
aVL
V2
V5
V5r
III
aVF
V3
V3r
V6
V6r
V1
II
V5r
40 Hz
25.0 mm/s
10.0 mm/mV
4 by 2.5s + 3 rhythm lds
MACVU 003C
12SLtm v250
KENDALL MEDI-TRACE
PRINTED IN U.S.A.

When do we need to see the Posterior Wall?

- Any time a patient presents with symptoms of ACS and the 12 Lead ECG shows ST Depression in Leads V1, V2, V3 and/or V4.

Whenever you see

ST DEPRESSION in Leads V1 - V4

☞ you must do a

POSTERIOR LEAD ECG

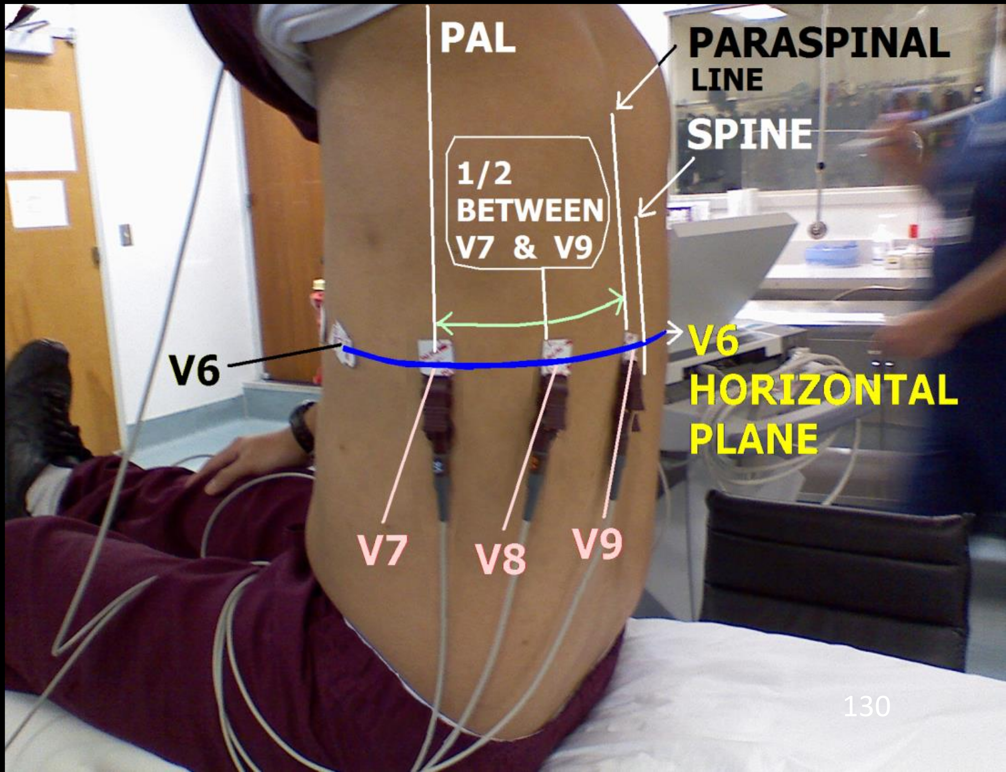
(V7 - V9)

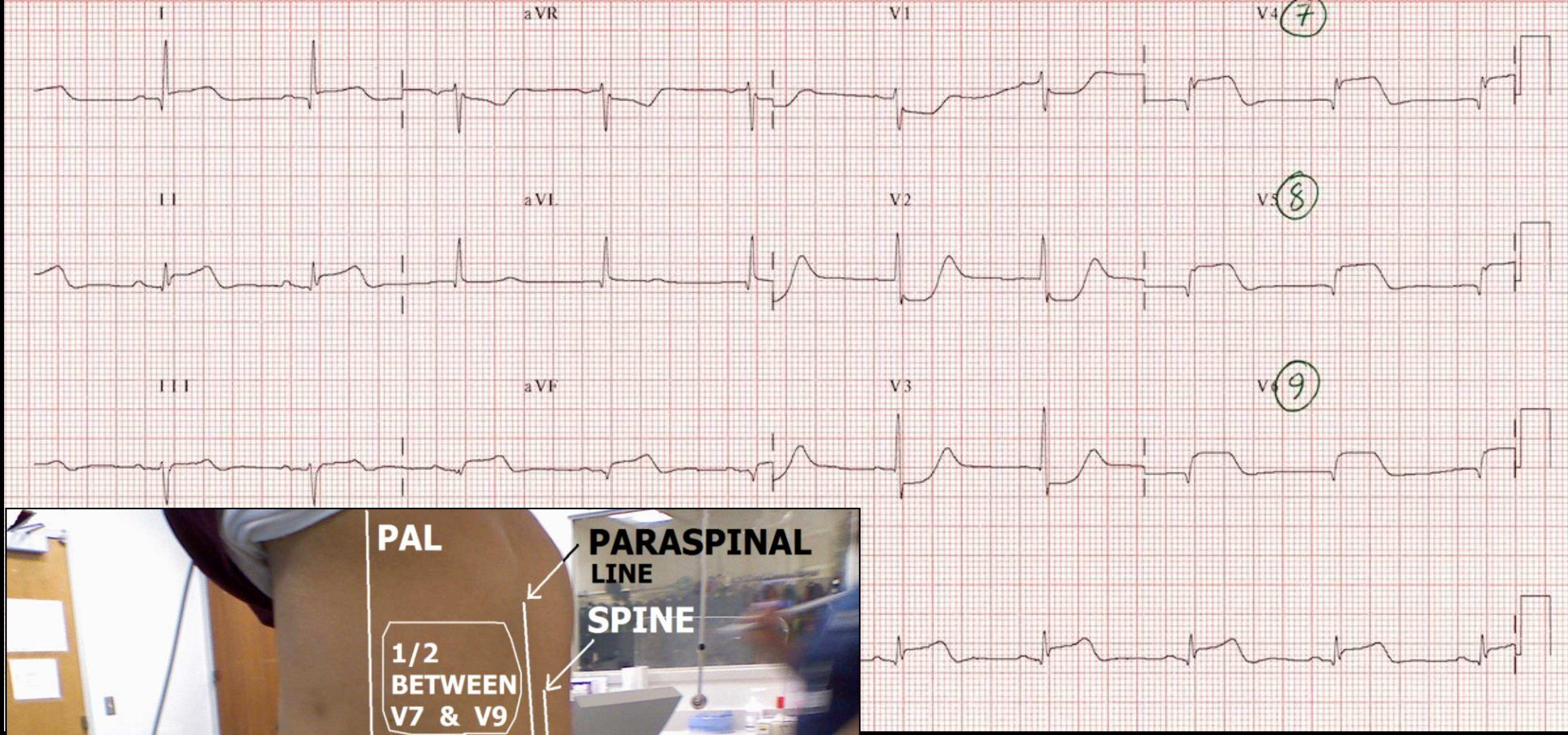
to see if you Patient is having a

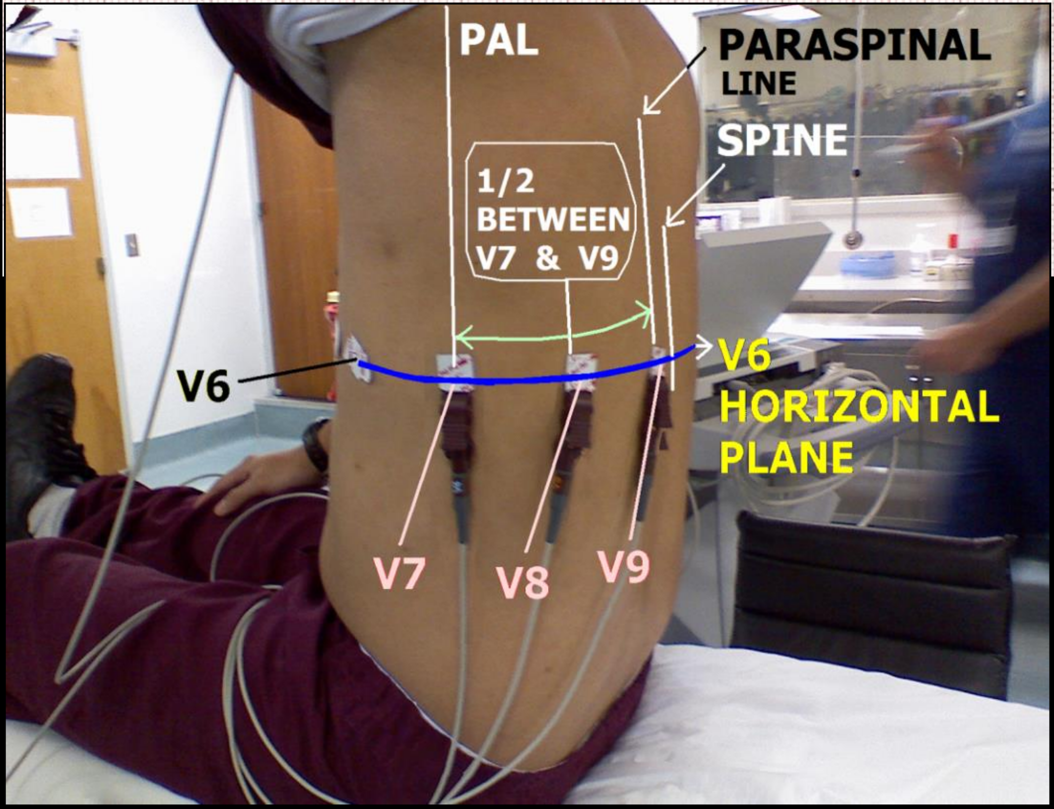
POSTERIOR WALL STEMI

Whenever your patient's ECG exhibits ST DEPRESSION in any of the ANTERIOR LEADS (V1-V4), CONSIDER the possibility of POSTERIOR WALL STEMI ! !

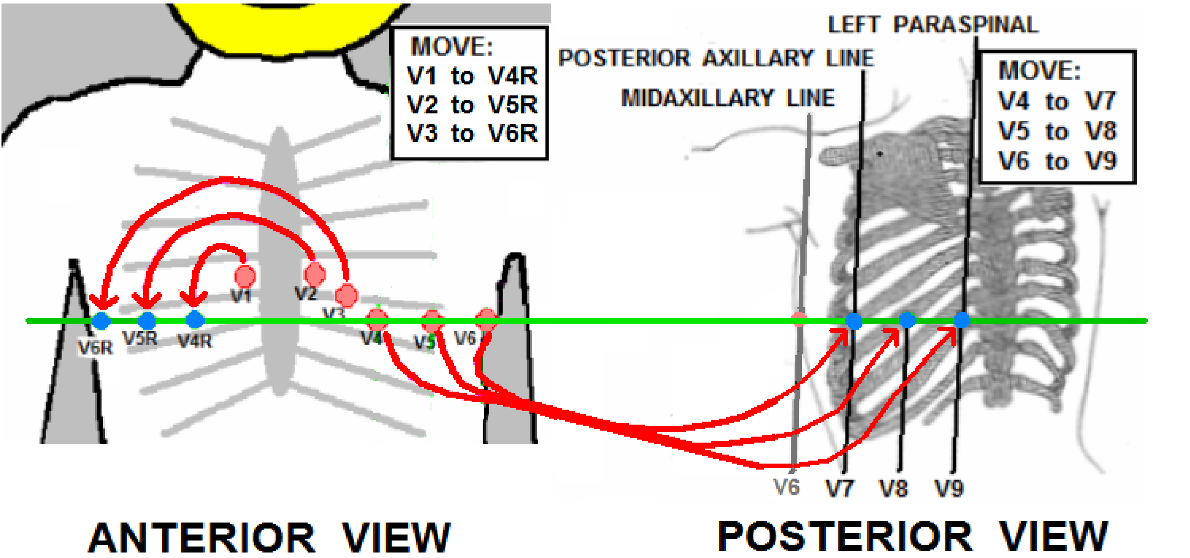
. . . To DIGANOSE Posterior Wall STEMI, we should see LEADS V7 – V9 !!

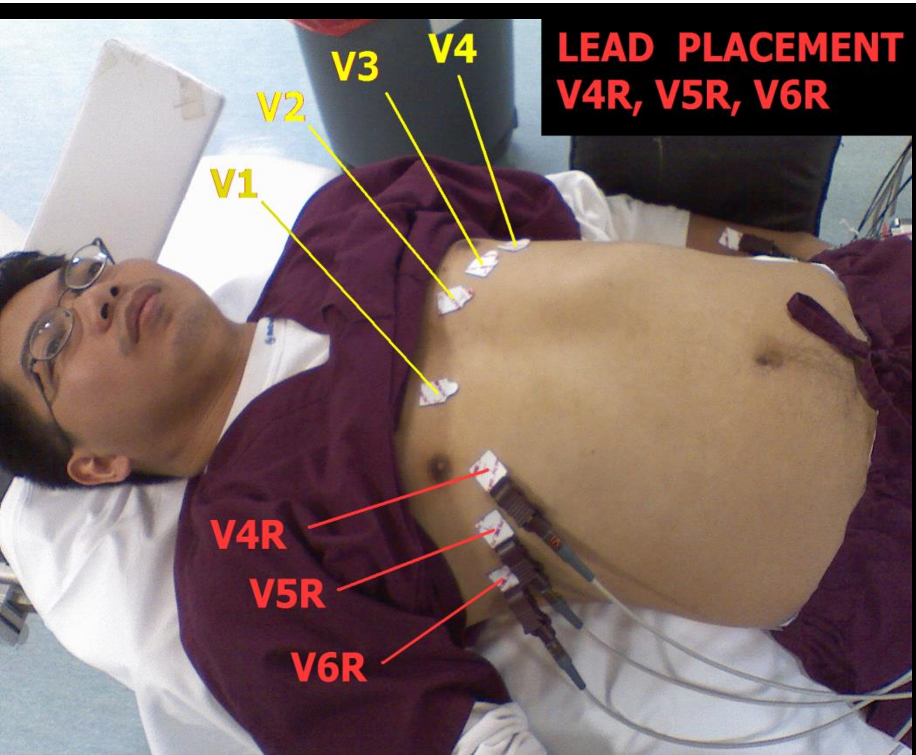


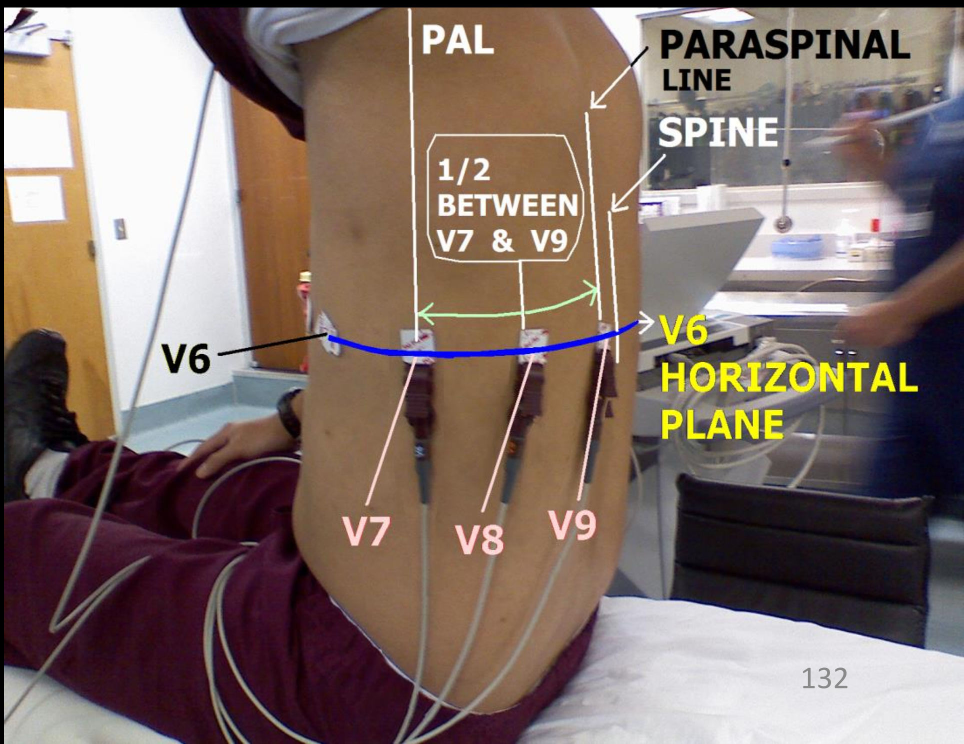

I
aVR
V1
V4 7
II
aVL
V2
V5 8
III
aVF
V3
V6 9

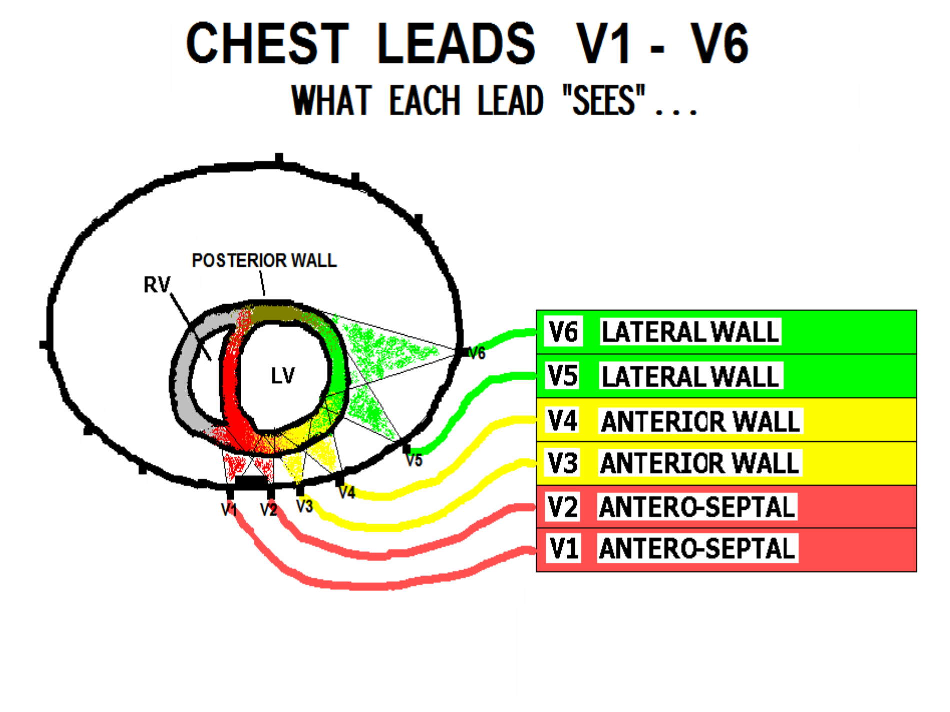

PAL
PARASPINAL
LINE
SPINE
1/2
BETWEEN
V7 & V9
V6
V6
HORIZONTAL
PLANE
V7
V8
V9

HOW TO REPOSITION 6 CHEST LEADS to OBTAIN 3 R VENTRICLE and 3 POSTERIOR LEADS



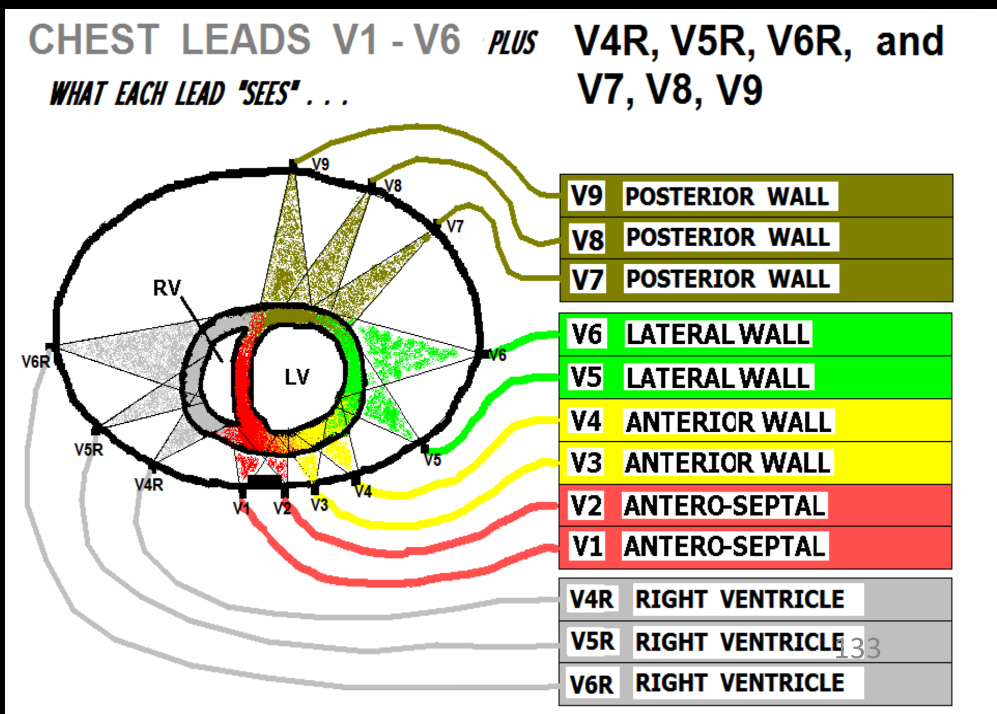


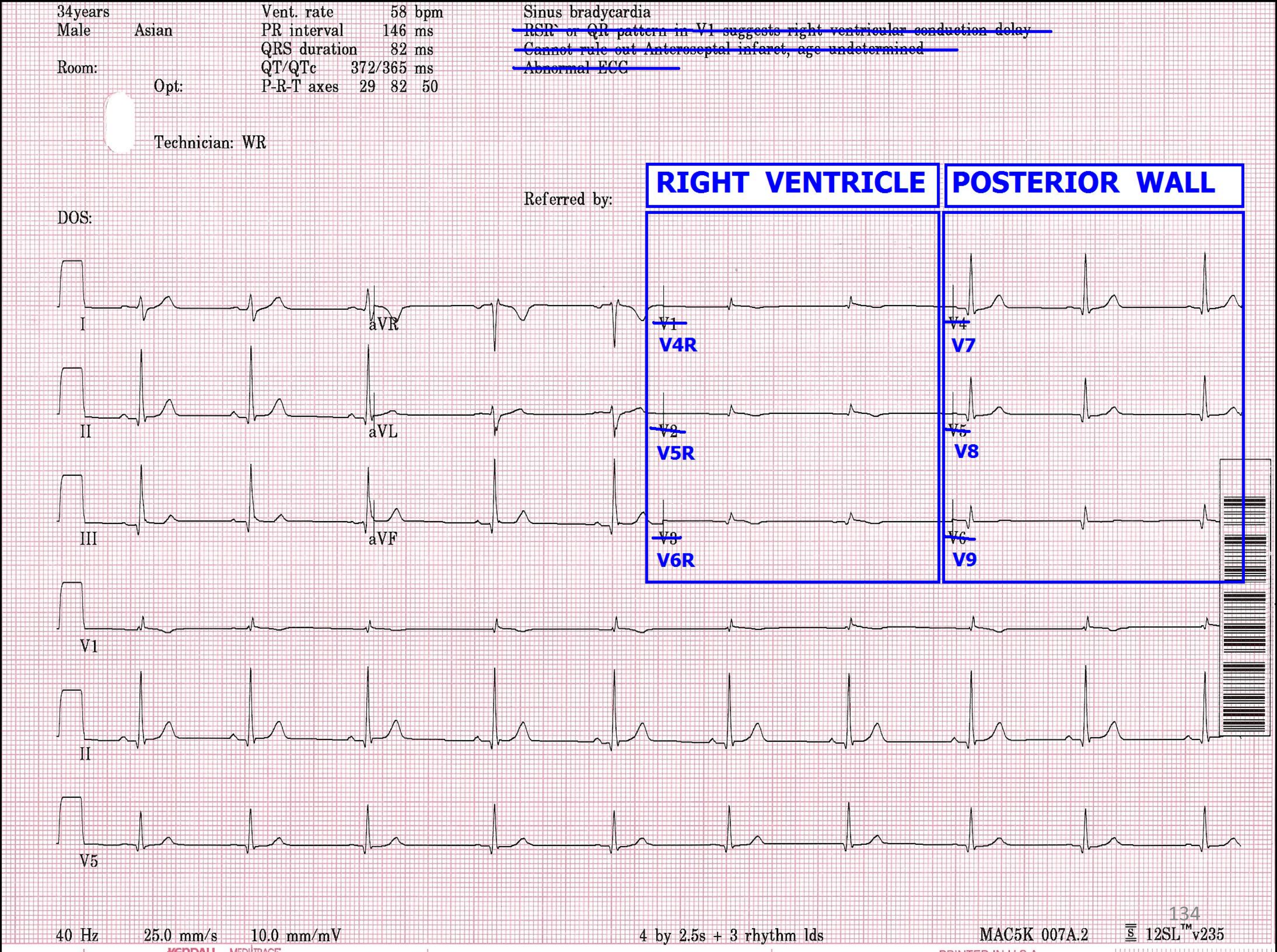




⇦ The 12 Lead ECG

The 18 Lead ECG ⇨





34years
Male Asian
Room:
Opt:
Technician: WR
DOS:
Vent. rate 58 bpm
PR interval 146 ms
QRS duration 82 ms
QT/QTc 372/365 ms
P-R-T axes 29 82 50
Sinus bradycardia
~~RSR' or QR pattern in V1 suggests right ventricular conduction delay~~
~~Cannot rule out Anteroseptal infarct, age undetermined~~
~~Abnormal ECG~~
Referred by:
RIGHT VENTRICLE
POSTERIOR WALL
I
aVR
~~V1~~ V4R
~~V4~~ V7
II
aVL
~~V2~~ V5R
~~V5~~ V8
III
aVF
~~V3~~ V6R
~~V6~~ V9
V1
II
V5
40 Hz 25.0 mm/s 10.0 mm/mV
4 by 2.5s + 3 rhythm lds
MAC5K 007A.2
12SL™v235

POSTERIOR WALL MI usually accompanies INFERIOR and/or LATERAL WALL MI !!!

POSTERIOR WALL MI usually accompanies INFERIOR and/or LATERAL WALL MI !!!

. . . . On rare occasions, we see isolated cases of POSTERIOR WALL MI

Pat ID [redacted]

RX

DX

[redacted]2019 22:07:54

[redacted] 46 yrs

[redacted]

Caucasian Female

Account # [redacted]

Bayfront Health Seven Rivers ED

Dept	ED
Room	[redacted]
Tech	LDC

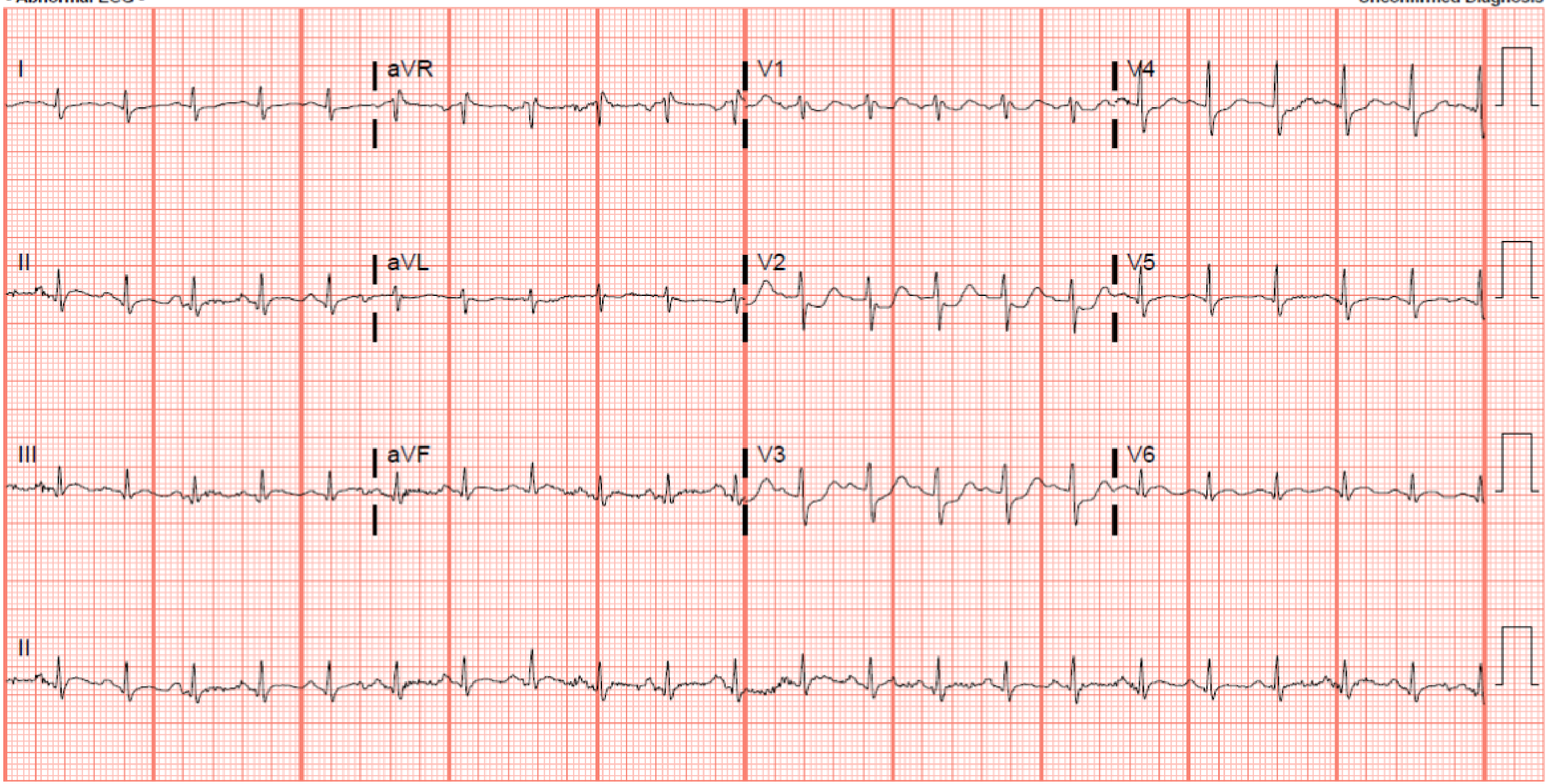
Rate	131
PR	128
QRSd	92
QT	317
QTc	468
--Axis--	
P	65
QRS	83
T	132

```
Sinus tachycardia
Probable inferior infarct, old
Posterior infarct, acute (LCx)
ST depression V1-V3, suggest recording posterior leads
NO PREVIOUS ECG AVAILABLE FOR COMPARISON
```

Req Provider: CHARLES NOLES

- Abnormal ECG -

Unconfirmed Diagnosis



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

Evaluating the ECG for ACS:

A TWO-STEP process:

Evaluating the ECG for ACS:

A TWO-STEP process:

STEP 1: Evaluate QRS Width

Evaluating the ECG for ACS:

A TWO-STEP process:

STEP 1: <u>**Evaluate QRS Width**</u>

STEP 2: <u>**Evaluate J Points, ST-Segment and T waves**</u> **in EVERY Lead**

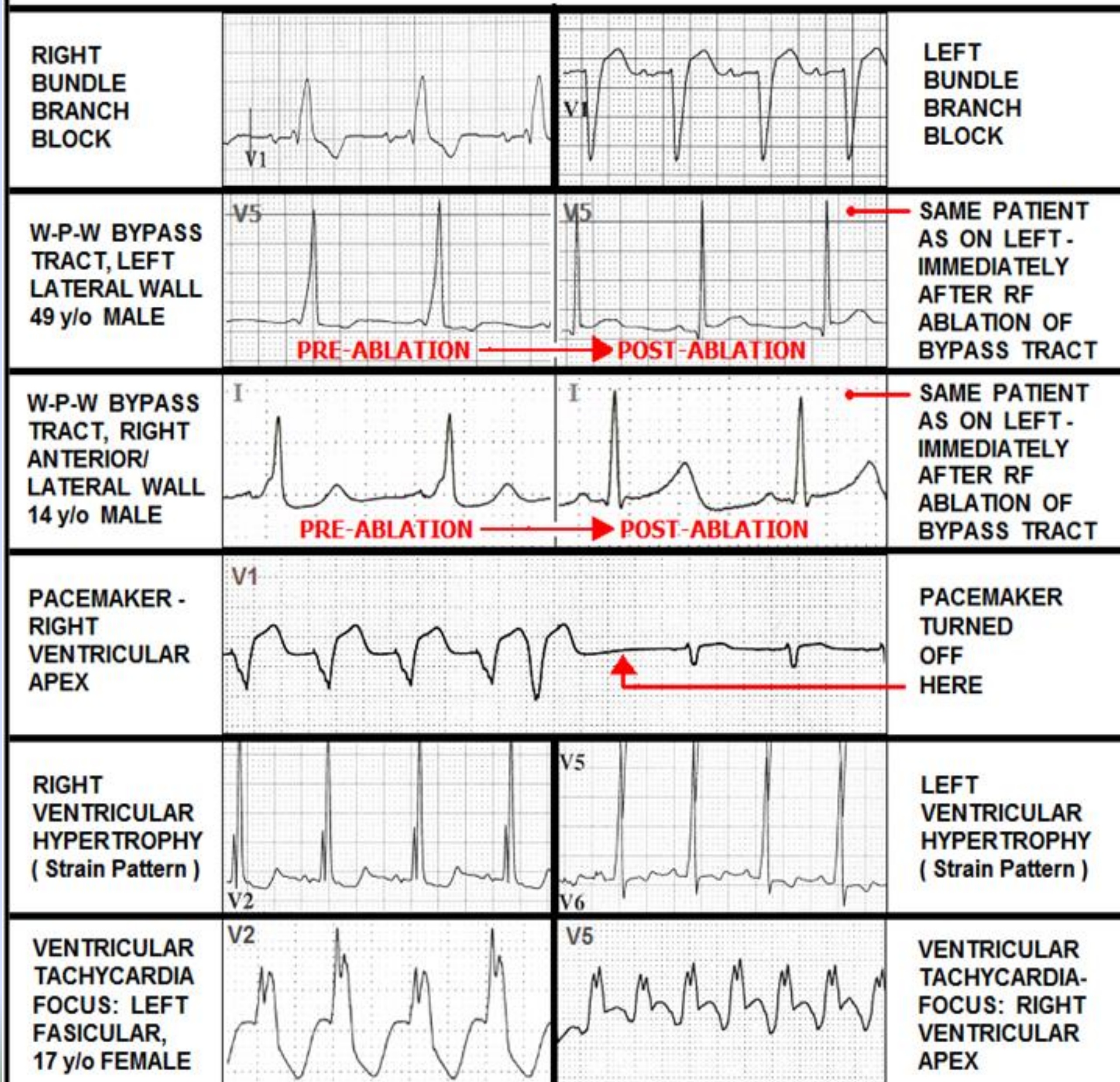
STEP 1 – evaluate QRS width:

- **QRS is ABNORMALLY WIDE (>120 ms),**
  - **indicates DEPOLARIZATION ABNORMALITY (e.g. "bundle branch block, Wolff-Parkinson-White Syndrome, etc).**

STEP 1 – evaluate QRS width:

- **QRS is ABNORMALLY WIDE (>120 ms),**
  - **indicates DEPOLARIZATION ABNORMALITY (e.g. "bundle branch block, Wolff-Parkinson-White Syndrome, etc).**
  - **DEPOLARIZATION ABNORMALITIES in turn cause REPOLARIZATION ABNORMALITIES, which alters the: *J Points, ST-Segments and/or T Waves.***

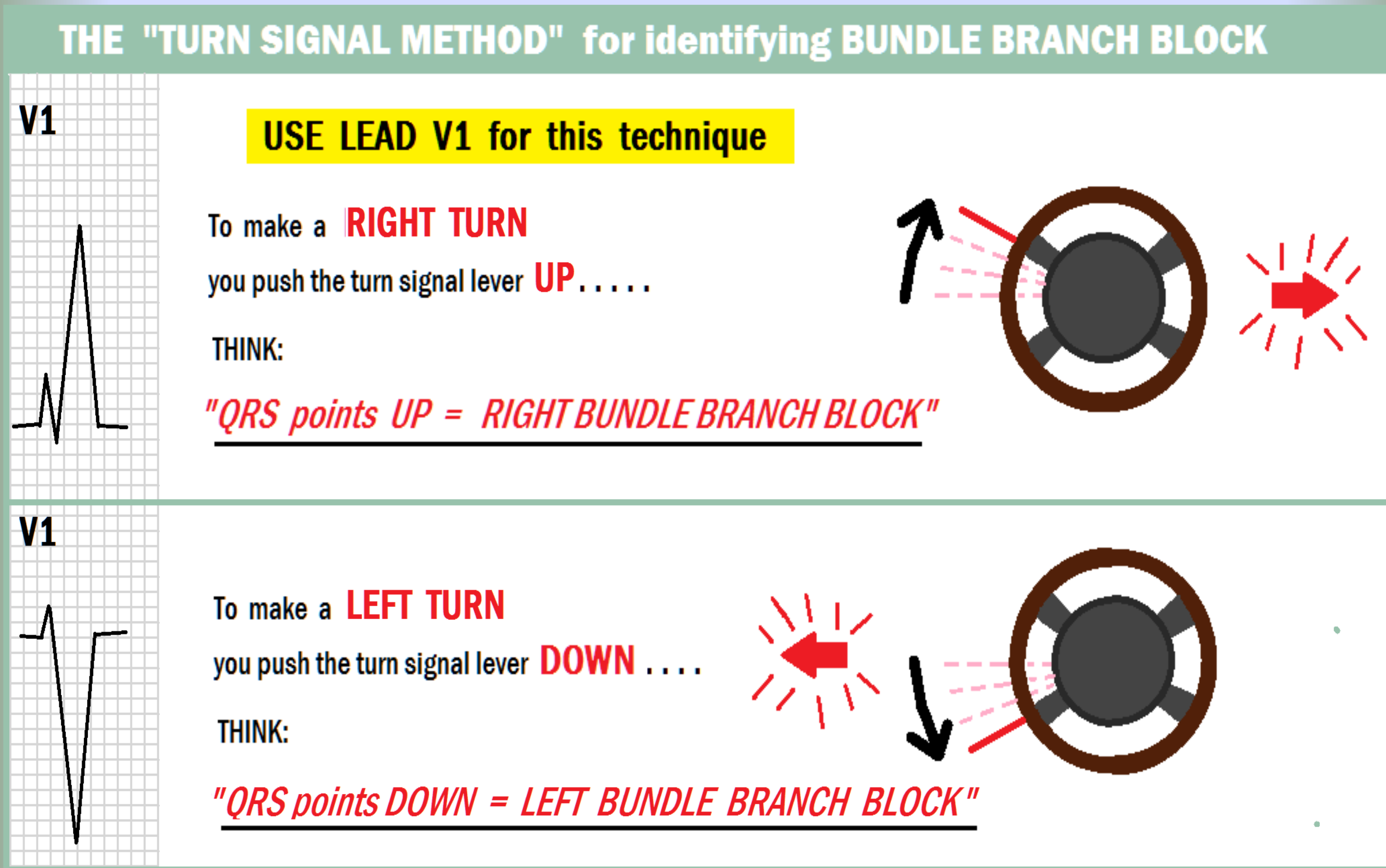
CONDITIONS THAT INCREASE QRS DURATION RESULT IN SECONDARY REPOLARIZATION ABNORMALITIES:



Wide QRS present:
QRSd > 120ms

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

Simple "Turn Signal Method" . . .

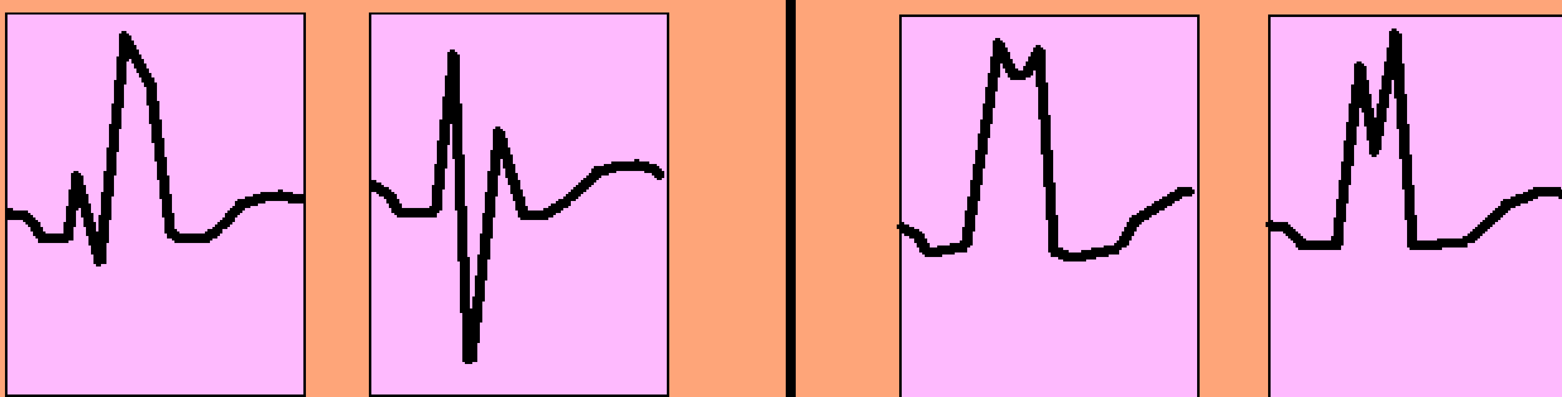


DIAGNOSING BUNDLE BRANCH BLOCK

USING LEADS V1, V2, and V5, V6:

LOCATING RsR' or RR' COMPLEXES:

V1 V2 V5 V6

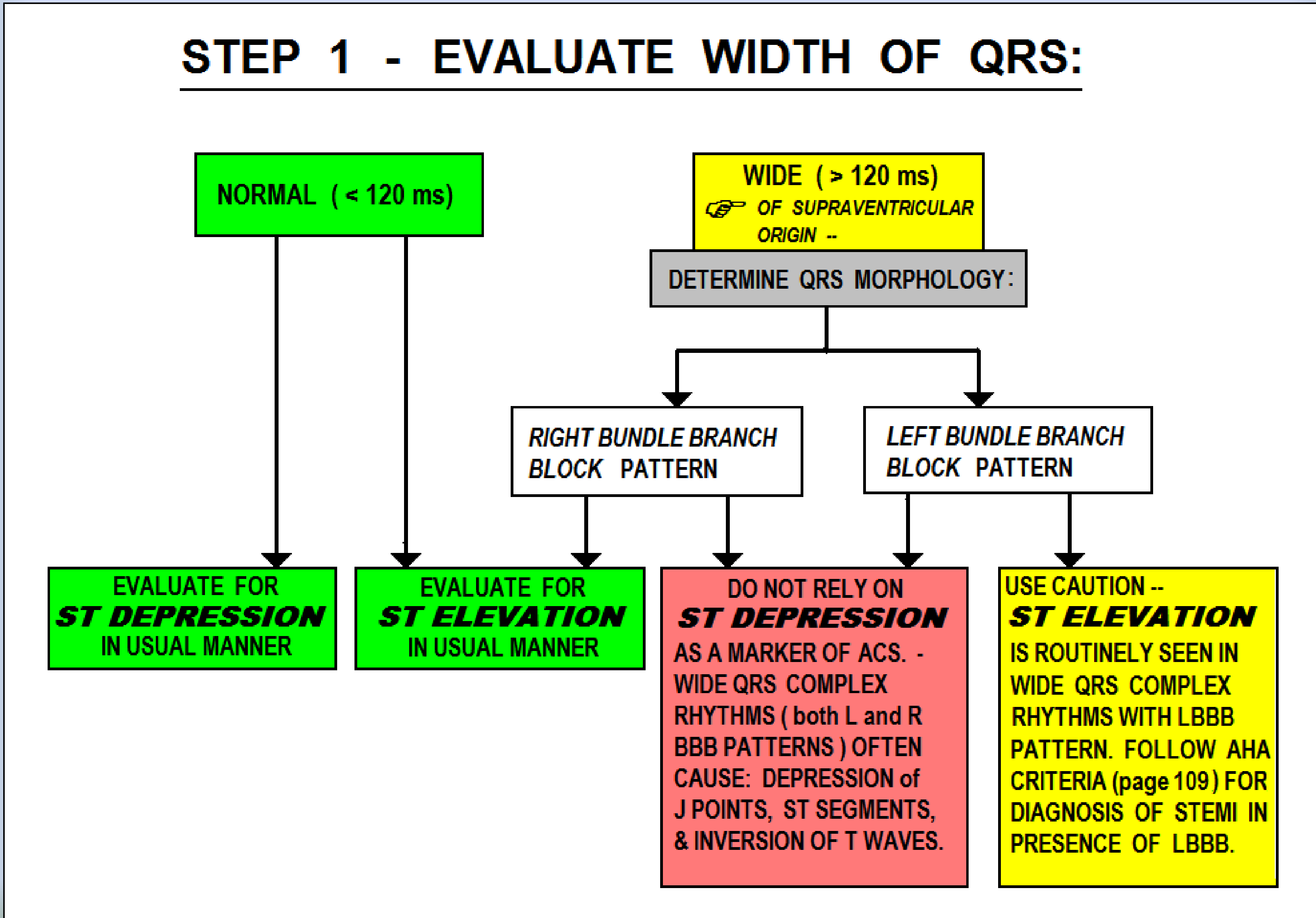


RIGHT BUNDLE BRANCH BLOCK

LEFT BUNDLE BRANCH BLOCK

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

Evaluating the ECG for ACS:



Wide QRS present:
(QRSd > 120ms)

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

RUPPERT, WAYNE ID: 099999999 4-Mar-2001

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

Technician: WR

Referred by: Unconfirmed

D.O.S.:

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

40 Hz 25.0 mm/s 10.0 mm/mV 4 by 2.5s + 3 rhythm lds MACVU 003C 12SLtm v250

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

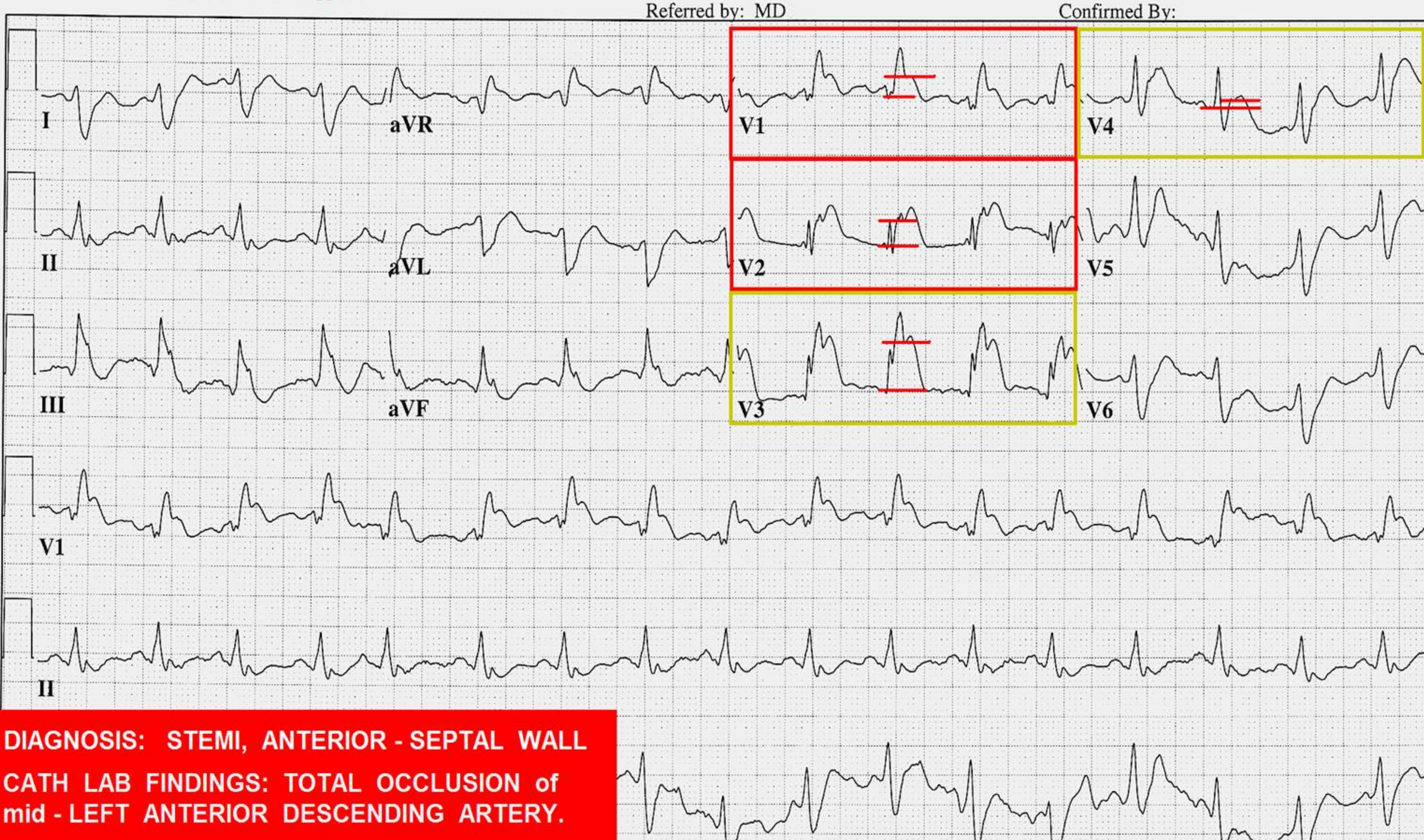
Room:ATL
Loc:3 Option:23

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.

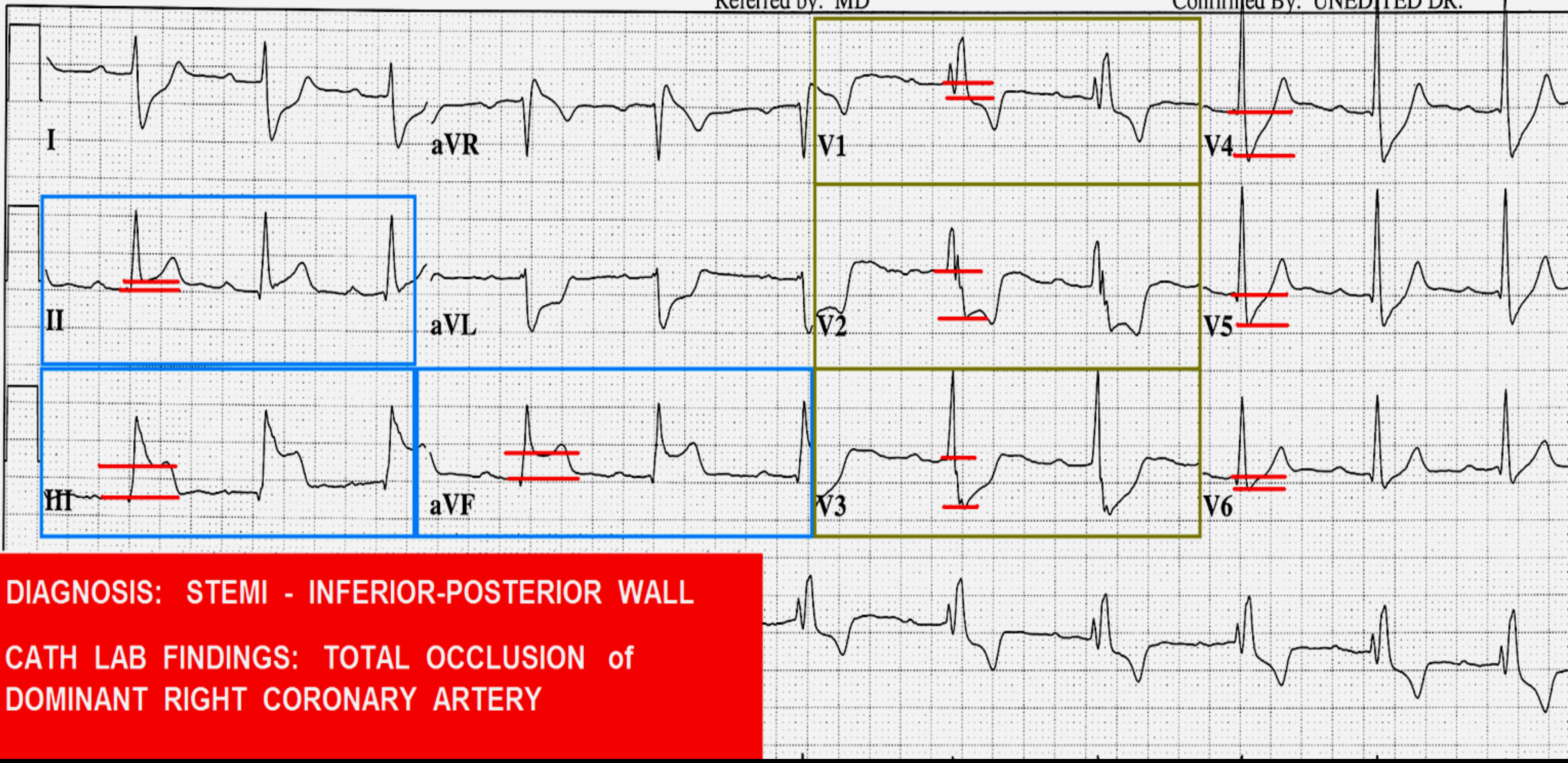
RBBB with CHEST PAIN - CASE 2 : ST ELEVATION LEADS II, III, aVF - WITH RECIPROCAL ST DEPRESSION in LEADS V1 - V6

25 yr		Vent. rate	67		BPM
Male	Caucasian	PR interval	258		ms
		QRS duration	136		ms
		QT/QTc	398/420		ms
Loc:3	Option:23	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		Vent. rate	110	BPM
Male	Caucasian	PR interval	170	ms
		QRS duration	148	ms
Room:CS–19		QT/QTc	366/495	ms
Loc:6	Option:41	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).***

Diagnosis of STEMI with LBBB pattern:

2013 ACC/AHA Guideline for Management of STEMI

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

Diagnosis of STEMI with LBBB pattern:

2013 ACC/AHA Guideline for Management of STEMI

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

Diagnosis of STEMI with LBBB pattern:

2013 ACC/AHA Guideline for Management of STEMI

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

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*

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: Confirmed By:

25mm/s 10mm/mV 40Hz 005C 12SL 4 CID: 11 EID:18 EDT:

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.

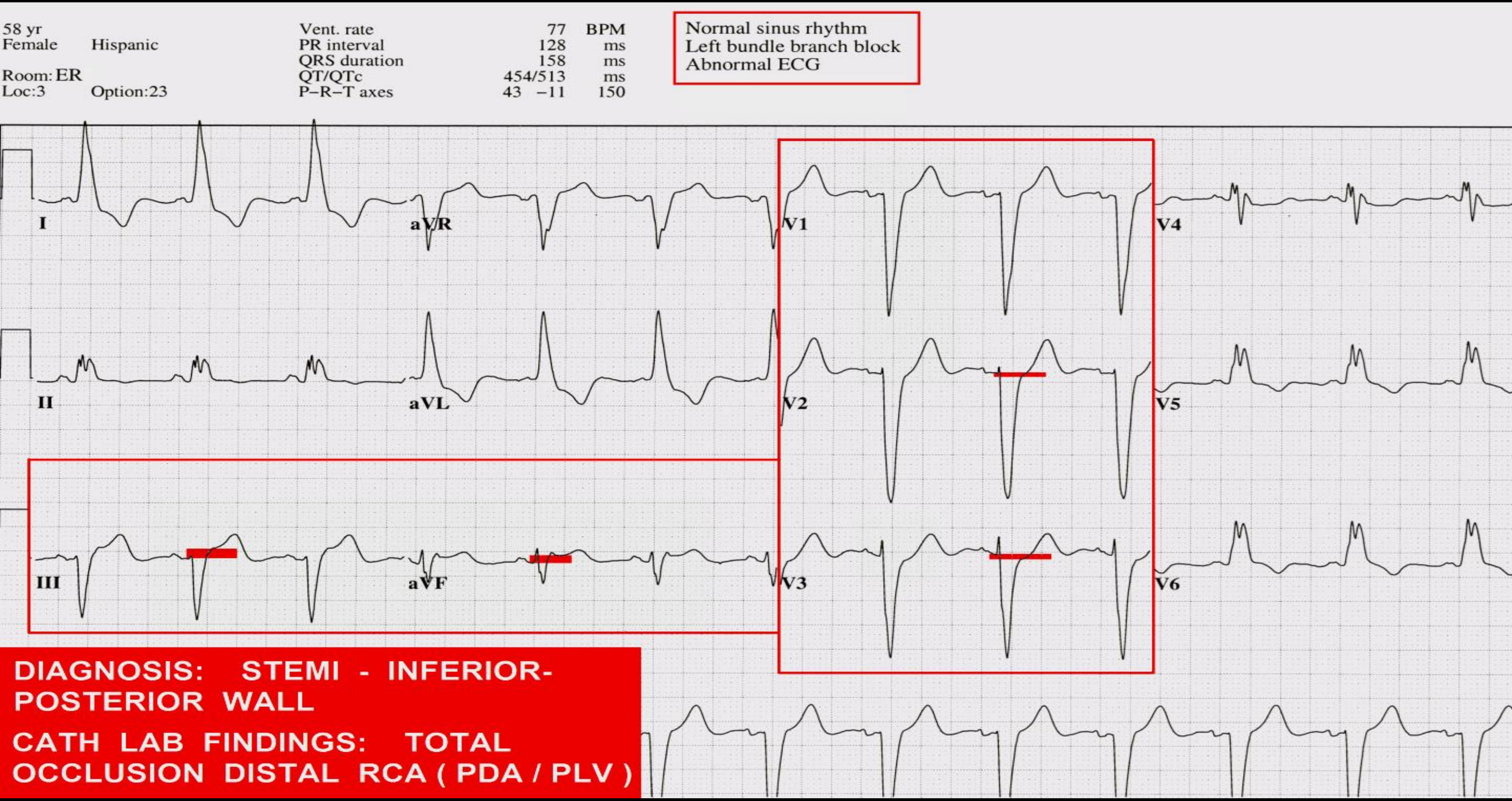
“Electrocardiographic Diagnosis of Evolving Acute Myocardial Infarction in the Presence of Left Bundle-Branch Block” Birnbaum et al, N Engl J Med 1996; 334:481-487

Be advised that 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.

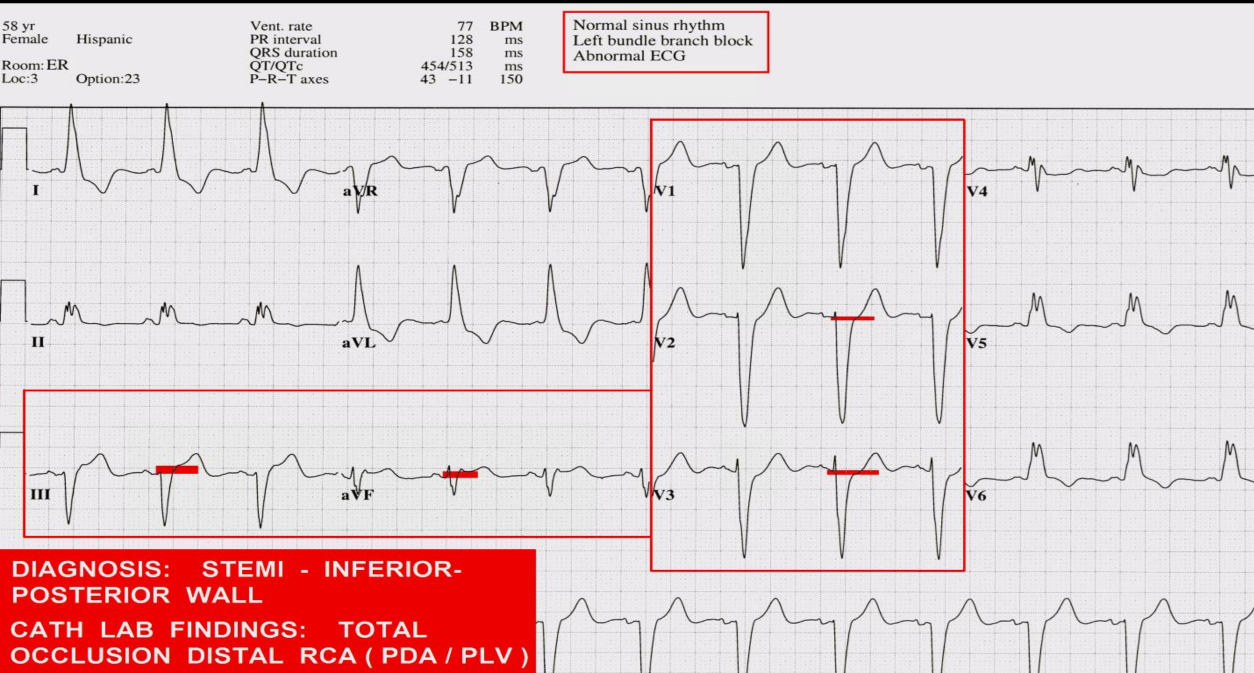
LBBB with CHEST PAIN - CASE 1 : PRESENTING EKG



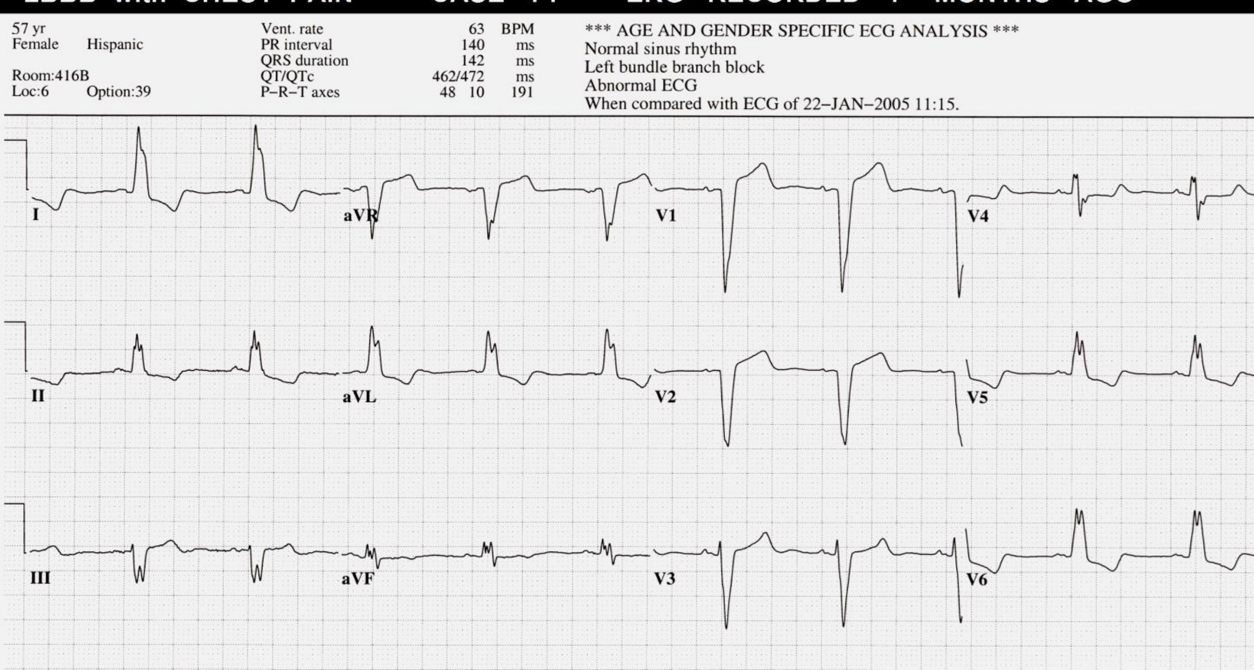
DIAGNOSIS: STEMI - INFERIOR-POSTERIOR WALL

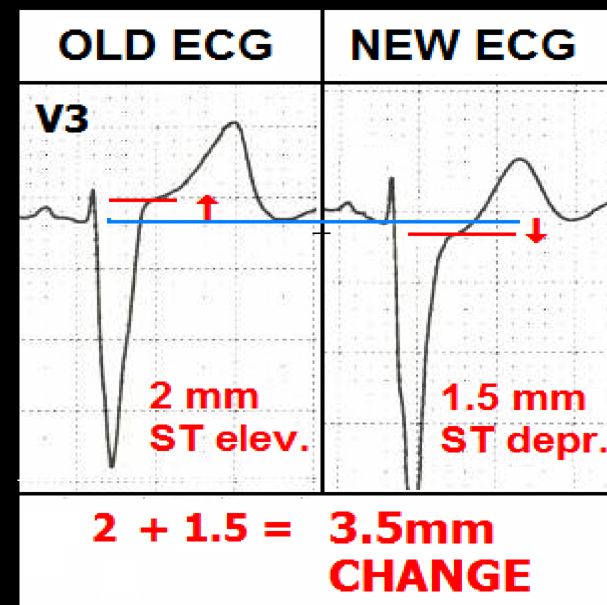
CATH LAB FINDINGS: TOTAL OCCLUSION DISTAL RCA (PDA / PLV)

LBBB with CHEST PAIN - CASE 1: PRESENTING EKG



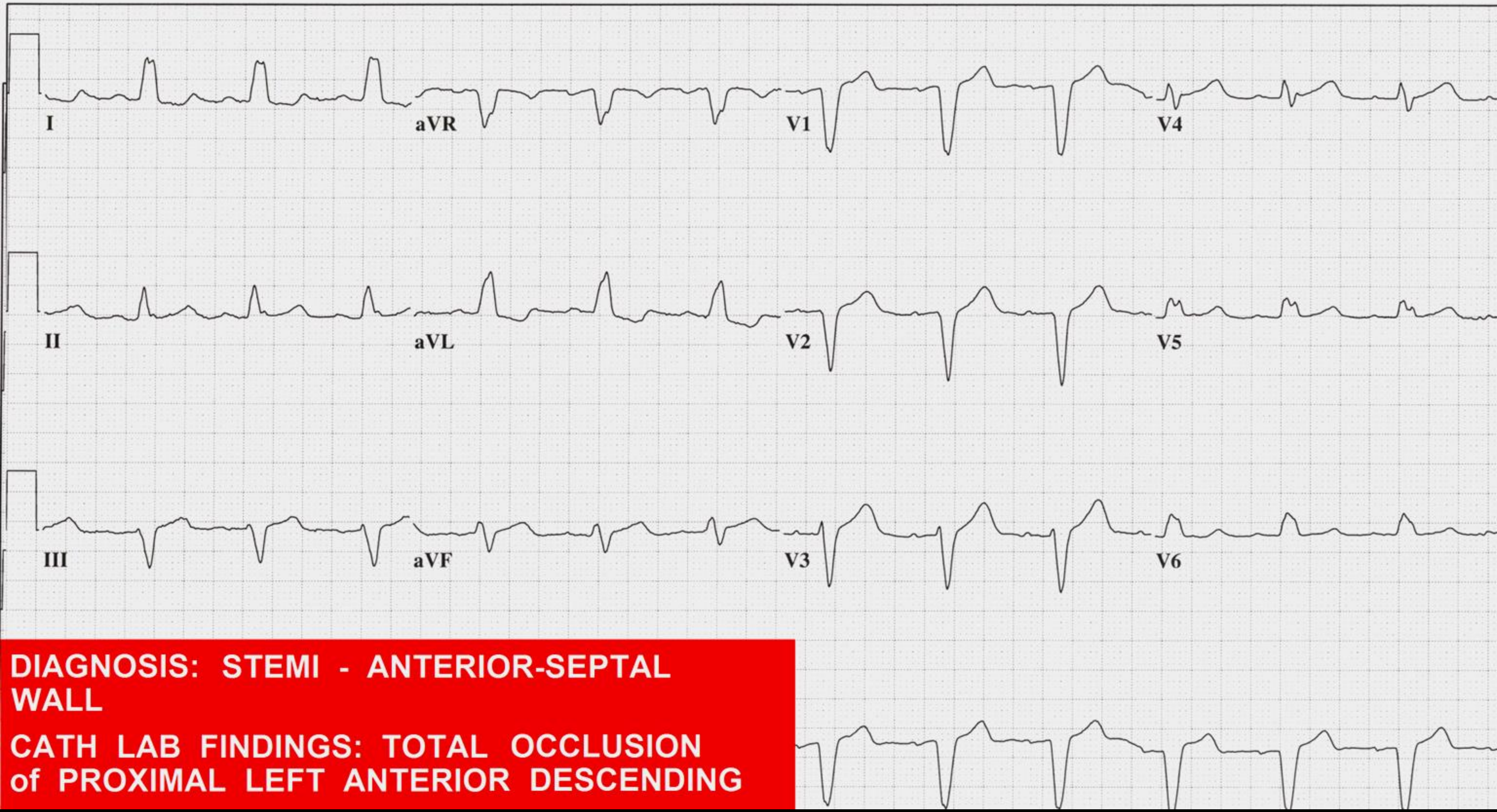
LBBB with CHEST PAIN - CASE 1: EKG RECORDED 7 MONTHS AGO





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

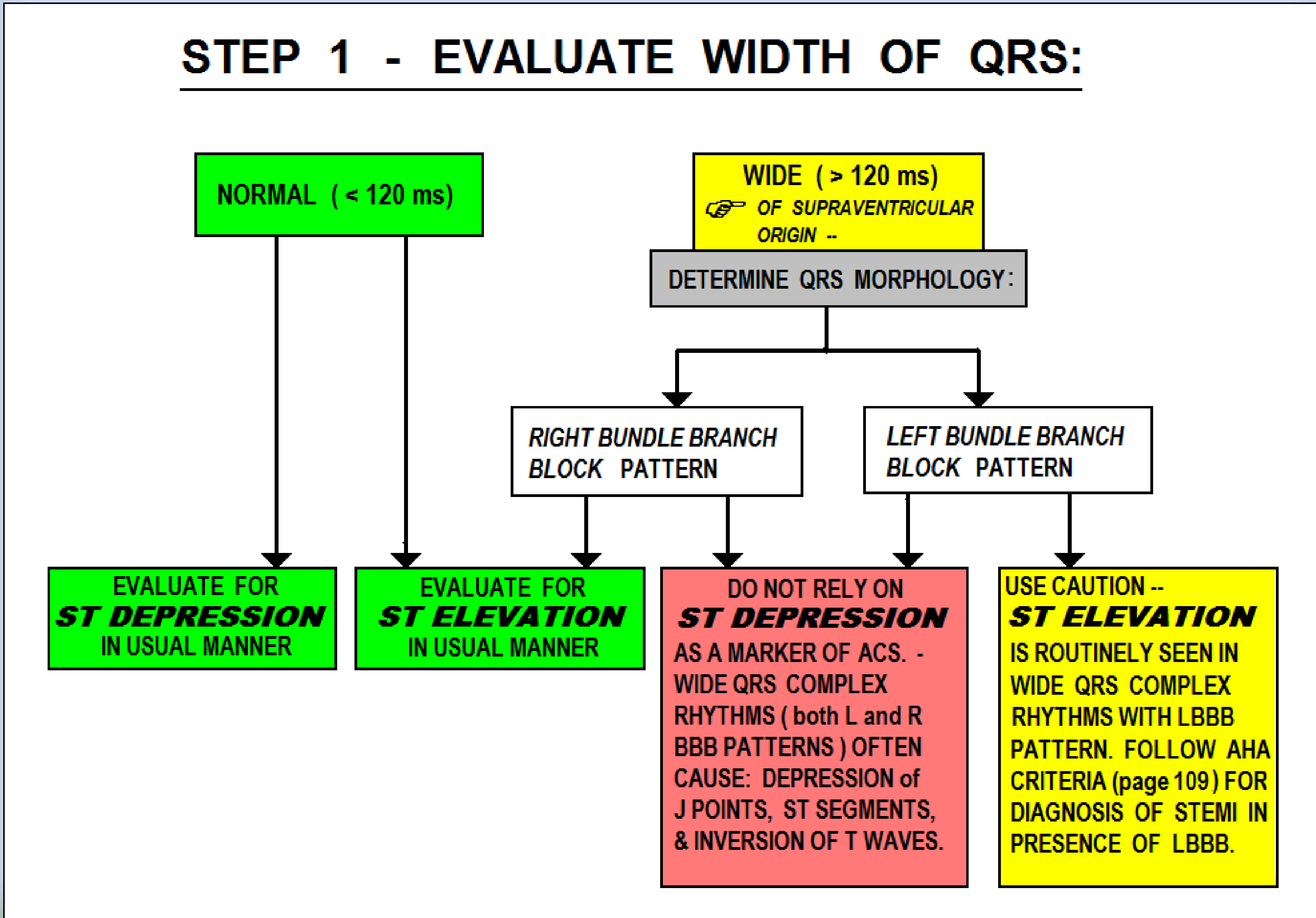
46 yr		Vent. rate	77	BPM	Normal sinus rhythm
Male	Caucasian	PR interval	172	ms	Left bundle branch block
		QRS duration	142	ms	Abnormal ECG
Room:ER		QT/QTc	446/504	ms	
Loc:3	Option:23	P–R–T axes	38 0	92	



DIAGNOSIS: STEMI - ANTERIOR-SEPTAL WALL

CATH LAB FINDINGS: TOTAL OCCLUSION of PROXIMAL LEFT ANTERIOR DESCENDING

Evaluating the ECG for ACS:



Evaluating the ECG for ACS:

Patients with Normal Width QRS

(QRSd < 120ms)

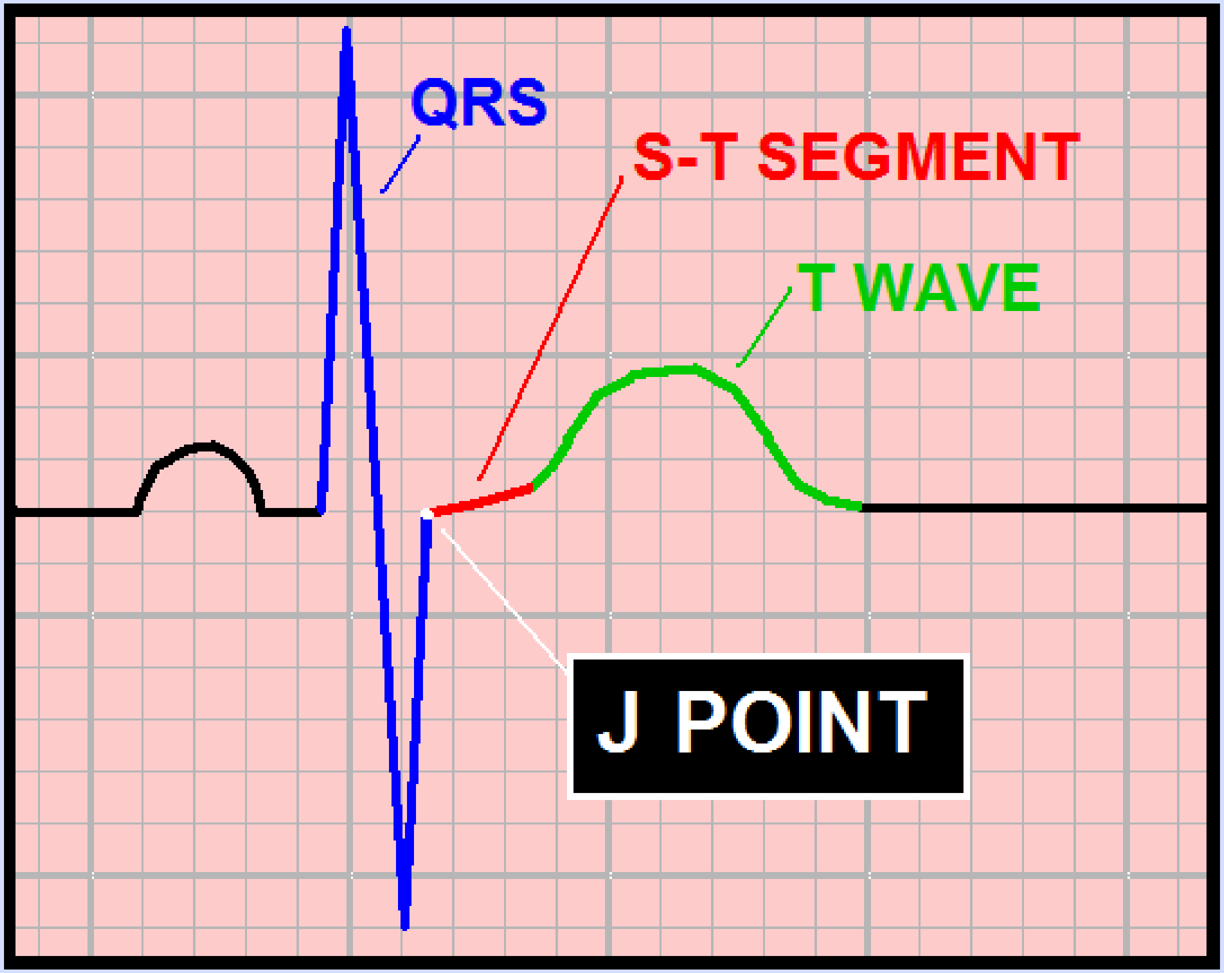
STEP 2 - EVALUATE the EKG for ACS

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

- J POINTS
- ST SEGMENTS
- T WAVES

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

Defining NORMAL – QRS <120ms:



When QRS duration is NORMAL (< 120 ms):

NORMAL ST - T WAVES

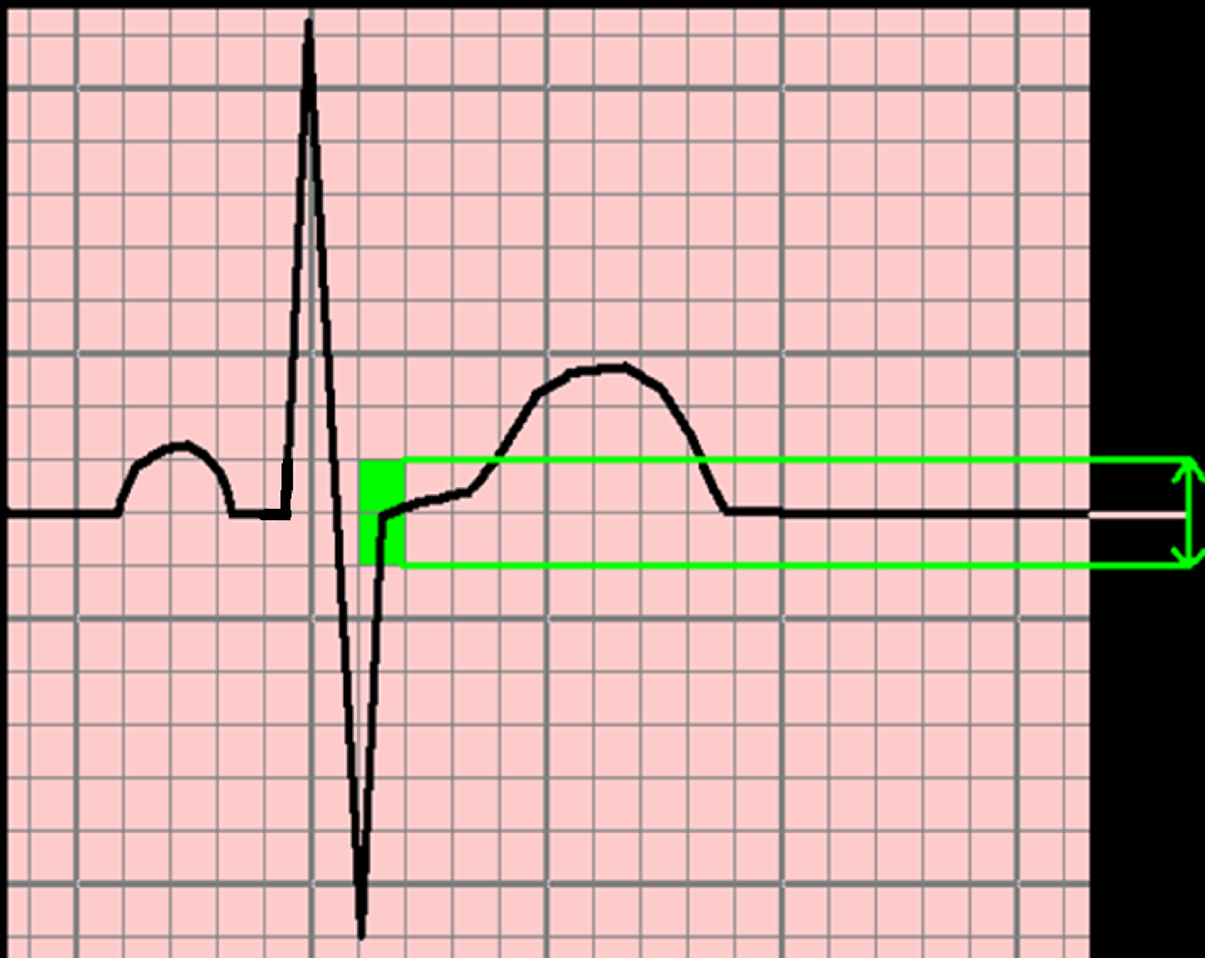
- WHEN QRS WIDTH IS NORMAL (< 120 ms)

ASSESS:

- J POINT: ISOELECTRIC (or < 1 mm dev.)
- ST SEG: SLIGHT, POSITIVE INCLINATION
- T WAVE: UPRIGHT, POSITIVE

☞ *in EVERY LEAD EXCEPT aVR ! !*

THE J POINT SHOULD BE . .

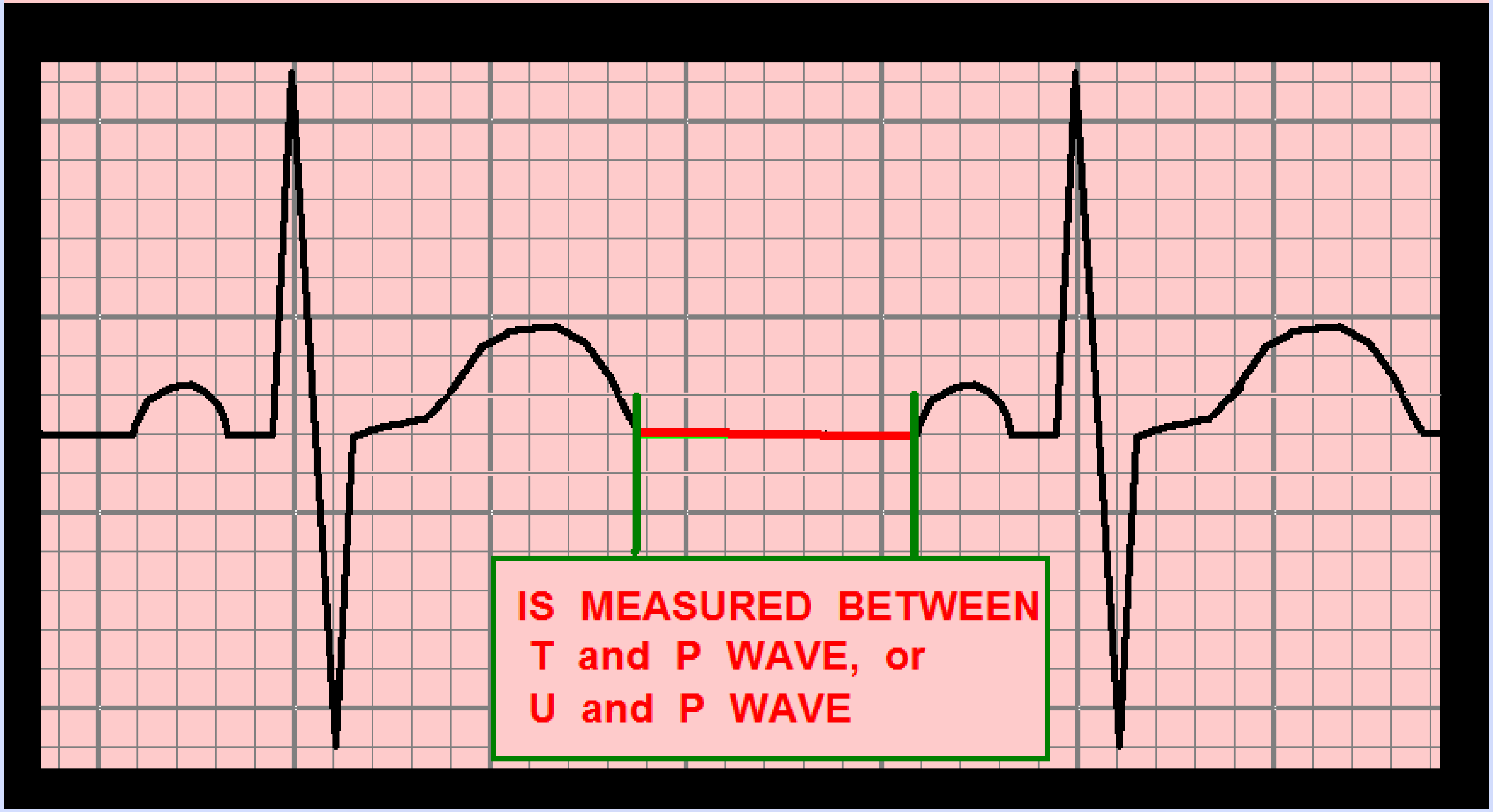


WITHIN
1 mm
ABOVE

OR

BELOW
the
ISOELECTRIC
LINE

THE ISOELECTRIC LINE

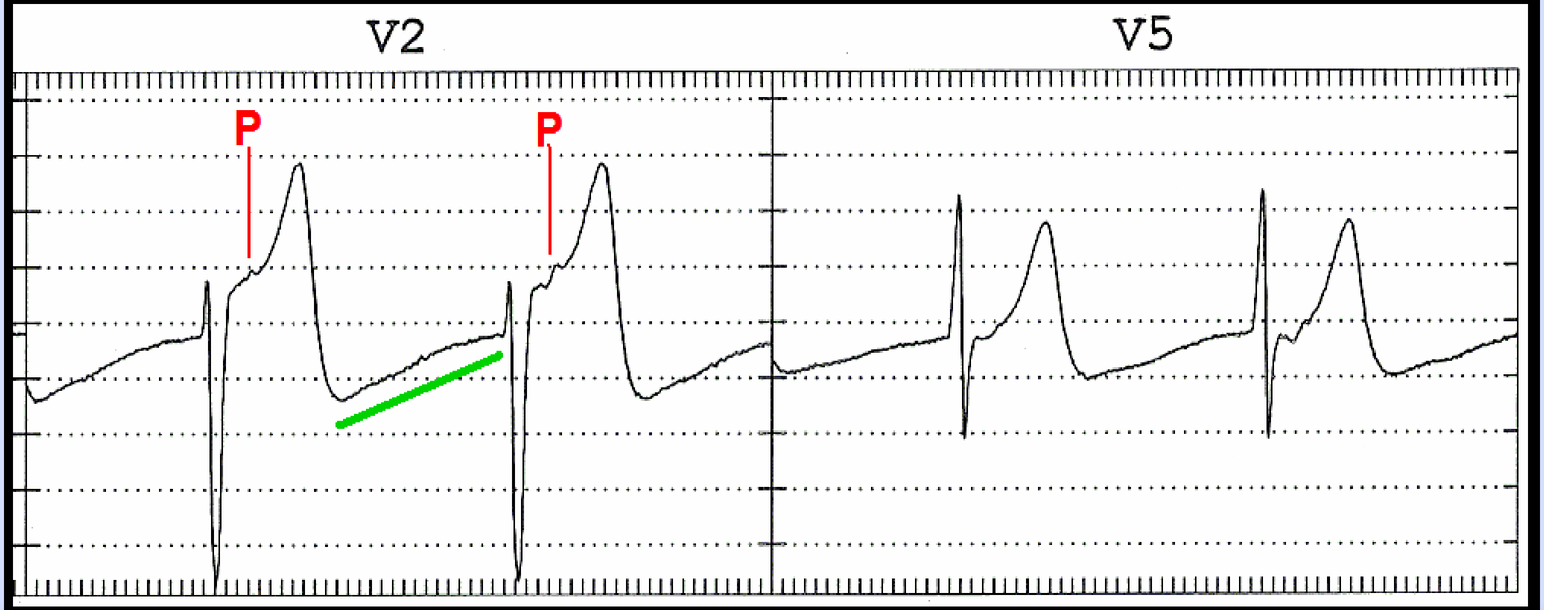


. . .the "flat line" between ECG complexes, when there is no detectable electrical activity . . .

The Isoelectric Line -
it's not always isoelectric !

THE ISOELECTRIC LINE

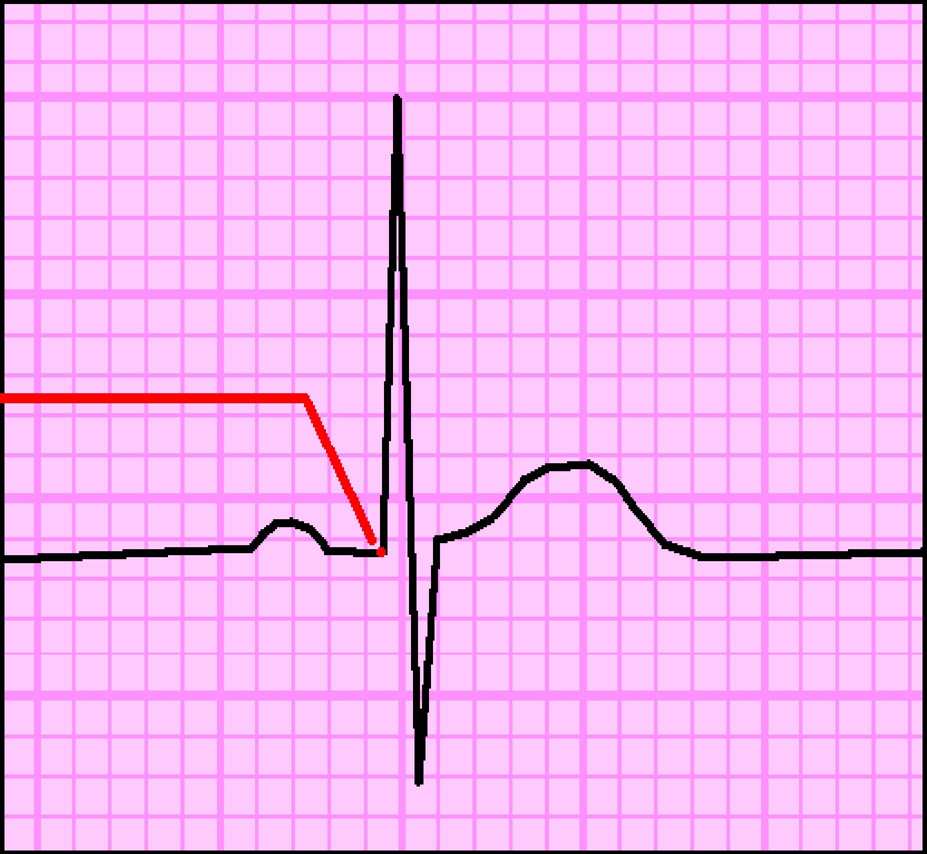
EKG from 13 y/o girl in ACCELERATED JUNCTIONAL RHYTHM.
note: upsloping T-P interval, and P buried in T waves.



THE P-Q JUNCTION

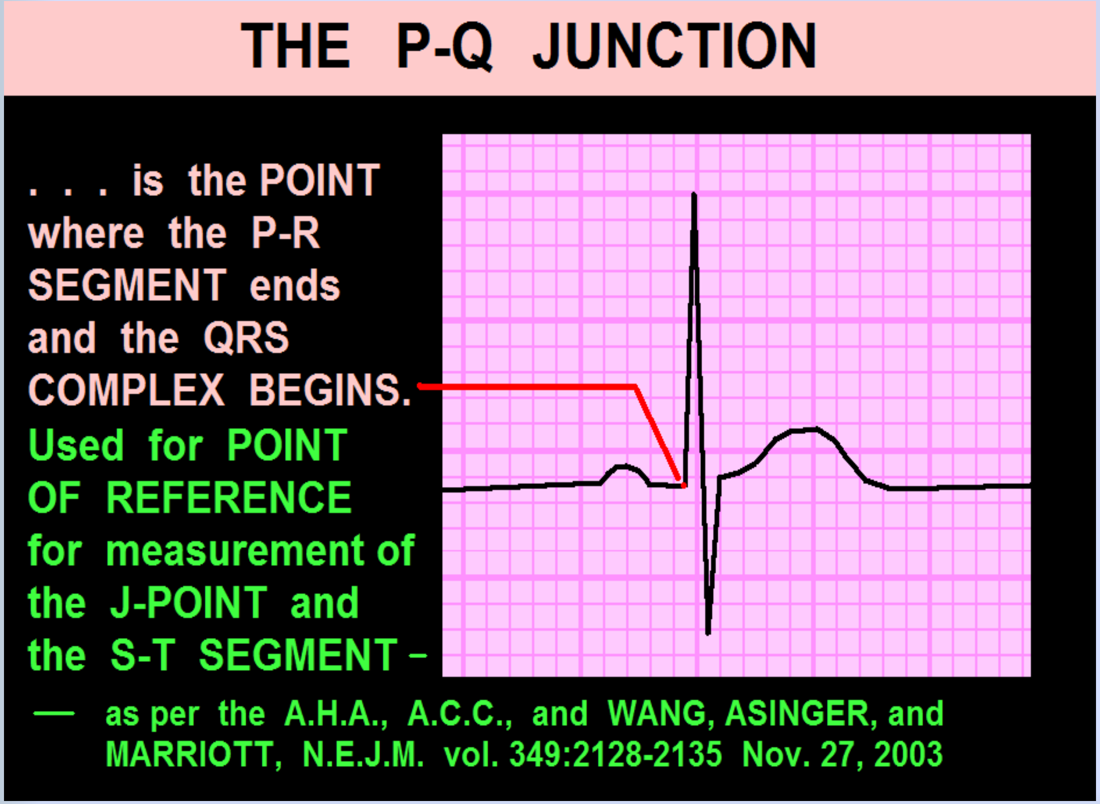
. . . is the POINT where the P-R SEGMENT ends and the QRS COMPLEX BEGINS.

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

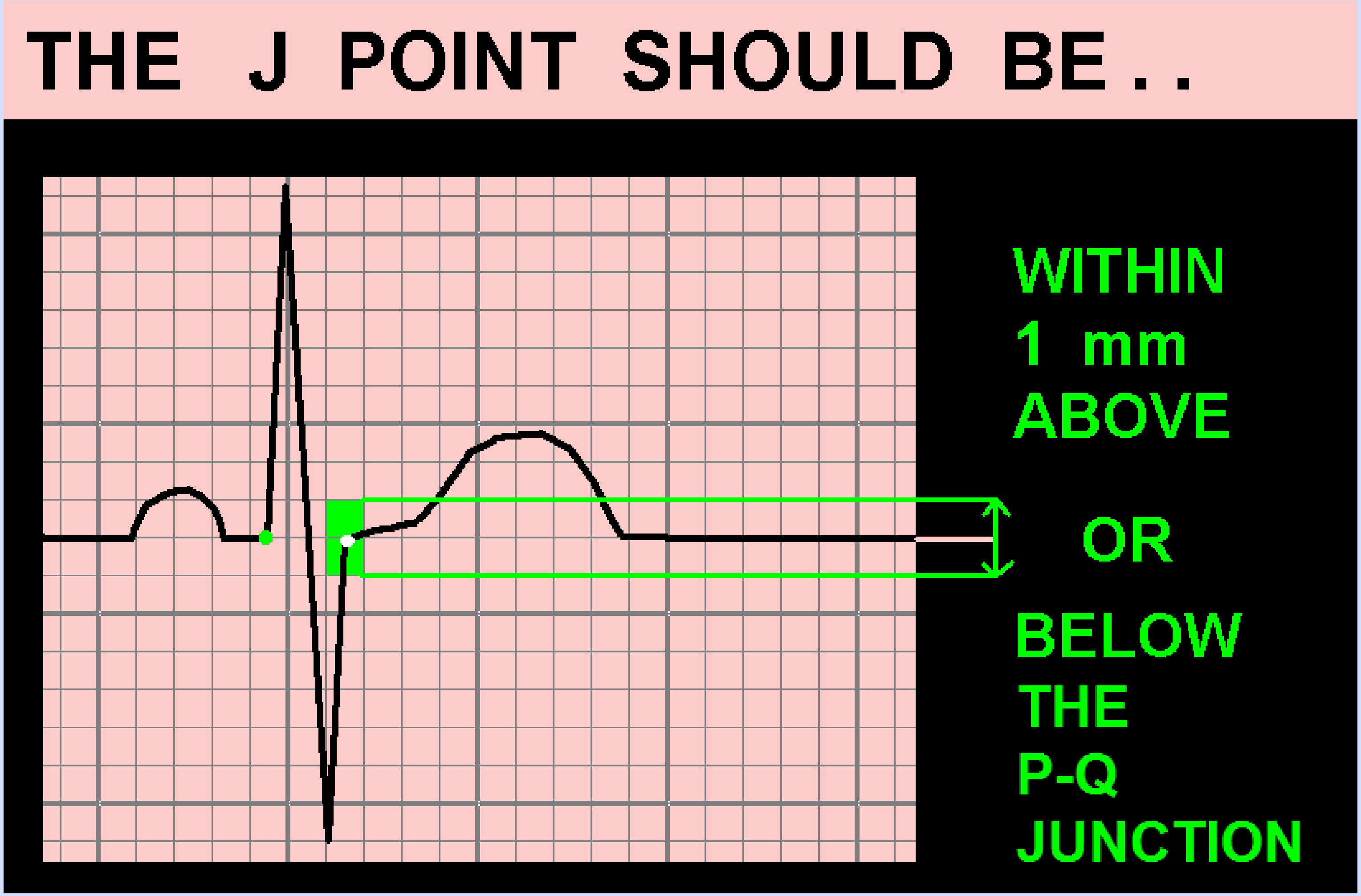


— as per the A.H.A., A.C.C., and WANG, ASINGER, and MARRIOTT, N.E.J.M. vol. 349:2128-2135 Nov. 27, 2003

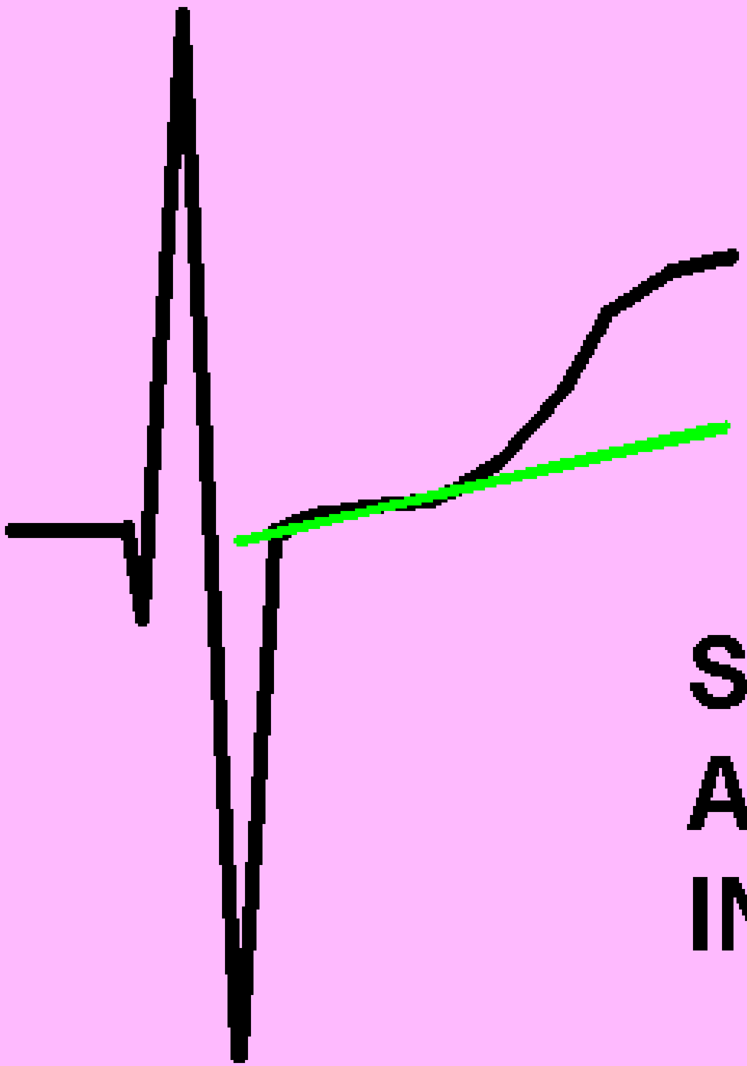
Use the P-Q junction as a reference point for measuring the J Point and ST-Segment when “iso-electric line is not iso-electric !



Defining NORMAL:

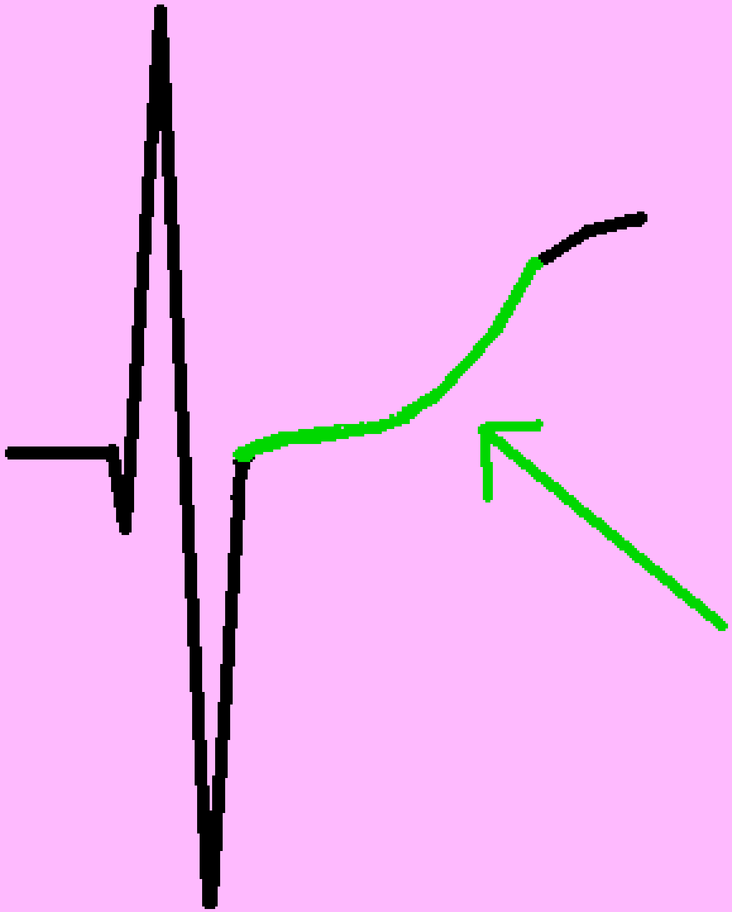


THE S-T SEGMENT



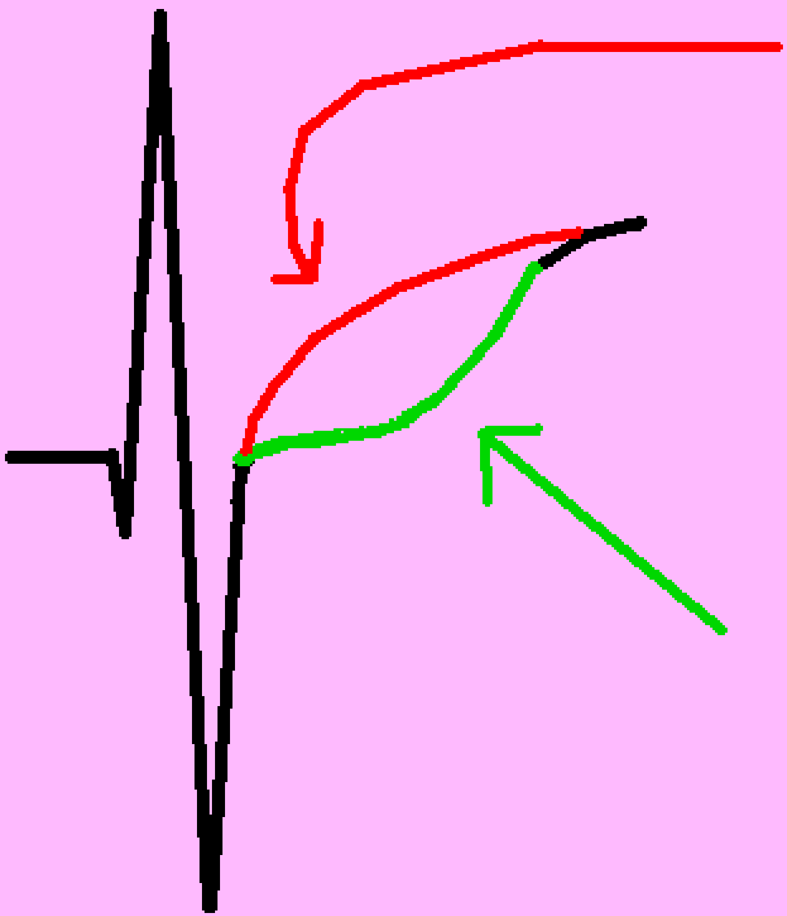
SHOULD HAVE
A "SLIGHT POSITIVE"
INCLINATION

THE S-T SEGMENT



SHOULD BE "CONCAVE" IN SHAPE . . .

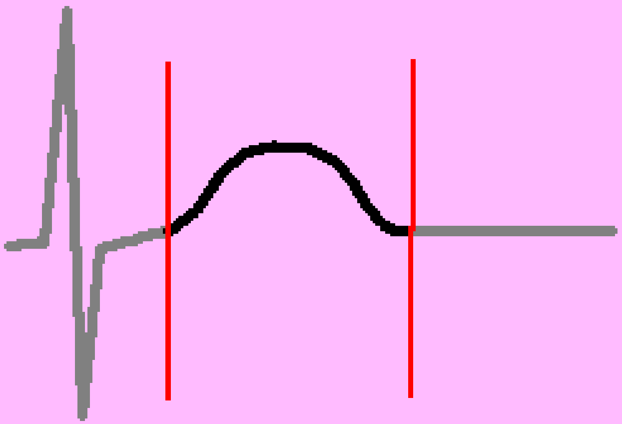
THE S-T SEGMENT



AS OPPOSED TO "CONVEX" IN SHAPE

SHOULD BE "CONCAVE" IN SHAPE . . .

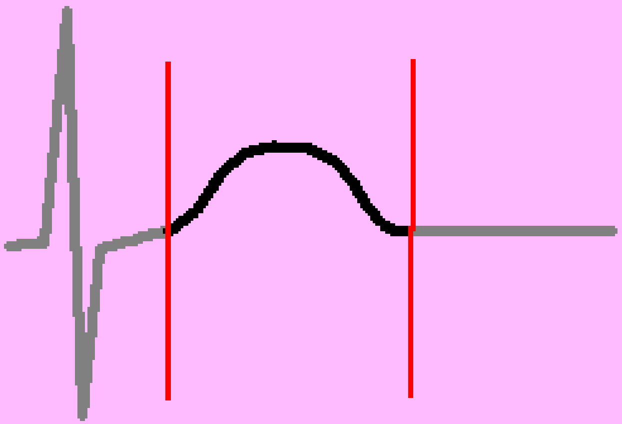
THE T WAVE



- SHOULD BE A "NICE," ROUNDED, CONVEX SHAPE

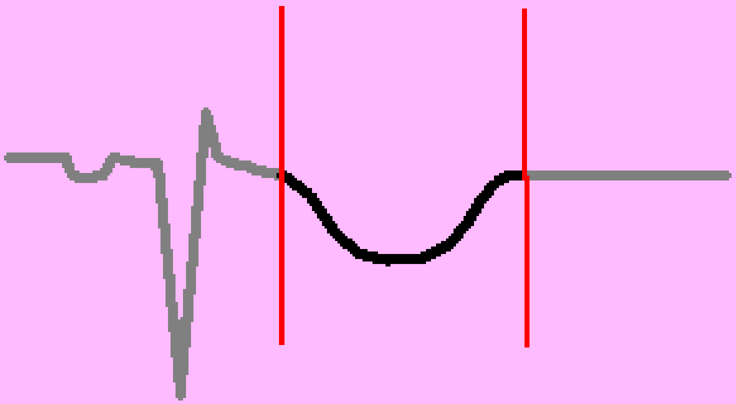
- SHOULD BE SYMMETRICAL

THE T WAVE



- SHOULD BE A "NICE," ROUNDED, CONVEX SHAPE
- SHOULD BE SYMMETRICAL
- SHOULD BE UPRIGHT IN ALL LEADS, EXCEPT AVR

THE T WAVE



LEAD AVR

- REMEMBER, IN LEAD AVR

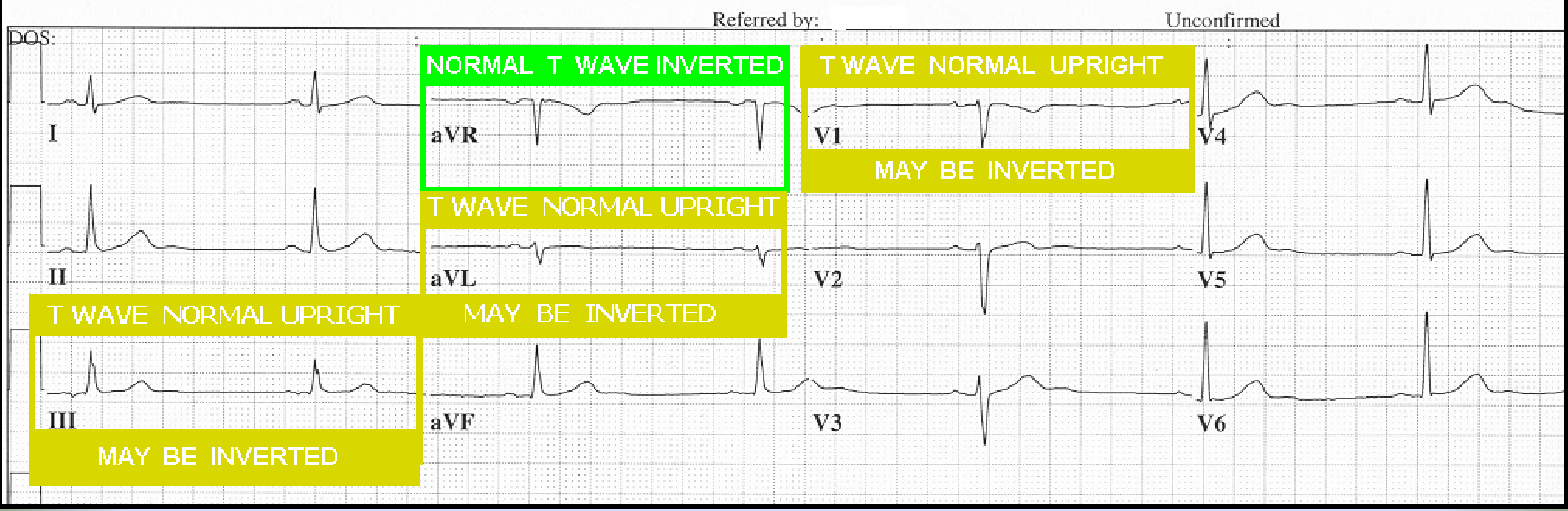
EVERYTHING

IS

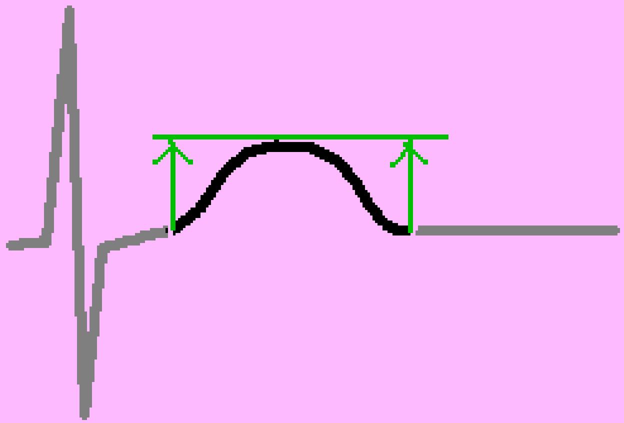
"UPSIDE-DOWN"

Normal Variants:
T Wave Inversion

Leads where the T WAVE may be INVERTED:



THE T WAVE



AMPLITUDE GUIDELINES:

- IN THE LIMB LEADS, SHOULD BE LESS THAN 1.0 mv (10 mm)
- IN THE PRECORDIAL LEADS, SHOULD BE LESS THAN 0.5 mv (5 mm)
- SHOULD NOT BE TALLER THAN R WAVE IN 2 OR MORE LEADS.

When QRS duration is NORMAL (< 120 ms):

NORMAL ST - T WAVES

- WHEN QRS WIDTH IS NORMAL (< 120 ms)

ASSESS:

- J POINT: ISOELECTRIC (or < 1 mm dev.)
- ST SEG: SLIGHT, POSITIVE INCLINATION
- T WAVE: UPRIGHT, POSITIVE

☞ ***in EVERY LEAD EXCEPT aVR ! !***

ECG Indicators
of ACS
in Patients with
Normal Width QRS Complexes
(QRS duration < 120 ms)

Multiple patterns of

ABNORMAL:

- J Point
- ST-Segment
- T Wave

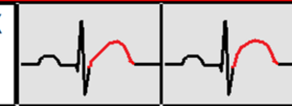
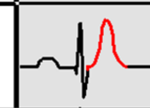
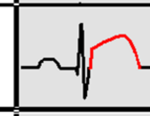
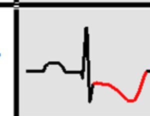
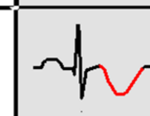
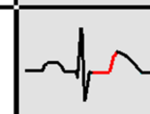
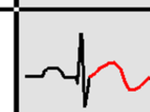
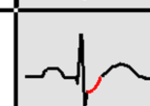
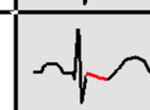
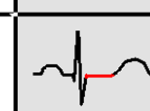
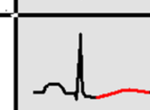
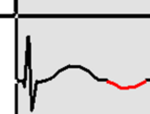
configurations may indicate ACS.

Remember, “IF IT’S NOT NORMAL, it’s *ABNORMAL !*”

BOOK PAGE: 83

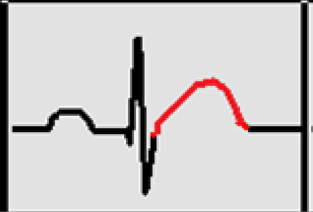
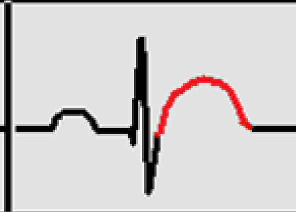
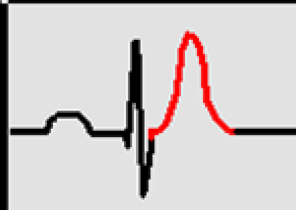
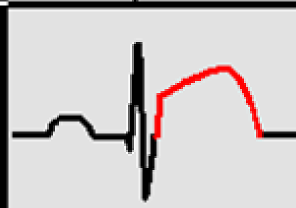
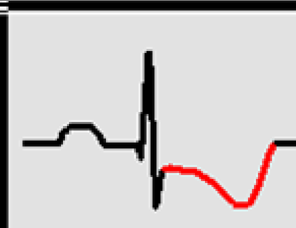
EKG PATTERNS of ACS & ISCHEMIA

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

	Pattern	Waveform	Associated conditions
!	FLAT or CONVEX J-T APEX SEGMENT		- Typical Cath Lab Finding: Coronary Artery Thrombus (TIMI Grade 1-2 blood flow)
!	HYPER-ACUTE T WAVE		- HYPERKALEMIA - TRANSMURAL ISCHEMIA - ACUTE MI - HYPERTROPHY
!	S-T SEGMENT ELEVATION at J POINT		- ACUTE MI - ACUTE PERICARDITIS / MYOCARDITIS - EARLY REPOLARIZATION
!	DEPRESSED J pt. DOWNSLOPING ST and INVERTED T		- ACUTE (NON-Q WAVE) MI - ACUTE MI - (RECIPROCAL CHANGES) - ISCHEMIA
	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
?	FLAT S-T SEGMENT > 120 ms		- ISCHEMIA
?	LOW VOLTAGE T WAVE WITH NORMAL QRS		- ISCHEMIA
?	U WAVE POLARITY OPPOSITE THAT OF T WAVE		- ISCHEMIA

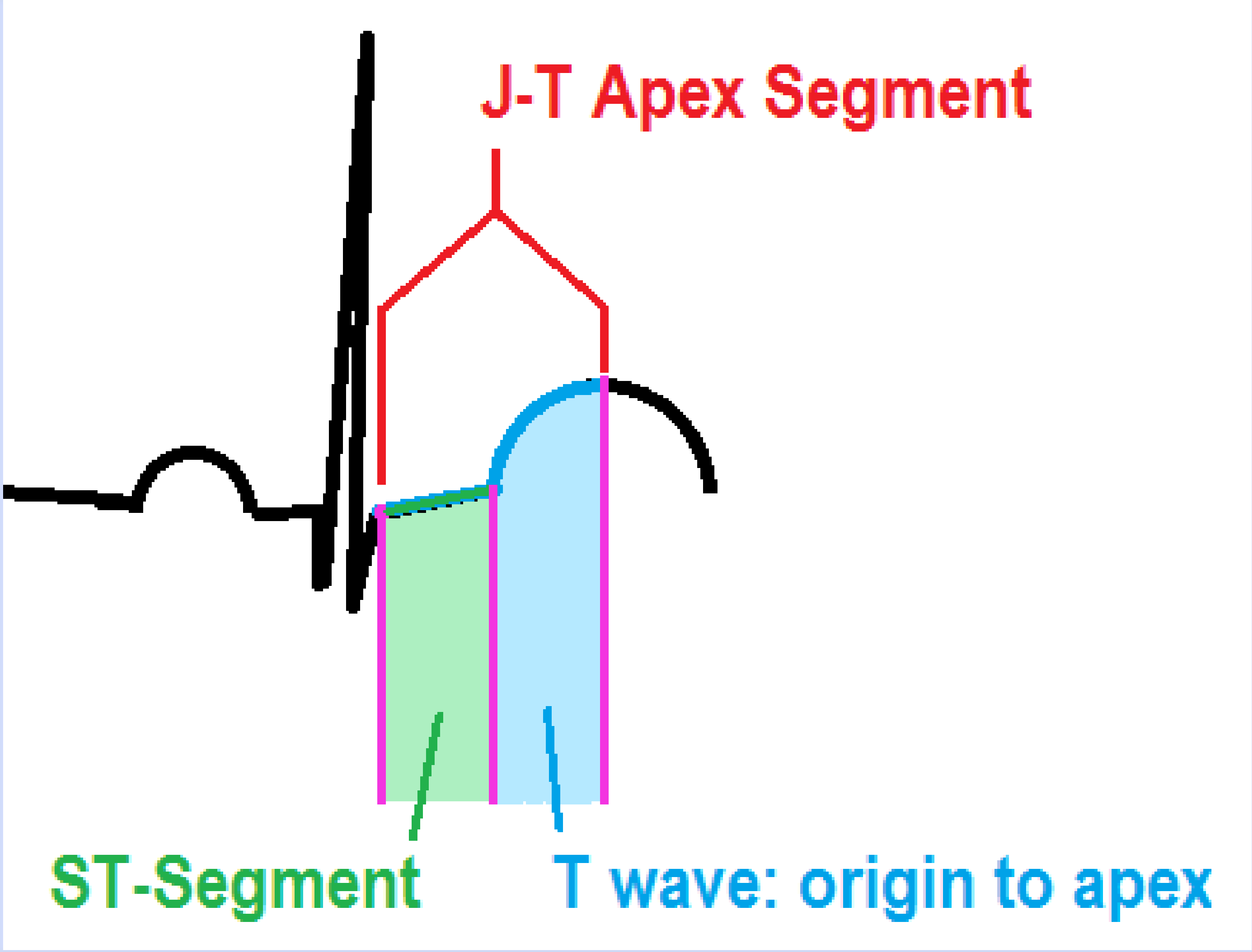
EKG PATTERNS of ACS & ISCHEMIA

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

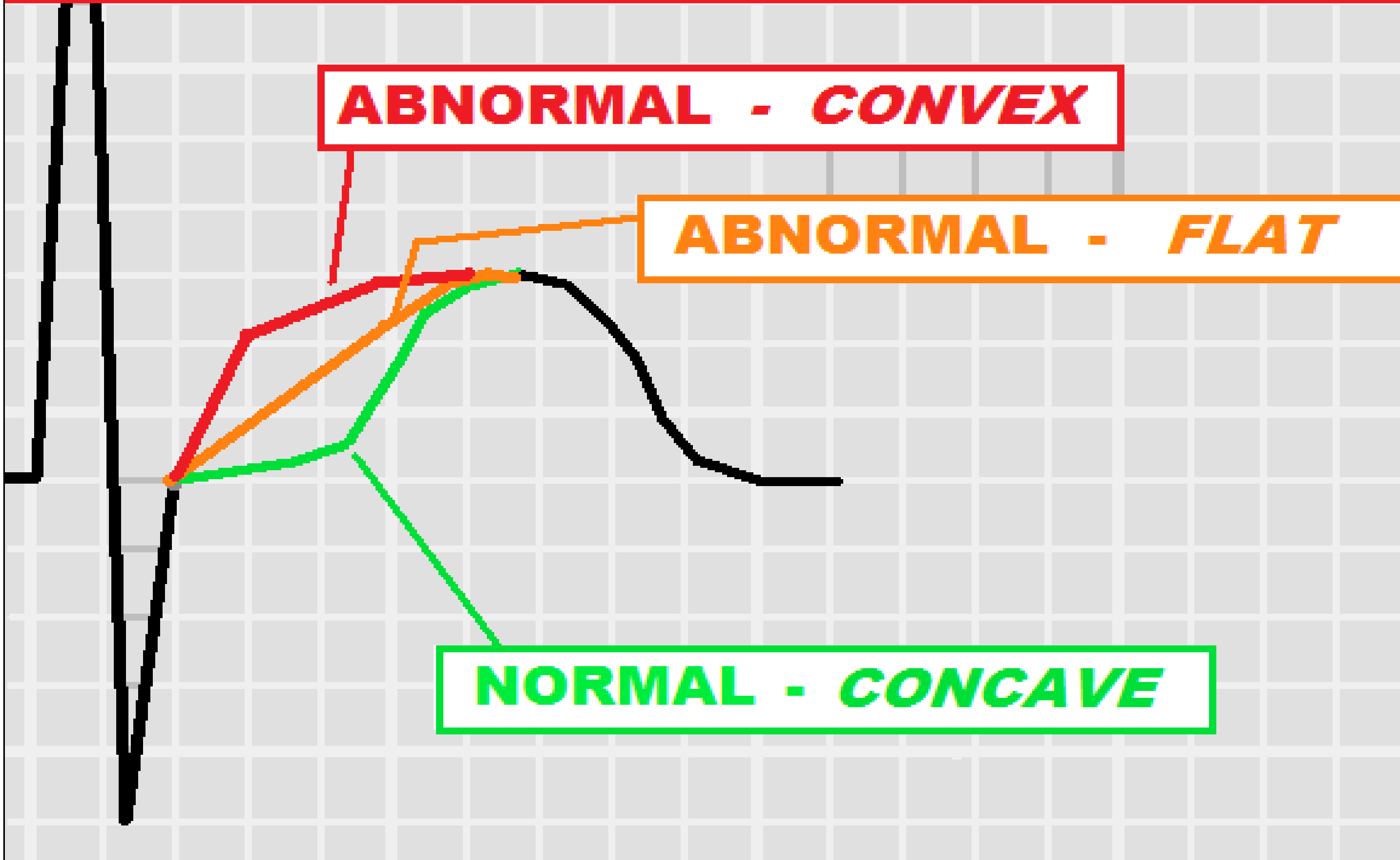
!	FLAT or CONVEX J-T APEX SEGMENT	 	- Typical Cath Lab Finding: Coronary Artery Thrombus (TIMI Grade 1-2 blood flow)
!	HYPER-ACUTE T WAVE		- HYPERKALEMIA - TRANSMURAL ISCHEMIA - ACUTE MI - HYPERTROPHY
!	S-T SEGMENT ELEVATION at J POINT		- ACUTE MI - ACUTE PERICARDITIS / MYOCARDITIS - EARLY REPOLARIZATION
!	DEPRESSED J pt. DOWNSLOPING ST and INVERTED T		- ACUTE (NON-Q WAVE) MI - ACUTE MI - (RECIPROCAL CHANGES) - ISCHEMIA

ECG Patterns associated with "EARLY PHASE MI:"

- *J-T Apex abnormalities*
- *Hyper-Acute T Waves*
- *ST-T Wave Changes*


J-T Apex Segment
ST-Segment
T wave: origin to apex

J - T APEX SEGMENT VARIATIONS

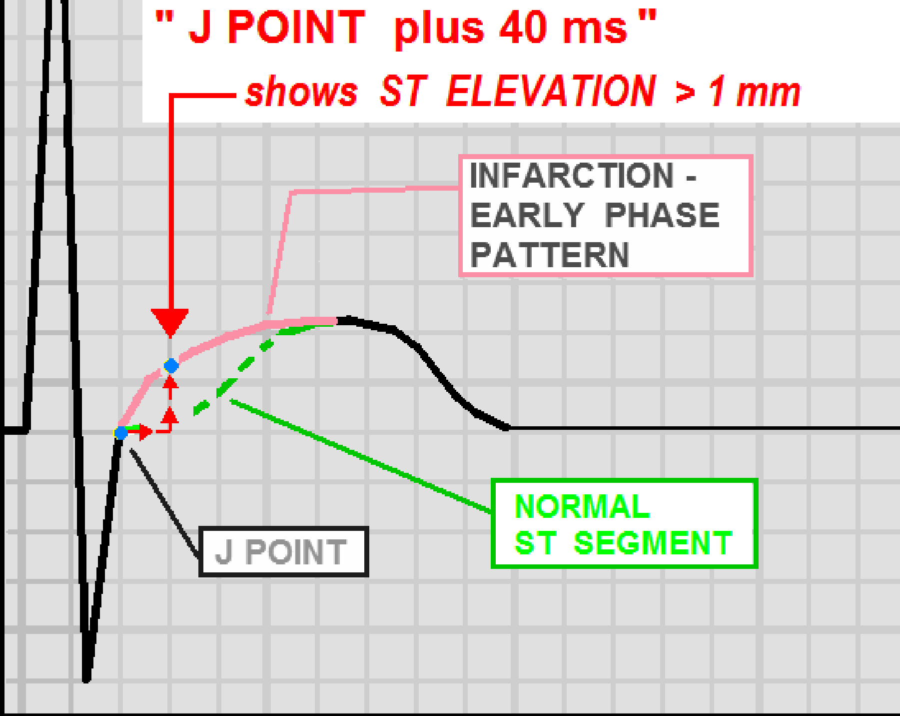


PATTERNS of EARLY INFARCTION

-- FLAT and CONVEX J-T APEX SEGMENTS

WHEN EVALUATING
for
ST SEGMENT
ELEVATION . . . .

From:
AMERICAN HEART ASSOCIATION
ACLS 2005 REVISIONS



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

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

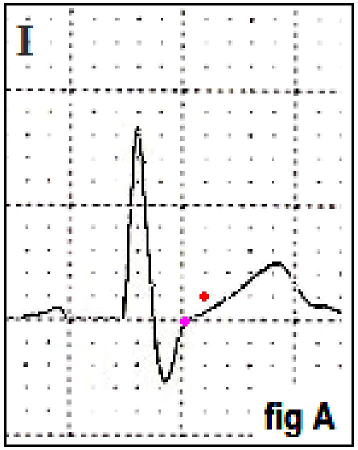


fig A

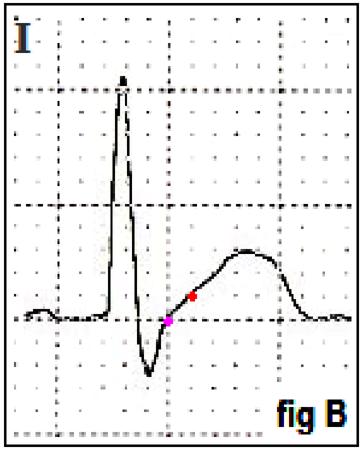
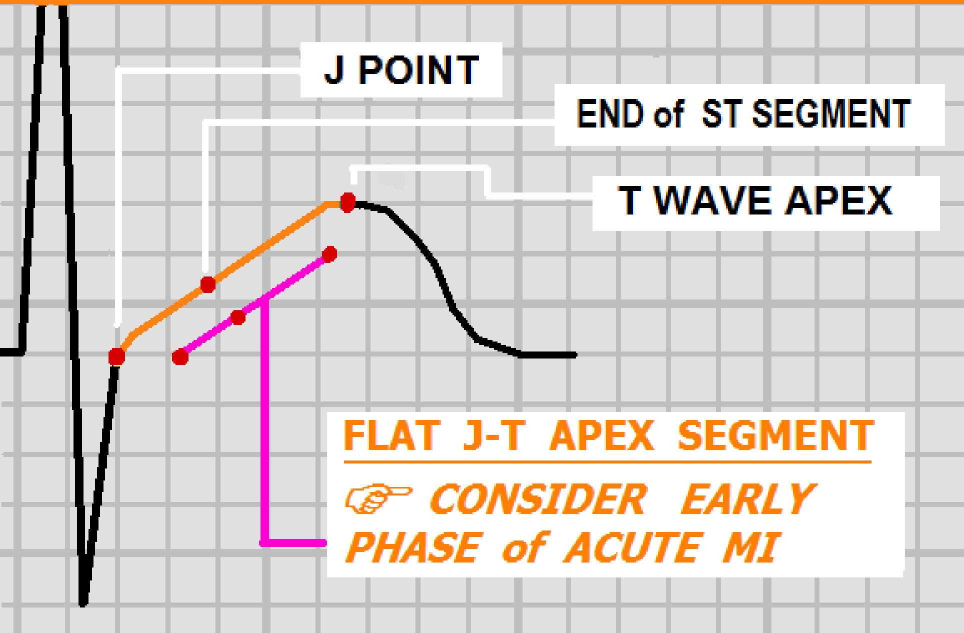


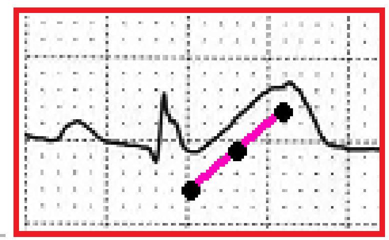
fig B

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

ABNORMAL J-T APEX SEGMENT



LEAD II

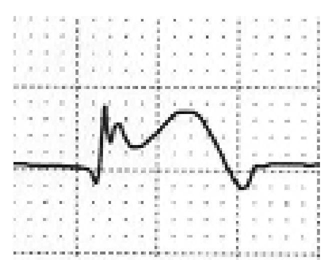


1839 hrs

41 y/o FEMALE

In ER C/O CHEST PAIN x 30 minutes.

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



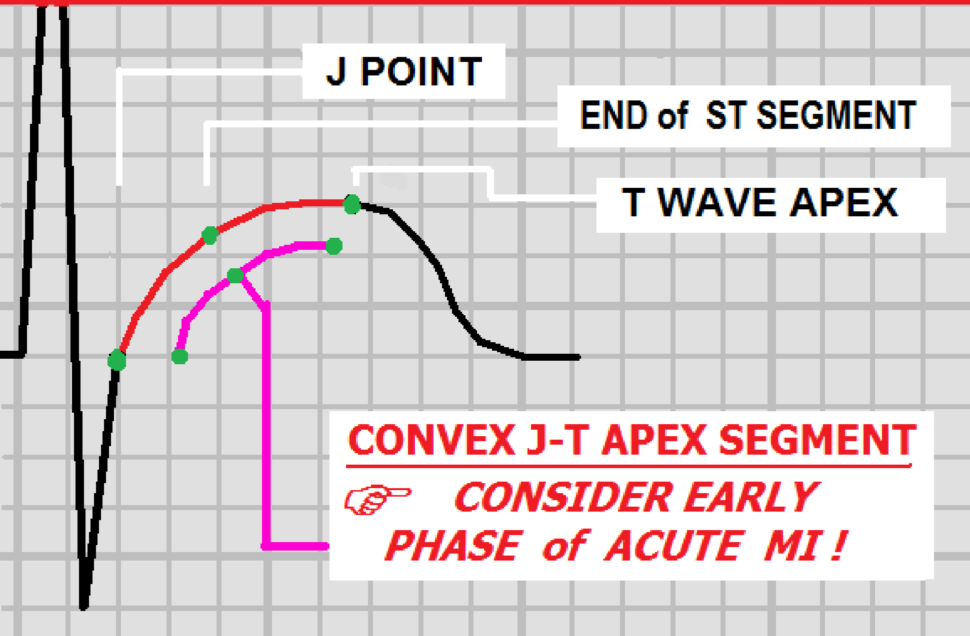
1850 hrs

STEMI - INFERIOR WALL

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

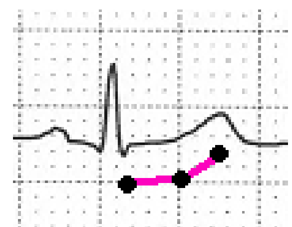
- CATH LAB FINDINGS: TOTAL OCCLUSION of the RIGHT CORONARY ARTERY

ABNORMAL J-T APEX SEGMENT

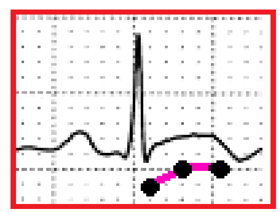


LEAD I

53 y/o MALE



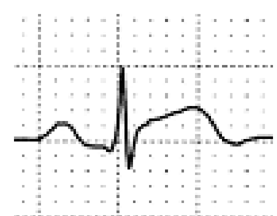
1 yr. PRIOR TO MI
NORMAL EKG
CONCAVE J - T APEX SEGMENT



0732 hrs

STEMI LATERAL WALL

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



0747 hrs

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

- CATH LAB FINDINGS: TOTAL OCCLUSION OF CIRCUMFLEX ARTERY

CASE STUDY: ABNORMAL J-T APEX SEGMENTS

CHIEF COMPLAINT and SIGNIFICANT HISTORY:

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

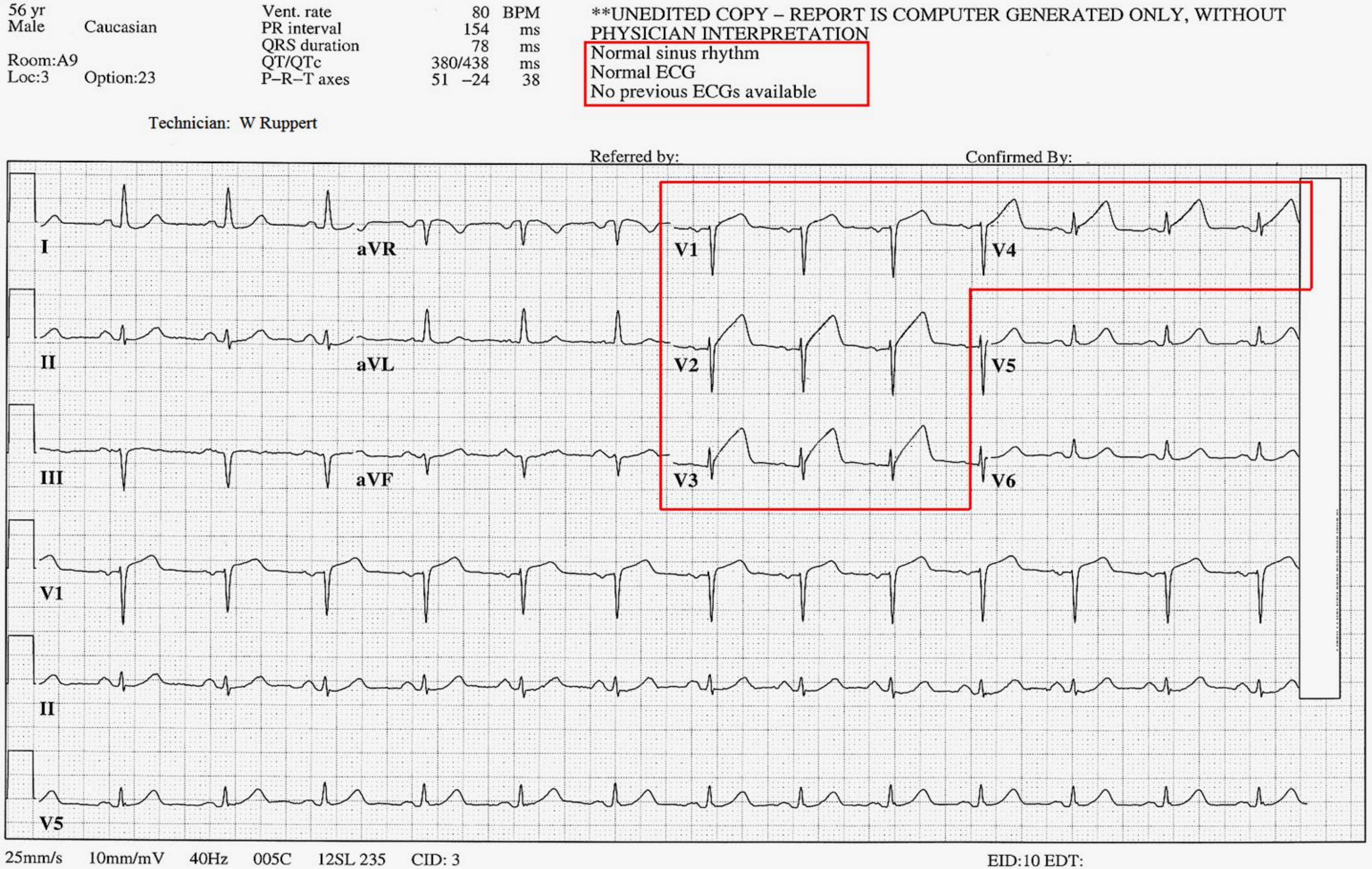
RISK FACTOR PROFILE:

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

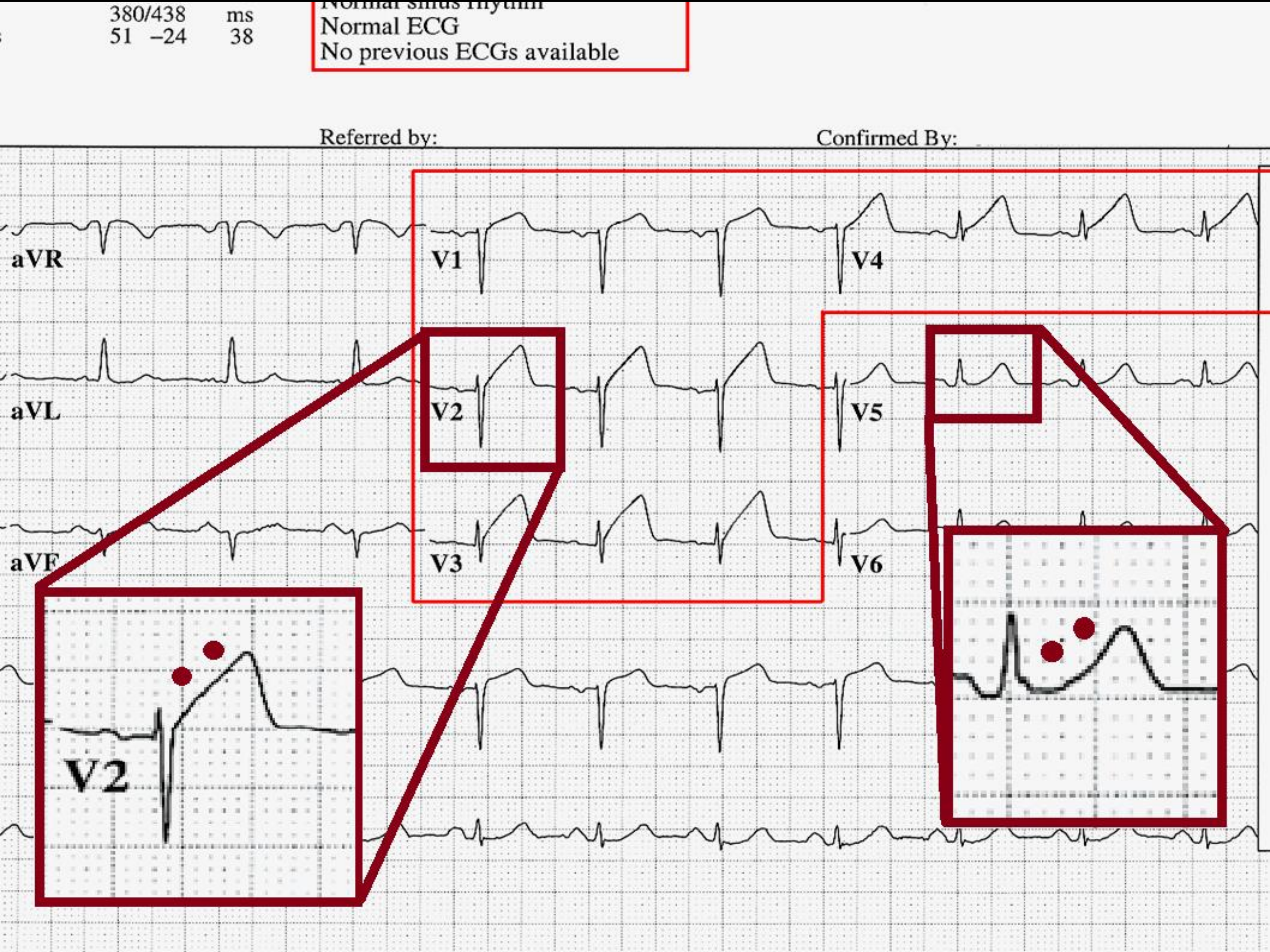
PHYSICAL EXAM: Patient supine on exam table, mildly anxious, currently complaining of "mild indigestion," skin is warm, pale, dry; REST OF EXAM is UNREMARKABLE.

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

LABS: JUST OBTAINED, RESULTS NOT AVAILABLE YET.

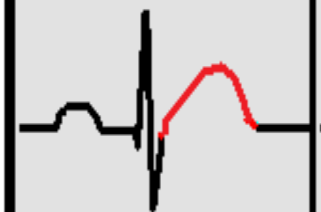
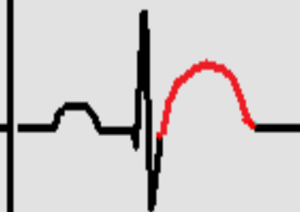
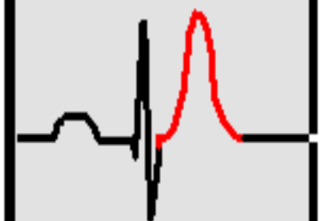
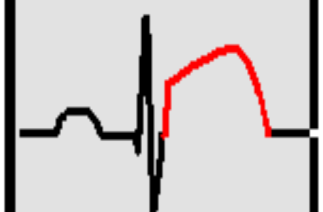
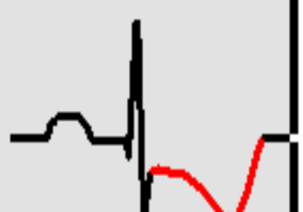


ECG COMPUTER DOES NOT NOTICE THE CONVEX J-T APEX SEGMENTS !


380/438 ms
51 −24 38
Normal sinus rhythm
Normal ECG
No previous ECGs available
Referred by:
Confirmed By:
aVR
aVL
aVF
V1
V2
V3
V4
V5
V6
V2

PATTERNS of ACS & ISCHEMIA

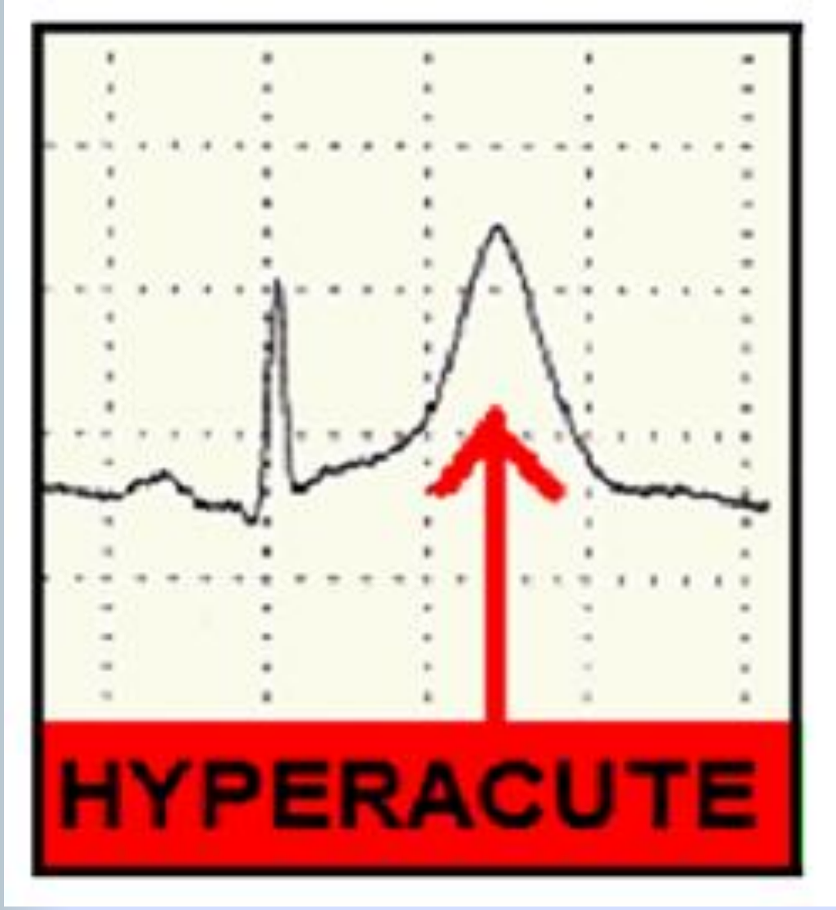
-- J POINT, ST SEGMENT, and T WAVE ABNORMALITIES --

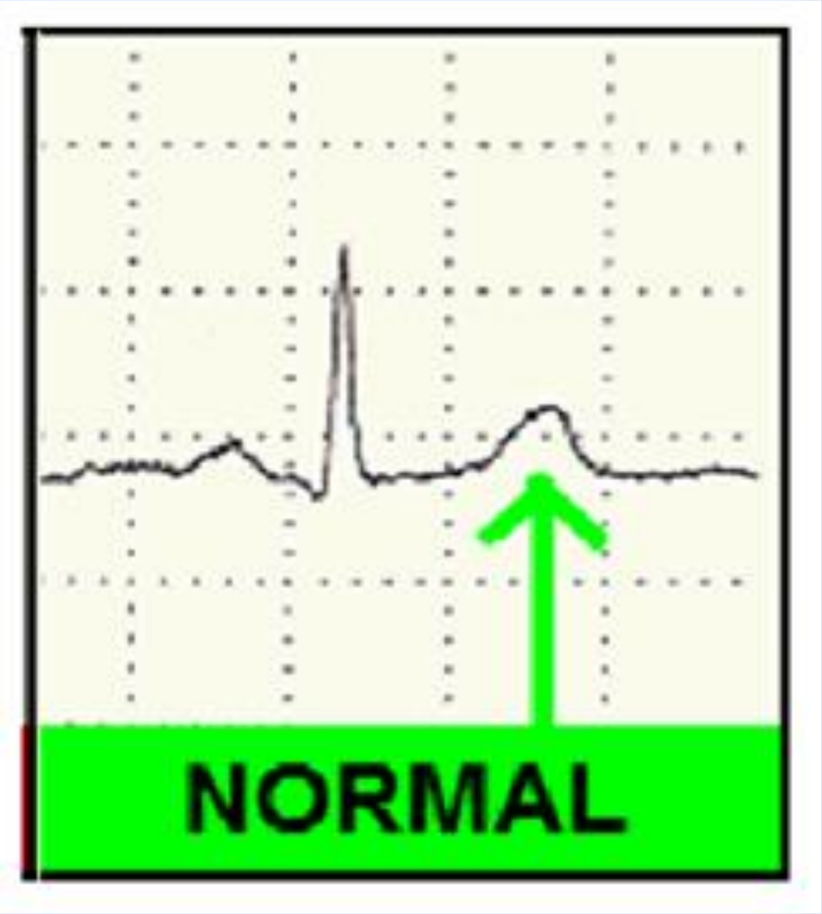
!	FLAT or CONVEX J-T APEX SEGMENT	 	***ACUTE MI*** ***EARLY PHASE***
!	HYPER-ACUTE T WAVE		***ACUTE MI*** ***EARLY PHASE***
!	S-T SEGMENT ELEVATION at J POINT		***ACUTE MI***
!	DEPRESSED J pt. DOWNSLOPING ST and INVERTED T		- **ACUTE (NON-Q WAVE) MI** - **ACUTE MI** - (RECIPROCAL CHANGES) - **ISCHEMIA**

HYPER-ACUTE T WAVES - COMMON ETIOLOGIES:

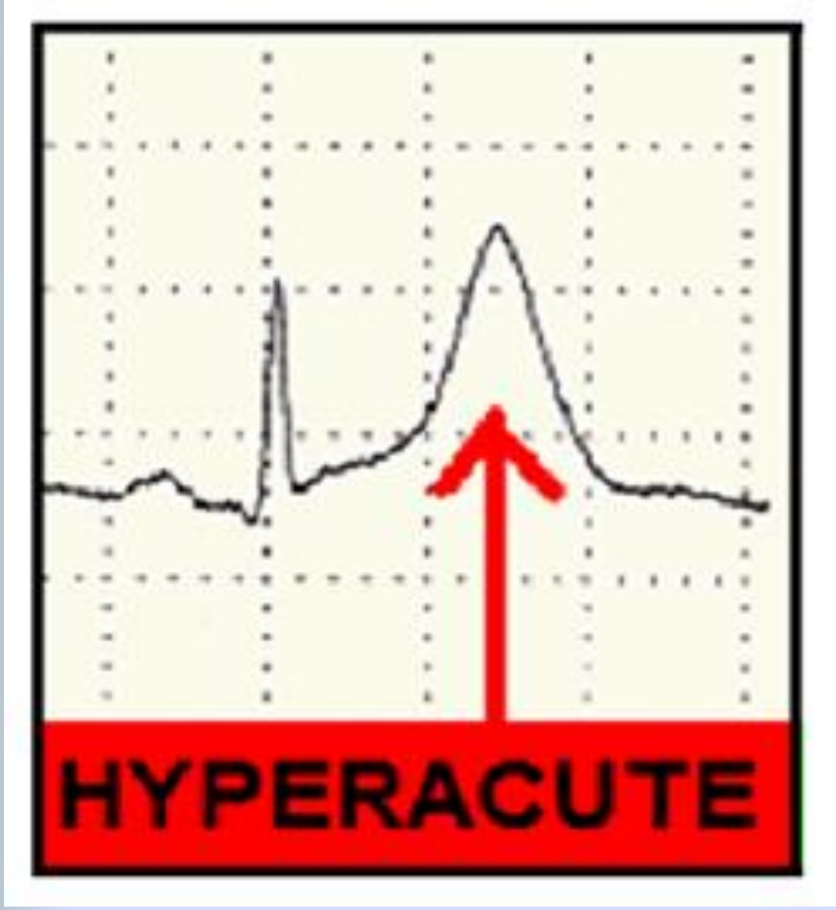
CONDITION:	SEE PAGE(S):
HYPERKALEMIA	XX - XX
ACUTE MI	XX - XX
TRANS-MURAL ISCHEMIA	XX - XX
HYPERTROPHY	XX - XX

T waves should not be HYPERACUTE



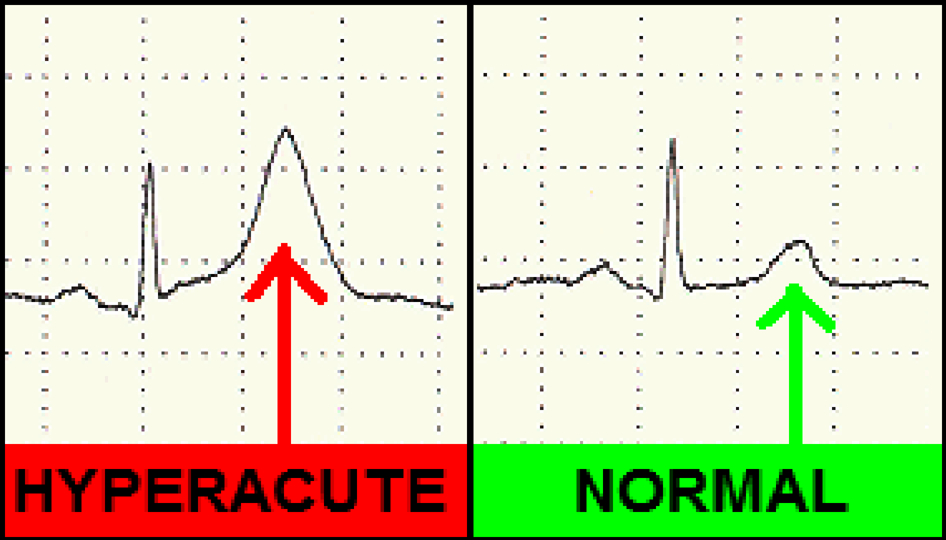


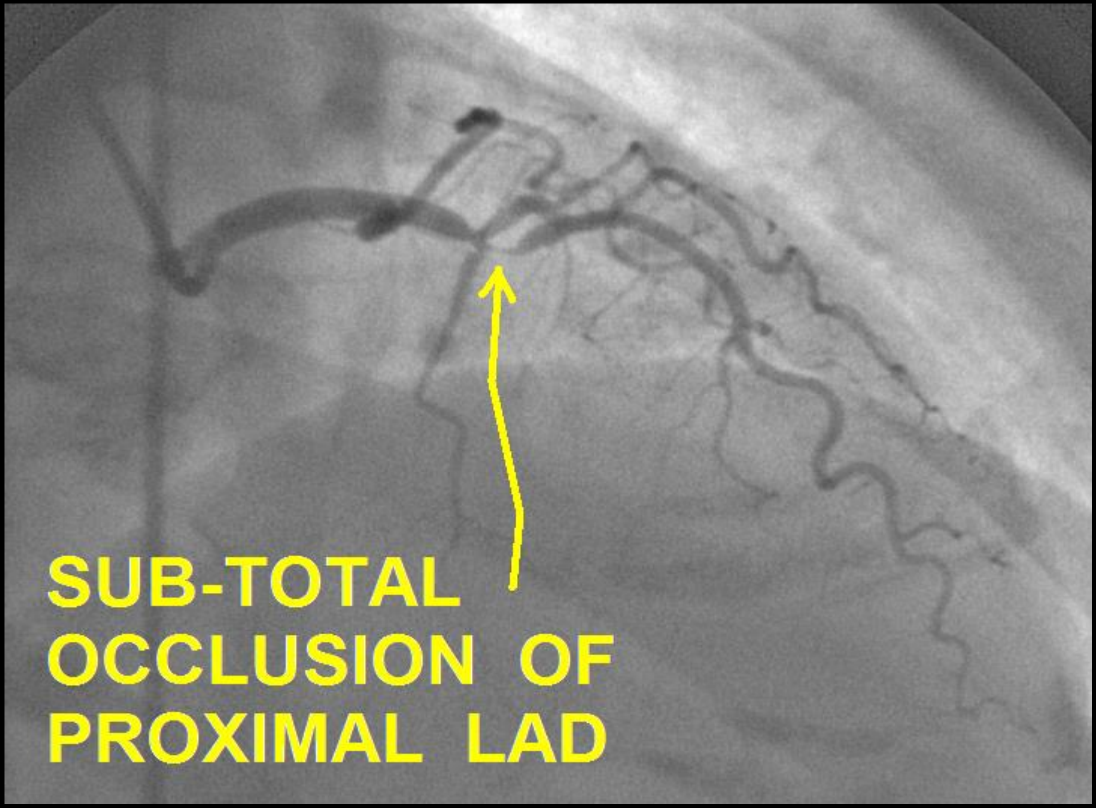
HYPERACUTE T Waves may indicate:



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

HYPERACUTE T WAVES





Helpful Clue: Hyper-Acute T Waves

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

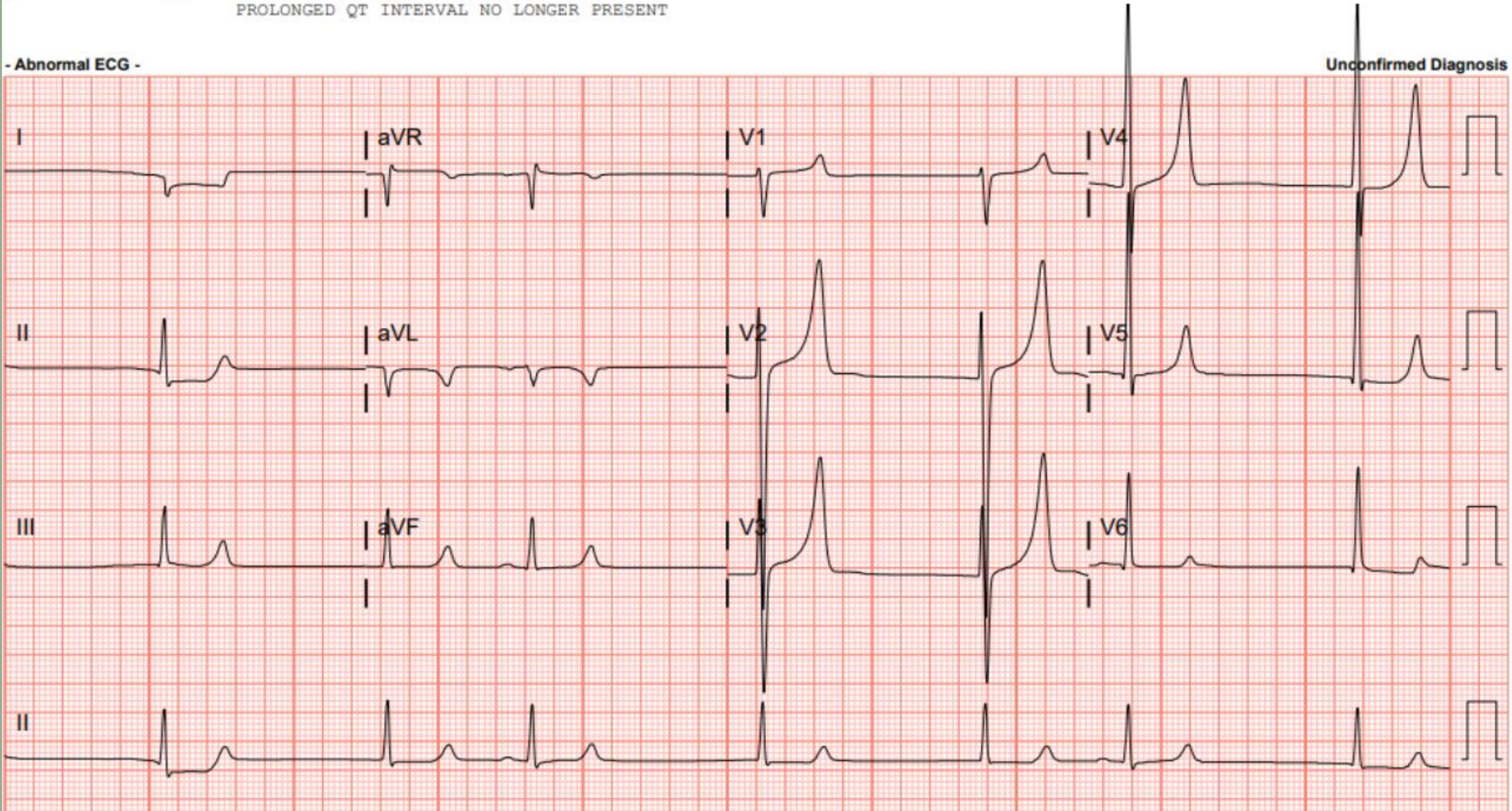
Rate	39	Right and left arm electrode reversal, interpretation assumes no reversal
PR	500	Sinus bradycardia
QRSd	117	Atrial premature complexes
QT	549	LVH with IVCD and secondary repol abnrm
QTc	443	Anterior ST elevation, probably due to LVH
--Axis--		COMPARED TO ECG 02/24/2020 21:46:48
P	0	SINUS BRADYCARDIA NOW PRESENT
QRS	96	INTRAVENTRICULAR CONDUCTION DELAY NOW PRESENT
T	117	ST (T WAVE) DEVIATION NOW PRESENT
		PROLONGED QT INTERVAL NO LONGER PRESENT

Req Provider: ONIER VILLARREA

K+ = 7.9

- Abnormal ECG -

Unconfirmed Diagnosis



ID: 23-Nov-

REGIONAL MEDICAL CENTER

55years
Female Caucasian

Room:

Vent. rate 57 bpm
PR interval 150 ms
QRS duration 102 ms
QT/QTc 472/459 ms
P-R-T axes 76 70 58

Sinus bradyc a
Possible Left atrial enlargement
Borderline ECG

ER ATTENDING REVIEW
NO STEMI
TIME 1511

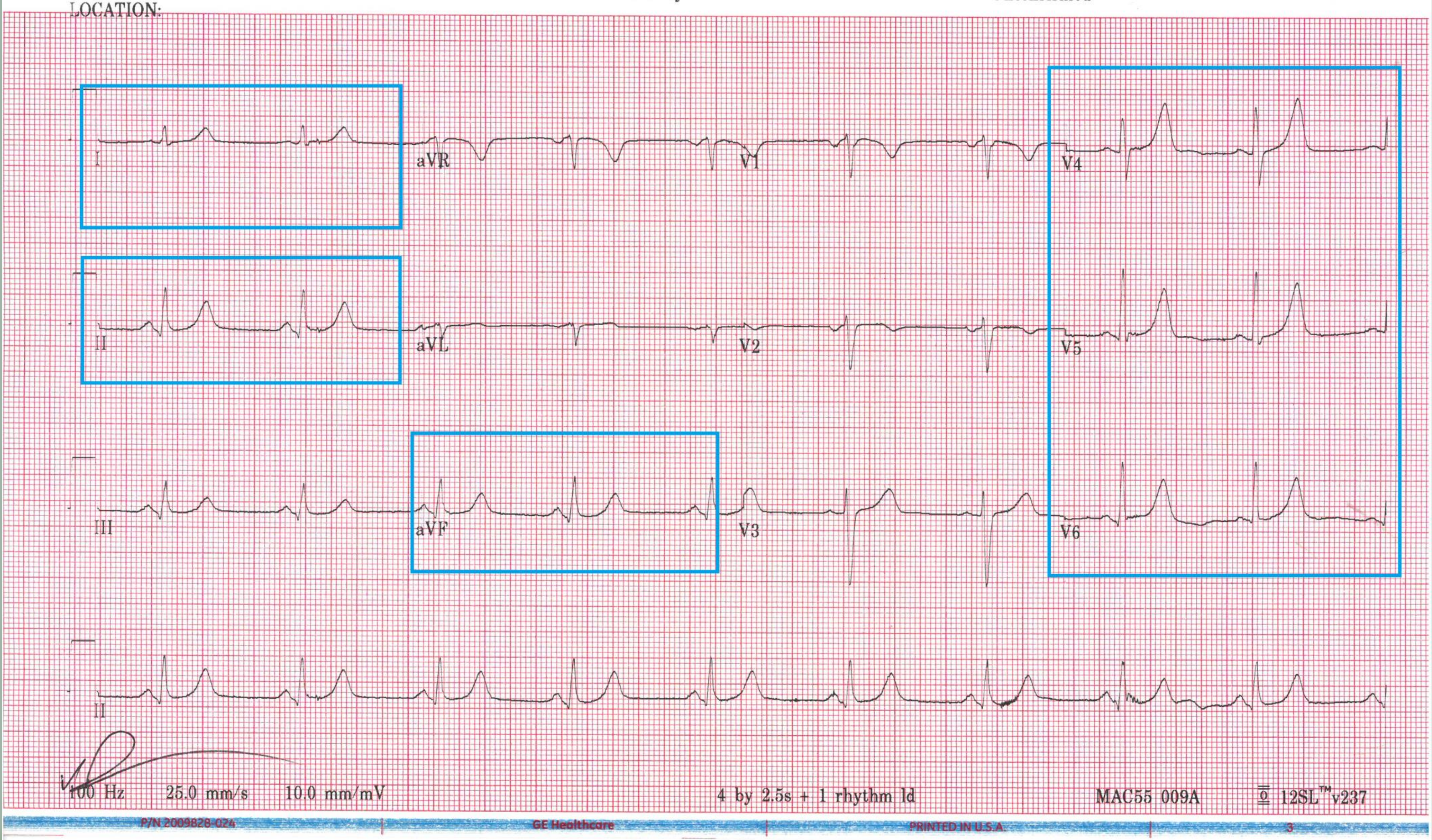
K+ = 6.7

Technician:
Test ind:

Referred by:

Unconfirmed

LOCATION:



Helpful Clue: Hyper-Acute T Waves

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

- **Hyper-acute T Wave noted in ONE ARTERIAL DISTRIBUTION** (Anterior / Lateral / Inferior) favors TRANSMURAL ISCHEMIA / Early Phase Acute MI

CASE STUDY: HYPERACUTE T WAVES

CHIEF COMPLAINT and SIGNIFICANT HISTORY:

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

RISK FACTOR PROFILE: NONE. CHOLESTEROL UNKNOWN.

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

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

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

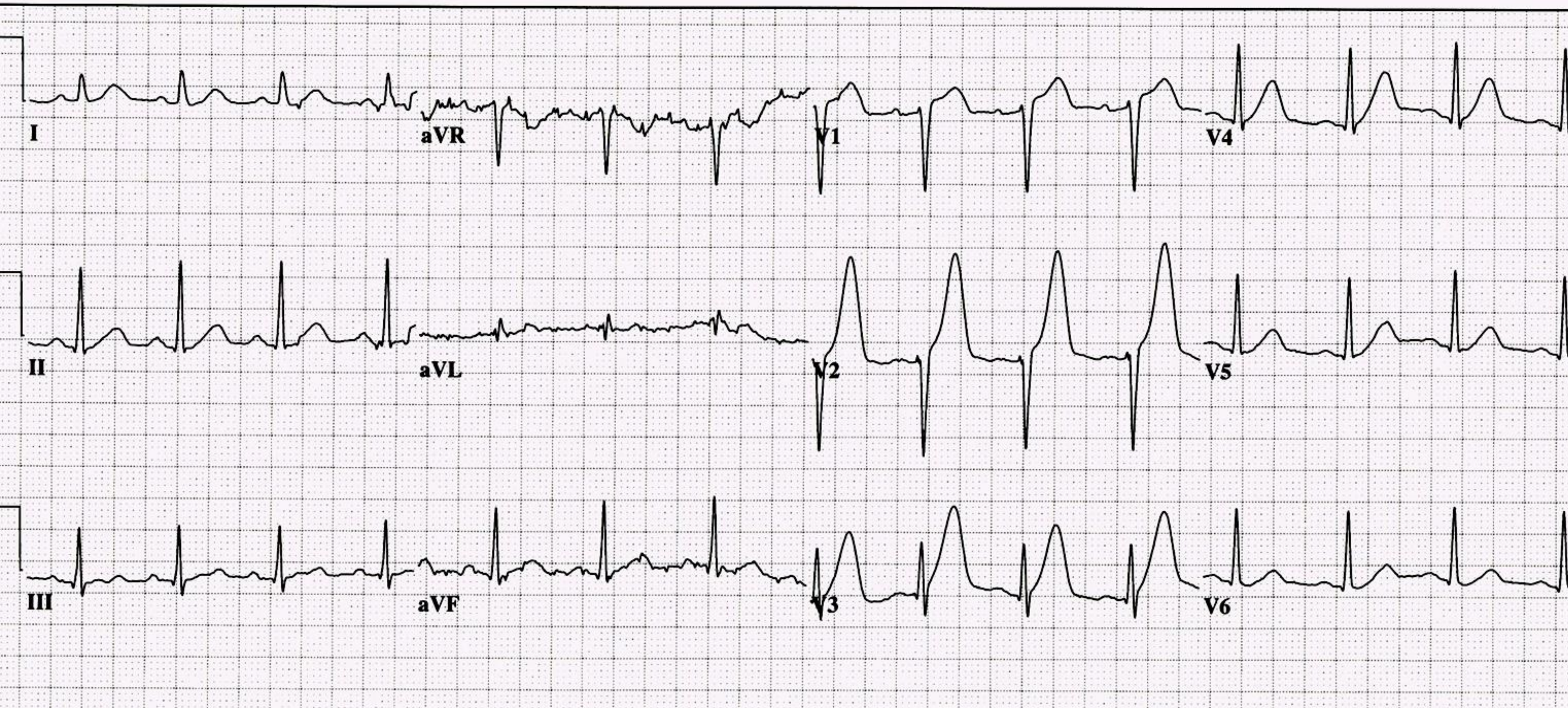
30 yr
Male Black

Room: ER
Loc: Option:

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

Normal sinus rhythm
Normal ECG
No previous ECGs available

NOTE COMPUTER INTERPRETATION



30 yr
Male Black

Room: ER
Loc: Option:

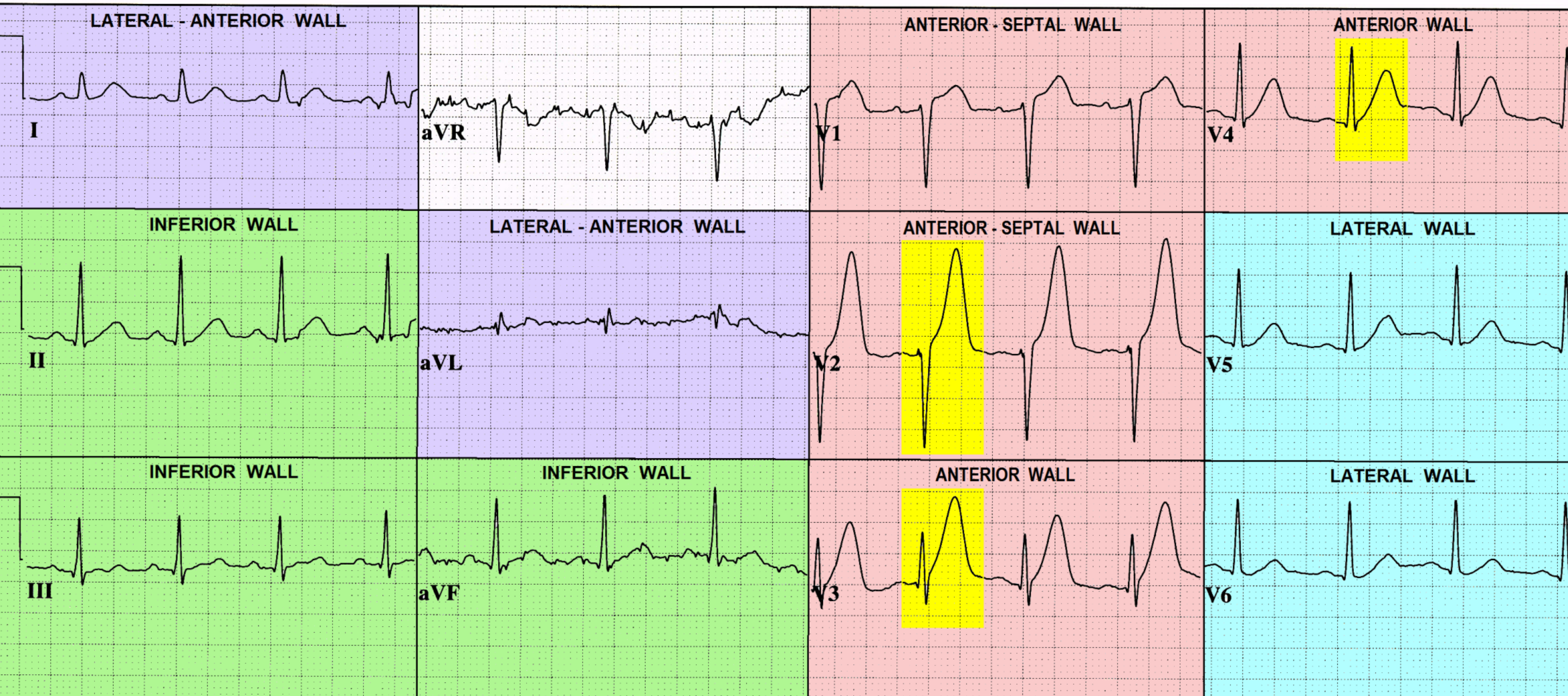
Vent. rate	88	BPM
PR interval	164	ms
QRS duration	90	ms
QT/QTc	370/447	ms
P–R–T axes	61 62	53

Normal sinus rhythm
Normal ECG
No previous ECGs available

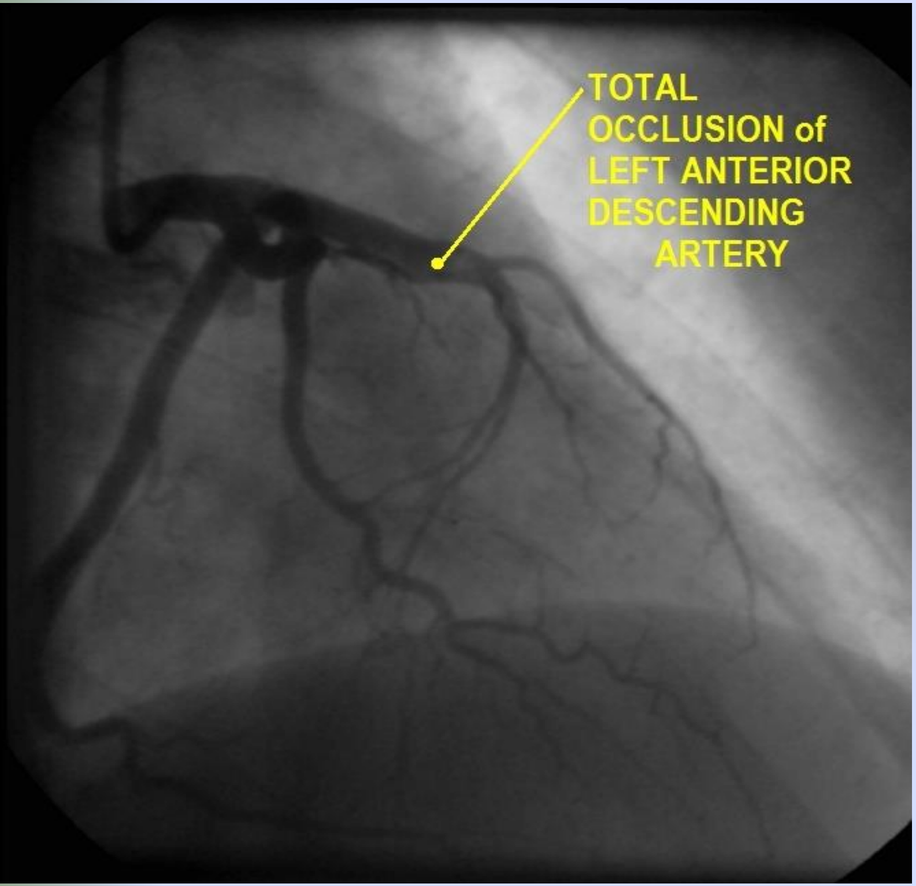
HIGHLIGHTED AREAS = HYPERACUTE T WAVES

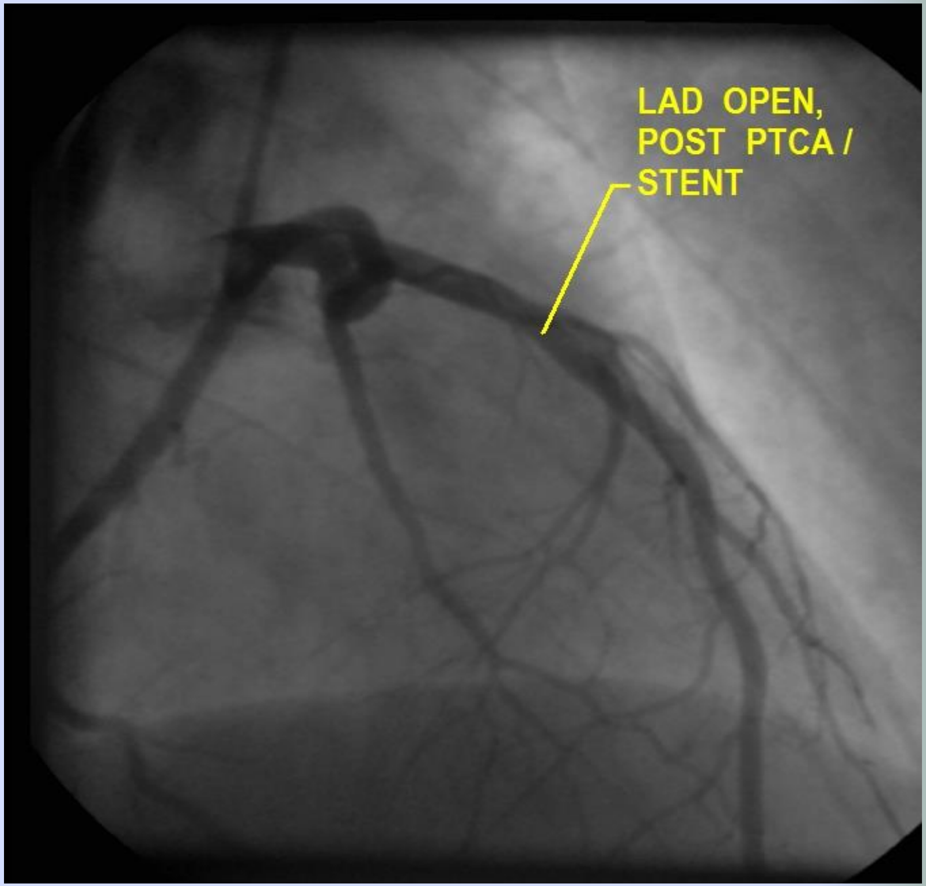
CORONARY ARTERIAL DISTRIBUTIONS:

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



Cath Lab findings:





Dynamic ST-T Wave Changes:

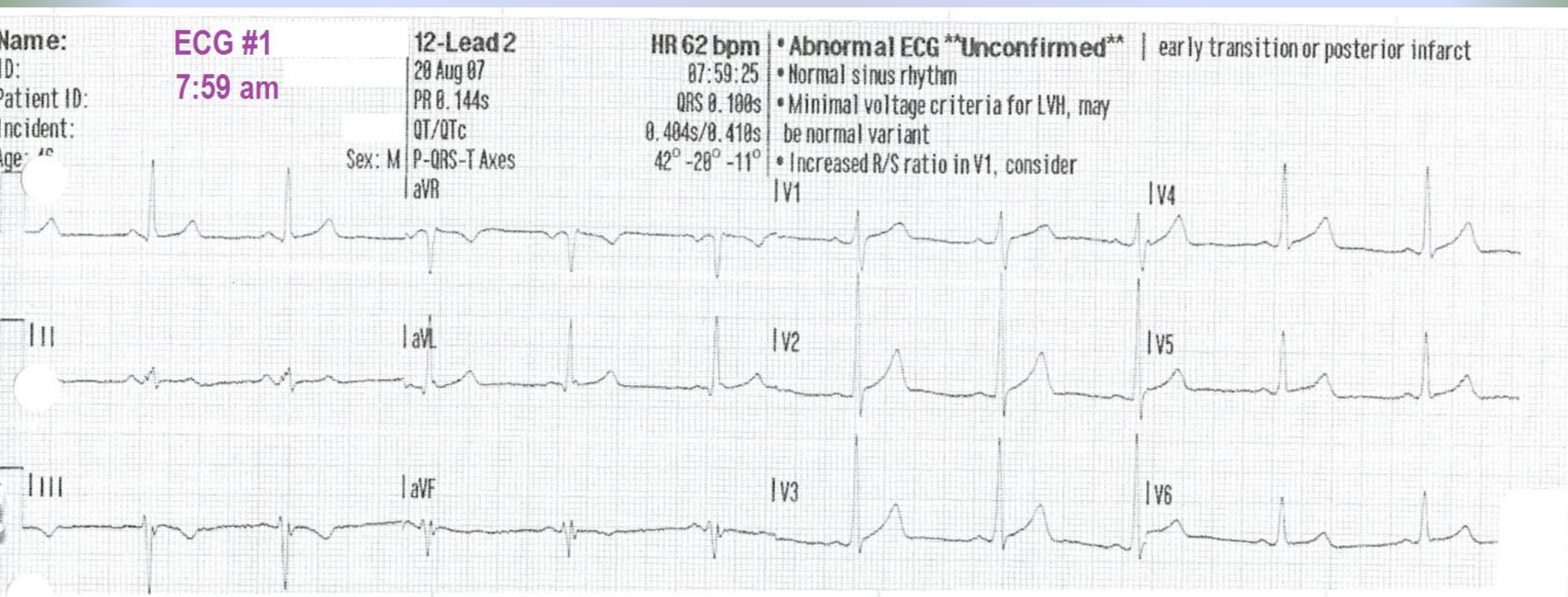
- Other than HEART RATE related variations (which affect intervals), ***J Points, ST-Segments and T Waves SHOULD NOT CHANGE.***

Dynamic ST-T Wave Changes:

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

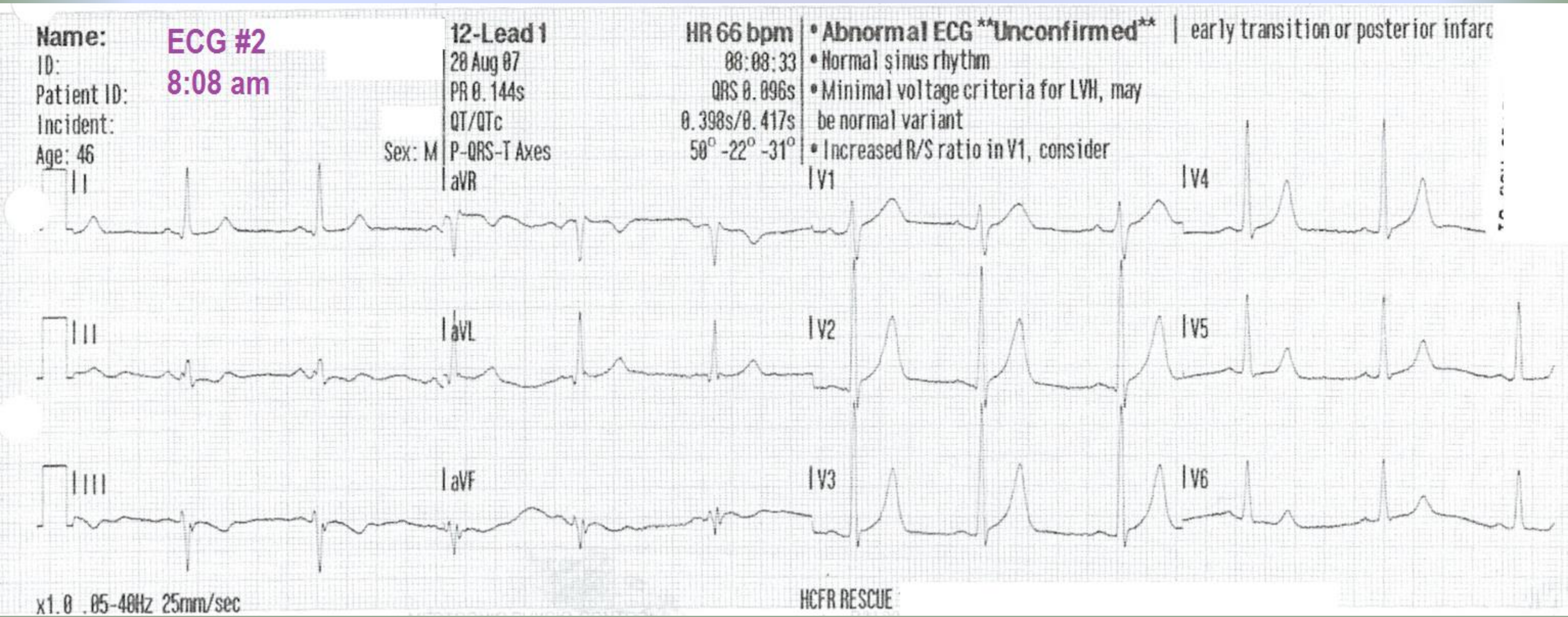
46 year old male

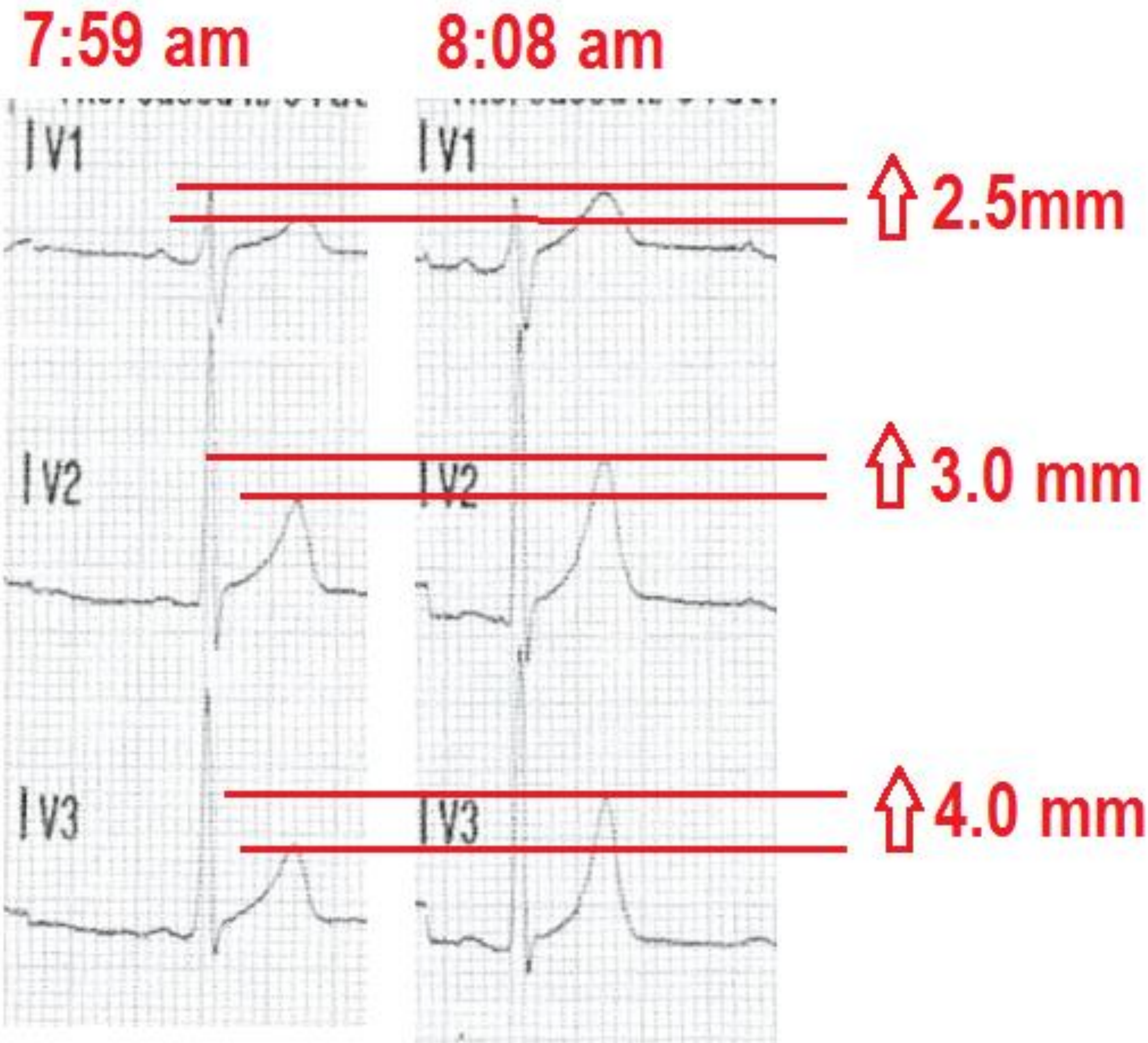
- Exertional dyspnea X "several weeks"
- Intermittent chest pressure X last 3 hours. Currently pain free.



46 year old male: ECG 1

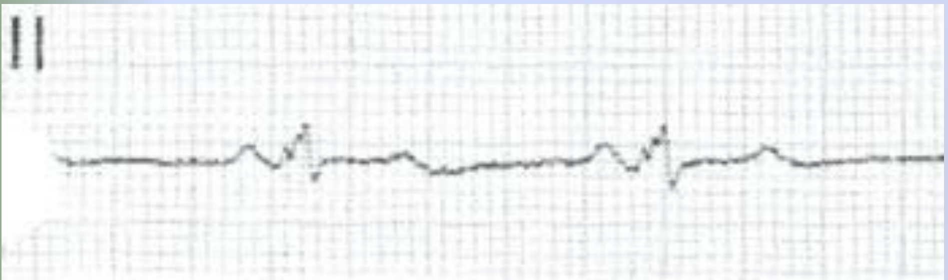
- Chest pressure has returned, “5” on 1-10 scale. 2nd ECG obtained due to “change in symptoms”:



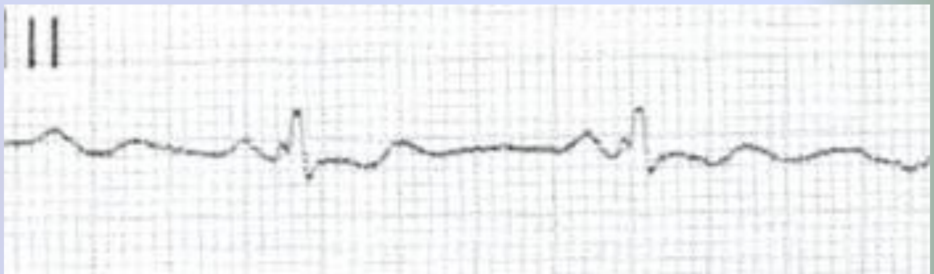

7:59 am
8:08 am
V1
V2
V3
⇧2.5mm
⇧3.0 mm
⇧4.0 mm

ST-Segment Depression

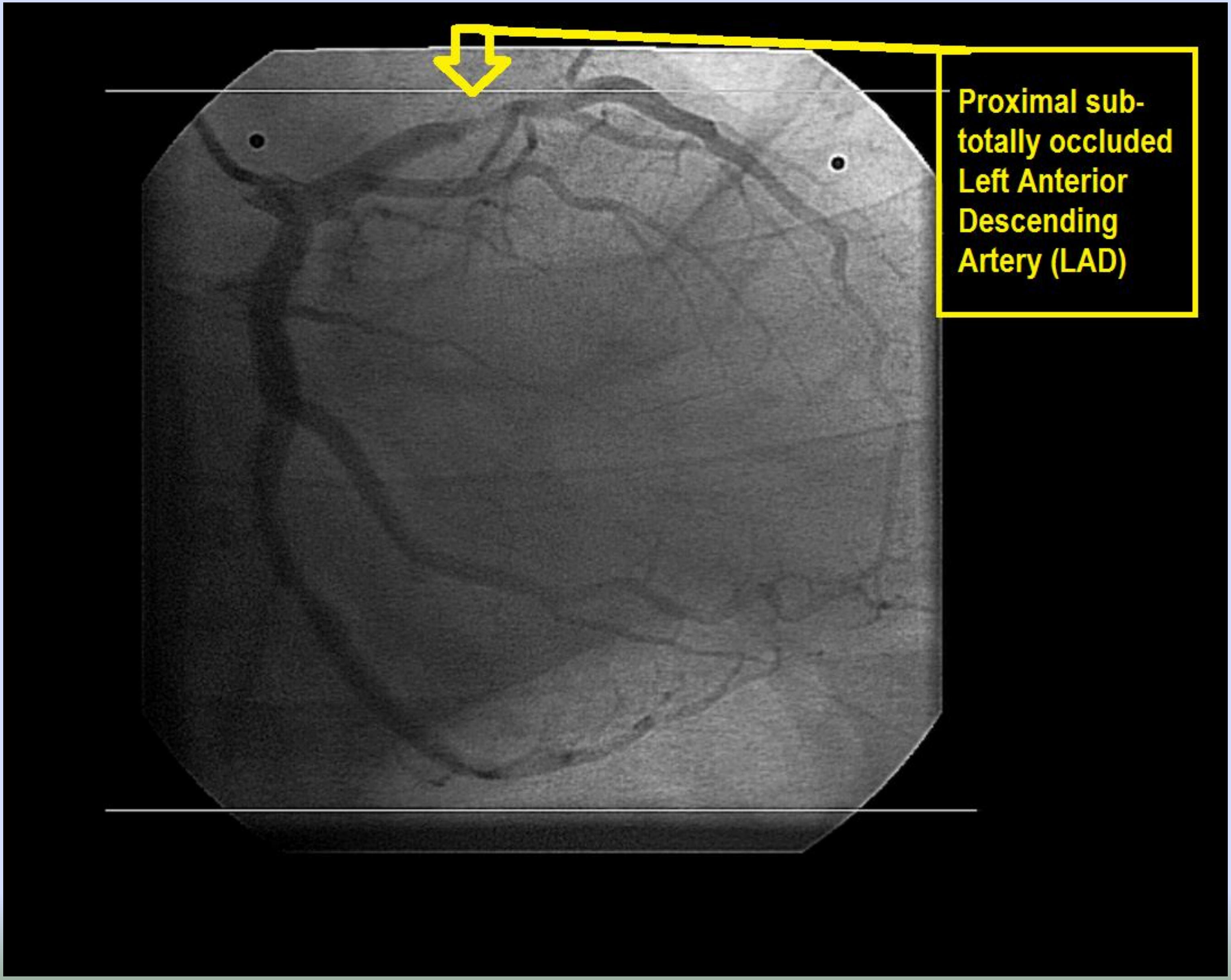
7:59 am



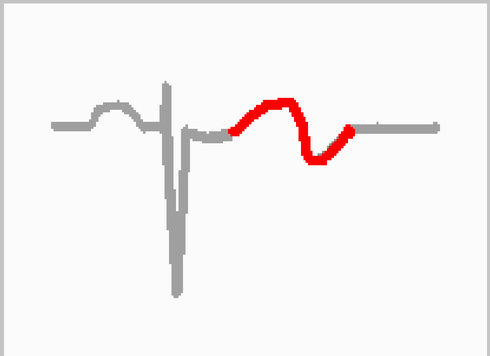
8:08 am



Cath Lab Angiography:



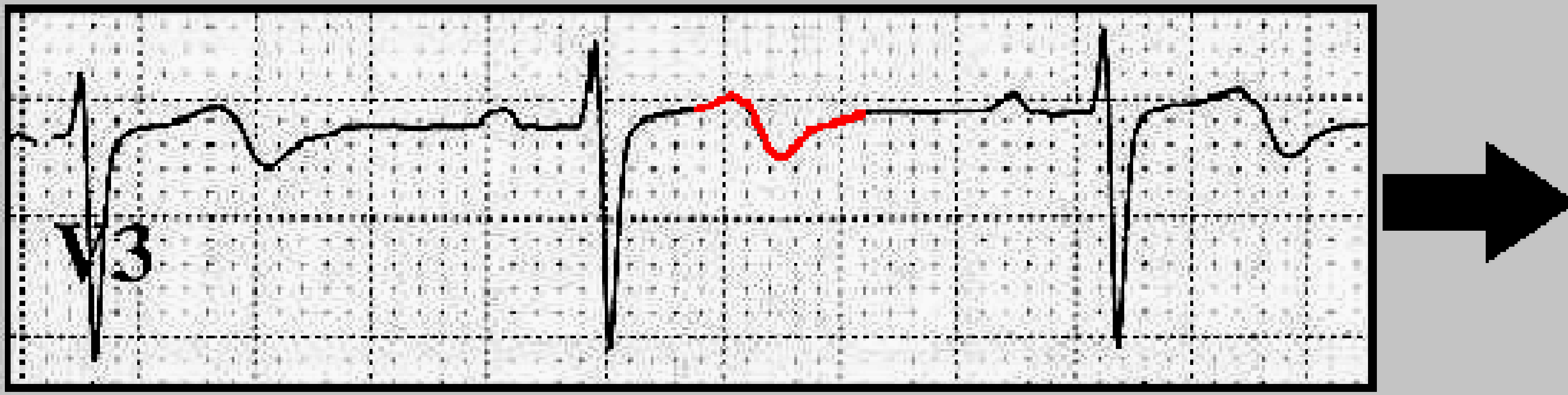
ISCHEMIA



BI-PHASIC T WAVE

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

BI-PHASIC T WAVES



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

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

Classic "Wellen's Syndrome:"

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

Wellen's Syndrome ETIOLOGY:

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

Wellen’s Syndrome EPIDEMIOLOGY & PROGNOSIS:

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

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

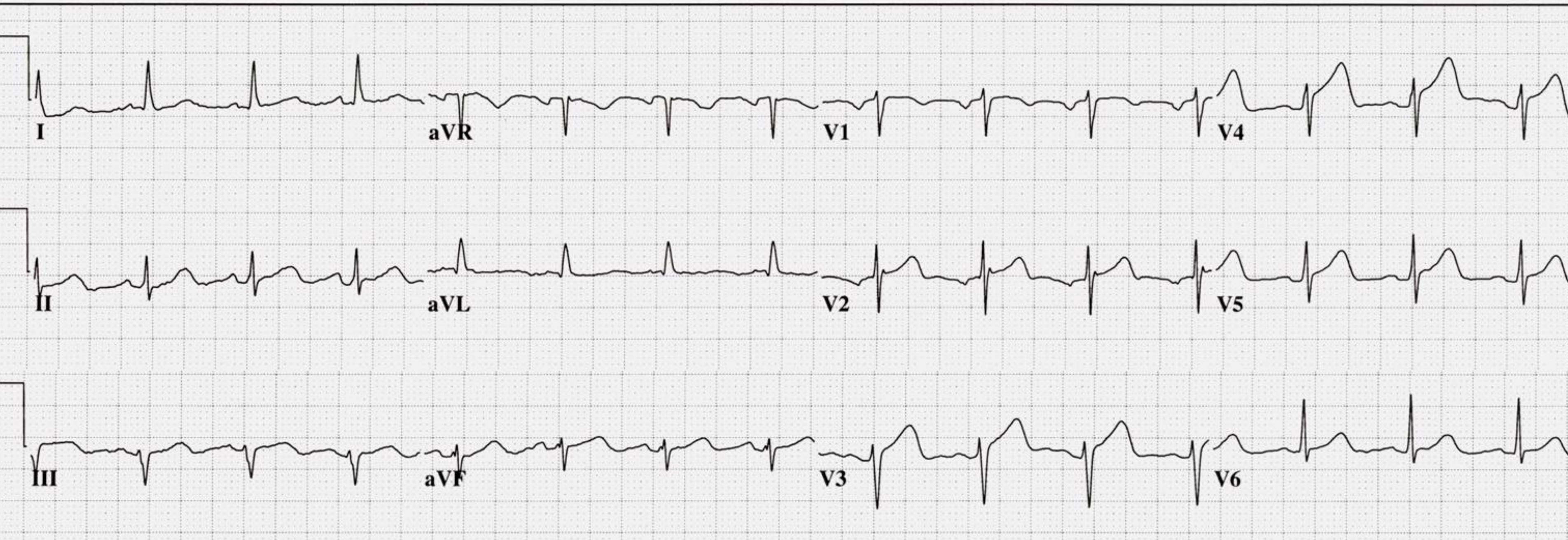
Wellen's Syndrome Case Study

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

Wellen’s Syndrome Case Study

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

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



Wellen’s Syndrome Case Study

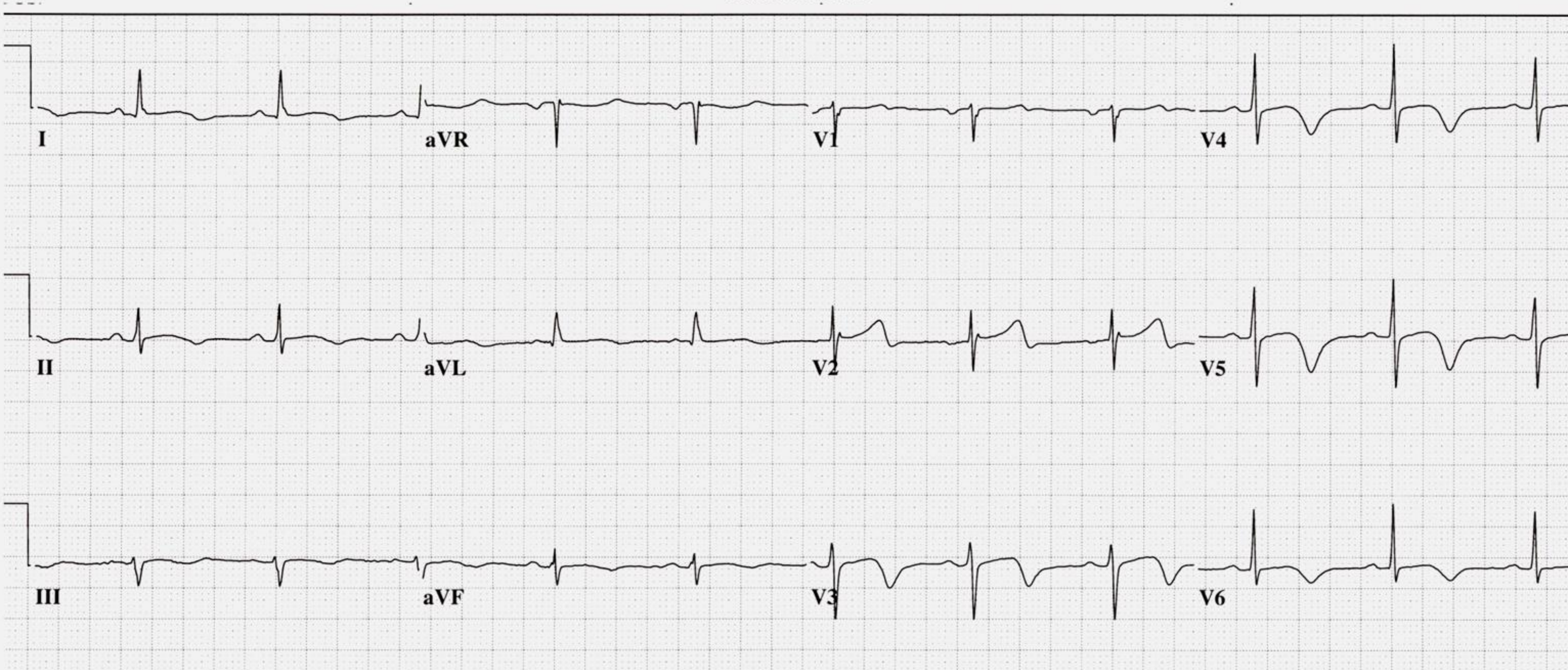
SERIAL EKG CASE STUDY 1 - EKG # 2 @ 09:42 HOURS

33 yr
Male Black

Room:A13
Loc:3 Option:23

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

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



DYNAMIC ST-T Wave Changes ARE PRESENT !!

NOW

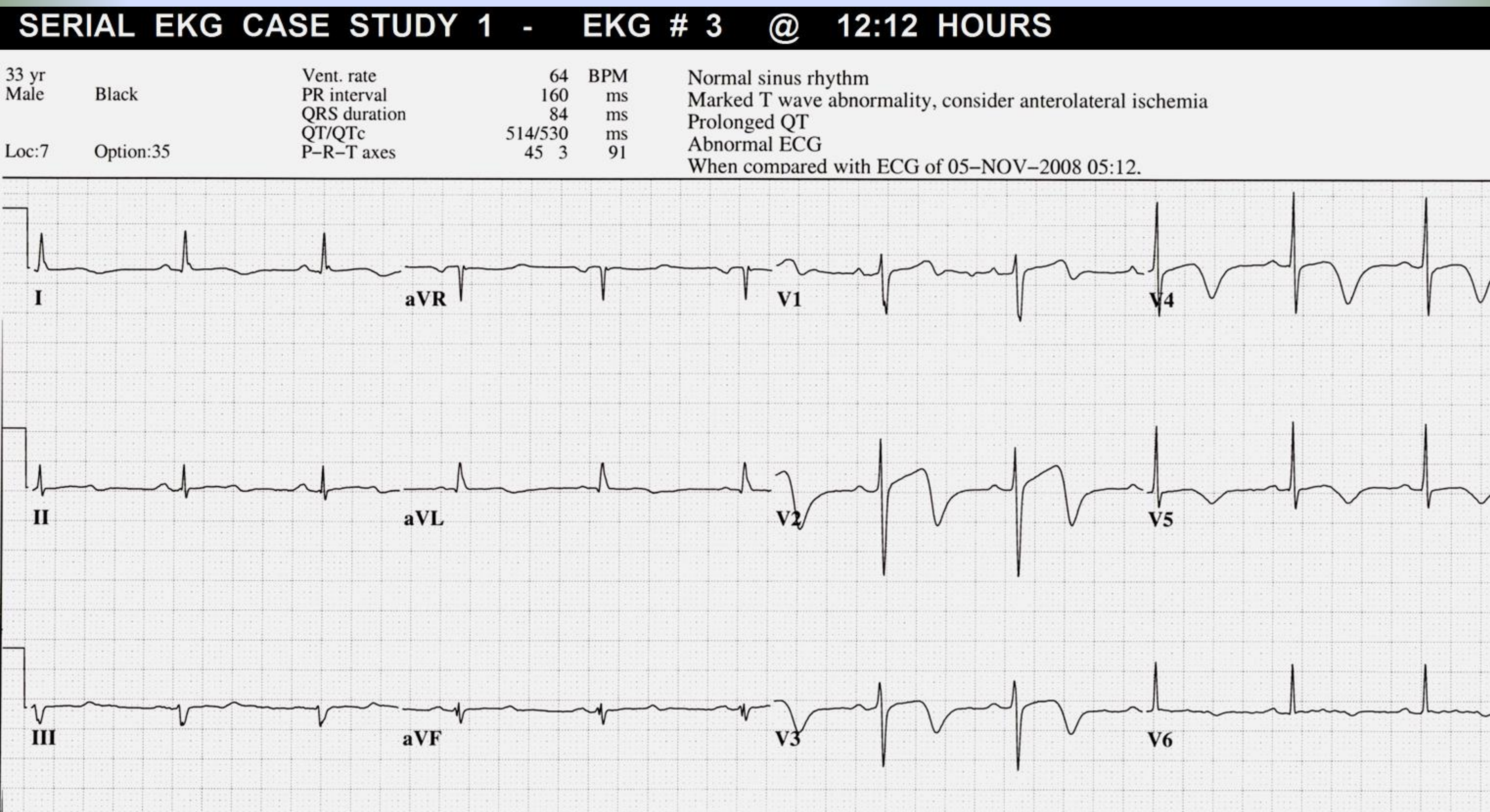
is the time for the

STAT CALL

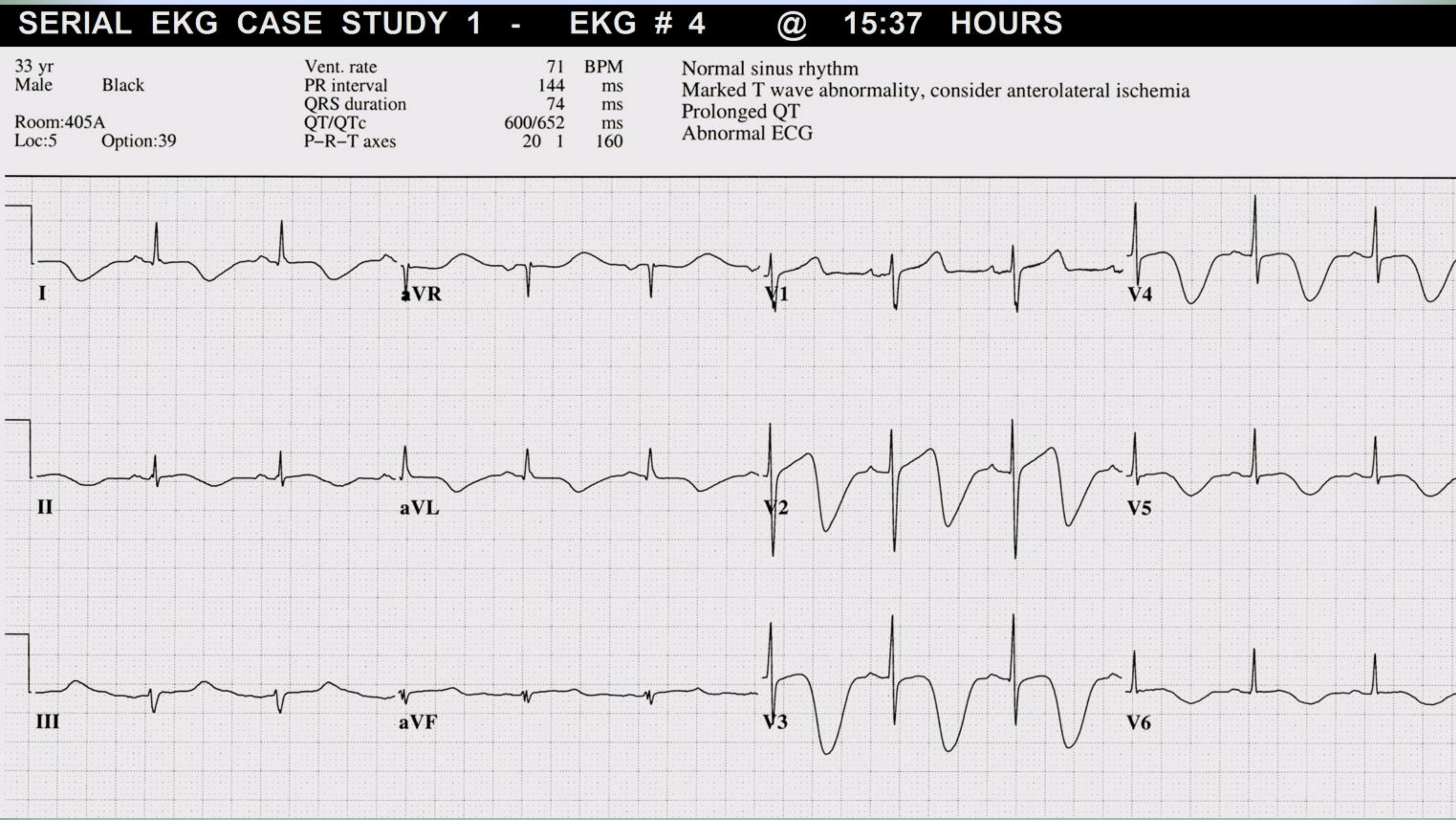
to the

CARDIOLOGIST !!!!

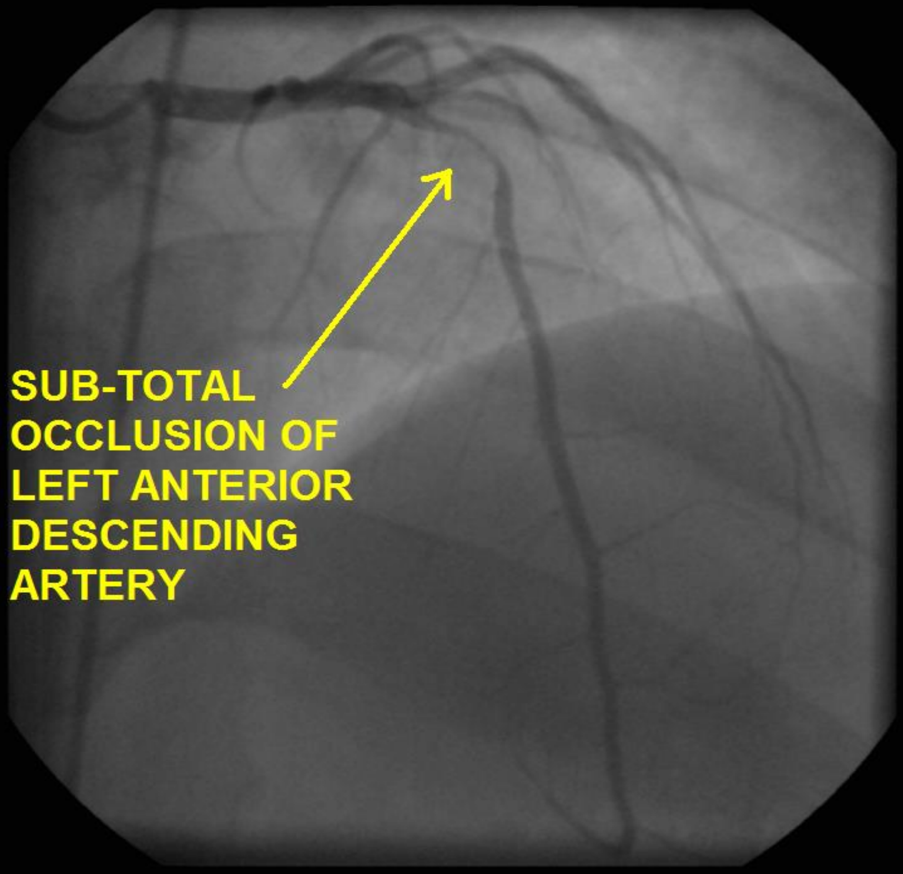
Wellen's Syndrome Case Study

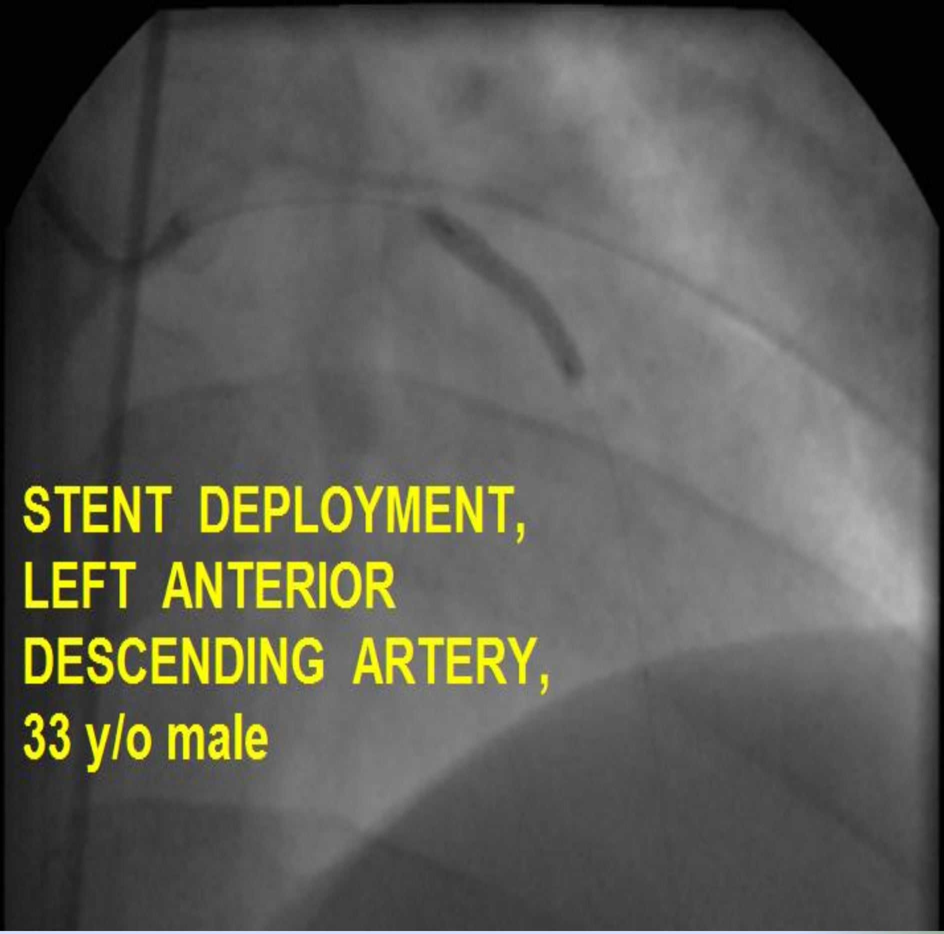


Wellen's Syndrome Case Study

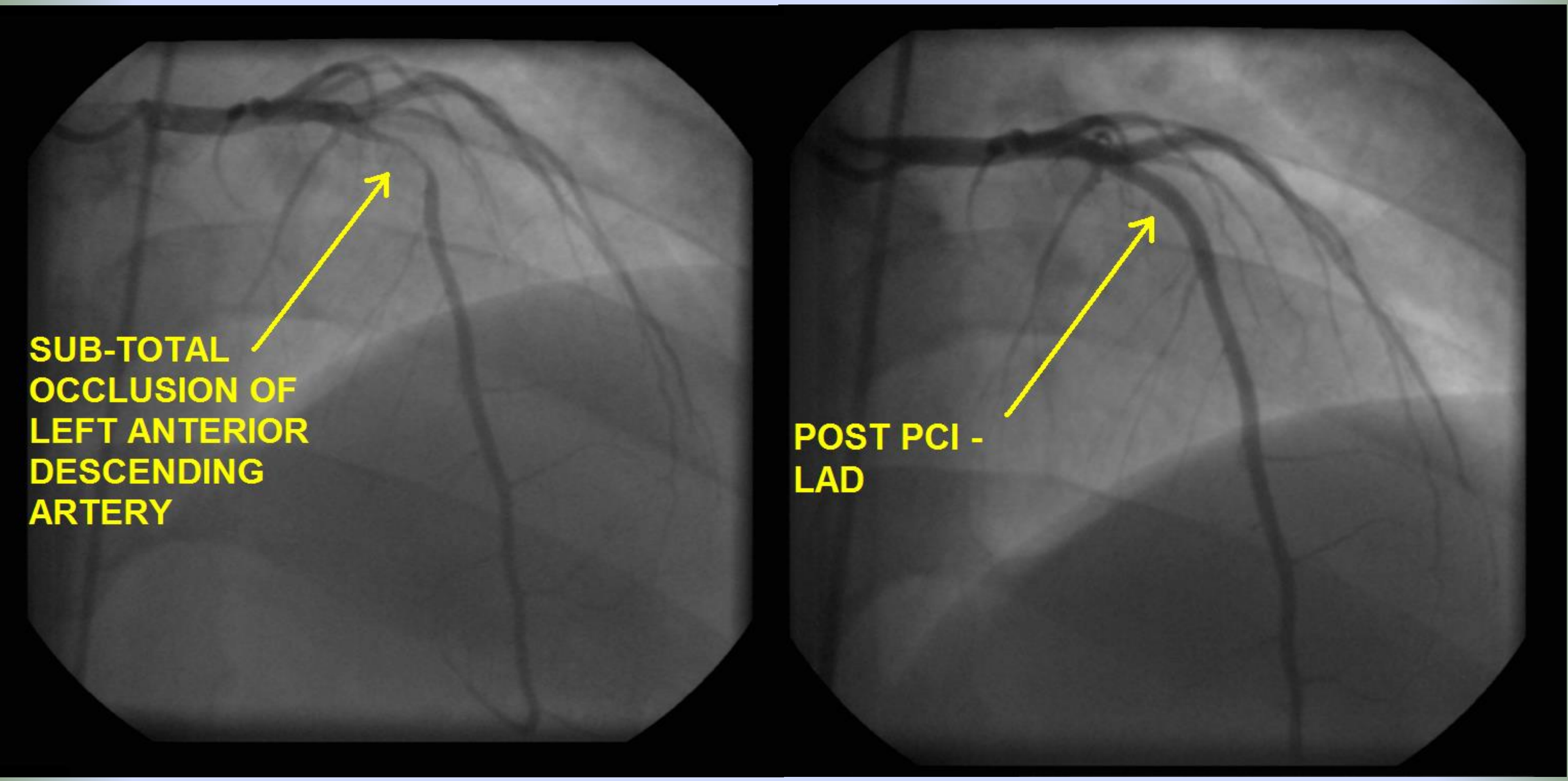


Wellen’s Syndrome Case Study





Wellen’s Syndrome Case Study

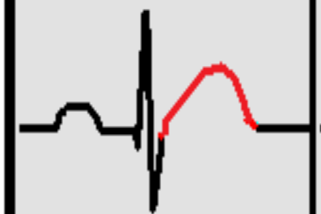
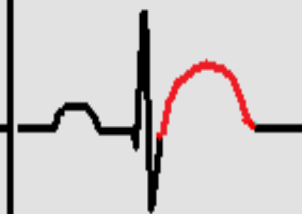
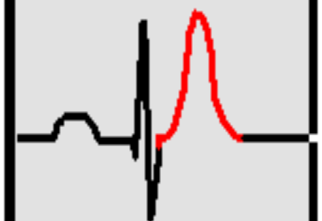
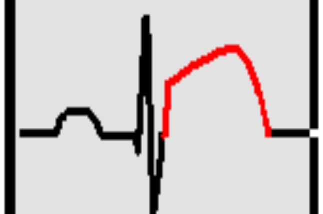
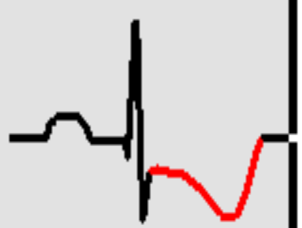


Additional Resources:

- Wellen's Syndrome, NEJM case study

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): <u>0.5</u> mm

Posterior Chest Leads

(V7 – V9): <u>0.5</u> mm

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

Abnormal ST Elevation Criteria: ACC/AHA 2009 "Standardization and Interpretation of the ECG, Part VI Acute Ischemia and Infarction," Galen Wagner, et al

Recommendations

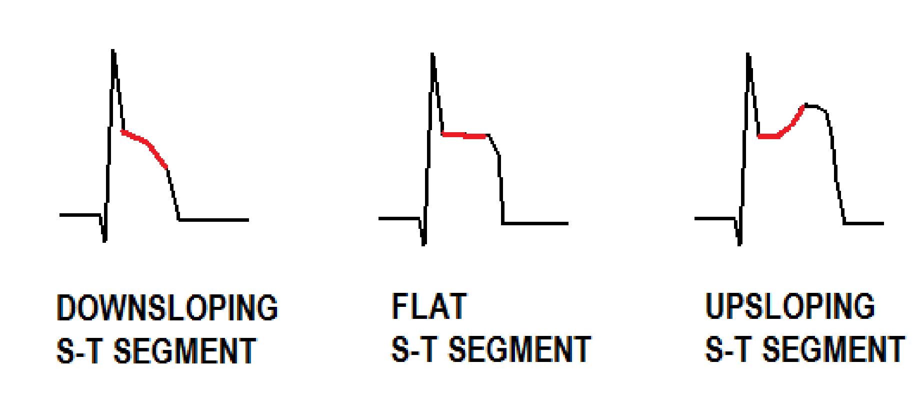
1. For men 40 years of age and older, the threshold value for abnormal J-point elevation should be 0.2 mV (2 mm) in leads V_2 and V_3 and 0.1 mV (1 mm) in all other leads.
2. For men less than 40 years of age, the threshold values for abnormal J-point elevation in leads V_2 and V_3 should be 0.25 mV (2.5 mm).
3. For women, the threshold value for abnormal J-point elevation should be 0.15 mV (1.5 mm) in leads V_2 and V_3 and greater than 0.1 mV (1 mm) in all other leads.
4. For men and women, the threshold for abnormal J-point elevation in V_3R and V_4R should be 0.05 mV (0.5 mm), except for males less than 30 years of age, for whom 0.1 mV (1 mm) is more appropriate.
5. For men and women, the threshold value for abnormal J-point elevation in V_7 through V_9 should be 0.05 mV (0.5 mm).
6. For men and women of all ages, the threshold value for abnormal J-point depression should be −0.05 mV (−0.5 mm) in leads V_2 and V_3 and −0.1 mV (−1 mm) in all other leads.

ST SEGMENT ELEVATION:

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

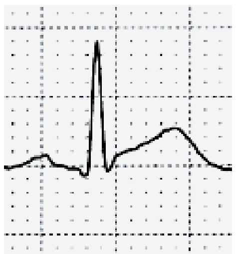
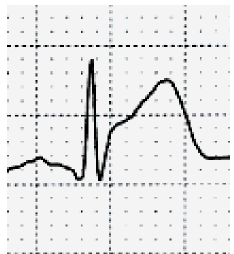
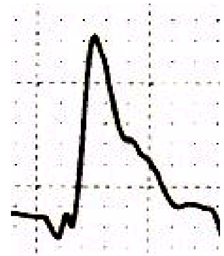
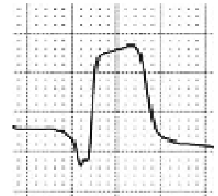
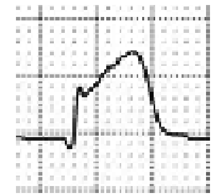
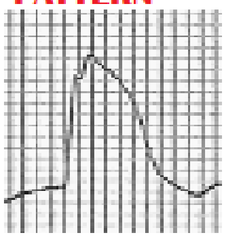
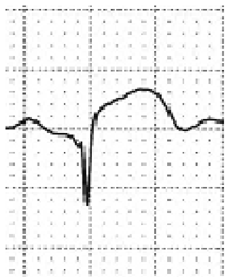
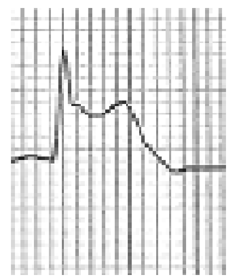
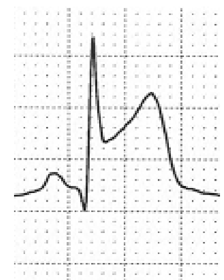
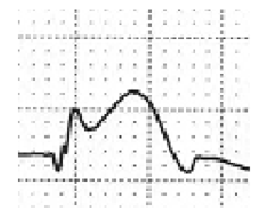
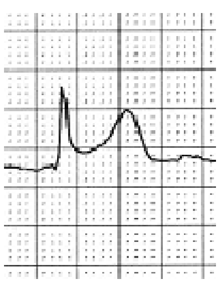
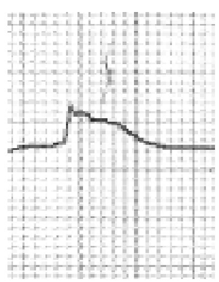
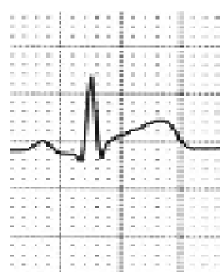
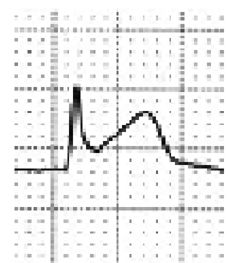
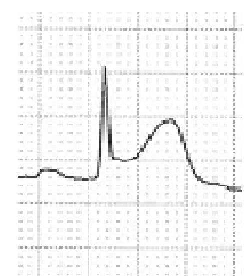
IN THIS CASE, a normal response to balloon occlusion of the RIGHT CORONARY ARTERY during PTCA in the CARDIAC CATH LAB

3 COMMON PATTERNS of ST SEGMENT ELEVATION From ACUTE MI:



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 STEMI.

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

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

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

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

ACUTE MI

COMPLICATIONS TO ANTICIPATE FOR ALL MI PATIENTS :

- LETHAL DYSRHYTHMIAS
- CARDIAC ARREST
- FAILURE OF STRUCTURE(S) SERVED BY THE BLOCKED ARTERY


Lancaster County, Pennsylvania
Winter, 2002

“NOWHERE”, NEW MEXICO, 1994

STEMI

- **Correlation of ECG Leads with Coronary Arterial Anatomy and the STRUCTURES SERVED by the OCCLUDED ARTERY . . . .**

STEMI

- **Correlation of ECG Leads with Coronary Arterial Anatomy and the STRUCTURES SERVED by the OCCLUDED ARTERY . . . .**

. . . . . Will serve as a "crystal ball," allowing you to ANTICIPATE complications of STEMI . . . .

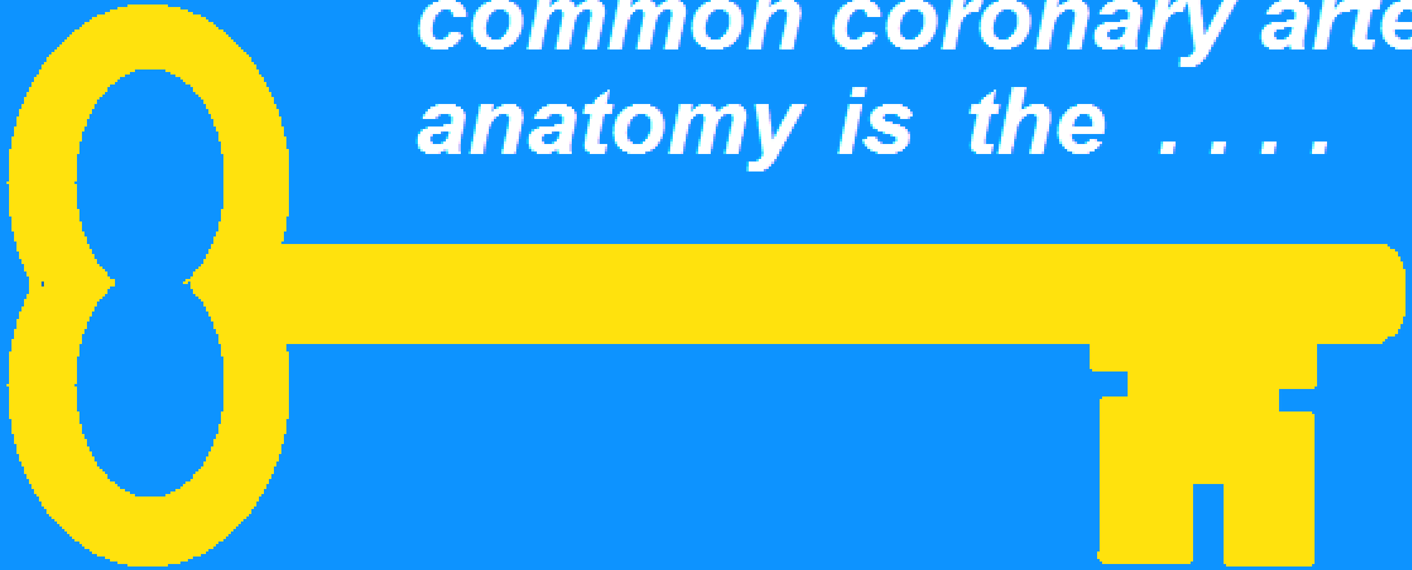
STEMI

- **Correlation of ECG Leads with Coronary Arterial Anatomy and the STRUCTURES SERVED by the OCCLUDED ARTERY . . . .**

. . . . . Will serve as a "crystal ball," allowing you to ANTICIPATE complications of STEMI . . . .

. . . . BEFORE they occur !!

"Having knowledge of common coronary artery anatomy is the . . . .



to understanding the PHYSIOLOGICAL CHANGES that occur during ACUTE MI."

"an INVALUABLE ASSET for ALL MEDICAL PROFESSIONALS who provide direct care to STEMI patients !"

The 12 Lead ECG becomes your "crystal ball !!"

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

CASE STUDY 1 - STEMI

CHIEF COMPLAINT and SIGNIFICANT HISTORY:

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

RISK FACTOR PROFILE:

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

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

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

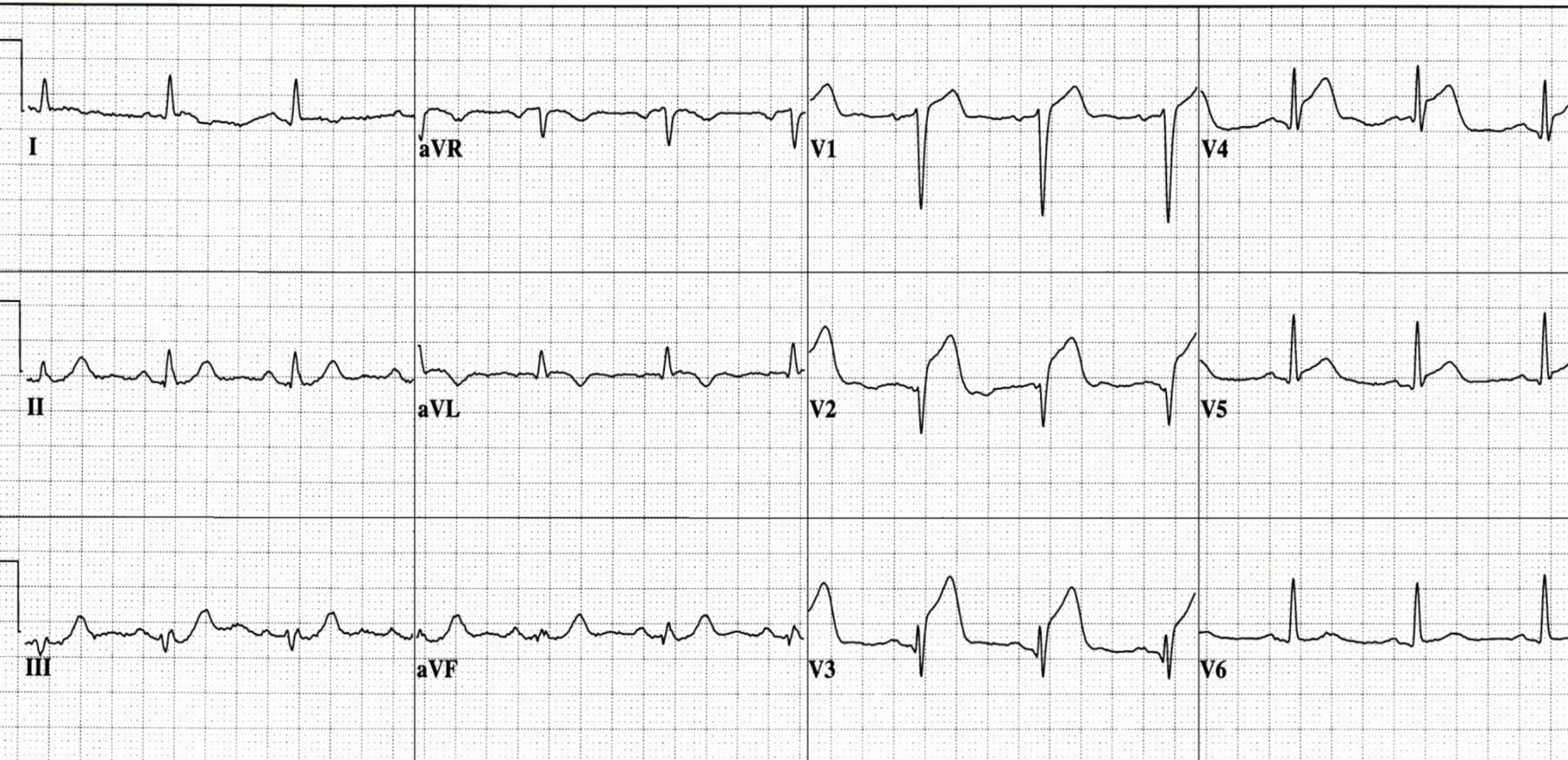
LABS: FIRST TROPONIN: 6.4

72 yr
Male Caucasian
Loc:3 Option:23

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

EVALUATE EKG for indicators of ACS:

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



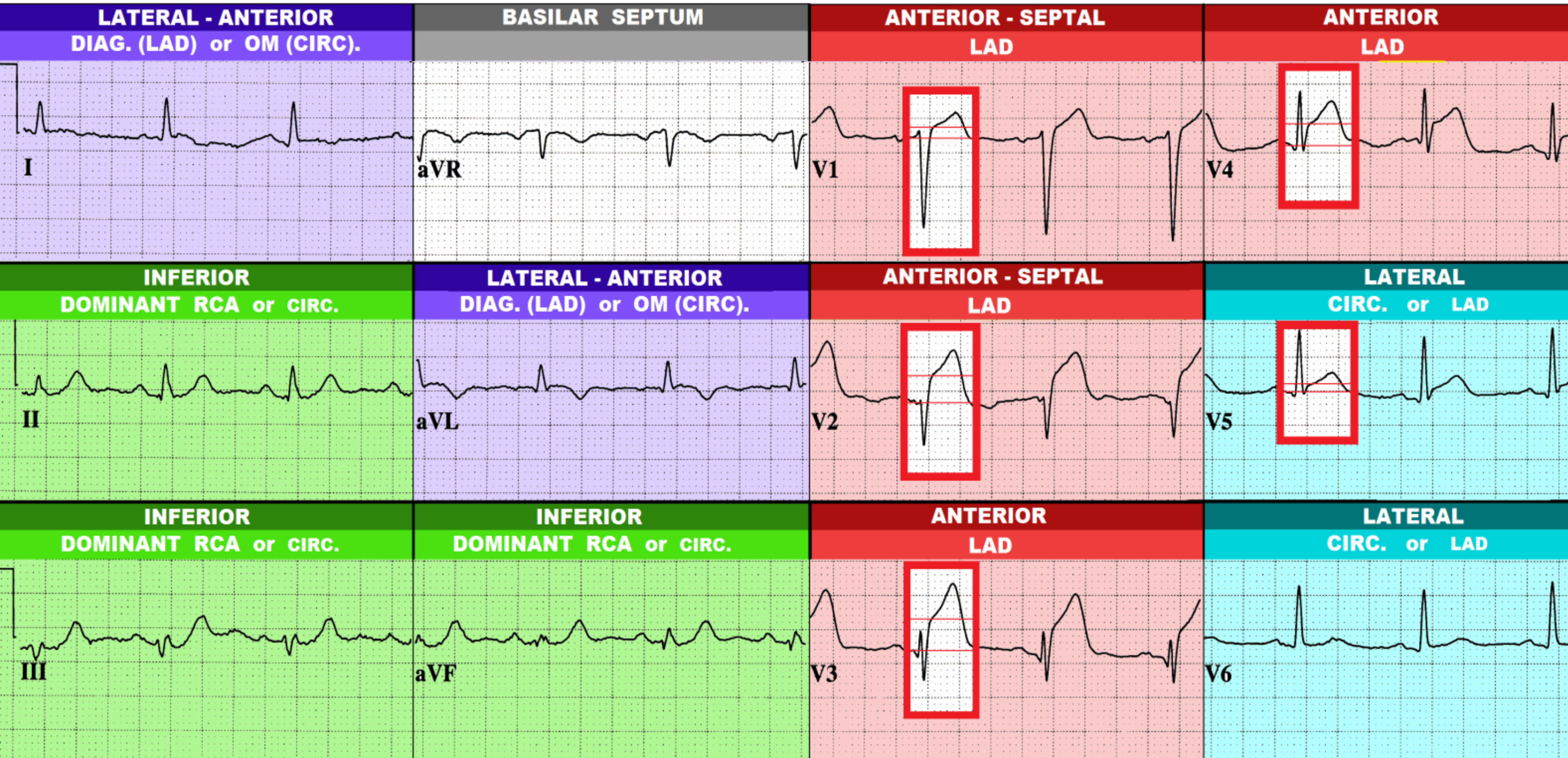
72 yr Male Caucasian

Loc: Option:2

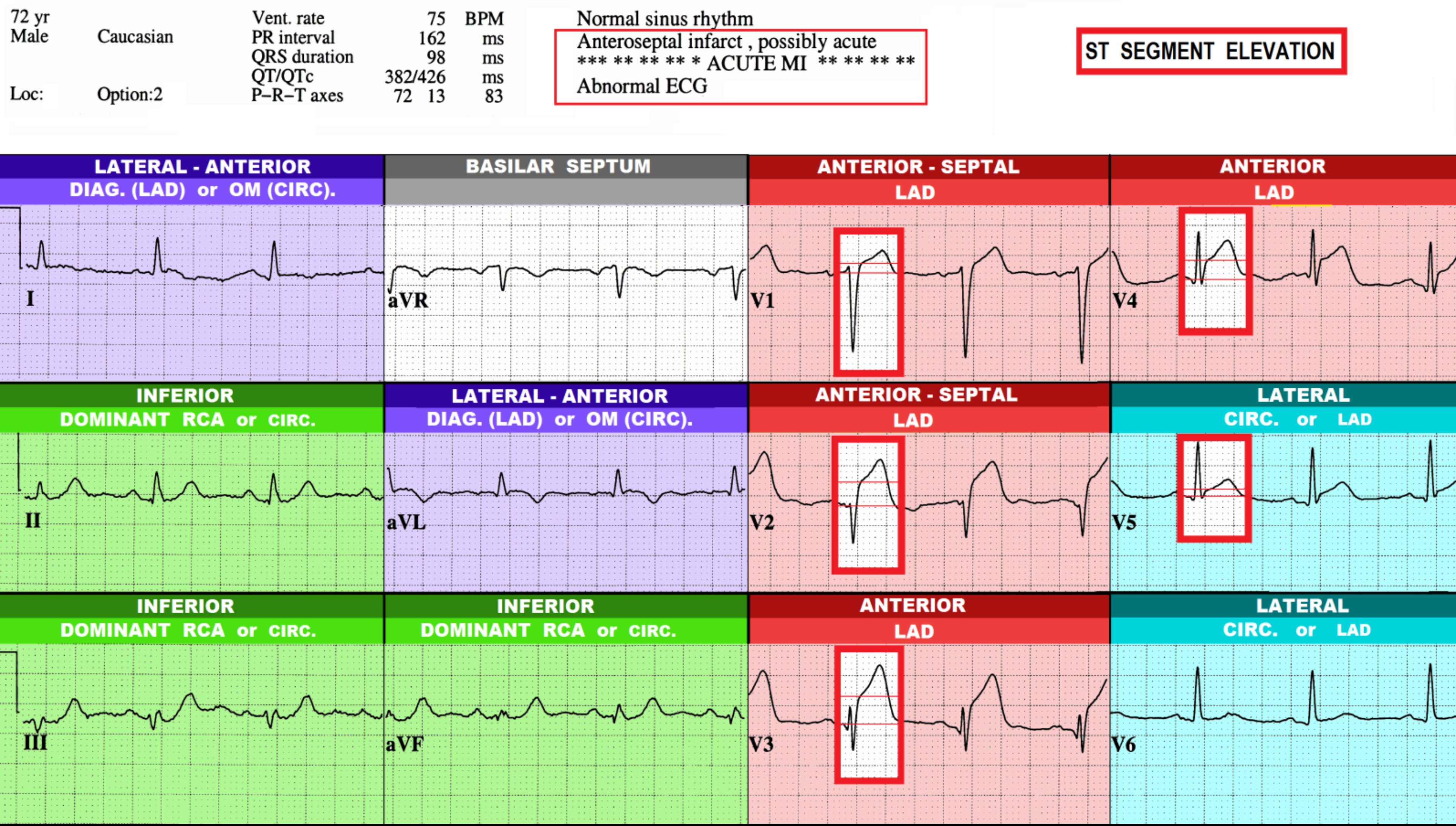
Vent. rate	75	BPM
PR interval	162	ms
QRS duration	98	ms
QT/QTc	382/426	ms
P–R–T axes	72 13	83

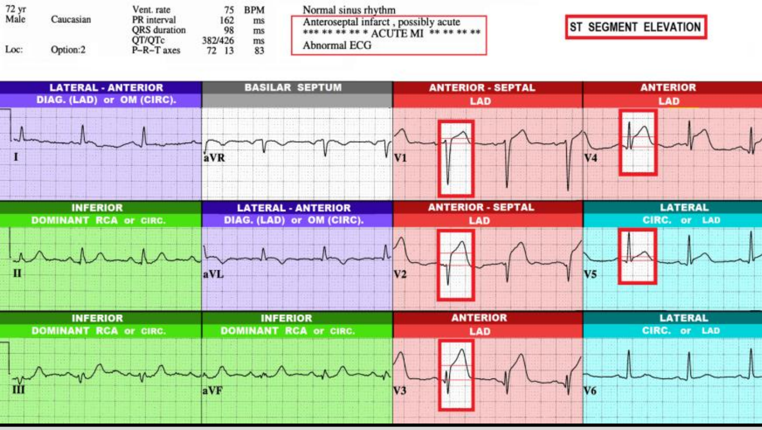
Normal sinus rhythm
Anteroseptal infarct , possibly acute
*** ** ** ** * ACUTE MI ** ** ** **
Abnormal ECG

ST SEGMENT ELEVATION



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


72 yr
Male
Caucasian
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
LATERAL - ANTERIOR
DIAG. (LAD) or OM (CIRC).
I
BASILAR SEPTUM
aVR
ANTERIOR - SEPTAL
LAD
V1
ANTERIOR
LAD
V4
INFERIOR
DOMINANT RCA or CIRC.
II
LATERAL - ANTERIOR
DIAG. (LAD) or OM (CIRC).
aVL
ANTERIOR - SEPTAL
LAD
V2
LATERAL
CIRC. or LAD
V5
INFERIOR
DOMINANT RCA or CIRC.
III
INFERIOR
DOMINANT RCA or CIRC.
aVF
ANTERIOR
LAD
V3
LATERAL
CIRC. or LAD
V6

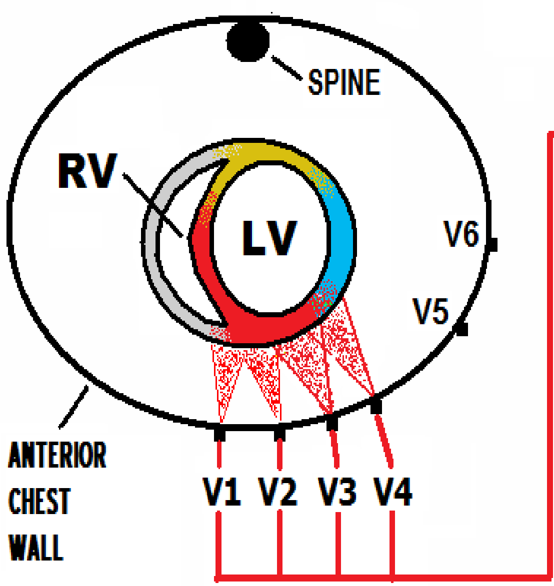


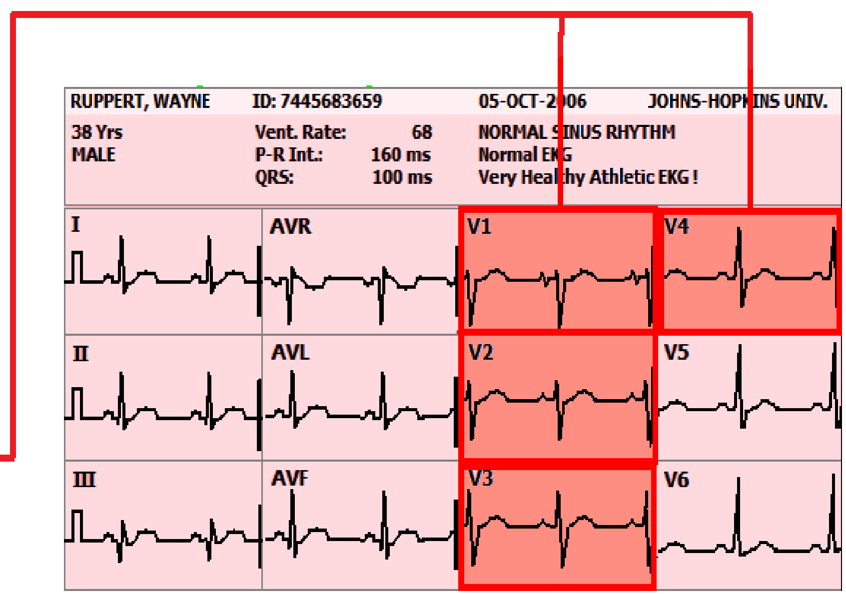
V1 - V4 VIEW THE ANTERIOR-SEPTAL WALL

of the LEFT VENTRICLE

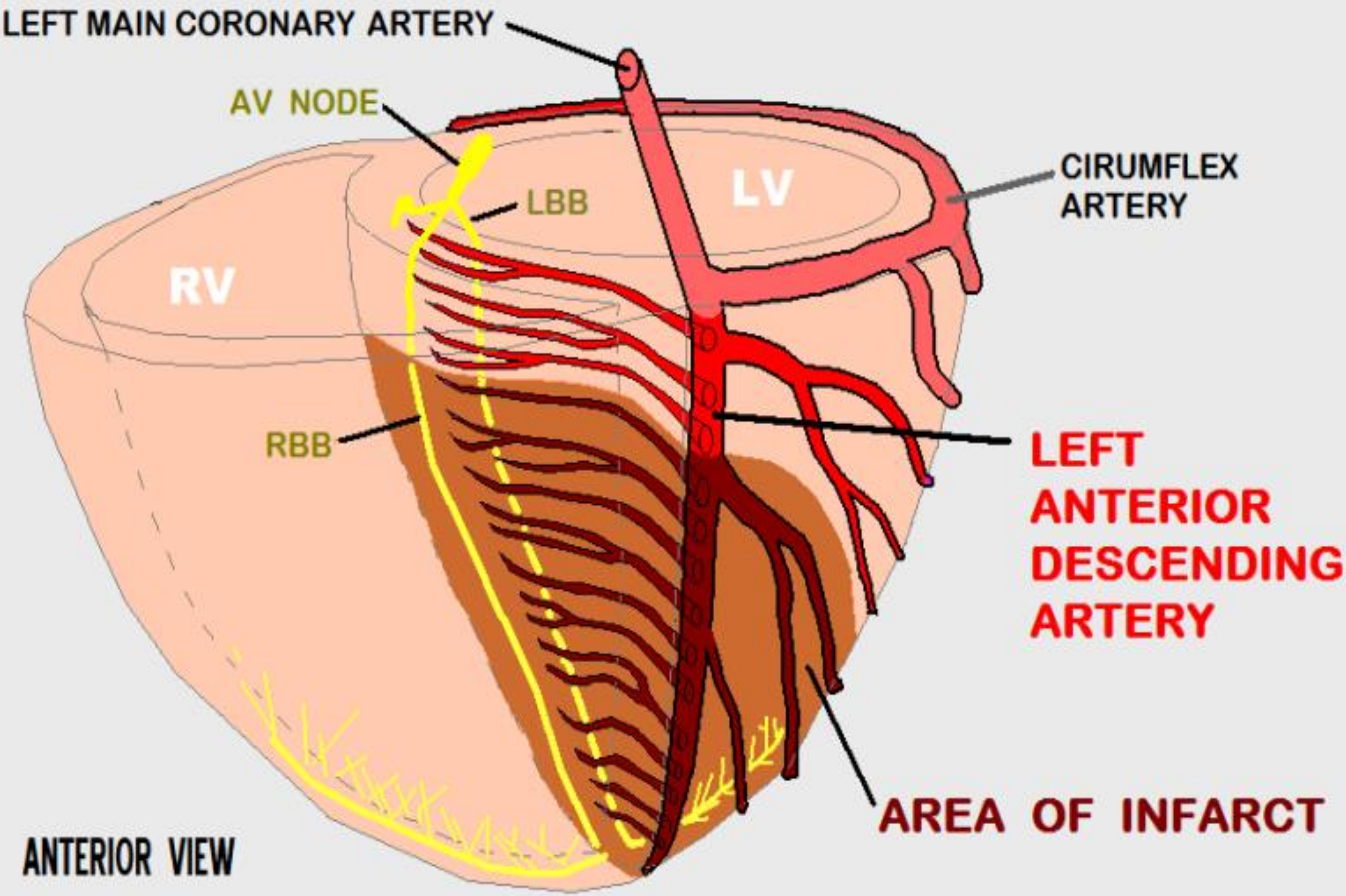
V1, V2 - ANTERIOR / SEPTAL

V3, V4 - ANTERIOR



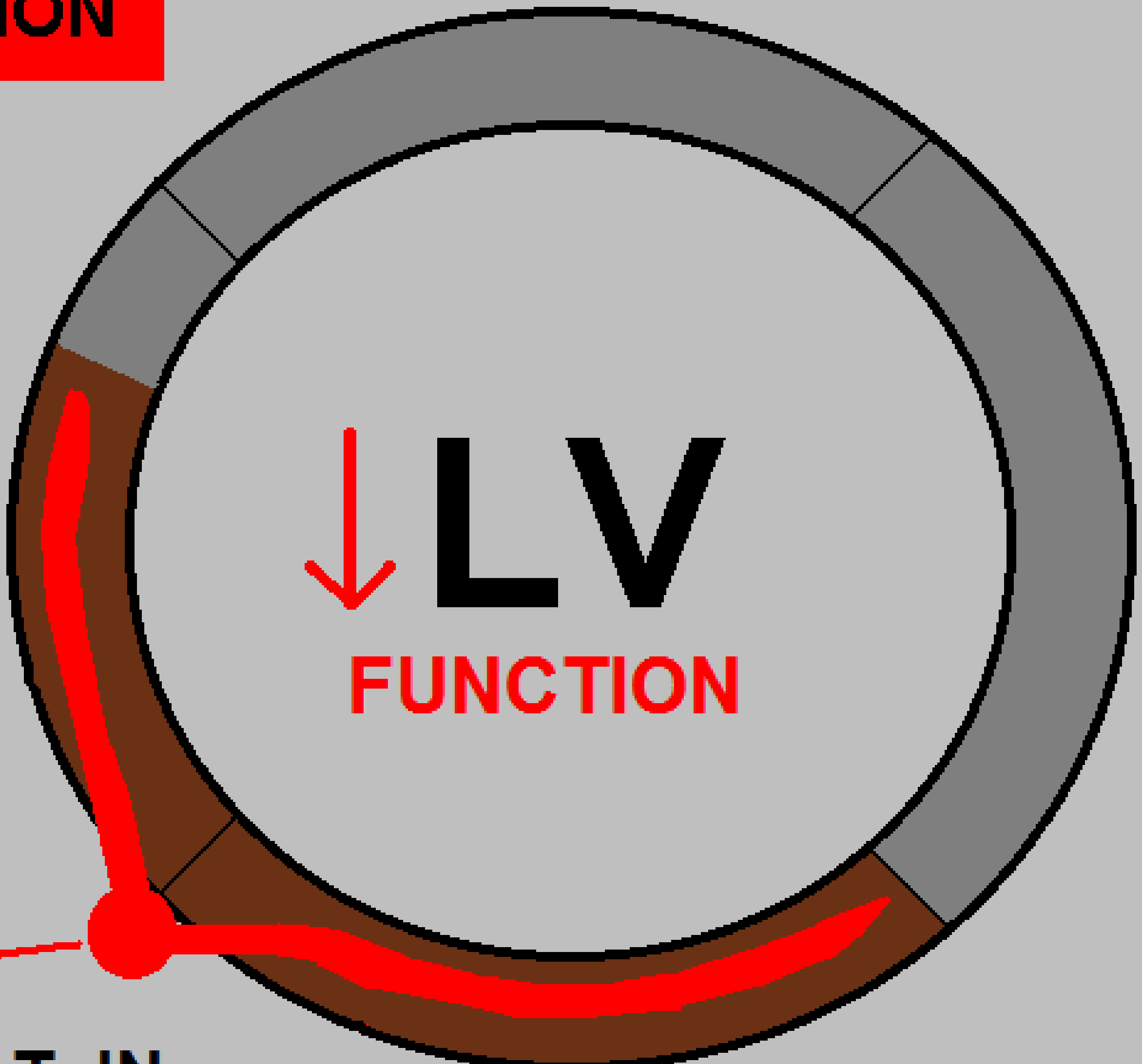


OCCLUSION of MID - LEFT ANTERIOR DESCENDING ARTERY



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
250 mL
Baxter
500 mg
DOBUTamine
250 mL
Baxter

LEFT ANTERIOR DESCENDING ARTERY (LAD)

- ANTERIOR WALL OF LEFT VENTRICLE

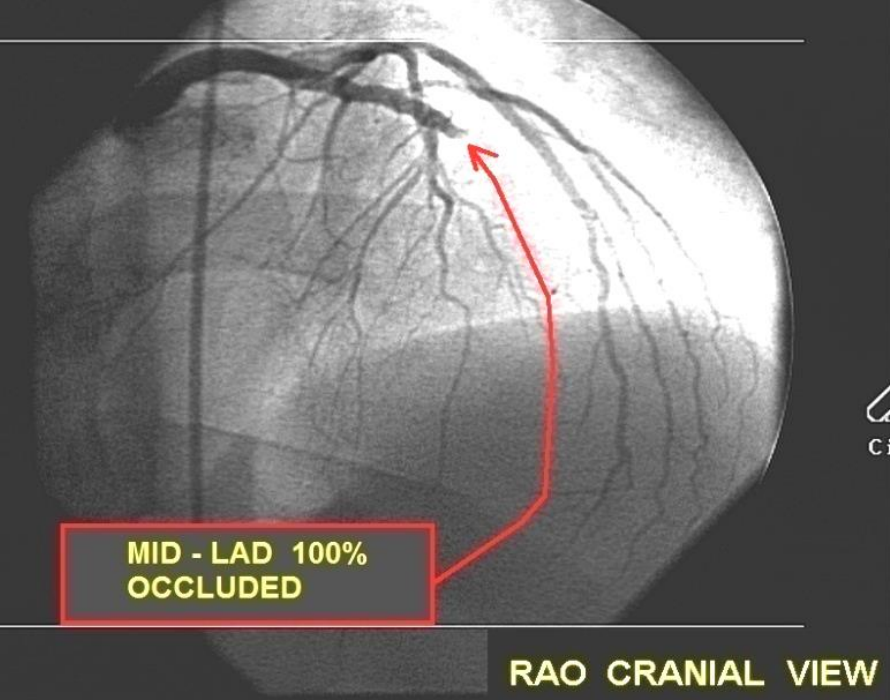
35 - 45 % OF LEFT VENTRICLE MUSCLE MASS

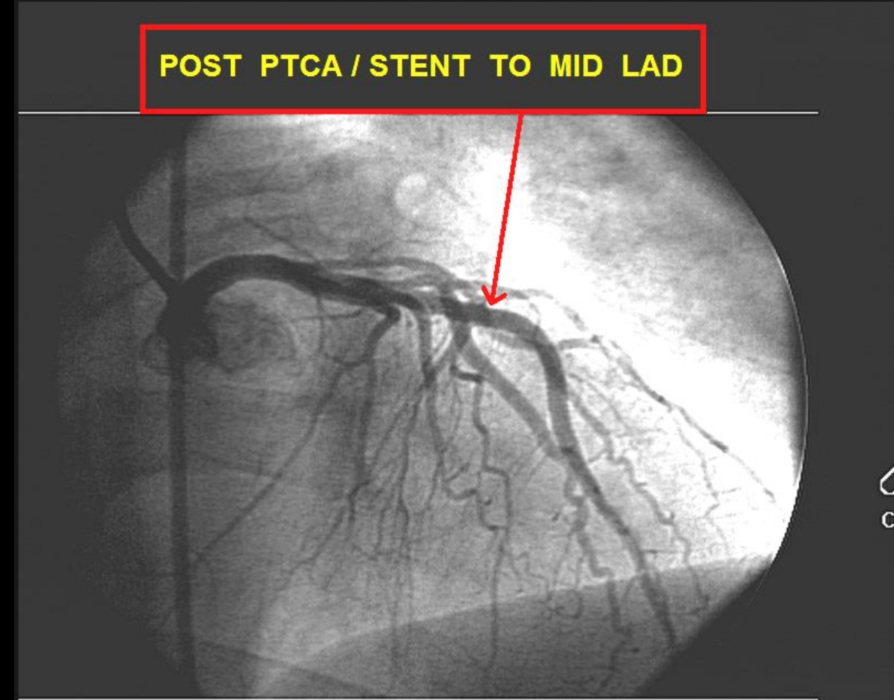
- SEPTUM, ANTERIOR 2/3

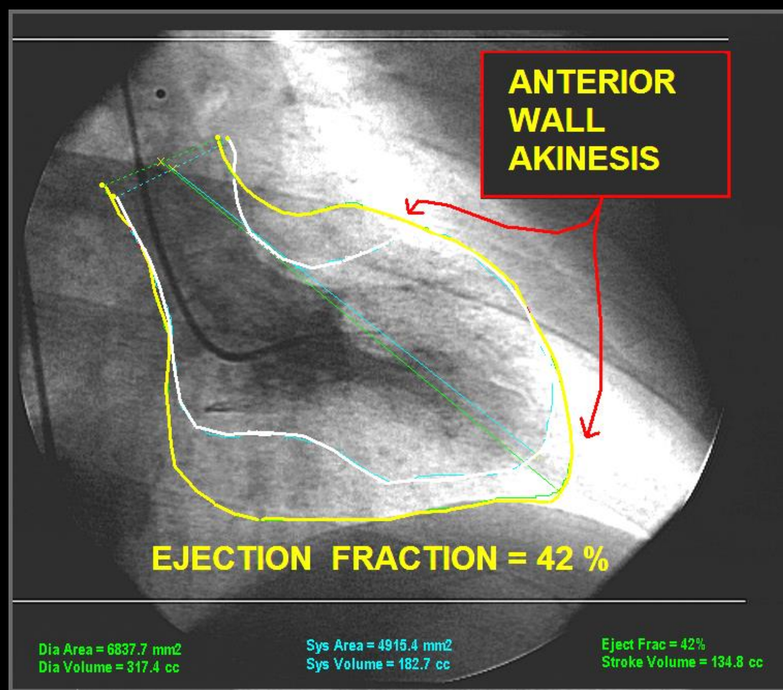
BUNDLE BRANCHES

- 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)


MID - LAD 100%
OCCLUDED
RAO CRANIAL VIEW


POST PTCA / STENT TO MID LAD


ANTERIOR
WALL
AKINESIS
EJECTION FRACTION = 42 %
Dia Area = 6837.7 mm2
Dia Volume = 317.4 cc
Sys Area = 4915.4 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.

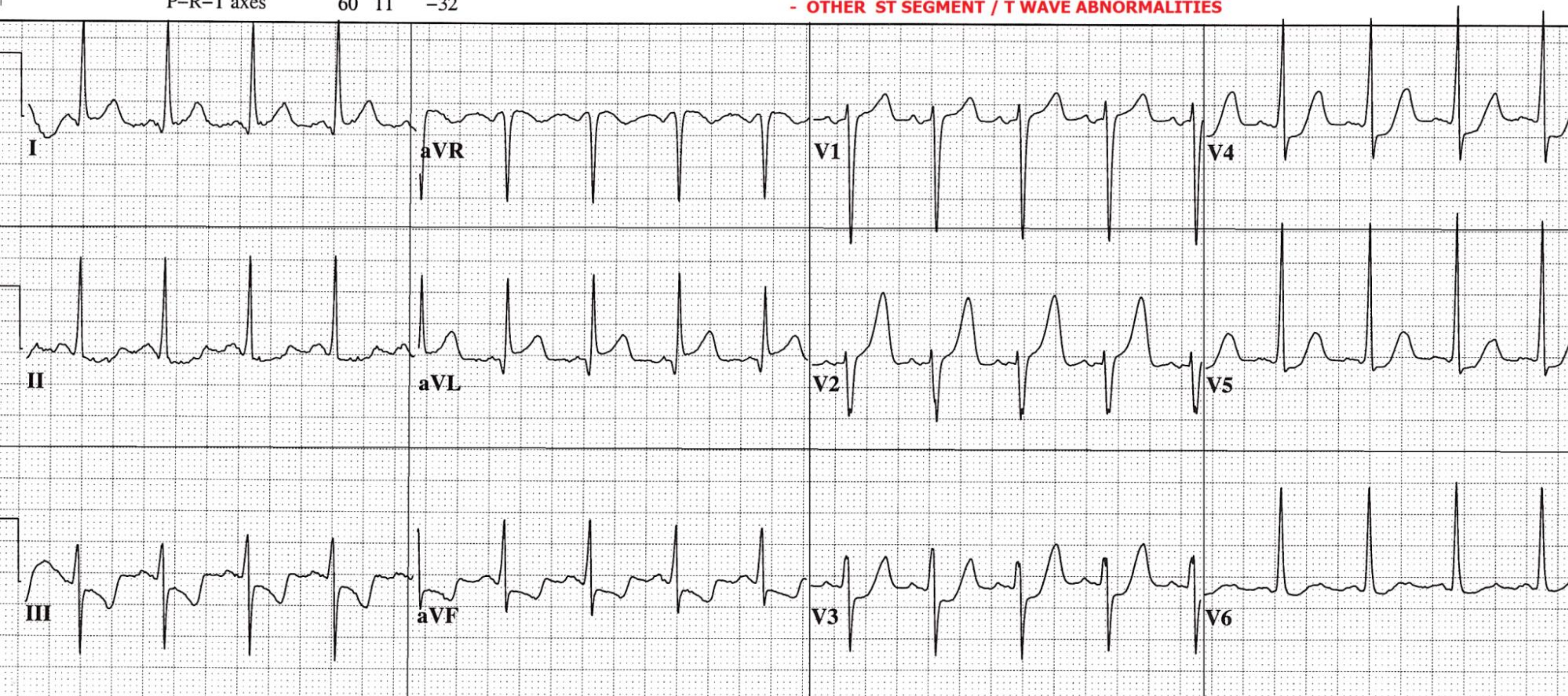
VITAL SIGNS: BP: 168/98, P: 110, R: 24, SAO2: 97% on O2 4 LPM via nasal canula

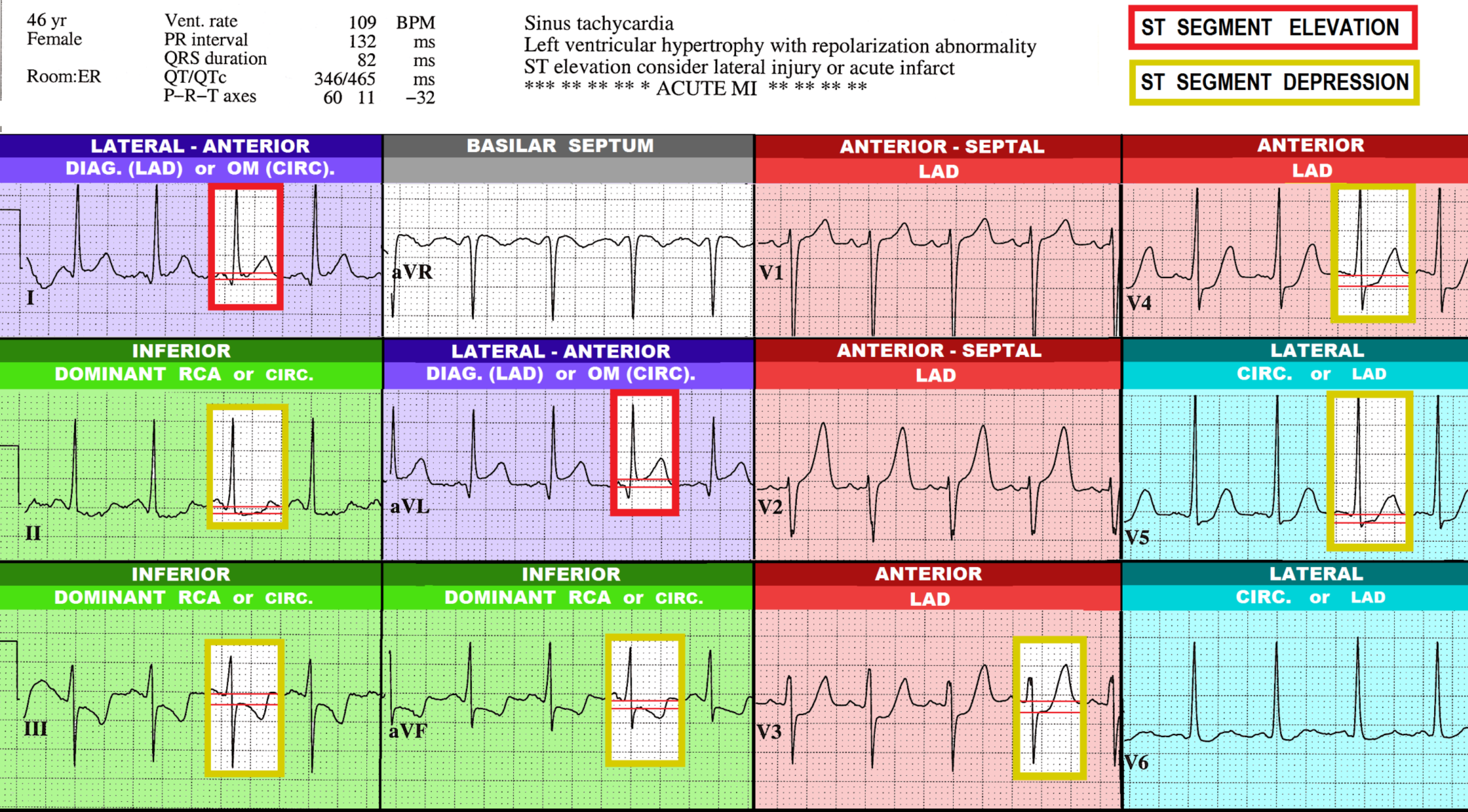
LABS: TROPONIN ultra = 2.8

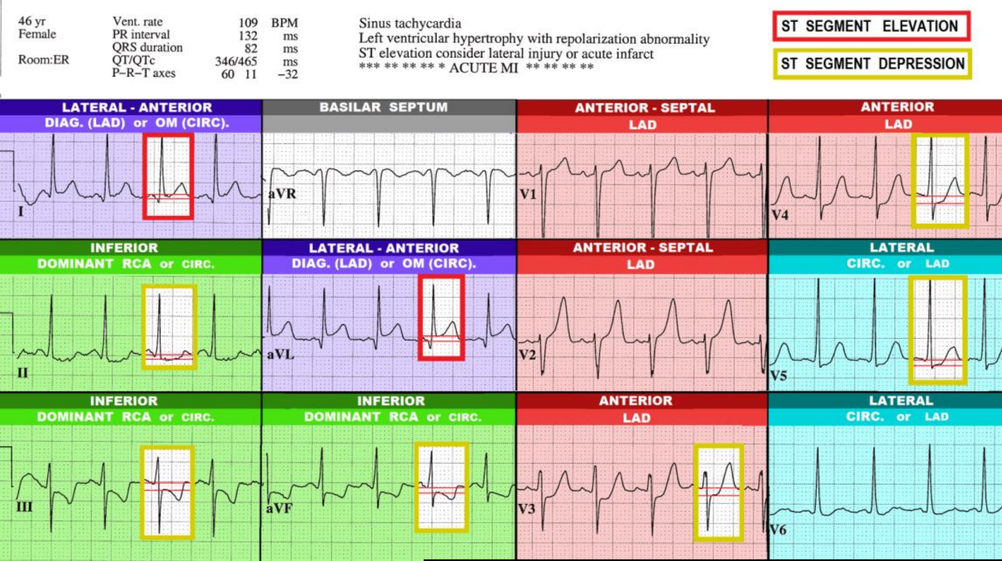
46 yr	Vent. rate	109	BPM
Female	PR interval	132	ms
	QRS duration	82	ms
Room:ER	QT/QTc	346/465	ms
	P–R–T axes	60 11	−32

☞ **EVALUATE EKG for indicators of ACS:**

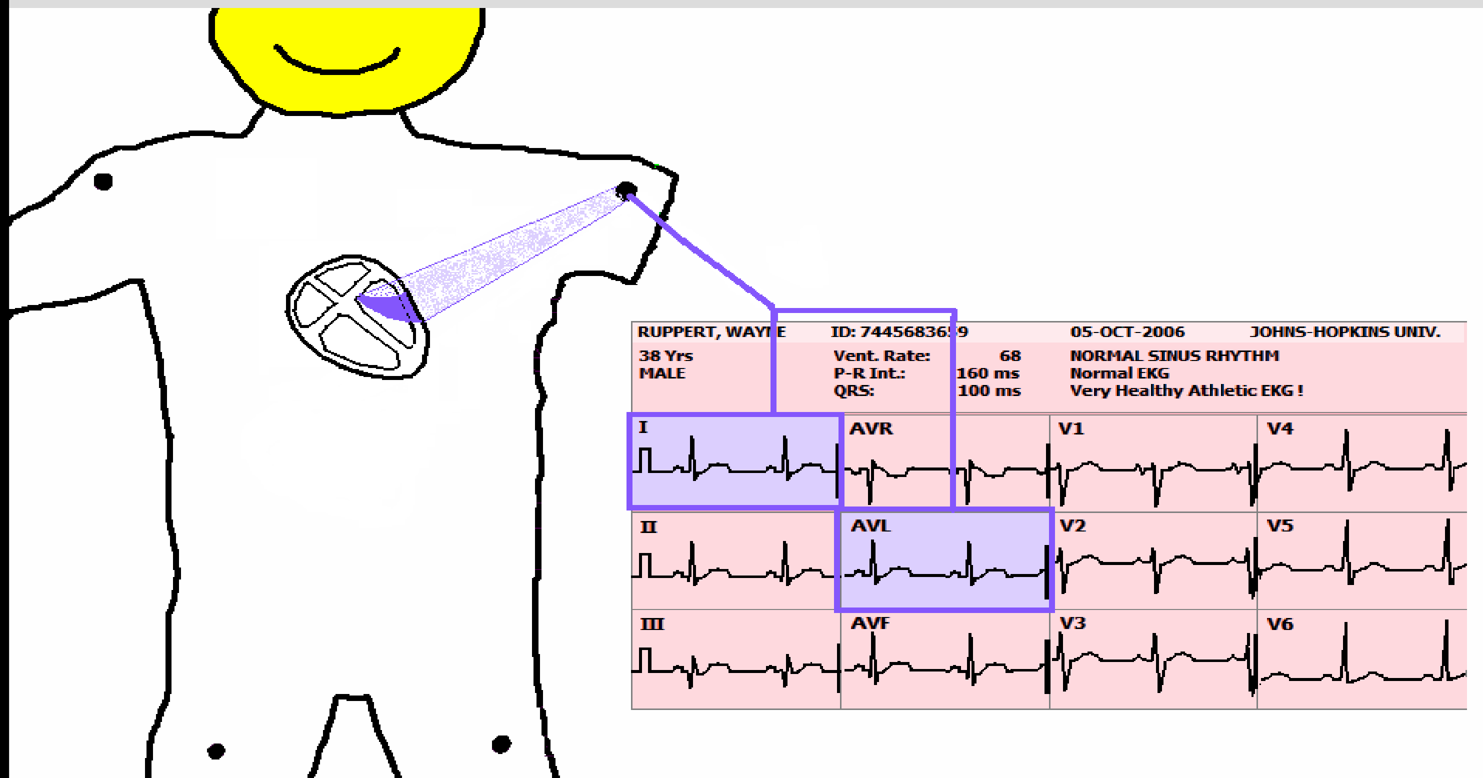
- ST SEGMENT ELEVATION / DEPRESSION
- HYPERACUTE T WAVES
- CONVEX ST SEGMENTS
- OTHER ST SEGMENT / T WAVE ABNORMALITIES



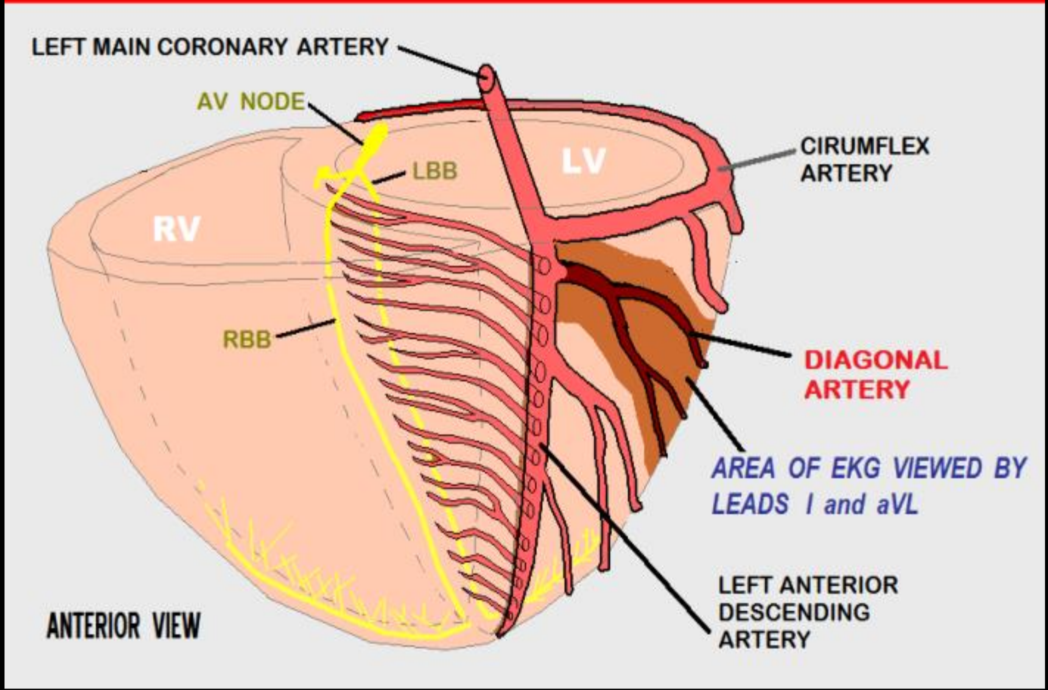

46 yr
Female
Room:ER
Vent. rate 109 BPM
PR interval 132 ms
QRS duration 82 ms
QT/QTc 346/465 ms
P–R–T axes 60 11 –32
Sinus tachycardia
Left ventricular hypertrophy with repolarization abnormality
ST elevation consider lateral injury or acute infarct
*** ** ** ** * ACUTE MI ** ** ** **
ST SEGMENT ELEVATION
ST SEGMENT DEPRESSION
LATERAL - ANTERIOR
DIAG. (LAD) or OM (CIRC).
I
BASILAR SEPTUM
aVR
ANTERIOR - SEPTAL
LAD
V1
ANTERIOR
LAD
V4
INFERIOR
DOMINANT RCA or CIRC.
II
LATERAL - ANTERIOR
DIAG. (LAD) or OM (CIRC).
aVL
ANTERIOR - SEPTAL
LAD
V2
LATERAL
CIRC. or LAD
V5
INFERIOR
DOMINANT RCA or CIRC.
III
INFERIOR
DOMINANT RCA or CIRC.
aVF
ANTERIOR
LAD
V3
LATERAL
CIRC. or LAD
V6



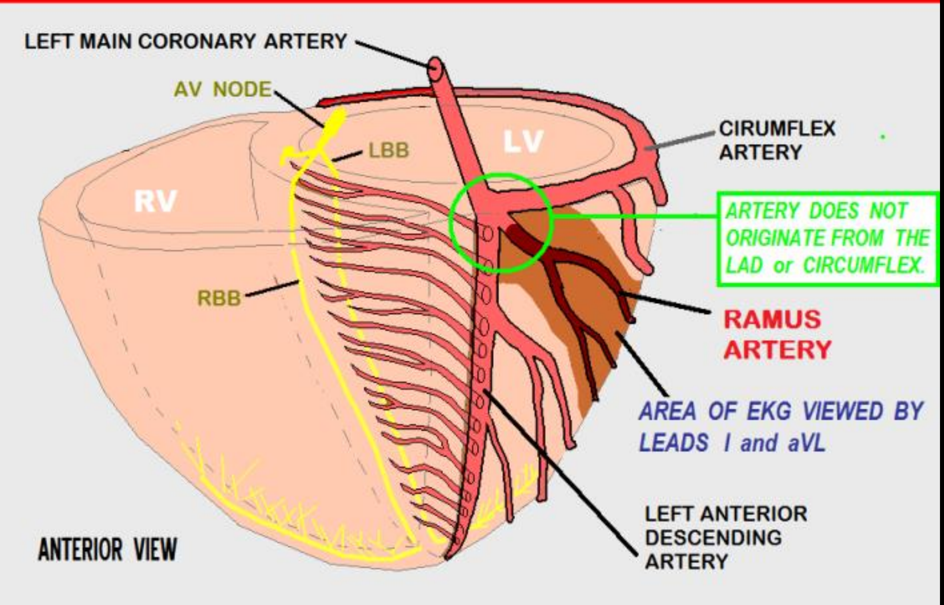
LEADS I and aVL view the ANTERIOR-LATERAL JUNCTION



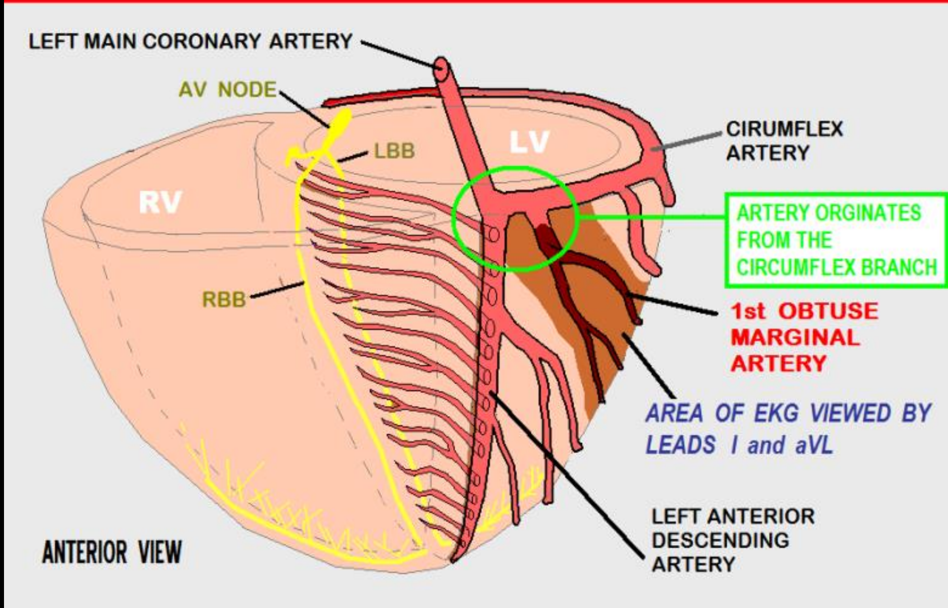
OCCLUSION of DIAGONAL ARTERY



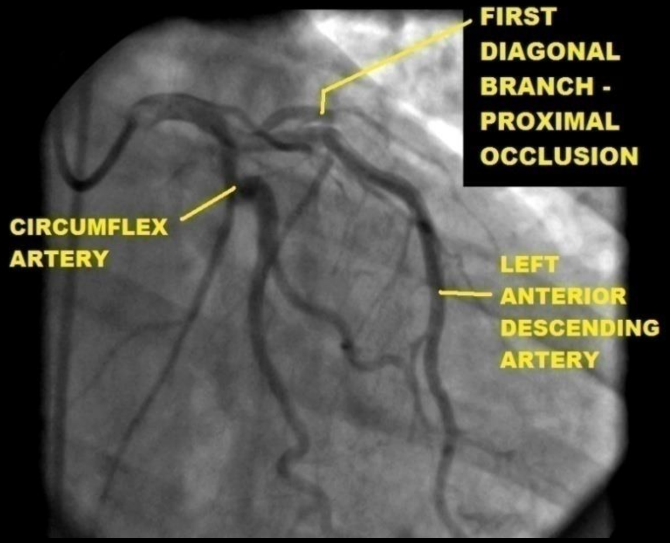
OCCLUSION of RAMUS ARTERY

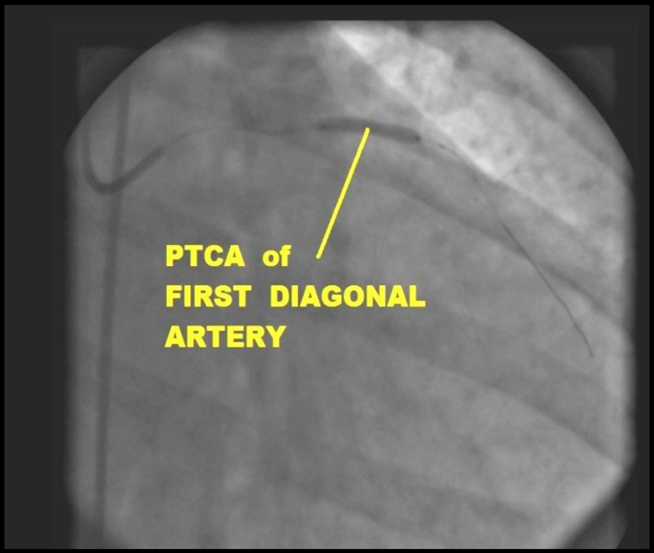


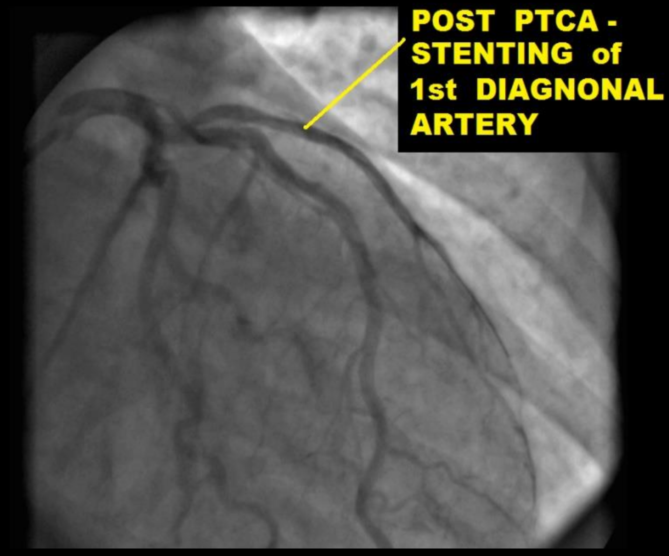
OCCLUSION of OBTUSE MARGINAL ARTERY

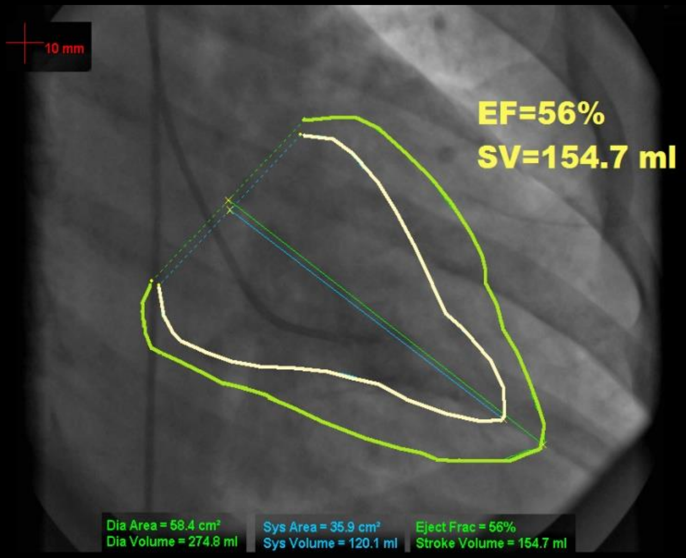


CASE PROGRESSION: As the patient was being prepared for transport to the Cardiac Cath Lab, she experienced an episode of Ventricular Fibrillation.









11111 11
Born 1/ 1941 77 Years

[redacted]
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 al

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

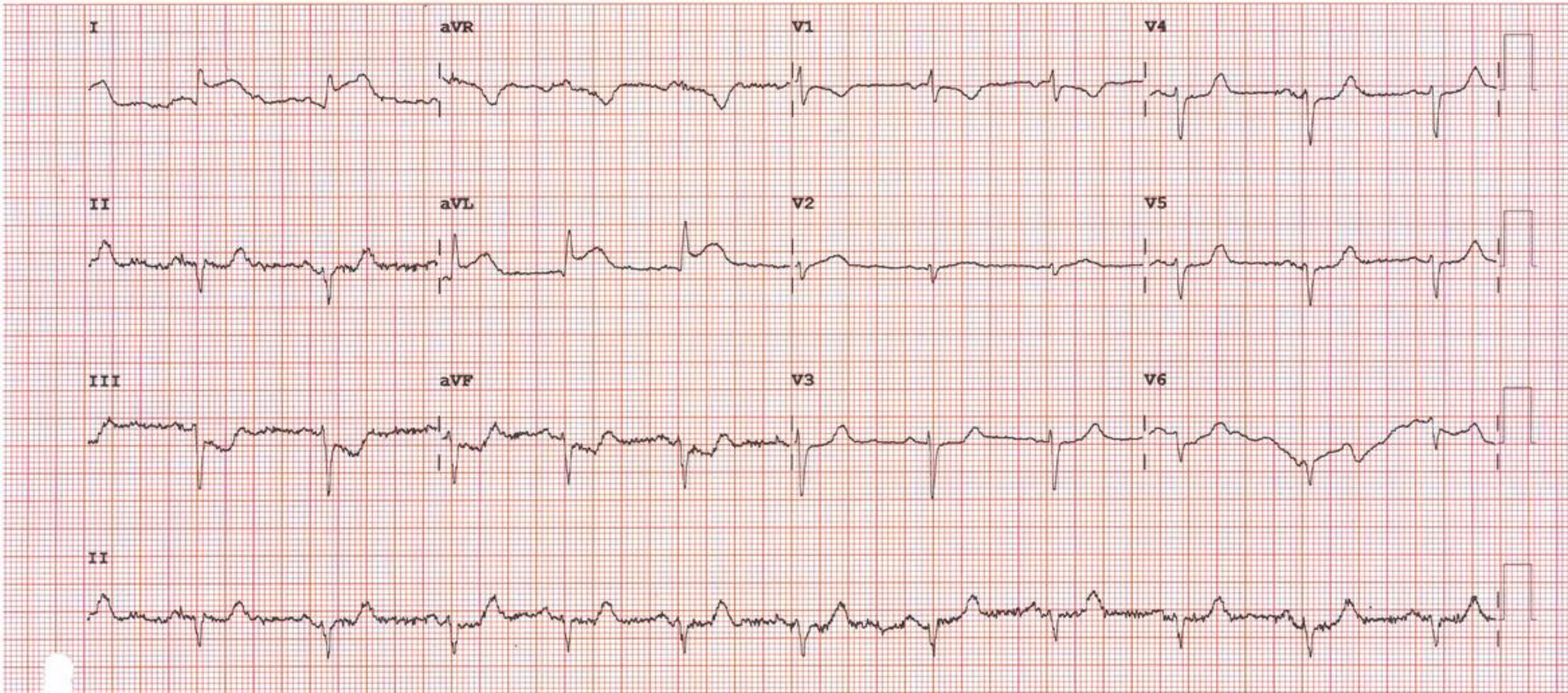
--AXIS--
P 56
QRS -51
T -7

- ABNORMAL ECG -

12 Lead; Standard Placement

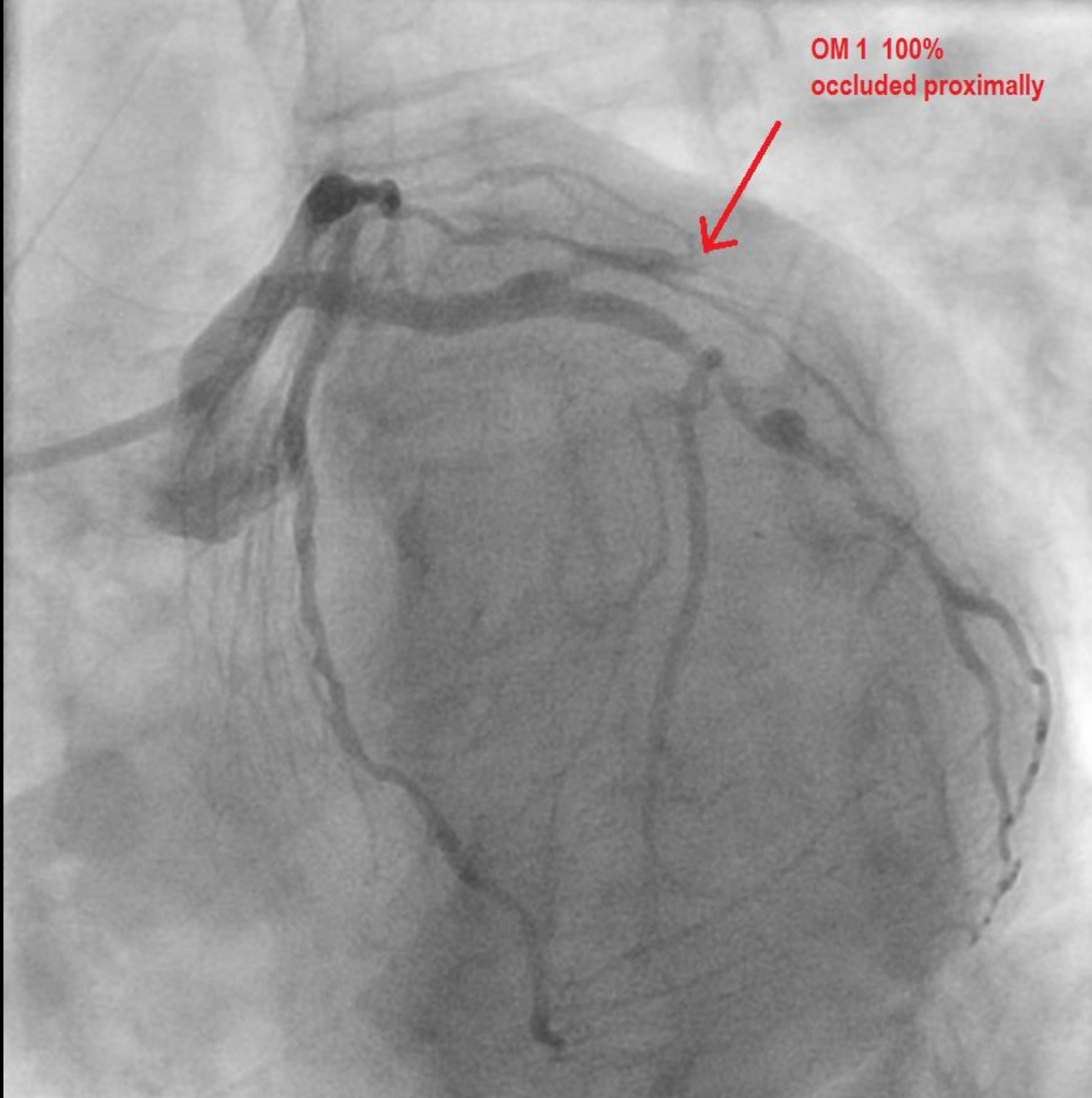
Unconfirmed Diagnosis

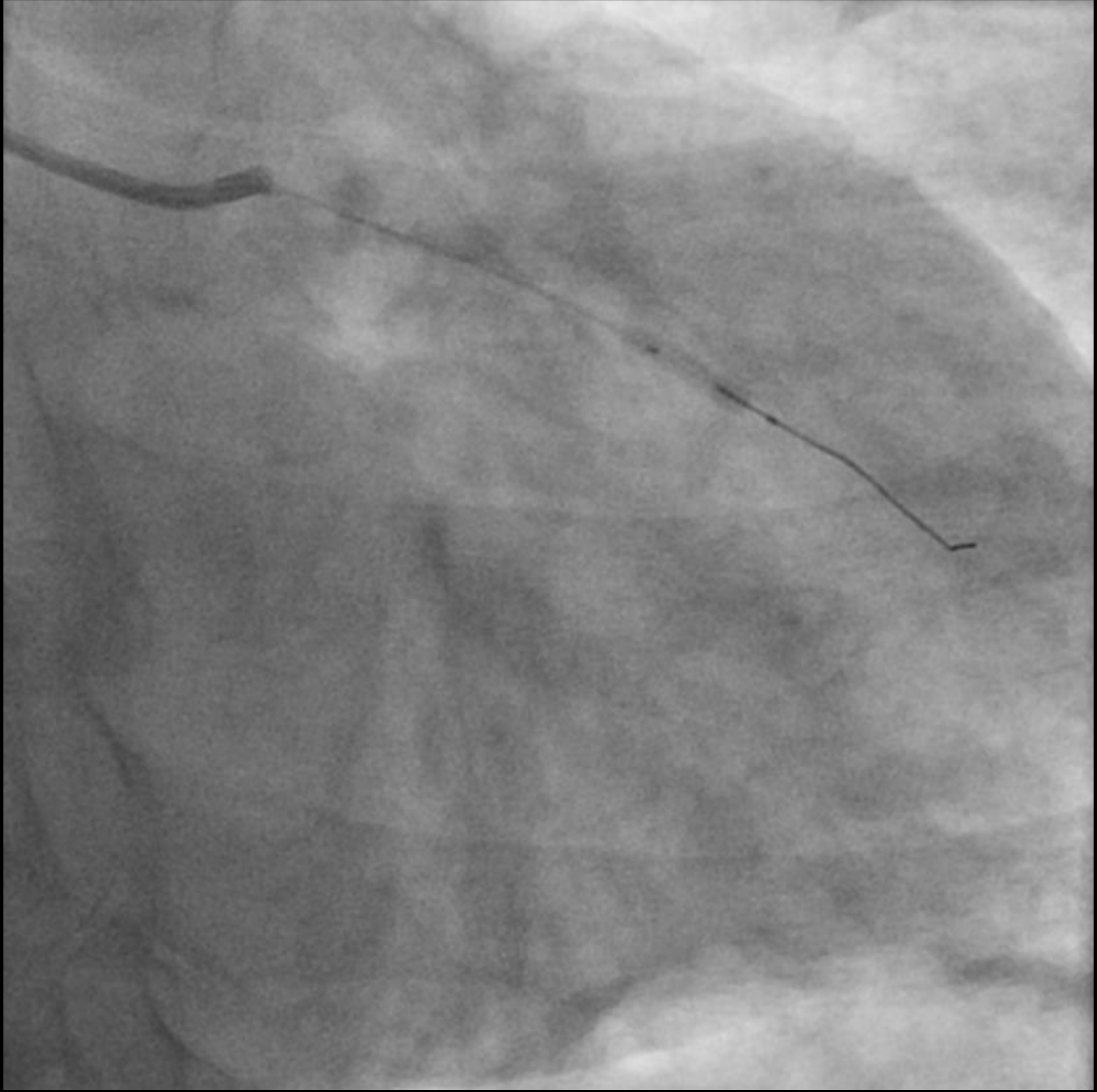
Physician
Date [redacted]
Time 1331
STEMI YES NO

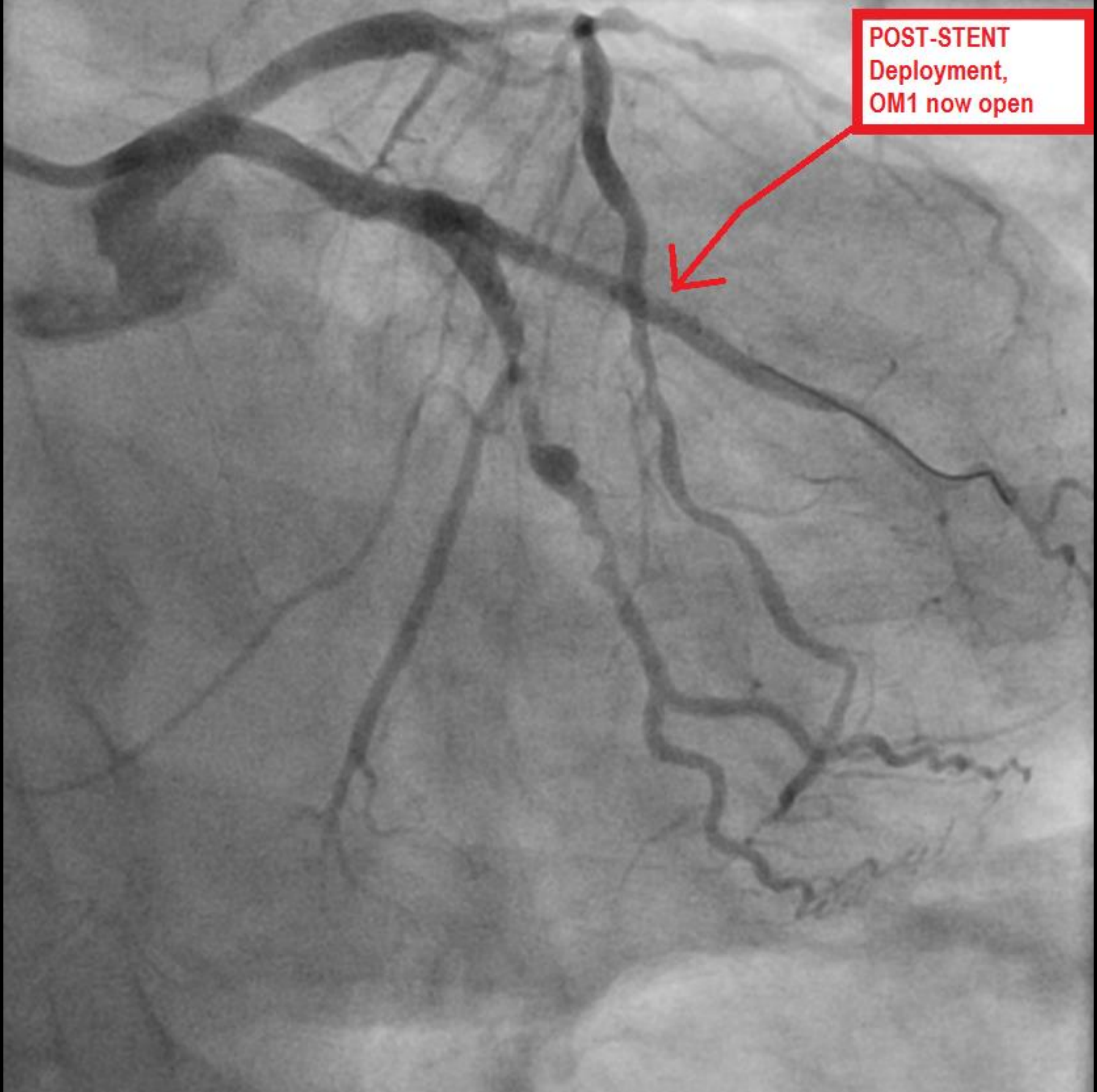


Device: Speed: 25 mm/sec Limb: 10 mm/mV Chest: 10.0 mm/mV F 60~ 0.15-100 Hz PH090A L P?

COVIDIEN Kendall REF 30768678


OM 1 100%
occluded proximally




POST-STENT
Deployment,
OM1 now open

CASE STUDY 3: STEMI

CHIEF COMPLAINT and SIGNIFICANT HISTORY:

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

RISK FACTOR PROFILE:

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

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

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

LABS: INITIAL CARDIAC MARKERS - NEGATIVE

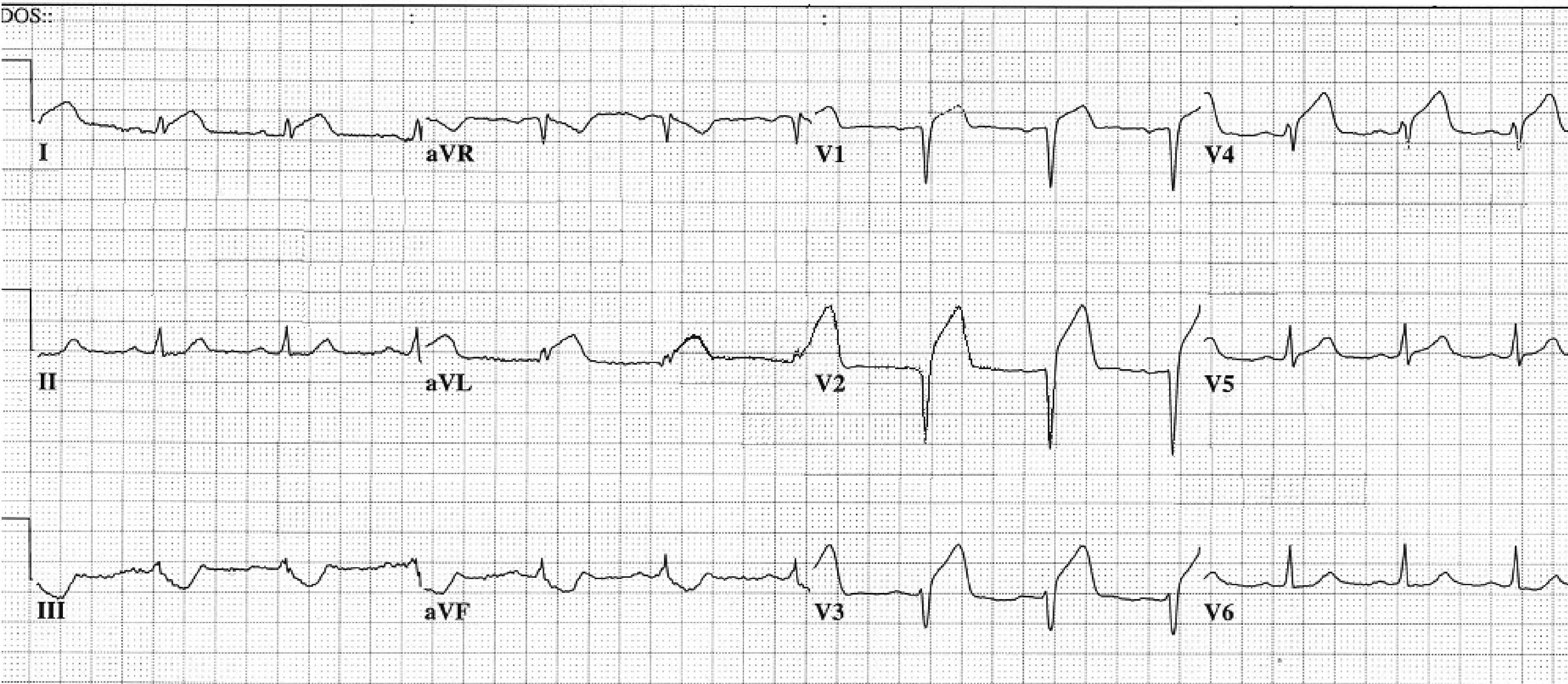
29 yr
Male Caucasian

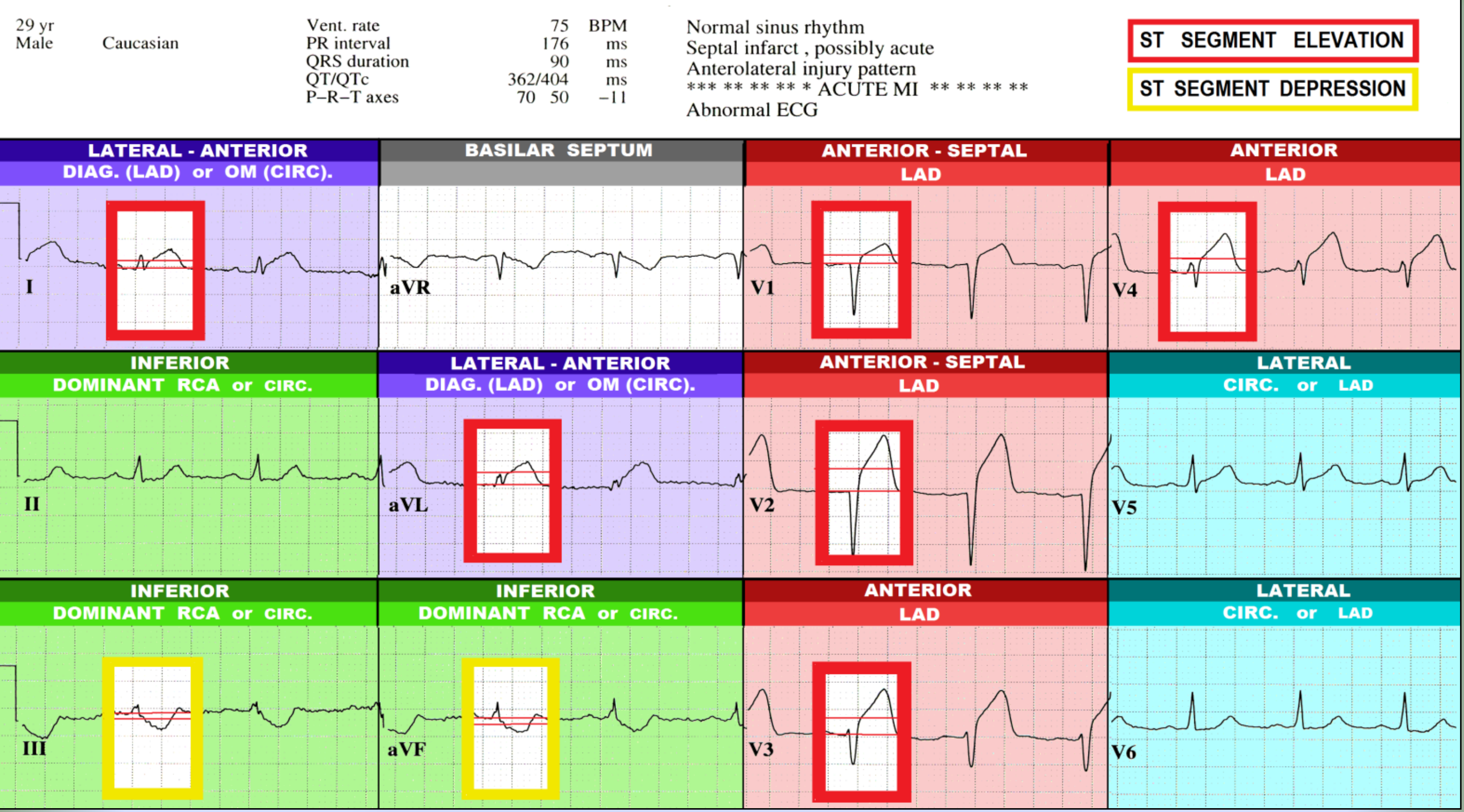
Loc:3 Option:20

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

EVALUATE the EKG for signs of ACS:

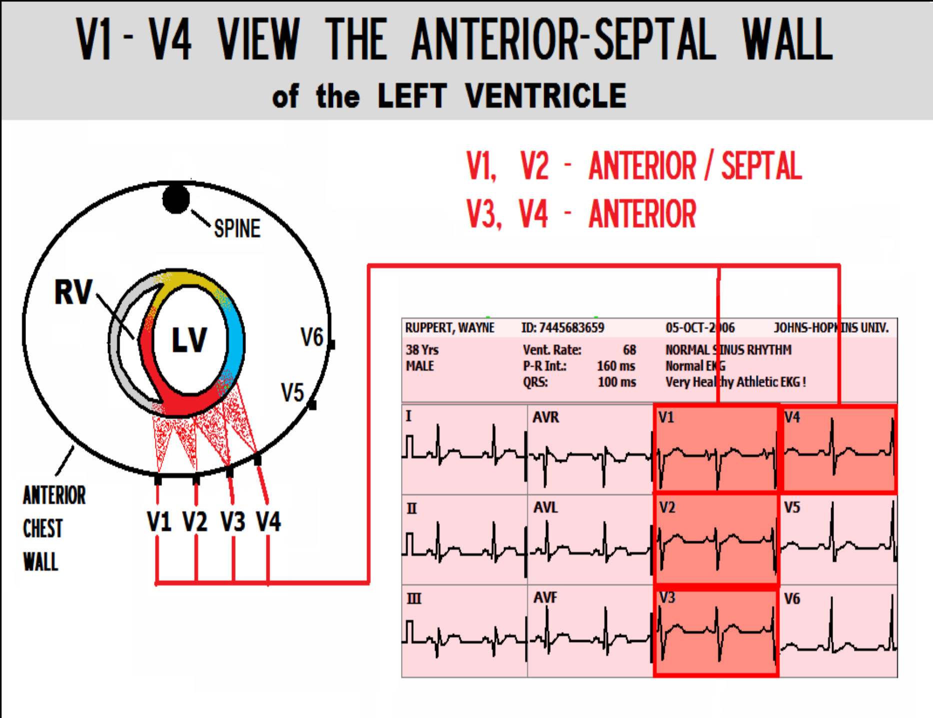
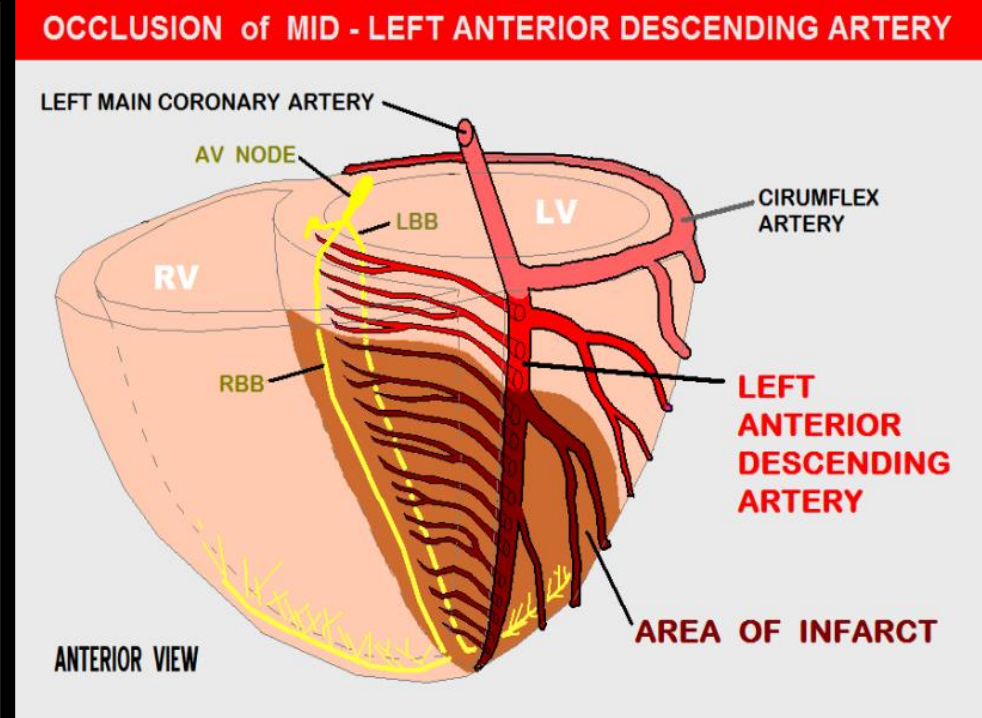
- ST SEGMENT ELEVATION / DEPRESSION
- HYPERACUTE T WAVES
- CONVEX / FLAT ST SEGMENTS
- OTHER ST - T WAVE ABNORMALITIES



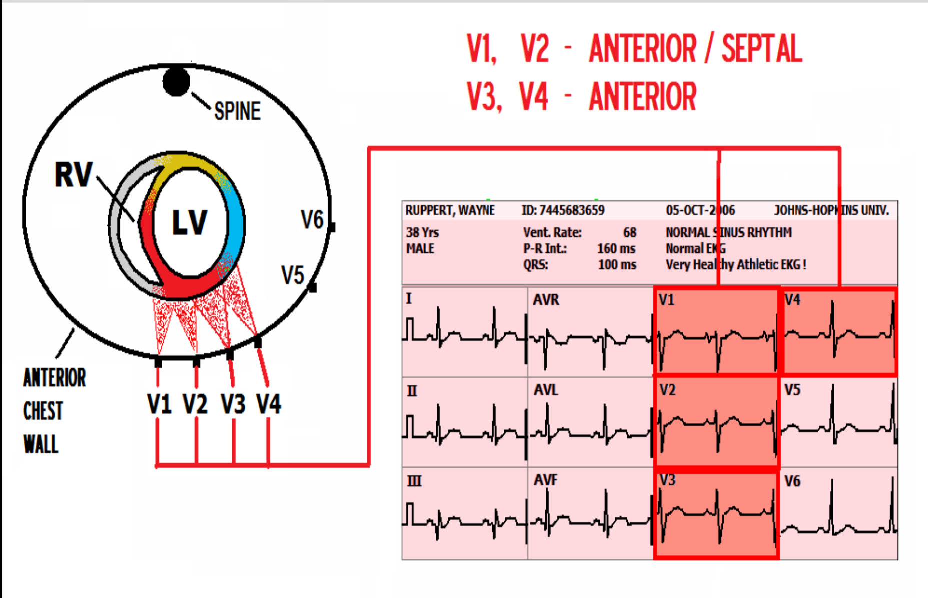


29 yr
Male
Caucasian
Vent. rate 75 BPM
PR interval 176 ms
QRS duration 90 ms
QT/QTc 362/404 ms
P-R-T axes 70 50 -11
Normal sinus rhythm
Septal infarct , possibly acute
Anterolateral injury pattern
*** ** ** ** * ACUTE MI ** ** ** **
Abnormal ECG
ST SEGMENT ELEVATION
ST SEGMENT DEPRESSION
LATERAL - ANTERIOR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

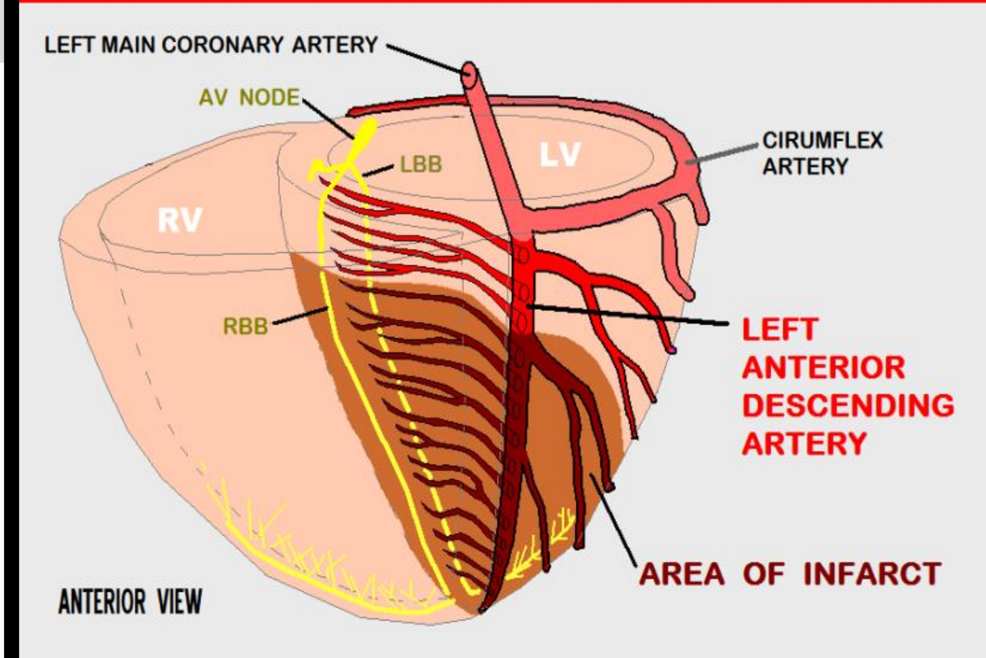
- **Reciprocal ST Depression is NOW PRESENT**
- **Additional ST Elevation is present in Leads I, AVL**


V1 - V4 VIEW THE ANTERIOR-SEPTAL WALL
of the LEFT VENTRICLE
V1, V2 - ANTERIOR / SEPTAL
V3, V4 - ANTERIOR
SPINE
RV
LV
V6
V5
ANTERIOR CHEST WALL
V1 V2 V3 V4
RUPPERT, WAYNE
ID: 7445683659
05-OCT-2006
JOHNS-HOPKINS UNIV.
38 Yrs
MALE
Vent. Rate: 68
P-R Int.: 160 ms
QRS: 100 ms
NORMAL SINUS RHYTHM
Normal EKG
Very Healthy Athletic EKG !
I
AVR
V1
V4
II
AVL
V2
V5
III
AVF
V3
V6

OCCLUSION of MID - LEFT ANTERIOR DESCENDING ARTERY
LEFT MAIN CORONARY ARTERY
AV NODE
LBB
LV
CIRUMFLEX ARTERY
RV
RBB
LEFT ANTERIOR DESCENDING ARTERY
AREA OF INFARCT
ANTERIOR VIEW

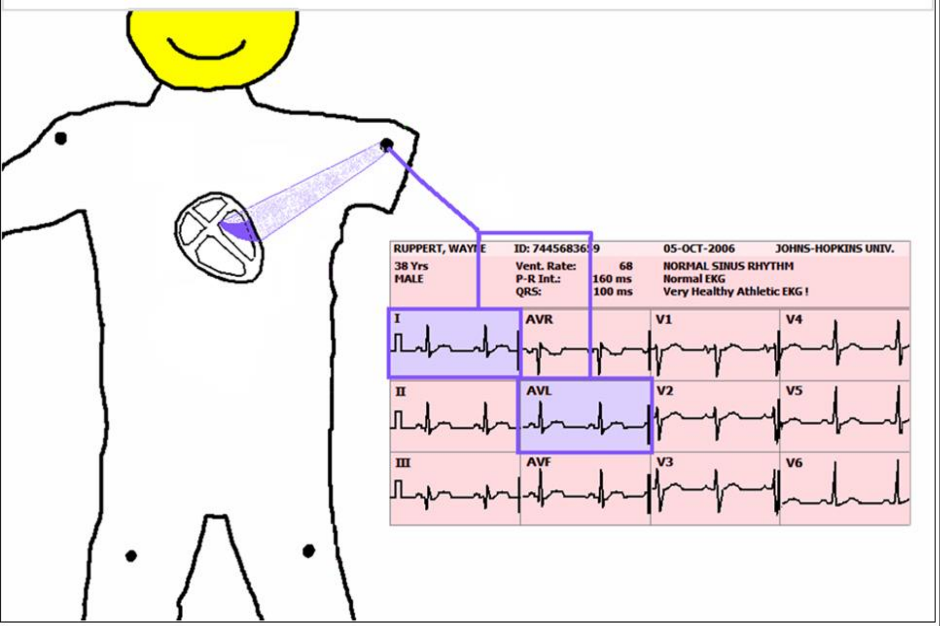
V1 - V4 VIEW THE ANTERIOR-SEPTAL WALL of the LEFT VENTRICLE



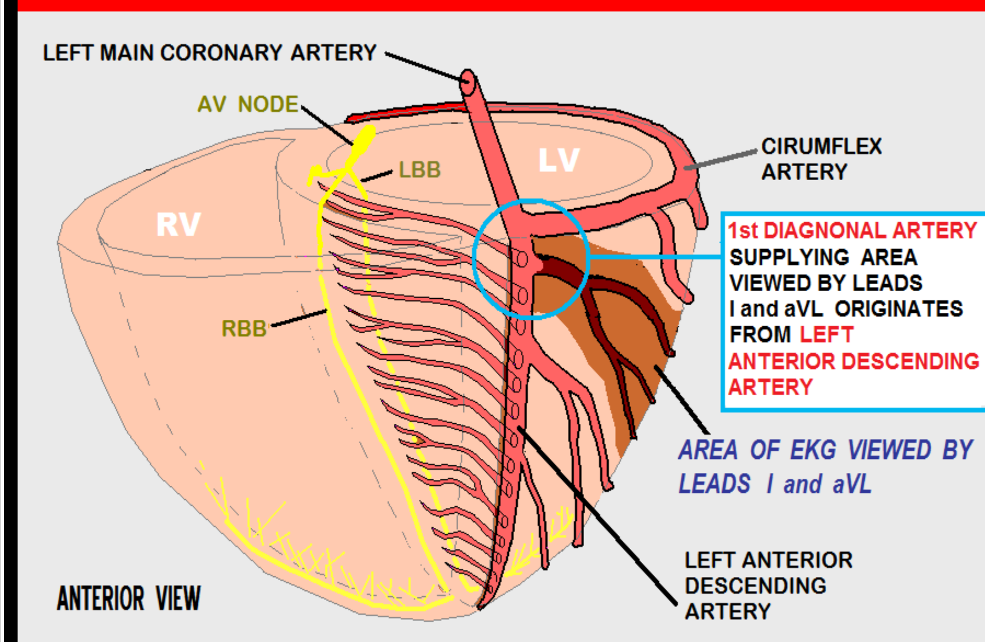
OCCLUSION of MID - LEFT ANTERIOR DESCENDING ARTERY

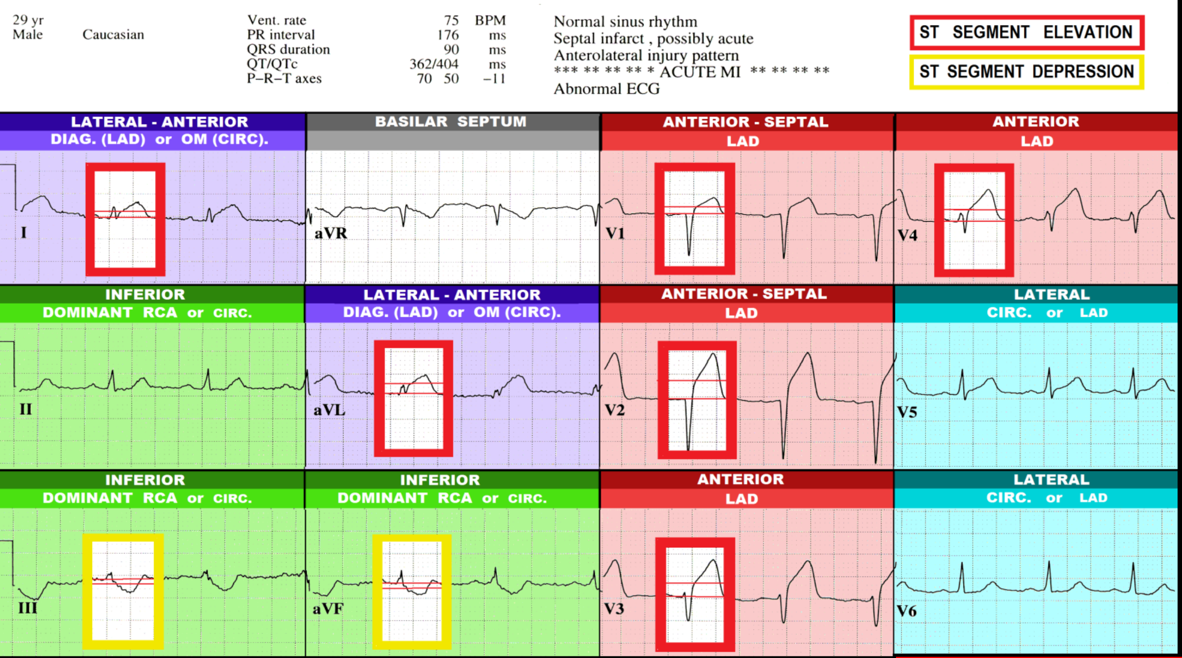


Leads I & AVL view the ANTERIOR-LATERAL JUNCTION

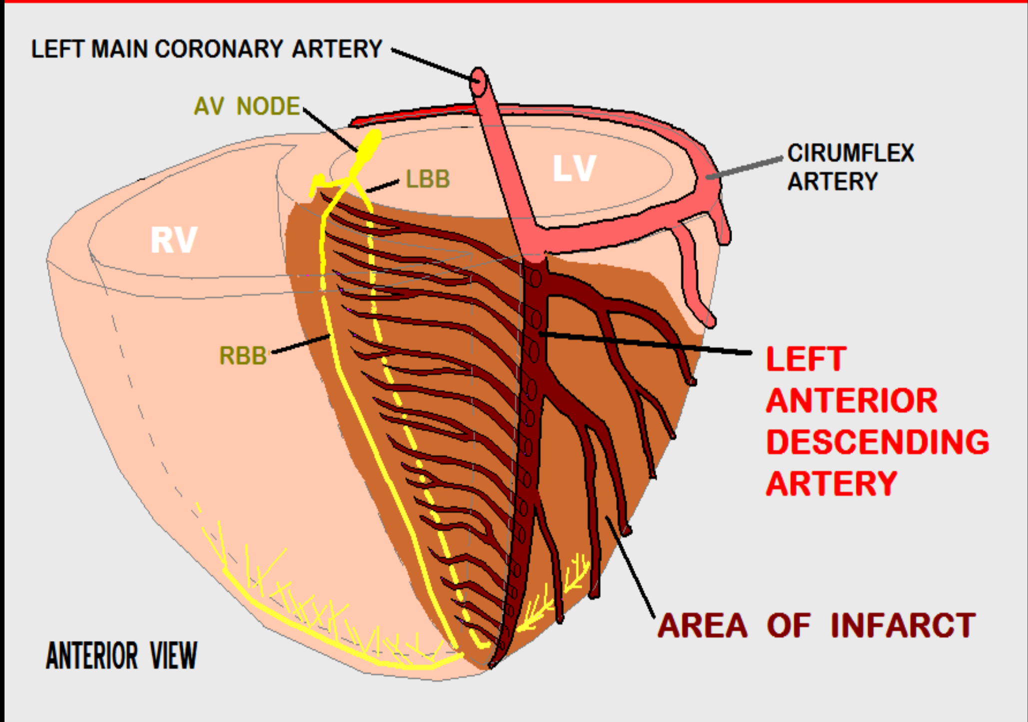


OCCLUSION of DIAGONAL ARTERY

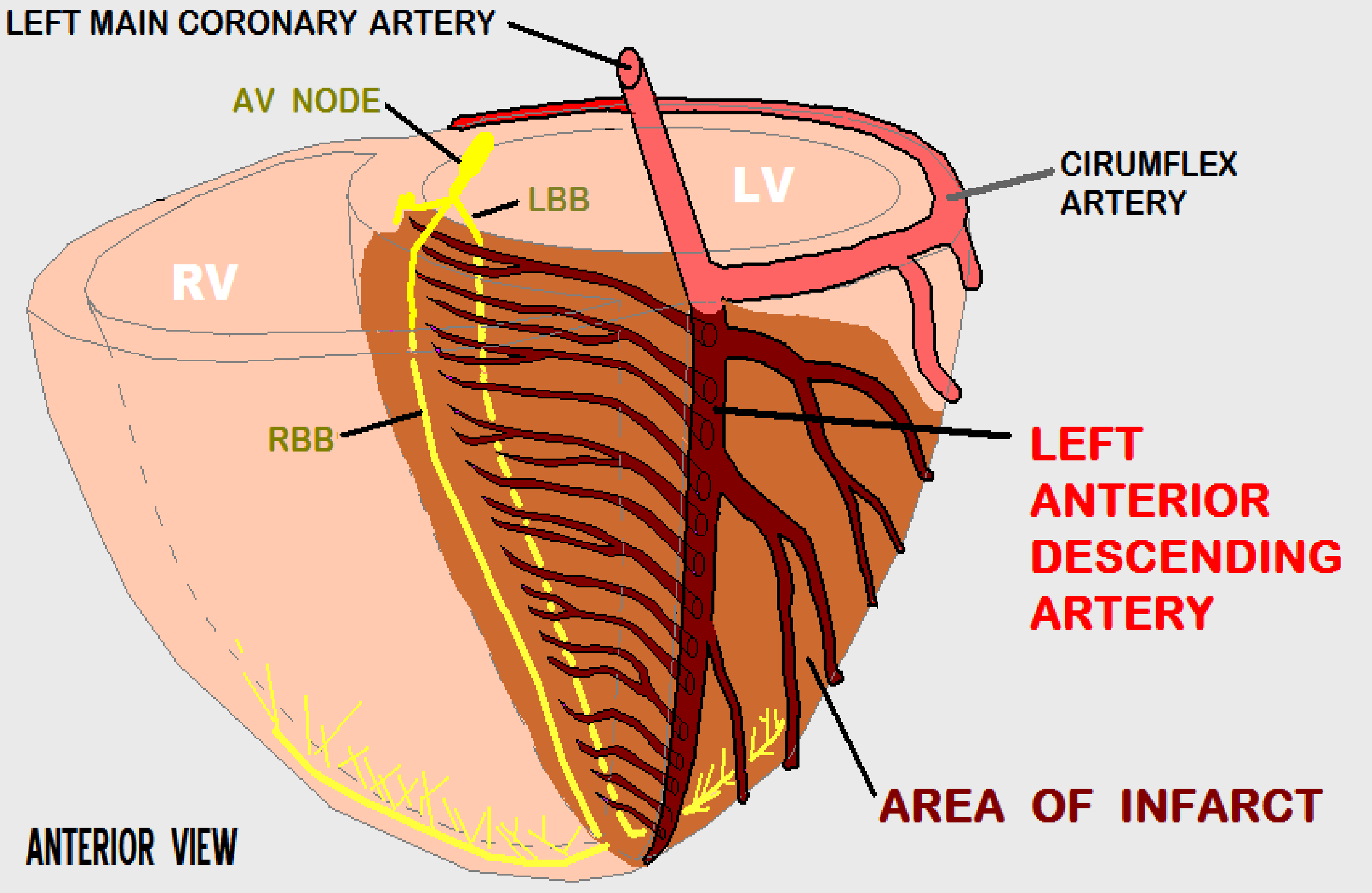




OCCLUSION of PROXIMAL LEFT ANTERIOR DESCENDING ARTERY



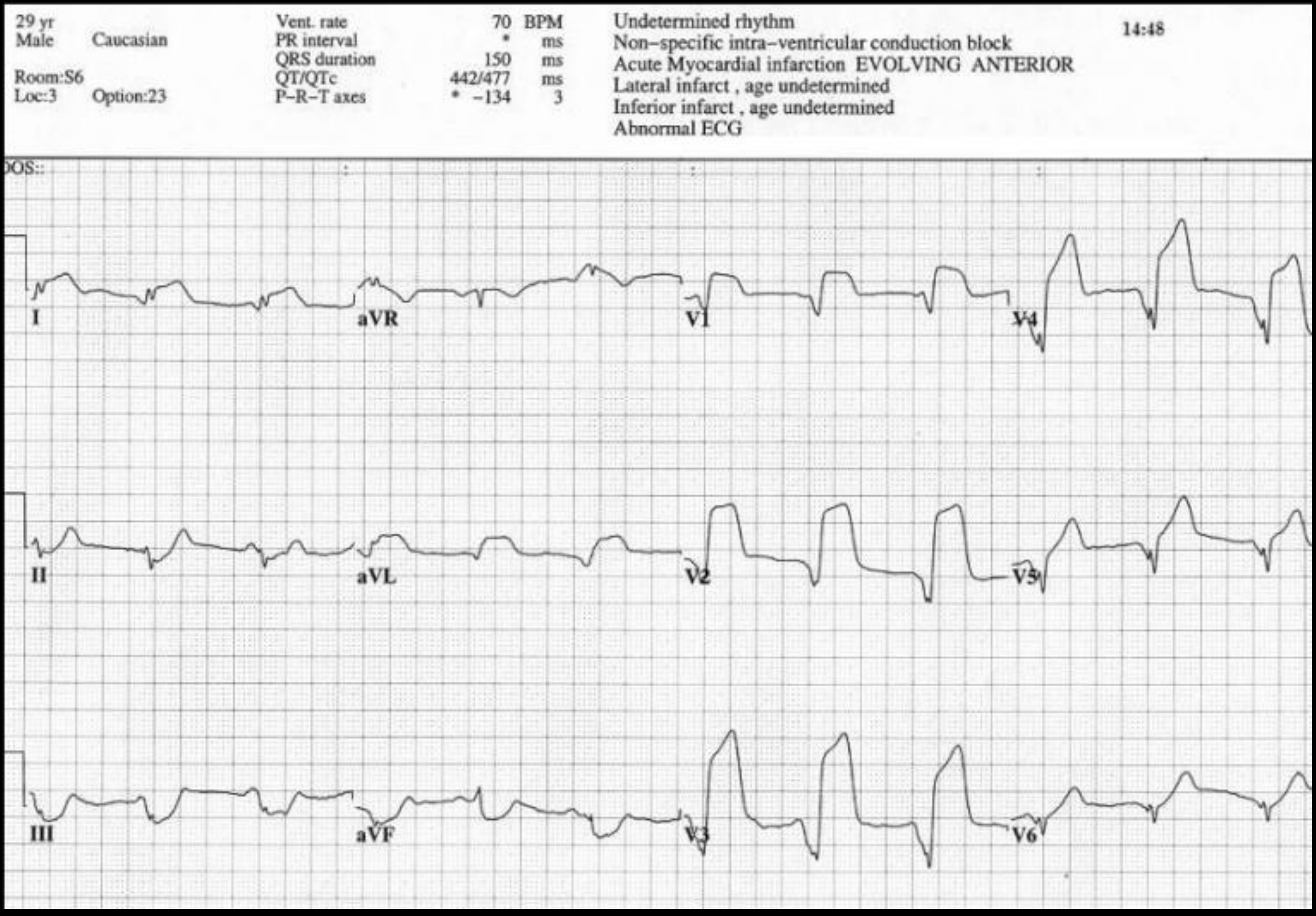
OCCLUSION of PROXIMAL LEFT ANTERIOR DESCENDING ARTERY

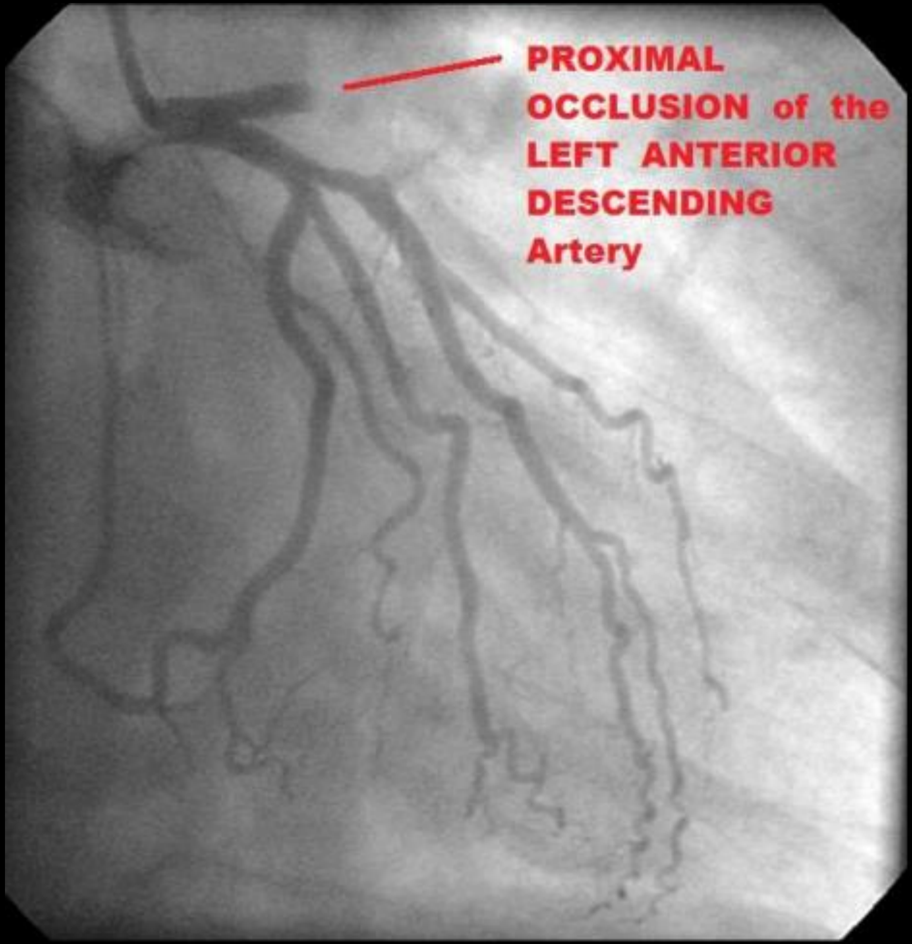


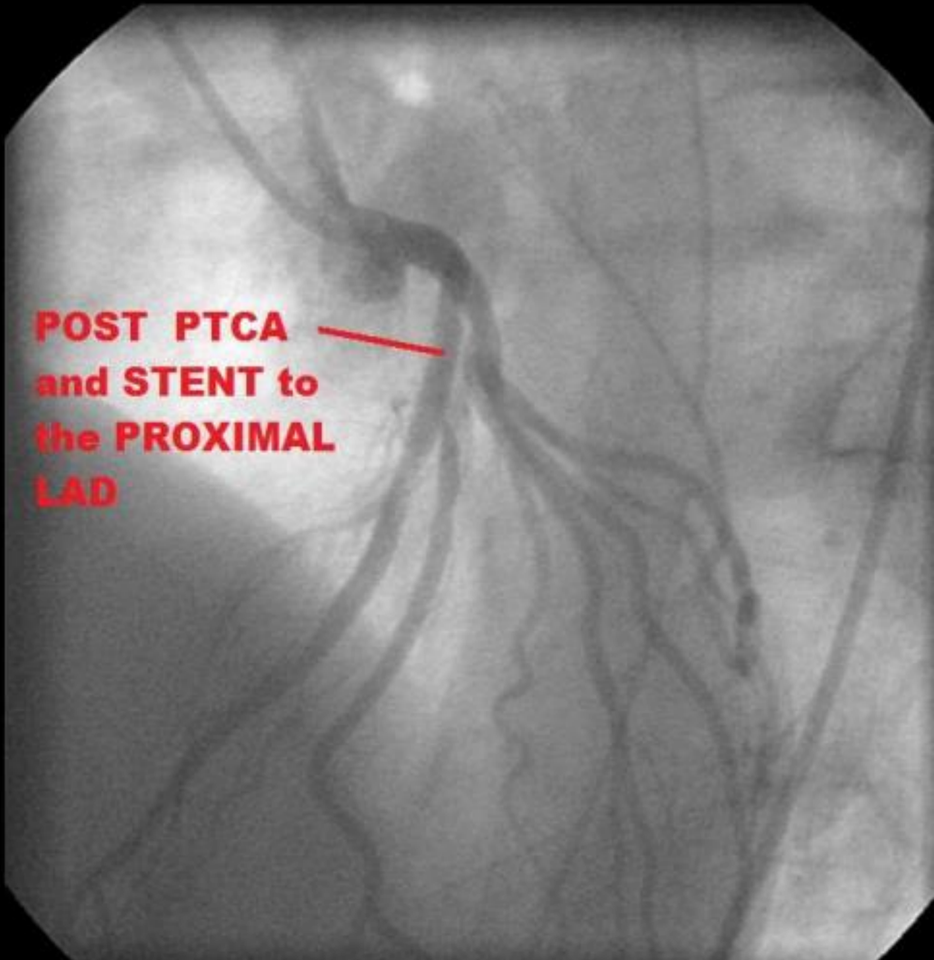
ANTICIPATED COMPLICATIONS of ANTERIOR-SEPTAL WALL STEMI & POSSIBLE INDICATED INTERVENTIONS:	
- CARDIAC ARREST	BCLS / ACLS
- CARDIAC DYSRHYTHMIAS (VT / VF)	ACLS (antiarrhythmics)
- PUMP FAILURE with CARDIOGENIC SHOCK	INOTROPE THERAPY: -DOPAMINE / DOBUTAMINE / LEVOPHED - INTRA-AORTIC BALLOON PUMP (use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

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

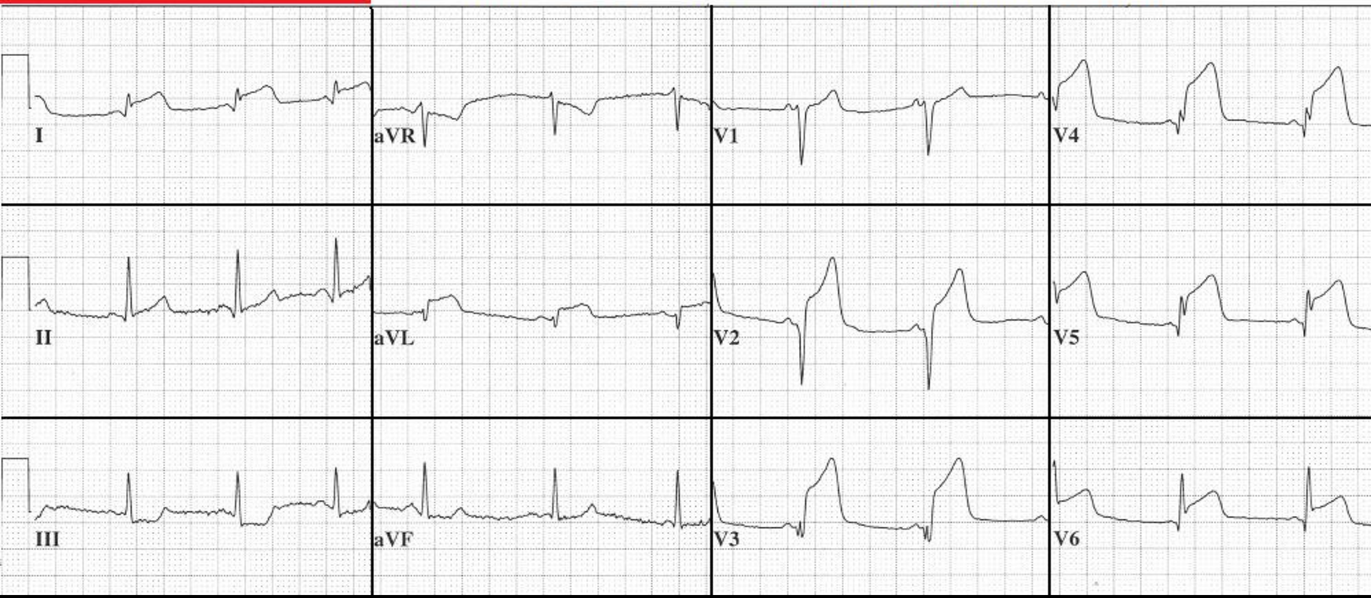
-WHAT THERAPEUTIC INTERVENTIONS SHOULD BE IMPLMENTED AT THIS POINT ?



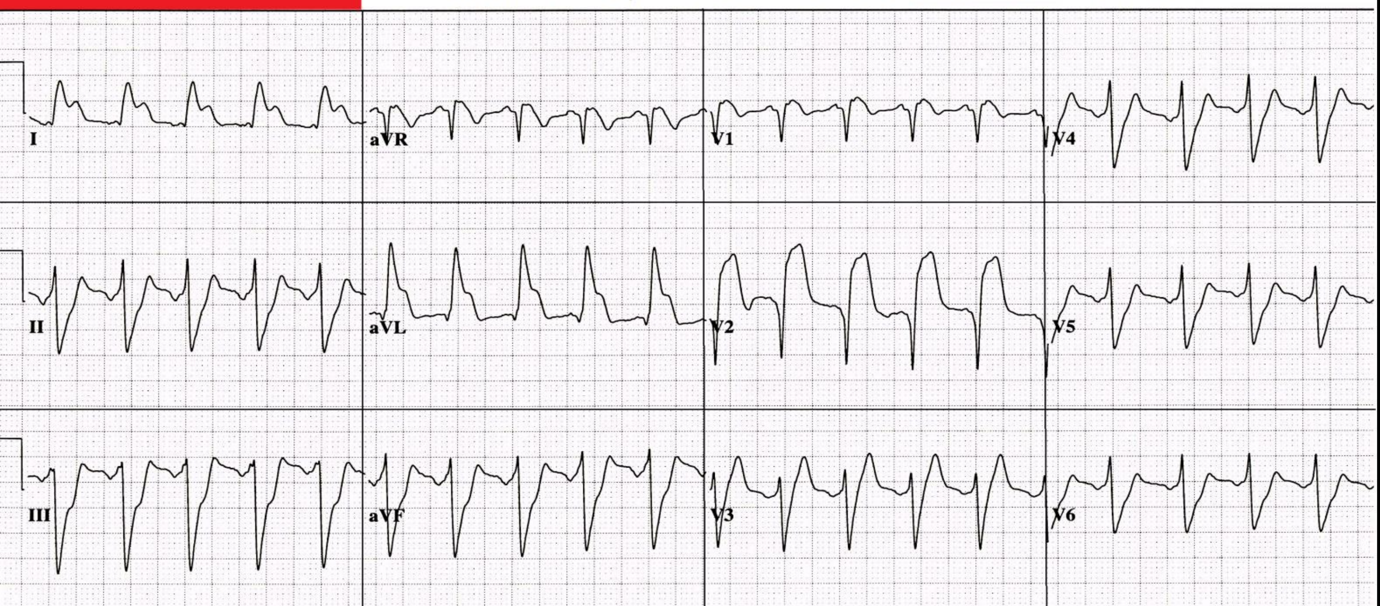

PROXIMAL OCCLUSION of the LEFT ANTERIOR DESCENDING Artery


POST PTCA and STENT to the PROXIMAL LAD

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

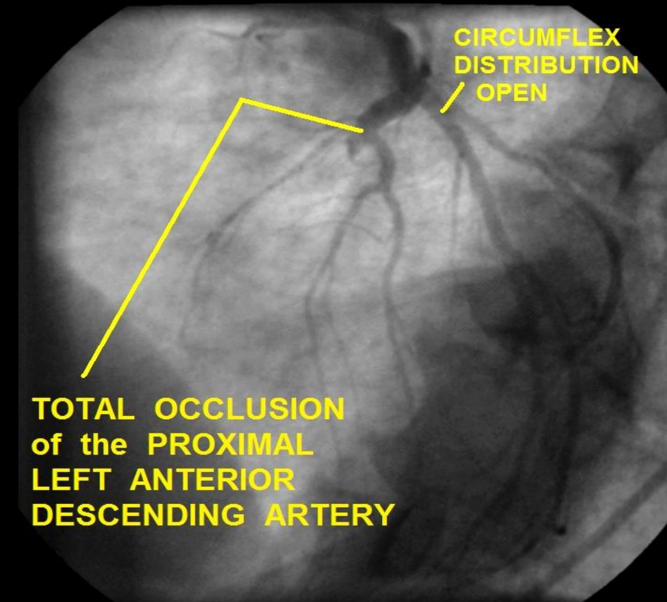


WHO SHOULD GO TO THE CATH LAB FIRST ?

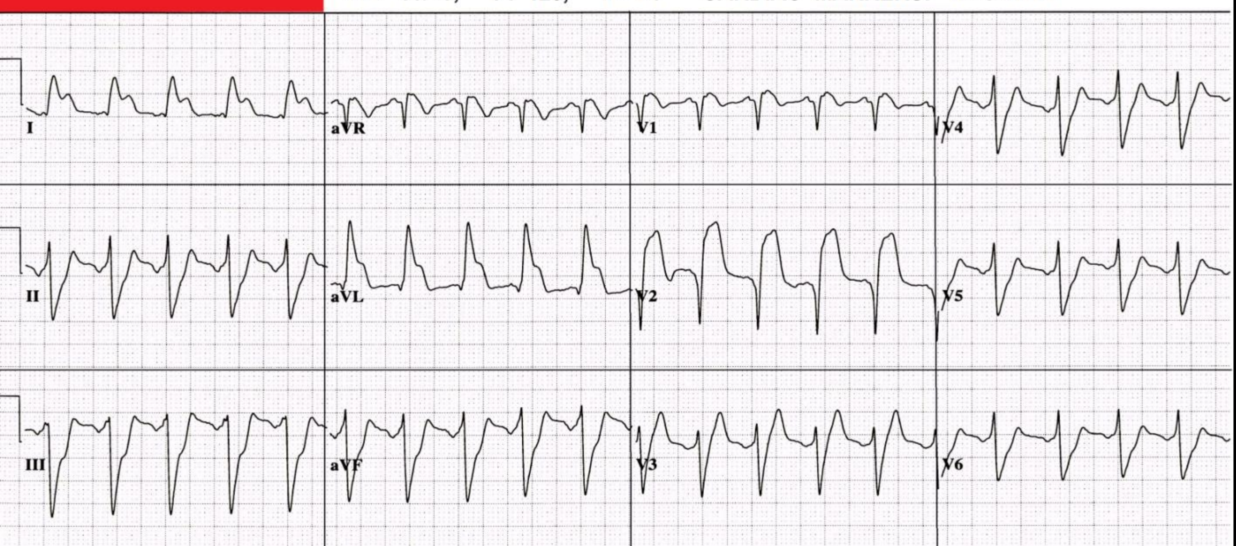
And . . . .

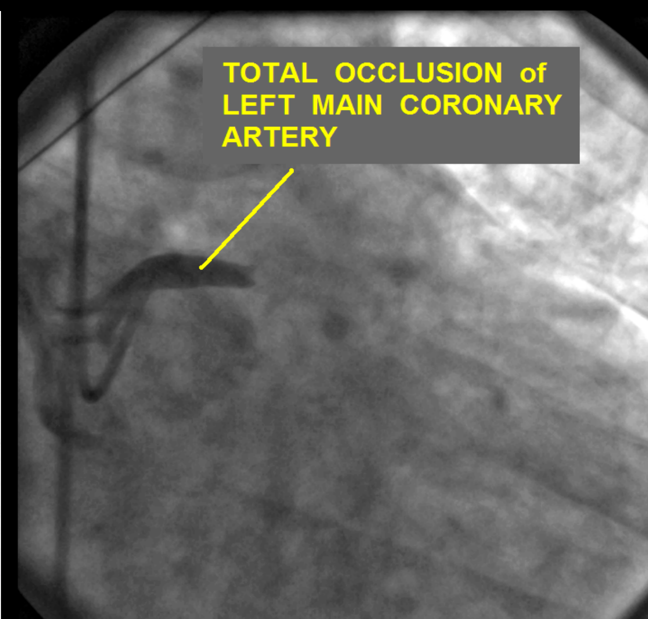
WHAT WOULD YOU DO WITH THE PATIENT WHO DID NOT GO TO THE CATH LAB ?

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

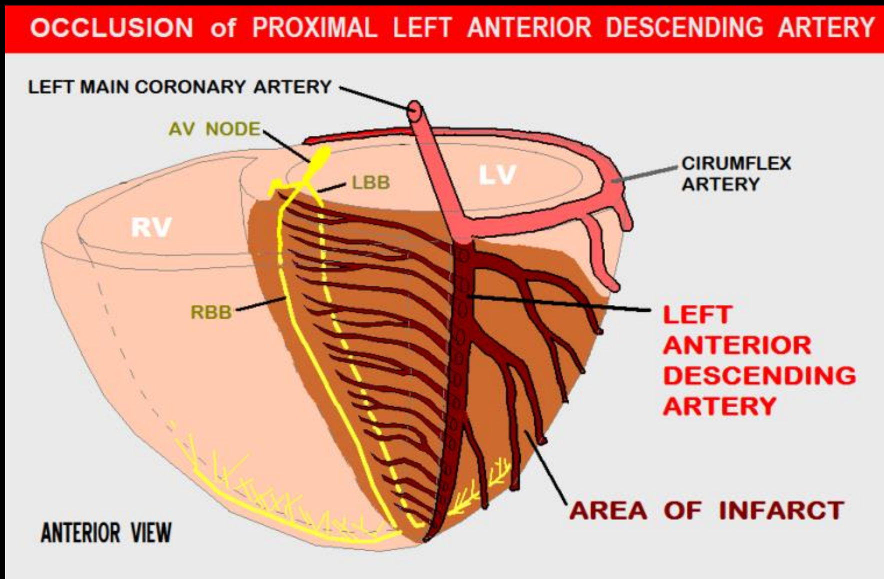


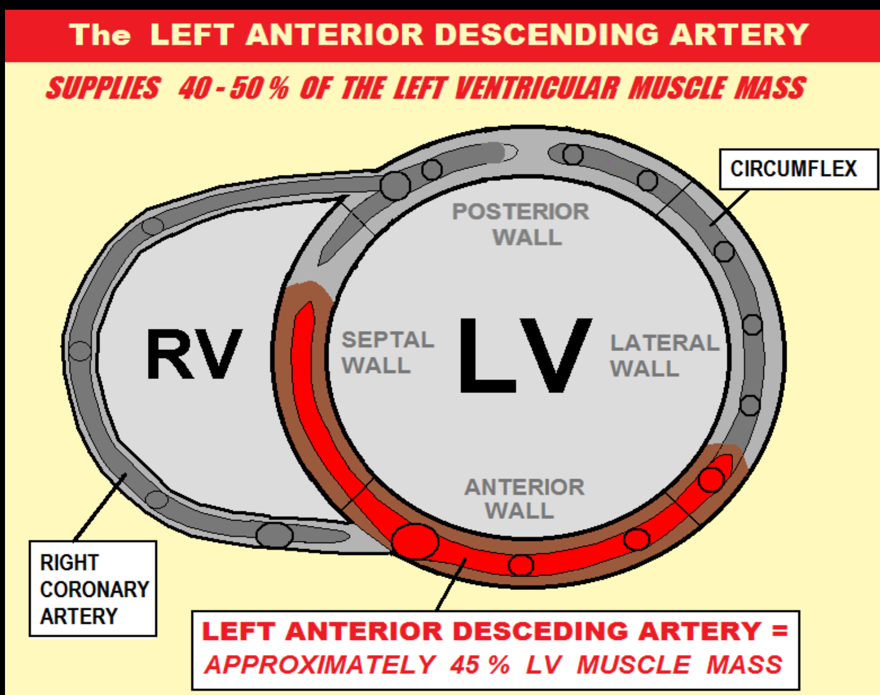
PATIENT B: 36 y/o MALE, CHEST PAIN x 1 HOUR,
BP: 80/48, P: 120, R: 28 CARDIAC MARKERS: NEGATIVE



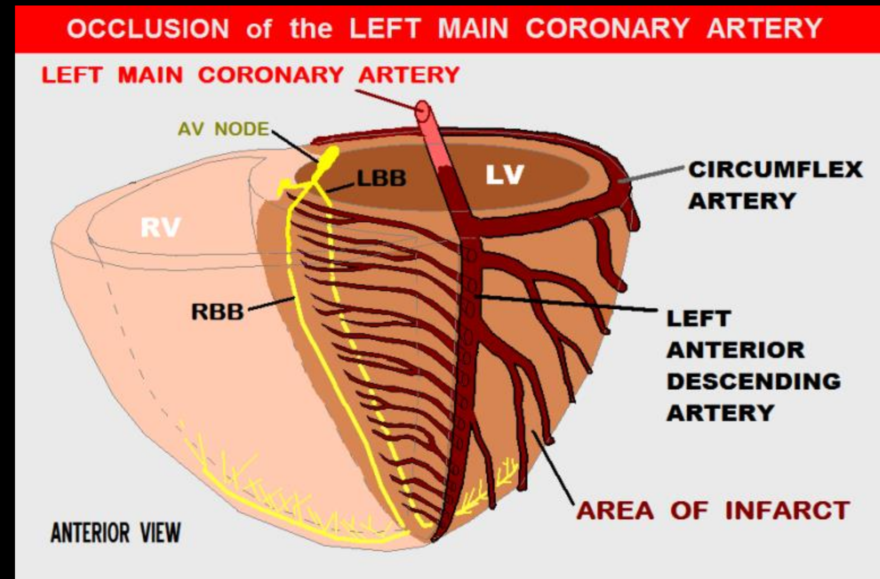


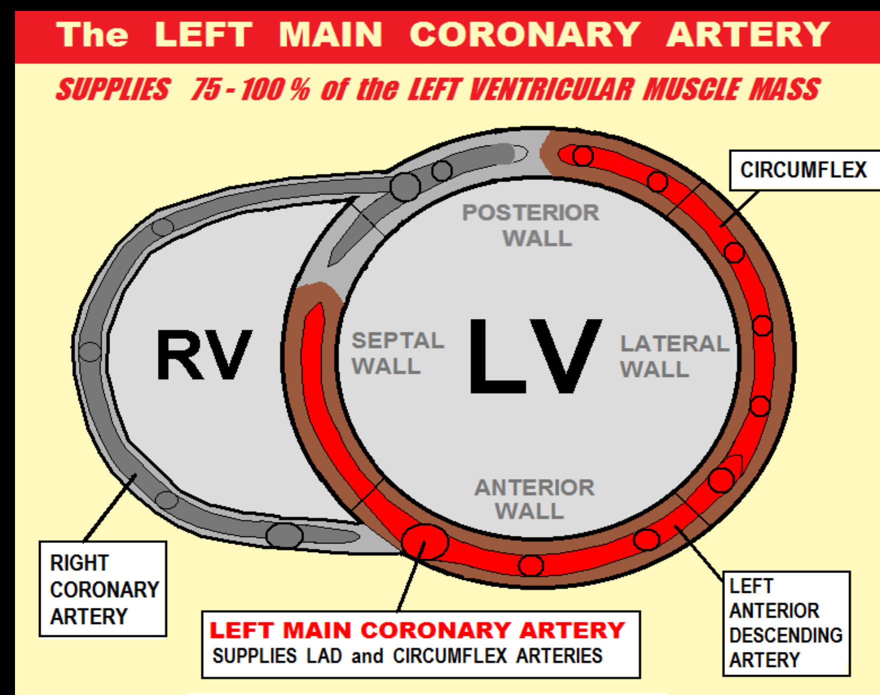
PATIENT A:





PATIENT B:

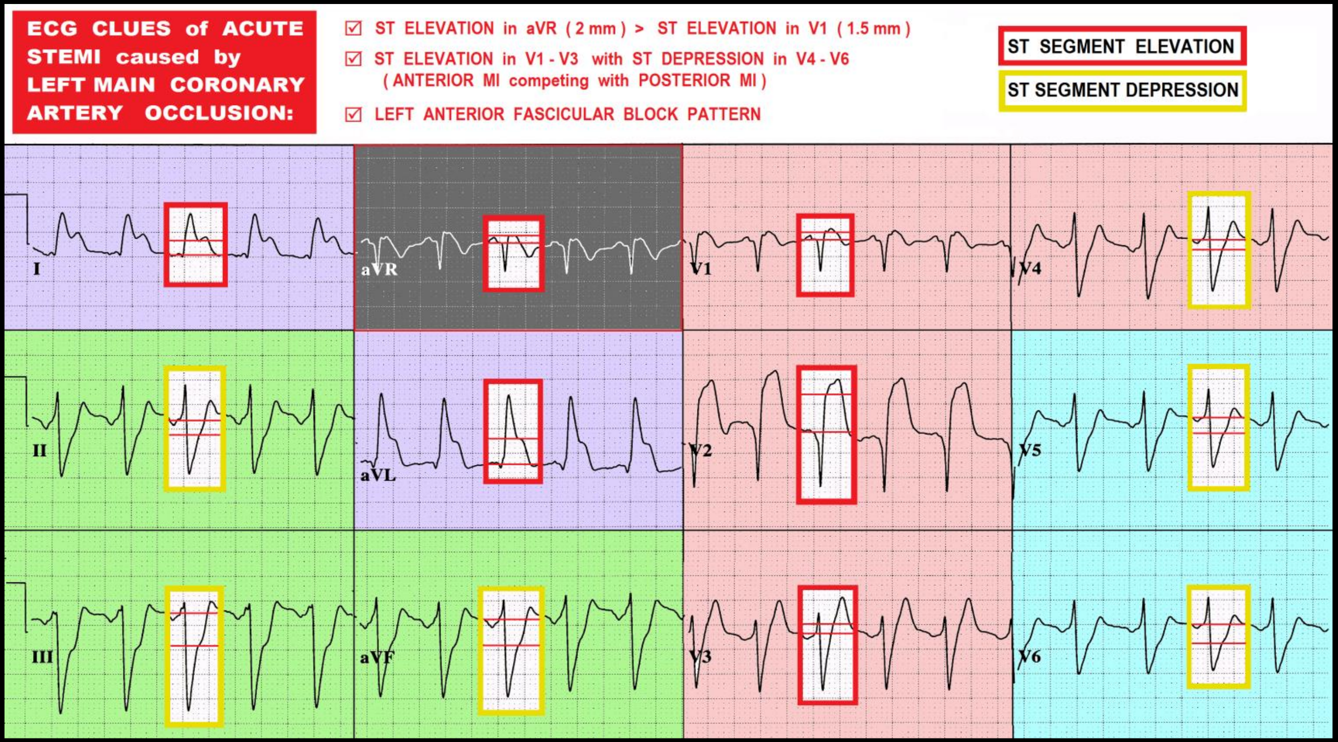




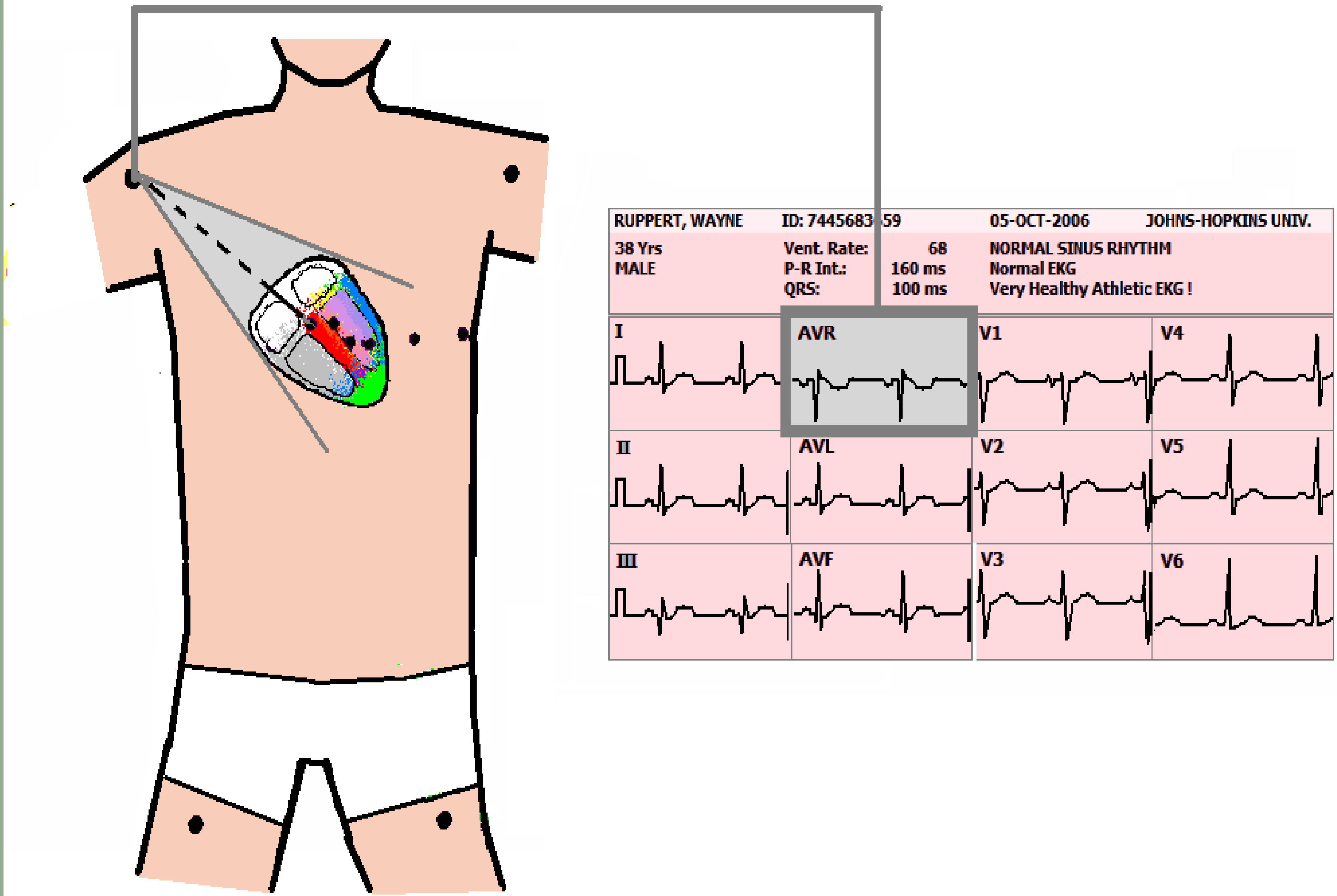
ECG Clues . . . for IDENTIFYING STEMI CAUSED BY LEFT MAIN CORONARY ARTERY occlusion:

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

* Kurisu et al, HEART 2004, SEPTEMBER: 90 (9): 1059-1060
+ Yamaji et al, JACC vol. 38, No. 5, 2001, November 1, 2001:1348-54

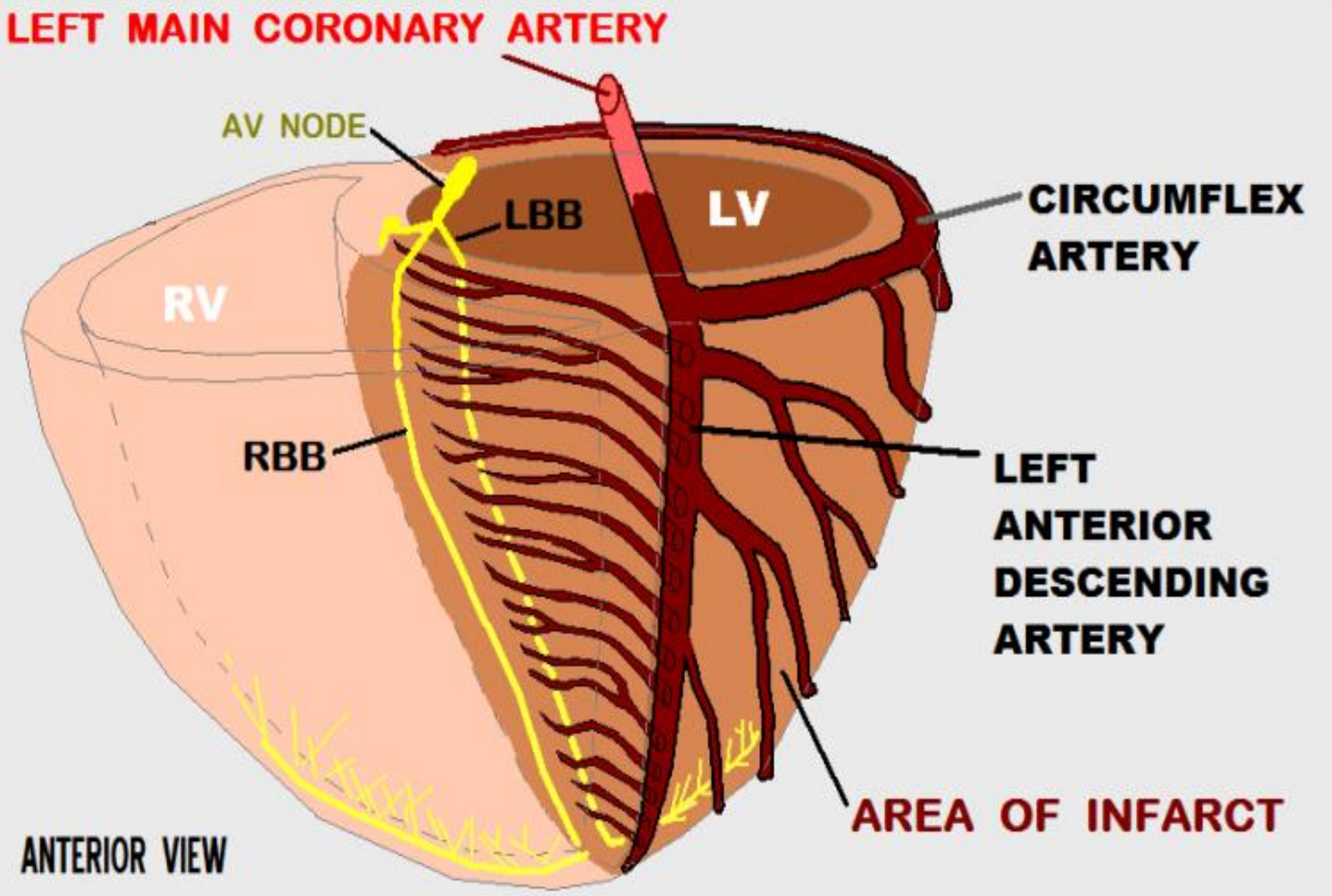


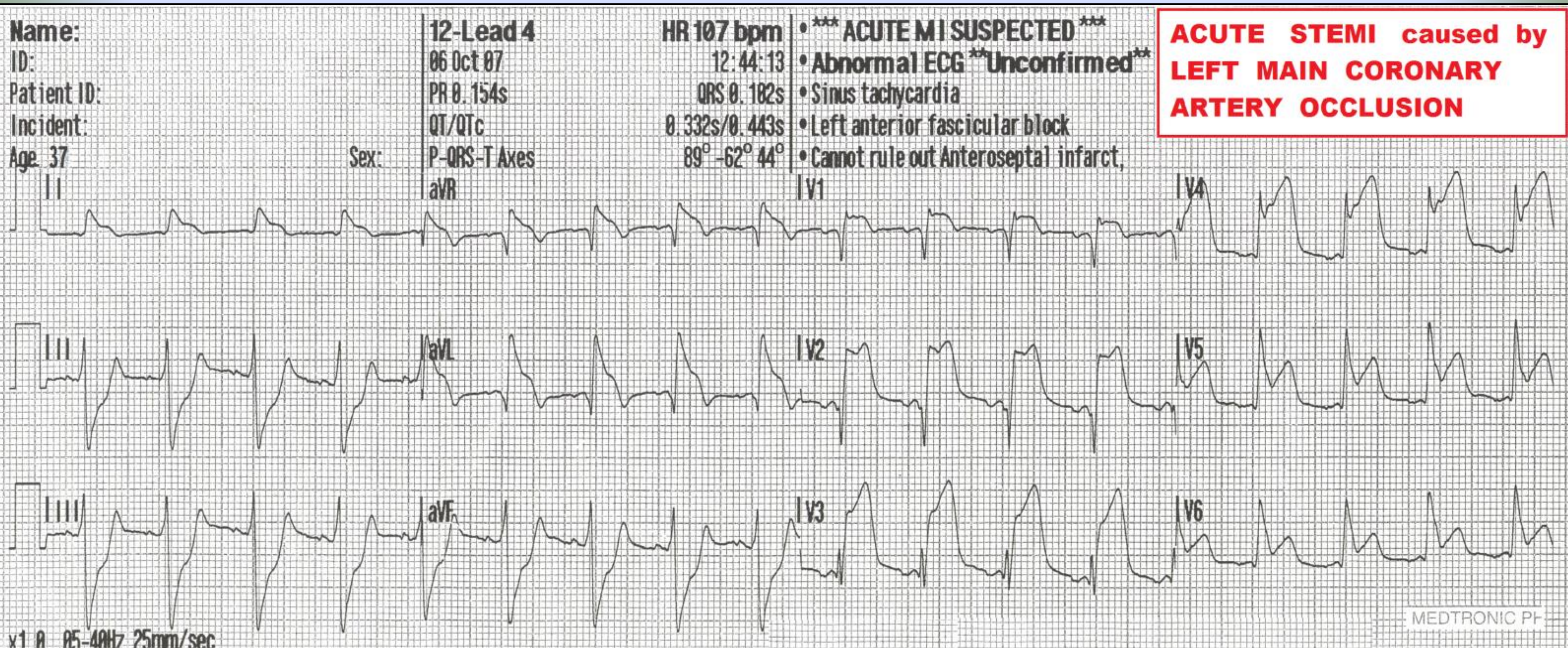
Lead AVR Views the BASILAR SEPTUM (region of the Bundle of His)



In STEMI with ST-Segment Elevation in Lead AVR,
This is indicative of
Left Main Coronary Artery Occlusion . . .

OCCLUSION of the LEFT MAIN CORONARY ARTERY



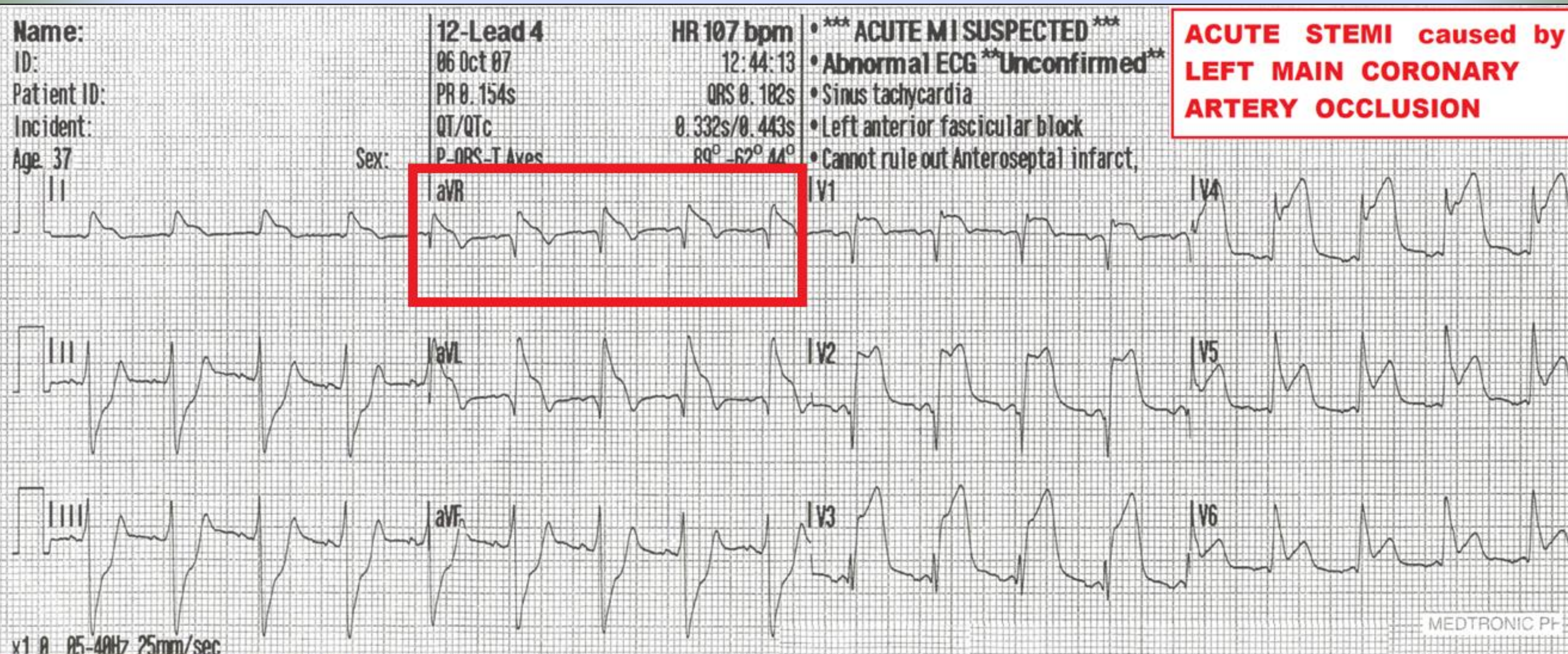


ACUTE STEMI caused by LEFT MAIN CORONARY ARTERY OCCLUSION

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

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
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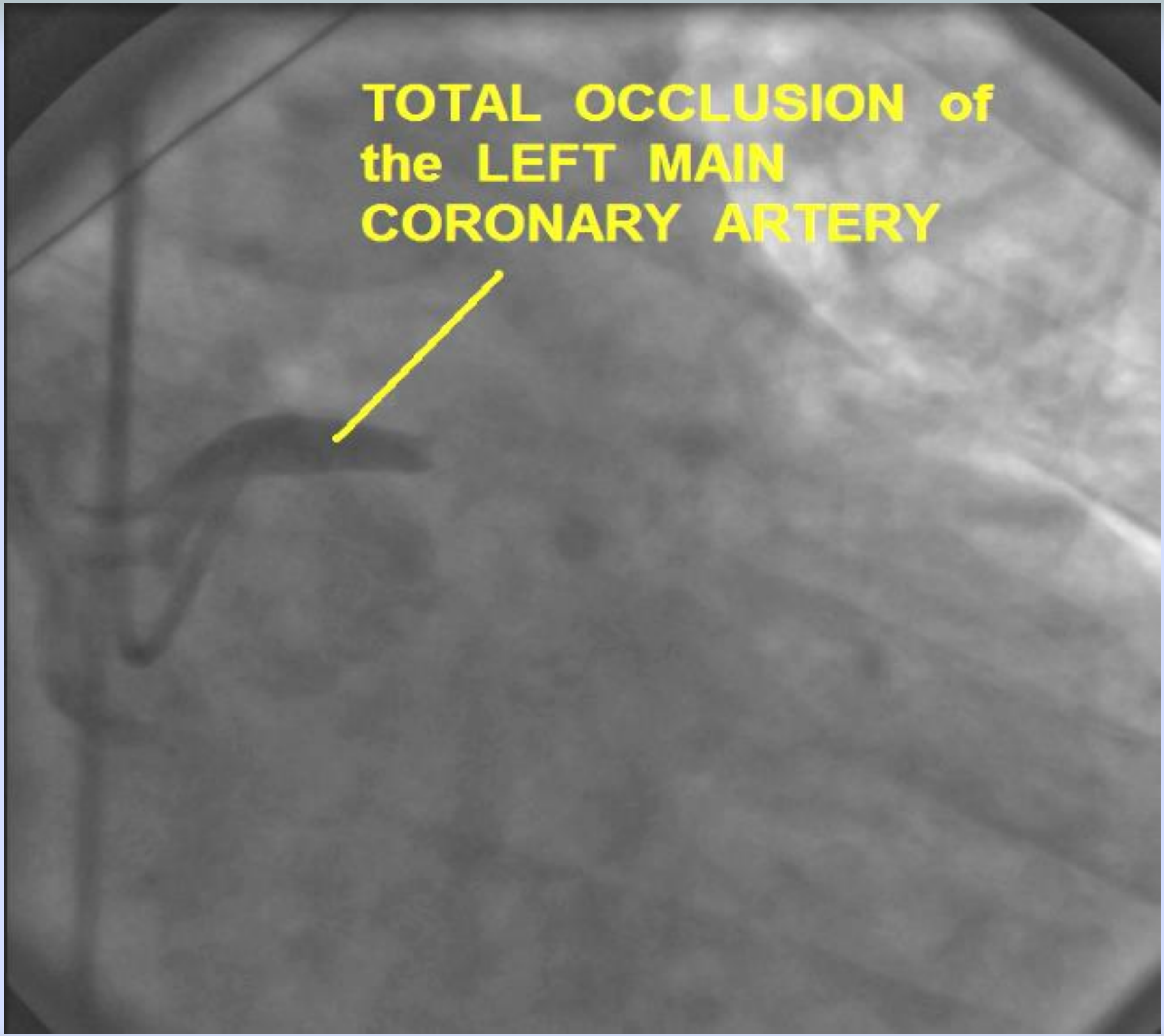
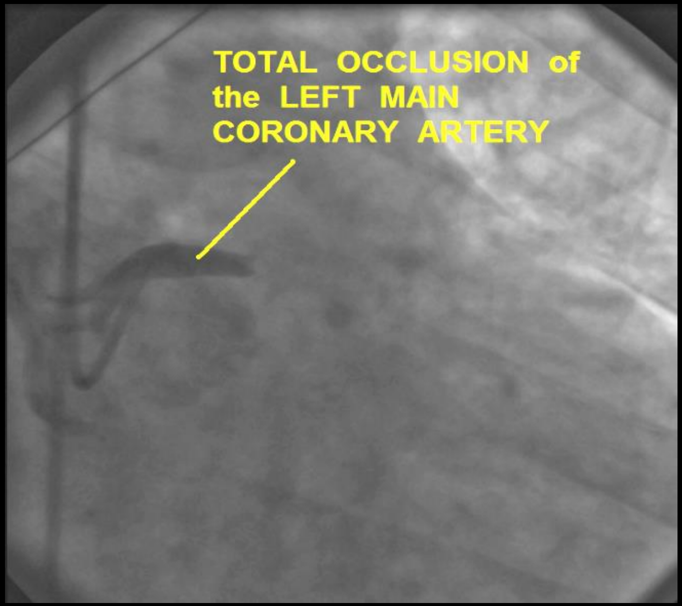
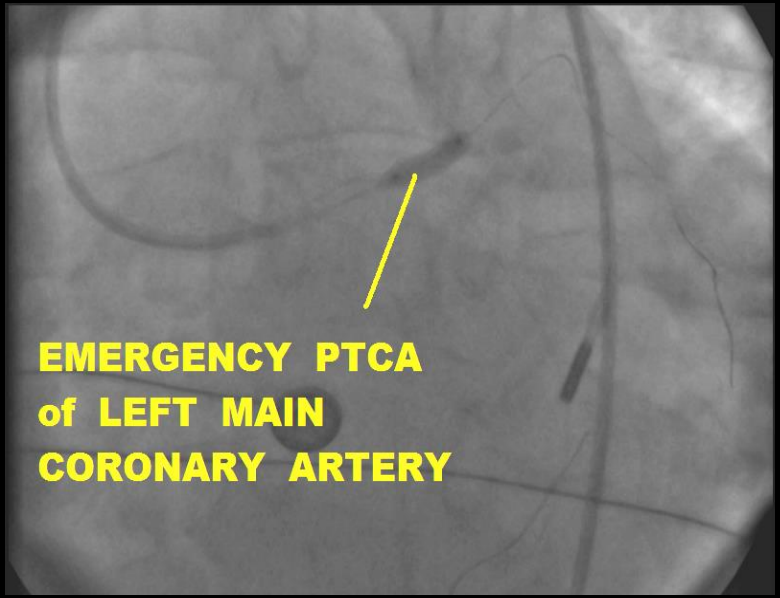
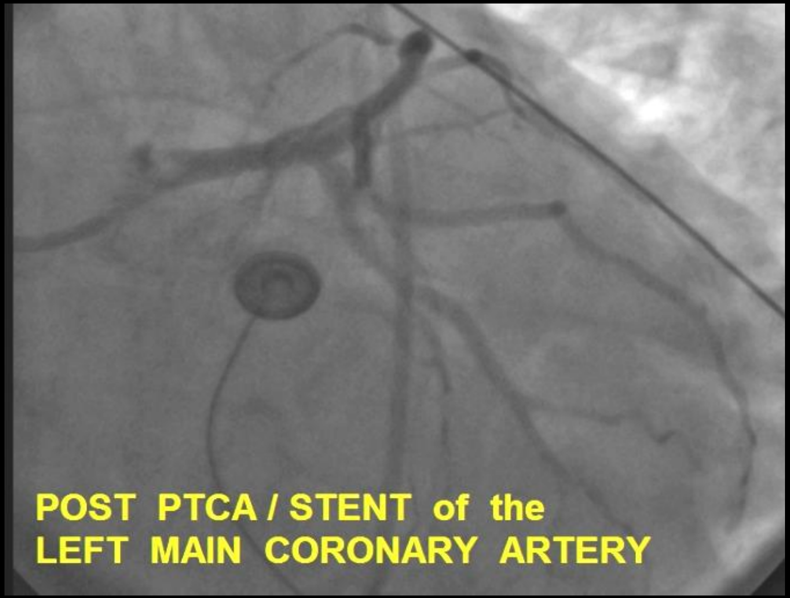
- ☑ ST ELEVATION in aVR GREATER THAN LEAD V1
- ☑ LEFT ANTERIOR FASCICULAR BLOCK PATTERN


TOTAL OCCLUSION of
the LEFT MAIN
CORONARY ARTERY







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.

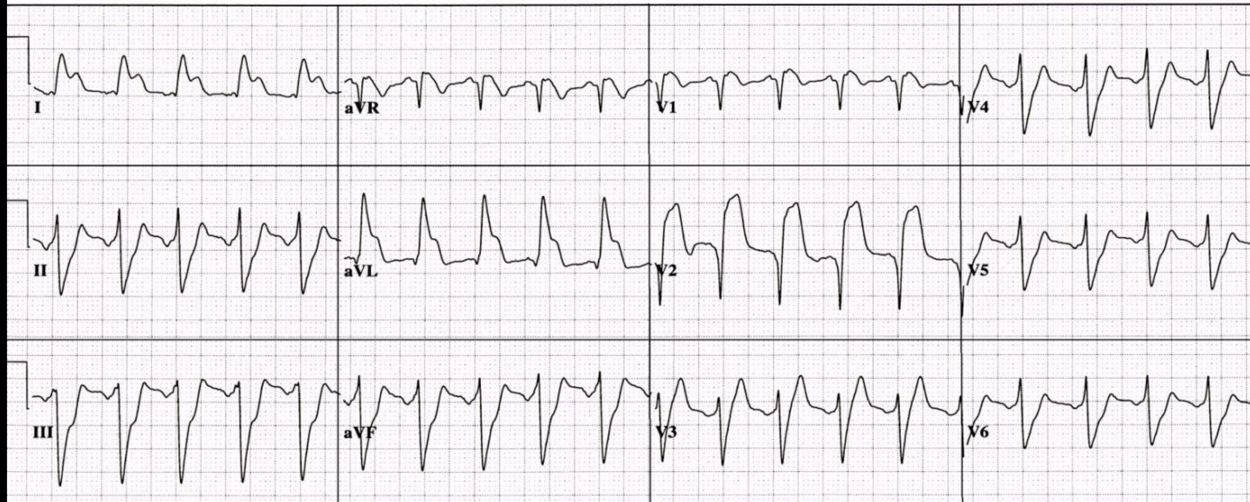
36 yr
Male Caucasian

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:

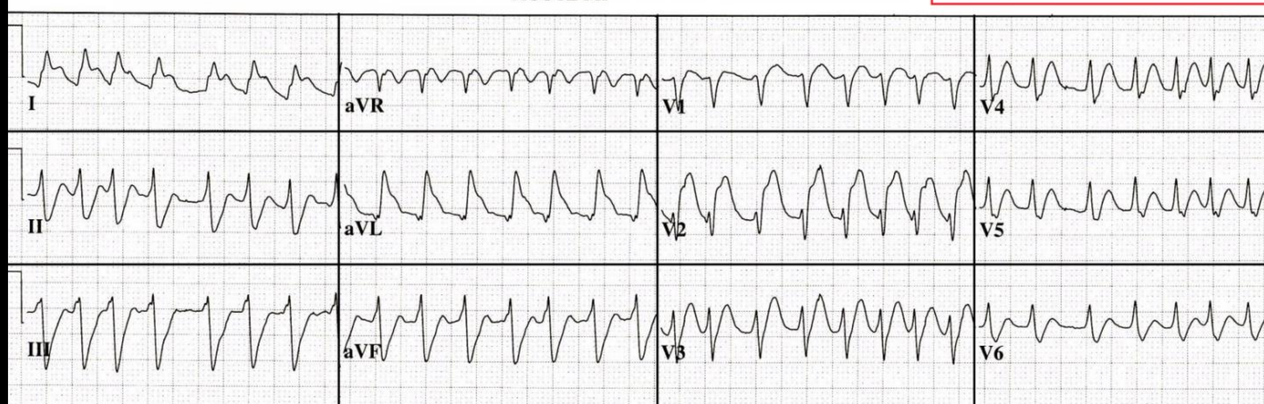
- ☑ ST ELEVATION in leads I and aVL
- ☑ INCONSISTENCY of ST SEGEMENT in leads V1 - V6 : V1 - V3 ST ELEVATION, V4 - V6 ST DEPRESSION (COMPETING FORCES of ANTERIOR vs. POSTERIOR M.I.)
- ☑ PATTERN of LEFT ANTERIOR FASCICULAR BLOCK (POS. QRS lead I; NEG rS leads II, III)
- ☑ ST ELEVATION in lead aVR > 0.5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

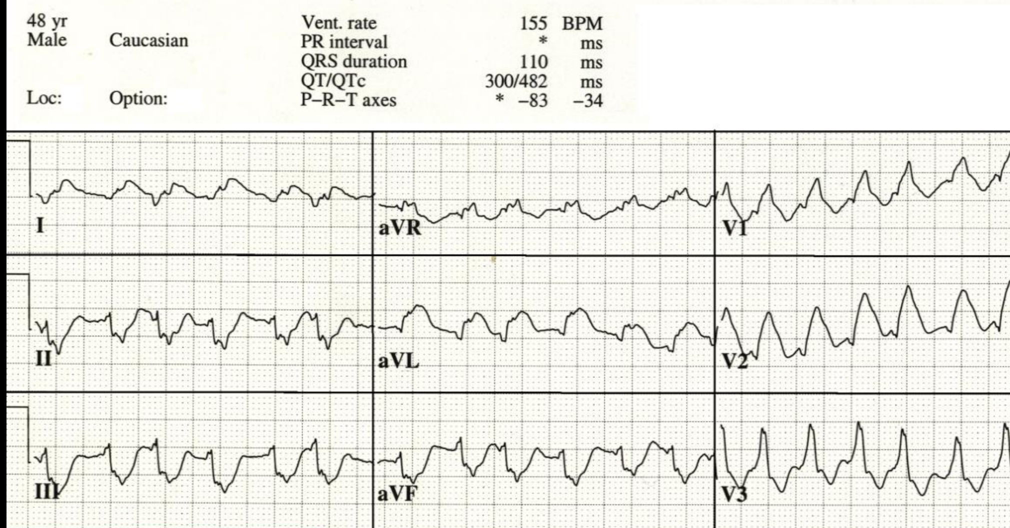
ACUTE STEMI caused by LEFT MAIN CORONARY ARTERY OCCLUSION



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)

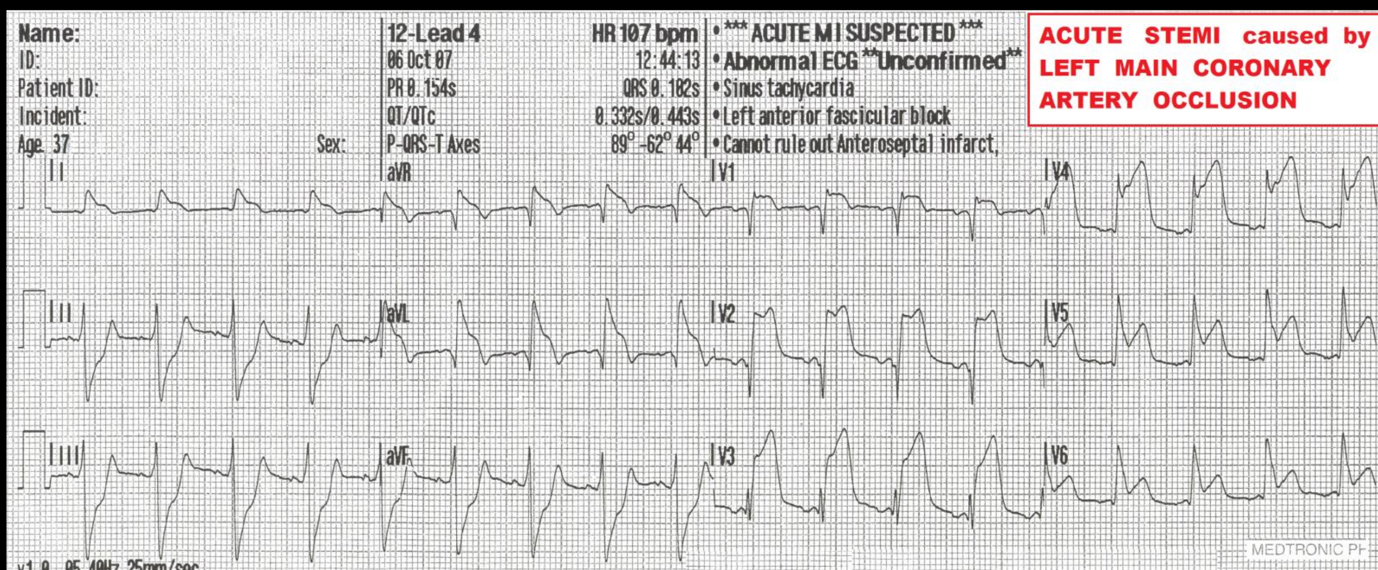
ACUTE STEMI caused by LEFT MAIN CORONARY ARTERY OCCLUSION



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

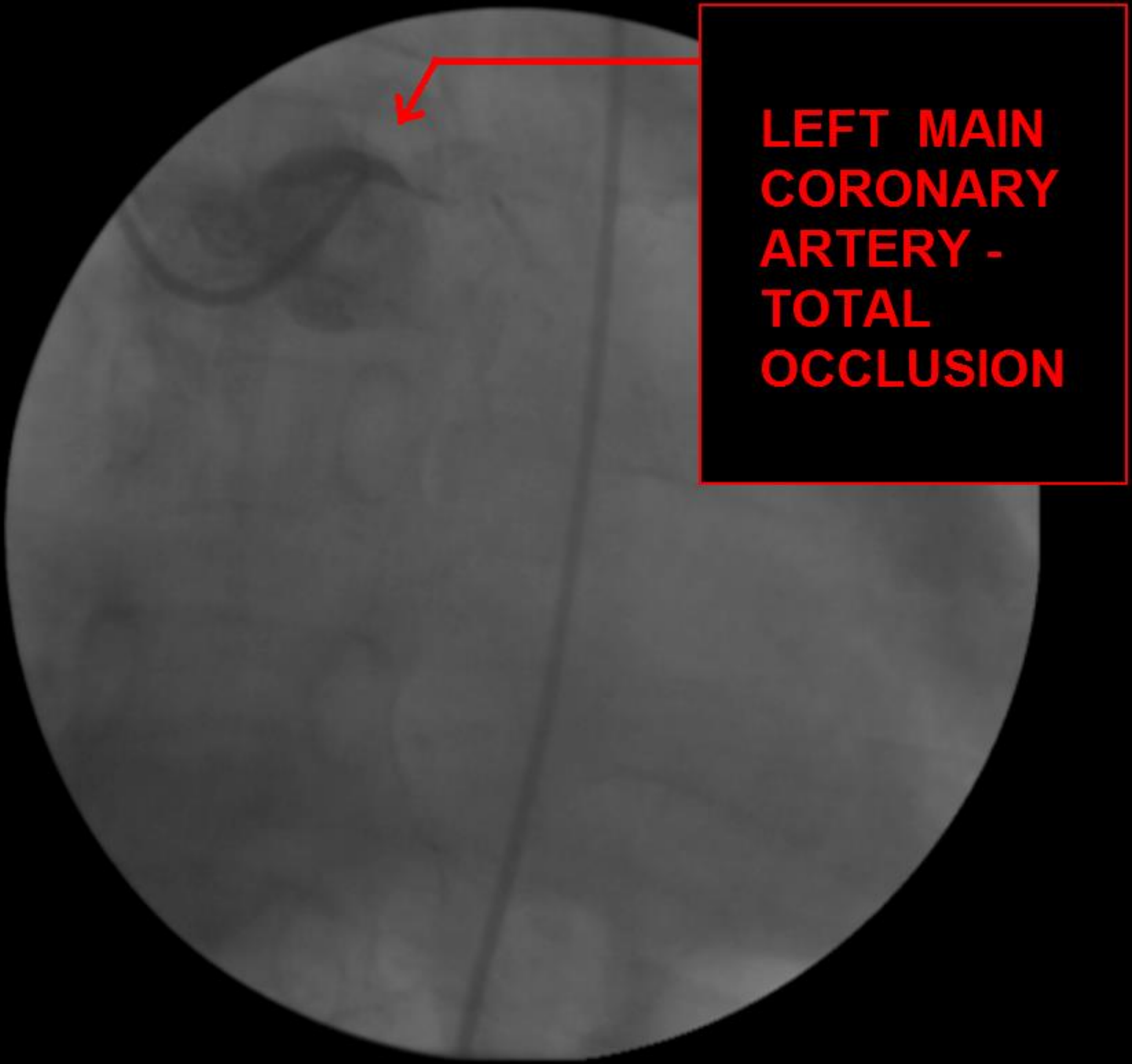
- ☑ ST ELEVATION in LEADS I, aVL, V1 - V2, V4 - V6 with ST DEPRESSION in V3: (COMPETING FORCES of ANTERIOR vs. POSTERIOR M.I.)
- ☑ RIGHT BUNDLE BRANCH BLOCK PATTERN, with
- ☑ LEFT ANTERIOR FASCICULAR BLOCK PATTERN

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


LEFT MAIN CORONARY ARTERY - TOTAL OCCLUSION

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.*

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

- ☑ ST ELEVATION in ANTERIOR LEADS (V1 - V4) and LATERAL LEADS (V5 & V6)
- ☑ ST DEPRESSION or ISOELCTRIC J POINTS may be seen in V LEADS . . . . mainly V2 and/or V3 *caused by COMPETING FORCES of ANTERIOR vs. POSTERIOR WALL MI.* *+
  - → NOTE: it is very unusual to see ST DEPRESSION in V LEADS with isolated ANTERIOR WALL MI when caused by occluded LAD.
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- ☑ ST DEPRESSION in LEADS II, III, and AVF. (in cases of LMCA occlusion of DOMINANT CIRCUMFLEX, leads II, III, and AVF may show ST ELEVATION or ISOELECTRIC J POINTS) *+
- ☑ NEW / PRESUMABLY NEW RBBB, and/or LEFT ANTERIOR FASICULAR BLOCK *+

* Kurisu et al, HEART 2004, SEPTEMBER: 90 (9): 1059-1060
+ Yamaji et al, JACC vol. 38, No. 5, 2001, November 1, 2001:1348-54

[Yamaji et al, JACC vol 38, No 5, 2001: 1348-54]

[Electrocardiogram patterns in acute left main occlusion: J Electrocardiol. 2008 Nov-Dec;41(6):626-9.]

In patients without STEMI, ST Elevation in AVR, when seen with global indications of ischemia (ST Depression in 8 leads or more), is indicative of advanced multi-vessel disease or significant Left Main Coronary Artery stenosis

“In patients with:

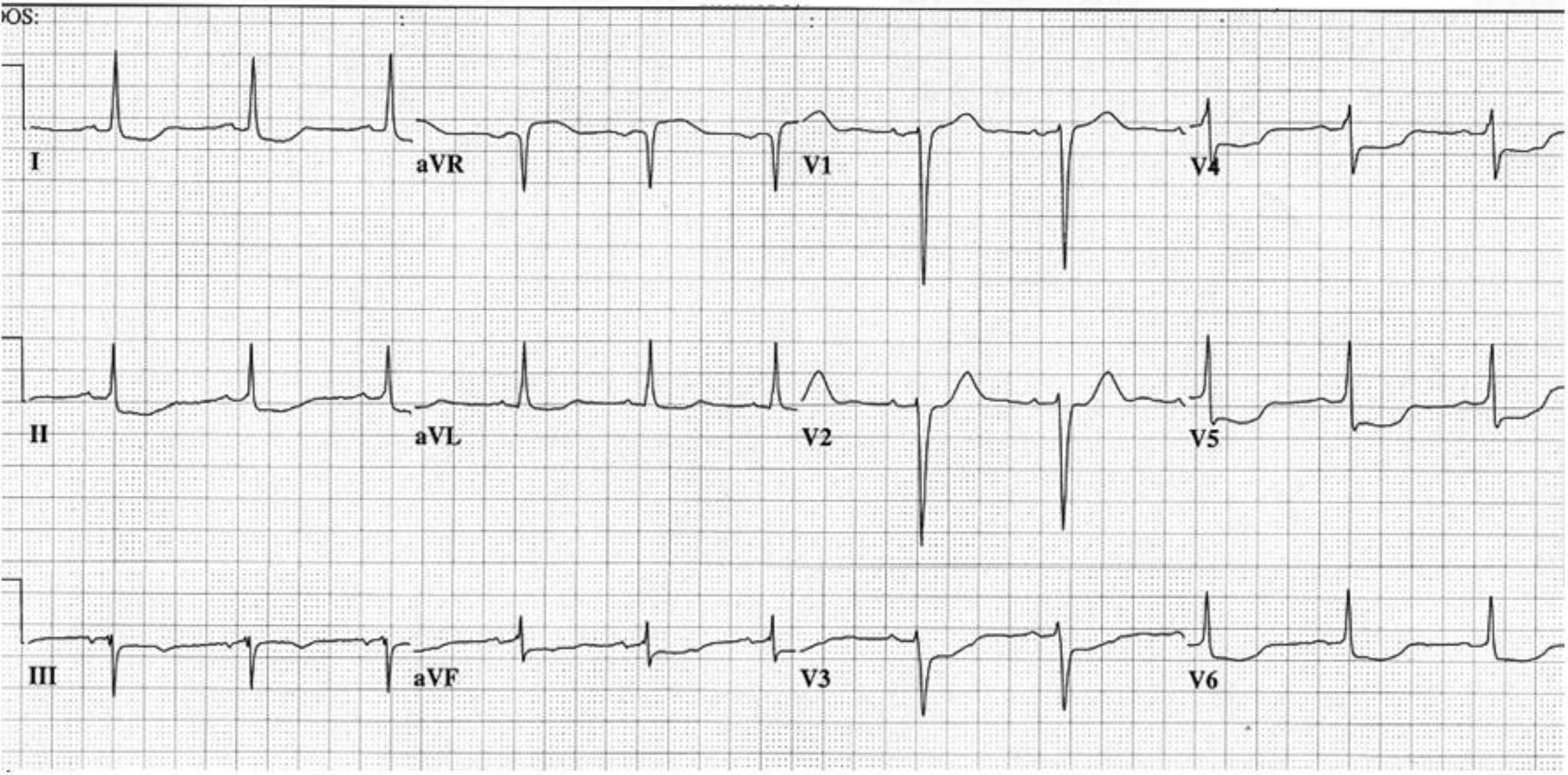
- **Angina at rest**
- **ST Elevation in AVR and ST Depression in 8 or more ECG leads (global ischemia), it is reported with a *75% predictive accuracy* of 3-vessel or left main coronary artery stenosis” . . .**

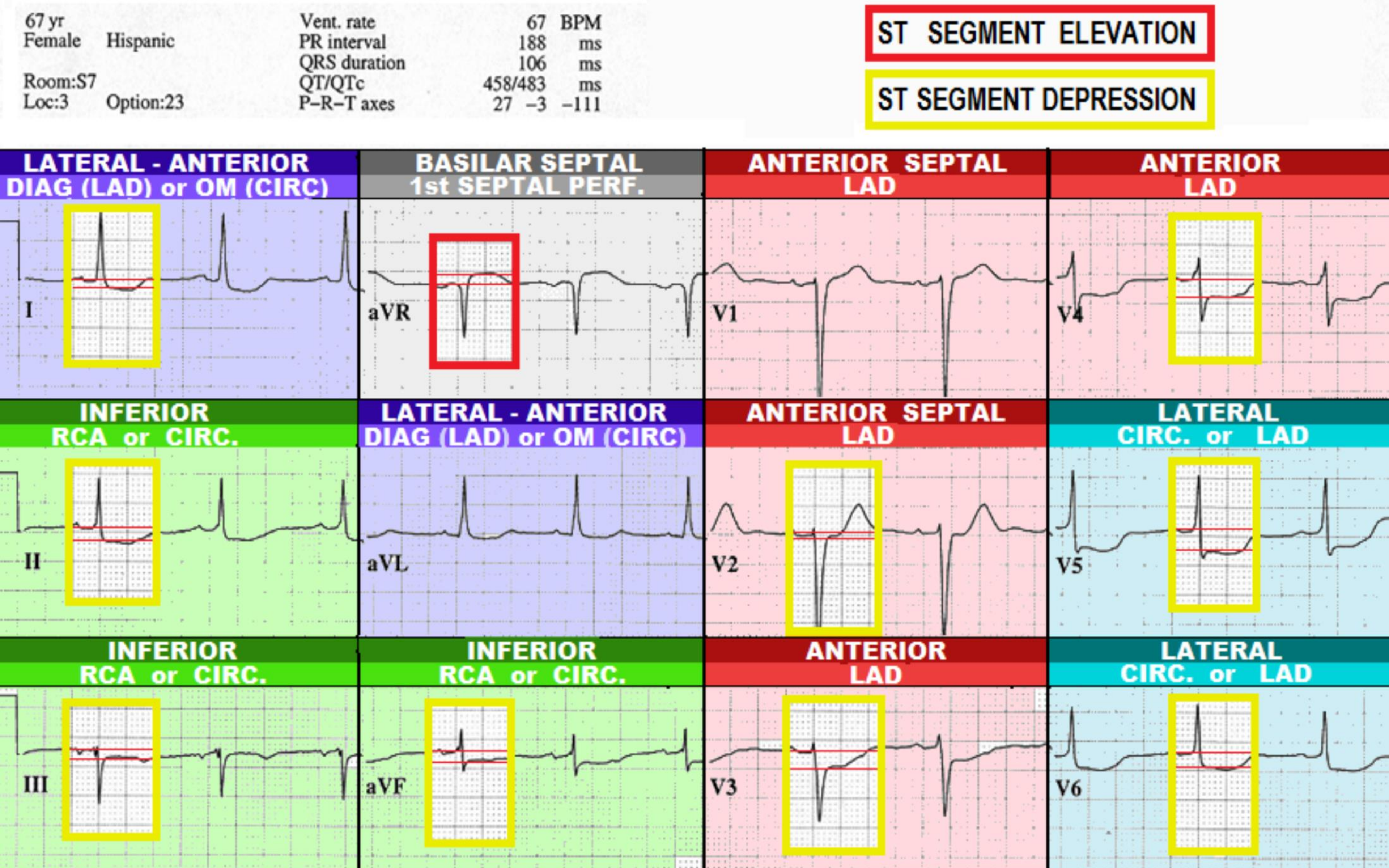
- Wagner et al, **2009 ACC/AHA Standardization and Interpretation of the ECG, Part VI, ACS**.

67 yr
Female Hispanic

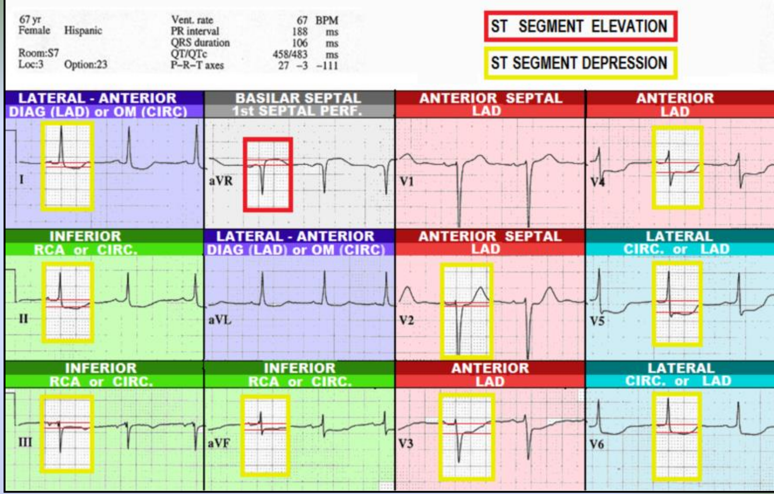
Room:S7
Loc:3 Option:23

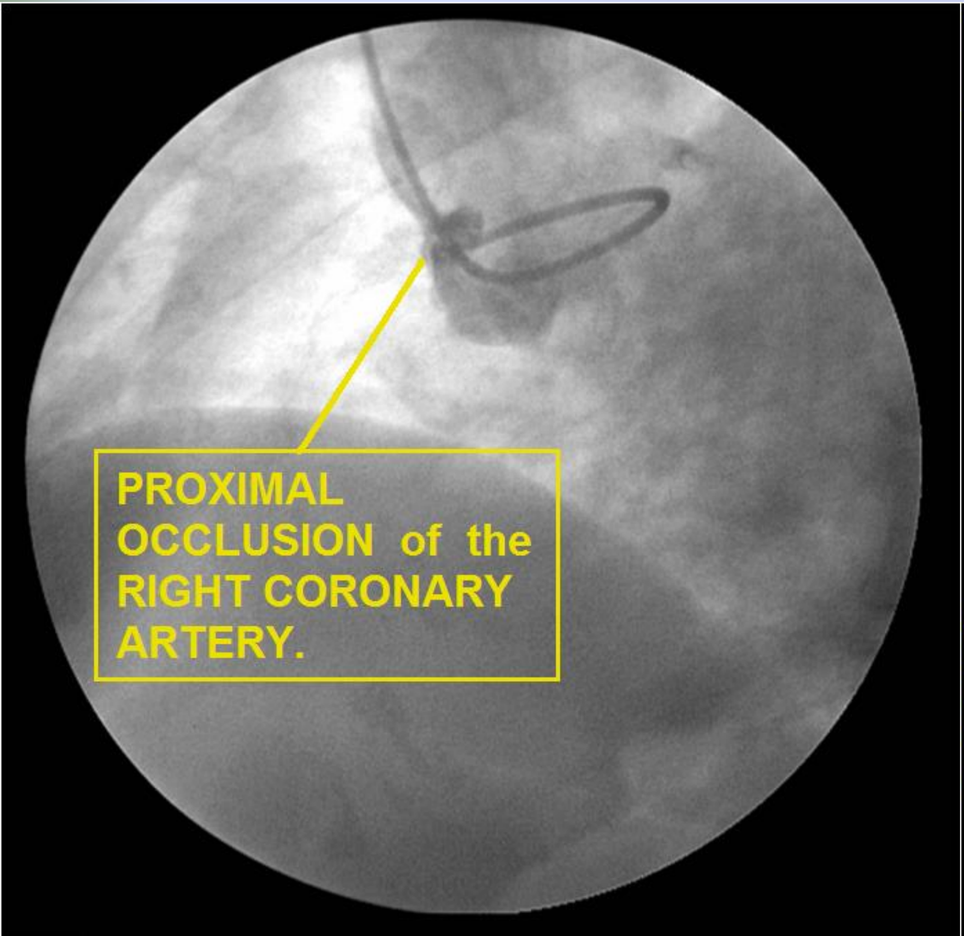
Vent. rate	67	BPM
PR interval	188	ms
QRS duration	106	ms
QT/QTc	458/483	ms
P–R–T axes	27 –3	–111

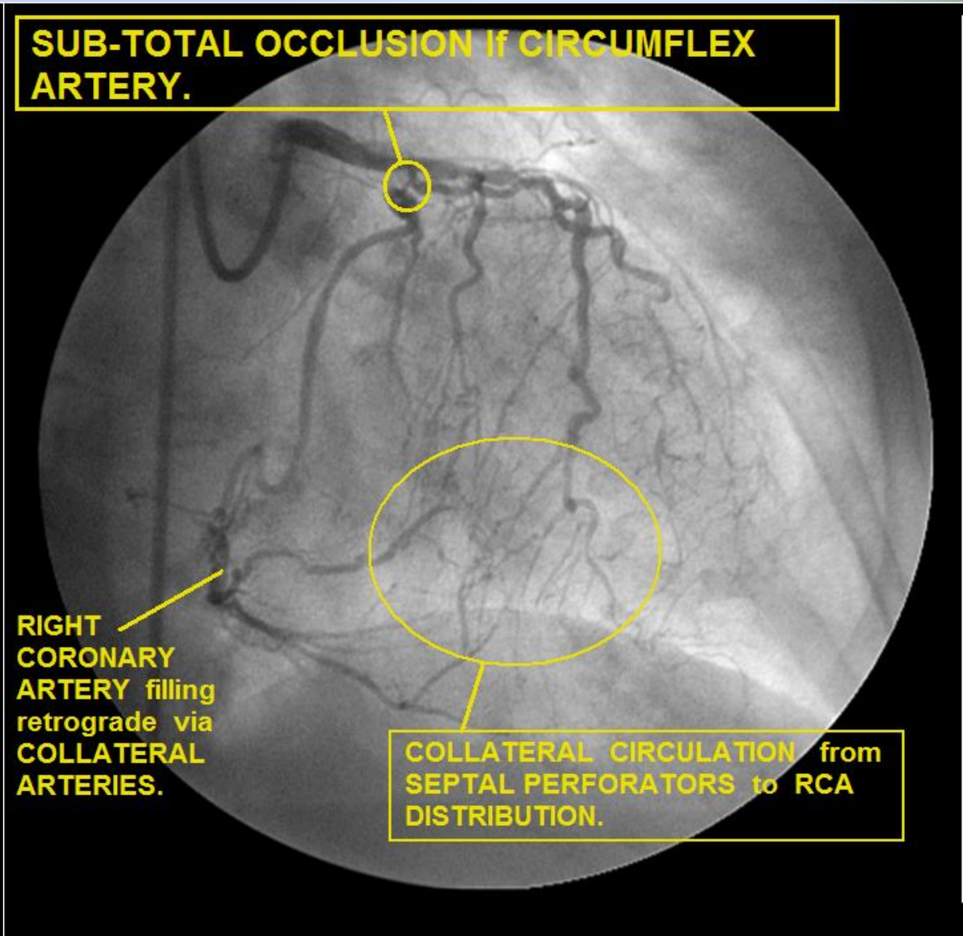



67 yr
Female Hispanic
Room:S7
Loc:3 Option:23
Vent. rate 67 BPM
PR interval 188 ms
QRS duration 106 ms
QT/QTc 458/483 ms
P–R–T axes 27 –3 –111
ST SEGMENT ELEVATION
ST SEGMENT DEPRESSION
LATERAL - ANTERIOR
DIAG (LAD) or OM (CIRC)
I
BASILAR SEPTAL
1st SEPTAL PERF.
aVR
ANTERIOR SEPTAL
LAD
V1
ANTERIOR
LAD
V4
INFERIOR
RCA or CIRC.
II
LATERAL - ANTERIOR
DIAG (LAD) or OM (CIRC)
aVL
ANTERIOR SEPTAL
LAD
V2
LATERAL
CIRC. or LAD
V5
INFERIOR
RCA or CIRC.
III
INFERIOR
RCA or CIRC.
aVF
ANTERIOR
LAD
V3
LATERAL
CIRC. or LAD
V6

Critical Triple Vessel Disease = *STAT Coronary Artery Bypass Surgery*







ANTICIPATED COMPLICATIONS of GLOBAL ISCHEMIA with POSSIBLE NSTEMI -- INTERVENTIONS to be CONSIDERED:

Patients with CHEST PAIN at REST and this ECG presentation have a 75% incidence of severe LMCA STENOSIS and/or TRIPLE - VESSEL DISEASE -- in such cases Coronary Artery Bypass Surgery (CABG) is frequently indicated.	PREHOSPITAL: if patient has no hospital preference consider transport to Chest Pain Center WITH Open Heart Surgery capabilities IF nearby. HOSPITAL: consider use of SHORT-ACTING intravenous GP IIb/IIIa receptor agonists
- ACTIVE CHEST PAIN	ACUTE CHEST PAIN PROTOCOL
- ISCHEMIA - CONSIDER DYSRHYTHMIAS	ACLS PROTOCOL
- INCREASED PROBABILITY of IMMINENT MYOCARDIAL INFARCTION	1. AGGRESSIVE SERIAL TROPONIN and SERIAL ECG PROTOCOLS (2014 AHA/ACC / NSTE-ACS Guidelines) 2. Positive TROPONIN: consider STAT

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.

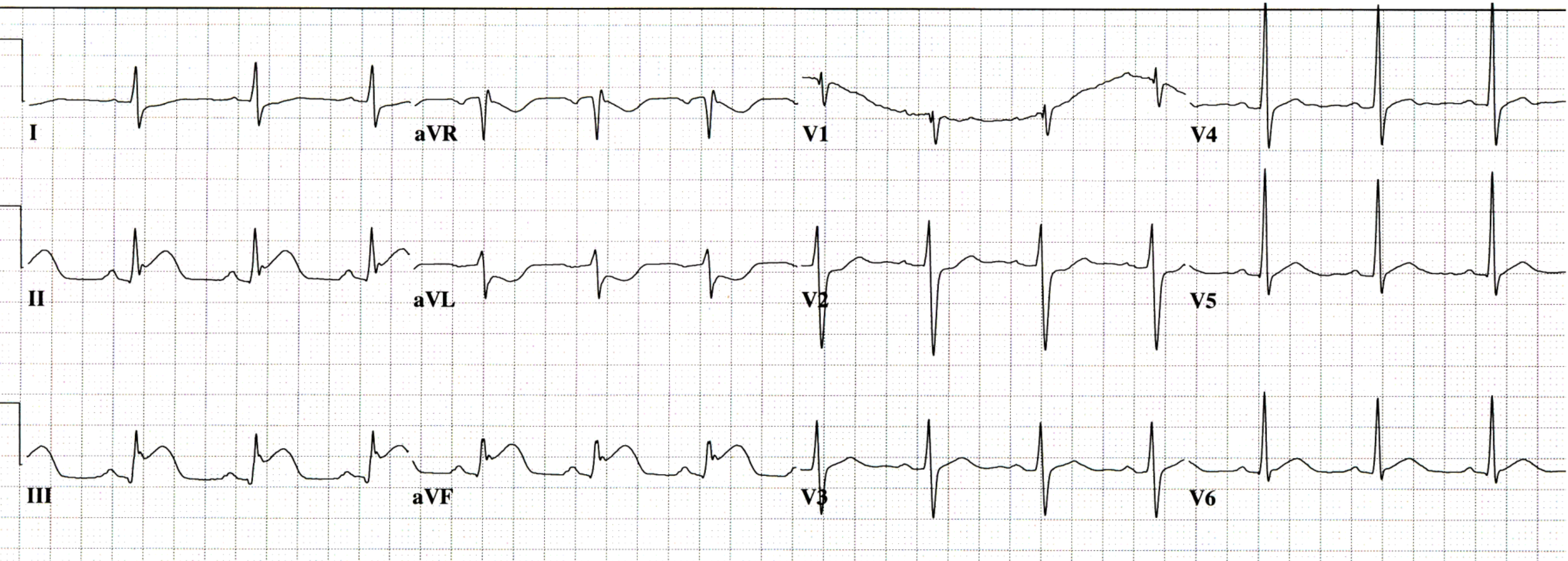
VITAL SIGNS: BP: 136/88 P: 88 R: 20 SAO2: 100% on 4 LPM O2

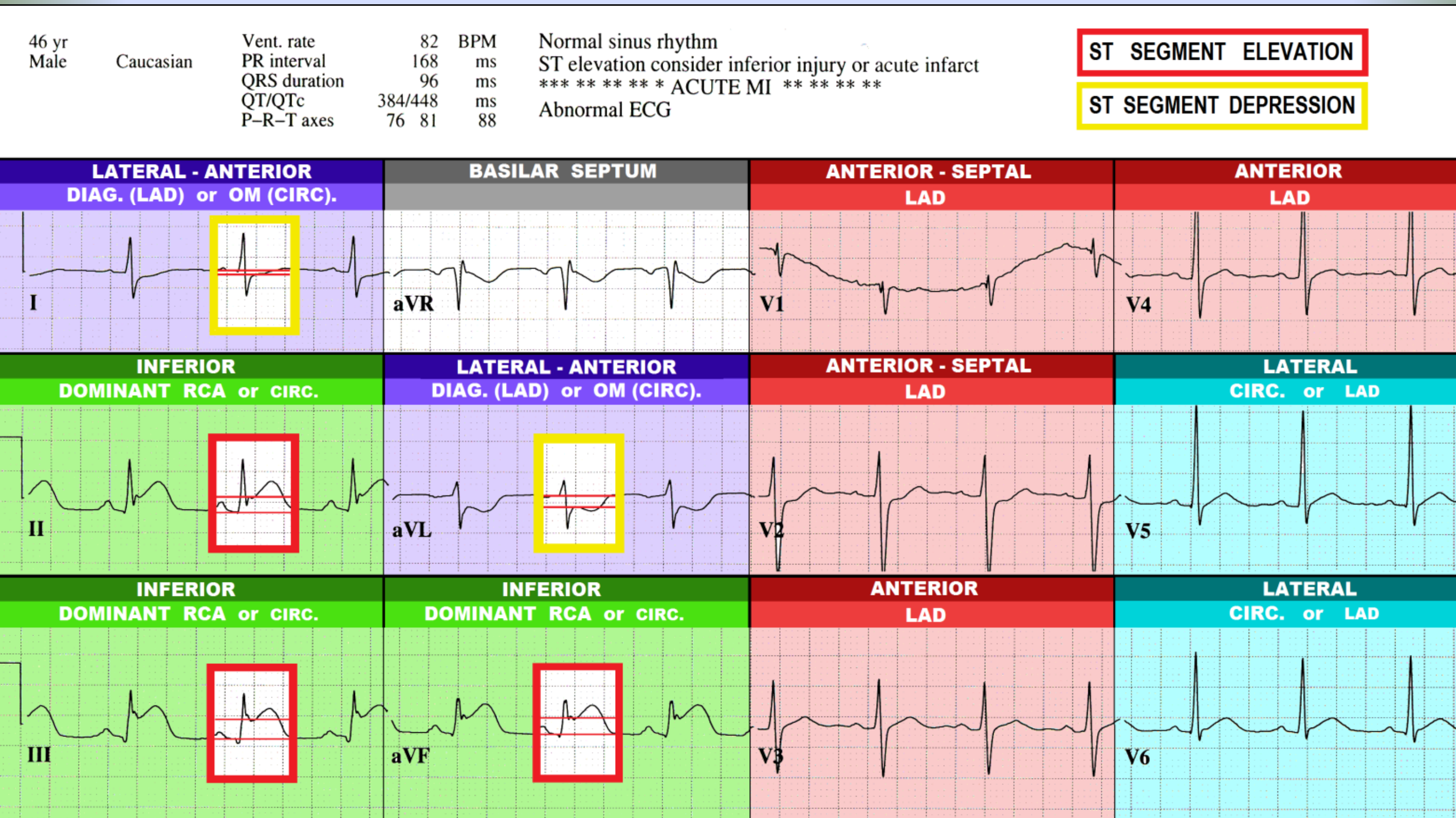
LABS: TROPONIN: < .04

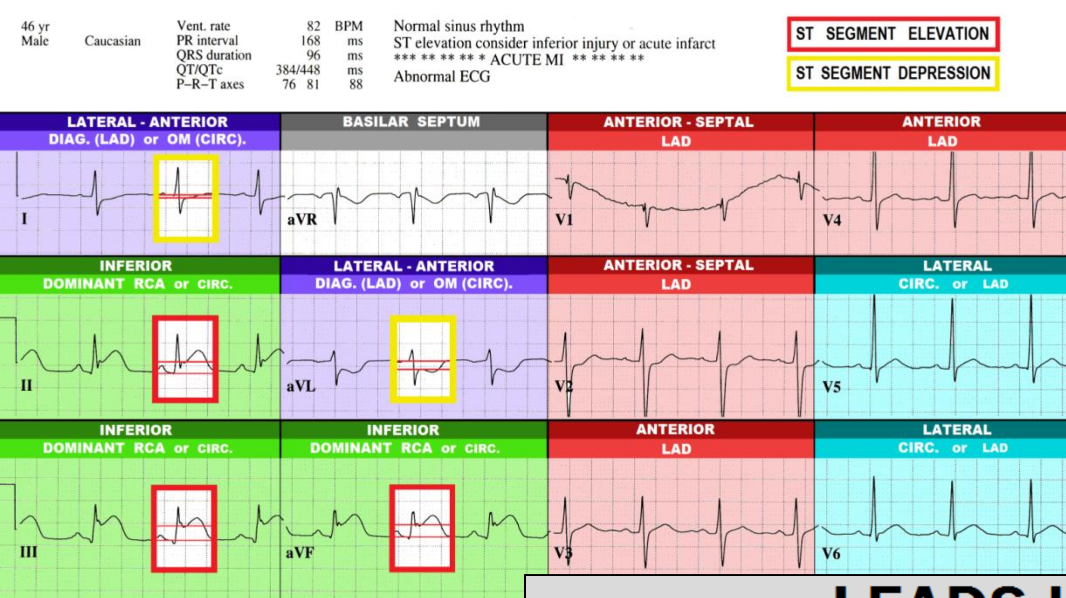
46 yr		Vent. rate	82	BPM
Male	Caucasian	PR interval	168	ms
		QRS duration	96	ms
		QT/QTc	384/448	ms
Loc:3	Option:23	P–R–T axes	76 81	88

☞ **EVALUATE EKG for indicators of ACS:**

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

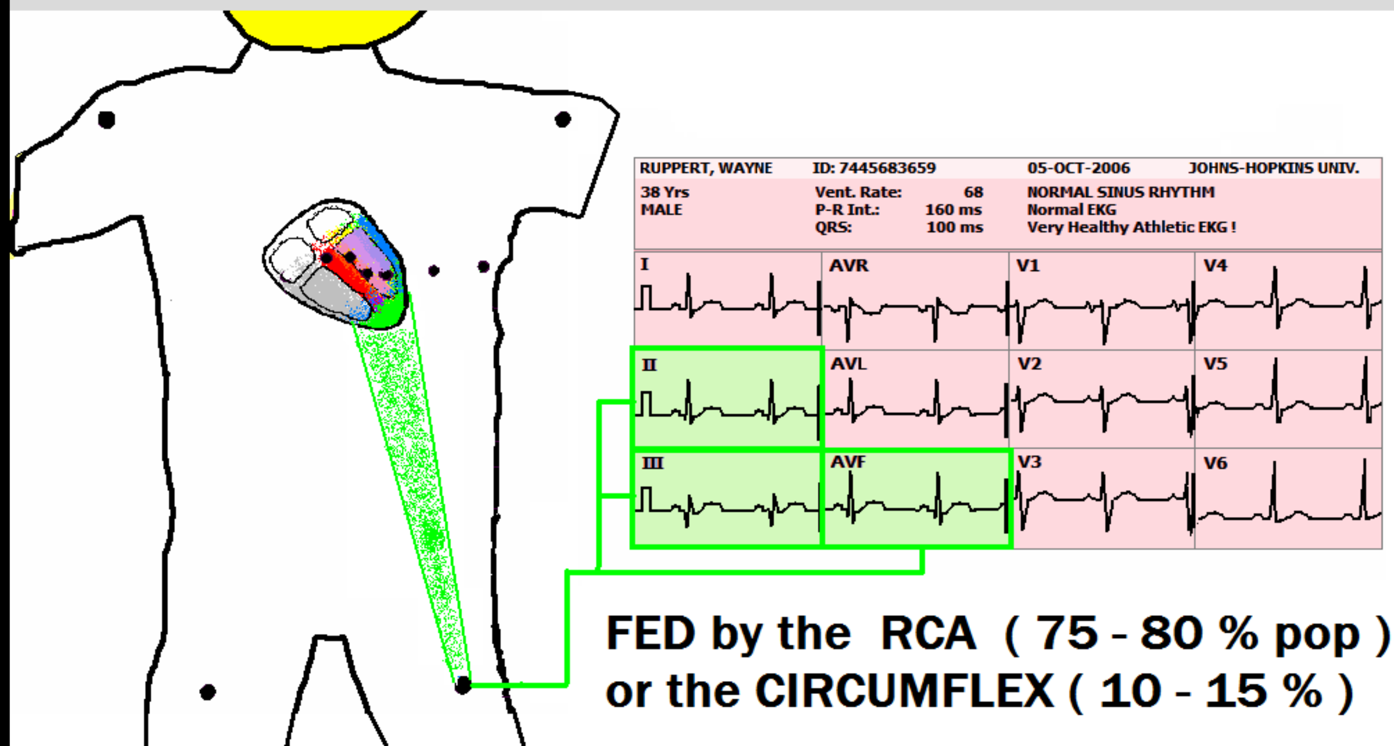



46 yr
Male
Caucasian
Vent. rate 82 BPM
PR interval 168 ms
QRS duration 96 ms
QT/QTc 384/448 ms
P–R–T axes 76 81 88
Normal sinus rhythm
ST elevation consider inferior injury or acute infarct
*** ** ** ** * ACUTE MI ** ** ** **
Abnormal ECG
ST SEGMENT ELEVATION
ST SEGMENT DEPRESSION
LATERAL - ANTERIOR
DIAG. (LAD) or OM (CIRC).
I
BASILAR SEPTUM
aVR
ANTERIOR - SEPTAL
LAD
V1
ANTERIOR
LAD
V4
INFERIOR
DOMINANT RCA or CIRC.
II
LATERAL - ANTERIOR
DIAG. (LAD) or OM (CIRC).
aVL
ANTERIOR - SEPTAL
LAD
V2
LATERAL
CIRC. or LAD
V5
INFERIOR
DOMINANT RCA or CIRC.
III
INFERIOR
DOMINANT RCA or CIRC.
aVF
ANTERIOR
LAD
V3
LATERAL
CIRC. or LAD
V6



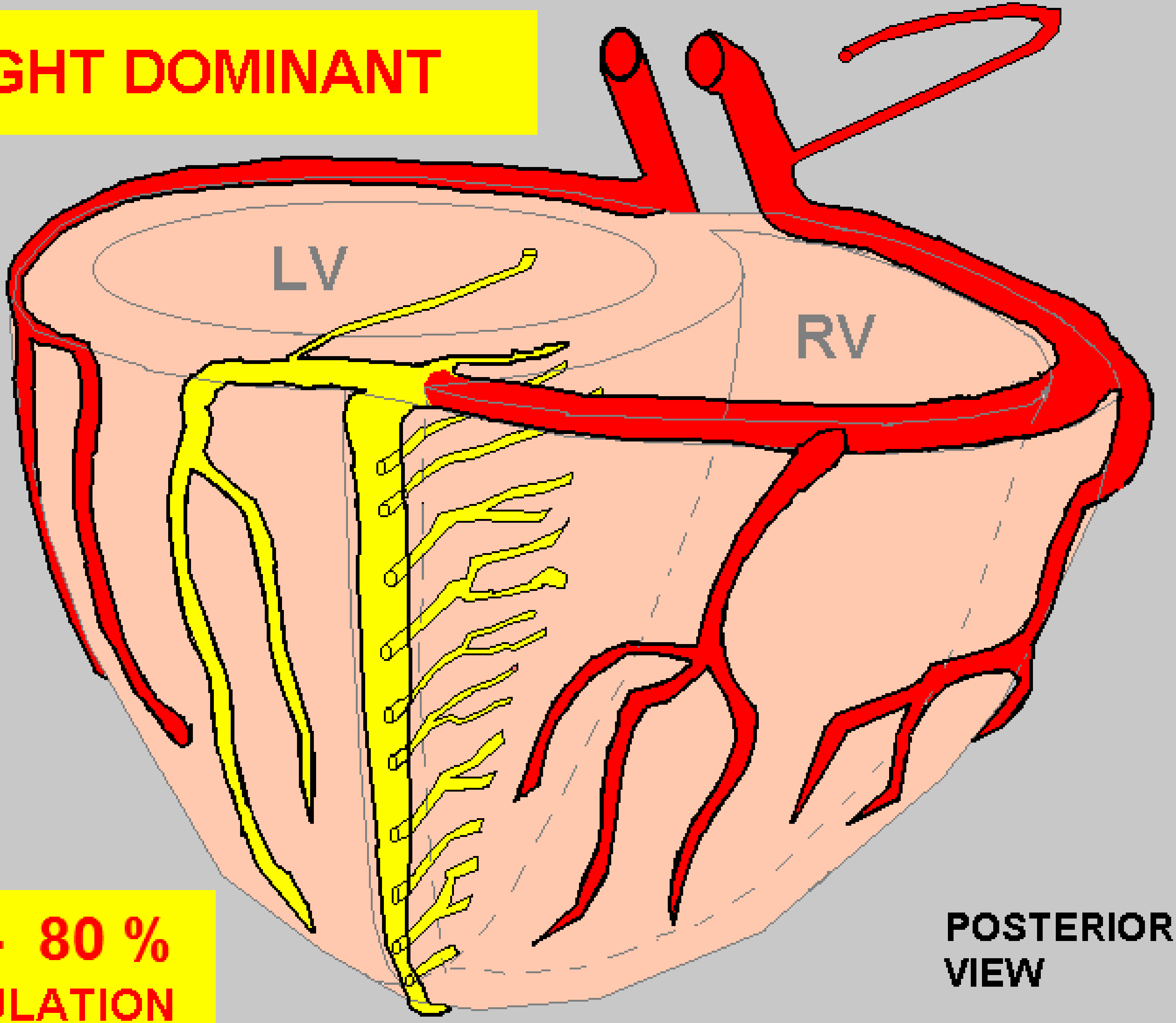
LEADS II, III, and aVF VIEW

INFERIOR WALL of the LEFT VENTRICLE



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

RIGHT DOMINANT



75 - 80 %
POPULATION

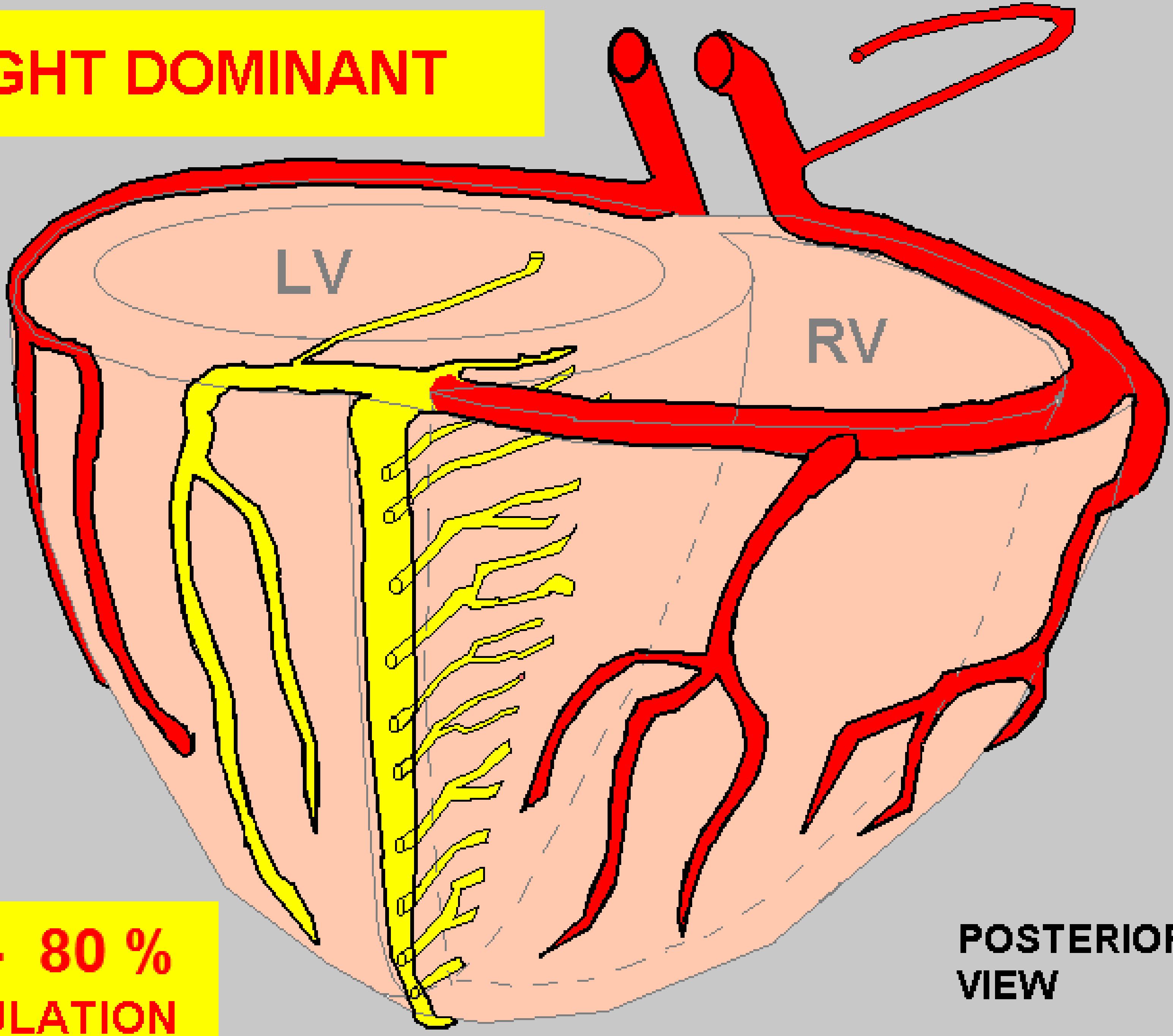
HELPFUL HINT . . . MEMORIZE THIS !

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

RIGHT DOMINANT



75 - 80 %
POPULATION

POSTERIOR
VIEW

A standard

12 LEAD EKG

Does NOT show the

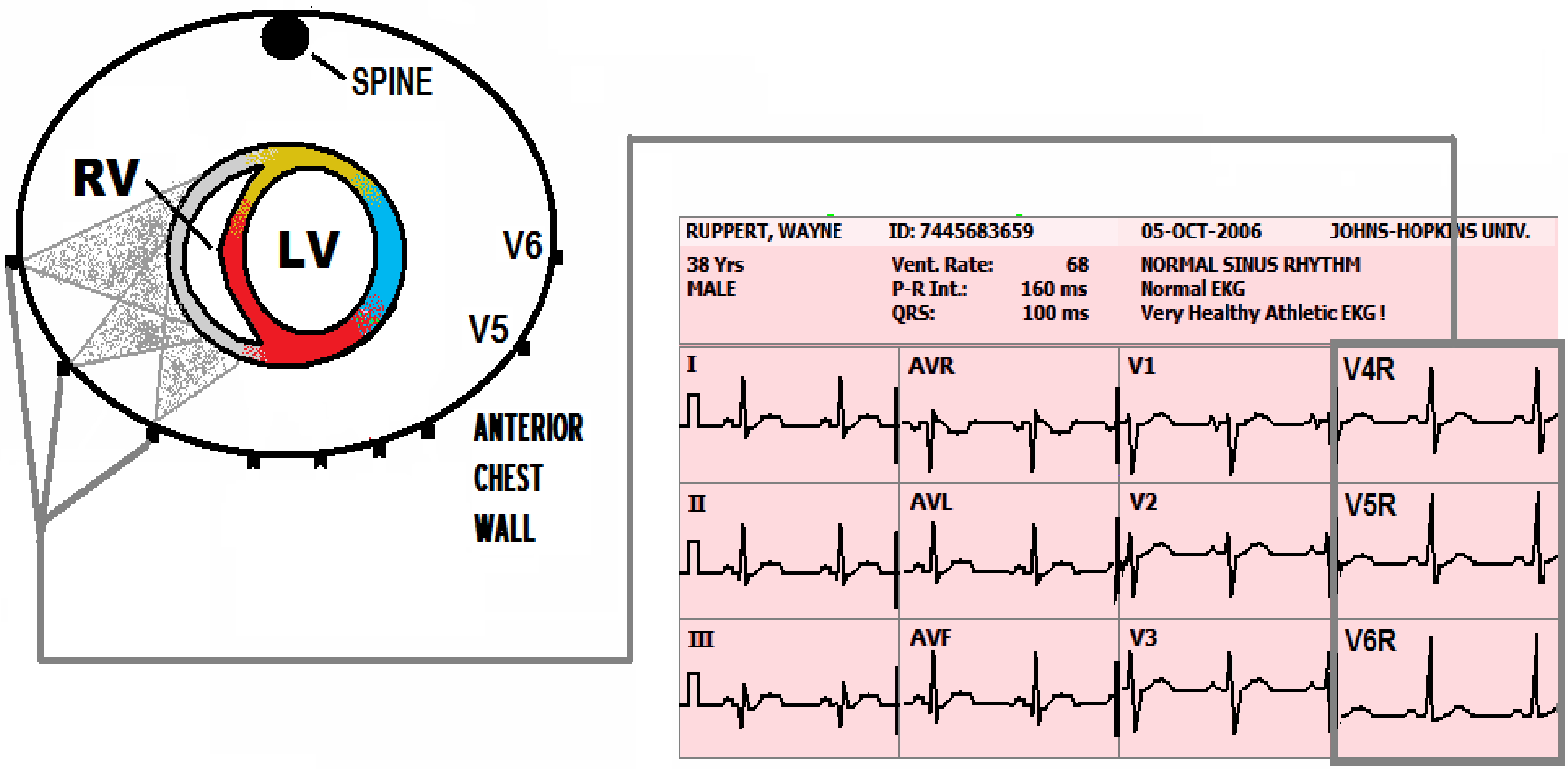
RIGHT VENTRICLE

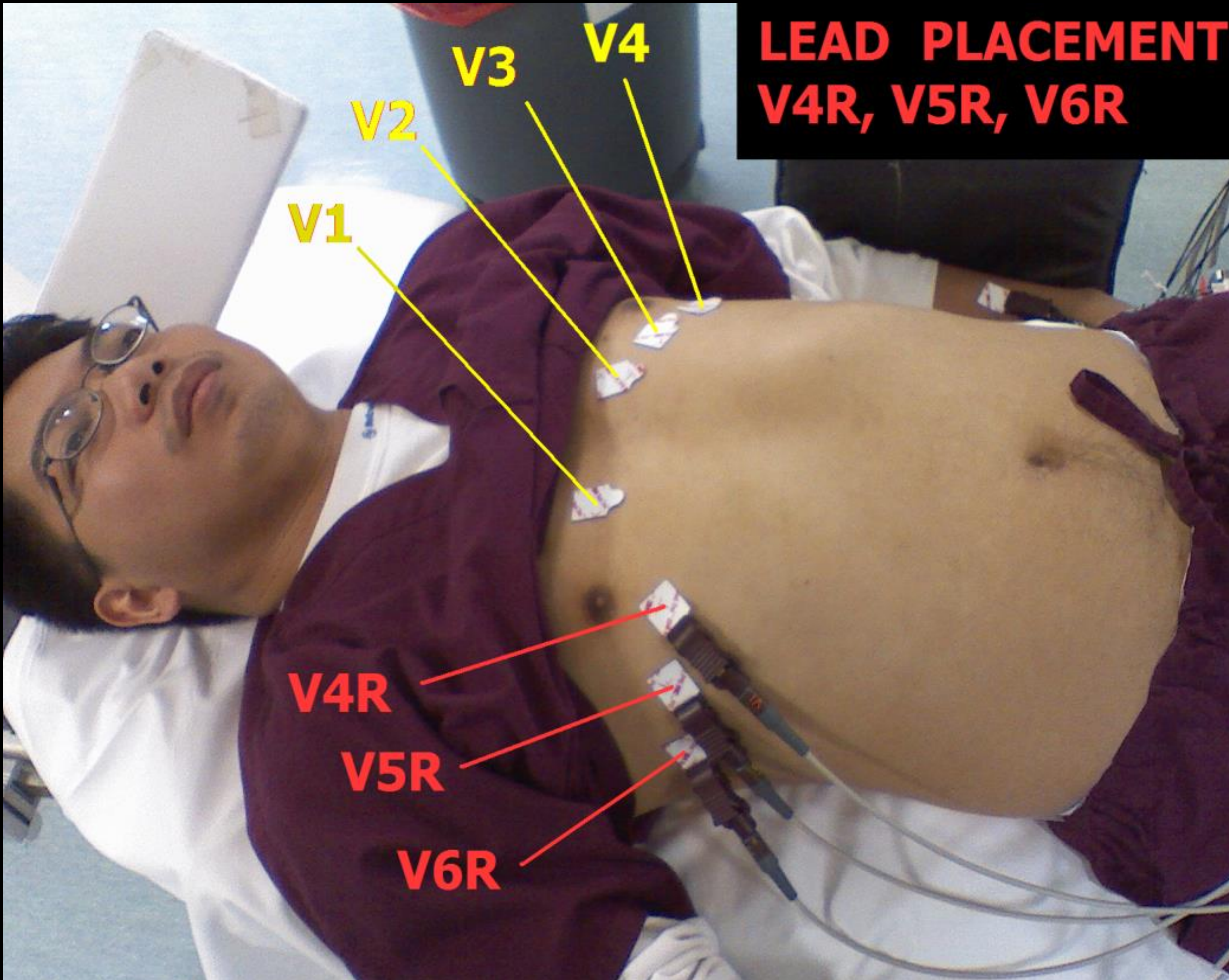
To see the
RIGHT VENTRICLE . . .

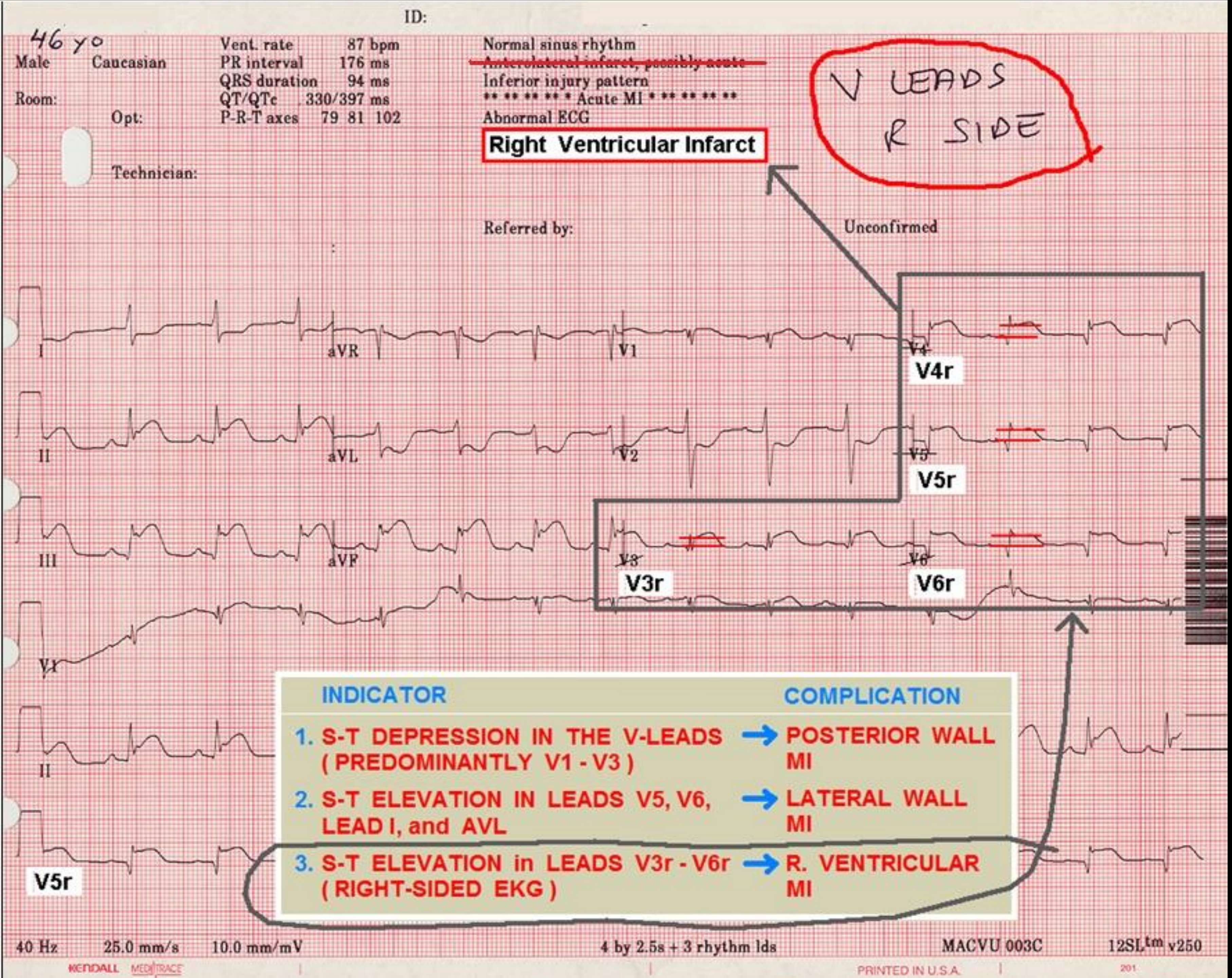
. . . such as in cases of
INFERIOR WALL M.I.

☞ You must do a
RIGHT - SIDED EKG ! !

V4R - V6R VIEW THE RIGHT VENTRICLE

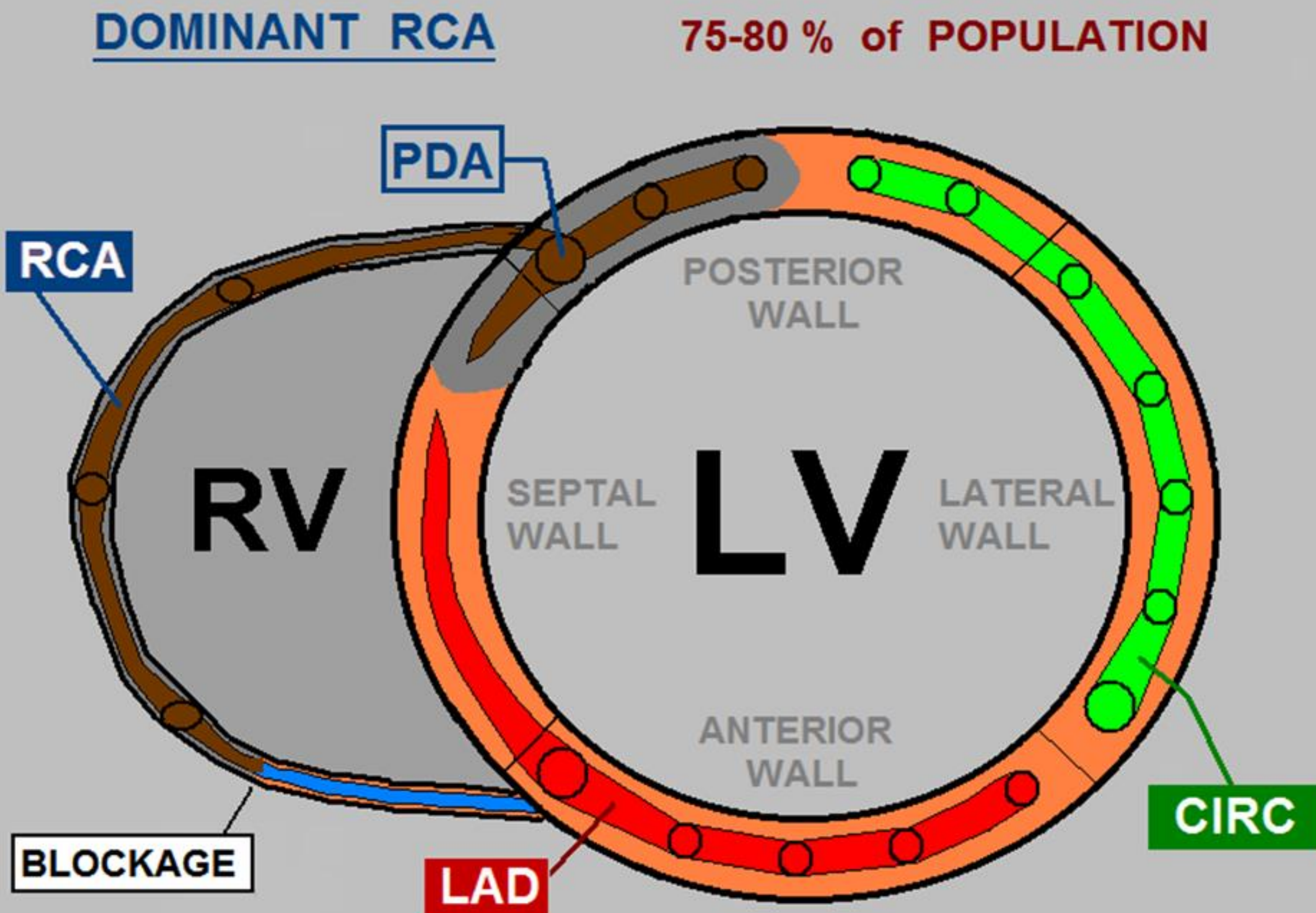



LEAD PLACEMENT
V4R, V5R, V6R
V1
V2
V3
V4
V4R
V5R
V6R



ID:
46 yo
Male Caucasian
Room:
Opt:
Technician:
Vent. rate 87 bpm
PR interval 176 ms
QRS duration 94 ms
QT/QTc 330/397 ms
P-R-T axes 79 81 102
Normal sinus rhythm
~~Anterolateral infarct, possibly acute~~
Inferior injury pattern
** ** ** ** * Acute MI * ** ** ** **
Abnormal ECG
Right Ventricular Infarct
V LEADS R SIDE
Referred by:
Unconfirmed
I
aVR
V1
V4r
II
aVL
V2
V5r
III
aVF
V3r
V6r
V1
II
V5r
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
40 Hz
25.0 mm/s
10.0 mm/mV
4 by 2.5s + 3 rhythm lds
MACVU 003C
12SLtm v250
KENDALL MEDITRACE
PRINTED IN U.S.A.

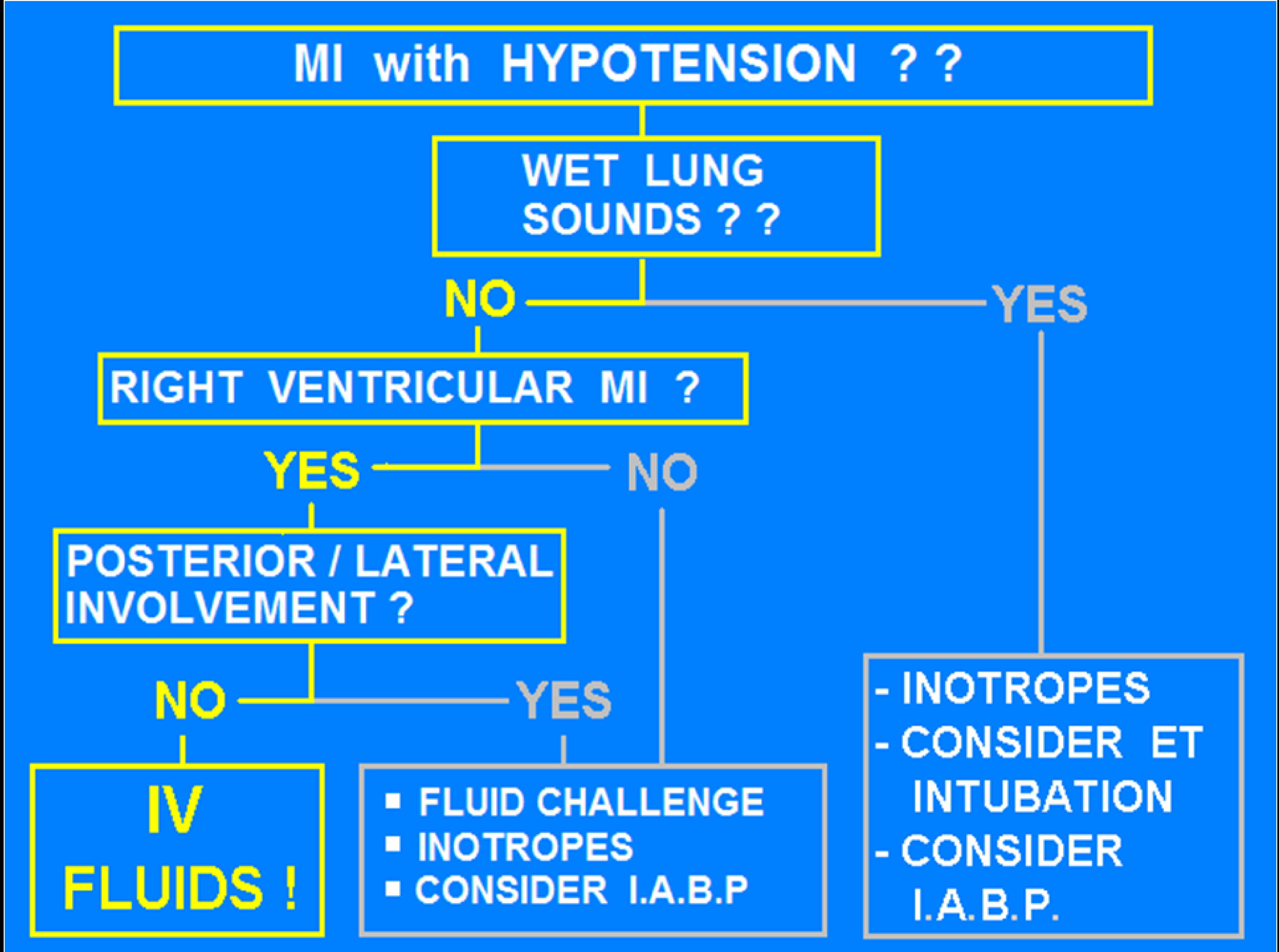
INFERIOR - RIGHT VENTRICULAR MI

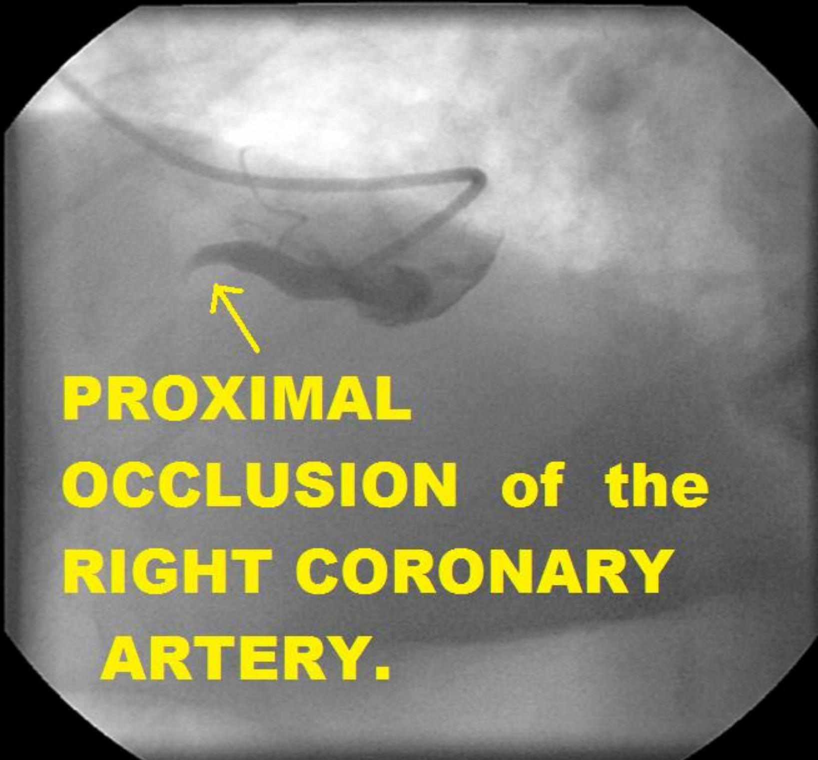


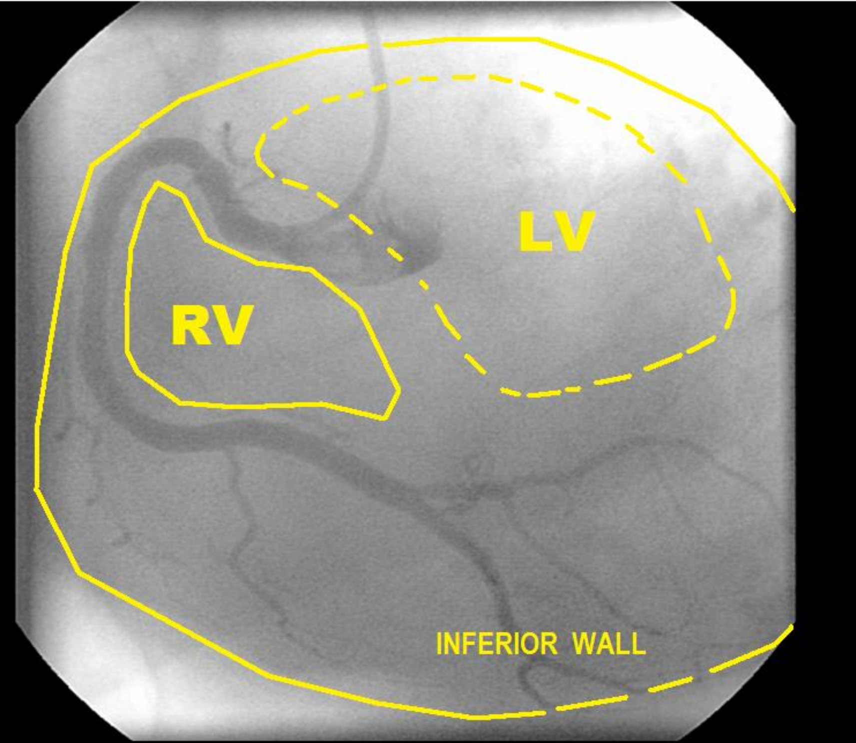
ANTICIPATED COMPLICATIONS of INFERIOR WALL STEMI secondary to
RCA Occlusion & POSSIBLE INDICATED INTERVENTIONS:

- 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.

If this patient becomes HYPOTENSIVE . . . . .


MI with HYPOTENSION ? ?
WET LUNG SOUNDS ? ?
NO
YES
RIGHT VENTRICULAR MI ?
YES
NO
POSTERIOR / LATERAL INVOLVEMENT ?
NO
YES
IV FLUIDS !
▪ FLUID CHALLENGE
▪ INOTROPES
▪ CONSIDER I.A.B.P
- INOTROPES
- CONSIDER ET INTUBATION
- CONSIDER I.A.B.P.





POST PTCA / STENT DEPLOYMENT TO PROXIMAL RCA

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**

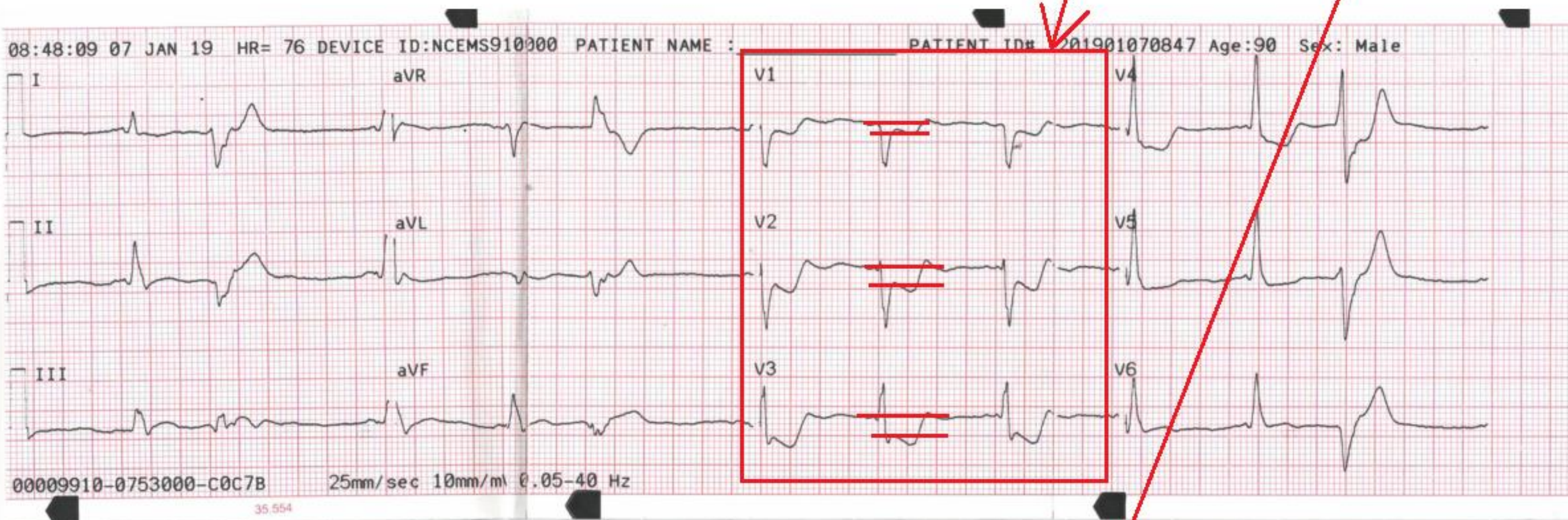
Correlation of Leads with ST Elevation and Cardiac Structures at Risk, based on STEMI in patients with Common Coronary Arterial Anatomy

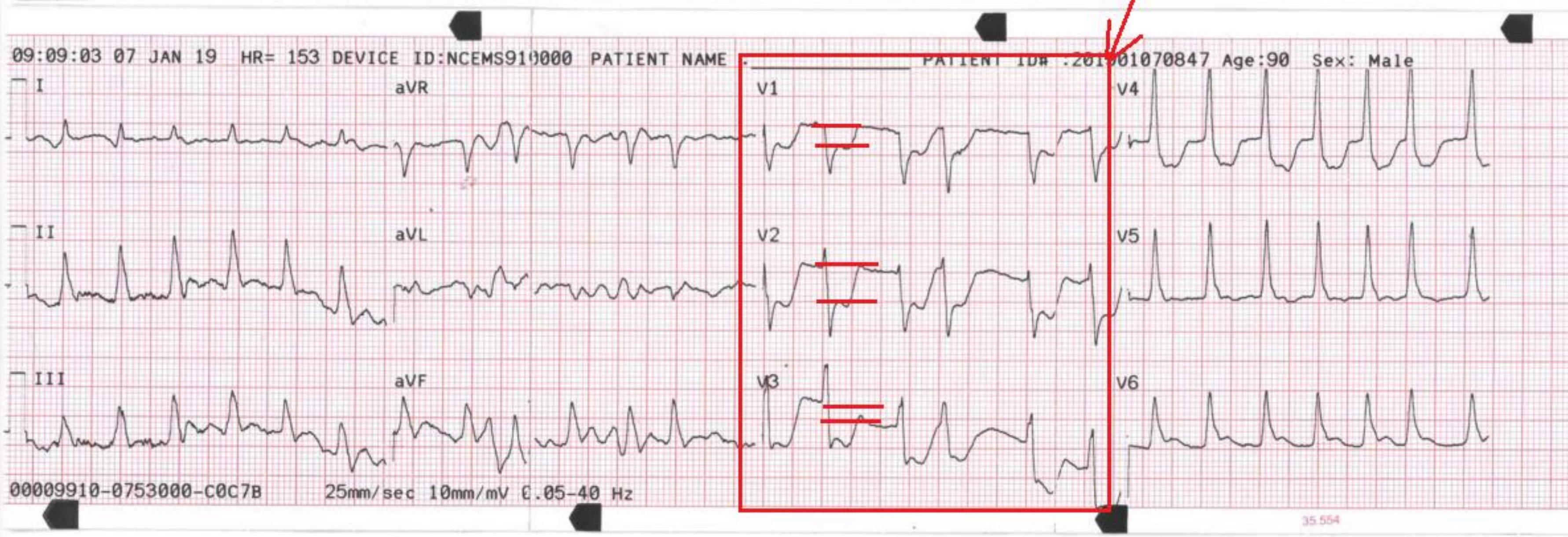
	ECG Leads:	Associated Region:	Coronary Artery:	Structures at Risk:
All Patients	V1 - V4	Anterior and Septal walls of LV	Left Anterior Descending (LAD) Atery	- 35 - 45% of LV muscle mass - Bundle of HIS - Bundle Branches
RCA Dominant	V5 - V6	Lateral wall LV, approx. 50% Posterior wall	Circumflex (Cx) (non - dominant)	- 20 - 30% LV muscle mass - Sinus Node (rare)
	II, III, AVF	Inferior Wall, approx. 50% Posterior wall	Right Coronary Artery (RCA)	- SA Node - Right Ventricle - AV Node
Cx Dominant	V5 - V6 + II, III, AVF	Lateral wall of LV Posterior Wall (all) Inferior Wall	Circumflex (Dominant)	- 45-55% LV muscle mass - SA Node (rare) - AV Node

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
```

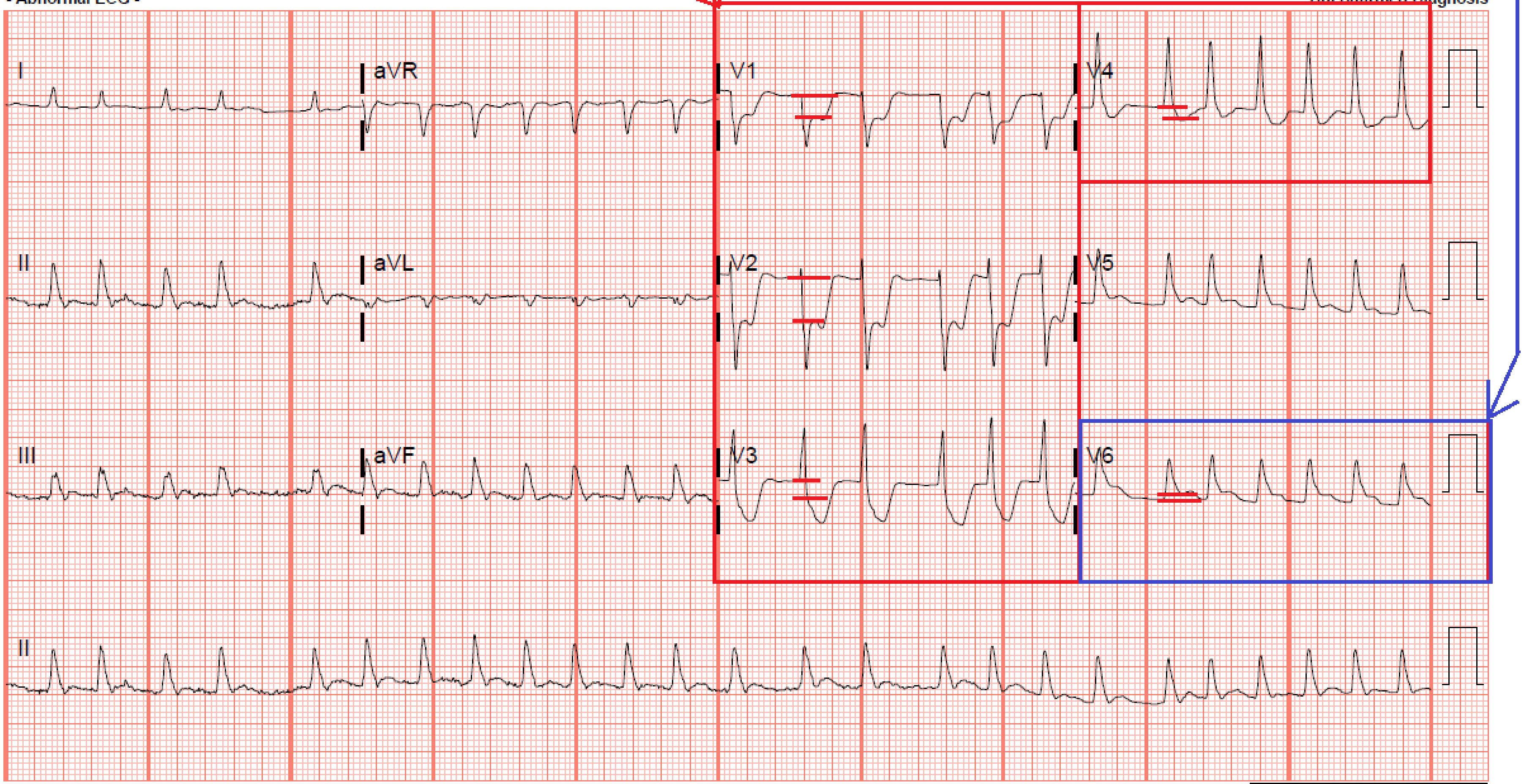
Req Provider:

ST Depression Leads V1 - V4

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

- Abnormal ECG -

Unconfirmed Diagnosis



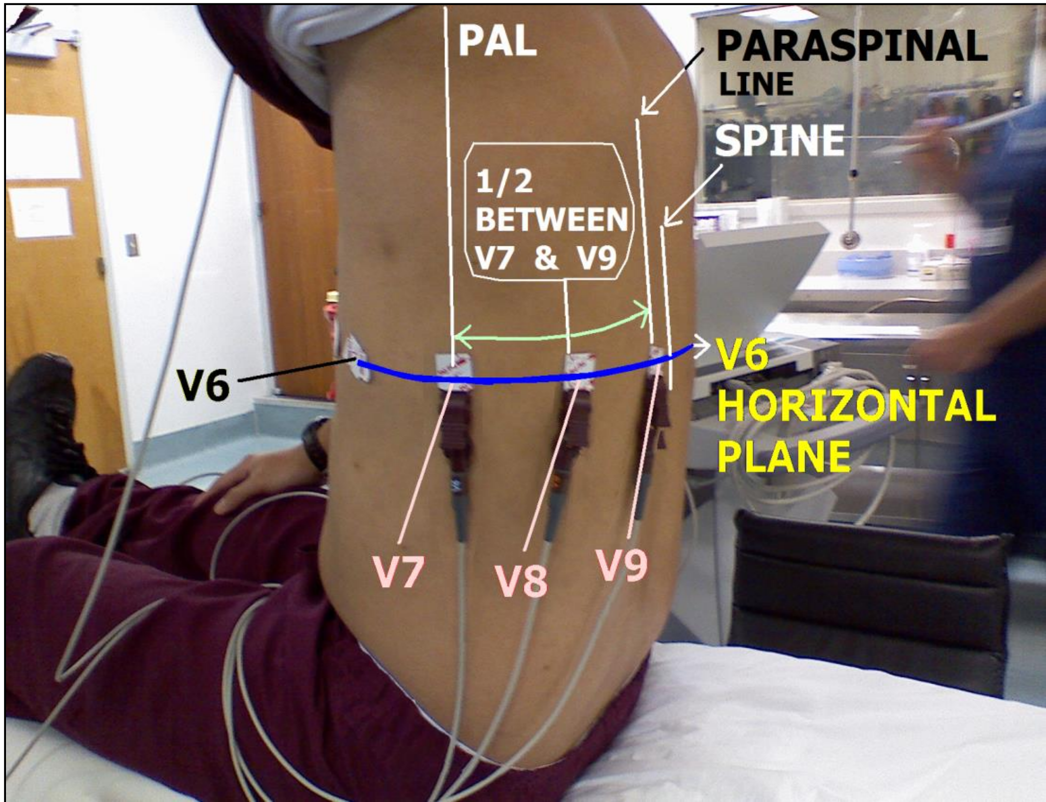
Philips PageWriter TC 25 mm/sec 10.00 mm/mV F 60~ 0.15 - 100 Hz

Causes of ST Depression V1-V4

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

Continued Exam in the ED....

- Upon noting ST Depression in Anterior Leads, 3 leads were placed on the patient's back. The lead wires for V4, V5 and V6, were repositioned, as shown here:
- The "Posterior Lead ECG" is seen on the next slide......



Pat ID [redacted]
[redacted] 79 yrs
RX
DX

01/07/2019 09:23:29

[redacted]
Caucasian Female
Account [redacted]

Bayfront Health Seven Rivers ED
Dept EDHD
Room EDH
Tech gp

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--		** Posterior Infarct - Acute **
P		
QRS	77	
T	121	

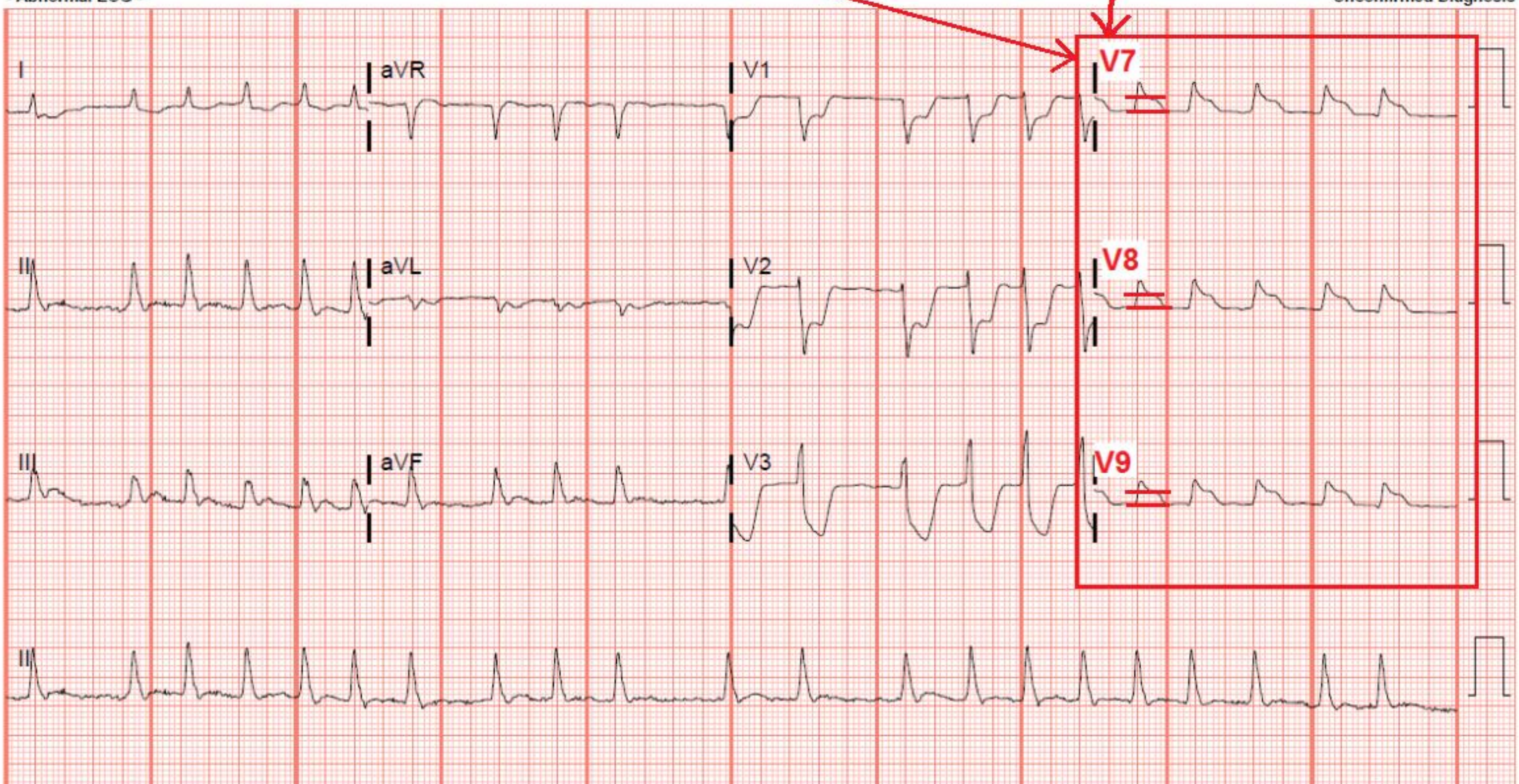
Req Provider: ONIER VILLARREAL

ACUTE POSTERIOR WALL STEMI

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."

- Abnormal ECG -

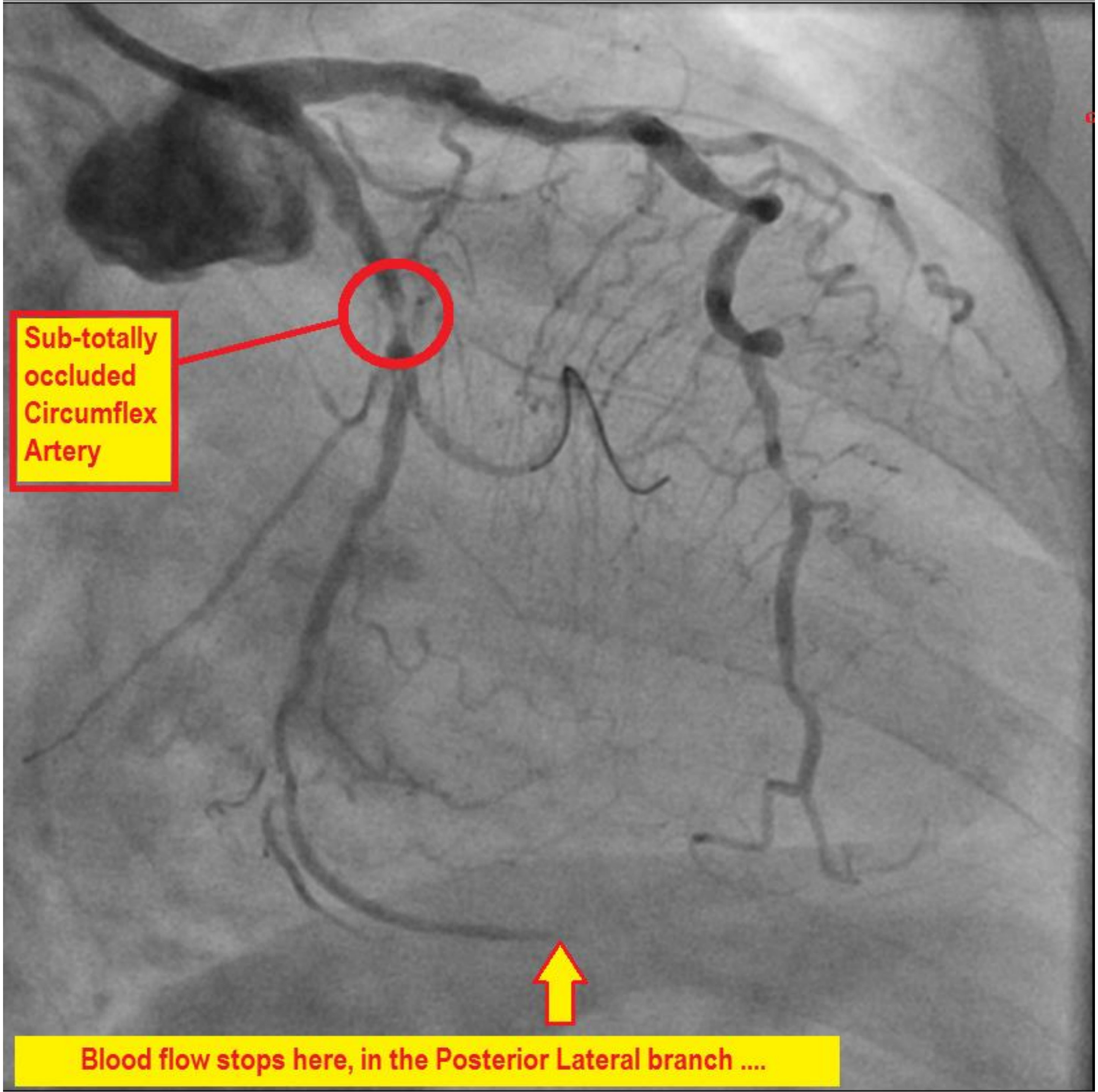
Unconfirmed Diagnosis

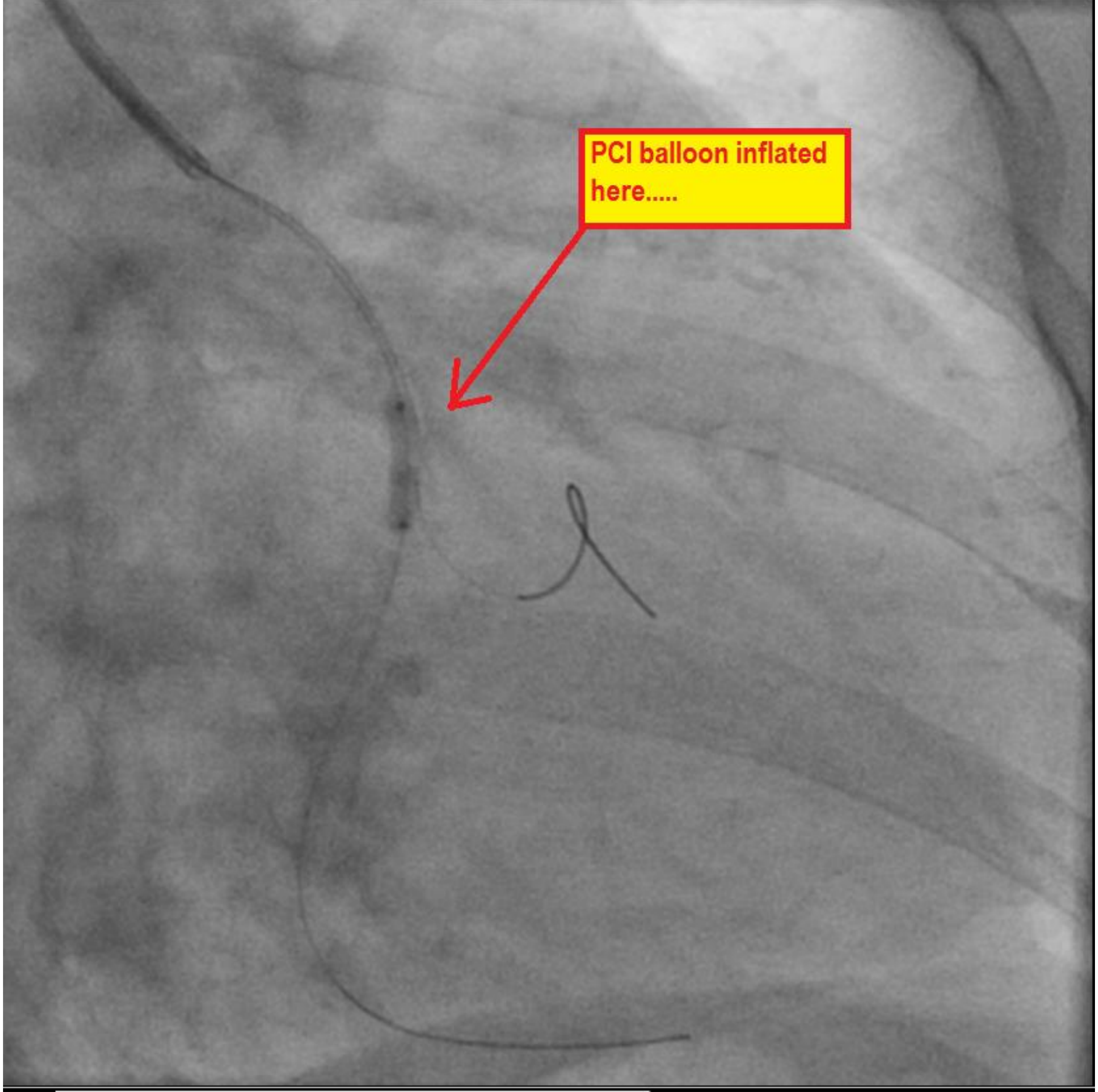


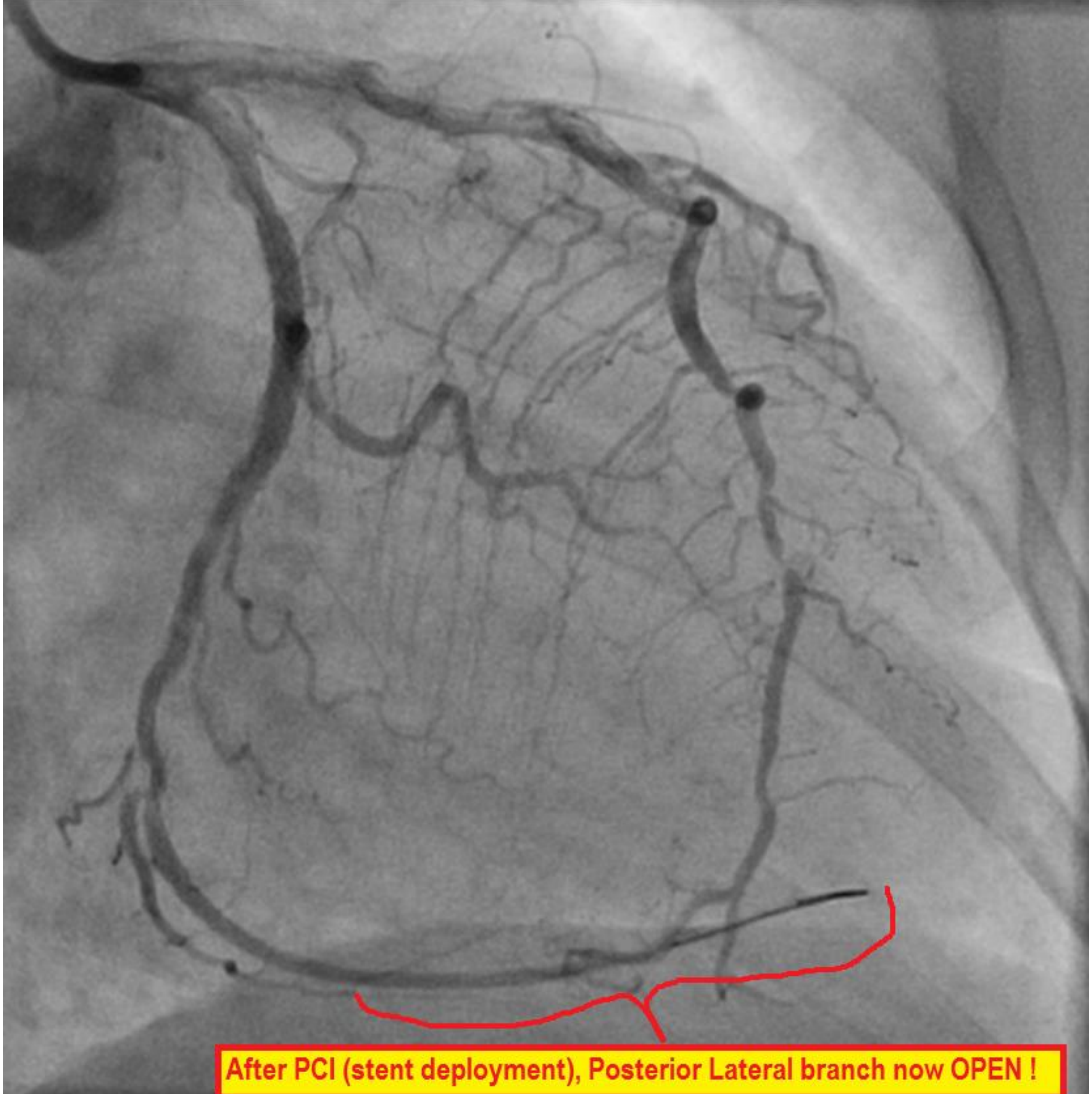
Philips PageWriter TC 25 mm/sec 10.00 mm/mV F 60~ 0.15 - 100 Hz

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.**

YOU MADE IT !!!

Any

???

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