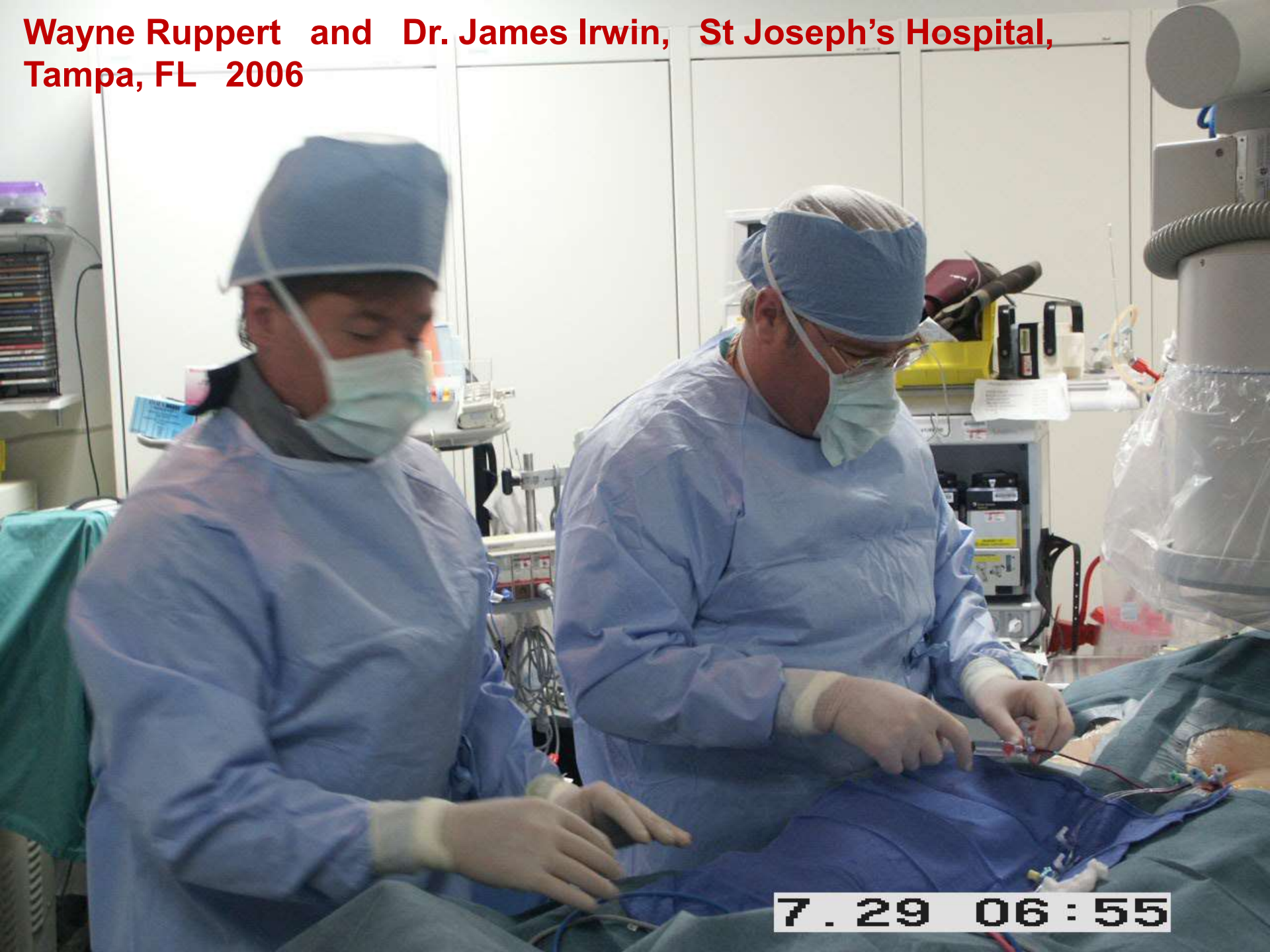
Bayfront Health
Seven Rivers

“The EMS 12 Lead – 101”

Wayne W Ruppert, CVT, CCCC, NREMT-P
Interventional Cardiovascular Technologist
Cardiovascular Coordinator
Bayfront Health Seven Rivers

Welcome !

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


Wayne Ruppert and Dr. James Irwin, St Joseph's Hospital, Tampa, FL 2006
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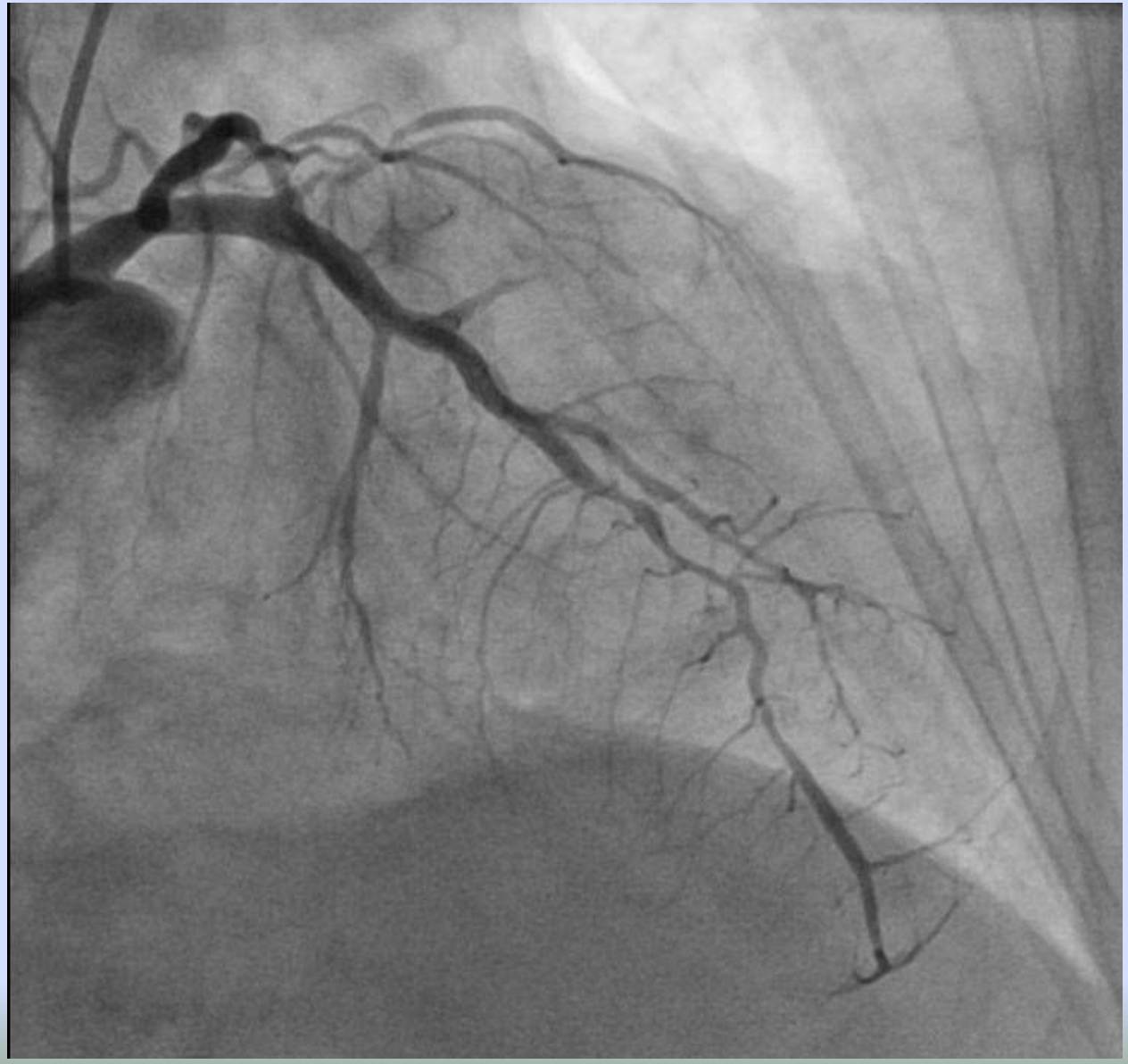
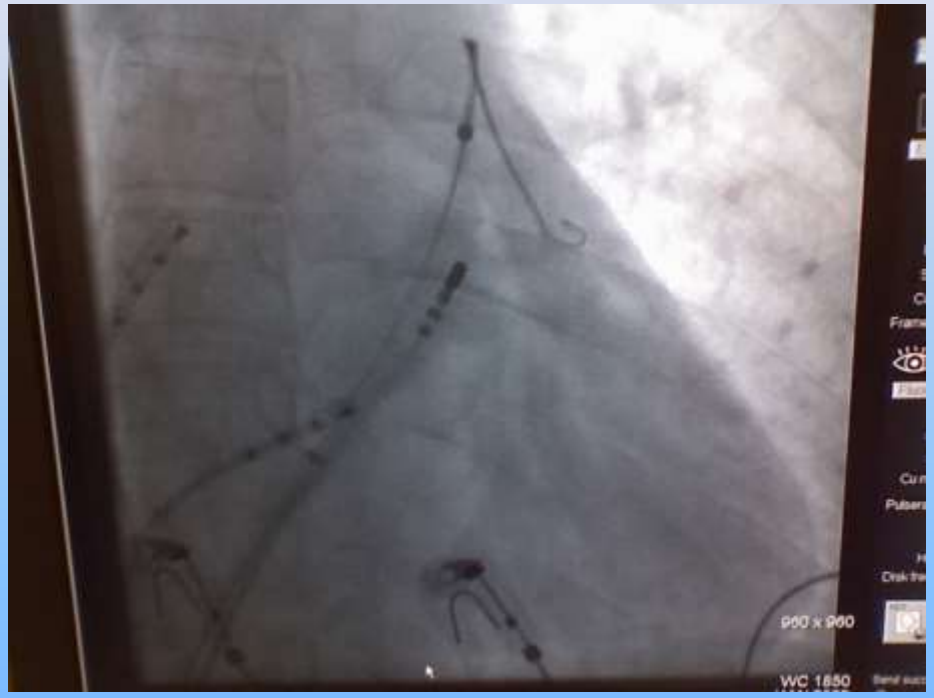
Cardiac Cath Lab

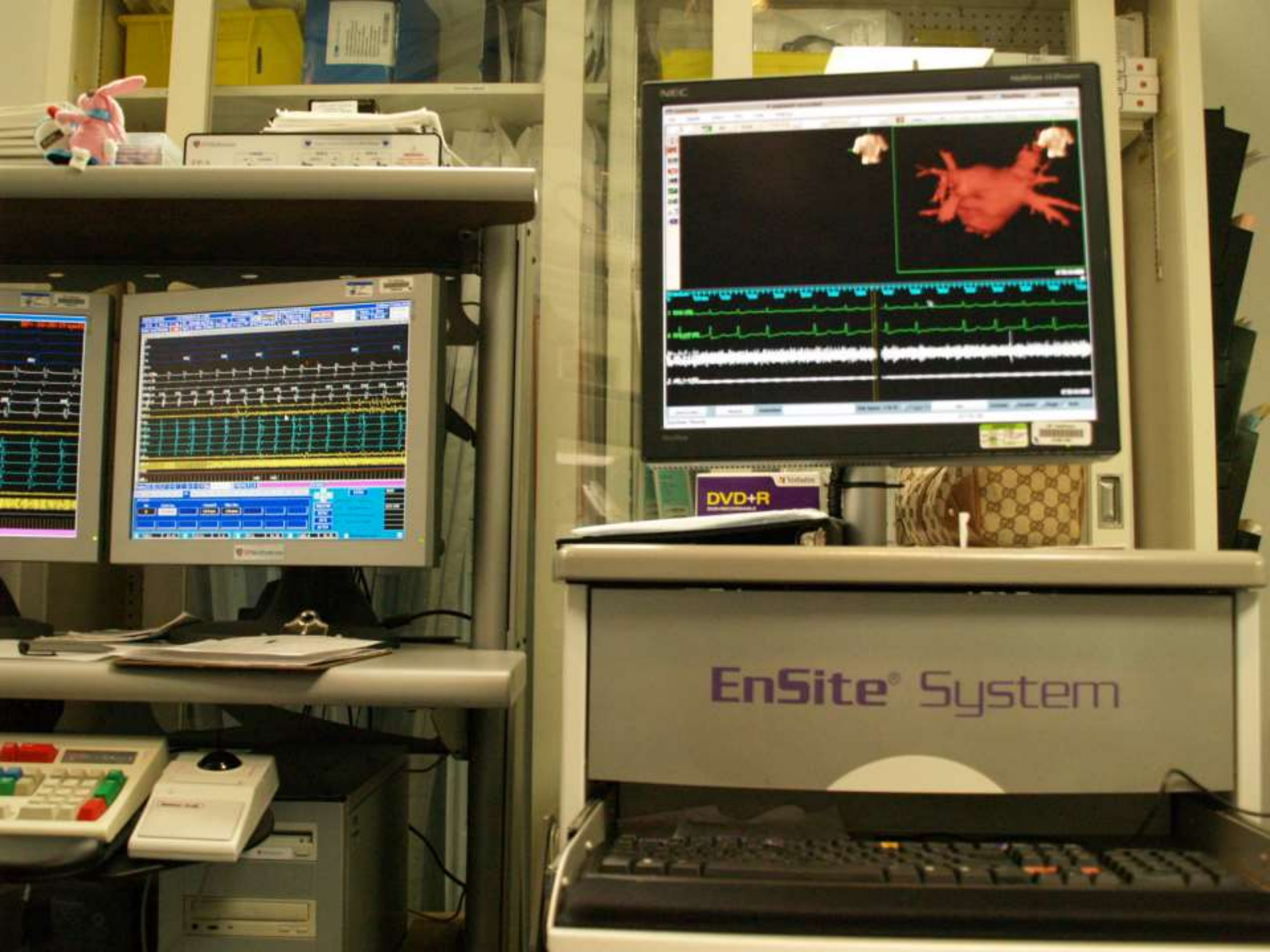


Electrophysiology Lab



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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Wayne Ruppert bio:

- Cardiovascular Coordinator 2012-present (coordinated 5 successful accreditations)
- Interventional Cardiovascular / Electrophysiology Technologist, 1995-Present.
- 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)
- Website: www.ECGtraining.org

In the CARDIAC CATHETERIZATION LAB, we read our patients' 12 Lead ECGs and then evaluate their coronary arteries and ventricular function during angiography. Stated in plain English, *we rapidly learn how to correlate 12 lead ECG findings with what's really going on inside our patients' hearts.* Seeing ECGs from this perspective adds a new dimension to understanding the complex pathophysiologies of cardiovascular disease.

This book prepares you to:

- INTERPRET 12 Lead ECGs.
- ASSIMILATE DATA derived from the 12 Lead ECG into a comprehensive patient evaluation process designed to maximize diagnostic accuracy, while taking into consideration the 12 Lead ECGs inherent LACK of SENSITIVITY and SPECIFICITY.
- IDENTIFY 13 PATTERNS associated with myocardial ischemia and infarction, including the most subtle ECG changes often missed by clinicians and the ECG machine's computerized interpretation software.
- CORRELATE each lead of the ECG with specific regions of the heart – and the CORONARY ARTERIAL DISTRIBUTION that commonly supplies it. In cases of STEMI, this knowledge prepares you to ANTICIPATE the FAILURE OF CRITICAL CARDIAC STRUCTURES – often *BEFORE THEY FAIL.*

For those who need to master essential material quickly, this book has been written with an expedited learning" feature, *designed to make learning as easy as 1 2 3:*

1. **READ the YELLOW HIGHLIGHTED TEXT**
2. **STUDY the GRAPHIC IMAGES, PICTURES and ECGs**
3. **CORRECTLY ANSWER the REVIEW QUESTIONS at the end of each section.**

This is an invaluable resource for every medical professional who evaluates patients and reads their 12 lead ECGs:

- *Fellows in Emergency, Cardiology, and Family Medicine*
- *Medical Residents*
- *Veteran Physicians wanting a good review in ACS patient evaluation*
- *Physician Assistants and Nurse Practitioners*
- *Emergency Department Nurses*
- *Coronary Care Unit and Cardiac Telemetry Nurses*
- *Walk-in Clinic Physicians and Nurses*
- *Paramedics*

"I think this book will be a wonderful addition to the textbooks that are already available, with a fresh perspective"

Joseph P. Ornato, MD, FACP, FACC, FACEP
- Professor and Chairman, Department of Emergency Medicine
Medical College of Virginia/Virginia Commonwealth University
- Medical Director, Richmond Ambulance Authority,
Richmond, Virginia

"This book integrates academic ECG principles with real-world clinical practice by incorporation of well chosen cath lab case studies into its curriculum. This combination lets readers see patients and their ECGs through the eyes of an experienced cath lab interventionalist, and provides a balanced approach to patient evaluation that compensates for the ECGs inherent lack of sensitivity and specificity. I highly recommend this book for all Emergency Medicine and Cardiology Fellows. For experienced clinicians, it's a superb review."

Humberto Coto, MD, FACP, FACC
- Chief of Interventional Cardiology
St. Joseph's Hospital
Tampa, Florida

ISBN 978-0-9829170-1-3
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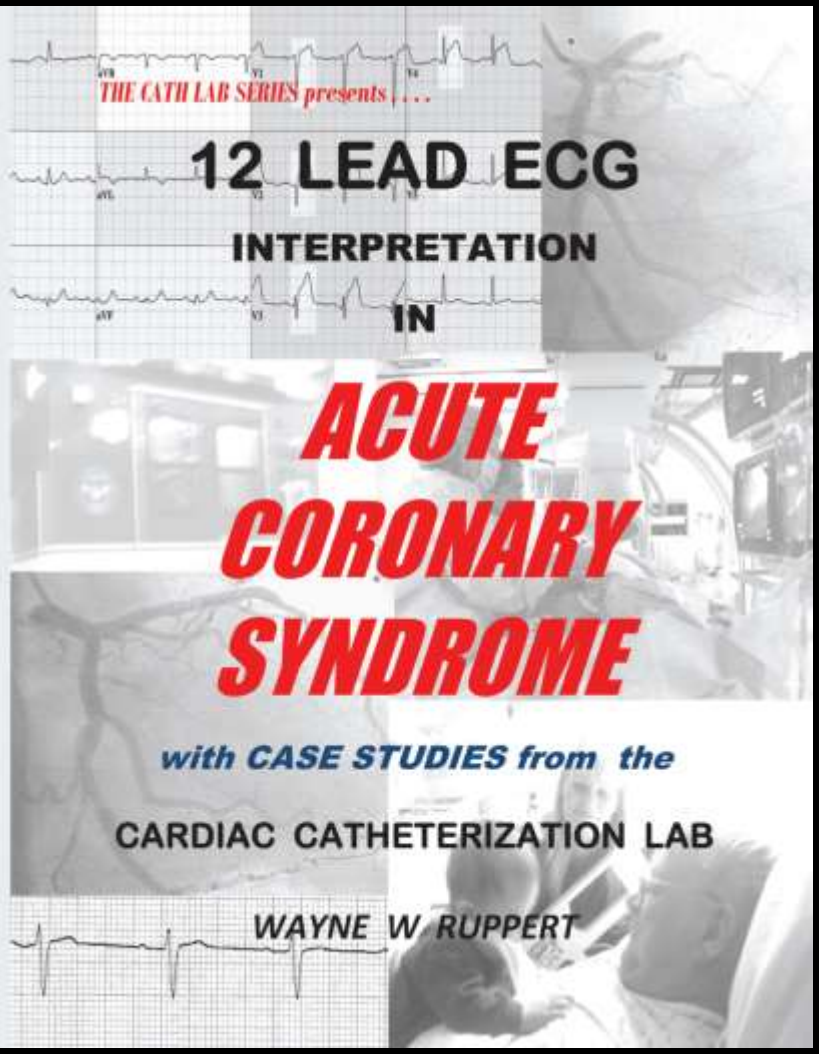
12 LEAD ECG INTERPRETATION in ACUTE CORONARY SYNDROME with CASE STUDIES from the CATH LAB – WAYNE RUPPERT



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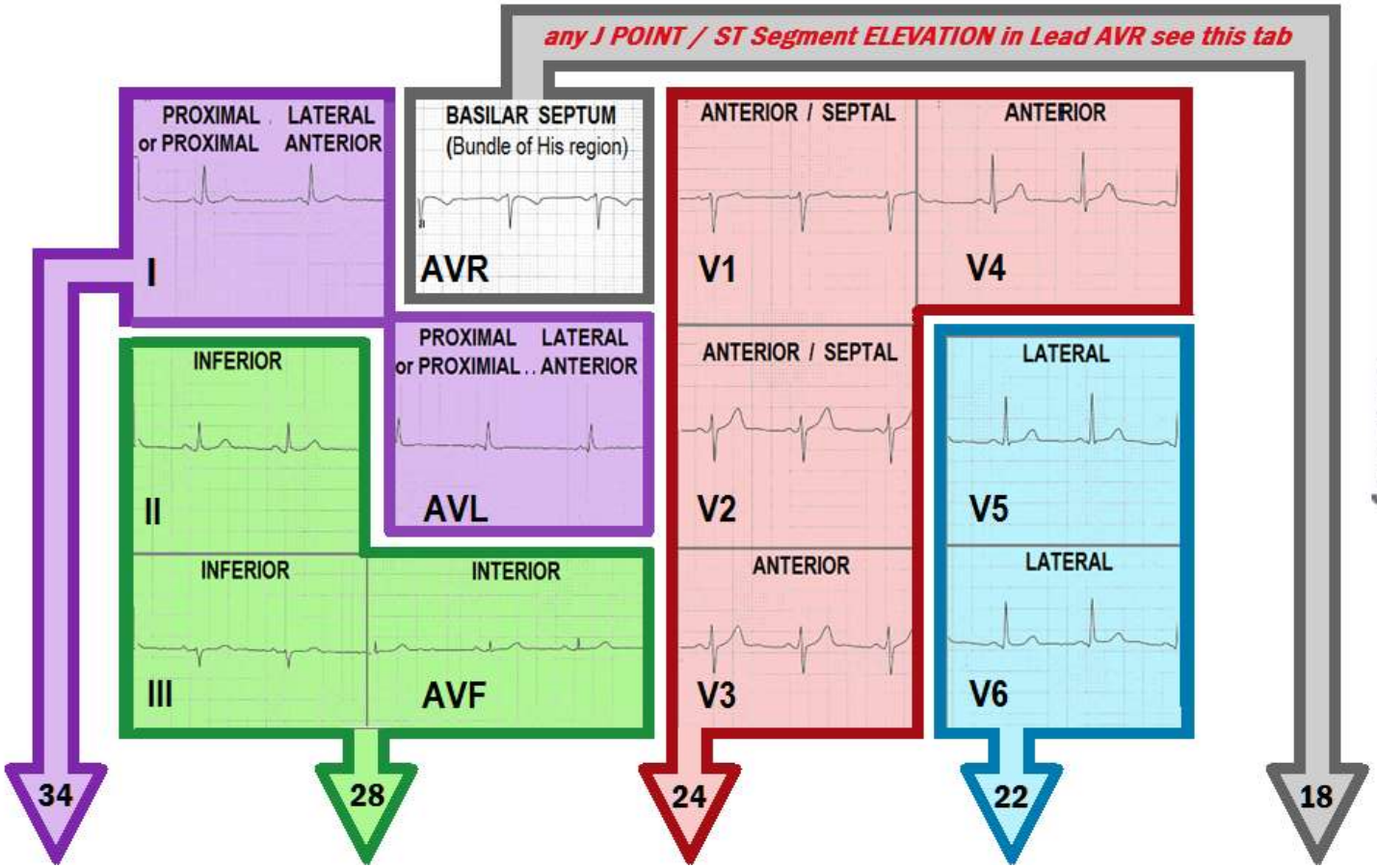
STEMI Assistant

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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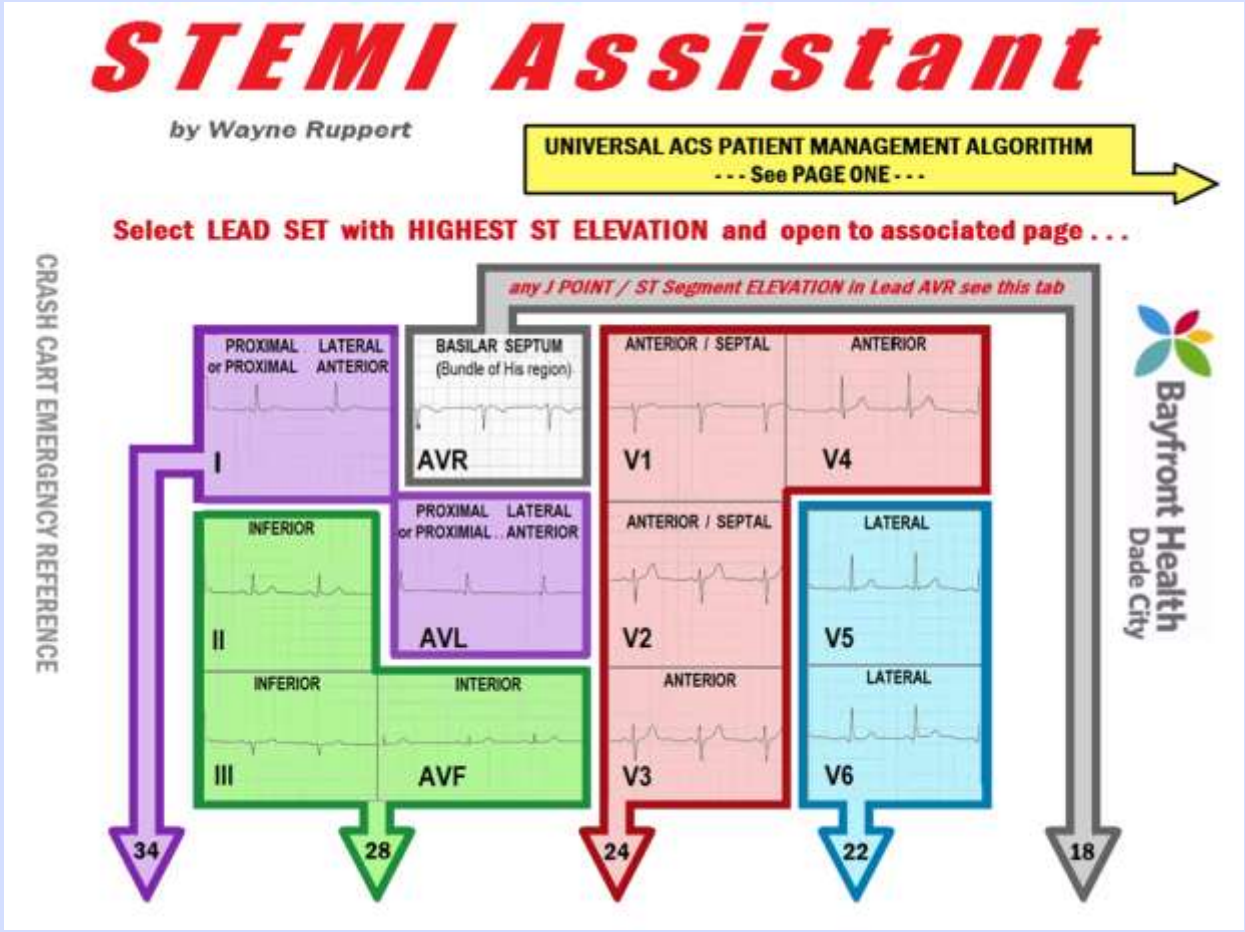

STEMI Assistant – Information Video

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Wayneruppert@aol.com

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October 25 & 26, 2017

Advanced Telemetry & 12 Lead ECG Workshop – Part 1

Observation Medicine Tract

By: Wayne W Ruppert, CVT, CCCC, NREMT-P

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Single Lead ECG – vs – 12 Leads

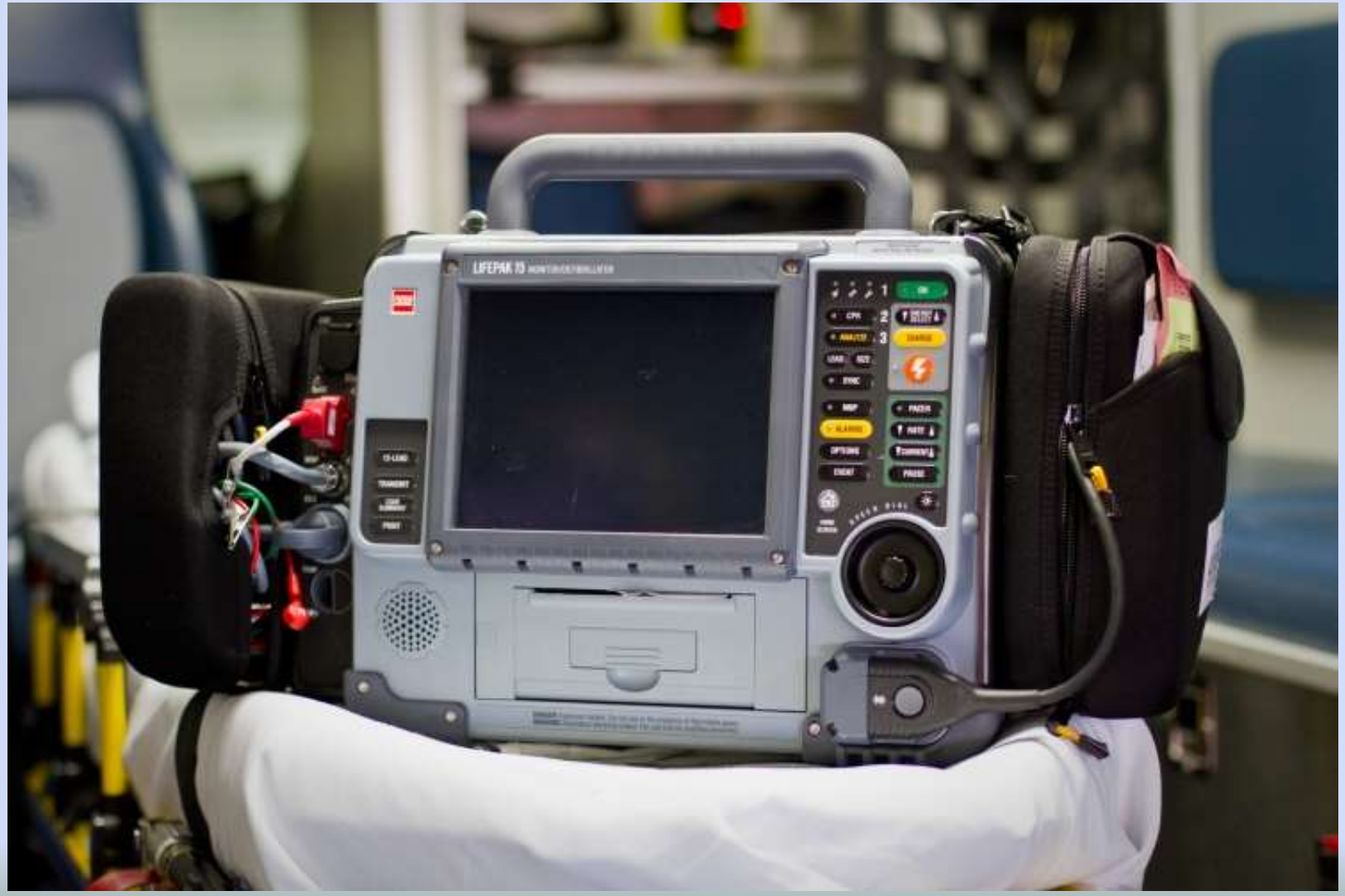
- Single lead "rhythm strips" are obtained to see *what rhythm the patient is currently in* (e.g.: NSR, atrial fibrillation, heart blocks, etc).
- 12 Lead ECG is used to see *if any part of the heart is not getting adequate blood supply* (i.e.: ischemia, infarction). Plus, it aids in the diagnosis of many other conditions……..

….Other 12 Lead ECG Diagnoses:

- **Bundle Branch Blocks* and Fascicular Blocks**
- **Necrosis (old MI, evolving MI*)**
- **V-Tach –vs– SVT with aberrancy**
- **Hypertrophy (enlargement of 1 or more chambers)**
- **Electrolyte imbalances**
- **Sudden Arrhythmia Death Syndromes:**
  - **Brugada, Long QT*, ARVD, CPVT, HCM,**
- **Wolff-Parkinson-White Syndrome**
- **Acute Myocarditis / Pericarditis**
- **And many more**

*** Covered in this course**

EMS 12 Lead ECG



OBTAINING
THE
12 LEAD ECG

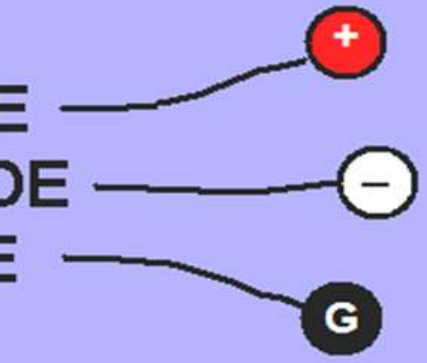
10 wires . . .

- 4 limb leads
- 6 chest (“V”) leads

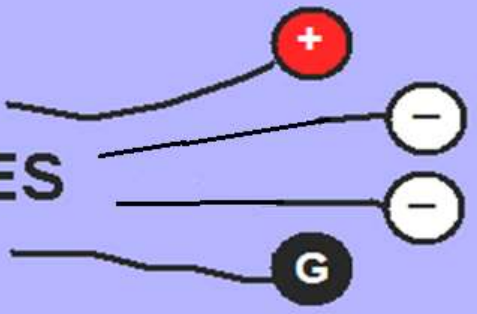
THE ECG MACHINE

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

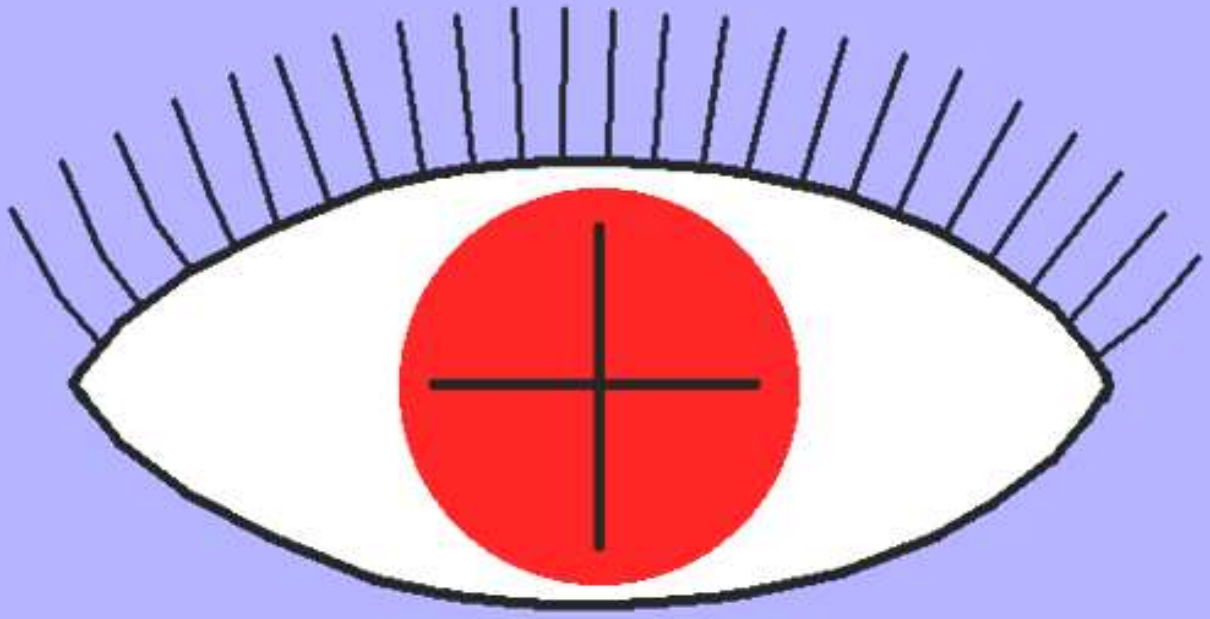
- LEADS I, II, III, and V1, V2, V3, V4, V5, V6



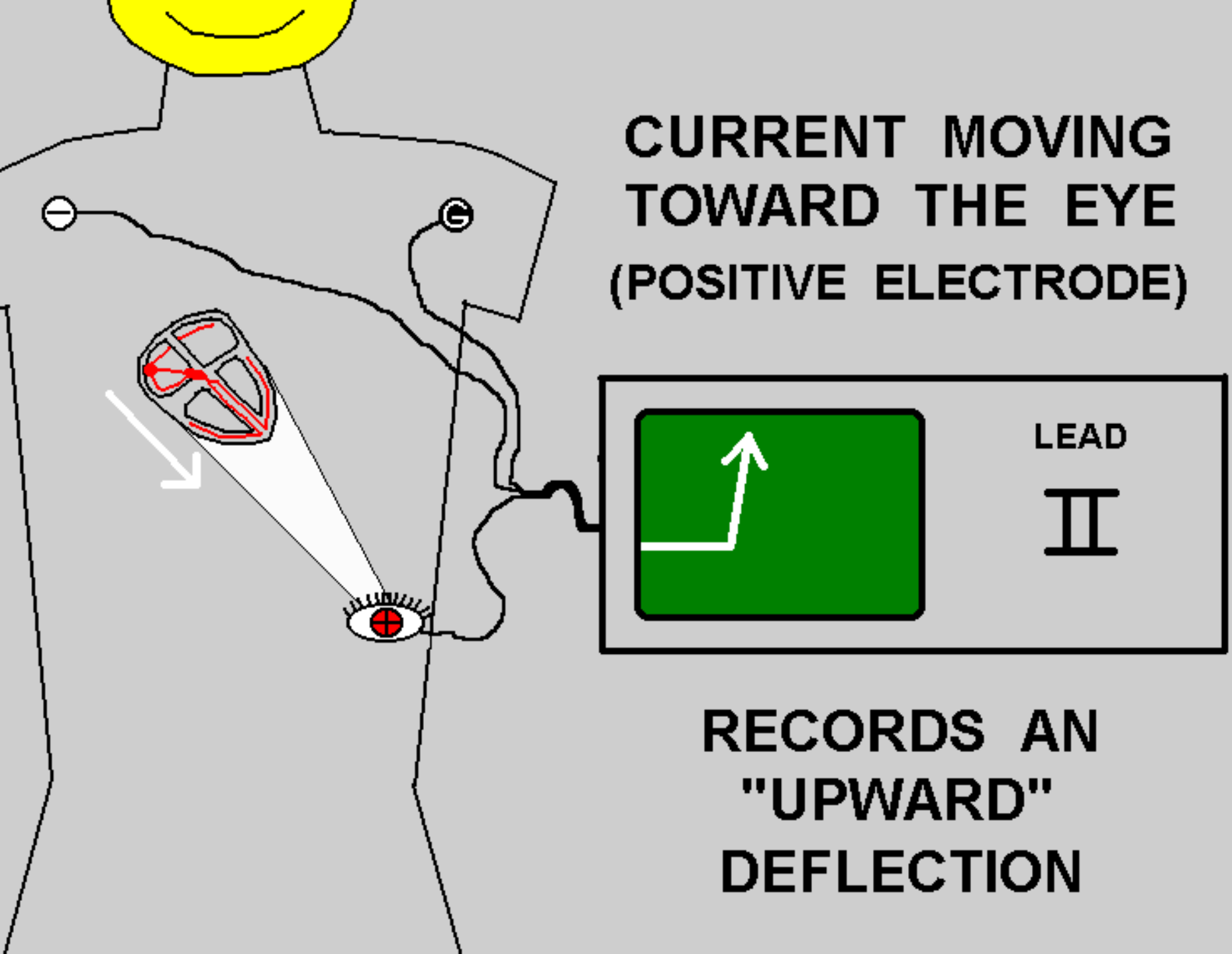
- LEADS AVR, AVL, and AVF

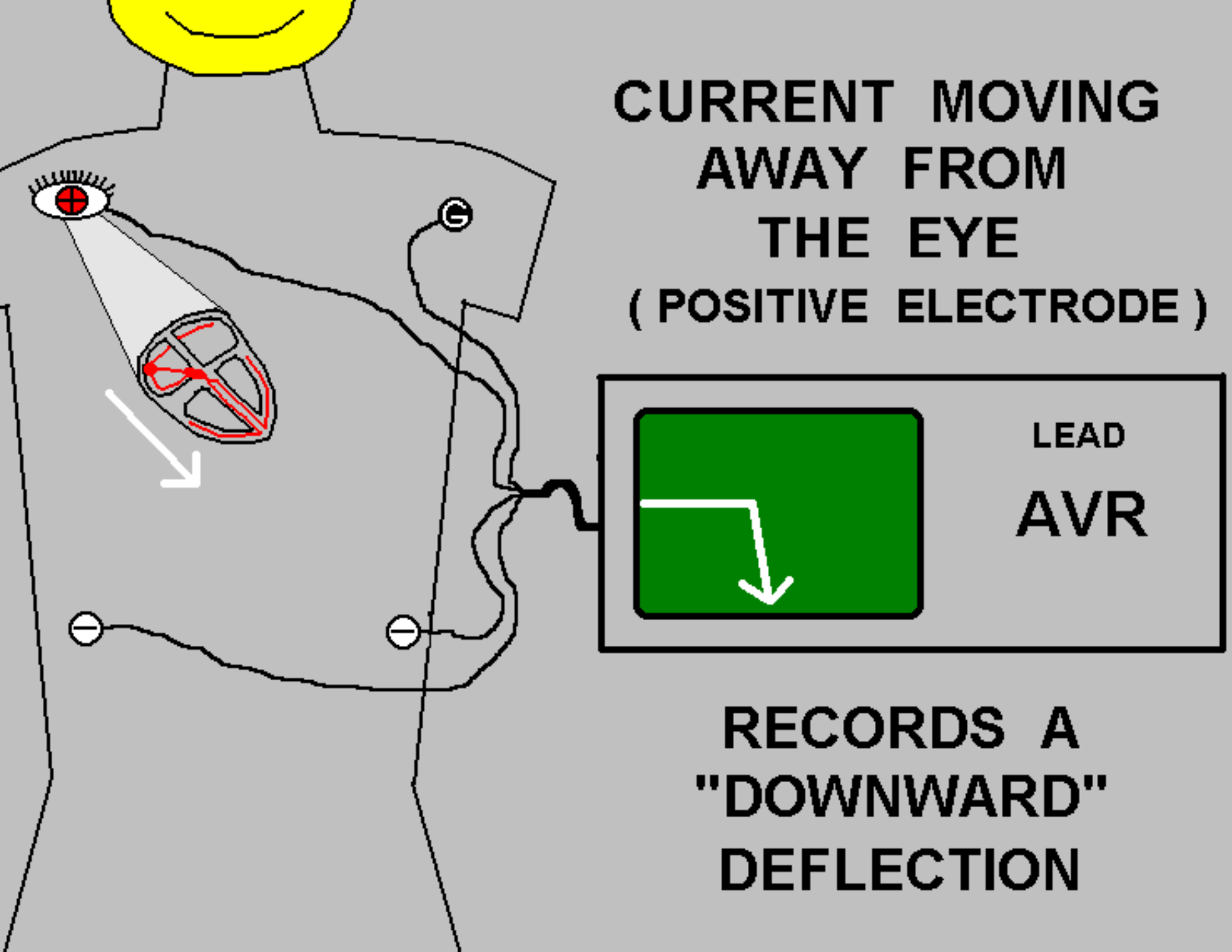


THE POSITIVE ELECTRODE

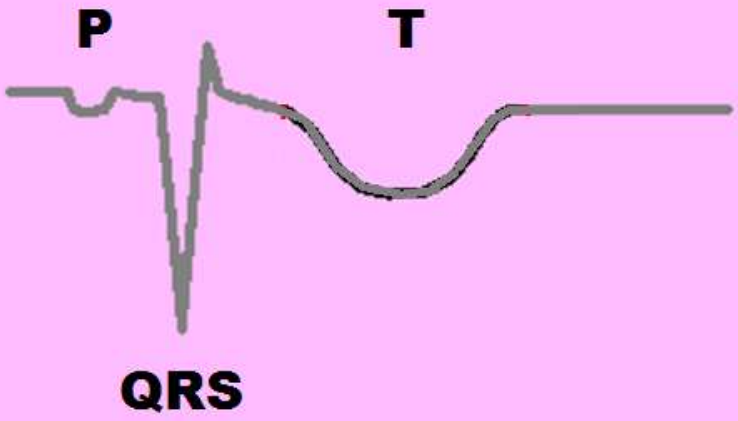


IS THE "EYE" . . .


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


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

LEAD AVR

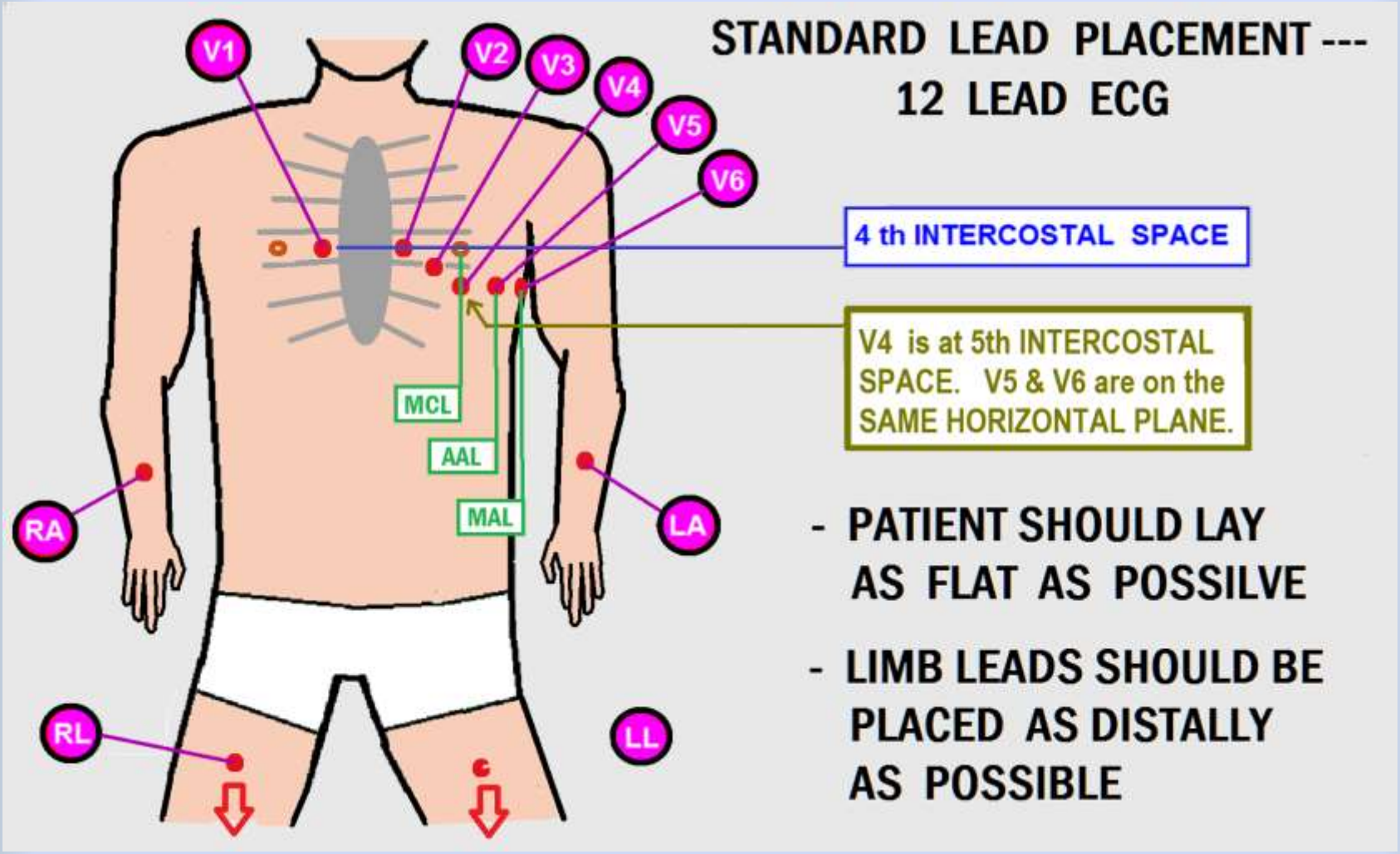


EVERYTHING

IS

"UPSIDE-DOWN"

Obtaining the 12 Lead ECG



Obtaining the 12 Lead ECG

- **Limb leads should be on the limbs.**

Obtaining the 12 Lead ECG

Recent AHA/ACC/HRS literature indicates QRS AMPLITUDE, Q WAVE DURATION, AXIS and WAVEFORM DEFLECTION can be altered when limb leads are placed on the patient's torso (Mason-Likar lead placement).

Therefore every effort should be made to place limb leads on the limbs.

AHA/ACC/HRS Scientific Statement

Recommendations for the Standardization and Interpretation of the Electrocardiogram

Part I: The Electrocardiogram and Its Technology

affected by monitoring lead placement; however, tracings that use torso electrodes differ in important ways from the standard 12-lead ECG. In addition to body position differences that affect the ECG,[109] monitoring electrodes placed on the trunk do not provide standard limb leads, and distortion of the central terminal alters the augmented limb leads and the precordial leads.[110,111] Tracings with Mason-Likar and other alternative lead placement may affect QRS morphology more than repolarization compared with the standard ECG; these differences can include false-negative and false-positive infarction criteria.[81,112] Motion artifact of the limbs is a particular problem for routine recording in neonates, infants, and

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Recommendations

ECGs recorded with torso placement of the extremity electrodes cannot be considered equivalent to standard ECGs for all purposes and should not be used interchangeably with standard ECGs for serial comparison. Evaluation of the effect of torso placement of limb leads on waveform amplitudes and

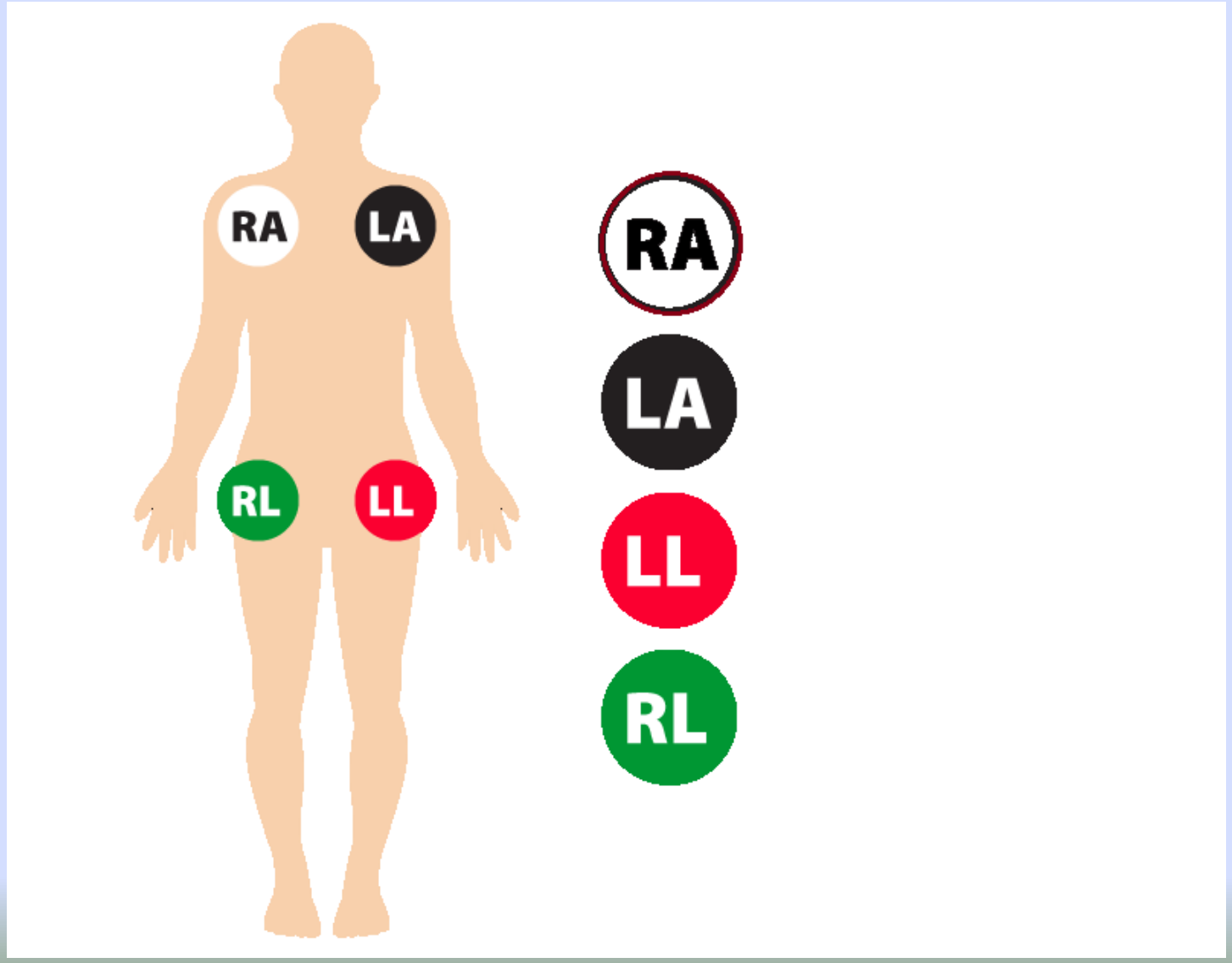
Obtaining the 12 Lead ECG

- **Limb leads should be on the limbs.**
- **When emergency circumstances dictate that limb leads be placed on patient's torso, the words "LIMB LEADS ON PATIENT'S TORSO" should be noted on the ECG.**

Obtaining the 12 Lead ECG

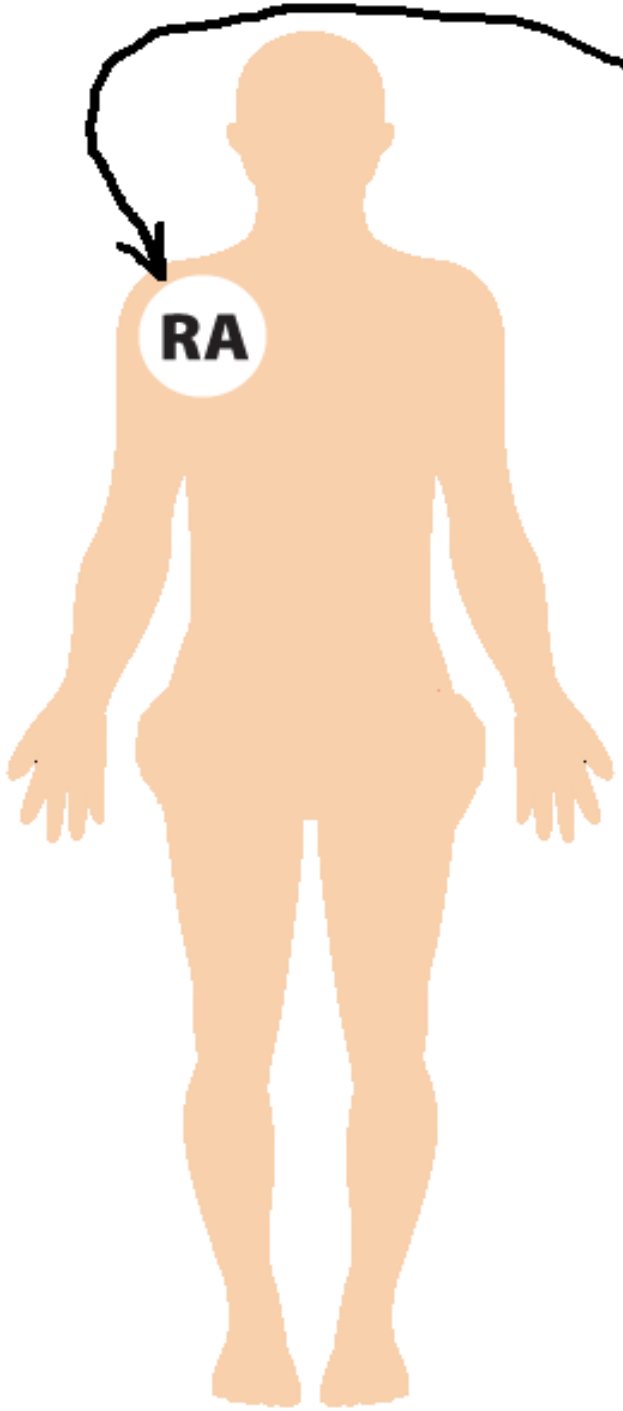
- **Limb leads should be on the limbs.**
- **When emergency circumstances dictate that limb leads be placed on patient's torso, the words "LIMB LEADS ON PATIENT'S TORSO" should be noted on the ECG.**
  - ***However in the field, it may not be possible or practical to put limb leads on limbs!***

Limb leads – field ECG

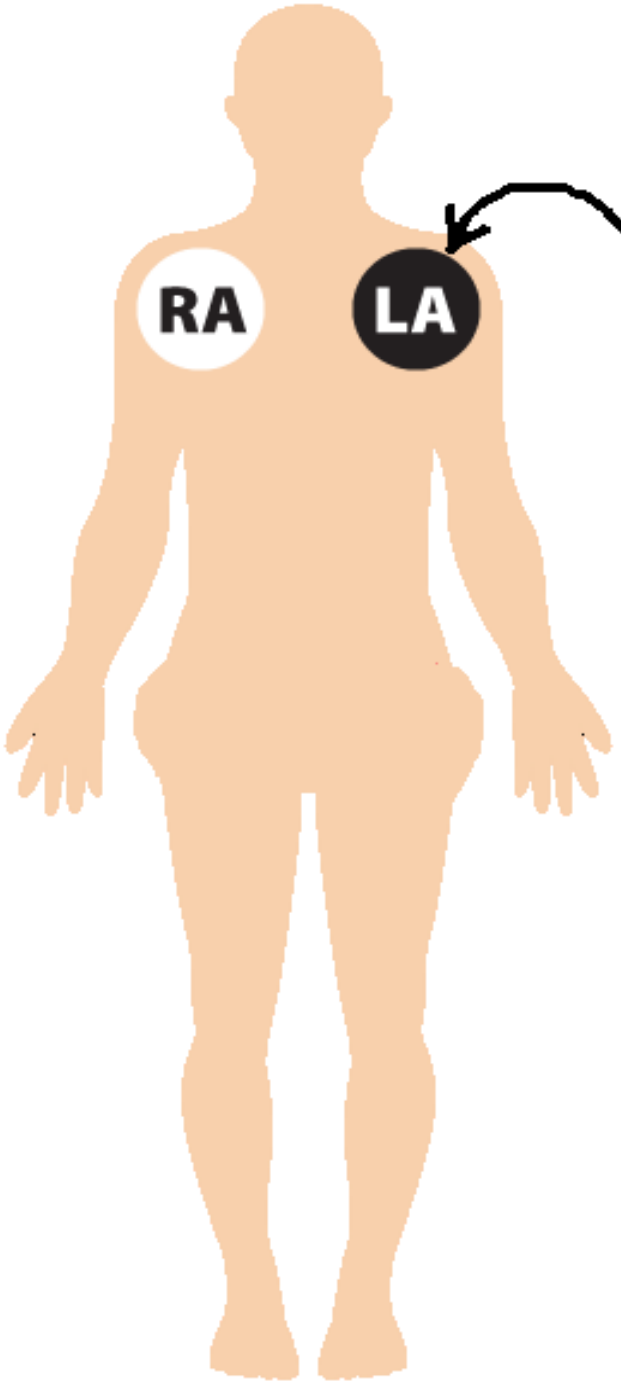


Remember this . . .

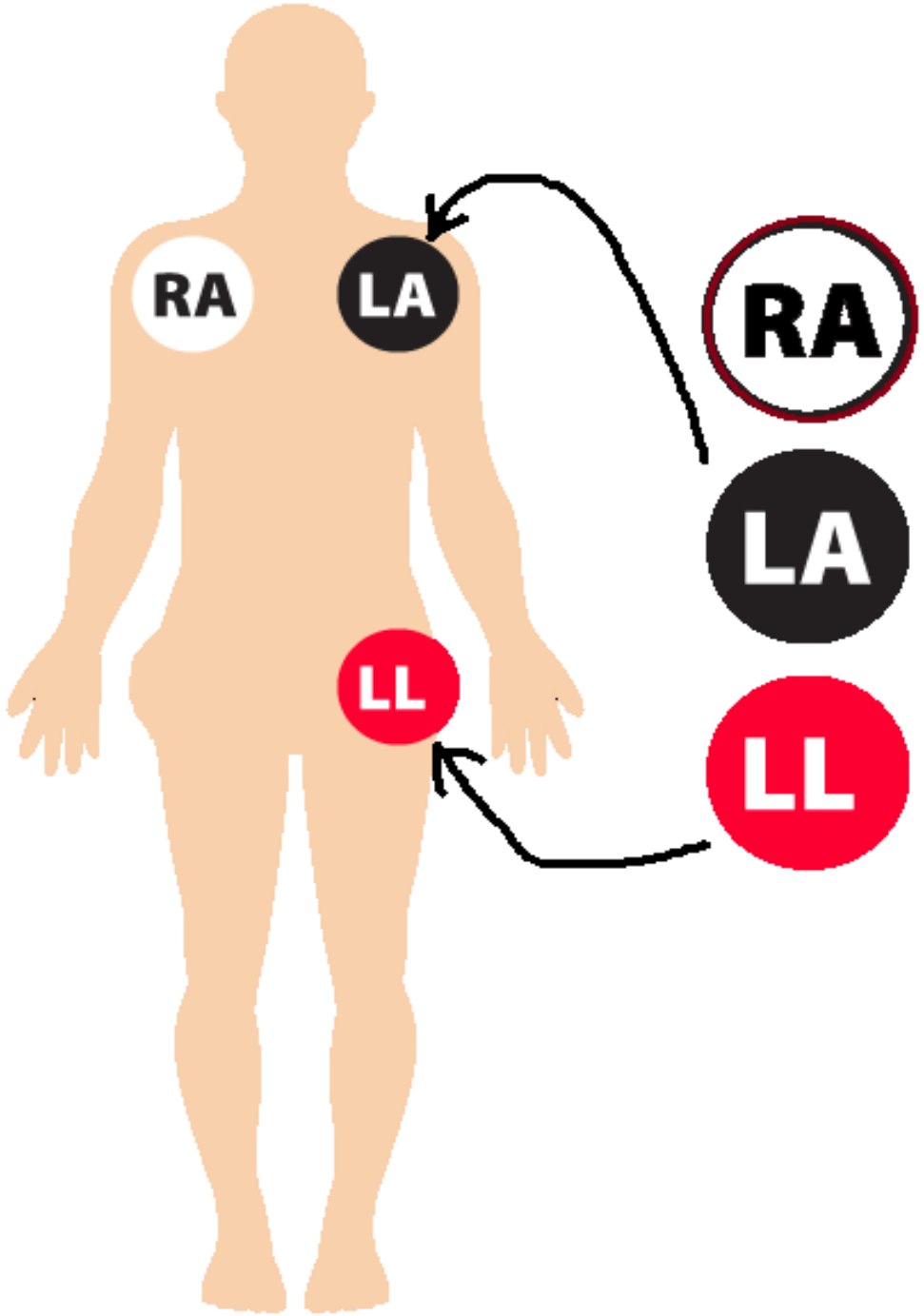
- White to the Right
- Smoke over Fire
- Green Grass below the White Clouds



"White to the Right" . . . .



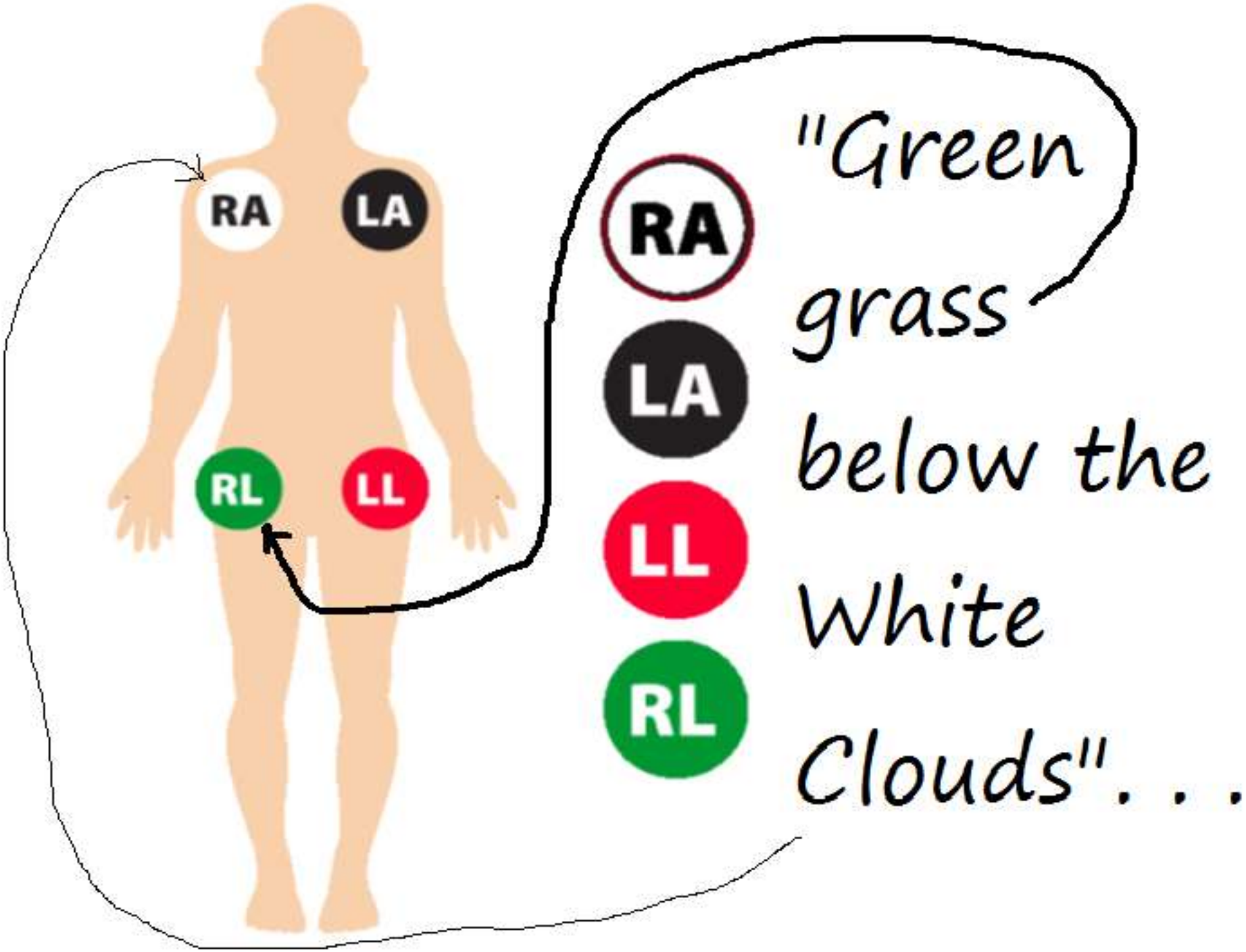
" Smoke . . .



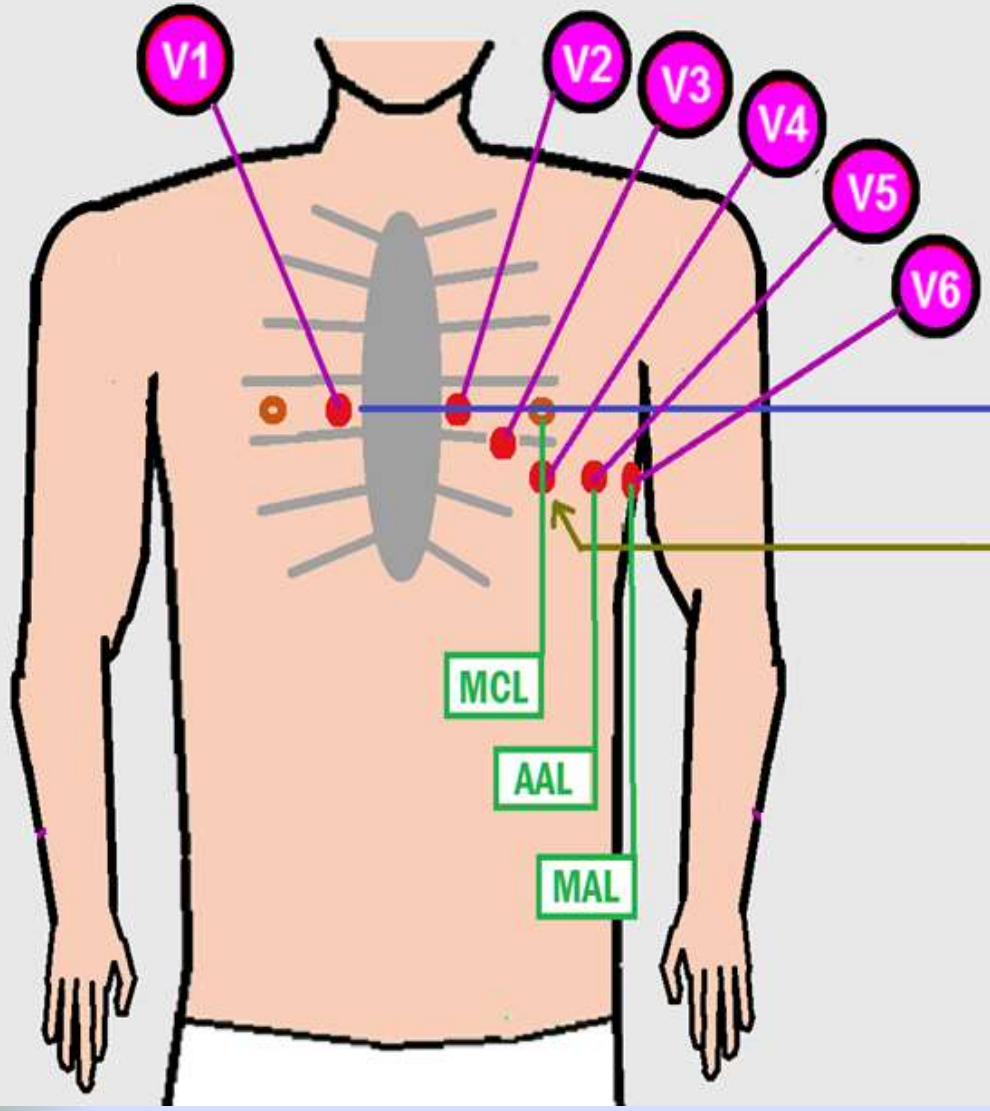
" Smoke . . .

over

Fire" !!


RA
LA
RL
LL
RA
LA
LL
RL
"Green grass below the White Clouds". . .

Chest Lead Placement



4 th INTERCOSTAL SPACE

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

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.**

AHA/ACC/HRS Scientific Statement

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Part I: The Electrocardiogram and Its Technology

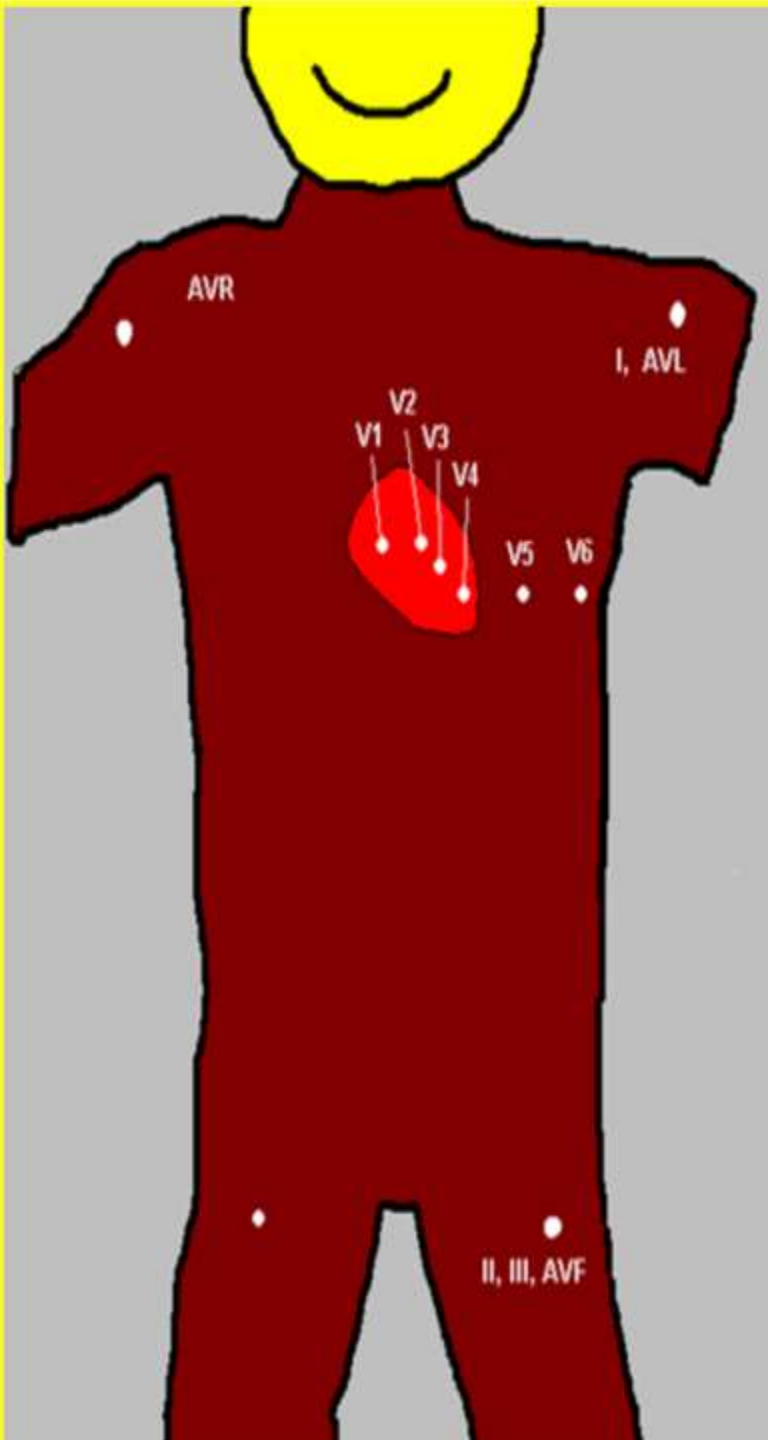
the often profound alterations in waveforms that can result from precordial electrode misplacement.[85,86] A common error is superior misplacement of V_1 and V_2 in the second or third intercostal space. This can result in reduction of initial R-wave amplitude in these leads, approximating 0.1 mV per 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]

Obtaining the 12 Lead ECG, etc

- Patient should lay as flat as possible
- If you see too much “artifact” on the ECG, you may have to coach patient to “relax all of your muscles” . . .
  - Arms
  - Legs
  - Chest
  - Abdomen, etc.

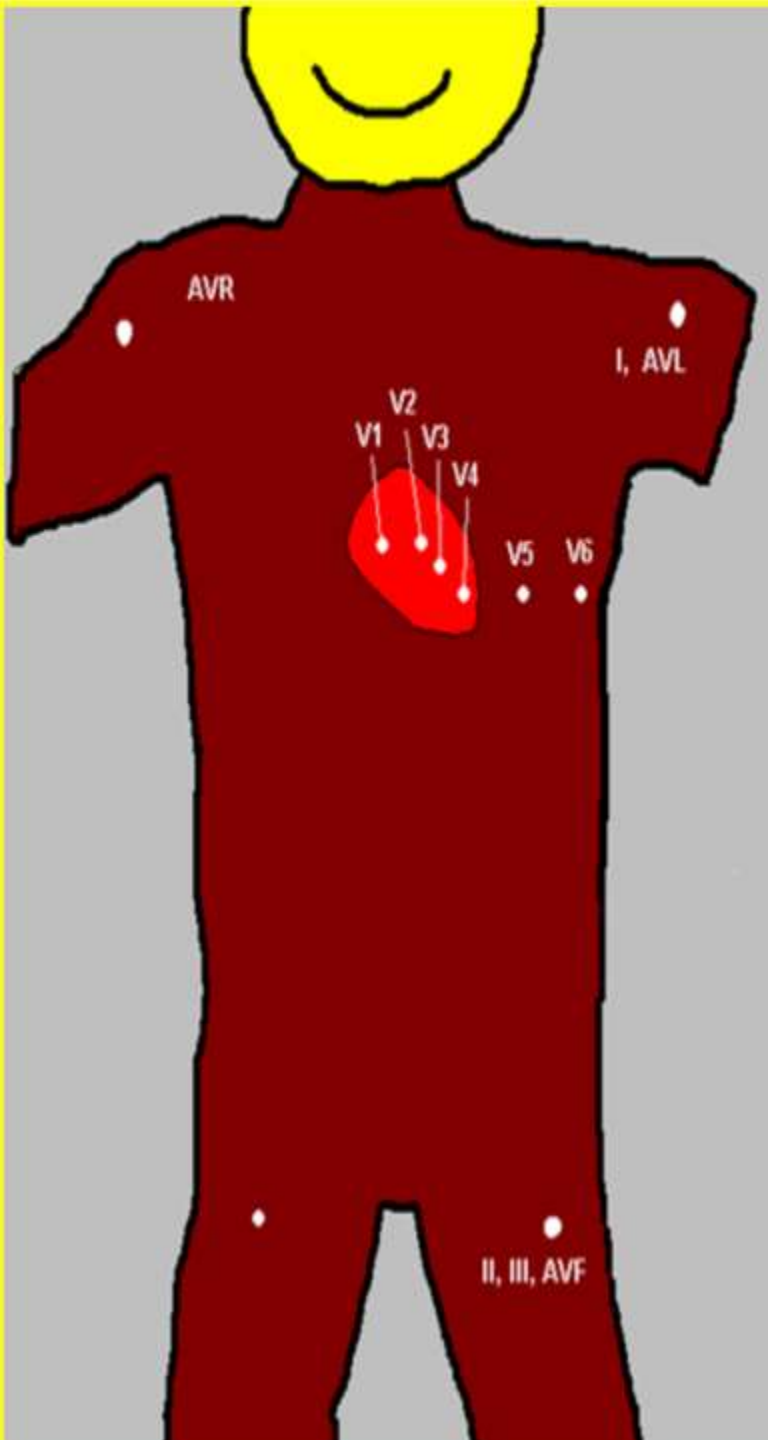
To help you understand what part of the heart each lead of a 12 Lead ECG “sees” . . . .

AREAS VIEWED by 12 LEAD ECG

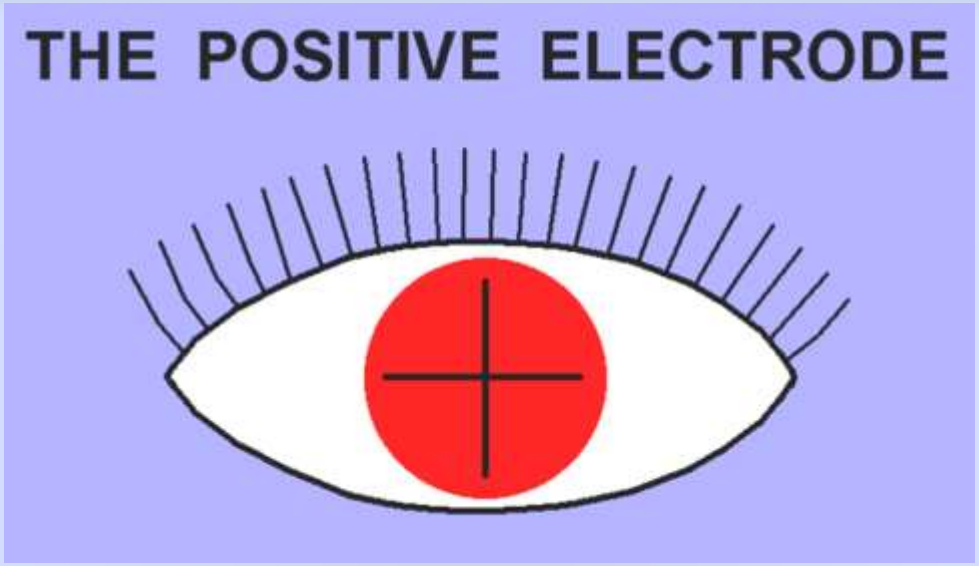


AVR
AVL, I
V1, V2
V3, V4
V5, V6
II, III, AVF

AREAS VIEWED by 12 LEAD ECG



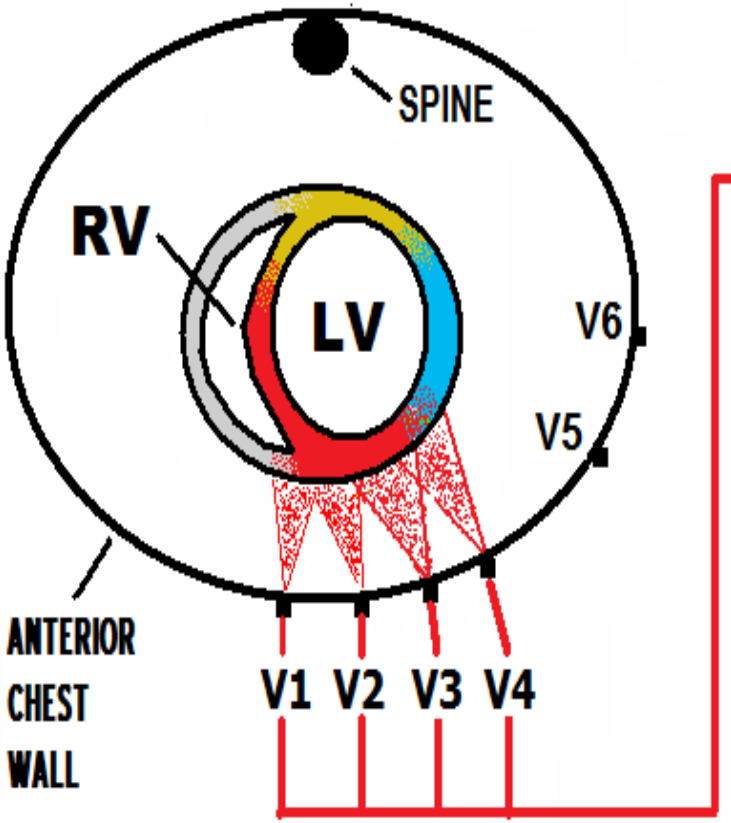
AVR	*BASILAR SEPTAL*
AVL, I	LATERAL ANTERIOR
V1, V2	ANTERIOR
	SEPTAL
	POSTERIOR (recip.)
V3, V4	ANTERIOR
V5, V6	LATERAL
II, III, AVF	INFERIOR



What each of the 12 Leads “sees,” in more detail . . . .

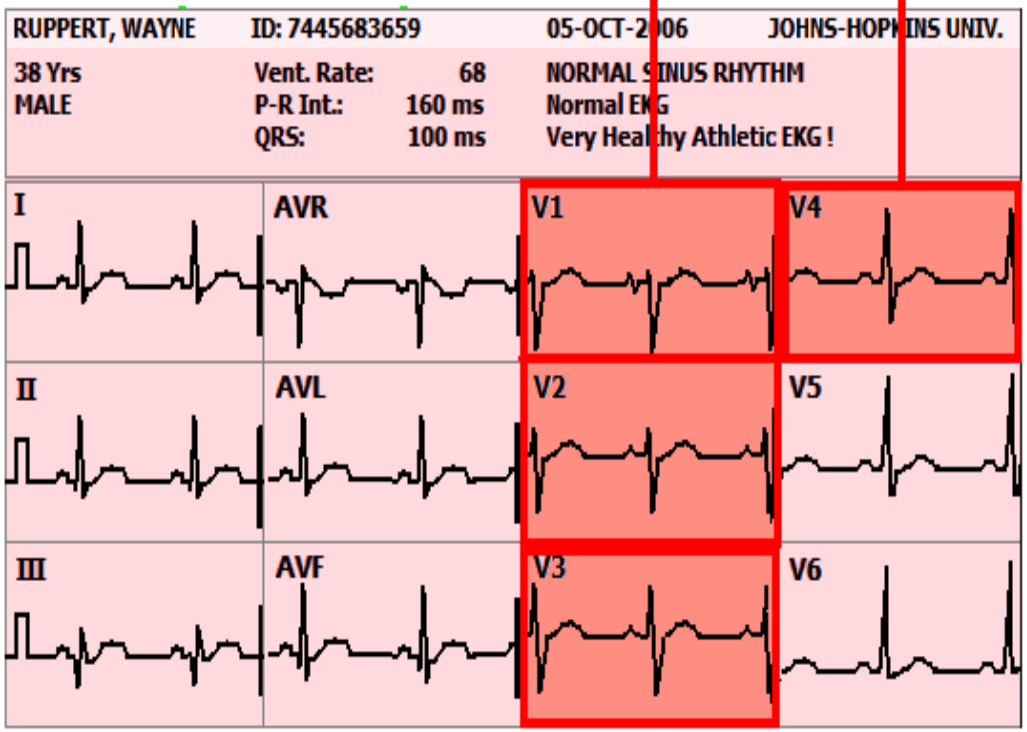
V1 - V4 VIEW THE ANTERIOR-SEPTAL WALL

of the LEFT VENTRICLE

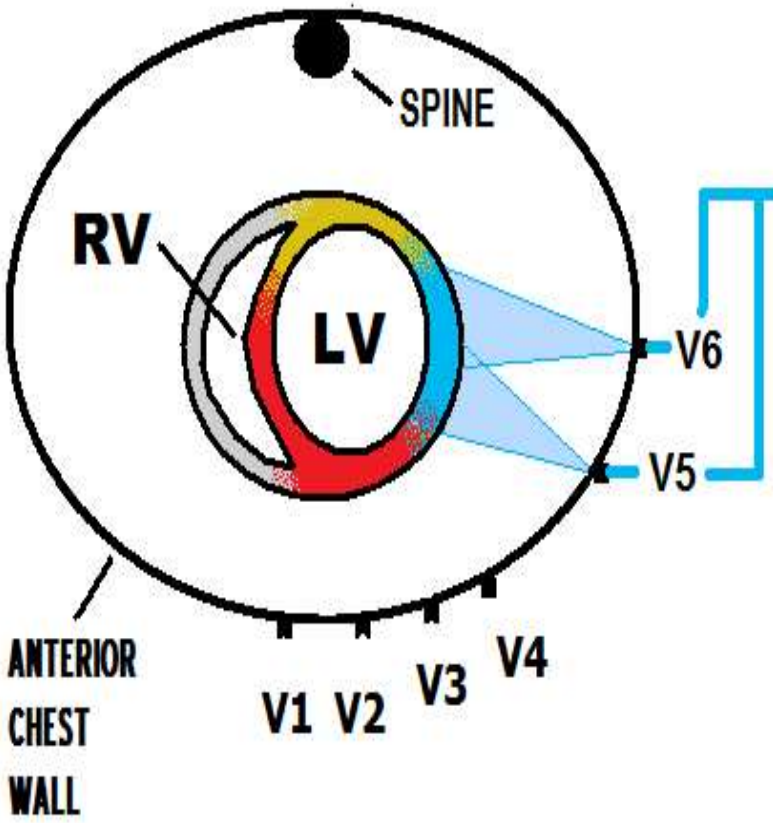


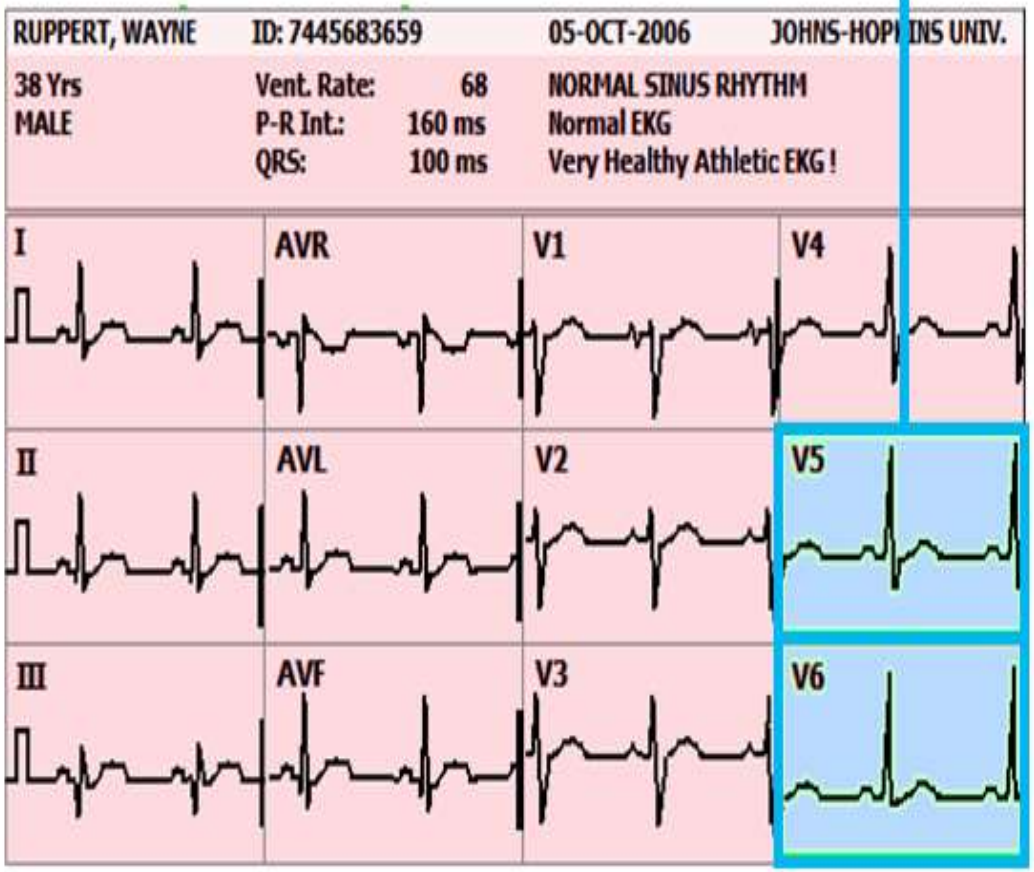
V1, V2 - ANTERIOR / SEPTAL

V3, V4 - ANTERIOR

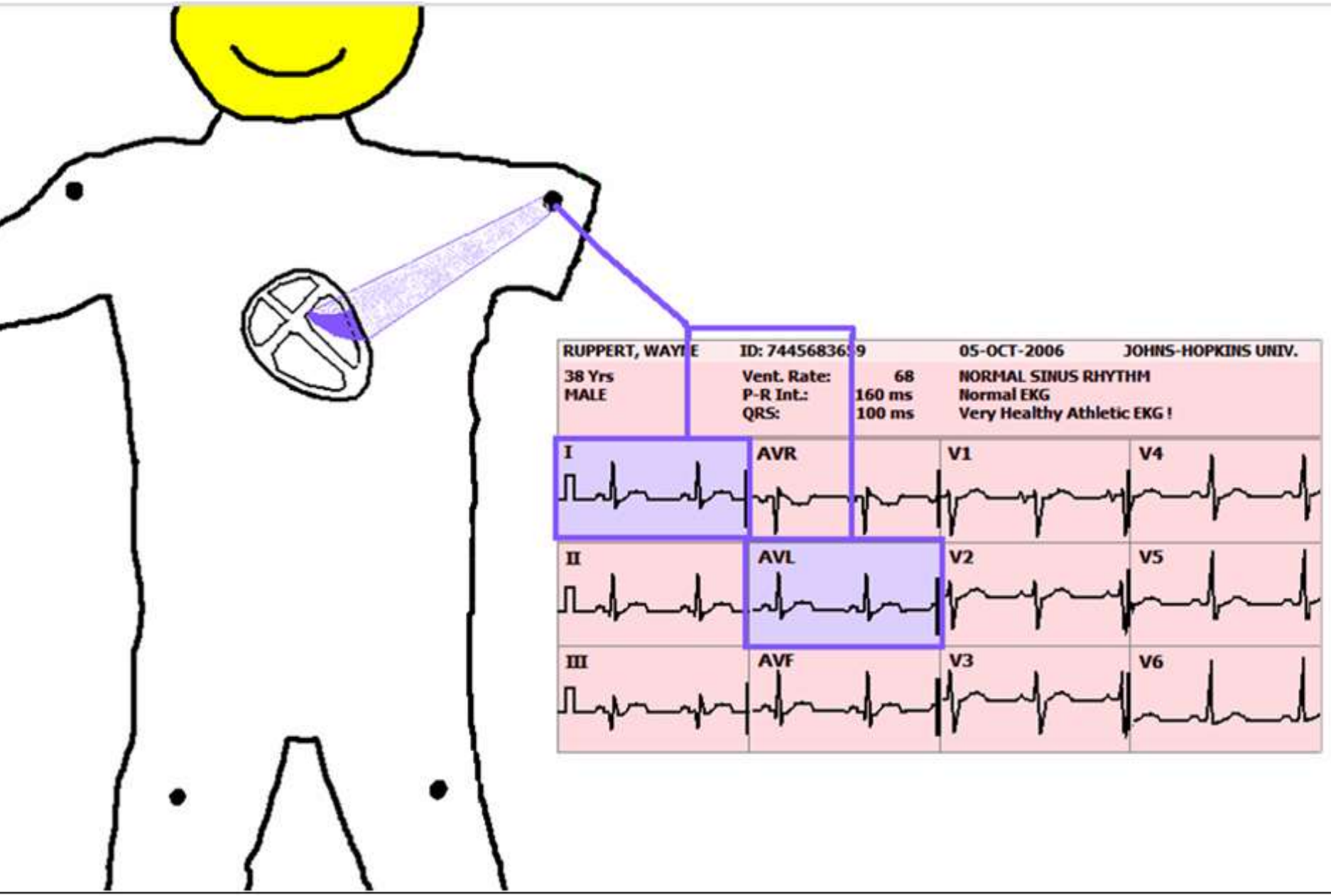


V5 - V6 VIEW THE LATERAL WALL
of the LEFT VENTRICLE

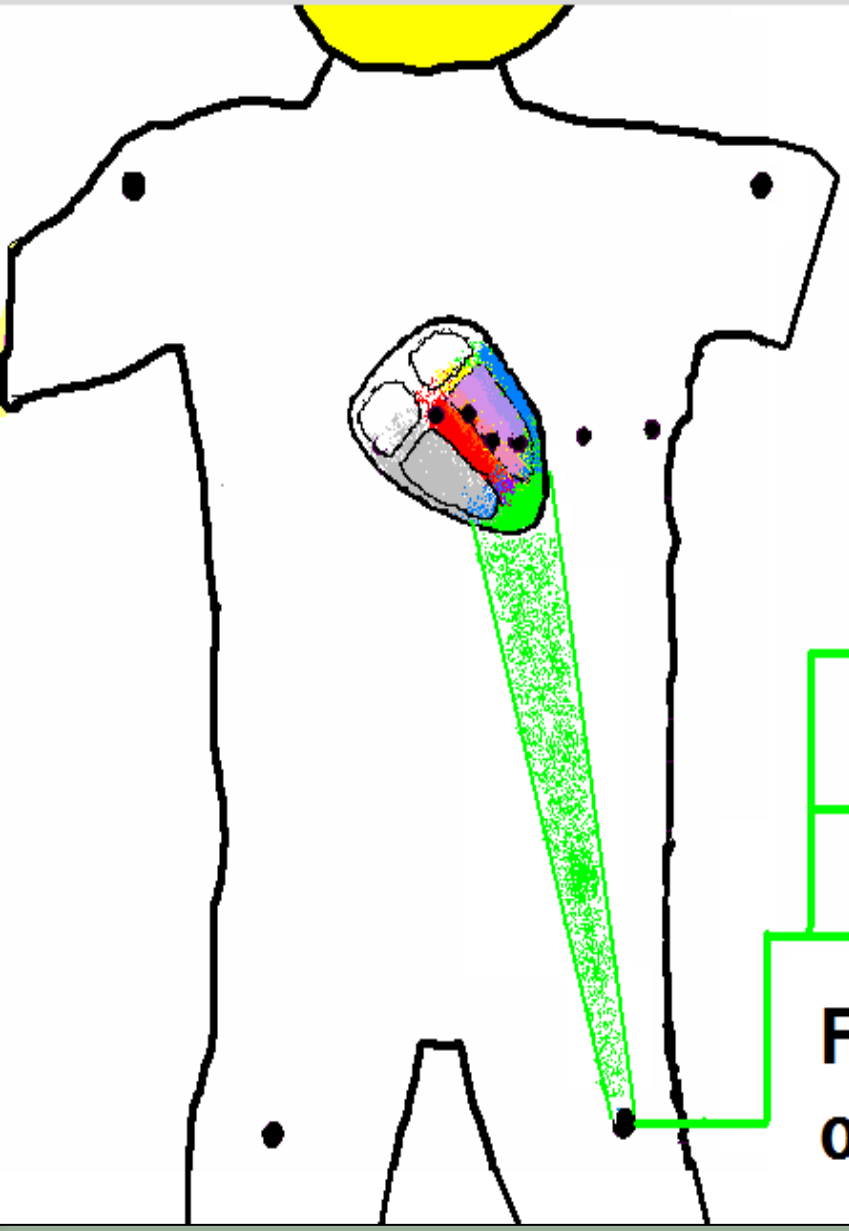


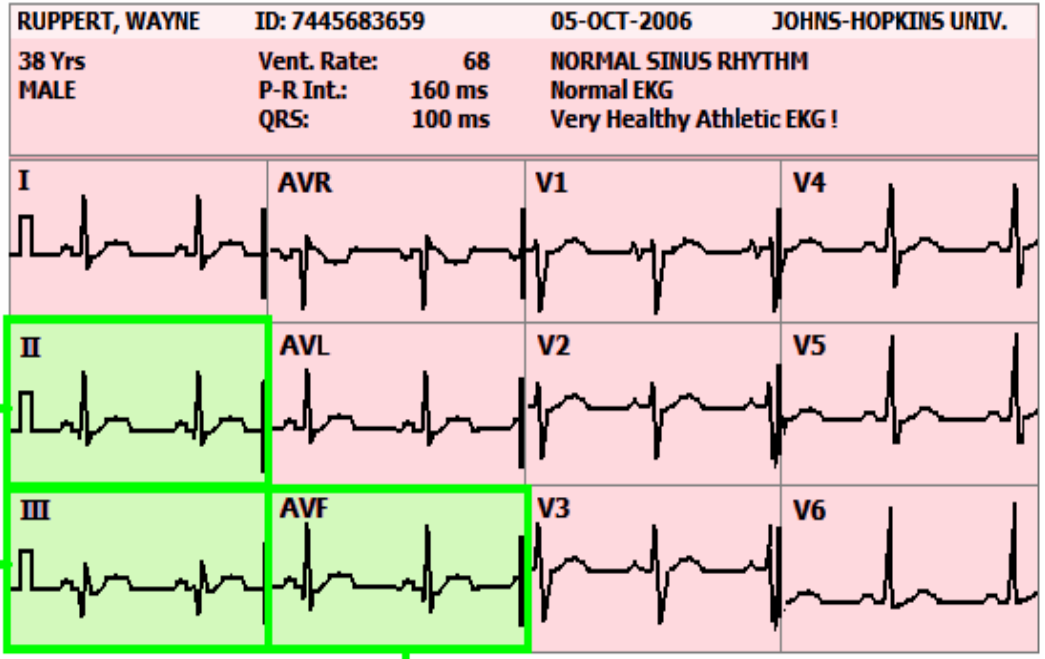


Leads I & AVL view the ANTERIOR-LATERAL JUNCTION



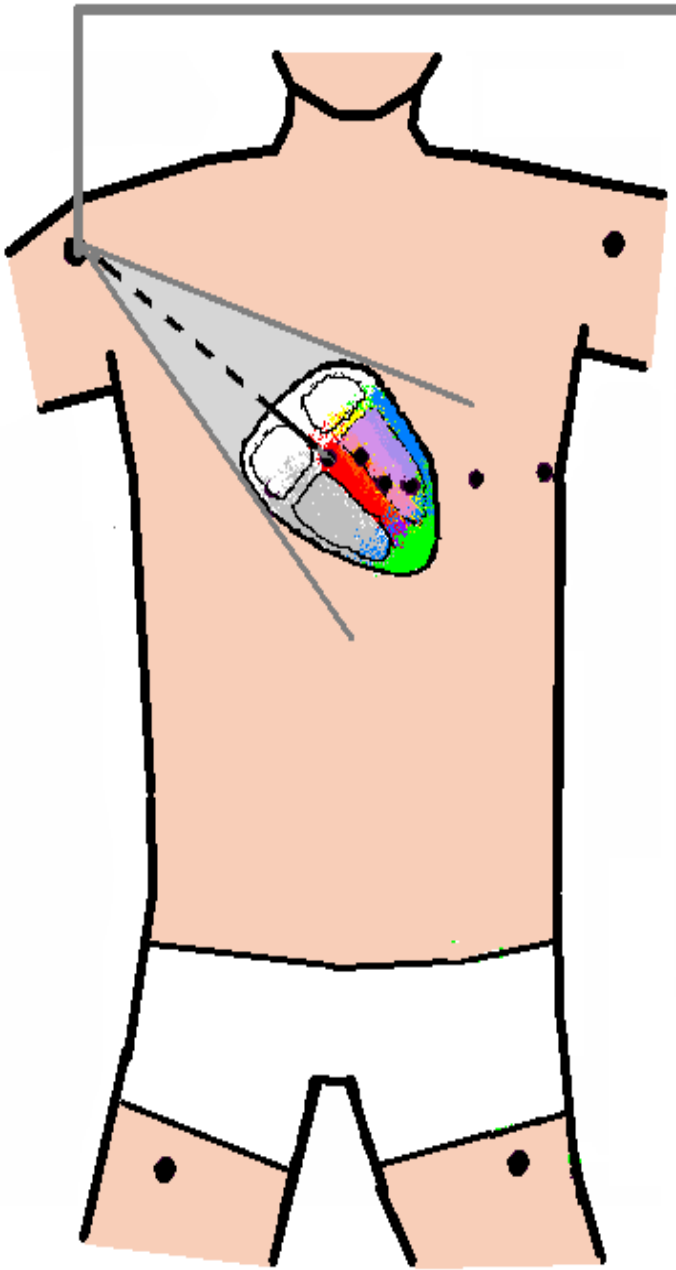
LEADS II, III, and aVF VIEW
INFERIOR WALL of the LEFT VENTRICLE

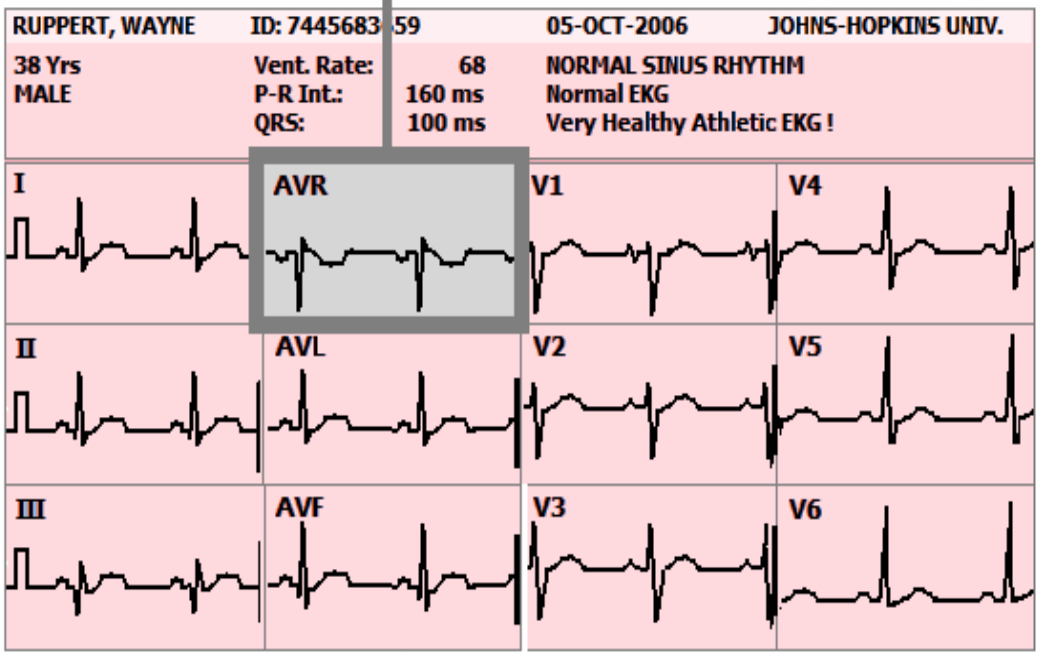




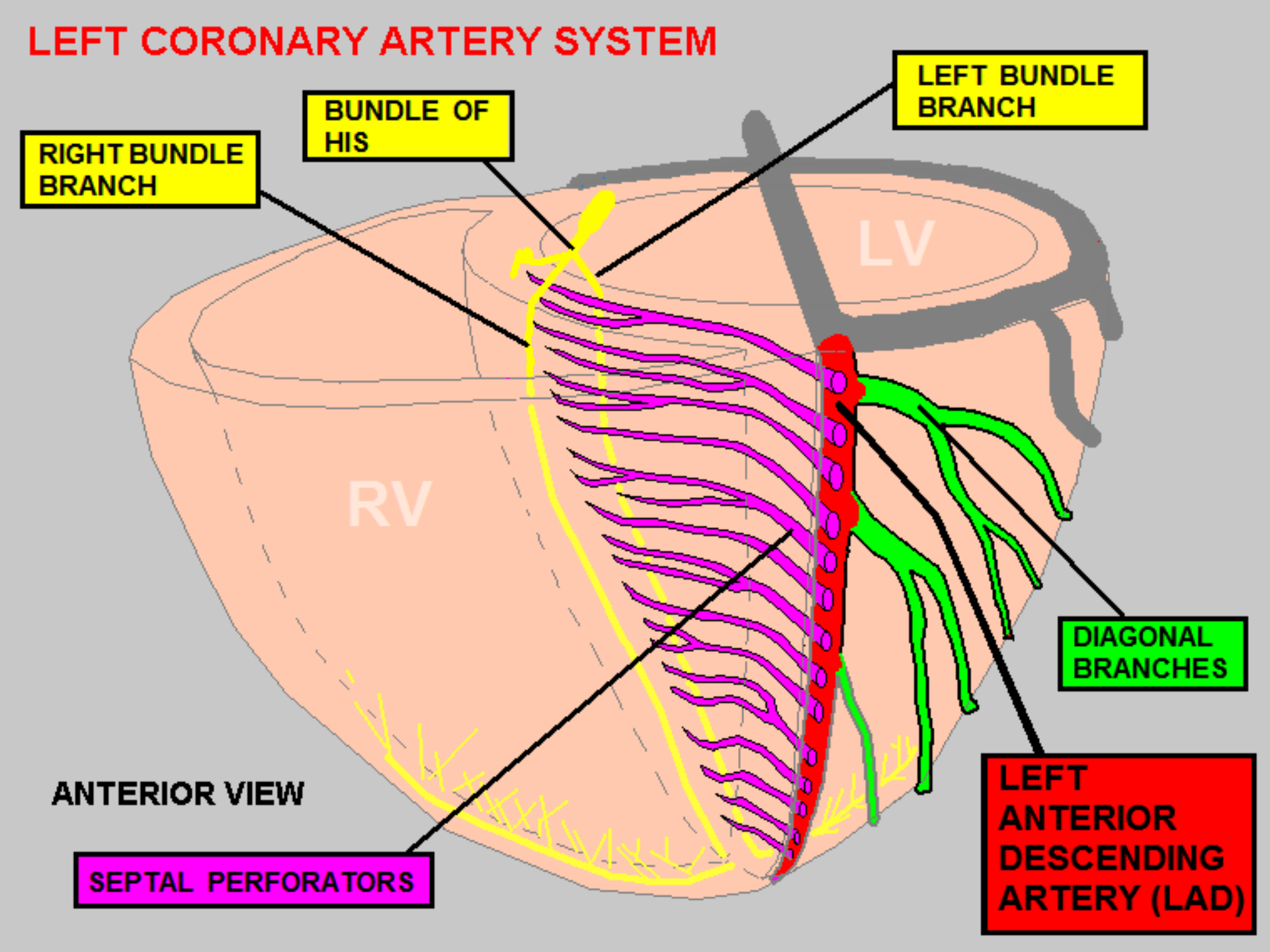
FED by the RCA (75 - 80 % pop)
or the CIRCUMFLEX (10 - 15 %)

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





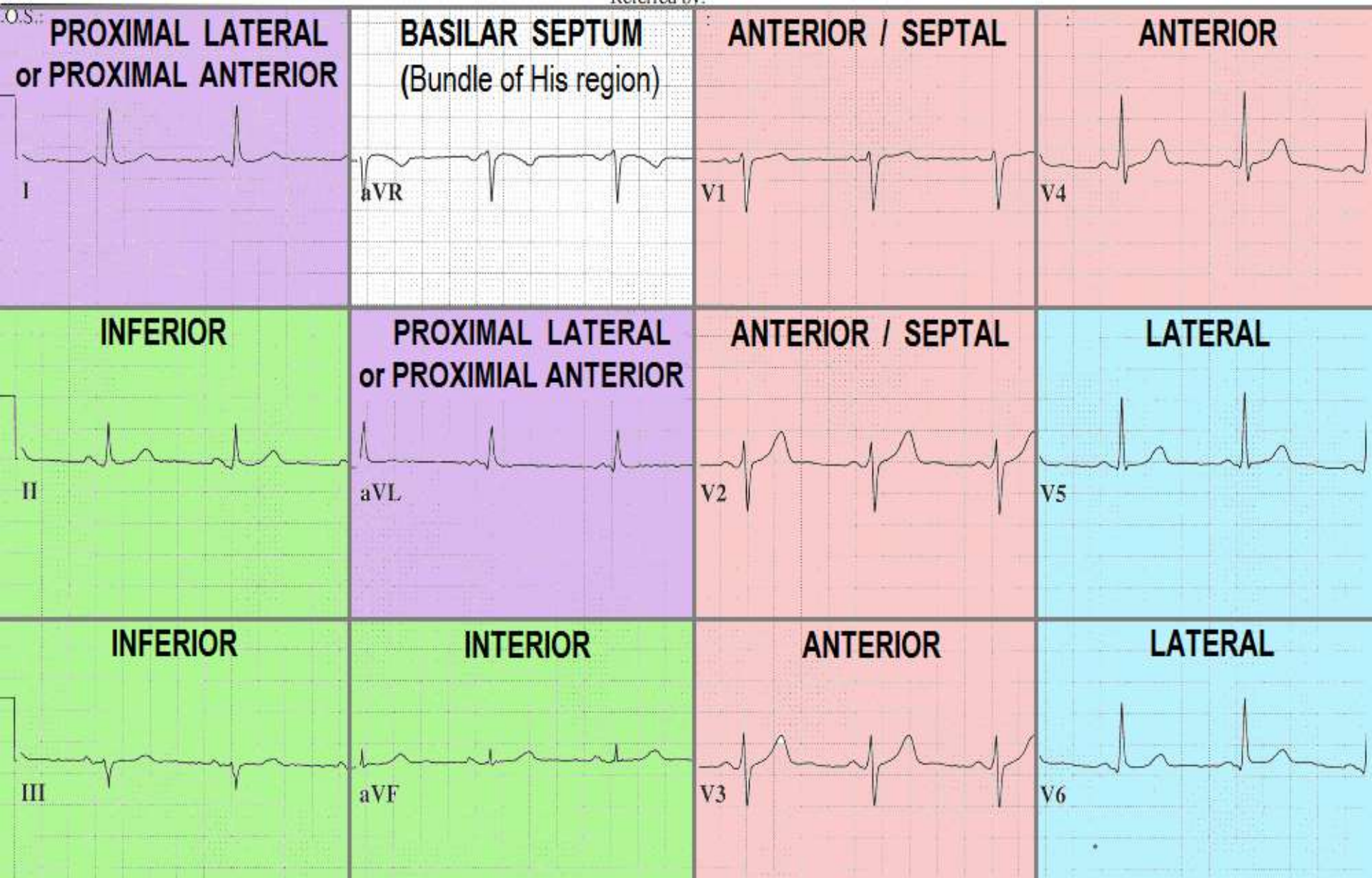
LEFT CORONARY ARTERY SYSTEM



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:

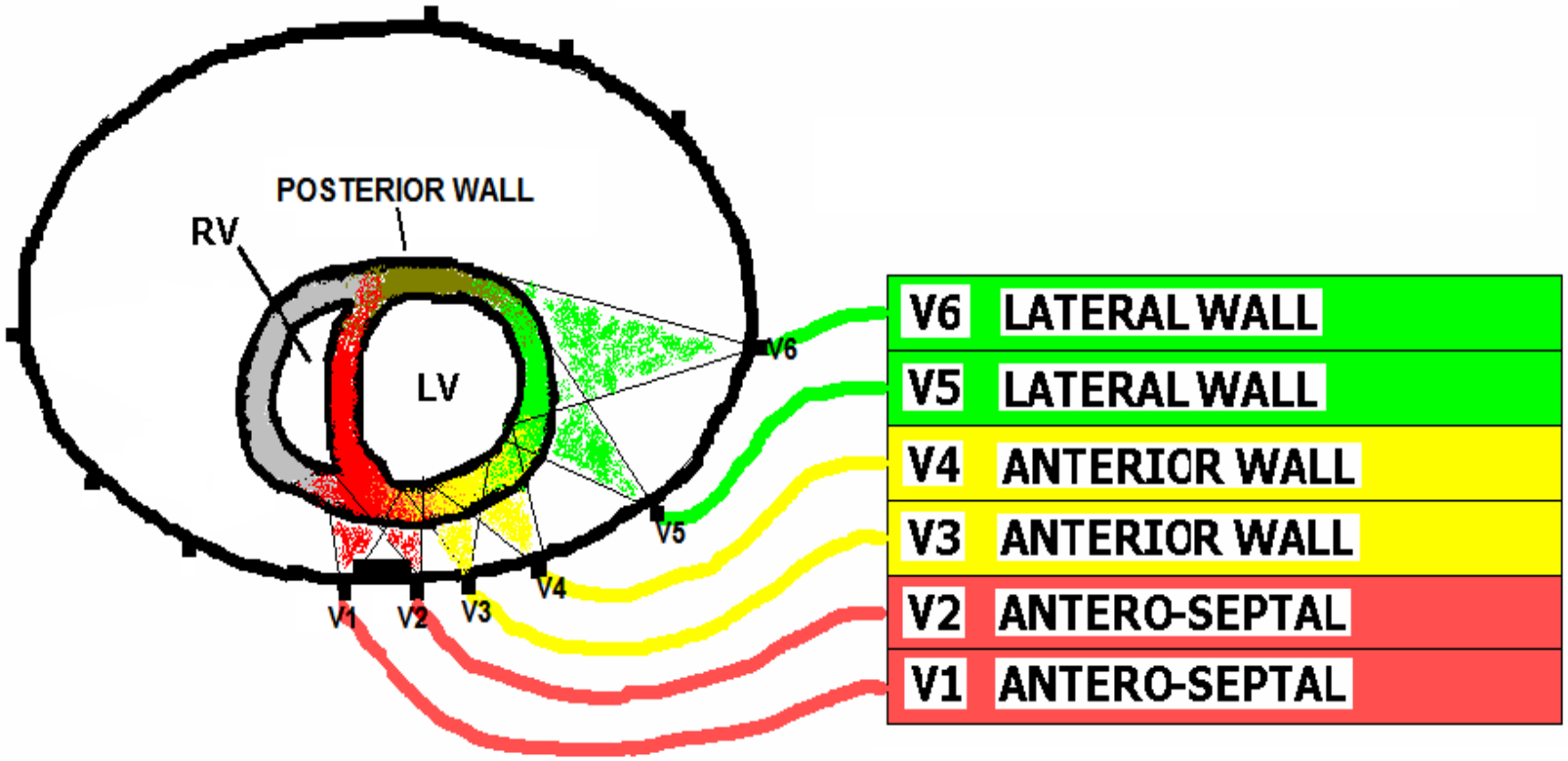


A 12 Lead ECG
sees MOST of the Heart,
but it has some
BLIND SPOTS !! . . . .

THE 12 LEAD ECG HAS TWO MAJOR BLIND SPOTS . .

CHEST LEADS V1 - V6

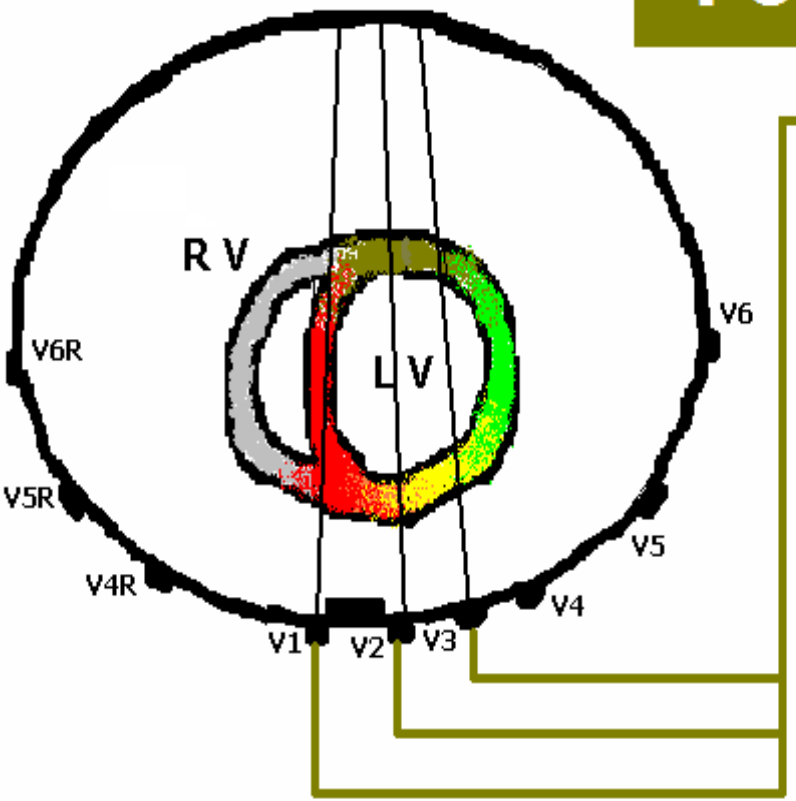
WHAT EACH LEAD "SEES" . . .

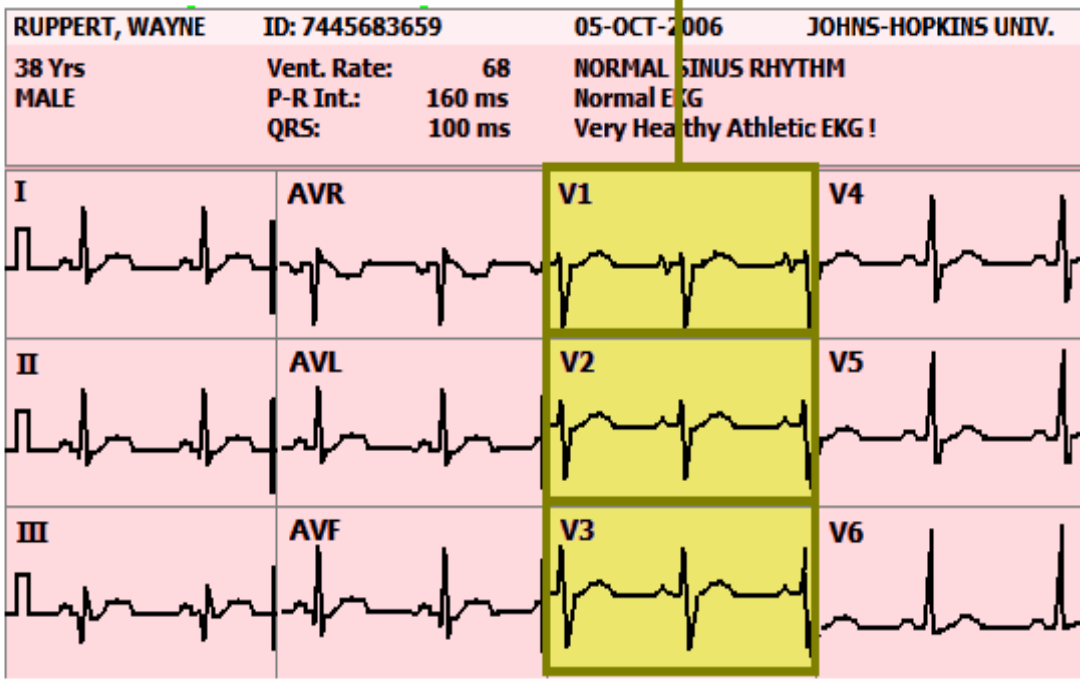


Regarding the **POSTERIOR WALL**, the Standard 12 Lead will give you some "good clues" that there's a PROBLEM by displaying what we call "***RECIPROCAL CHANGES***"….kind of like seeing "reflected changes" in a mirror……

LEADS V1 - V3 *view the*

POSTERIOR WALL



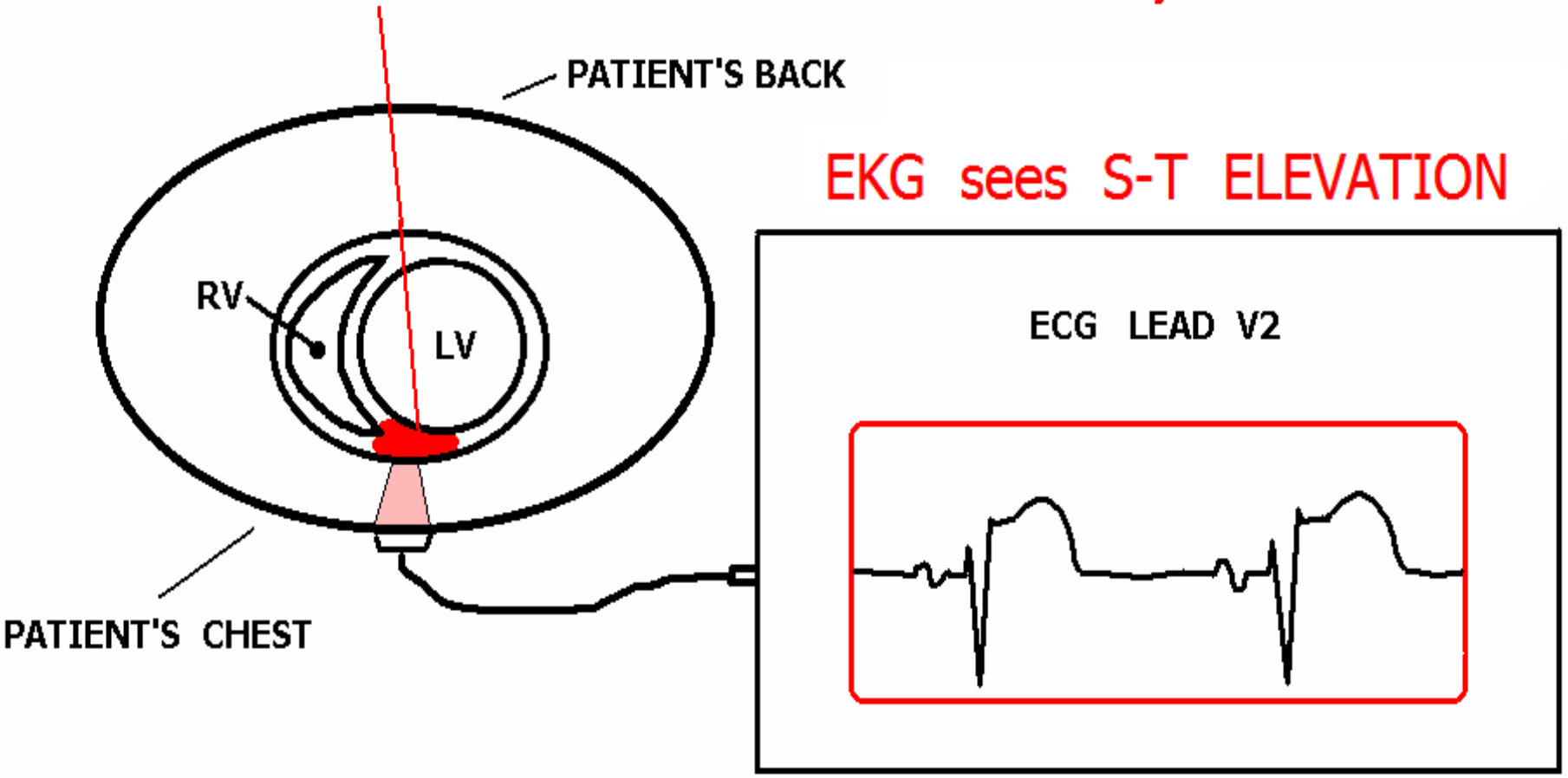


via RECIPROCAL CHANGES.

HOW EKG VIEWS INDICATIVE CHANGES

EXAMPLE:

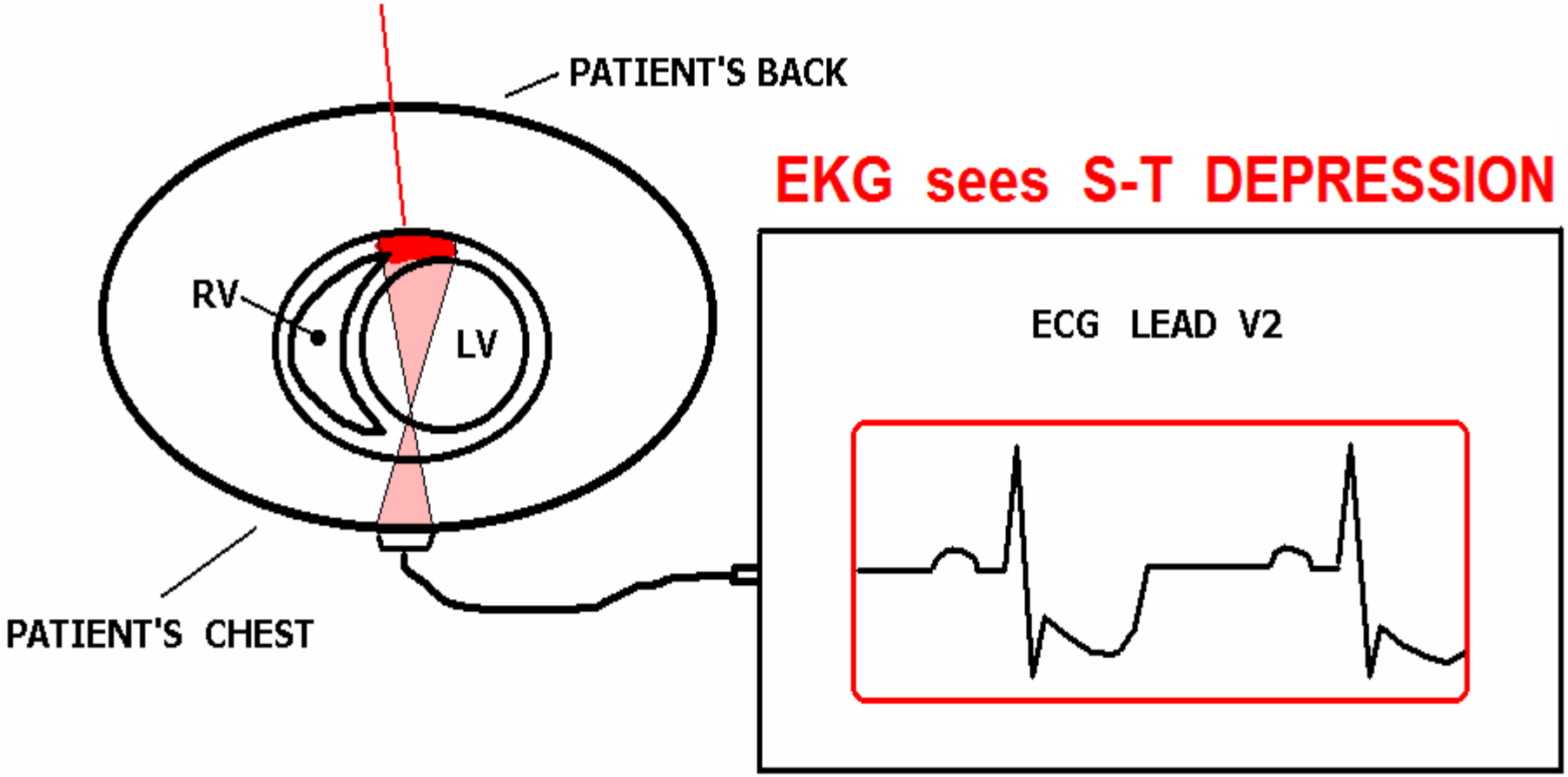
AREA OF ACUTE INFARCTION - ANTERIOR/SEPTAL



HOW EKG VIEWS RECIPROCAL CHANGES

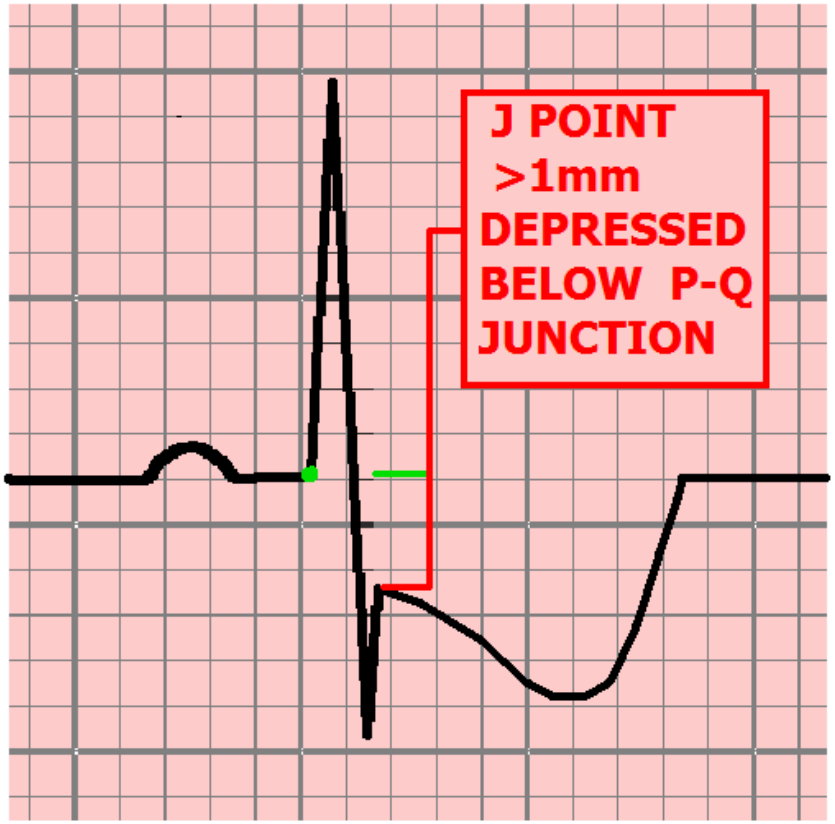
EXAMPLE:

AREA OF ACUTE INFARCTION - POSTERIOR WALL



ST DEPRESSION can be from any other these conditions:

S-T SEGMENT DEPRESSION - COMMON ETIOLOGIES:



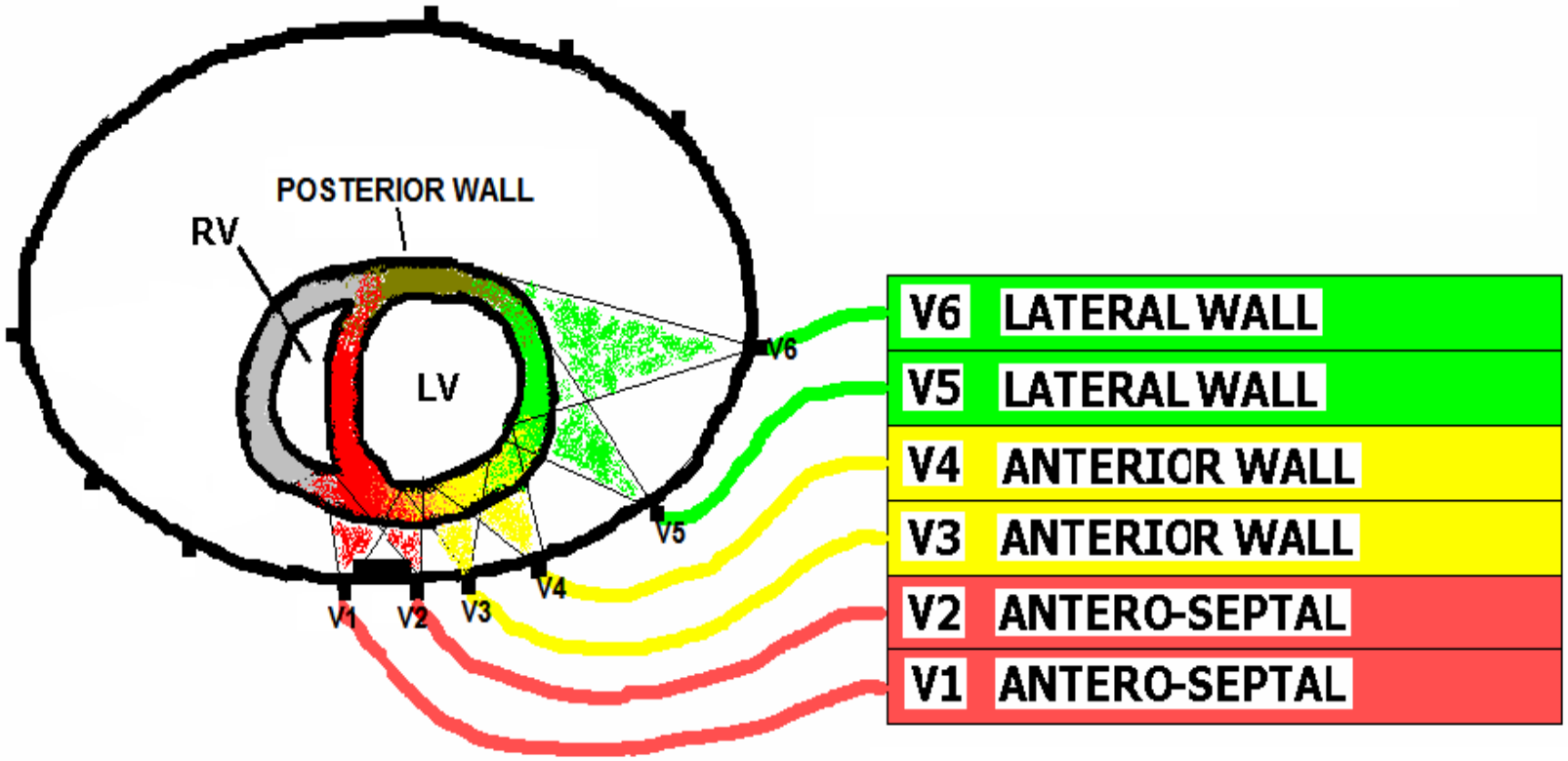
CONDITION:

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

THE 12 LEAD ECG HAS TWO MAJOR BLIND SPOTS . .

CHEST LEADS V1 - V6

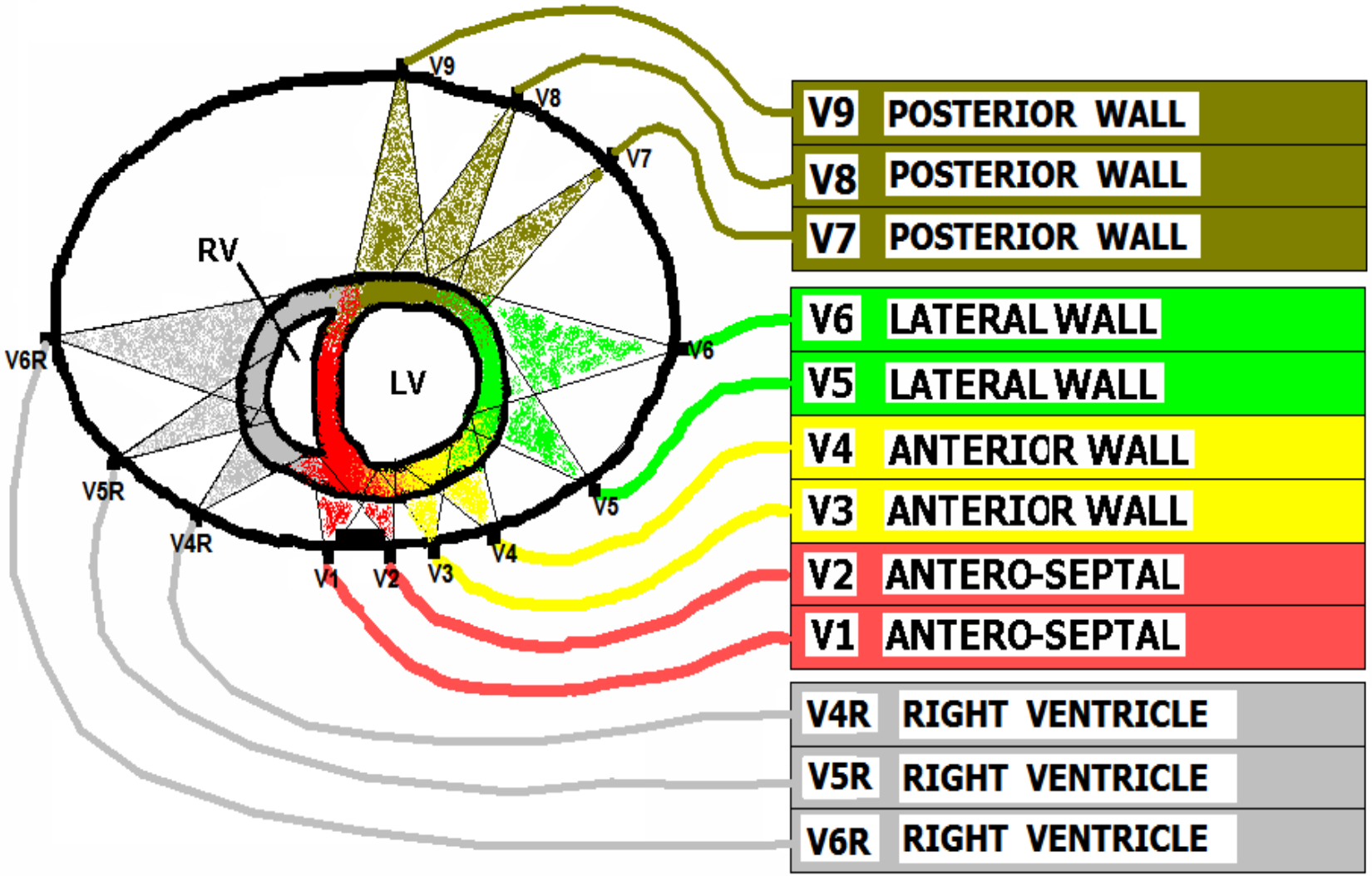
WHAT EACH LEAD "SEES" . . .



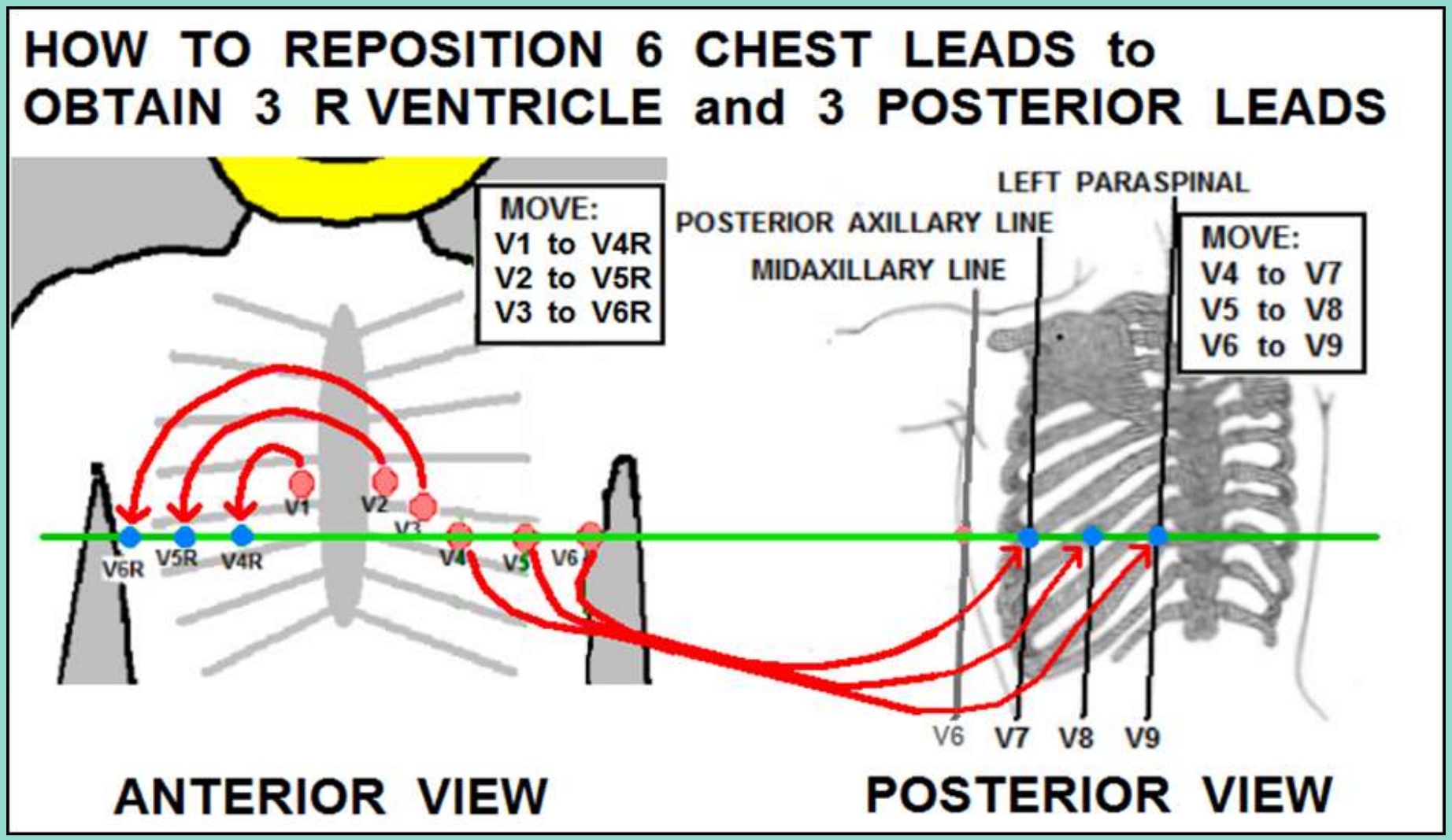
THE 18 LEAD ECG COVERS THE ENTIRE HEART . .

CHEST LEADS V1 - V6 *PLUS* V4R, V5R, V6R, and V7, V8, V9

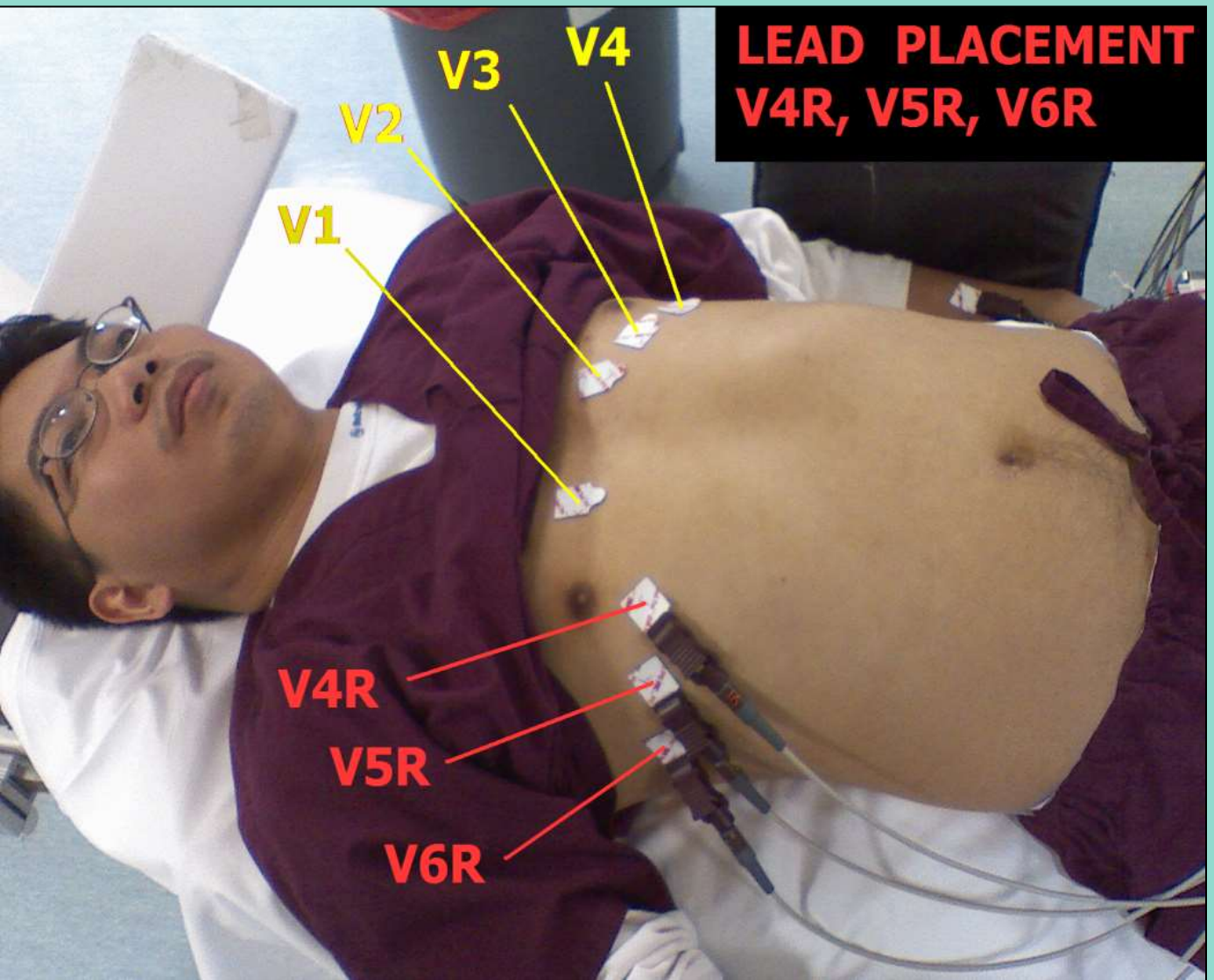
WHAT EACH LEAD "SEES" . . .



To do 18 Lead ECG with 12 Lead machine – after you obtain 12 Lead, reposition CHEST LEADS to this configuration, then print !

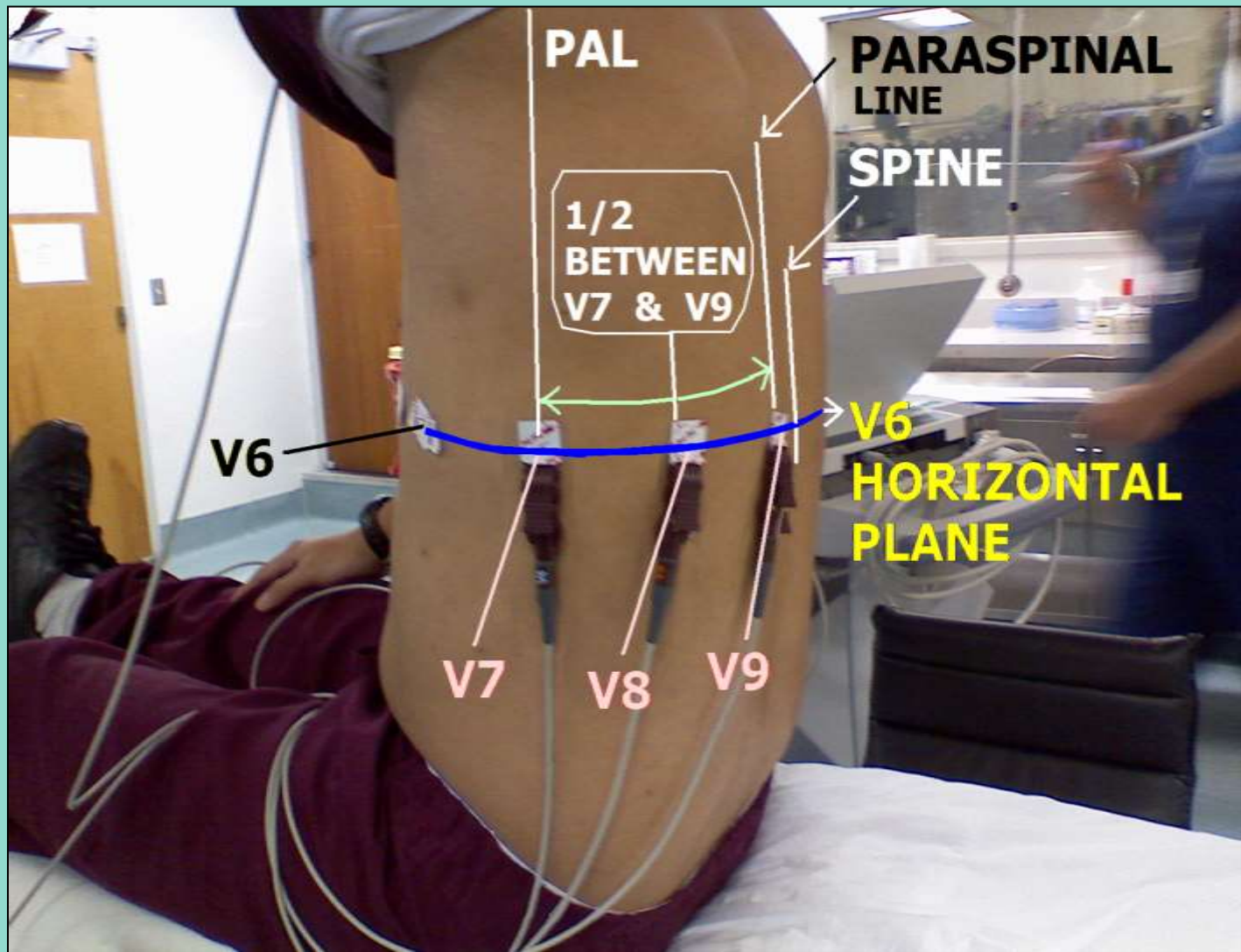


RIGHT SIDED ECG is indicated whenever you see INFERIOR WALL STEMI !!

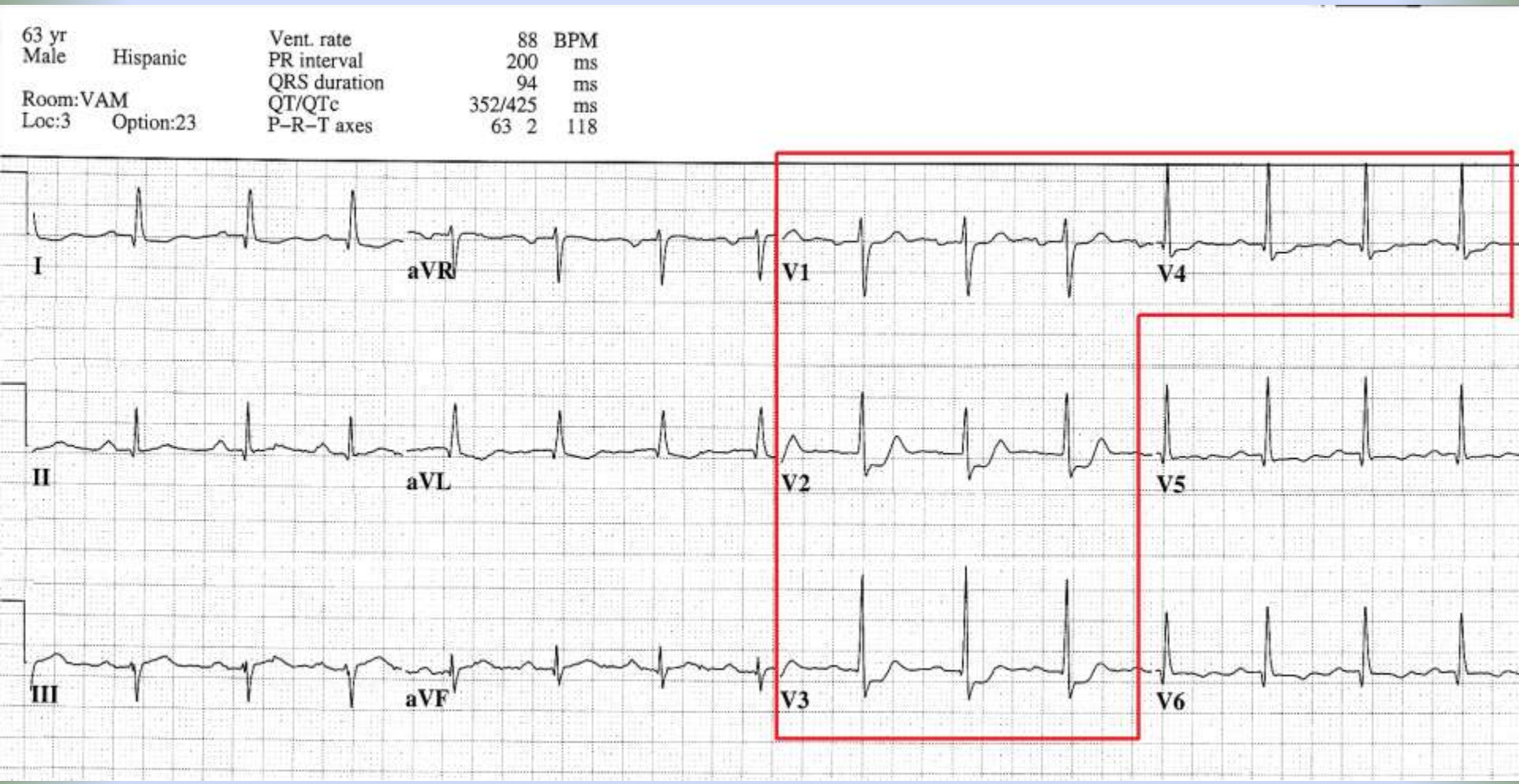


POSTERIOR ECG is indicated whenever you see ST DEPRESSION

In Leads V1-V4



ST Depression in V1 – V4 . . . .



INDICATIONS for 18 Lead ECG include:

- **INFERIOR WALL MI**
  - ☞ Right sided ECG
- **ST Depression V1-V4**
  - ☞ Posterior ECG

Practical application of

18 Lead ECGs

is presented in the

CASE STUDIES

section of this curriculum.

Before we go any farther, you should know . . .

Sometimes,

ECGs

LIE to us !

ECGs and USED CAR SALESMEN often have MUCH in common !

THE ECG in PERSPECTIVE:

PROBLEMS with ECG:

↓ SENSITIVITY

(FALSE NEGATIVES)

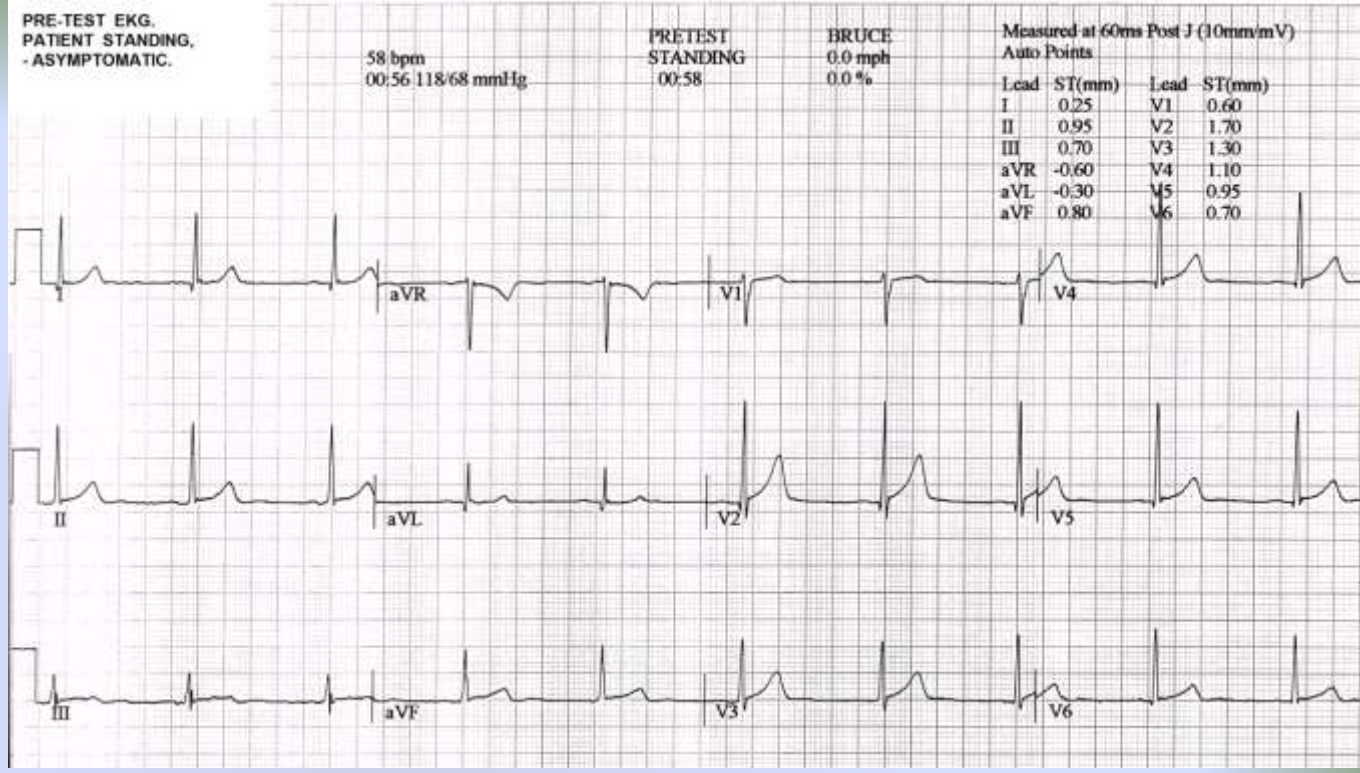
↓ SPECIFICITY

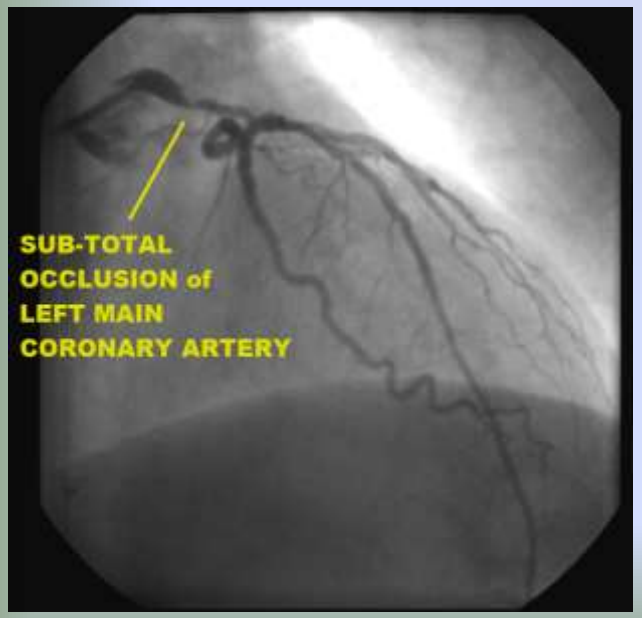
(FALSE POSITIVES)

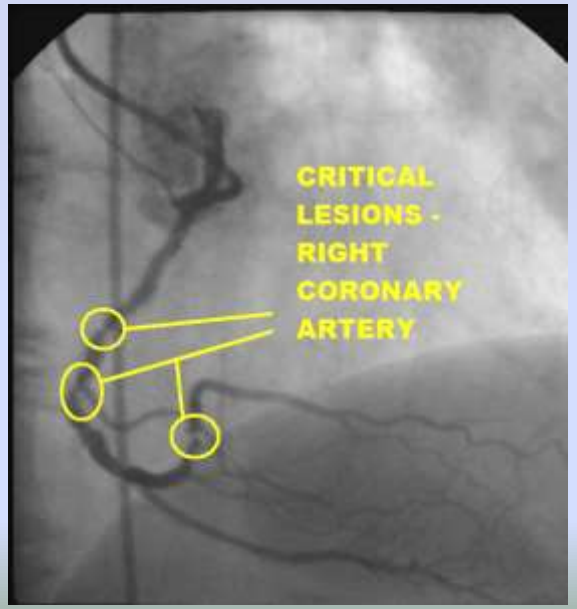
PROBLEMS WITH SENSITIVITY . . .

NORMAL ECG.

But . . . . .



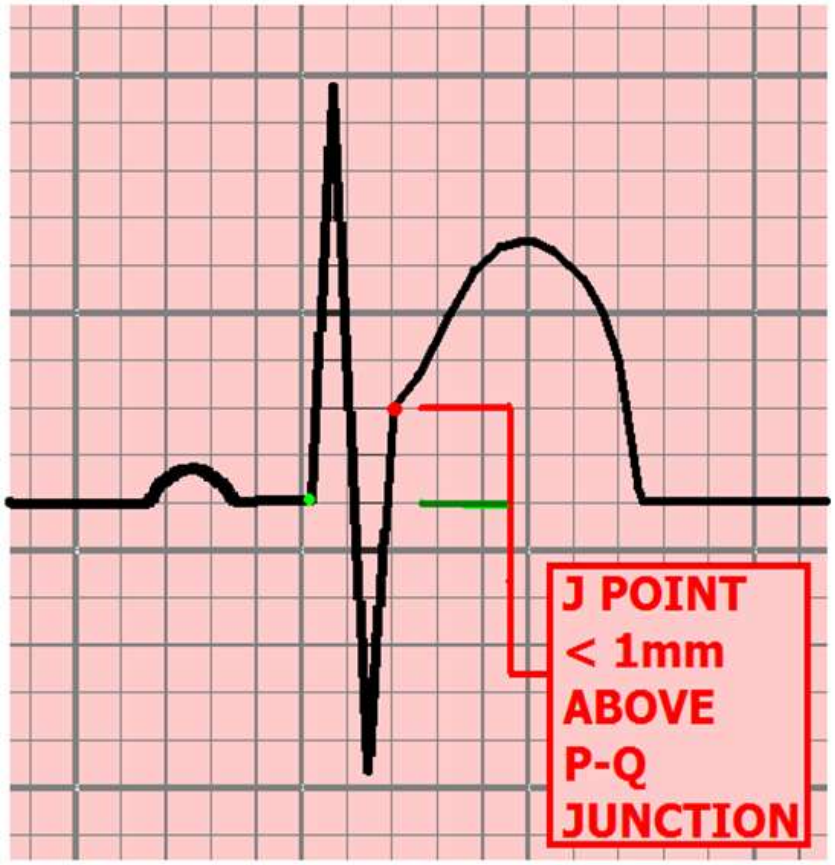




LETHAL TRIPLE VESSEL DISEASE

PROBLEMS WITH SPECIFICITY . . .

S-T SEGMENT ELEVATION - COMMON ETIOLOGIES:

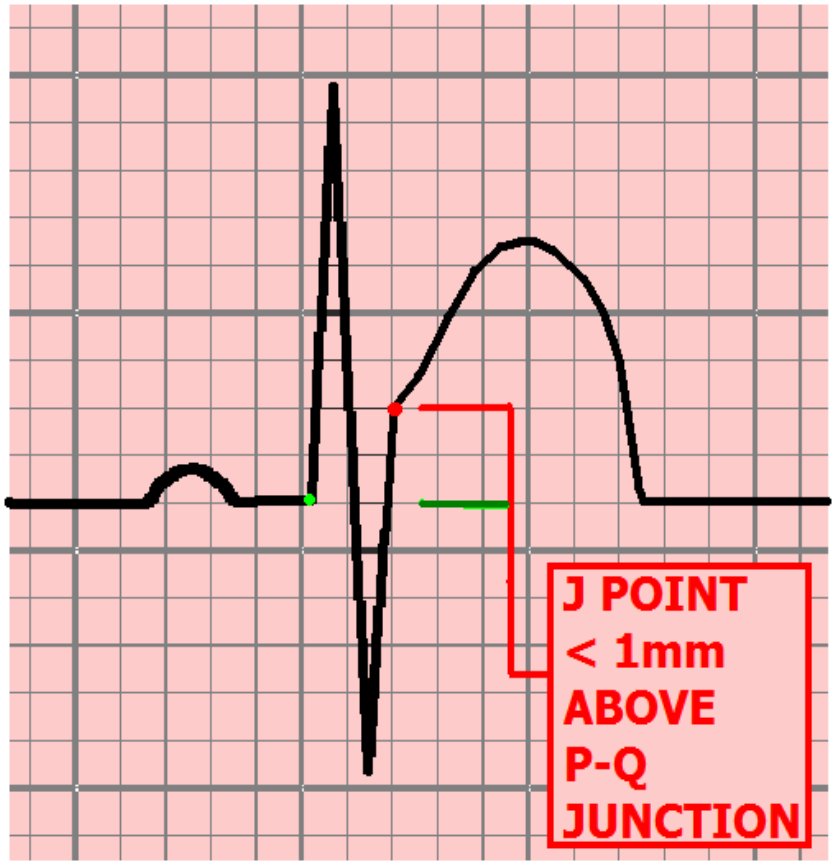


CONDITION:

- **ACUTE INFARCTION (STEMI)**

PROBLEMS WITH SPECIFICITY . . .

S-T SEGMENT ELEVATION - COMMON ETIOLOGIES:



CONDITION:

- ACUTE INFARCTION
- HYPERKALEMIA
- BRUGADA SYNDROME
- PULMONARY EMBOLUS
- INTRACRANIAL BLEED
- MYOCARDITIS / PERICARDITIS
- L. VENT. HYPERTROPHY
- PRINZMETAL'S ANGINA
- L. BUNDLE BRANCH BLOCK
- PACED RHYTHM
- EARLY REPOLARIZATION & "MALE PATTERN" S-T ELEV.

77 Years Male 7/2/2015 9:44:46

1North (06)

Rate	83	. SINUS RHYTHM.....normal P axis, V-rate 50- 99
		. RIGHT BUNDLE BRANCH BLOCK.....QRSd>120, terminal axis(90,270)
PR	152	. ANTEROLATERAL INFARCT, ACUTE.....Q >35mS, ST >0.20mV, V2-V6
QRSD	122	
QT	412	
QTc	485	

--AXIS--

P	59
QRS	14
T	33

12 Lead; Standard Placement

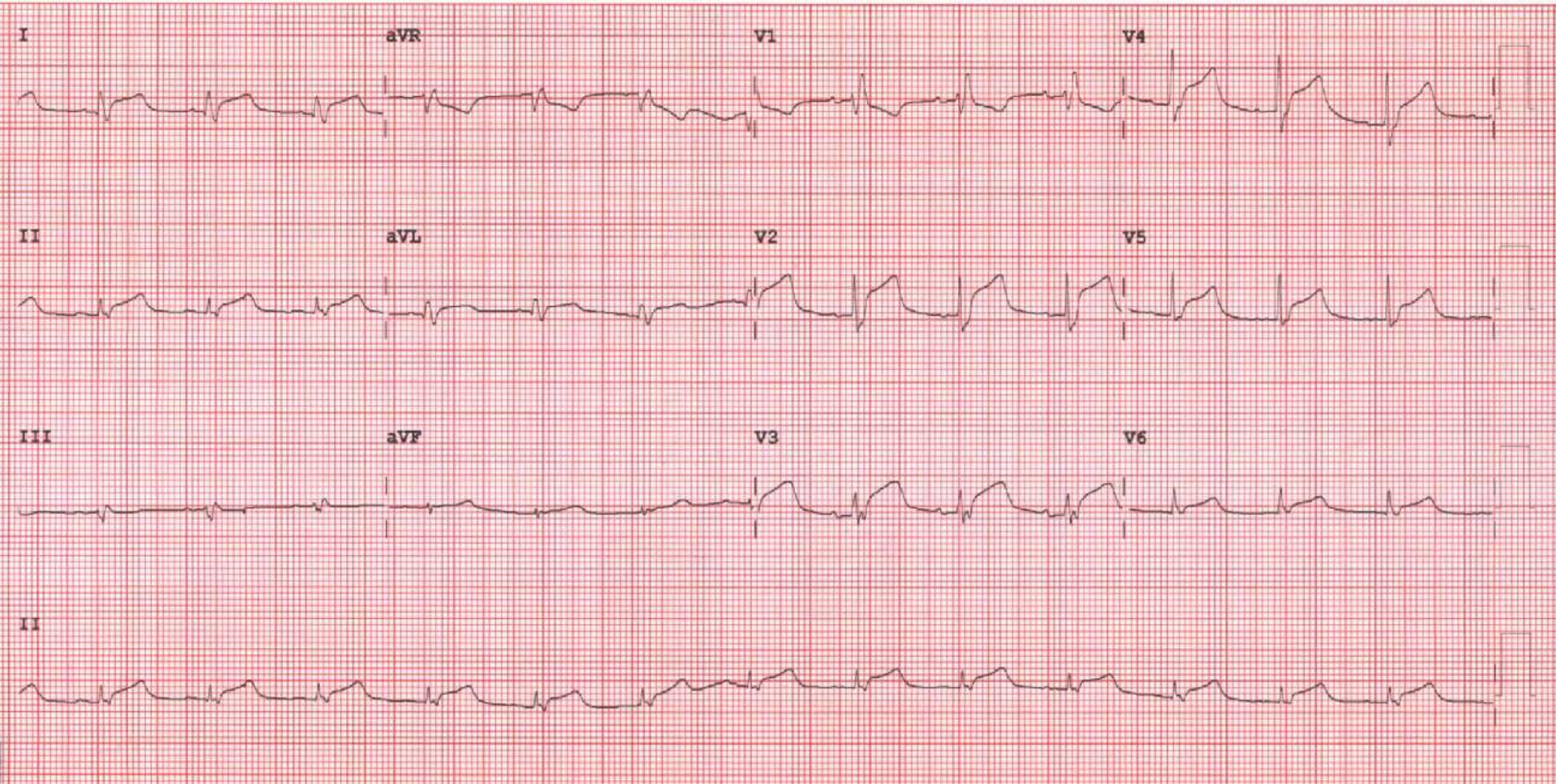
- ABNORMAL ECG -

>>> Acute MI <<<

Requested by:

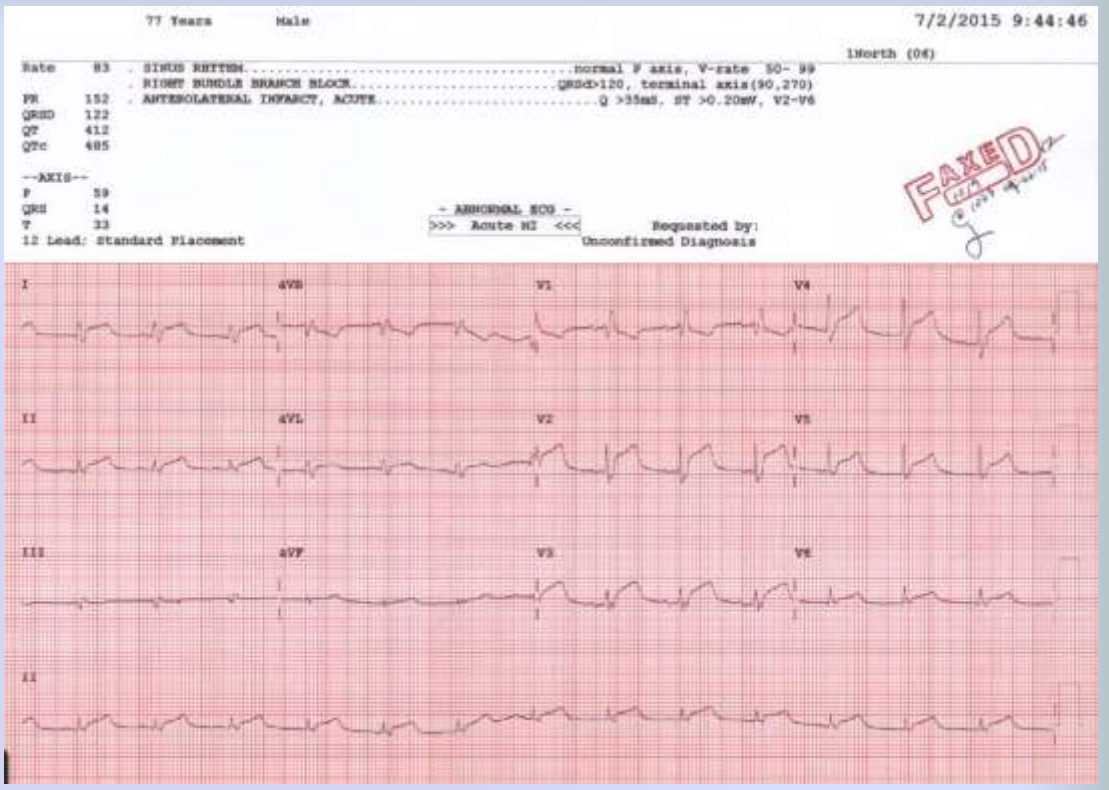
Unconfirmed Diagnosis

FAXED 10/9 @ 1023 CA 10.15



Patient:

- **Asymptomatic**
- **Troponin normal**
- **Cardiac Cath angiography = "no obstructive CAD."**
- **Discharge diagnosis:**

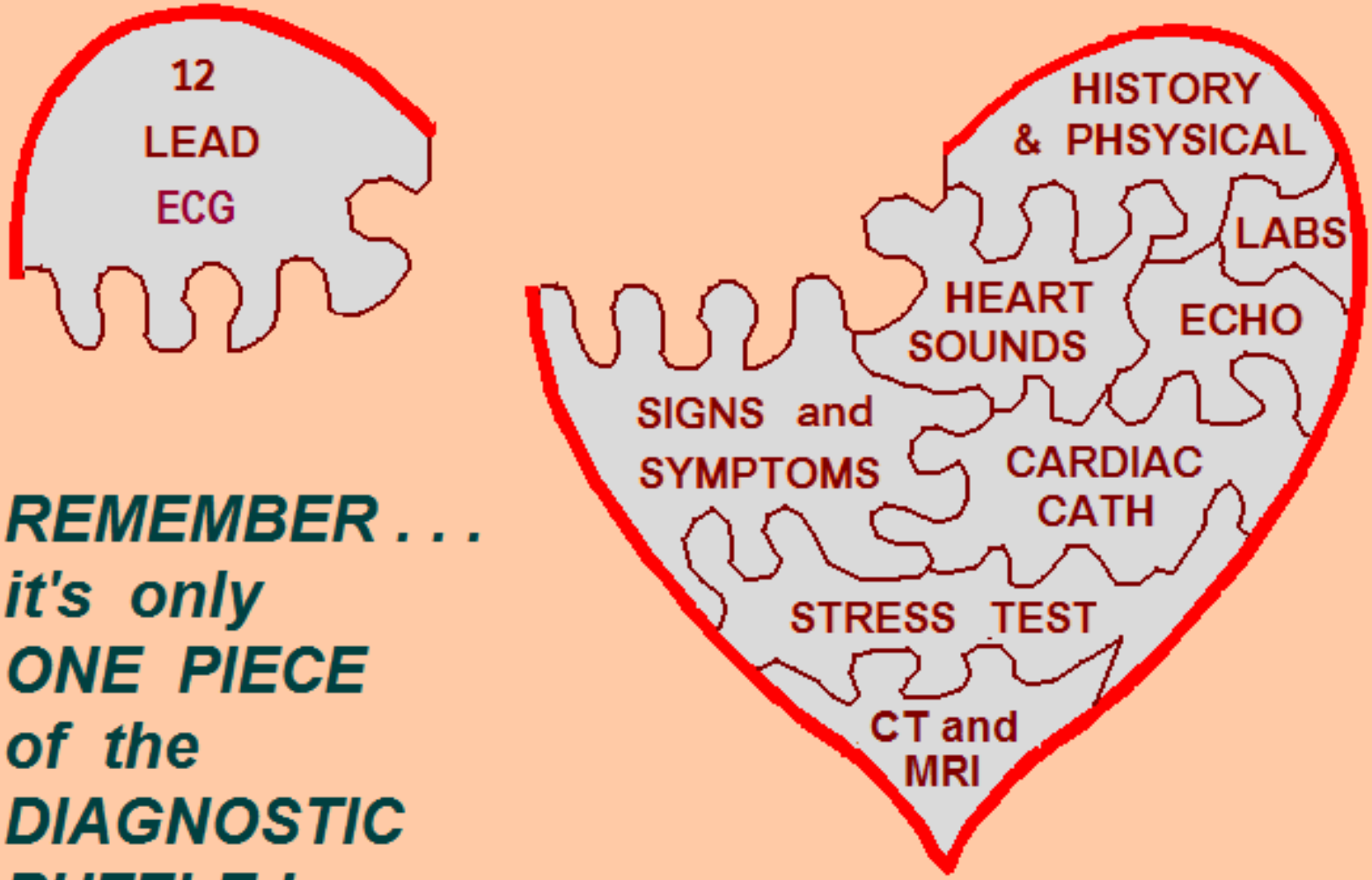


EARLY REPOLARIZATION. This degree of ST Elevation in early repolarization is VERY RARE: The only such ECG I have seen in approximately 13,000 cardiac catheterizations.

Despite the ECG's problematic issues with
Lack of Sensitivity
&
Lack of Specificity,
The 12 Lead ECG remains one of our QUICKEST, most cost-efficient front-line Triage Tools that we have today.

So how do we know when the ECG is telling us the truth ???

REMEMBER . . . . Keep the ECG Results in PROPER PERSPECTIVE . . . .



REMEMBER . . .
it's only
ONE PIECE
of the
DIAGNOSTIC
PUZZLE !

- ***In the hospital we utilize ACS Risk Stratification tools – such as The HEART Score. We also have Troponins, Echo, CT and Cardiac Cath. In the field, you have far fewer resources!!***

- ***What do you have in the field?***
  - ***Symptoms***
  - ***Risk Factors***
  - ***ECG***
  - ***Physical Exam***

The QUADRAD of ACS

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

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

You arrive at a patient's residence. The scene is safe, and you're led into the living room by the patient's daughter . . .

The instant you see the patient, you assess for:

- **CAB** (pulse, breathing) the patient is awake, to you know he has a pulse and you see him breathing
- **Shock Assessment . . . .**

SHOCK ASSESSMENT

SHOCK =

INADEQUTE TISSUE PERFUSION

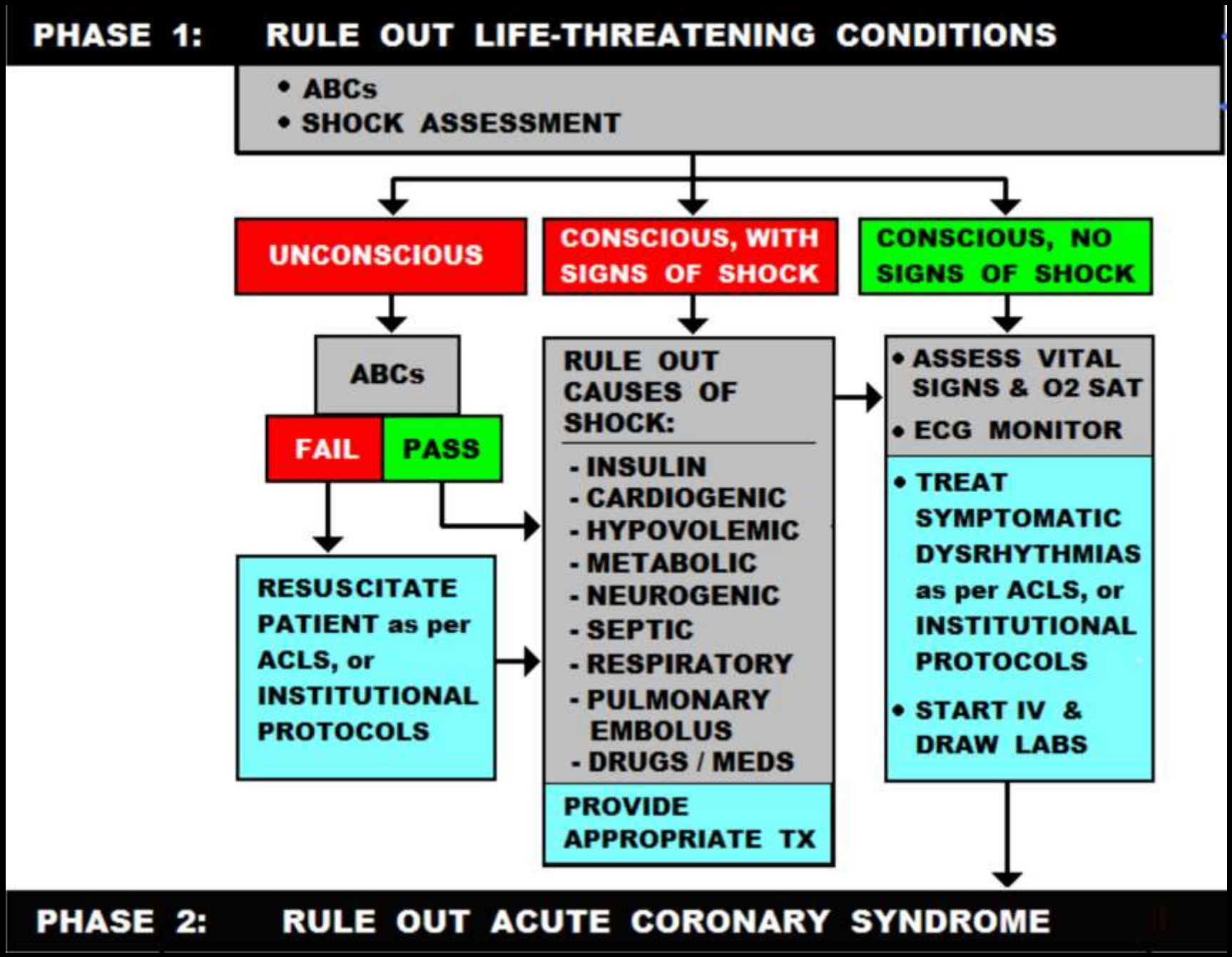
- STARTS THE INSTANT YOU SEE PATIENT
- ENDS WHEN YOU REACH THE PATIENT'S SIDE

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

FAIL the SHOCK SURVEY ?

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


PHASE 1: RULE OUT LIFE-THREATENING CONDITIONS
• ABCs
• SHOCK ASSESSMENT
UNCONSCIOUS
CONSCIOUS, WITH SIGNS OF SHOCK
CONSCIOUS, NO SIGNS OF SHOCK
ABCs
FAIL
PASS
RESUSCITATE PATIENT as per ACLS, or INSTITUTIONAL PROTOCOLS
RULE OUT CAUSES OF SHOCK:
- INSULIN
- CARDIOGENIC
- HYPOVOLEMIC
- METABOLIC
- NEUROGENIC
- SEPTIC
- RESPIRATORY
- PULMONARY EMBOLUS
- DRUGS / MEDS
PROVIDE APPROPRIATE TX
• ASSESS VITAL SIGNS & O2 SAT
• ECG MONITOR
• TREAT SYMPTOMATIC DYSRHYTHMIAS as per ACLS, or INSTITUTIONAL PROTOCOLS
• START IV & DRAW LABS
PHASE 2: RULE OUT ACUTE CORONARY SYNDROME

The QUADRAD of ACS

- [x] **PRESENTING SYMPTOMS**
- [ ] **RISK FACTOR PROFILE**
- [ ] **ECG ABNORMALITIES**
- [ ] **CARDIAC MARKERS**

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

CHIEF COMPLAINT

KEY WORDS:

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

SHORTNESS BREATH

DIZZINESS / LIGHTHEADEDNESS

ETC. ETC. ETC.

TYPICAL SYPTOMS of ACUTE CORNARY SYNDROME:

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

INFARCTION

- - - "Classic Symptoms" - - -

QUICK ASSESSMENT "SHORT FORM"

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

stable angina

1. SYMPTOMS START DURING PHYSICAL EXERTION.

2. SYMPTOMS ARE "PREDICTABLE"

VS.

unstable angina

1. SYMPTOMS MAY START AT ANY TIME, EVEN DURING REST

2. SYMPTOMS ARE *NEW*, *DIFFERENT*, or *WORSE* THAN PREVIOUS EPISODES

BEWARE of the patient with "INTERMITTENT CHEST PAIN" . . . .

ATYPICAL SYMPTOMS of ACS

? ? ?

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

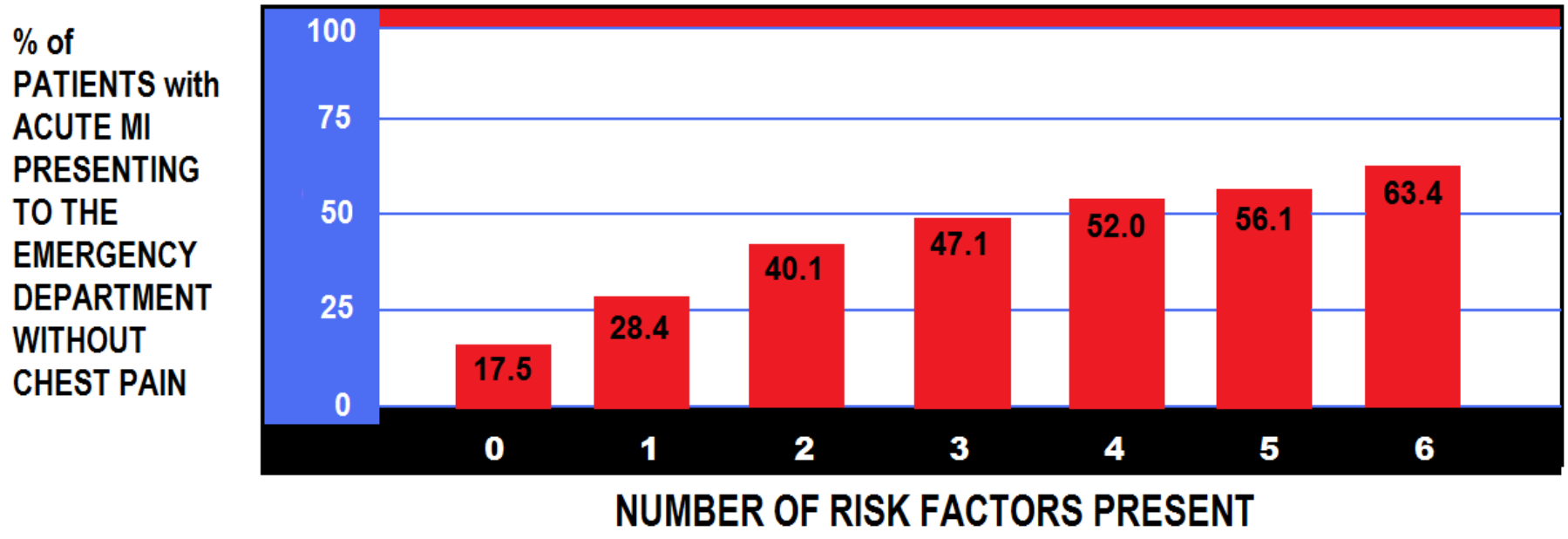
Stroke (previous history of)
Heart failure (previous history of)
Race (non-white)
Elderly (age 75+)
Women
Diabetes mellitus

* 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)
Indigestion
Nausea
Dizziness
Syncope
Fatigue
Abdominal pain
Cold sweats
Elevated heart rate
Dsypnea

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

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

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

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

WOMEN'S MAJOR SYMPTOMS DURING THEIR HEART ATTACK:

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

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

Circulation, 2003:108;2619-2623

Physical Exam – Clues of MI:

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

The QUADRAD of ACS

- [x] **PRESENTING SYMPTOMS**
- [x] **RISK FACTOR PROFILE**
- [ ] **ECG ABNORMALITIES**
- [ ] **CARDIAC MARKERS**

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

3 or more major RISK FACTORS gets you a "checkmark" in the RISK FACTOR box!

The QUADRAD of ACS

- [x] PRESENTING SYMPTOMS
- [x] RISK FACTOR PROFILE
- [ ] ECG ABNORMALITIES
- [ ] CARDIAC MARKERS

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

RISK FACTORS

for the development of

CORONARY ARTERY DISEASE:

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

per the AMERICAN HEART ASSOCIATION

HEART

HEART score for chest pain patients			
History	Highly suspicious	2	
	Moderately suspicious	1	
	Slightly suspicious	0	
ECG	Significant ST-deviation	2	
	Non specific repolarisation disturbance / LBTB / PM	1	
	Normal	0	
Age	≥ 65 years	2	
	> 45 and < 65 years	1	
	≤ 45 years	0	
Risk factors	≥ 3 risk factors or history of atherosclerotic disease*	2	
	1 or 2 risk factors	1	
	No risk factors known	0	
Troponin	≥ 3x normal limit	2	
	> 1 and < 3x normal limit	1	
	≤ 1x normal limit	0	
		Total	

***Risk factors for atherosclerotic disease:**

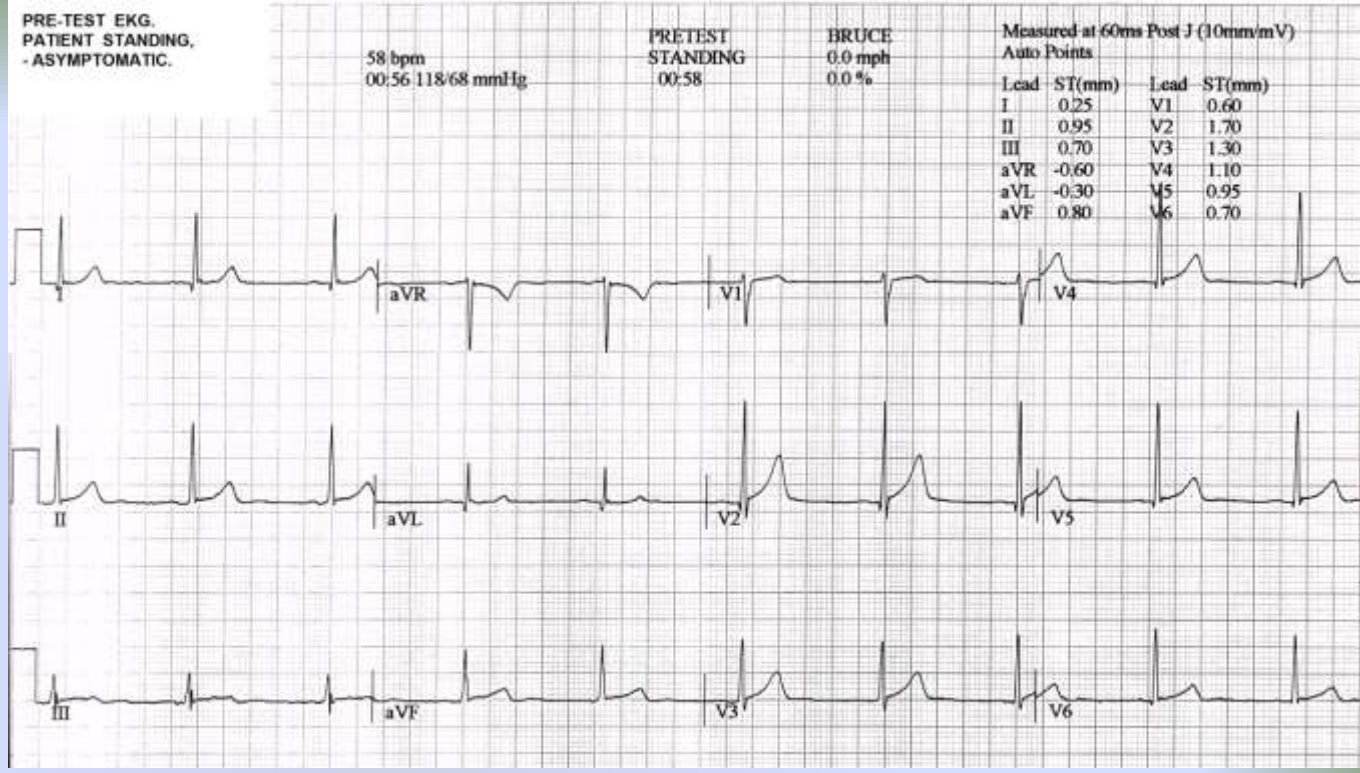
Hypercholesterolemia	Cigarette smoking
Hypertension	Positive family history
Diabetes Mellitus	Obesity

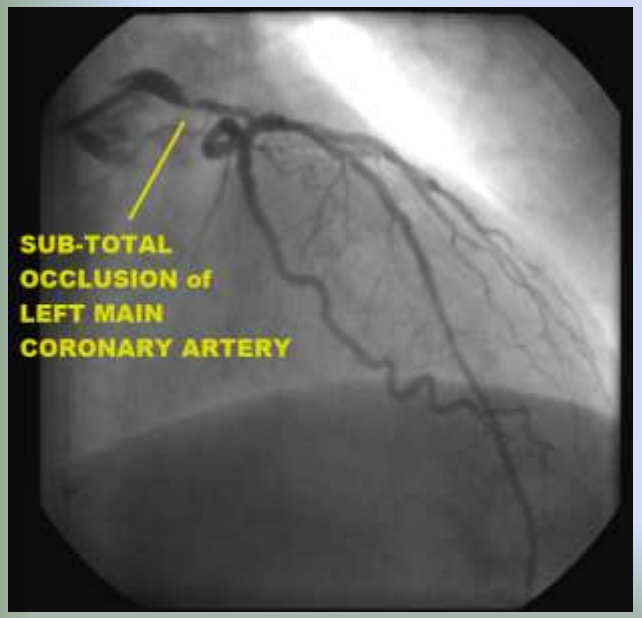
Here is the HEART Score! Let's see what the score is for our patient with the NORMAL ECG ….who had Critical Triple Vessel Disease and needed STAT Bypass Surgery! ….

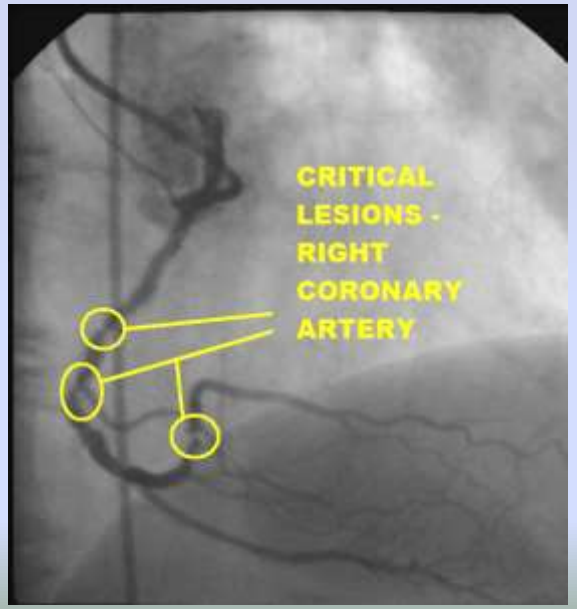
PROBLEMS WITH SENSITIVITY . . .

NORMAL ECG.

But . . . . .







LETHAL TRIPLE VESSEL DISEASE

HEART

HEART score for chest pain patients			
History	Highly suspicious	2	
	Moderately suspicious	1	
	Slightly suspicious	0	
ECG	Significant ST-deviation	2	
	Non specific repolarisation disturbance / LBTB / PM	1	
	Normal	0	
Age	≥ 65 years	2	
	> 45 and < 65 years	1	
	≤ 45 years	0	
Risk factors	≥ 3 risk factors or history of atherosclerotic disease*	2	
	1 or 2 risk factors	1	
	No risk factors known	0	
Troponin	≥ 3x normal limit	2	
	> 1 and < 3x normal limit	1	
	≤ 1x normal limit	0	
		Total	

***Risk factors for atherosclerotic disease:**

Hypercholesterolemia	Cigarette smoking
Hypertension	Positive family history
Diabetes Mellitus	Obesity

H = chest pain = 2

E = ECG normal = 0

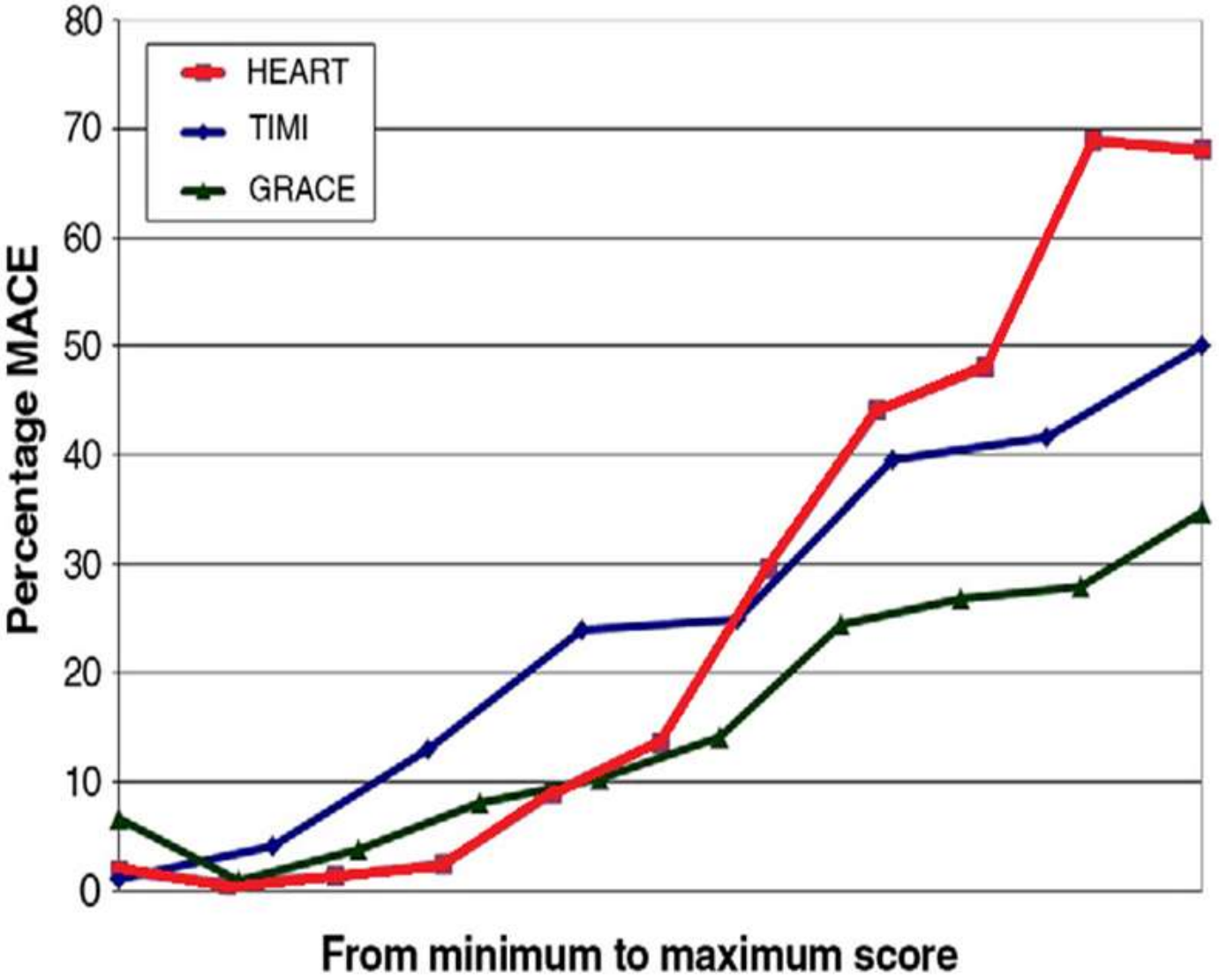
A = 63 = 1

R = 3 risk factors = 2

T = Trop. NL = 0

HEART Score: = 5

Comparison of PREDICTIVE RELIABILITY of the HEART SCORE to the Modified TIMI and GRACE ACS Risk Scores:



The New England Medical Journal

Some Basic Vocabulary:

- **Ischemia** = Inadequate blood supply to cells, but cells are still getting blood. Cellular Oxygen Demand is HIGHER than the Oxygen Supply.
- **Infarction** = blood supply to cells has been cut off. Cells are no longer receiving oxygen or glucose. Cells survive by consuming available glycogen reserves, convert to ANAEROBIC metabolism. Unless blood supply is restored, cells die when glycogen reserves are depleted.

Some Basic Vocabulary:

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

Unstable Angina

stable angina

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

VS.

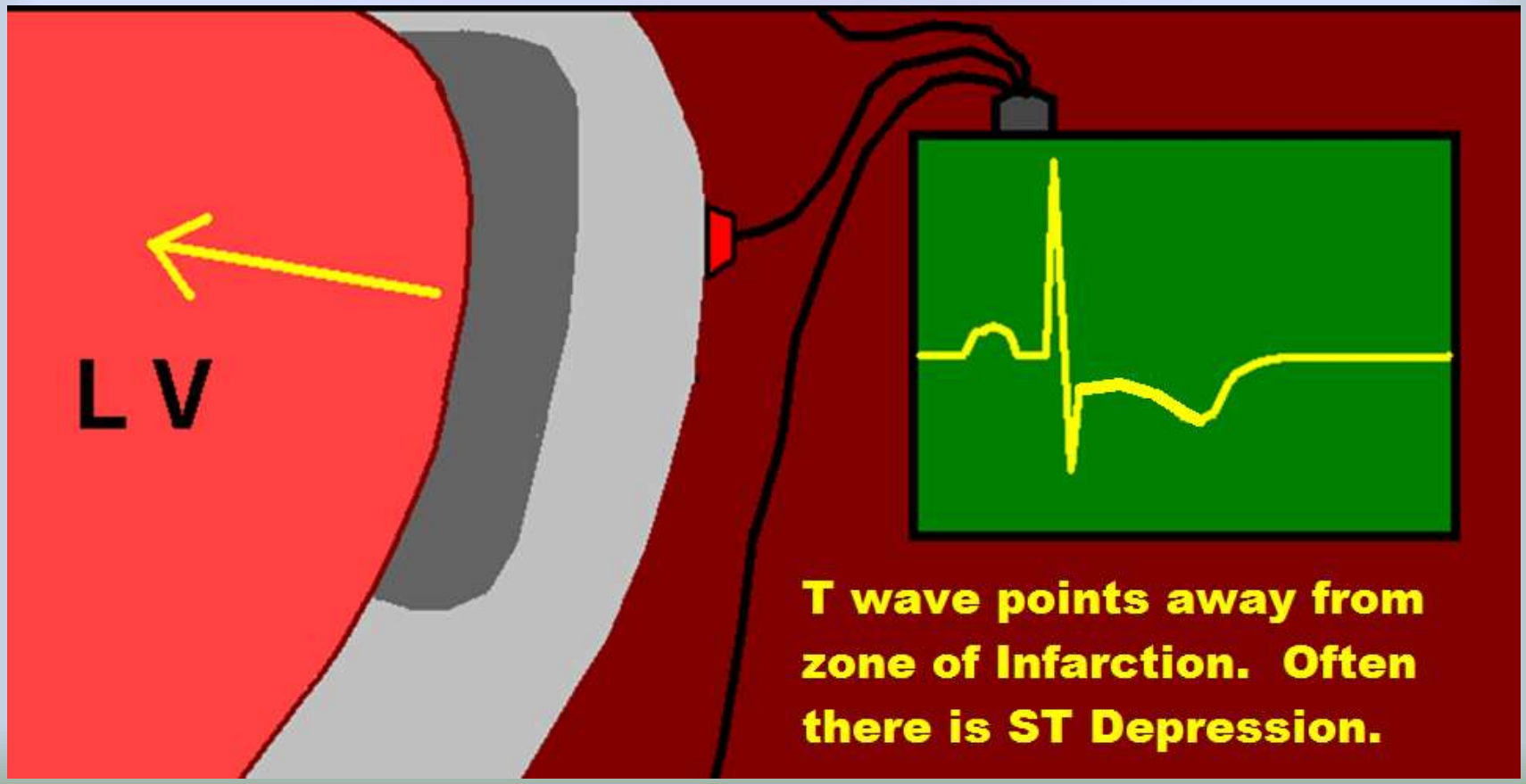
unstable angina

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

Non-STEMI (NSTEMI)

Non-ST Segment Elevation Myocardial Infarction.

"sub-endocardial MI" . . . "partial wall thickness"



Non-STEMI (NSTEMI)

Non-ST Segment Elevation Myocardial Infarction.

"sub-endocardial MI" . . . "partial wall thickness"

The 12 Lead ECG may show:

- ST Depression
- Other ST Segment changes
- Inverted T wave
- **THE ECG MAY BE TOTALLY NORMAL**.

Non-STEMI (NSTEMI)

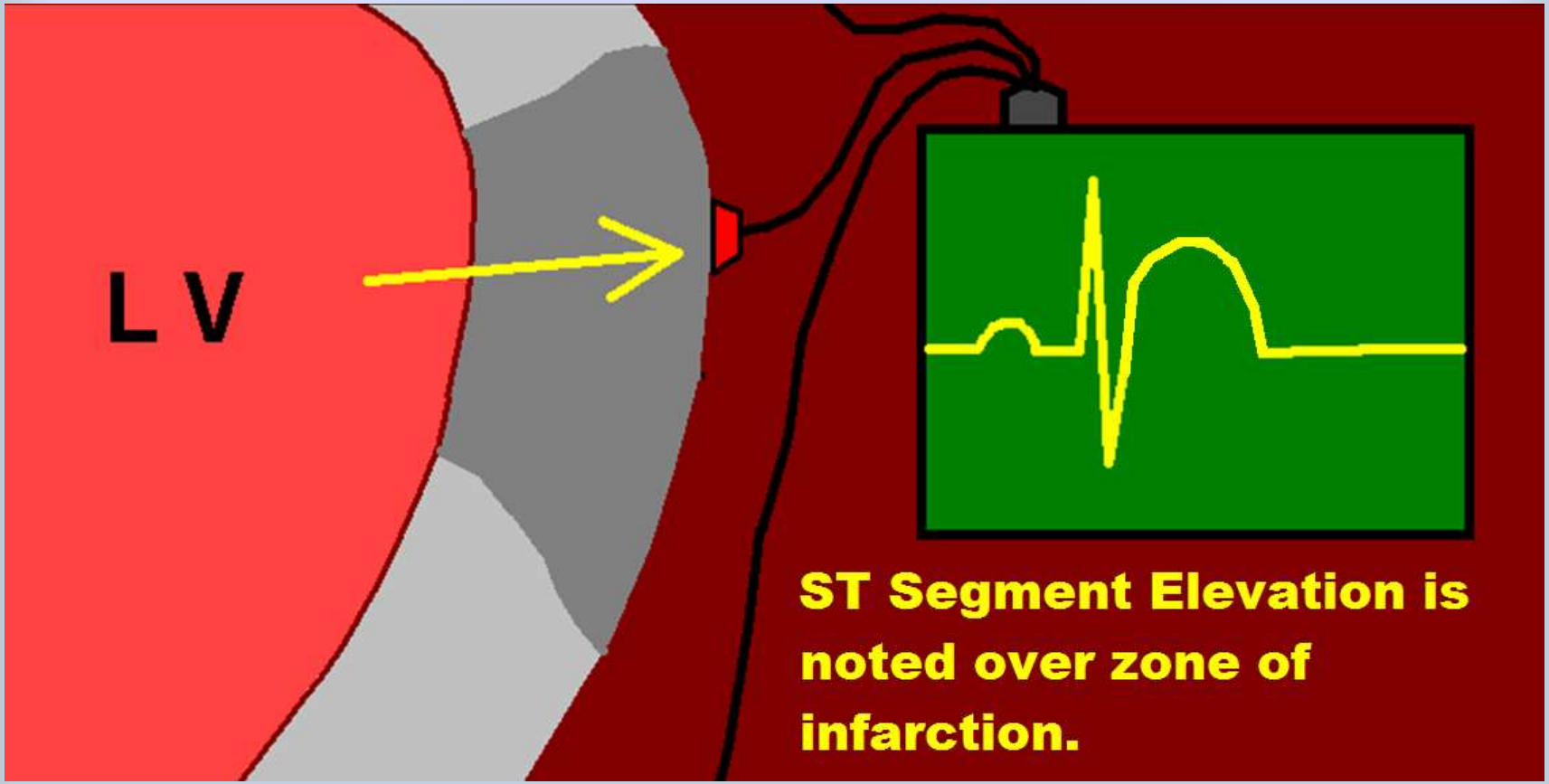
Non-ST Segment Elevation Myocardial Infarction.

"sub-endocardial MI" . . . "partial wall thickness"

This is a "Partial Wall Thickness" MI, heart cells are dying, and the Troponin becomes detectable in the patient's bloodstream. Usually "less severe" than a STEMI, patient needs blood thinners and to get to the cath lab in 24-48 hours.

STEMI

- ST Segment Elevation Myocardial Infarction.



Non-STEMI (NSTEMI)

ST Segment Elevation Myocardial Infarction.

("full-wall thickness," Transmural event)

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

A quick review of some very basic ECG concepts:

- When you turn on the ECG machine, it defaults to normal values…..
  - Records at 25mm/ second (horizontal axis)
  - Amplitude (vertical axis) is set so “ 1 mv = 10 small (1mm) boxes.”

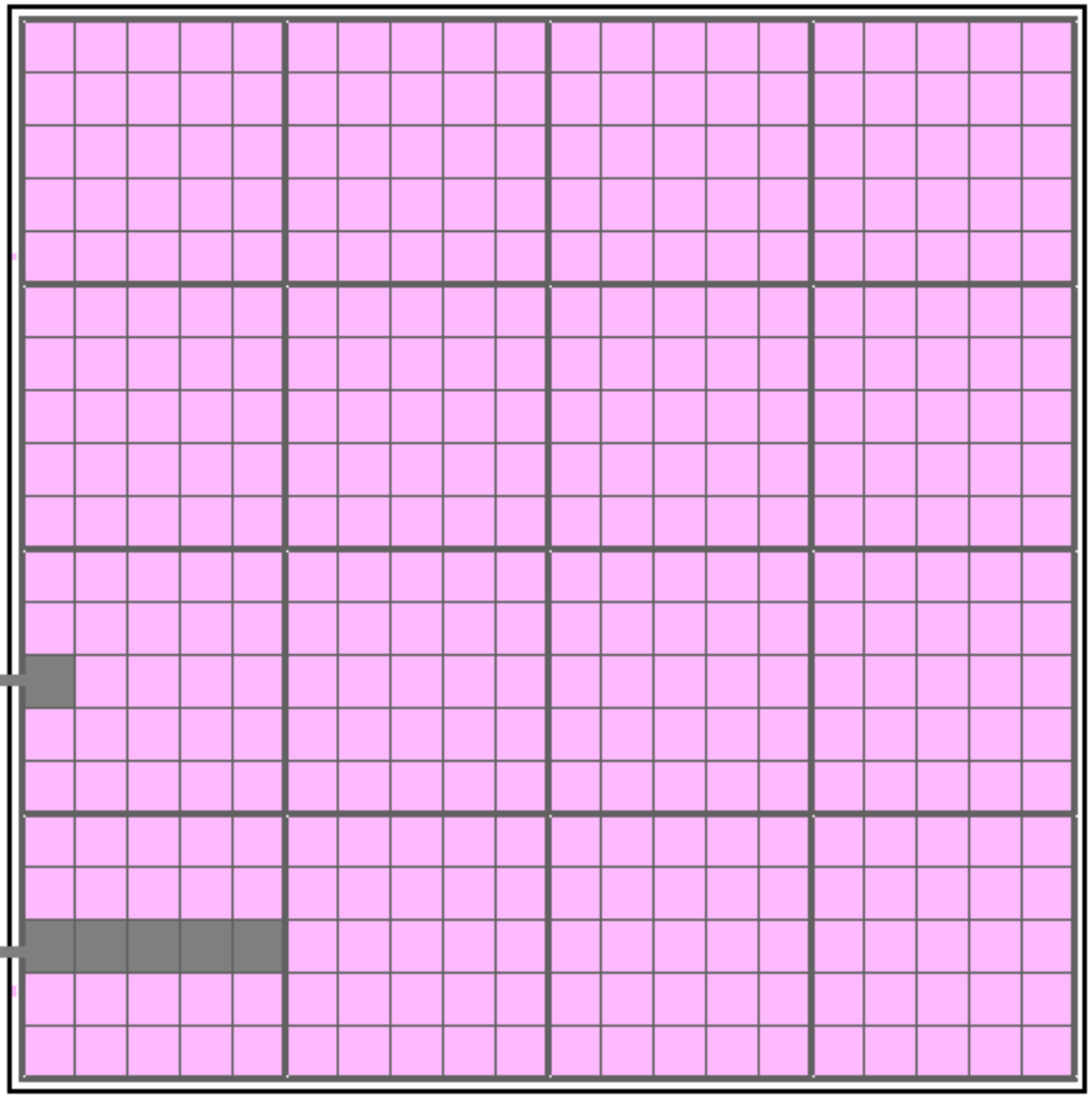
ECG PAPER - THE HORIZONTAL AXIS:

THE HORIZONTAL AXIS REPRESENTS TIME . . .

STANDARD SPEED FOR RECORDING ADULT EKGs = 25 mm / SECOND

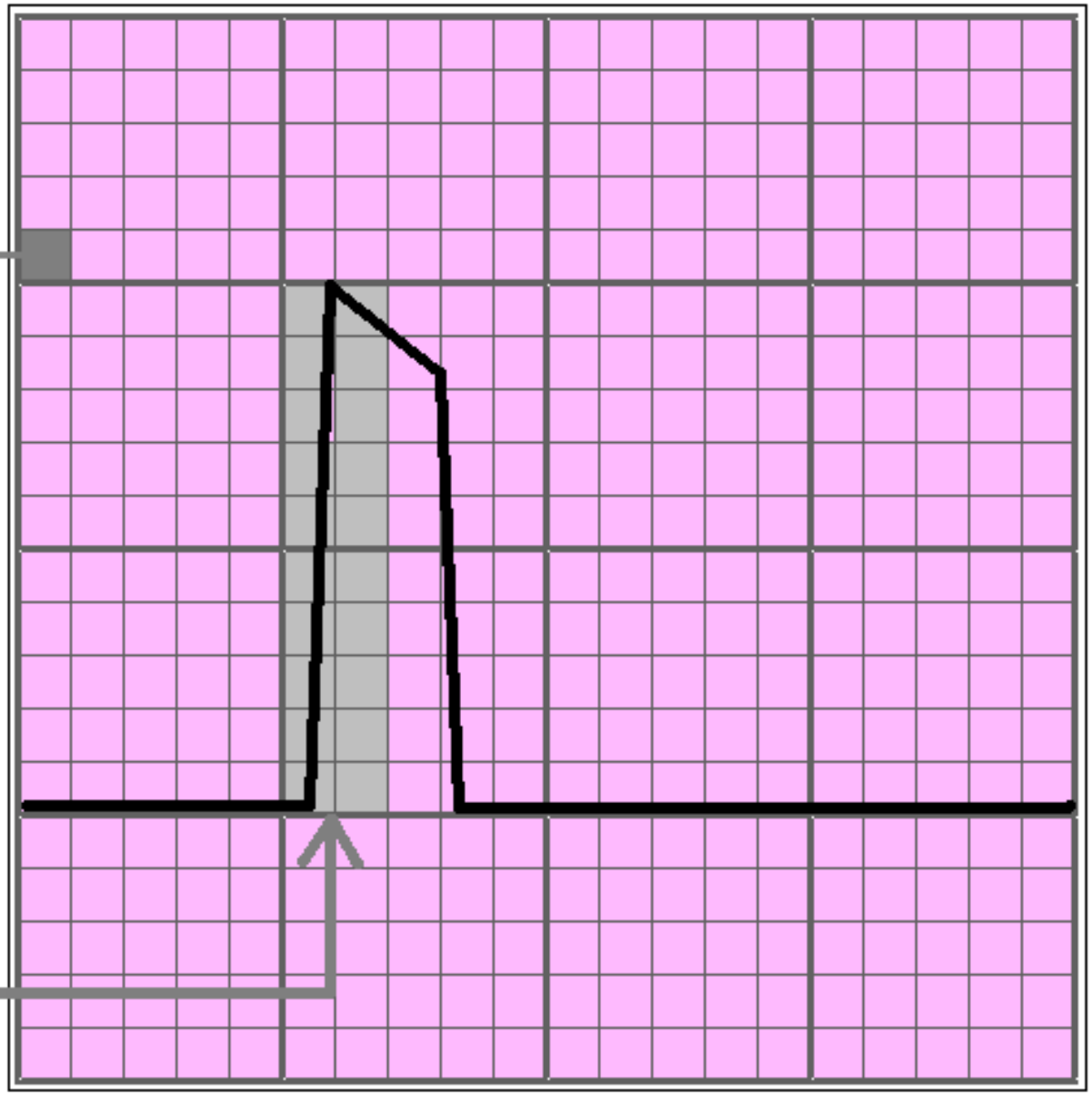
EACH 1mm BOX = .04 SECONDS, or 40 MILLISECONDS (40 ms)

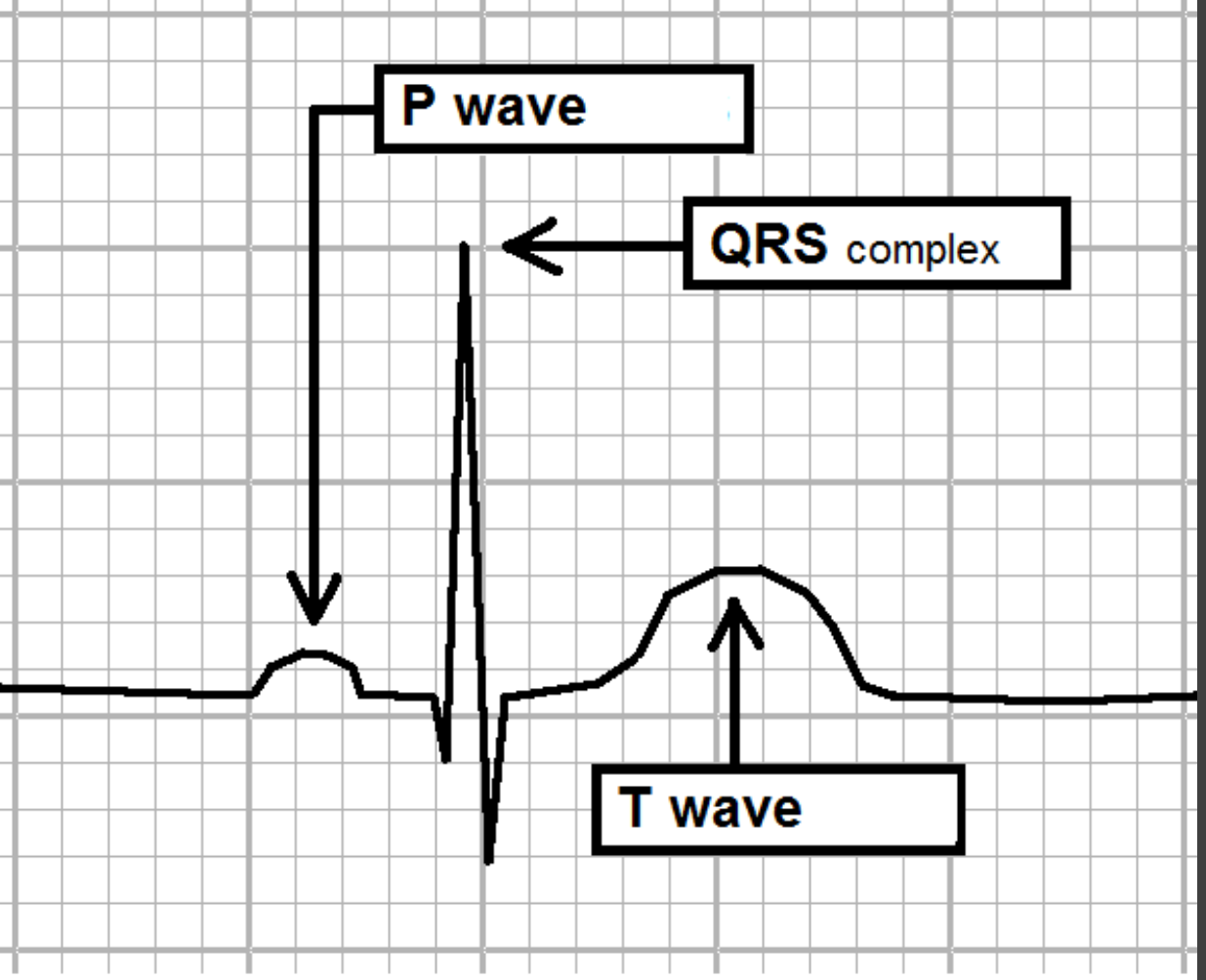
5 SMALL BOXES = .20 SECONDS, or 200 MILLISECONDS (200 ms)



ECG PAPER - THE VERTICAL AXIS:

- SMALL BOXES = 1mm SQUARES
- THE VERTICAL AXIS REPRESENTS AMPLITIUDE (VOLTAGE)
- IN VERTICAL DIRECTION, THERE ARE 5 SMALL BOXES IN EACH LARGE (5mm) BOX
- 1 mv CALIBRATION SPIKE = 10 mm





P WAVE =
ATRIAL DEPOLARIZATION

QRS COMPLEX =
VENTRICULAR DEPOLARIZATION (contracting)

T WAVE =
VENTRICULAR REPOLARIZATION (recharging)

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

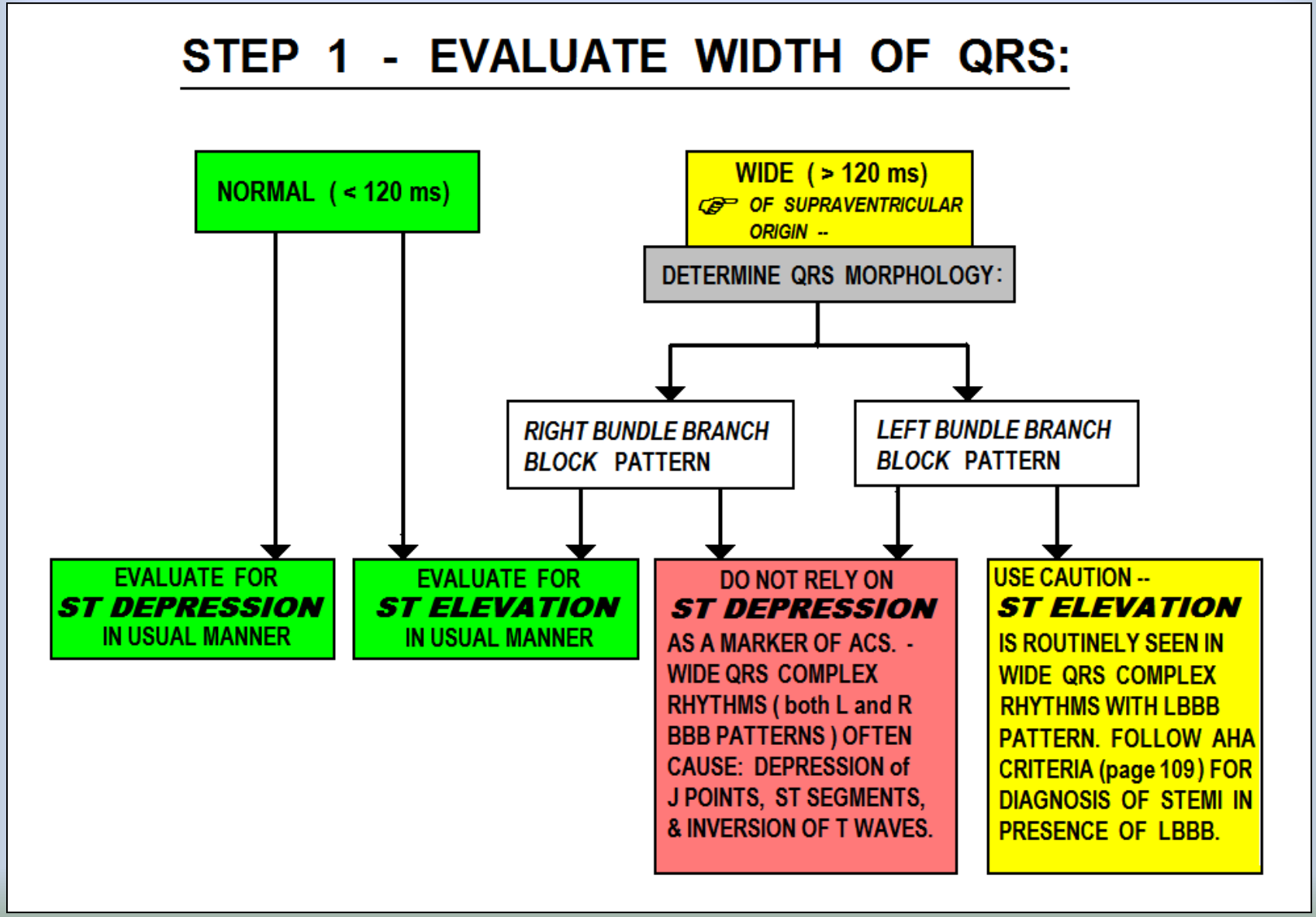
Q: To evaluate the patient for ischemia or infarction, what part of the ECG do we look at?

A: We evaluate the

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

…… in each lead !

Evaluating the ECG for ACS:



Evaluating the ECG for ACS:

Patients with Normal Width QRS (QRSd < 120ms)

STEP 2 - EVALUATE the EKG for ACS

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

- J POINTS
- ST SEGMENTS
- T WAVES

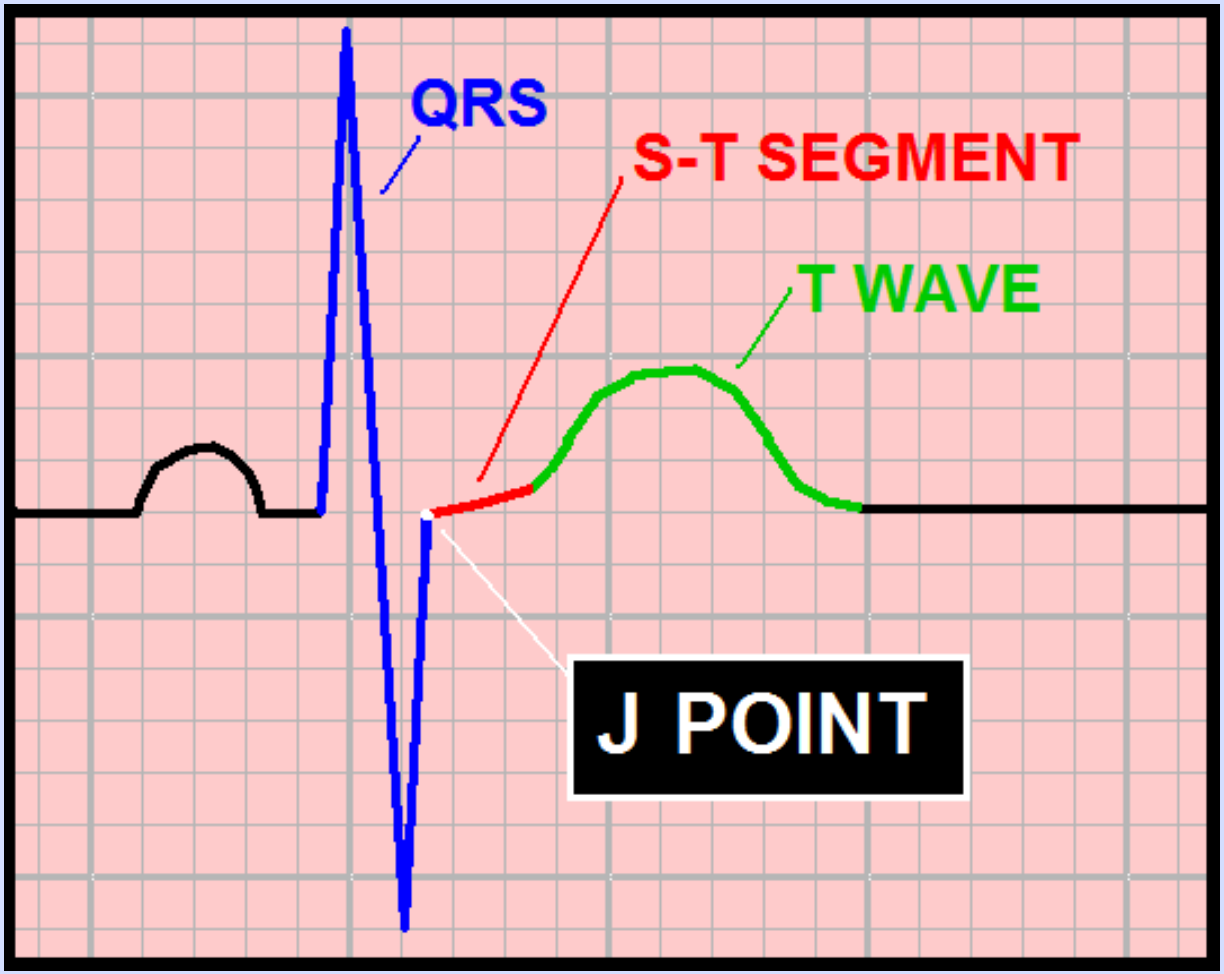
CAREFULLY SCRUTINIZE THESE MARKERS IN EVERY LEAD OF THE 12 LEAD EKG, TO DETERMINE IF THEY ARE *NORMAL* or *ABNORMAL*.

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

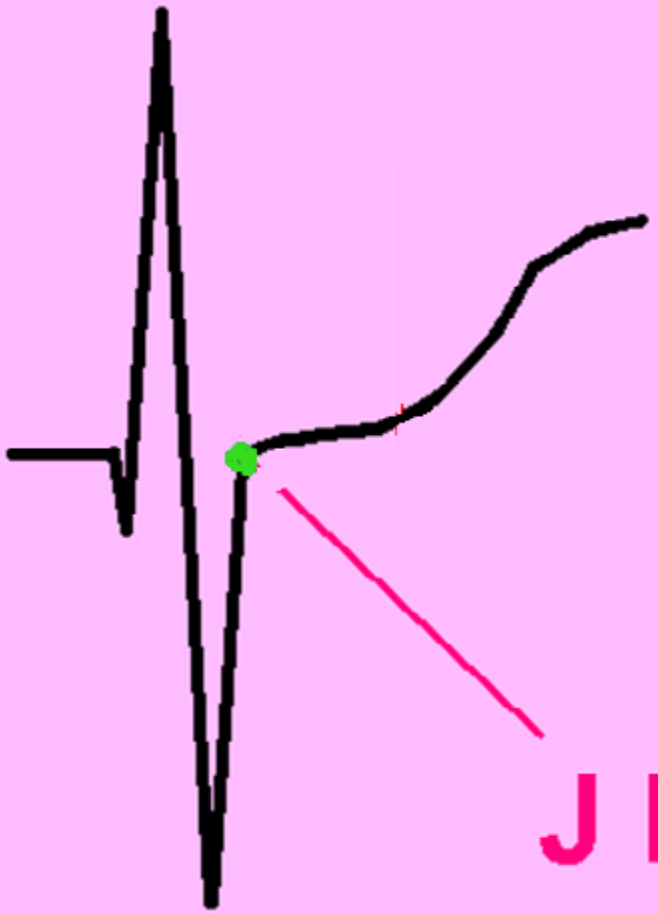
Q: Why is QRS width an issue when we look at J Points, ST Segments and T Waves??

A: When the QRS is abnormally wide (> 120ms), it ALTERS the J Points, ST Segements and T Waves.

Defining NORMAL – QRS <120ms:

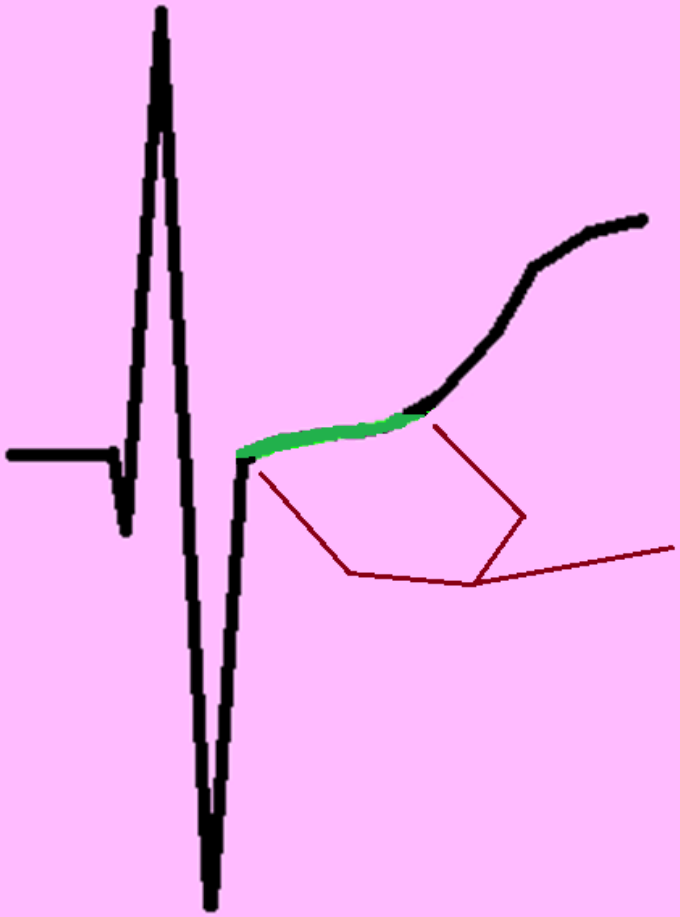


THE J POINT

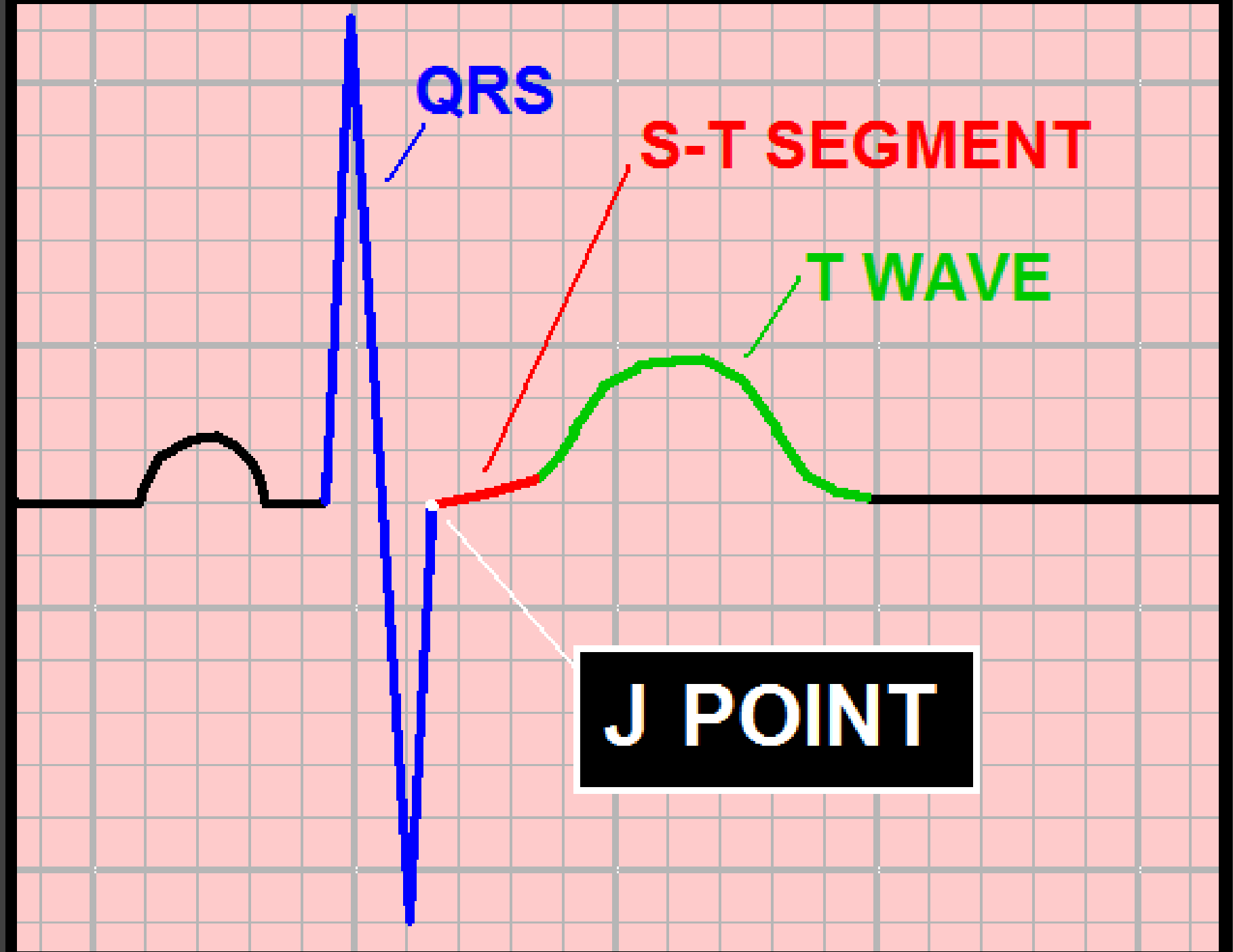


is where the QRS complex ends and the S-T Segment begins.

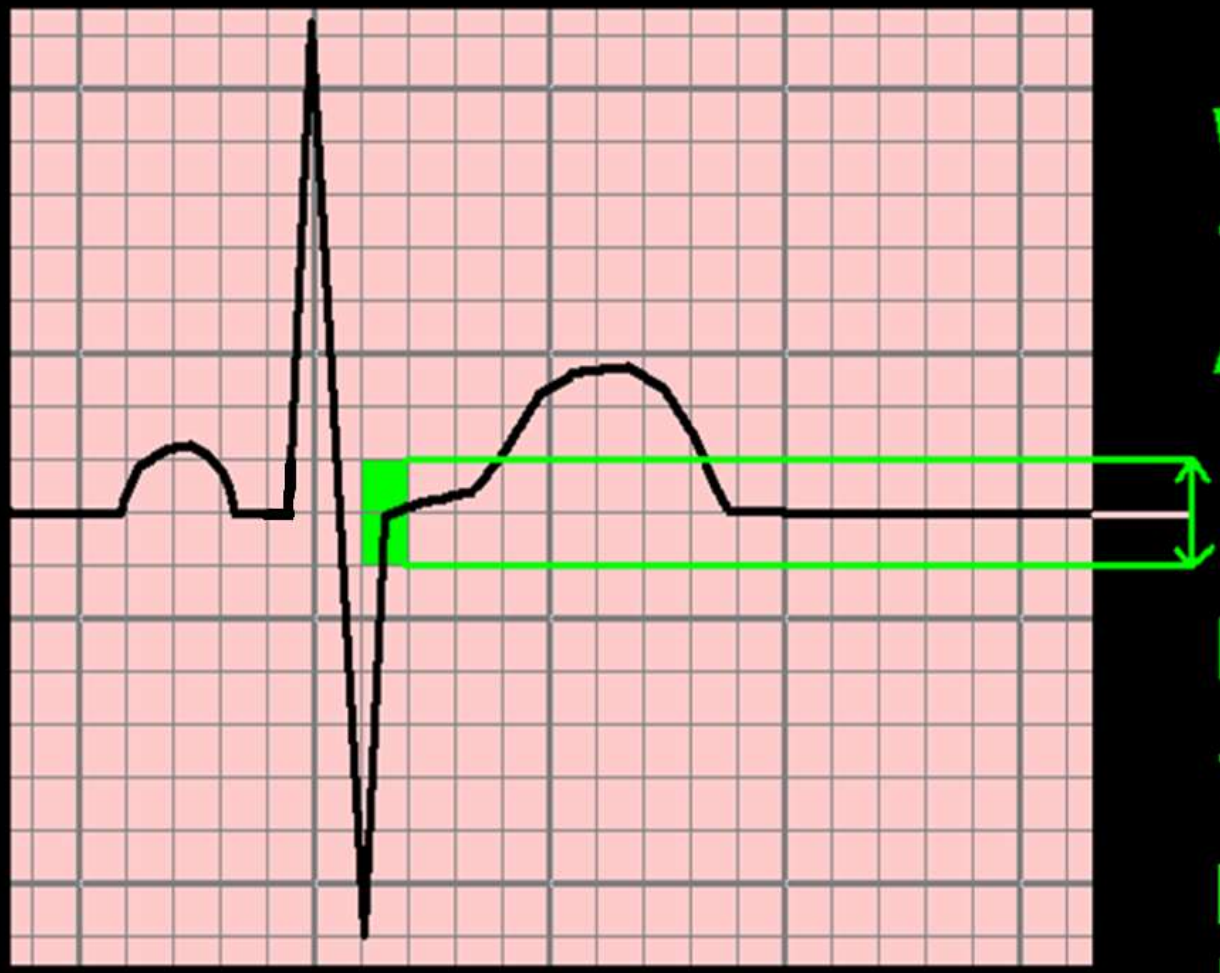
THE S-T SEGMENT



Extends from the J POINT to the T Wave


QRS
S-T SEGMENT
T WAVE
J POINT

THE J POINT SHOULD BE . .

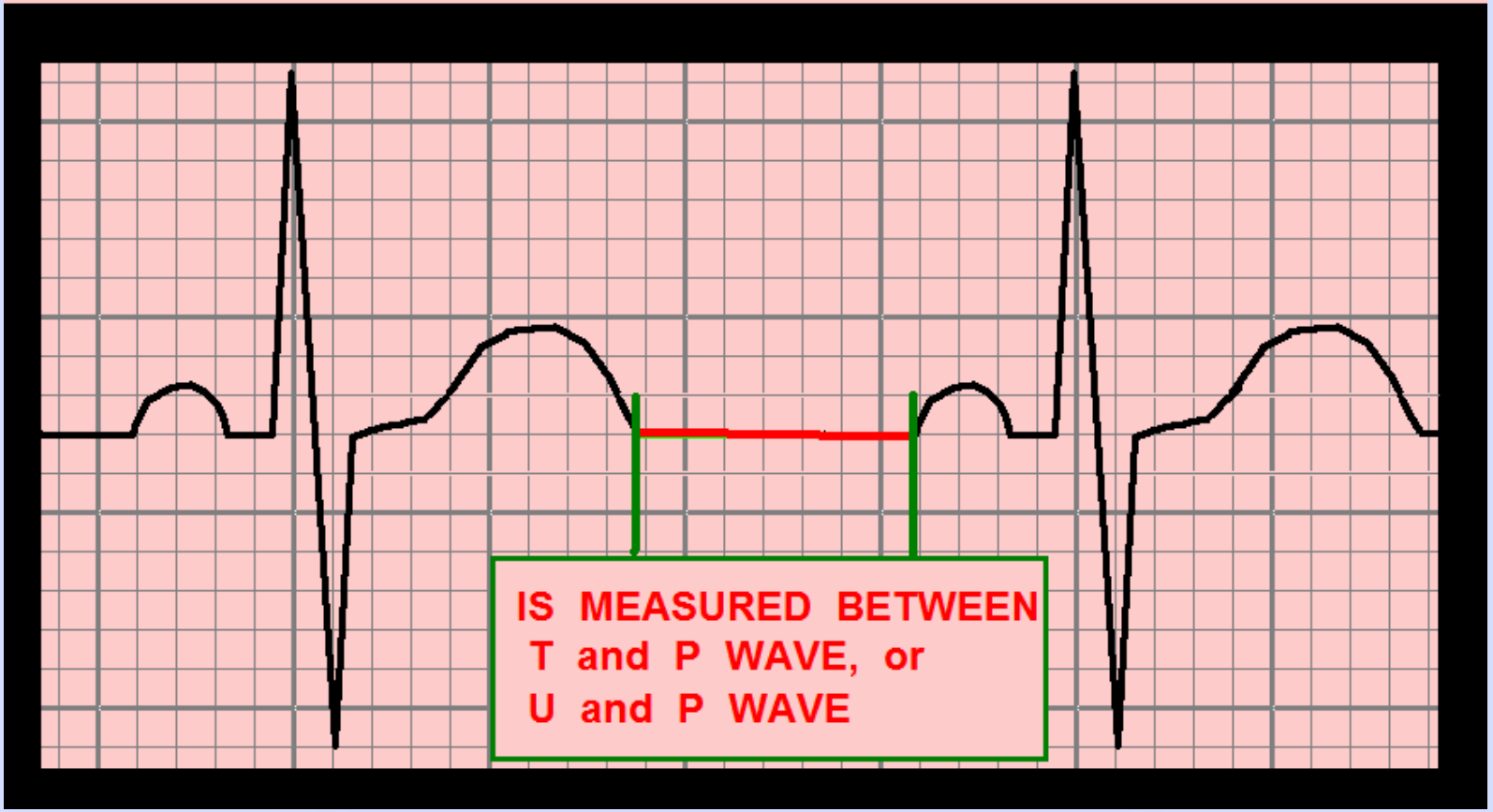


WITHIN
1 mm
ABOVE

OR

BELOW
the
ISOELECTRIC
LINE

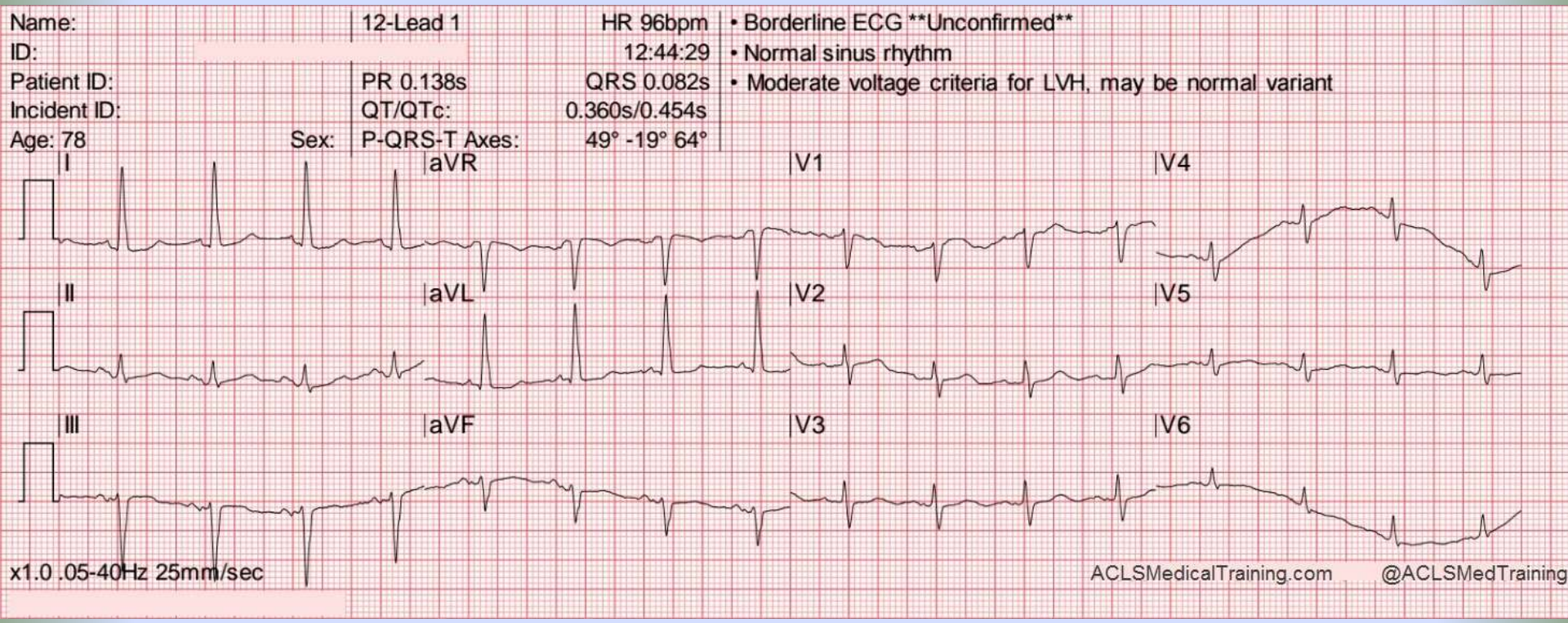
THE ISOELECTRIC LINE



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

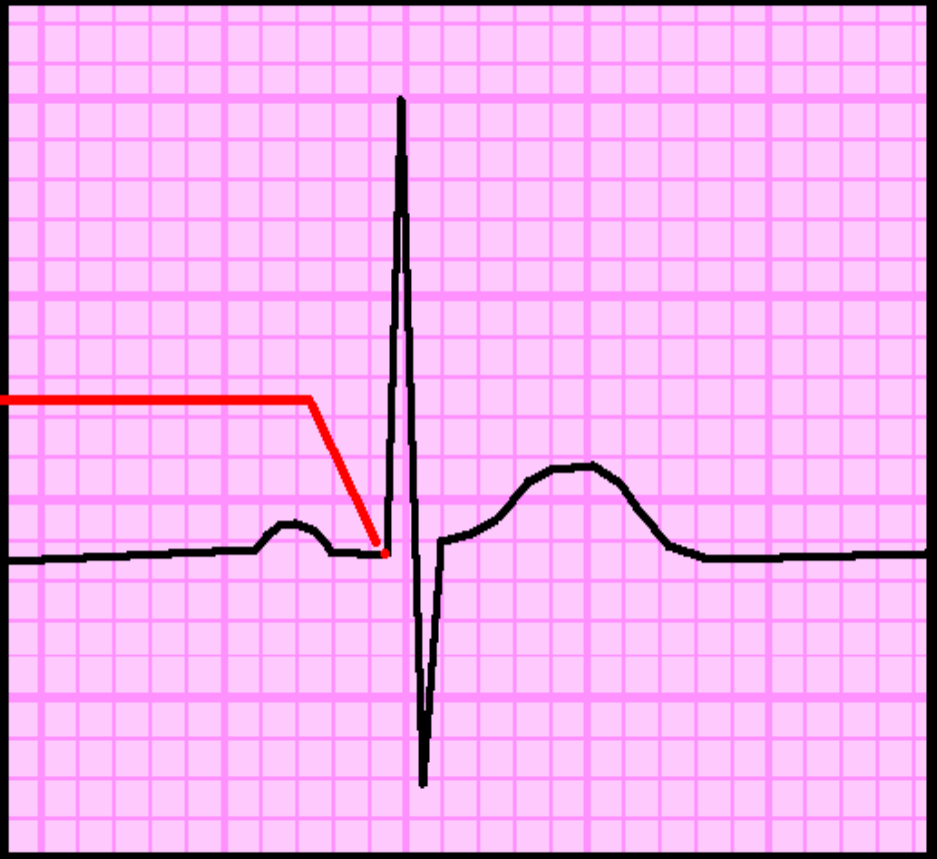
The Isoelectric Line -

it's not always isoelectric !



THE P-Q JUNCTION

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



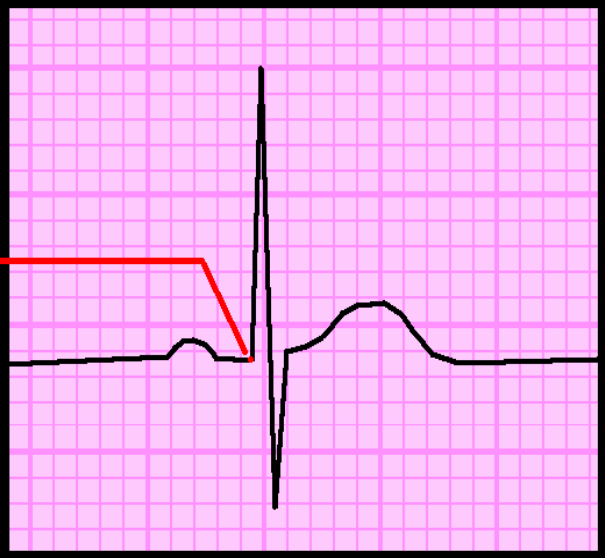
Used for POINT OF REFERENCE for measurement of the J-POINT and the S-T SEGMENT –

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

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

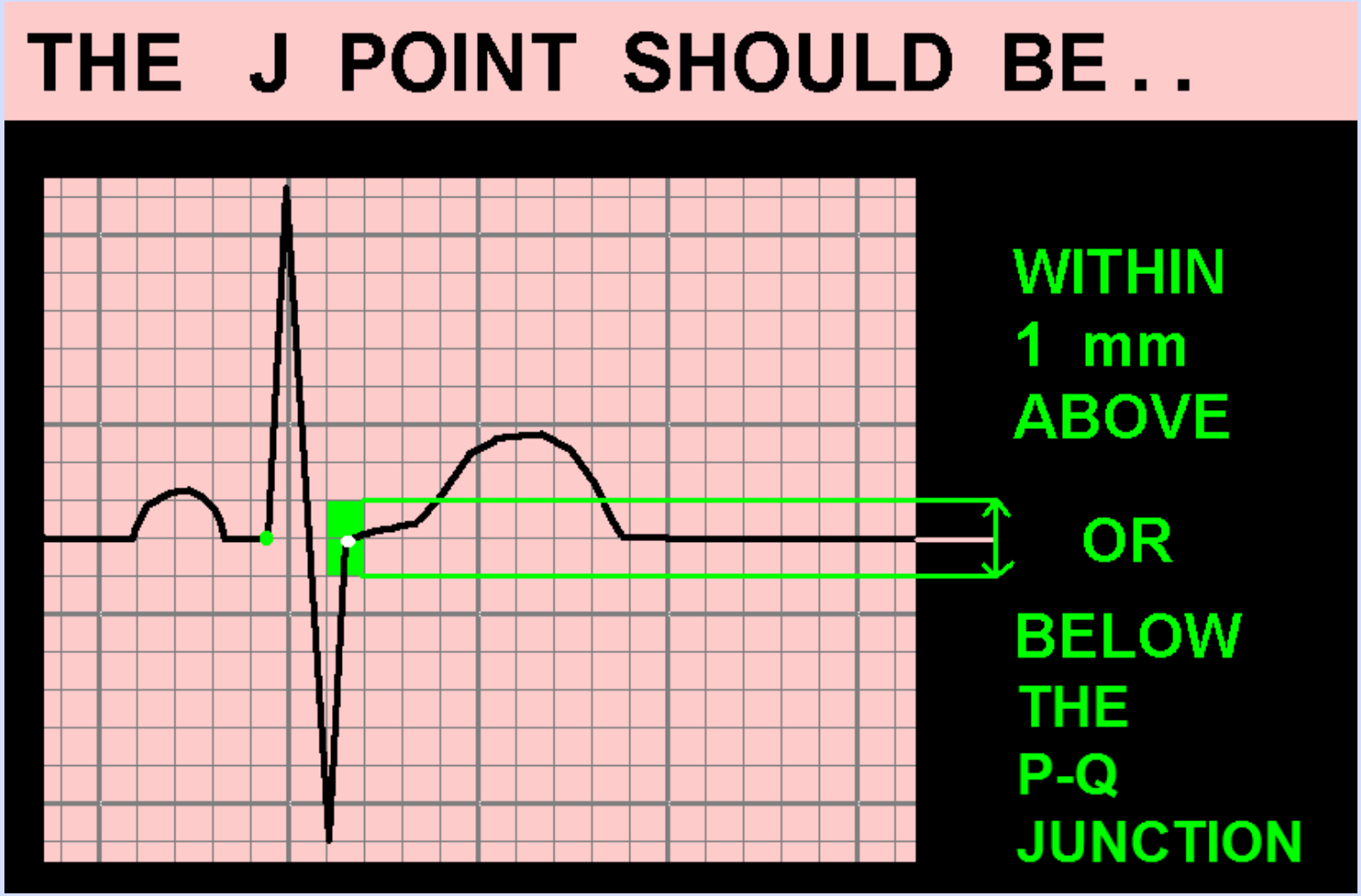
THE P-Q JUNCTION

. . . 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 –

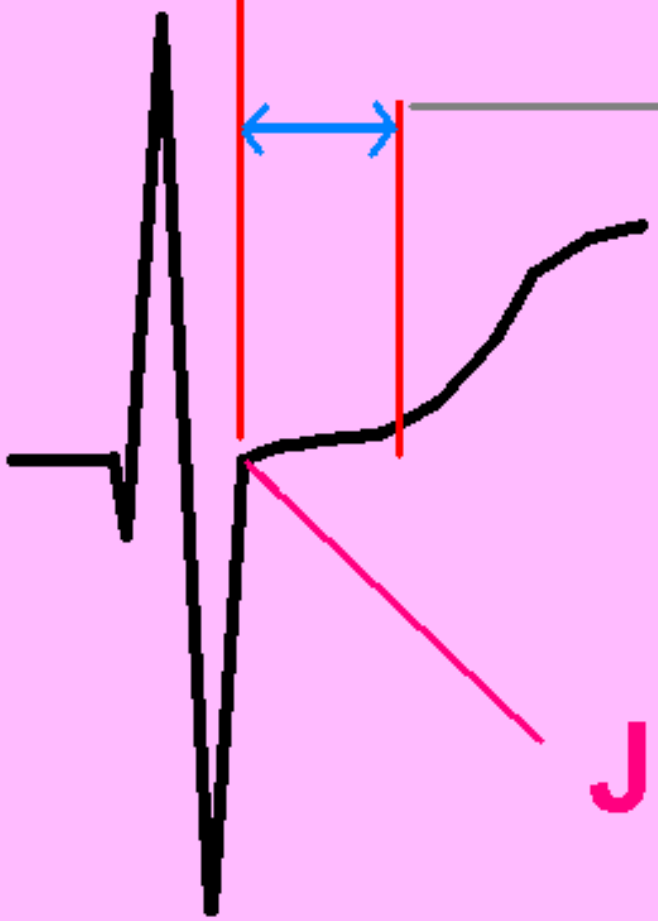


— as per the A.H.A., A.C.C., and WANG, ASINGER, and MARRIOTT, N.E.J.M. vol. 349:2128-2135 Nov. 27, 2003

Defining NORMAL:



THE S-T SEGMENT

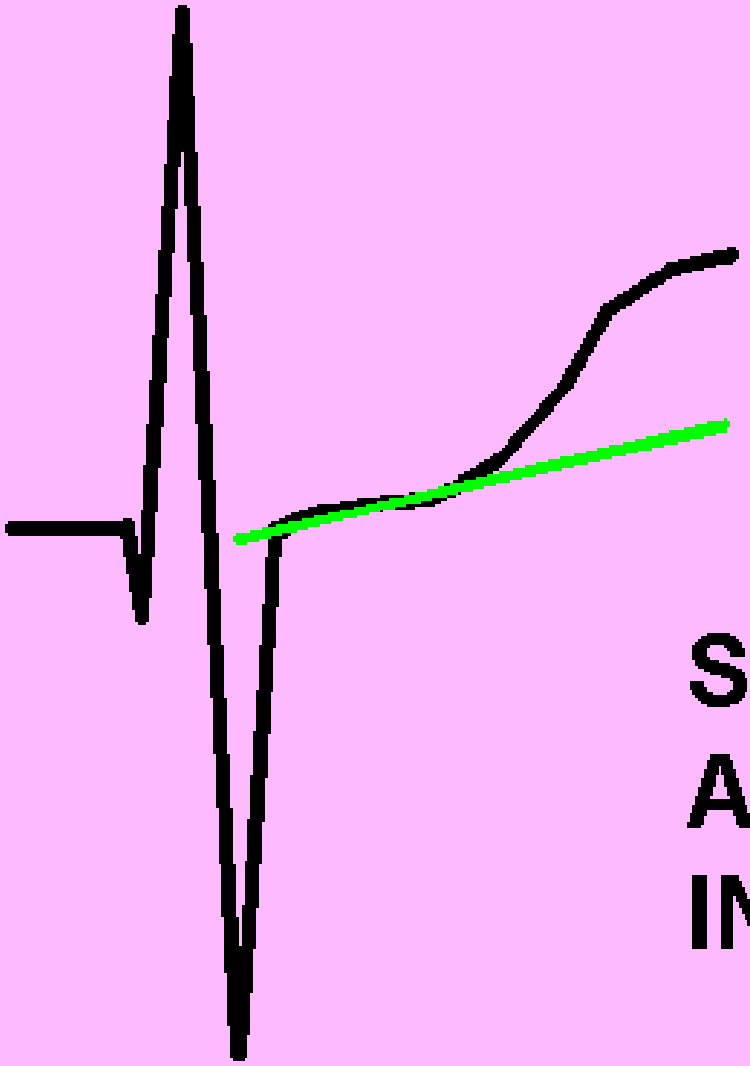


BEGINS AT J POINT

ENDS AT BEGINNING OF T WAVE

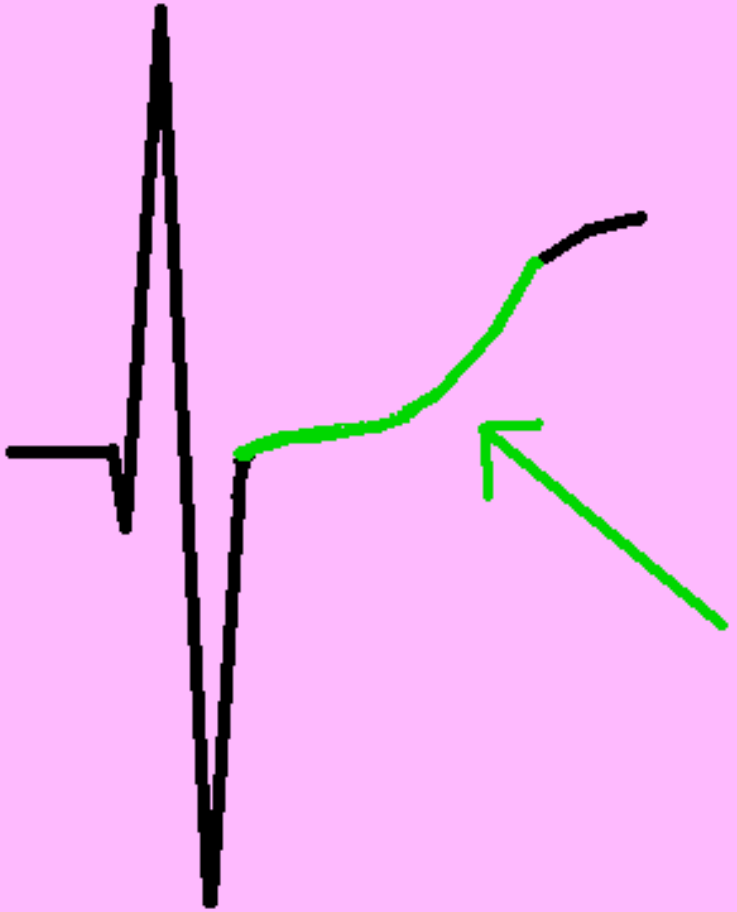
J POINT

THE S-T SEGMENT



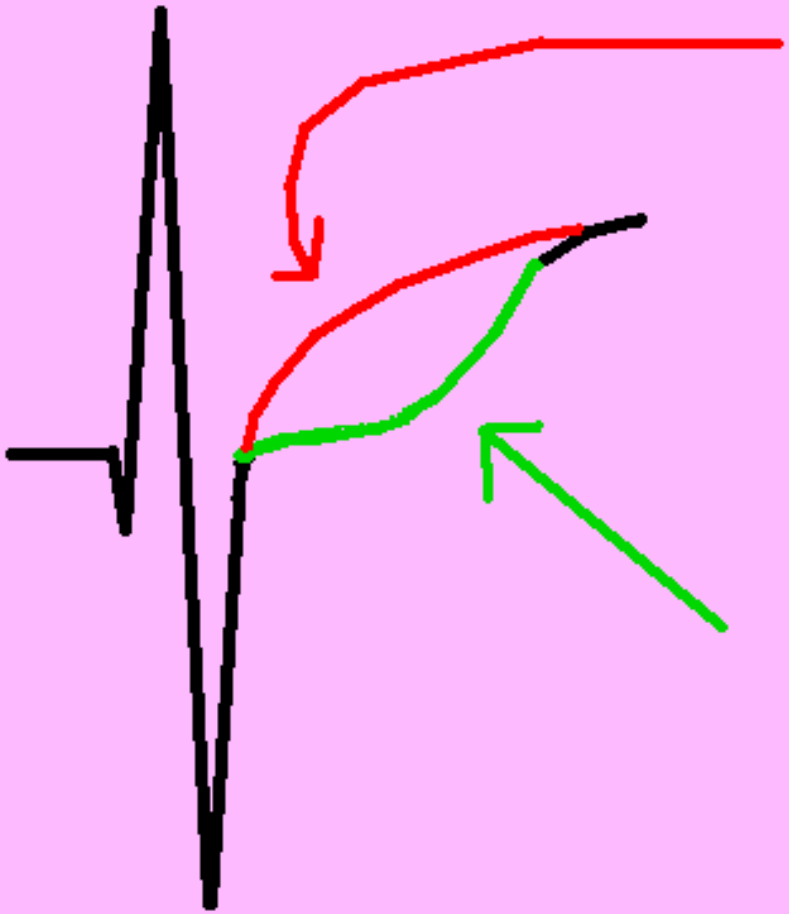
SHOULD HAVE
A "SLIGHT POSITIVE"
INCLINATION

THE S-T SEGMENT



SHOULD BE "CONCAVE" IN SHAPE . . .

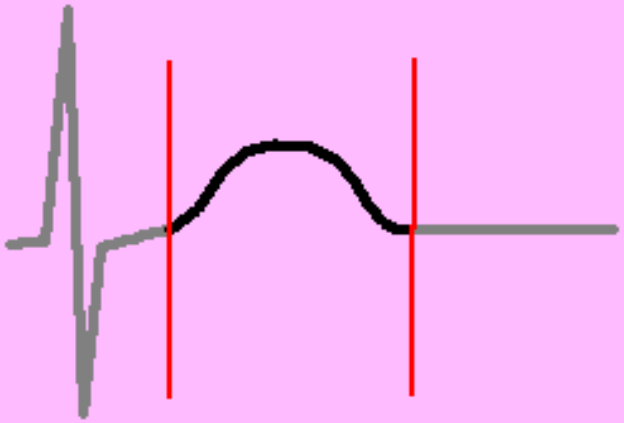
THE S-T SEGMENT



AS OPPOSED TO "CONVEX" IN SHAPE

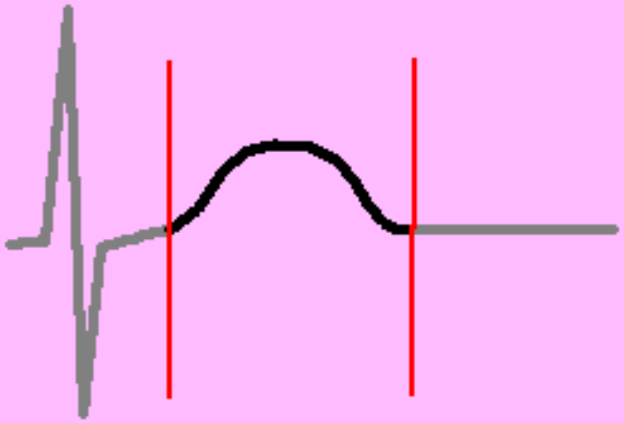
SHOULD BE "CONCAVE" IN SHAPE . . .

THE T WAVE



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

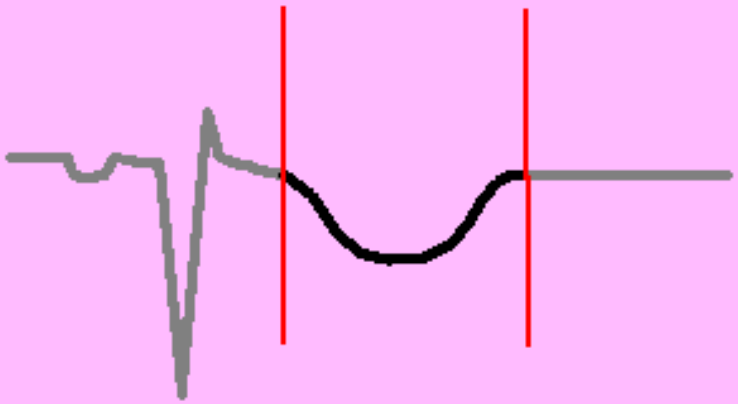
THE T WAVE



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

- SHOULD BE SYMMETRICAL
- SHOULD BE UPRIGHT IN ALL LEADS, EXCEPT AVR

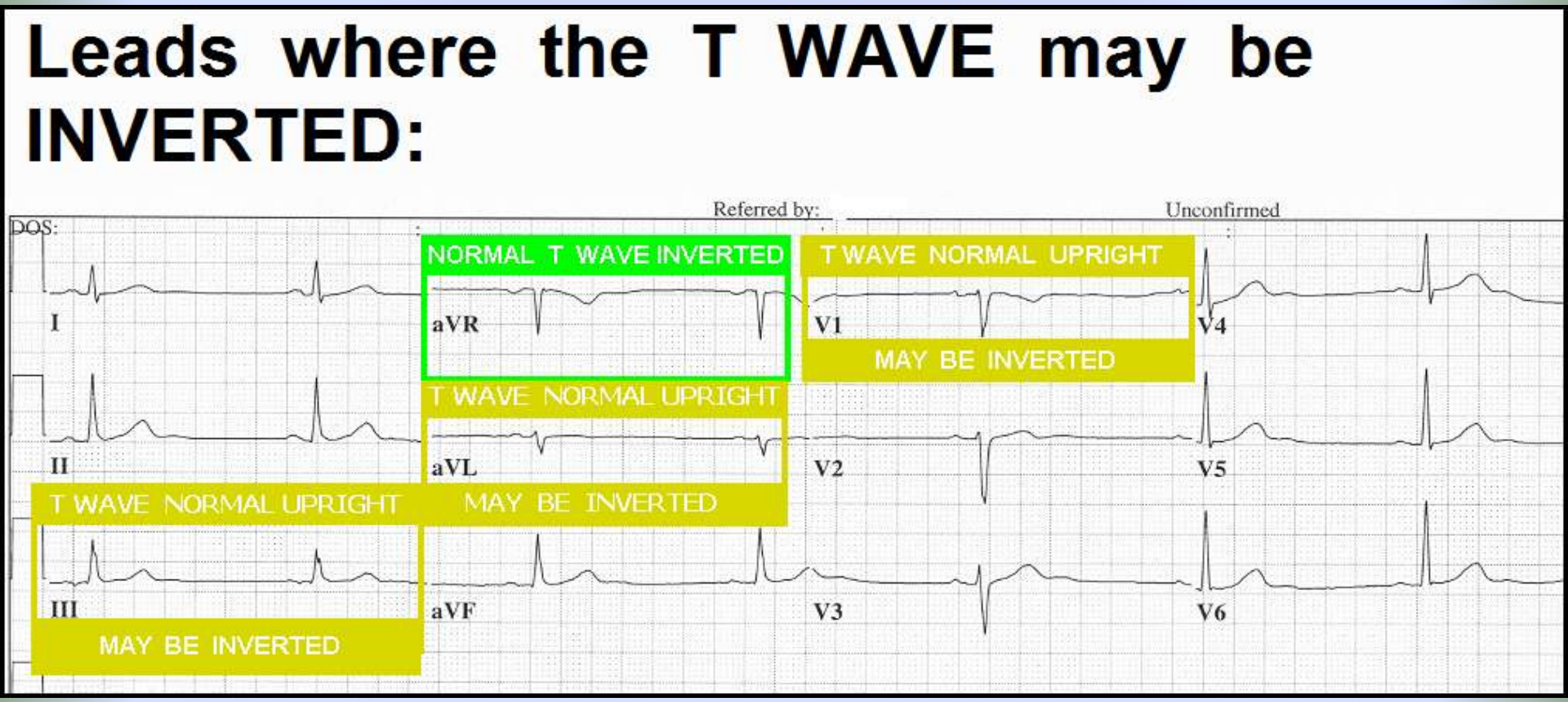
THE T WAVE



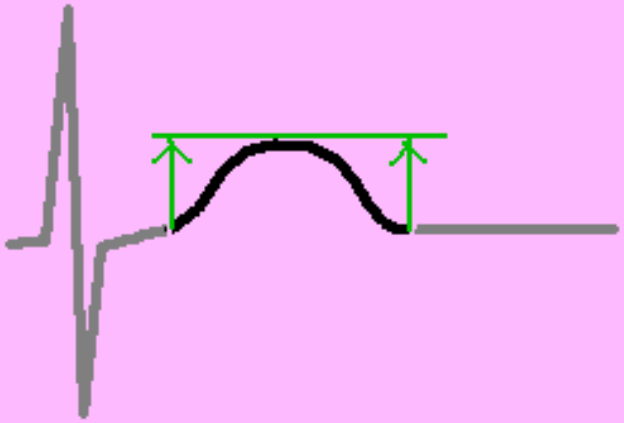
LEAD AVR

- REMEMBER, IN LEAD AVR *EVERYTHING* IS "UPSIDE-DOWN"

Normal Variants:
T Wave Inversion



THE T WAVE



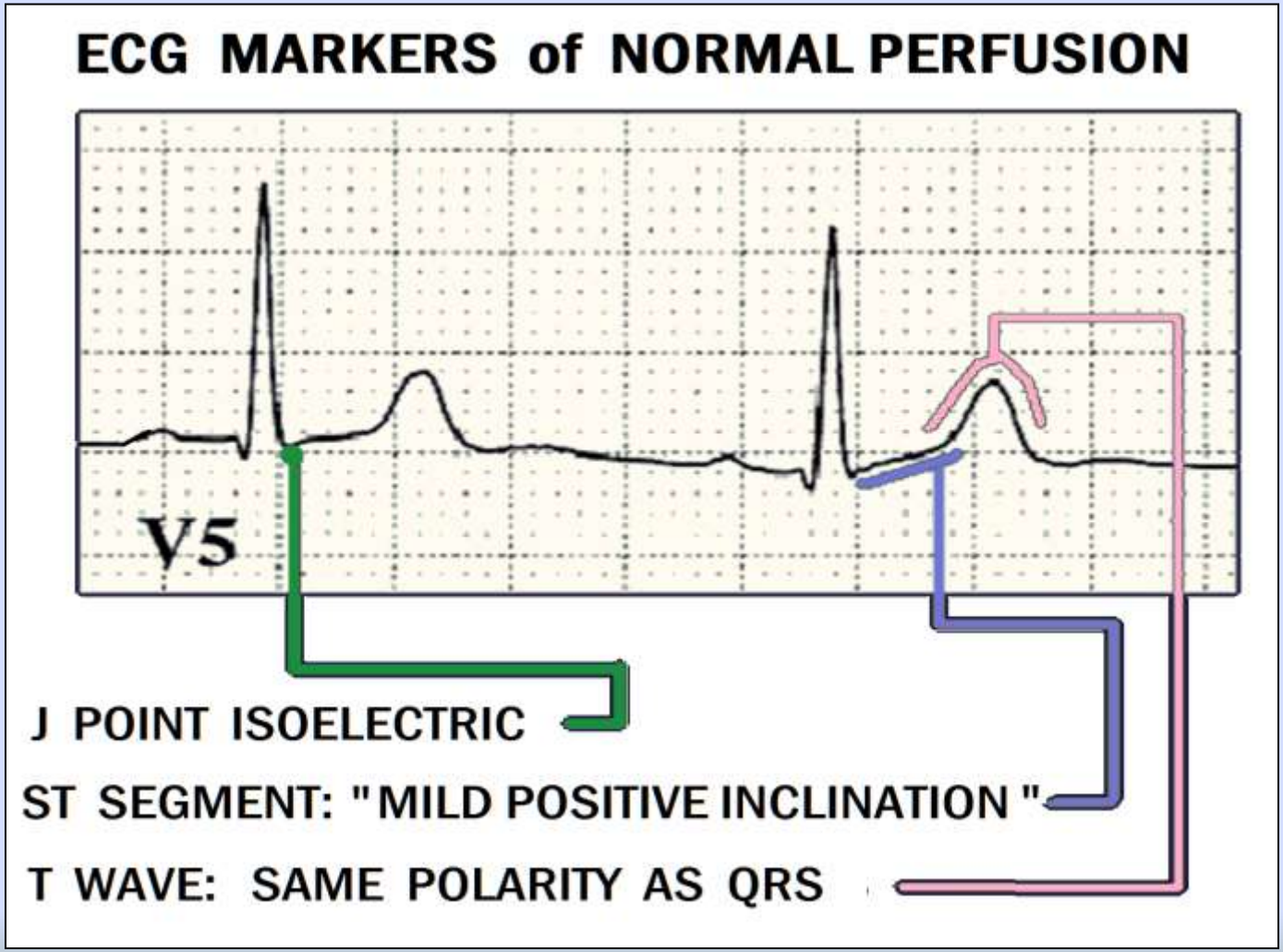
AMPLITUDE GUIDELINES:

- 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.

The next slide shows an ECG waveform with ***normal*** J Points, ST Segments and T waves……

THINK OF THIS AS YOUR "MEASURING STICK" of what NORMAL is !!!

Patients with normal QRS duration (QRS < 120 ms) :



Q: If the previous slide showed what *normal* J Points, ST Segments and T waves look like, what is ABNORMAL ?

Q: If the previous slide showed what *normal* J Points, ST Segments and T waves look like, what is ABNORMAL ?

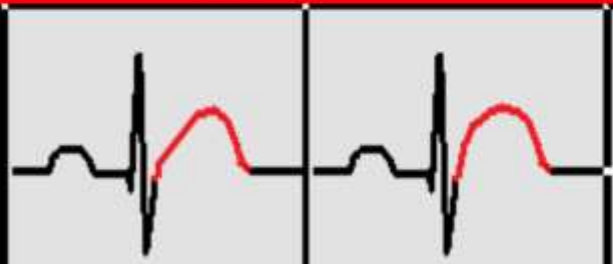
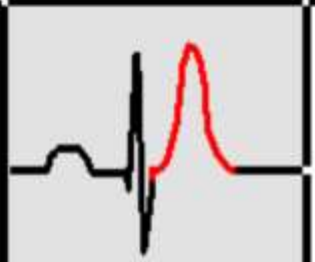
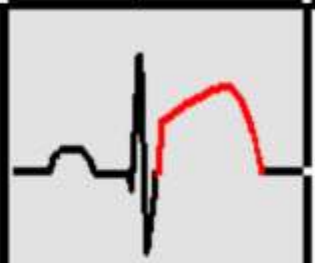
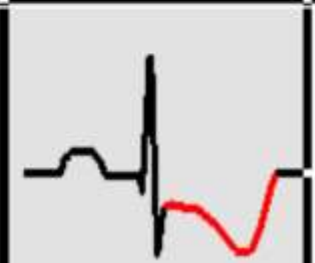
A: EVERYTHING ELSE !!!

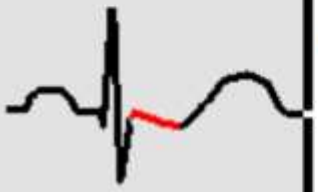
Up Next:

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

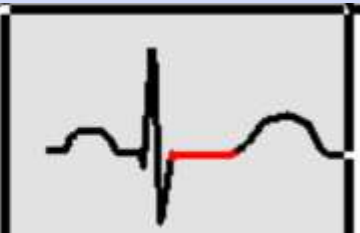
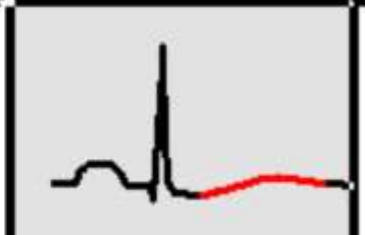
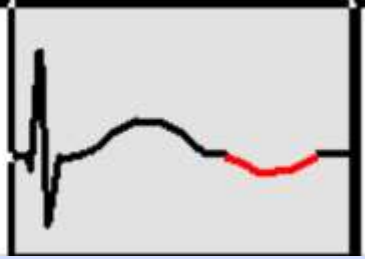
PATTERNS of ACS & ISCHEMIA

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

!	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**

INVERTED T WAVE		- MYOCARDITIS - ELECTROLYTE IMBAL. - ISCHEMIA
SHARP S-T T ANGLE		- ACUTE MI (NOT COMMON) - ISCHEMIA
BI-PHASIC T WAVE (WELLEN'S)		- SUB-TOTAL LAD LESION - VASOSPASM - HYPERTROPHY
DEPRESSED J POINT with UPSLOPING ST		- ISCHEMIA
DOWNSLOPING S-T SEGMENT		- ISCHEMIA

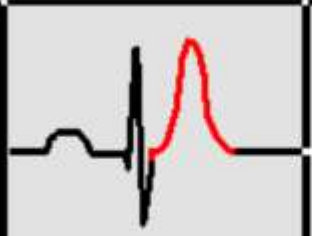
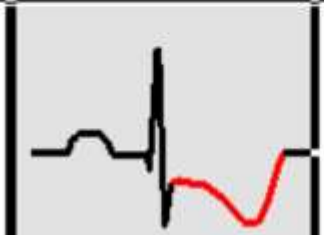
Some less common, less reliable possible indicators of ACS:

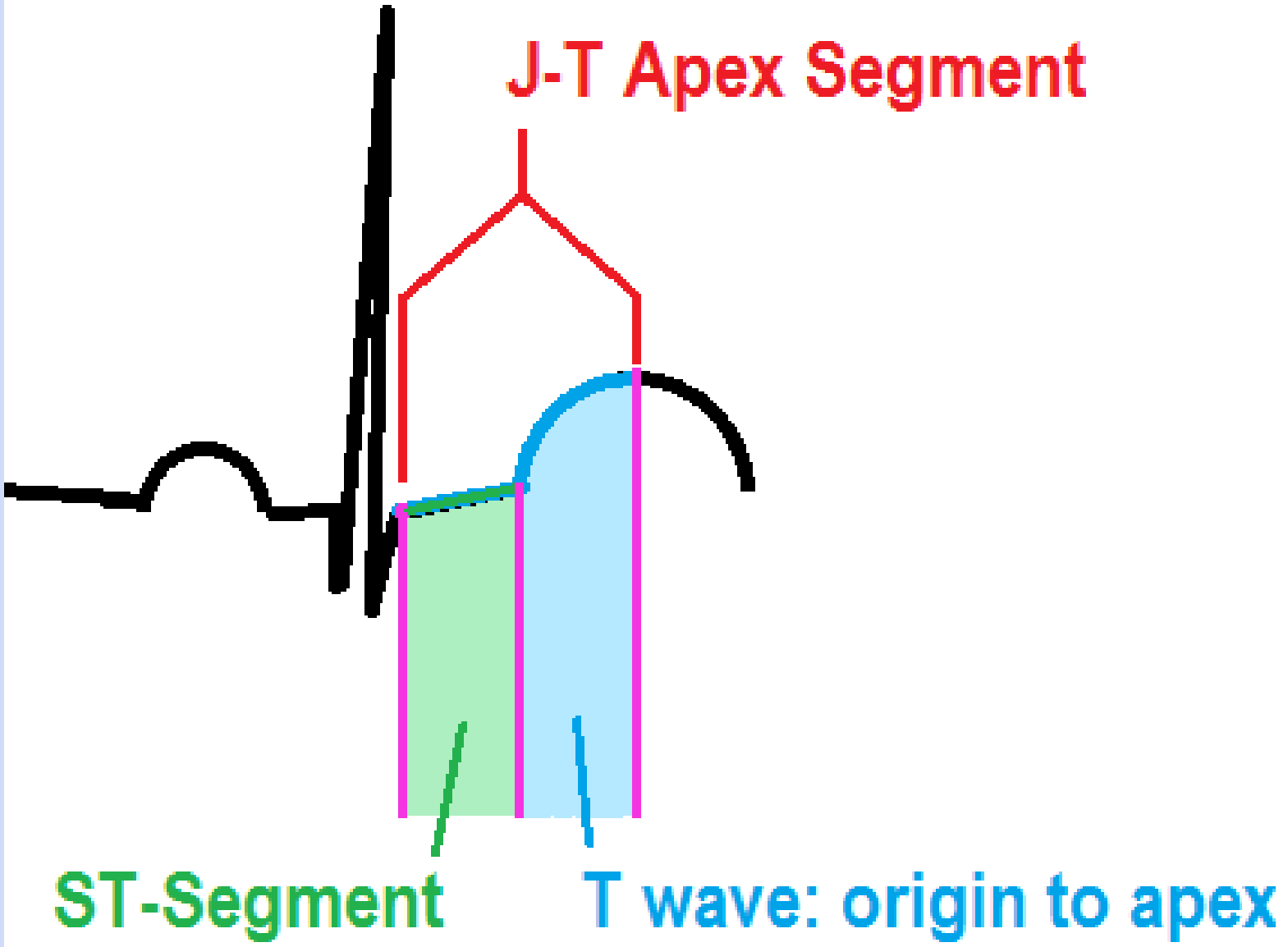
?	FLAT S-T SEGMENT > 120 ms		- ISCHEMIA
?	LOW VOLTAGE T WAVE WITH NORMAL QRS		- ISCHEMIA
?	U WAVE POLARITY OPPOSITE THAT OF T WAVE		- ISCHEMIA

LET'S START HERE . . . .

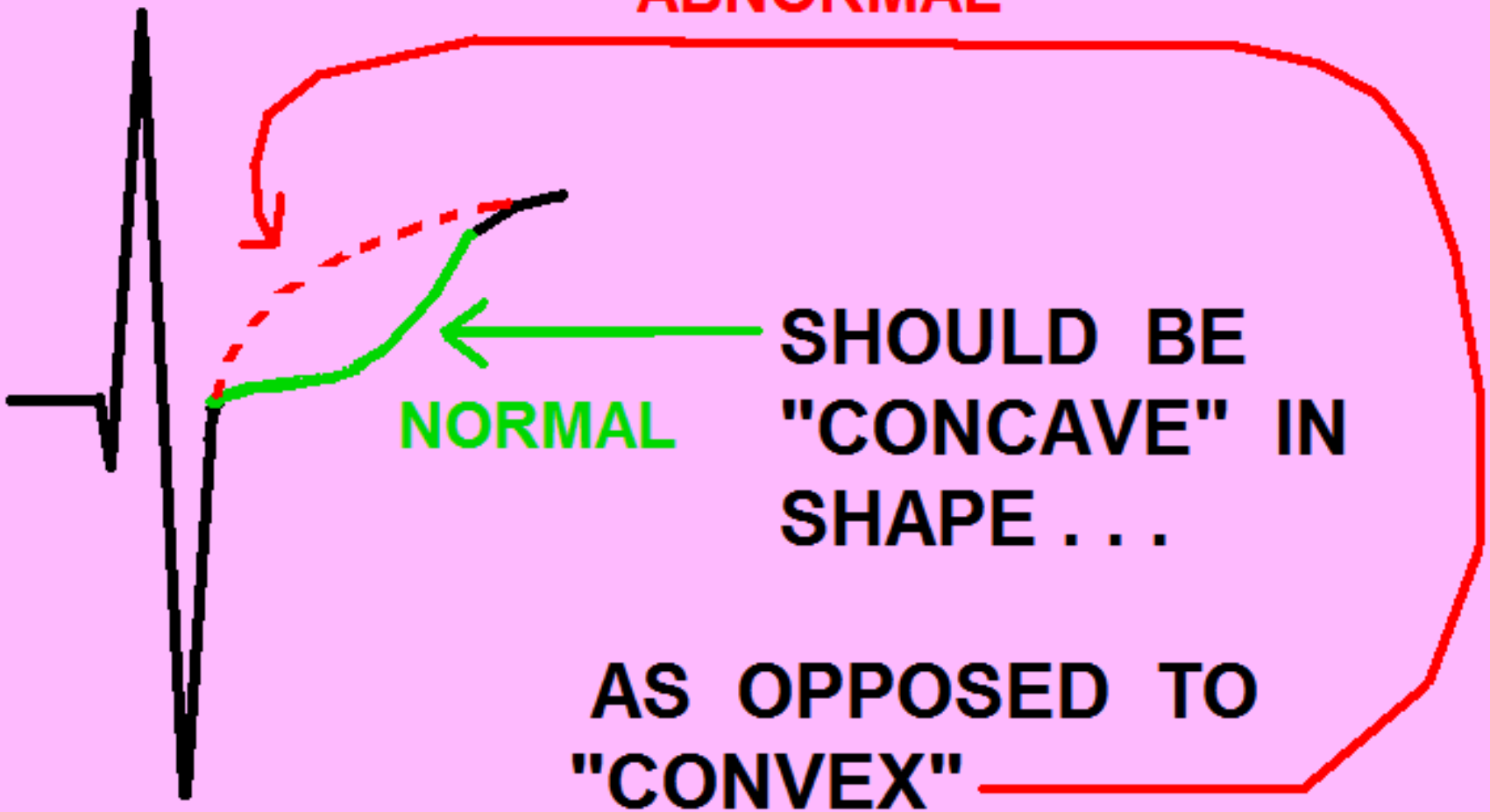
PATTERNS of ACS & ISCHEMIA

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

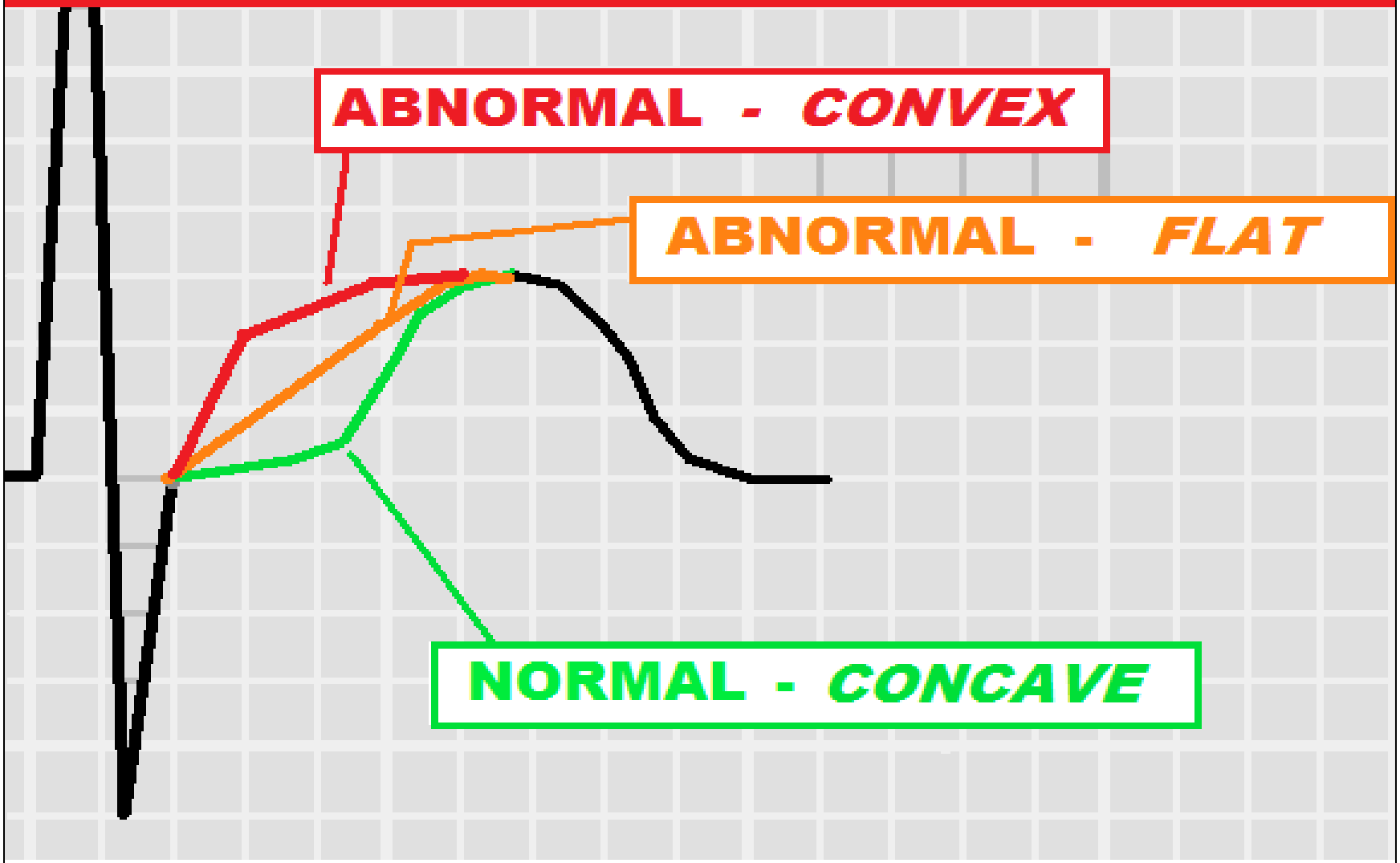
!	FLAT or CONVEX J-T APEX SEGMENT		**ACUTE MI** EARLY PHASE
!	HYPER-ACUTE T WAVE		**ACUTE MI** EARLY PHASE
!	S-T SEGMENT ELEVATION at J POINT		**ACUTE MI**
!	DEPRESSED J pt. DOWNSLOPING ST and INVERTED T		- **ACUTE (NON-Q WAVE) MI** - **ACUTE MI** - (RECIPROCAL CHANGES) - **ISCHEMIA**


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

THE S-T SEGMENT



J - T APEX SEGMENT VARIATIONS

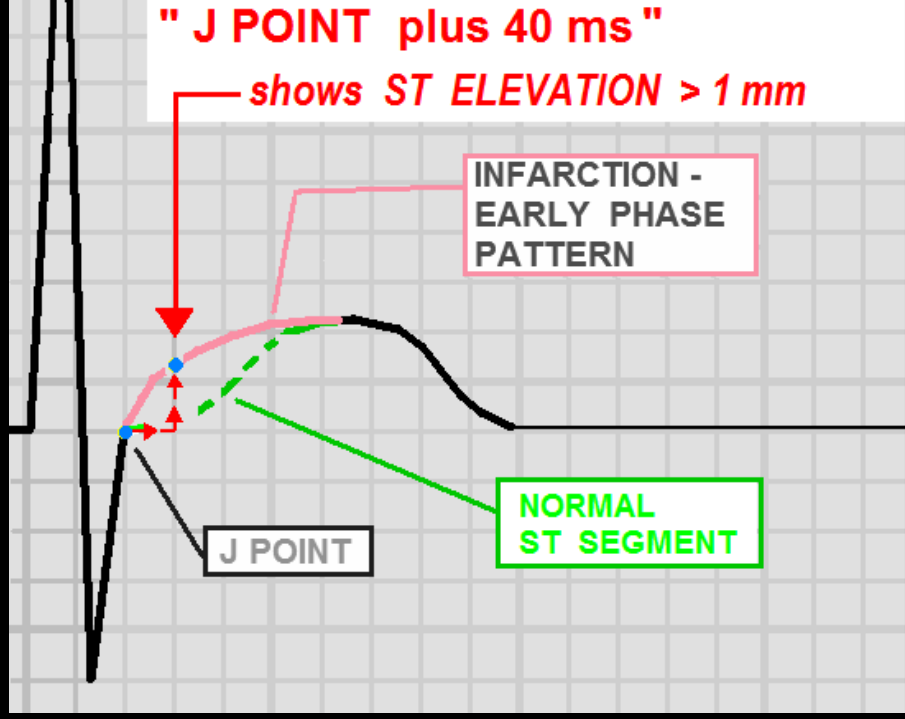


PATTERNS of EARLY INFARCTION

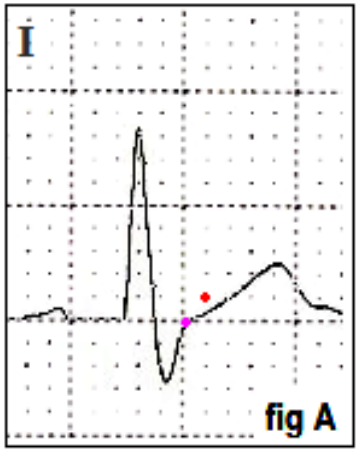
-- FLAT and CONVEX J-T APEX SEGMENTS

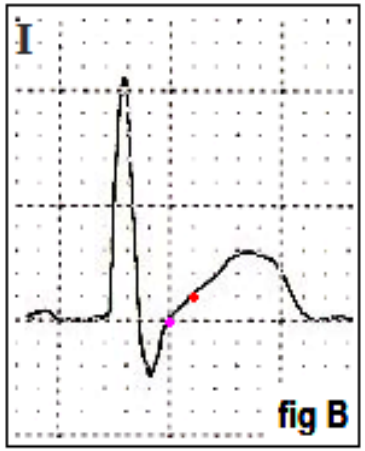
WHEN EVALUATING for ST SEGMENT ELEVATION . . . . . .

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.

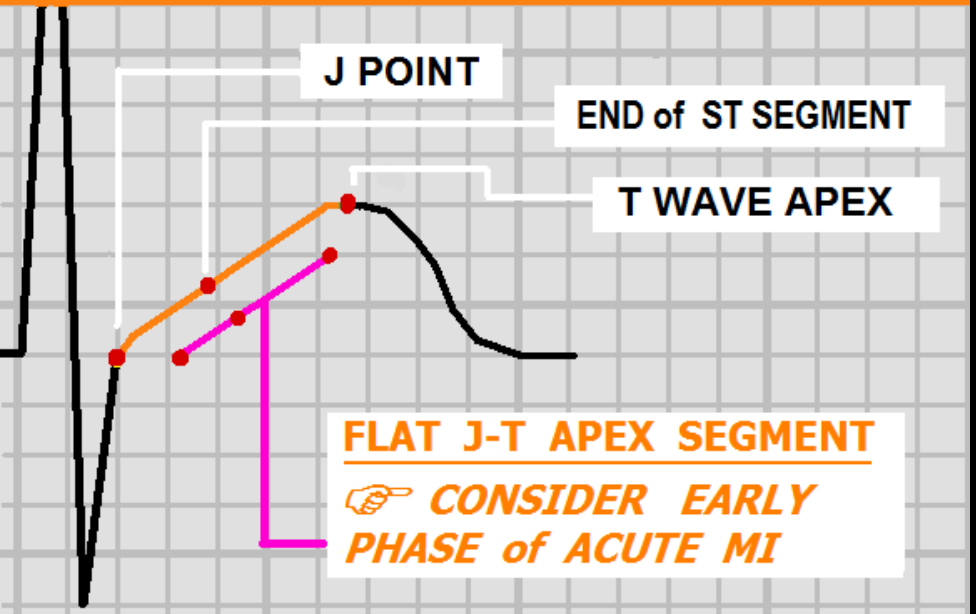




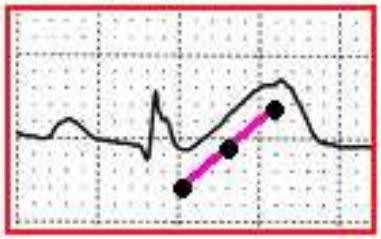
During a 20 second BALLOON OCCLUSION of the patient's LAD during routine PTCA, the ST segment assumes a CONVEX shape. When measured 40 ms beyond the J POINT, the ST segment is elevated > 1 mm. This phenonemon is seen routinely in the cath lab prior to the occurance of ST ELEVATION at the J POINT during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

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).

ABNORMAL J-T APEX SEGMENT



LEAD II

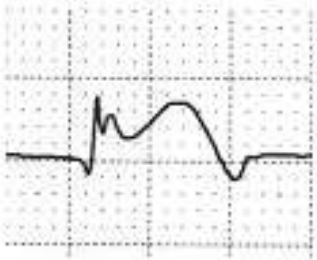


1839 hrs

41 y/o FEMALE

In ER C/O CHEST PAIN x 30 minutes.

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



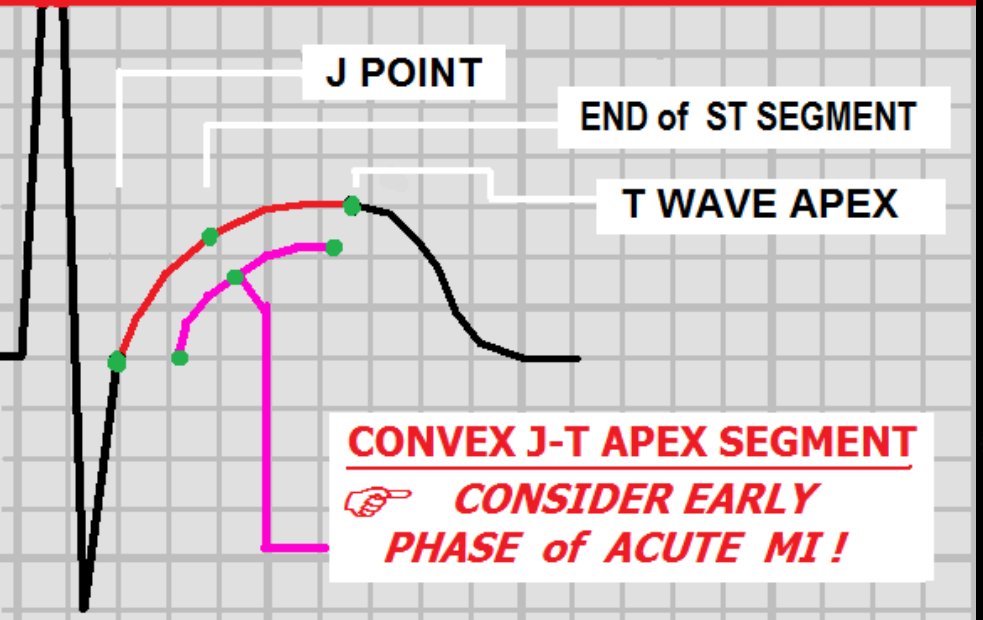
1850 hrs

STEMI - INFERIOR WALL

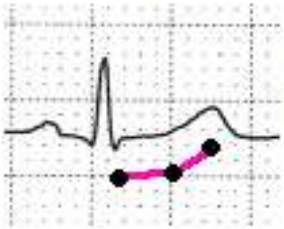
11 MINUTES LATER, S-T ELEVATION at the J POINT IS NOTED.

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

ABNORMAL J-T APEX SEGMENT

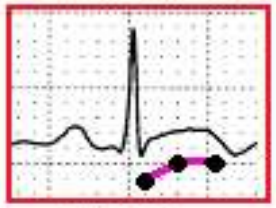


LEAD I



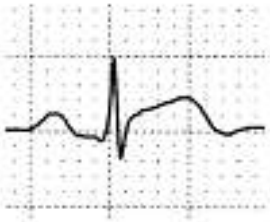
53 y/o MALE

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.

56 yr
Male Caucasian

Room:A9
Loc:3 Option:23

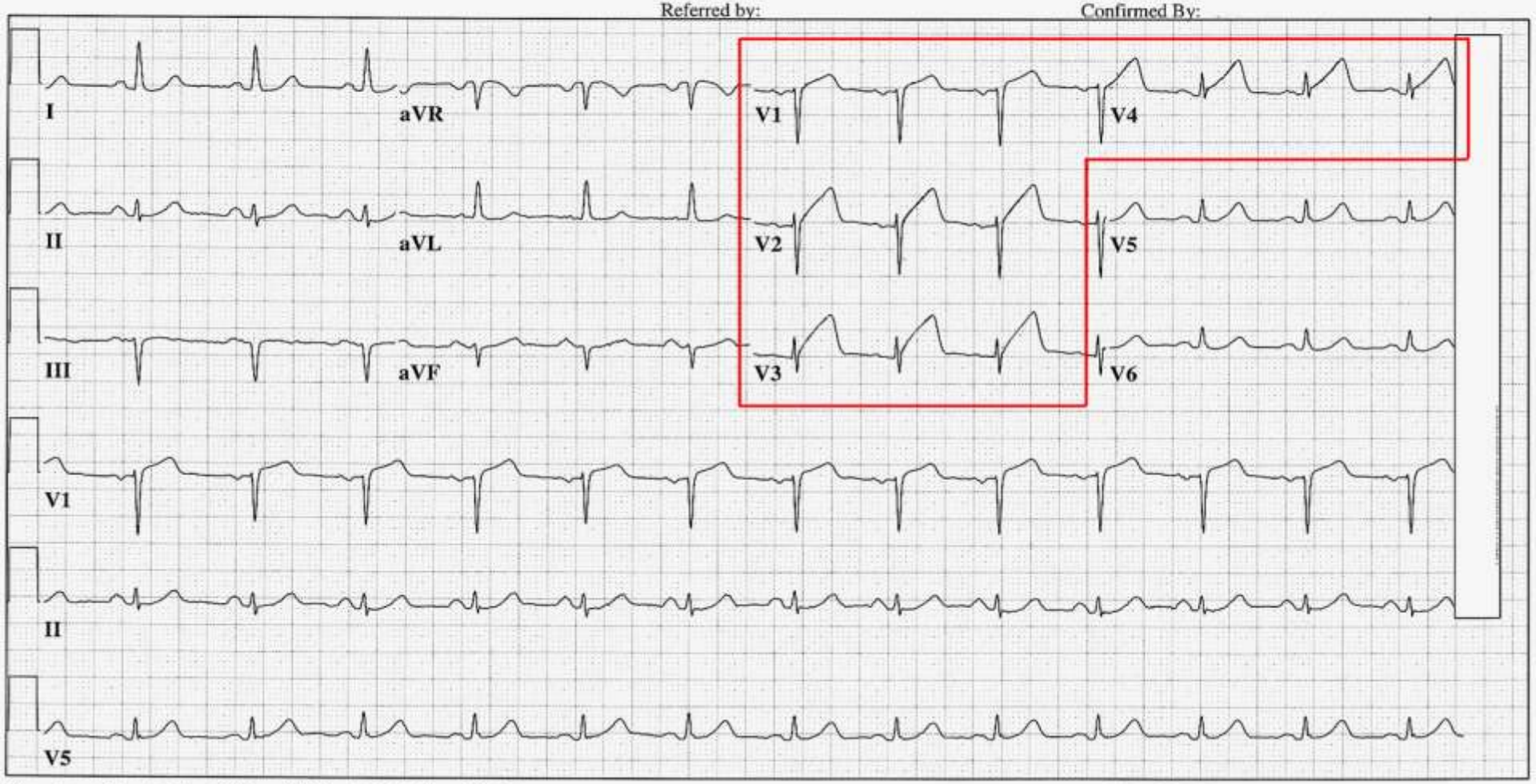
Vent. rate	80	BPM
PR interval	154	ms
QRS duration	78	ms
QT/QTc	380/438	ms
P–R–T axes	51 –24	38

**UNEDITED COPY – REPORT IS COMPUTER GENERATED ONLY, WITHOUT PHYSICIAN INTERPRETATION

Normal sinus rhythm
Normal ECG
No previous ECGs available

Technician: W Ruppert

Referred by: Confirmed By:

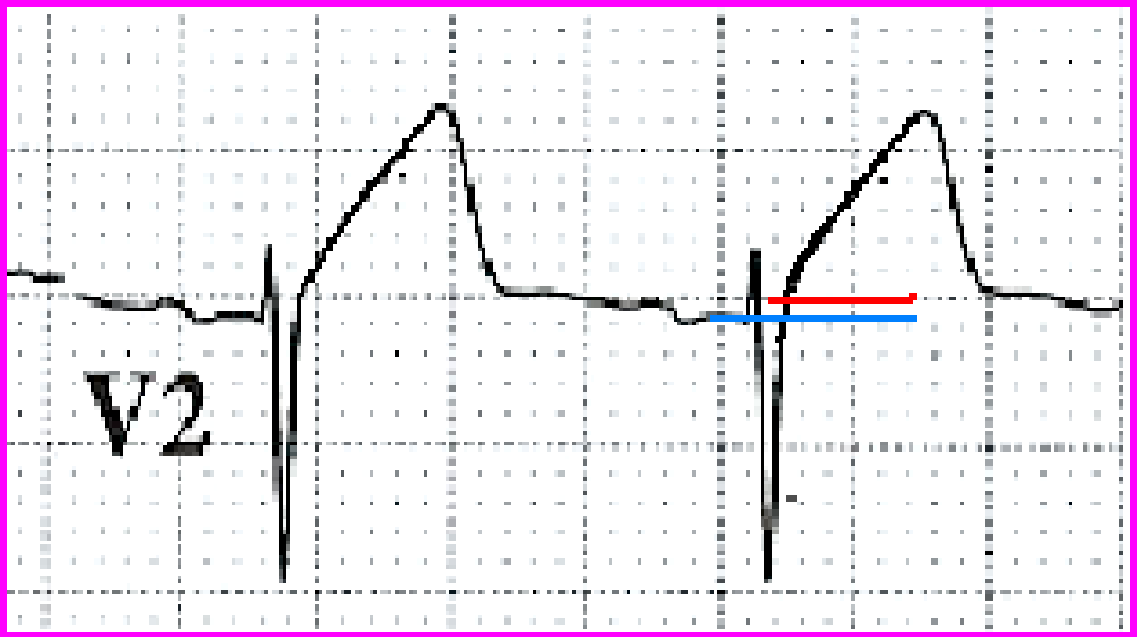


25mm/s 10mm/mV 40Hz 005C 12SL 235 CID: 3

EID:10 EDT:

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

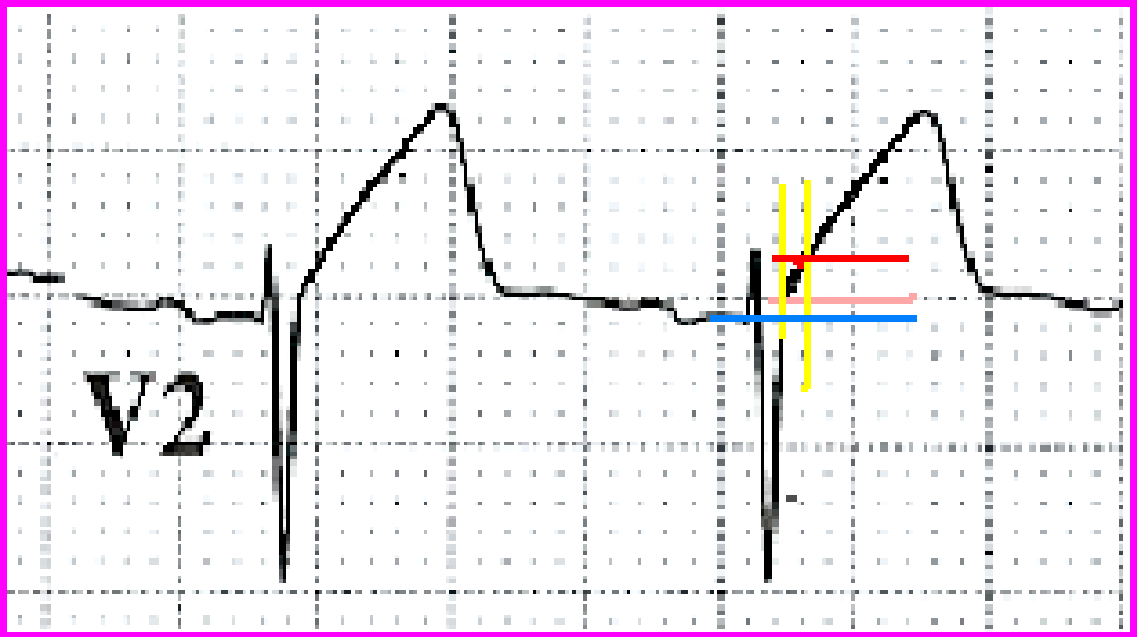
measurement of S-T elevation



S-T elevation at J point = 0.5 mm

ACUTE MI = S-T elev. > 1.0 mm

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

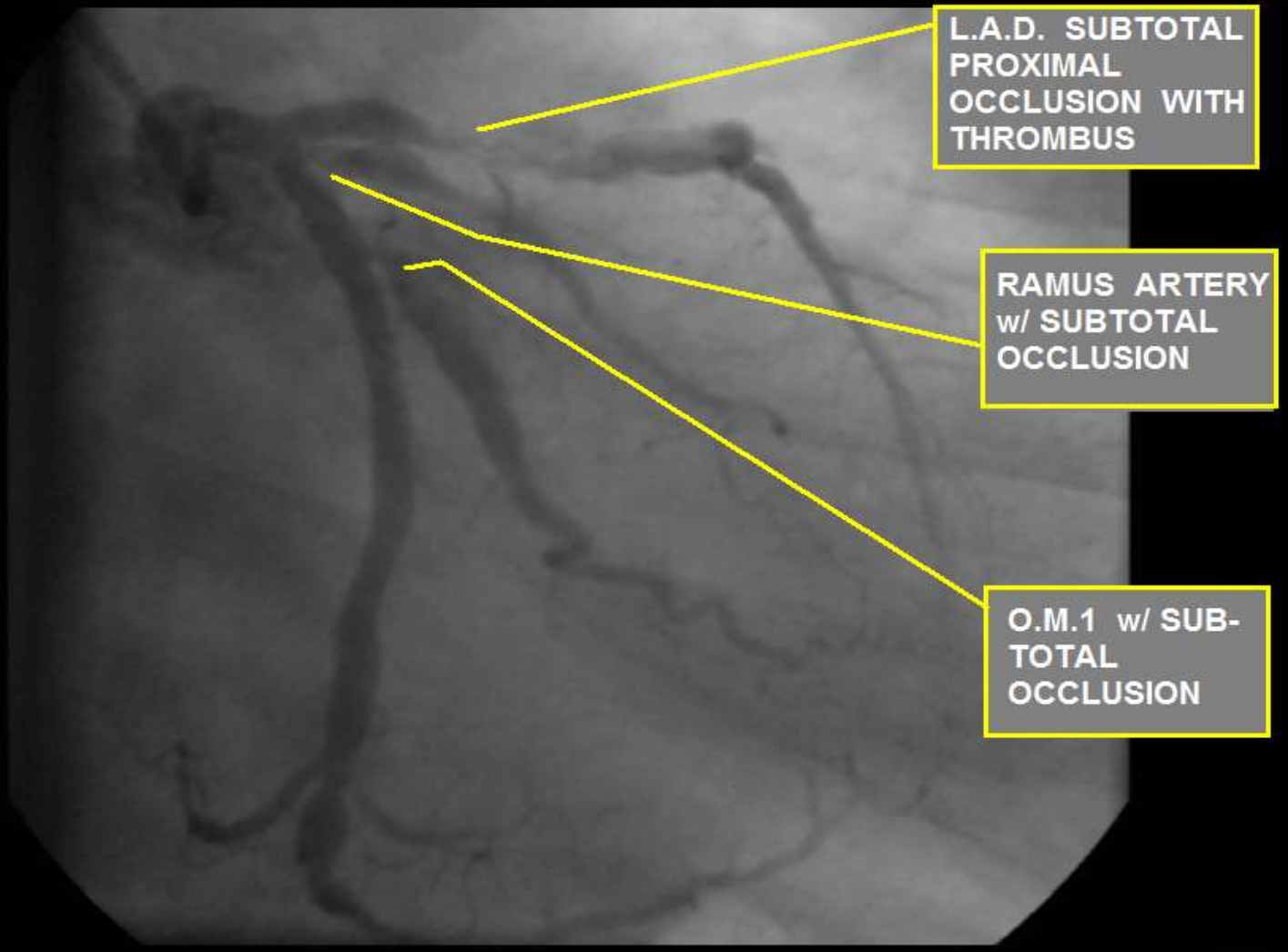


S-T elevation at J point = 0.5 mm

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

ACUTE MI = S-T elev. > 1.0 mm

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



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

ECG Patterns associated with "EARLY PHASE MI:"

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

12:33:40

Seven R[illegible]rs Regiona
Dept: 2 so[illegible]
Room: er

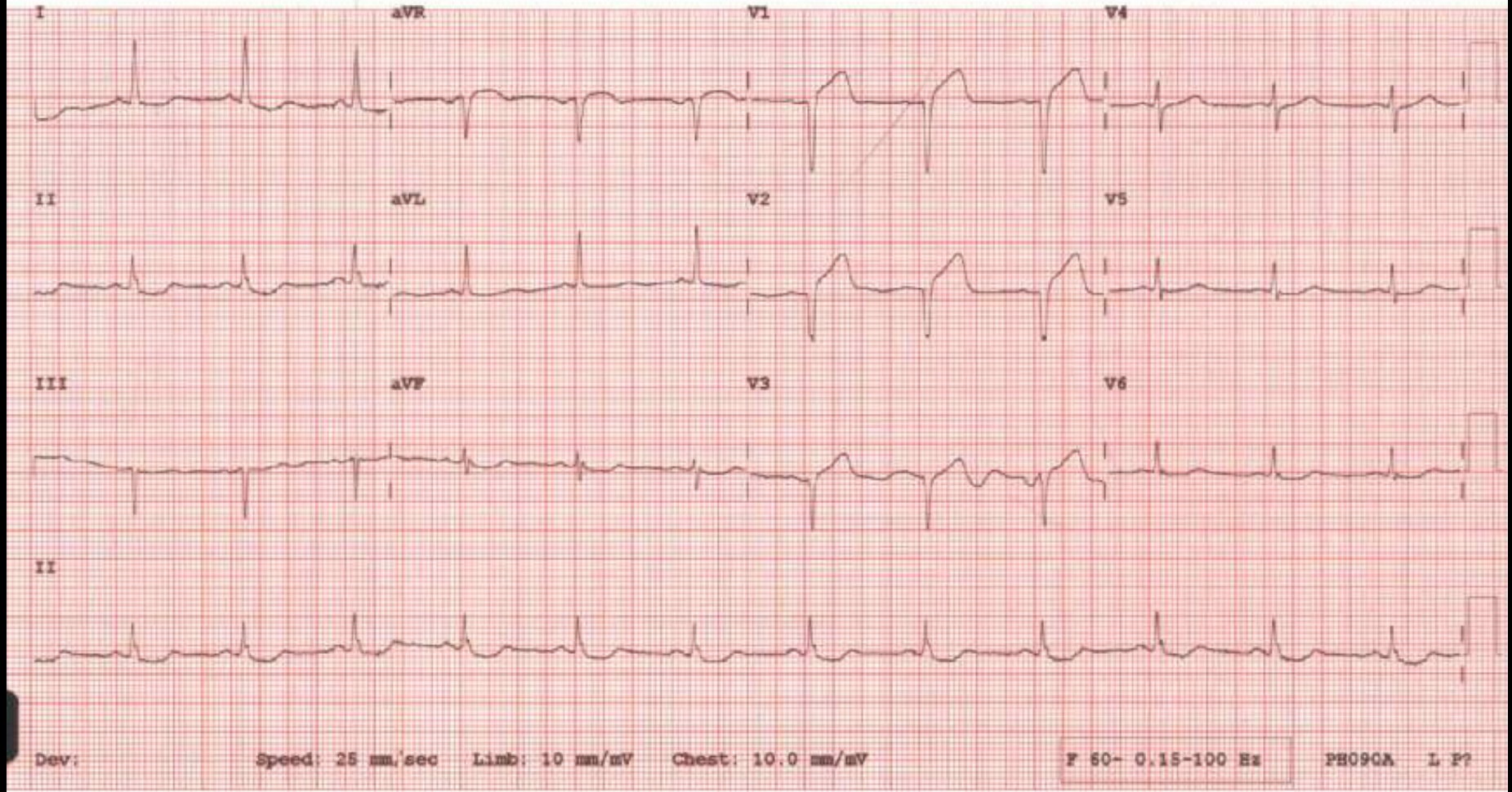
Rate	75	. SINUS RHYTHM.....normal P axis, V-rate 50- 99
		. CONSIDER ANTEROSEPTAL INFARCT.....Q >30mS, V1 V2
PR	140	. BORDERLINE REPOLARIZATION ABNORMALITY.....ST dep & abnormal T
QRSD	90	. BASELINE WANDER IN LEAD(S) V1,V2
QT	376	
QTc	420	

--AXIS--	
P	35
QRS	6
T	193

SEVEN RIVERS REGIONAL MED CTR

- ABNORMAL ECG -

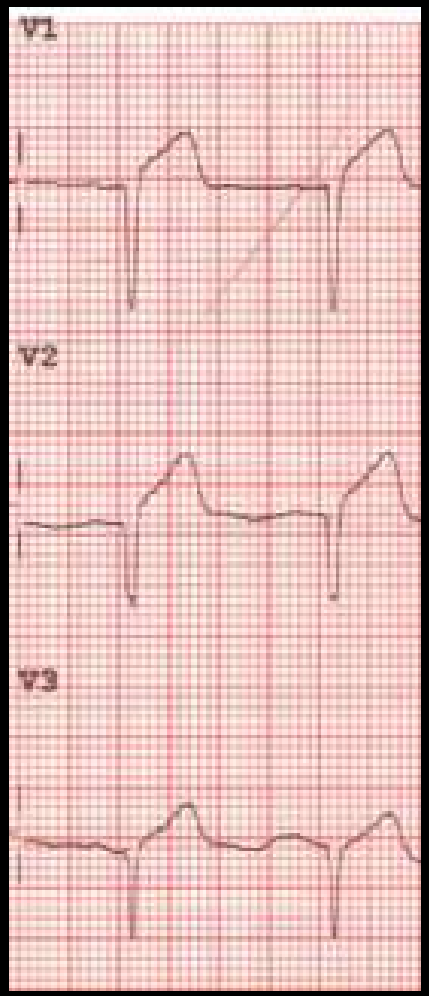
Unconfirmed Diagnosis



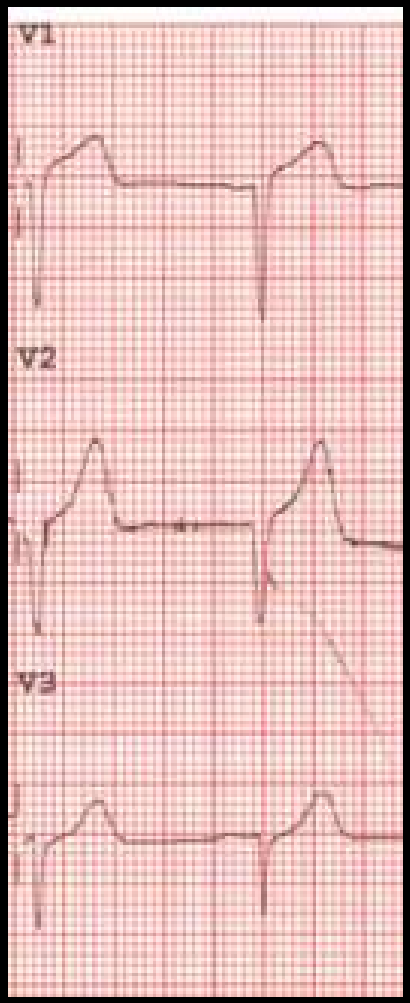
Dev: Speed: 25 mm/sec Limb: 10 mm/mV Chest: 10.0 mm/mV F 60- 0.15-100 Hz PH090A L P?

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

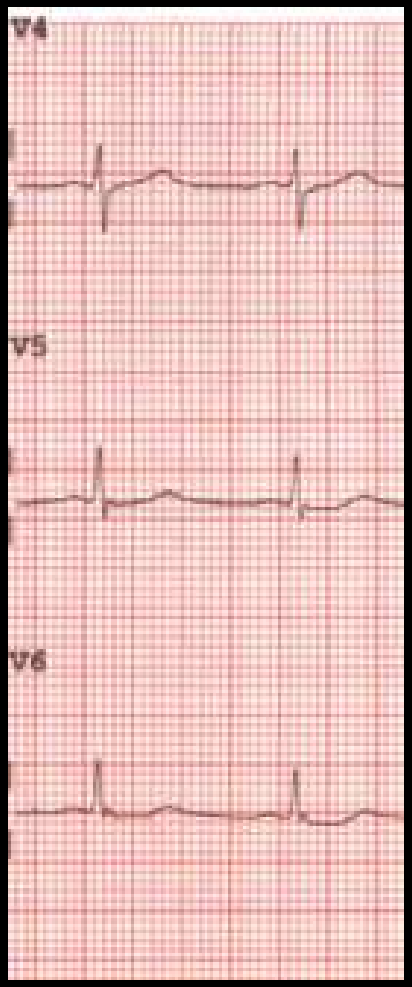
1st ECG



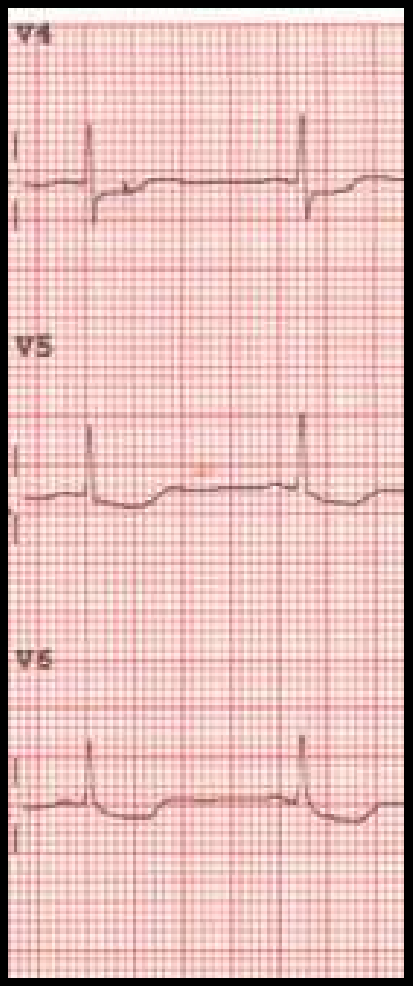
2nd ECG

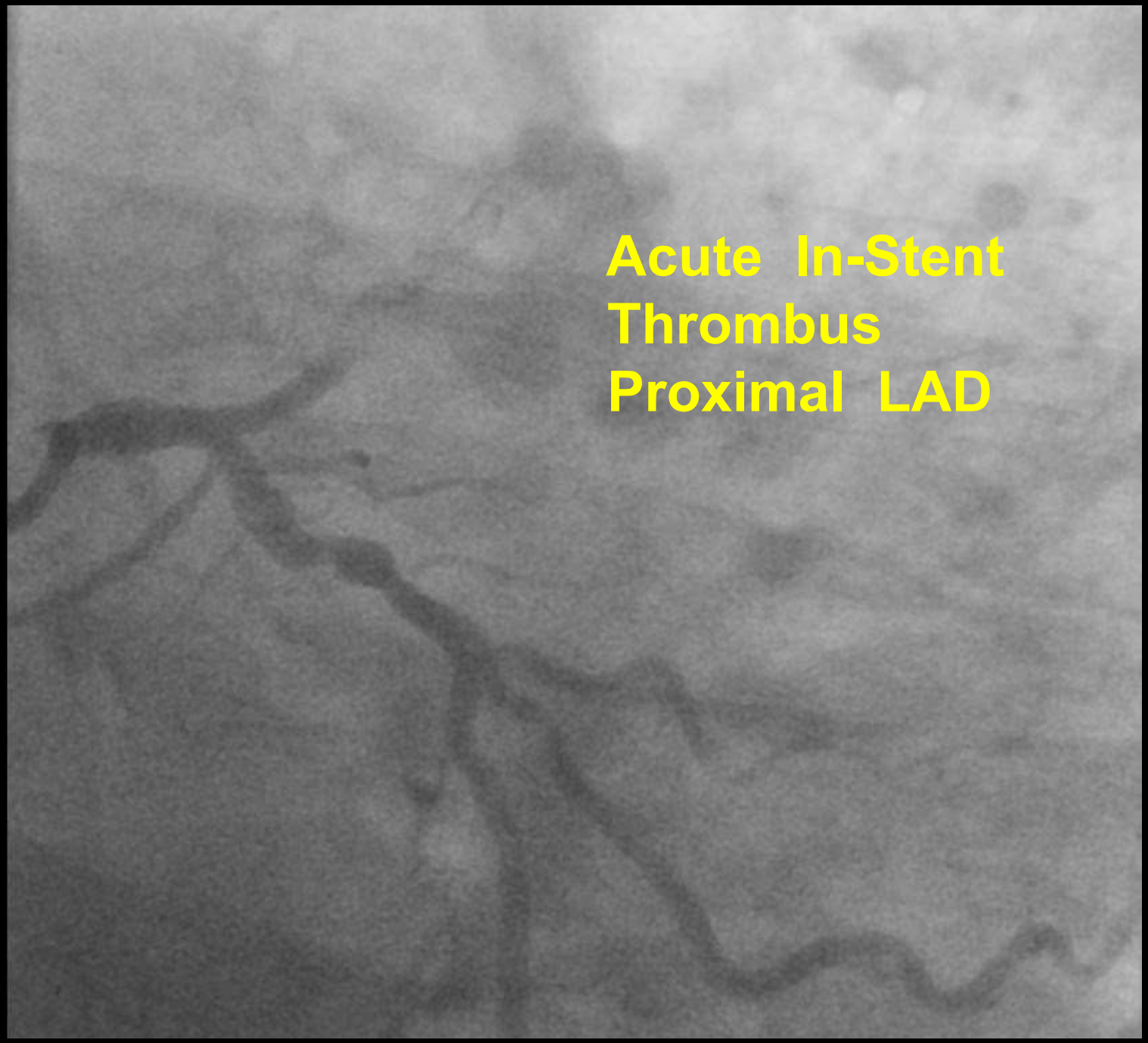


1st ECG



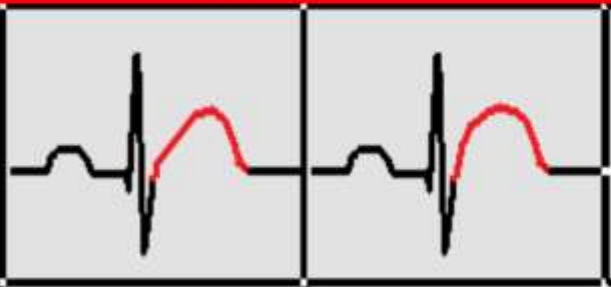
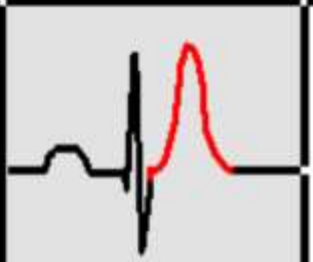
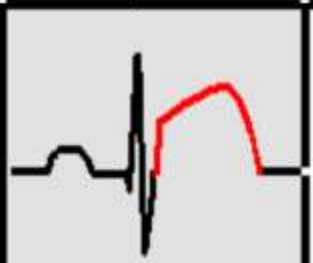
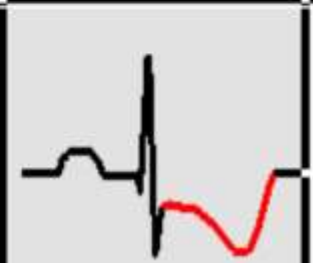
2nd ECG



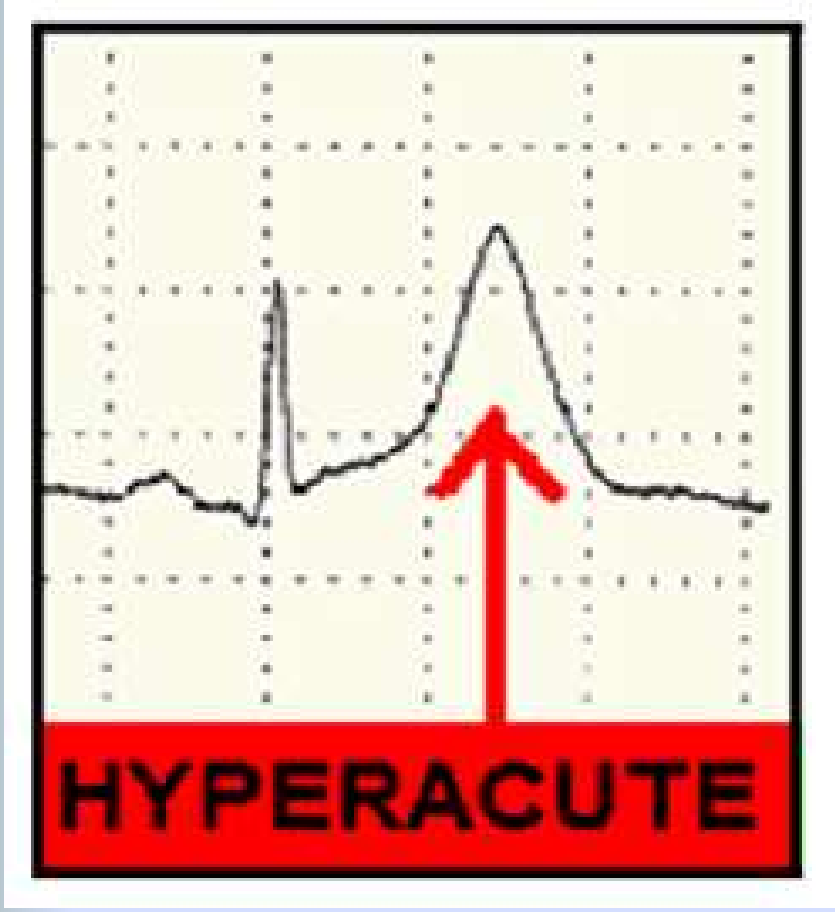

Acute In-Stent
Thrombus
Proximal LAD

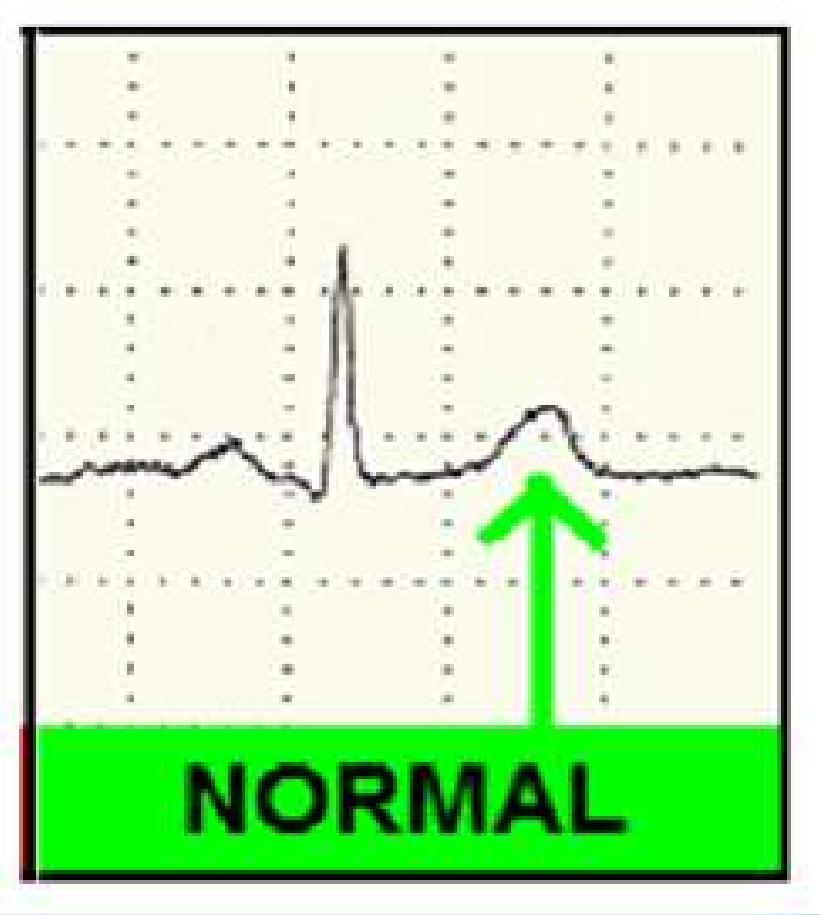
PATTERNS of ACS & ISCHEMIA

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

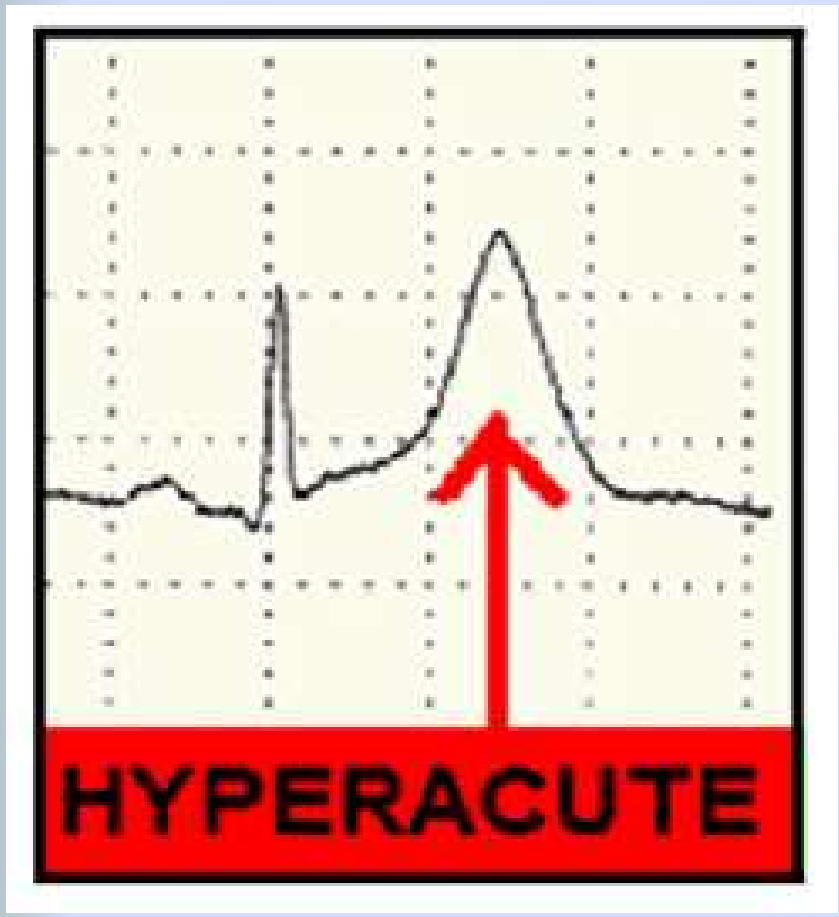
!	FLAT or CONVEX J-T APEX SEGMENT		**ACUTE MI** EARLY PHASE
!	HYPER-ACUTE T WAVE		**ACUTE MI** EARLY PHASE
!	S-T SEGMENT ELEVATION at J POINT		**ACUTE MI**
!	DEPRESSED J pt. DOWNSLOPING ST and INVERTED T		- **ACUTE (NON-Q WAVE) MI** - **ACUTE MI** - (RECIPROCAL CHANGES) - **ISCHEMIA**

T waves should not be HYPERACUTE



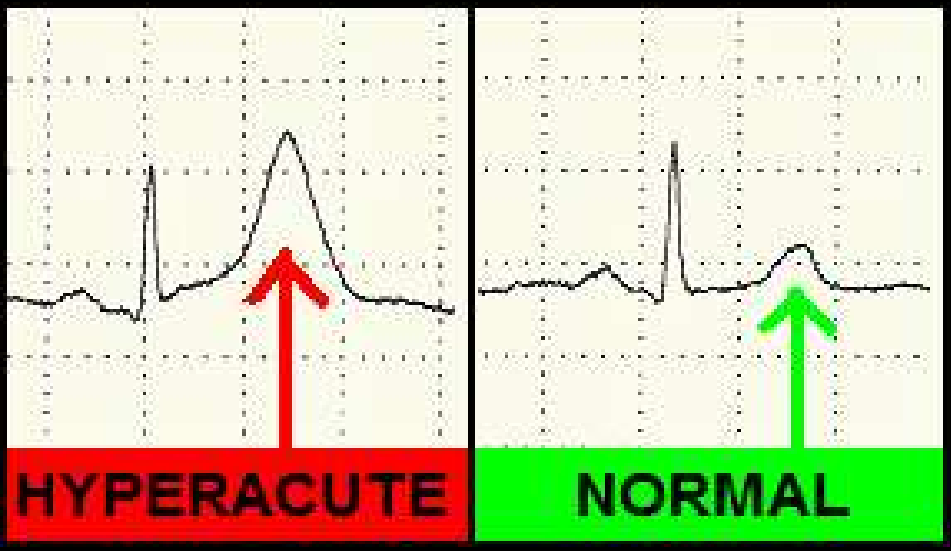


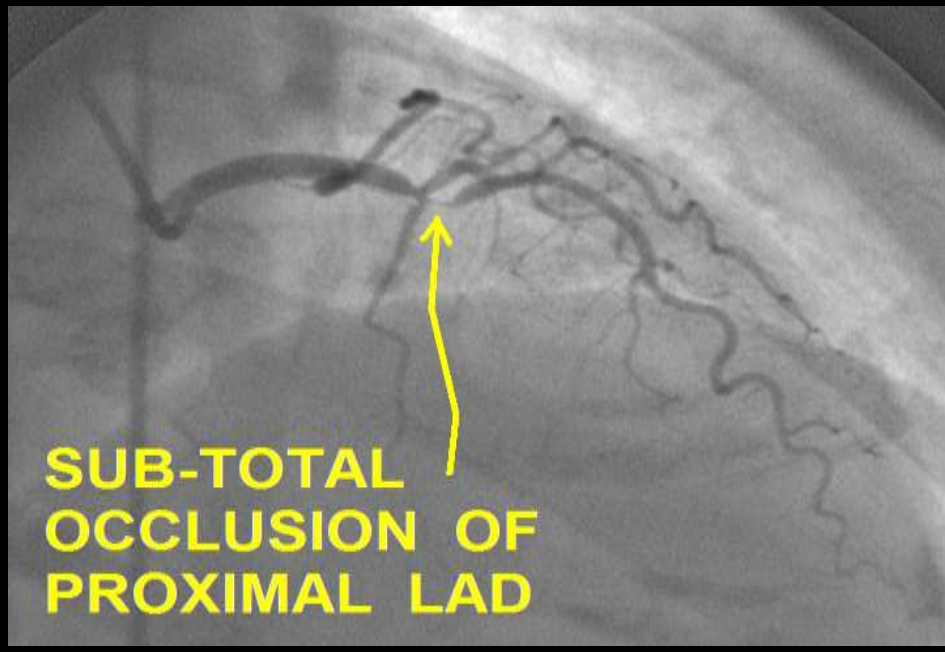
HYPERACUTE T Waves may indicate:



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

HYPERACUTE T WAVES





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

Helpful Clue: Hyper-Acute T Waves

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

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

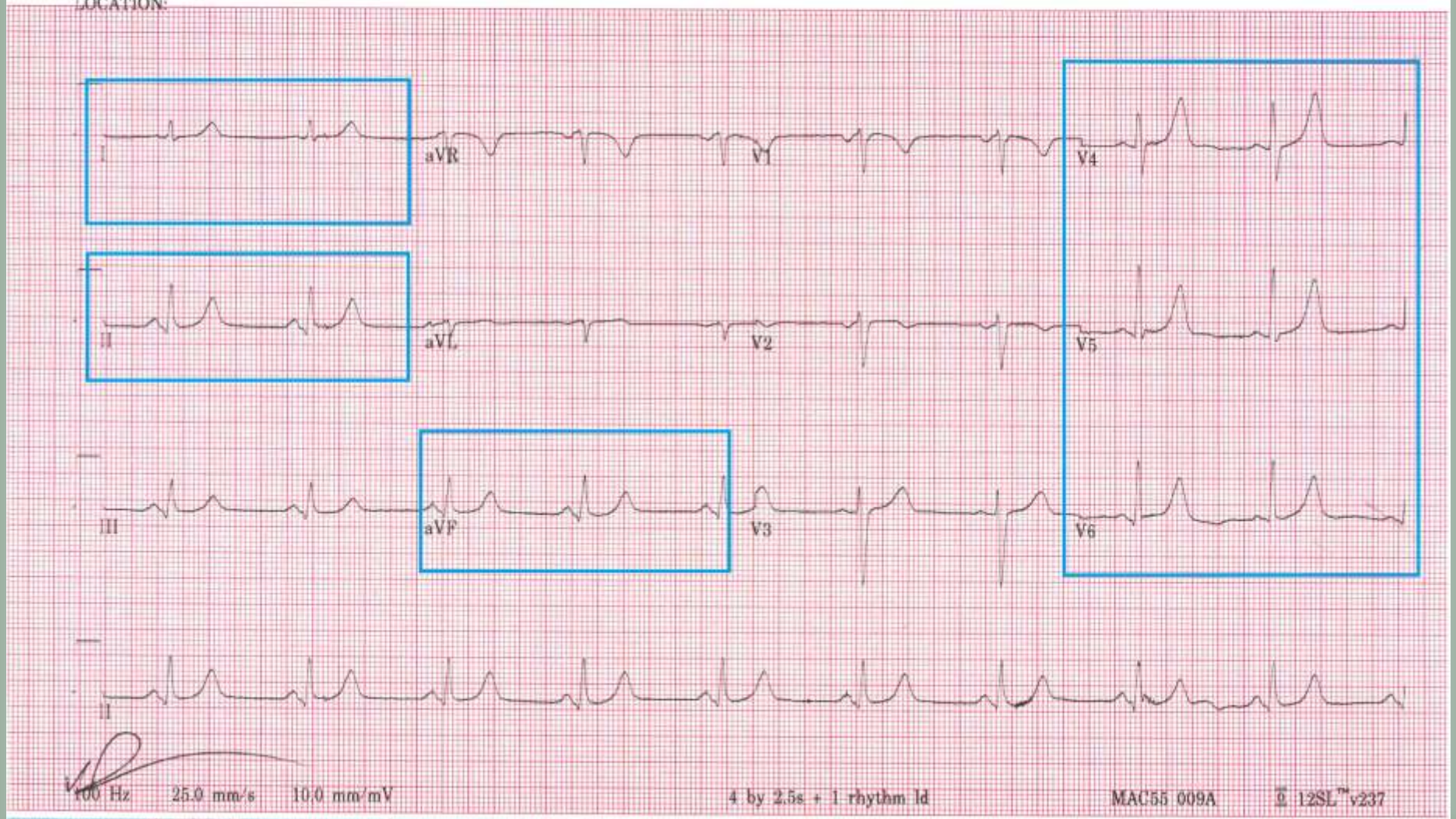
K+ = 6.7

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

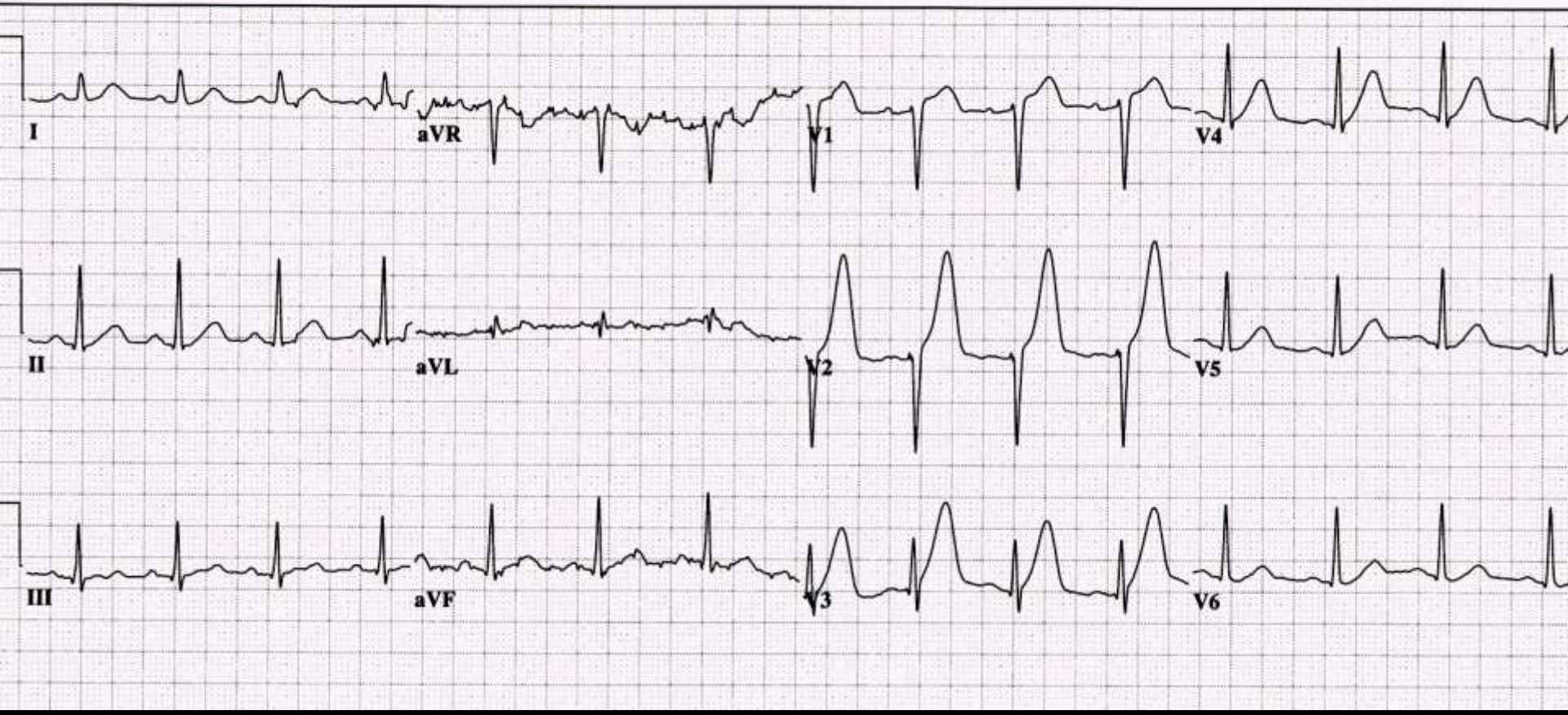
30 yr
Male Black

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

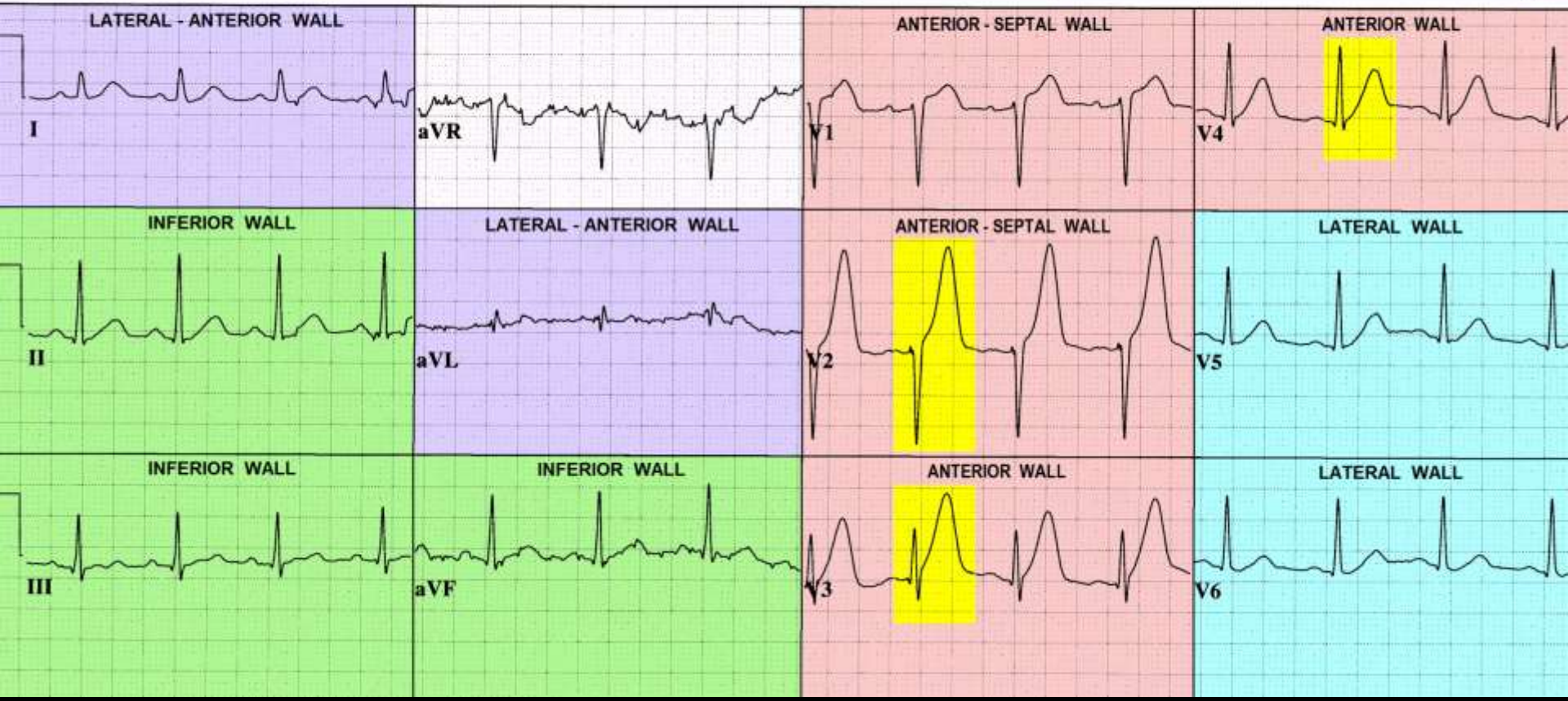
CORONARY ARTERIAL DISTRIBUTIONS:

V1 - V4 = LEFT ANTERIOR DESCENDING (LAD)

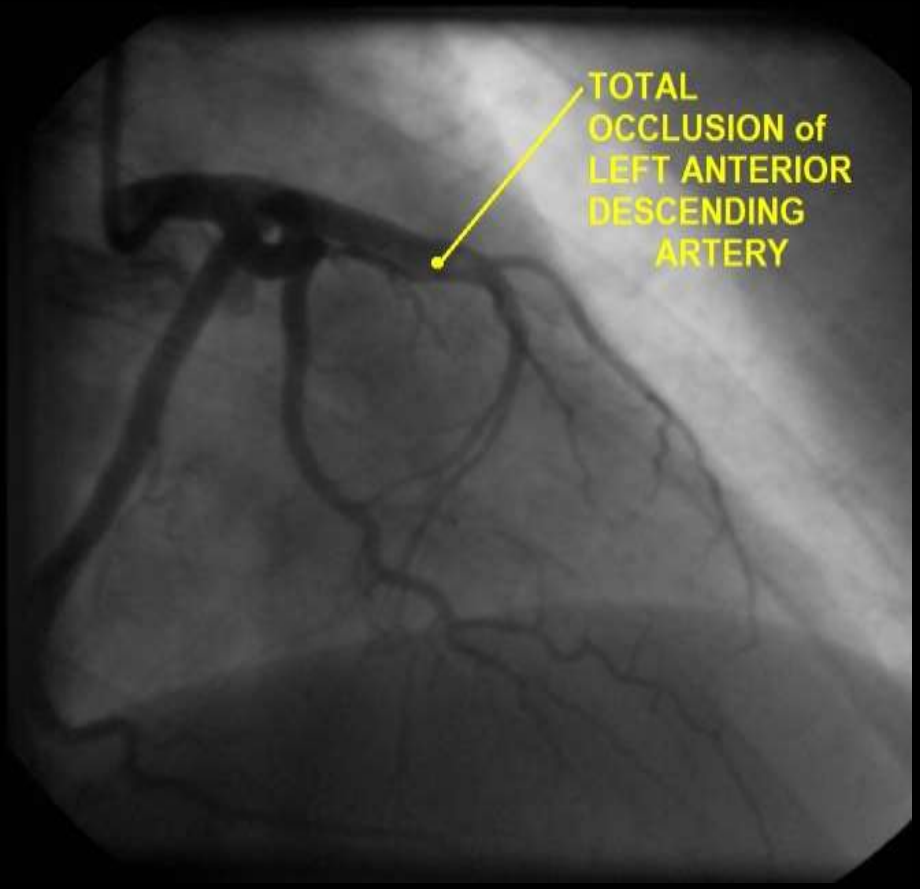
I, AVL = DIAGONAL (DIAG) off the LAD or OBTUSE MARGINAL (OM) off CIRCUMFLEX (CX)

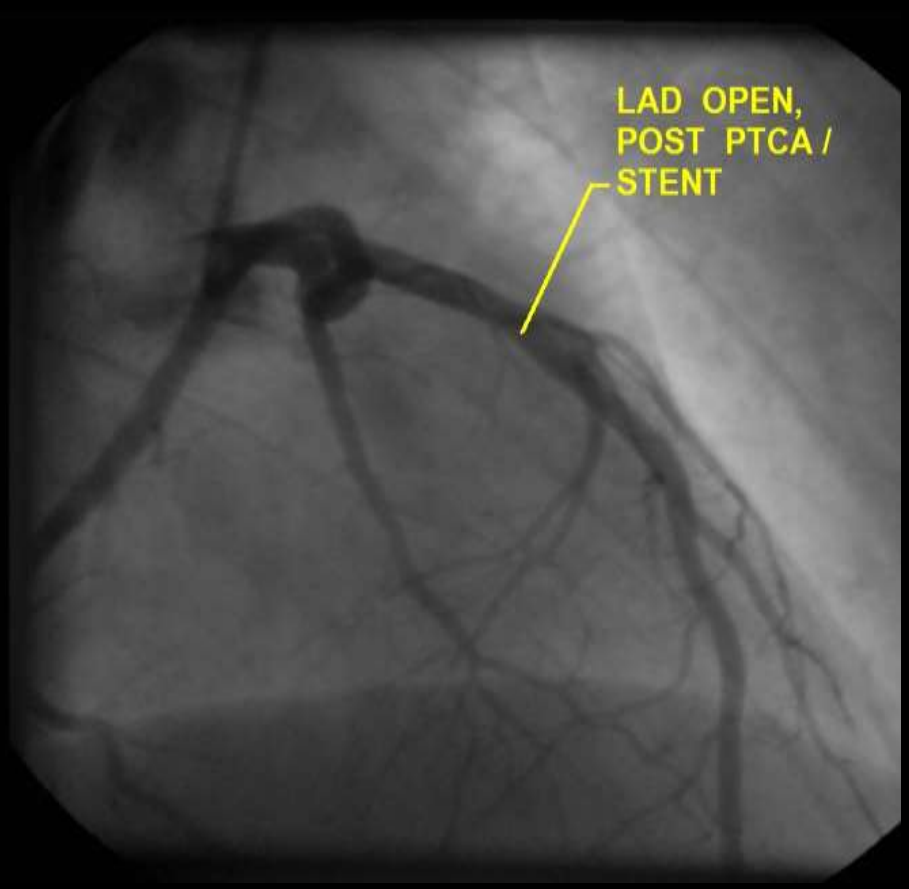
V5, V6 = CIRCUMFLEX

II, III, AVF = RIGHT CORONARY ARTERY or CX



Cath Lab findings:





Dynamic ST-T Wave Changes:

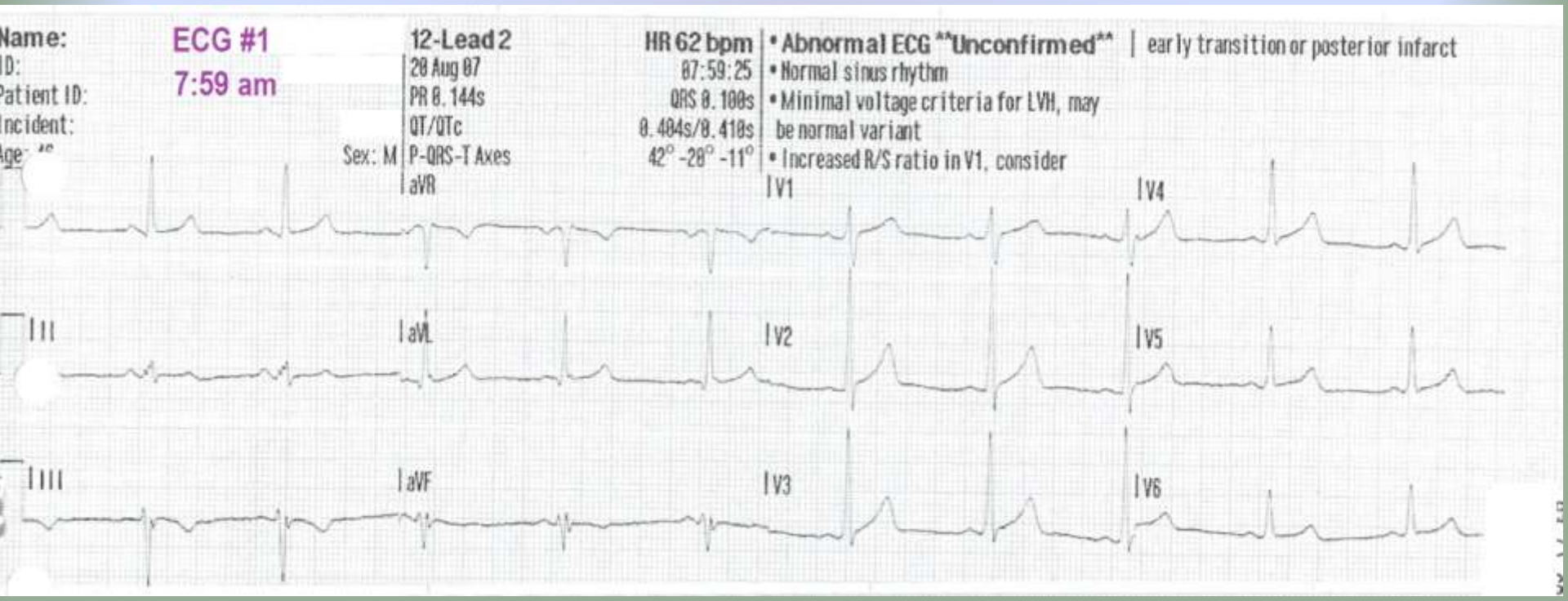
- Other than HEART RATE related variations (which affect intervals), ***J Points, ST-Segments and T Waves SHOULD NOT CHANGE.***

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.**

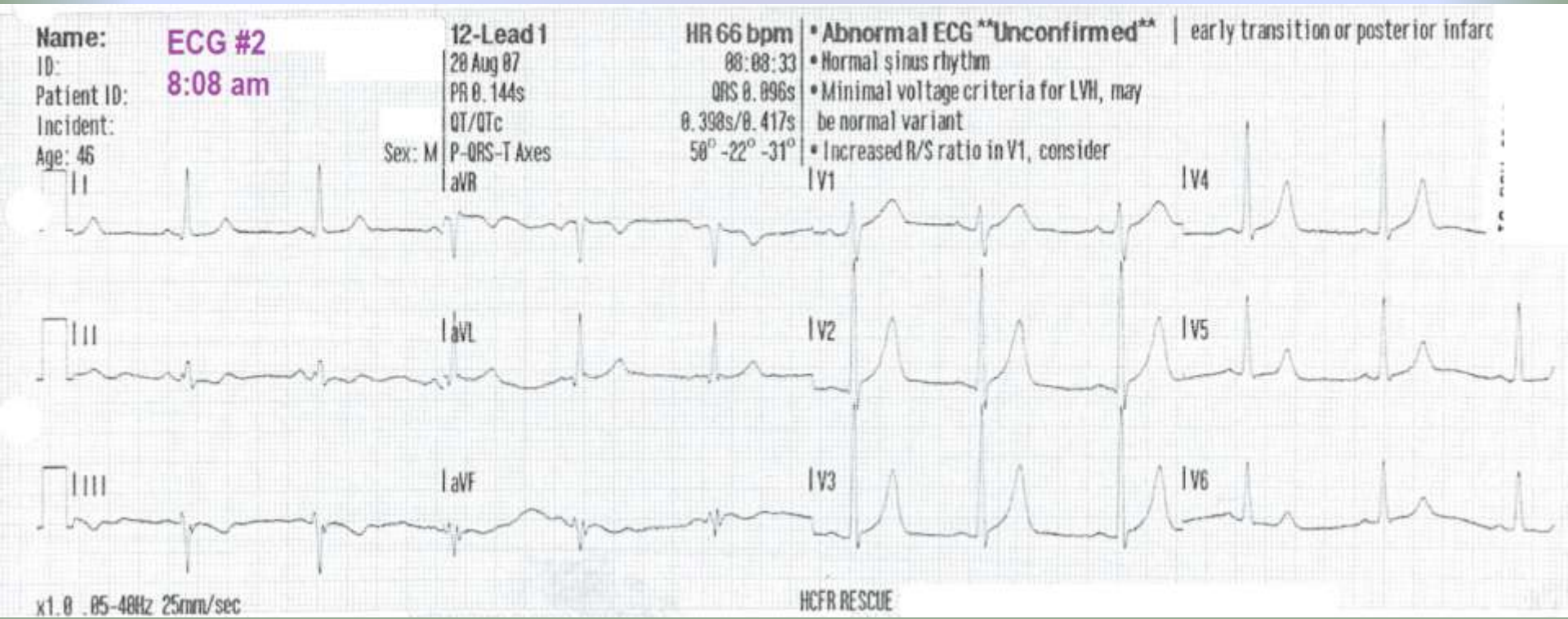
46 year old male

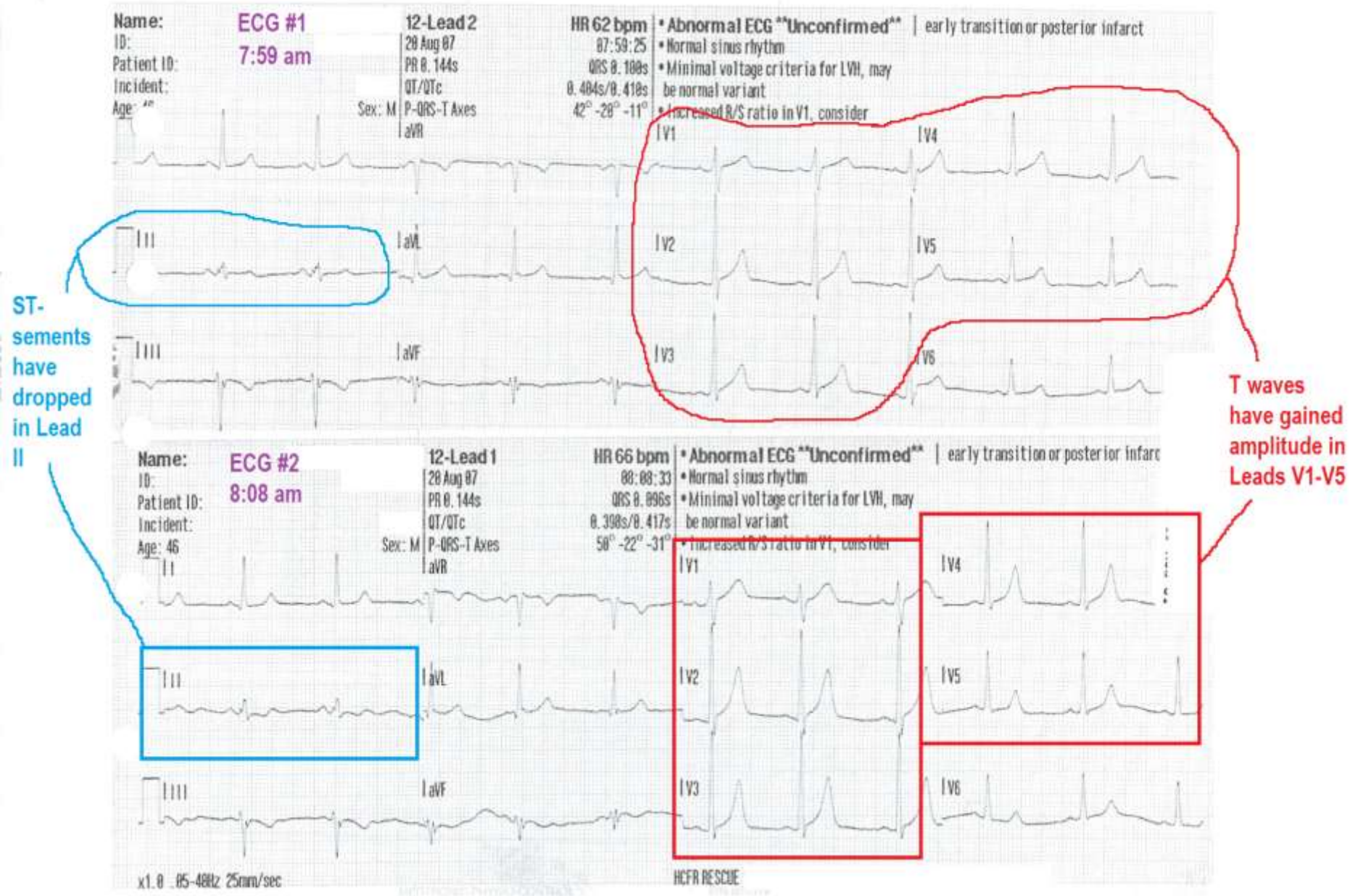
- Exertional dyspnea X “several weeks”
- Intermittent chest pressure X last 3 hours. Currently pain free.

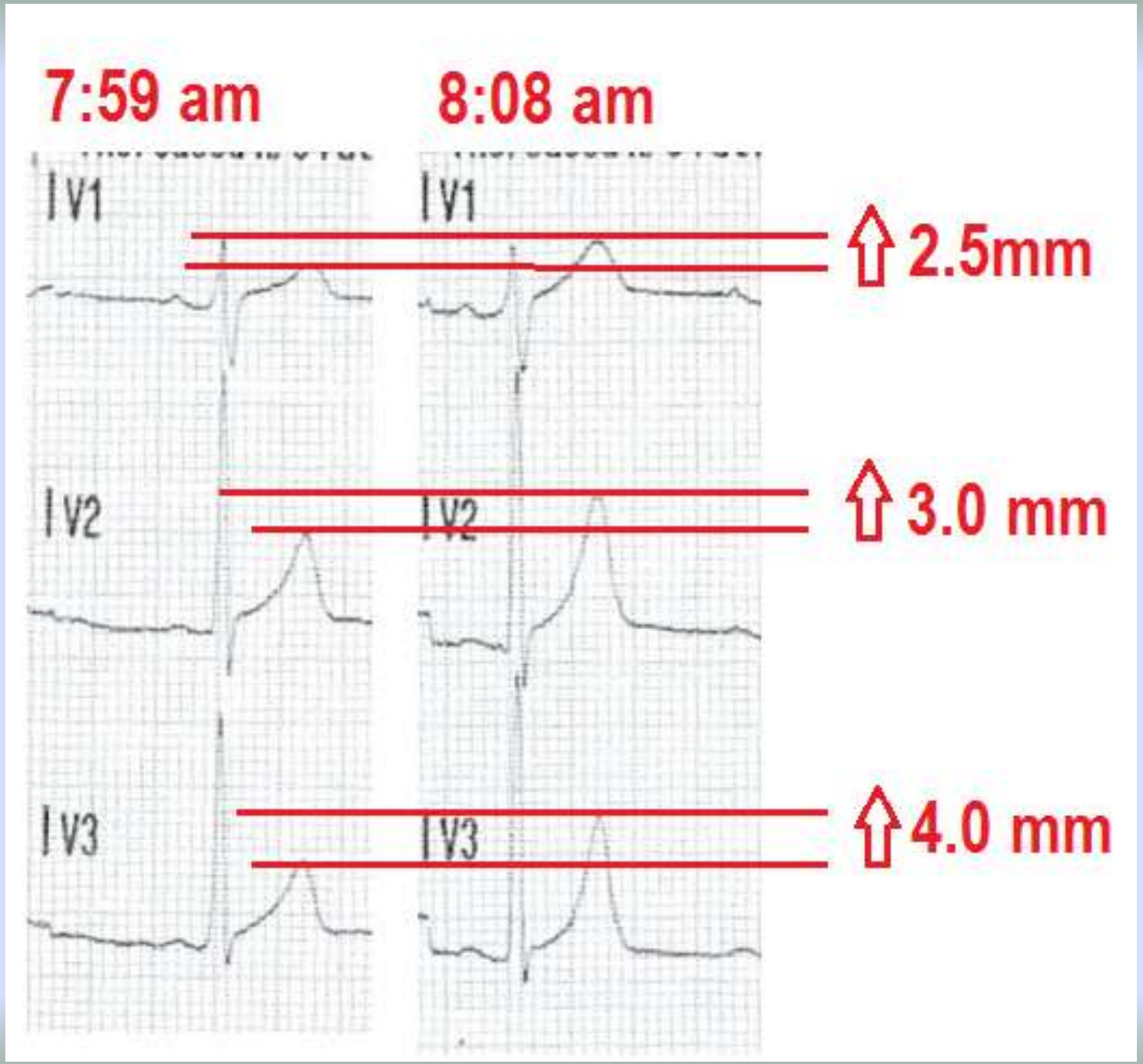


46 year old male: ECG 1

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

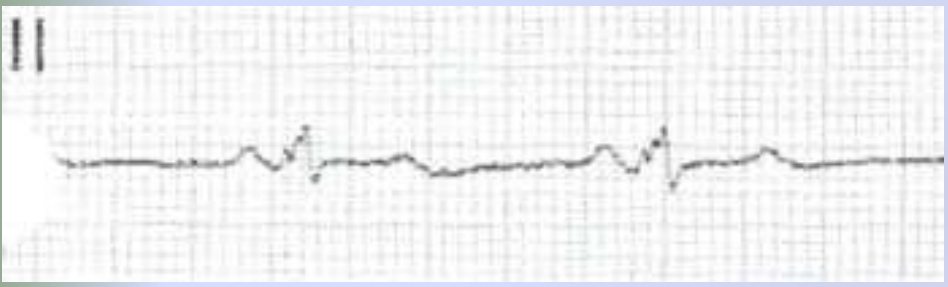



Name:
ID:
Patient ID:
Incident:
Age:
ECG #1
7:59 am
12-Lead 2
20 Aug 07
PR 0.144s
QT/QTc
Sex: M
P-QRS-T Axes
aVR
HR 62 bpm
07:59:25
QRS 0.100s
0.404s/0.410s
42° -28° -11°
• Abnormal ECG **Unconfirmed**
• Normal sinus rhythm
• Minimal voltage criteria for LVH, may be normal variant
• Increased R/S ratio in V1, consider
early transition or posterior infarct
I
II
III
aVL
aVF
V1
V2
V3
V4
V5
V6
ST-segments have dropped in Lead II
T waves have gained amplitude in Leads V1-V5
Name:
ID:
Patient ID:
Incident:
Age: 46
ECG #2
8:08 am
12-Lead 1
20 Aug 07
PR 0.144s
QT/QTc
Sex: M
P-QRS-T Axes
aVR
HR 66 bpm
08:08:33
QRS 0.096s
0.398s/0.417s
50° -22° -31°
• Abnormal ECG **Unconfirmed**
• Normal sinus rhythm
• Minimal voltage criteria for LVH, may be normal variant
early transition or posterior infarc
x1.0 .05-40Hz 25mm/sec
HCFR RESCUE

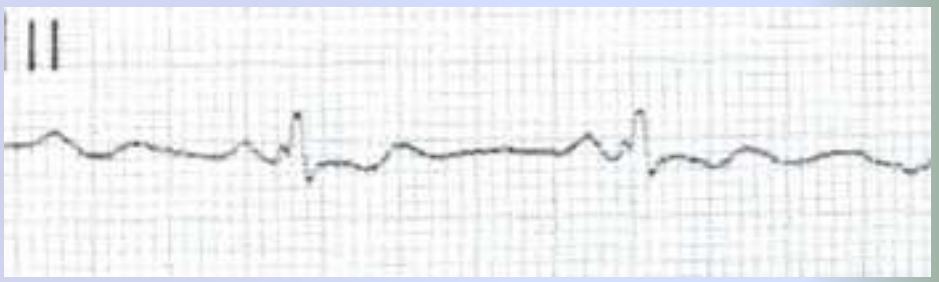

7:59 am
8:08 am
V1
V1
2.5mm
V2
V2
3.0 mm
V3
V3
4.0 mm

ST-Segment Depression

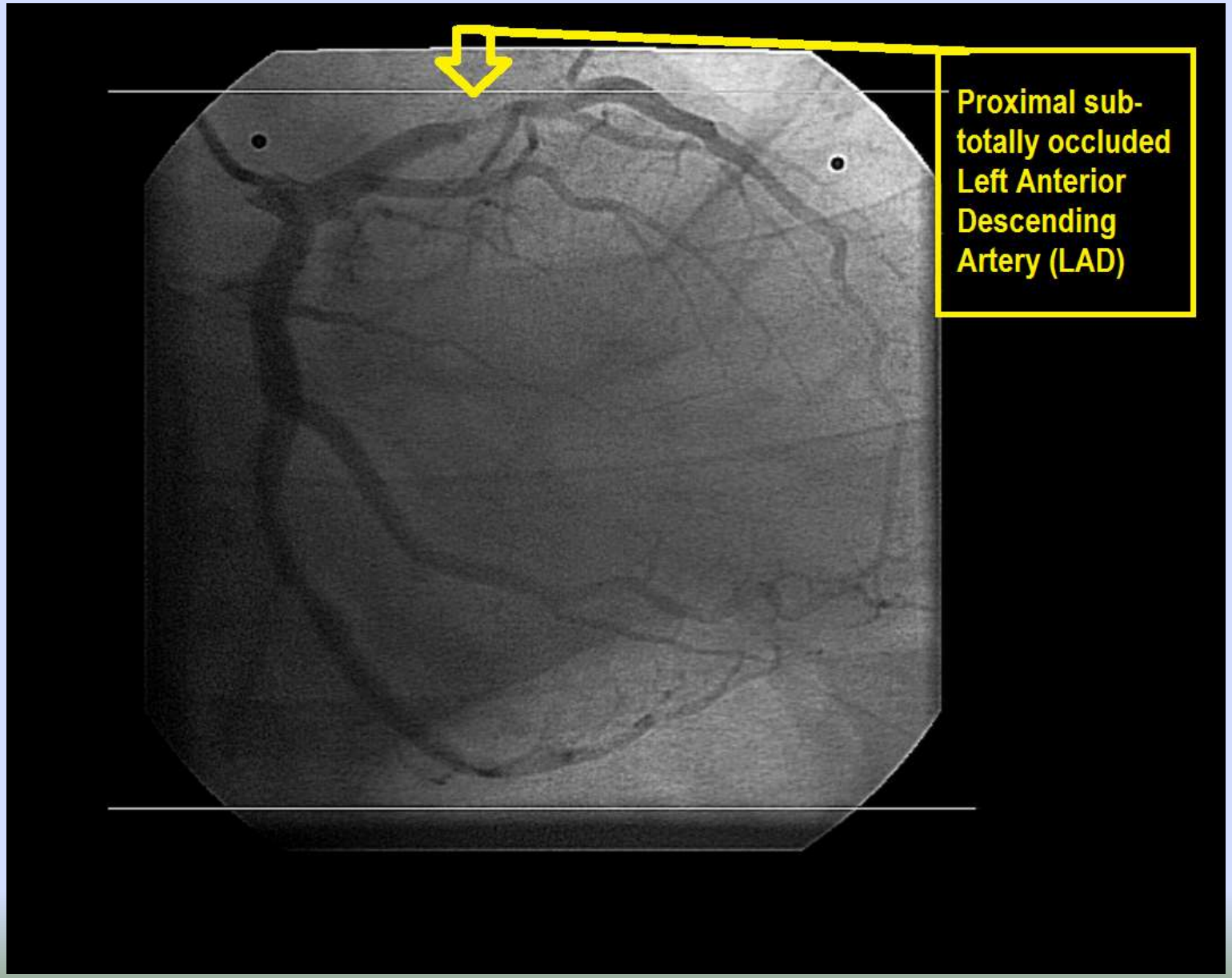
7:59 am



8:08 am



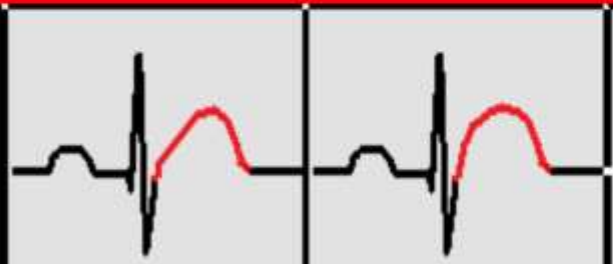
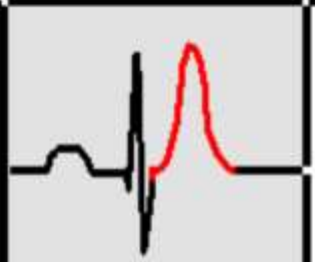
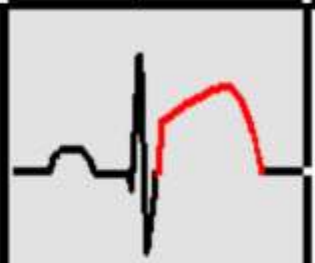
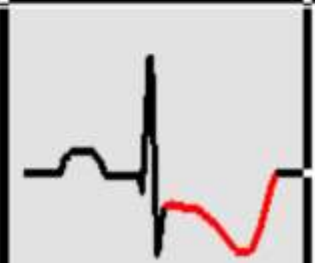
Cath Lab Angiography:



“NOWHERE”, NEW MEXICO, 1994

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)

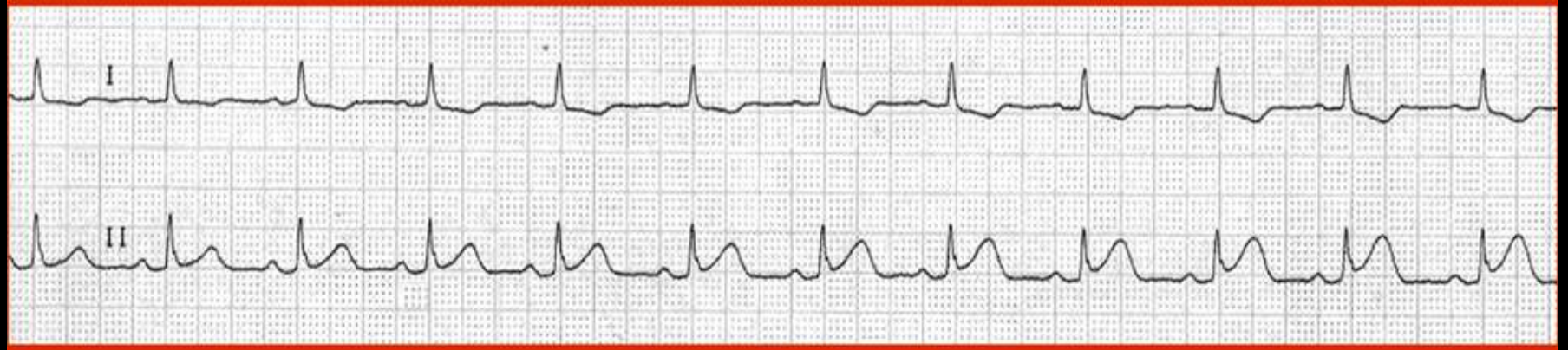
FEMALES ---------- 1.5 mm

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**

ST SEGMENT ELEVATION:

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



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

3 COMMON PATTERNS of ST SEGMENT ELEVATION From ACUTE MI:

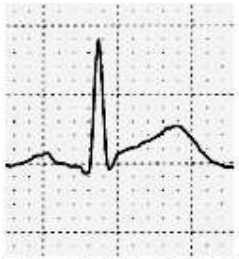
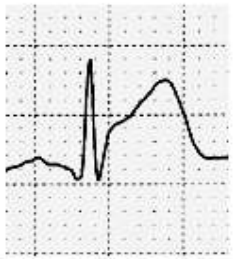
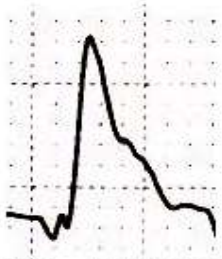
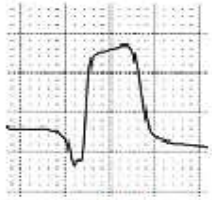
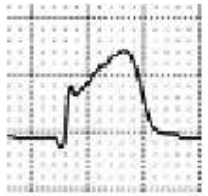
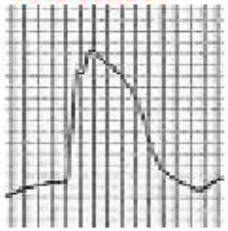
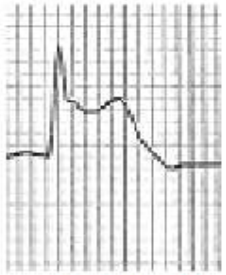
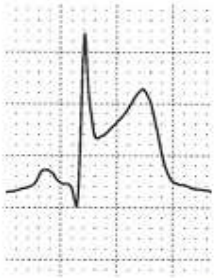
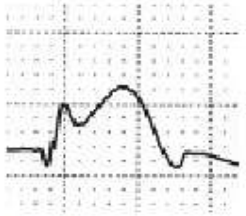
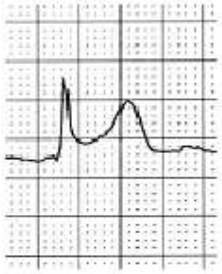
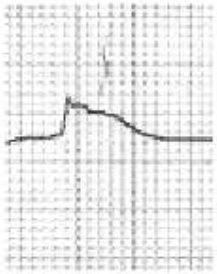
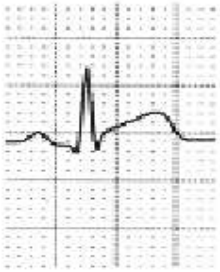
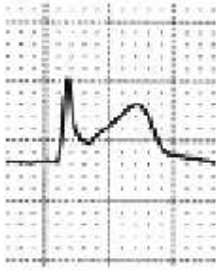
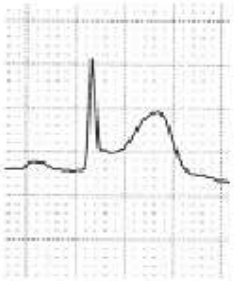
DOWNSLOPING S-T SEGMENT

FLAT S-T SEGMENT

UPSLOPING S-T SEGMENT

ST SEGMENT ELEVATION in ACUTE MI:

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

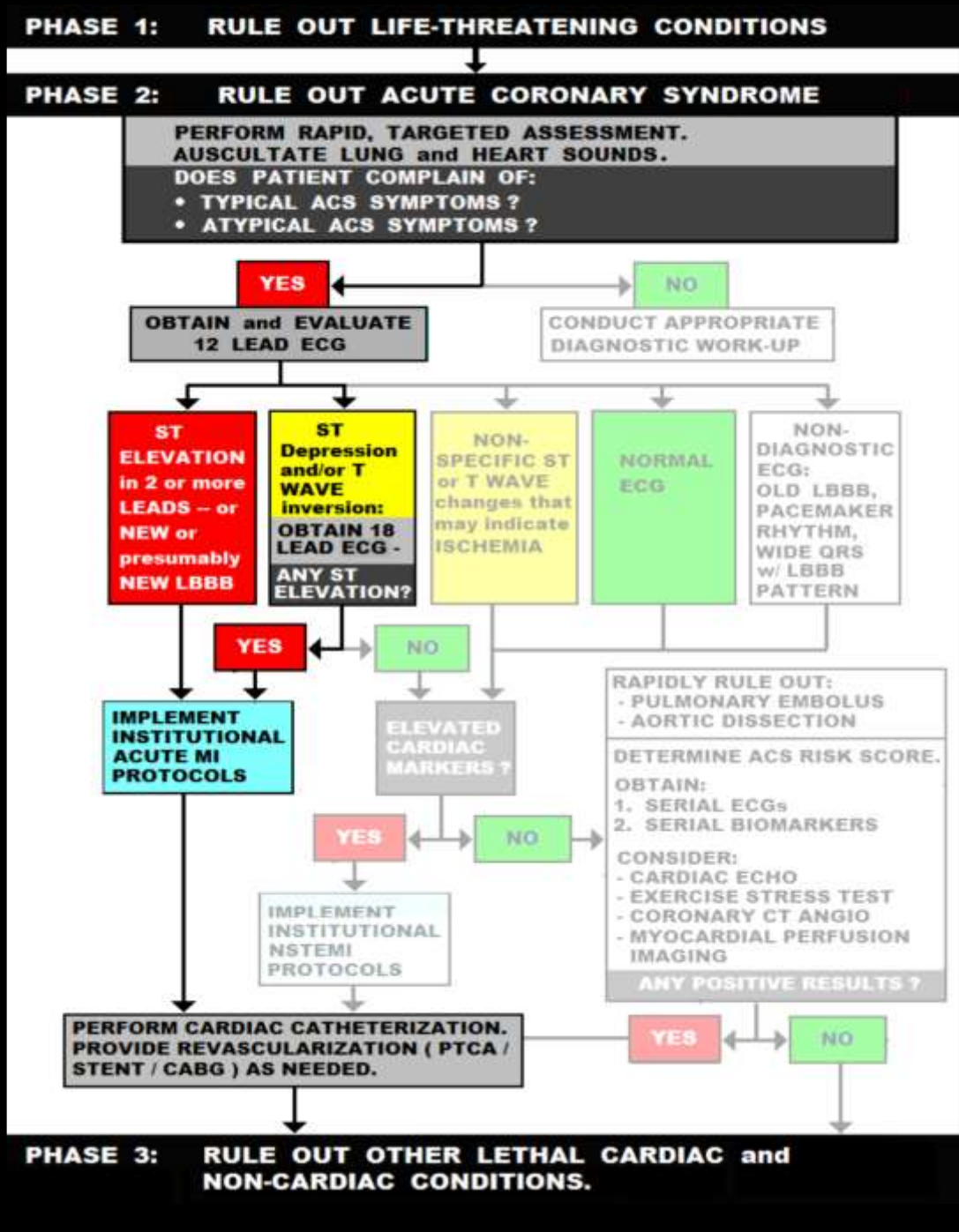
 V5 - ANTERIOR LATERAL MI	 V4 - ANTERIOR LATERAL MI	 aVL - ANTERIOR LATERAL MI	"TOOMBSTONE" PATTERN  V2 - ANTERIOR LATERAL MI	"FIREMAN'S HAT" PATTERN  V3- ANTERIOR LATERAL MI
"TOOMBSTONE" PATTERN  V4- ANTERIOR LATERAL MI	 V5- ANTERIOR LATERAL MI	 V5-ANTERIOR LATERAL MI	 II - INFERIOR POSTERIOR MI	"FIREMAN'S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

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

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

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

STEMI CASE STUDIES



ACUTE MI

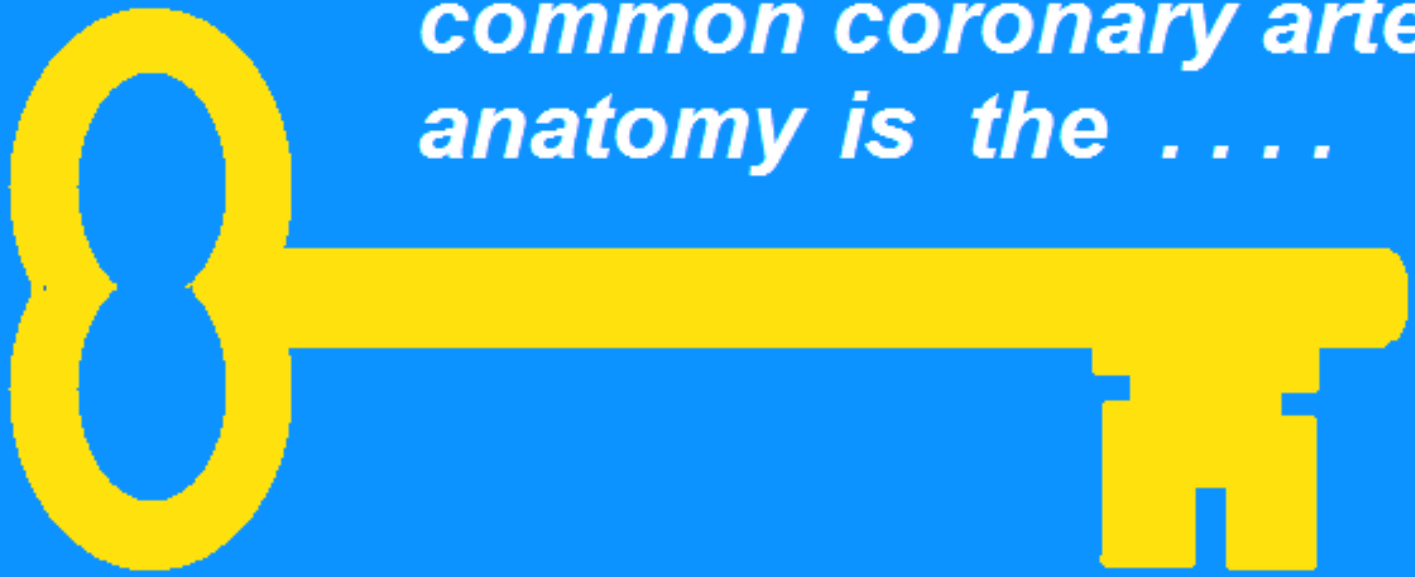
COMPLICATIONS TO ANTICIPATE FOR ALL MI PATIENTS :

LETHAL DYSRHYTHMIAS

CARDIAC ARREST

FAILURE OF STRUCTURE(S) SERVED BY THE BLOCKED ARTERY

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



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

"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

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

CASE STUDY 1 - STEMI

CHIEF COMPLAINT and SIGNIFICANT HISTORY:

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

RISK FACTOR PROFILE:

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

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

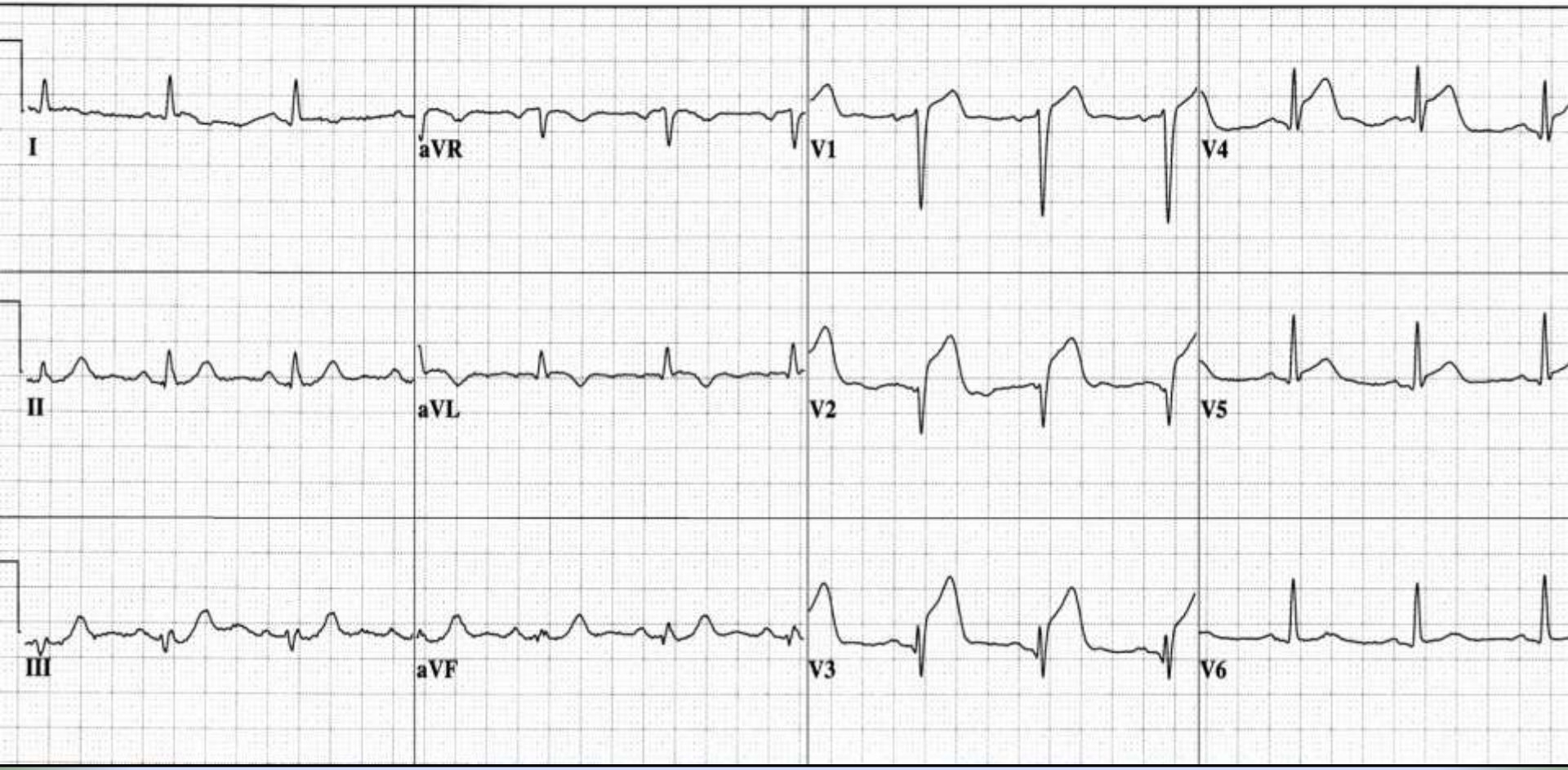
VITAL SIGNS: BP: 100/64, P: 75, R: 20, SAO2: 94%

LABS: FIRST TROPONIN: 6.4

72 yr		Vent. rate	75	BPM
Male	Caucasian	PR interval	162	ms
		QRS duration	98	ms
		QT/QTc	382/426	ms
Loc:3	Option:23	P-R-T axes	72 13	83

EVALUATE EKG for indicators of ACS:

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



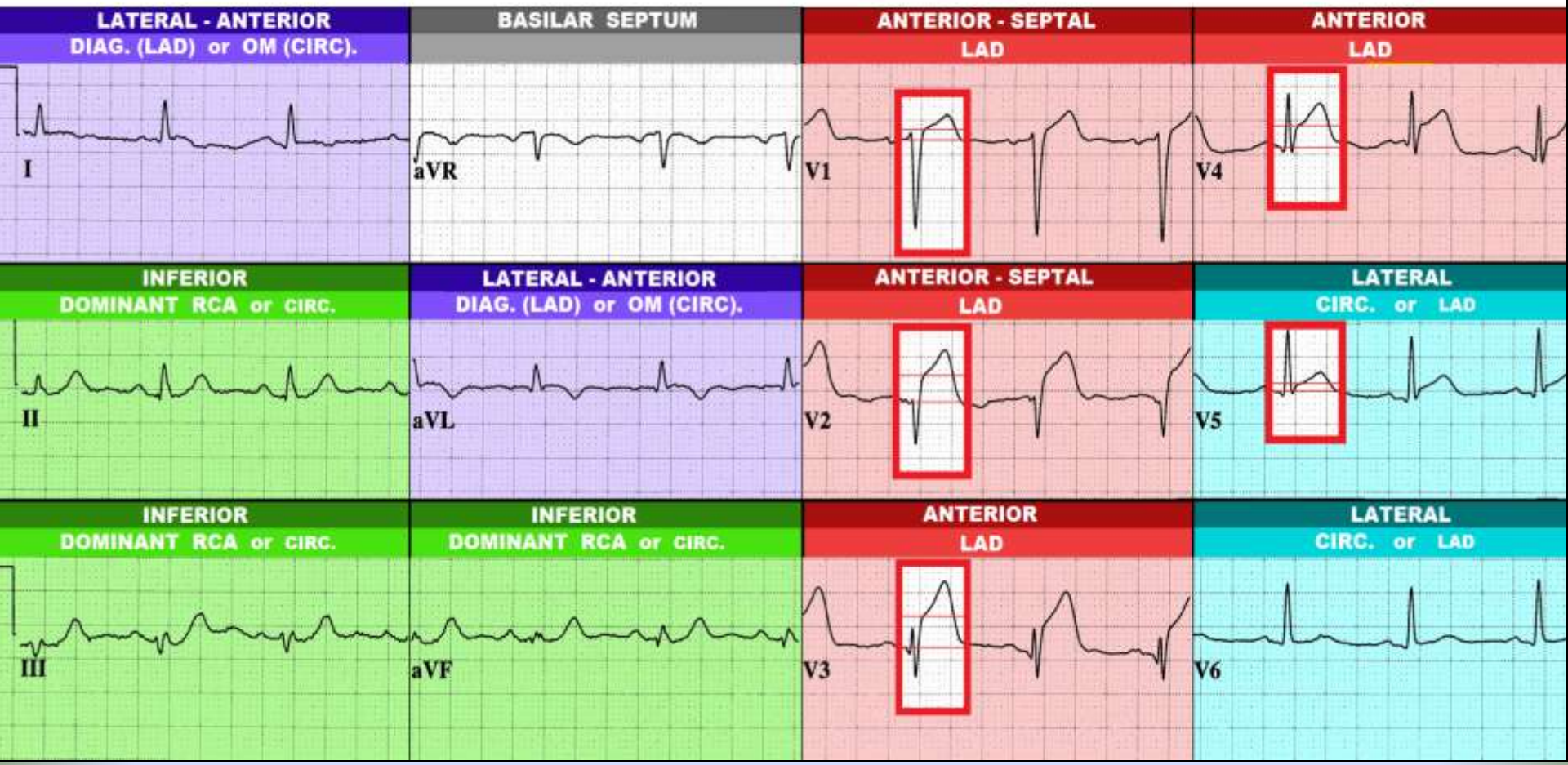
72 yr
Male Caucasian

Loc: Option:2

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

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

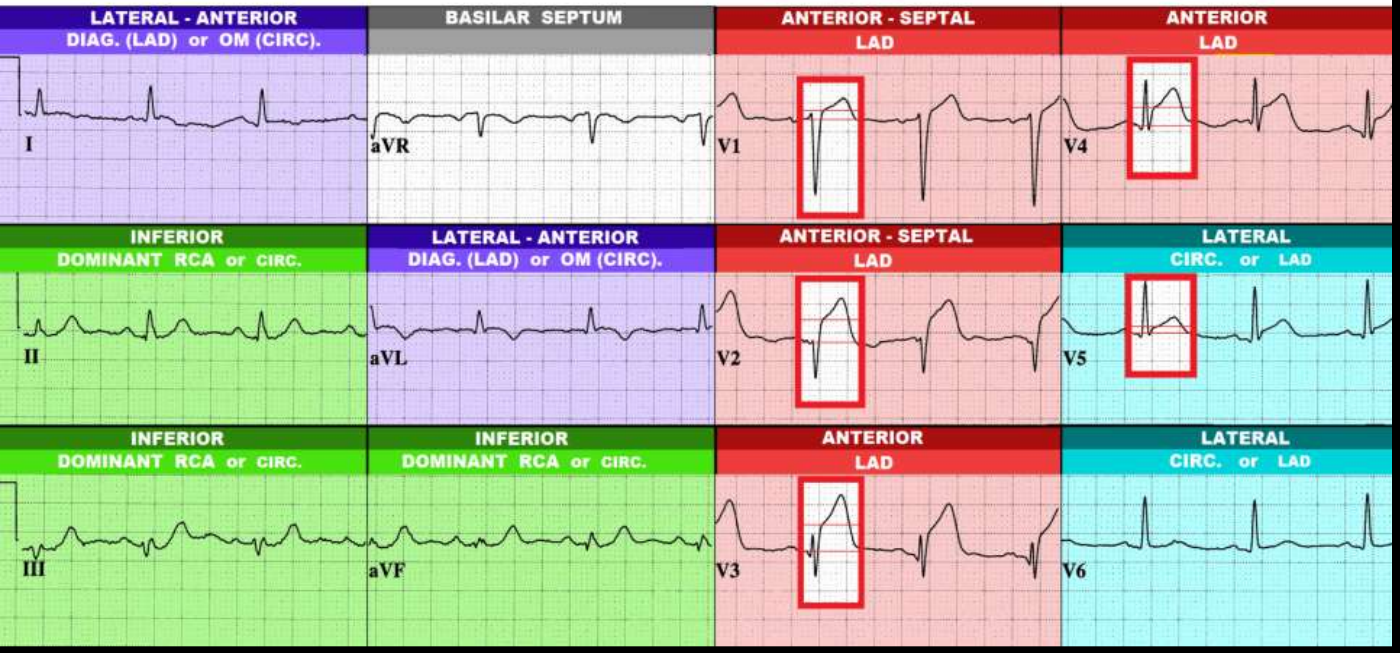
ST SEGMENT ELEVATION



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

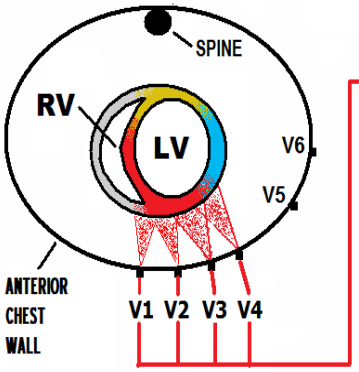
72 yr		Vent. rate	75	BPM	Normal sinus rhythm
Male	Caucasian	PR interval	162	ms	Anteroseptal infarct , possibly acute
		QRS duration	98	ms	*** ** ** ** * ACUTE MI ** ** ** **
		QT/QTc	382/426	ms	Abnormal ECG
Loc:	Option:2	P-R-T axes	72 13	83	

ST SEGMENT ELEVATION



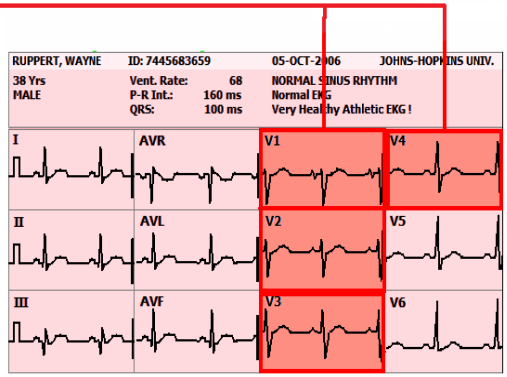
V1 - V4 VIEW THE ANTERIOR-SEPTAL WALL

of the LEFT VENTRICLE



V1, V2 - ANTERIOR / SEPTAL

V3, V4 - ANTERIOR



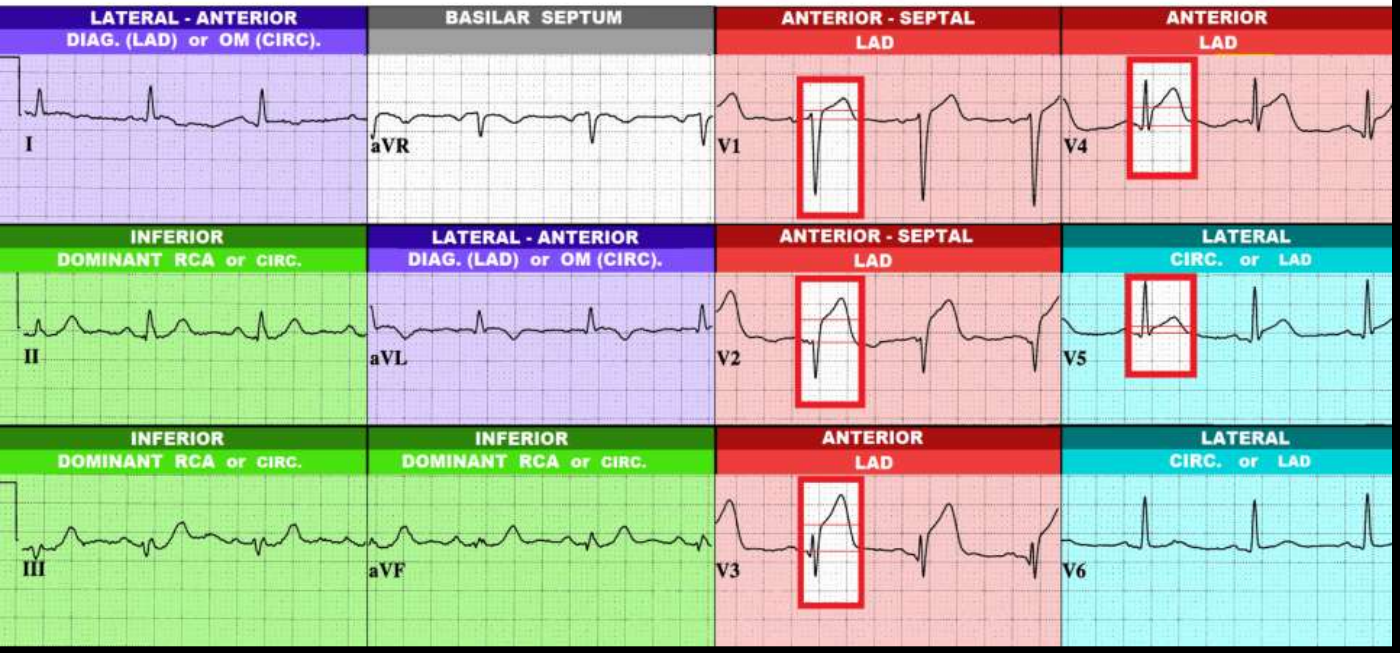
72 yr
Male
Caucasian

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

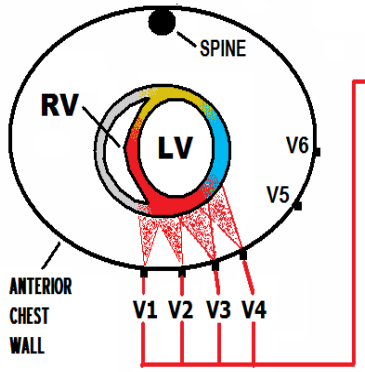
Normal sinus rhythm
Anteroseptal infarct , possibly acute
*** ** ** ** * ACUTE MI ** ** ** **
Abnormal ECG

ST SEGMENT ELEVATION

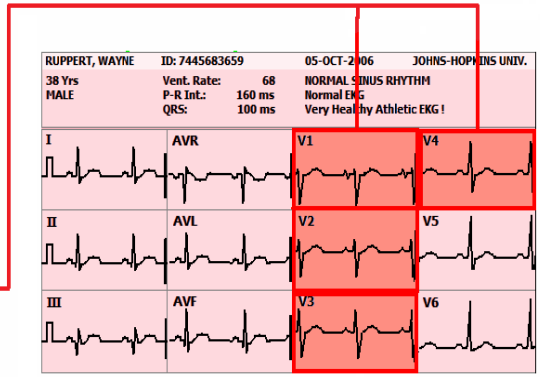


V1 - V4 VIEW THE ANTERIOR-SEPTAL WALL

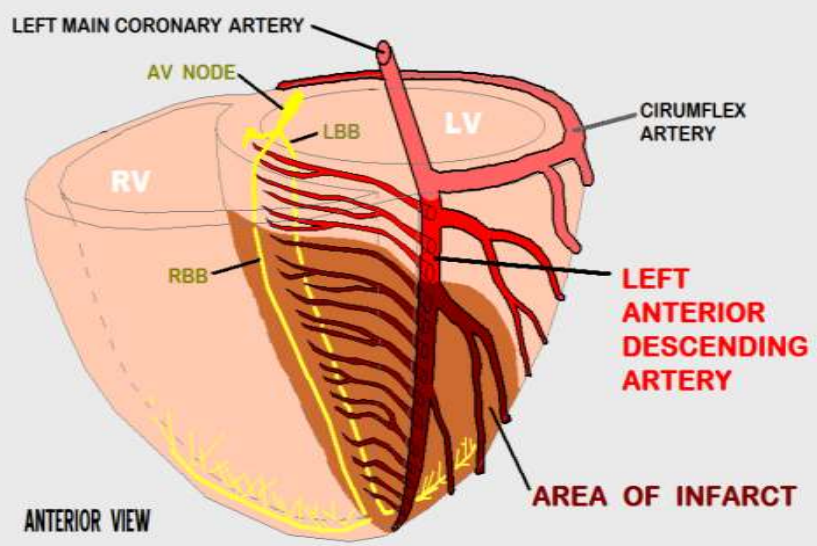
of the LEFT VENTRICLE



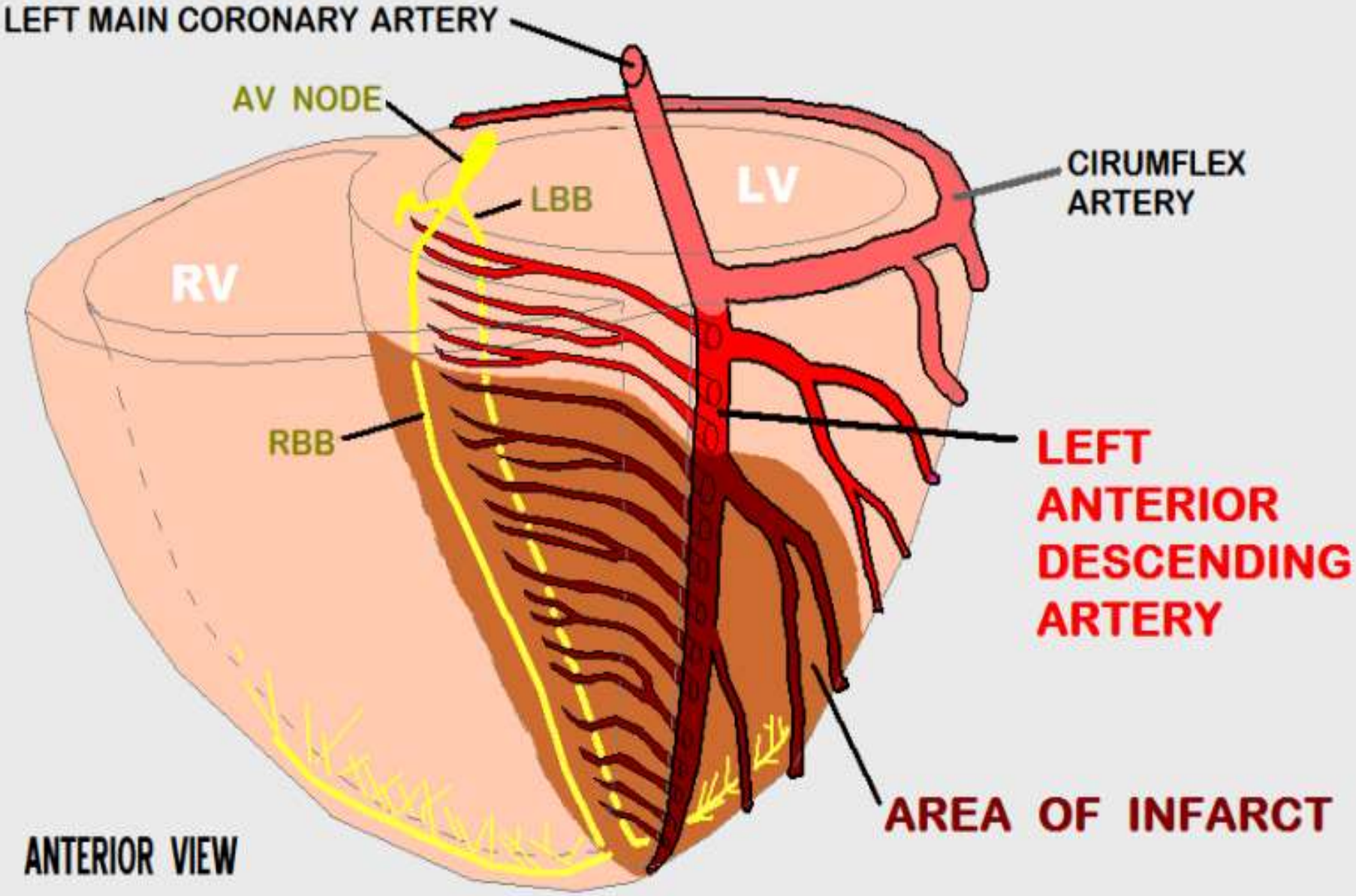
V1, V2 - ANTERIOR / SEPTAL
V3, V4 - ANTERIOR



OCCLUSION of MID - LEFT ANTERIOR DESCENDING ARTERY

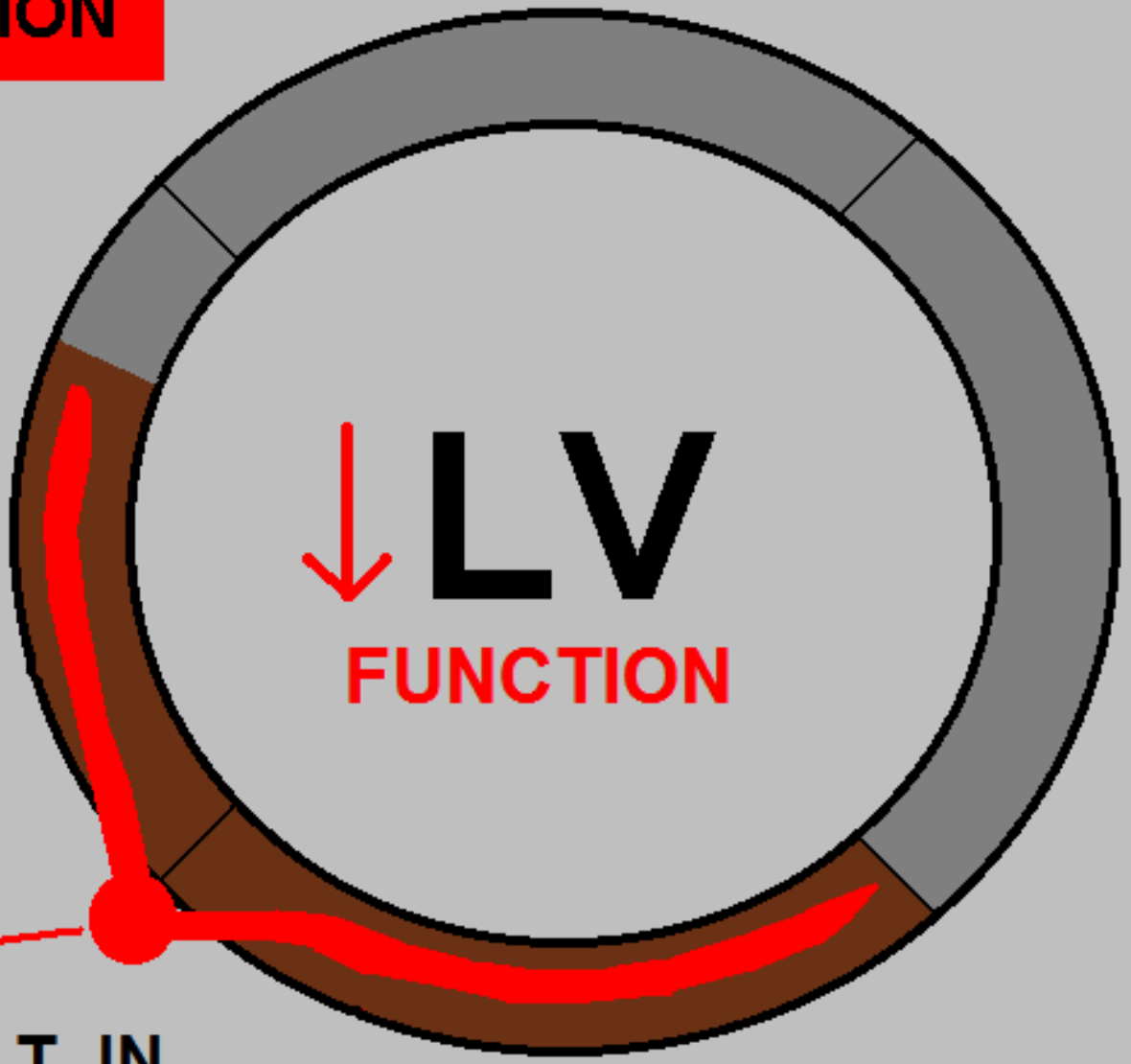


OCCLUSION of MID - LEFT ANTERIOR DESCENDING ARTERY



LAD DISTRIBUTION

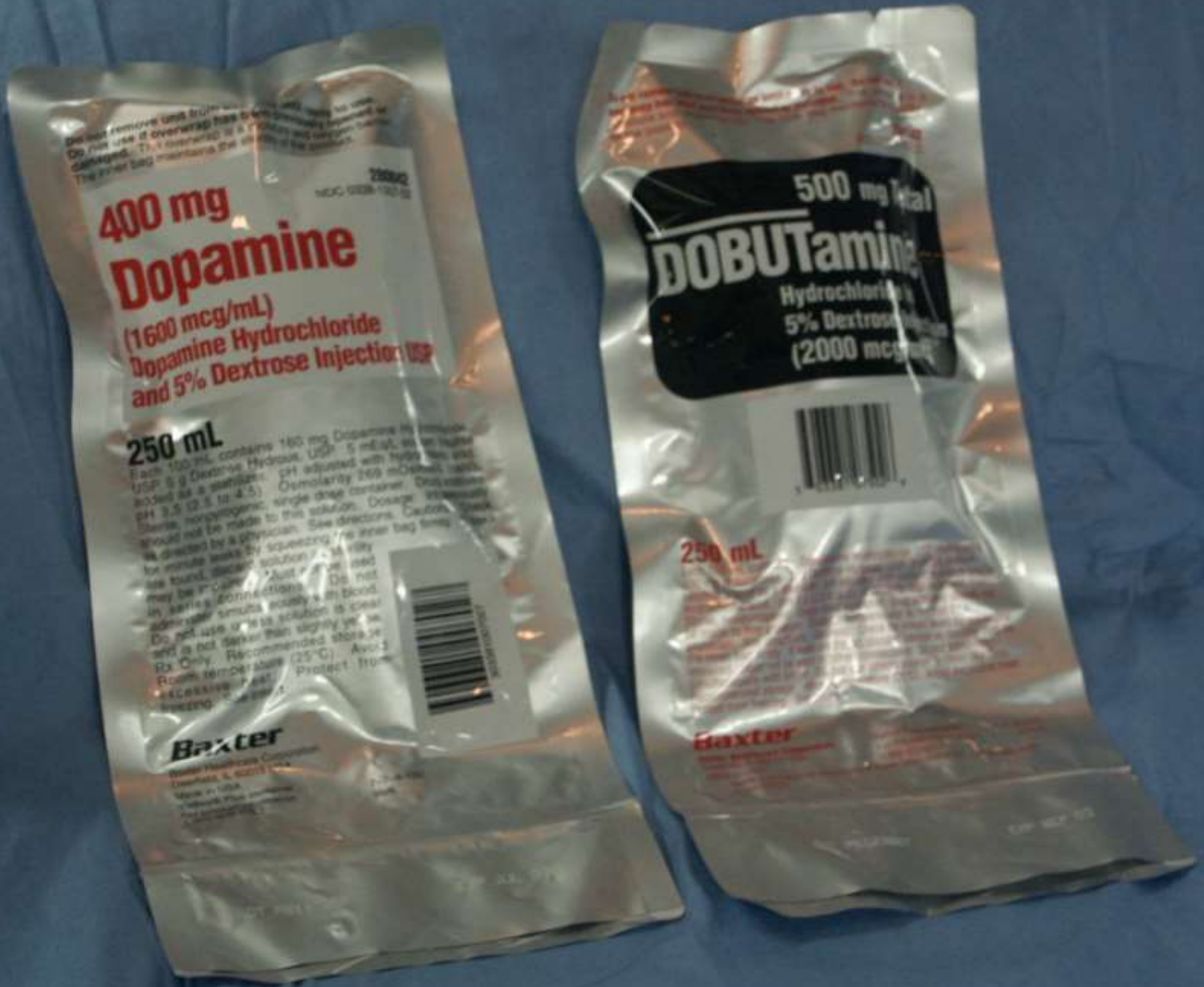
35 - 45 % of LV MUSCLE MASS



A BLOCKAGE OF THE LAD

CAN RESULT IN LV PUMP FAILURE --

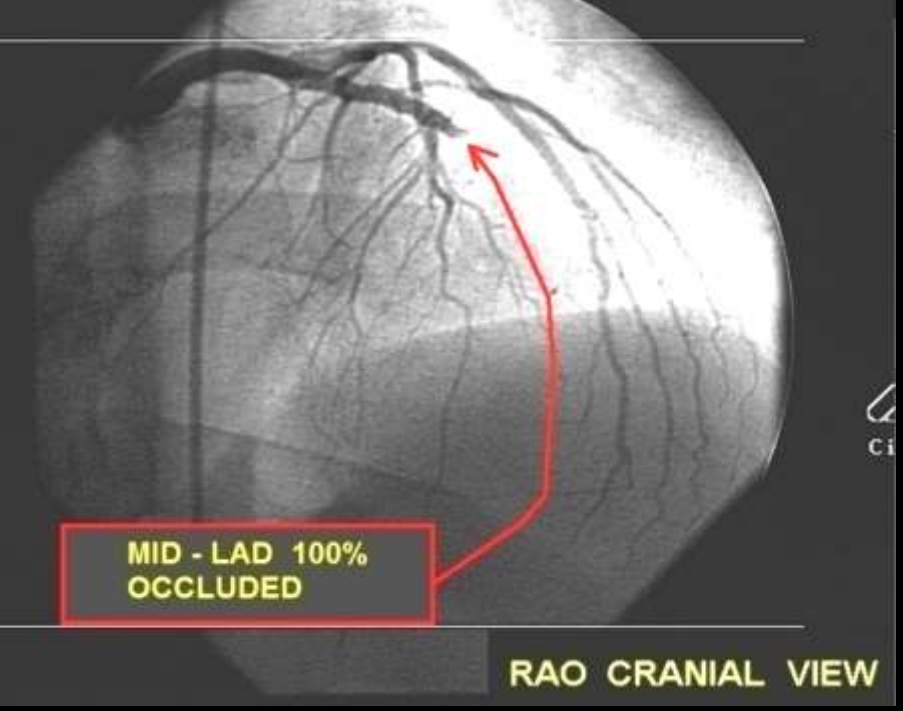
- CARDIOGENIC SHOCK
- PULMONARY EDEMA

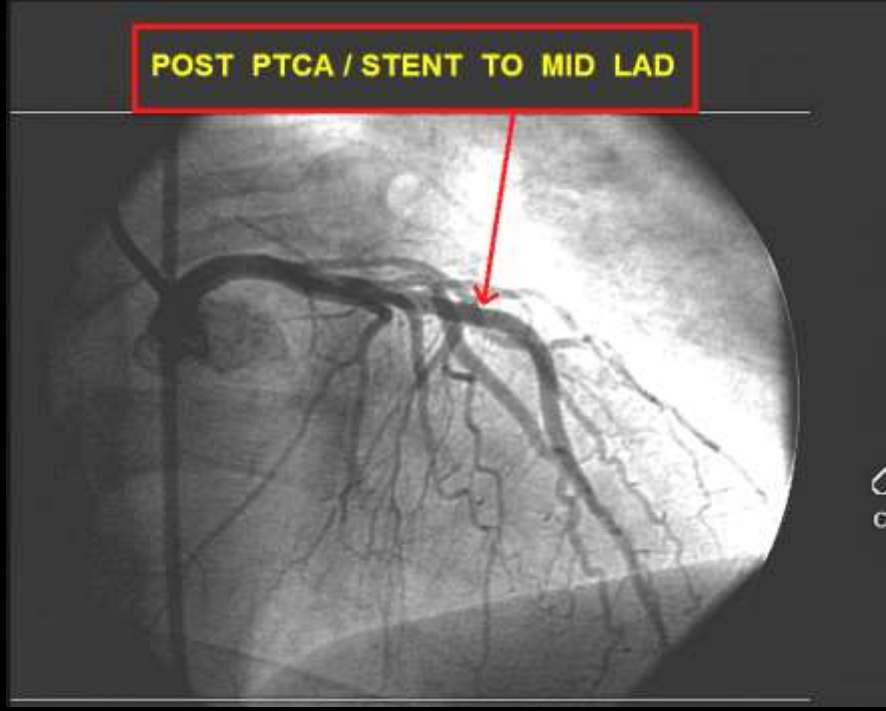

400 mg
Dopamine
(1600 mcg/mL)
Dopamine Hydrochloride
and 5% Dextrose Injection USP
250 mL
Baxter
500 mg Total
DOBUTamine
Hydrochloride in
5% Dextrose
250 mL
Baxter

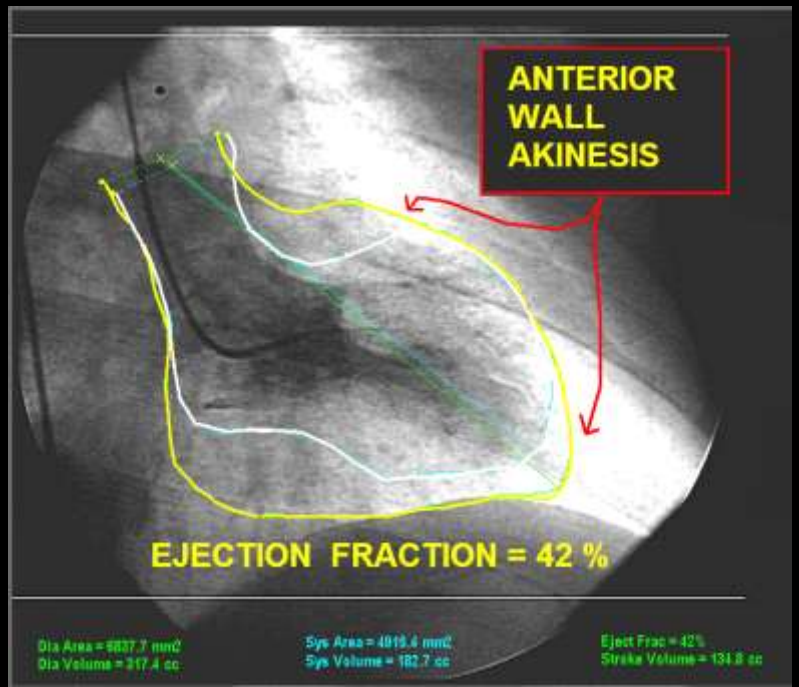
LEFT ANTERIOR DESCENDING ARTERY (LAD)

- ANTERIOR WALL OF LEFT VENTRICLE
- 35 - 45 % OF LEFT VENTRICLE MUSCLE MASS
- SEPTUM, ANTERIOR 2/3
- BUNDLE BRANCHES
- ANTERIOR-MEDIAL PAPILLARY MUSCLE

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


MID - LAD 100%
OCCLUDED
RAO CRANIAL VIEW


POST PTCA / STENT TO MID LAD


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

CASE STUDY 2: STEMI

CHIEF COMPLAINT and SIGNIFICANT HISTORY:

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

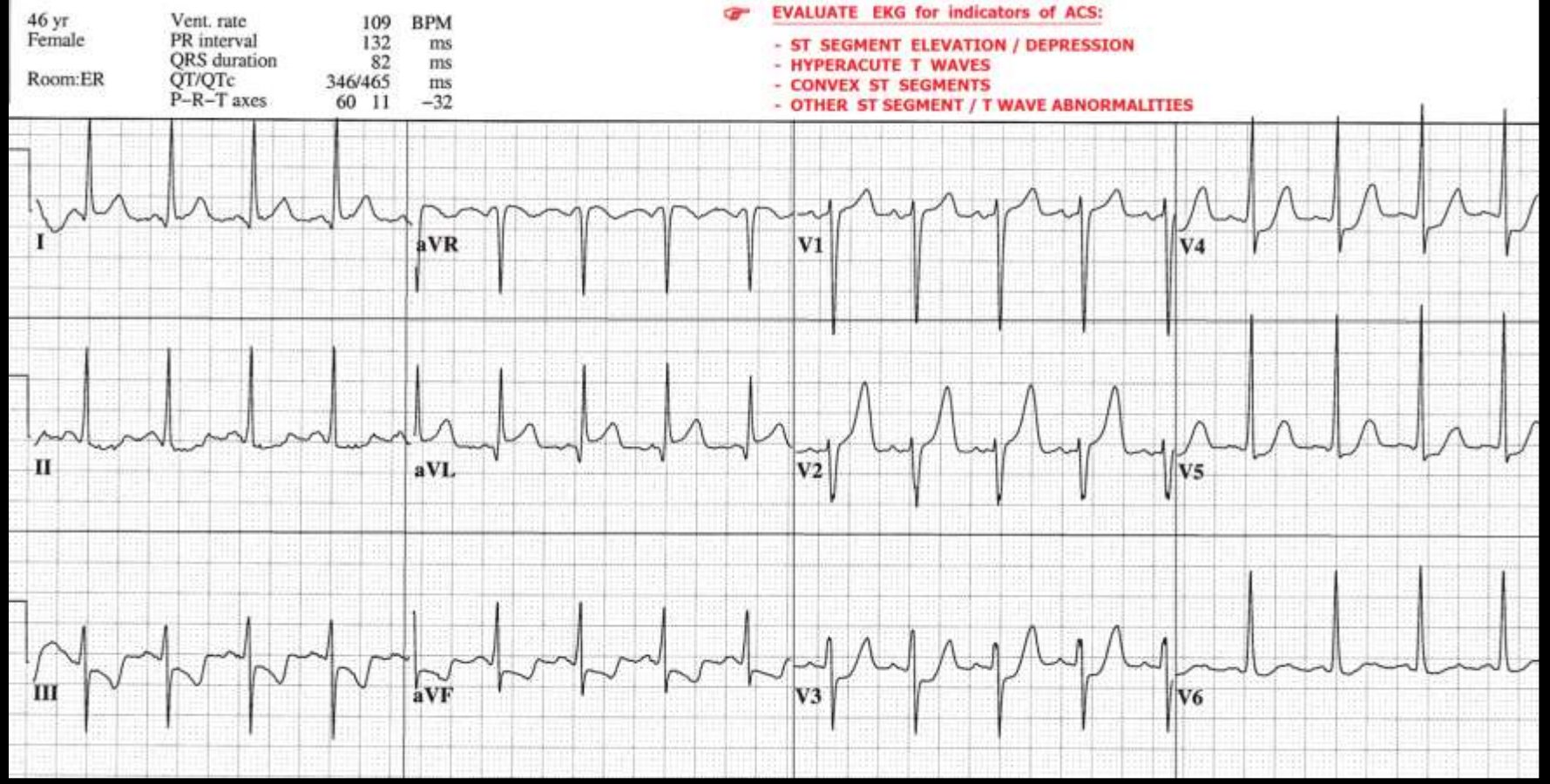
RISK FACTOR PROFILE:

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

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

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

LABS: TROPONIN ultra = 2.8



CASE STUDY QUESTIONS:

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

46 yr
Female

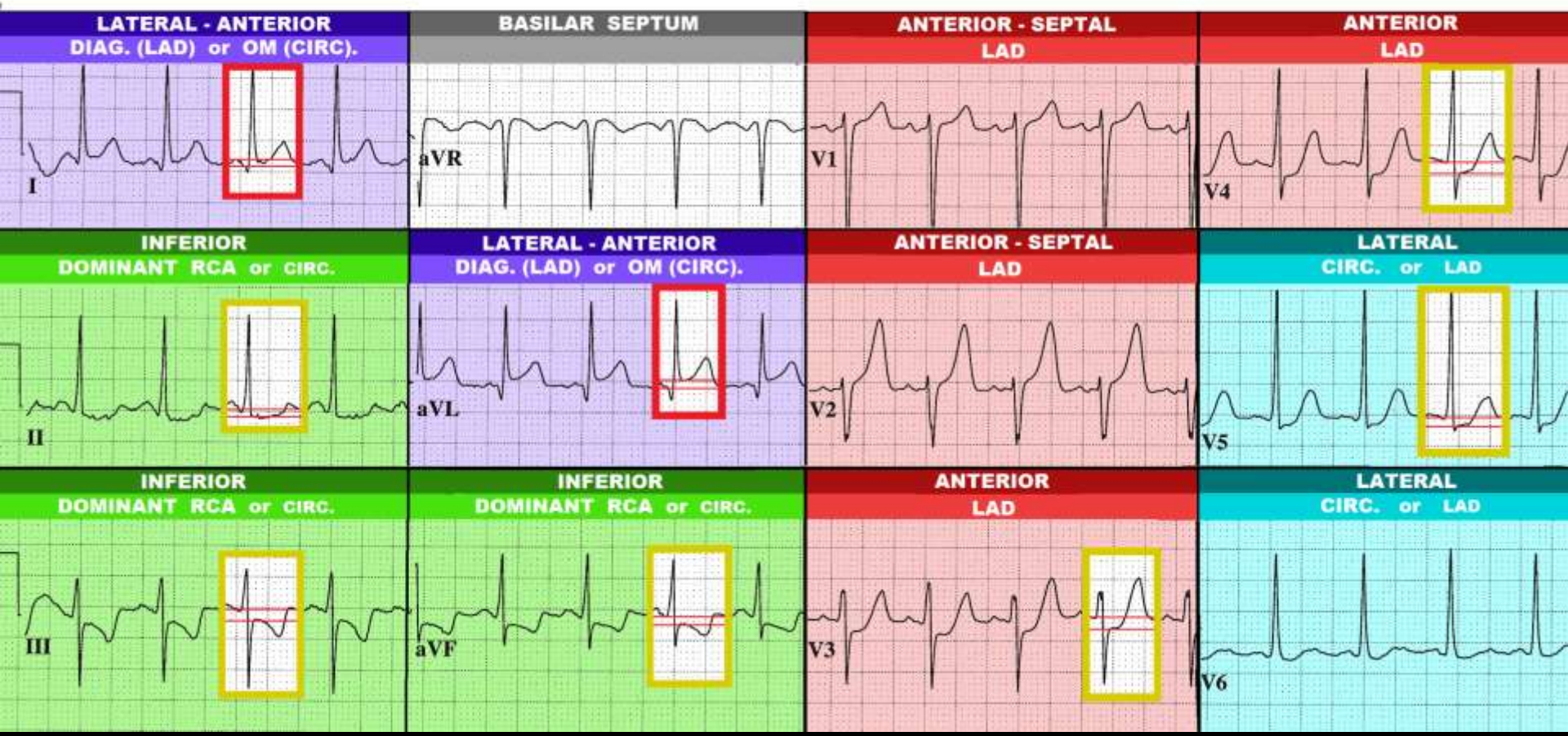
Room:ER

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

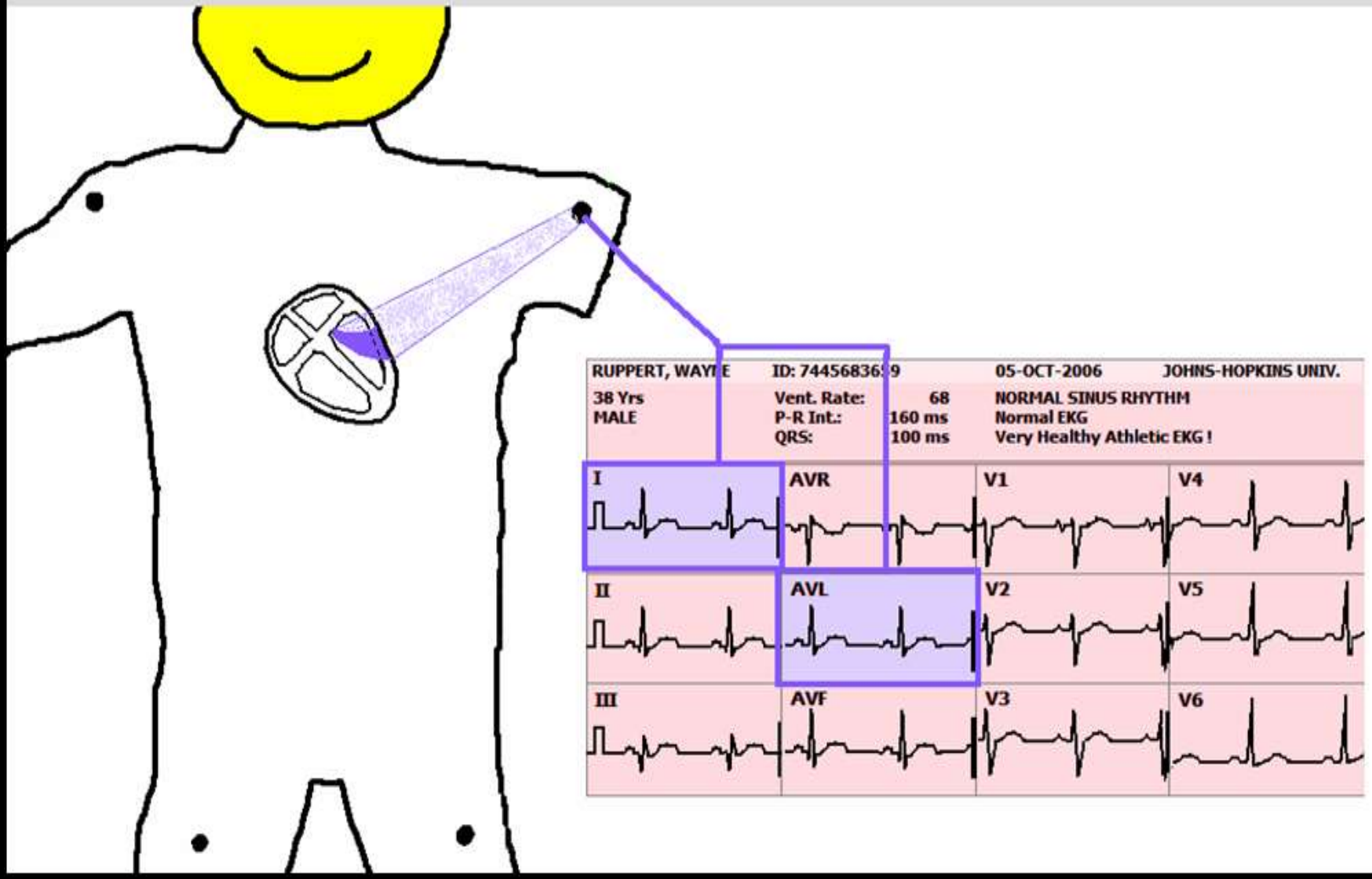
Sinus tachycardia
Left ventricular hypertrophy with repolarization abnormality
ST elevation consider lateral injury or acute infarct
*** ** ** ** * ACUTE MI ** ** ** **

ST SEGMENT ELEVATION

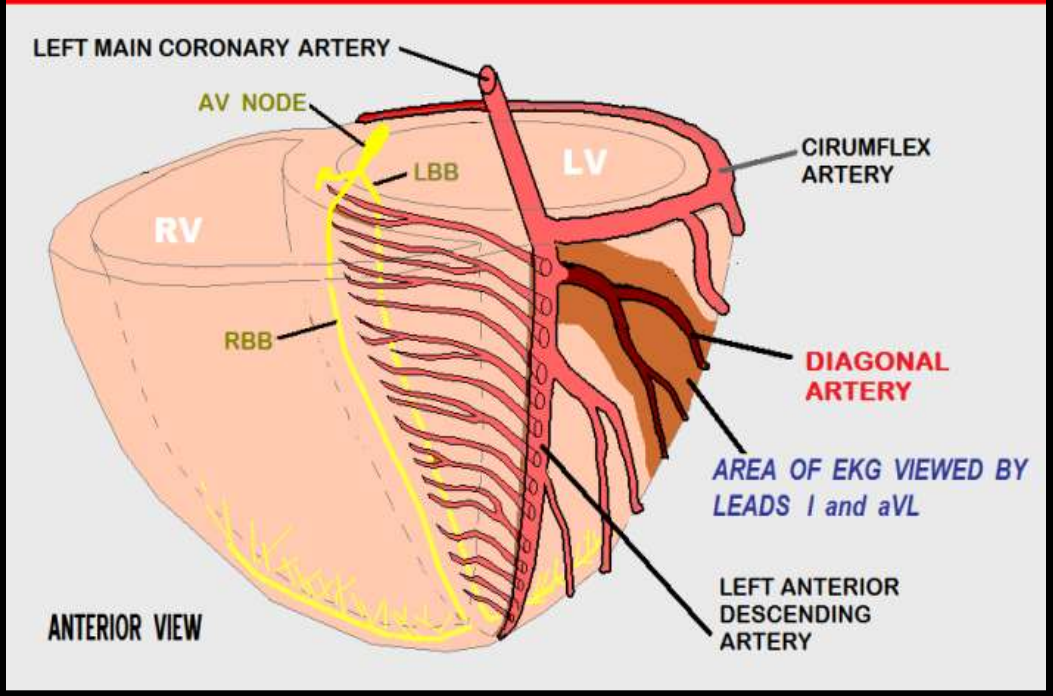
ST SEGMENT DEPRESSION



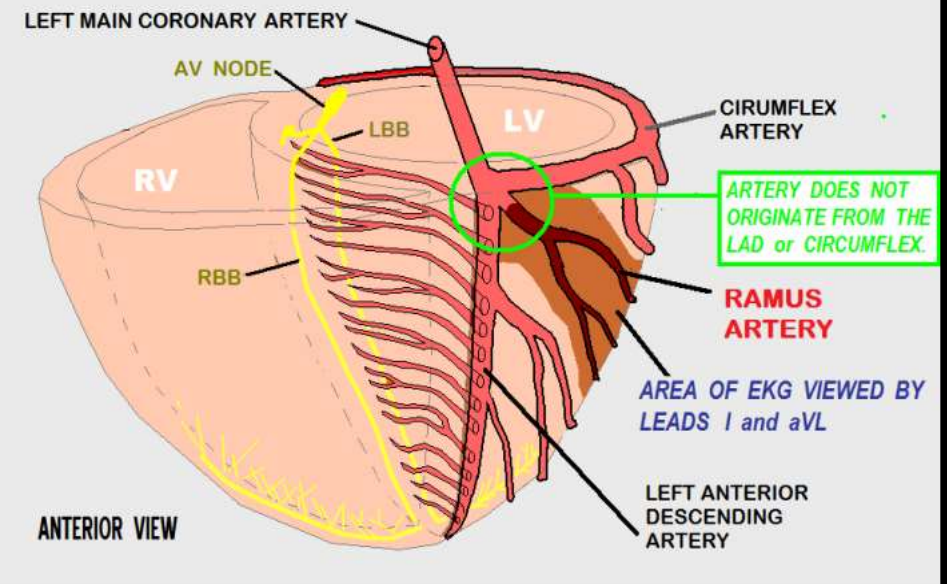
LEADS I and aVL view the ANTERIOR-LATERAL JUNCTION



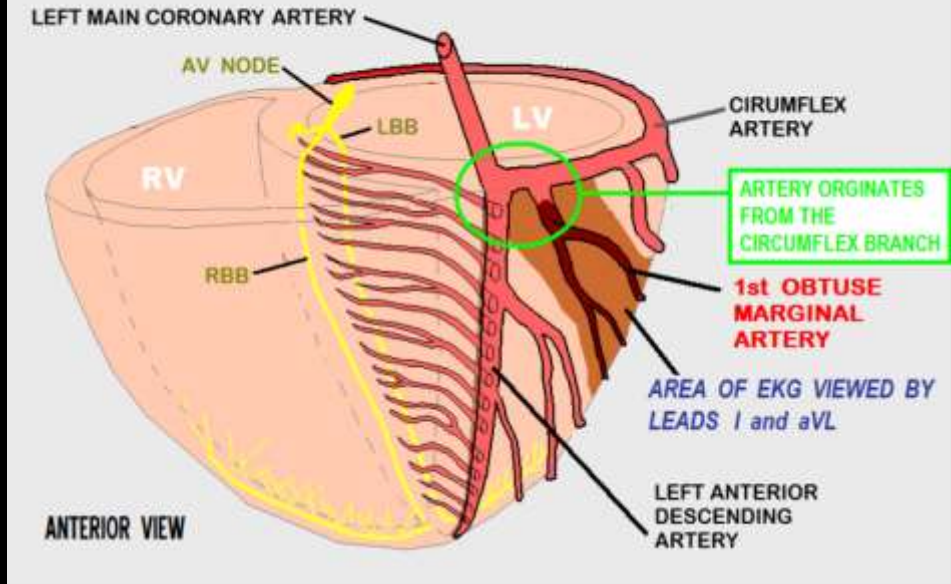
OCCLUSION of DIAGONAL ARTERY



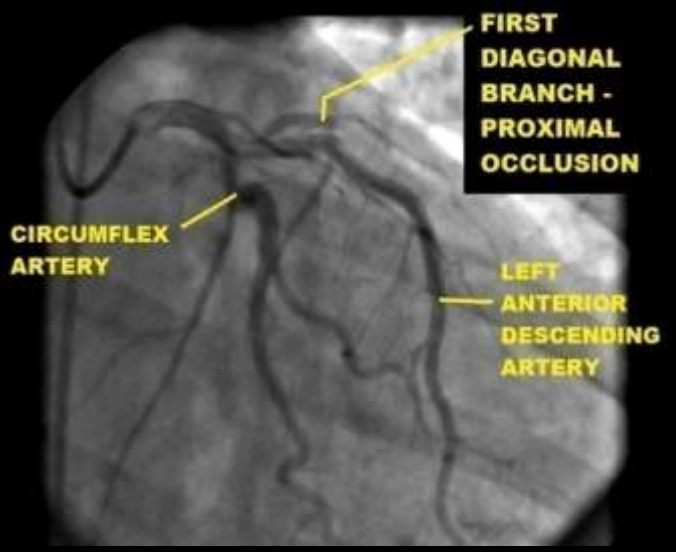
OCCLUSION of RAMUS ARTERY

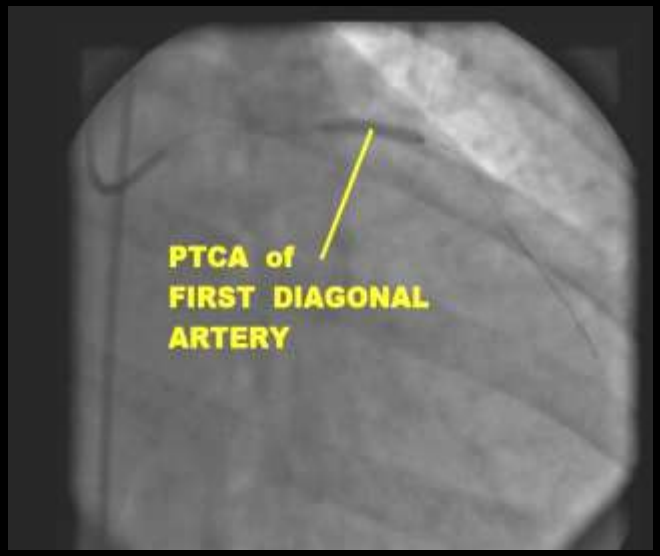


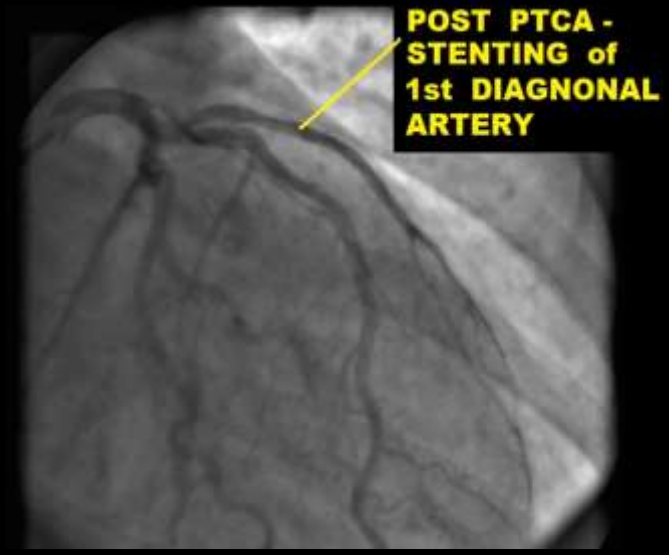
OCCLUSION of OBTUSE MARGINAL ARTERY

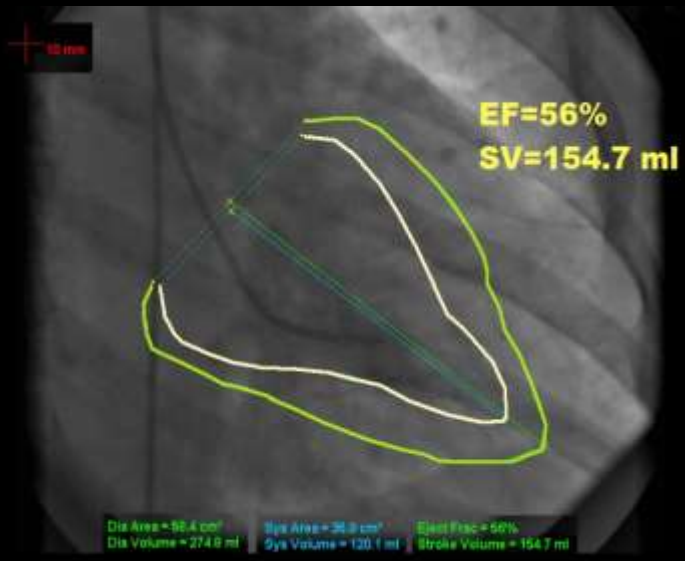


CASE PROGRESSION: As the patient was being prepared for transport to the Cardiac Cath Lab, she experienced an episode of Ventricular Fibrillation.









CASE STUDY SUMMARY

ST ELEVATION: I, aVL

ST DEPRESSION: II, III, aVF, V3 - V5

SUSPECTED DIAGNOSIS: ACUTE LATERAL WALL M.I.

SUSPECTED "CULPRIT ARTERY" (if applicable):

USUALLY ONE OF THE SMALLER SIDE-BRANCH ARTERIES:

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

IMMEDIATE CONCERNS FOR ALL STEMI PATIENTS:

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

CRITICAL STRUCTURES COMPROMISED:	POTENTIAL COMPLICATIONS:	POSSIBLE CRITICAL INTERVENTIONS:
15-30% of the LV MUSCLE MASS →	POSSIBLE MODERATE LV PUMP FAILURE →	INOTROPIC AGENTS ET INTUBATION I.A.B.P. INSERTION

CASE STUDY 3: STEMI

CHIEF COMPLAINT and SIGNIFICANT HISTORY:

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

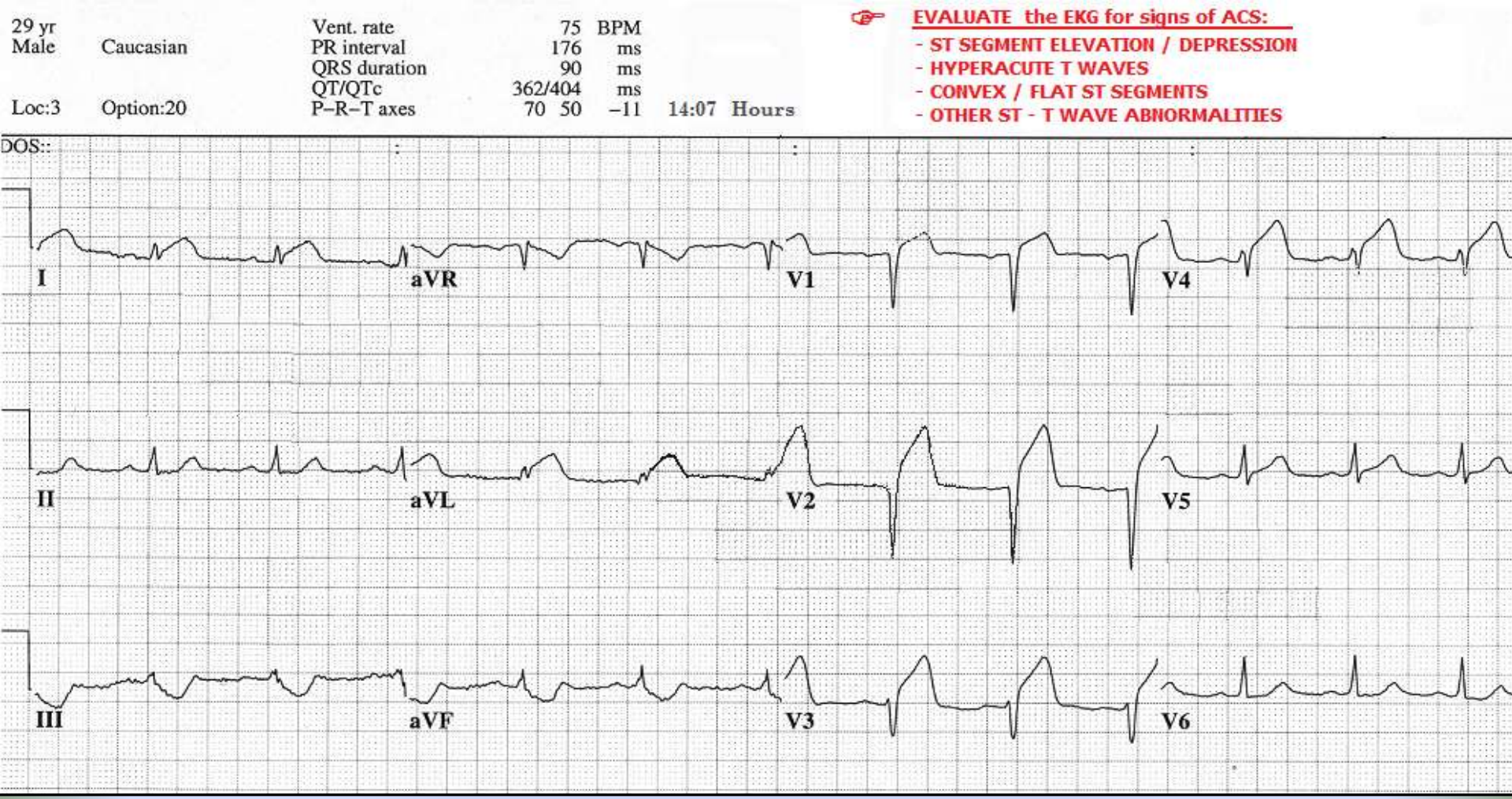
RISK FACTOR PROFILE:

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

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

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

LABS: INITIAL CARDIAC MARKERS - NEGATIVE


29 yr
Male
Caucasian
Loc:3
Option:20
Vent. rate 75 BPM
PR interval 176 ms
QRS duration 90 ms
QT/QTc 362/404 ms
P-R-T axes 70 50 -11
14:07 Hours
EVALUATE the EKG for signs of ACS:
- ST SEGMENT ELEVATION / DEPRESSION
- HYPERACUTE T WAVES
- CONVEX / FLAT ST SEGMENTS
- OTHER ST - T WAVE ABNORMALITIES
DOS::
I
aVR
V1
V4
II
aVL
V2
V5
III
aVF
V3
V6

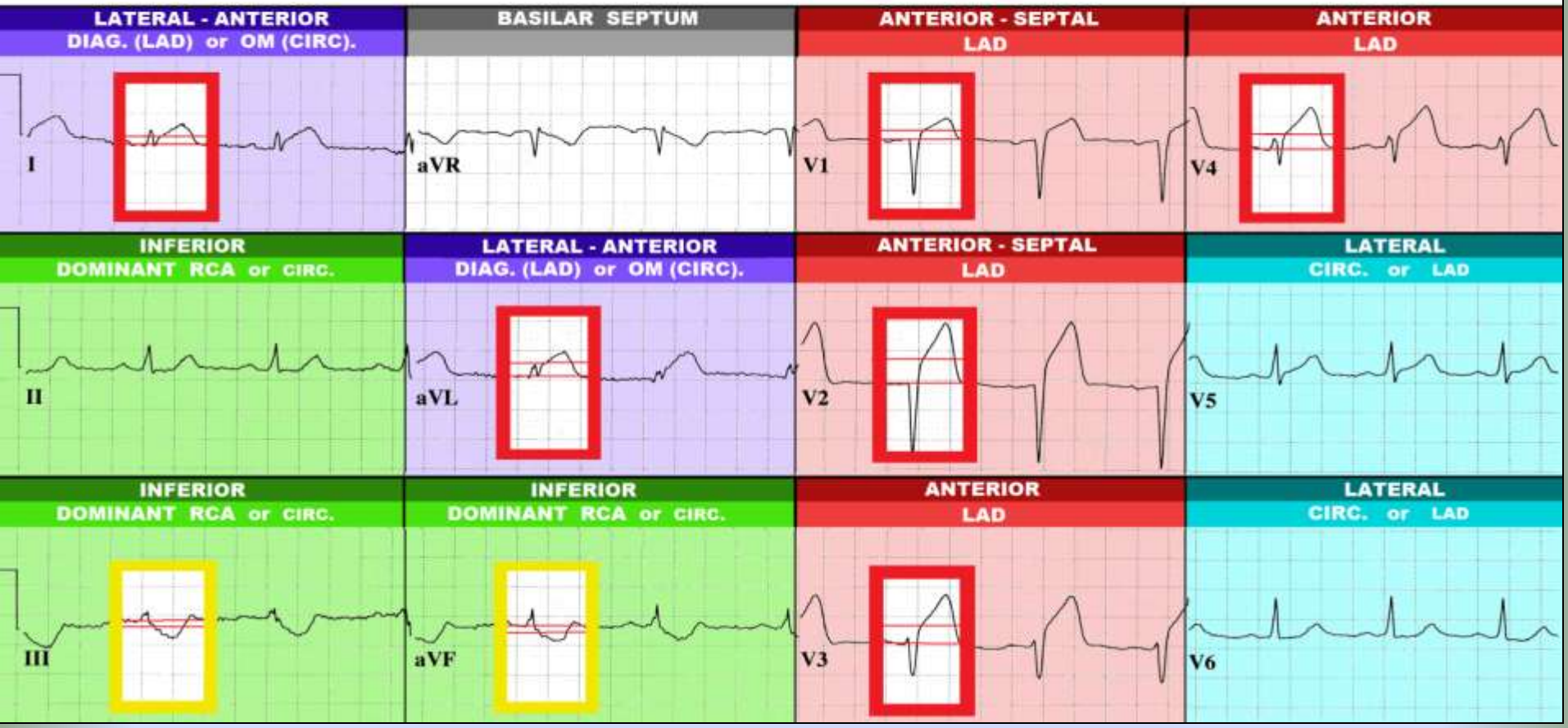
29 yr
Male
Caucasian

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

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

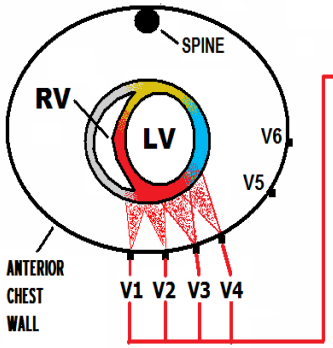
ST SEGMENT ELEVATION

ST SEGMENT DEPRESSION

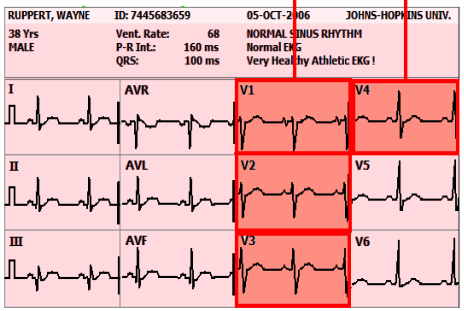


- **Reciprocal ST Depression is NOW PRESENT**
- **Additional ST Elevation is present in Leads I, AVL**

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



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



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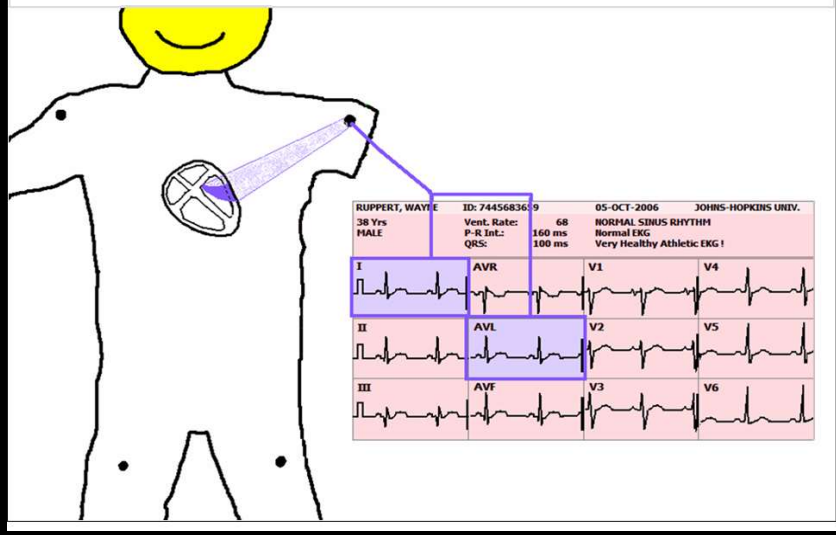
Leads I & AVL view the ANTERIOR-LATERAL JUNCTION



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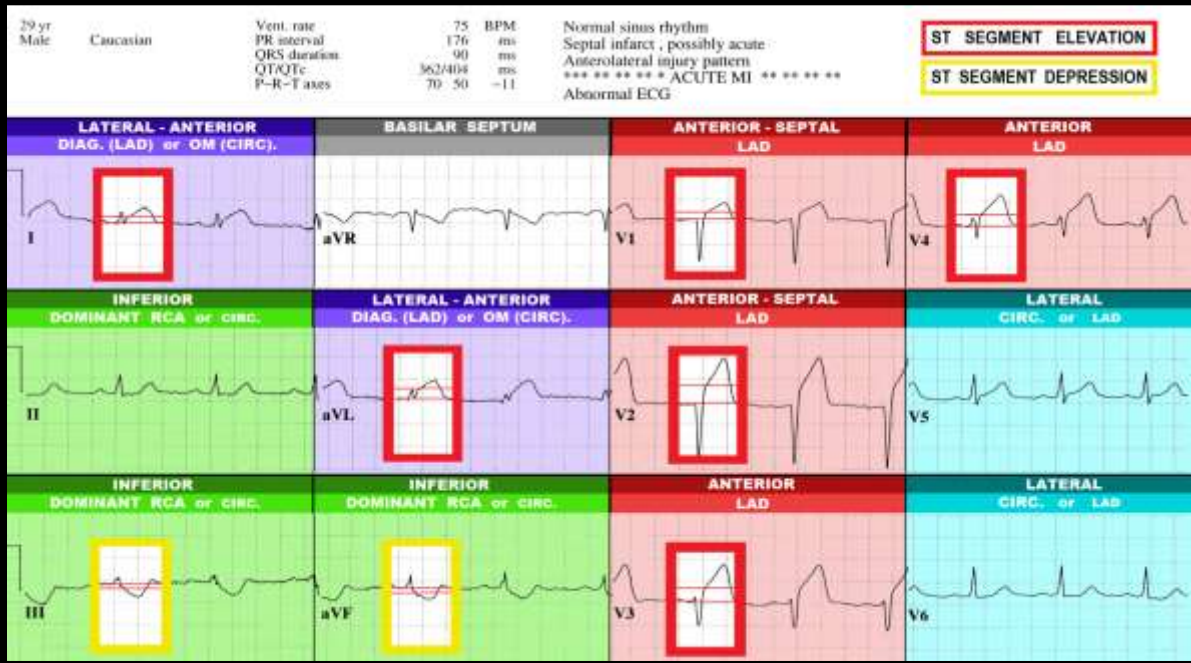
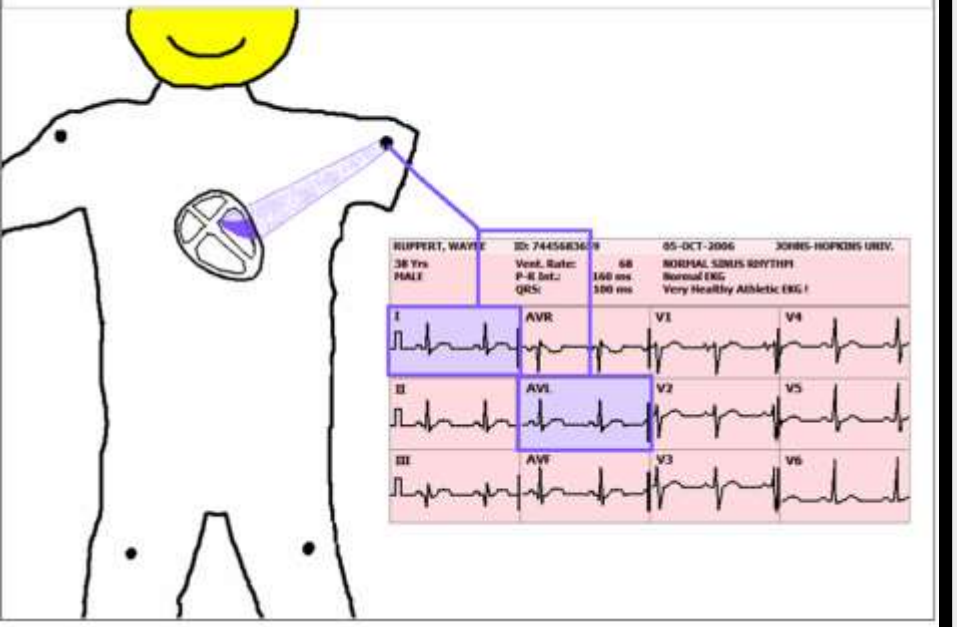
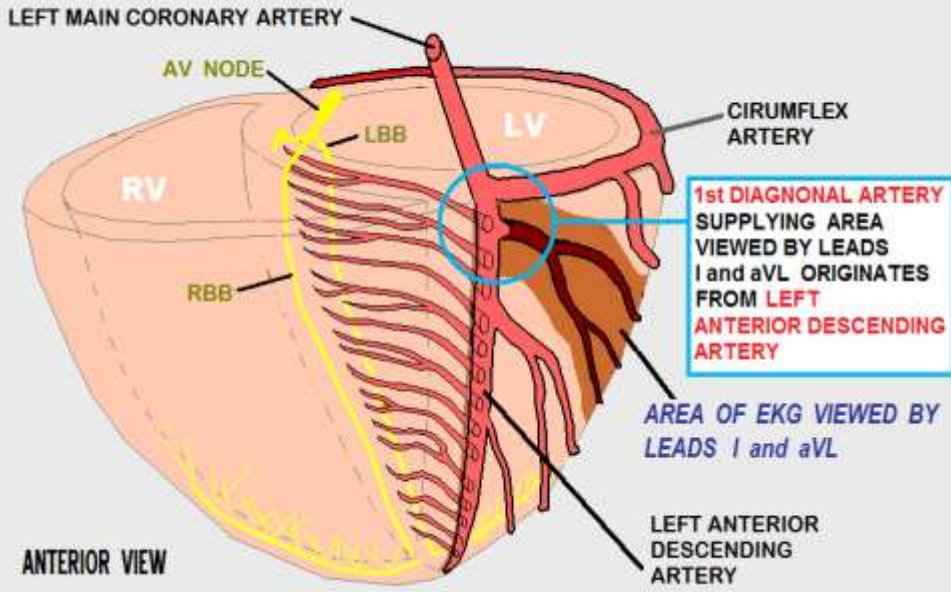


Leads I & AVL view the ANTERIOR-LATERAL JUNCTION

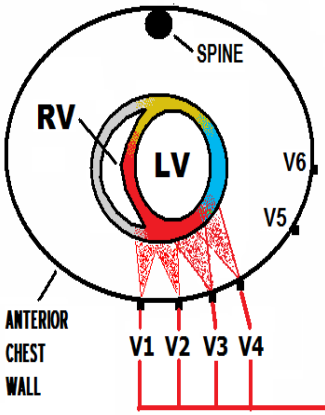


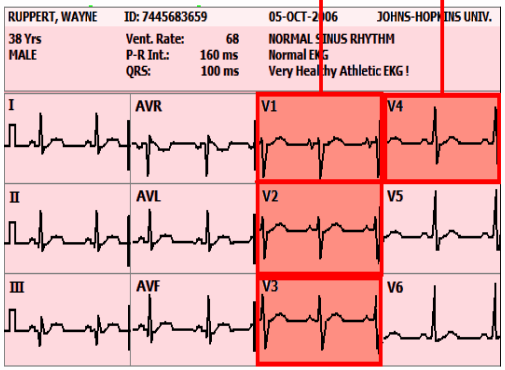
OCCLUSION of DIAGONAL ARTERY



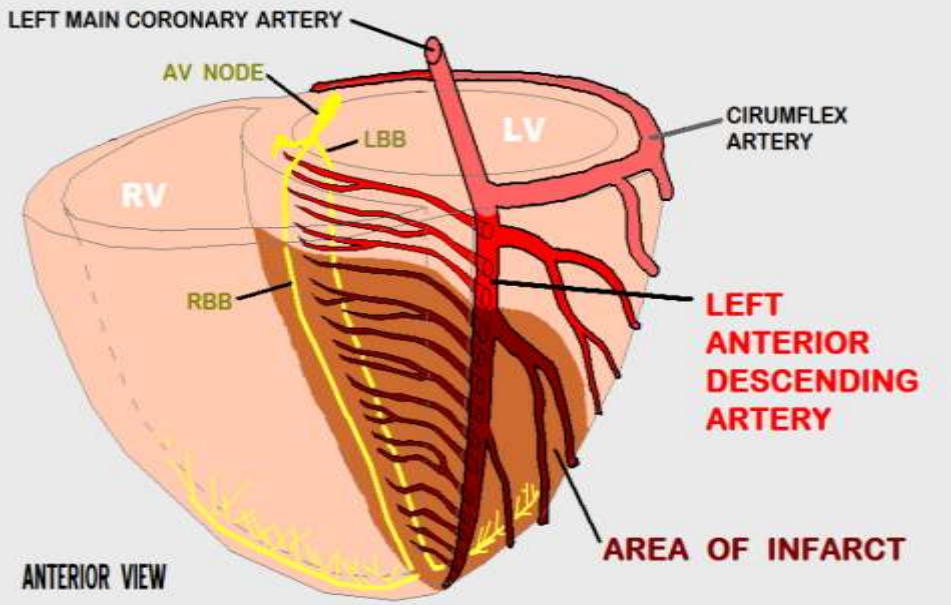
V1 - V4 VIEW THE ANTERIOR-SEPTAL WALL of the LEFT VENTRICLE

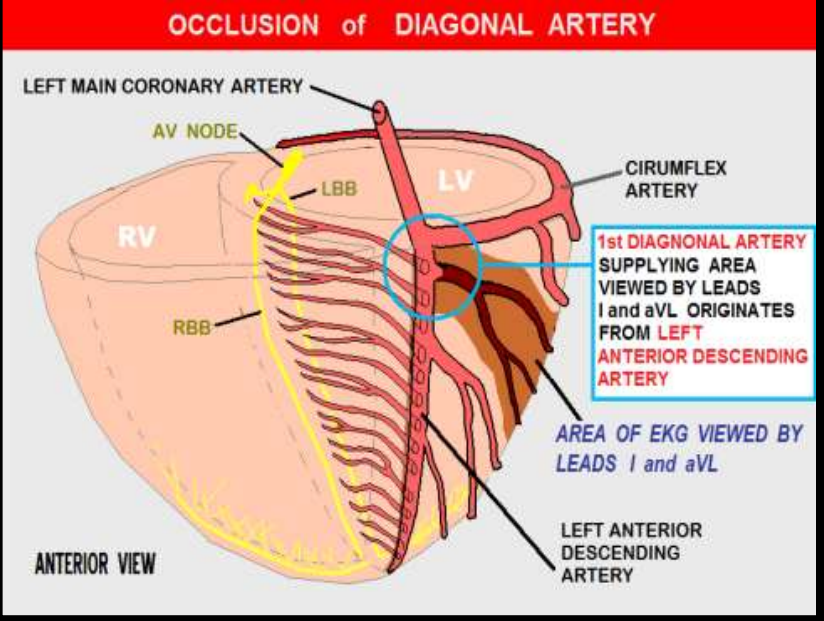
V1, V2 - ANTERIOR / SEPTAL
V3, V4 - ANTERIOR



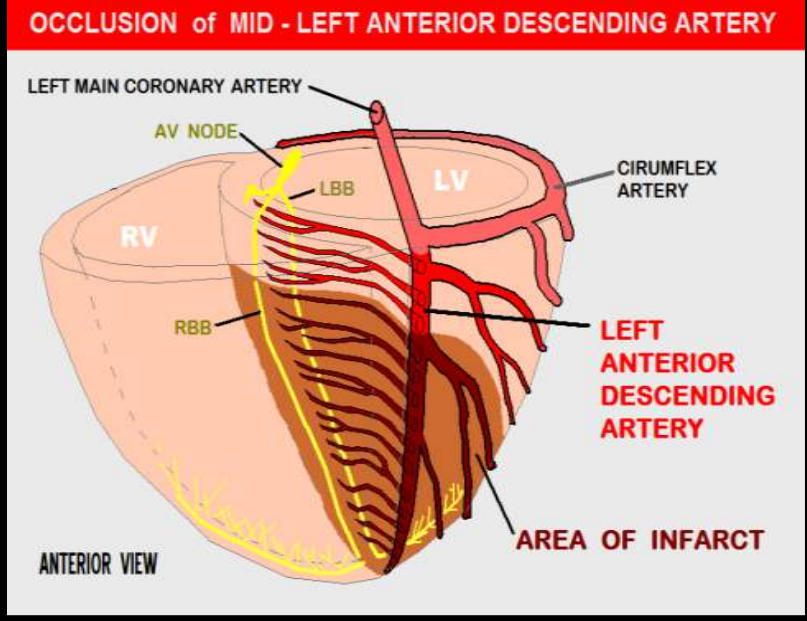


OCCLUSION of MID - LEFT ANTERIOR DESCENDING ARTERY

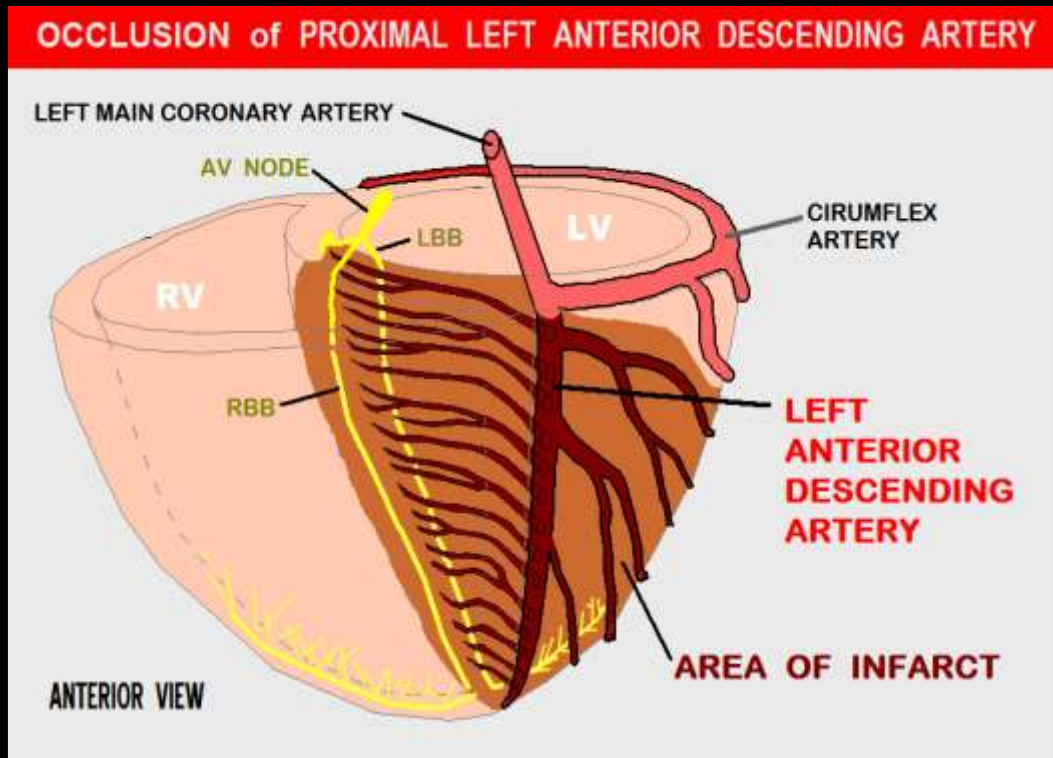


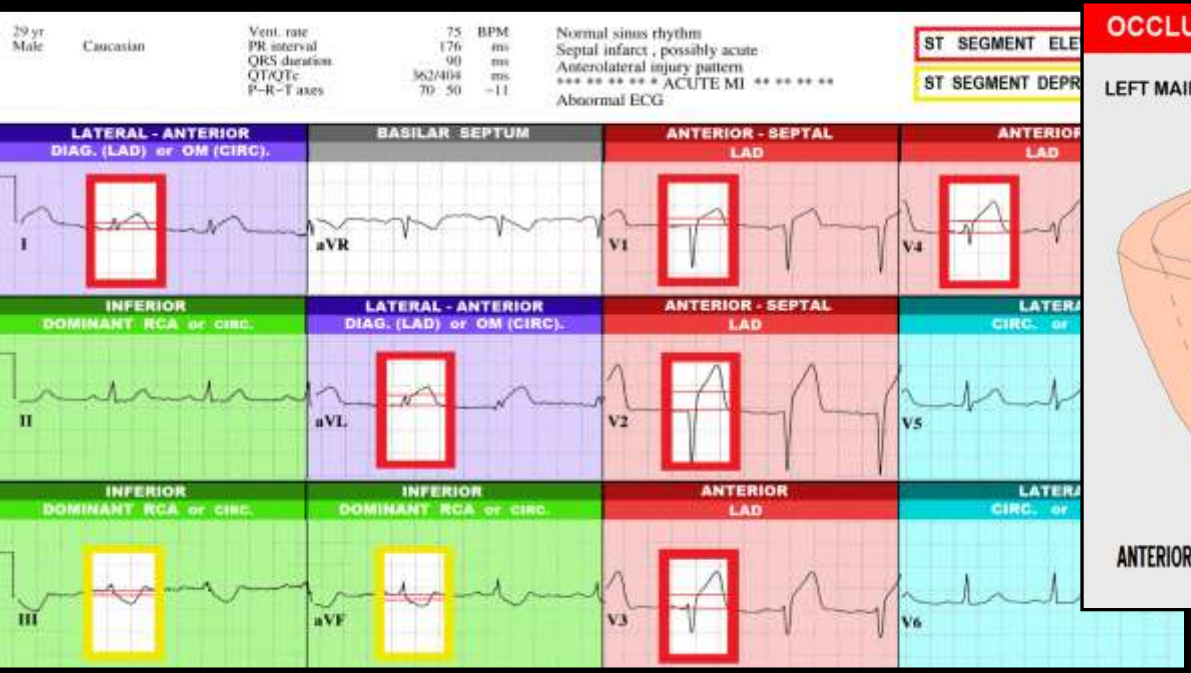

OCCLUSION of DIAGONAL ARTERY
LEFT MAIN CORONARY ARTERY
AV NODE
LBB
LV
CIRUMFLEX ARTERY
RV
RBB
1st DIAGNONAL ARTERY SUPPLYING AREA VIEWED BY LEADS I and aVL ORIGINATES FROM LEFT ANTERIOR DESCENDING ARTERY
AREA OF EKG VIEWED BY LEADS I and aVL
LEFT ANTERIOR DESCENDING ARTERY
ANTERIOR VIEW

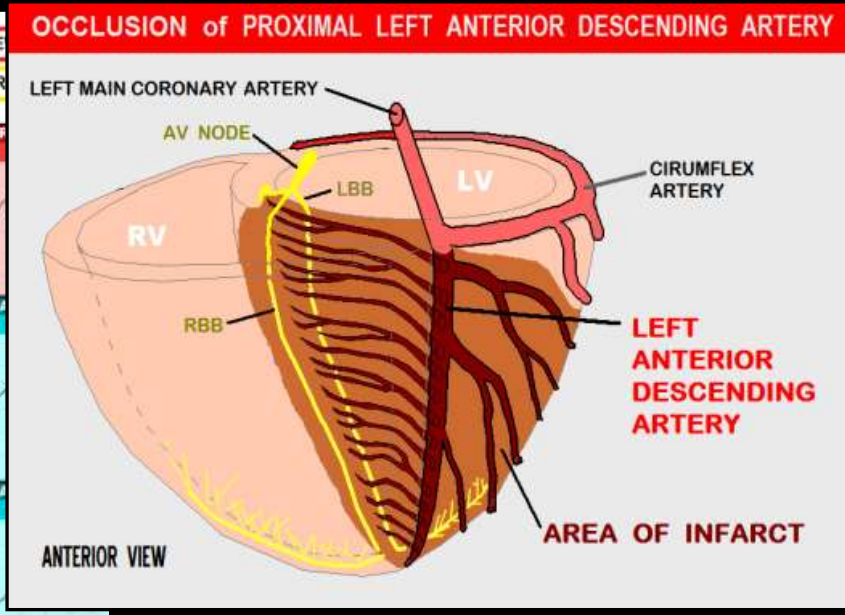
+

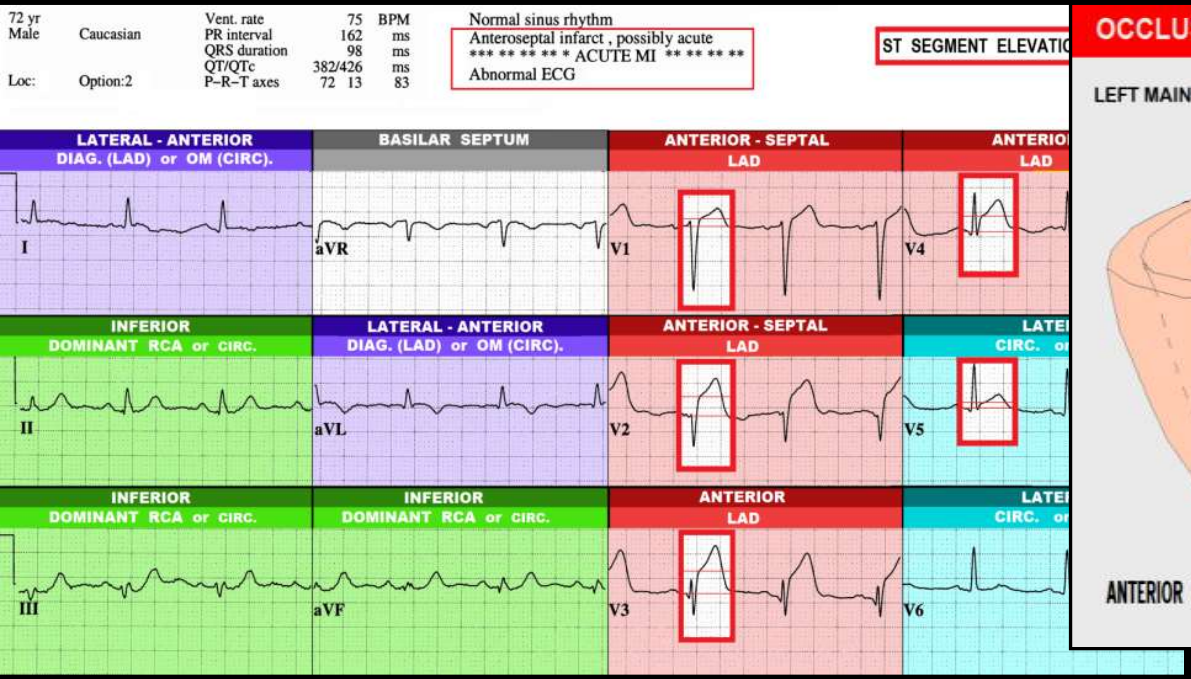

OCCLUSION of MID - LEFT ANTERIOR DESCENDING ARTERY
LEFT MAIN CORONARY ARTERY
AV NODE
LBB
LV
CIRUMFLEX ARTERY
RV
RBB
LEFT ANTERIOR DESCENDING ARTERY
AREA OF INFARCT
ANTERIOR VIEW

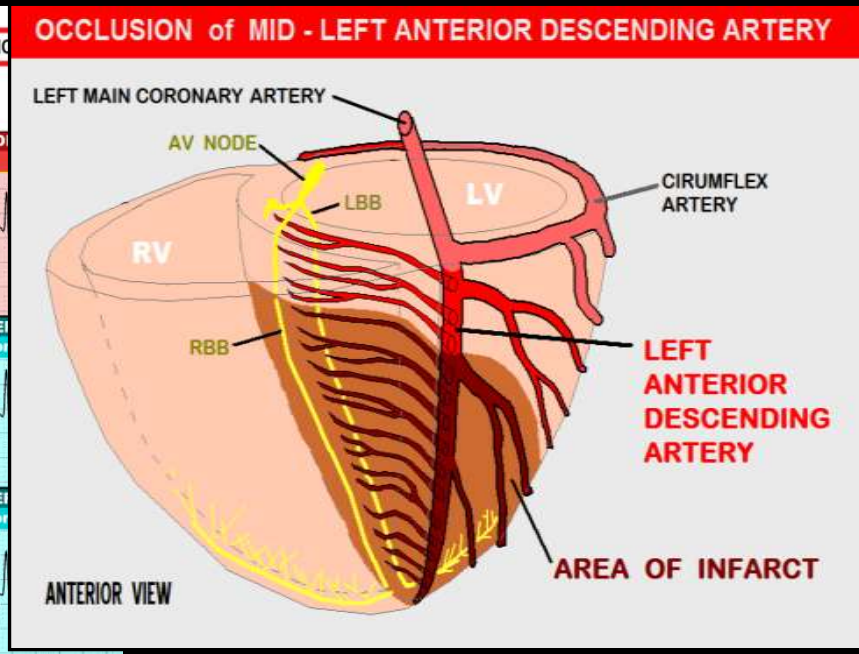
=


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

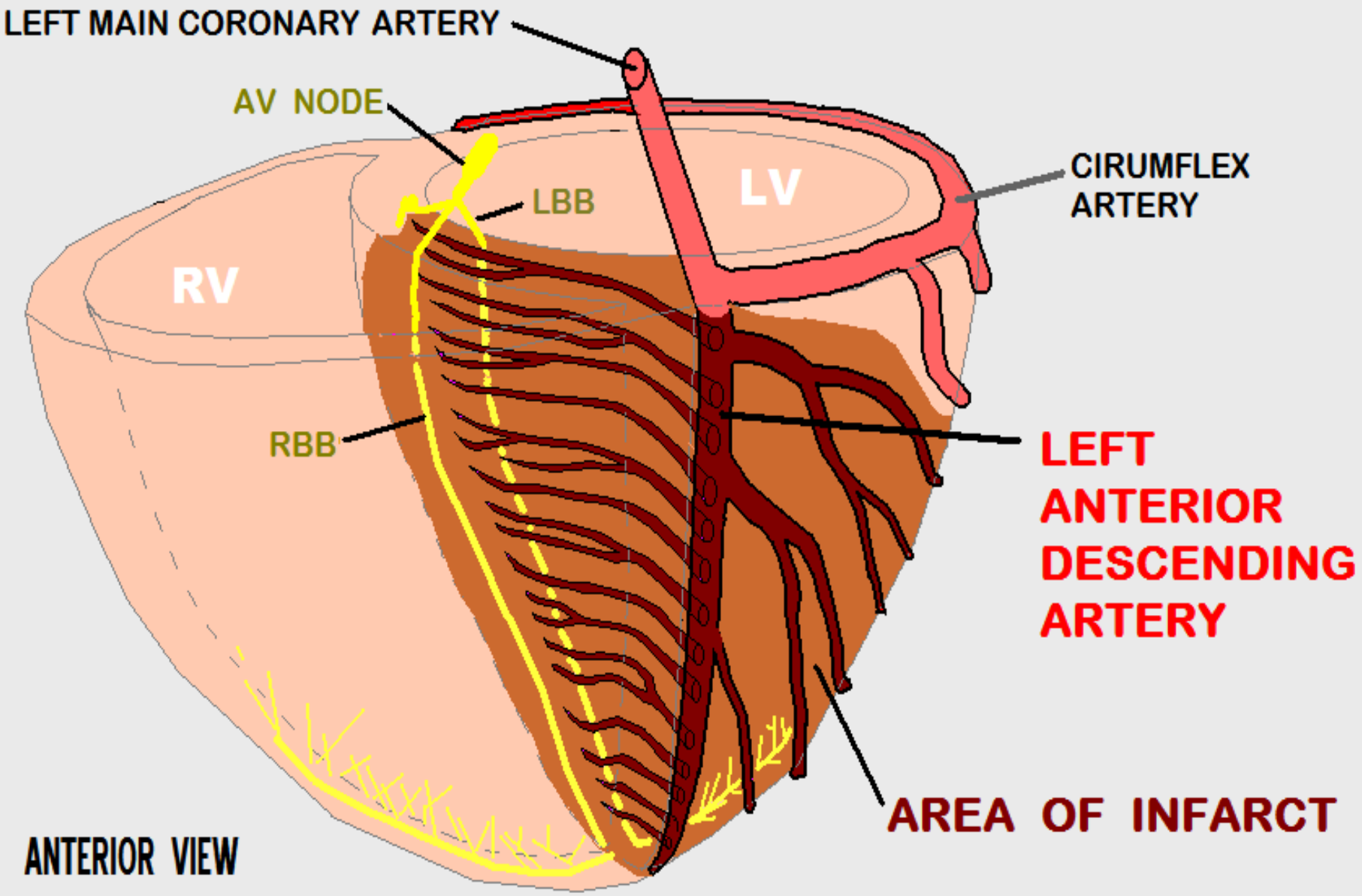

29 yr
Male
Caucasian
Vent. rate 75 BPM
PR interval 176 ms
QRS duration 90 ms
QT/QTc 362/404 ms
P-R-T axes 70 50 -11
Normal sinus rhythm
Septal infarct , possibly acute
Anterolateral injury pattern
*** ** ** ** * ACUTE MI ** ** ** **
Abnormal ECG
ST SEGMENT ELE
ST SEGMENT DEPR
LATERAL - ANTERIOR
DIAG.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


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


72 yr
Male
Caucasian
Loc:
Option:2
Vent. rate 75 BPM
PR interval 162 ms
QRS duration 98 ms
QT/QTc 382/426 ms
P-R-T axes 72 13 83
Normal sinus rhythm
Anteroseptal infarct , possibly acute
*** ** ** ** * ACUTE MI ** ** ** **
Abnormal ECG
ST SEGMENT ELEVATIO
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
LATE
CIRC. o
II
aVL
V2
V5
INFERIOR
DOMINANT RCA or CIRC.
INFERIOR
DOMINANT RCA or CIRC.
ANTERIOR
LAD
LATE
CIRC. o
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

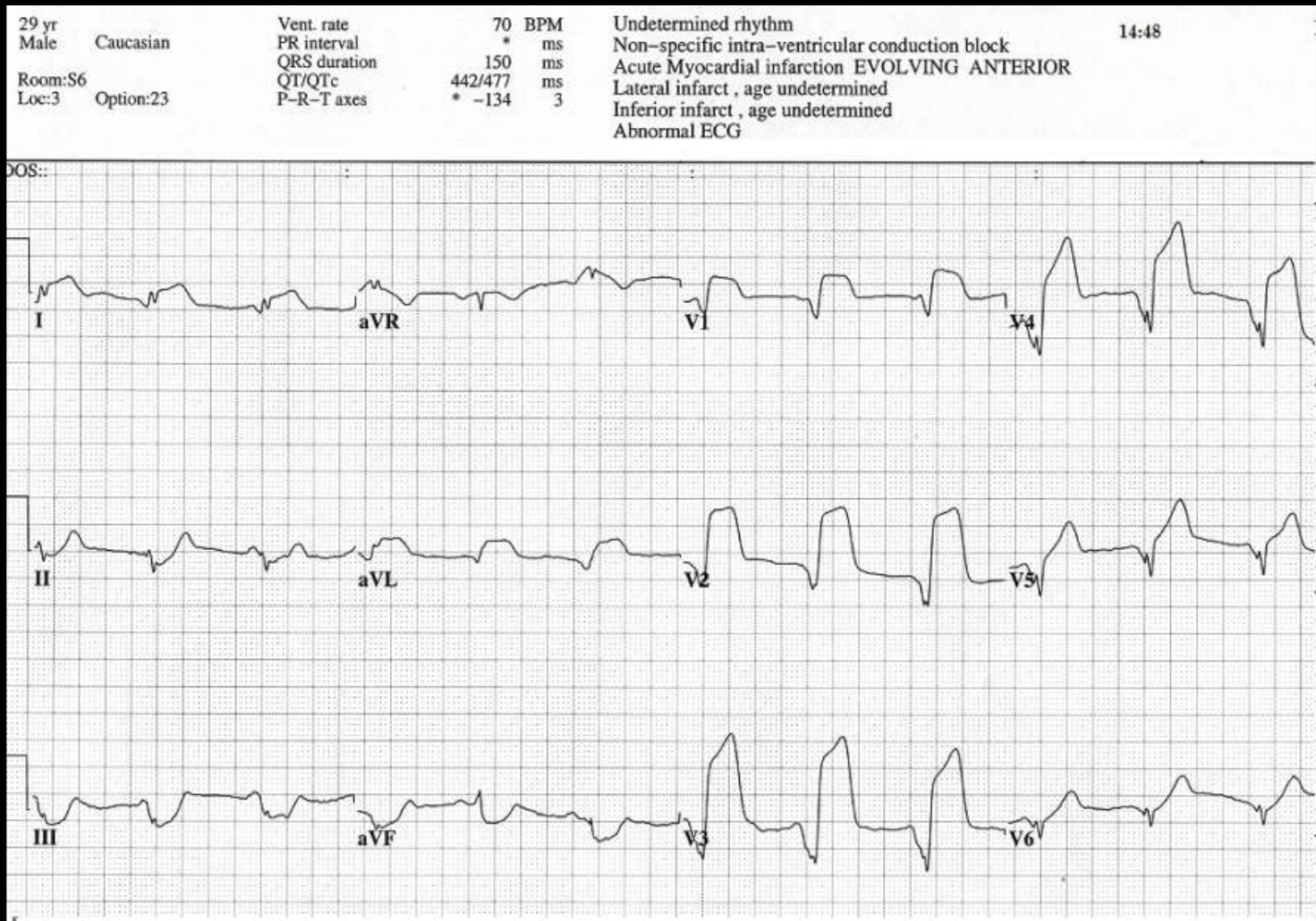
OCCLUSION of PROXIMAL LEFT ANTERIOR DESCENDING ARTERY

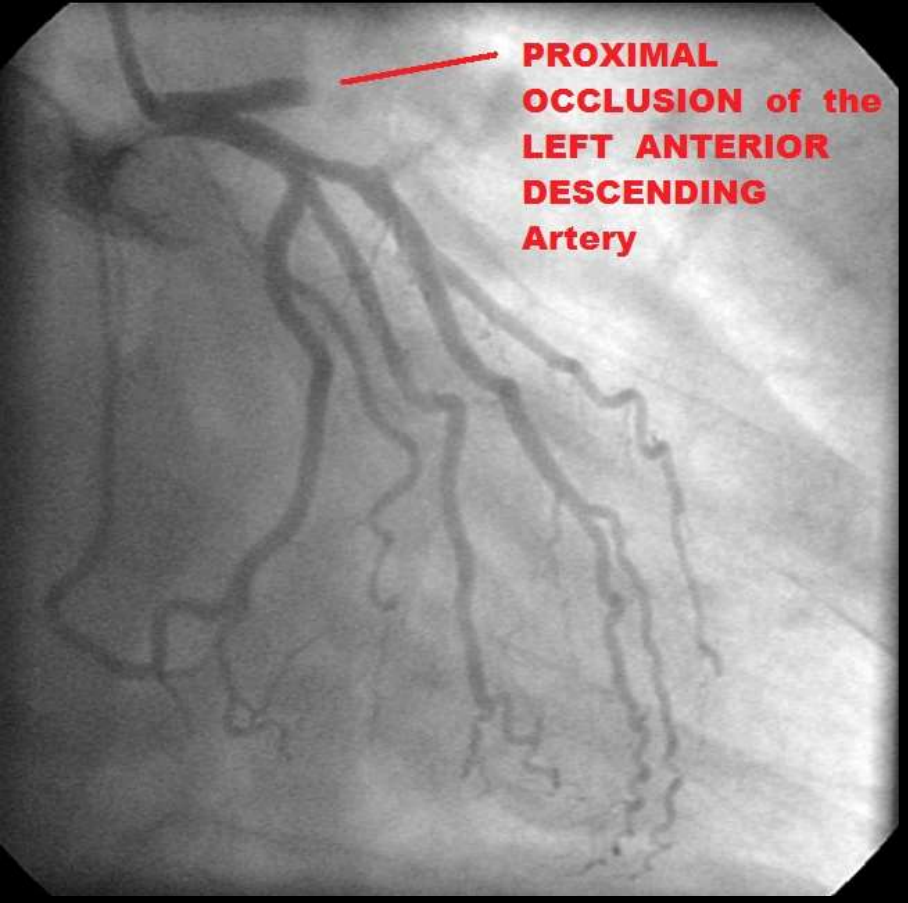


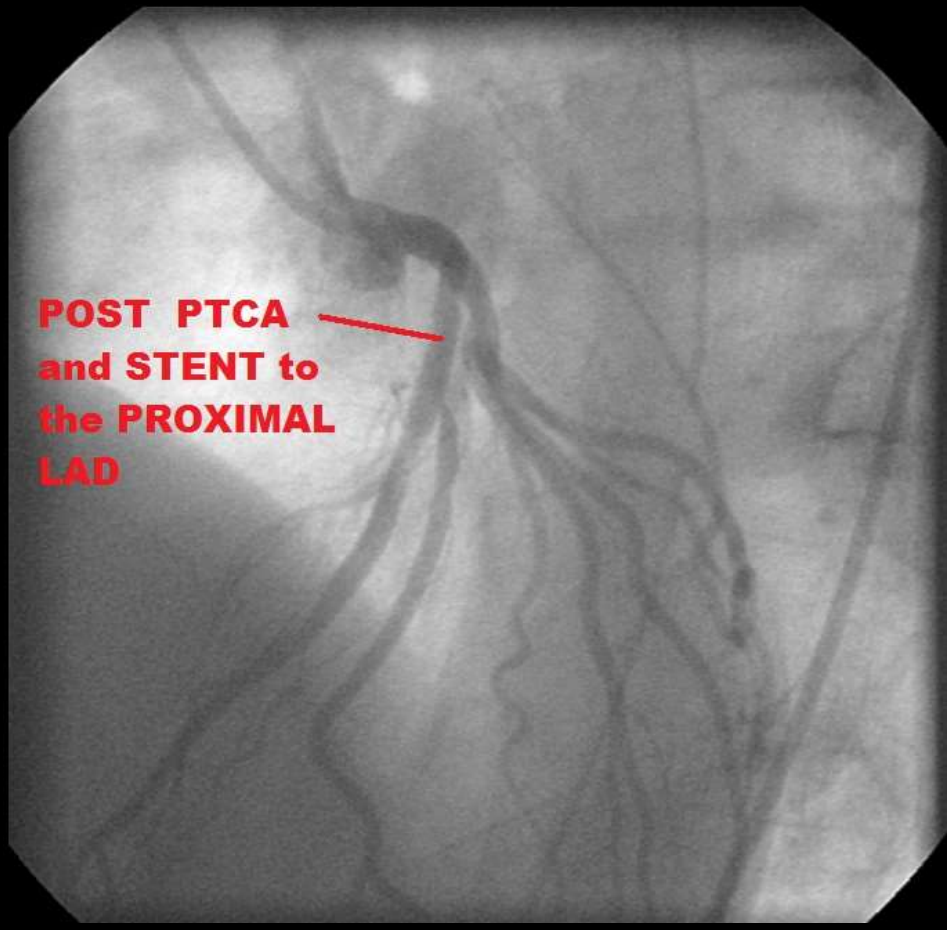
ANTICIPATED COMPLICATIONS of ANTERIOR-SEPTAL WALL STEMI & POSSIBLE INDICATED INTERVENTIONS:	
- CARDIAC ARREST	BCLS / ACLS
- CARDIAC DYSRHYTHMIAS (VT / VF)	ACLS (antiarrhythmics)
- PUMP FAILURE with CARDIOGENIC SHOCK	INOTROPE THERAPY: -DOPAMINE / DOBUTAMINE / LEVOPHED - INTRA-AORTIC BALLOON PUMP (use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

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

-WHAT THERAPEUTIC INTERVENTIONS SHOULD BE IMPLMENTED AT THIS POINT ?




PROXIMAL
OCCLUSION of the
LEFT ANTERIOR
DESCENDING
Artery

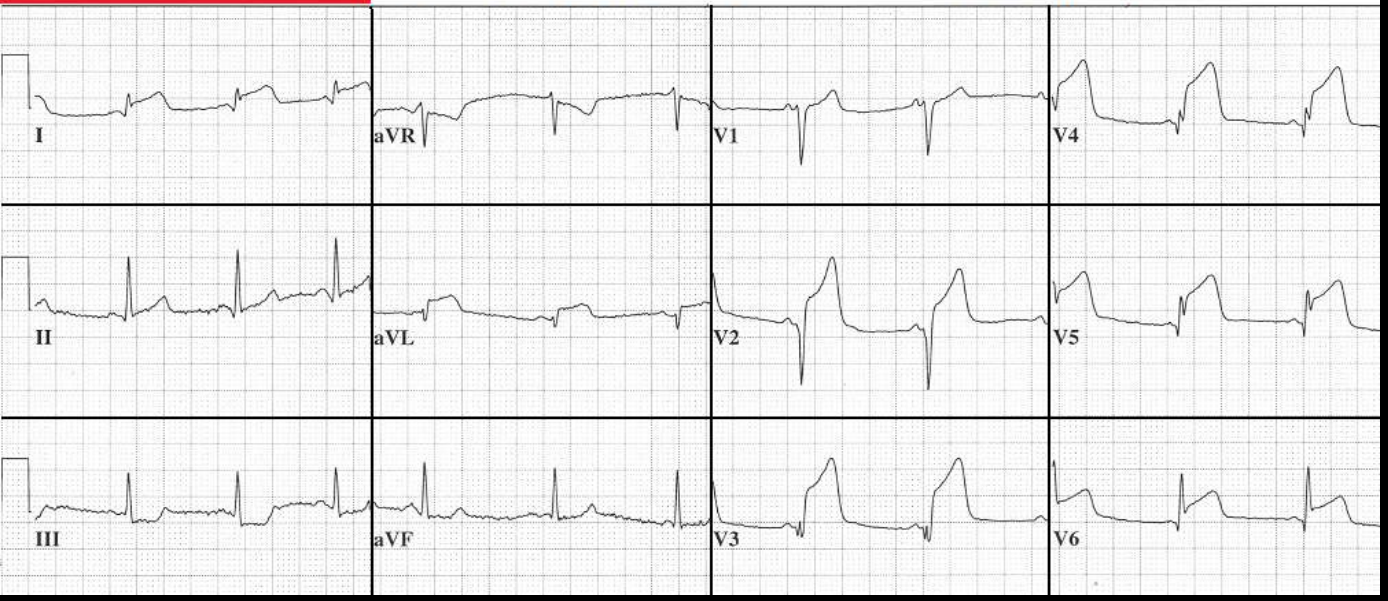

POST PTCA
and STENT to
the PROXIMAL
LAD

CASE STUDY 4: CRITICAL DECISIONS SCENARIO

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

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

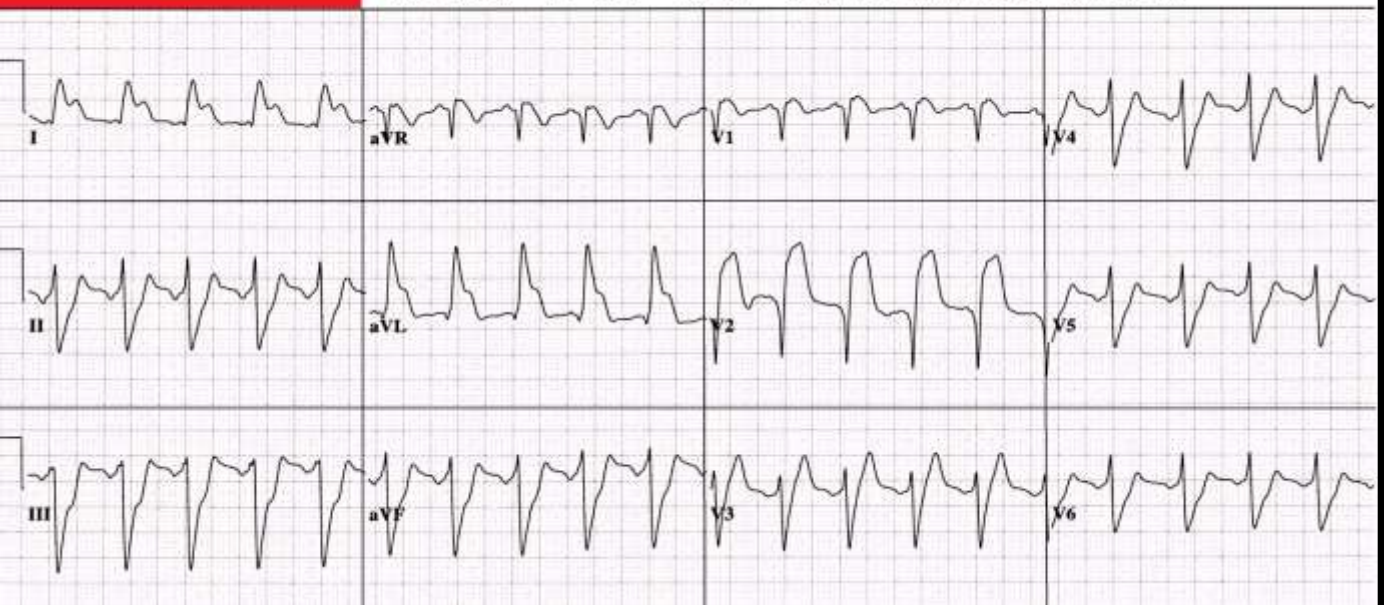
PATIENT A: 44 y/o MALE, CHEST PAIN x 1 HOUR,
BP: 78/46, P: 70, R: 28. CARDIAC MARKERS: NEGATIVE



WHO SHOULD GO TO THE CATH LAB FIRST ?

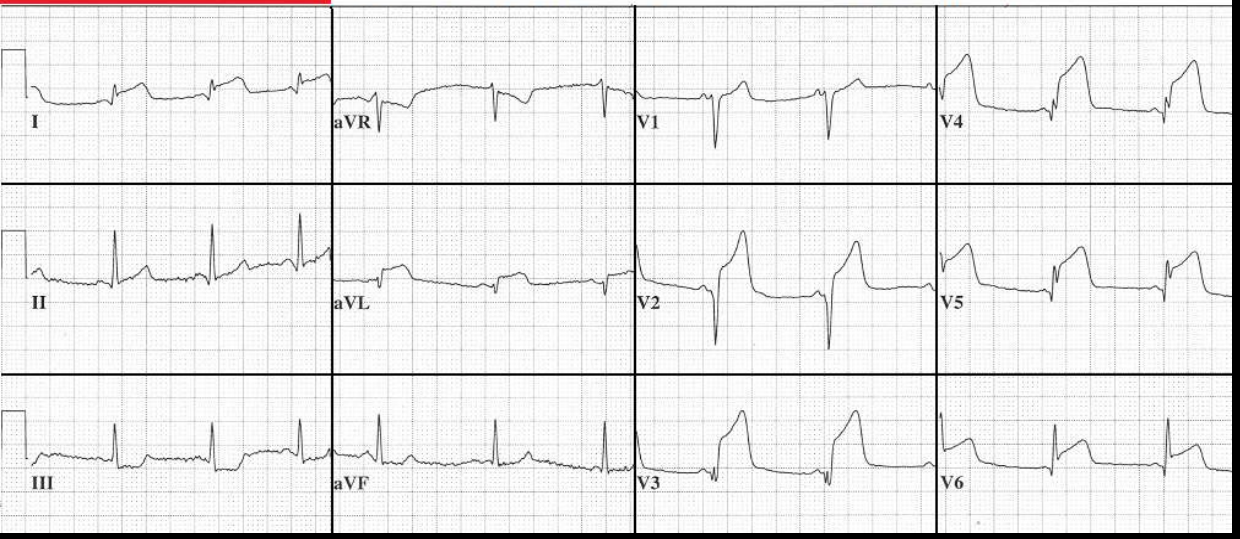
And . . . .

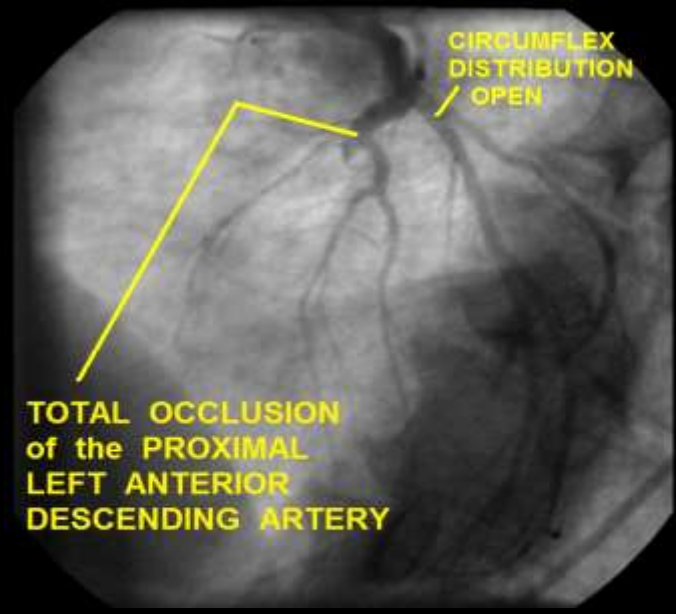
PATIENT B: 36 y/o MALE, CHEST PAIN x 1 HOUR,
BP: 80/48, P: 120, R: 28 CARDIAC MARKERS: NEGATIVE



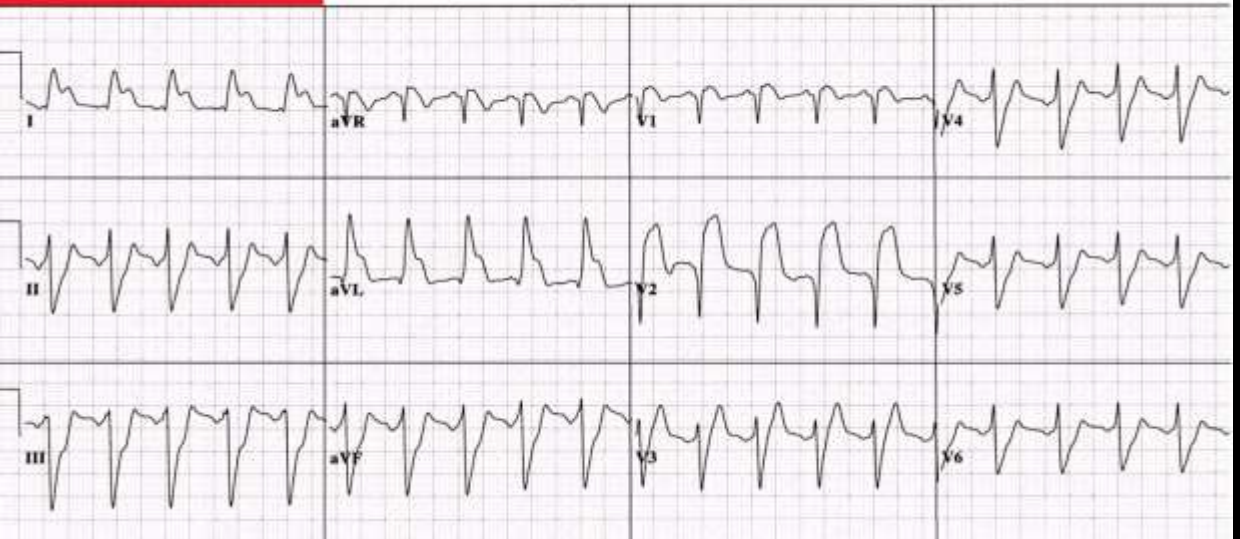
WHAT WOULD YOU DO WITH THE PATIENT WHO DID NOT GO TO THE CATH LAB ?

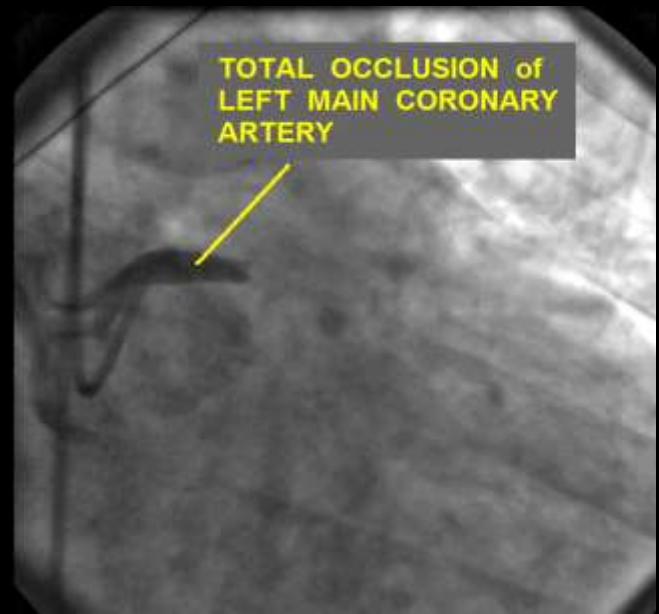
PATIENT A: 44 y/o MALE, CHEST PAIN x 1 HOUR,
BP: 78/46, P: 70, R: 28. CARDIAC MARKERS: NEGATIVE



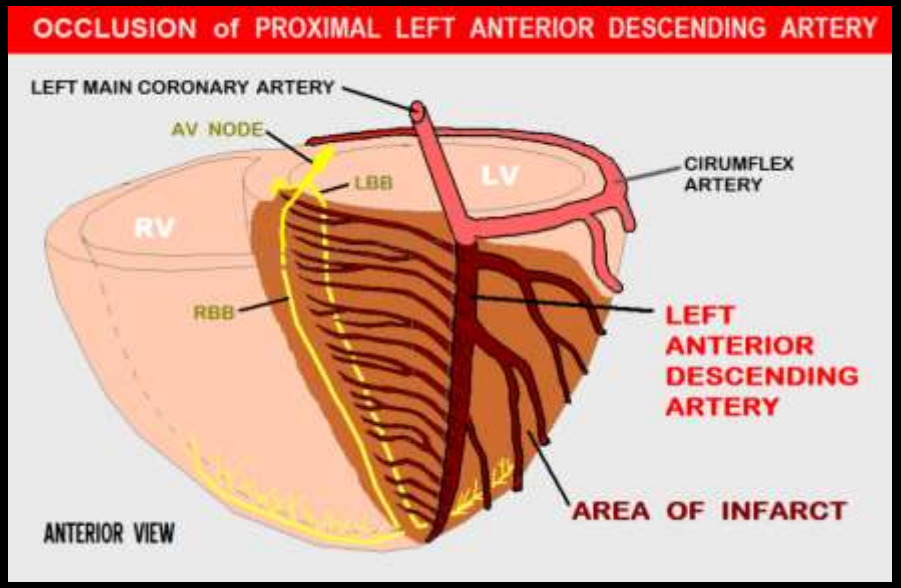


PATIENT B: 36 y/o MALE, CHEST PAIN x 1 HOUR,
BP: 80/48, P: 120, R: 28 CARDIAC MARKERS: NEGATIVE

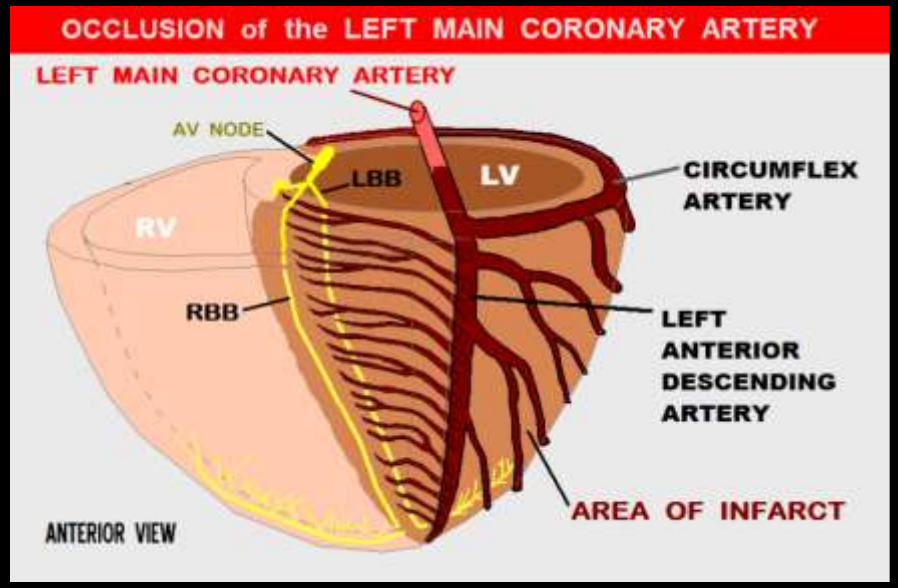


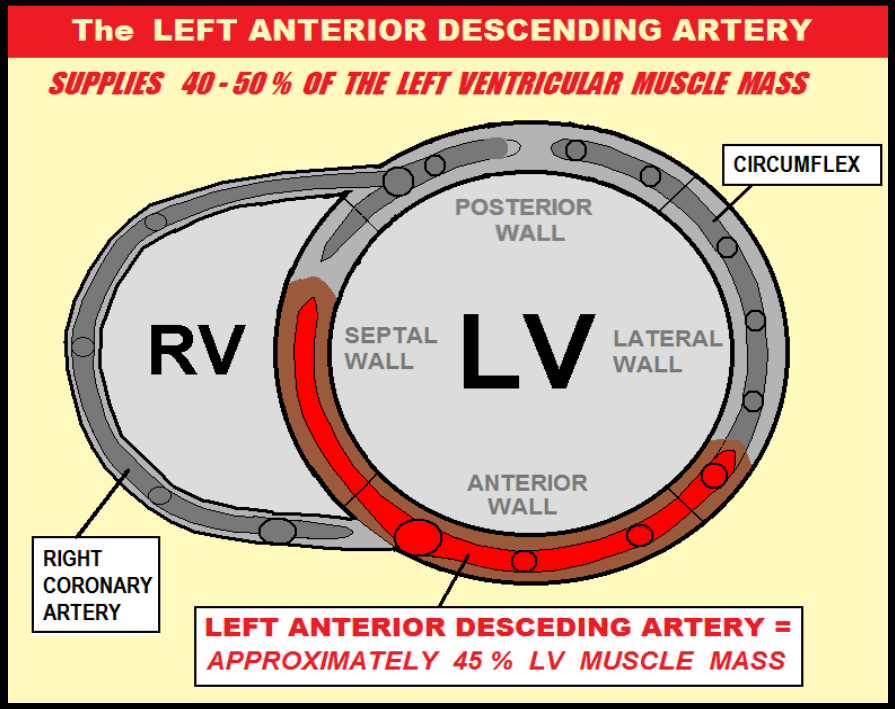


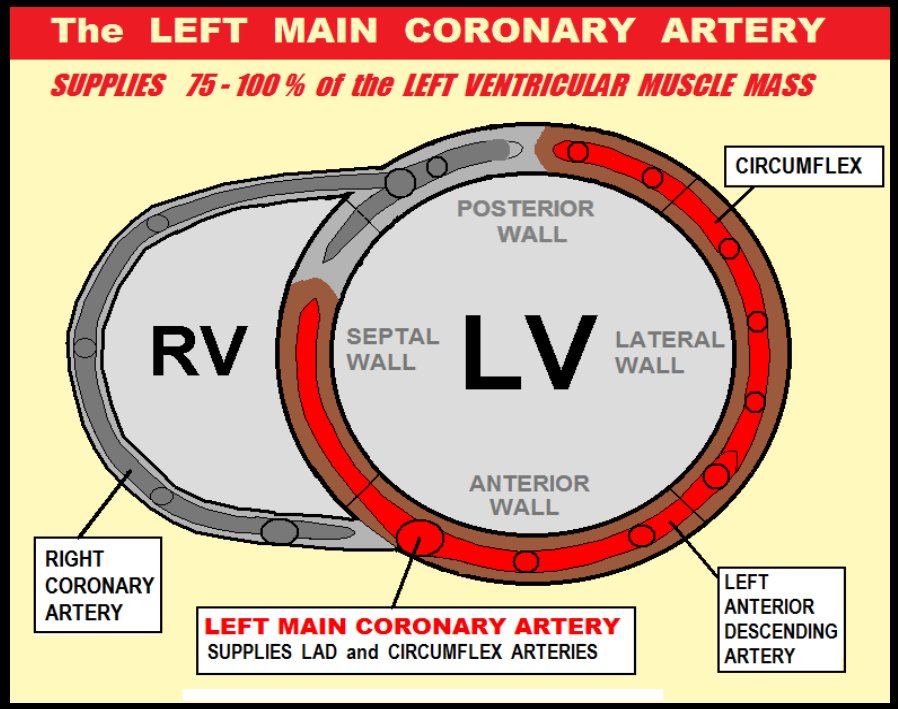
PATIENT A:



PATIENT B:



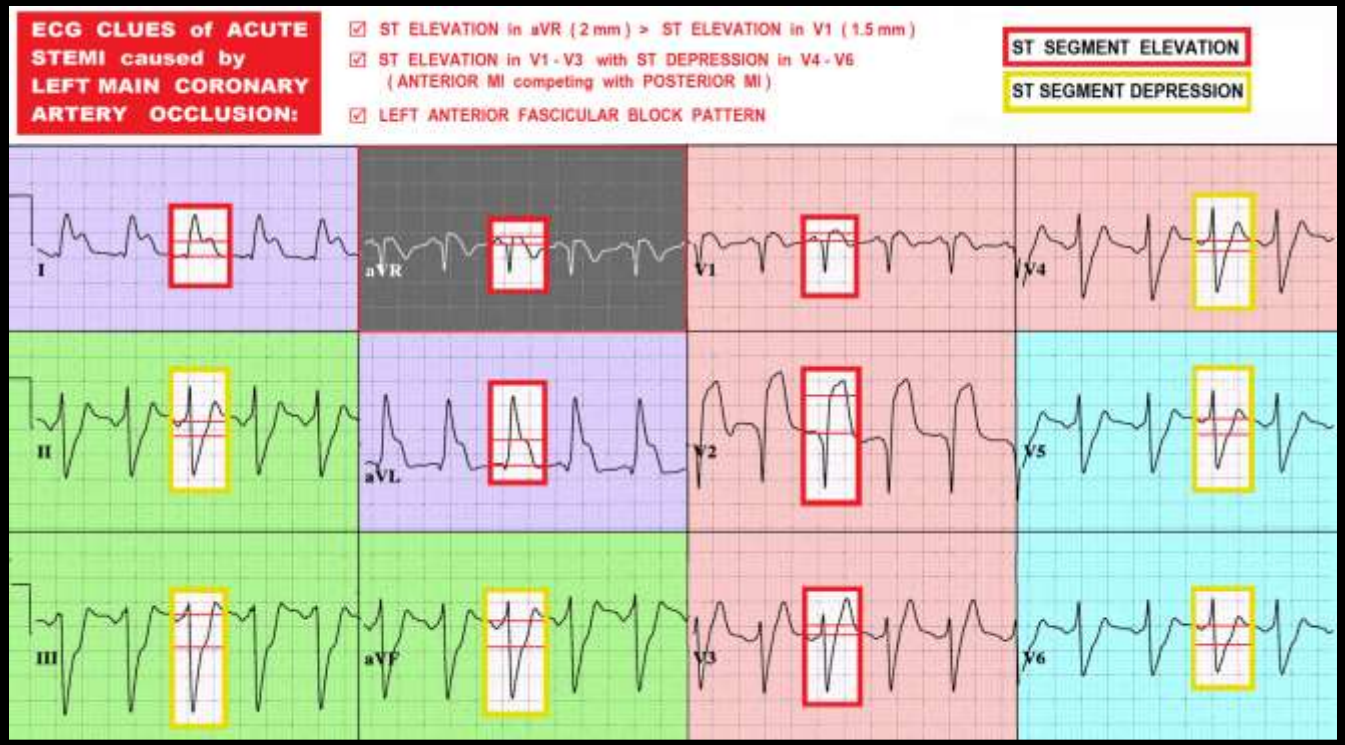




ECG Clues . . . for IDENTIFYING STEMI CAUSED BY LEFT MAIN CORONARY ARTERY occlusion:

- ☑ 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



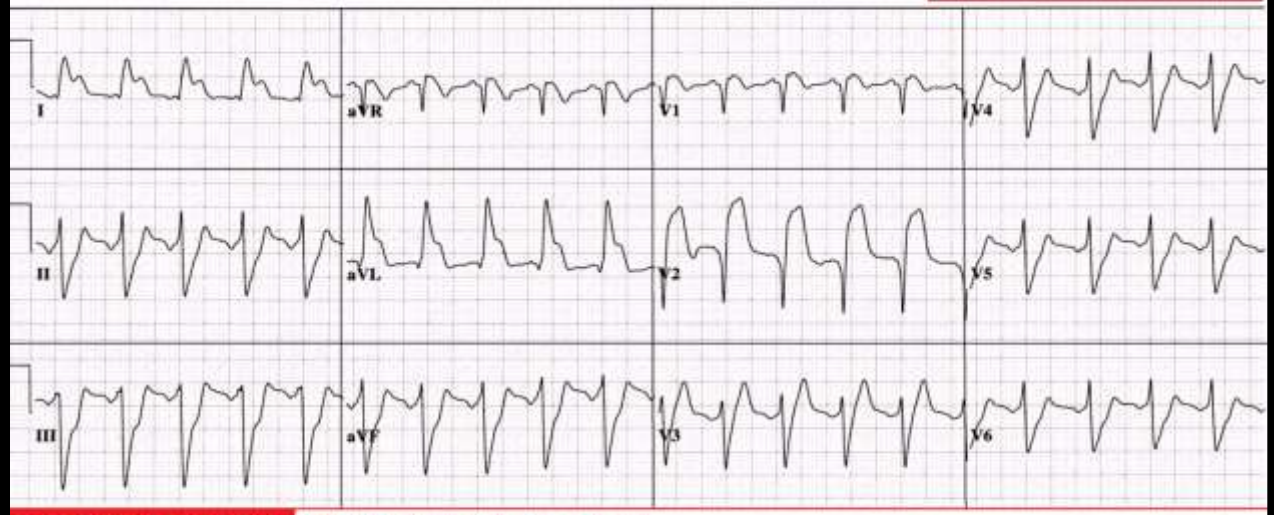
36 yr
Male
Caucasian

Room:C-
Loc:3

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

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

ACUTE STEMI caused by LEFT MAIN CORONARY ARTERY OCCLUSION



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

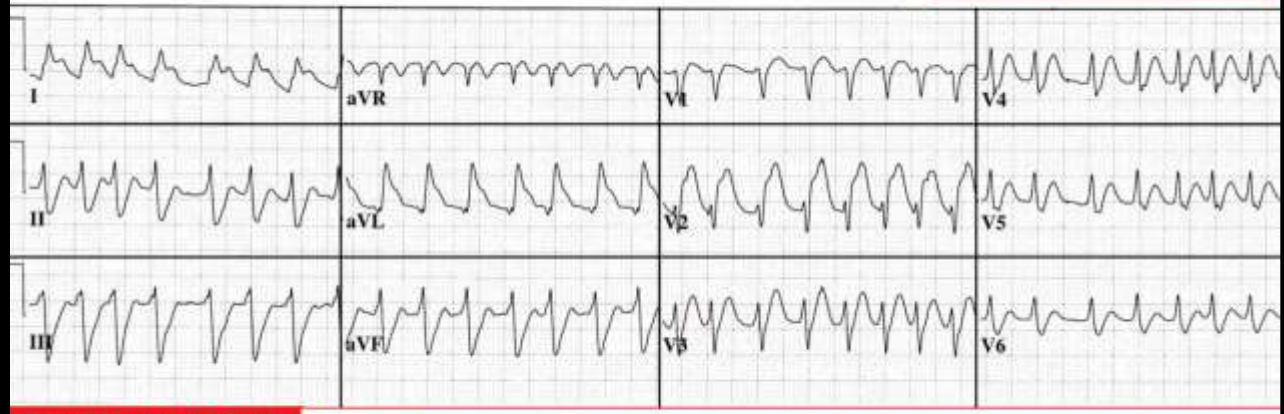
- ☑ ST ELEVATION in leads I and aVL
- ☑ INCONSISTENCY of ST SEGEMENT in leads V1 - V6 : V1 - V3 ST ELEVATION, V4 - V6 ST DEPRESSION (COMPETING FORCES of ANTERIOR vs. POSTERIOR M.I.)
- ☑ PATTERN of LEFT ANTERIOR FASCICULAR BLOCK (POS. QRS lead I; NEG rS leads II, III)
- ☑ ST ELEVATION in lead aVR > 0.5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

43 yr
Male

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

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

ACUTE STEMI caused by LEFT MAIN CORONARY ARTERY OCCLUSION



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

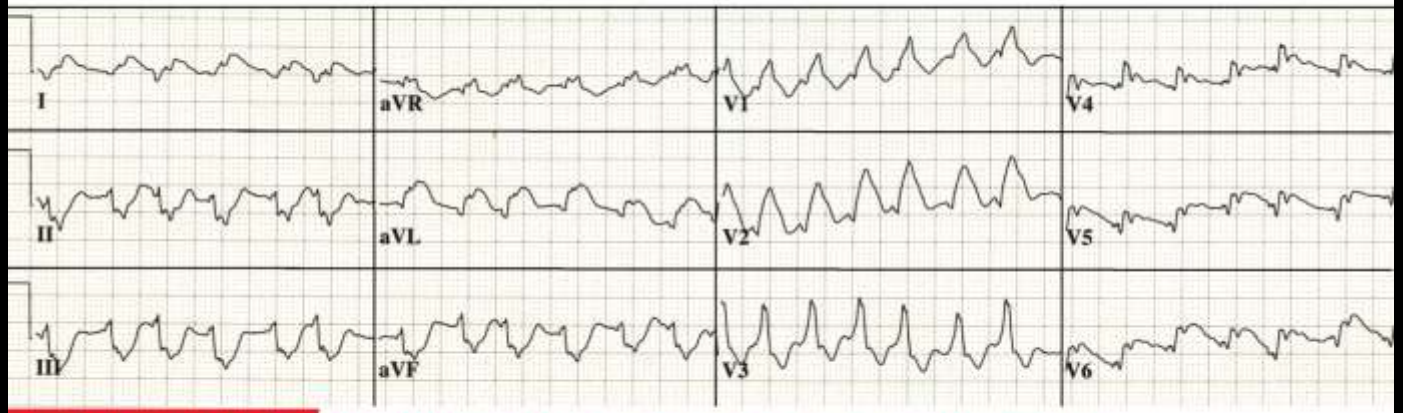
- ☑ ST ELEVATION in leads I and aVL
- ☑ INCONSISTENCY of ST SEGEMENT in leads V1 - V6 : V1 - V2 ST ELEVATION, V3 - V6 ST DEPRESSION (COMPETING FORCES of ANTERIOR vs. POSTERIOR M.I.)
- ☑ PATTERN of LEFT ANTERIOR FASCICULAR BLOCK (POS. QRS lead I; NEG rS leads II, III)

48 yr
Male Caucasian

Loc: Option:

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

ACUTE STEMI caused by LEFT MAIN CORONARY ARTERY OCCLUSION



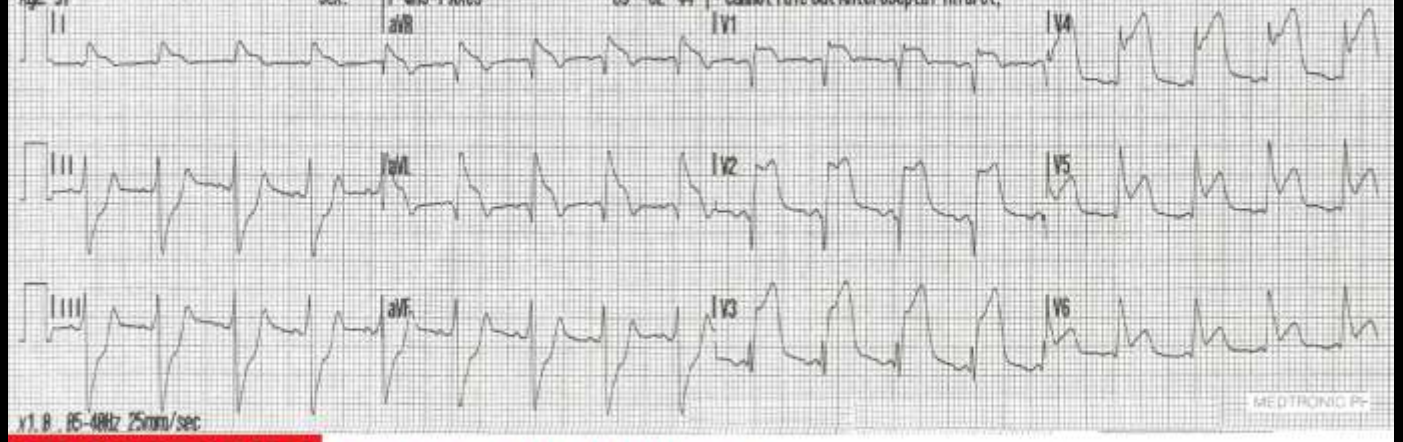
ECG CLUES of ACUTE STEMI caused by LEFT MAIN CORONARY ARTERY OCCLUSION:

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

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

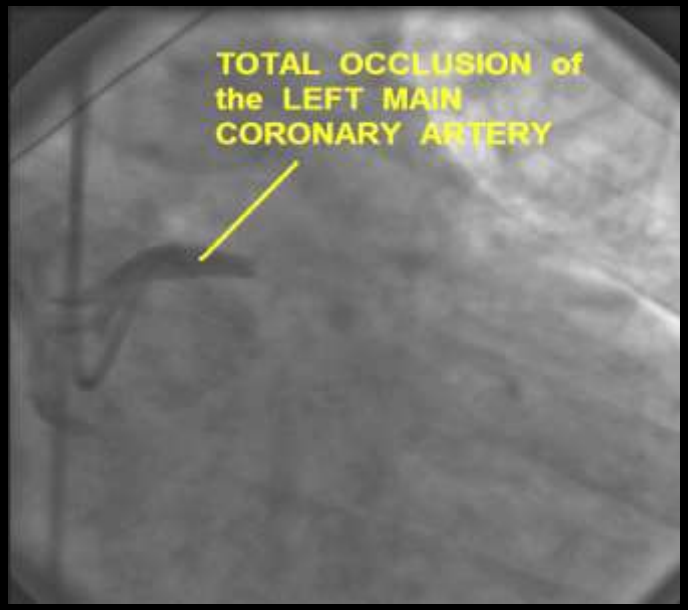
12-Lead 4	HR 107 bpm	*** ACUTE MI SUSPECTED ***
06 Oct 87	12:44:13	* Abnormal ECG **Unconfirmed**
PR 0.154s	QRS 0.102s	* Sinus tachycardia
QT/QTc	0.332s/0.443s	* Left anterior fascicular block
P-QRS-T Axes	89° -62° 44°	* Cannot rule out Anteroseptal infarct,

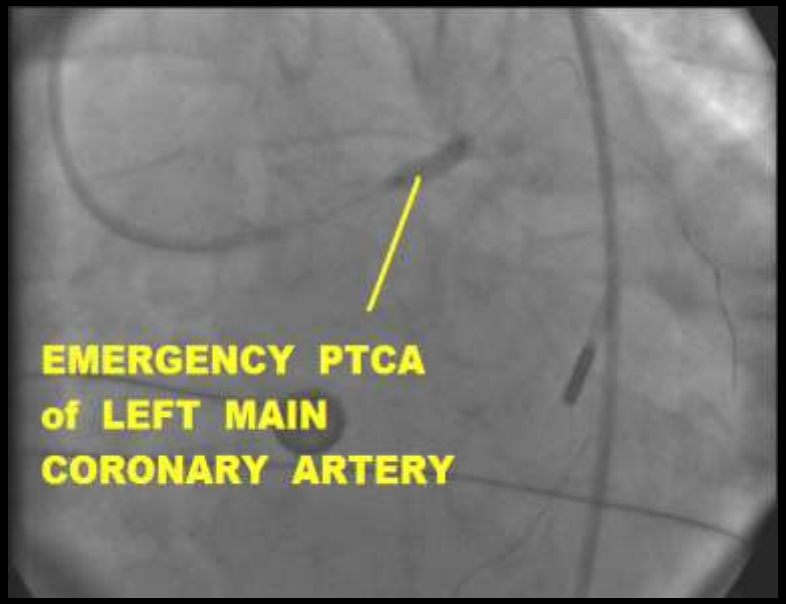
ACUTE STEMI caused by LEFT MAIN CORONARY ARTERY OCCLUSION



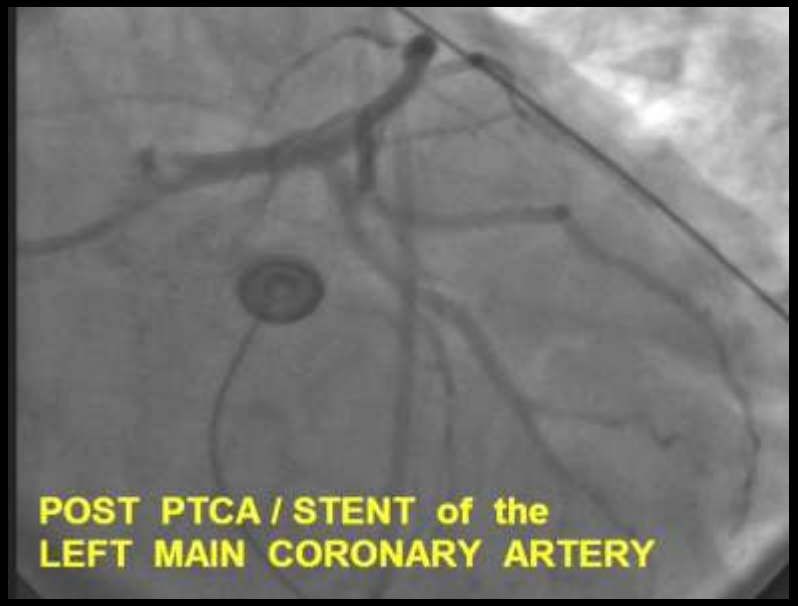
ECG CLUES of ACUTE STEMI caused by LEFT MAIN CORONARY ARTERY OCCLUSION:

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





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



CASE STUDY 4: CRITICAL DECISIONS SCENARIO

CONCLUSIONS:

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

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

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

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

CASE STUDY 7 - STEMI

CHIEF COMPLAINT and SIGNIFICANT HISTORY:

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

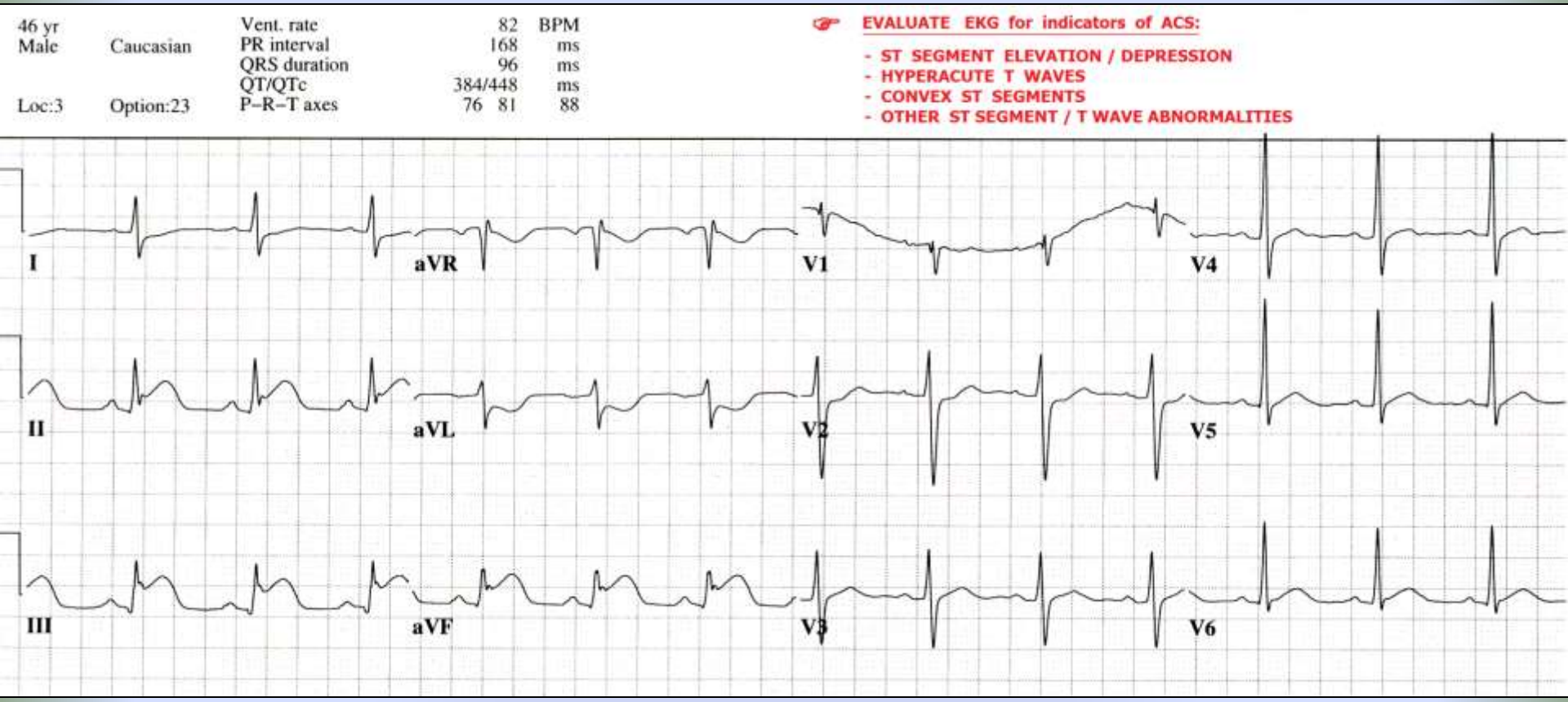
RISK FACTOR PROFILE:

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

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

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

LABS: TROPONIN: < .04


46 yr
Male
Caucasian
Loc:3
Option:23
Vent. rate 82 BPM
PR interval 168 ms
QRS duration 96 ms
QT/QTc 384/448 ms
P–R–T axes 76 81 88
EVALUATE EKG for indicators of ACS:
- ST SEGMENT ELEVATION / DEPRESSION
- HYPERACUTE T WAVES
- CONVEX ST SEGMENTS
- OTHER ST SEGMENT / T WAVE ABNORMALITIES
I
aVR
V1
V4
II
aVL
V2
V5
III
aVF
V3
V6

46 yr
Male

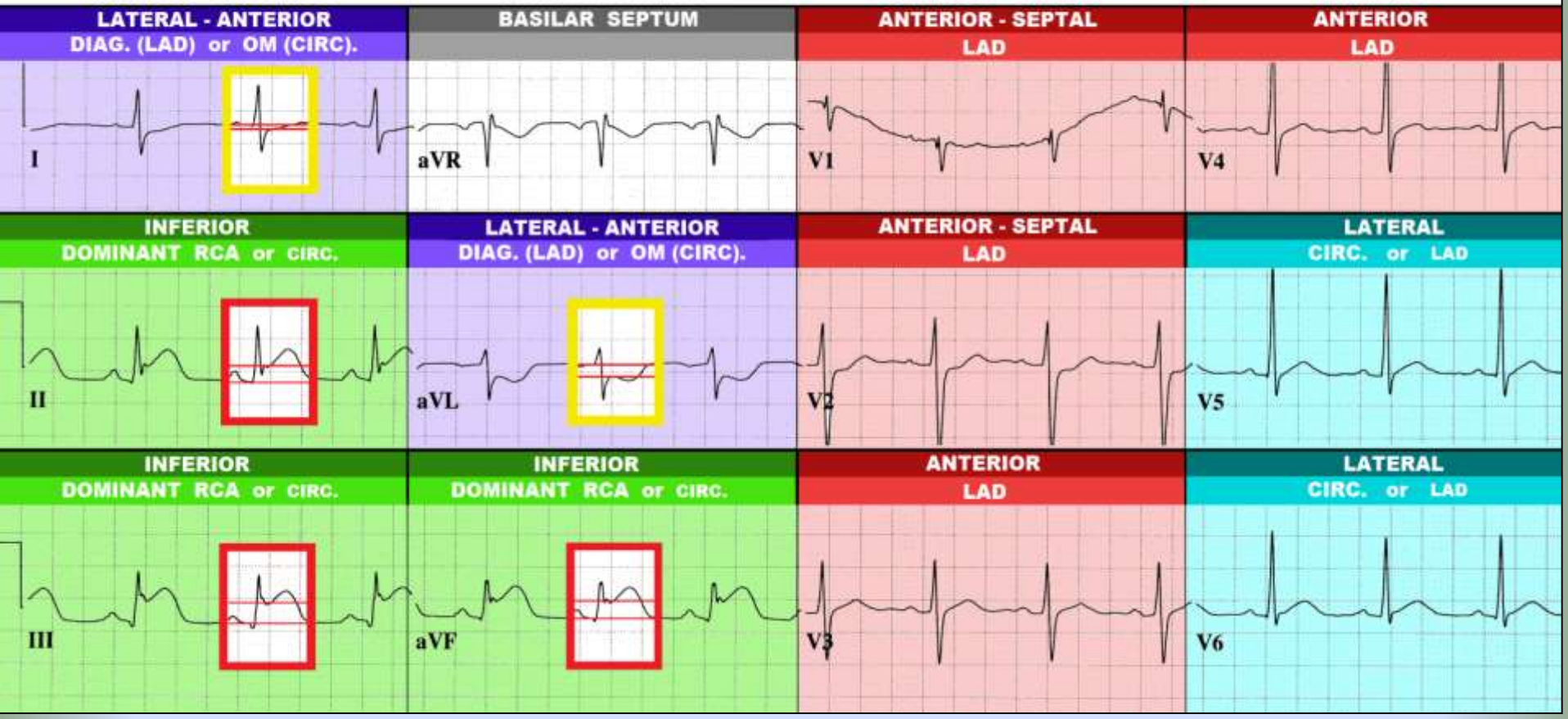
Caucasian

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

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

ST SEGMENT ELEVATION

ST SEGMENT DEPRESSION



46 yr
Male

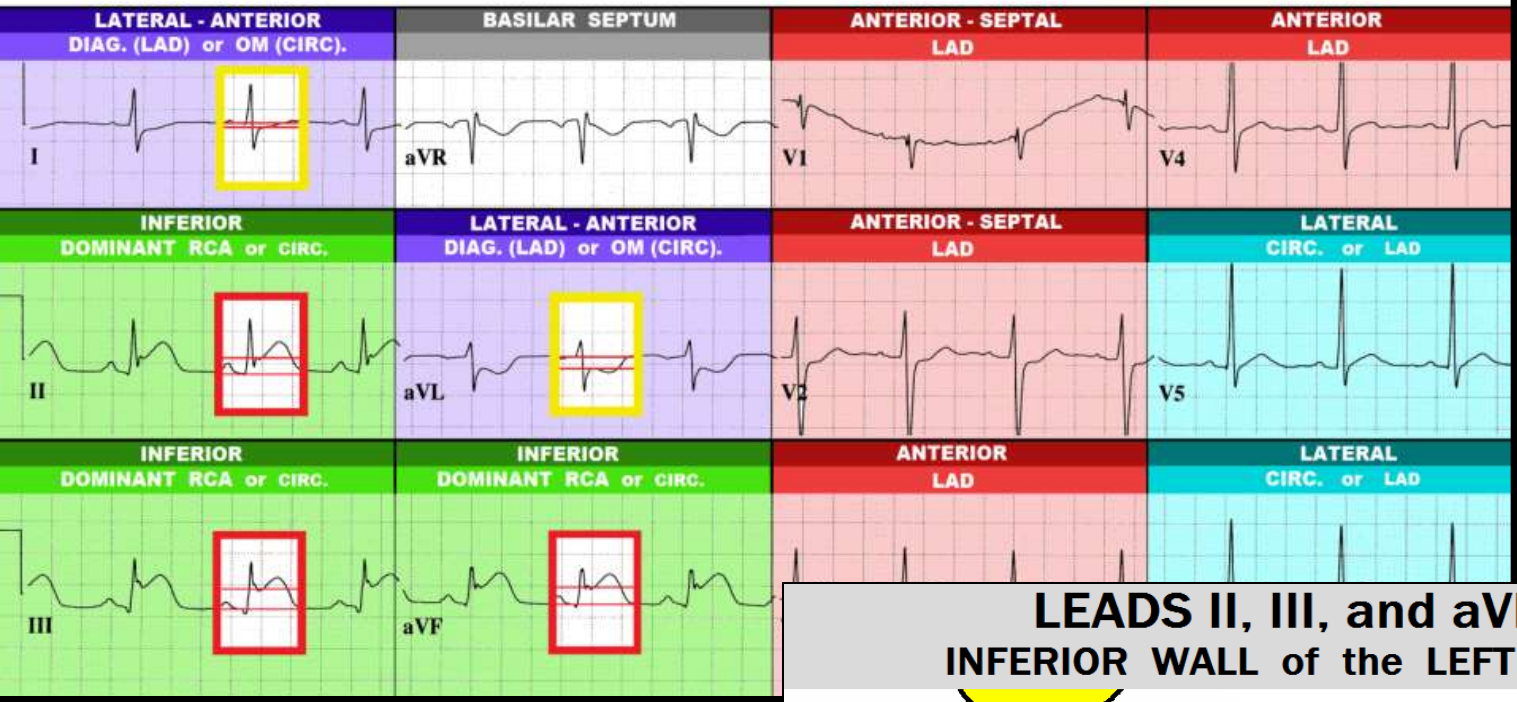
Caucasian

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

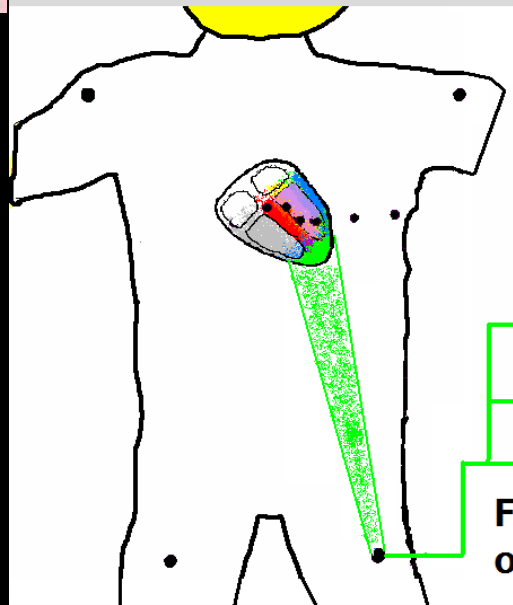
Normal sinus rhythm
ST elevation consider inferior injury or acute infarct
*** ** ** ** * ACUTE MI ** ** ** **
Abnormal ECG

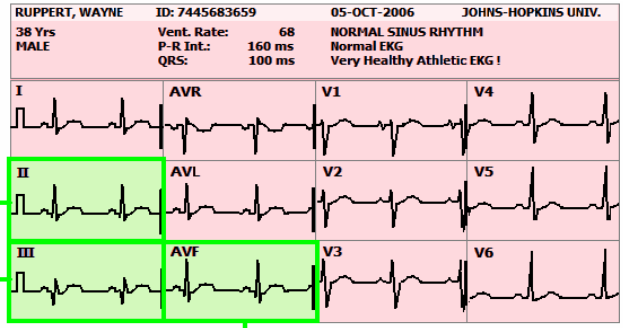
ST SEGMENT ELEVATION

ST SEGMENT DEPRESSION



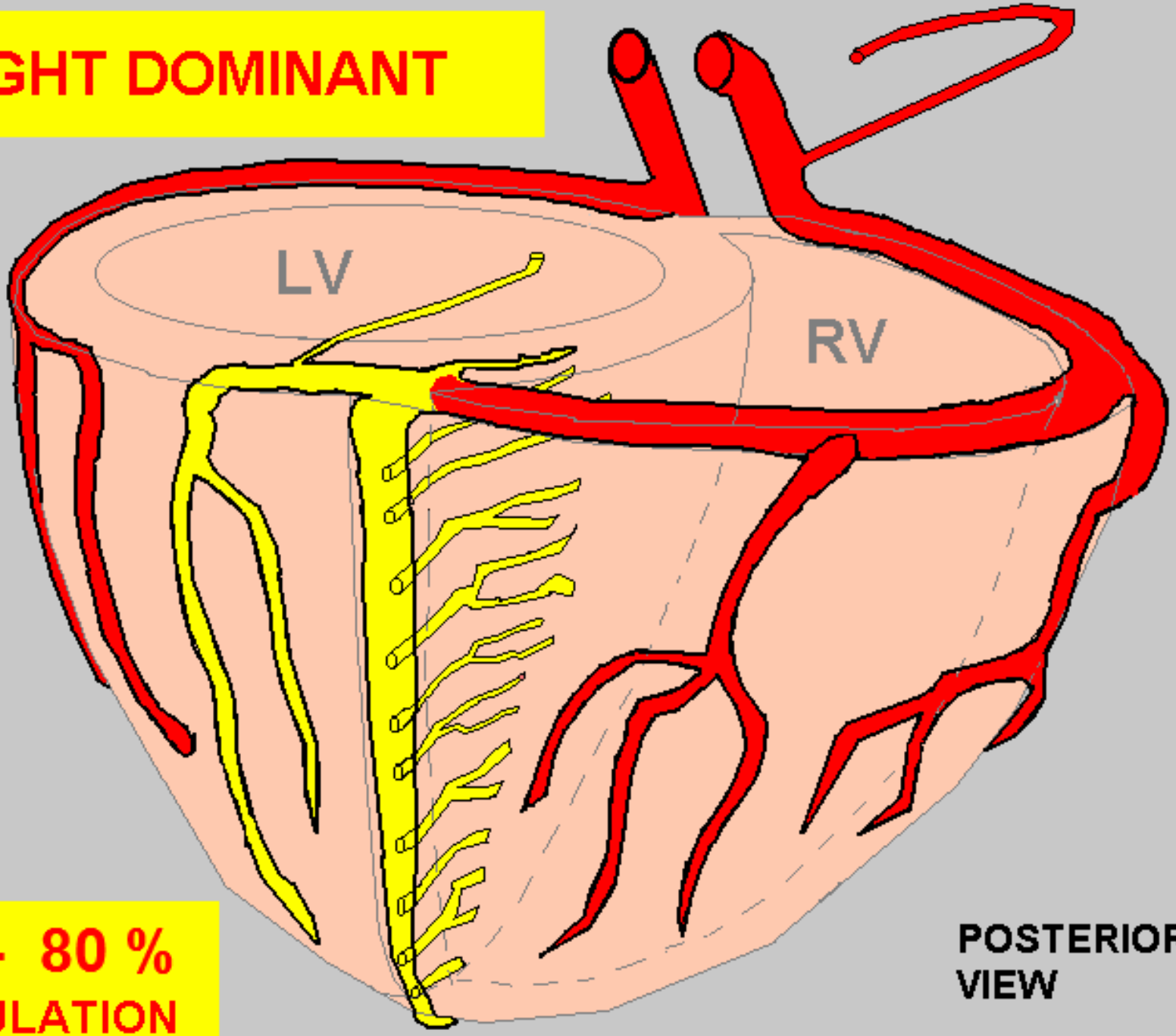
LEADS II, III, and aVF VIEW
INFERIOR WALL of the LEFT VENTRICLE





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

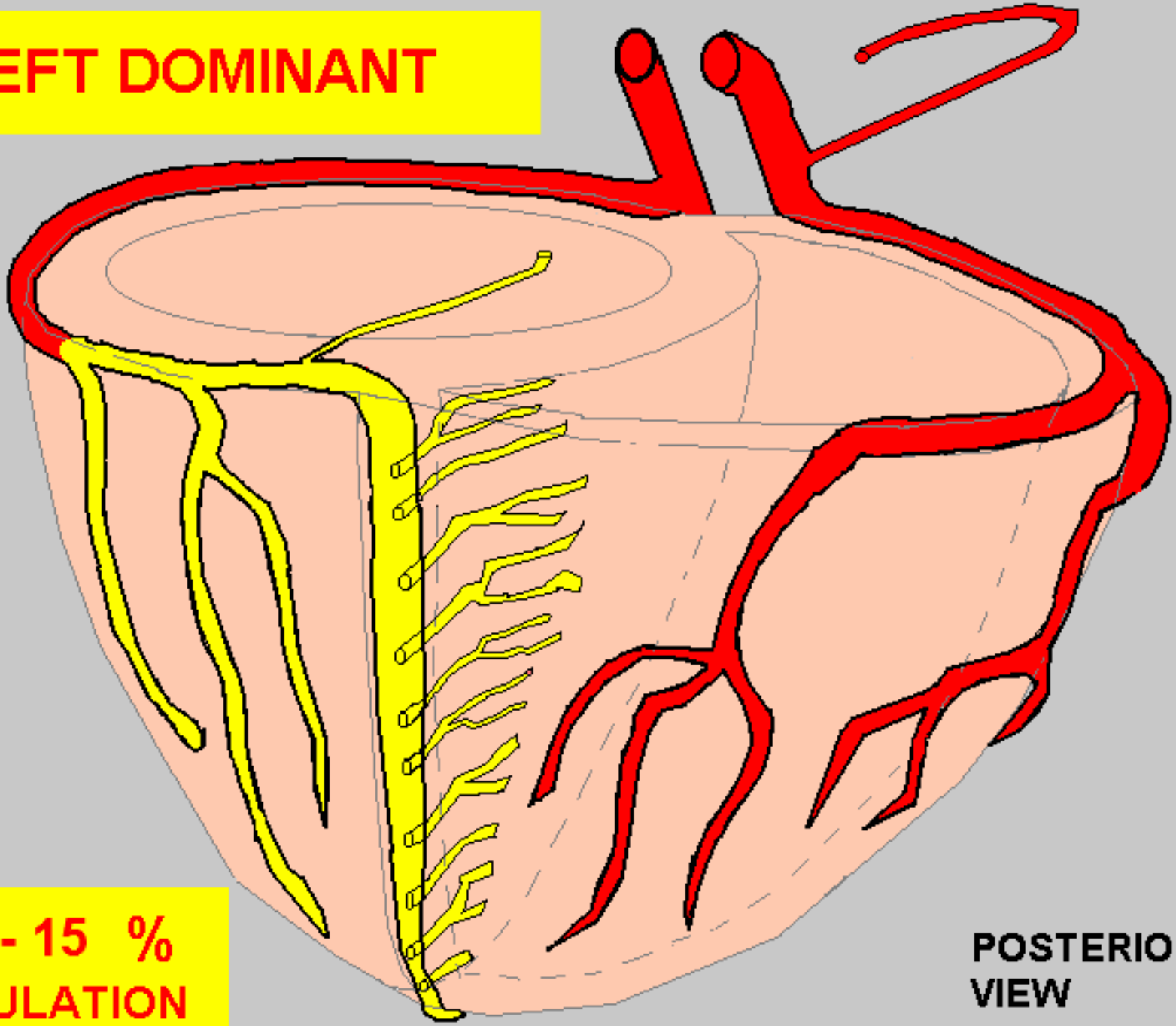
RIGHT DOMINANT



75 - 80 %
POPULATION

POSTERIOR VIEW

LEFT DOMINANT



10 - 15 %
POPULATION

POSTERIOR
VIEW

HELPFUL HINT . . . MEMORIZE THIS !

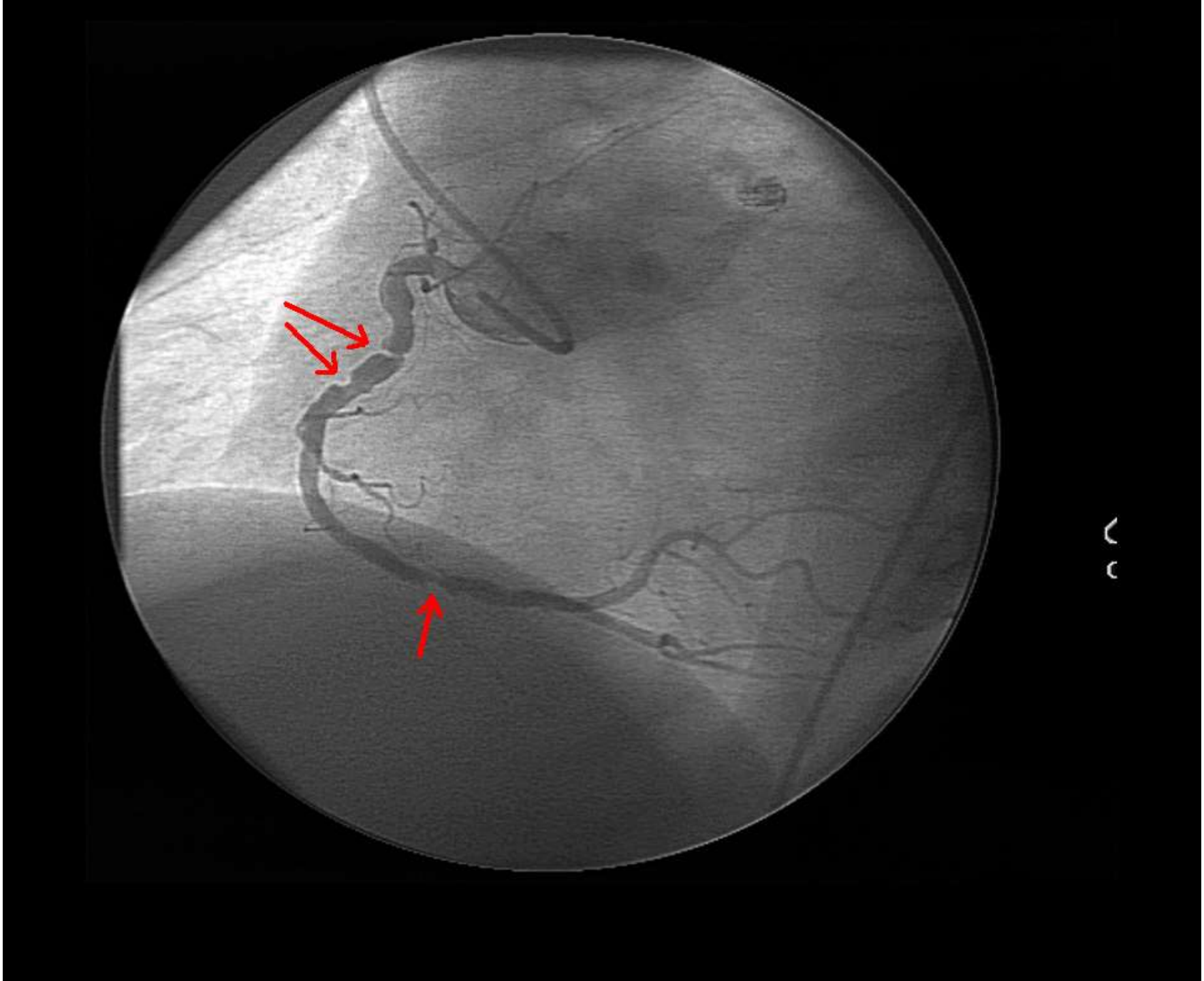
RIGHT CORONARY ARTERY (RCA)

RIGHT DOMINANT SYSTEMS

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

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

- CARDIAC ARREST	BCLS / ACLS
- CARDIAC DYSRHYTHMIAS (VT / VF)	ACLS (antiarrhythmics)
- SINUS BRADYCARDIA	ATROPINE 0.5mg, REPEAT as needed UP TO 3mg. (follow ACLS and/or UNIT protocols)
- HEART BLOCKS (1st, 2nd & 3rd Degree HB)	ATROPINE 0.5mg, REPEAT as needed UP TO 3mg, Transcutaneous Pacing, (follow ACLS and/or UNIT protocols)
- RIGHT VENTRICULAR MYOCARDIAL INFARCTION	- The standard 12 Lead ECG does NOT view the Right Ventricle. - You must do a RIGHT-SIDED ECG to see if RV MI is present. - Do NOT give any Inferior Wall STEMI patient NITRATES or DIURETICS until RV MI has been RULED OUT.
- POSTERIOR WALL INFARCTION	- POSTERIOR WALL MI presents on the 12 Lead ECG as ST DEPRESSION in Leads V1 - V3. - POSTERIOR WALL MI is NOT PRESENT ON THIS ECG.



A standard

12 LEAD EKG

Does NOT show the

RIGHT VENTRICLE

To see the

RIGHT VENTRICLE . . .

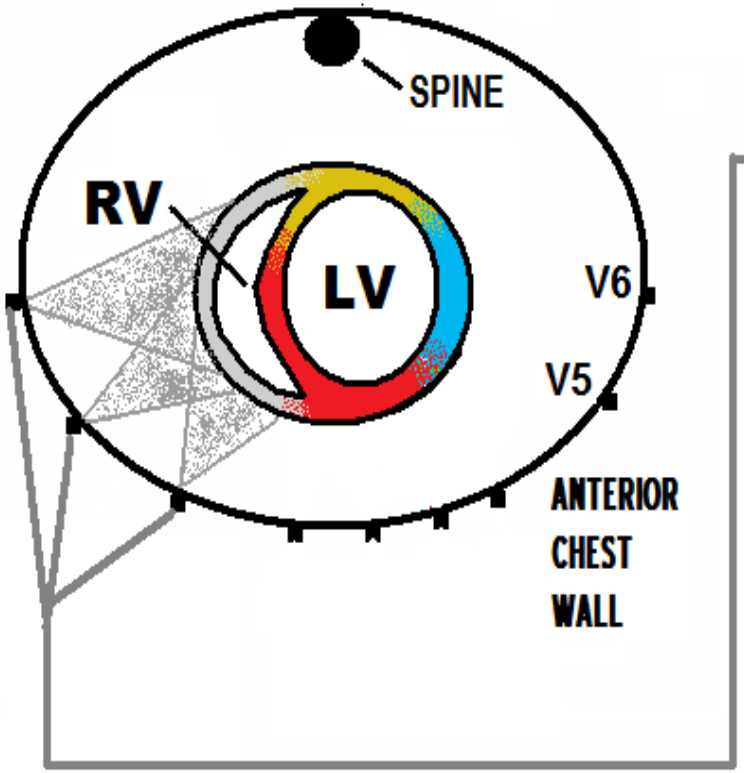
. . . such as in cases of

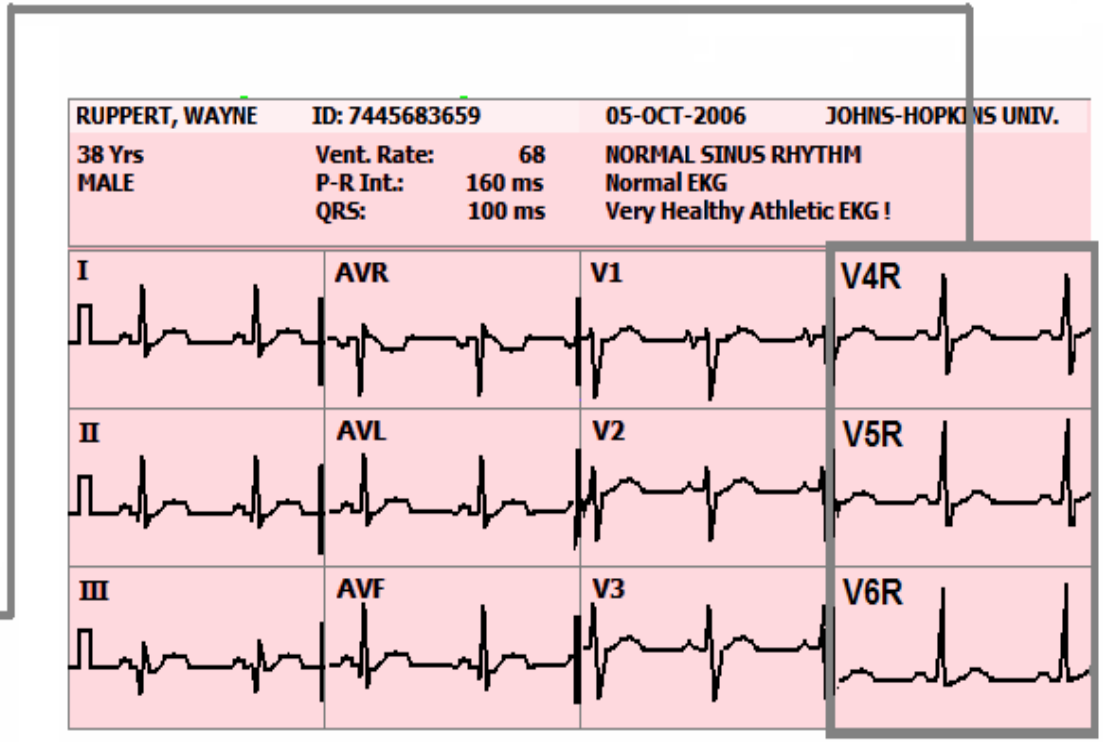
INFERIOR WALL M.I.

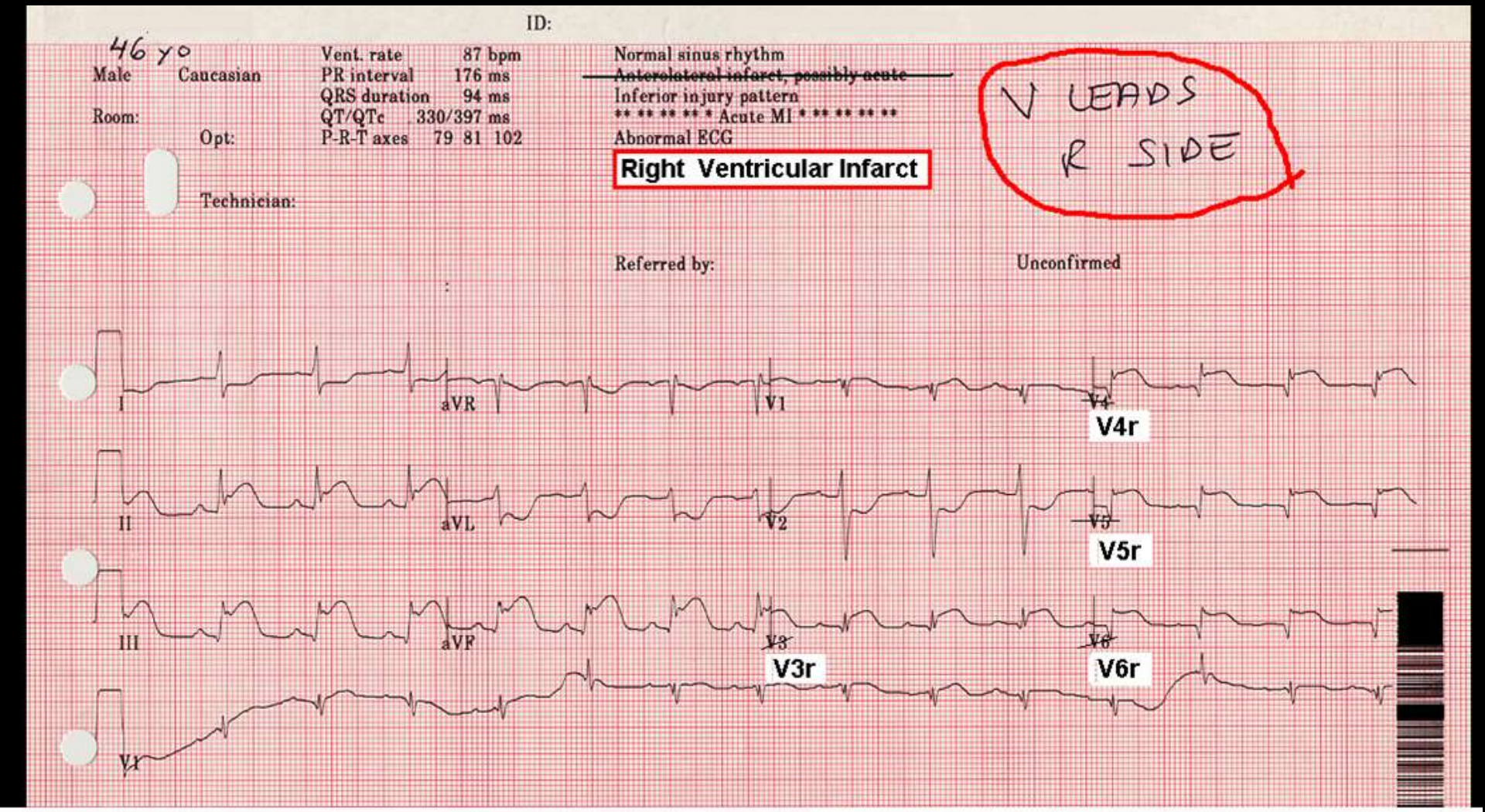
☞ You must do a

RIGHT - SIDED EKG ! !

V4R - V6R VIEW THE RIGHT VENTRICLE







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

IN ***EVERY*** CASE of

INFERIOR WALL STEMI

You must first *RULE OUT*
RIGHT VENTRICULAR MI
BEFORE giving any:

- NITROGLYCERIN
- Diuretics

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

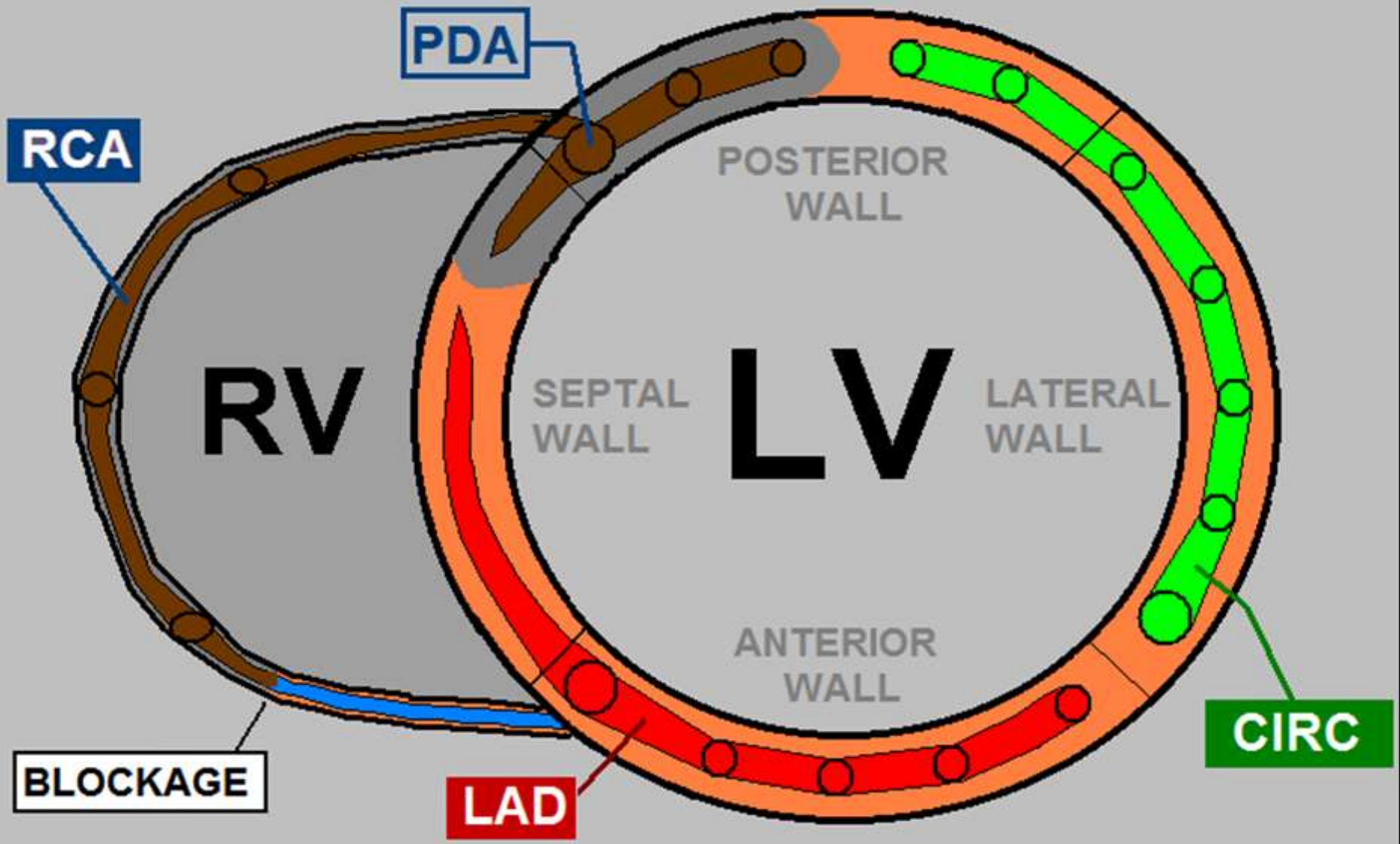
They precipitate SEVERE HYPOTENSION

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

INFERIOR - RIGHT VENTRICULAR MI

DOMINANT RCA

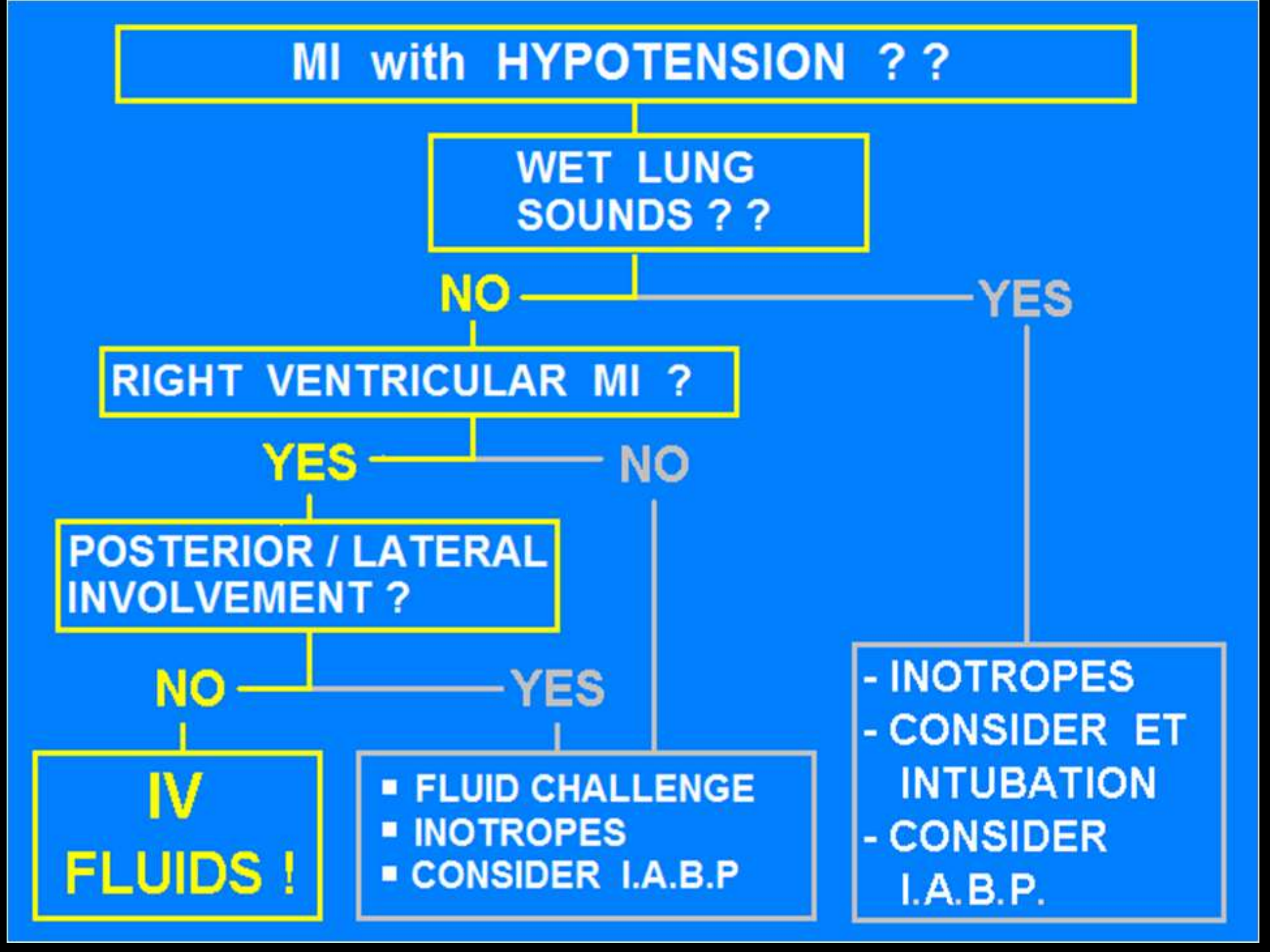
75-80 % of POPULATION

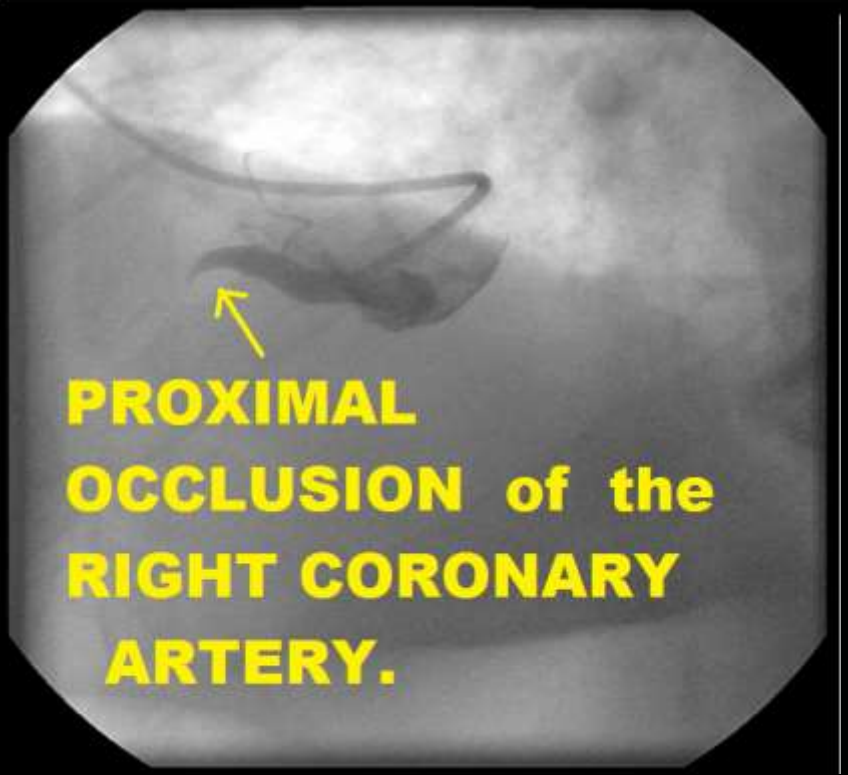


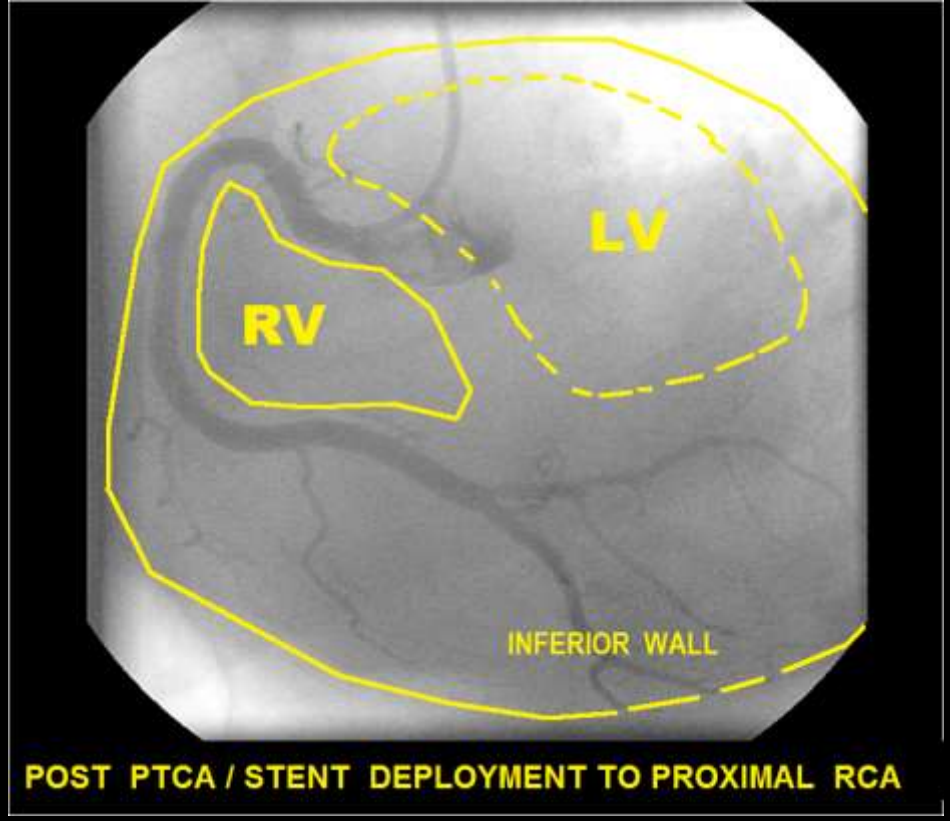
ANTICIPATED COMPLICATIONS of INFERIOR - RIGHT VENRICULAR WALL STEMI secondary to PROXIMAL RCA Occlusion & POSSIBLE INDICATED INTERVENTIONS:

- CARDIAC ARREST	BCLS / ACLS
- CARDIAC DYSRHYTHMIAS (VT / VF)	ACLS (antiarrhythmics)
- SINUS BRADYCARDIA	ATROPINE 0.5mg, REPEAT as needed UP TO 3mg. (follow ACLS and/or UNIT protocols)
- HEART BLOCKS (1st, 2nd & 3rd Degree HB)	ATROPINE 0.5mg, REPEAT as needed UP TO 3mg, Transcutaneous Pacing, (follow ACLS and/or UNIT protocols)
- RIGHT VENTRICULAR MYOCARDIAL INFARCTION	- NITRATES and DIURETICS are CONTRA-INDICATED. - TREAT HYPOTENSION WITH FLUIDS. (It is Not uncommon to give 500-2000ml of NORMAL SALINE to stabilize BP.
- POSTERIOR WALL INFARCTION	- POSTERIOR WALL MI presents on the 12 Lead ECG as ST DEPRESSION in Leads V1 - V3. - POSTERIOR WALL MI is NOT PRESENT ON THIS ECG.

If this patient becomes HYPOTENSIVE . . . . .


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





POST PTCA / STENT DEPLOYMENT TO PROXIMAL RCA

CASE STUDY 9 - STEMI

CHIEF COMPLAINT and SIGNIFICANT HISTORY:

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

RISK FACTOR PROFILE:

- CIGARETTE SMOKER
- HYPERTENSION
- HIGH LDL CHOLESTEROL

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

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

LABS: TROPONIN: < .04

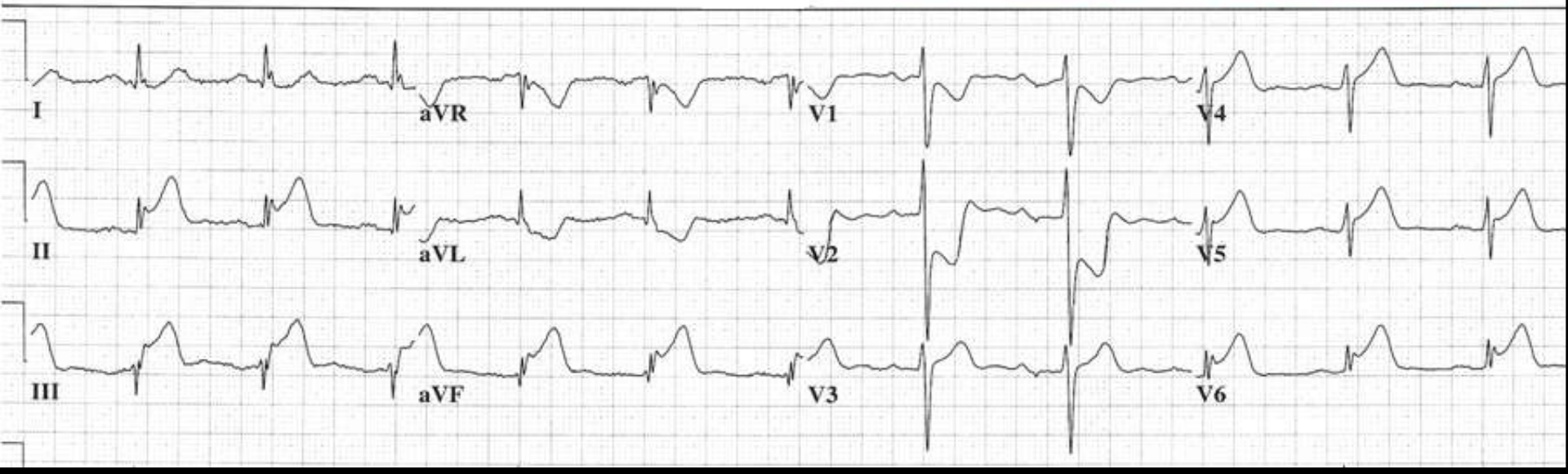
SHOCK ASSESSMENT

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

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

EVALUATE EKG for indicators of ACS:

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



CASE STUDY QUESTIONS:

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

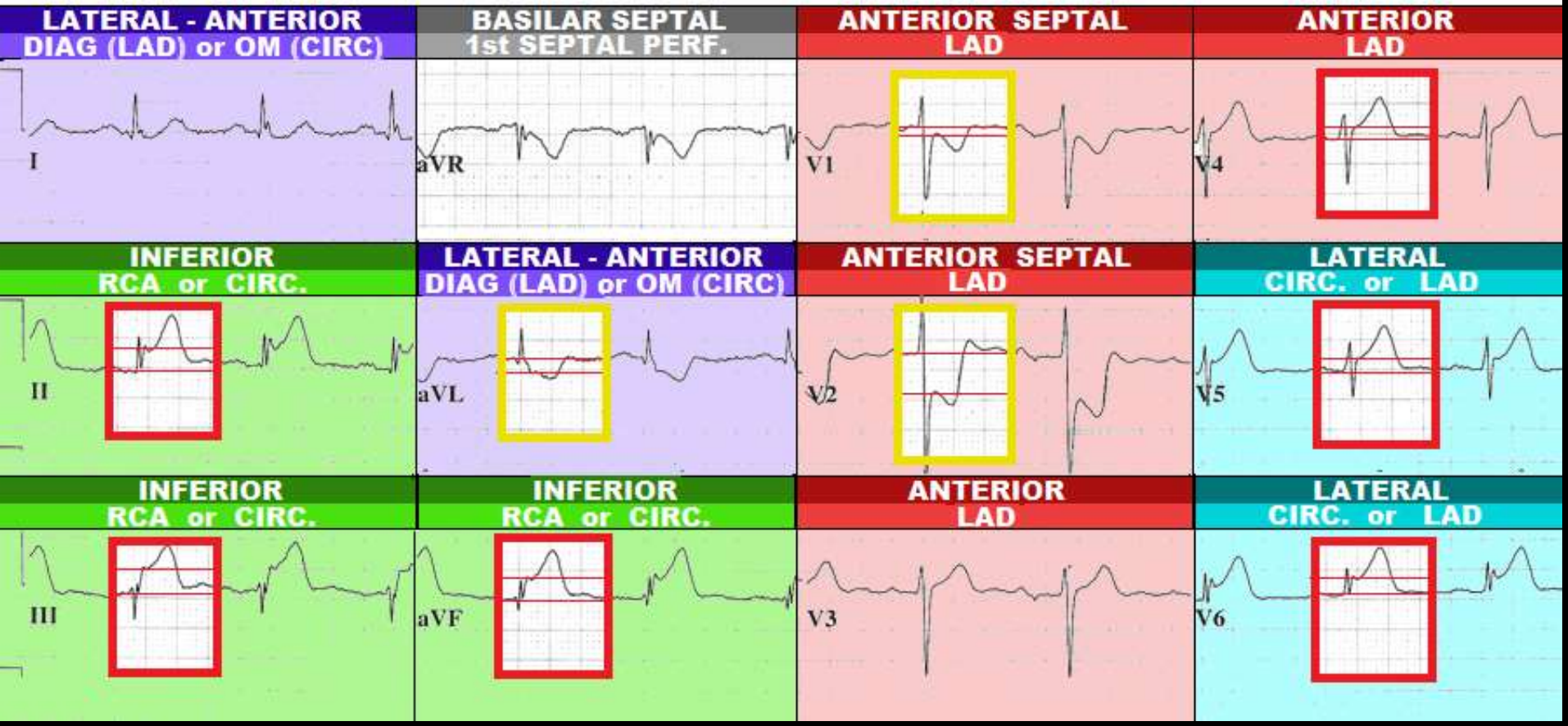
42 yr
Male
Caucasian

Loc:3
Option:23

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

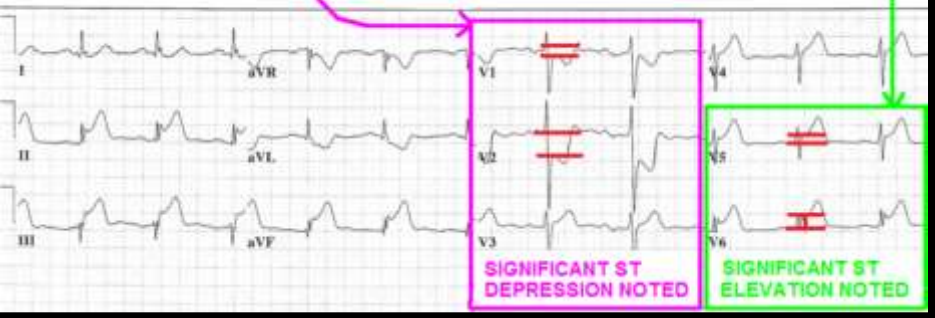
*** Acute MI ***
Inferior-Posterior-Lateral Injury Pattern

ST SEGMENT ELEVATION
ST SEGMENT DEPRESSION

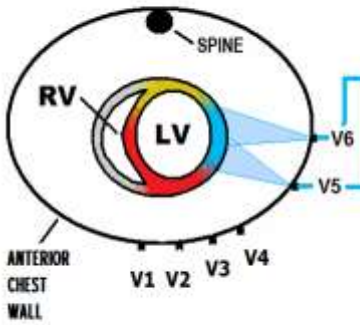


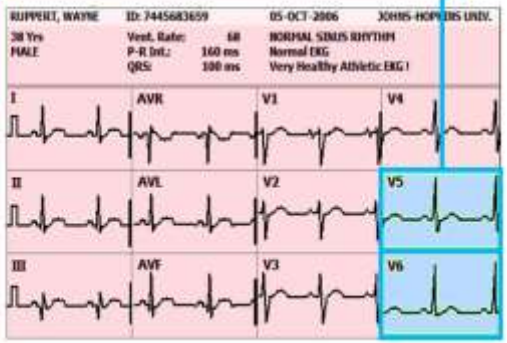
R SIDED ECG was obtained, NO ST ELEVATION was noted in RV Leads

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

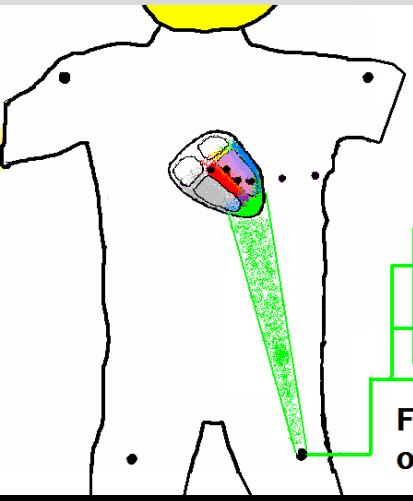


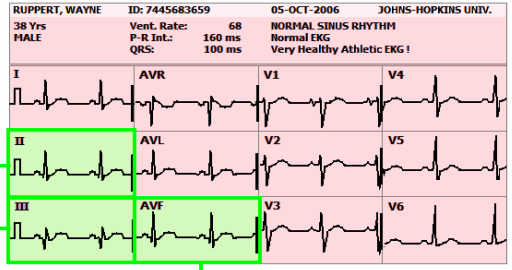
V5 - V6 VIEW THE LATERAL WALL of the LEFT VENTRICLE





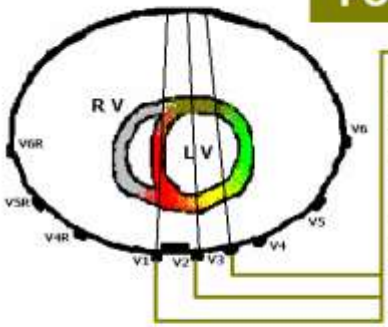
LEADS II, III, and aVF VIEW
INFERIOR WALL of the LEFT VENTRICLE

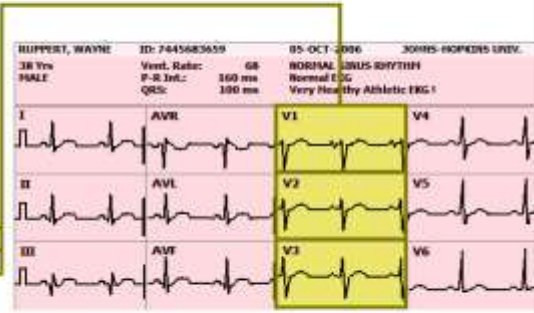




FED by the RCA (75 - 80 % pop)
or the CIRCUMFLEX (10 - 15 %)

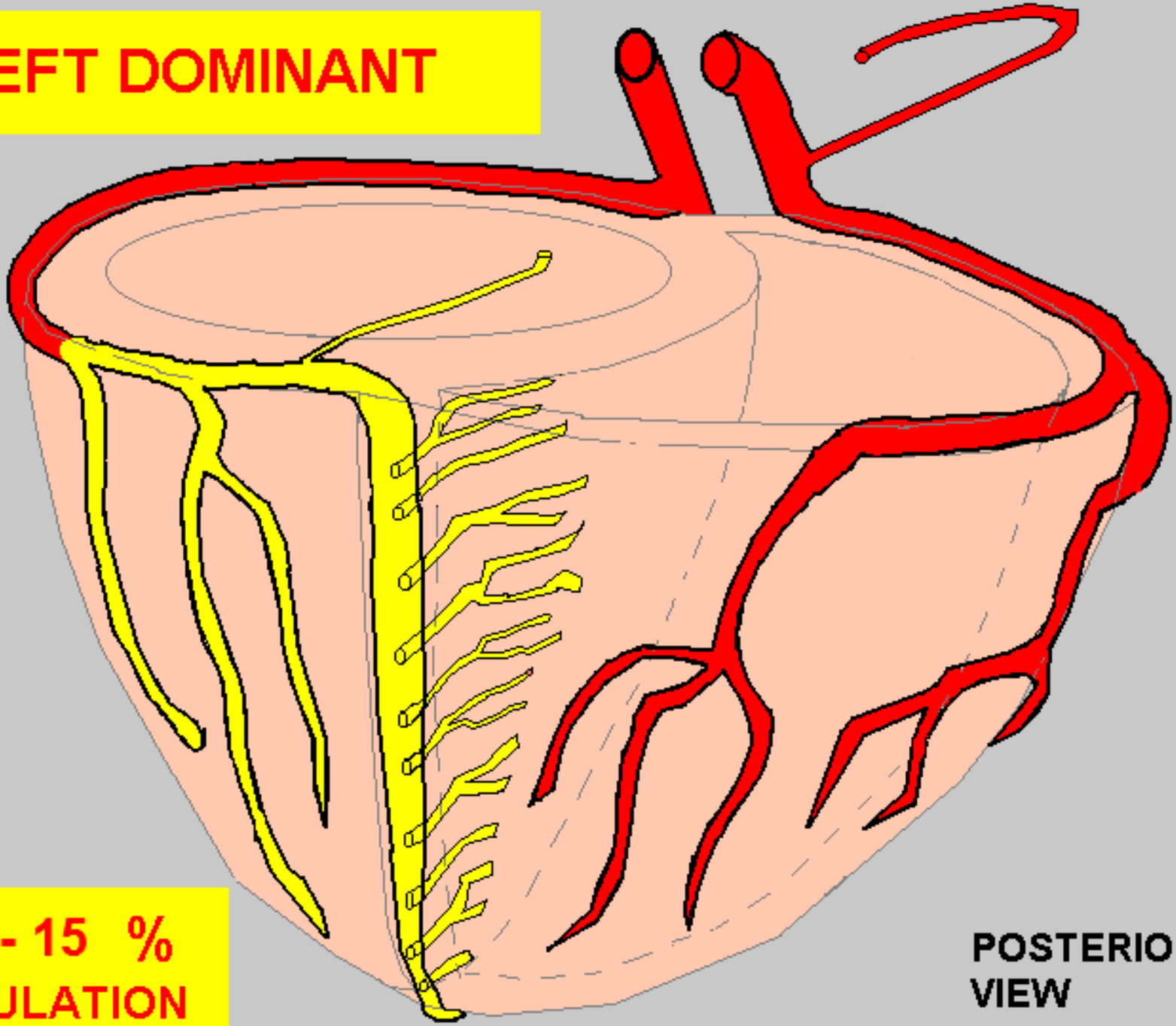
LEADS V1 - V3 *view the* POSTERIOR WALL





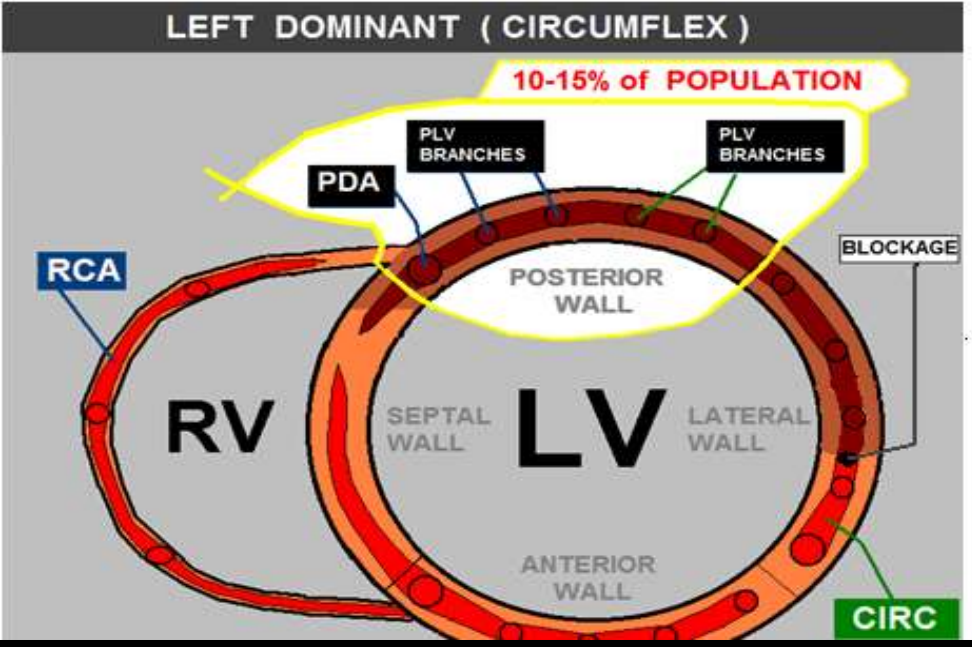
via RECIPROCAL CHANGES.

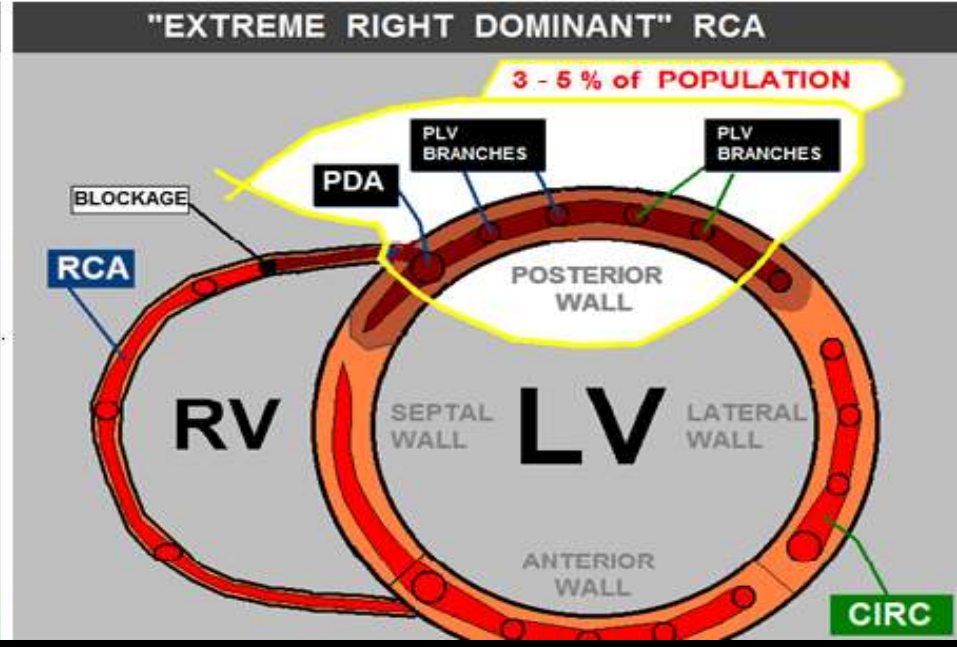
LEFT DOMINANT



10 - 15 %
POPULATION

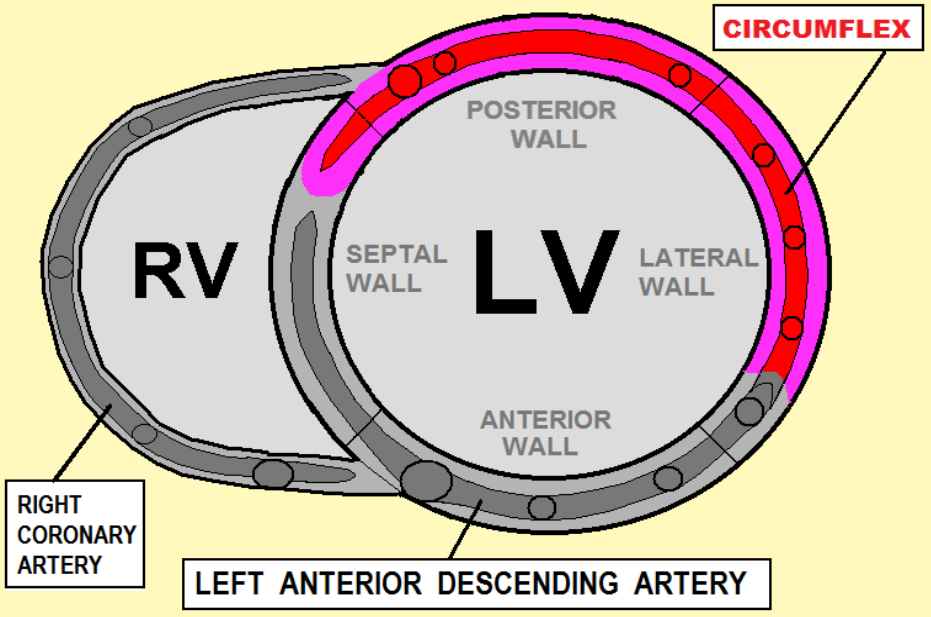
POSTERIOR
VIEW





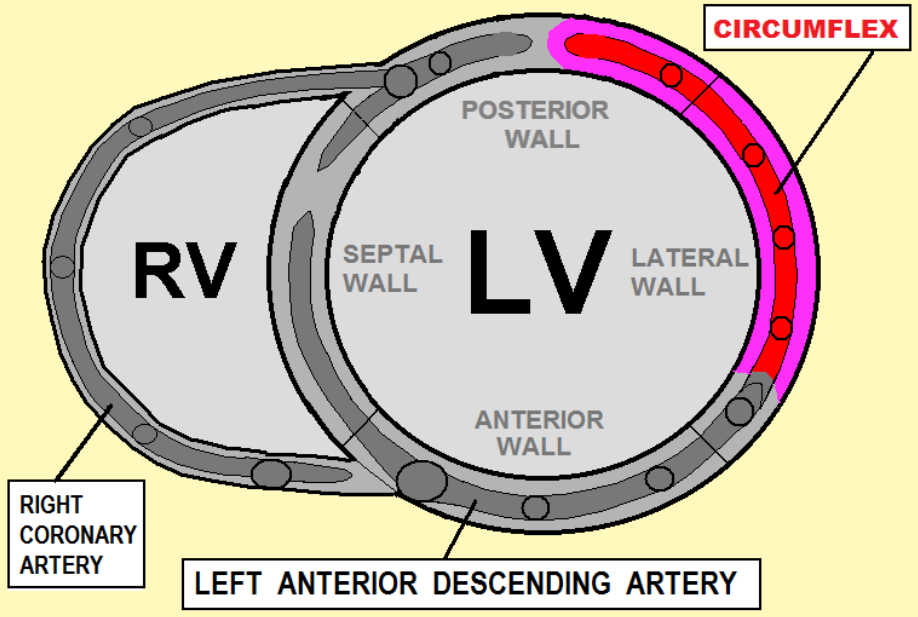
The DOMINANT CIRCUMFLEX ARTERY . . .

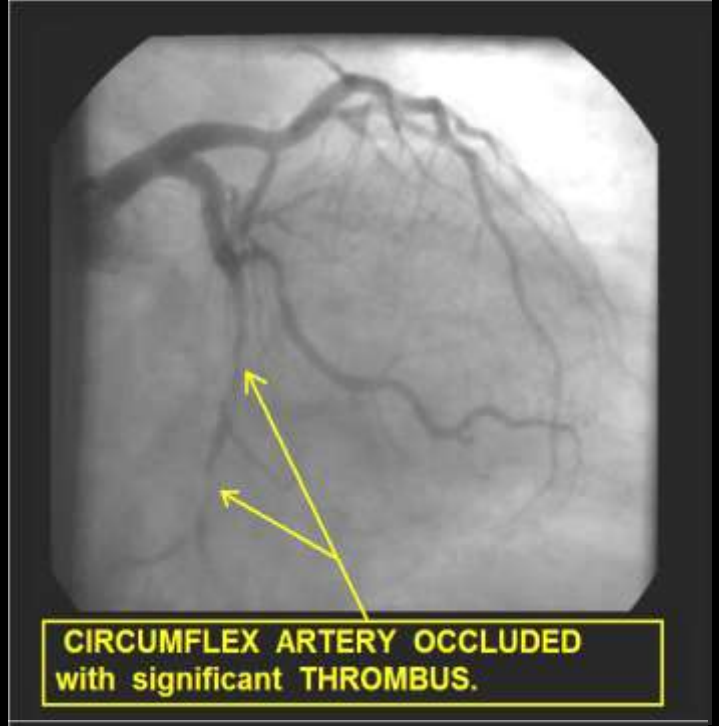
SUPPLIES 35 - 55% OF THE LEFT VENTRICULAR MUSCLE MASS

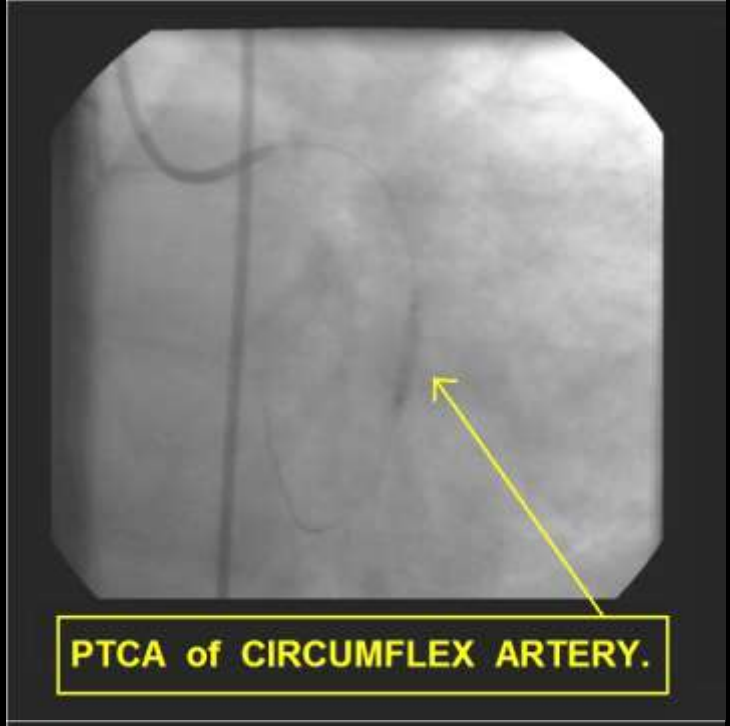


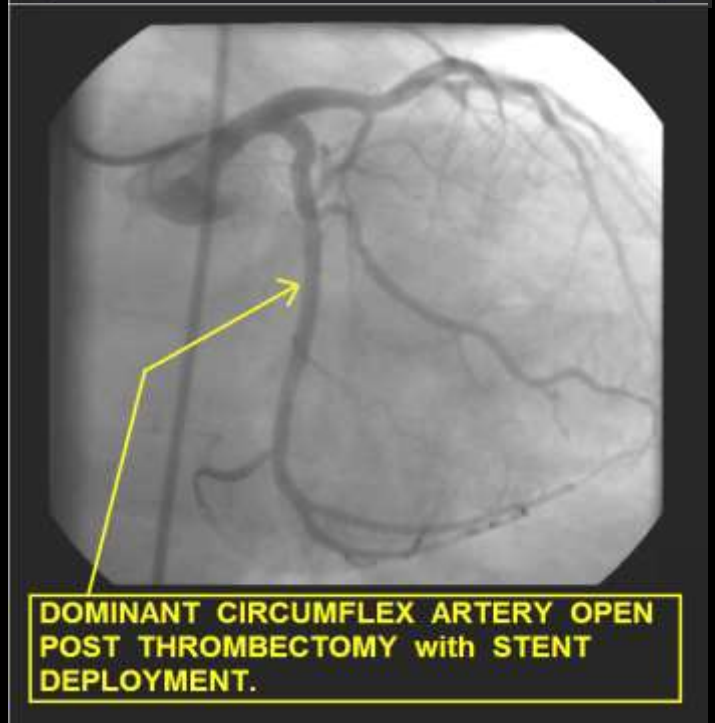
The NON - DOMINANT CIRCUMFLEX ARTERY

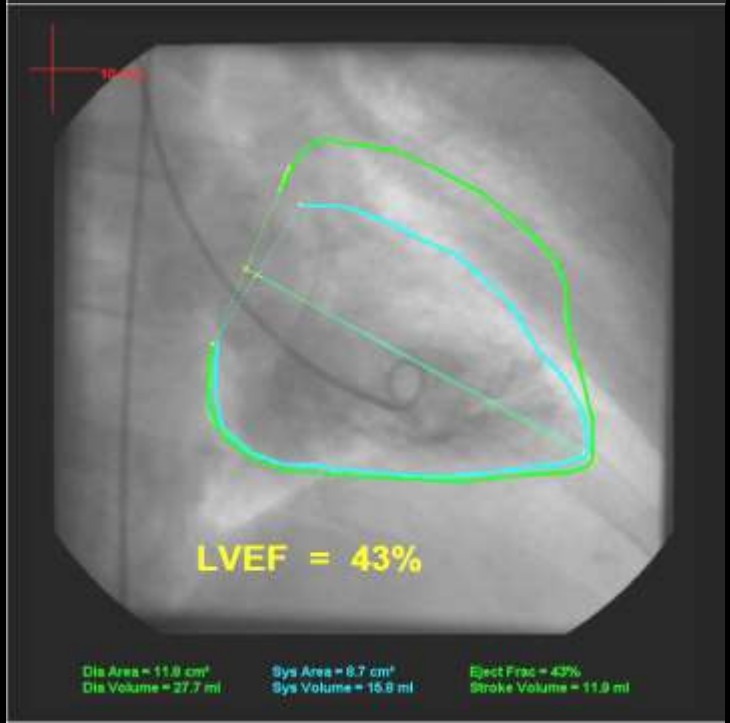
SUPPLIES 25-30 % OF THE LEFT VENTRICULAR MUSCLE MASS




CIRCUMFLEX ARTERY OCCLUDED
with significant THROMBUS.


PTCA of CIRCUMFLEX ARTERY.


DOMINANT CIRCUMFLEX ARTERY OPEN
POST THROMBECTOMY with STENT
DEPLOYMENT.


LVEF = 43%
Dia Area = 11.8 cm²
Dia Volume = 27.7 ml
Sys Area = 8.7 cm²
Sys Volume = 15.8 ml
Eject Frac = 43%
Stroke Volume = 11.9 ml

CASE STUDY SUMMARY

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

ST DEPRESSION: V1 - V3, POSSIBLY I and aVL

SUSPECTED DIAGNOSIS: ACUTE INFERIOR - POSTERIOR - LATERAL MI

SUSPECTED "CULPRIT ARTERY" (if applicable):

OCCLUSION of DOMINANT CIRCUMFLEX ARTERY

IMMEDIATE CONCERNS FOR ALL STEMI PATIENTS:

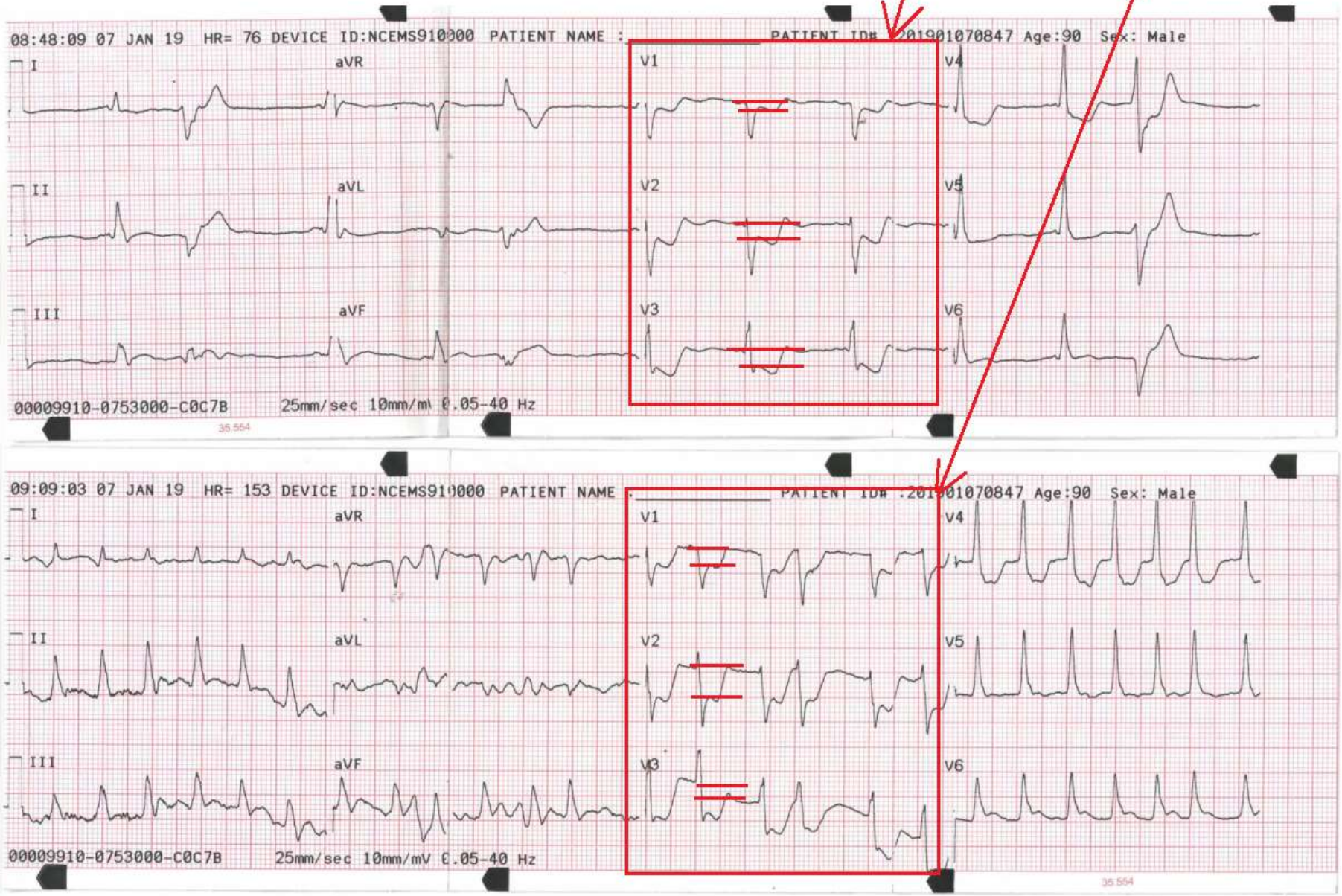
- BE PREPARED TO MANAGE SUDDEN CARDIAC ARREST (PRIMARY V - FIB / V- TACH, BRADYCARDIAS / HEART BLOCKS)
- STAT REPERFUSION THERAPY: THROMBOLYTICS vs. CARDIAC CATHETERIZATION and PCI
- CONSIDER NEEDS FOR ANTI-PLATELET and ANTI-COAGULATION THERAPY

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

Case Study- January 2019

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

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



Initial Exam in ED

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

Pat ID [redacted]

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

[redacted]
Caucasian Female
Account # [redacted]

Bayfront Health Seven Rivers ED
Dept ED
Room ED01
Tech gp

RX
DX

Rate	153
PR	
QRSd	117
QT	260
QTc	415
--Axis--	
P	
QRS	73
T	78

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

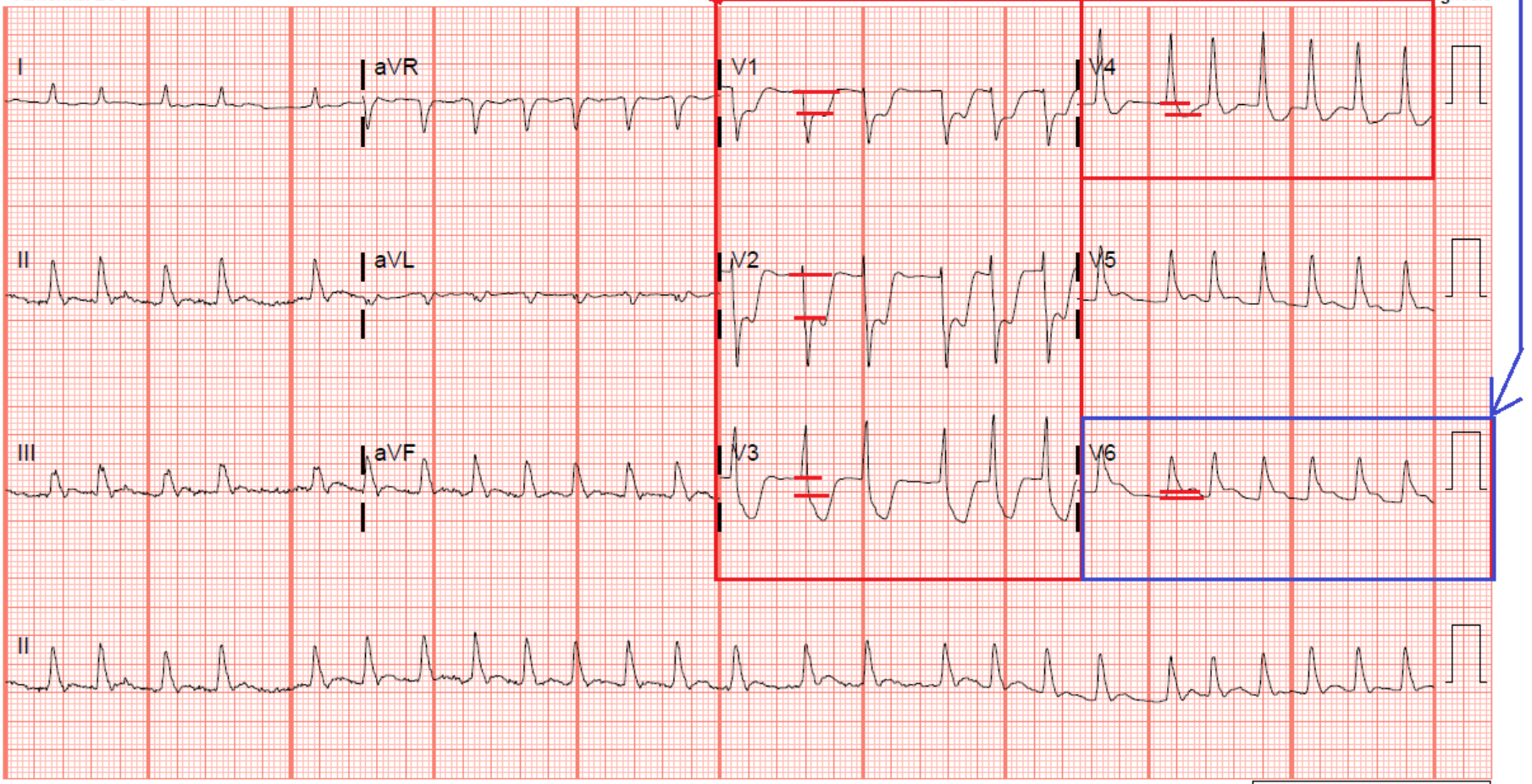
Req Provider:

ST Depression Leads V1 - V4

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

- Abnormal ECG -

Unconfirmed Diagnosis



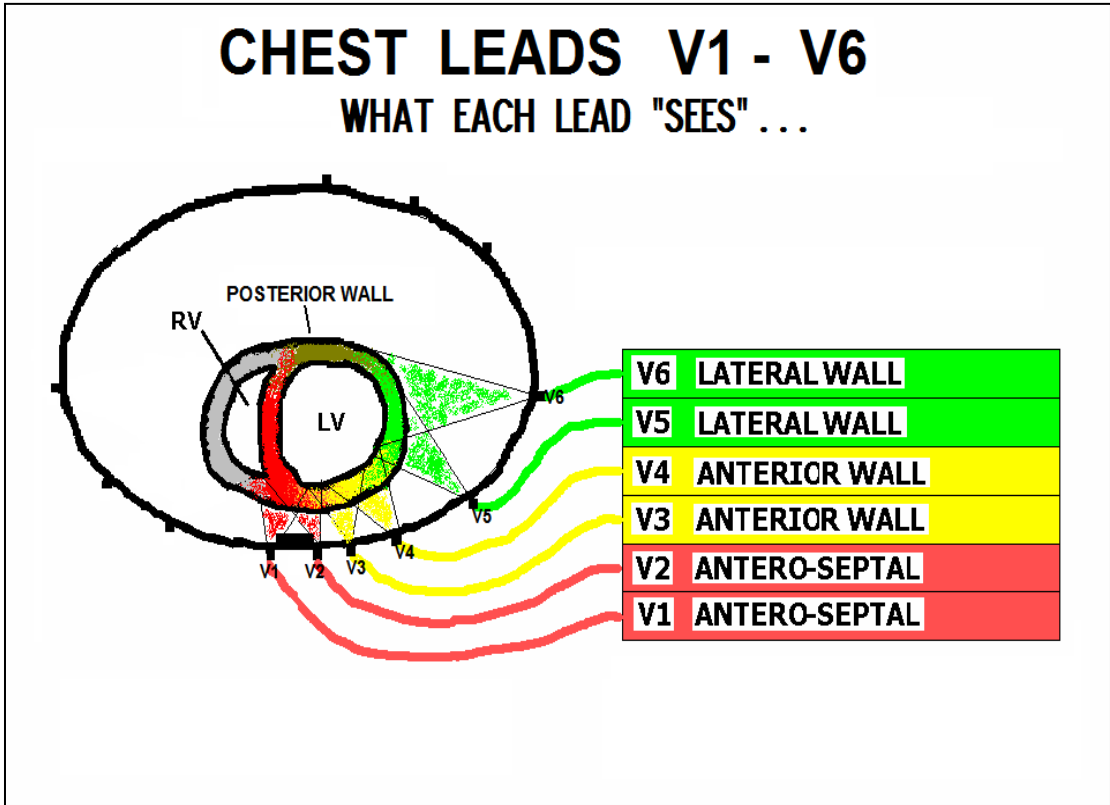
Philips PageWriter TC | 25 mm/sec | 10.00 mm/mV | F 60~ 0.15 - 100 Hz

Causes of ST Depression V1-V4

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

Posterior Wall STEMI….

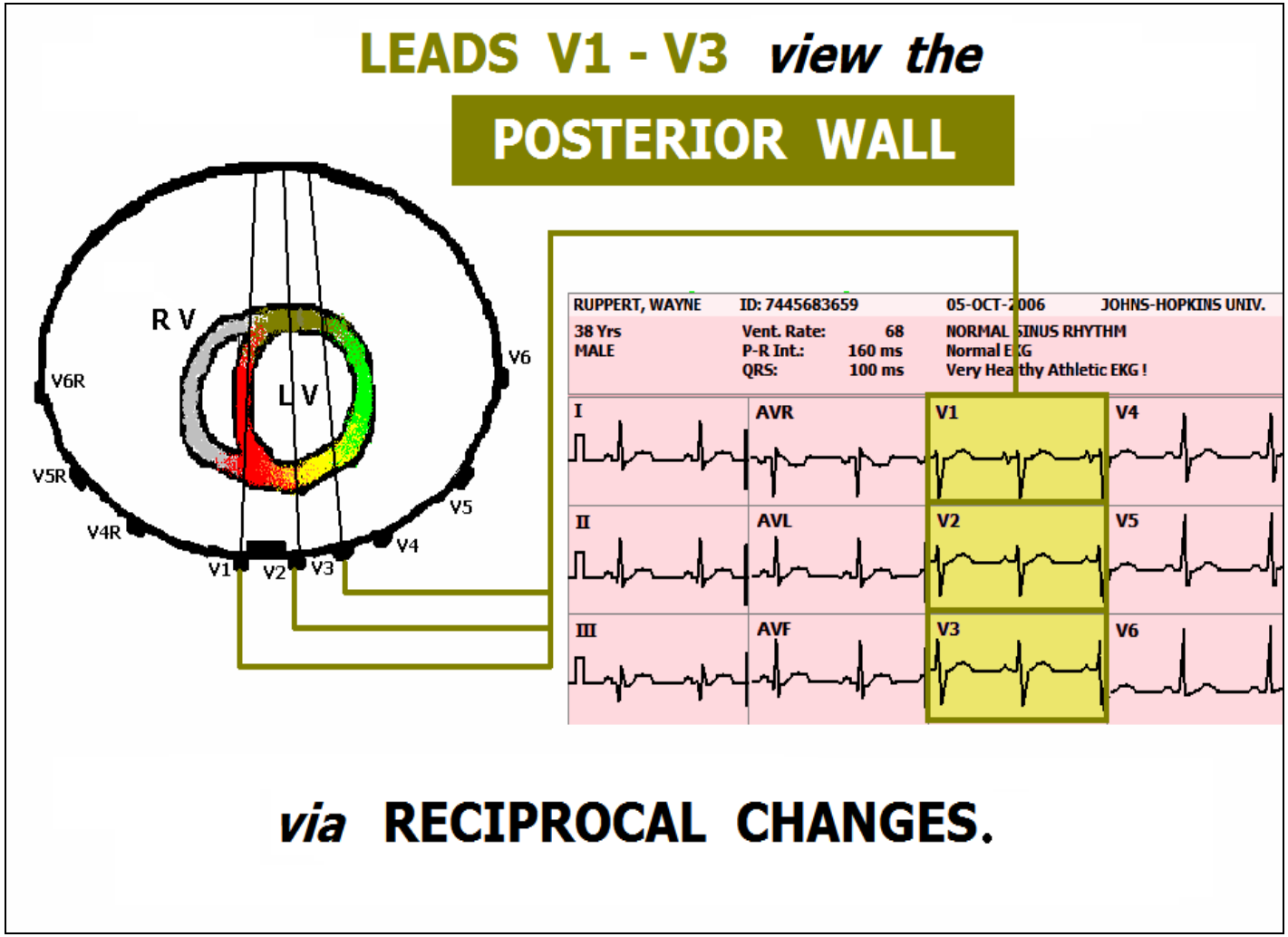
- **Does not show ST elevation on standard 12 lead ECG** because NONE of the 12 leads view the Posterior Wall directly….



Posterior Wall STEMI….

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

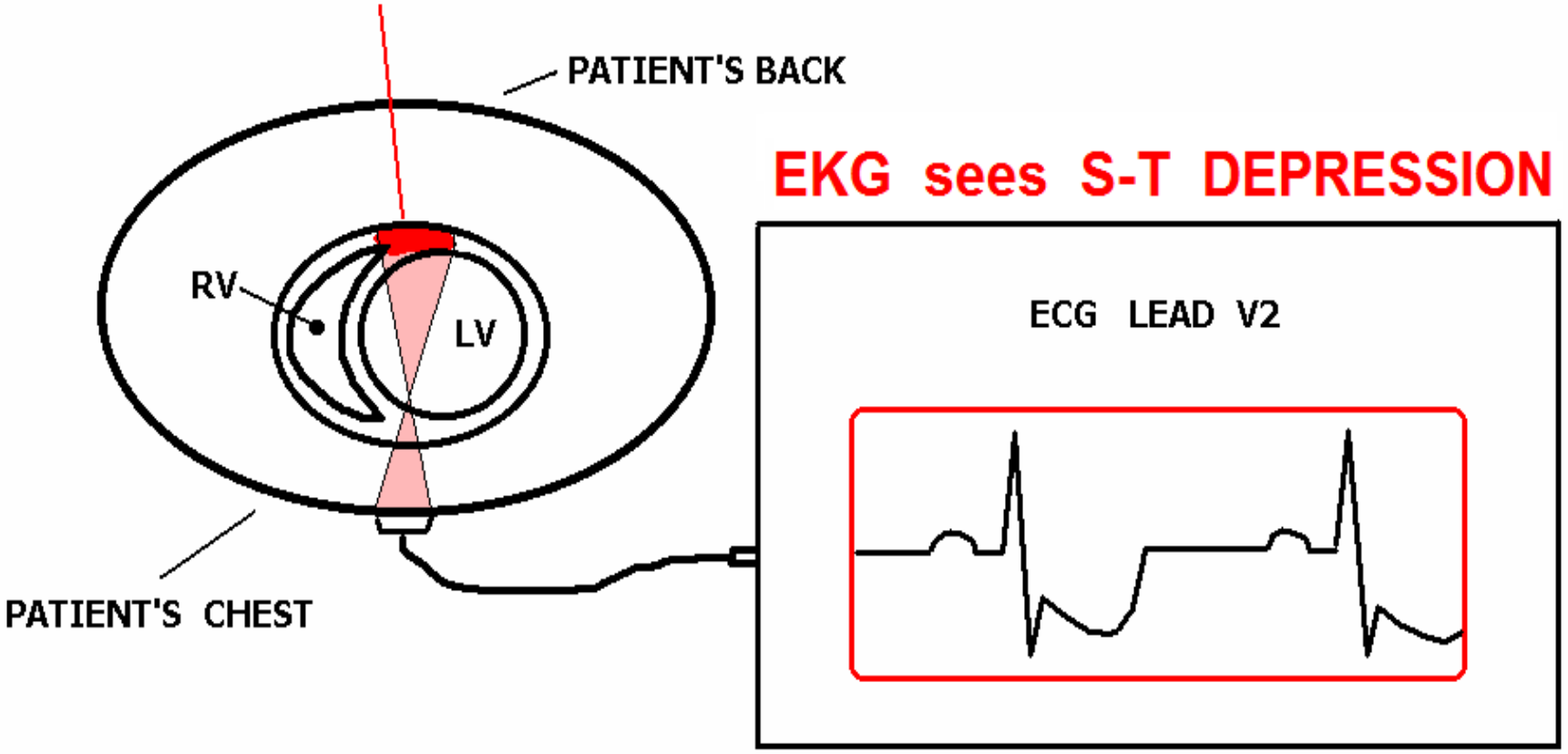
V1-V3 see the Posterior Wall ONLY through RECIPROCAL changes (ST Depression)



HOW EKG VIEWS RECIPROCAL CHANGES

EXAMPLE:

AREA OF ACUTE INFARCTION - POSTERIOR WALL

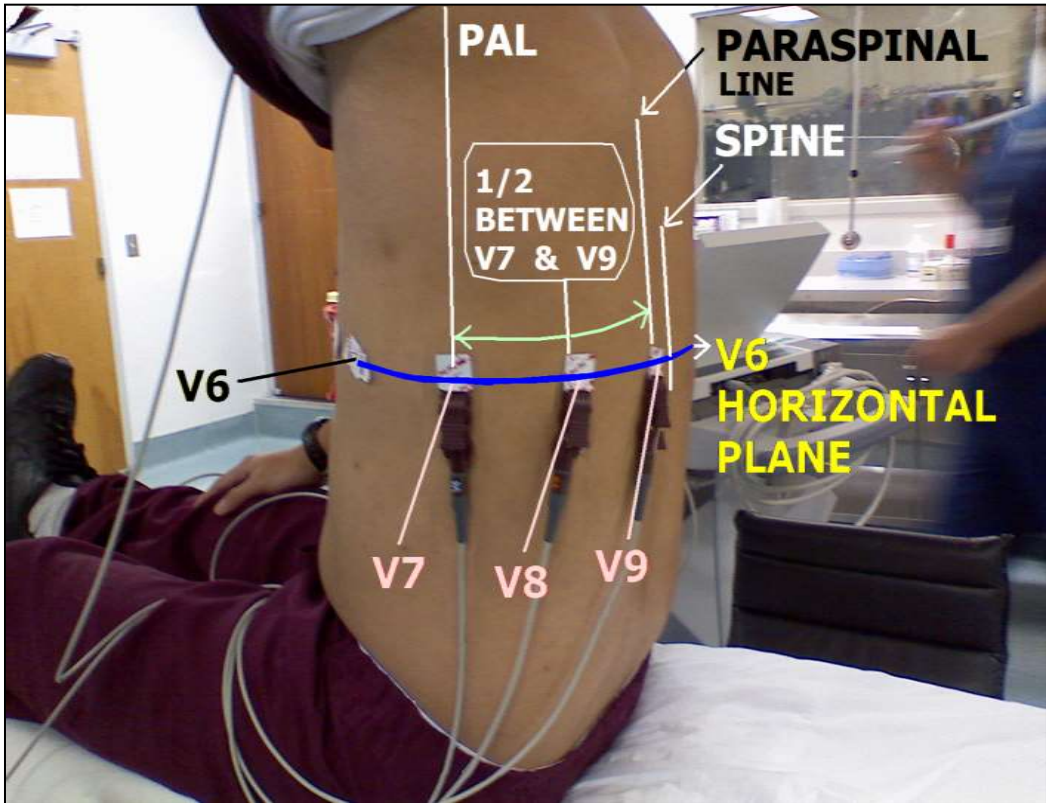


Posterior Wall STEMI….

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

Continued Exam in the ED….

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



Pat ID [redacted]

01/07/2019 09:23:29
[redacted] 79 yrs

[redacted]
Caucasian Female
Account [redacted]

Bayfront Health Seven Rivers ED
Dept EDHD
Room EDH
Tech gp

RX
DX

Req Provider: ONIER VILLARREAL

Rate	133	Atrial fibrillation
PR		~~Anterolateral infarct, acute~~
QRSd	114	Prolonged QT interval
QT	337	COMPARED TO ECG 01/07/2019 09:21:04
QTc	502	PROLONGED QT INTERVAL NOW PRESENT
--Axis--		
P		
QRS	77	
T	121	

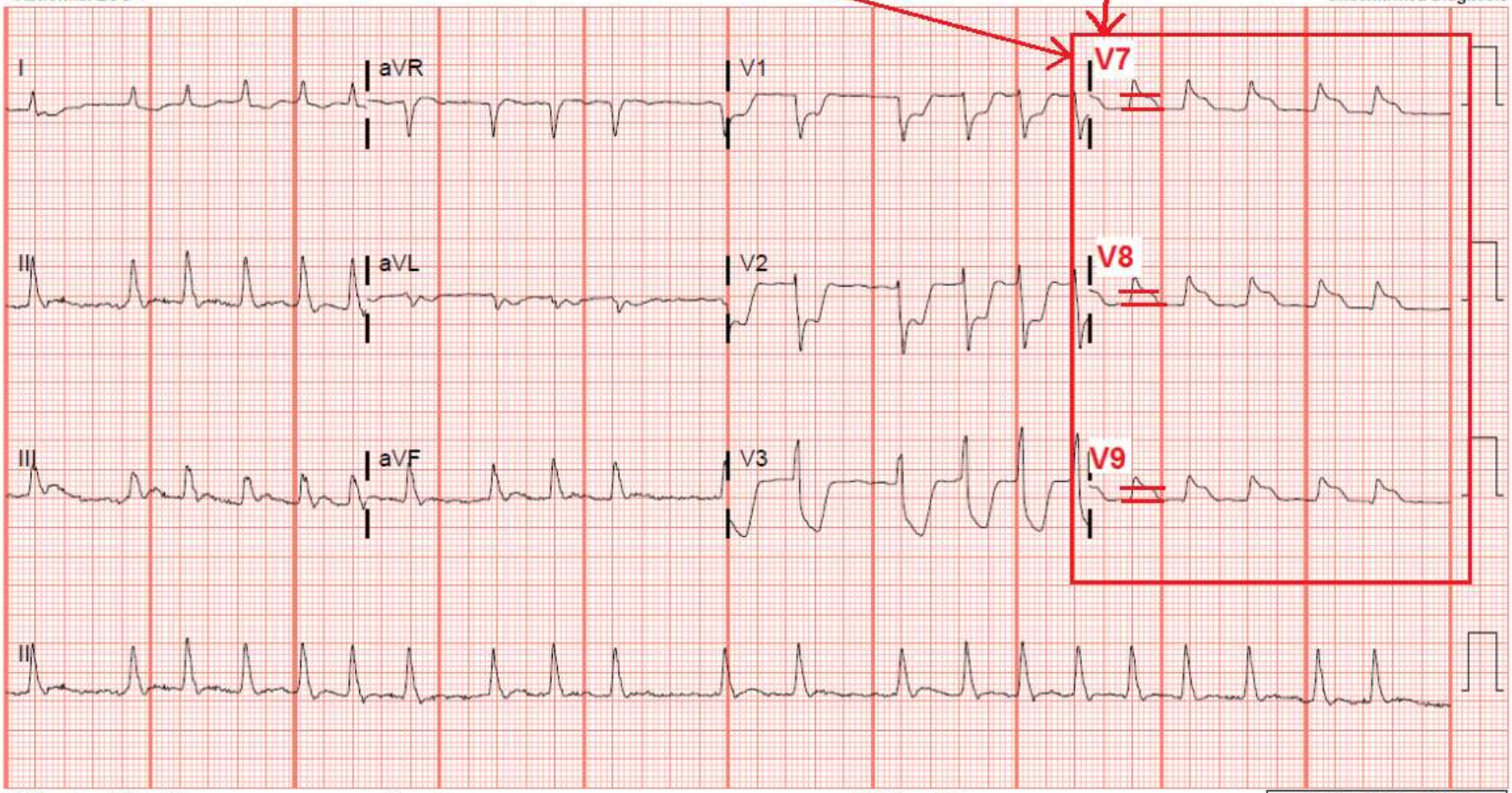
**** Posterior Infarct - Acute ****

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

ACUTE POSTERIOR WALL STEMI

- Abnormal ECG -

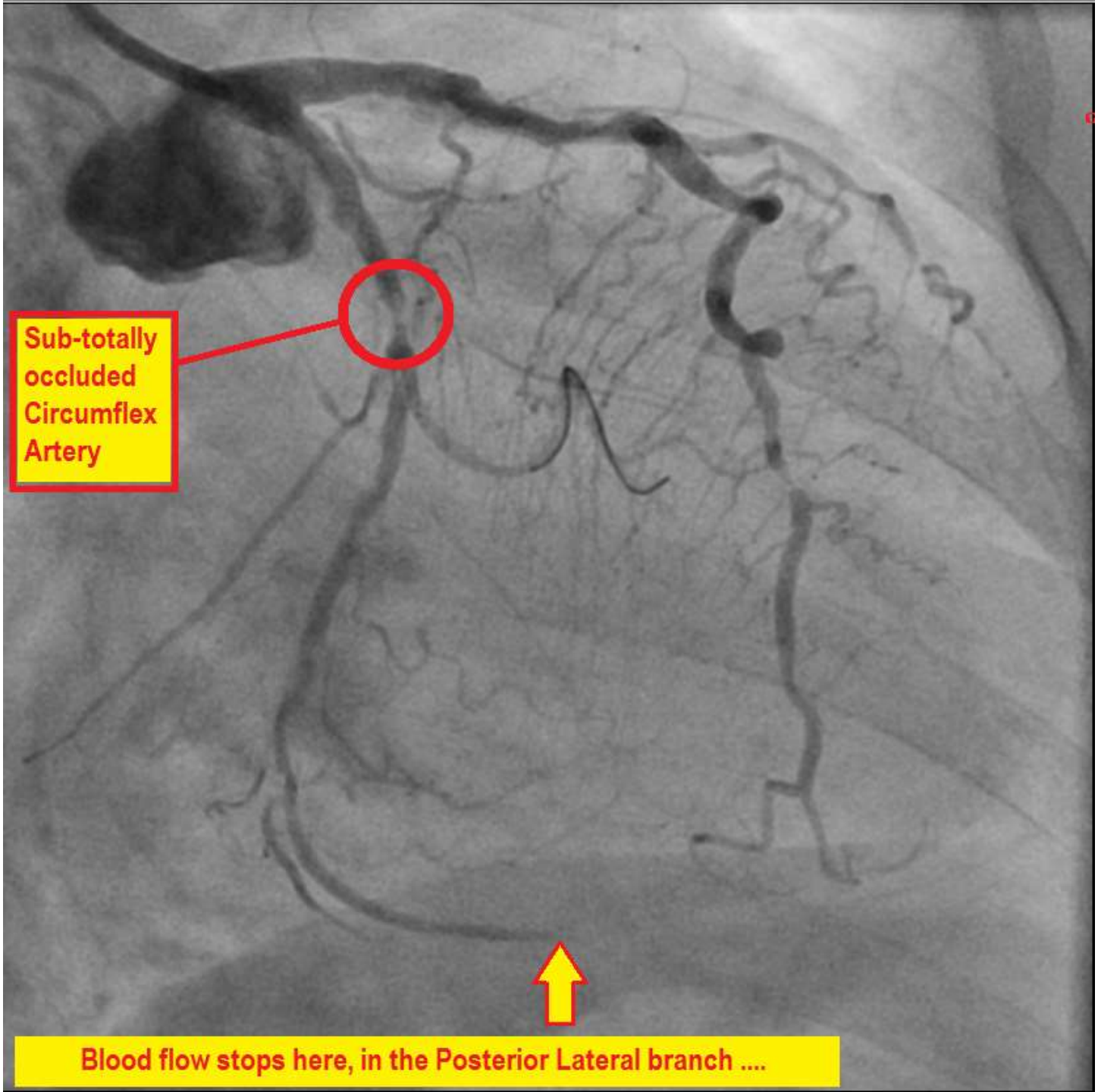
Unconfirmed Diagnosis

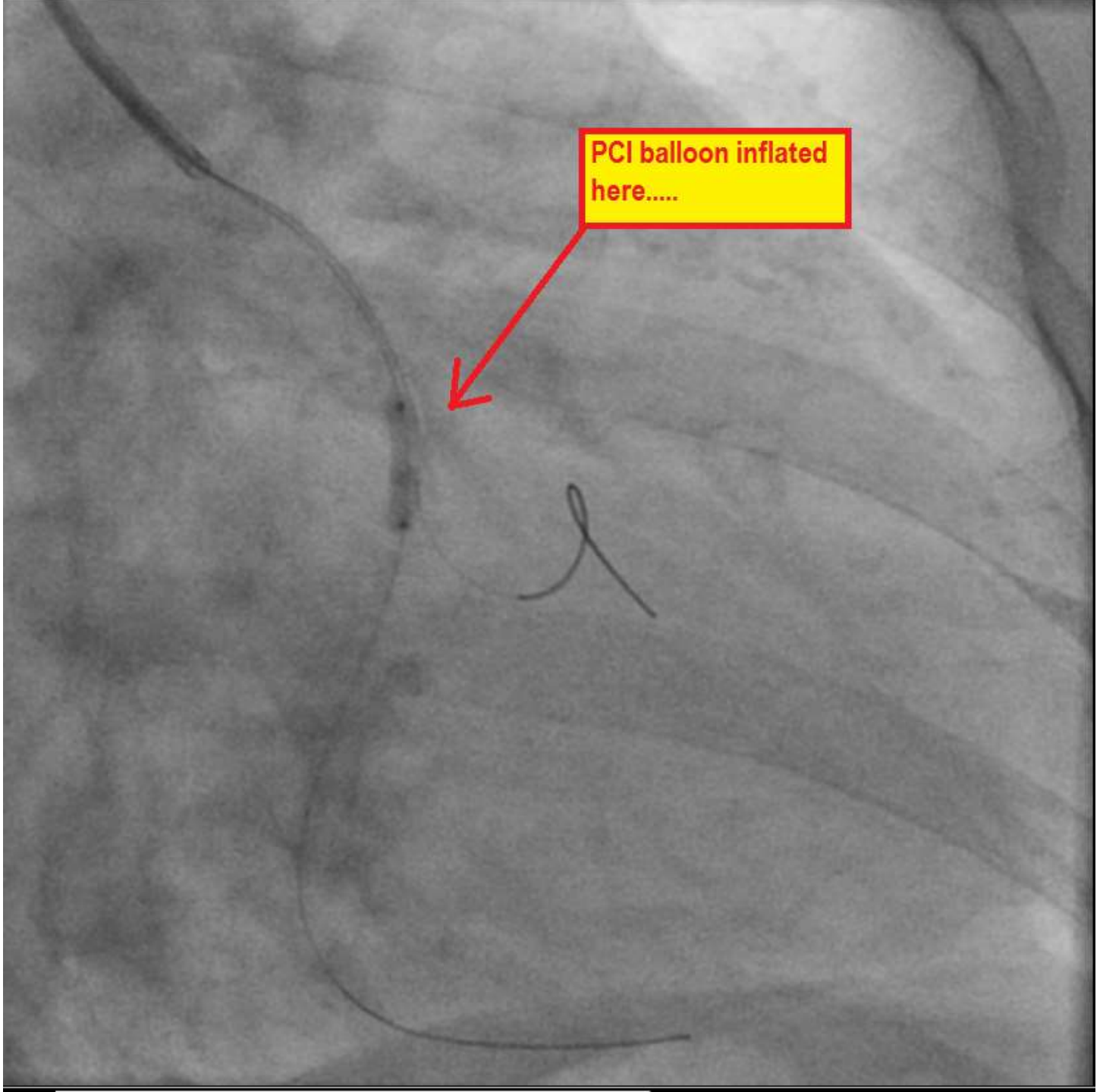


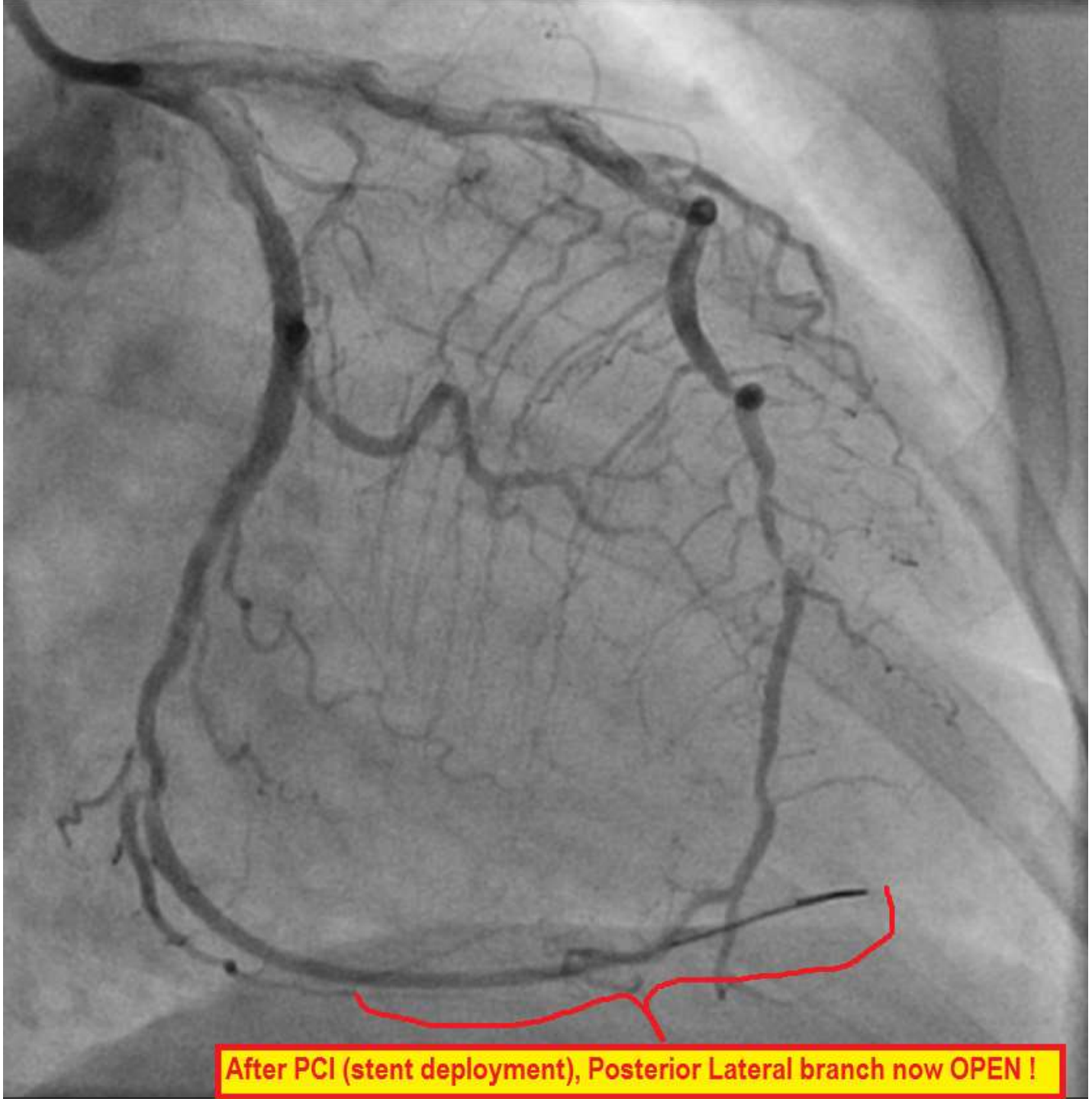
Philips PageWriter TC | 25 mm/sec | 10.00 mm/mV | F 60~ 0.15 - 100 Hz

STEMI Alert !

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


Sub-totally occluded Circumflex Artery
Blood flow stops here, in the Posterior Lateral branch ....


PCI balloon inflated here.....


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

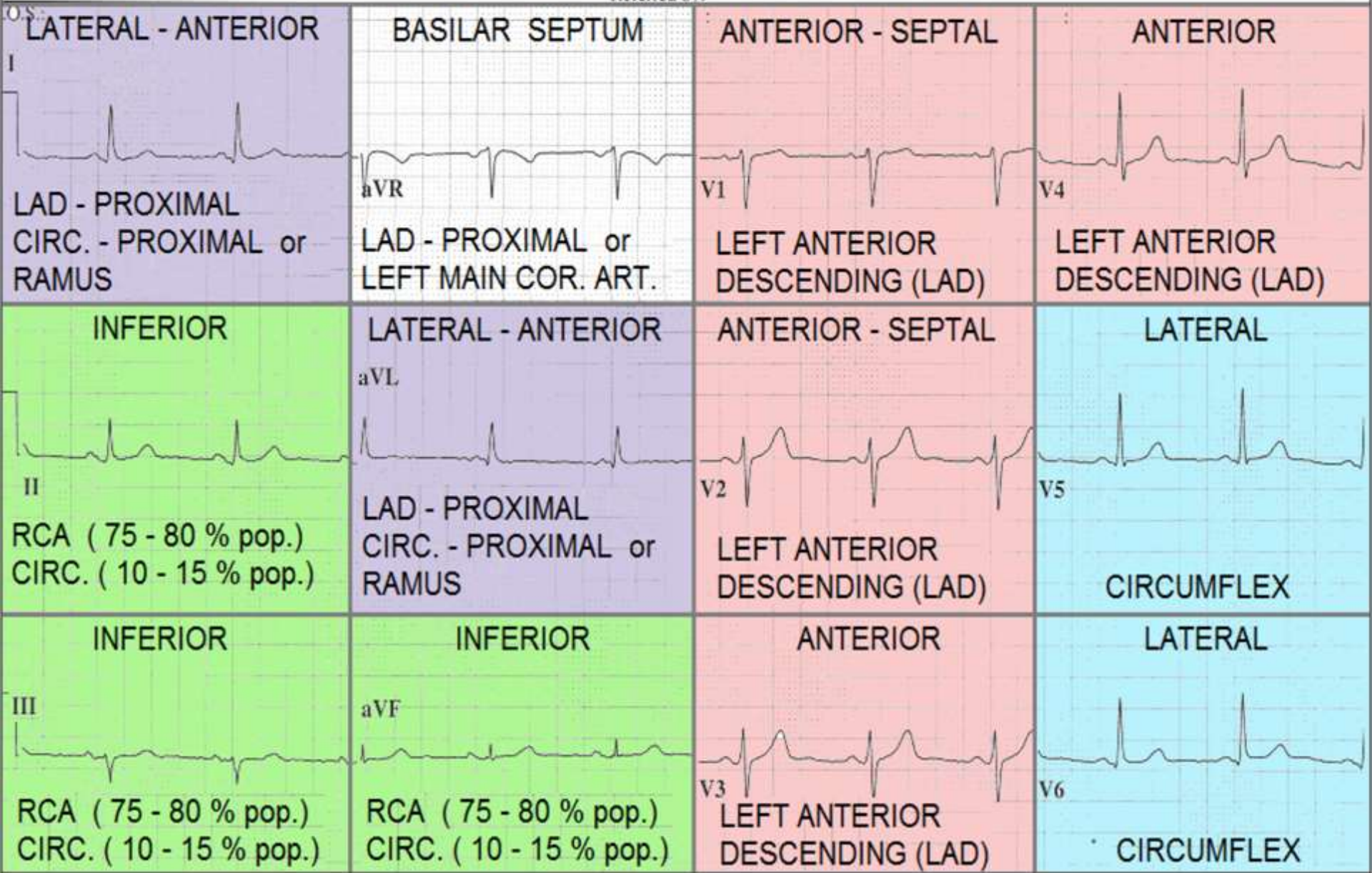
SUMMARY

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

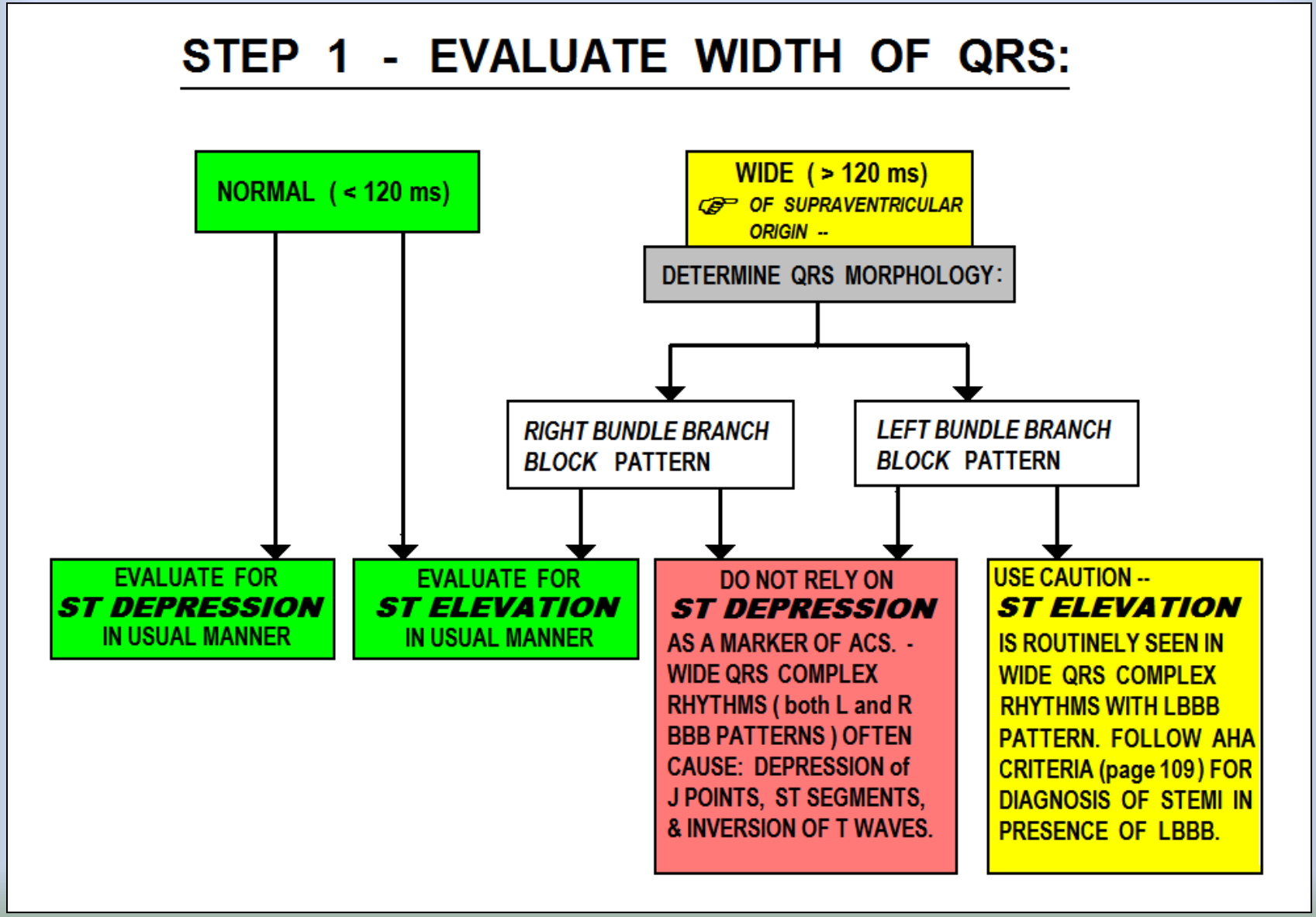
Vent. rate	64	BPM
PR interval	130	ms
QRS duration	96	ms
QT/QTc	396/408	ms
P–R–T axes	40 11	61

Normal sinus rhythm
Normal ECG
No previous ECGs available

Referred by:



Evaluating the ECG for ACS:



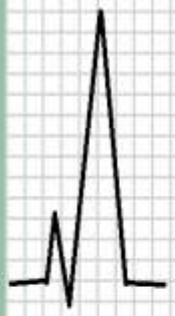
Wide QRS present:
QRSd > 120ms

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

Simple “Turn Signal Method” . . .

THE "TURN SIGNAL METHOD" for identifying BUNDLE BRANCH BLOCK

V1



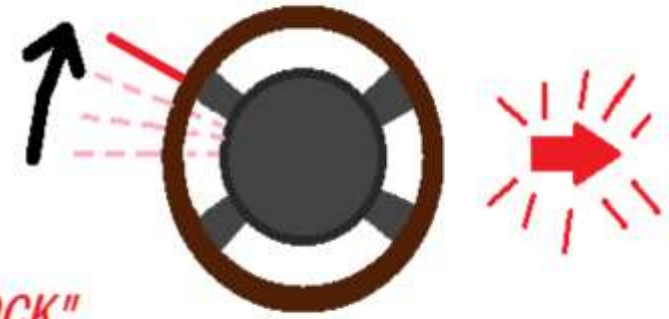
USE LEAD V1 for this technique

To make a **RIGHT TURN**

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

THINK:

"QRS points UP = RIGHT BUNDLE BRANCH BLOCK"



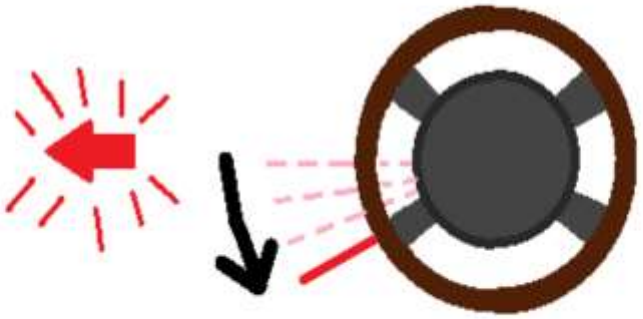
V1

To make a **LEFT TURN**

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

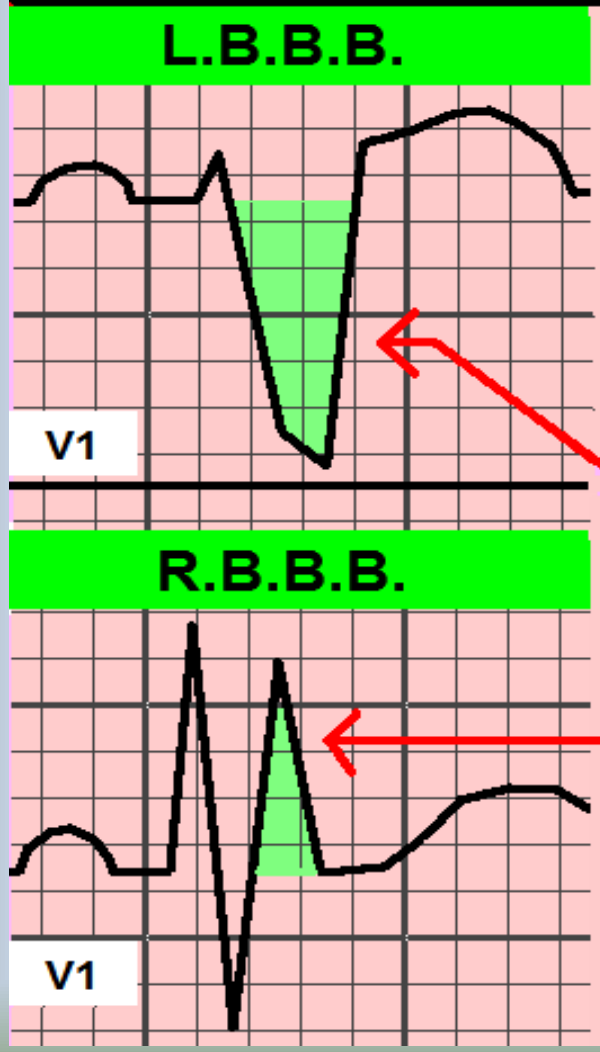
THINK:

"QRS points DOWN = LEFT BUNDLE BRANCH BLOCK"



“Terminal Phase of QRS Method”. . .

DIAGNOSING BUNDLE BRANCH BLOCK



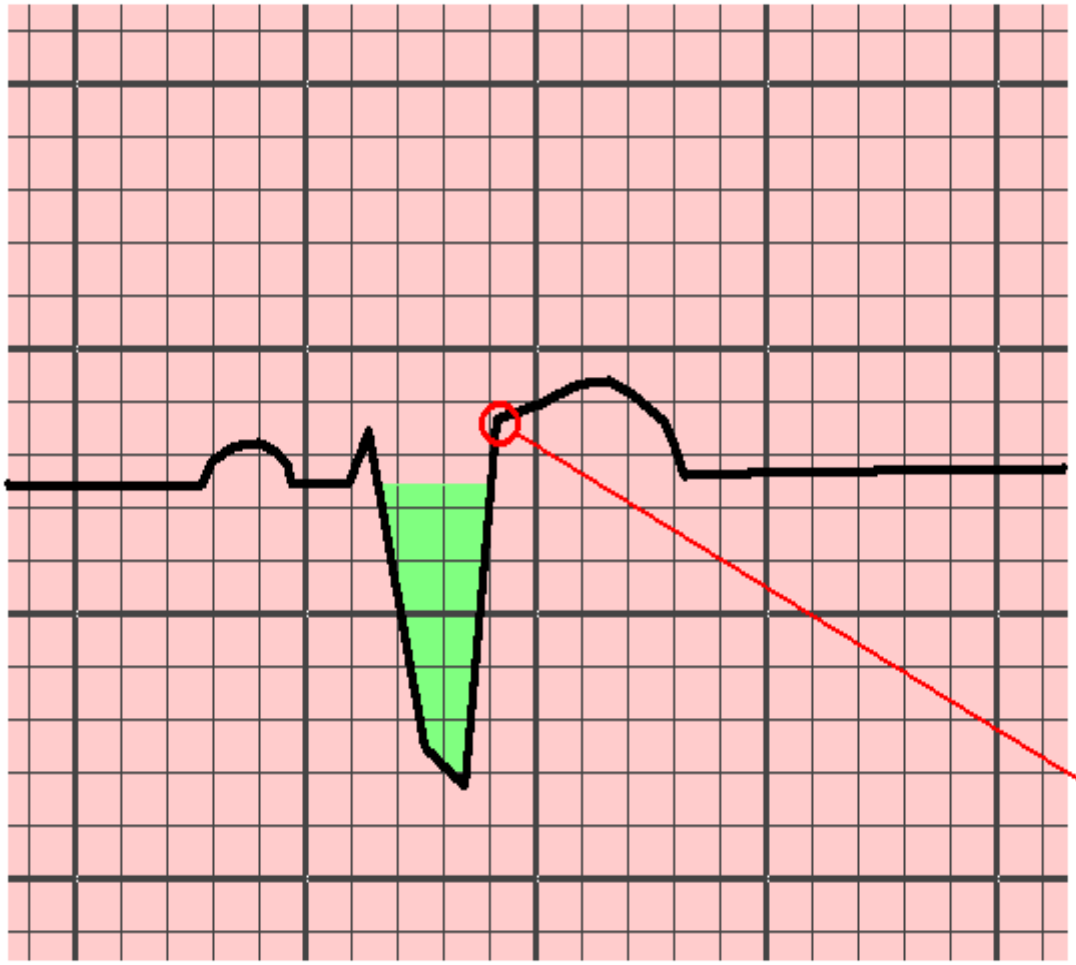
USING LEAD V1

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

NEGATIVE = LEFT BUNDLE BRANCH BLOCK

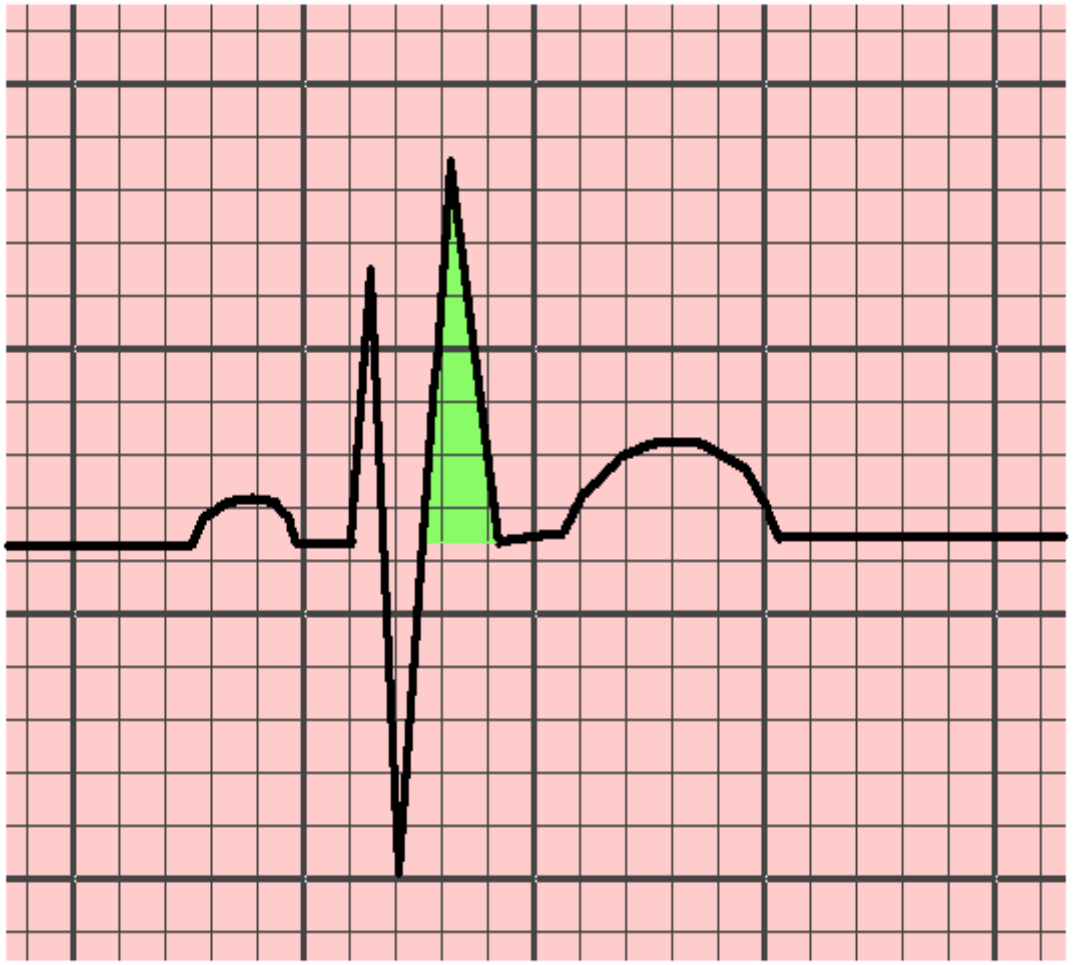
POSITIVE = RIGHT BUNDLE BRANCH BLOCK

DIAGNOSING LBBB IN LEAD V1:



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

DIAGNOSING RBBB IN LEAD V1:



- **WIDER THAN 120 ms (.12)**

(or 3 little boxes)

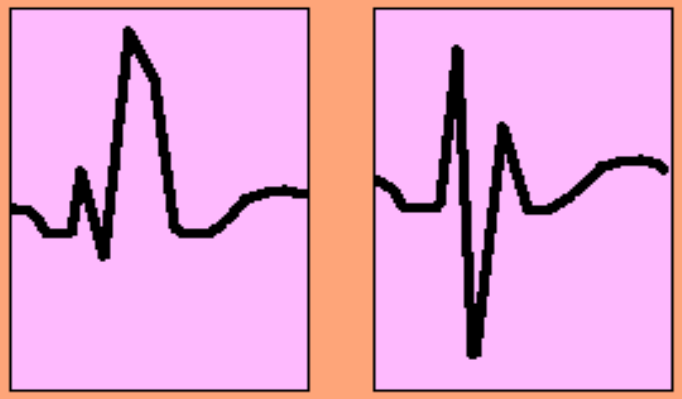
- **TERMINAL PHASE (LAST PART) OF QRS COMPLEX IS POSITIVE DEFLECTION**

DIAGNOSING BUNDLE BRANCH BLOCK

USING LEADS V1, V2, and V5, V6:

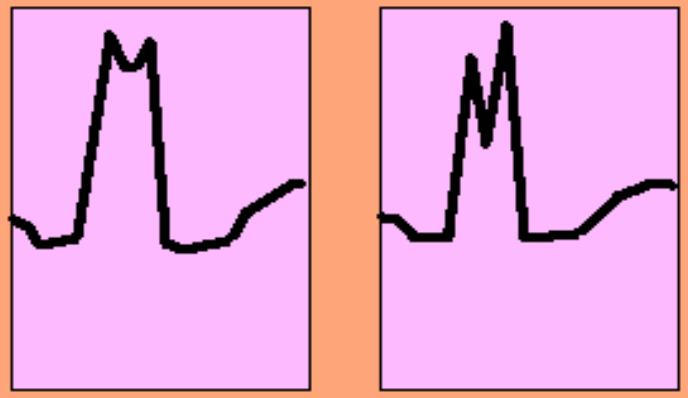
LOCATING RsR' or RR' COMPLEXES:

V1 V2



RIGHT BUNDLE BRANCH BLOCK

V5 V6



LEFT BUNDLE BRANCH BLOCK

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

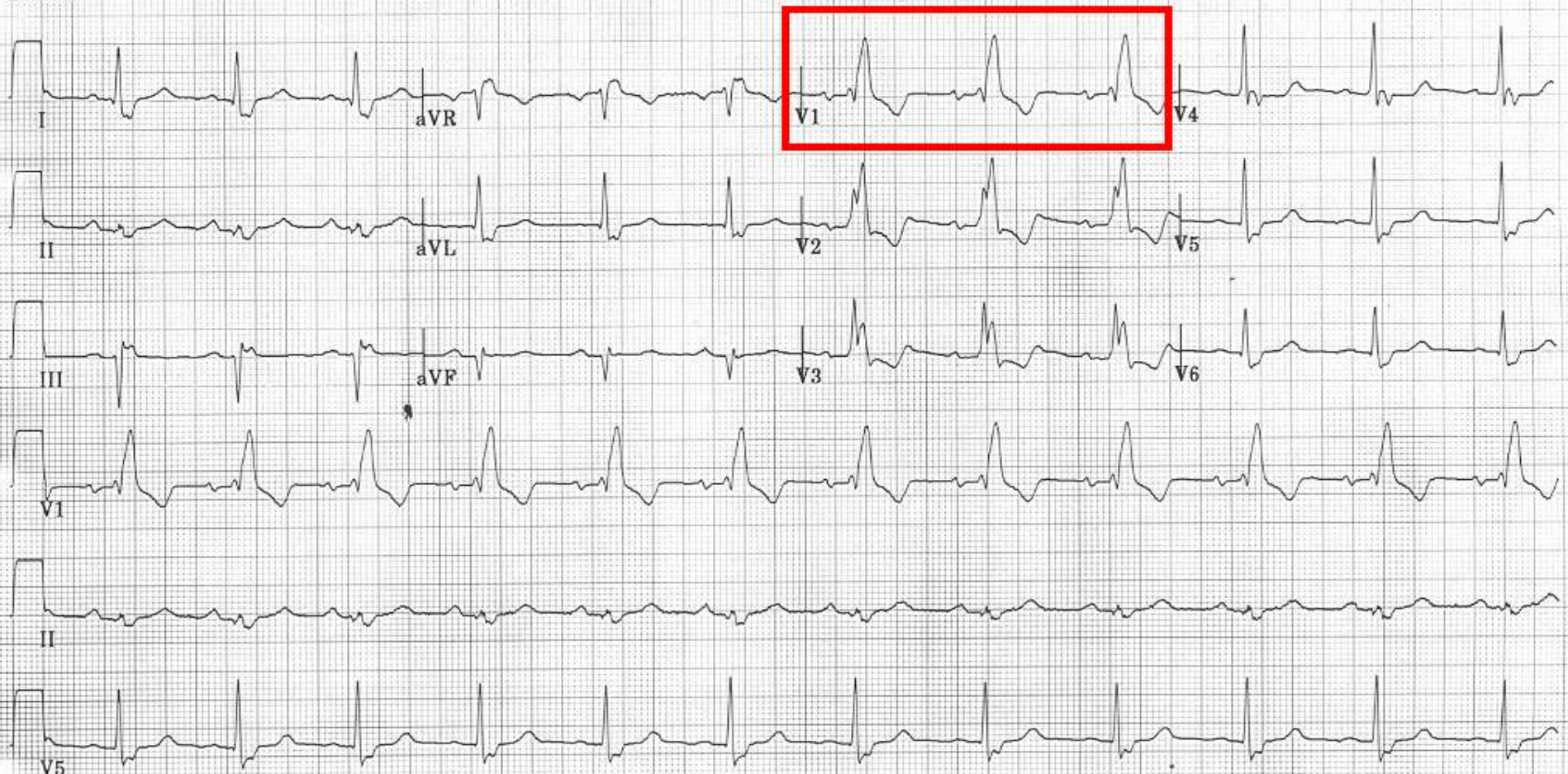
RUPPERT, WAYNE ID: 099999999 4-Mar-2001

74years		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

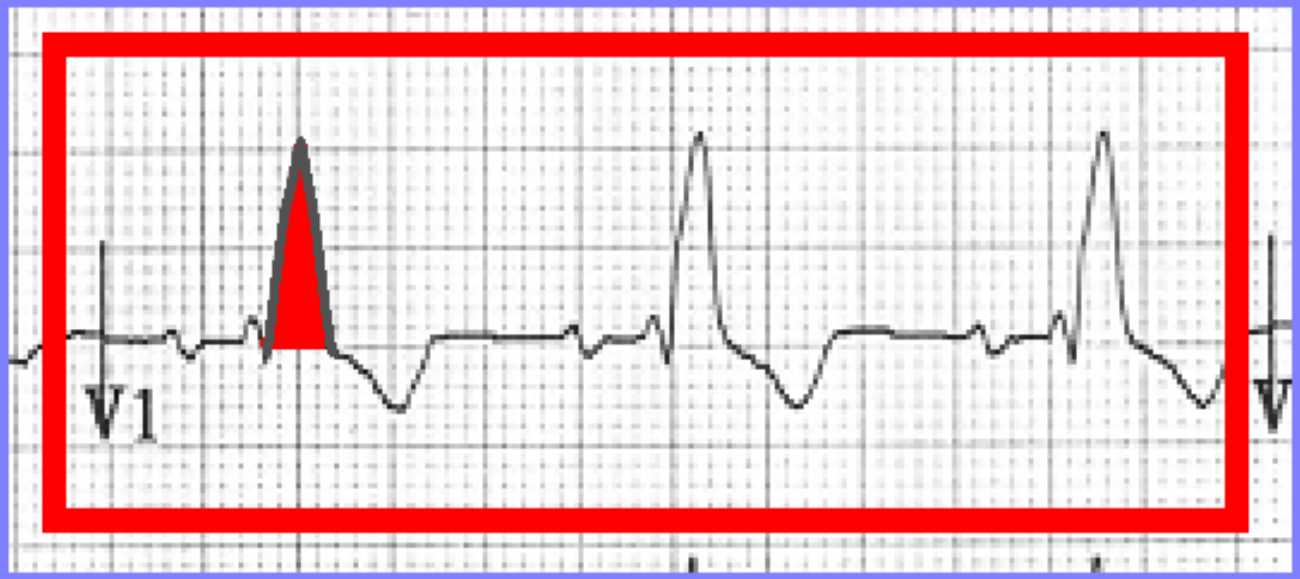
D.O.S.:



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

TERMINAL PHASE OF QRS IS

POSITIVE



= RIGHT BUNDLE BRANCH BLOCK

09:16:40

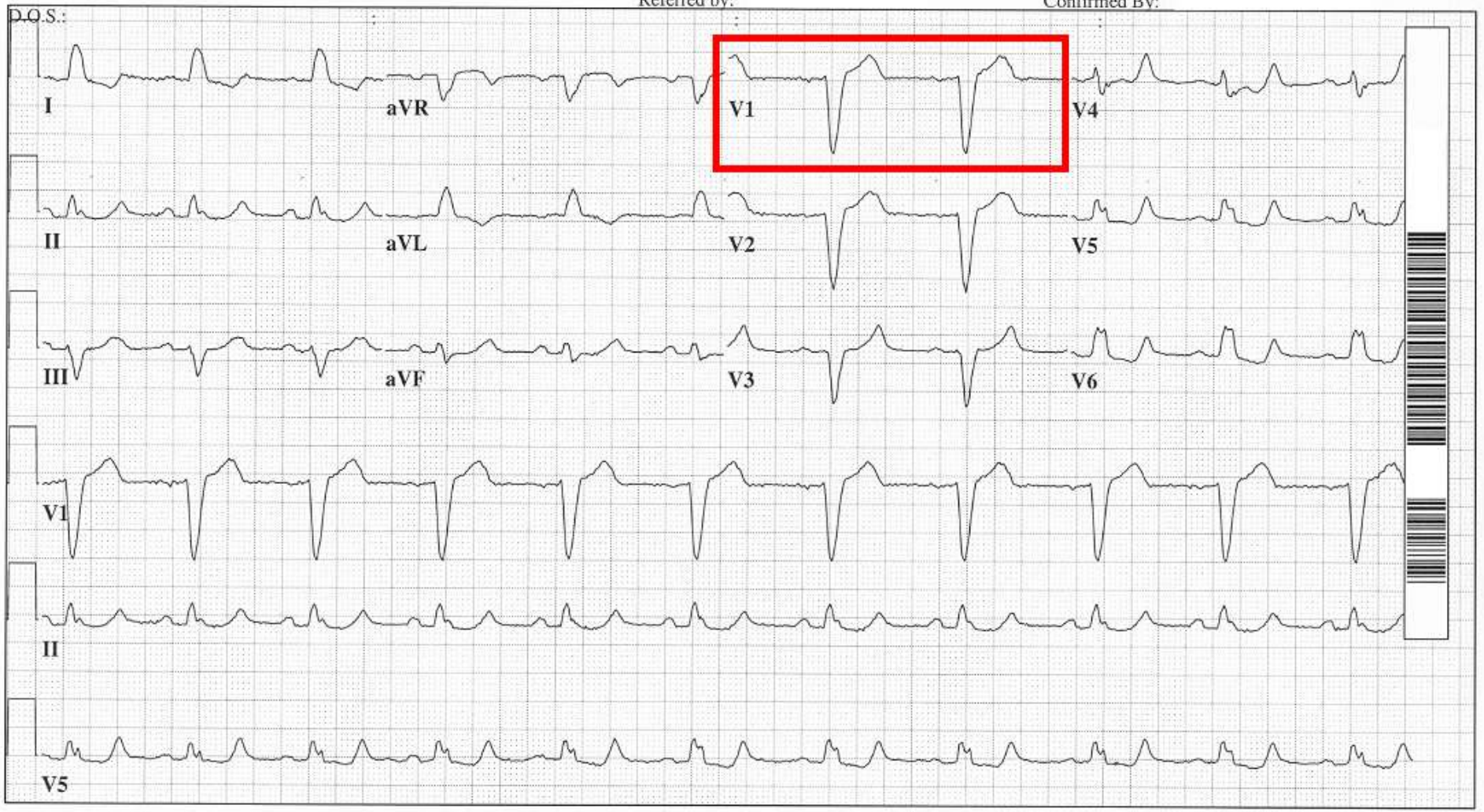
74 yr		Vent. rate	64	BPM	Normal sinus rhythm
Female	Caucasian	PR interval	188	ms	Left bundle branch block
		QRS duration	152	ms	Abnormal ECG
		QT/QTc	472/486	ms	When compared with ECG of 28-MAY-2003 06:36,
Loc:7	Option:35	P-R-T axes	78 3	106	

EKG #WR03029959

Technician: WW

Referred by: Confirmed By:

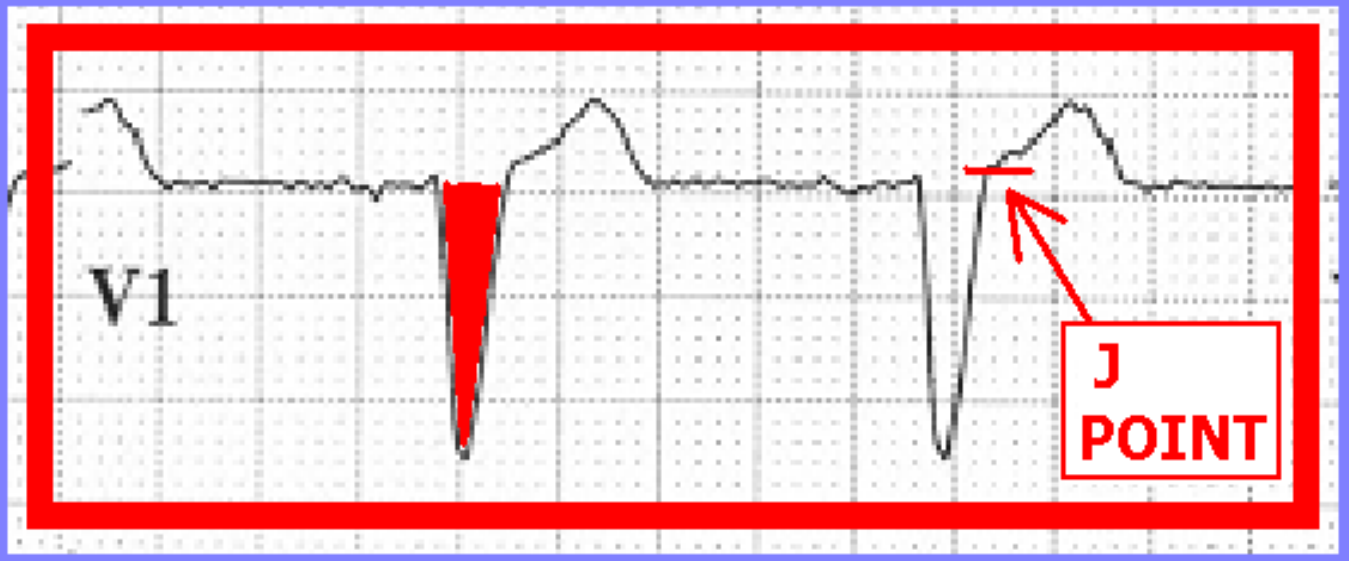
P.O.S.:



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

EID:5 EDT:

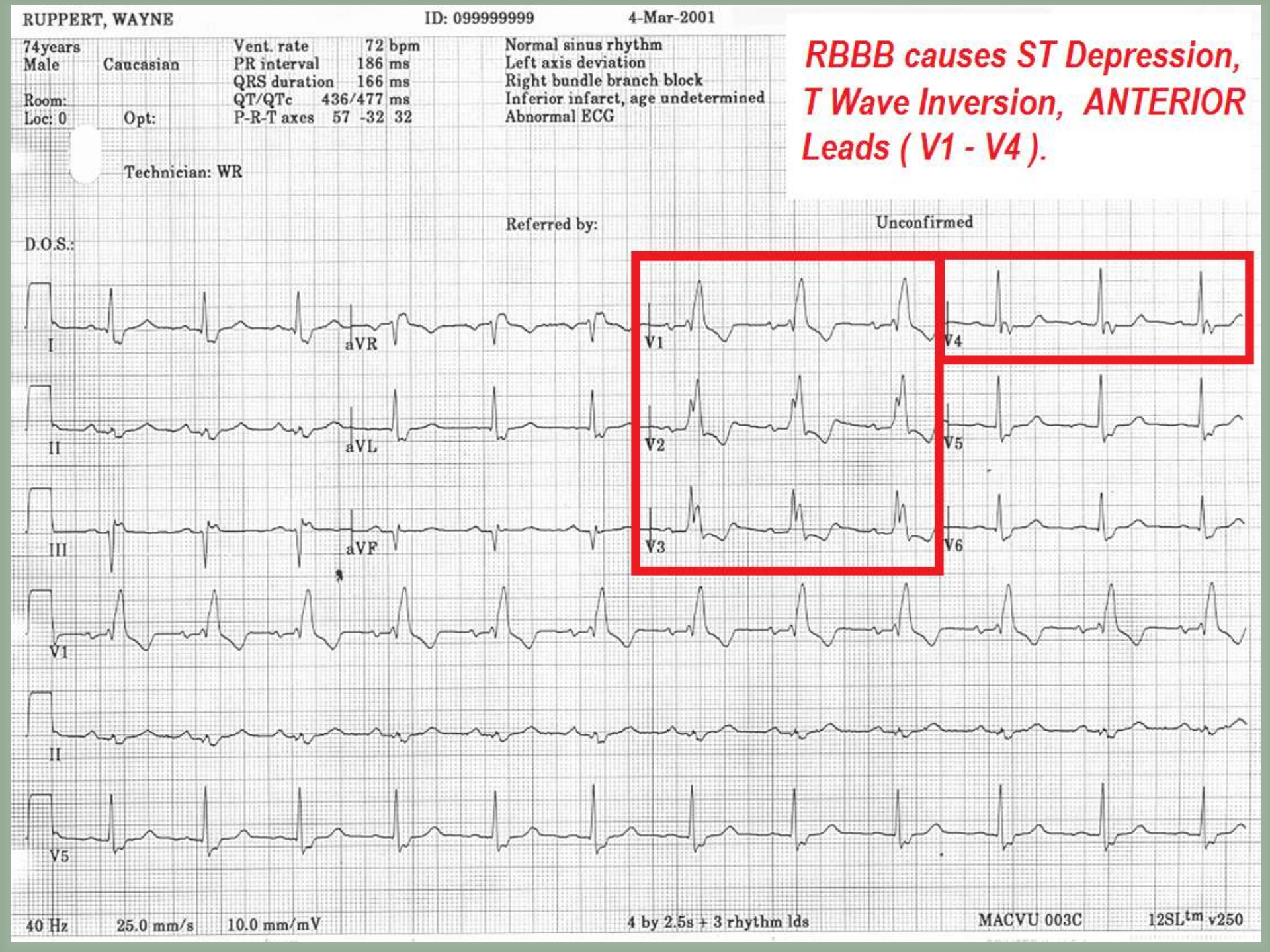
TERMINAL PHASE OF QRS IS NEGATIVE



= LEFT BUNDLE BRANCH BLOCK

Wide QRS present:
(QRSd > 120ms)

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



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

Wide QRS present:
(QRSd > 120ms)

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

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

48 yr
Male Caucasian

Room:ATL
Loc:3 Option:23

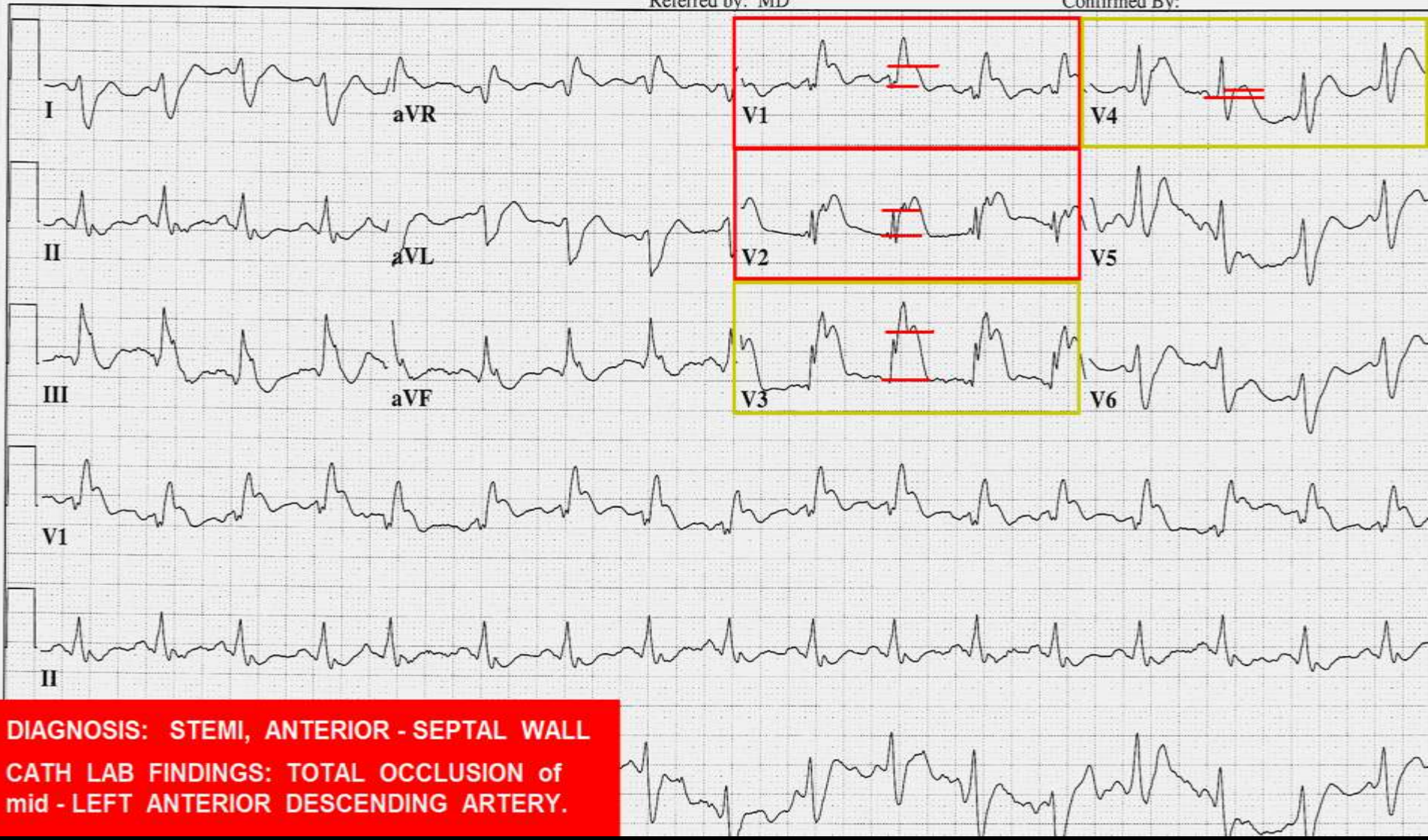
Vent. rate	102	BPM
PR interval	130	ms
QRS duration	168	ms
QT/QTc	400/521	ms
P–R–T axes	60 114	–19

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

Technician: W Ruppert

Referred by: MD

Confirmed By:



DIAGNOSIS: STEMI, ANTERIOR - SEPTAL WALL

CATH LAB FINDINGS: TOTAL OCCLUSION of mid - LEFT ANTERIOR DESCENDING ARTERY.

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

25 yr
Male Caucasian

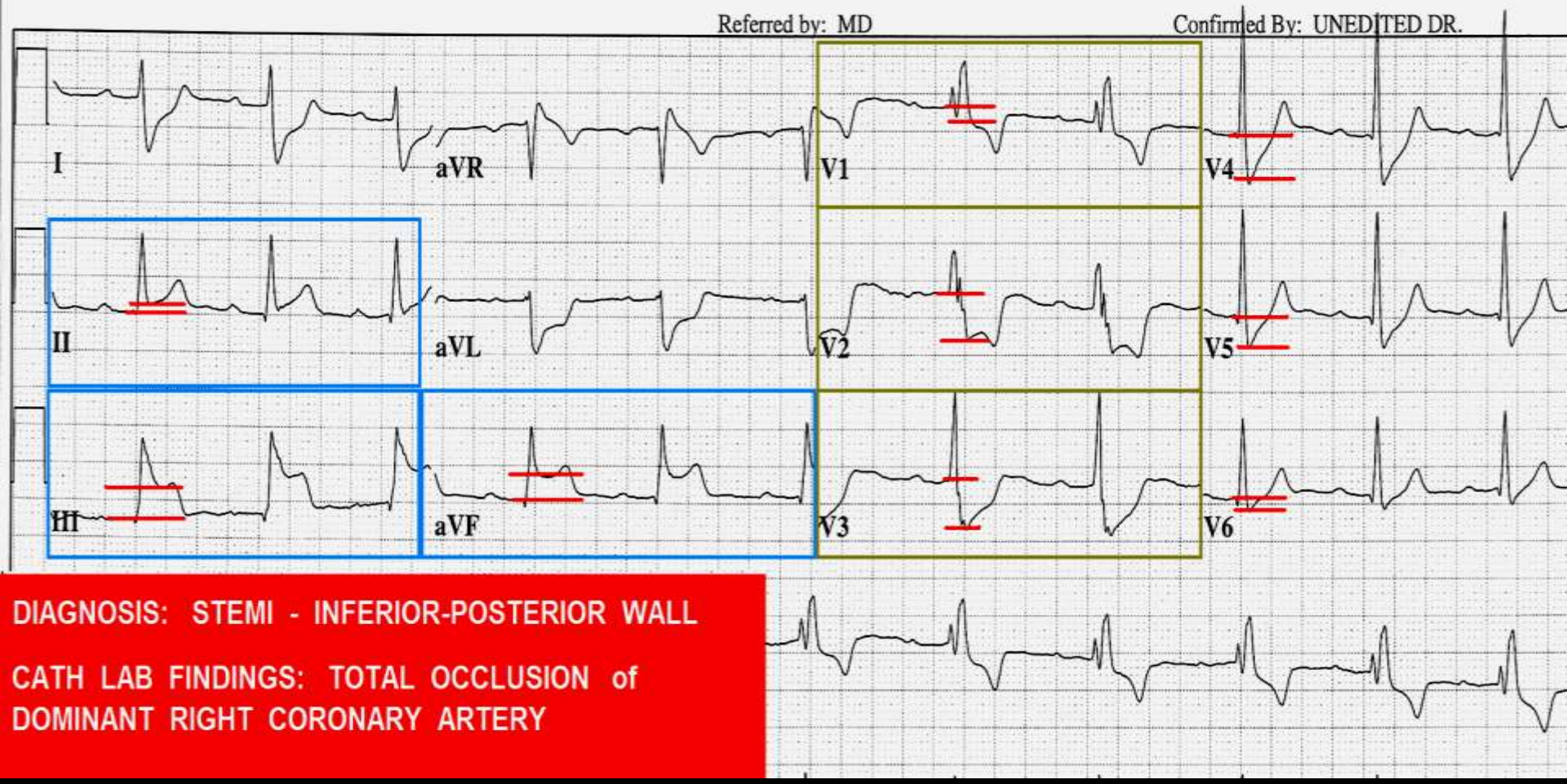
Loc:3 Option:23

Vent. rate	67	BPM
PR interval	258	ms
QRS duration	136	ms
QT/QTc	398/420	ms
P-R-T axes	44 94	82

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

Referred by: MD

Confirmed By: UNEDITED DR.



DIAGNOSIS: STEMI - INFERIOR-POSTERIOR WALL

CATH LAB FINDINGS: TOTAL OCCLUSION of DOMINANT RIGHT CORONARY ARTERY

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

75 yr
Male Caucasian

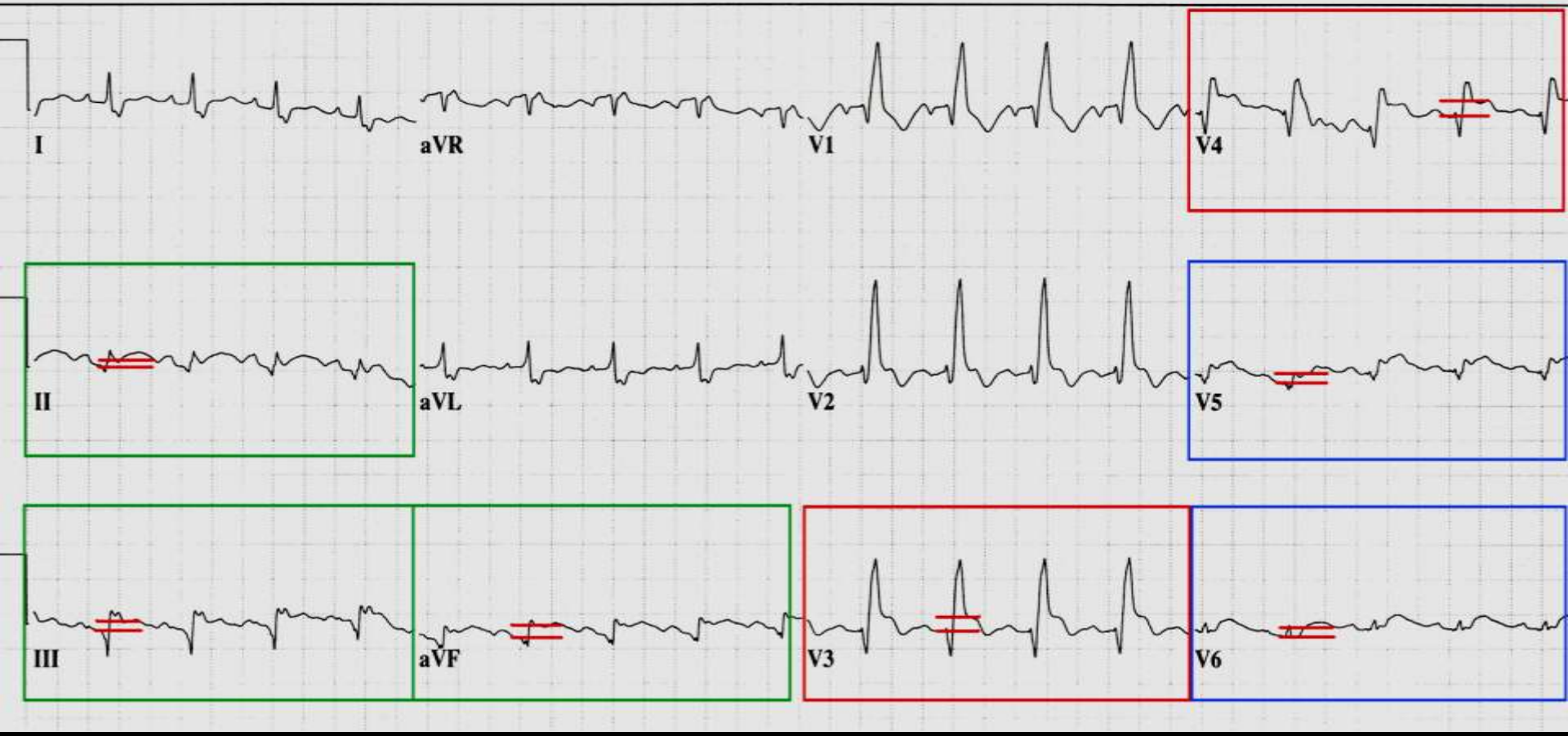
Room:CS–19
Loc:6 Option:41

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

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

ACUTE LATERAL - INFERIOR - ANTERIOR AMI

CATH LAB FINDINGS: OCCLUDED VEIN GRAFT TO THE CIRCUMFLEX DISTRIBUTION (DOMINANT CIRCUMFLEX)



Wide QRS present:

(QRSd > 120ms)

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

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(QRSd > 120ms)

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

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  - ***Can cause up to 5mm of J Point Elevation in normally calibrated ECG (1mm=10mv)***

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(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***

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

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

A.H.A. ACLS GUIDELINES

1. If patient has a CONFIRMED HISTORY of LBBB, rely on:
   - CARDIAC MARKERS
   - SYMPTOMS
   - RISK FACTOR PROFILE
   - HIGH INDEX OF SUSPICION

   for diagnosis of STEMI

2. If patient has:

   a) previously NORMAL ECGs (no LBBB)

   -- or --

   b) no old ECGs available for comparison

   consider diagnosis as STEMI until proven otherwise.

78 yr
Female Black

Room:ICU5
Loc:6 Option:19

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

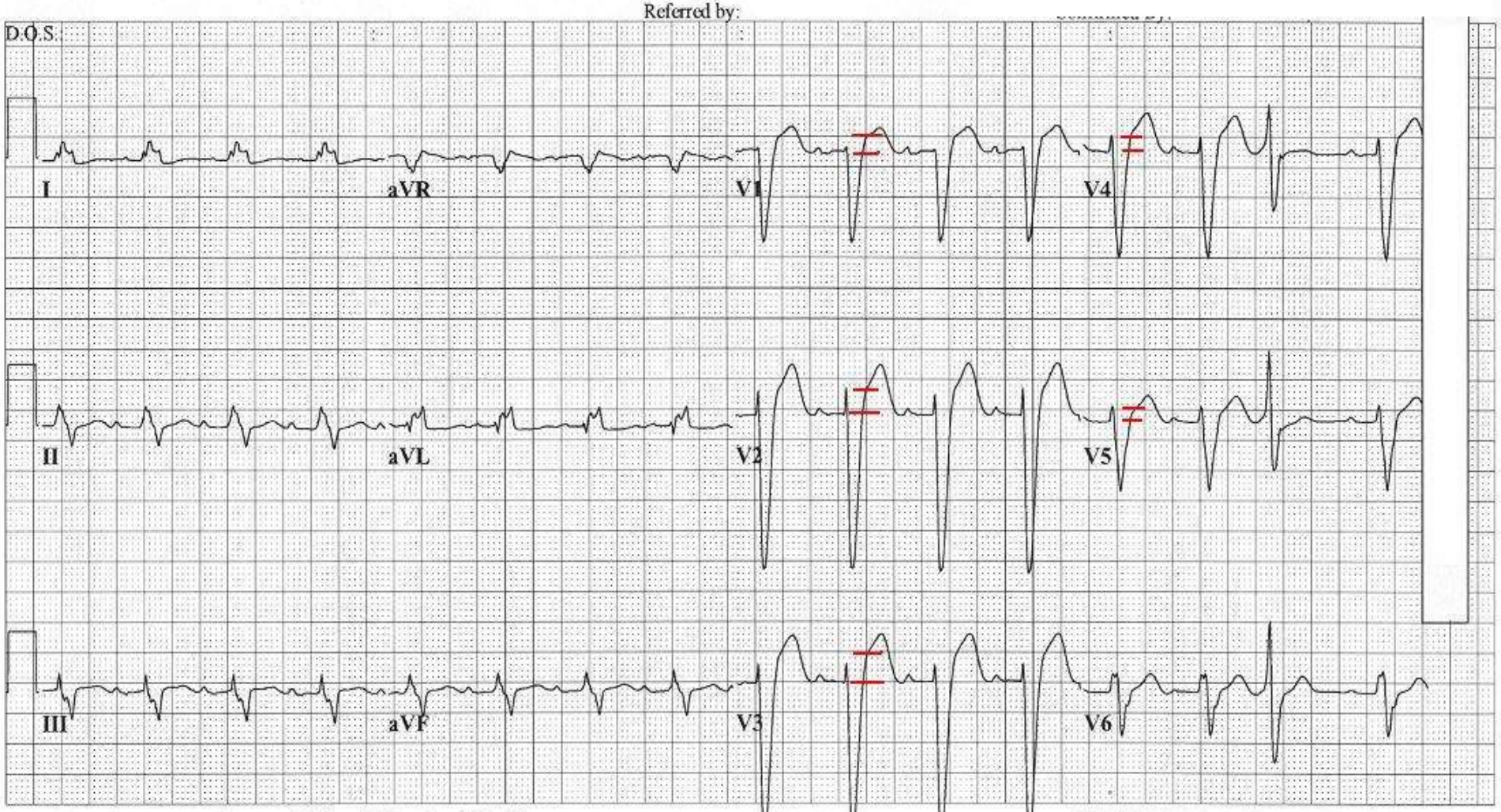
Normal sinus rhythm with occasional Premature ventricular complexes
Left bundle branch block
Abnormal ECG

- Normal arteries
- Normal LV Function
- No hypertrophy

Technician: EKG CLASS #WR03602718

Referred by:

D.O.S.



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

EID:18 EDT:

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.

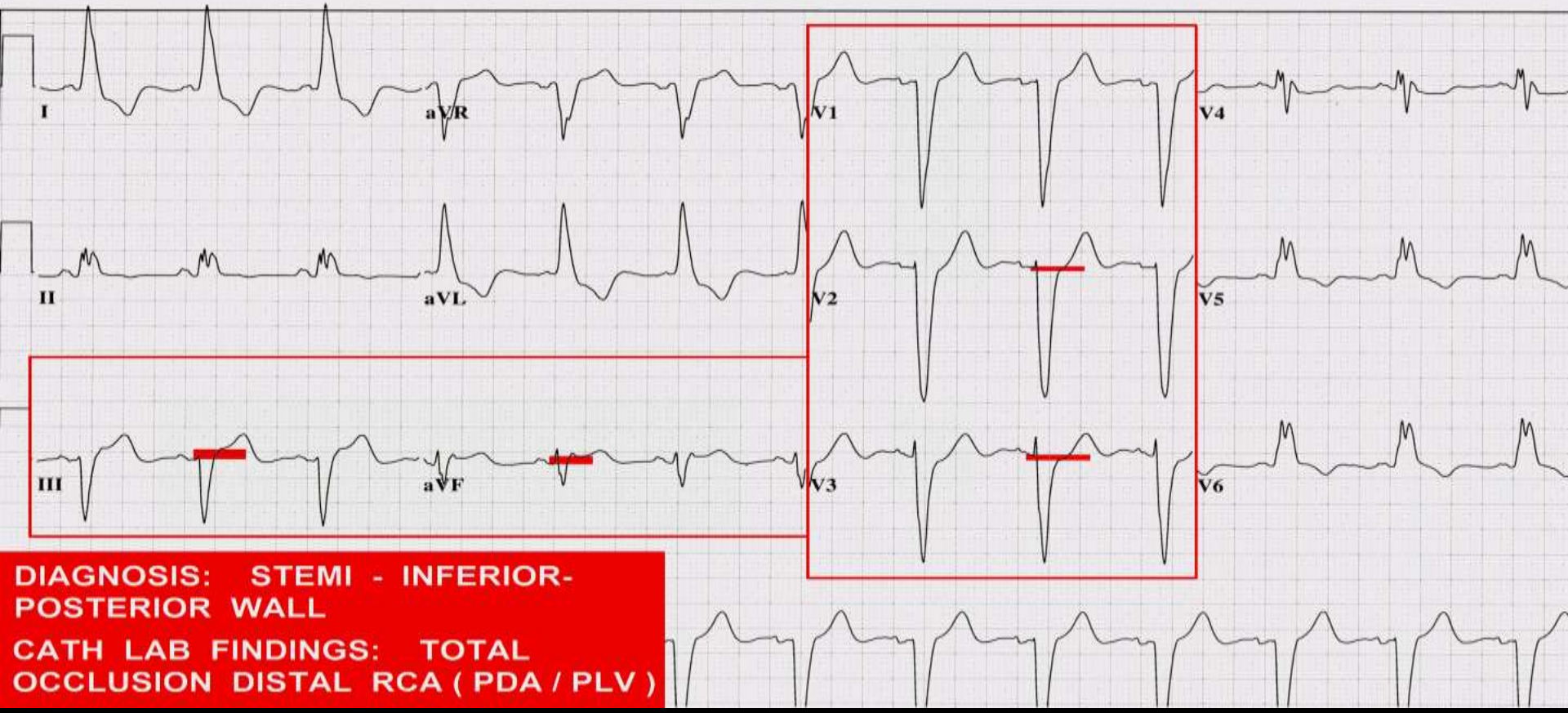
LBBB with CHEST PAIN - CASE 1 : PRESENTING EKG

58 yr
Female Hispanic

Room: ER
Loc:3 Option:23

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

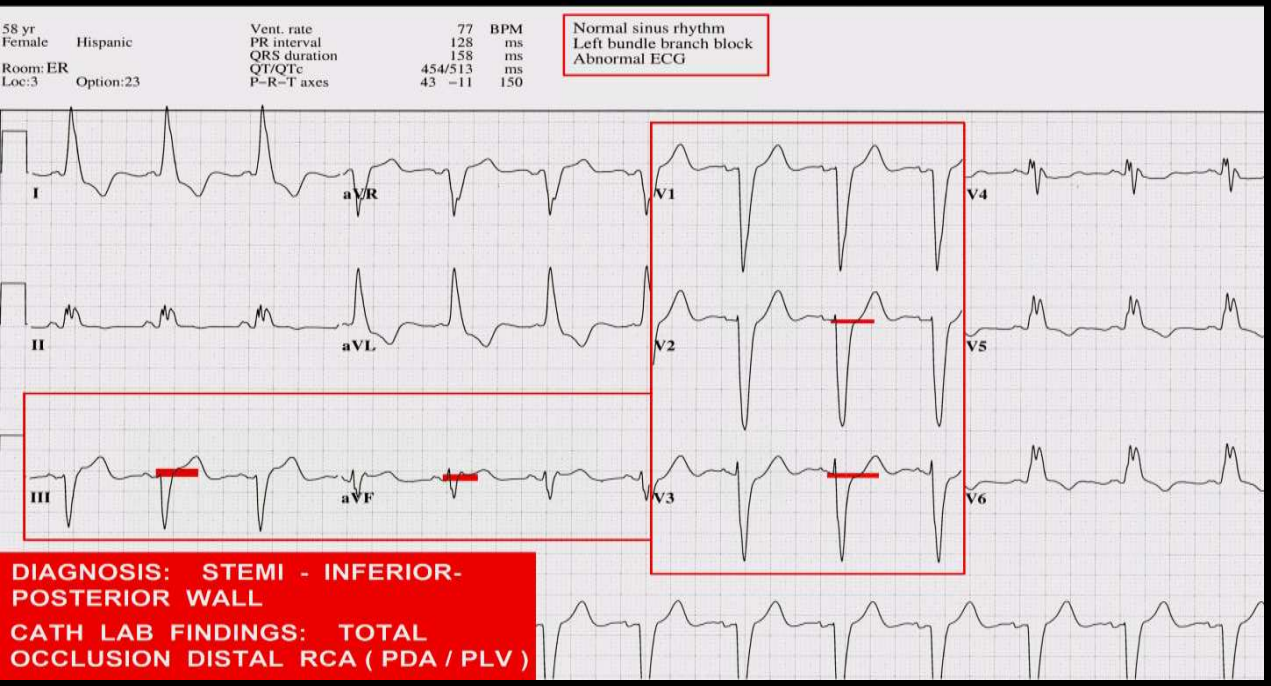
Normal sinus rhythm
Left bundle branch block
Abnormal ECG



DIAGNOSIS: STEMI - INFERIOR-POSTERIOR WALL

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

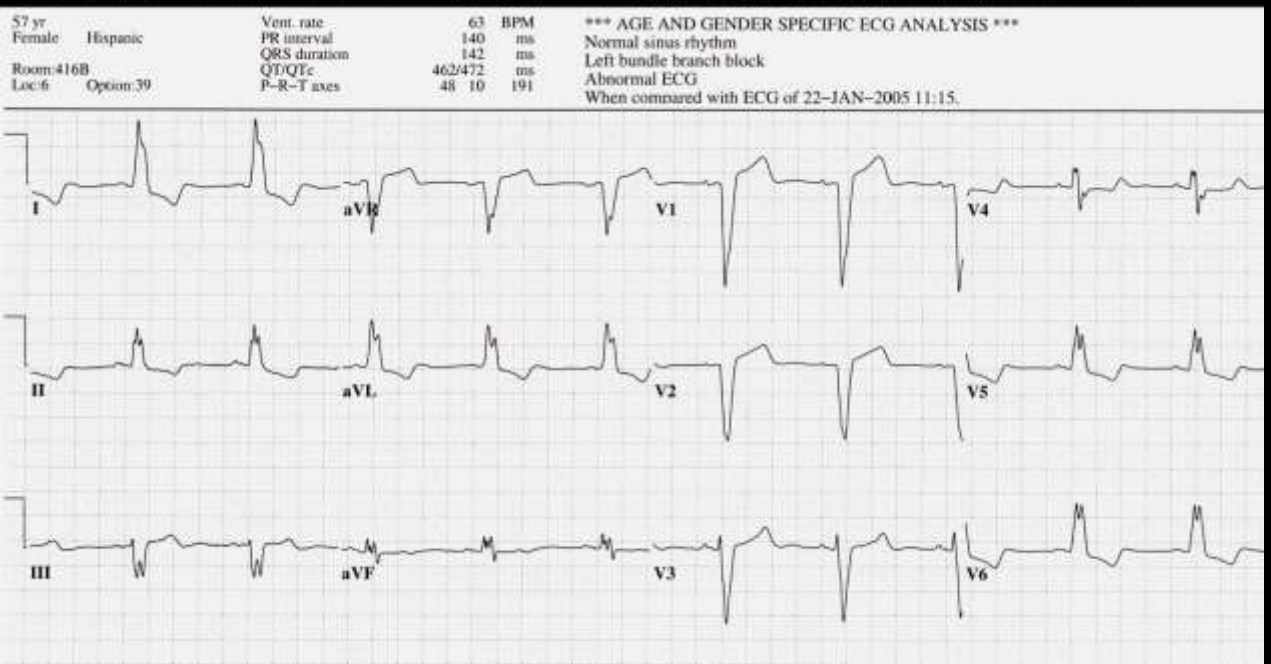
LBBB with CHEST PAIN - CASE 1: PRESENTING EKG

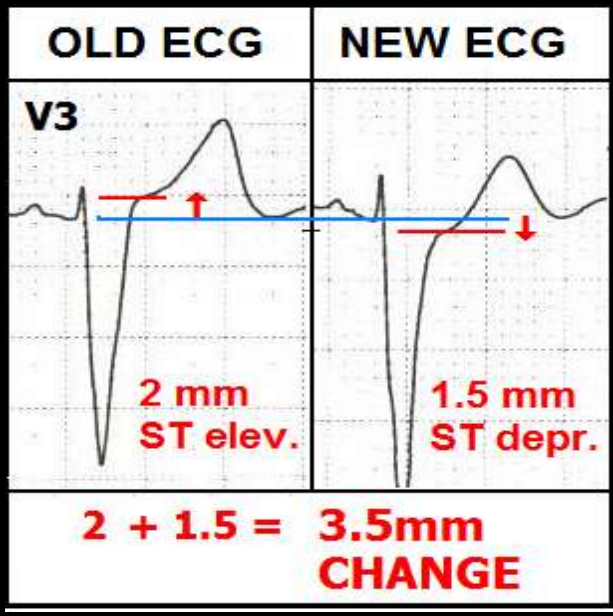


DIAGNOSIS: STEMI - INFERIOR-POSTERIOR WALL

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

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





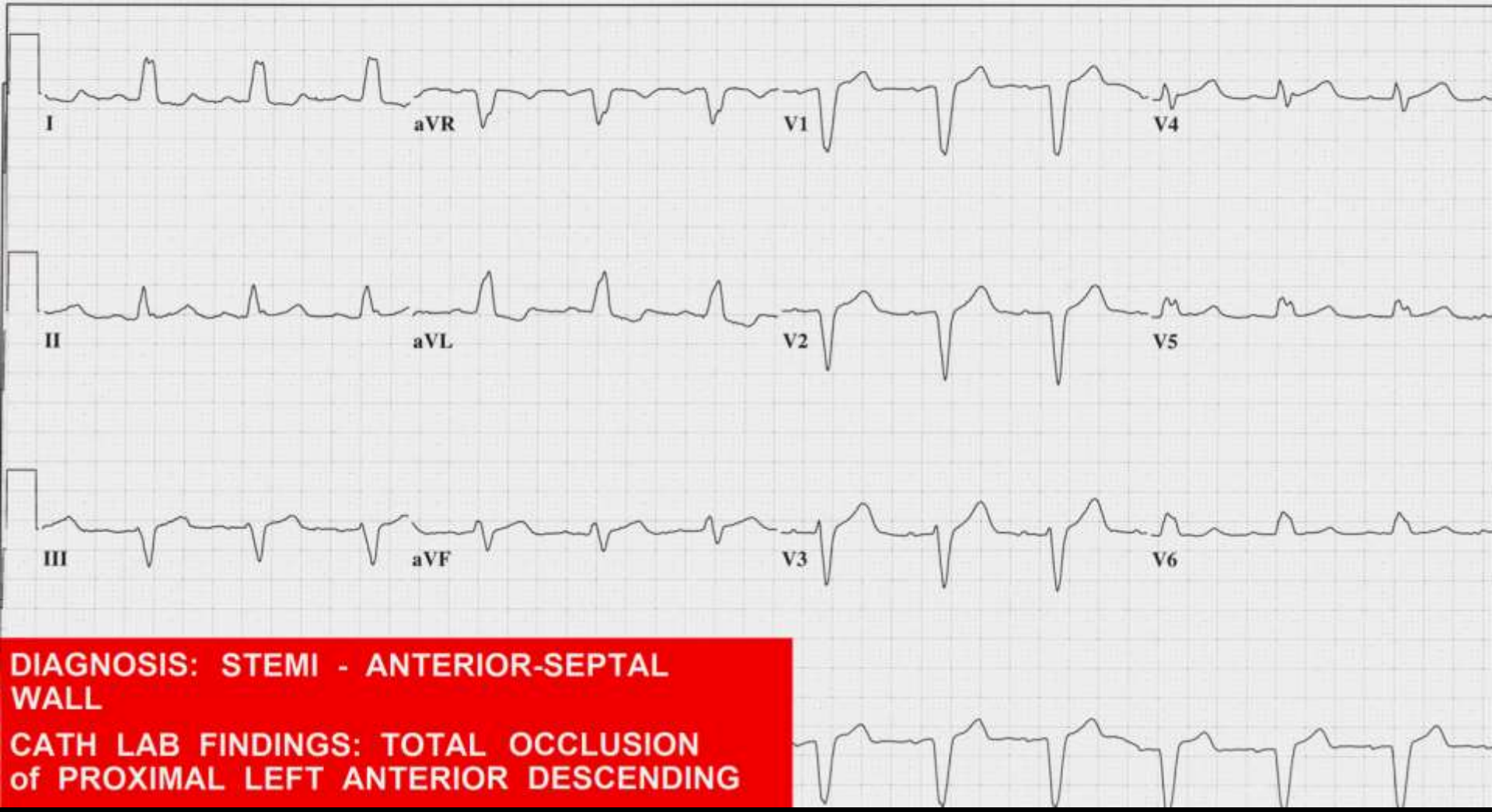
LBBB with CHEST PAIN - CASE 2: *NEW ONSET of LBBB*

46 yr
Male Caucasian

Room:ER
Loc:3 Option:23

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

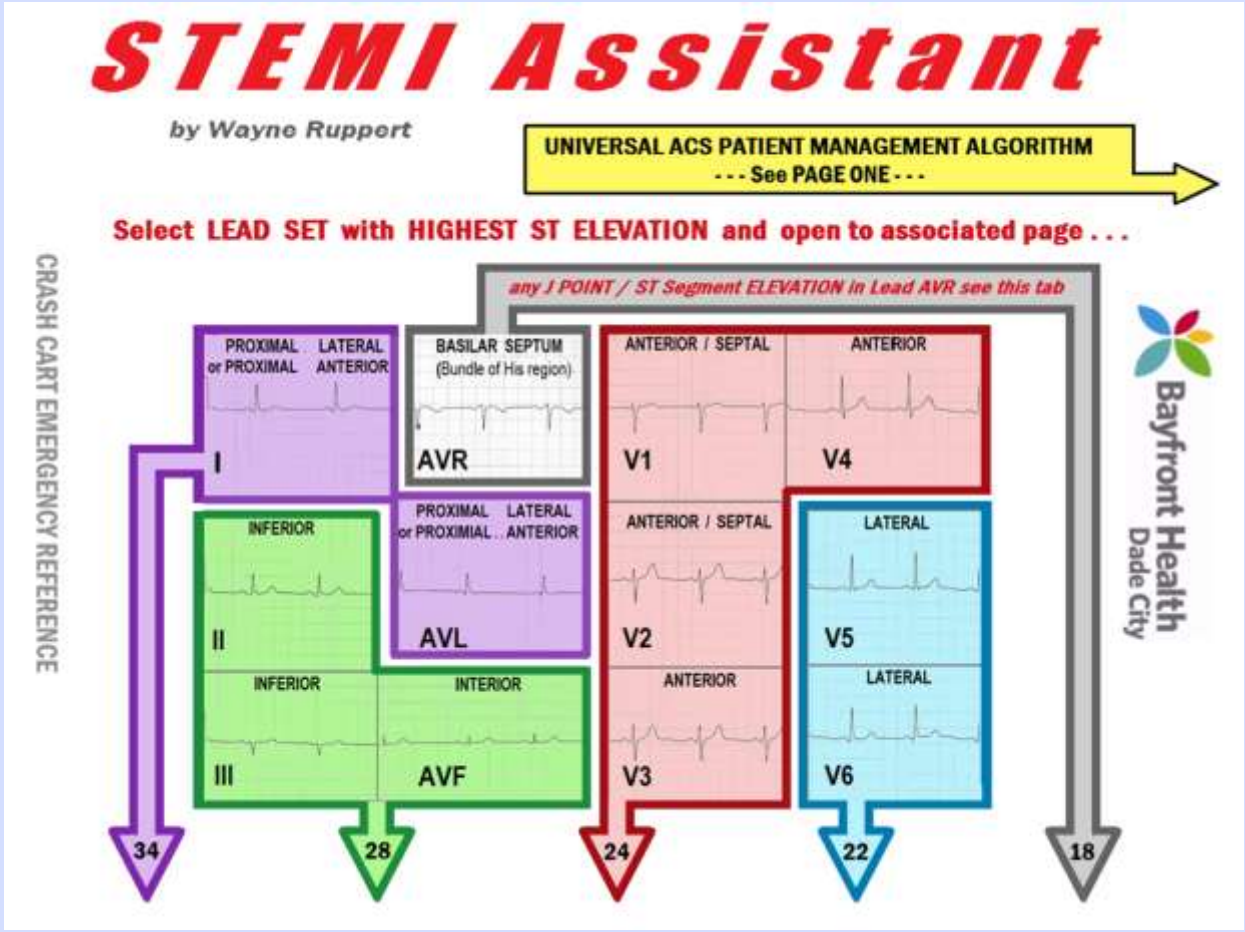
Normal sinus rhythm
Left bundle branch block
Abnormal ECG



DIAGNOSIS: STEMI - ANTERIOR-SEPTAL WALL

CATH LAB FINDINGS: TOTAL OCCLUSION of PROXIMAL LEFT ANTERIOR DESCENDING

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



STEMI Assistant – Information Video

Helpful STEMI ECG Resources

[1] "Use of the Electrocardiogram in Acute Myocardial Infarction," Zimetbaum, et al, NEJM 348:933-940

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

ECG in STEMI – excellent powerpoint – quick reference, in-depth material

Helpful STEMI ECG Resources

Download Non-ED STEMI Protocol - example

Download STEMI Alert ED Physicians Order Set

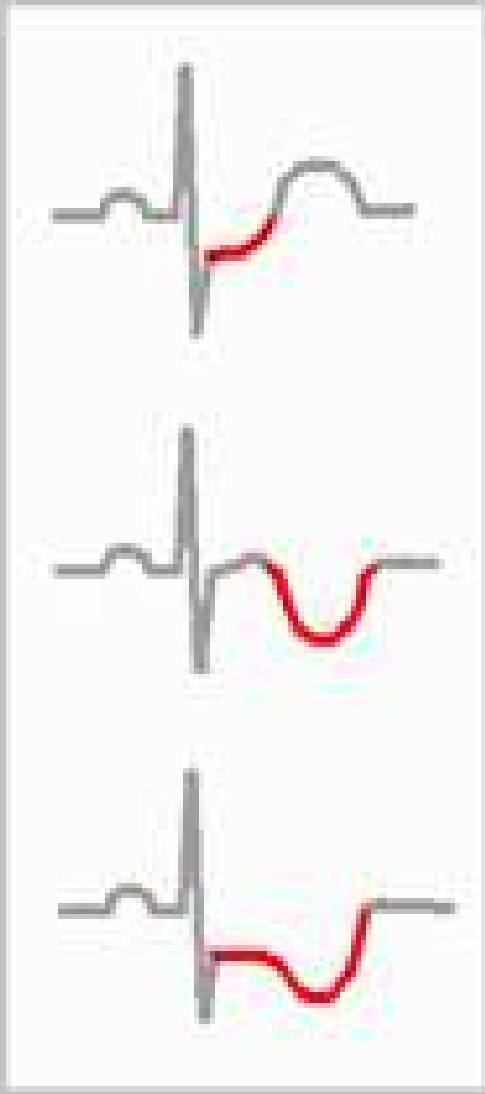
ISCHEMIA

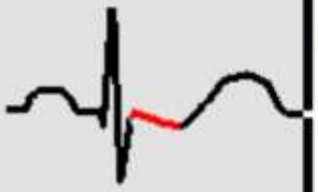
HELPFUL PATTERNS . . .

J POINT DEPRESSION
(> 1 mm)

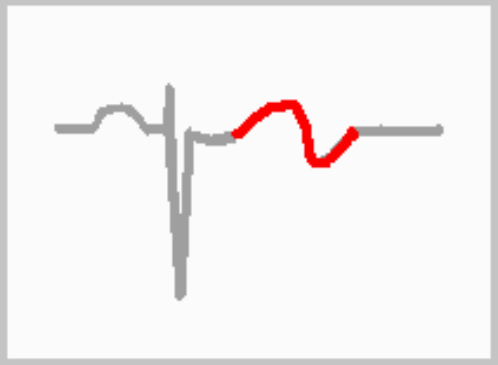
INVERTED T WAVES

J POINT DEPRESSION
+ INVERTED T WAVES



INVERTED T WAVE		- MYOCARDITIS - ELECTROLYTE IMBAL. - ISCHEMIA
SHARP S-T T ANGLE		- ACUTE MI (NOT COMMON) - ISCHEMIA
BI-PHASIC T WAVE (WELLEN'S)		- SUB-TOTAL LAD LESION - VASOSPASM - HYPERTROPHY
DEPRESSED J POINT with UPSLOPING ST		- ISCHEMIA
DOWNSLOPING S-T SEGMENT		- ISCHEMIA

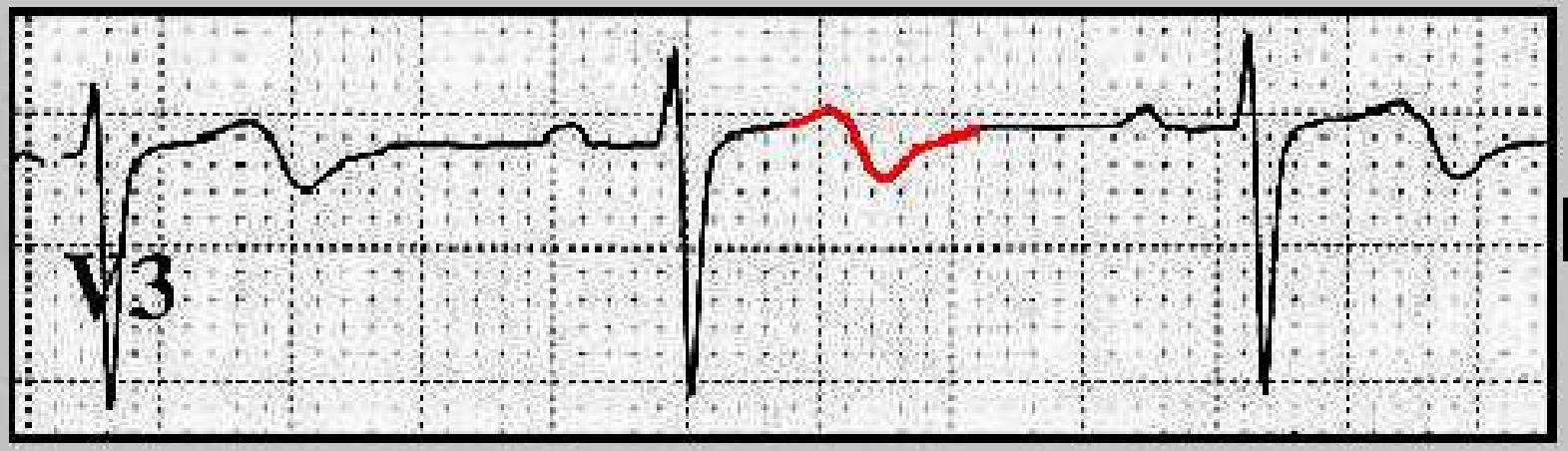
ISCHEMIA



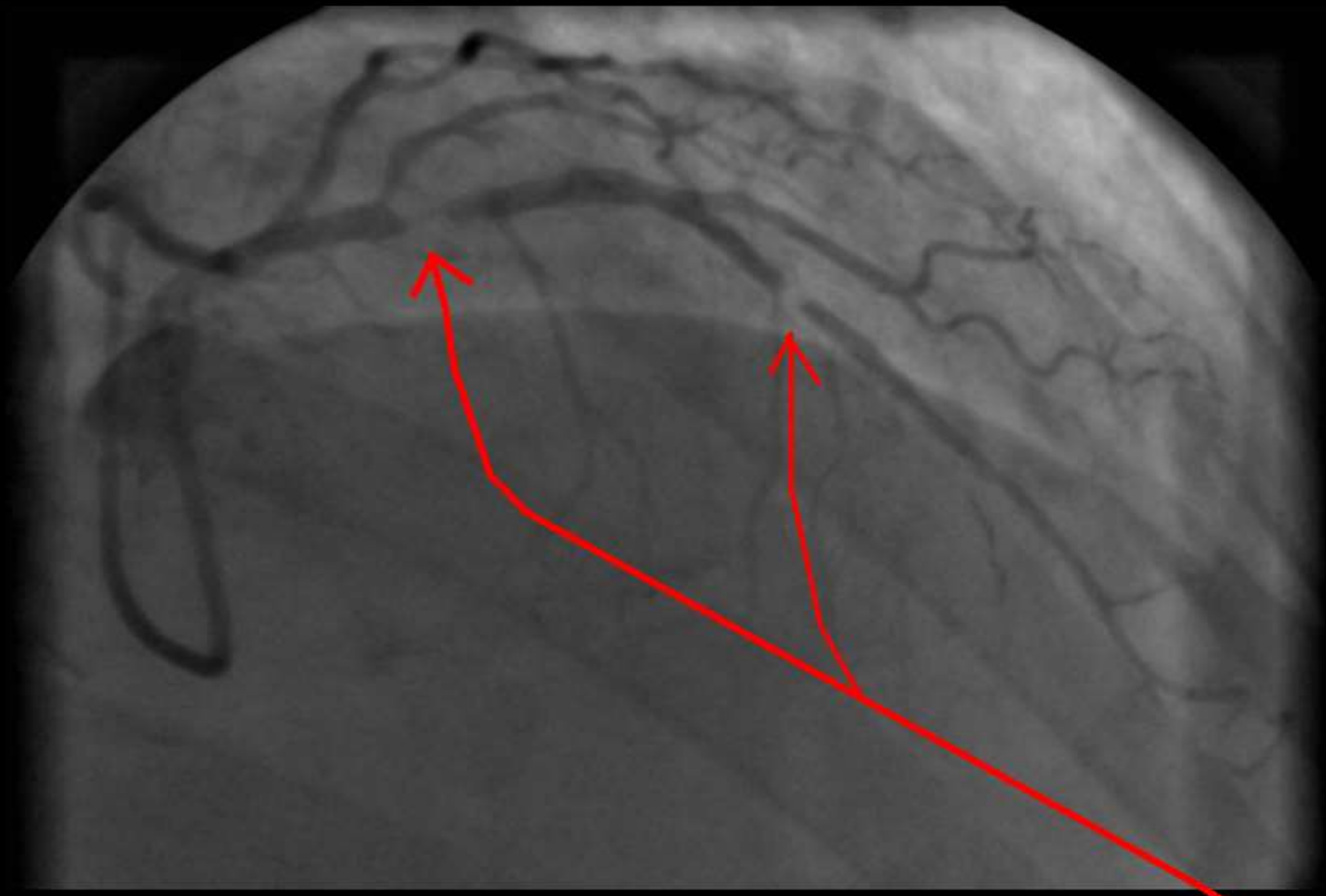
BI-PHASIC T WAVE

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

BI-PHASIC T WAVES



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



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

Classic "Wellen's Syndrome:"

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

Wellen's Syndrome ETIOLOGY:

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

Wellen's Syndrome EPIDEMIOLOGY & PROGNOSIS:

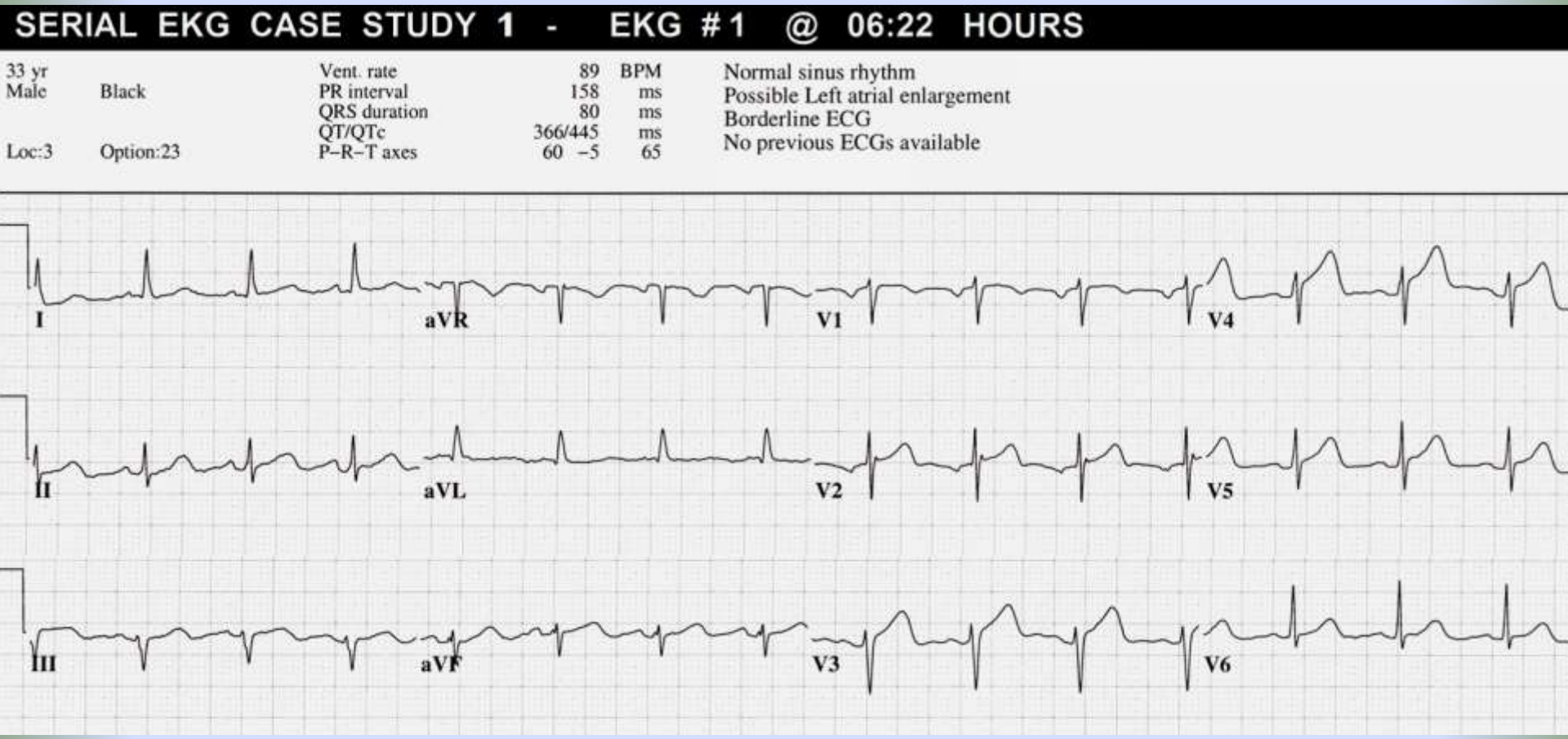
- **Present in 14-18% of patients admitted with unstable angina**
- **75% patients not treated developed extensive Anterior MI within 3 weeks.**
- ***Median Average time from presentation to Acute Myocardial Infarction – 8 days***

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

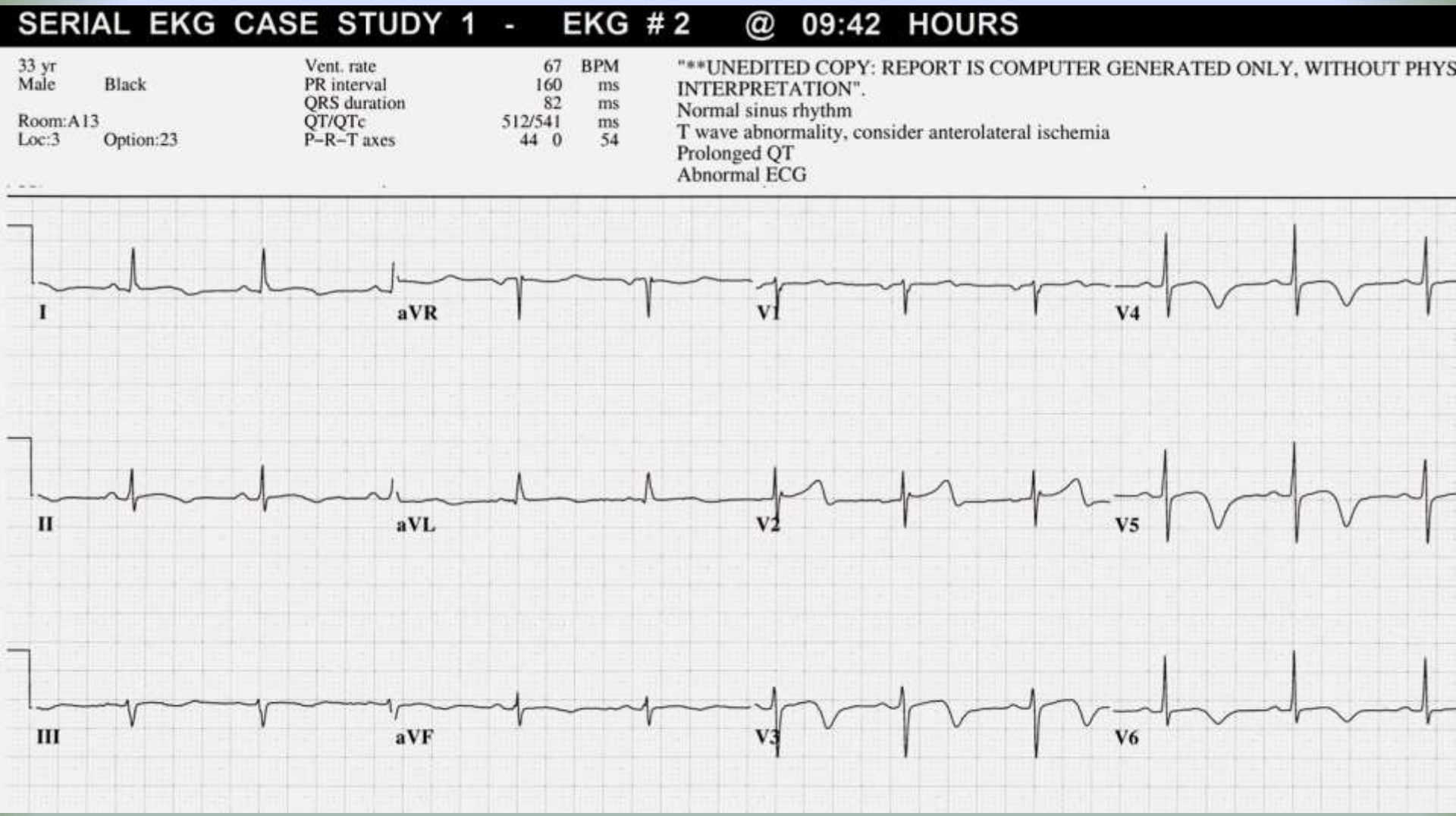
Wellen's Syndrome Case Study

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

Wellen's Syndrome Case Study



Wellen's Syndrome Case Study

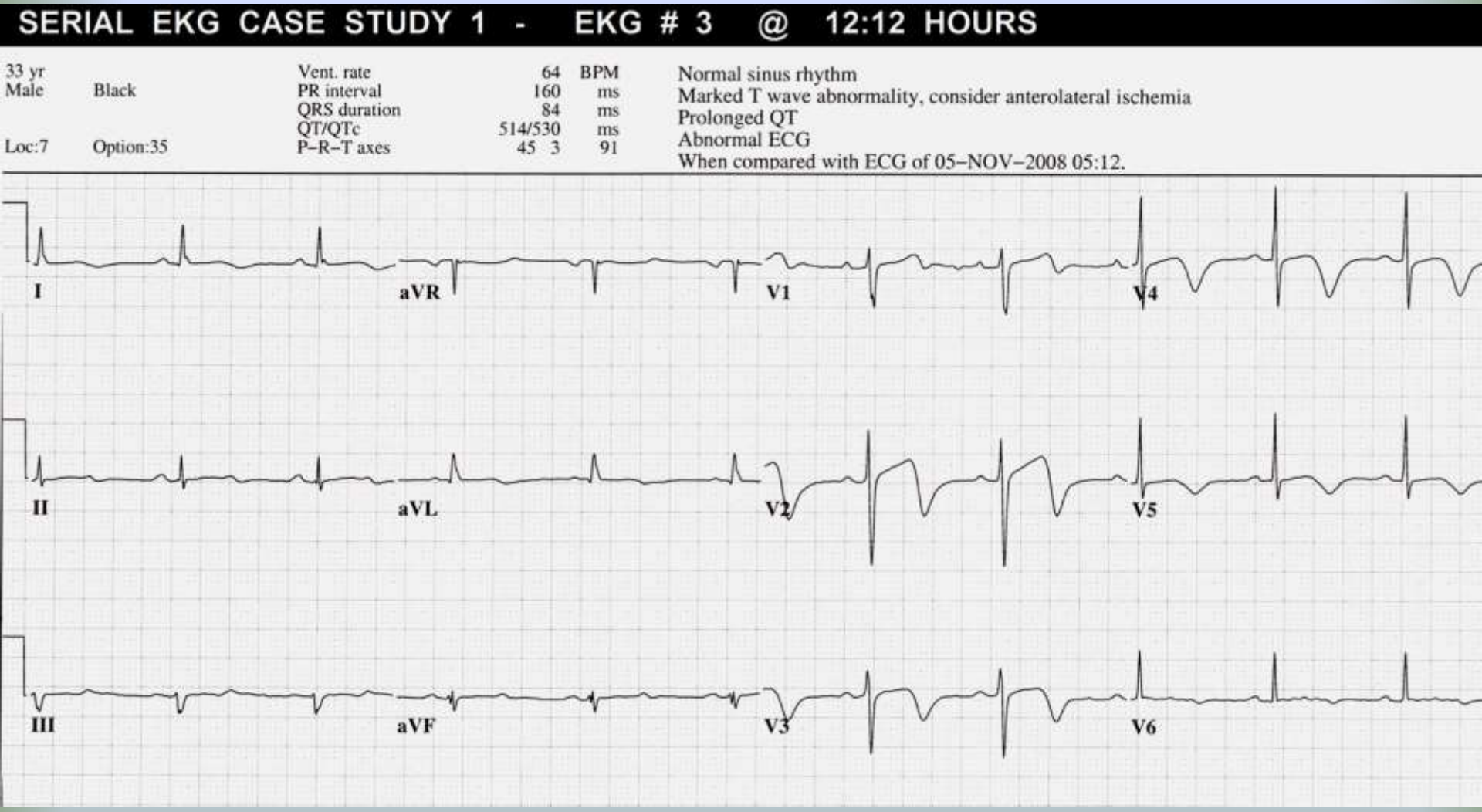


DYNAMIC ST-T Wave Changes ARE PRESENT !!

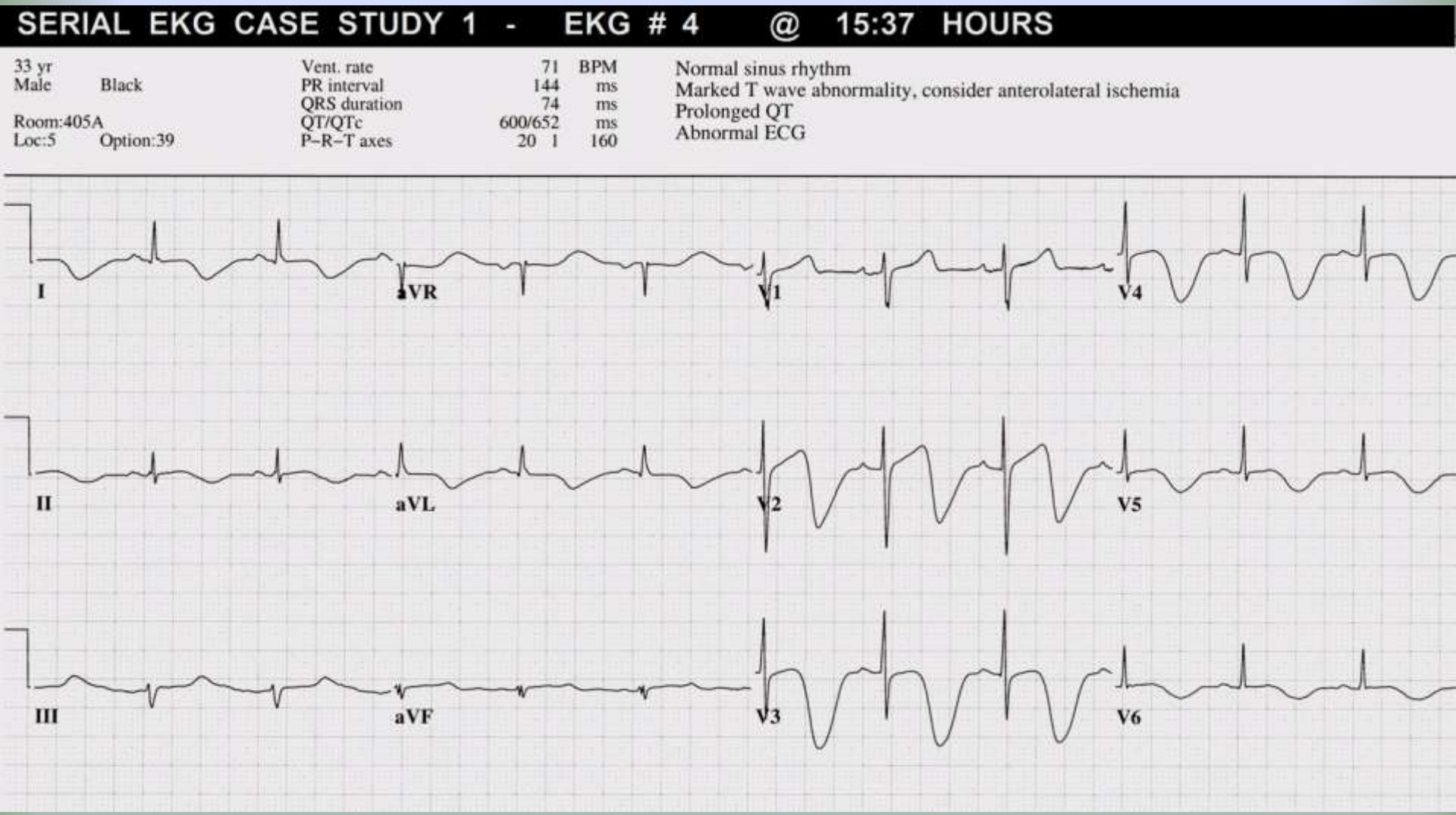
NOW

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

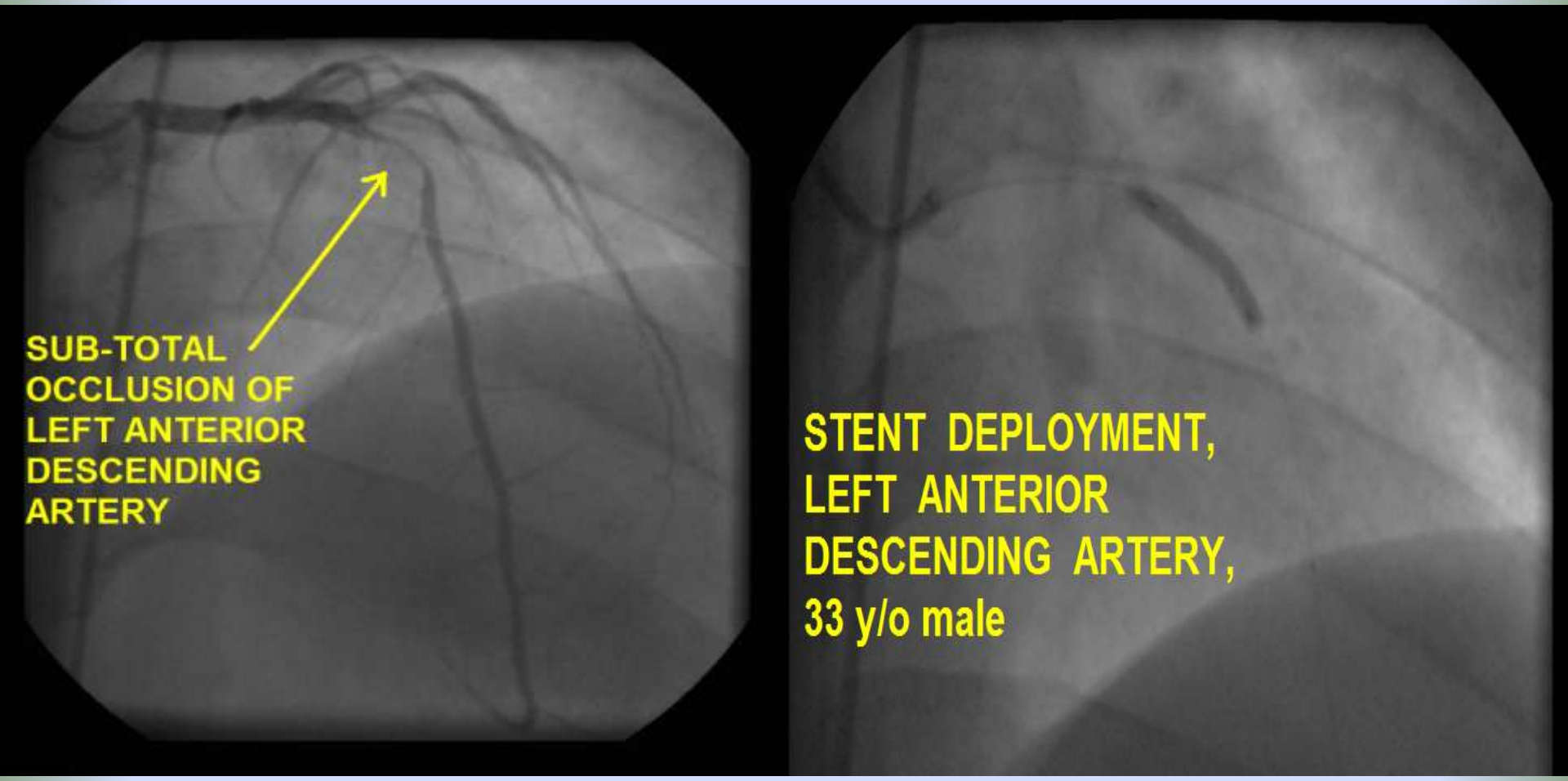
Wellen's Syndrome Case Study



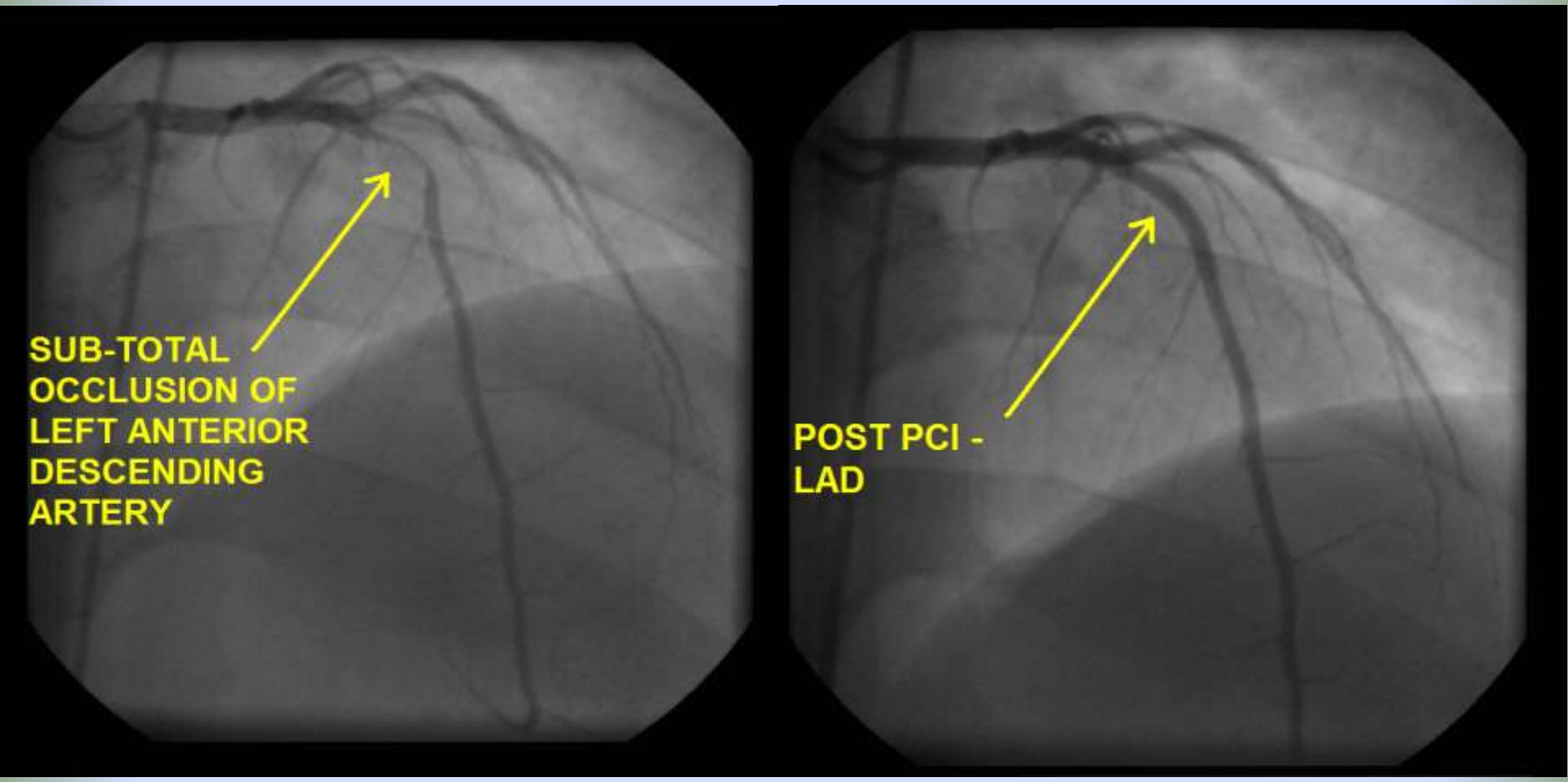
Wellen's Syndrome Case Study



Wellen's Syndrome Case Study



Wellen's Syndrome Case Study



Additional Resources:

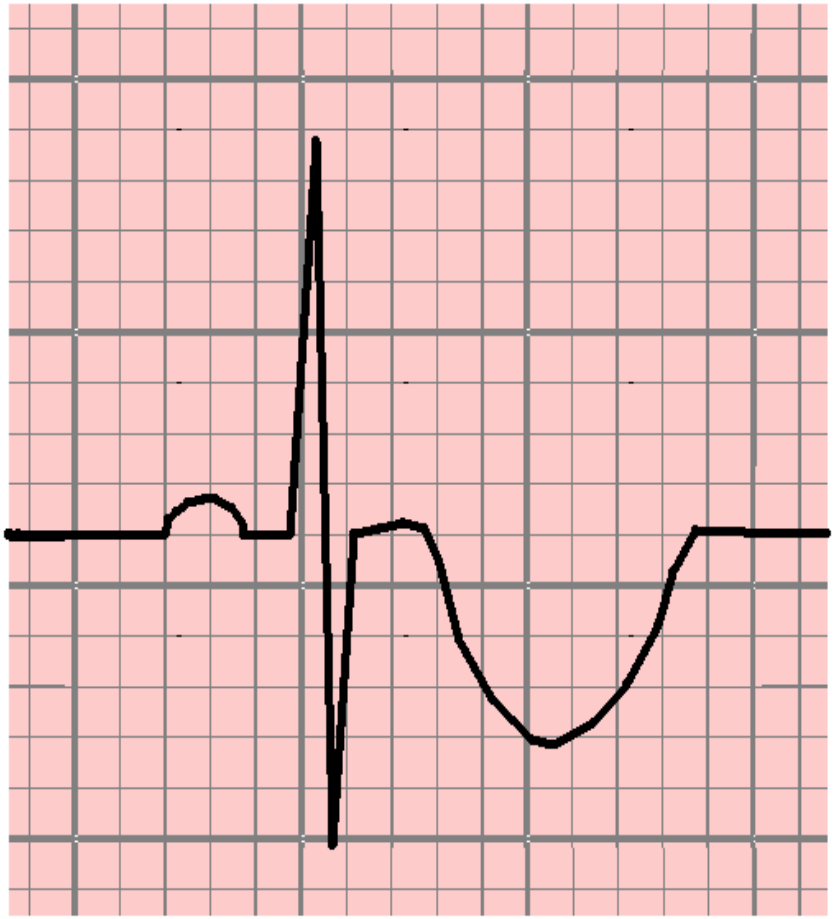
- Wellen's Syndrome, NEJM case study

S-T SEGMENT DEPRESSION - COMMON ETIOLOGIES:

CONDITION:

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

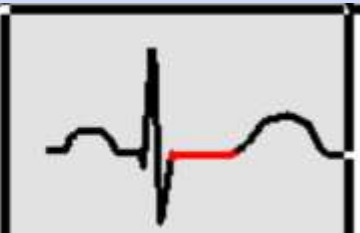
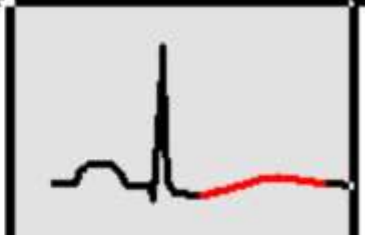
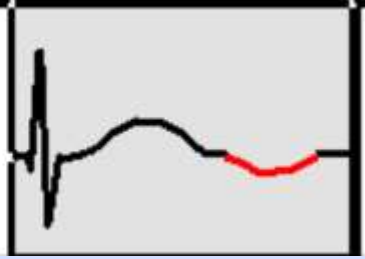
T WAVE INVERSION - COMMON ETIOLOGIES:



CONDITION:

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

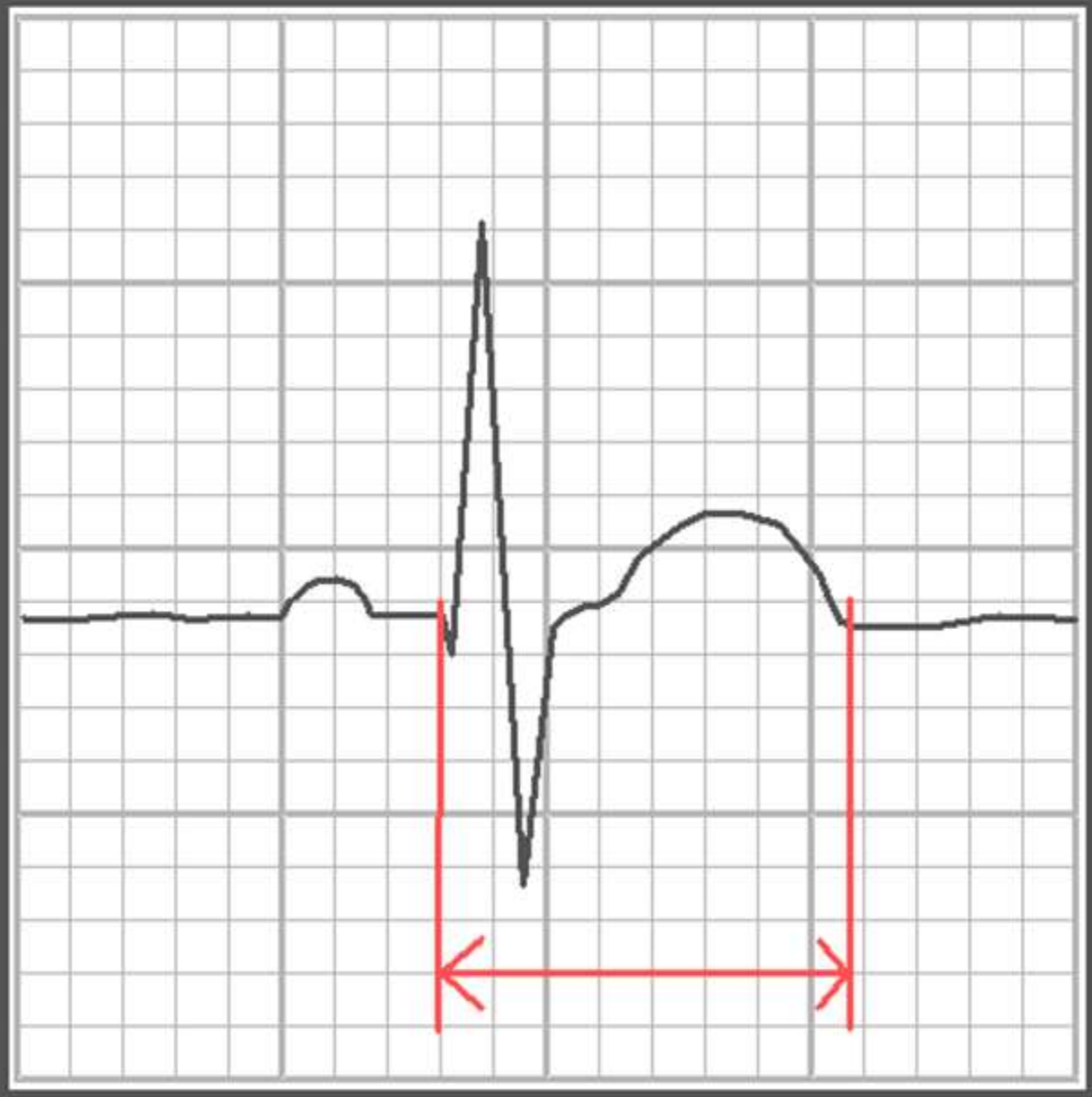
Some less common, less reliable possible indicators of ACS:

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

Long QT Syndrome

Q - T INTERVAL

- VARIES BASED ON HEART RATE AND SEX



THE *QTc INTERVAL

*QTc = Q-T interval, *corrected* for heart rate

HEART RATE	MALE	FEMALE
150	0.25	0.28
125	0.26	0.29
100	0.31	0.34
93	0.32	0.35
83	0.34	0.37
71	0.37	0.40
60	0.40	0.44
50	0.44	0.48
43	0.47	0.51

Annals of Internal Medicine, 1988 109:905.

Determining the QTc

Manual calculation:

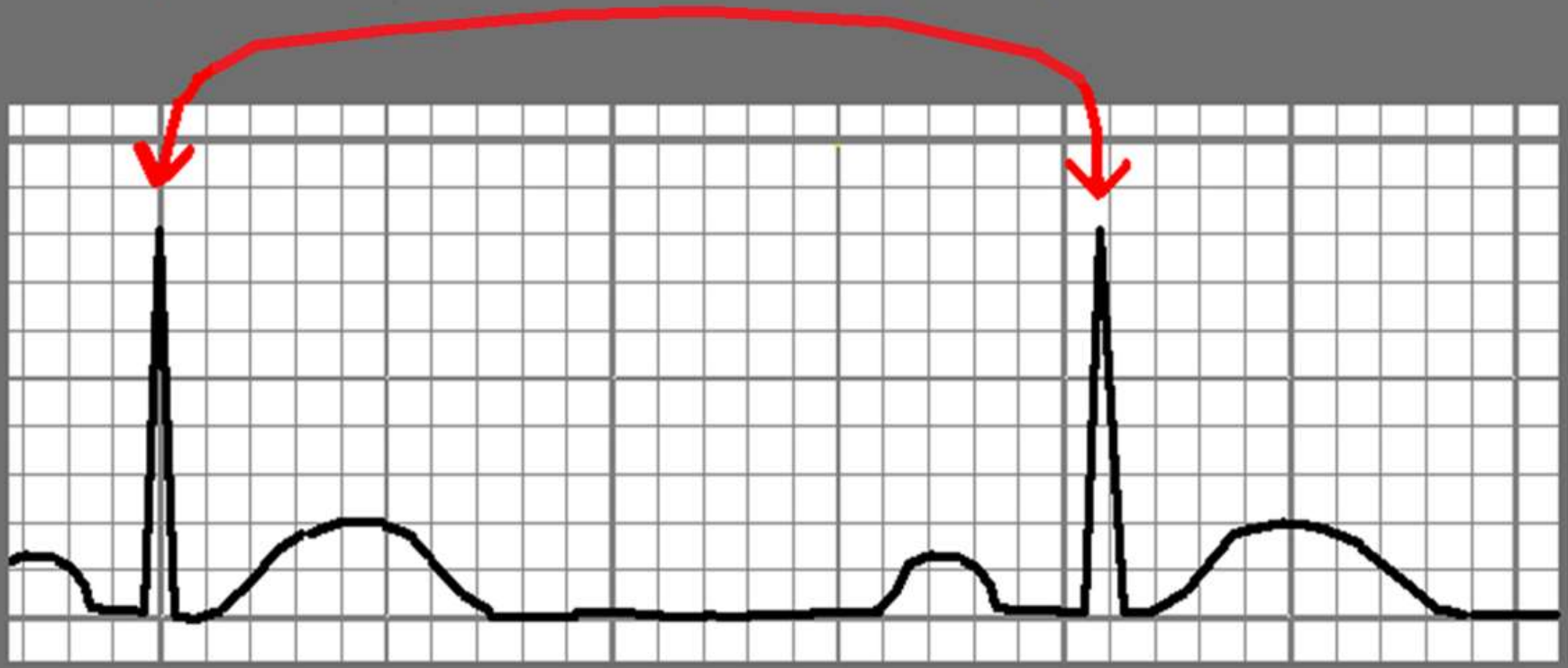
QT CORRECTION FORMULAS:

Bazett's	$QTc=QT/\sqrt{RR}$
Fredericia	$QTc=QT/(RR)1/3$
Framingham	$QTc=QT+0.154(1-RR)$
Rautaharju	$QTp=656/(1+HR/100)$

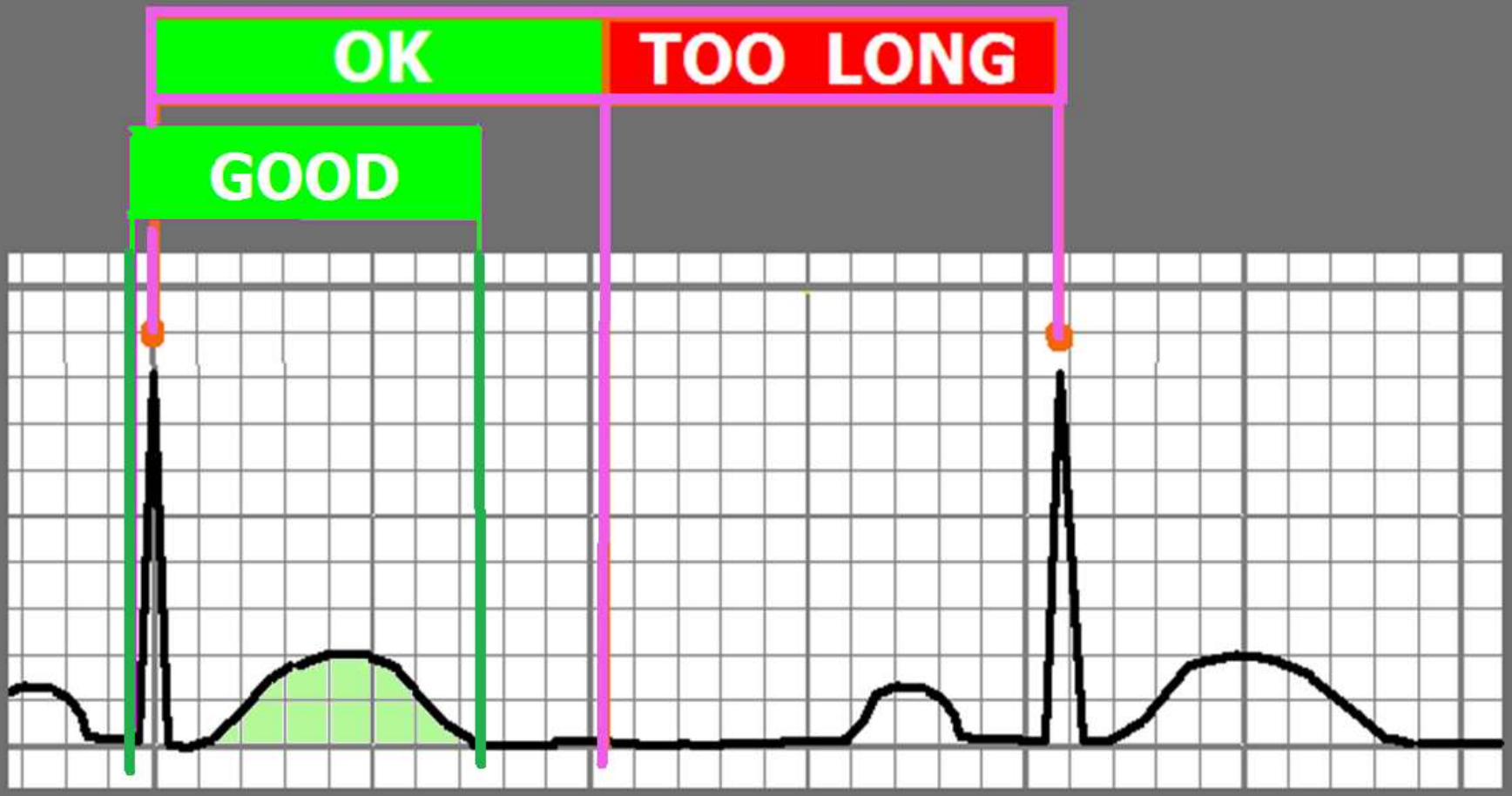
DETERMINING Q-T INTERVAL LIMITS

THE "QUICK PEEK" METHOD

- Relatively accurate method to quickly identify patients with abnormal QT Intervals.
  - Applies to patients with normal heart rates (60-100) and narrow QRS (QRSd <120ms)



The Q - T Interval should be LESS THAN 1/2 the R - R Interval



The Q - T Interval should be LESS THAN 1/2 the R - R Interval

Determining the QT / QTc

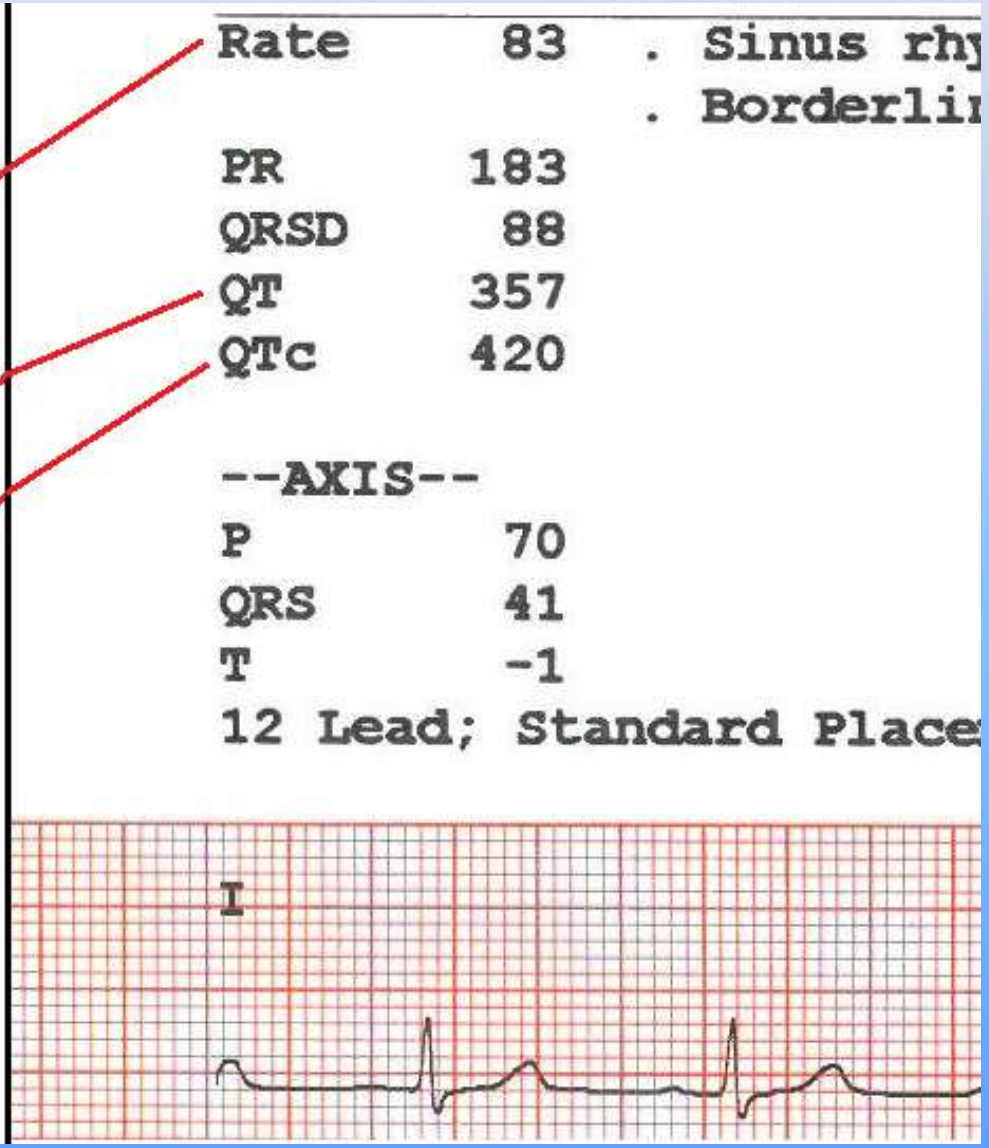
Method 1 – 12 Lead ECG Report:

Standard 12 Lead ECG printout . . .

Heart Rate = 83

QT Interval = 357

QTc = 420

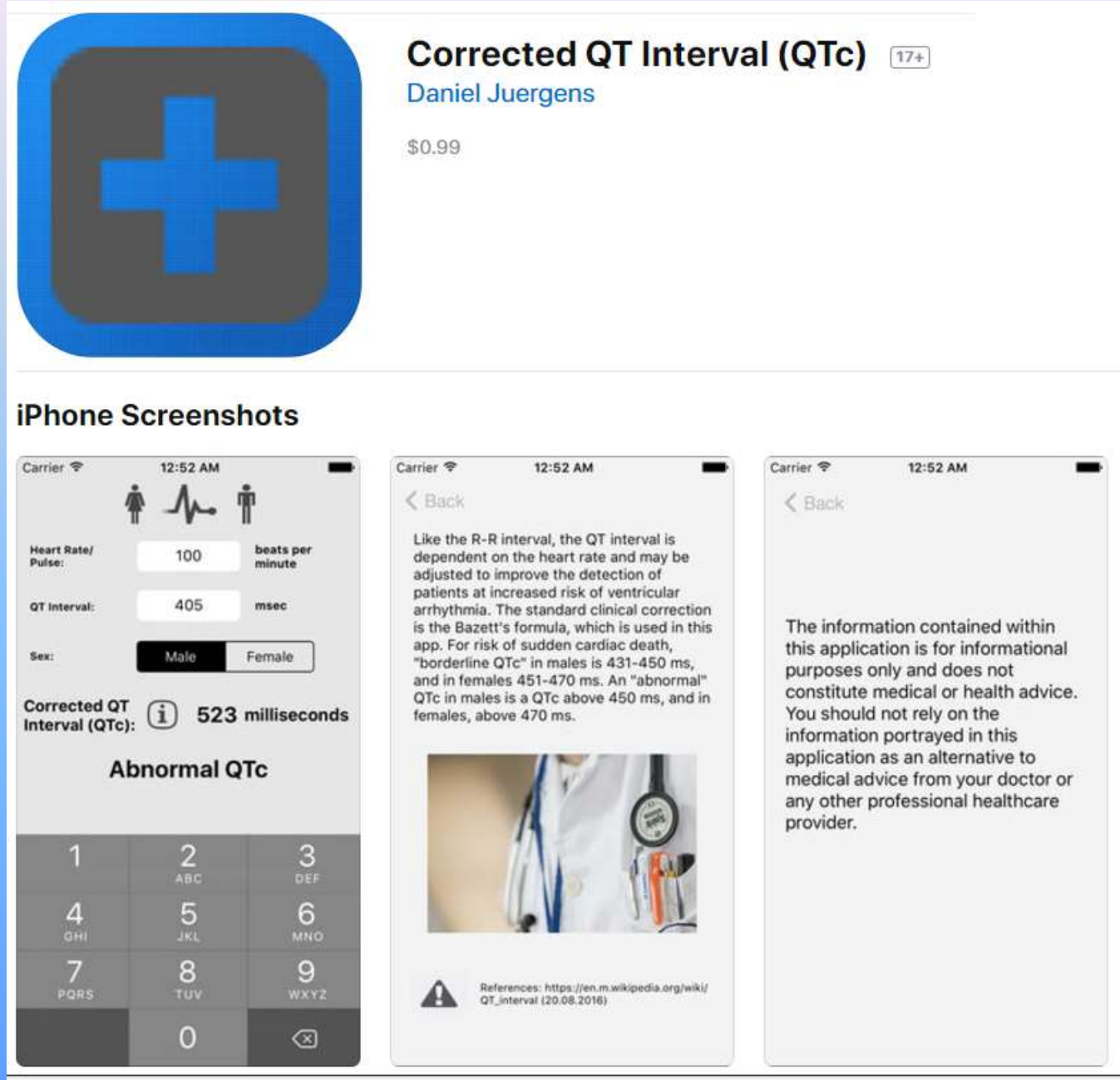


Determining the QTc

Method 4, Use a Smartphone App:

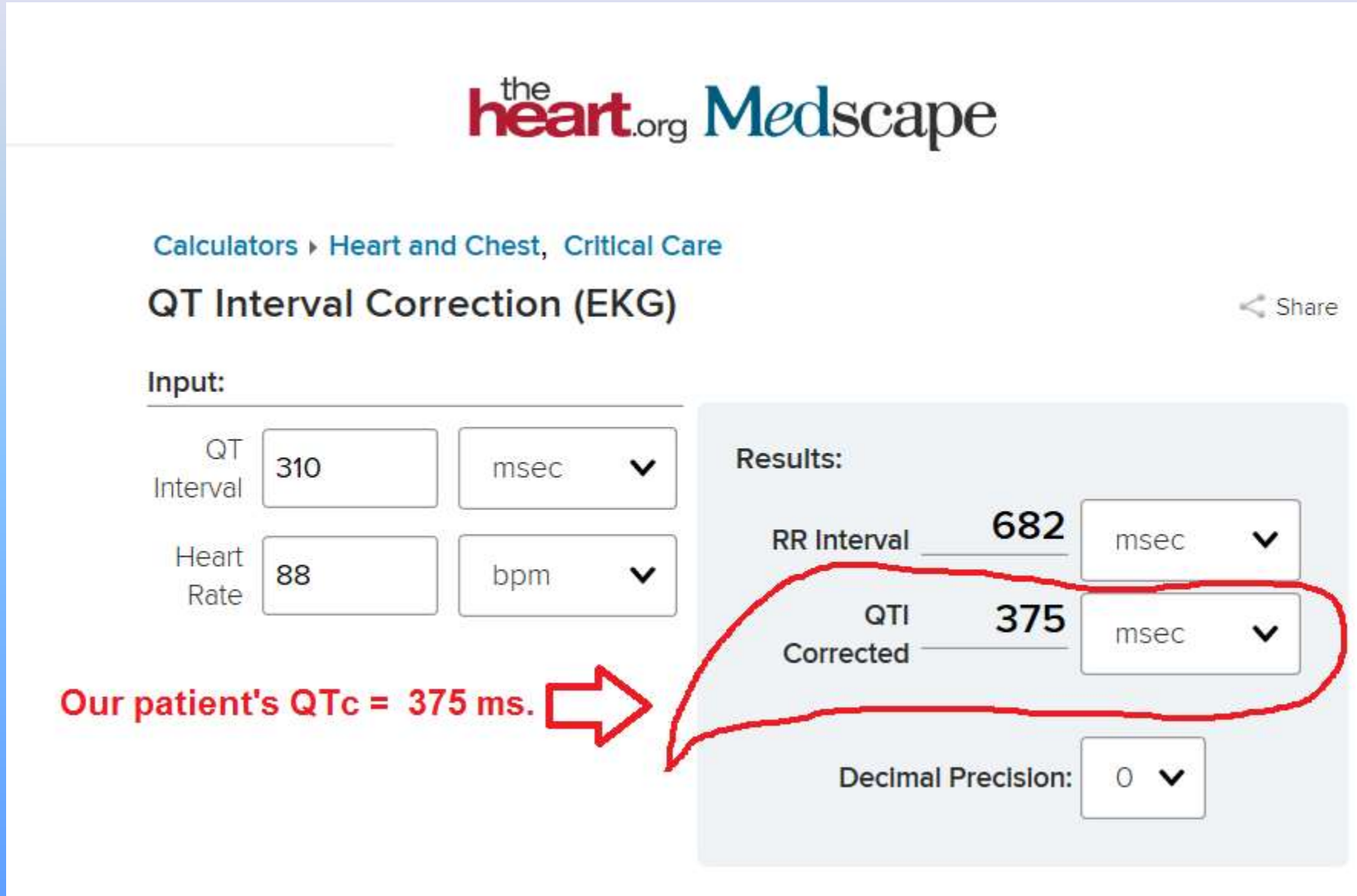
- **iPhone**
  - https://itunes.apple.com/us/app/corrected-qt-interval-qtc/id1146177765?mt=8
- **Android**
  - https://play.google.com/store/apps/details?id=com.medsam.qtccalculator&hl=en

“There’s an APP for that!”



Determining the QTc

Method 3, Use a Web-based App:



QTc Values:

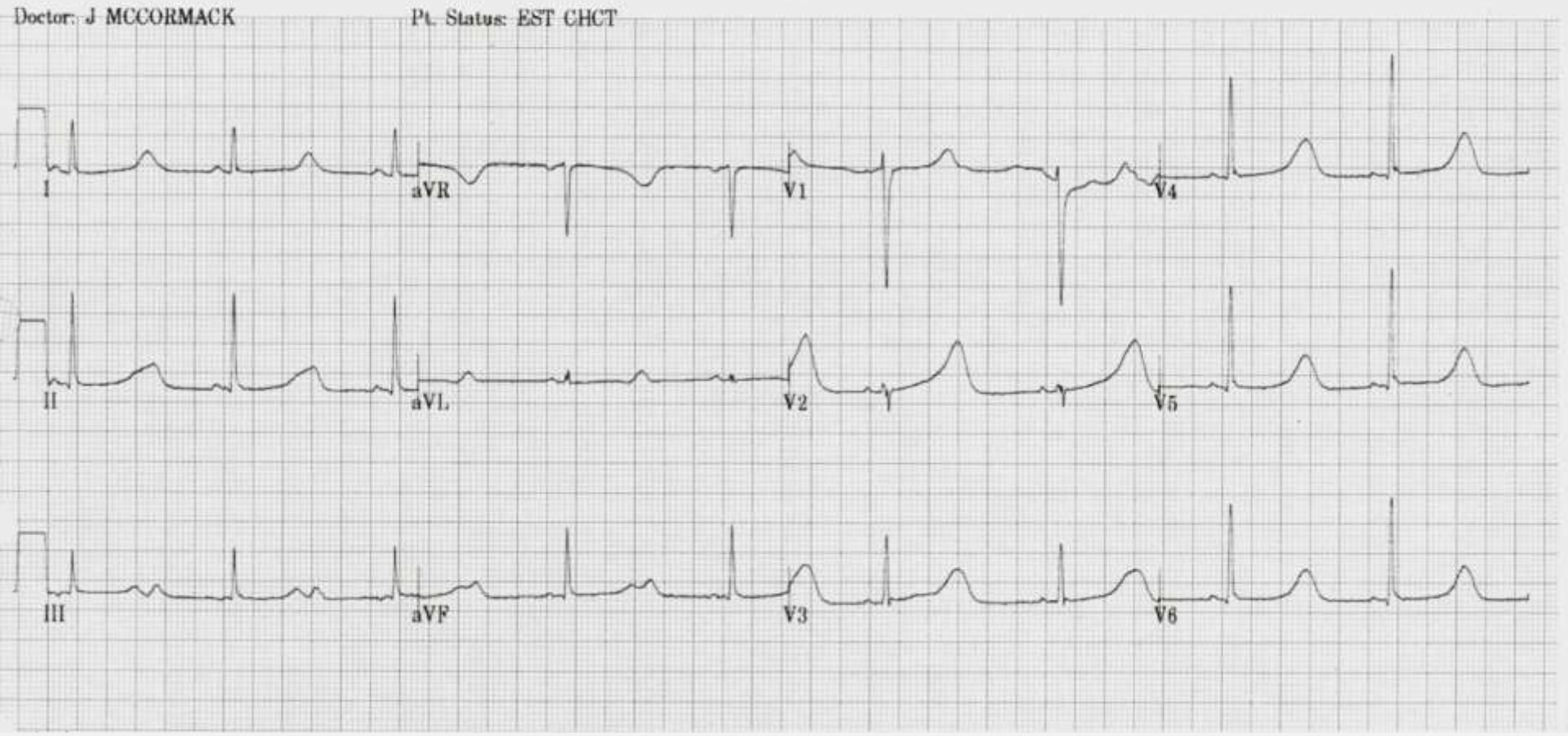
Too Short:	**< 390 ms**
Normal	
-Males:	**390 - 450 ms**
-Females:	**390 - 460 ms**
Borderline High	
-Males:	**450 - 500 ms**
-Females:	**460 - 500 ms**
High (All Genders):	**500 - 600 ms**
Critical High (associated with TdP):	**600 + ms**

SOURCE: "ACC/AHA/HRS Recommendations for Standardization and Interpretation of the ECG, Part IV: The ST Segment, T and U Waves, and the QT Interval" Rautaharju et al 2009

22 y/o FEMALE

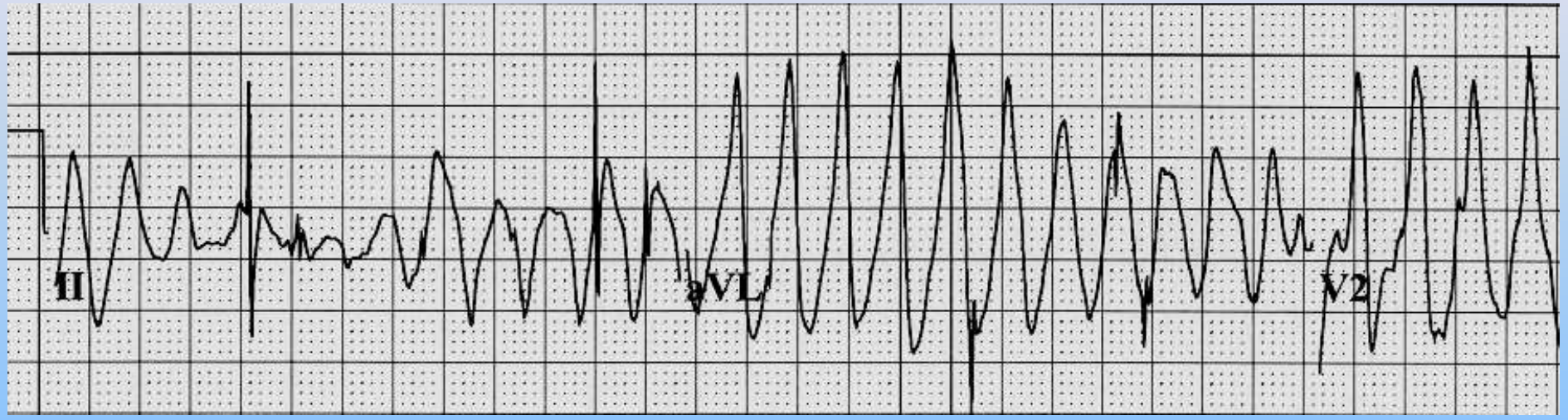
Vent. rate	53 bpm
PR interval	110 ms
QRS duration	84 ms
QT/QTc	678/636 ms
P-R-T axes	25 60 48

PEDIATRIC CARDIOLOGY ASSOCIATES



WHEN THE “QUICK PEEK” METHOD for QT INTERAL EVALUATION IS APPLIED TO THE ABOVE ECG, WHAT IS THE RESULT?

Dysrhythmia Associated with Mortality, Triggered by LQTS: *Torsades de Pointes*



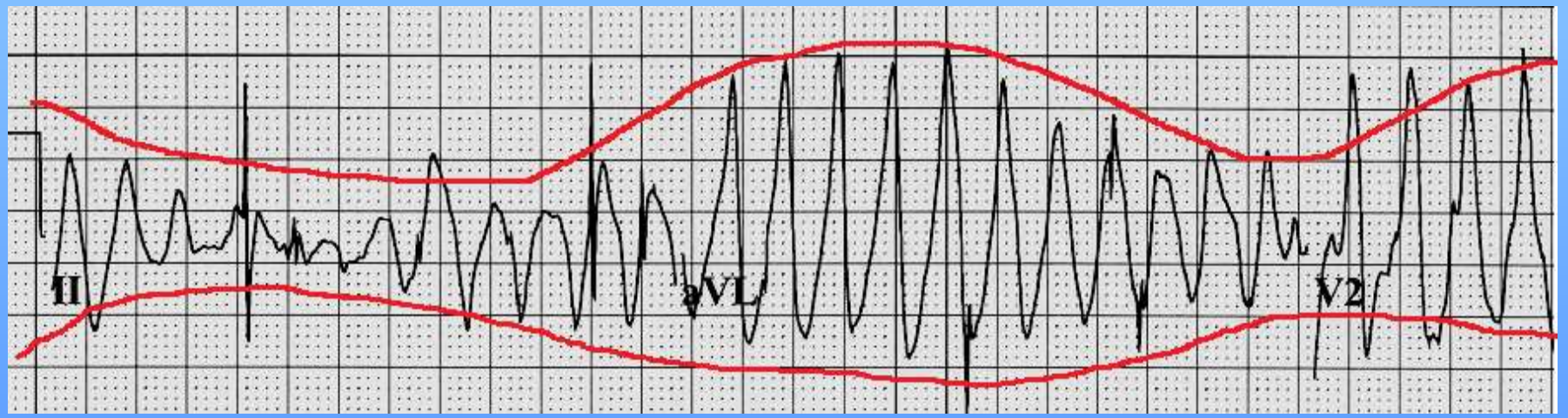
Torsades de Pointes (TdP) – HEMODYNAMICS:

- **Decreased – to – NO Cardiac Output**
- **Often patient PULSELESS during episode**
- **Patients often report SYNCOPE when TdP self-terminates.**
- **May DETERIORATE into VENTRICULAR FIBRILLATION and CARDIAC ARREST. ("Sudden Death")**

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

resembles . . . . .

a piece of Twisted Ribbon !



Evolving MI & “Old MI”

• Q WAVES •

Normal Q Waves

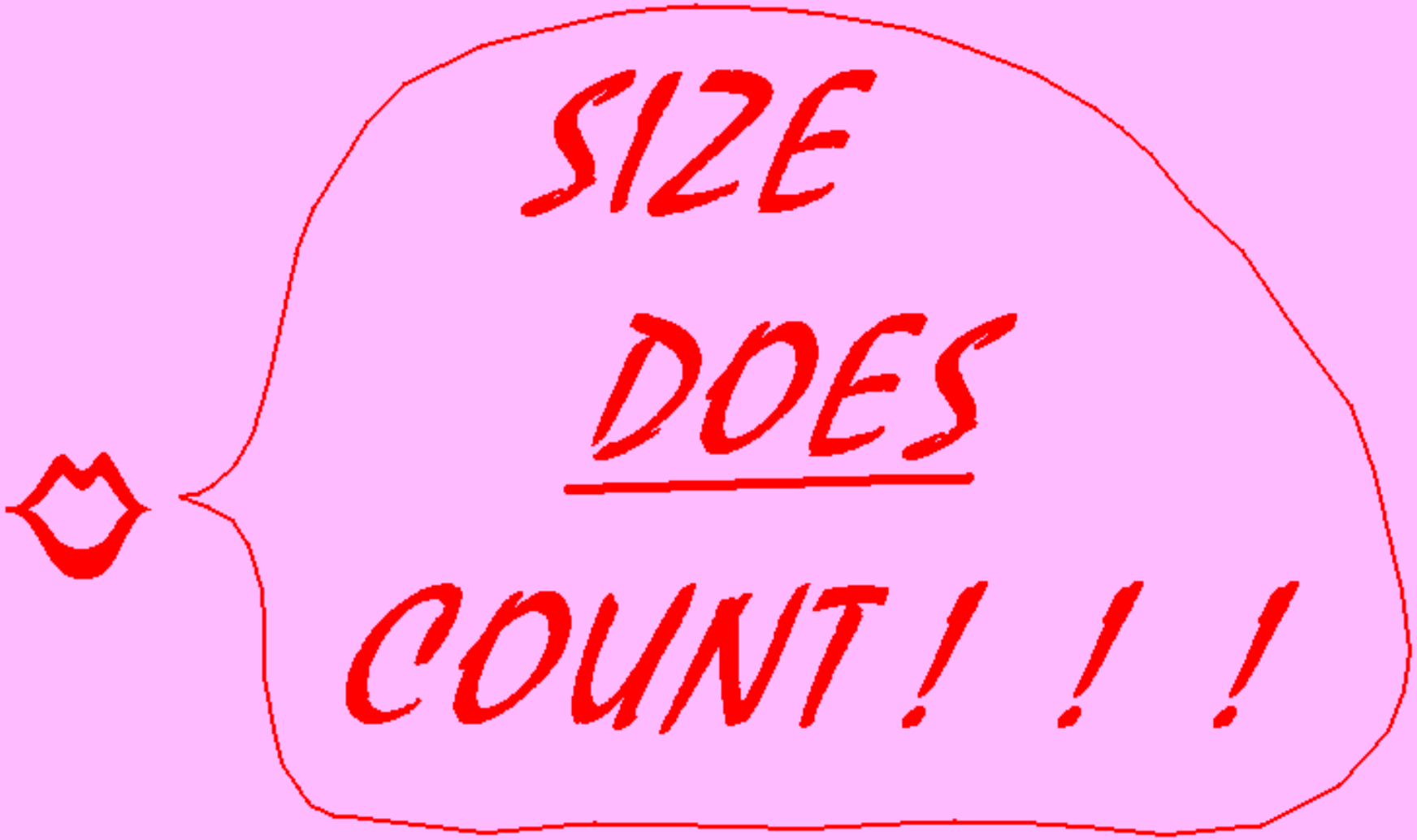
caused by depolarization of the intraventricular septum

Abnormal Q Waves -

caused by:

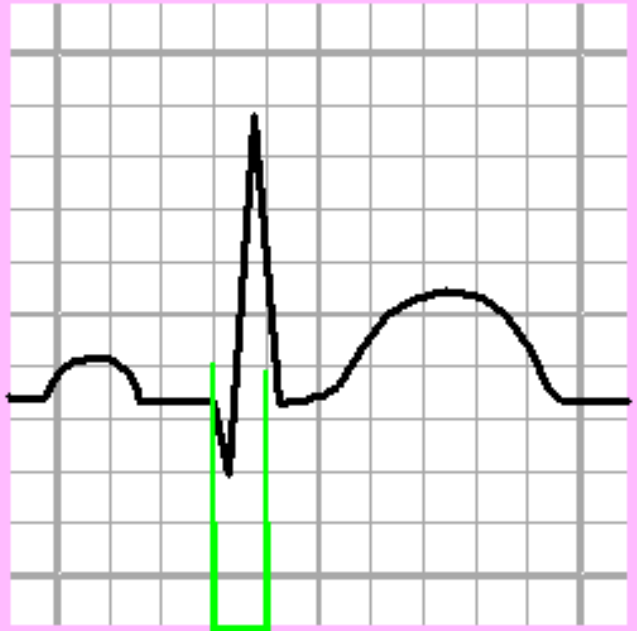
- necrosis (old infarction)
- hypertrophy

• Q WAVES •



THE QRS COMPLEX

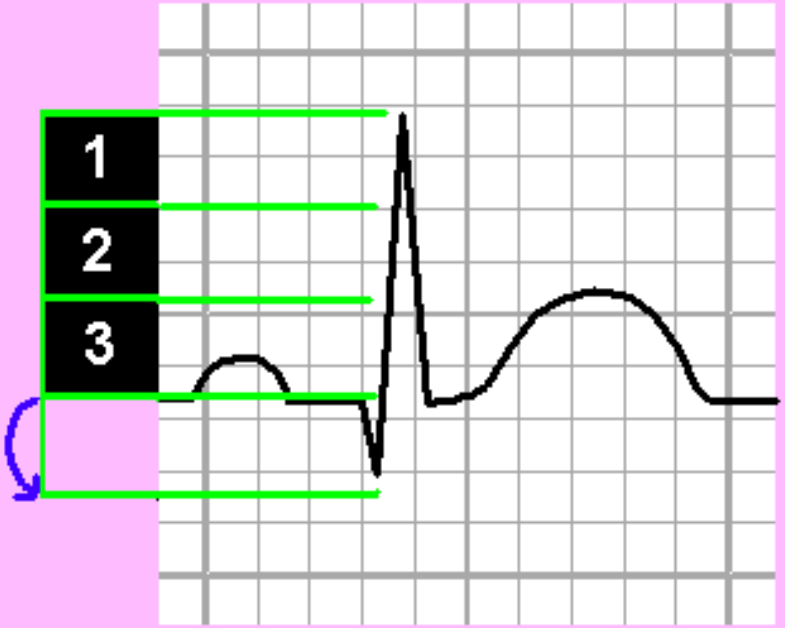
GENERAL RULES FOR NORMAL Q WAVES - WIDTH



LESS THAN .40 (1 mm) WIDE

THE QRS COMPLEX

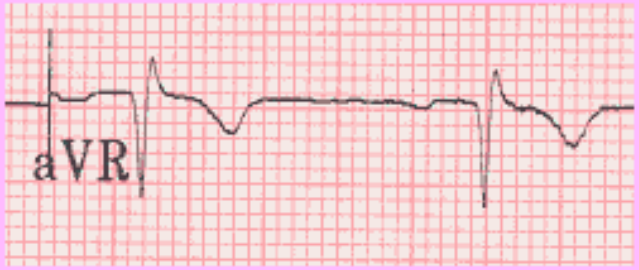
GENERAL RULES FOR NORMAL Q WAVES - HEIGHT



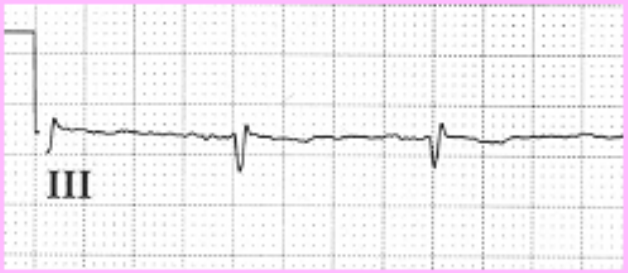
☞ LESS THAN 1/3 THE HEIGHT OF THE R WAVE

THE QRS COMPLEX

NORMAL Q WAVES
EXCEPTIONS TO THE RULES



LEAD AVR



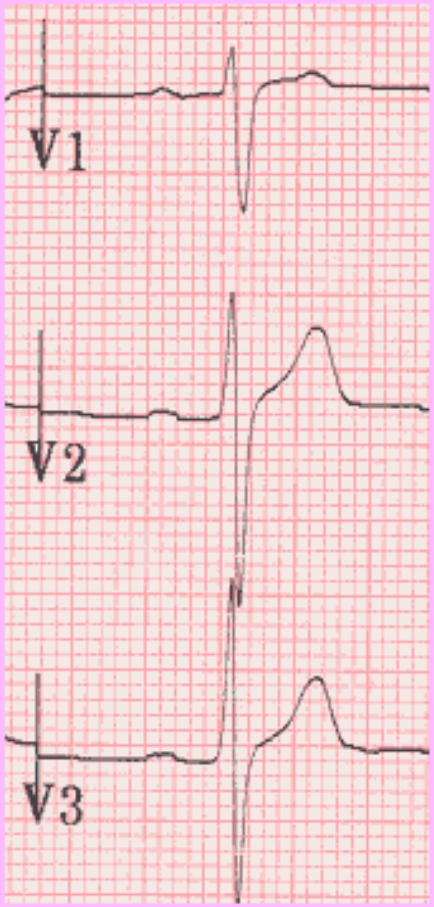
LEAD Ⅲ

☞ THE Q WAVE CAN BE ANY SIZE

THE QRS COMPLEX

NORMAL Q WAVES
EXCEPTIONS TO THE RULES

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



THE QRS COMPLEX

Q WAVE RULES - SUMMARY:

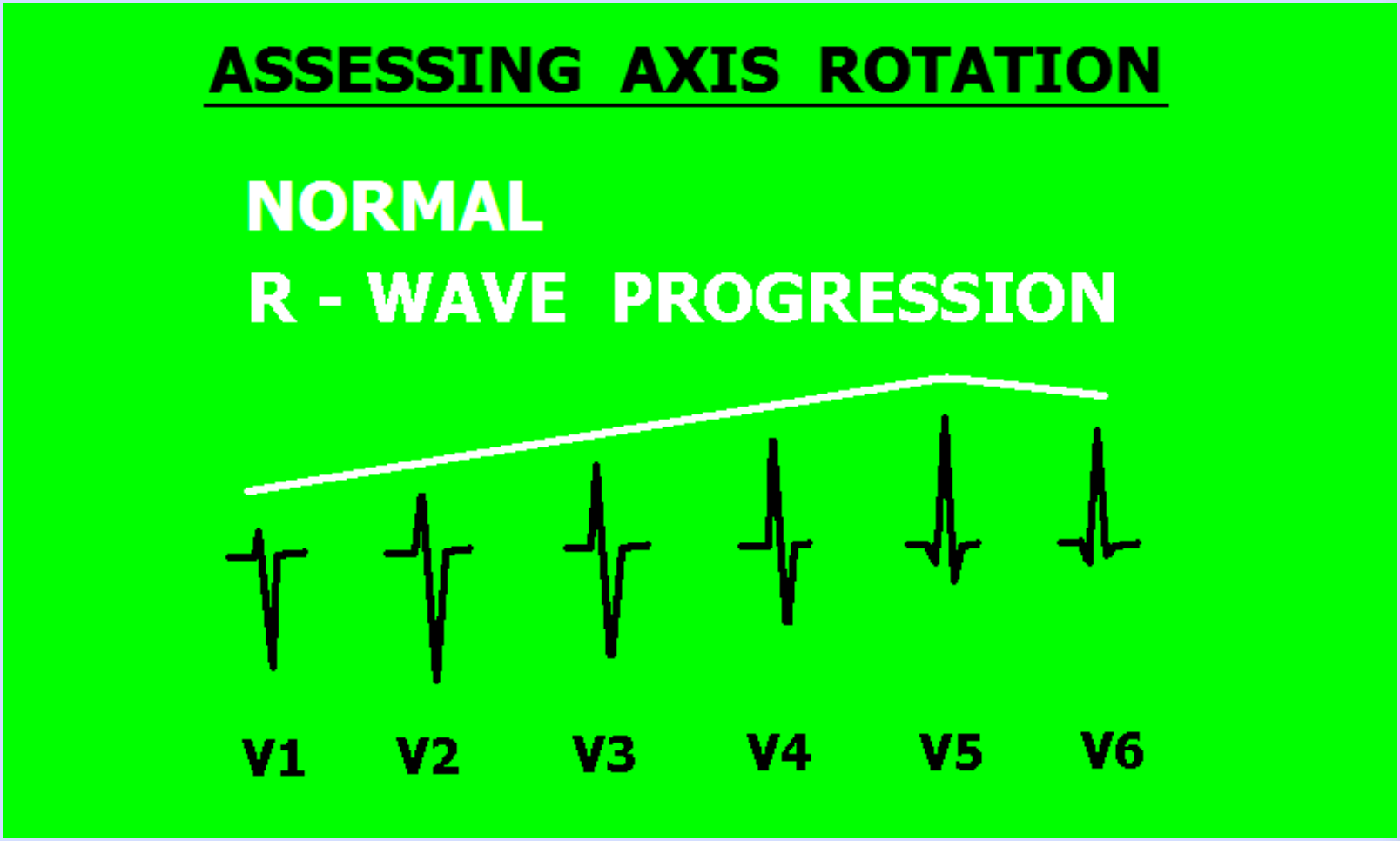
- Q WAVES SHOULD BE LESS THAN .40 WIDE (1 mm)

- Q WAVES SHOULD BE LESS THAN 1/3 THE HEIGHT OF THE R WAVE

- Q WAVES CAN BE ANY SIZE IN LEADS III and AVR

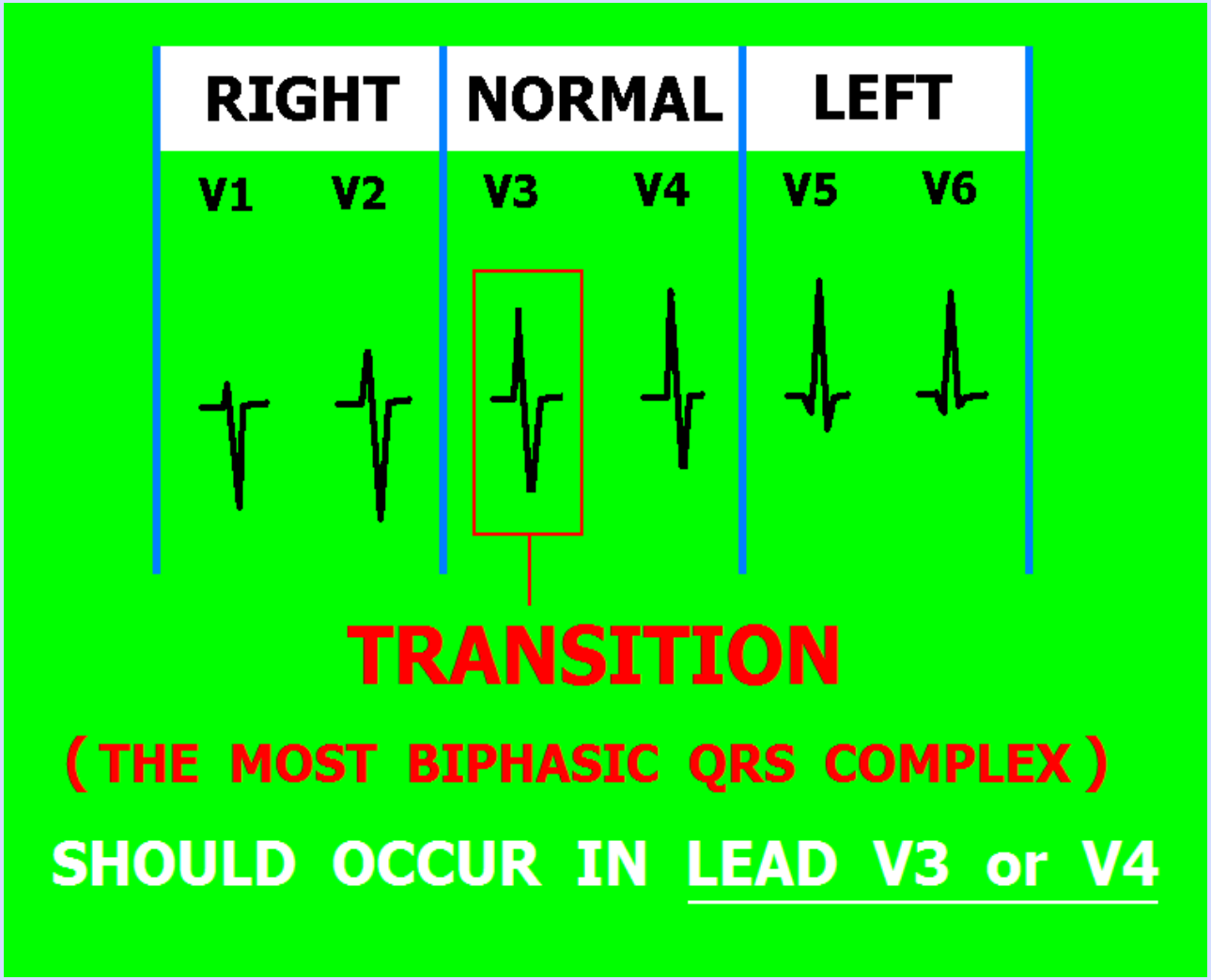
- THERE SHOULD BE NO Q WAVES IN LEADS V1, V2, or V3

The NORMAL ECG



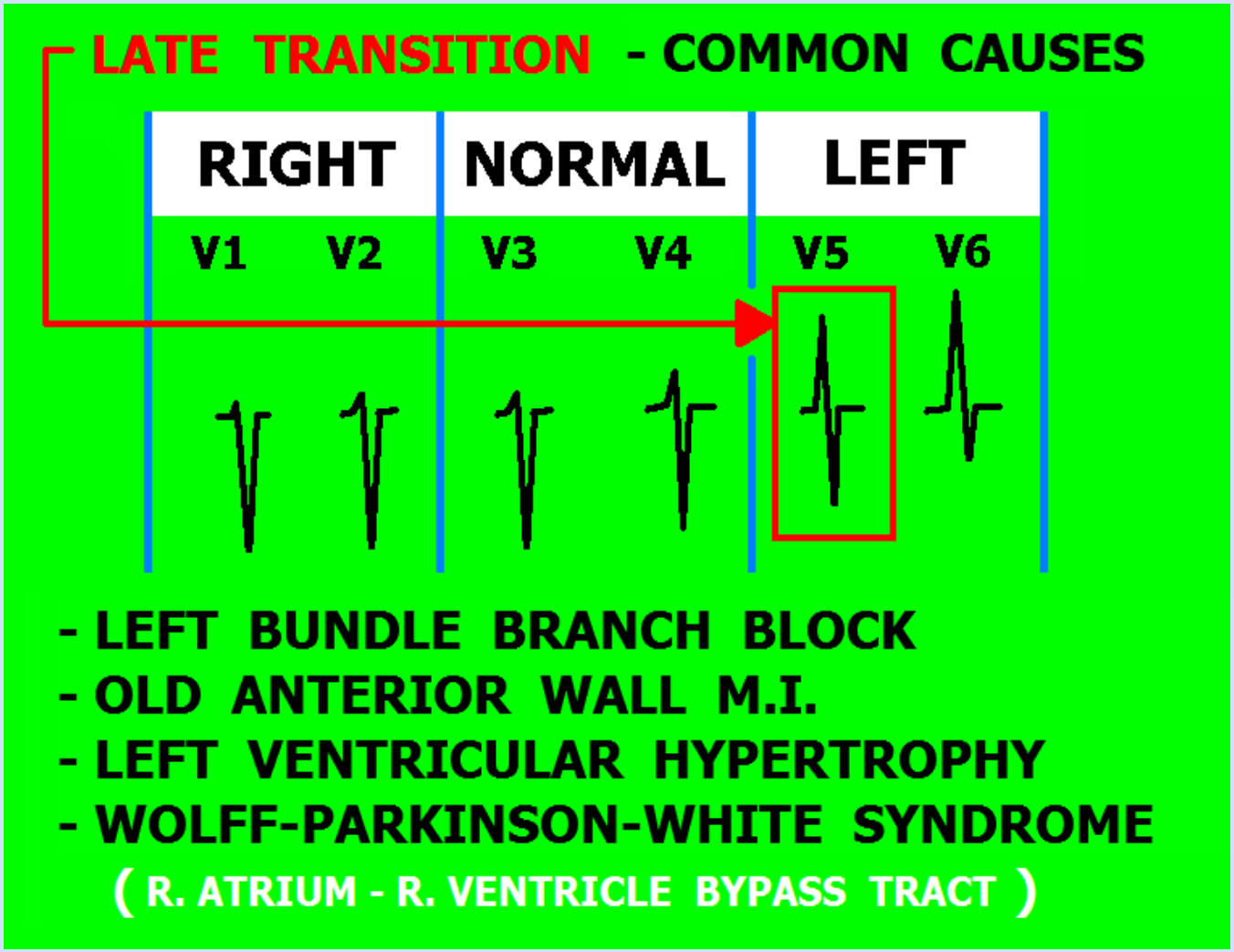
R wave amplitude (size) gradually increases from V1 through V6 . . . .

The NORMAL ECG



In V3 or V4, the QRS complex becomes Biphasic.

“Poor R Wave Progression” . . . .



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

EVOLVING STEMI:

-ST SEGMENTS DROP

-Q WAVES FORM

-R WAVE PROGRESSION CHANGES IN PRECORDIAL LEADS.

Q WAVE RULES - SUMMARY:

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

EVOLVING STEMI:

-ST SEGMENTS DROP

-Q WAVES FORM

-R WAVE PROGRESSION CHANGES IN PRECORDIAL LEADS.

91 yr
Female Caucasian

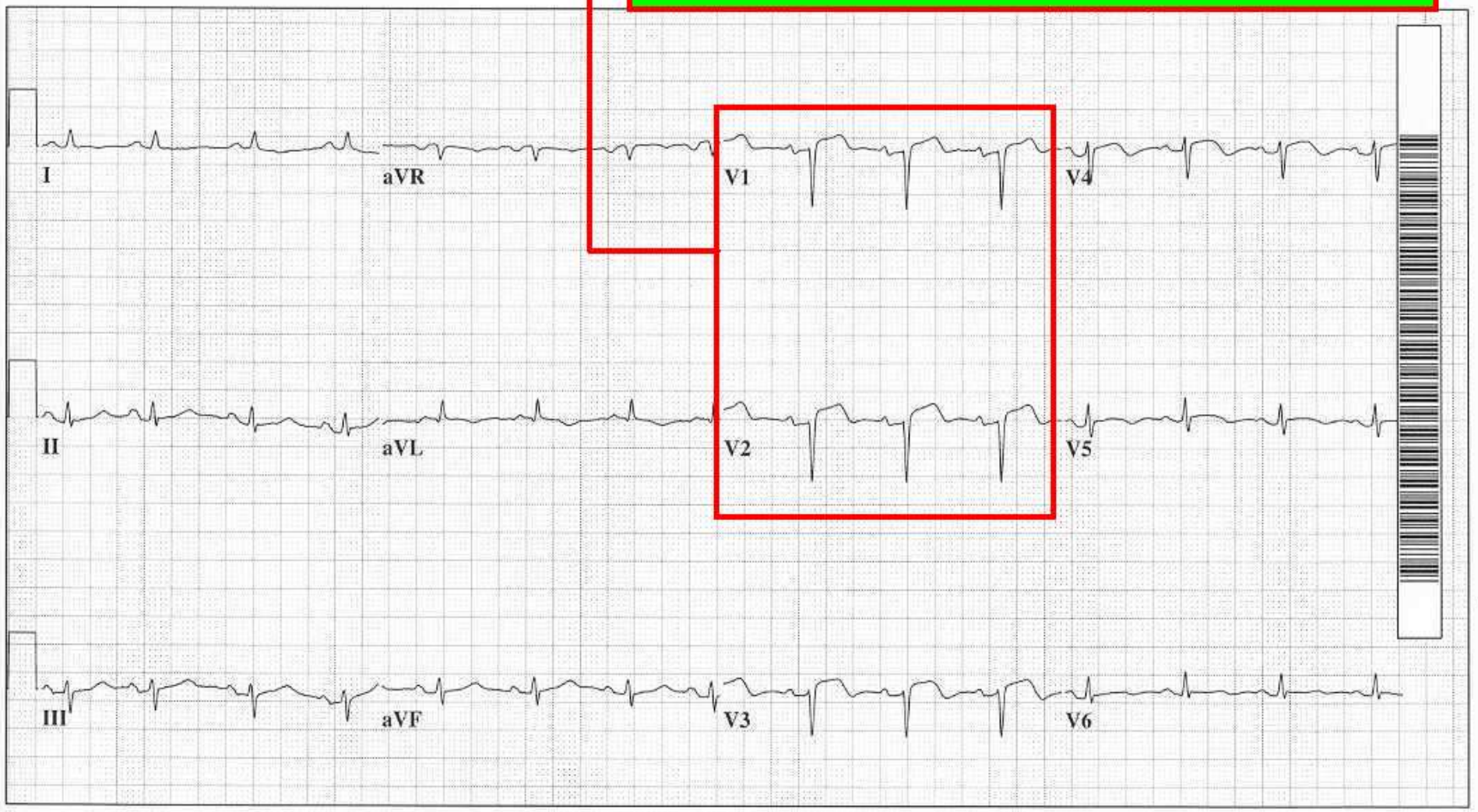
Room:3
Loc:1 Option:1

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

Normal sinus rhythm
Possible Anterior infarct
Abnormal ECG

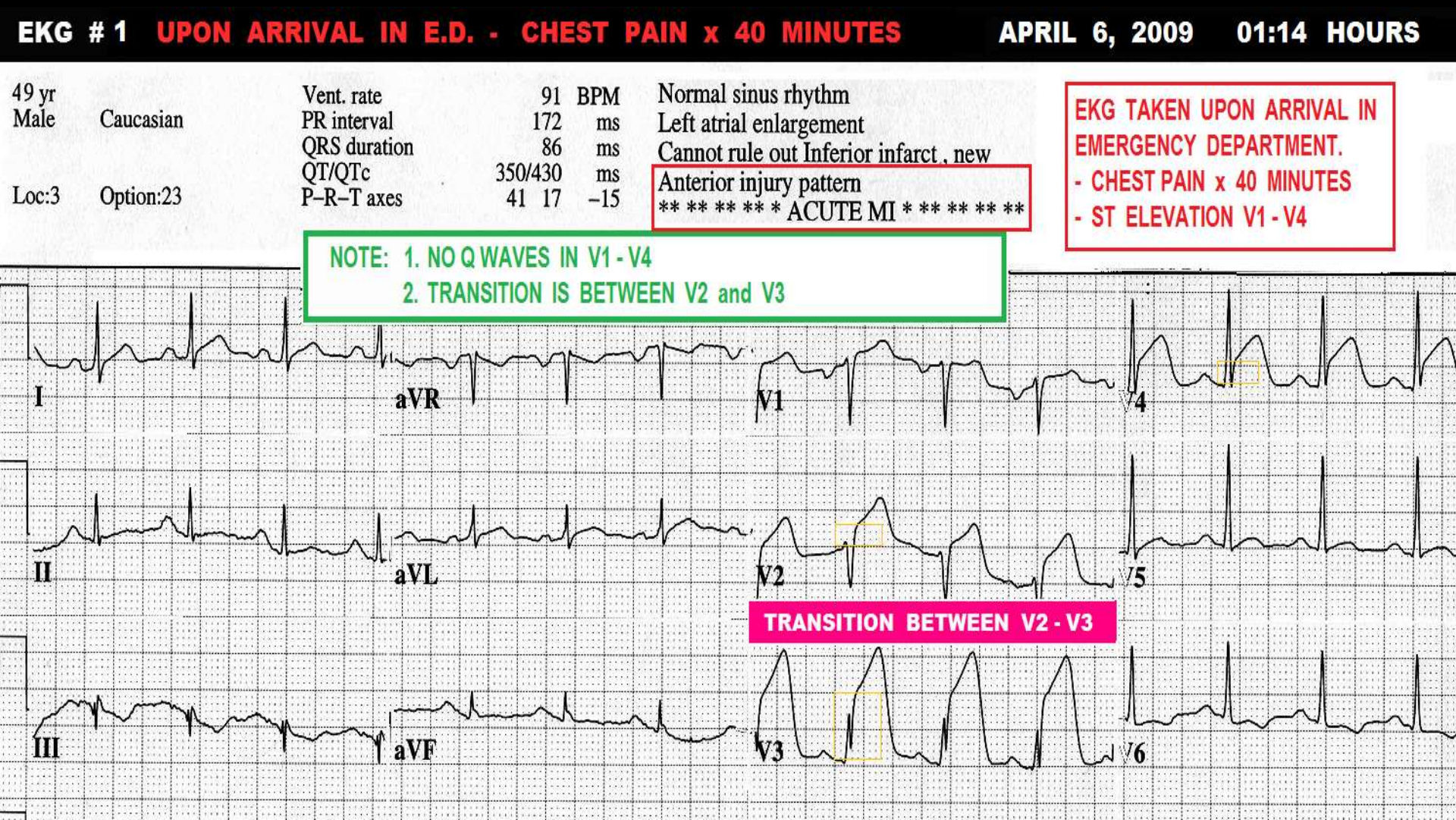
Technician ID: EKG CLASS # WR03110848

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

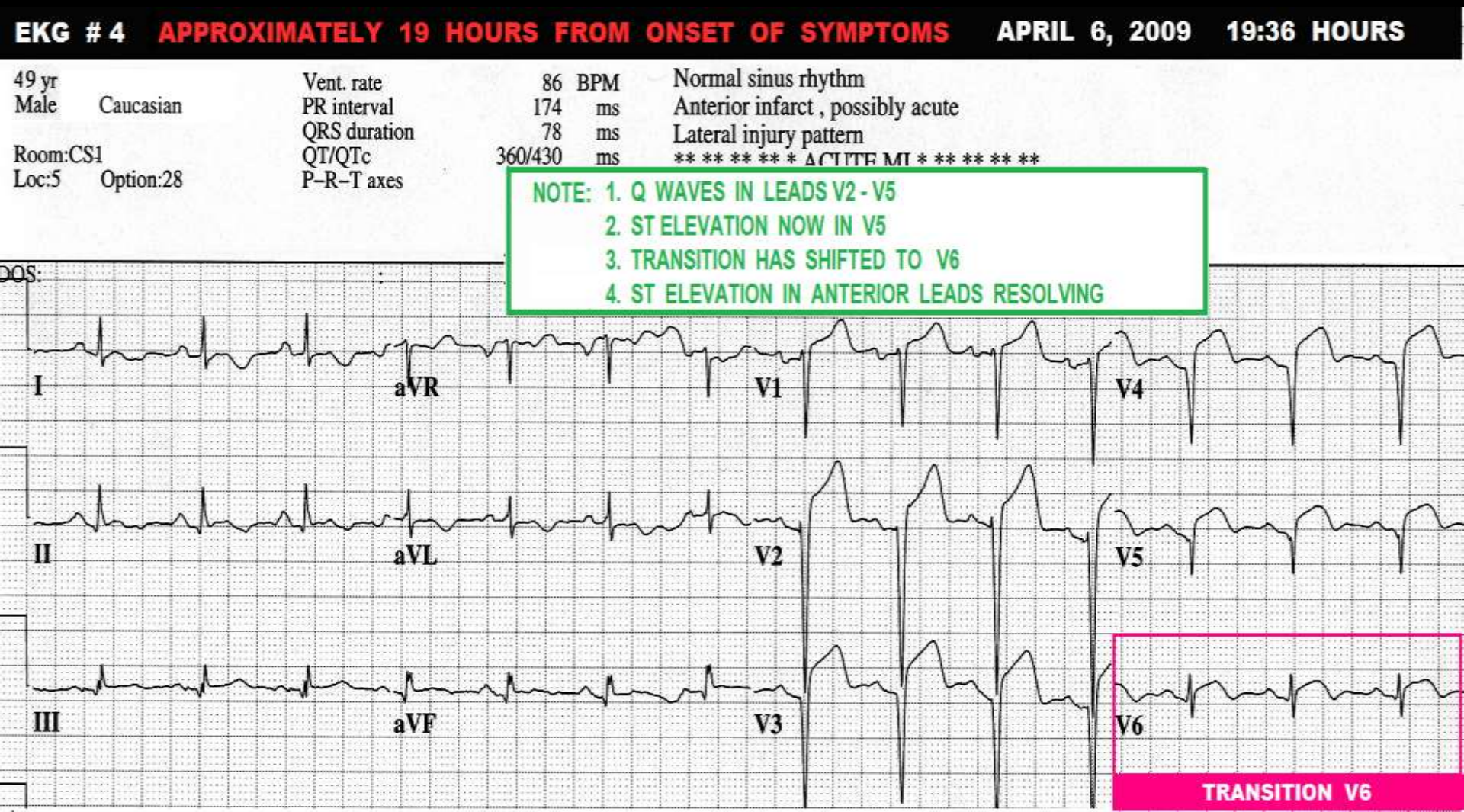


25mm/s 10mm/mV 100Hz 005C 12SL 4 CID: 5

ACUTE ANTERIOR WALL STEMI



EVOLVING ANTERIOR WALL STEMI



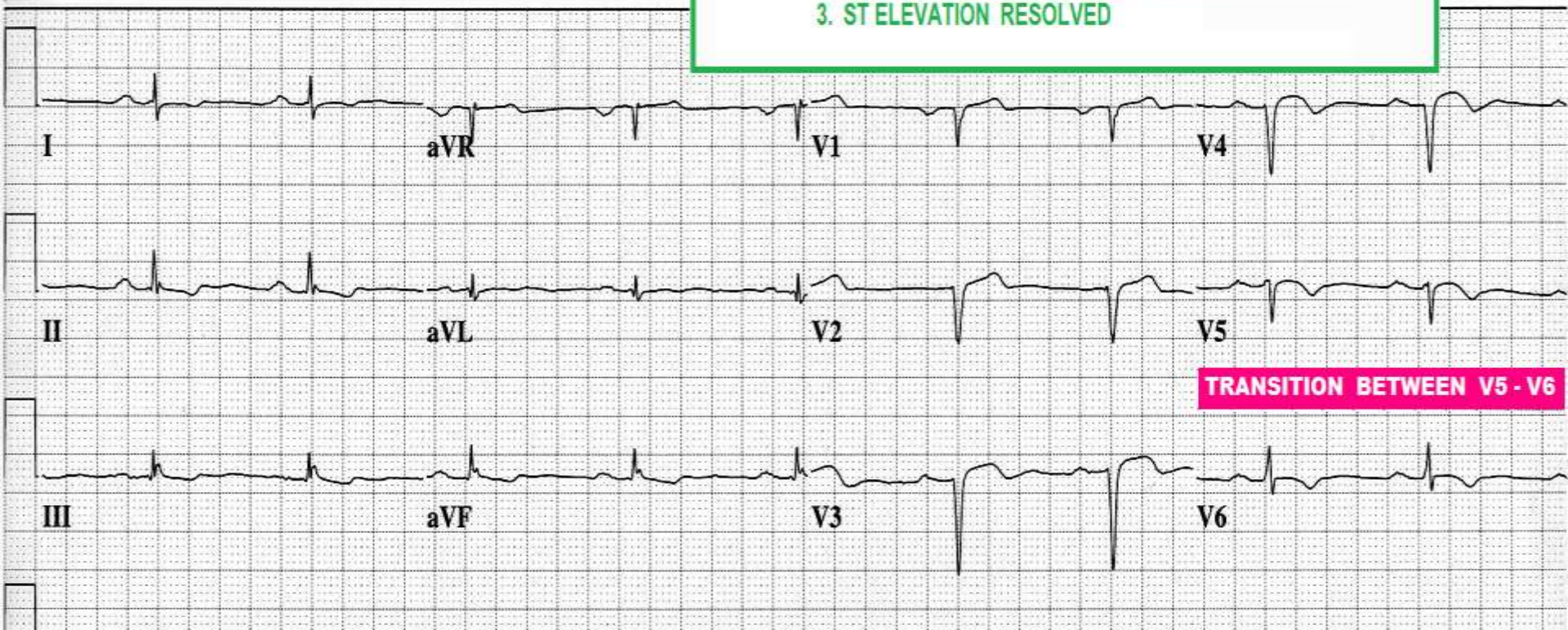
FULLY EVOLVED ANTERIOR WALL MI

POST - INFARCTION EKG TAKEN 1 YEAR AFTER ANTERIOR WALL MI

50 yr		Vent. rate	57	BPM
Male	Caucasian	PR interval	216	ms
		QRS duration	96	ms
Room:		QT/QTc	392/381	ms
Loc:	Option:	P–R–T axes	40 58	–120

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

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



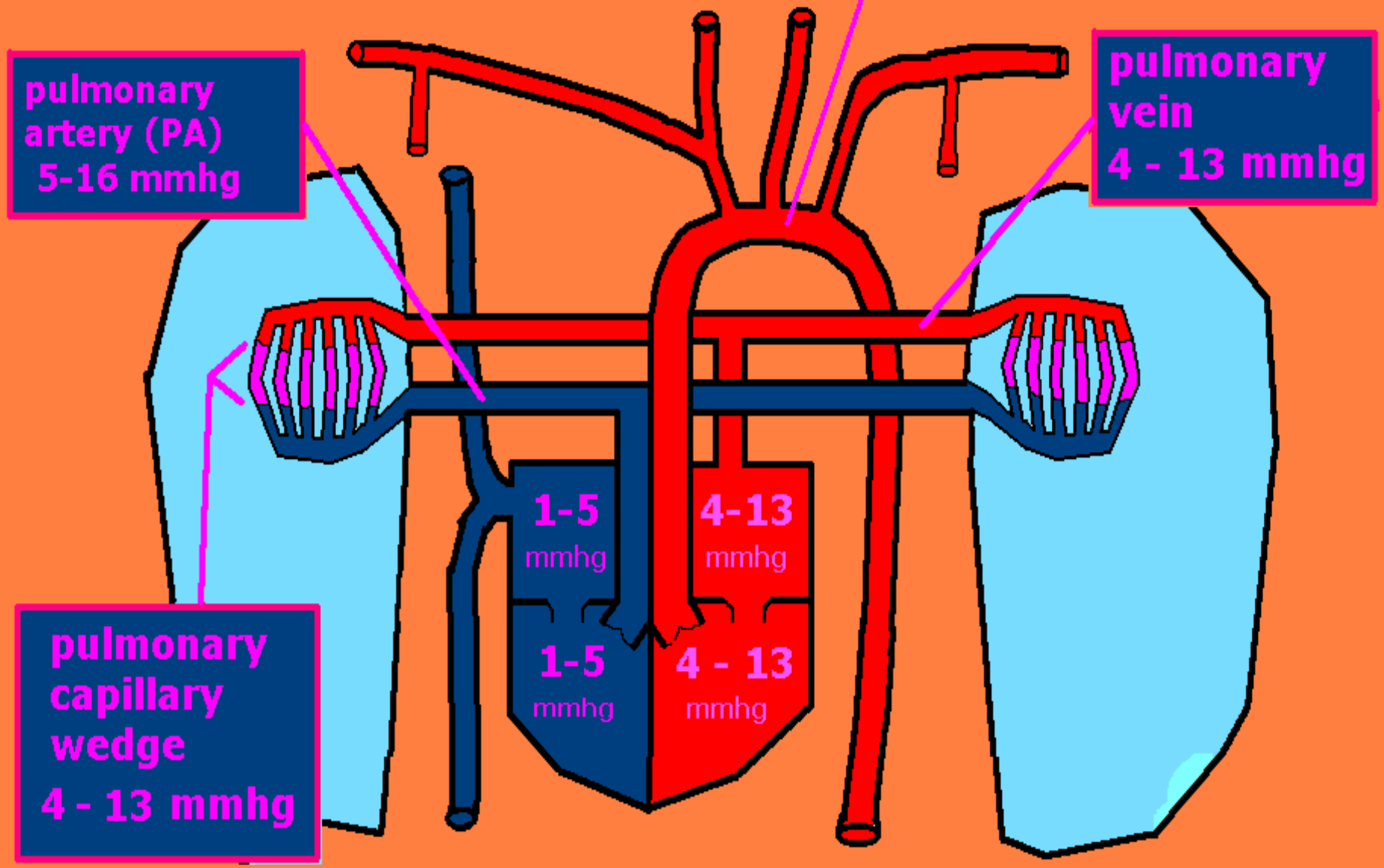
Additional Materials:

VERY BASIC HEART SOUNDS ASSESSMENT

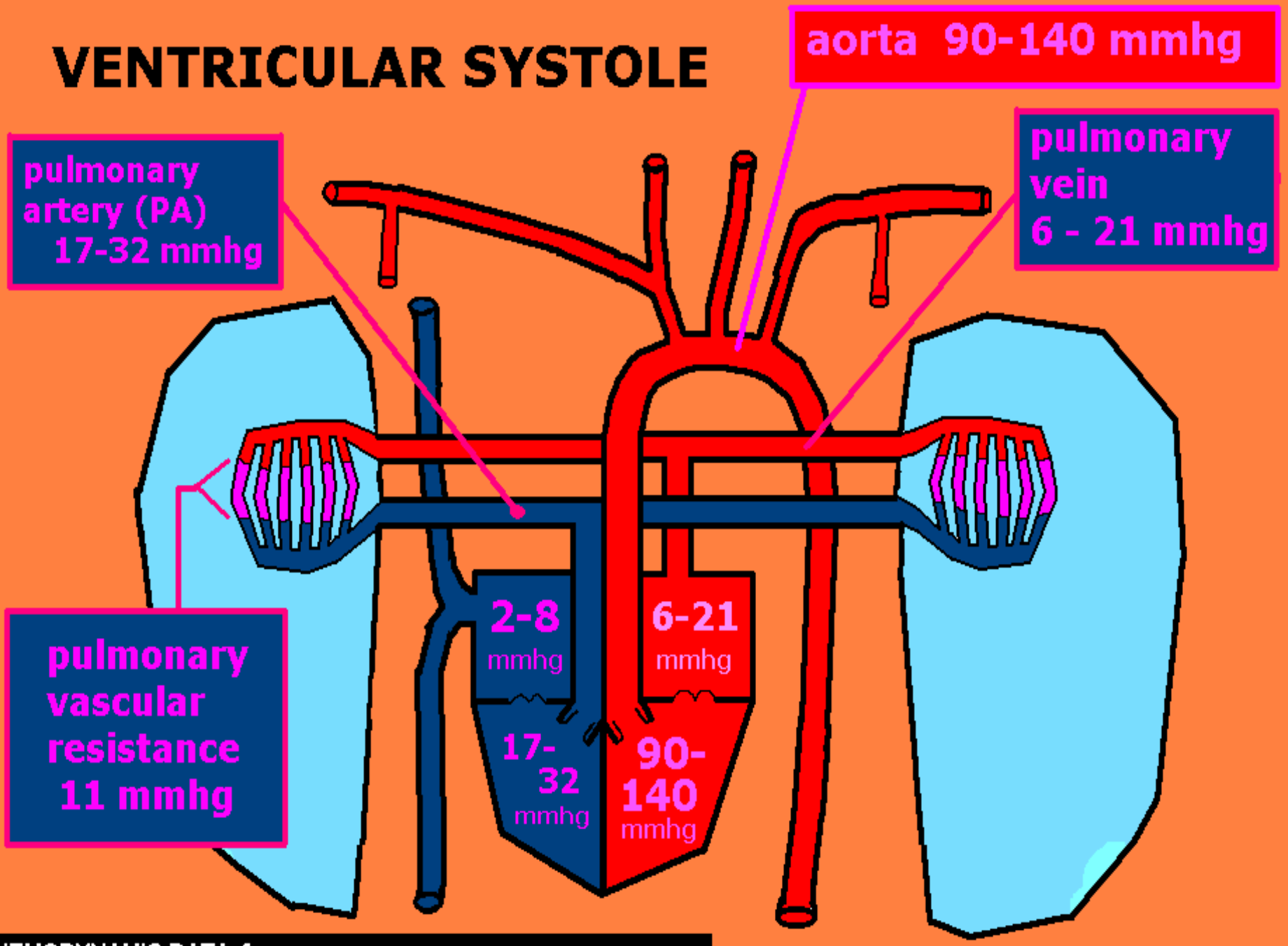
ABNORMAL EKG CHANGES THAT MAY PRESENT WITH ABNORMAL HEART SOUNDS:

- ACUTE MI
- CHAMBER HYPERTROPHY
- RECENT MI (NECROSIS)
- PERICARDITIS

DIASTOLE


aorta
60 - 90 mmhg
pulmonary
artery (PA)
5-16 mmhg
pulmonary
vein
4 - 13 mmhg
1-5
mmhg
4-13
mmhg
1-5
mmhg
4 - 13
mmhg
pulmonary
capillary
wedge
4 - 13 mmhg

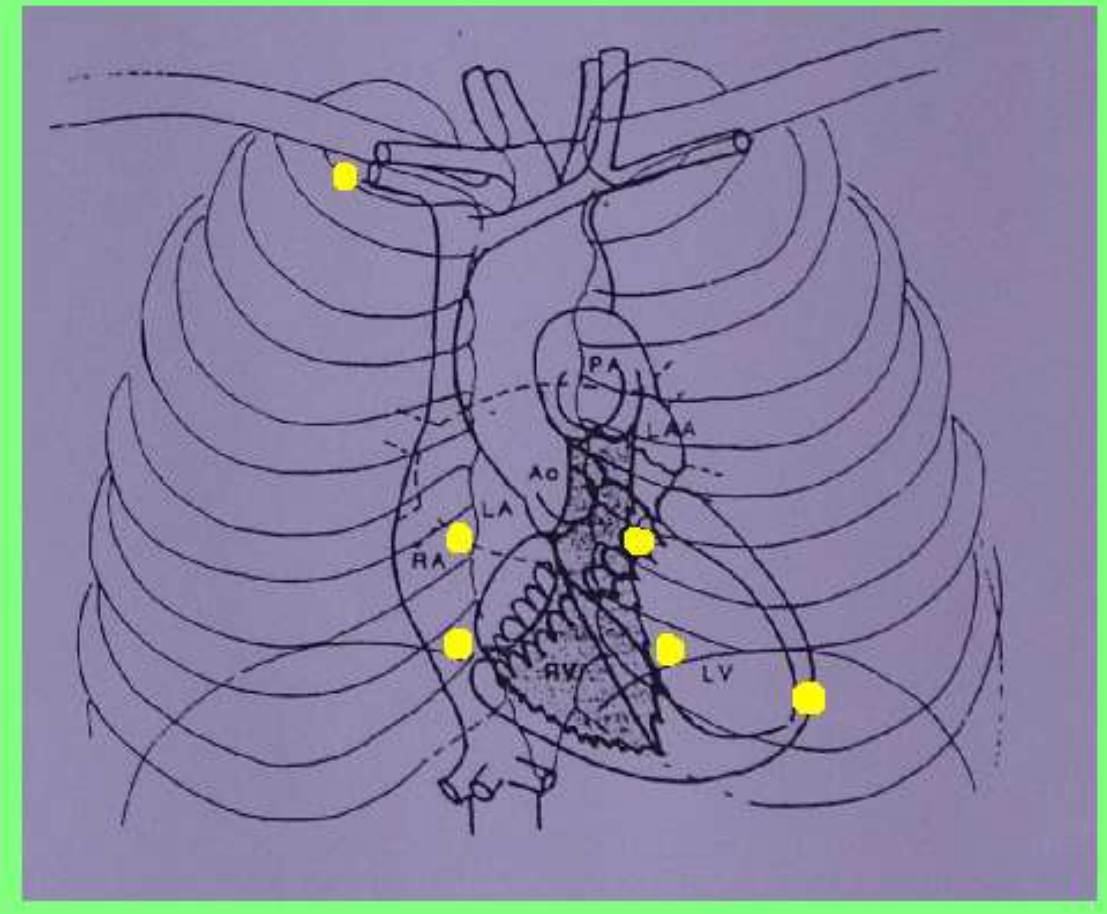
VENTRICULAR SYSTOLE



HEMODYNAMIC DATA from:
"The Cardiac Catheterization Handbook," Morton J. Kearn, MD

HEART SOUNDS ASSESSMENT

HEART SOUNDS ASSESSMENT



VERY BASIC HEART SOUNDS ASSESSMENT

- Normal Heart Sounds
- Murmurs
  - systolic
  - diastolic
- Friction Rubs

SCOTT DAVIDSON, RN auscultating heart sounds at
St. Joseph's Hospital Heart Institute
Tampa, FL

HEART SOUNDS ASSESSMENT

HEART SOUNDS ARE GENERATED BY THE SOUND OF THE HEART VALVES CLOSING.

THERE ARE TWO NORMAL HEART SOUNDS, KNOWN AS: S-1 and S-2

WE OFTEN DESCRIBE THESE HEART SOUNDS AS "LUB - DUP"

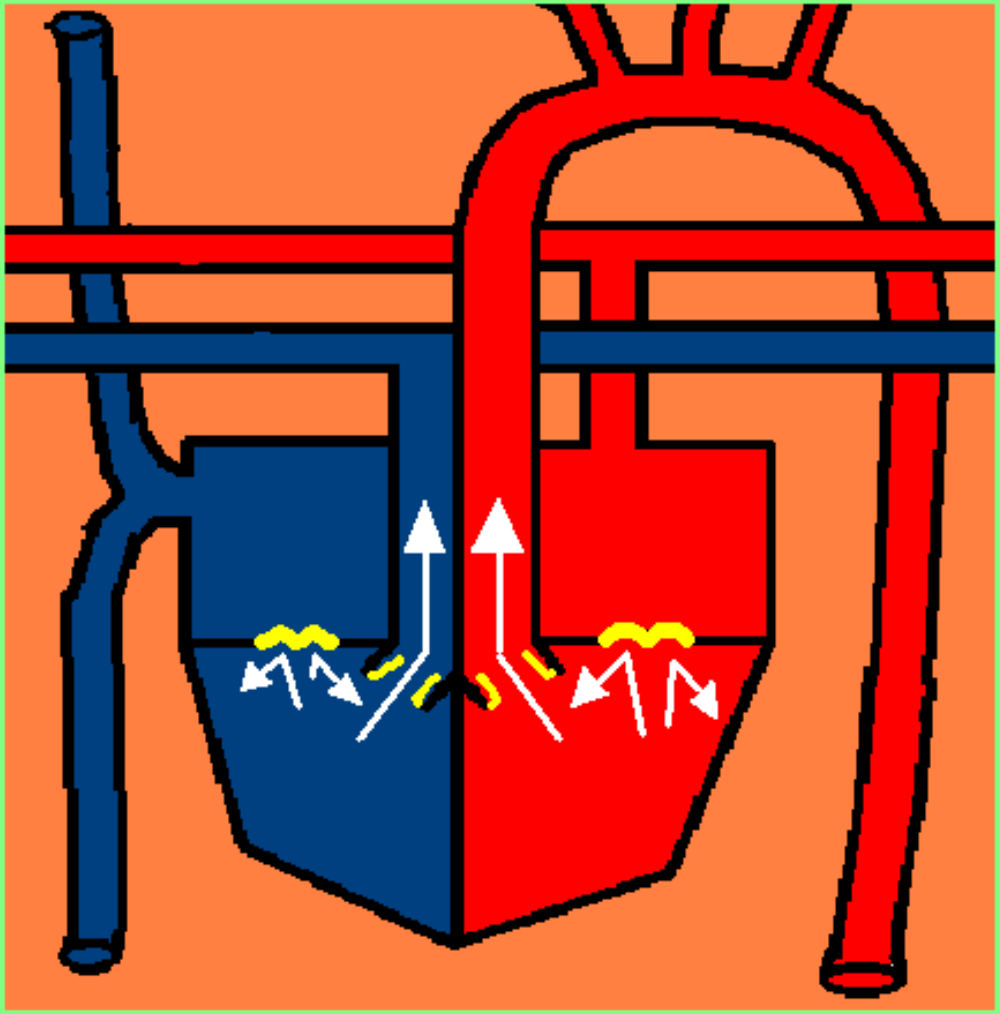
VERY BASIC HEART SOUNDS ASSESSMENT

ABNORMAL SOUND	SUSPECTED EKG CHANGES
MURMURS - SYSTOLIC - DIASTOLIC	- ACUTE MI - CHAMBER HYPERTROPHY - NECROSIS - RECENT EXTNSIVE MI (7-10 days)
FRICTION RUB	- ACUTE MI - RECENT MI (NECROSIS) - PERICARDITIS

HEART SOUNDS ASSESSMENT

S-1 BEGINNING OF SYSTOLE.

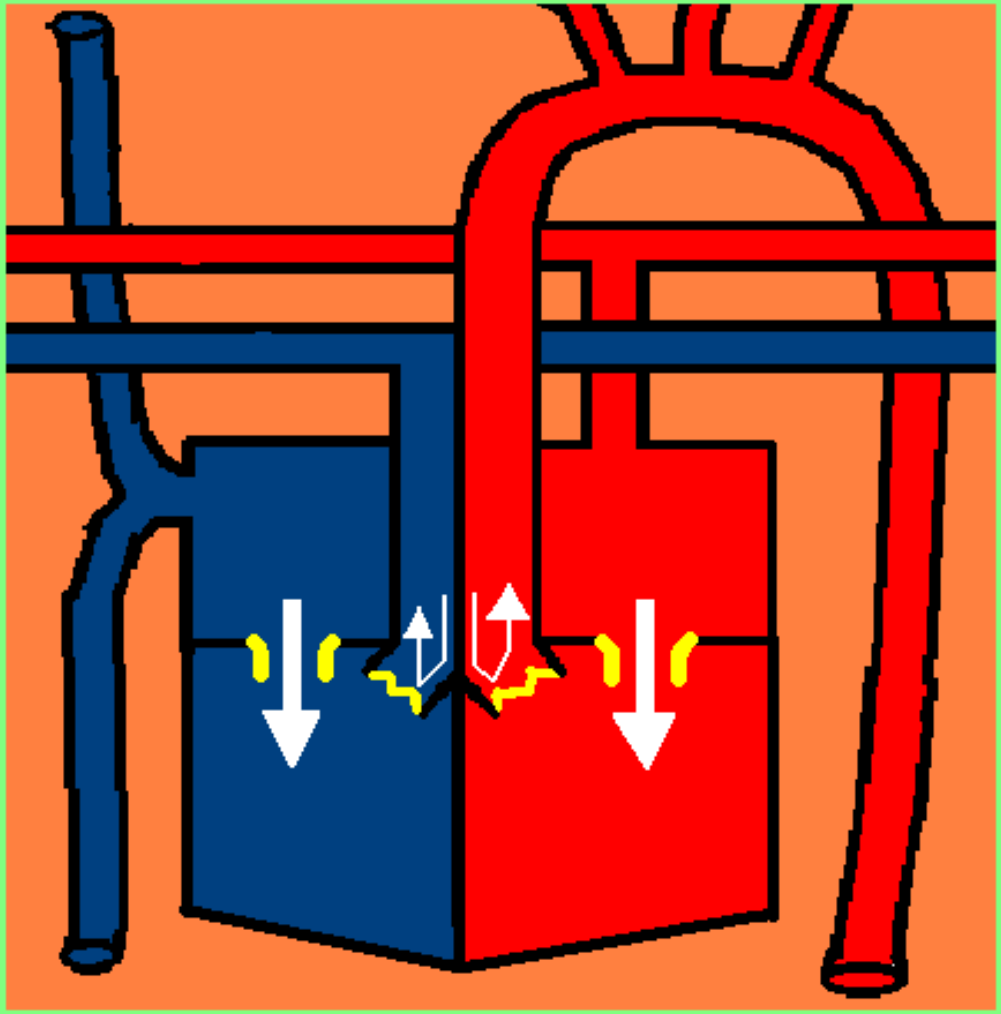
SOUND OF THE MITRAL AND TRICUSPID VALVES CLOSING.



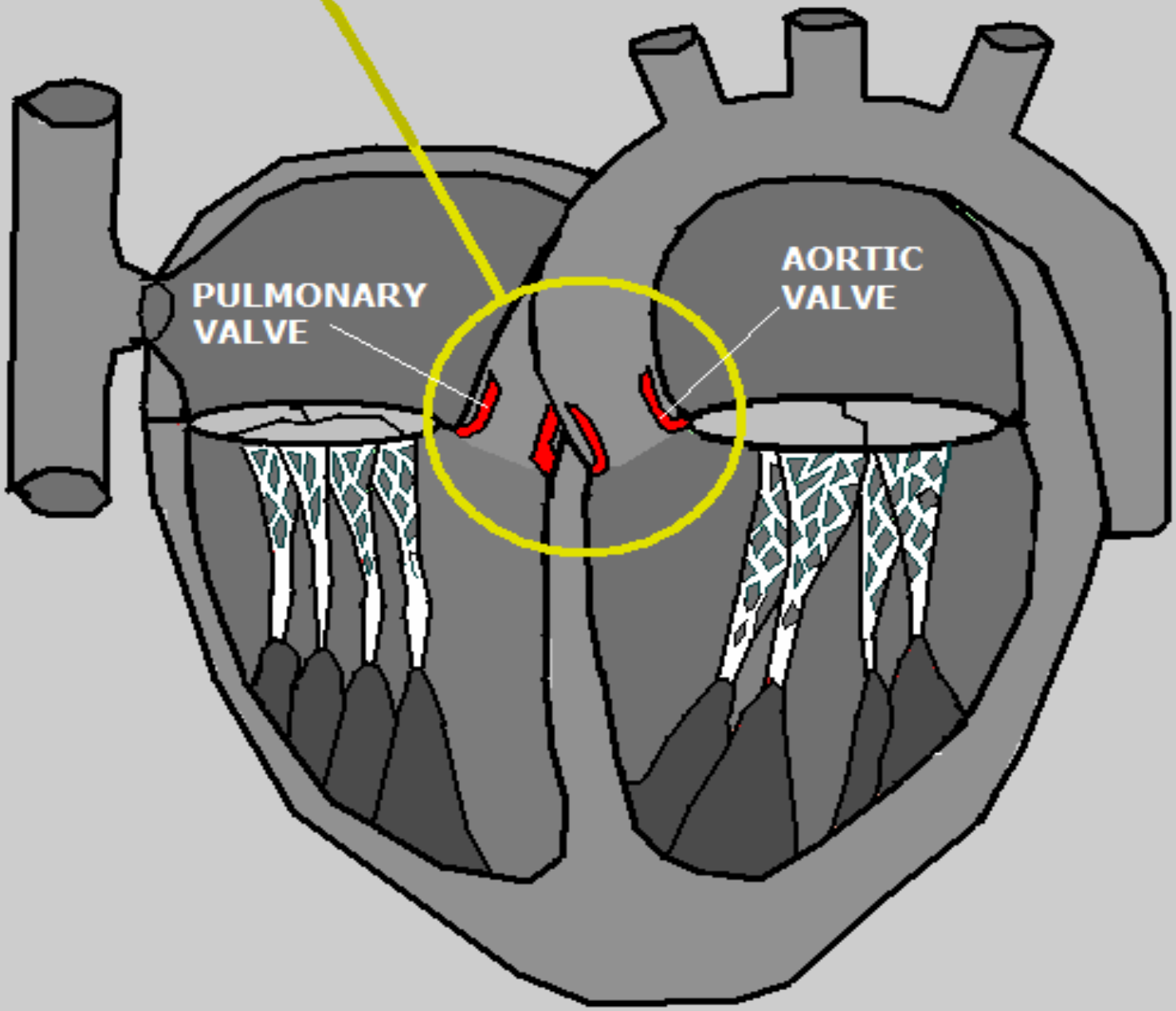
HEART SOUNDS ASSESSMENT

S-2 OCCURS AT THE END OF SYSTOLE (THE BEGINNING OF DIASTOLE).

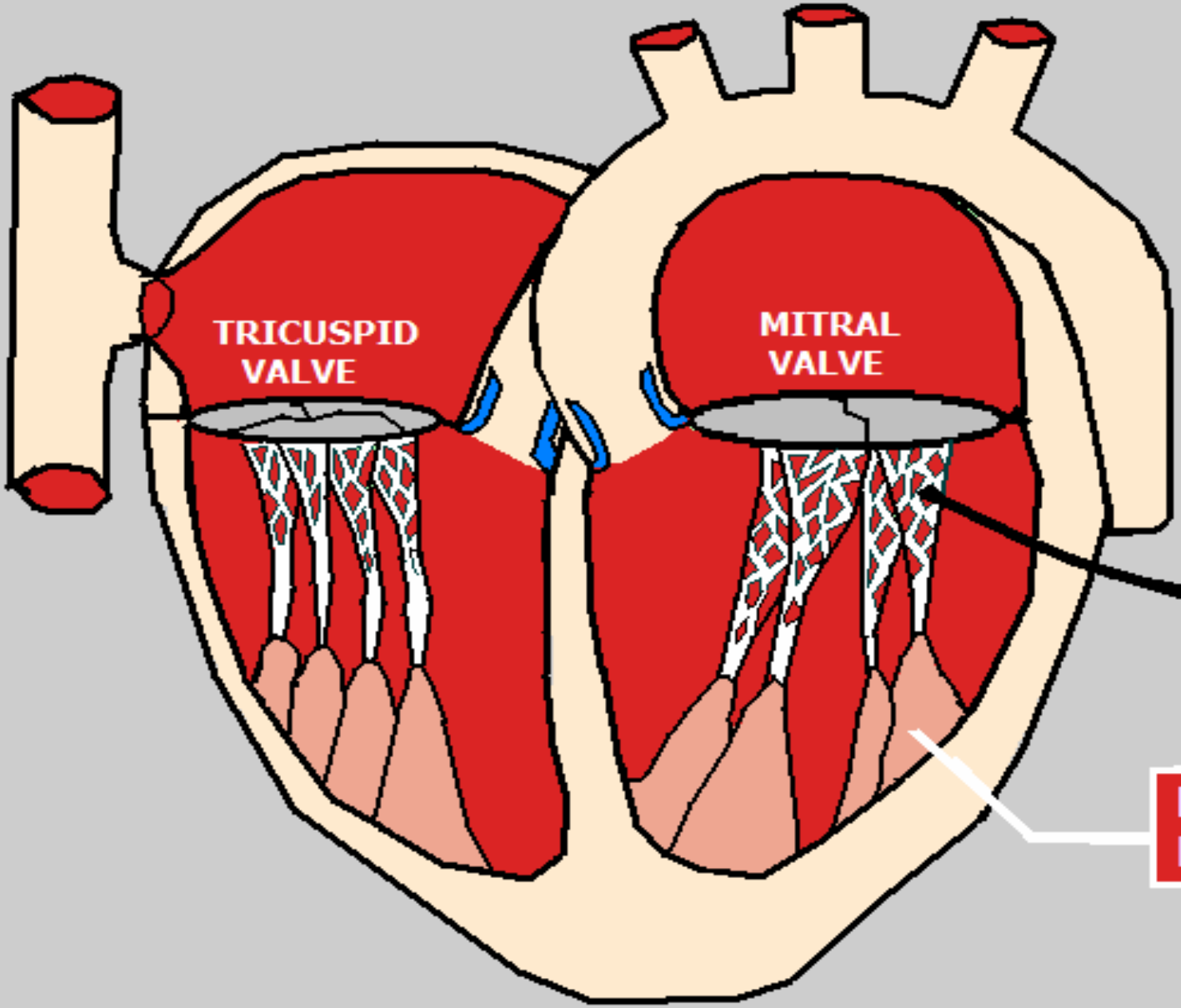
IT IS THE SOUND OF THE AORTIC AND PULMONARY VALVES CLOSING.



THE SEMILUNAR VALVES



ATRIO-VENTRICULAR VALVES



ARE SECURED TO THE ENDO-CARDIAL SURFACE BY THE

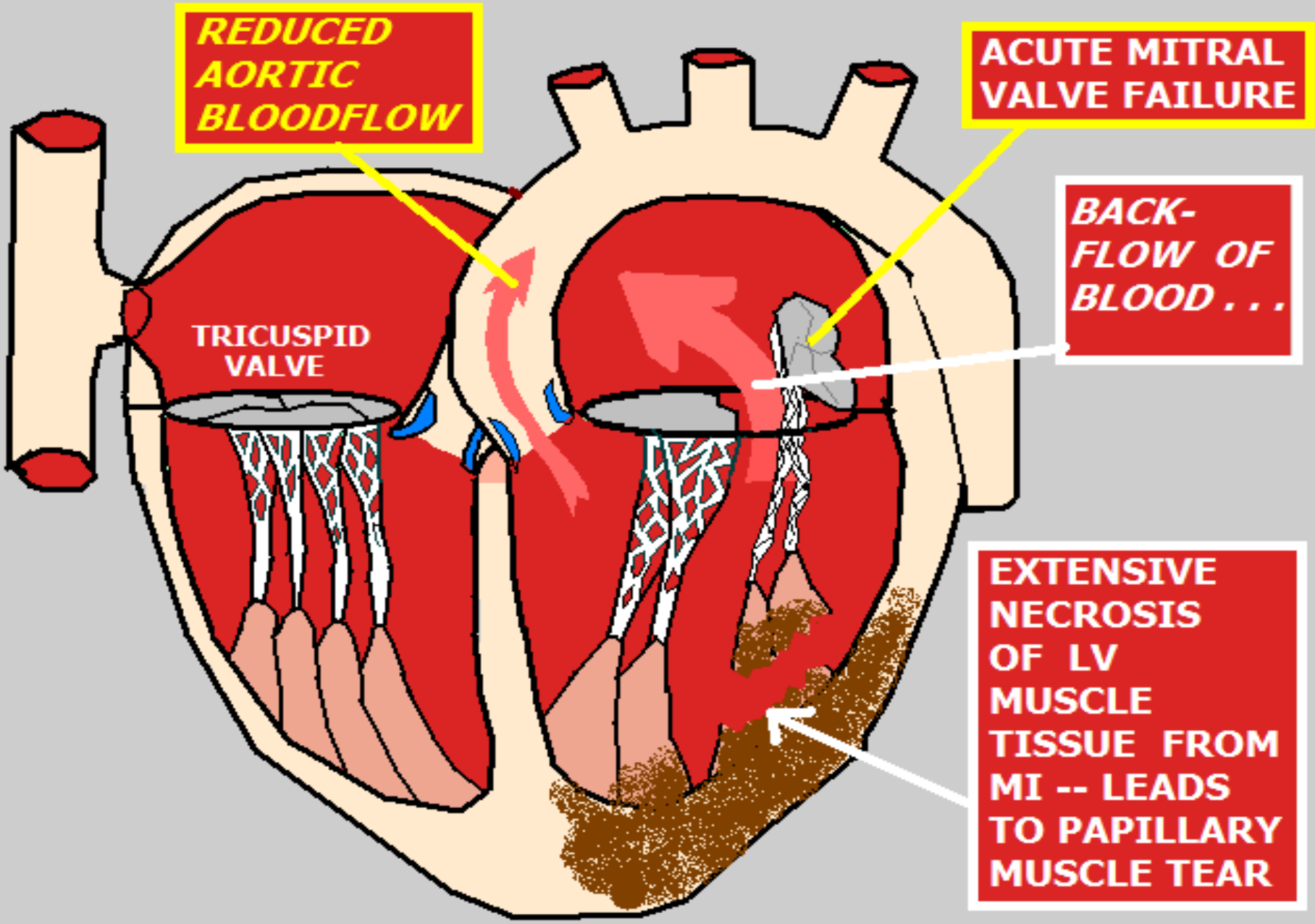
CHORDAE TENDINEAE

AND THE

PAPILLARY MUSCLES

ACUTE MITRAL REGURGITATION

DURING VENTRICULAR SYSTOLE



BASIC HEART SOUNDS ASSESSMENT

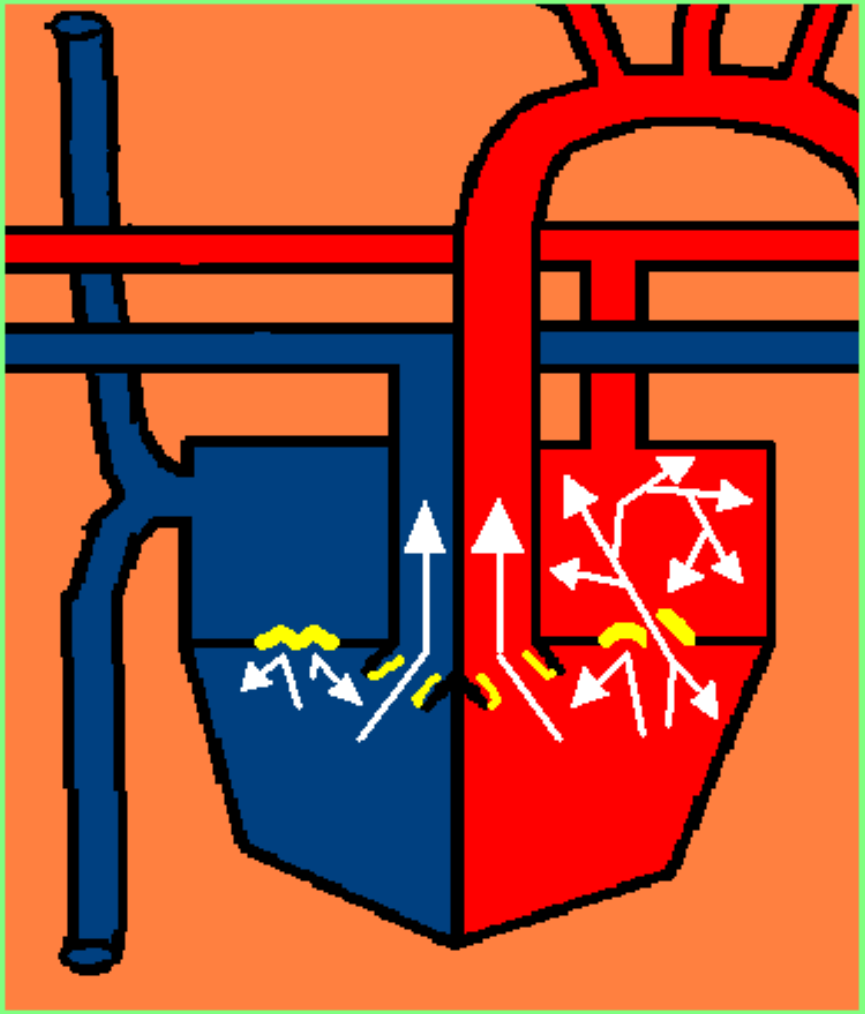
**MURMUR = "SWOOSH"
SOUND CAUSED BY THE
SOUND OF TURBULENCE.**

S-1 MURMUR SOUNDS LIKE:

**"SWOOSH-DUB . . . . SWOOSH-
DUB . . . . SWOOSH-DUB . . . .
SWOOSH-DUB . . . "**

CAUSE OF SYSTOLIC (S 1) MURMUR

- **DAMAGE TO MITRAL and/or TRICUSPID VALVE(s)**
- **CAUSES REGURGITATION**



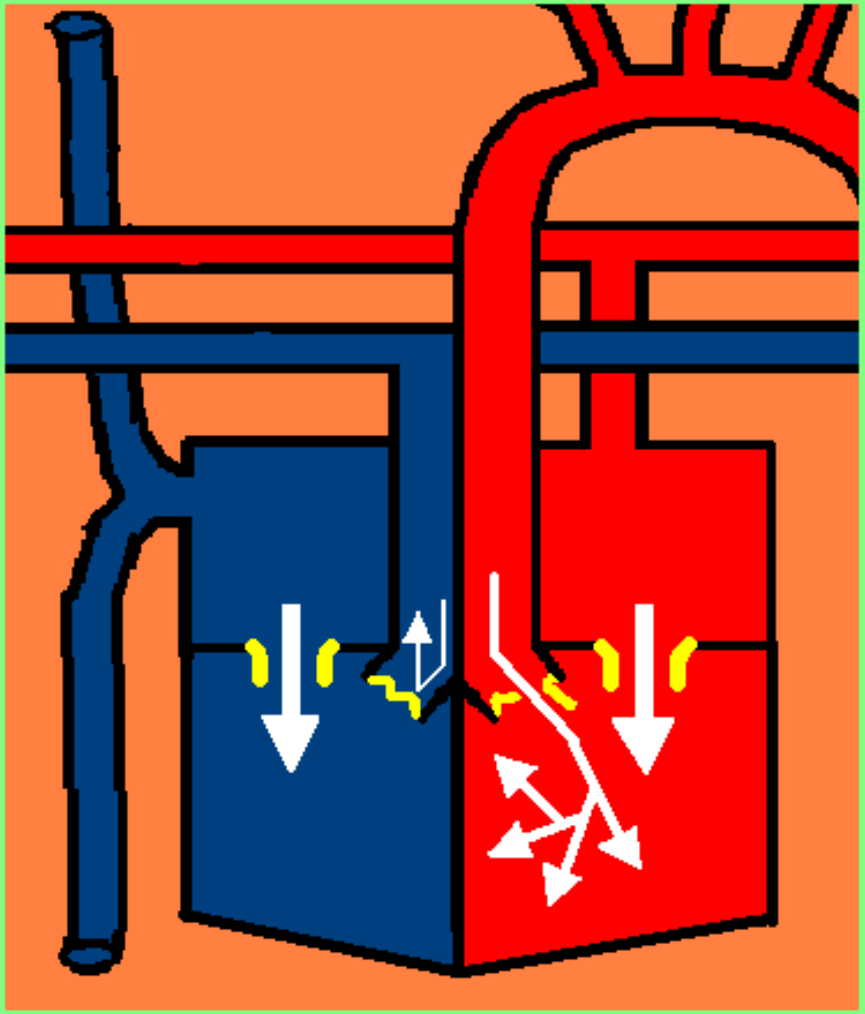
- **MOST SYSTOLIC MURMURS CAUSED BY MITRAL VALVE FAILURE.**

- **ACUTE MITRAL VALVE REGURGITATION IS A POTENTIALLY LETHAL COMPLICATION OF ACUTE / RECENT EXTENSIVE TRANSMURAL MI**

ACUTE MITRAL VALVE RUPTURE USUALLY OCCURS 7-10 DAYS POST EXTENSIVE MI (e.g.: INFERIOR POSTERIOR LATERAL MI).

CAUSE OF DIASTOLIC (S2) MURMUR

- **DAMAGE TO AORTIC and/or PULMONIC VALVE(s)**
- **CAUSES REGURGITATION**



BASIC HEART SOUNDS ASSESSMENT

MURMUR = "SWOOSH"
SOUND CAUSED BY THE
SOUND OF TURBULENCE.

S-2 MURMUR SOUNDS LIKE:

"LUB-SWOOSH . . . . LUB-SWOOSH . . . . .LUB-SWOOSH . . . . LUB-SWOOSH . . . "

- AORTIC VALVE FAILURE MOST COMMON CAUSE OF S-2 MURMUR

- DUE TO THE HIGHER PRESSURES OF THE LEFT SIDE OF THE HEART

BASIC HEART SOUNDS ASSESSMENT

FRICTION RUB

- ASSOCIATED WITH PERICARDITIS
- SOUNDS LIKE THE GENTLE RUBBING OF SANDPAPER
- HAS 3 COMPONENTS: SYSTOLIC, EARLY, and LATE DIASTOLIC

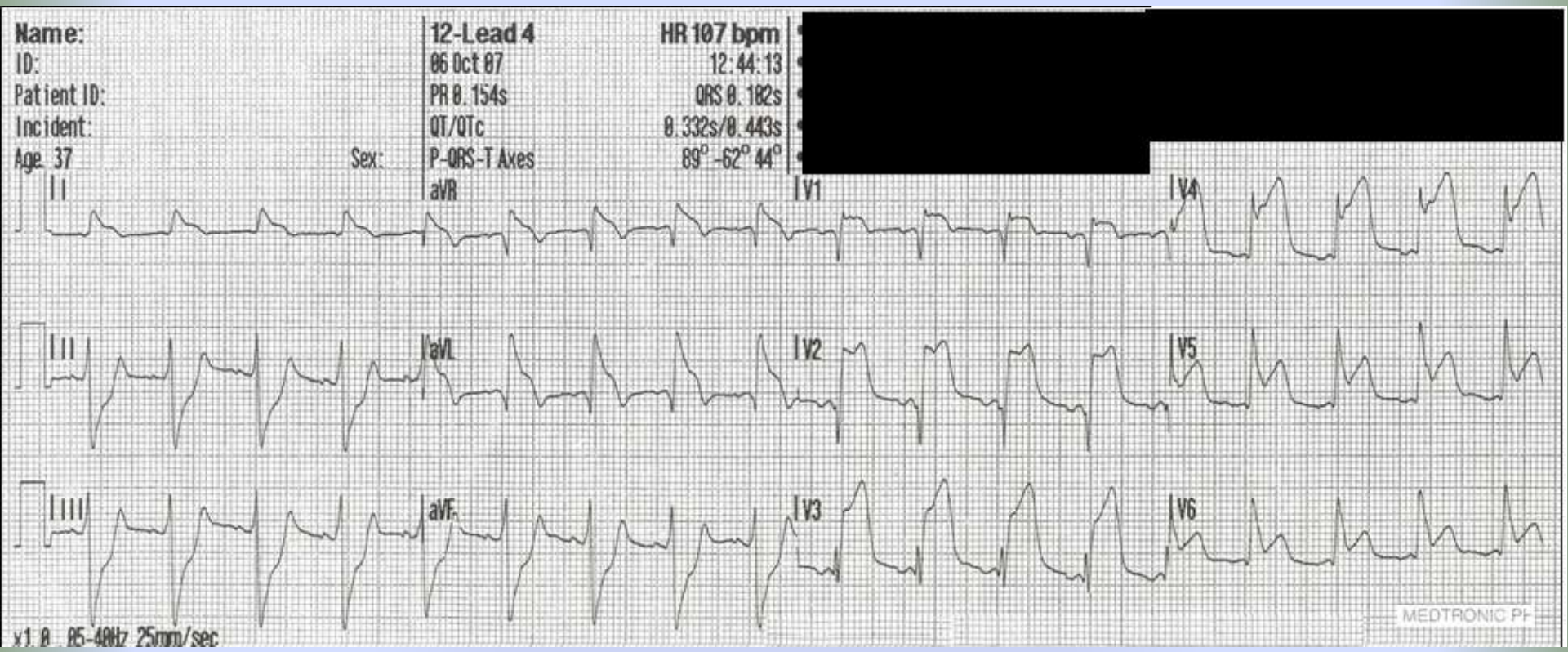
BASIC HEART SOUNDS ASSESSMENT

FRICTION RUB

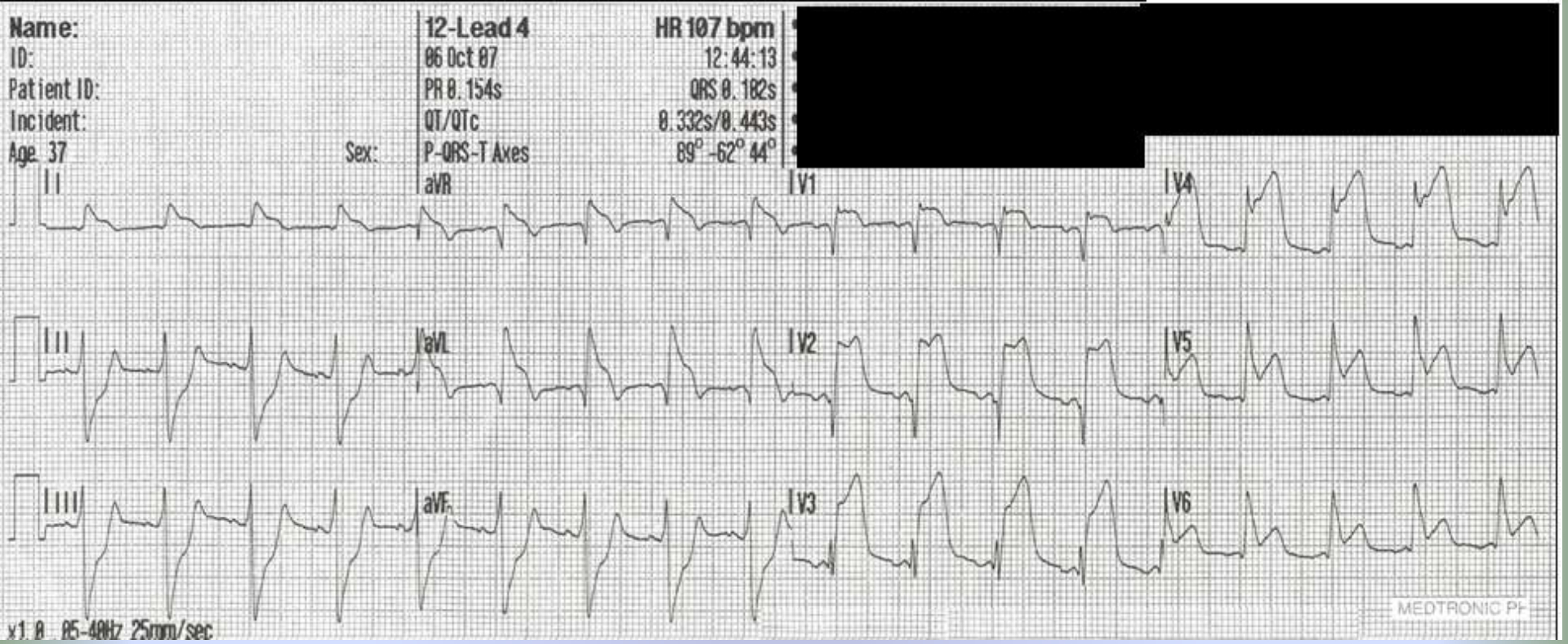
- IS PRESENT IN MOST ACUTE TRANSMURAL MI PATIENTS
- MAY BE PRESENT WITHIN HOURS AFTER ONSET
- IS TRANSIENT -- MAY LAST FOR A FEW DAYS

Practice ECGs . . .

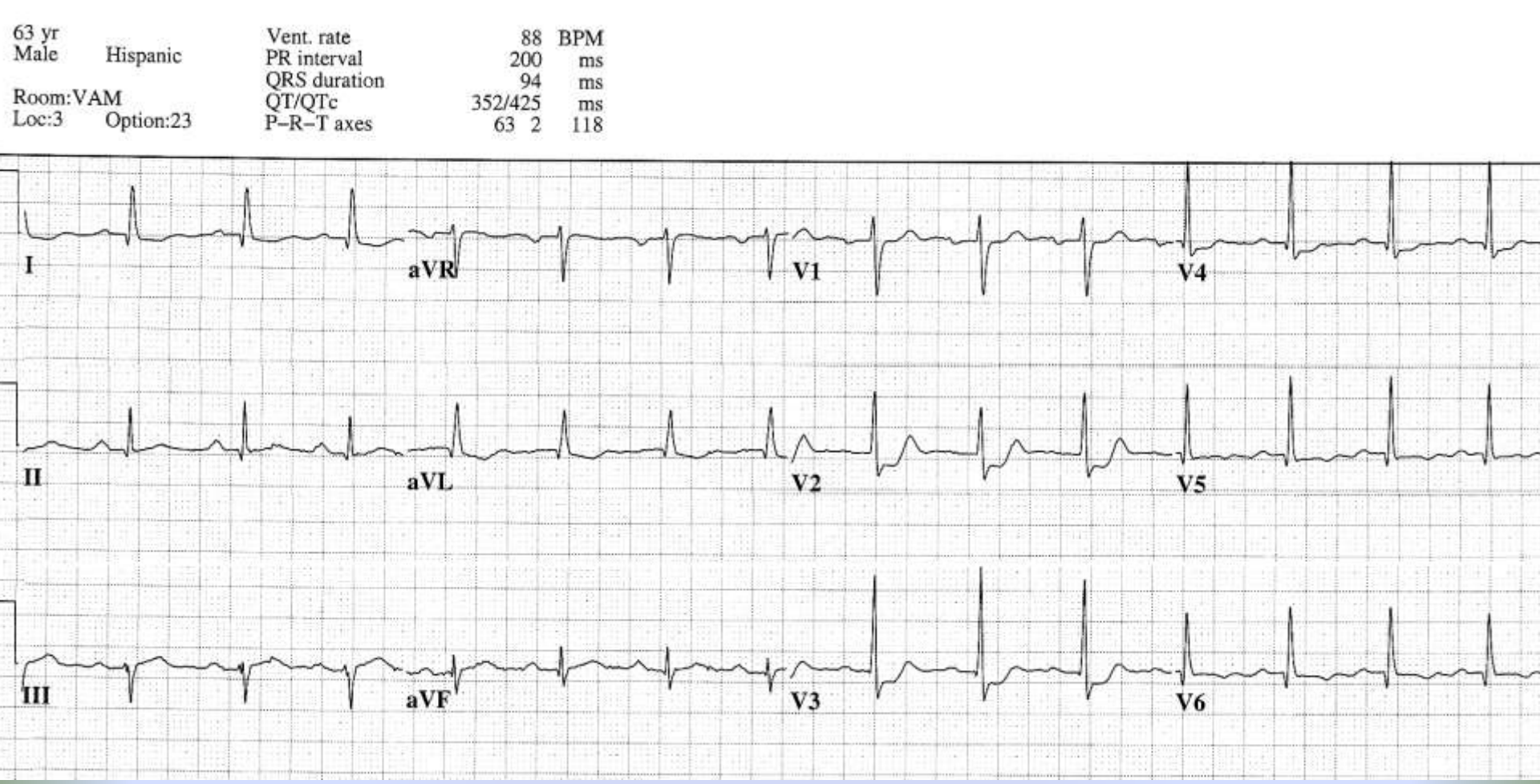
Let's review . . . .



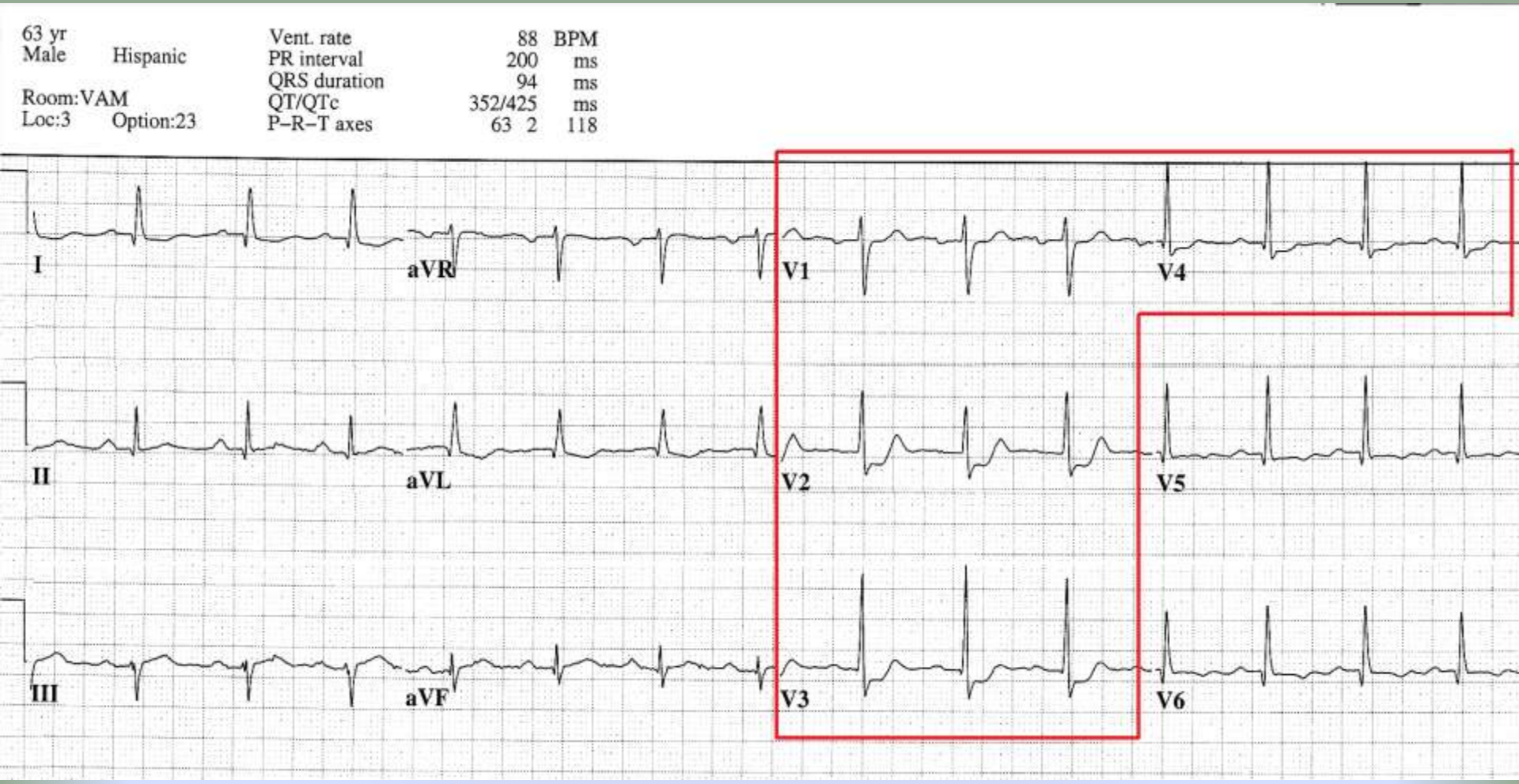
1. ECG abnormality(ies)?
2. Possible diagnosis?
3. Action / Intervention?



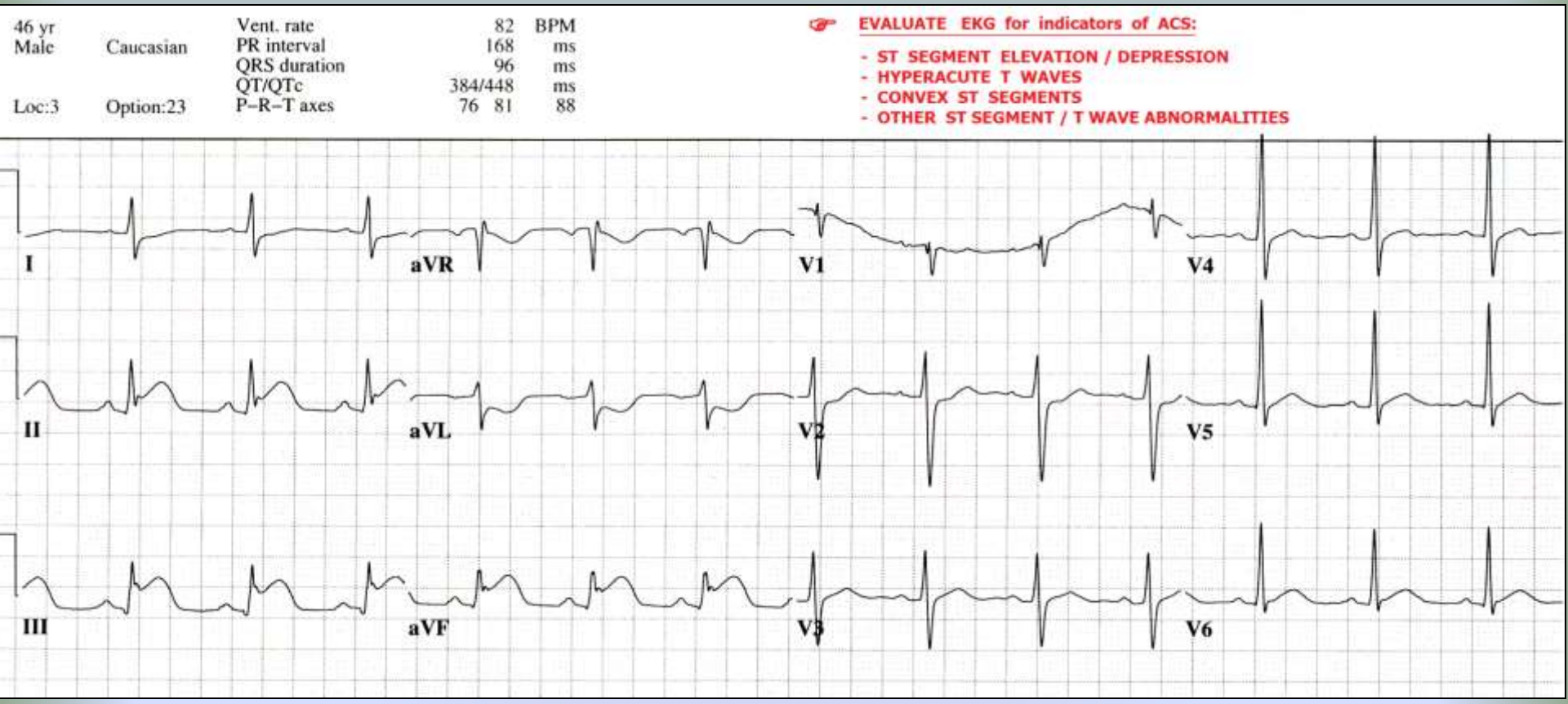
1. ECG abnormality(ies)? ST Elevation Leads I, AVR AVL, V1, V2, V3, V4, V5 & V6. ST Depression II, III and AVF
2. Possible diagnosis? Acute Anterolateral Wall STEMI secondary to Left Main Coronary Artery occlusion (widow-maker MI).
3. Action / Intervention? STAT CATH LAB vs STAT Thrombolytics. Prepare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



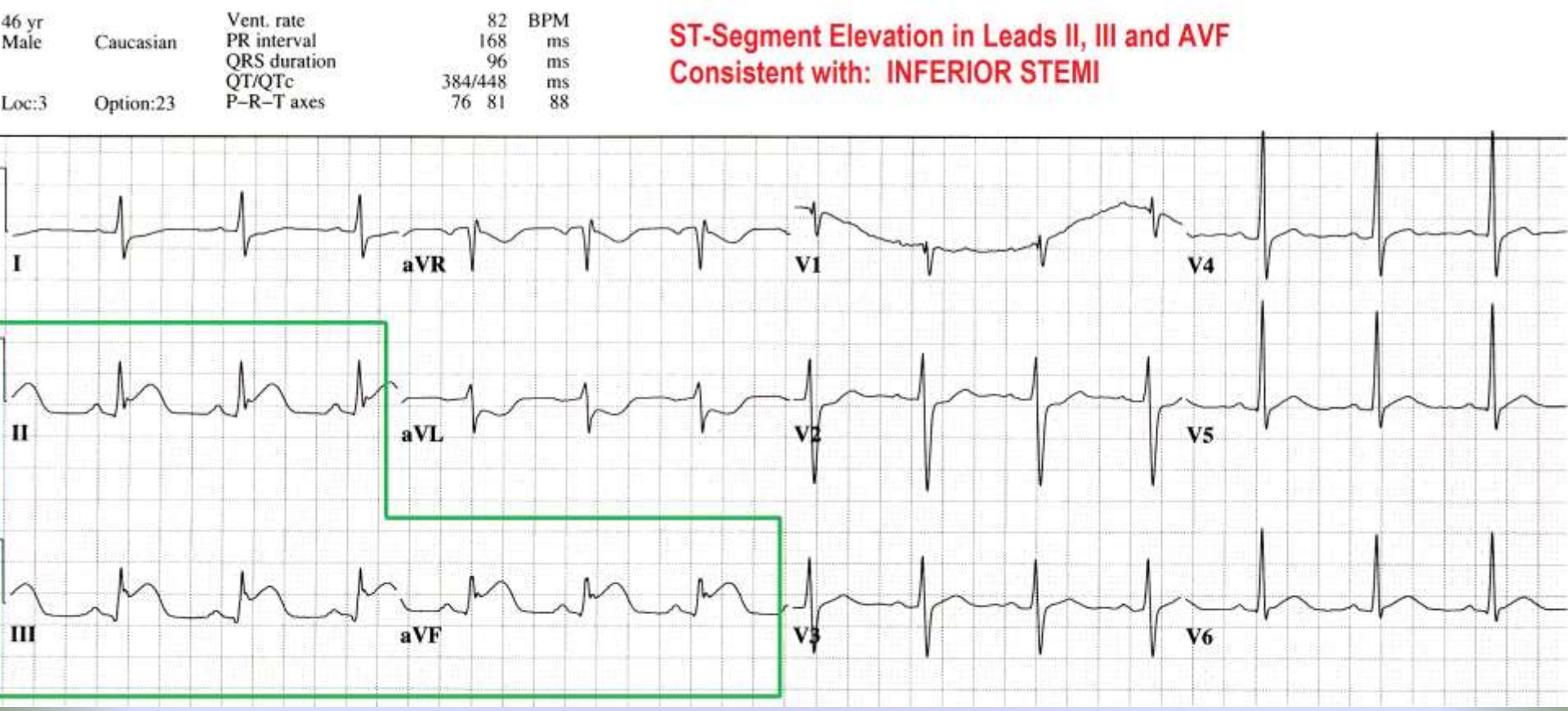
1. ECG abnormality(ies)?
2. Possible diagnosis?
3. Action / Intervention?



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

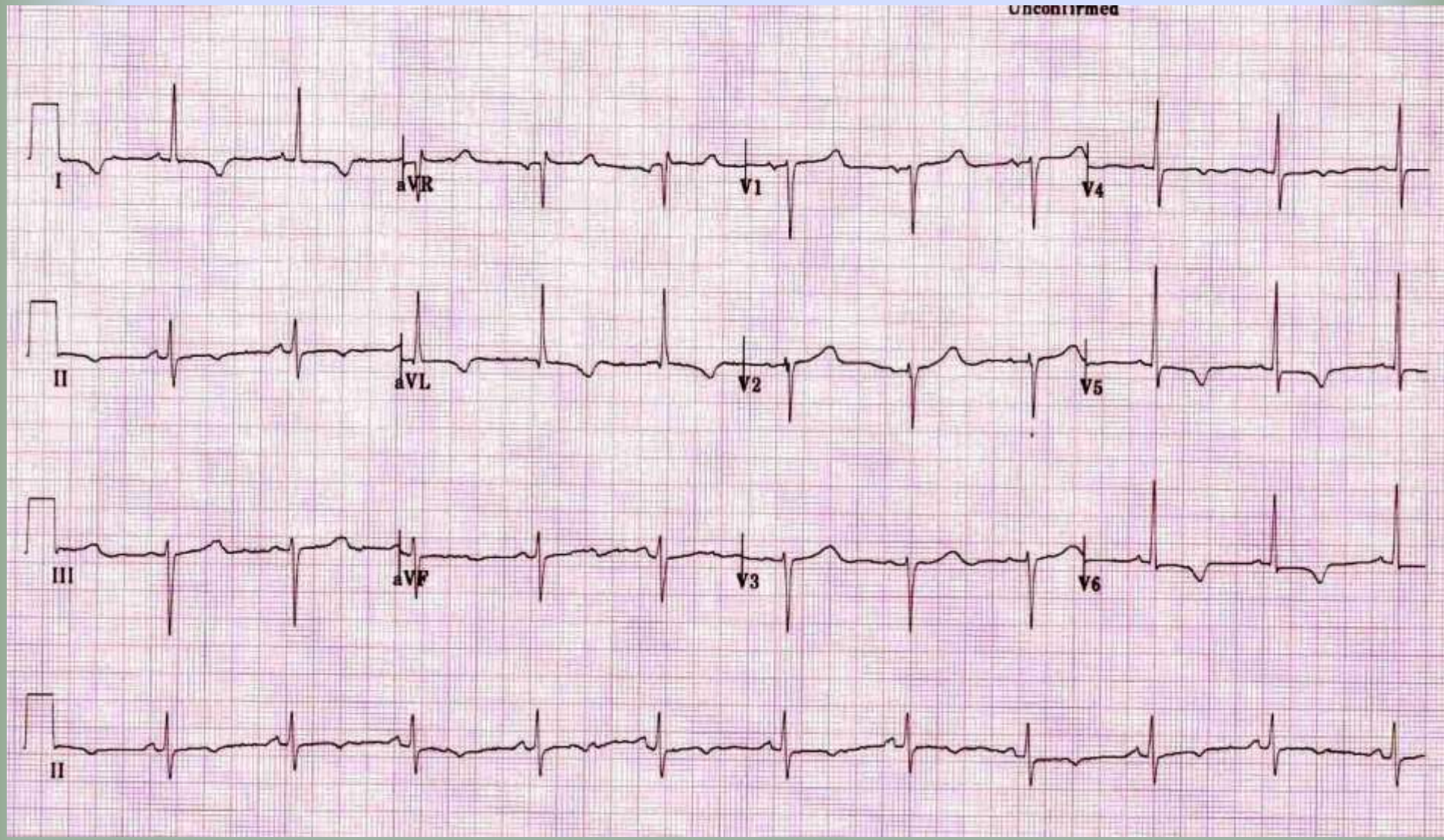


1. ECG abnormality(ies)?
2. Possible diagnosis?
3. Action / Intervention?

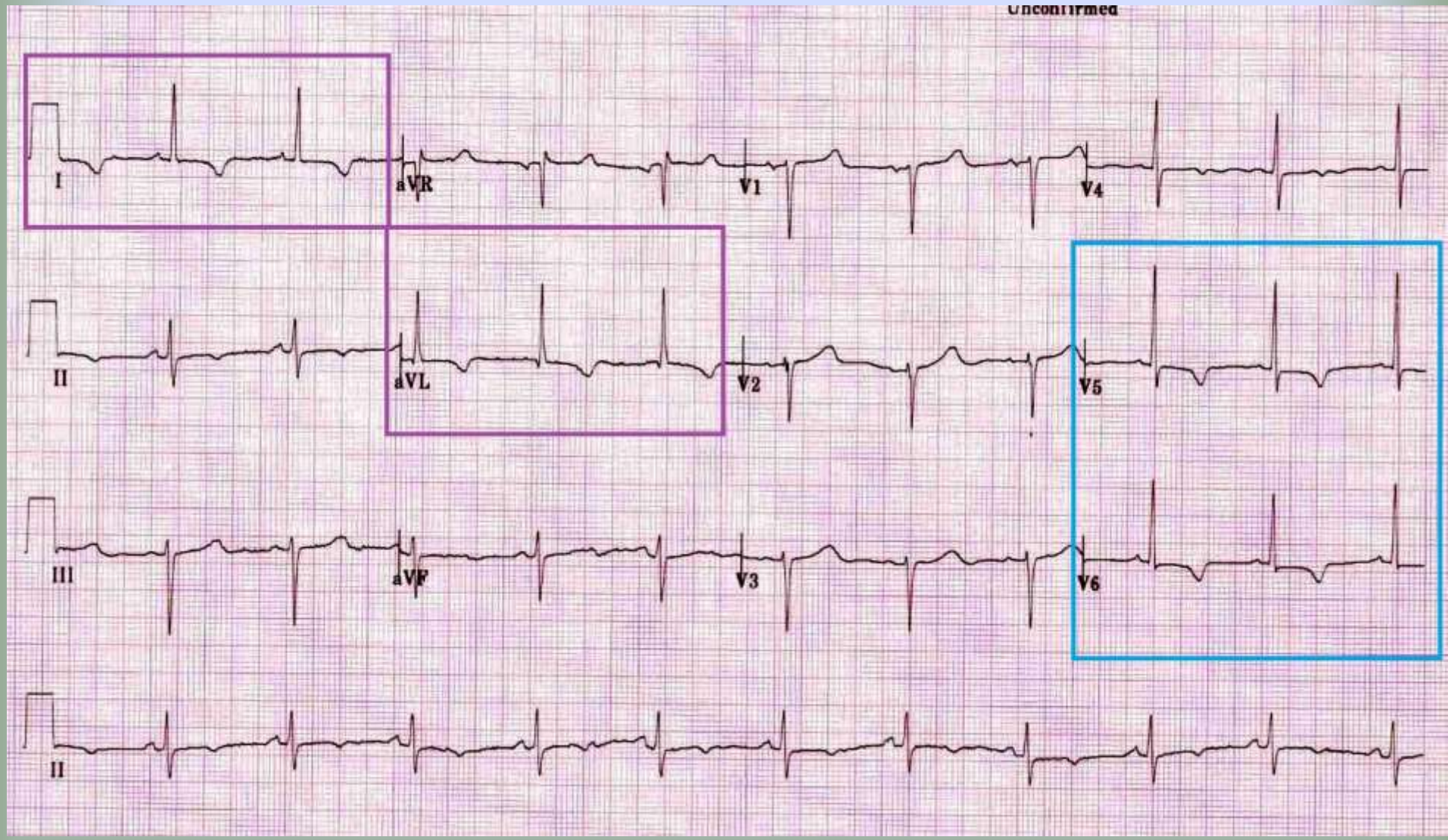


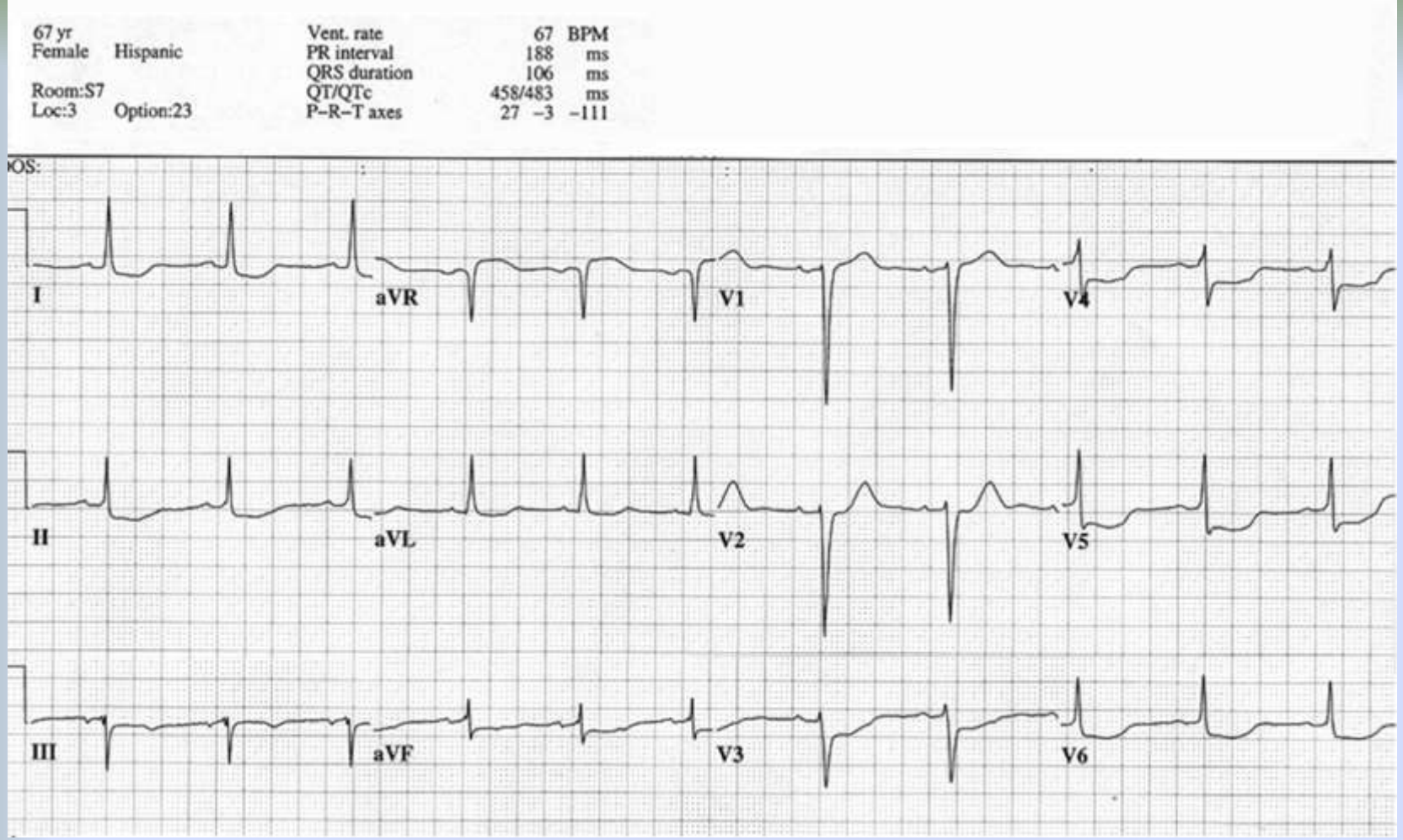
1. ECG abnormality(ies)? ST Elevation, Leads II,III & AVF
2. Possible diagnosis? Inferior Wall STEMI
3. Action / Intervention? 1. Do R-sided ECG, *prepare for* Atropine administration, external pacing, cardiac arrest, STAT cath lab visit !

What leads show signs of possible ACS?

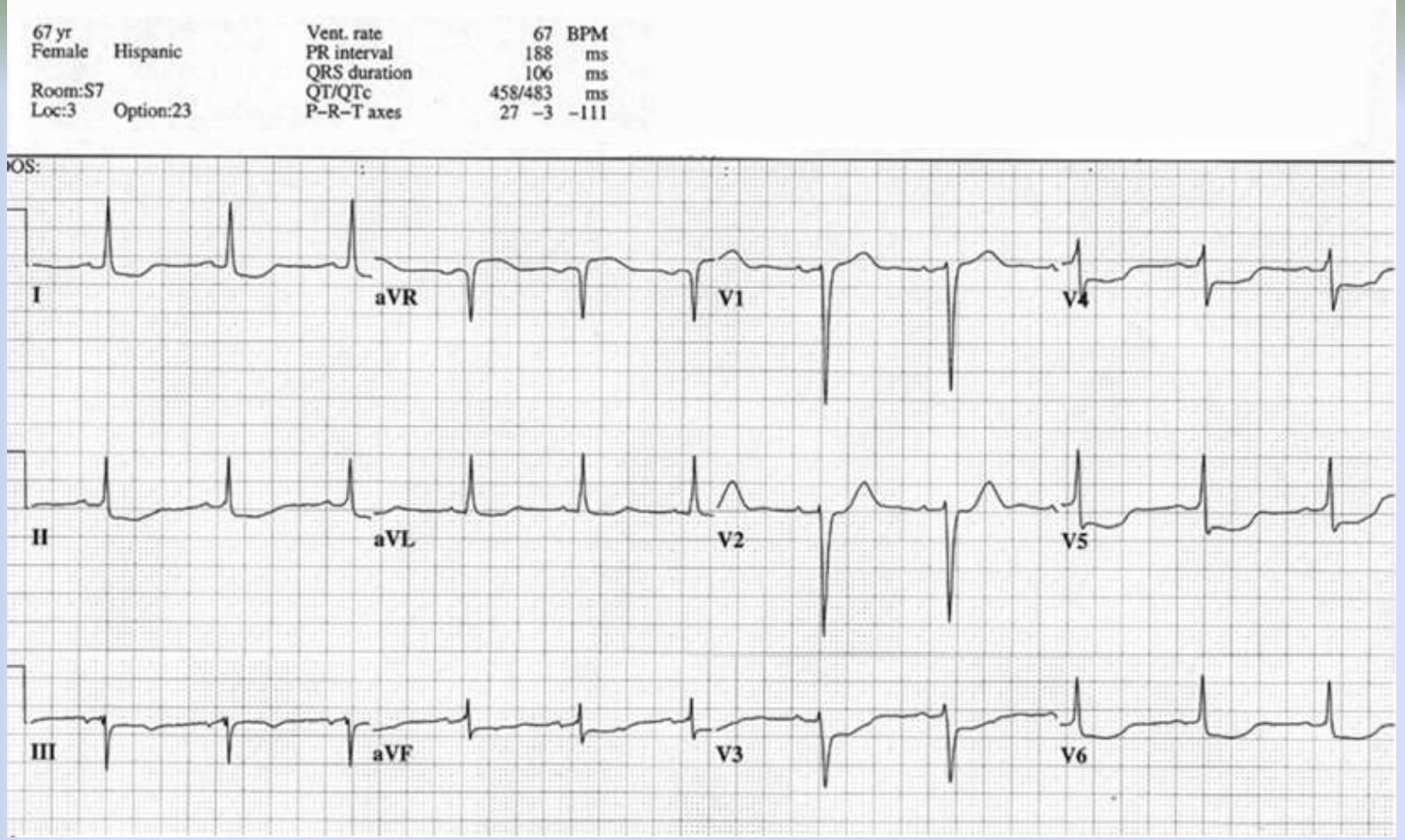


12 Lead ECG
shows ISCHEMIC CHANGES Lateral Wall:

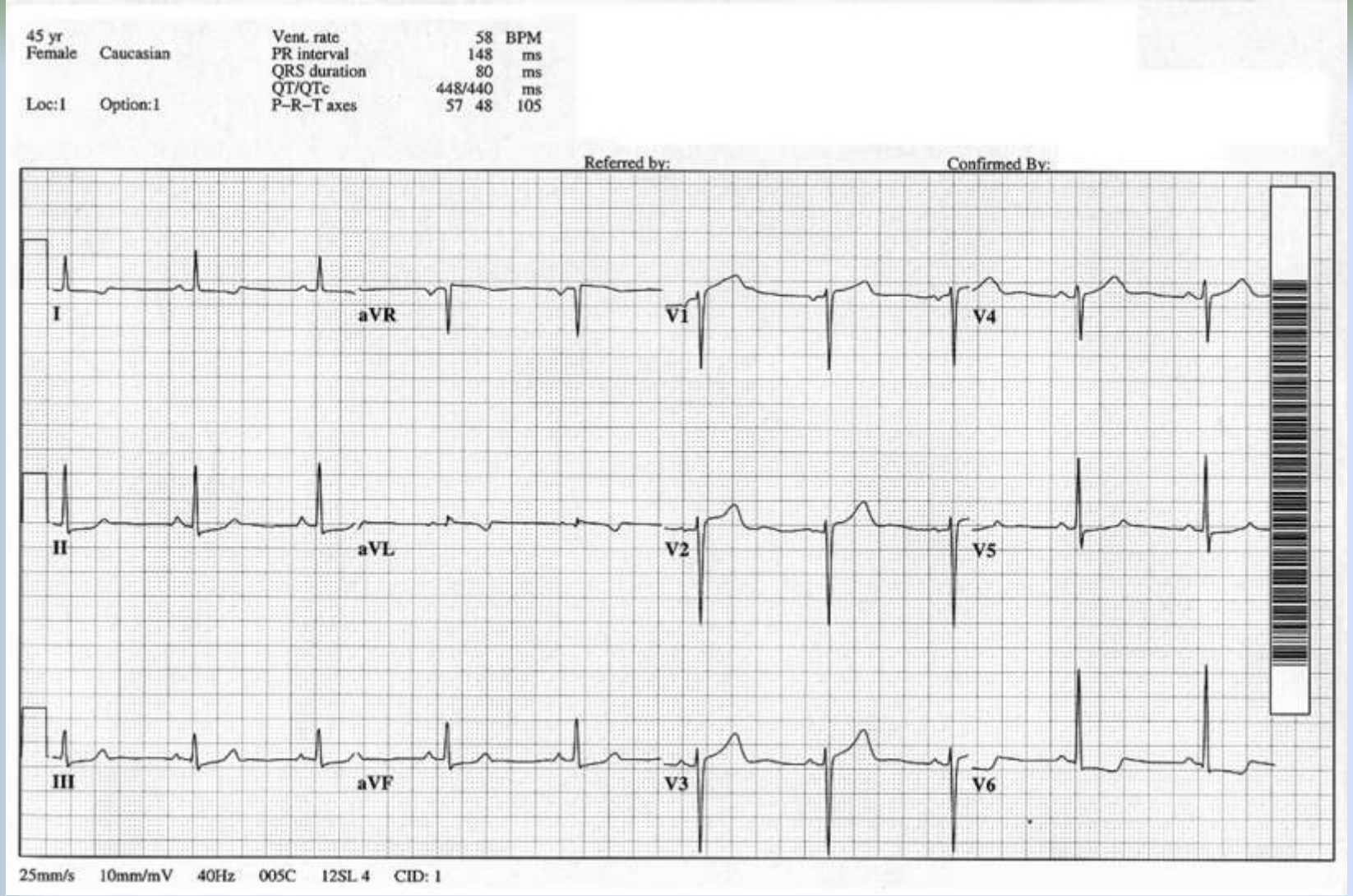




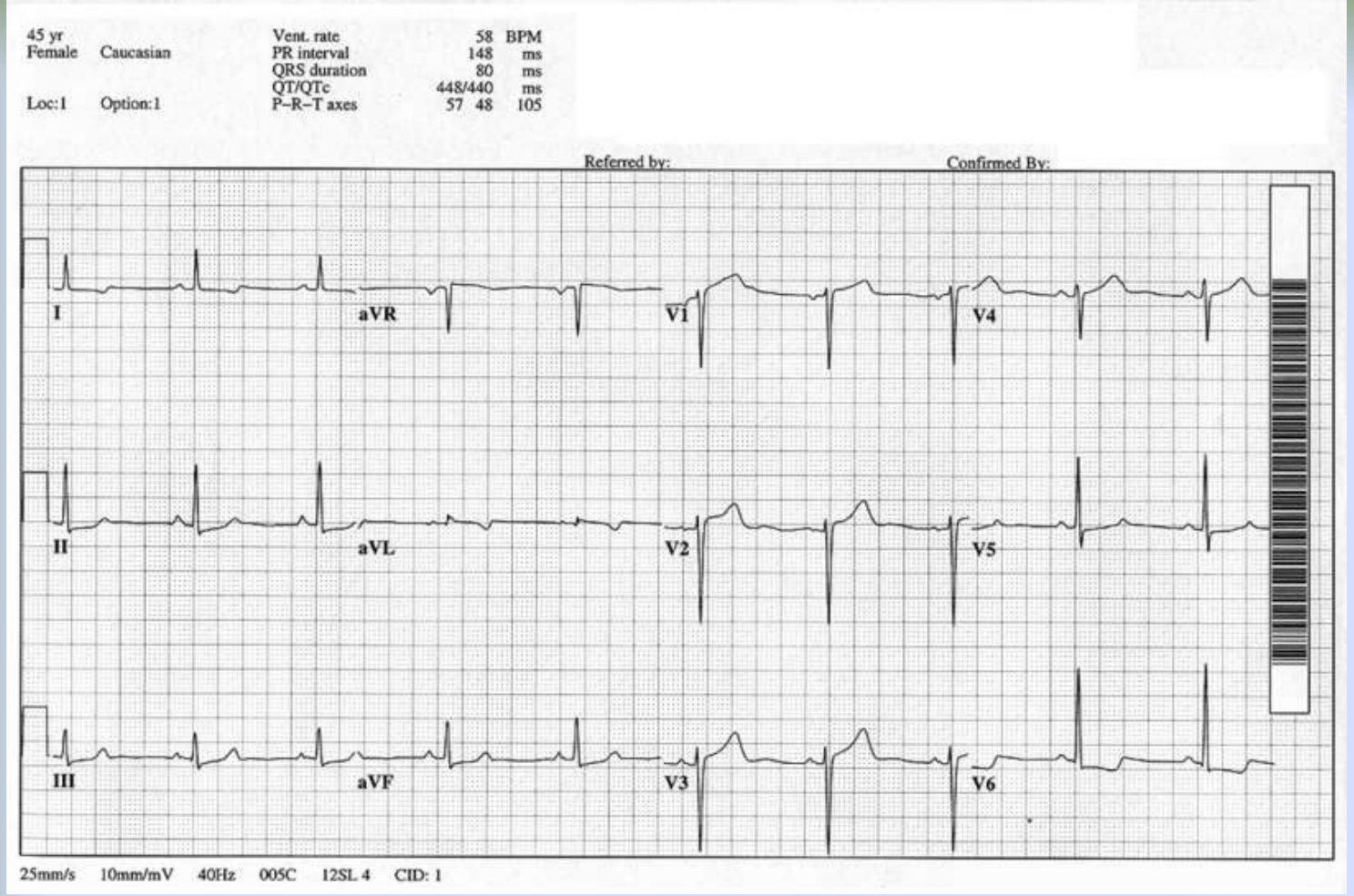
1. ECG abnormality(ies)?
2. Possible diagnosis?
3. Action / Intervention?



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



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



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

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

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