ACC/AHA Guideline-Driven In-Hospital ECG Monitoring

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Standards for Inpatient Electrocardiographic Monitoring

Oct 04, 2017 | Richard L. Weinberg, MD, PhD, FACC

Authors:	Sandau KE, Funk M, Auerbach A, et al., on behalf of the American Heart Association Council on Cardiovascular and Stroke Nursing; Council on Clinical Cardiology; and Council on Cardiovascular Disease in the Young.
Citation:	**Update to Practice Standards for Electrocardiographic Monitoring in Hospital Settings: A Scientific Statement From the American Heart Association. *Circulation* 2017;Oct 3:[Epub ahead of print].**

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AHA SCIENTIFIC STATEMENT

Update to Practice Standards for Electrocardiographic Monitoring in Hospital Settings

A Scientific Statement From the American Heart Association

Endorsed by the American College of Cardiology, American Association of Critical-Care Nurses, and Pediatric and Congenital Electrophysiology Society

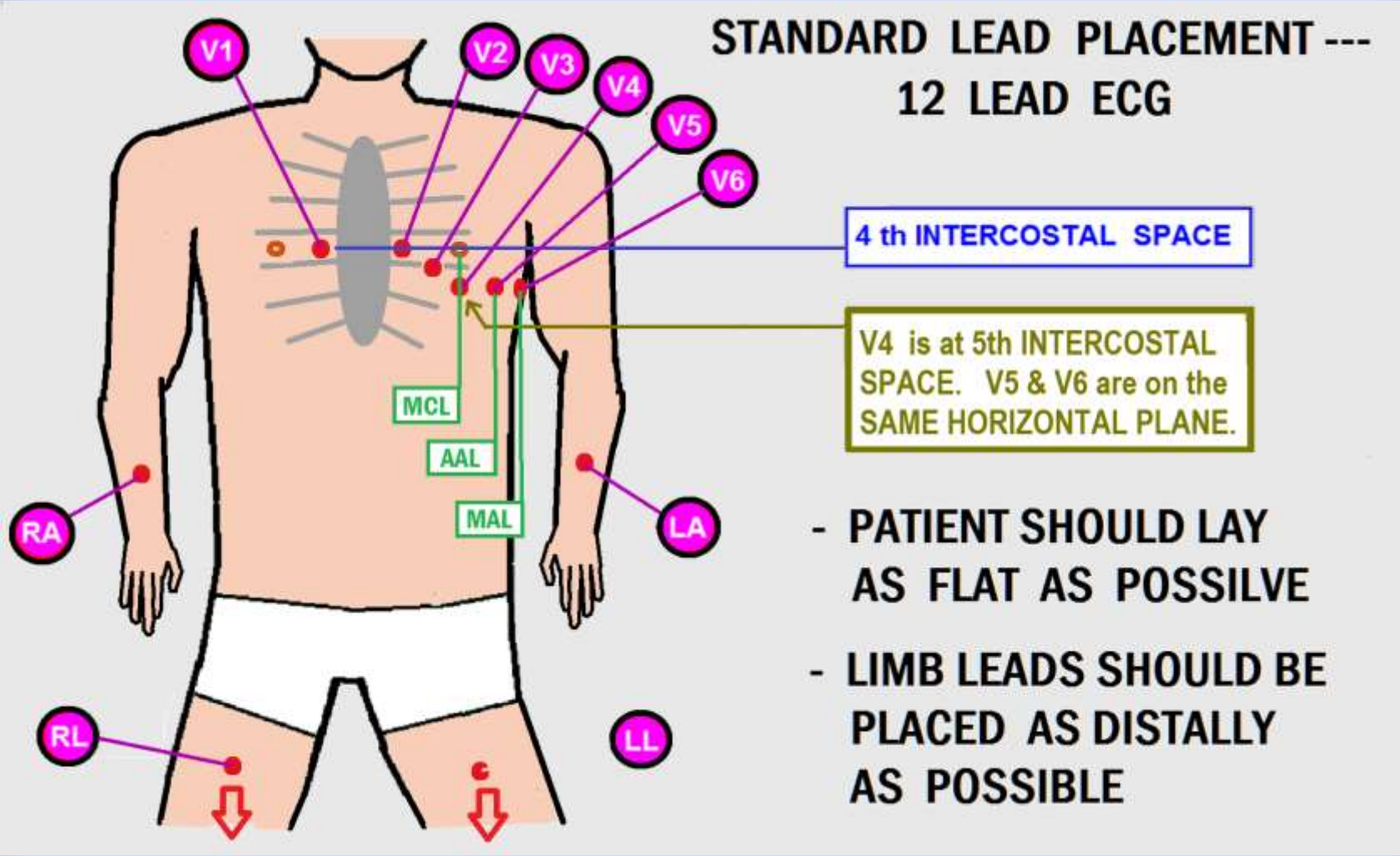
The comprehensive document is grouped into 5 sections: (1) Overview of Arrhythmia, Ischemia, and QTc Monitoring; (2) Recommendations for Indication and Duration of Electrocardiographic Monitoring presented by patient population; (3) Organizational Aspects: Alarm Management, Education of Staff, and Documentation; (4) Implementation of Practice Standards; and (5) Call for Research.

The goals of electrocardiographic monitoring have expanded from simple heart rate and basic rhythm determination to the diagnosis of complex arrhythmias, the detection of acute and often silent myocardial ischemia, and the identification of drug-induced prolonged QT interval. The first American Heart Association (AHA) scientific statement on practice standards for electrocardiographic monitoring in hospital settings was published in 2004[1] and provided an interprofessional, comprehensive review of evidence and recommendations for continuous electrocardiographic monitoring of hospitalized patients.

Understanding “multiple leads”…

- Correct location of each ECG Lead

Obtaining the 12 Lead ECG



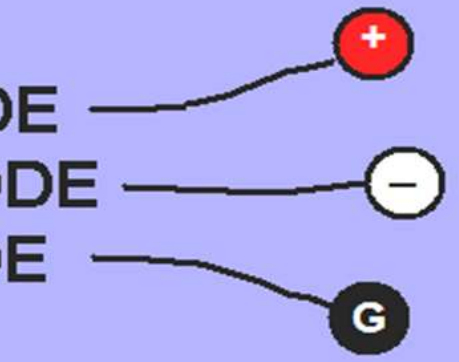
Understanding “multiple leads”…

- Correct location of each ECG Lead
- Region of the Heart viewed by each Lead

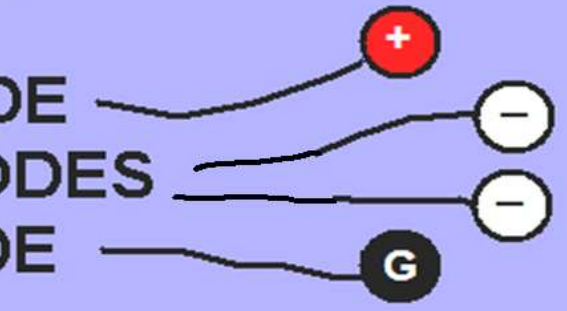
THE ECG MACHINE

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

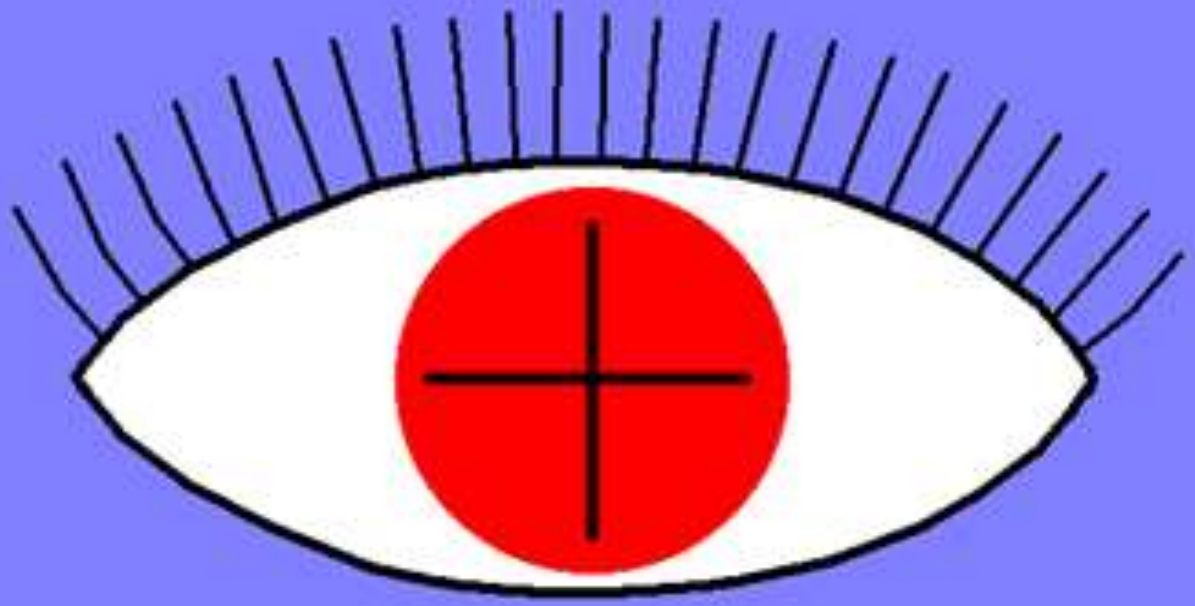
- LEADS I, II, III, and V1, V2, V3, V4, V5, V6



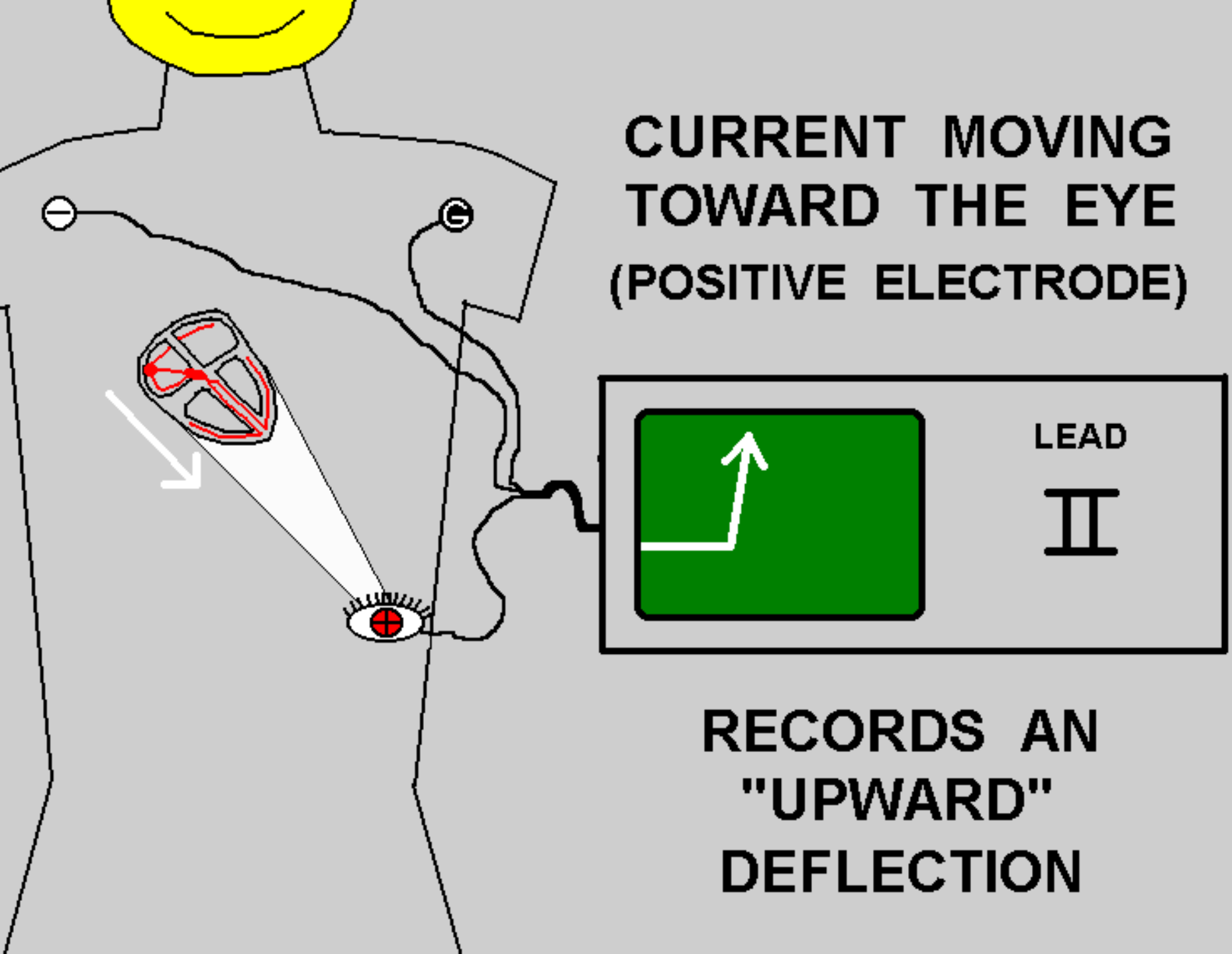
- LEADS AVR, AVL, and AVF

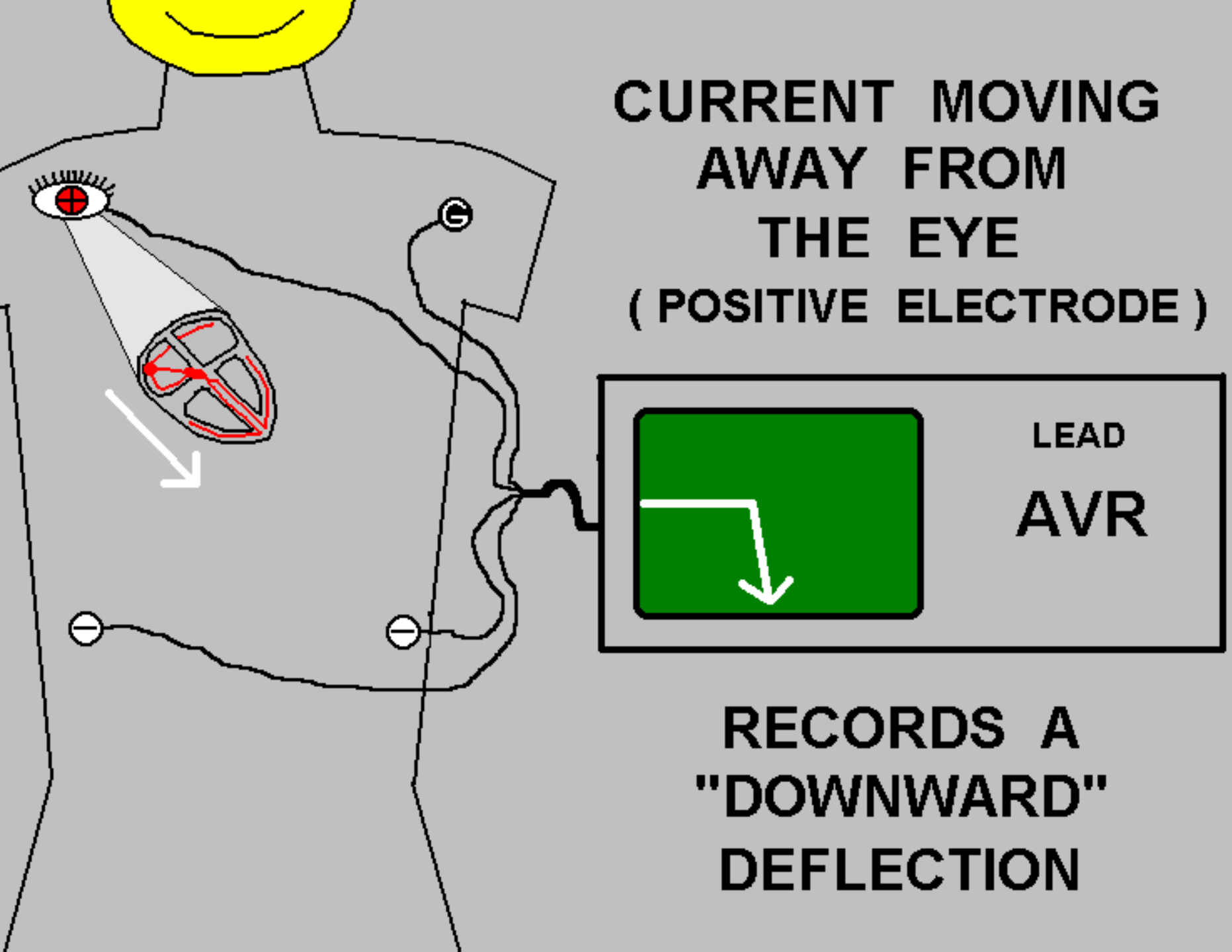


THE POSITIVE ELECTRODE

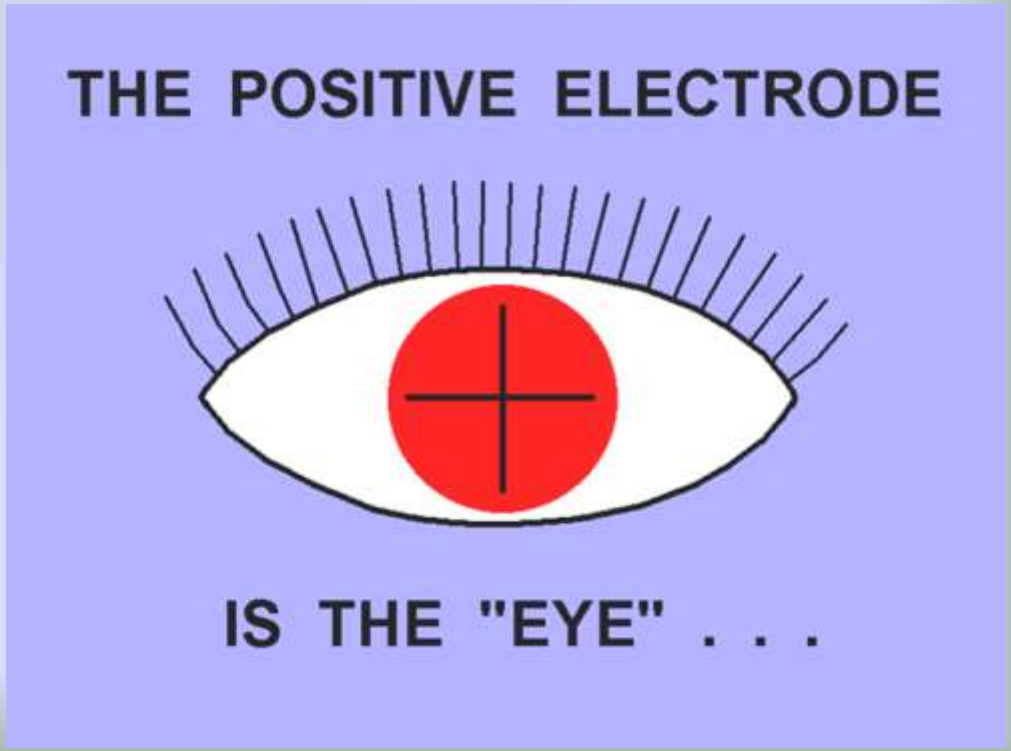


IS THE "EYE" . . .


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

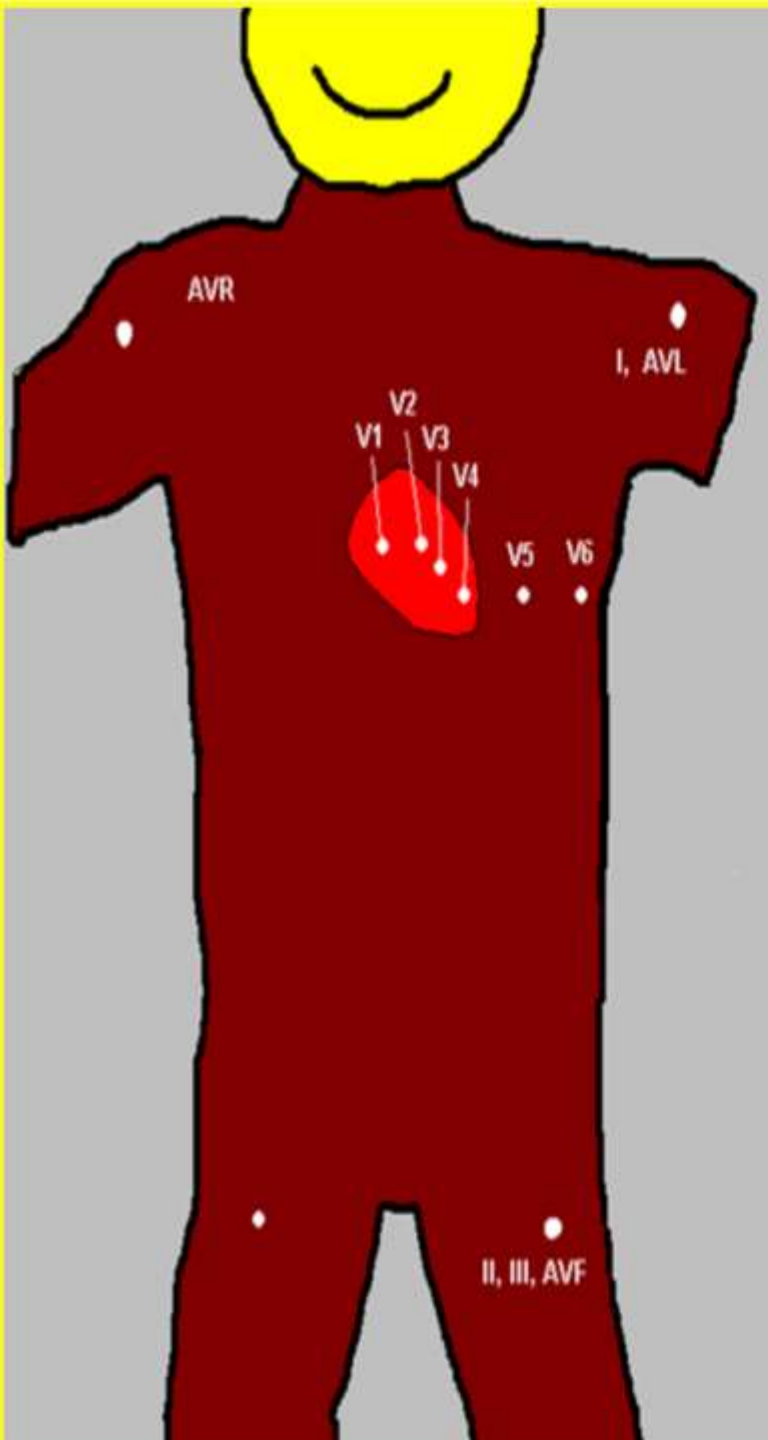

CURRENT MOVING AWAY FROM THE EYE
(POSITIVE ELECTRODE)
LEAD
AVR
RECORDS A "DOWNWARD" DEFLECTION

What part of the HEART does each lead SEE ?



Imagine a body made of clear glass, with only a HEART inside. We dip this body in liquid chocolate, and then scratch holes in each spot where we normally place the ECG leads . . . . .

AREAS VIEWED by 12 LEAD ECG



AVR

AVL, I

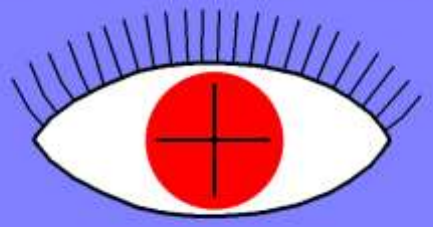
V1, V2

V3, V4

V5, V6

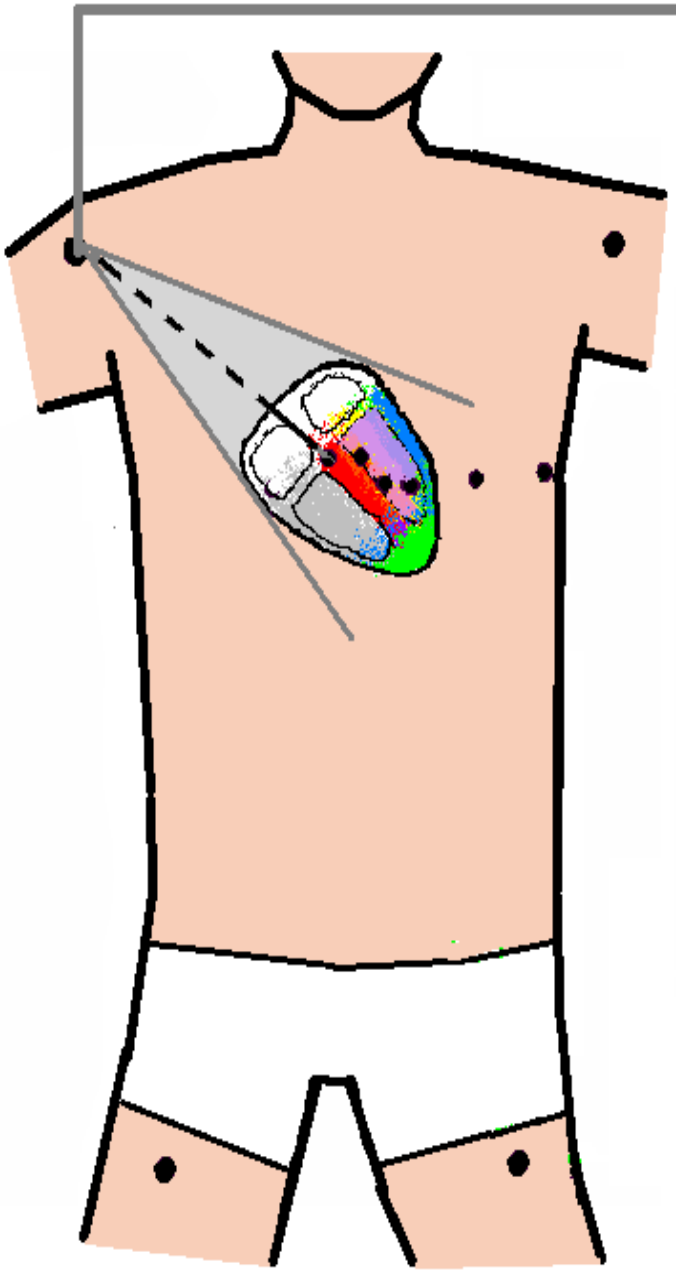
II, III, AVF

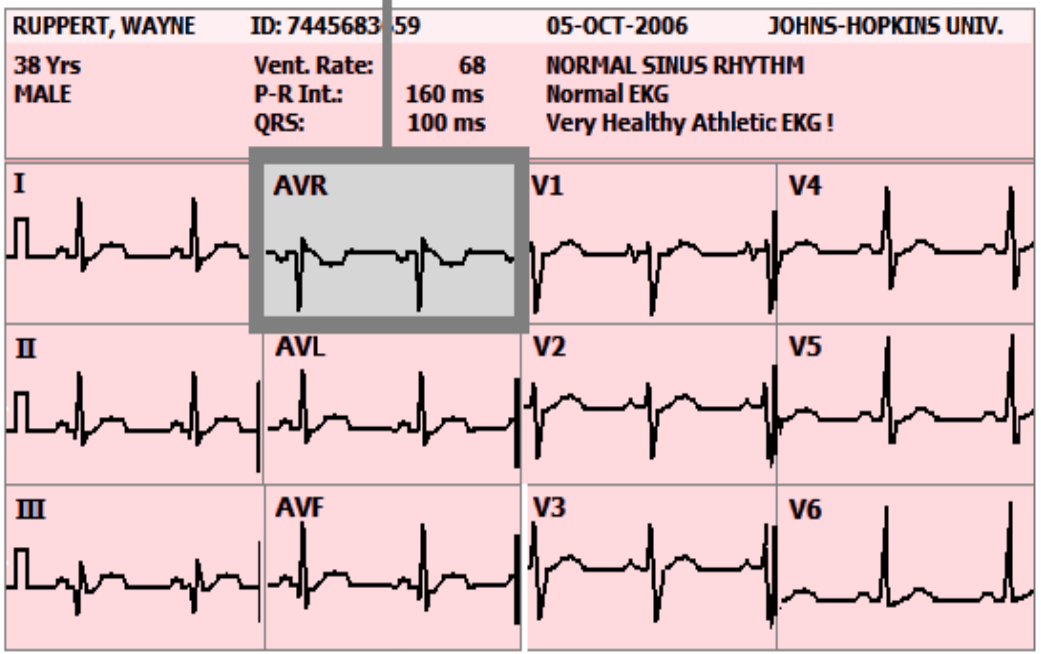
THE POSITIVE ELECTRODE



IS THE "EYE" . . .

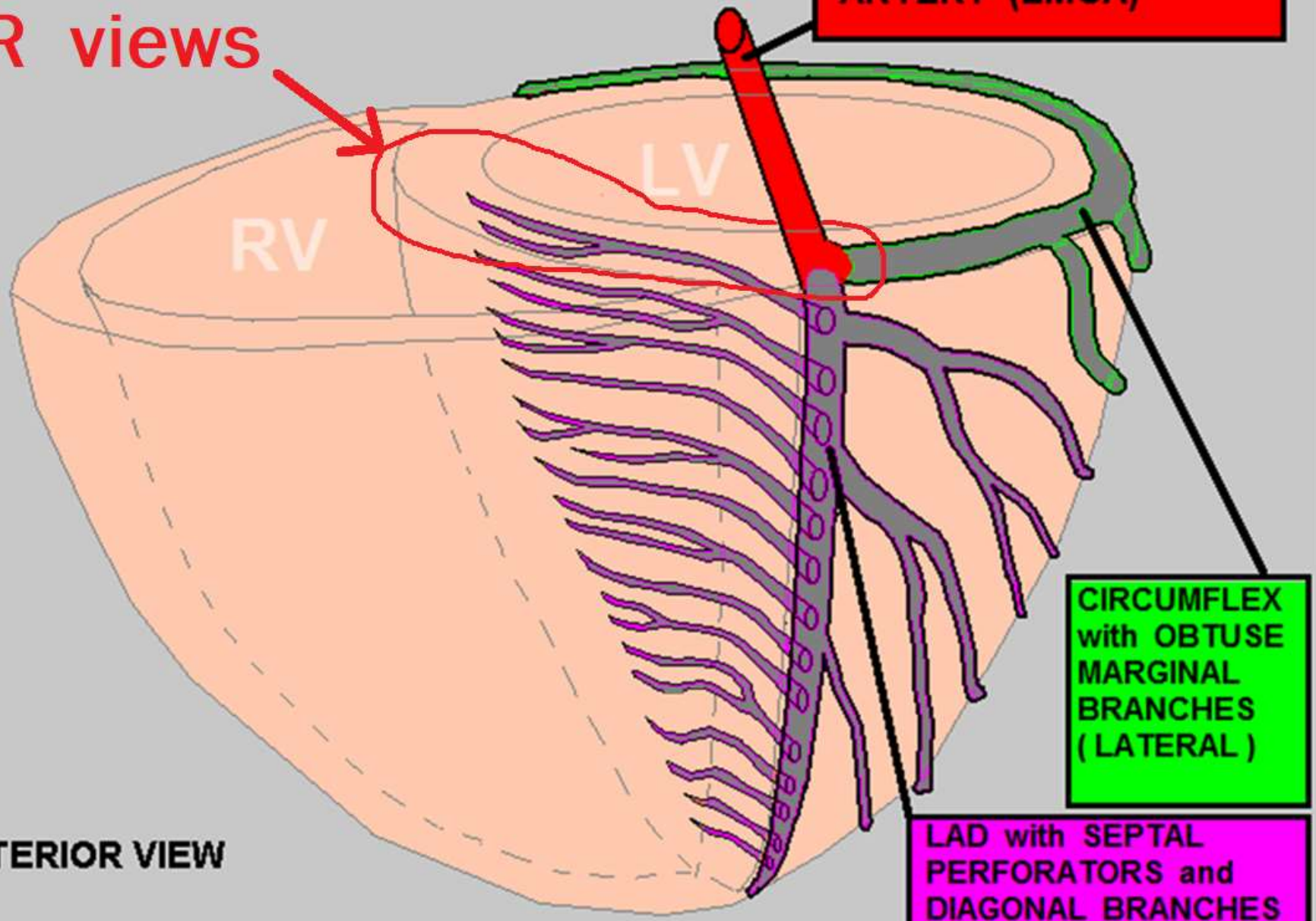
Lead AVR Views the BASILAR SEPTUM (region of the Bundle of His)



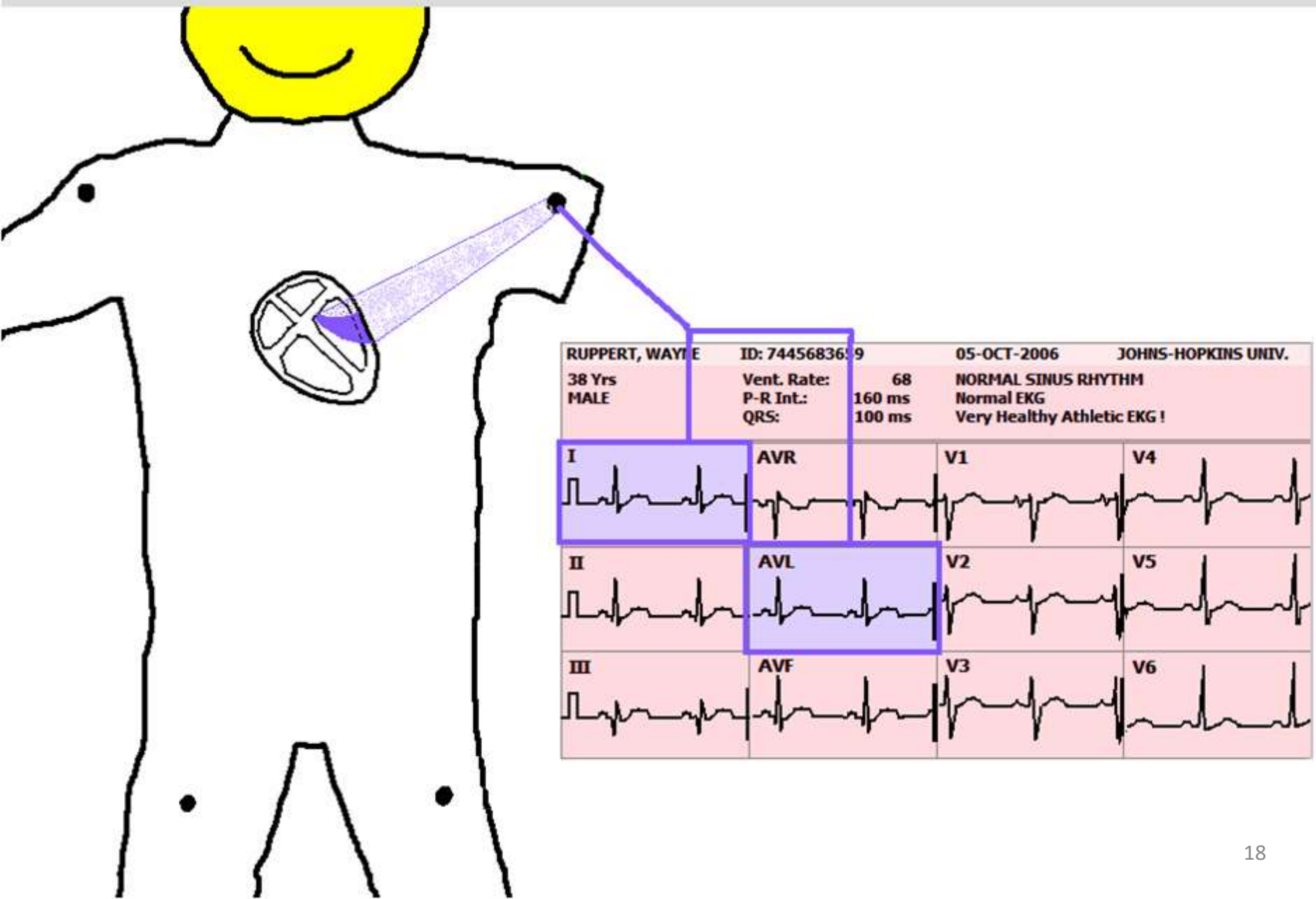


LEFT CORONARY ARTERY SYSTEM

AVR views

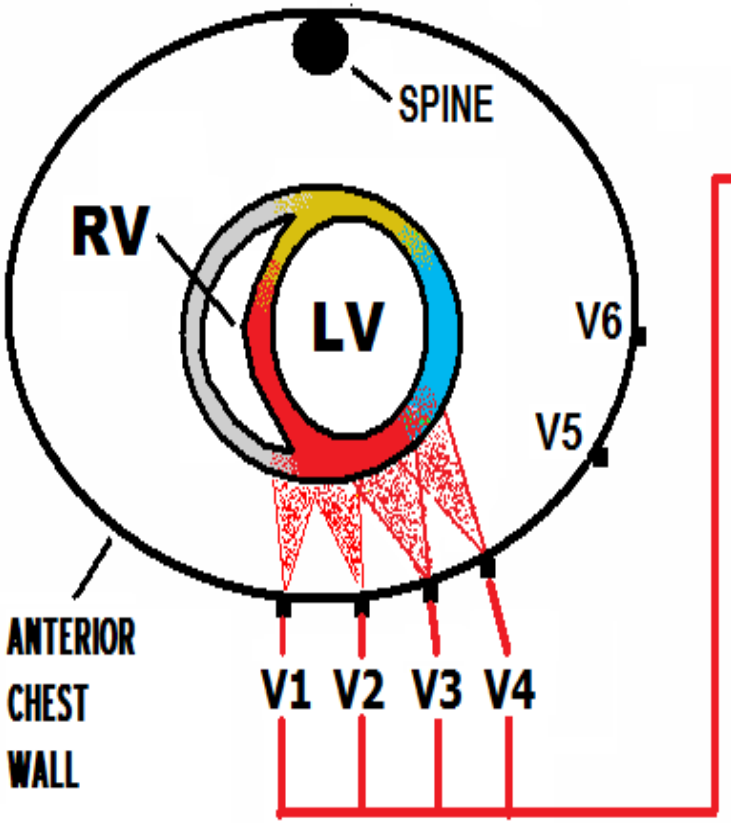


LEADS I and aVL VIEW the LATERAL - ANTERIOR WALL



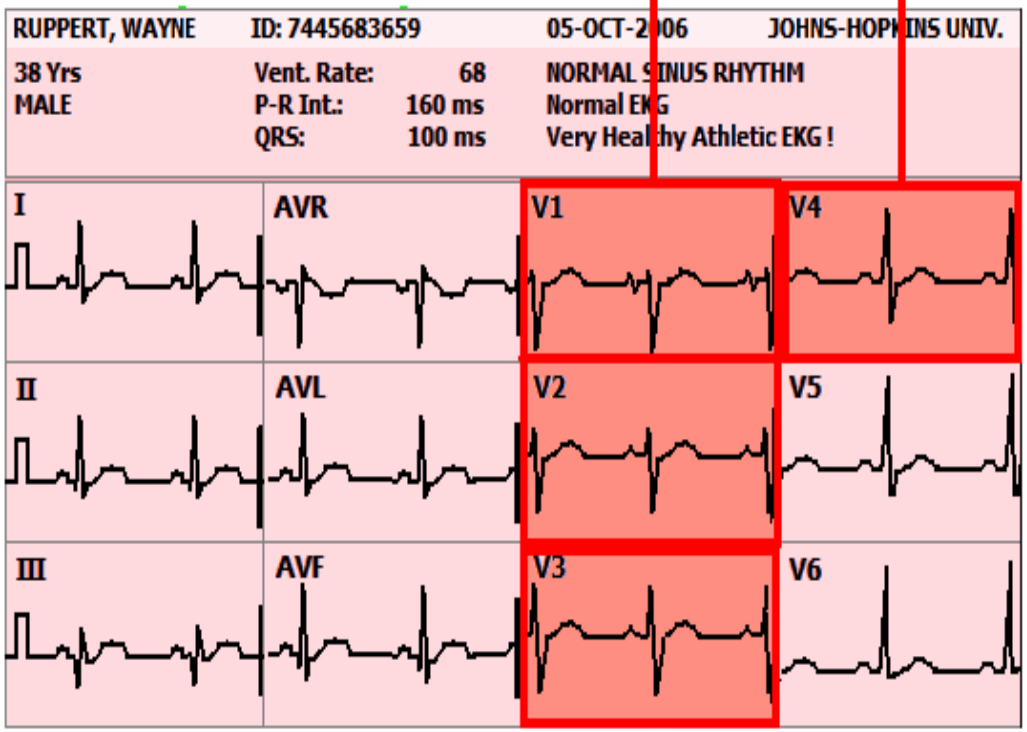
V1 - V4 VIEW THE ANTERIOR-SEPTAL WALL

of the LEFT VENTRICLE



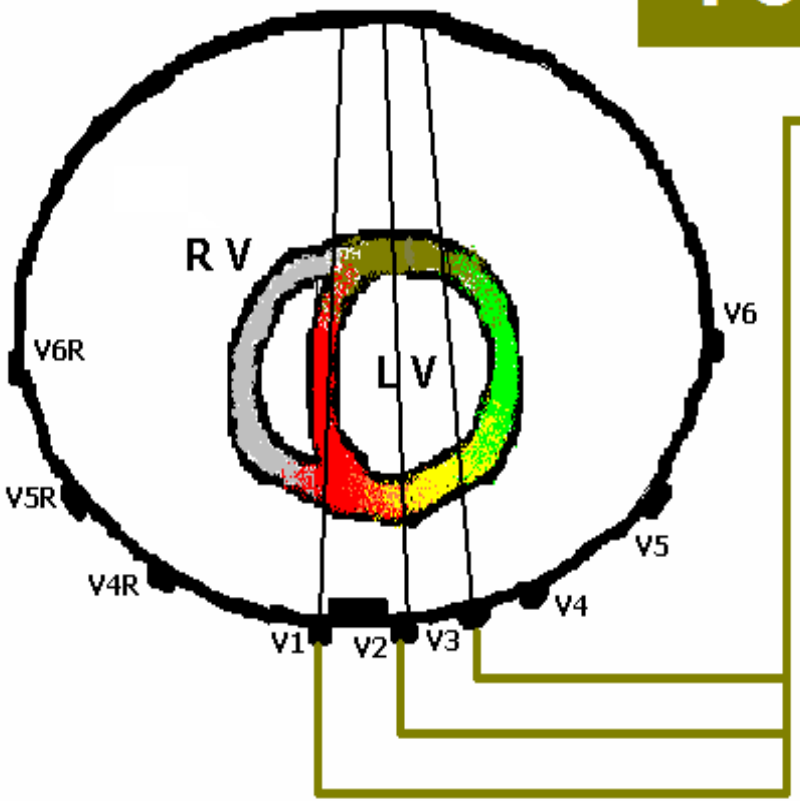
V1, V2 - ANTERIOR / SEPTAL

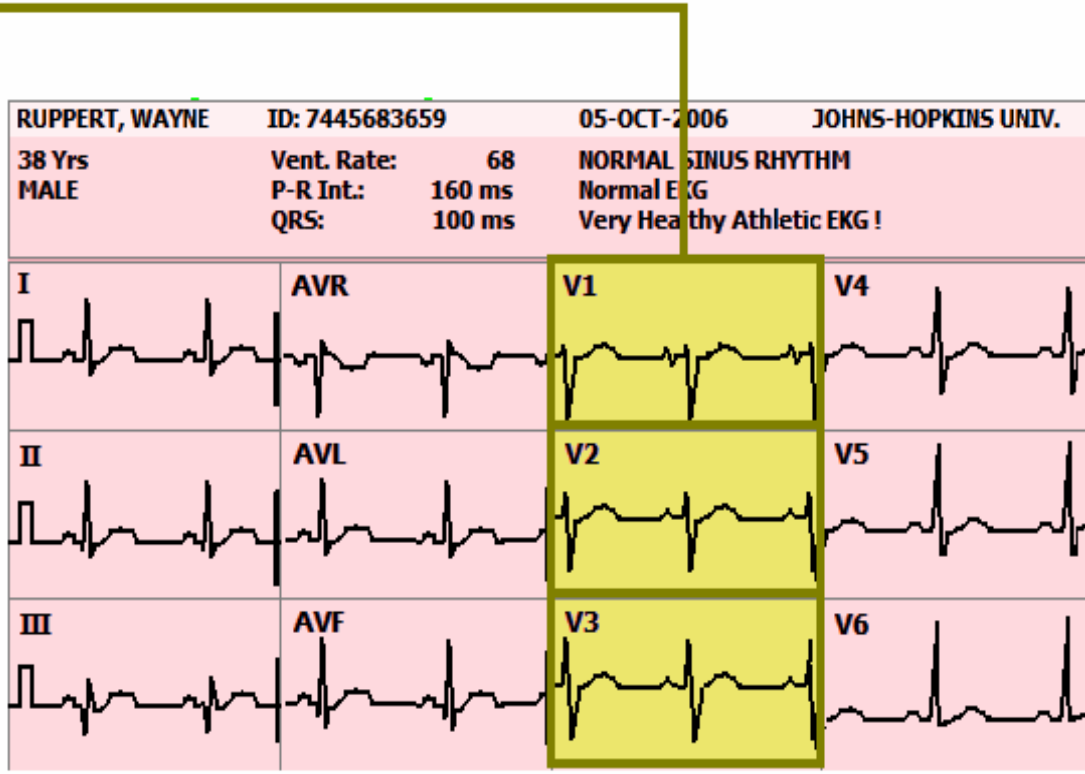
V3, V4 - ANTERIOR



LEADS V1 - V3 *view the*

POSTERIOR WALL



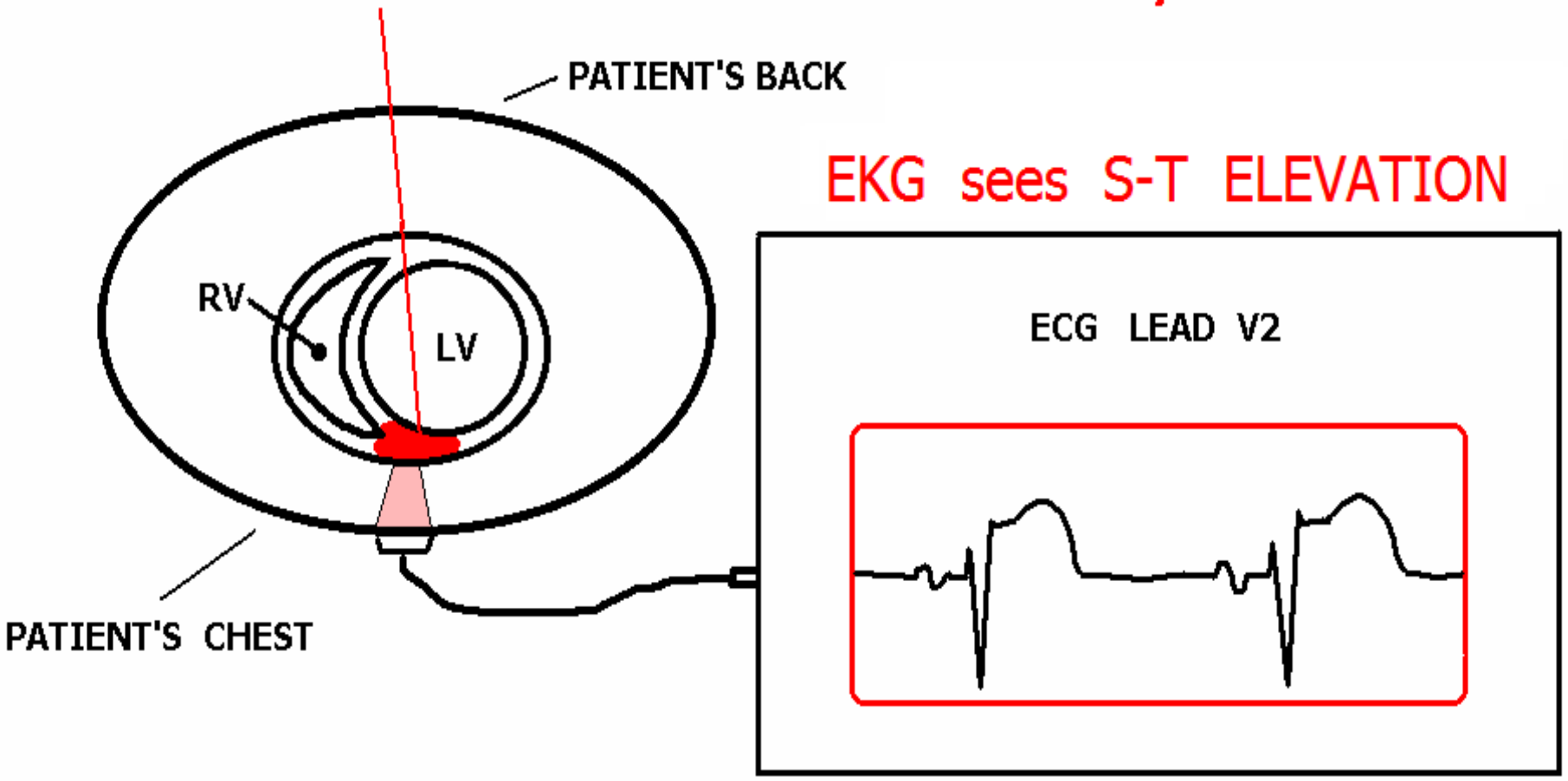


via RECIPROCAL CHANGES.

HOW EKG VIEWS INDICATIVE CHANGES

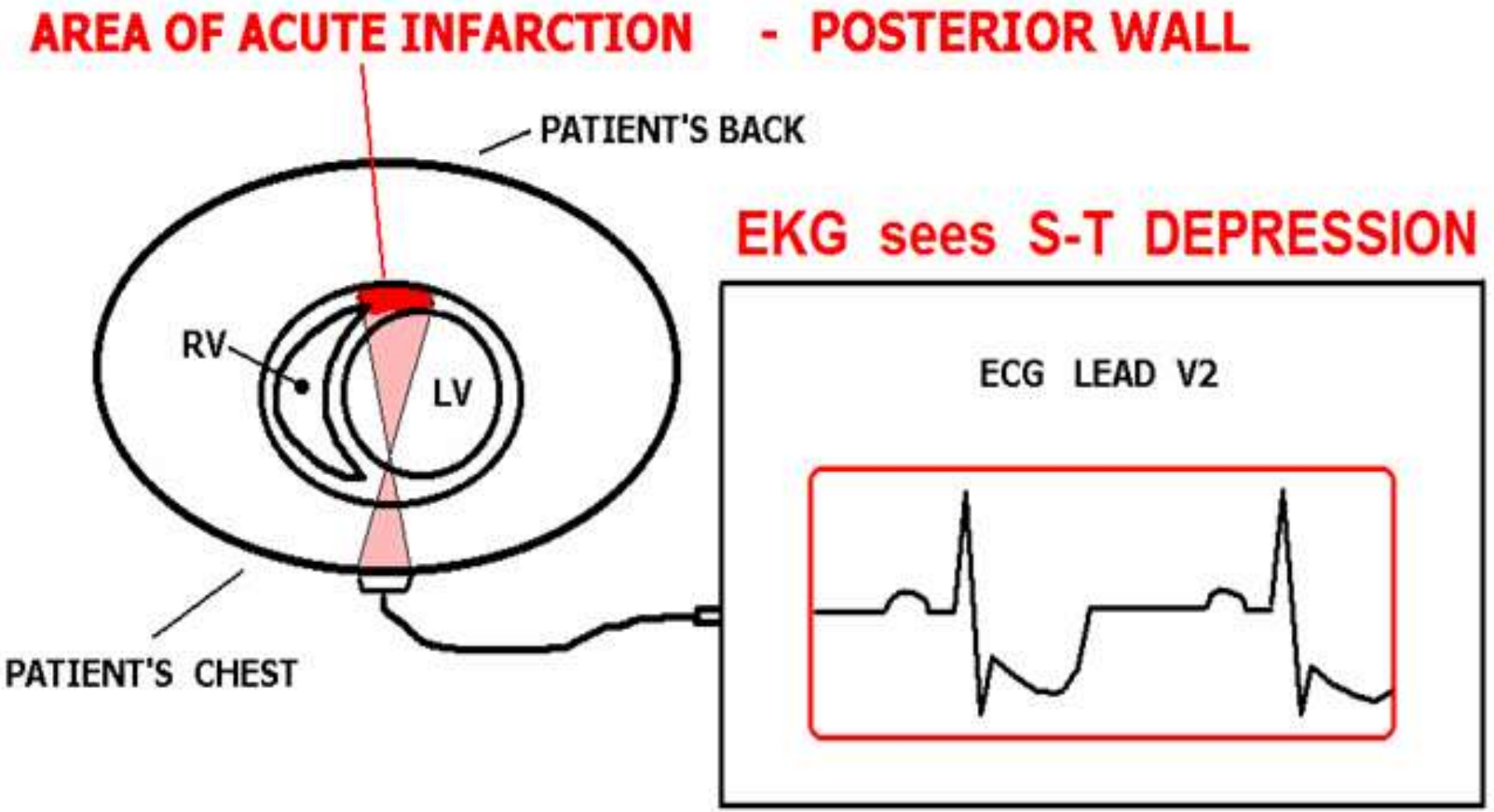
EXAMPLE:

AREA OF ACUTE INFARCTION - ANTERIOR/SEPTAL



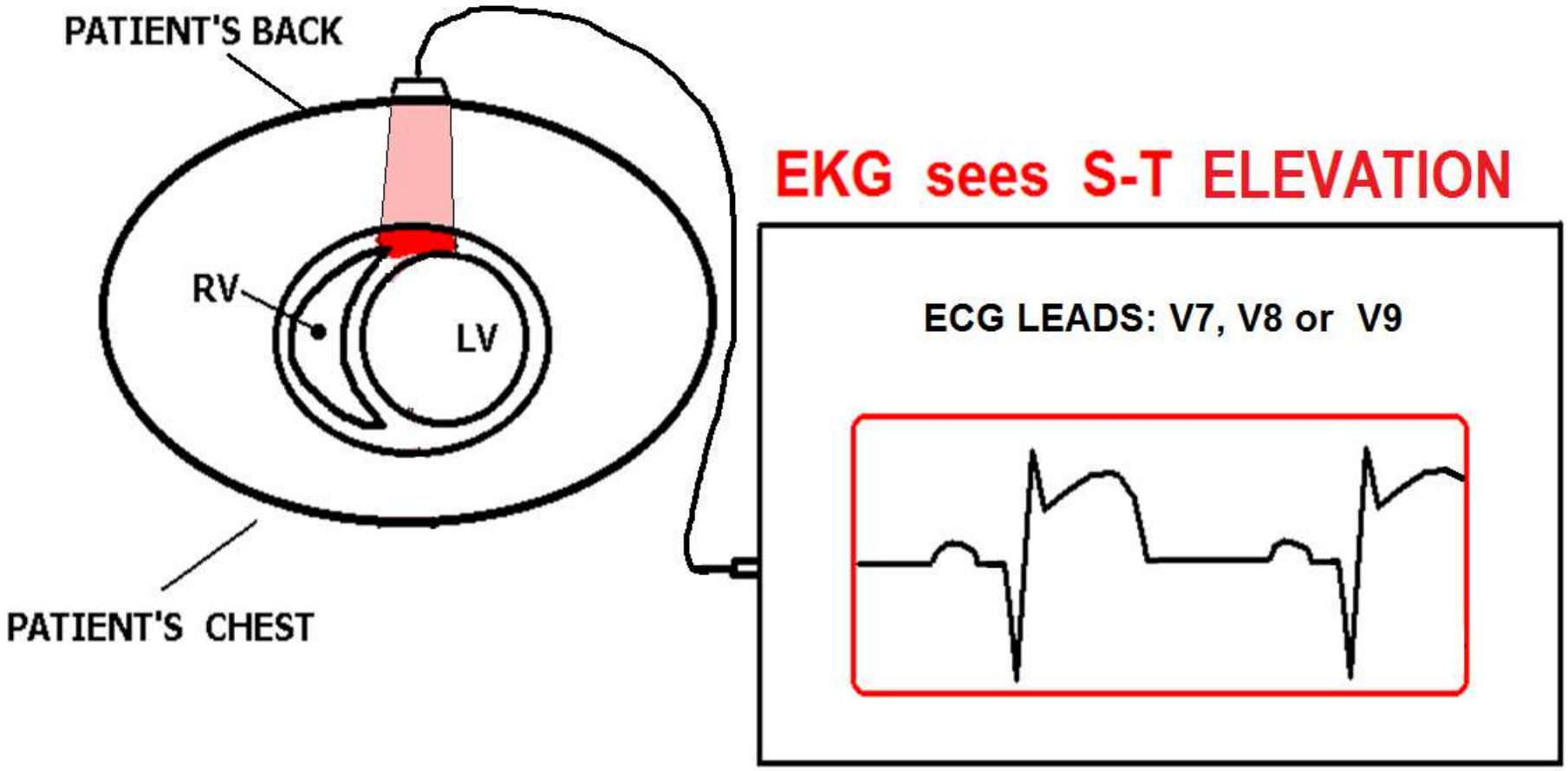
HOW EKG VIEWS RECIPROCAL CHANGES

EXAMPLE:

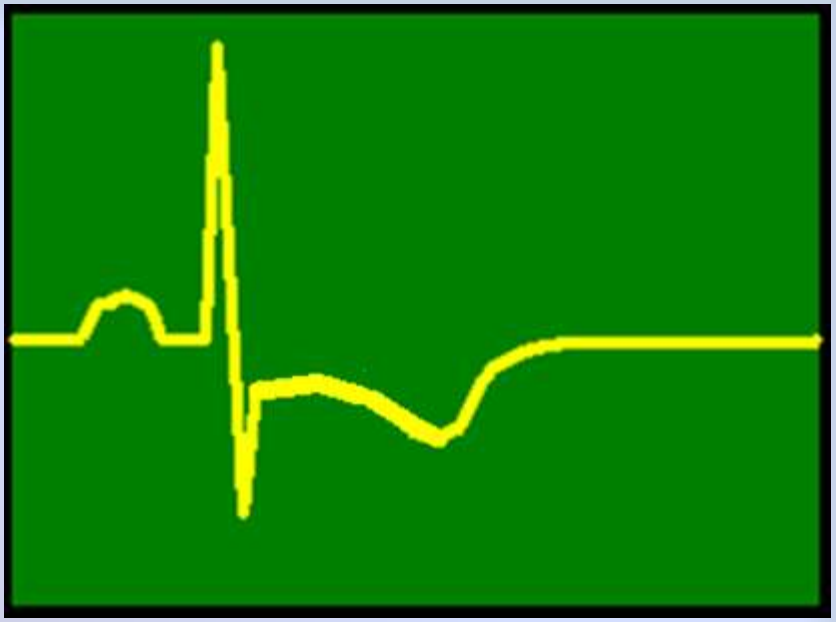


If we put ECG leads on the BACK of a PATIENT who is having an

ACUTE POSTERIOR WALL MI . . . . .

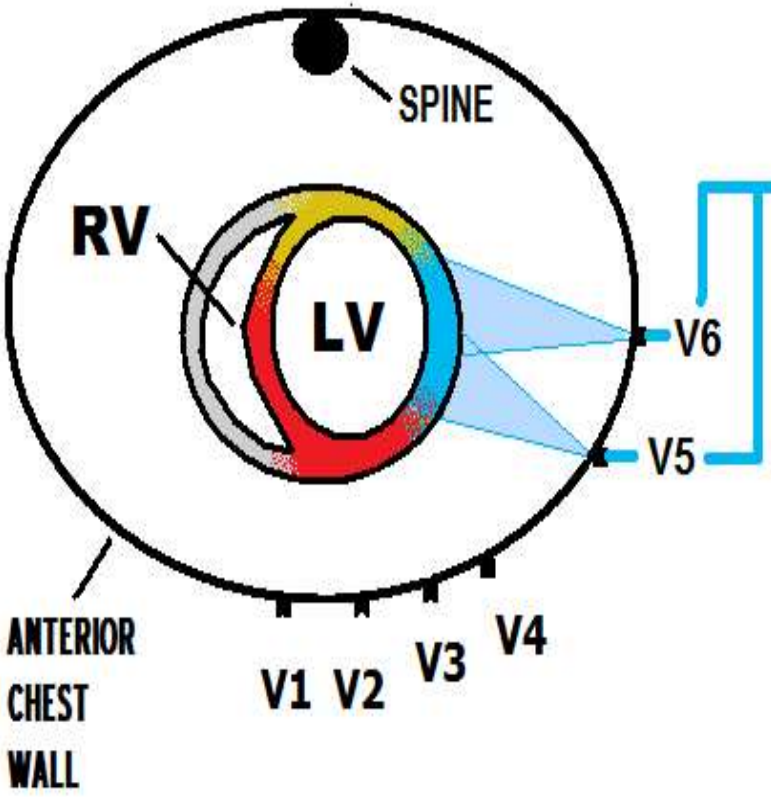


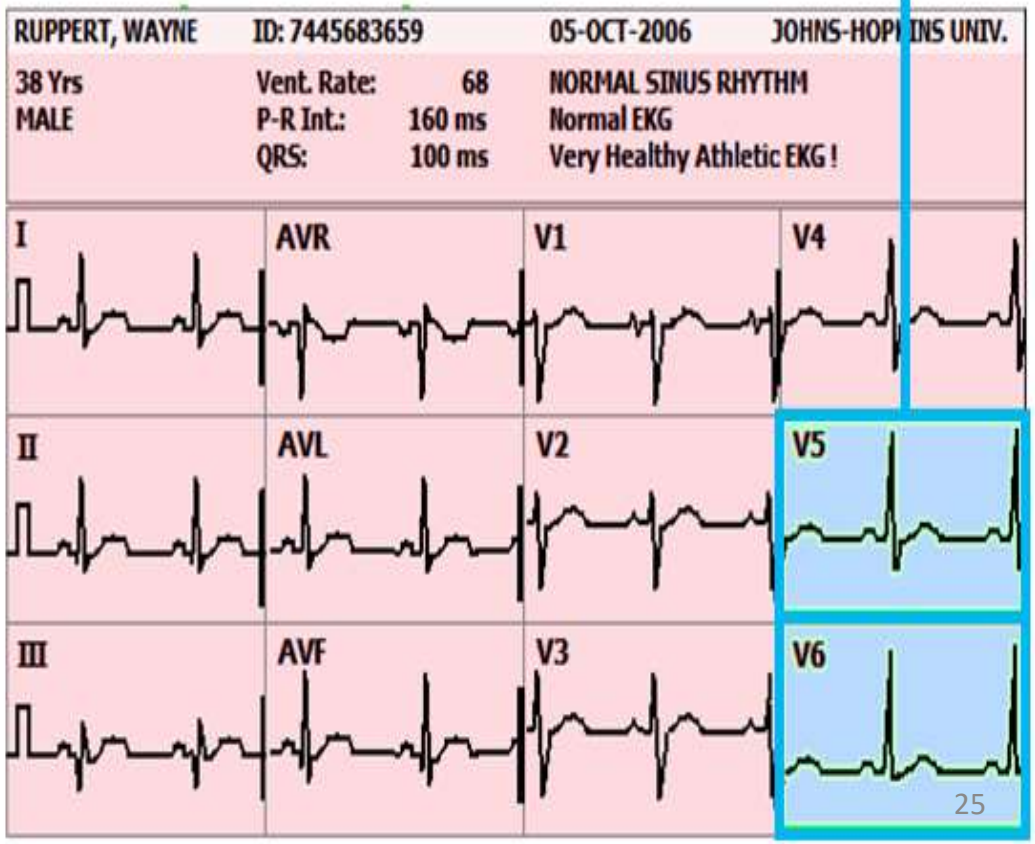
ST Depression can indicate:



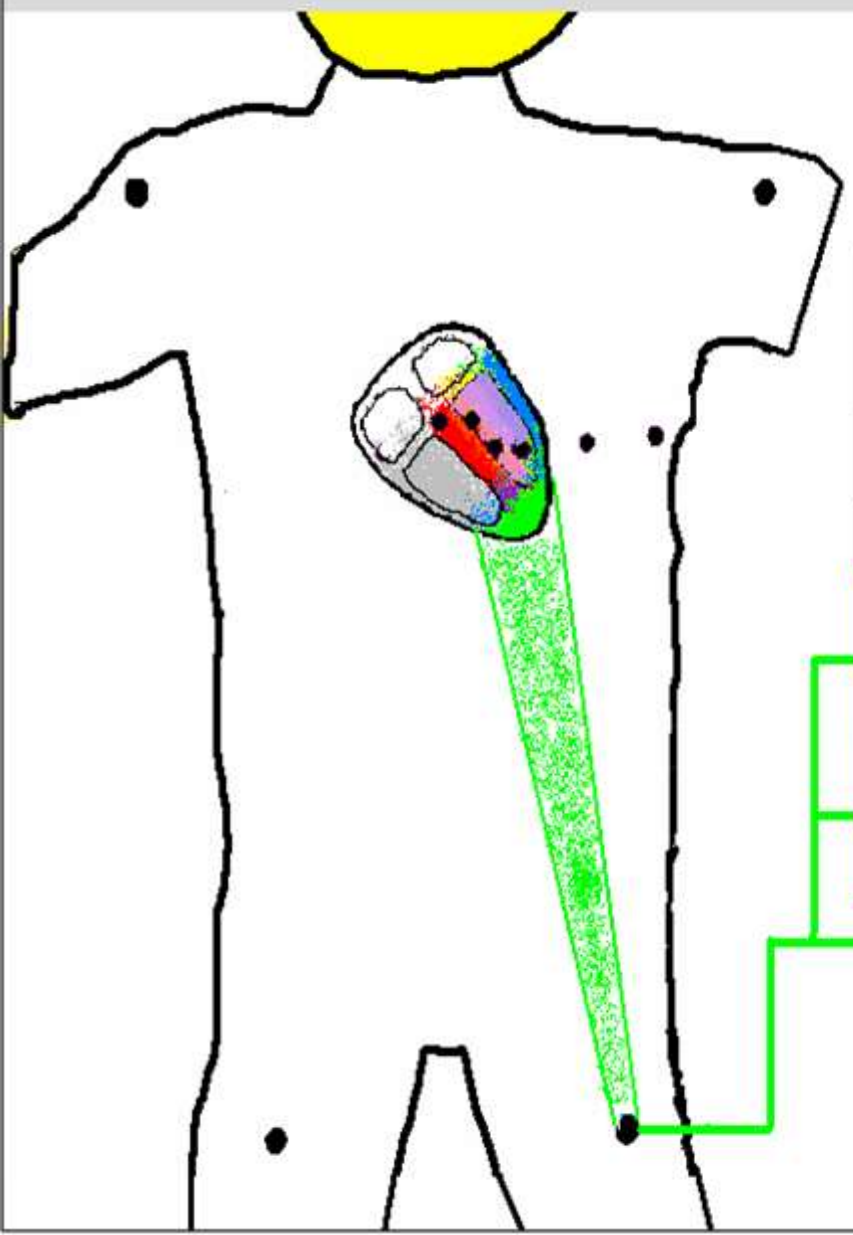
- ISCHEMIA
- “Partial-wall thickness” MI (NSTEMI)
- STEMI (in the opposite side of the heart)
- Other things (like RBBB, certain medications, etc).

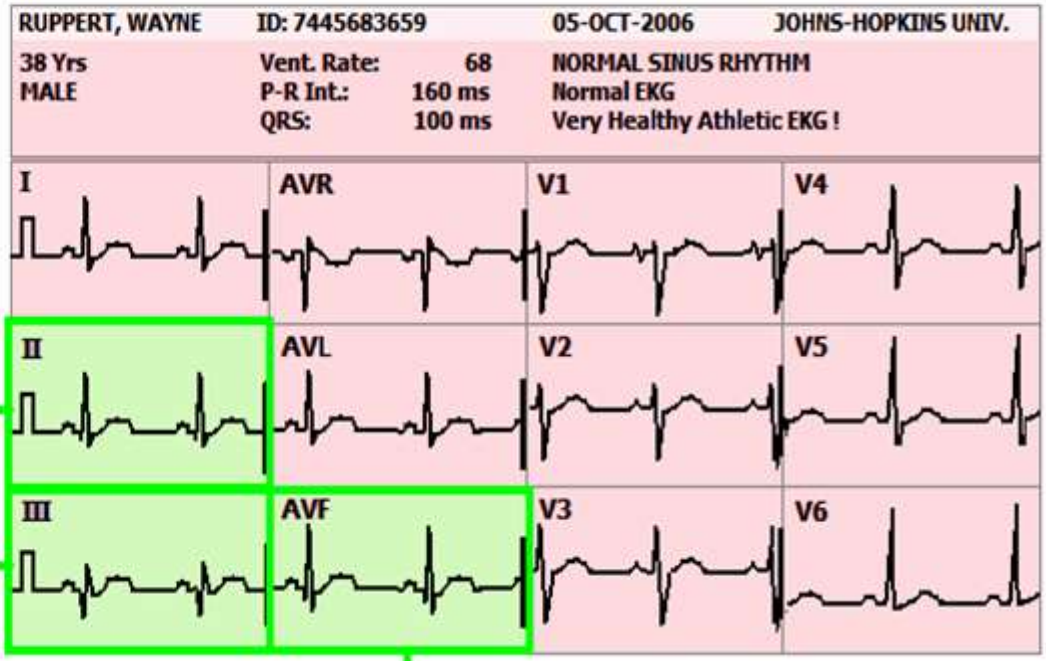
V5 - V6 VIEW THE LATERAL WALL
of the LEFT VENTRICLE

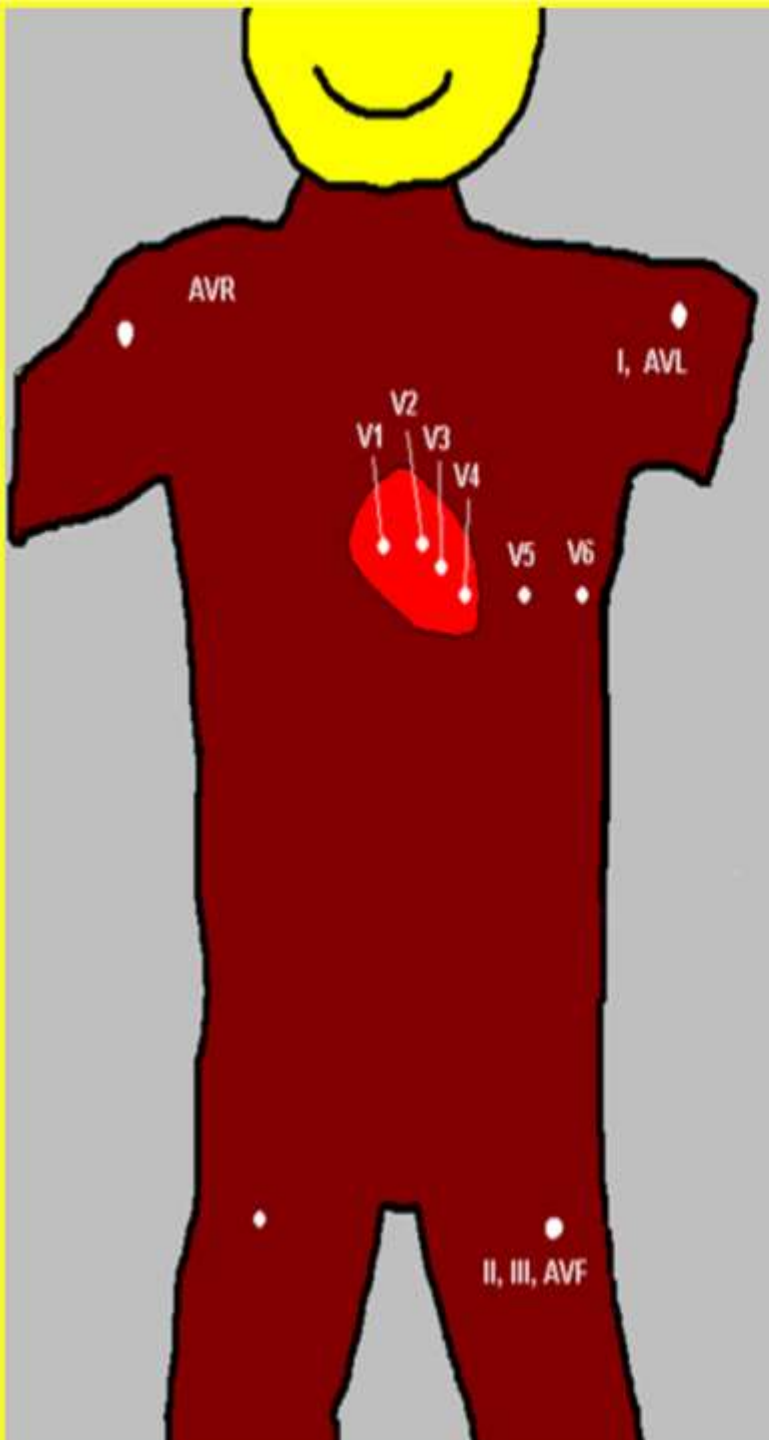




LEADS II, III, and aVF VIEW
INFERIOR WALL of the LEFT VENTRICLE







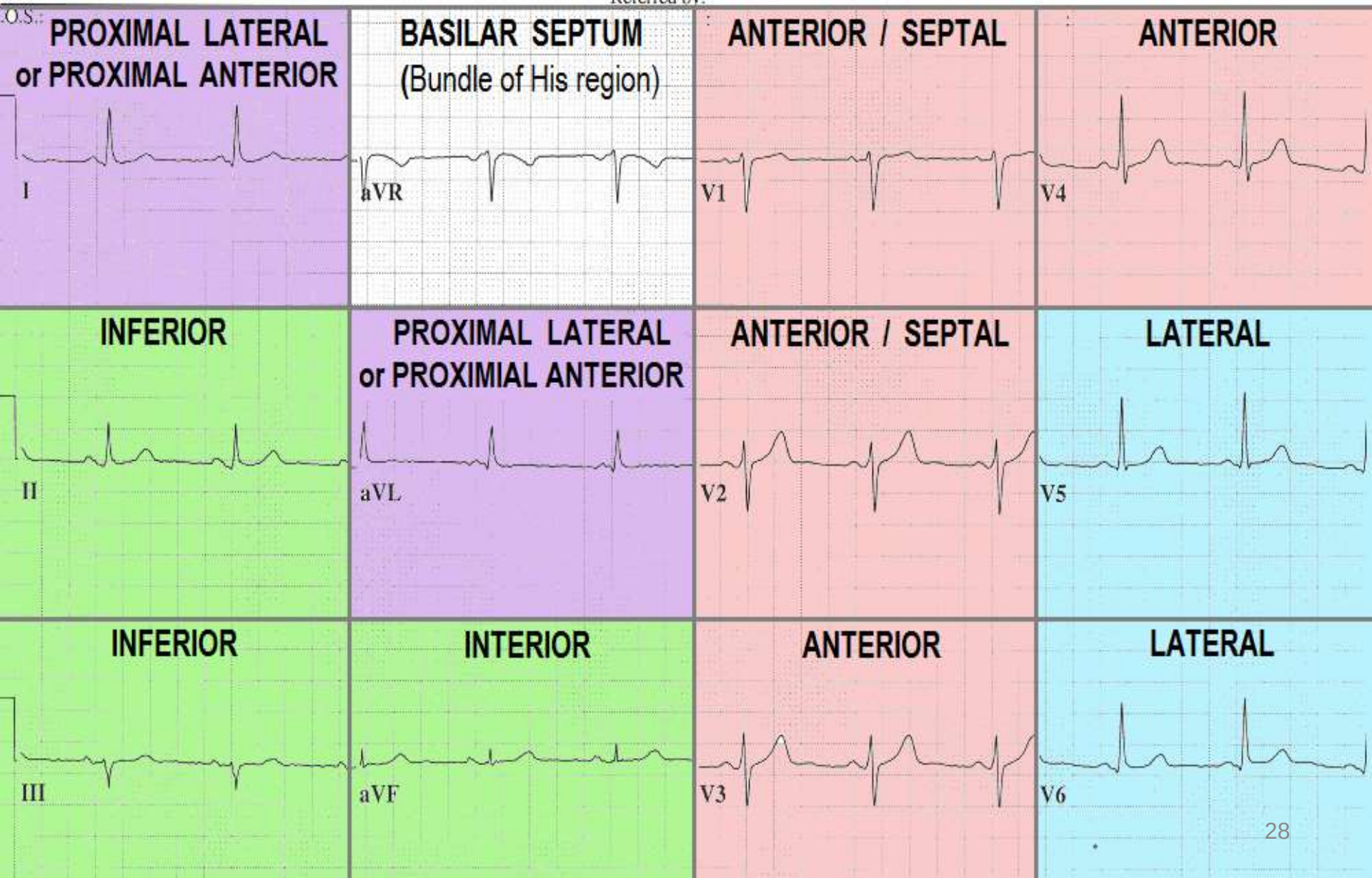
AREAS VIEWED by 12 LEAD ECG

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

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

Normal sinus rhythm
Normal ECG
No previous ECGs available

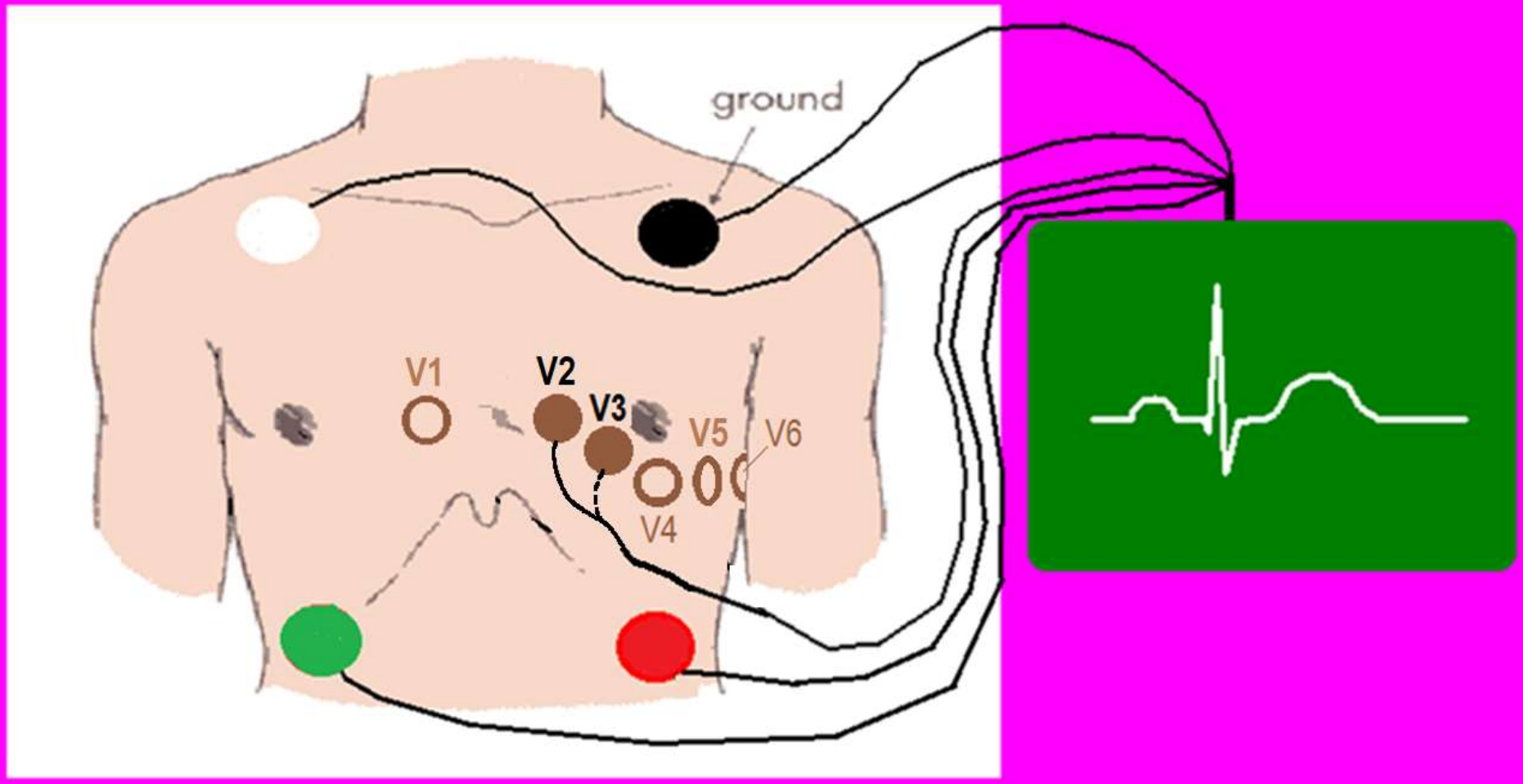
Referred by:



The Patient Arrives . . .

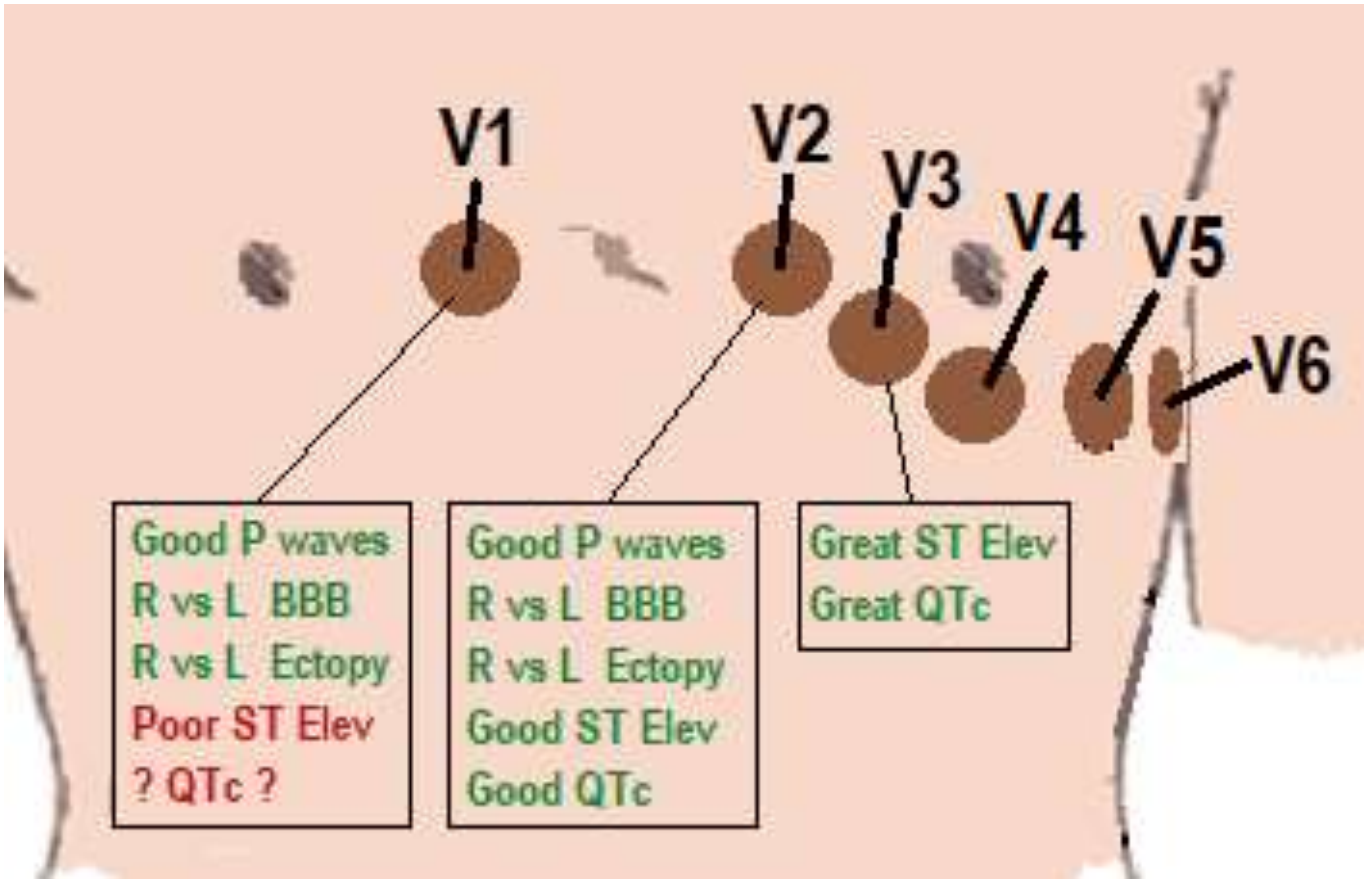
- Standard Tele / ECG hookup:
  - LEAD II
  - LEAD V2

LEAD PLACEMENT

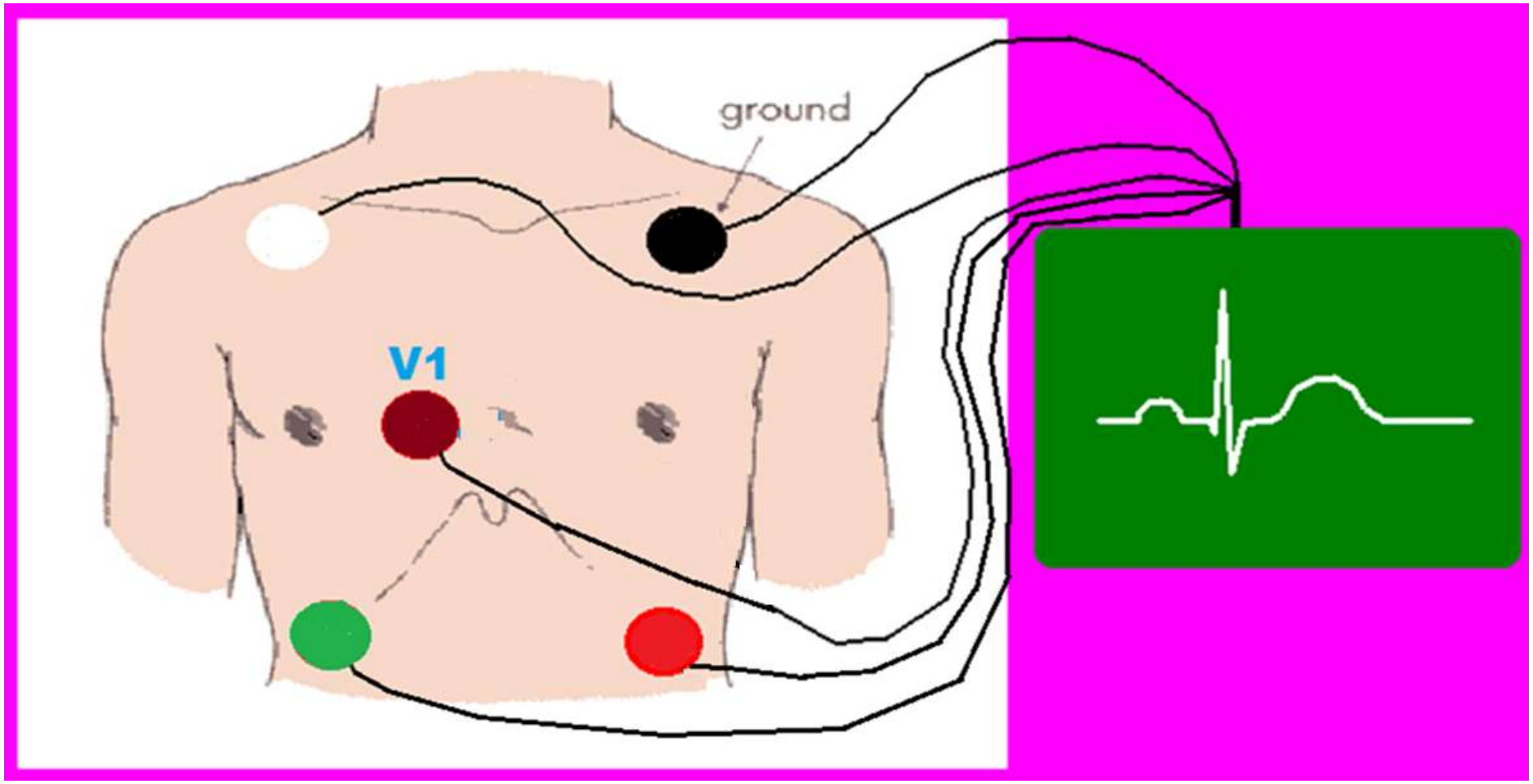


5 WIRE TELEMETRY UNIT

Lead V2 – GOOD Choice……



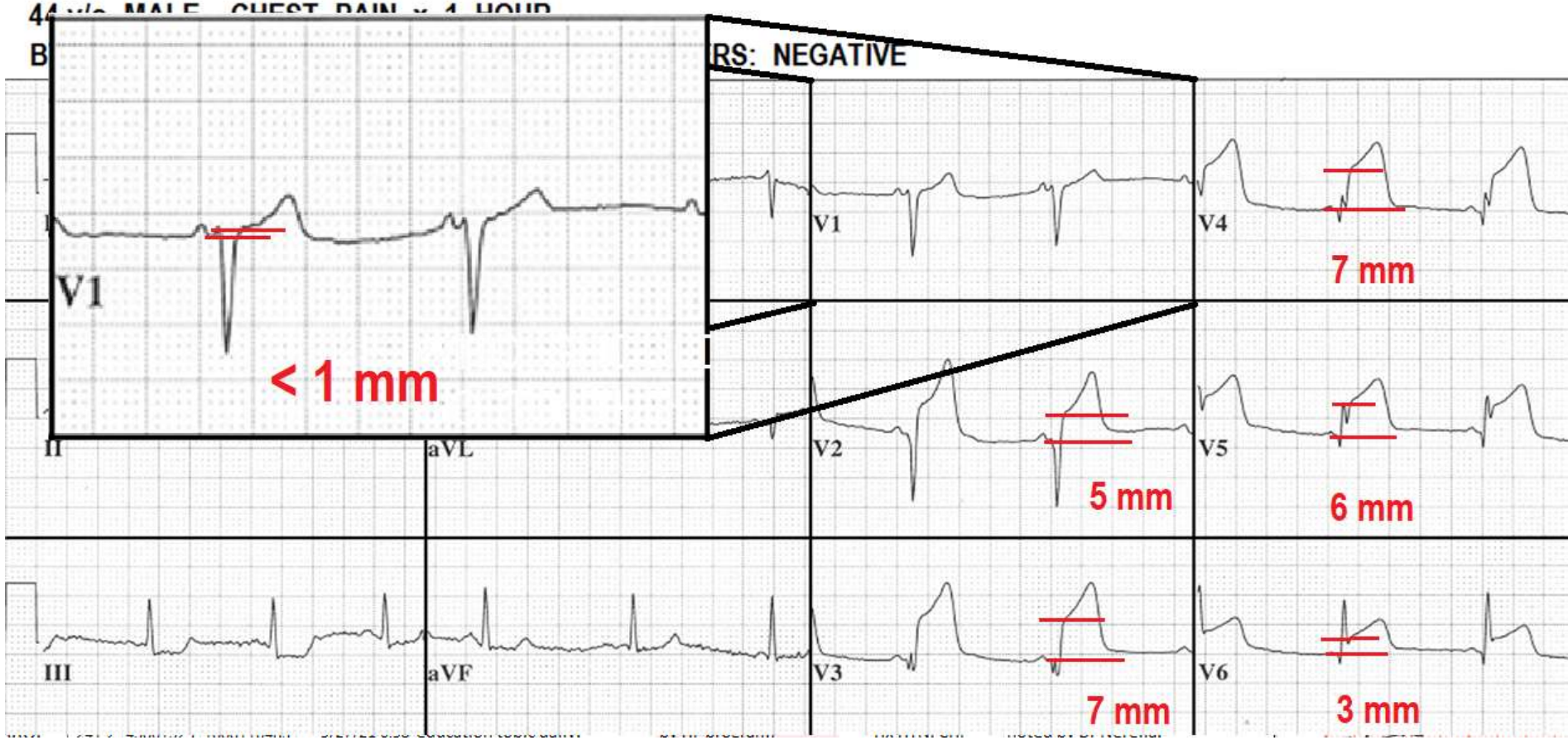
Why not V1 ? (we've used V1 for years!)



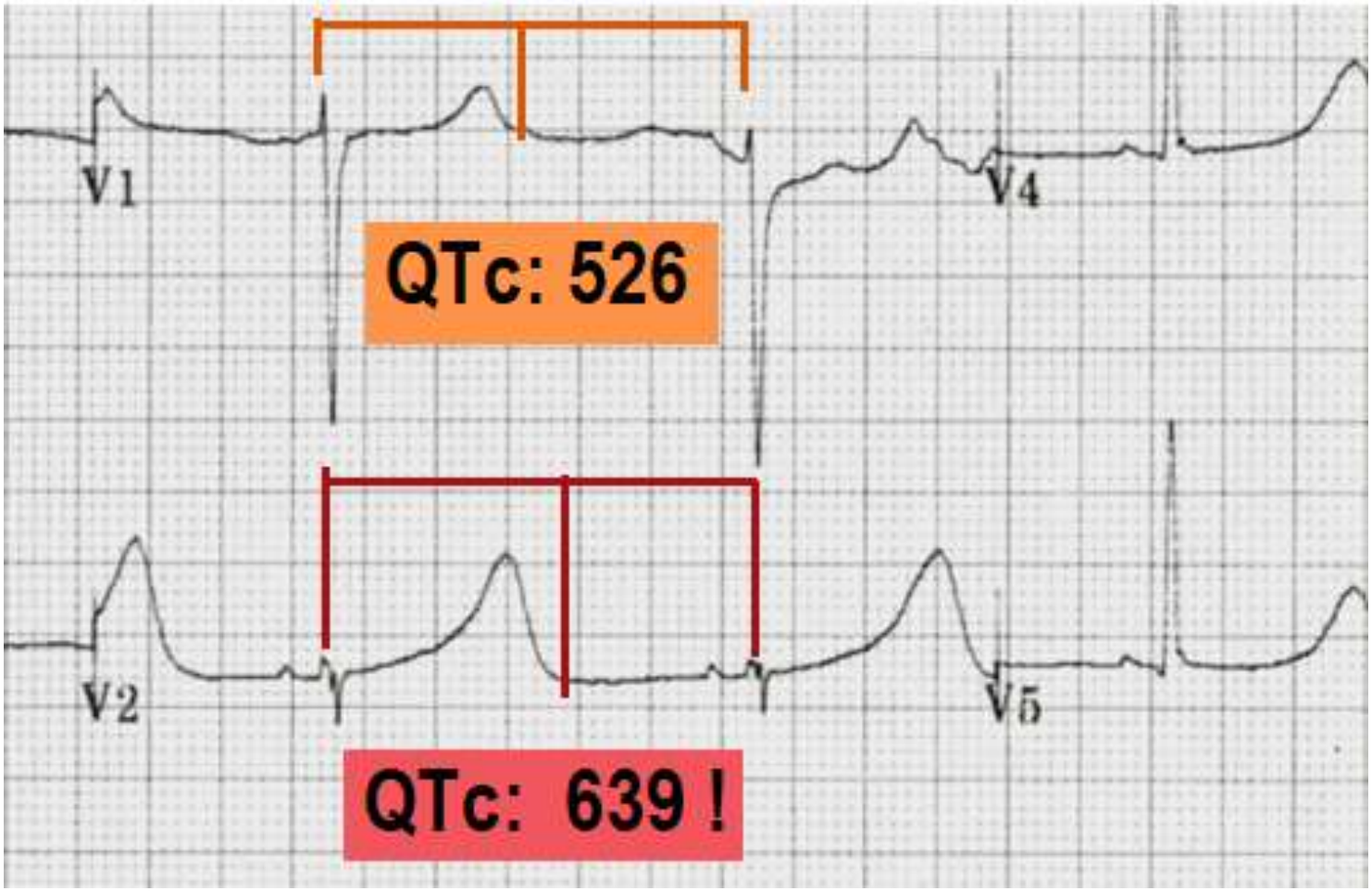
Why not V1 ? *(often won't see STEMI !)*

If you were only monitoring Leads II and V1, you ***would NOT detect this patient's STEMI ! !***

Ineffectiveness of LEAD V1 for early detection of Anterioseptal STEMI



Why not V1 ? (may not detect critical QTc)



The Patient Arrives . . .

- Standard Tele / ECG hookup:
  - LEAD II
  - LEAD V2
- Evaluate patient: any symptoms 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**

ATYPICAL SYMPTOMS of ACS

? ? ?

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

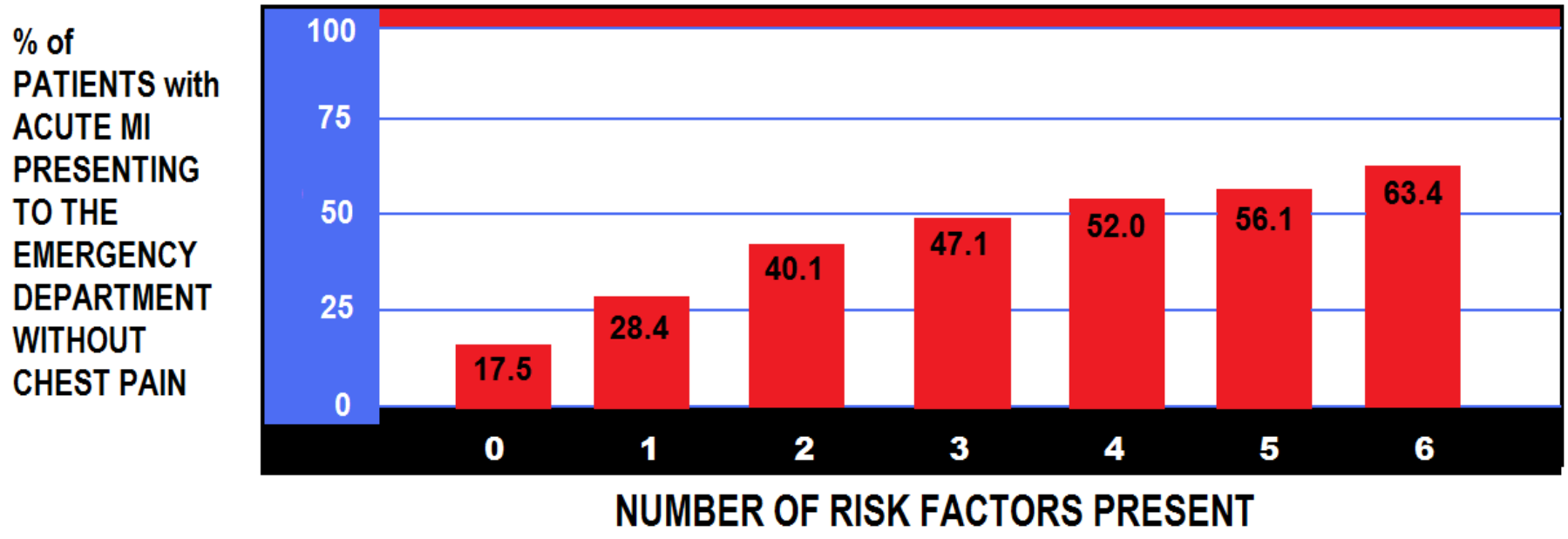
Stroke (previous history of)
Heart failure (previous history of)
Race (non-white)
Elderly (age 75+)
Women
Diabetes mellitus

* 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 Patient Arrives . . .

- Standard Tele / ECG hookup:
  - LEAD II
  - LEAD V2
- Evaluate patient: any symptoms of ACS ?
- Review 12 Lead ECG. Look for:
  - Signs of ischemia
  - QT prolongation

Evaluating the ECG for ACS:

A TWO-STEP process:

Evaluating the ECG for ACS:

A TWO-STEP process:

STEP 1: Evaluate QRS Width

Evaluating the ECG for ACS:

A TWO-STEP process:

STEP 1: Evaluate QRS Width

STEP 2: Evaluate J Points, ST-Segment and T waves in EVERY Lead

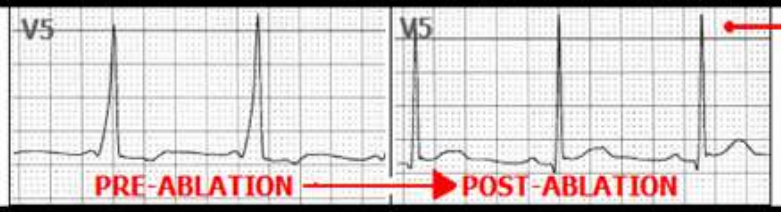
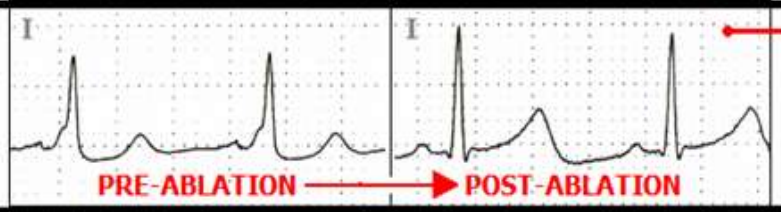
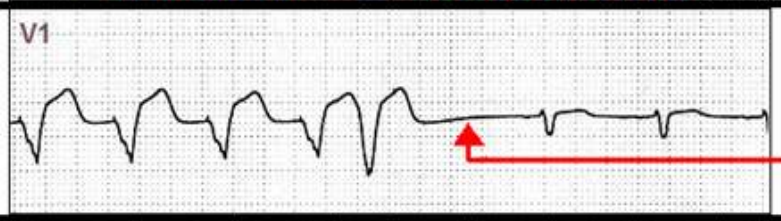
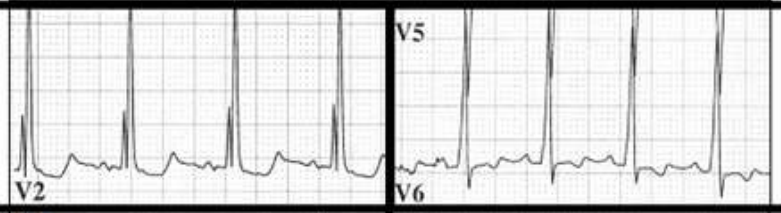
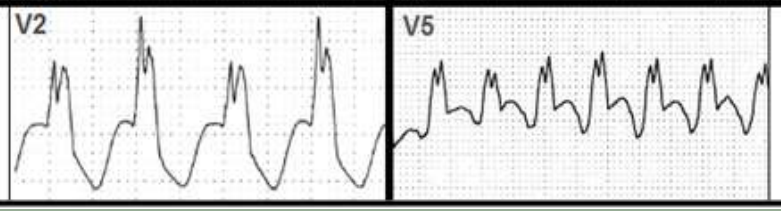
STEP 1 – evaluate QRS width:

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

STEP 1 – evaluate QRS width:

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

CONDITIONS THAT INCREASE QRS DURATION RESULT IN SECONDARY REPOLARIZATION ABNORMALITIES:

RIGHT BUNDLE BRANCH BLOCK		LEFT BUNDLE BRANCH BLOCK
W-P-W BYPASS TRACT, LEFT LATERAL WALL 49 y/o MALE		SAME PATIENT AS ON LEFT - IMMEDIATELY AFTER RF ABLATION OF BYPASS TRACT
W-P-W BYPASS TRACT, RIGHT ANTERIOR/ LATERAL WALL 14 y/o MALE		SAME PATIENT AS ON LEFT - IMMEDIATELY AFTER RF ABLATION OF BYPASS TRACT
PACEMAKER - RIGHT VENTRICULAR APEX		PACEMAKER TURNED OFF HERE
RIGHT VENTRICULAR HYPERTROPHY (Strain Pattern)		LEFT VENTRICULAR HYPERTROPHY (Strain Pattern)
VENTRICULAR TACHYCARDIA FOCUS: LEFT FASICULAR, 17 y/o FEMALE		VENTRICULAR TACHYCARDIA- FOCUS: RIGHT VENTRICULAR APEX

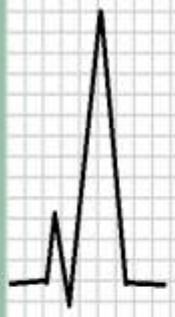
Wide QRS present:
QRSd > 120ms

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

Simple “Turn Signal Method” . . .

THE "TURN SIGNAL METHOD" for identifying BUNDLE BRANCH BLOCK

V1



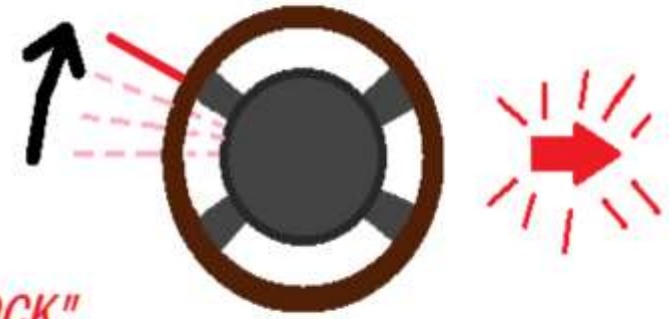
USE LEAD V1 for this technique

To make a **RIGHT TURN**

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

THINK:

"QRS points UP = RIGHT BUNDLE BRANCH BLOCK"



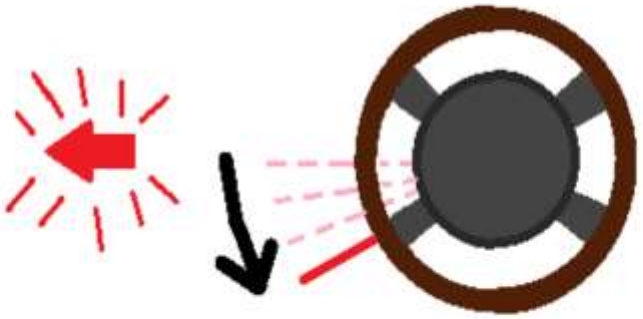
V1

To make a **LEFT TURN**

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

THINK:

"QRS points DOWN = LEFT BUNDLE BRANCH BLOCK"

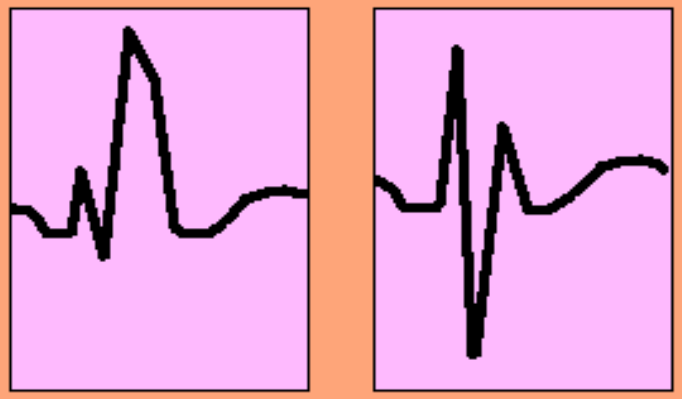


DIAGNOSING BUNDLE BRANCH BLOCK

USING LEADS V1, V2, and V5, V6:

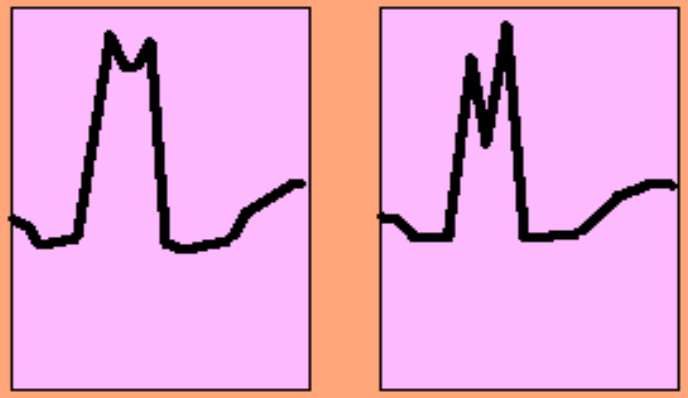
LOCATING RsR' or RR' COMPLEXES:

V1 V2



RIGHT BUNDLE BRANCH BLOCK

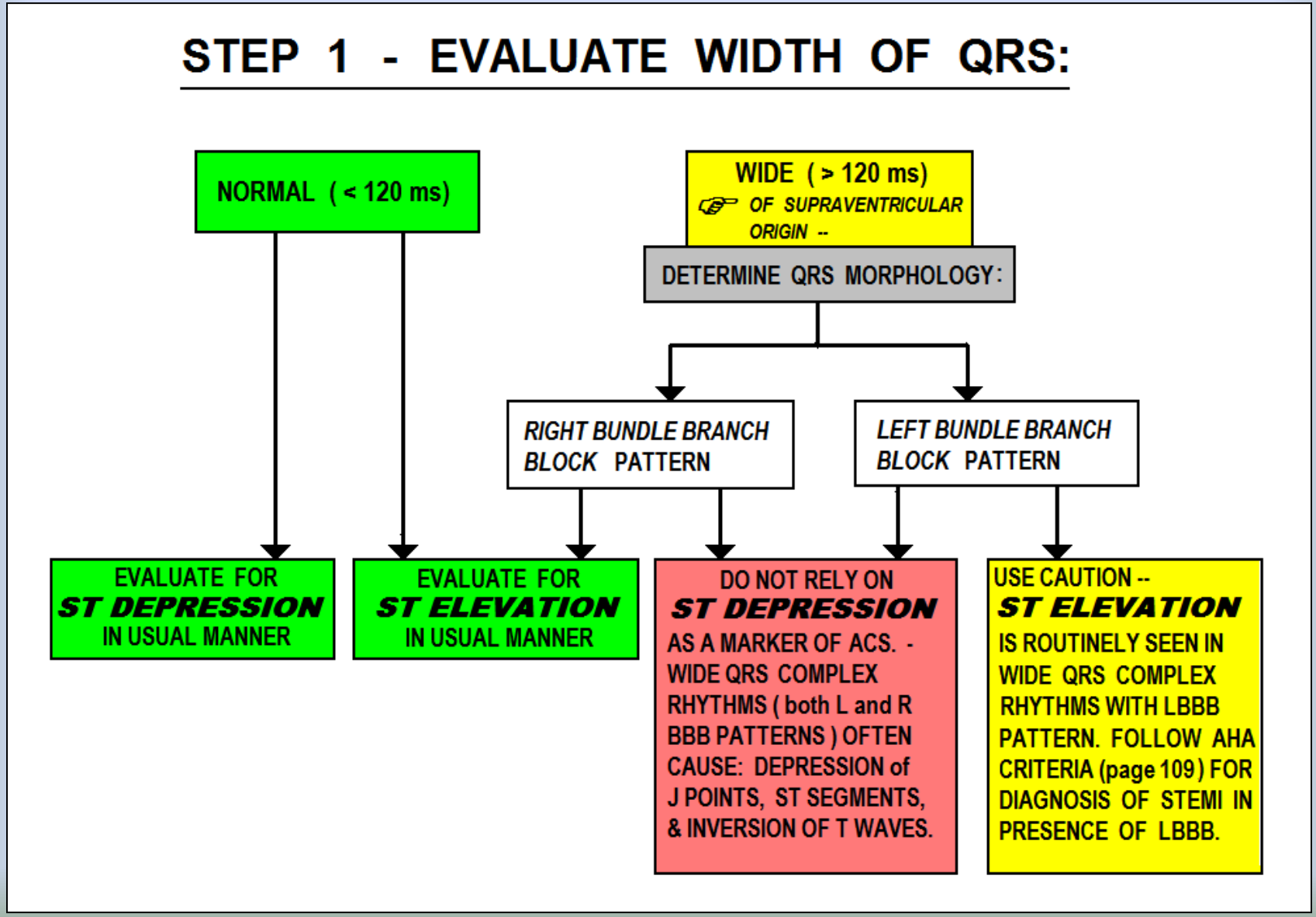
V5 V6



LEFT BUNDLE BRANCH BLOCK

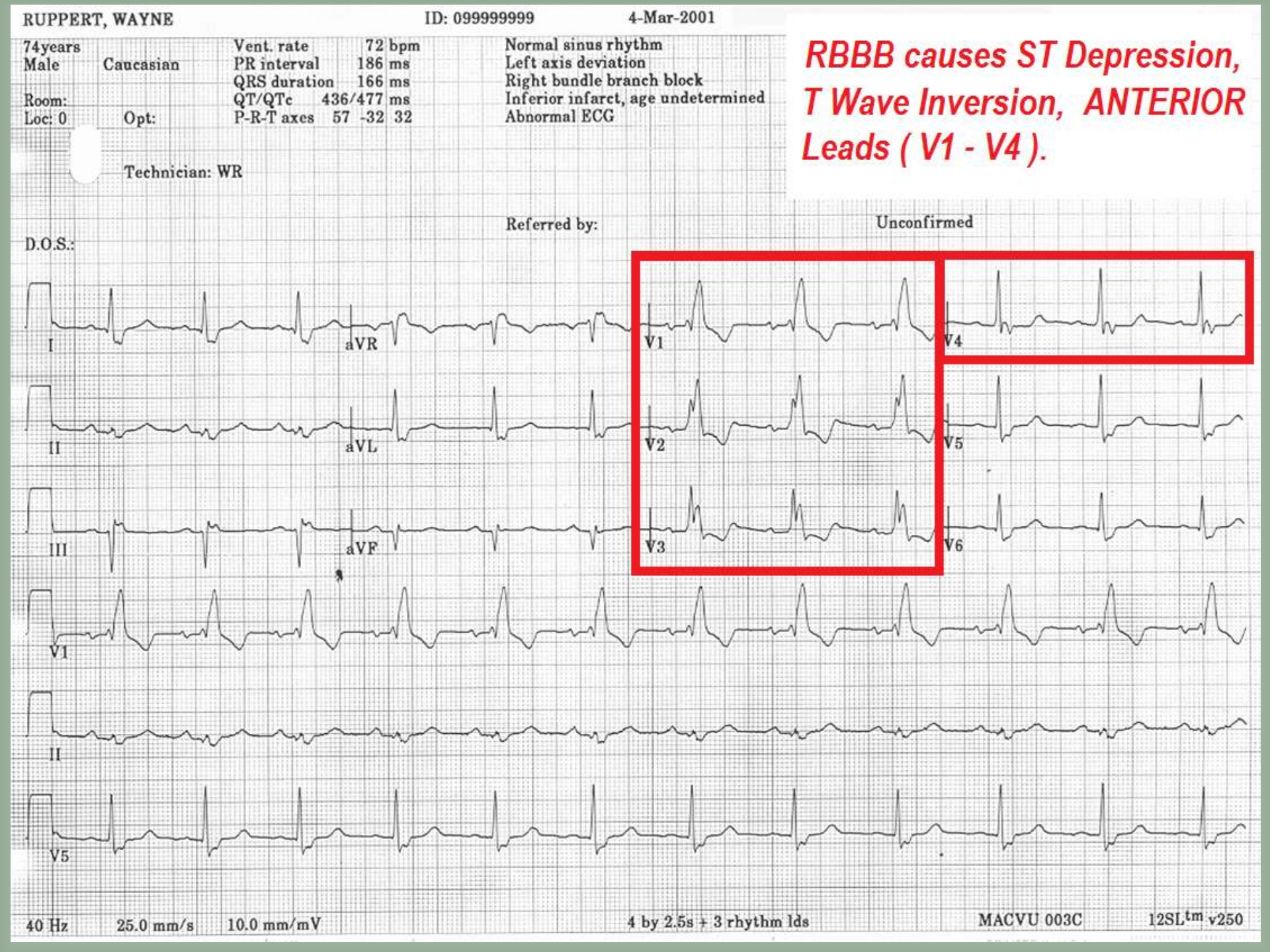
From: “Rapid Interpretation of ECGs” by Dale Dubin, MD

Evaluating the ECG for ACS:



Wide QRS present:
(QRSd > 120ms)

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


RUPPERT, WAYNE
ID: 099999999
4-Mar-2001
74years
Male
Caucasian
Vent. rate 72 bpm
PR interval 186 ms
QRS duration 166 ms
QT/QTc 436/477 ms
P-R-T axes 57 -32 32
Normal sinus rhythm
Left axis deviation
Right bundle branch block
Inferior infarct, age undetermined
Abnormal ECG
Room:
Loc: 0
Opt:
Technician: WR
Referred by:
Unconfirmed
D.O.S.:
RBBB causes ST Depression, T Wave Inversion, ANTERIOR Leads (V1 - V4).
I
aVR
V1
V4
II
aVL
V2
V5
III
aVF
V3
V6
V1
II
V5
40 Hz
25.0 mm/s
10.0 mm/mV
4 by 2.5s + 3 rhythm lds
MACVU 003C
12SL tm v250

Wide QRS present:
(QRSd > 120ms)

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

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

48 yr
Male Caucasian

Room:ATL
Loc:3 Option:23

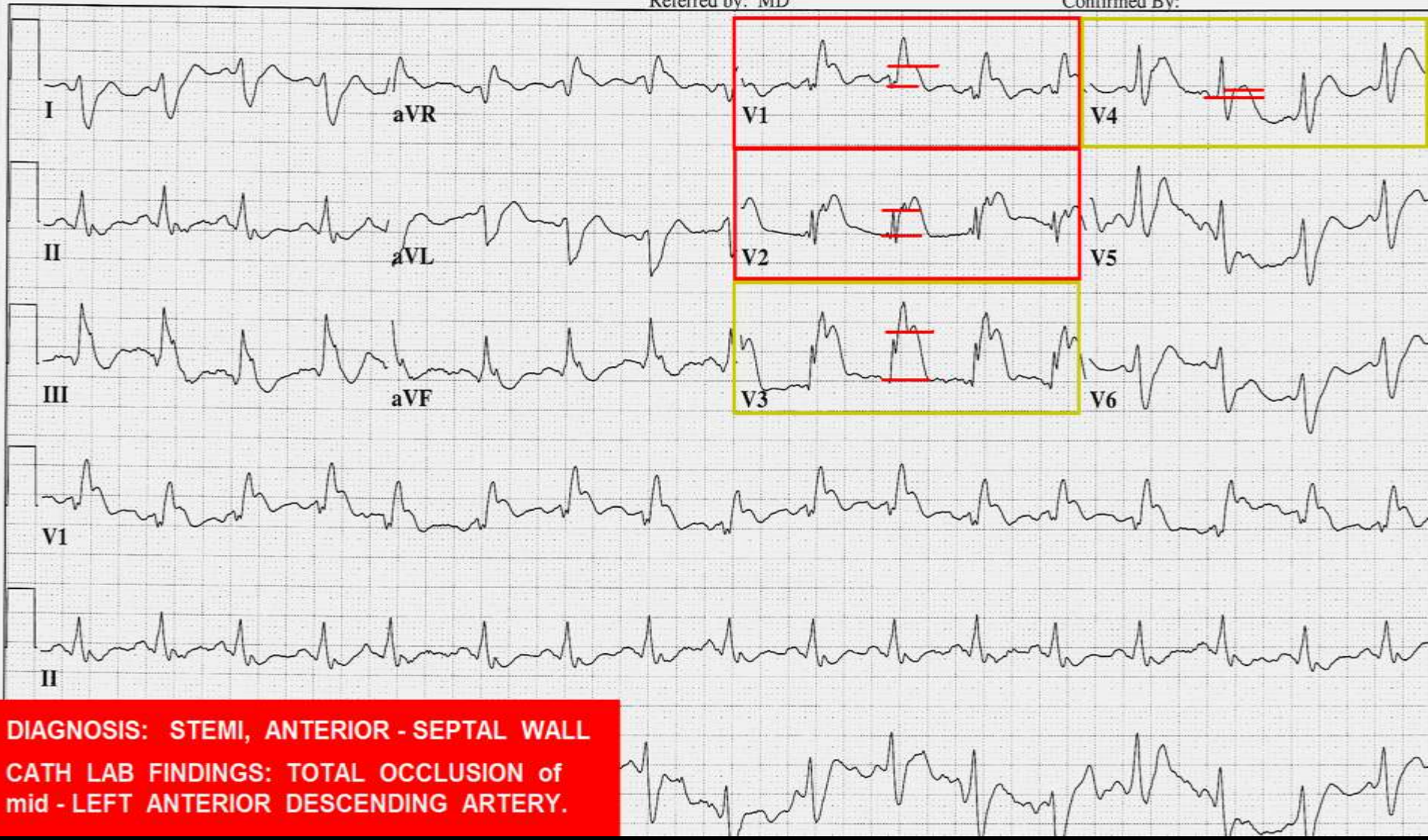
Vent. rate	102	BPM
PR interval	130	ms
QRS duration	168	ms
QT/QTc	400/521	ms
P–R–T axes	60 114	–19

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

Technician: W Ruppert

Referred by: MD

Confirmed By:



DIAGNOSIS: STEMI, ANTERIOR - SEPTAL WALL

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

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

25 yr
Male Caucasian

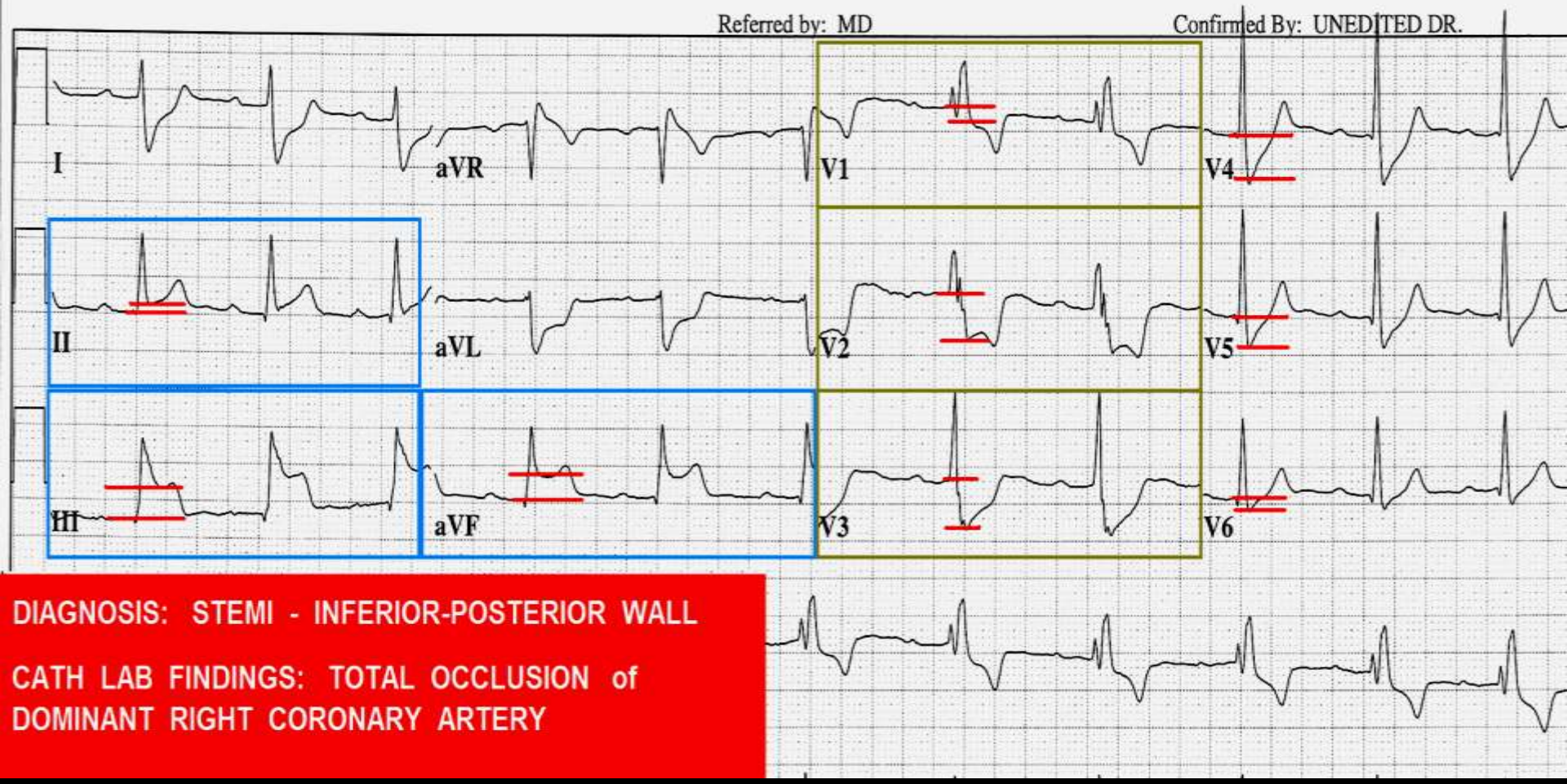
Loc:3 Option:23

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

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

Referred by: MD

Confirmed By: UNEDITED DR.



DIAGNOSIS: STEMI - INFERIOR-POSTERIOR WALL

CATH LAB FINDINGS: TOTAL OCCLUSION of DOMINANT RIGHT CORONARY ARTERY

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

75 yr
Male Caucasian

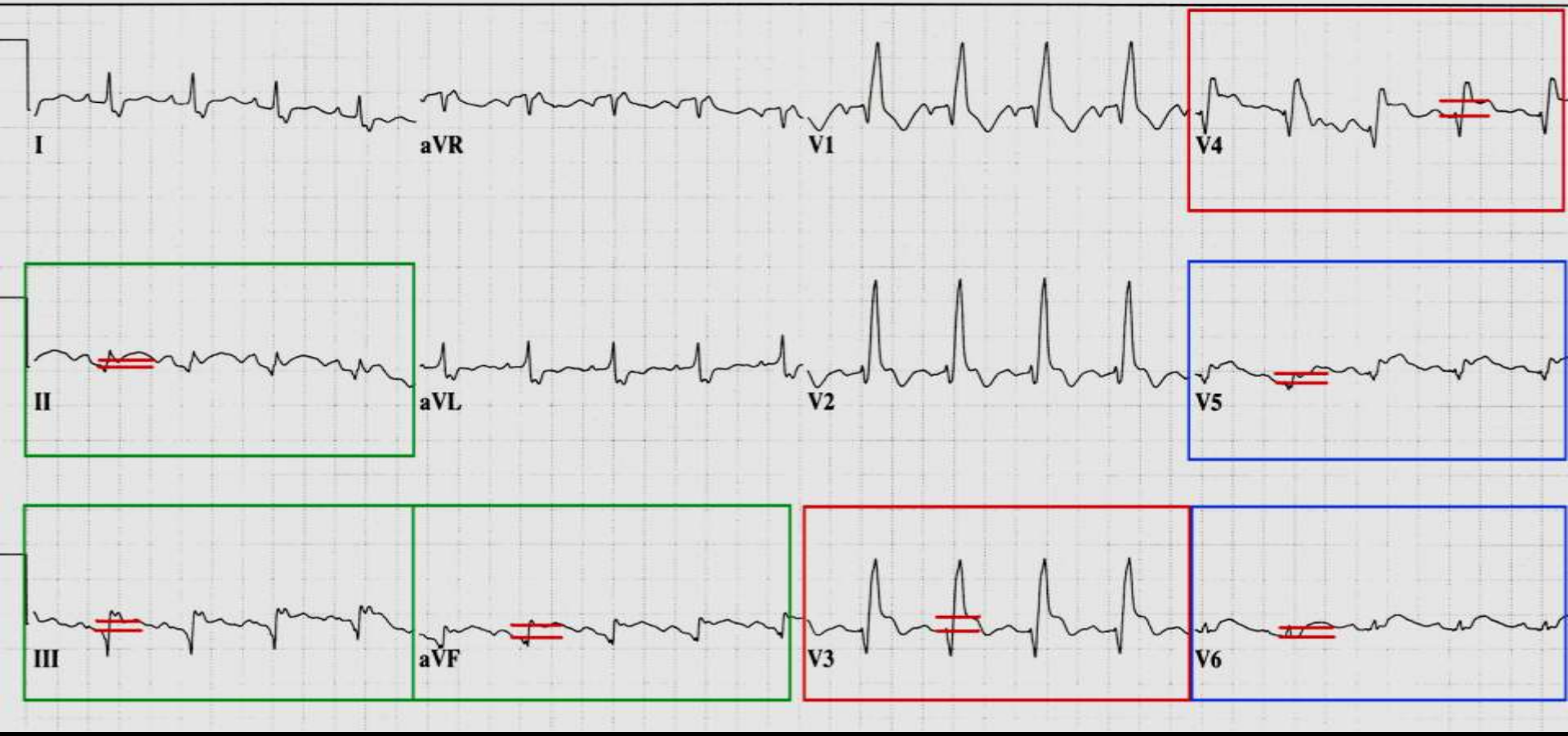
Room:CS–19
Loc:6 Option:41

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

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

ACUTE LATERAL - INFERIOR - ANTERIOR AMI

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



Wide QRS present:

(QRSd > 120ms)

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

Wide QRS present:

(QRSd > 120ms)

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

Wide QRS present:

(QRSd > 120ms)

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

Wide QRS present:

(QRSd > 120ms)

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

Diagnosis of STEMI with LBBB pattern:

2013 ACC/AHA Guideline for Management of STEMI

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

Diagnosis of STEMI with LBBB pattern:

2013 ACC/AHA Guideline for Management of STEMI

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

Diagnosis of STEMI with LBBB pattern:

2013 ACC/AHA Guideline for Management of STEMI

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

Diagnosis of STEMI with LBBB pattern:

2013 ACC/AHA Guideline for Management of STEMI

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

78 yr
Female Black

Room:ICU5
Loc:6 Option:19

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

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

- Normal arteries
- Normal LV Function
- No hypertrophy

Technician: EKG CLASS #WR03602718

Referred by:

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.

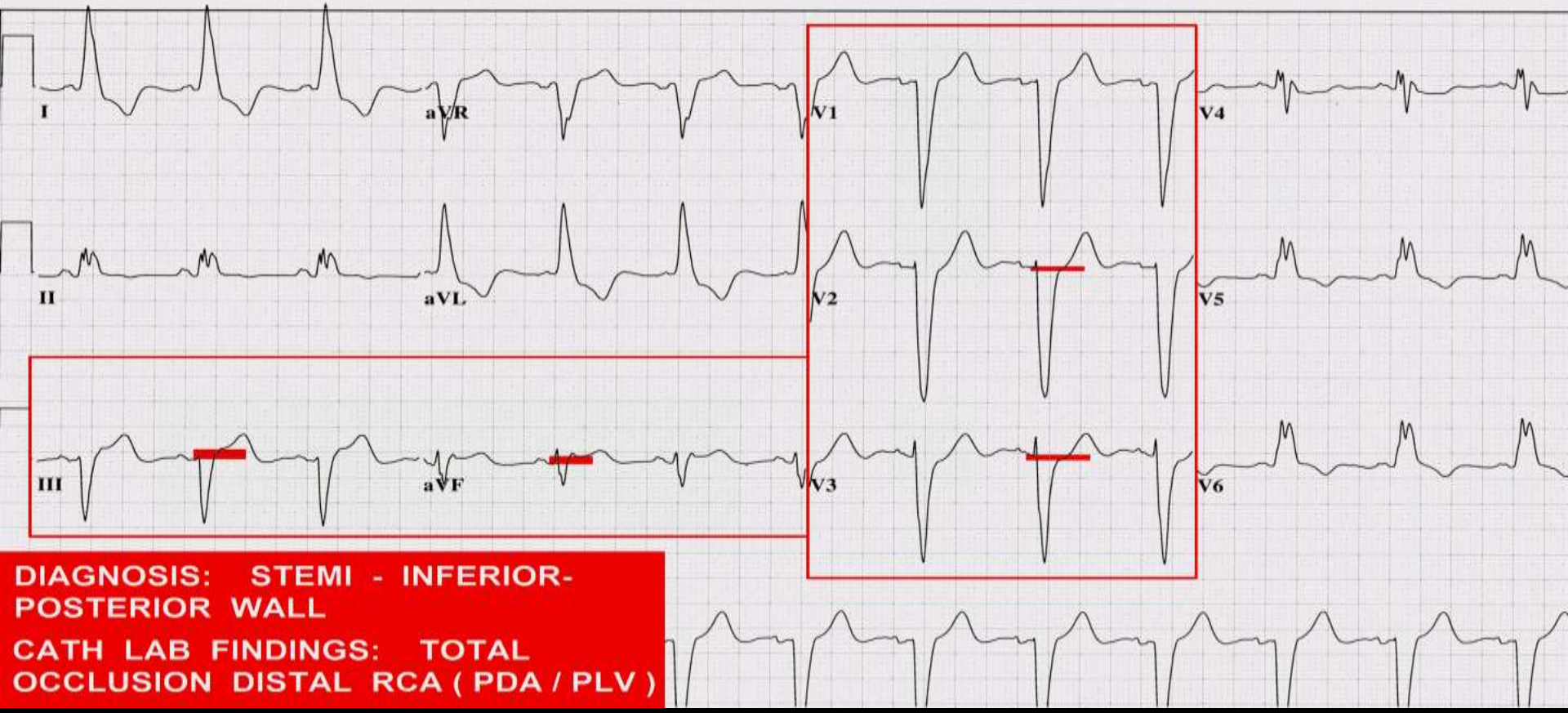
LBBB with CHEST PAIN - CASE 1 : PRESENTING EKG

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

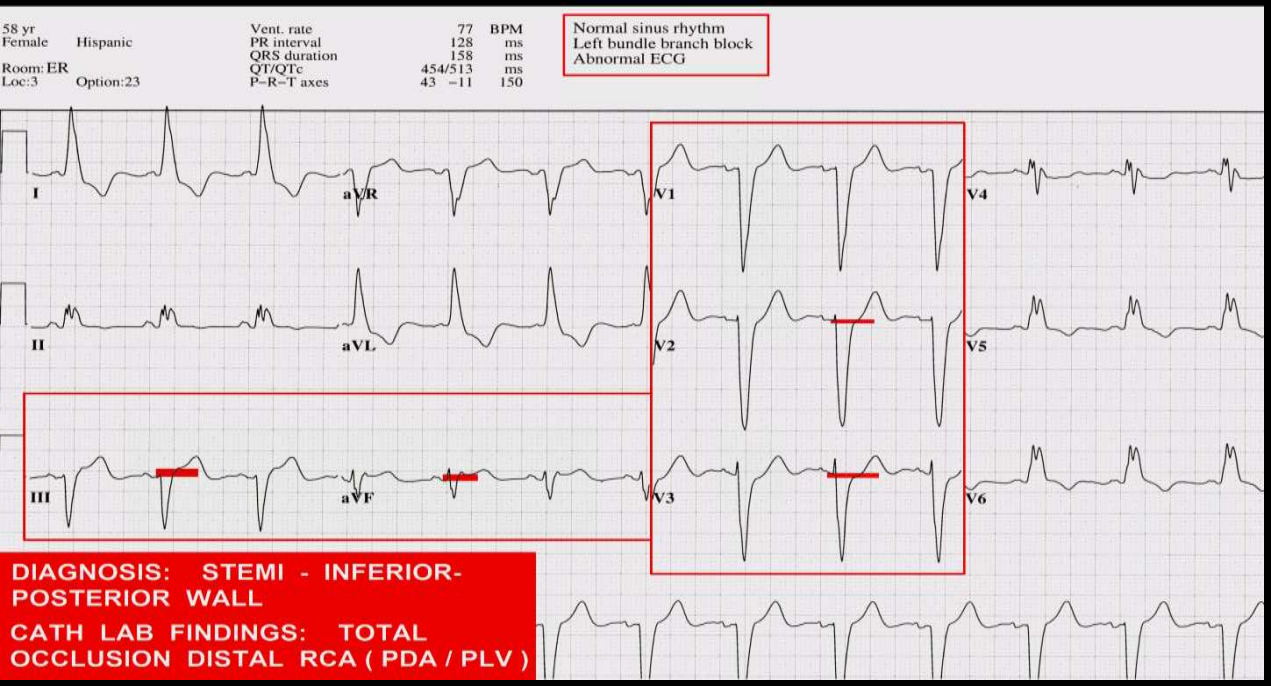
Normal sinus rhythm
Left bundle branch block
Abnormal ECG



DIAGNOSIS: STEMI - INFERIOR-POSTERIOR WALL

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

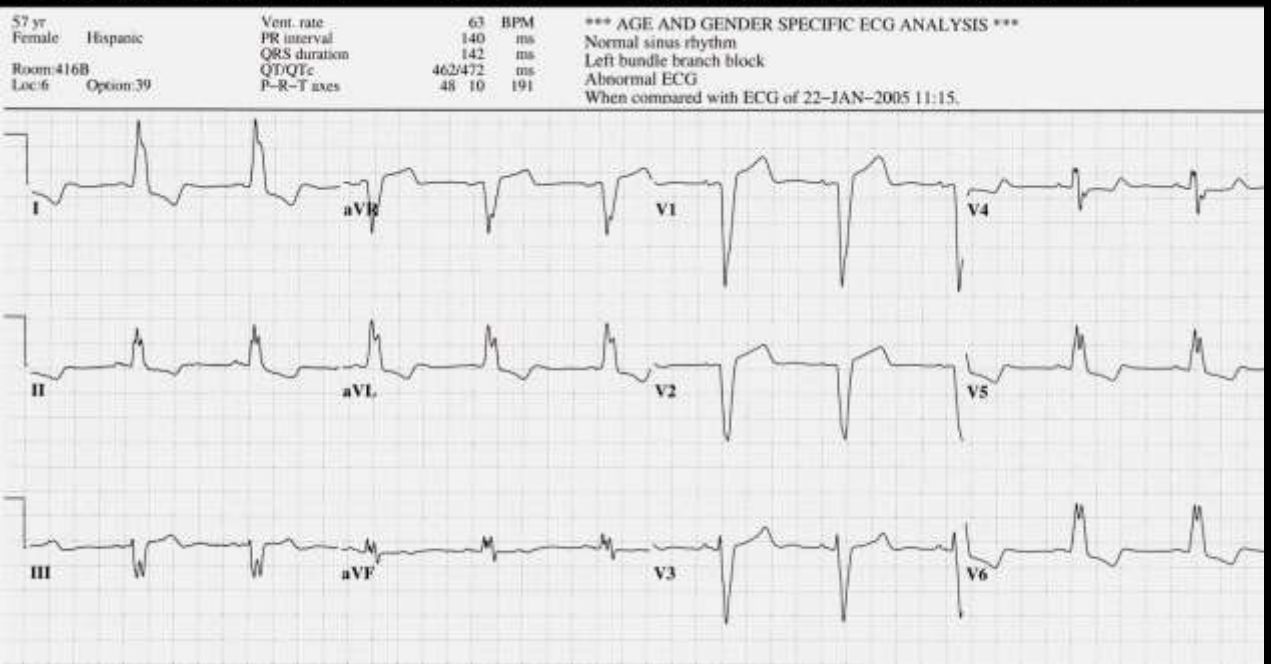
LBBB with CHEST PAIN - CASE 1: PRESENTING EKG

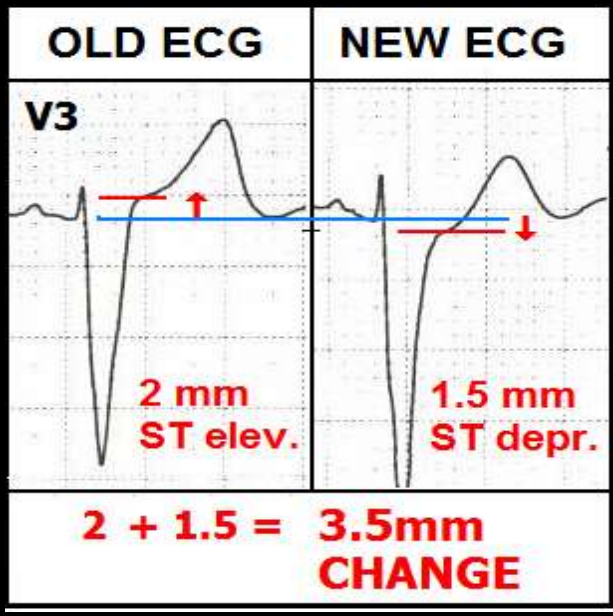


DIAGNOSIS: STEMI - INFERIOR-POSTERIOR WALL

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

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





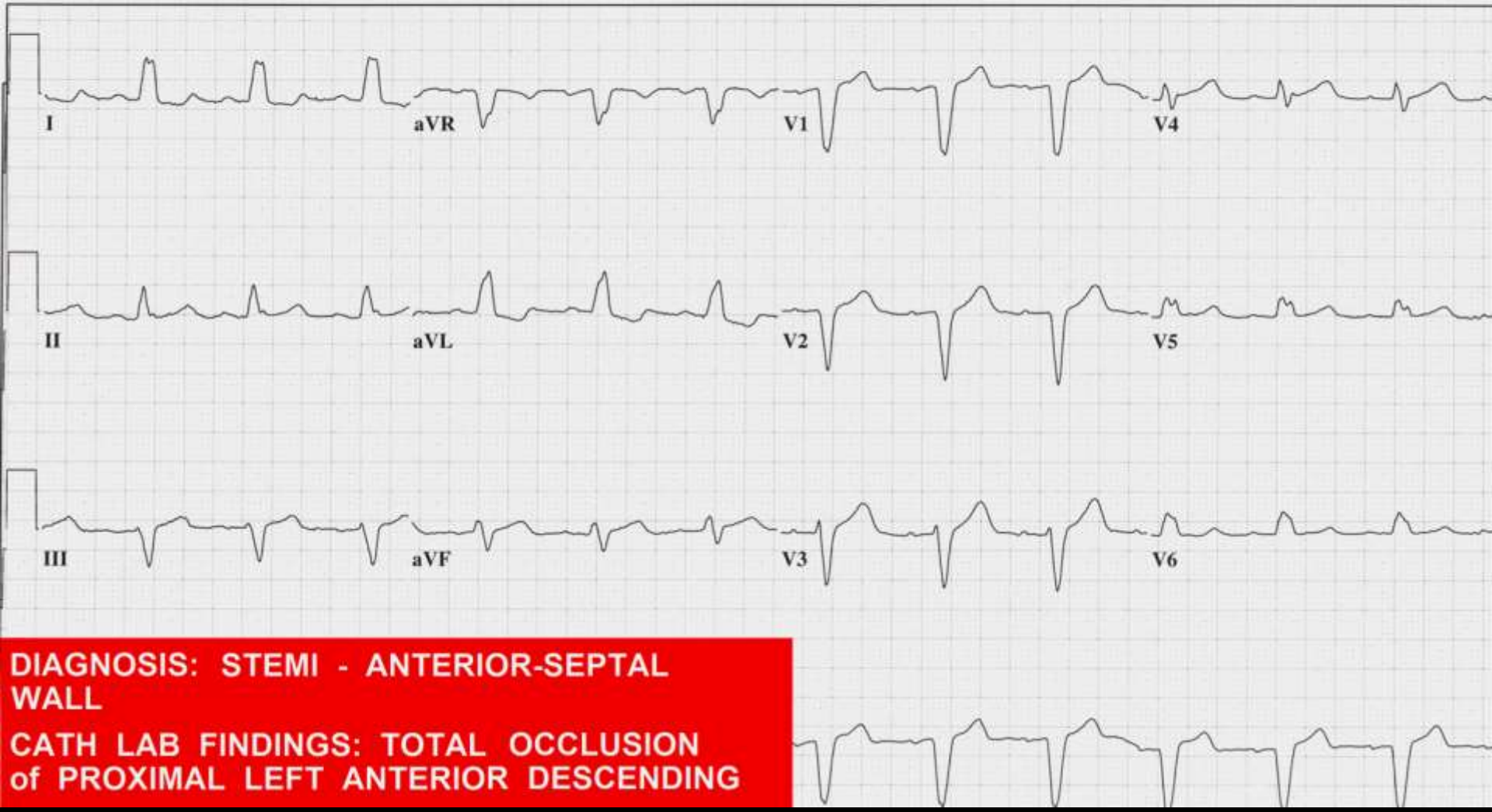
LBBB with CHEST PAIN - CASE 2: *NEW ONSET of LBBB*

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

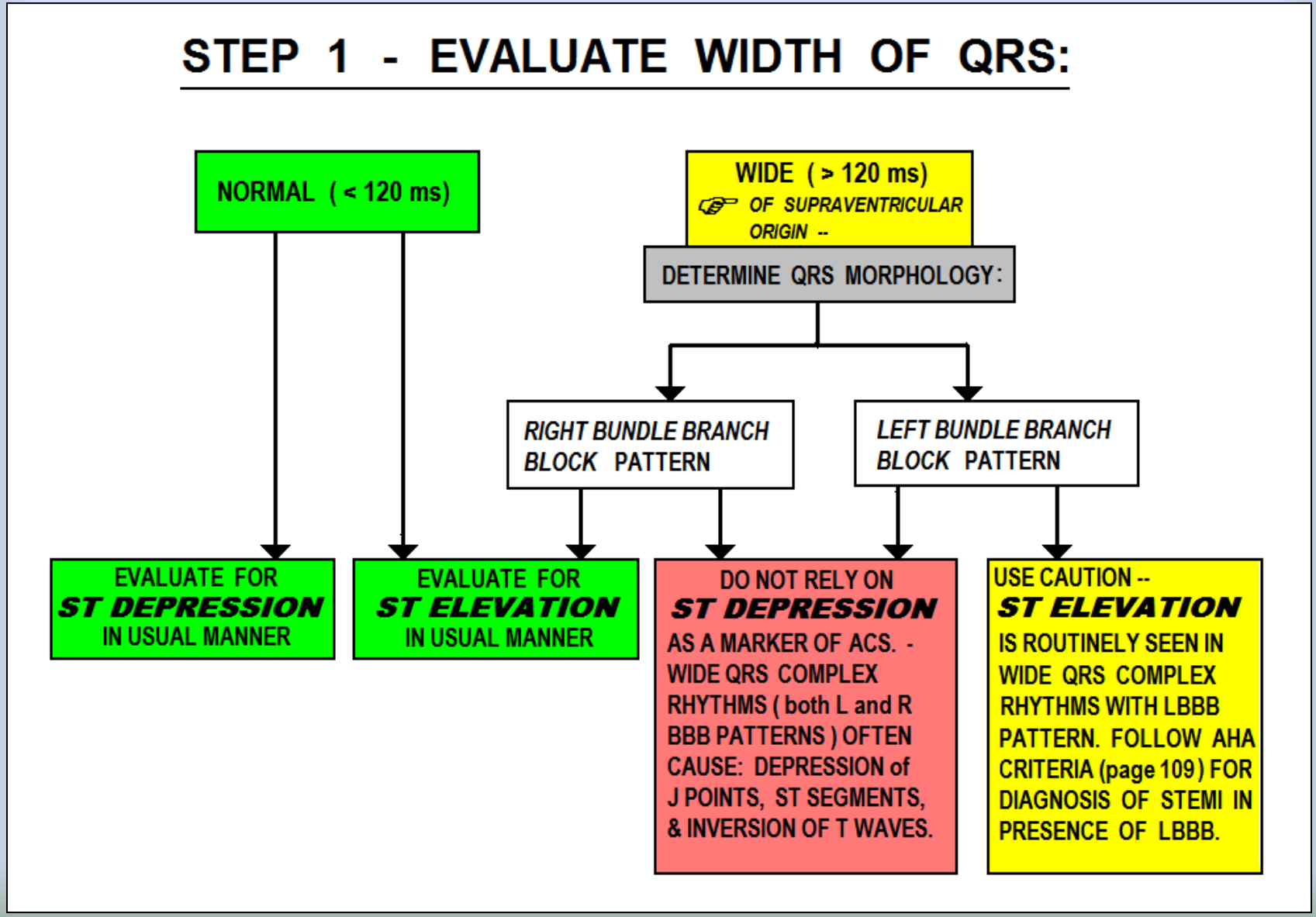
Normal sinus rhythm
Left bundle branch block
Abnormal ECG



DIAGNOSIS: STEMI - ANTERIOR-SEPTAL WALL

CATH LAB FINDINGS: TOTAL OCCLUSION of PROXIMAL LEFT ANTERIOR DESCENDING

Evaluating the ECG for ACS:



Evaluating the ECG for ACS:

Patients with Normal Width QRS (QRSd < 120ms)

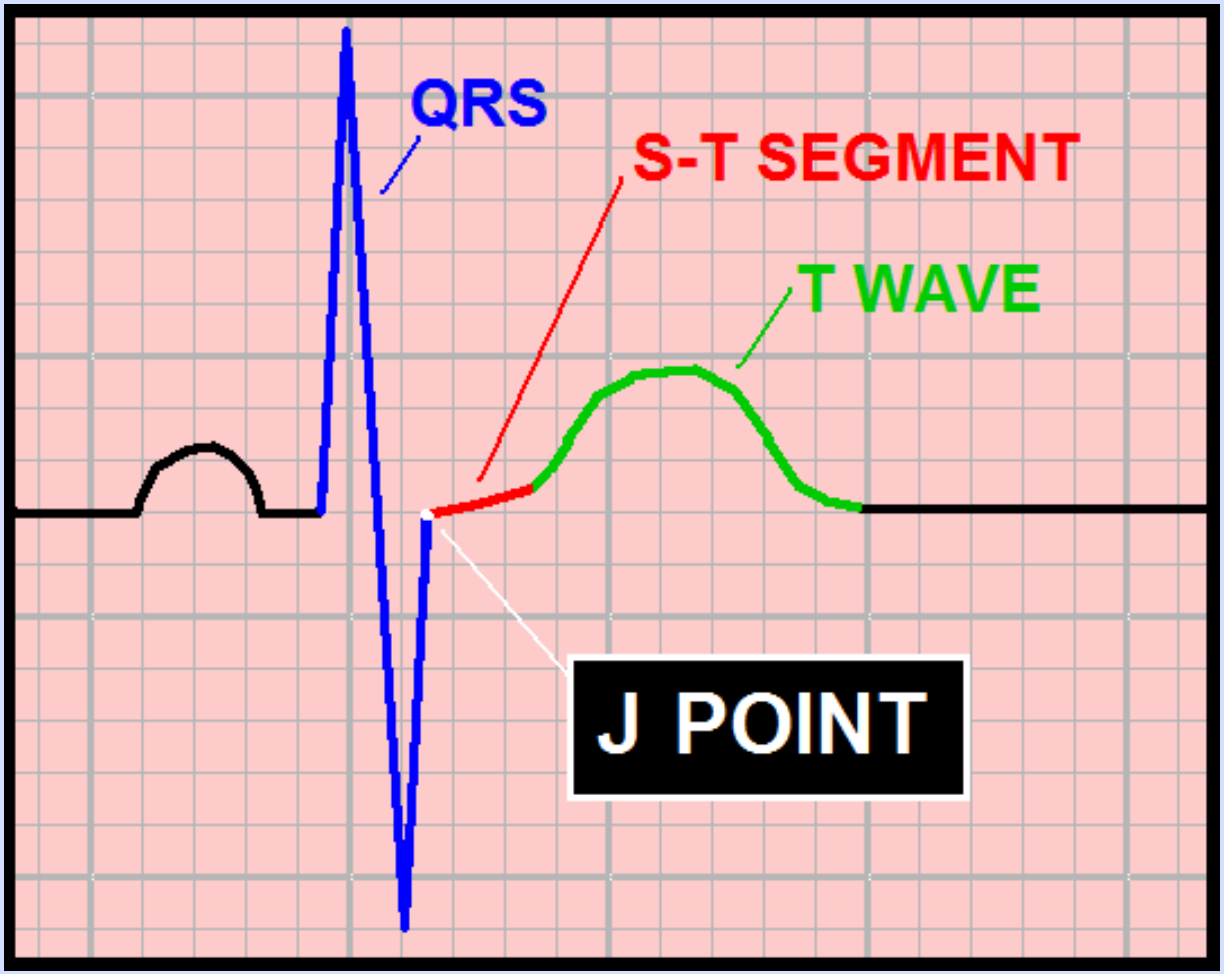
STEP 2 - EVALUATE the EKG for ACS

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

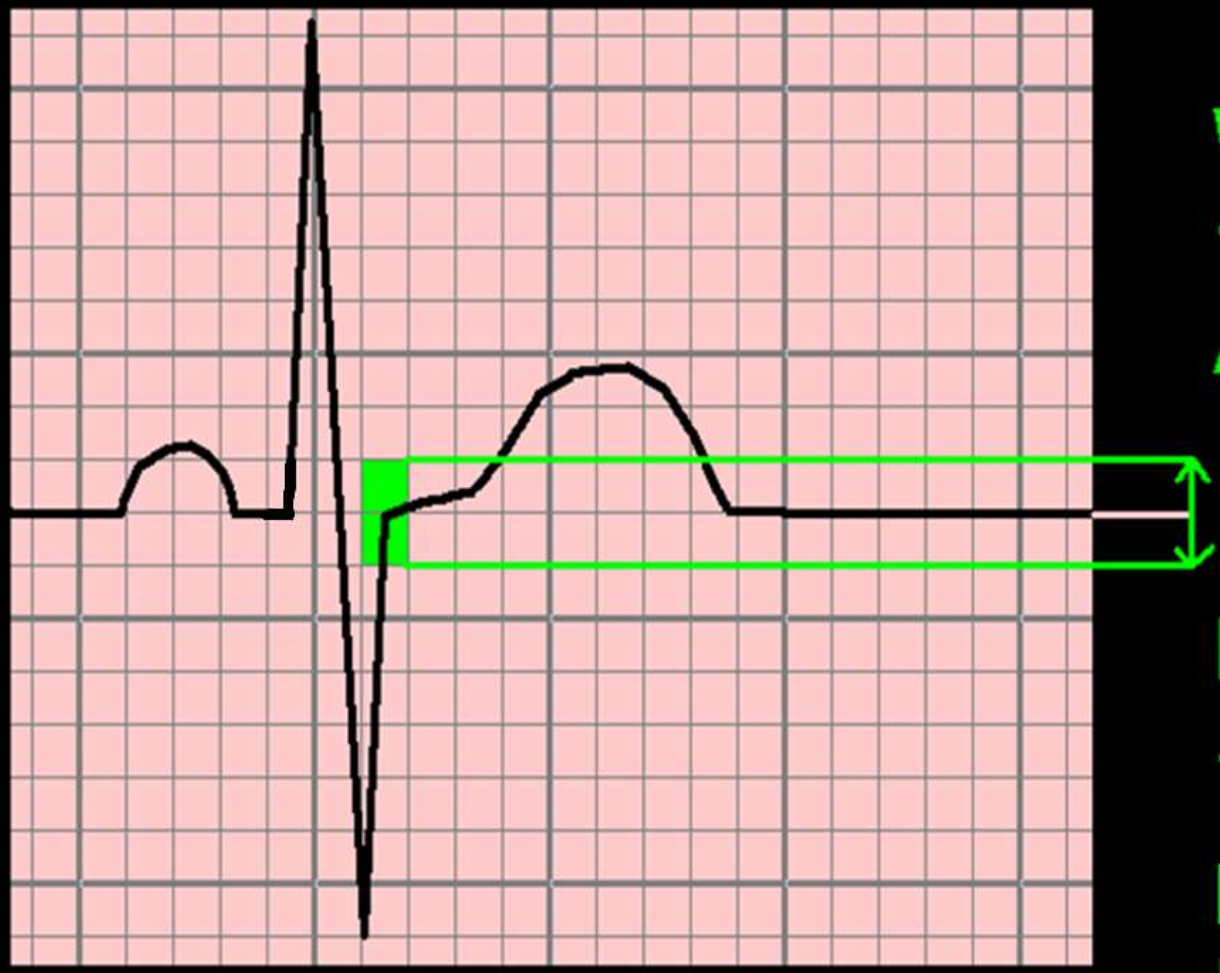
- J POINTS
- ST SEGMENTS
- T WAVES

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

Defining NORMAL:



THE J POINT SHOULD BE . .

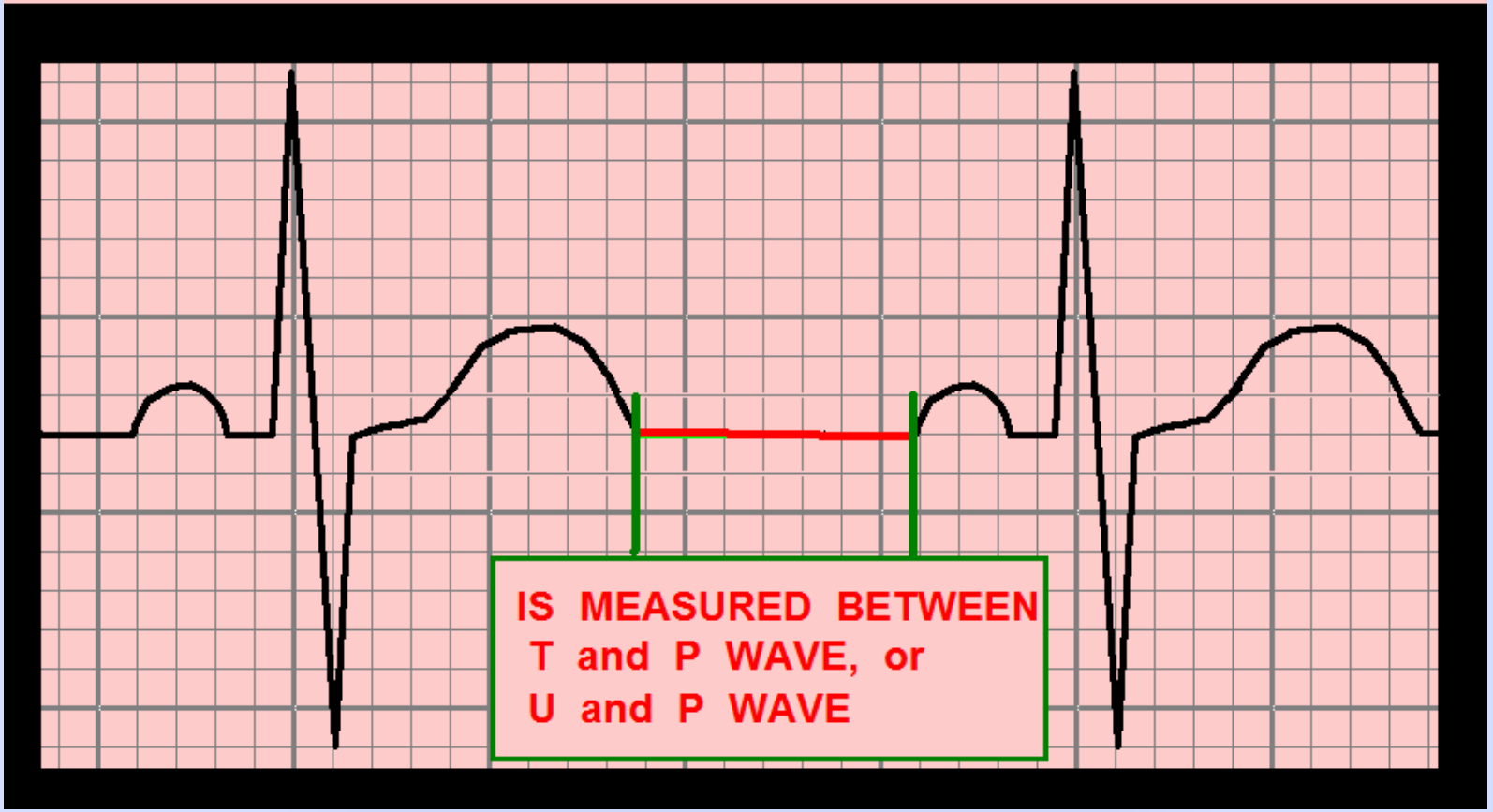


WITHIN
1 mm
ABOVE

OR

BELOW
the
ISOELECTRIC
LINE

THE ISOELECTRIC LINE



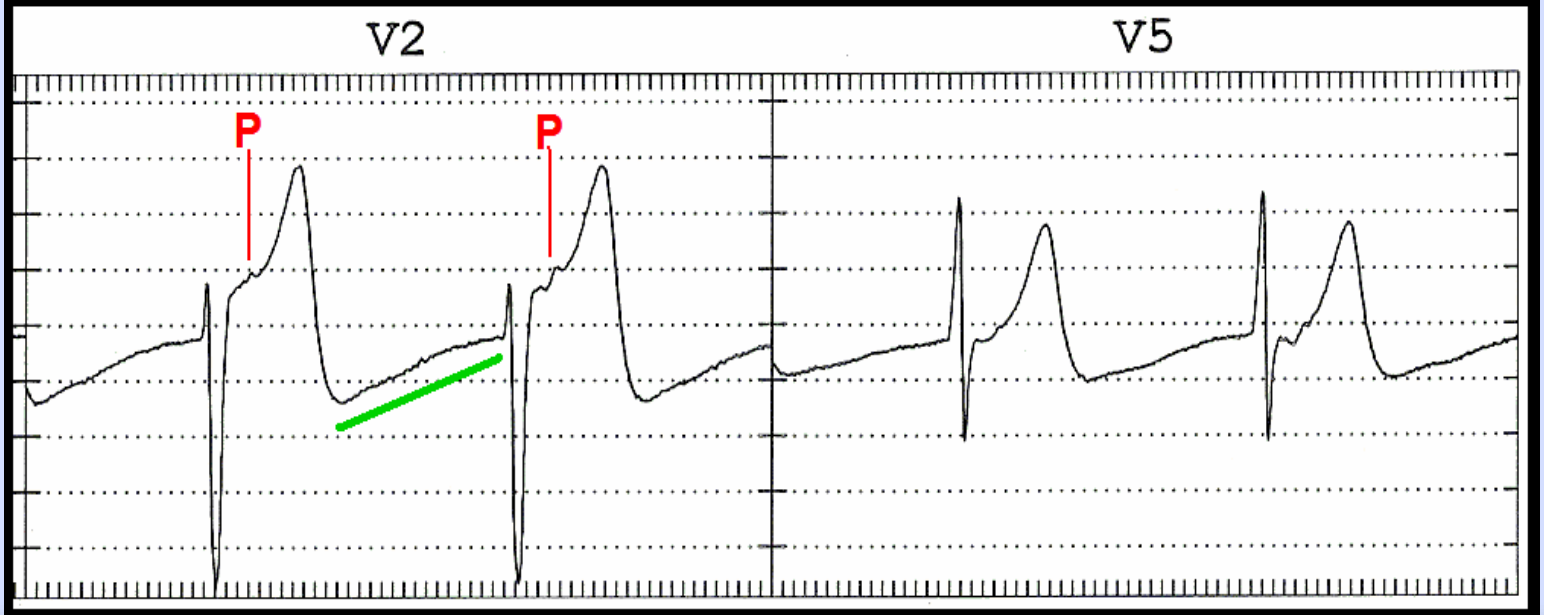
. . .the “flat line” between ECG complexes, when there is no detectable electrical activity . . .

The Isoelectric Line -

it's not always isoelectric !

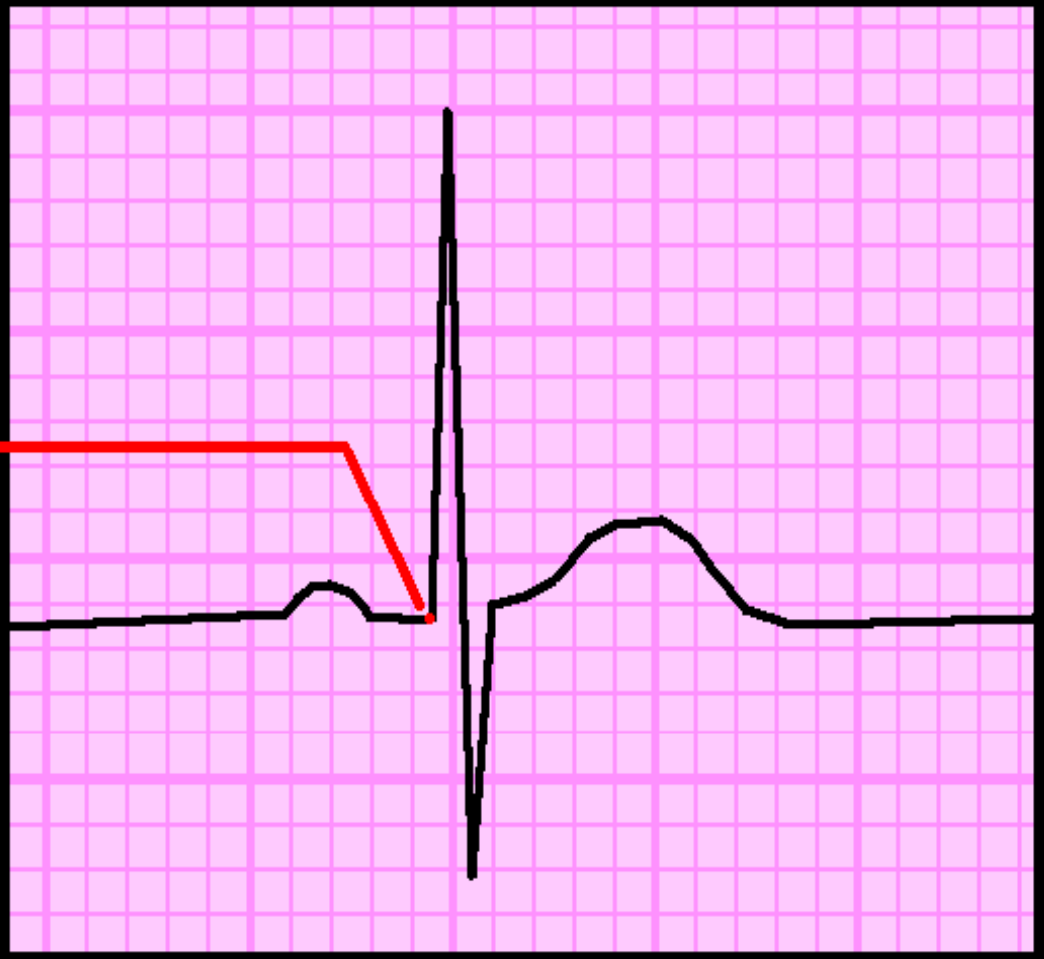
THE ISOELECTRIC LINE

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



THE P-Q JUNCTION

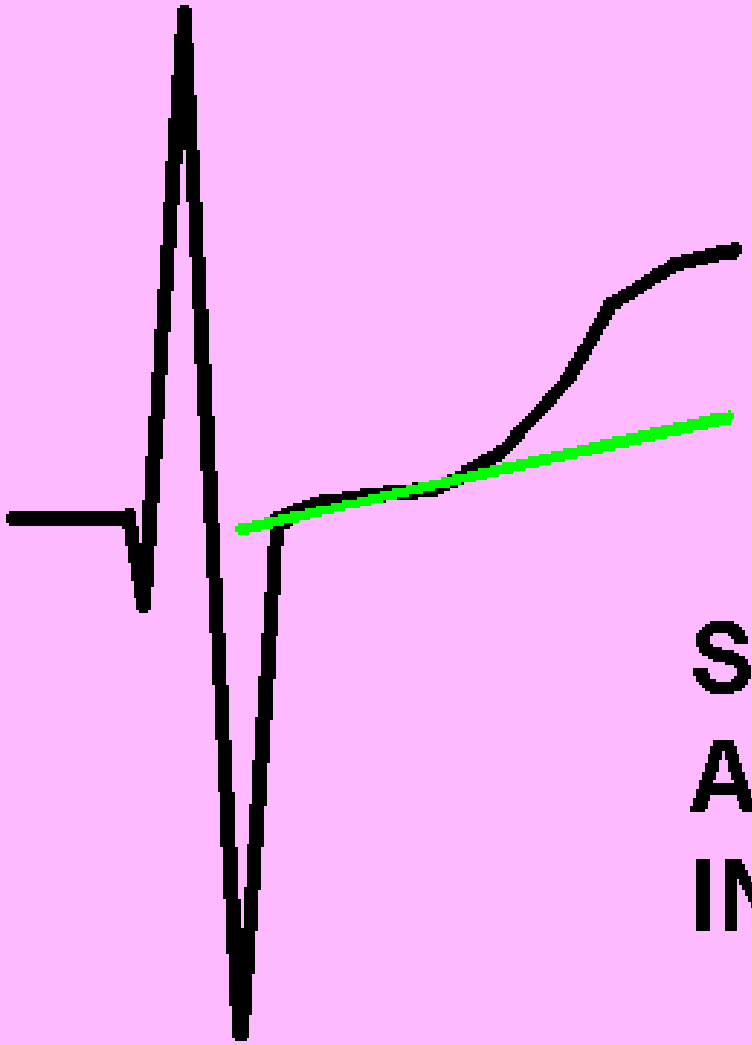
. . . is the POINT where the P-R SEGMENT ends and the QRS COMPLEX BEGINS.



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

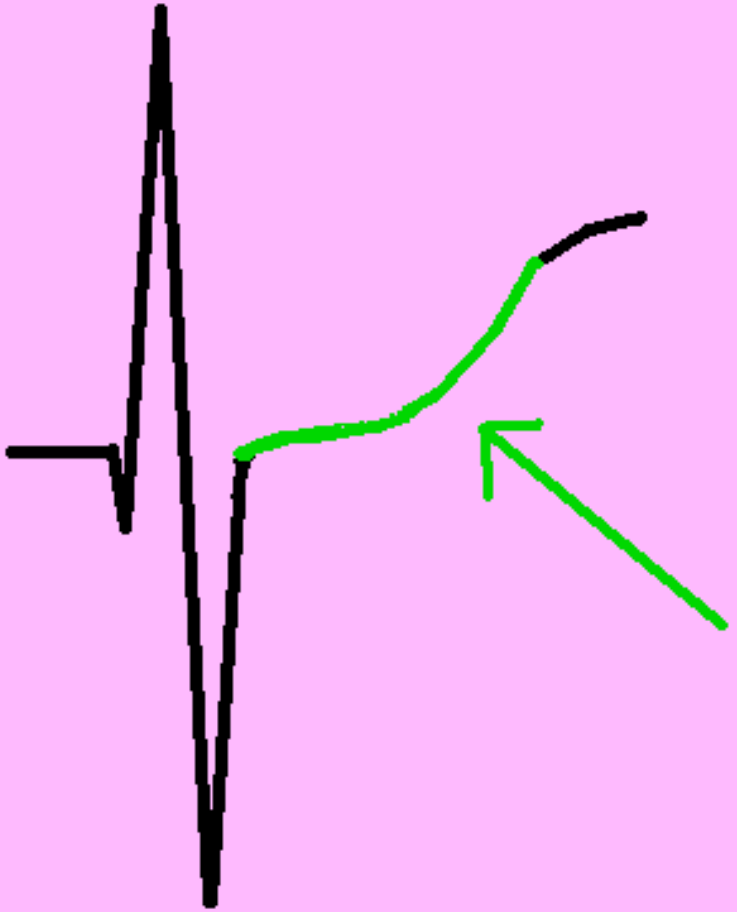
— as per the A.H.A., A.C.C., and WANG, ASINGER, and MARRIOTT, N.E.J.M. vol. 349:2128-2135 Nov. 27, 2003

THE S-T SEGMENT



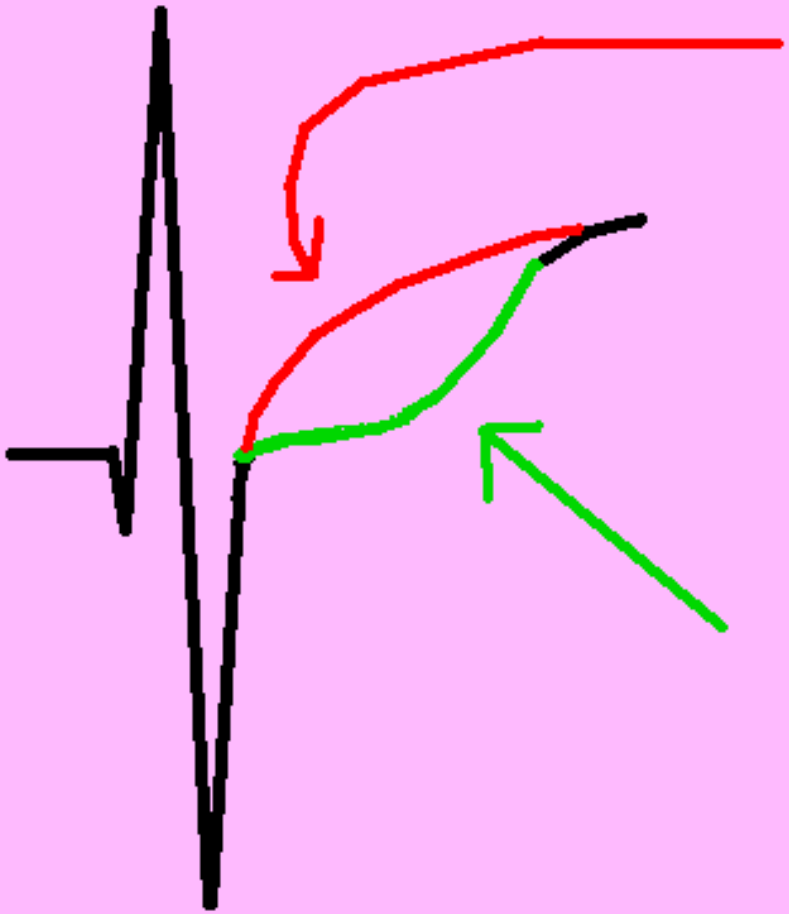
SHOULD HAVE
A "SLIGHT POSITIVE"
INCLINATION

THE S-T SEGMENT



SHOULD BE "CONCAVE" IN SHAPE . . .

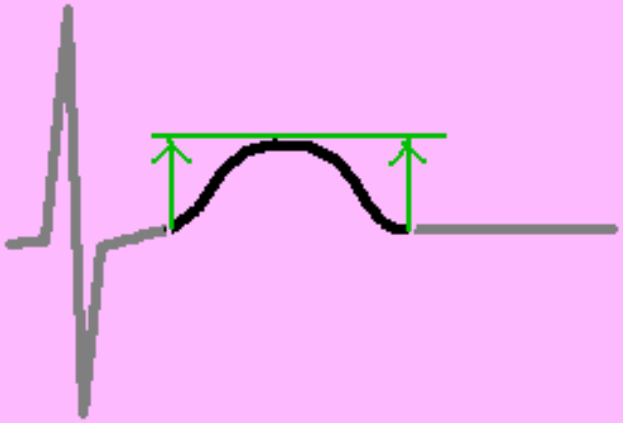
THE S-T SEGMENT



AS OPPOSED TO "CONVEX" IN SHAPE

SHOULD BE "CONCAVE" IN SHAPE . . .

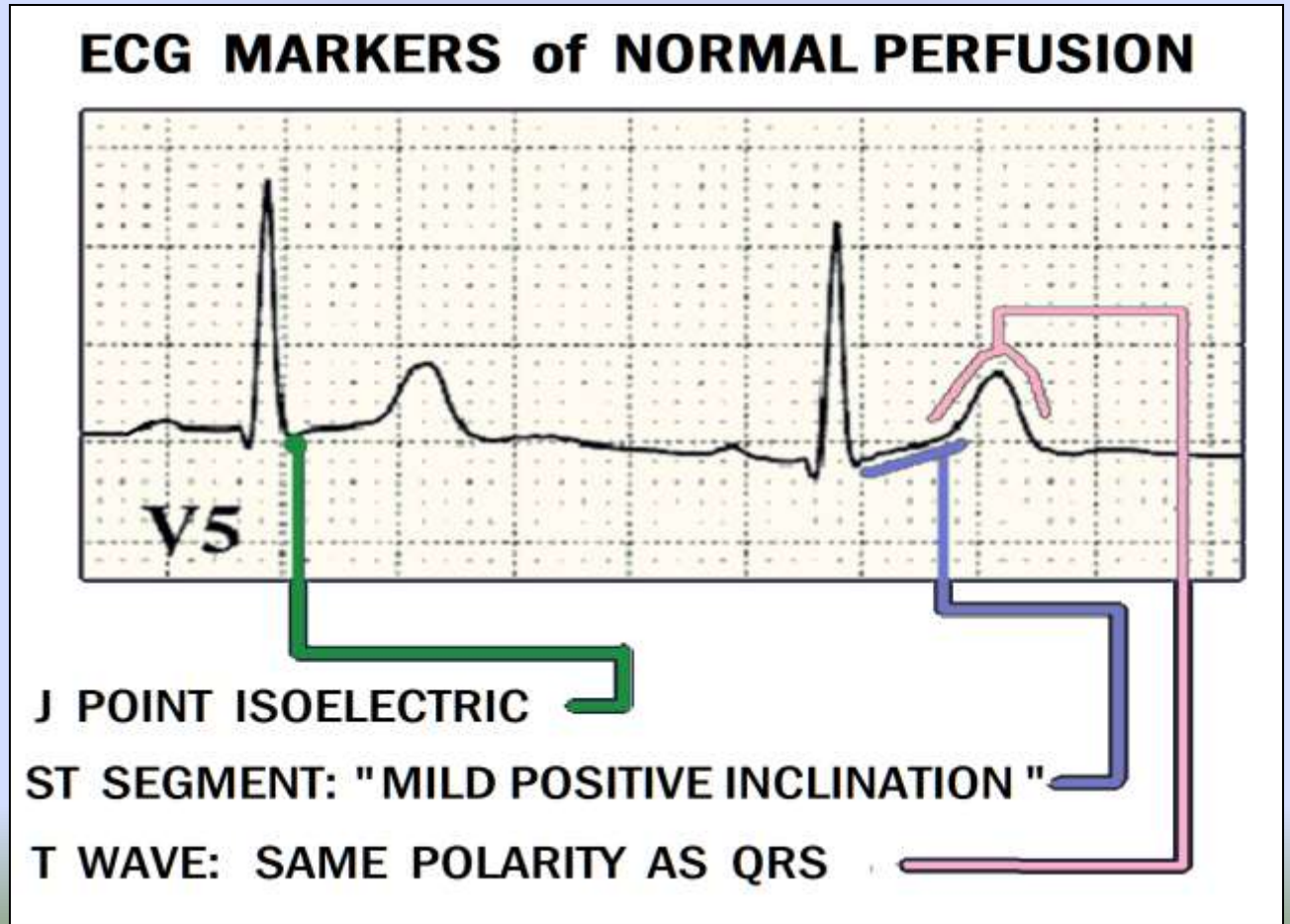
THE T WAVE



AMPLITUDE GUIDELINES:

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

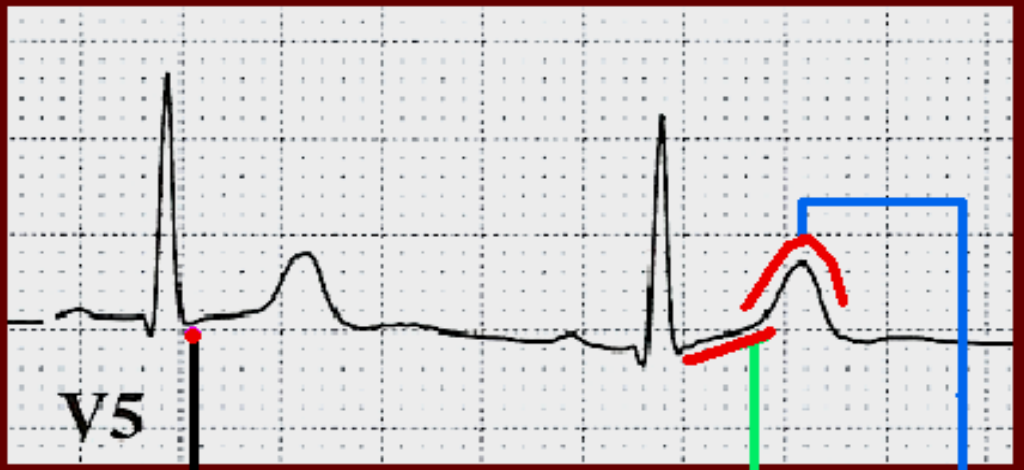
When QRS width is normal (<120ms), use this example of NORMAL as your



When QRS duration is NORMAL (< 120 ms):

NORMAL ST - T WAVES

- WHEN QRS WIDTH IS NORMAL (< 120 ms)



ASSESS:

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

☞ *in EVERY LEAD EXCEPT aVR ! !*

[redacted] [redacted] [redacted]

DOB [redacted] 75 Years Female (2)

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

PR 161
QRSD 90
QT 350
QTc 394

--AXIS--
P 50
QRS 51
T 44

12 Lead; Standard Placement

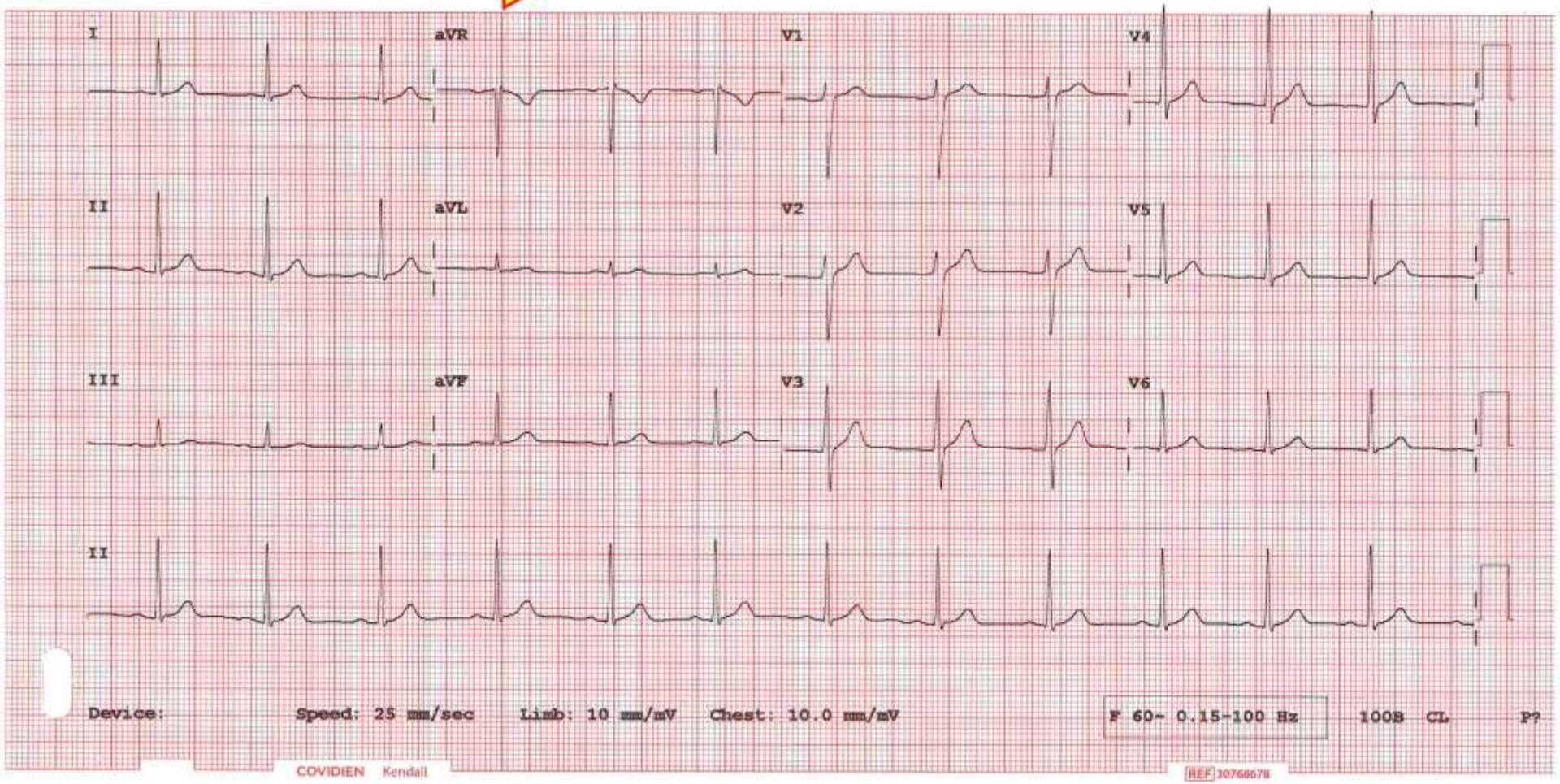
[redacted] TECH SD

[redacted]

- NORMAL ECG -

Unconfirmed Diagnosi

[redacted]



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

COVIDIEN Kendall REF 30768678

The Normal 12 Lead EKG

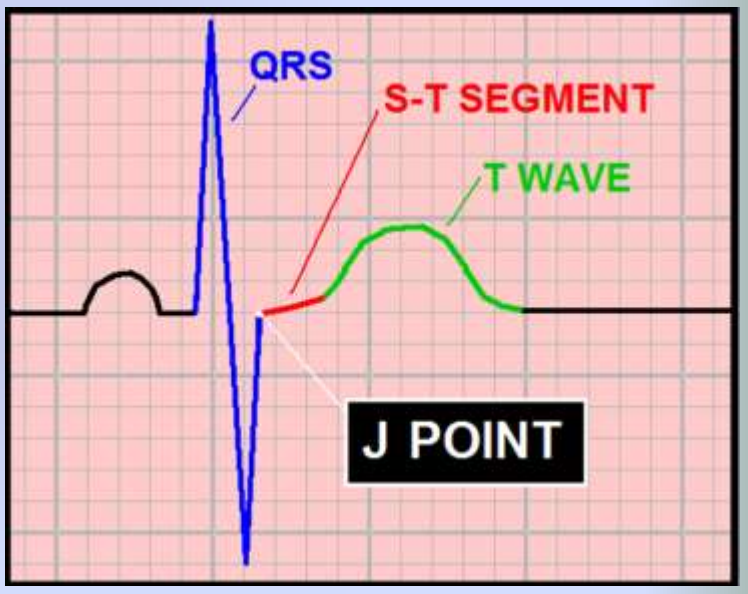
- NSR (rate 60-100, regular rhythm)
- P Waves upright all leads except aVR
- P Waves inverted lead aVR, possibly V1
- QRS upright Leads I, II, III, aVL, aVF, V5, V6
- QRS inverted Leads aVR, V1, V2
- QRS biphasic: Leads V3, V4
- P wave size: up to 2mm tall, 2.5mm long
- QRS height Limb Leads: 5-15mm tall
- QRS height V Leads 10-15mm tall
- QRS width: not to exceed 3mm (120 ms)
- Overall QRS Amplitude: not greater than 30mm

The Normal 12 Lead EKG

- T waves – Upright all Leads except aVR
- T wave – Inverted in Lead aVR
- (everything is inverted in lead aVR)
- T wave MAY be inverted (as a normal variant) in Leads III and aVL.
- Overall QRS Amplitude: not greater than 30mm

QUESTION:

If we just defined *NORMAL,* what is



***ABNORMAL* ? ?**

ANSWER:

EVERYTHING ELSE.

If it isn't NORMAL

is

ABNORMAL !!

Simply stated, if the

- J Points
- ST-Segments
- T Waves

are *NOT NORMAL*,
they are ***ABNORMAL.*** . . .

. . . And whenever the

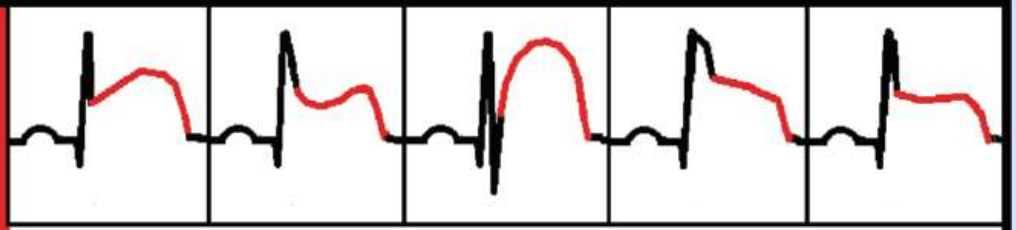
- J Points
- ST-Segments
- T Waves

are ***ABNORMAL,*** *it can be an INDICATION of* ***ACUTE CORONARY SYNDROME !***

NORMAL PERFUSION

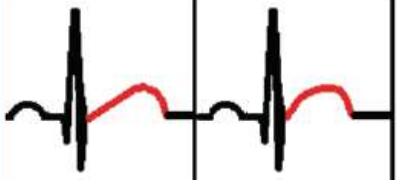
- J POINT ISOELECTRIC
- ST SEGMENT: slight POSITIVE inclination
- ST-T JUNCTION is CONCAVE
- T WAVE smaller than R wave, SMOOTH, ROUNDED (NOT HYPER-ACUTE). T Wave INVERTED in lead AVR, upright in all other leads.

STEMI



- J POINT EVEVATED 1mm or more in 2 or more contiguous leads
  (exception: V2 & V3: men can have up to 2mm, women 1.5mm of normal J Point Elevation)
- ST SEGMENT usually CONVEX, may be UPSLOPING, FLAT, or DOWNSLOPING as seen in the examples above.

PATTERNS CONSISTENT WITH EARLY PHASE ACUTE MI



J POINT to APEX of T WAVE:
- FLAT (example to far left)
  or
- CONVEX (examplet to immediate left)

HYPERACUTE T WAVES
- **J POINT ISOELECTRIC or ELEVATED**
- **PEAK of T Wave POINTED, may exceed amplitude of R Wave**
- **Consider Acute MI / Pending MI**
- **Can ALSO indicate: Transmural Ischemia, Hyperkalemia**

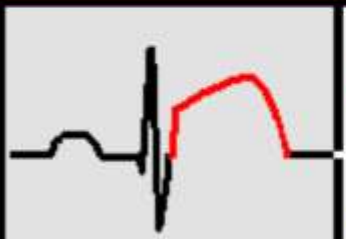
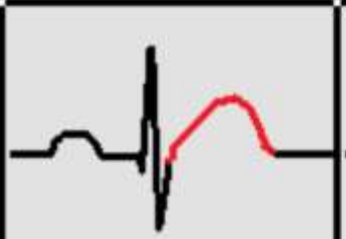
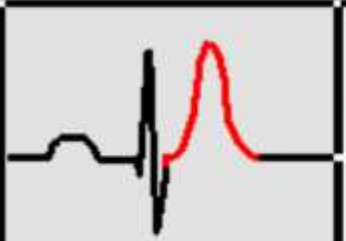
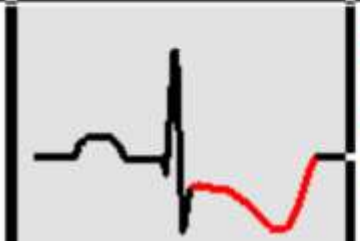
DYNAMIC CHANGES to a patient's J POINT, ST SEGMENT and/or T WAVE during SERIAL ECGs is a strong indicator of UNSTABLE ISCHEMIA or EARLY INFARCTION

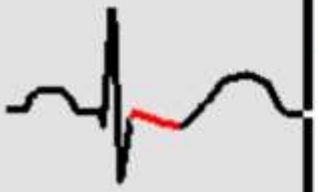
ACUTE MI or ISCHEMIA

J POINT DEPRESSION, Downsloping ST SEGMENT, inverted T Wave
- **Consider NSTEMI: check cardiac markers**
- **If ST Depression noted in Leads V1 - V4, consider Posterior Wall STEMI: obtain Posterior Lead ECG (see page 7 for details).**
- **If Acute MI not present, rule out MYOCARDIAL ISCHEMIA**

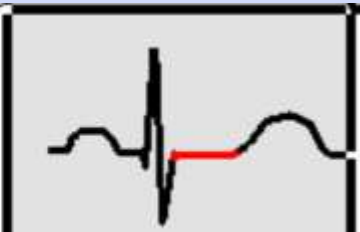
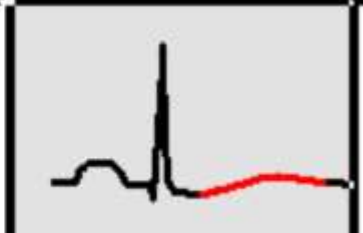
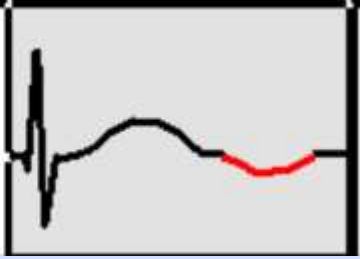
13 ECG PATTERNS of ACS & ISCHEMIA

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

!	S-T SEGMENT ELEVATION at J POINT		- ACUTE MI - ACUTE PERICARDITIS / MYOCARDITIS - EARLY REPOLARIZATION
!	FLAT or CONVEX J-T APEX SEGMENT	 	- ACUTE MI - ISCHEMIA
!	HYPER-ACUTE T WAVE		- HYPERKALEMIA - TRANSMURAL ISCHEMIA - ACUTE MI - HYPERTROPHY
!	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

Evaluate QTc

- “QUICK PEEK” Method
- QTc – vs – QT Interval

Lead Selection: QT Interval

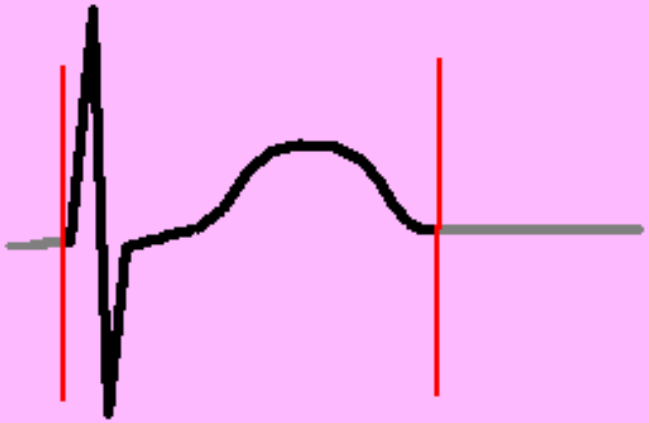
- Targeted QT measurement using 12 Lead ECG:

Appropriate Lead Selection

The AHA/ACC Foundation/Heart Rhythm Society recommendations for the standardization and interpretation of the ECG (2009) recommend selecting the electrocardiographic lead with the longest T wave when monitoring the QT interval

Chest Leads
V2 & V3
often display
LONGEST QT Intervals.

THE Q-T INTERVAL



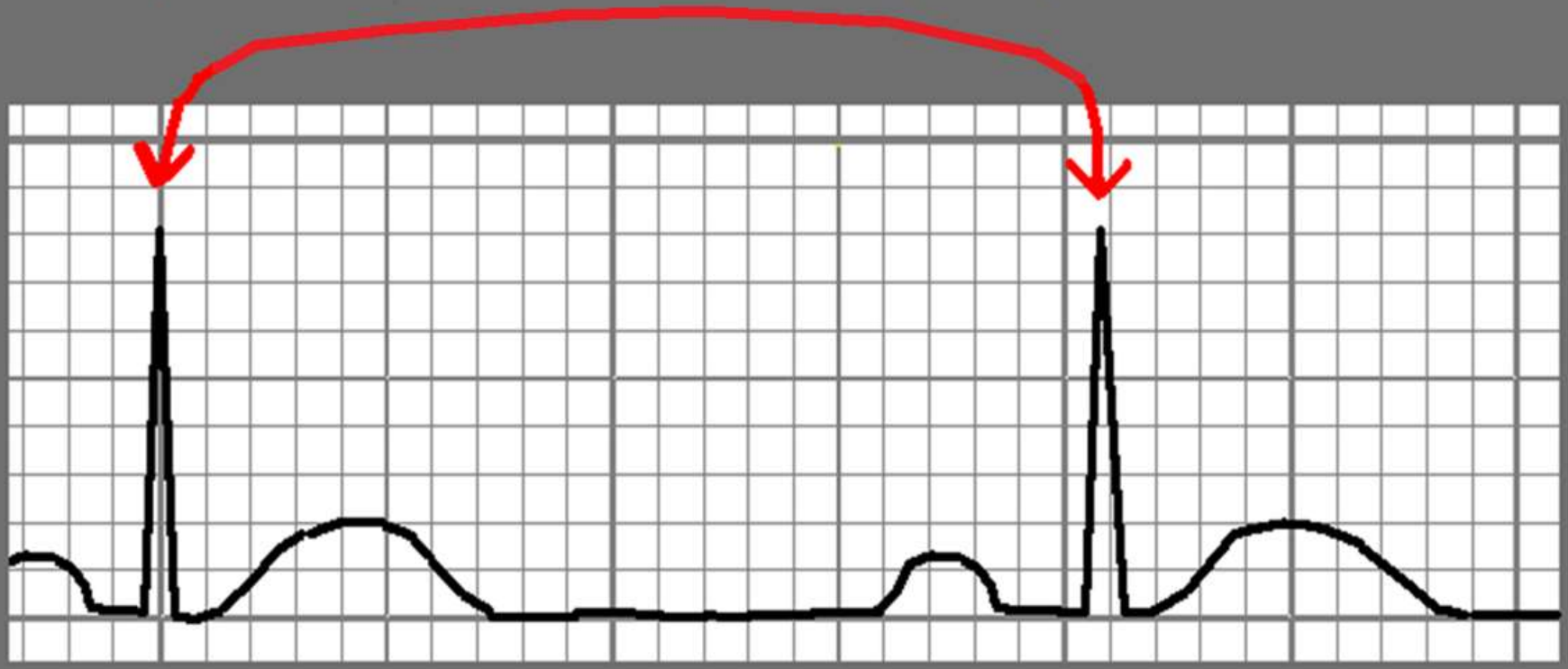
- BEGINNING OF QRS COMPLEX TO THE END OF THE T WAVE

- NORMAL VALUES VARY BASED ON HEART RATE
- SEVERAL WAYS TO DETERMINE NORMAL LIMITS

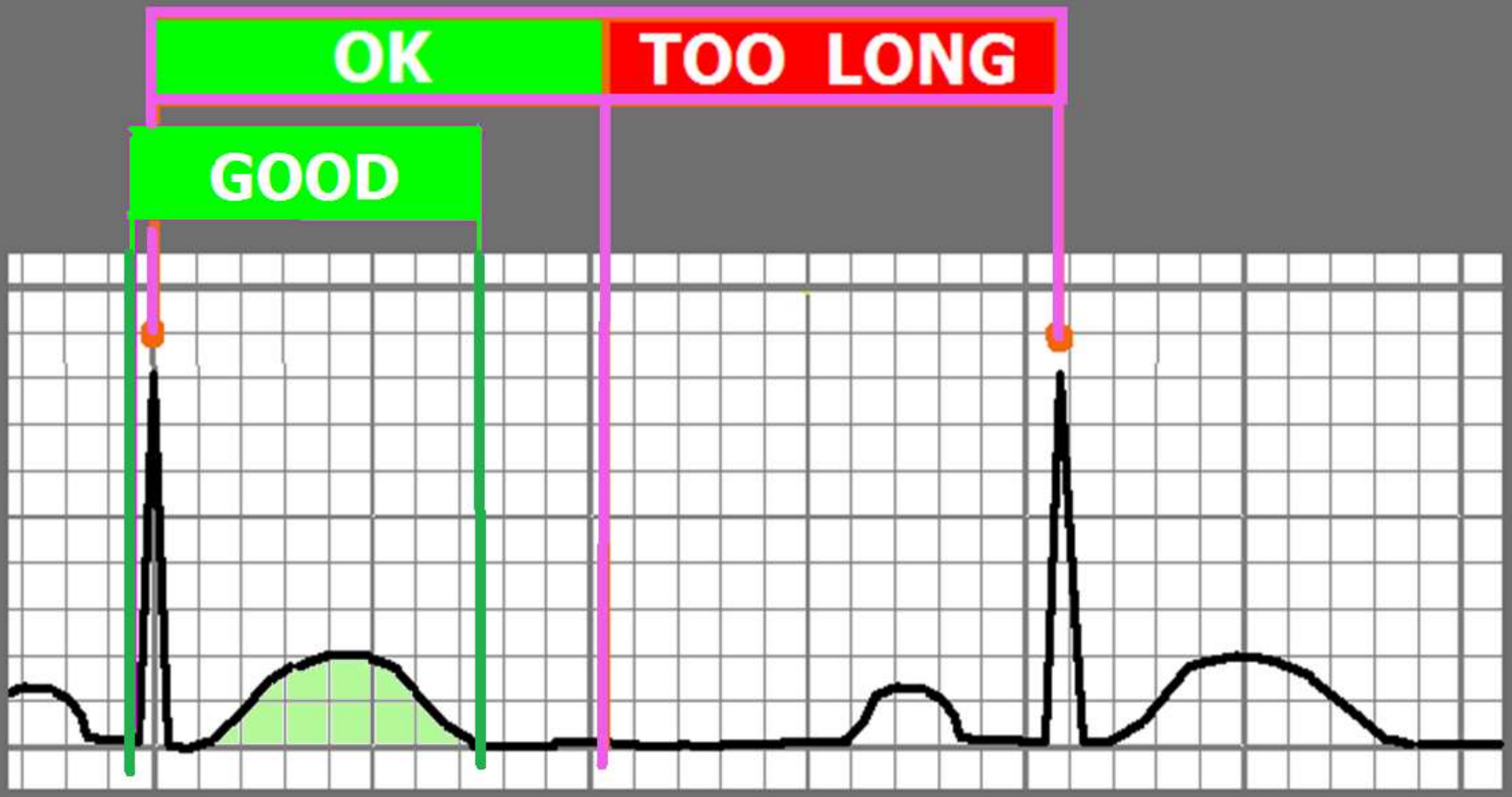
DETERMINING Q-T INTERVAL LIMITS

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

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	$QTp=656/(1+HR/100)$

Methods to obtain QTc:

- Look at 12 Lead ECG printout (at top of page)

Determining the QT / QTc

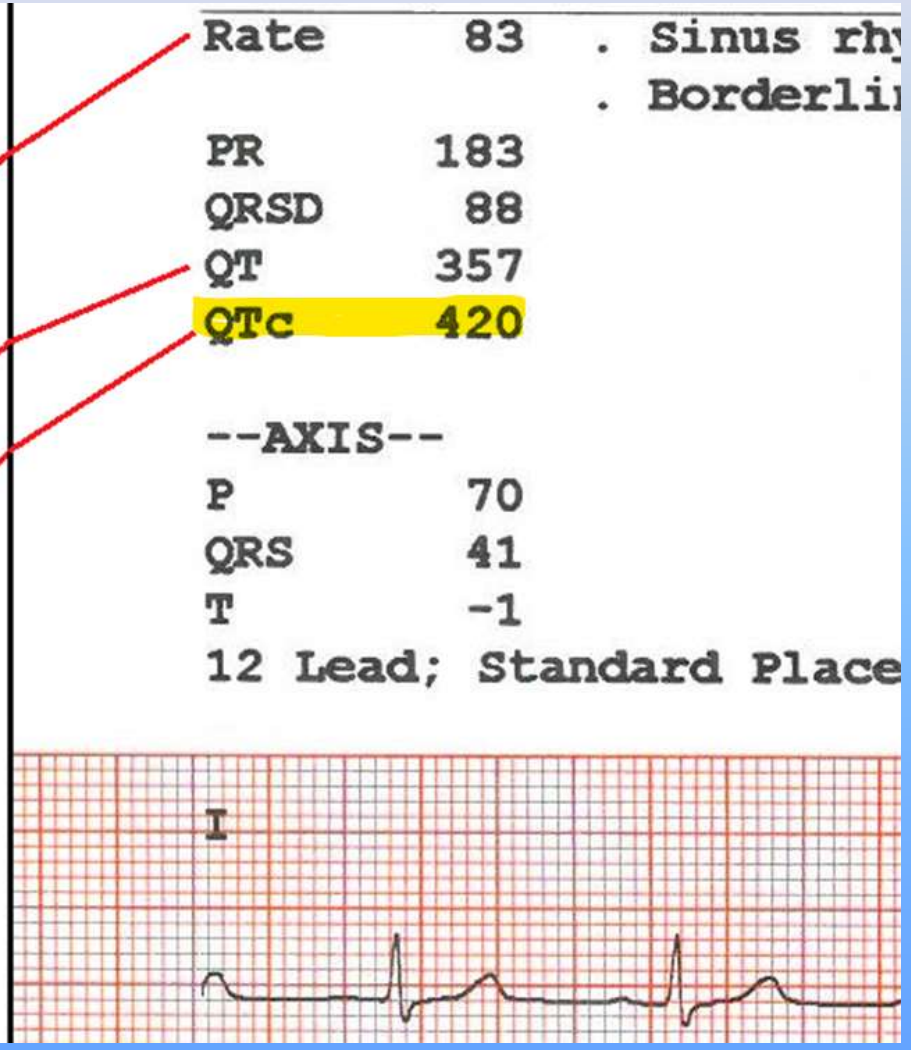
Method 1 – 12 Lead ECG Report:

Standard 12 Lead ECG printout . . .

Heart Rate = 83

QT Interval = 357

QTc = 420



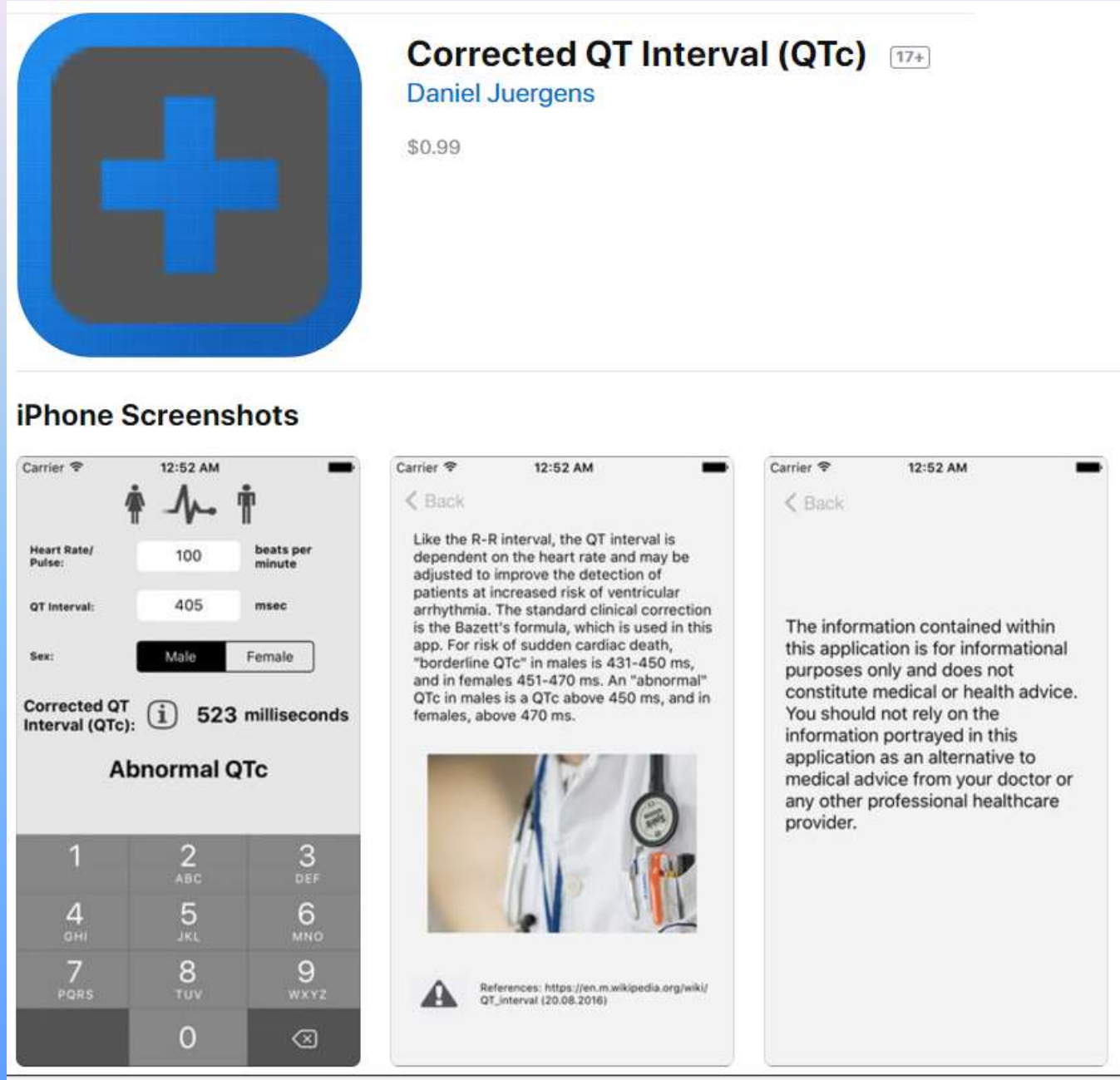
Methods to obtain QTc:

- Look at 12 Lead ECG printout (at top of page)
- Call Monitor Tech – they can give immediate value

Methods to obtain QTc:

- Look at 12 Lead ECG printout (at top of page)
- Call Monitor Tech – they can give immediate value
- Calculate it yourself using smartphone App

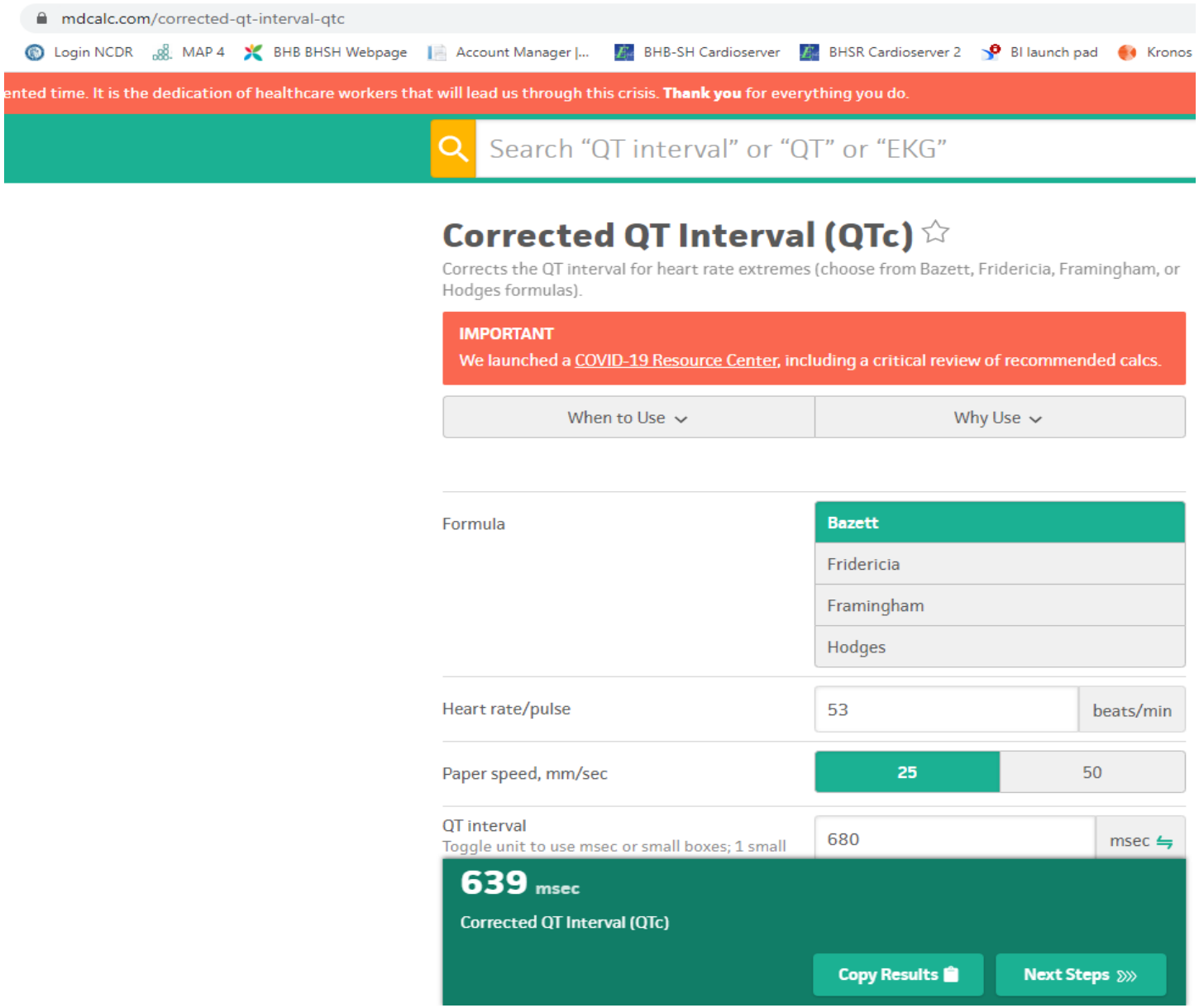
“There’s an APP for that!”



Determining the QTc

- **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

Web-based (mdcalc.com):



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

Prolonged QT Interval

- QTc 500 – 520 may be due to oral antiarrhythmics (sotalol, amiodarone, etc)
- QTc above 500: NOT ADVISABLE to administer any QT prolonging meds
  - Check electrolytes (especially K, Mg, Ca)
- QTc 550 and above: advise immediate discontinuance of all QT prolonging meds
- ***QTc 600+ ANTICIPATE Torsades de Pointes (TdP)***

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

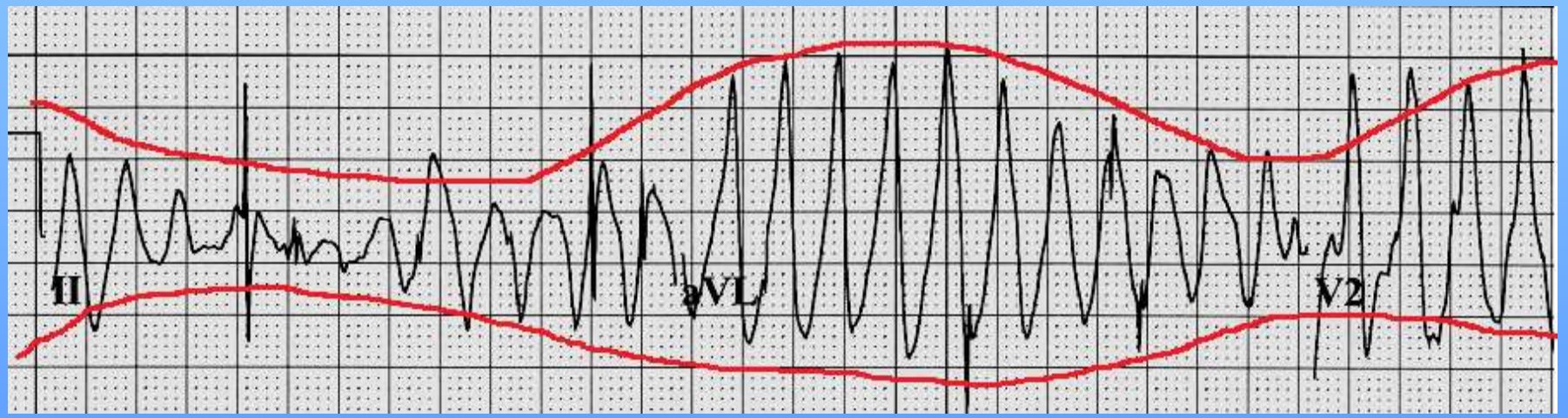
Torsades de Pointes (TdP) – HEMODYNAMICS:

- **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 !



WIDE COMPLEX TACHYCARDIA
TORSADES de POINTES

(QRS > 120 ms)

ABC s

NO PULSE	PULSE - UNSTABLE	PULSE - STABLE
GO TO V - FIB ALGORITHM !	▪ IMMEDIATE DEFIBRILLATION START IV CONSIDER SEDATION	▪ O2 / IV / EKG ▪ MAGNESIUM INFUSION 1 - 2 gm OVER 5 - 60 min.

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

OTHER CONSIDERATIONS:

- EVALUATE BASELINE ECG RHYTHM FOR PRONGED Q-T INVERVAL.
- EVALUATE PATIENT'S MEDS FOR Q-T PROLONGING DRUGS
  . . . if PATIENT HAS BEEN RECEIVING ANY Q-T PROLONGING DRUGS, IMMEDIATELY DISCONTINUE AND CONTACT PHYSICIAN STAT.
- EVALUATE PATIENT HISTORY FOR PREVIOUS EVENTS OF "SYNCOPE OF UNKOWN ETIOLOGY"
- EVALUATE PATIENT FOR FAMILY HISTORY FOR SUDDEN CARDIAC DEATH

REPORT ANY ABNORMAL FINDINGS TO PHYSICIAN.

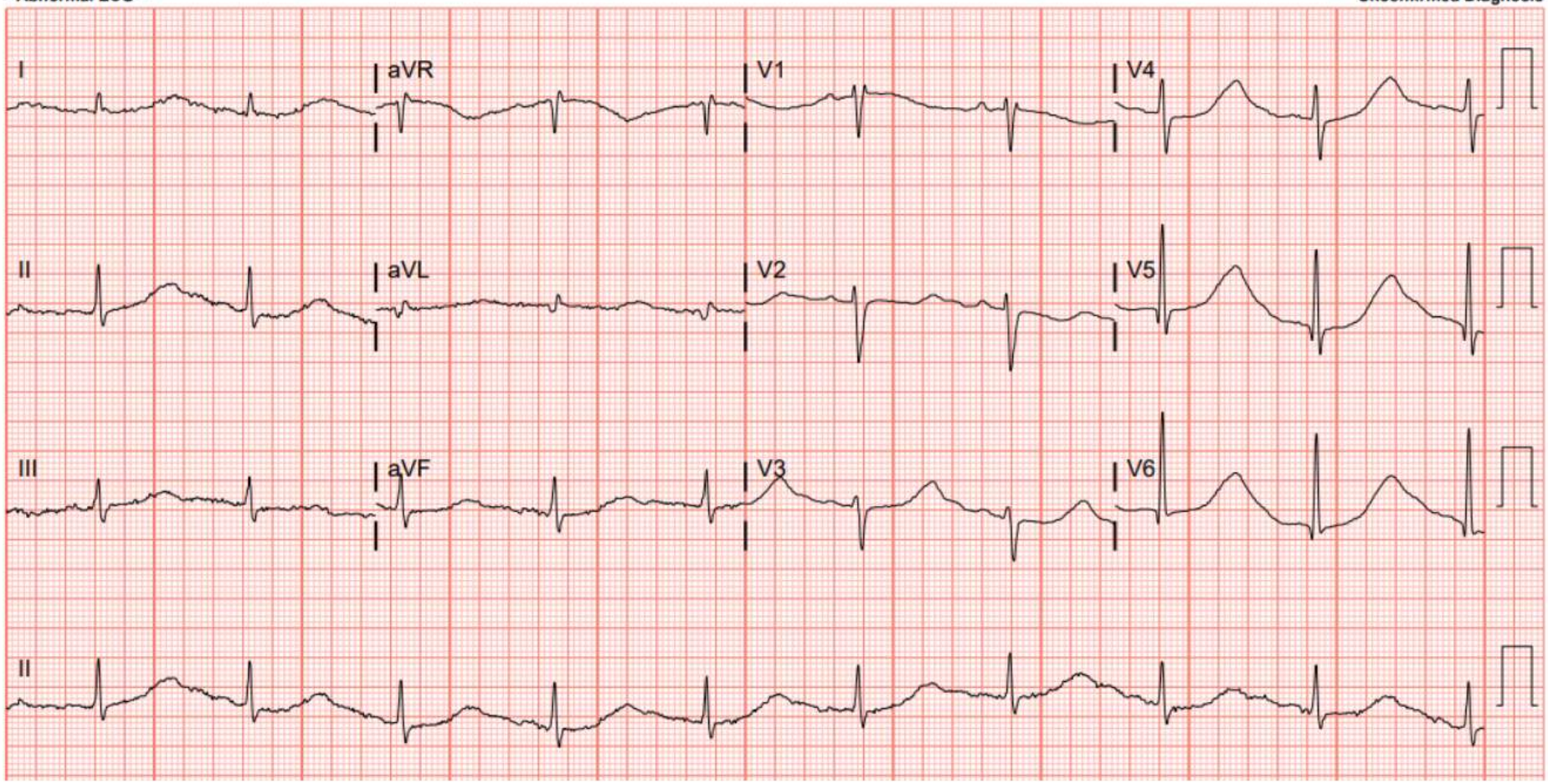
Rate	58
PR	185
QRSd	126
QT	668
QTc	657
--Axis--	
P	107
QRS	61
T	45

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

Req Provider: Rafael Santiago-Aponte

- Abnormal ECG -

Unconfirmed Diagnosis

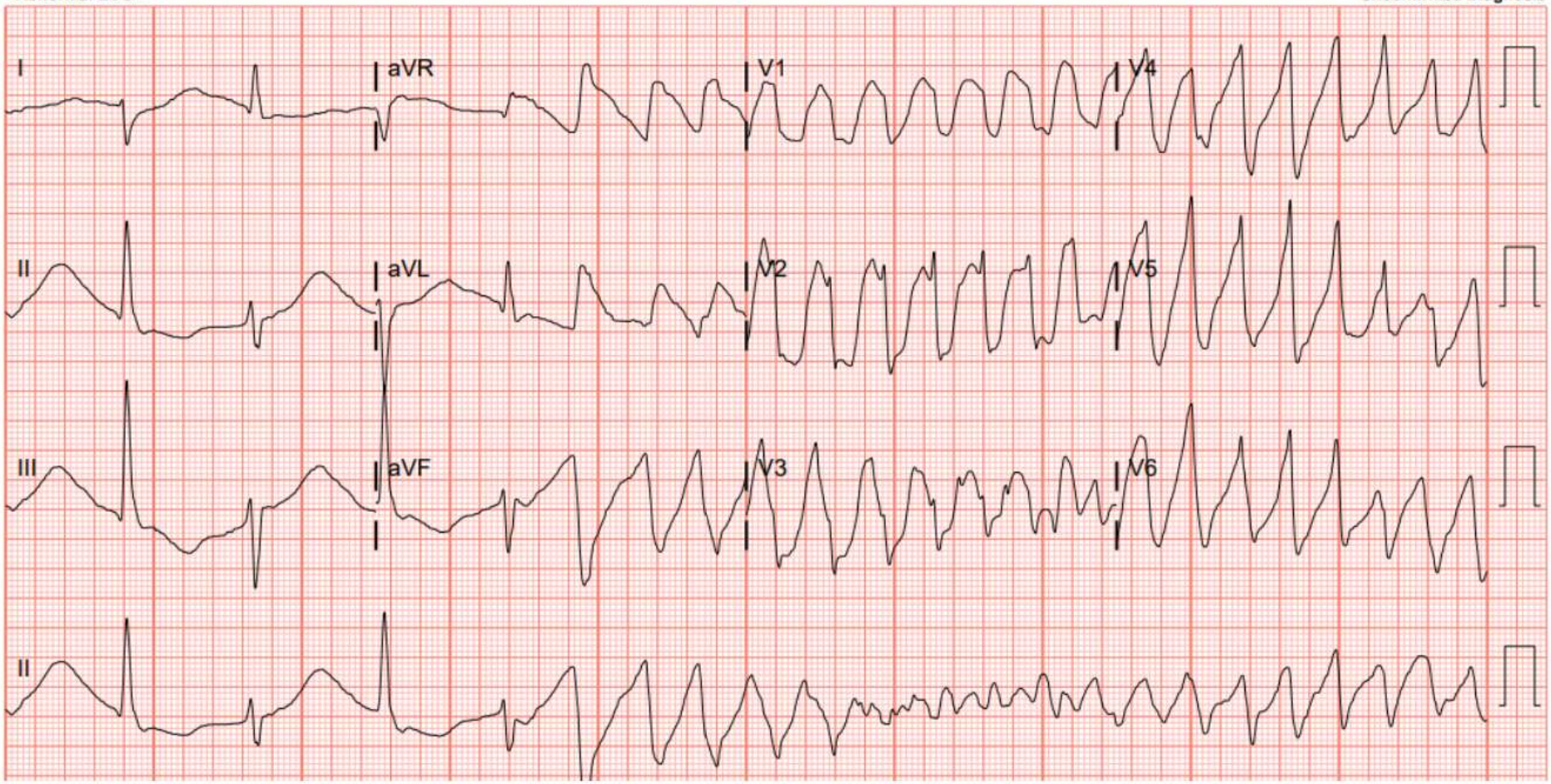


Rate	156	Atrial fibrillation
PR		Ventricular tachycardia, unsustained
QRSd	138	RBBB and LPFB
QT	456	Repol abnrm suggests ischemia, diffuse leads
QTc	735	Baseline wander in lead(s) II,III,aVR,aVF,V1,V2,V3,V4
--Axis--		COMPARED TO ECG 07/22/2020 15:32:52
P		ATRIAL FIBRILLATION NOW PRESENT
QRS	102	VENTRICULAR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

Req Provider: Rafael Santiago-Aponte

- Abnormal ECG -

Unconfirmed Diagnosis



Prolonged QT Interval

- Congenital (14 subtypes)

CONGENITAL LONG QT SYNDROMES:

ECG PATTERNS of 3 MOST COMMON VARIATIONS:

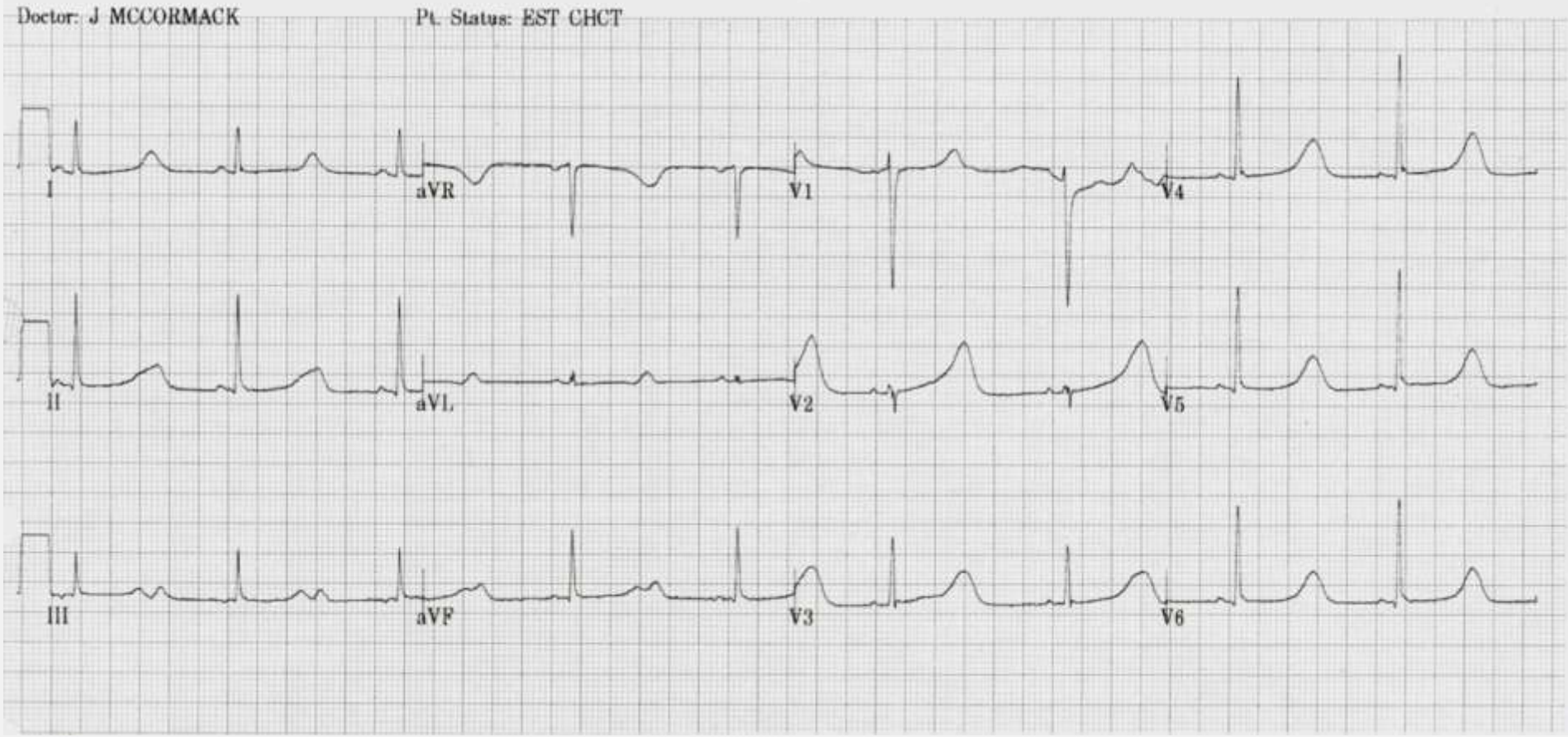
Type	Current	Functional Effect	Frequency Among LQTS	ECG[12,13]	Triggers Lethal Cardiac Event[10]	Penetrance*
LQTS1	K	↓	30%-35%		Exercise (68%) Emotional Stress (14%) Sleep, Repose (9%) Others (19%)	62%
LQTS2	K	↓	25%-30%		Exercise (29%) Emotional Stress (49%) Sleep, Repose (22%)	75%
LQTS3	Na	↑	5%-10%		Exercise (4%) Emotional Stress (12%) Sleep, Repose (64%) Others (20%)	90%

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

Chief Complaint: "Grand-Mal Seizures"
…. *With NO postictal phase!*

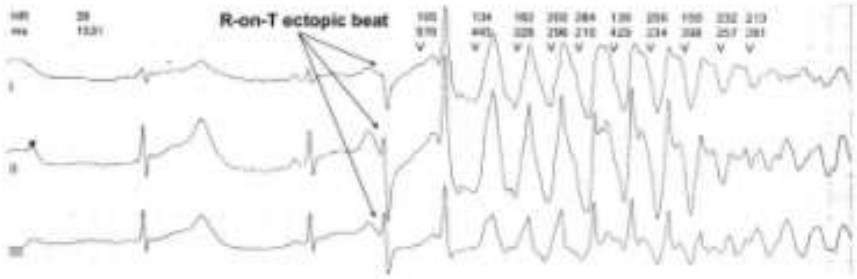


WHEN THE "QUICK PEEK" METHOD for QT INTERAL EVALUATION IS APPLIED TO THE ABOVE ECG, WHAT IS THE RESULT?

Long QT Syndromes and Torsade de Pointes

Gan-Xin Yan

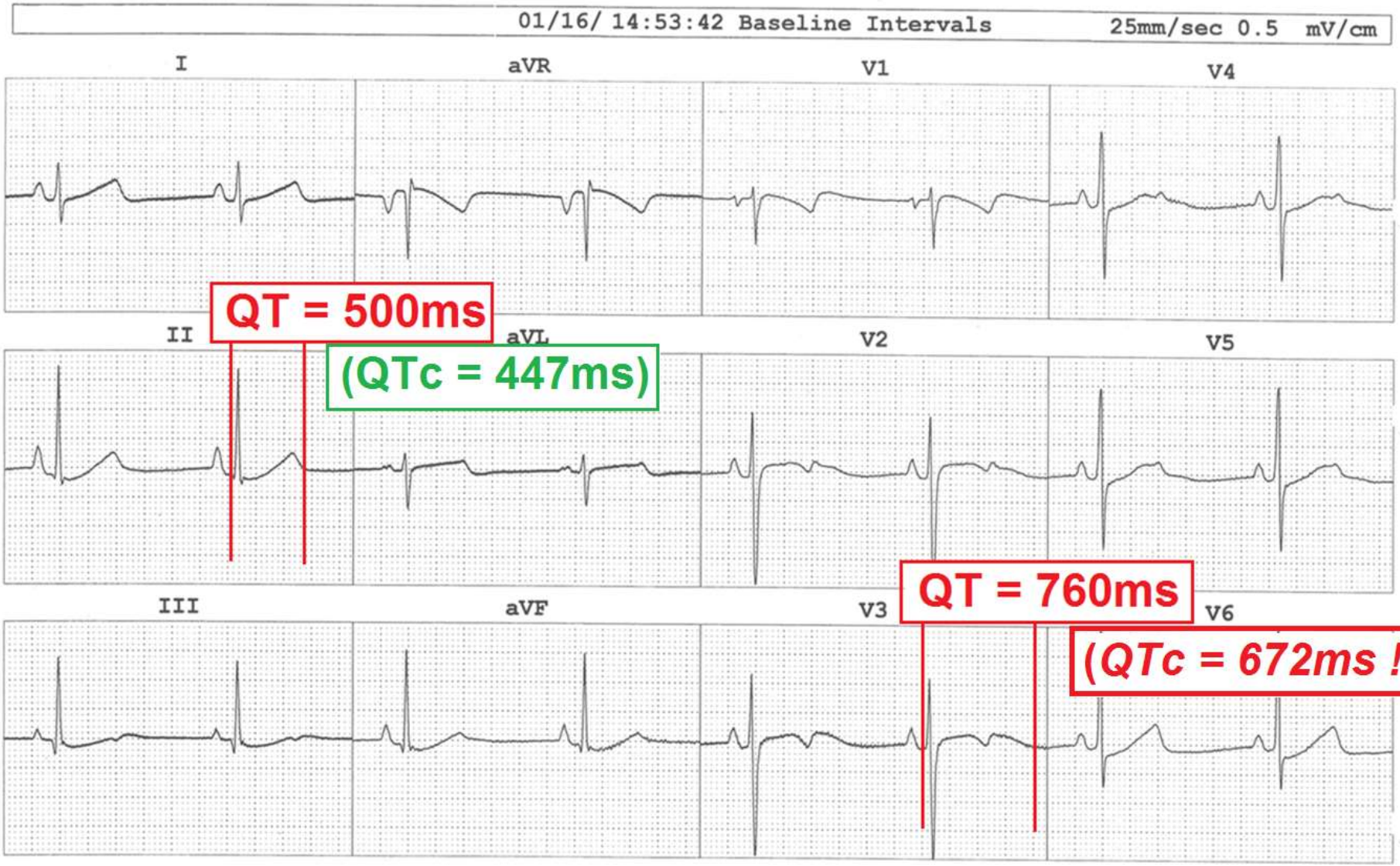
I. Long QT syndrome: What every physician needs to know.



Long QT syndrome (LQTS) is an inherited disorder of delayed ventricular repolarization characterized by a prolonged QT interval on electrocardiography (ECG) and a propensity to torsades de pointes (TdP). TdP by definition is: (1) a polymorphic ventricular tachycardia that occurs specifically under conditions of QT prolongation; and (2) it is almost always initiated by R-on-T ectopic beats. Clinical manifestations of TdP include syncope (fainting), seizure (epilepsy), or sudden cardiac death. As shown in Figure 1, an episode of sustained TdP was recorded in a patient aged 13 years with LQTS type 2. The episode during which the boy had "seizures" was triggered by the alarm clock in the early morning.

Figure 1:

Torsade de pointes in a long QT syndrome type 2 patient.



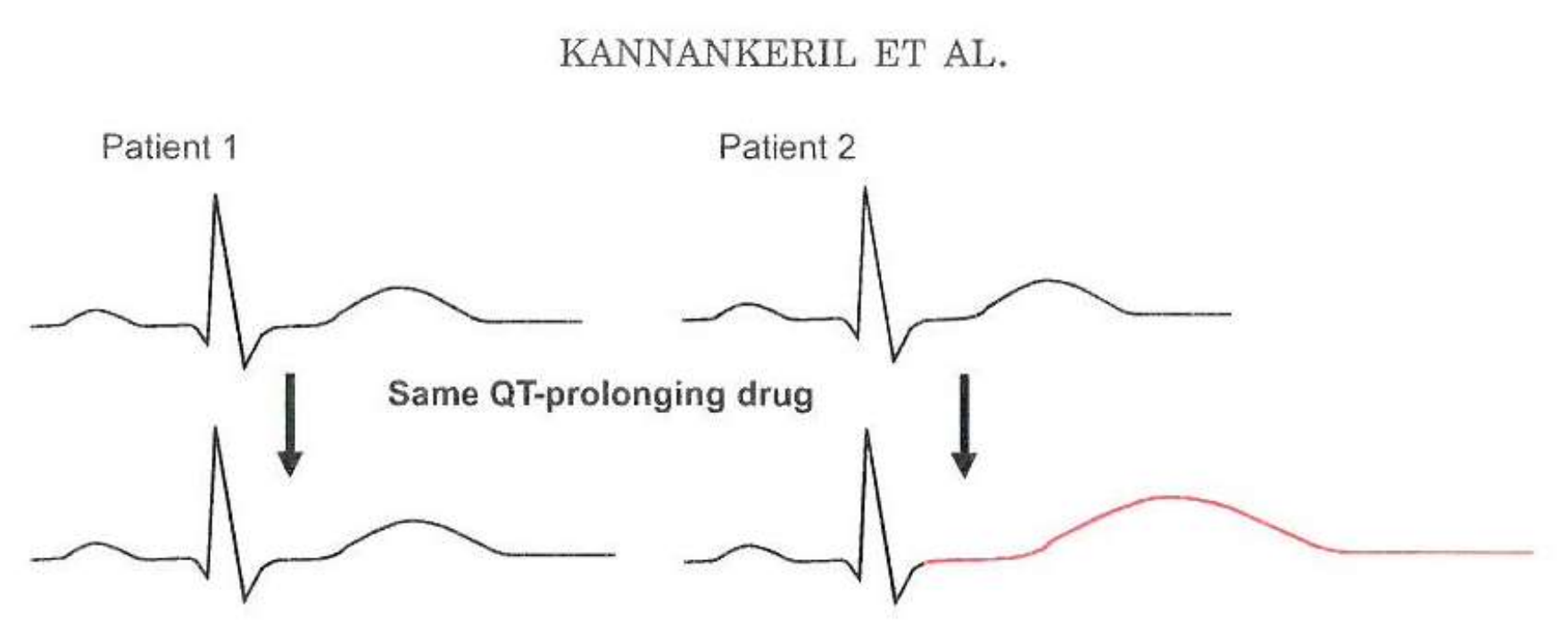
This ECG illustrates the degree of variation that can be noted between different leads on the 12 Lead ECG. ALWAY measure the QT Interval in the lead with the GREATEST value.

Prolonged QT Interval

- Congenital
- Acquired
  - **MEDICATION INDUCED** – MAJOR CAUSE of IN-HOSPITAL MORTALITY
  - Electrolyte Imbalances (hypomagnesemia, hypokalemia, hypercalcemia)
  - Increased intracranial pressure
  - HYPOTHERMIA (accidental and Induced TTM)

PATIENT 1: NORMAL

PATIENT 2: Genetic susceptibility; sensitivity to QT prolonging drugs:



Click here for link to paper by Kannankeril et al (2010 Pharmacological Reviews) that describes genetic susceptibility described above.

QT Prolongation -- *STAT Intervention:*

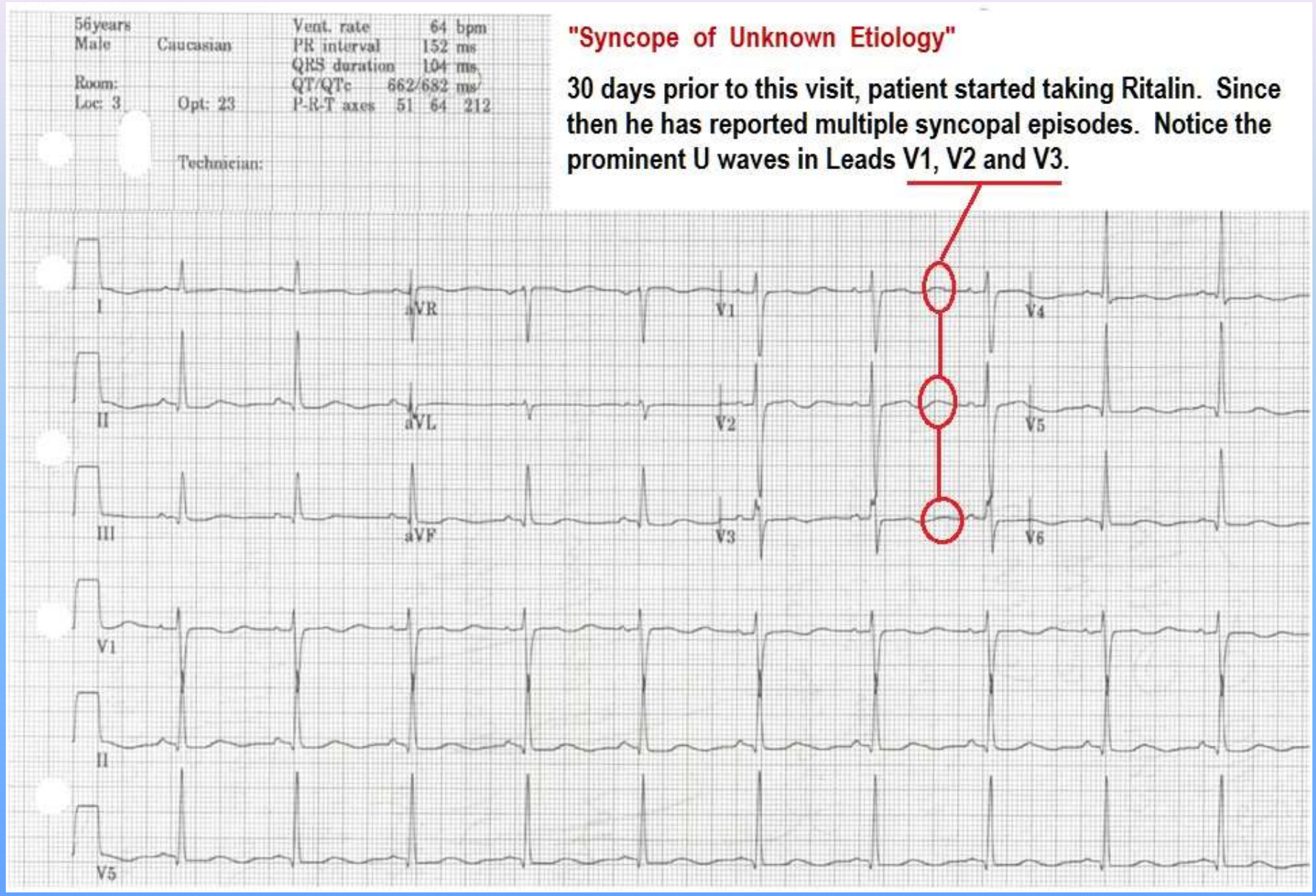
☞ ***Avoidance of Meds that are known to prolong the QT Interval. Click here to search medications at CREDIBLEMEDS.ORG***

Commonly used QT prolonging meds include:

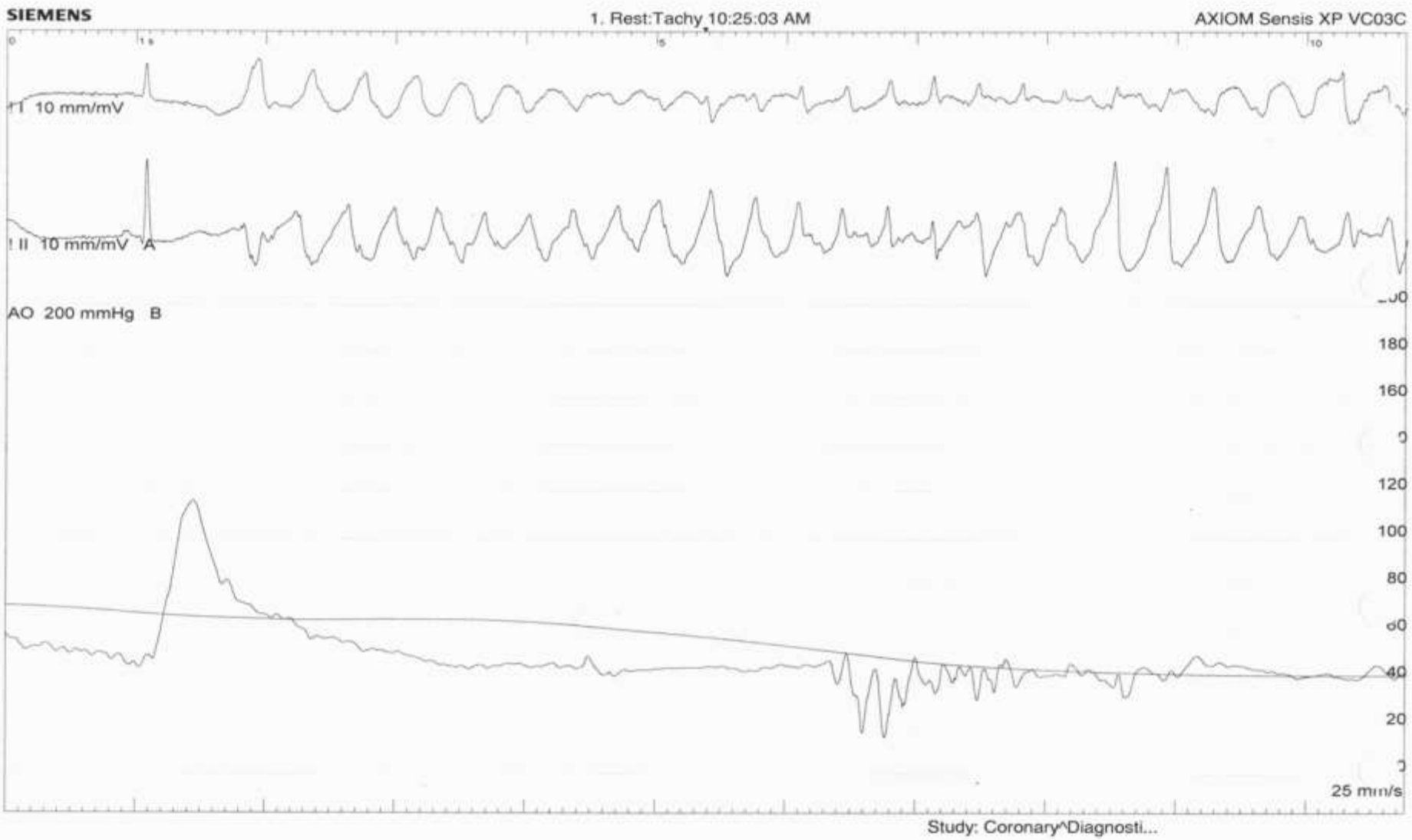
-Amiodarone
-Procainamide
-Levaquin
-Erythromycin
-Norpace
-Tequin
-Benadryl
-Ritalin
-Pseudophedrine
-Haloperidol
-Thorazine
-Propulcid
-Zofran
-Ilbutilide

and MANY more!

Medication induced LQTS with TdP and Cardiac Arrest - Case Study: 56 year old male

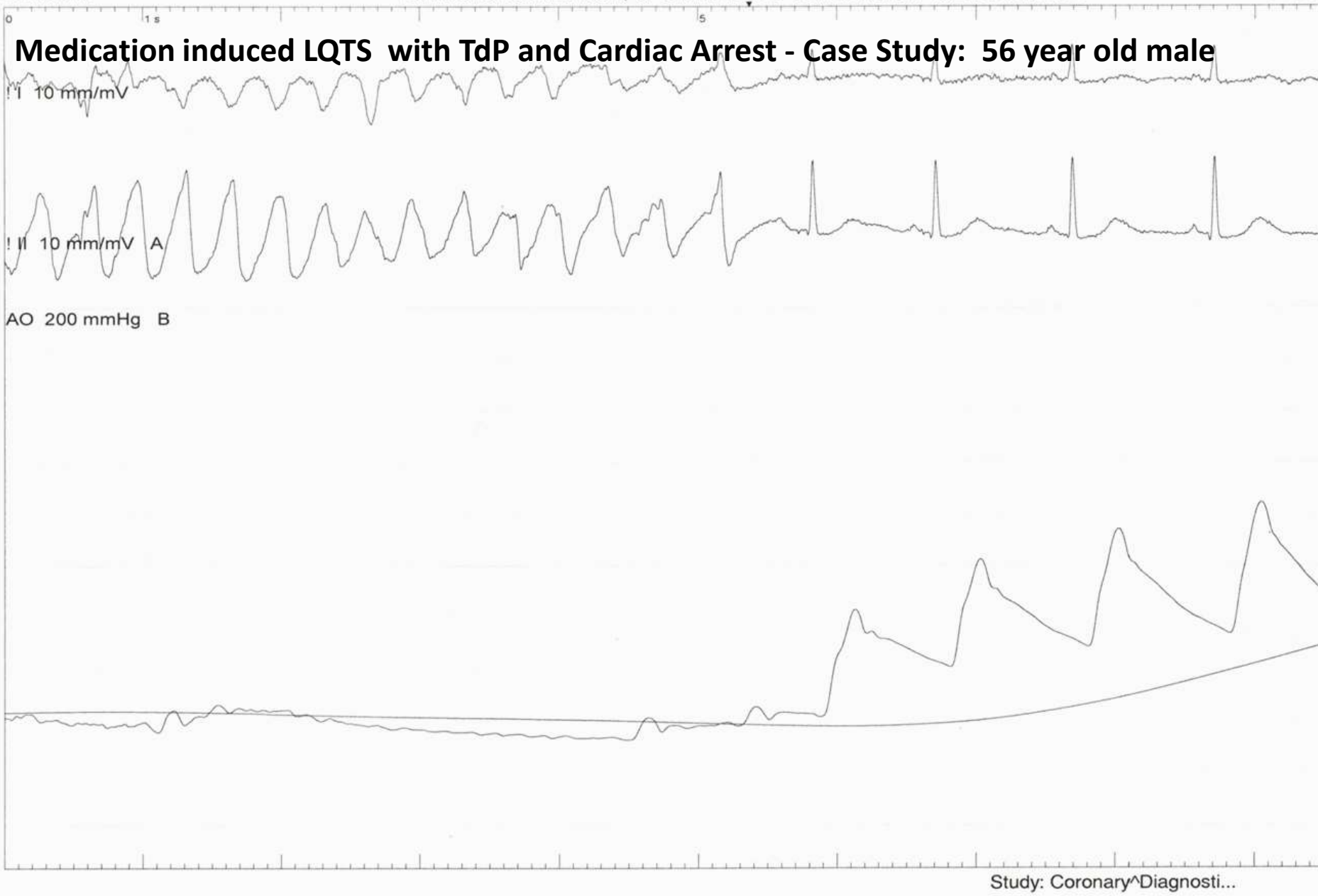


Medication induced LQTS with TdP and Cardiac Arrest - Case Study: 56 year old male



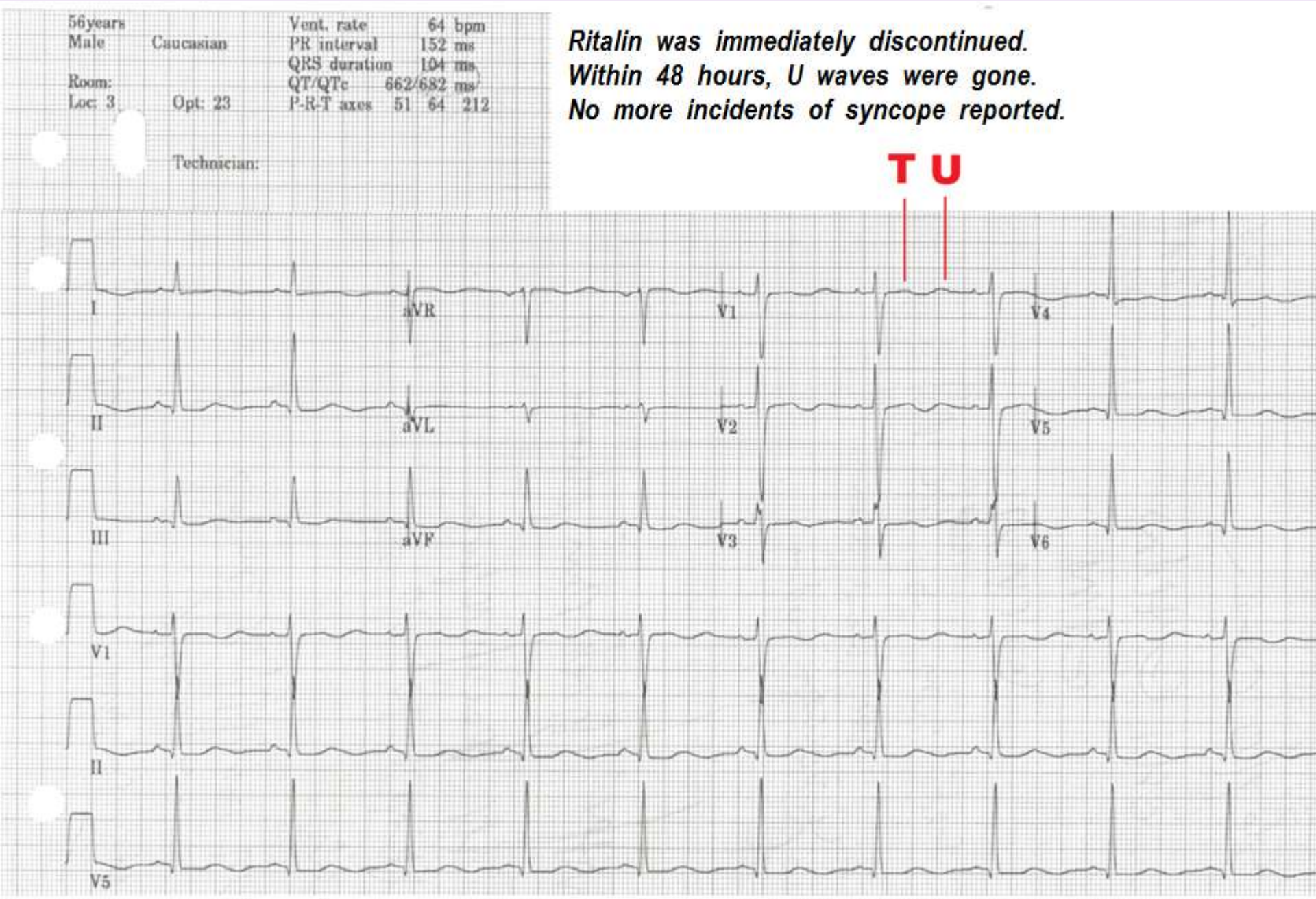
Run of Torsades de Pointes occurred during Cardiac Catheterization . . .

Medication induced LQTS with TdP and Cardiac Arrest - Case Study: 56 year old male



Torsades de Pointes self-terminates just before aborted Defibrillation

Medication induced LQTS with TdP and Cardiac Arrest - Case Study: 56 year old male



www.crediblemeds.org

- Smartphone Apps
- List of clinical factors associated with prolonged QTc and/or Torsades de Pointes (TdP)

Other QT issues

- A-fib: challenging to calculate QTc due to varying R-R intervals. The next slide show the forumulas for a more accurate calculation . . .

From: **What Clinicians Should Know About the QT Interval**
JAMA. 2003;289(16):2120-2127. doi:10.1001/jama.289.16.2120

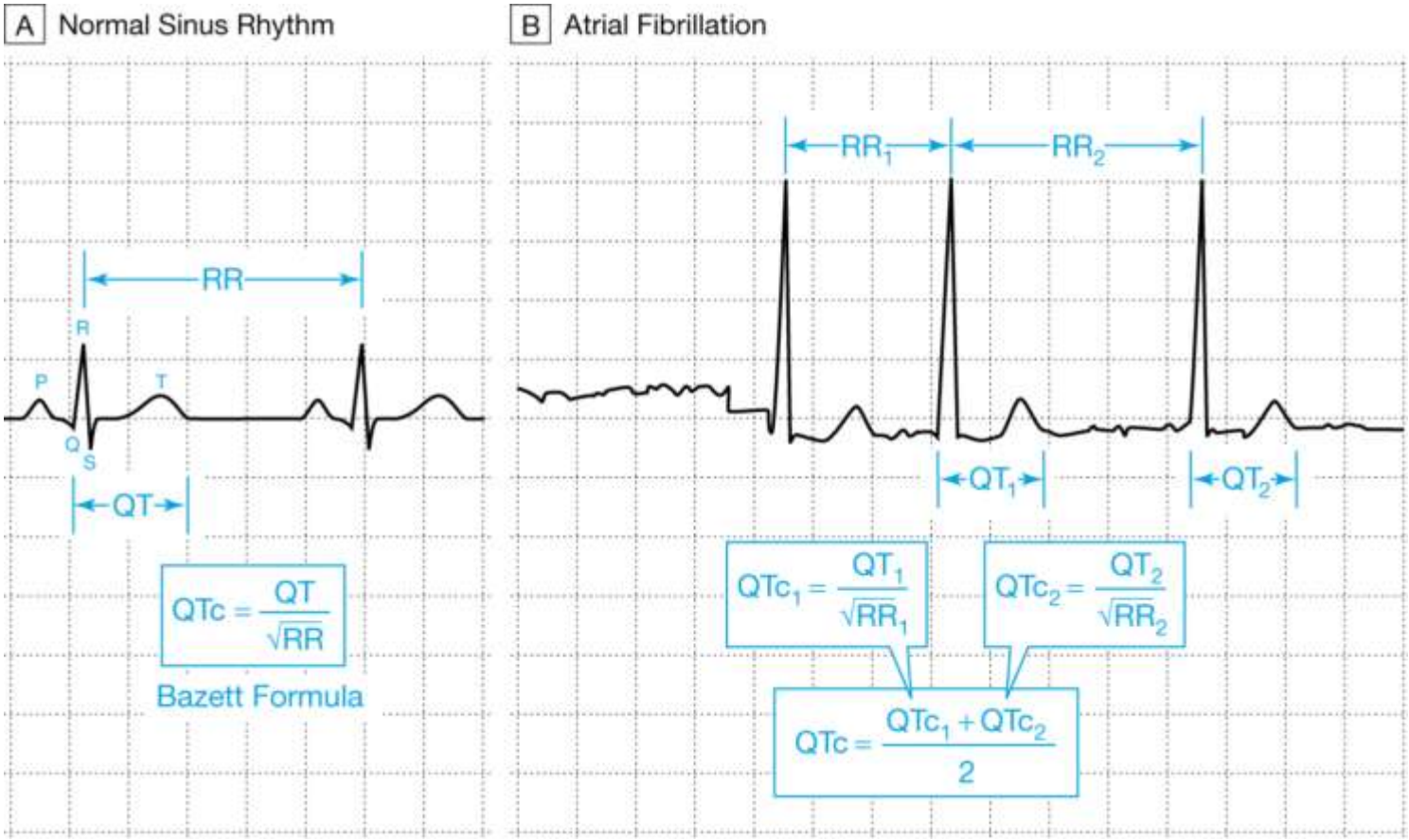


Figure Legend:

QTc indicates corrected QT interval; RR, R-R interval. A, Normalsinus rhythm; the Bazett formula is used to correct the QT interval for theheart rate. B, Atrial fibrillation; QT interval is calculated by taking theaverage of QT intervals with shortest and longest preceding R-R intervals.

Other QT issues

- A-fib: challenging to calculate QTc due to varying R-R intervals.
- Wide QRS (QRSd >120ms): The delay in depolarization (widening of QRS) will also delay repolarization. Therefore a QT interval that appears “elongated” may be due to nothing more than a Bundle Branch Block.

[Determining QT Interval when Bundle Branch Block is Present: Science Direct (Elsevier October, 2020) click here to download article]

FIRST DESCRIBED FORMULA FOR LBBB: $QT_m = QT_{LBBB} - 48.5\% * QRS_{LBBB}$

SIMPLIFIED FORMULA FOR BBB: $QT_m = QT_{BBB} - 50\% * QRS_{BBB}$

QT_m = estimated QT interval after application of the Formula

QT_{LBBB} = measured QT interval in presence of LBBB

QRS_{LBBB} = measured QRS interval in presence of LBBB

QT_{BBB} = measured QT interval in presence of any BBB

QRS_{BBB} = measured QRS interval in presence of any BBB

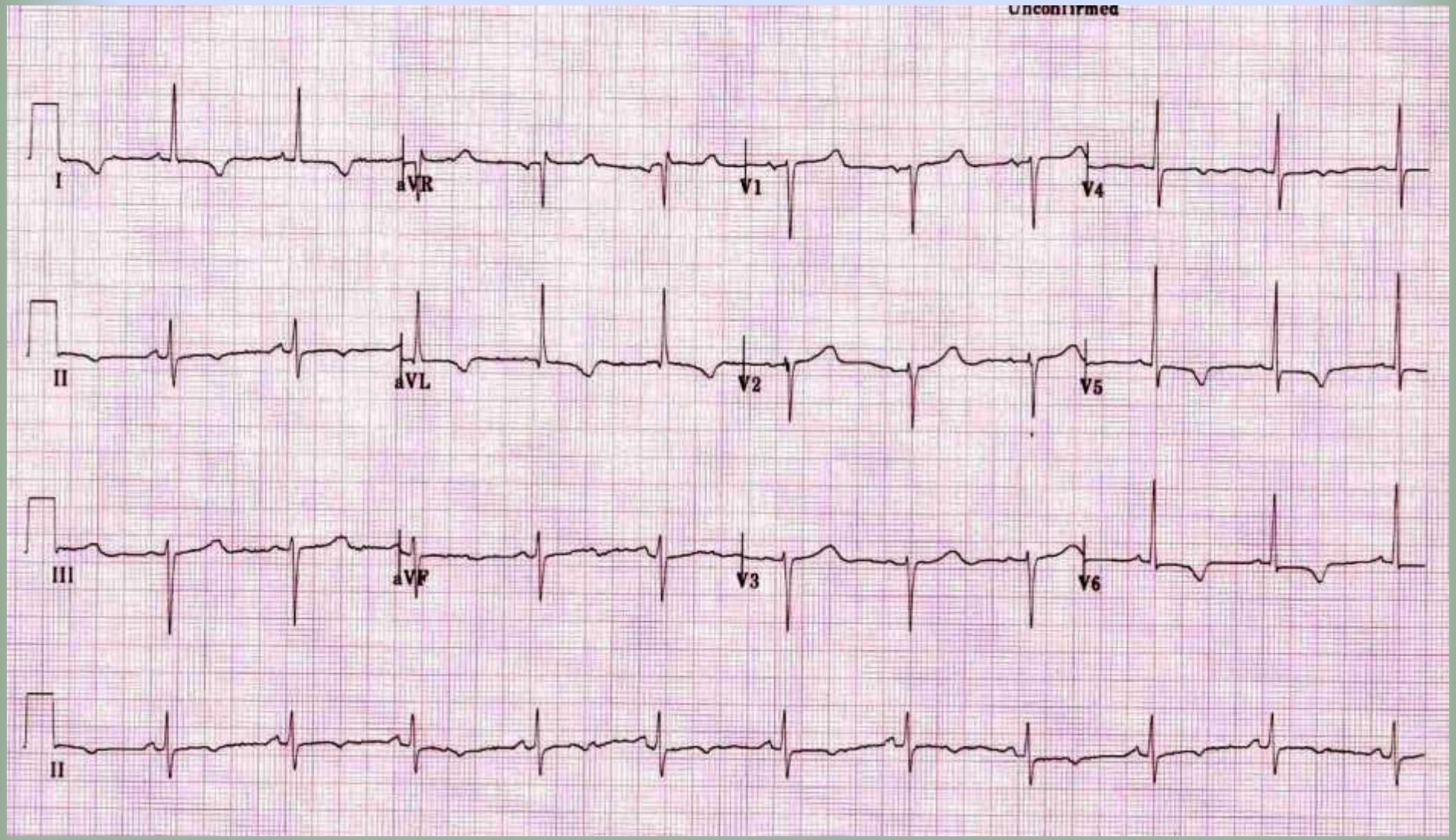
The Patient Arrives . . .

- Standard Tele / ECG hookup:
  - LEAD II
  - LEAD V2
- Evaluate patient: any symptoms of ACS ?
- Review 12 Lead ECG. Look for:
  - Signs of ischemia
  - QT prolongation
- REPOSITION ECG Leads (if indicated)

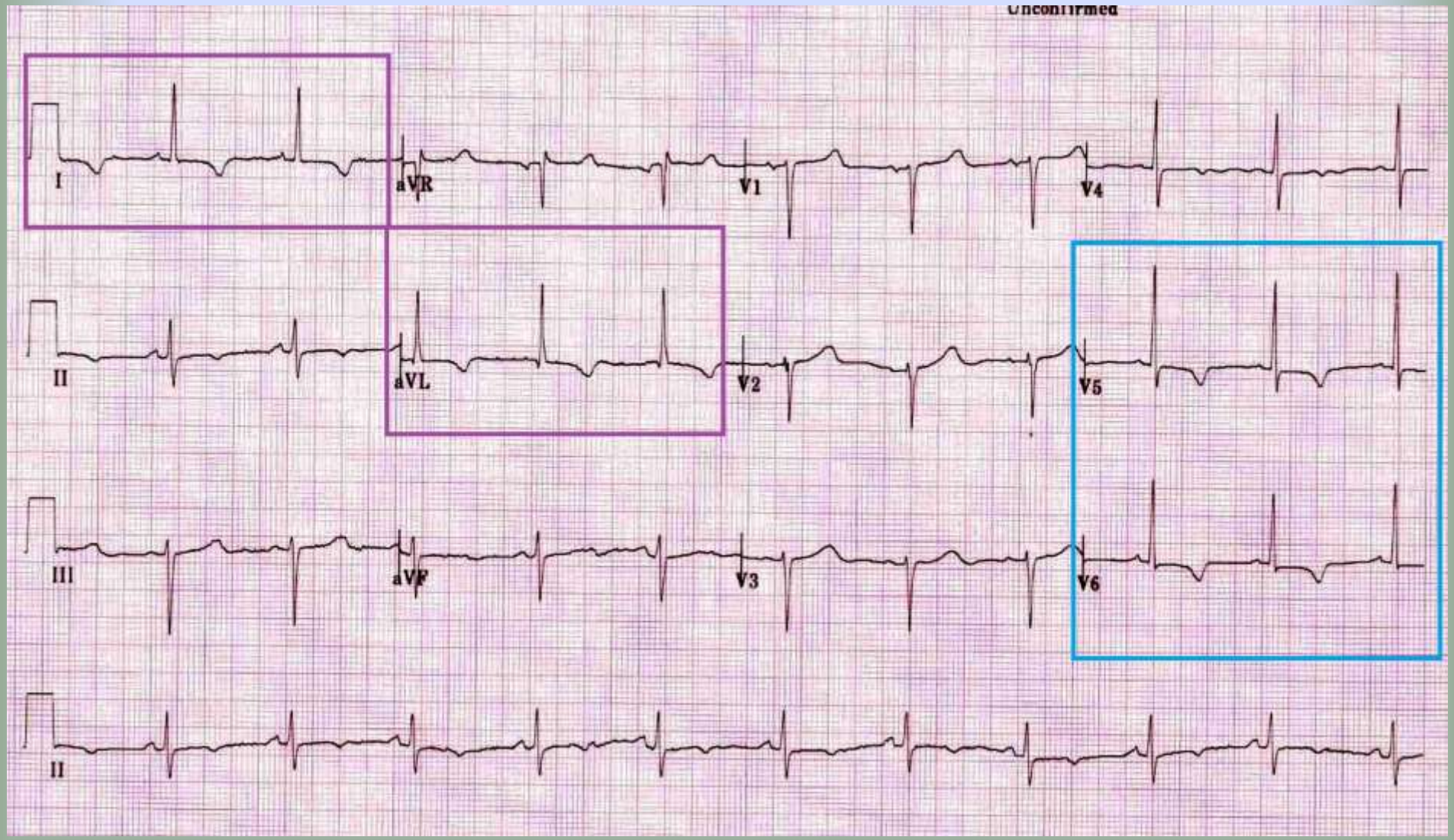
Tele Lead Selection: ABNORMAL 12 Lead ECG (ischemia)

- Review patient's 12 Lead EKG
- Select Lead displaying "worst" signs of ischemia (ST segment, T wave abnormalities) to be the lead used for continuous monitoring
- Set the "automated ST Segment Alarm" for this lead.

What leads show signs of possible ACS?

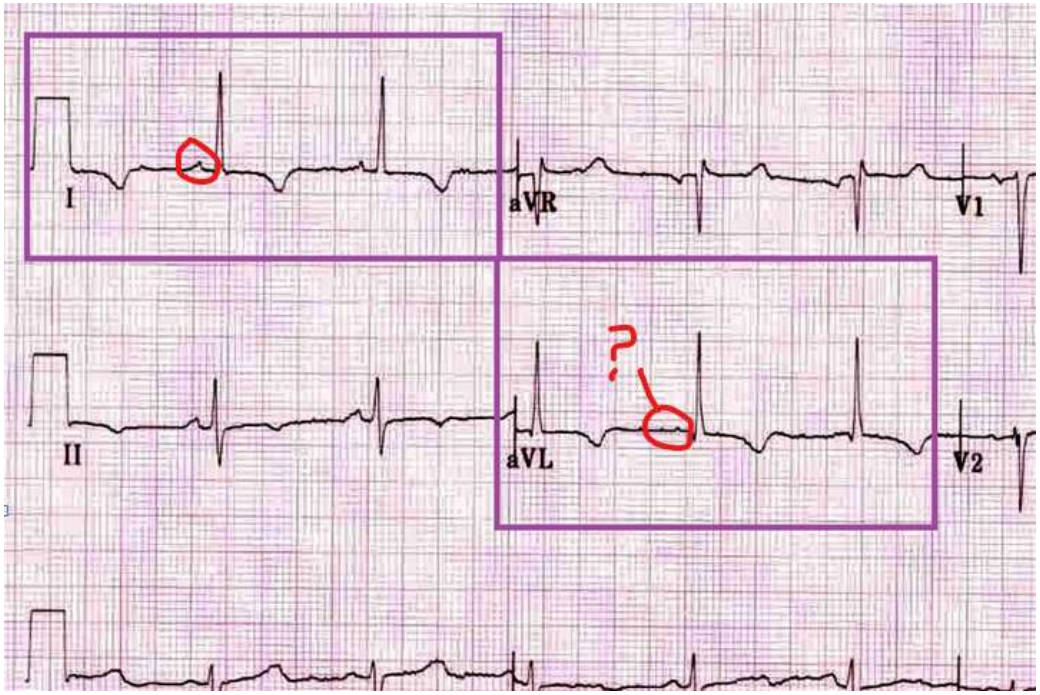


12 Lead ECG
shows ISCHEMIC CHANGES Lateral Wall:



Lead Selection: 12 Lead ABNORMAL

- Limb Lead I →



- V2 (if QTc is 500 or more and/or patient receiving QT prolonging medication)
- V5 (if QTc <500ms and patient is NOT receiving QT prolonging meds).

What's the rationale behind monitoring the ECG lead viewing the region of known/suspected ischemia?

The “common sense” rationale:

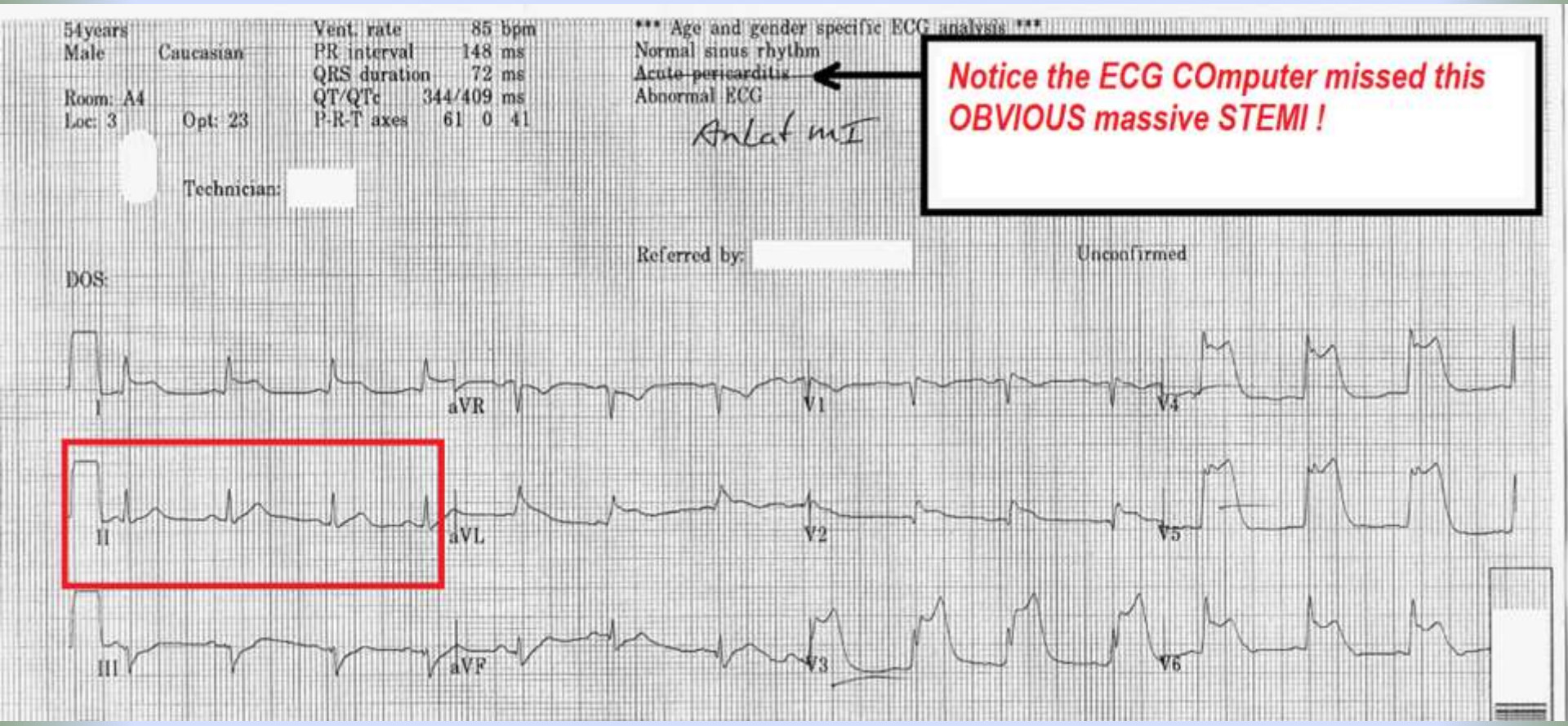
If your friend says, “pick me up in front of my house in 15 minutes.”

. . . You wouldn’t drive around to the back of the house and watch for your friend at the back door.

If you were only monitoring Lead II on this patient with *suspected Anterior Wall ischemia . . . . .*

.

YOU WOULD MISS THIS:



AND you may have noted the subtle ECG changes LONG BEFORE the patient's MI evolved into this massive ANTERIOR LATERAL STEMI.

CONTINUOUS MONITORING

- ST Segments
- QT Intervals

Critical Baseline Settings:

- **Heart Rate** (upper / lower)
  - Keeps you informed of patient condition changes
  - Aids you in medication rate management (IV infusions, e.g.: Cardizem)
- **ST-Segment** (ACS)
- **QT Interval** (all patients, patients receiving QT prolonging medications)

Clinical Alarm Management Resources

- American Journal of Critical Care – Monitoring Clinical Alarms.

- To download a sample CLINICAL ALARMS MONITORING POLICY and a CLINCIAL ALARMS PARAMETERS example, CLICK HERE. This will take you to my "PDF Downloads" page on my website.

Sample ECG Alerts:

"**ECG Alert Values**:" When any of the following ECG disturbances are noted, a nurse should immediately assess the patient for hemodynamic compromise and determine need to activate Rapid Response. A STAT 12 Lead ECG should be obtained (unless Code Blue status), and the Physician should be notified.

a. Acute change in heart rate <40 or greater than >130
b. New QT Interval prolongation
c. 2nd or 3rd Degree Heart Block
d. Sinus Arrest with periods of Asystole ("Pause")
e. New Onset Atrial Fibrillation or Atrial Flutter
f. Premature Ventricular Contractions that are Multifocal, 2 or more coupled together, R on T, or greater than 6 per minute
g. Ventricular Tachycardia or Wide QRS Tachycardia of unknown origin
h. Torsades de Pointes*
i. Ventricular Fibrillation or Asystole
j. Pacemaker spikes without QRS (Failure to Capture)
k. Changes in QRS width (new onset Bundle Branch Block)
l. Changes to the J Point, ST Segment and/or T waves

Alarm Fatigue. It's REAL….

Excerpt from Circulation 2017:

ST-segment alarms (9647) remained high and needed further follow-up interventions.[47] In 5 ICUs in a single hospital during a period of 31 days, Drew et al[50] reported that 91% of the 6196 alarms for ST-segment changes were considered nonactionable. Unfortunately, until this unacceptable rate of false and nonactionable alarms can be addressed, we can no longer give a COR I recommendation because false and nonactionable alarm signals distract the nurse, bother the patient, and desensitize clinicians to respond to alarms.[47,49,50,55]

ST-segment monitoring software in its current state

If the ST-Segment alarm activates, what should you do ??

If the ST-Segment alarm activates, what should you do ??

- **Go assess the patient!**
  - **Are there any symptoms now present?**
  - **Changes in prior symptoms?**
- **Get a STAT 12 Lead ECG ! . . . *And***

If the ST-Segment alarm activates, what should you do ??

- **Go assess the patient!**
  - **Are there any symptoms now present?**
  - **Changes in prior symptoms?**
- **Get a STAT 12 Lead ECG !** ***. . . And***
- ***Compare it to the last ECG(s)!***

A ***CRITICAL INDICATOR***

of

worsening ischemia

and/or

EARLY INFARCTION

is

DYNAMIC CHANGES

to the patient's

J Points, ST-Segments and T Waves.

J ST T should never change

Dynamic ST-T wave changes . . .

Potential Issues ?

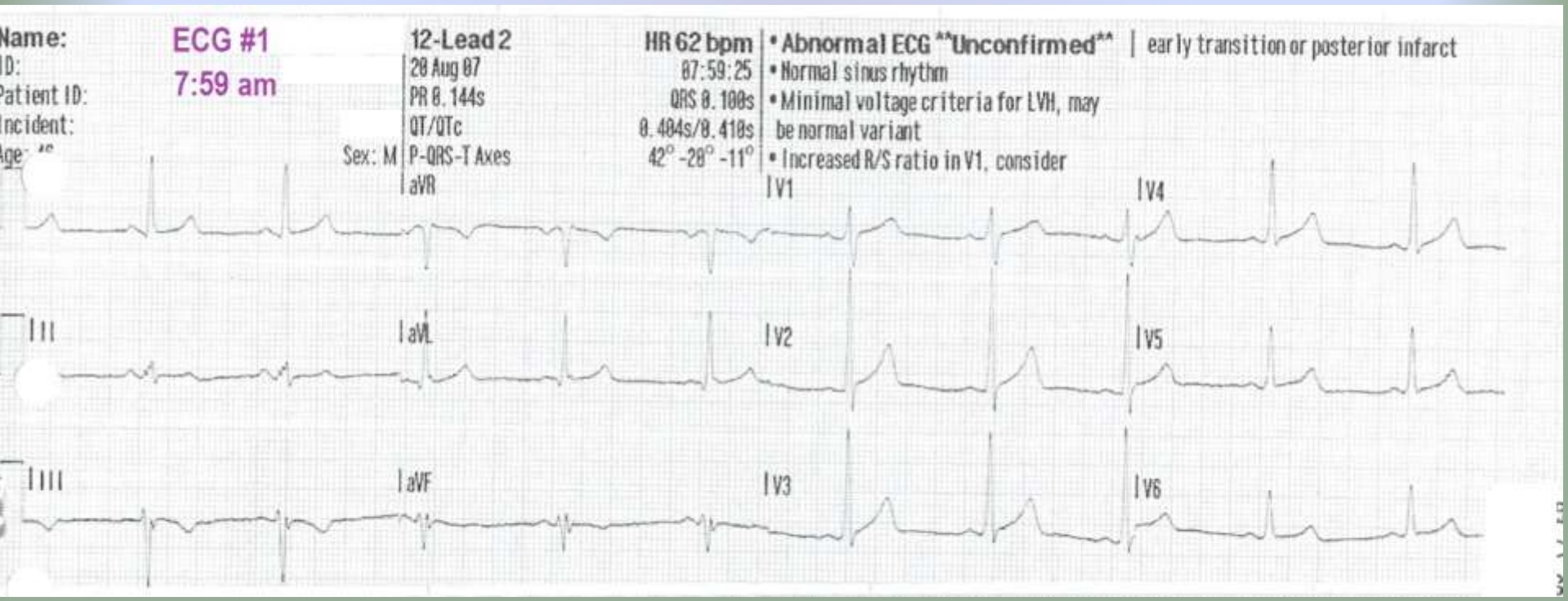
1. Progressive Inferior ischemia

2. NSTEMI

3. Reciprocal ST Changes from Anterior STEMI

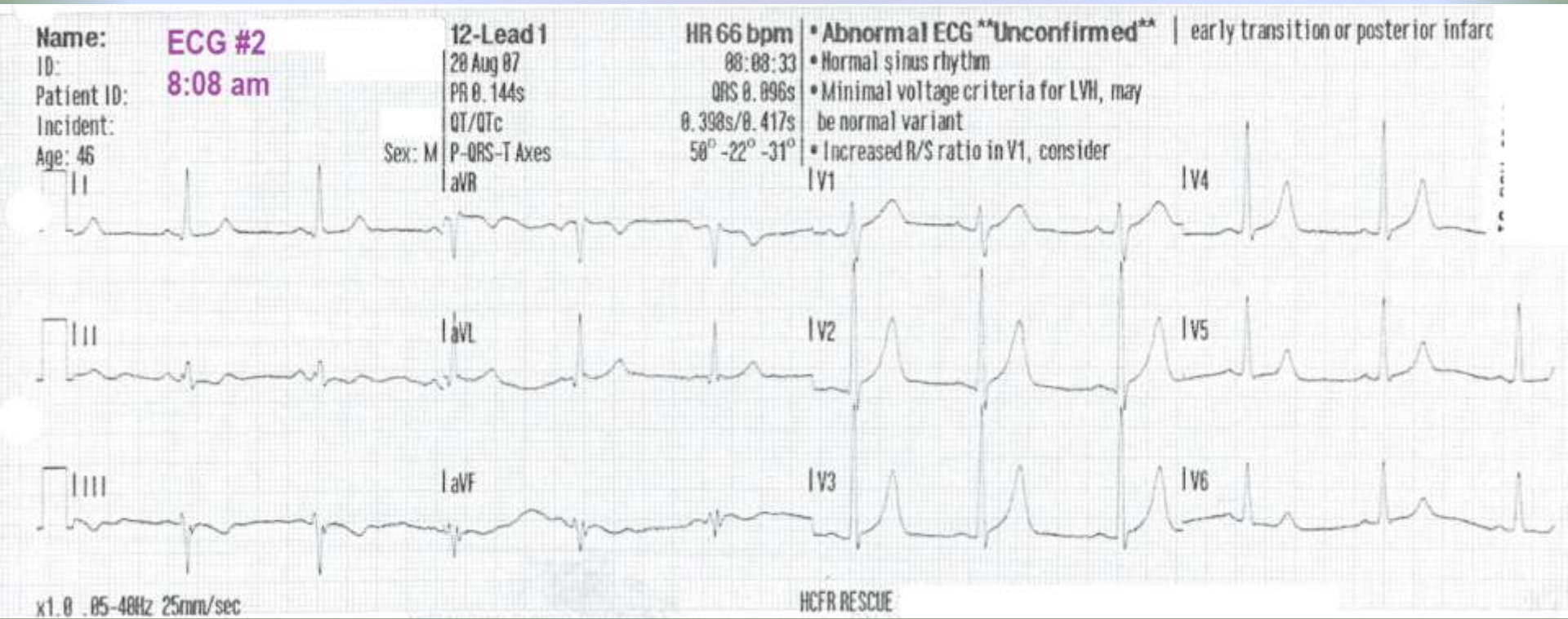
46 year old male

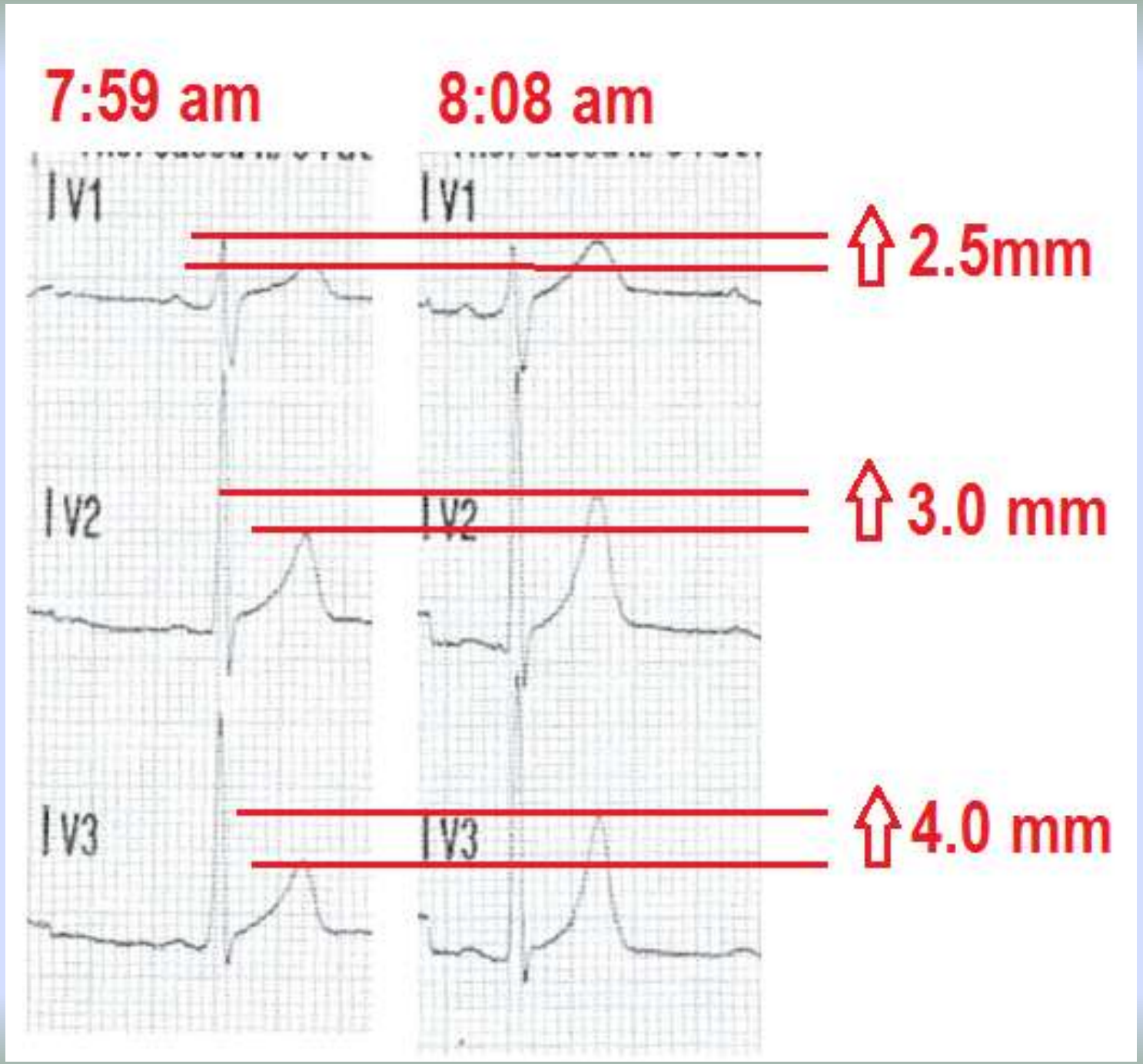
- Exertional dyspnea X “several weeks”
- Intermittent chest pressure X last 3 hours. Currently pain free.



46 year old male: ECG 1

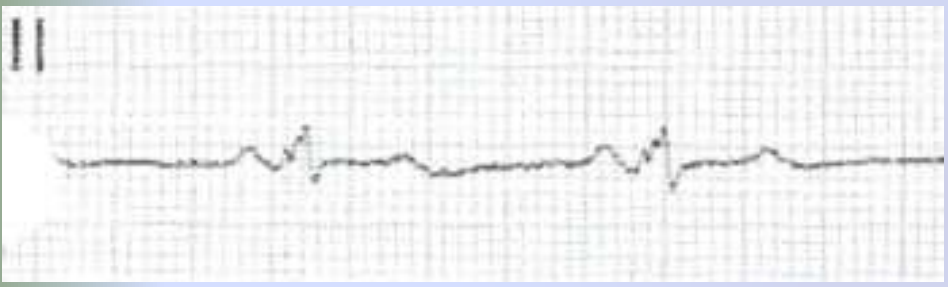
- Chest pressure has returned, “5” on 1-10 scale. 2nd ECG obtained due to “change in symptoms”:



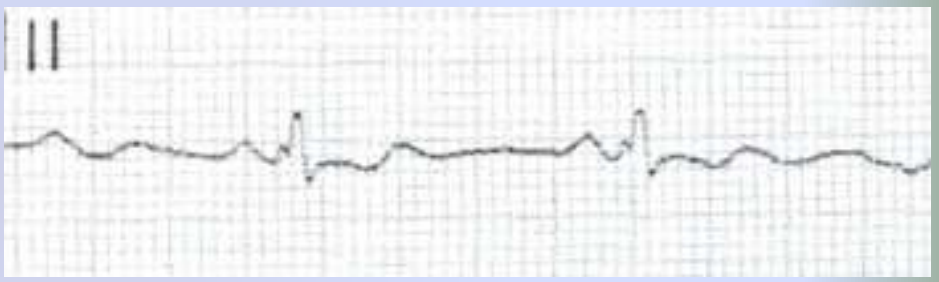

7:59 am
8:08 am
V1
V1
2.5mm
V2
V2
3.0 mm
V3
V3
4.0 mm

ST-Segment Depression

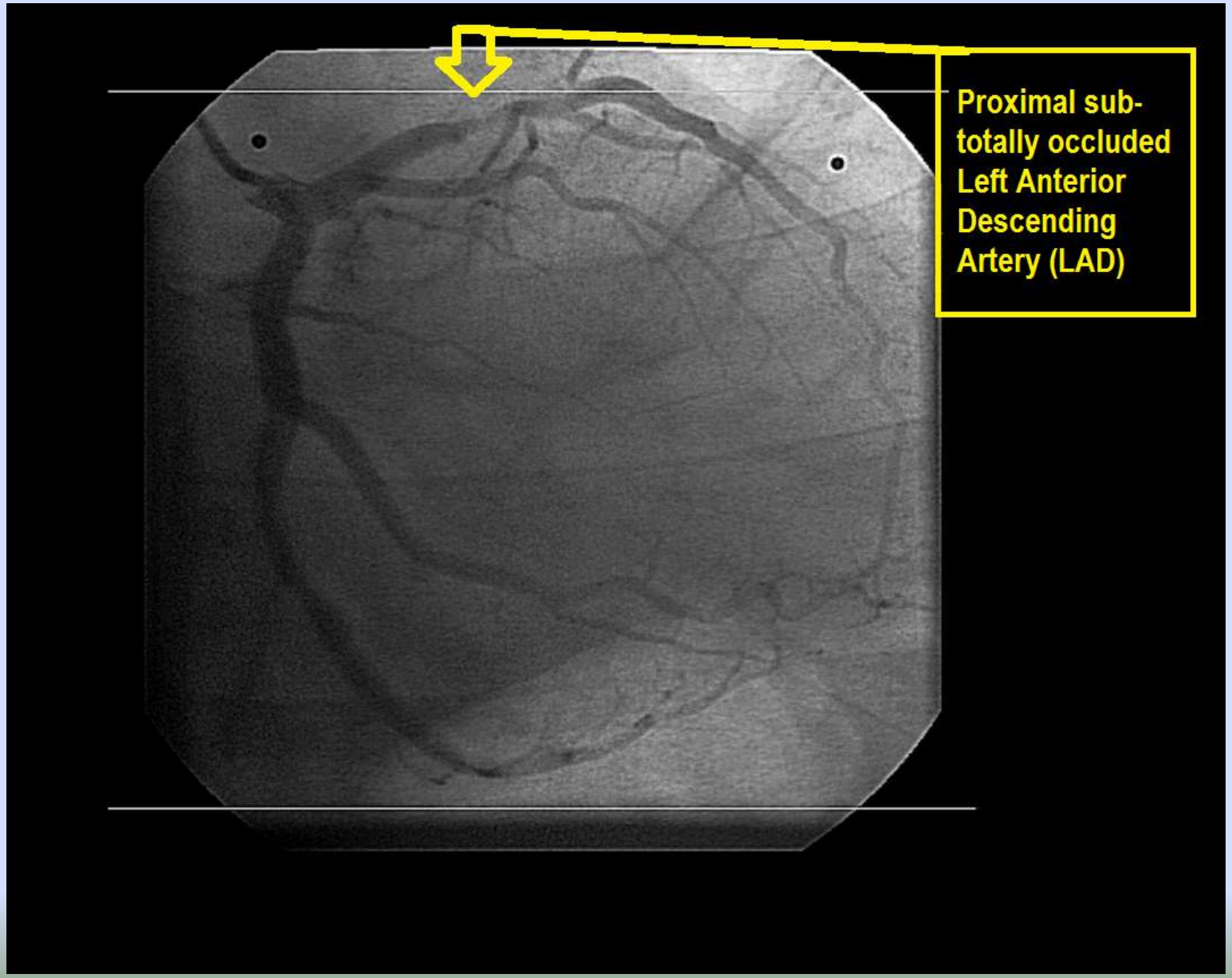
7:59 am



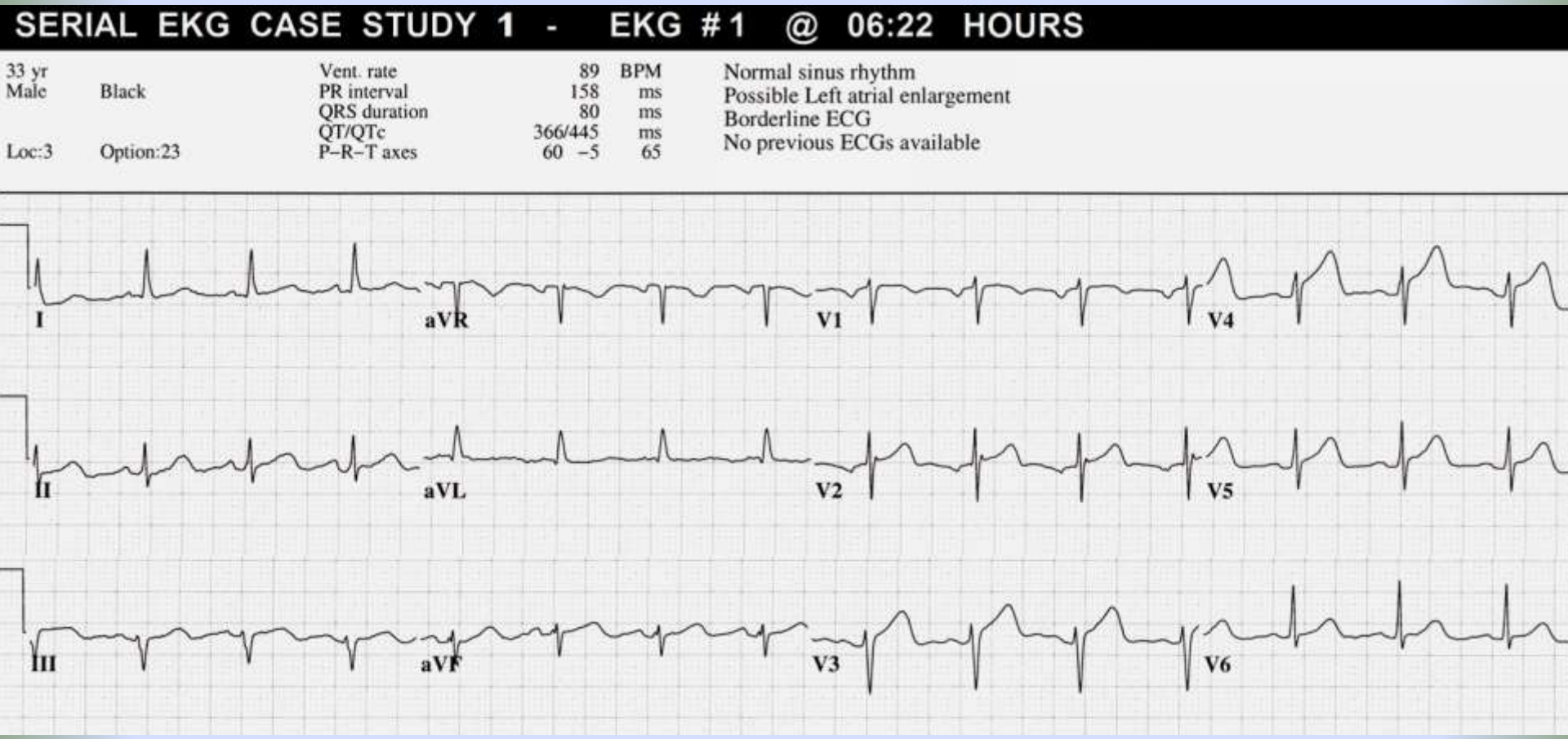
8:08 am



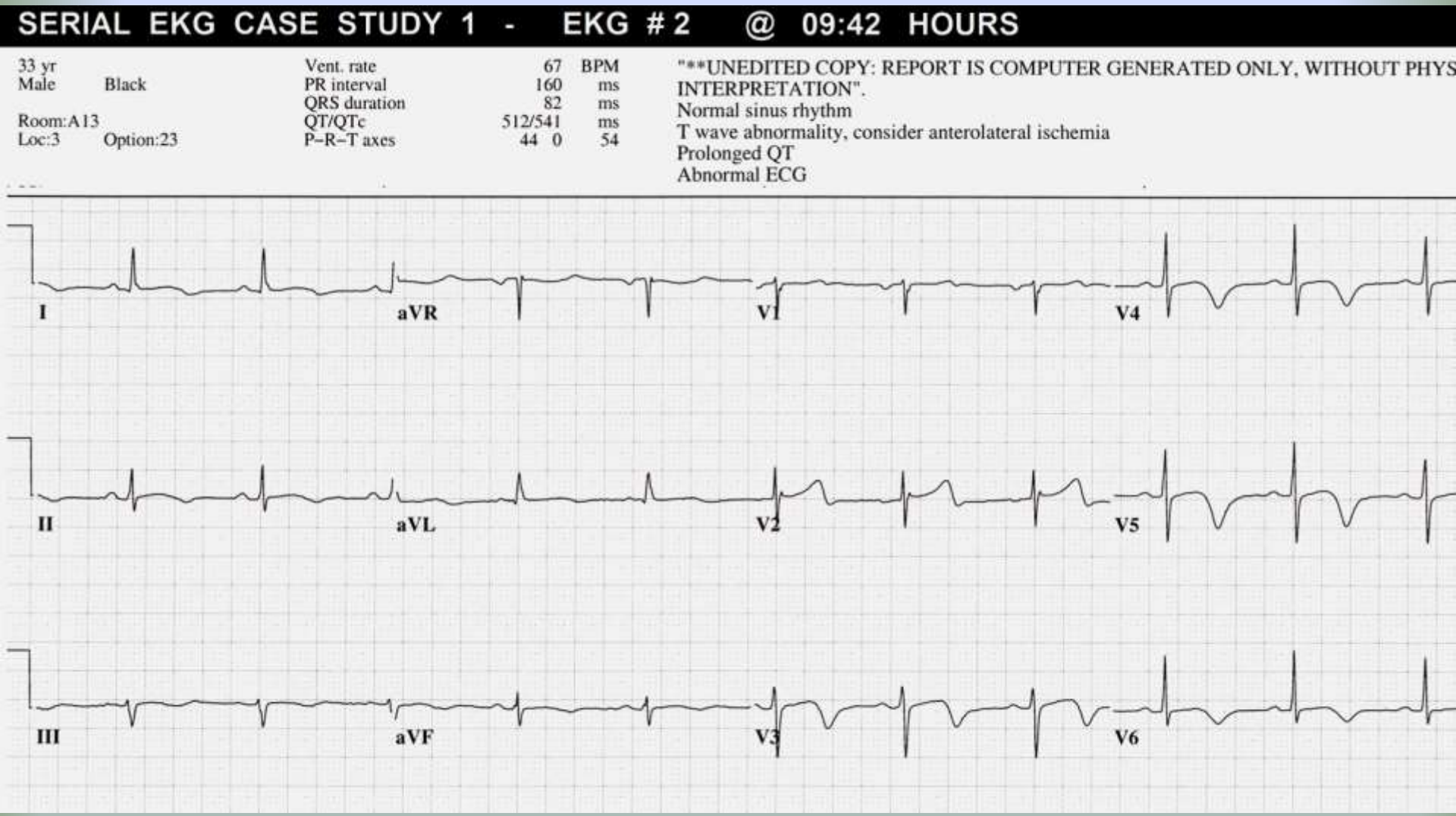
Cath Lab Angiography:



Dynamic ST-T Wave Changes



Dynamic ST-T Wave Changes

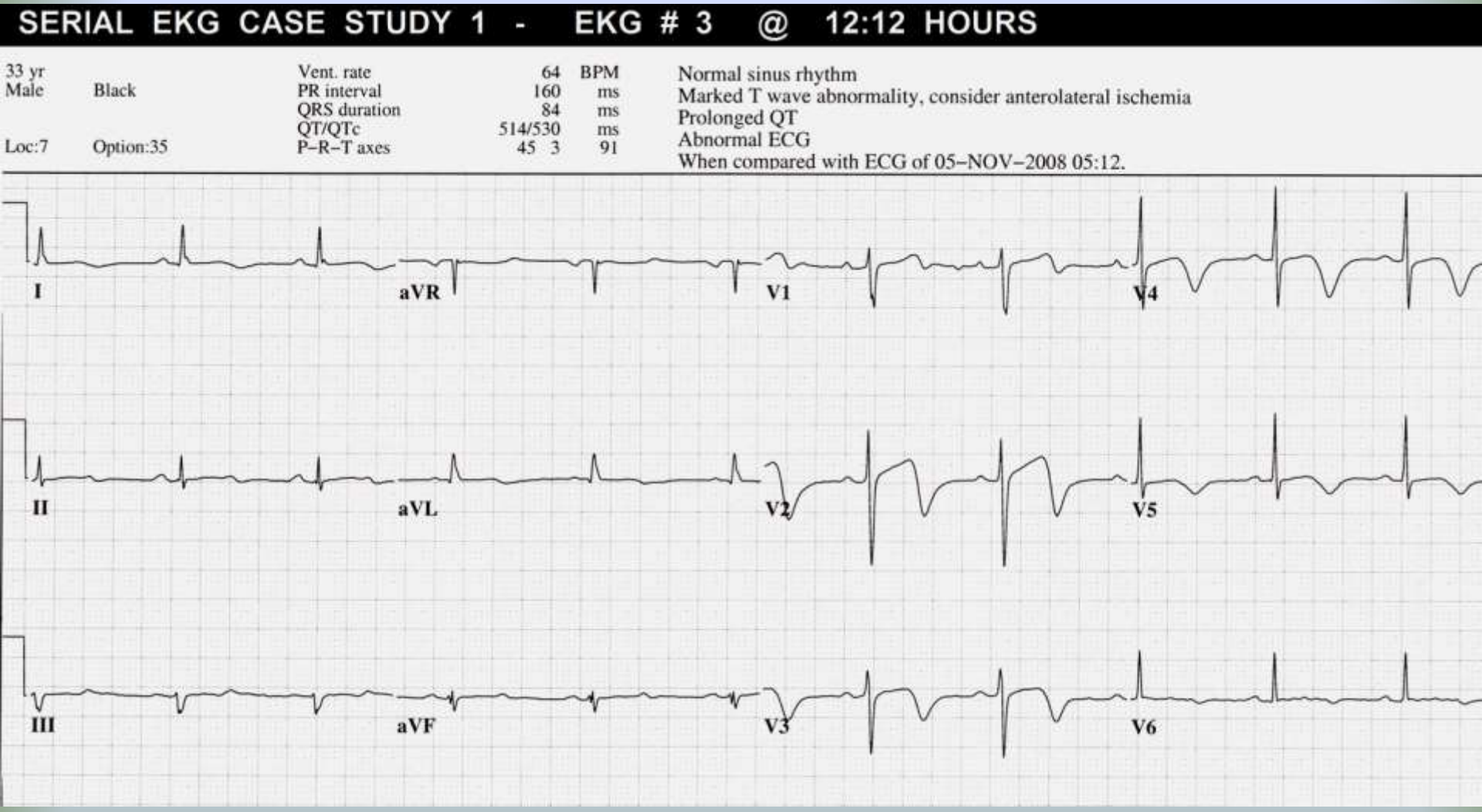


DYNAMIC ST-T Wave Changes ARE PRESENT !!

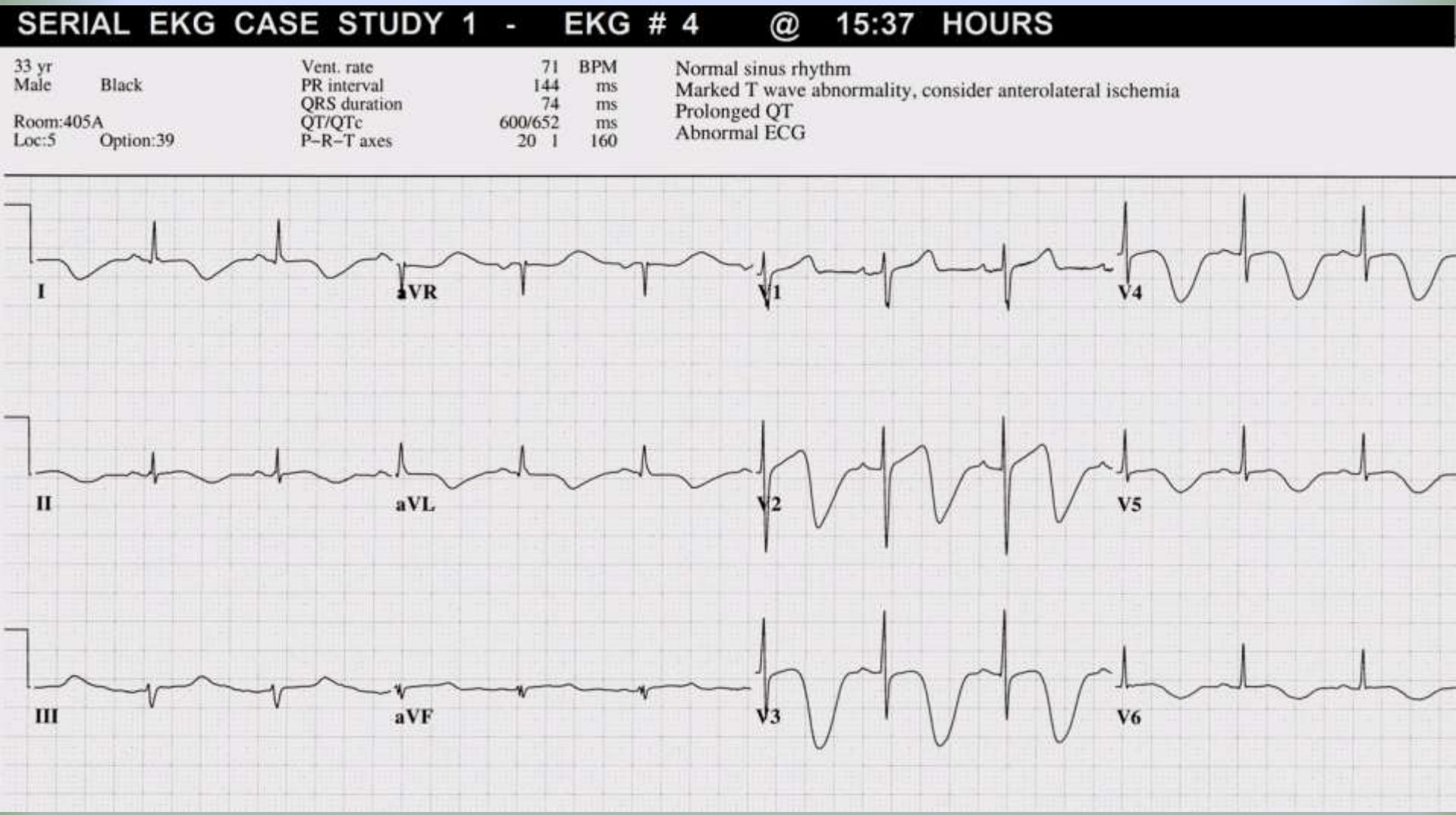
NOW

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

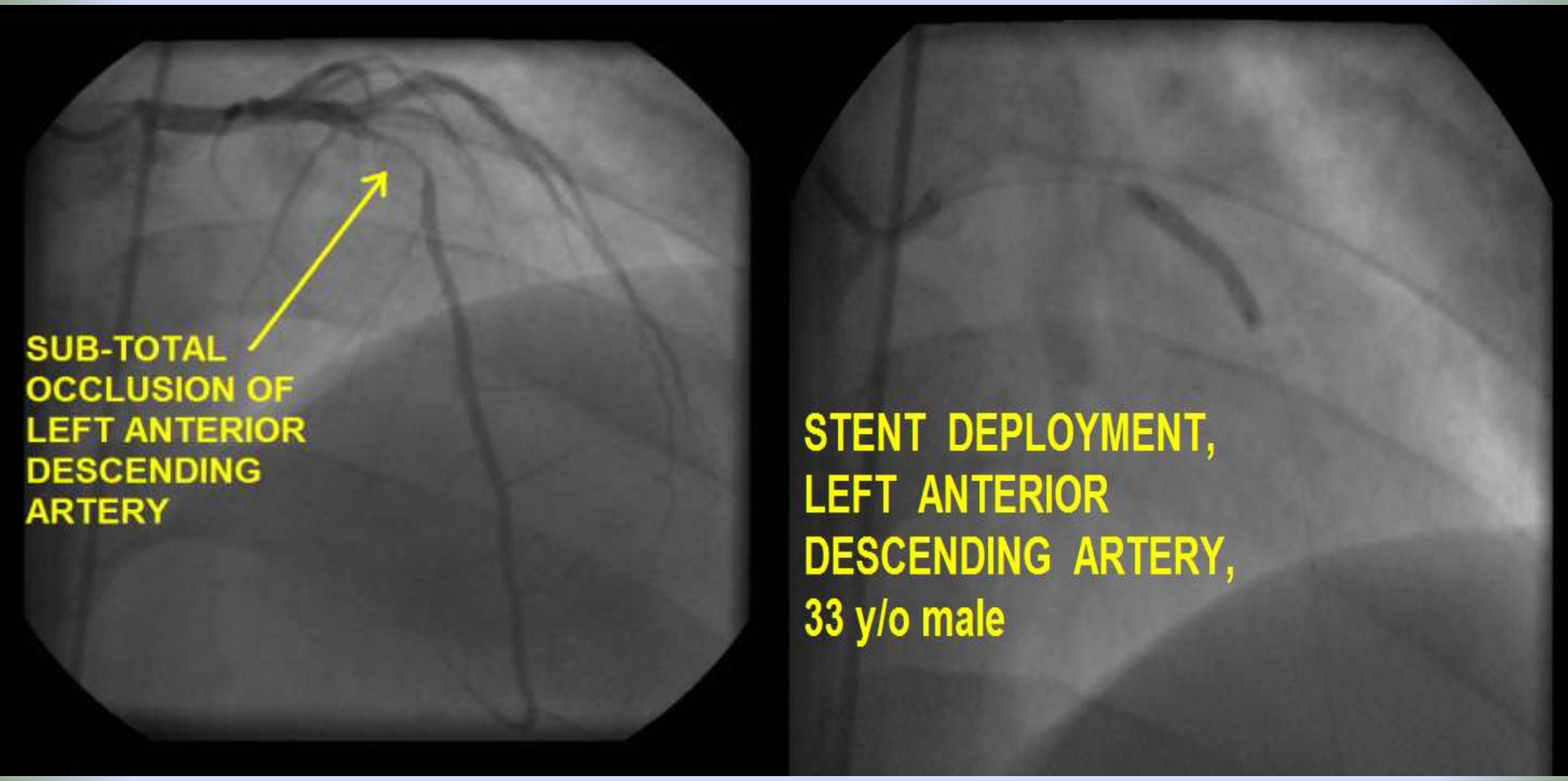
Dynamic ST-T Wave Changes



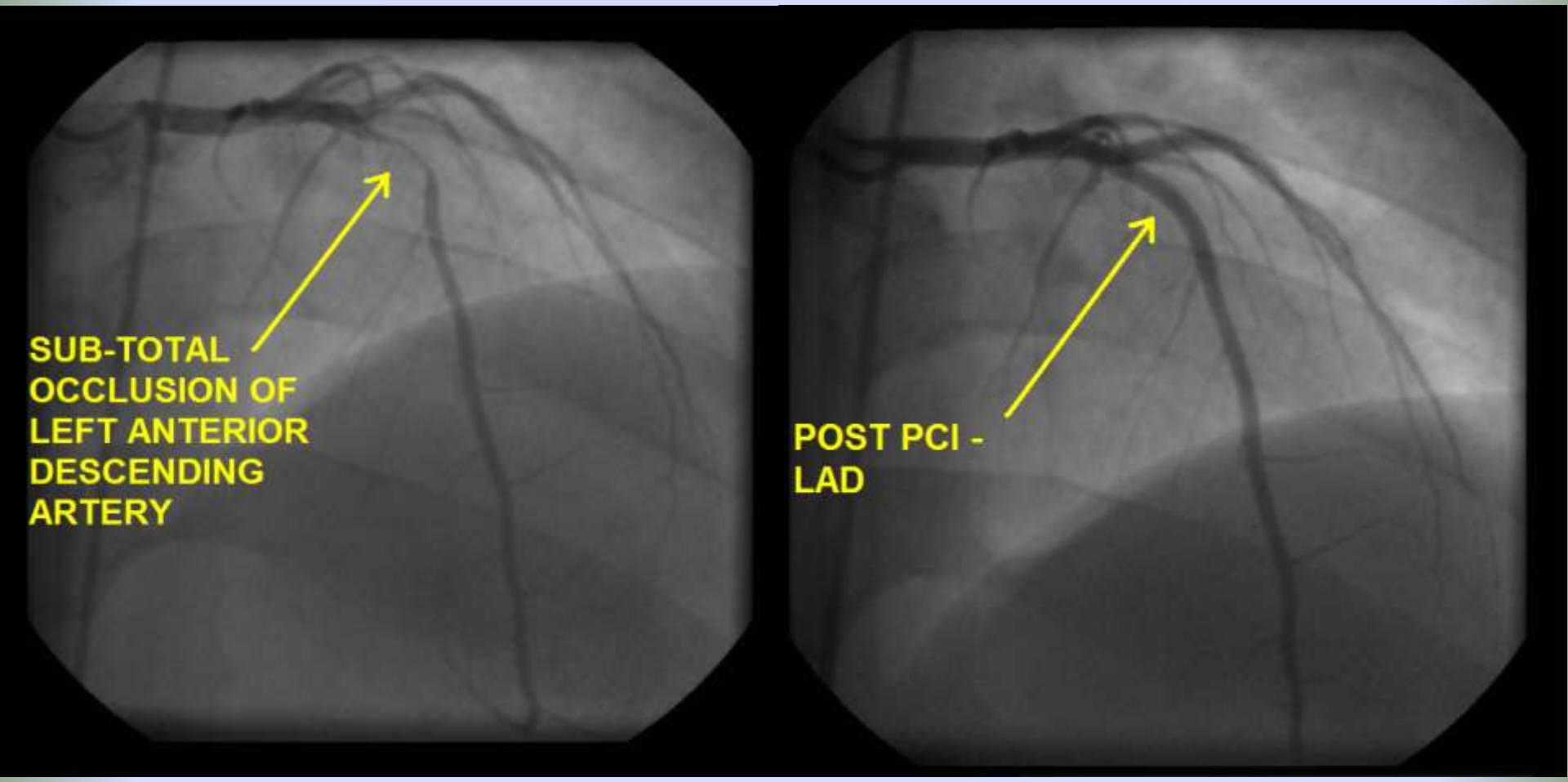
Dynamic ST-T Wave Changes



Dynamic ST-T Wave Changes



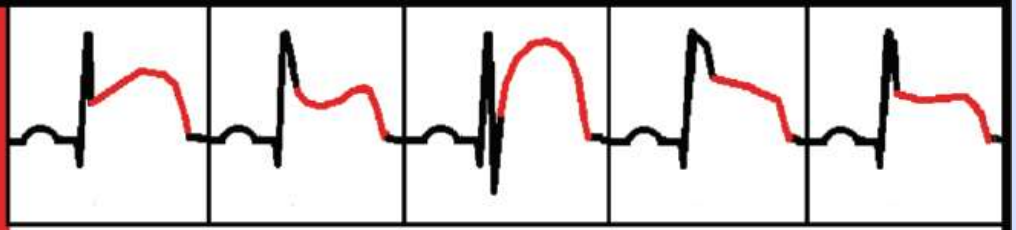
Dynamic ST-T Wave Changes



NORMAL PERFUSION

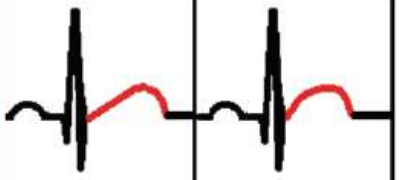
- J POINT ISOELECTRIC
- ST SEGMENT: slight POSITIVE inclination
- ST-T JUNCTION is CONCAVE
- T WAVE smaller than R wave, SMOOTH, ROUNDED (NOT HYPER-ACUTE). T Wave INVERTED in lead AVR, upright in all other leads.

STEMI



- J POINT EVEVATED 1mm or more in 2 or more contiguous leads
  (exception: V2 & V3: men can have up to 2mm, women 1.5mm of normal J Point Elevation)
- ST SEGMENT usually CONVEX, may be UPSLOPING, FLAT, or DOWNSLOPING as seen in the examples above.

PATTERNS CONSISTENT WITH EARLY PHASE ACUTE MI



J POINT to APEX of T WAVE:
- FLAT (example to far left)
  or
- CONVEX (examplet to immediate left)

HYPERACUTE T WAVES
- **J POINT ISOELECTRIC or ELEVATED**
- **PEAK of T Wave POINTED, may exceed amplitude of R Wave**
- **Consider Acute MI / Pending MI**
- **Can ALSO indicate: Transmural Ischemia, Hyperkalemia**

DYNAMIC CHANGES to a patient's J POINT, ST SEGMENT and/or T WAVE during SERIAL ECGs is a strong indicator of UNSTABLE ISCHEMIA or EARLY INFARCTION

ACUTE MI or ISCHEMIA

J POINT DEPRESSION, Downsloping ST SEGMENT, inverted T Wave
- **Consider NSTEMI: check cardiac markers**
- **If ST Depression noted in Leads V1 - V4, consider Posterior Wall STEMI: obtain Posterior Lead ECG (see page 7 for details).**
- **If Acute MI not present, rule out MYOCARDIAL ISCHEMIA**

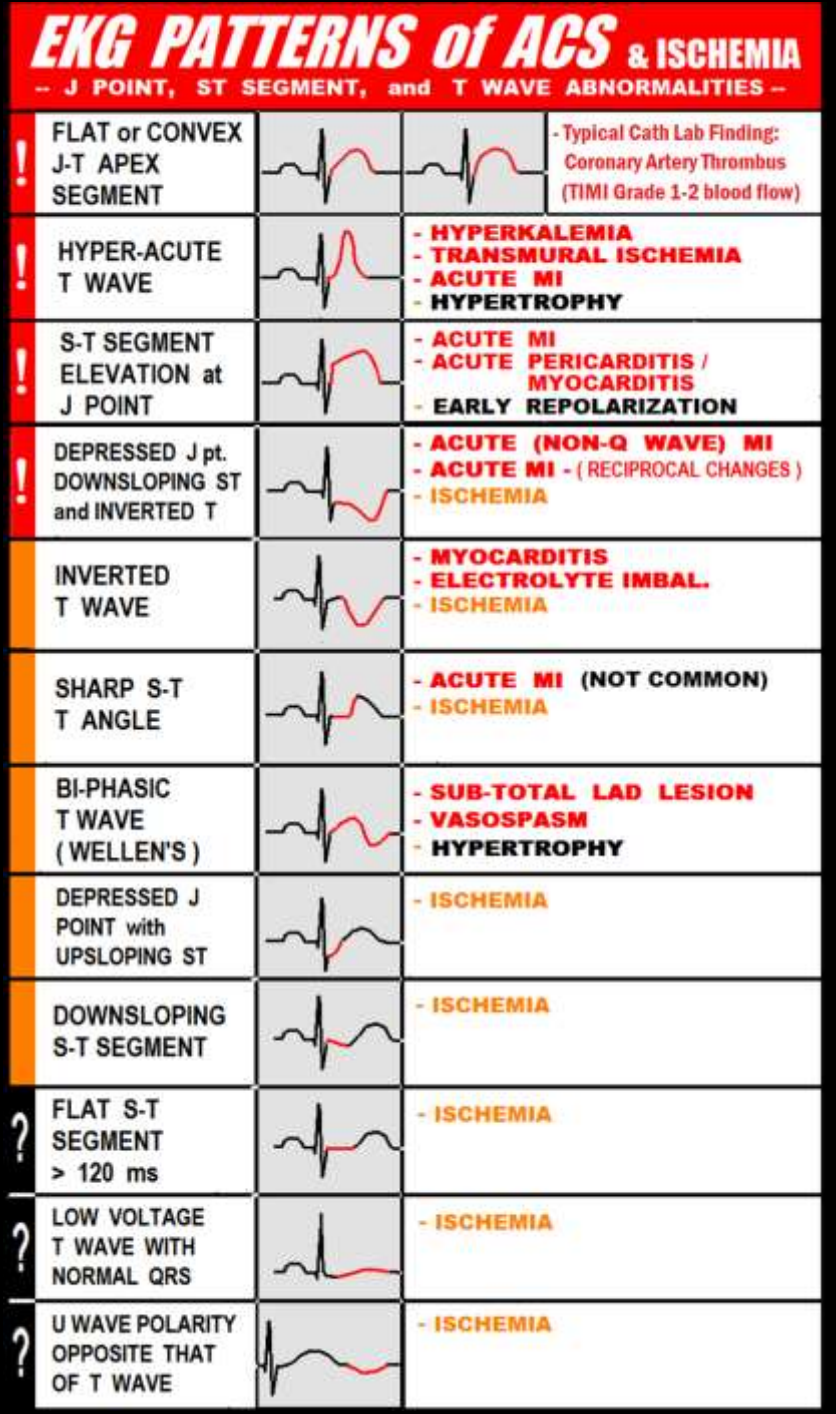
Multiple patterns of **ABNORMAL:**

- **J Point**
- **ST-Segment**
- **T Wave**

configurations **may indicate ACS.**

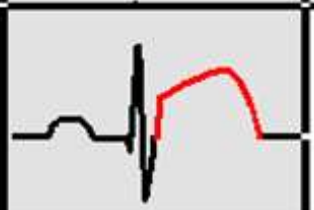
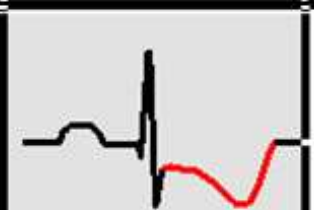
Remember, "IF IT'S NOT **NORMAL**, it's ***ABNORMAL !***"

BOOK PAGE: 83



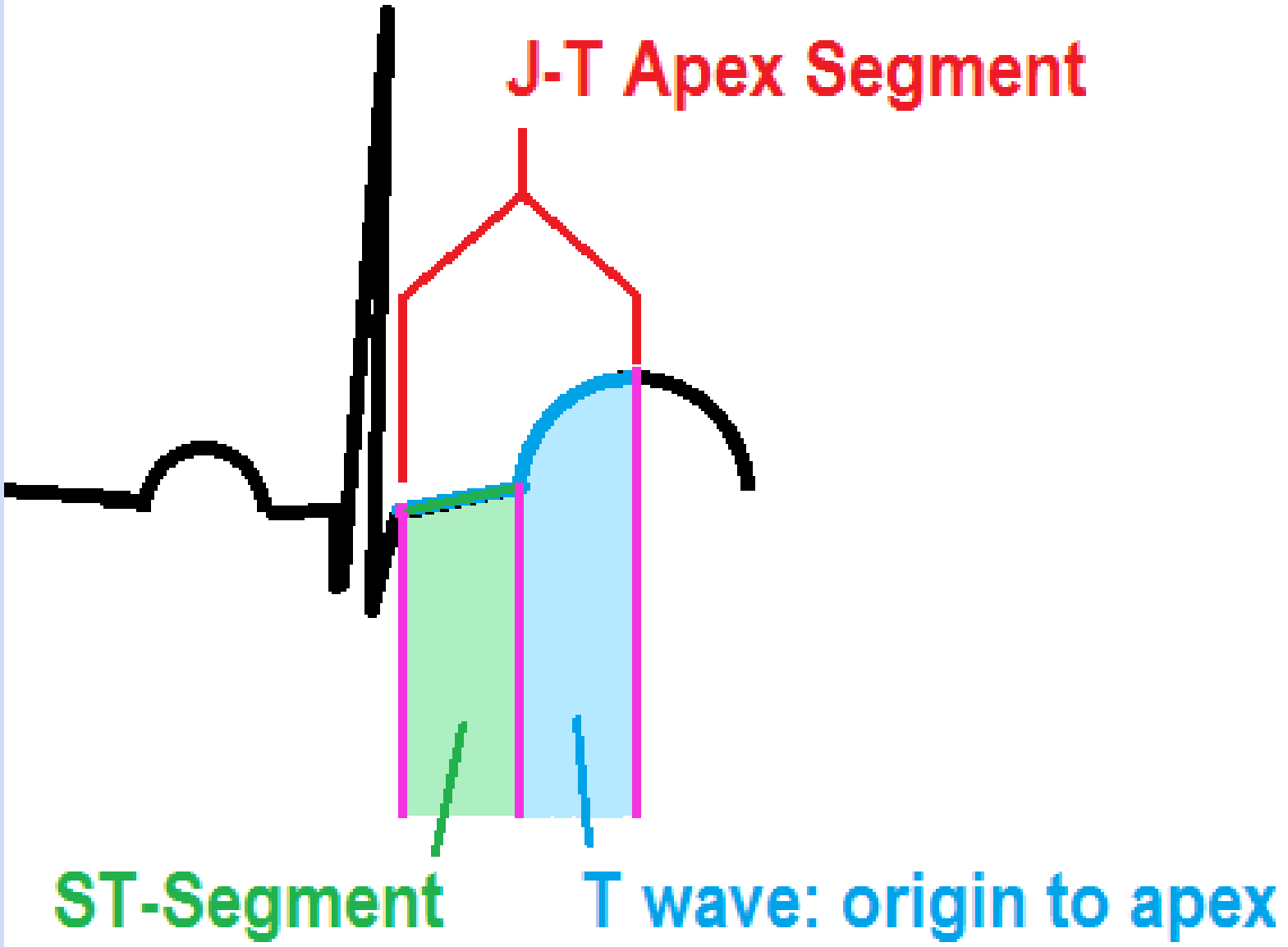
EKG PATTERNS of ACS & ISCHEMIA

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

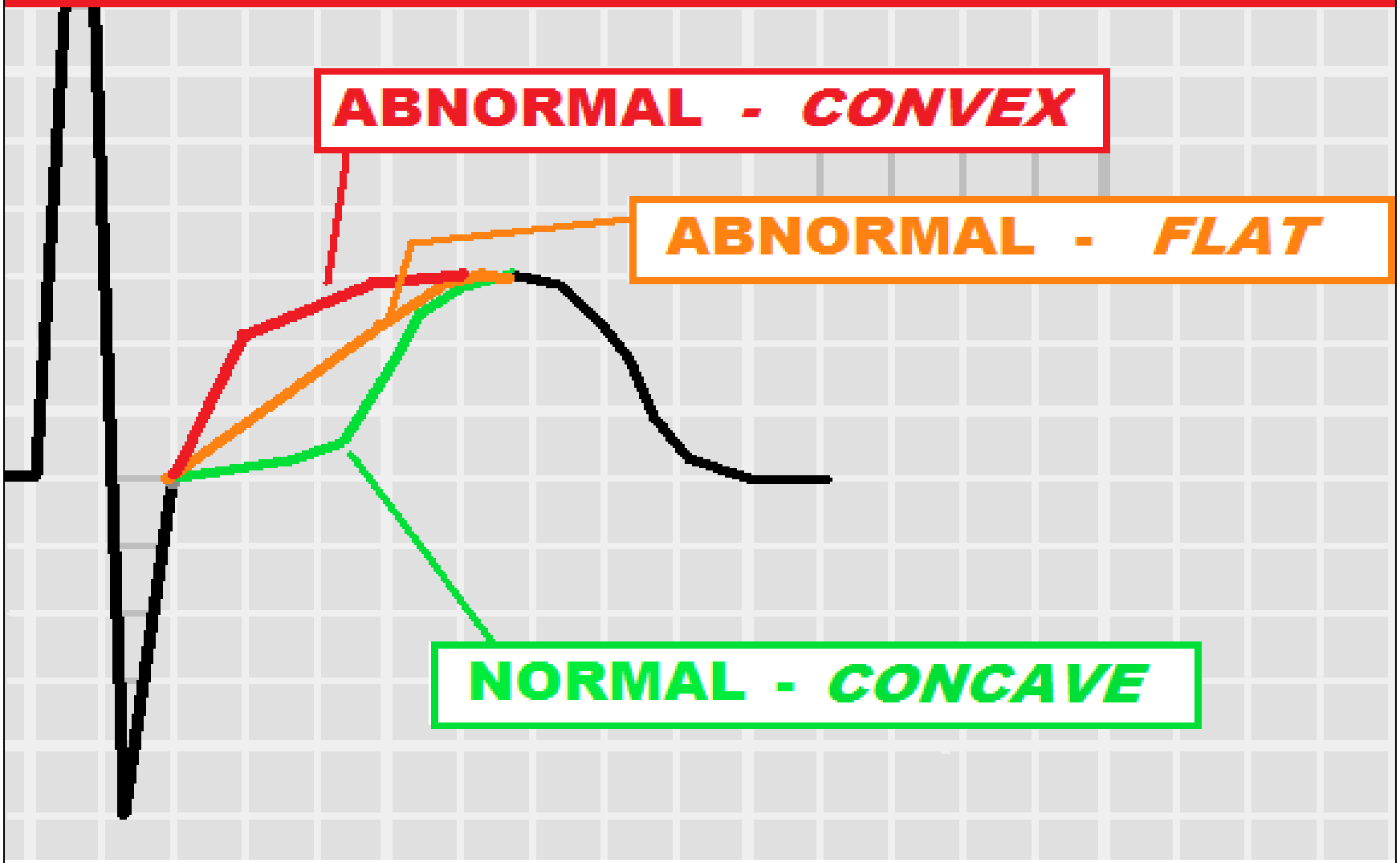
!	FLAT or CONVEX J-T APEX SEGMENT		- Typical Cath Lab Finding: Coronary Artery Thrombus (TIMI Grade 1-2 blood flow)
!	HYPER-ACUTE T WAVE		- HYPERKALEMIA - TRANSMURAL ISCHEMIA - ACUTE MI - HYPERTROPHY
!	S-T SEGMENT ELEVATION at J POINT		- ACUTE MI - ACUTE PERICARDITIS / MYOCARDITIS - EARLY REPOLARIZATION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

ECG Patterns associated with "EARLY PHASE MI:"

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


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

J - T APEX SEGMENT VARIATIONS

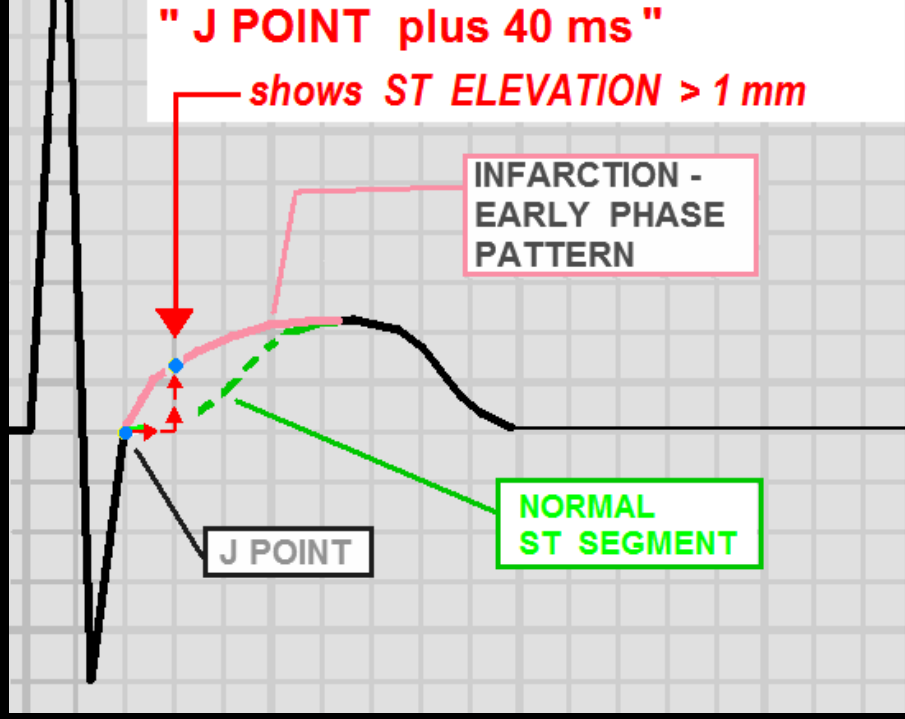


PATTERNS of EARLY INFARCTION

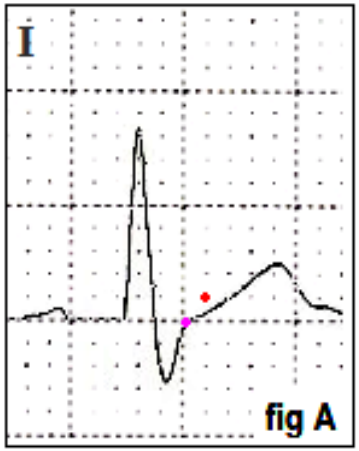
-- FLAT and CONVEX J-T APEX SEGMENTS

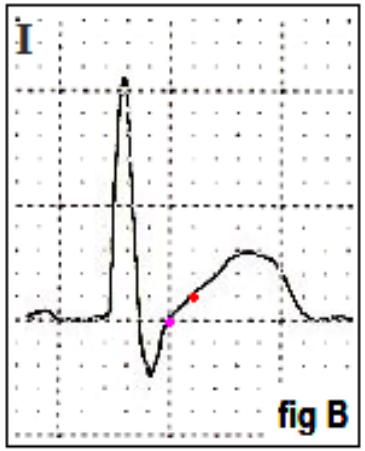
WHEN EVALUATING for ST SEGMENT ELEVATION . . . . . .

From:
AMERICAN HEART ASSOCIATION
ACLS 2005 REVISIONS



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

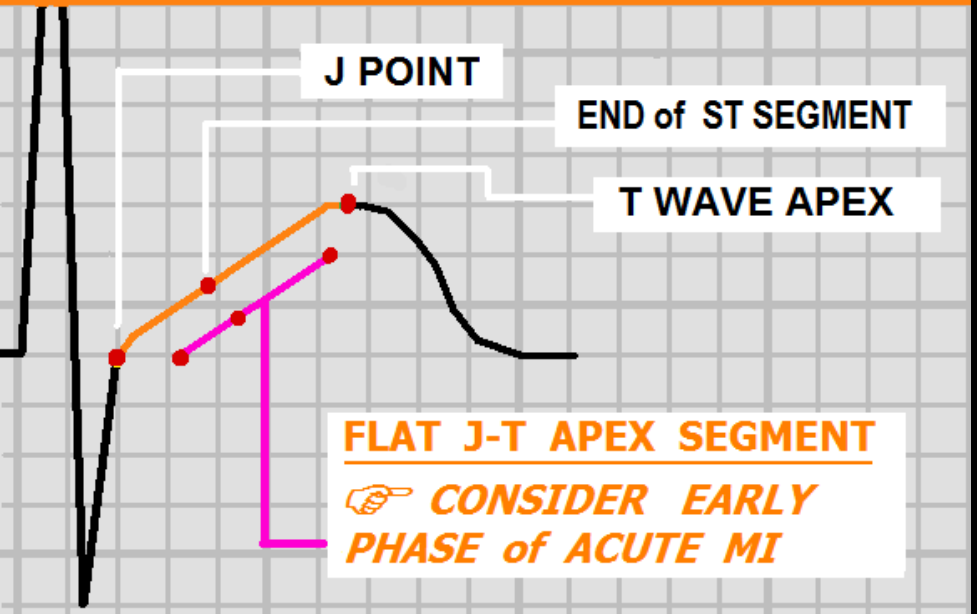




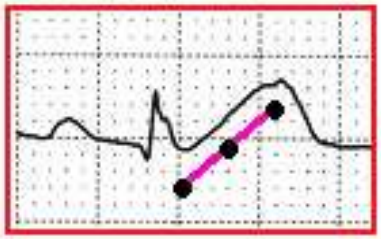
During a 20 second BALLOON OCCLUSION of the patient's LAD during routine PTCA, the ST segment assumes a CONVEX shape. When measured 40 ms beyond the J POINT, the ST segment is elevated > 1 mm. This phenonemon is seen routinely in the cath lab prior to the occurance of ST ELEVATION at the J POINT during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

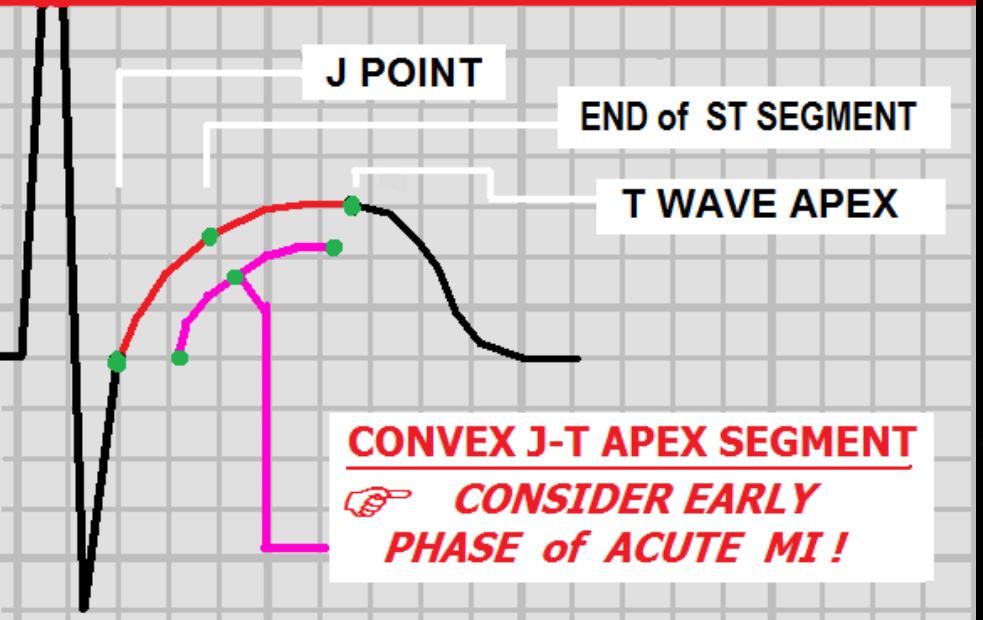
1850 hrs

STEMI - INFERIOR WALL

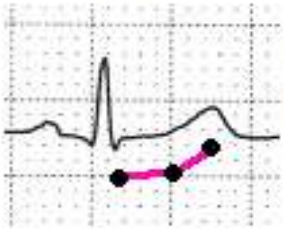
11 MINUTES LATER, S-T ELEVATION at the J POINT IS NOTED.

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

ABNORMAL J-T APEX SEGMENT

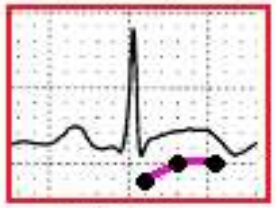


LEAD I



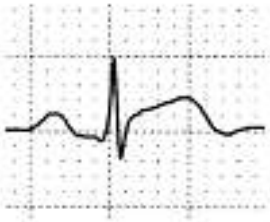
53 y/o MALE

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

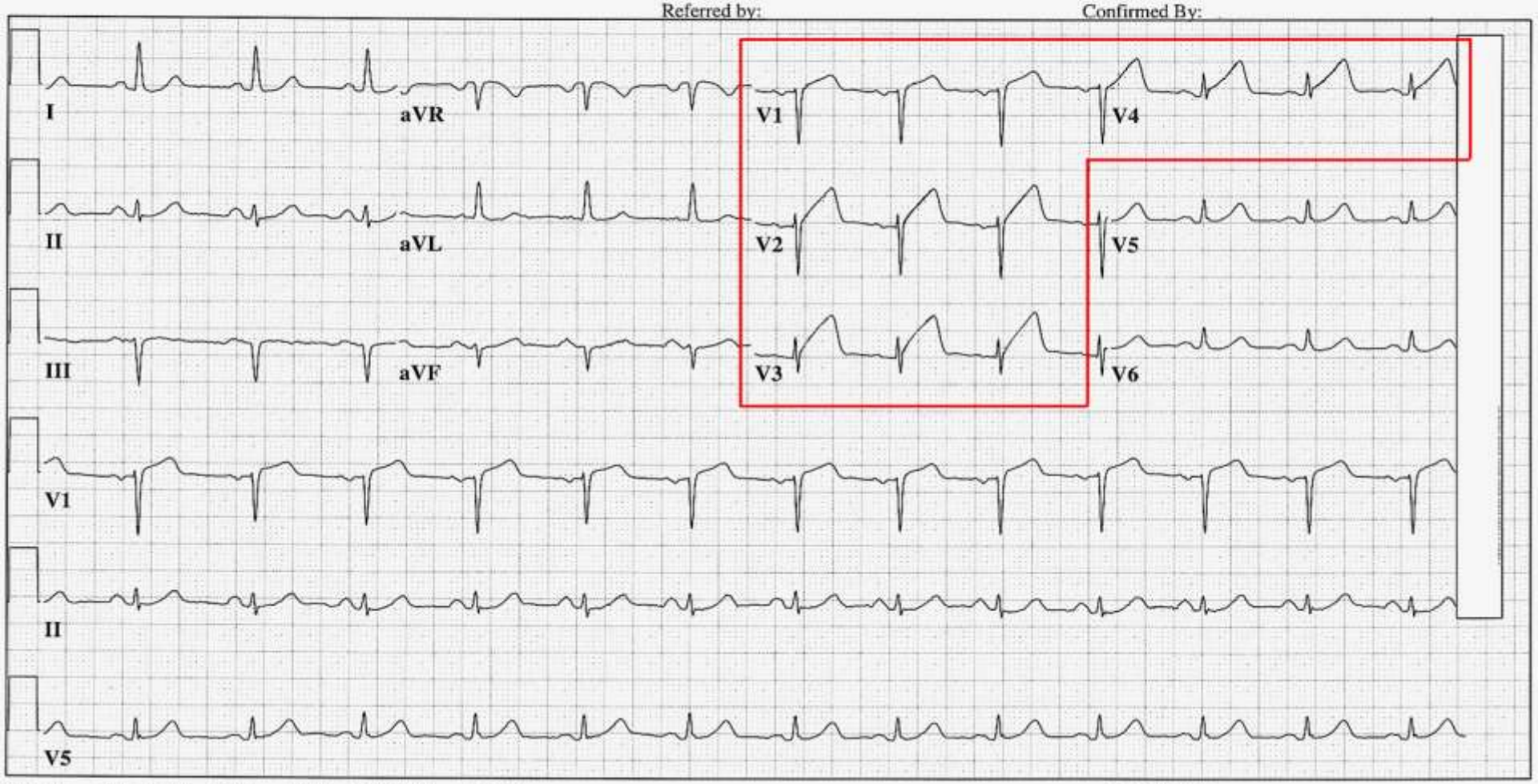
Vent. rate	80	BPM
PR interval	154	ms
QRS duration	78	ms
QT/QTc	380/438	ms
P–R–T axes	51 –24	38

**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:

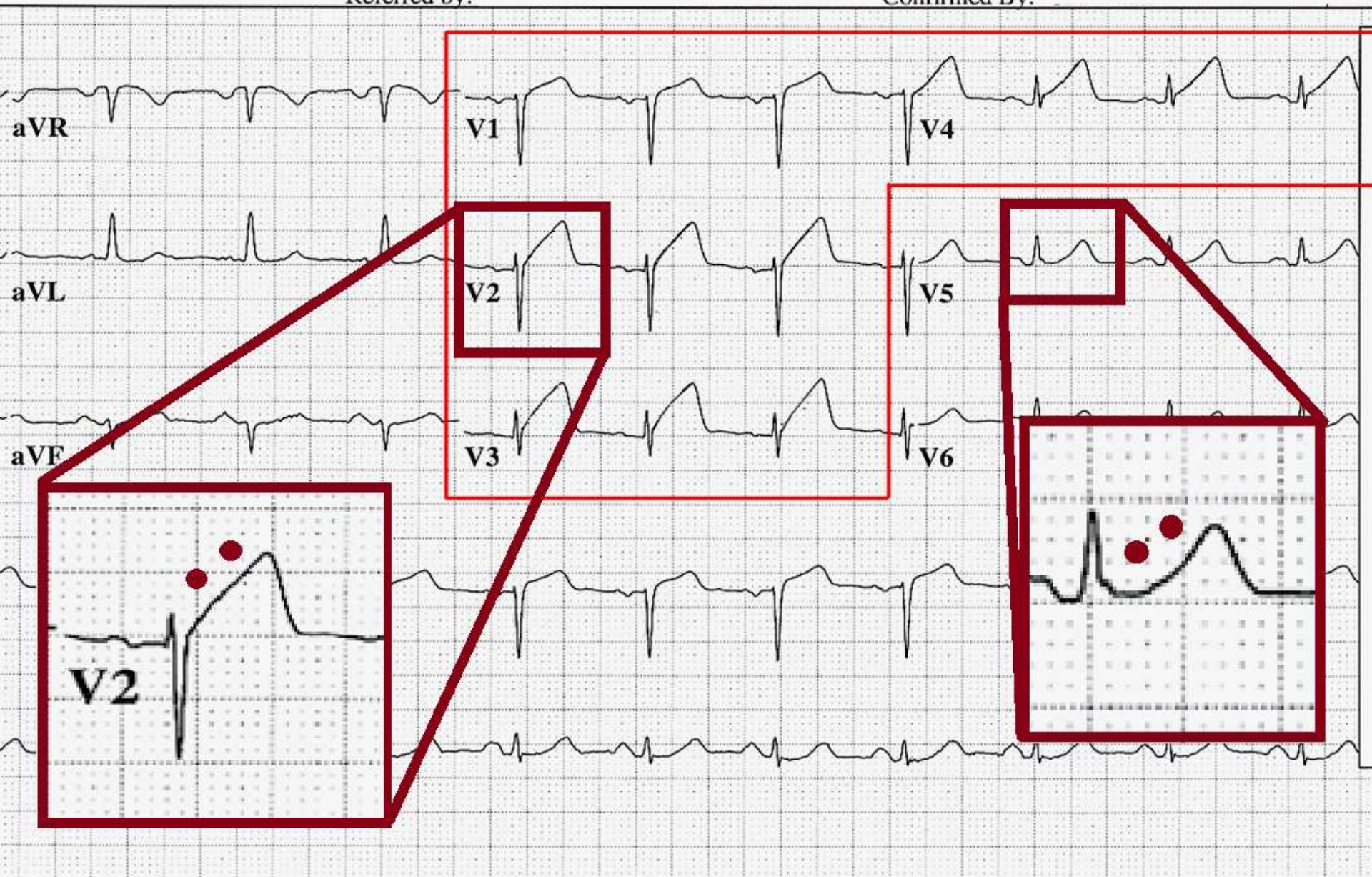
ECG COMPUTER DOES NOT NOTICE THE CONVEX J-T APEX SEGMENTS !

380/438 ms
51 –24 38

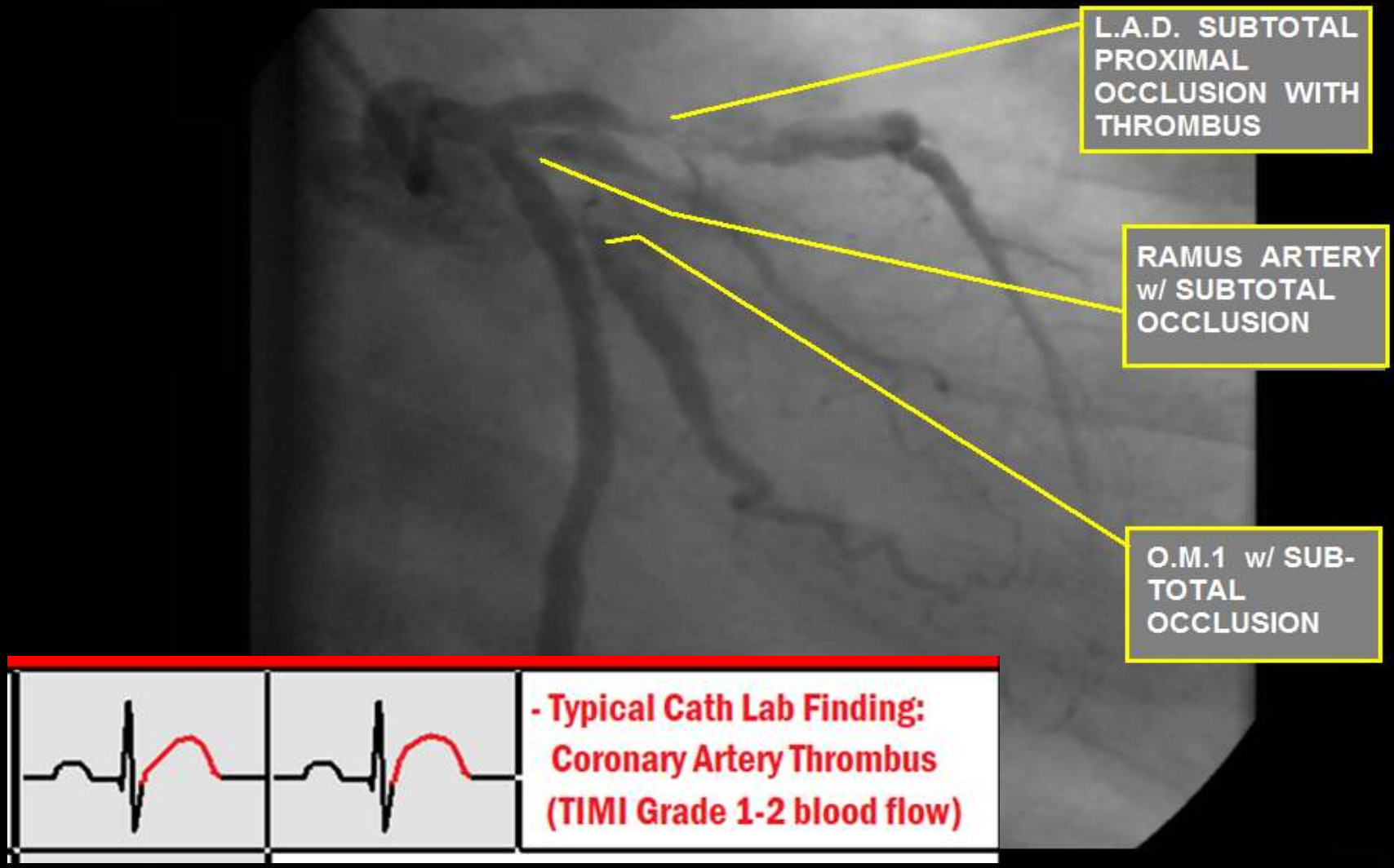
Normal sinus rhythm
Normal ECG
No previous ECGs available

Referred by:

Confirmed By:



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

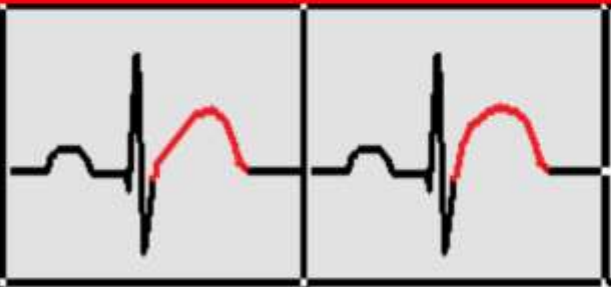
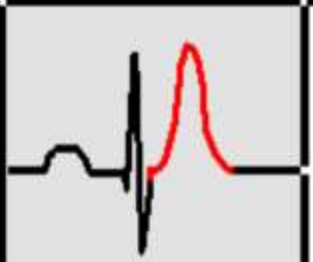
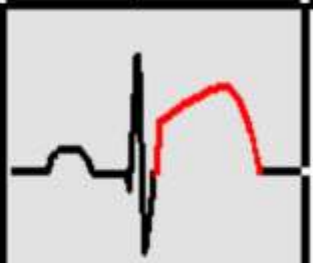
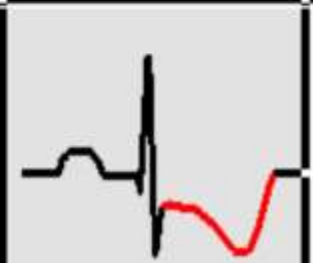


- Typical Cath Lab Finding:
  Coronary Artery Thrombus
  (TIMI Grade 1-2 blood flow)

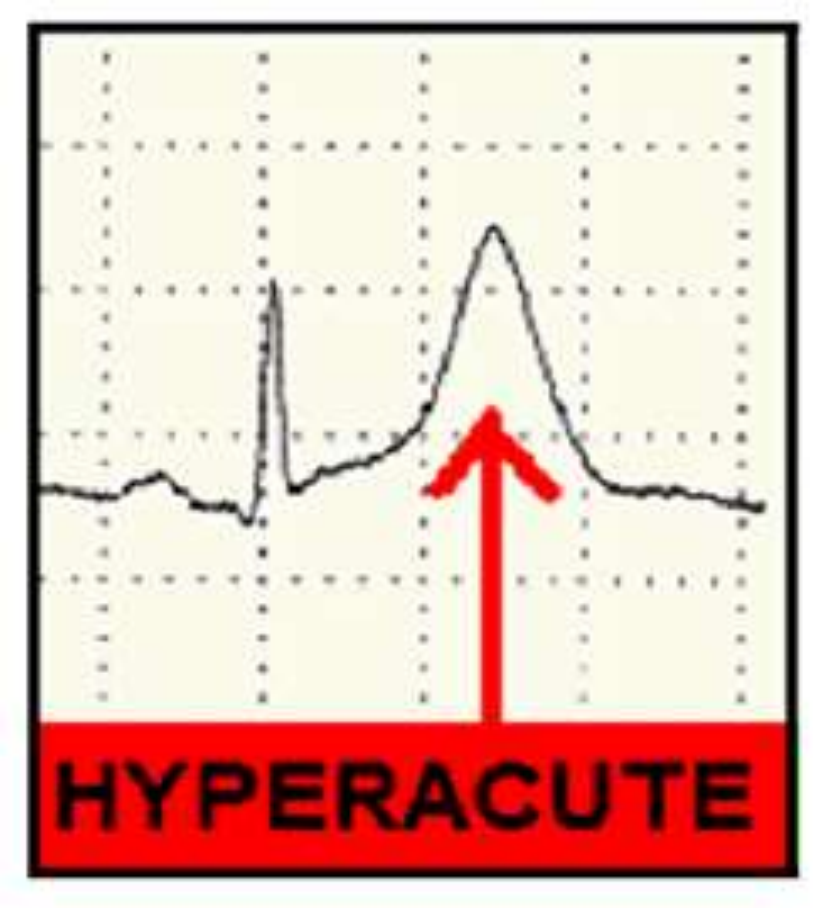
TREATMENT PLAN : EMERGENCY CORONARY ARTERY BYPASS SURGERY (4 VESSEL)

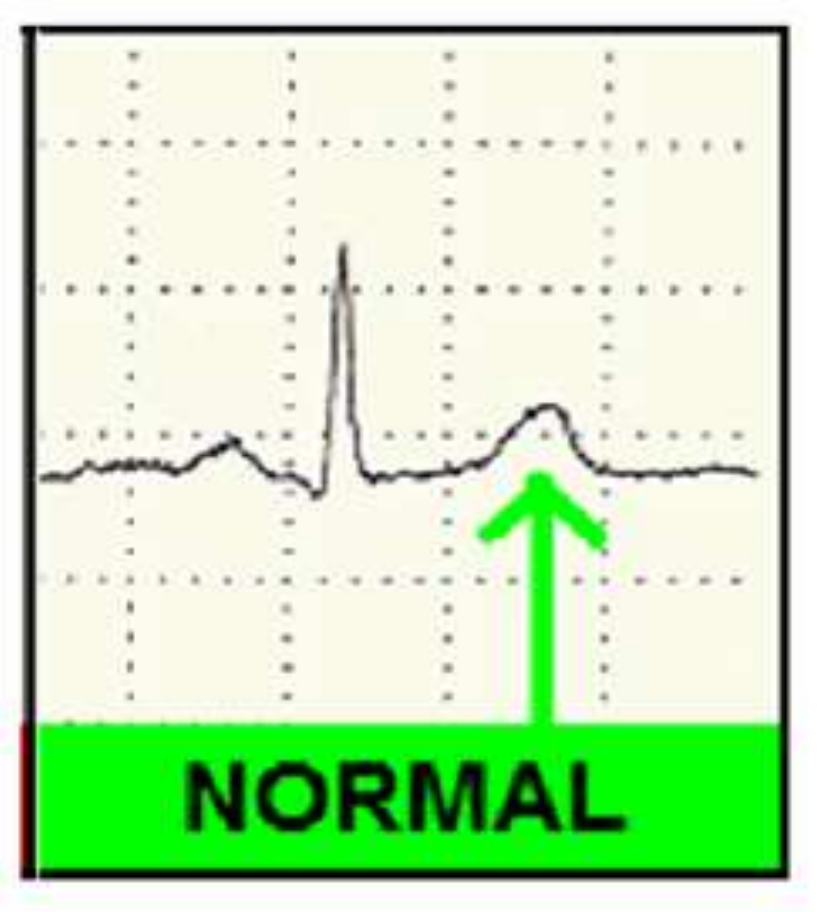
PATTERNS of ACS & ISCHEMIA

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

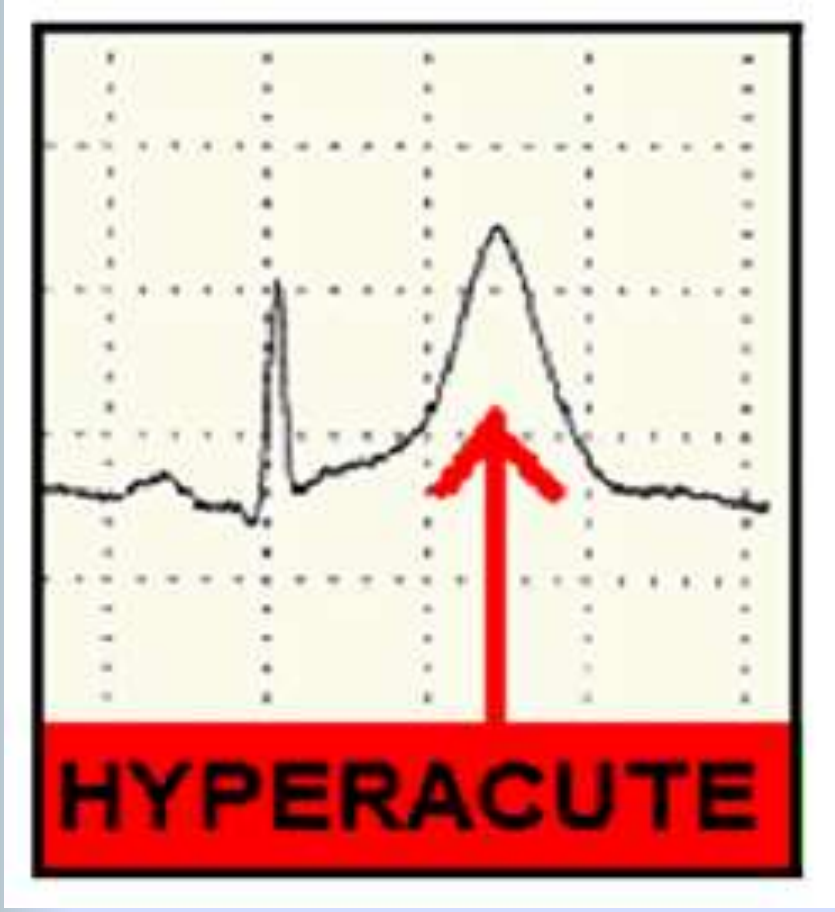
!	FLAT or CONVEX J-T APEX SEGMENT		**ACUTE MI** EARLY PHASE
!	HYPER-ACUTE T WAVE		**ACUTE MI** EARLY PHASE
!	S-T SEGMENT ELEVATION at J POINT		**ACUTE MI**
!	DEPRESSED J pt. DOWNSLOPING ST and INVERTED T		- **ACUTE (NON-Q WAVE) MI** - **ACUTE MI** - (RECIPROCAL CHANGES) - **ISCHEMIA**

T waves should not be HYPERACUTE



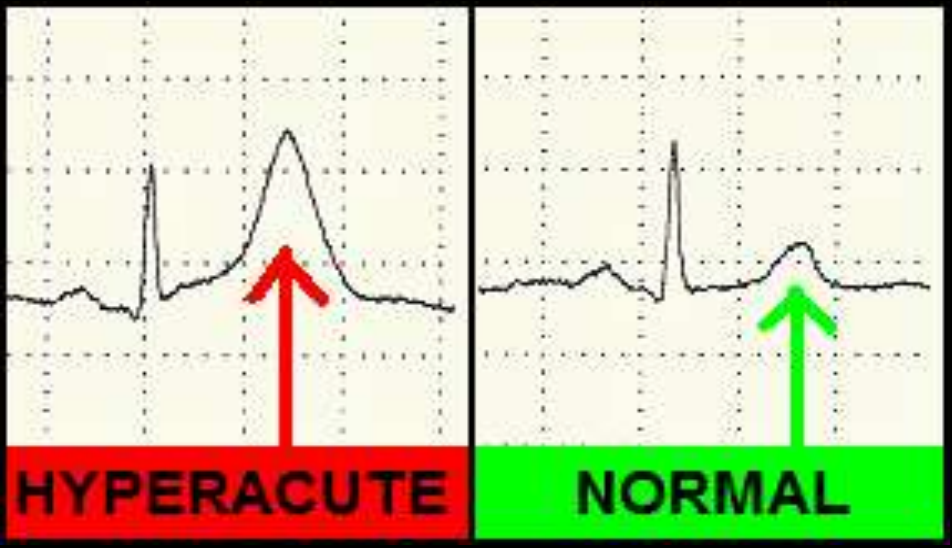


HYPERACUTE T Waves may indicate:



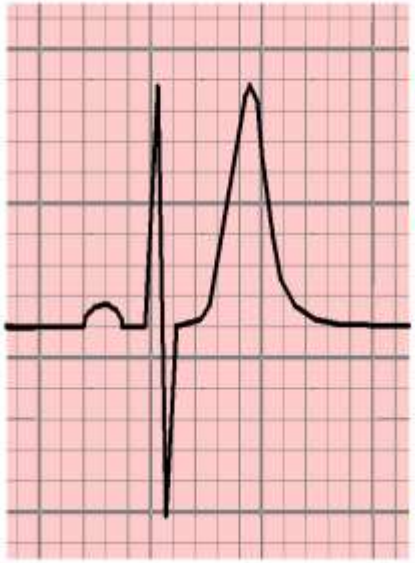
- **Early phase Acute MI**
- **Transmural ischemia** (usually seen in one region of the ECG)
- **Hyperkalemia** (seen globally across ECG)
- **Hypertrophy**

HYPERACUTE T WAVES

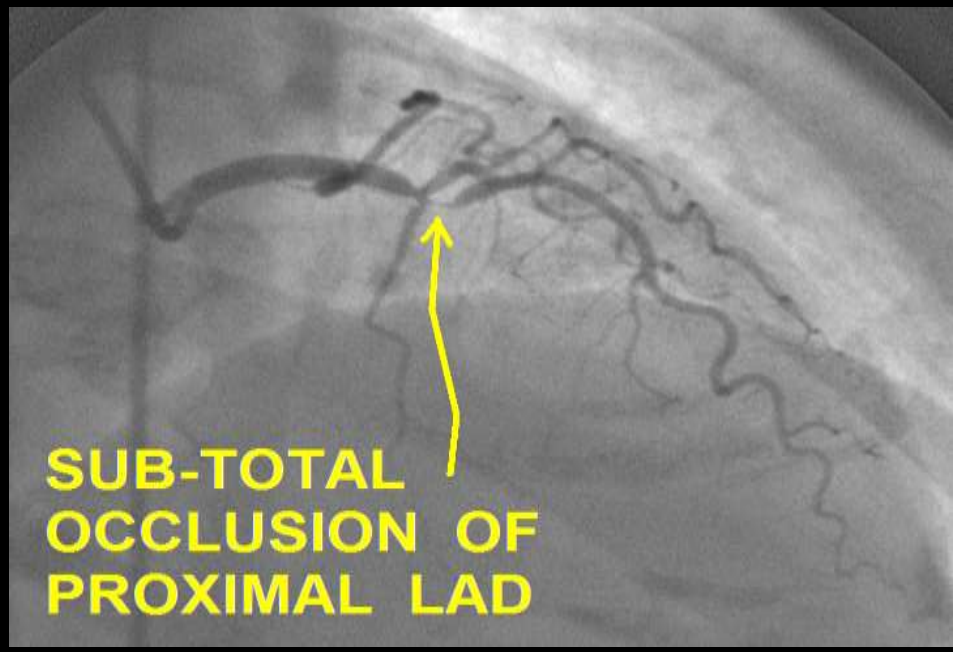


BOOK PAGE: 88

HYPER-ACUTE T WAVES - COMMON ETIOLOGIES:



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



Helpful Clue: Hyper-Acute T Waves

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

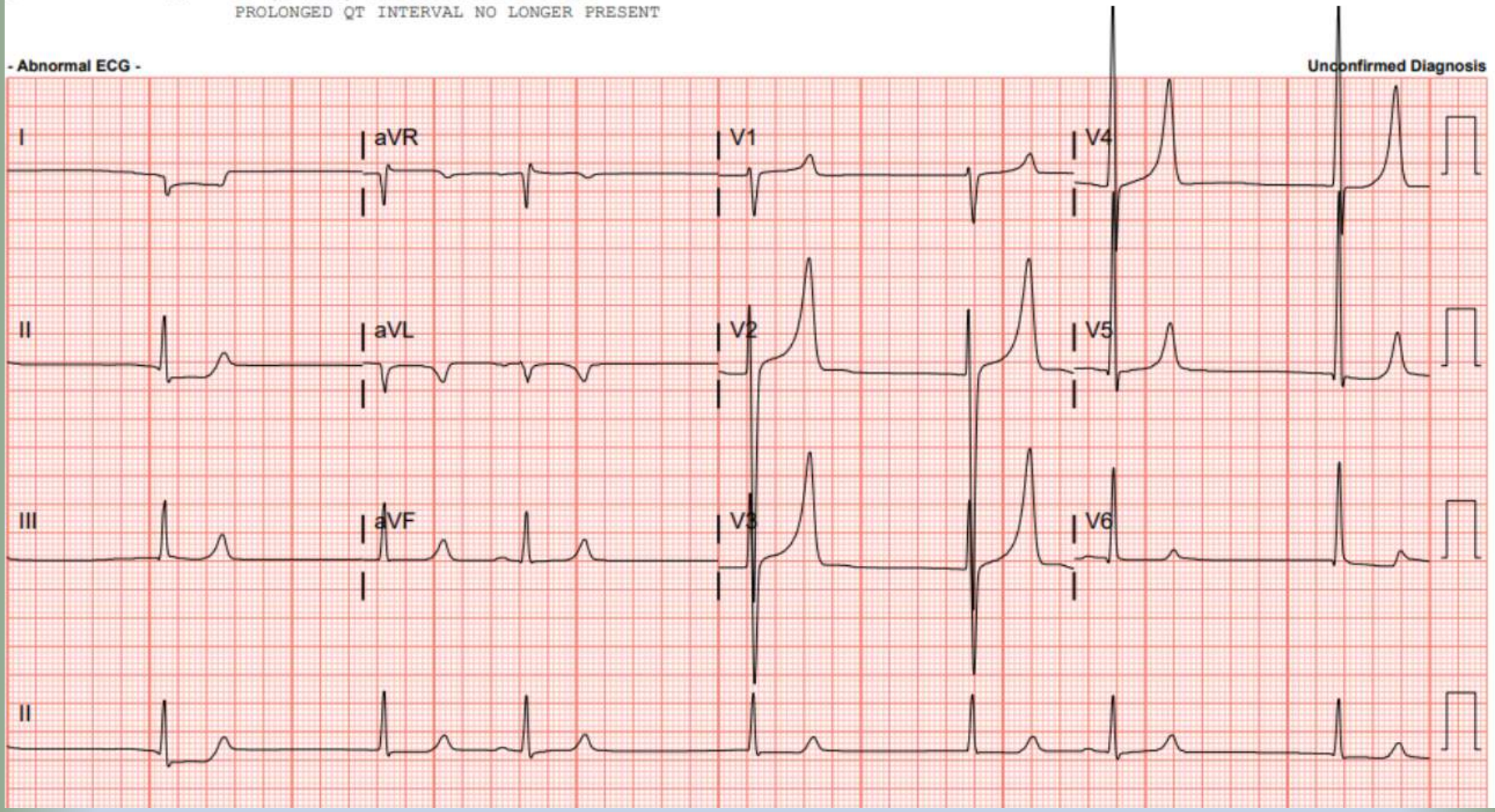
Rate	39	Right and left arm electrode reversal, interpretation assumes no reversal
PR	500	Sinus bradycardia
QRSd	117	Atrial premature complexes
QT	549	LVH with IVCD and secondary repol abnrm
QTc	443	Anterior ST elevation, probably due to LVH
--Axis--		COMPARED TO ECG 02/24/2020 21:46:48
P	0	SINUS BRADYCARDIA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

Req Provider: ONIER VILLARREA

K+ = 7.9

- Abnormal ECG -

Unconfirmed Diagnosis



ID:

23-Nov-

REGIONAL MEDICAL CENTER

55years
Female Caucasian

Room:

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

Sinus bradyc a
Possible Left atrial enlargement
Borderline ECG

ER ATTENDING REVIEW
NO STEMI
TIME 1511

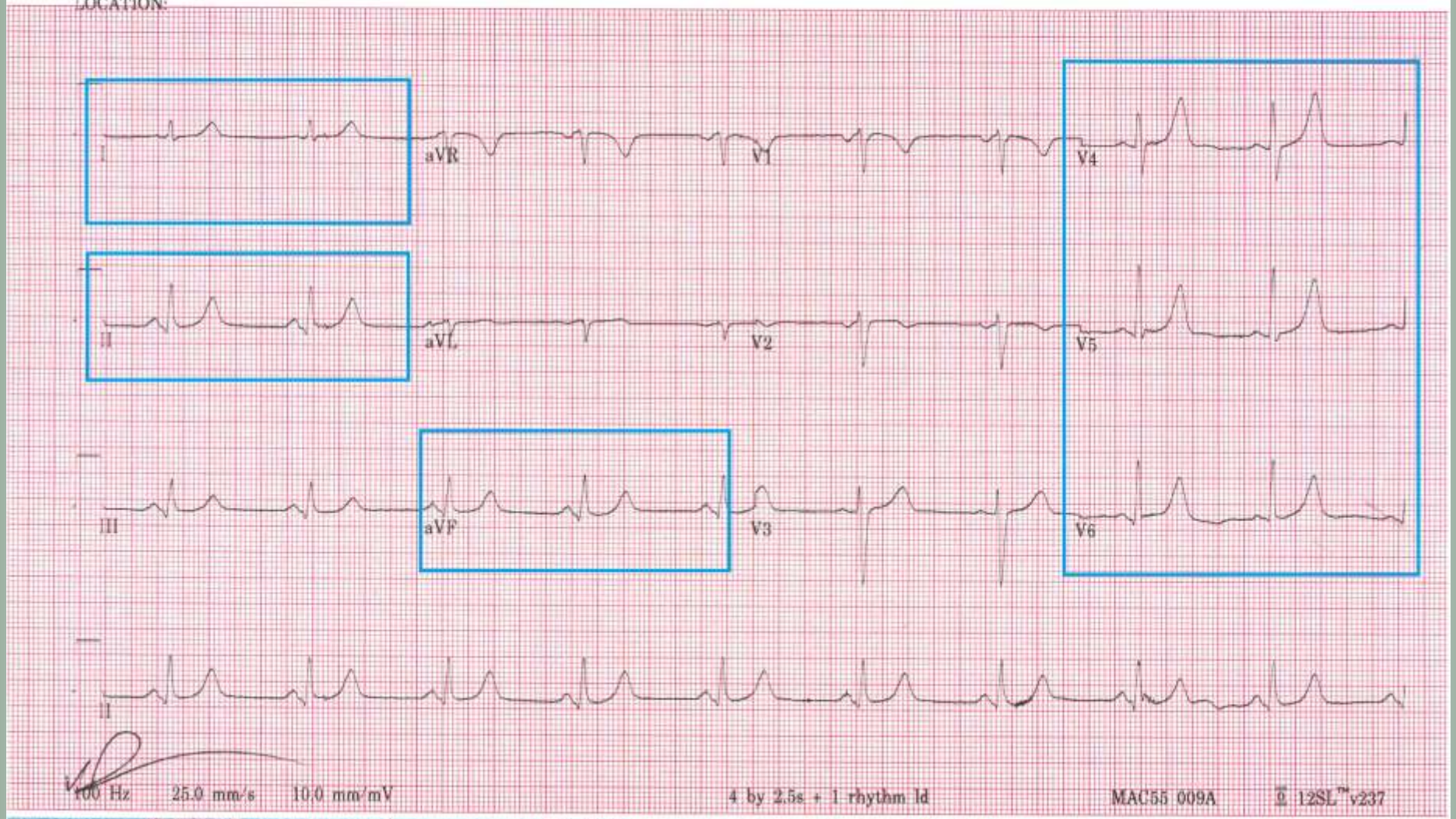
K+ = 6.7

Technician:
Test ind:

Referred by:

Unconfirmed

LOCATION:



Helpful Clue: Hyper-Acute T Waves

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

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

CASE STUDY: HYPERACUTE T WAVES

CHIEF COMPLAINT and SIGNIFICANT HISTORY:

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

RISK FACTOR PROFILE: NONE. CHOLESTEROL UNKNOWN.

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

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

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

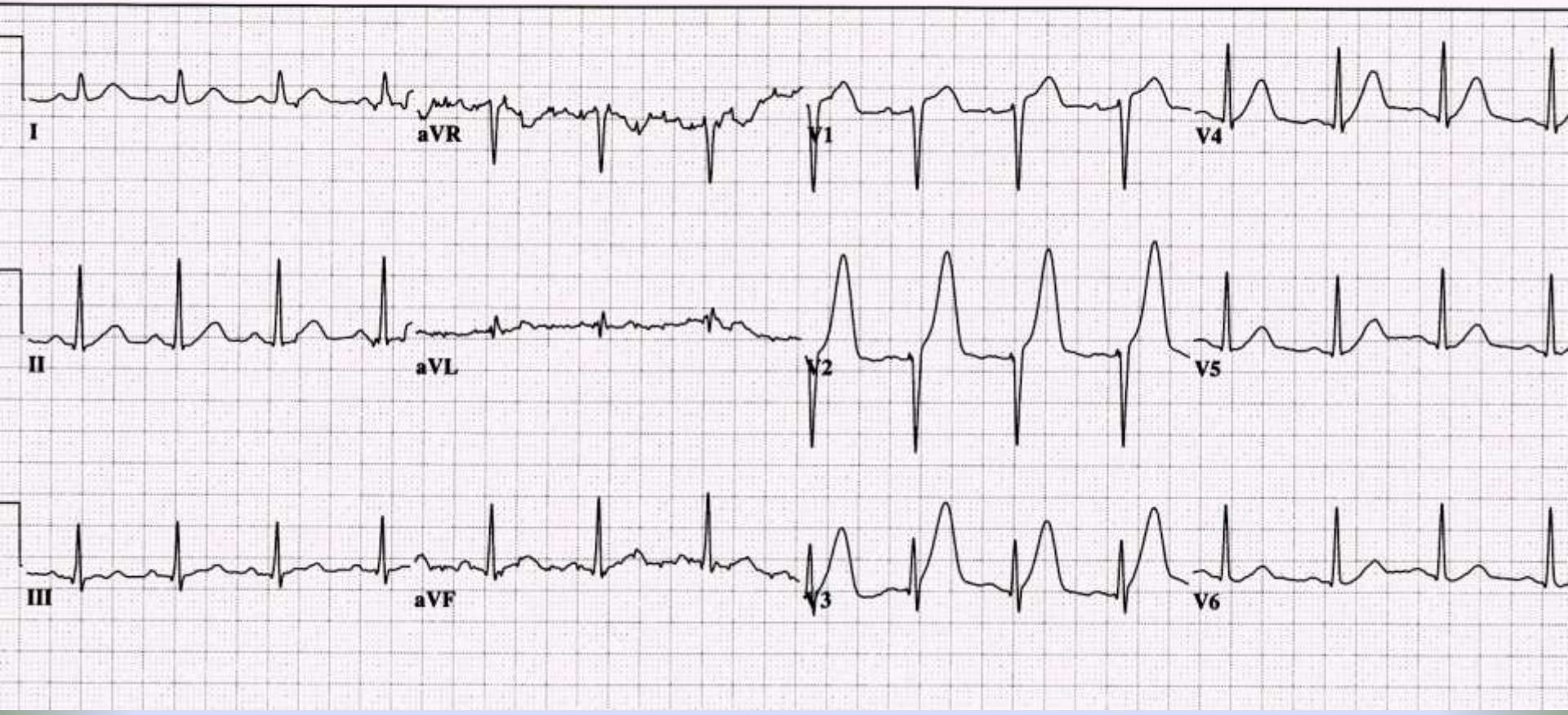
30 yr
Male Black

Room: ER
Loc: Option:

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

Normal sinus rhythm
Normal ECG
No previous ECGs available

← NOTE COMPUTER INTERPRETATION



30 yr
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Vent. rate	88	BPM
PR interval	164	ms
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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

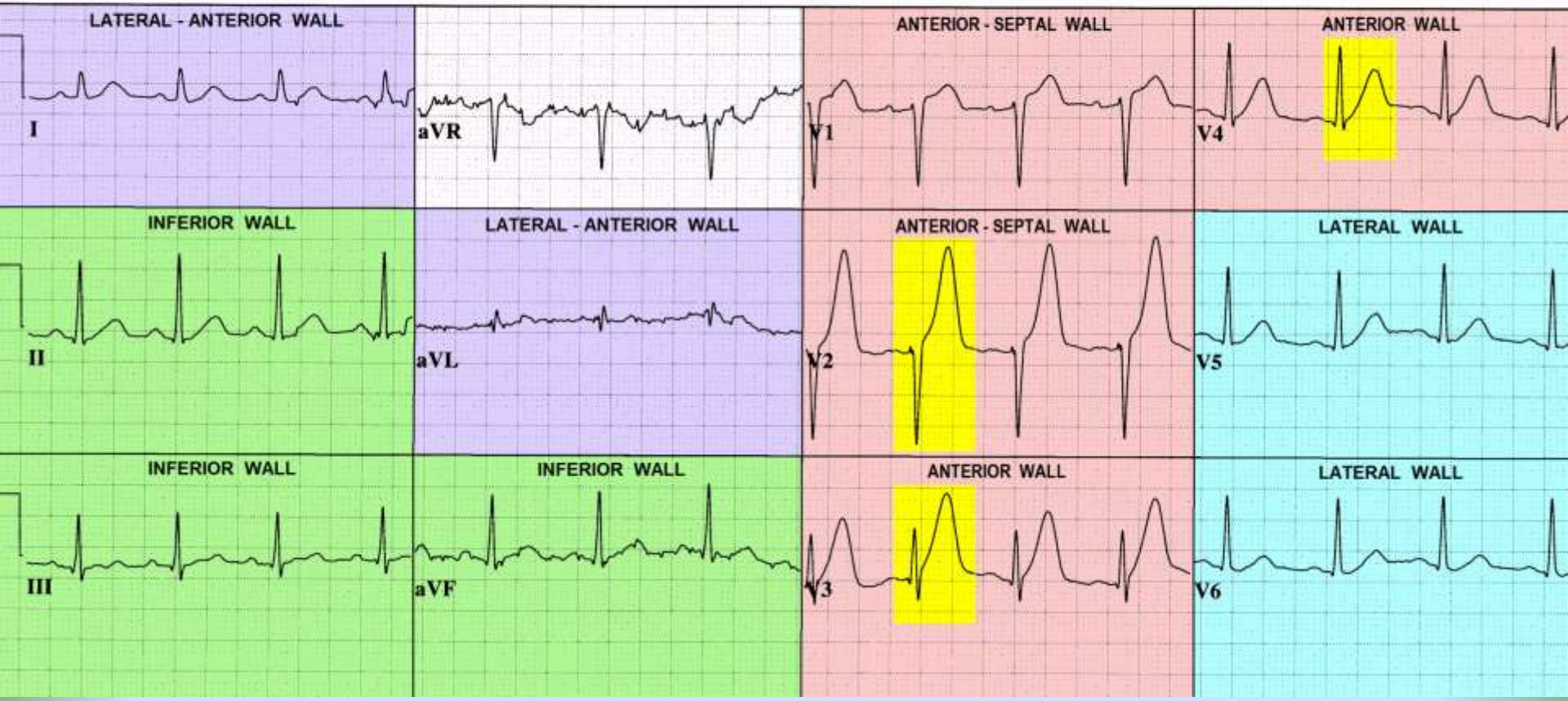
CORONARY ARTERIAL DISTRIBUTIONS:

V1 - V4 = LEFT ANTERIOR DESCENDING (LAD)

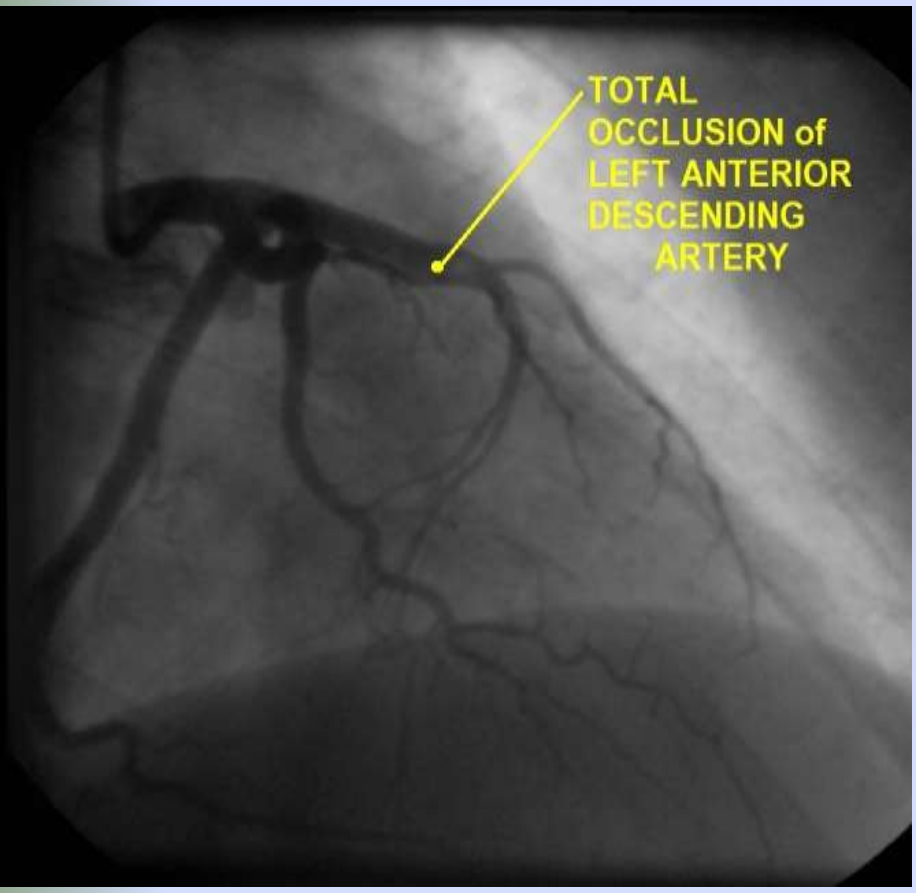
I, AVL = DIAGONAL (DIAG) off the LAD or OBTUSE MARGINAL (OM) off CIRCUMFLEX (CX)

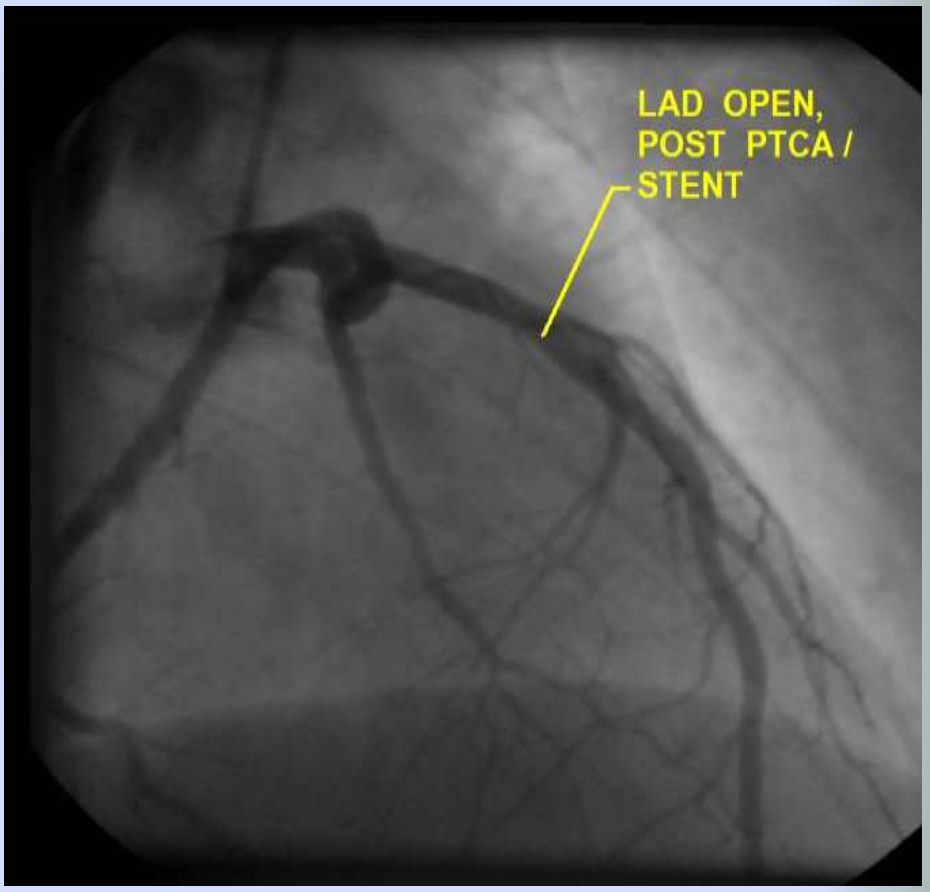
V5, V6 = CIRCUMFLEX

II, III, AVF = RIGHT CORONARY ARTERY or CX



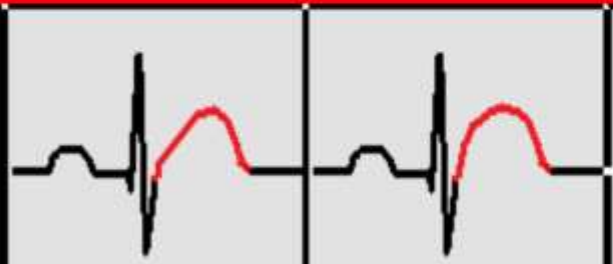
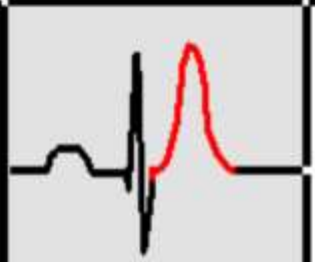
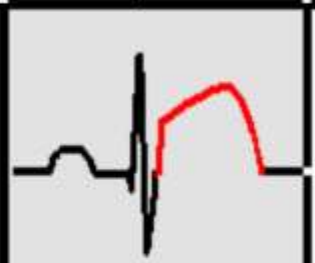
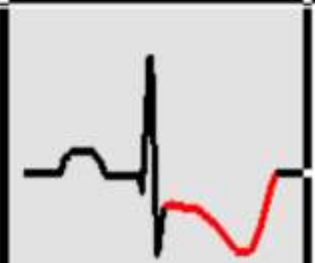
Cath Lab findings:





PATTERNS of ACS & ISCHEMIA

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

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

ECG CRITERIA for DIAGNOSIS of STEMI:

(ST ELEVATION @ J POINT)

*LEADS V2 and V3:

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

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

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

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

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

STEMI Criteria for 18 Lead ECGs:

Right-Sided Chest Leads

(V3R – V6R): 0.5 mm

Posterior Chest Leads

(V7 – V9): 0.5 mm

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

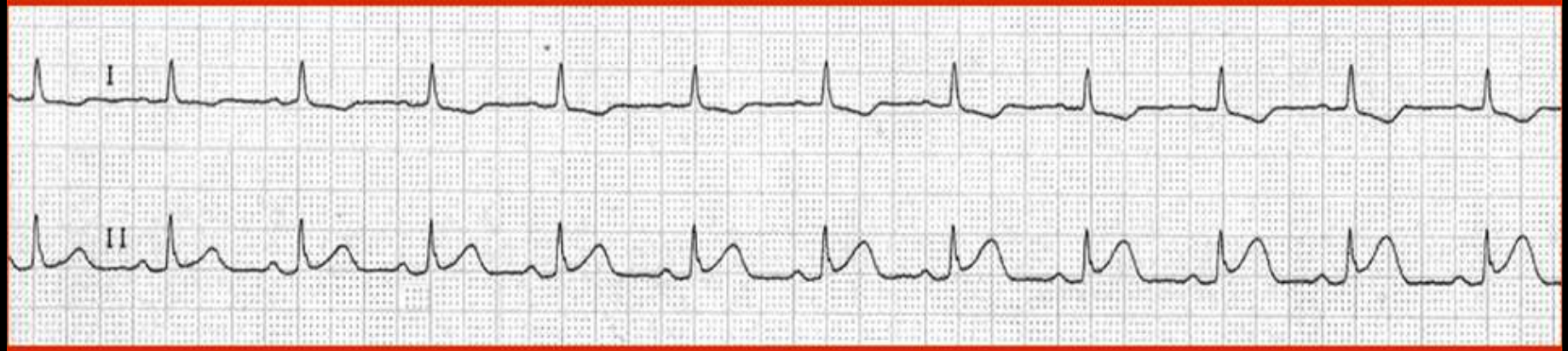
Abnormal ST Elevation Criteria: ACC/AHA 2009 "Standardization and Interpretation of the ECG, Part VI Acute Ischemia and Infarction," Galen Wagner, et al

Recommendations

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

ST SEGMENT ELEVATION:

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



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

3 COMMON PATTERNS of ST SEGMENT ELEVATION From ACUTE MI:

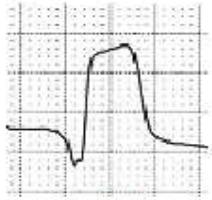
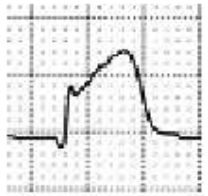
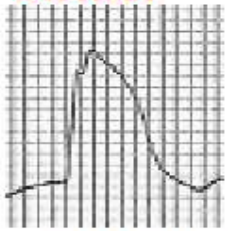
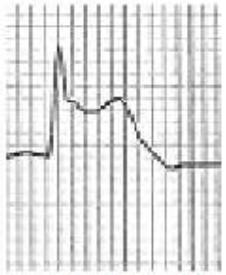
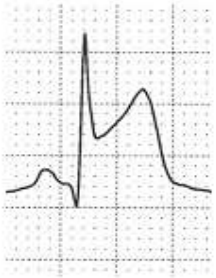
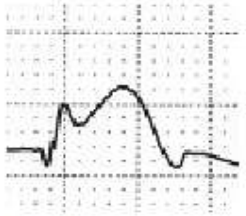
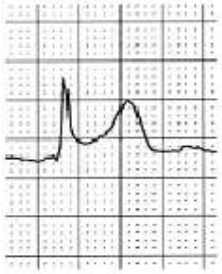
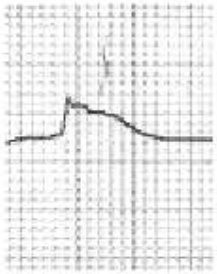
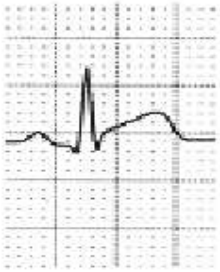
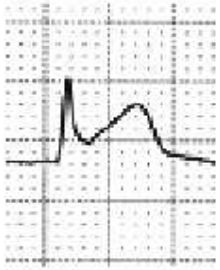
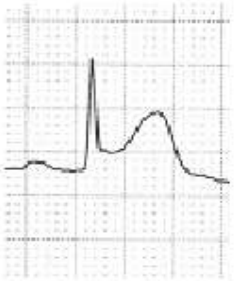
DOWNSLOPING S-T SEGMENT

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 STEMI.

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

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

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

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

ACUTE MI

COMPLICATIONS TO ANTICIPATE FOR ALL MI PATIENTS :

LETHAL DYSRHYTHMIAS

CARDIAC ARREST

FAILURE OF STRUCTURE(S) SERVED BY THE BLOCKED ARTERY

STEMI

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

STEMI

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

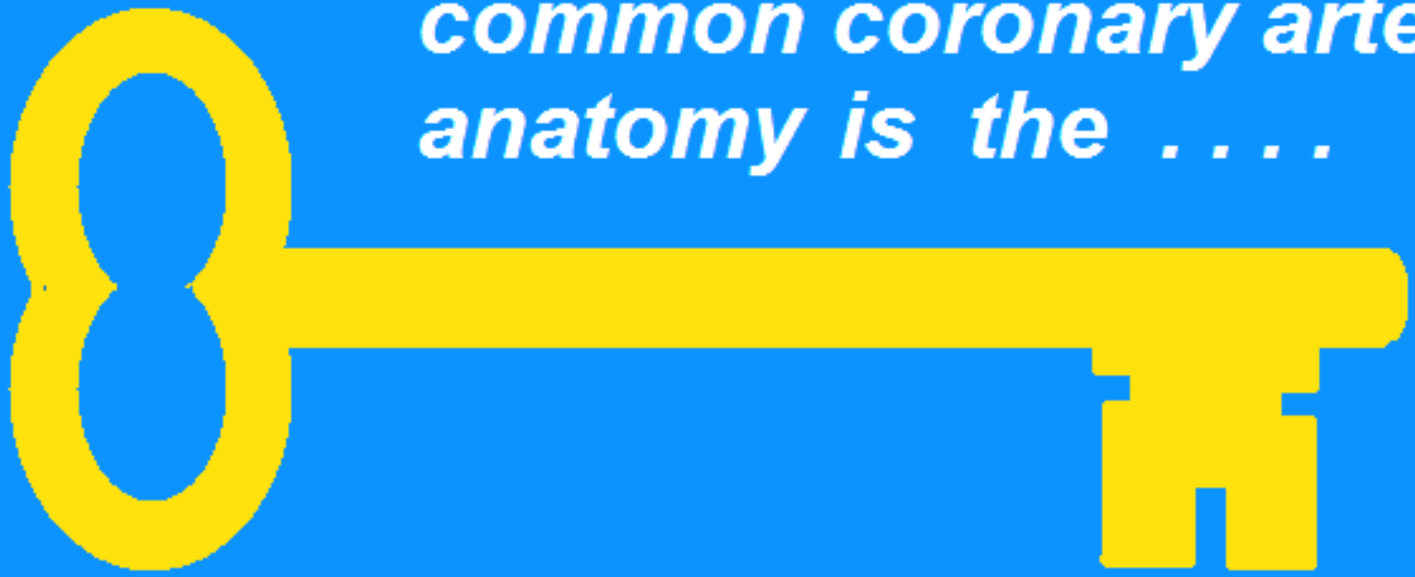
. . . . . Will serve as a "crystal ball," allowing you to ANTICIPATE complications of STEMI . . . .

STEMI

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

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

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



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

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

INTERPRET THE EKG, THEN:

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

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

CASE STUDY 1 - STEMI

CHIEF COMPLAINT and SIGNIFICANT HISTORY:

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

RISK FACTOR PROFILE:

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

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

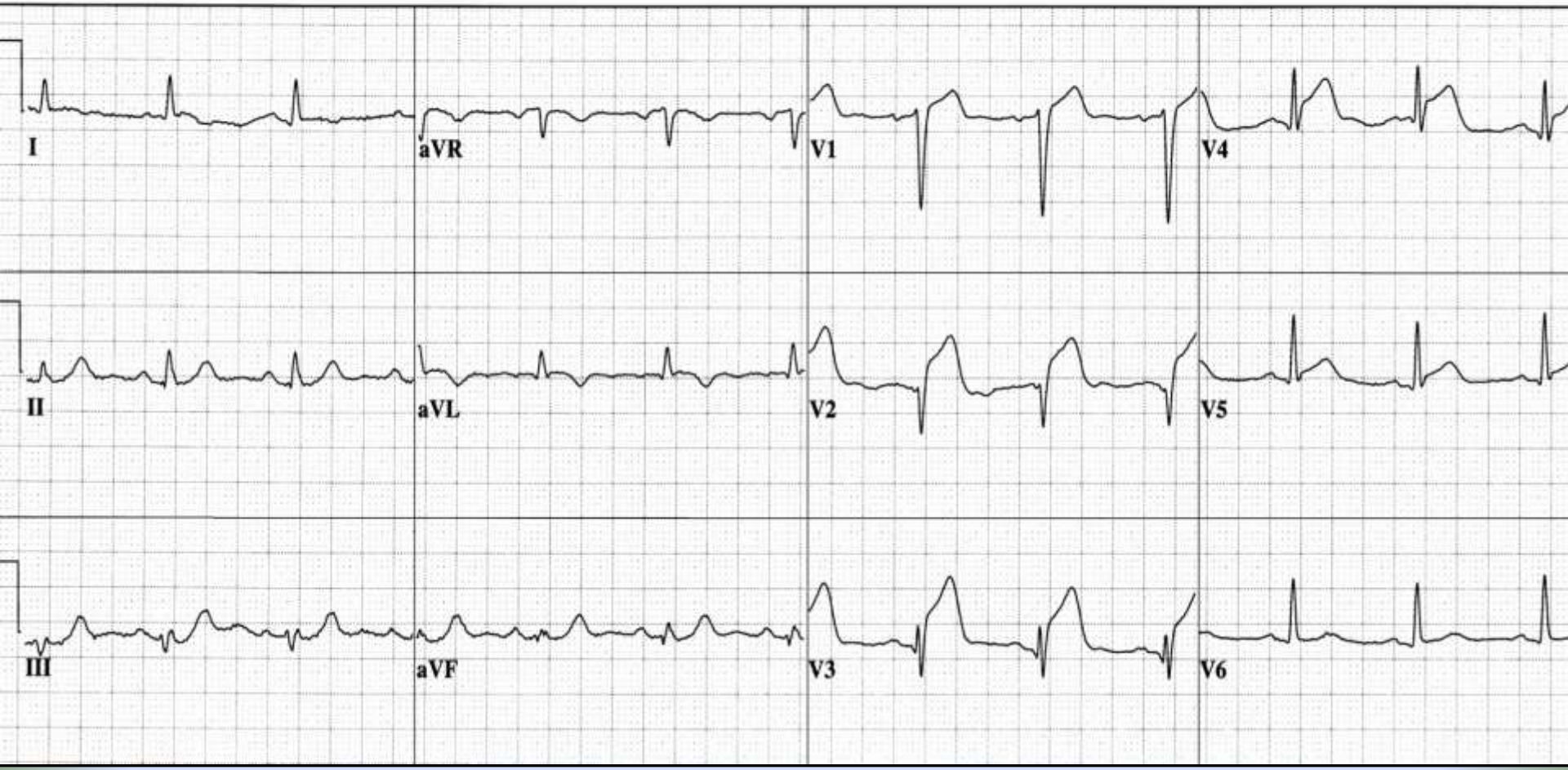
VITAL SIGNS: BP: 100/64, P: 75, R: 20, SAO2: 94%

LABS: FIRST TROPONIN: 6.4

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

EVALUATE EKG for indicators of ACS:

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



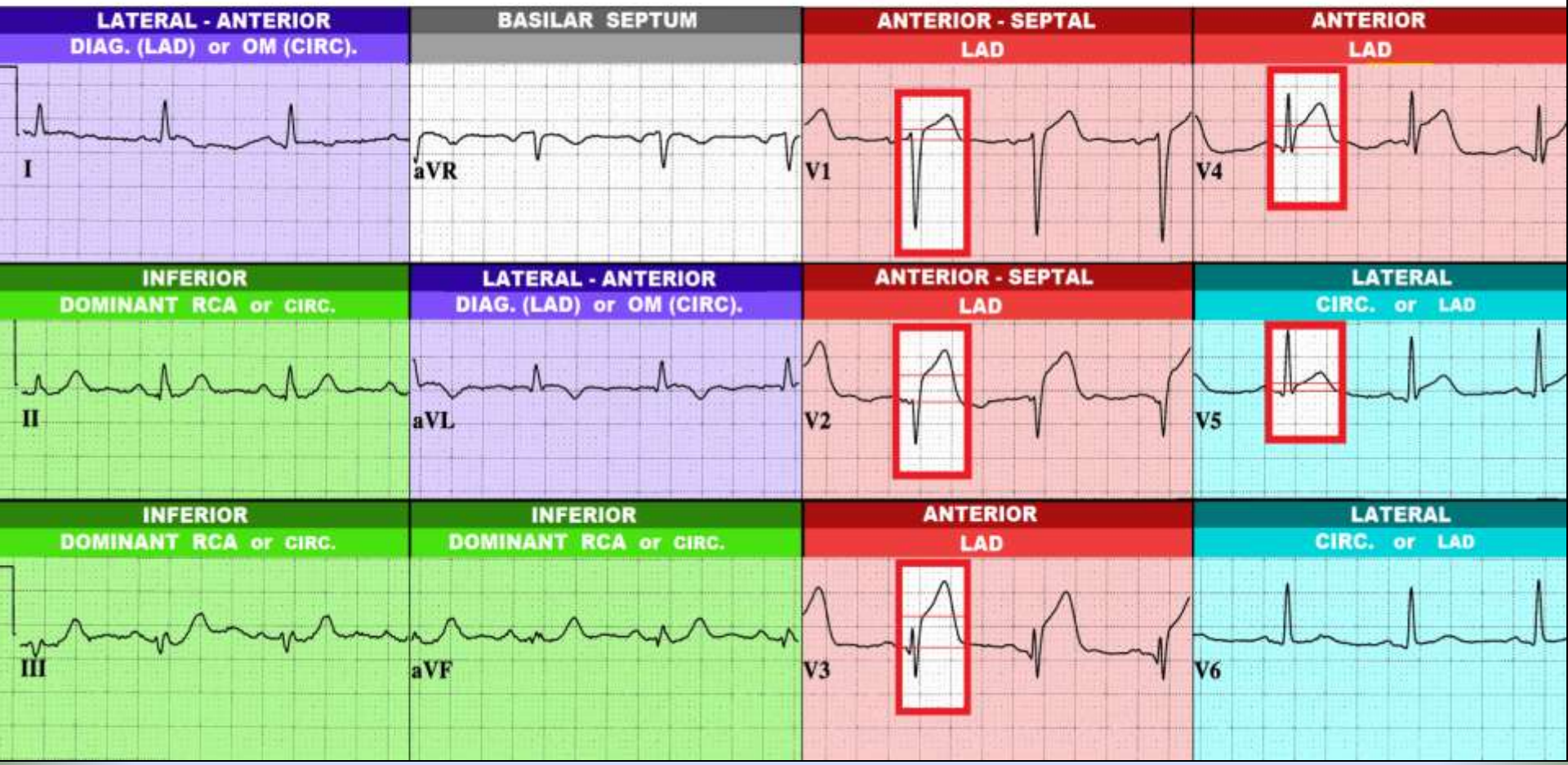
72 yr
Male Caucasian

Loc: Option:2

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

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

ST SEGMENT ELEVATION



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

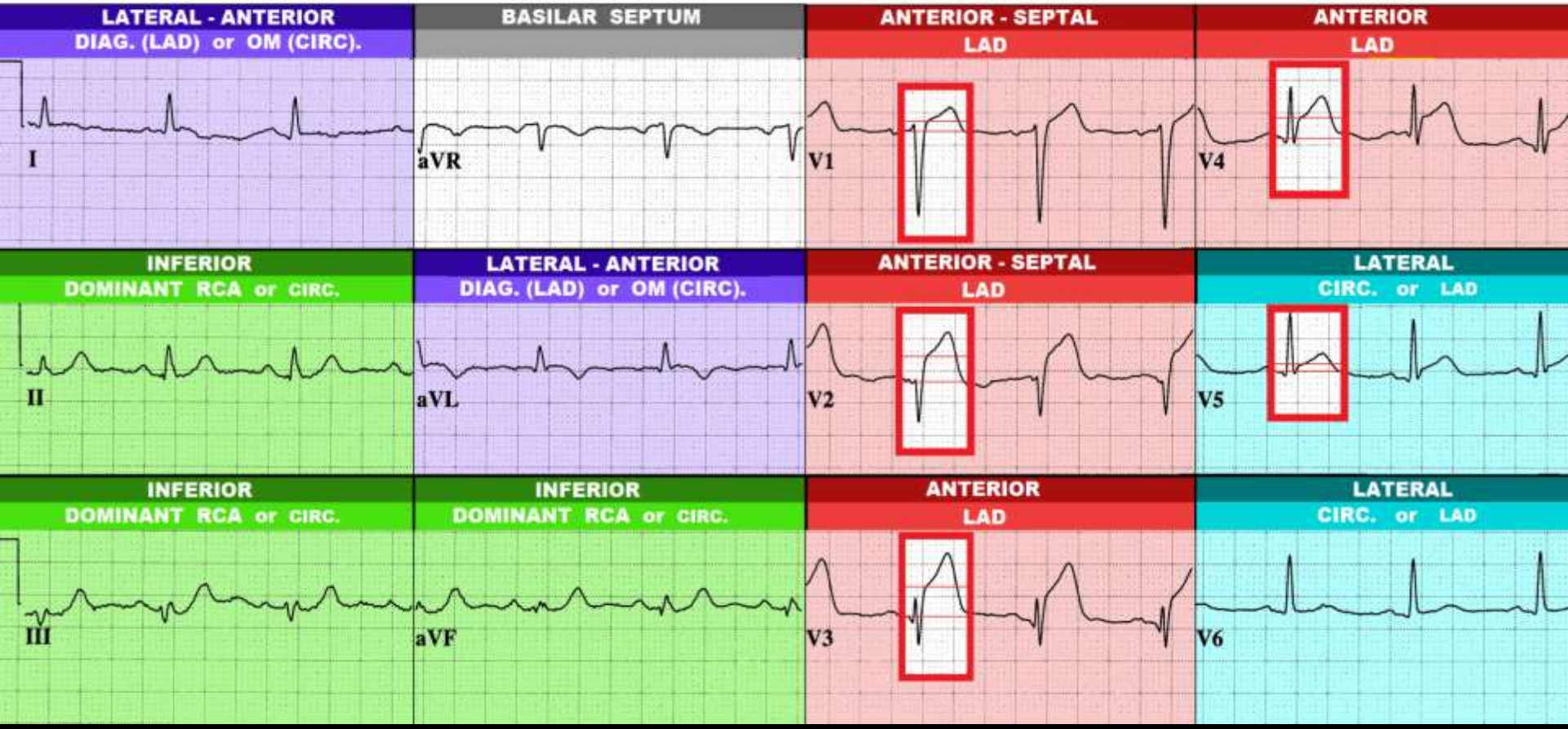
72 yr
Male Caucasian

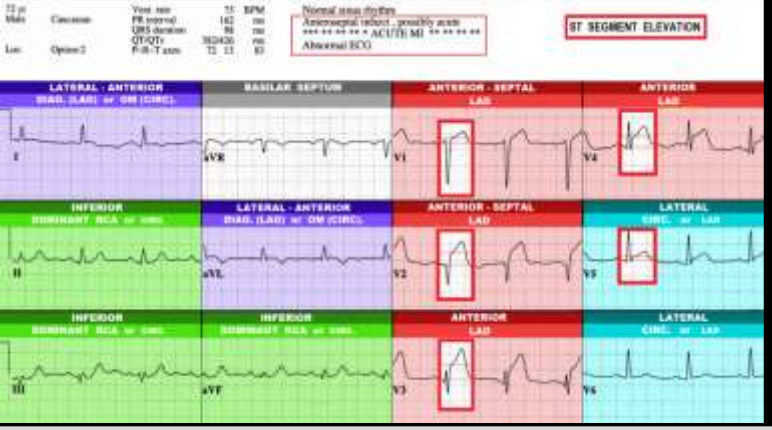
Loc: Option:2

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

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

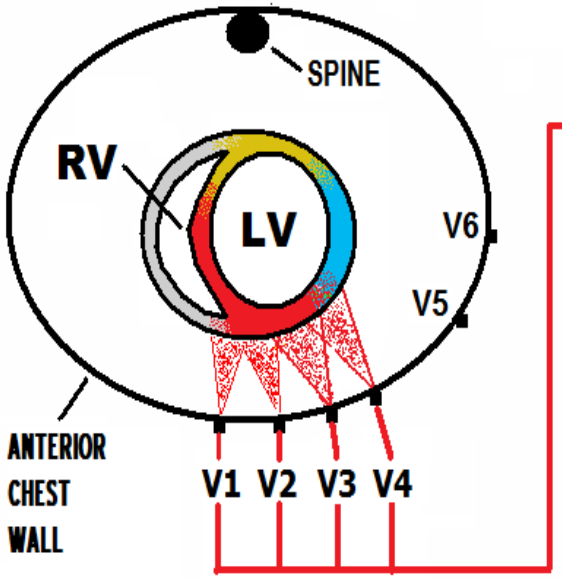
ST SEGMENT ELEVATION





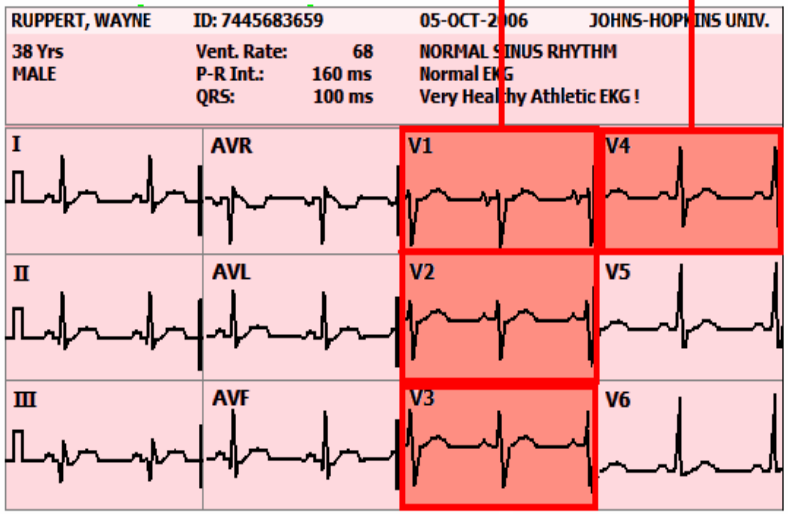
V1 - V4 VIEW THE ANTERIOR-SEPTAL WALL

of the LEFT VENTRICLE

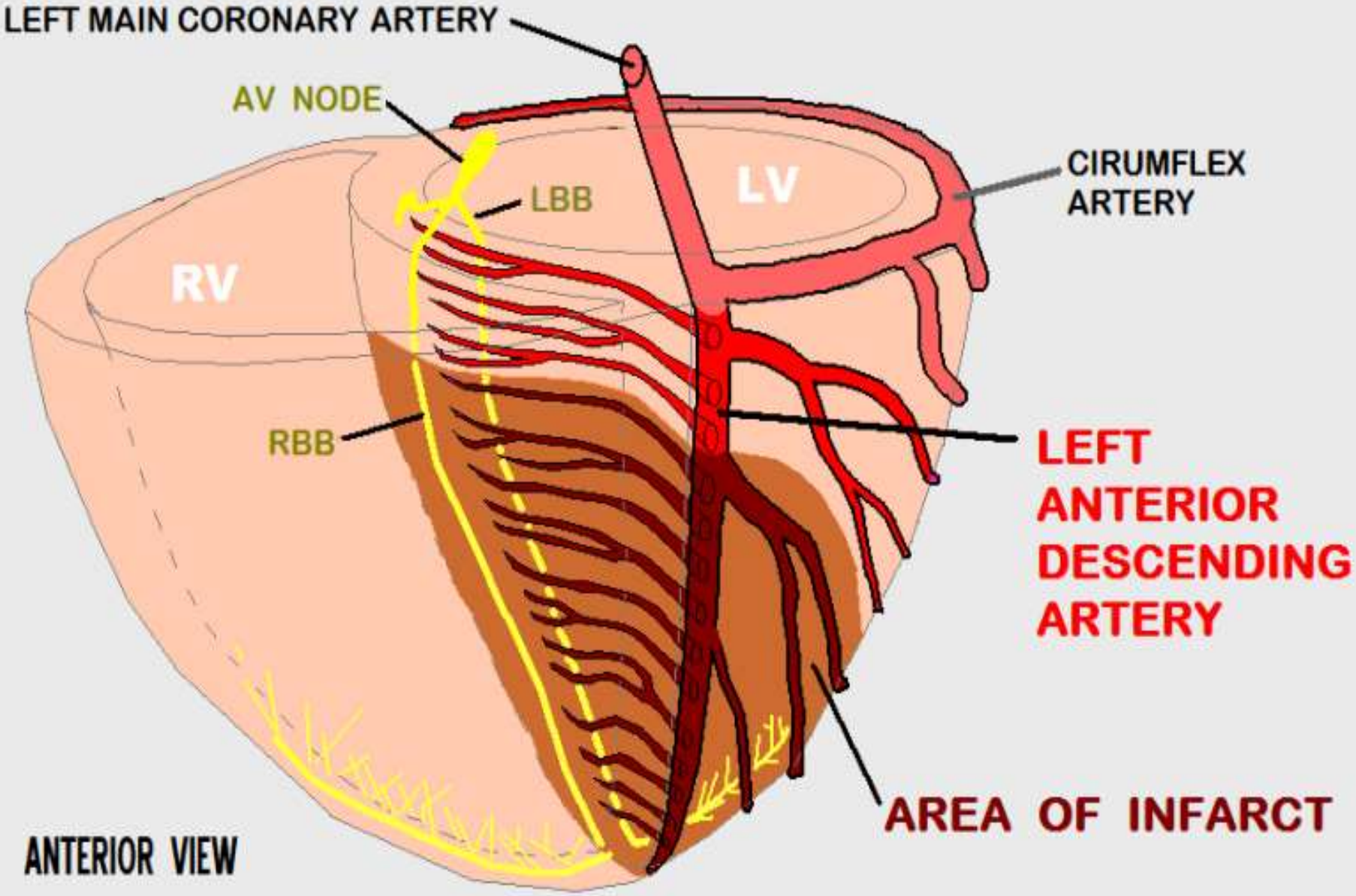


V1, V2 - ANTERIOR / SEPTAL

V3, V4 - ANTERIOR

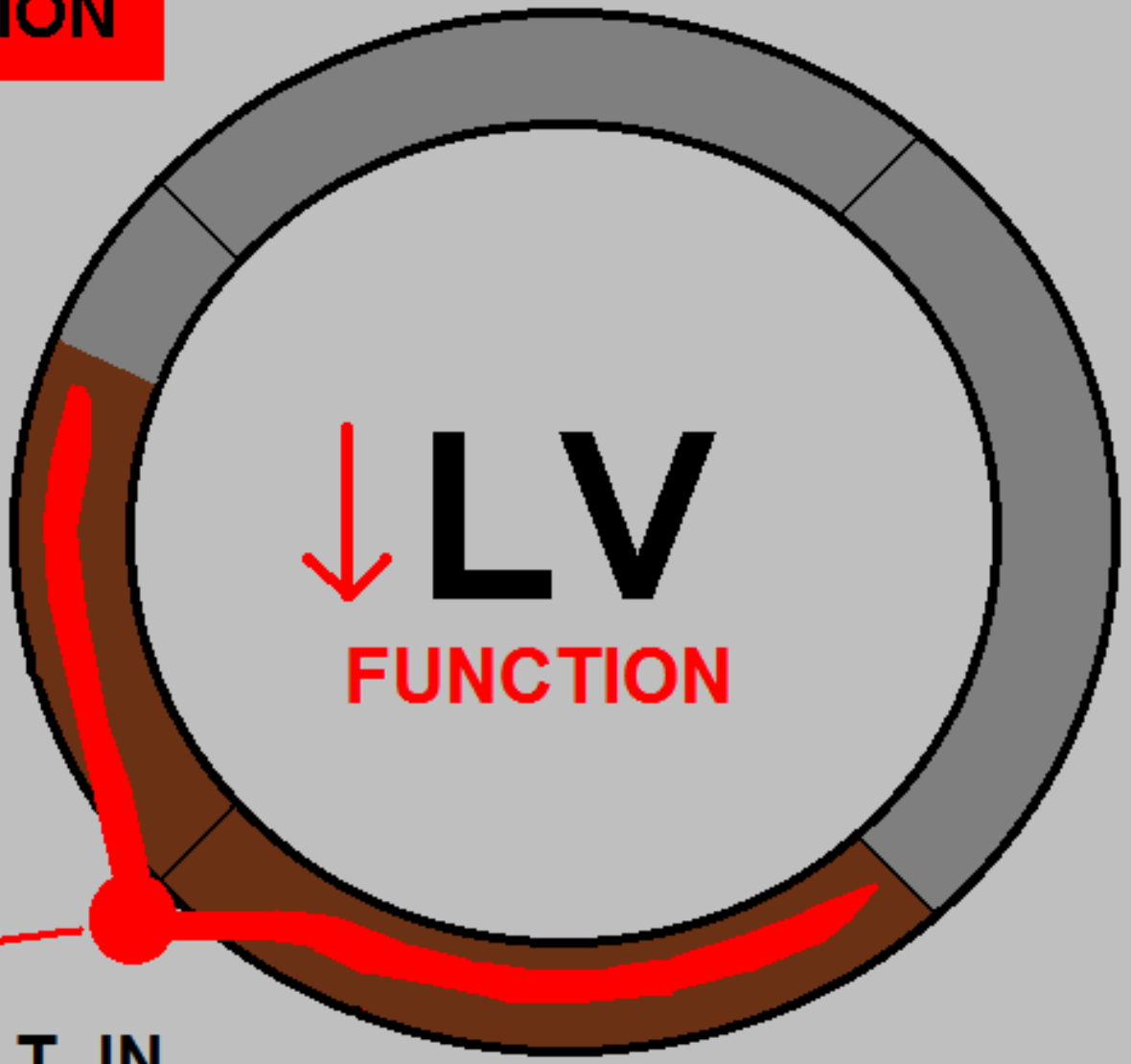


OCCLUSION of MID - LEFT ANTERIOR DESCENDING ARTERY



LAD DISTRIBUTION

35 - 45 % of LV MUSCLE MASS



A BLOCKAGE OF THE LAD

CAN RESULT IN LV PUMP FAILURE --

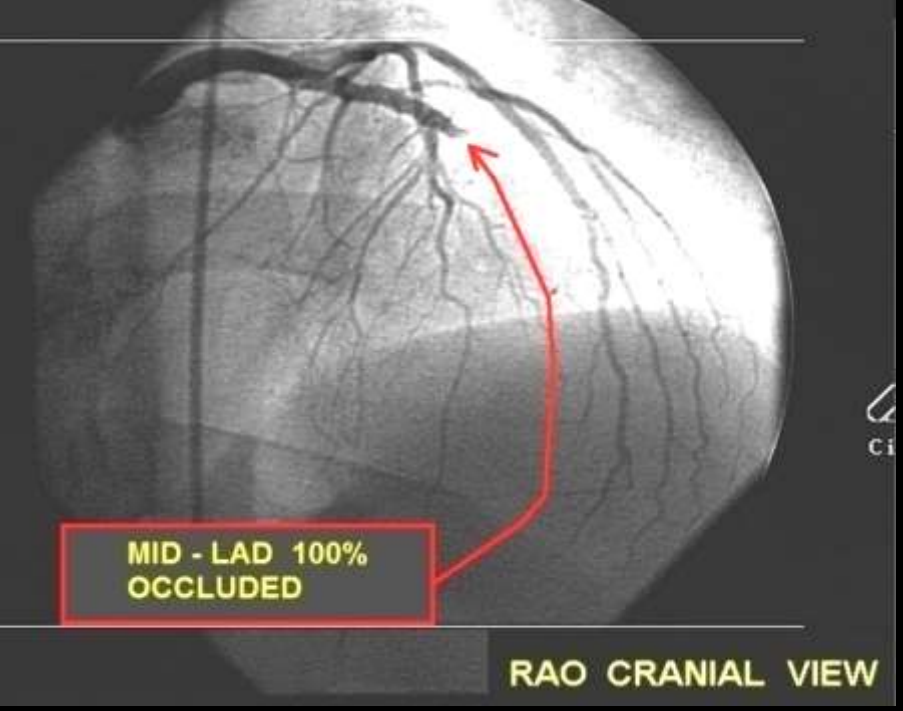
- CARDIOGENIC SHOCK
- PULMONARY EDEMA

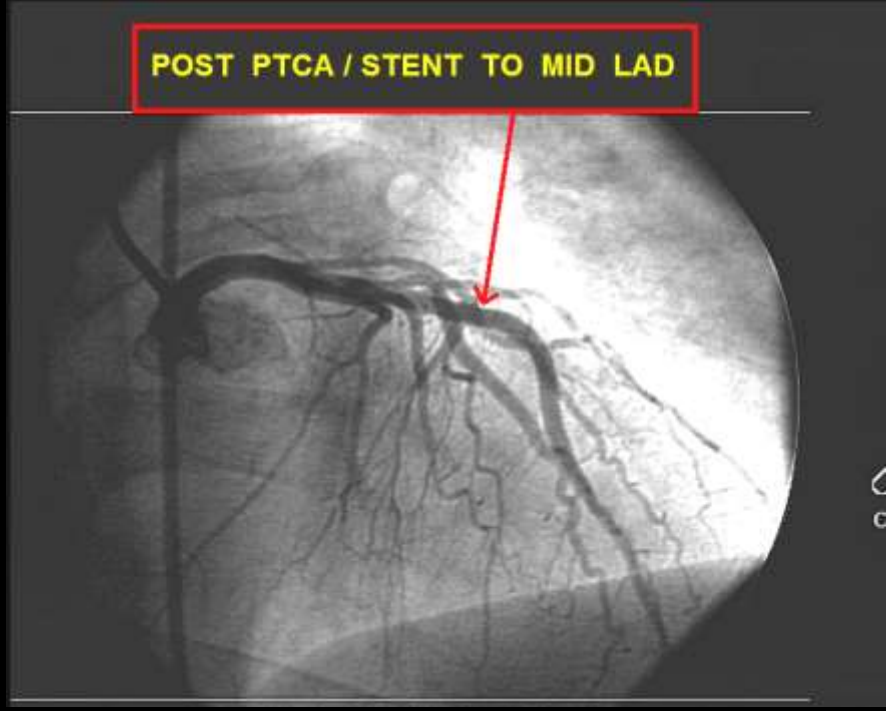

400 mg
Dopamine
(1600 mcg/mL)
Dopamine Hydrochloride
and 5% Dextrose Injection USP
250 mL
Baxter
500 mg Total
DOBUTamine
Hydrochloride in
5% Dextrose
250 mL
Baxter

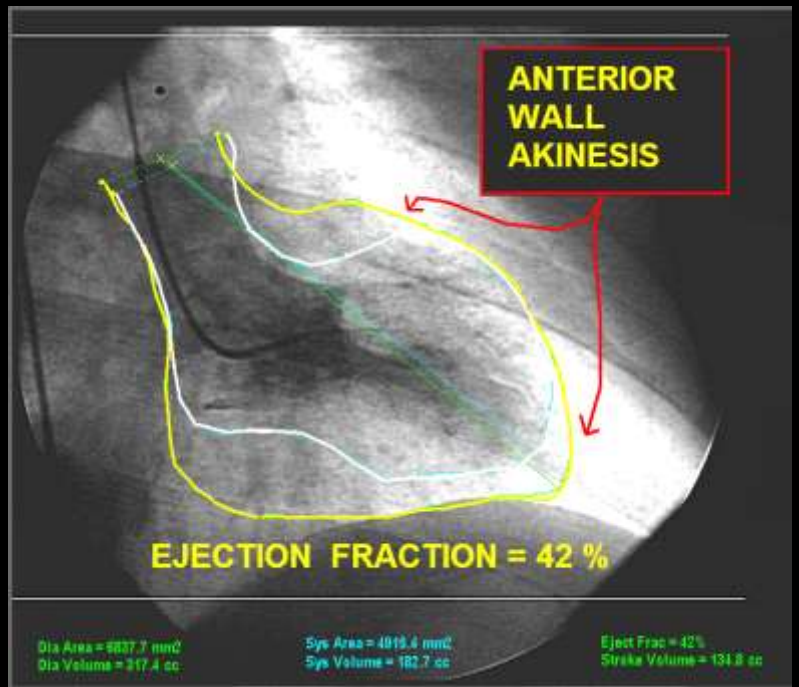
LEFT ANTERIOR DESCENDING ARTERY (LAD)

- 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 %

CASE STUDY 2: STEMI

CHIEF COMPLAINT and SIGNIFICANT HISTORY:

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

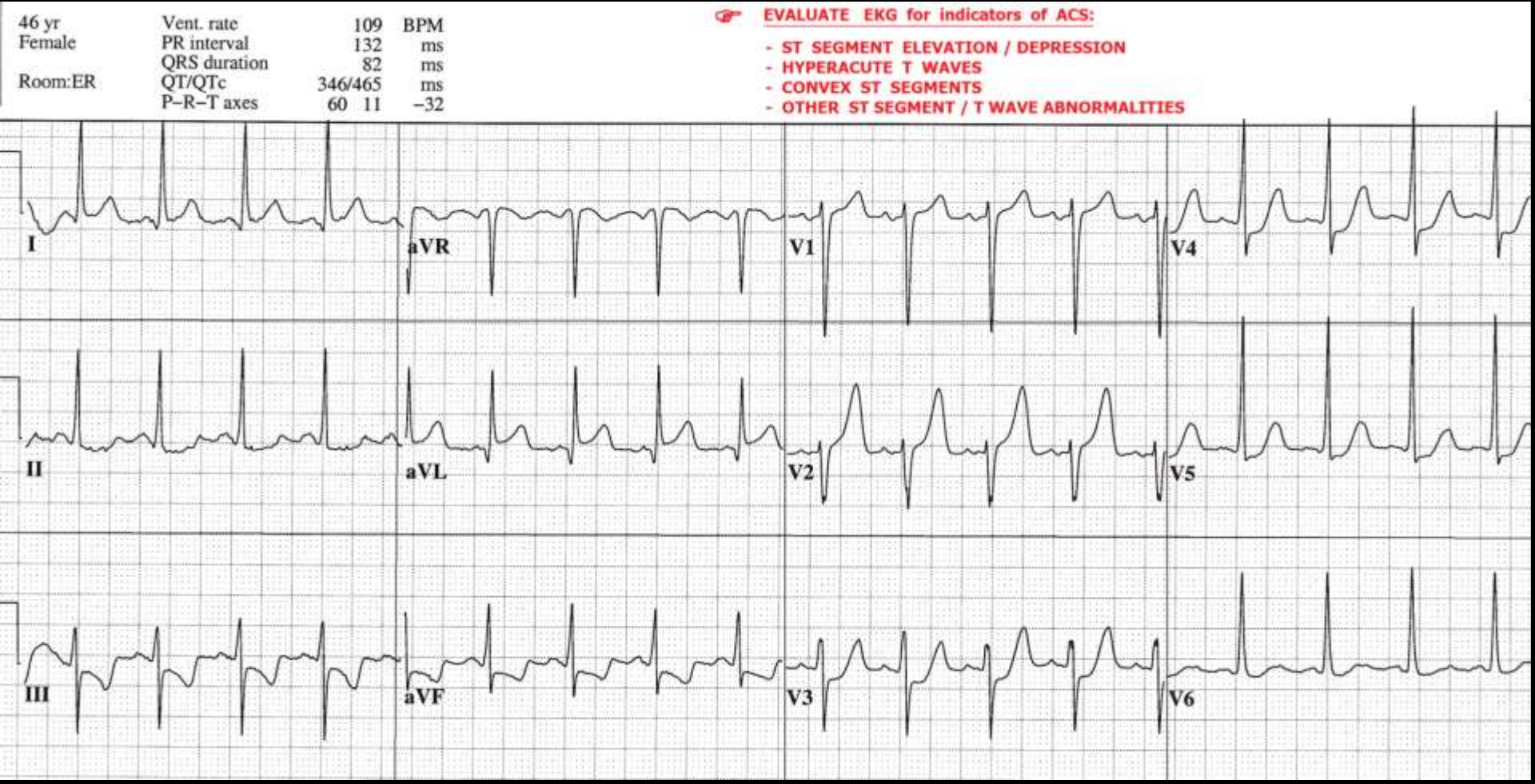
RISK FACTOR PROFILE:

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

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

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

LABS: TROPONIN ultra = 2.8


46 yr
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
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
Female

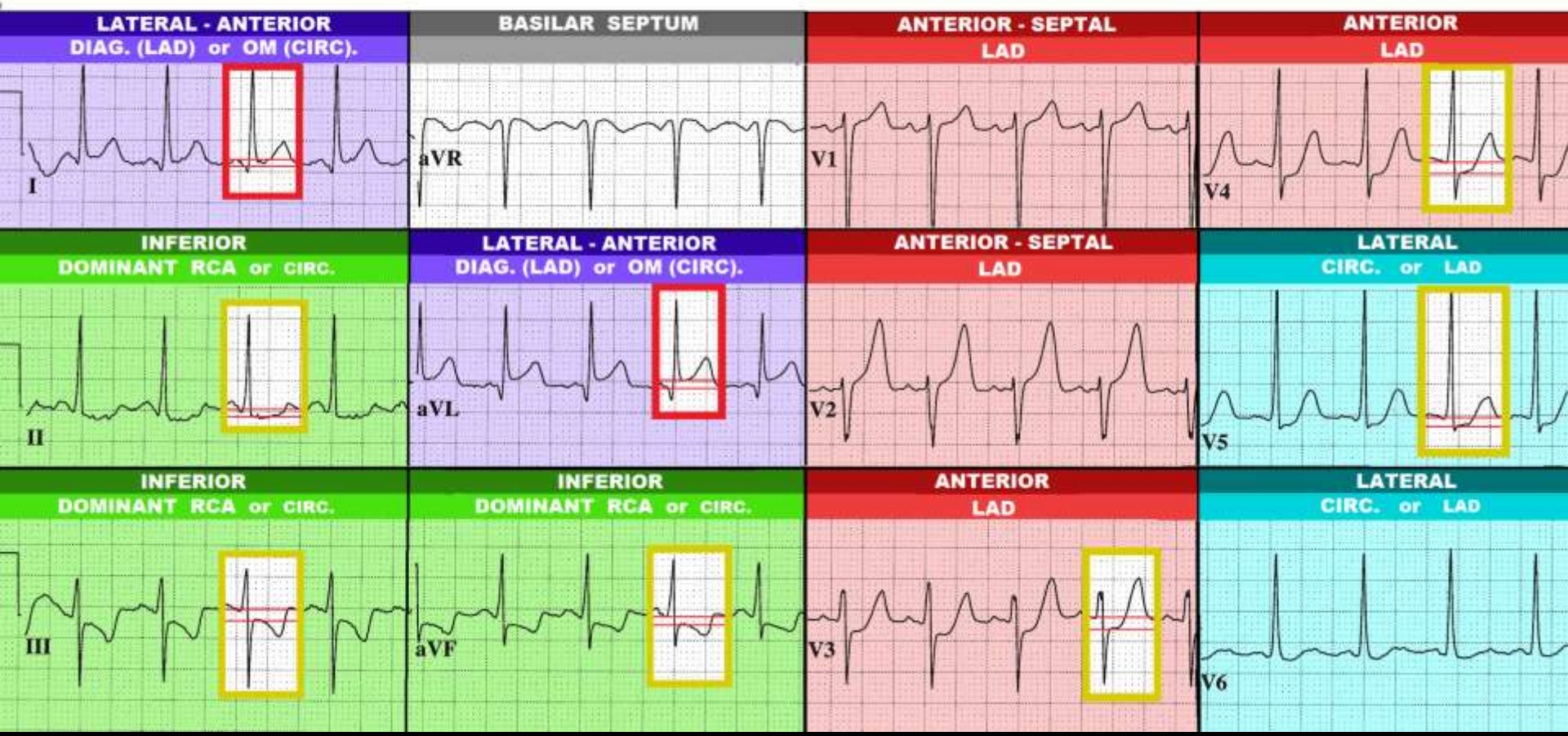
Room:ER

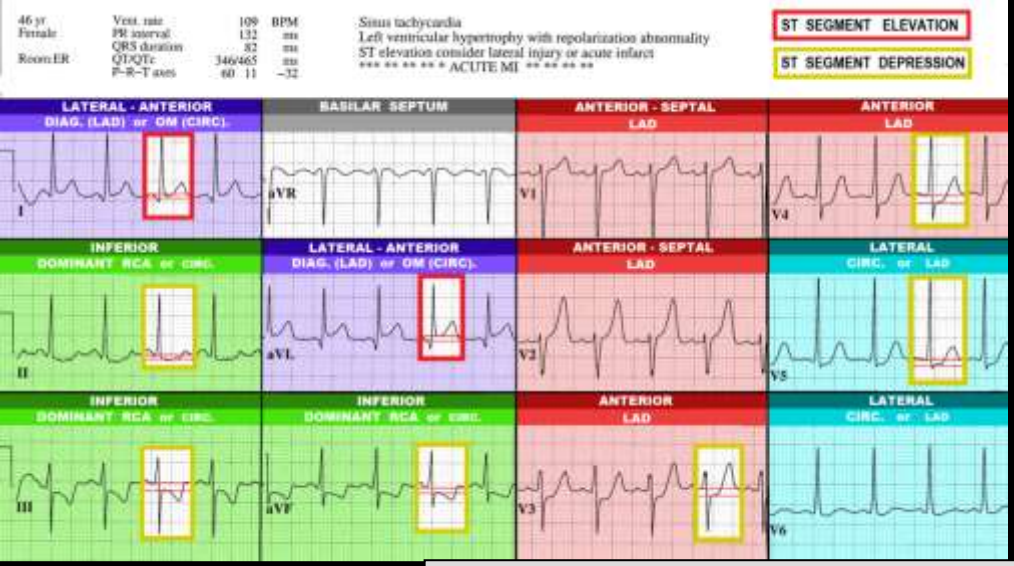
Vent. rate	109	BPM
PR interval	132	ms
QRS duration	82	ms
QT/QTc	346/465	ms
P–R–T axes	60 11	–32

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

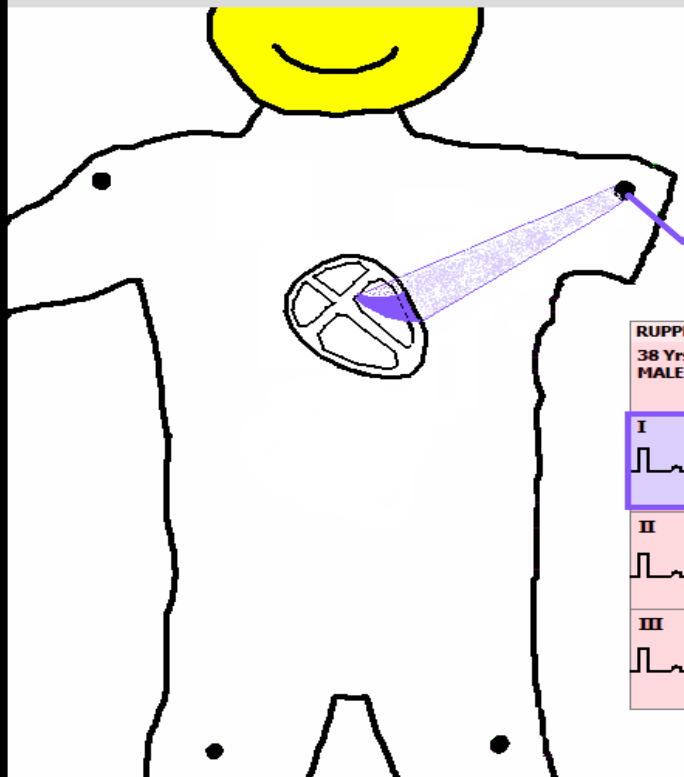
ST SEGMENT ELEVATION

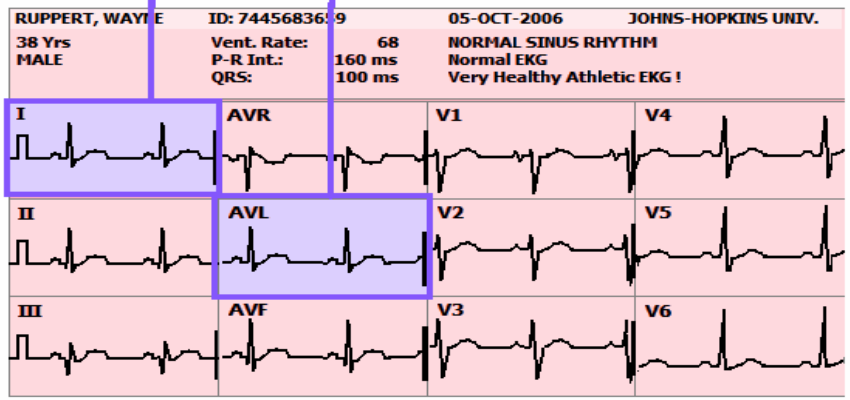
ST SEGMENT DEPRESSION



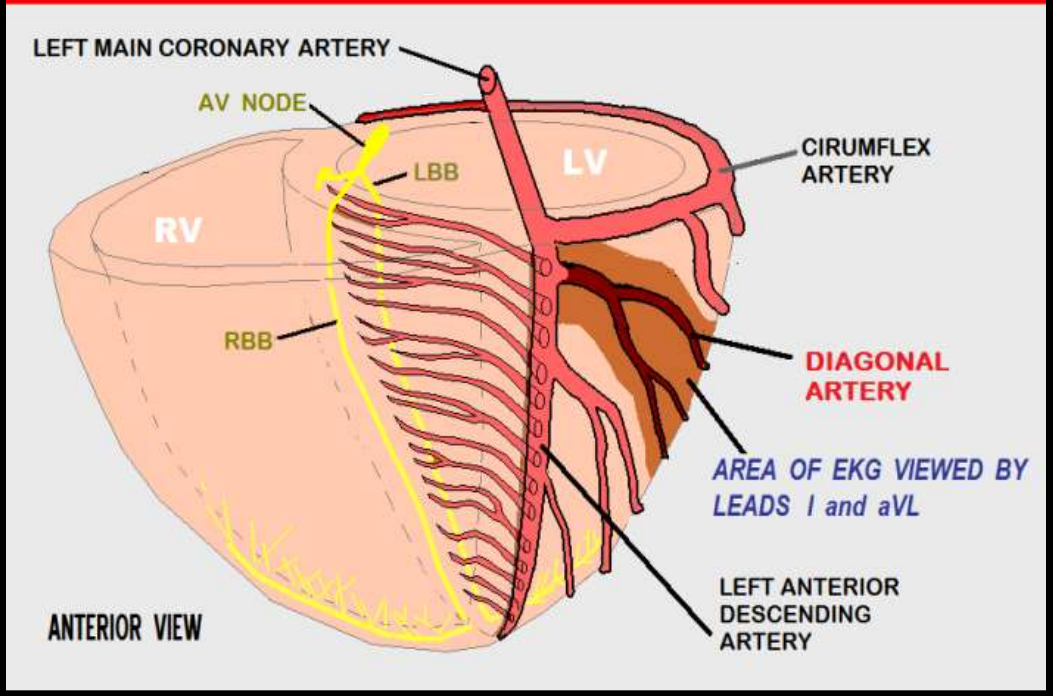


LEADS I and aVL view the ANTERIOR-LATERAL JUNCTION

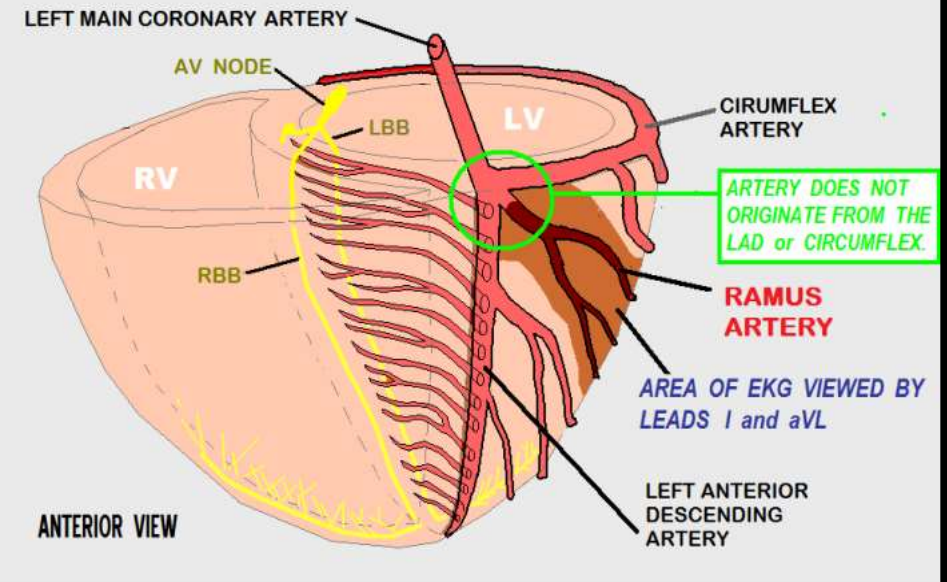




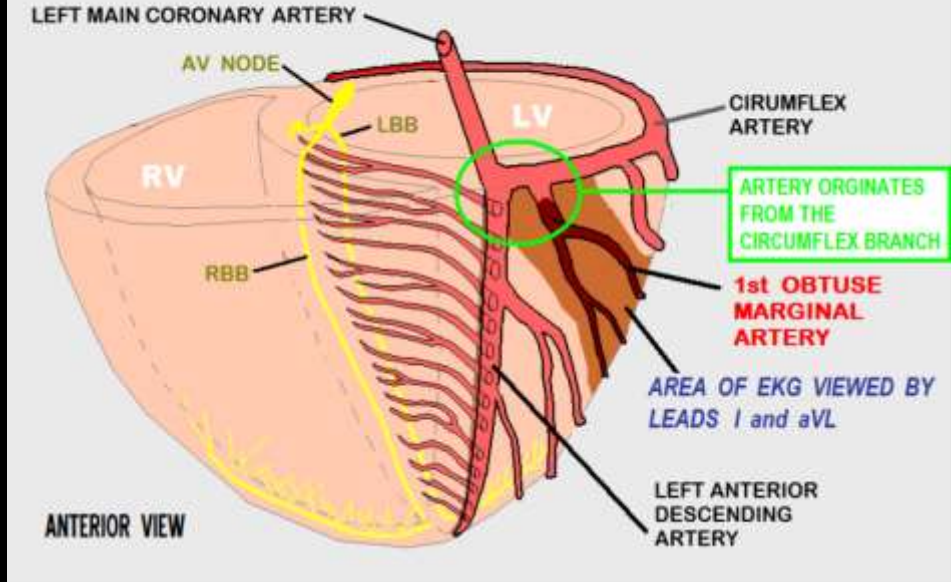
OCCLUSION of DIAGONAL ARTERY



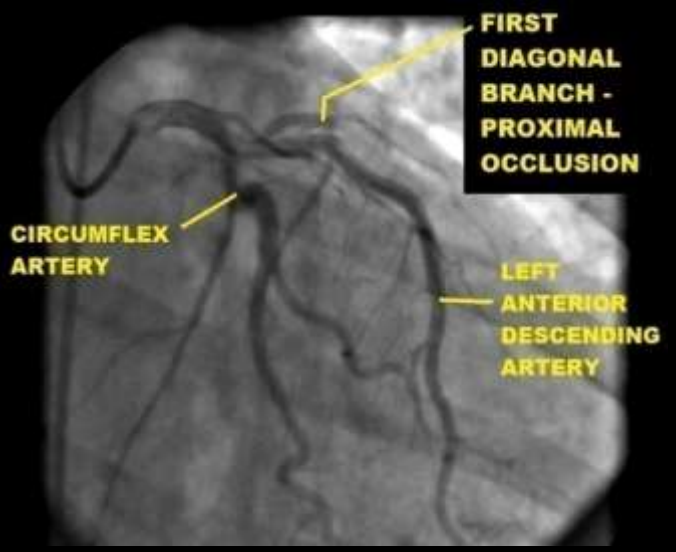
OCCLUSION of RAMUS ARTERY

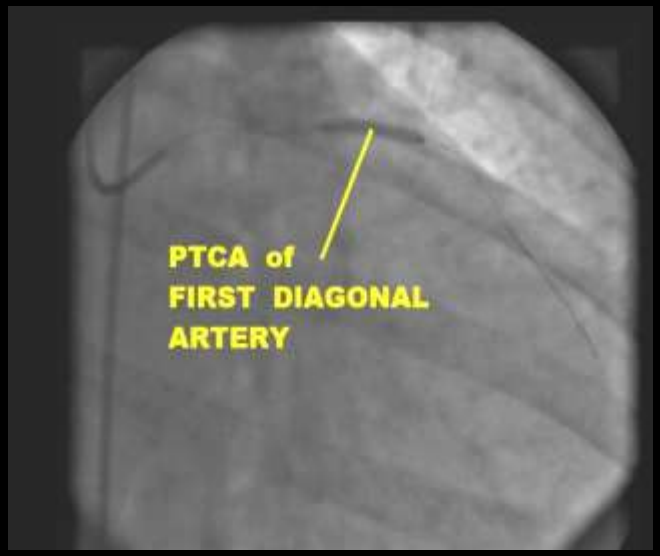


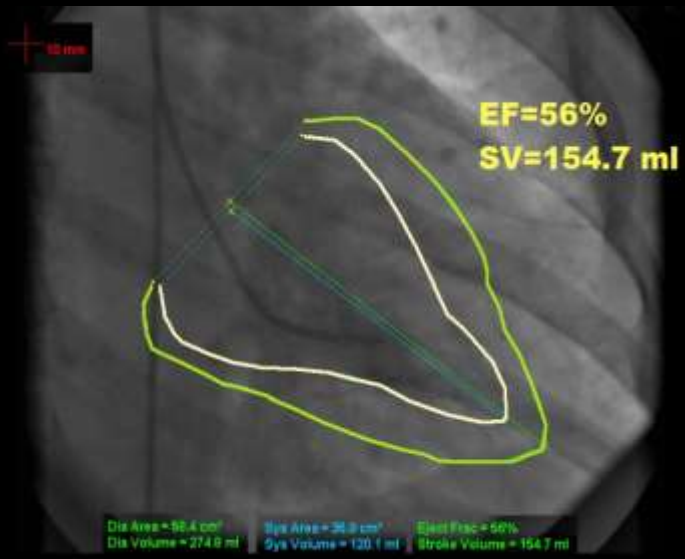
OCCLUSION of OBTUSE MARGINAL ARTERY



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







[redacted]

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

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

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

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

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

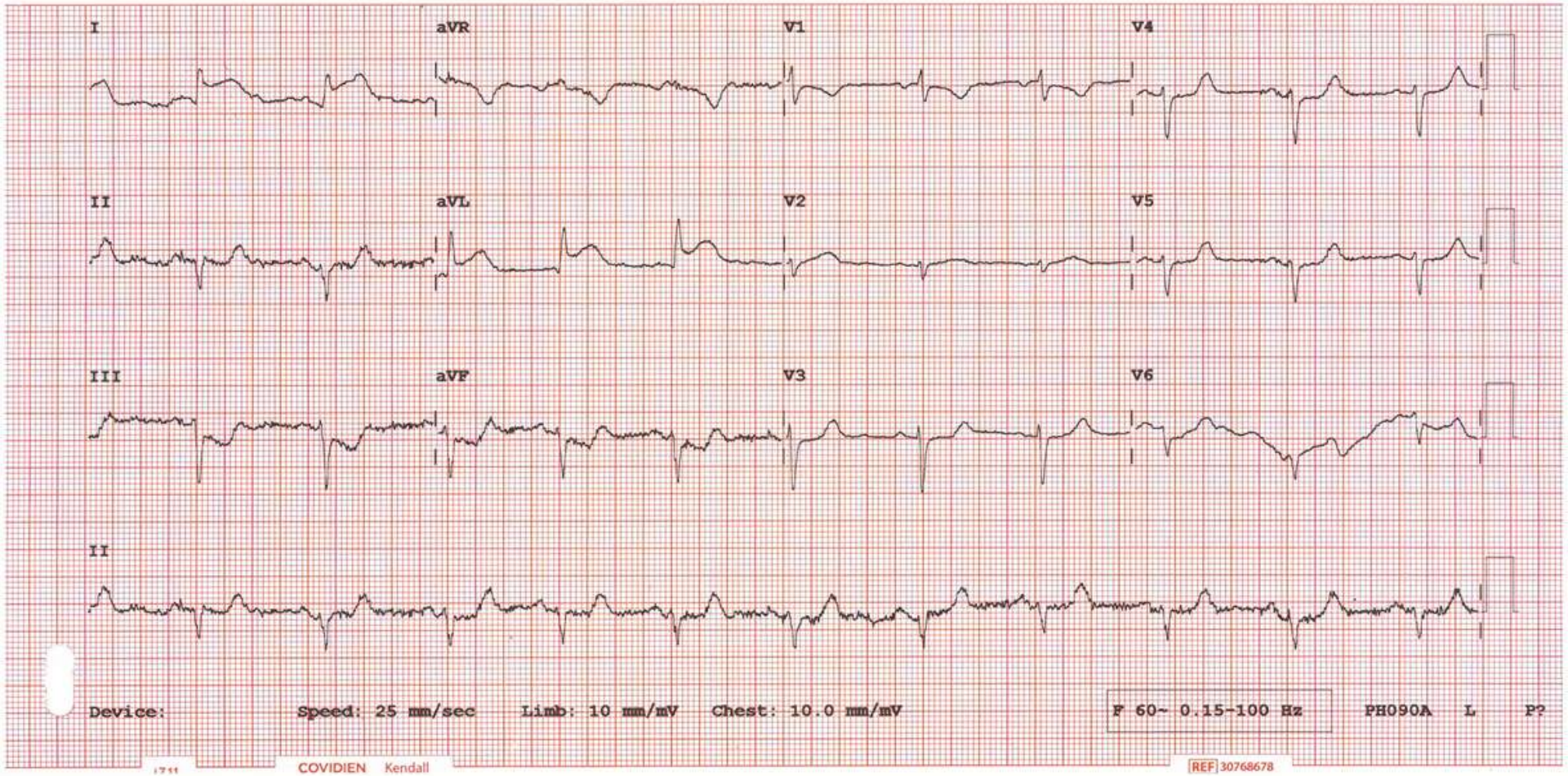
Room: er11

Physician [redacted]
Date
Time 1331
STEMI YES NO

- ABNORMAL ECG -

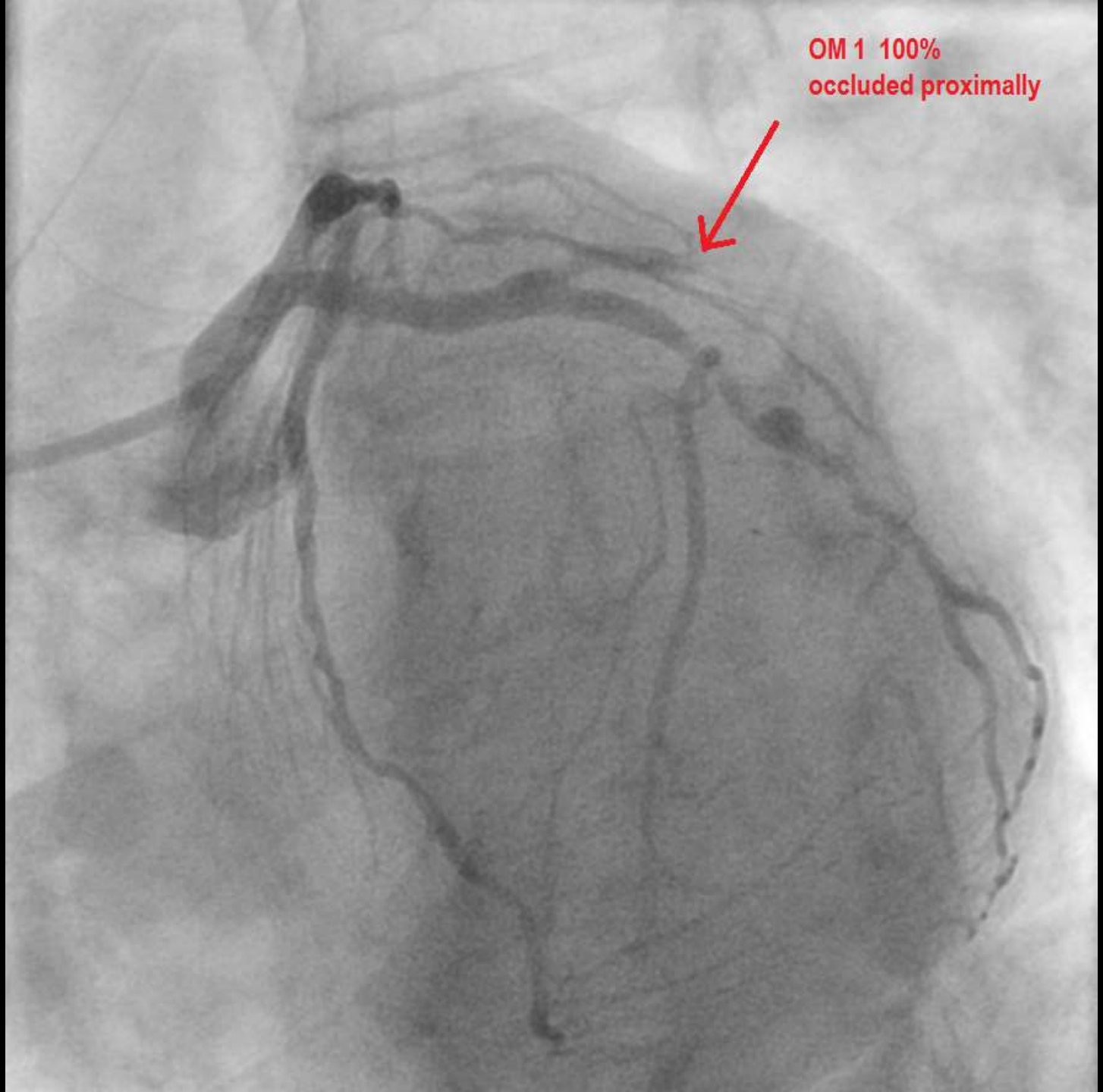
12 Lead; Standard Placement

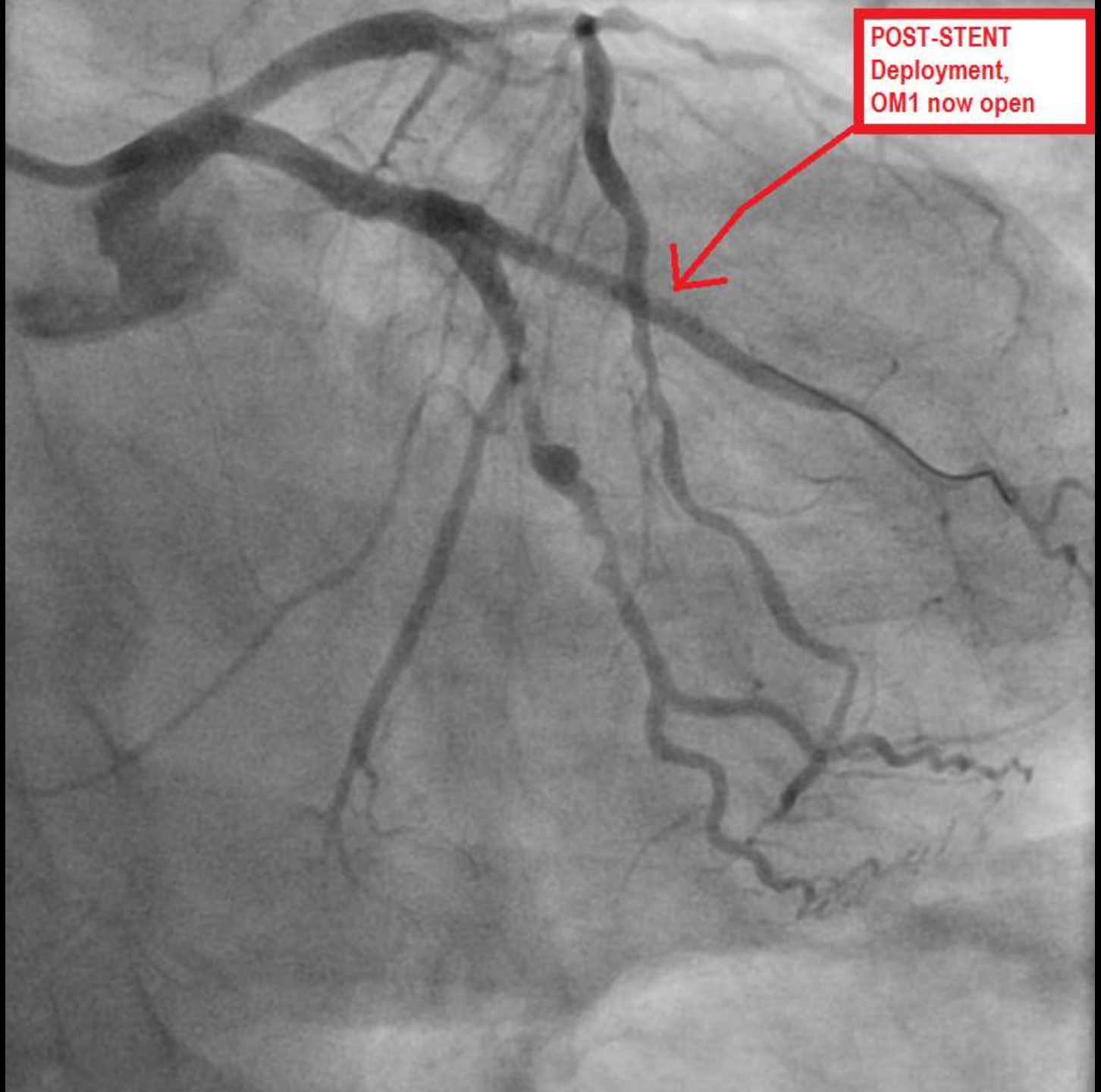
Unconfirmed Diagnosis



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

COVIDIEN Kendall REF 30768678


OM 1 100%
occluded proximally


POST-STENT
Deployment,
OM1 now open

CASE STUDY 3: STEMI

CHIEF COMPLAINT and SIGNIFICANT HISTORY:

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

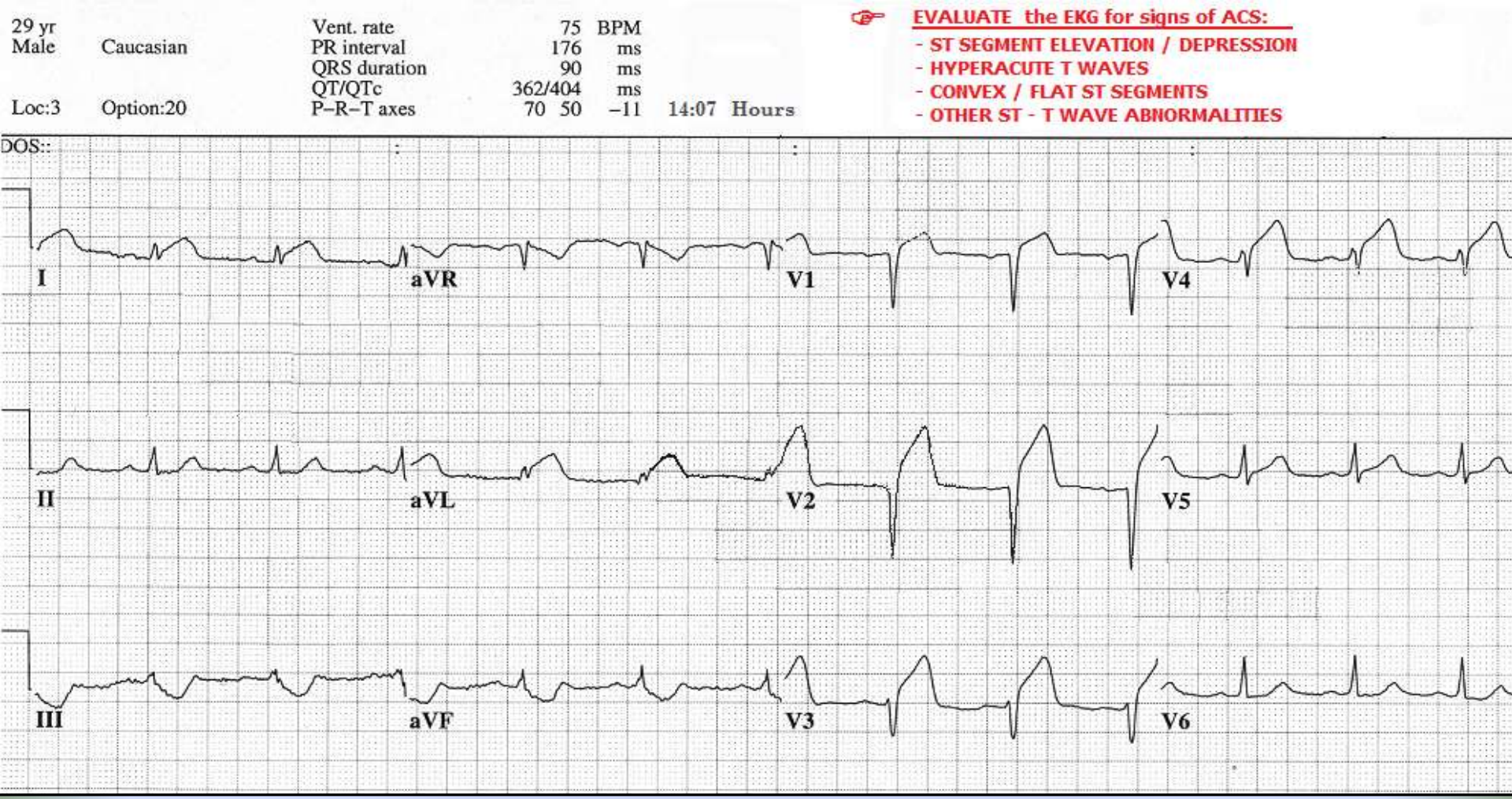
RISK FACTOR PROFILE:

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

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

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

LABS: INITIAL CARDIAC MARKERS - NEGATIVE


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

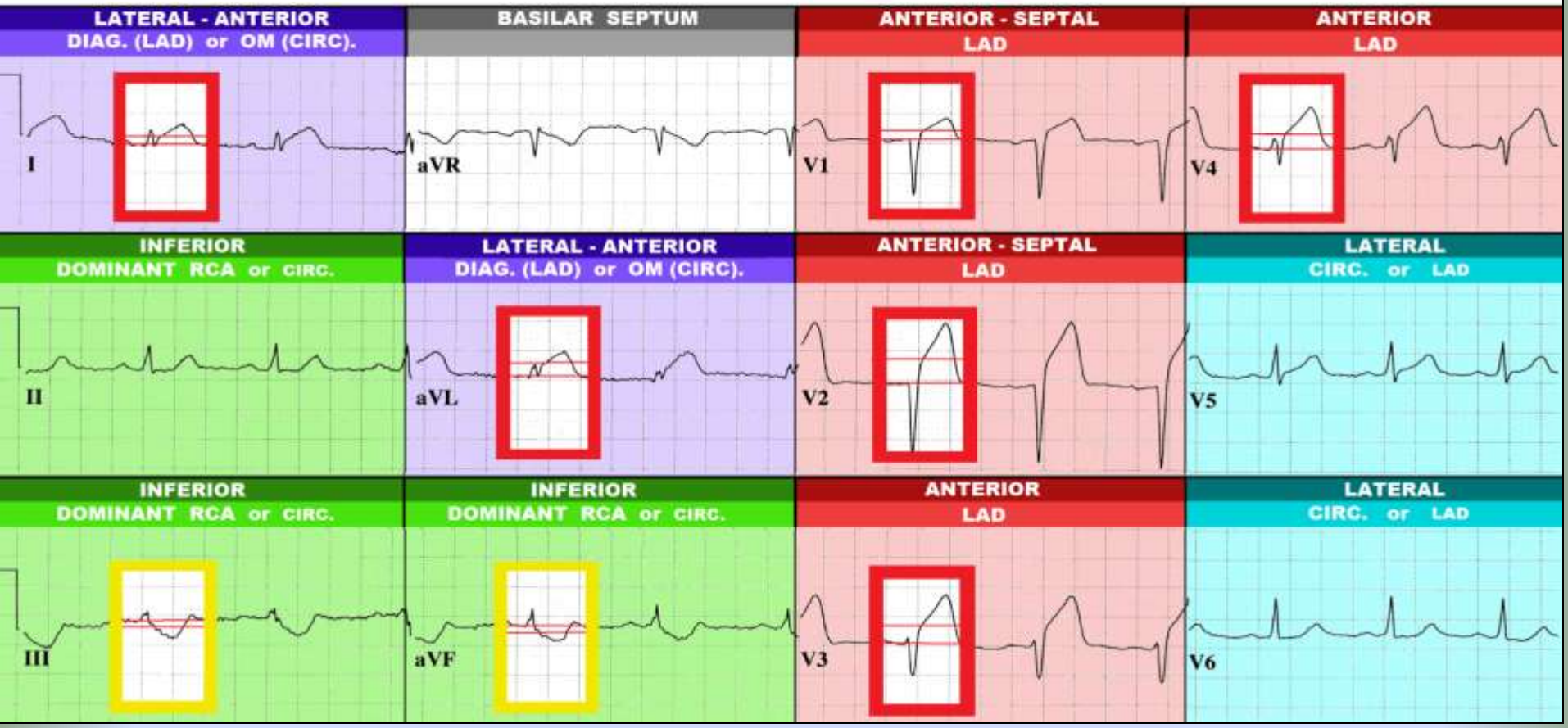
29 yr
Male
Caucasian

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

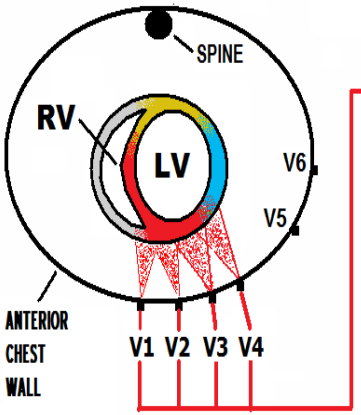
ST SEGMENT DEPRESSION



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

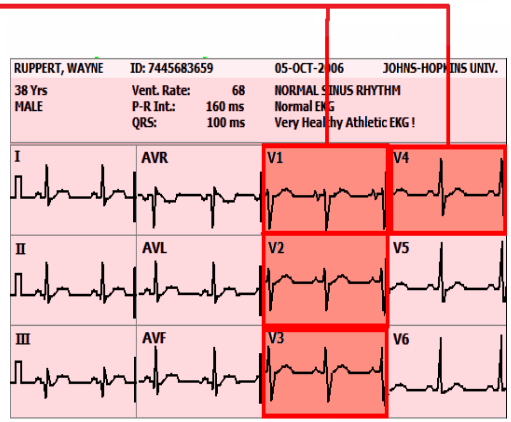
V1 - V4 VIEW THE ANTERIOR-SEPTAL WALL

of the LEFT VENTRICLE

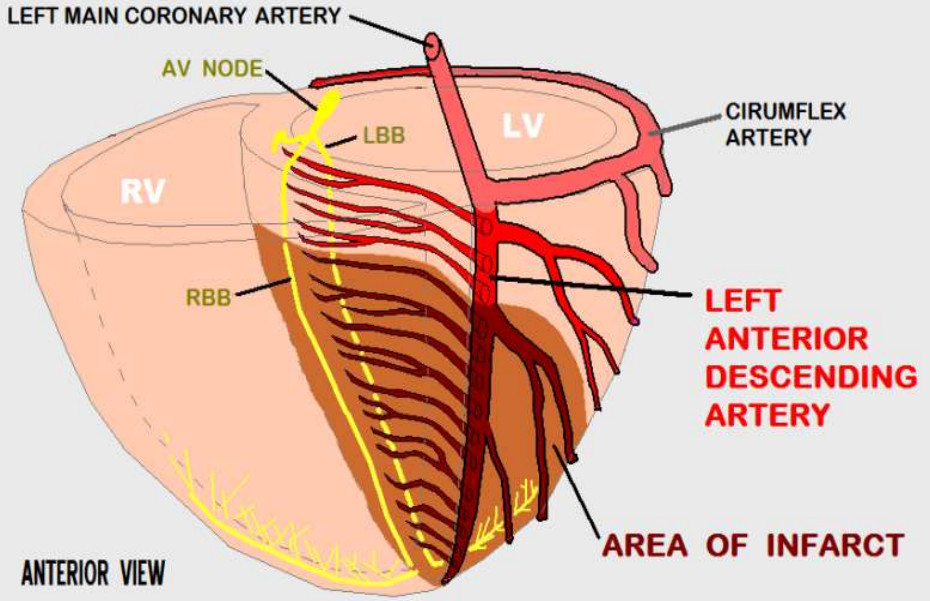


V1, V2 - ANTERIOR / SEPTAL

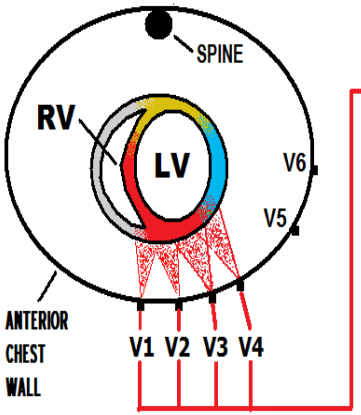
V3, V4 - ANTERIOR



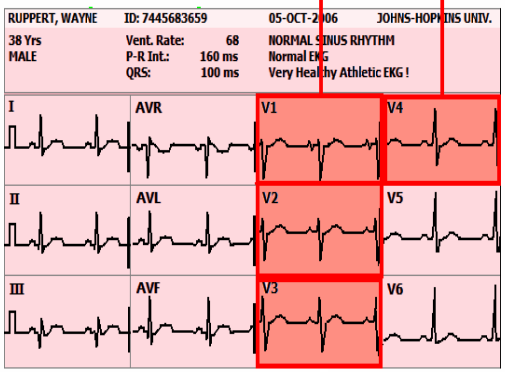
OCCLUSION of MID - LEFT ANTERIOR DESCENDING ARTERY



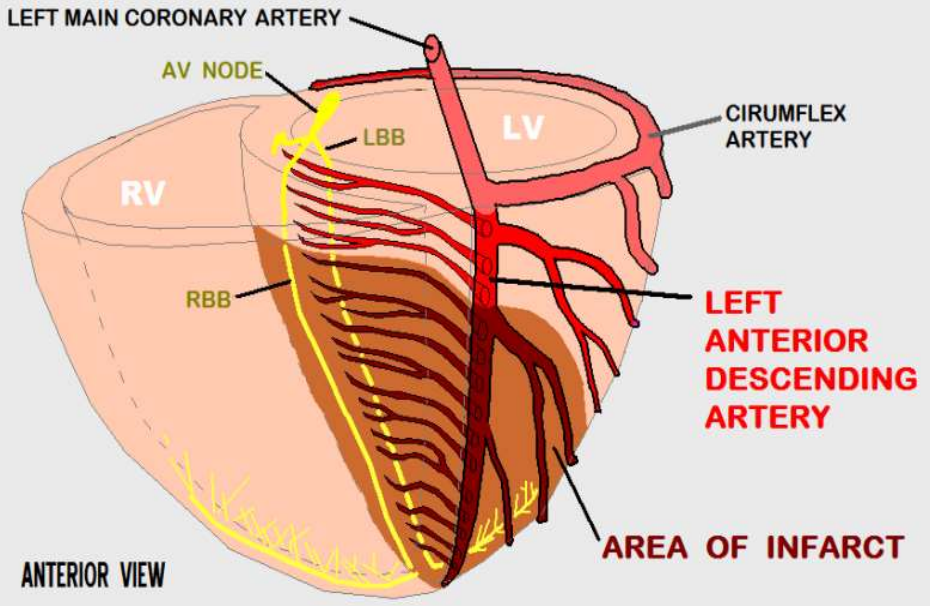
V1 - V4 VIEW THE ANTERIOR-SEPTAL WALL
of the LEFT VENTRICLE



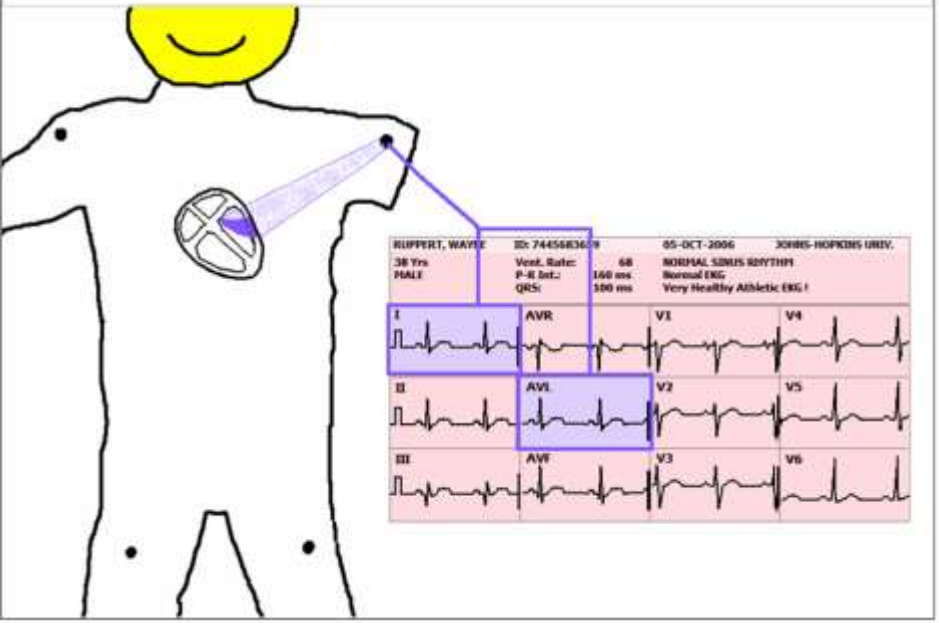
V1, V2 - ANTERIOR / SEPTAL
V3, V4 - ANTERIOR



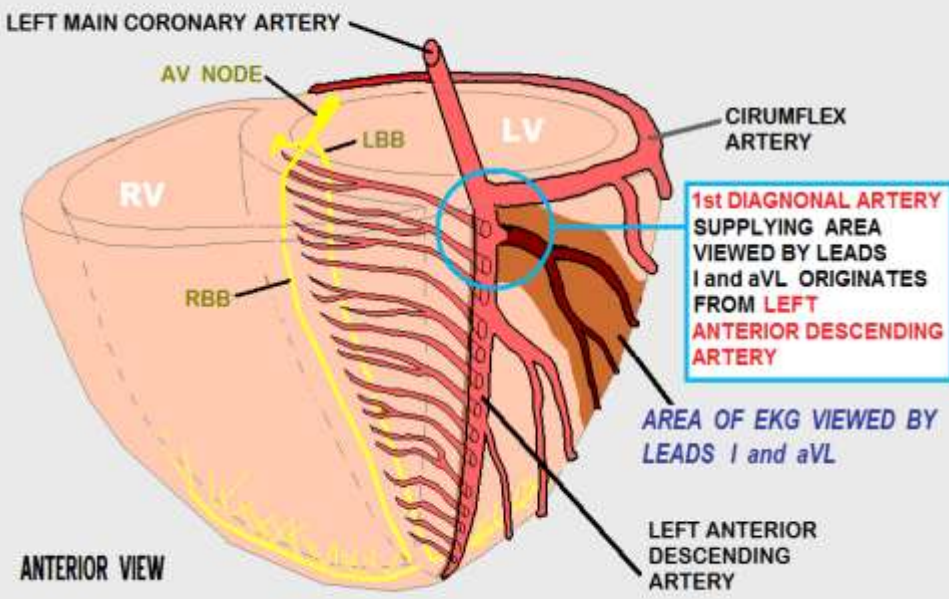
OCCLUSION of MID - LEFT ANTERIOR DESCENDING ARTERY

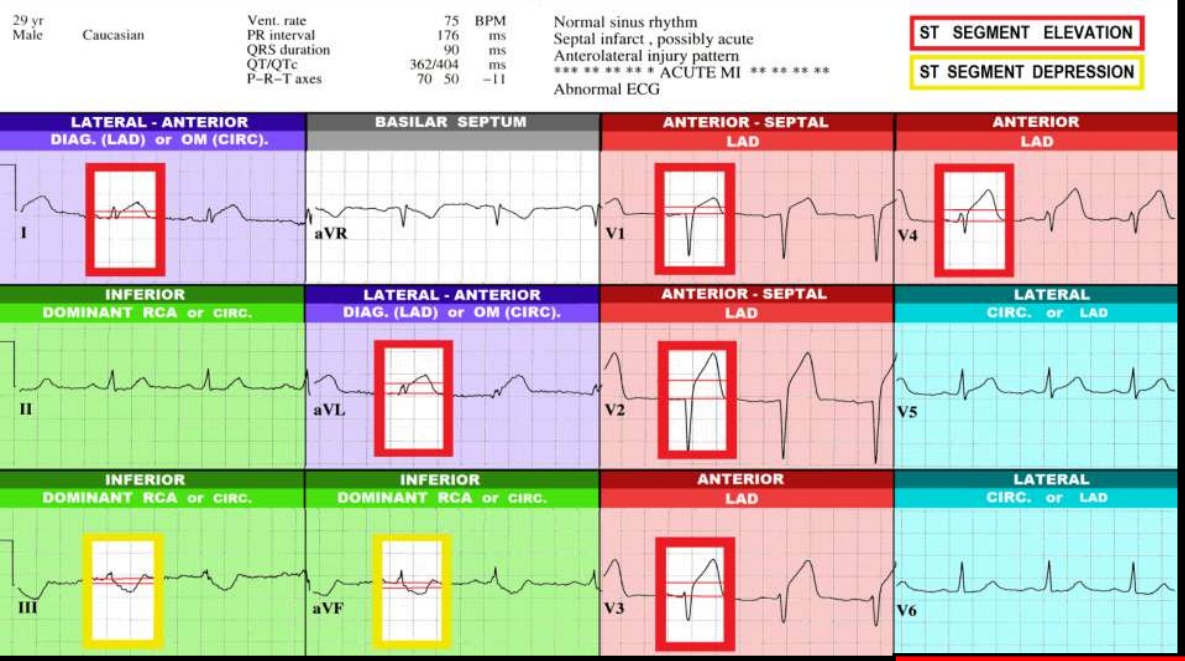


Leads I & AVL view the ANTERIOR-LATERAL JUNCTION



OCCLUSION of DIAGONAL ARTERY




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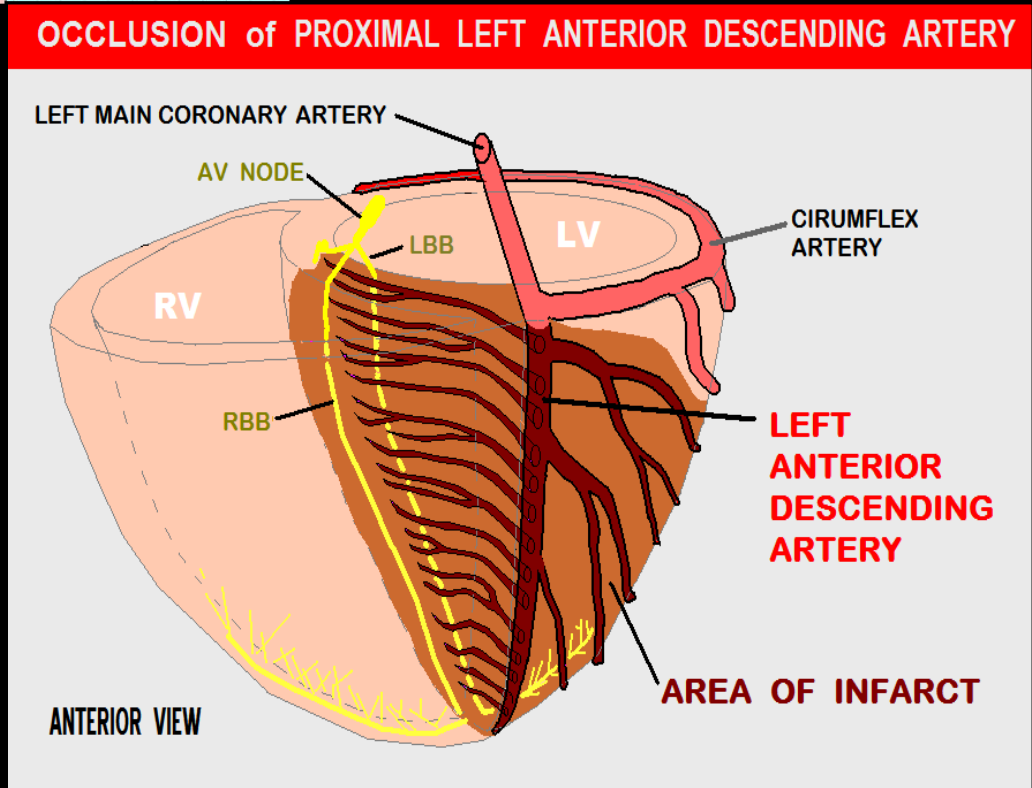
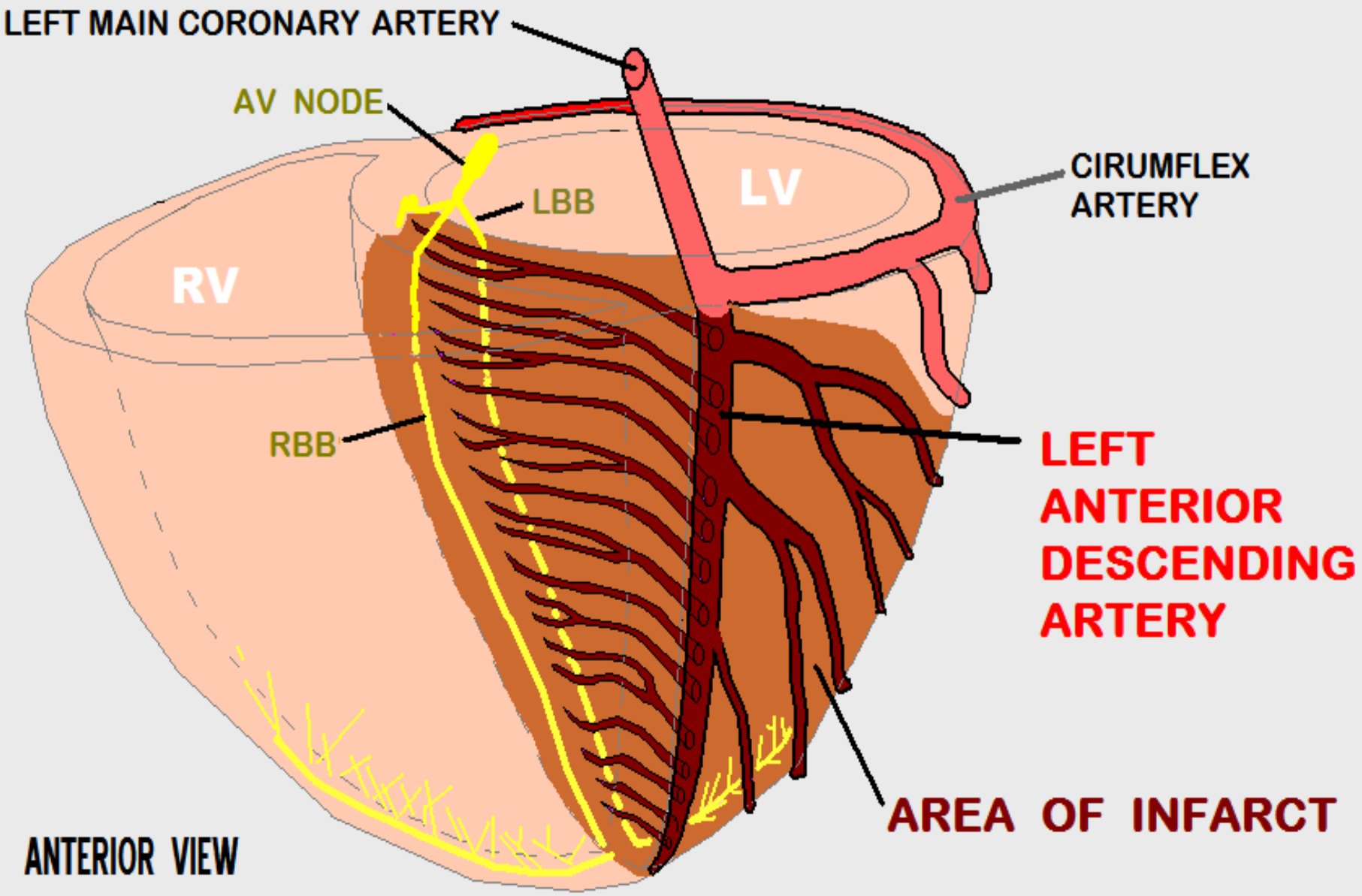
P-R-T axes 70 50 -11
Normal sinus rhythm
Septal infarct , possibly acute
Anterolateral injury pattern
*** ** ** ** * ACUTE MI ** ** ** **
Abnormal ECG
ST SEGMENT ELEVATION
ST SEGMENT DEPRESSION
LATERAL - ANTERIOR
DIAG. (LAD) or OM (CIRC).
I
BASILAR SEPTUM
aVR
ANTERIOR - SEPTAL
LAD
V1
ANTERIOR
LAD
V4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


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

OCCLUSION of PROXIMAL LEFT ANTERIOR DESCENDING ARTERY

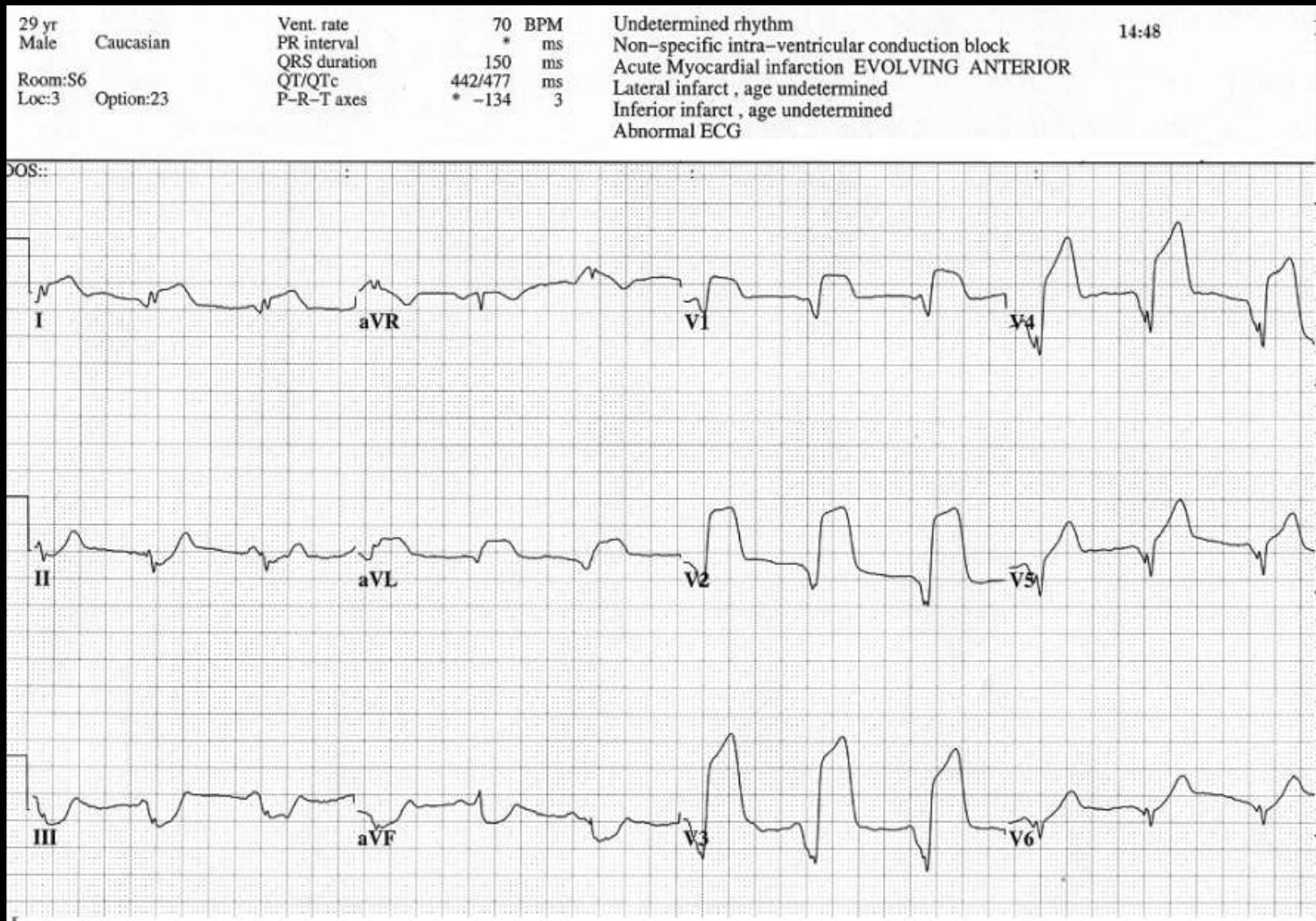


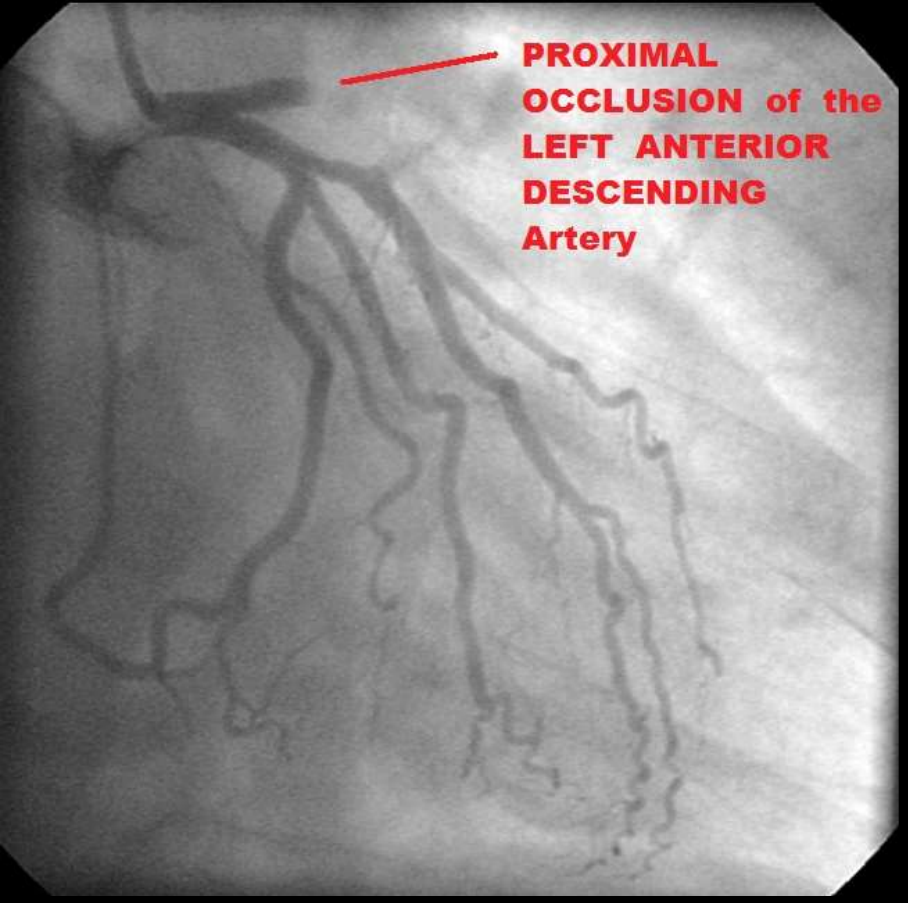
ANTICIPATED COMPLICATIONS of ANTERIOR-SEPTAL WALL STEMI & POSSIBLE INDICATED INTERVENTIONS:	
- CARDIAC ARREST	BCLS / ACLS
- CARDIAC DYSRHYTHMIAS (VT / VF)	ACLS (antiarrhythmics)
- PUMP FAILURE with CARDIOGENIC SHOCK	INOTROPE THERAPY: -DOPAMINE / DOBUTAMINE / LEVOPHED - INTRA-AORTIC BALLOON PUMP (use 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

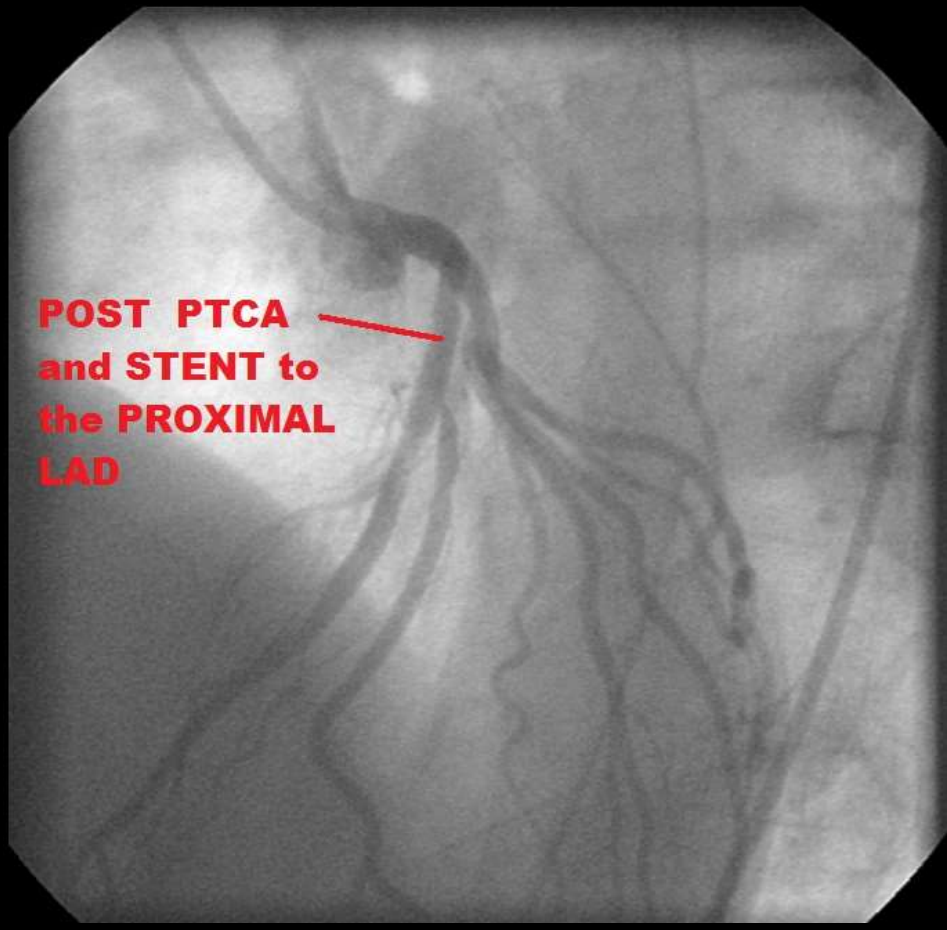
WHILE AWAITING THE CATH LAB TEAM, THE PATIENT BEGAN VOMITING. SKIN BECAME ASHEN & DIAPHORETIC. REPEAT BP = 50/30.

WHILE AWAITING THE CATH LAB 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 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.

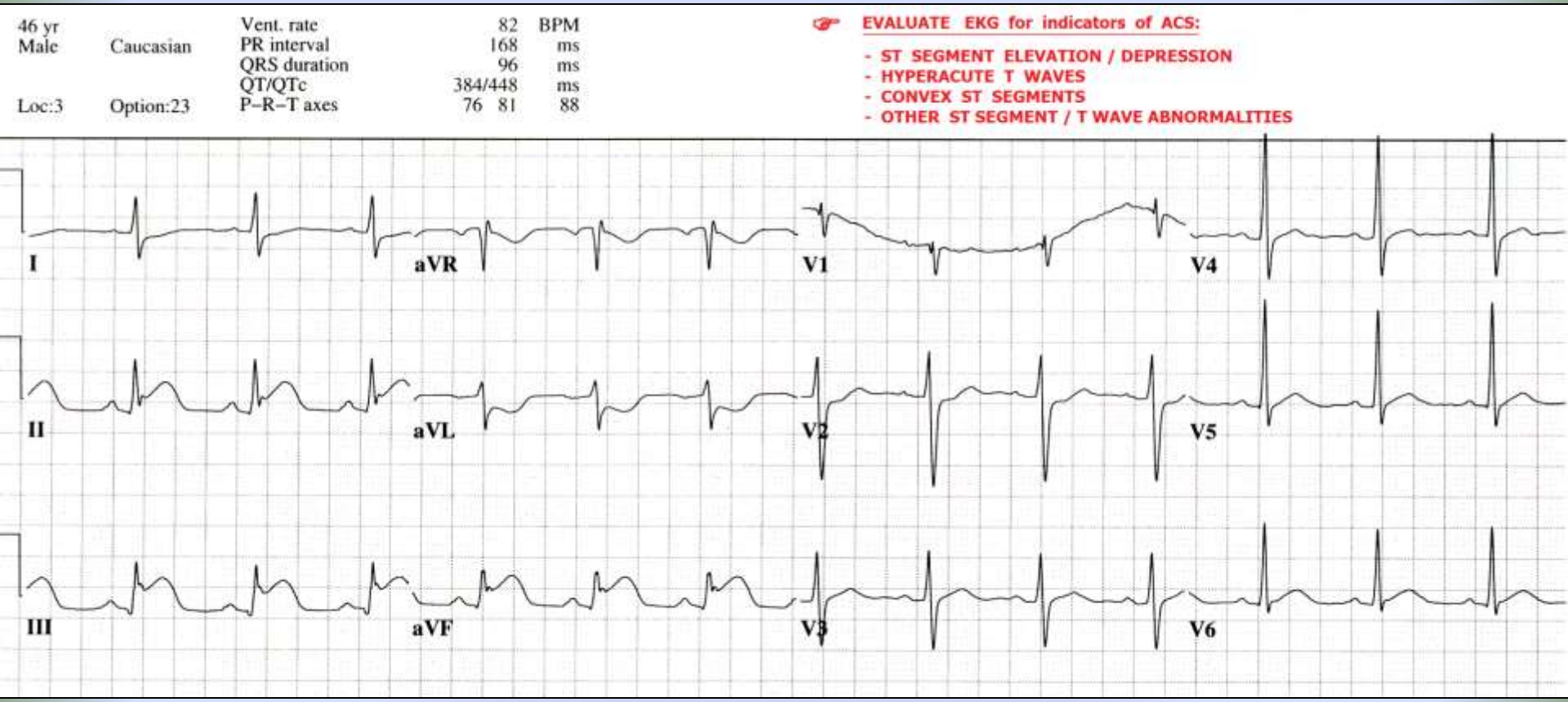
RISK FACTOR PROFILE:

- 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

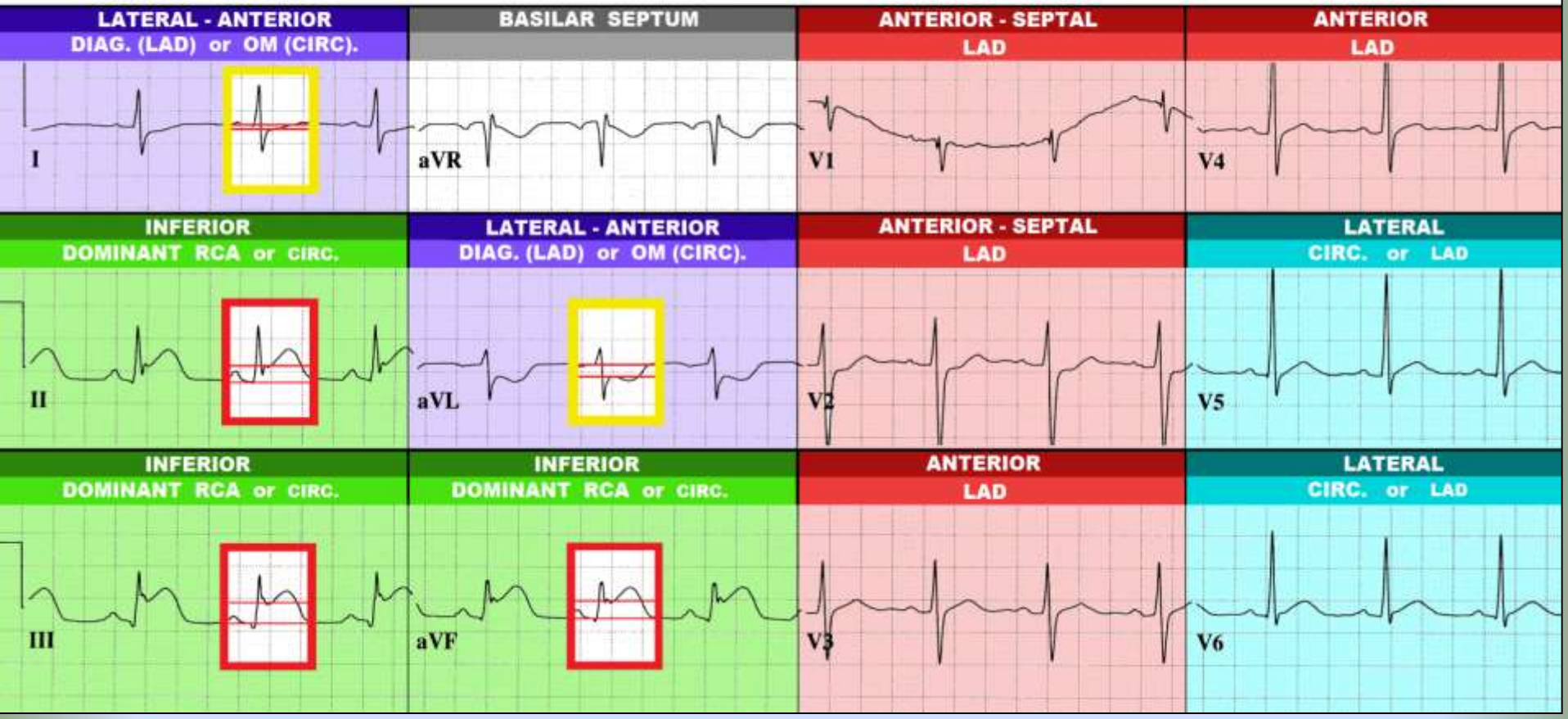
Caucasian

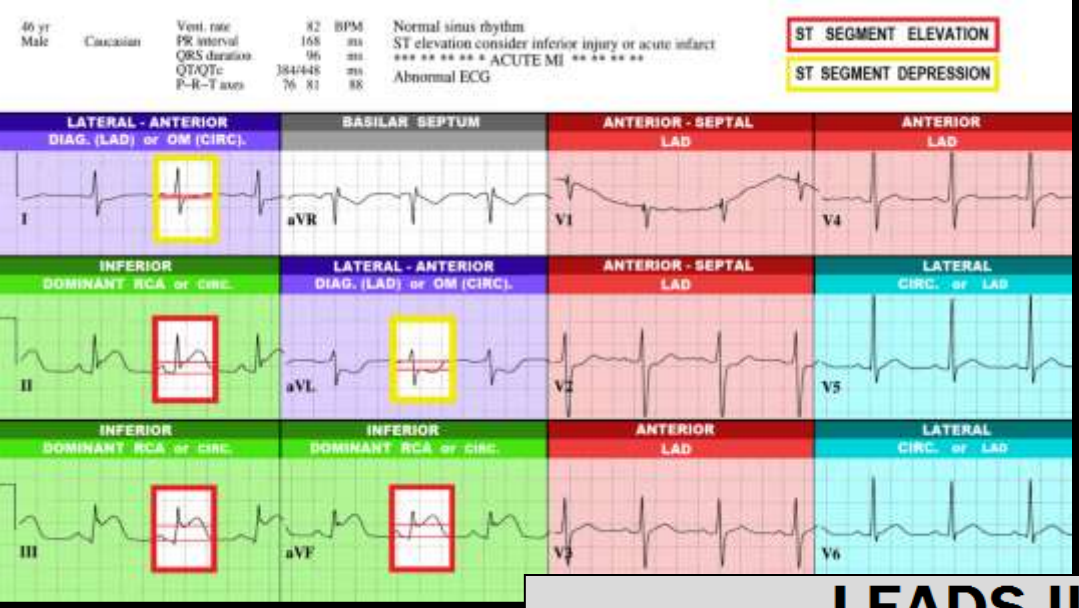
Vent. rate	82	BPM
PR interval	168	ms
QRS duration	96	ms
QT/QTc	384/448	ms
P–R–T axes	76 81	88

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

ST SEGMENT ELEVATION

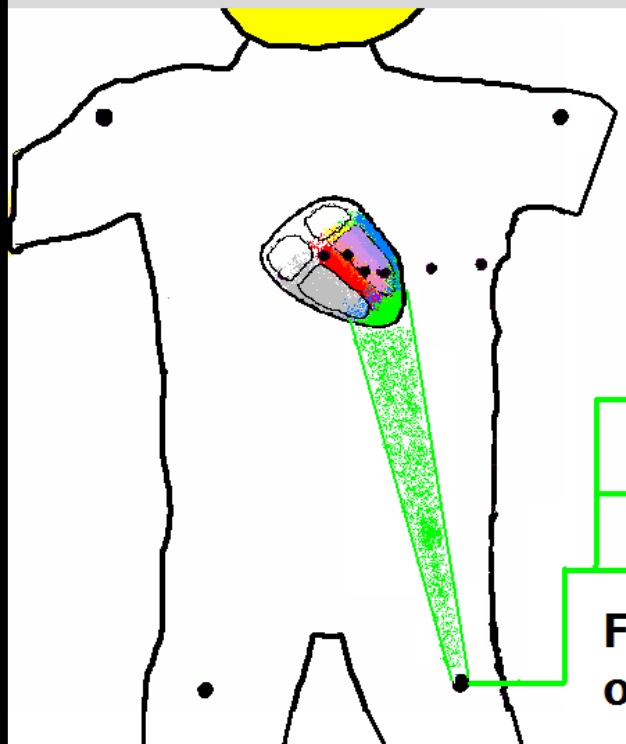
ST SEGMENT DEPRESSION

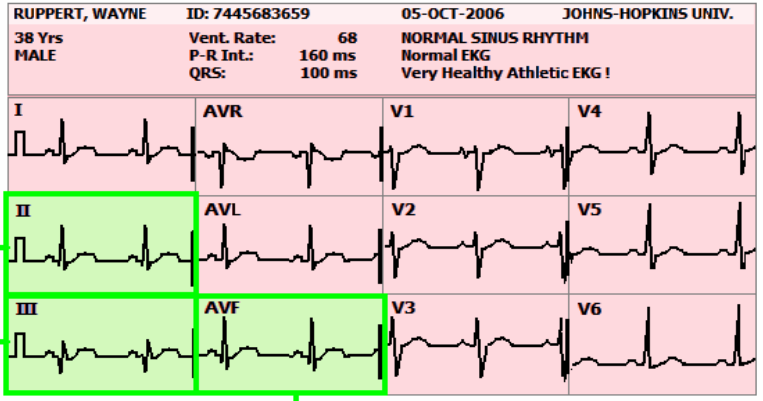




LEADS II, III, and aVF VIEW

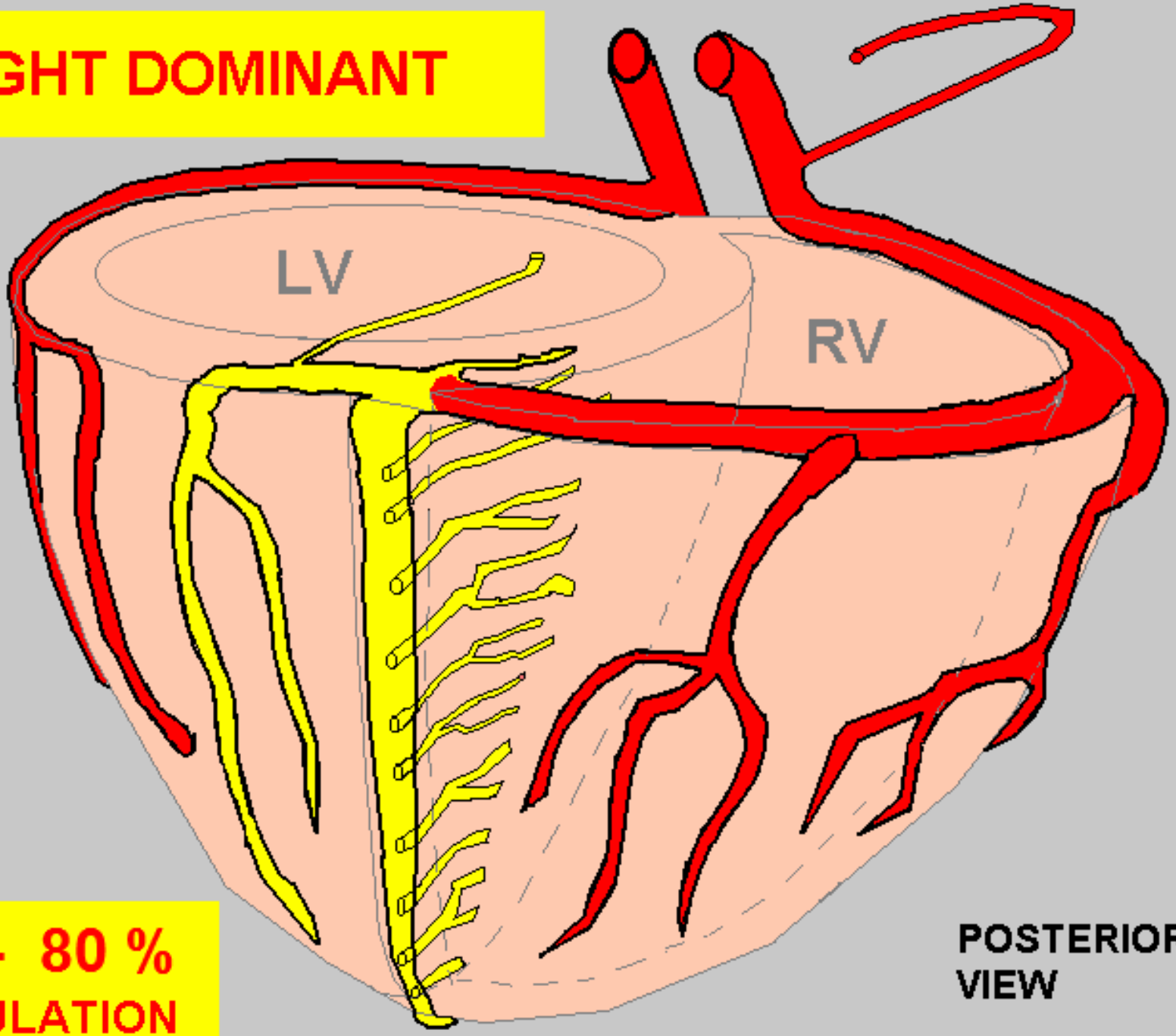
INFERIOR WALL of the LEFT VENTRICLE





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

RIGHT DOMINANT



75 - 80 %
POPULATION

POSTERIOR VIEW

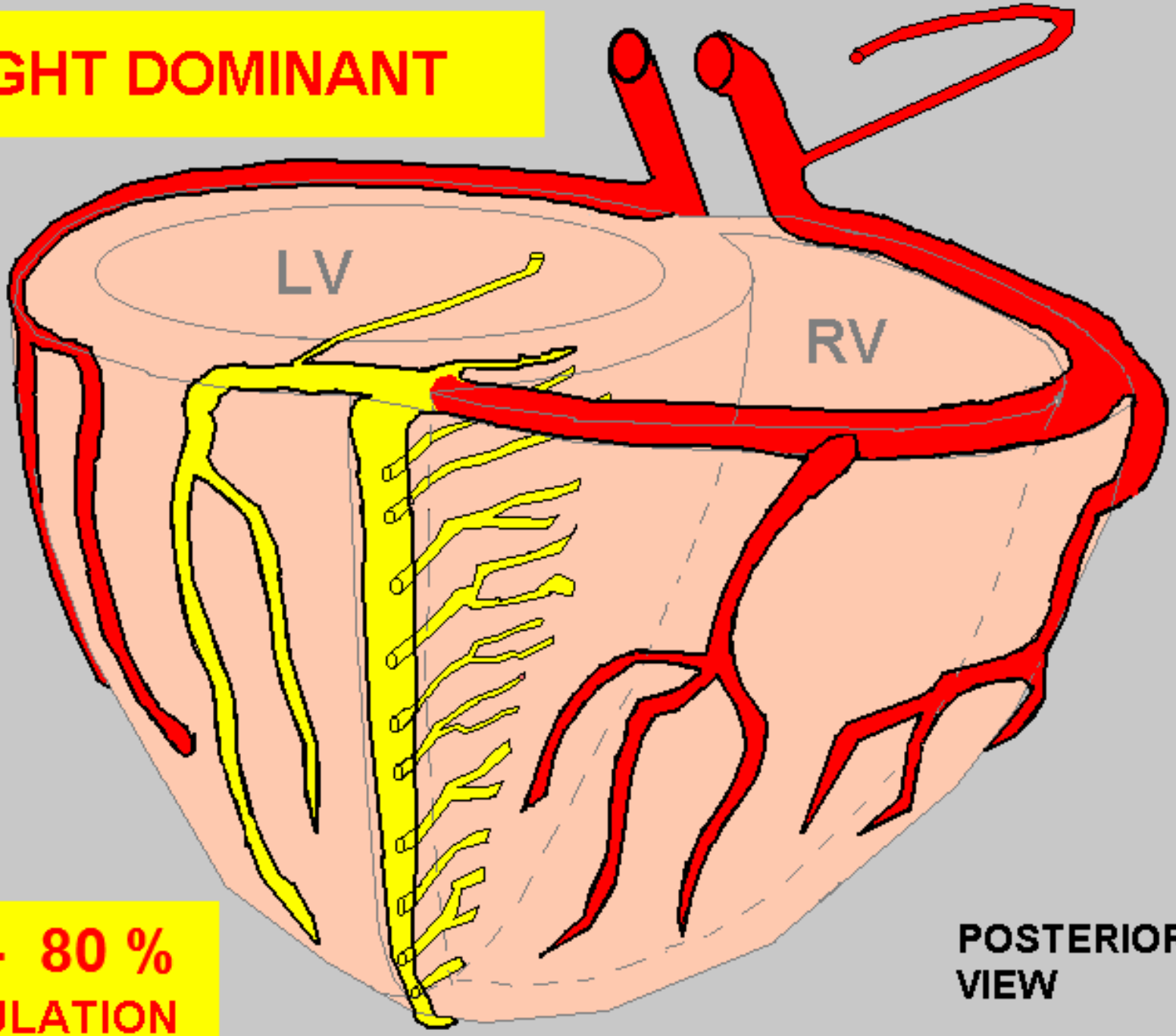
HELPFUL HINT . . . MEMORIZE THIS !

RIGHT CORONARY ARTERY (RCA)

RIGHT DOMINANT SYSTEMS

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

RIGHT DOMINANT



75 - 80 %
POPULATION

POSTERIOR VIEW

A standard

12 LEAD EKG

Does NOT show the

RIGHT VENTRICLE

To see the

RIGHT VENTRICLE . . .

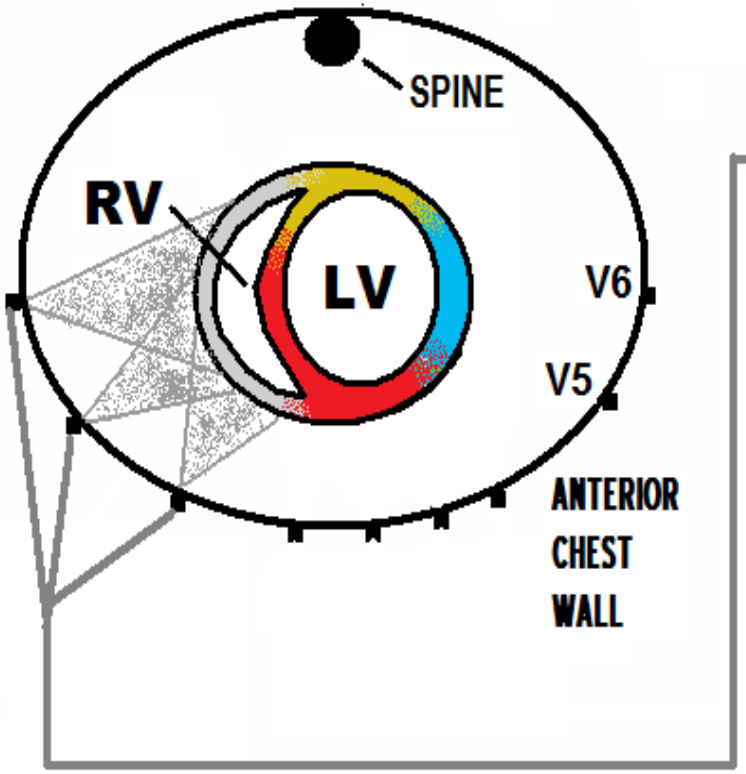
. . . such as in cases of

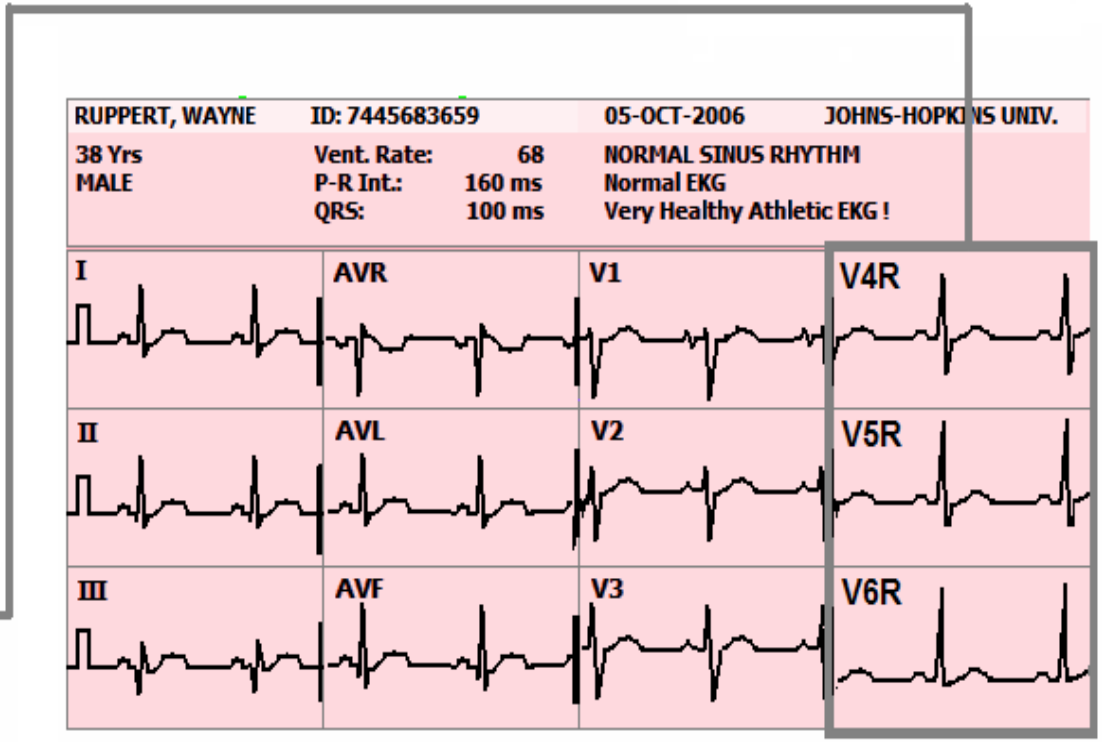
INFERIOR WALL M.I.

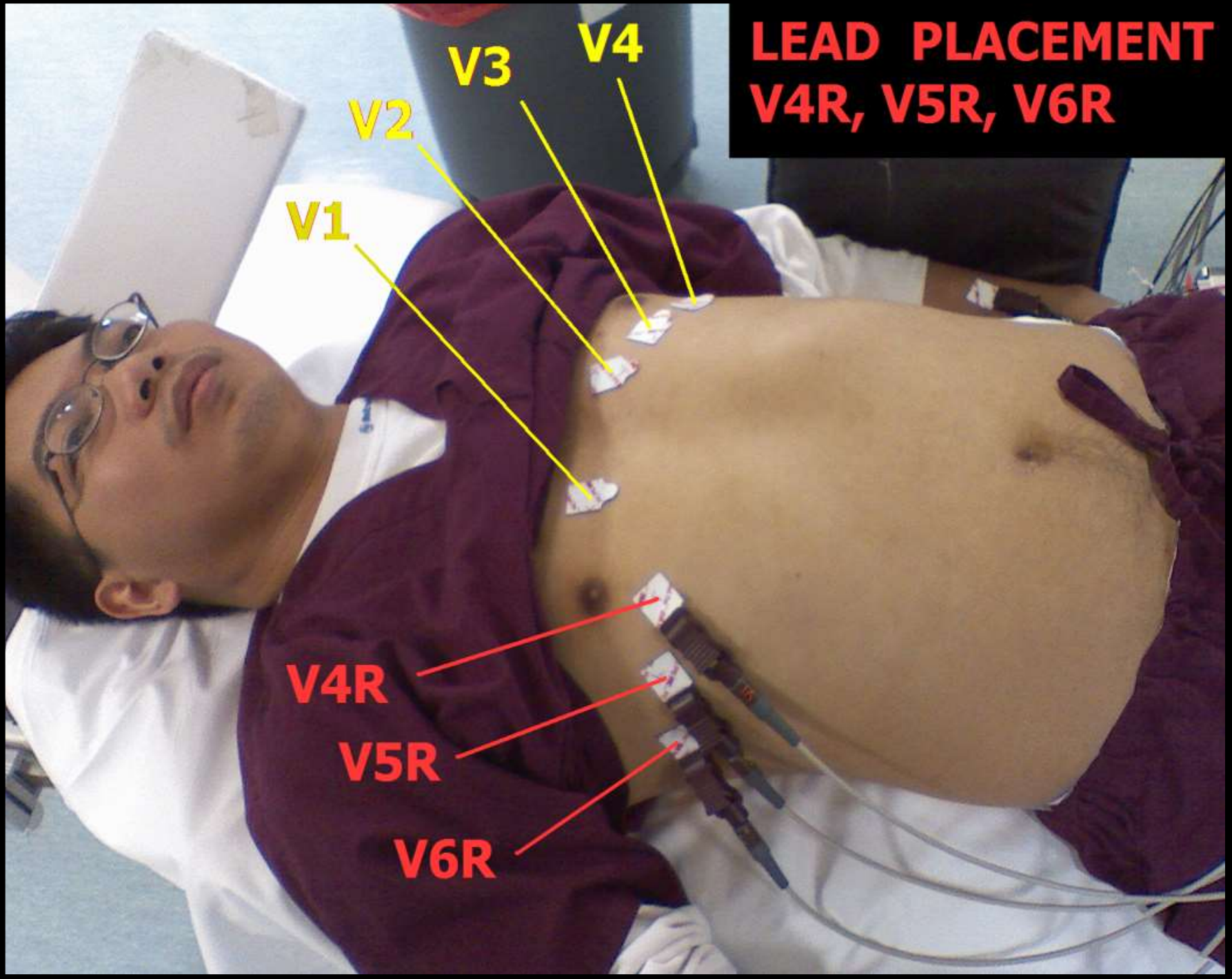
☞ You must do a

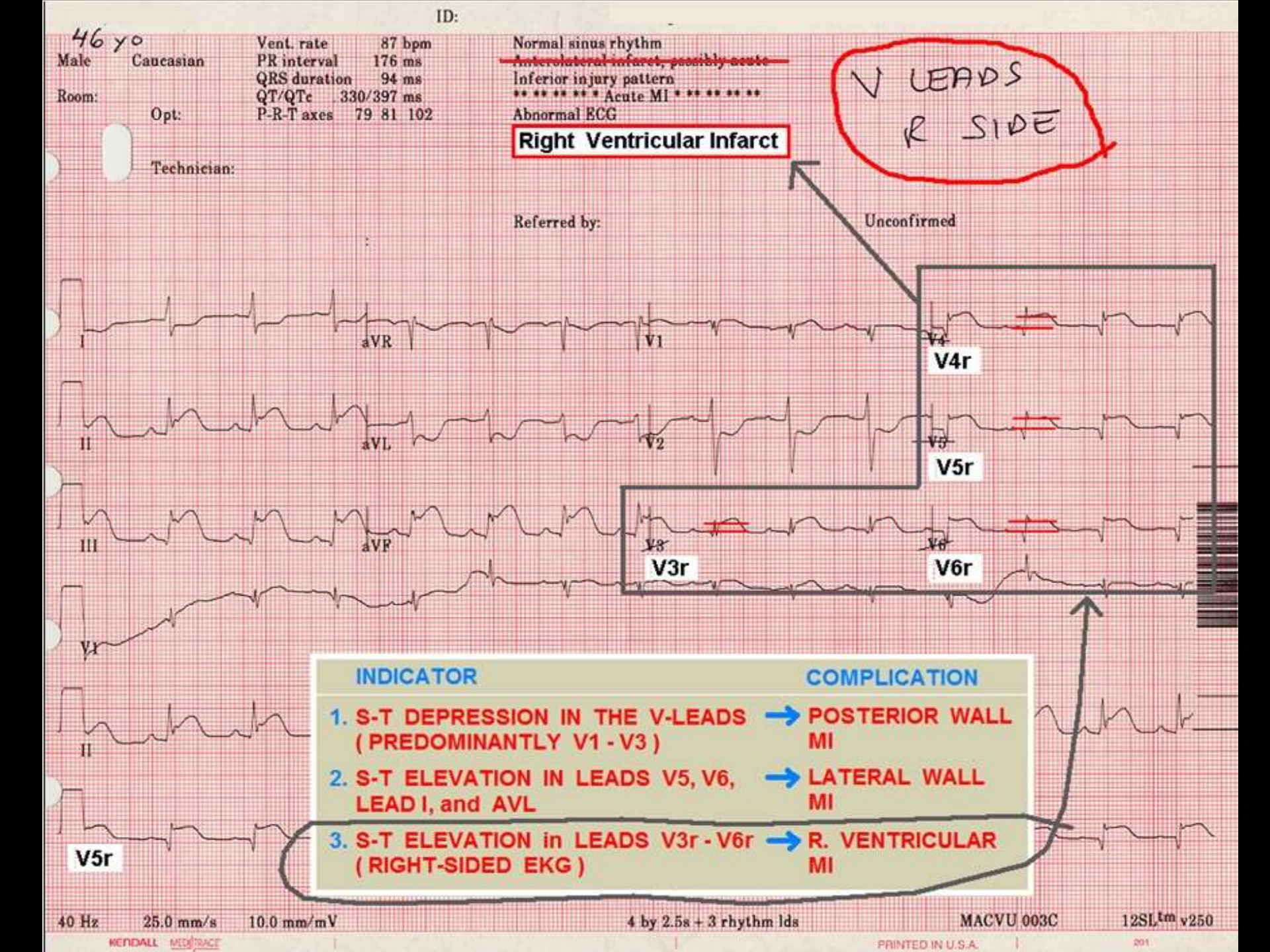
RIGHT - SIDED EKG ! !

V4R - V6R VIEW THE RIGHT VENTRICLE





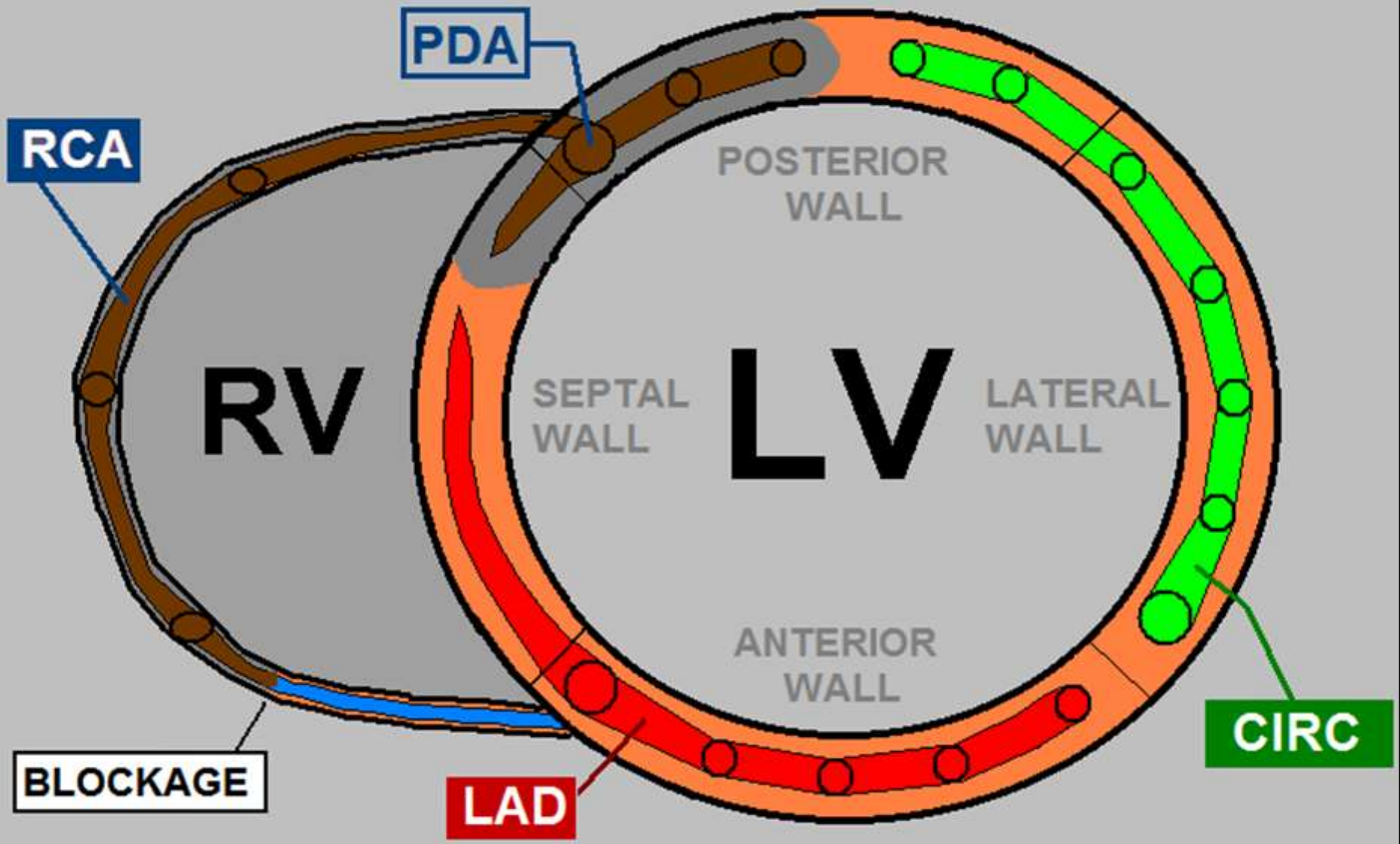

LEAD PLACEMENT
V4R, V5R, V6R
V1
V2
V3
V4
V4R
V5R
V6R


ID:
46 yo
Male Caucasian
Room:
Opt:
Technician:
Vent. rate 87 bpm
PR interval 176 ms
QRS duration 94 ms
QT/QTc 330/397 ms
P-R-T axes 79 81 102
Normal sinus rhythm
Inferior injury pattern
** ** ** ** * Acute MI * ** ** ** **
Abnormal ECG
Right Ventricular Infarct
V LEADS
R SIDE
Referred by:
Unconfirmed
I
aVR
V1
V4
V4r
II
aVL
V2
V5
V5r
III
aVF
V3
V3r
V6
V6r
V1
II
V5r
INDICATOR
COMPLICATION
1. S-T DEPRESSION IN THE V-LEADS (PREDOMINANTLY V1 - V3) → POSTERIOR WALL MI
2. S-T ELEVATION IN LEADS V5, V6, LEAD I, and AVL → LATERAL WALL MI
3. S-T ELEVATION in LEADS V3r - V6r (RIGHT-SIDED EKG) → R. VENTRICULAR MI
40 Hz 25.0 mm/s 10.0 mm/mV
4 by 2.5s + 3 rhythm lds
MACVU 003C
12SL tm v250
KENDALL MEDITRACE
PRINTED IN U.S.A.

INFERIOR - RIGHT VENTRICULAR MI

DOMINANT RCA

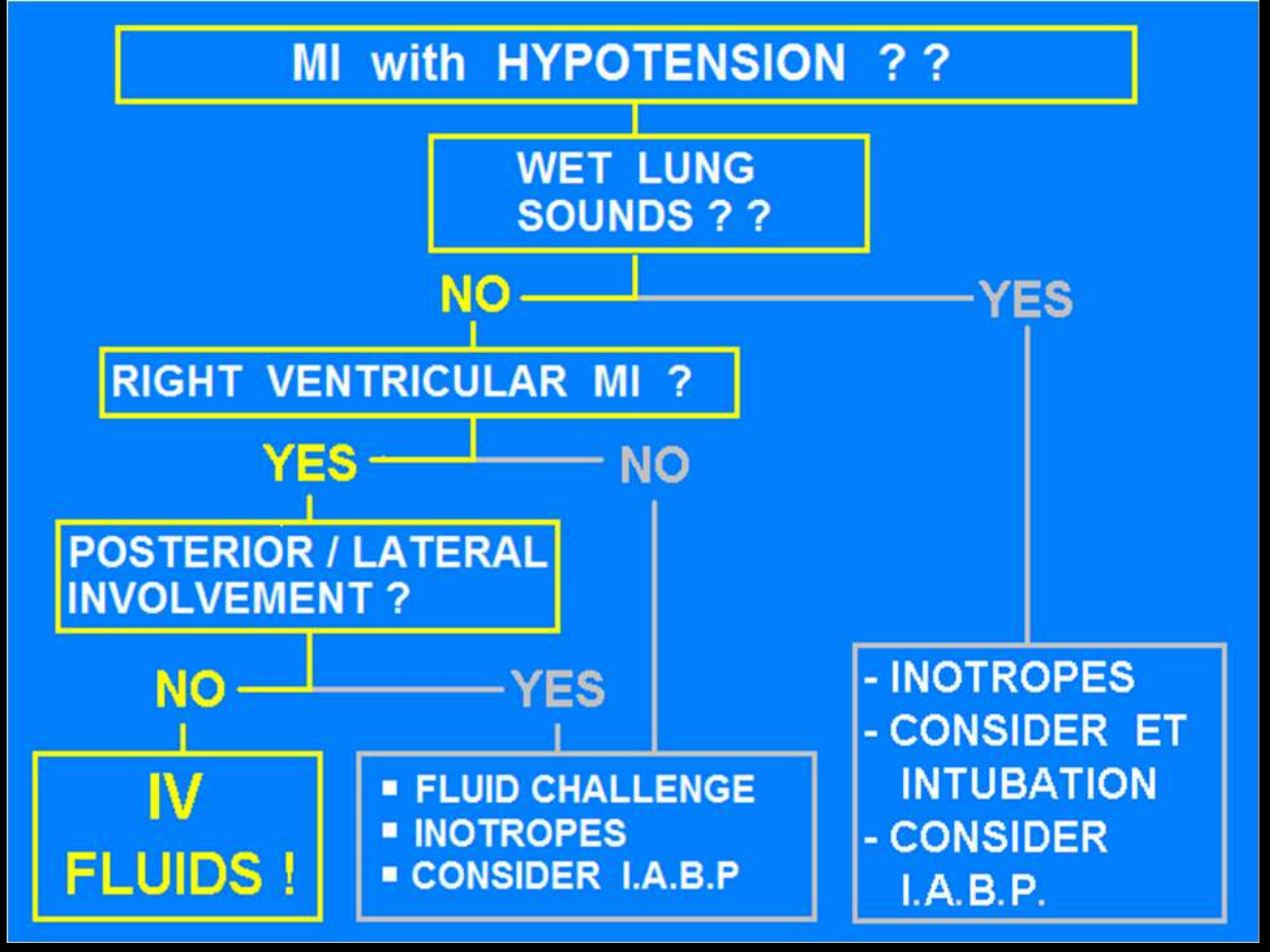
75-80 % of POPULATION

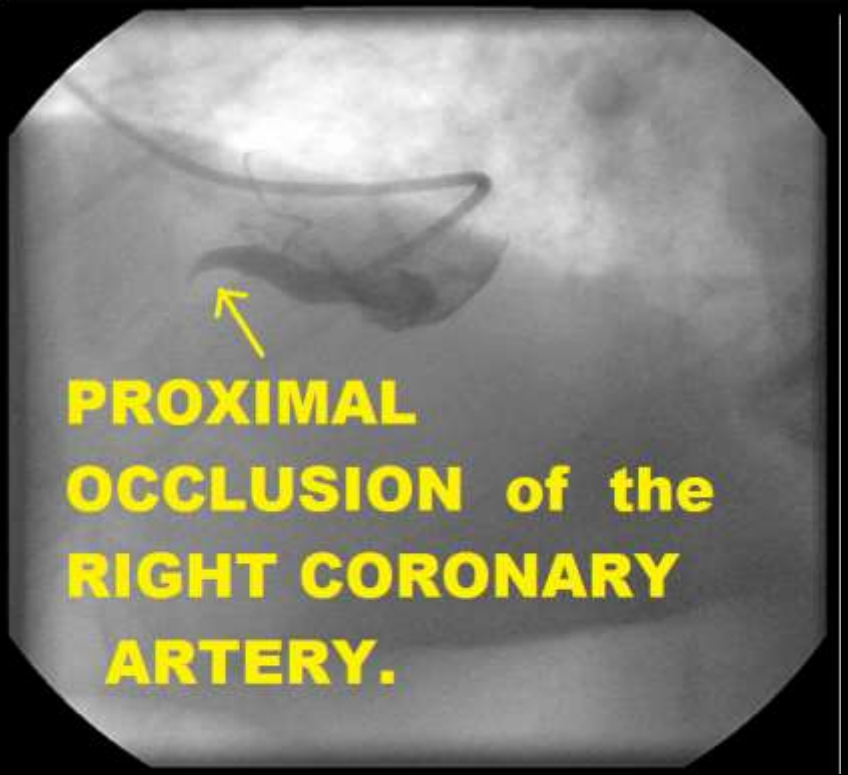


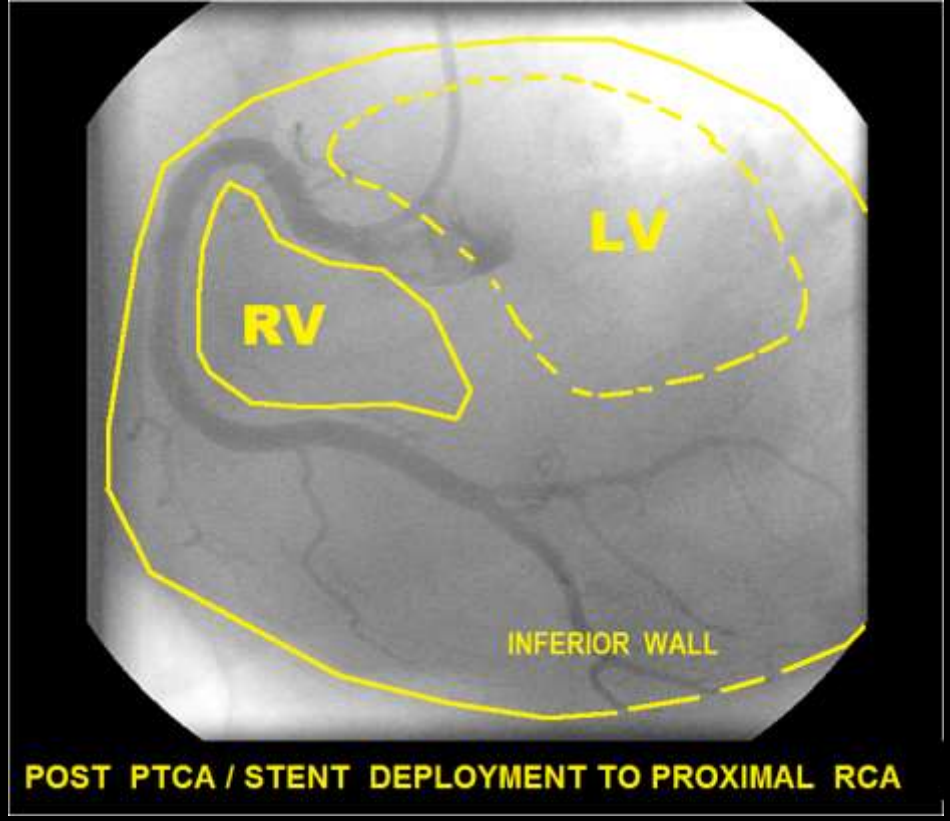
ANTICIPATED COMPLICATIONS of INFERIOR WALL STEMI secondary to RCA Occlusion & POSSIBLE INDICATED INTERVENTIONS:

- 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.

If this patient becomes HYPOTENSIVE . . . . .


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





POST PTCA / STENT DEPLOYMENT TO PROXIMAL RCA

IN ***EVERY*** CASE of

INFERIOR WALL STEMI

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

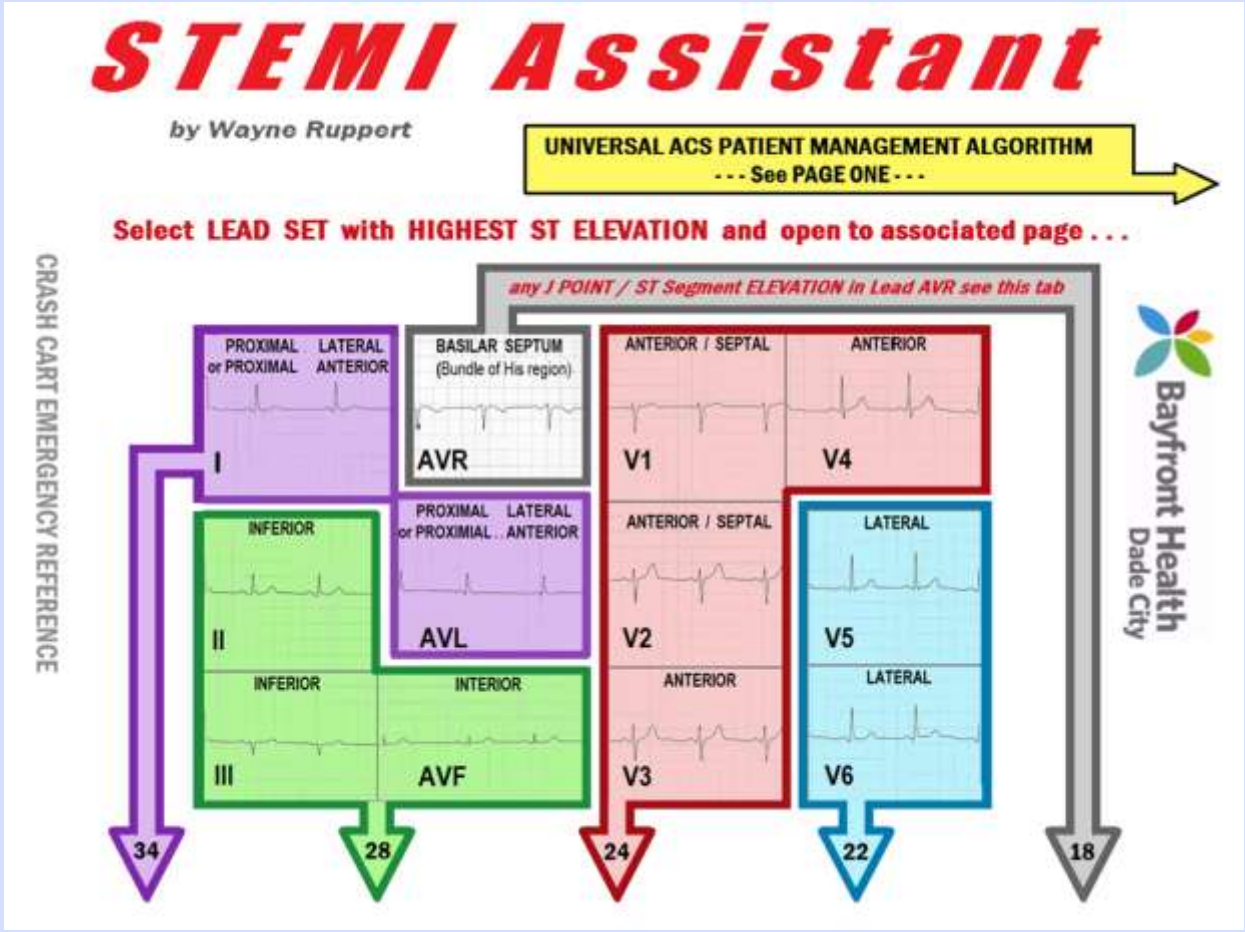
- NITROGLYCERIN
- Diuretics

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

They precipitate SEVERE HYPOTENSION

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

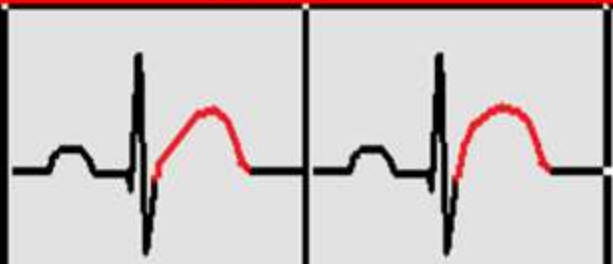
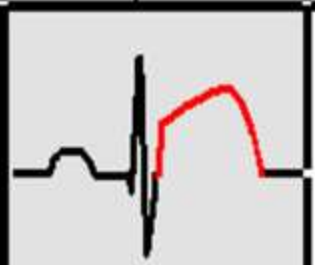
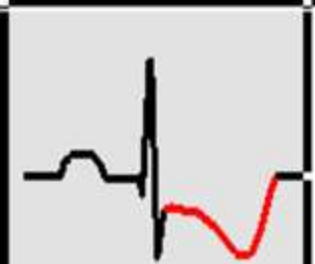
STEMI Assistant: an Emergency Crash Cart Interactive Reference Manual - free Download



STEMI Assistant – Information Video

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**

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

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

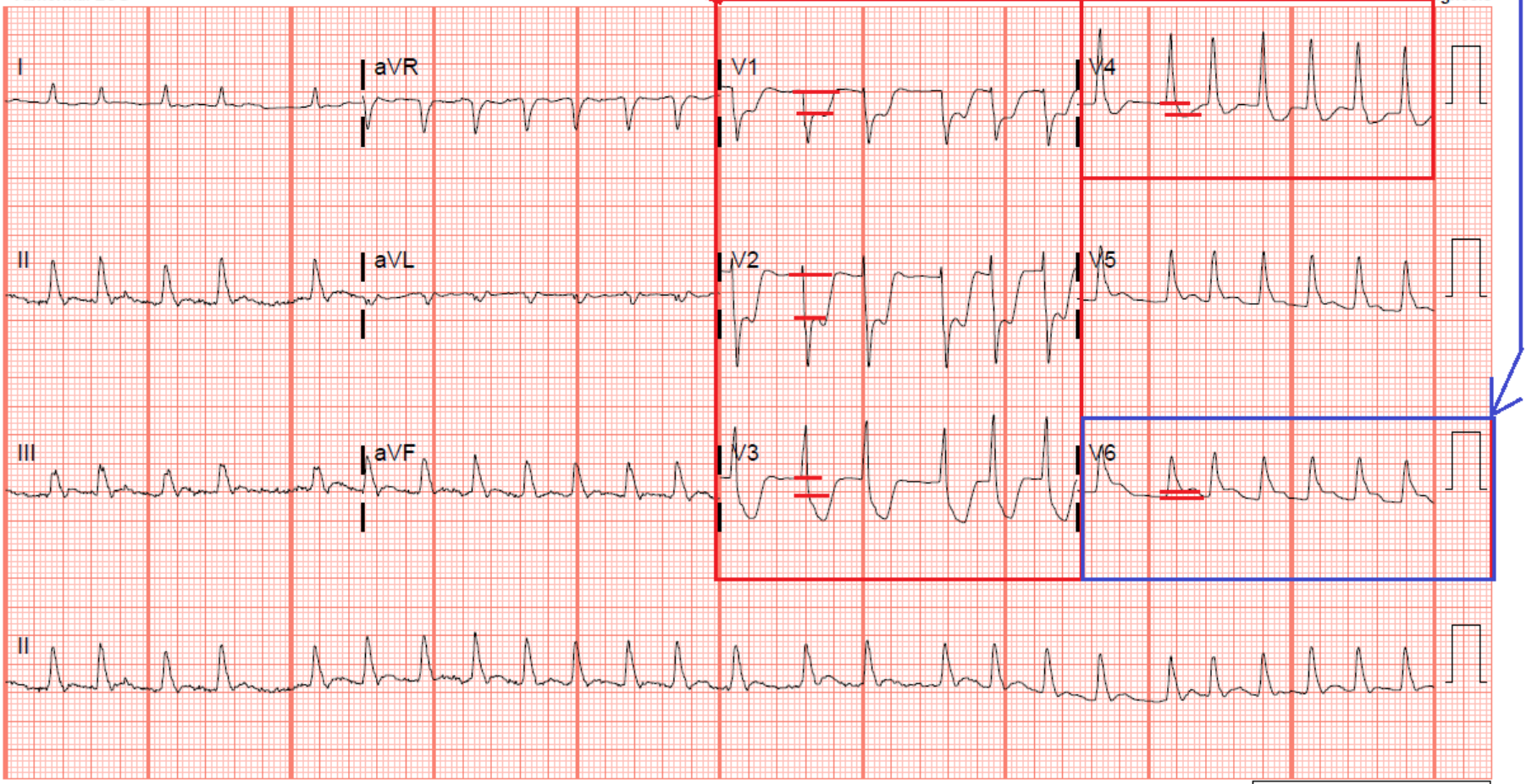
Req Provider:

ST Depression Leads V1 - V4

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

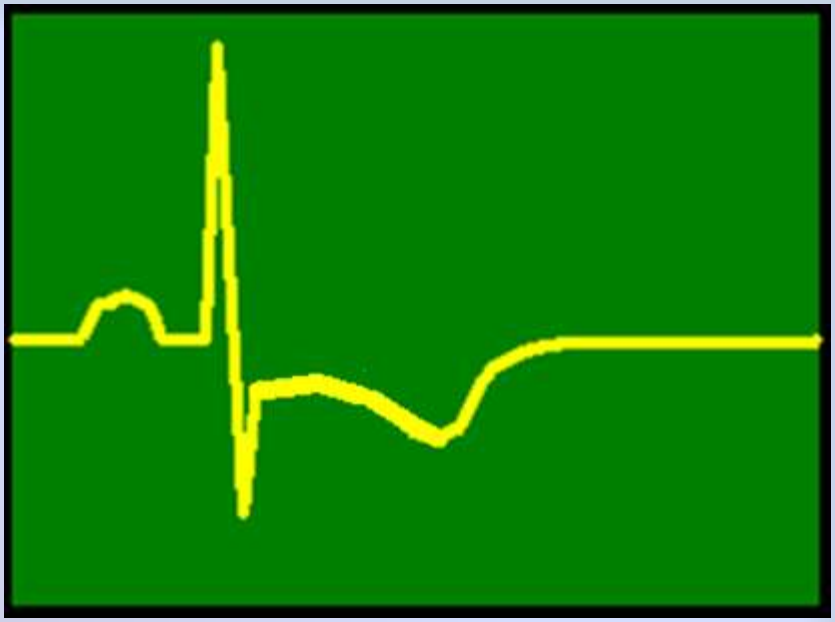
- Abnormal ECG -

Unconfirmed Diagnosis



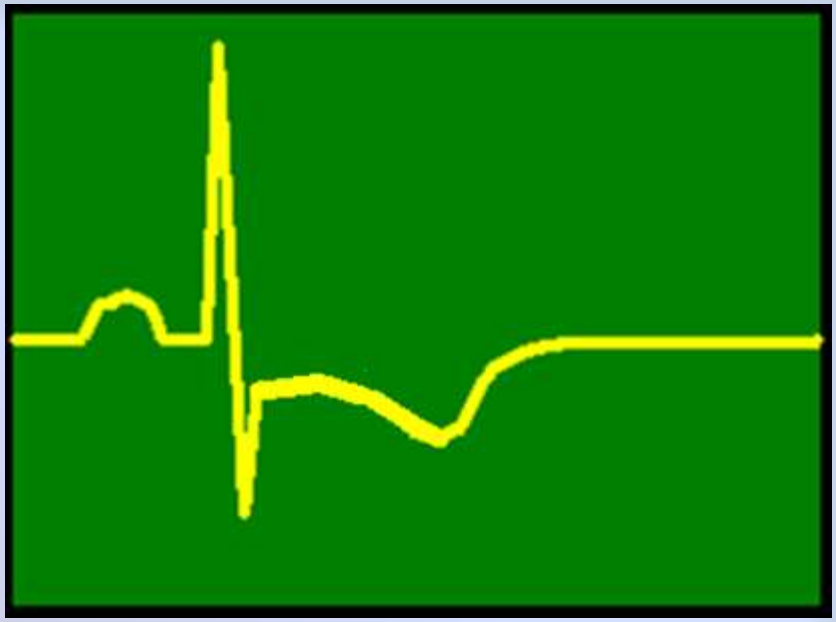
Philips PageWriter TC | 25 mm/sec | 10.00 mm/mV | F 60~ 0.15 - 100 Hz

ST Depression in Leads V1 – V4:



- **Direct view of ISCHEMIA (anterior wall)**

ST Depression in Leads V1 – V4:

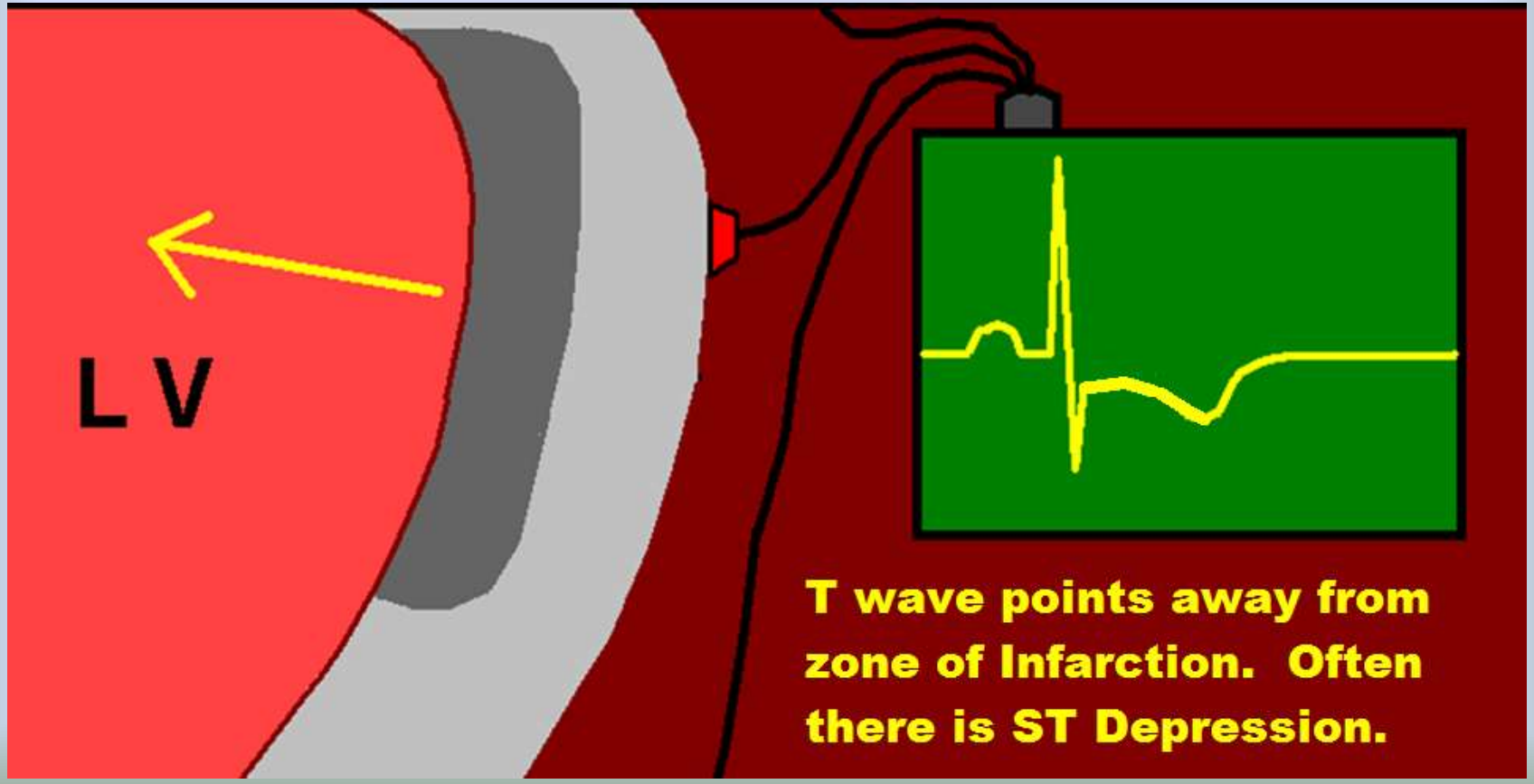


- Direct view of ISCHEMIA (anterior wall)
- Direct view of NSTEMI (anterior wall)

Non-STEMI (NSTEMI)

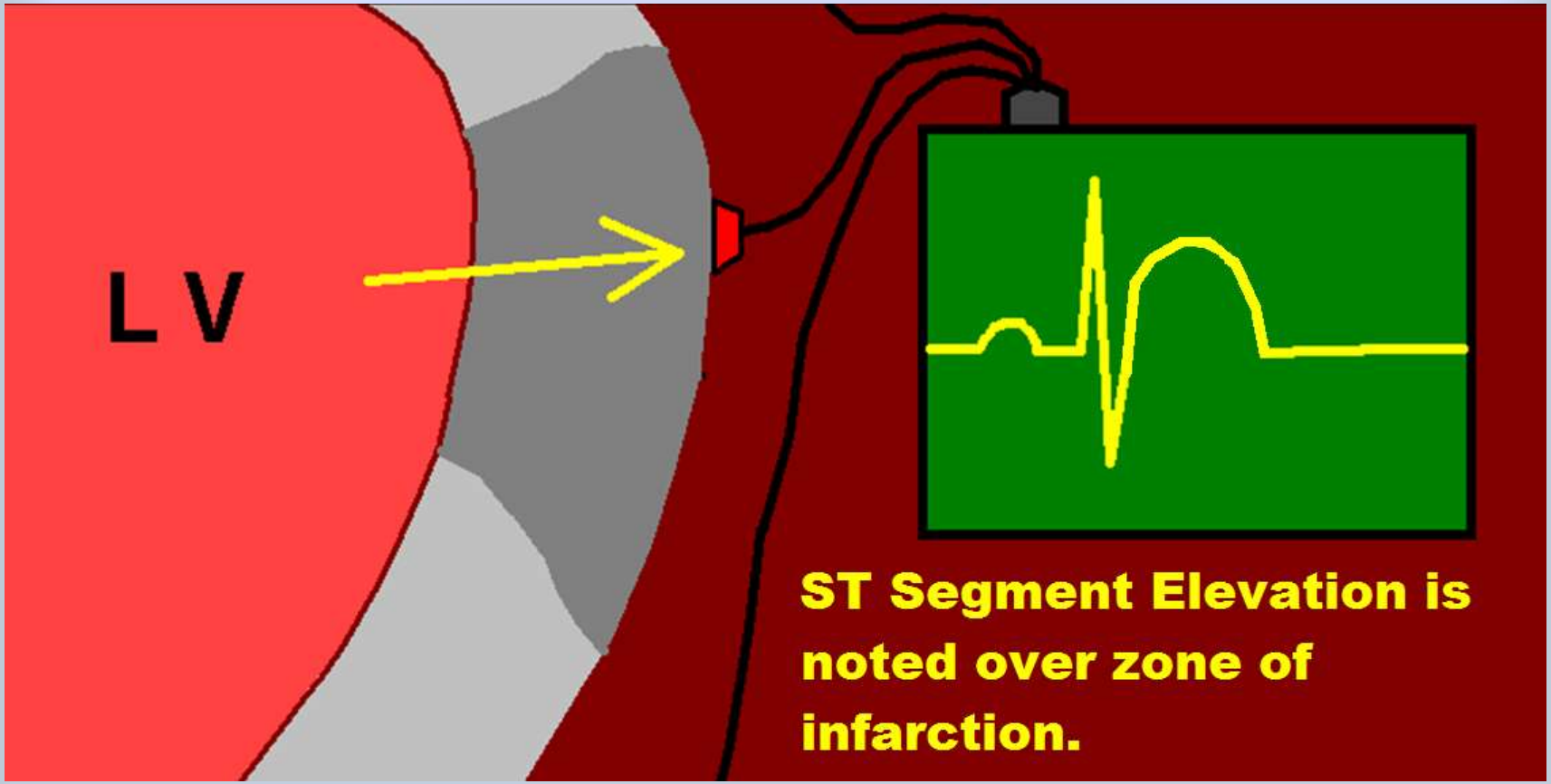
Non-ST Segment Elevation Myocardial Infarction.

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

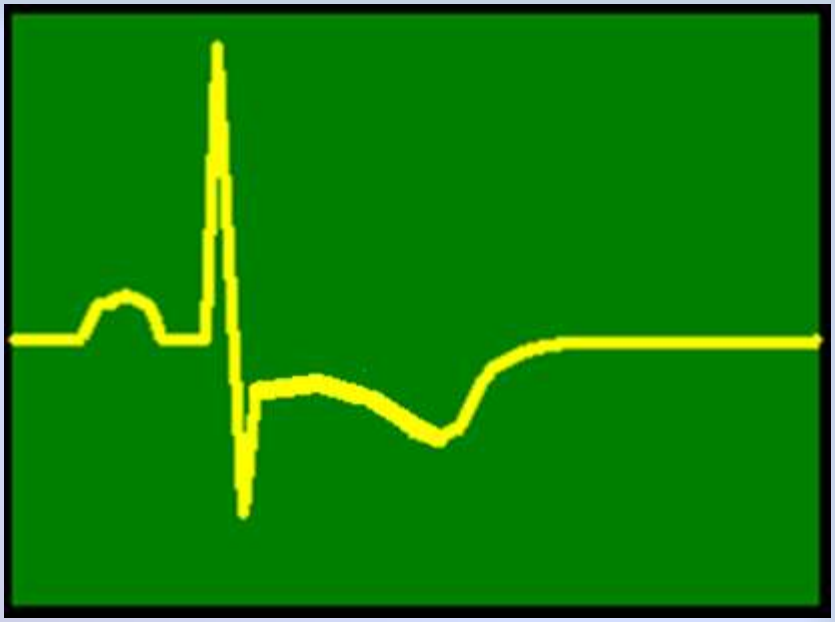


STEMI

- ST Segment Elevation Myocardial Infarction.



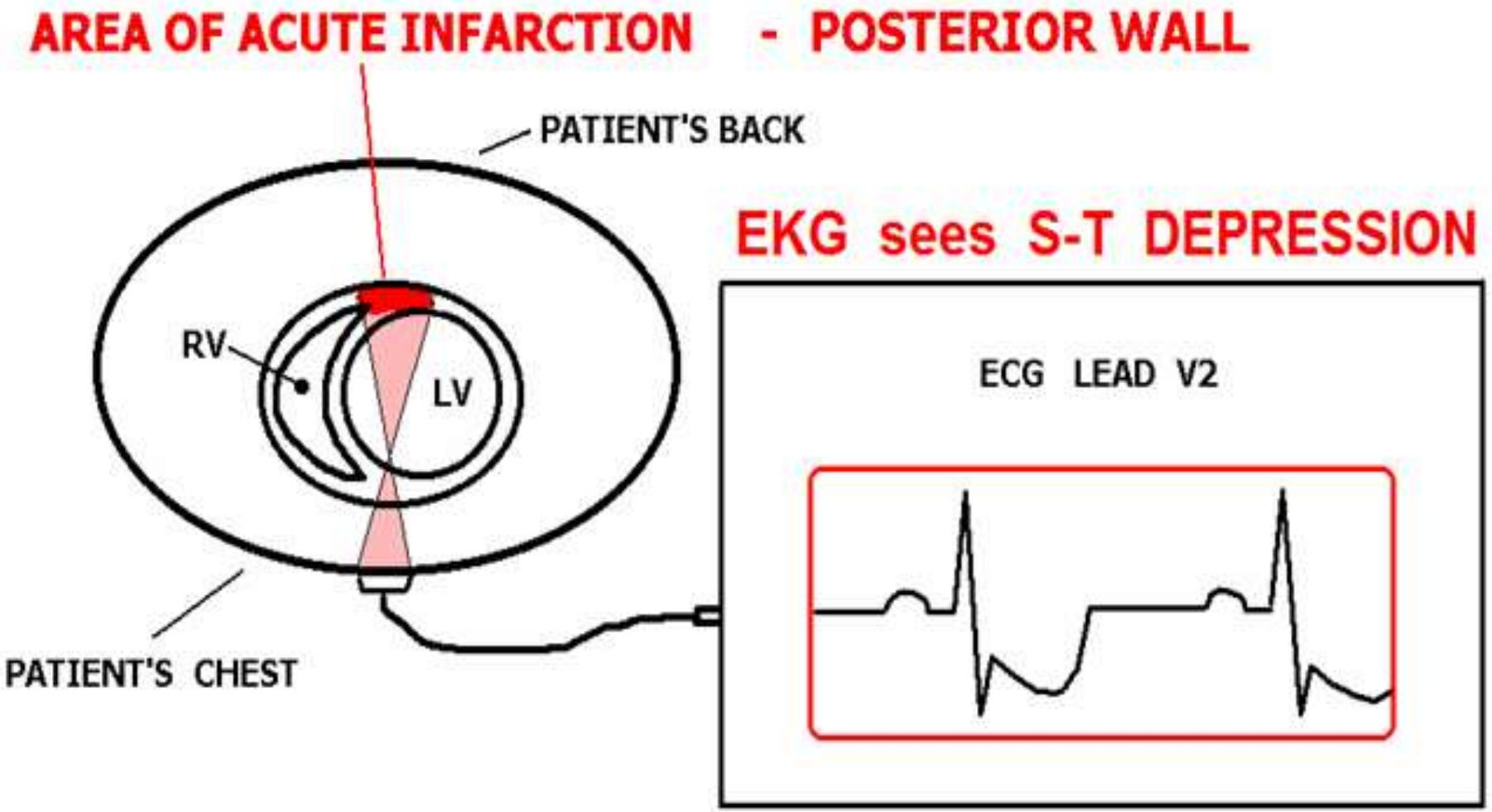
ST Depression in Leads V1 – V4:



- Direct view of ISCHEMIA (anterior wall)
- Direct view of NSTEMI (anterior wall)
- Reciprocal view of STEMI (opposite side of heart - posterior wall)

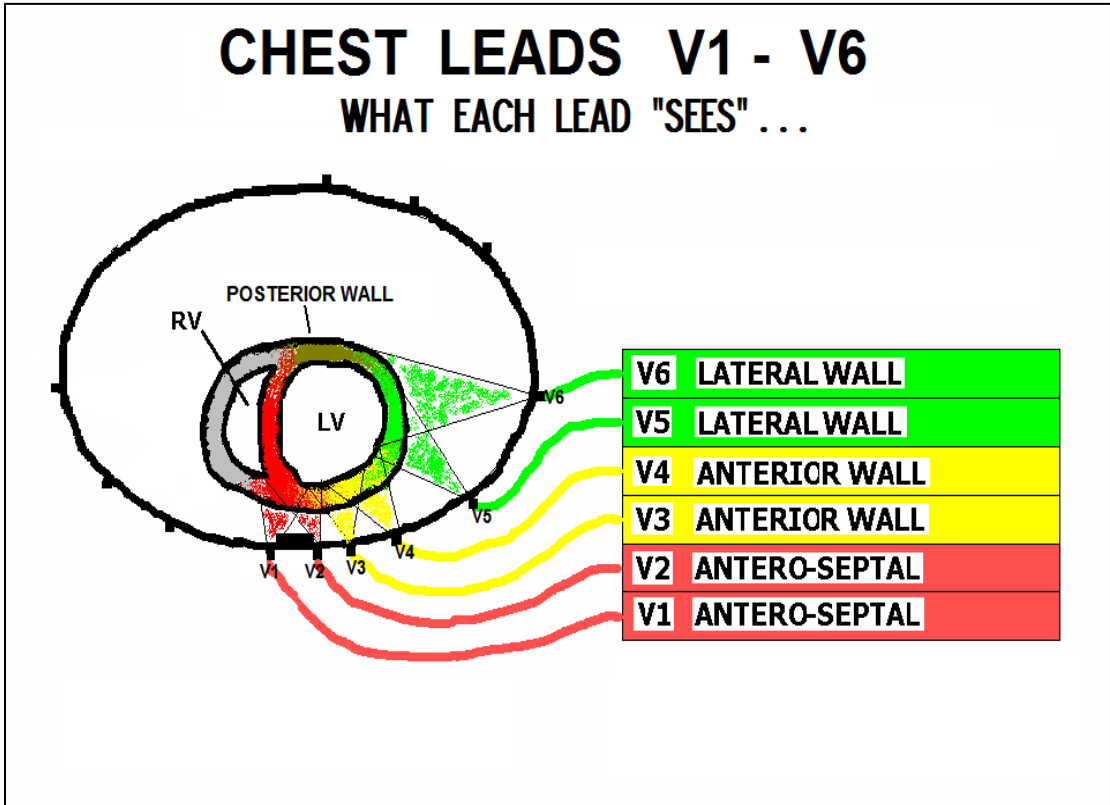
HOW EKG VIEWS RECIPROCAL CHANGES

EXAMPLE:



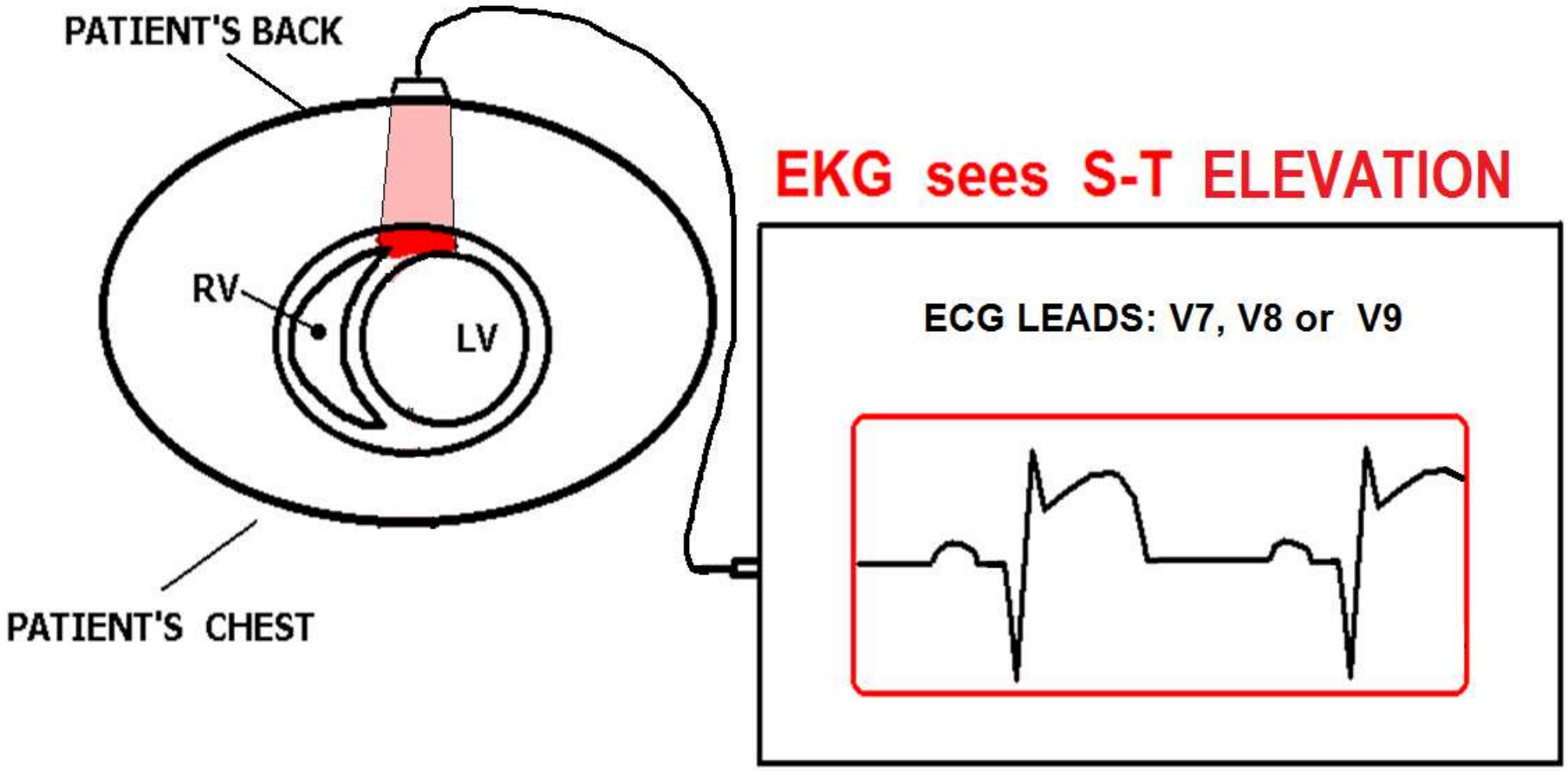
Posterior Wall STEMI….

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



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

ACUTE POSTERIOR WALL MI . . . . .



Whenever you see

ST DEPRESSION in Leads V1 - V4

you must do a

POSTERIOR LEAD ECG

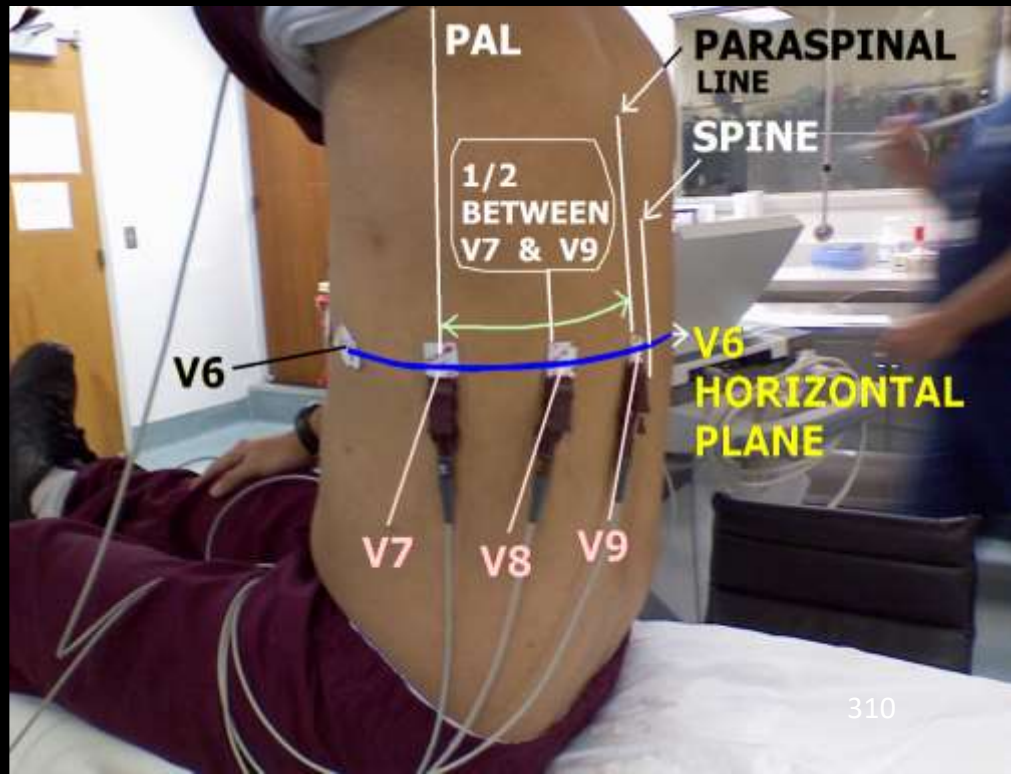
(V7 - V9)

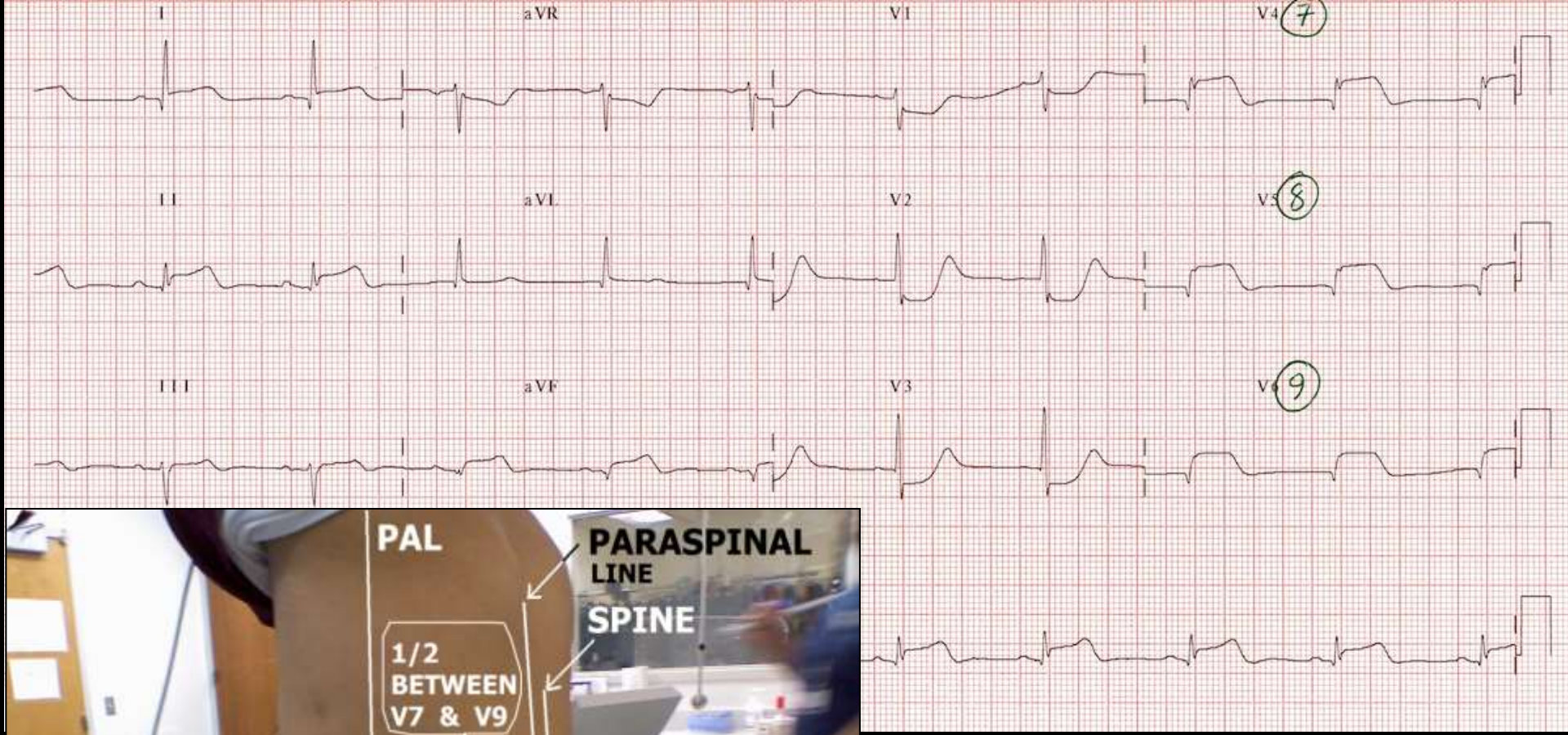
to see if you Patient is having a

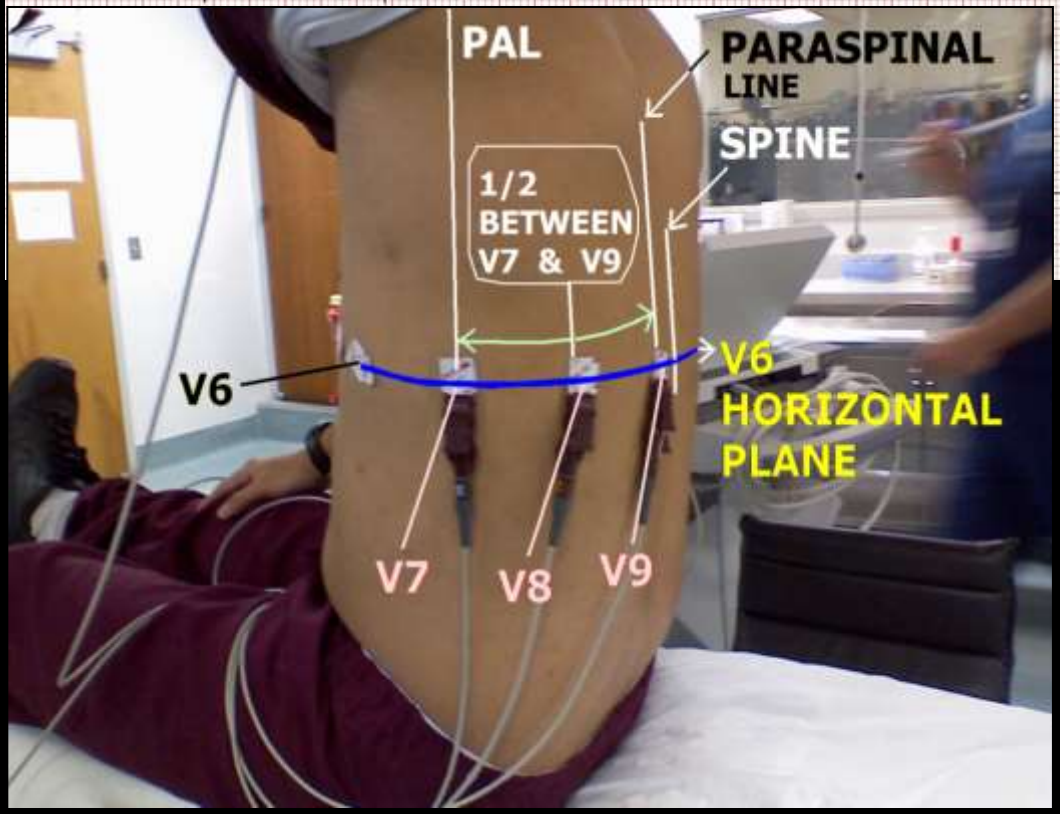
POSTERIOR WALL STEMI

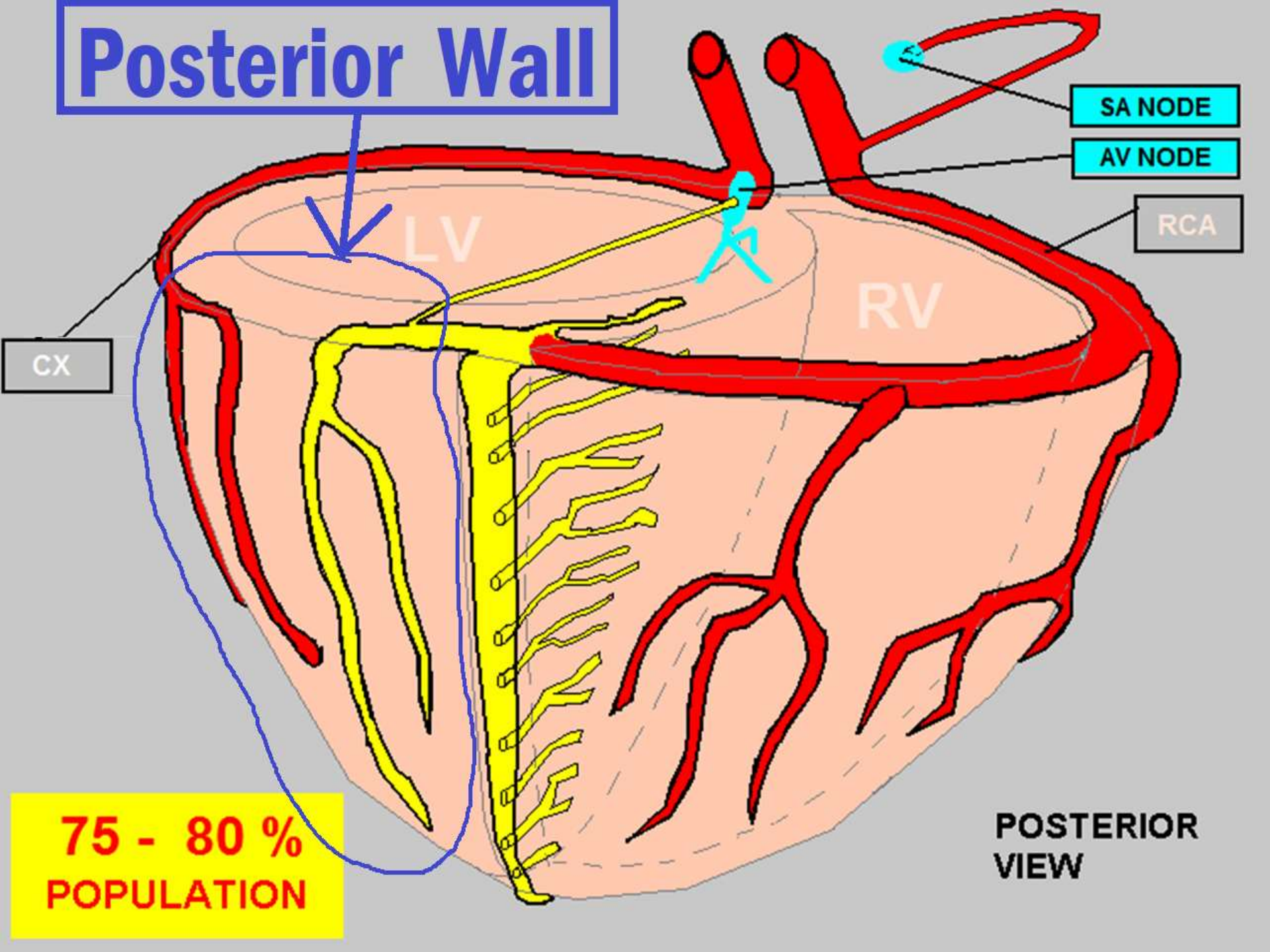
Whenever your patient's ECG exhibits ST DEPRESSION in any of the ANTERIOR LEADS (V1-V4), CONSIDER the possibility of POSTERIOR WALL STEMI ! !

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

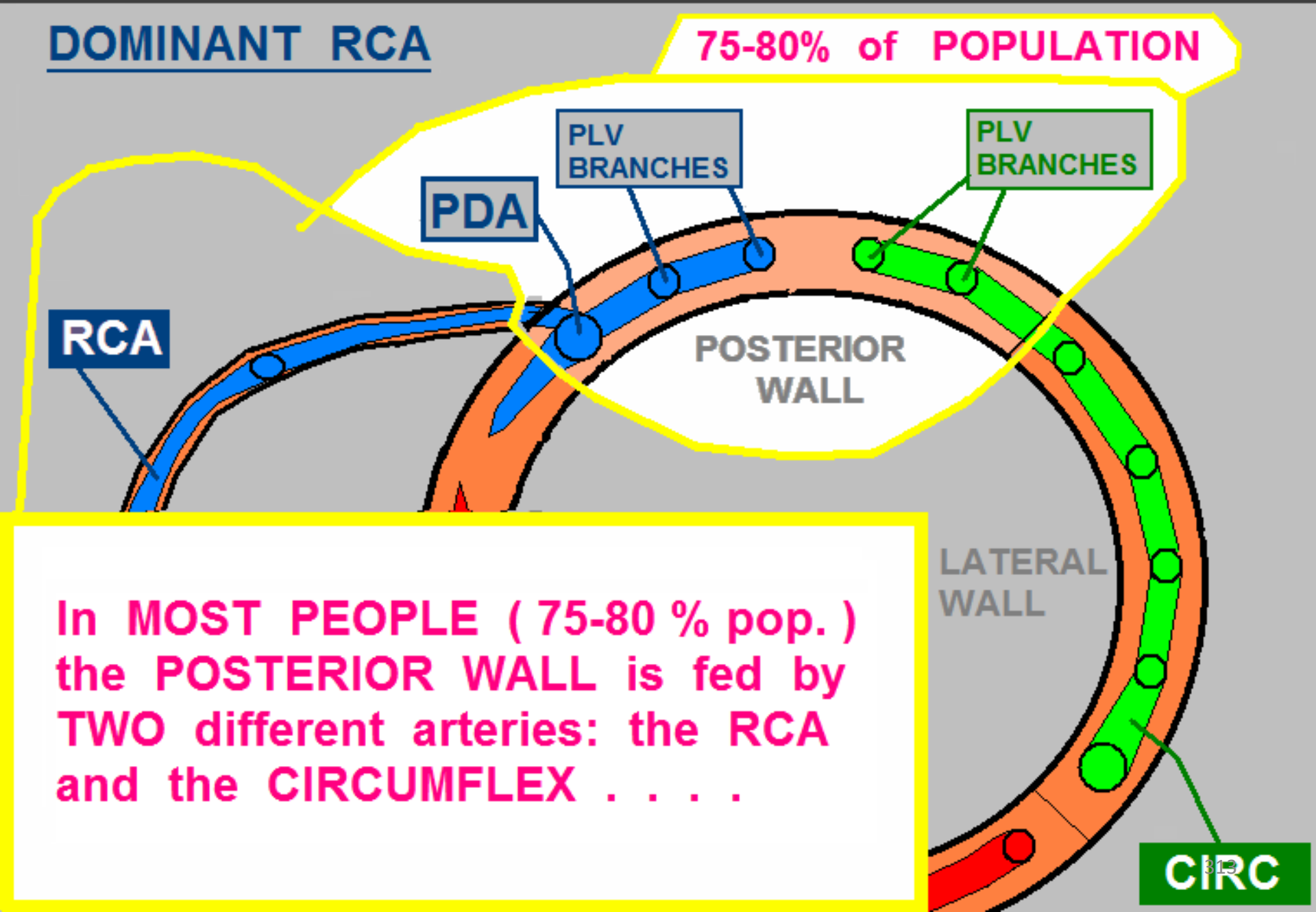



I
aVR
V1
V4
II
aVL
V2
V5
III
aVF
V3
V6
7
8
9


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


Posterior Wall
SA NODE
AV NODE
RCA
LV
RV
CX
75 - 80 %
POPULATION
POSTERIOR
VIEW

POSTERIOR WALL BLOOD SUPPLY



In MOST PEOPLE (75-80 % pop.) the POSTERIOR WALL is fed by TWO different arteries: the RCA and the CIRCUMFLEX . . . .

Congrats!!

YOU SURVIVED !!!!

???