The LIFSAVING Electrocardiogram

PART I

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Crystal River, FL

Interventional Cardiovascular
& Electrophysiology Lab
Technologist

PRE-REQUISITES:

BASIC ECG INTERPRETATION SKILLS:

- This is NOT a Basic ECC Rhythms course.
- If you're in this class, you should already know your basic rhythms.

The Lifesaving ECG Course:

AM Session CONTENTS:

- **Introduction and The ECG in Perspective**
- **Essential Cardiac A & P**
  - **Cellular (nerve, muscle, connective)**
  - **Structural (chambers / valves / Fibrous Skeleton)**
- **Heart Sounds**
  - **Acute Mitral Regurgitation**

The Lifesaving ECG Course:

AM Session CONTENTS, continued:

- **Wolff-Parkinson-White Syndrome**
- **ECG Principles**
- **Coronary Artery Anatomy and Correlation with the 12 Lead ECG**
- **Waveforms and Intervals**
- **Bundle Branch Blocks**
- **Axis Deviation and Rotation**

The Lifesaving ECG Course:

PM Session CONTENTS:

- **Sudden Cardiac Death Syndromes**
  - Long QT
  - Hypertrophic Cardiomyopathy
  - Arrythmogenic Right Ventricular Cardiomyopathy
  - Brugada Syndrome
- **Acute Coronary Syndromes**

  With Cath Lab Case Studies

WHO

are

U

???

Wayne Ruppert - Bio:

- Cardiovascular Coordinator 2012-present (coordinated 4 successful accreditations)
- Interventional Cardiovascular / Electrophysiology Technologist, 1995-Present. (Approx 13,000 patients)
- Author of: "**12 Lead ECG Interpretation in Acute Coronary Syndrome with Case Studies from the Cardiac Cath Lab**," 2010, TriGen publishing / Ingram Books
- Author of: "**STEMI Assistant**," 2014, TriGen publishing / Ingram Books
- Florida Nursing CE Provider # 50-12998
- 12 Lead ECG Instructor, 1994-present (multiple hospitals, USF College of Medicine 1994)
- Website: www.ECGtraining.org

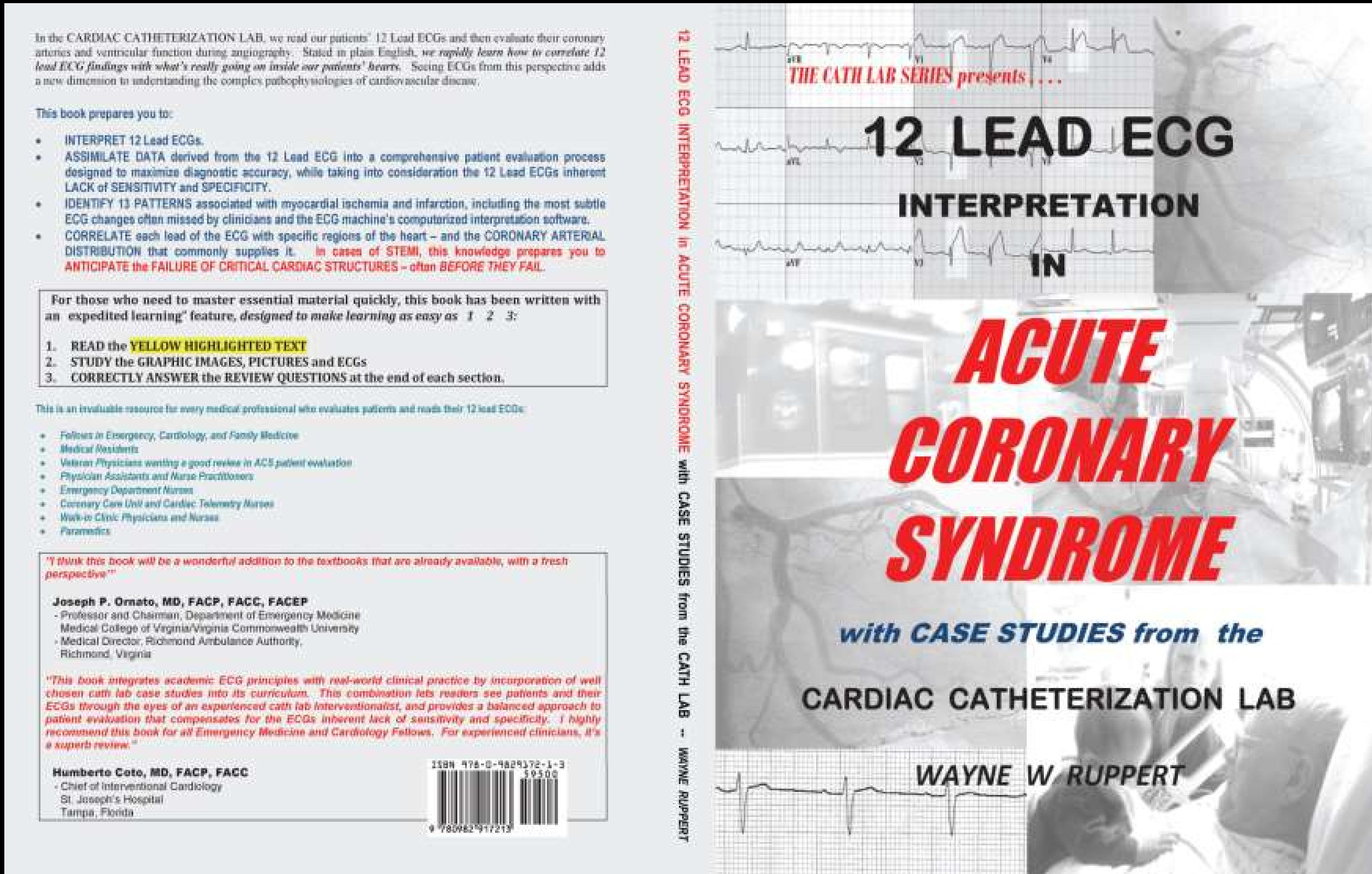

7.29 06:55

Electrophysiology Lab Case Studies

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

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

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



www.TriGenPress.com

www.ECGtraining.org

BarnesandNoble.com

Amazon.com

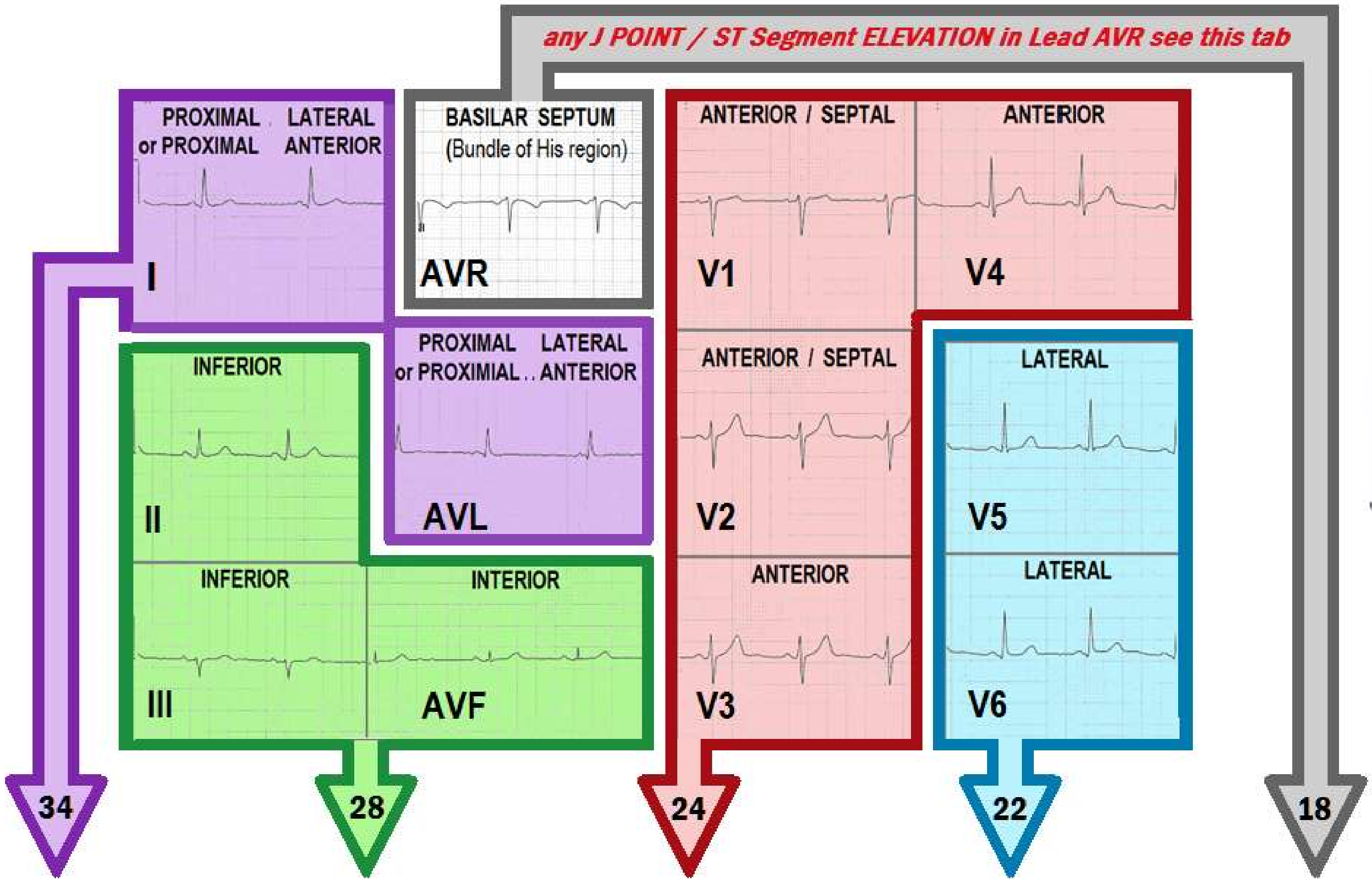
STEMI Assistant

by Wayne Ruppert

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

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

CRASH CART EMERGENCY REFERENCE



Bayfront Health
Dade City

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Wayne.ruppert@bayfronthealth.com

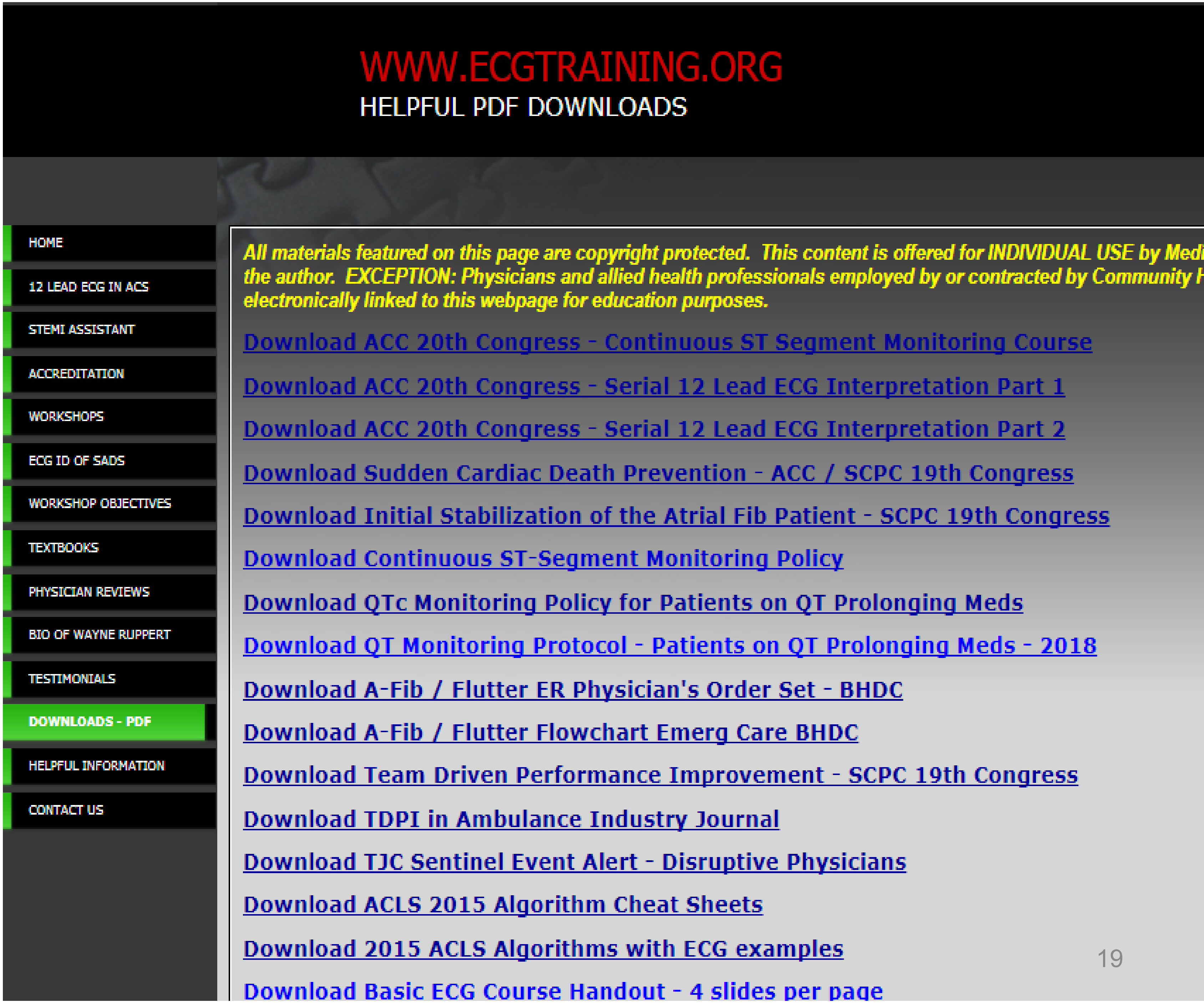
The Lifesaving ECG Course:

BASIS:

- **Current ACC/AHA Guidelines and Recommendations**
- **Multiple additional recent Evidence-Based Journal Articles**
- **ECGs from case files of the author, Wayne Ruppert**
- **Graphic art / images from published textbooks authored by Wayne Ruppert**

www.ECGtraining.org
www.practicalclinicalskills.com

Go to ECGtraining.org then select DOWNLOADS PDF from menu bar



Then Select:

The Lifesaving 12 Lead ECG - Part 1

The Lifesaving 12 Lead ECG - Part 2

The EKG in PERSPECTIVE

1. Much development in the 1950s and 60s, and at that time, EKGs were the primary diagnostic tool.

2. Today we have better diagnostic tools (e.g. ECHO, CARDIAC CATH, EP STUDIES) that sometimes conflict with traditional EKG-made diagnoses.

3. Some EKG findings are more accurate and reliable than others .

AND . . .

Sometimes,
ECGs
LIE to us !

ECGs and USED CAR SALESMEN often have MUCH in common !

The EKG in PERSPECTIVE

PROBLEMS WITH EKGs . . .

↓ SENSITIVITY

(FALSE NEGATIVES)

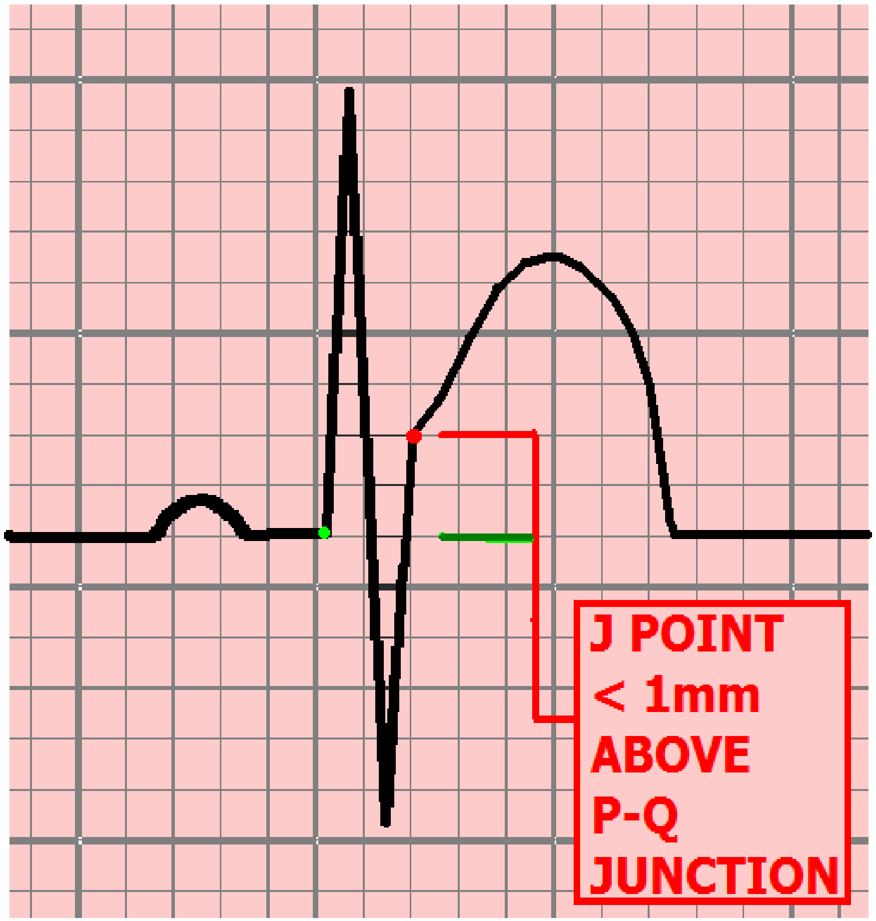
↓ SPECIFICITY

(FALSE POSITIVES)

AND . . .

PROBLEMS WITH SPECIFICITY . . .

S-T SEGMENT ELEVATION - COMMON ETIOLOGIES:



CONDITION:

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

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

1North (06)

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

--AXIS--

P	59
QRS	14
T	33

12 Lead; Standard Placement

- ABNORMAL ECG -

>>> Acute MI <<<

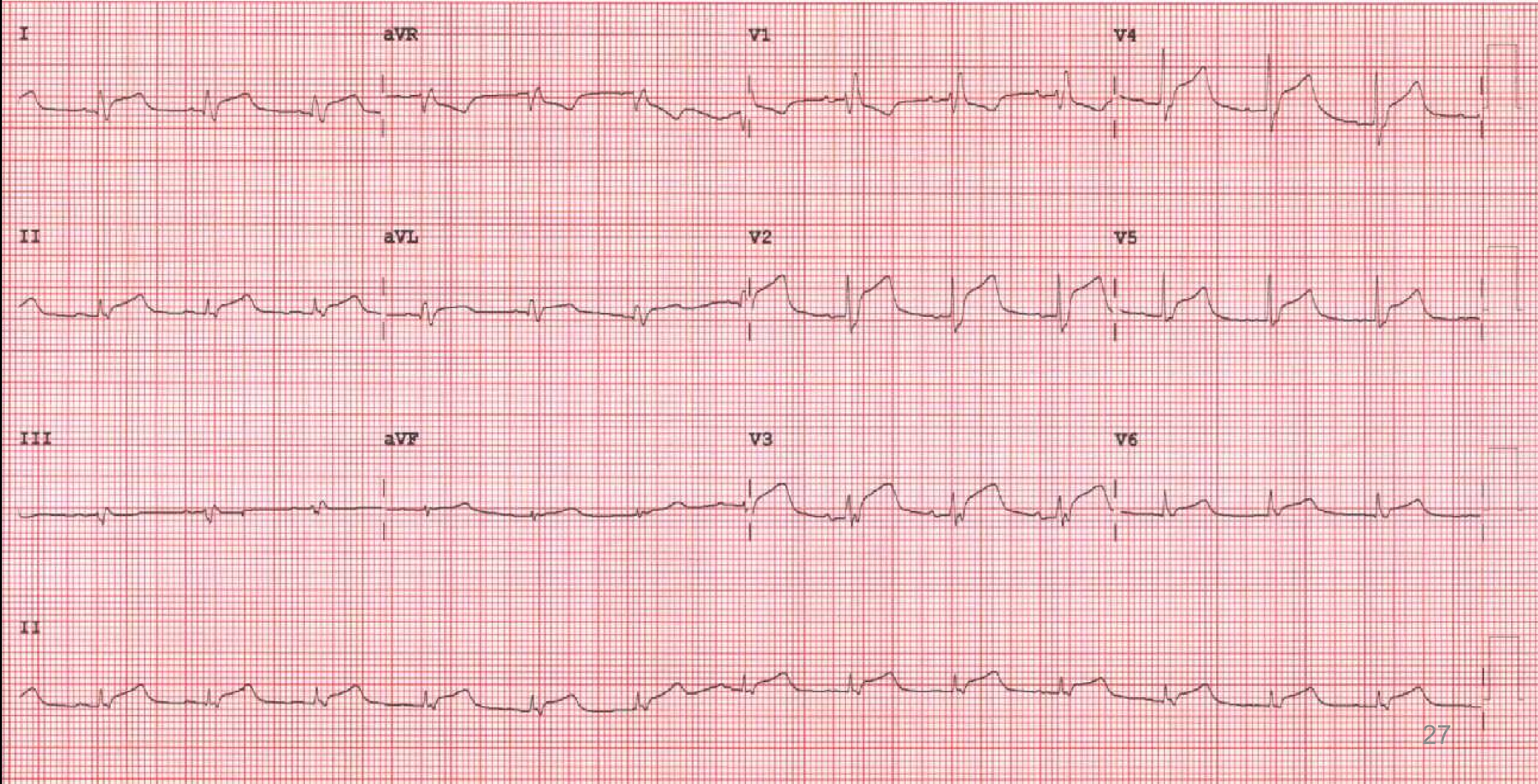
Requested by:

Unconfirmed Diagnosis

FAXED

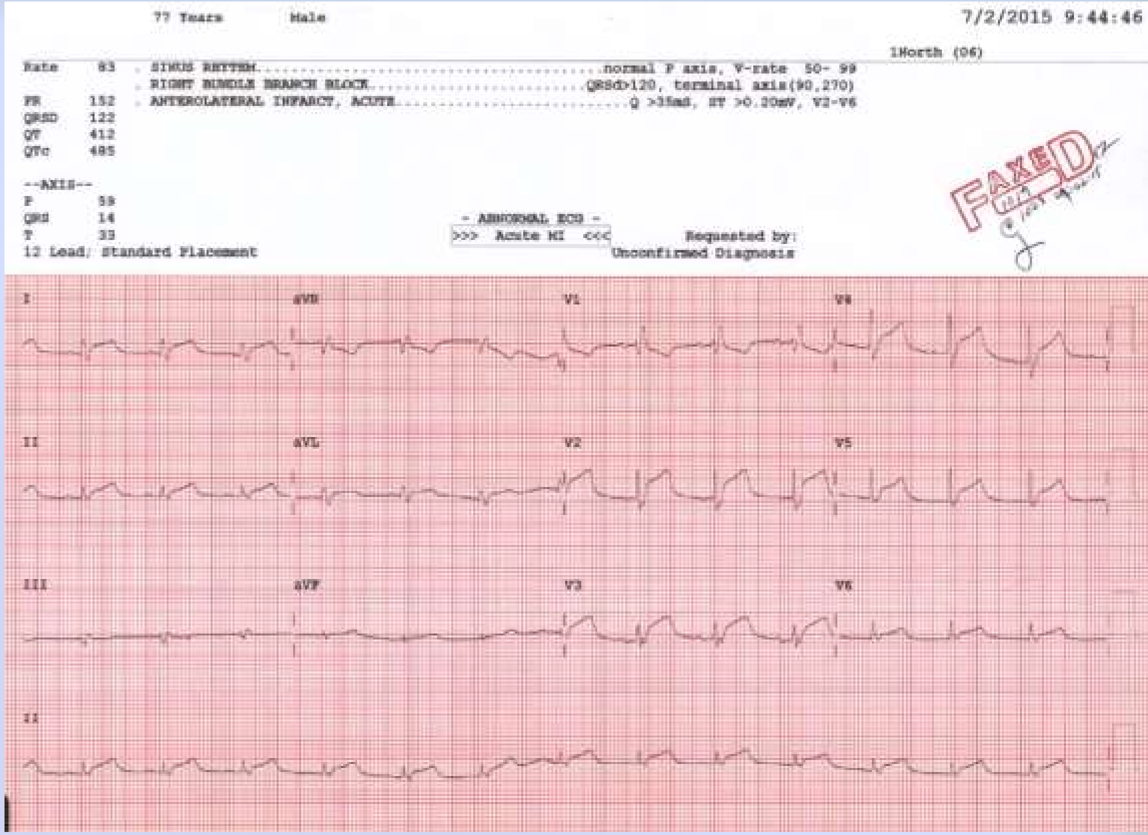
1019

@ 1023 07-02-15



Patient:

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



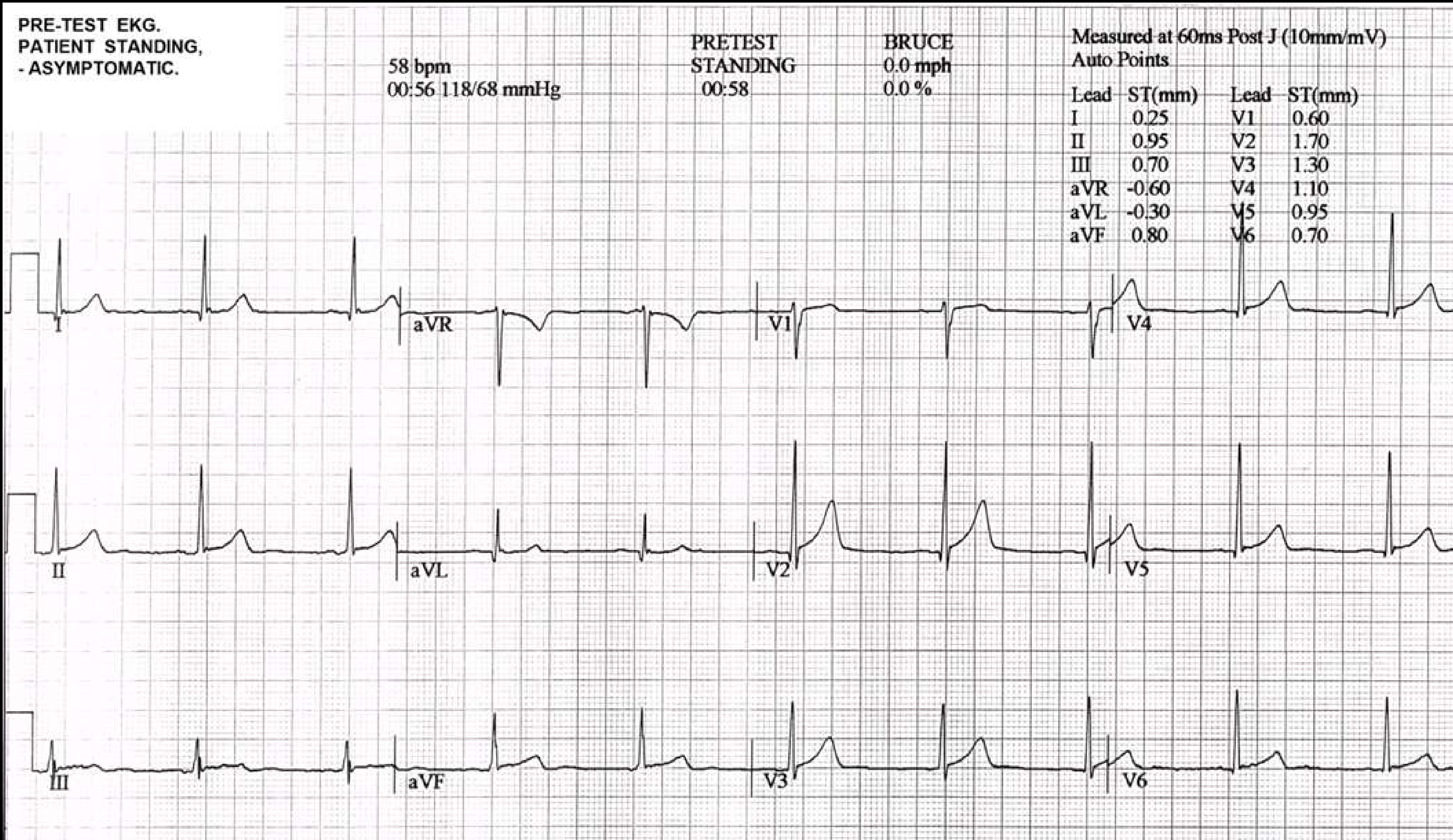
EARLY REPOLARIZATION. This degree of ST Elevation in early repolarization is VERY RARE: The only such ECG I have seen in approximately 13,000 cardiac catheterizations.

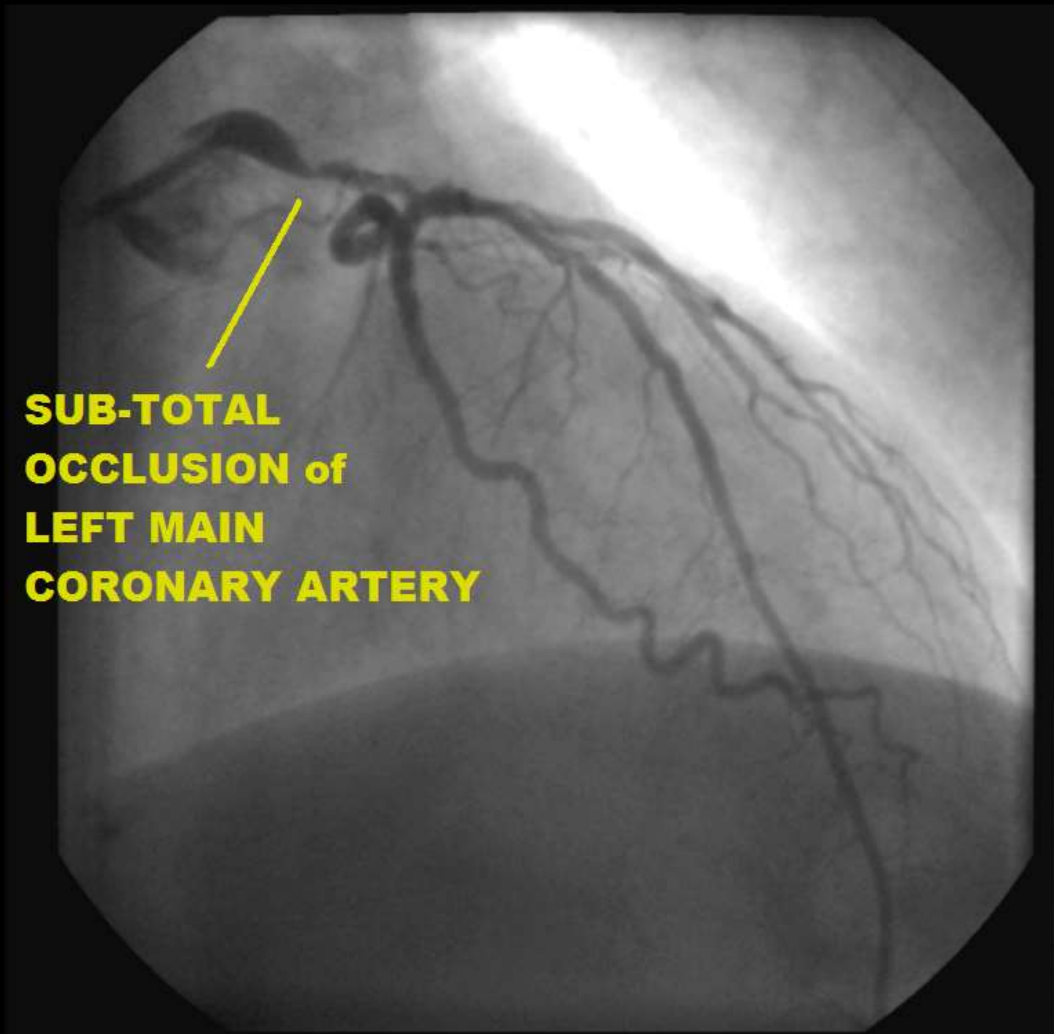
EKGs in PERSPECTIVE, con't:

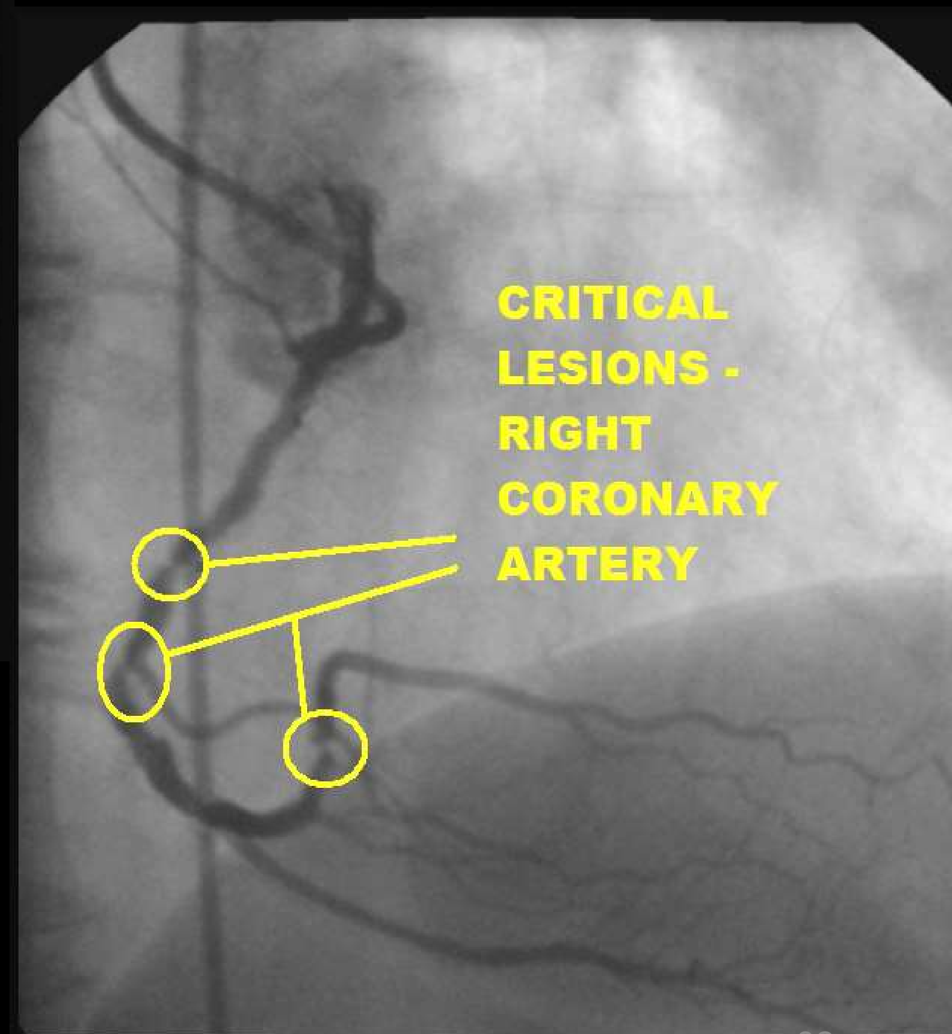
One of the MOST MISLEADING scenarios of all is when the EKG APPEARS **PERFECTLY NORMAL** . . .

. . . but MASKS serious, LIFE - THREATENING CONDITIONS.

that is why YOU must do a THOROUGH PATIENT EVALUATION . . . and have a HIGH INDEX OF SUSPICION ! ! !


PRE-TEST EKG.
PATIENT STANDING,
- ASYMPTOMATIC.
58 bpm
00:56 118/68 mmHg
PRETEST
STANDING
00:58
BRUCE
0.0 mph
0.0 %
Measured at 60ms Post J (10mm/mV)
Auto Points
Lead ST(mm) Lead ST(mm)
I 0.25 V1 0.60
II 0.95 V2 1.70
III 0.70 V3 1.30
aVR -0.60 V4 1.10
aVL -0.30 V5 0.95
aVF 0.80 V6 0.70
I
aVR
V1
V4
II
aVL
V2
V5
III
aVF
V3
V6

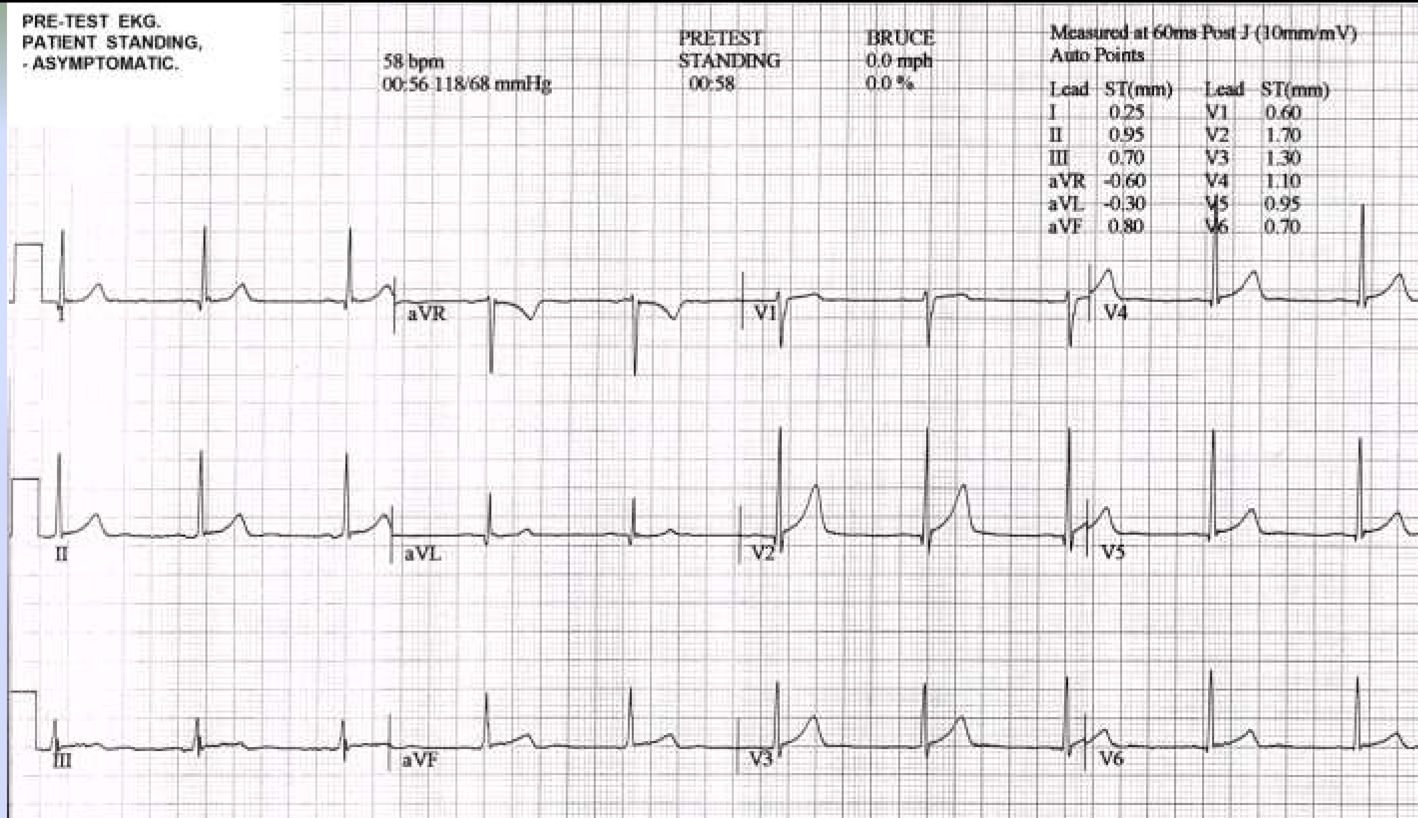

SUB-TOTAL
OCCLUSION of
LEFT MAIN
CORONARY ARTERY

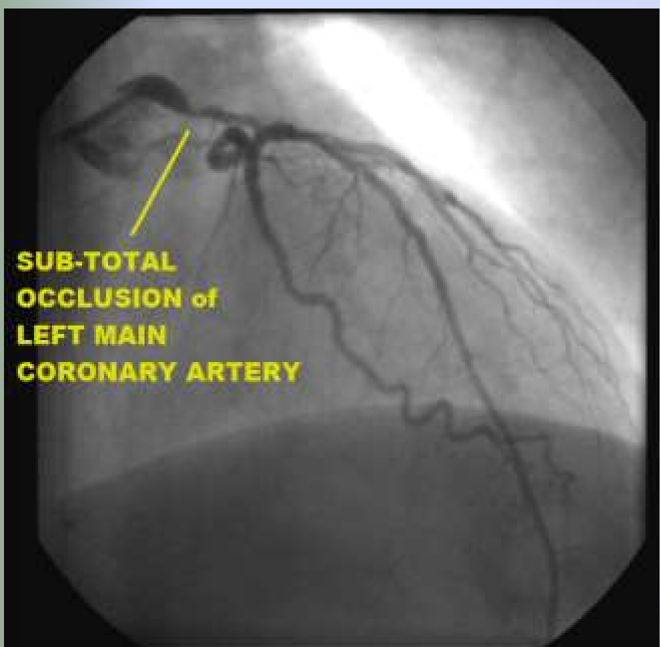

CRITICAL
LESIONS -
RIGHT
CORONARY
ARTERY

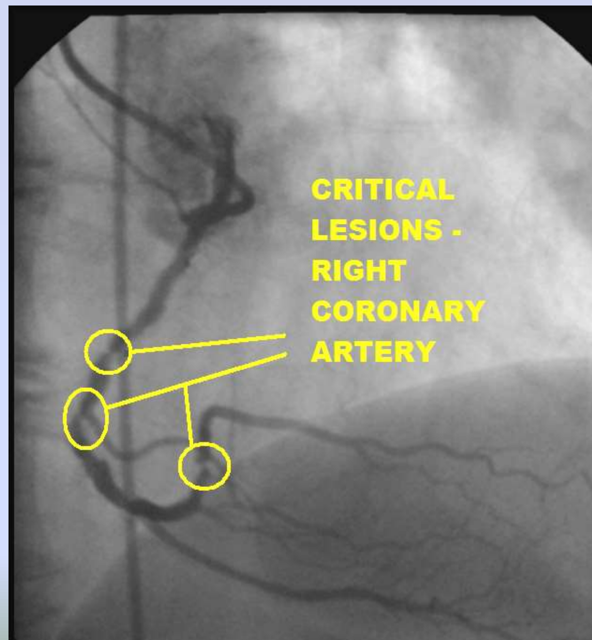
PROBLEMS WITH SENSITIVITY . . .

NORMAL ECG.

But . . . . .

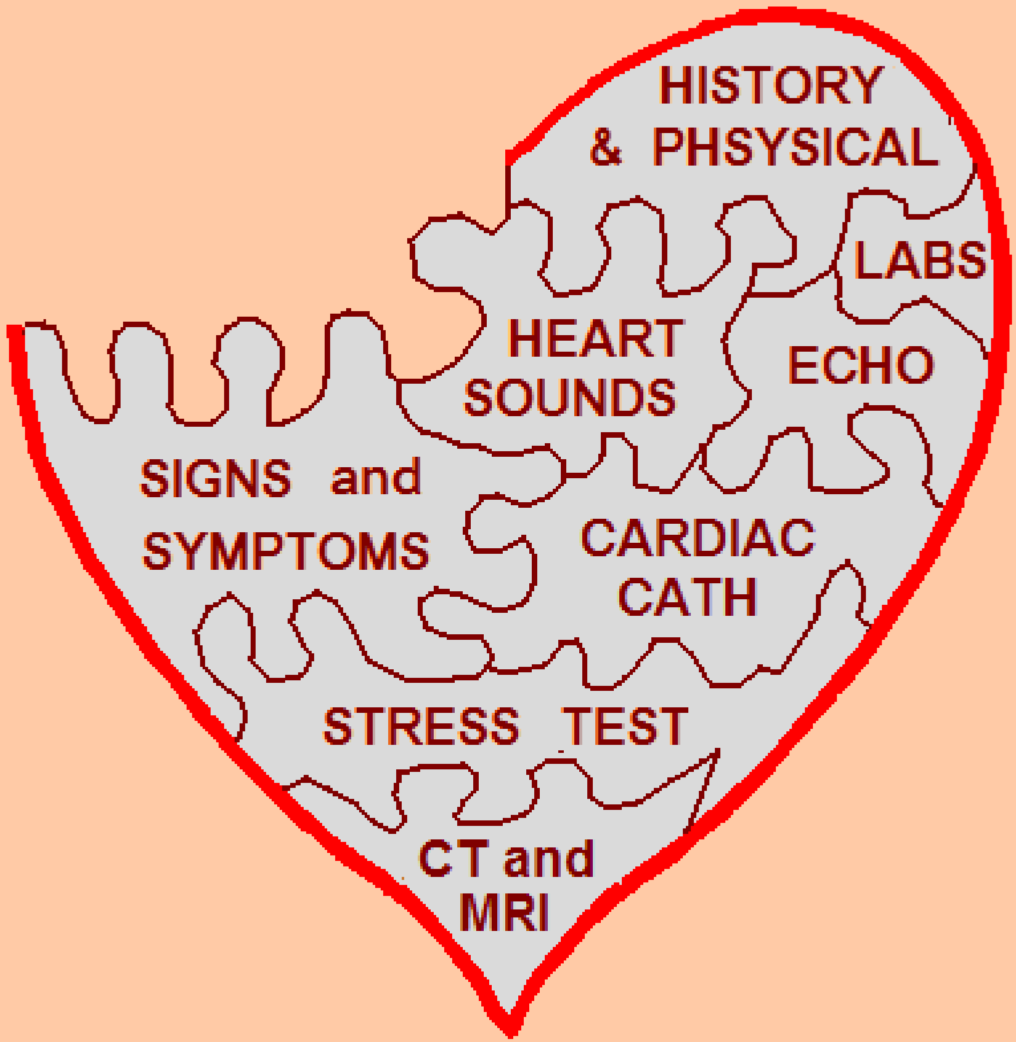






LETHAL TRIPLE VESSEL DISEASE

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



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

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

- ***We utilize ACS Risk Stratification* to compensate for the ECG's lack of sensitivity and specificity, to aid us in clinical decision-making and to improve our diagnostic accuracy.**

HEART

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

***Risk factors for atherosclerotic disease:**

Hypercholesterolemia
Hypertension
Diabetes Mellitus
Cigarette smoking
Positive family history
Obesity

C-Statistic scores achieved in this study:

HEART:	0.83
TIMI:	0.75
GRACE:	0.70

C-Statistic interpretation:

A score of "1.00" would mean the score predicts outcome with 100% perfection. A score of 0.50 is the same as a "50/50 coin toss." A score of LESS THAN 0.50 means that the score predicts the opposite outcome.

US HEART Score Validation

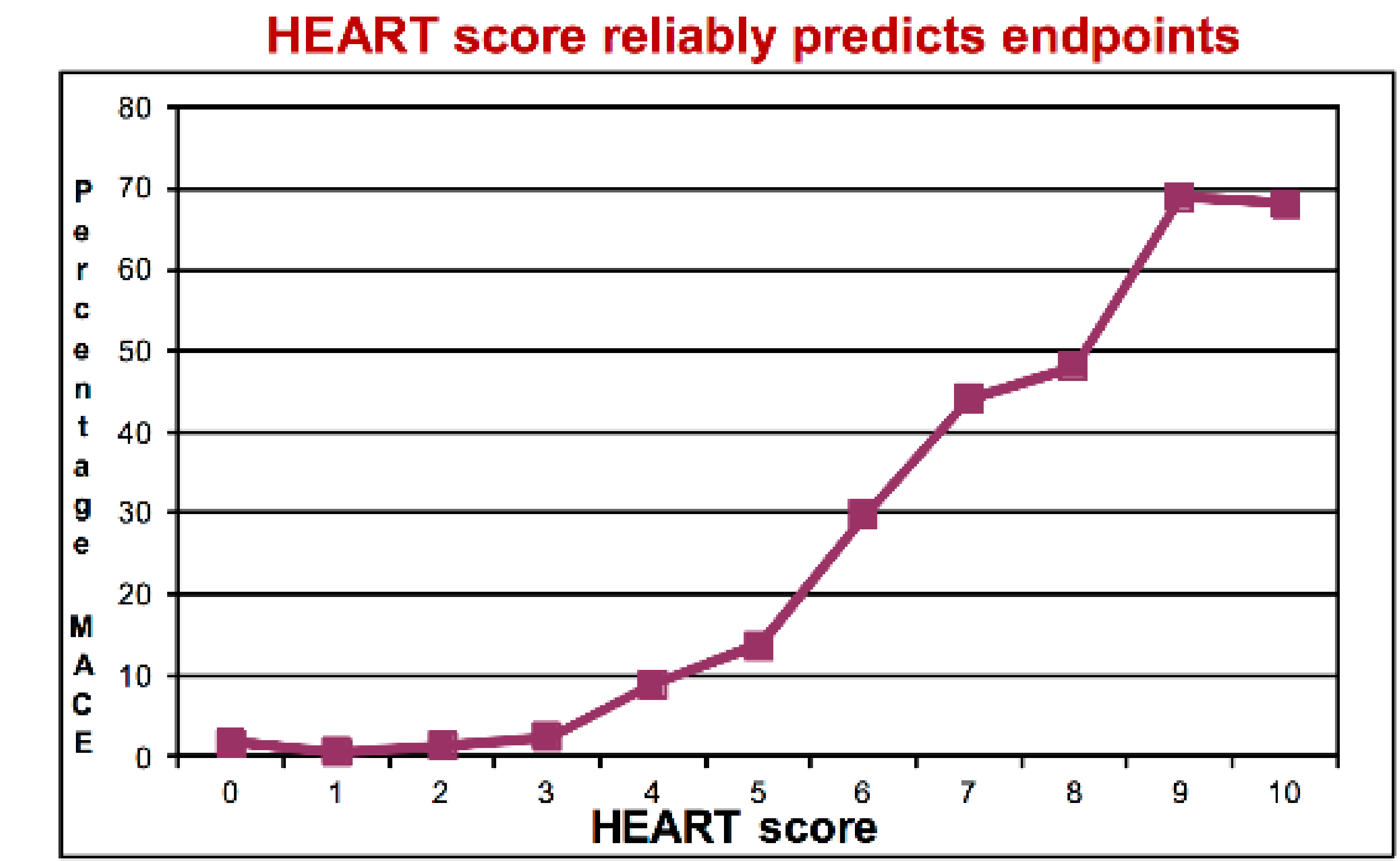
- 1,070 observation unit patients at Wake Forest
- ☞ ***Out performed clinician gestalt !***

Mahler et. al, Crit Path Cardiol, 2011
Mahler et. al, Int J Cardiol, 2013

The HEART Score:

Score	% pts	MACE/n	MACE	Death	Policy
0-3	32%	38/1993	1.9%	0.05%	Discharge
4-6	51%	413/3136	13%	1.3%	Observation Risk management
7-10	17%	518/1045	50%	2.8%	Observation Treatment, CAG

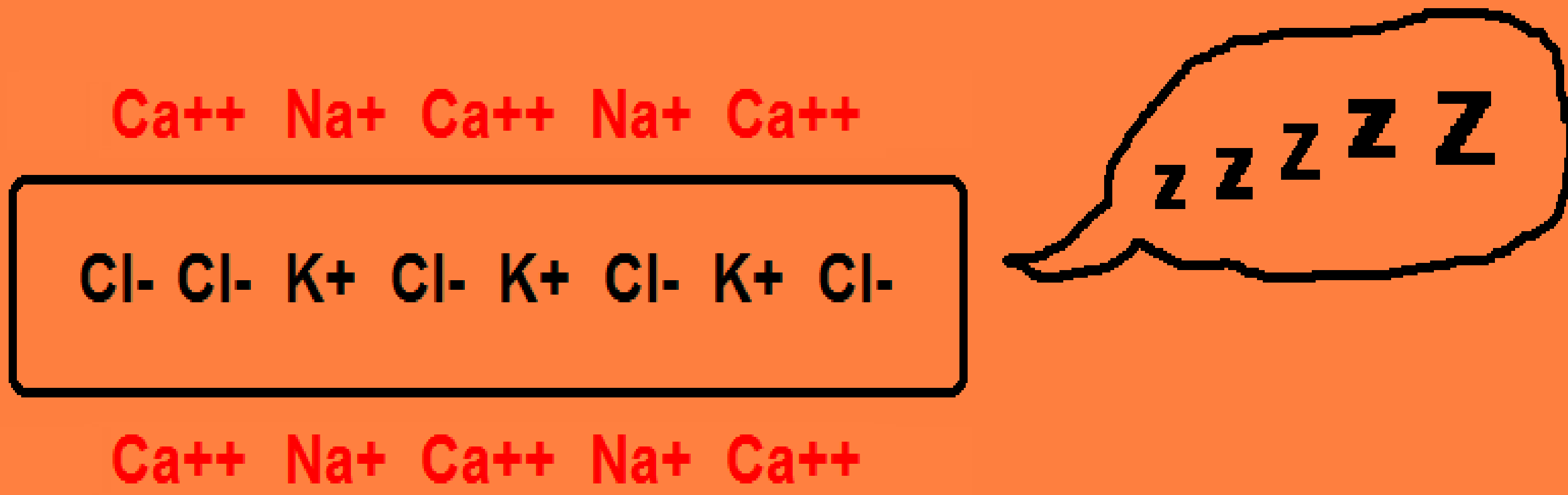
Heart Score Reliability



Cardiac A & P

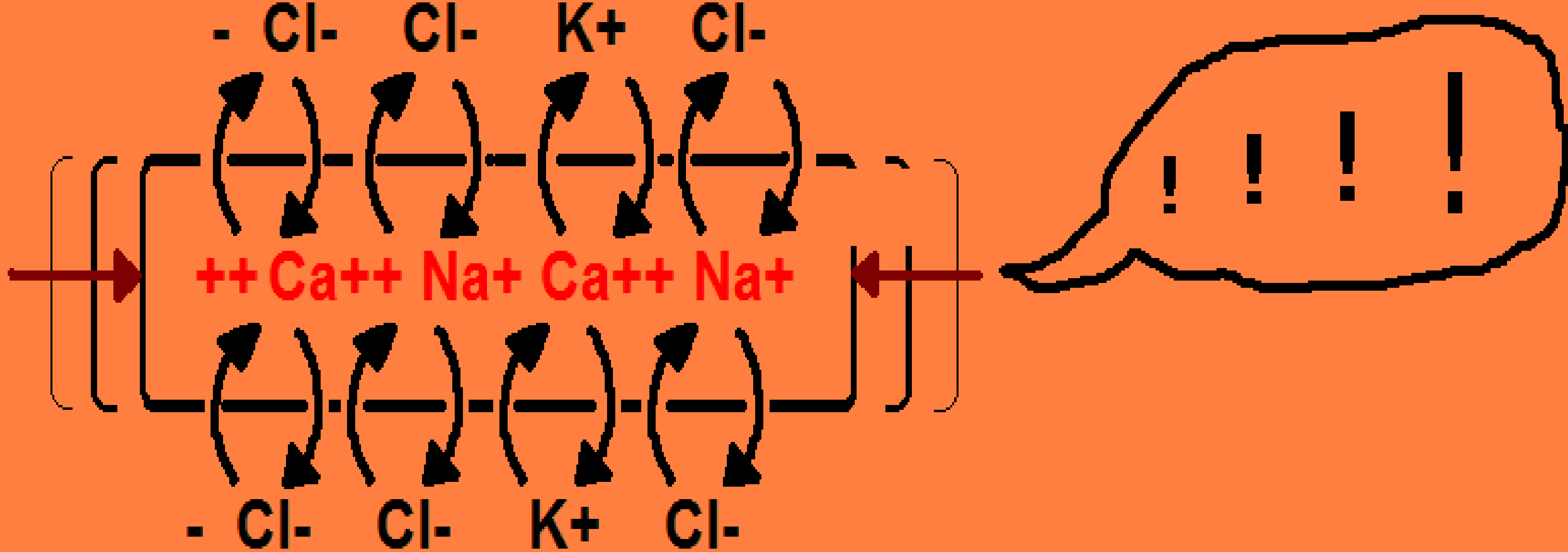
CARDIAC ANATOMY and PHYSIOLOGY "101"

CARDIAC CELLS AT REST have POSITIVE charged IONS on the OUTSIDE of the cell membrane, and NEGATIVE charged IONS on the INSIDE



CARDIAC ANATOMY and PHYSIOLOGY "101"

. . . when the IONS shift . . . that is, the POSITIVE IONS that were on the outside TRADE PLACES with the NEGATIVE IONS that were on the INSIDE . . . .



. . . THE CELL CONTRACTS !

THIS (OF COURSE) IS KNOW AS . . .

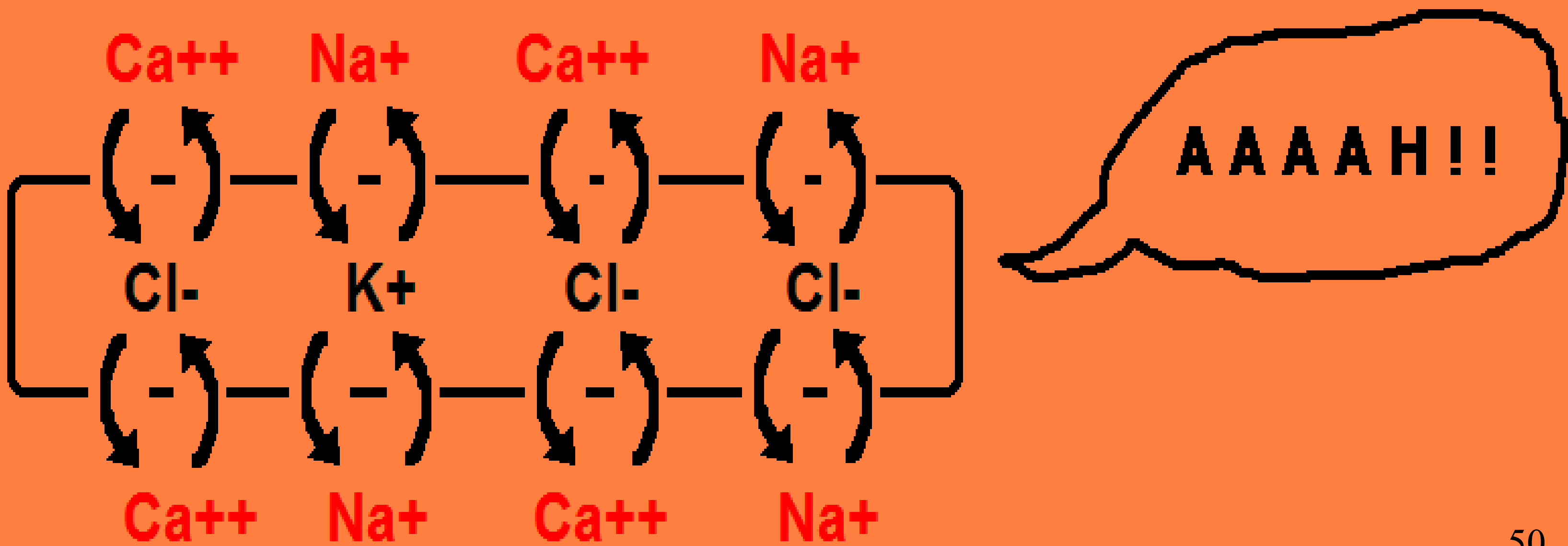
DEPOLARIZATION

WHEN EVERYTHING IS WORKING PROPERLY, THE WAVE OF DEPOLARIZING CELLS CAUSES THE HEART TO CONTRACT, AND PUMP BLOOD TO THE LUNGS AND THE SYSTEMIC CIRCULATION

AFTER DEPOLARIZATION, THE CELLS RELAX.

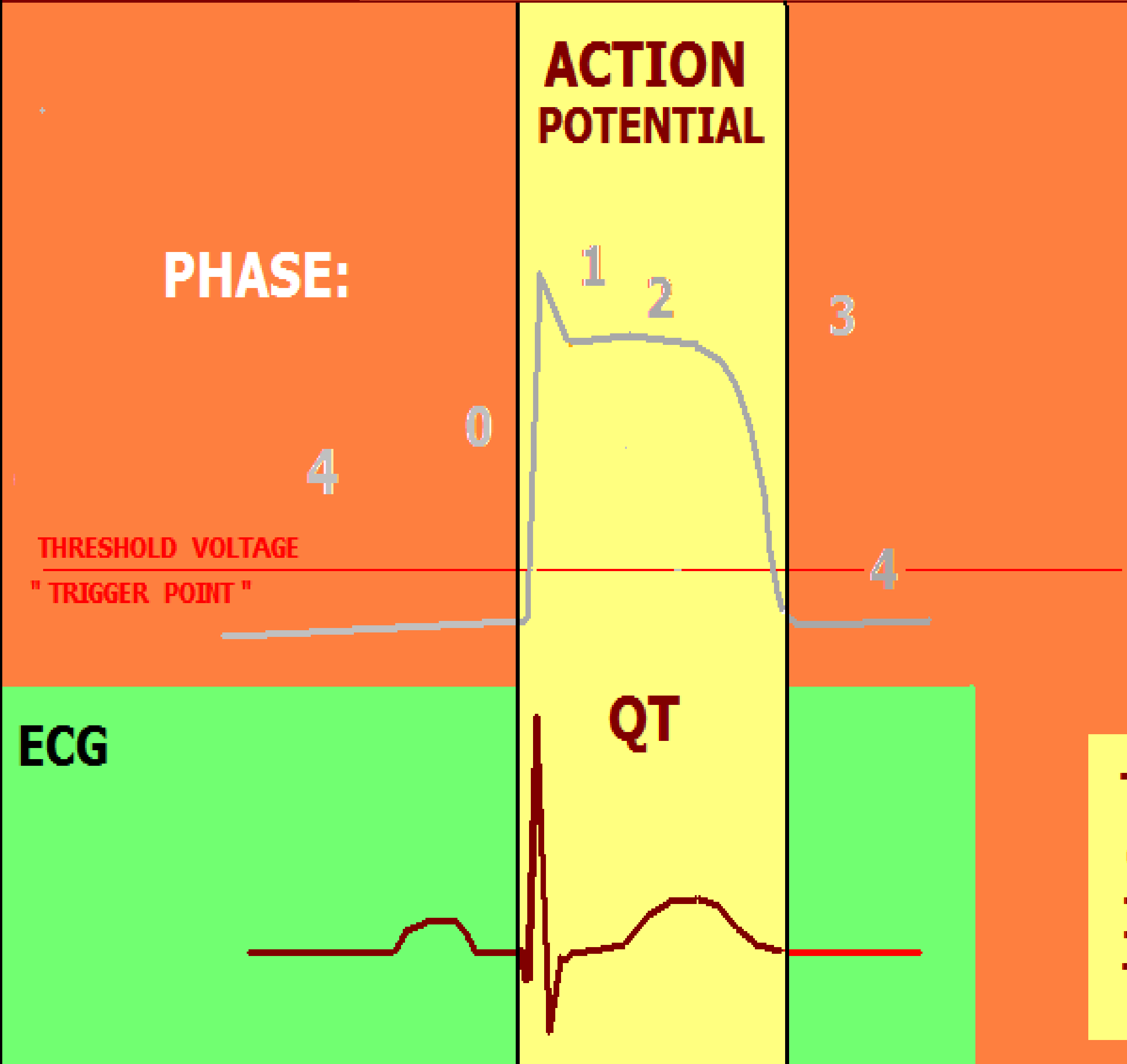
THE IONS RETURN TO THEIR ORIGINAL POSITIONS --

THIS PROCESS IS KNOWN AS REPOLARIZATION



CARDIAC ANATOMY and PHYSIOLOGY "101"

VENTRICULAR MUSCLE CELL ACTION POTENTIAL



CELL " STATUS: "

4
- CELL REPOLARIZED
- -80 to -90 mV CHARGE
- SLIGHT " LEAKAGE " OF IONS

0
- RAPID INFLUX OF + CHARGED SODIUM IONS
- CELL DEPOLARIZATION

1
- SODIUM EXITS CELL
- REPOLARIZATION BEGINS

2
- CALCIUM IONS CONTINUE TO ENTER CELL

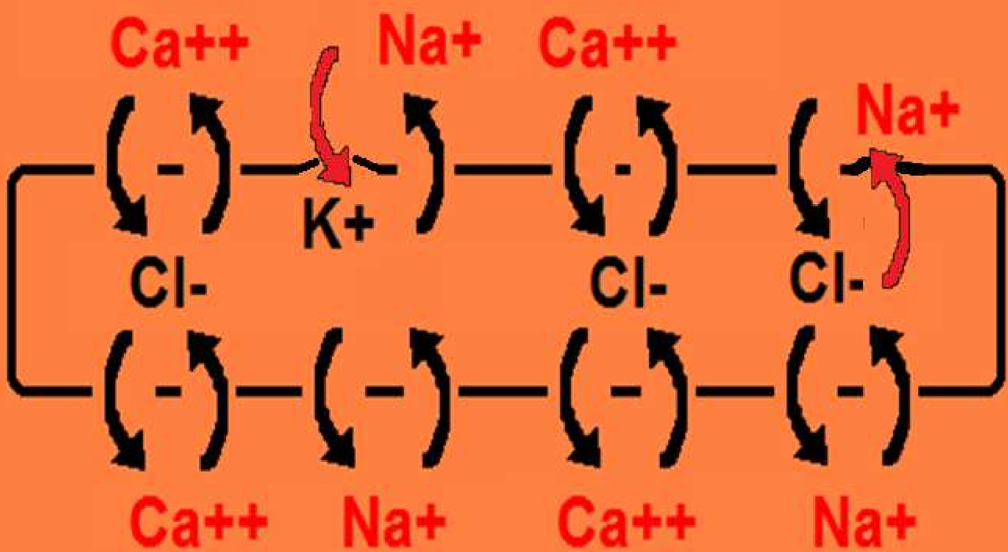
3
- CALCIUM CHANNELS CLOSE

THE ACTION POTENTIAL
(OF VENTRICULAR MUSCLE CELLS)
IS ROUGHLY EQUAL TO THE Q - T INTERVAL

CARDIAC ANATOMY and PHYSIOLOGY "101"

When ION CHANNELS are MALFORMED, the abnormal channel shape may DELAY the transfer of IONS . . . . .

. . . . this can DELAY REPOLARIZATION, which will show on the ECG as "QT Prolongation"



CARDIAC ANATOMY and PHYSIOLOGY "101"

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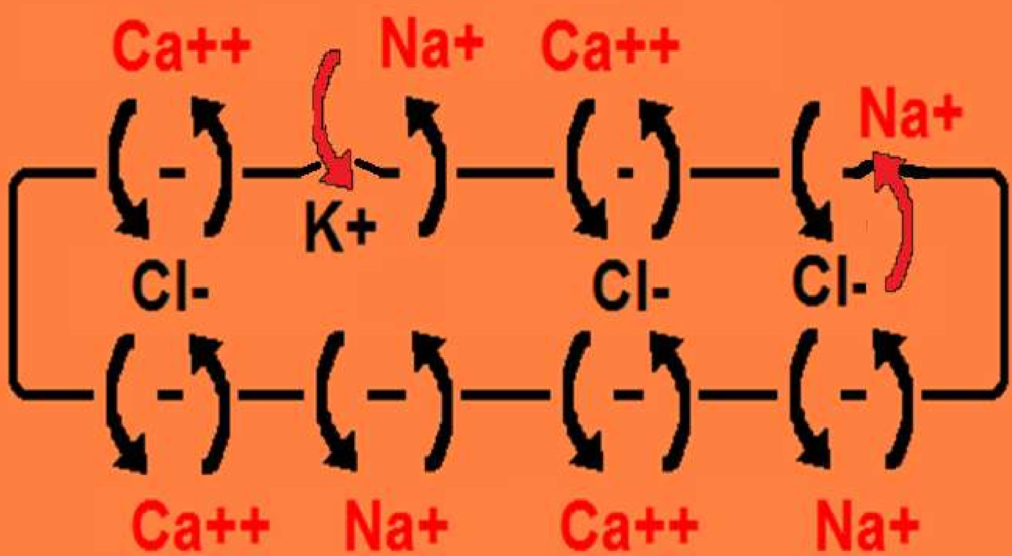
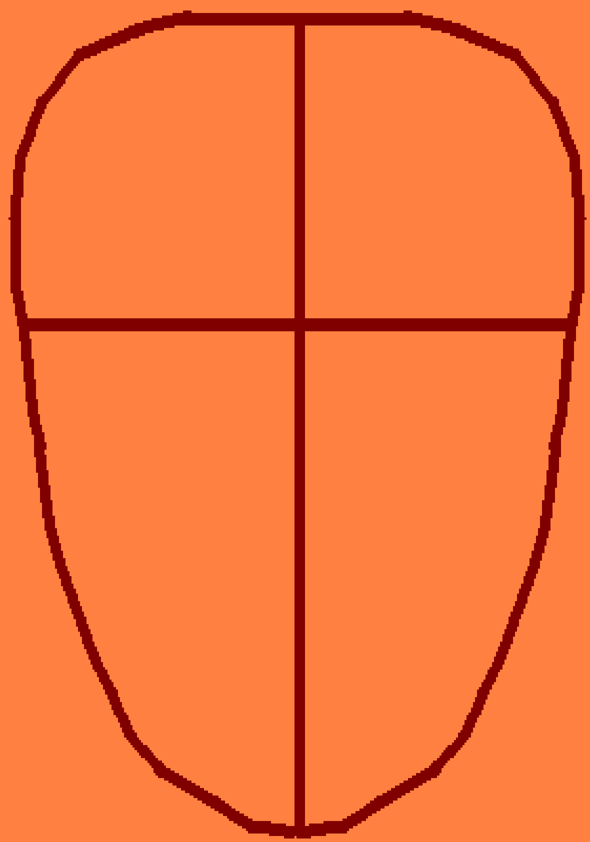


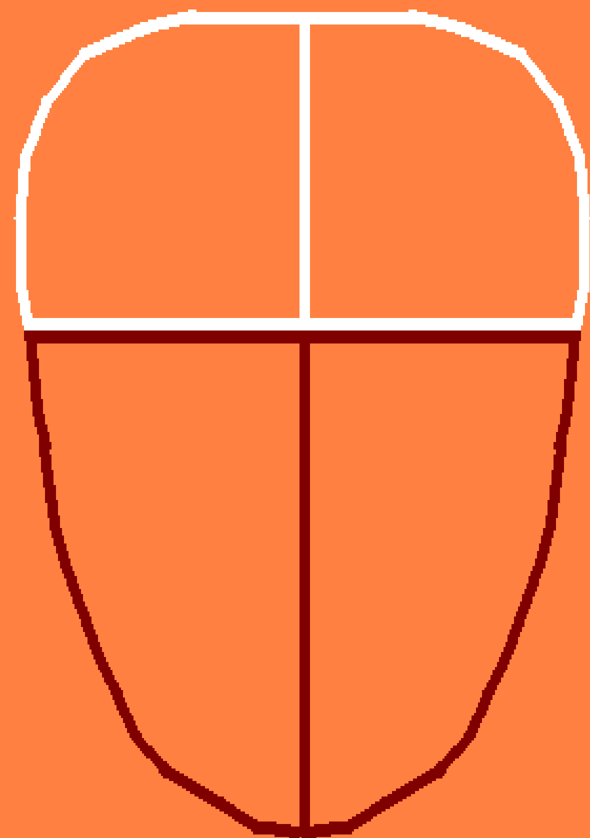
. . . . which can lead to LETHAL DYSRHYTHMIAS such as Torsades de Pointes, CARDIAC ARREST and SUDDEN DEATH.

FOUR CHAMBERED PUMP



FOUR CHAMBERED PUMP...

2 ATRIUM

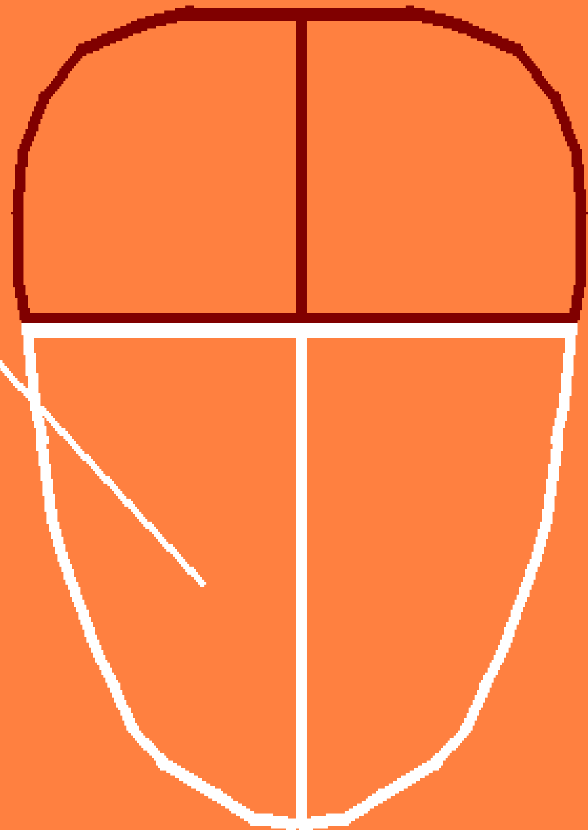


PRIMARY JOB:

"PACK VENTRICLES FULL OF BLOOD"

FOUR CHAMBERED PUMP...

2 VENTRICLES



PRIMARY JOB:

"PUMP BLOOD TO THE LUNGS AND THE REST OF THE BODY"

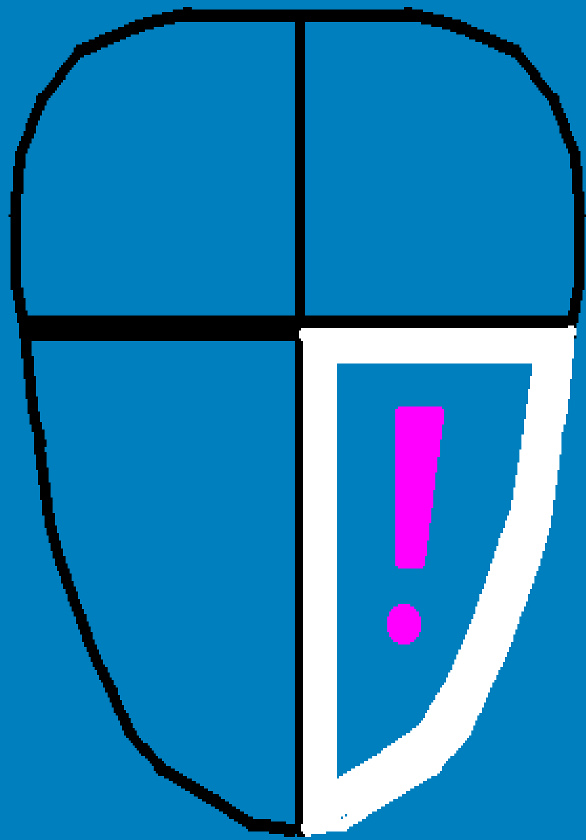
THE CHAMBER MOST IMPORTANT TO KEEPING THE PATIENT ALIVE

(and the ONLY one you can't live without)

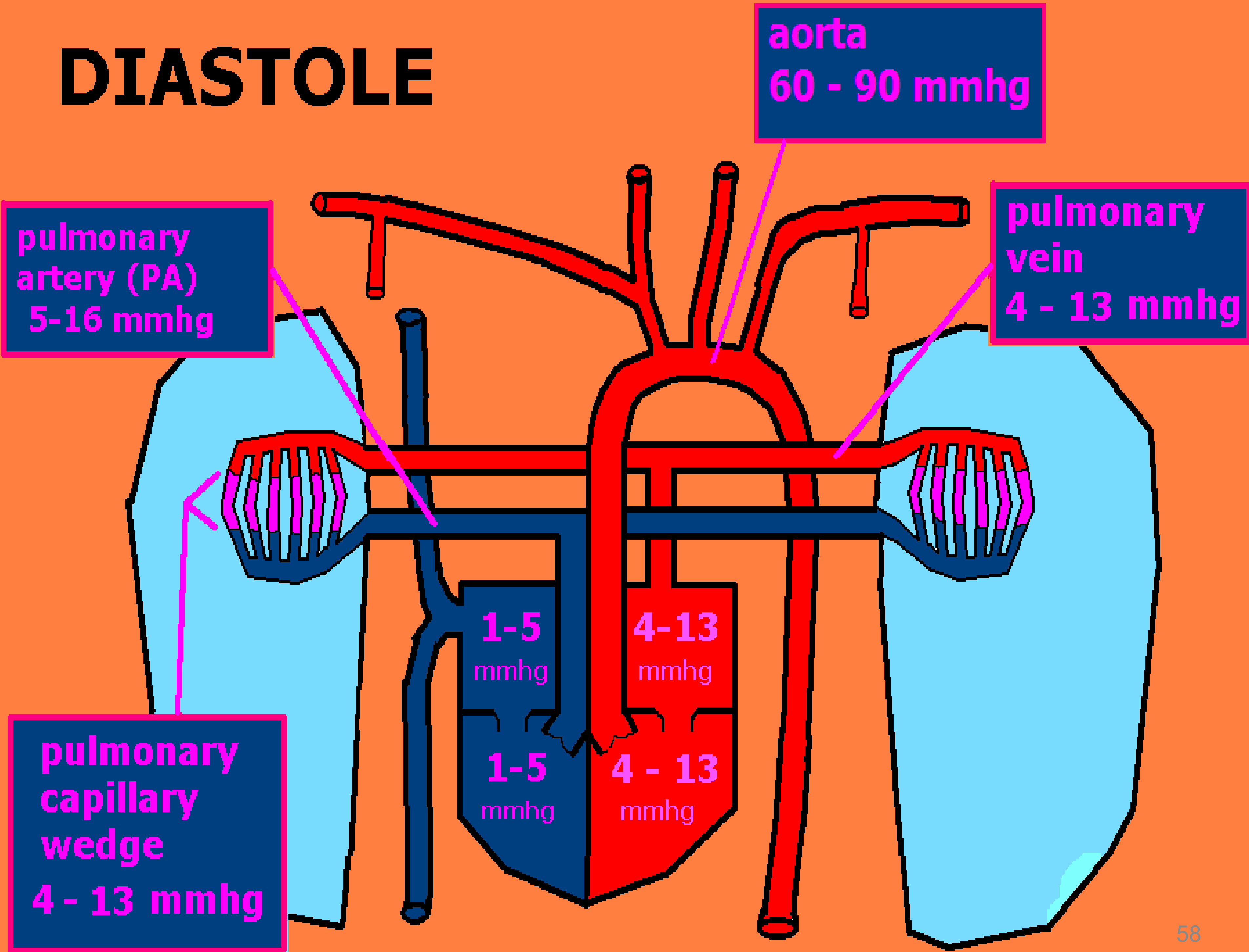
IS THE

LEFT VENTRICLE

WHICH WE WILL REFER TO AS **THE PUMP**

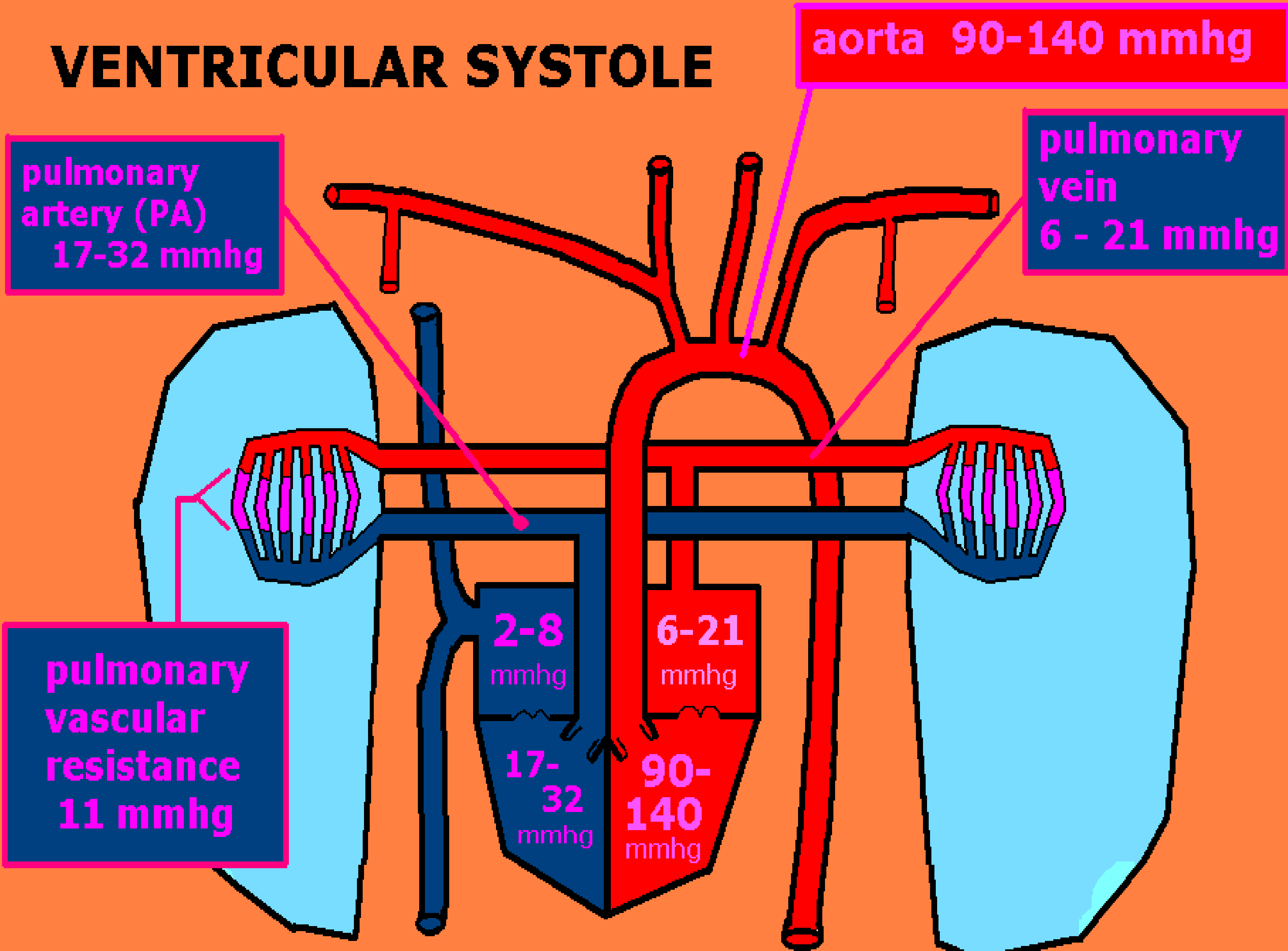


DIASTOLE



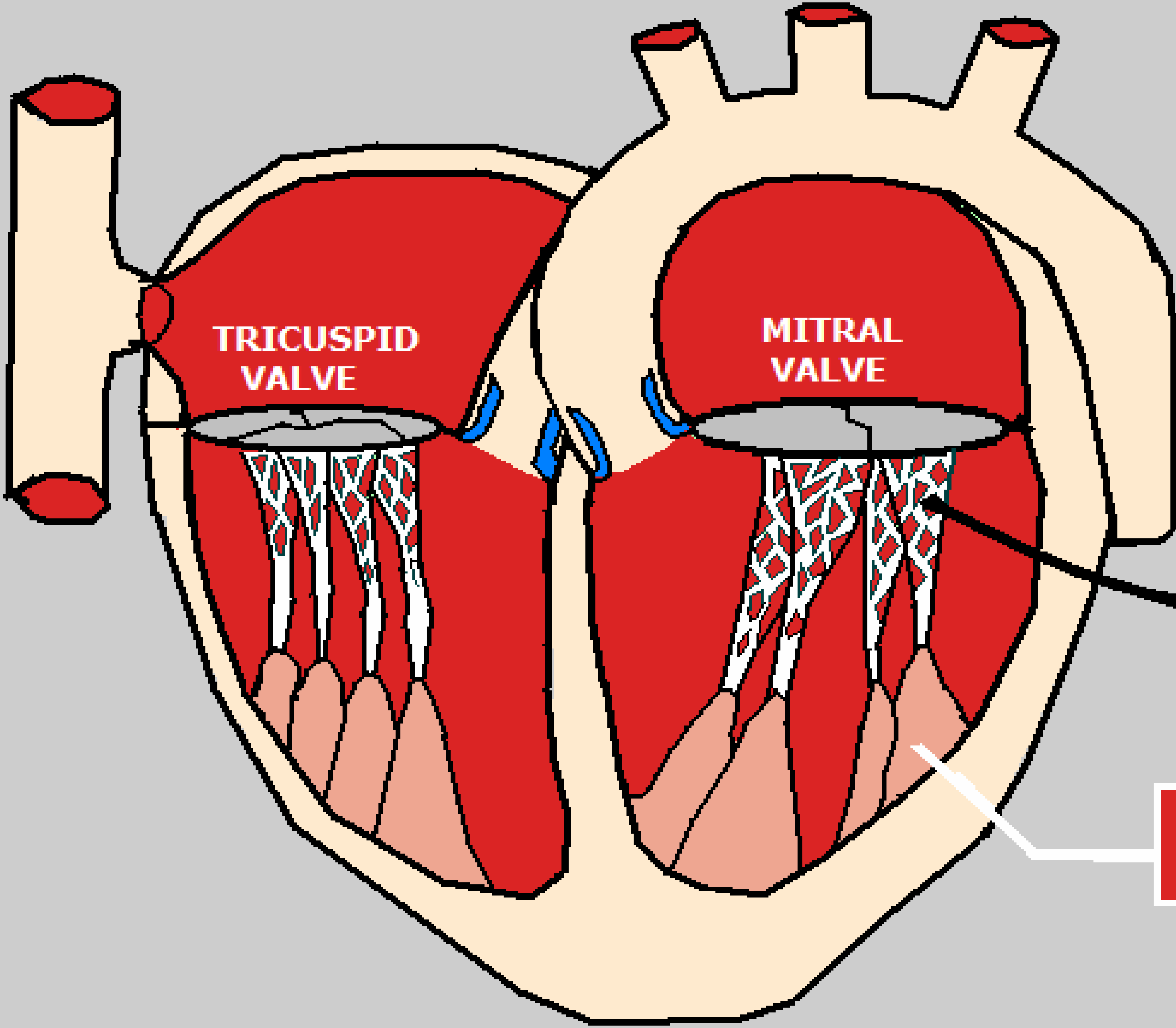
aorta
60 - 90 mmhg
pulmonary
artery (PA)
5-16 mmhg
pulmonary
vein
4 - 13 mmhg
1-5
mmhg
4-13
mmhg
1-5
mmhg
4 - 13
mmhg
pulmonary
capillary
wedge
4 - 13 mmhg

VENTRICULAR SYSTOLE



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

ATRIO-VENTRICULAR VALVES



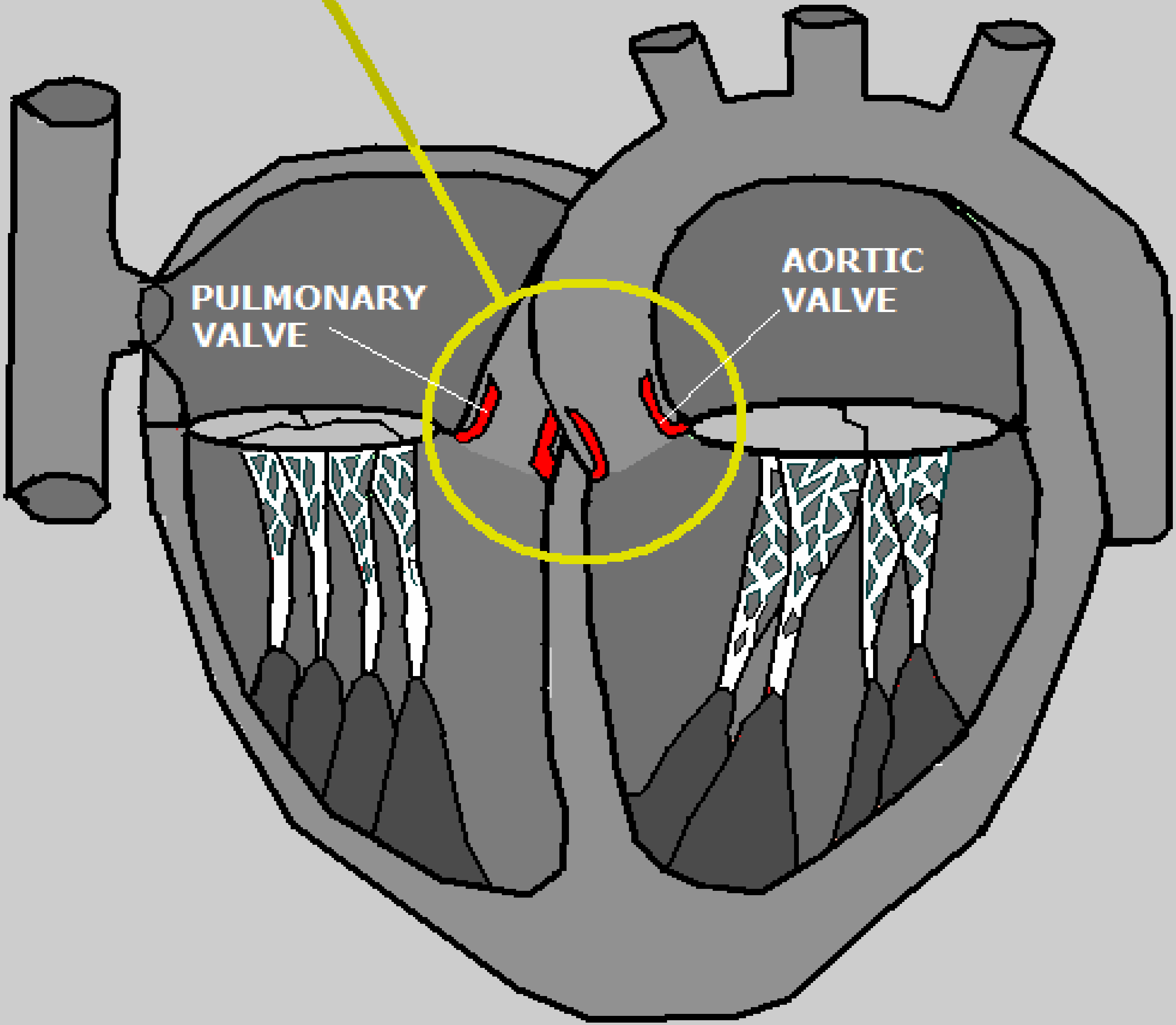
ARE SECURED TO THE ENDO-CARDIAL SURFACE BY THE

CHORDAE TENDINEAE

AND THE

PAPILLARY MUSCLES

THE SEMILUNAR VALVES



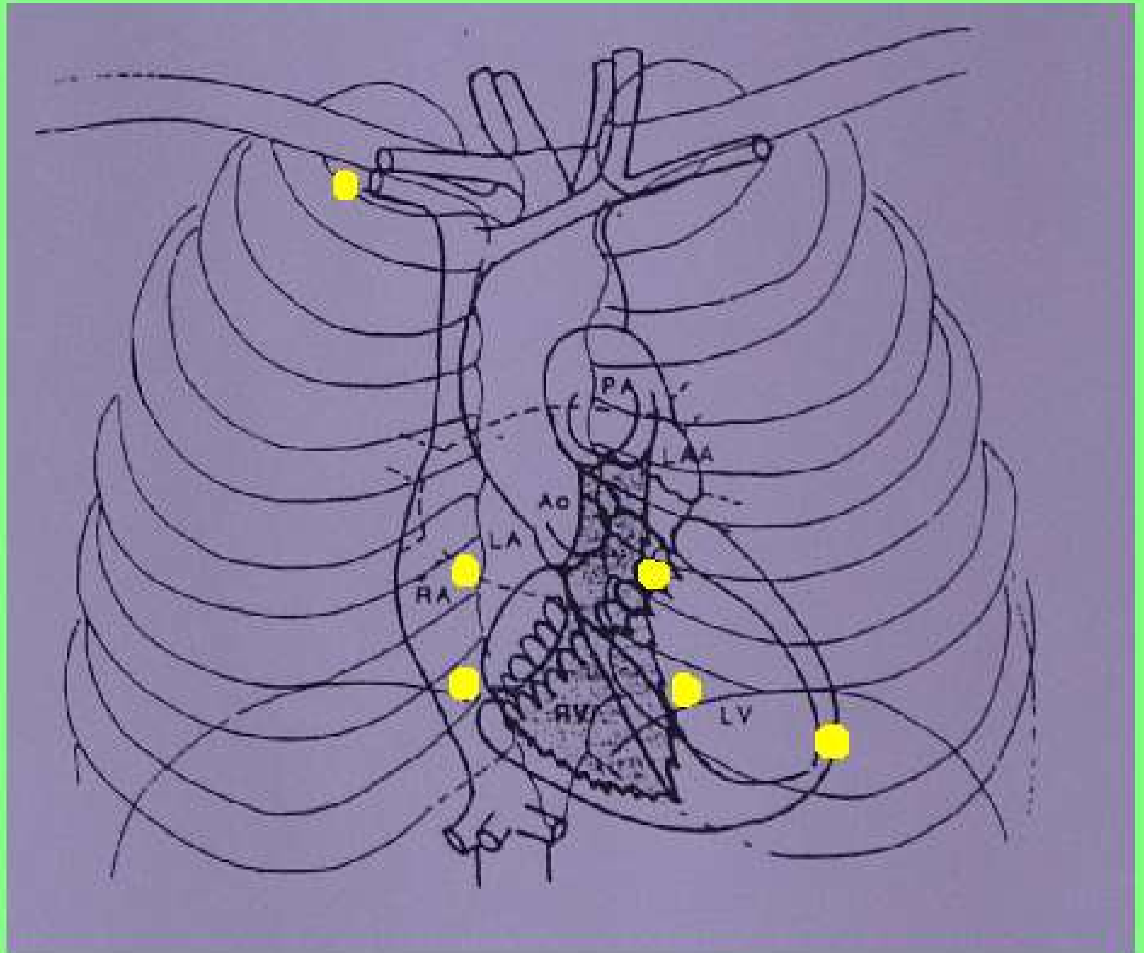
VERY BASIC HEART SOUNDS ASSESSMENT

ABNORMAL EKG CHANGES THAT MAY PRESENT WITH ABNORMAL HEART SOUNDS :

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

HEART SOUNDS ASSESSMENT

HEART SOUNDS ASSESSMENT



VERY BASIC HEART SOUNDS ASSESSMENT

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

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

HEART SOUNDS ASSESSMENT

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

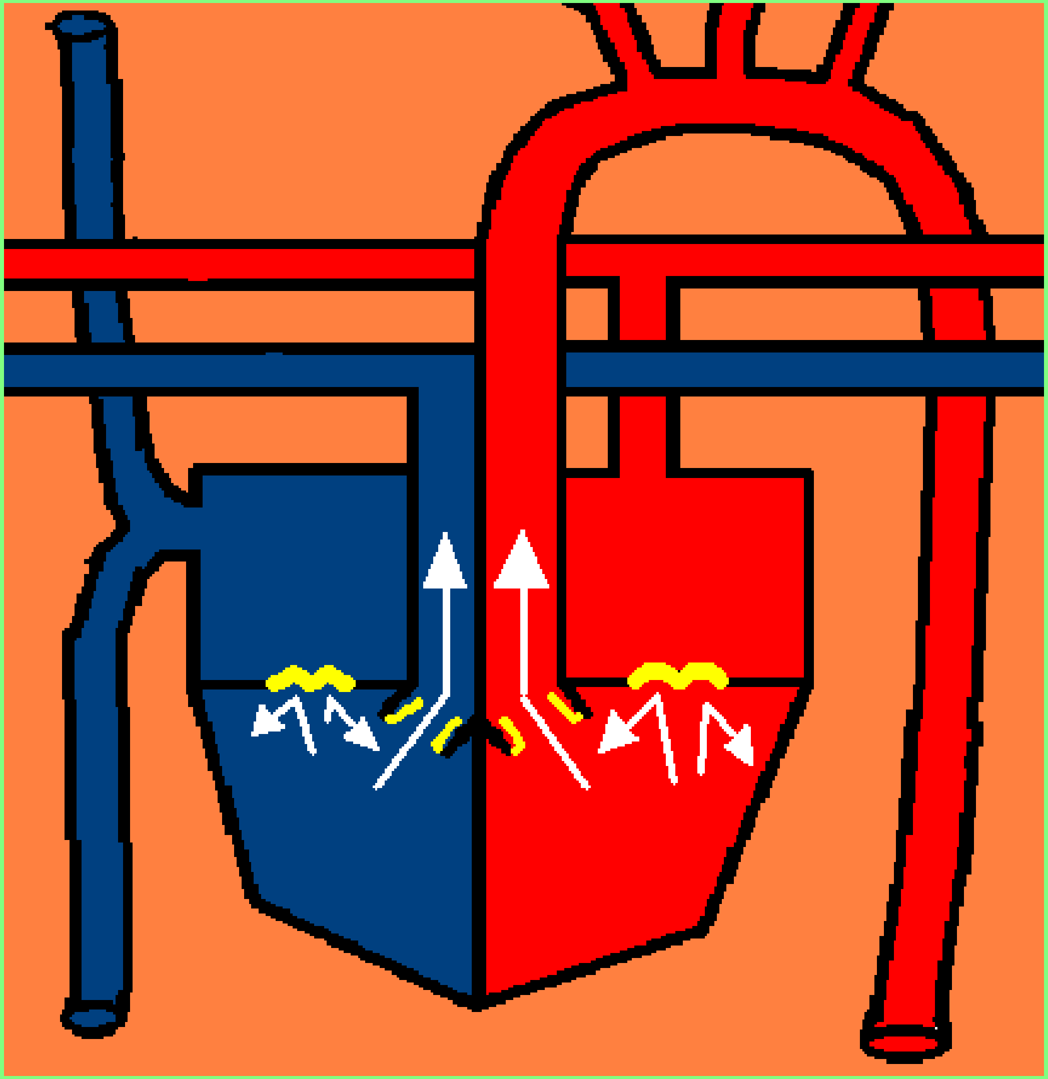
THERE ARE TWO NORMAL HEART SOUNDS, KNOWN AS: **S-1** and **S-2**

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

HEART SOUNDS ASSESSMENT

S-1
BEGINNING
OF
SYSTOLE.

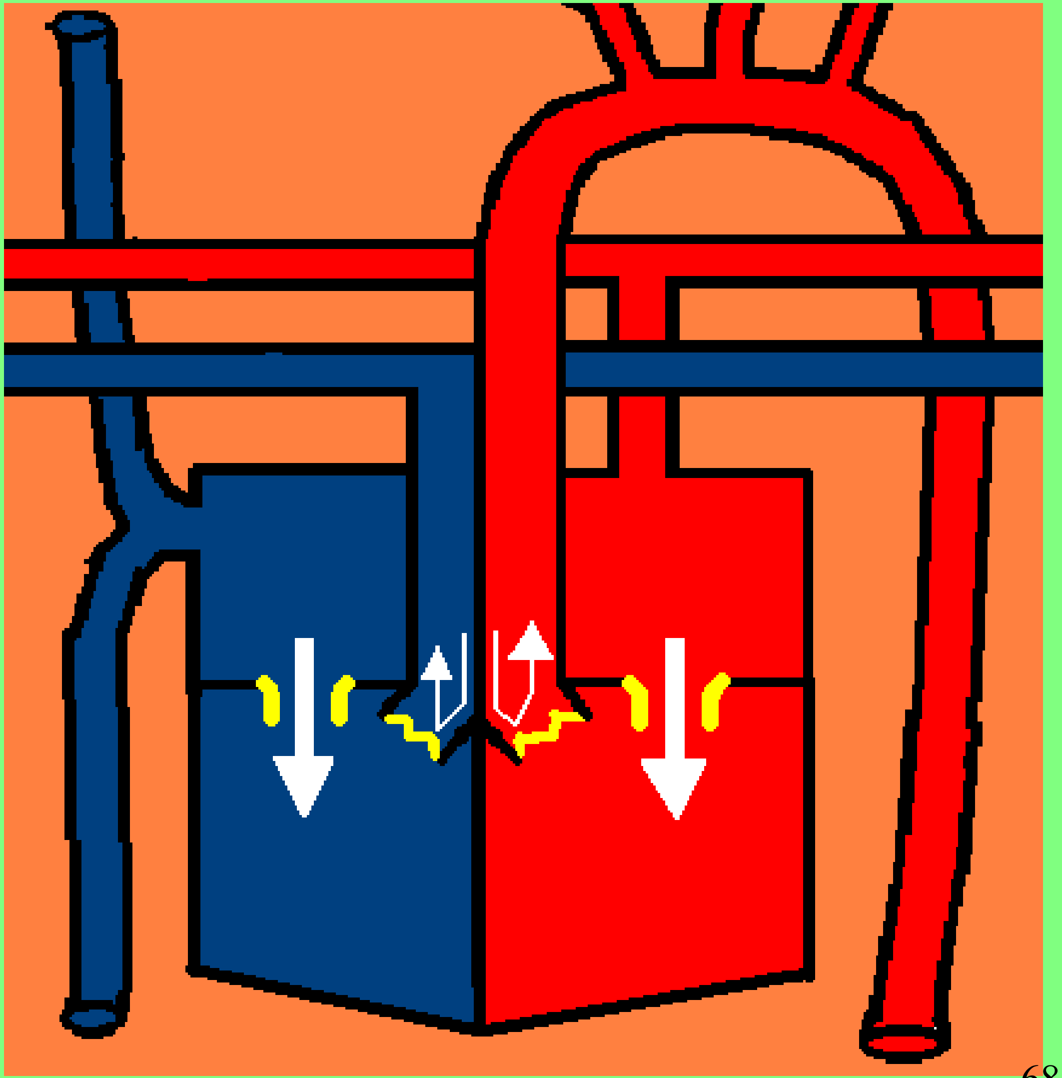
SOUND OF
THE
MITRAL
AND
TRICUSPID
VALVES
CLOSING.



HEART SOUNDS ASSESSMENT

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

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

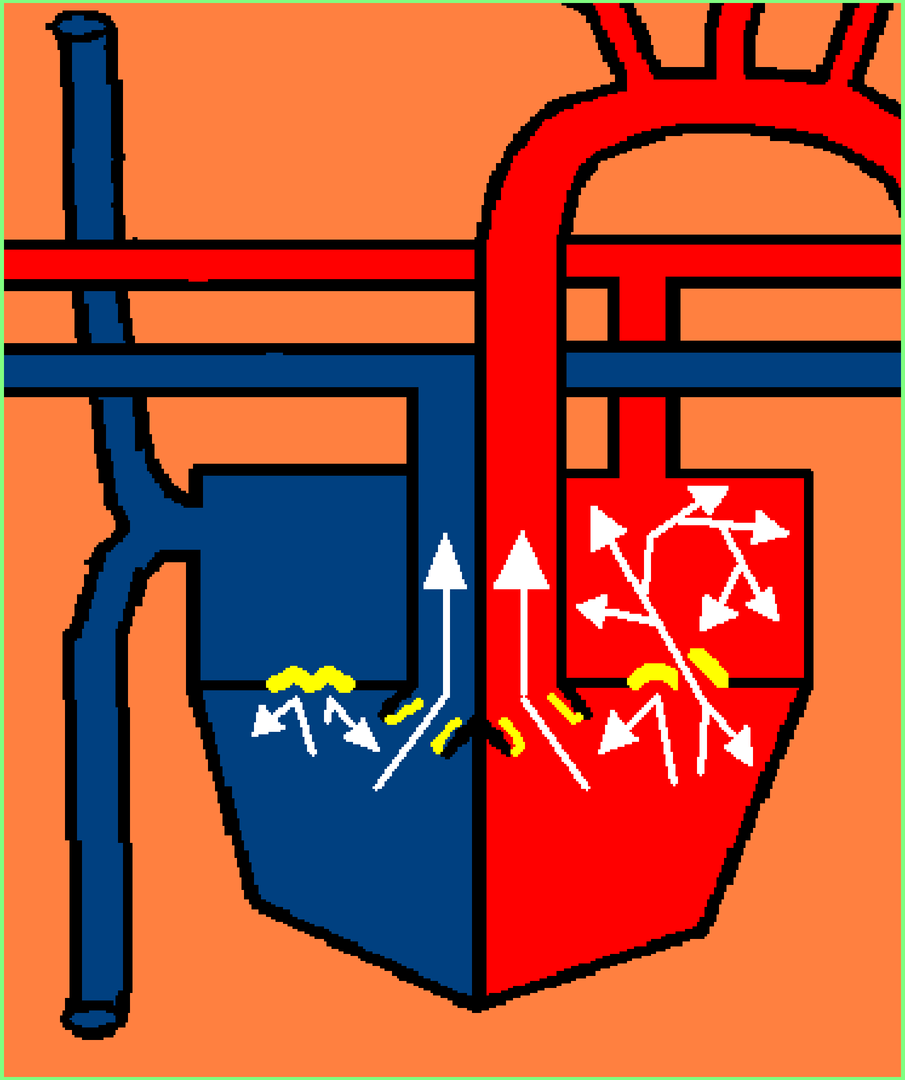


VERY BASIC HEART SOUNDS ASSESSMENT

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

CAUSE OF SYSTOLIC (S 1) MURMUR

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



BASIC HEART SOUNDS ASSESSMENT

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

S-1 MURMUR SOUNDS LIKE:

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

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

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

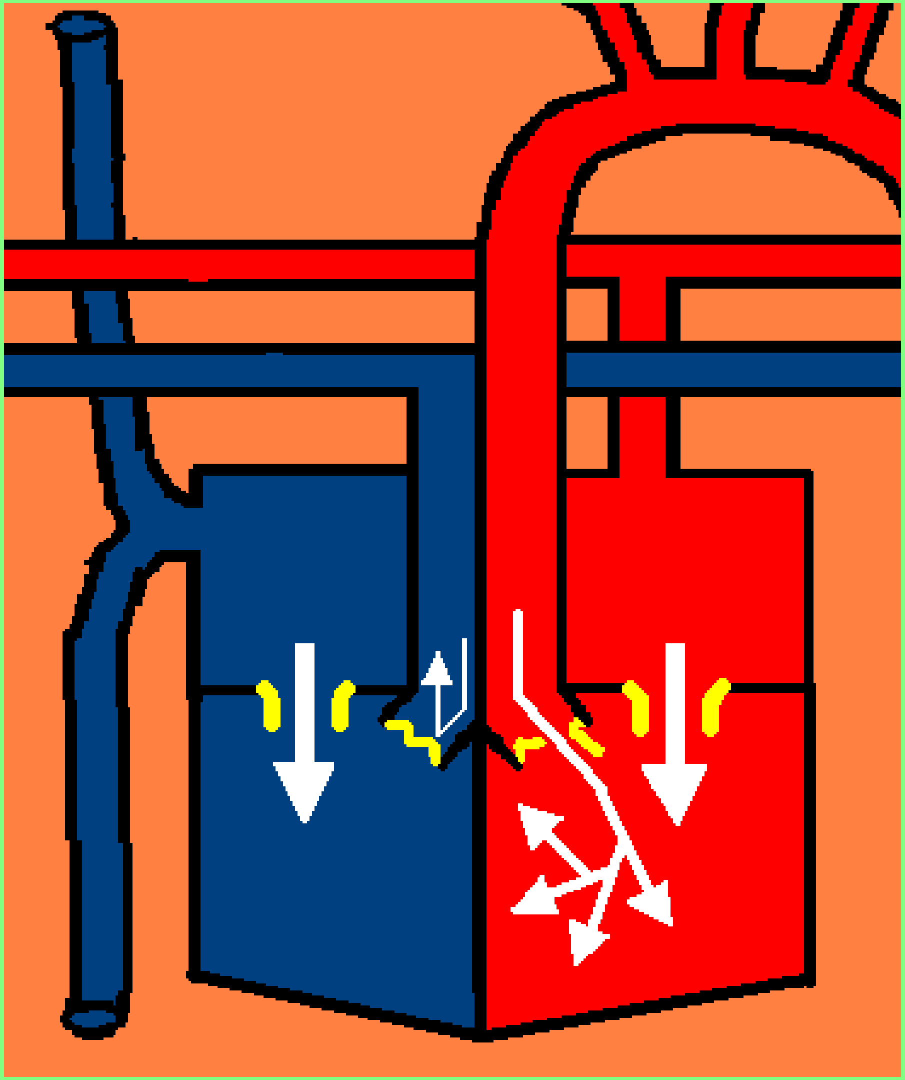
- MOST SYSTOLIC MURMURS CAUSED BY MITRAL VALVE FAILURE.

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

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

CAUSE OF DIASTOLIC (S 2) MURMUR

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



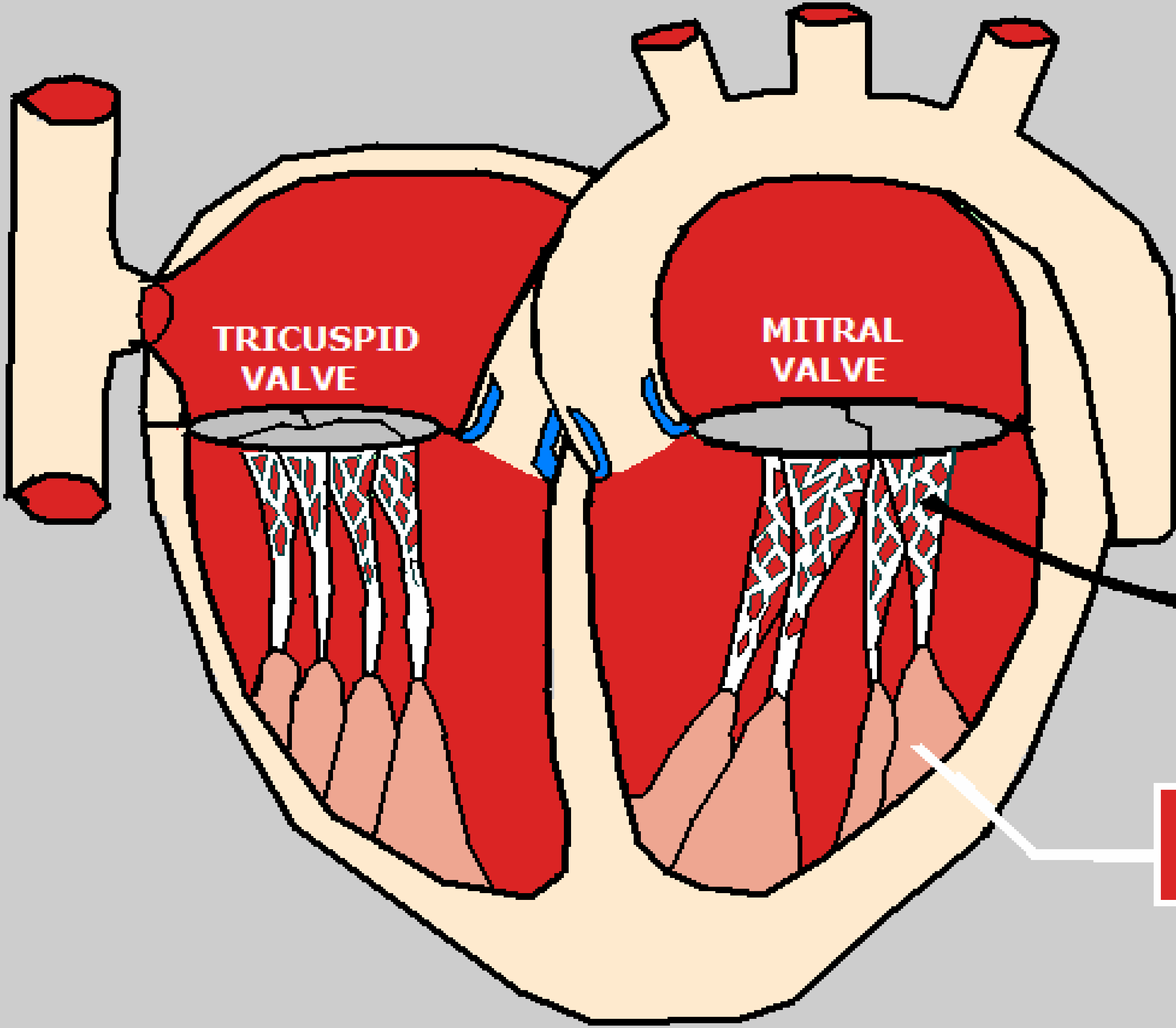
Chronic Valvular REGURGITATION (Leaky Valve) leads to elevated heart chamber pressures and HYPERTROPHY.

Chronic Valvular STENOSIS (“Creaky” Valve) leads to Cardiac Muscle STRAIN and HYPERTROPHY.

ACUTE Mitral Valve REGURGITATION can be caused by EXTENSIVE "Multi-Site" Myocardial Infarction and Necrosis – which results in PAPILLARY MUSCLE NECROSIS and PAPILLARY MUSCLE TEAR.

Papillary muscles are attached to "multiple surfaces" . . . . .

ATRIO-VENTRICULAR VALVES



ARE SECURED TO THE ENDO-CARDIAL SURFACE BY THE

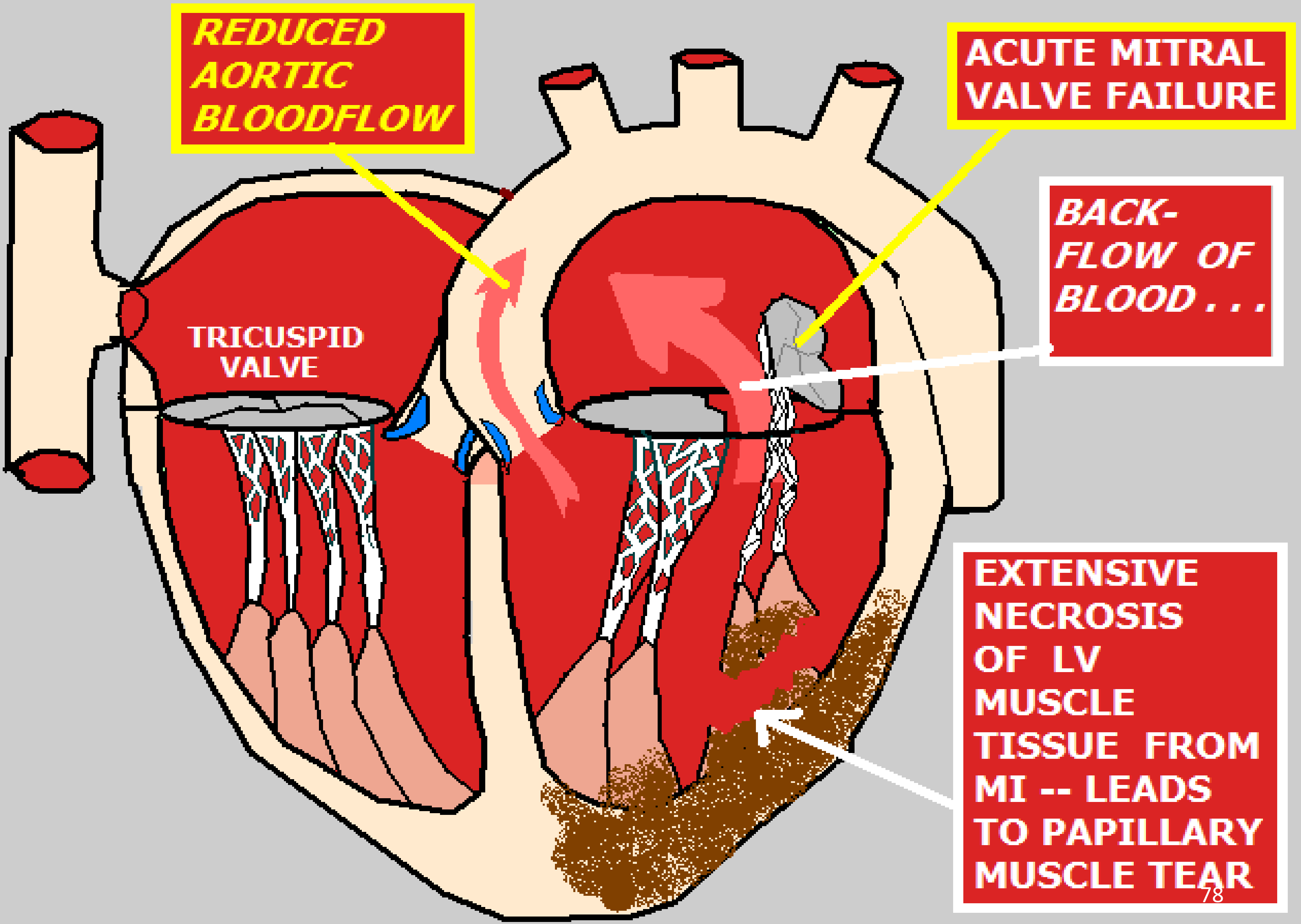
CHORDAE TENDINEAE

AND THE

PAPILLARY MUSCLES

ACUTE MITRAL REGURGITATION

DURING VENTRICULAR SYSTOLE



Symptoms of Acute Mitral Regurgitation: :

- SHOCK
- PROFOUND HYPTENSION
- PINK, FROTHY SPUTUM, PULMONARY EDEMA
- SYSTOLIC (S1) MURMUR

"SWOOSH – DUB…………..SWOOSH – DUB …………………SWOOSH – DUB"

BASIC HEART SOUNDS ASSESSMENT

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

S-2 MURMUR SOUNDS LIKE:

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

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

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

BASIC HEART SOUNDS ASSESSMENT

FRICTION RUB

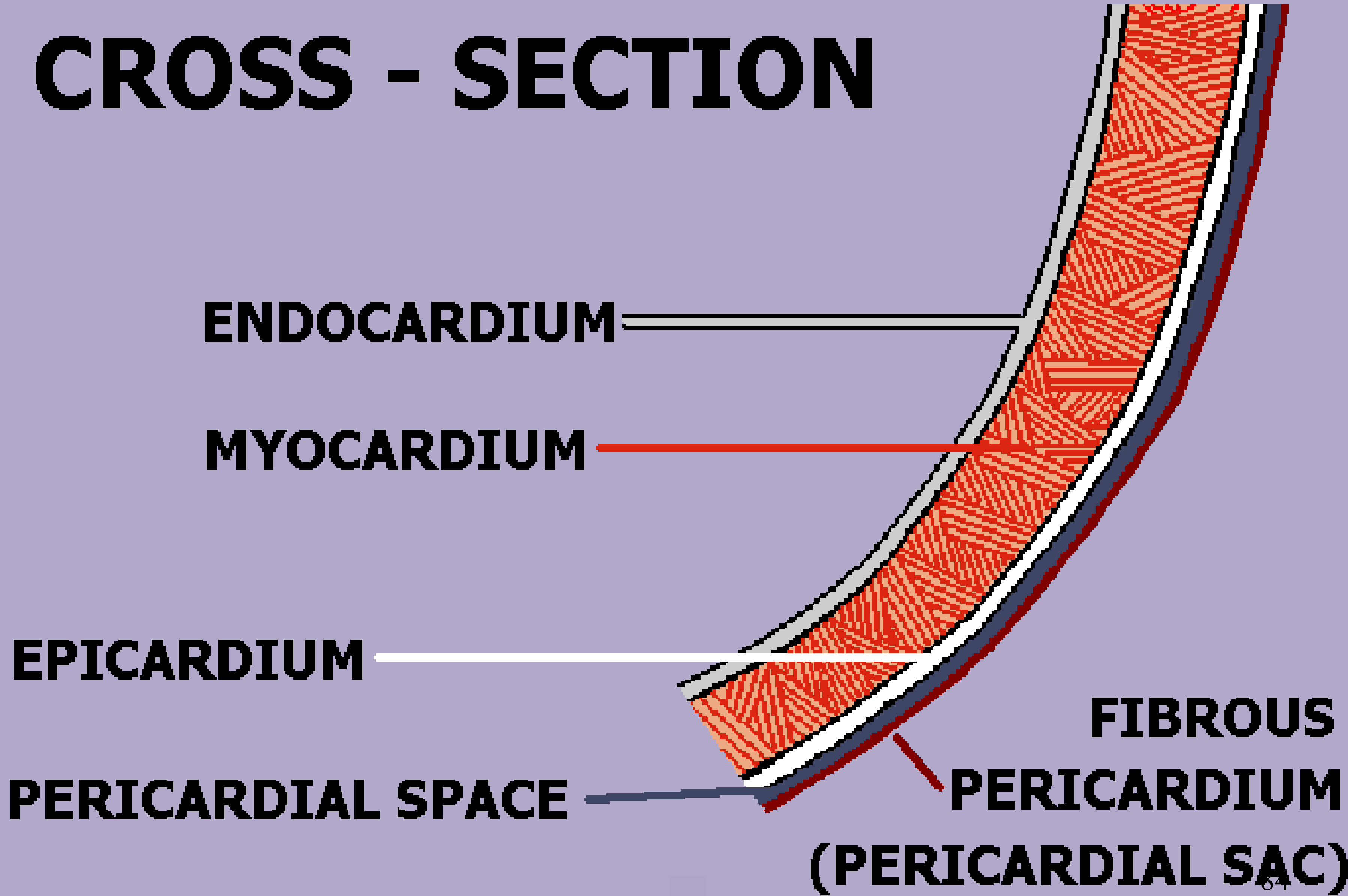
- ASSOCIATED WITH PERICARDITIS
- SOUNDS LIKE THE GENTLE RUBBING OF SANDPAPER
- HAS 3 COMPONENTS: SYSTOLIC, EARLY, and LATE DIASTOLIC

BASIC HEART SOUNDS ASSESSMENT

FRICTION RUB

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

MYOCARDIAL CROSS - SECTION

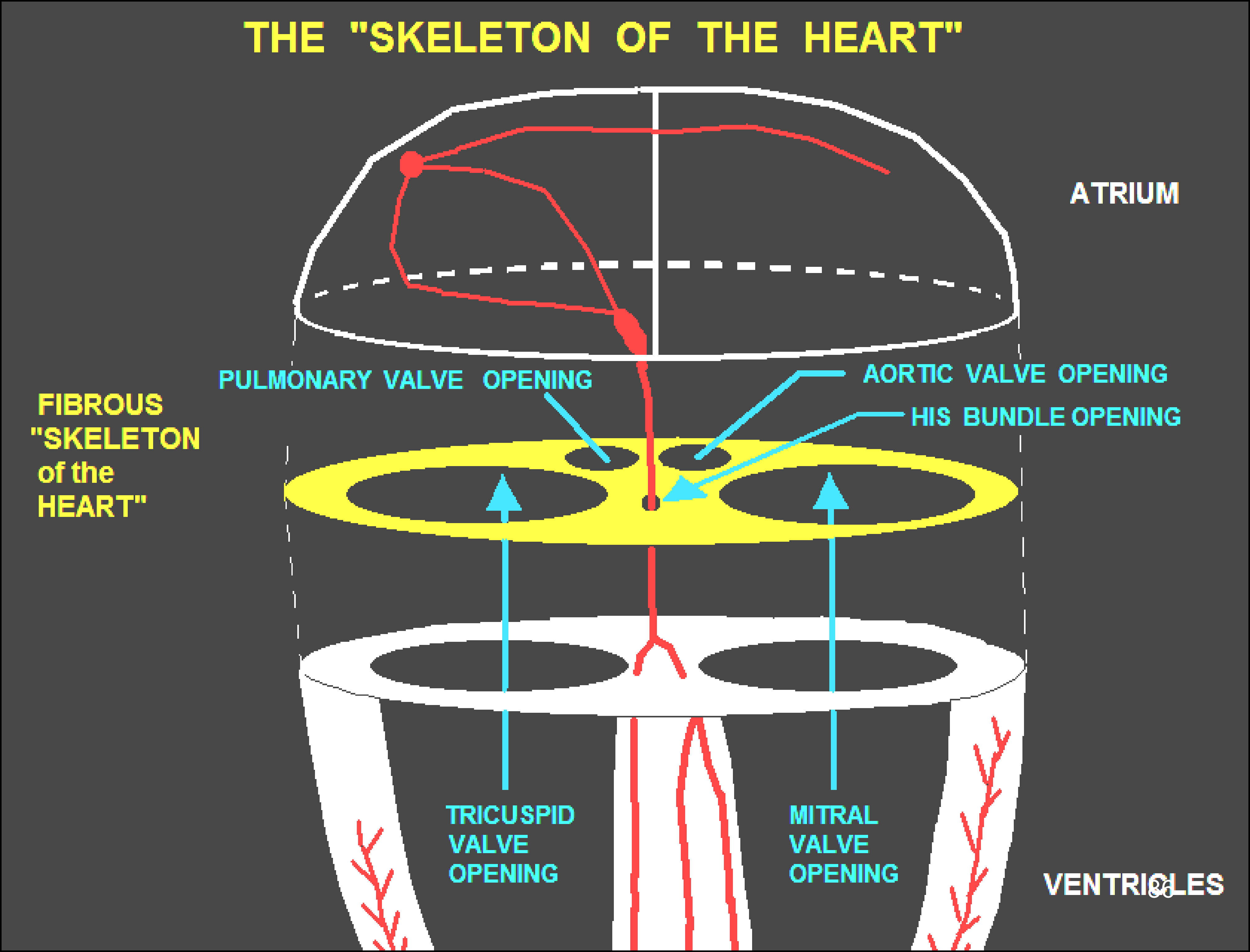


NORMAL AMOUNT OF

FLUID IN

PERICARDIAL SPACE =

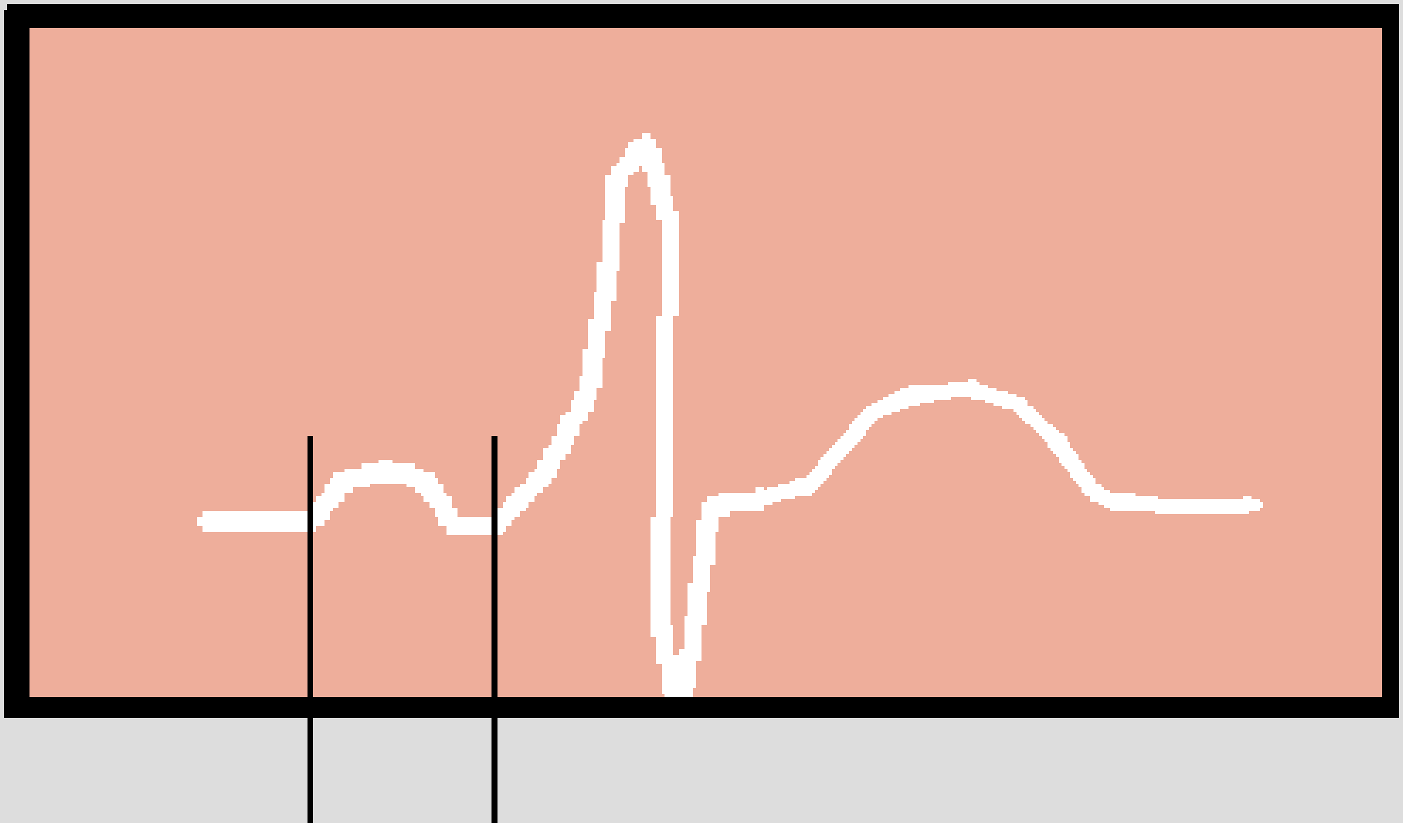
20 - 50 cc



THE "SKELETON OF THE HEART"
ATRIUM
PULMONARY VALVE OPENING
AORTIC VALVE OPENING
HIS BUNDLE OPENING
FIBROUS "SKELETON of the HEART"
TRICUSPID VALVE OPENING
MITRAL VALVE OPENING
VENTRICLES

WOLFF-PARKINSON-WHITE

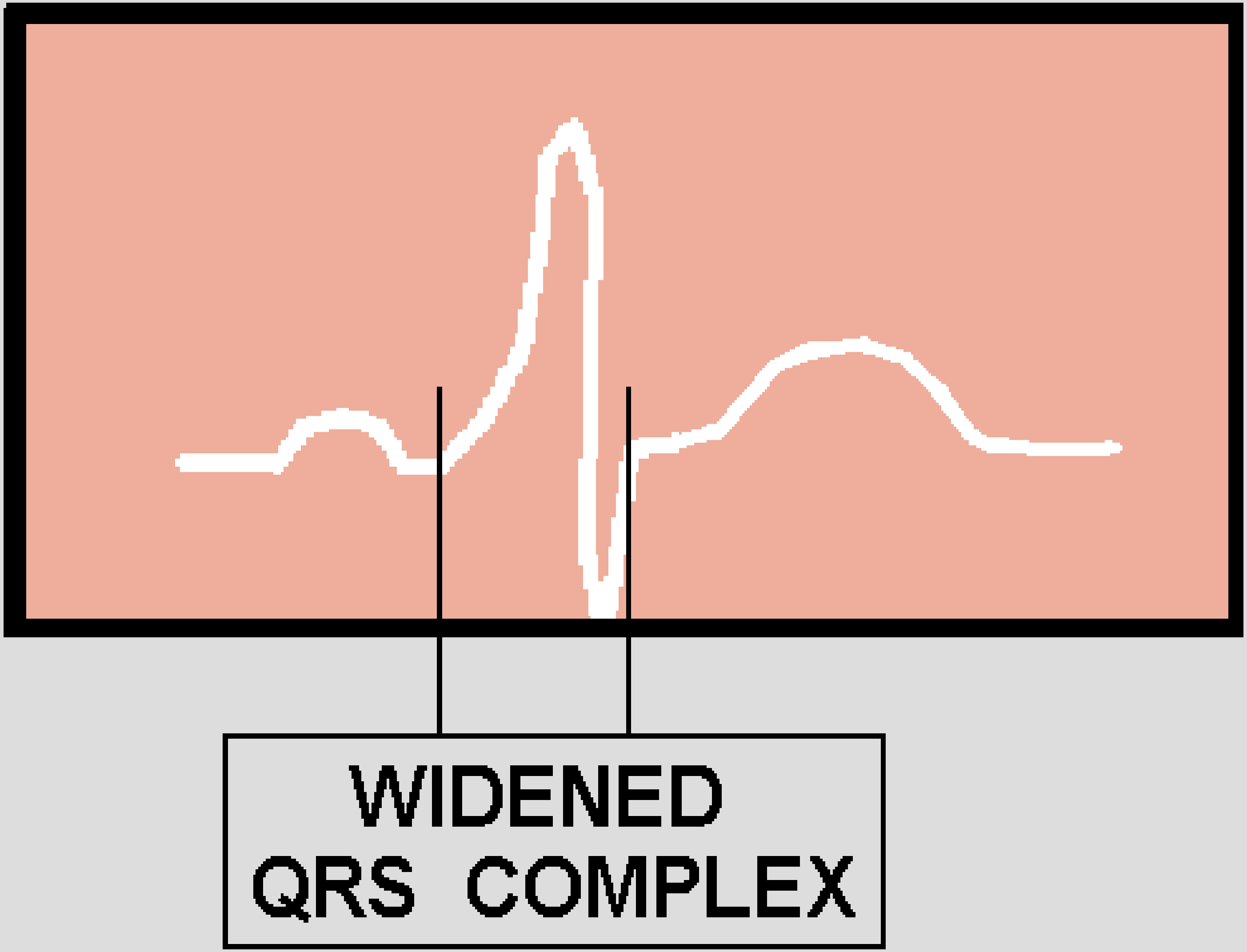
EKG CHARACTERISTICS



SHORTENED
P-R INTERVAL

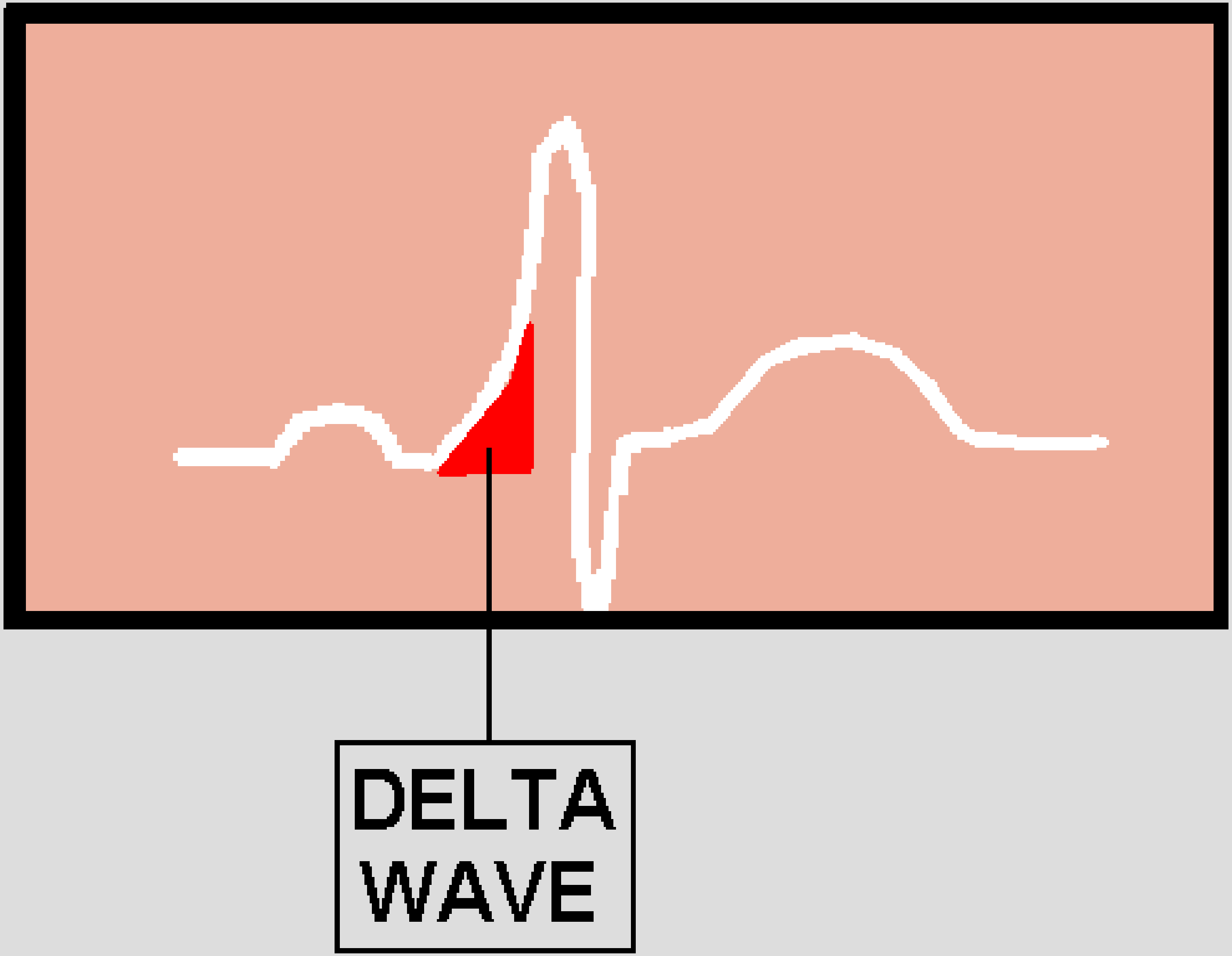
WOLFF-PARKINSON-WHITE

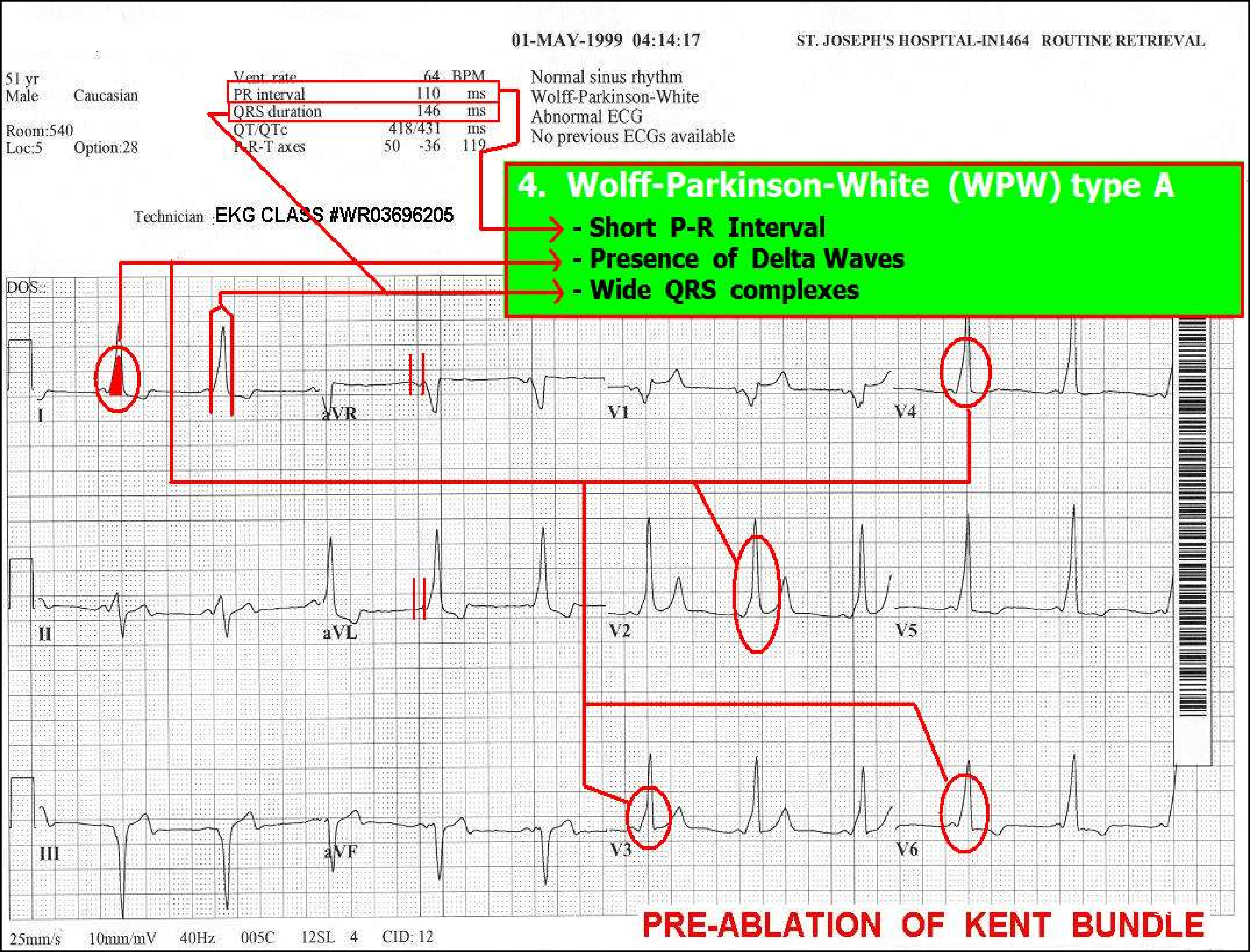
EKG CHARACTERISTICS



WOLFF-PARKINSON-WHITE

EKG CHARACTERISTICS




01-MAY-1999 04:14:17
ST. JOSEPH'S HOSPITAL-IN1464 ROUTINE RETRIEVAL
51 yr
Male Caucasian
Room:540
Loc:5 Option:28
Vent. rate 64 BPM
PR interval 110 ms
QRS duration 146 ms
QT/QTc 418/431 ms
P-R-T axes 50 -36 119
Normal sinus rhythm
Wolff-Parkinson-White
Abnormal ECG
No previous ECGs available
Technician EKG CLASS #WR03696205
4. Wolff-Parkinson-White (WPW) type A
- Short P-R Interval
- Presence of Delta Waves
- Wide QRS complexes
DOS:
I
aVR
V1
V4
II
aVL
V2
V5
III
aVF
V3
V6
PRE-ABLATION OF KENT BUNDLE
25mm/s 10mm/mV 40Hz 005C 12SL 4 CID: 12

17–MAY–1997 15:32:09 ST. JOSEPH'S WOMEN'S–WOMEN' ROUTINE RETRIEVAL

16 yr
Female Caucasian

Room:REC
Loc:20 Option:50

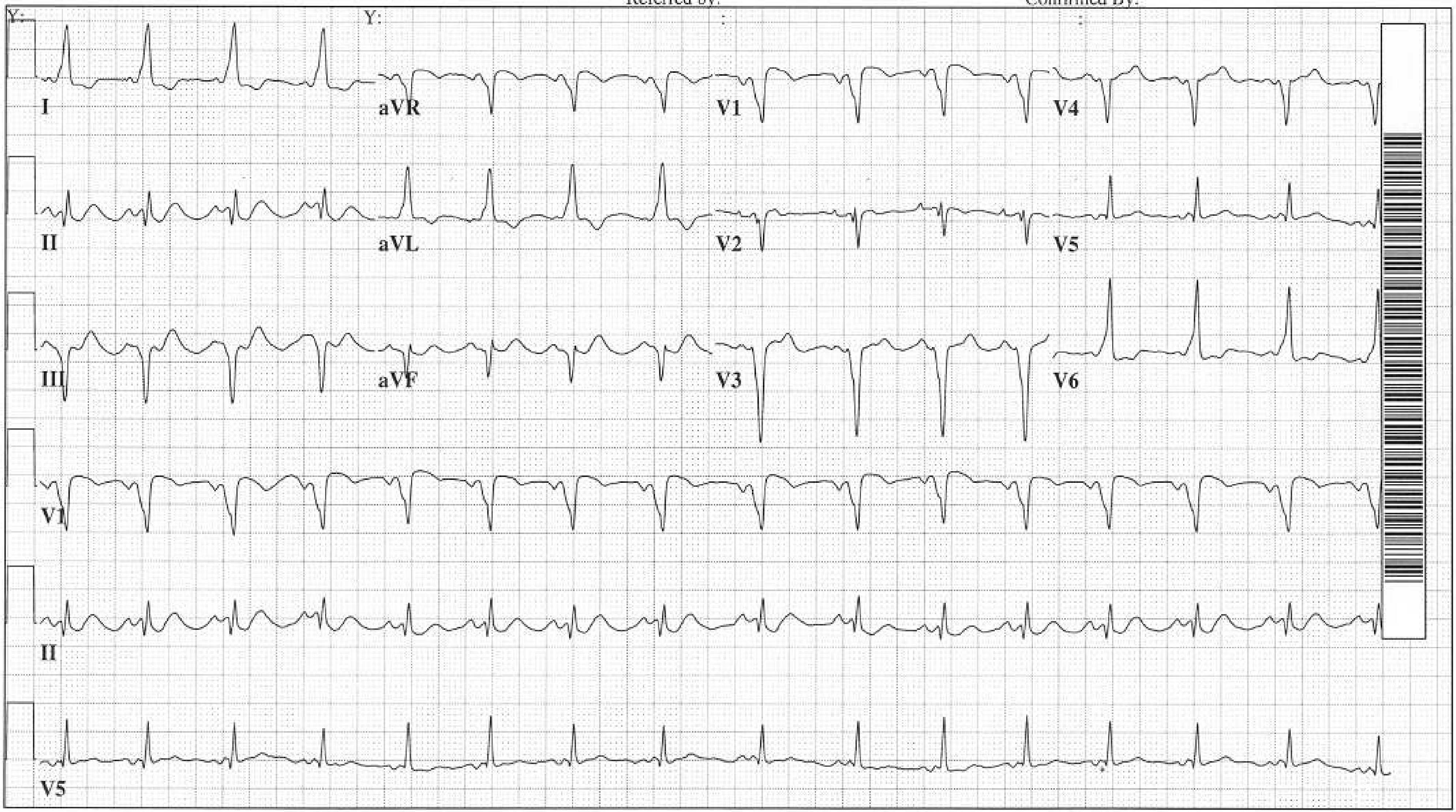
Vent. rate	92	BPM
PR interval	112	ms
QRS duration	118	ms
QT/QTc	356/440	ms
P–R–T axes	59 –22	107

Normal sinus rhythm with sinus arrhythmia
Left atrial enlargement
Anterior infarct , age undetermined
Inferior infarct , age undetermined
ST & T wave abnormality, consider lateral ischemia
Wolff–Parkinson–White
Abnormal ECG
No previous ECGs available

History:Unknown
Technician: DP
Test ind:EKG

EKG CLASS #WR030100
60783

Referred by: Confirmed By:



25mm/s 10mm/mV 40Hz 005C 12SL 250 CID: 12

EID:18 EDT: 16:01 17–MAY–1997 ORDER:

17–MAY–1997 15:32:09 ST. JOSEPH'S WOMEN'S–WOMEN' ROUTINE RETRIEVAL

16 yr
Female Caucasian

Room:REC
Loc:20 Option:50

Vent. rate	92	BPM
PR interval	112	ms
QRS duration	118	ms
QT/QTc	356/440	ms
P–R–T axes	59 –22	107

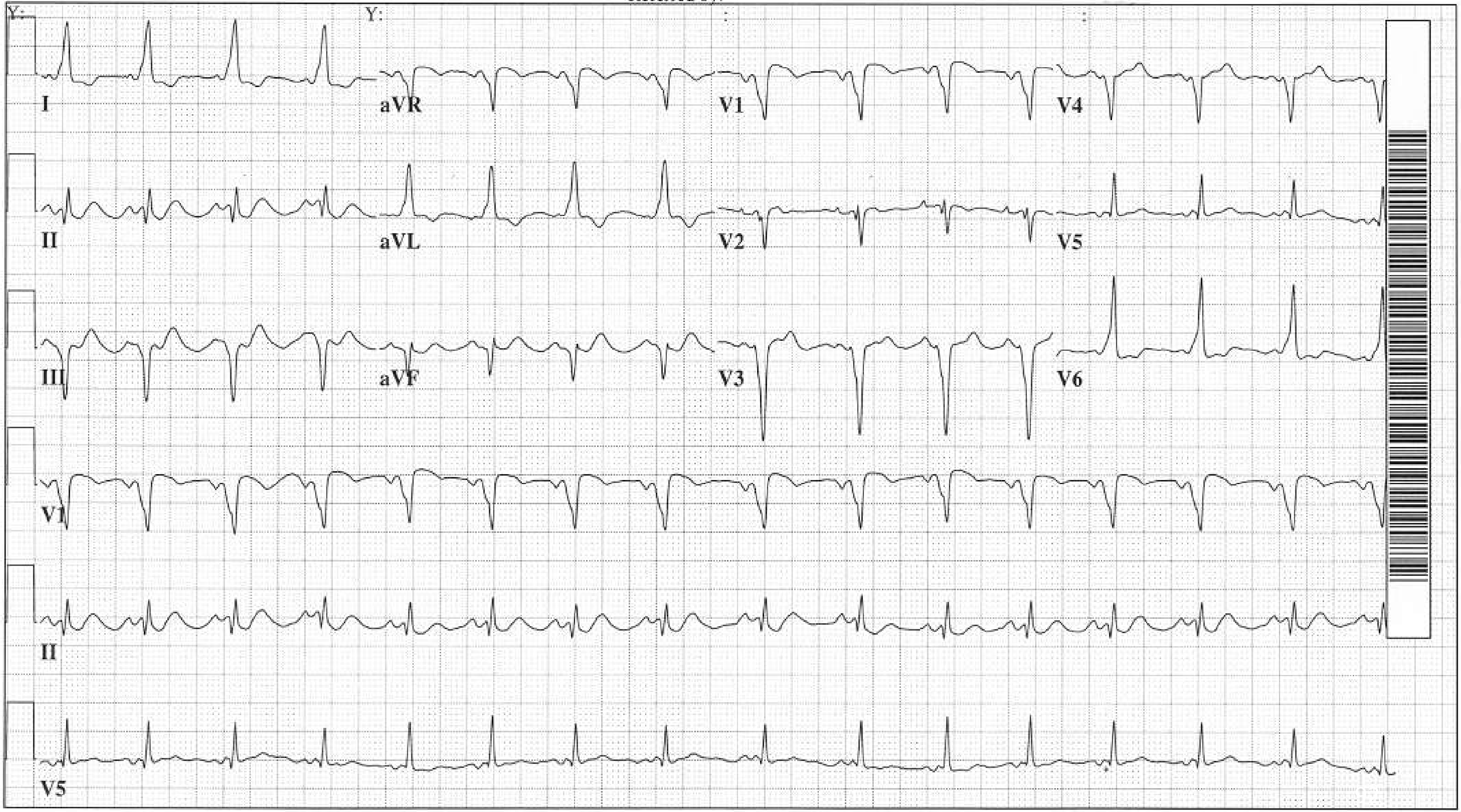
Normal sinus rhythm with sinus arrhythmia
~~Left atrial enlargement~~
~~Anterior infarct , age undetermined~~
~~Inferior infarct , age undetermined~~
~~ST & T wave abnormality, consider lateral ischemia~~
Wolff–Parkinson–White
Abnormal ECG
No previous ECGs available

History:Unknown
Technician: DP
Test ind:EKG

EKG CLASS #WR030100
60783

WOLFF-PARKINSON-WHITE
TYPE B

Referred by:



25mm/s 10mm/mV 40Hz 005C 12SL 250 CID: 12 EID:18 EDT: 16:01 17–MAY–1997 ORDER:

Patients with Wolff-Parkinson-White:
- Typically Pediatric / Young Adult
- May not know they have it
- May experience episodes of "palpitations" or "Very Fast Heartbeat."

The W-P-W often CAUSES A-fib, and the patient CALLS 911 or PRESENTS TO THE ED like this . . . .

37 y/o male

Chief Complaint: Lightheadedness, Palpitations, Shortness of Breath

HPI: Sudden onset of above symptoms approx. 1 hour ago

PMH: HTN (non-compliant)

37 y/o male

PE: Alert, oriented, restless, cool, pale, dry skin. PERL, No JVD, Lungs clear. Abd soft non tender, Extremities: WNL, no edema

Meds: None, NKDA

VS: BP 106/50, P 180, R 26, SAO2 93%

ST. JOSEPH'S HOSPITAL-

37 yr		Vent. rate	180	BPM
Male	Caucasian	PR interval	*	ms
		QRS duration	148	ms
Room:OP		QT/QTc	284/491	ms
Loc:8	Option:16	P–R–T axes	* –77	103

WIDE QRS TACHYCARDIA – POSSIBLE VT
Right bundle branch block PATTERN
Abnormal ECG

Med: Unknown

Referred by: Confirmed By:

25mm/s 10mm/mV 40Hz 005C 12SL 72 CID: 0

Physician correctly identified Atrial Fibrillation with Rapid Ventricular Response.

However did NOT identify the Wolff-Parkinson-White component.

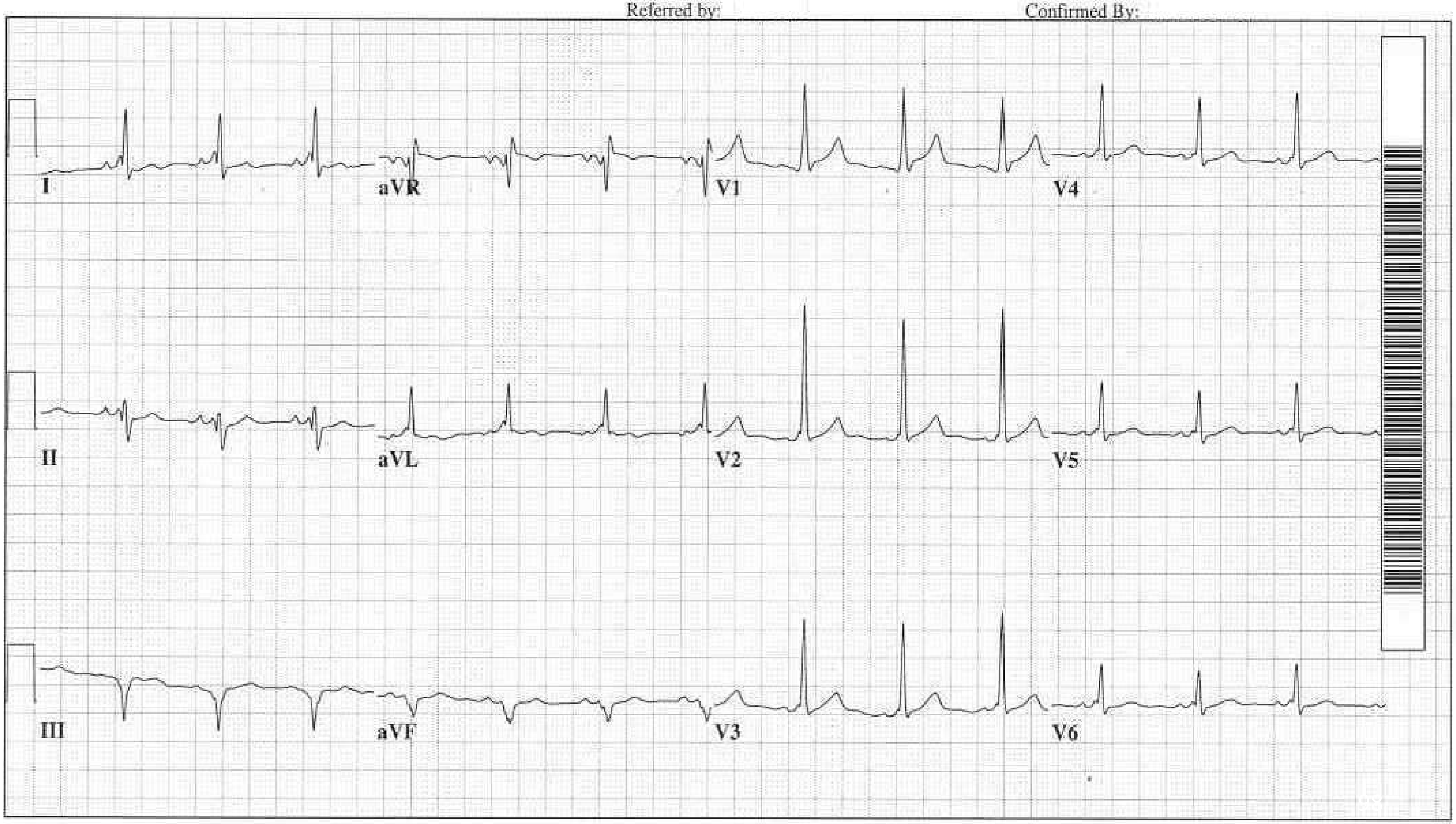
Patient was given Diltiazem – promptly converted to - ***VENTRICULAR FIBRILLATION.***

ST. JOSEPH'S HOSPITAL- ROUTINE RETRIEVAL

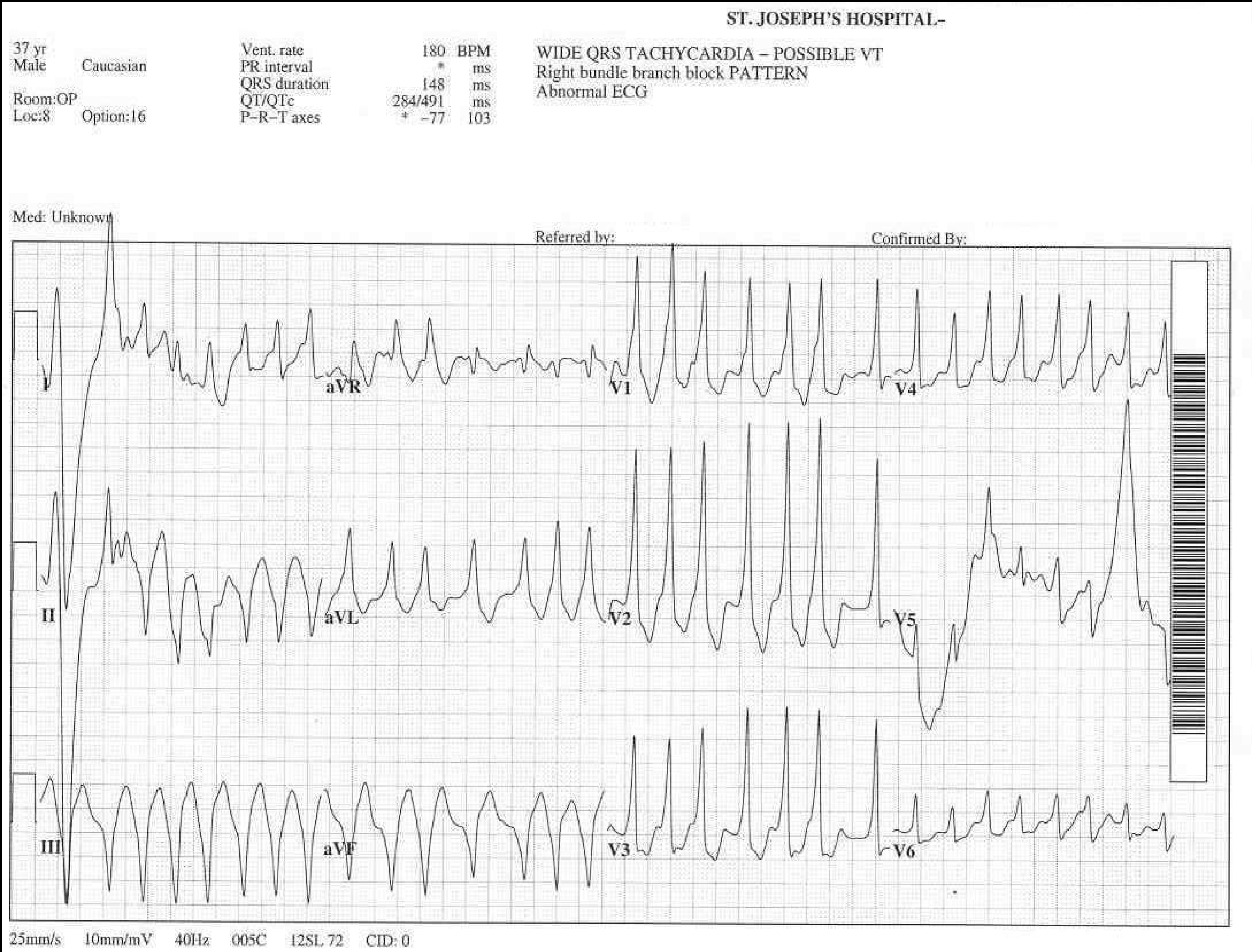
37 yr		Vent. rate	82		BPM
Male	Caucasian	PR interval	132		ms
		QRS duration	128		ms
Room:OP		QT/QTc	392/458		ms
Loc:8	Option:19	P–R–T axes	77	–44	154

Normal sinus rhythm
Ventricular pre–excitation, WPW pattern type A
Abnormal ECG

Referred by: Confirmed By:

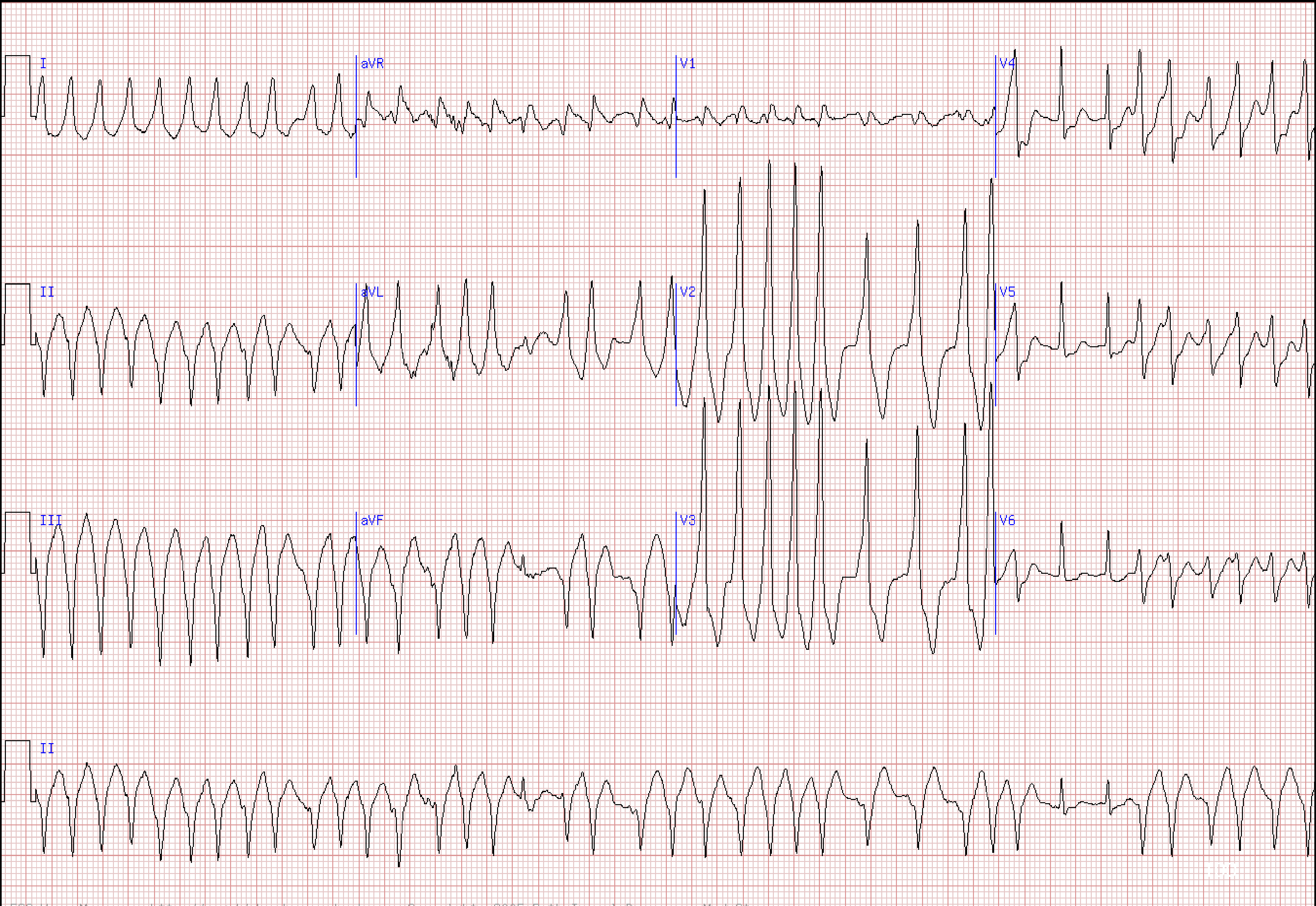


25mm/s 10mm/mV 40Hz 005C 12SL 78 CID: 0



-NOTE IRREGULARITY OF RHYTHM - (SUGGESTIVE of A-FIB)
-LOOK FOR DELTA WAVES

17 year old male: W-P-W with Afib & RVR

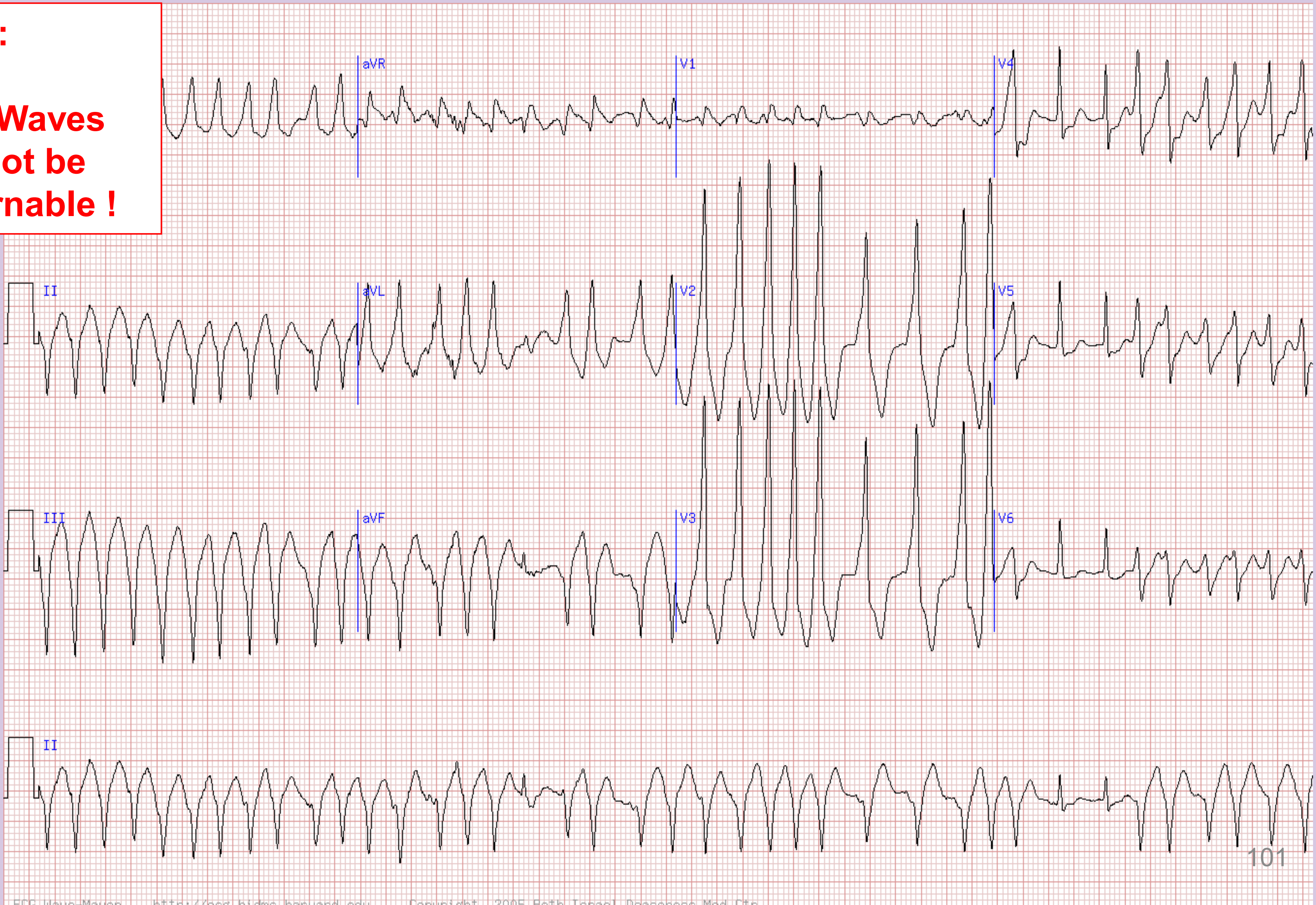


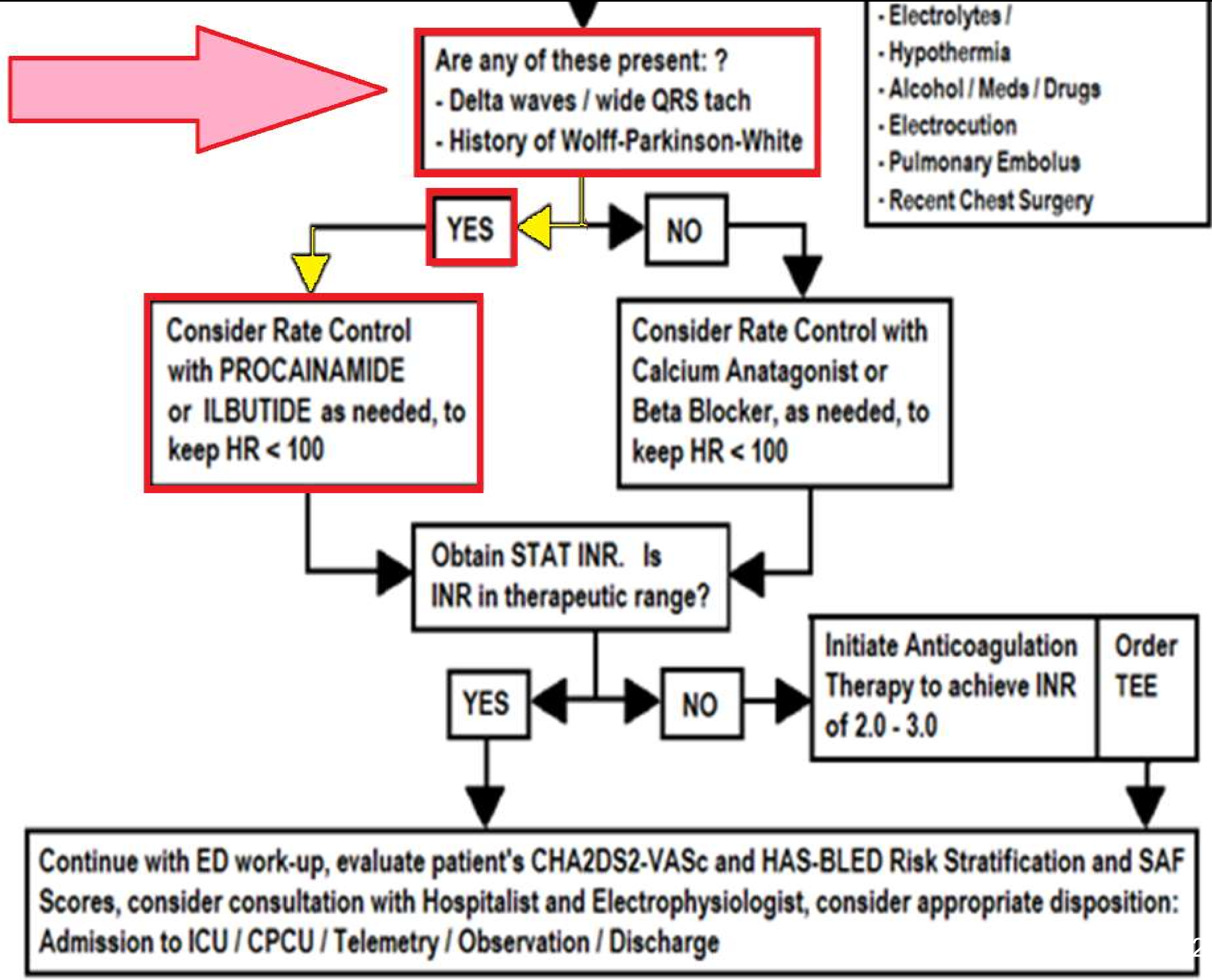
CHARACTERISTICS of W-P-W with Afib & RVR:

- **WIDE COMPLEX TACHYCARDIA**
- **IRREGULARLY IRREGULAR R – R INTERVALS !!**

NOTE:

Delta Waves may not be discernable !




- Electrolytes /
- Hypothermia
- Alcohol / Meds / Drugs
- Electrocution
- Pulmonary Embolus
- Recent Chest Surgery
Are any of these present: ?
- Delta waves / wide QRS tach
- History of Wolff-Parkinson-White
YES
NO
Consider Rate Control with PROCAINAMIDE or ILBUTIDE as needed, to keep HR < 100
Consider Rate Control with Calcium Anatagonist or Beta Blocker, as needed, to keep HR < 100
Obtain STAT INR. Is INR in therapeutic range?
YES
NO
Initiate Anticoagulation Therapy to achieve INR of 2.0 - 3.0
Order TEE
Continue with ED work-up, evaluate patient's CHA2DS2-VASc and HAS-BLED Risk Stratification and SAF Scores, consider consultation with Hospitalist and Electrophysiologist, consider appropriate disposition: Admission to ICU / CPCU / Telemetry / Observation / Discharge

WIDE COMPLEX TACHYCARDIA (QRS > 120 ms)

MONOPHASIC

ABC s

NO PULSE

GO TO
V - FIB
ALGORITHM !

PULSE - UNSTABLE

- IMMEDIATE SYNC. CARDIOVERSION:
  - 100 j biphasic
  - consider sedation
- INCREASE joules
- MEDS:
  - PROCAINAMIDE
  - AMIODARONE

PULSE - STABLE

- O2, IV-IO, EKG
- MEDS:
  - ADENOSINE 6-12 (only if REGULAR)
  - PROCAINAMIDE (20-50mg/min)
  - AMIODARONE (150 over 10min + 1mg/ min INFUSION

WIDE COMPLEX TACHYCARDIA (QRS > 120 ms)

MONOPHASIC

ABC s

NO PULSE

GO TO
V - FIB
ALGORITHM !

PULSE - UNSTABLE

- IMMEDIATE SYNC. CARDIOVERSION:
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  -PROCAINAMIDE
  -AMIODARONE

PULSE - STABLE

- O2, IV-IO, EKG
- MEDS:
  - ~~ADENOSINE 6-12 (only if REGULAR)~~
  - PROCAINAMIDE (20-50mg/min)
  - ~~AMIODARONE (150 over 10min + 1mg/ min INFUSION)~~

NO AV NODAL BLOCKERS
(e.g. ADENOSINE, CALCIUM CHANNEL BLOCKERS)
FOR WIDE COMPLEX TACHYCARDIAS THAT COULD BE ATRIAL FIBRILLATION with Pre-Excitation (W-P-W)

“ROAD TO FOREVER,” Rt 385, Oklahoma panhandle, 1999

OBTAINING
THE
12 LEAD ECG

And have it interpreted by a physician or mid-level provider
…within 10 minutes !

Obtaining the 12 Lead ECG

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

Obtaining the 12 Lead ECG

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

Obtaining the 12 Lead ECG

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

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

AHA/ACC/HRS Scientific Statement

Recommendations for the Standardization and Interpretation of the Electrocardiogram

Part I: The Electrocardiogram and Its Technology

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

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

AHA/ACC/HRS Scientific Statement

Recommendations for the Standardization and Interpretation of the Electrocardiogram

Part I: The Electrocardiogram and Its Technology

Recommendations

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

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

Leads V1 & V2 on 12 Lead ECG:

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

AHA/ACC/HRS Scientific Statement

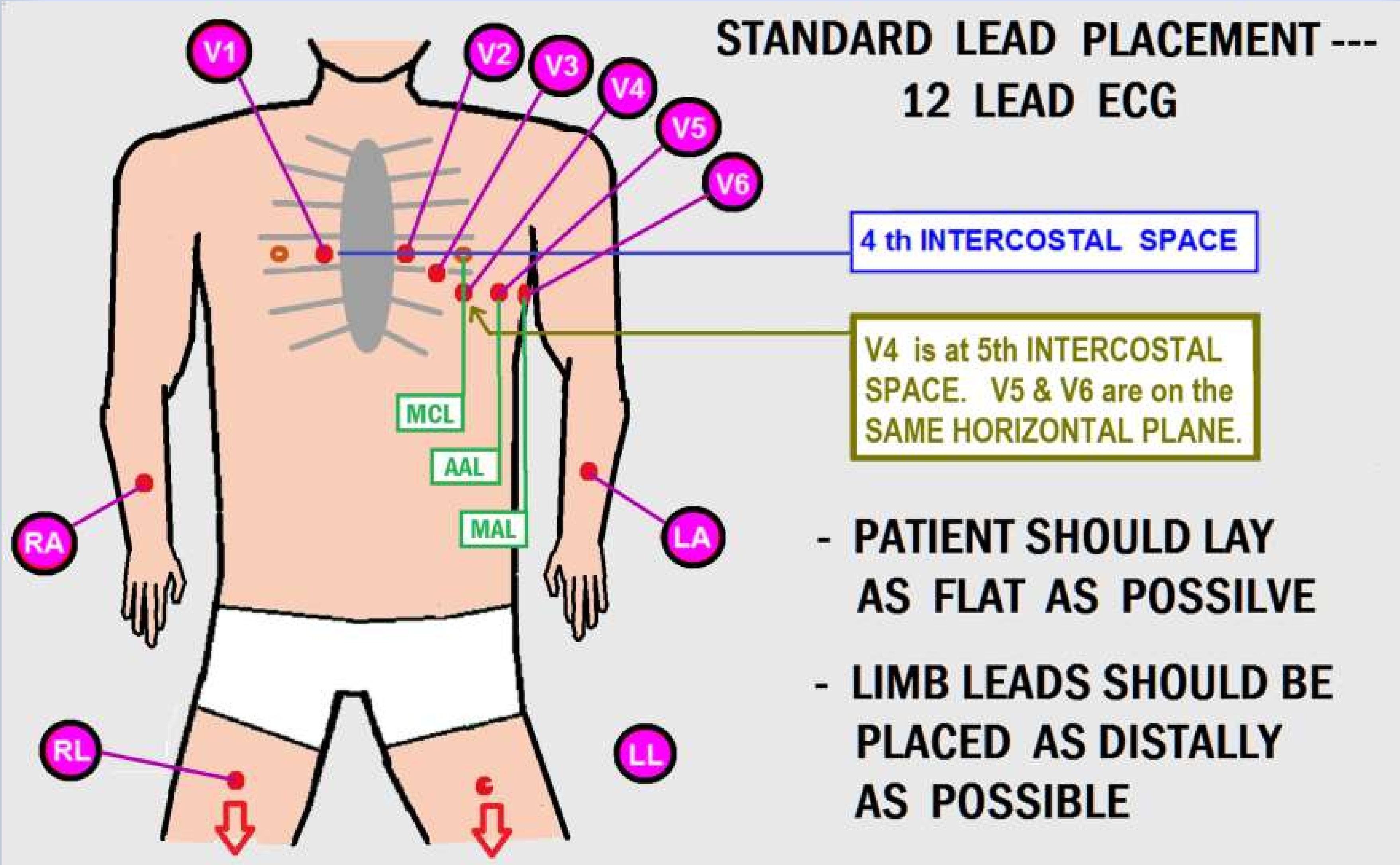
Recommendations for the Standardization and Interpretation of the Electrocardiogram

Part I: The Electrocardiogram and Its Technology

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

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

Obtaining the 12 Lead ECG

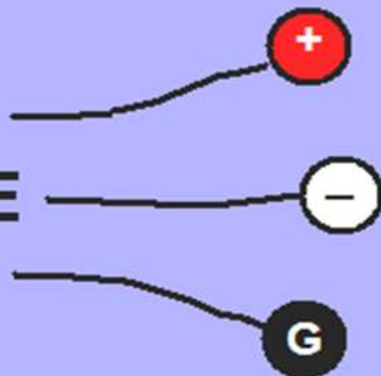


THE ECG MACHINE

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

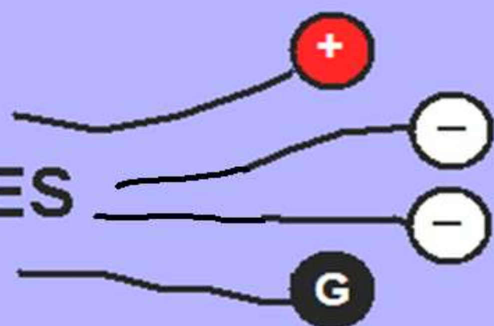
- LEADS I, II, III, and V1, V2, V3, V4, V5, V6

1 POSITIVE ELECTRODE
1 NEGATIVE ELECTRODE
1 GROUND ELECTRODE

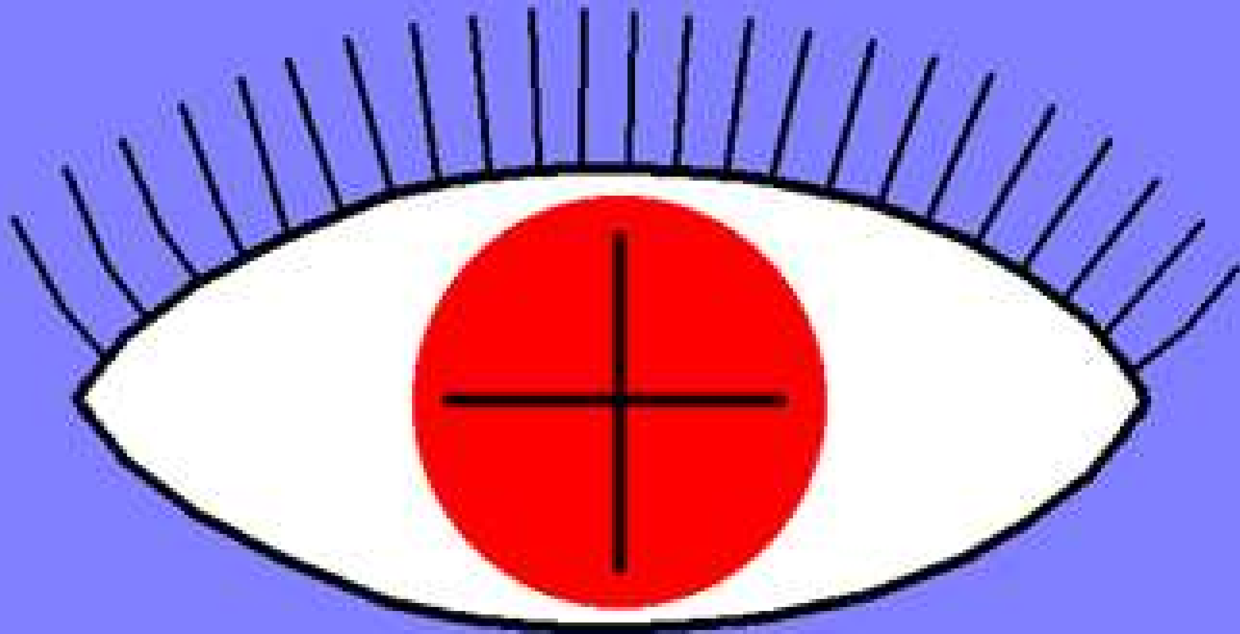


- LEADS AVR, AVL, and AVF

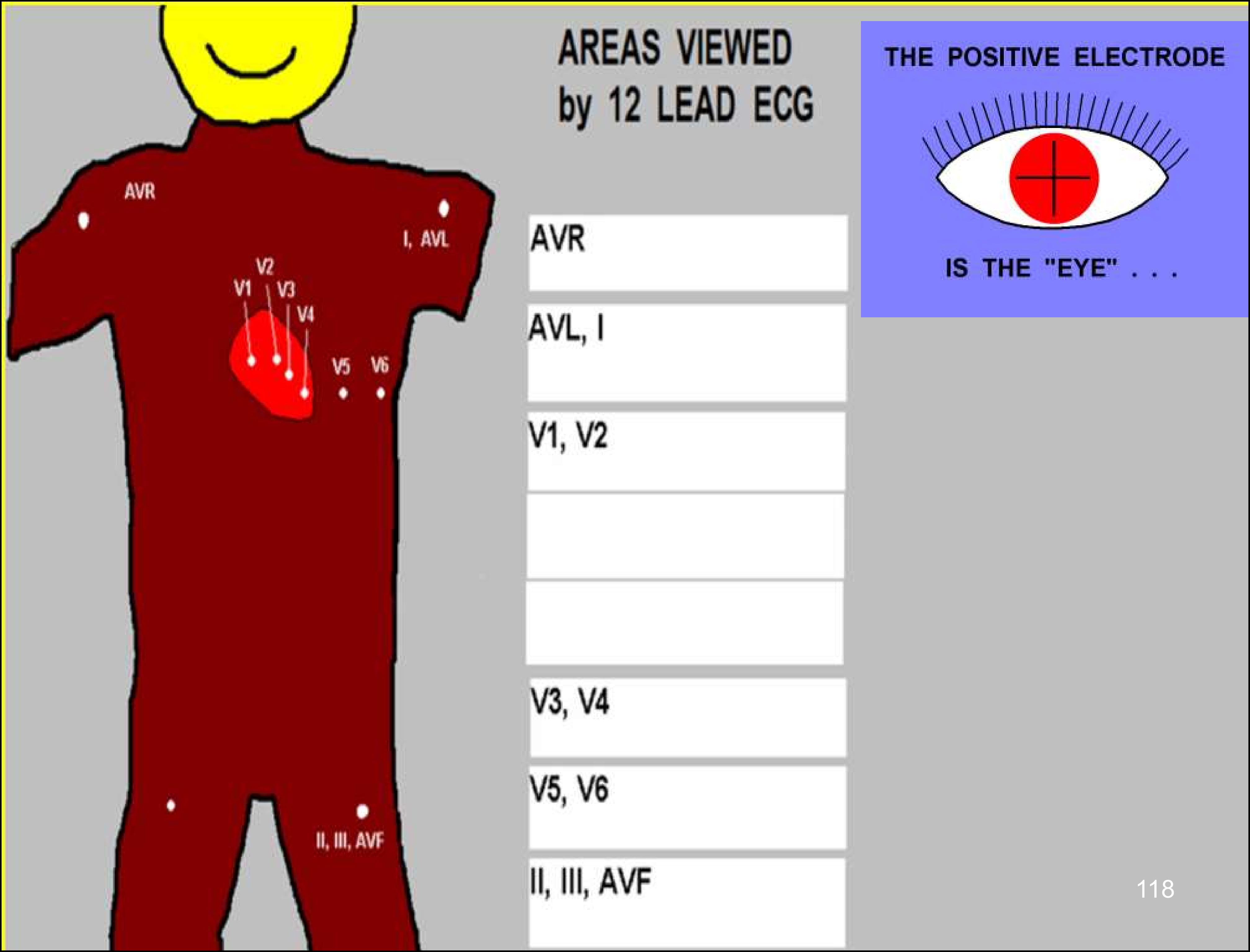
1 POSITIVE ELECTRODE
2 NEGATIVE ELECTRODES
1 GROUND ELECTRODE



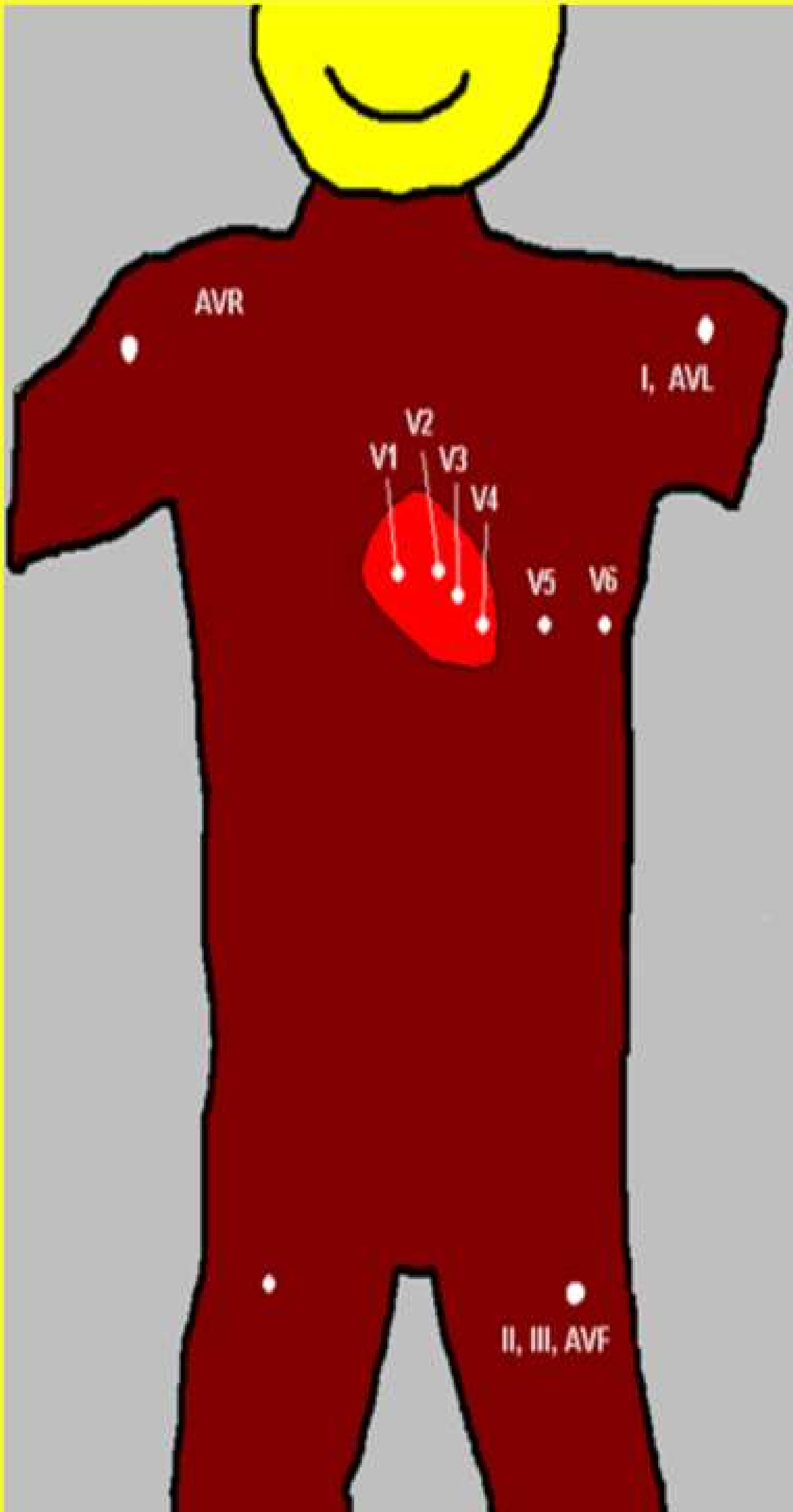
THE POSITIVE ELECTRODE



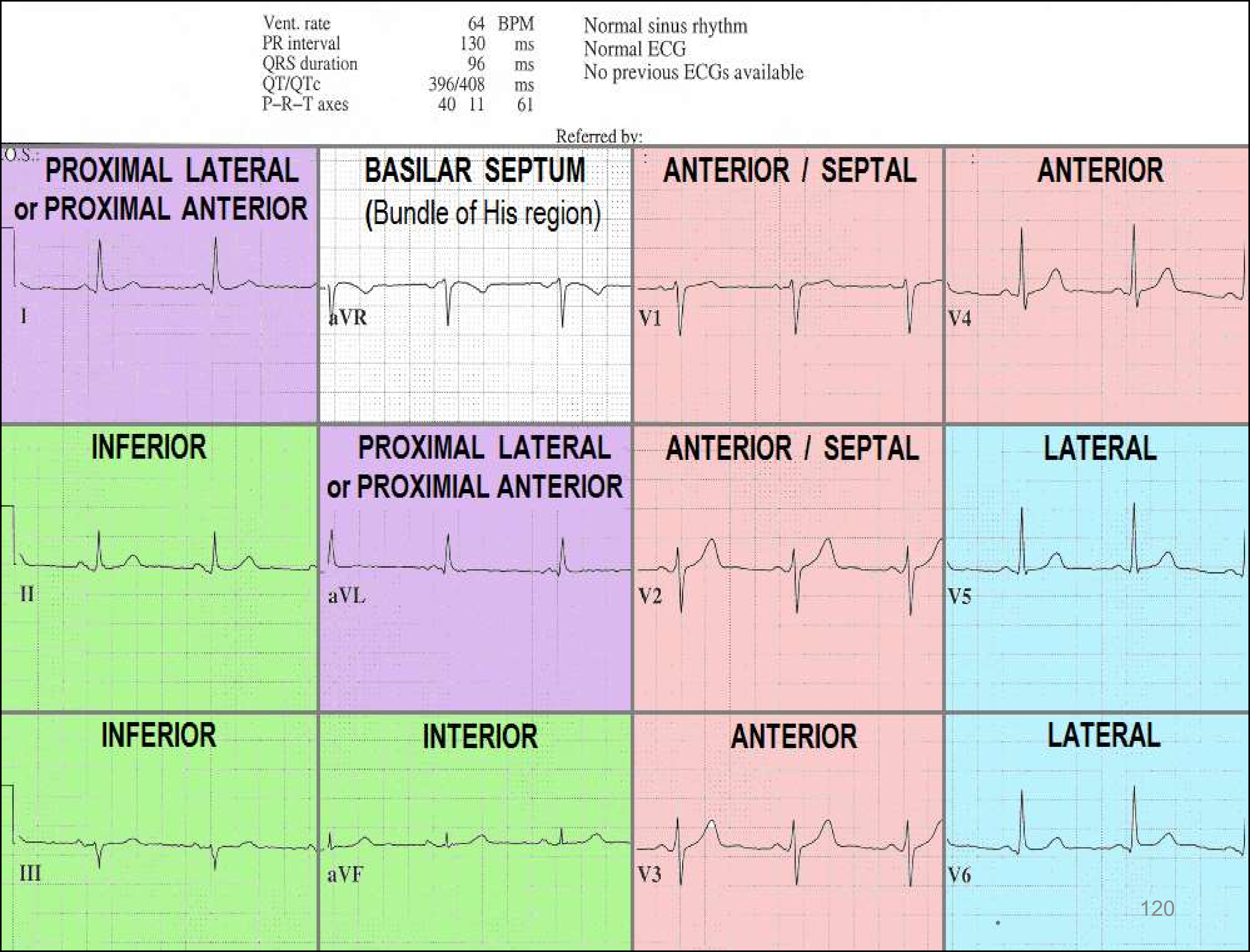
IS THE "EYE" . . .


AREAS VIEWED
by 12 LEAD ECG
AVR
I, AVL
V1
V2
V3
V4
V5
V6
II, III, AVF
AVR
AVL, I
V1, V2
V3, V4
V5, V6
II, III, AVF
THE POSITIVE ELECTRODE
IS THE "EYE" . . .

AREAS VIEWED by 12 LEAD ECG



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



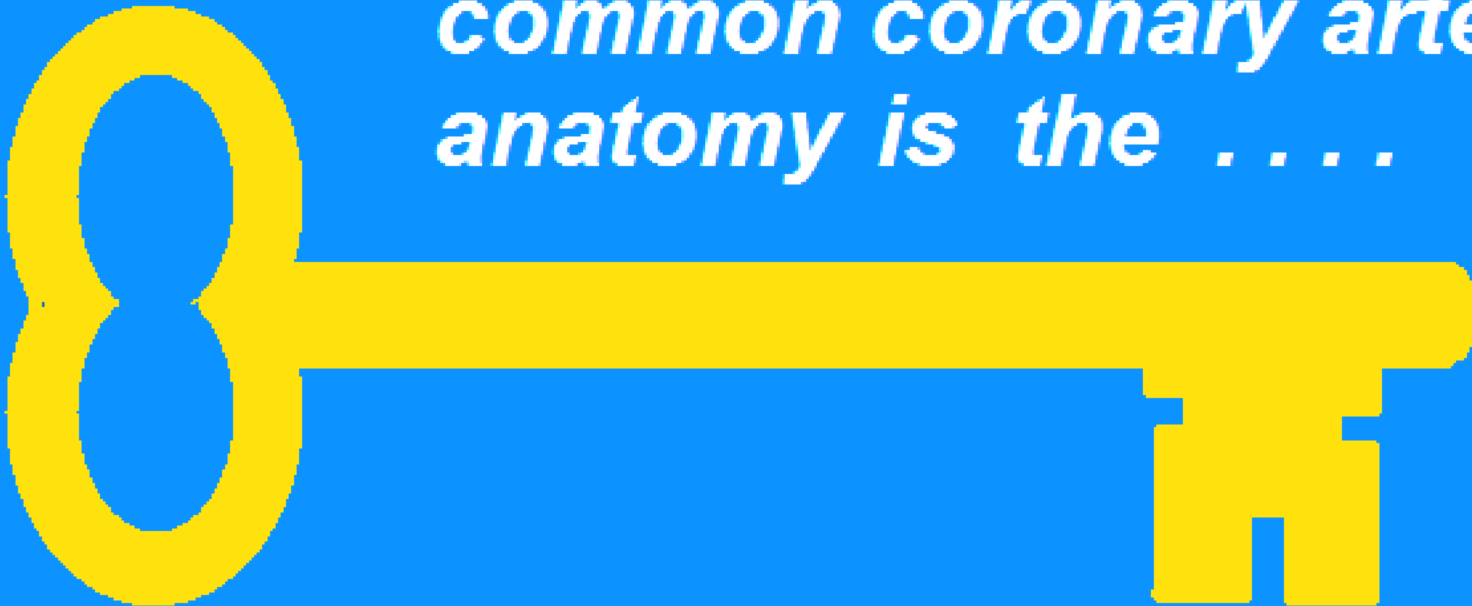
Vent. rate 64 BPM
PR interval 130 ms
QRS duration 96 ms
QT/QTc 396/408 ms
P–R–T axes 40 11 61
Normal sinus rhythm
Normal ECG
No previous ECGs available
Referred by:
PROXIMAL LATERAL or PROXIMAL ANTERIOR
I
BASILAR SEPTUM (Bundle of His region)
aVR
ANTERIOR / SEPTAL
V1
ANTERIOR
V4
INFERIOR
II
PROXIMAL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

THE CORONARY

ARTERIES

STRUCTURES SERVED BY THE CORONARY ARTERIES

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



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

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

INTERPRET THE EKG, THEN:

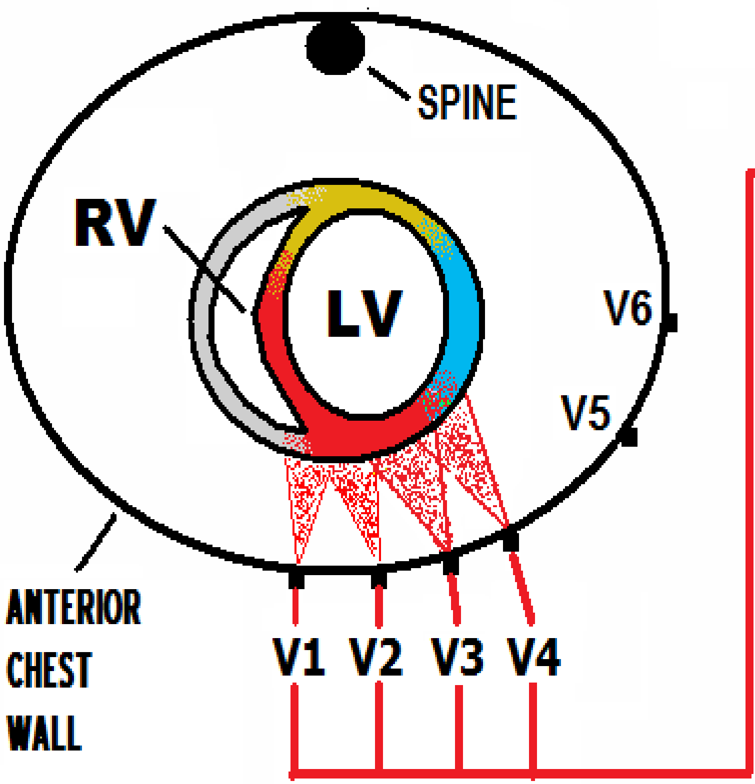
- IDENTIFY THE AREA OF THE HEART WITH A PROBLEM . . .
- RECALL THE ARTERY WHICH SERVES THAT REGION . . .
- RECALL OTHER STRUCTURES SERVED BY THAT ARTERY . . .
- ANTICIPATE FAILURE OF THOSE STRUCTURES . . .
- ***INTERVENE APPROPRIATELY !***

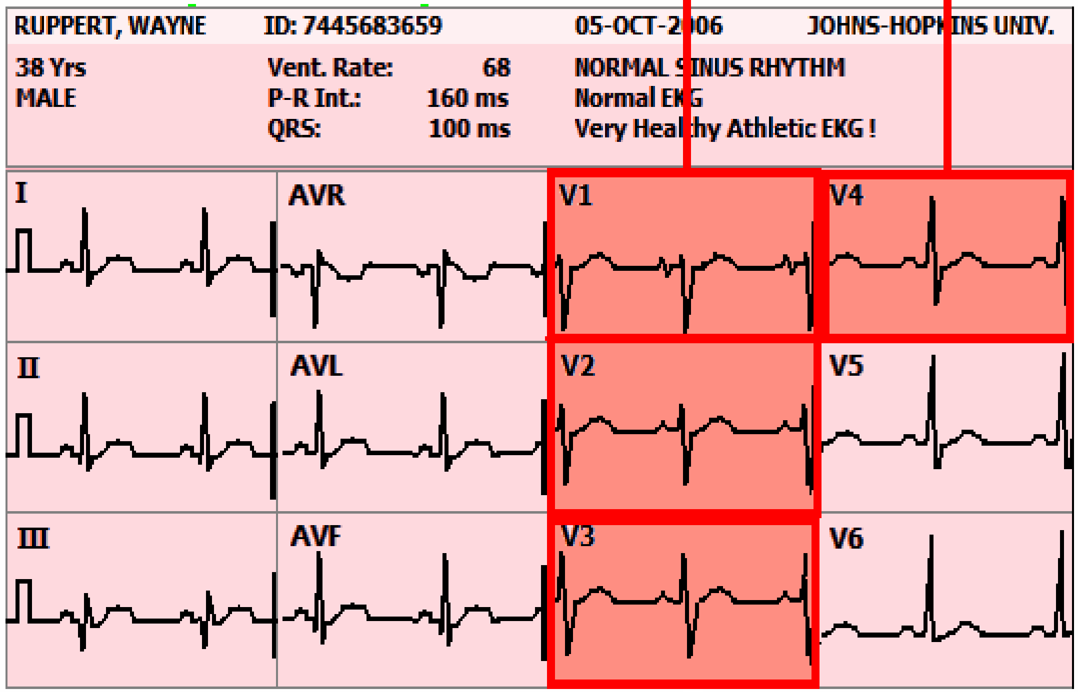
V1 - V4 VIEW THE ANTERIOR-SEPTAL WALL

of the LEFT VENTRICLE

V1, V2 - ANTERIOR / SEPTAL

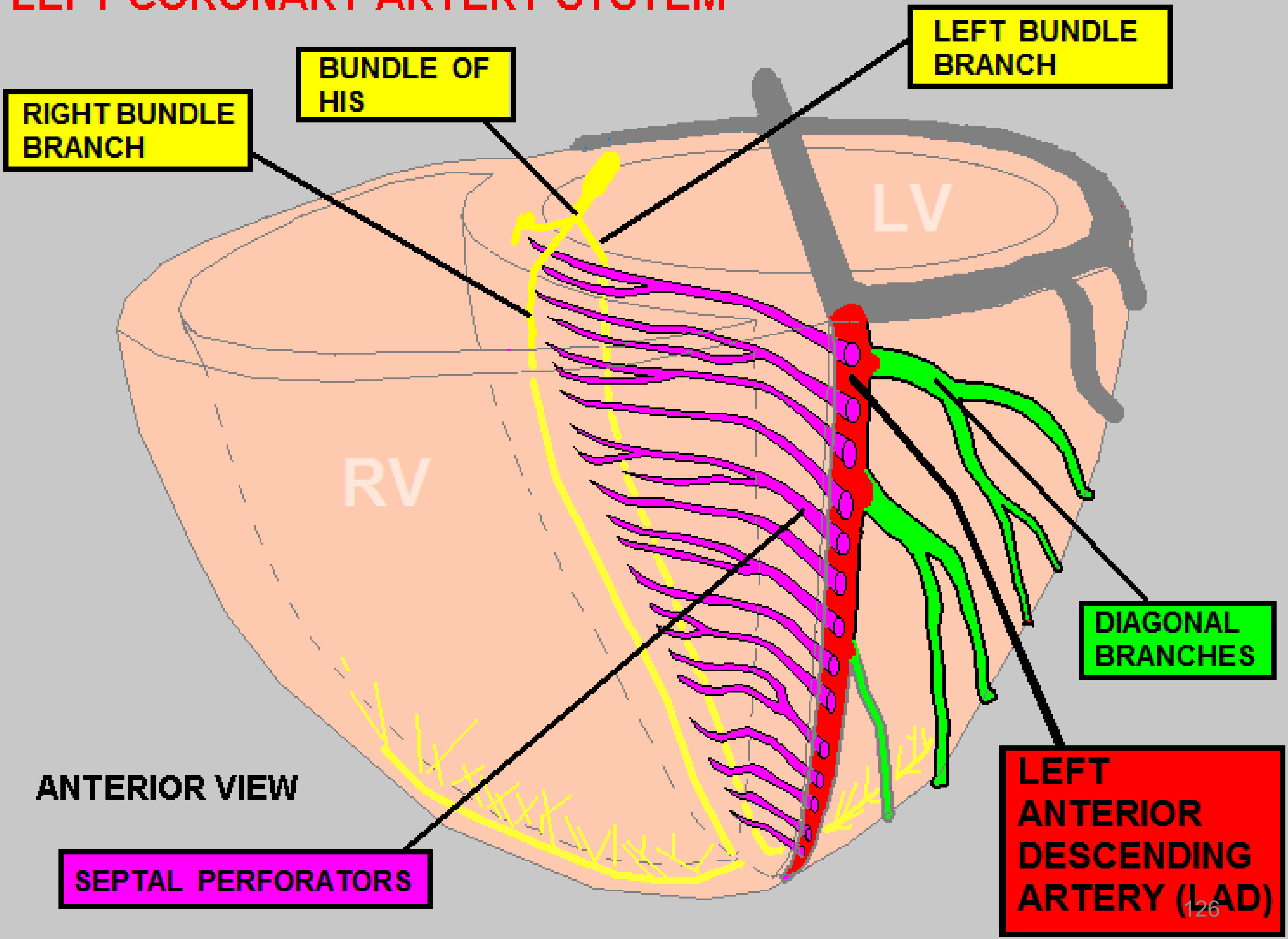
V3, V4 - ANTERIOR

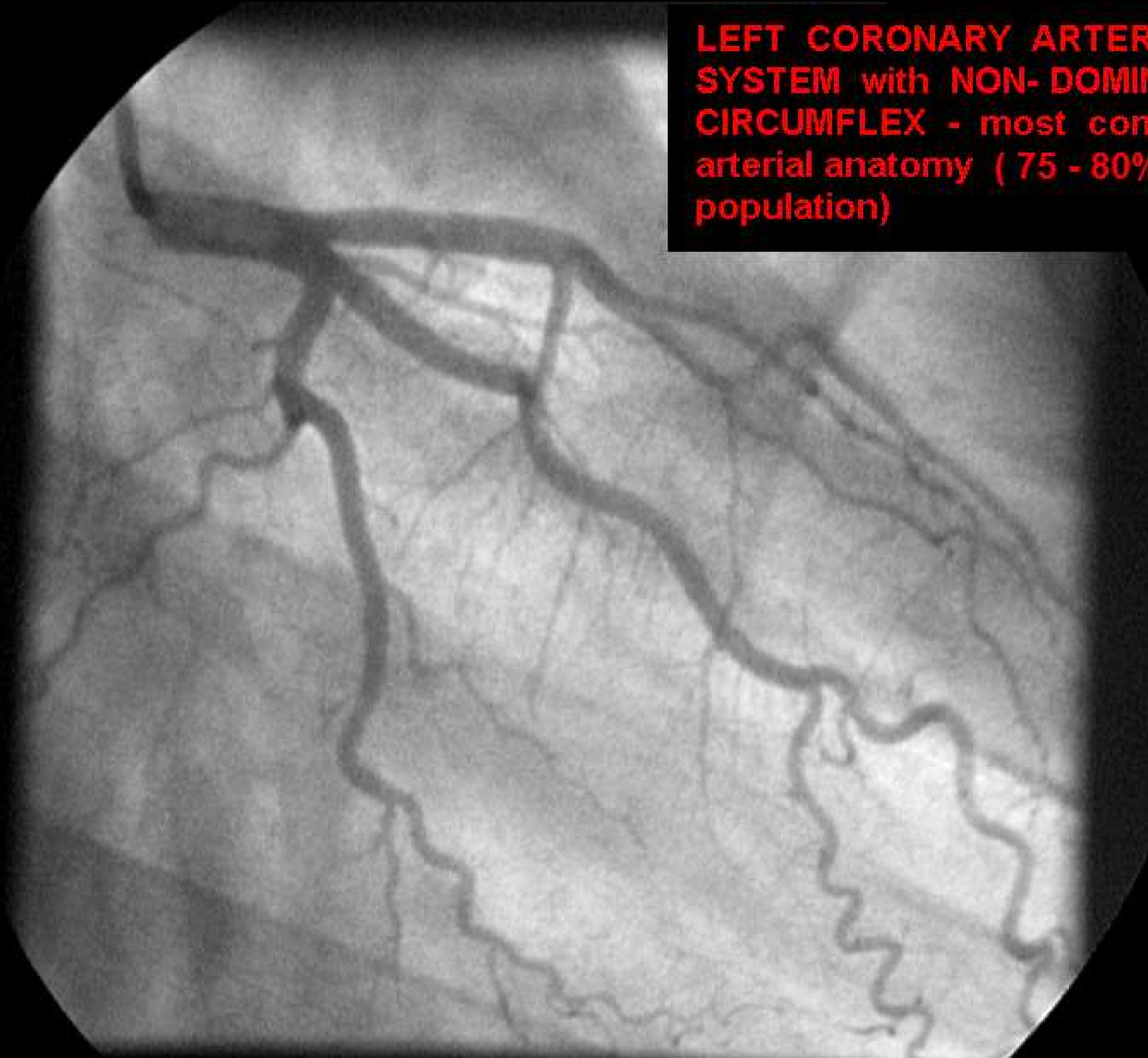




Which Coronary Artery typically Supplies the ANTERIOR WALL ?

LEFT CORONARY ARTERY SYSTEM





LEFT CORONARY ARTERY SYSTEM with NON- DOMINANT CIRCUMFLEX - most common arterial anatomy (75 - 80% of population)

HELPFUL HINT . . . MEMORIZE THIS !

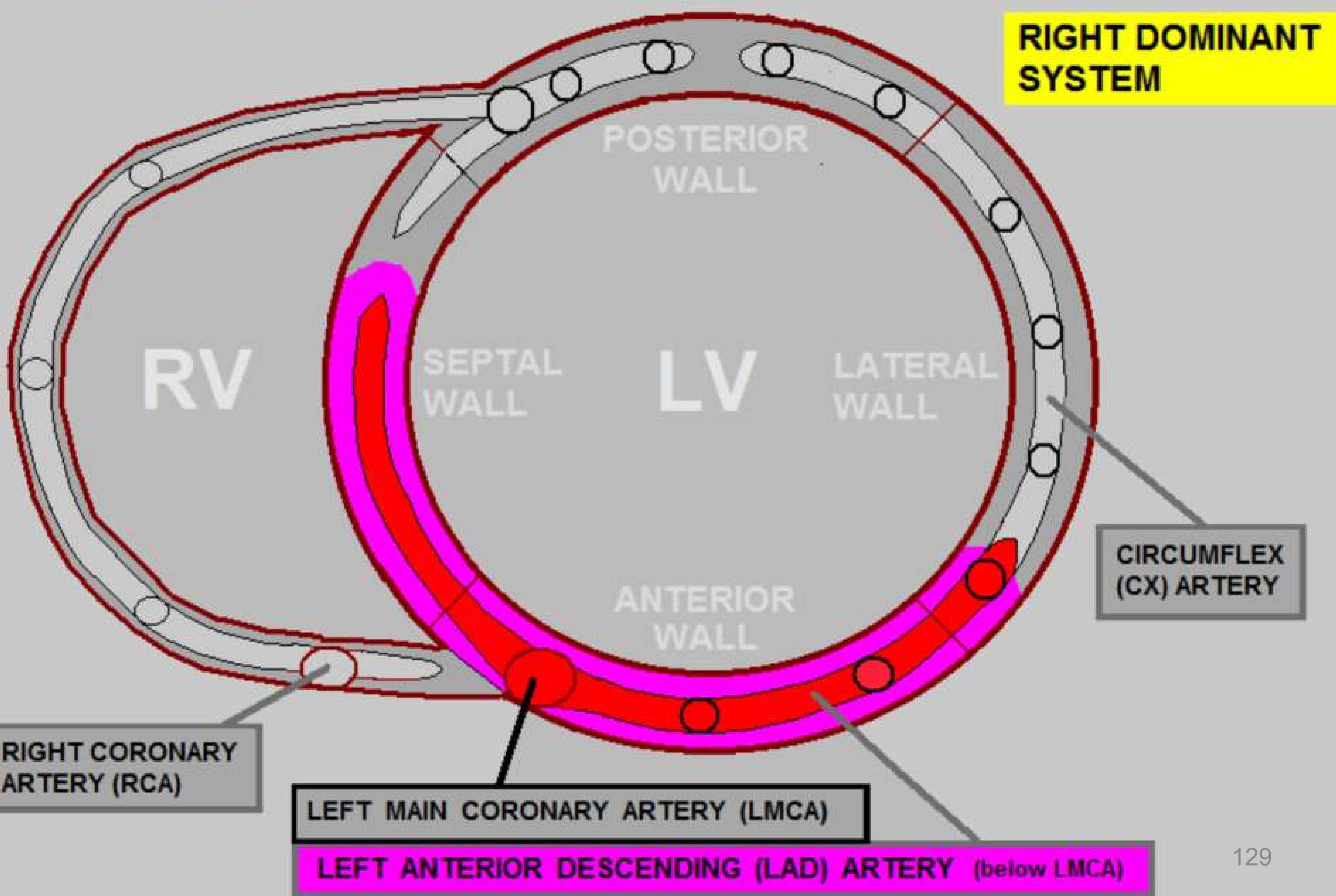
LEFT ANTERIOR DESCENDING ARTERY (LAD)

- BUNDLE OF HIS
- BUNDLE BRANCHES ( )
- 35 - 45 % OF LV MUSCLE MASS
  - ANTERIOR WALL
  - SEPTAL WALL (anterior 2/3)

cutaway view of the

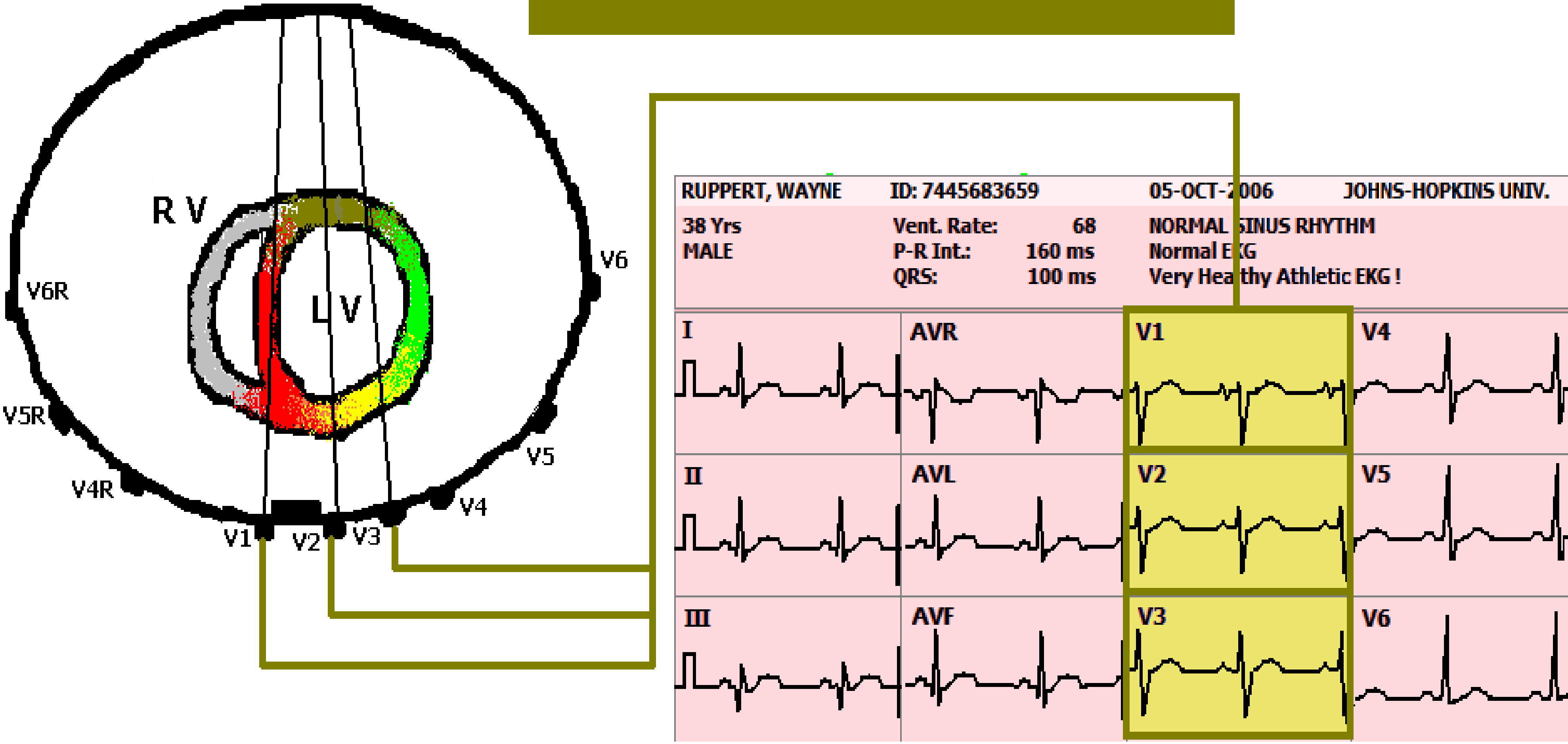
LEFT ANTERIOR DESCENDING ARTERY (LAD)

SUPPLIES APPROX. 35 - 45% of the LV MUSCLE MASS



LEADS V1 - V3 *view the*

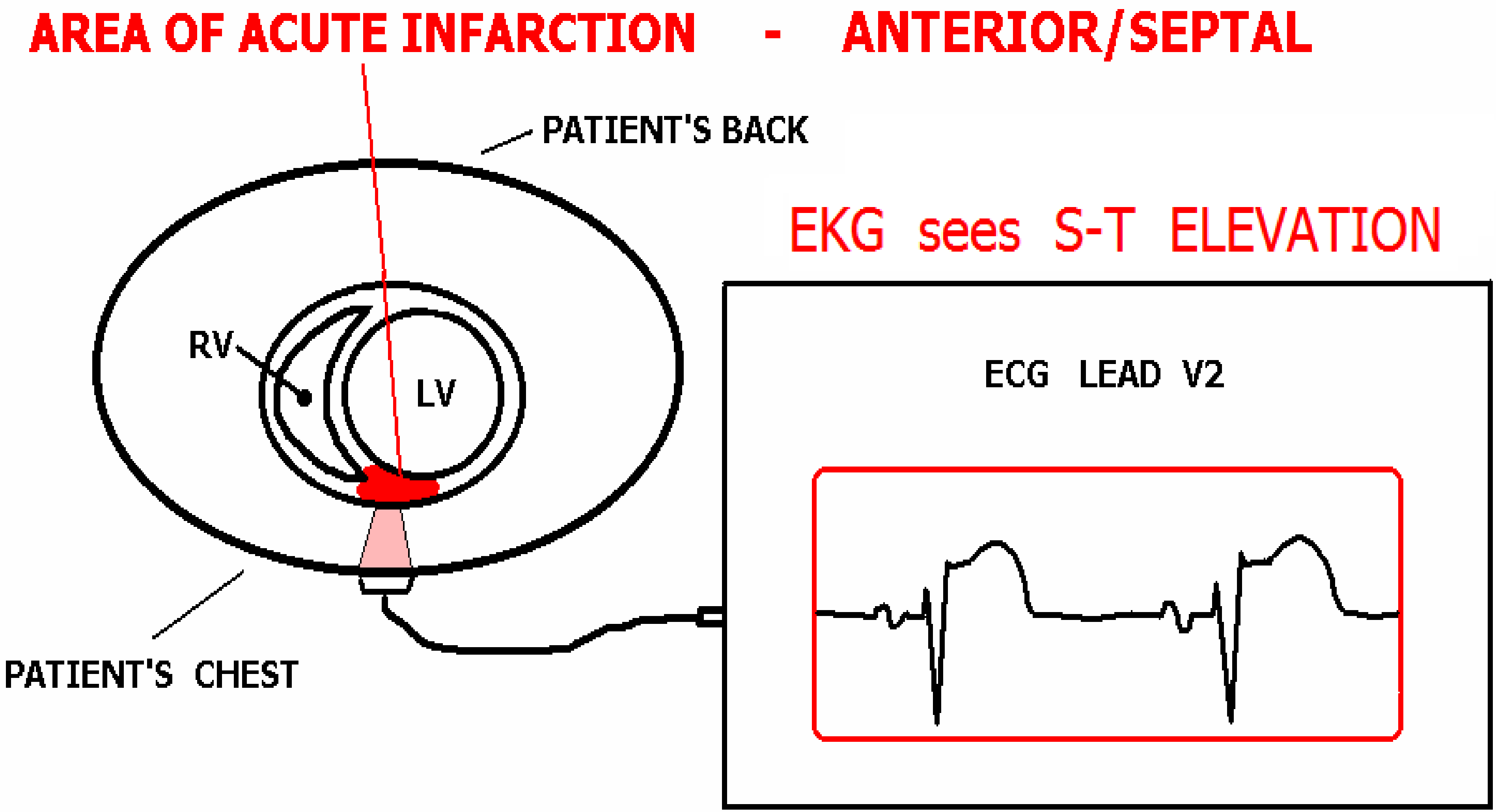
POSTERIOR WALL



via RECIPROCAL CHANGES.

HOW EKG VIEWS INDICATIVE CHANGES

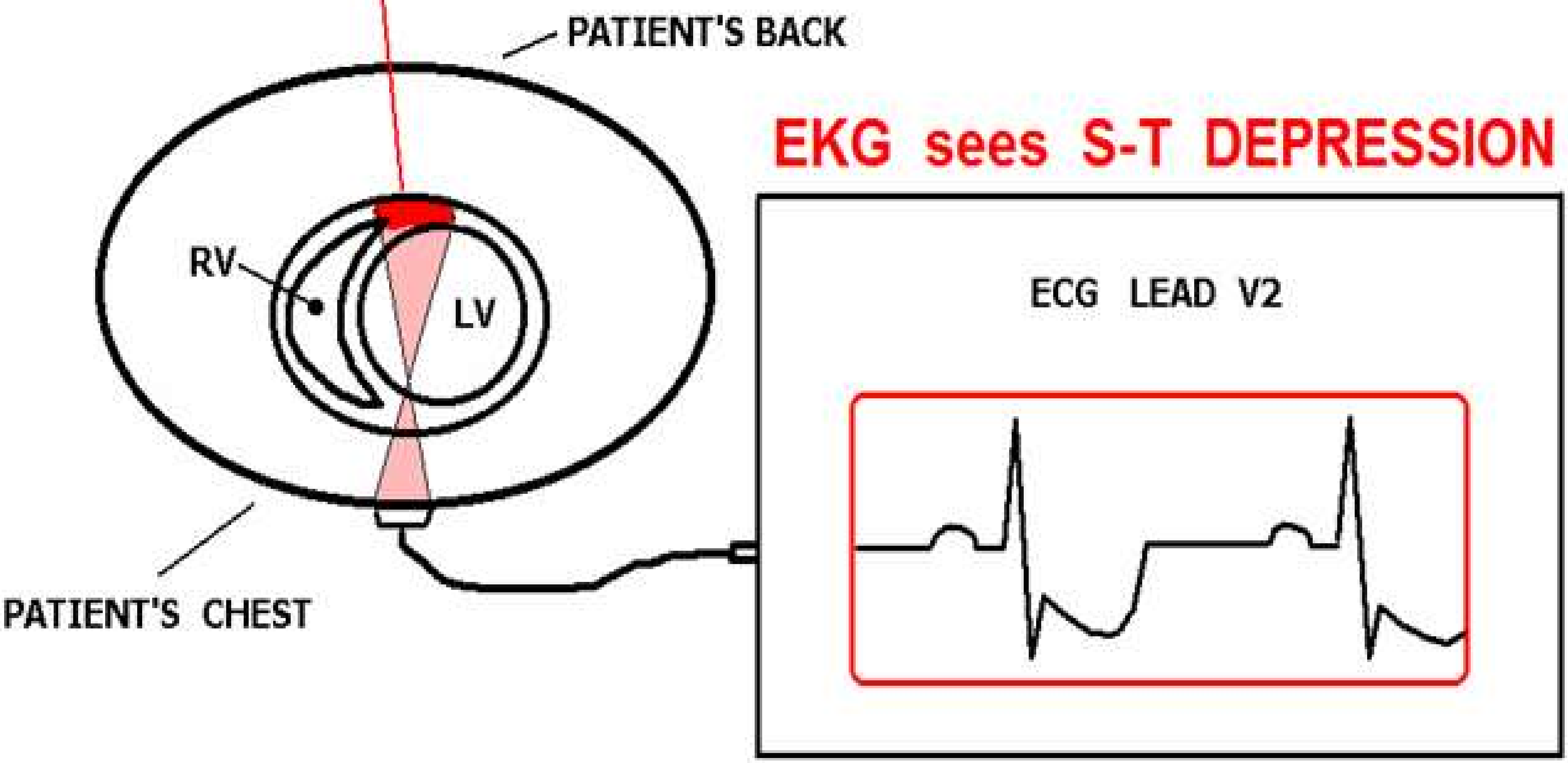
EXAMPLE:



HOW EKG VIEWS RECIPROCAL CHANGES

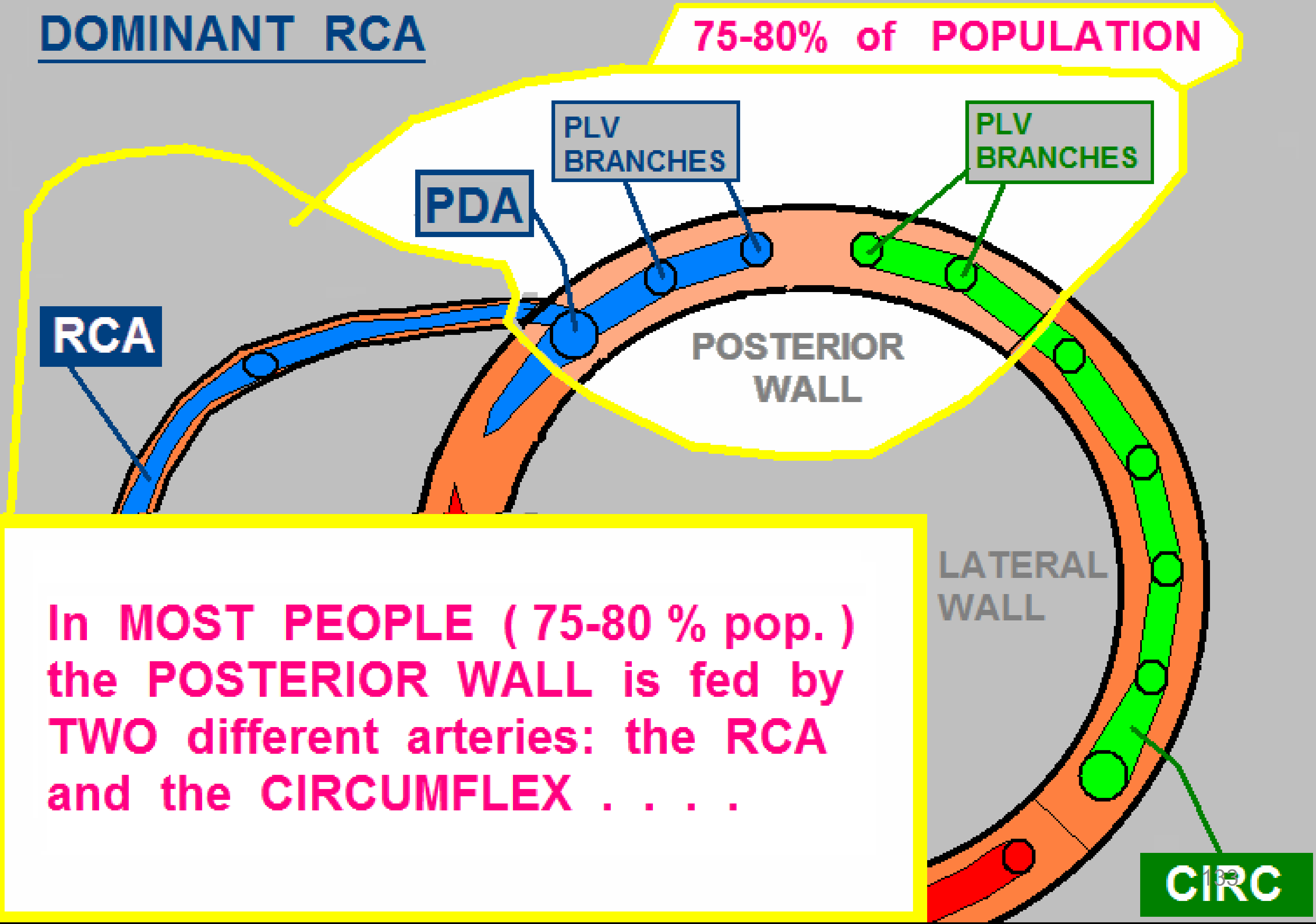
EXAMPLE:

AREA OF ACUTE INFARCTION - POSTERIOR WALL



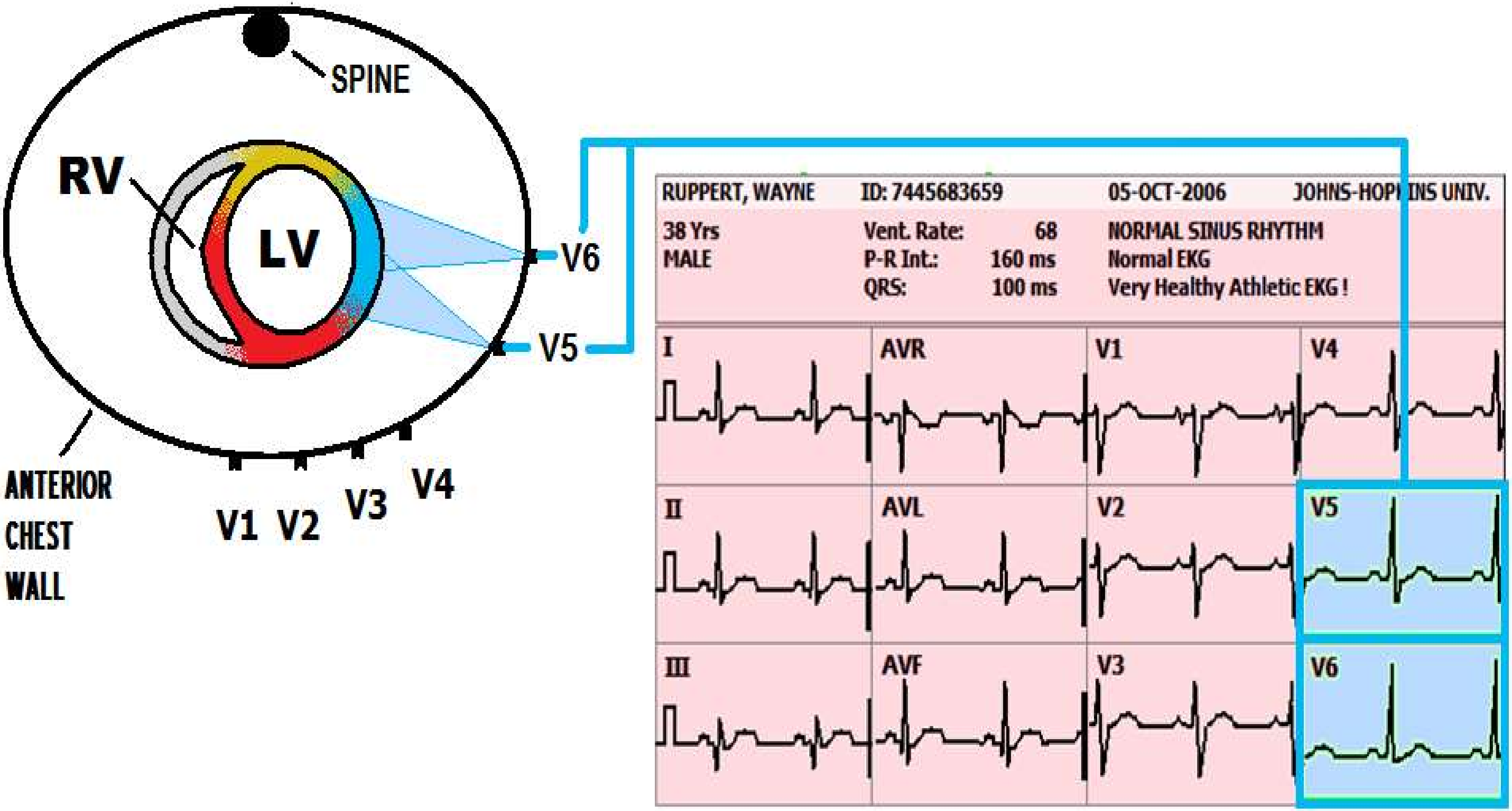
POSTERIOR WALL BLOOD SUPPLY

DOMINANT RCA



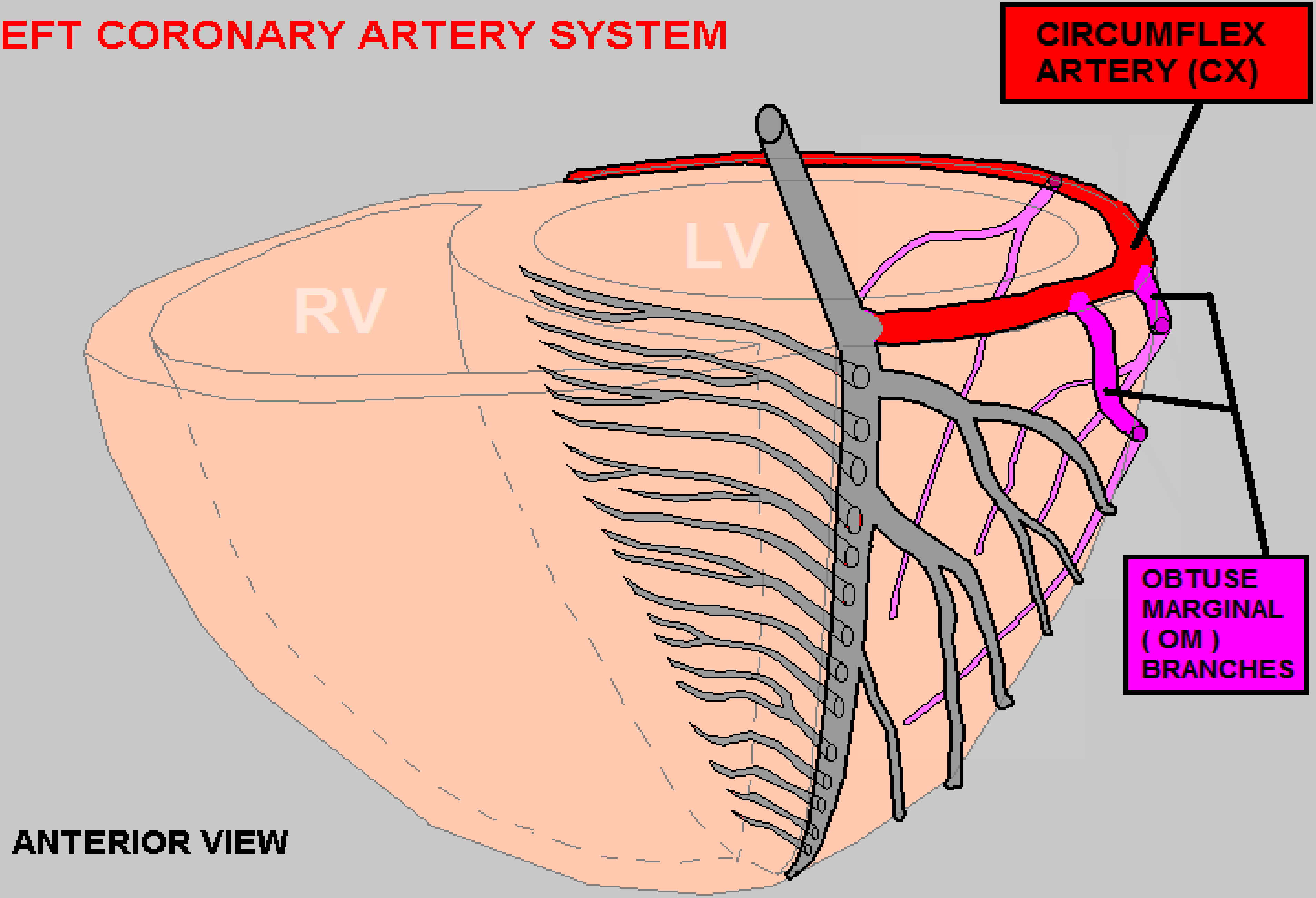
In MOST PEOPLE (75-80 % pop.) the POSTERIOR WALL is fed by TWO different arteries: the RCA and the CIRCUMFLEX . . . .

V5 - V6 VIEW THE LATERAL WALL
of the LEFT VENTRICLE

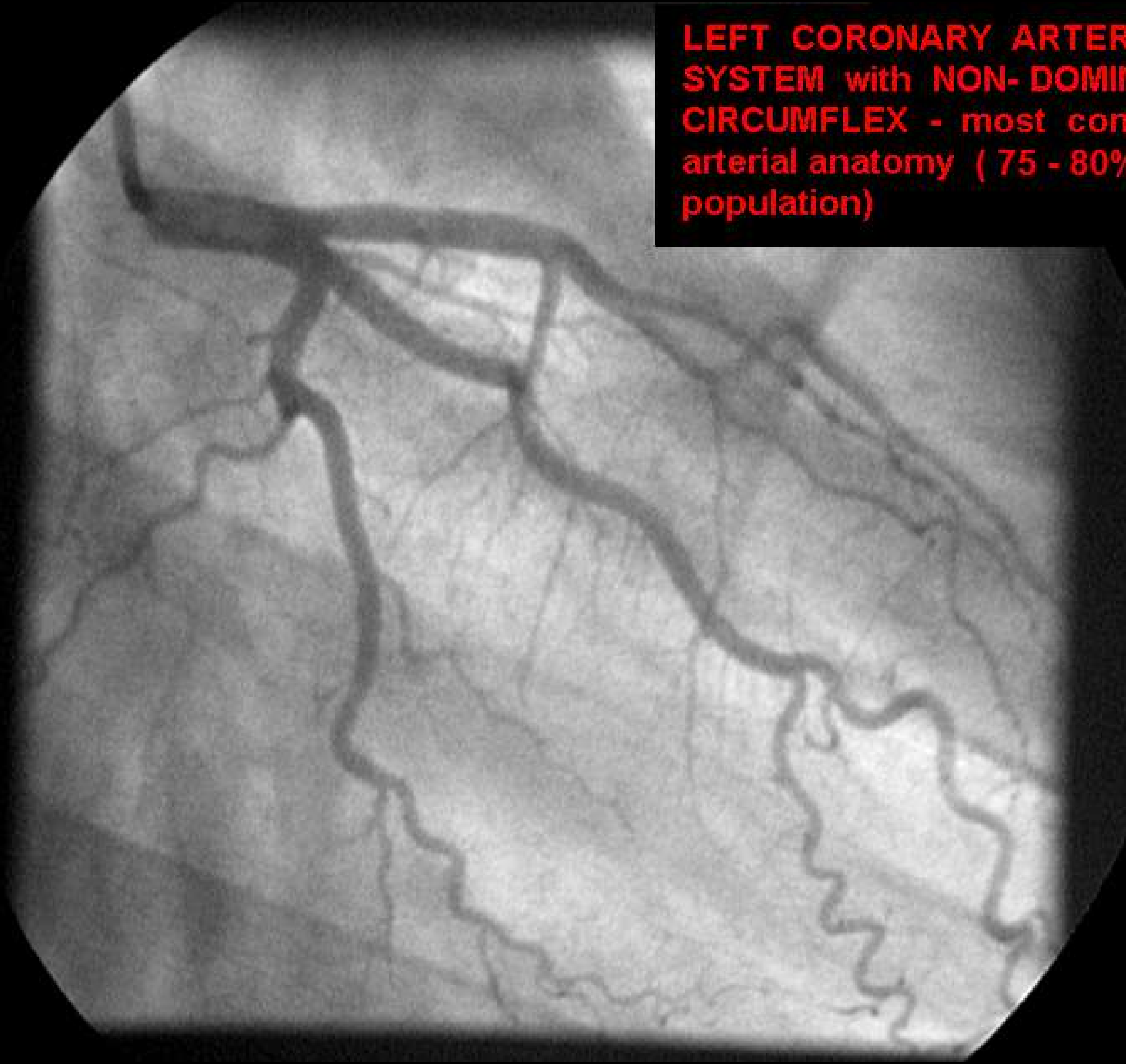


Which Coronary Artery typically Supplies the LATERAL WALL ?

LEFT CORONARY ARTERY SYSTEM



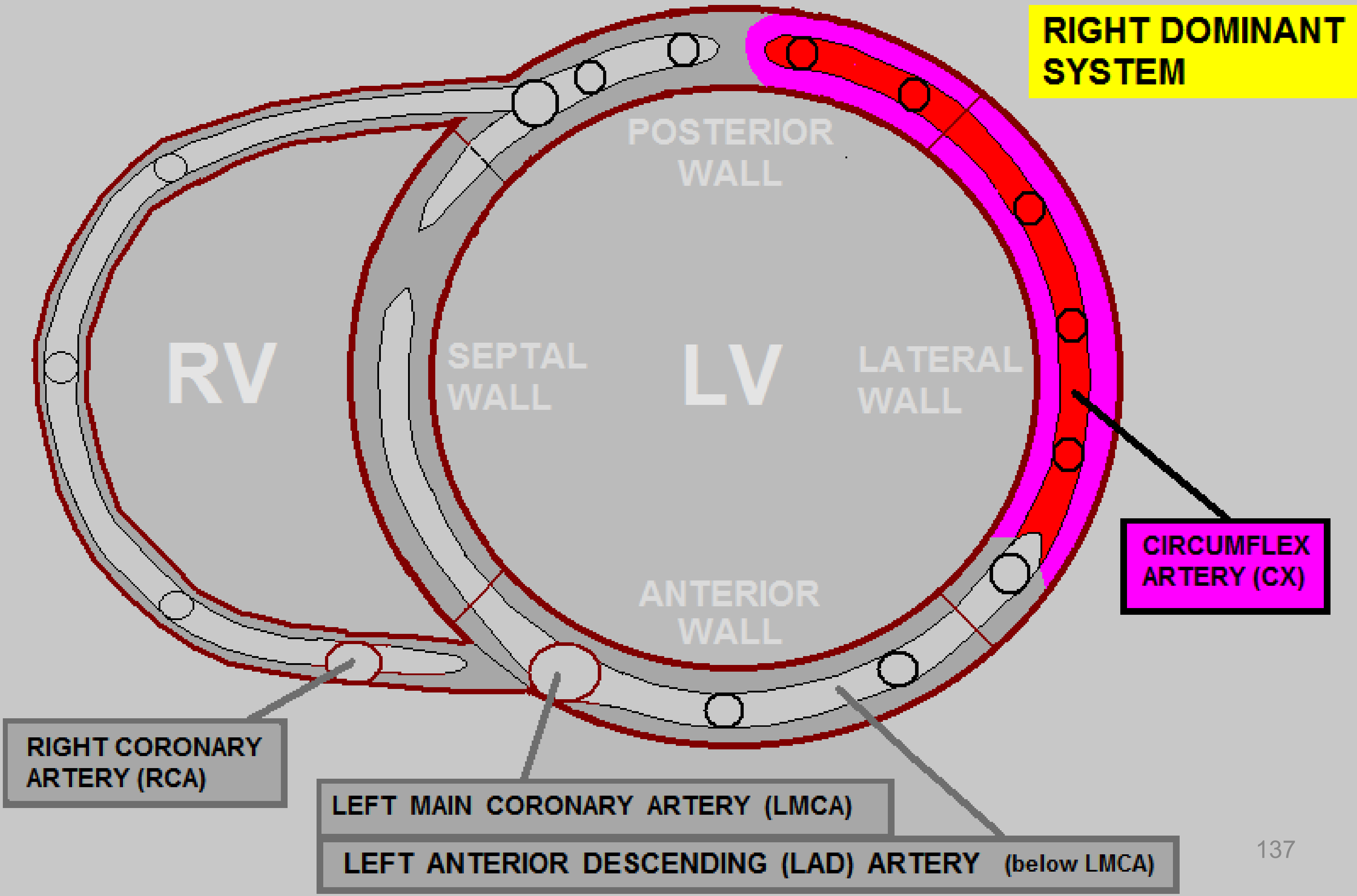
LEFT CORONARY ARTERY SYSTEM with NON- DOMINANT CIRCUMFLEX - most common arterial anatomy (75 - 80% of population)



cutaway view of the

CIRCUMFLEX ARTERY (CX) DISTRIBUTION

SUPPLIES 20 - 30 % of the LV MUSCLE MASS



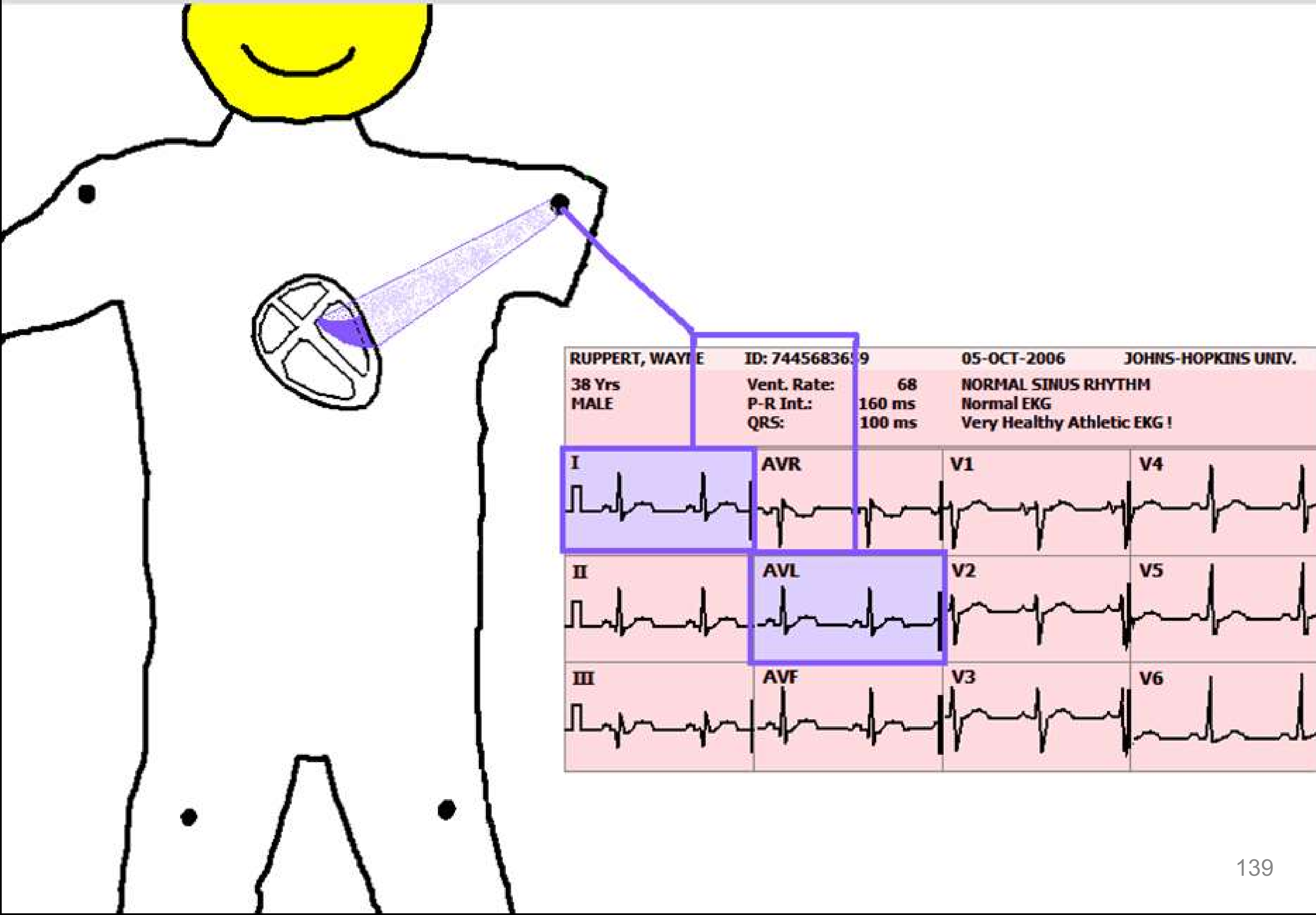
HELPFUL HINT . . . MEMORIZE THIS !

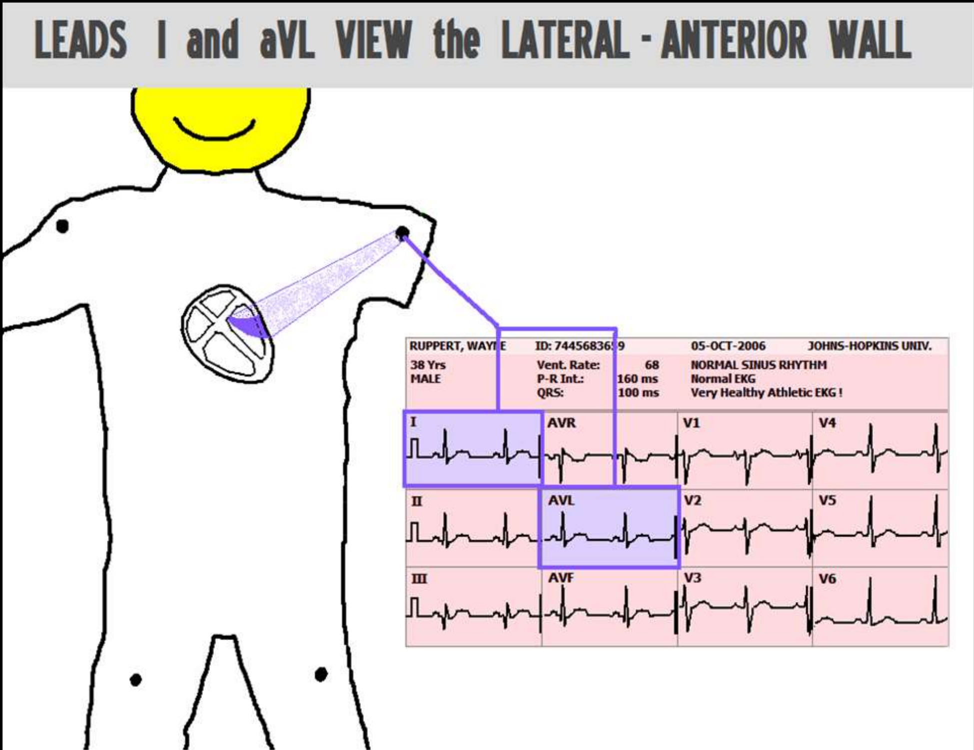
CIRCUMFLEX ARTERY (CX)

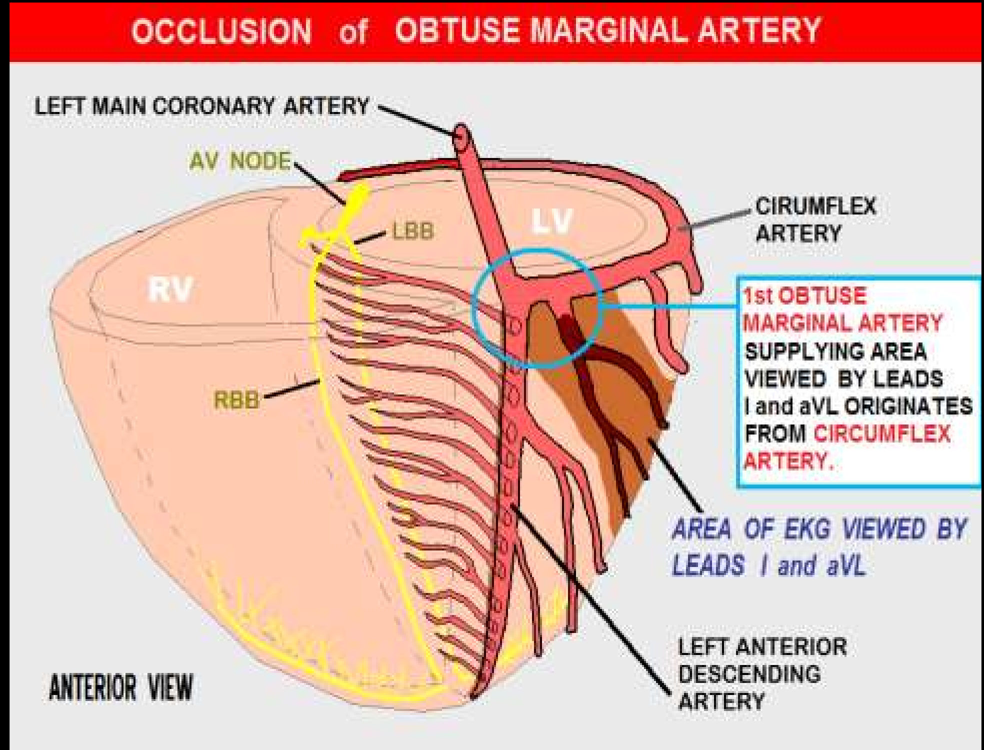
RIGHT DOMINANT SYSTEMS

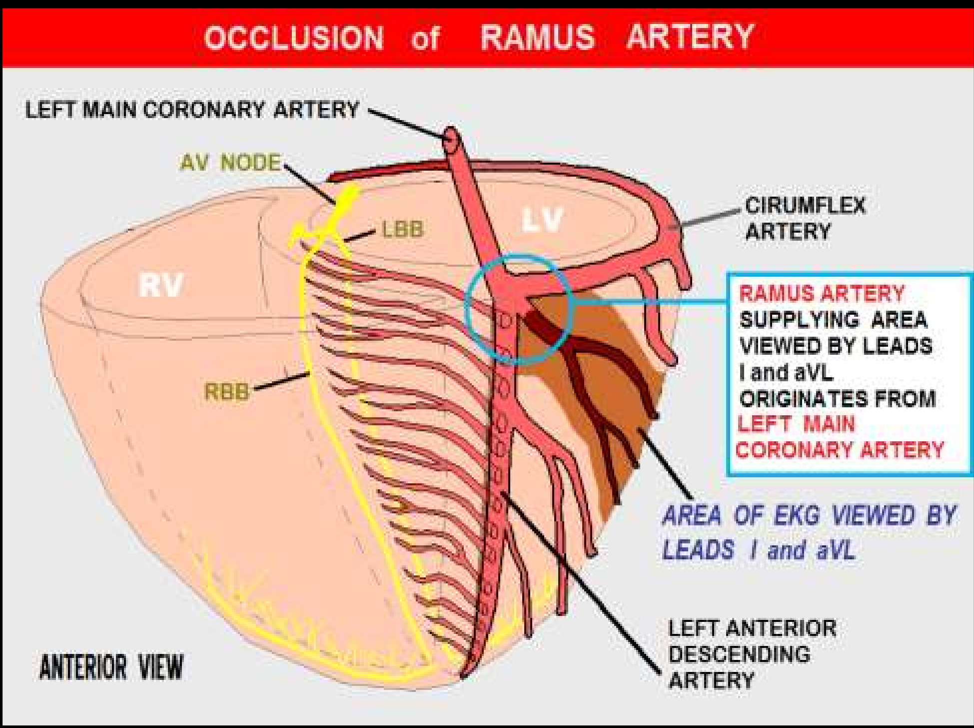
- LEFT ATRIUM
- SINUS NODE (45% of the population)
- LEFT VENTRICLE: 20 - 30 % of muscle mass
  - LATERAL WALL
  - up to 1/2 of POSTERIOR WALL

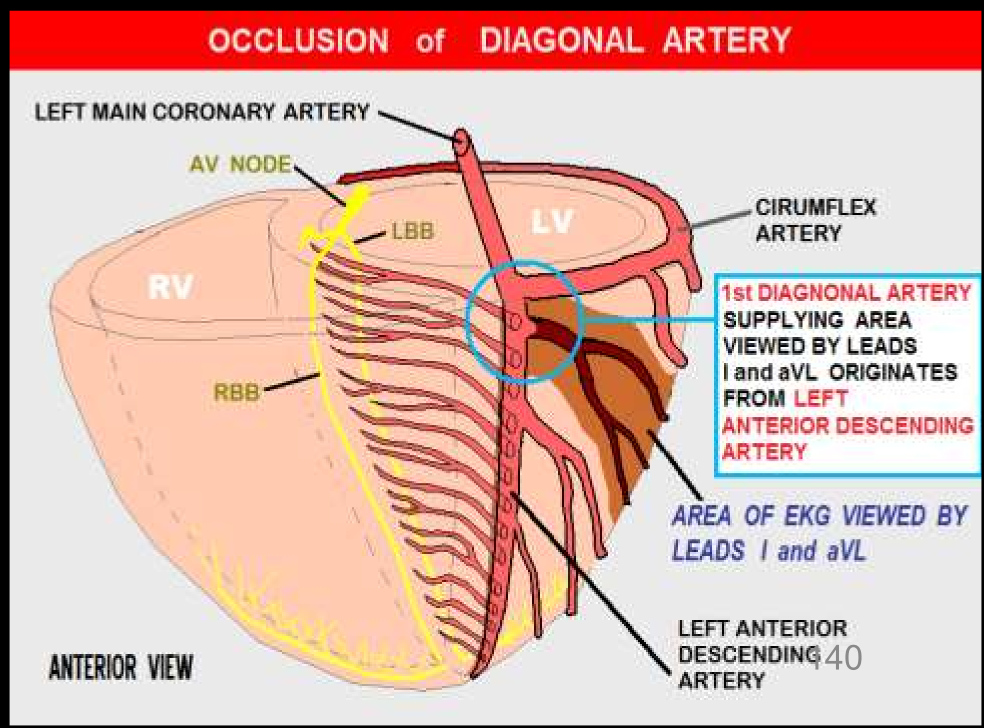
LEADS I and aVL VIEW the LATERAL - ANTERIOR WALL

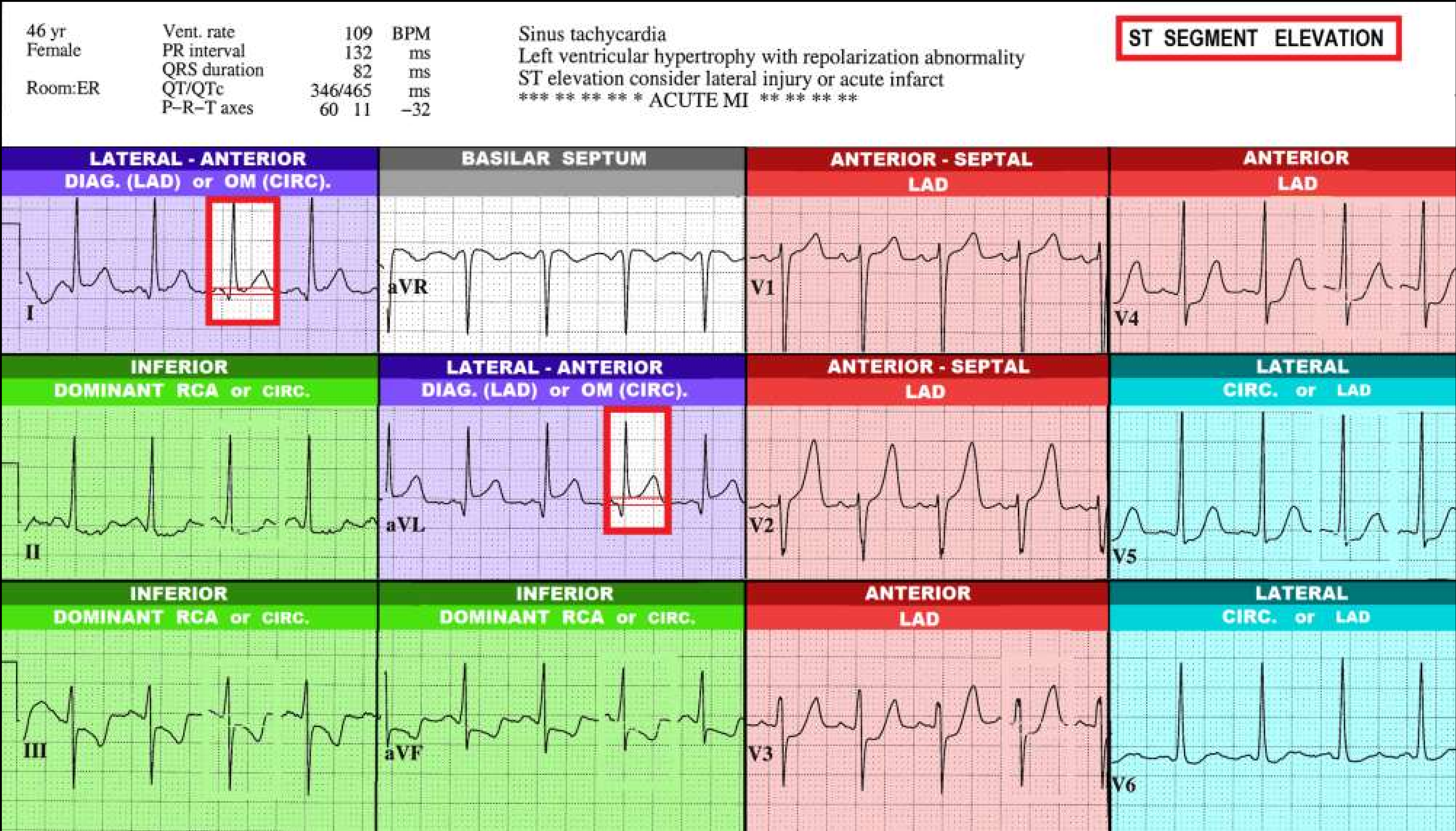



LEADS I and aVL VIEW the LATERAL - ANTERIOR WALL
RUPPERT, WAYNE
ID: 744568369
05-OCT-2006
JOHNS-HOPKINS UNIV.
38 Yrs
MALE
Vent. Rate: 68
P-R Int.: 160 ms
QRS: 100 ms
NORMAL SINUS RHYTHM
Normal EKG
Very Healthy Athletic EKG !
I
AVR
V1
V4
II
AVL
V2
V5
III
AVF
V3
V6


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


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

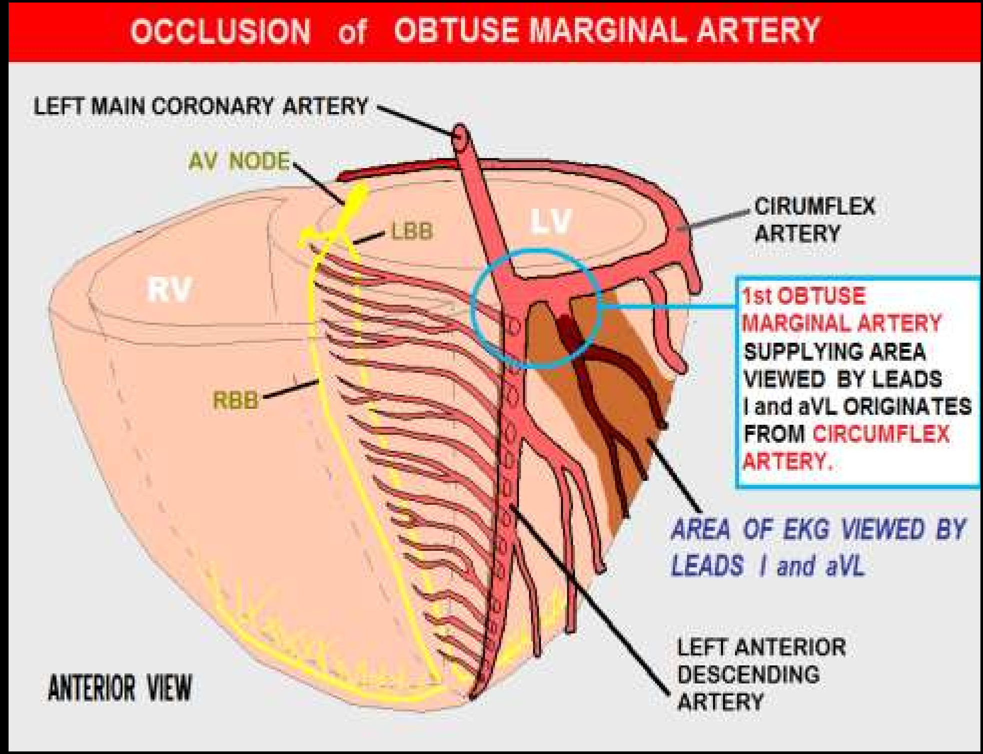

OCCLUSION of DIAGONAL ARTERY
LEFT MAIN CORONARY ARTERY
AV NODE
LBB
LV
CIRUMFLEX ARTERY
RV
1st DIAGNONAL ARTERY SUPPLYING AREA VIEWED BY LEADS I and aVL ORIGINATES FROM LEFT ANTERIOR DESCENDING ARTERY
RBB
AREA OF EKG VIEWED BY LEADS I and aVL
LEFT ANTERIOR DESCENDING ARTERY
ANTERIOR VIEW

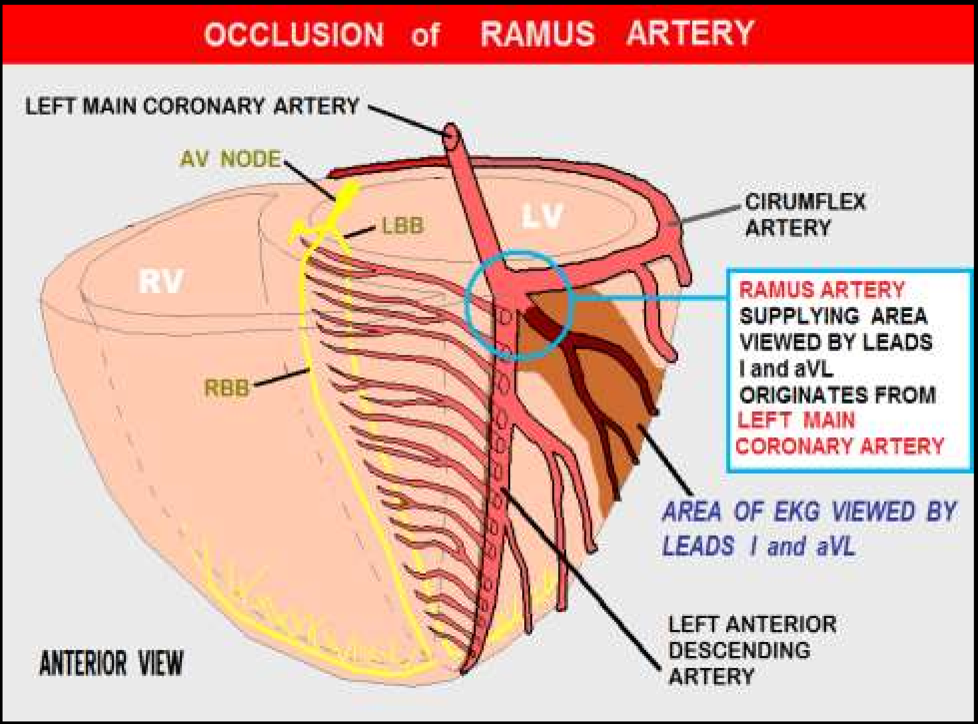


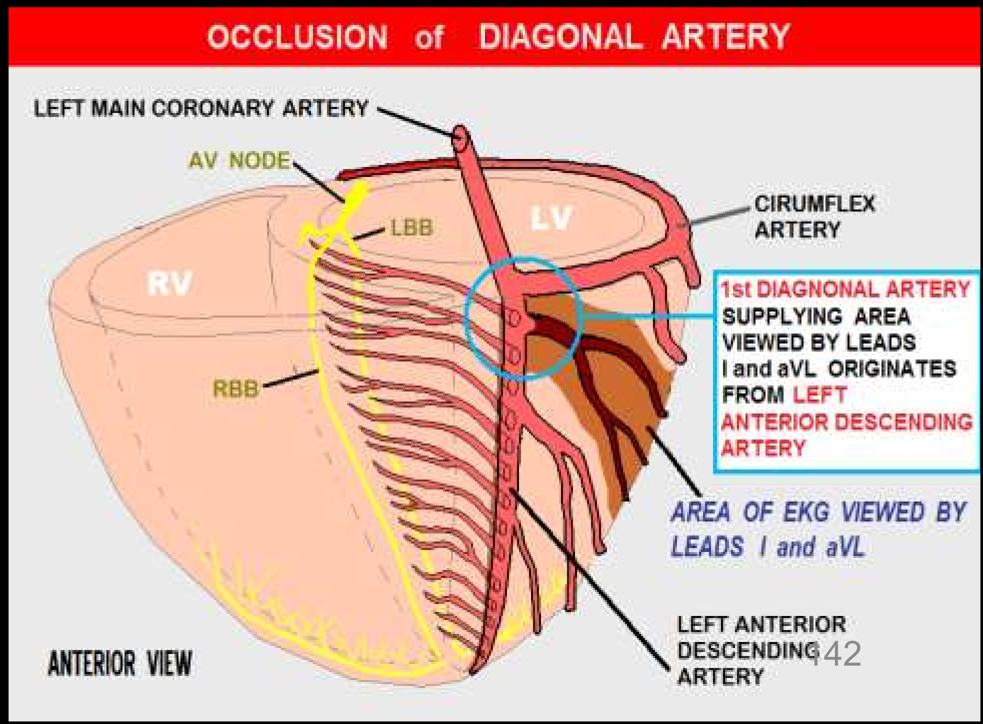
ST Segment elevation ONLY in Leads I and aVL

Usually indicates the "Culprit Artery" is most likely One of the following:

- RAMUS BRANCH
- 1st DIAGONAL off of LAD
- 1st OBTUSE MARGINAL off of CIRCUMFLEX

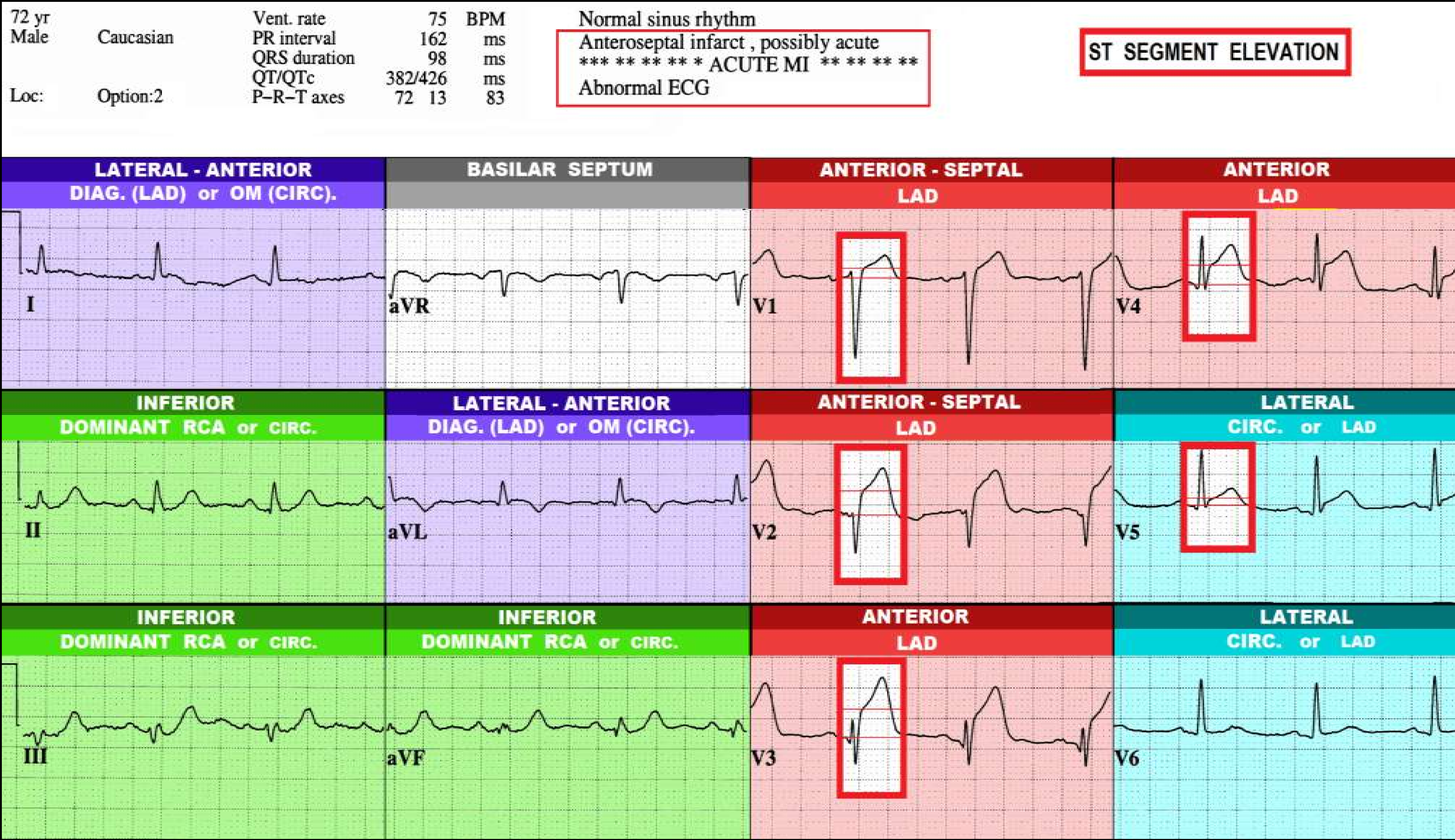






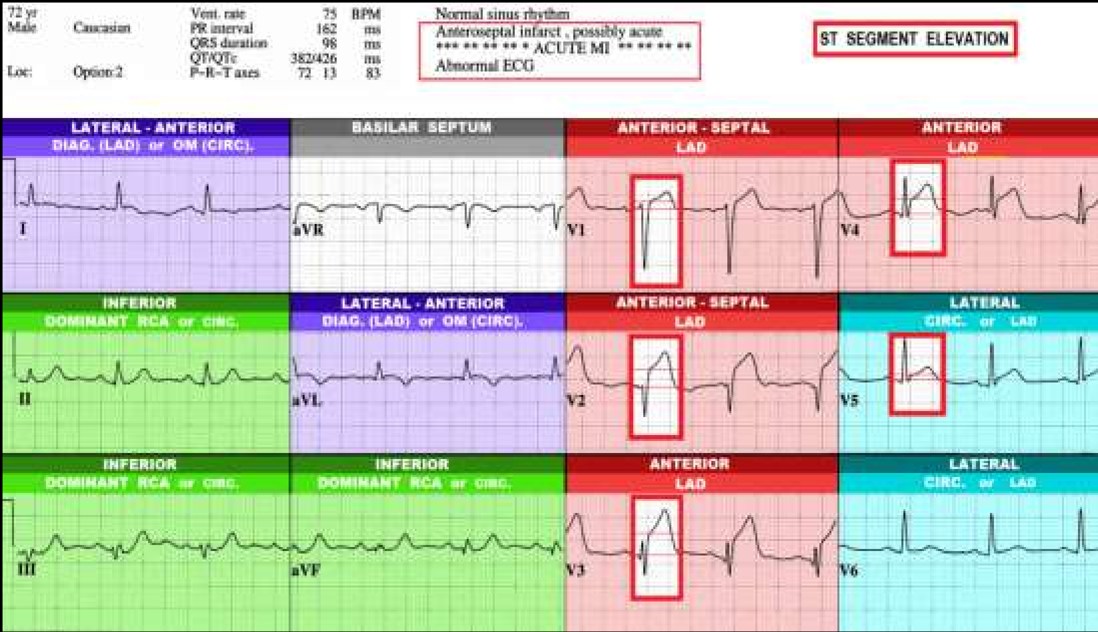
Here’s why we care:
Think of Leads I and aVL as

“THE POWERBALL “ . . . . .



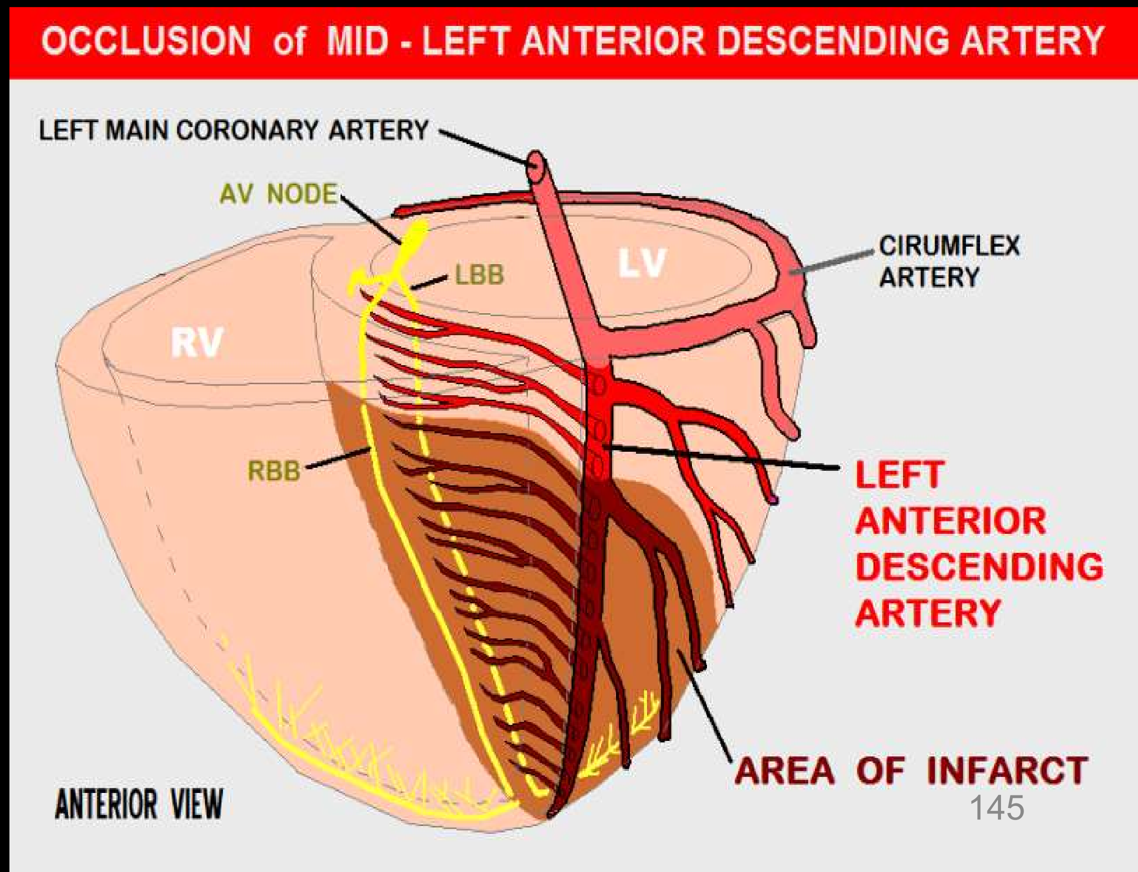
If you patient's ECG shows

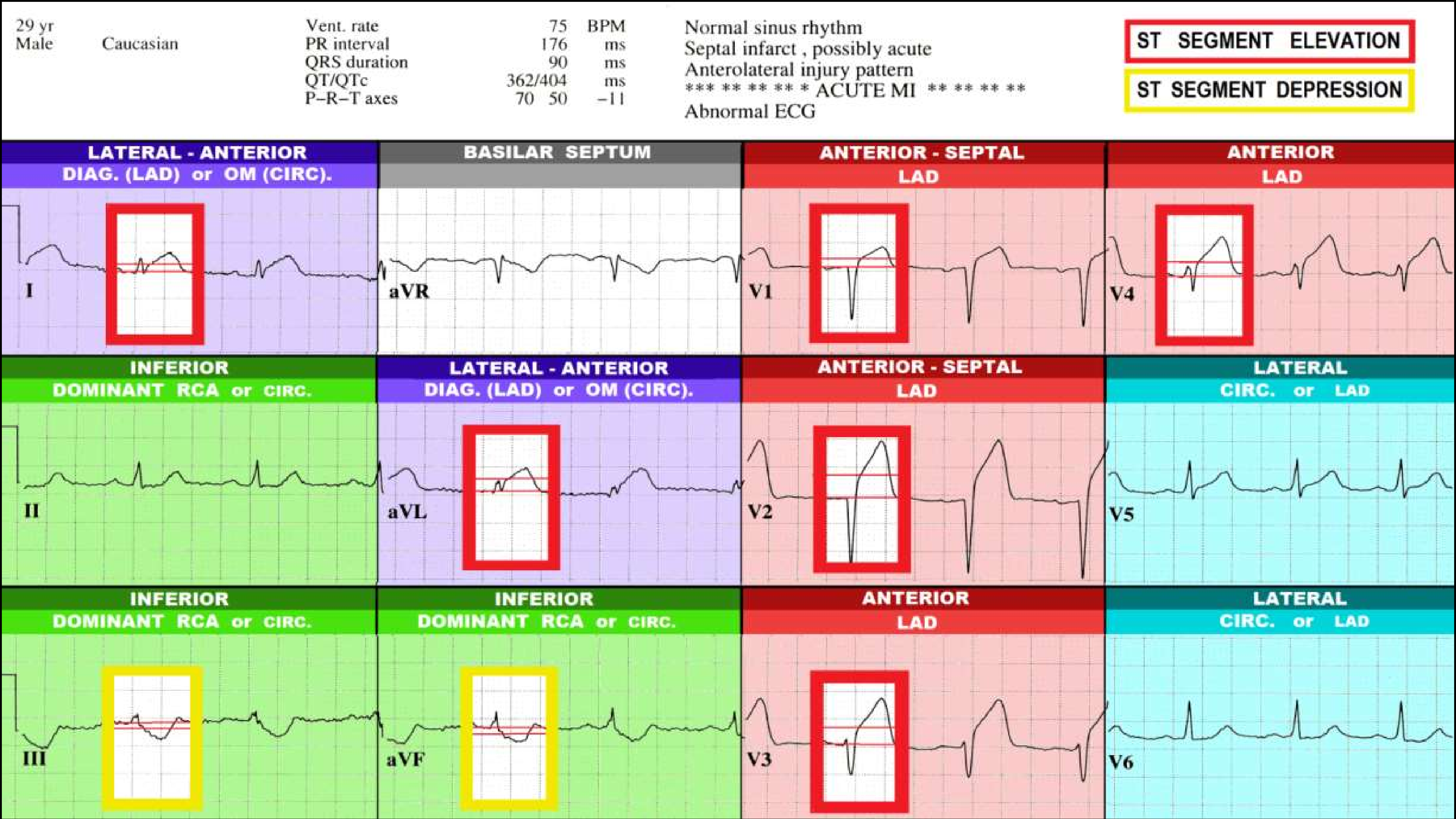
ST Elevation in Leads V1 – V4 . . . .



If your patient's ECG shows ST Elevation in Leads V1 – V4 . . .

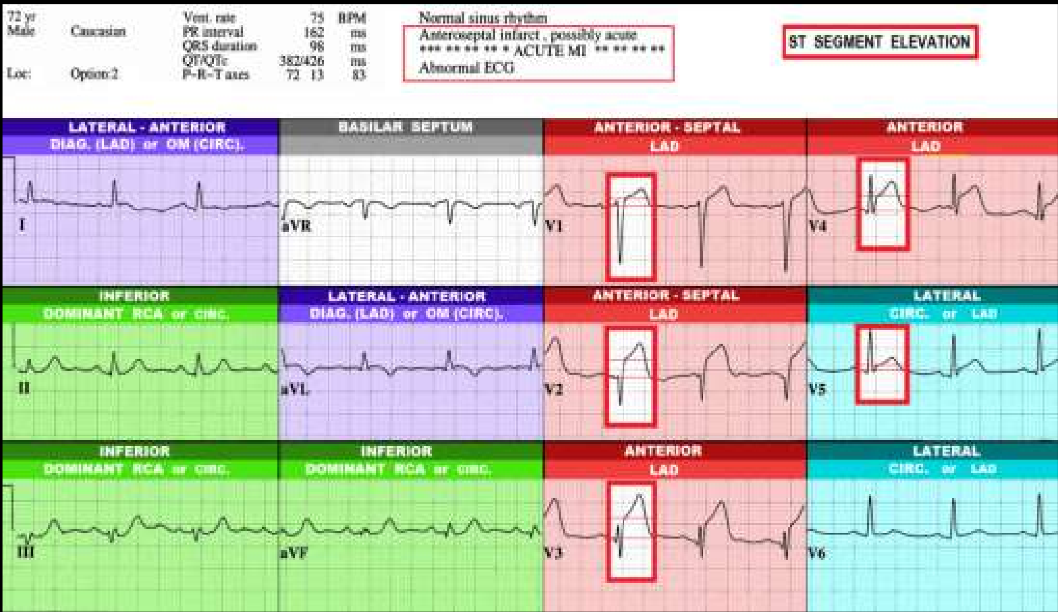
The obstruction is usually located at The MID – LAD level.

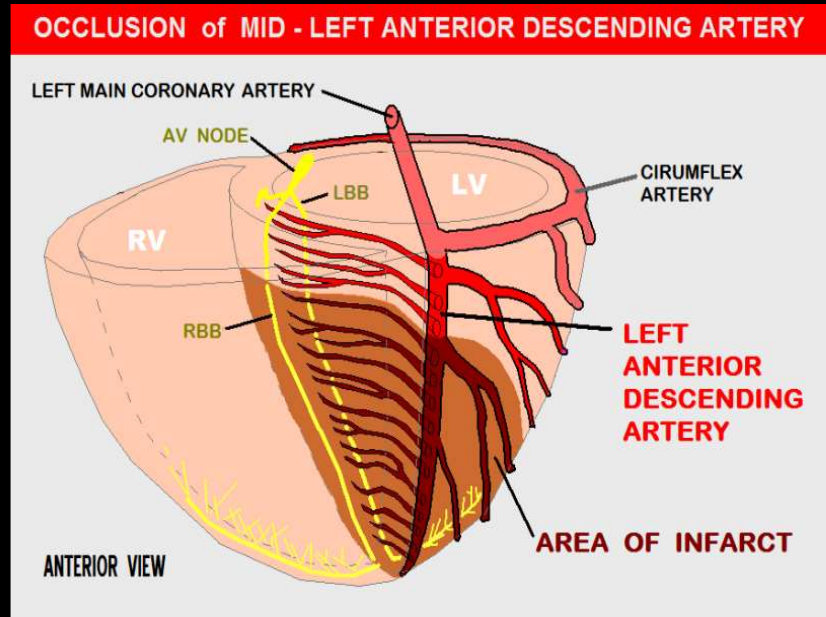




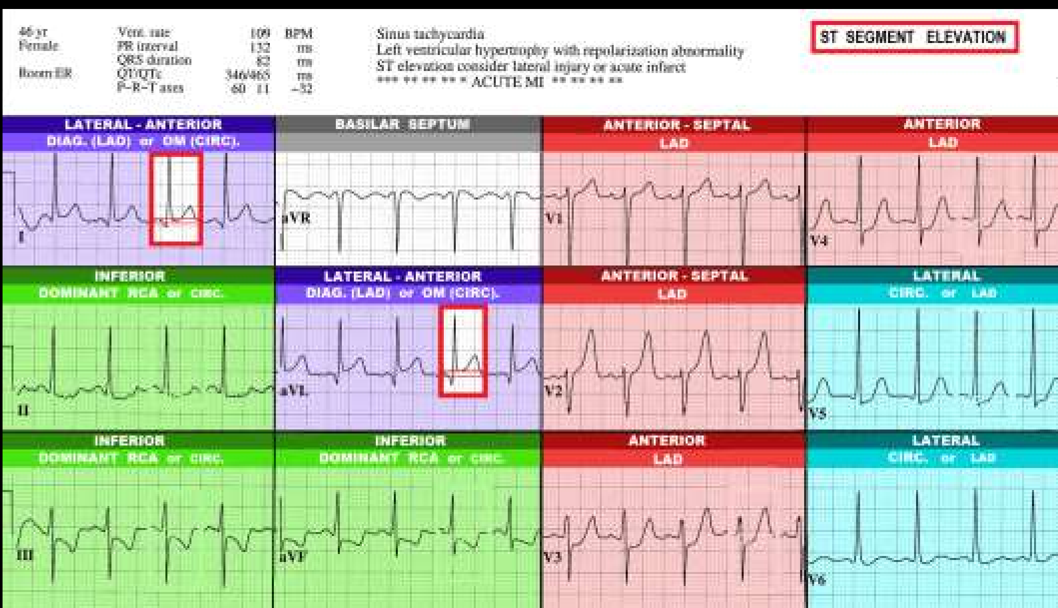
This patient’s ECG shows ST ↑ in V1 – V4 ***AND Leads I and aVL*** . . .

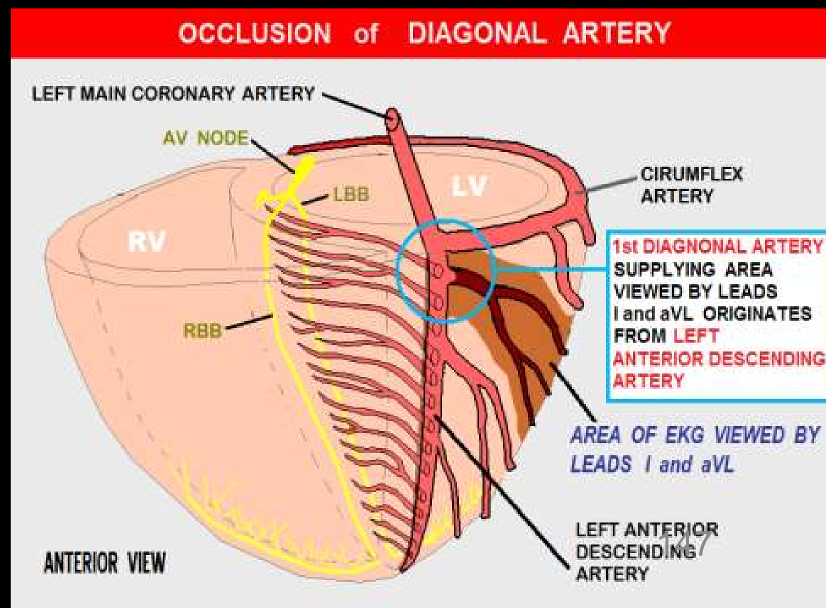
That means WE ADD THIS :



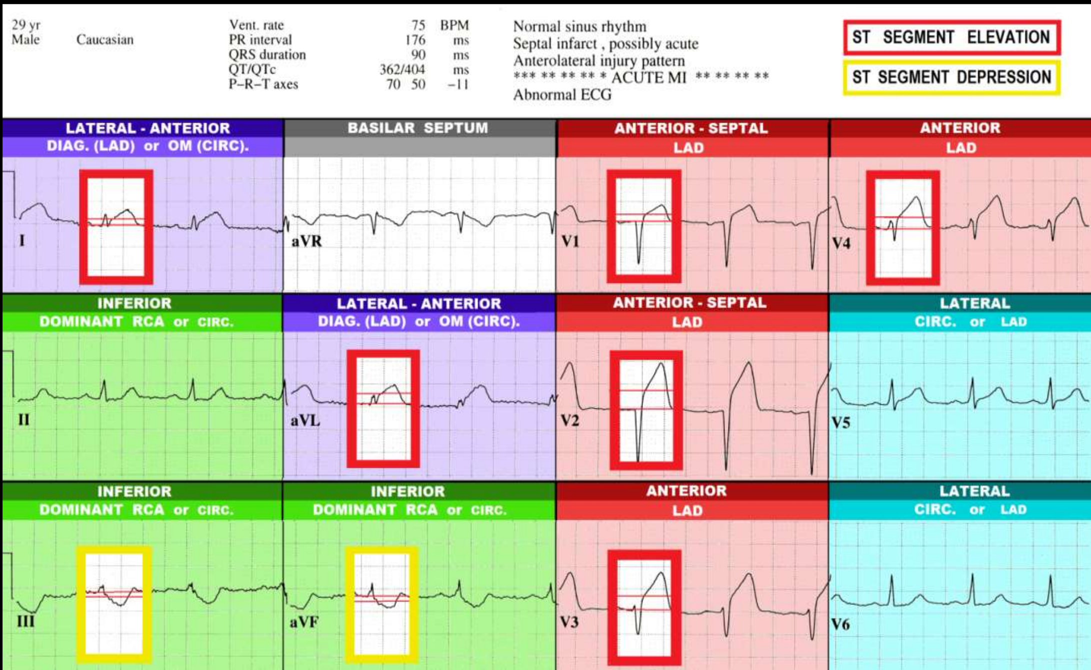


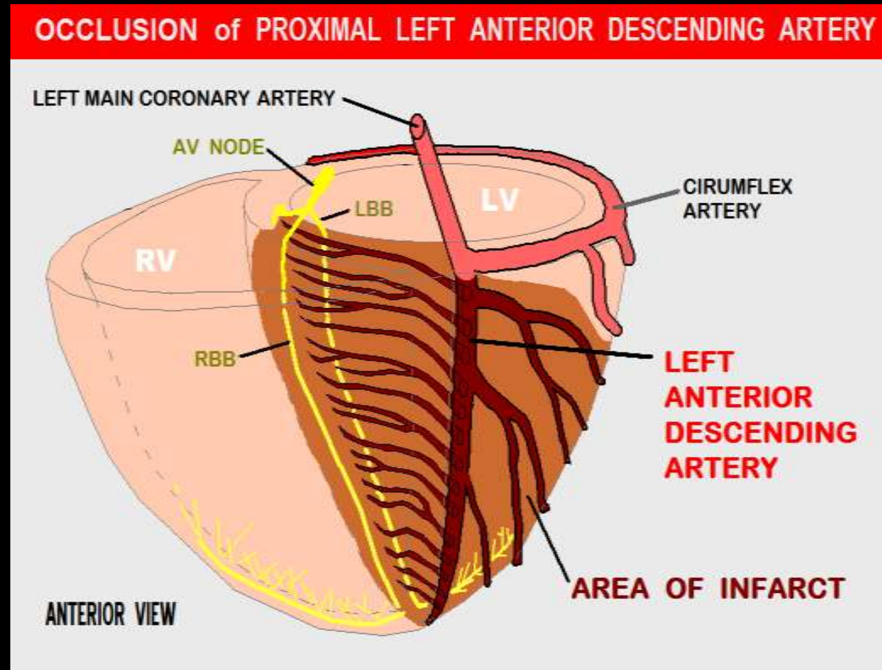
TO THIS :





AND WE GET THIS . . . .

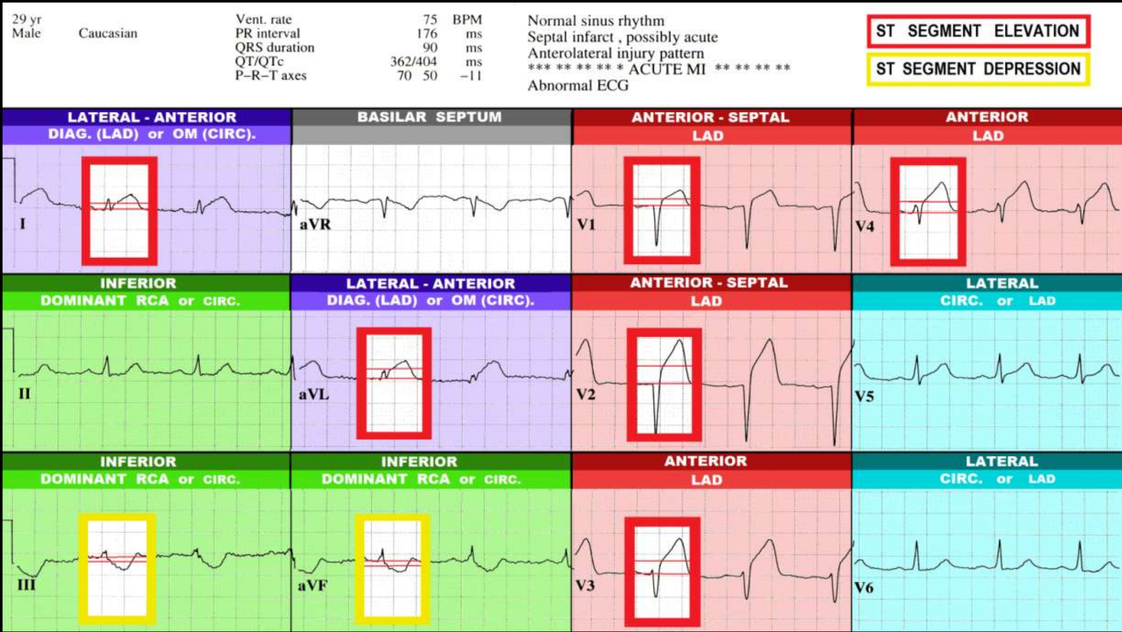




*Our patient just hit the **POWERBALL !***

[1] Use of the Electrocardiogram in Acute Myocardial Infarction,"

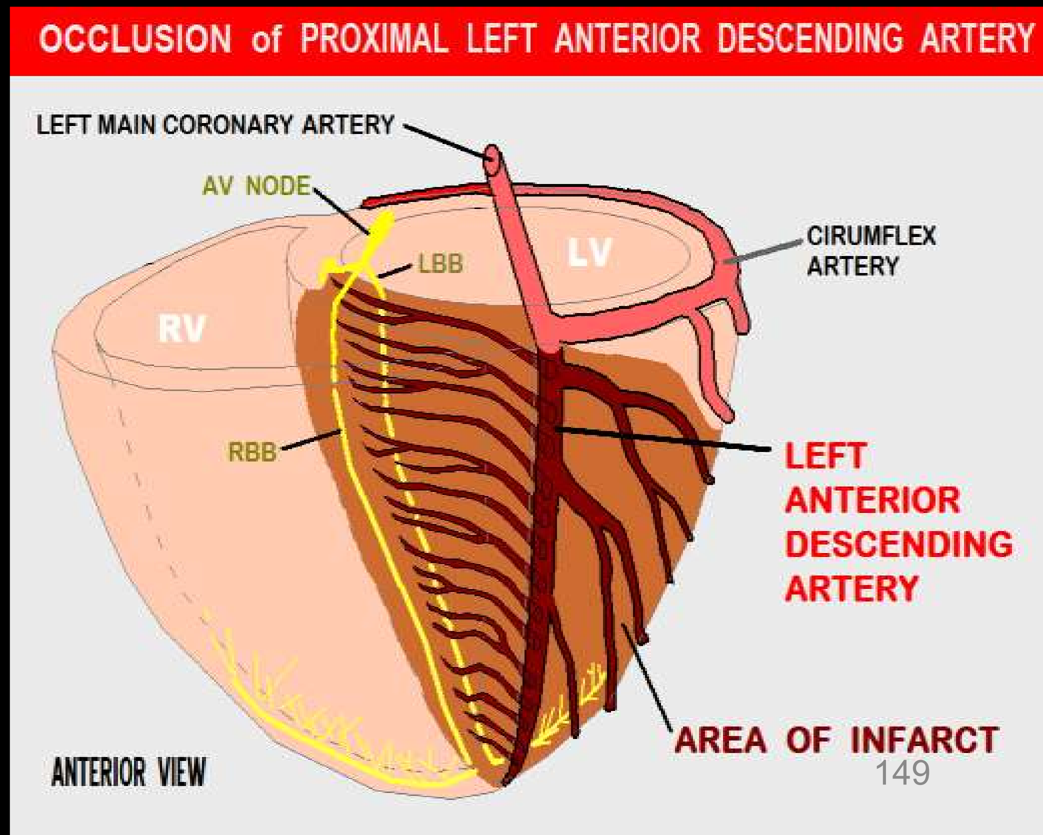
Zimetbaum, et al, NEJM 348:933-940

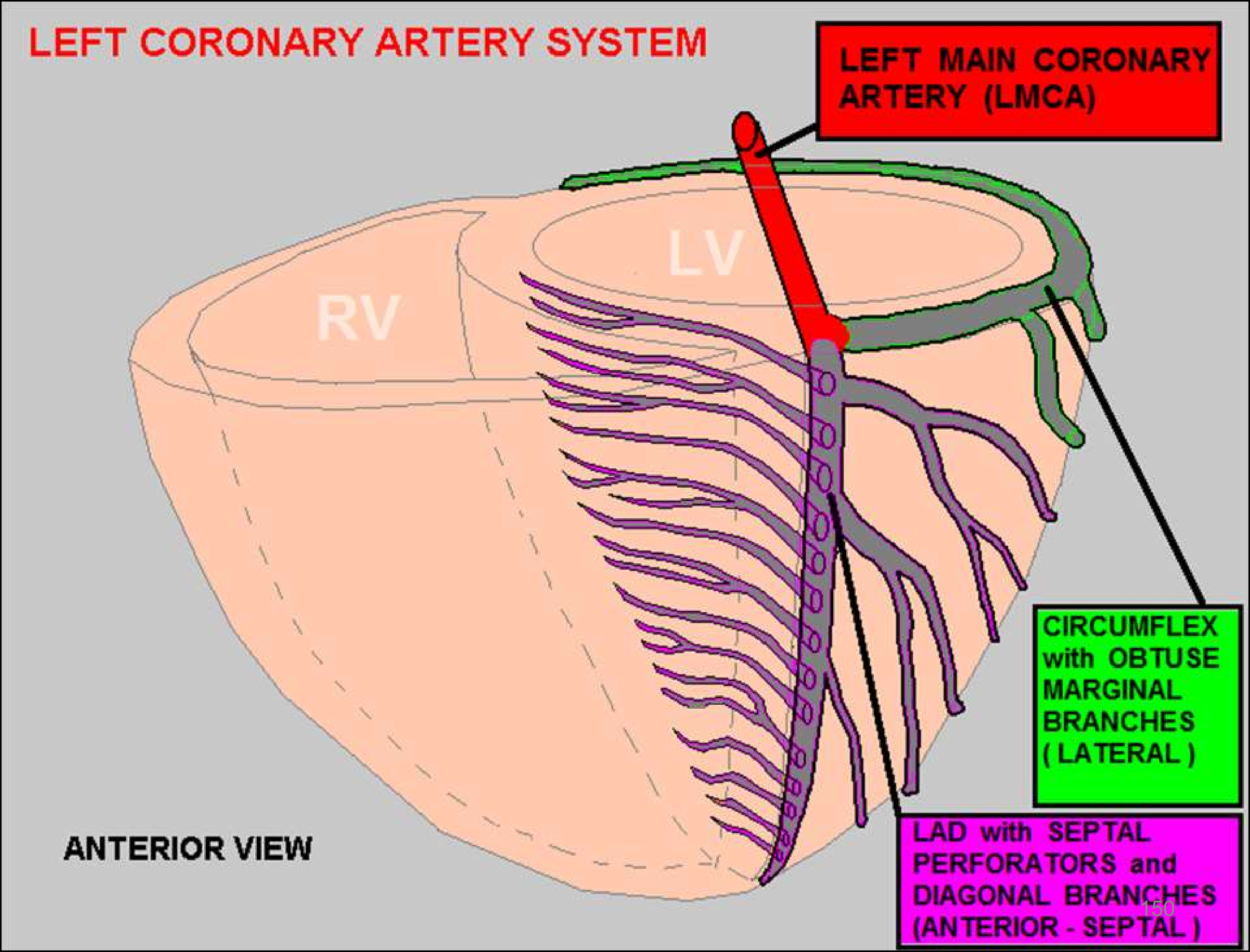


If you patient's ECG shows ST Elevation in Leads V1 – V4 & I and aVL . . .

The obstruction is usually located at in the PROXIMAL LAD, above the level of the 1st Diagonal Branch ! !

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

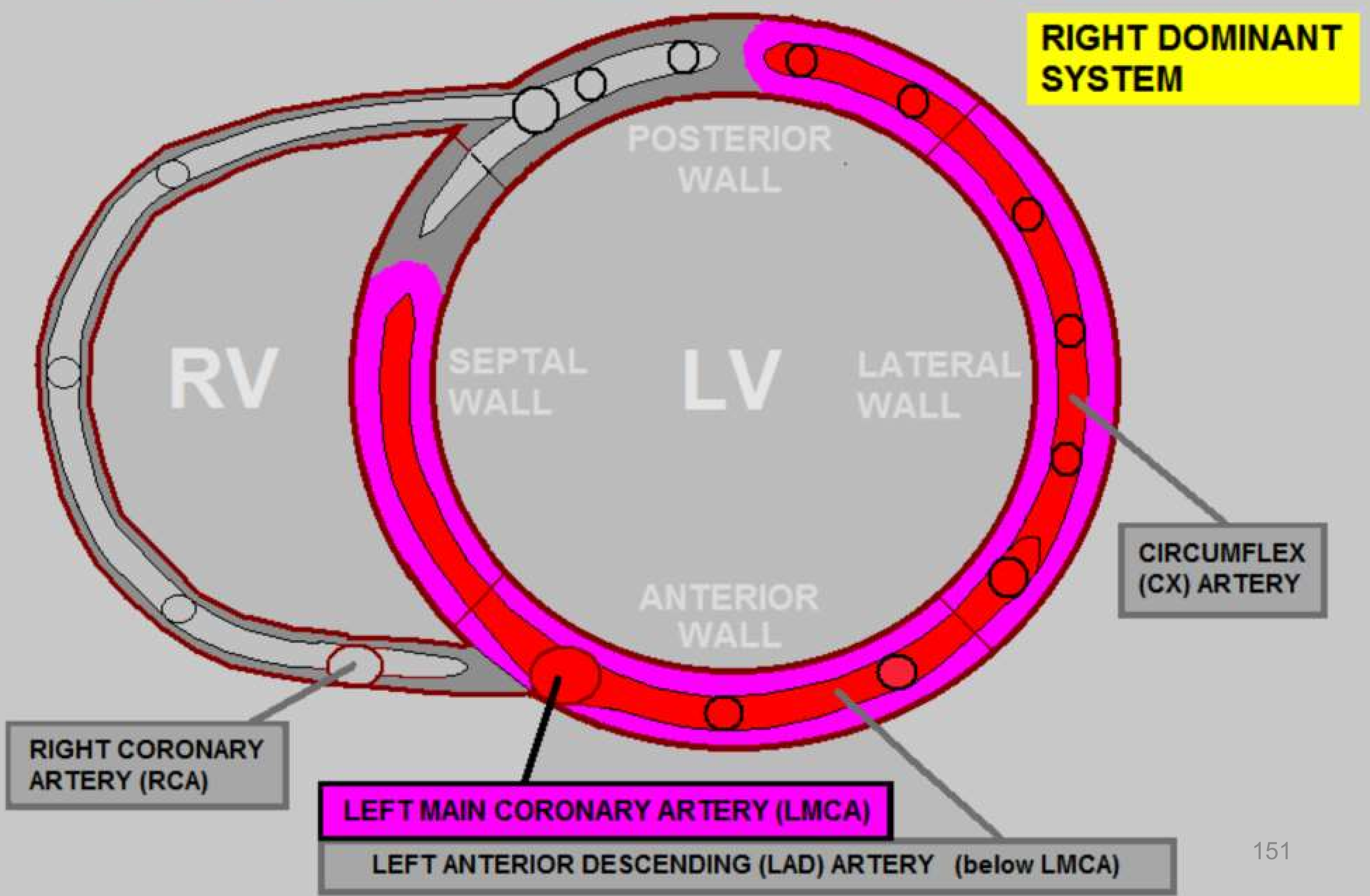



LEFT CORONARY ARTERY SYSTEM
LEFT MAIN CORONARY ARTERY (LMCA)
LV
RV
CIRCUMFLEX with OBTUSE MARGINAL BRANCHES (LATERAL)
LAD with SEPTAL PERFORATORS and DIAGONAL BRANCHES (ANTERIOR - SEPTAL)
ANTERIOR VIEW

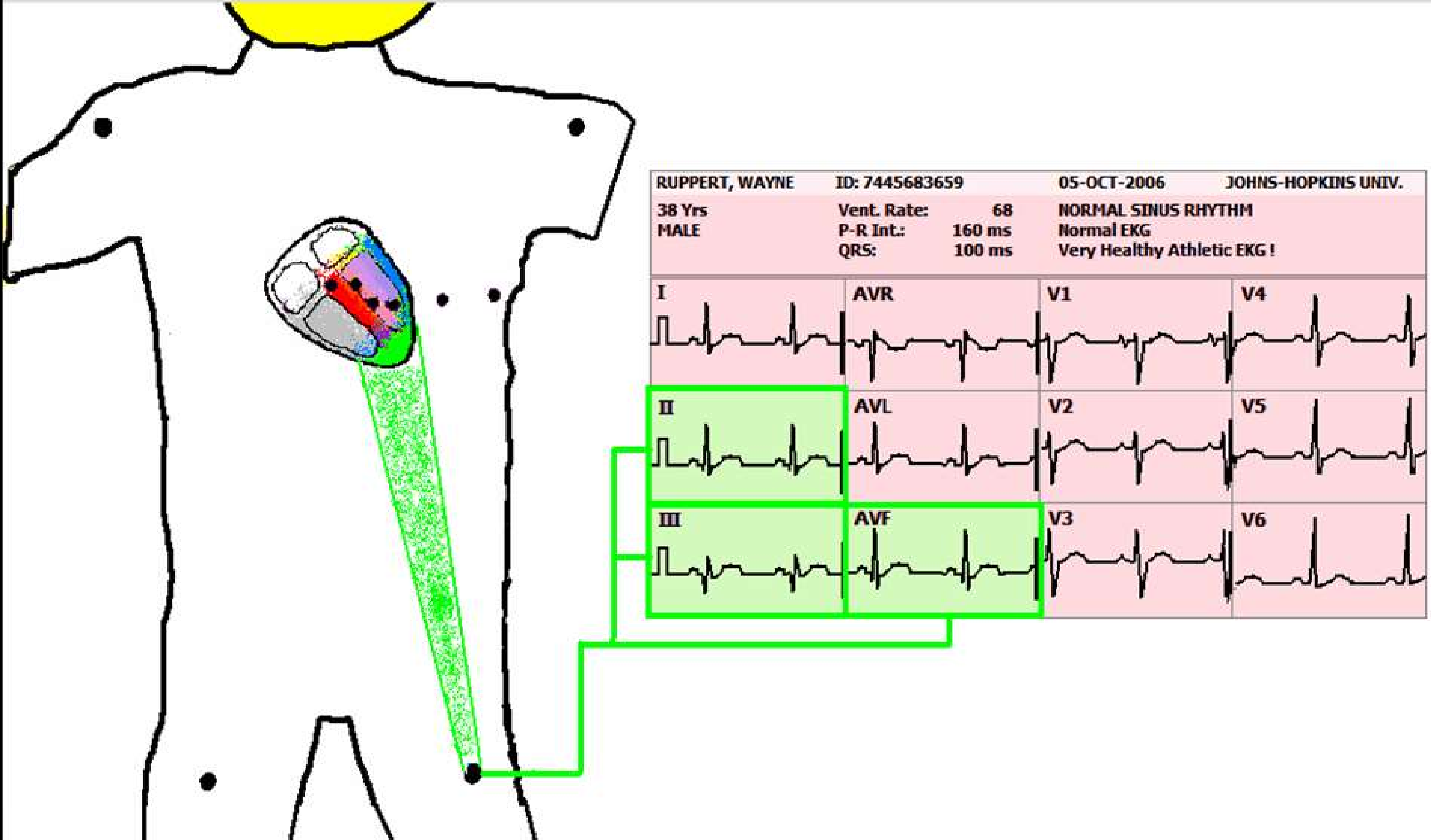
cutaway view of the

LEFT MAIN CORONARY ARTERY (LMCA)

☛ **SUPPLIES APPROXIMATELY 75% OF LV MUSCLE MASS**

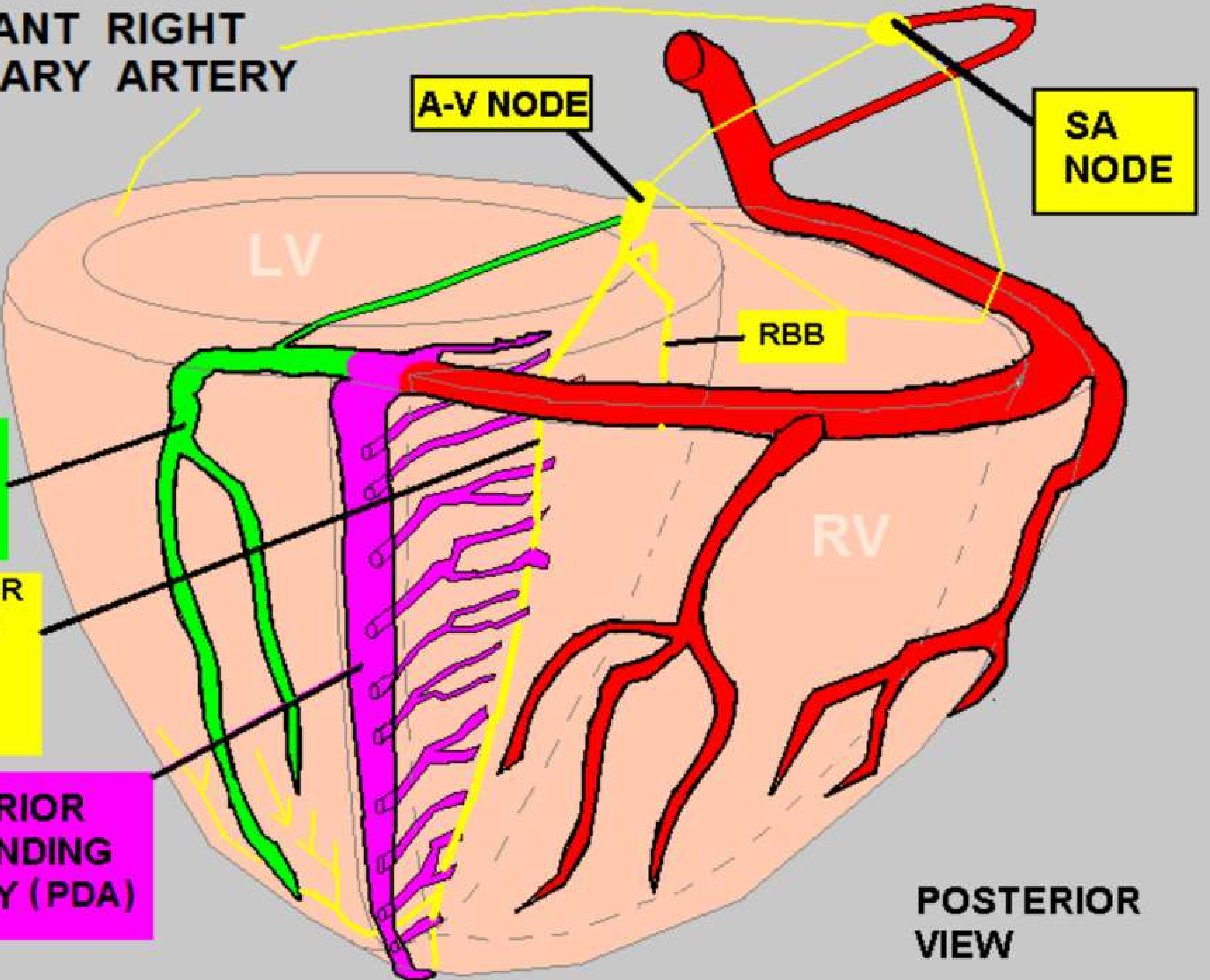


LEADS II, III, and aVF VIEW
INFERIOR WALL of the LEFT VENTRICLE



Which CORONARY ARTERY usually supplies the INFERIOR WALL ?

DOMINANT RIGHT CORONARY ARTERY



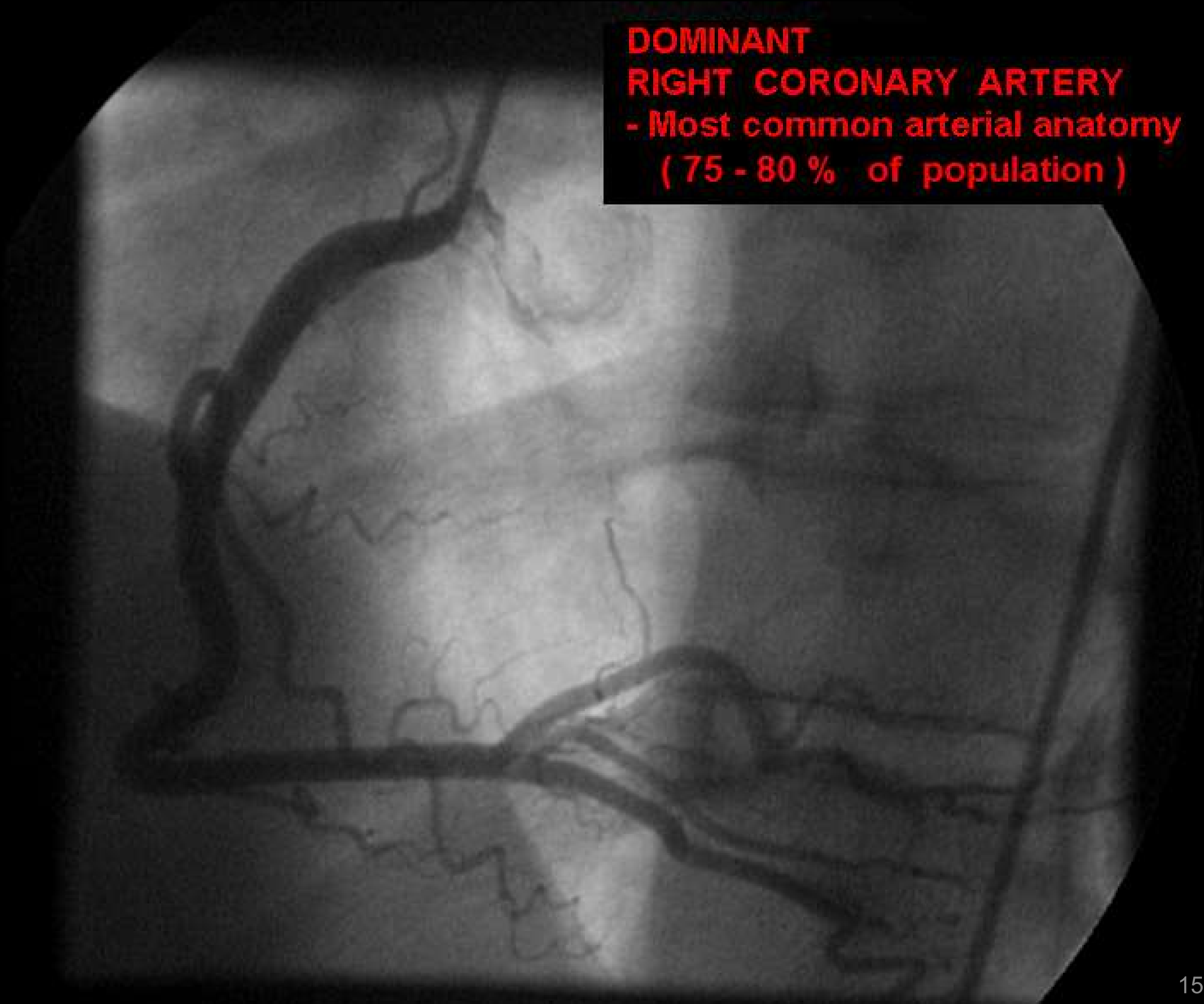
75 - 80% of the POPULATION HAVE THIS CORONARY ARTERY ANATOMY

HELPFUL HINT . . . MEMORIZE THIS !

RIGHT CORONARY ARTERY (RCA)

RIGHT DOMINANT SYSTEMS

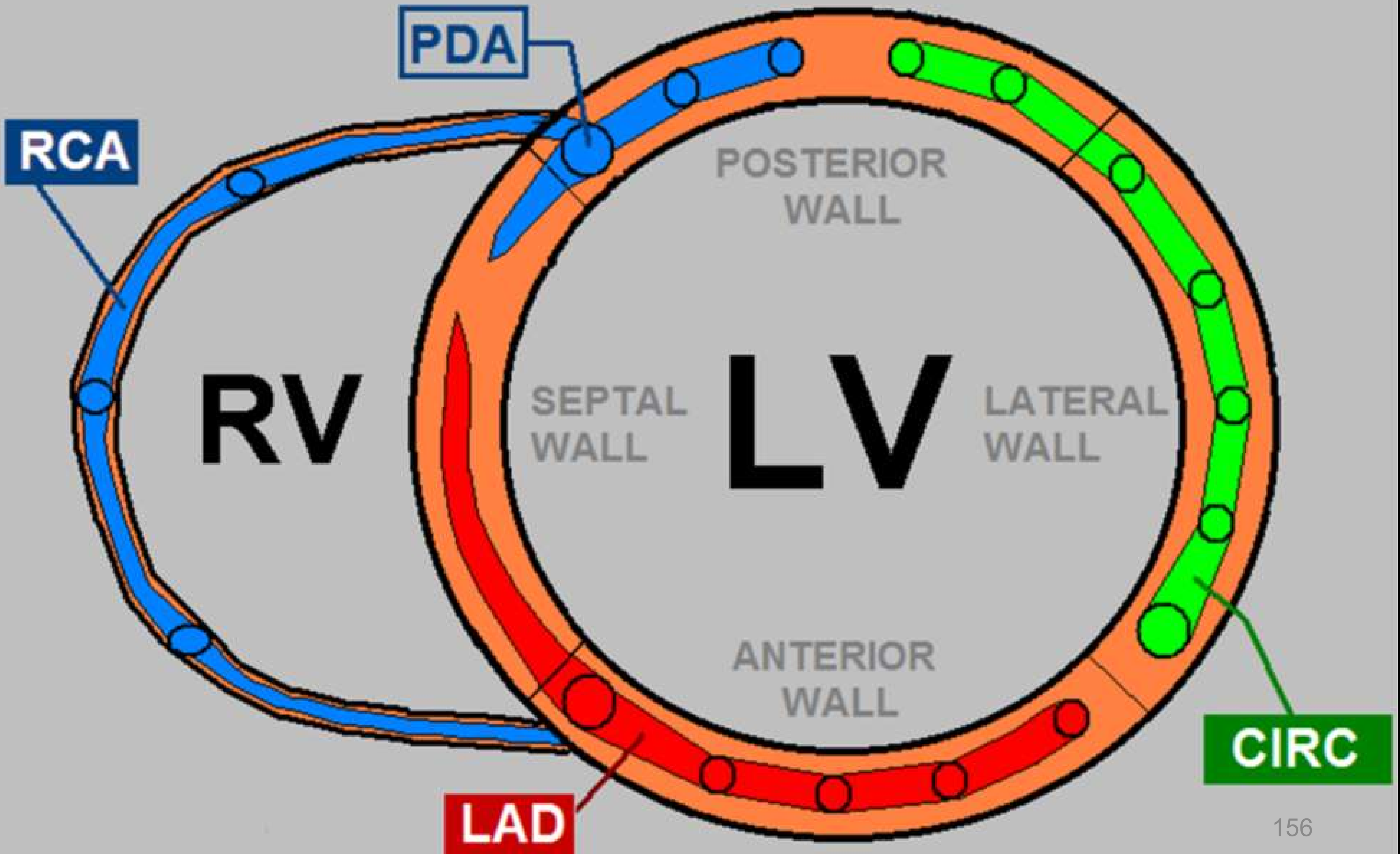
- RIGHT ATRIUM
- SINUS NODE (55% of the population)
- RIGHT VENTRICLE - 100 % of muscle mass
- LEFT VENTRICLE: 15 - 25 % of muscle mass
  - INFERIOR WALL
  - approx. 1/2 of POSTERIOR WALL
- AV NODE


DOMINANT
RIGHT CORONARY ARTERY
- Most common arterial anatomy
(75 - 80 % of population)

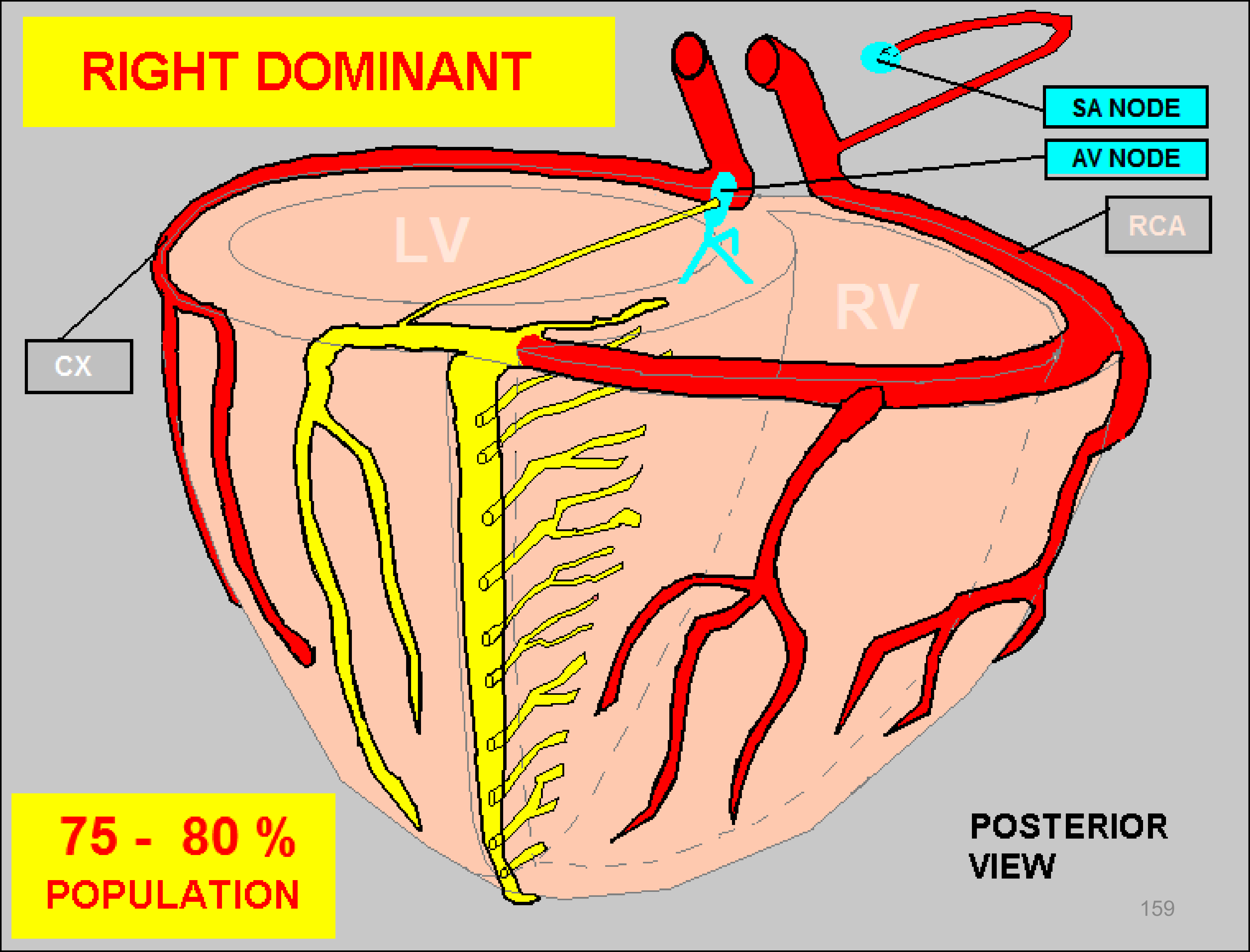
ARTERIAL DISTRIBUTION - MYOCARDIUM

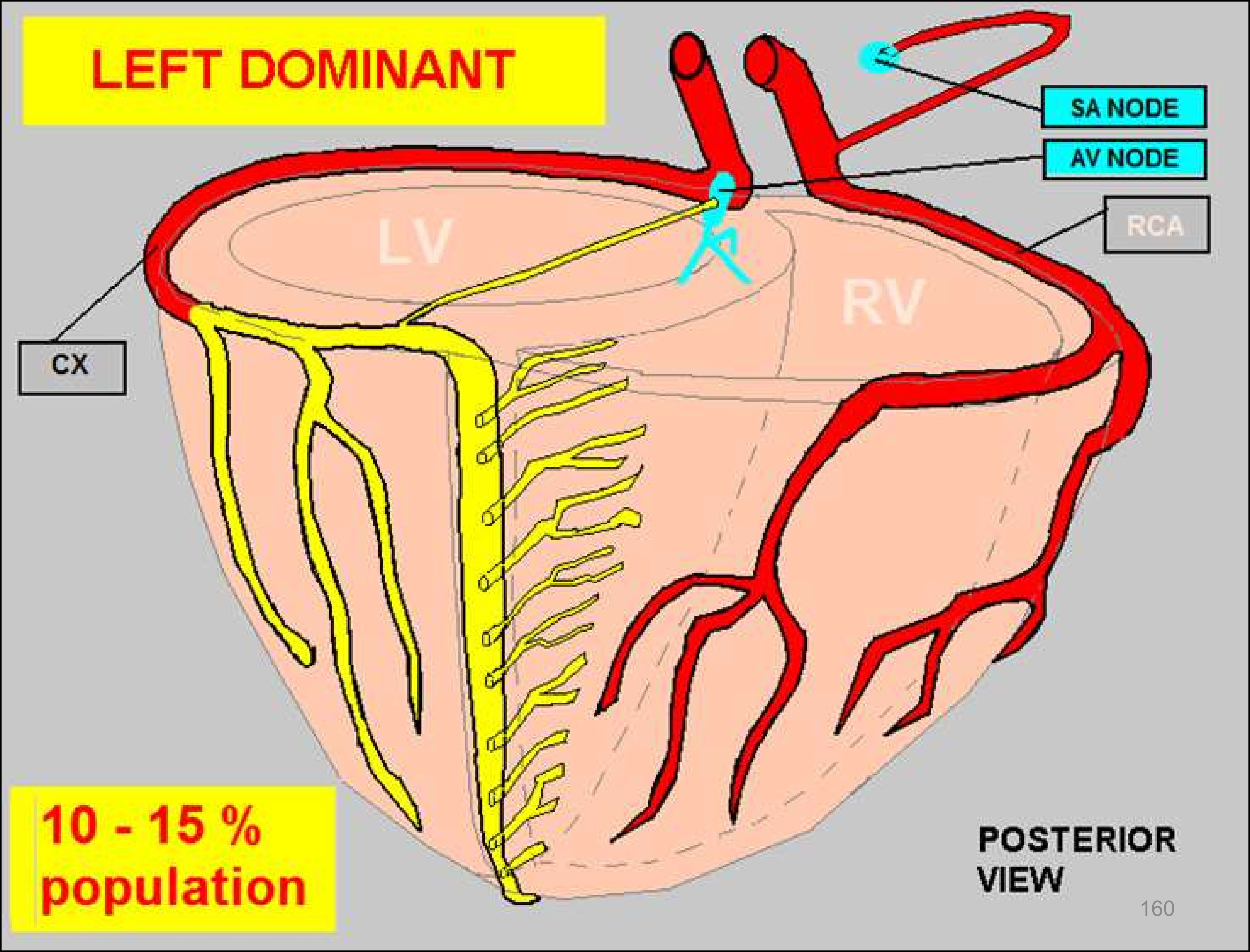
DOMINANT RCA

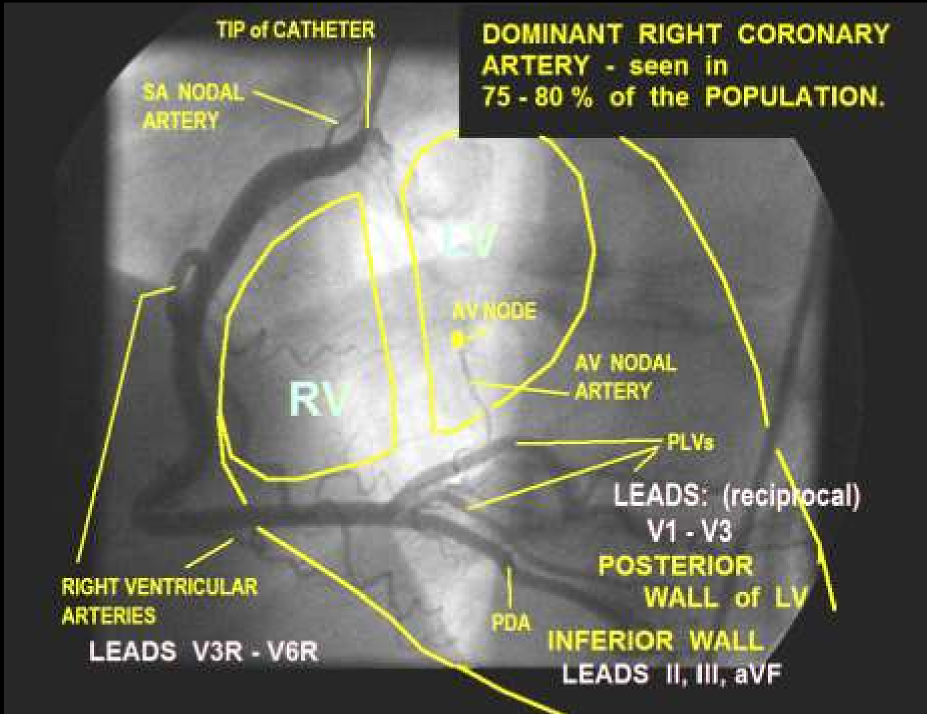
75-80 % of POPULATION

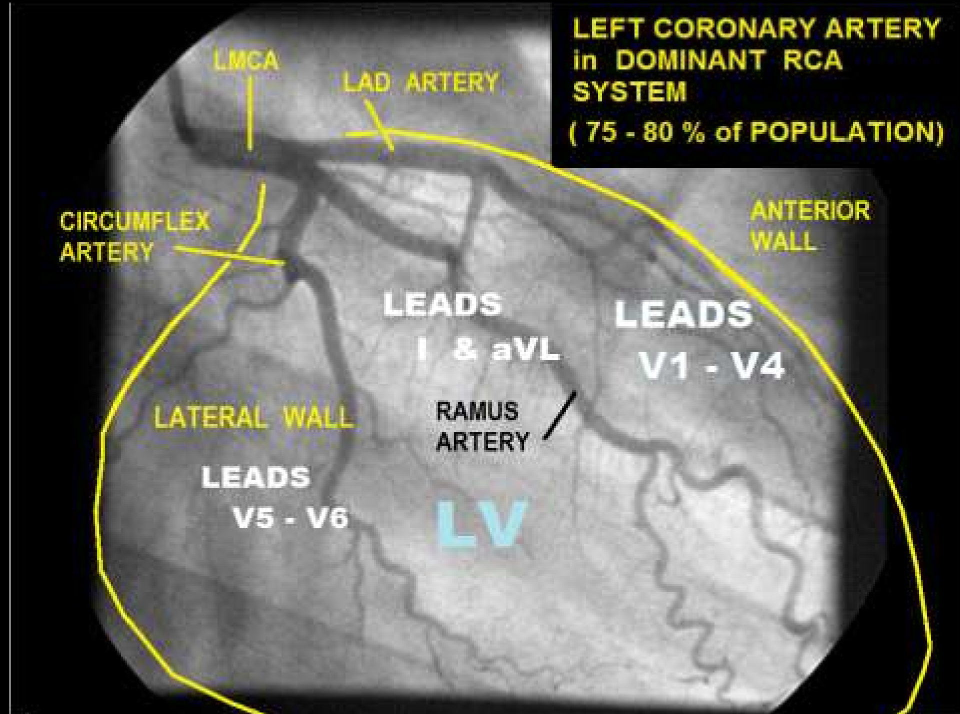


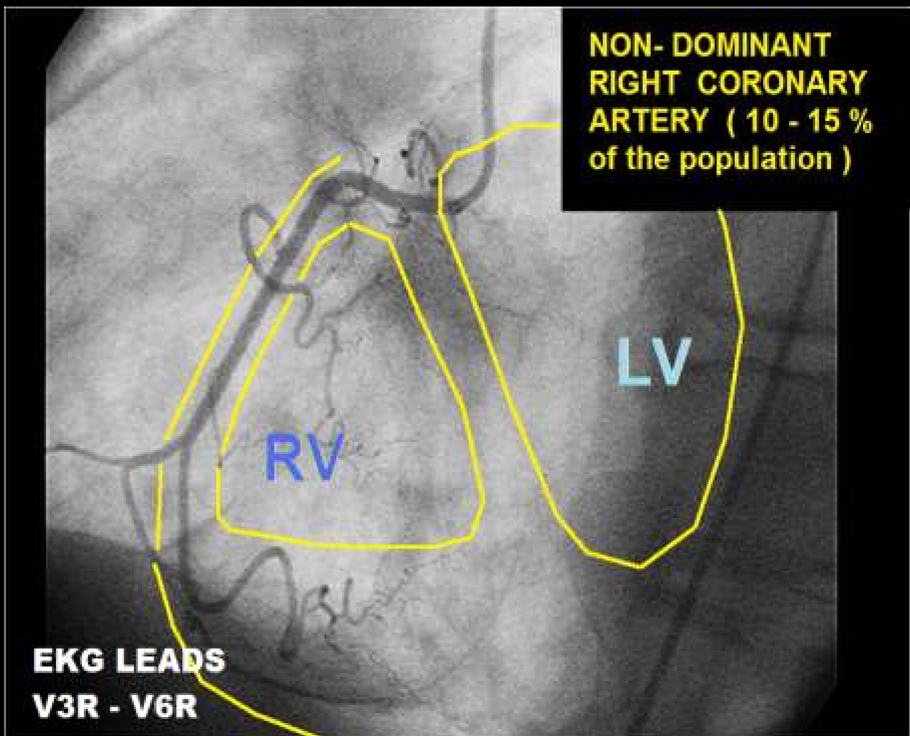
So if the Right Coronary Artery Is DOMINANT in 75 – 80% of the POPULATION, what accounts for the Other 20 – 25% ??

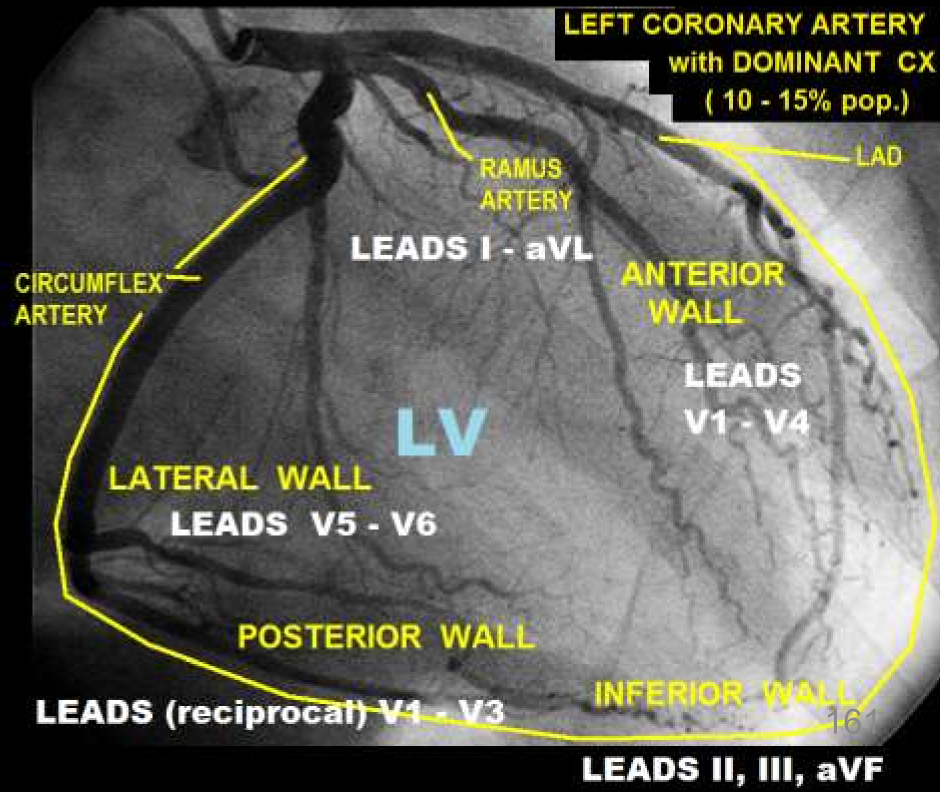

RIGHT DOMINANT
SA NODE
AV NODE
RCA
LV
RV
CX
75 - 80 %
POPULATION
POSTERIOR
VIEW

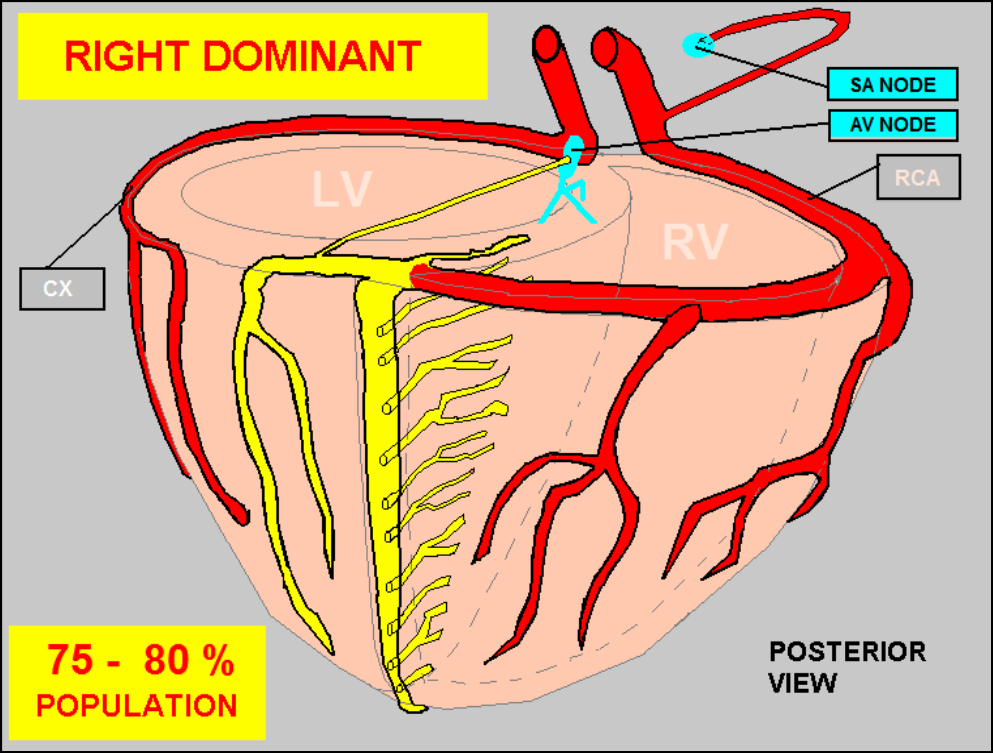

LEFT DOMINANT
SA NODE
AV NODE
RCA
LV
RV
CX
10 - 15 %
population
POSTERIOR
VIEW
160

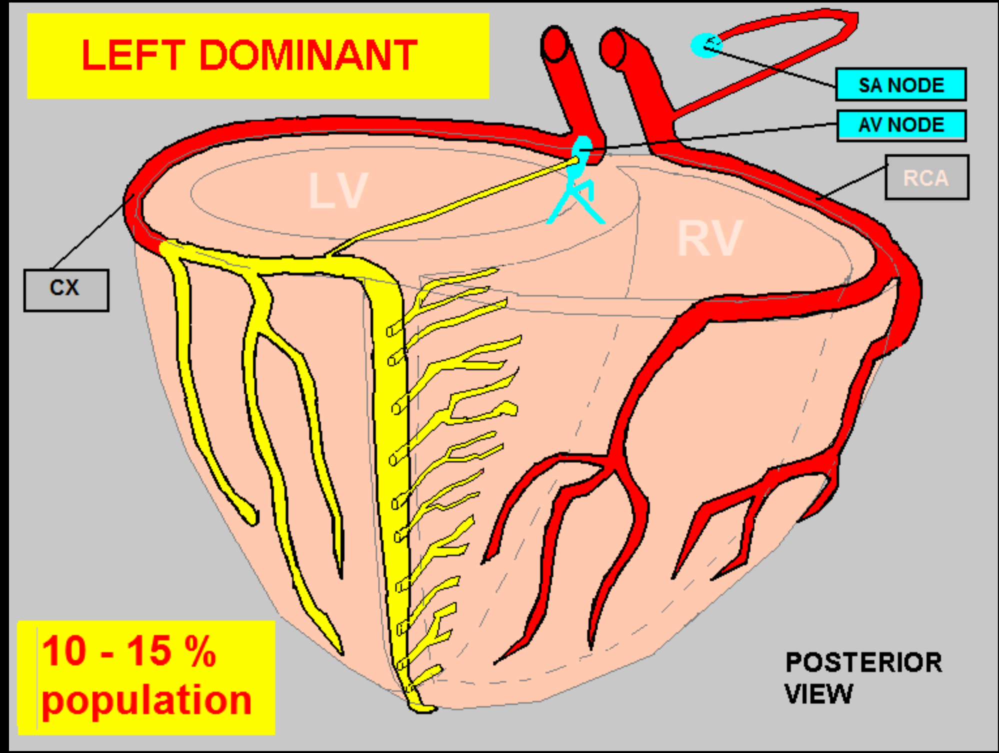

TIP of CATHETER
DOMINANT RIGHT CORONARY ARTERY - seen in 75 - 80 % of the POPULATION.
SA NODAL ARTERY
LV
AV NODE
RV
AV NODAL ARTERY
PLVs
LEADS: (reciprocal) V1 - V3
POSTERIOR WALL of LV
RIGHT VENTRICULAR ARTERIES
PDA
INFERIOR WALL
LEADS V3R - V6R
LEADS II, III, aVF

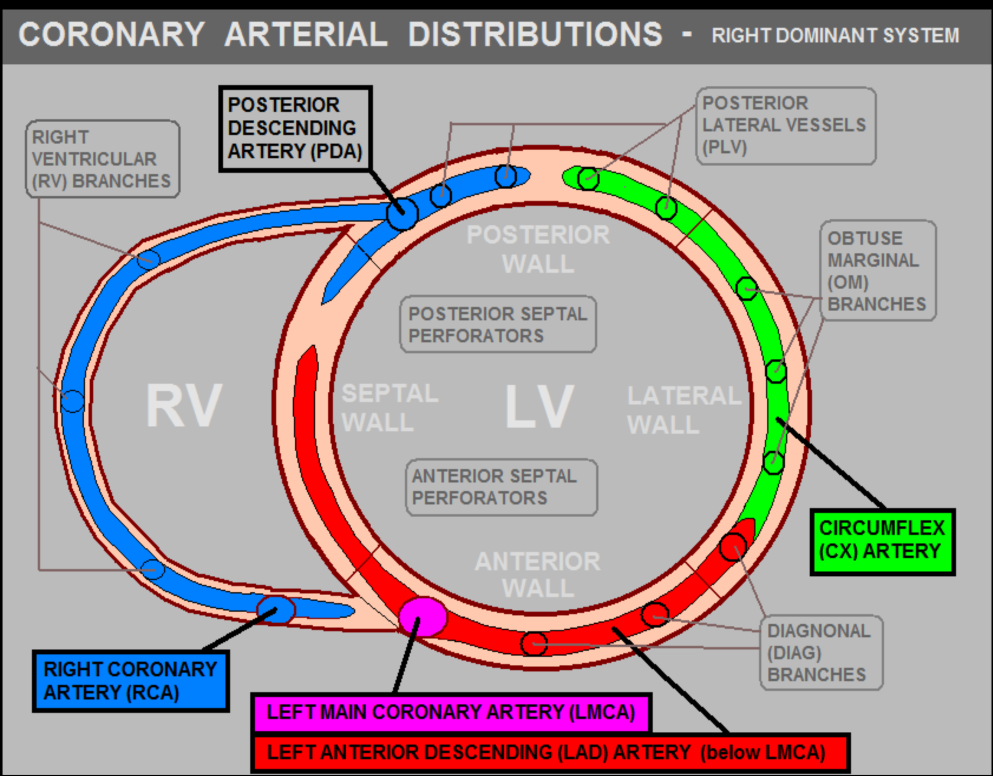

LMCA
LAD ARTERY
LEFT CORONARY ARTERY in DOMINANT RCA SYSTEM
(75 - 80 % of POPULATION)
CIRCUMFLEX ARTERY
ANTERIOR WALL
LEADS I & aVL
LEADS V1 - V4
LATERAL WALL
RAMUS ARTERY
LEADS V5 - V6
LV

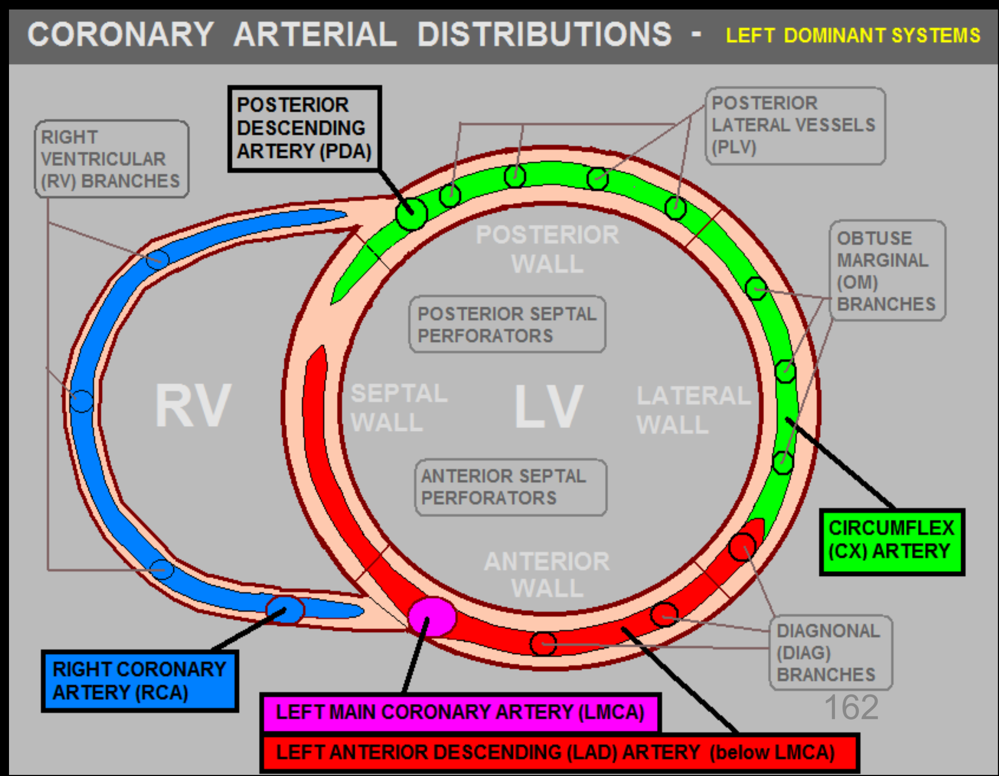

NON- DOMINANT RIGHT CORONARY ARTERY (10 - 15 % of the population)
LV
RV
EKG LEADS V3R - V6R


LEFT CORONARY ARTERY with DOMINANT CX (10 - 15% pop.)
LAD
RAMUS ARTERY
LEADS I - aVL
ANTERIOR WALL
CIRCUMFLEX ARTERY
LEADS V1 - V4
LV
LATERAL WALL
LEADS V5 - V6
POSTERIOR WALL
INFERIOR WALL
LEADS (reciprocal) V1 - V3
LEADS II, III, aVF


RIGHT DOMINANT
SA NODE
AV NODE
RCA
CX
LV
RV
75 - 80 %
POPULATION
POSTERIOR
VIEW


LEFT DOMINANT
SA NODE
AV NODE
RCA
CX
LV
RV
10 - 15 %
population
POSTERIOR
VIEW


CORONARY ARTERIAL DISTRIBUTIONS - RIGHT DOMINANT SYSTEM
RIGHT VENTRICULAR (RV) BRANCHES
POSTERIOR DESCENDING ARTERY (PDA)
POSTERIOR LATERAL VESSELS (PLV)
POSTERIOR WALL
OBTUSE MARGINAL (OM) BRANCHES
POSTERIOR SEPTAL PERFORATORS
RV
SEPTAL WALL
LV
LATERAL WALL
ANTERIOR SEPTAL PERFORATORS
CIRCUMFLEX (CX) ARTERY
ANTERIOR WALL
DIAGNONAL (DIAG) BRANCHES
RIGHT CORONARY ARTERY (RCA)
LEFT MAIN CORONARY ARTERY (LMCA)
LEFT ANTERIOR DESCENDING (LAD) ARTERY (below LMCA)


CORONARY ARTERIAL DISTRIBUTIONS - LEFT DOMINANT SYSTEMS
RIGHT VENTRICULAR (RV) BRANCHES
POSTERIOR DESCENDING ARTERY (PDA)
POSTERIOR LATERAL VESSELS (PLV)
POSTERIOR WALL
OBTUSE MARGINAL (OM) BRANCHES
POSTERIOR SEPTAL PERFORATORS
RV
SEPTAL WALL
LV
LATERAL WALL
ANTERIOR SEPTAL PERFORATORS
CIRCUMFLEX (CX) ARTERY
ANTERIOR WALL
DIAGNONAL (DIAG) BRANCHES
RIGHT CORONARY ARTERY (RCA)
LEFT MAIN CORONARY ARTERY (LMCA)
LEFT ANTERIOR DESCENDING (LAD) ARTERY (below LMCA)
162

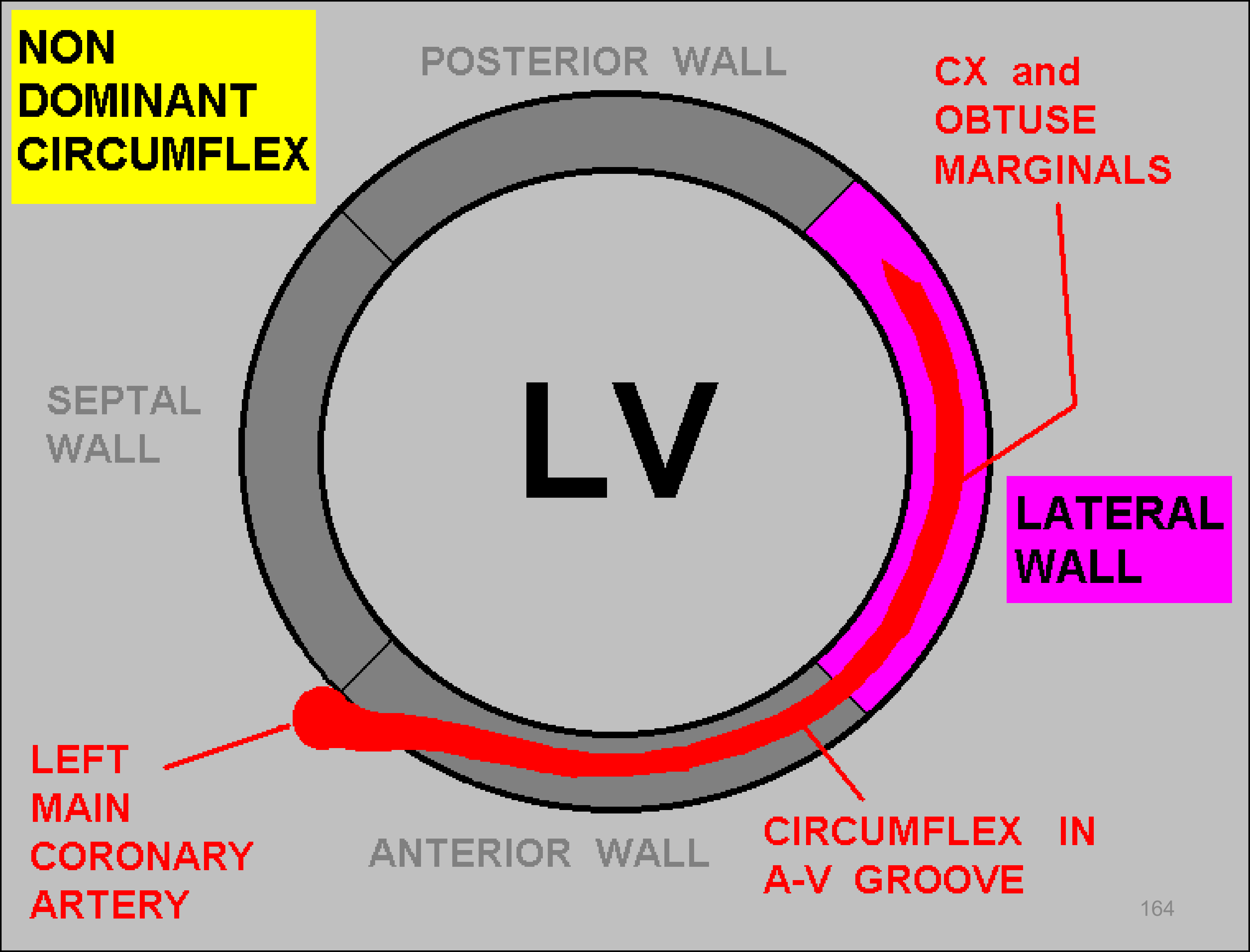
CIRCUMFLEX ARTERY (CX)

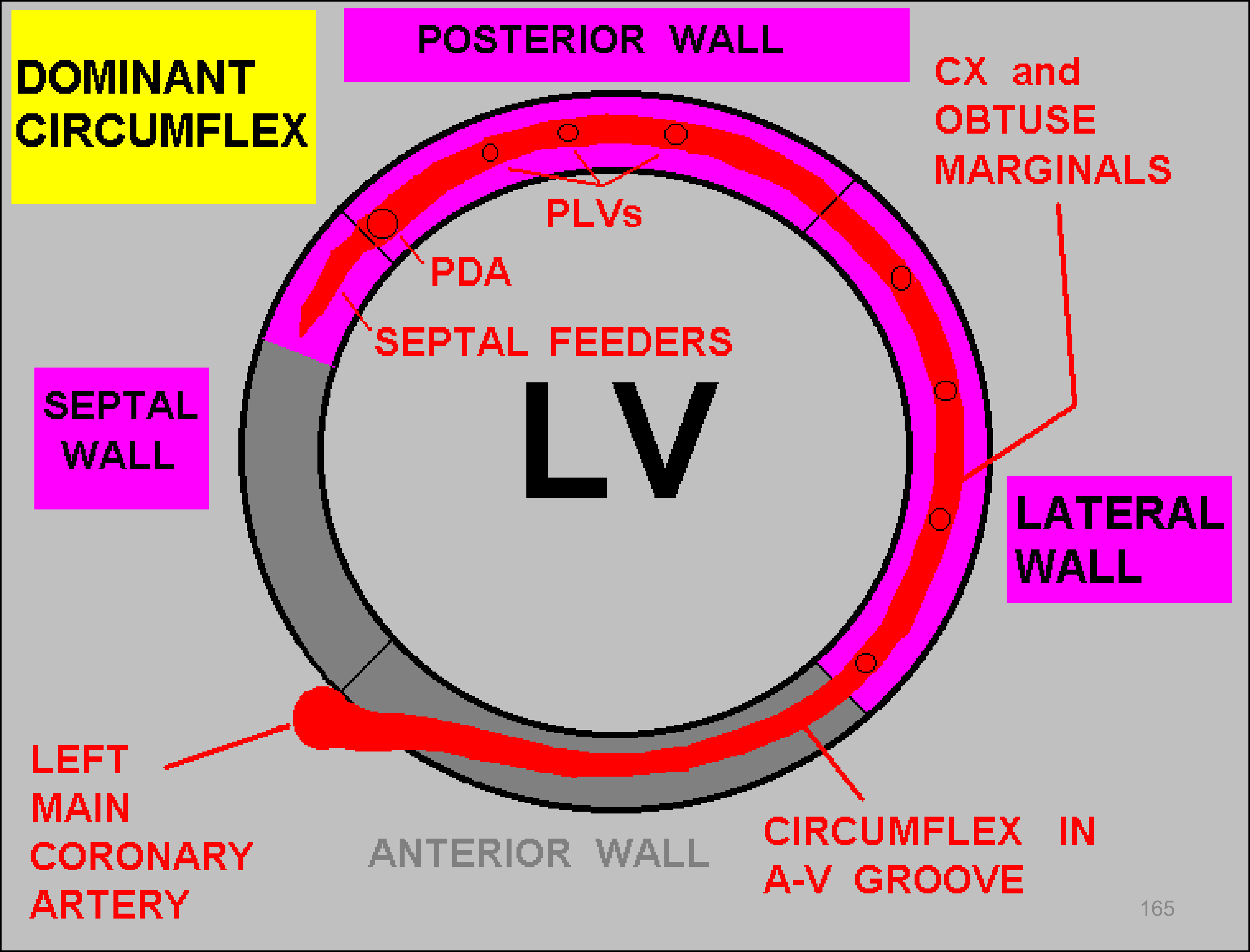
- NON-DOMINANT CX:

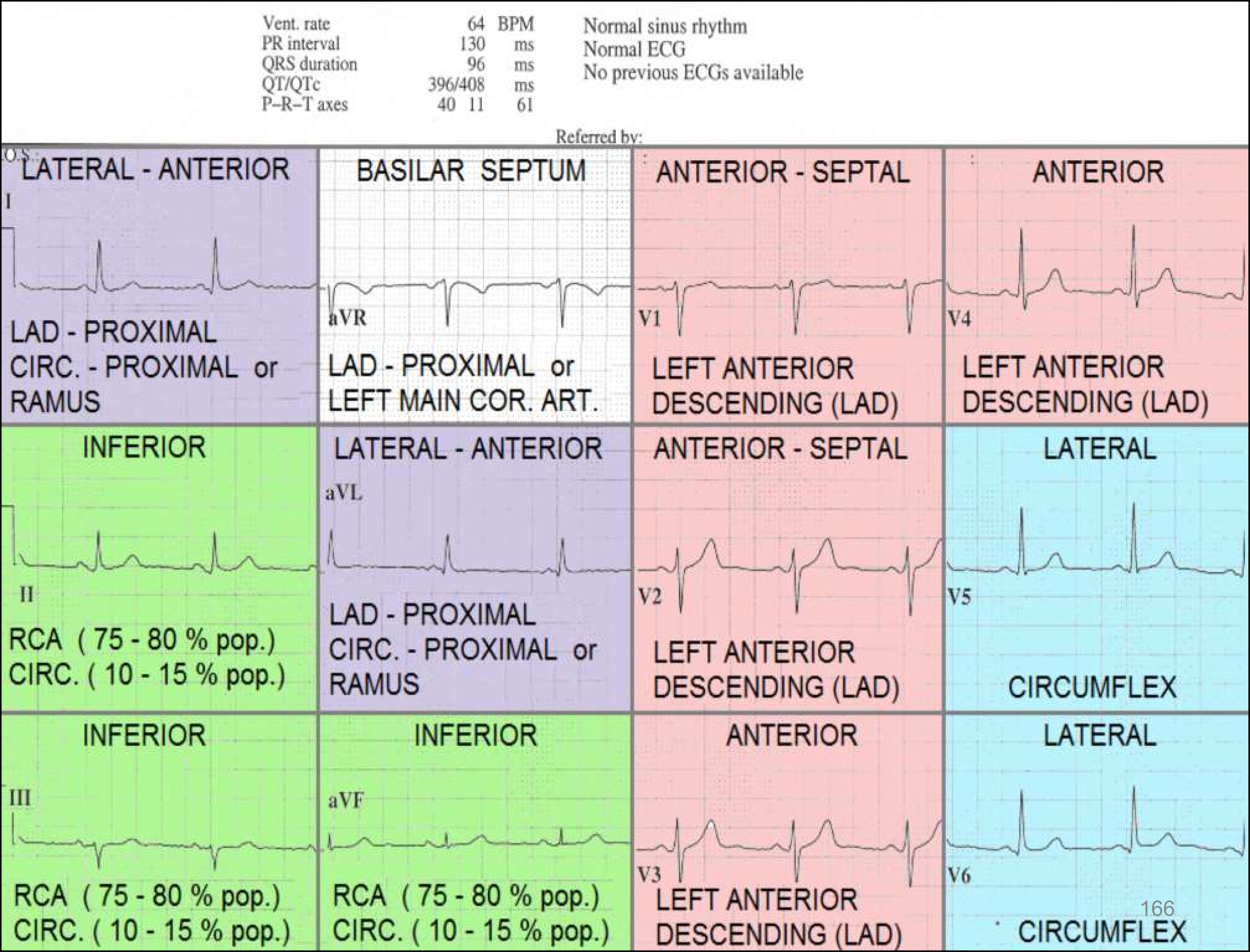
CX	=	15 - 30% OF LV MASS

- DOMINANT CX:

CX	=	15 - 30% OF LV MASS
+ PDA	=	15 - 25% OF LV MASS
TOTAL		30 - 55% OF LV MASS


NON DOMINANT CIRCUMFLEX
POSTERIOR WALL
CX and OBTUSE MARGINALS
SEPTAL WALL
LV
LATERAL WALL
LEFT MAIN CORONARY ARTERY
ANTERIOR WALL
CIRCUMFLEX IN A-V GROOVE


DOMINANT
CIRCUMFLEX
POSTERIOR WALL
CX and
OBTUSE
MARGINALS
PLVs
PDA
SEPTAL FEEDERS
LV
SEPTAL
WALL
LATERAL
WALL
LEFT
MAIN
CORONARY
ARTERY
ANTERIOR WALL
CIRCUMFLEX IN
A-V GROOVE


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:
LATERAL - ANTERIOR
I
LAD - PROXIMAL
CIRC. - PROXIMAL or
RAMUS
BASILAR SEPTUM
aVR
LAD - PROXIMAL or
LEFT MAIN COR. ART.
ANTERIOR - SEPTAL
V1
LEFT ANTERIOR
DESCENDING (LAD)
ANTERIOR
V4
LEFT ANTERIOR
DESCENDING (LAD)
INFERIOR
II
RCA (75 - 80 % pop.)
CIRC. (10 - 15 % pop.)
LATERAL - ANTERIOR
aVL
LAD - PROXIMAL
CIRC. - PROXIMAL or
RAMUS
ANTERIOR - SEPTAL
V2
LEFT ANTERIOR
DESCENDING (LAD)
LATERAL
V5
CIRCUMFLEX
INFERIOR
III
RCA (75 - 80 % pop.)
CIRC. (10 - 15 % pop.)
INFERIOR
aVF
RCA (75 - 80 % pop.)
CIRC. (10 - 15 % pop.)
ANTERIOR
V3
LEFT ANTERIOR
DESCENDING (LAD)
LATERAL
V6
CIRCUMFLEX

A standard

12 LEAD EKG

Does NOT show the

RIGHT VENTRICLE

To see the

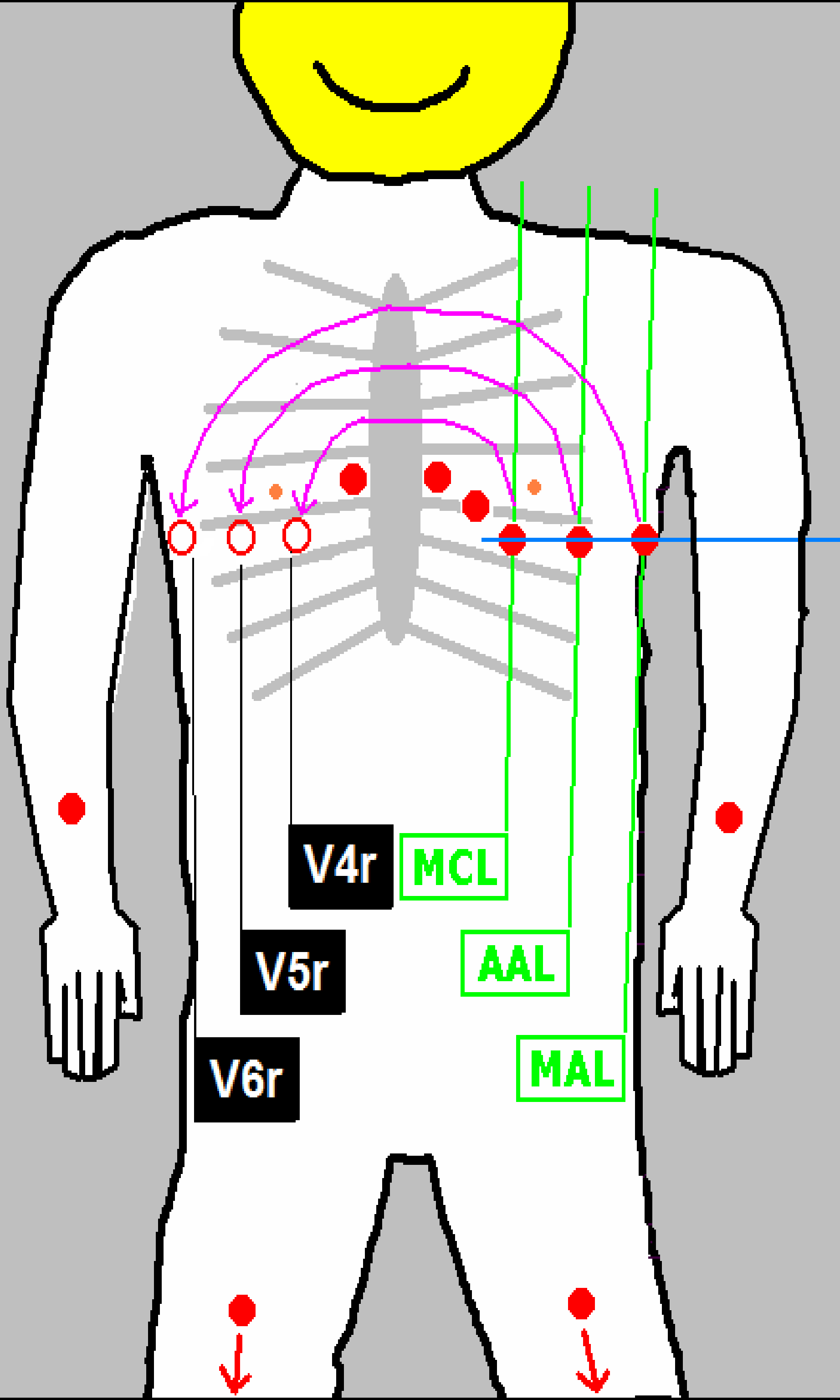
RIGHT VENTRICLE . . .

. . . such as in cases of

INFERIOR WALL M.I.

☞ You must do a

RIGHT - SIDED EKG ! !



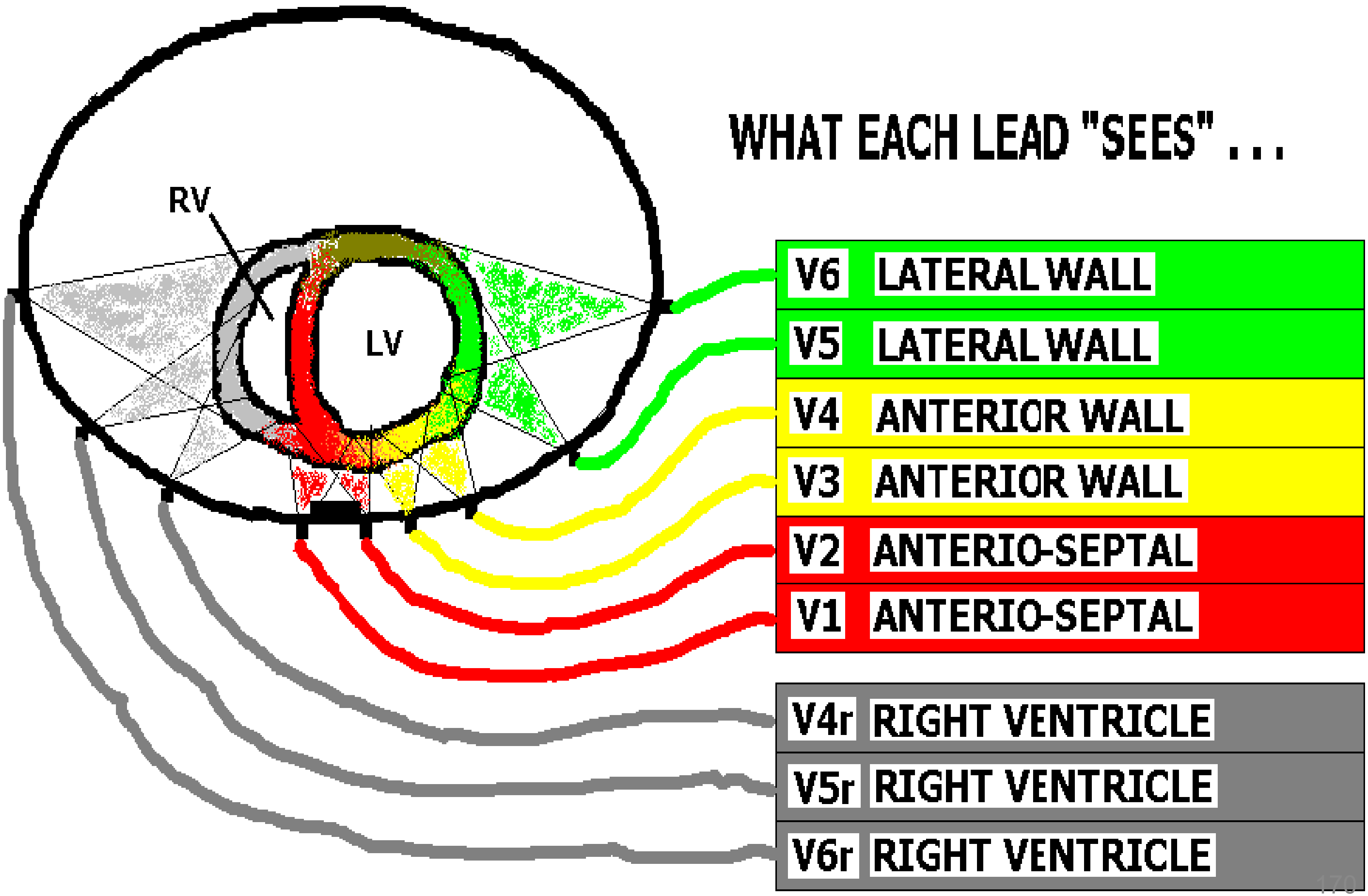
To do a
RIGHT - SIDED EKG . .

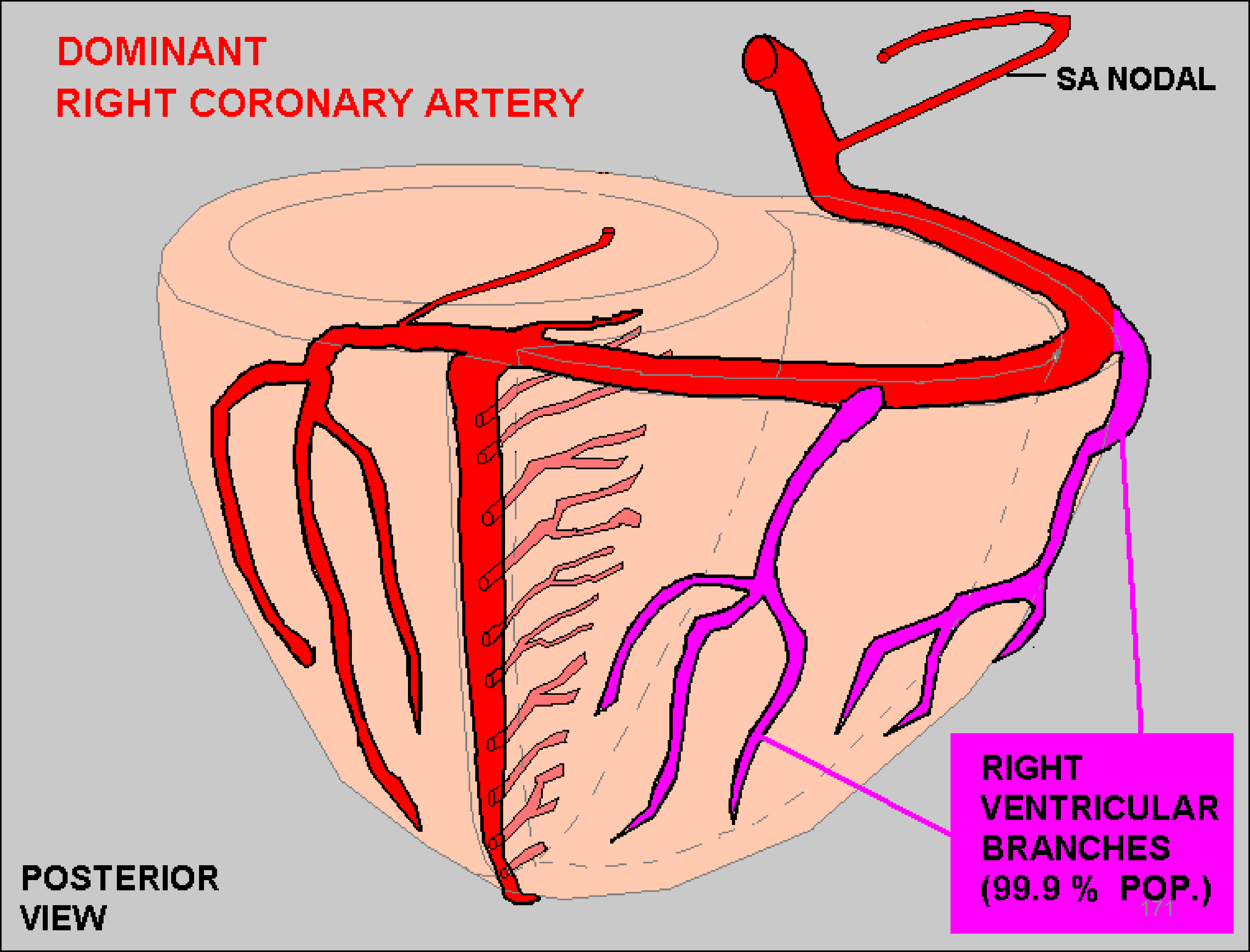
MOVE leads
V4, V5, and V6

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

THE V - LEADS

WHAT EACH LEAD "SEES" . . .




DOMINANT
RIGHT CORONARY ARTERY
SA NODAL
RIGHT VENTRICULAR BRANCHES (99.9 % POP.)
POSTERIOR VIEW

ID:

46 yo

Male Caucasian

Room:

Opt:

Technician:

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

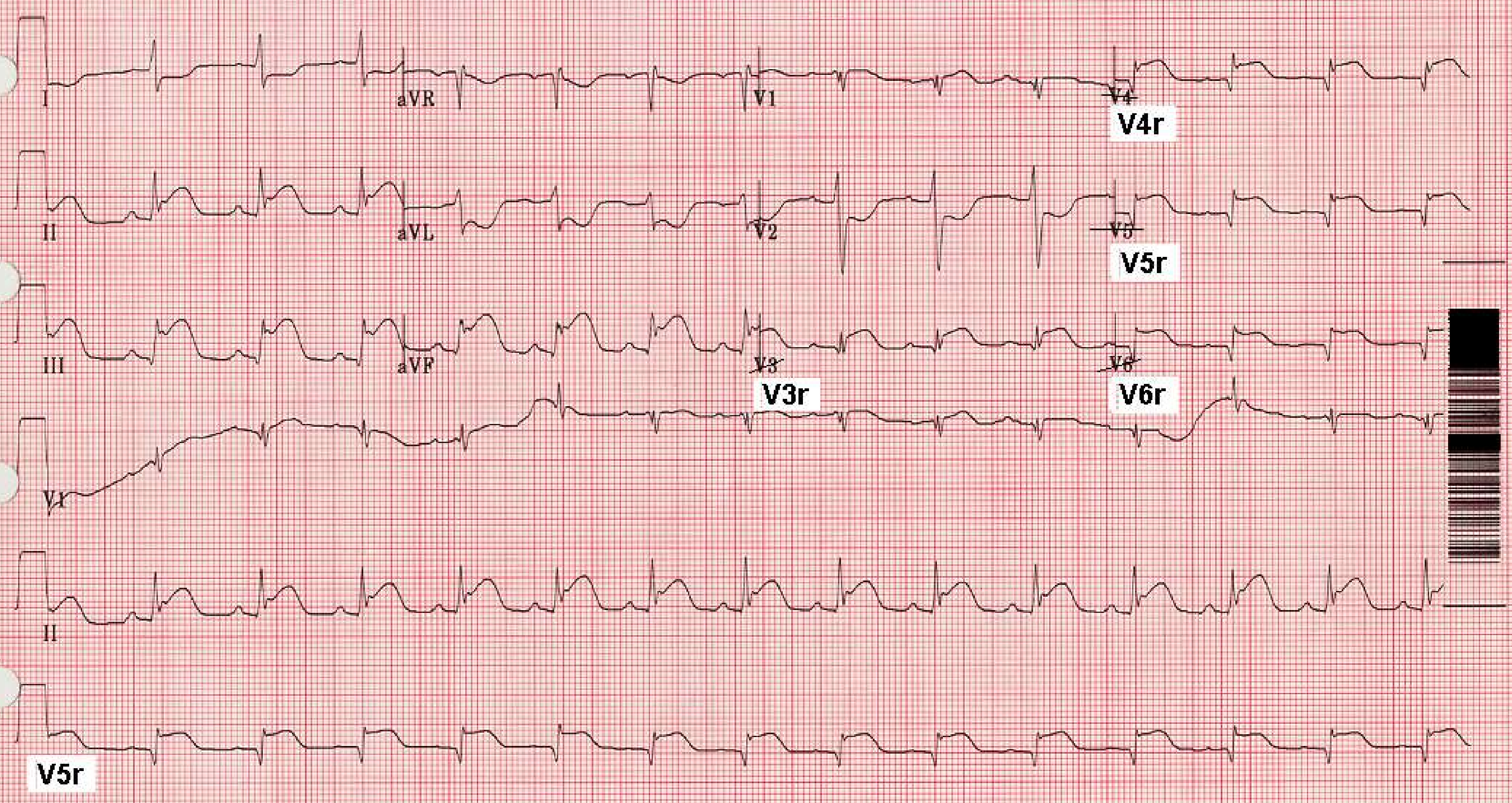
Normal sinus rhythm
~~Anterolateral infarct, possibly acute~~
Inferior injury pattern
** ** ** ** * Acute MI * ** ** ** **
Abnormal ECG

Right Ventricular Infarct

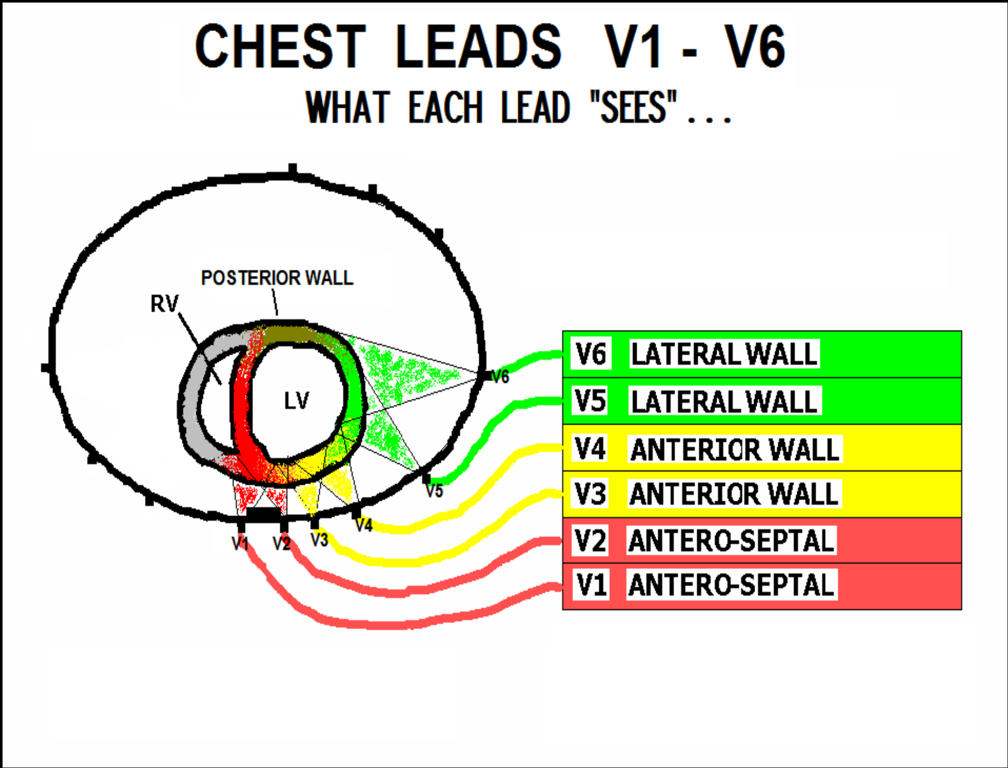
V LEADS
R SIDE

Referred by:

Unconfirmed

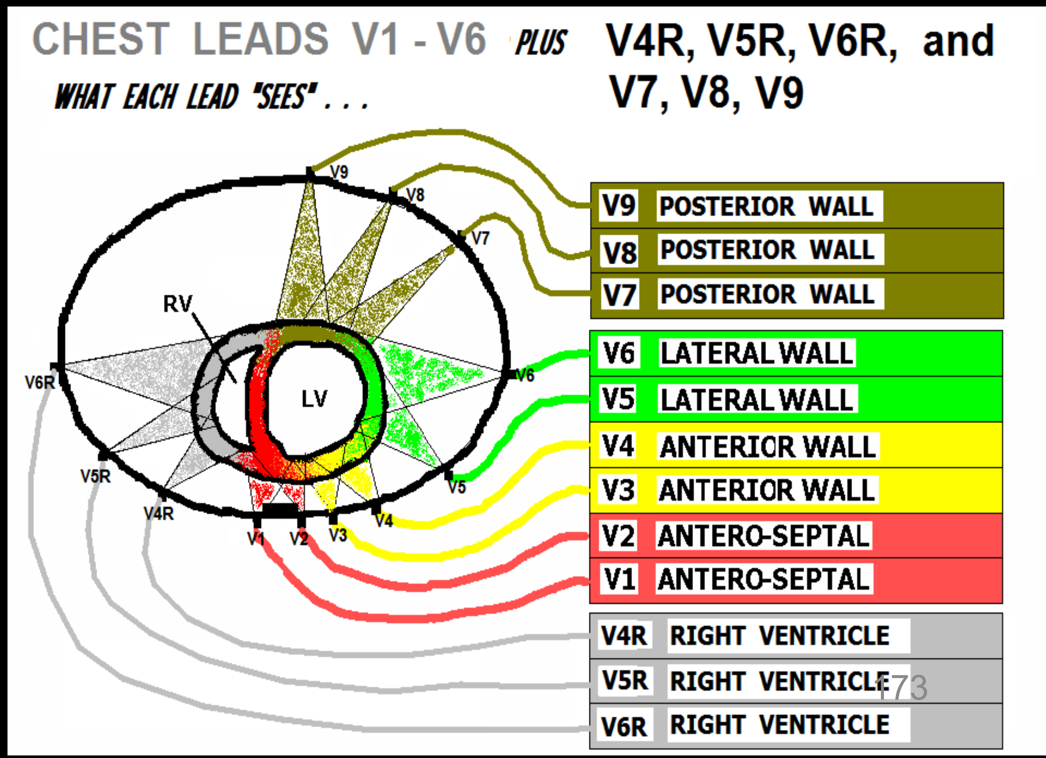


40 Hz 25.0 mm/s 10.0 mm/mV 4 by 2.5s + 3 rhythm lds MACVU 003C 12SL™ v250

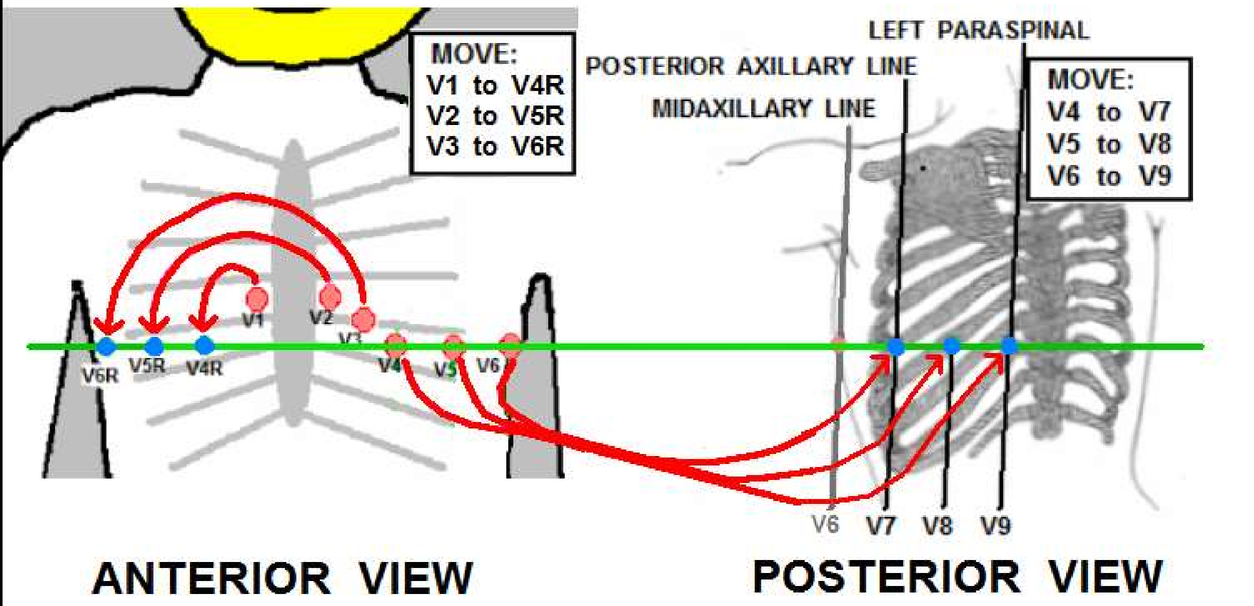


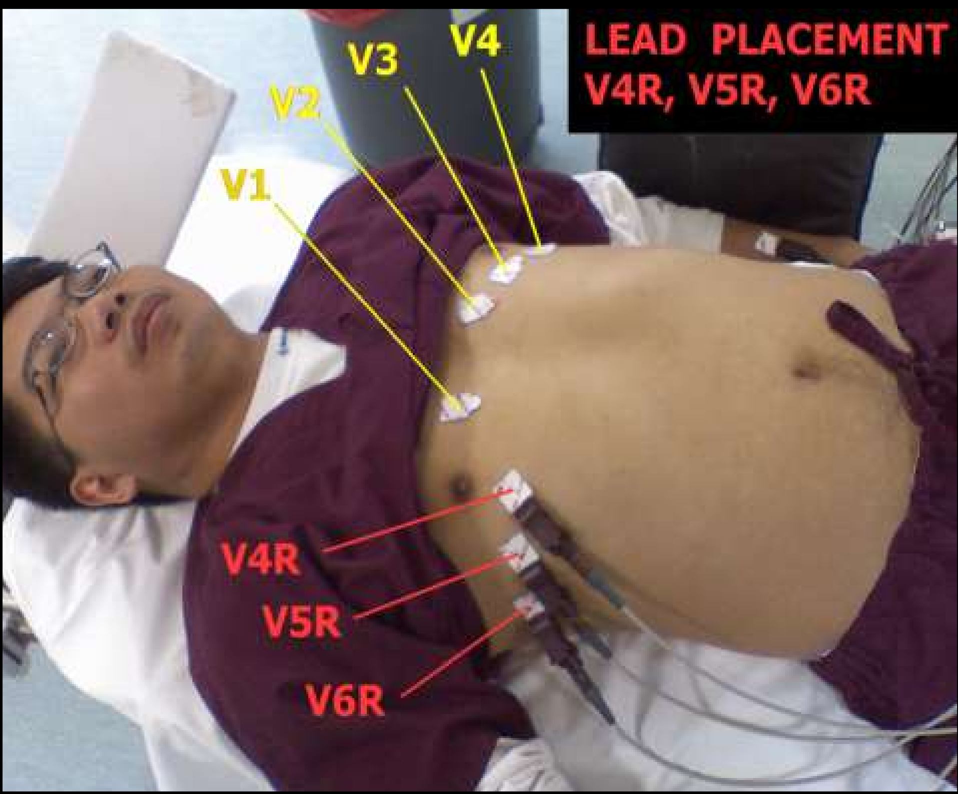
⇦ The 12 Lead ECG

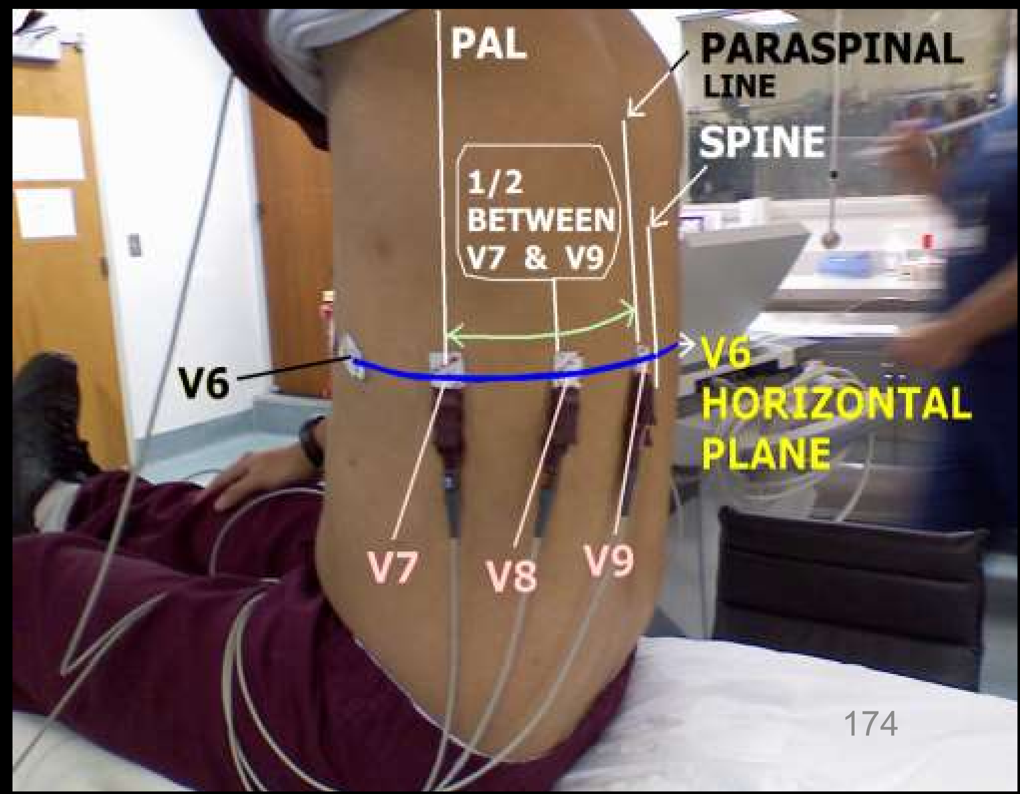
The 18 Lead ECG ⇨

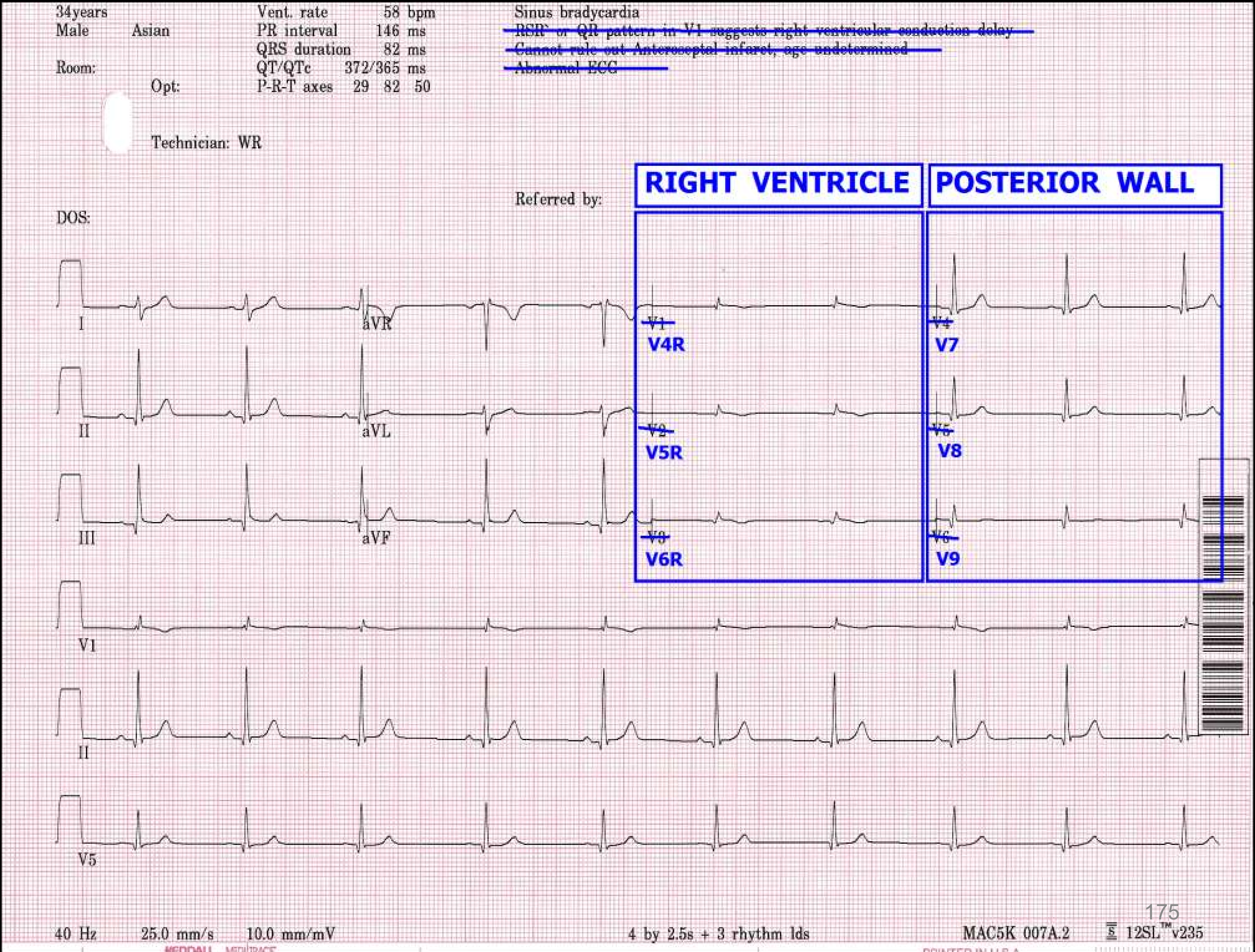


HOW TO REPOSITION 6 CHEST LEADS to OBTAIN 3 R VENTRICLE and 3 POSTERIOR LEADS








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

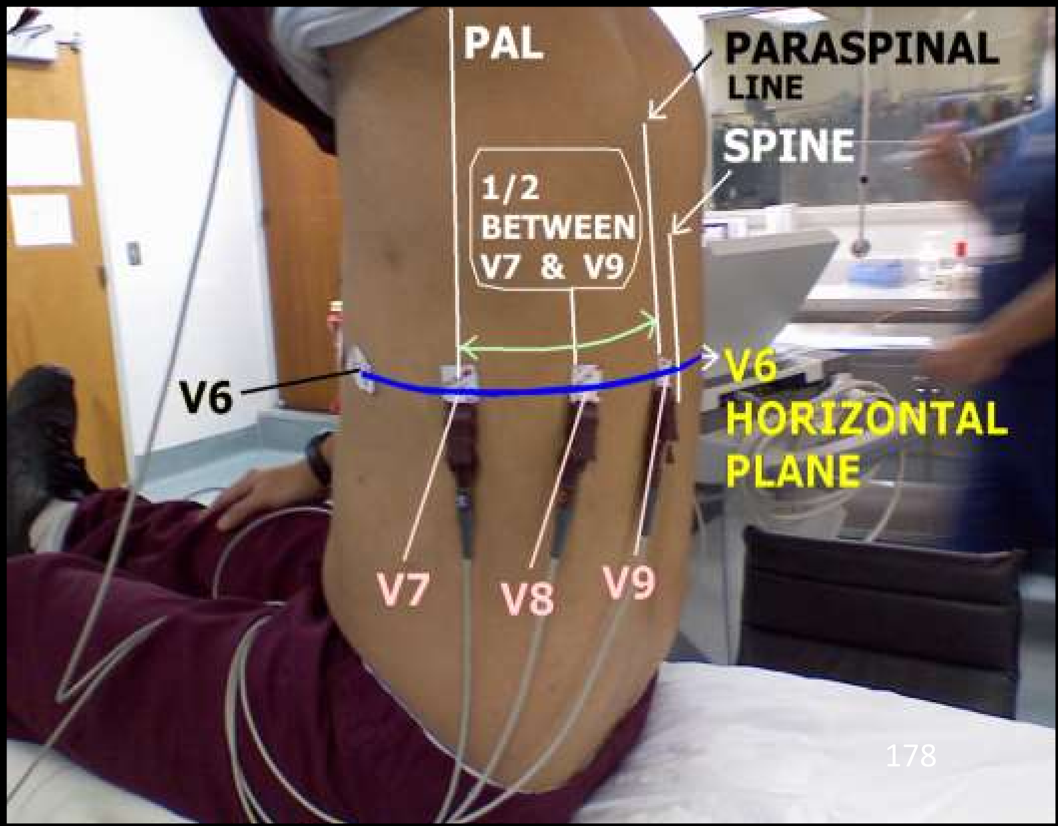
POSTERIOR WALL MI usually accompanies INFERIOR and/or LATERAL WALL MI !!!

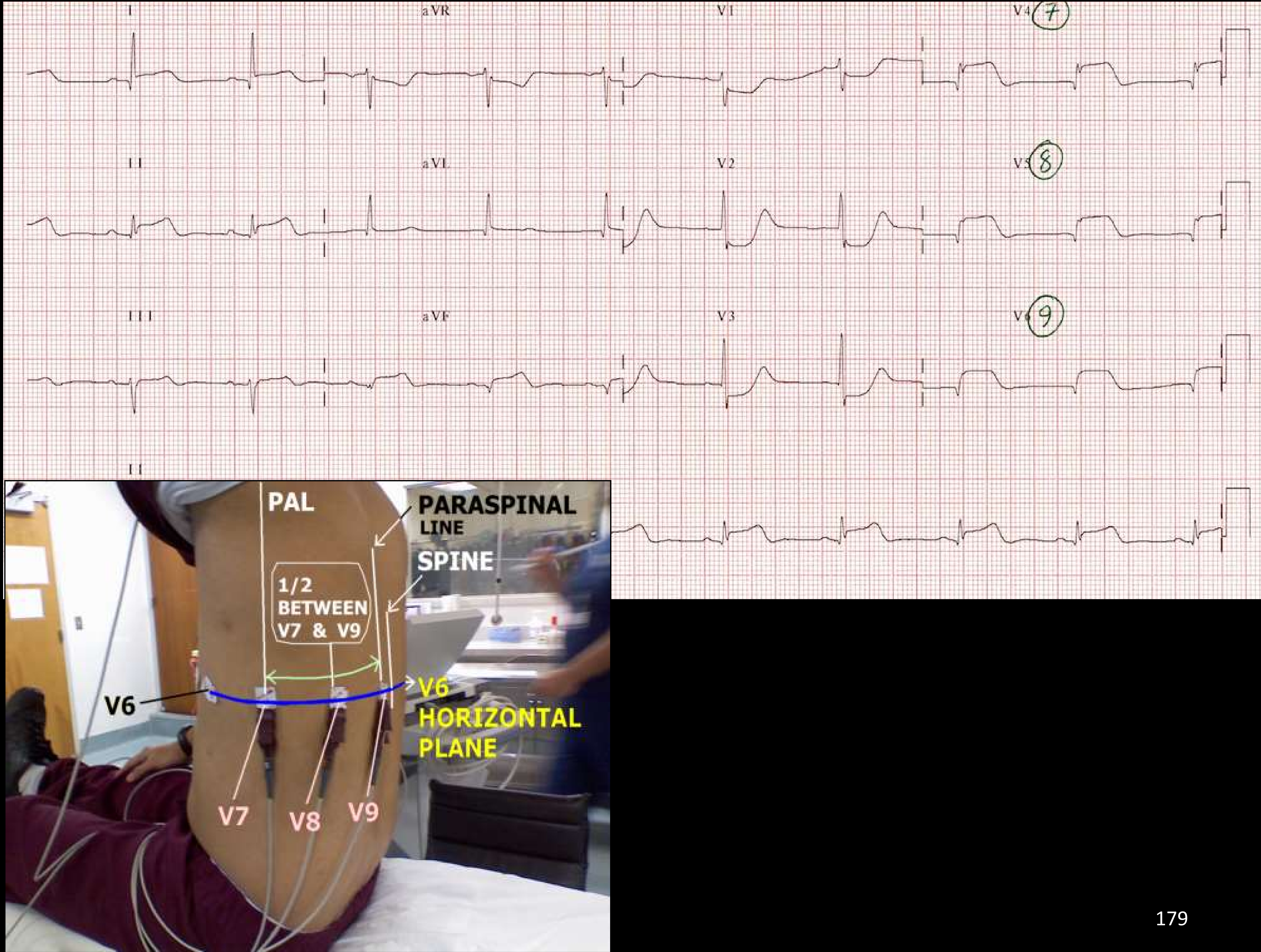
POSTERIOR WALL MI usually accompanies INFERIOR and/or LATERAL WALL MI !!!

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

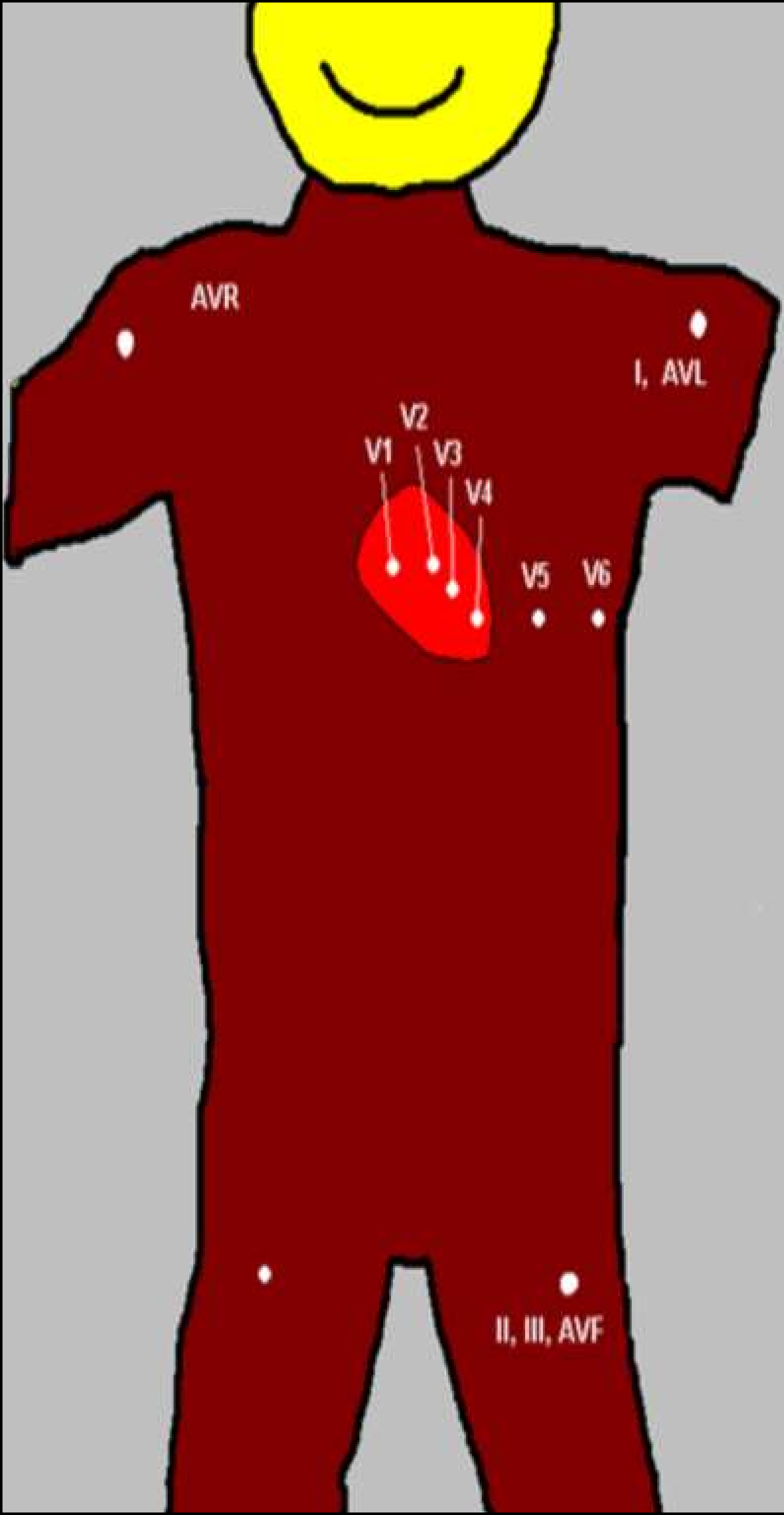
Whenever your patient's ECG exhibits ST DEPRESSION in any of the ANTERIOR LEADS (V1-V4), CONSIDER the possibility of POSTERIOR WALL STEMI ! !

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





I
aVR
V1
V4
7
II
aVL
V2
V5
8
III
aVF
V3
V6
9
II
PAL
PARASPINAL
LINE
SPINE
1/2
BETWEEN
V7 & V9
V6
V6
HORIZONTAL
PLANE
V7
V8
V9



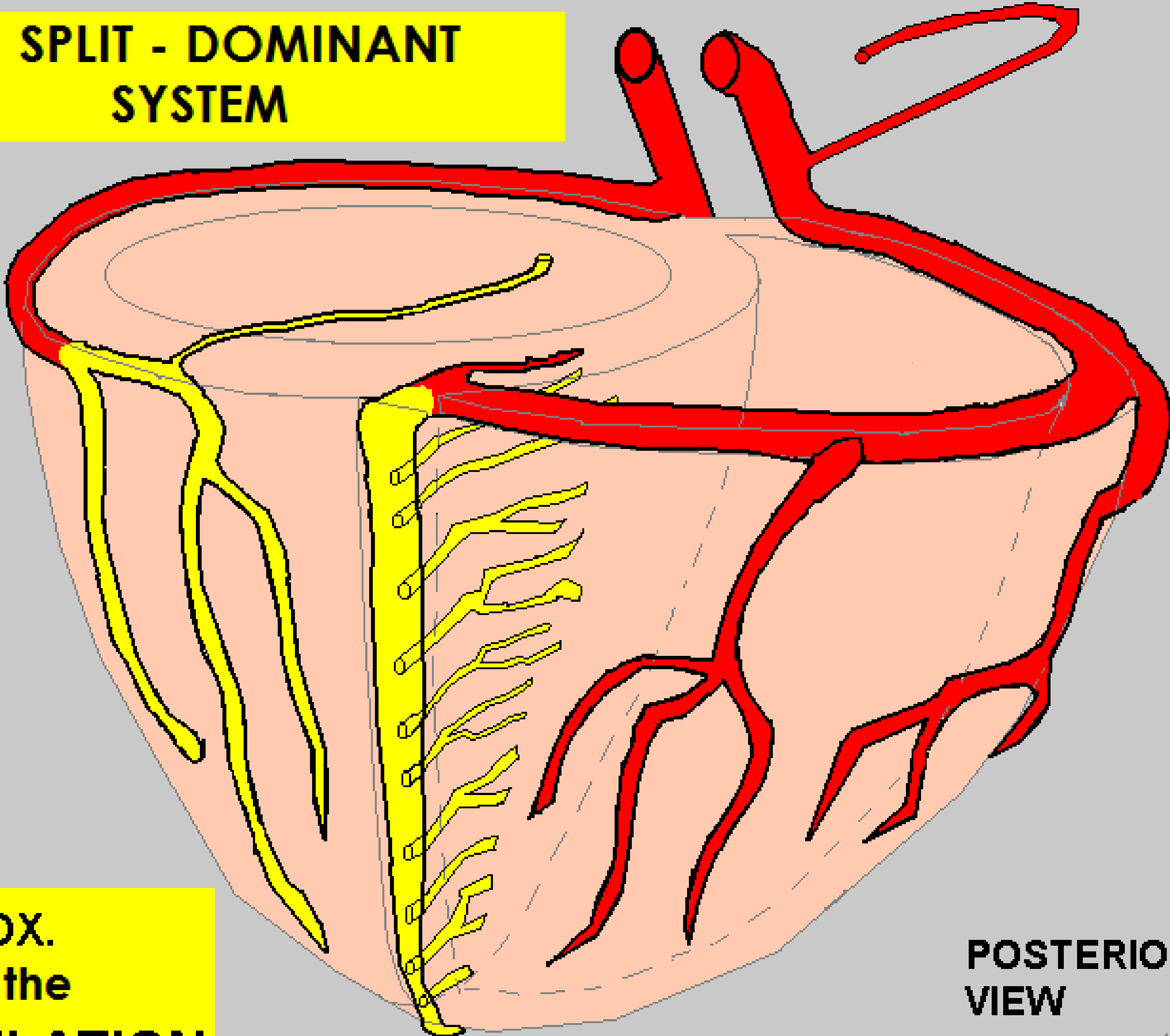
AREAS VIEWED by 12 LEAD ECG + TYPICAL CORONARY ARTERIAL DISTRIBUTION

AVR	*BASILAR SEPTAL*	→	1st SEPTAL PERFORATOR
AVL, I	LATERAL ANTERIOR	→	1st DIAGONAL or RAMUS or 1st OBTUSE MARGINAL
V1, V2	ANTERIOR	→	LEFT ANTERIOR DESCENDING
	SEPTAL	→	LEFT ANTERIOR DESCENDING
	POSTERIOR (recip.)	→	POSTERIOR LATERAL VESSELS
V3, V4	ANTERIOR	→	LEFT ANTERIOR DESCENDING
V5, V6	LATERAL	→	CIRCUMFLEX
II, III, AVF	INFERIOR	→	RIGHT CORONARY ARTERY or CIRCUMFLEX

RIGHT DOMINANT and LEFT DOMINANT systems account for approximately 90 % of the population. . . .

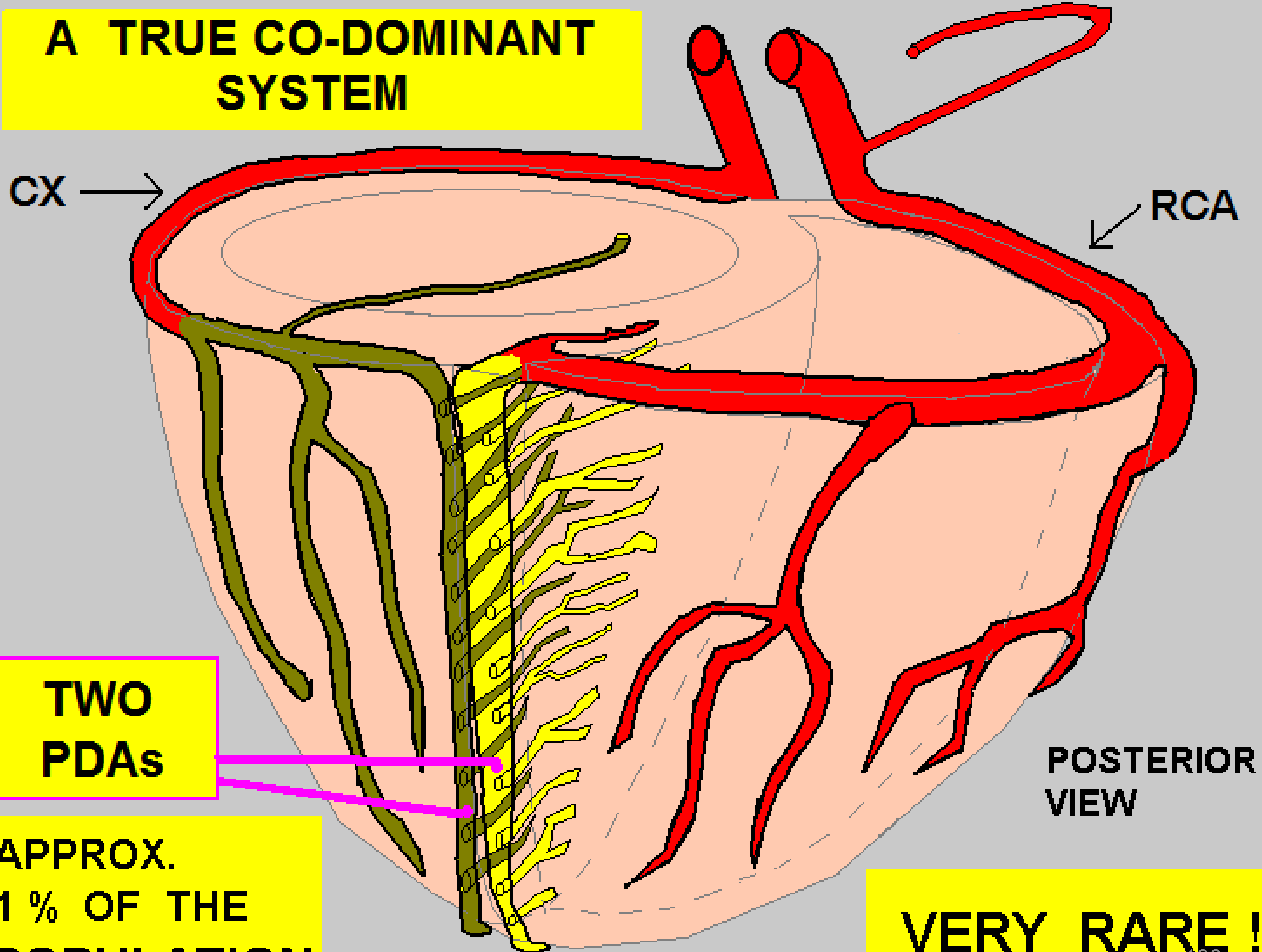
COMING UP ... some LESS COMMON variations that comprise the remaining 10%. . .

A SPLIT - DOMINANT SYSTEM



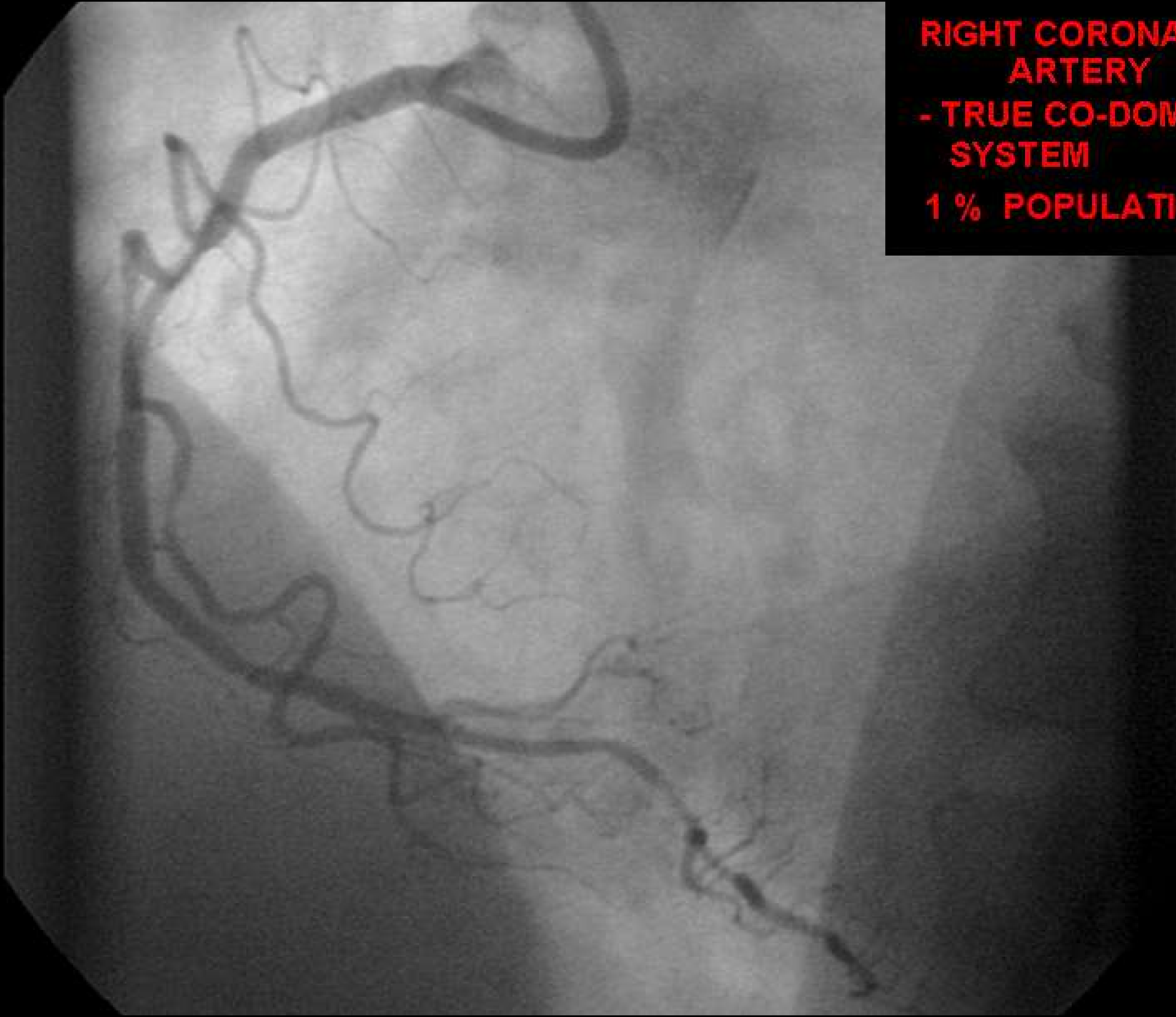
APPROX. 5% of the POPULATION

A TRUE CO-DOMINANT SYSTEM



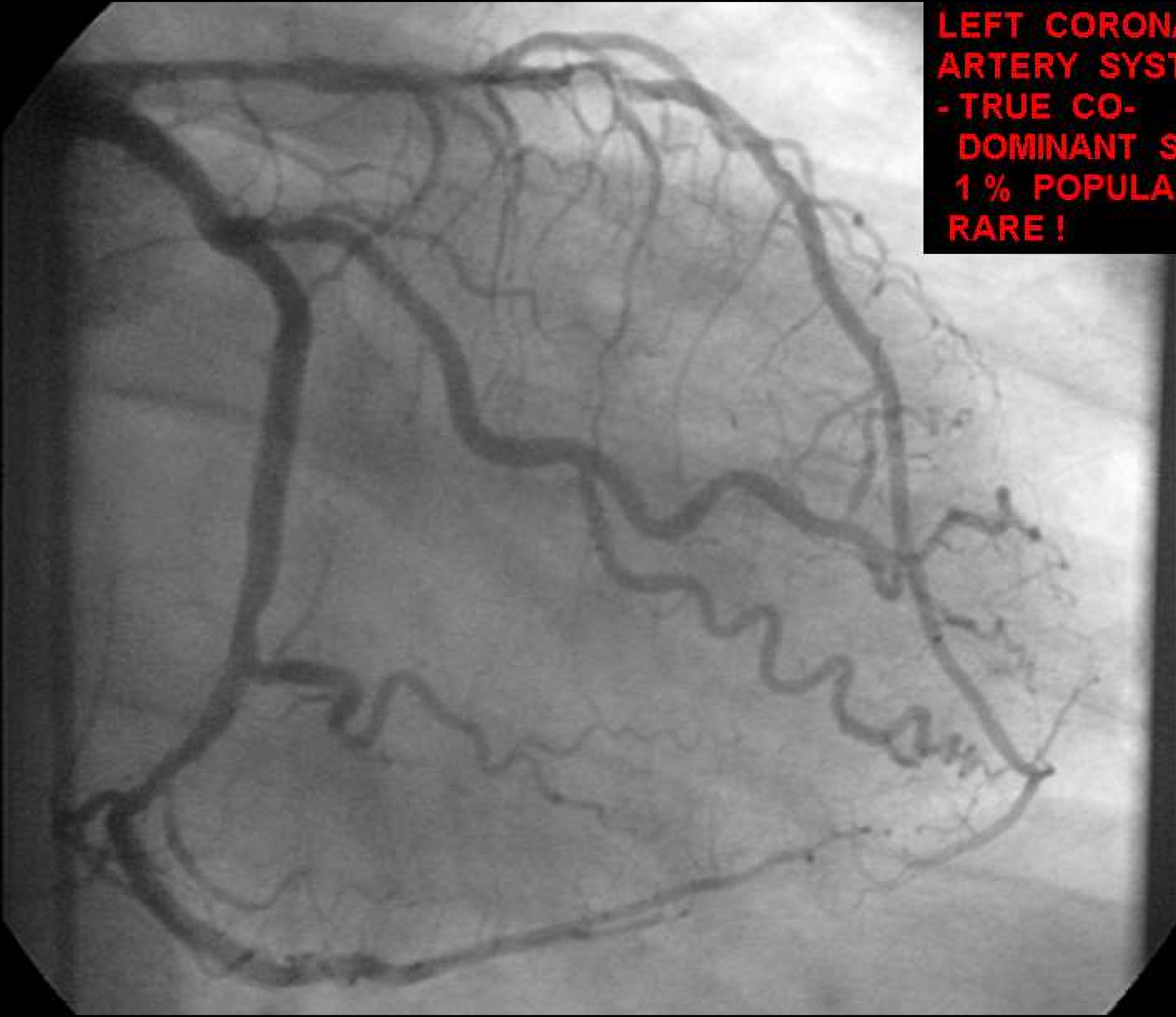
APPROX. 1 % OF THE POPULATION

VERY RARE !



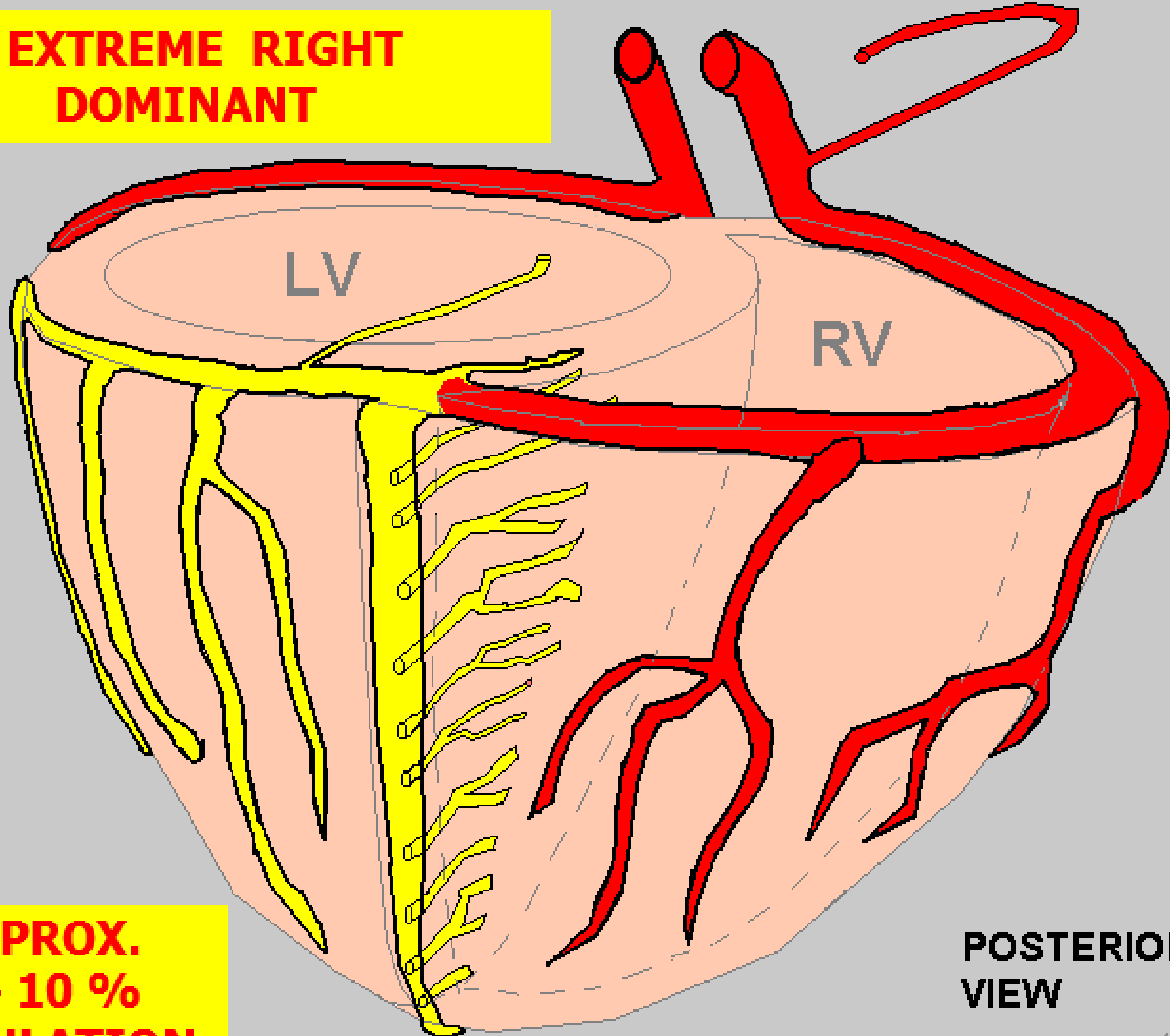
RIGHT CORONARY ARTERY
- TRUE CO-DOMINANT SYSTEM

1 % POPULATION



LEFT CORONARY ARTERY SYSTEM
- TRUE CO-DOMINANT SYSTEM
1 % POPULATION
RARE !

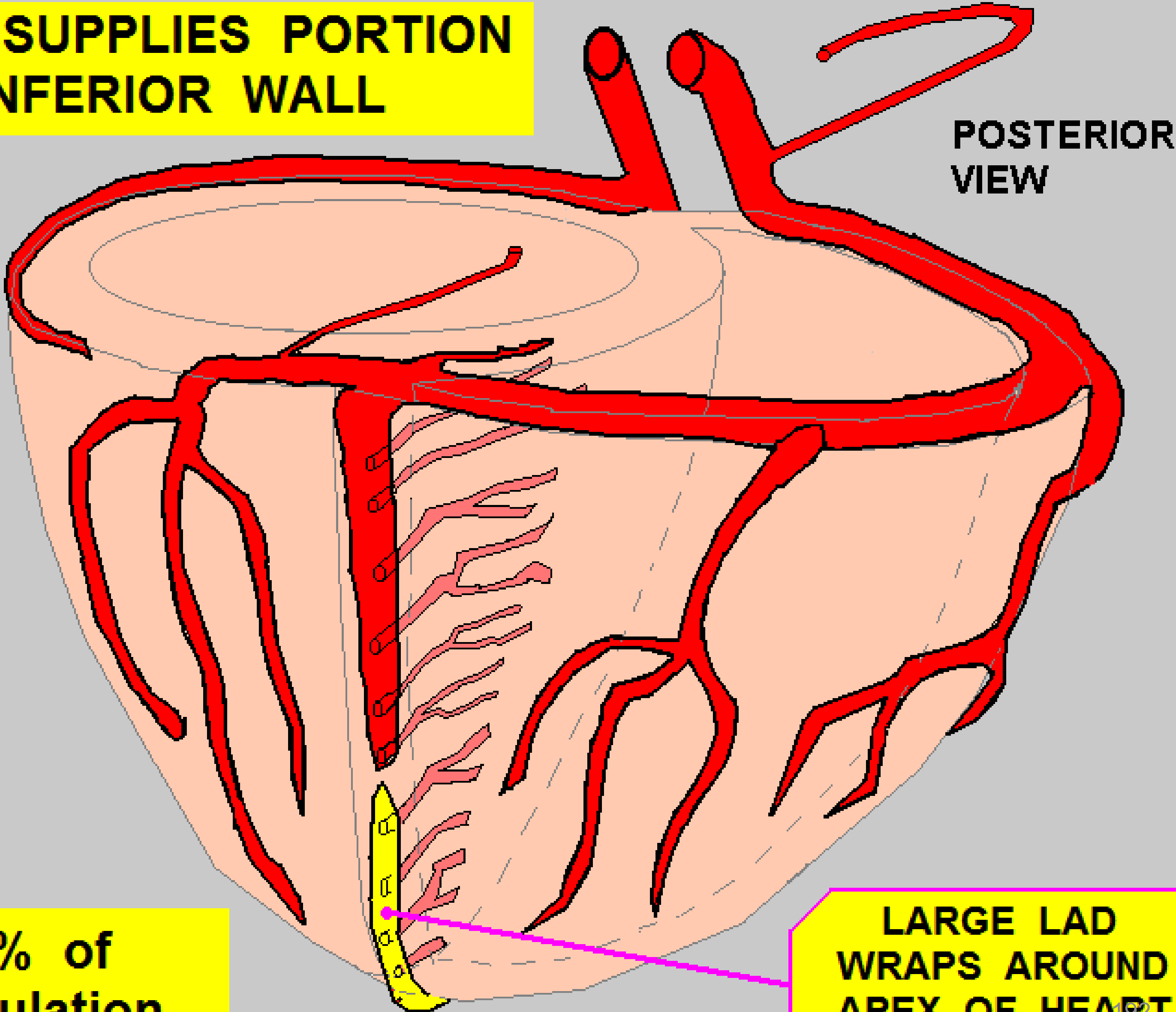
EXTREME RIGHT DOMINANT



APPROX. 5 - 10 % POPULATION

POSTERIOR VIEW

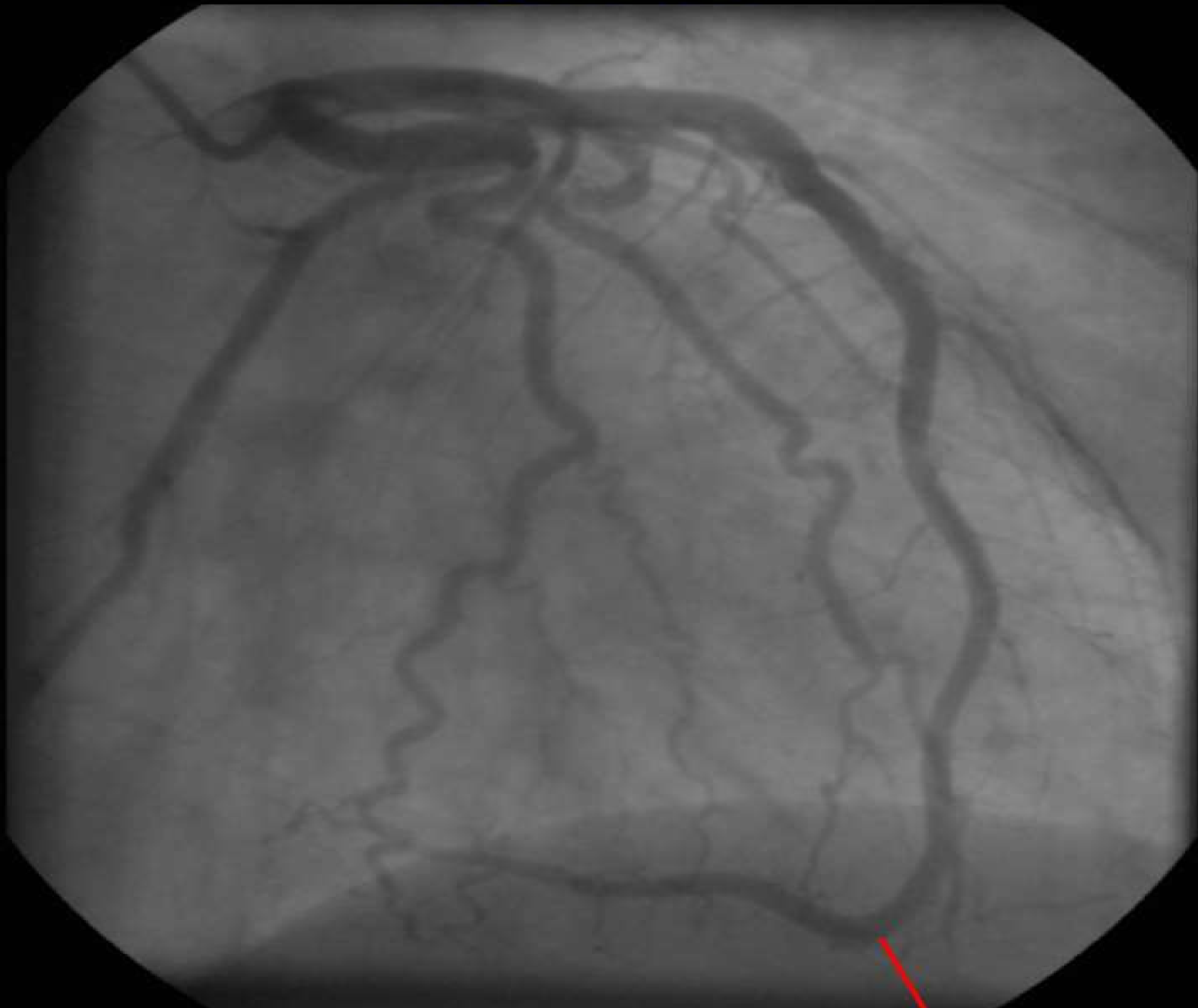
LAD SUPPLIES PORTION OF INFERIOR WALL



< 5 % of population

LARGE LAD WRAPS AROUND APEX OF HEART

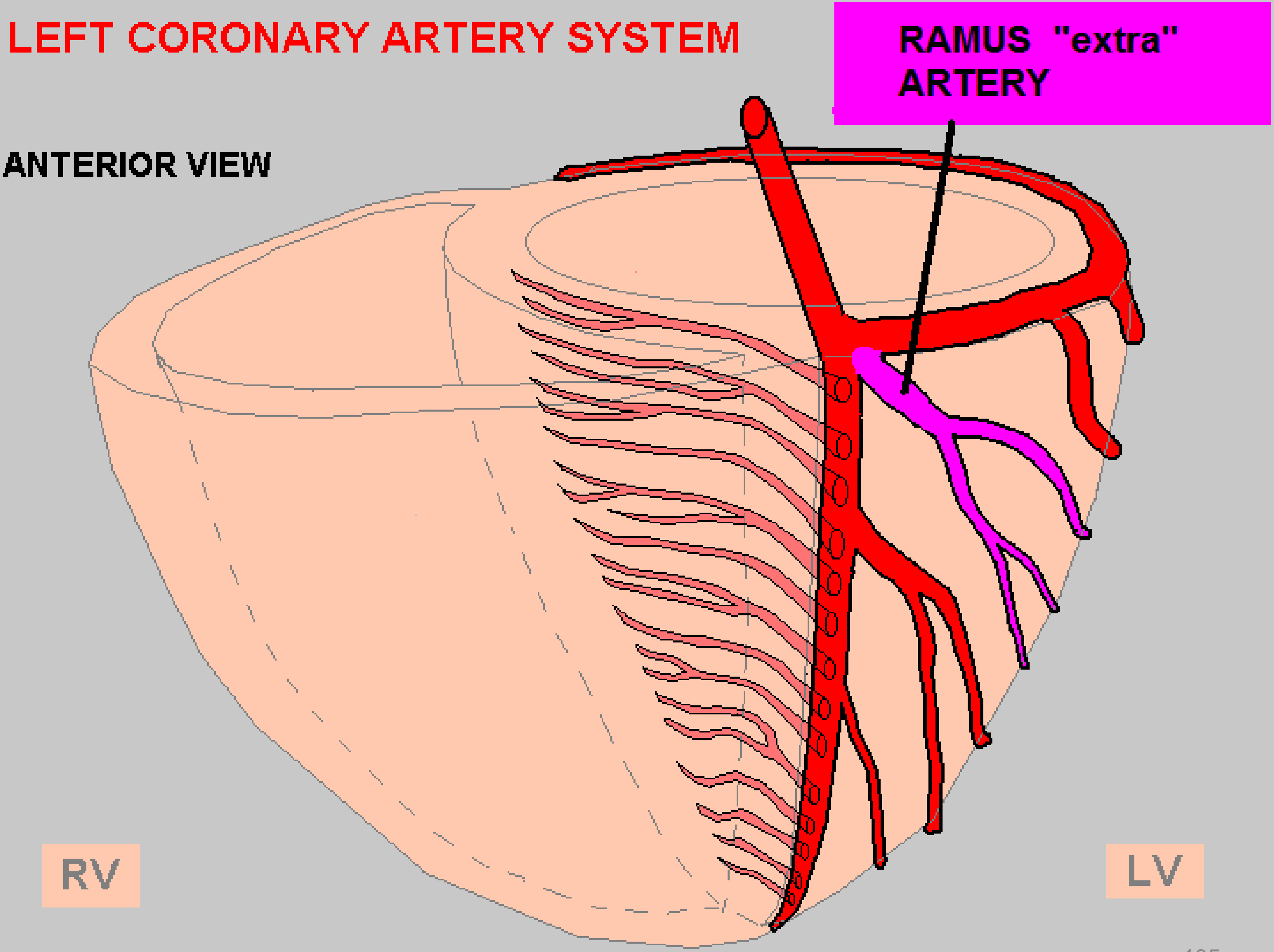
ANTERIOR VIEW

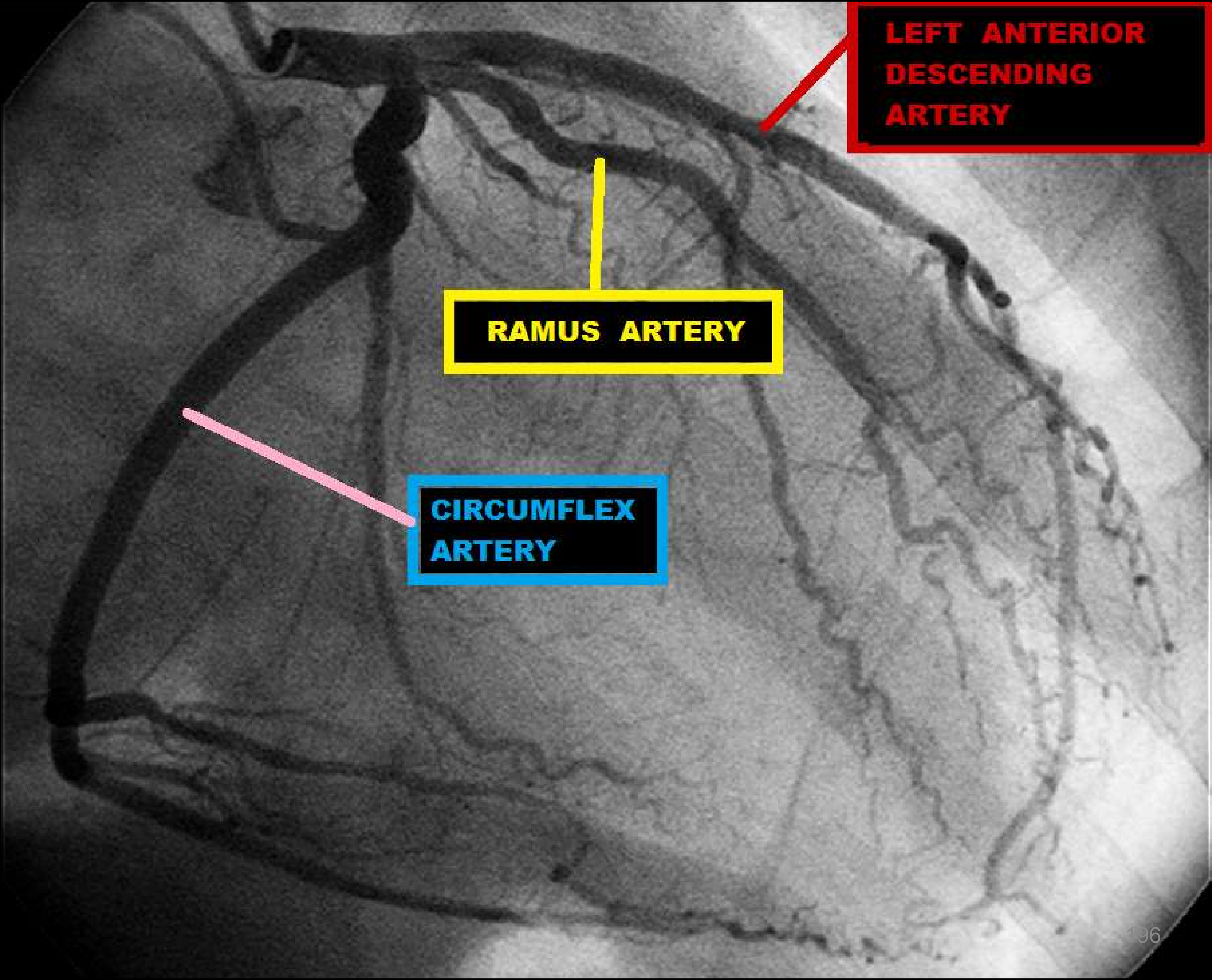


LEFT ANTERIOR DESCENDING artery wraps around apex of heart and supplies INFERIOR WALL

SMALL, NON-DOMINANT RCA

LEFT CORONARY ARTERY SYSTEM




LEFT ANTERIOR DESCENDING ARTERY
RAMUS ARTERY
CIRCUMFLEX ARTERY

CORONARY

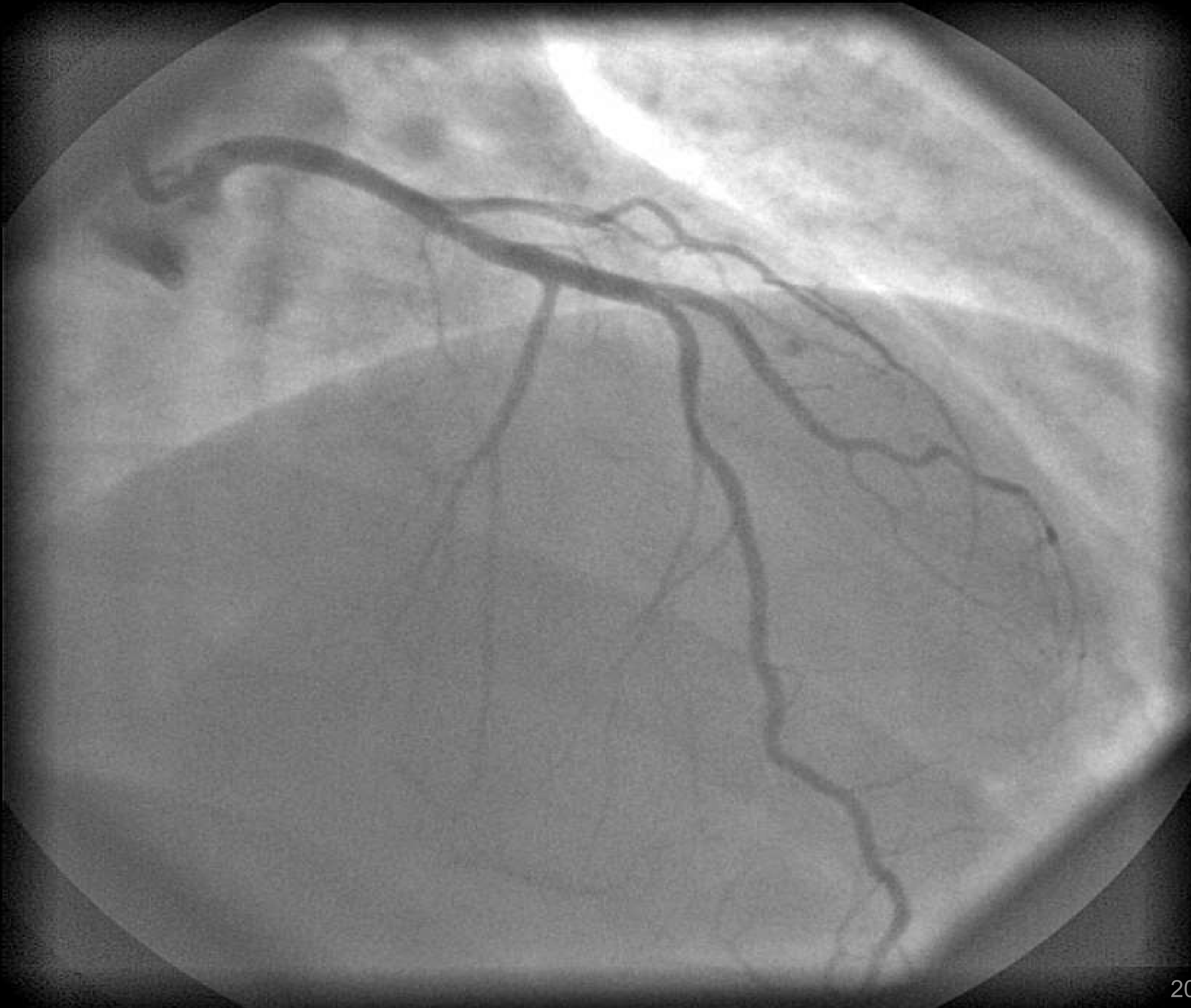
ARTERY

ANOMALITIES

CIRCUMFLEX

Originates From the

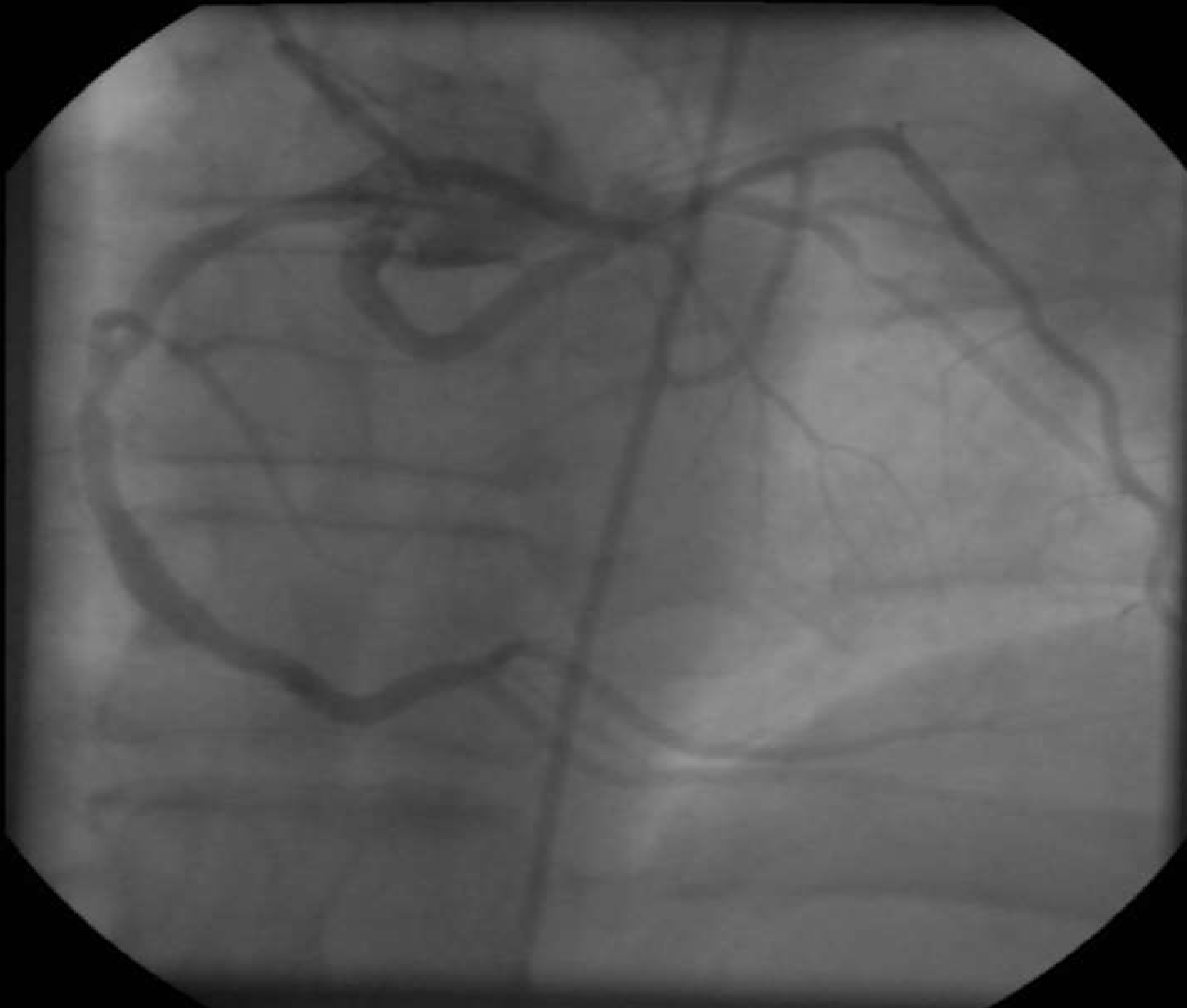
RCA

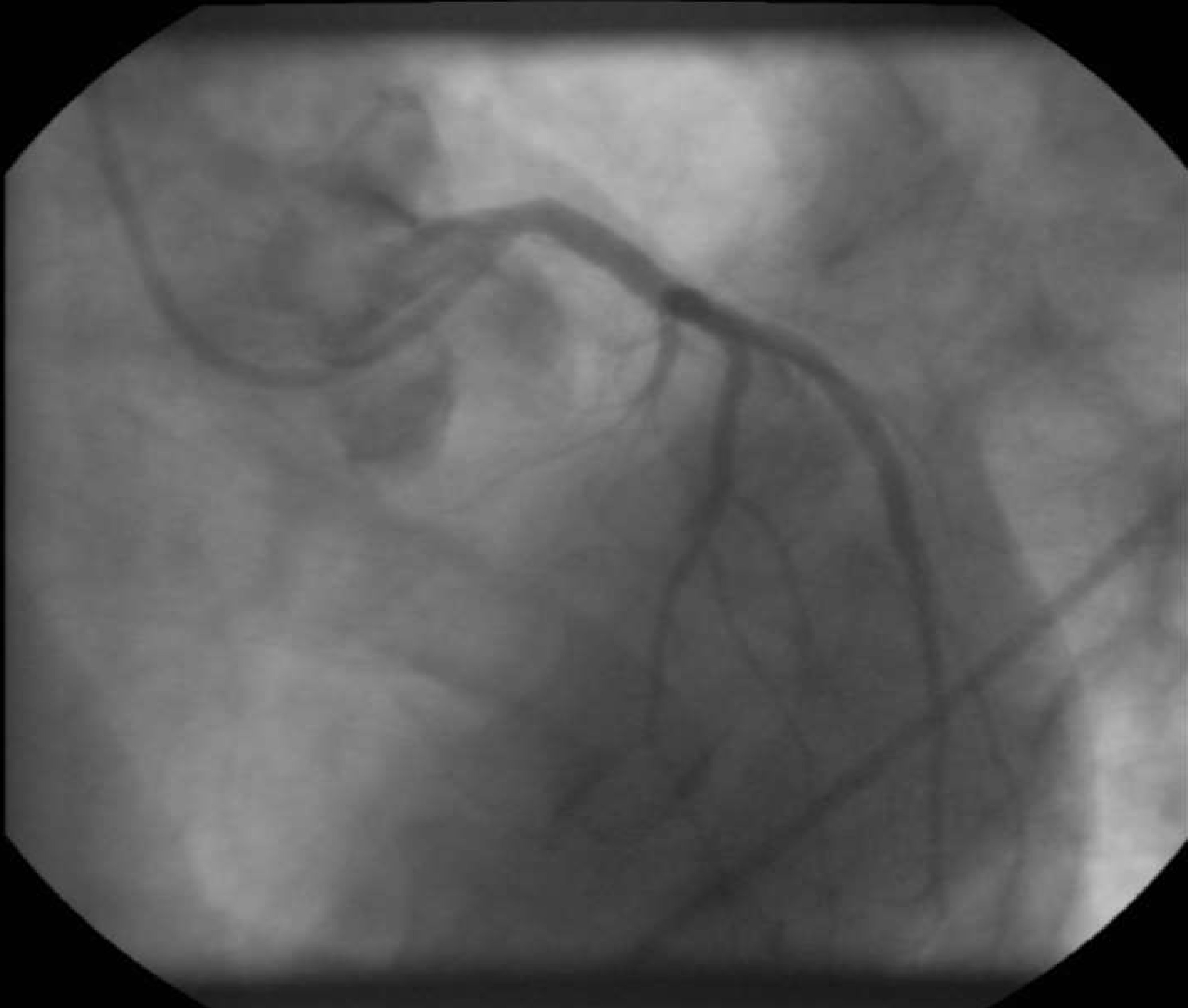


LAD

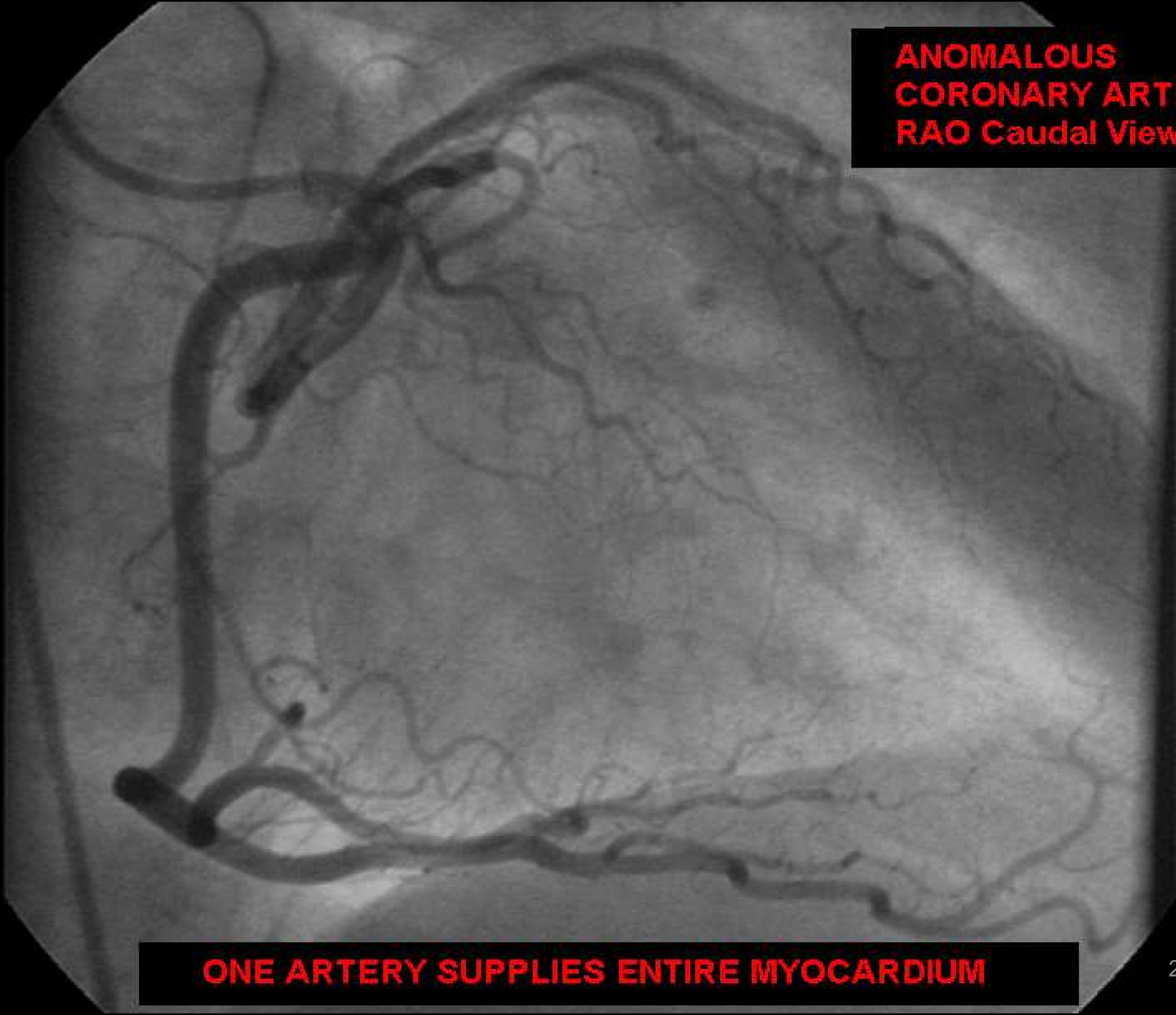
originates from

RCA

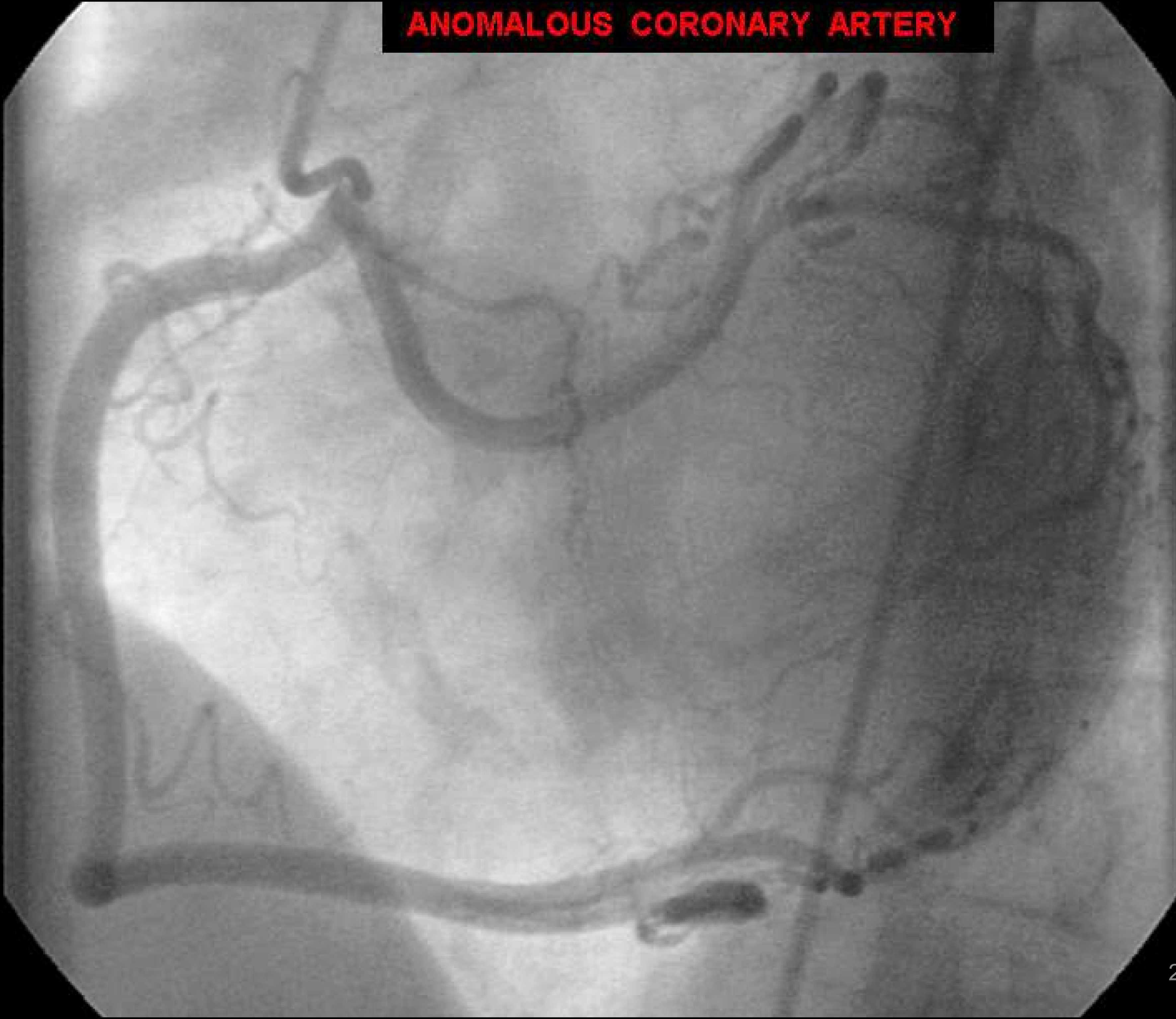




SINGLE
ARTERY
SUPPLIES
ENTIRE
HEART


ANOMALOUS
CORONARY ARTERY
RAO Caudal View
ONE ARTERY SUPPLIES ENTIRE MYOCARDIUM

ANOMALOUS CORONARY ARTERY

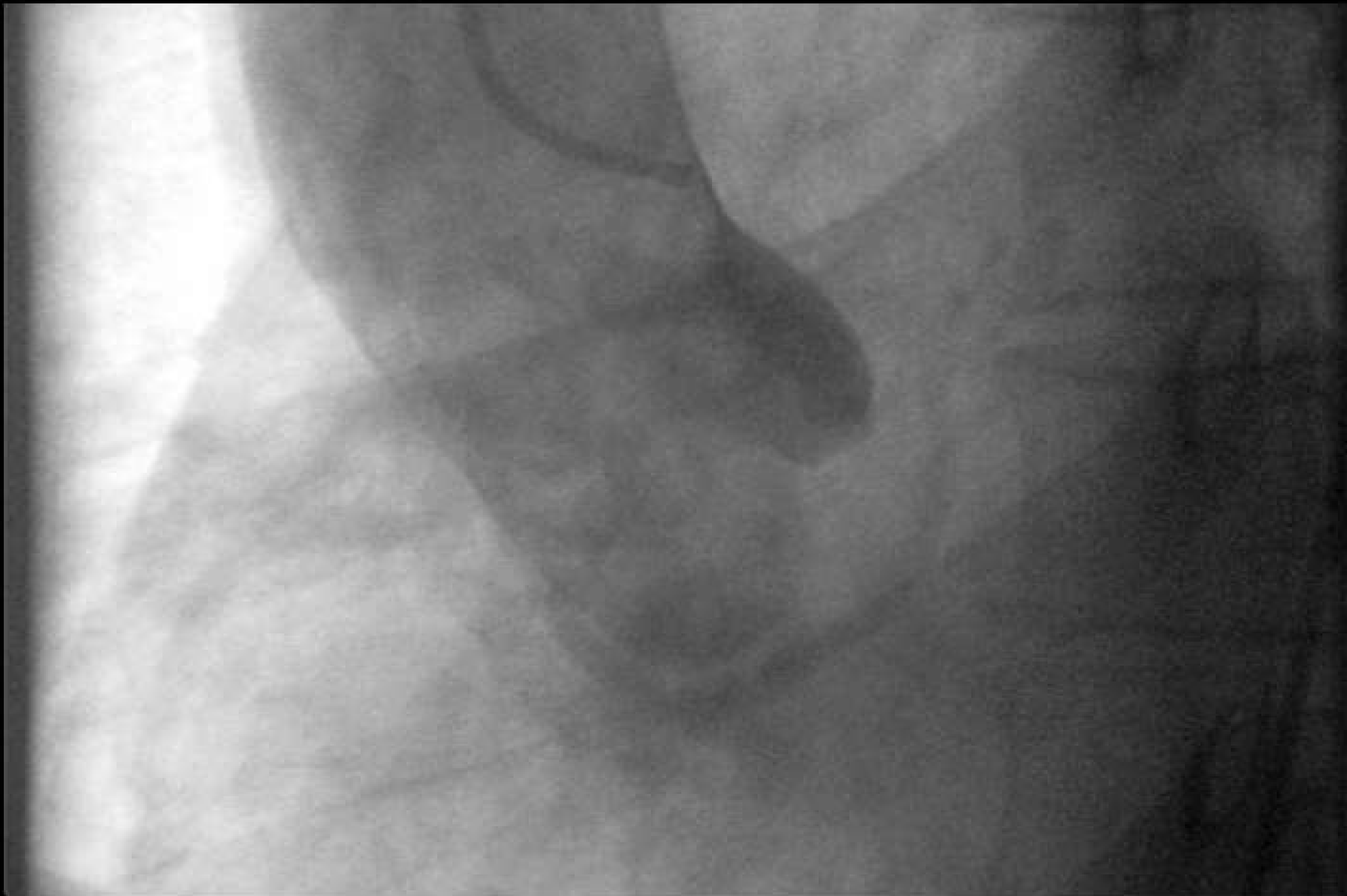


SIGNIFICANT INCREASE OF SUDDEN DEATH

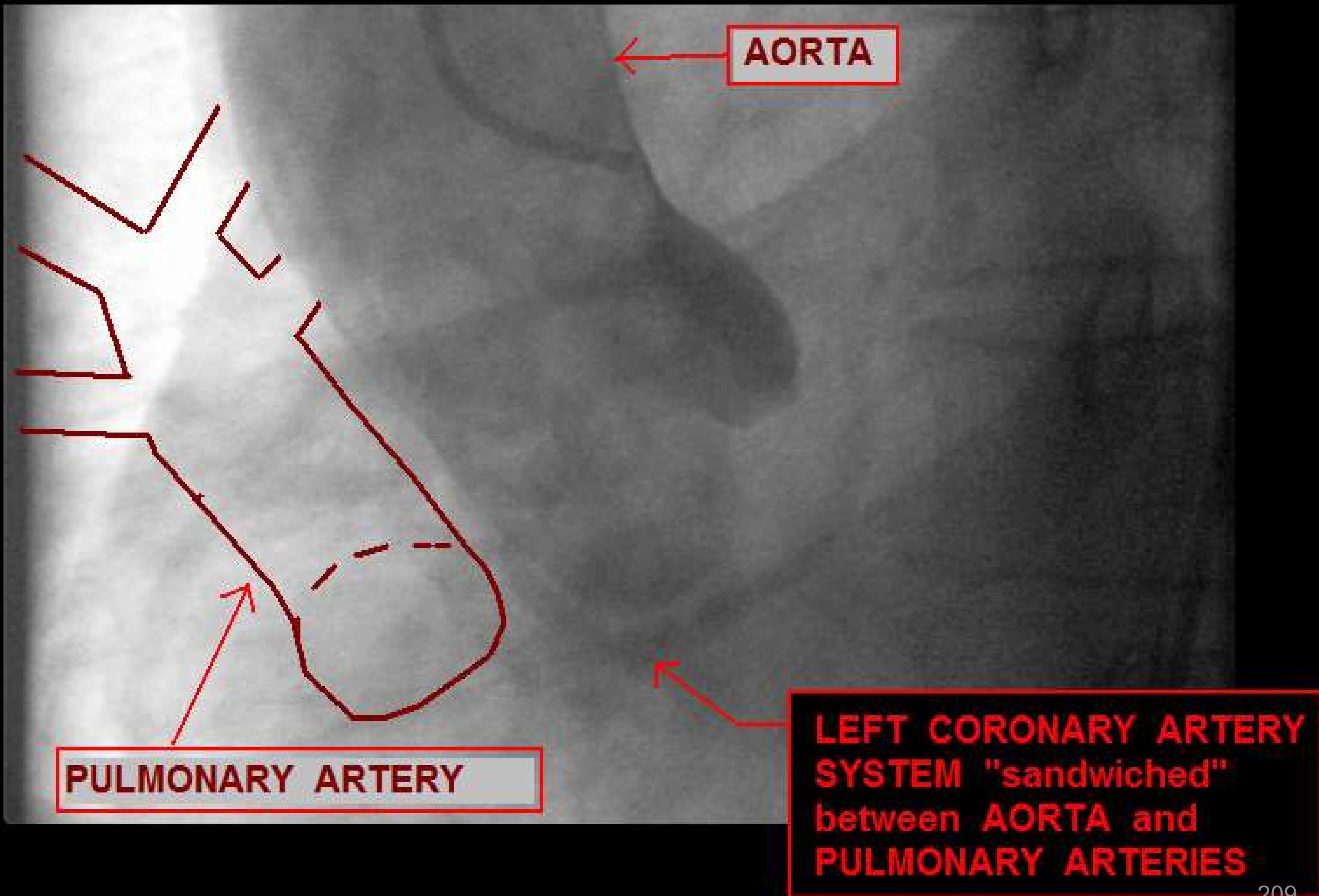
for people with anomalous coronary artery

- due to constriction of the circumflex branch as it wraps around AORTA
- this condition can be corrected surgically.

Aortic Root Injection of Patient With Anomalous Coronary Artery

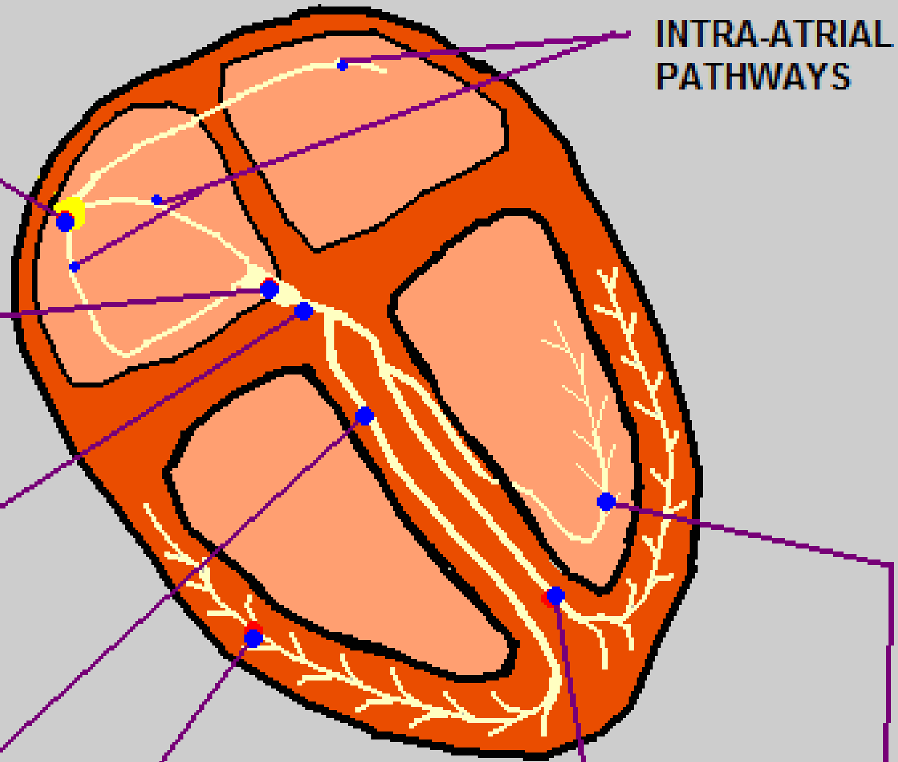


Aortic Root Injection of Patient With Anomalous Coronary Artery




hang in there ! ....
it's almost LUNCH TIME ! ! ! !
Wayne "Will" Ruppert, III

The Cardiac Electrical System



SINUS NODE
- INHERENT RATE 60 - 100
- BLOOD SUPPLY:
  - INFERIOR WALL (RCA) or
  - LATERAL WALL (CIRC.)

AV NODE
- INHERENT RATE 40 - 60
- BLOOD SUPPLY:
  - INFERIOR WALL (RCA or CIRC.)

BUNDLE OF HIS
- INHERENT RATE 40 - 60
- BLOOD SUPPLY:
  - ANTERIOR WALL (LAD)

RIGHT BUNDLE BRANCH
- BLOOD SUPPLY:
  - ANTERIOR WALL (LAD)

PURKINJE FIBERS
- INHERENT RATE 1 - 40

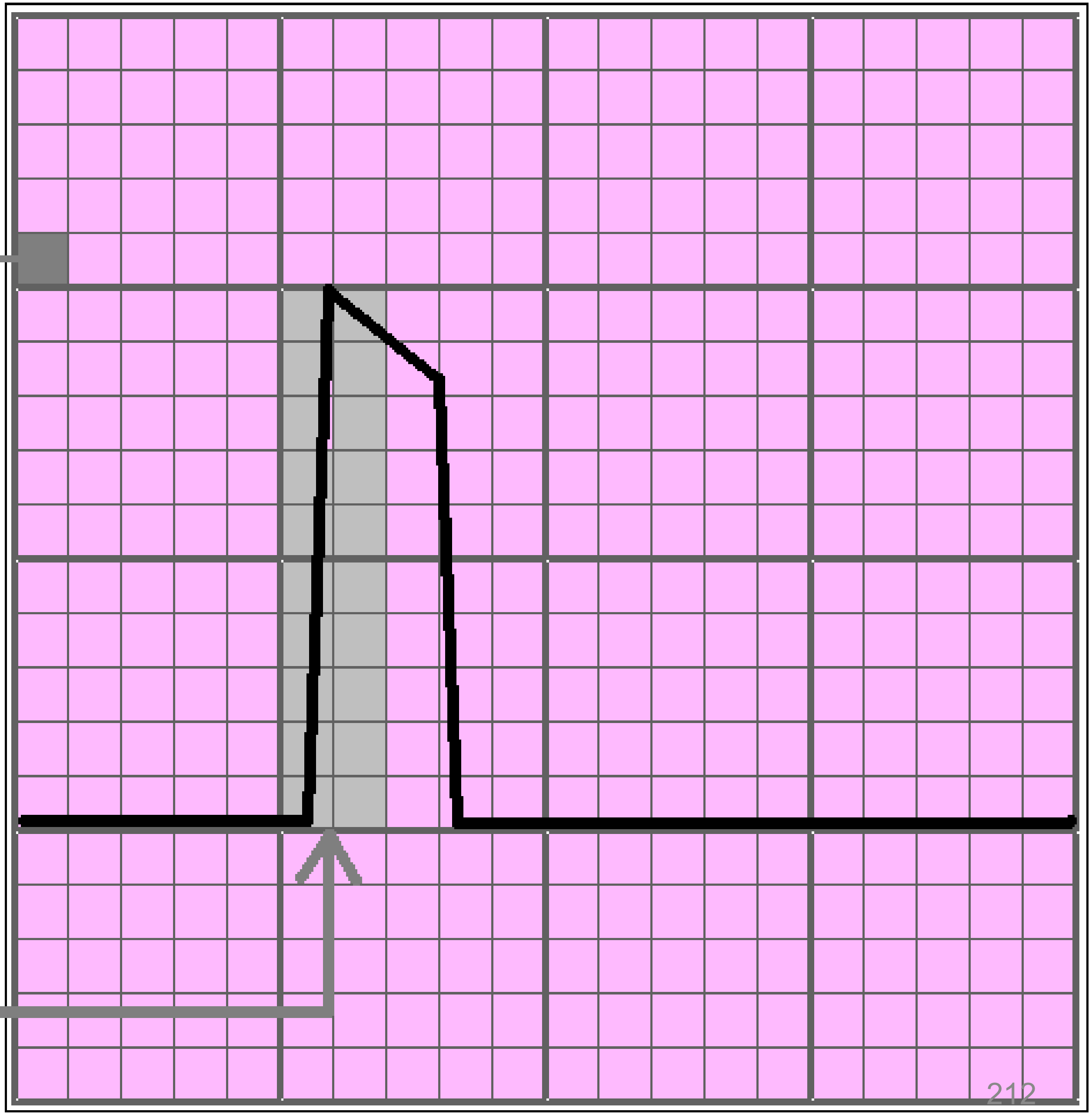
LEFT BUNDLE BRANCH

ANTERIOR FASCICLE
- BLOOD SUPPLY:
  - ANTERIOR WALL (LAD)

POSTERIOR FASCICLE
- BLOOD SUPPLY:
  - INFERIOR WALL (RCA or CIRC)

ECG PAPER - THE VERTICAL AXIS:

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



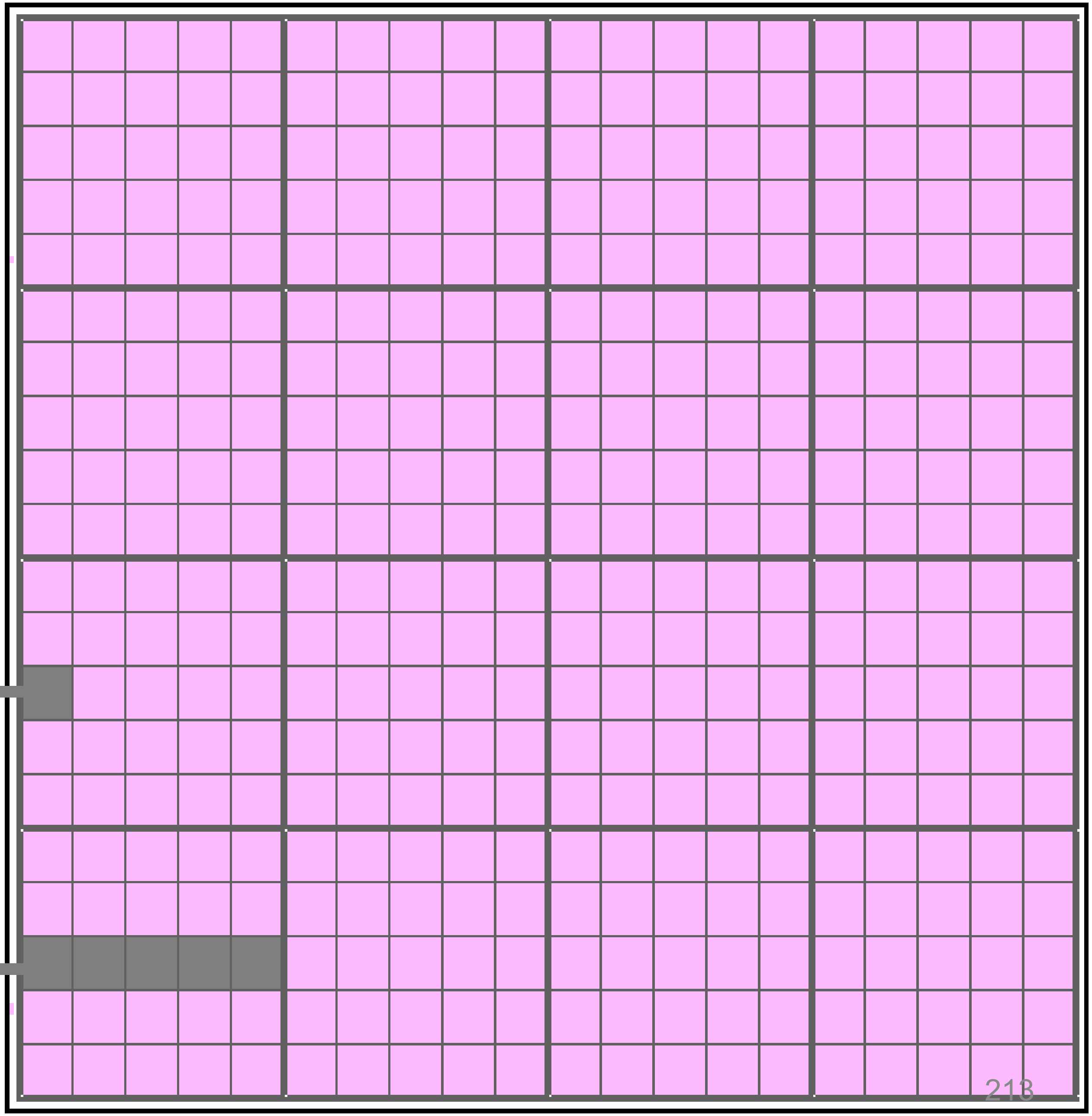
ECG PAPER - THE HORIZONTAL AXIS:

THE HORIZONTAL AXIS REPRESENTS TIME . . .

STANDARD SPEED FOR RECORDING ADULT EKGs = 25 mm / SECOND

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

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



THE ECG MACHINE

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

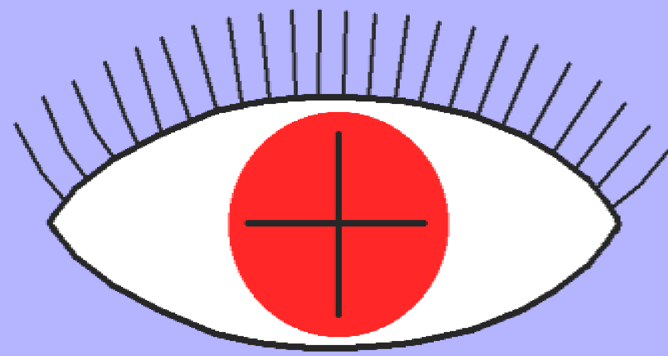
- LEADS I, II, III, and V1, V2, V3, V4, V5, V6

  1 POSITIVE ELECTRODE
  1 NEGATIVE ELECTRODE
  1 GROUND ELECTRODE

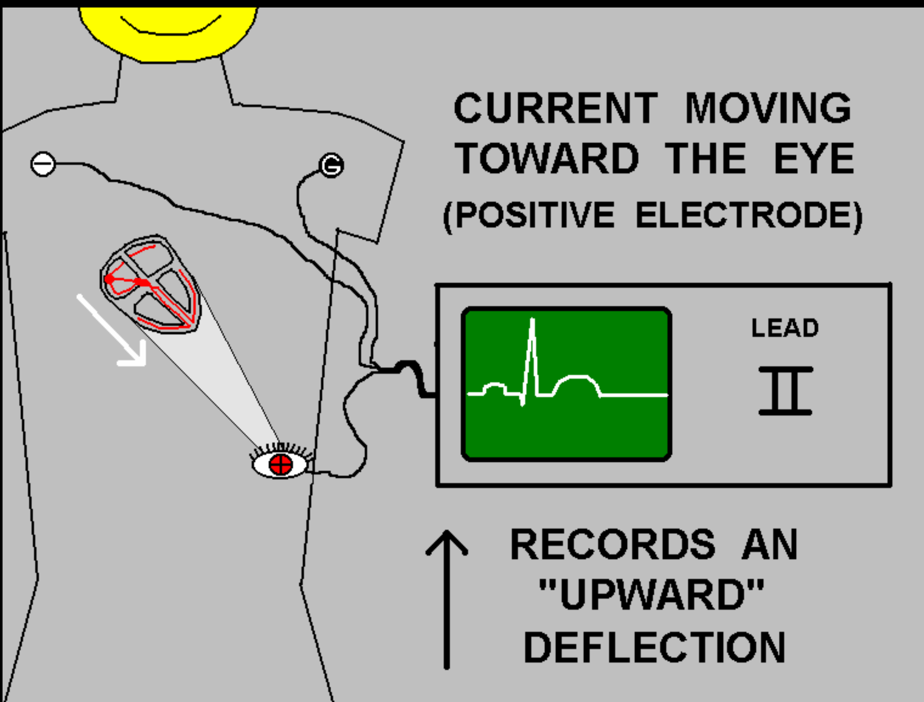
- LEADS AVR, AVL, and AVF

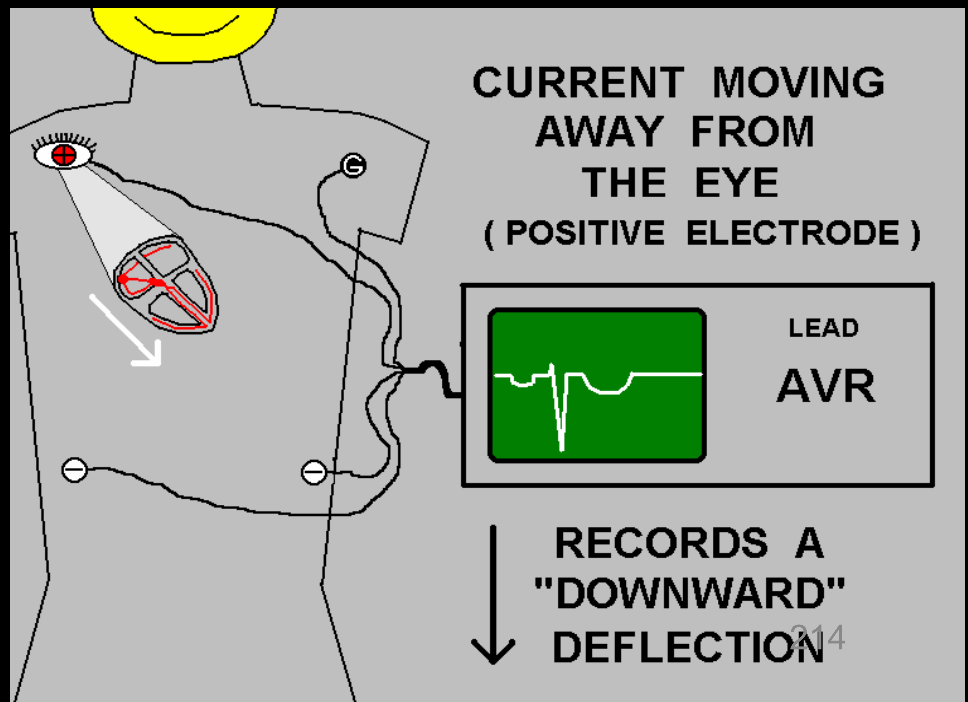
  1 POSITIVE ELECTRODE
  2 NEGATIVE ELECTRODES
  1 GROUND ELECTRODE

THE POSITIVE ELECTRODE



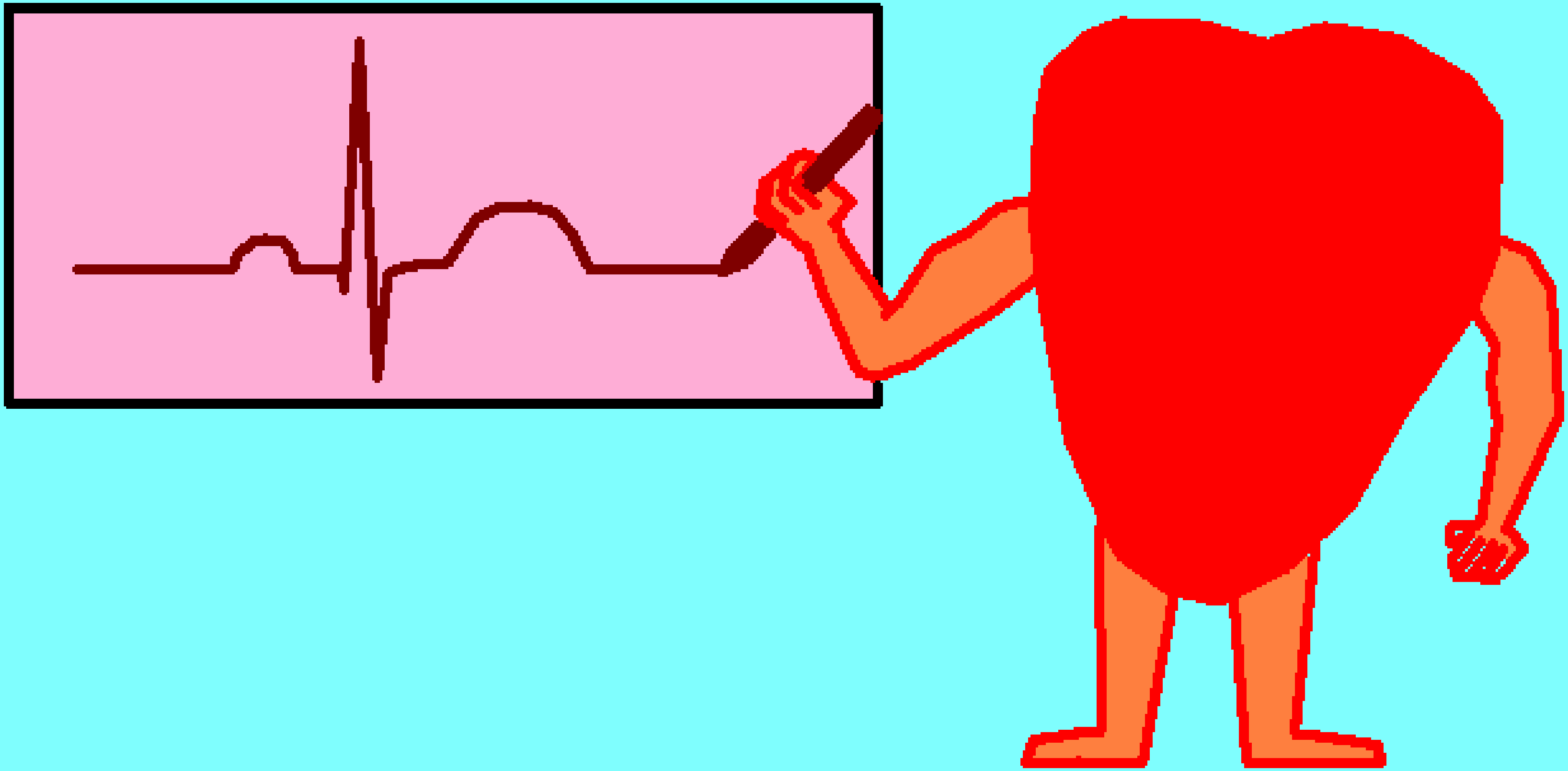
IS THE "EYE" . . .





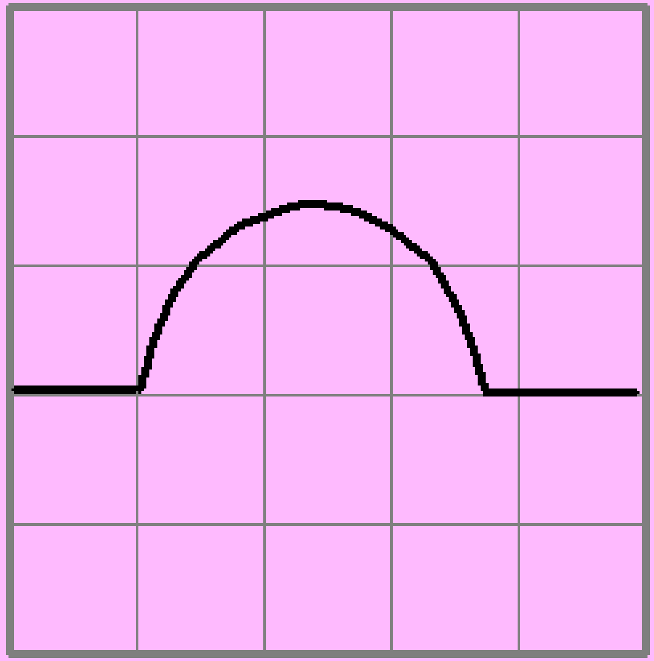
PUTTING IT ALL ON PAPER . . .

WAVEFORMS and INTERVALS . . .



THE P WAVE

- SHOULD BE UPRIGHT, CONVEX-SHAPED DOME IN ALL LEADS EXCEPT AVR and V1



- SHOULD BE LESS THAN .2 mv (2 mm) HIGH

- SHOULD BE LESS THAN 100 ms (2.5mm) LONG

THE P WAVE

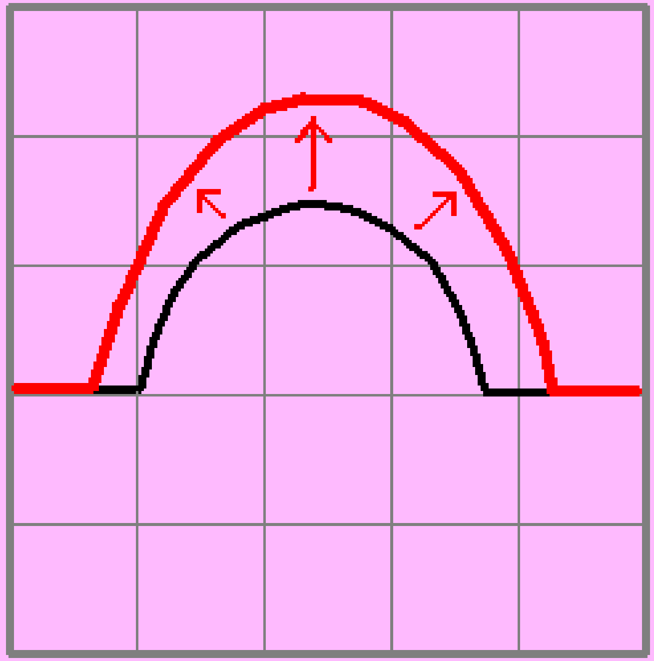
When the P WAVE

is

TOO LARGE

We think of

ATRIAL HYPERTROPHY

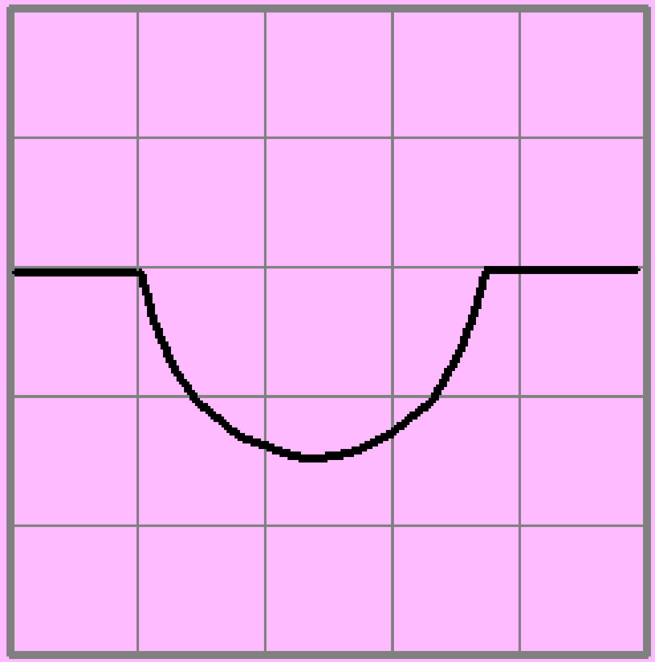


(SPECIFIC CRITERIA FOR ATRIAL HYPERTROPHY IS DISCUSSED IN MORE DETAIL IN THE "CHAMBER HYPERTROPHY" SECTION)

THE P WAVE

- SHOULD BE INVERTED IN LEAD AVR

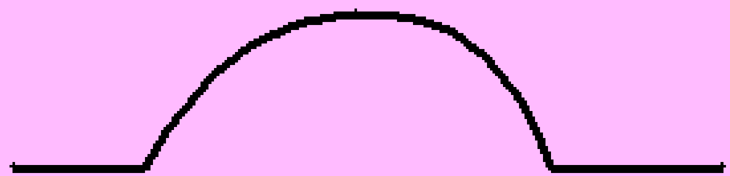
LEAD AVR



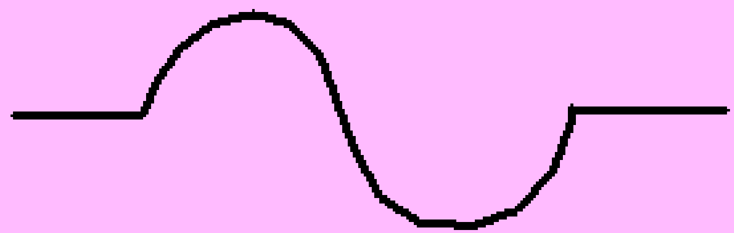
THE P WAVE

IN LEAD V1 MAY BE:

- POSITIVE

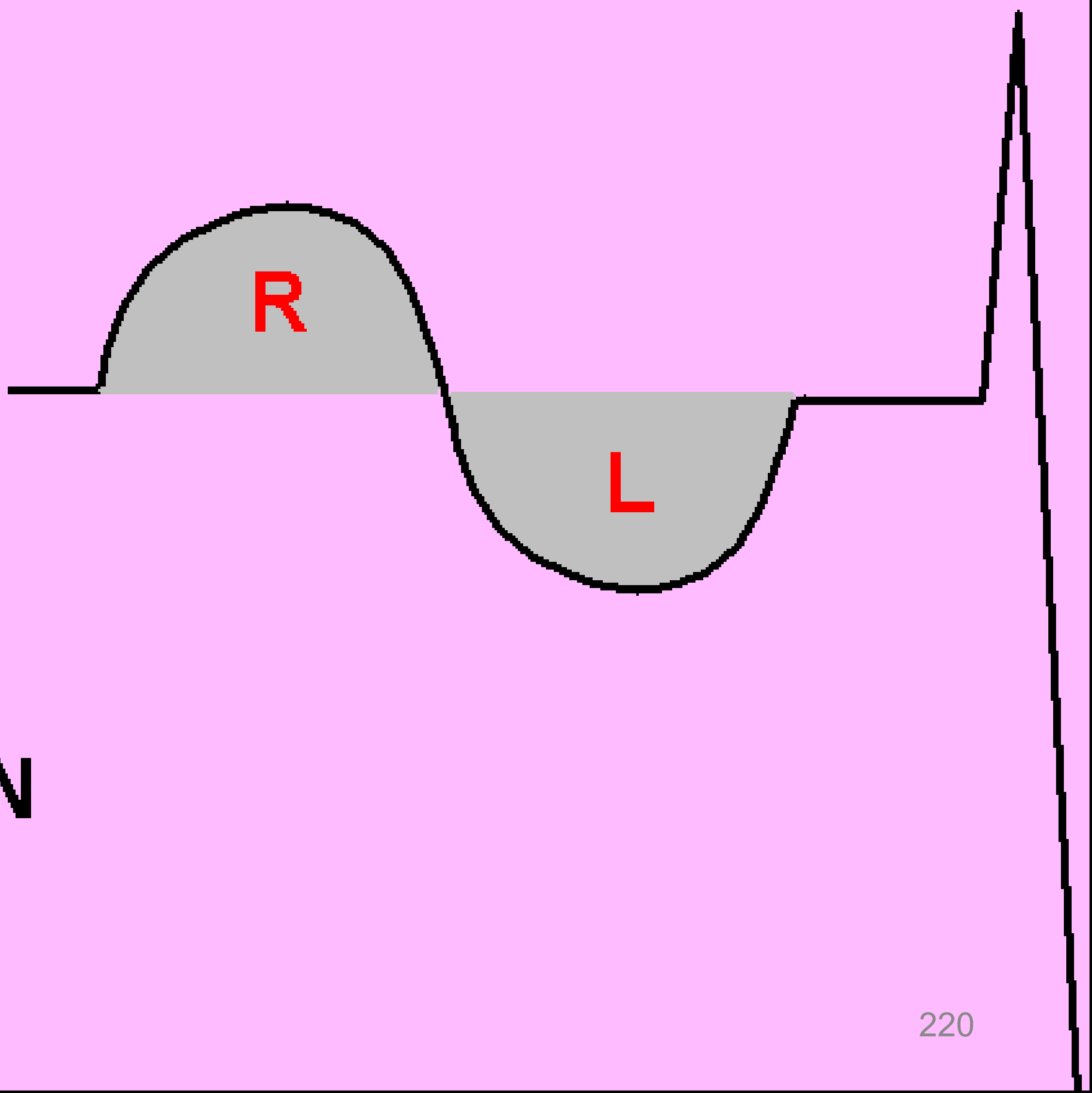


- OR BI-PHASIC

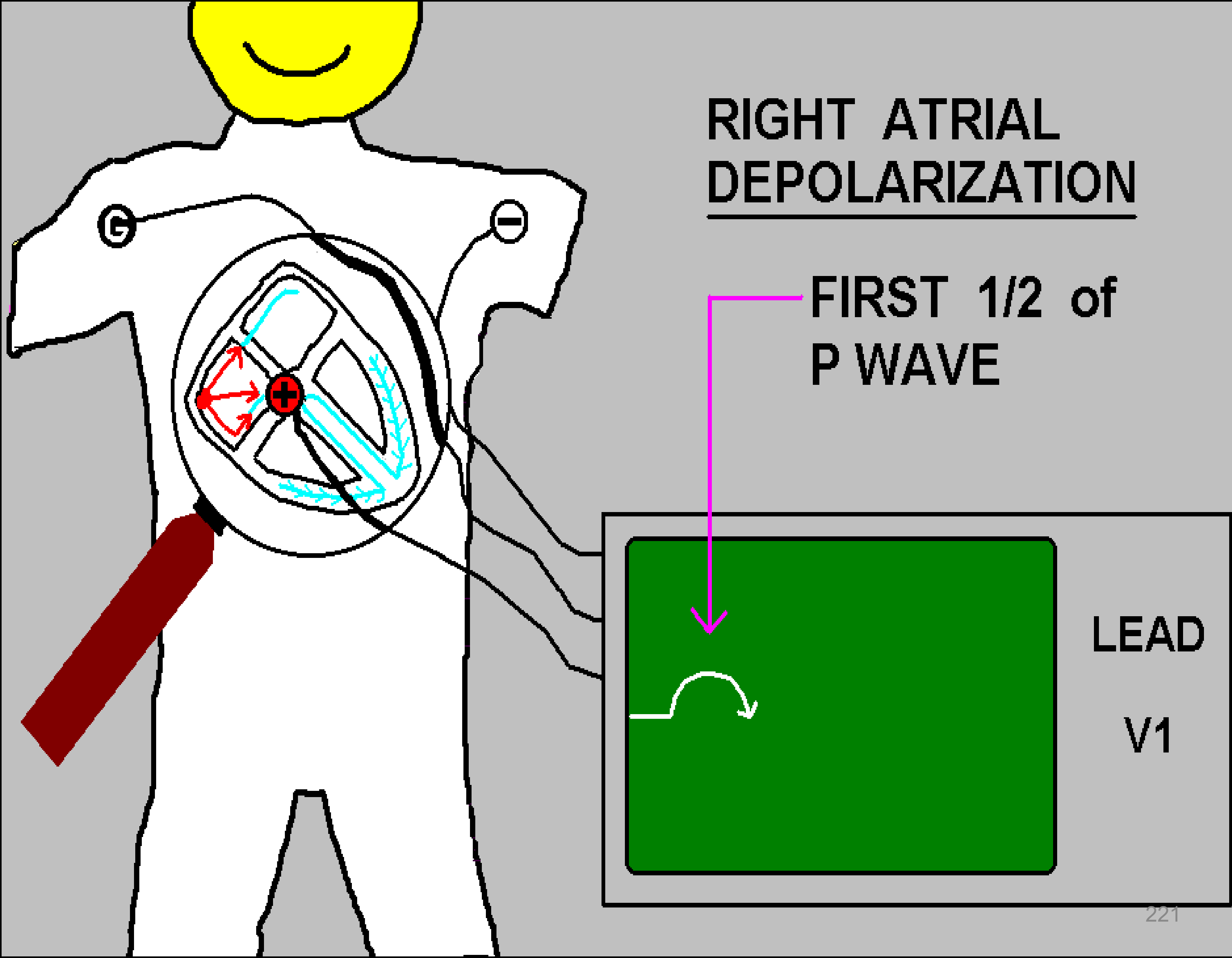


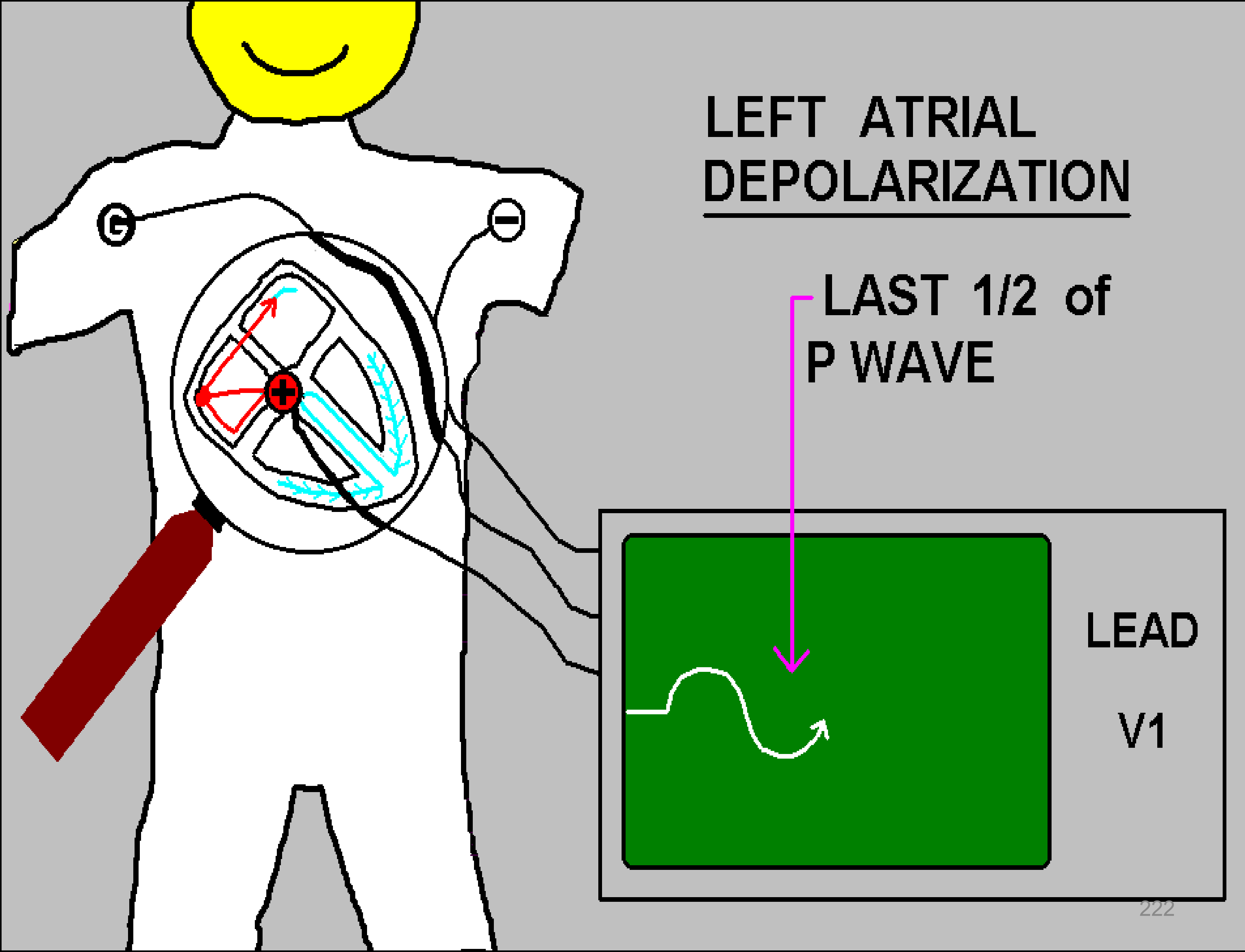
THE P WAVE

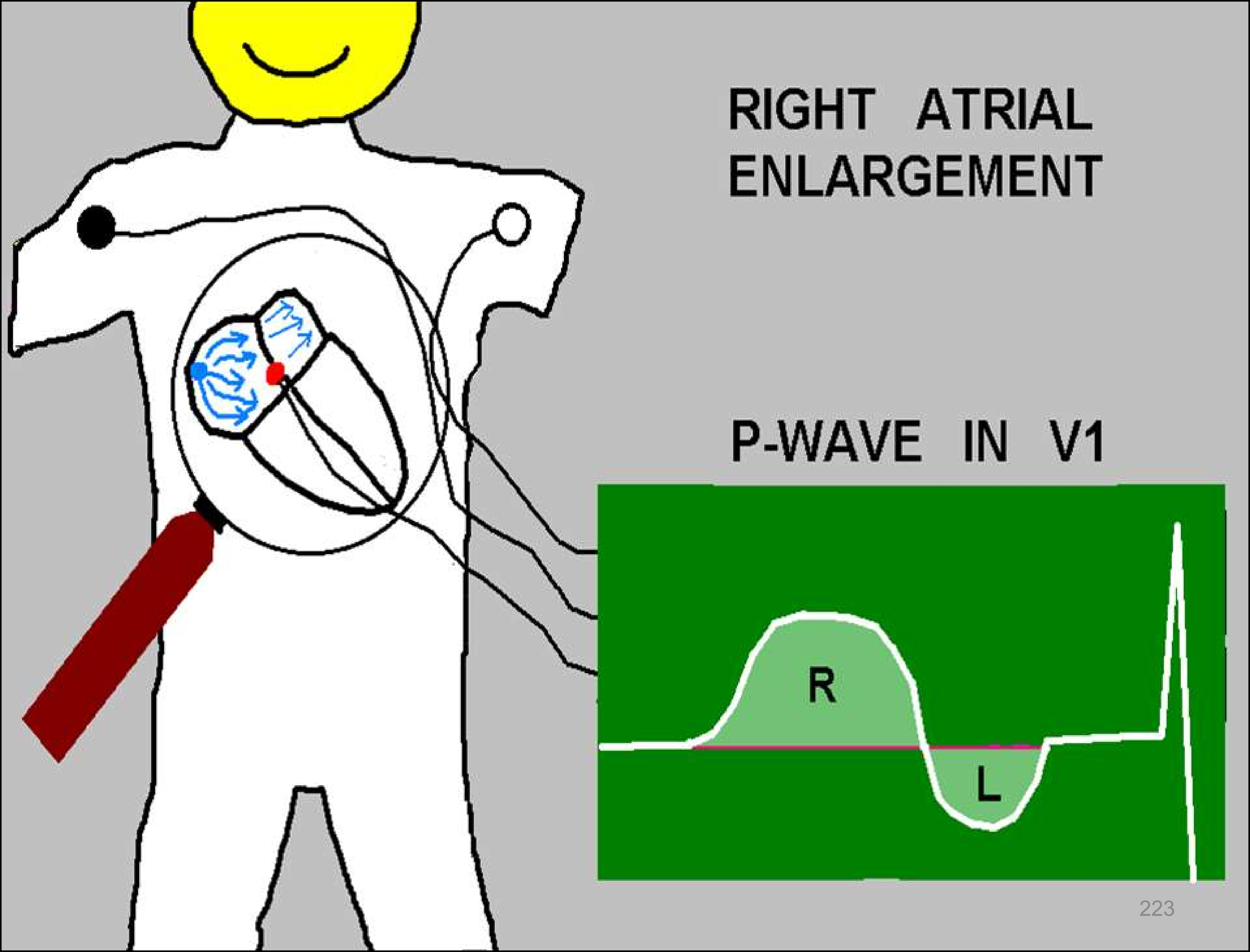
- WHEN THE P WAVE IS BI-PHASIC IN V1, IT DISPLAYS BOTH R and L ATRIAL DEPOLARIZATION



RIGHT ATRIAL DEPOLARIZATION

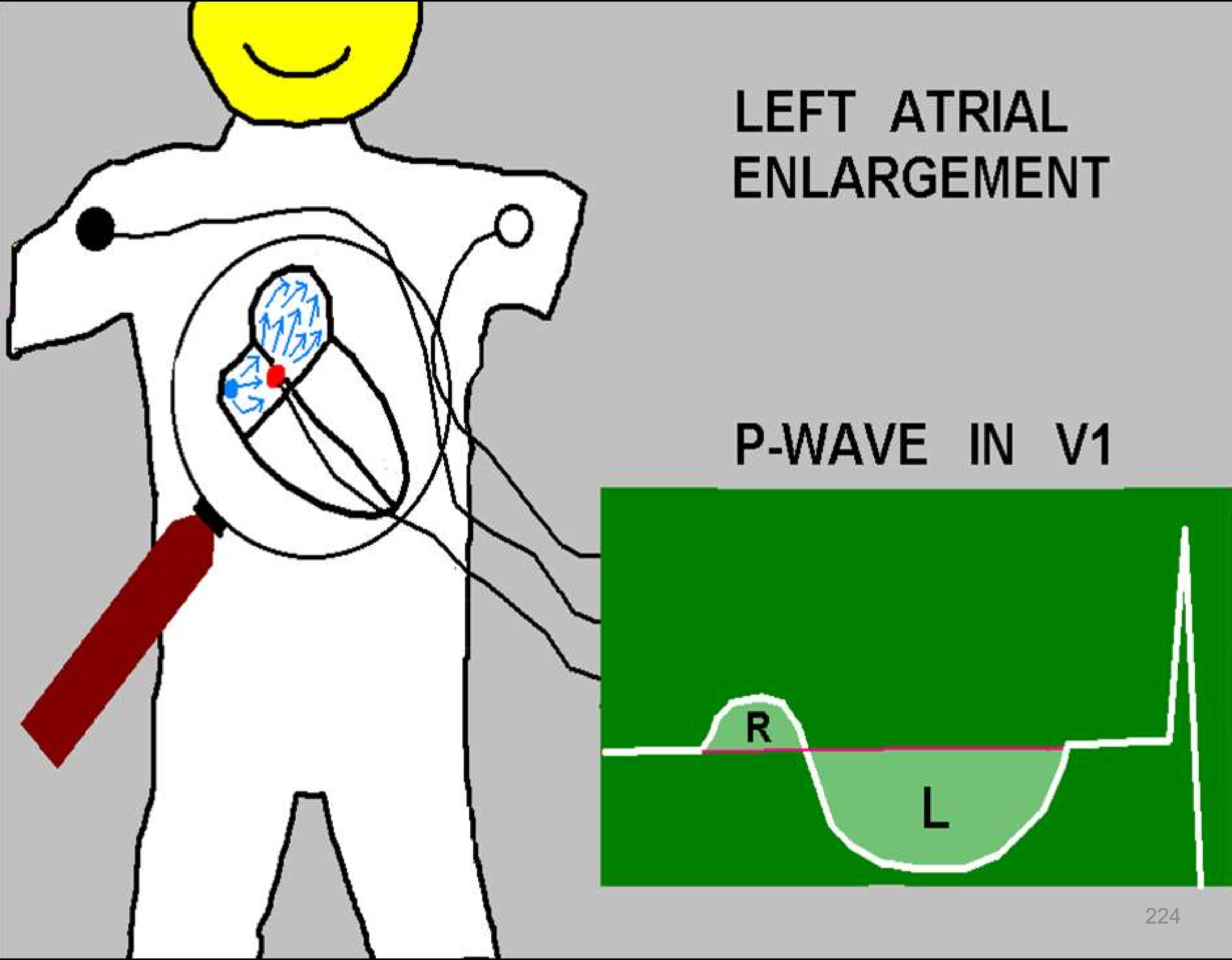



LEFT ATRIAL DEPOLARIZATION
G
LAST 1/2 of P WAVE
LEAD
V1


RIGHT ATRIAL ENLARGEMENT
P-WAVE IN V1
R
L

LEFT ATRIAL ENLARGEMENT

P-WAVE IN V1



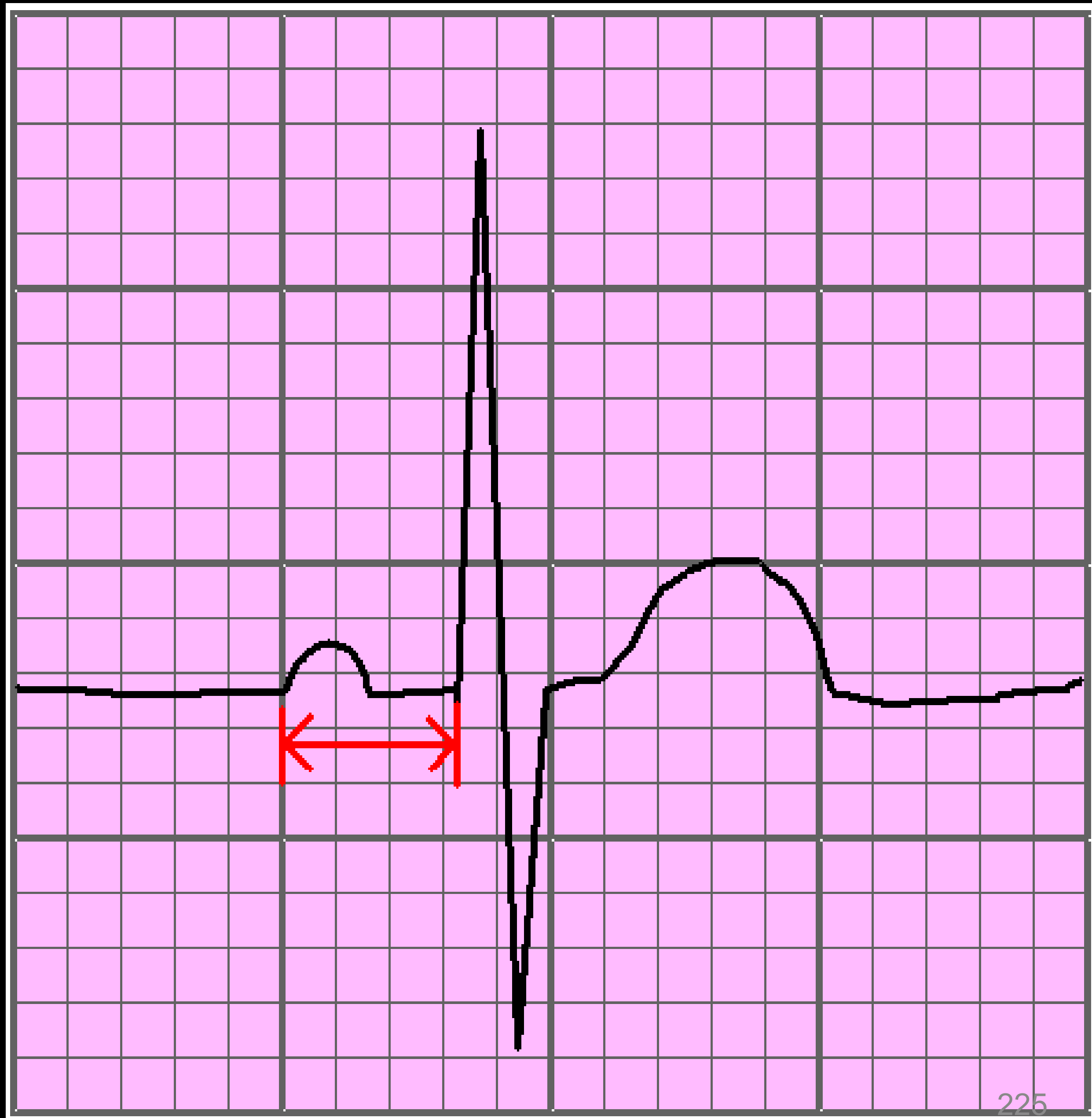
NORMAL P-R INTERVAL

.12 - .20 SEC

or

120 - 200

mSEC



P - R INTERVAL TOO SHORT . . .

LESS THAN 120 mSEC

THINK:

- ECTOPIC ATRIAL ACTIVITY
- PRE-EXCITATION (WPW)
- JUNCTIONAL (nearly on top of QRS, possibly inverted)

P - R INTERVAL TOO LONG

GREATER THAN 200 mSEC

THINK:

- HEART BLOCK

THE P-R SEGMENT

SHOULD

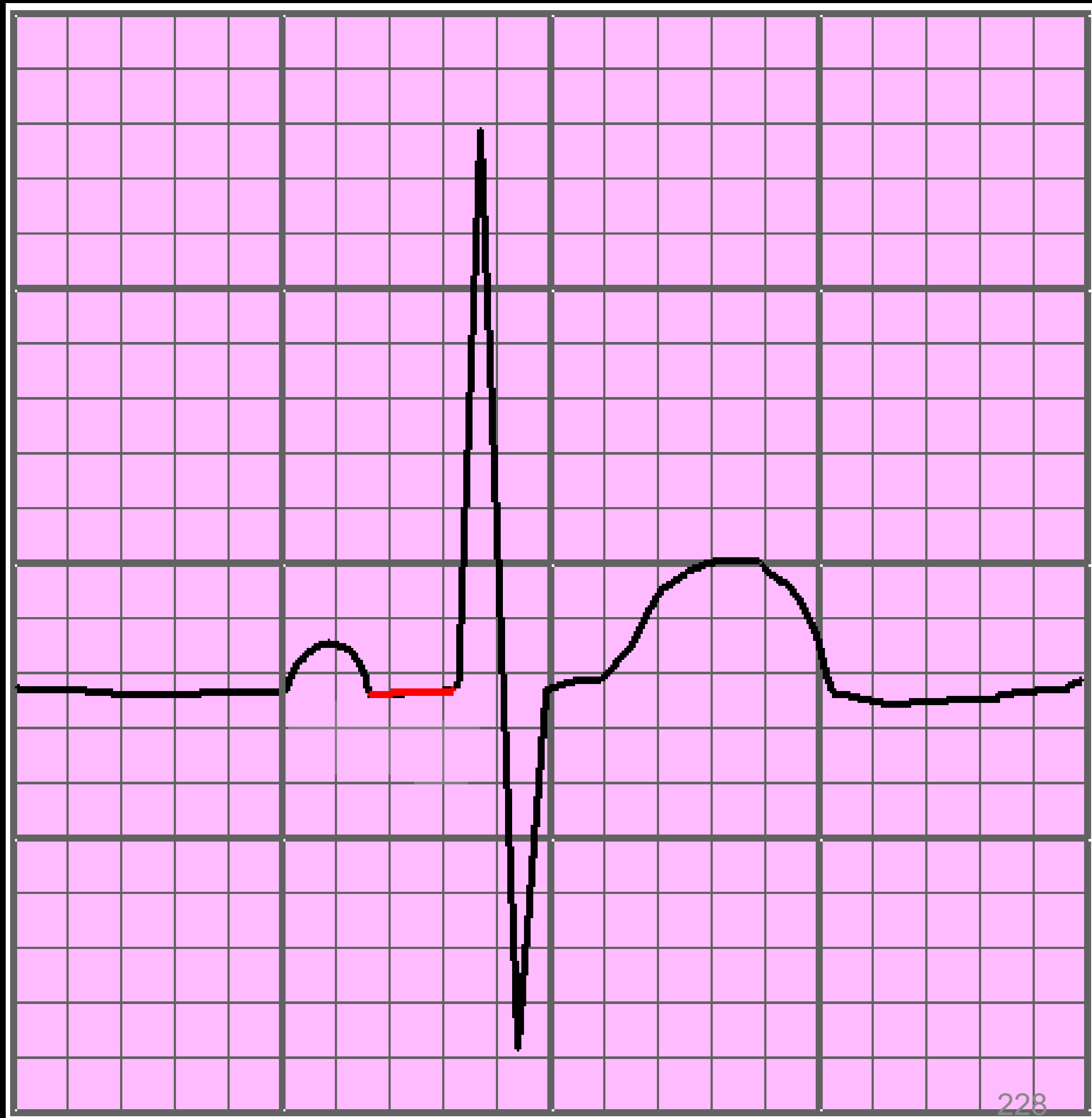
RETURN TO

THE

ISO-

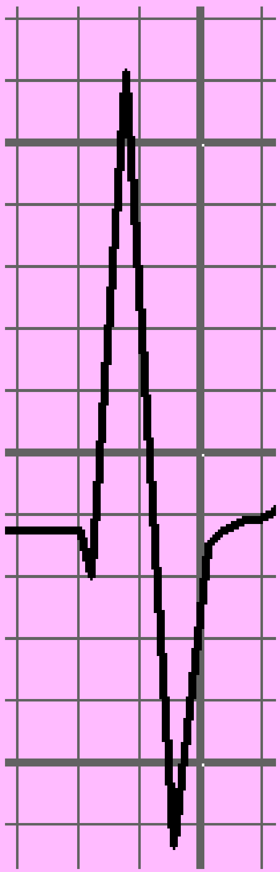
ELECTRIC

LINE.



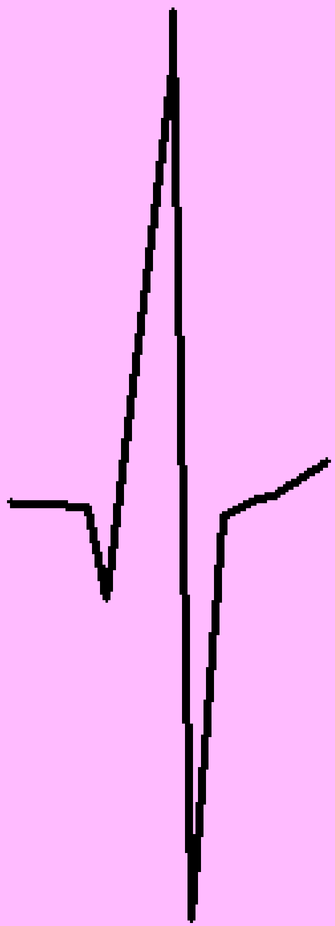
THE QRS COMPLEX

- MAY BE POSITIVE, NEGATIVE, OR BI- PHASIC, BASED ON THE LEAD VIEWED
- TOTAL WIDTH SHOULD BE LESS THAN 120 ms / or .12



THE QRS COMPLEX

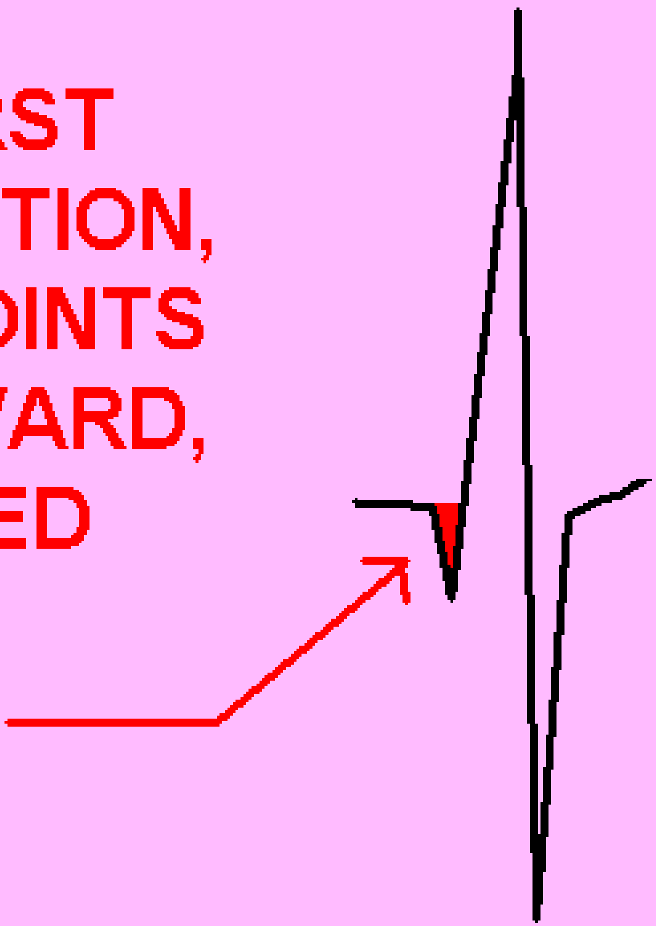
THIS QRS COMPLEX CONSISTS OF 3 DEFLECTIONS . . . .



THE QRS COMPLEX

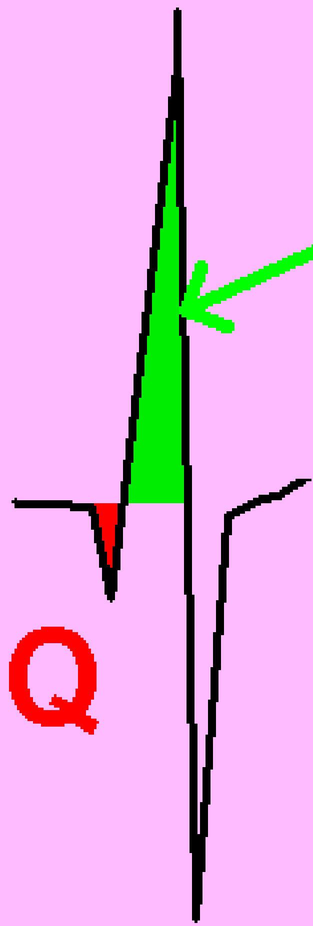
THIS QRS COMPLEX CONSISTS OF 3 DEFLECTIONS . . . .

THE FIRST DEFLECTION, IF IT POINTS DOWNWARD, IS NAMED THE "Q WAVE"



THE QRS COMPLEX

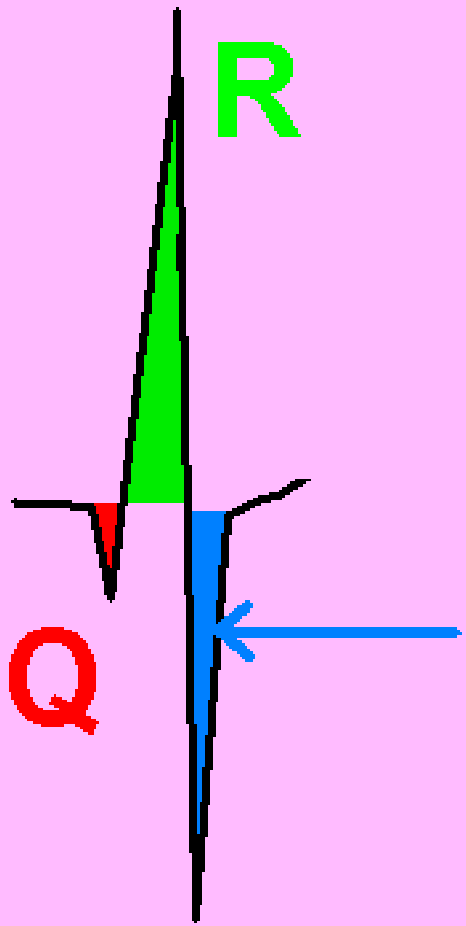
THIS QRS COMPLEX CONSISTS OF 3 DEFLECTIONS . . . .



THE FIRST POSITIVE DEFECTION IS KNOW AS THE "R" WAVE

THE QRS COMPLEX

THIS QRS COMPLEX CONSISTS OF 3 DEFLECTIONS . . . .

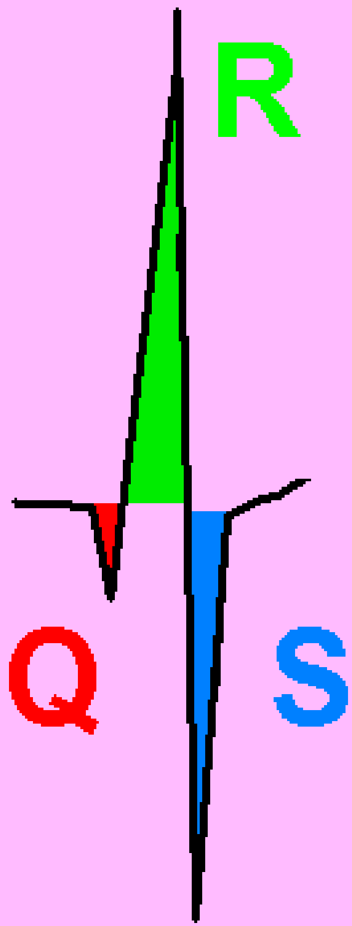


A NEGATIVE DEFLECTION AFTER THE R WAVE IS CALLED THE " S " WAVE

THE QRS COMPLEX

THIS QRS COMPLEX CONSISTS OF
3 DEFLECTIONS . . . .

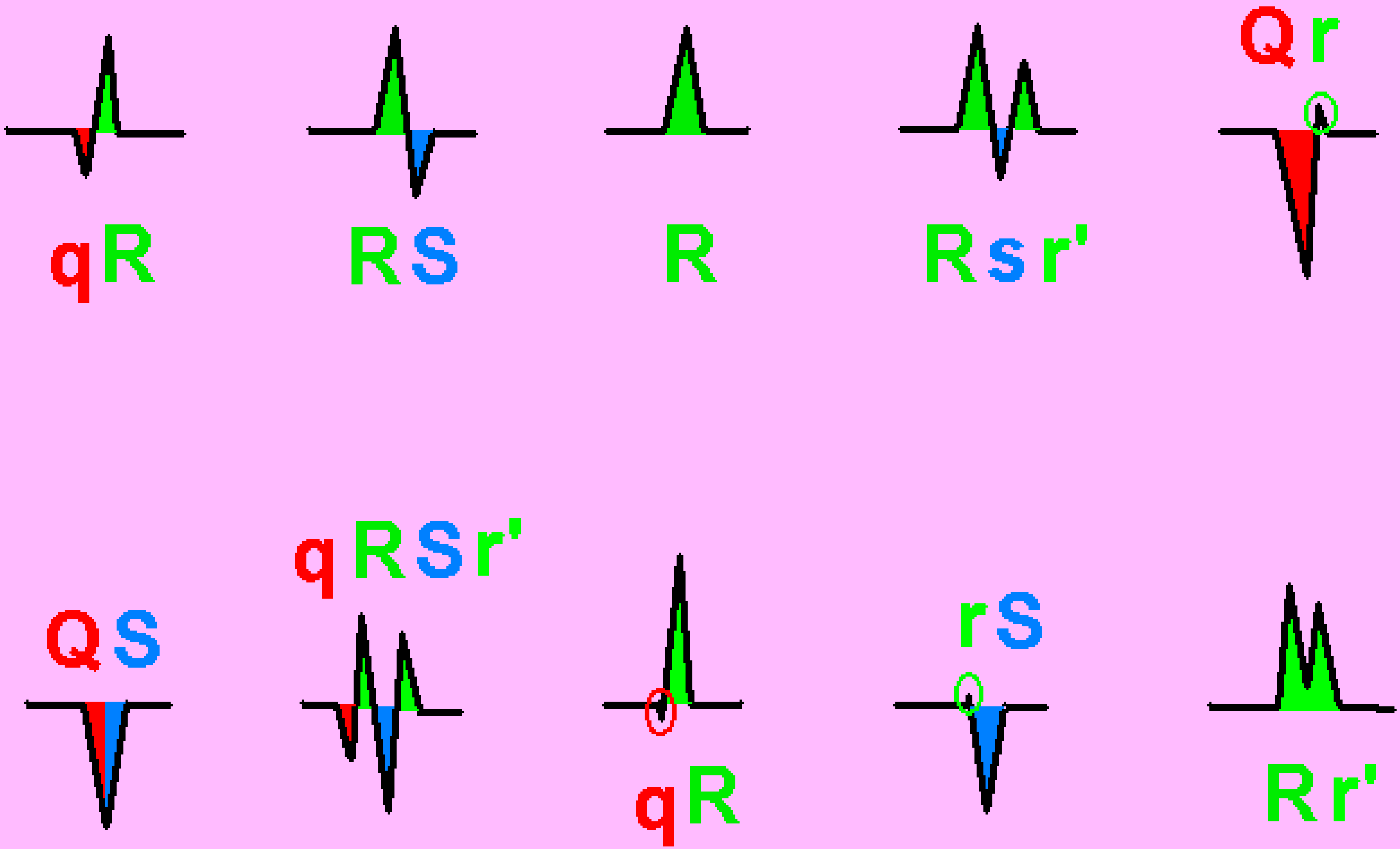
AND IS
THE <u>ONLY</u>
TRUE
"QRS"
COMPLEX



SOME OF
THE OTHER
VARIATIONS
INCLUDE . . . .

THE QRS COMPLEX

WHAT ARE THESE COMPLEXES ??



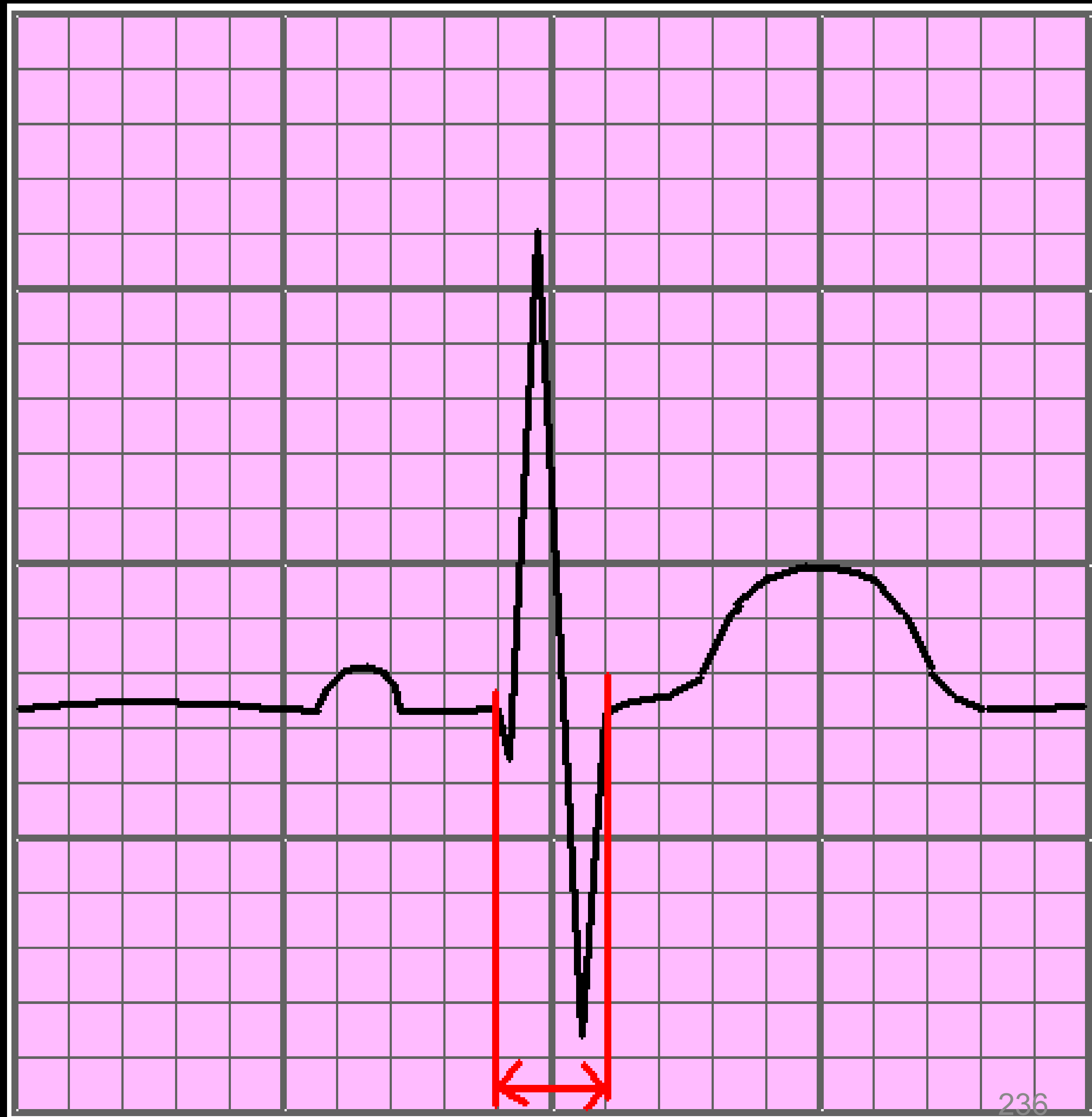
QRS INTERVAL

LESS THAN

.12

OR

120 mSEC



QRS COMPLEX TOO WIDE

WIDER THAN 120 mSEC

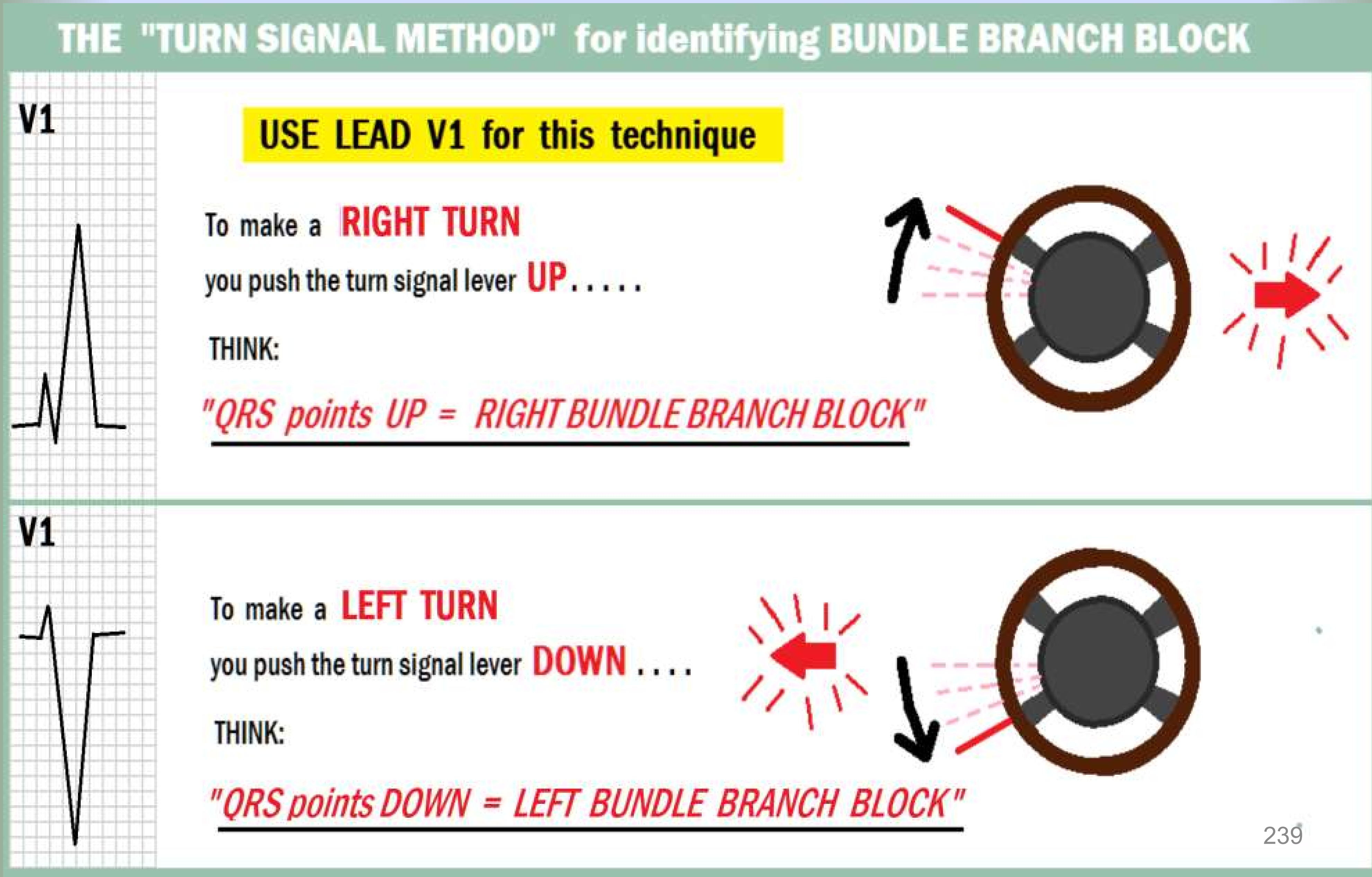
THINK:

- BUNDLE BRANCH BLOCK
- VENTRICULAR COMPEX (ES)
- PACED RHYTHM
- L VENTRICULAR HYPERTROPHY
- ELECTROLYTE IMBAL. ($\uparrow K^{+}$ $\downarrow Ca^{++}$)
- DELTA WAVE (PRE-EXCITATION)

Wide QRS present:
QRSd > 120ms

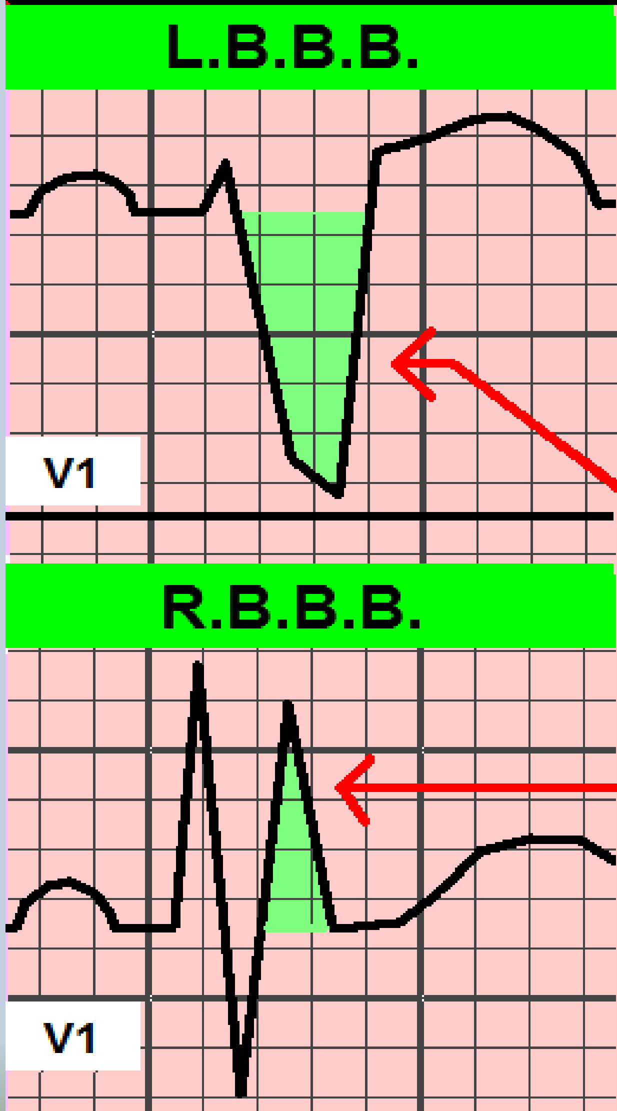
- Determine RIGHT vs. LEFT Bundle Branch Block Pattern

Simple “Turn Signal Method” . . .



“Terminal Phase of QRS Method”. . .

DIAGNOSING BUNDLE BRANCH BLOCK



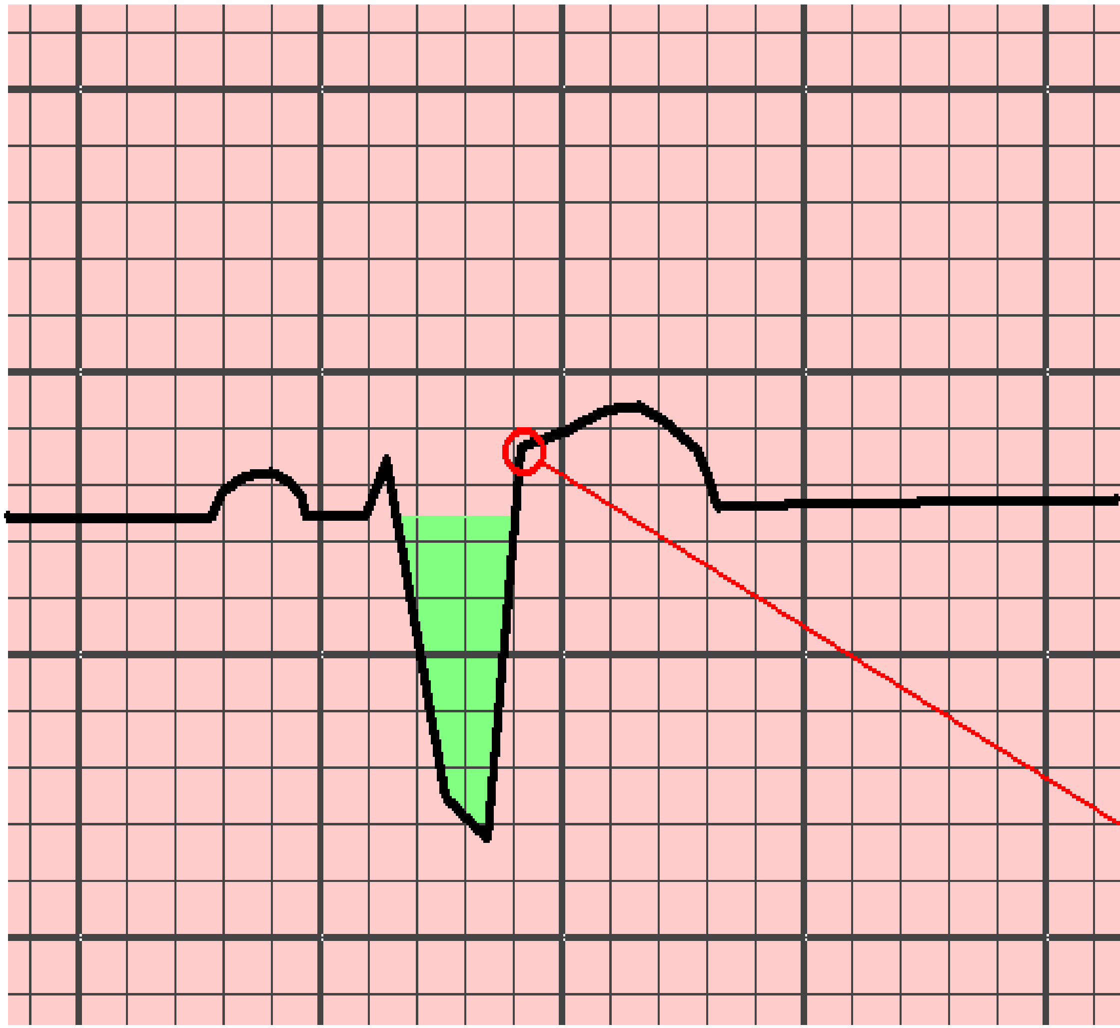
USING LEAD V1

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

NEGATIVE = LEFT BUNDLE BRANCH BLOCK

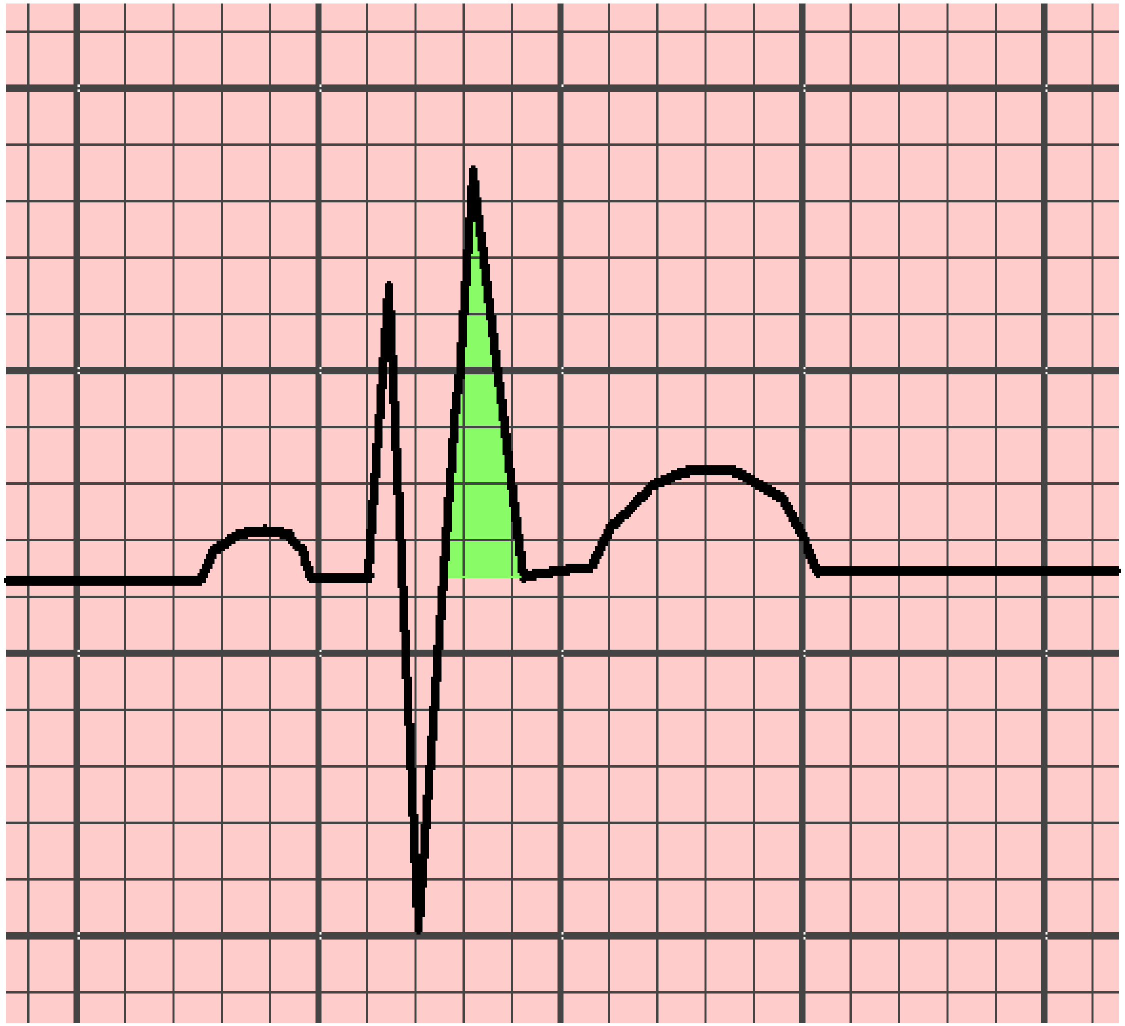
POSITIVE = RIGHT BUNDLE BRANCH BLOCK

DIAGNOSING LBBB IN LEAD V1:



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

DIAGNOSING RBBB IN LEAD V1:



- WIDER THAN 120 ms (.12)

(or 3 little boxes)

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

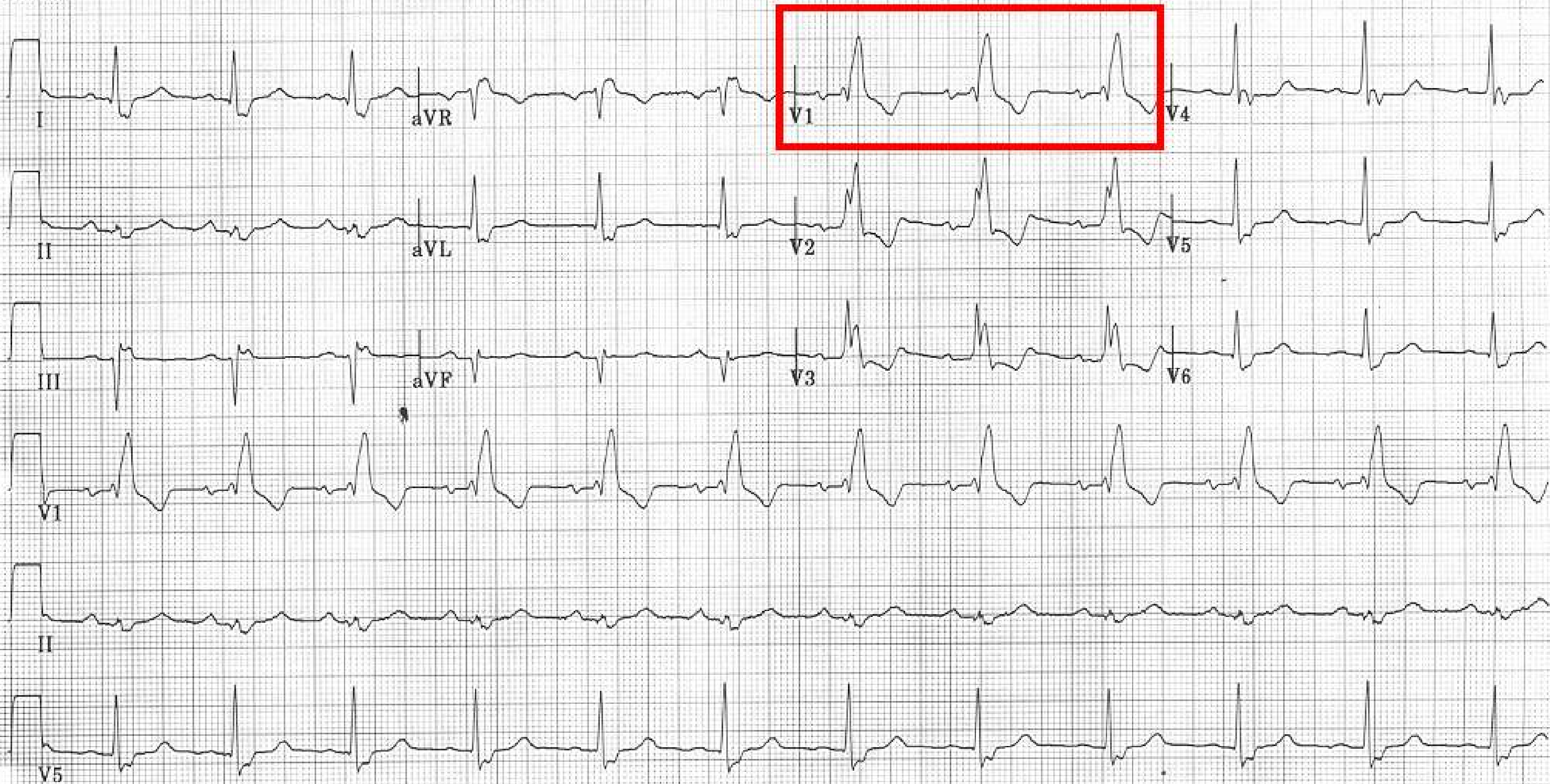
RUPPERT, WAYNE ID: 099999999 4-Mar-2001

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

Technician: WR

Referred by: Unconfirmed

D.O.S.:



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

TERMINAL PHASE OF QRS IS

POSITIVE

= RIGHT BUNDLE BRANCH BLOCK

09:16:40

74 yr
Female Caucasian

Loc:7 Option:35

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

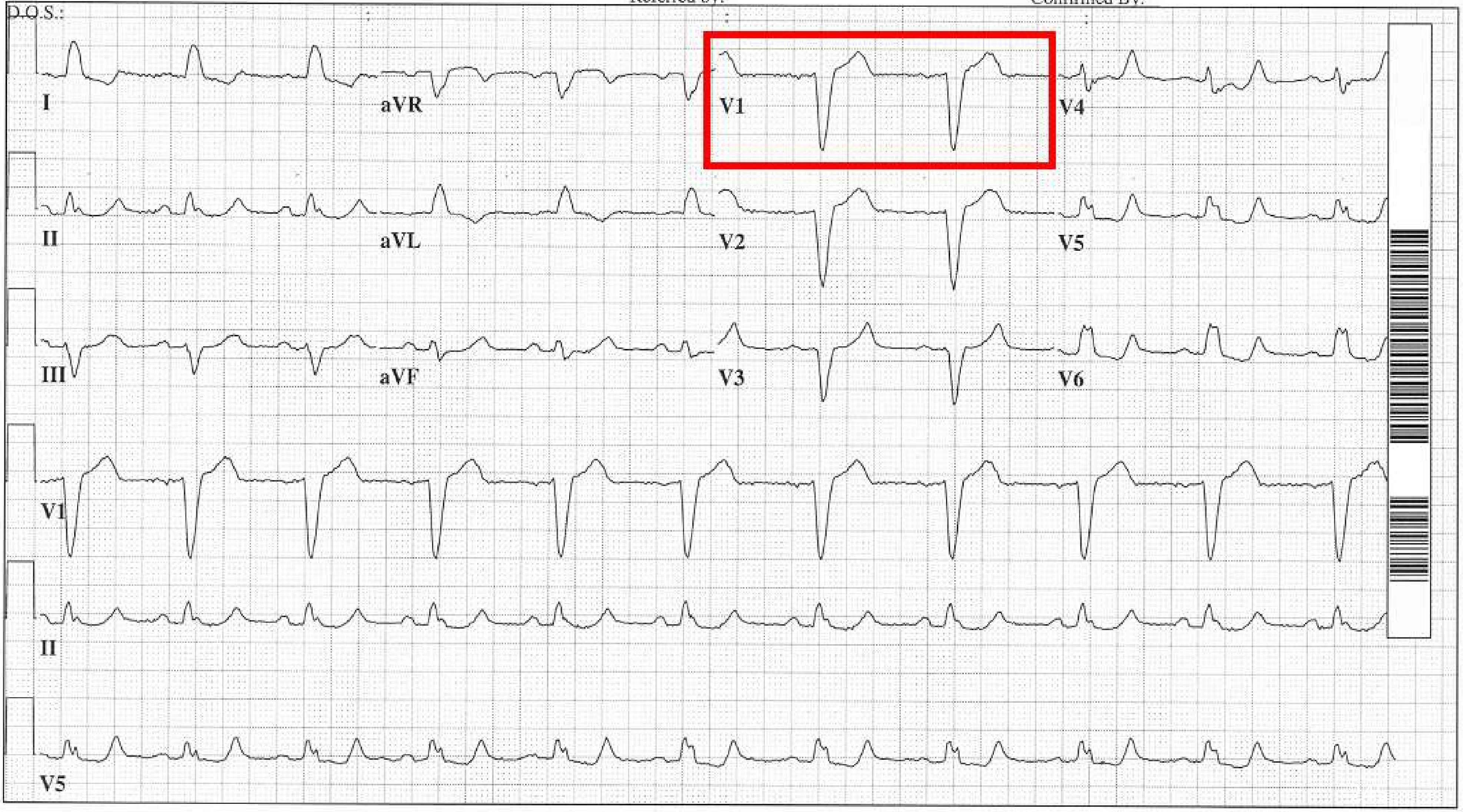
EKG #WR03029959

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

Technician: WW

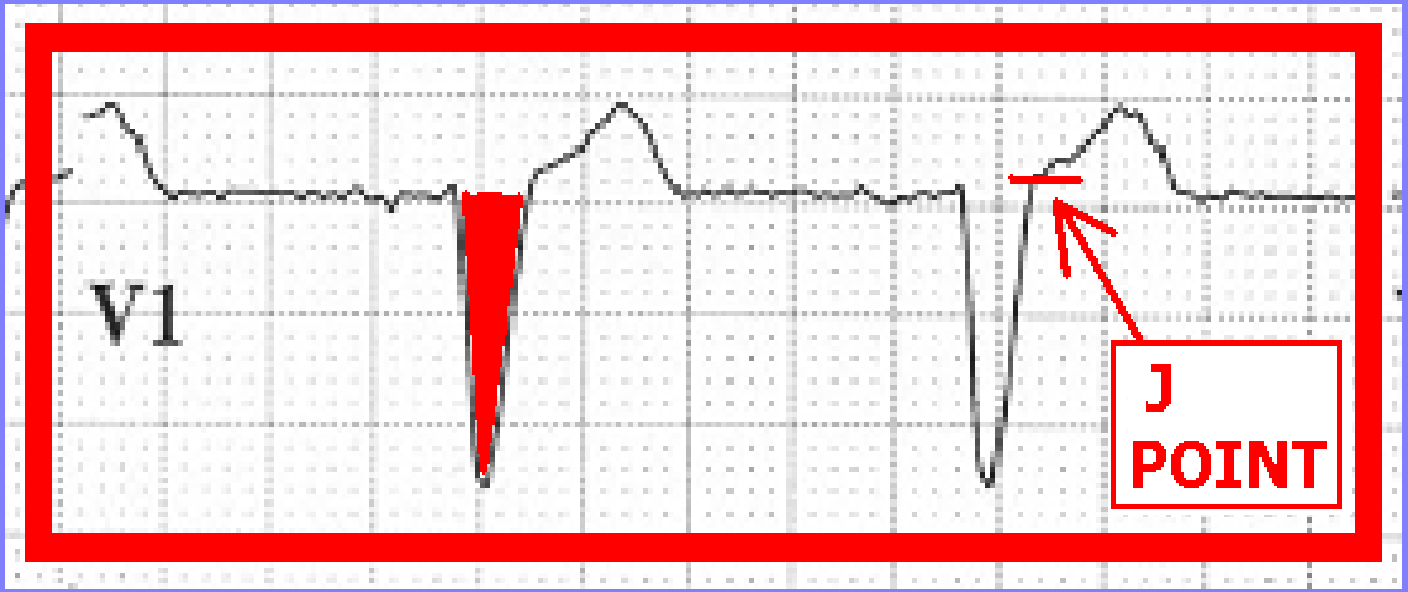
Referred by: Confirmed By:

D.O.S.:



25mm/s 10mm/mV 40Hz 005C 12SL 229 CID: 0 EID:5 EDT:

TERMINAL PHASE OF QRS IS NEGATIVE

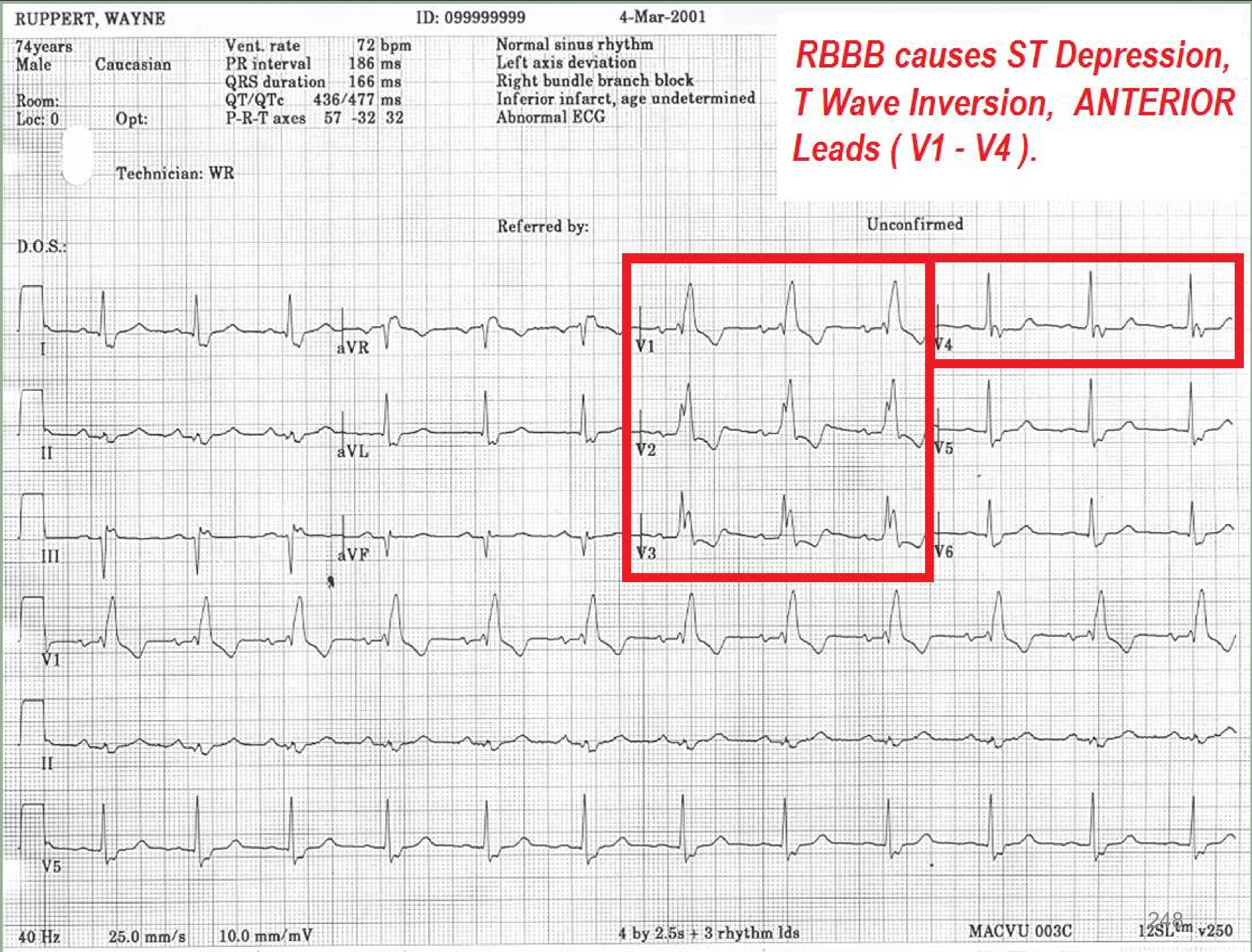


= LEFT BUNDLE BRANCH BLOCK

Wide QRS present:
(QRSd > 120ms)

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

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

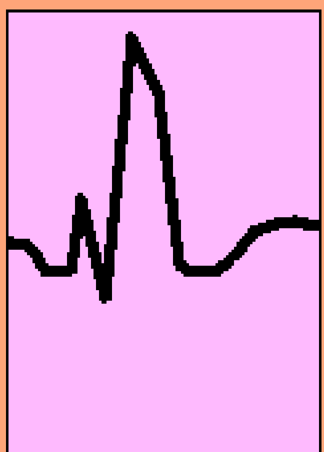


DIAGNOSING BUNDLE BRANCH BLOCK

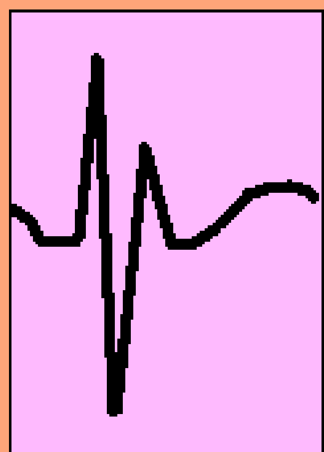
USING LEADS V1, V2, and V5, V6:

LOCATING RsR' or RR' COMPLEXES:

V1

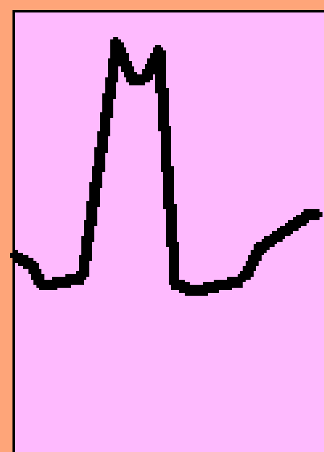


V2



RIGHT BUNDLE BRANCH BLOCK

V5



V6

LEFT BUNDLE BRANCH BLOCK

THE QRS COMPLEX

QRS HEIGHT

is a reflection of the QRS AMPLITUDE.

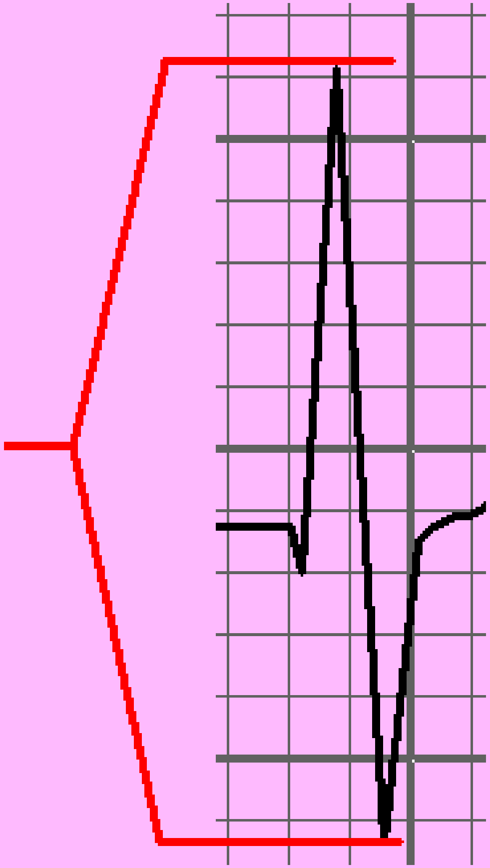
The NORMAL QRS AMPLITUDE varies from one lead to another . . .

THE QRS COMPLEX

QRS AMPLITUDE

is influenced by:

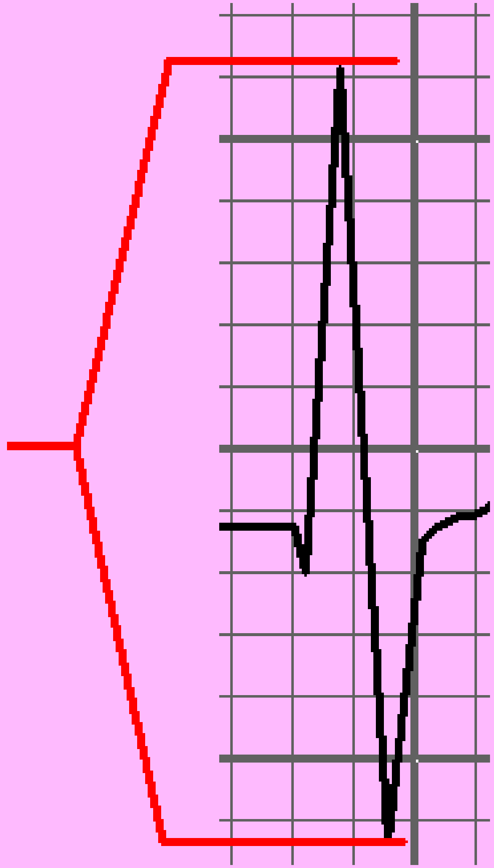
- age
- physical fitness
- body size
- conduction system disorders
- chamber hypertrophy



THE QRS COMPLEX

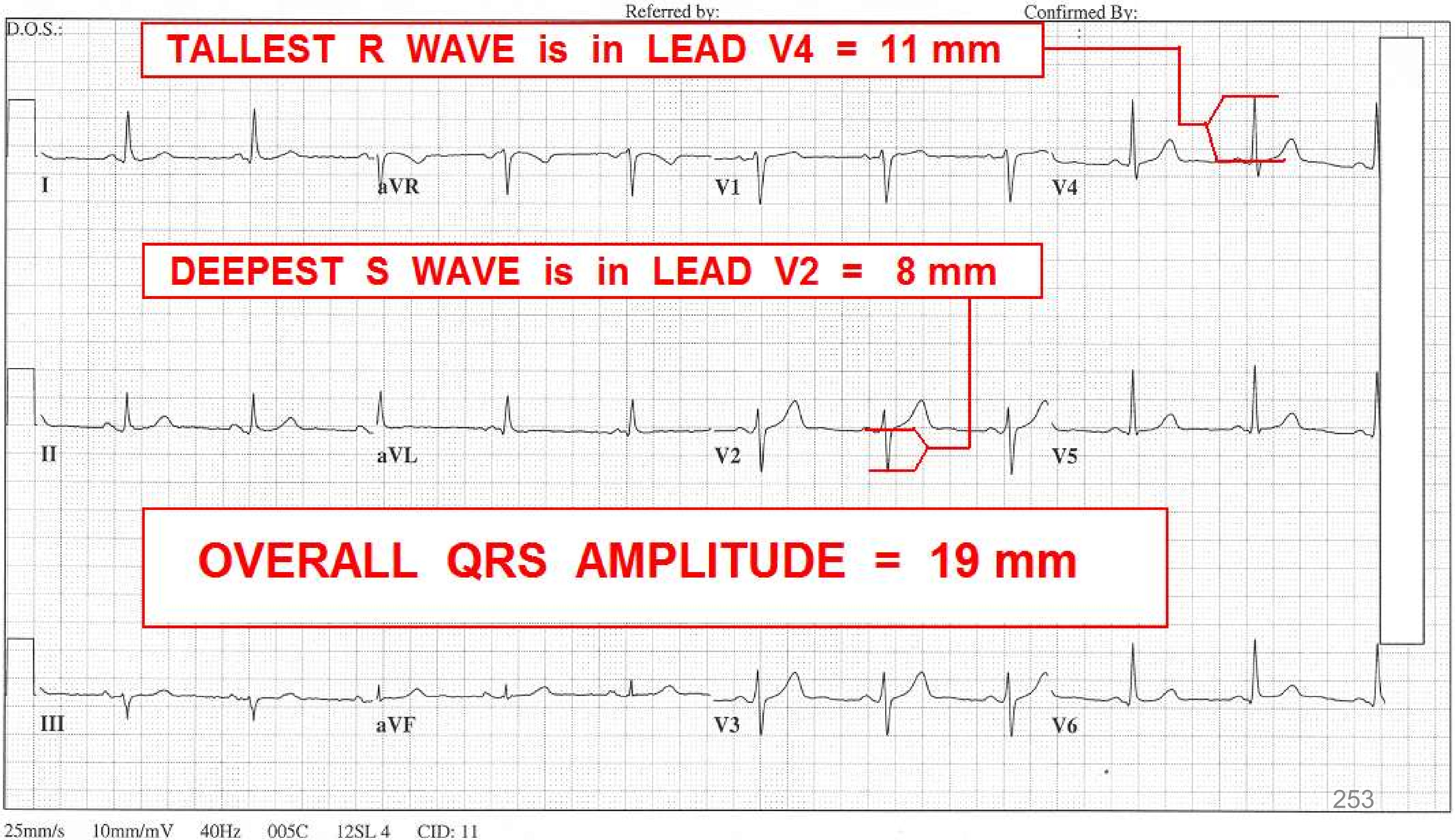
QRS AMPLITUDE

is measured by finding the TALLEST POSITIVE DEFLECTION (R WAVE) and the DEEPEST NEGATIVE DEFLECTION (S WAVE) on the 12 LEAD EKG and ADDING THE VALUES TOGETHER



MEASURING THE "OVERALL QRS AMPLITUDE"

Add the SIZE of the TALLEST R WAVE to the SIZE of the DEEPEST S WAVE . . . .



THE QRS COMPLEX

QRS AMPLITUDE

MAXIMUM NORMAL VALUES are difficult to define due to differences in PATIENT AGE, BODY SIZE, and FITNESS.

HOWEVER A GENERAL VALUE GUIDELINE IS: 3.0 mV (30 mm on normally calibrated EKG)

OVERALL QRS AMPLITUDE TOO HIGH:

(GREATER THAN 3.0 mV / 30 mm)

THINK:

☛ VENTRICULAR HYPERTROPHY

Hypertrophy “Cheats”:

- WHEN QRS COMPLEX(ES) “SPEAR” OUTSIDE OF THEIR SPACE.
- WHEN QRS COMPLEXES SPEAR THROUGH OTHER LEADS ! . . . . . .

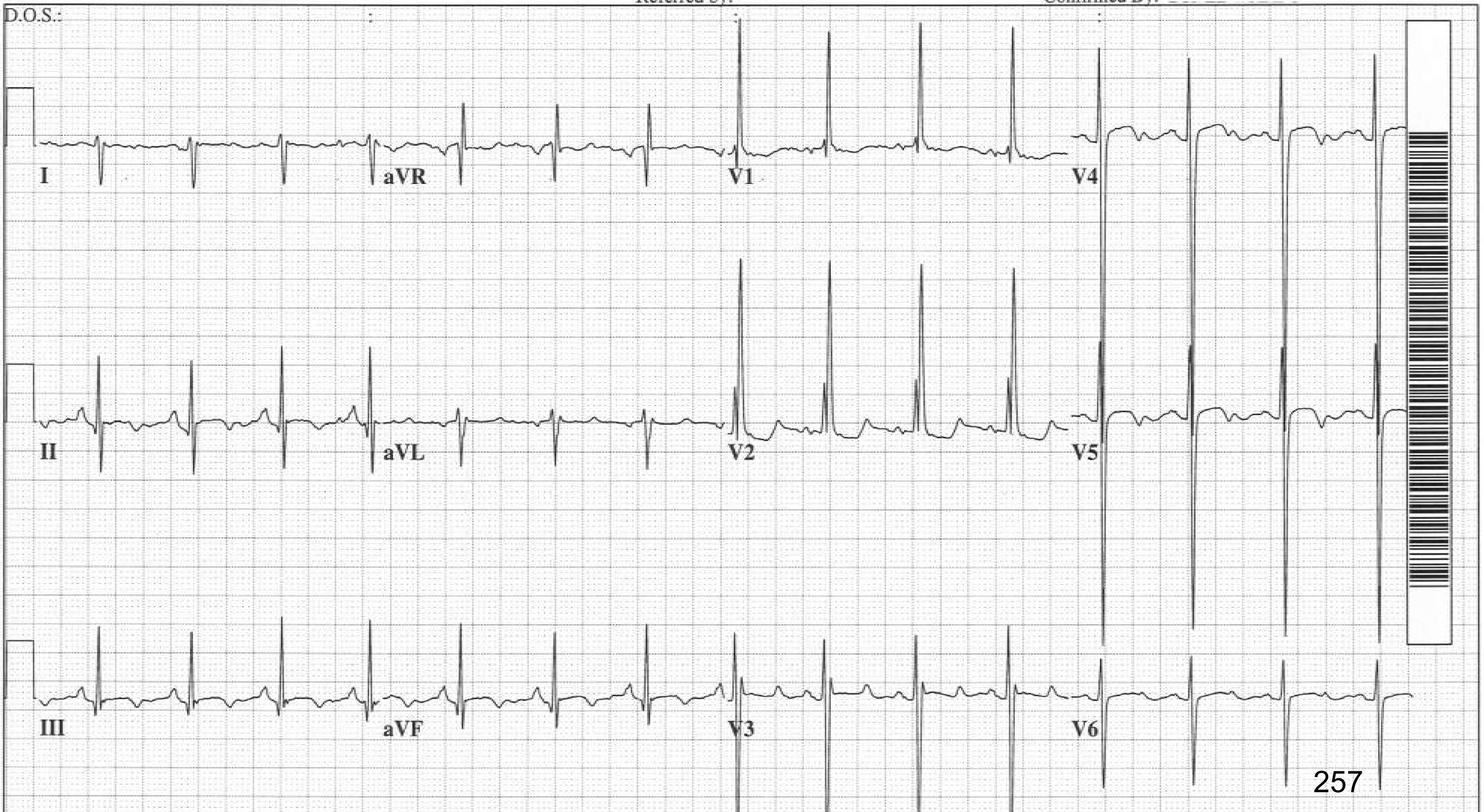
14–JUL–1997 14:30:58 ST. JOSEPH'S HOSPITAL–ER ROUTINE RETRIEVAL

17 yr		Vent. rate	90	BPM
Male	Black	PR interval	136	ms
		QRS duration	94	ms
Room:ER		QT/QTc	378/462	ms
Loc:3	Option:16	P–R–T axes	77 123	58

Normal sinus rhythm
Right atrial enlargement
Right axis deviation
Incomplete right bundle branch block , plus right ventricular hypertrophy
NORMAL SINUS INFERIOR LATERAL CHANGES
Abnormal ECG

EKG CLASS #WRO3616941

Referred by: Confirmed By:



25mm/s 10mm/mV 40Hz 005C 12SL 4 CID: 11 EID:11 EDT: 17:04 15–JUL–1997 ORDER:

19-JUN-1997 22:28:08 ST. JOSEPH'S HOSPITAL-ER ROUTINE RETRIEVAL

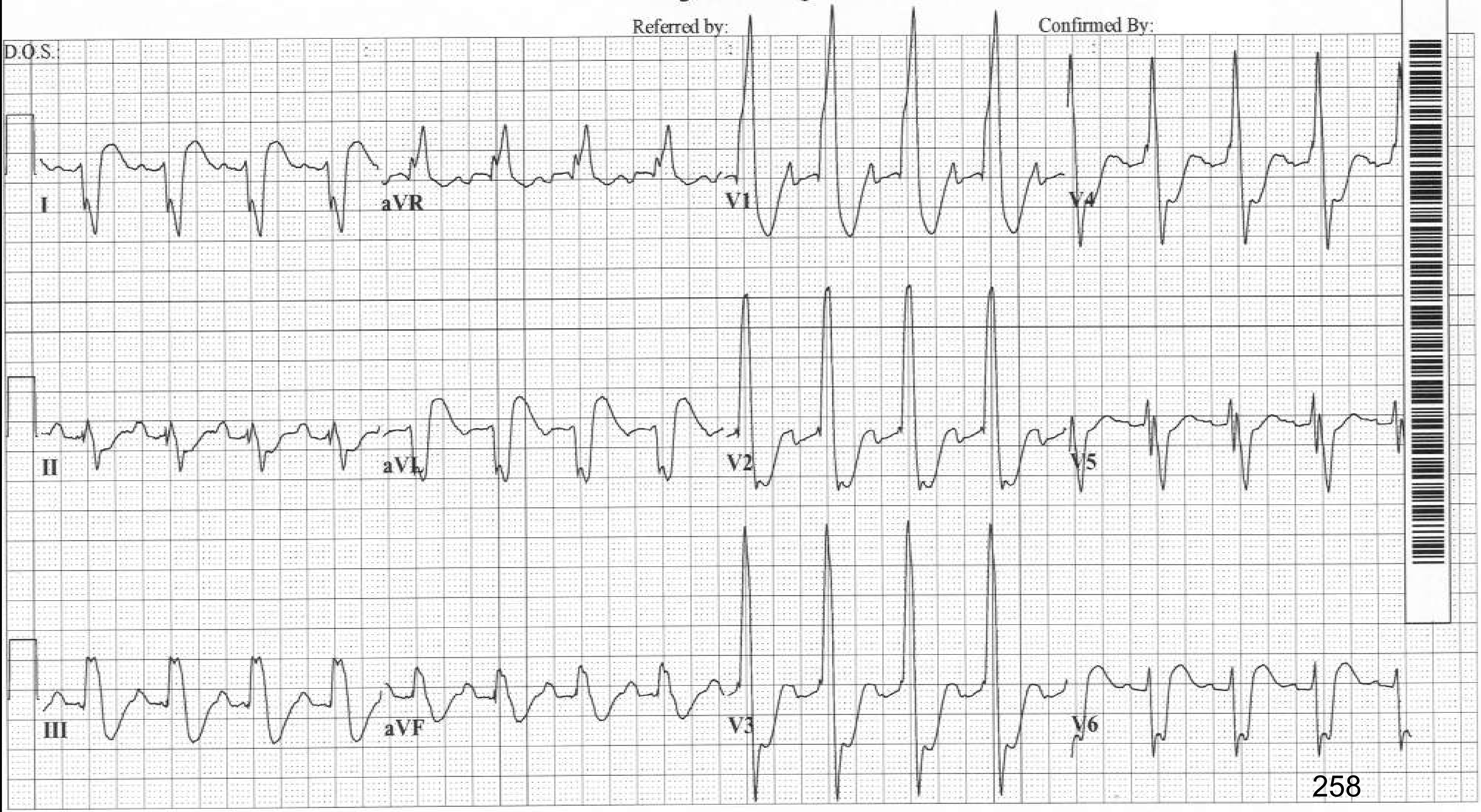
53 yr		Vent. rate	100	BPM
Male	Caucasian	PR interval	198	ms
		QRS duration	186	ms
Room:ER S3		QT/QTc	380/490	ms
Loc:3	Option:18	P-R-T axes	79 163	-20

Normal sinus rhythm
Left atrial enlargement
Right bundle branch block , plus right ventricular hypertrophy
Left posterior fascicular block
*** Bifascicular block ***
NONSPECIFIC ST CHANGES
Abnormal ECG
When compared with ECG of 21-APR-1996 11:44,
No significant change was found

EKG CLASS #WR03028722

Referred by: Confirmed By:

D.O.S.:



258

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

EID:13 EDT: 23:01 20-JUN-1997 ORDER:

18–NOV–2002 02:15:46 ST. JOSEPH'S HOSPITAL–ER 1ST PREVIOUS

53 yr		Vent. rate	115	BPM
Male	Black	PR interval	160	ms
		QRS duration	92	ms
Room:ER		QT/QTc	316/437	ms
Loc:3	Option:23	P–R–T axes	76 –39	59

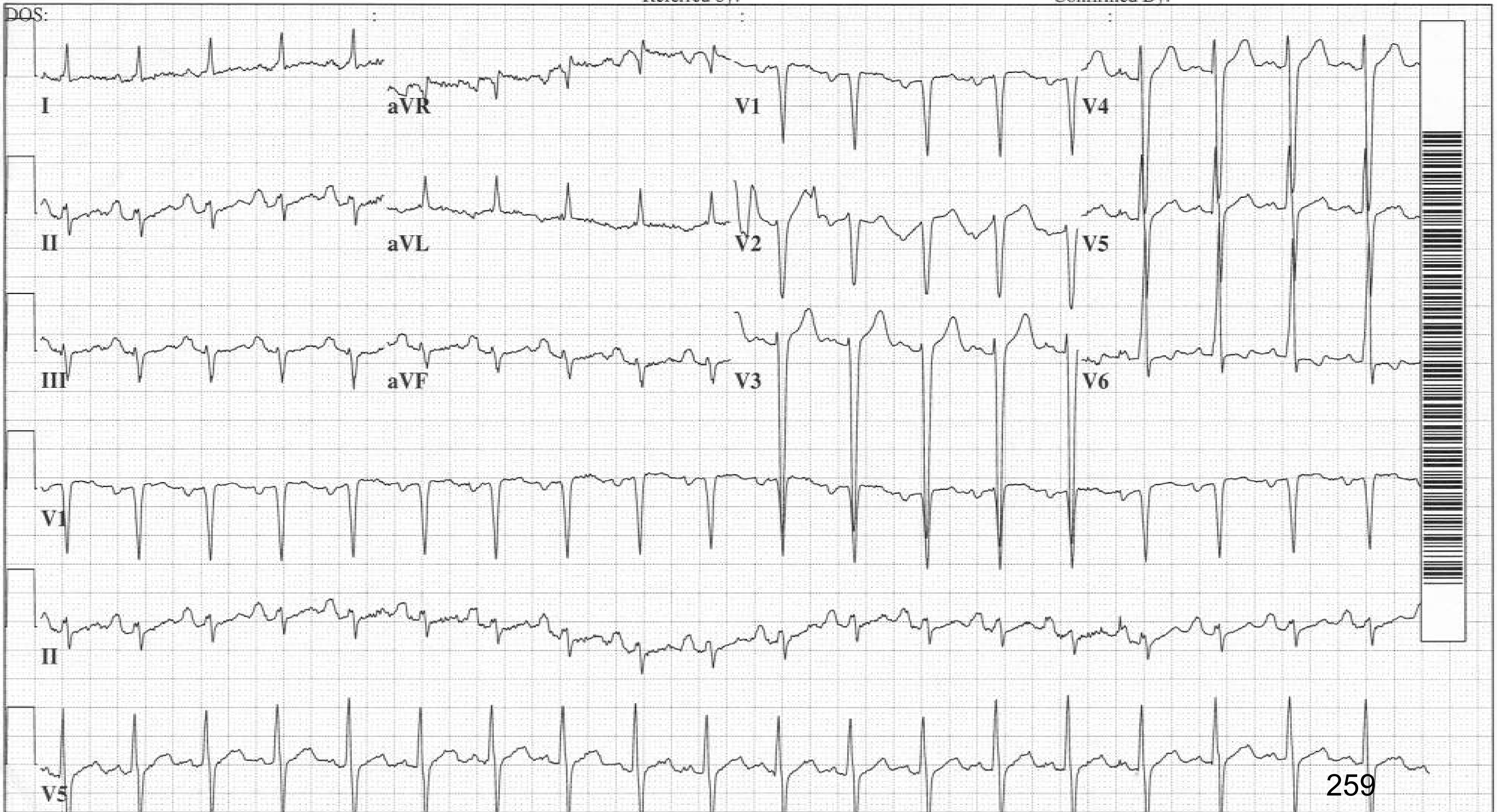
EKG CLASS #WR03896717

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

Sinus tachycardia
Possible Left atrial enlargement
Left axis deviation
Left ventricular hypertrophy
Abnormal ECG
No previous ECGs available

Referred by: Confirmed By:

DOS:



25mm/s 10mm/mV 40Hz 005C 12SL 233 CID: 7 EID:28 EDT: 11:27 18–NOV–2002 ORDER:

10–APR–2003 11:49:36 ST. JOSEPH'S HOSPITAL–CCR ROUTINE RETRIEVAL

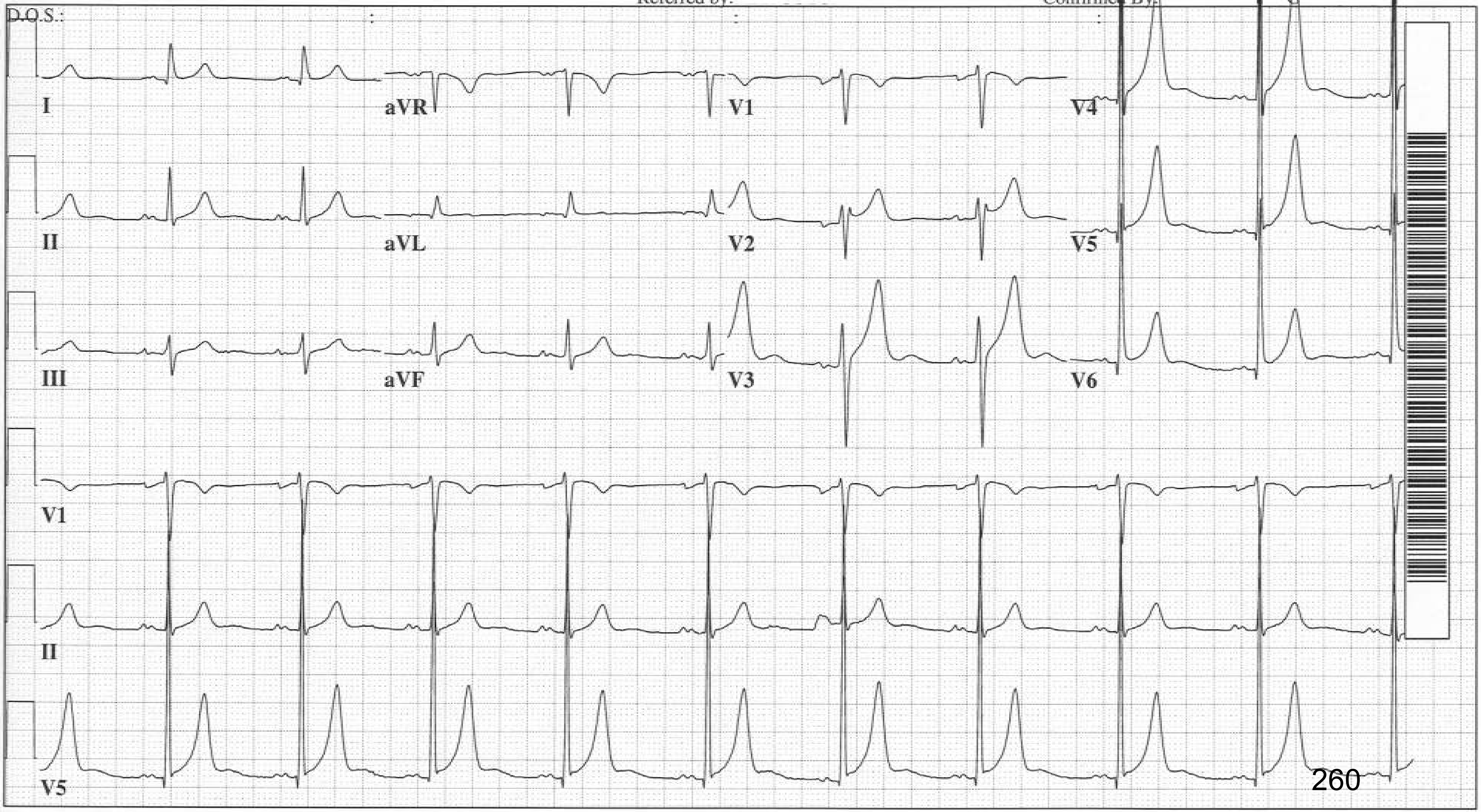
61 yr		Vent. rate	60	BPM	
Male	Black	PR interval	176	ms	
		QRS duration	90	ms	
		QT/QTc	400/400	ms	
Loc:7	Option:35	P–R–T axes	62 33	60	

Normal sinus rhythm
Voltage criteria for left ventricular hypertrophy
Abnormal ECG
When compared with ECG of 02–SEP–2002 09:00,
Vent. rate has decreased BY 44 BPM

EKG CLASS #WR03503400

Referred by: Confirmed By: G

D.O.S.:



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

EID:28 EDT: 10:43 14–APR–2003 ORDER:

THE QRS COMPLEX

QRS AMPLITUDE

<u>CRITERIA FOR MINIMUM AMPLITUDE:</u>

Abnormally LOW QRS VOLTAGE occurs when the OVERALL QRS is:

$\leq$ 0.5 mV IN ANY LIMB LEAD

— *and* —

$\leq$ 1.0 mV IN ANY PRECORDIAL LEAD

OVERALL QRS AMPLITUDE TOO LOW:

(VERTICAL QRS SIZE)

THINK (in absence of obvious OBESITY) :

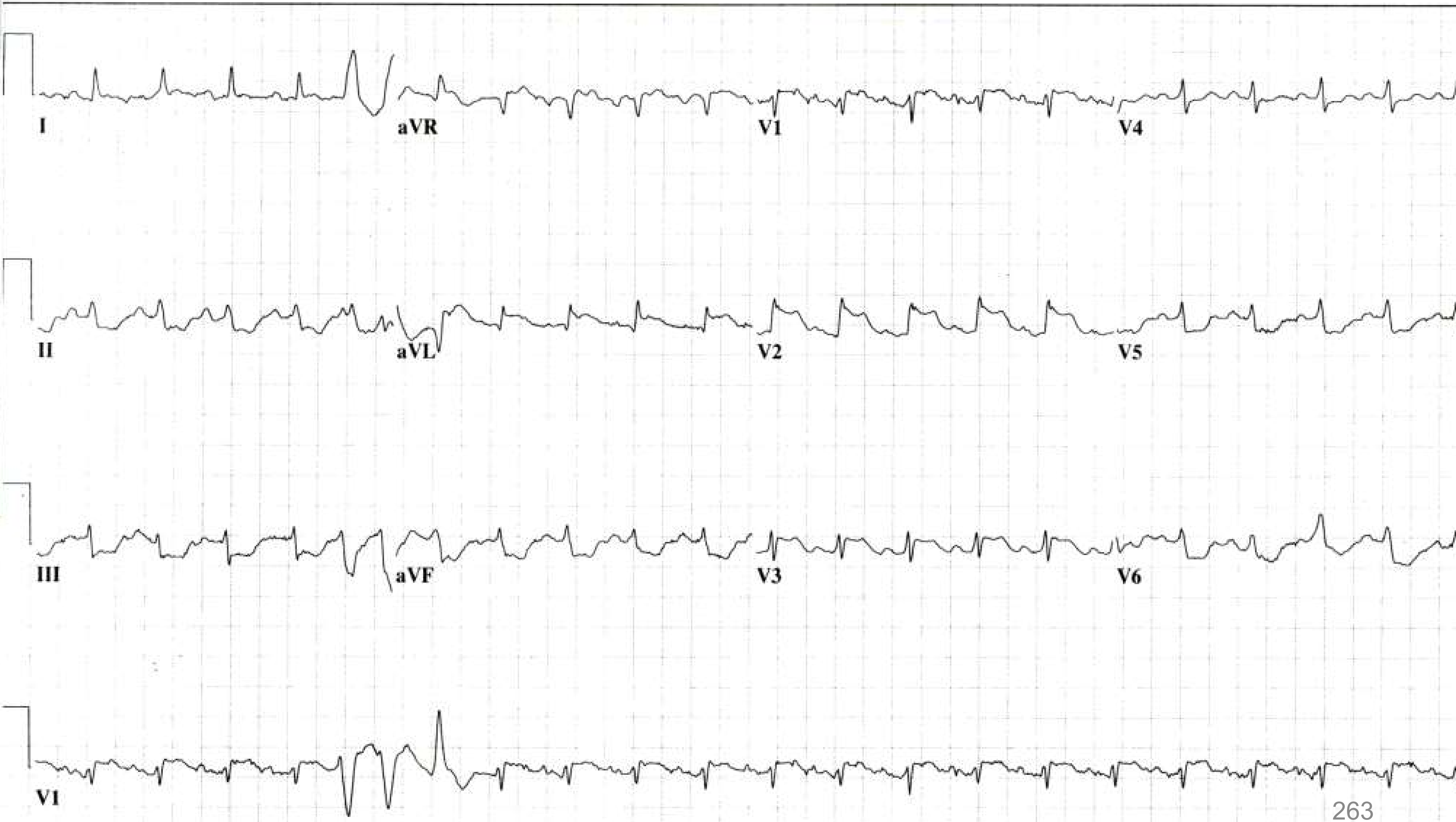
- MYOCARDITIS / CONSTRICTIVE PERICARDITIS
- EFFUSIONS / TAMPONADE
- COPD c HYPERINFLATION
- AMYLOIDOSIS (abnormal protein accumulation in organs)
- SCLERODERMA (abnormal hardening of skin)
- HEMACHROMOTOSIS (excessive iron buildup in blood / organs)
- MYXEDEMA (thyroid disorder)

33 yr
Female Black

Room:ATL
Loc:3 Option:23

Vent. rate	132	BPM
PR interval	154	ms
QRS duration	76	ms
QT/QTc	282/417	ms
P–R–T axes	51 17	–80

"**unedited copy: report is computer generated only, without physician interpretation".
*** Age and gender specific ECG analysis ***
Sinus tachycardia with occasional , and consecutive
Premature ventricular complexes
Low voltage QRS
ST elevation consider anterolateral injury or acute infarct
*** ** ** ** * ACUTE MI ** ** ** **
Abnormal ECG
No previous ECGs available



33 yr
Female Black

Room:ATL
Loc:3 Option:23

Vent. rate	132	BPM
PR interval	154	ms
QRS duration	76	ms
QT/QTc	282/417	ms
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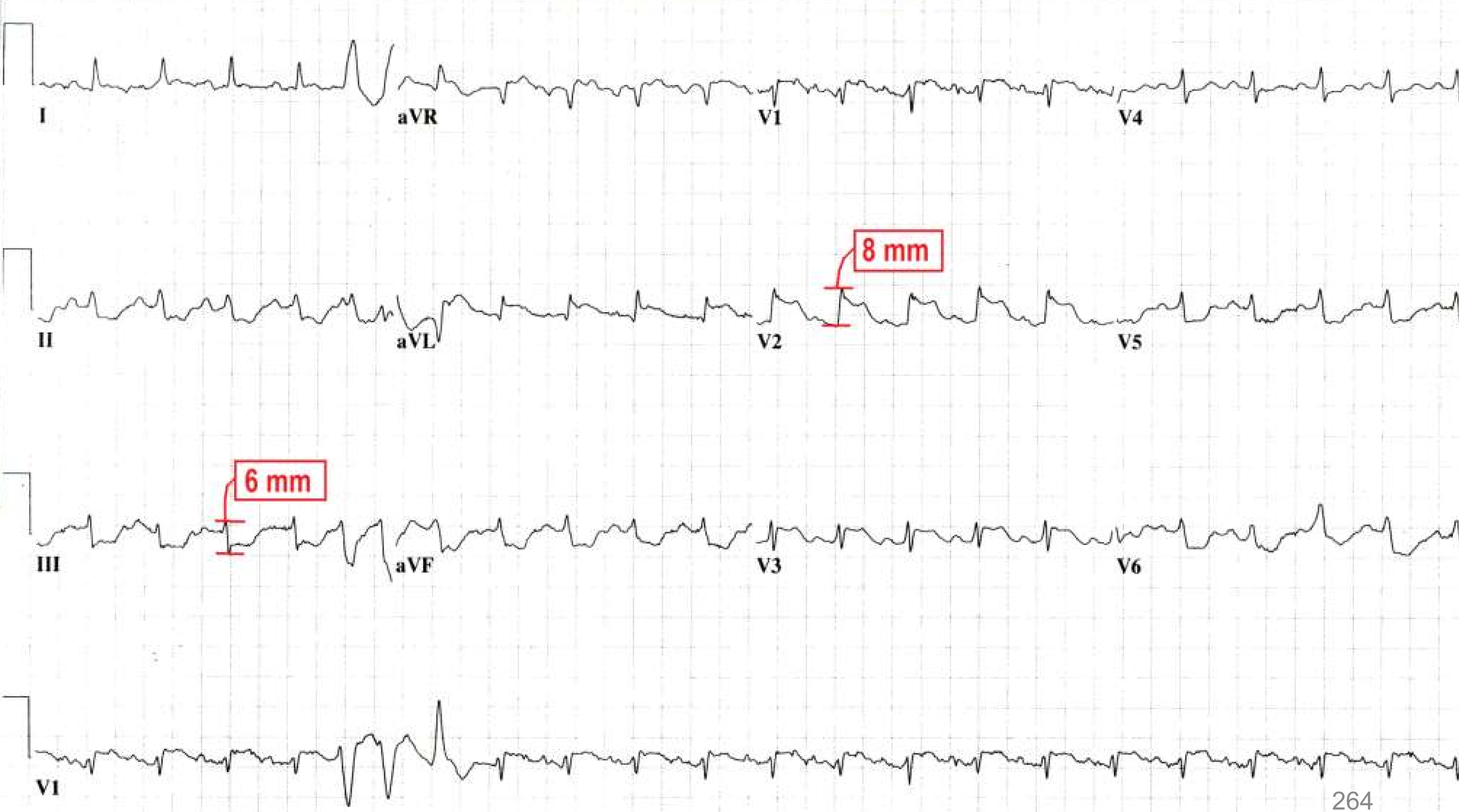
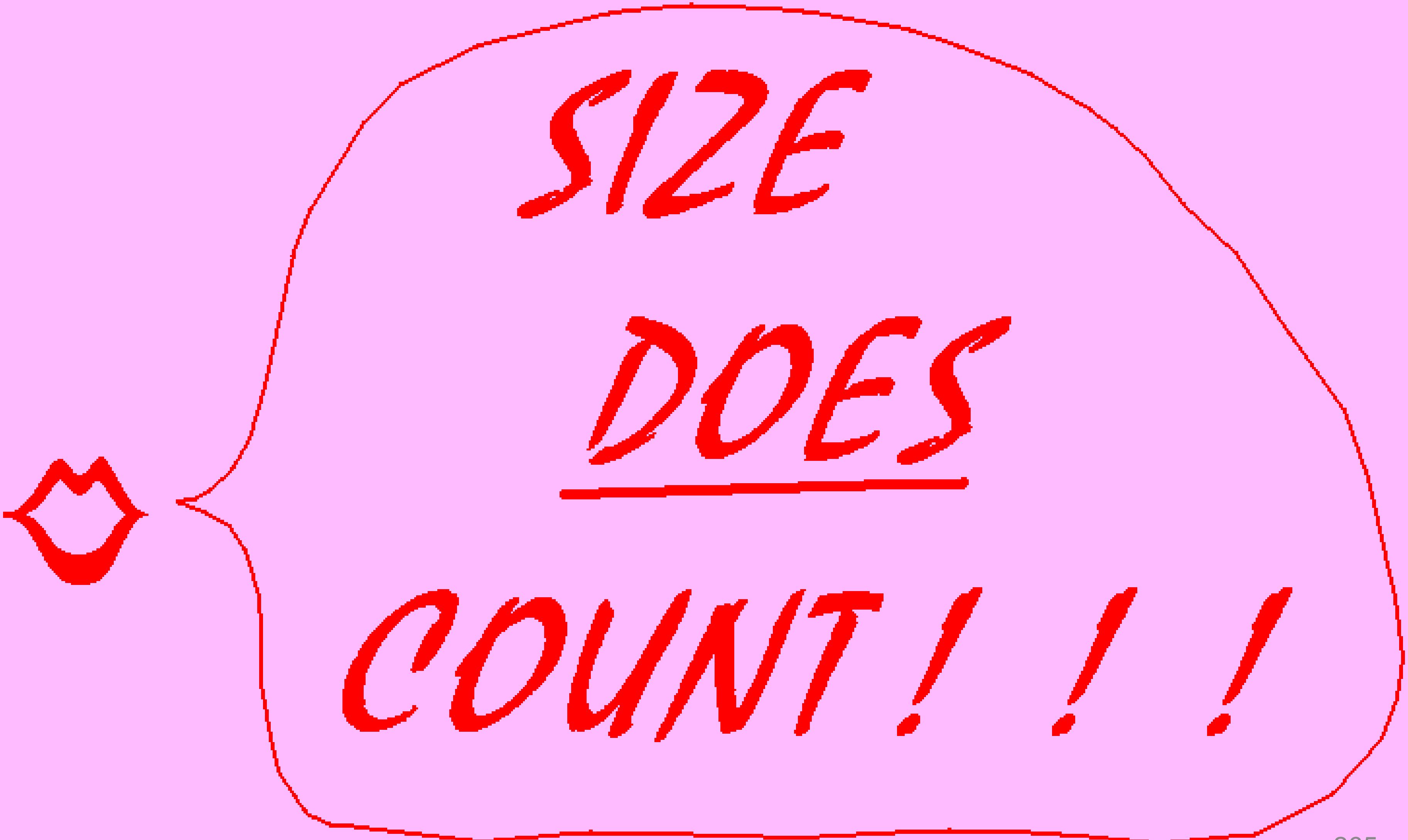
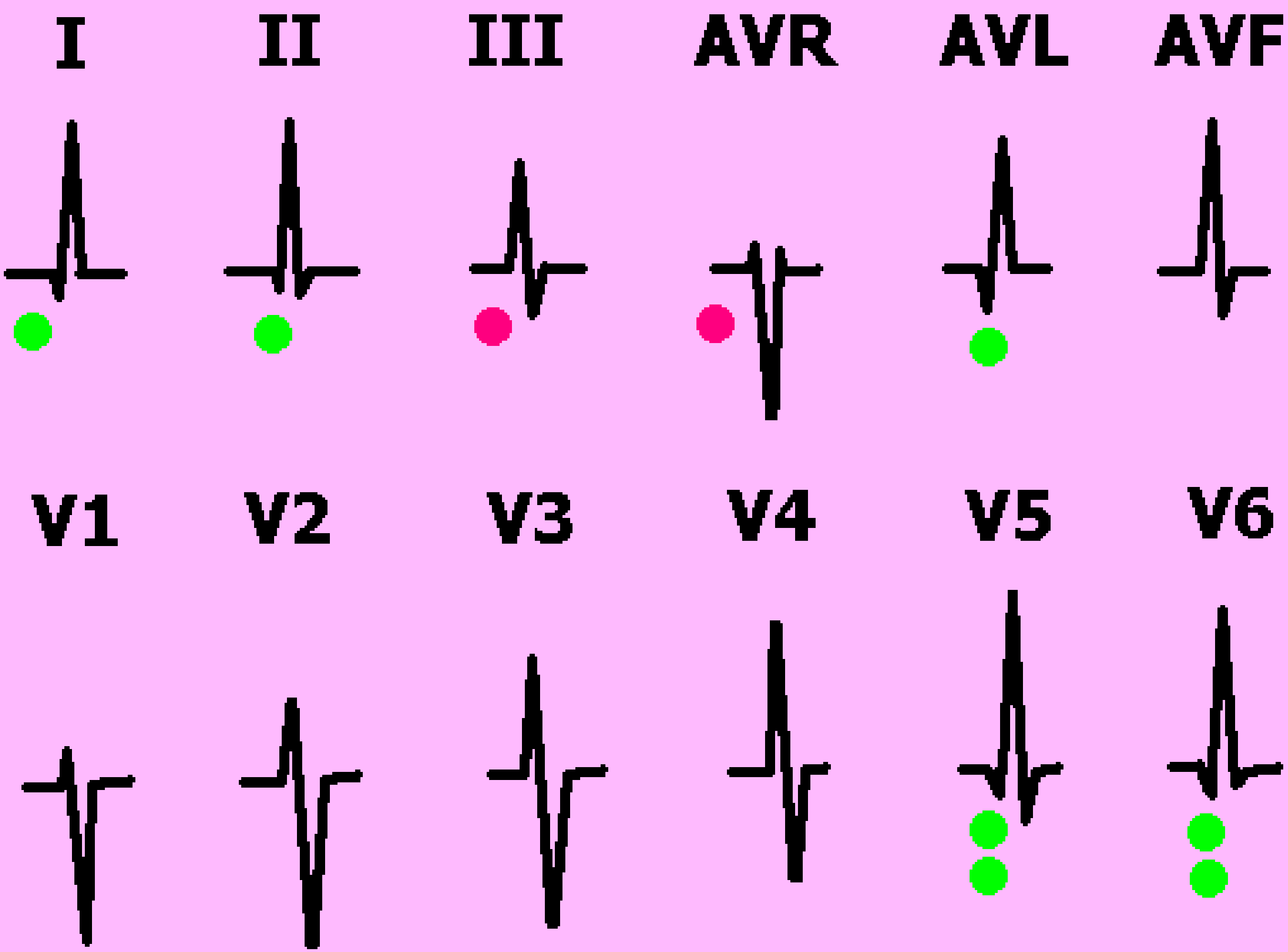


• Q WAVES •



LEADS WHERE Q WAVES ARE NORMAL

- Normal Q WAVES caused by SEPTAL DEPOLARIZATION



● Q WAVES NORMAL AND FREQUENTLY SEEN	●● Q WAVES EXPECTED	● Q WAVES, IF PRESENT, CAN NORMALLY BE ANY SIZE

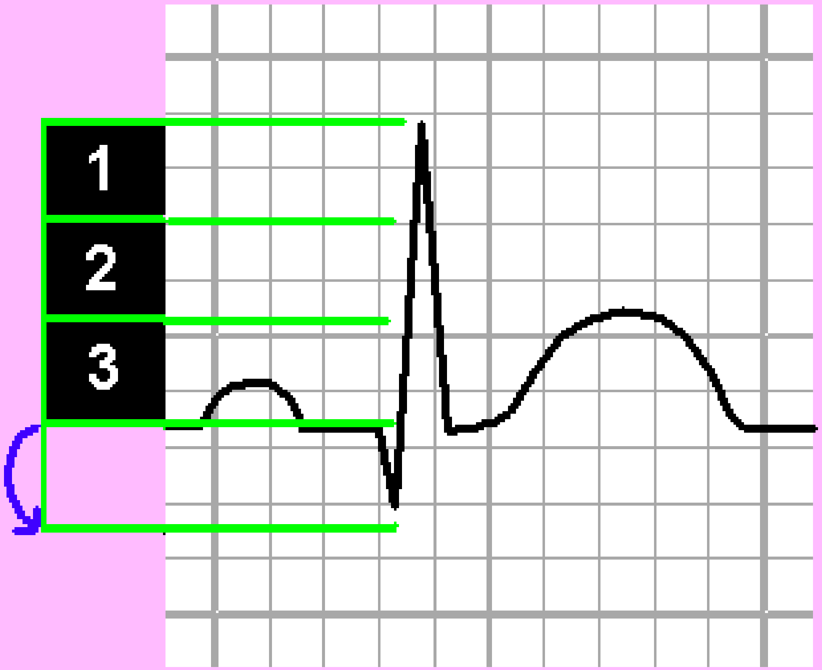
THE QRS COMPLEX

GENERAL RULES FOR NORMAL Q WAVES - WIDTH

LESS THAN .40 (1 mm) WIDE

THE QRS COMPLEX

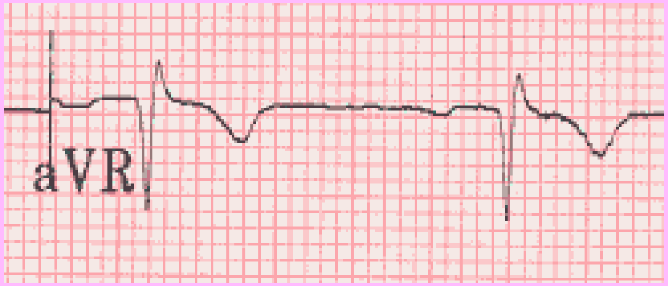
GENERAL RULES FOR NORMAL Q WAVES - HEIGHT



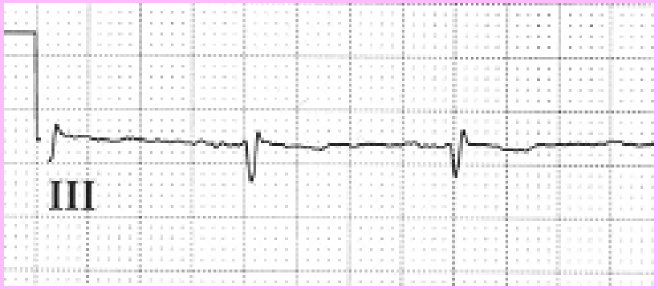
☞ LESS THAN 1/3 THE HEIGHT OF THE R WAVE

THE QRS COMPLEX

NORMAL Q WAVES
EXCEPTIONS TO THE RULES



LEAD AVR



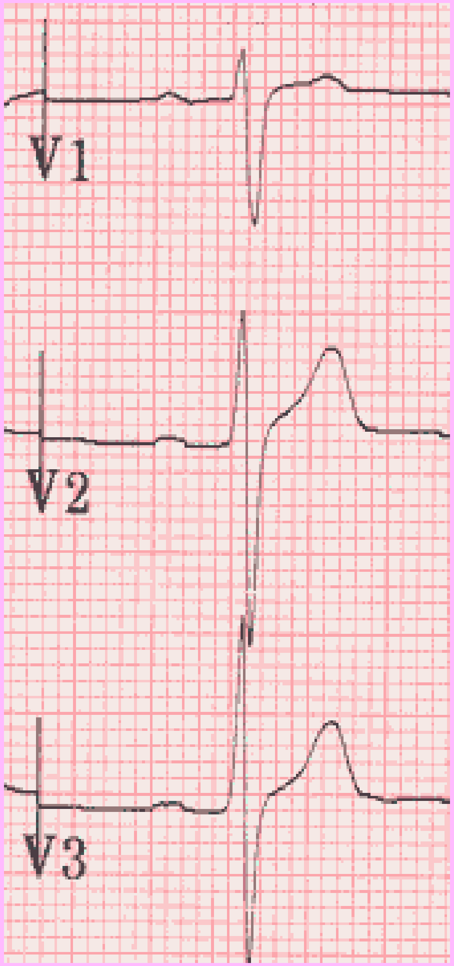
LEAD III

☞ THE Q WAVE CAN BE ANY SIZE

THE QRS COMPLEX

NORMAL Q WAVES
EXCEPTIONS TO THE RULES

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



THE QRS COMPLEX

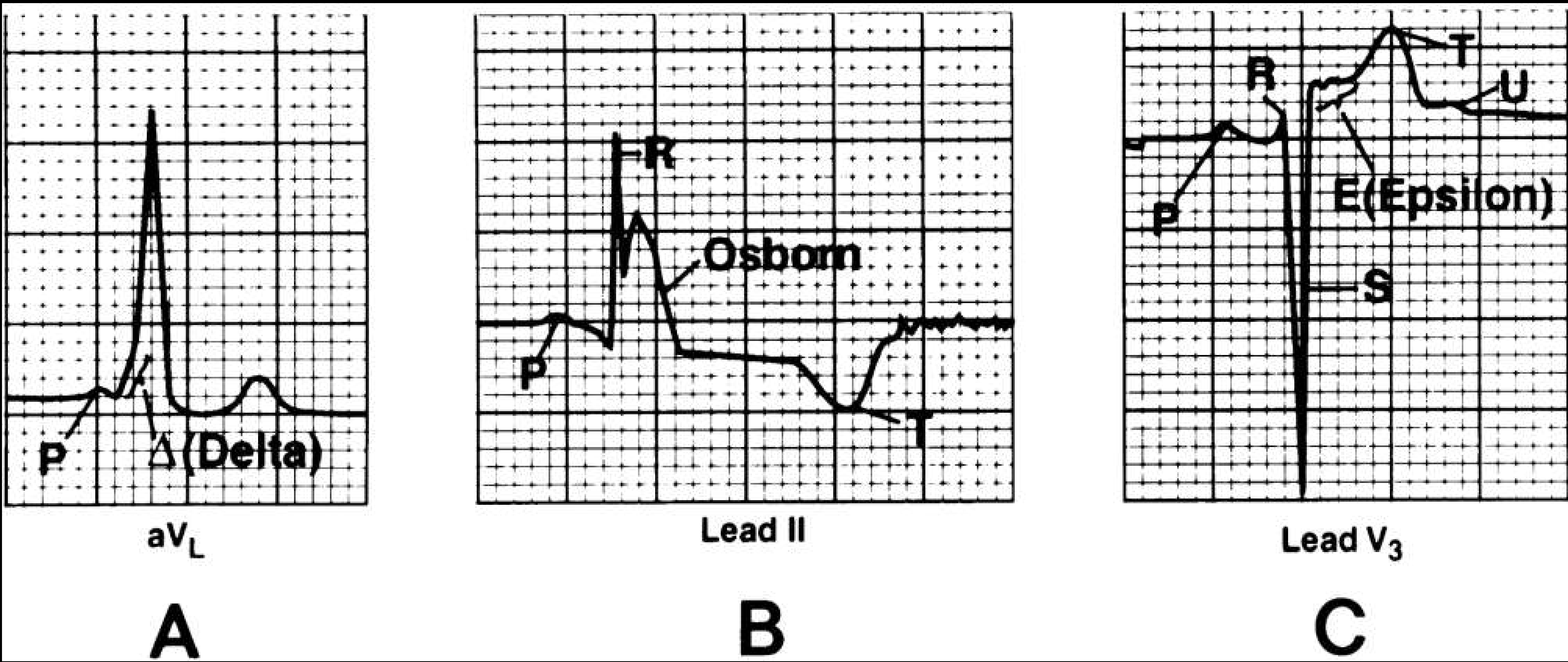
Q WAVE RULES - SUMMARY:

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

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

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

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



A. Delta wave, seen in Wolff-Parkinson-White Syndrome
B. Osborn's wave, seen in HYPOTHERMIA
C. Epsilon's wave, seen in Right Ventricular Dysplasia

Circulation

American Heart Association
Learn and Live

NORMAL ST - T WAVES

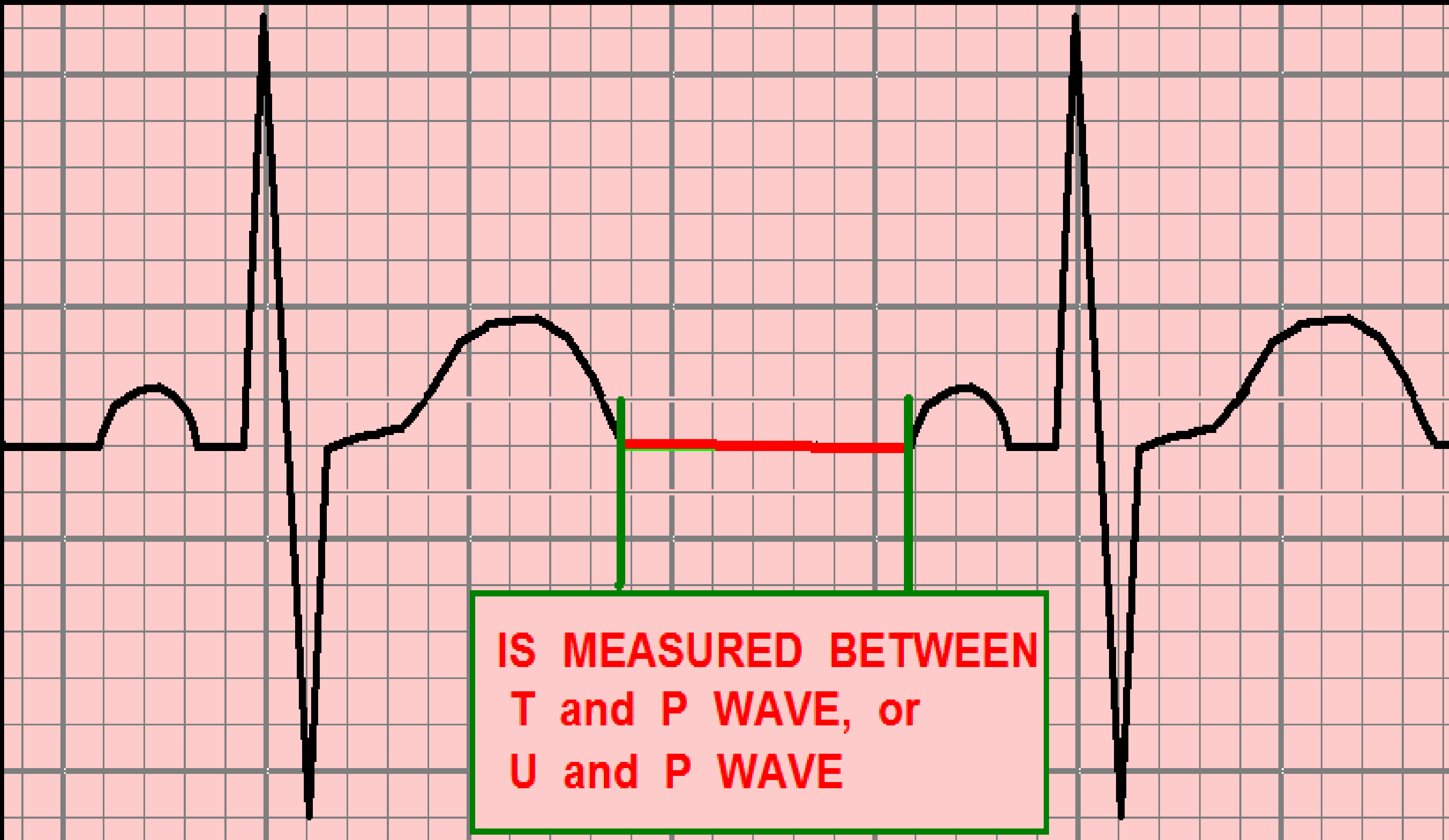
- WHEN QRS WIDTH IS NORMAL (< 120 ms)

ASSESS:

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

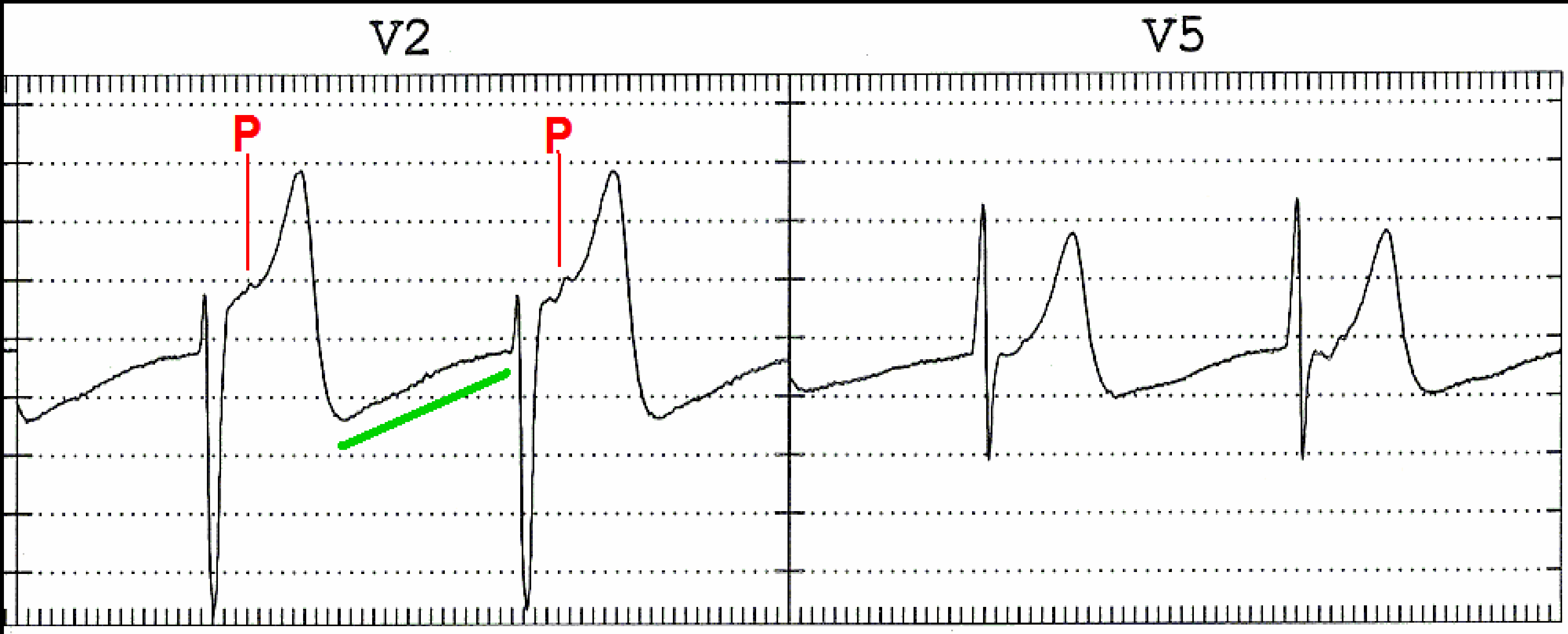
☞ ***in EVERY LEAD EXCEPT aVR ! !***

THE ISOELECTRIC LINE



THE ISOELECTRIC LINE

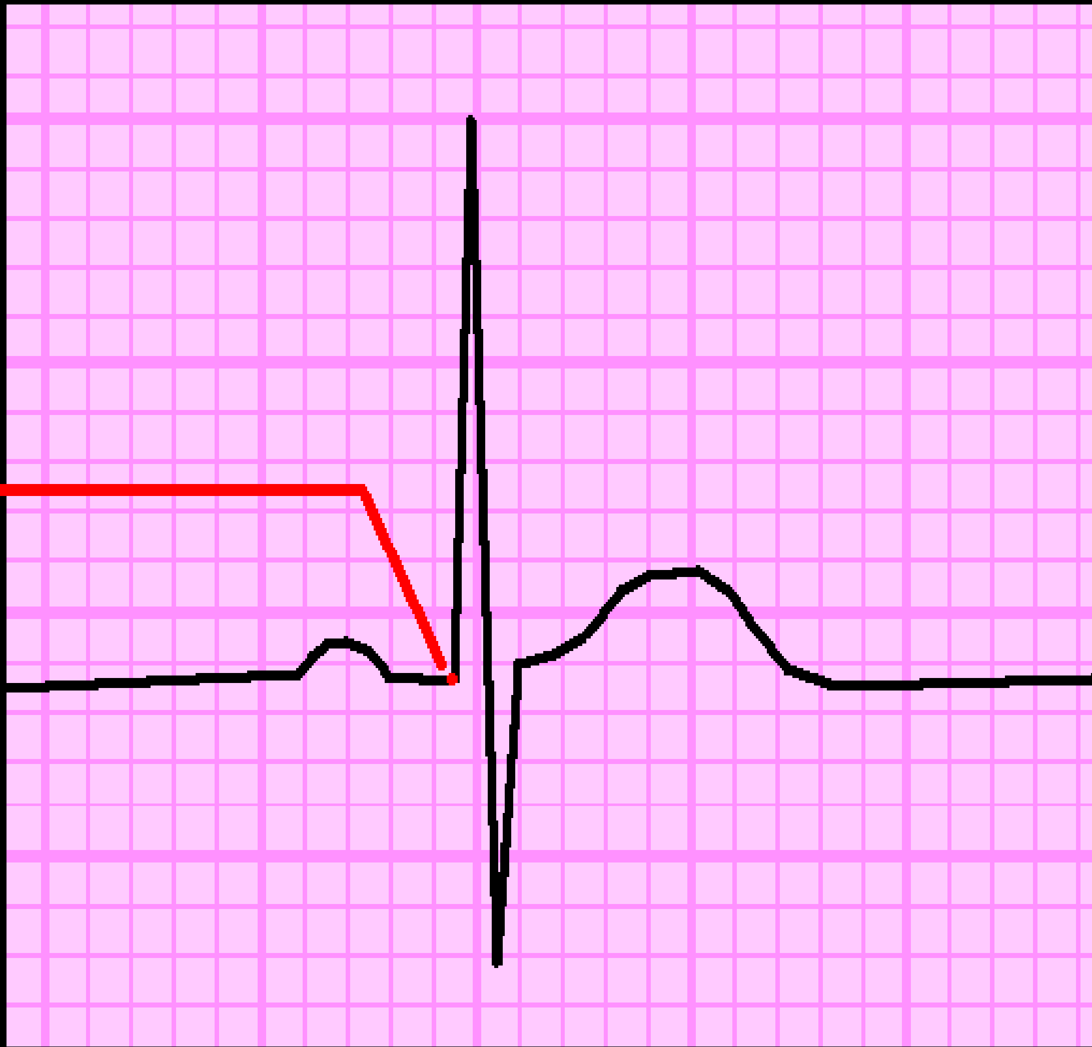
EKG from 13 y/o girl in ACCELERATED JUNCTIONAL RHYTHM.
note: upsloping T-P interval, and P buried in T waves.



THE P-Q JUNCTION

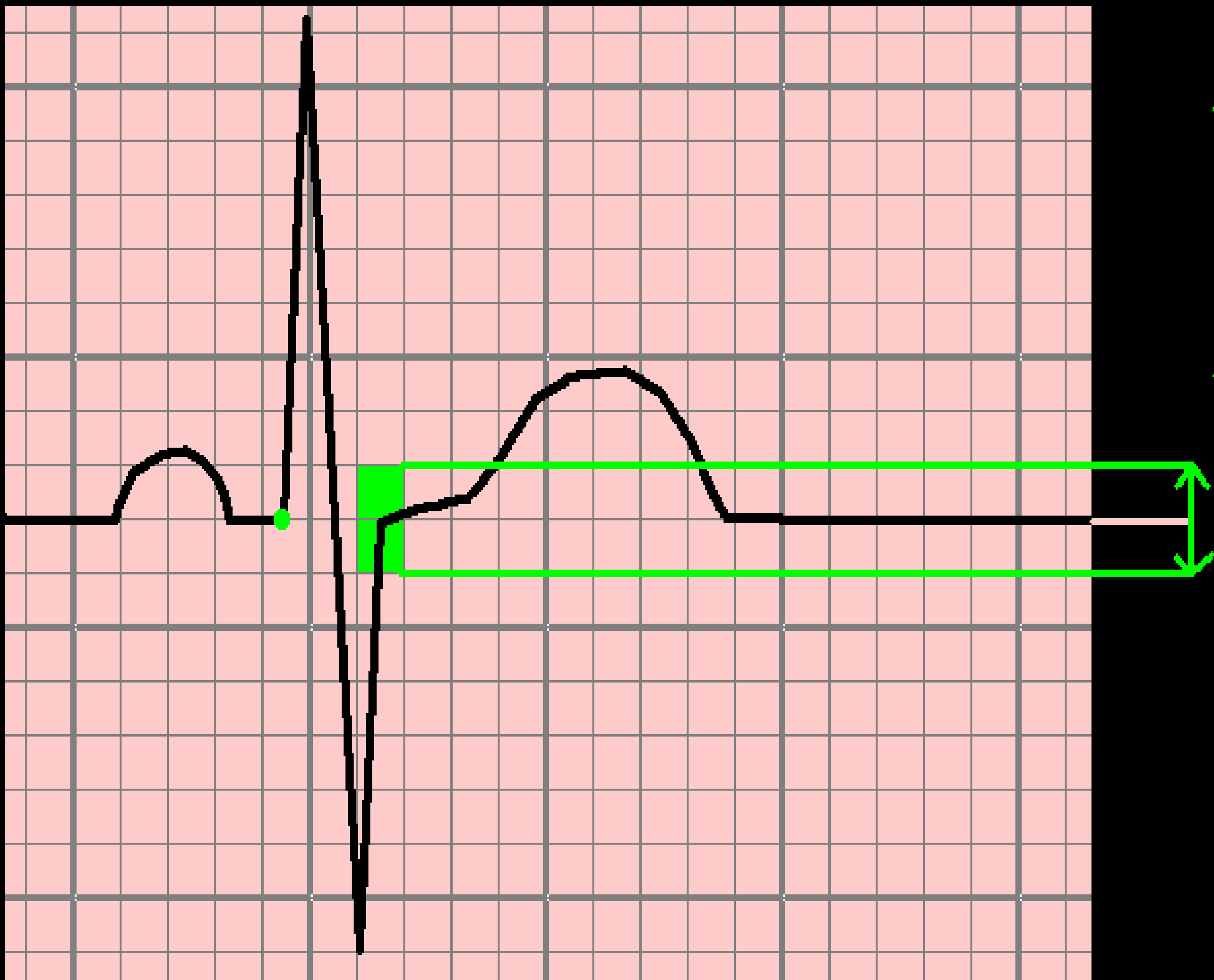
. . . is the POINT where the P-R SEGMENT ends and the QRS COMPLEX BEGINS.

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 J POINT SHOULD BE..

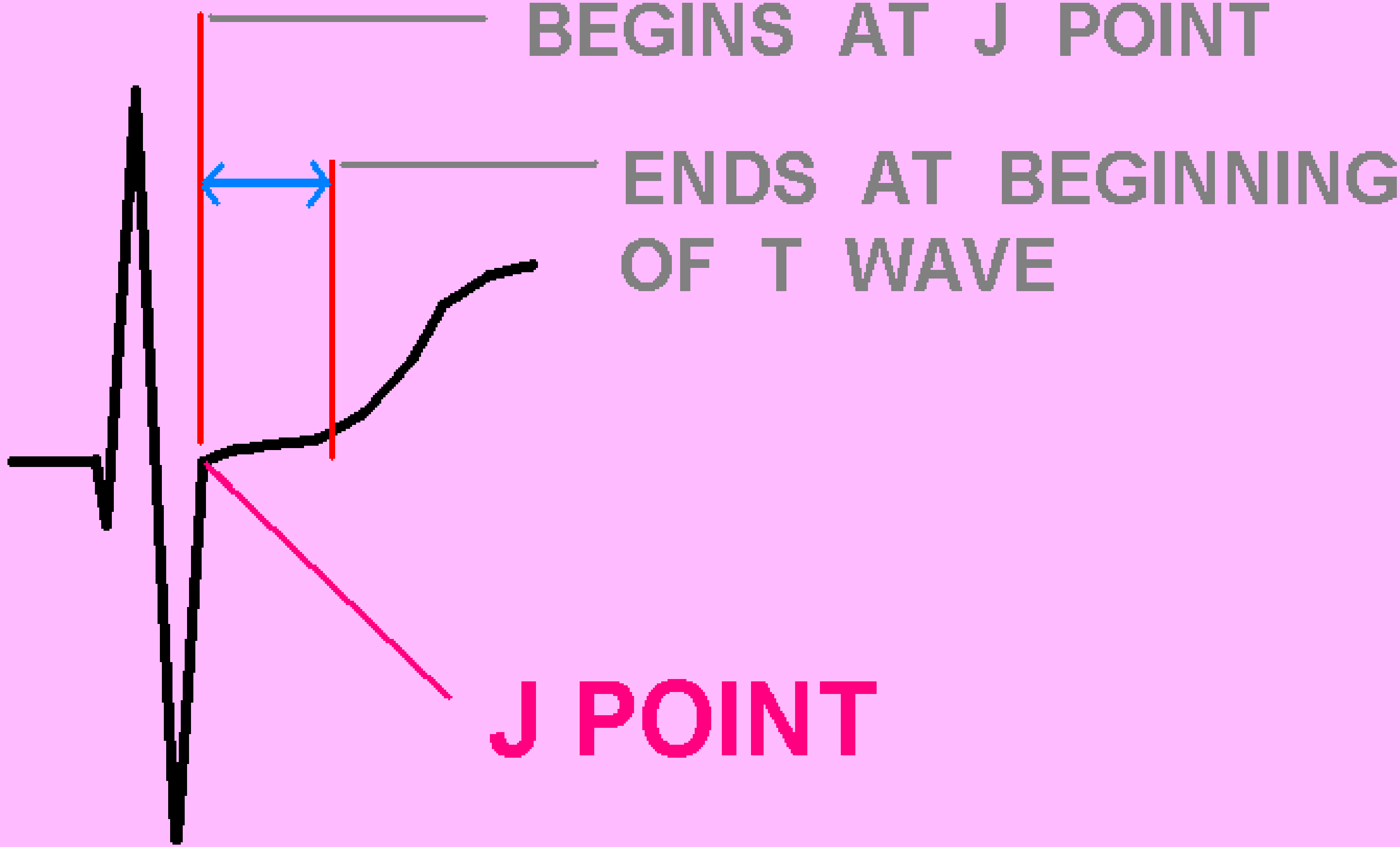


WITHIN
1 mm
ABOVE

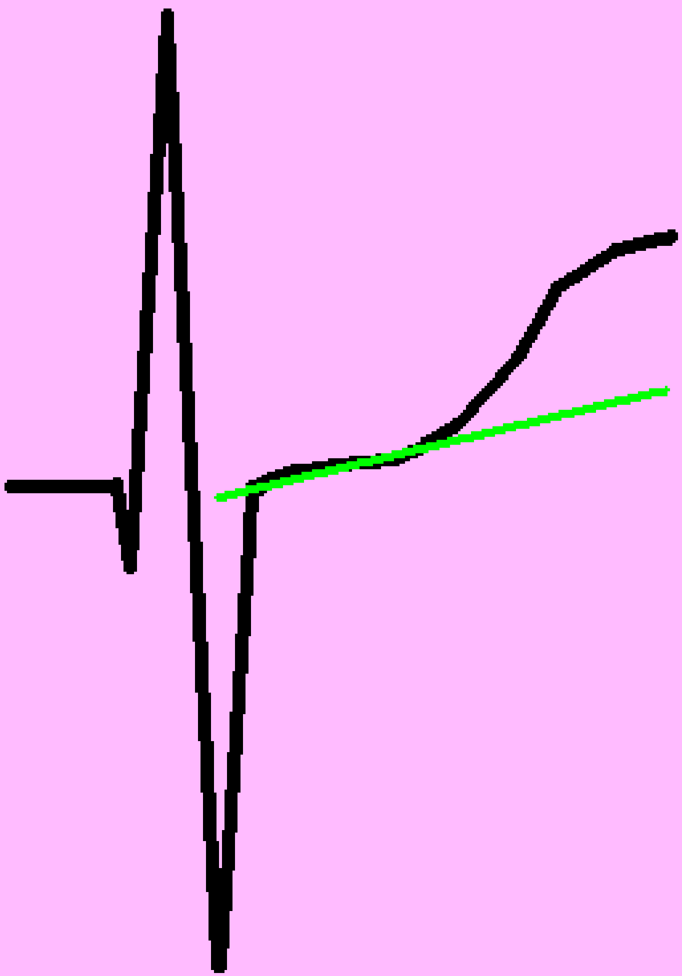
OR

BELOW
THE
P-Q
JUNCTION

THE S-T SEGMENT

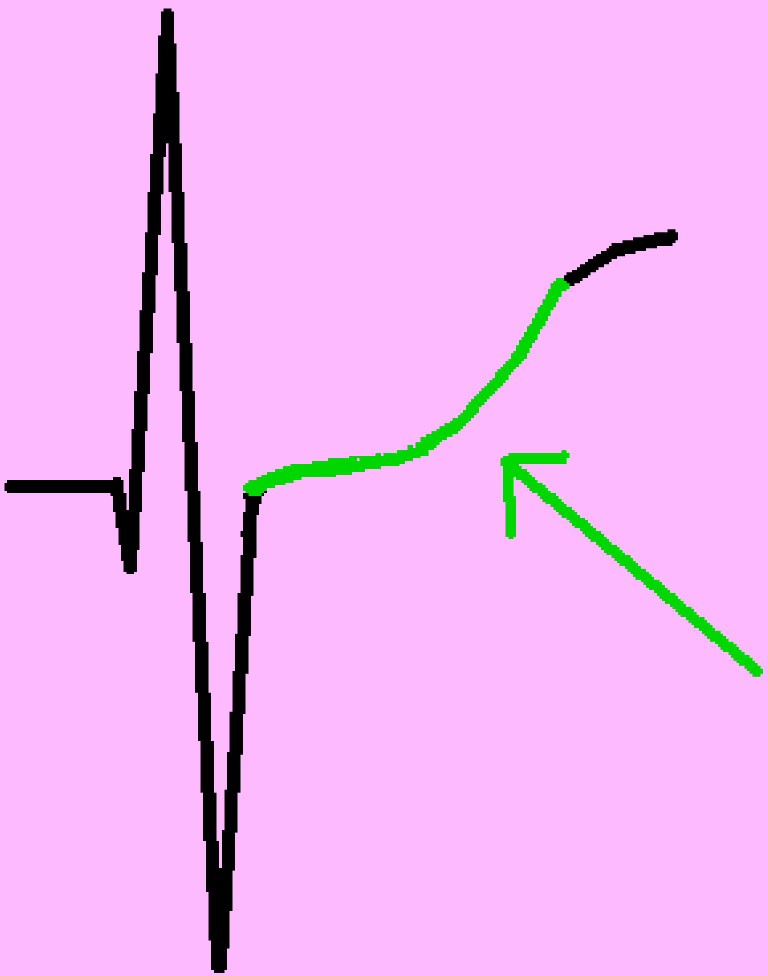


THE S-T SEGMENT



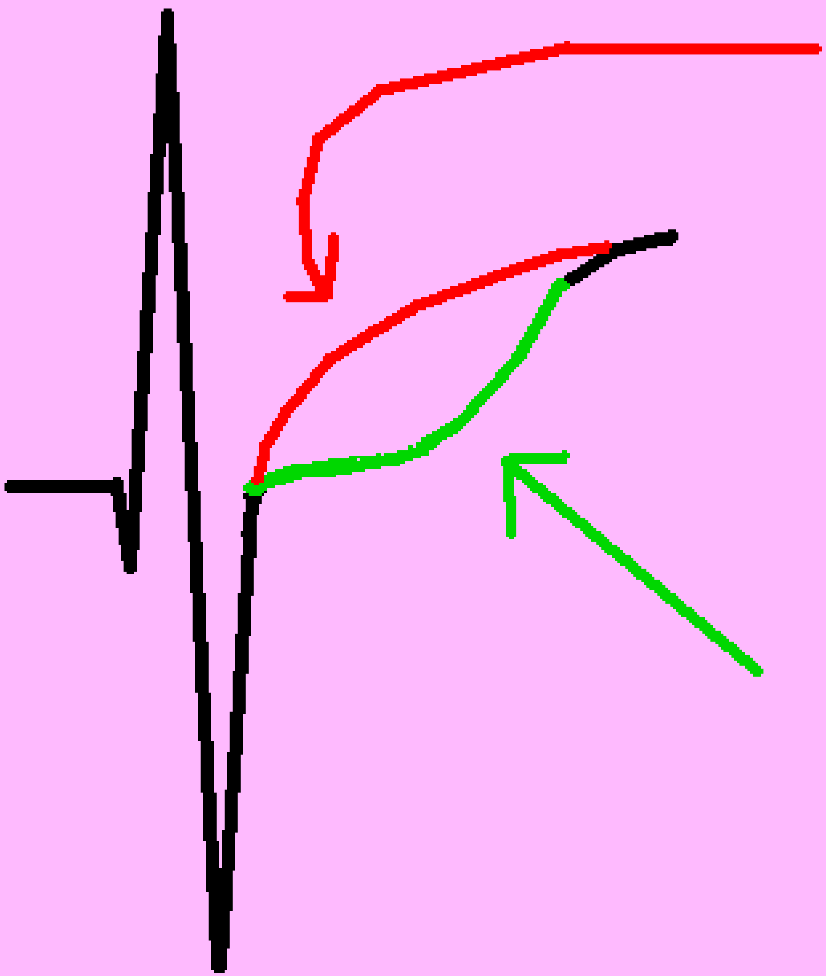
SHOULD HAVE
A "SLIGHT POSITIVE"
INCLINATION

THE S-T SEGMENT



SHOULD BE "CONCAVE" IN SHAPE . . .

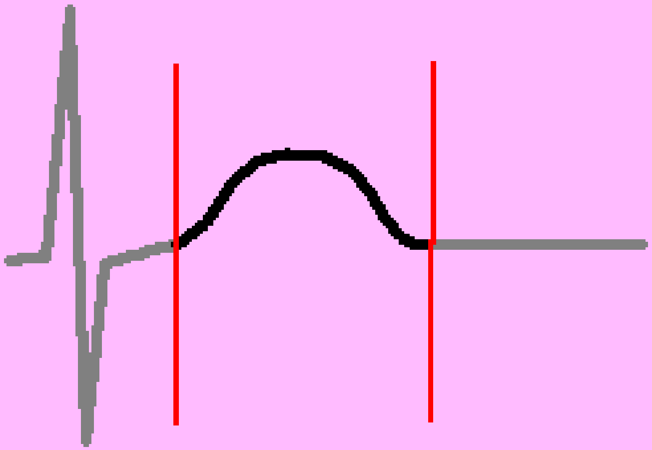
THE S-T SEGMENT



AS OPPOSED TO "CONVEX" IN SHAPE

SHOULD BE "CONCAVE" IN SHAPE . . .

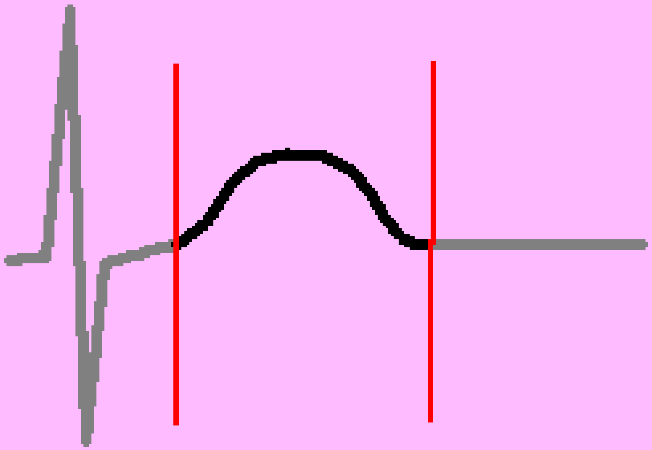
THE T WAVE



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

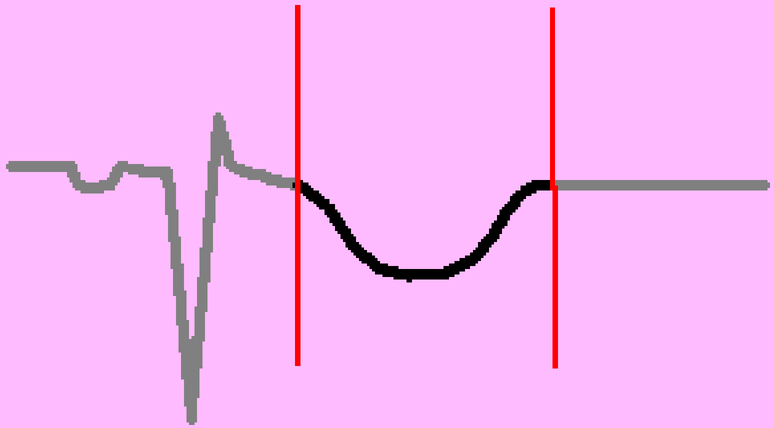
- SHOULD BE SYMMETRICAL

THE T WAVE



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

THE T WAVE



LEAD AVR

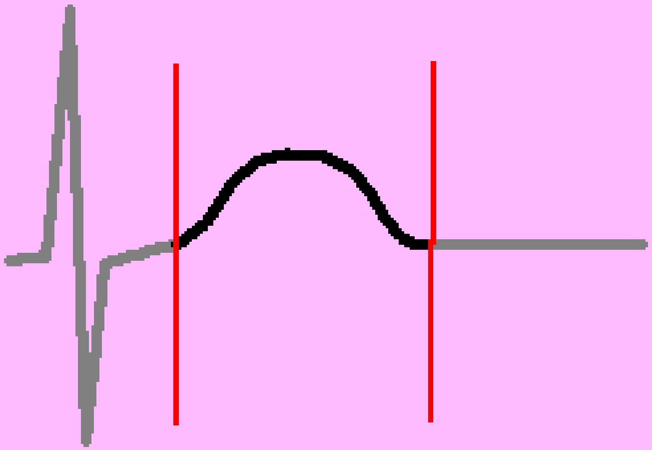
- REMEMBER, IN LEAD AVR

EVERYTHING

IS

"UPSIDE-DOWN"

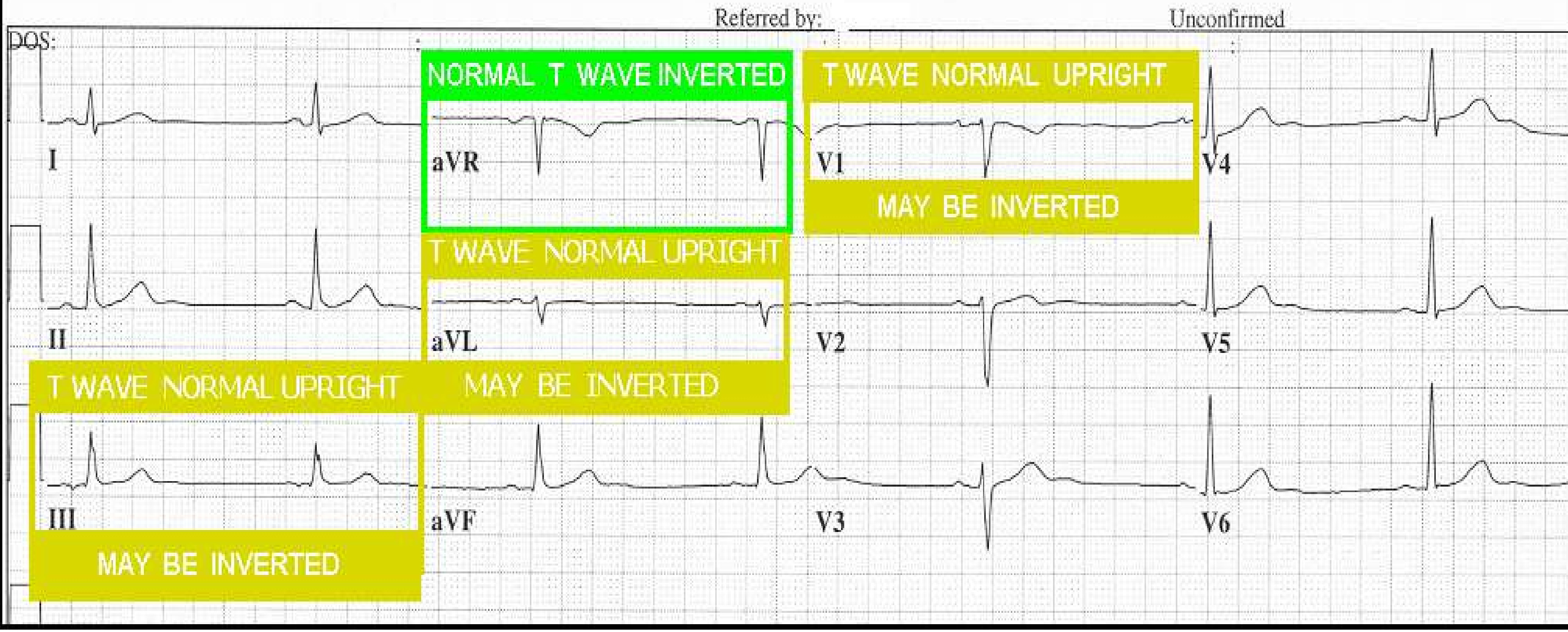
THE T WAVE



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

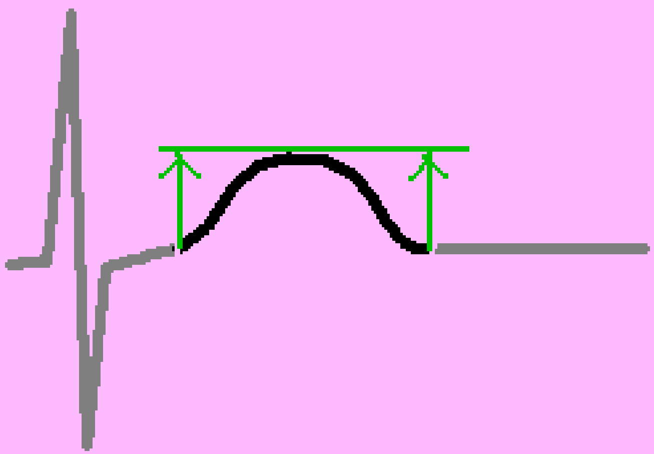
- SHOULD BE SYMMETRICAL
- SHOULD BE UPRIGHT IN ALL LEADS, EXCEPT AVR
- MAY BE INVERTED IN LEADS I, III, and V1

Leads where the T WAVE may be INVERTED:



An inverted T wave in TWO OR MORE CONTIGUOUS LEADS = potential problem (ischemia)

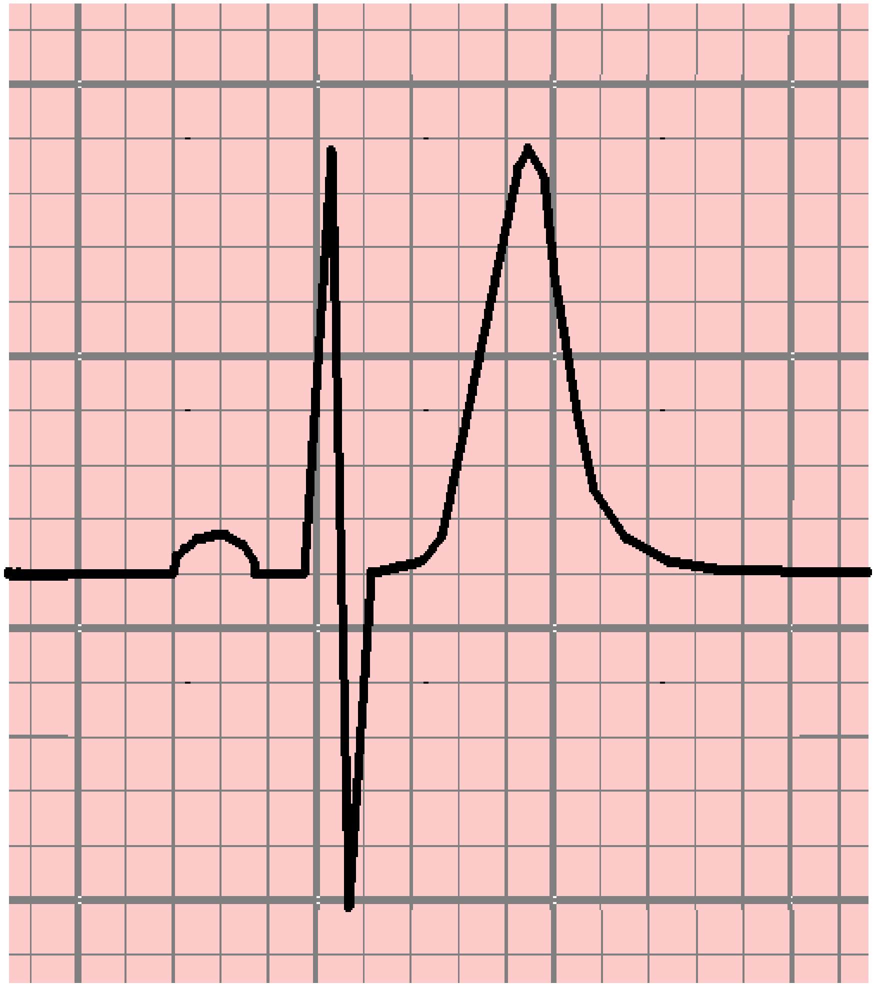
THE T WAVE



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.

HYPER-ACUTE T WAVES - COMMON ETIOLOGIES:

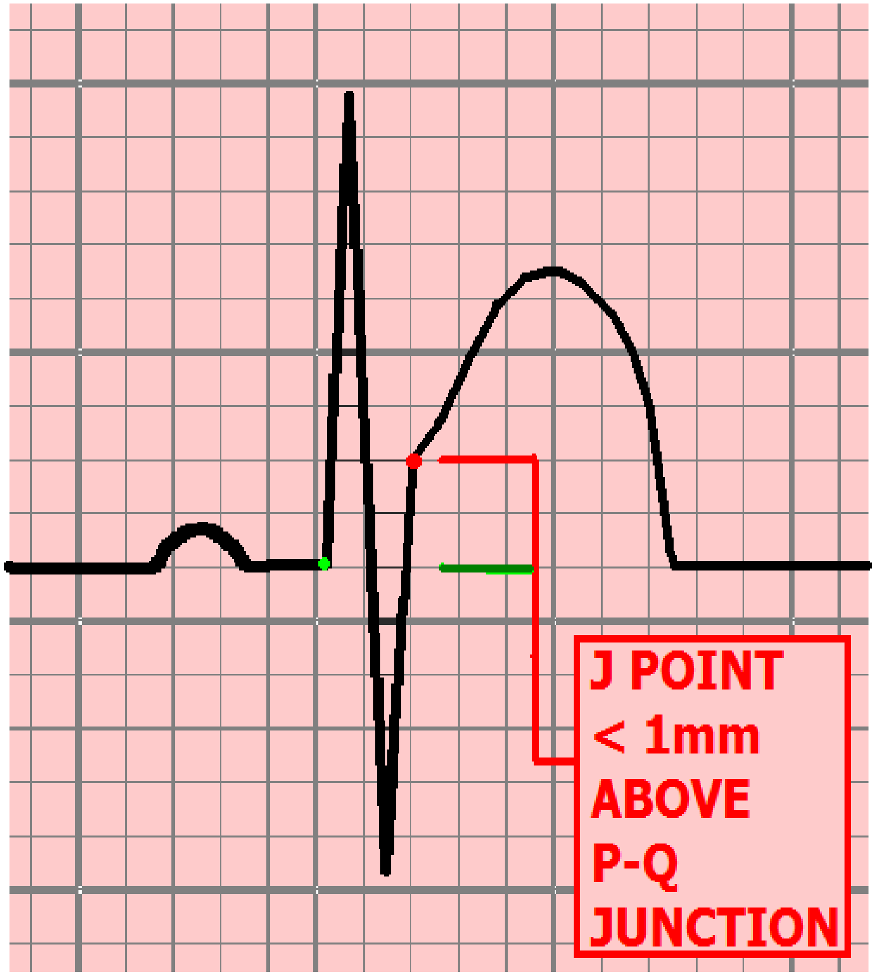


CONDITION:

- HYPERKALEMIA
- ACUTE MI
- TRANSMURAL ISCHEMIA
- HYPERTROPHY

MORE INFORMATION ON HYPERACUTE T WAVES COMING UP SOON . . .

S-T SEGMENT ELEVATION - COMMON ETIOLOGIES:

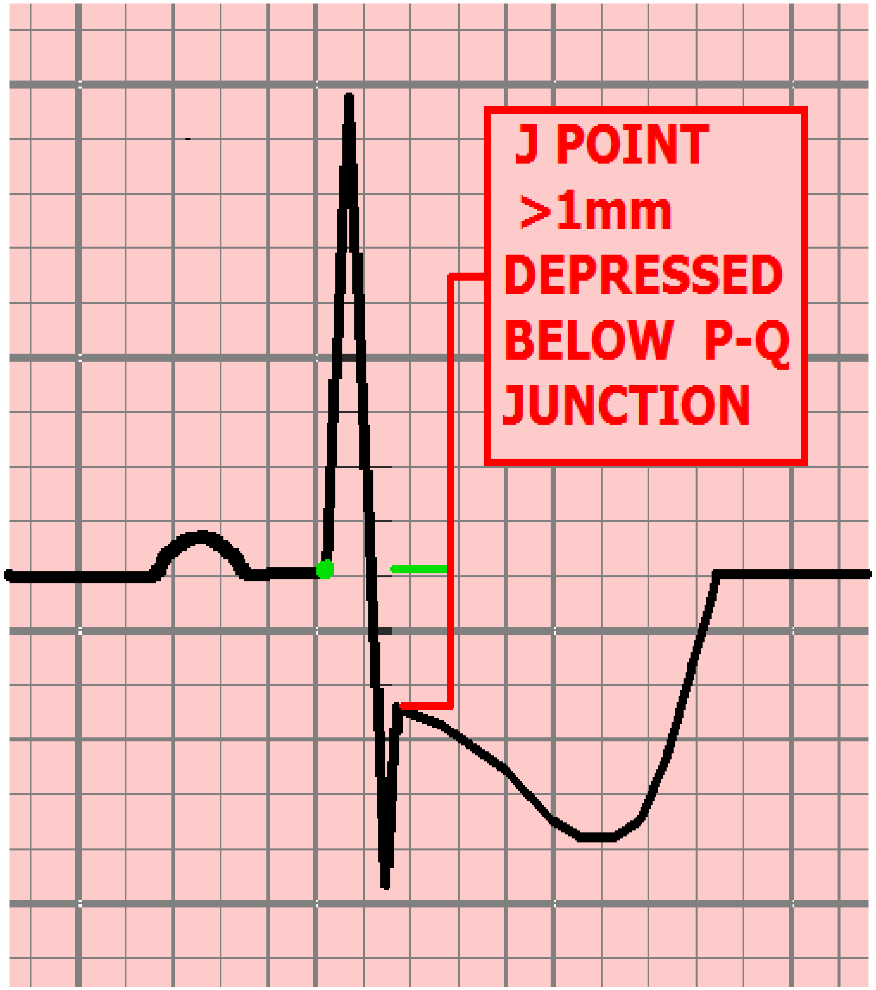


CONDITION:

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

ON THE NEXT PAGE IN YOUR BOOK ARE SOME EXAMPLES OF THE ABOVE CONDITIONS

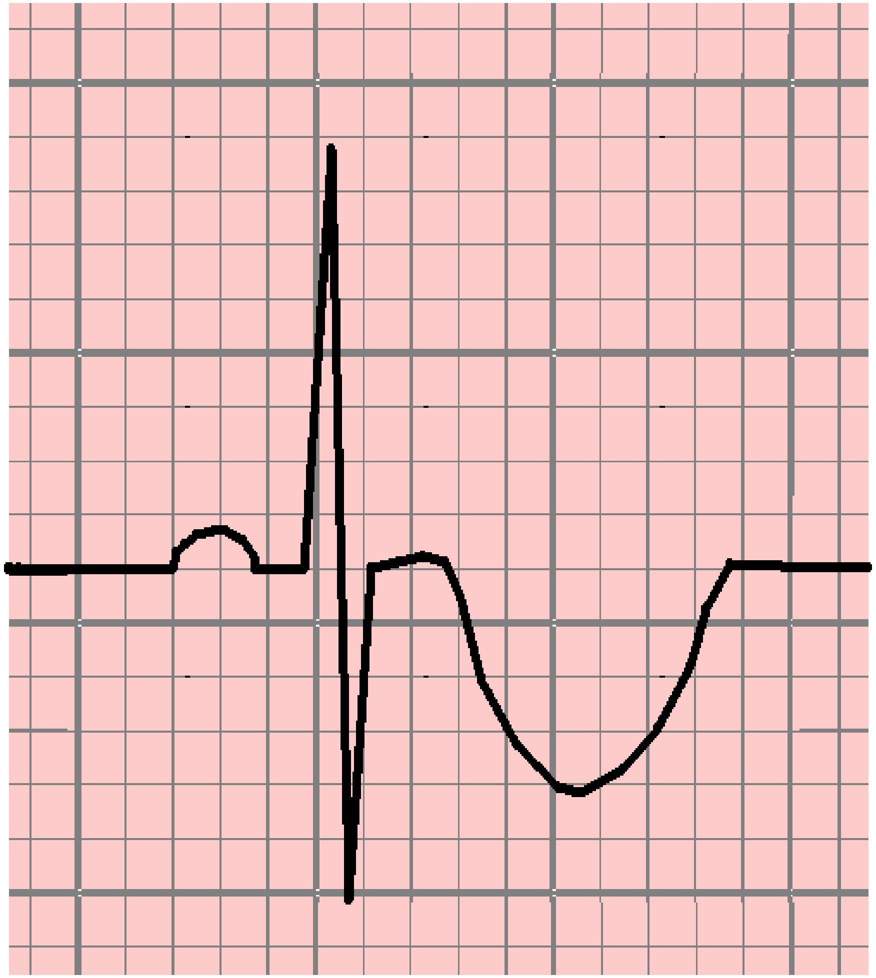
S-T SEGMENT DEPRESSION - COMMON ETIOLOGIES:



CONDITION:

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

T WAVE INVERSION - COMMON ETIOLOGIES:



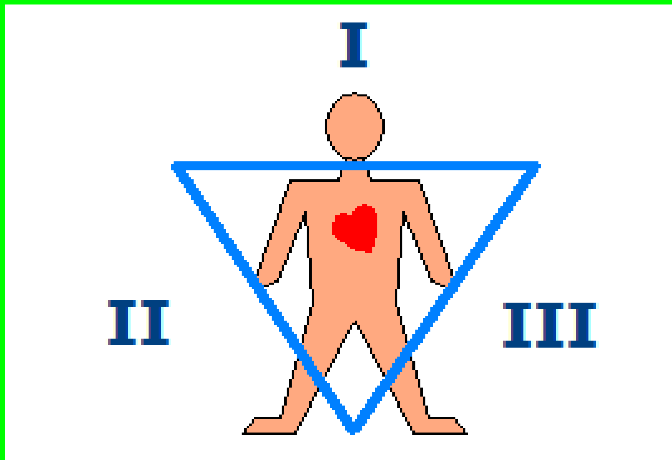
CONDITION:

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

☞ EVALUATE THE AXIS IN BOTH PLANES

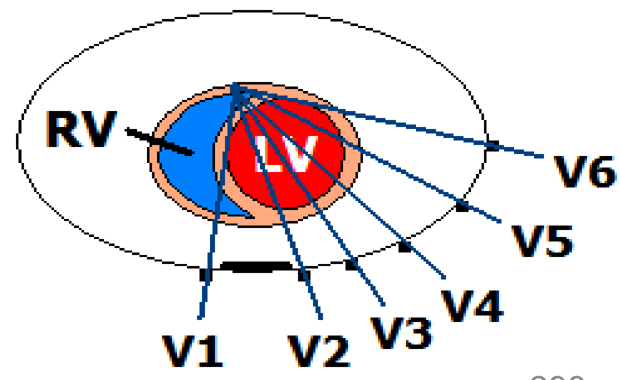
- **VERTICAL**

  " AXIS DEVIATION "

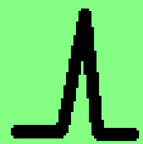


- **HORIZONTAL**

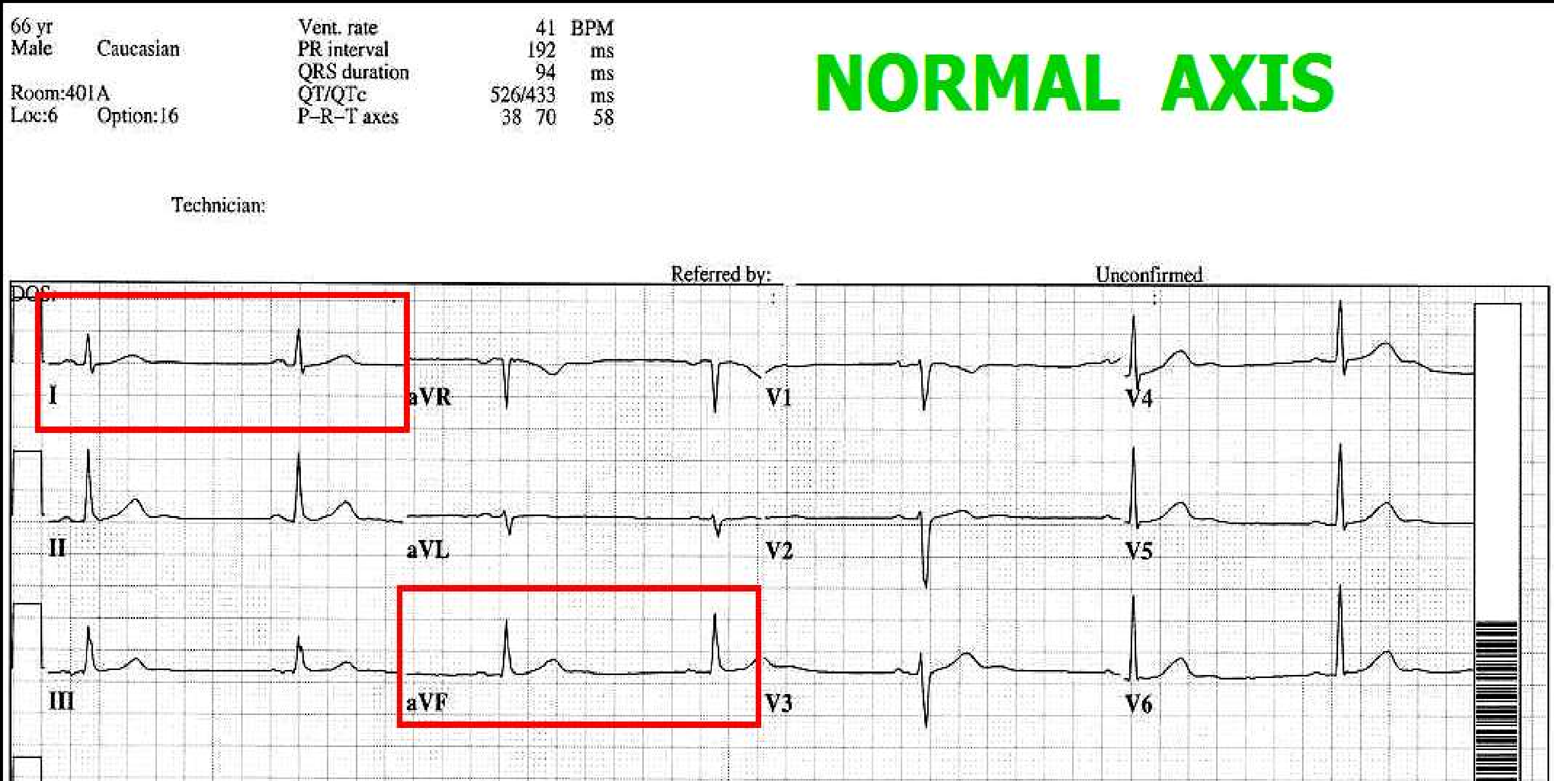
  " AXIS ROTATION "



AXIS DEVIATION

	LEAD I	LEAD AVF
NORMAL		
LEFT		
RIGHT		
FAR RIGHT		

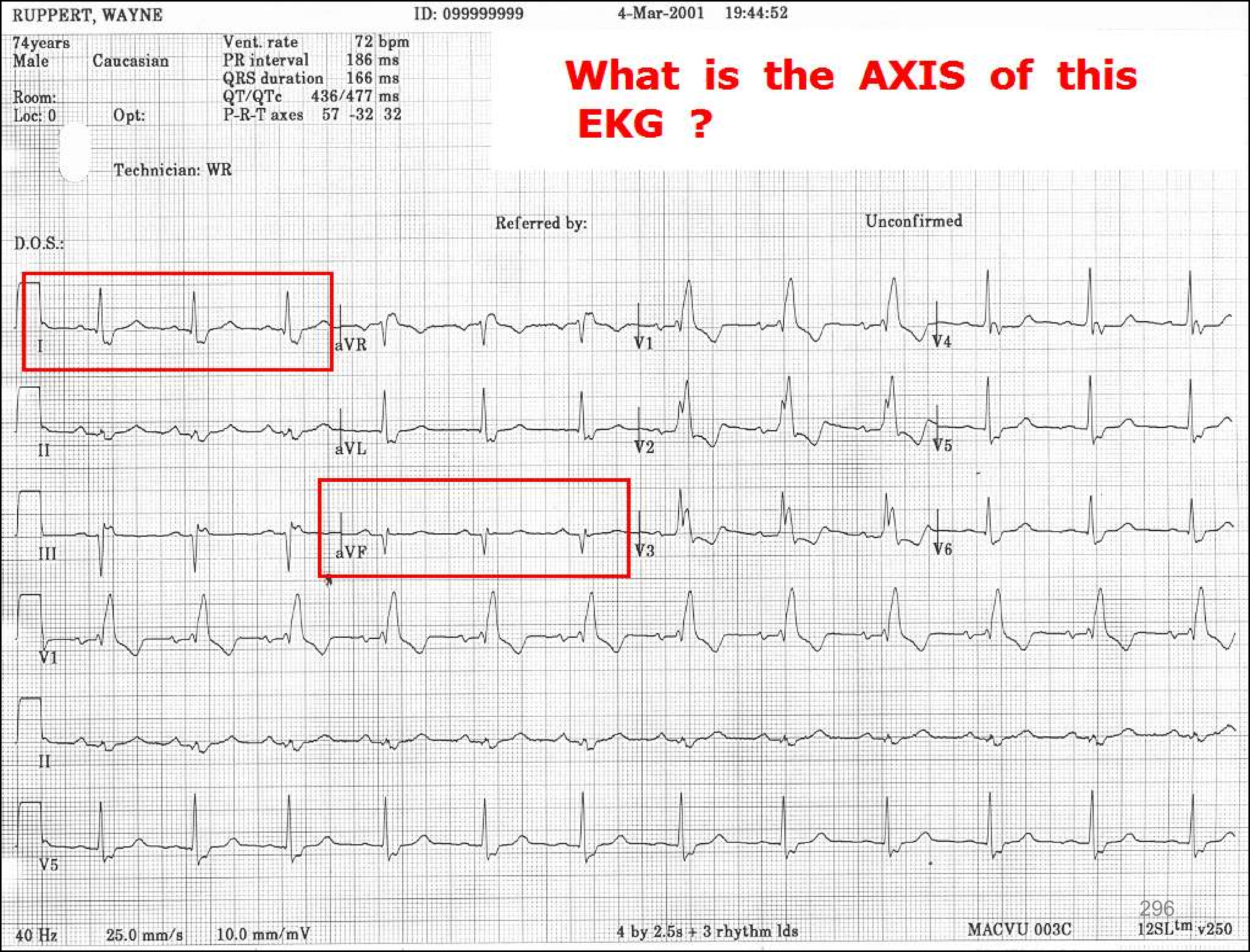
NORMAL AXIS



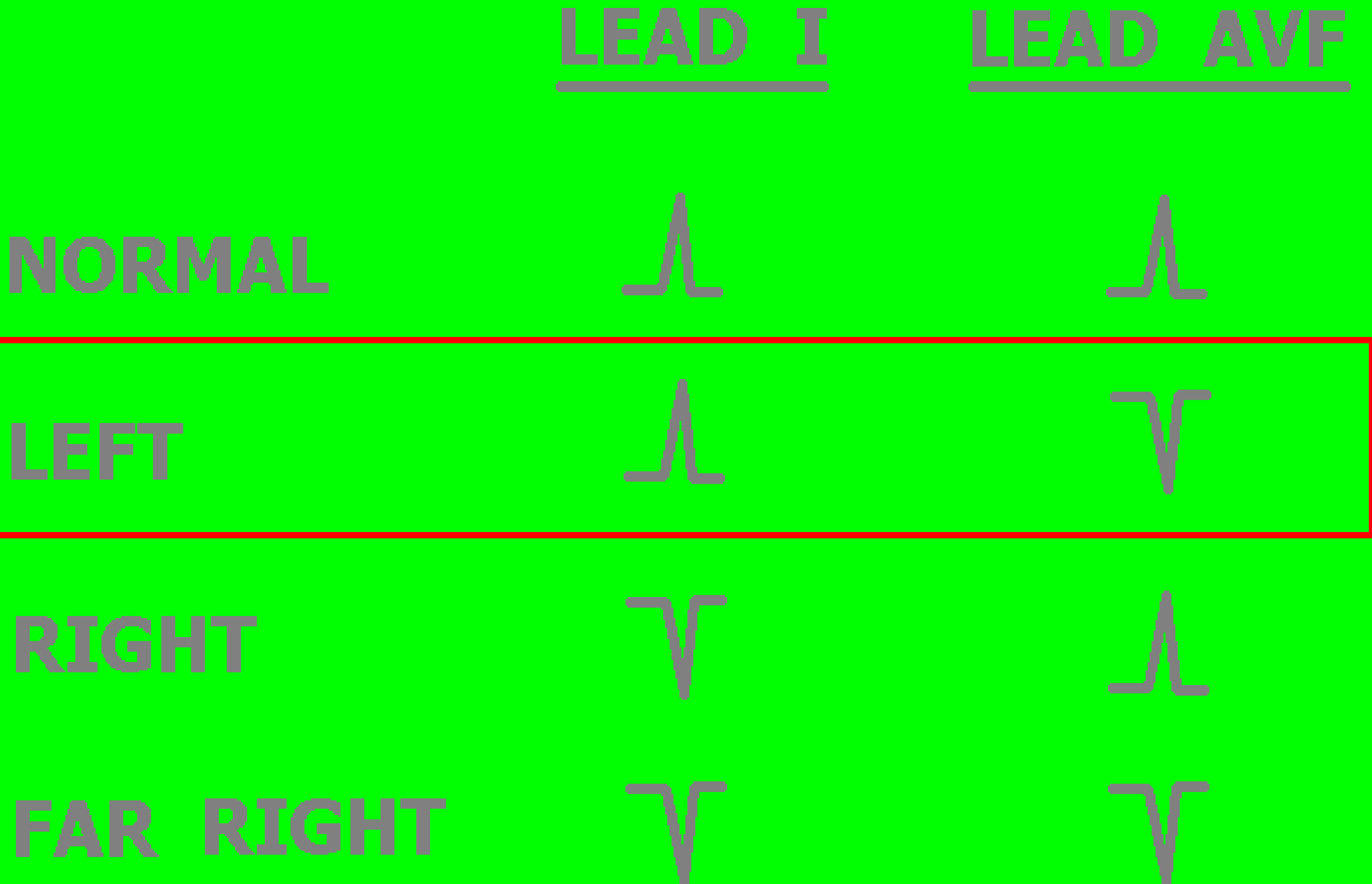
☞ AXIS DEVIATION

	LEAD I	LEAD AVF
NORMAL	⋀	⋀
LEFT	⋀	⋁
RIGHT	⋁	⋀
FAR RIGHT	⋁	⋁

What is the AXIS of this EKG ?



AXIS DEVIATION



COMMON CONDITIONS WHICH *MAY* CAUSE

LEFT AXIS DEVIATION:

- LEFT BUNDLE BRANCH BLOCK
- PACEMAKER
- C.O.P.D.
- LEFT VENTRICULAR HYPERTROPHY
- OLD INFERIOR WALL MI
- HYPERKALEMIA
- LEFT ANTERIOR FASCICULAR BLOCK
- WOLFF-PARKINSON-WHITE (types A & B)

11:18:02

81 yr
Female Hispanic

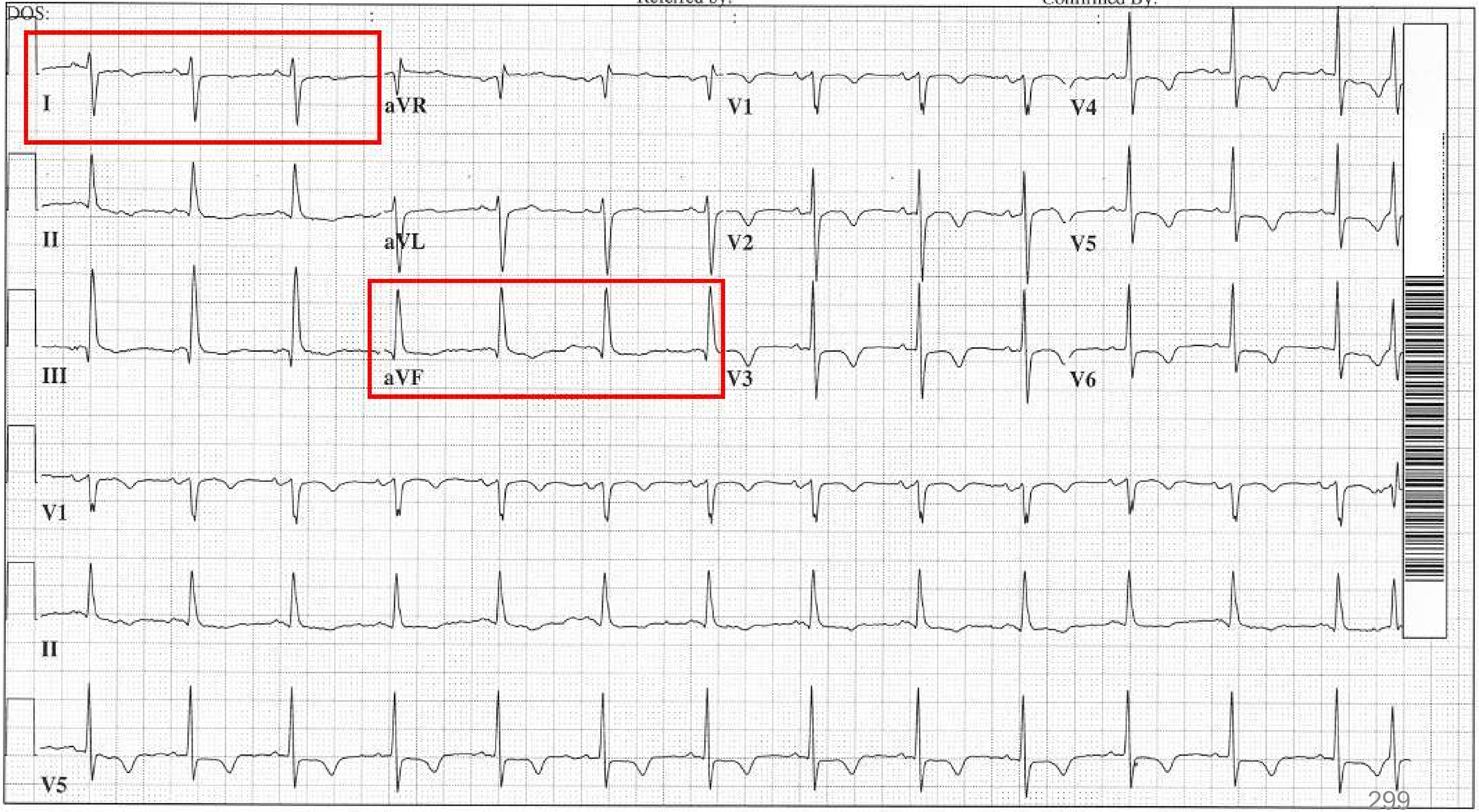
Room:303A
Loc:6 Option:11

Vent. rate	82	BPM
PR interval	128	ms
QRS duration	86	ms
QT/QTc	392/457	ms
P–R–T axes	38 112	–142

What is the AXIS of this EKG ?

Technician: EKG CLASS CODE
WR03899892

Referred by: Confirmed By:



25mm/s 10mm/mV 40Hz 005C 12SL 233 CID: 6 EID:13 EDT:

☞ AXIS DEVIATION

COMMON CONDITIONS WHICH *MAY* CAUSE

RIGHT AXIS DEVIATION:

- NORMAL FOR PEDS & TALL, THIN ADULTS
- RIGHT VENTRICULAR HYPERTROPHY
- OLD LATERAL WALL MI
- LEFT POSTERIOR FASICULAR BLOCK
- PULMONARY EMBOLUS
- DEXTROCARDIA
- C.O.P.D.
- ATRIAL / VENTRICULAR SEPTAL DEFECTS

02:55:00

Male Caucasian

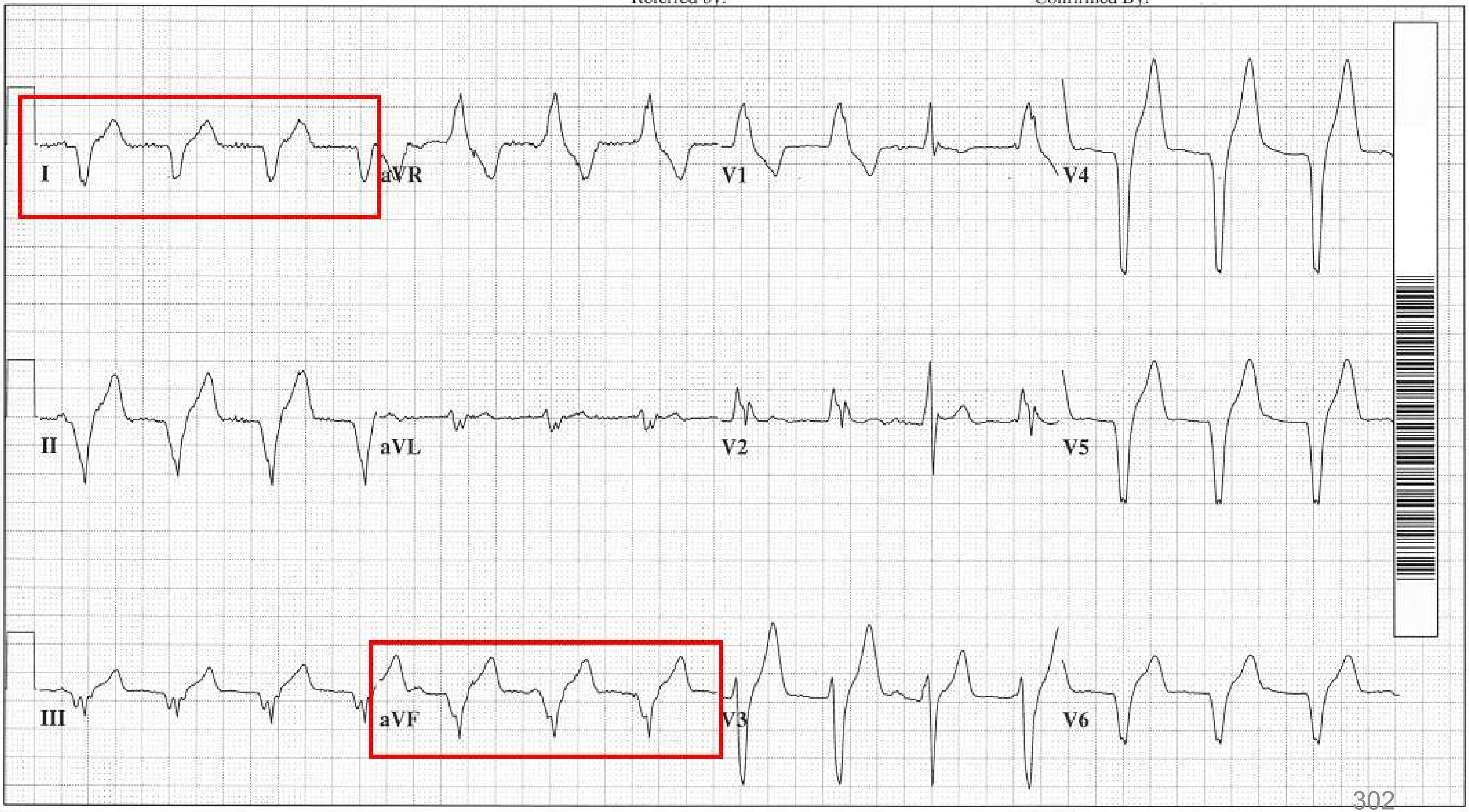
Room:5
Loc:1

Vent. rate	92	BPM
PR interval	*	
QRS duration	172	ms
QT/QTc	420/520	ms
P–R–T axes	* –123	61

EKG CLASS CODE #WR03611255

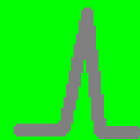
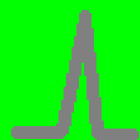
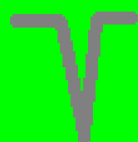
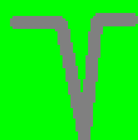
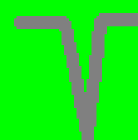
ACCELERATED IDIOVENTRICULAR RHYTHM

Referred by: Confirmed By:



25mm/s 10mm/mV 100Hz 005C 12SL 4 CID: 5 EID:17 EDT:

☞ AXIS DEVIATION

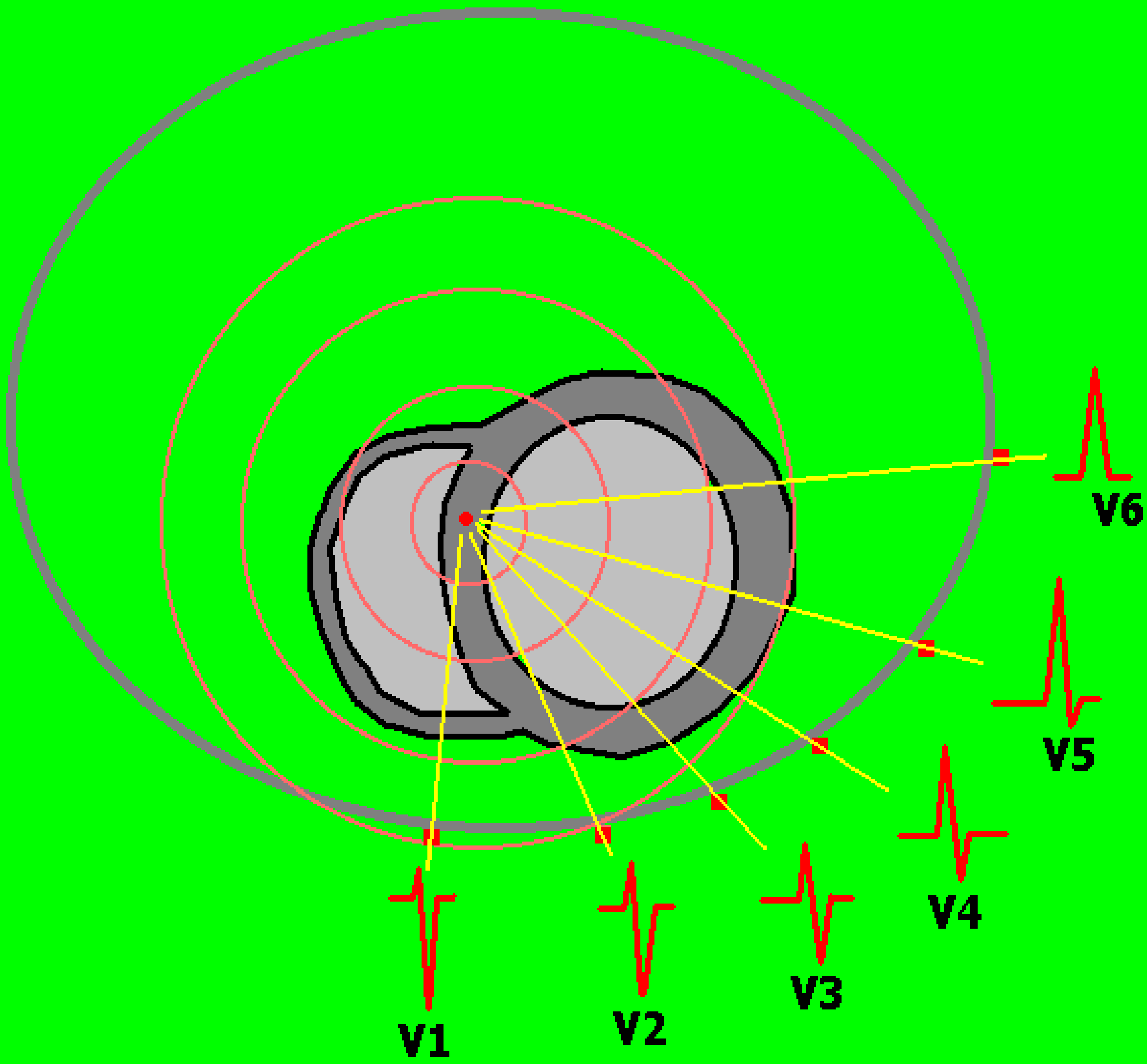
	LEAD I	LEAD AVF
NORMAL		
LEFT		
RIGHT		
FAR RIGHT		

COMMON CONDITIONS WHICH *MAY* CAUSE

(NO-MAN'S LAND AXIS)
<u>FAR RIGHT AXIS DEVIATION:</u>

- LEAD TRANSPOSITION
- PACEMAKER RHYTHMS
- VENTRICULAR RHYTHMS
- C.O.P.D.
- HYPERKALEMIA

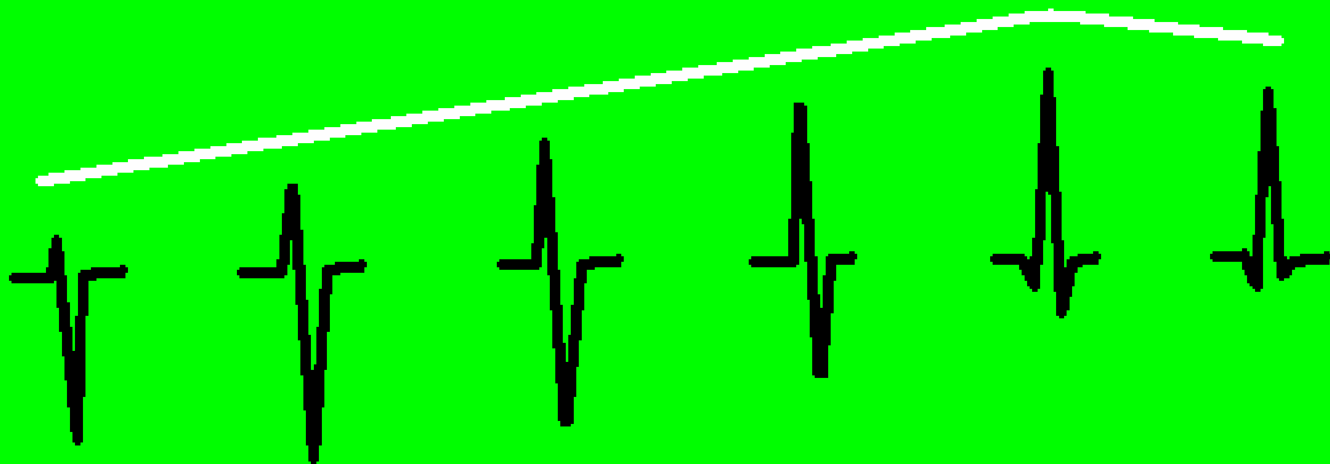
AXIS ROTATION



ASSESSING AXIS ROTATION:

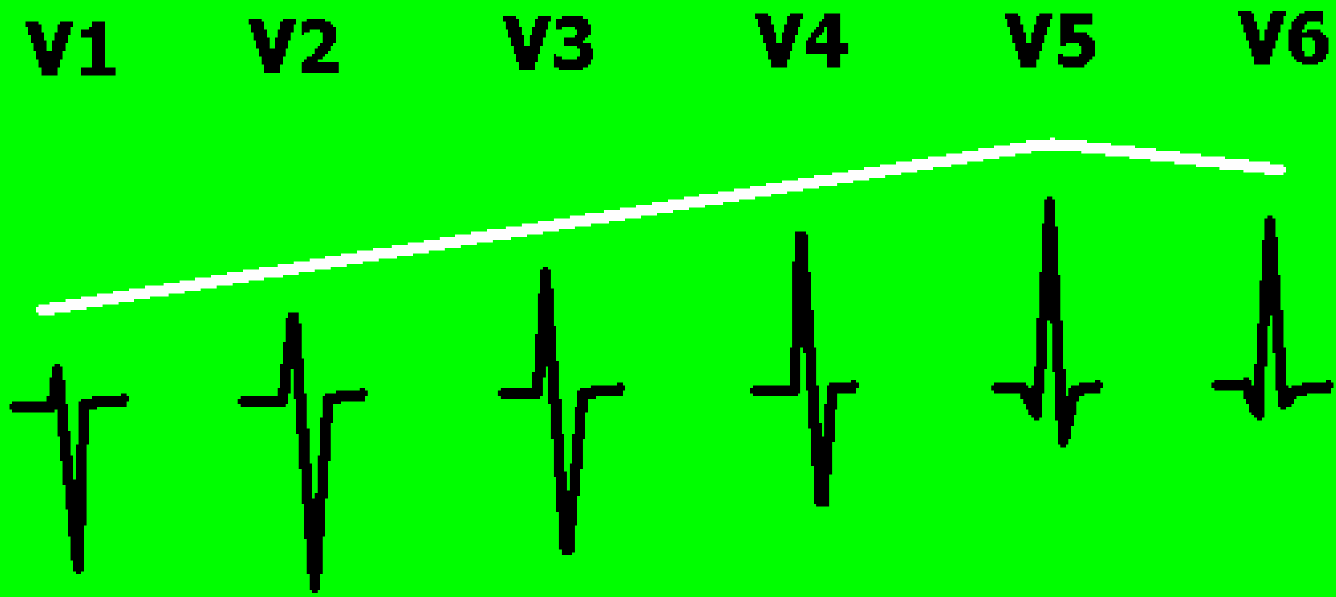
V1 V2 V3 V4 V5 V6

1. R - WAVE PROGRESSION



2. IDENTIFICATION OF TRANSITION

ASSESSING AXIS ROTATION:



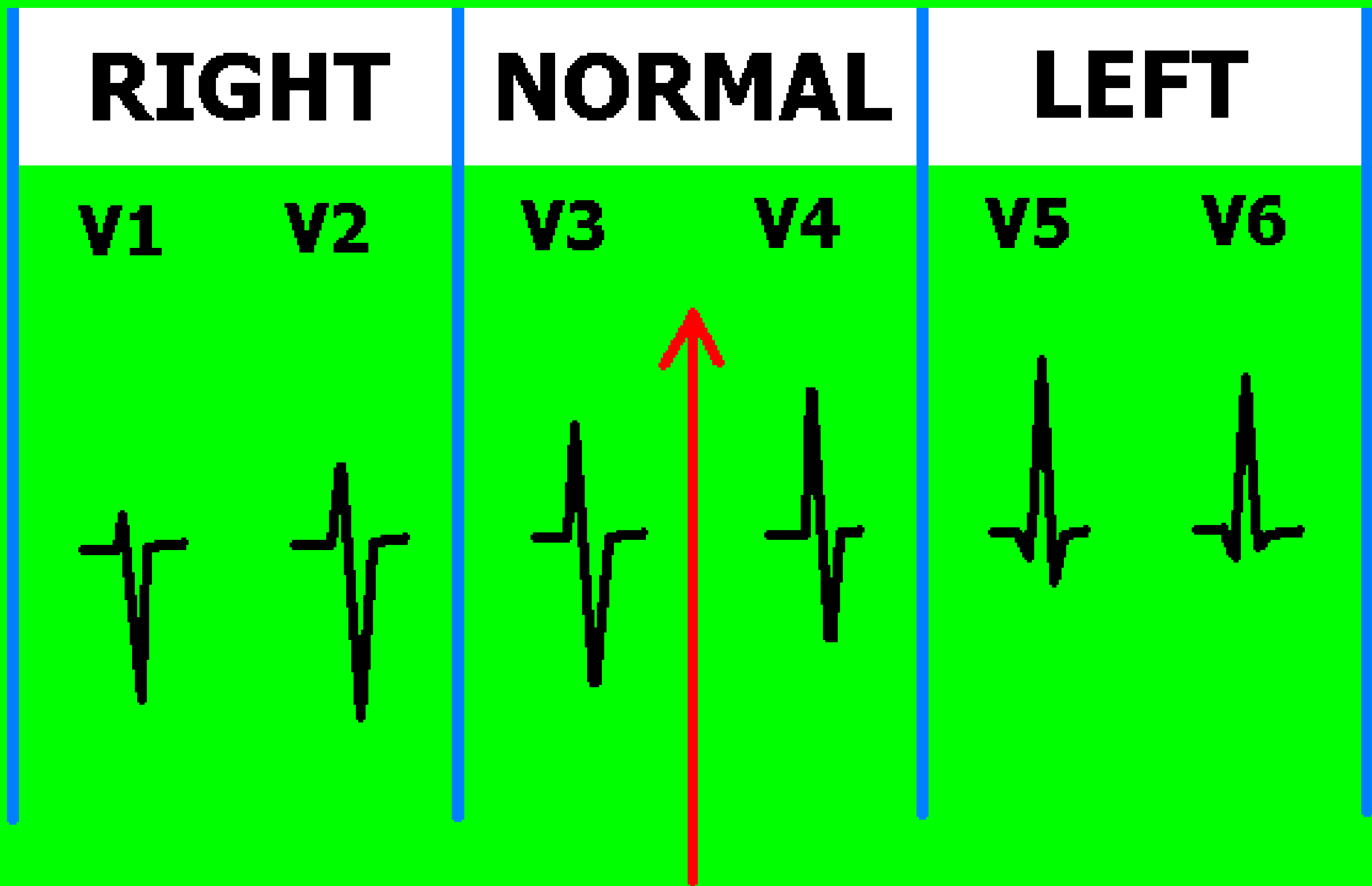
3. RECALL COMMON PATTERNS of ABNORMAL R-WAVE PROGRESSION to help you build your list of POSSIBLE DIAGNOSES.

AXIS ROTATION

TRANSITION

OCCURS IN THE LEAD WHERE THE QRS IS THE MOST BIPHASIC

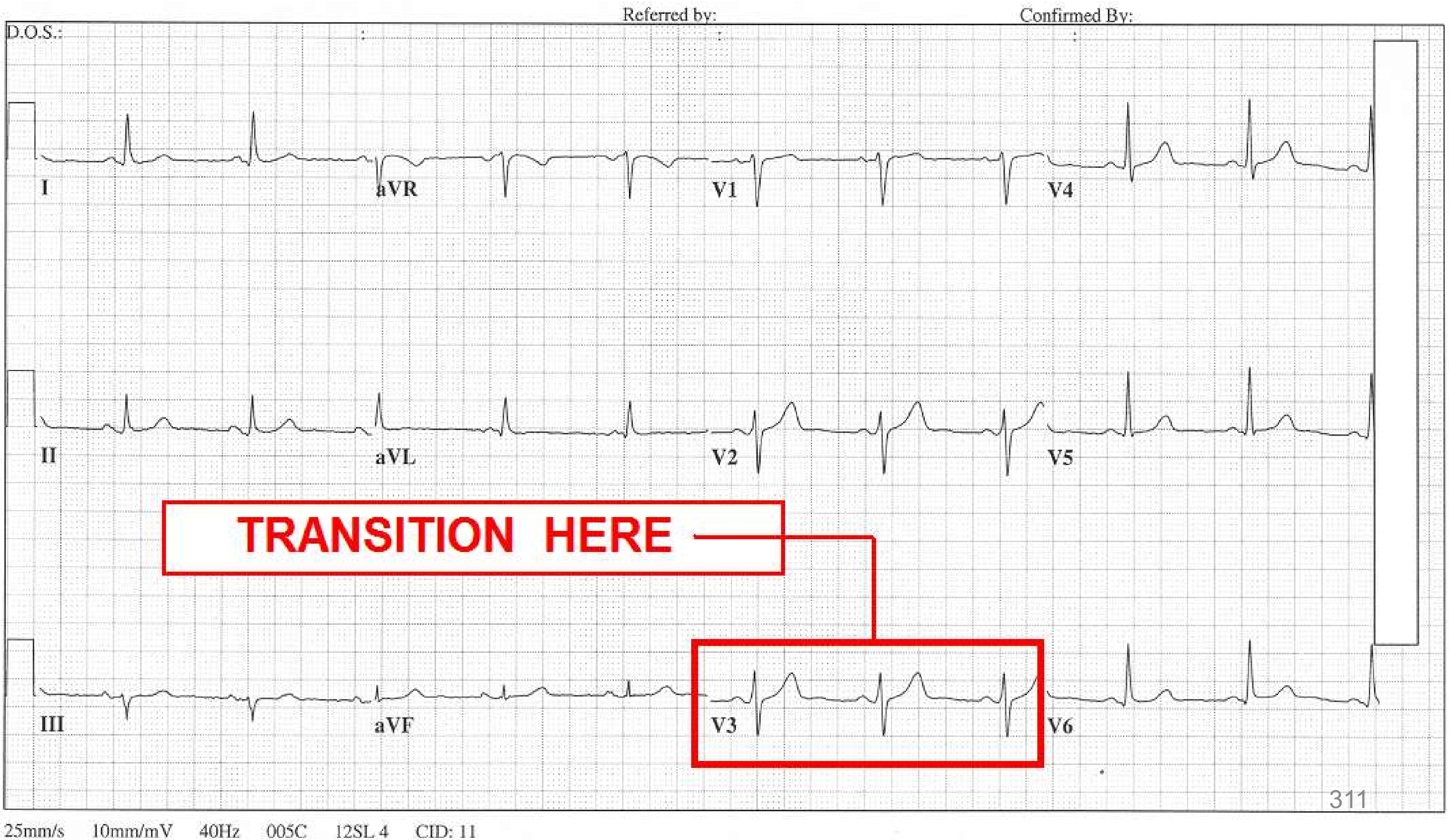
AXIS ROTATION



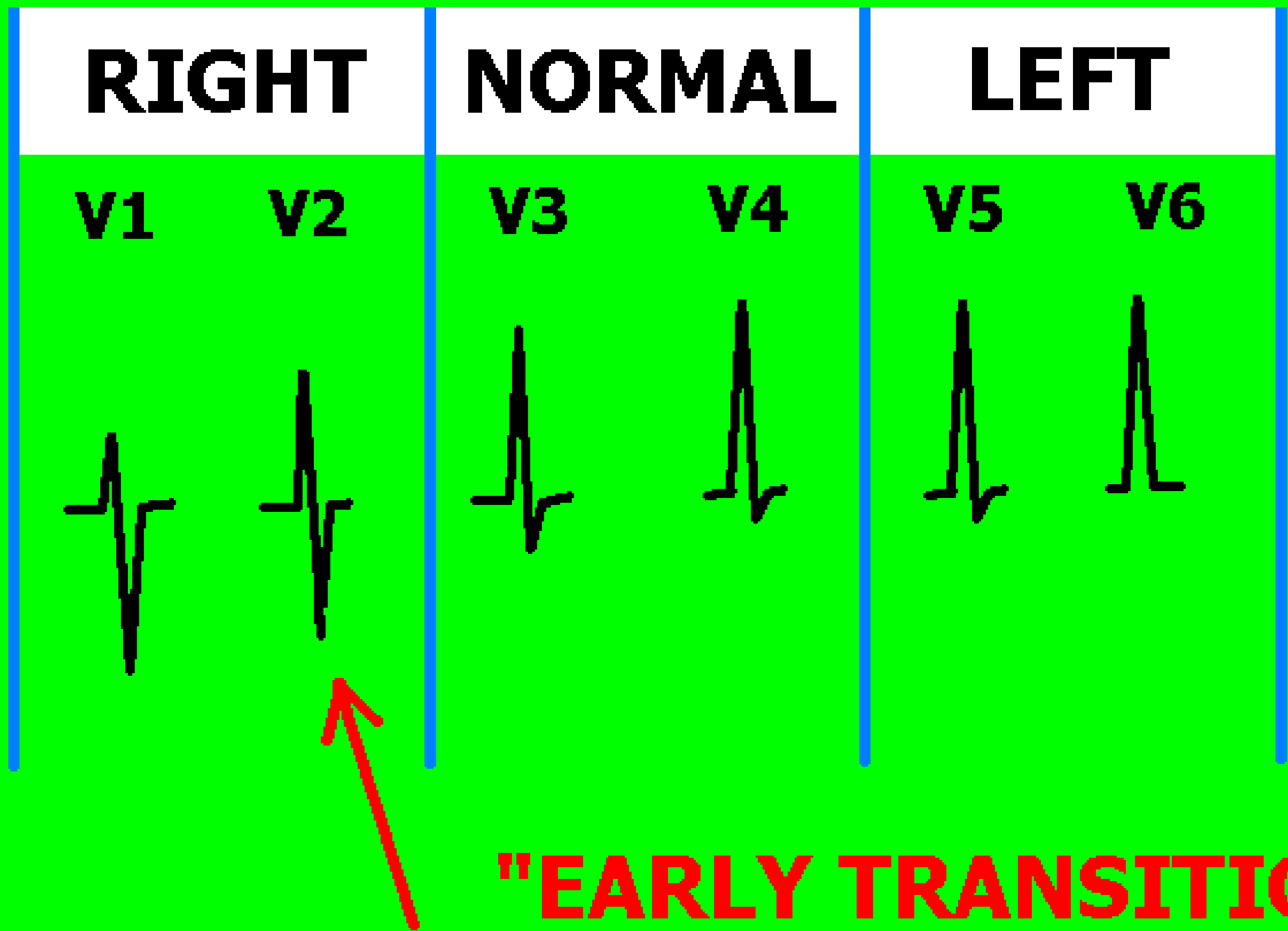
TRANSITION SHOULD OCCUR IN LEADS V3 or V4

NORMAL TRANSITION

IS BETWEEN LEADS V3 and V4



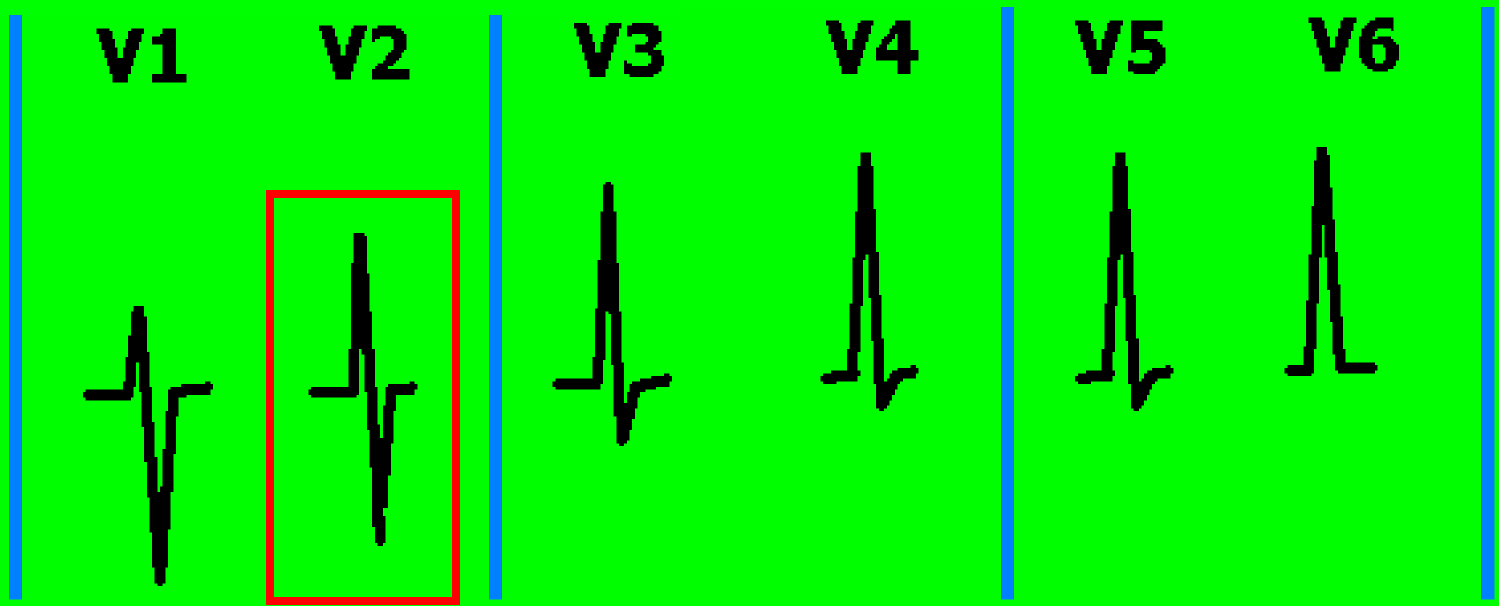
AXIS ROTATION



"EARLY TRANSITION"

"SHIFTED TO THE RIGHT"

* COMMON CAUSES of EARLY TRANSITION



1. Right Bundle Branch Block
2. Right Ventricular Hypertrophy
3. Old Posterior Wall MI
4. Wolff-Parkinson-White (type A)

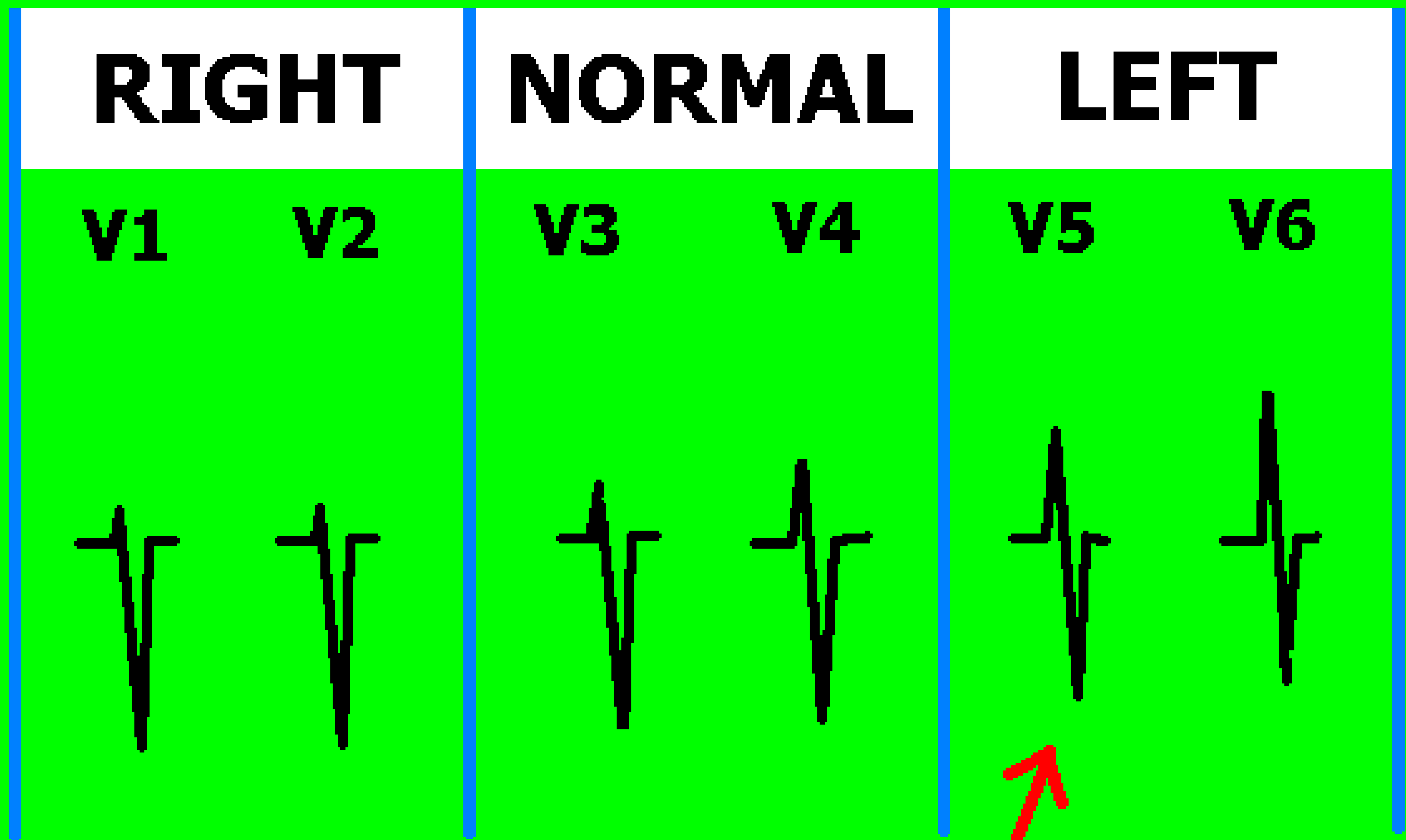
LEFT - SIDED PATHWAY - FROM MARRIOTT'S "Practical Electrocardiography - 10th Edition," 2000

COMMON CAUSES OF EARLY TRANSITION

....SOME HELPFUL CLUES:

1. **Right Bundle Branch Block (RBBB)**
   - QRS wider than 120ms
   - Supraventricular rhythm (normal P : QRS relationship)
   - RSR' or RR' ("notching") in V1, V2, and/or V3
2. **Right Ventricular Hypertrophy (RVH)**
   - Corresponding Right Atrial Hypertrophy (RAH)
   - Right Axis Deviation (RAD)
   - QRS in LEAD I more NEGATIVE than POSITIVE (R<S)
3. **Old Posterior Wall MI**
   - Usually accompanied by OLD INFERIOR WALL MI
   - Does NOT abnormally widen the QRS complex
4. **Wolff-Parkinson-White (WPW) type A**
   - Short P-R Interval
   - Presence of Delta Waves
   - Wide QRS complexes

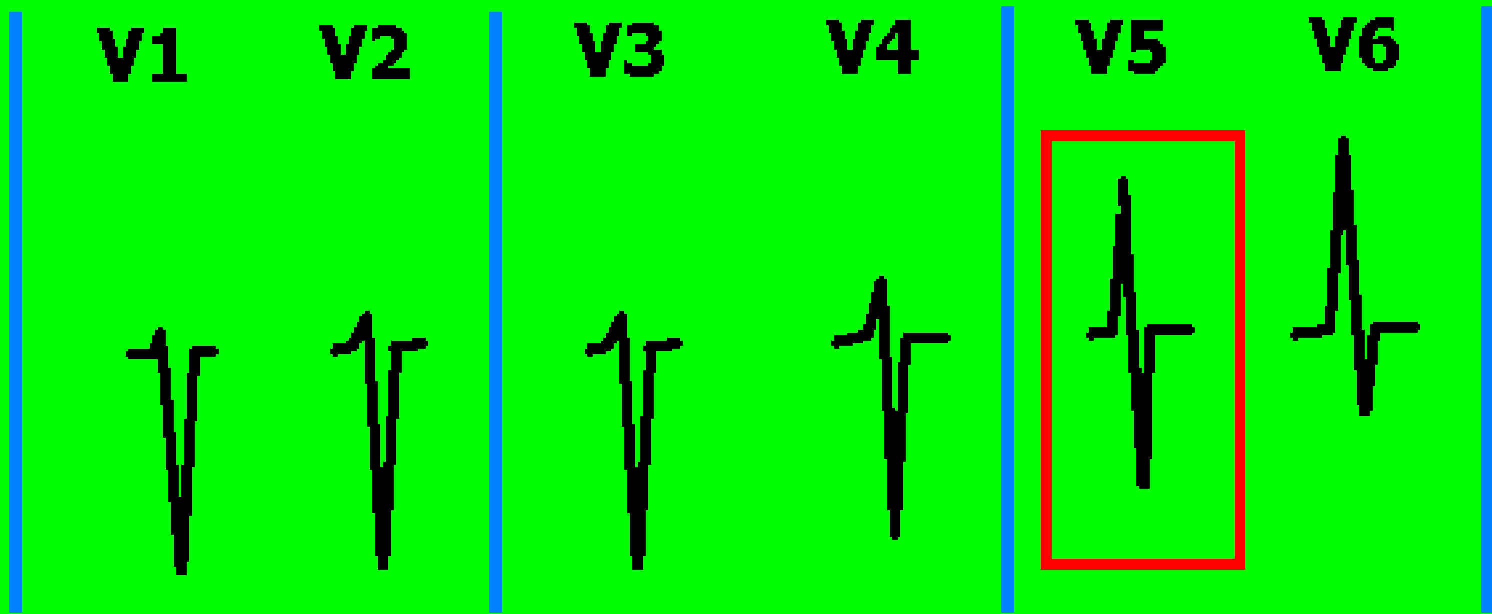
AXIS ROTATION



"LATE TRANSITION"

"SHIFTED TO THE LEFT"

COMMON CAUSES of LATE TRANSITION



1. Old Anterior Wall M.I.
2. Left Bundle Branch Block
3. Left Ventricular Hypertrophy
4. Wolff-Parkinson-White (type B)

RIGHT- SIDED PATHWAY - FROM MARRIOTT'S
"Practical Electrocardiography - 10th Edition," 2000

COMMON CAUSES OF LATE TRANSITION

. . . . WITH SOME *COMMON* HELPFUL CLUES:

1. **Old Anterior MI**
   - Q Waves in V1, V2, and /or V3
   - Other causes of LATE TRANSITION ruled out
2. **Left Bundle Branch Bock (LBBB)**
   - Supraventricular Rhythm
   - QRS wider than 120 ms (.12 sec)
   - RsR' or RR' ("notching") in V5 and/or V6
3. **Left Ventricular Hypertrophy (LVH)**
   - Corresponding Left Atrial Hypertrophy (LAH)
   - T wave Strain Pattern V5 / V6
   - Intrinsicoid Deflection in V5 / V6 > 45 ms
   - V1 S wave + V5 or V6 R wave > 35 mm
   - R or S wave in any LIMB LEAD > 2.0 mV (20 mm)
4. **Wolff-Parkinson-White (Type B)**
   - Presence of DELTA waves
   - Short P-R Interval (< 120 ms)
   - Wide QRS (> 120 ms)

MOM and DAD at Lee's Diner, York, PA 2006