# Bayfront Health Hospitals

Bayfront Health Seven Rivers, Crystal River, FL

Bayfront Health Brooksville, Brooksville, FL

Seven Rivers Freestanding ED, Citrus Hills, FL


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ACCREDITED
AMERICAN COLLEGE OF CARDIOLOGY
CHEST PAIN CENTER
PRIMARY PCI WITH RESUSCITATION

ACCREDITED
AMERICAN COLLEGE OF CARDIOLOGY
HEART FAILURE

# The Lifesaving 12 Lead ECG: Part 1

**Wayne W Ruppert, CVT, CCCC, NREMT-P**
**Regional Cardiovascular Coordinator**
Chest Pain Center, Heart Failure and Therapeutic Hypothermia Programs

CERTIFIED CARDIOVASCULAR CARE COORDINATOR

# Welcome !


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

# 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

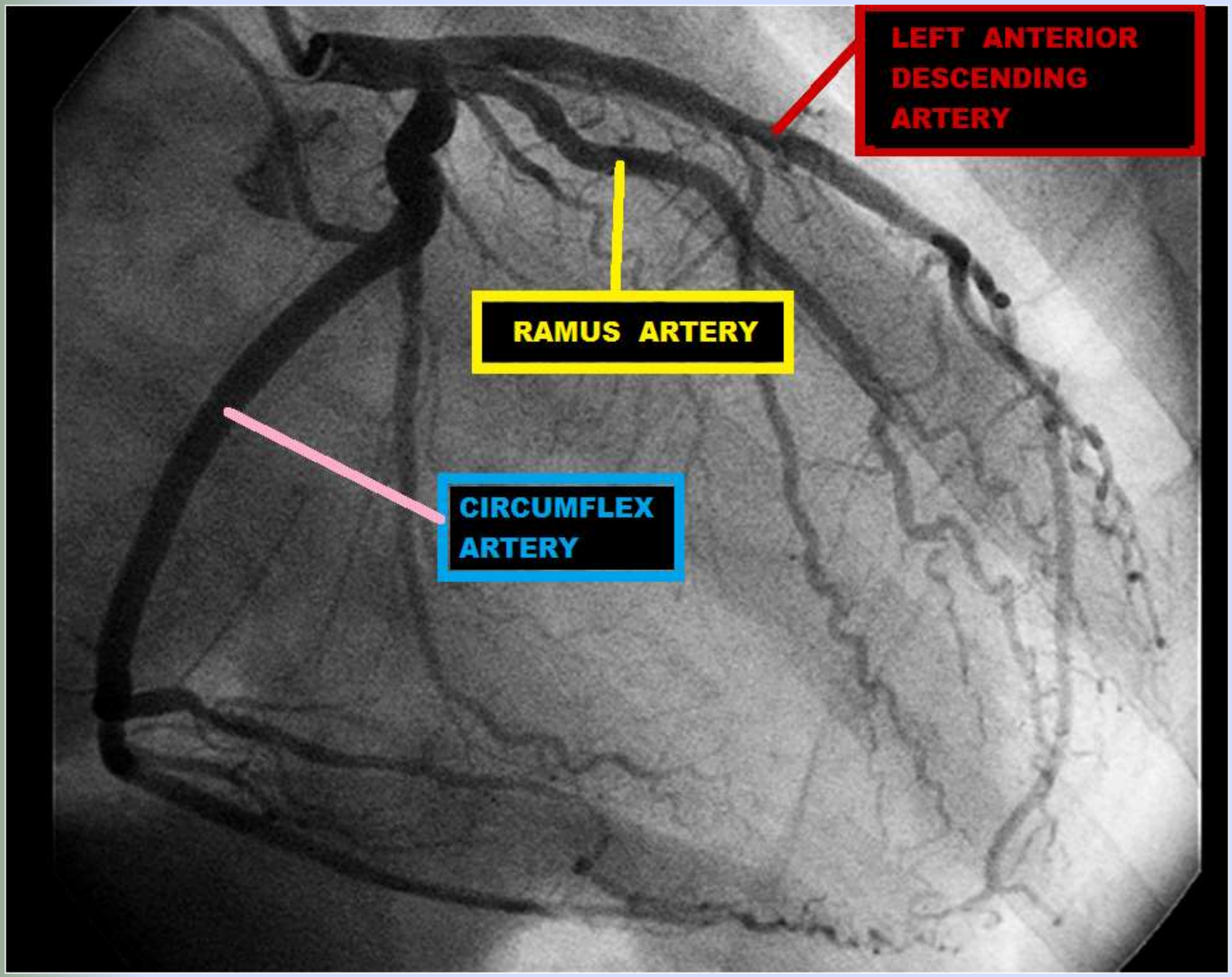
# Source of Curriculum:

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

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

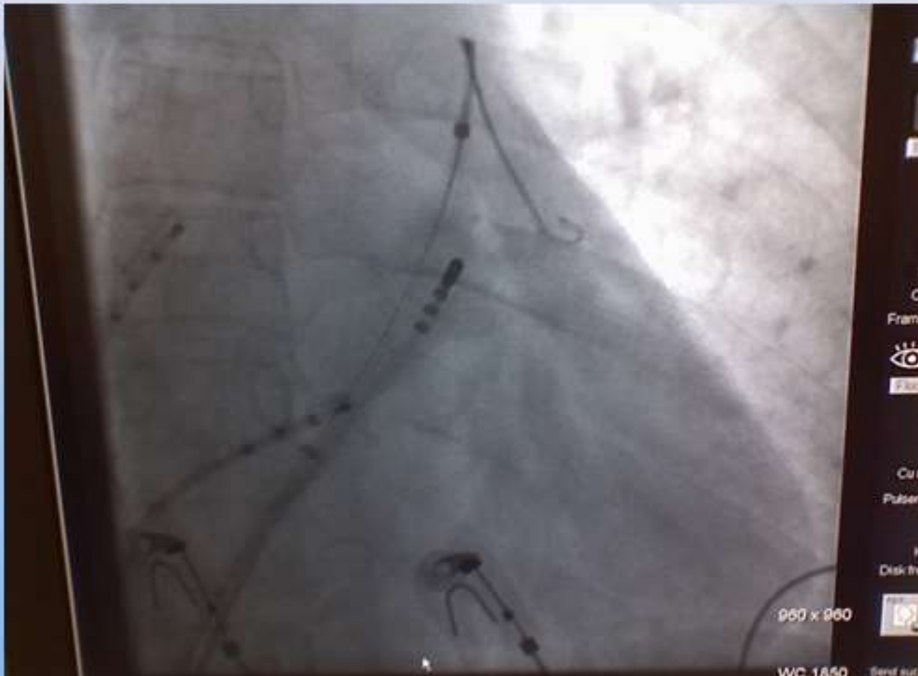

Wayne Ruppert and Dr. James Irwin, St Joseph’s Hospital, Tampa, 7/29/2004

# Cardiac Cath Lab Advantage:




Correlation of ECG leads with SPECIFIC cardiac anatomic structures.

# Electrophysiology Lab Case Studies




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

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

# EP Lab Advantage:


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

# Source of Curriculum:

- Case Studies from Cardiac Catheterization and Electrophysiology Labs, 1996 – Present
- Current Evidence-based Research
  - Journal of the American College of Cardiology (JACC)
  - American Heart Association (AHA) Circulation
  - ACC/AHA Guidelines
  - New England Journal of Medicine

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- Case Studies from Cardiac Catheterization and Electrophysiology Labs, 1996 – Present
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  - American Heart Association (AHA) Circulation
  - ACC/AHA Guidelines
  - New England Journal of Medicine
- Two peer reviewed, published textbooks

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

**This book prepares you to:**

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

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

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

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

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

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

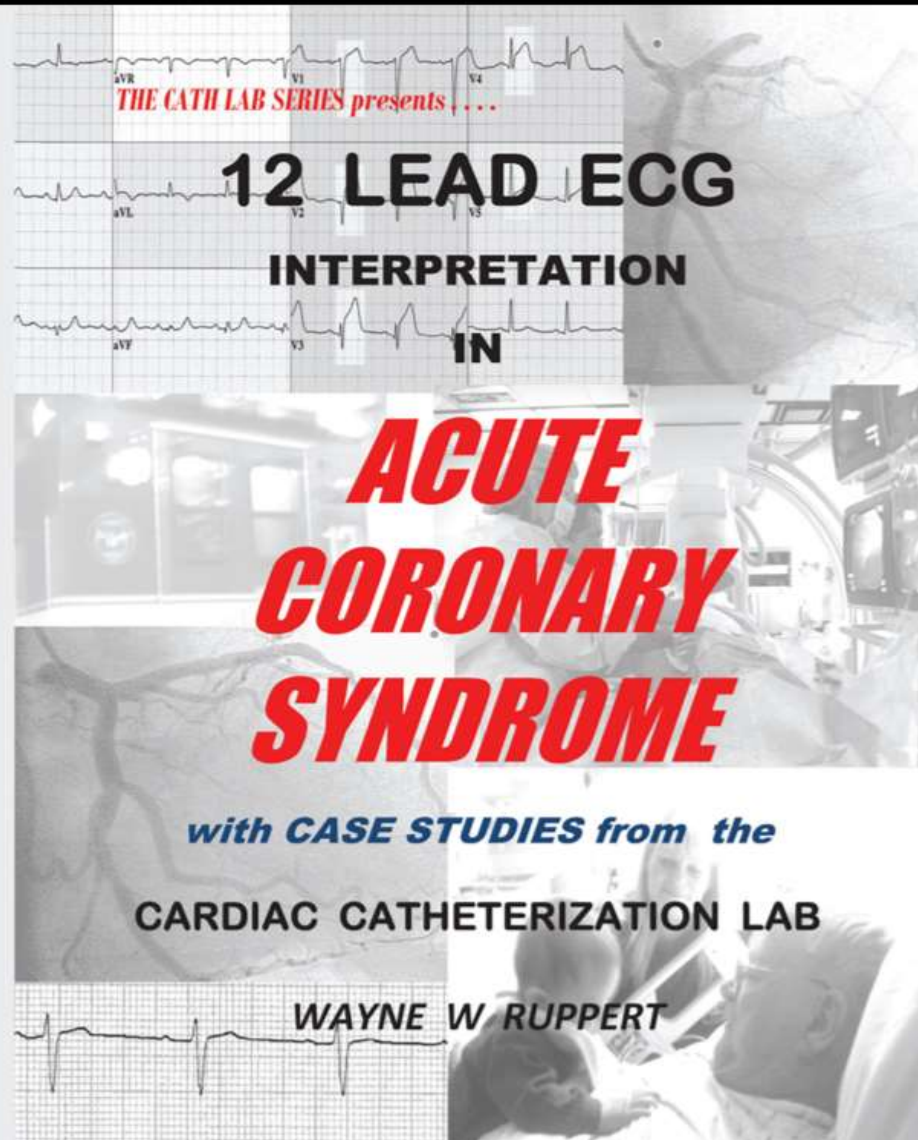
**Joseph P. Ornato, MD, FACP, FACC, FACEP**
- Professor and Chairman, Department of Emergency Medicine
Medical College of Virginia/Virginia Commonwealth University
- Medical Director, Richmond Ambulance Authority,
Richmond, Virginia

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

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

ISBN 978-0-9829172-1-3
59500
9 780982 917213

12 LEAD ECG INTERPRETATION in ACUTE CORONARY SYNDROME with CASE STUDIES from the CATH LAB -- WAYNE RUPPERT




www.TriGenPress.com

www.ECGtraining.org

BarnesandNoble.com

Amazon.com

# TEXTBOOK REVIEWED BY:

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

Humberto Coto, MD, FACP, FACC, Chief of Cardiology, St. Joseph's Hospital

Matthew Glover, MD, FACP, FACC, Interventional Cardiologist, St. Joseph's Hospital

Xavier Prida, MD, FACP, FACC, Interventional Cardiologist, St. Joseph's Hospital

Charles Sand, MD, FACP, FACEP, Emergency Department Physician, St. Joseph's Hospital

Printed and Marketed Worldwide by The Ingram Book Company
2010 - Current

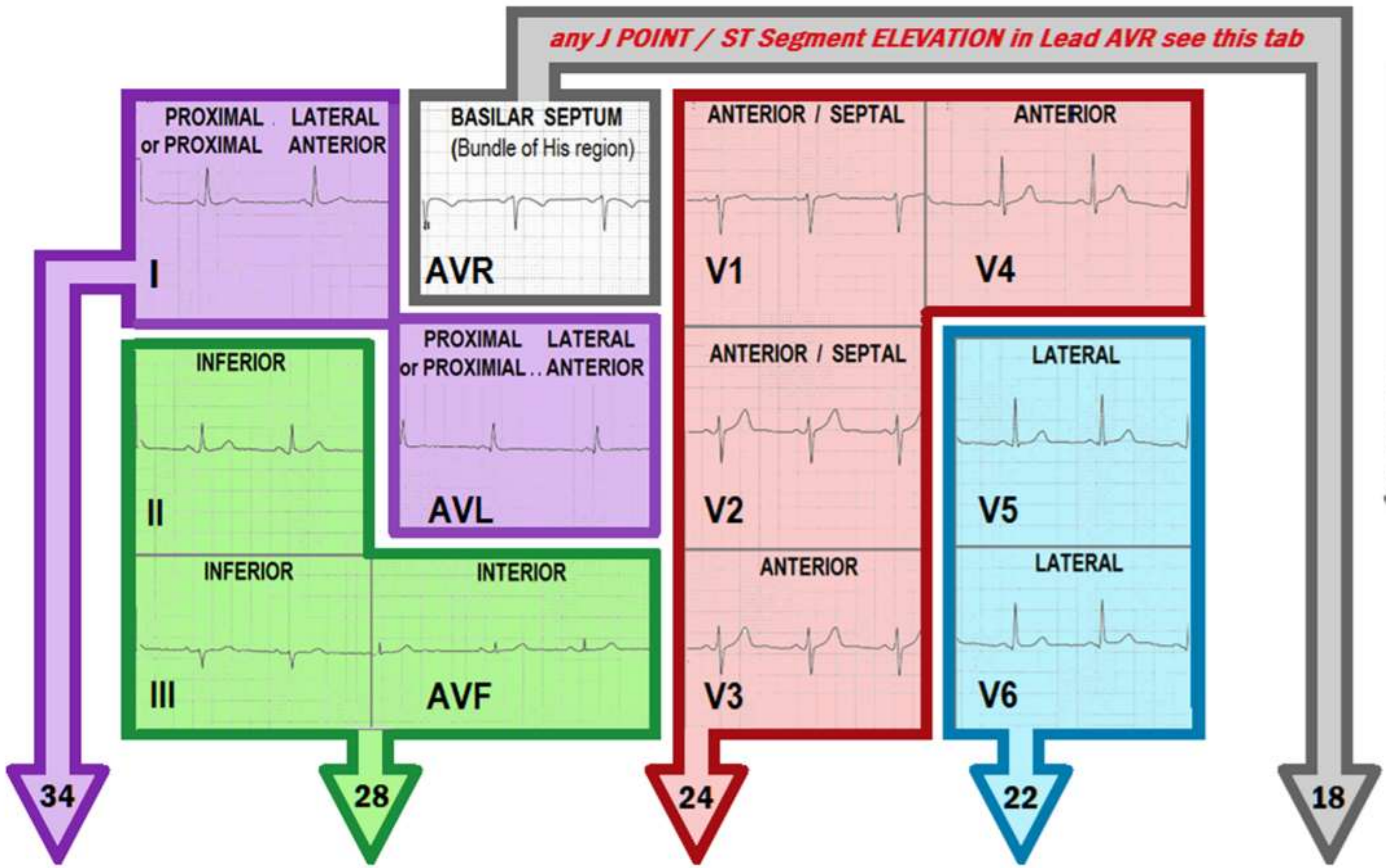
# STEMI Assistant

by Wayne Ruppert

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

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

CRASH CART EMERGENCY REFERENCE




Bayfront Health
Dade City

# TEXTBOOK REVIEWED BY:

Barbra Backus, MD, PhD Inventor of "The HEART Score," University Medical Center, Utrech, Netherlands

Michael R. Gunderson, National Director, Clinical and Health IT, American Heart Association

Anna Ek, AACC, BSN, RN Accreditation Review Specialist, The American College of Cardiology

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

Printed and Marketed Worldwide by The Ingram Book Company
2010 - Current

# STEMI Assistant

Tutorial Video

Free download – electronic copy (PDF file)

# Copyright 2010, 2015, 2018



Wayne.ruppert@bayfronthealth.com

# COURSE PRE-REQUISITE:

***You should already have Basic Single-Lead ECG Rhythm Strip Interpretation Skills.***

**THIS COURSE IS NOT A BASIC ECG RHYTHMS COURSE. If you are not already reasonably comfortable with interpreting and understanding basic ECG dysrhythmias (i.e.: heart blocks, A-Fib, V-Tach, etc.) we DO NOT recommend that you attend this workshop; instead we recommend our "Basic ECG Rhythms Workshop."**

# The Lifesaving 12 Lead ECG Course:

Is a condensed curriculum focused on acute conditions which are associated with a high degree of morbidity and mortality:

# The Lifesaving 12 Lead ECG Course:

Is a condensed curriculum focused on acute conditions which are associated with a high degree of morbidity and mortality:

1. Acute Coronary Syndromes
   - STEMI (pre-infarction, acute & evolving / old MI)
   - NSTEMI
   - Unstable Angina
   - Low Risk Chest Pain

# The Lifesaving 12 Lead ECG Course:

**Is a condensed curriculum focused on acute conditions which are associated with a high degree of morbidity and mortality:**

2. **Sudden Cardiac Death Syndromes**
   - **Long QT Syndrome (Congenital & Drug Induced)**
   - **Brugada Syndrome**
   - **Cardiomyopathy (Hypertrophic and other)**
   - **Arrhythmogenic Right Ventricular Dysplasia**
   - **Wolff-Parkinson-White Syndrome**
   - **Catecholinergic Polymorphic Ventricular Tachy.**

# ***SUGGESTION*** *for optimal learning…….*

**To get the most from this class:**

- Do not try to write down or memorize every point.

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**To get the most from this class:**

- Do not try to write down or memorize every point.
- DOWNLOAD this PowerPoint in its entirety – review and study it at you own pace.
- For now …. Simply LISTEN to everything that is said.   If it "makes sense," then you're learning.
- In other words, *"just go along for the ride."*

# The Lifesaving 12 Lead ECG Course:

**Session 1 (morning session) Contents:**

- **Introduction and The ECG in Perspective**
- **Risk Stratification: The HEART Score**
- **Essential Cardiac A & P**
  - **Cellular (depolarization / repolarization)**
  - **Structural**
- **Heart Sounds and Valvular Function**

# The Lifesaving 12 Lead ECG Course:

**Session 1 Contents,** continued**:**

- **Bypass Tract Pathophysiology**
- **ECG Principles**
- **Coronary Artery Anatomy and Correlation with the 12 Lead ECG**
- **Waveforms and Intervals**
- **Bundle Branch Blocks**
- **Axis Deviation and Rotation**

# The Lifesaving 12 Lead ECG Course:

**<u>Session 2 (afternoon session) Contents:</u>**

- **Sudden Cardiac Death Syndromes**
  - **Long QT**
  - **Hypertrophic Cardiomyopathy**
  - **Arrythmogenic Right Ventricular Cardiomyopathy**
  - **Brugada Syndrome**
- **Application of The HEART Score**
- **Acute Coronary Syndromes**

  **With Cath Lab Case Studies**

# Helpful Web Resources:

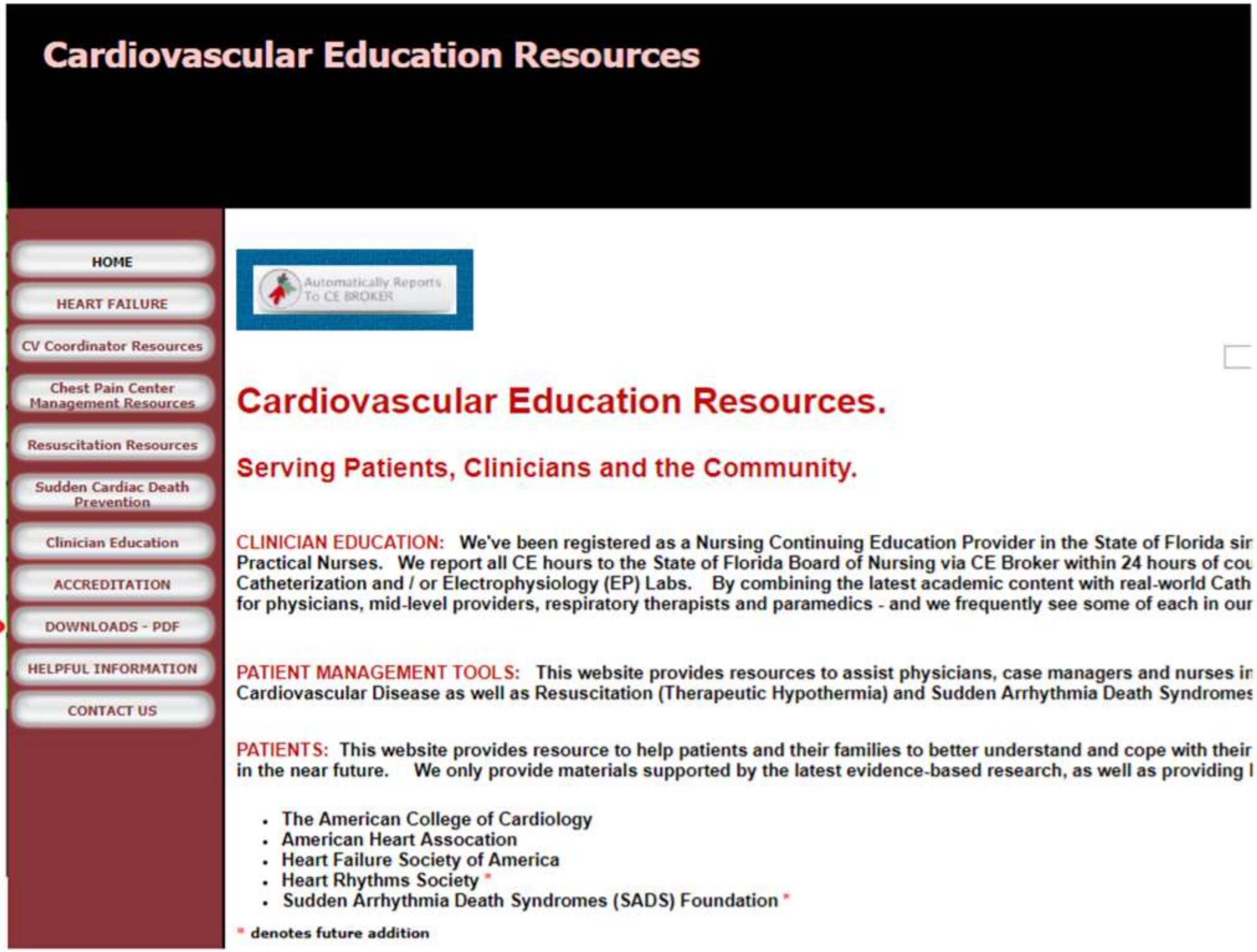
www.practicalclinicalskills.com

www.skillstat.com/tools/ecg-simulator

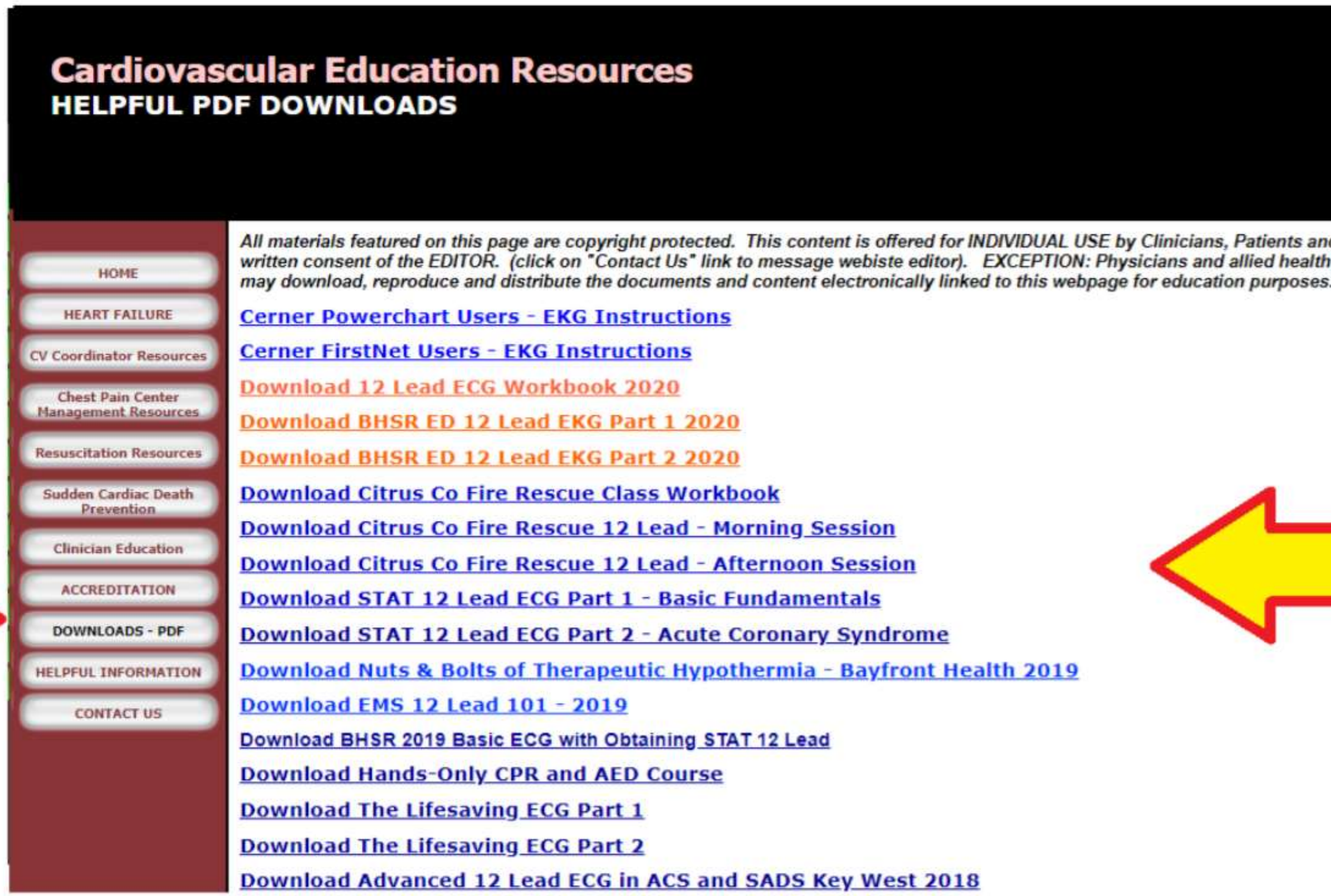
www.ECGtraining.org

# 1. Go to: www.ECGtraining.org

# 2. Select "Downloads PDF" from menu bar



1. Go to: www.ECGtraining.org
2. Select "Downloads PDF" from menu bar
3. Select your courses



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 )

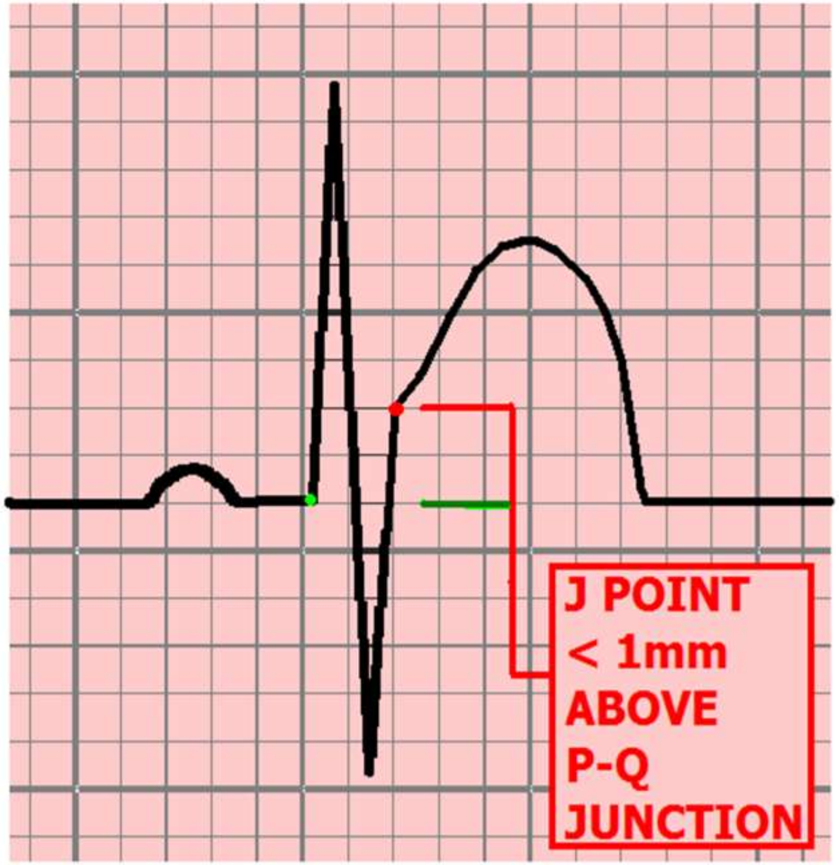
↓ SPECIFICITY

( 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

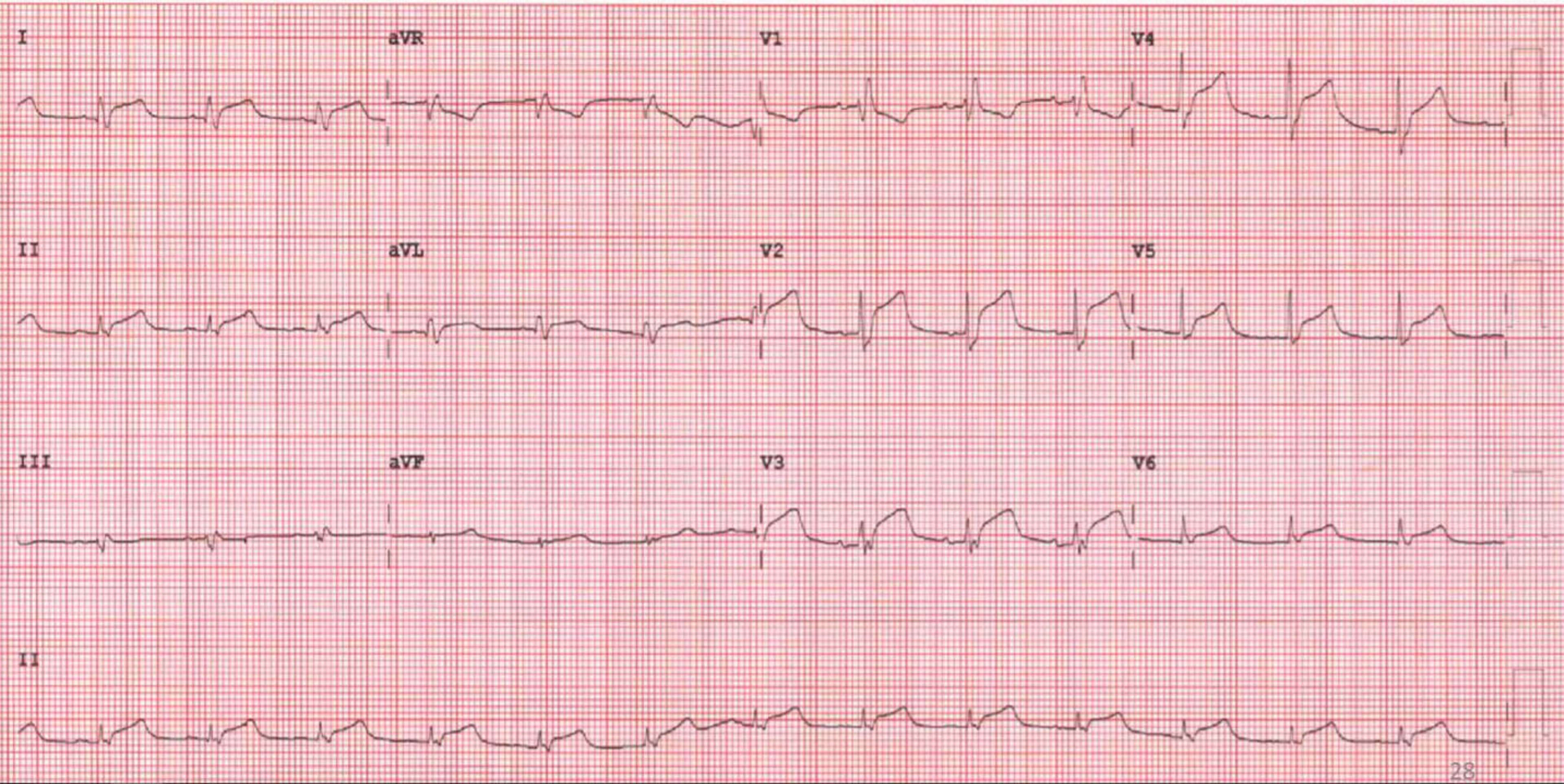
- ABNORMAL ECG -

>>> Acute MI <<<

Requested by:

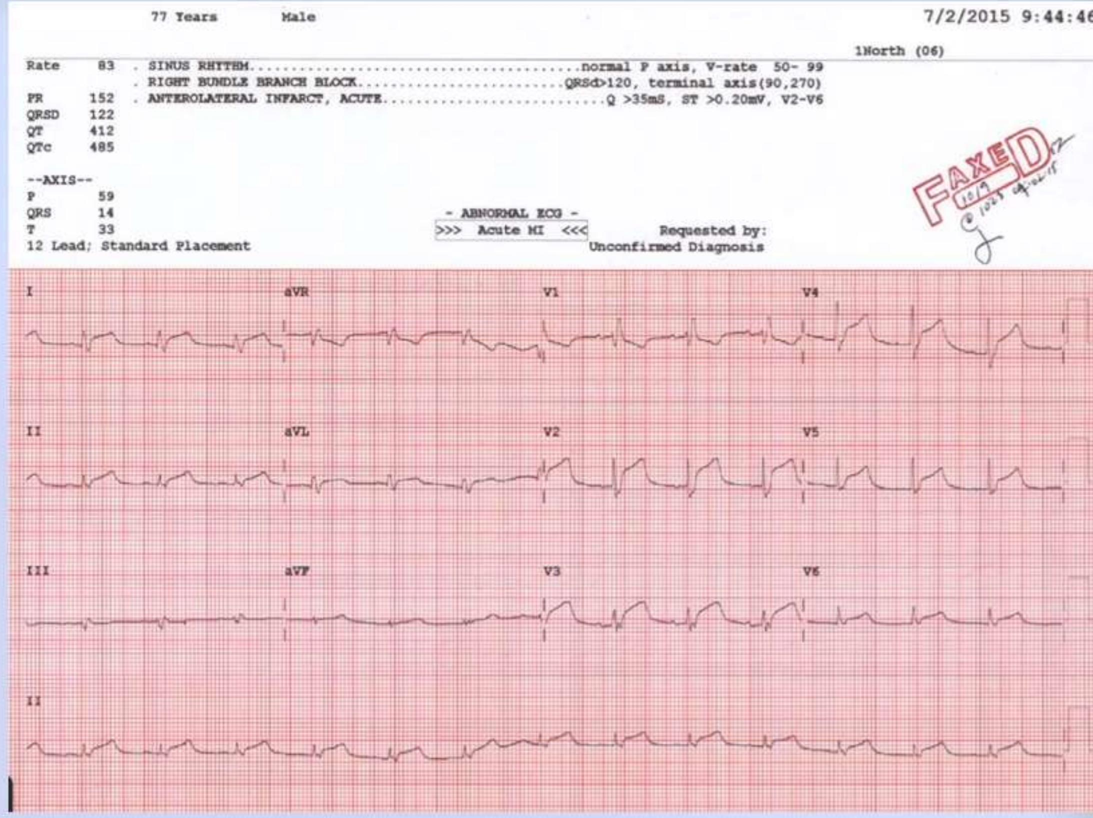
Unconfirmed Diagnosis

FAXED



## Patient:

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



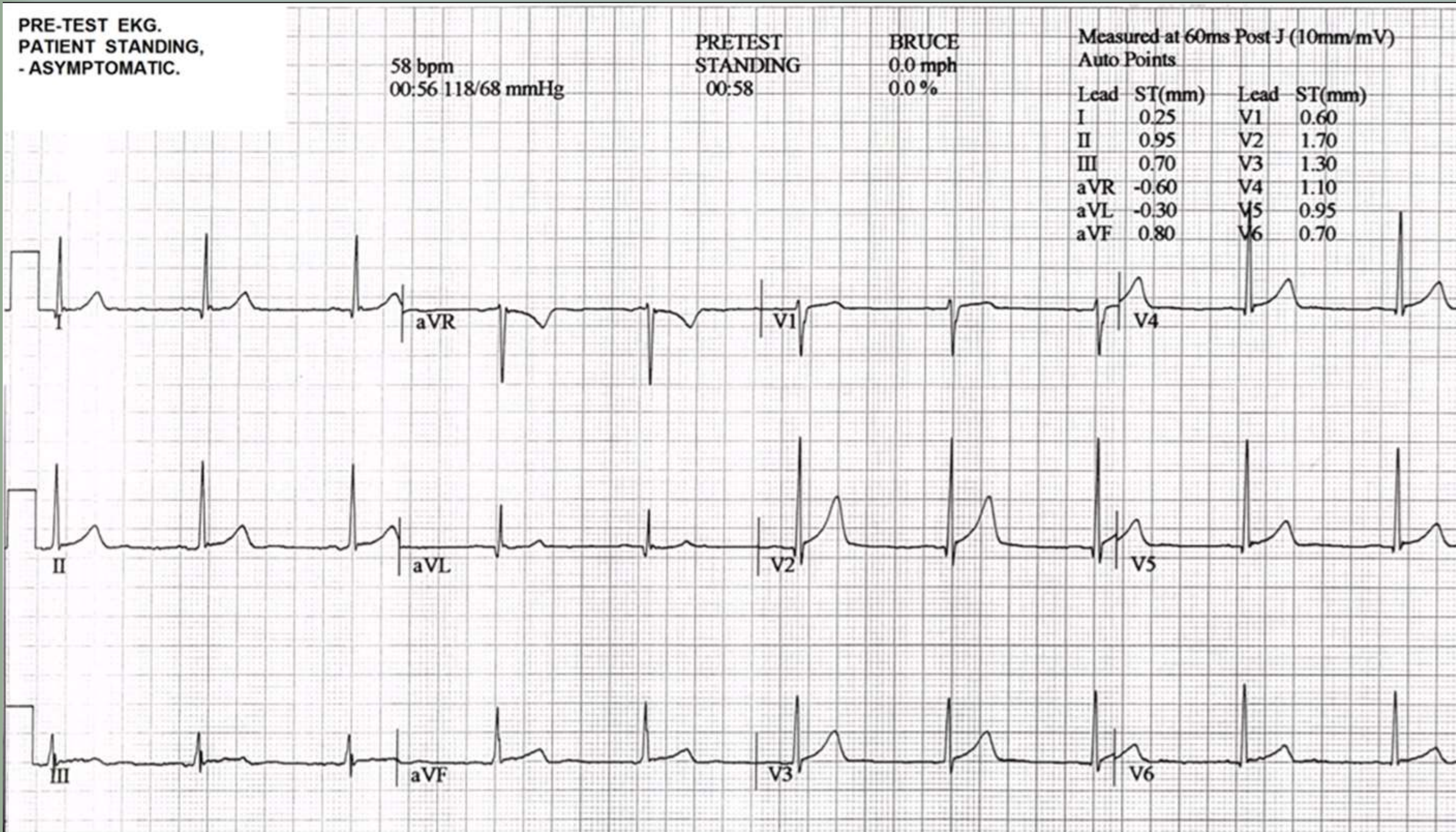

**EARLY REPOLARIZATION. This degree of ST Elevation in early repolarization is VERY RARE: The only such ECG I have seen in approximately 13,000 cardiac catheterizations.**

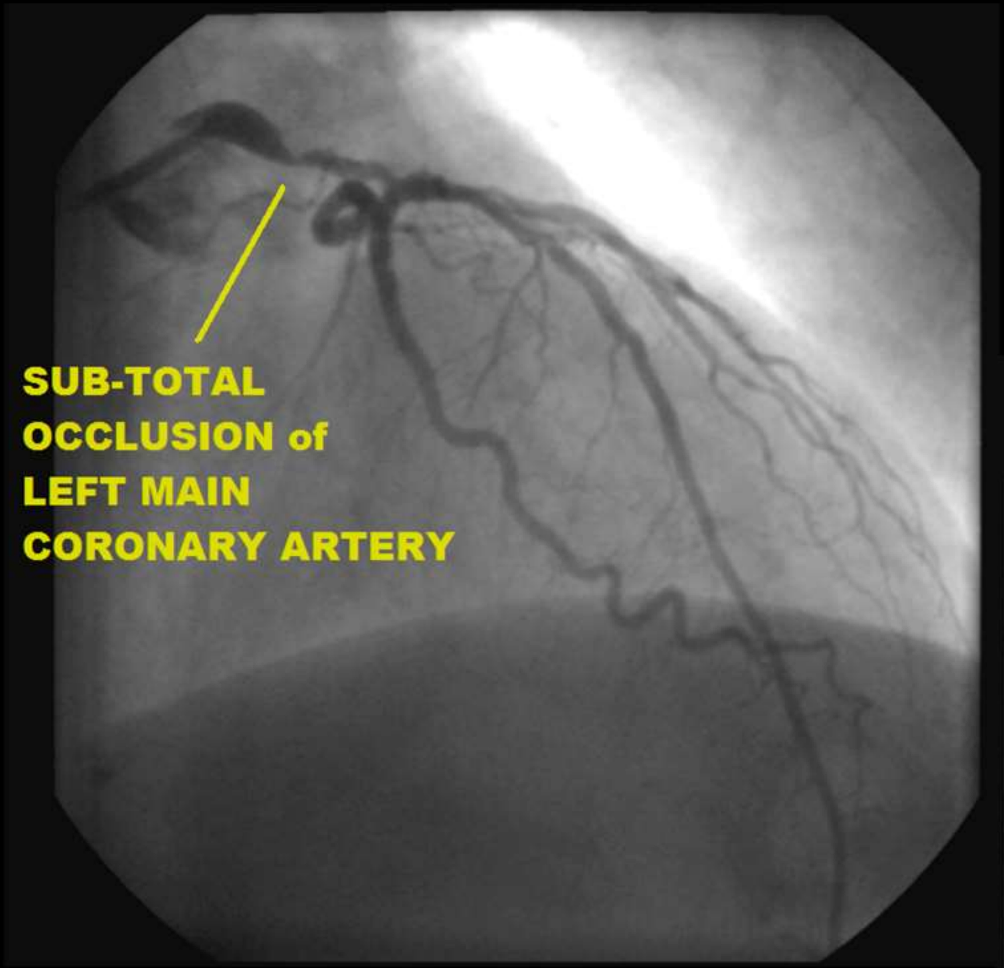
# EKGs in PERSPECTIVE, con't:

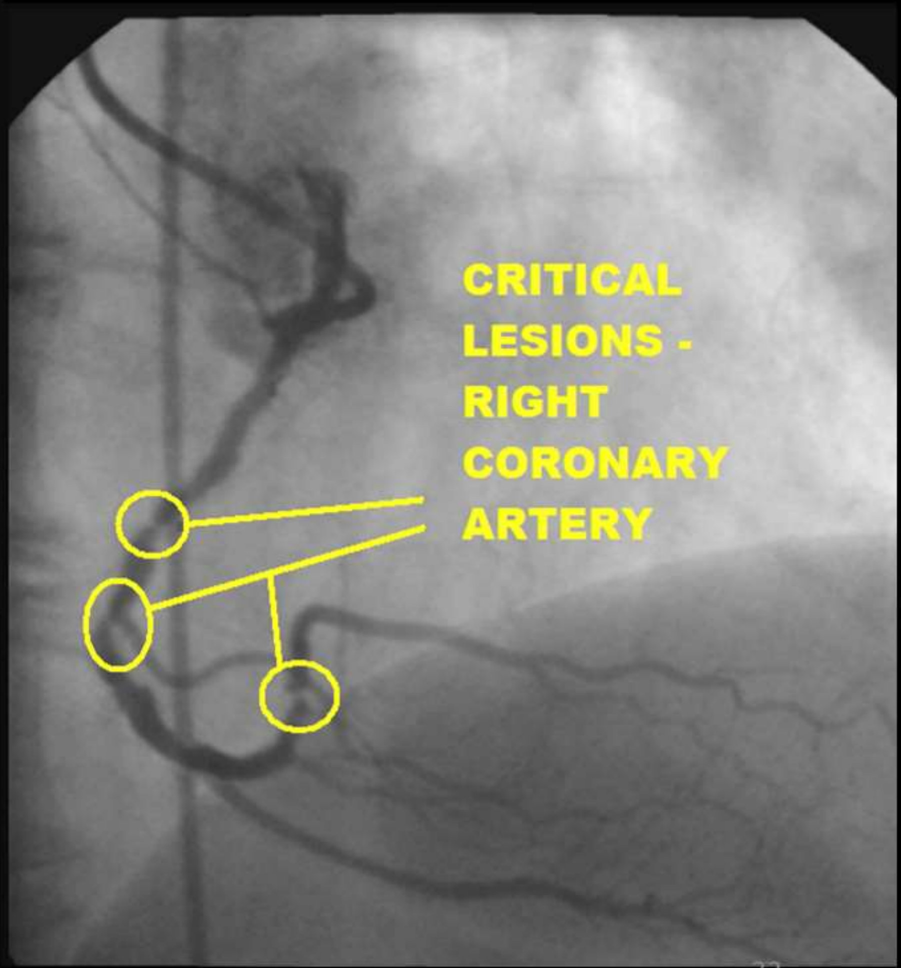
**One of the MOST MISLEADING scenarios of all** is when the EKG APPEARS **PERFECTLY NORMAL** . . .

. . . 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

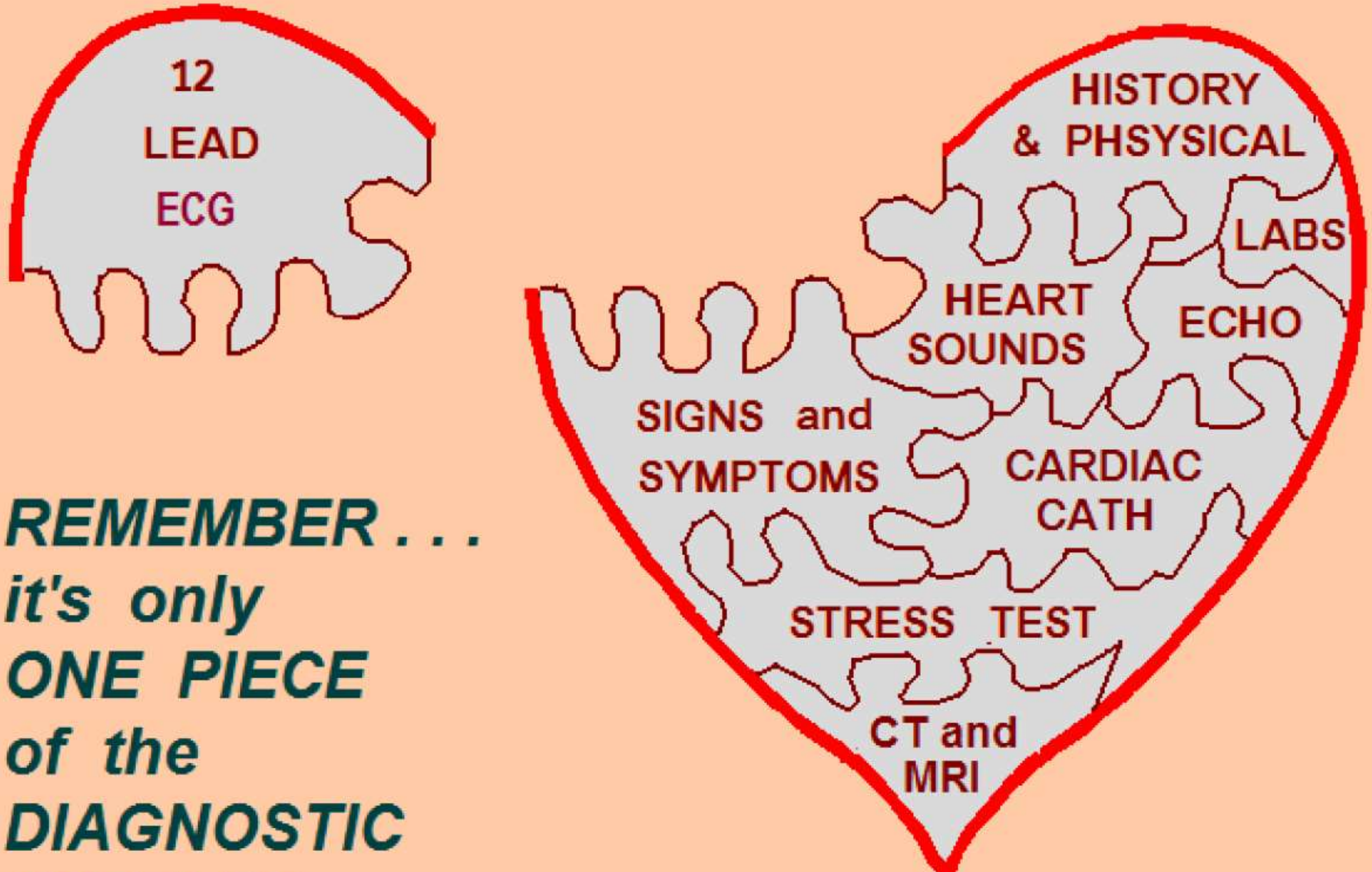

CRITICAL
LESIONS -
RIGHT
CORONARY
ARTERY

*"From time to time, the EKG – derived diagnosis will be* ***TOTALLY INCORRECT.***"

**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.***

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




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

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

- ***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

App Store Preview

Open the Mac App Store to buy and download apps.

# HEART Pathway 12+

Chest pain. Risk-stratified.

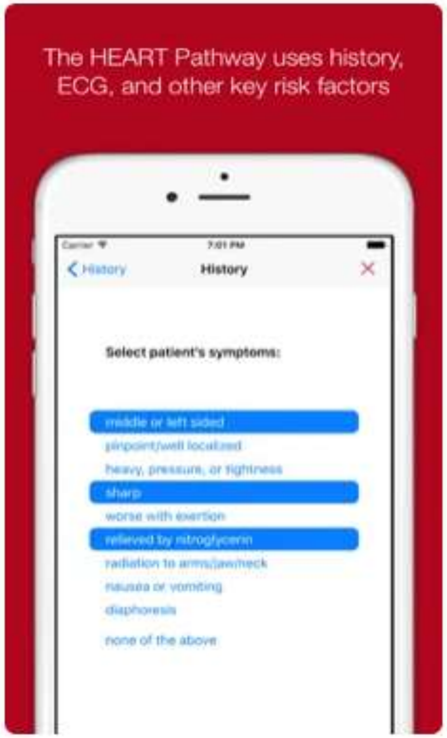
Impathiq

Designed for iPhone

★★★★★ 4.5 • 13 Ratings

Free

## iPhone Screenshots

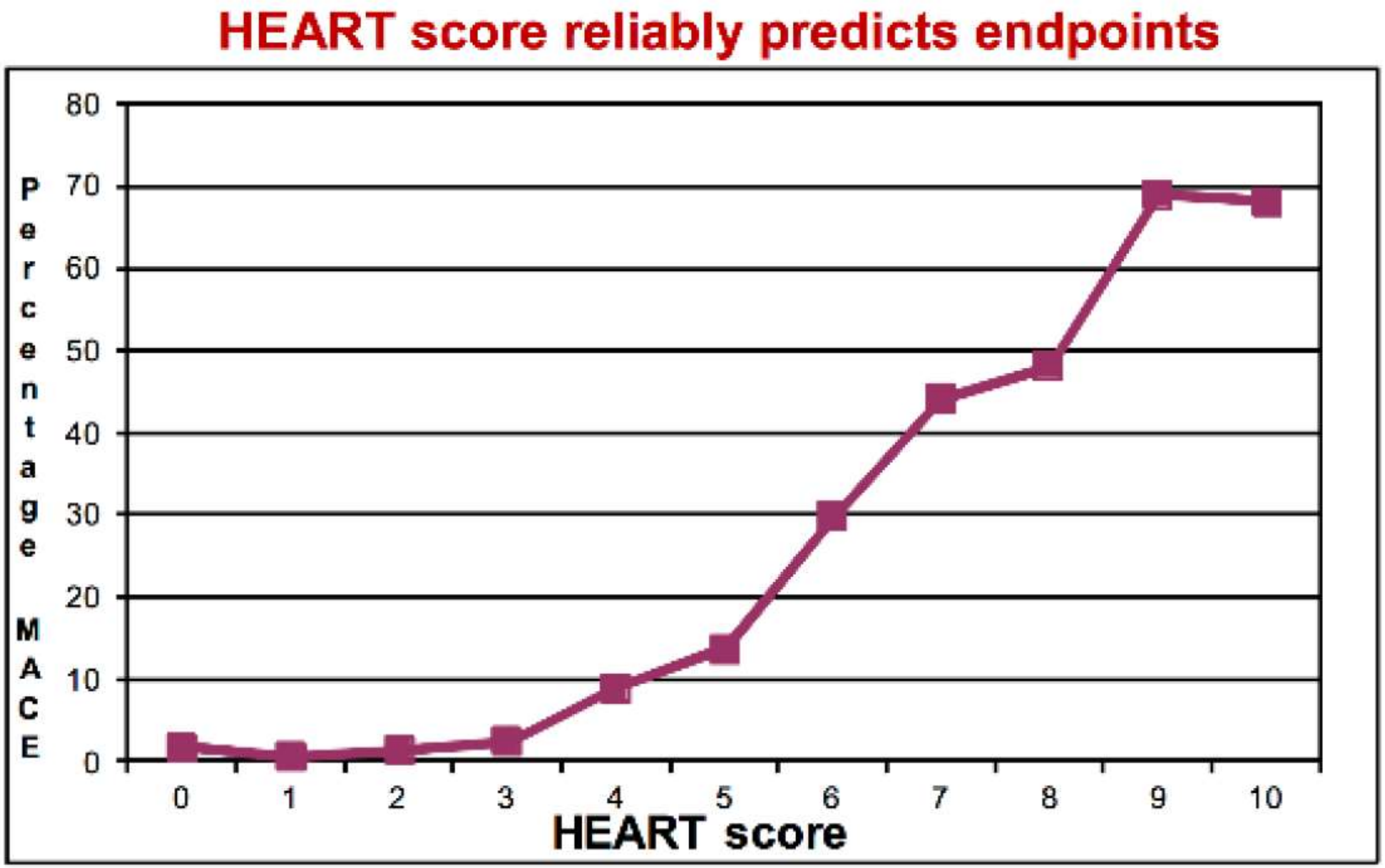





# The HEART Score

| Score | Common Diagnosis: | Disposition: |
|---|---|---|
| 0-3 | Low Risk Chest Pain | Early Discharge with referral |
| 4-6 | Low Risk Chest Pain<br>Unstable Angina | Observation Unit or Admission Tele |
| 7-10 | Unstable Angina<br>NSTEMI<br>STEMI | Tele Admission<br>ICU Admission<br>STAT Cath Lab |

# Heart Score Reliability



# CAUSES OF EKG ABNORMALITIES

PROBLEMS WITH THE HEART'S

- BLOOD SUPPLY
- ELECTRICAL SYSTEM
- PHYSICAL STRUCTURE
- CELLULAR FUNCTION

# CAUSES OF EKG ABNORMALITIES

## PROBLEMS WITH THE HEART'S

- BLOOD SUPPLY
  - ISCHEMIA
  - INFARCTION
  - NECROSIS
- ELECTRICAL SYSTEM
- PHYSICAL STRUCTURE
- CELLULAR FUNCTION

# CAUSES OF EKG ABNORMALITIES

## PROBLEMS WITH THE HEART'S

- BLOOD SUPPLY
- ELECTRICAL SYSTEM
  - AUTOMATICITY
  - REENTRY
  - PRE-EXCITATION
- PHYSICAL STRUCTURE
- CELLULAR FUNCTION

# CAUSES OF EKG ABNORMALITIES

## PROBLEMS WITH THE HEART'S

- BLOOD SUPPLY
- ELECTRICAL SYSTEM
- PHYSICAL STRUCTURE
  - CONGENITAL DEFECTS
  - HYPERTROPHY
  - VALVULAR DYSFUNCTION
- CELLULAR FUNCTION

# CAUSES OF EKG ABNORMALITIES

## PROBLEMS WITH THE HEART'S

- BLOOD SUPPLY
- ELECTRICAL SYSTEM
- PHYSICAL STRUCTURE
- CELLULAR FUNCTION
  - ELECTROLYTES
  - MEDICATIONS / DRUGS
  - BODY TEMPERATURE
  - PH

# Cardiac A & P

# CARDIAC ANATOMY and PHYSIOLOGY "101"

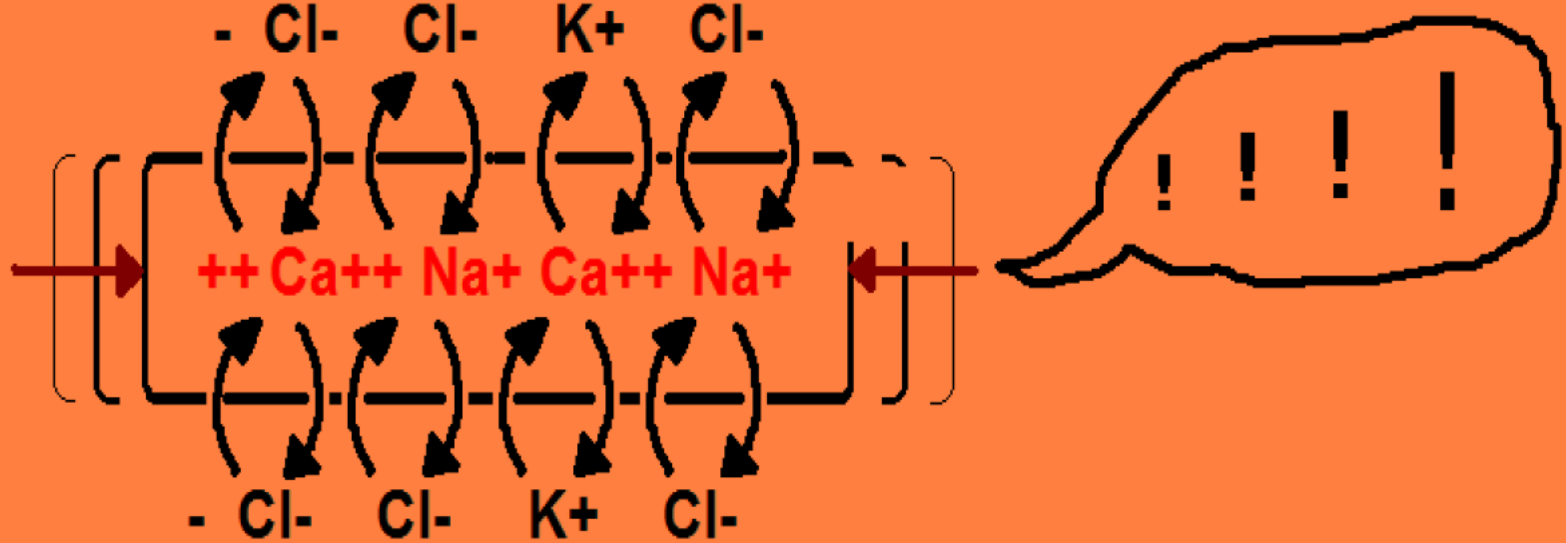
**CARDIAC CELLS AT REST have POSITIVE charged IONS on the OUTSIDE of the cell membrane, and NEGATIVE charged IONS on the INSIDE**

Ca++ Na+ Ca++ Na+ Ca++

Cl- Cl- K+ Cl- K+ Cl- K+ Cl-

Ca++ Na+ Ca++ Na+ Ca++

**. . . 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 !

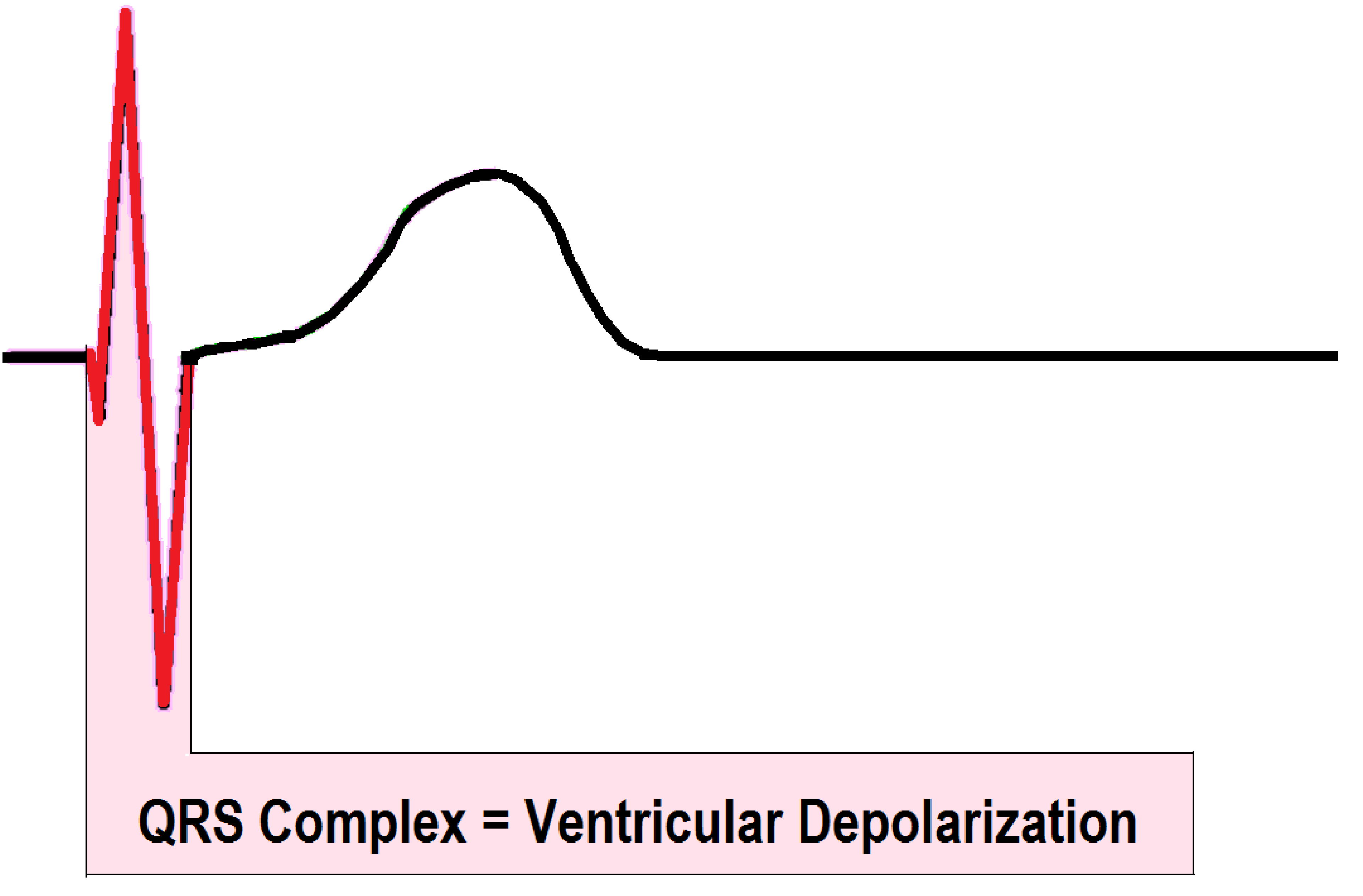
## THIS (OF COURSE) IS KNOW AS . . .

# 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**

# **Ventricular Depolarization**:

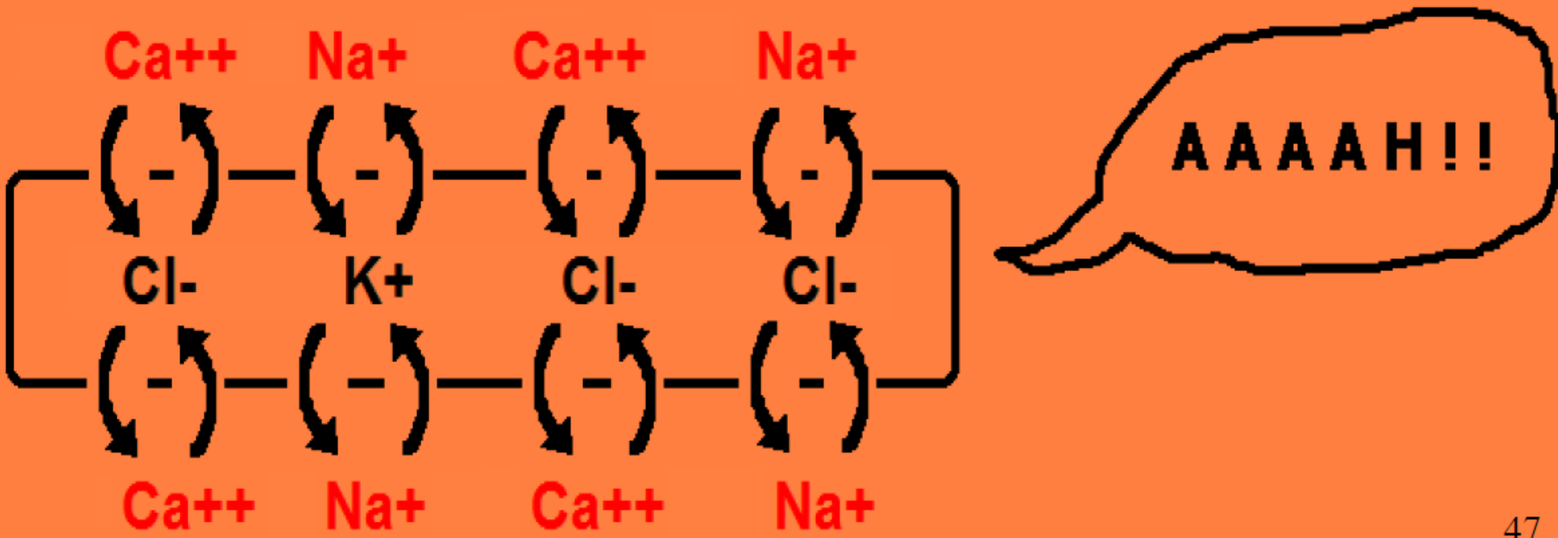
- Is represented by the **QRS Complex**


QRS Complex = Ventricular Depolarization

**AFTER DEPOLARIZATION, THE CELLS RELAX.**

**THE IONS RETURN TO THEIR ORIGINAL POSITIONS --**

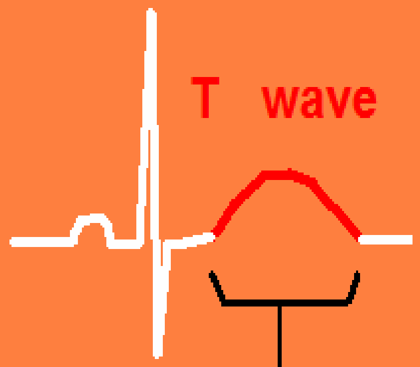
**THIS PROCESS IS KNOWN AS REPOLARIZATION**



CARDIAC ANATOMY and PHYSIOLOGY "101"

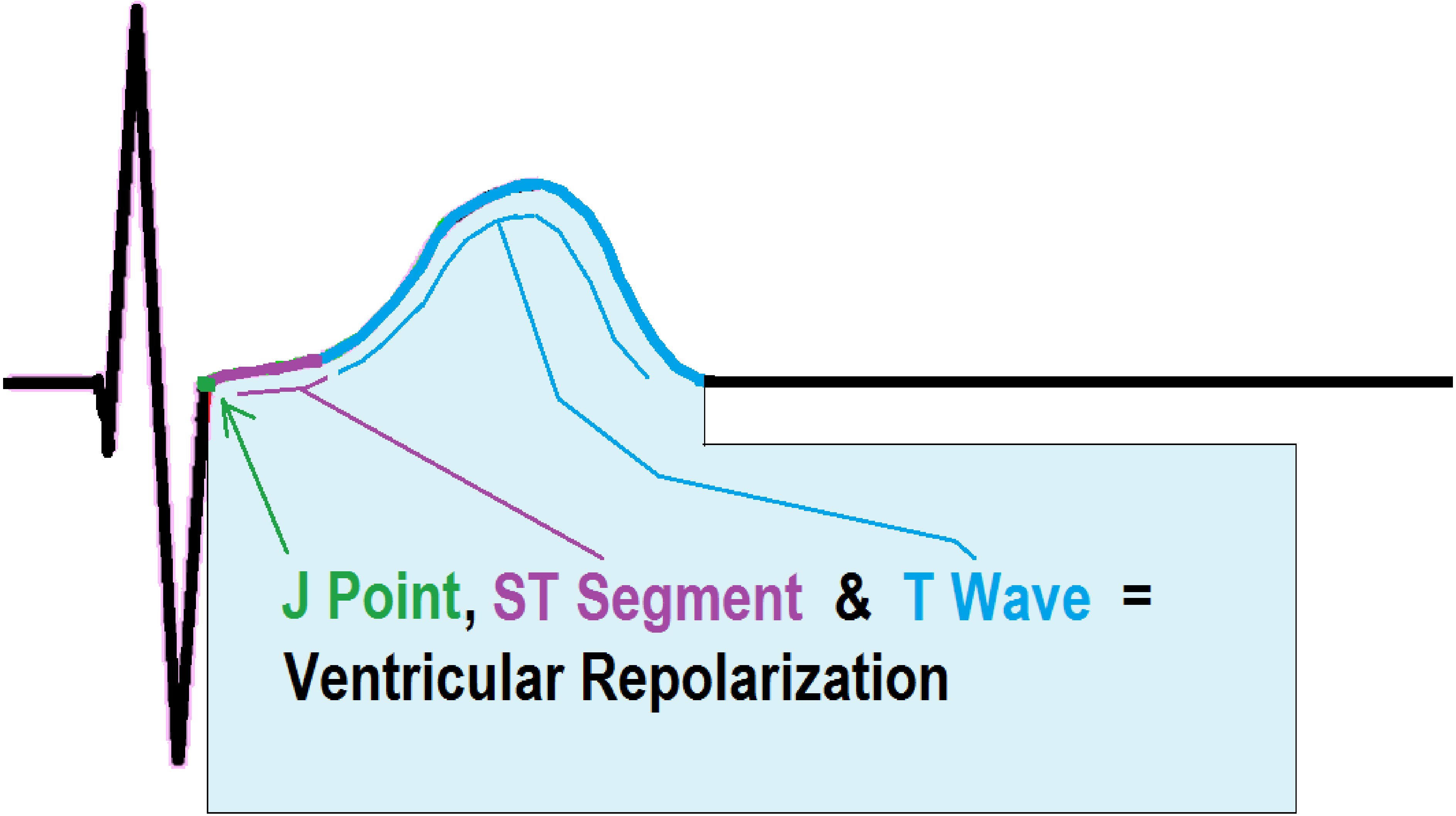
## ☞ IMPORTANT CONCEPT:

ALL MYOCARDIAL CELLS **DO NOT**
REPOLARIZE AT THE EXACT
SAME MOMENT --
LIKE DEPOLARIZATION,
THE PROCESS OF REPOLARIZATION
OCCURS IN A "WAVE-LIKE" MANNER

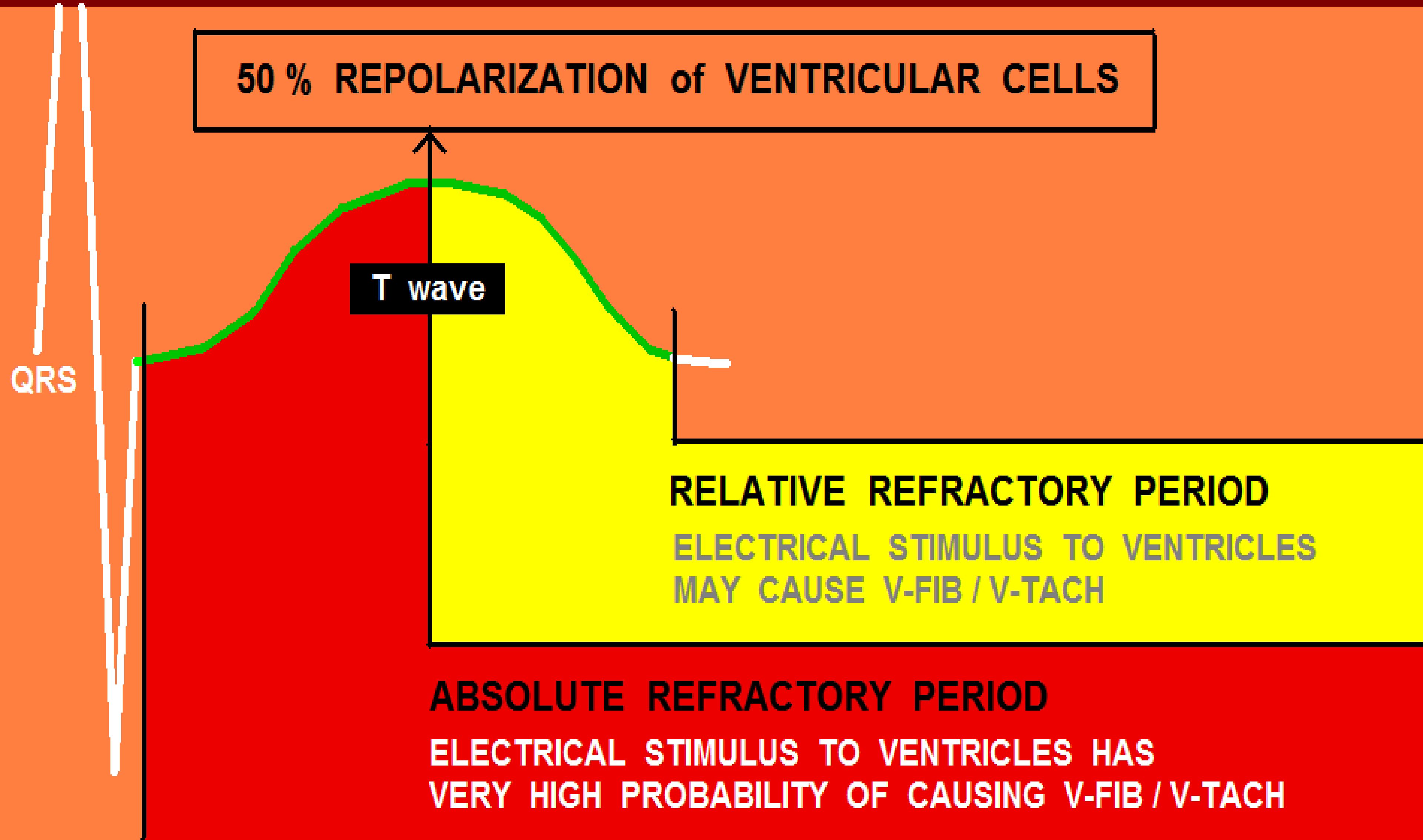


# **Repolarization** on the ECG:

- Is represented by the:
  - **J Point**
  - **ST Segment**
  - **T Wave**


J Point, ST Segment & T Wave =
Ventricular Repolarization

# CARDIAC ANATOMY and PHYSIOLOGY "101"



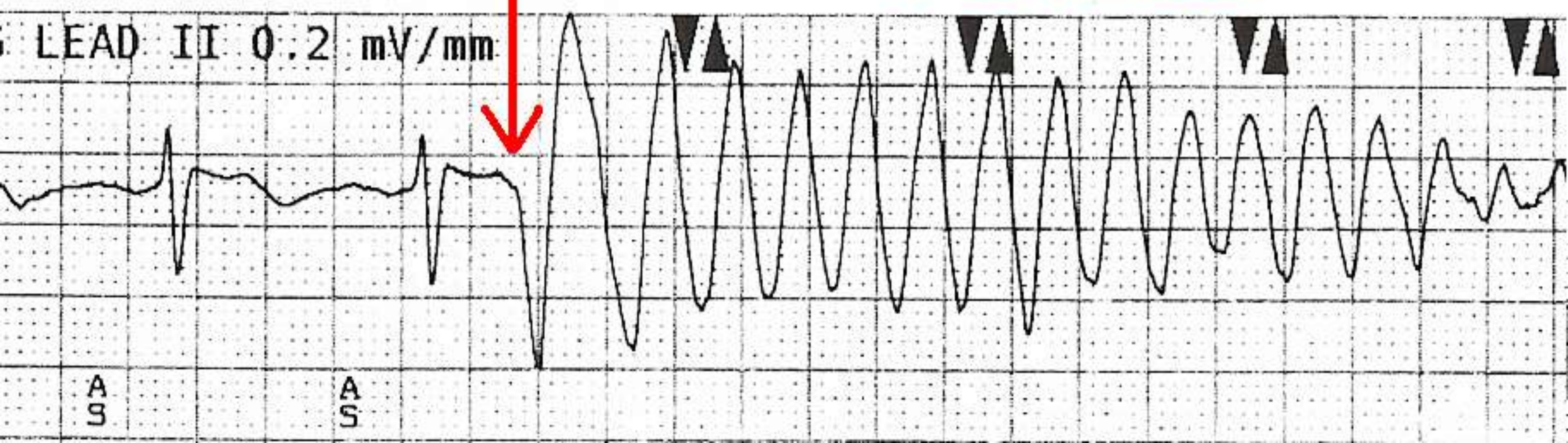
# ROUTINE TEST OF ICD

## ELECTRICAL IMPULSE ADMINISTERED DURING ABSOLUTE REFRACTORY PERIOD -- INDUCES VENTRICULAR FIBRILLATION

08-Sep-2006 18:01:47

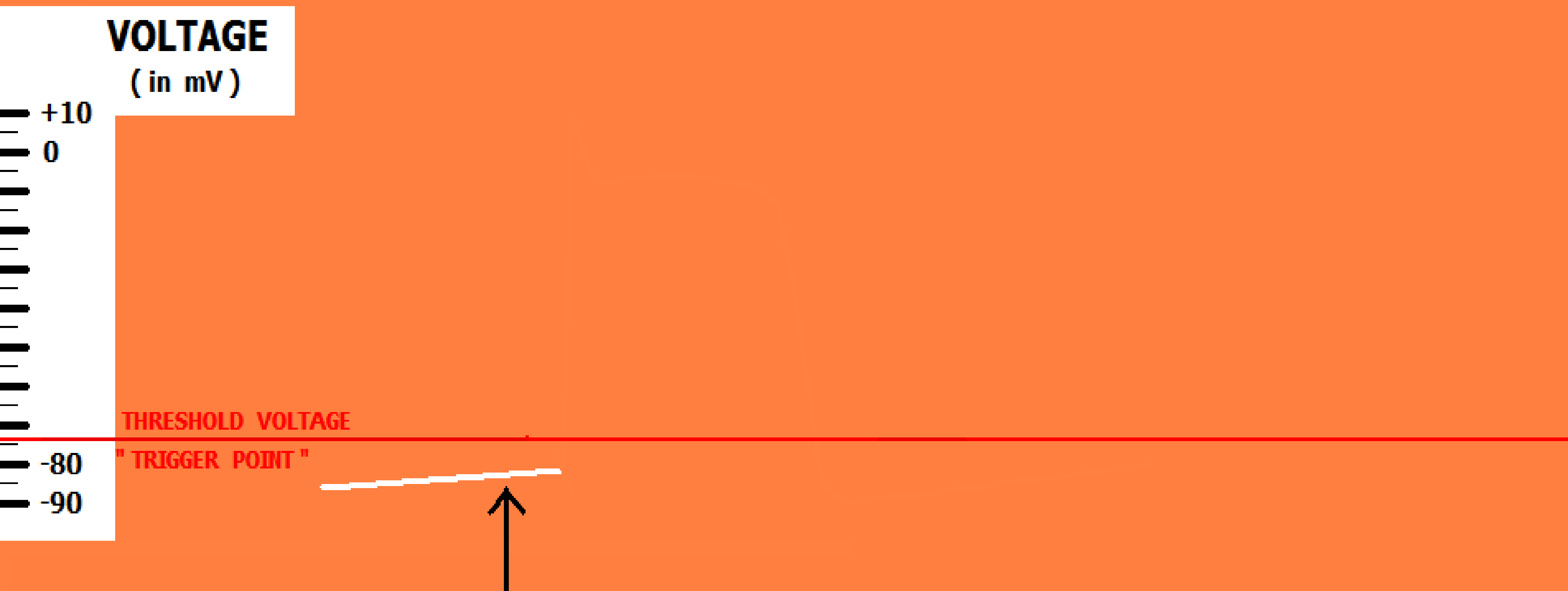
Test Started

**SPECIAL THANKS TO:**
**Ray Heinley**
**Medtronic Corporation**
**for this contribution**



# CARDIAC ANATOMY and PHYSIOLOGY "101"

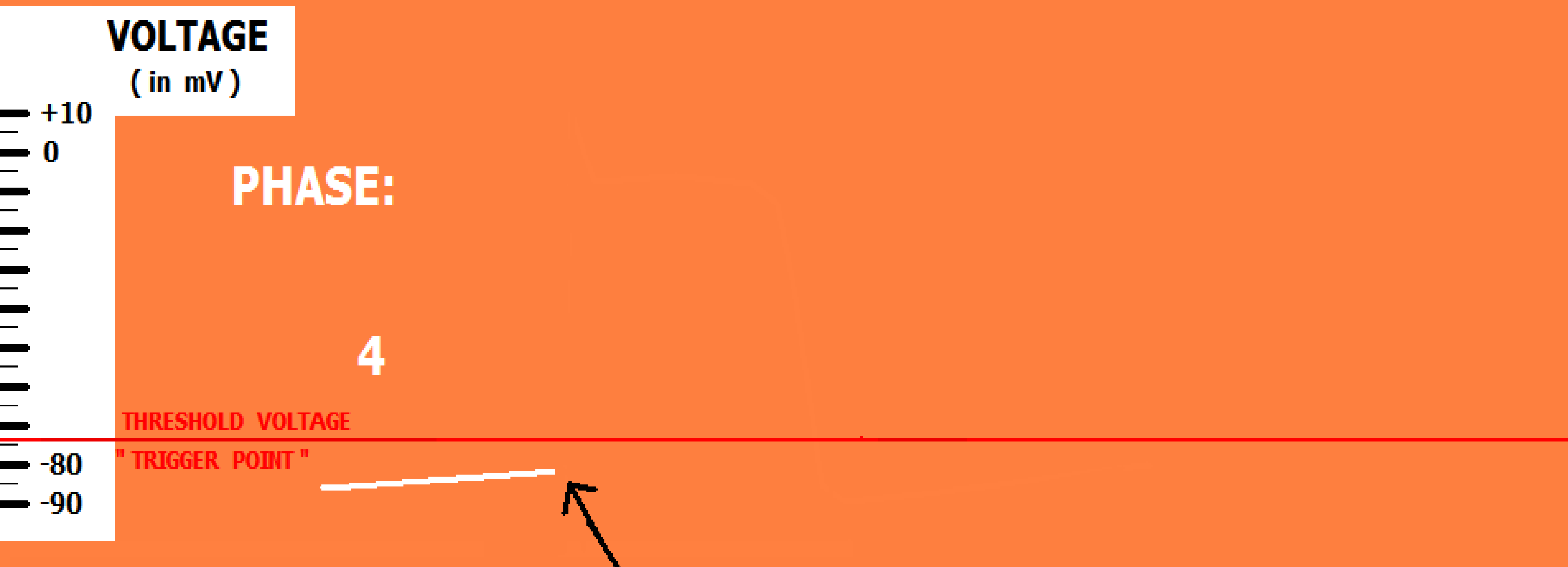
## VENTRICULAR MUSCLE CELL ACTION POTENTIAL




DURING PHASE 4, CELLS " LEAK OUT " SOME OF THEIR NEGATIVELY CHARGED IONS, CAUSING THE INSIDE OF THE CELL TO HAVE A LESS-NEGATIVE CHARGE . . .

# CARDIAC ANATOMY and PHYSIOLOGY "101"

## VENTRICULAR MUSCLE CELL ACTION POTENTIAL




**ONE OF TWO EVENTS WILL CAUSE THE CELL TO DEPOLARIZE:**

# CARDIAC ANATOMY and PHYSIOLOGY "101"

## VENTRICULAR MUSCLE CELL ACTION POTENTIAL


**ONE OF TWO EVENTS WILL CAUSE THE CELL TO DEPOLARIZE:**

1. A NEIGHBORING CELL DEPOLARIZES, TRIGGERING A "CHAIN REACTION"

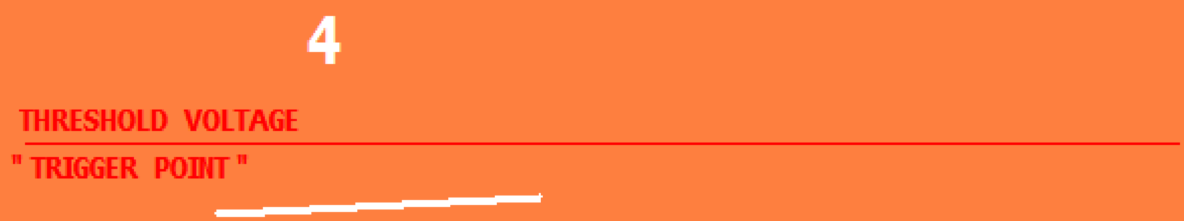
# CARDIAC ANATOMY and PHYSIOLOGY "101"

## VENTRICULAR MUSCLE CELL ACTION POTENTIAL

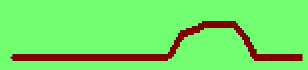
**CELL " STATUS: "**

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

**PHASE:**

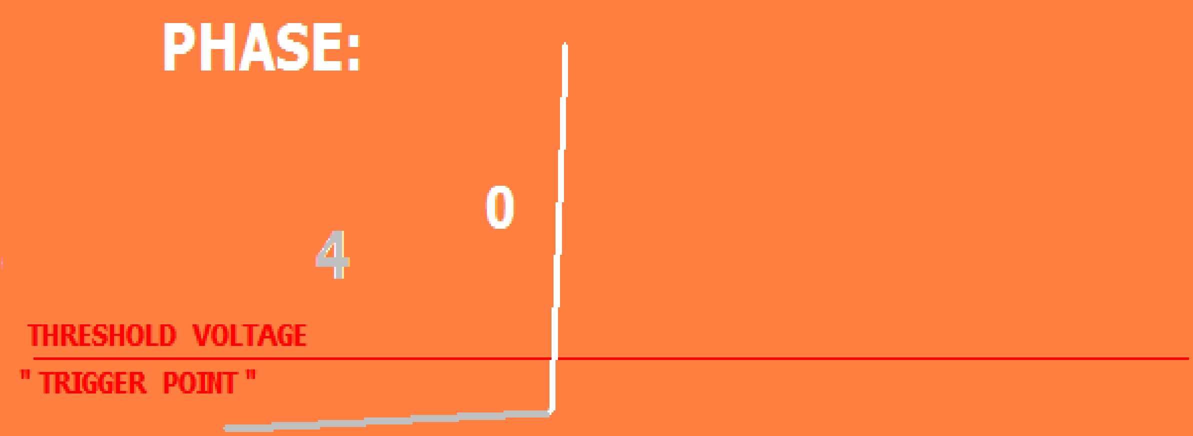


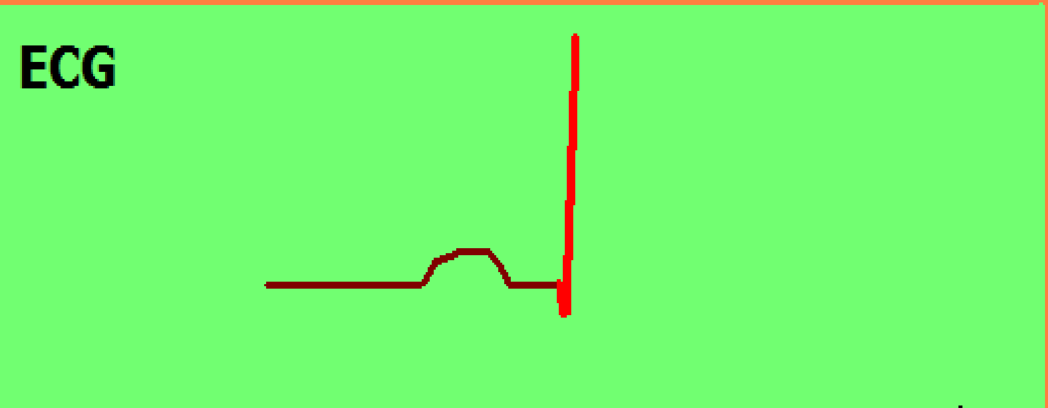

**ECG**



# CARDIAC ANATOMY and PHYSIOLOGY "101"

## VENTRICULAR MUSCLE CELL ACTION POTENTIAL




**CELL " STATUS: "**

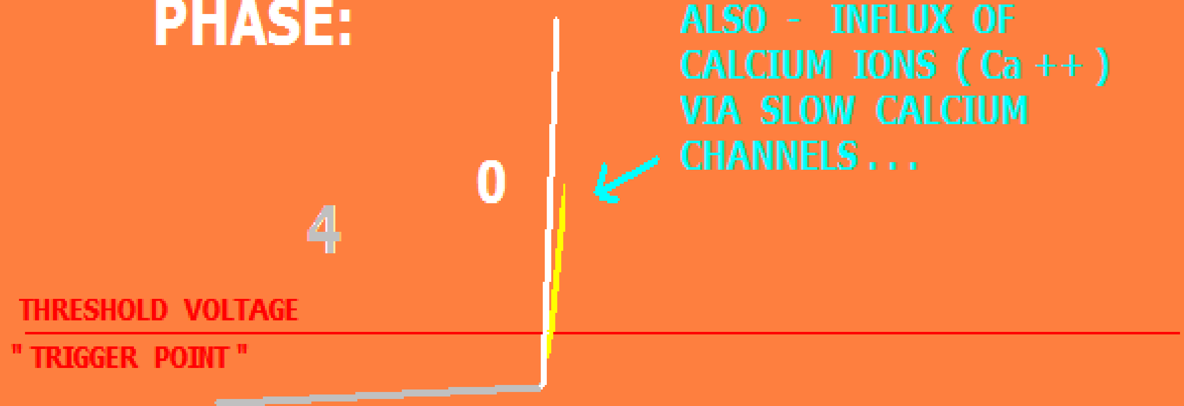
4
- CELL REPOLARIZED
- -80 to -90 mV CHARGE
- SLIGHT " LEAKAGE " OF IONS

0:
- IN TYPICAL MUSCLE CELLS, PHASE 0 INITIATED BY: CELLS "PUSHED OVER TRIGGER POINT " BY:
  - PACEMAKER CELLS
  - NEIGHBOR MUSCLE CELL DEPOLARIZATION
- RAPID INFLUX OF POSITIVELY CHARGED SODIUM IONS via " FAST CHANNELS "
- CELL DEPOLARIZATION

# CARDIAC ANATOMY and PHYSIOLOGY "101"

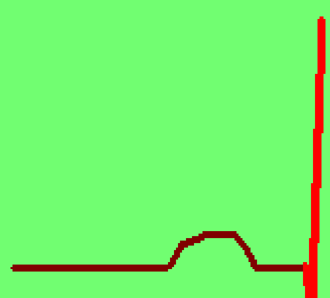
## VENTRICULAR MUSCLE CELL ACTION POTENTIAL

PHASE:




ALSO - INFLUX OF CALCIUM IONS ( Ca ++ ) VIA SLOW CALCIUM CHANNELS . . .

ECG



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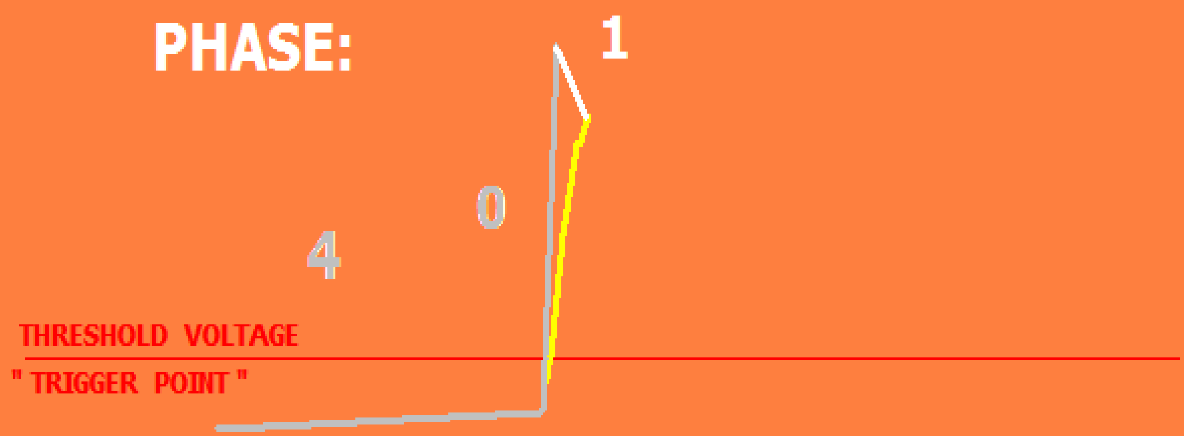
# CARDIAC ANATOMY and PHYSIOLOGY "101"

## VENTRICULAR MUSCLE CELL ACTION POTENTIAL




**CELL " STATUS: "**

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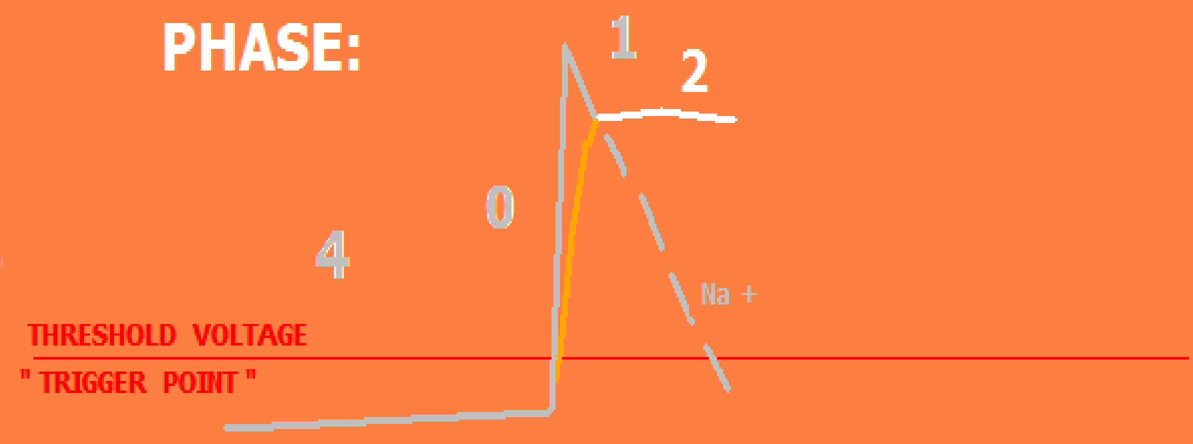
- CELL REPOLARIZED
- -80 to -90 mV CHARGE
- SLIGHT " LEAKAGE " OF IONS

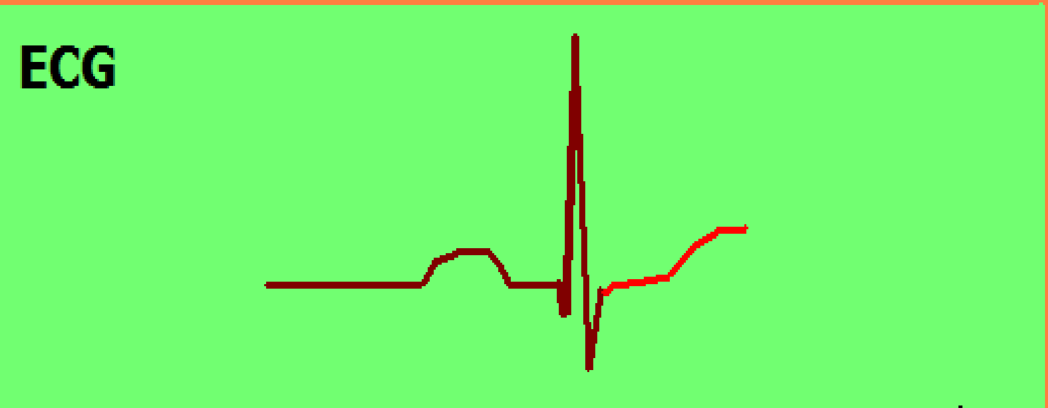
0
- RAPID INFLUX OF + CHARGED SODIUM IONS
- CELL DEPOLARIZATION

1:
- SODIUM IONS BEGIN TO EXIT THE CELL
- THIS BEGINS THE REPOLARIZATION PROCESS

# CARDIAC ANATOMY and PHYSIOLOGY "101"

## VENTRICULAR MUSCLE CELL ACTION POTENTIAL

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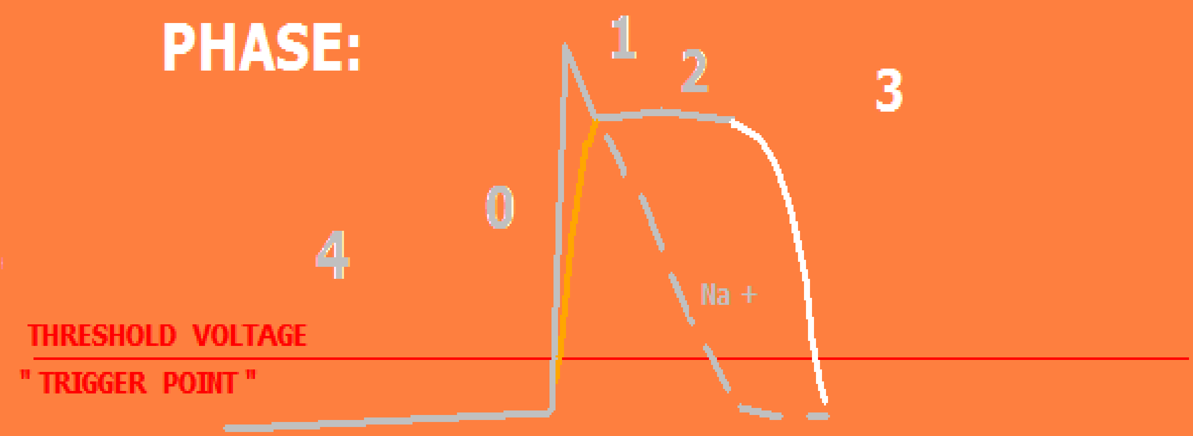
- CELL DEPOLARIZATION

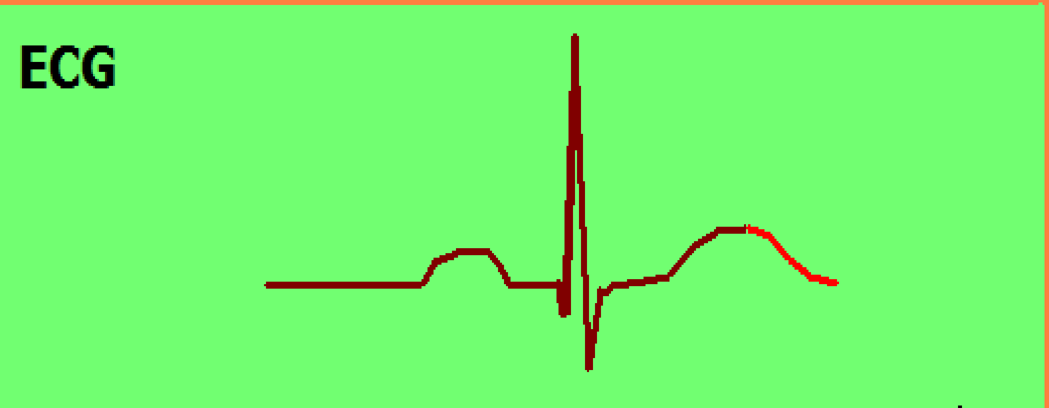
1
- SODIUM EXITS CELL
- REPOLARIZATION BEGINS

2
- CALCIUM IONS ARE COMPLETING THEIR " SLOW ENTRY " OF CARDIAC CELLS, PROLONGING THE ACTION POTENTIAL

# CARDIAC ANATOMY and PHYSIOLOGY "101"

## VENTRICULAR MUSCLE CELL ACTION POTENTIAL

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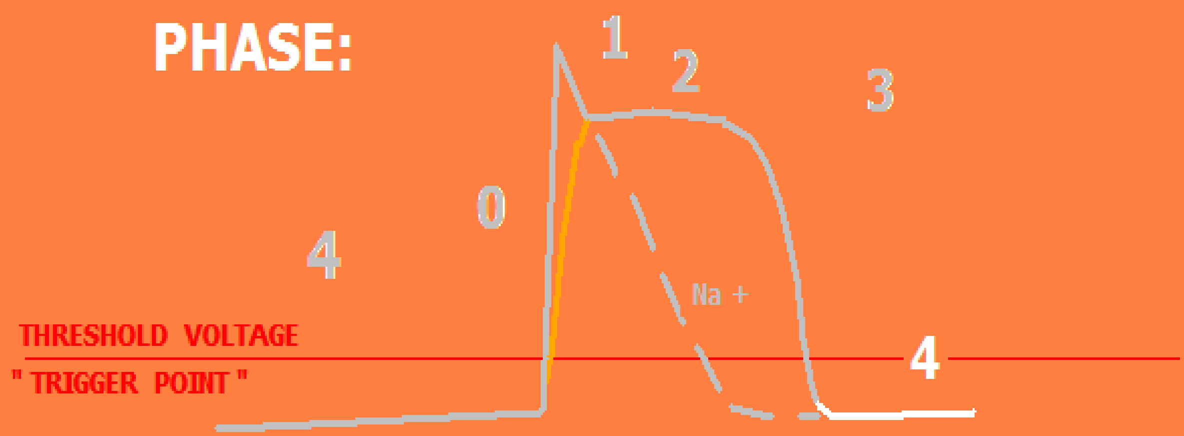
- SODIUM EXITS CELL
- REPOLARIZATION BEGINS

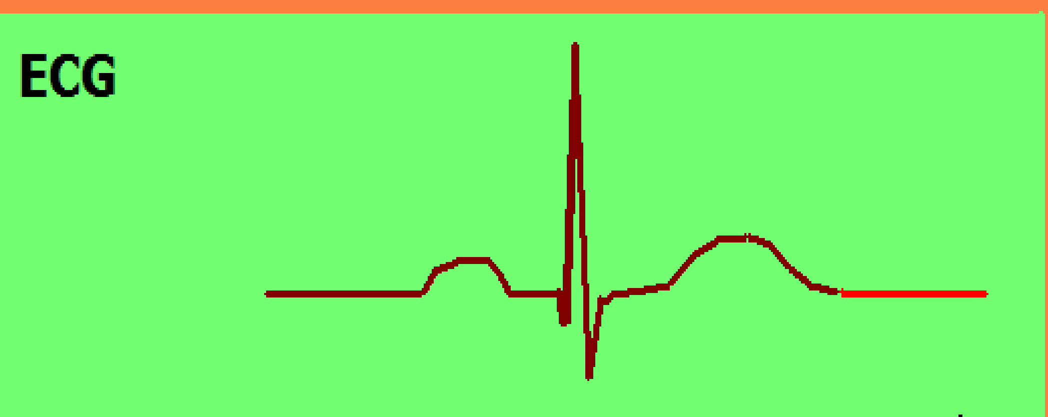
2
- CALCIUM IONS CONTINUE TO ENTER CELL

3
- CALCIUM CHANNELS CLOSE

# CARDIAC ANATOMY and PHYSIOLOGY "101"

## VENTRICULAR MUSCLE CELL ACTION POTENTIAL

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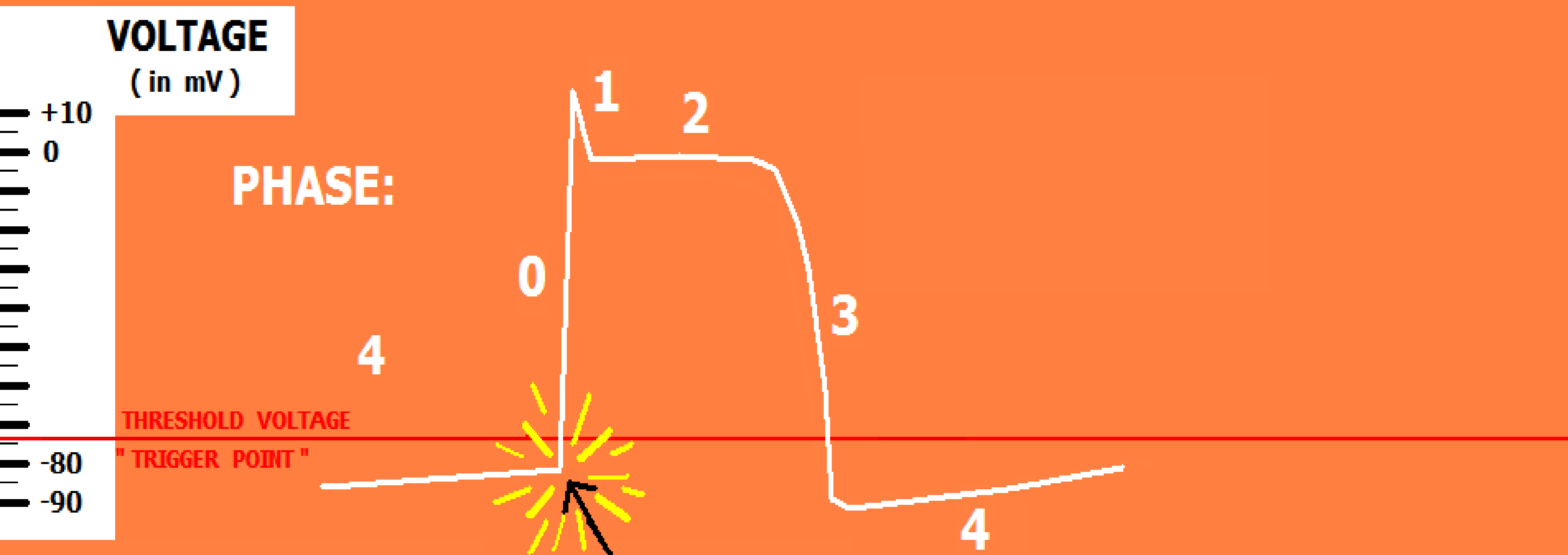
3
- CALCIUM CHANNELS CLOSE

ONE CARDIAC CYCLE ( HEART BEAT ) IS NOW COMPLETE.

# CARDIAC ANATOMY and PHYSIOLOGY "101"

## VENTRICULAR MUSCLE CELL ACTION POTENTIAL




**ONE OF TWO EVENTS WILL CAUSE THE CELL TO DEPOLARIZE:**

1. A NEIGHBORING CELL DEPOLARIZES, TRIGGERING A "CHAIN REACTION" CAUSING EACH OF ITS NEIGHBORING CELLS TO DEPOLARIZE

# CARDIAC ANATOMY and PHYSIOLOGY "101"

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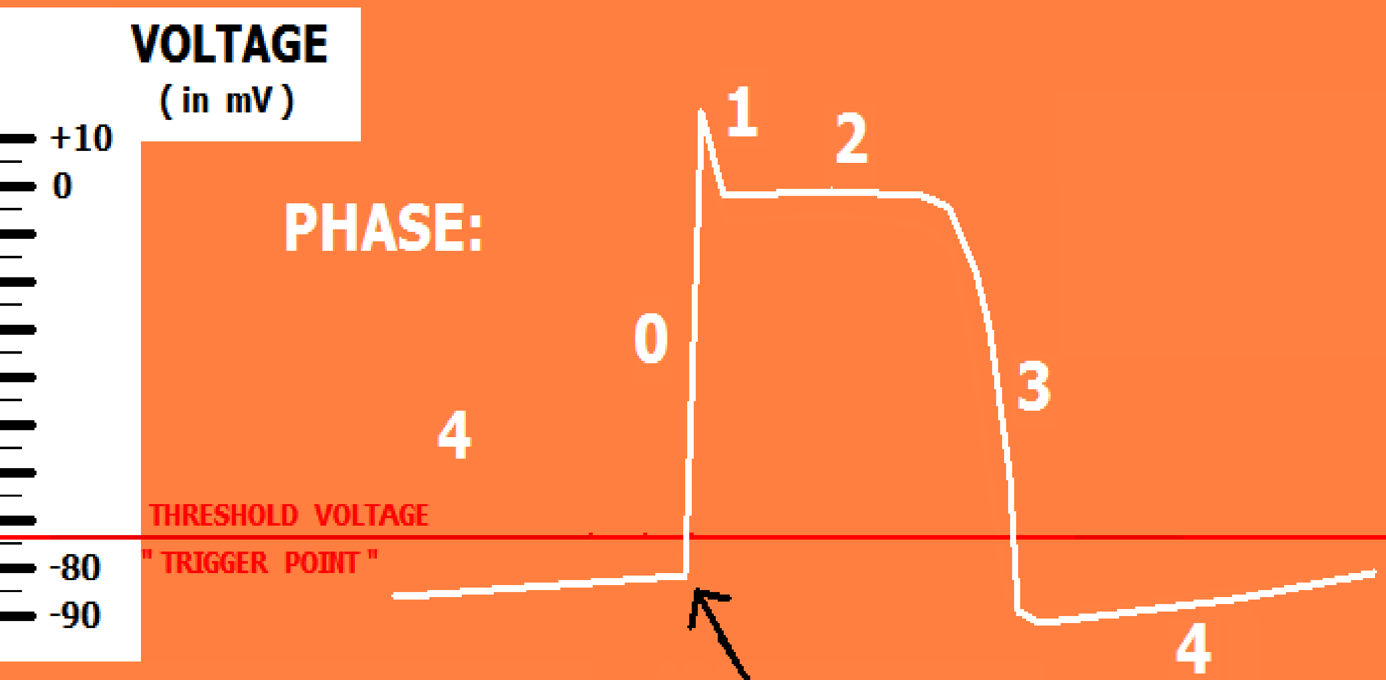


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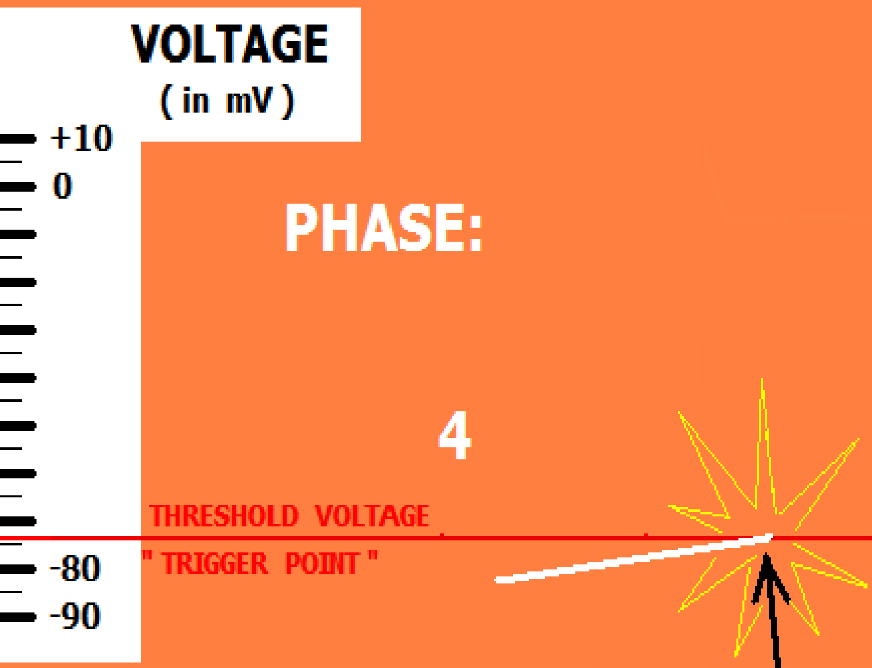
. . . . . OR . . . . .

# CARDIAC ANATOMY and PHYSIOLOGY "101"

## VENTRICULAR MUSCLE CELL ACTION POTENTIAL

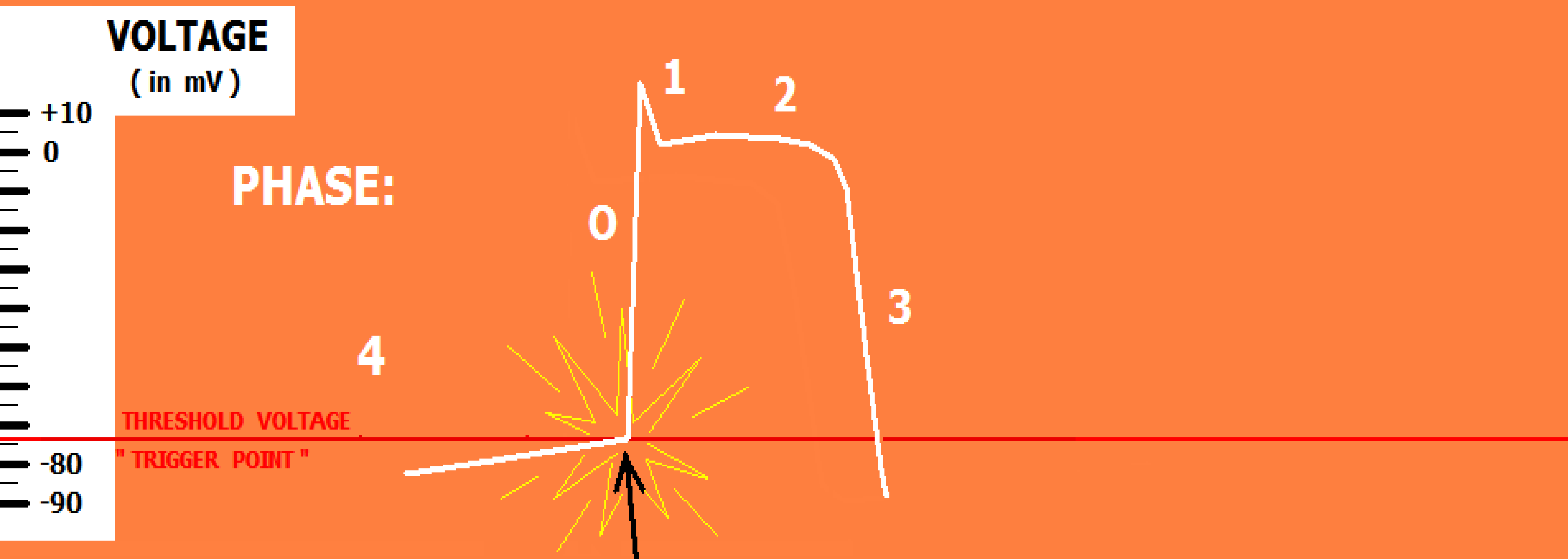



**ONE OF TWO EVENTS WILL CAUSE THE CELL TO DEPOLARIZE:**

2. THE CELL WILL " LEAK " ENOUGH OF IT'S OWN IONS TO CAUSE IT TO REACH THE **THRESHOLD VOLTAGE**, ( a.k.a the " **TRIGGER POINT** " )

# CARDIAC ANATOMY and PHYSIOLOGY "101"

## VENTRICULAR MUSCLE CELL ACTION POTENTIAL

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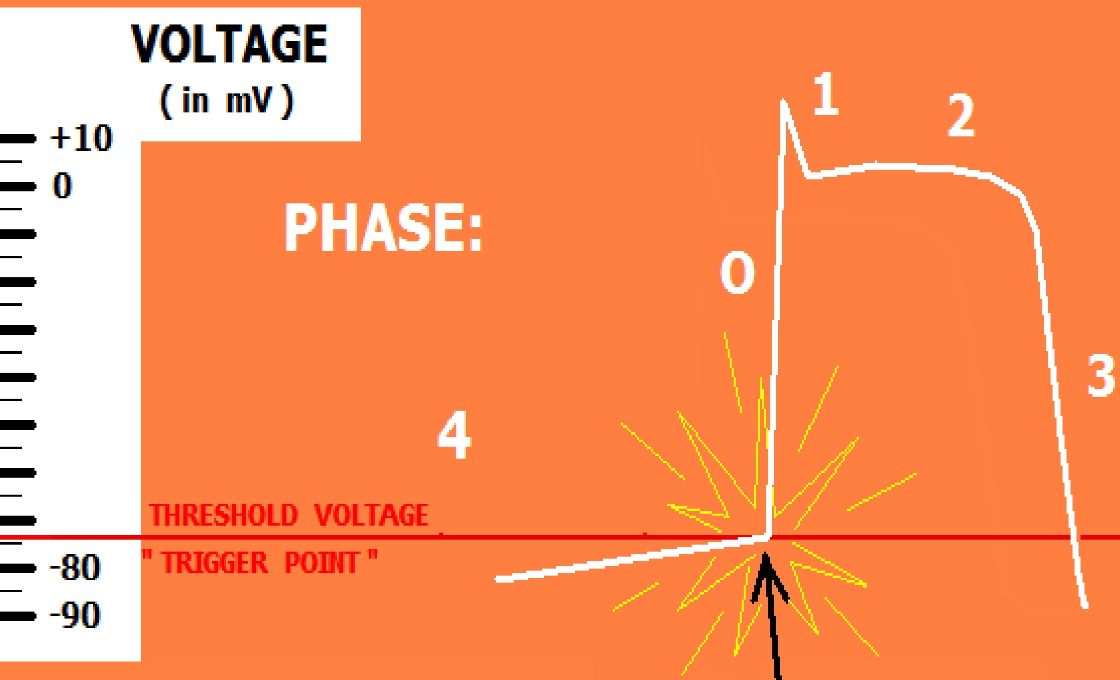
# CARDIAC ANATOMY and PHYSIOLOGY "101"

## VENTRICULAR MUSCLE CELL ACTION POTENTIAL




THIS IS KNOWN AS ***AUTOMATICITY***

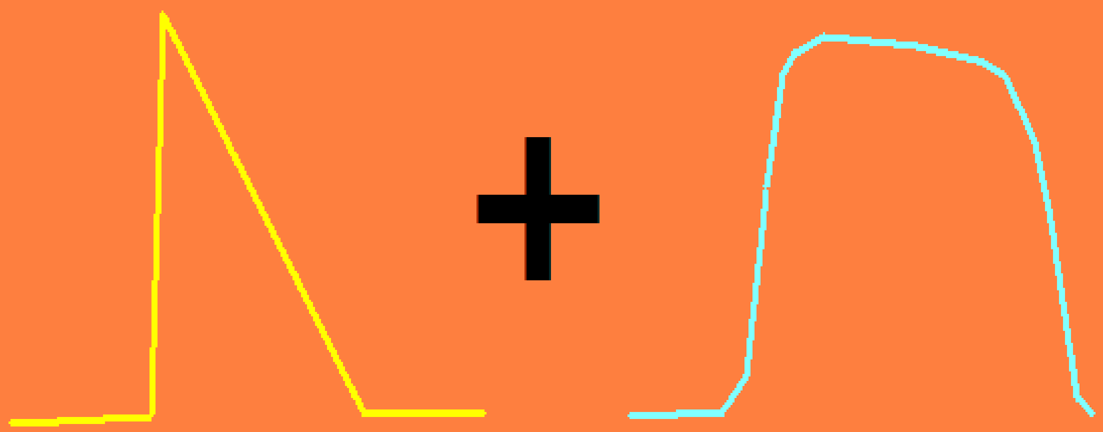
ONE OF TWO EVENTS WILL CAUSE THE CELL TO DEPOLARIZE:

2. THE CELL WILL " LEAK " ENOUGH OF IT'S OWN IONS TO CAUSE IT TO REACH THE THRESHOLD VOLTAGE, ( a.k.a the " TRIGGER POINT " ) CAUSING THE CELL TO DEPOLARIZE ITSELF . . . and then in turn, it's neighbors

CARDIAC ANATOMY and PHYSIOLOGY "101"

## COMPONENTS OF ACTION POTENTIAL WAVEFORM

CARDIAC MUSCLE CELLS COMBINE



FAST SODIUM CHANNELS AND SLOW CALCIUM CHANNELS

# CARDIAC ANATOMY and PHYSIOLOGY "101"

## COMPONENTS OF ACTION POTENTIAL WAVEFORM

CARDIAC MUSCLE CELLS COMBINE

FAST SODIUM CHANNELS AND SLOW CALCIUM CHANNELS

# CARDIAC ANATOMY and PHYSIOLOGY "101"

## COMPONENTS OF ACTION POTENTIAL WAVEFORM

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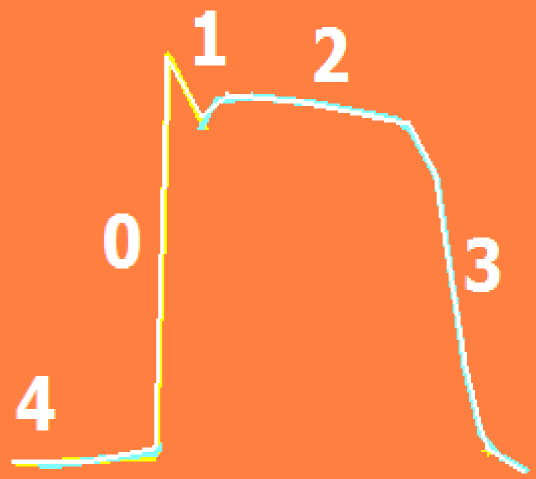
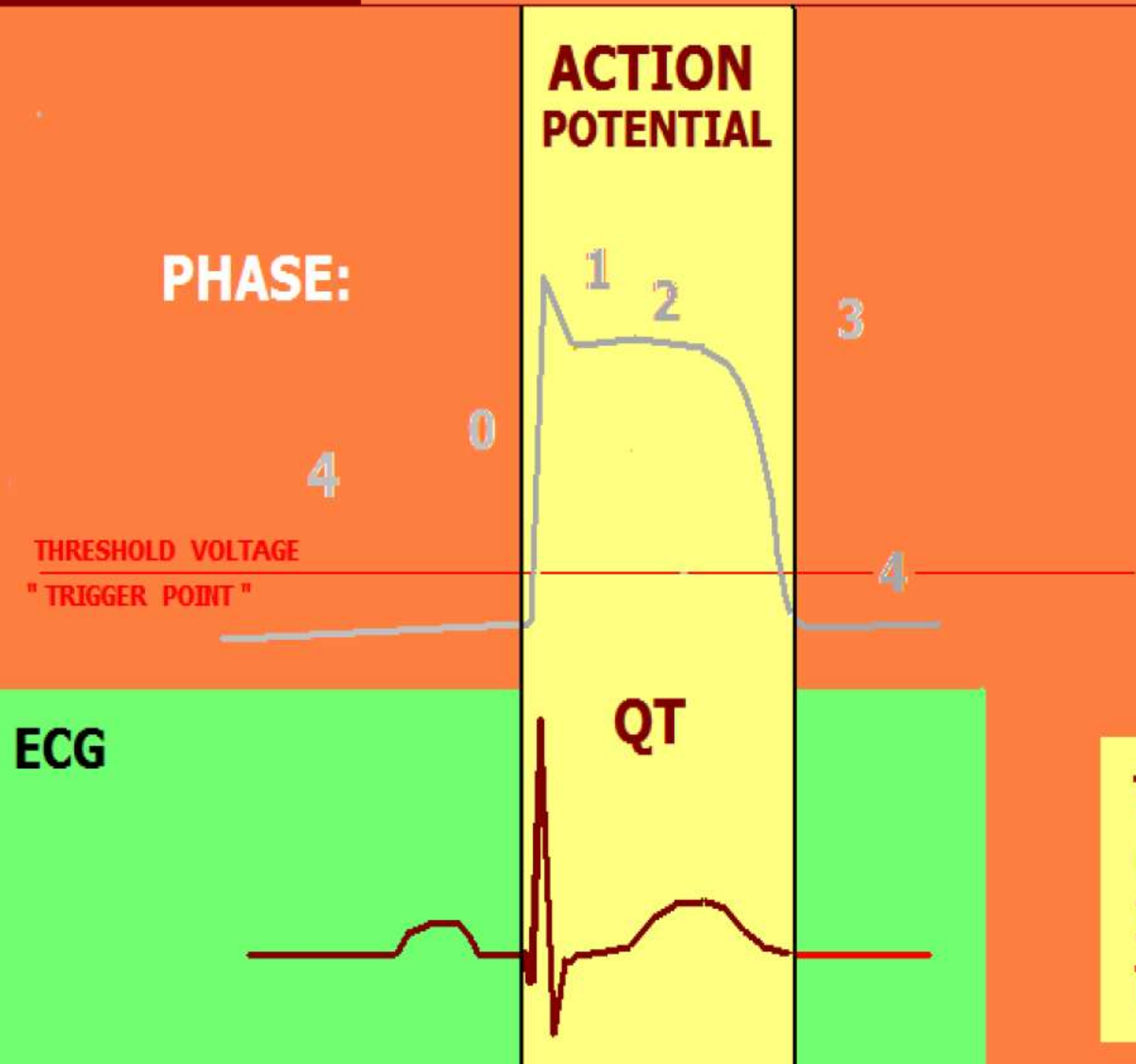



FAST SODIUM CHANNELS AND SLOW CALCIUM CHANNELS

. . . to get that familiar "action potential" shape !

# CARDIAC ANATOMY and PHYSIOLOGY "101"

## VENTRICULAR MUSCLE CELL ACTION POTENTIAL




**CELL " STATUS: "**

4
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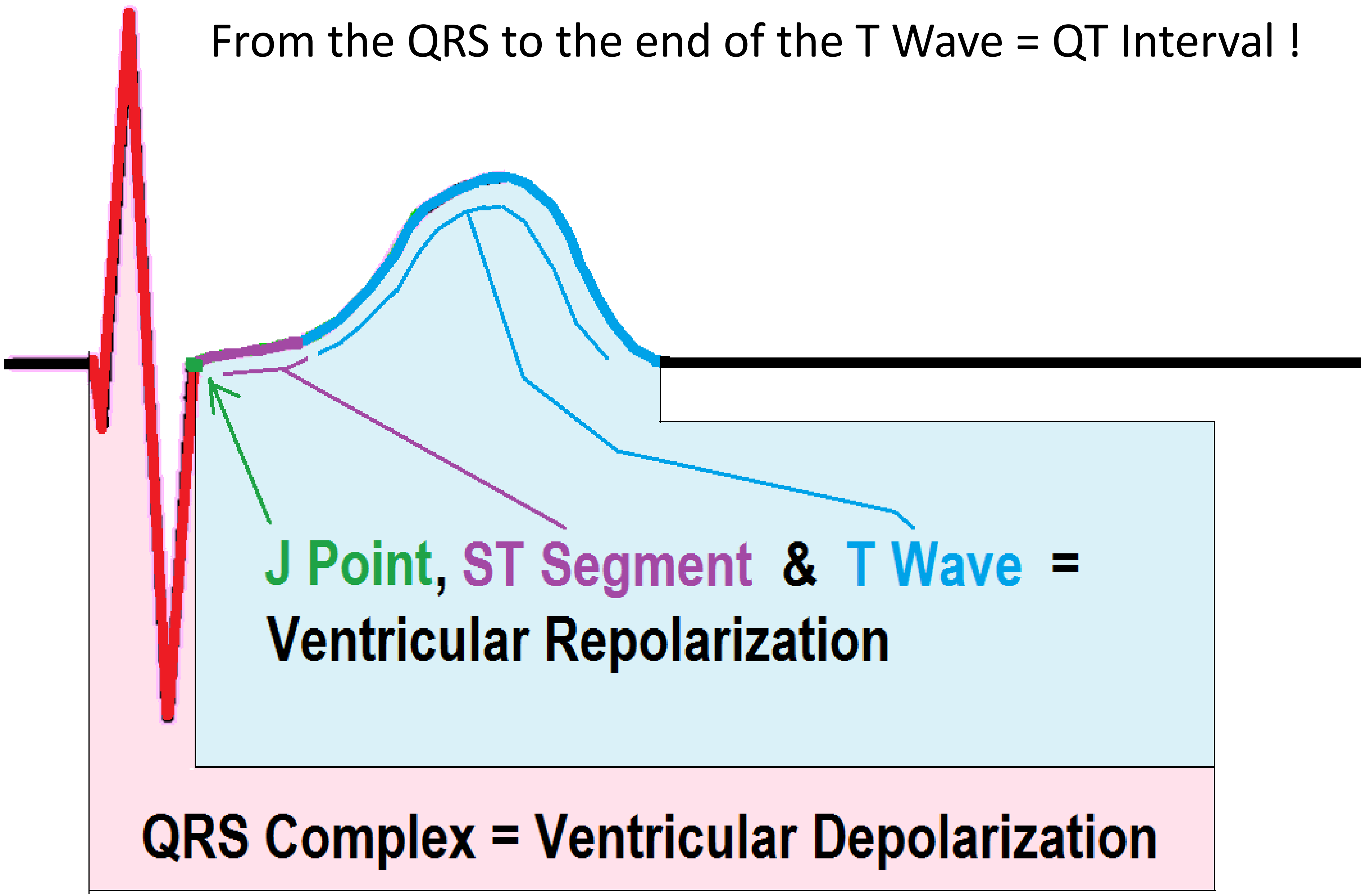
0
- RAPID INFLUX OF + CHARGED SODIUM IONS
- CELL DEPOLARIZATION

1
- SODIUM EXITS CELL
- REPOLARIZATION BEGINS

2
- CALCIUM IONS CONTINUE TO ENTER CELL

3
- CALCIUM CHANNELS CLOSE

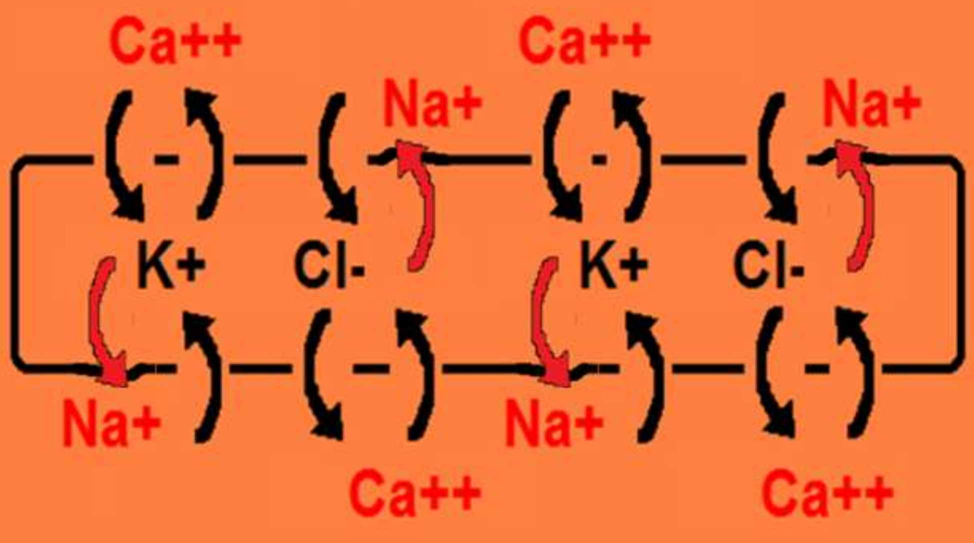
**THE ACTION POTENTIAL**
**( OF VENTRICULAR MUSCLE CELLS )**
**IS ROUGHLY EQUAL TO THE Q - T INTERVAL**


From the QRS to the end of the T Wave = QT Interval !
J Point, ST Segment & T Wave =
Ventricular Repolarization
QRS Complex = Ventricular Depolarization

# CARDIAC ANATOMY and PHYSIOLOGY "101"

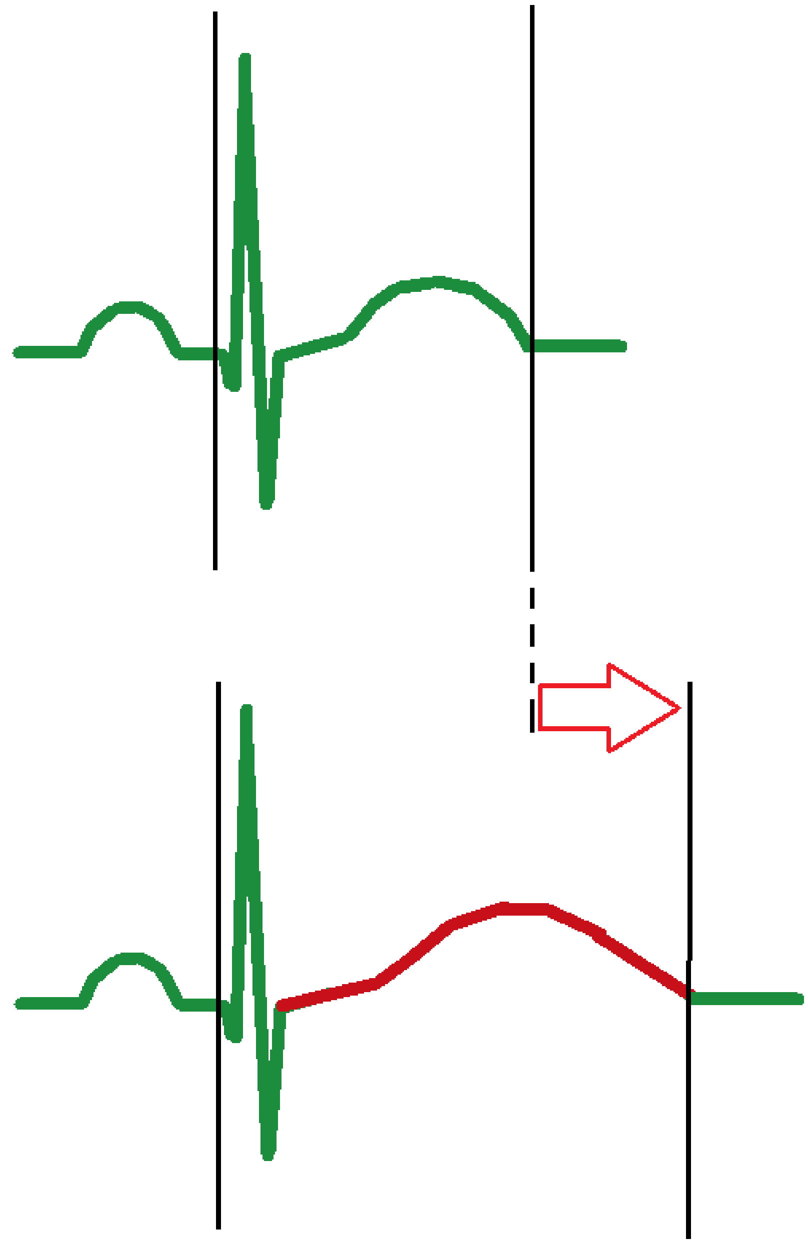
**When ION CHANNELS are MALFORMED, the abnormal channel shape may DELAY the transfer of IONS . . . . .**

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



Normal
QT Interval

ABNORMAL
(prolonged)
QT Interval



# CARDIAC ANATOMY and PHYSIOLOGY "101"

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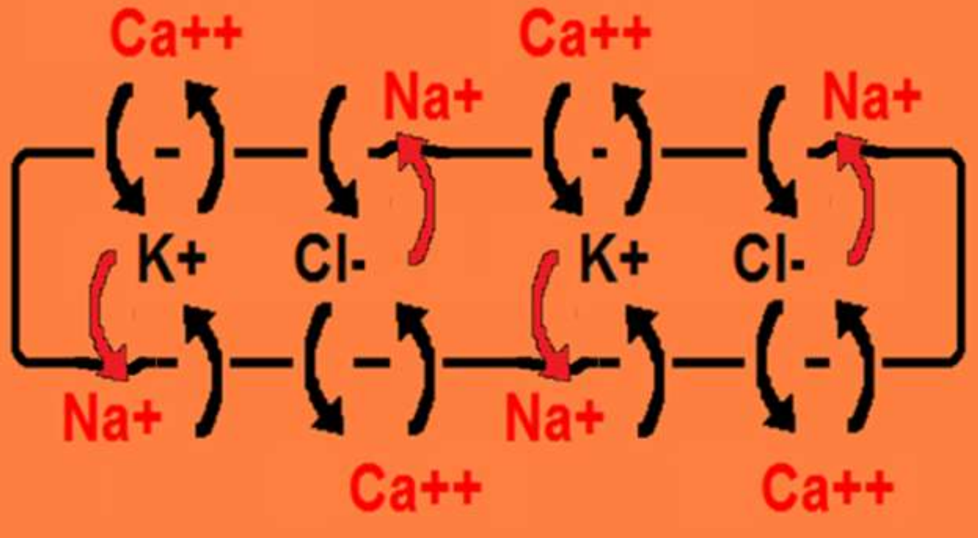
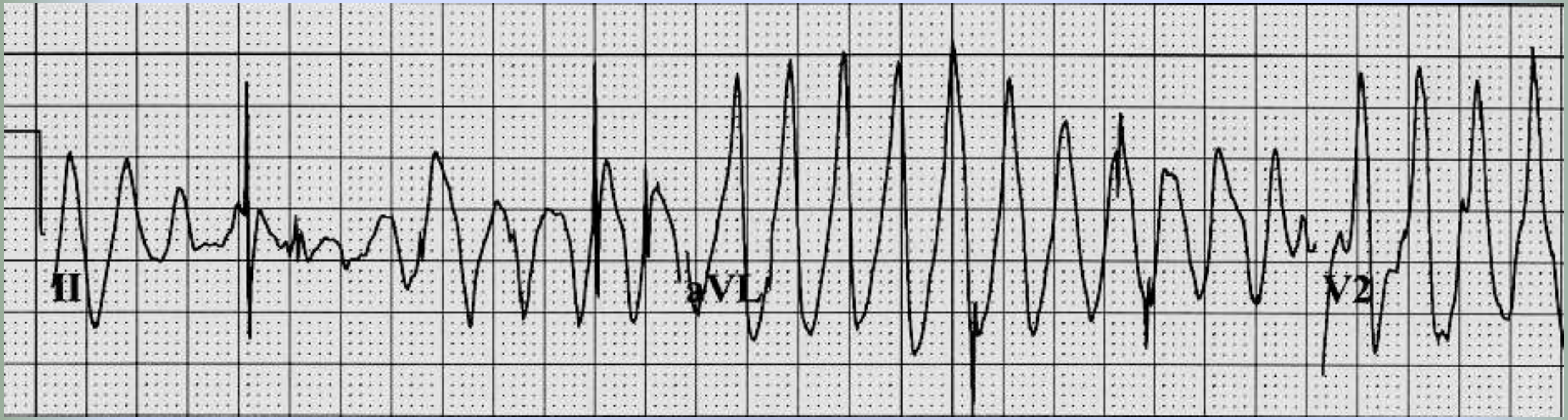


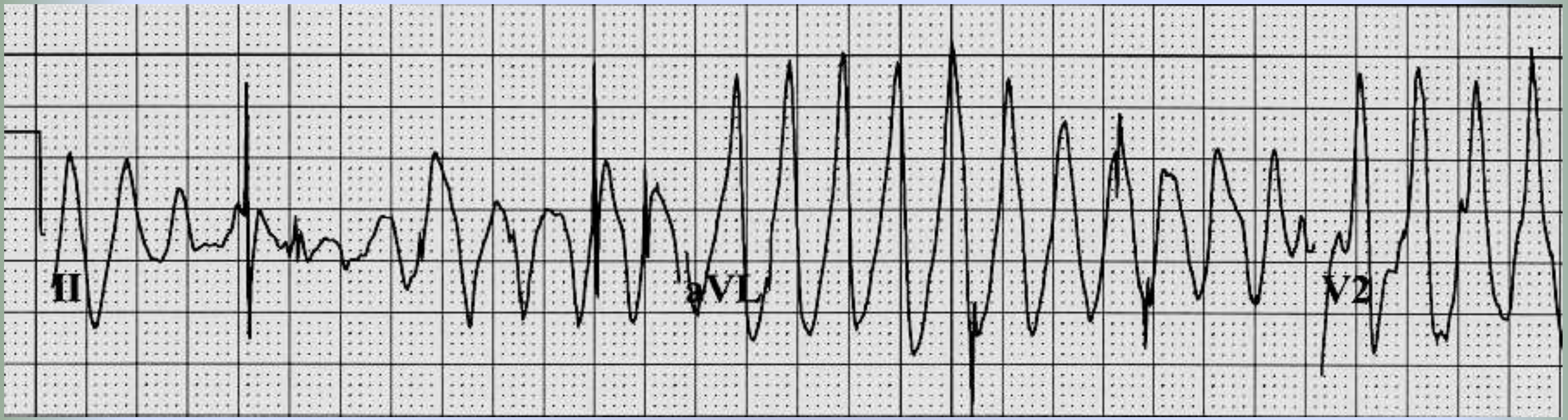

**which can lead to Torsades . . . Cardiac Arrest . . . and *SUDDEN DEATH.***

# *Torsades de Pointes (TdP)*




- Common cause: QTc > 600 ms
- Patients typically have little to no cardiac output when in this rhythm
- TdP may self-terminate or deteriorate into **VENTRICULAR FIBRILLATION**

# *Torsades de Pointes (TdP)*

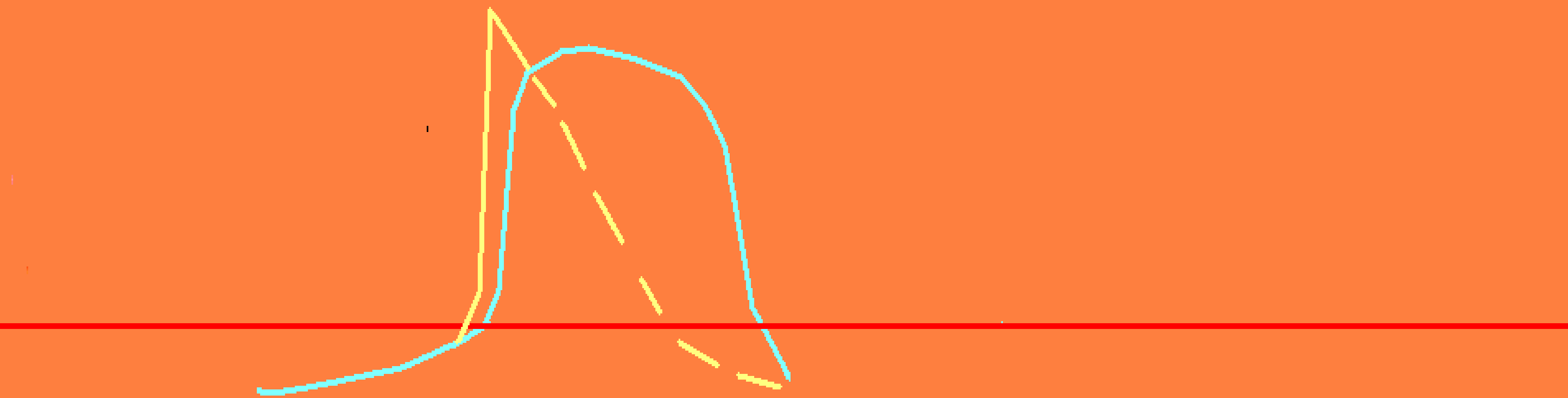



- **Common cause: QTc > 600 ms**
- Patients typically have little to no cardiac output when in this rhythm
- TdP may self-terminate or deteriorate into **VENTRICULAR FIBRILLATION**

# CARDIAC ANATOMY and PHYSIOLOGY "101"

## COMPONENTS OF ACTION POTENTIAL WAVEFORM

### CARDIAC PACEMAKER CELLS
### ( SINUS NODE and A-V NODE )



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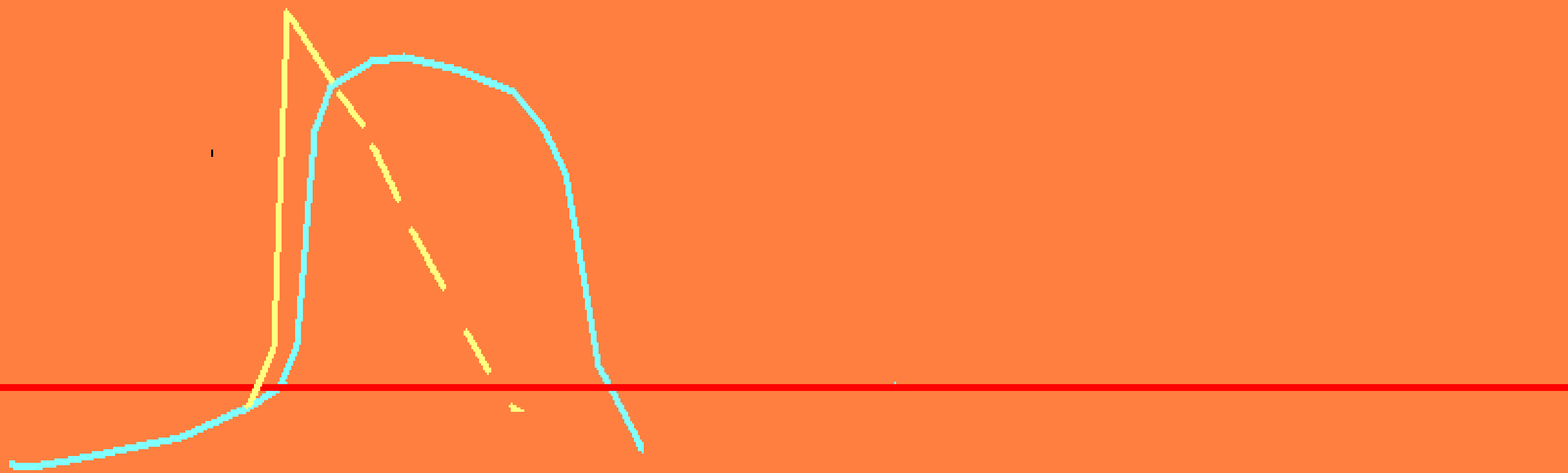
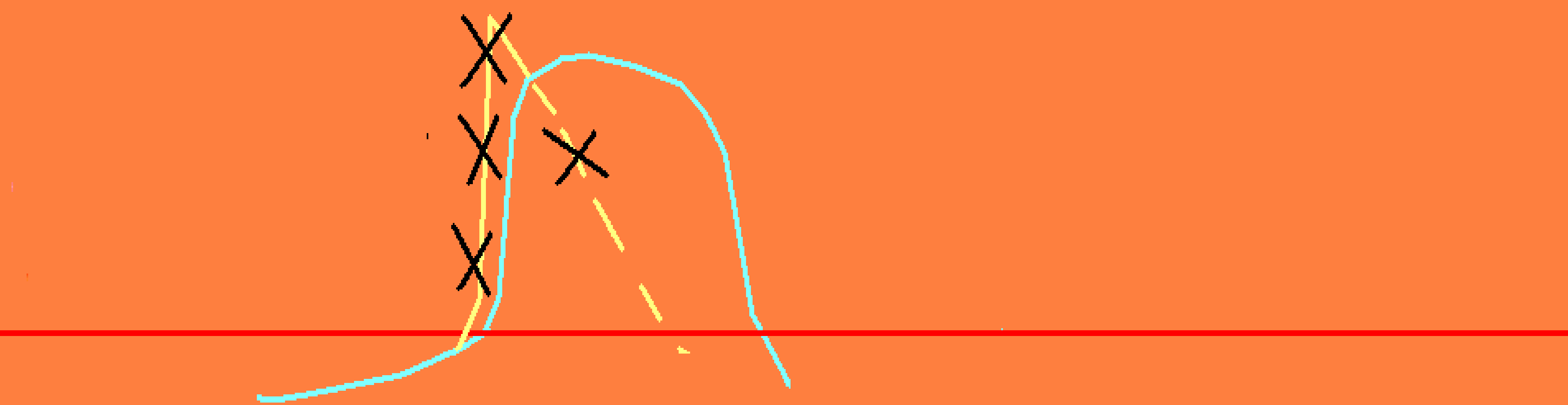


DO NOT HAVE FAST SODIUM CHANNELS . . .

# CARDIAC ANATOMY and PHYSIOLOGY "101"

## COMPONENTS OF ACTION POTENTIAL WAVEFORM

### CARDIAC PACEMAKER CELLS
### ( SINUS NODE and A-V NODE )



DO NOT HAVE FAST SODIUM CHANNELS . . .

## COMPONENTS OF ACTION POTENTIAL WAVEFORM

### CARDIAC PACEMAKER CELLS
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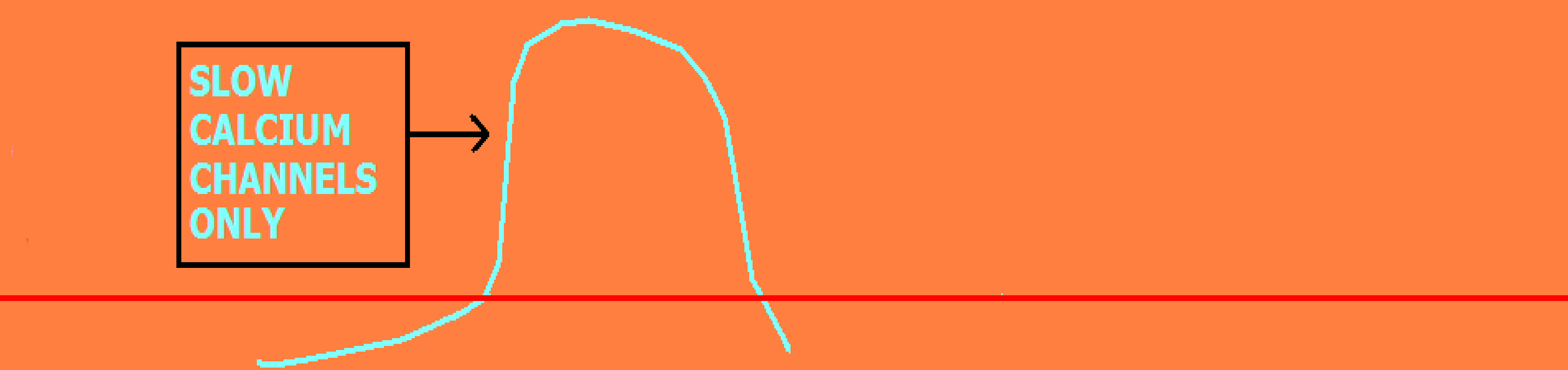
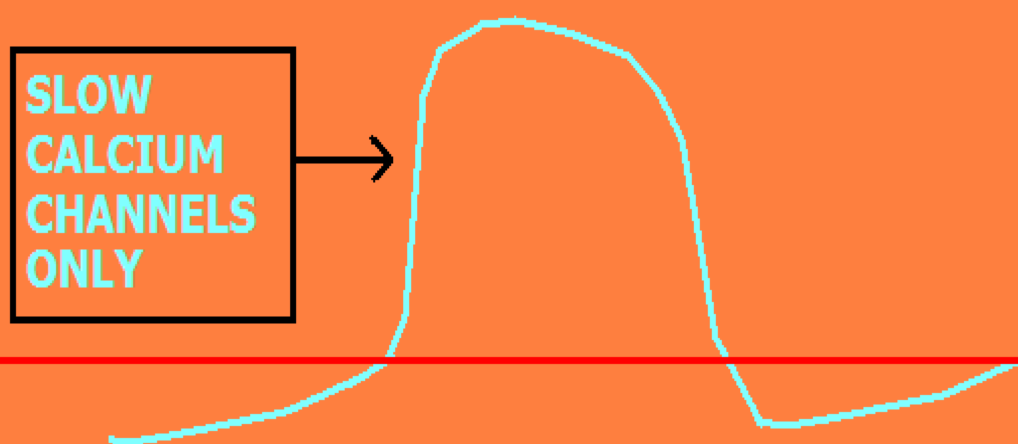


## COMPONENTS OF ACTION POTENTIAL WAVEFORM

### CARDIAC PACEMAKER CELLS
### ( SINUS NODE and A-V NODE )




AND THEY " LEAK OUT "
IONS AT A FASTER RATE
THAN MUSCLE CELLS

# CARDIAC ANATOMY and PHYSIOLOGY "101"

## COMPONENTS OF ACTION POTENTIAL WAVEFORM

CARDIAC PACEMAKER CELLS
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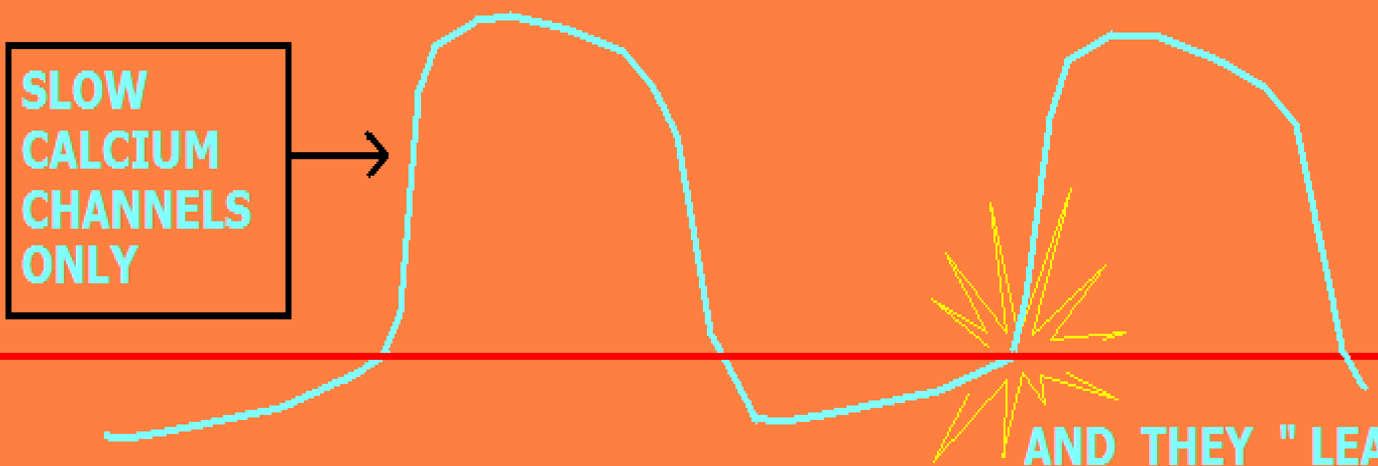
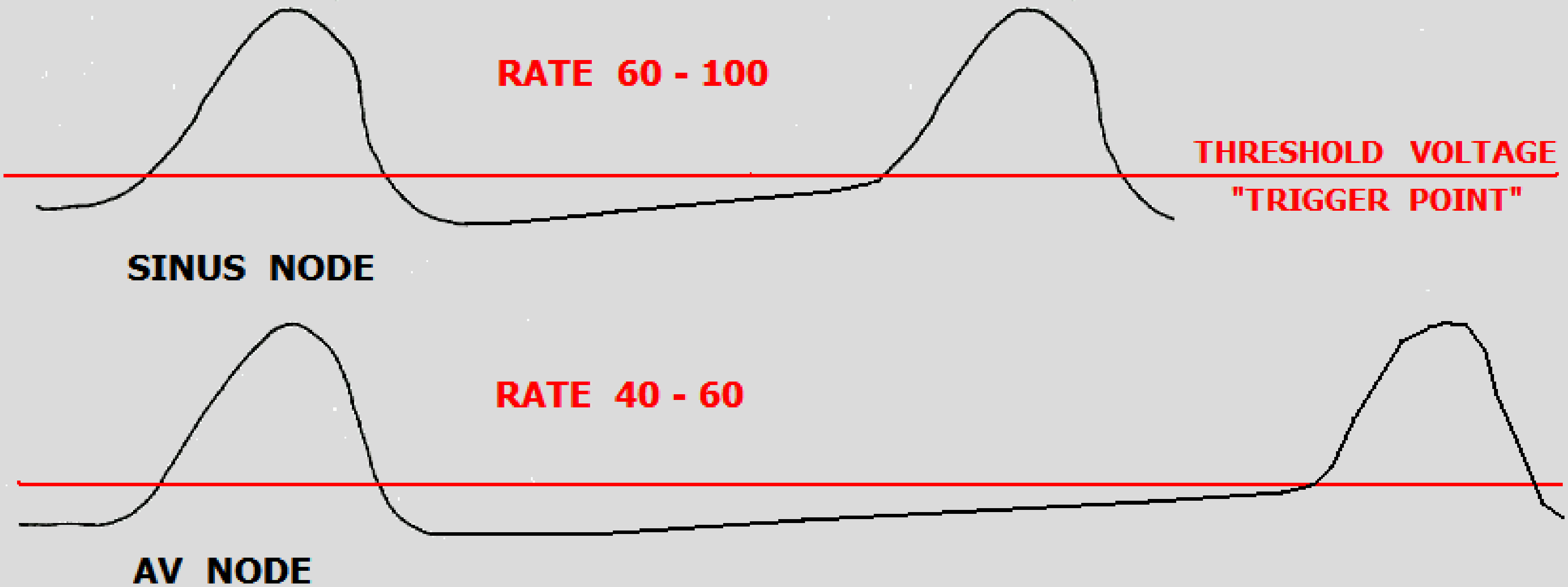



AND THEY " LEAK OUT "
IONS AT A FASTER RATE
THAN MUSCLE CELLS -- FAST
ENOUGH TO HIT THE
VOLTAGE THRESHOLD and
DEPOLARIZE THEMSLEVES !

# DIFFERENCES IN ACTION POTENTIAL IN DIFFERENT TYPES OF HEART CELLS

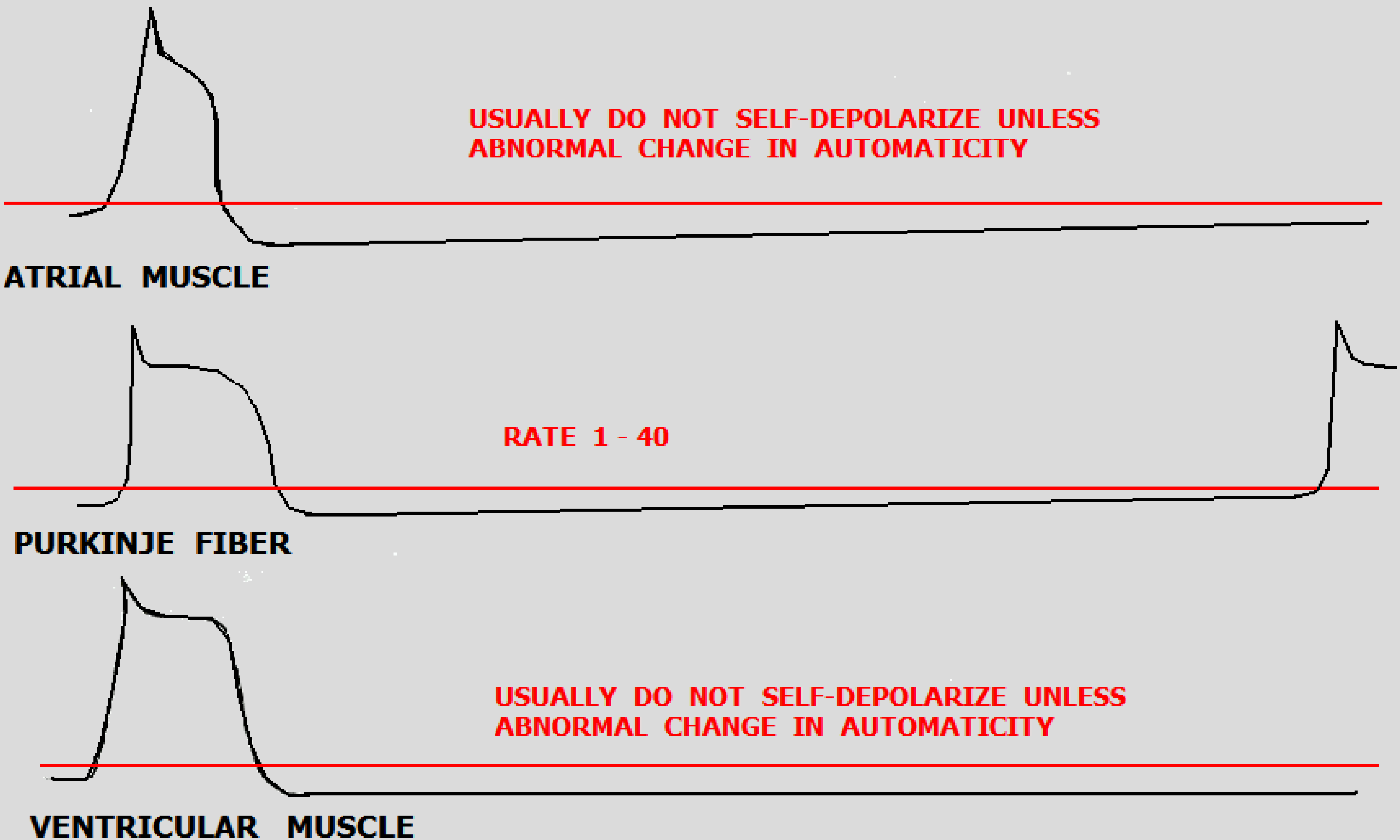
## CARDIAC PACEMAKER CELLS



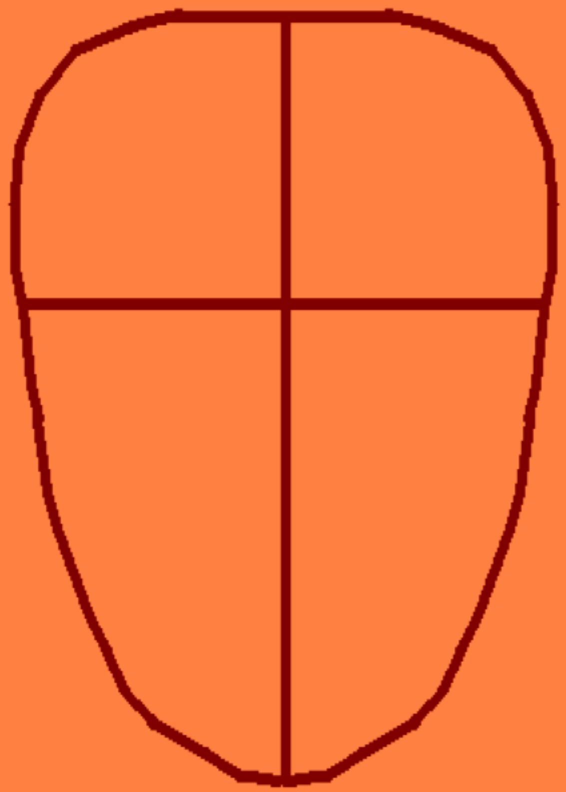

**DIFFERENCES IN "LEAKAGE RATES" OF IONS DURING PHASE 4 DETERMINE THE CELL'S "INHERENT FIRING RATES"**

# DIFFERENCES IN ACTION POTENTIAL IN DIFFERENT TYPES OF HEART CELLS

## MUSCLE and PURKINJE FIBER ACTION POTENTIALS

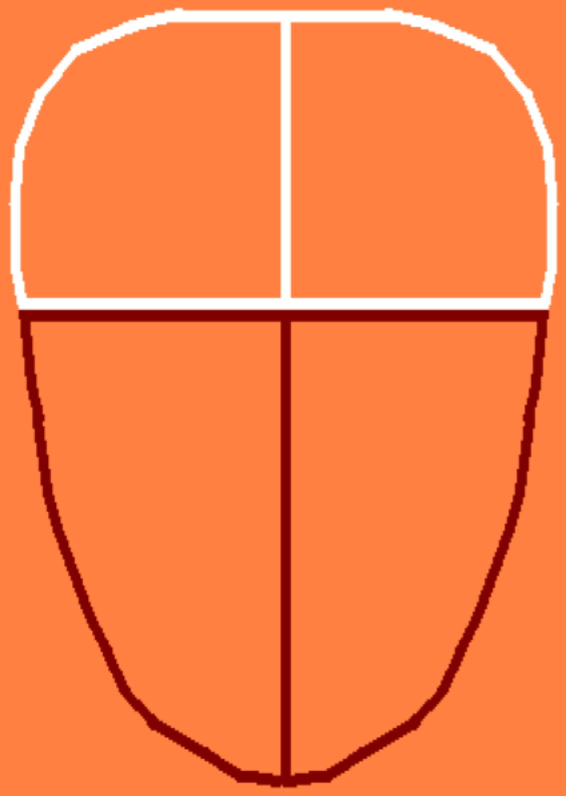


# FOUR CHAMBERED PUMP



# FOUR CHAMBERED PUMP...

2 ATRIUM

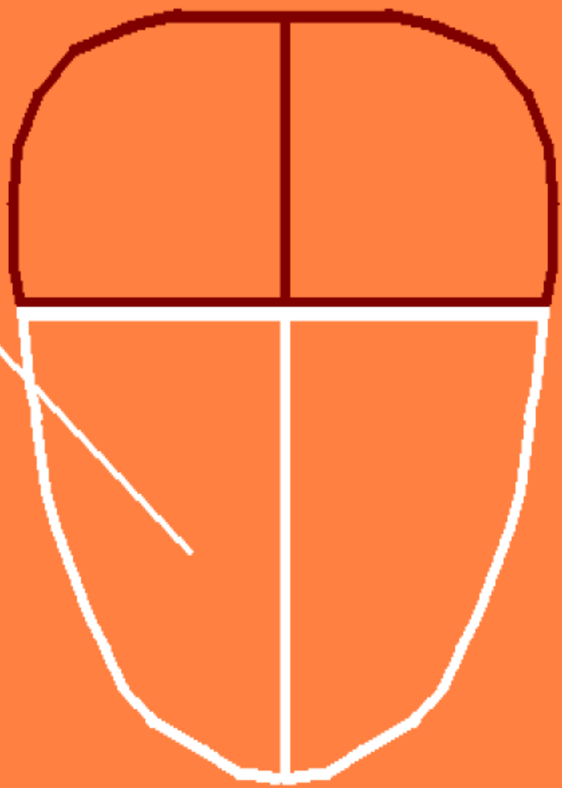


**PRIMARY JOB:**

"PACK VENTRICLES FULL OF BLOOD"

# FOUR CHAMBERED PUMP . . .

2 VENTRICLES



**PRIMARY JOB:**

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

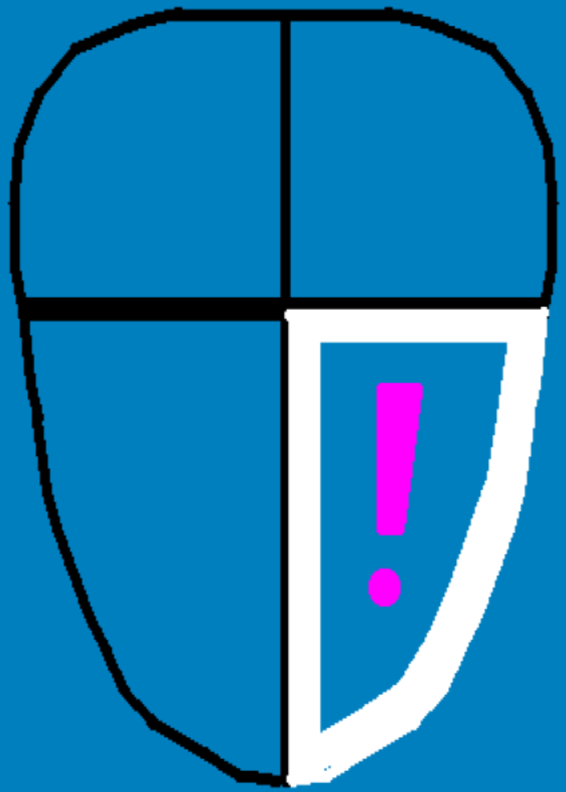
THE CHAMBER MOST IMPORTANT TO KEEPING THE PATIENT ALIVE

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

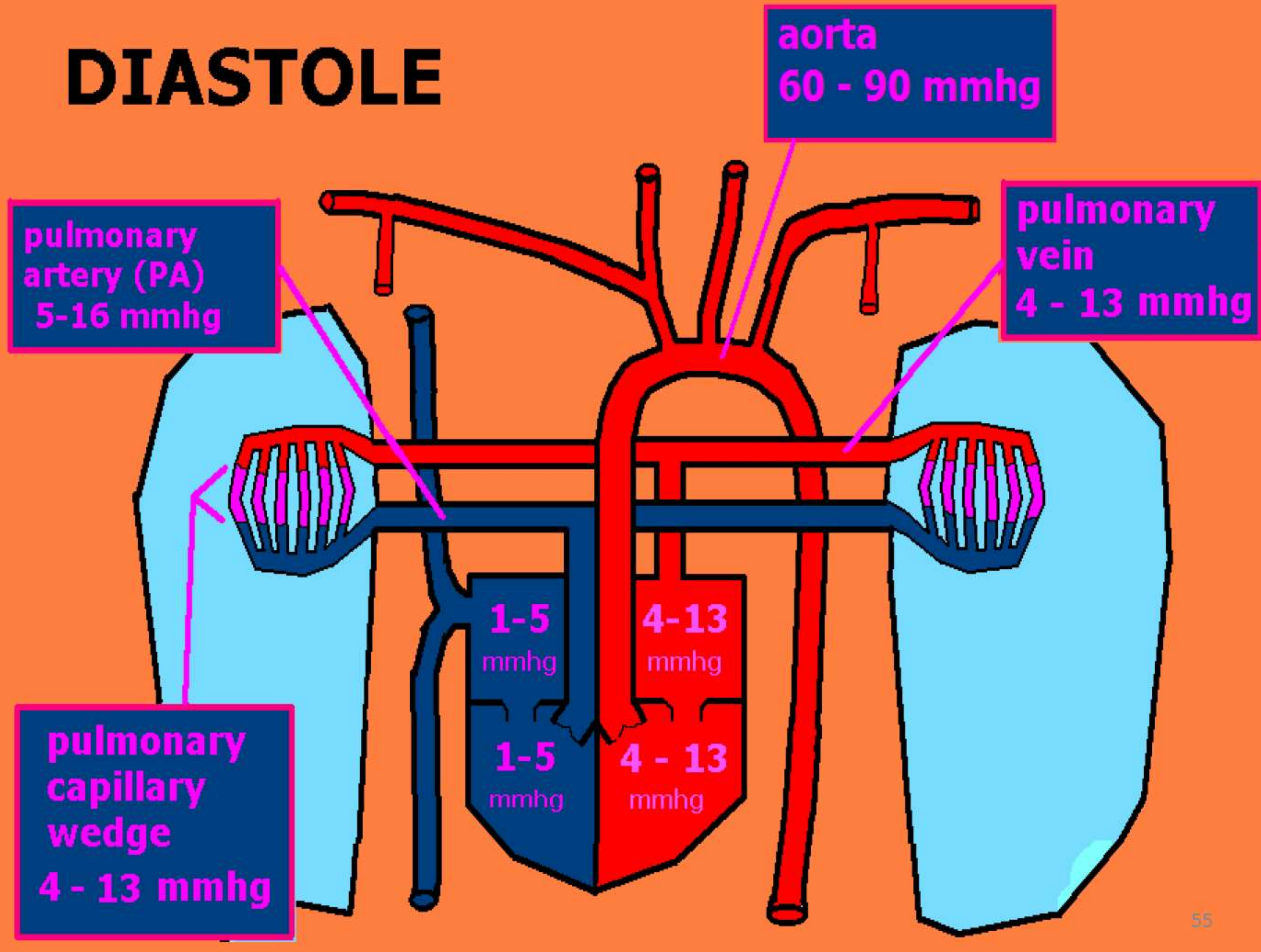
IS THE

LEFT VENTRICLE

WHICH WE WILL REFER TO AS THE PUMP

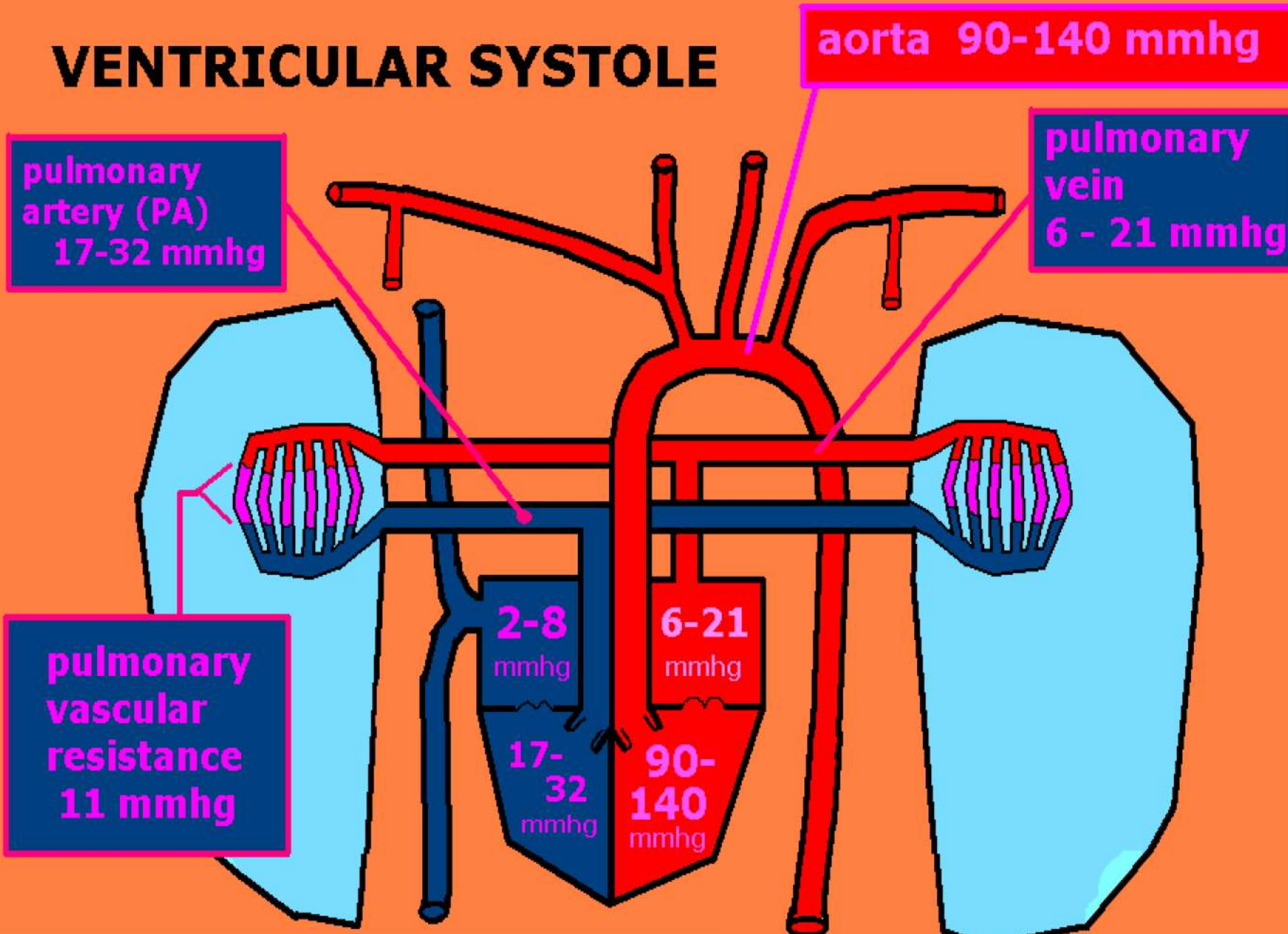


# DIASTOLE



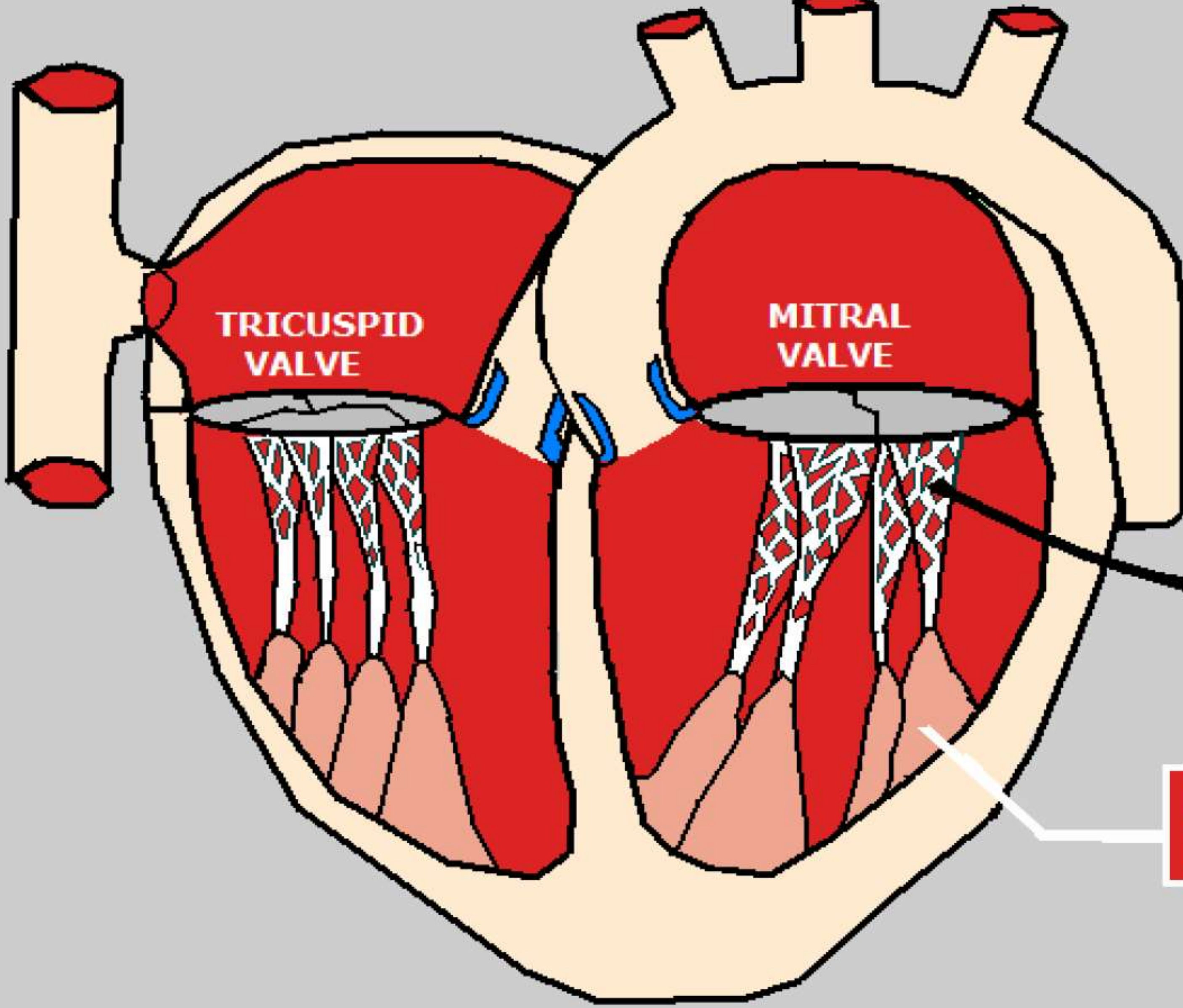
aorta
60 - 90 mmhg
pulmonary artery (PA)
5-16 mmhg
pulmonary vein
4 - 13 mmhg
1-5
mmhg
4-13
mmhg
1-5
mmhg
4 - 13
mmhg
pulmonary capillary wedge
4 - 13 mmhg

# VENTRICULAR SYSTOLE




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

# ATRIO-VENTRICULAR VALVES



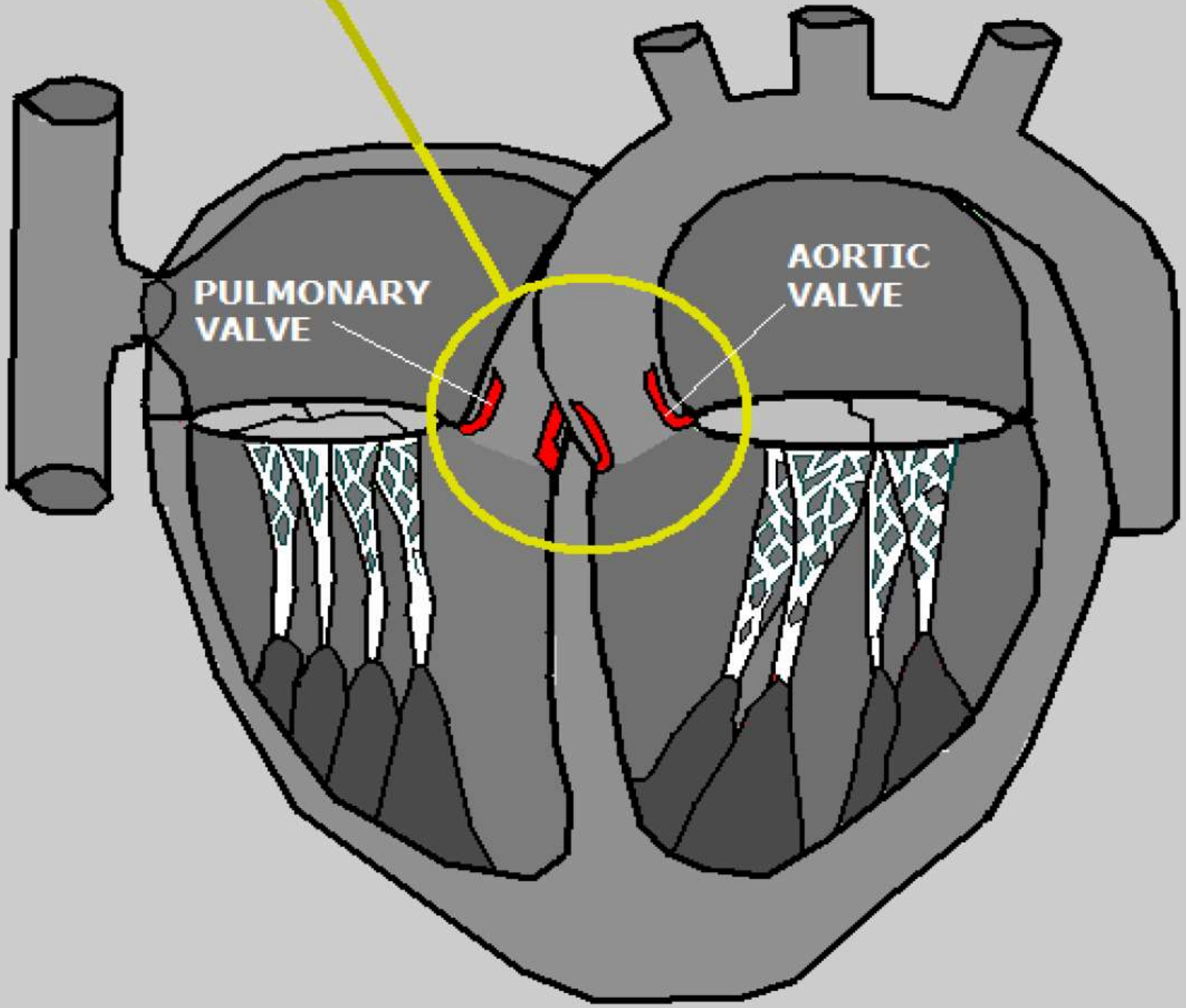

ARE SECURED TO THE ENDO-CARDIAL SURFACE BY THE

CHORDAE TENDINEAE

AND THE

PAPILLARY MUSCLES

# THE SEMILUNAR VALVES



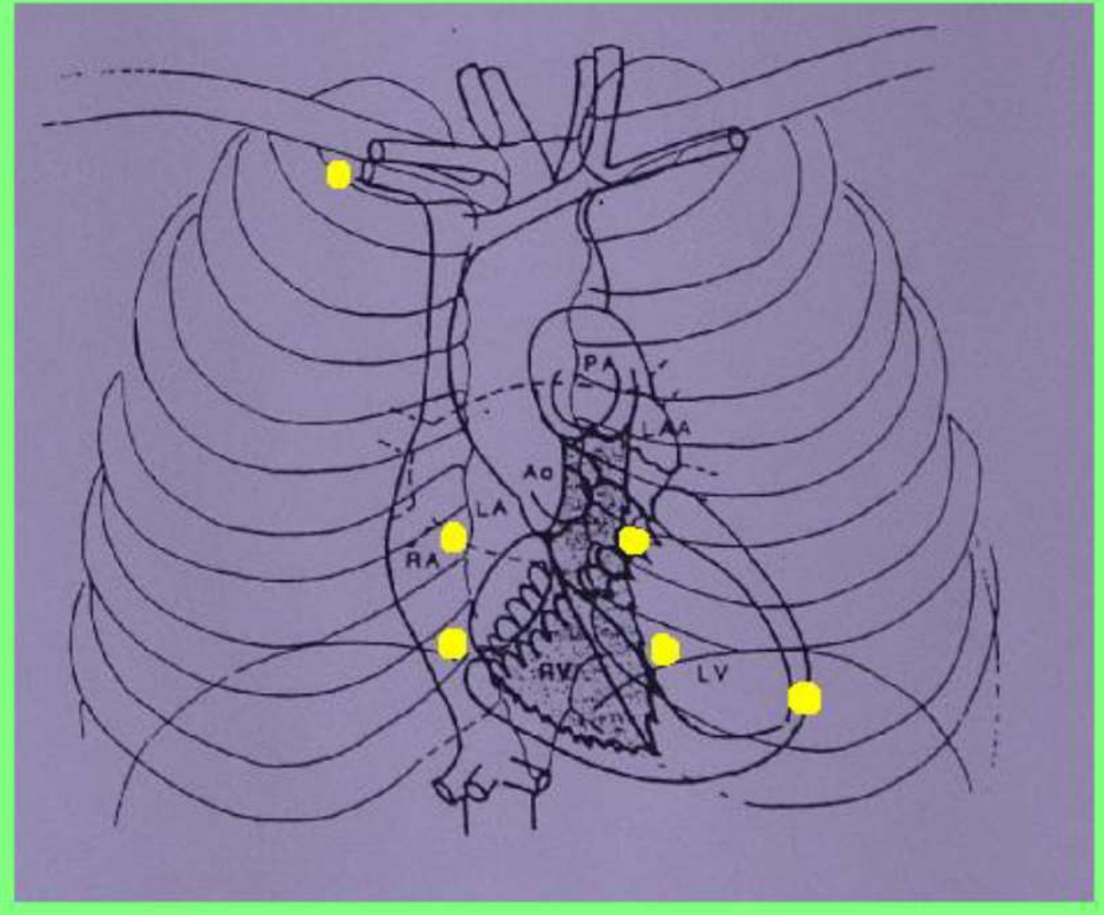
# VERY BASIC HEART SOUNDS ASSESSMENT

## 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.

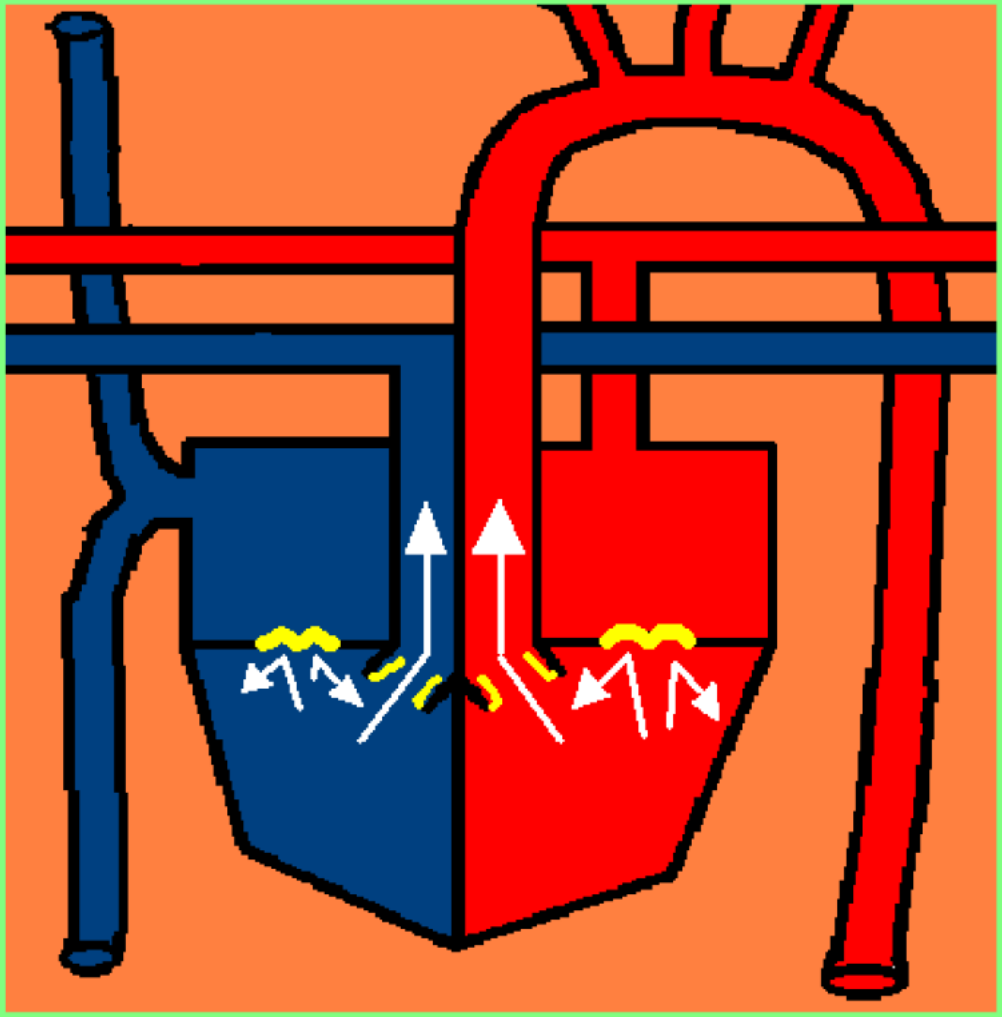
THERE ARE TWO NORMAL HEART SOUNDS, KNOWN AS: **S-1** and **S-2**

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

# HEART SOUNDS ASSESSMENT

**S-1 BEGINNING OF SYSTOLE.**

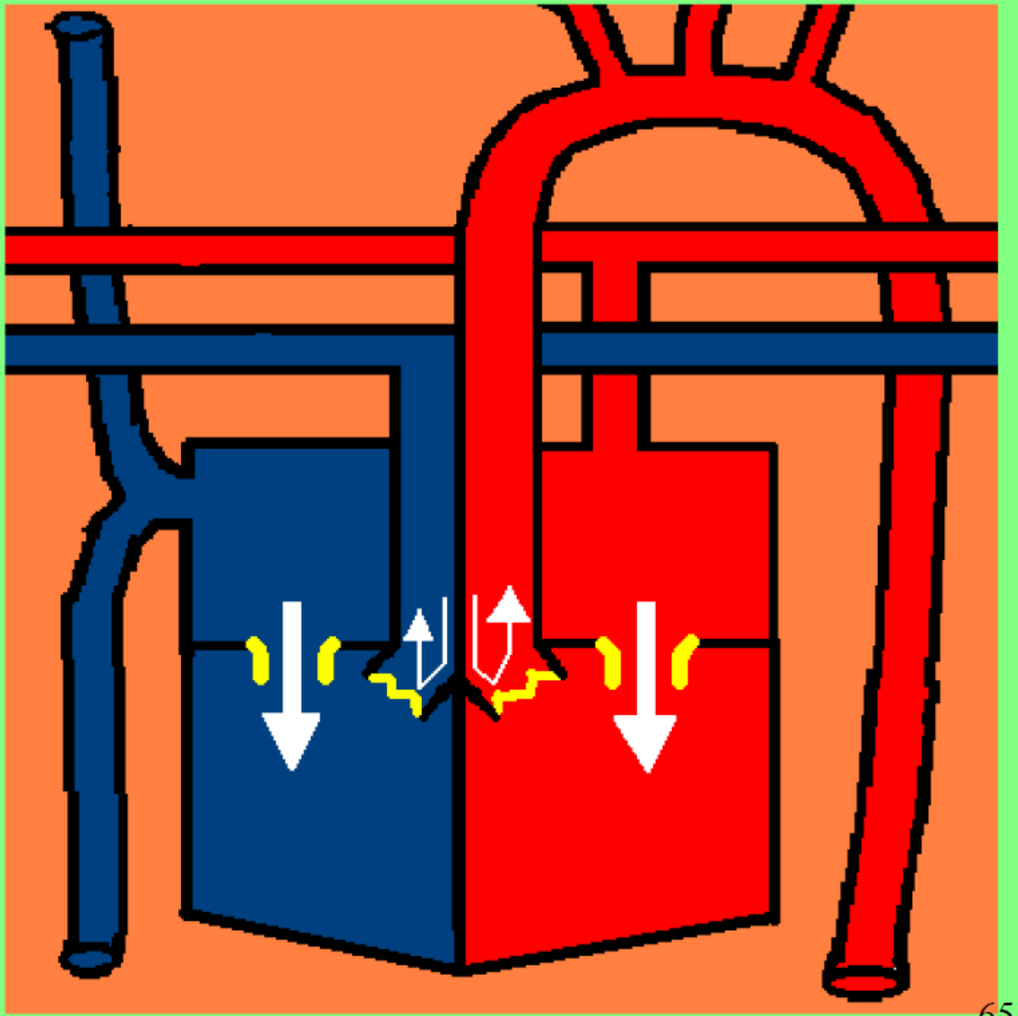
**SOUND OF THE MITRAL AND TRICUSPID VALVES CLOSING.**



# 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.

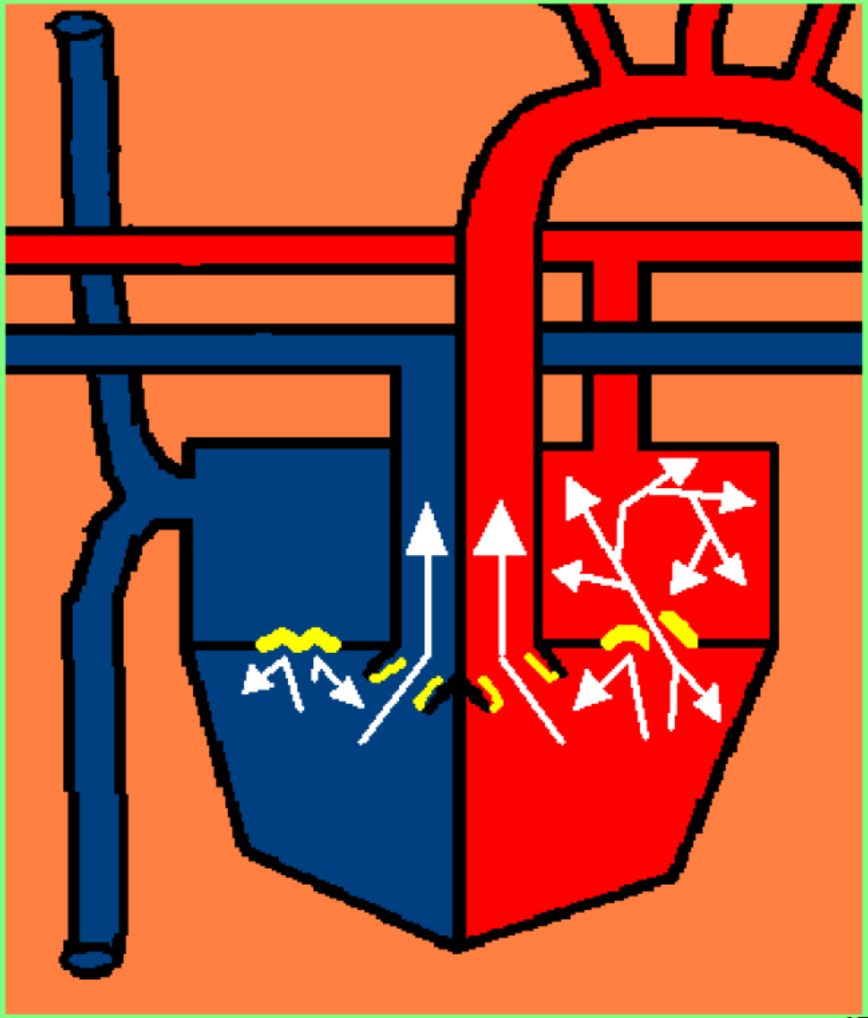


# VERY BASIC HEART SOUNDS ASSESSMENT

| ABNORMAL SOUND | SUSPECTED EKG CHANGES |
|---|---|
| MURMURS<br>- SYSTOLIC<br>- DIASTOLIC | - ACUTE MI<br>- CHAMBER HYPERTROPHY<br>- NECROSIS - RECENT EXTENSIVE MI (7-10 days) |
| FRICTION RUB | - ACUTE MI<br>- RECENT MI (NECROSIS)<br>- 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 . . . "**

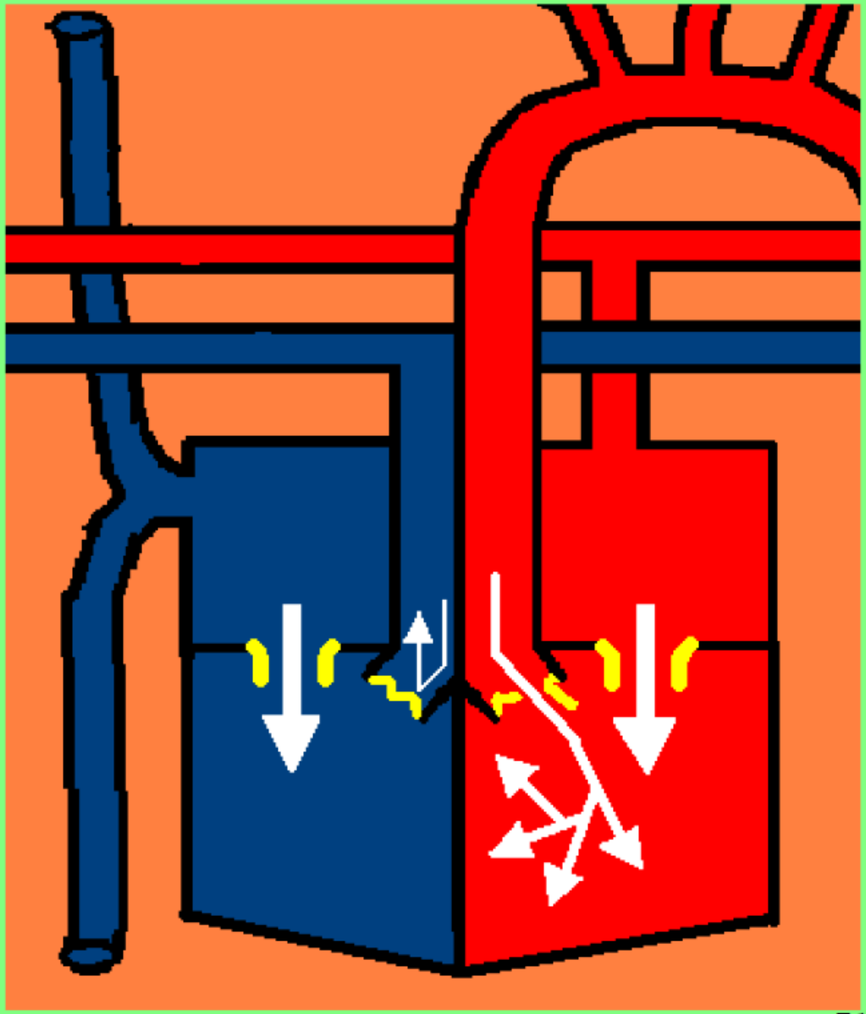
- MOST SYSTOLIC MURMURS CAUSED BY MITRAL VALVE FAILURE.

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

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

# CAUSE OF DIASTOLIC (S2) MURMUR

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



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

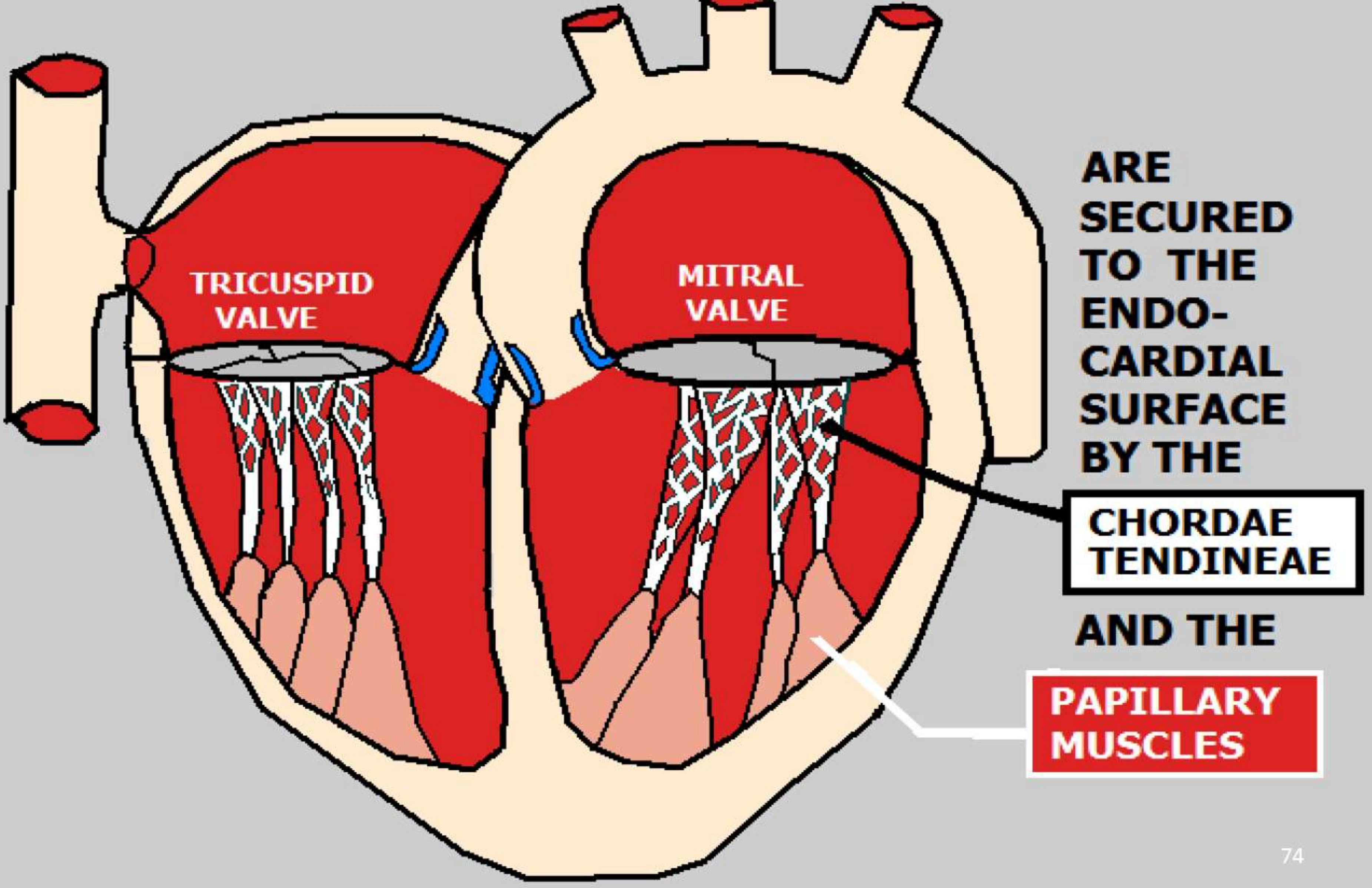
Chronic **Valvular STENOSIS** ("Creaky" Valve) leads to Cardiac Muscle STRAIN and HYPERTROPHY.

BOTH conditions, if untreated, eventually leads to **HEART FAILURE.**

**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" . . . . .**

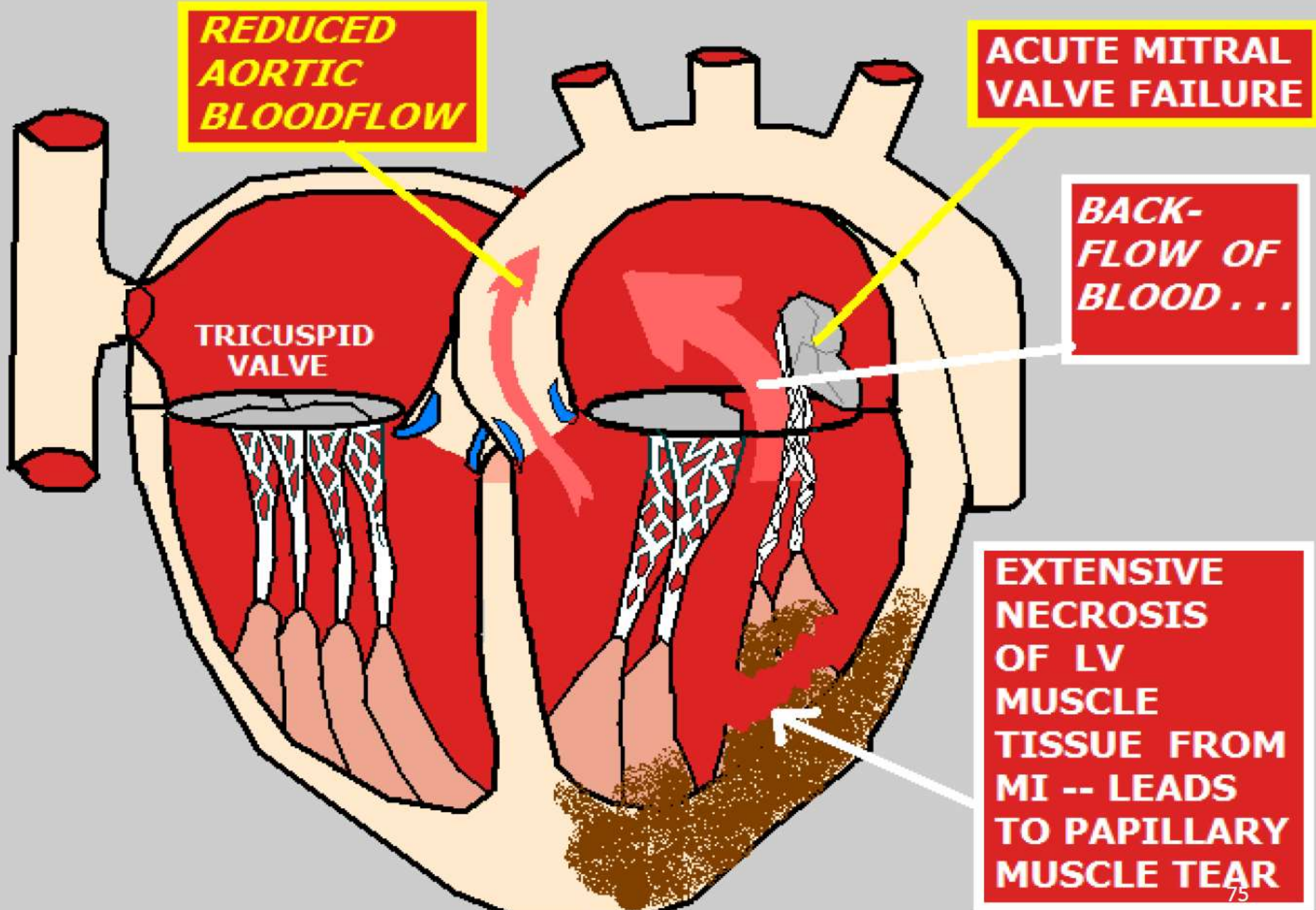
# ATRIO-VENTRICULAR VALVES




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 HYPOTENSION
- 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 . . . "**

# Heart Sounds: S3

- S3 sounds like: “ kenTUCky . . . kenTUCky”

- Caused by: increased atrial pressure.

- S3 is associated with: **Heart Failure, Dilated Cardiomyopathy.**

# Heart Sounds: S4

- S4 sounds like: "TENnessee. . . TENnessee"

- Caused by: stiffened left ventricle.

- S4 is associated with: **Hypertension, Aortic Stenosis, Ischemic** or **Hypertrophic Cardiomyopathy.**

Access
University of Washington
Department of Medicine
----------
Heart Sound Simulator

# BASIC HEART SOUNDS ASSESSMENT

## FRICTION RUB

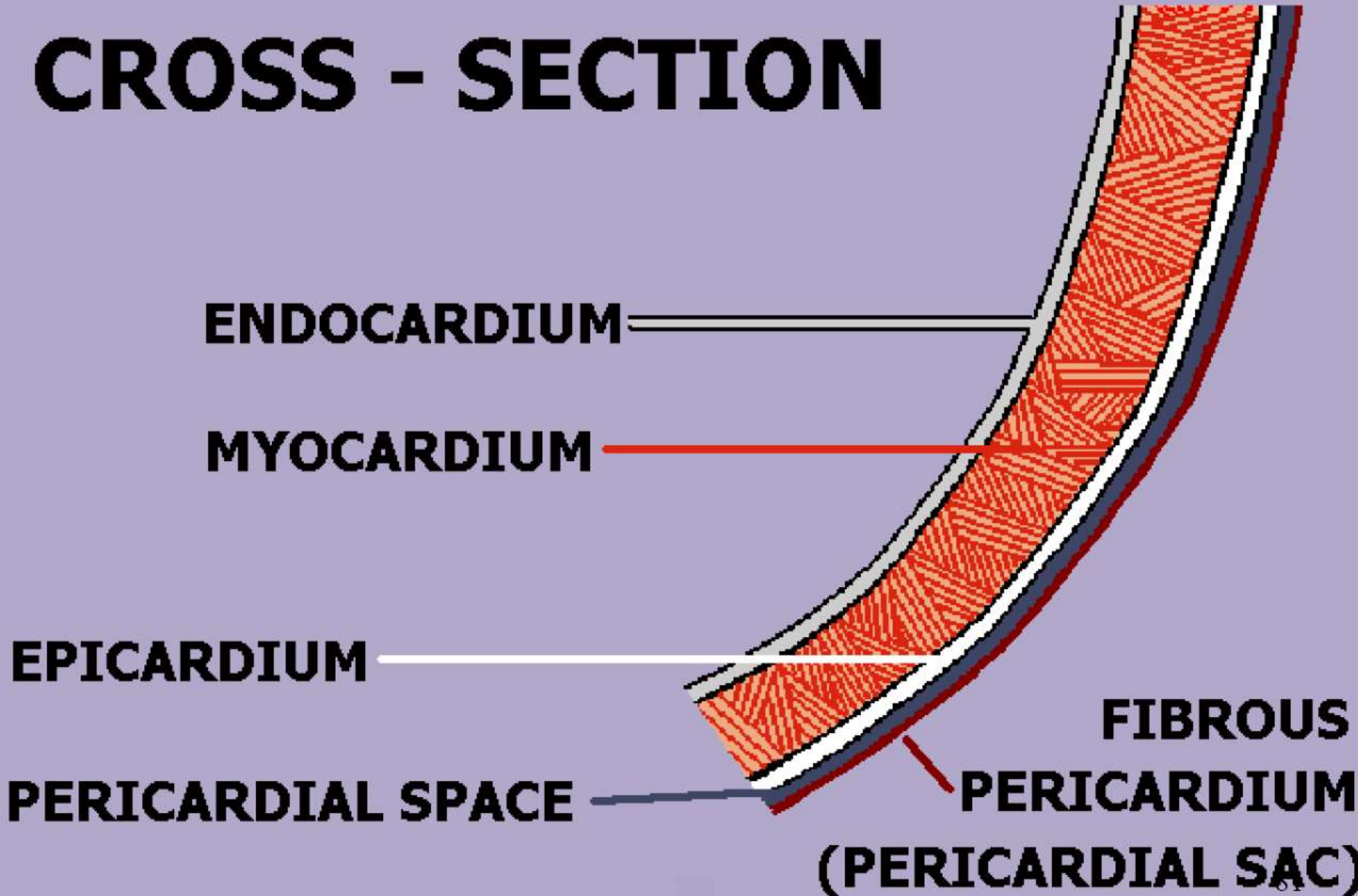
- ASSOCIATED WITH PERICARDITIS
- SOUNDS LIKE THE GENTLE RUBBING OF SANDPAPER
- HAS 3 COMPONENTS: SYSTOLIC, EARLY, and LATE DIASTOLIC

# 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

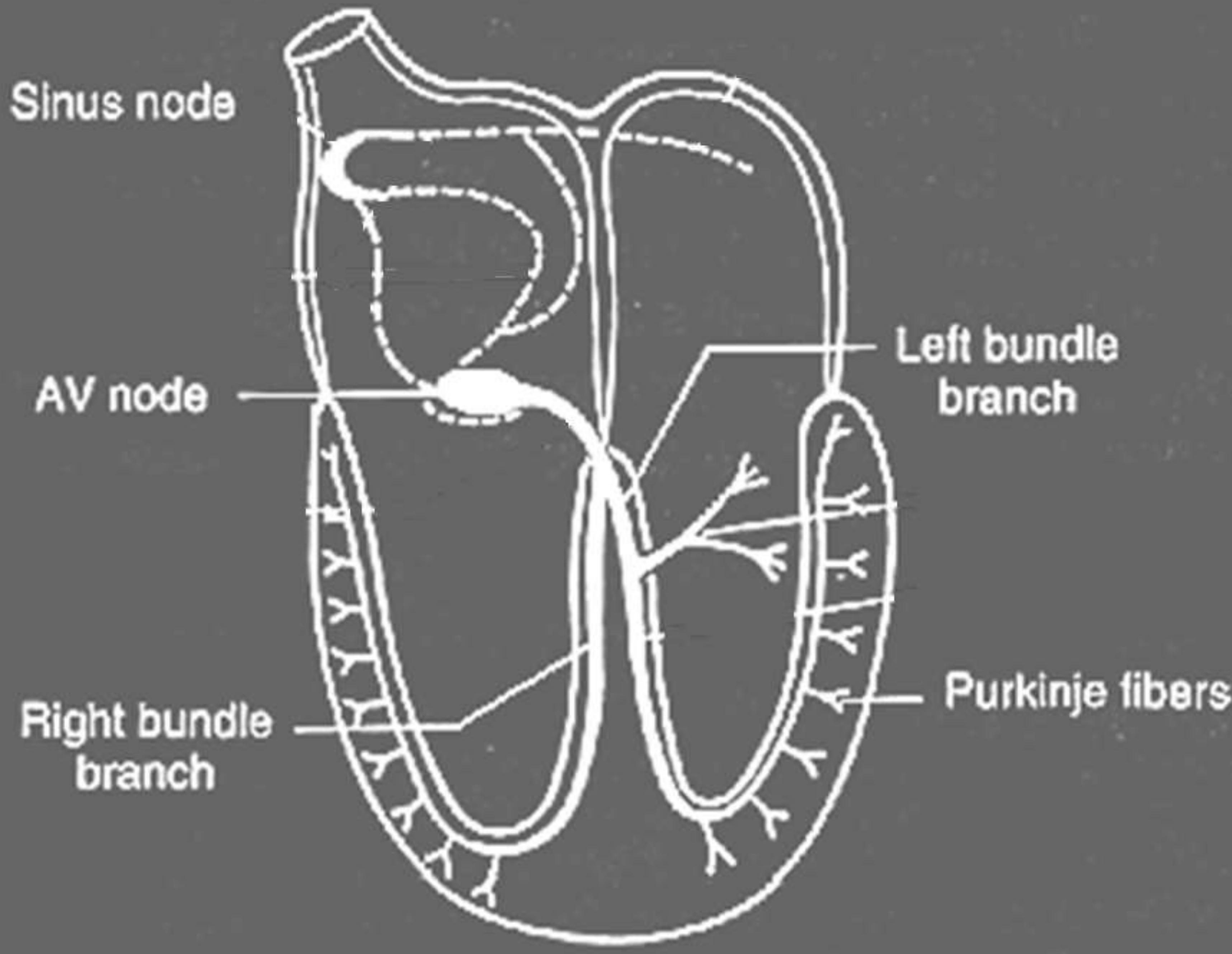


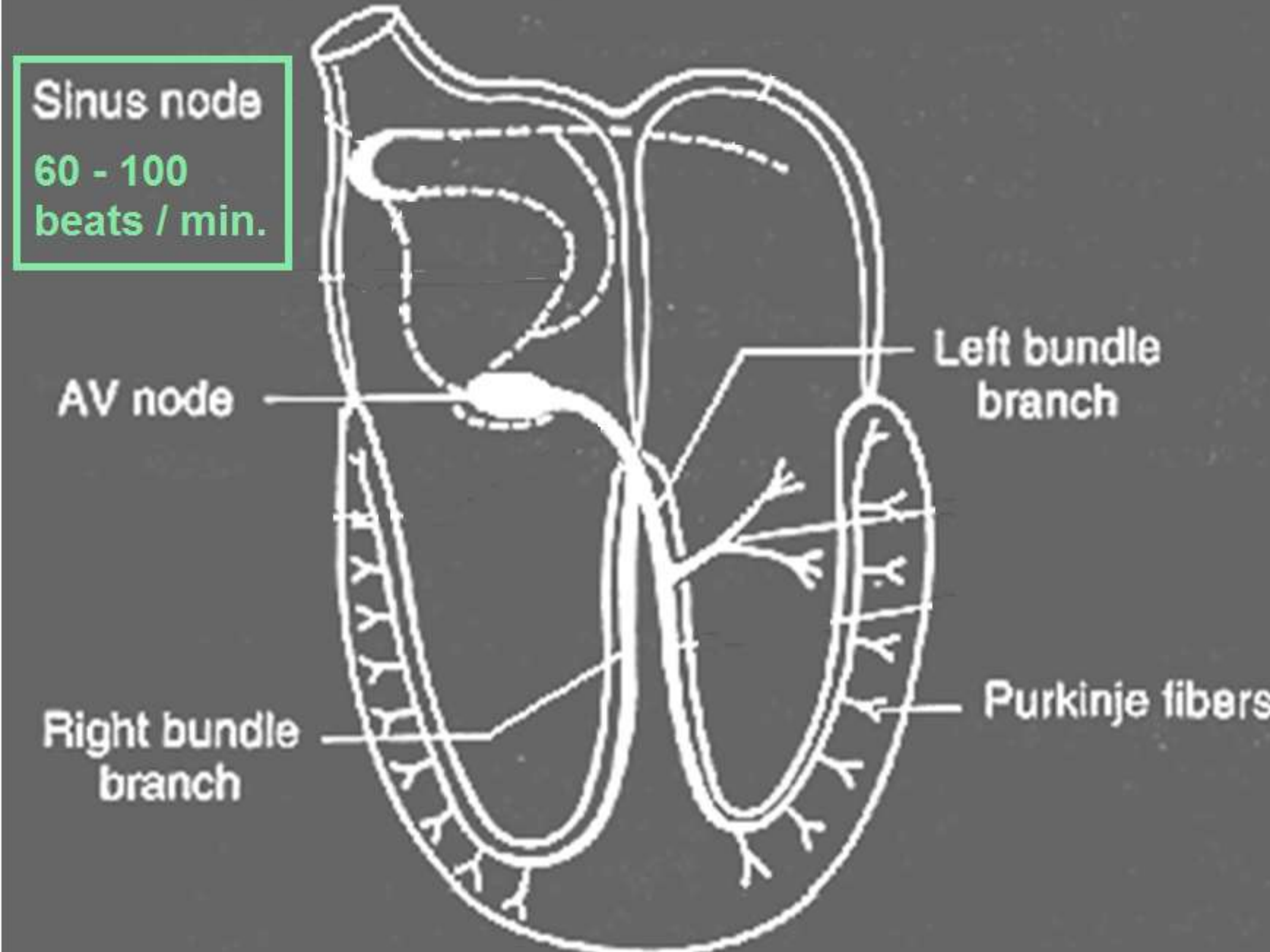
NORMAL AMOUNT OF

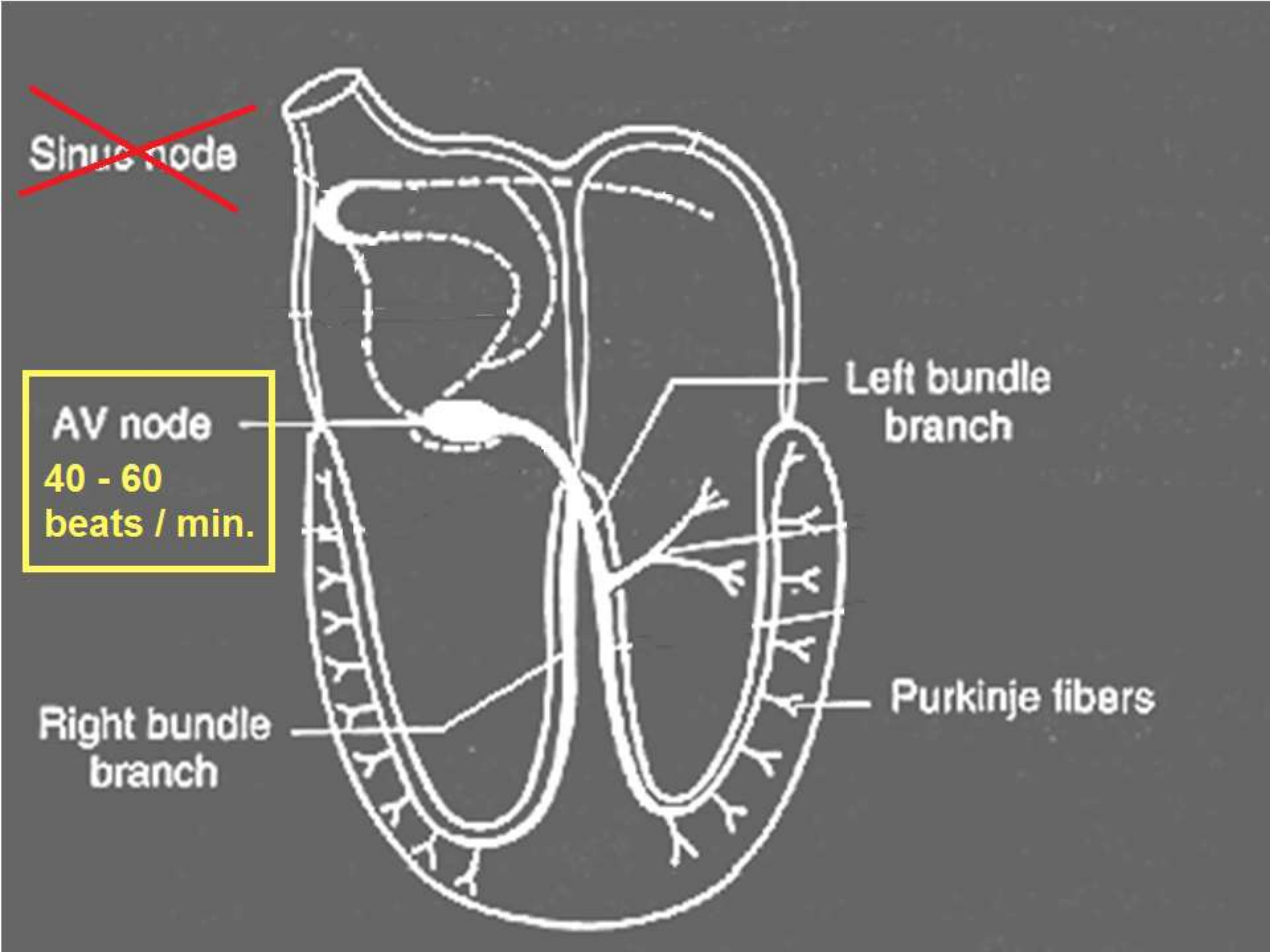
FLUID IN

PERICARDIAL SPACE =

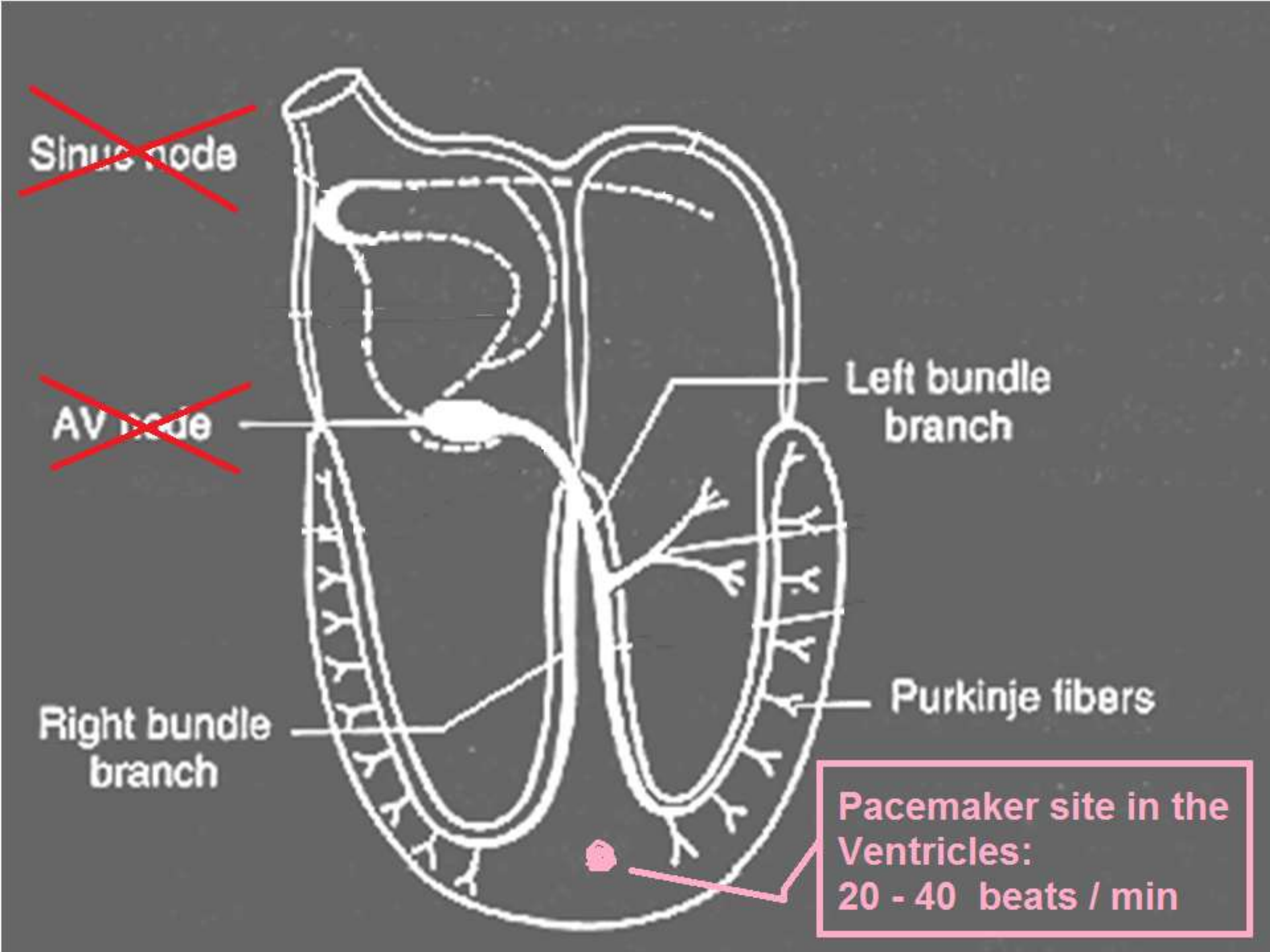
20 - 50 cc


Sinus node
AV node
Left bundle branch
Purkinje fibers
Right bundle branch

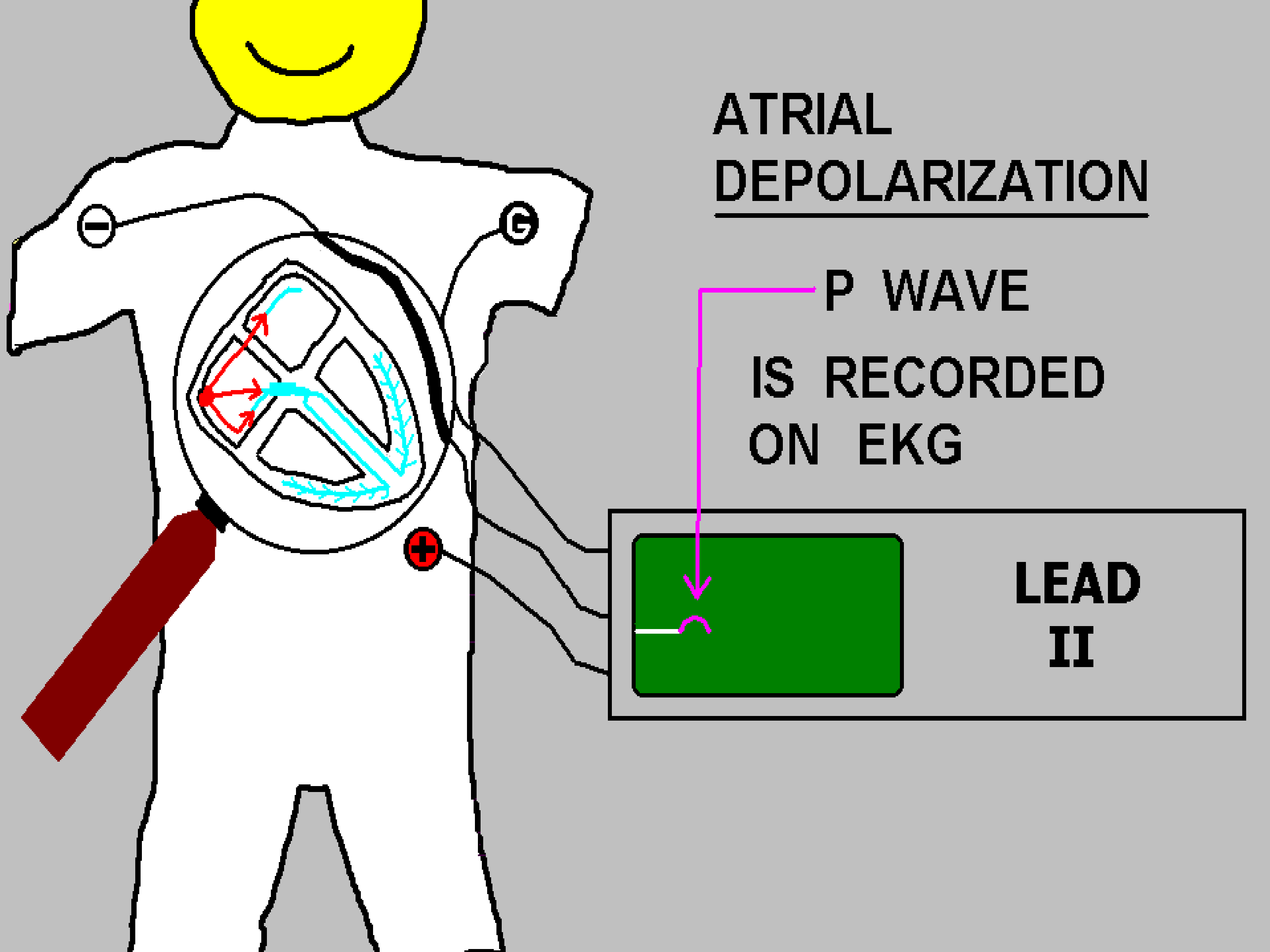

Sinus node
60 - 100
beats / min.
AV node
Left bundle
branch
Purkinje fibers
Right bundle
branch

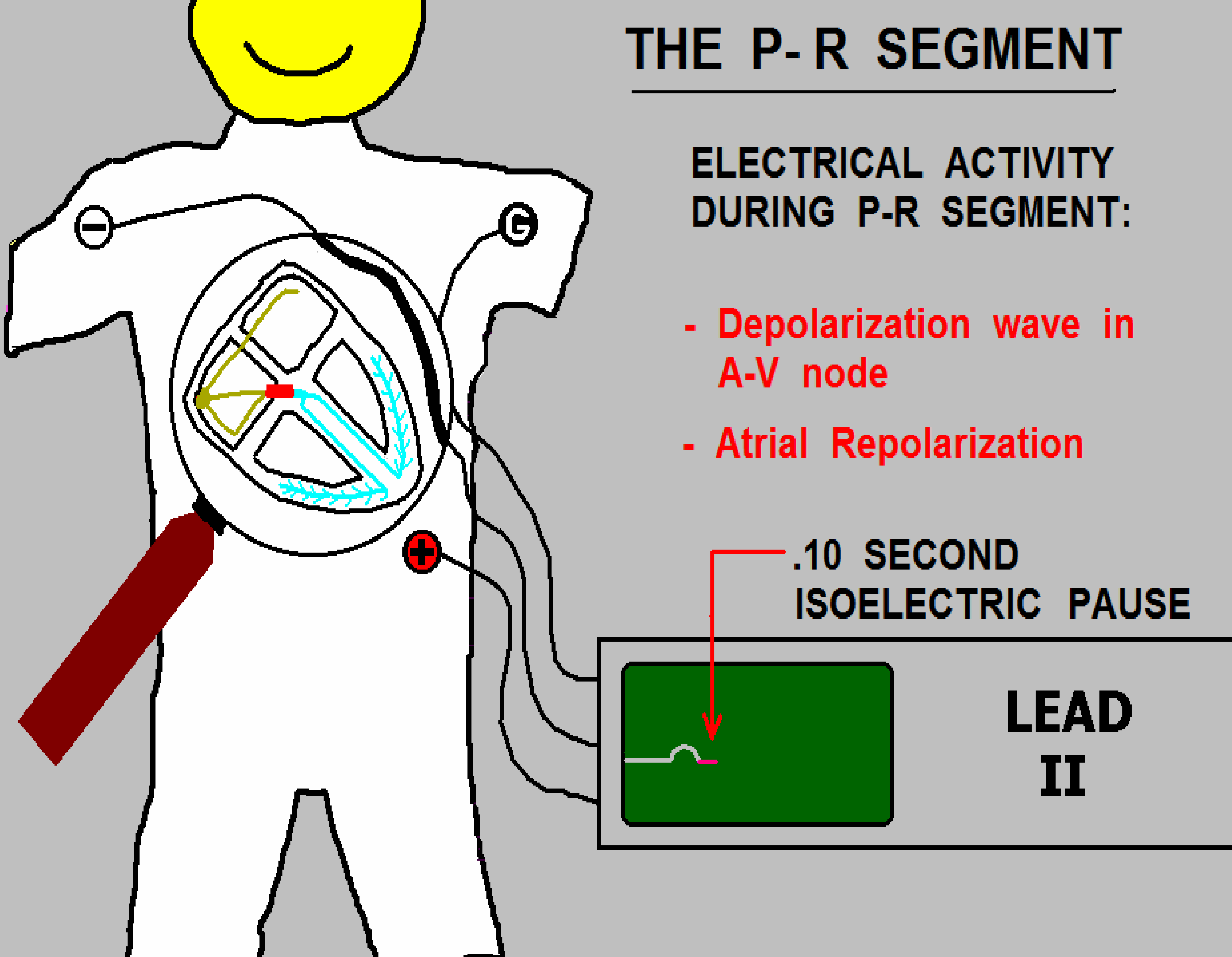


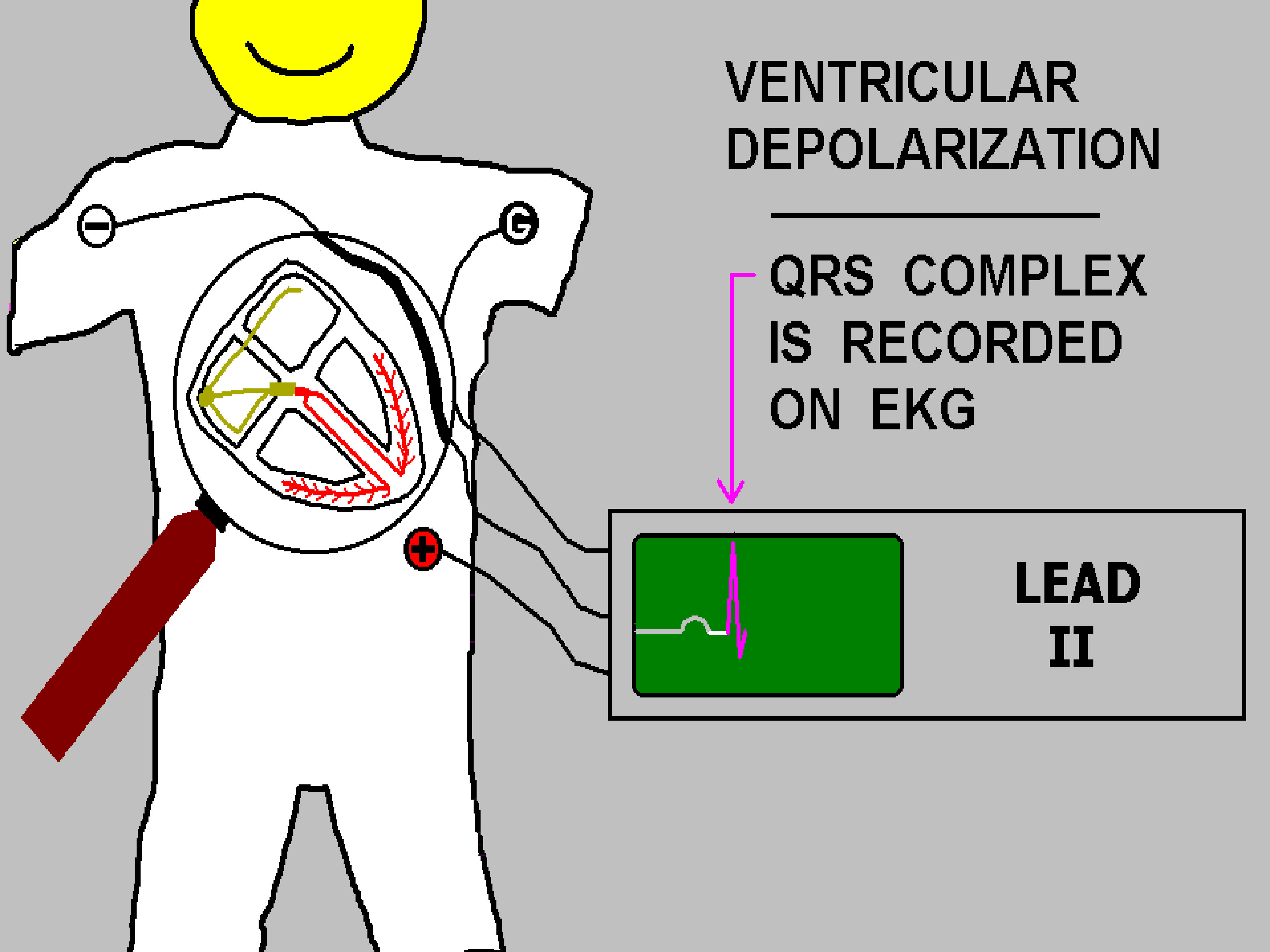
~~Sinus node~~
AV node
40 - 60
beats / min.
Left bundle
branch
Purkinje fibers
Right bundle
branch

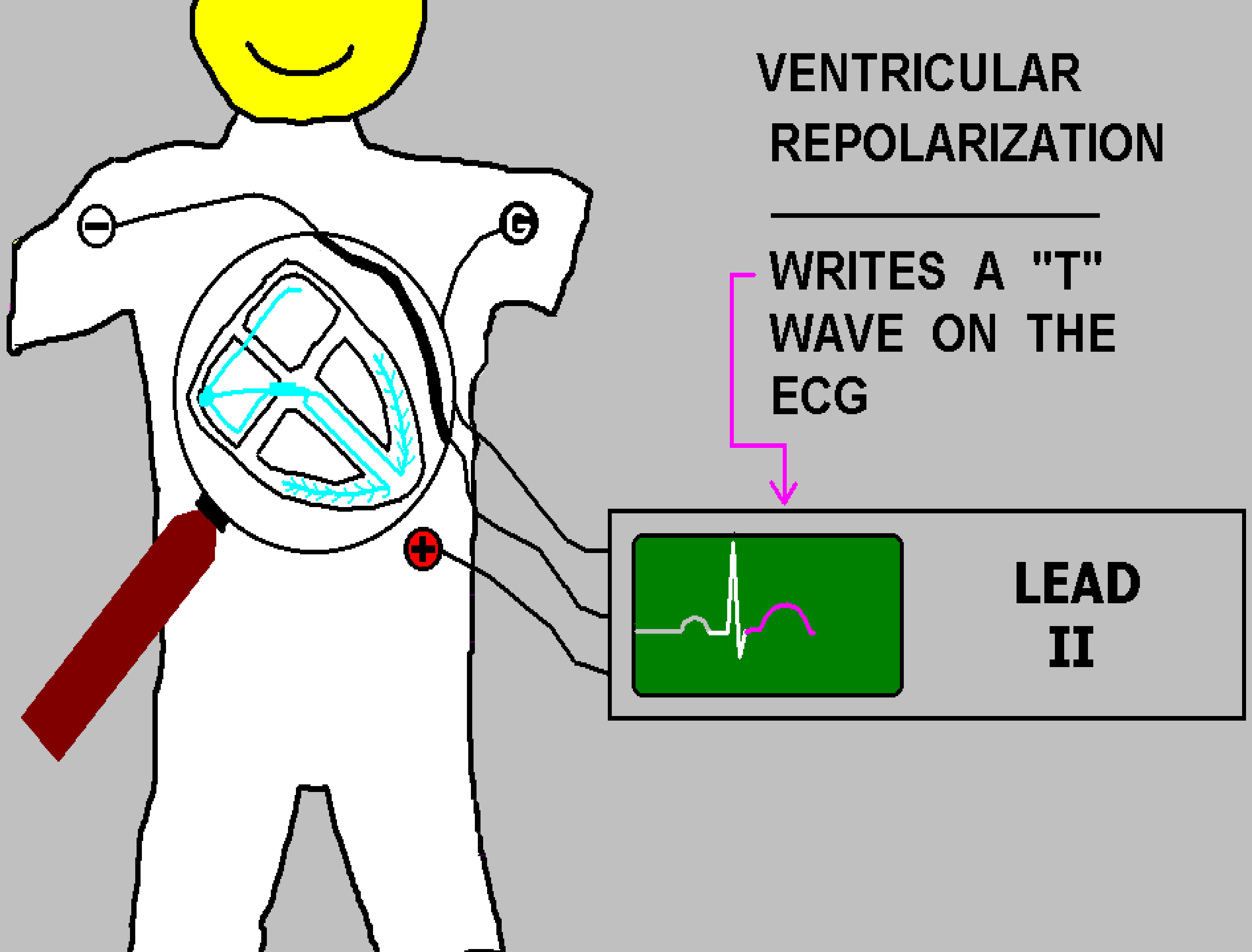


~~Sinus node~~
~~AV node~~
Left bundle branch
Purkinje fibers
Right bundle branch
Pacemaker site in the Ventricles:
20 - 40 beats / min

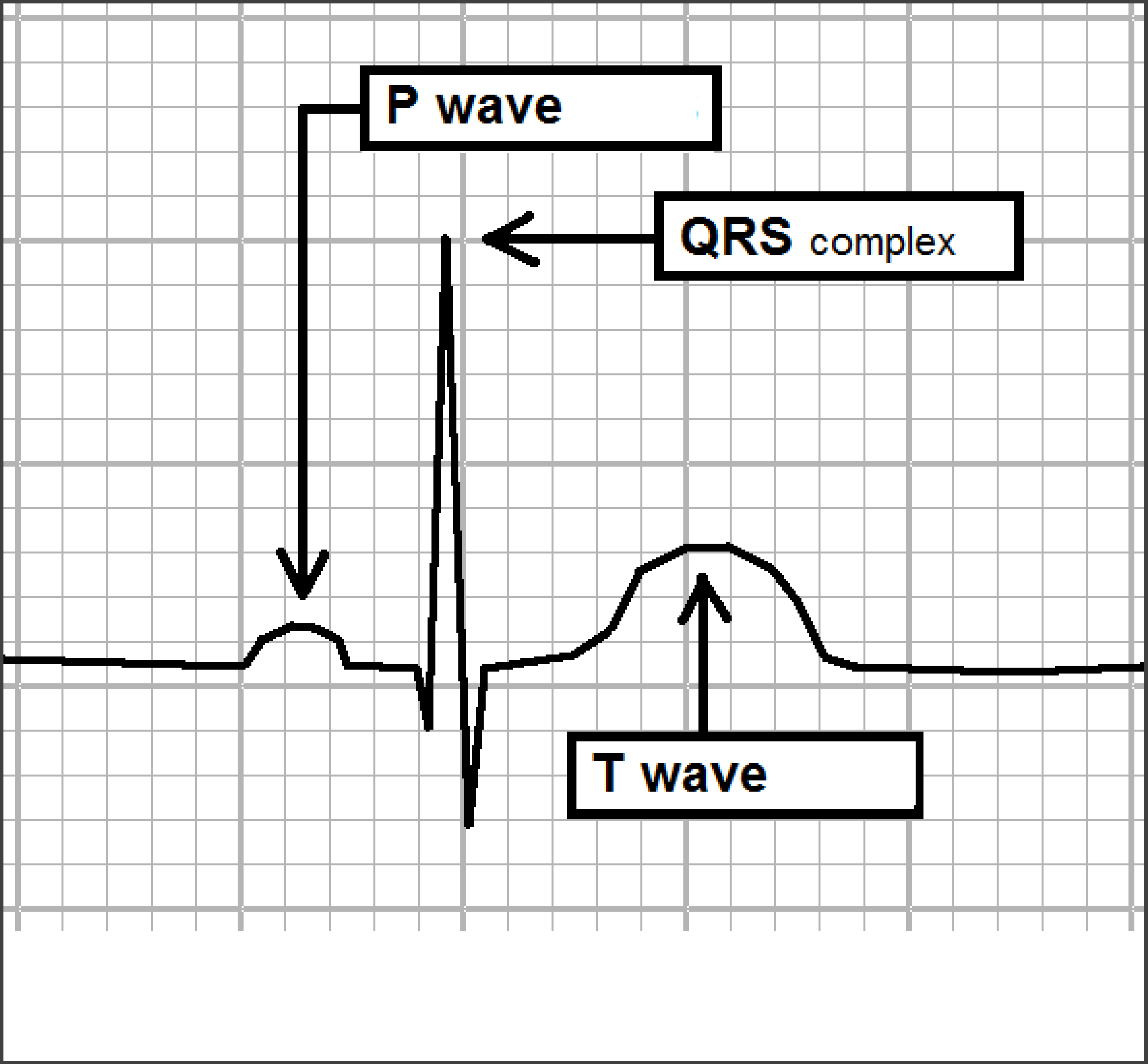

ATRIAL
DEPOLARIZATION
P WAVE
IS RECORDED
ON EKG
LEAD
II
G


THE P- R SEGMENT
ELECTRICAL ACTIVITY
DURING P-R SEGMENT:
- Depolarization wave in
A-V node
- Atrial Repolarization
.10 SECOND
ISOELECTRIC PAUSE
LEAD
II
G


VENTRICULAR DEPOLARIZATION
QRS COMPLEX IS RECORDED ON EKG
LEAD II


VENTRICULAR
REPOLARIZATION
WRITES A "T" WAVE ON THE ECG
LEAD
II

# REVIEW of NORMAL ECG Waveforms:




**P WAVE =**
ATRIAL DEPOLARIZATION

**QRS COMPLEX =**
VENTRICULAR DEPOLARIZATION (contracting)

**T WAVE =**
VENTRICULAR REPOLARIZATION (recharging)

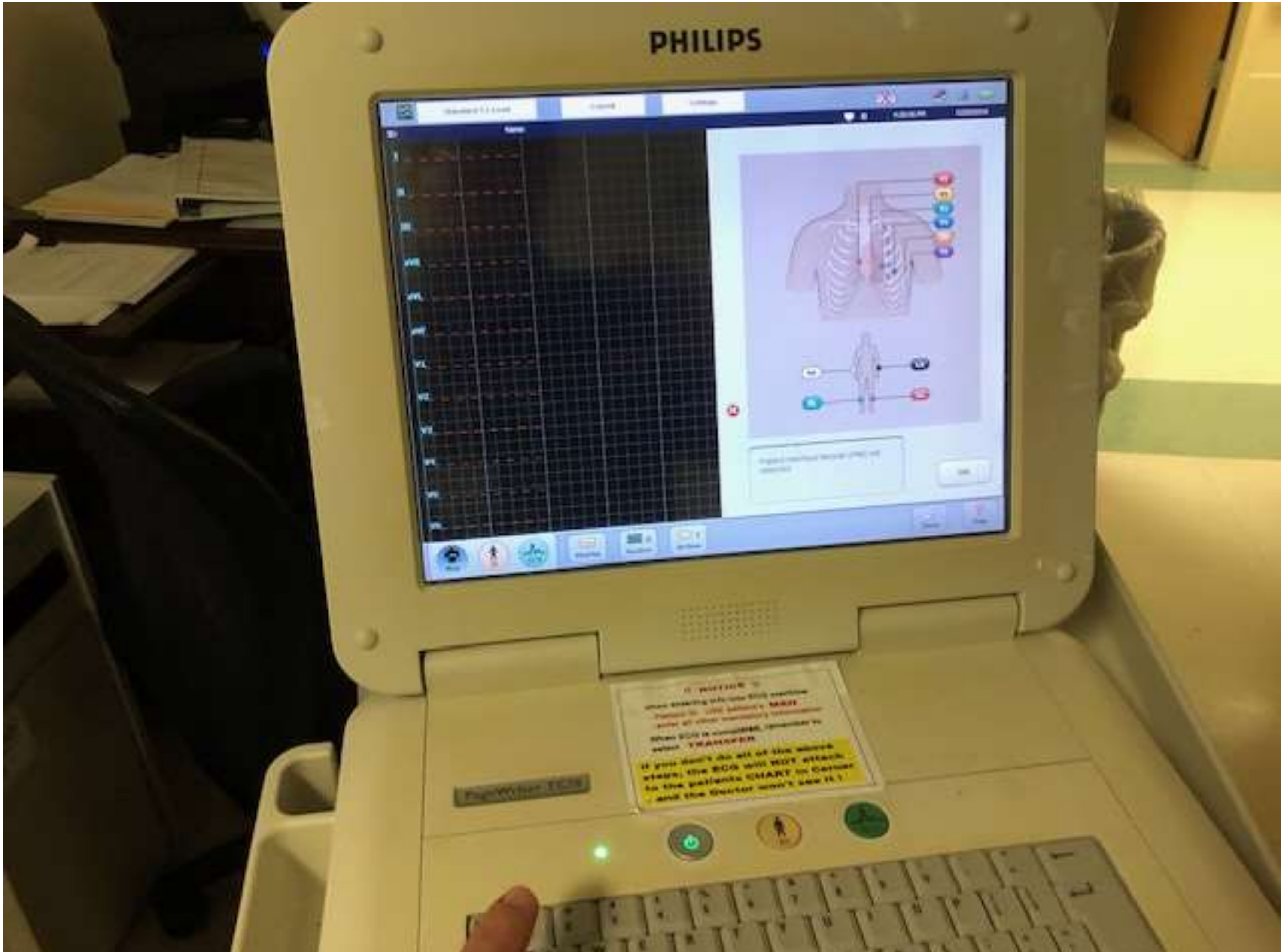
OLD BARN, SHREWSBURY, PA -- 2001

# EMS 12 Lead ECG

# 10 wires . . .

- 4 limb leads
- 6 chest (“V”) leads


PHILIPS


PHILIPS

# 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 particular problem for routine recording in neonates, infants, and

**AHA/ACC/HRS Scientific Statement**

# Recommendations for the Standardization and Interpretation of the Electrocardiogram

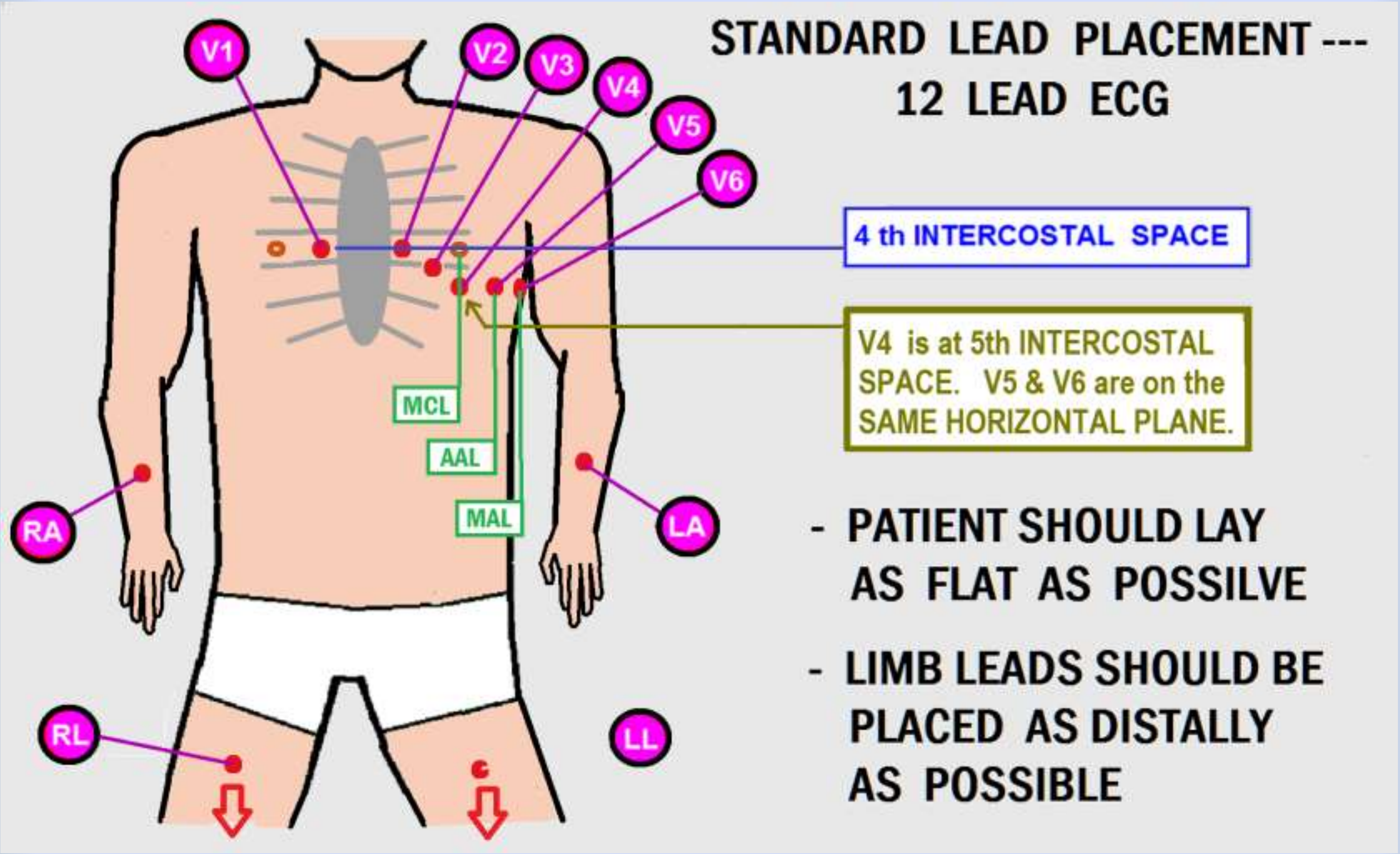
## Part I: The Electrocardiogram and Its Technology

***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**

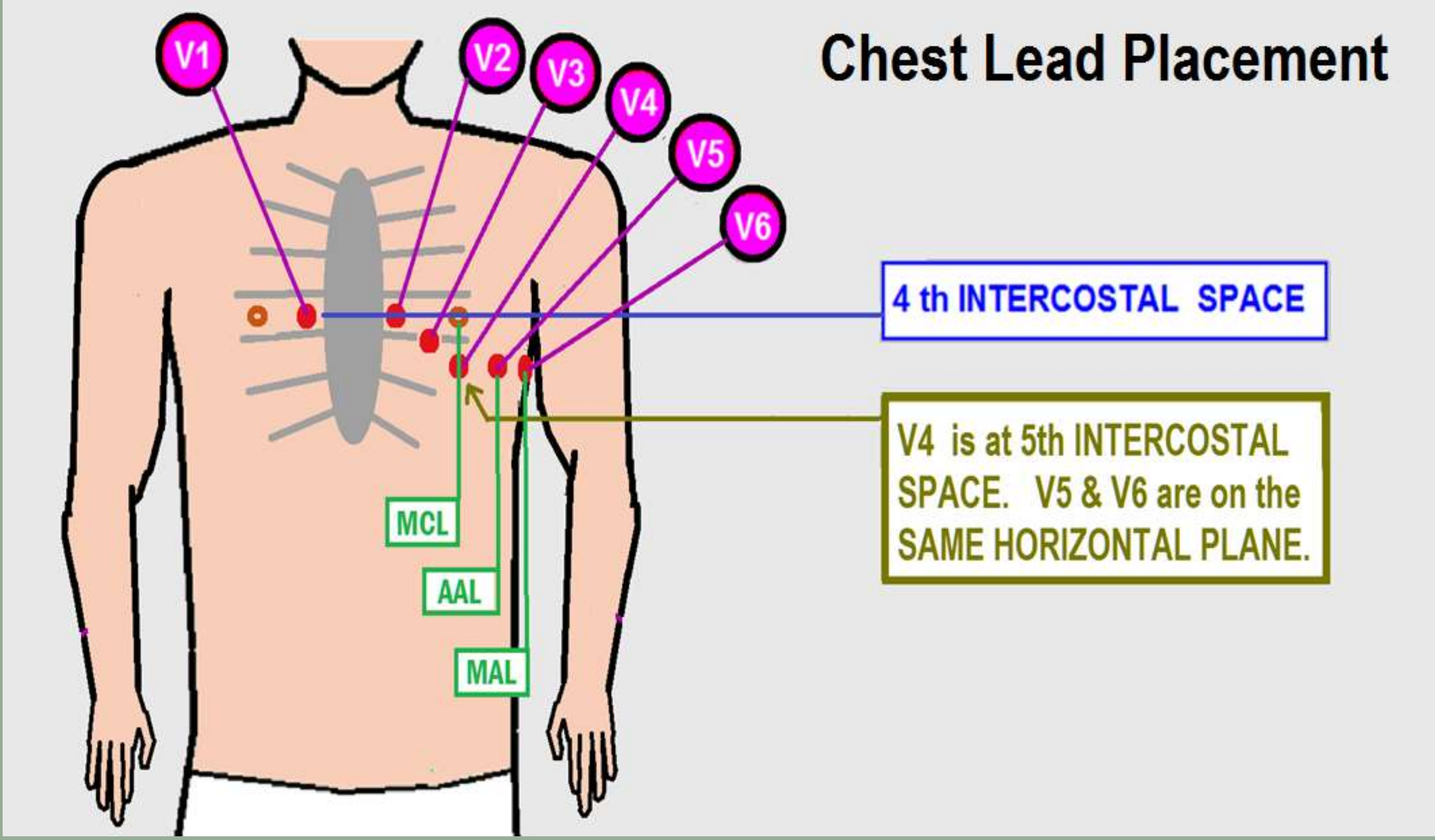
# Obtaining the 12 Lead ECG



# Leads V1 & V2 on 12 Lead ECG:

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

# CORRECT Lead placement:



[redacted] [redacted] [redacted]

DOB [redacted] 75 Years Female (2)

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

PR 161
QRSD 90
QT 350
QTc 394

[redacted]

TECH SD

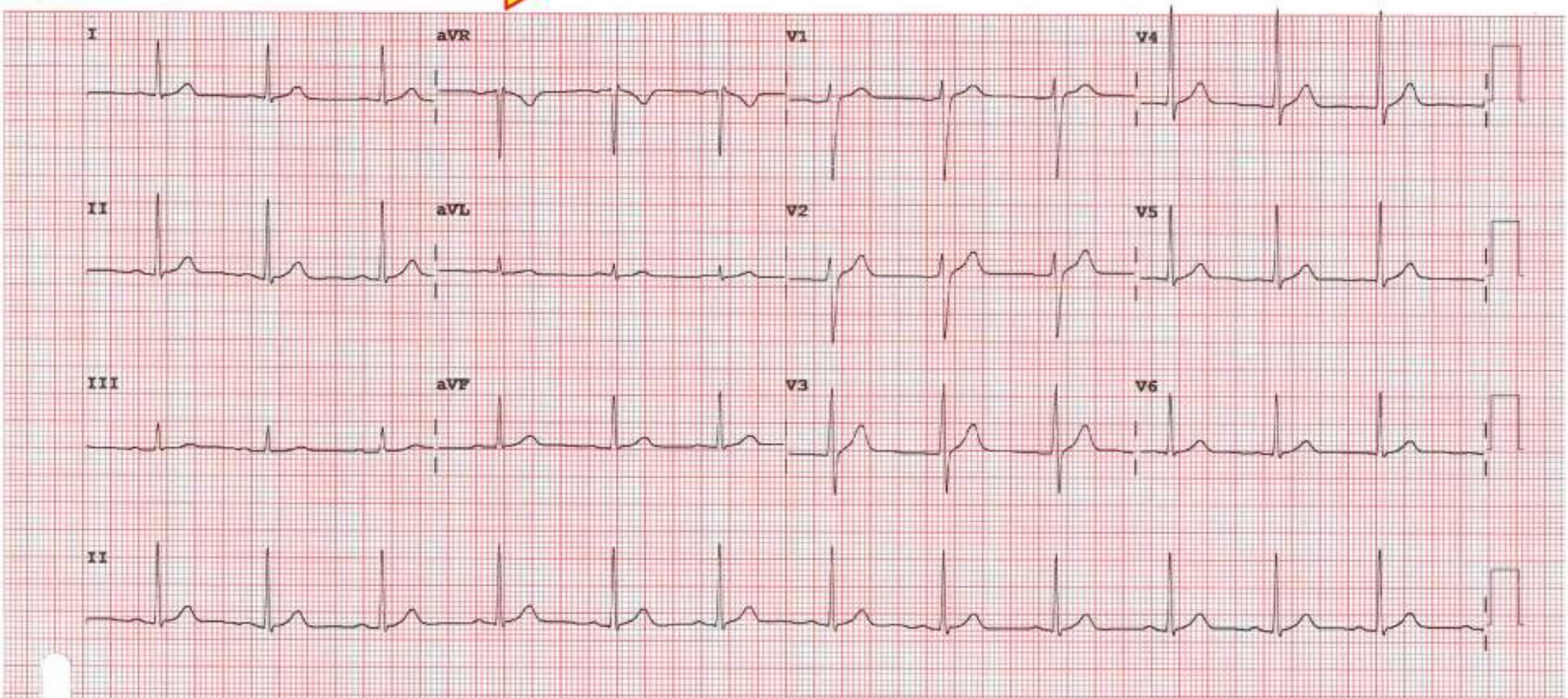
[redacted] [redacted]

--AXIS--
P 50
QRS 51
T 44

12 Lead; Standard Placement

- NORMAL ECG -

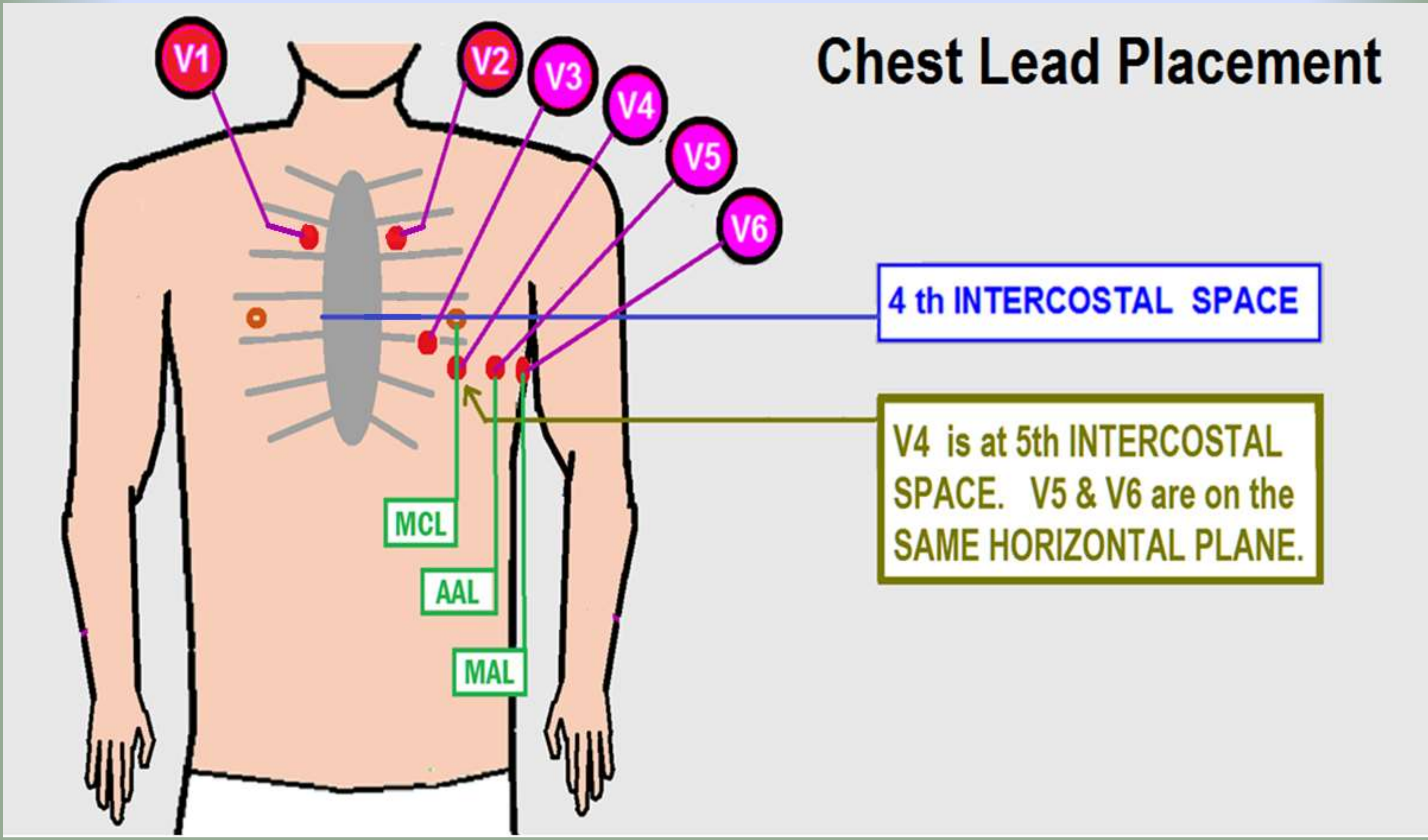
Unconfirmed Diagnosi




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

COVIDIEN Kendall REF 30768078

# INCORRECT Lead placement:



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

DOB [redacted]1988 30 Years Female (1)

3NE

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

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

PR 157
QRSD 96
QT 365
QTc 445

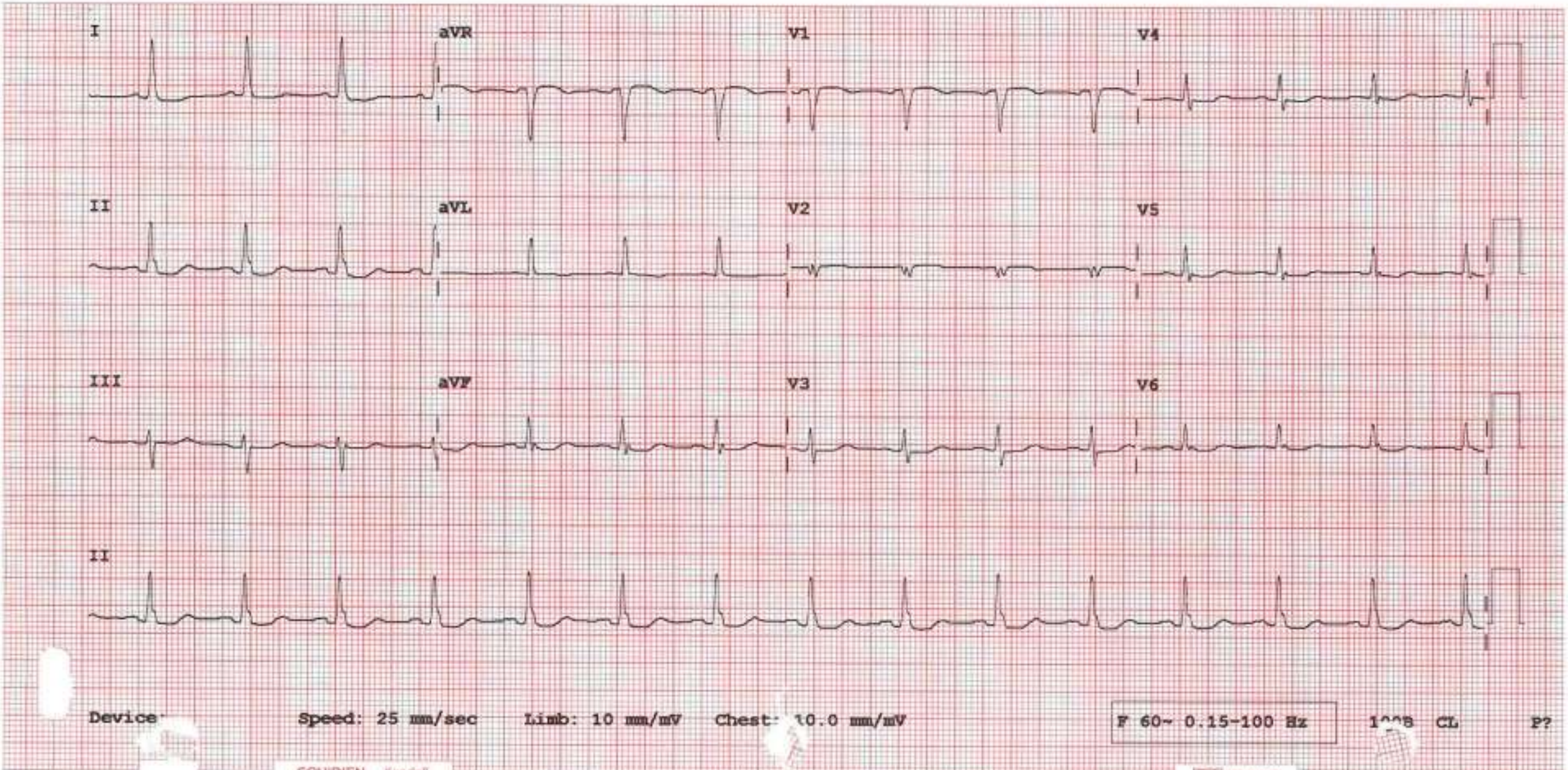
--AXIS--
P 46
QRS 24
T 86

12 Lead; Standard Placement

[redacted]

- ABNORMAL ECG -

Unconfirmed Diagnosis



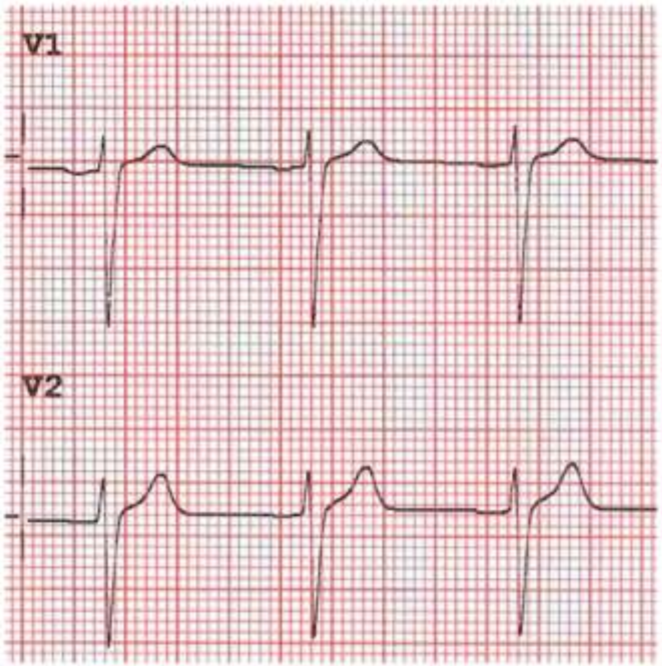
**AHA/ACC/HRS Scientific Statement**

# Recommendations for the Standardization and Interpretation of the Electrocardiogram

## Part I: The Electrocardiogram and Its Technology

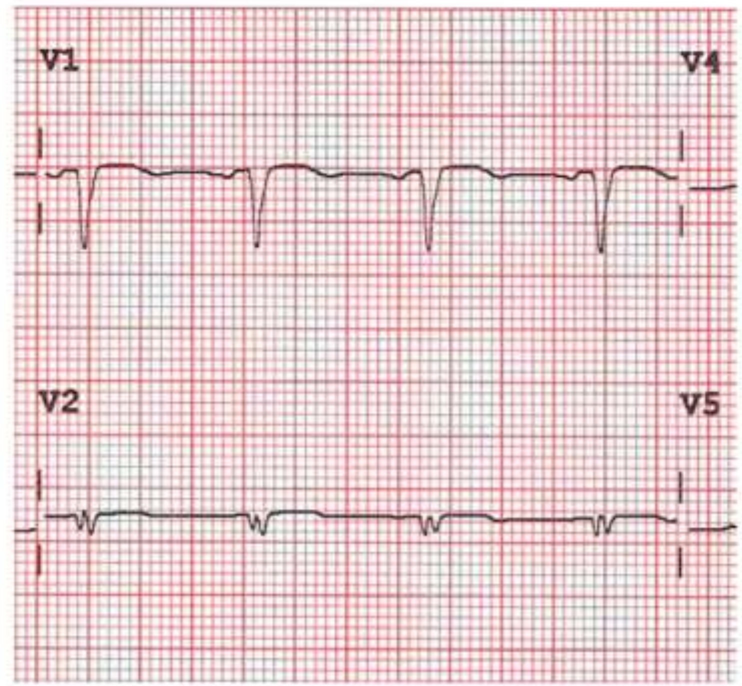
the often profound alterations in waveforms that can result from precordial electrode misplacement.[85,86] A common error is superior misplacement of $V_1$ and $V_2$ in the second or third intercostal space. This can result in reduction of initial R-wave amplitude in these leads, approximating 0.1 mV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

## Correct Lead Placement




# RS = NO old MI

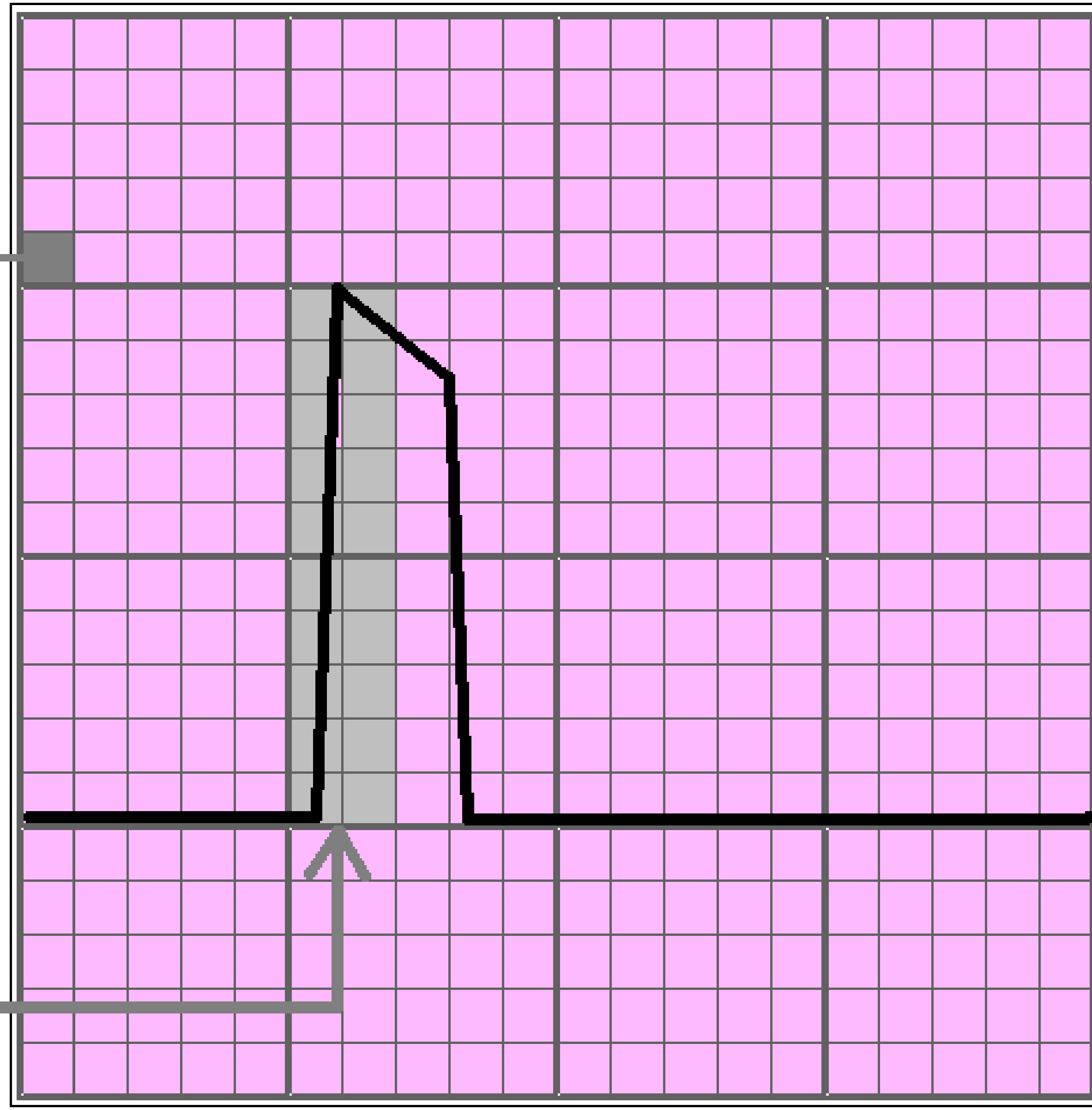
## Incorrect Lead Placement




# QS = old MI

# 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



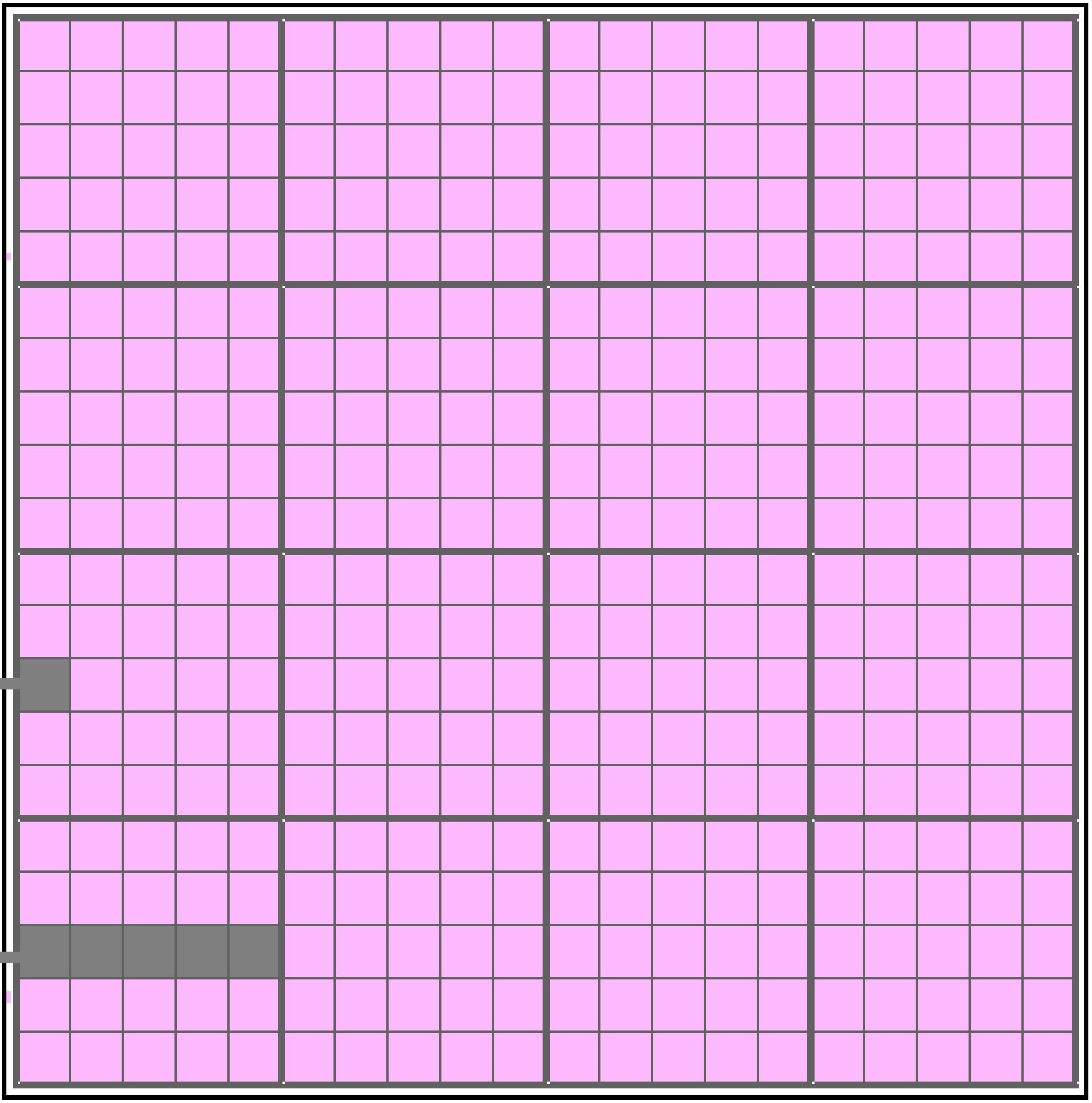
# ECG PAPER - THE HORIZONTAL AXIS:

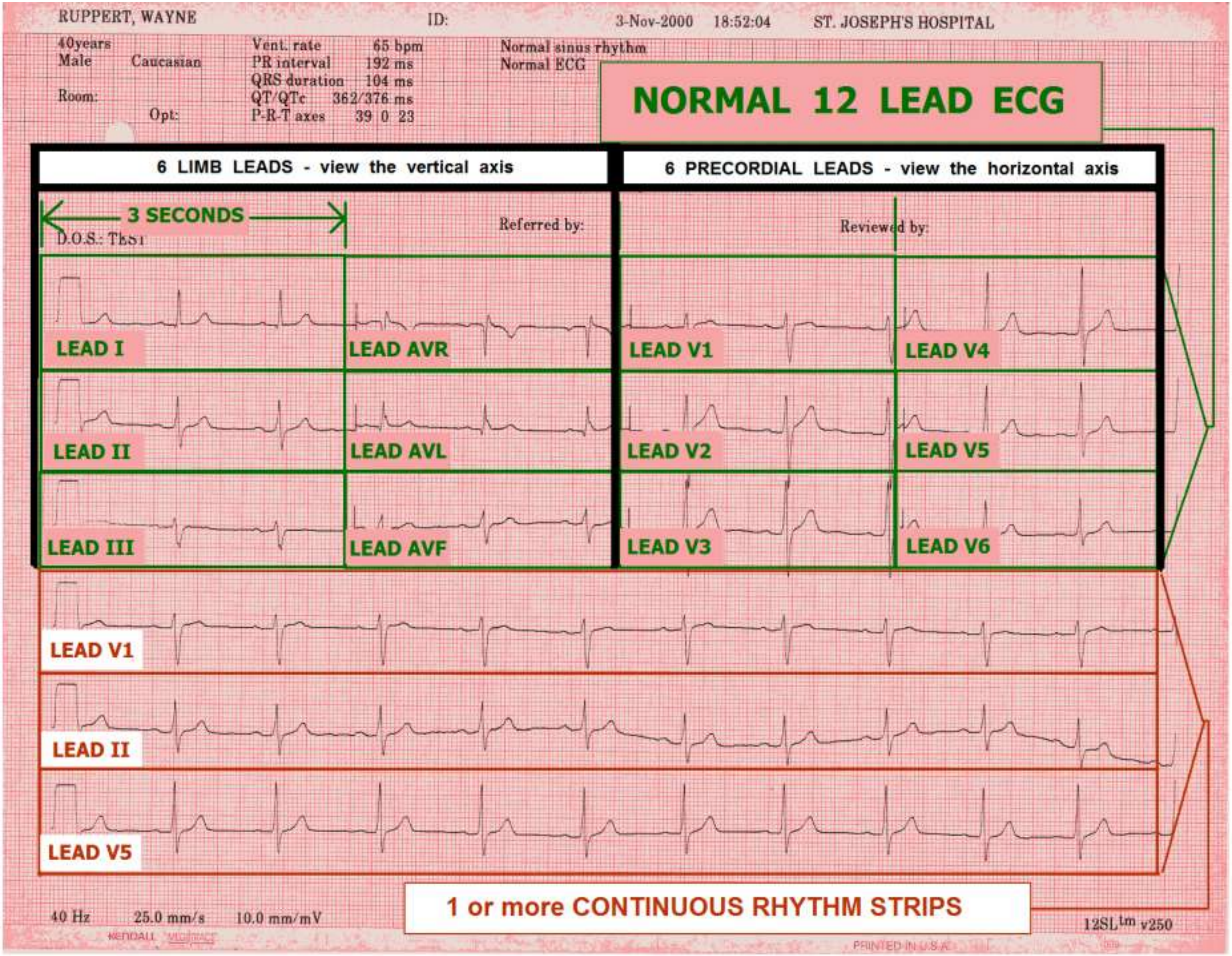
THE HORIZONTAL AXIS REPRESENTS TIME . . .

STANDARD SPEED FOR RECORDING ADULT EKGs = 25 mm / SECOND

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

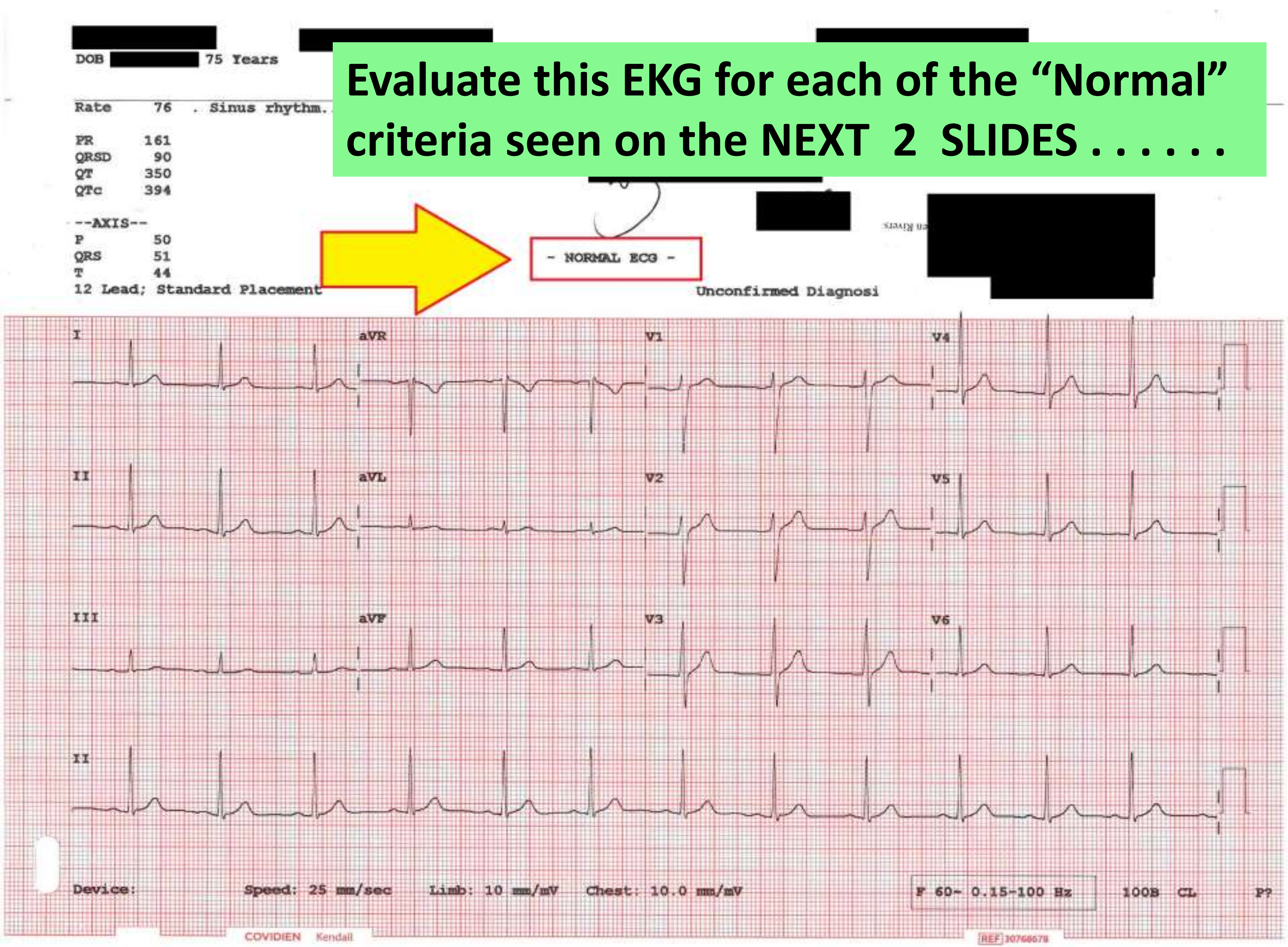
5 SMALL BOXES = .20 SECONDS, or 200 MILLISECONDS (200 ms)





RUPPERT, WAYNE
ID:
3-Nov-2000 18:52:04
ST. JOSEPH'S HOSPITAL
40years
Male Caucasian
Room:
Opt:
Vent. rate 65 bpm
PR interval 192 ms
QRS duration 104 ms
QT/QTc 362/376 ms
P-R-T axes 39 0 23
Normal sinus rhythm
Normal ECG
NORMAL 12 LEAD ECG
6 LIMB LEADS - view the vertical axis
6 PRECORDIAL LEADS - view the horizontal axis
3 SECONDS
D.O.S.: TEST
Referred by:
Reviewed by:
LEAD I
LEAD AVR
LEAD V1
LEAD V4
LEAD II
LEAD AVL
LEAD V2
LEAD V5
LEAD III
LEAD AVF
LEAD V3
LEAD V6
LEAD V1
LEAD II
LEAD V5
1 or more CONTINUOUS RHYTHM STRIPS
40 Hz
25.0 mm/s
10.0 mm/mV
12SL™ v250
PRINTED IN U.S.A.

**Evaluate this EKG for each of the “Normal” criteria seen on the NEXT 2 SLIDES . . . . . .**



# The Normal 12 Lead EKG

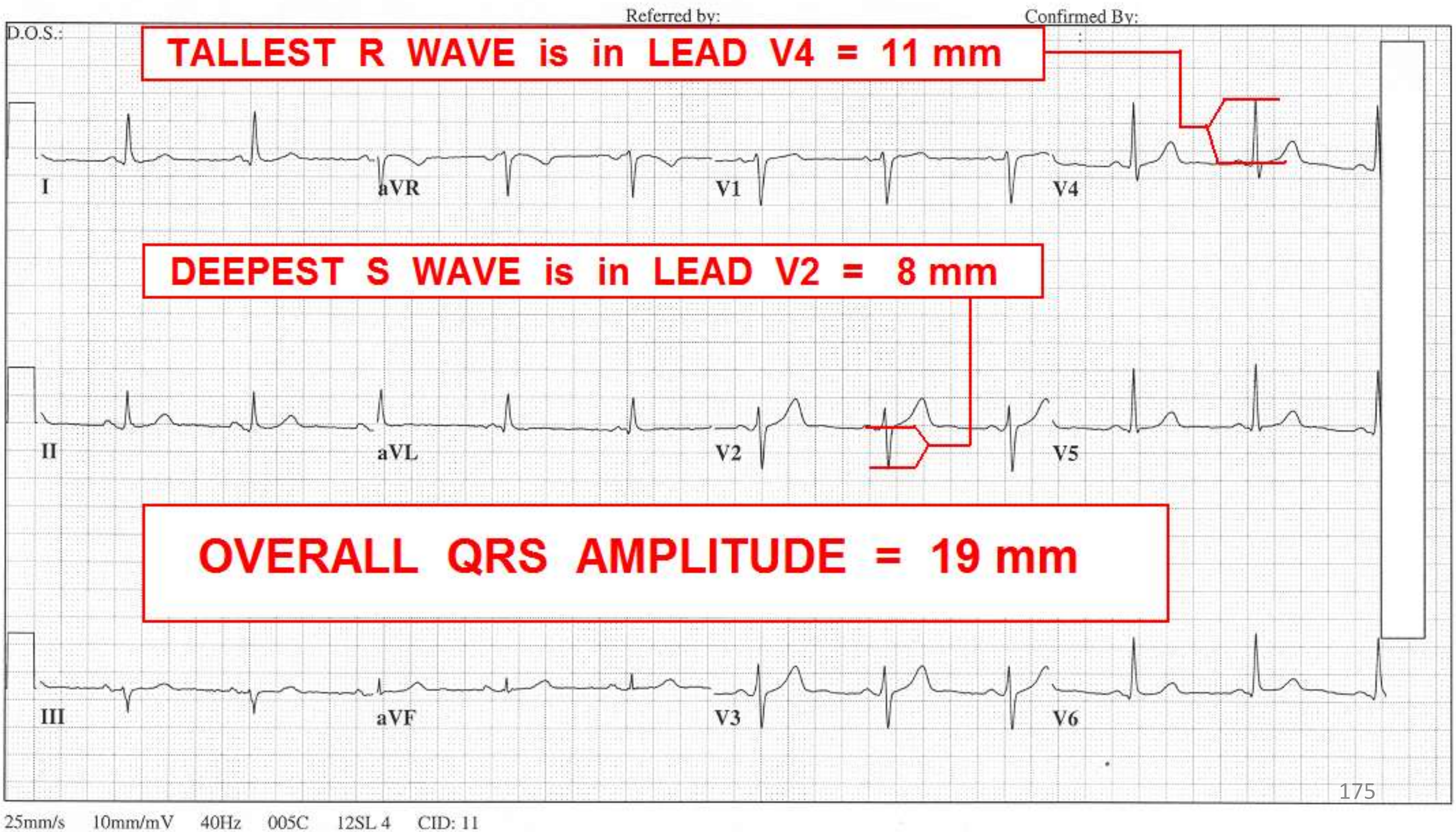
- NSR (rate 60-100, regular rhythm)
- P Waves upright all leads except aVR
- P Waves inverted lead aVR, possibly V1
- QRS upright Leads I, II, III, aVL, aVF, V5, V6
- QRS inverted Leads aVR, V1, V2
- QRS biphasic: Leads V3, V4
- P wave size:  up to 2mm tall, 2.5mm long
- QRS height Limb Leads: 5-15mm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

# The Normal 12 Lead EKG

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

# MEASURING THE "OVERALL QRS AMPLITUDE"

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



# 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

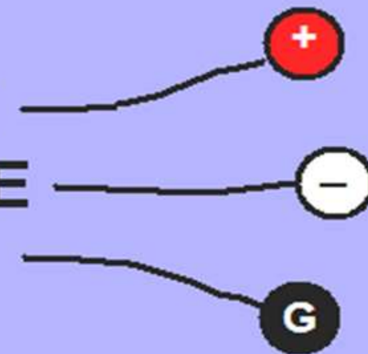
***in EVERY LEAD EXCEPT aVR ! !***

# THE ECG MACHINE

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

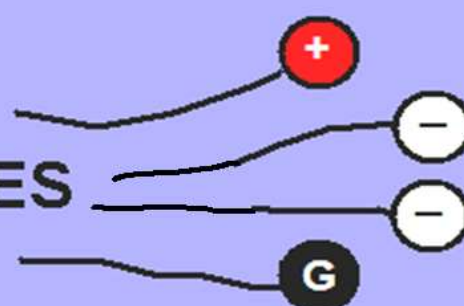
- LEADS I, II, III, and V1, V2, V3, V4, V5, V6

1 POSITIVE ELECTRODE
1 NEGATIVE ELECTRODE
1 GROUND ELECTRODE



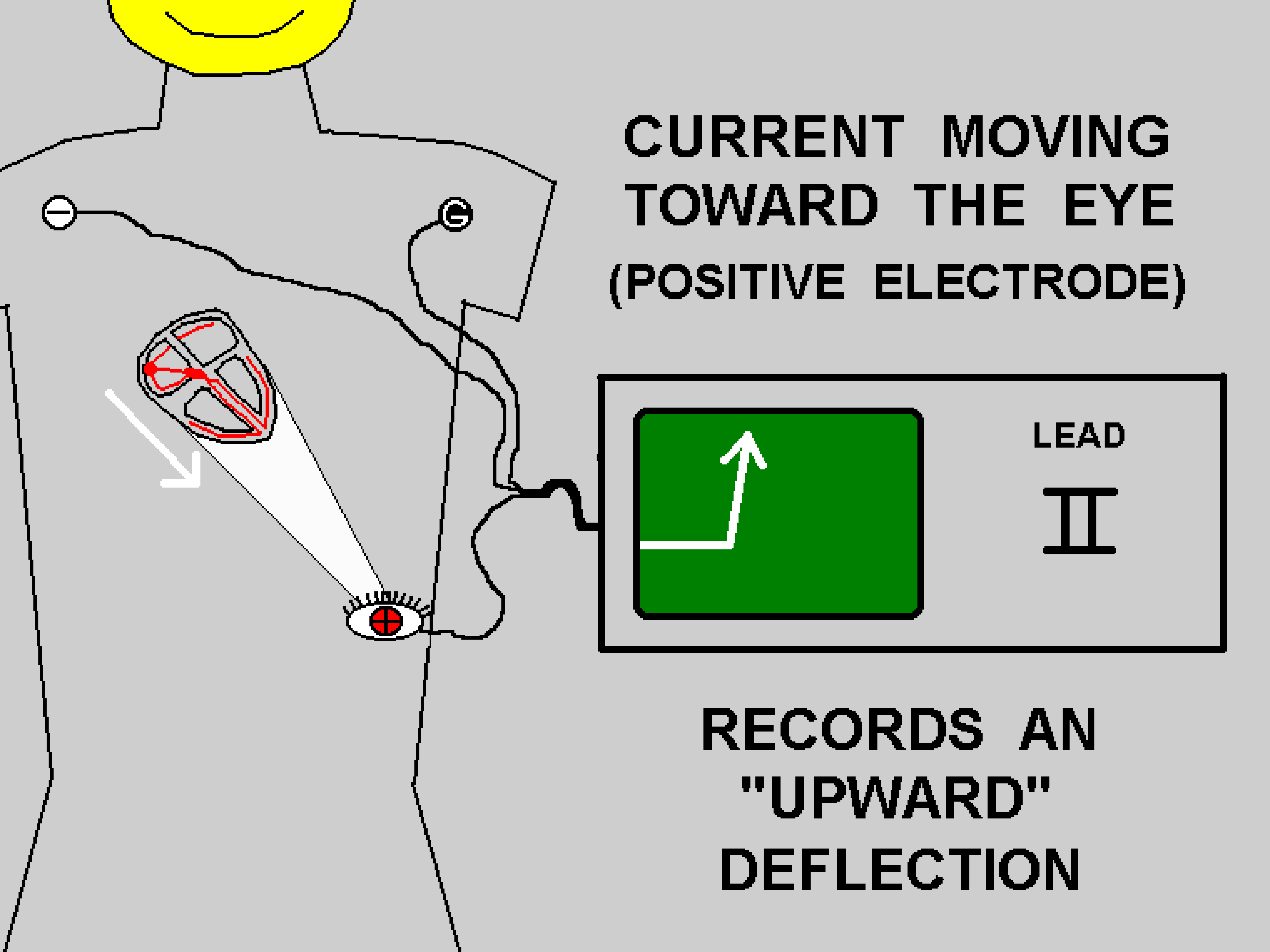

- LEADS AVR, AVL, and AVF

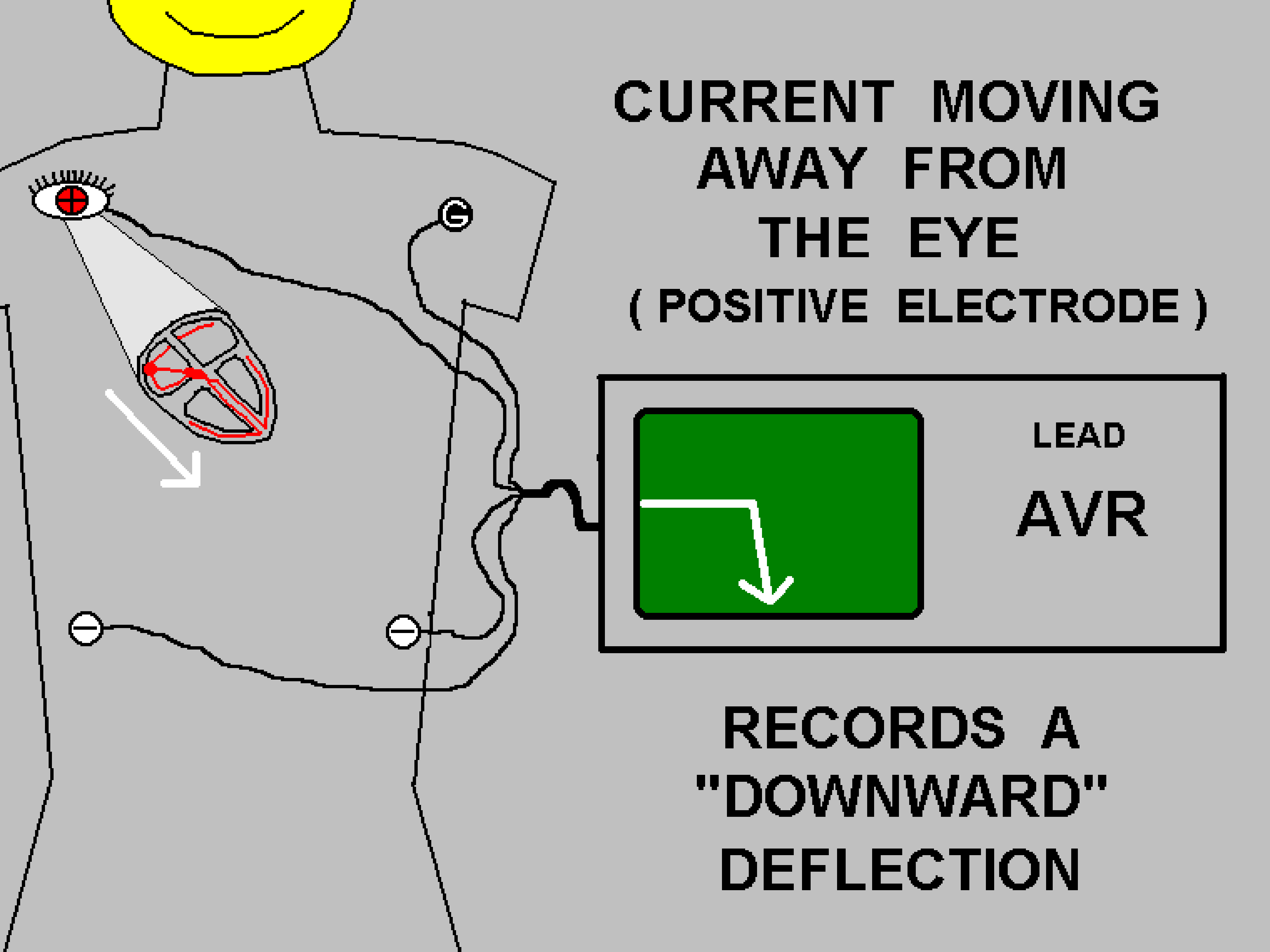
1 POSITIVE ELECTRODE
2 NEGATIVE ELECTRODES
1 GROUND ELECTRODE



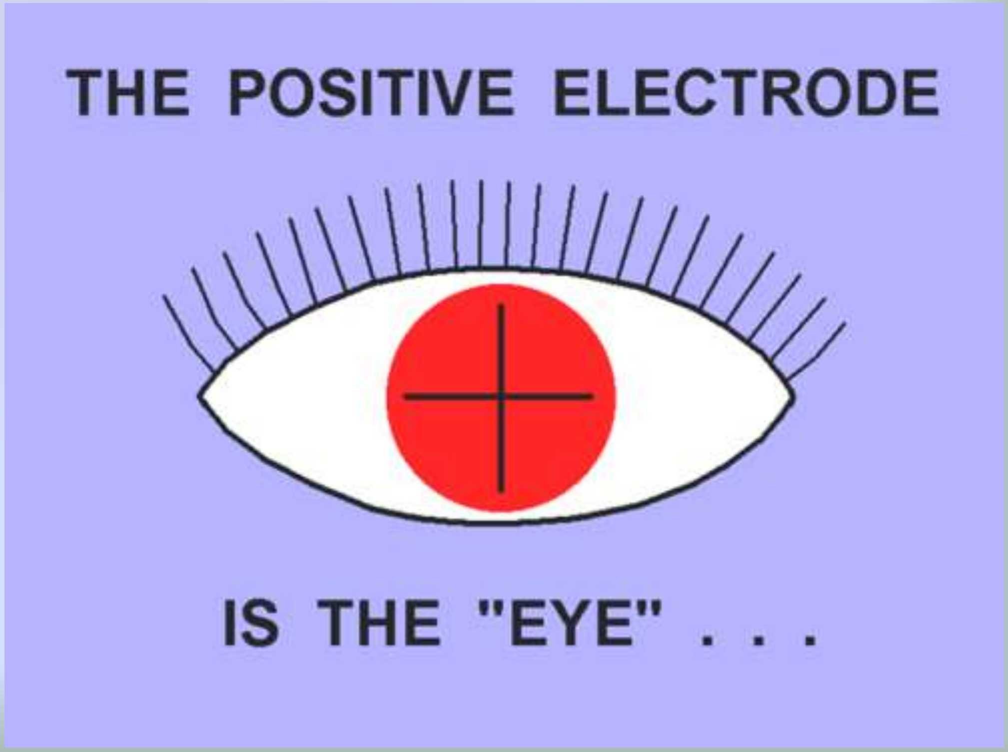
THE POSITIVE ELECTRODE

IS THE "EYE" . . .

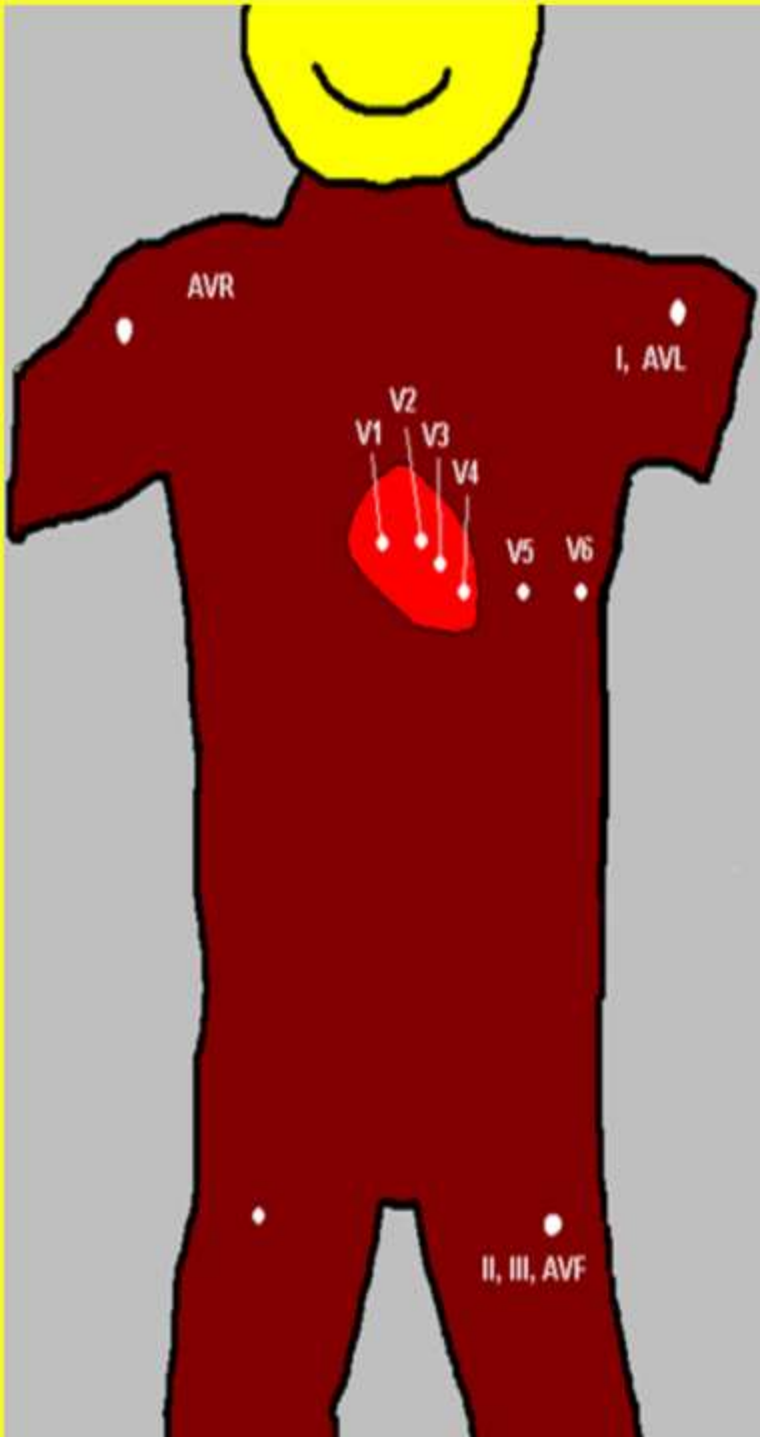

CURRENT MOVING
TOWARD THE EYE
(POSITIVE ELECTRODE)
G
LEAD
II
RECORDS AN
"UPWARD"
DEFLECTION


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

# *What part of the HEART does each lead SEE ?*



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




# AREAS VIEWED by 12 LEAD ECG

AVR

AVL, I

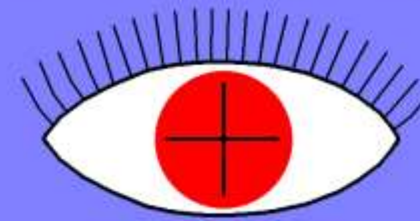
V1, V2

V3, V4

V5, V6

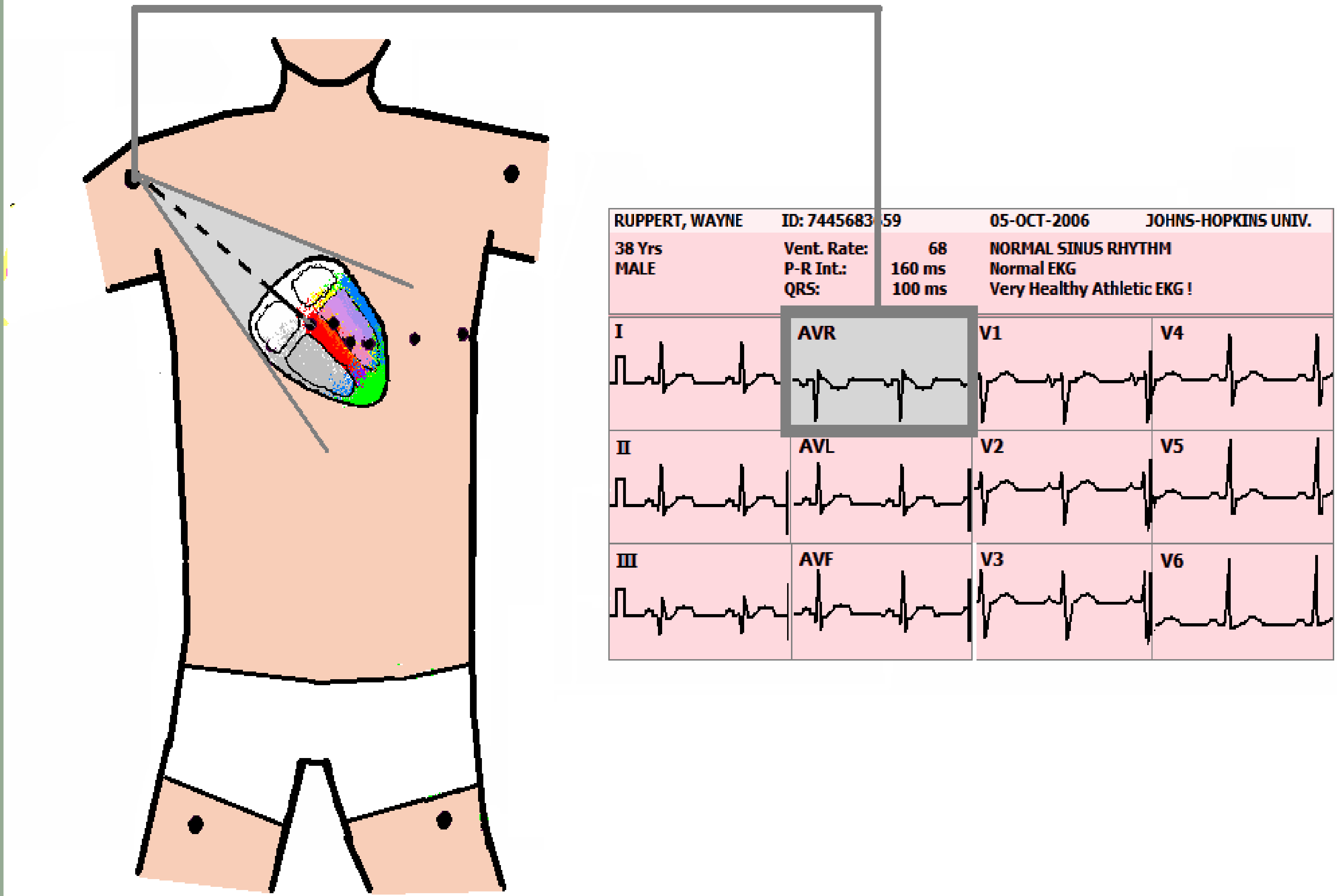
II, III, AVF

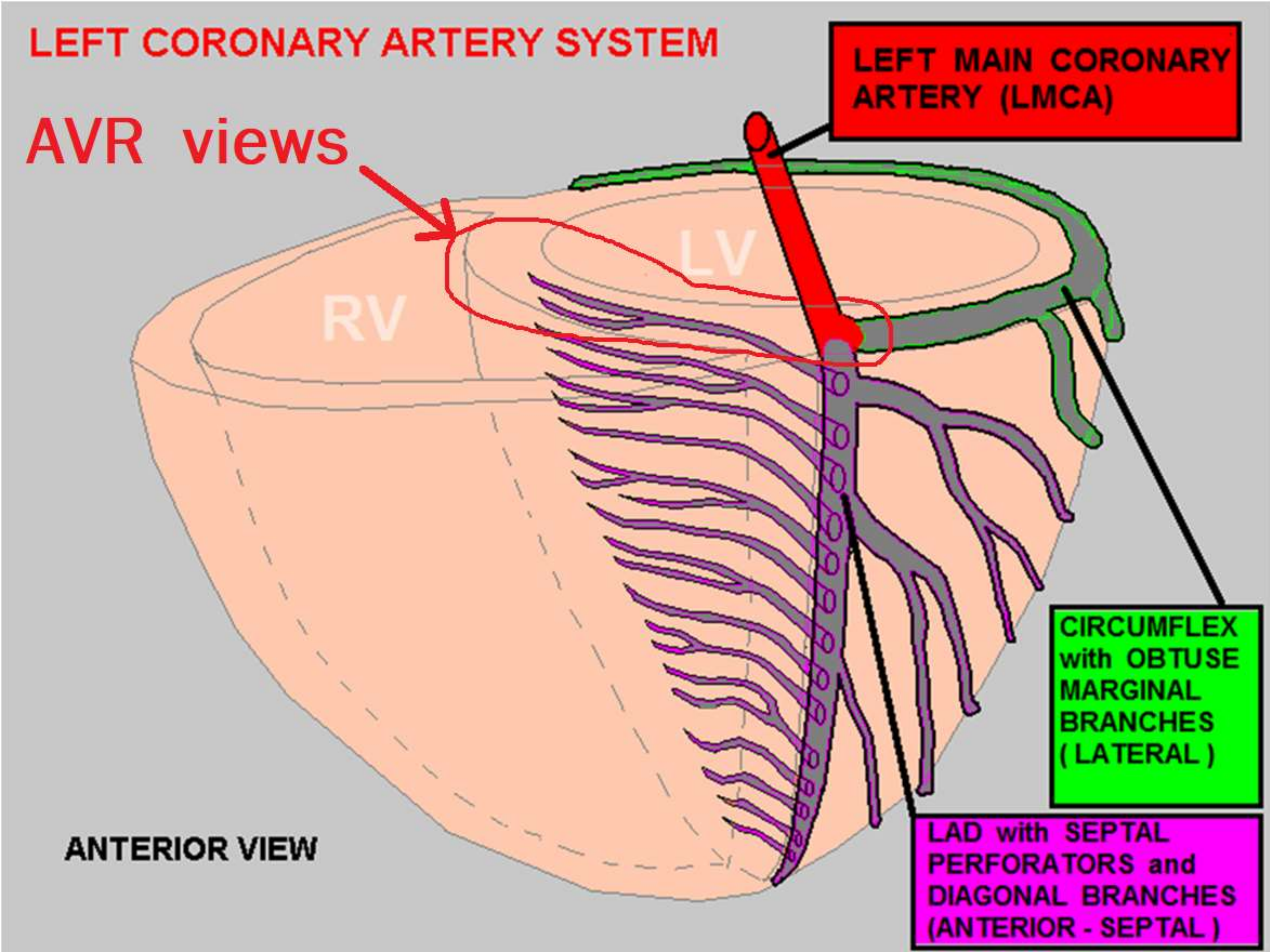
THE POSITIVE ELECTRODE



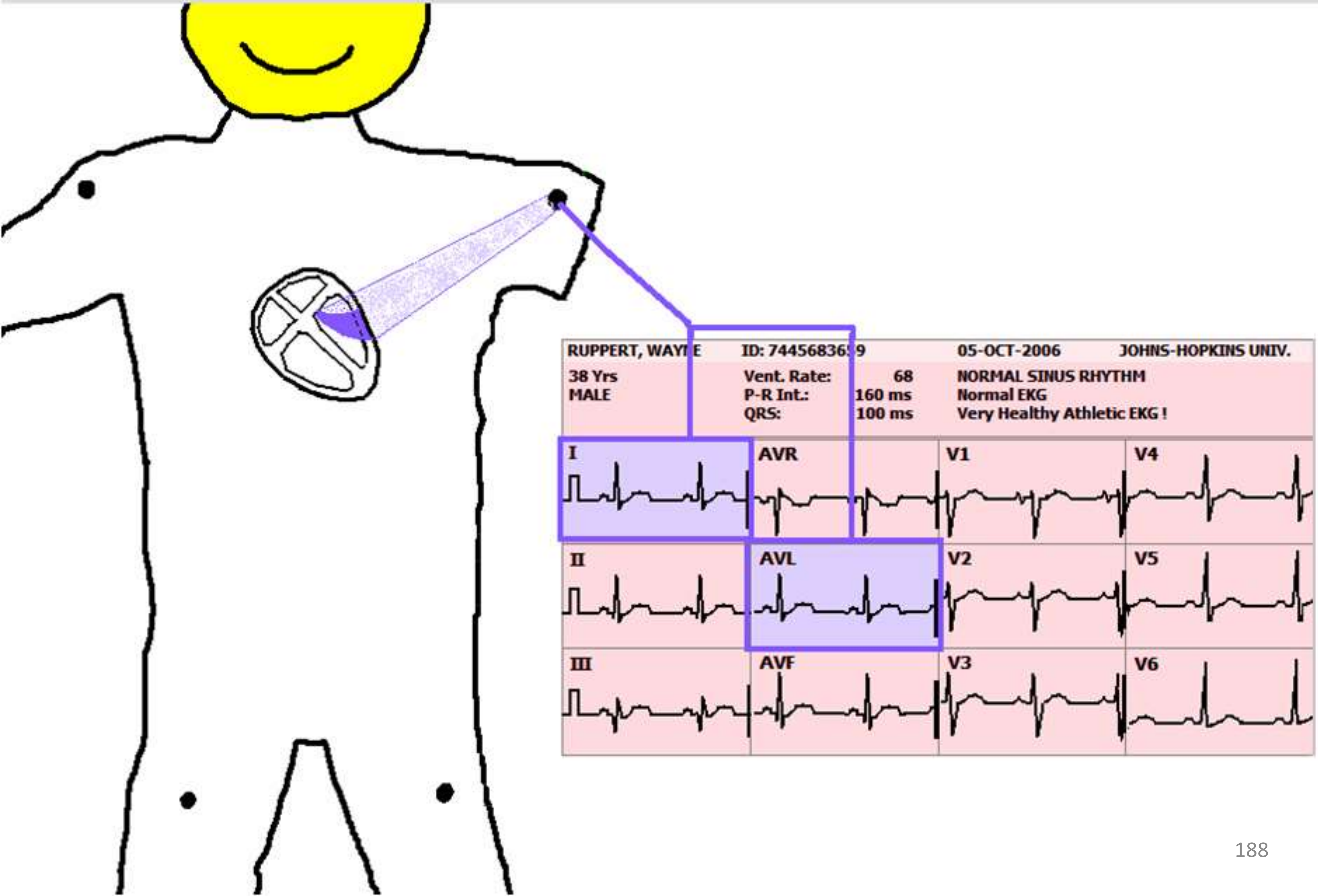
IS THE "EYE" . . .

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



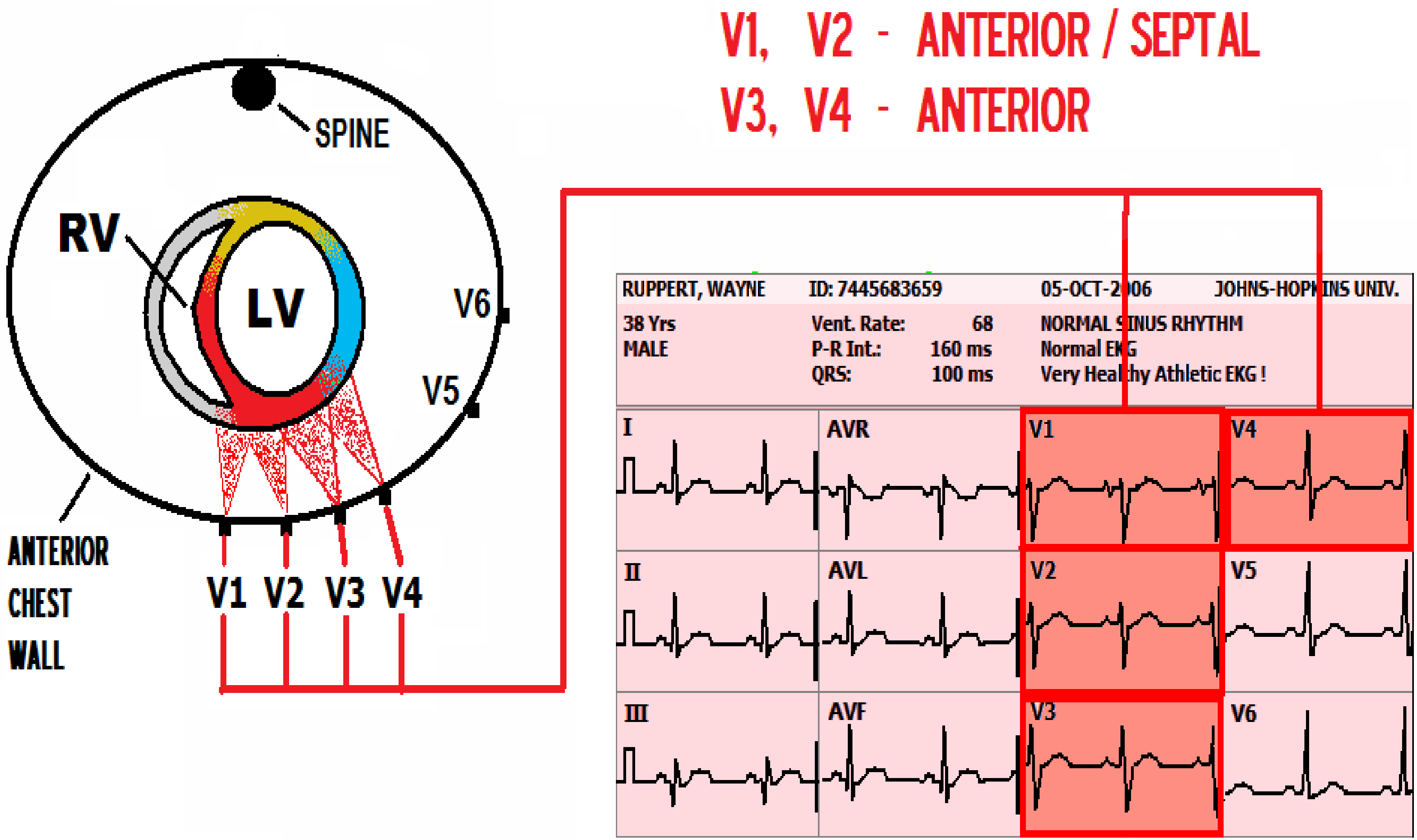

LEFT CORONARY ARTERY SYSTEM
LEFT MAIN CORONARY ARTERY (LMCA)
AVR views
LV
RV
CIRCUMFLEX with OBTUSE MARGINAL BRANCHES ( LATERAL )
LAD with SEPTAL PERFORATORS and DIAGONAL BRANCHES (ANTERIOR - SEPTAL )
ANTERIOR VIEW

# LEADS I and aVL VIEW the LATERAL - ANTERIOR WALL



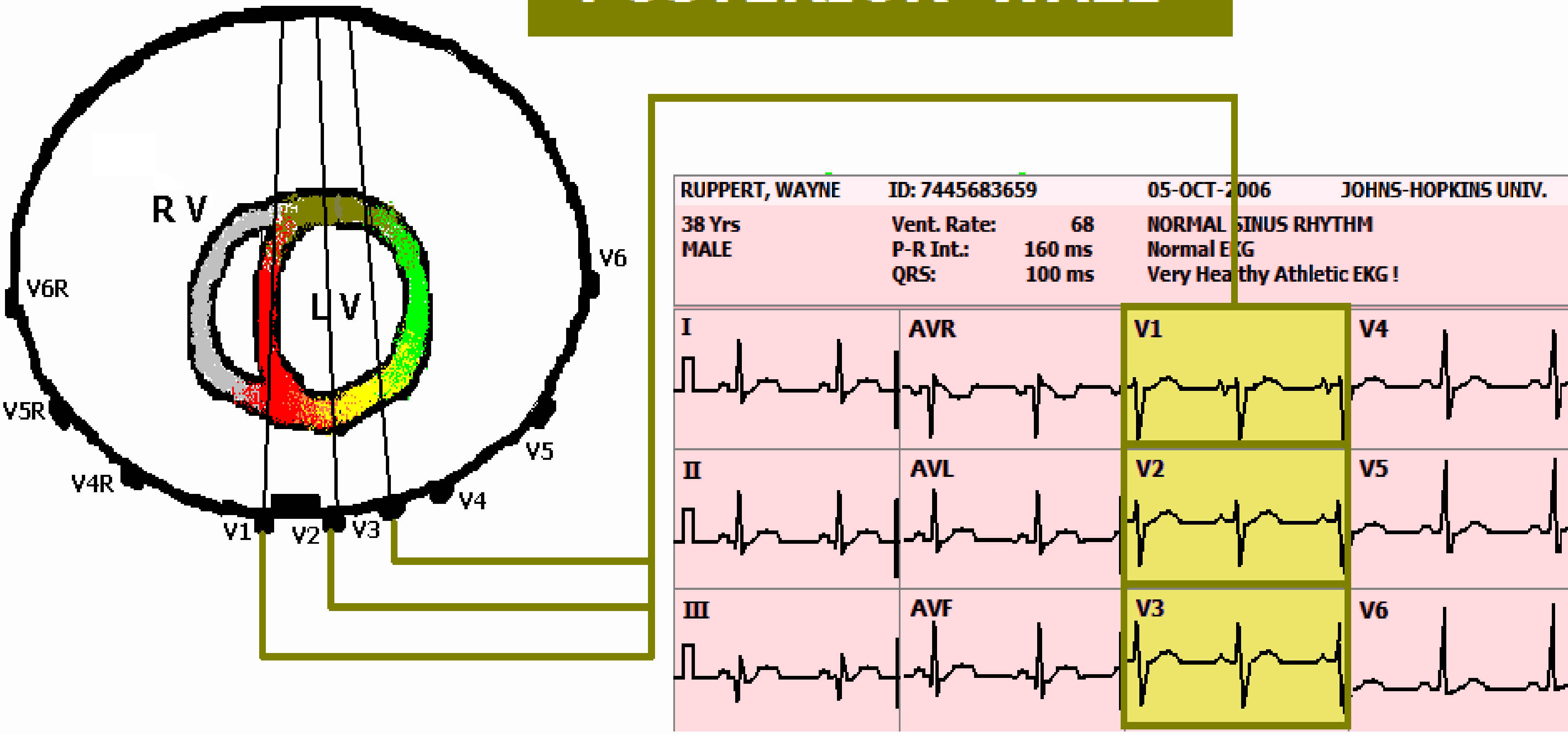
# V1 - V4 VIEW THE ANTERIOR-SEPTAL WALL

## of the LEFT VENTRICLE



# LEADS V1 - V3 *view the*

# POSTERIOR WALL

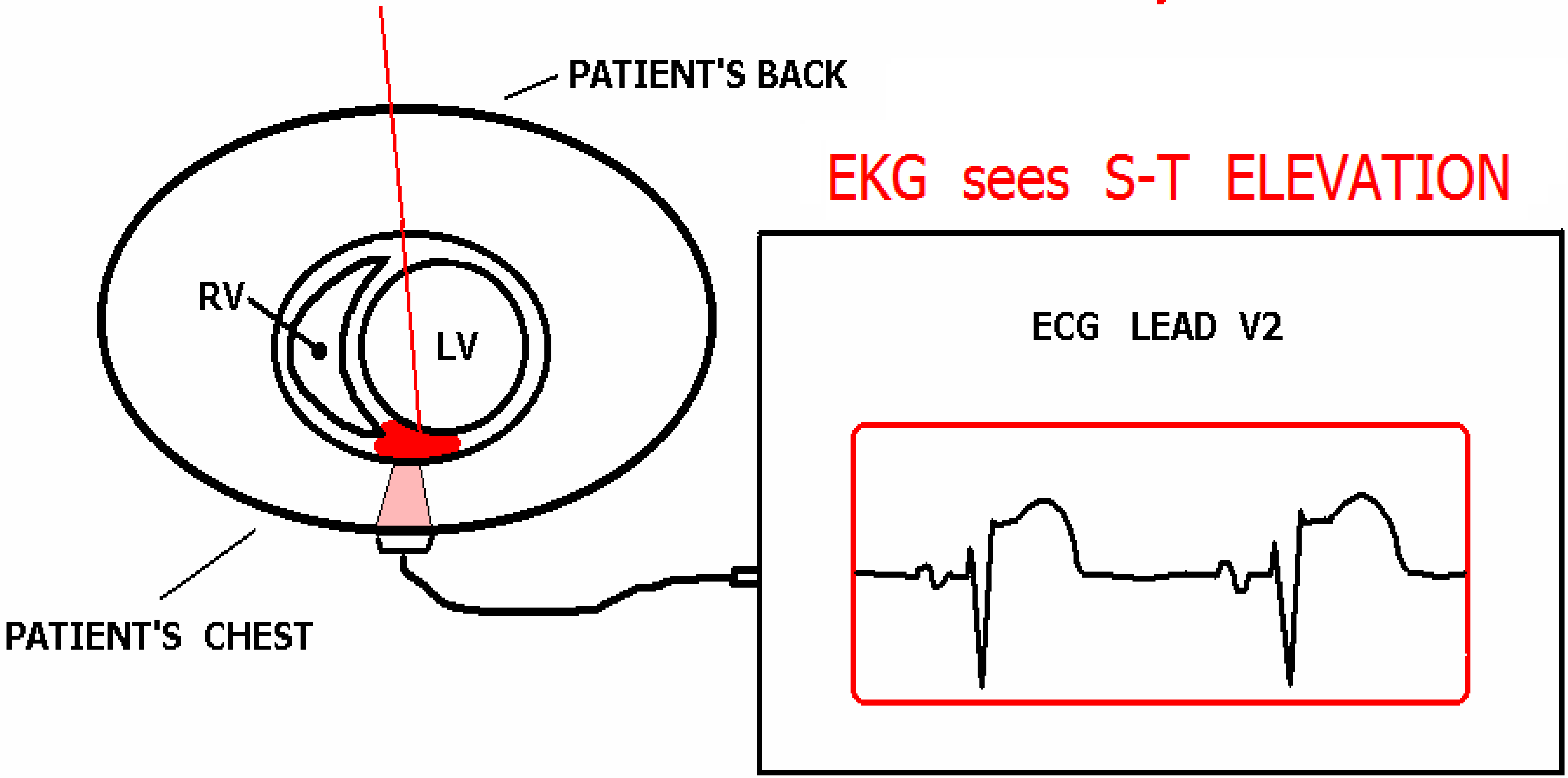



## *via* RECIPROCAL CHANGES.

# HOW EKG VIEWS INDICATIVE CHANGES

**EXAMPLE:**

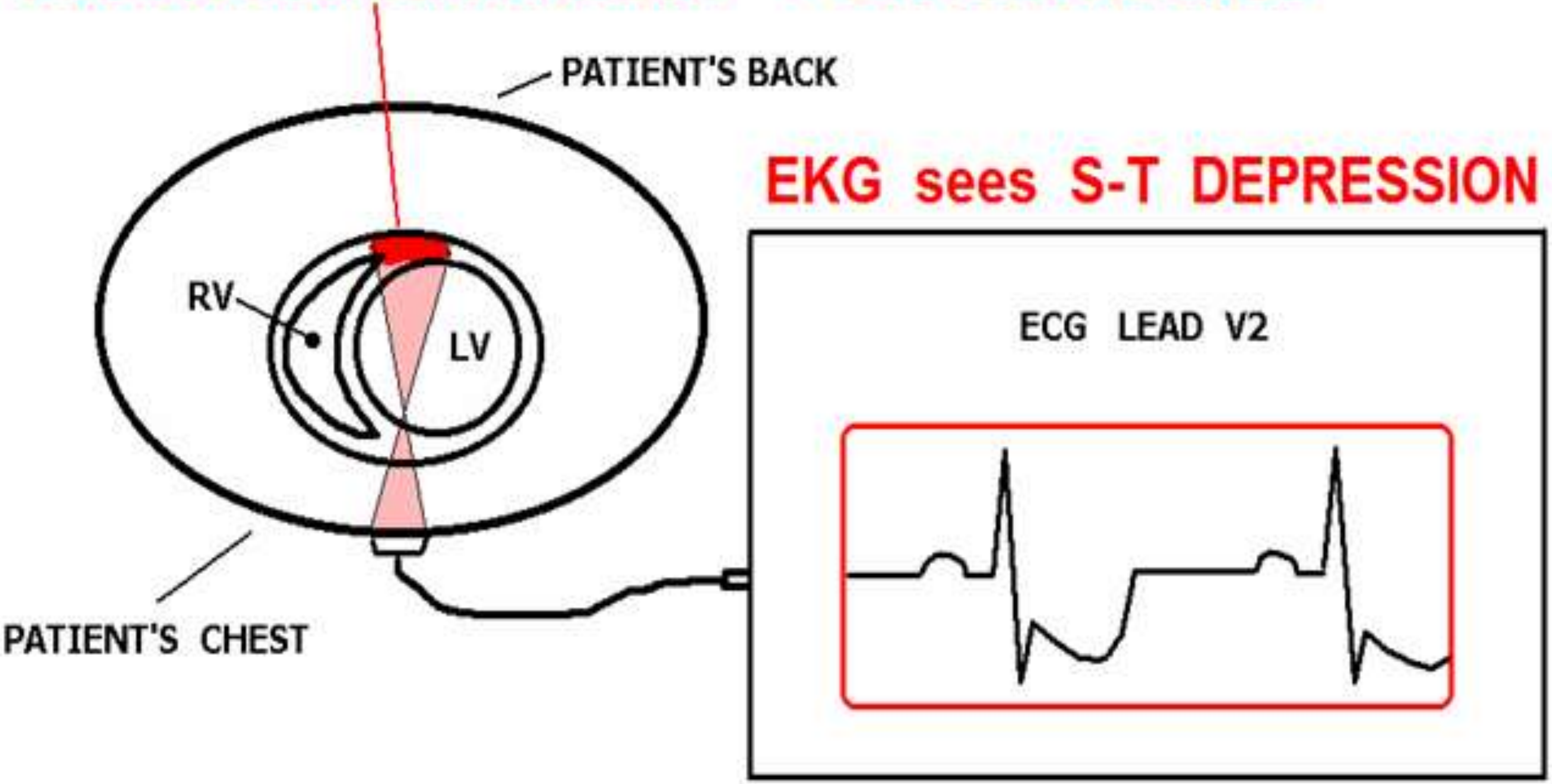
**AREA OF ACUTE INFARCTION - ANTERIOR/SEPTAL**



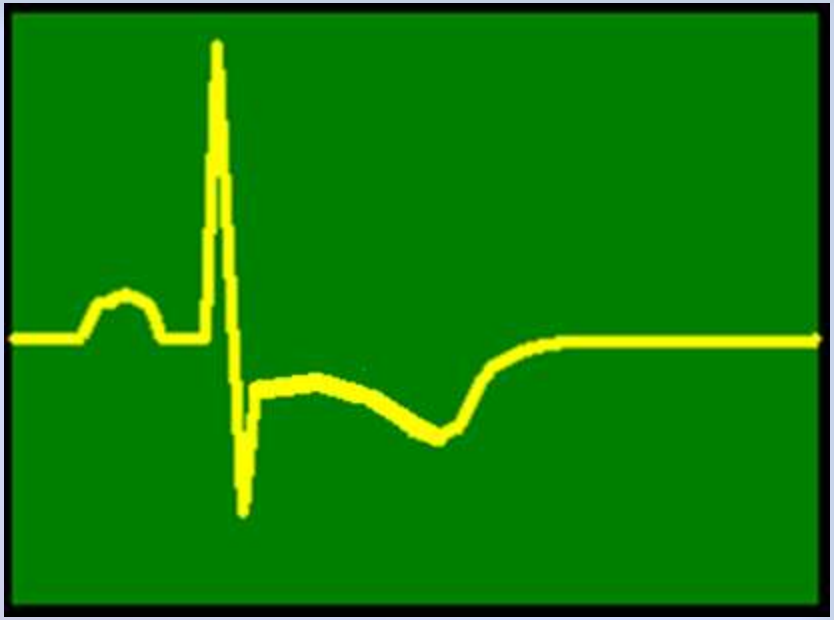
# HOW EKG VIEWS RECIPROCAL CHANGES

**EXAMPLE:**

**AREA OF ACUTE INFARCTION - POSTERIOR WALL**



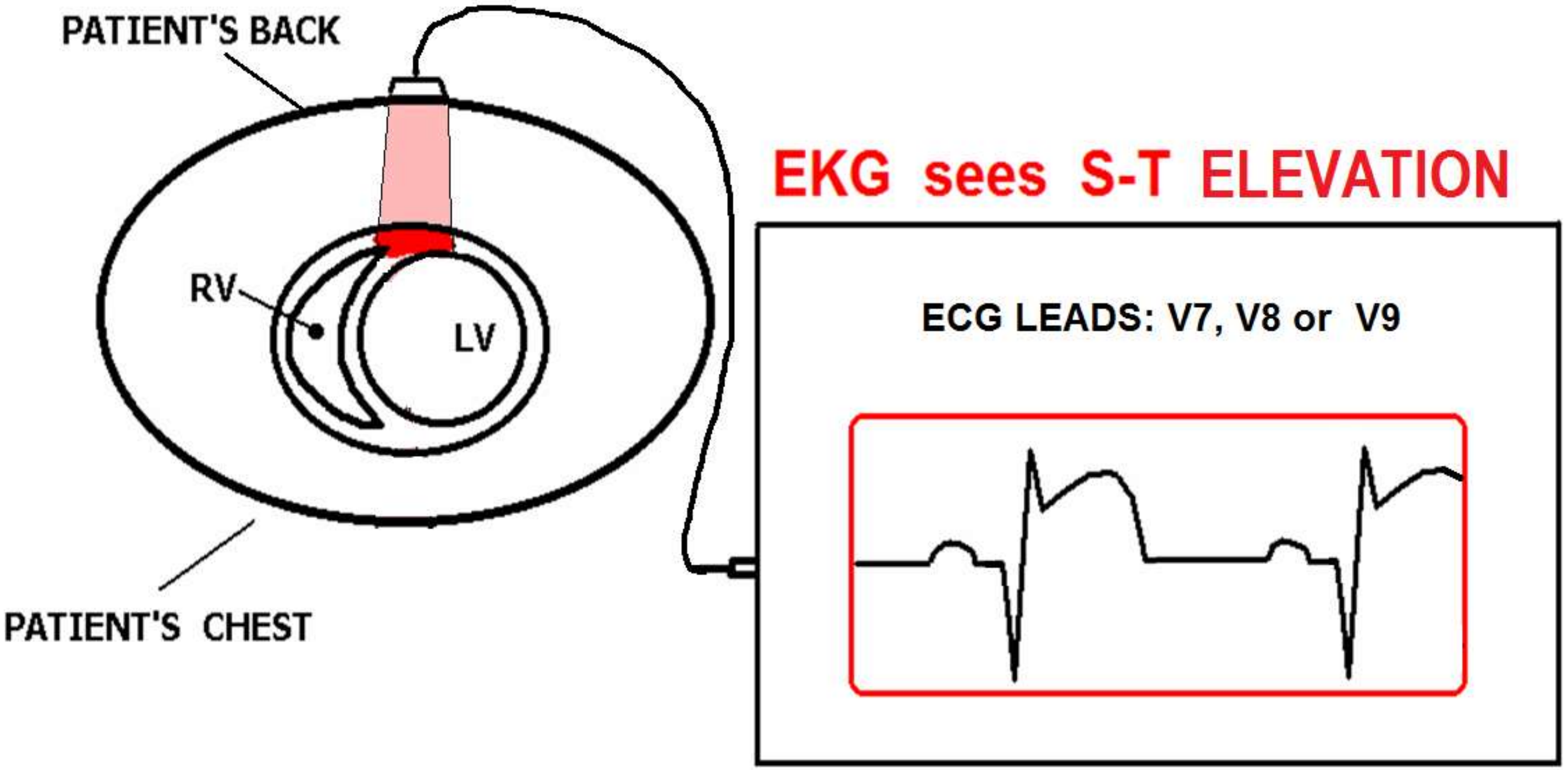
# ST Depression can indicate:



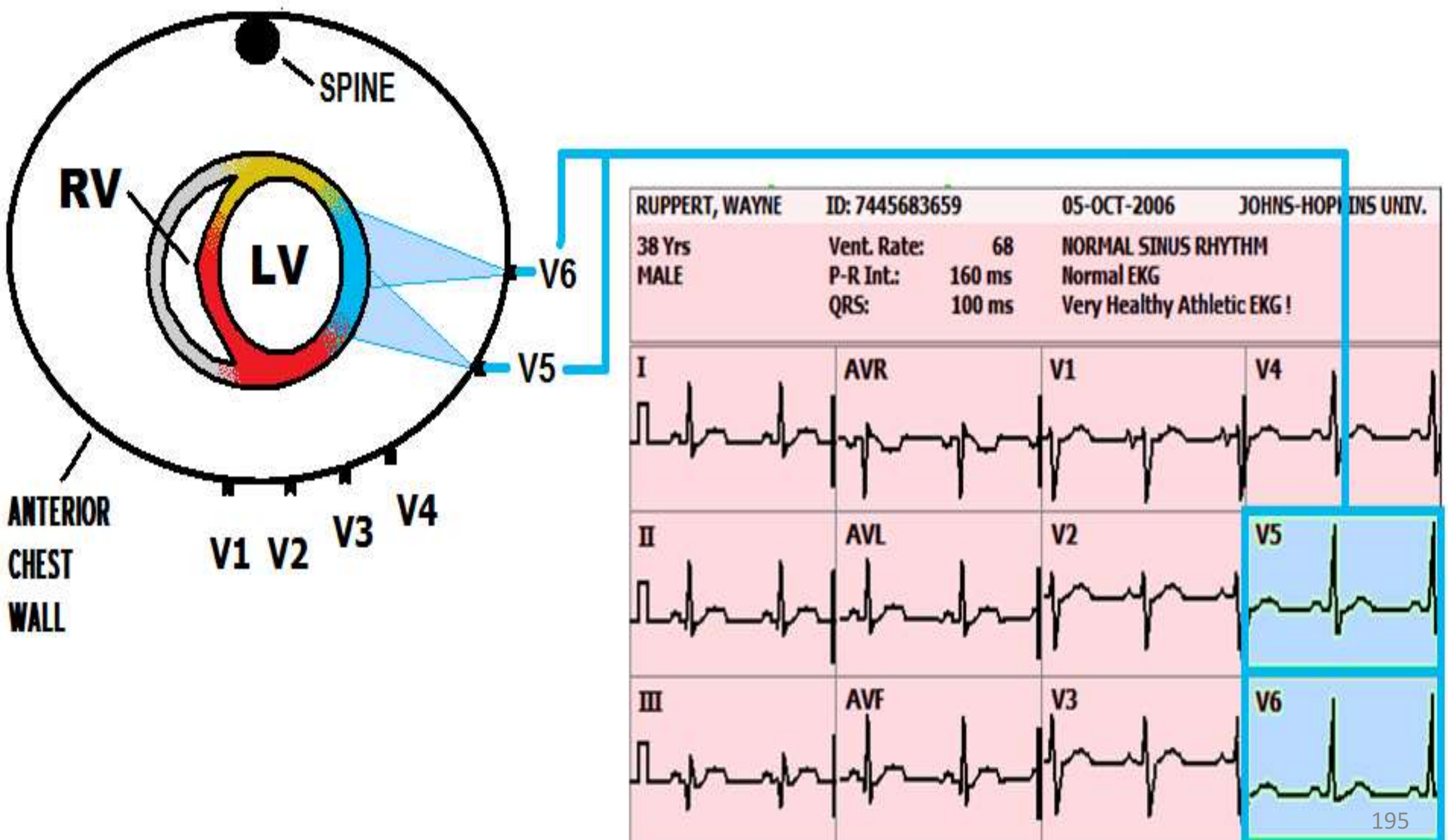
- ISCHEMIA
- “Partial-wall thickness” MI  (NSTEMI)
- STEMI (in the opposite side of the heart)
- Other things (like RBBB, certain medications, etc).

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

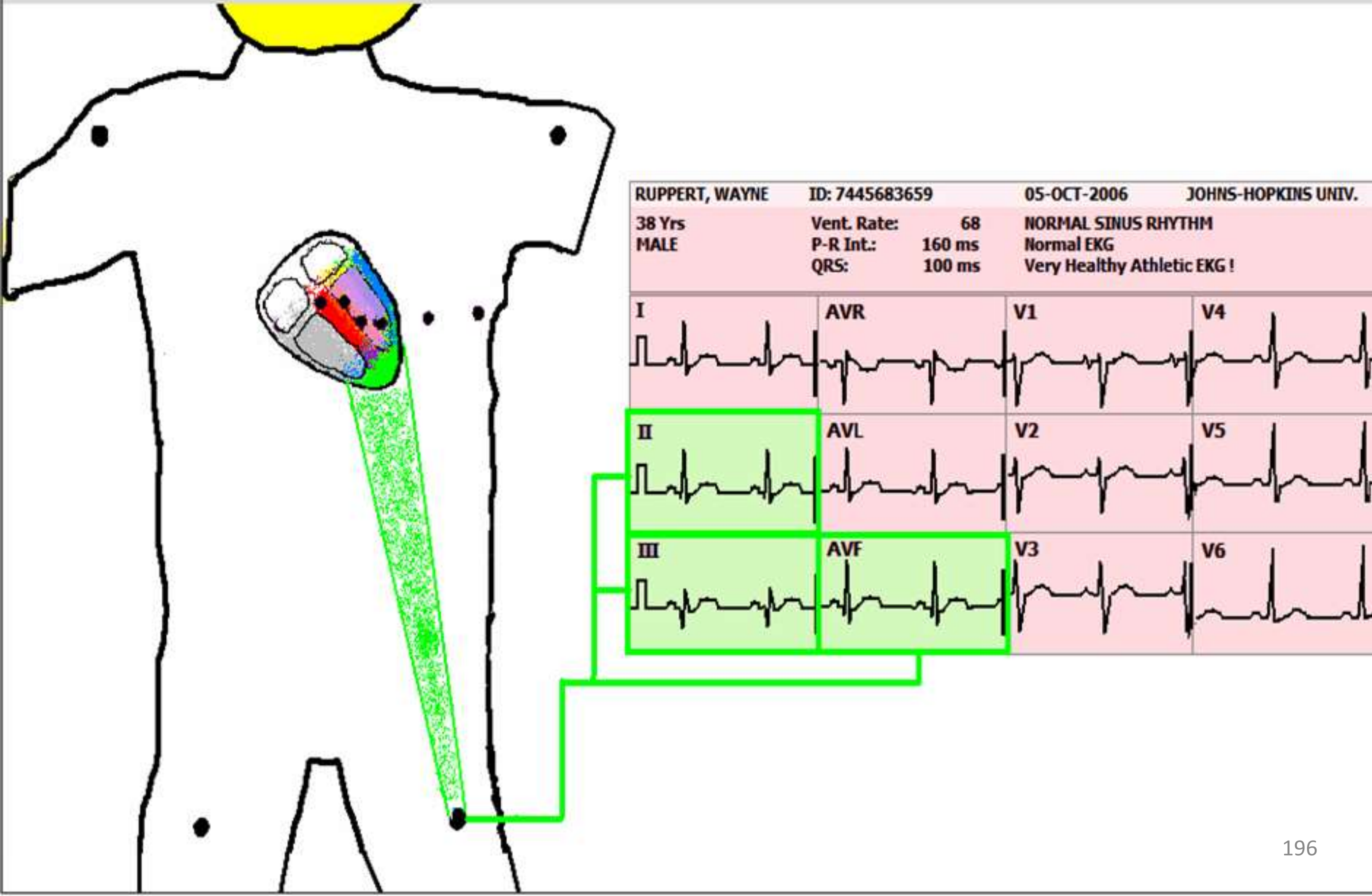
## ACUTE POSTERIOR WALL MI . . . . .



# V5 - V6 VIEW THE LATERAL WALL
## of the LEFT VENTRICLE

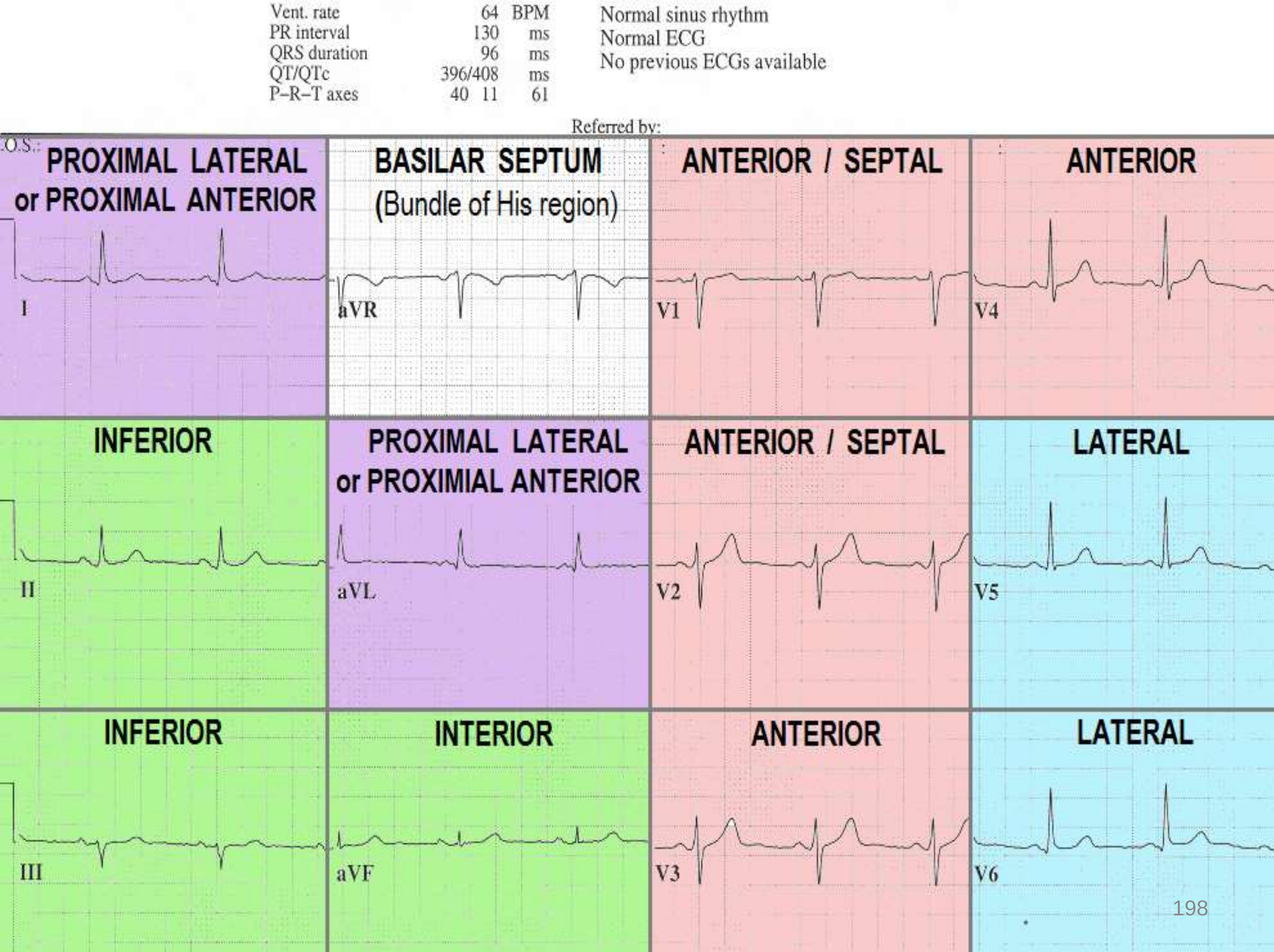


# LEADS II, III, and aVF VIEW
## INFERIOR WALL of the LEFT VENTRICLE

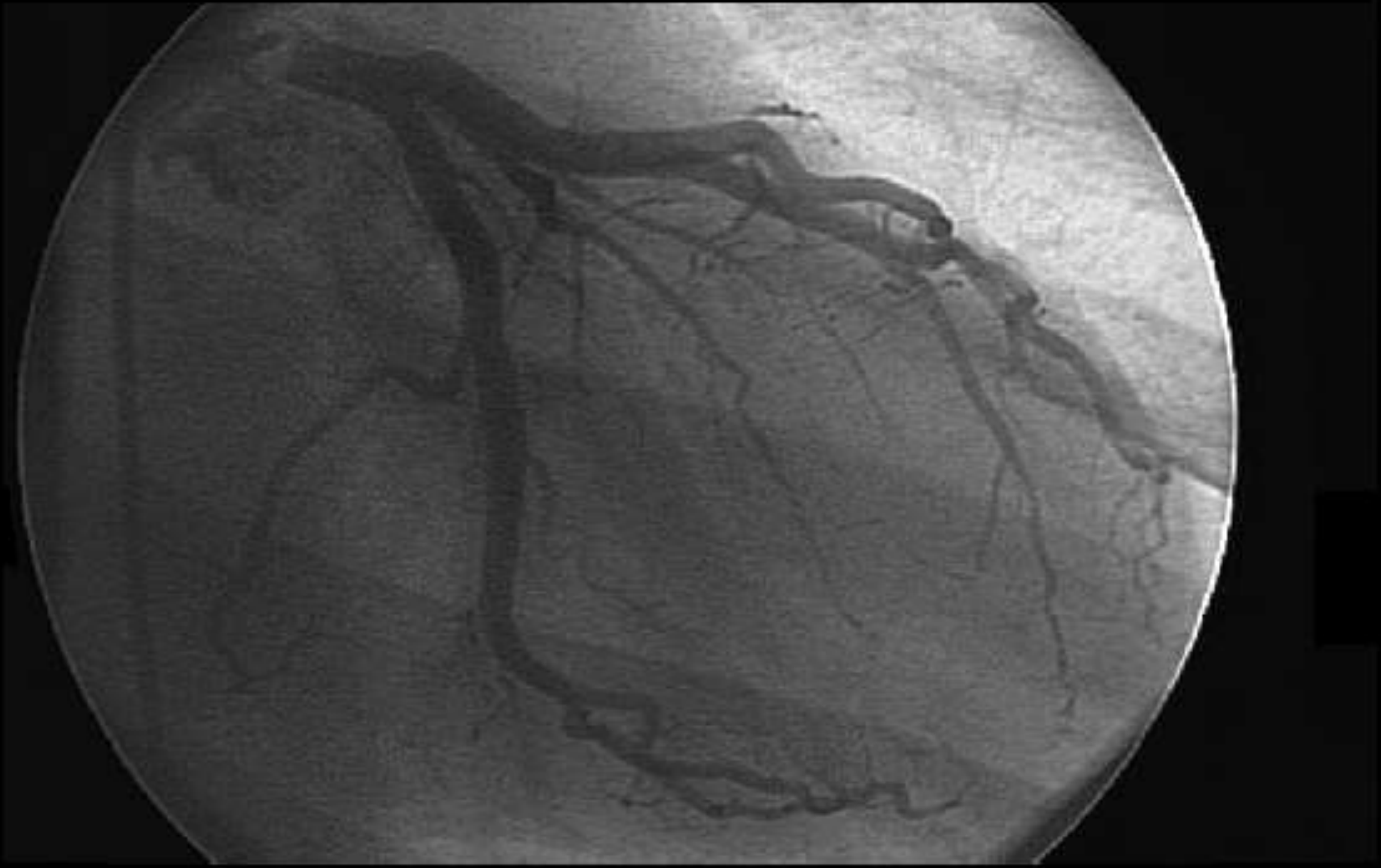



# AREAS VIEWED by 12 LEAD ECG

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


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

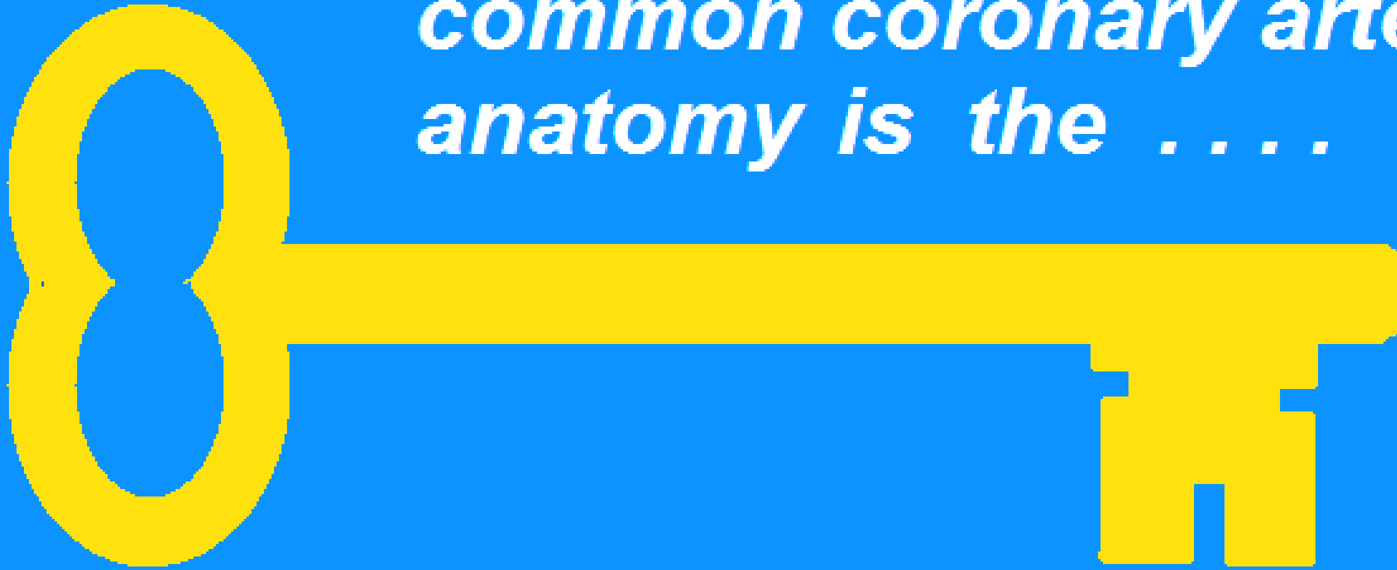
THE CORONARY



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 !"*

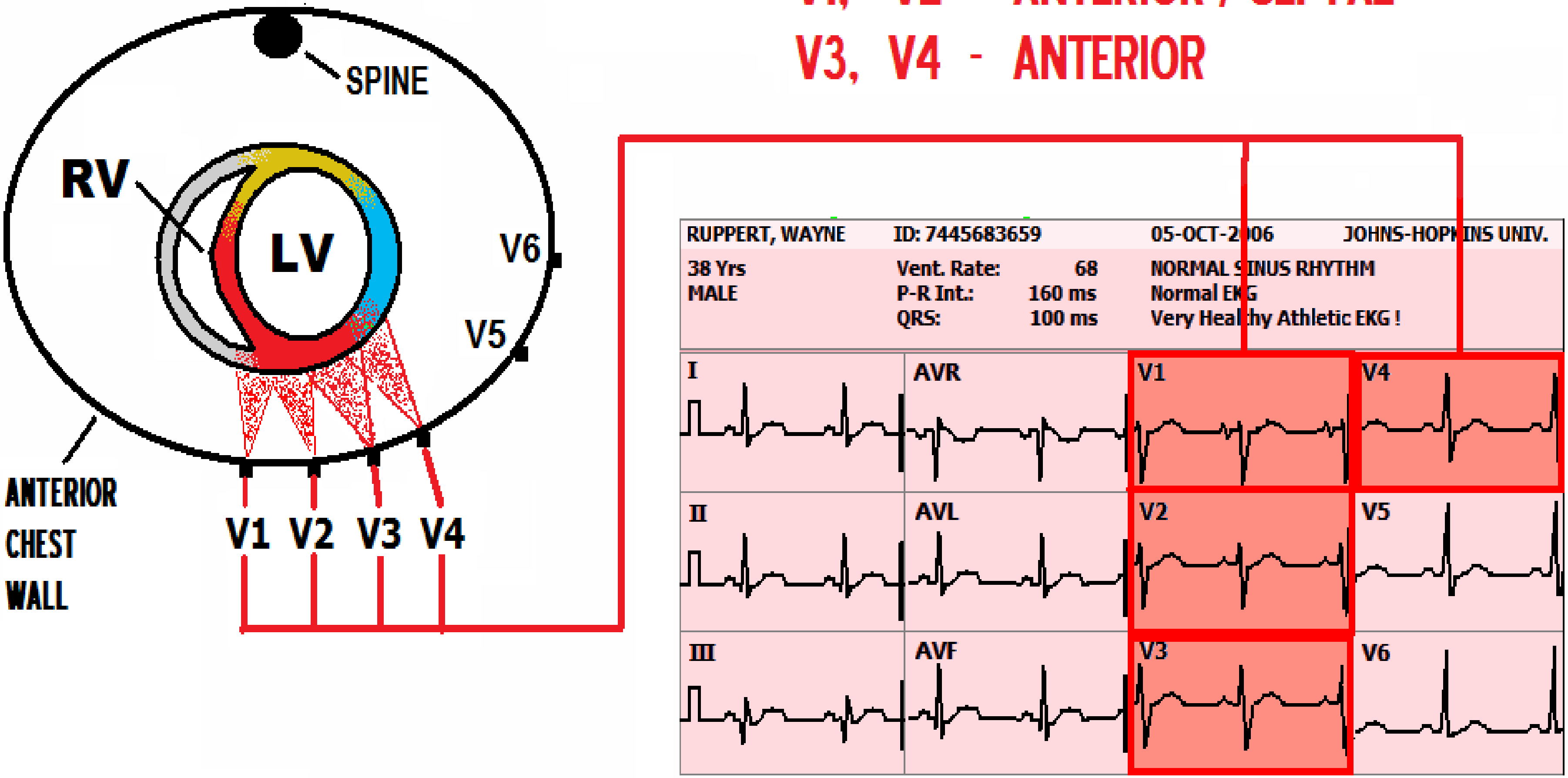
# The 12 Lead ECG becomes your "crystal ball !!"

# INTERPRET THE EKG, THEN:

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

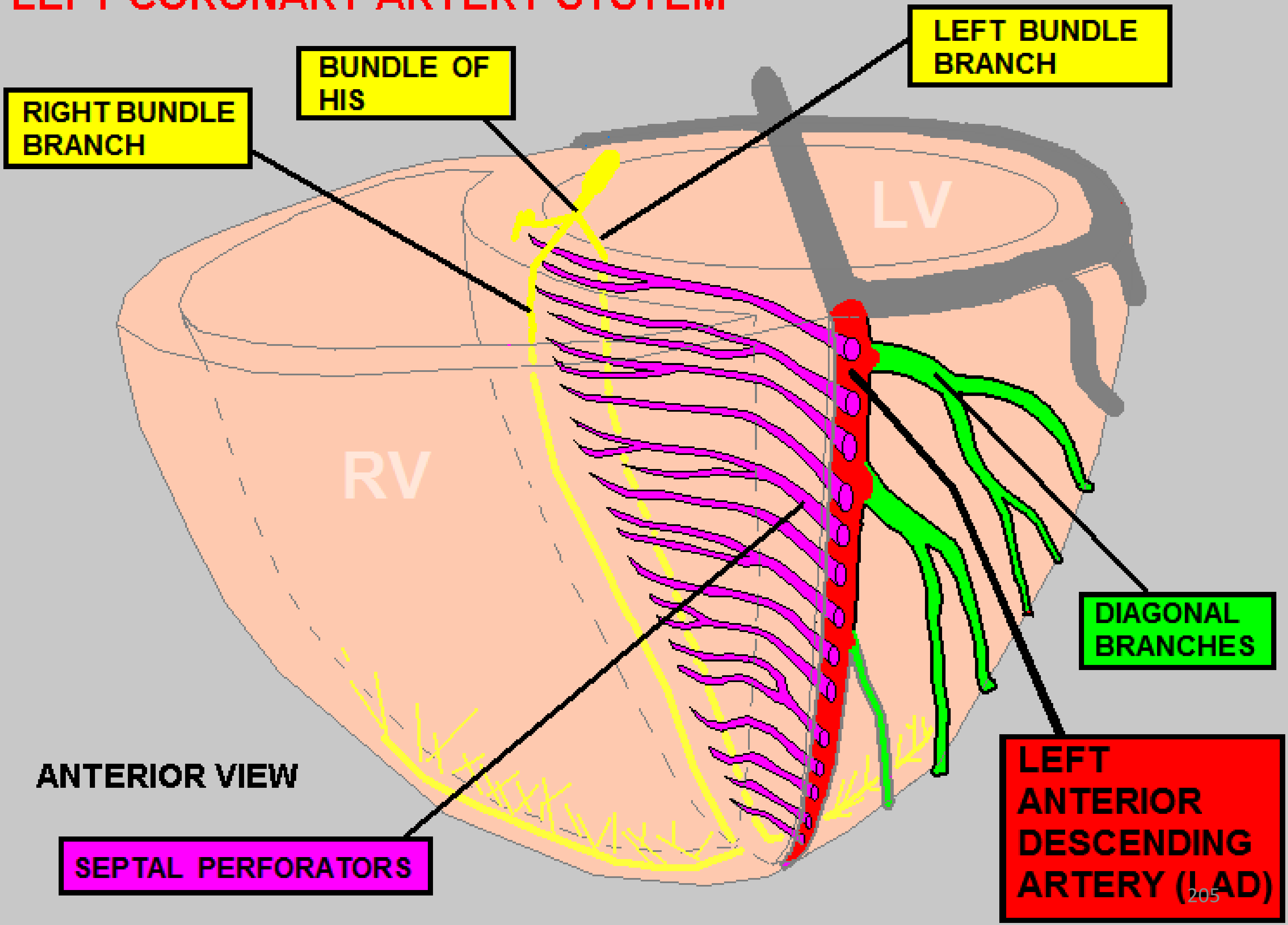
# V1 - V4 VIEW THE ANTERIOR-SEPTAL WALL
## of the LEFT VENTRICLE

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

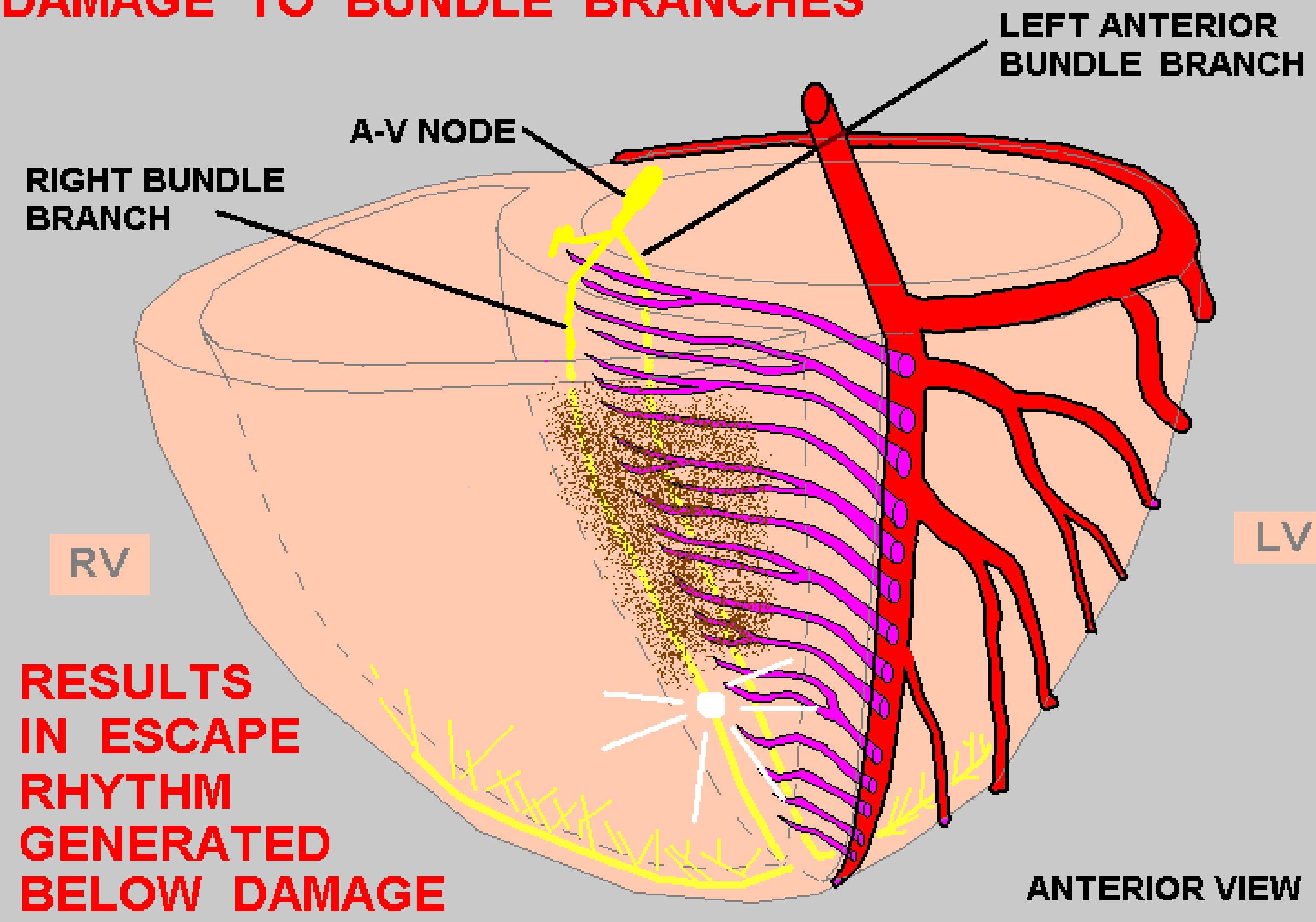



**Which Coronary Artery typically Supplies the ANTERIOR WALL ?**

# LEFT CORONARY ARTERY SYSTEM



# DAMAGE TO BUNDLE BRANCHES

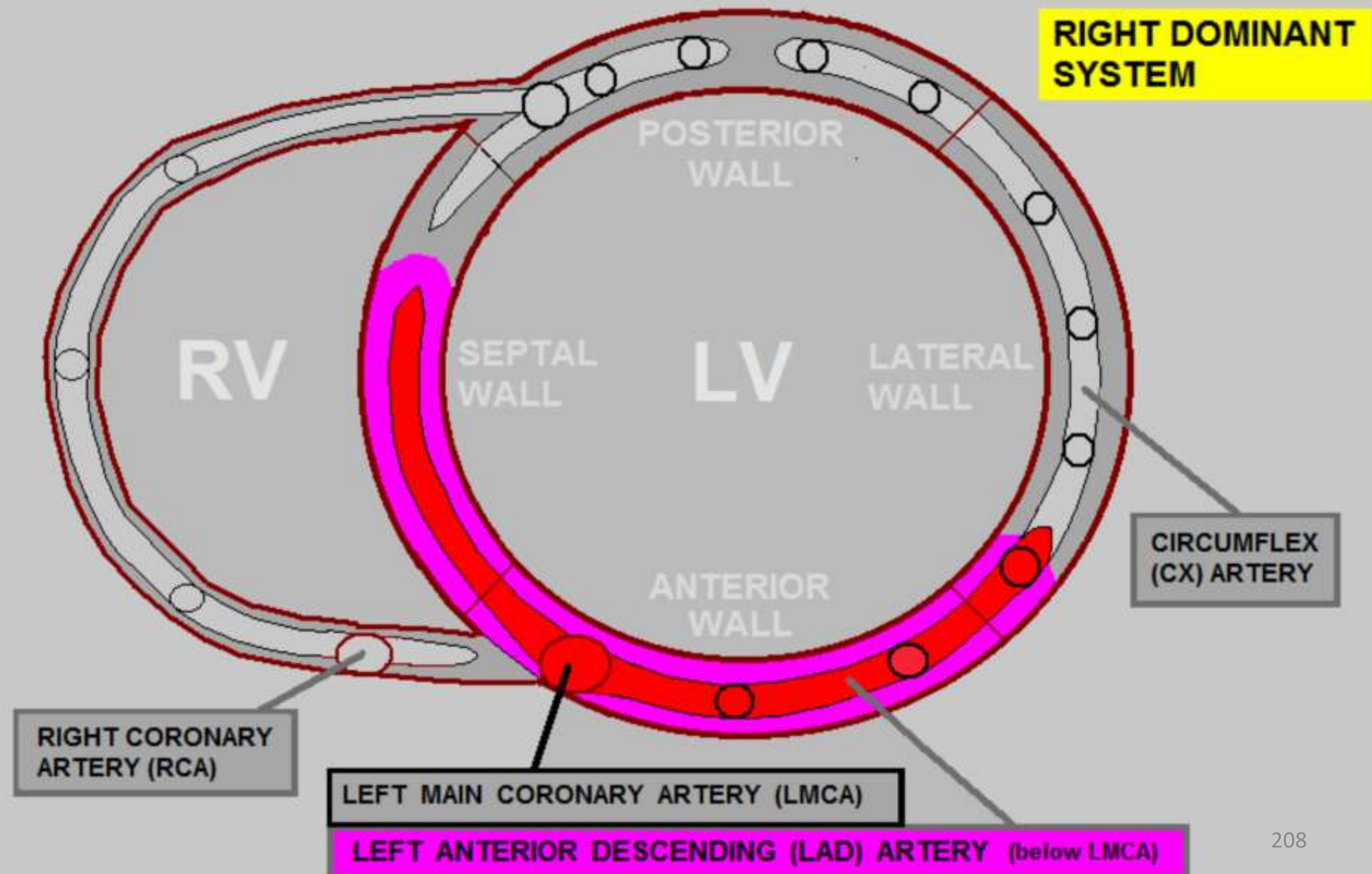



**RESULTS IN ESCAPE RHYTHM GENERATED BELOW DAMAGE**

cutaway view of the

# LEFT ANTERIOR DESCENDING ARTERY (LAD)

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



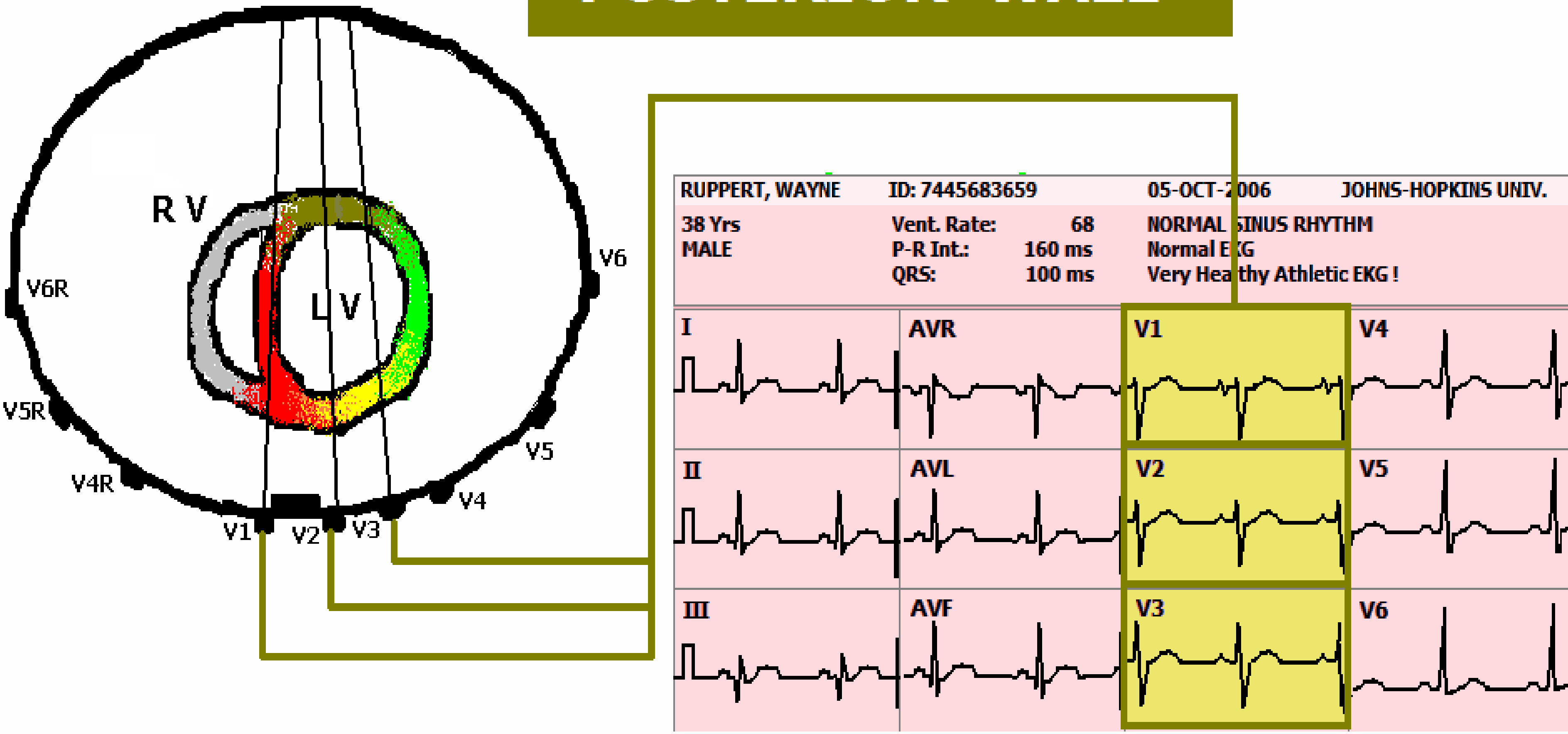
HELPFUL HINT . . . MEMORIZE THIS !

# LEFT ANTERIOR DESCENDING ARTERY (LAD)

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

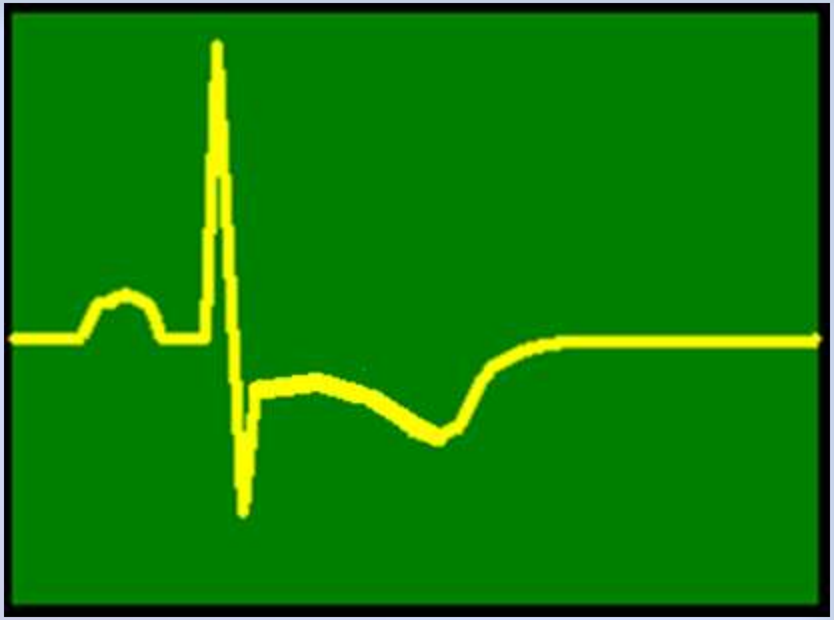
# LEADS V1 - V3 *view the*

# POSTERIOR WALL



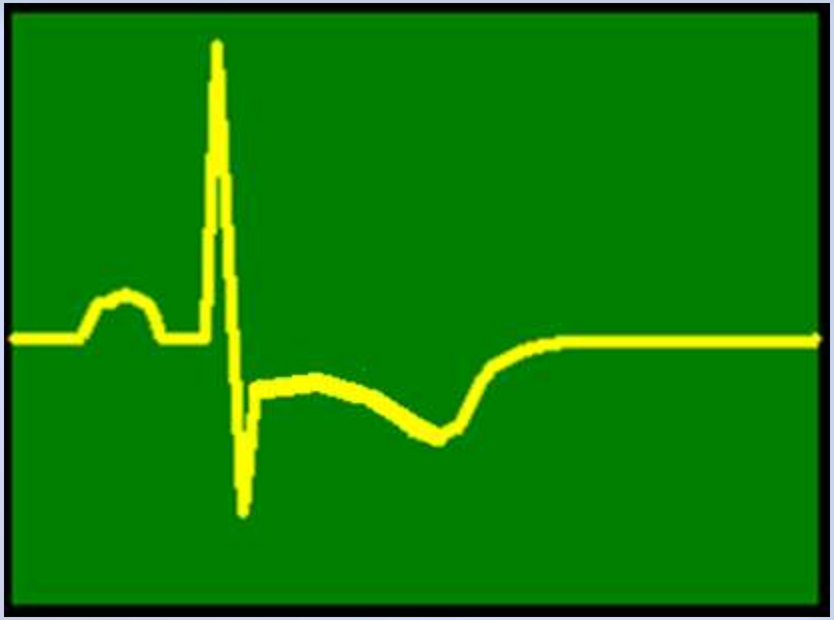

# *via* RECIPROCAL CHANGES.

# ST Depression in Leads V1 – V4:



- Direct view of ISCHEMIA  (anterior wall)

# ST Depression in Leads V1 – V4:

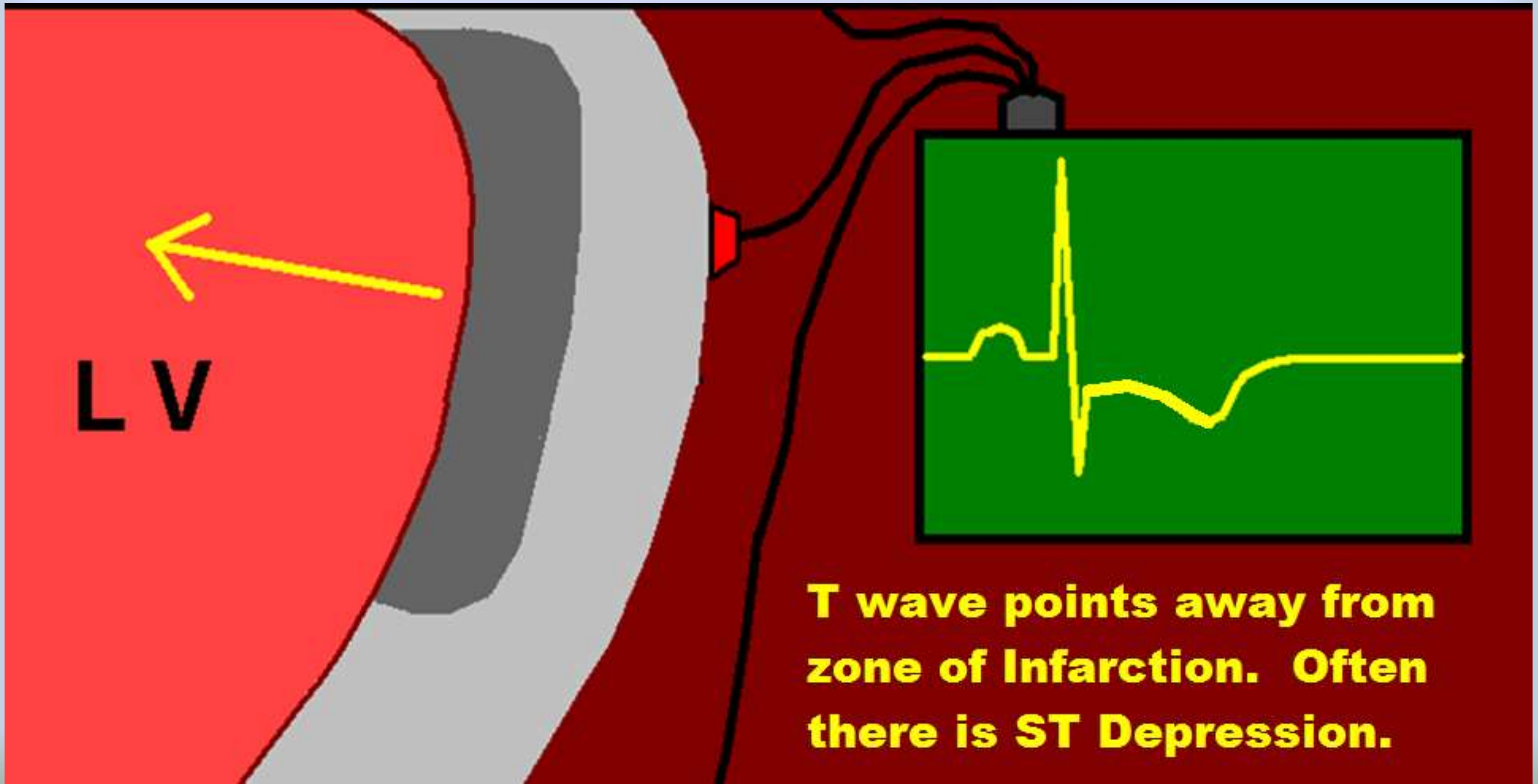


- **Direct view of ISCHEMIA  (anterior wall)**
- **Direct view of NSTEMI  (anterior wall)**

# Non-STEMI (NSTEMI)

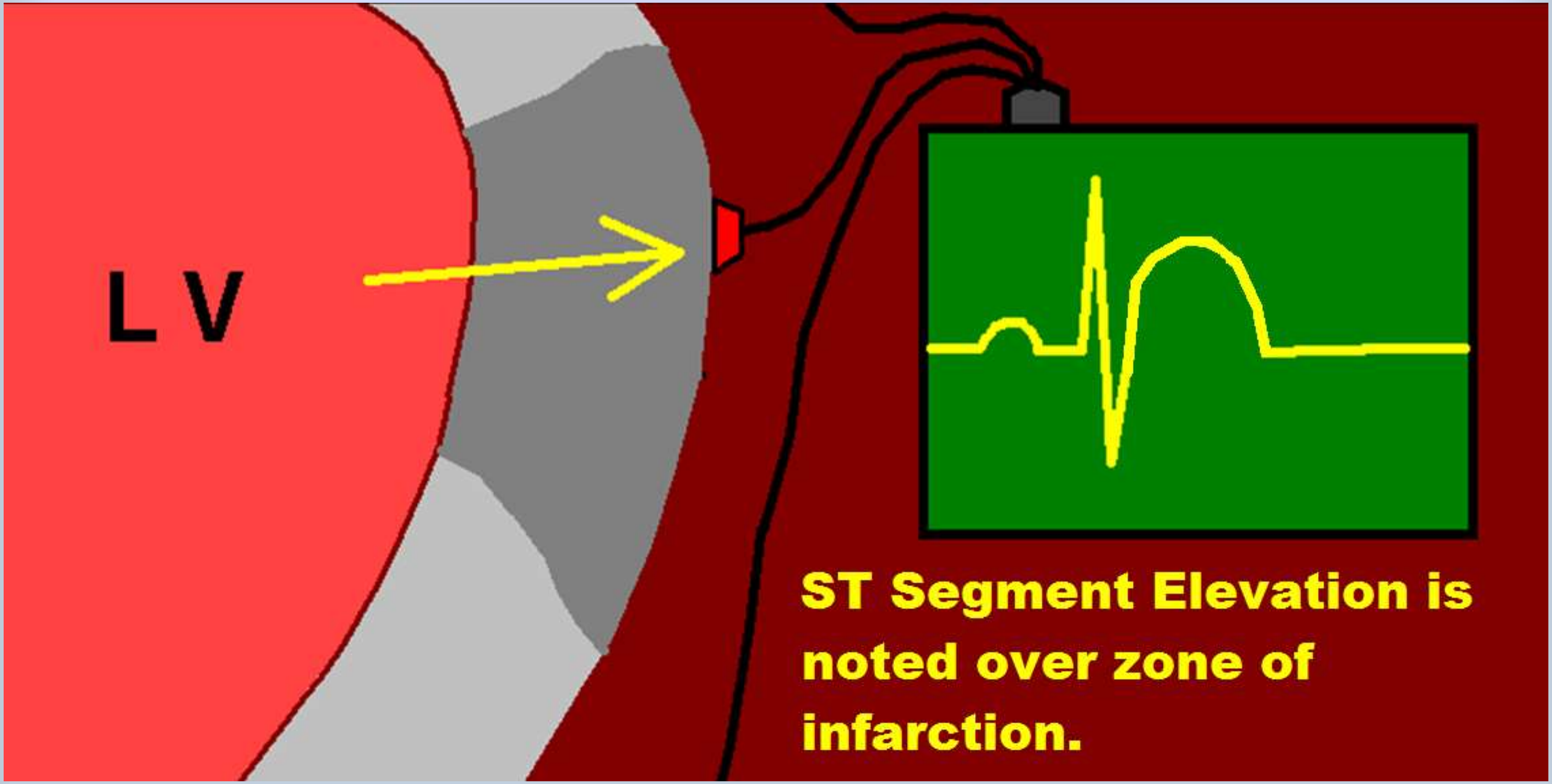
Non-ST Segment Elevation Myocardial Infarction.

“sub-endocardial MI” . . . “partial wall thickness”

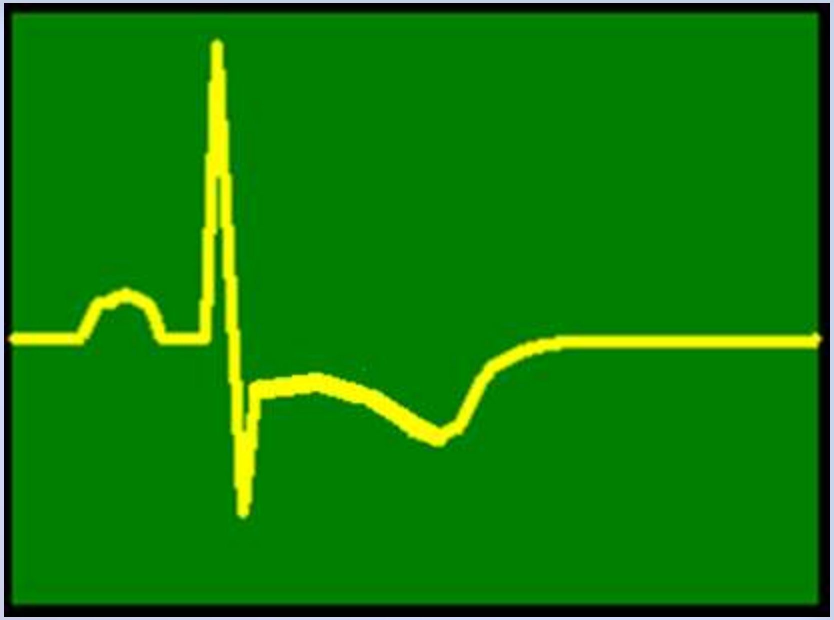


# STEMI

- ST Segment Elevation Myocardial Infarction.



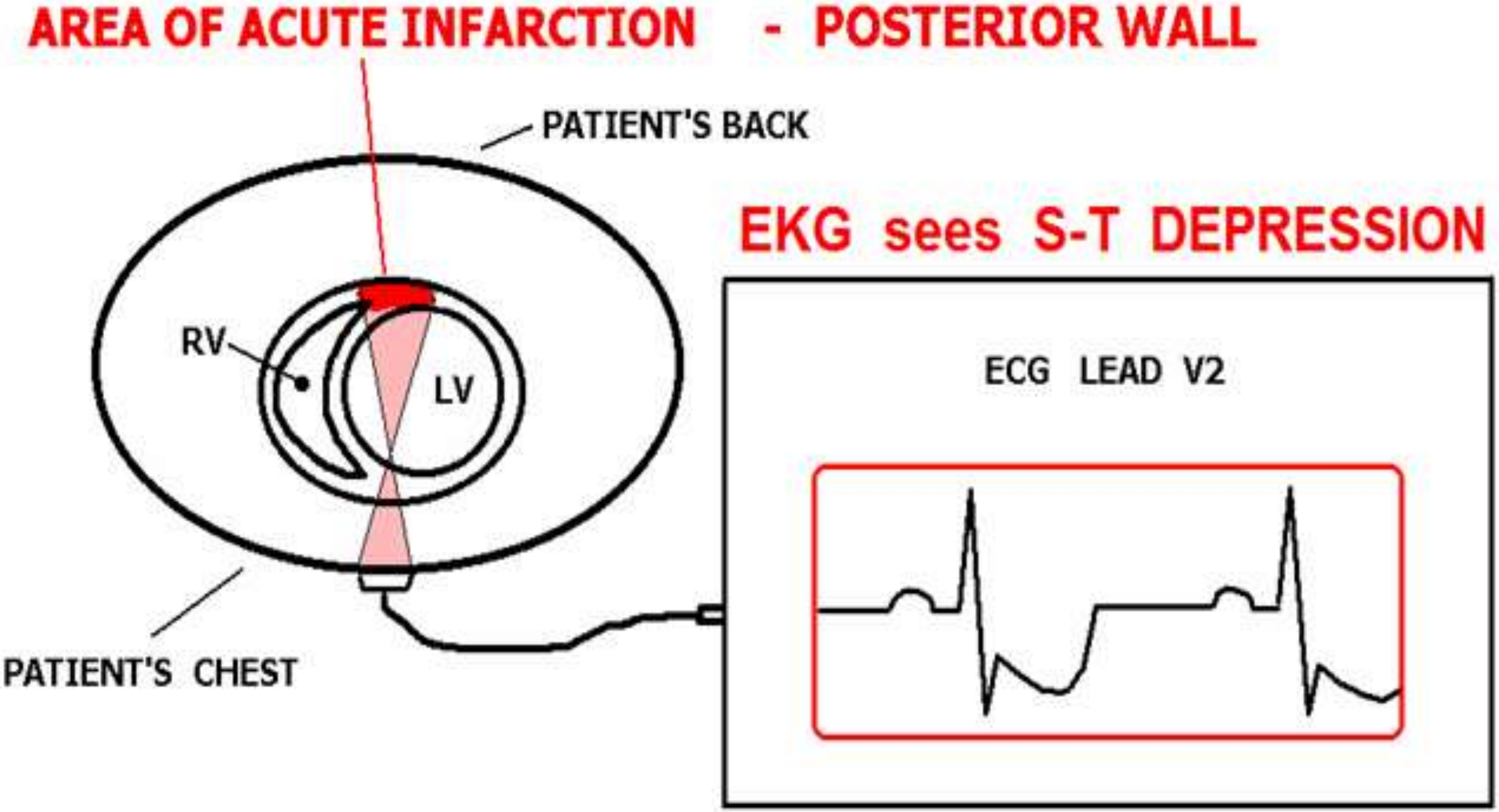
# ST Depression in Leads V1 – V4:



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

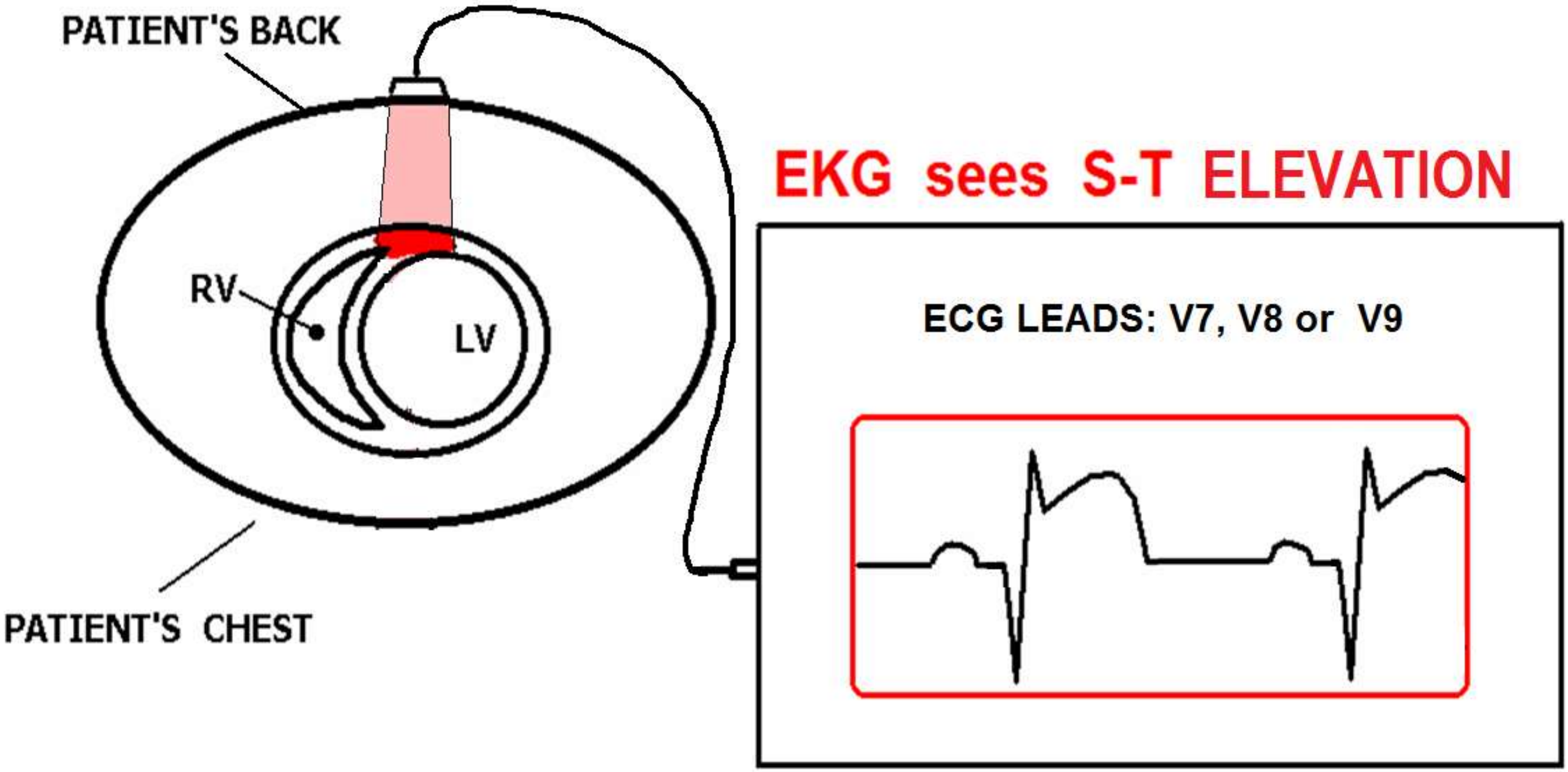
# HOW EKG VIEWS RECIPROCAL CHANGES

**EXAMPLE:**

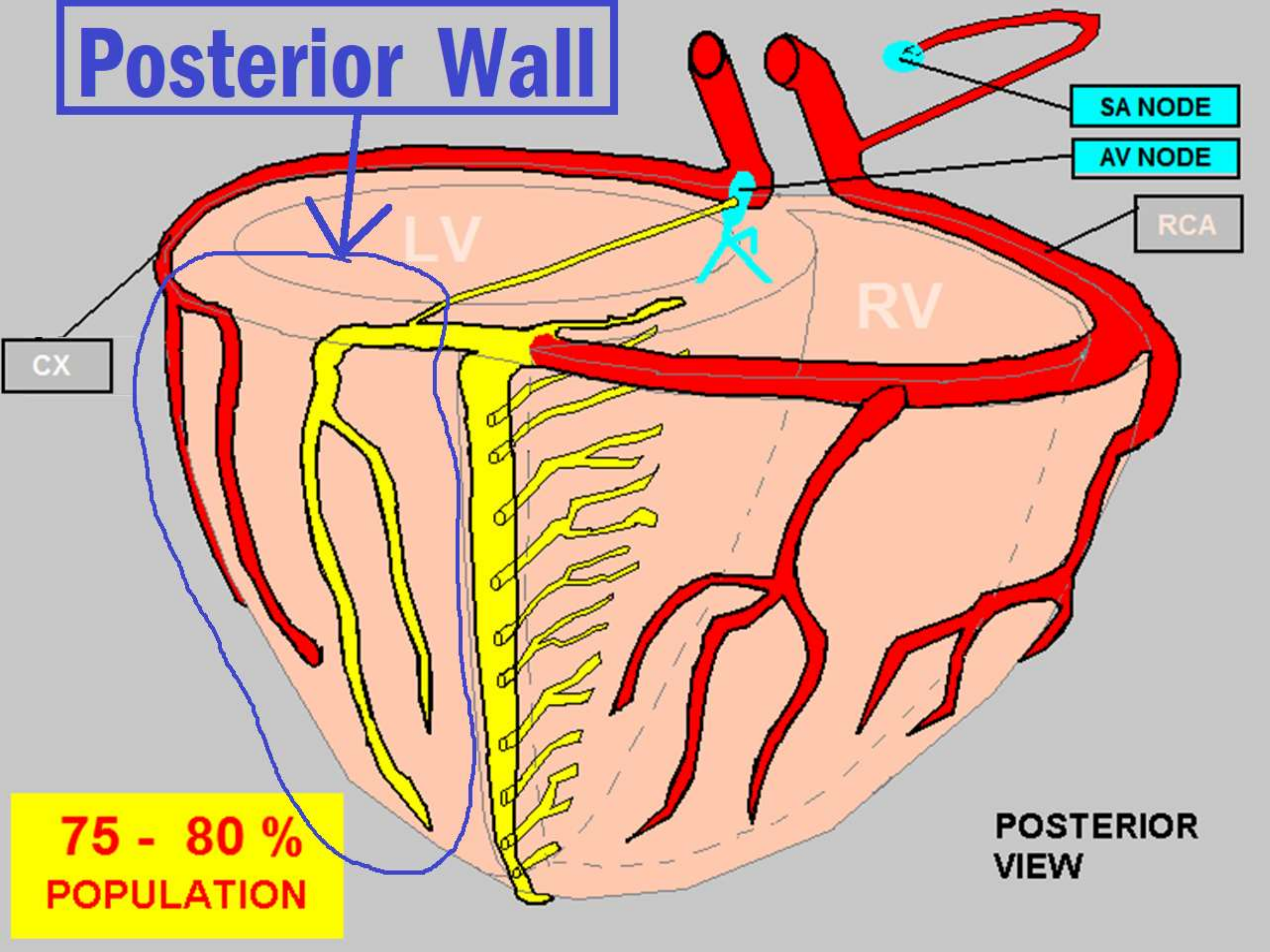


# If we put ECG leads on the BACK of a PATIENT who is having an

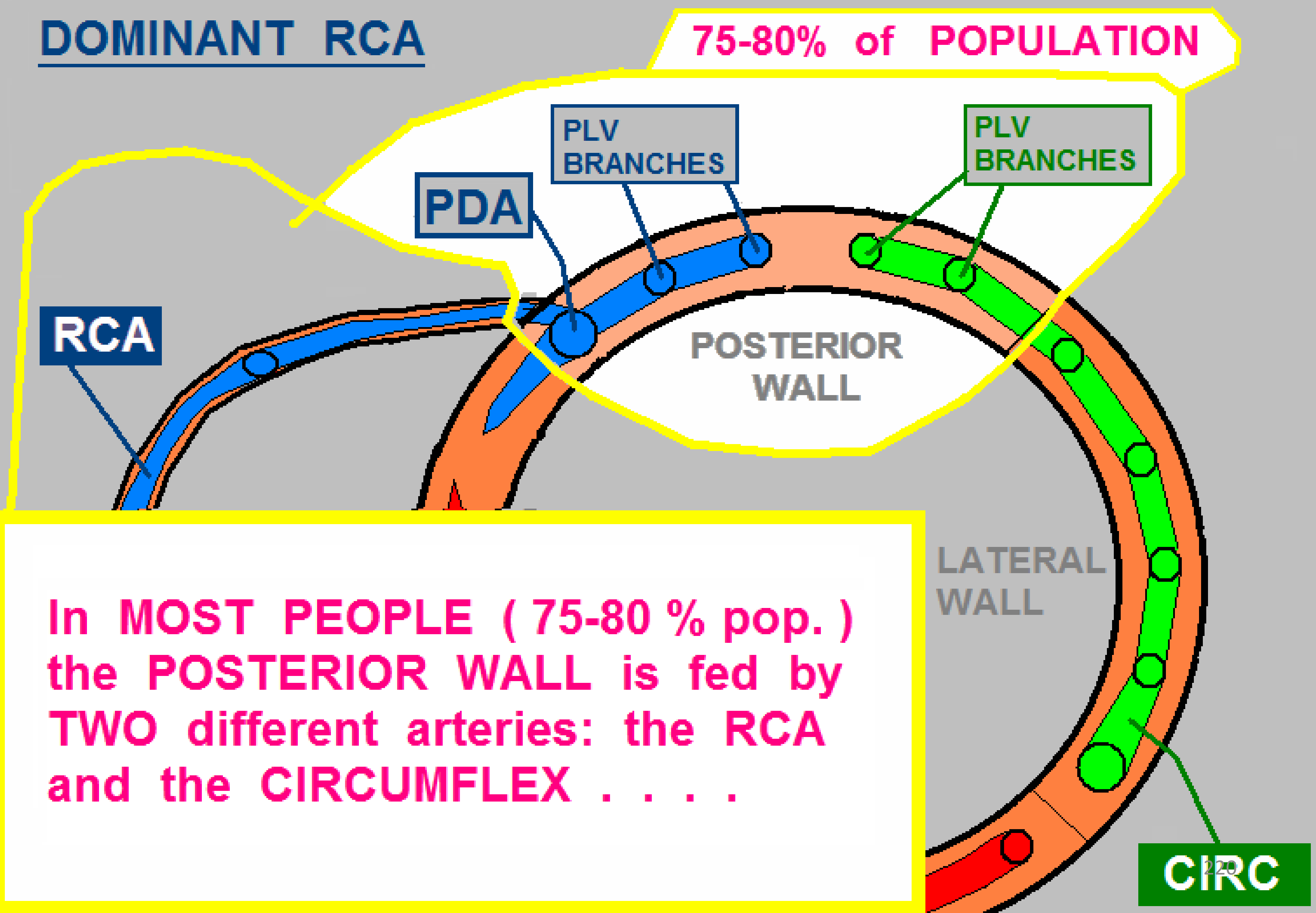
## ACUTE POSTERIOR WALL MI . . . . .



# Posterior Wall



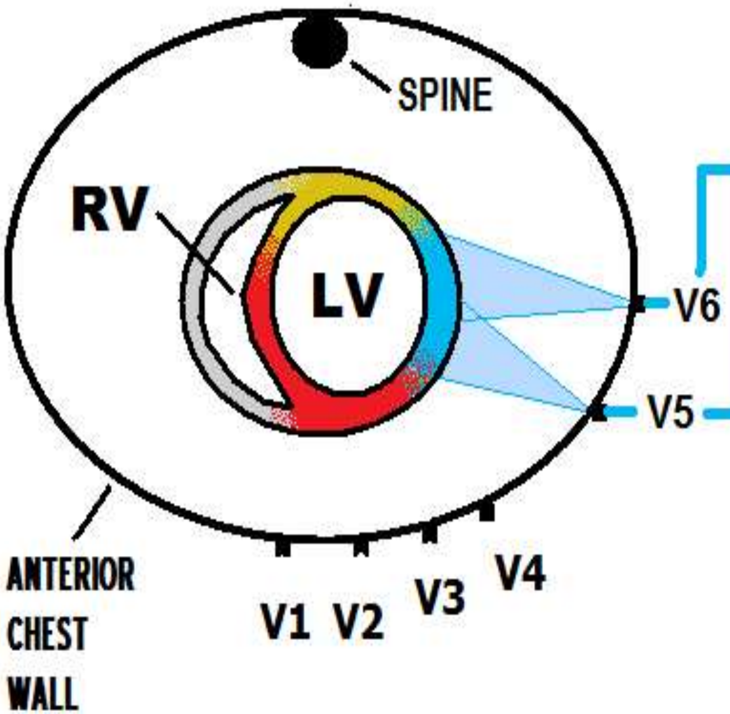
# POSTERIOR WALL BLOOD SUPPLY

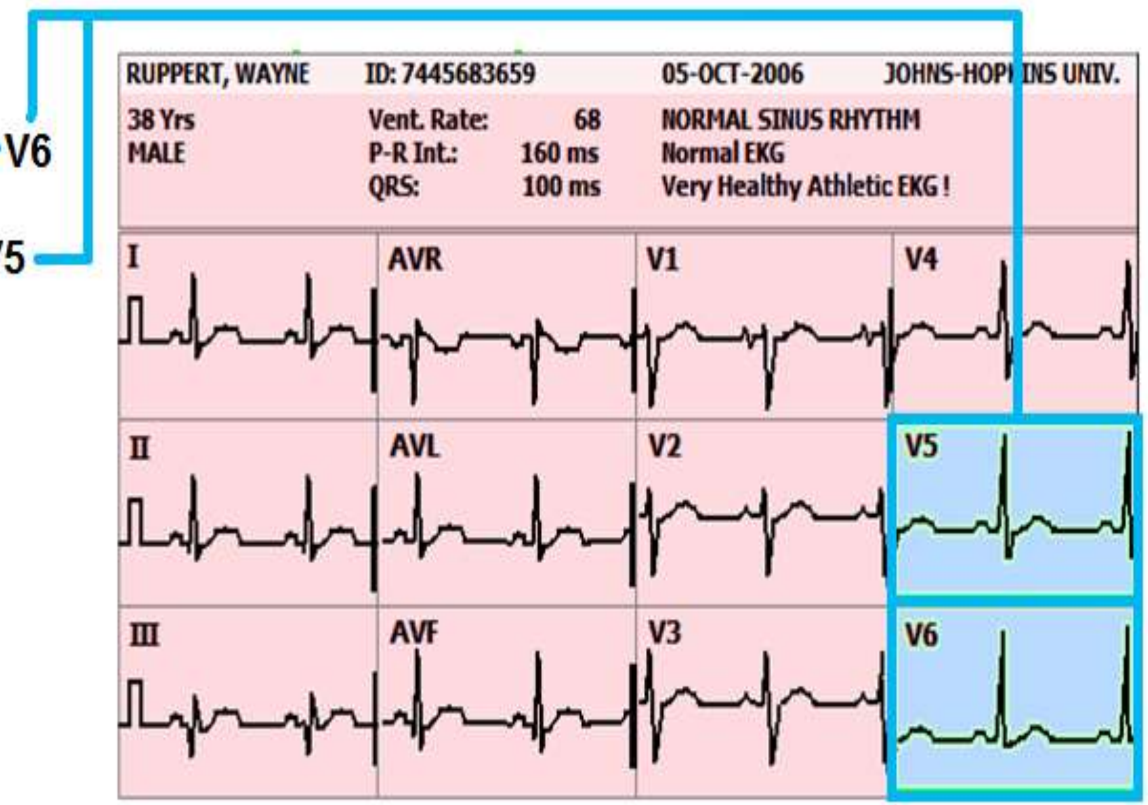



In MOST PEOPLE ( 75-80 % pop. ) the POSTERIOR WALL is fed by TWO different arteries: the RCA and the CIRCUMFLEX . . . .

# V5 - V6 VIEW THE LATERAL WALL

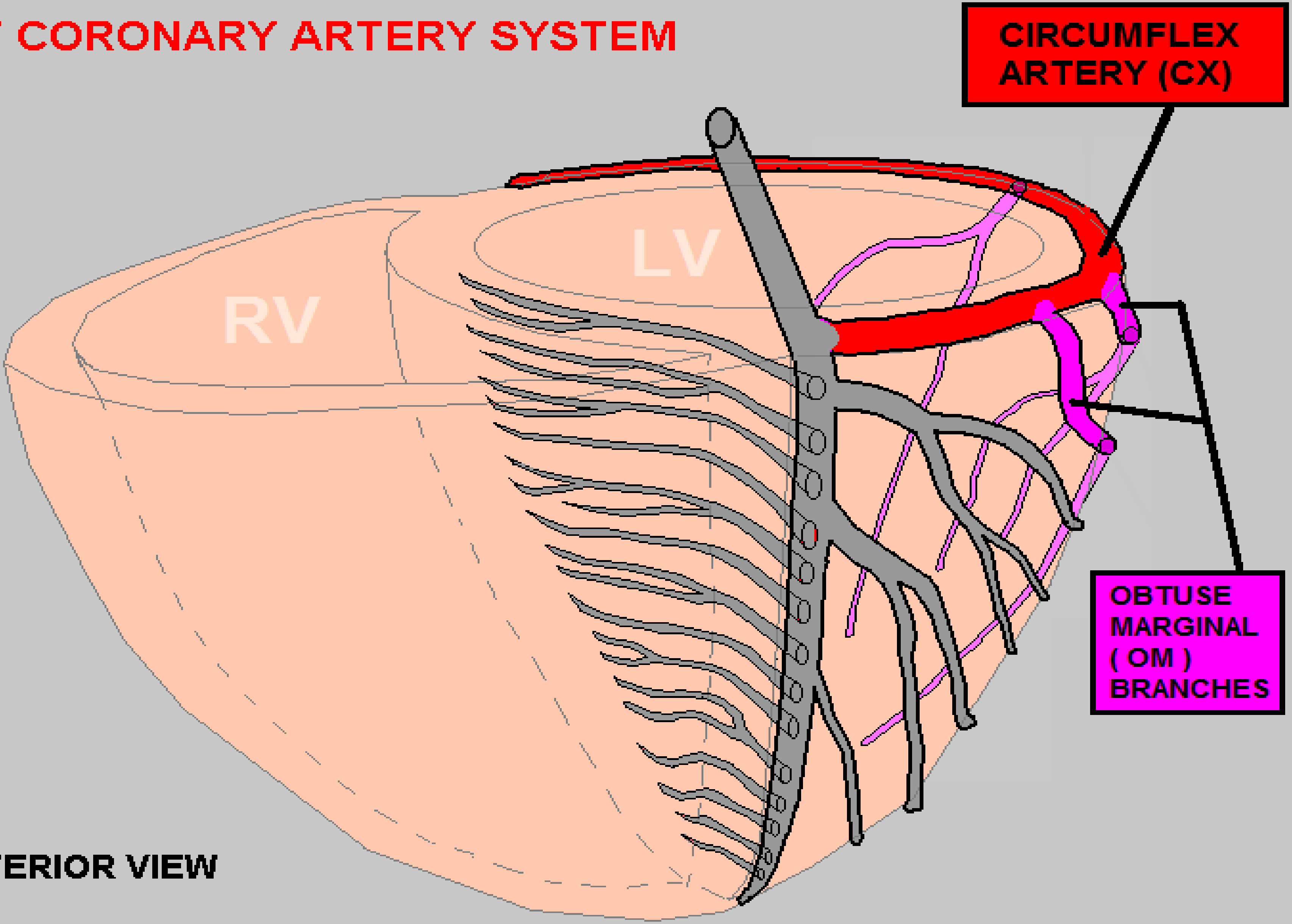
## of the LEFT VENTRICLE




**Which Coronary Artery typically Supplies the LATERAL WALL ?**

# LEFT CORONARY ARTERY SYSTEM

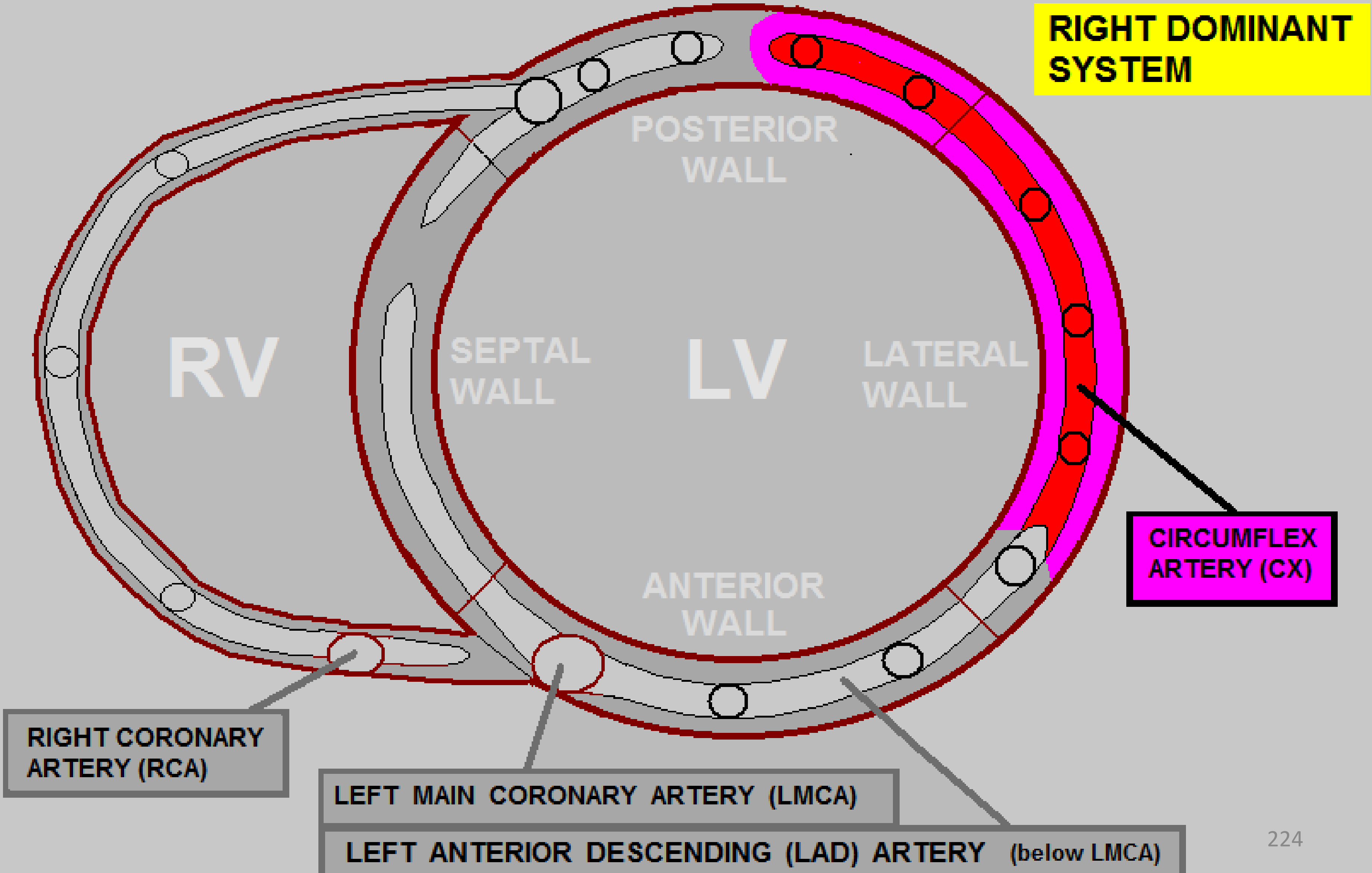



ANTERIOR VIEW

*cutaway view of the*

# CIRCUMFLEX ARTERY (CX) DISTRIBUTION

SUPPLIES 20 - 30 % of the LV MUSCLE MASS



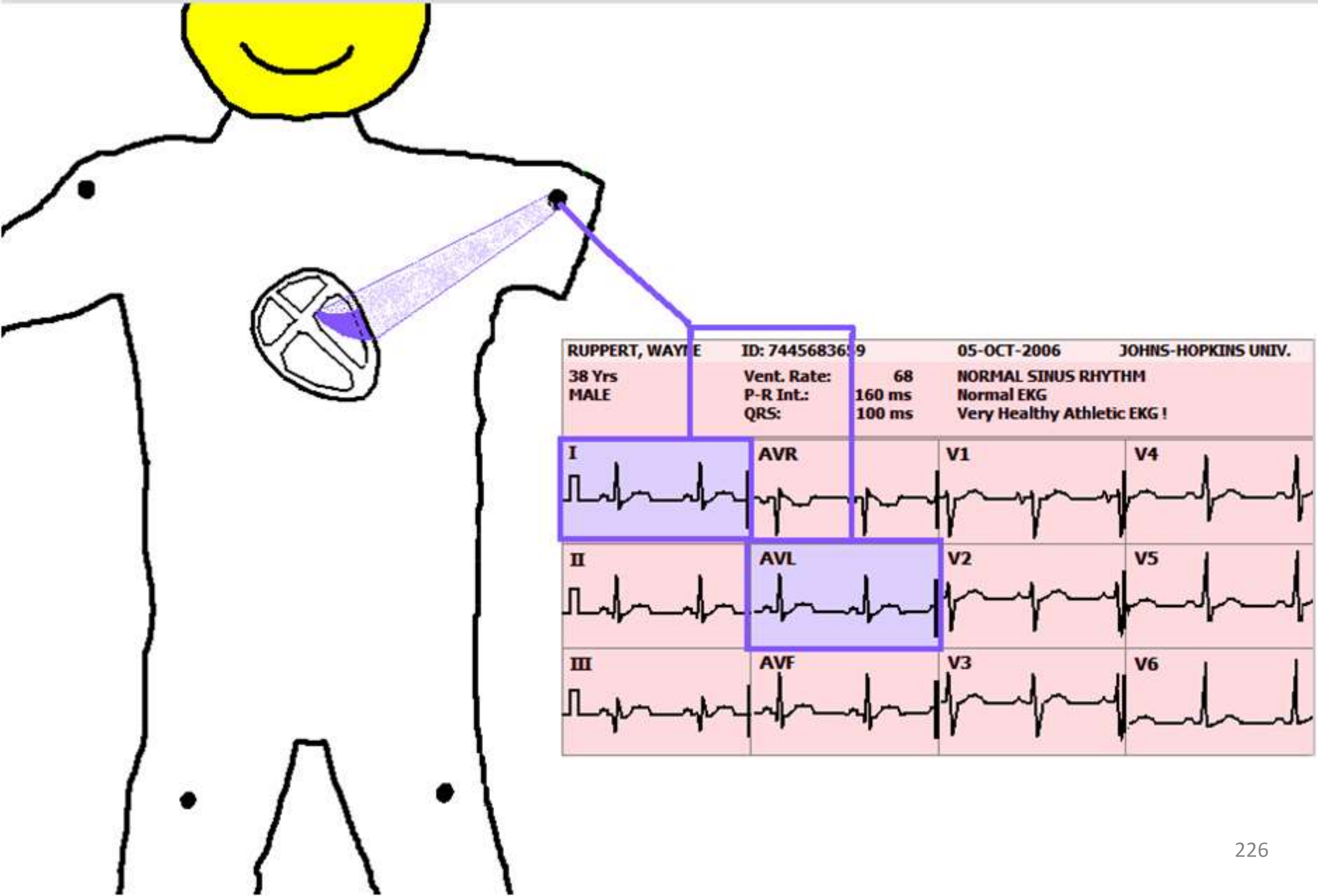
HELPFUL HINT . . . MEMORIZE THIS !

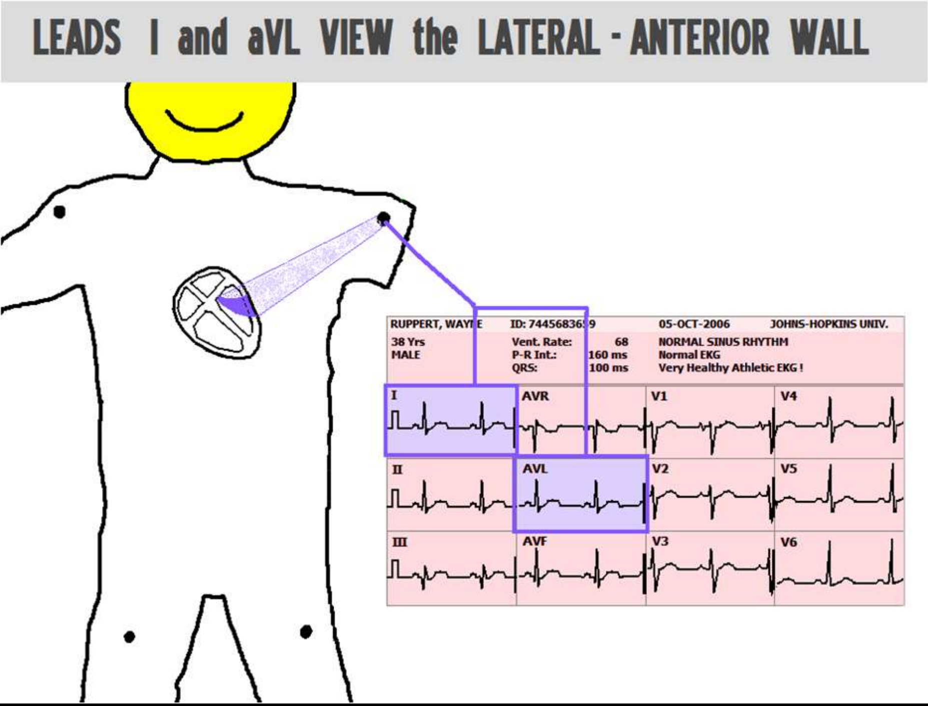
## CIRCUMFLEX ARTERY ( CX )

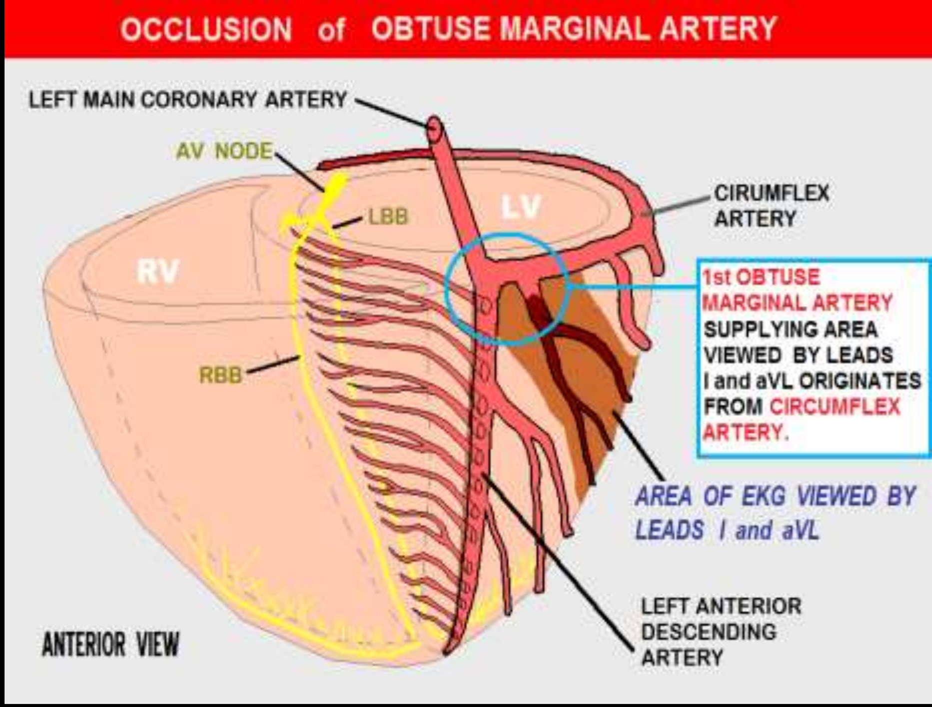
RIGHT DOMINANT SYSTEMS

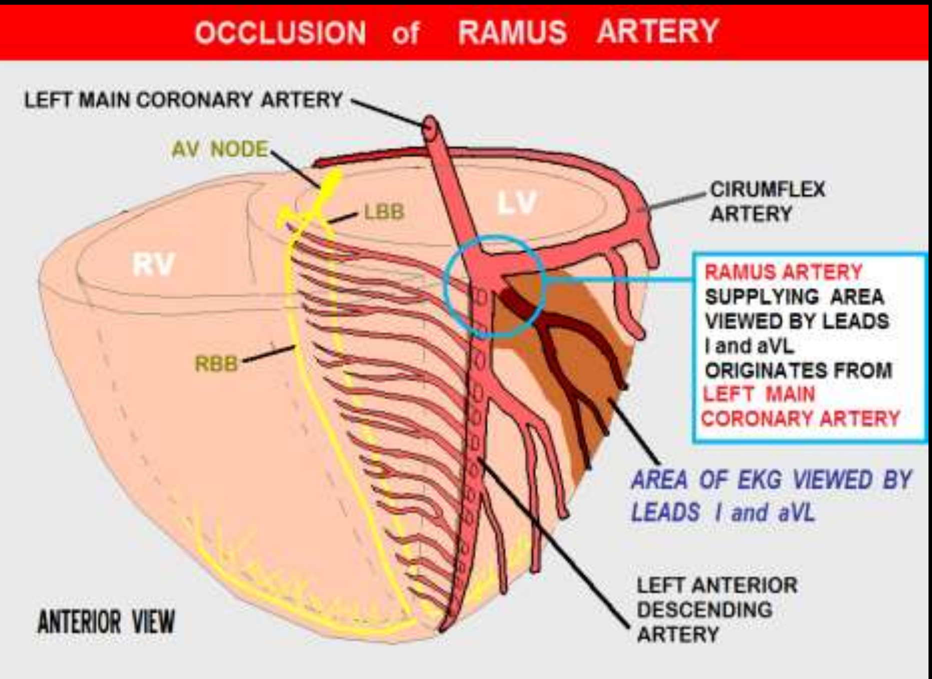
- LEFT ATRIUM
- SINUS NODE ( 5% of the population )
- LEFT VENTRICLE: 20 - 30 % of muscle mass
  - LATERAL WALL
  - up to 1/2 of POSTERIOR WALL

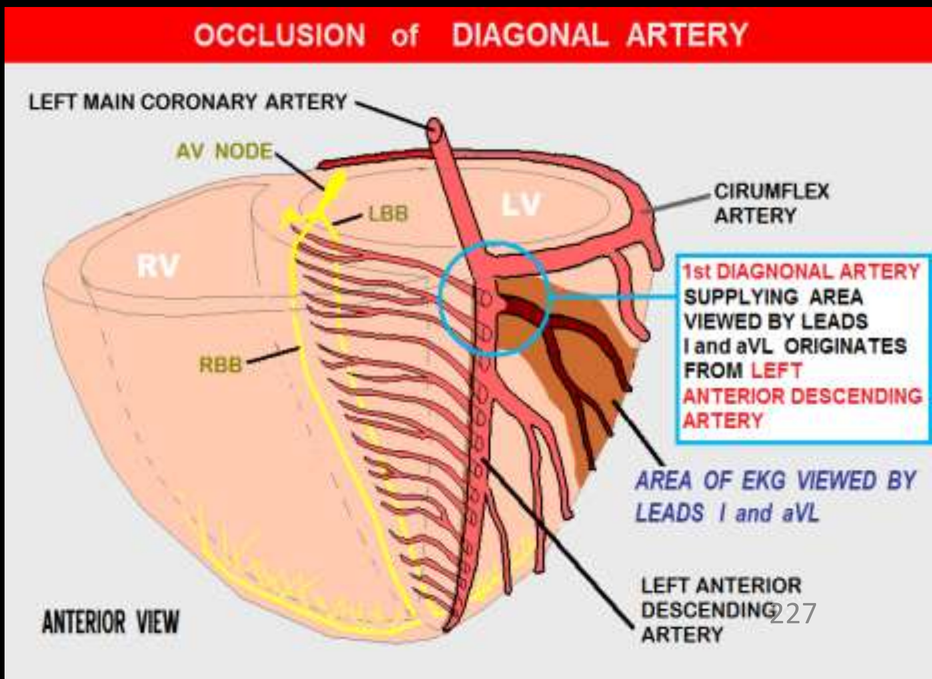
# LEADS I and aVL VIEW the LATERAL - ANTERIOR WALL

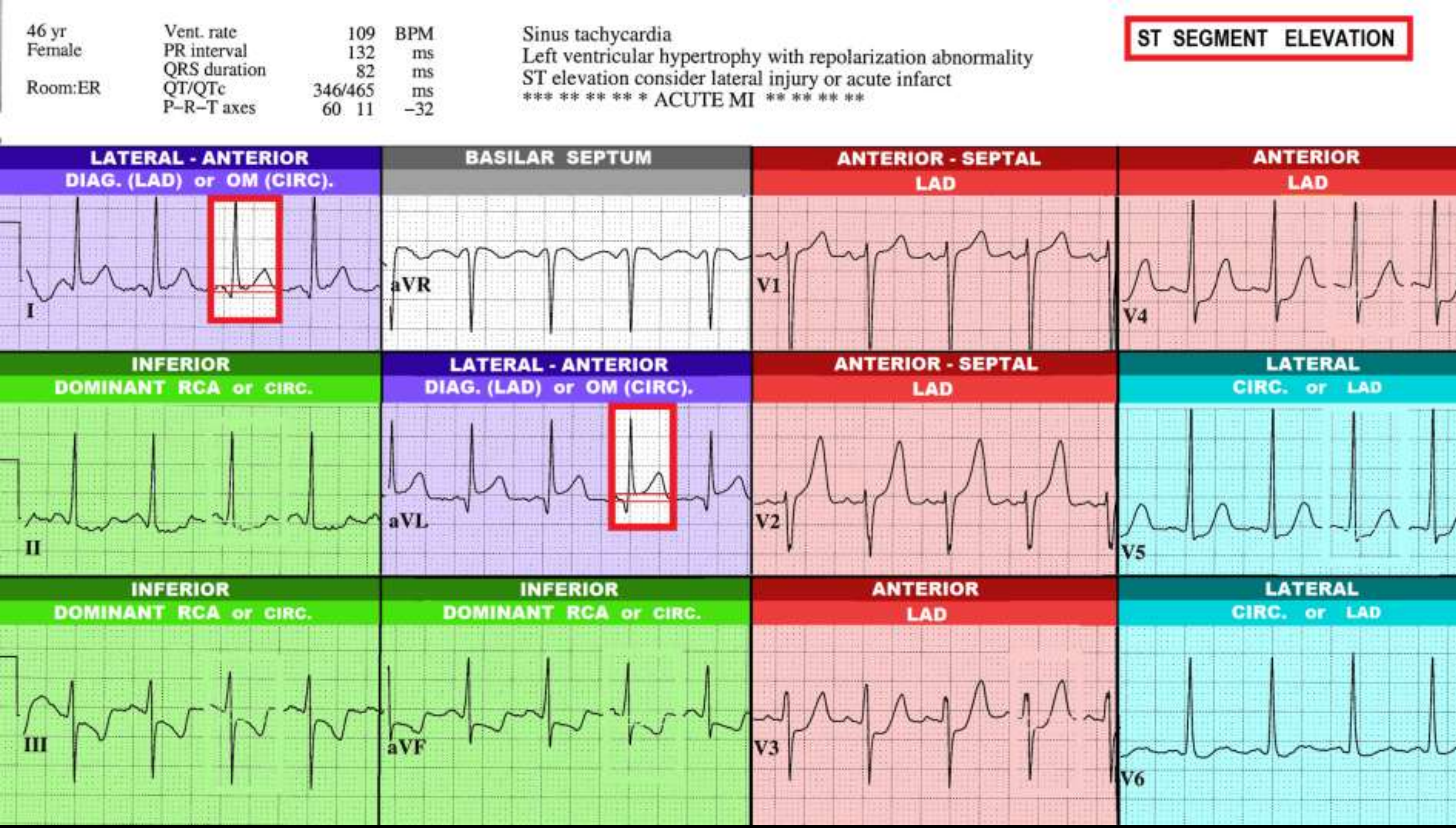



LEADS I and aVL VIEW the LATERAL - ANTERIOR WALL
RUPPERT, WAYNE
05-OCT-2006
JOHNS-HOPKINS UNIV.
38 Yrs
MALE
Vent. Rate: 68
P-R Int.: 160 ms
QRS: 100 ms
NORMAL SINUS RHYTHM
Normal EKG
Very Healthy Athletic EKG !
I
AVR
V1
V4
II
AVL
V2
V5
III
AVF
V3
V6


OCCLUSION of OBTUSE MARGINAL ARTERY
LEFT MAIN CORONARY ARTERY
AV NODE
LBB
LV
RV
CIRUMFLEX ARTERY
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
RV
CIRUMFLEX ARTERY
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

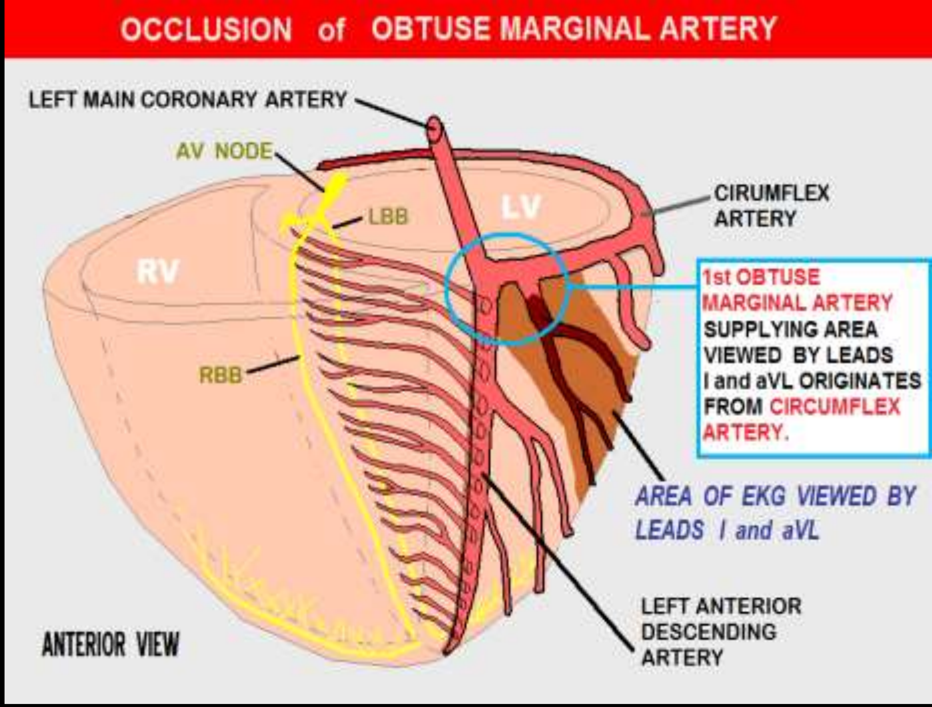

OCCLUSION of DIAGONAL ARTERY
LEFT MAIN CORONARY ARTERY
AV NODE
LBB
LV
RV
CIRUMFLEX ARTERY
1st DIAGNONAL ARTERY SUPPLYING AREA VIEWED BY LEADS I and aVL ORIGINATES FROM LEFT ANTERIOR DESCENDING ARTERY
RBB
AREA OF EKG VIEWED BY LEADS I and aVL
LEFT ANTERIOR DESCENDING ARTERY
ANTERIOR VIEW

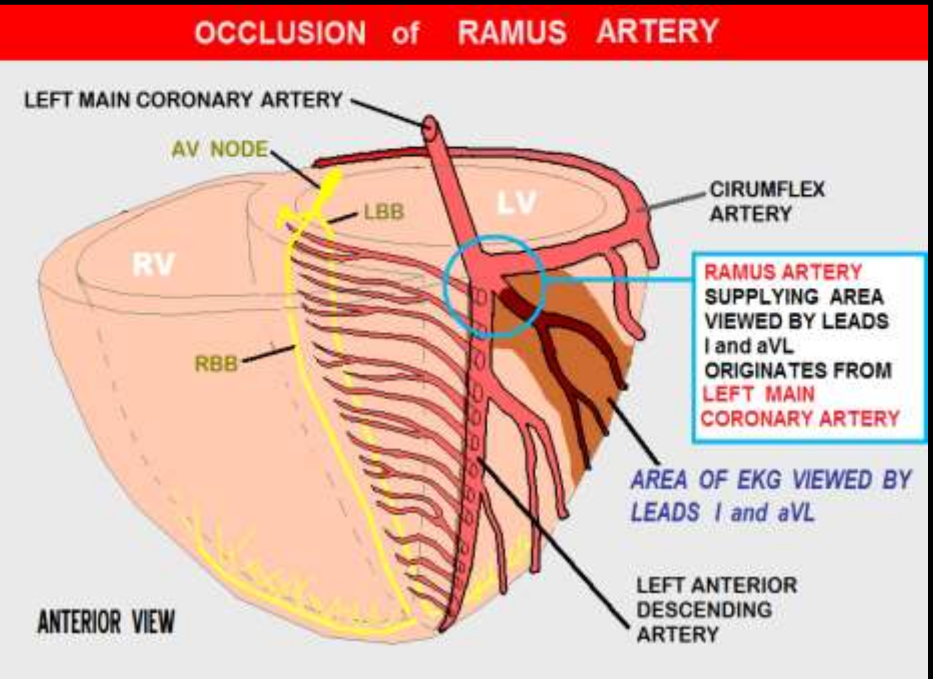


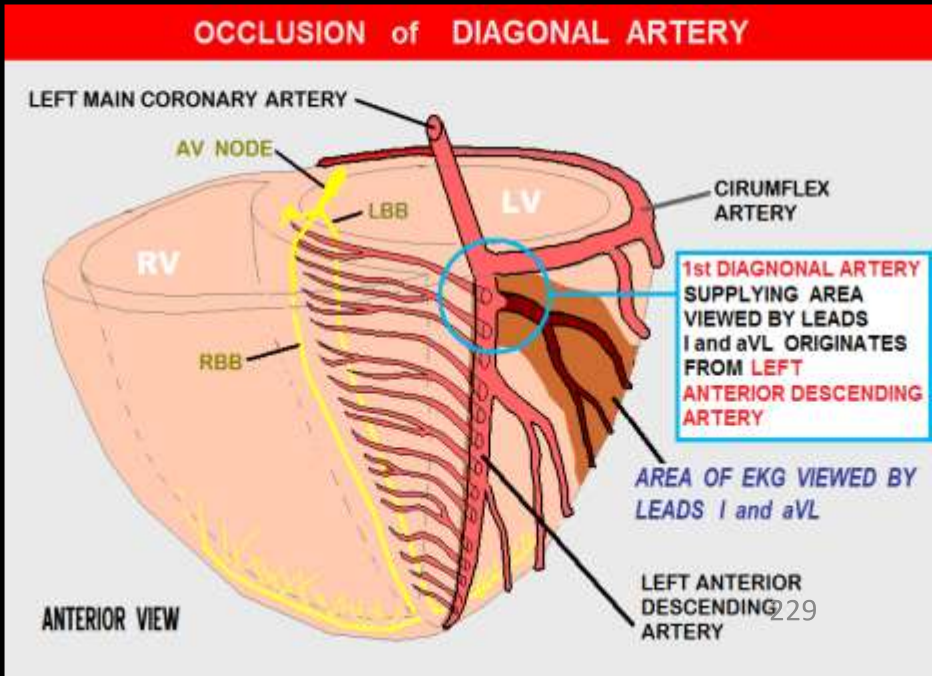

# ST Segment elevation ONLY in Leads I and aVL

ST Elevation isolated to Leads I and aVL - usually indicates the "Culprit Artery" is most likely One of the following:

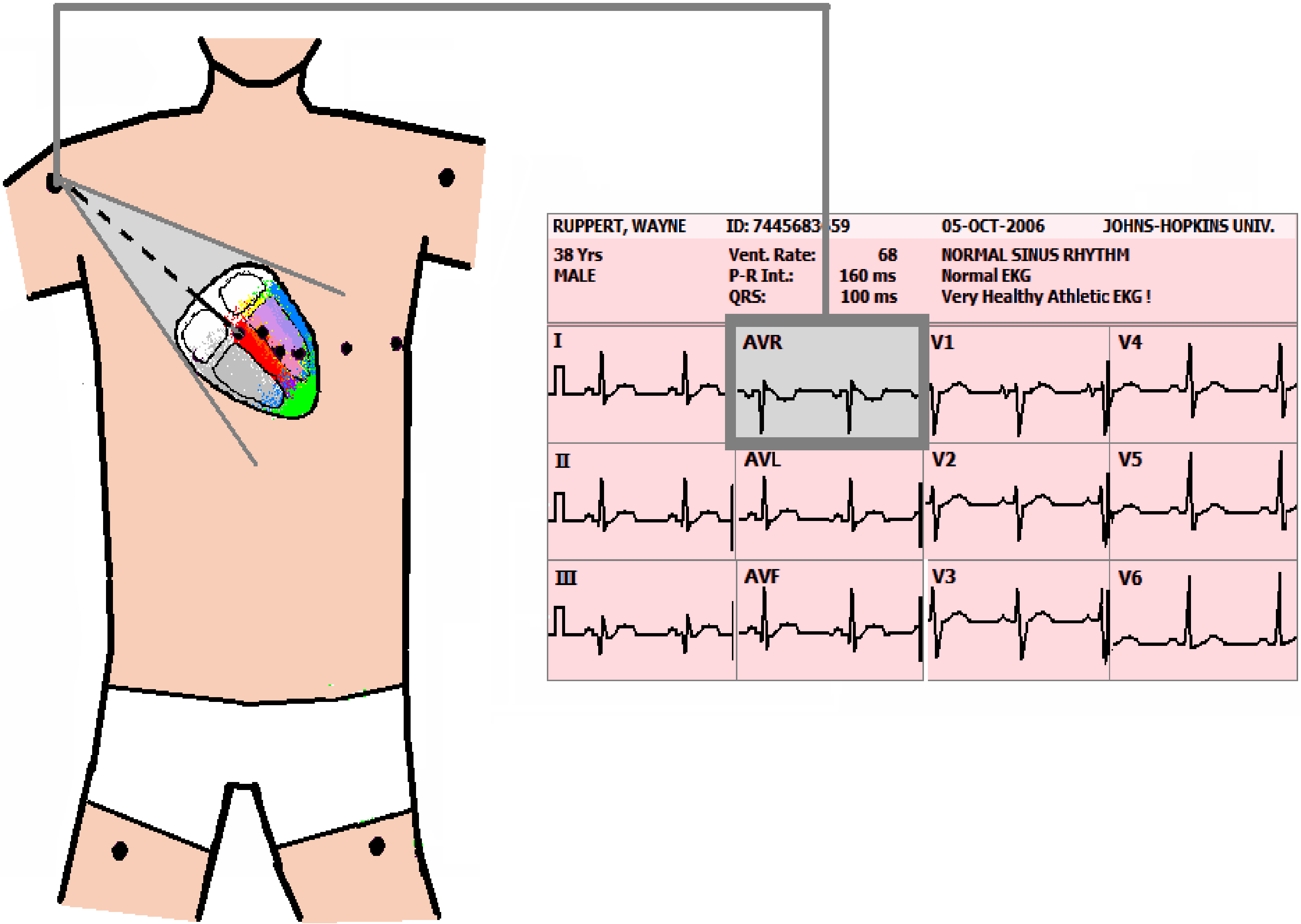
- RAMUS BRANCH
- 1st DIAGONAL off of LAD
- 1st OBTUSE MARGINAL off of CIRCUMFLEX

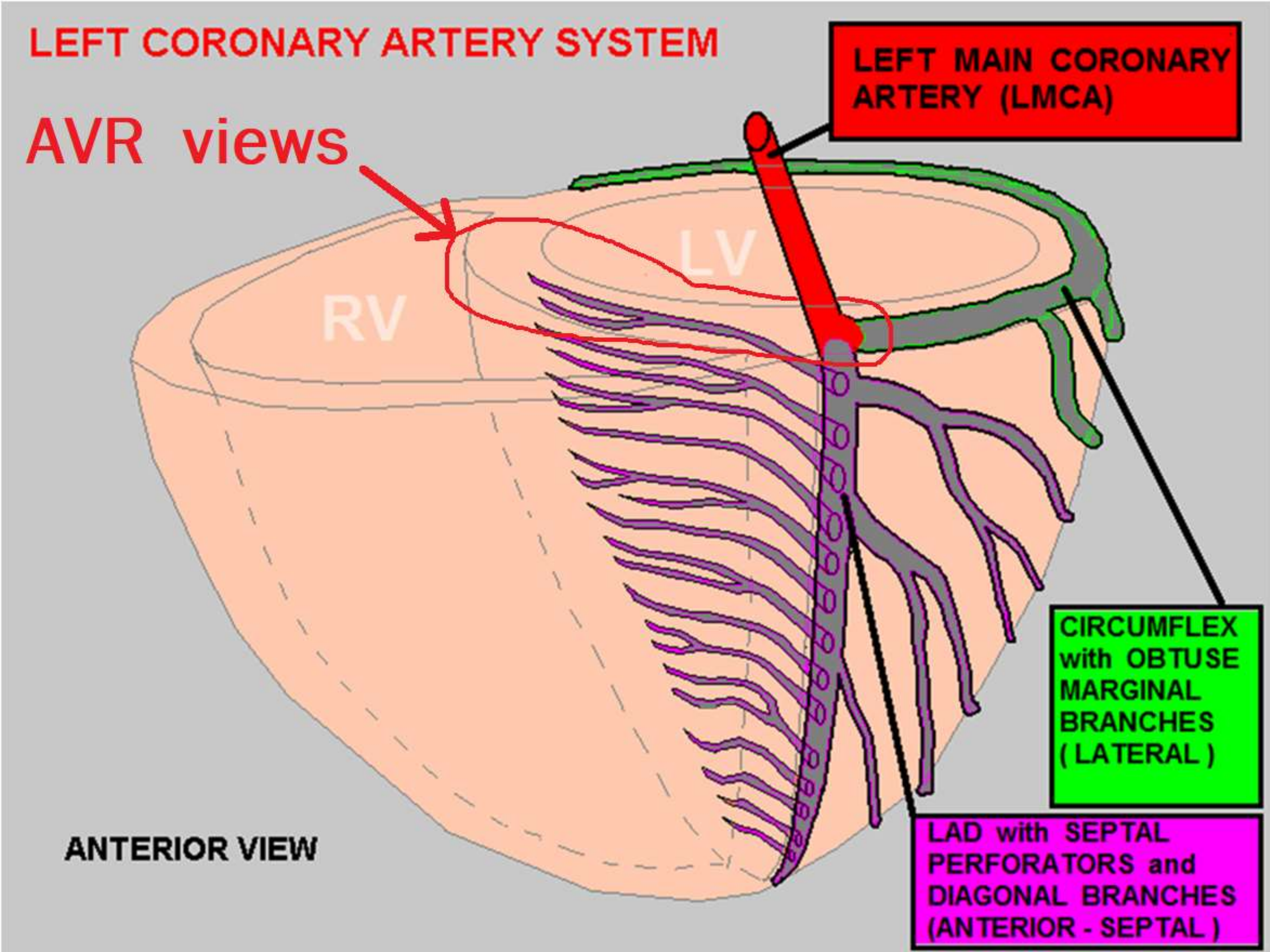


# Lead AVR Views the BASILAR SEPTUM (region of the Bundle of His)



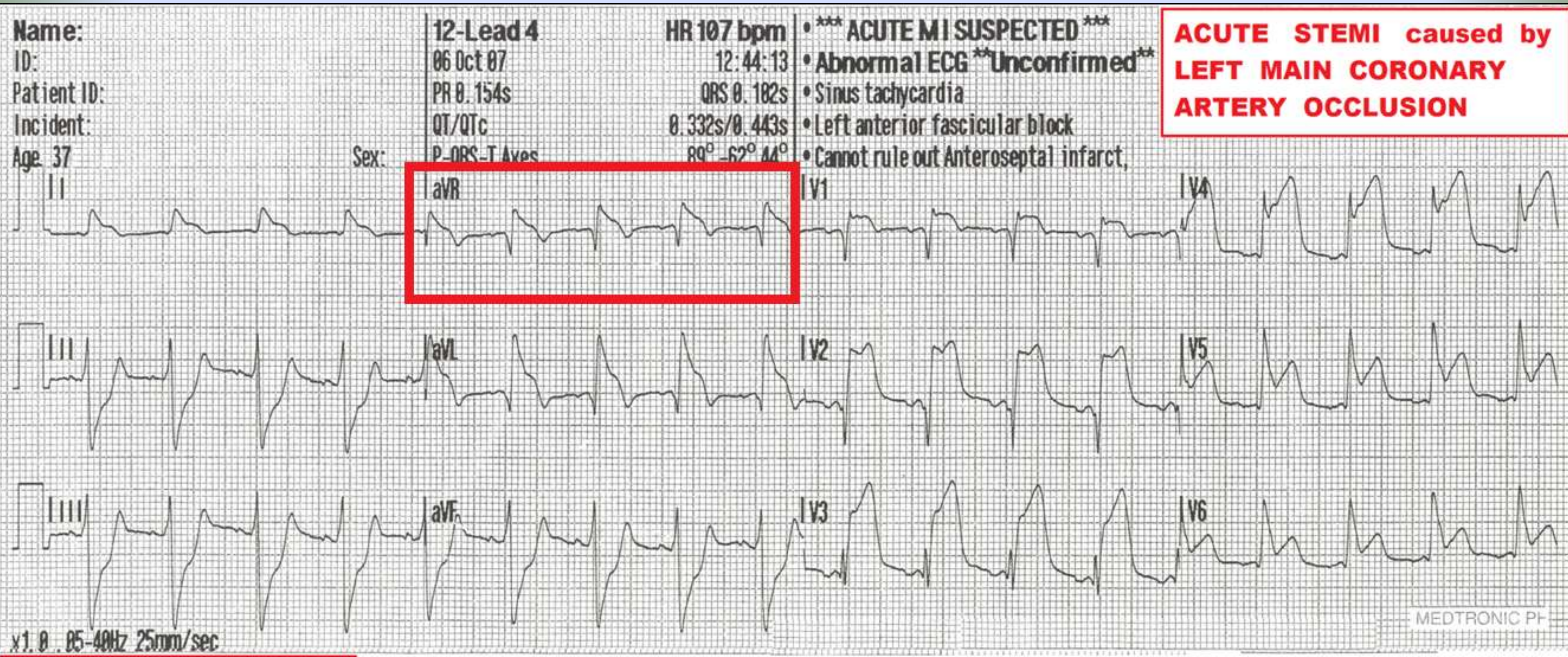


LEFT CORONARY ARTERY SYSTEM
LEFT MAIN CORONARY ARTERY (LMCA)
AVR views
LV
RV
CIRCUMFLEX with OBTUSE MARGINAL BRANCHES ( LATERAL )
LAD with SEPTAL PERFORATORS and DIAGONAL BRANCHES (ANTERIOR - SEPTAL )
ANTERIOR VIEW

When LEAD AVR shows ST Elevation:

- **STEMI:** consider occlusion of the Left Main Coronary Artery.

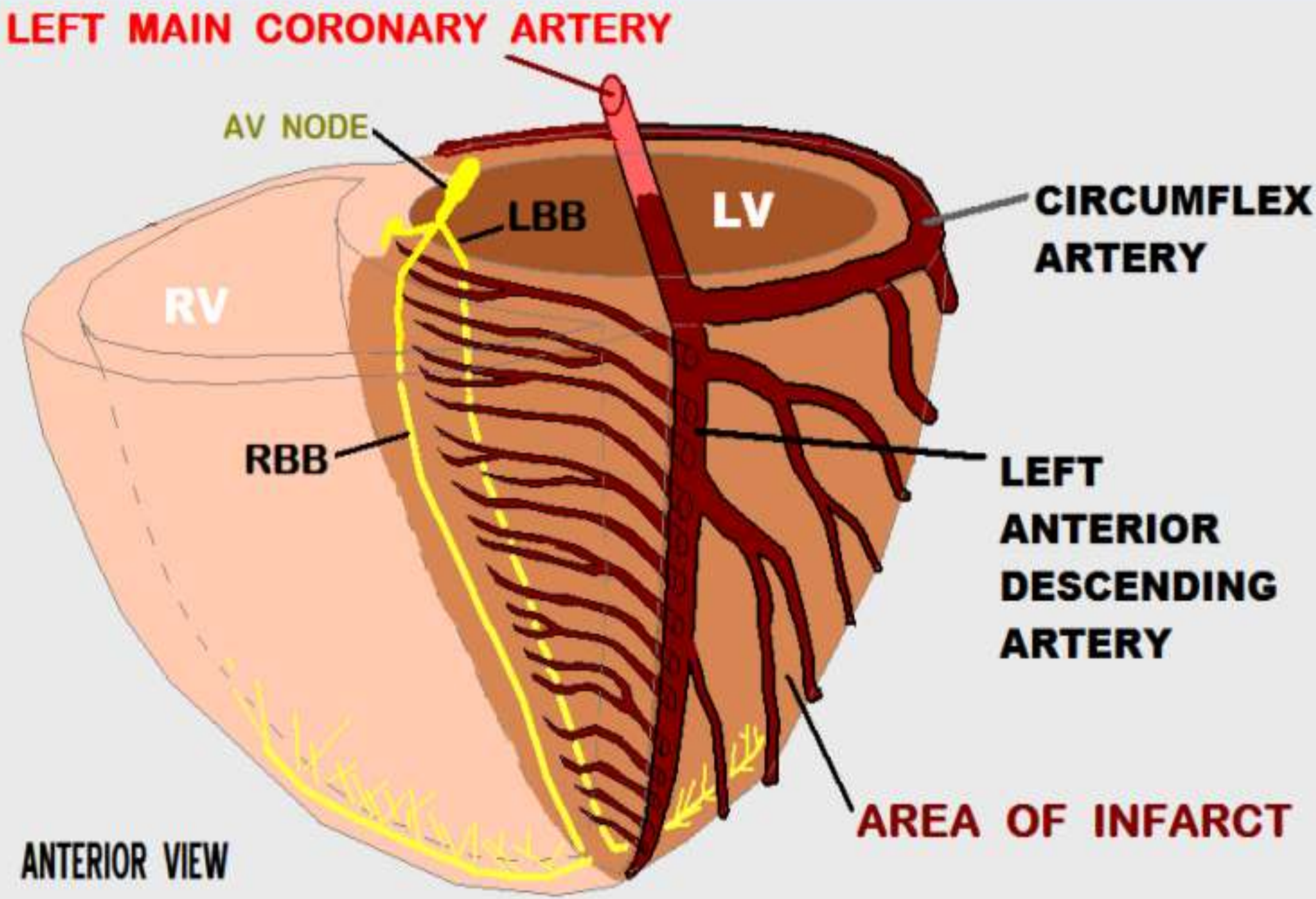
**ACUTE STEMI caused by LEFT MAIN CORONARY ARTERY OCCLUSION**

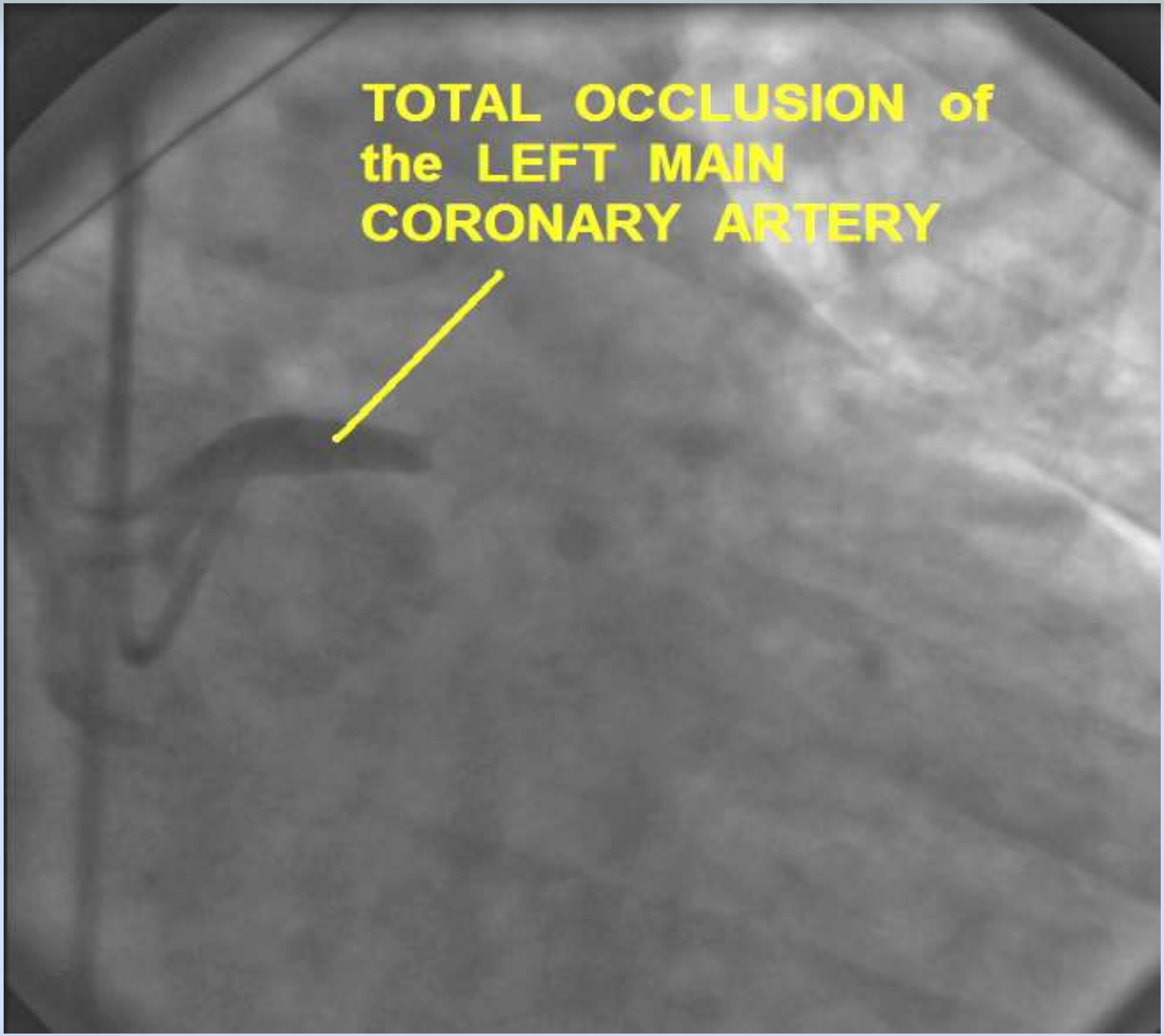



**ECG CLUES of ACUTE STEMI caused by LEFT MAIN CORONARY ARTERY OCCLUSION:**

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

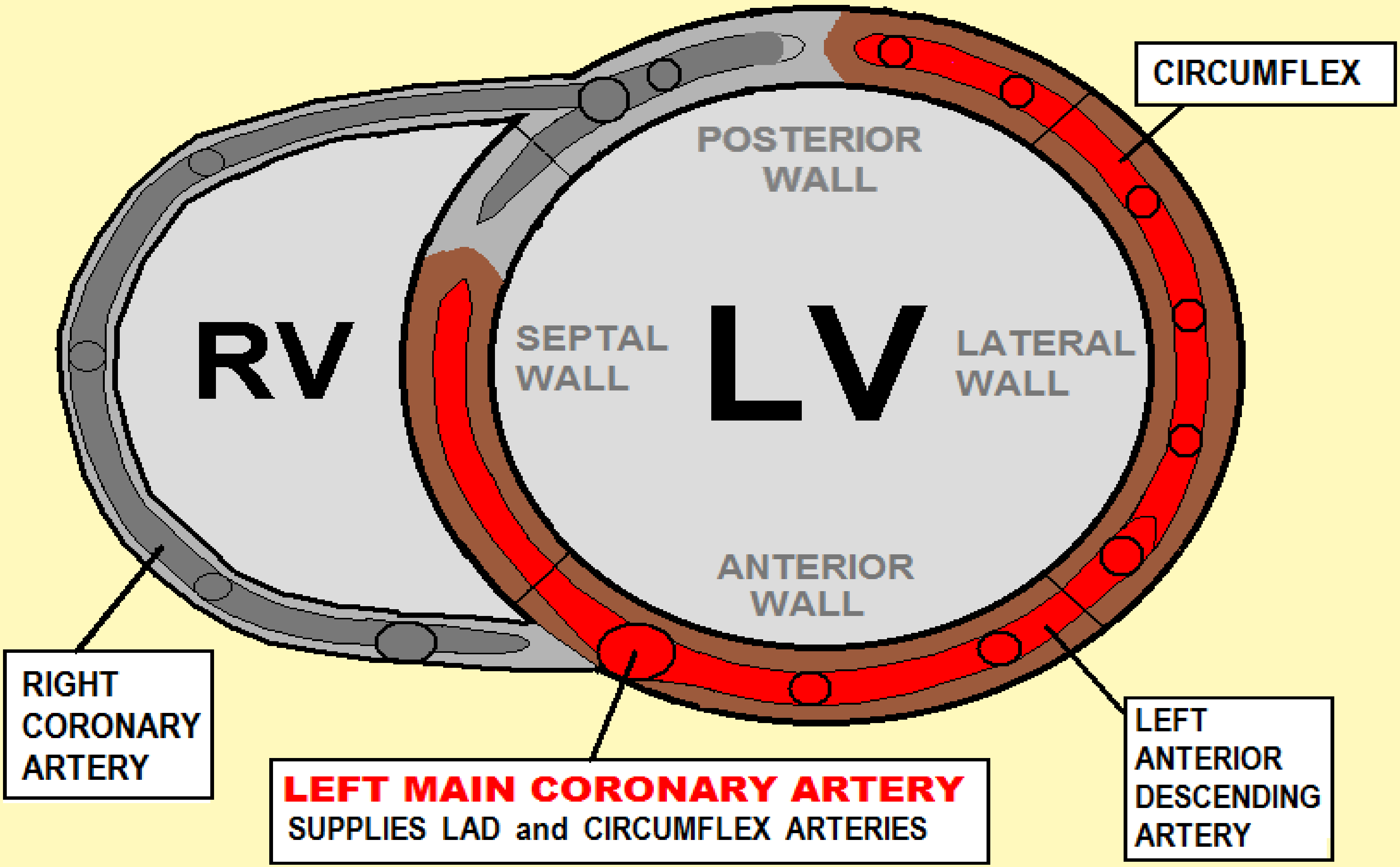
# OCCLUSION of the LEFT MAIN CORONARY ARTERY




TOTAL OCCLUSION of
the LEFT MAIN
CORONARY ARTERY

# The LEFT MAIN CORONARY ARTERY

***SUPPLIES 75 - 100 % of the LEFT VENTRICULAR MUSCLE MASS***



When LEAD AVR shows ST Elevation:

- **STEMI:** consider occlusion of the Left Main Coronary Artery.

When LEAD AVR shows ST Elevation:

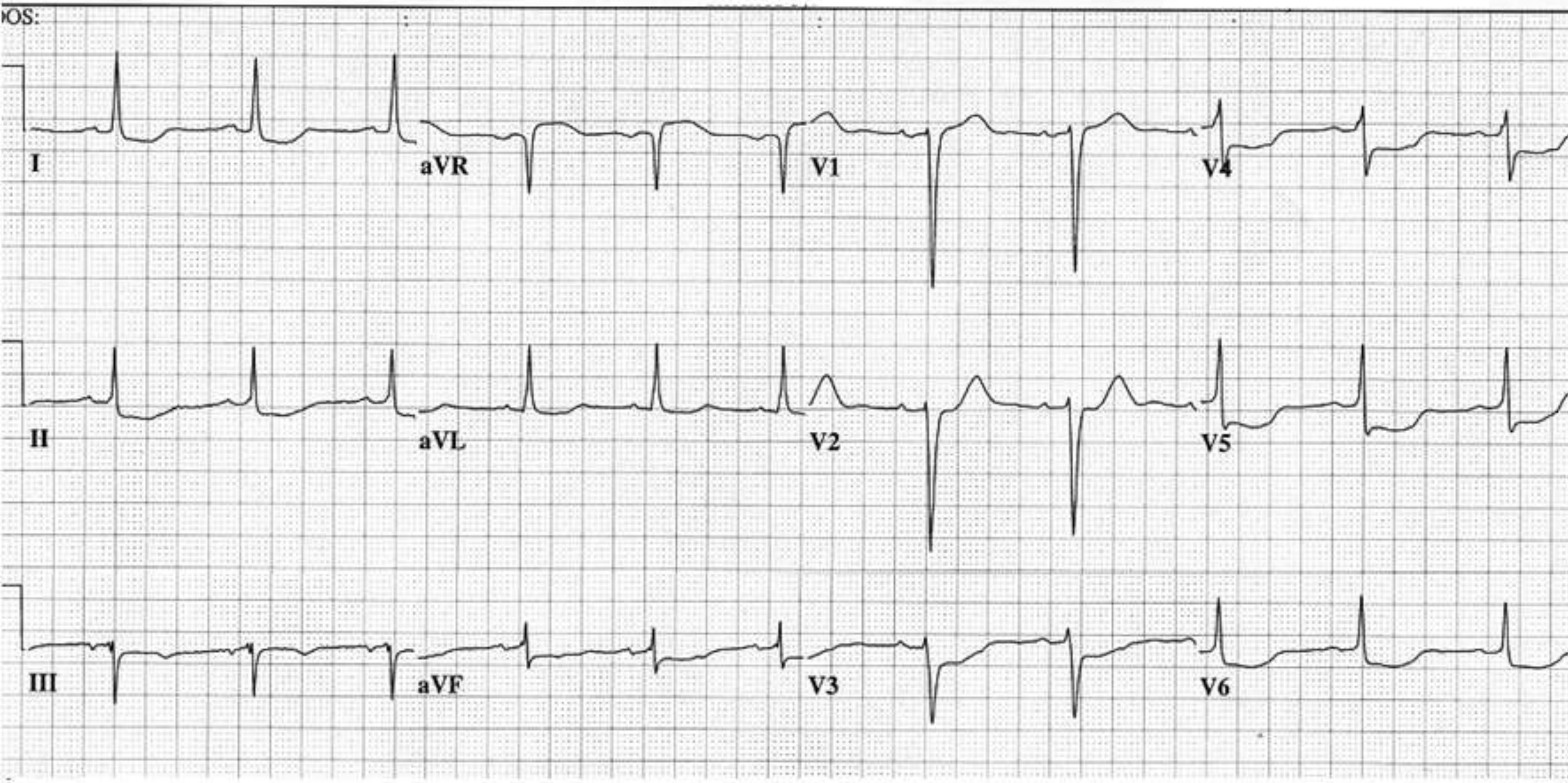
- **STEMI:** consider occlusion of the Left Main Coronary Artery.
- **NSTEMI** and **Unstable Angina** consider LMCA Occlusion – or TRIPLE VESSEL DISEASE

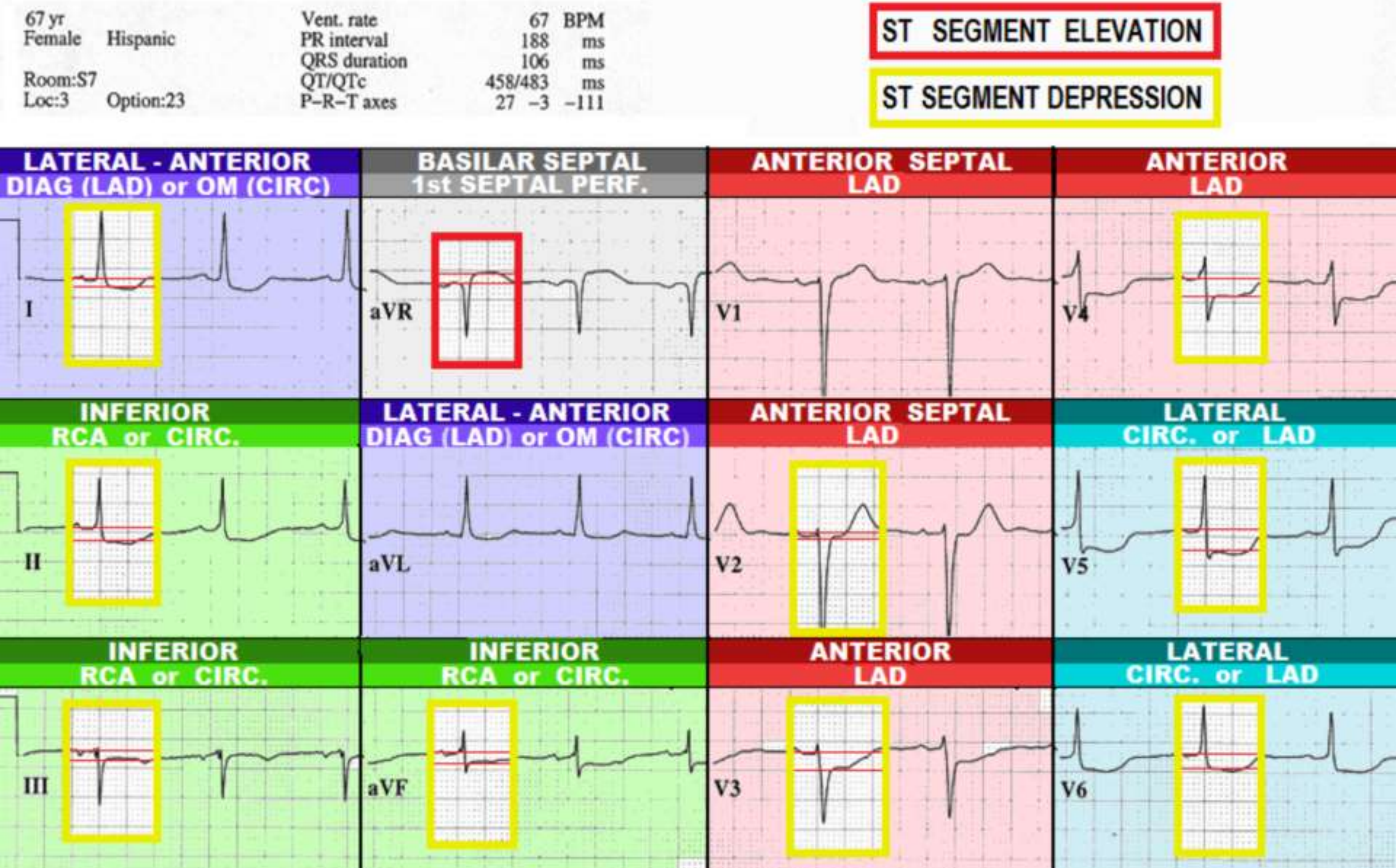
**In patients without STEMI, ST Elevation in AVR, when seen with global indications of ischemia (ST Depression in 8 leads or more), is indicative of advanced multi-vessel disease or significant Left Main Coronary Artery stenosis**

67 yr
Female Hispanic

Room:S7
Loc:3 Option:23

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



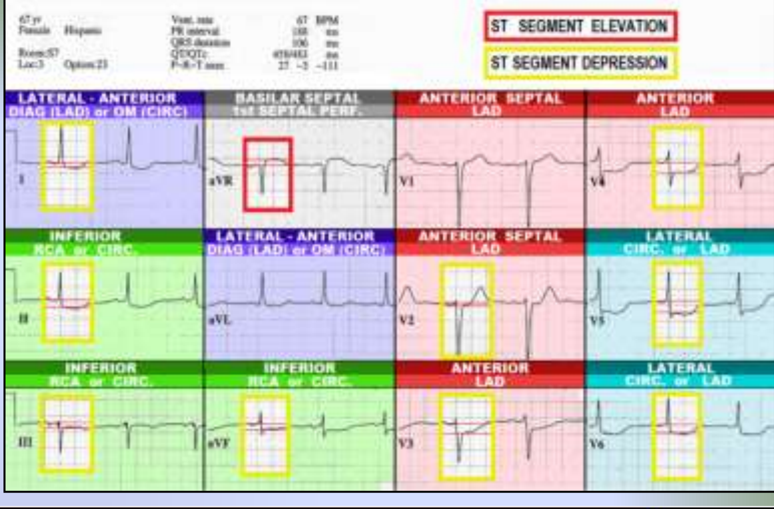


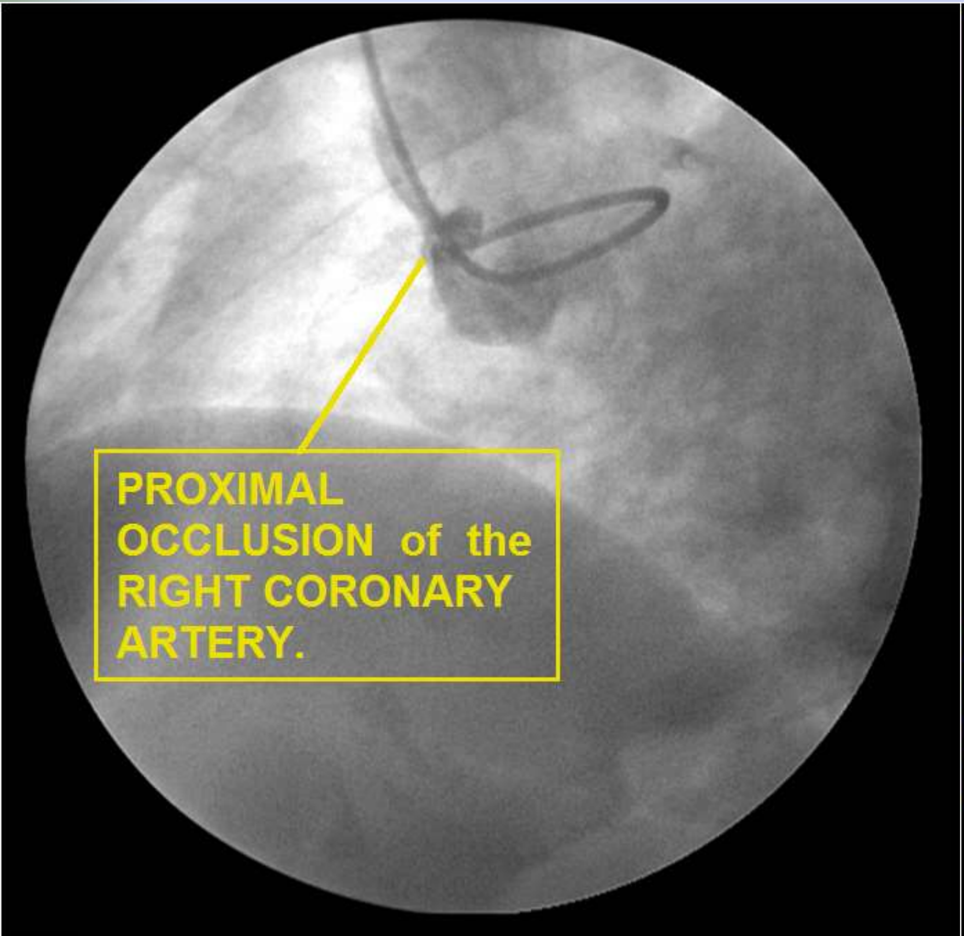
67 yr
Female Hispanic
Room:S7
Loc:3 Option:23
Vent. rate 67 BPM
PR interval 188 ms
QRS duration 106 ms
QT/QTc 458/483 ms
P-R-T axes 27 -3 -111
ST SEGMENT ELEVATION
ST SEGMENT DEPRESSION
LATERAL - ANTERIOR
DIAG (LAD) or OM (CIRC)
I
BASILAR SEPTAL
1st SEPTAL PERF.
aVR
ANTERIOR SEPTAL
LAD
V1
ANTERIOR
LAD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

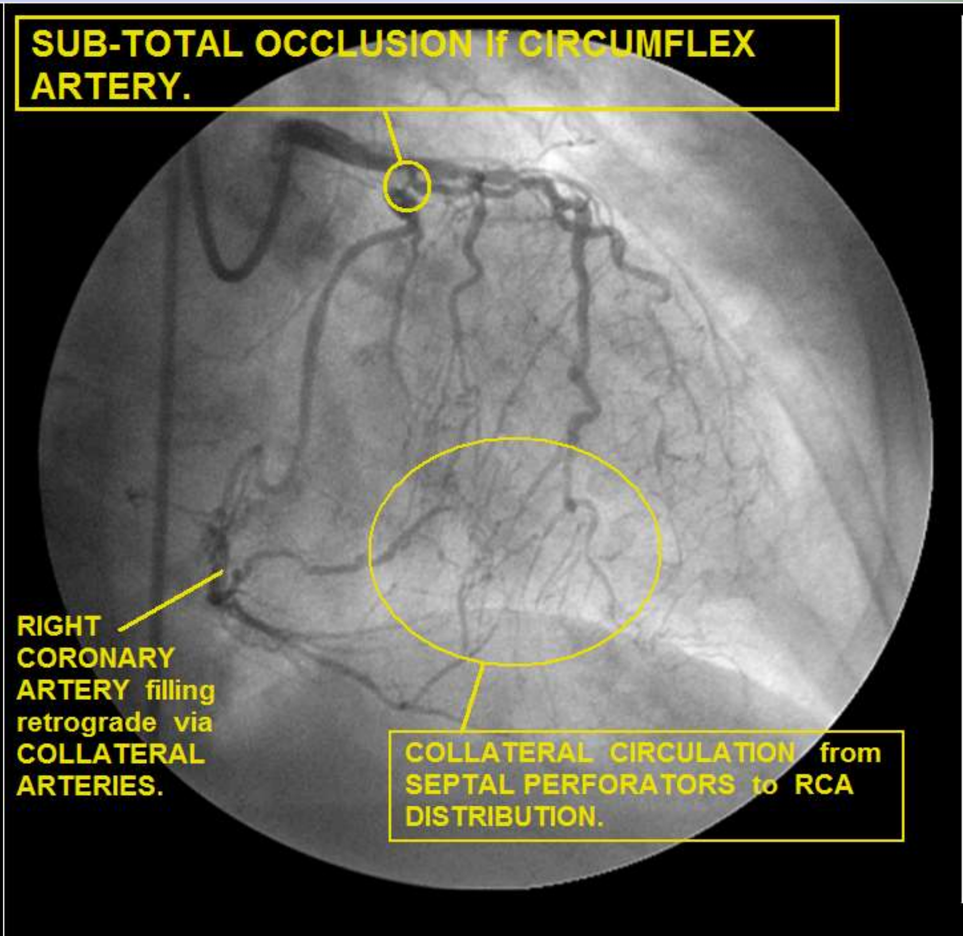
# GLOBAL ISCHEMIA

- **ST Elevation Lead aVR**
- **ST Depression in 8 or more other Leads**
- **Indicates either SUB-TOTALLY OCCLUDED LEFT MAIN CORONARY ARTERY – or – TRIPLE VESSEL DISEASE.**
- ***MOST PATIENTS WITH THIS ECG PRESENTATION REQUIRE OPEN HEART SURGERY.***

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



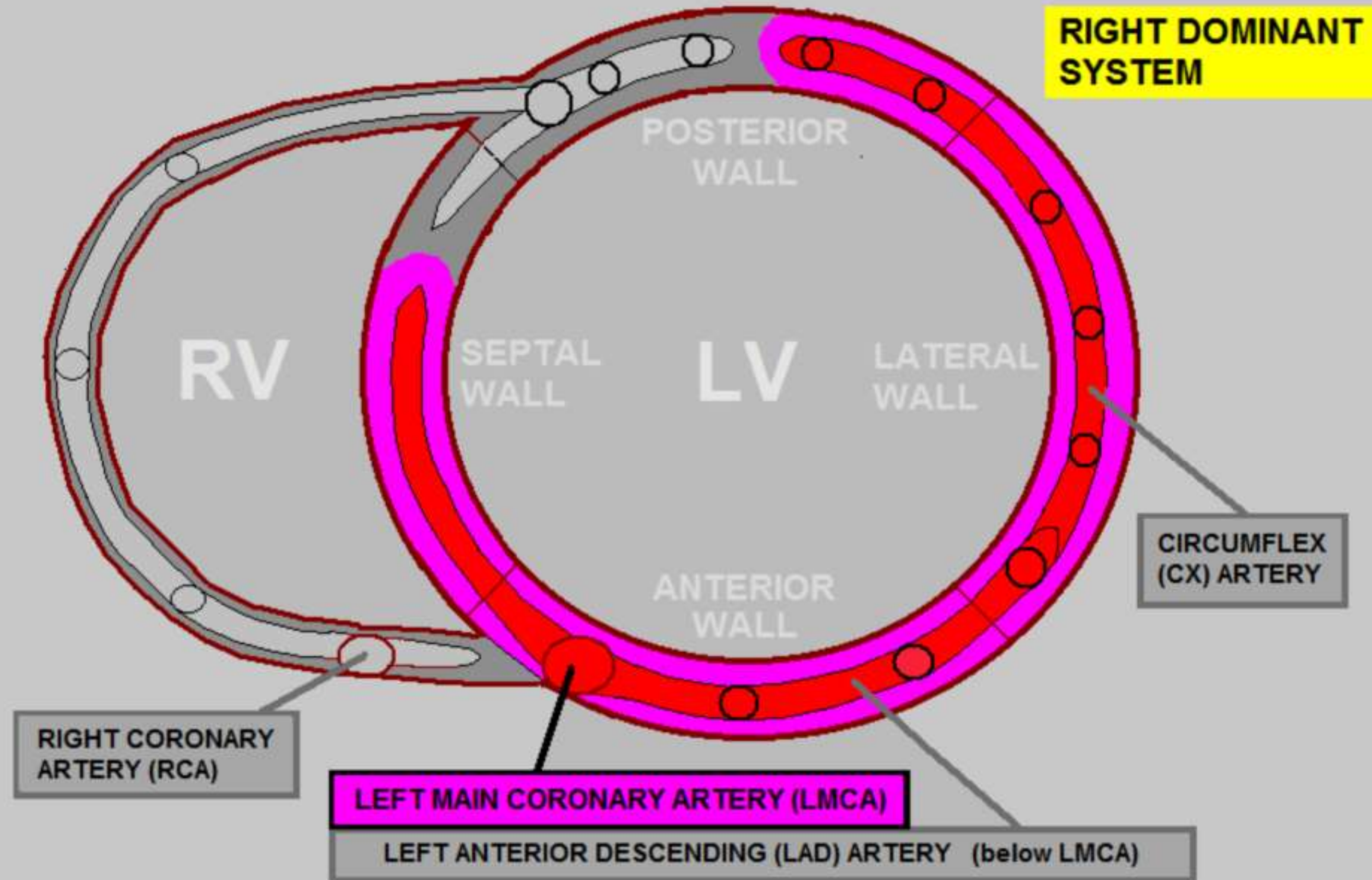



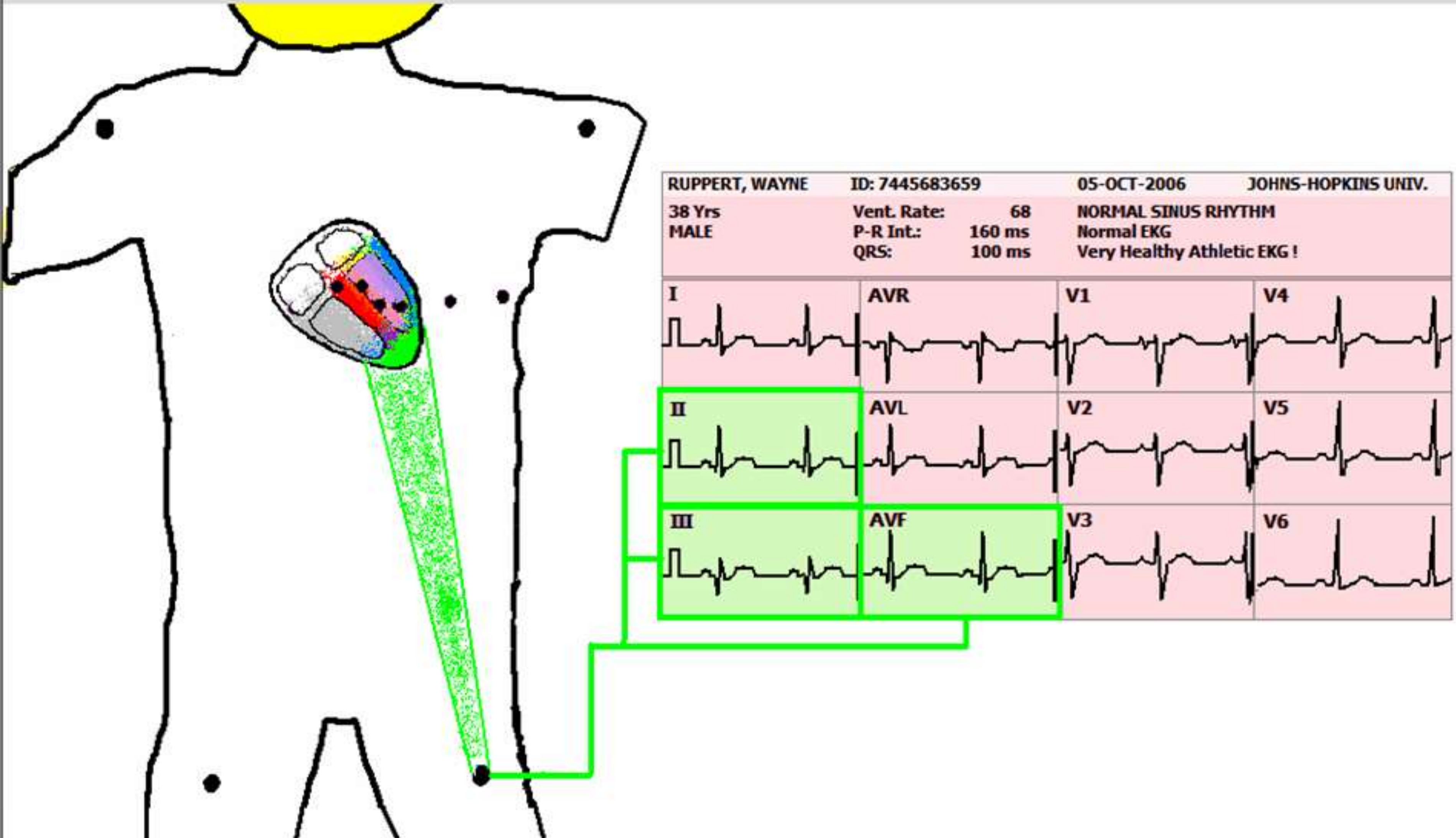
*cutaway view of the*

# LEFT MAIN CORONARY ARTERY (LMCA)

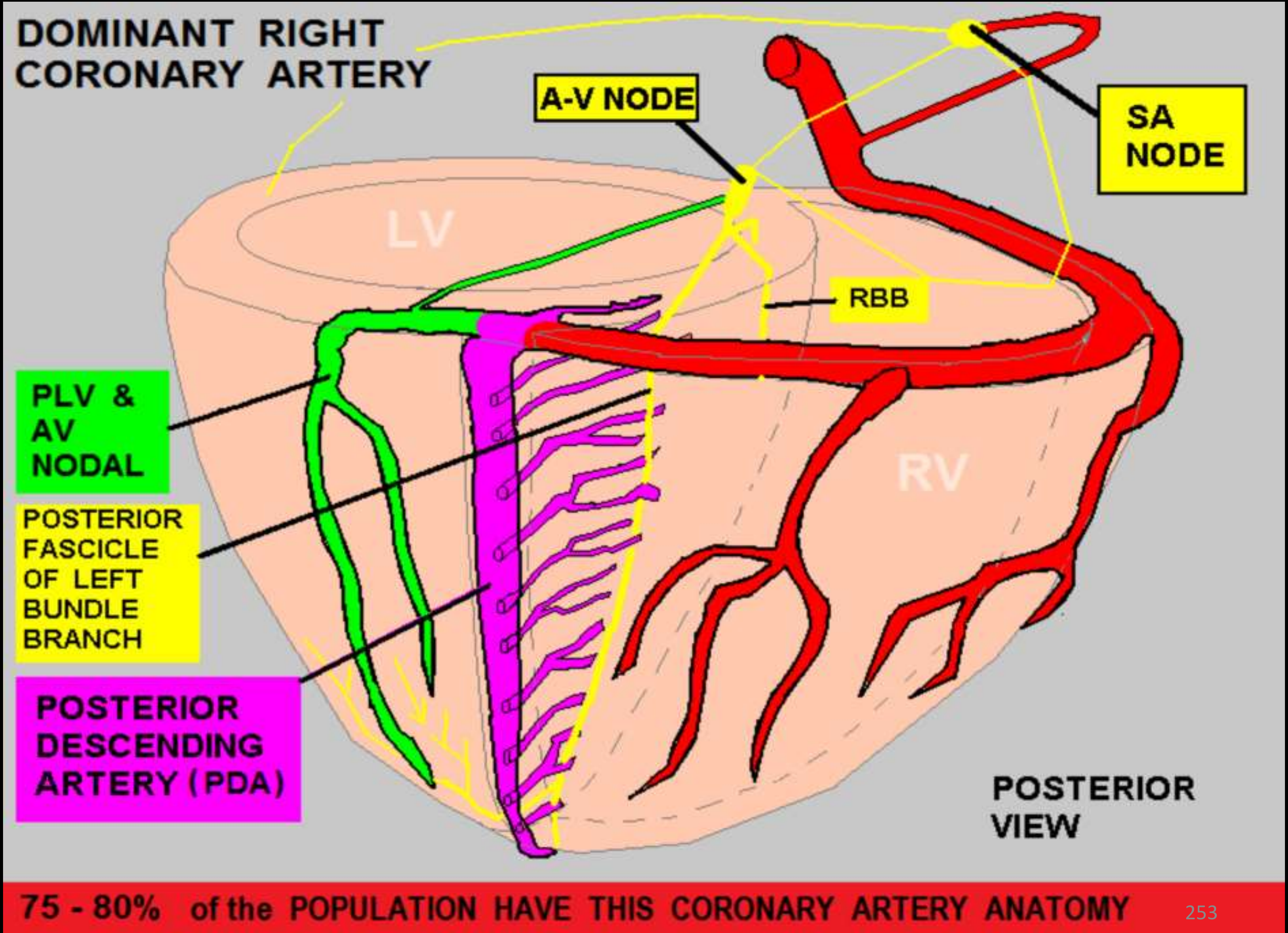
☞ **SUPPLIES APPROXIMATELY 75% OF LV MUSCLE MASS**



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




Which CORONARY ARTERY usually supplies the INFERIOR WALL ?



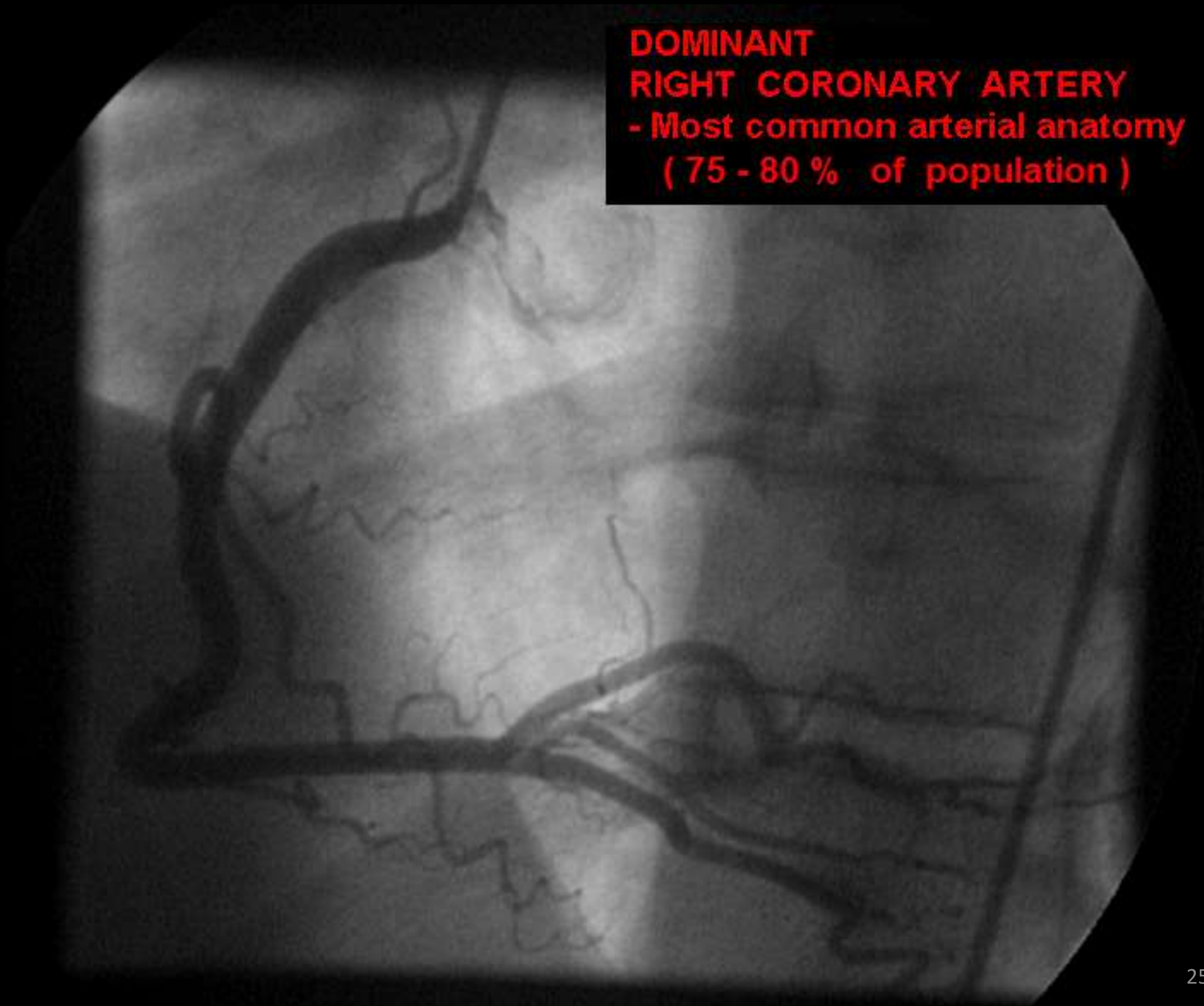
DOMINANT RIGHT CORONARY ARTERY
A-V NODE
SA NODE
LV
RBB
PLV & AV NODAL
POSTERIOR FASCICLE OF LEFT BUNDLE BRANCH
RV
POSTERIOR DESCENDING ARTERY (PDA)
POSTERIOR VIEW
75 - 80% of the POPULATION HAVE THIS CORONARY ARTERY ANATOMY

HELPFUL HINT . . . MEMORIZE THIS !

## RIGHT CORONARY ARTERY ( RCA )

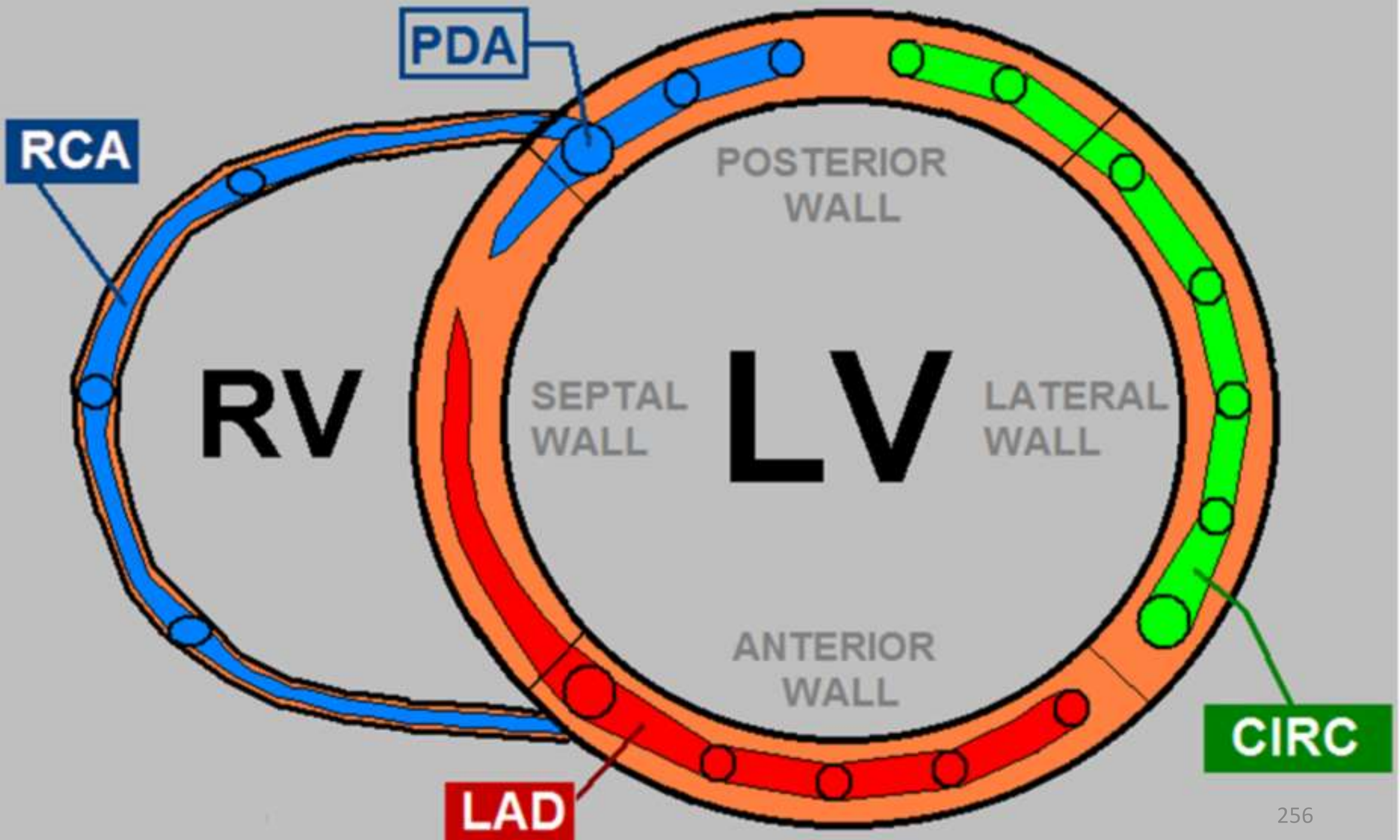
RIGHT DOMINANT SYSTEMS

- 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 )

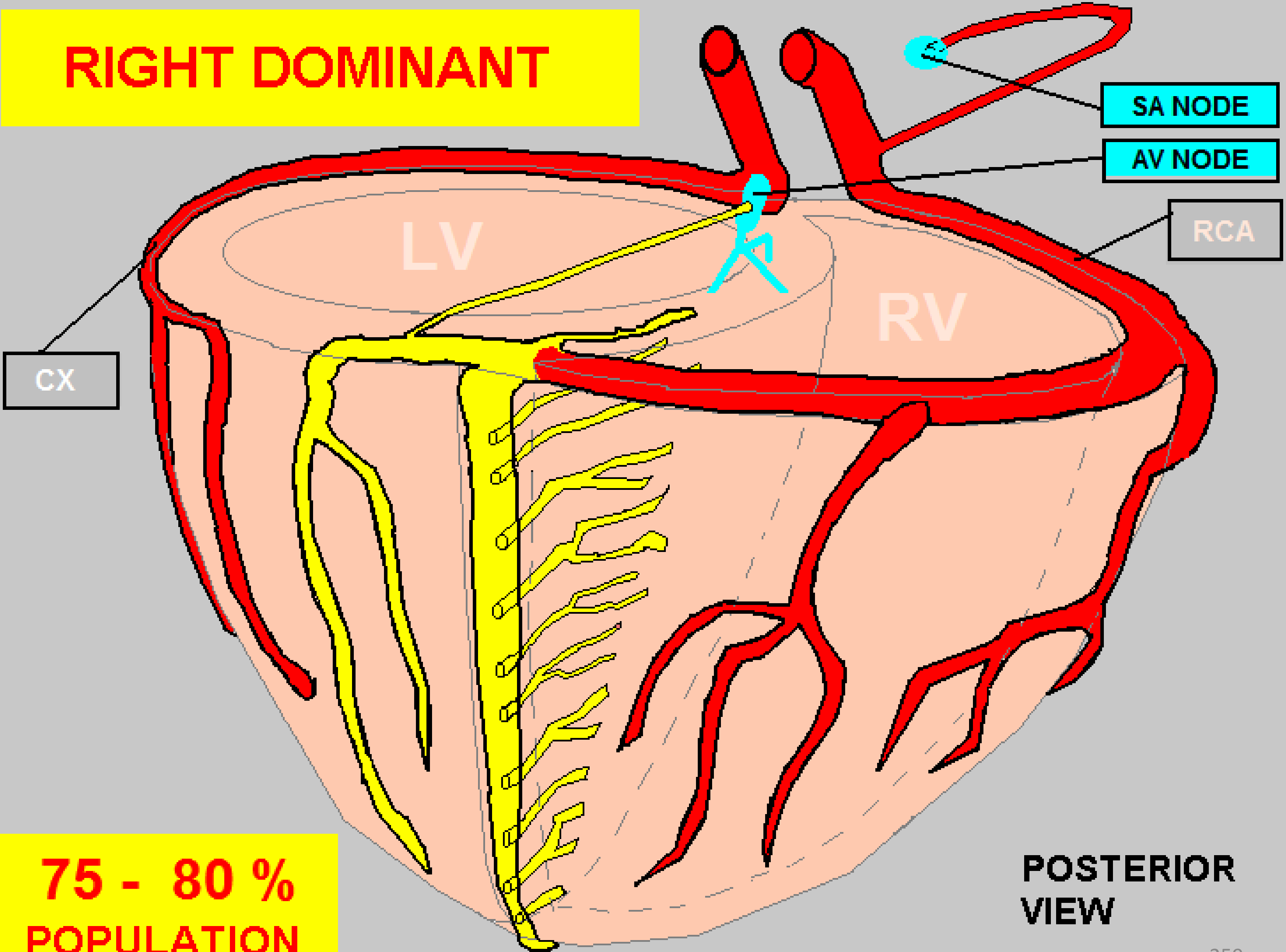
# ARTERIAL DISTRIBUTION - MYOCARDIUM

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% ??**

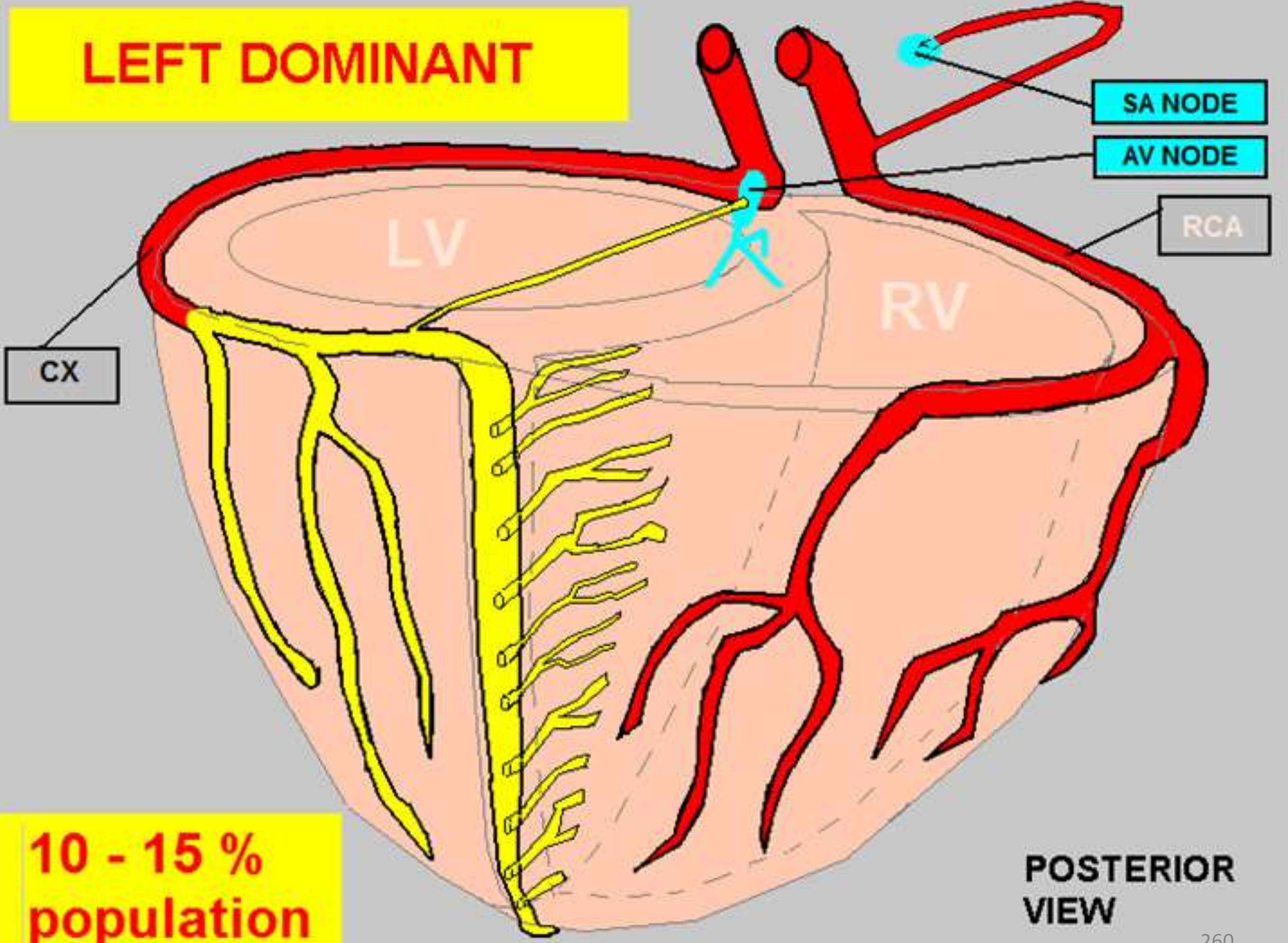
# RIGHT DOMINANT



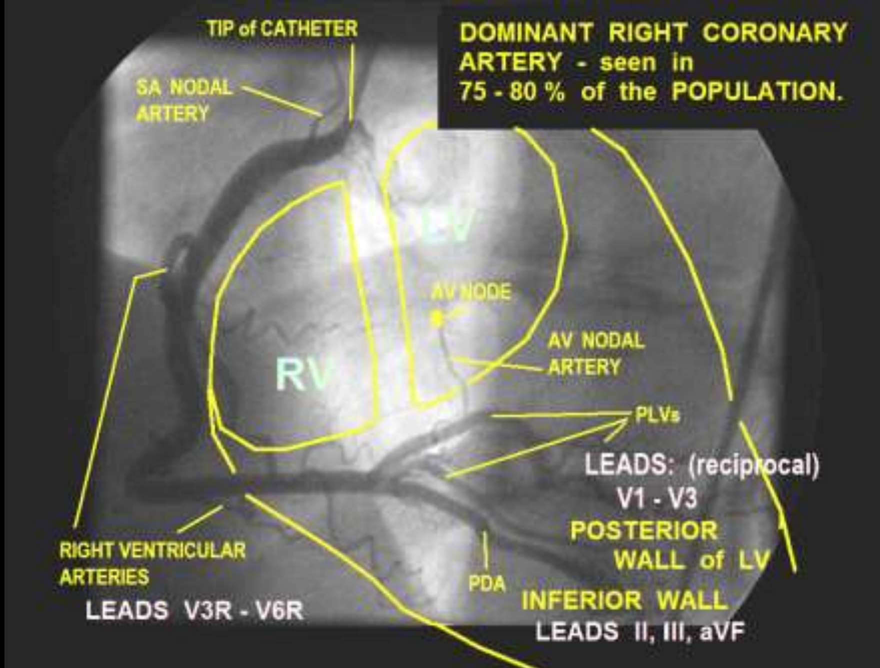

**75 - 80 %**
**POPULATION**

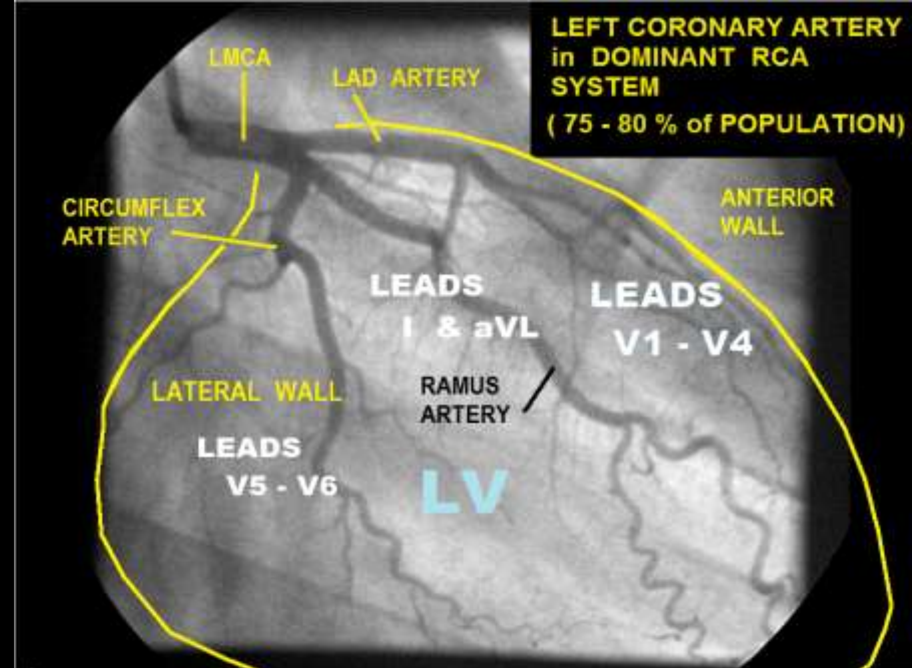
**POSTERIOR VIEW**

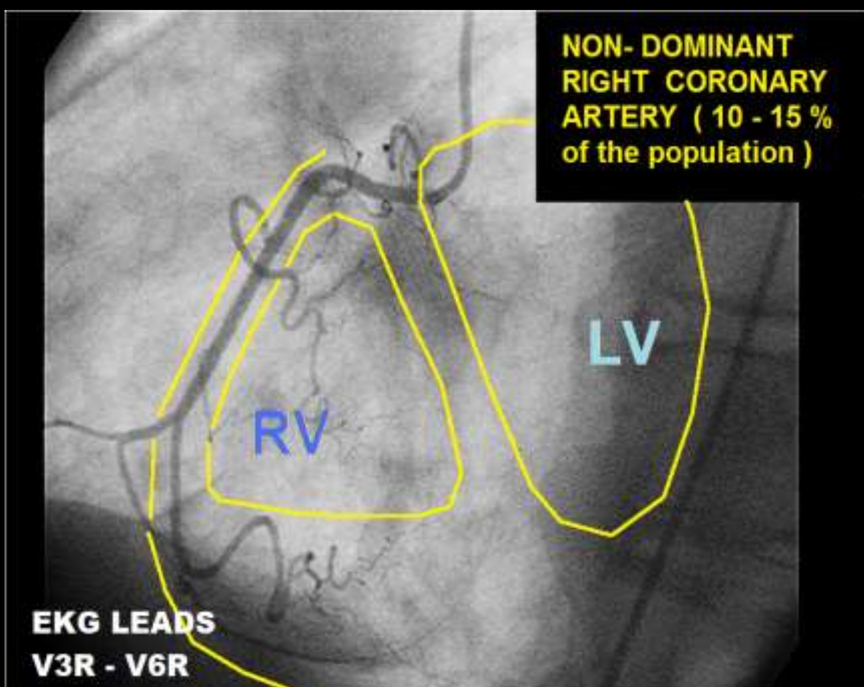
# LEFT DOMINANT

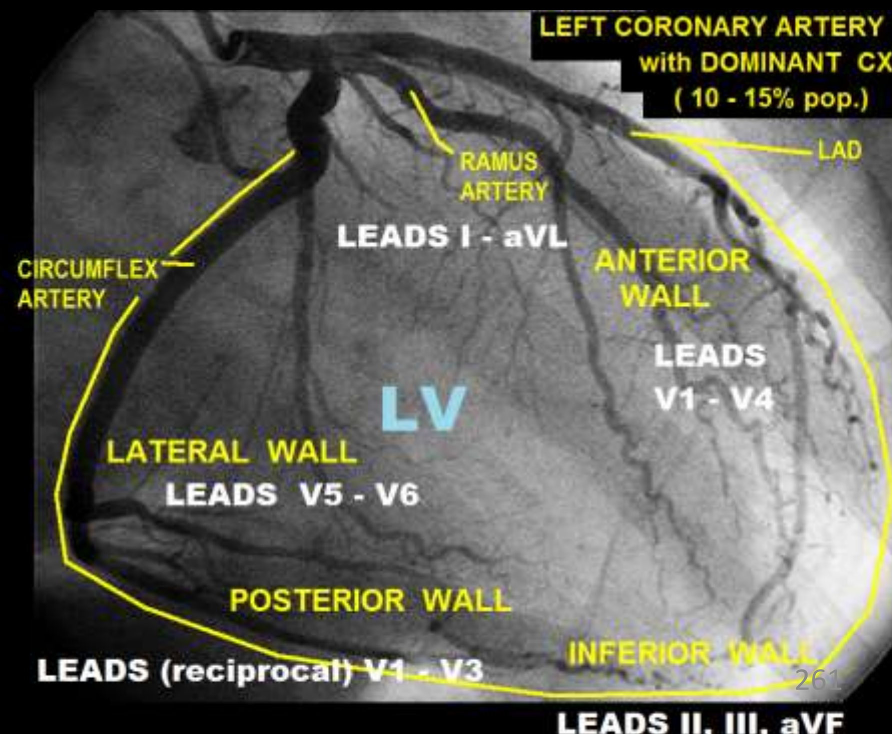


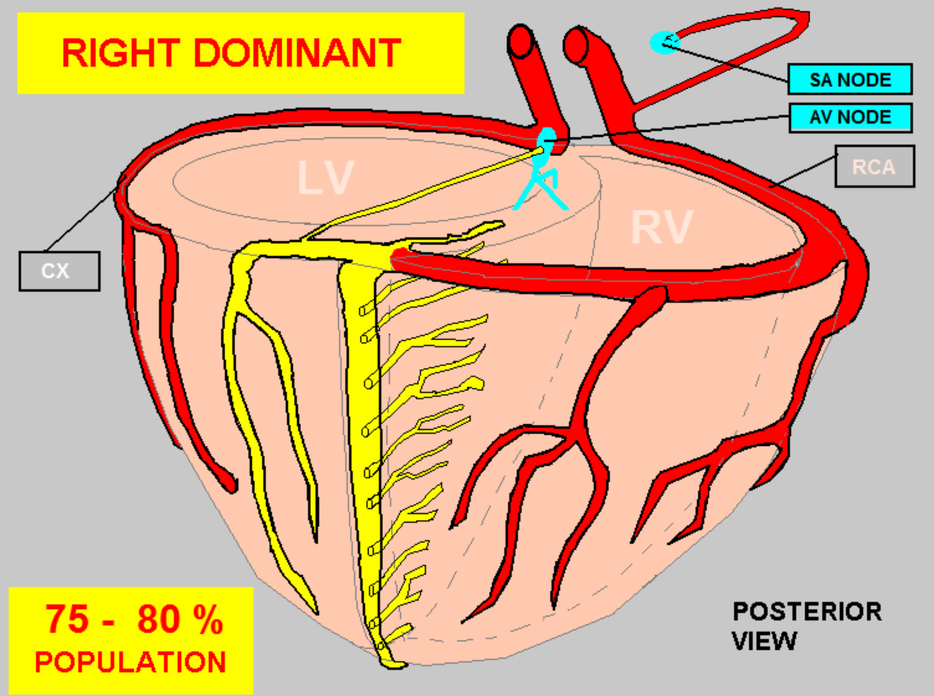

**10 - 15 % population**

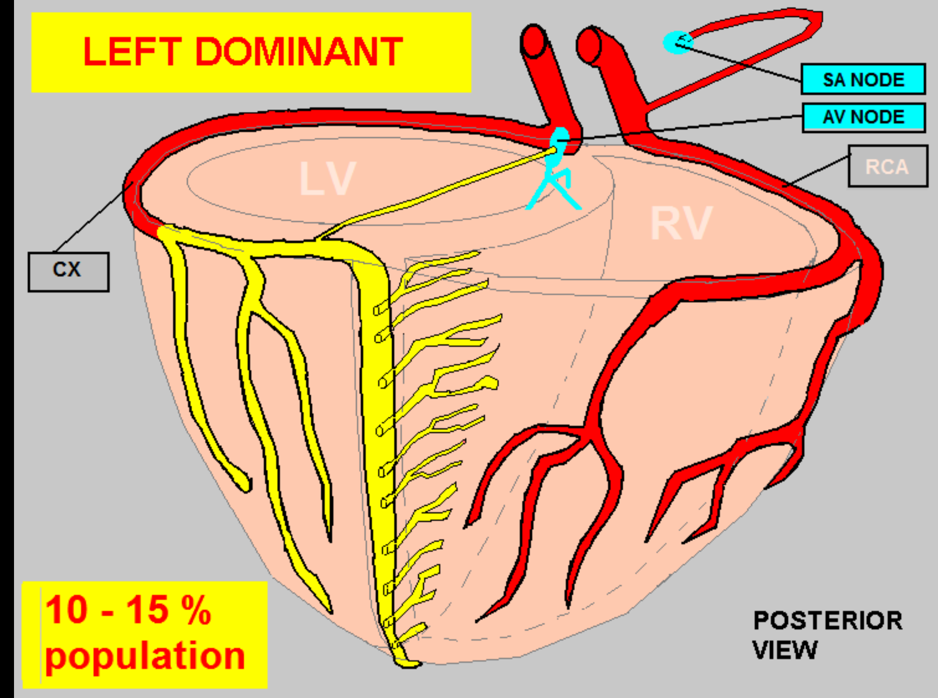

TIP of CATHETER
DOMINANT RIGHT CORONARY ARTERY - seen in 75 - 80 % of the POPULATION.
SA NODAL ARTERY
LV
AV NODE
RV
AV NODAL ARTERY
PLVs
LEADS: (reciprocal) V1 - V3
POSTERIOR WALL of LV
RIGHT VENTRICULAR ARTERIES
LEADS V3R - V6R
PDA
INFERIOR WALL
LEADS II, III, aVF

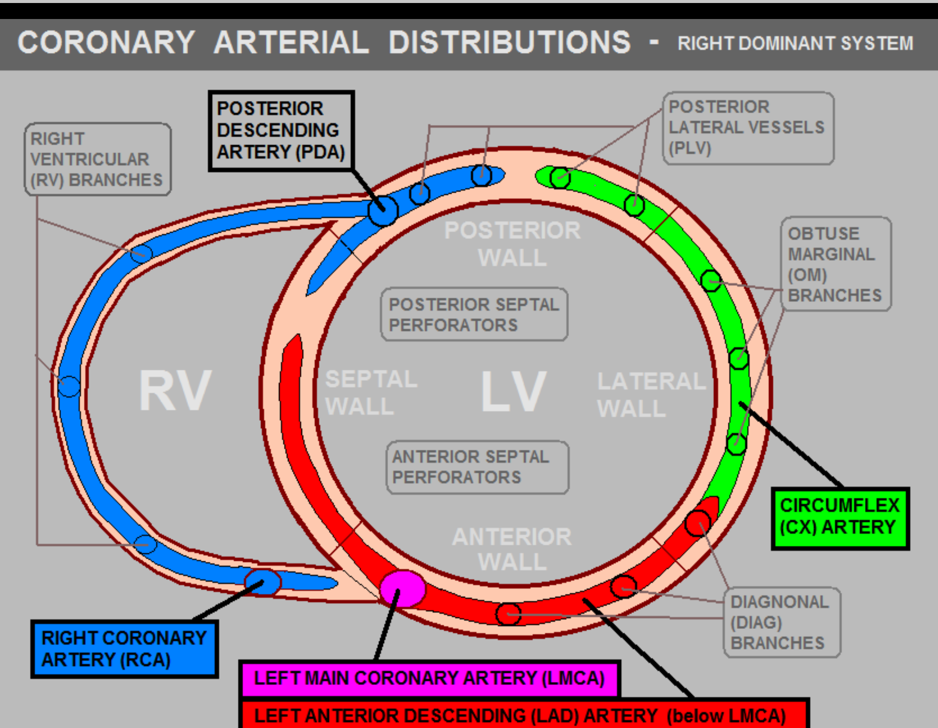

LMCA
LAD ARTERY
LEFT CORONARY ARTERY in DOMINANT RCA SYSTEM
( 75 - 80 % of POPULATION)
CIRCUMFLEX ARTERY
ANTERIOR WALL
LEADS I & aVL
LEADS V1 - V4
LATERAL WALL
RAMUS ARTERY
LEADS V5 - V6
LV

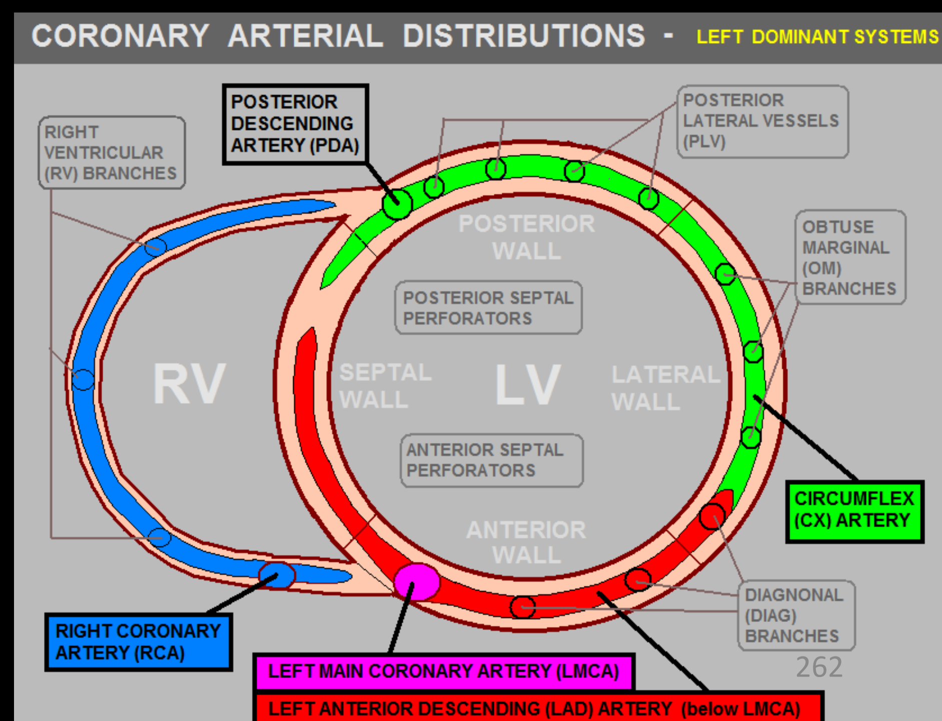

NON- DOMINANT RIGHT CORONARY ARTERY ( 10 - 15 % of the population )
LV
RV
EKG LEADS V3R - V6R


LEFT CORONARY ARTERY with DOMINANT CX ( 10 - 15% pop.)
RAMUS ARTERY
LAD
LEADS I - aVL
CIRCUMFLEX ARTERY
ANTERIOR WALL
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
LV
RV
CX
75 - 80 %
POPULATION
POSTERIOR
VIEW


LEFT DOMINANT
SA NODE
AV NODE
RCA
LV
RV
CX
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)

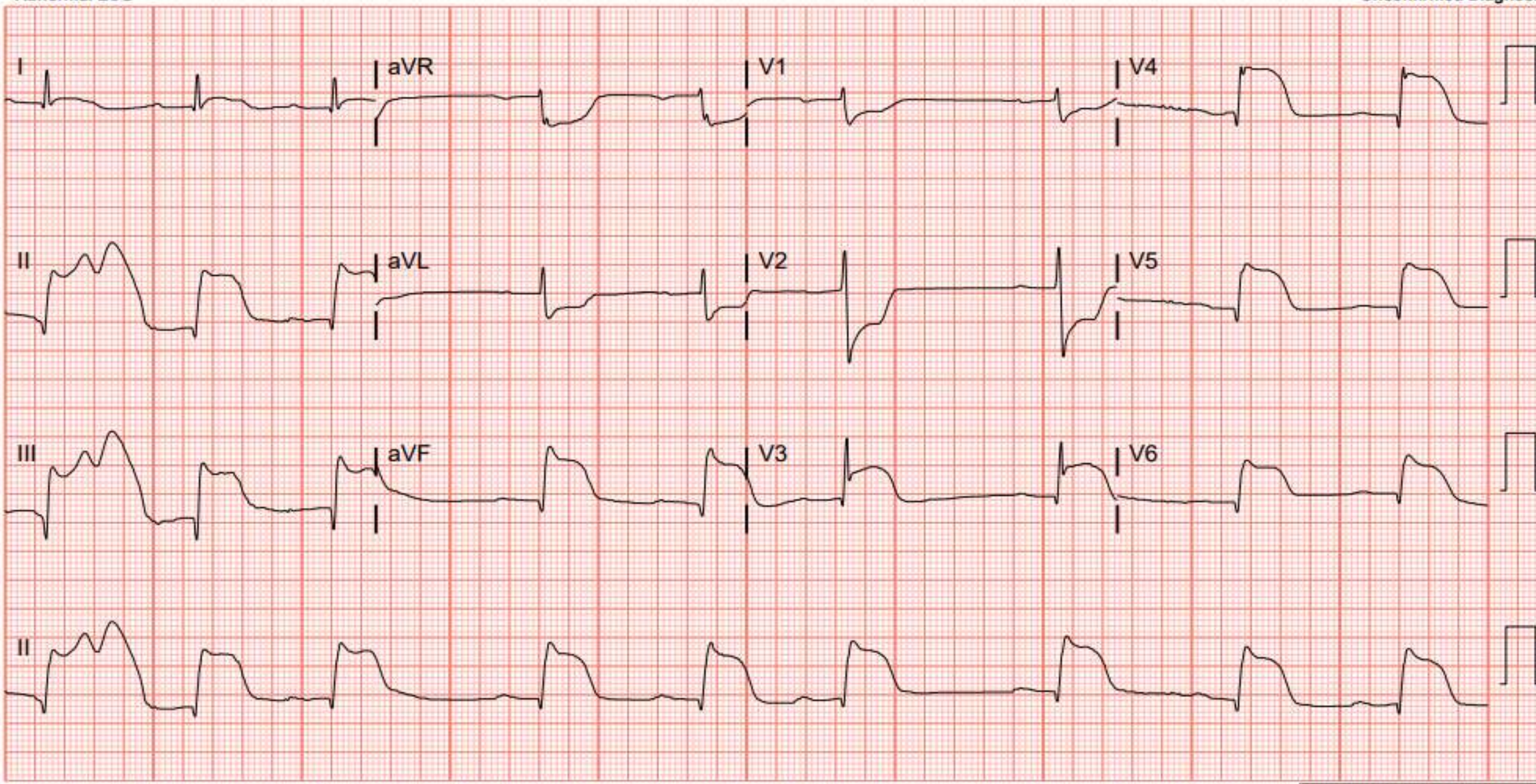
Pat ID [redacted] 01/20/2021 07:46:46 [redacted] Bayfront Health Seven Rivers ED

08/17/1955 65 yrs

| | | | |
|---|---|---|---|
| RX | | Dept | ED |
| DX | Account # [redacted] | Room | EDWR |
| | | Tech | mg |

| | | | |
|---|---|---|---|
| Rate | 54 | Sinus or ectopic atrial rhythm | Req Provider: Xandus Chen |
| PR | 329 | Atrial premature complex | |
| QRSd | 139 | Prolonged PR interval | |
| QT | 437 | Nonspecific intraventricular conduction delay | |
| QTc | 415 | Inferoposterior infarct, acute (LCx) | |
| --Axis-- | | Anterolateral infarct, acute | |
| P | -83 | Baseline wander in lead(s) V3,V4 | |
| QRS | 80 | NO PREVIOUS ECG AVAILABLE FOR COMPARISON | |
| T | 77 | | |

**- Abnormal ECG -** **Unconfirmed Diagnosis**




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

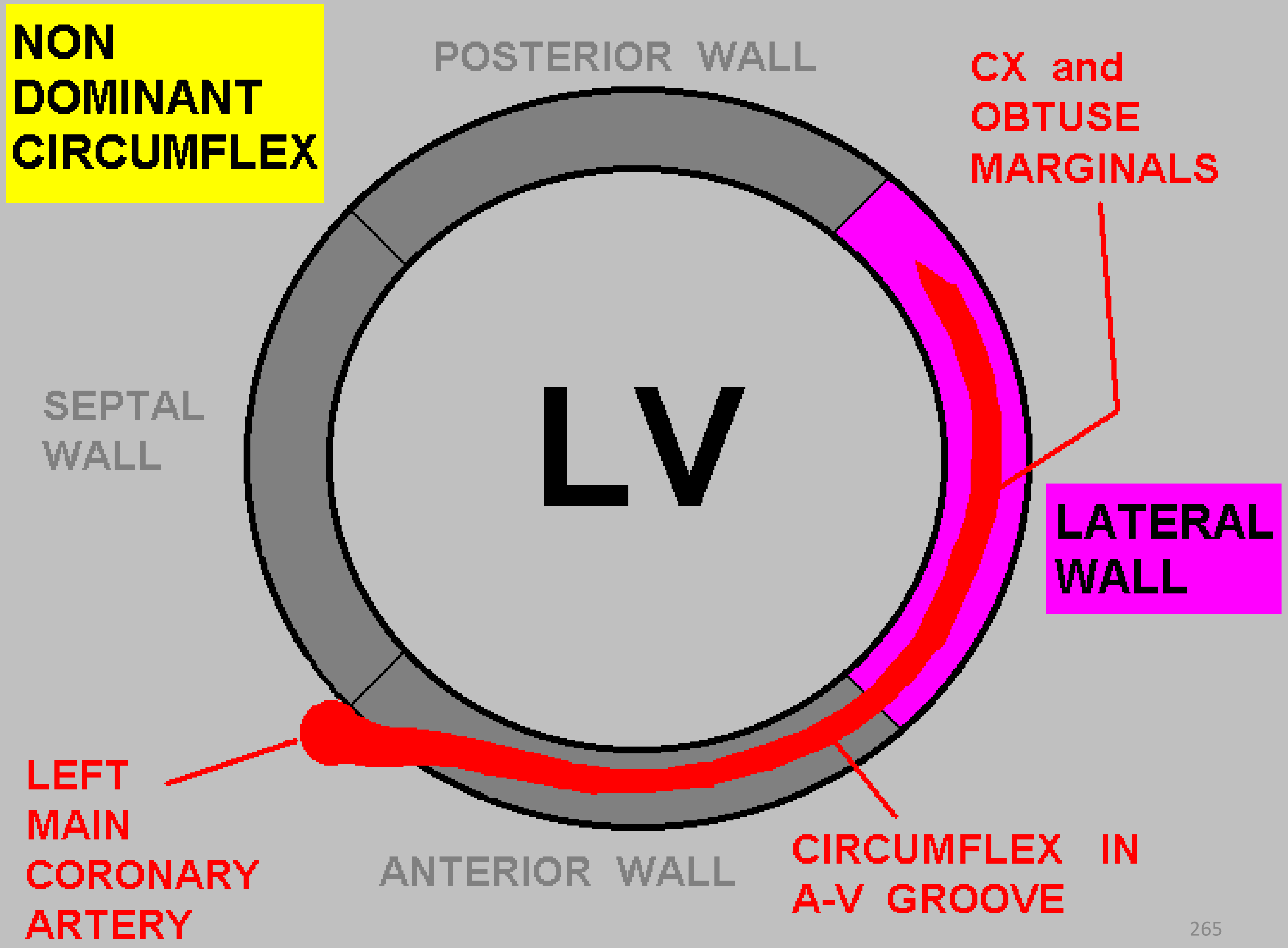
# CIRCUMFLEX ARTERY ( CX )

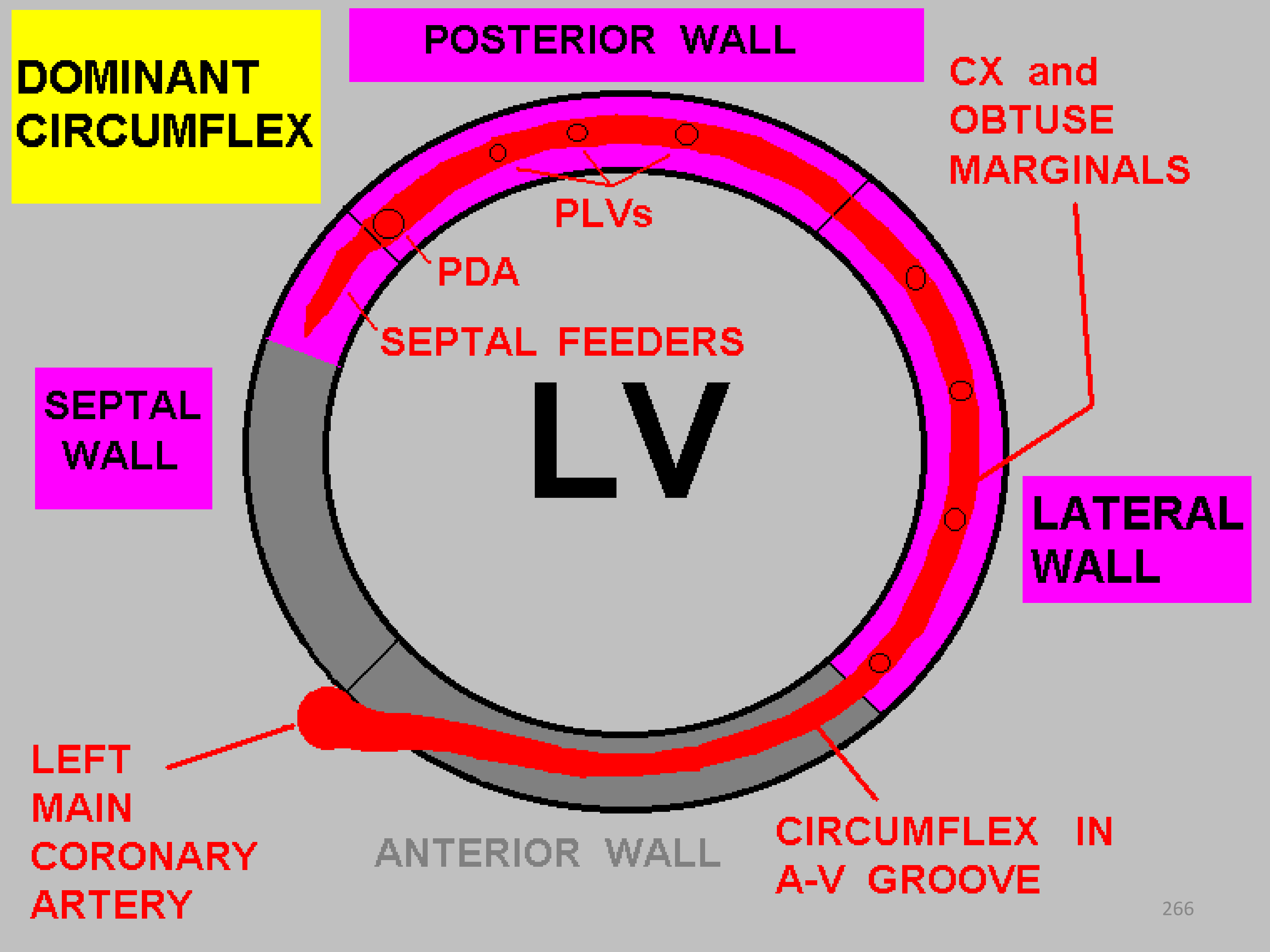
- NON-DOMINANT CX:

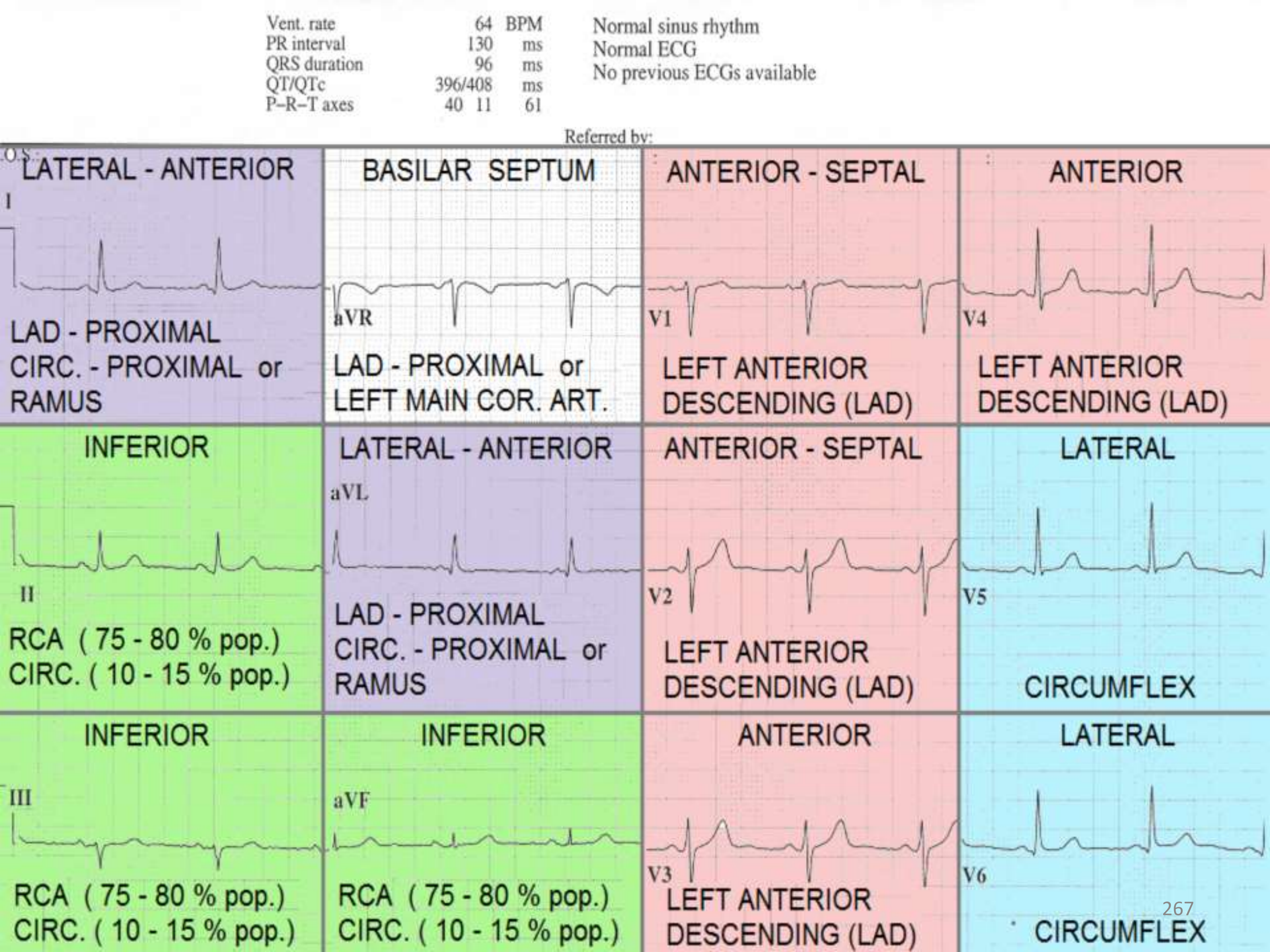
CX = 15 - 30% OF LV MASS

- 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



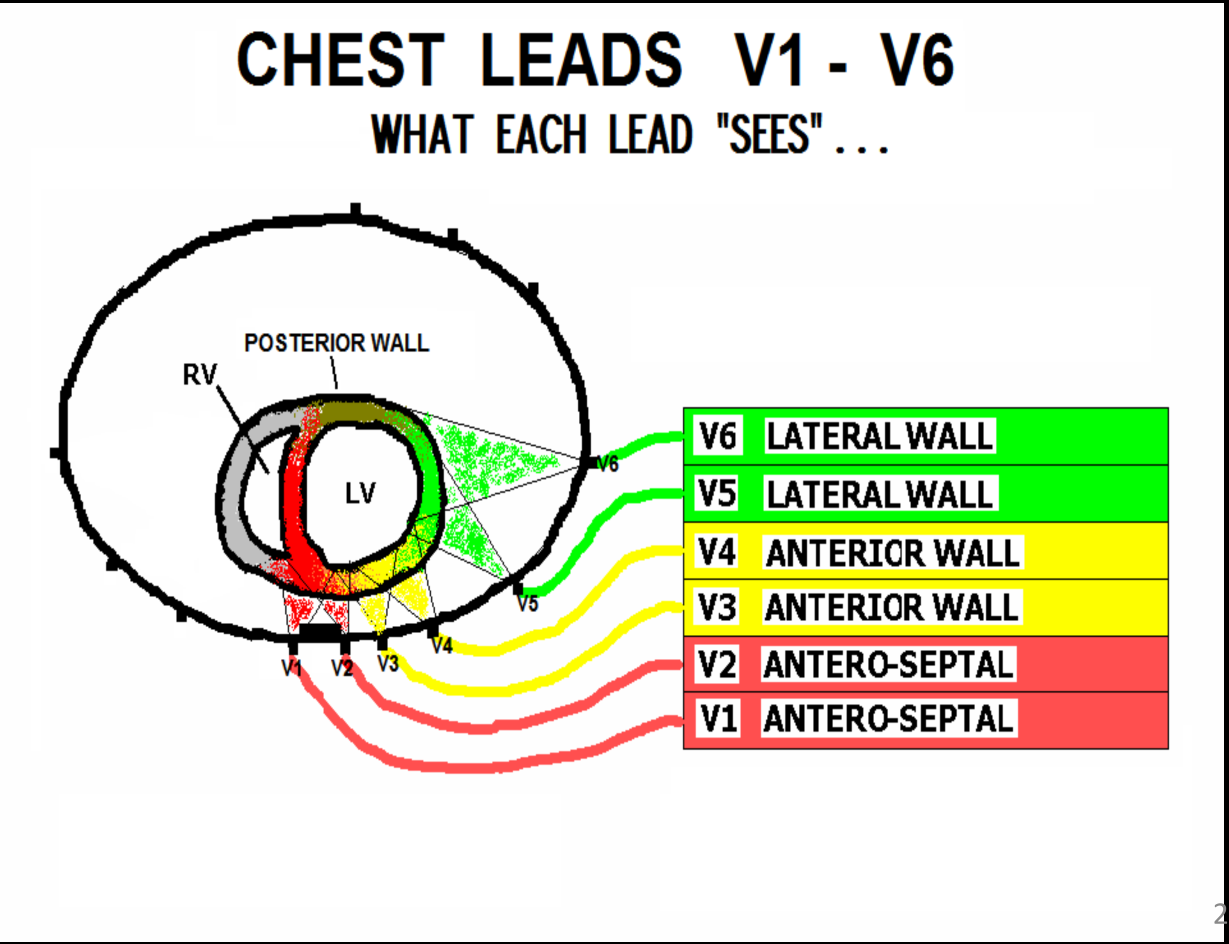
Vent. rate 64 BPM
PR interval 130 ms
QRS duration 96 ms
QT/QTc 396/408 ms
P-R-T axes 40 11 61
Normal sinus rhythm
Normal ECG
No previous ECGs available
Referred by:
LATERAL - ANTERIOR
I
LAD - PROXIMAL
CIRC. - PROXIMAL or
RAMUS
BASILAR SEPTUM
aVR
LAD - PROXIMAL or
LEFT MAIN COR. ART.
ANTERIOR - SEPTAL
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

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

The POSTERIOR WALL

&

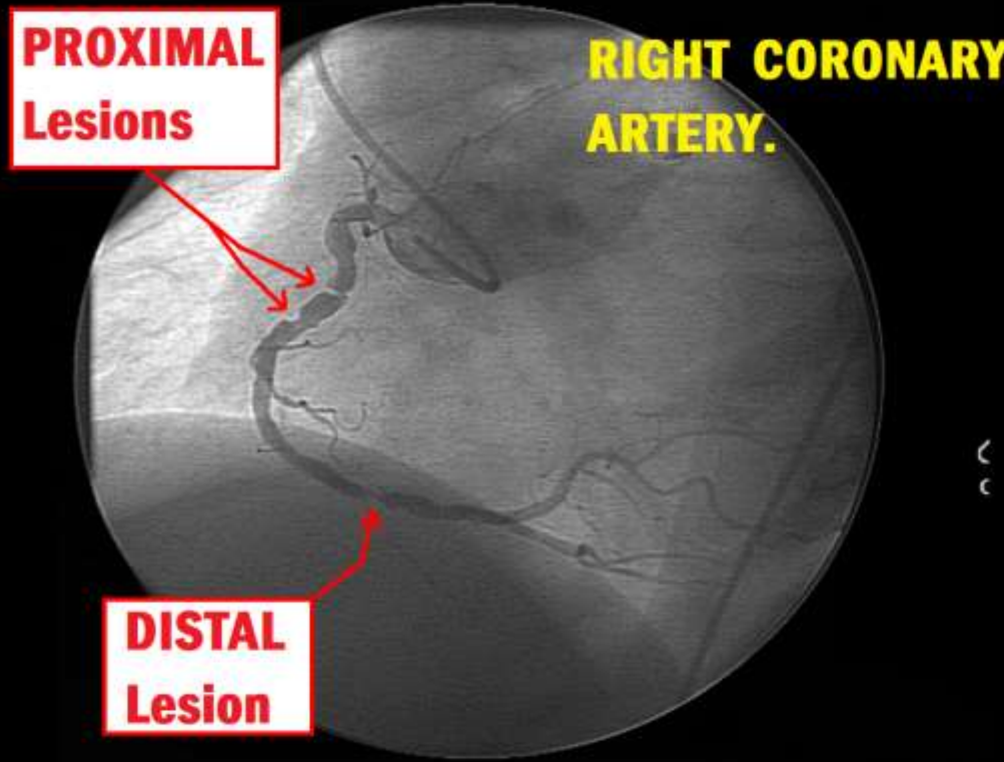
RIGHT VENTRICLE

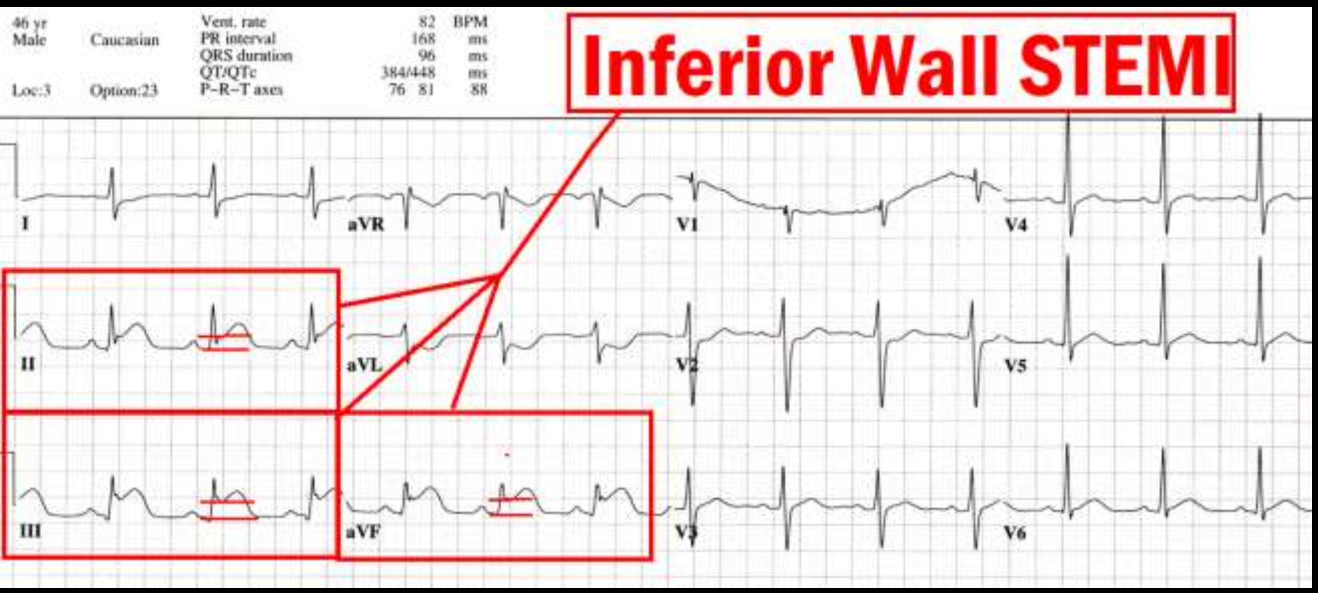


# When do we need to see the Right Ventricle?

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

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



To see the

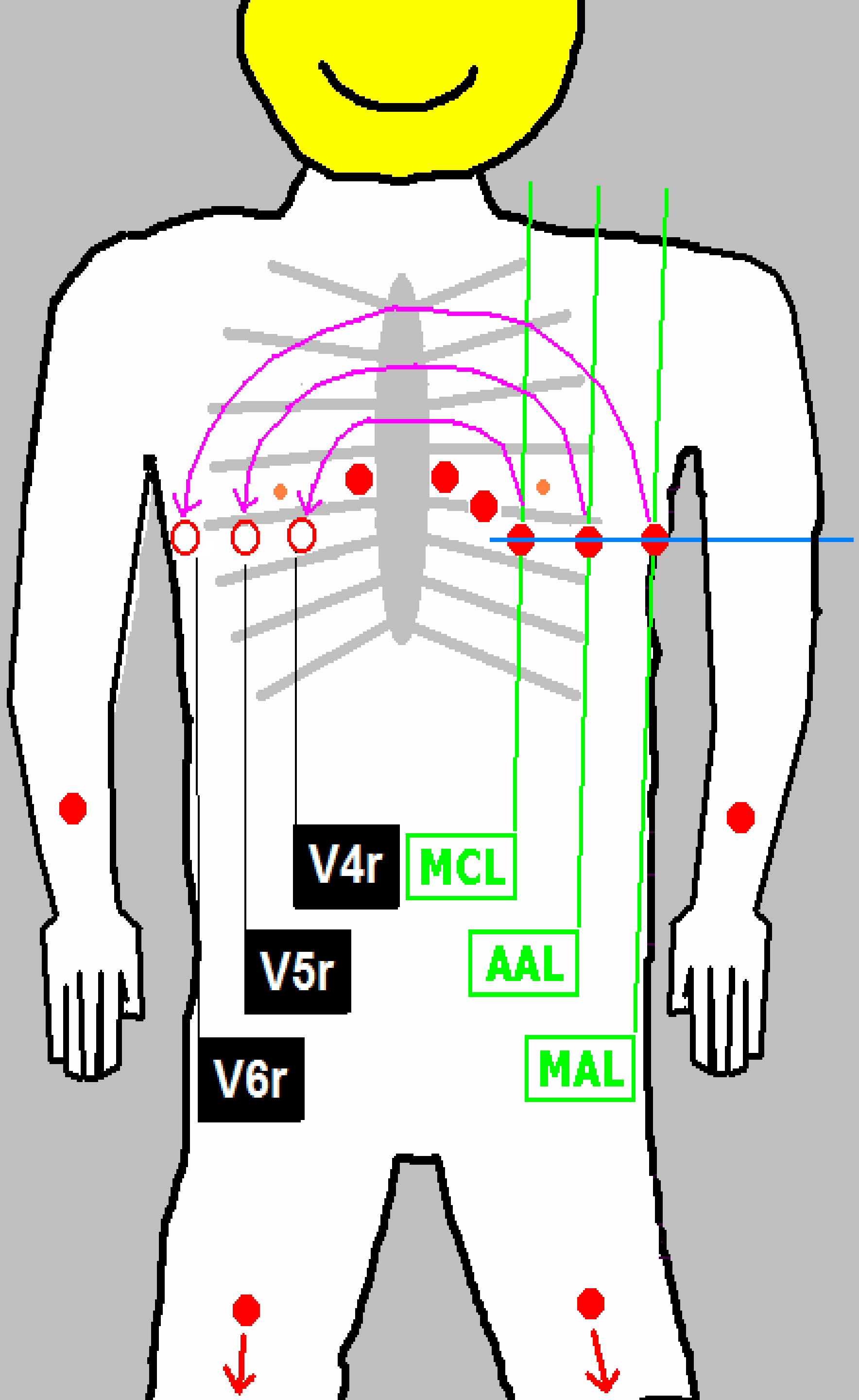
RIGHT VENTRICLE . . .

. . . such as in cases of

INFERIOR WALL M.I.

☞ You must do a

RIGHT - SIDED EKG ! !

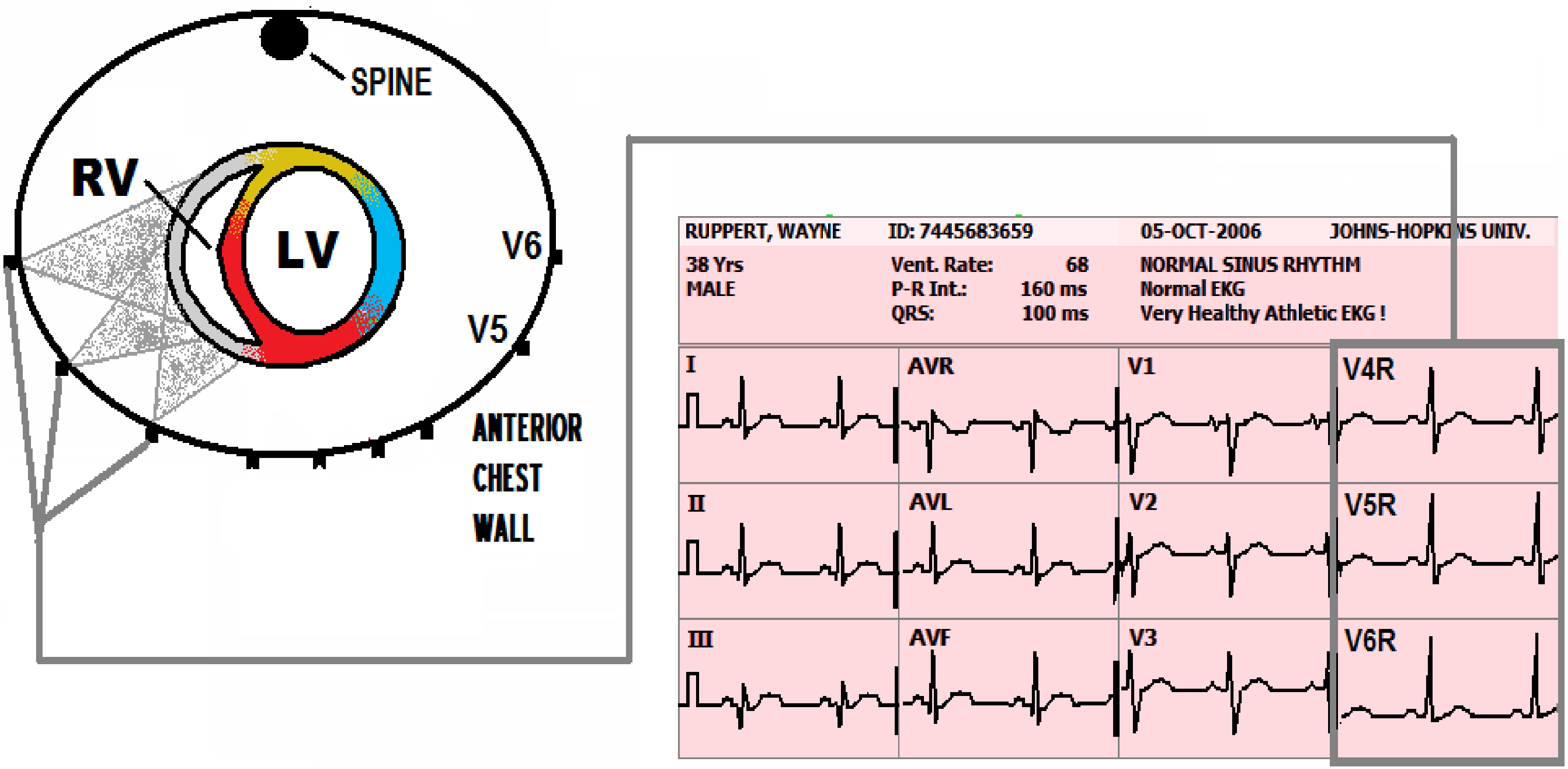



To do a
RIGHT - SIDED EKG . .

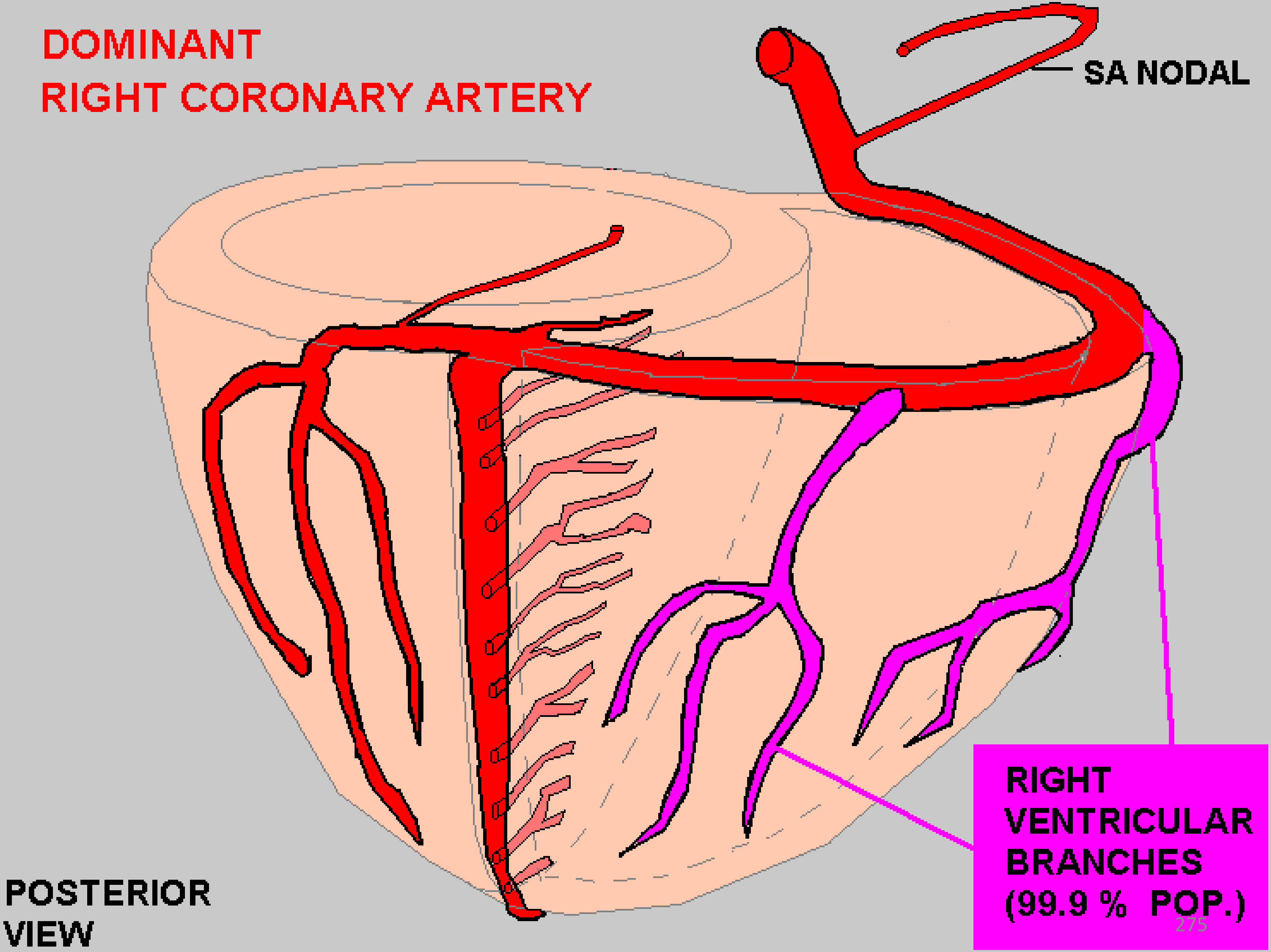
MOVE leads
V4, V5, and V6

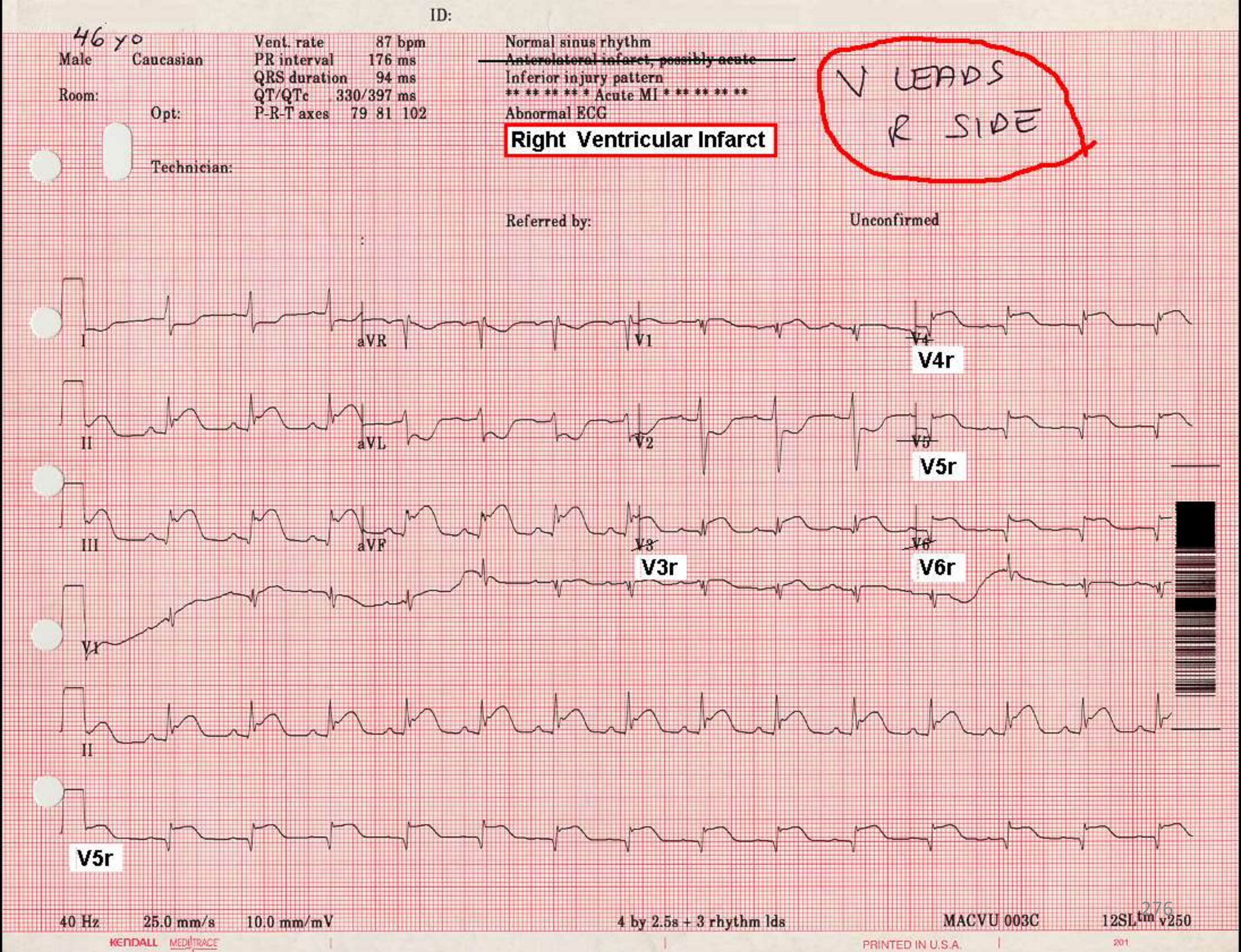
to the corresponding
placement on the
RIGHT SIDE of patient's
chest . . .

# V4R - V6R VIEW THE RIGHT VENTRICLE



## DOMINANT RIGHT CORONARY ARTERY




ID:
46 yo
Male Caucasian
Room:
Opt:
Technician:
Vent. rate 87 bpm
PR interval 176 ms
QRS duration 94 ms
QT/QTc 330/397 ms
P-R-T axes 79 81 102
Normal sinus rhythm
~~Anterolateral infarct, possibly acute~~
Inferior injury pattern
** ** ** ** * Acute MI * ** ** ** **
Abnormal ECG
Right Ventricular Infarct
V LEADS R SIDE
Referred by:
Unconfirmed
I
aVR
V1
V4
V4r
II
aVL
V2
V5
V5r
III
aVF
V3
V3r
V6
V6r
V1
II
V5r
40 Hz 25.0 mm/s 10.0 mm/mV
4 by 2.5s + 3 rhythm lds
MACVU 003C
12SLtm v250
KENDALL MEDITRACE
PRINTED IN U.S.A.
201

# When do we need to see the Posterior Wall?

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

Whenever you see

**ST DEPRESSION** in Leads V1 - V4

☞ you must do a

**POSTERIOR LEAD ECG**

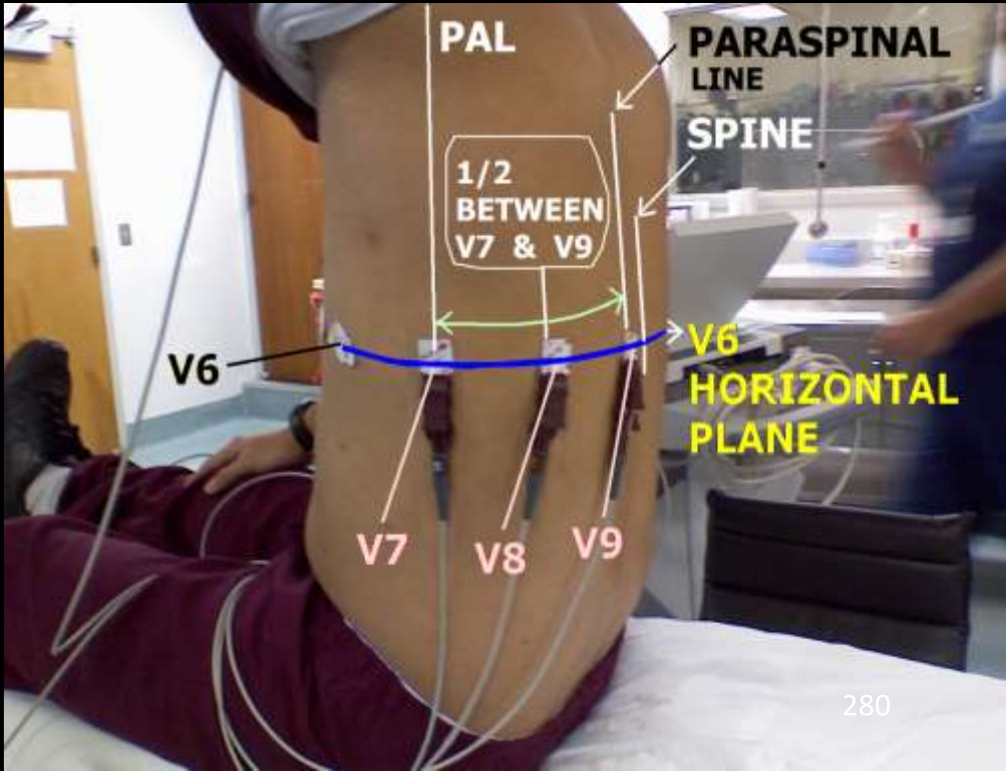
( V7 - V9 )

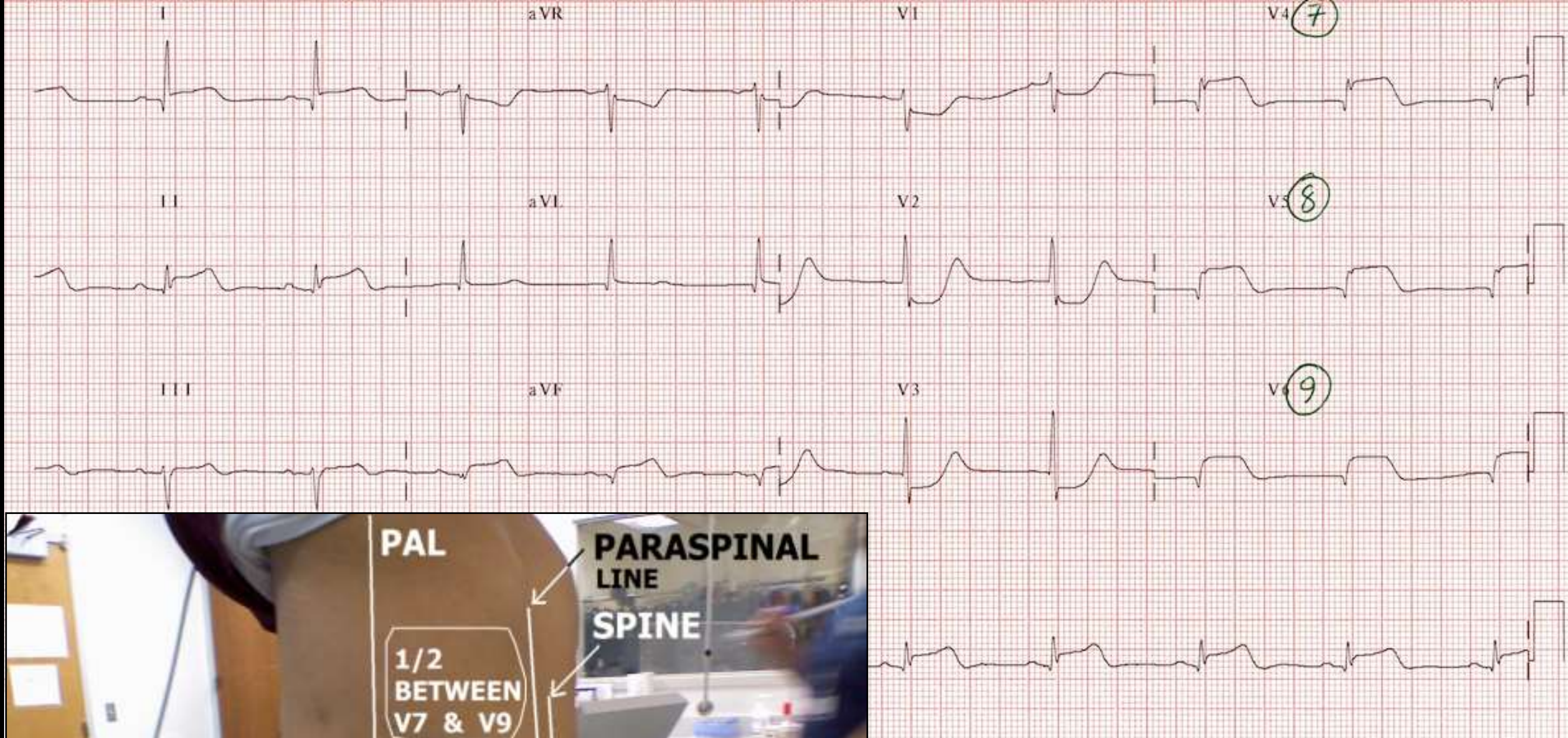
to see if you Patient is having a

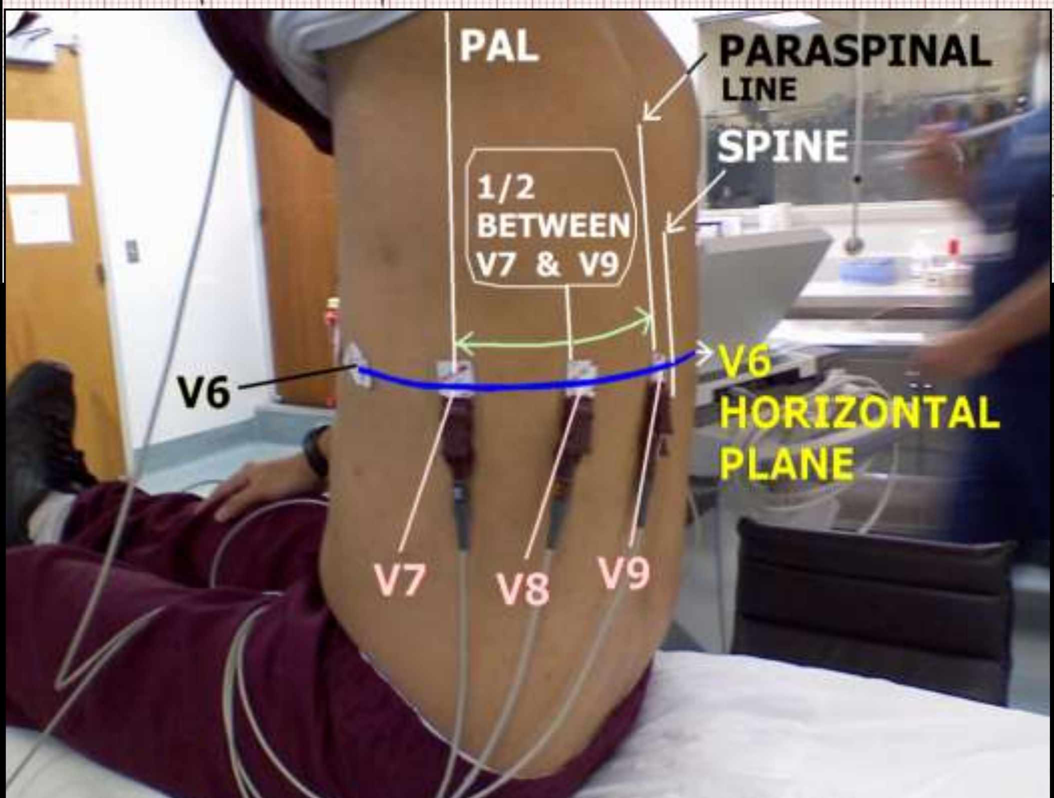
**POSTERIOR WALL STEMI**

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

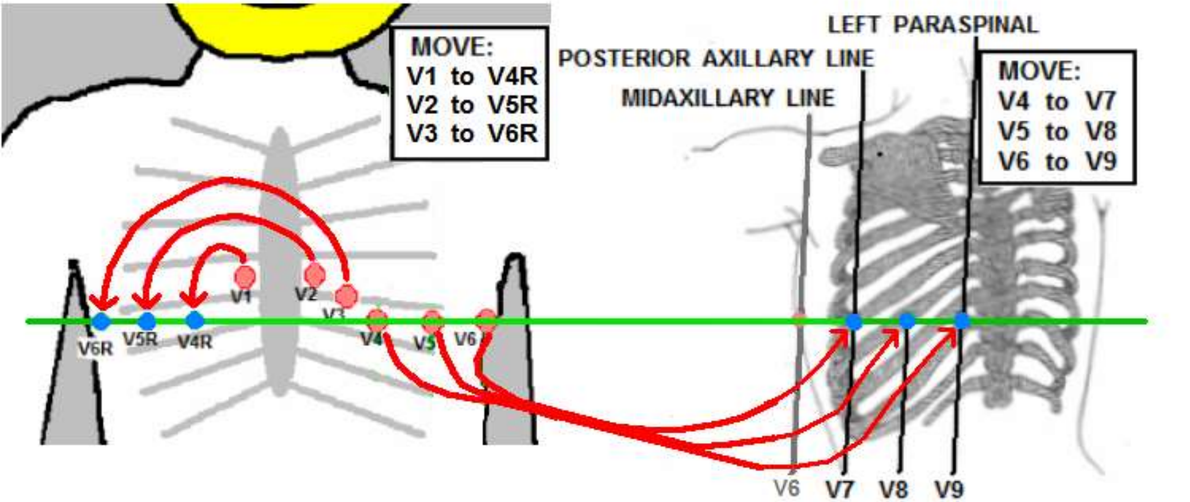
. . . To DIGANOSE Posterior Wall STEMI, we should see LEADS V7 – V9 !!




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

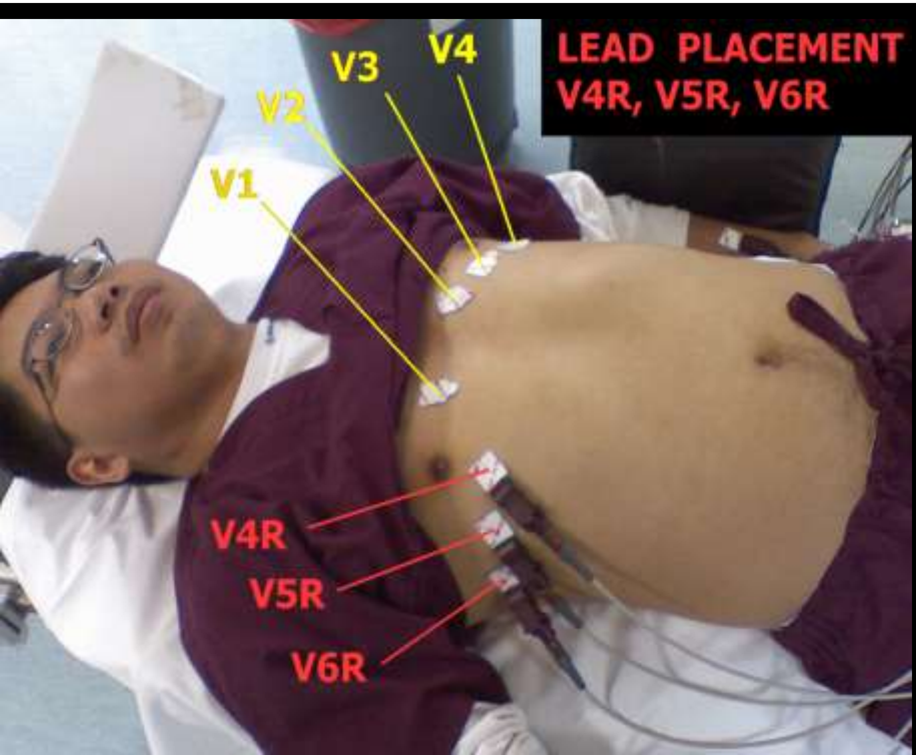

PAL
PARASPINAL
LINE
SPINE
1/2
BETWEEN
V7 & V9
V6
V6
HORIZONTAL
PLANE
V7
V8
V9

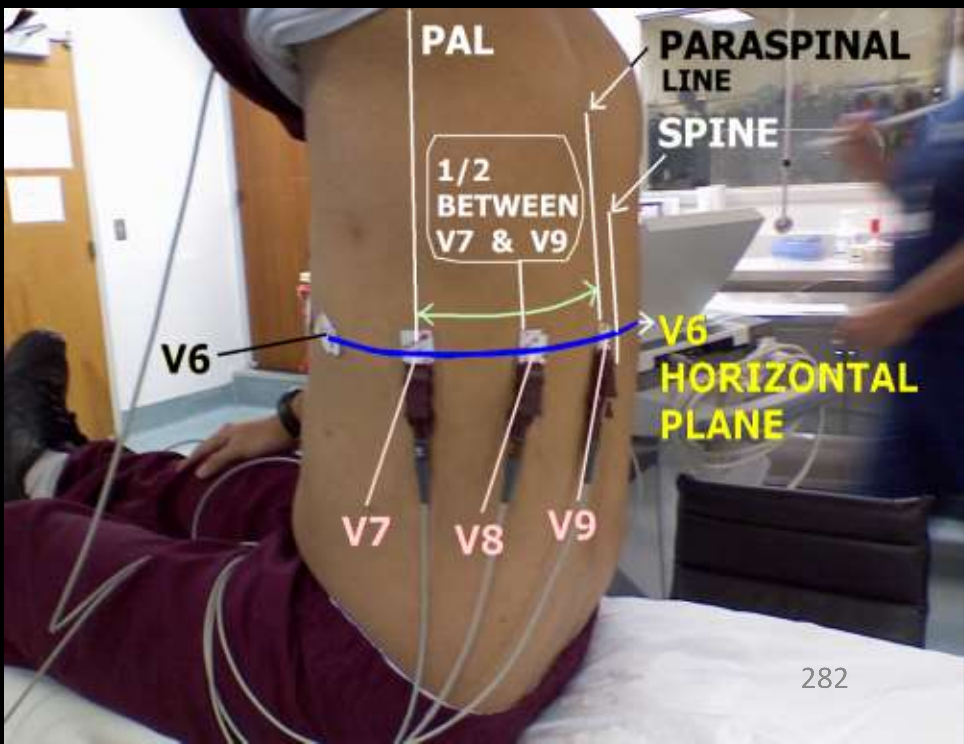
# HOW TO REPOSITION 6 CHEST LEADS to OBTAIN 3 R VENTRICLE and 3 POSTERIOR LEADS

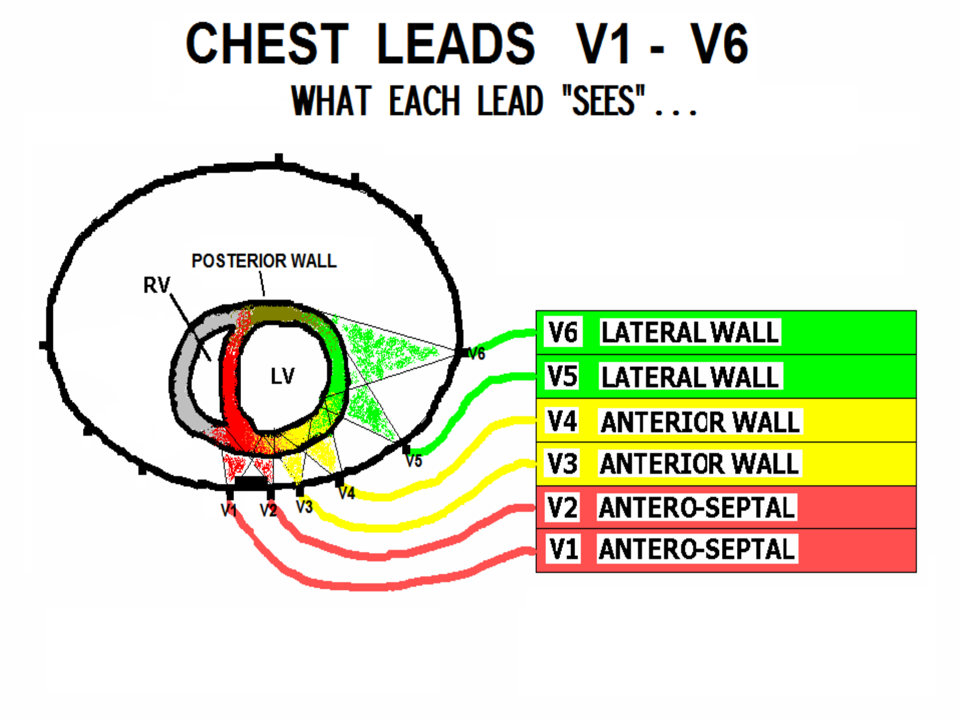



ANTERIOR VIEW

POSTERIOR VIEW

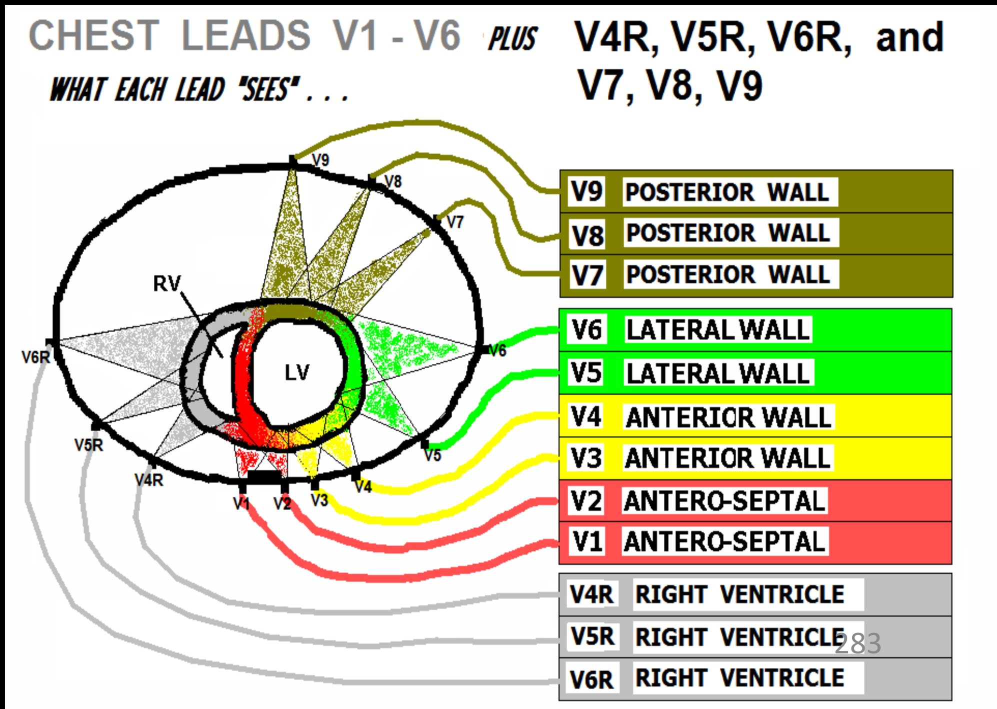


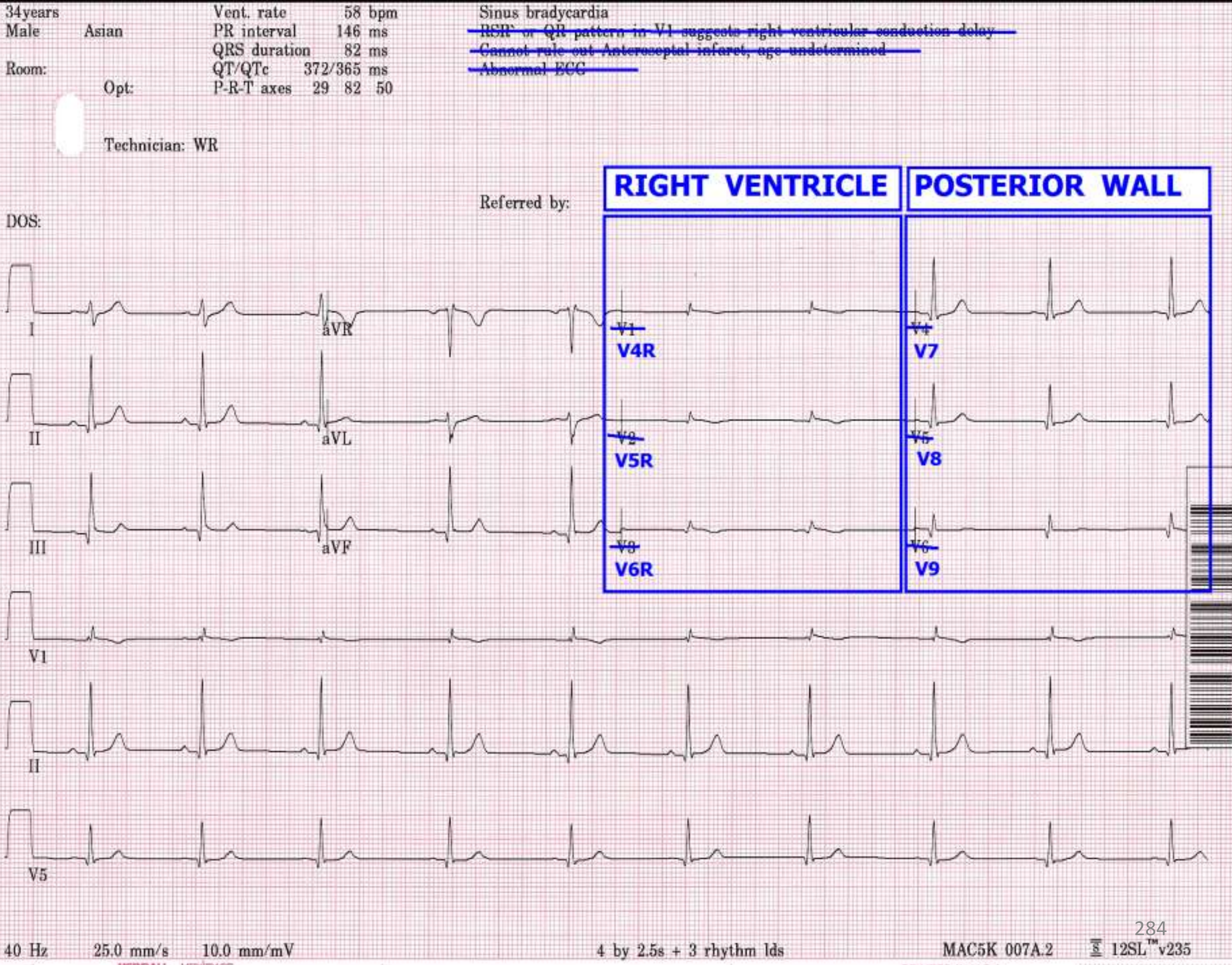






⇦ The 12 Lead ECG

The 18 Lead ECG ⇨




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

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

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

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

Pat ID [redacted]

[redacted] 2019 22:07:54

[redacted] 46 yrs

[redacted]

Caucasian Female

Account # [redacted]

Bayfront Health Seven Rivers ED

Dept ED

Room [redacted]

Tech LDC

RX

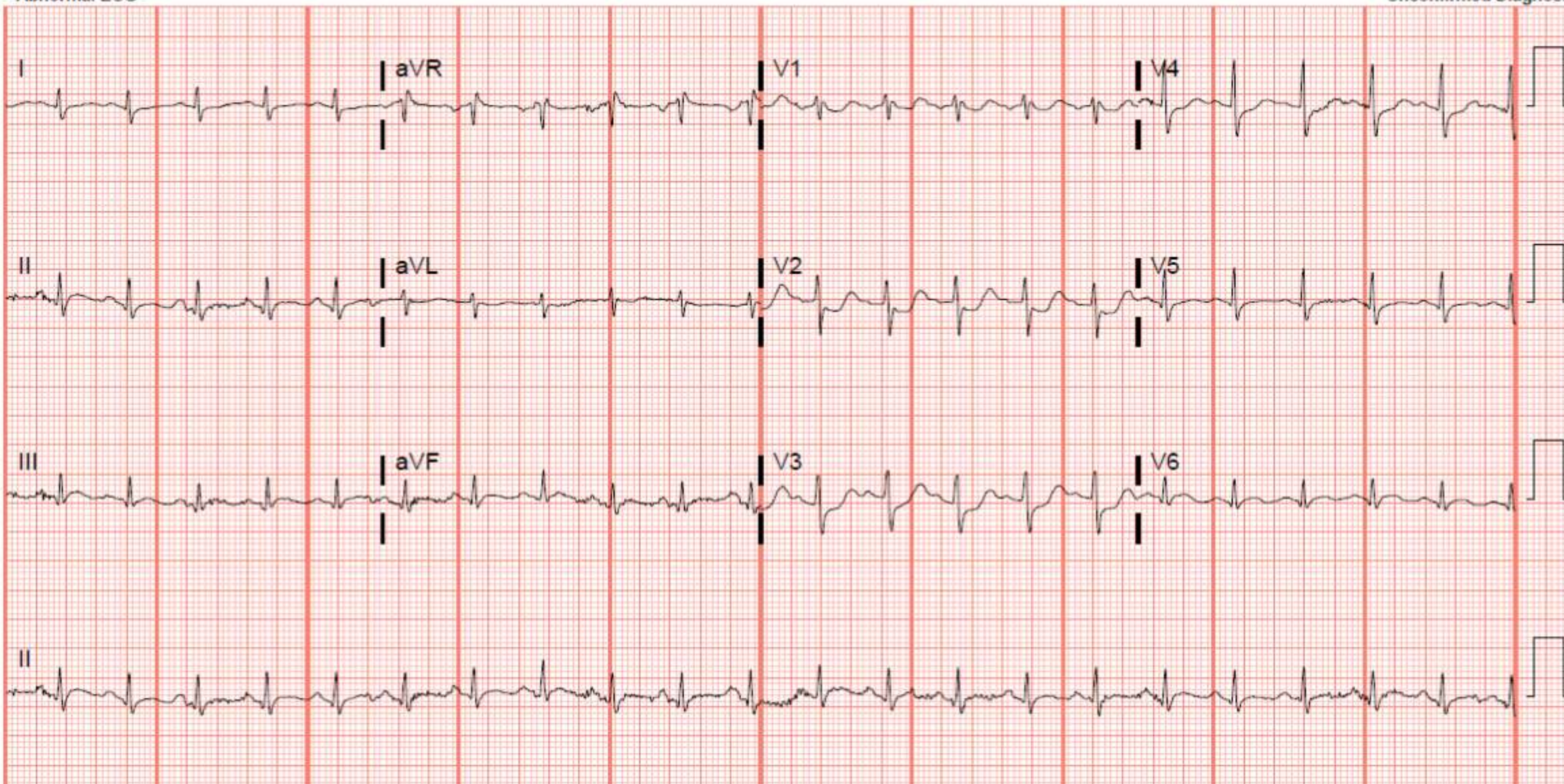
DX

| | | |
|---|---|---|
| Rate | 131 | Sinus tachycardia |
| PR | 128 | Probable inferior infarct, old |
| QRSd | 92 | Posterior infarct, acute (LCx) |
| QT | 317 | ST depression V1-V3, suggest recording posterior leads |
| QTc | 468 | NO PREVIOUS ECG AVAILABLE FOR COMPARISON |
| --Axis-- | | |
| P | 65 | |
| QRS | 83 | |
| T | 132 | |

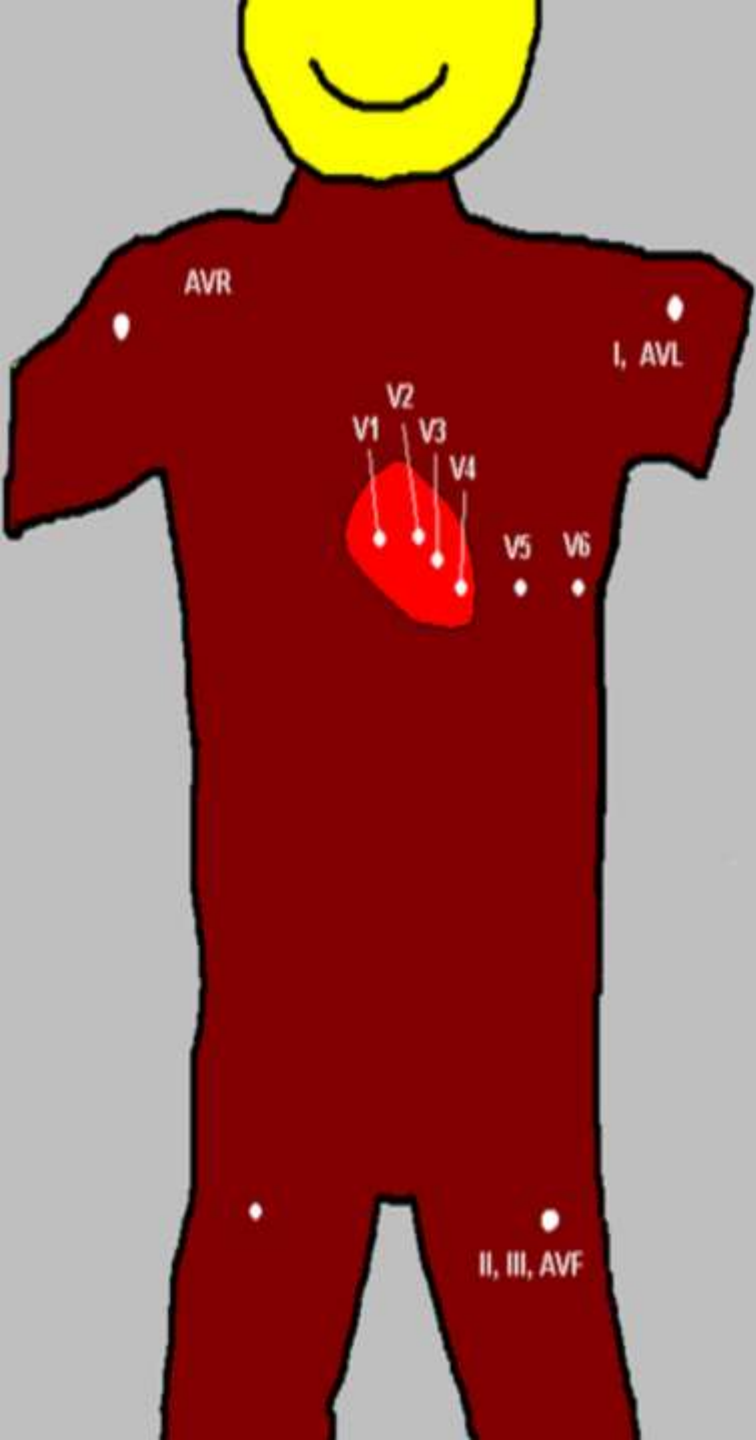
Req Provider: CHARLES NOLES

- Abnormal ECG -

Unconfirmed Diagnosis




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




# 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 |

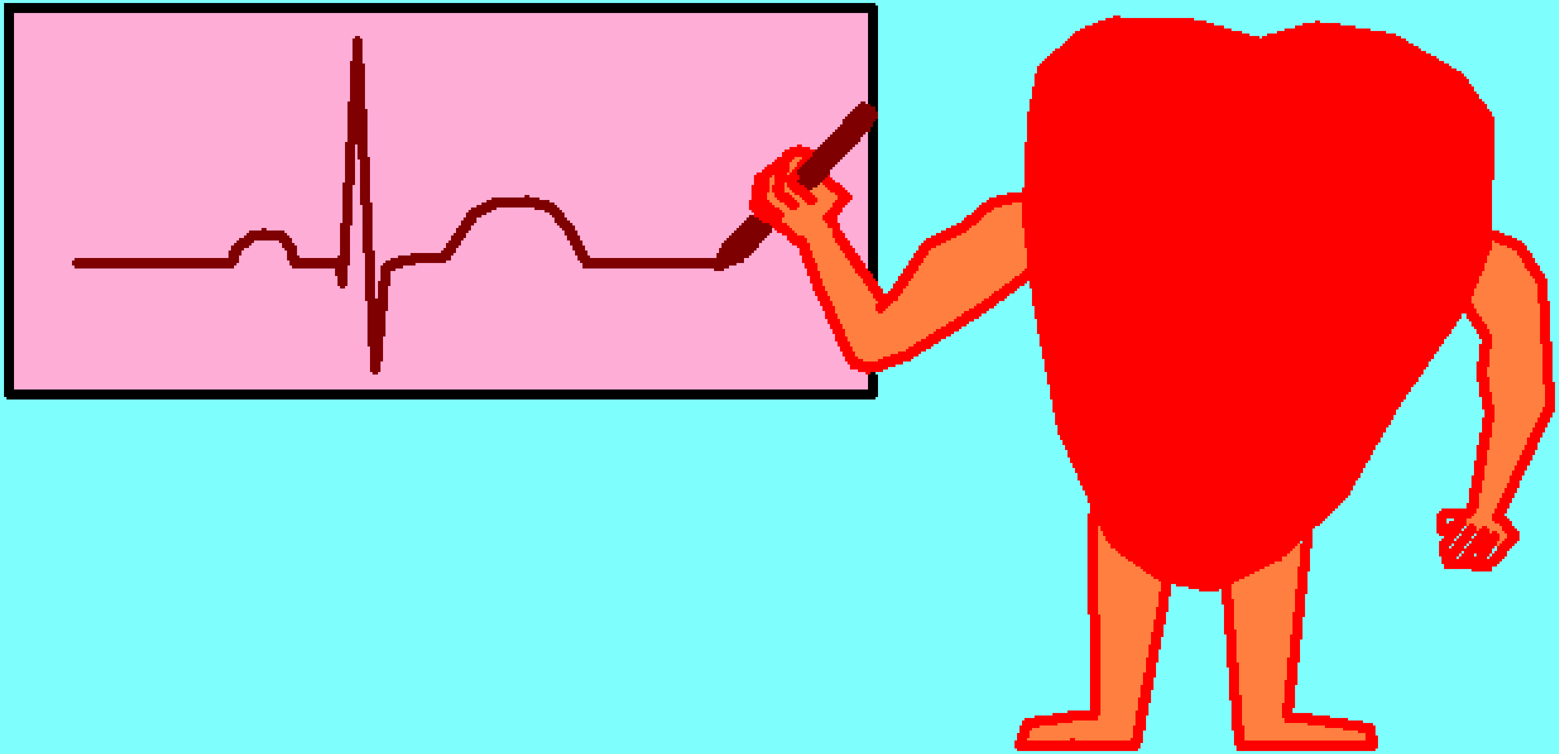
RIGHT DOMINANT and LEFT DOMINANT systems account for approximately 90 % of the population. . . . .

The other 10% of the population have a wide diversity of coronary arterial anatomies. Please see the DOWNLOADABLE PDF version of this presentation to view this optional material !!

“ROAD  TO  FOREVER,”    Rt  385,  Oklahoma panhandle,  1994

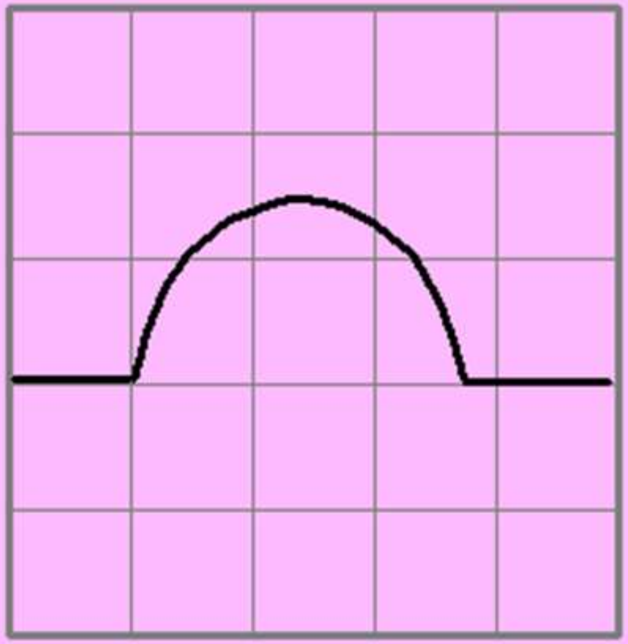
# PUTTING IT ALL ON PAPER . . .

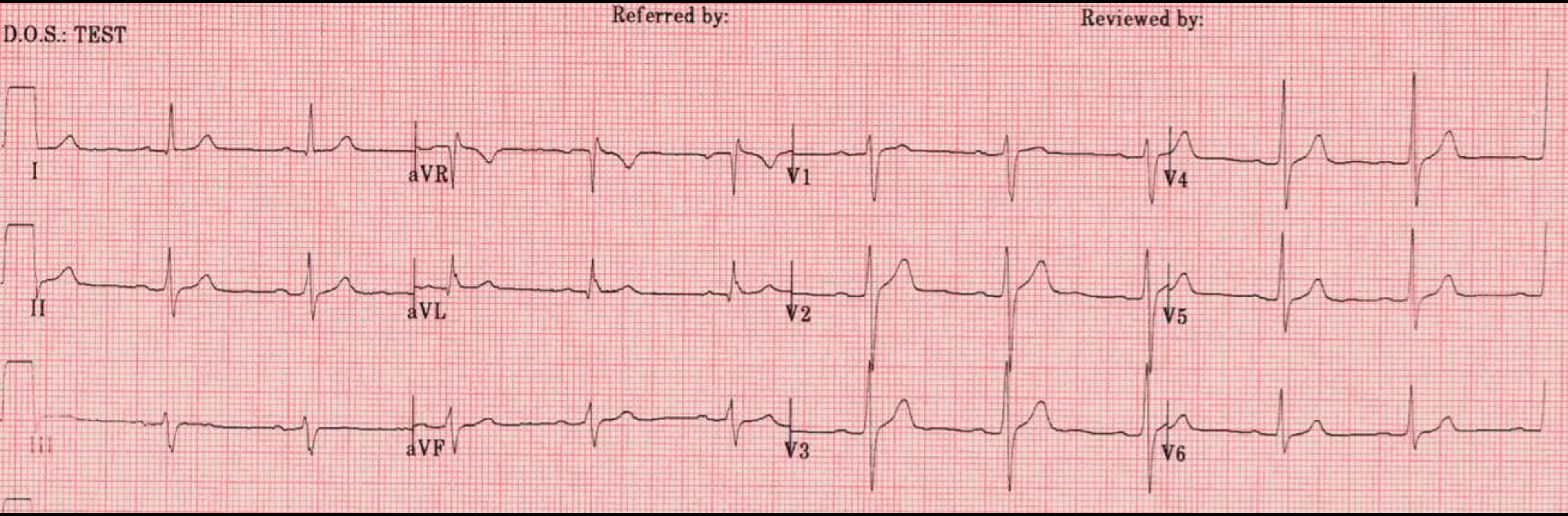
***WAVEFORMS and INTERVALS . . .***



# THE P WAVE

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

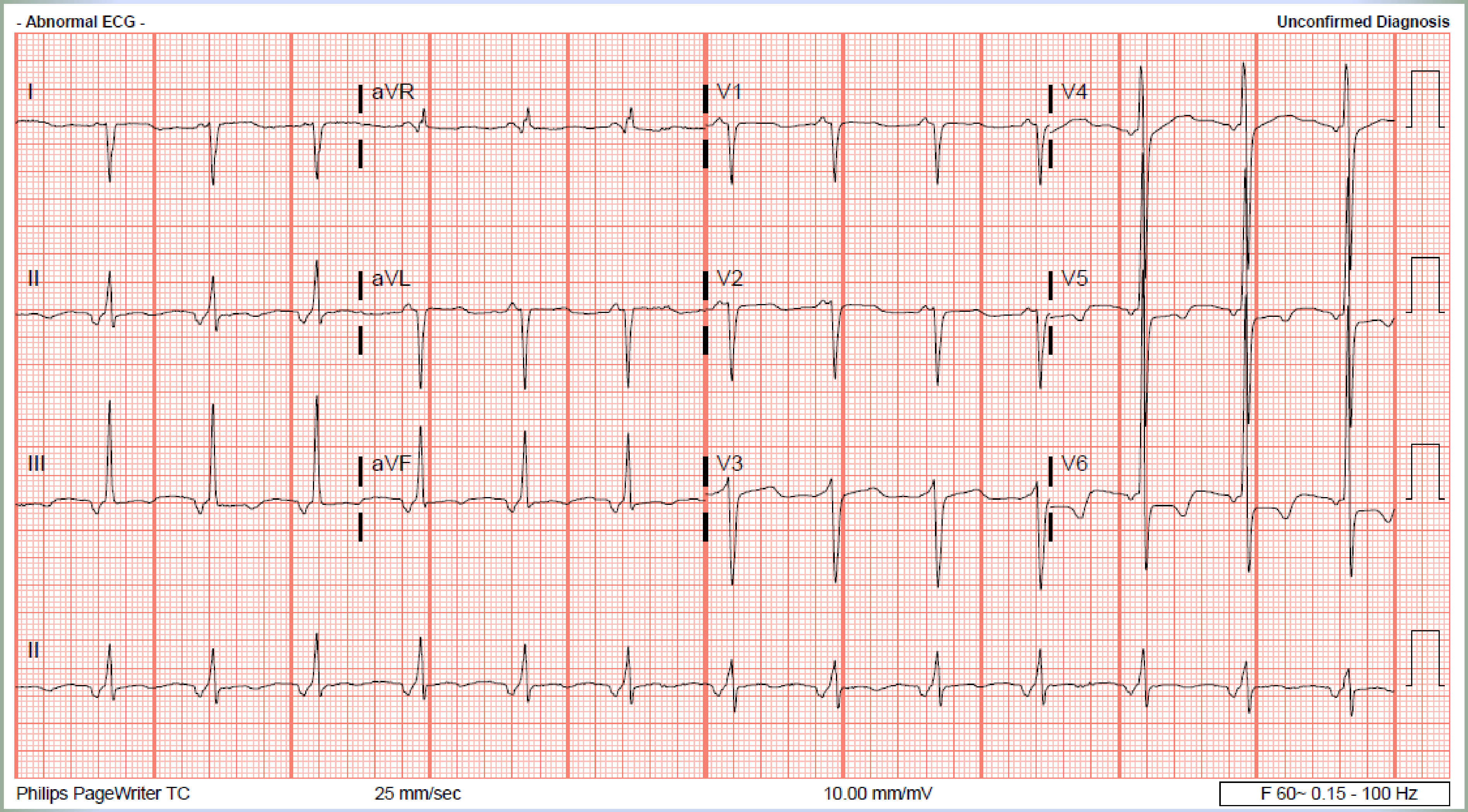



D.O.S.: TEST
Referred by:
Reviewed by:
I
aVR
V1
V4
II
aVL
V2
V5
III
aVF
V3
V6

# P Wave Axis

- P waves with abnormal axis ("not pointing in the right direction") may signify ectopic atrial beats.
- When P waves are inverted in most leads with an abnormally short P-R interval (<120ms) the origin of the rhythm may be the AV node (Junctional Rhythm).

# Inverted P waves & short P-R interval:

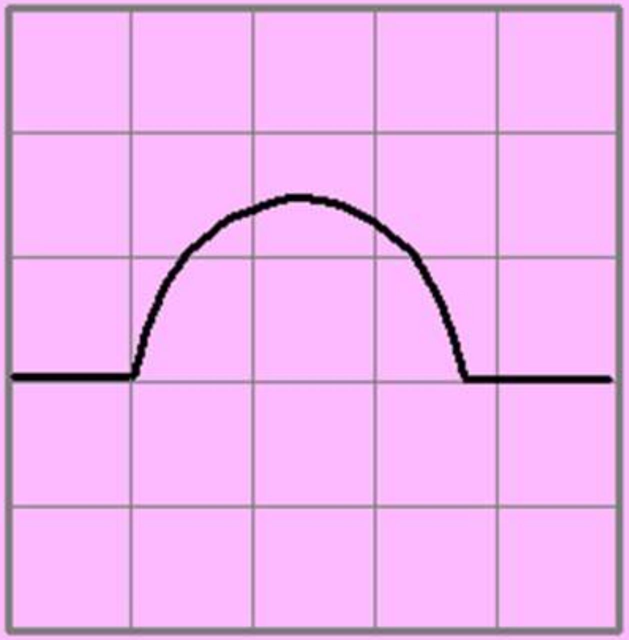


# Evaluate P Wave for Atrial Hypertrophy

- Evaluate amplitude and duration in Lead II

# THE P WAVE

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



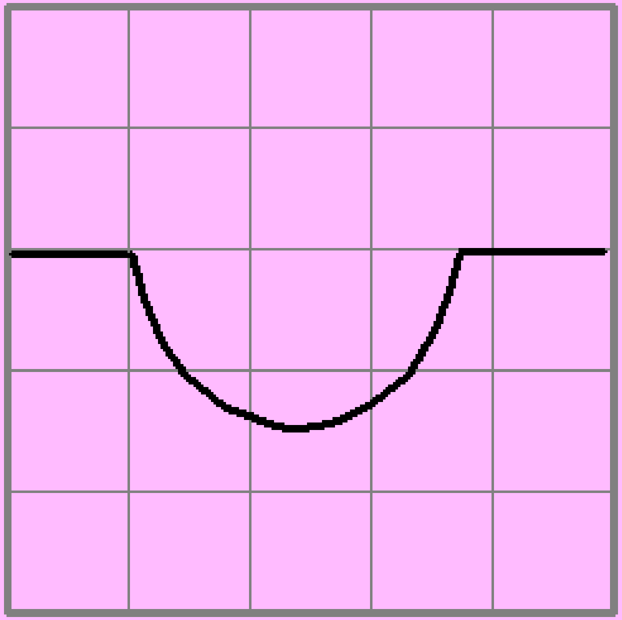
- SHOULD BE LESS THAN .2 mv (2 mm) HIGH

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

# THE P WAVE

- SHOULD BE INVERTED IN LEAD AVR

LEAD AVR



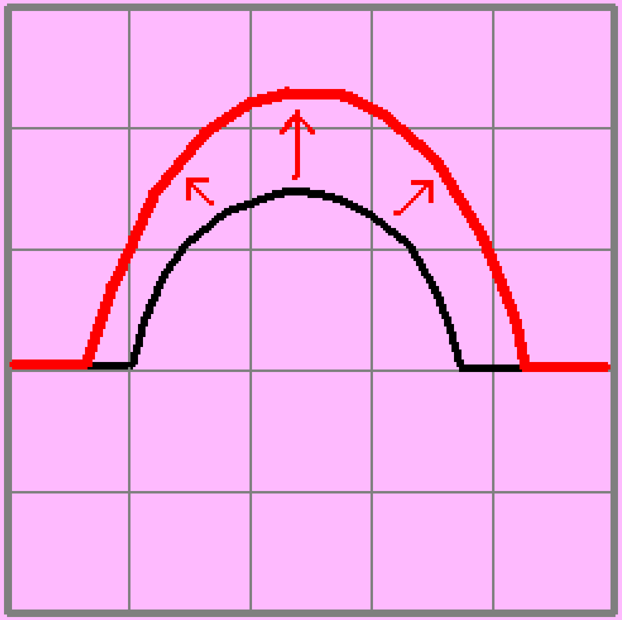
# THE P WAVE

When the P WAVE

is

**TOO LARGE**

We think of



**ATRIAL HYPERTROPHY**

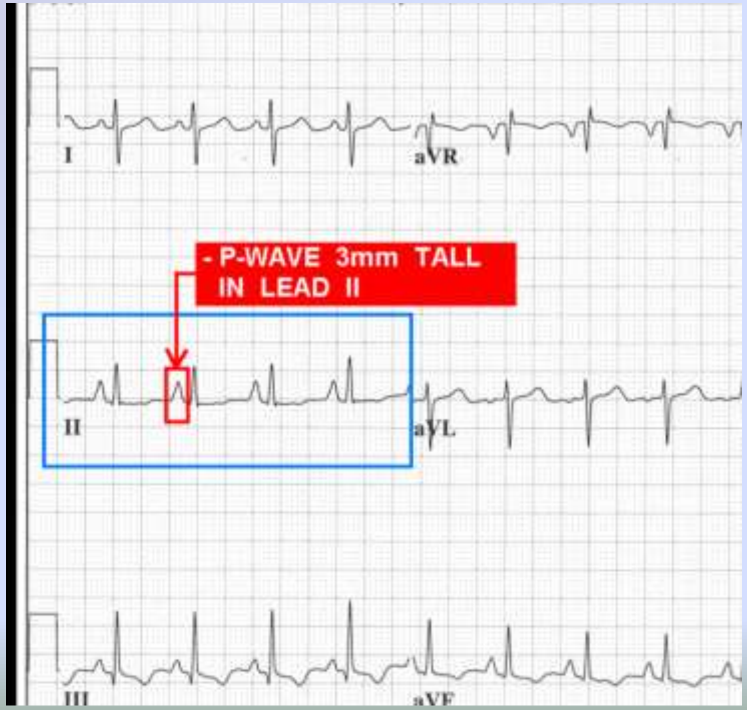
( SPECIFIC CRITERIA FOR ATRIAL HYPERTROPHY IS DISCUSSED IN MORE DETAIL IN THE "CHAMBER HYPERTROPHY" SECTION )

# Evaluate P Wave for Atrial Hypertrophy

- Evaluate amplitude and duration in ***<u>Lead II</u>***

# Evaluate P Wave for Atrial Hypertrophy

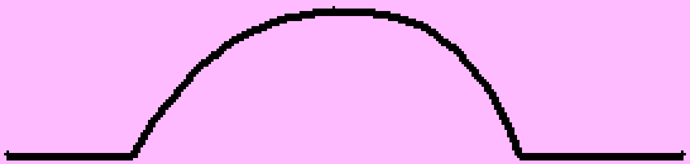
- Evaluate amplitude and duration in Lead II
- If the P wave it “too tall (>2mm) or too long (>2.5mm)” in Lead II, ***then go to Lead V1*** to evaluate P wave . . . .



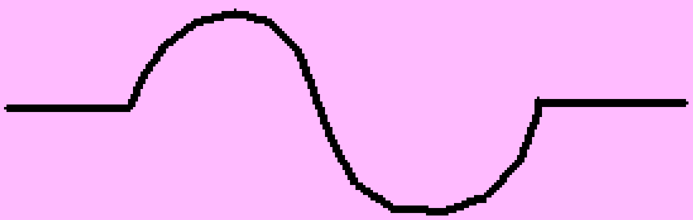
# THE P WAVE

IN LEAD V1 MAY BE:

- POSITIVE

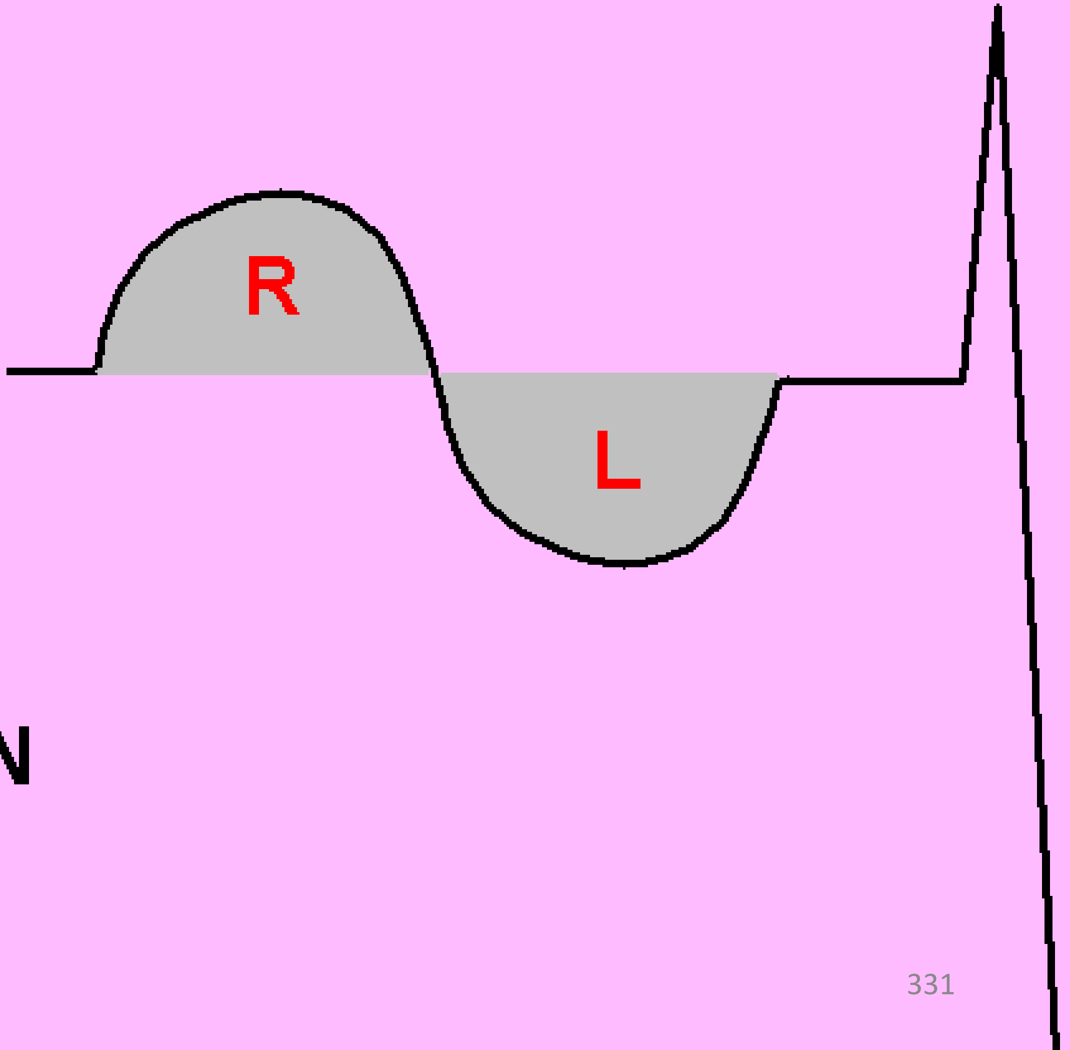


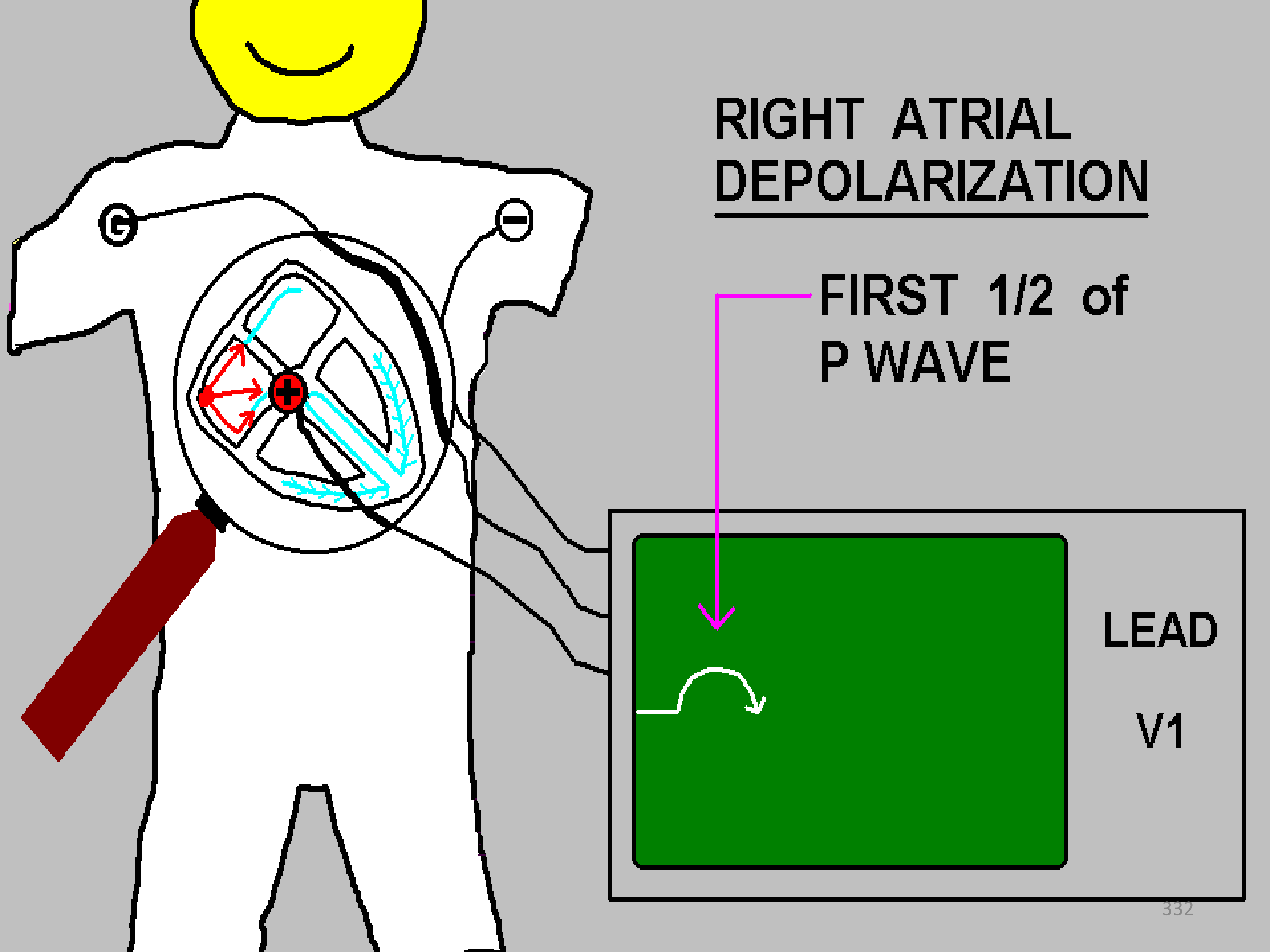
- OR BI-PHASIC



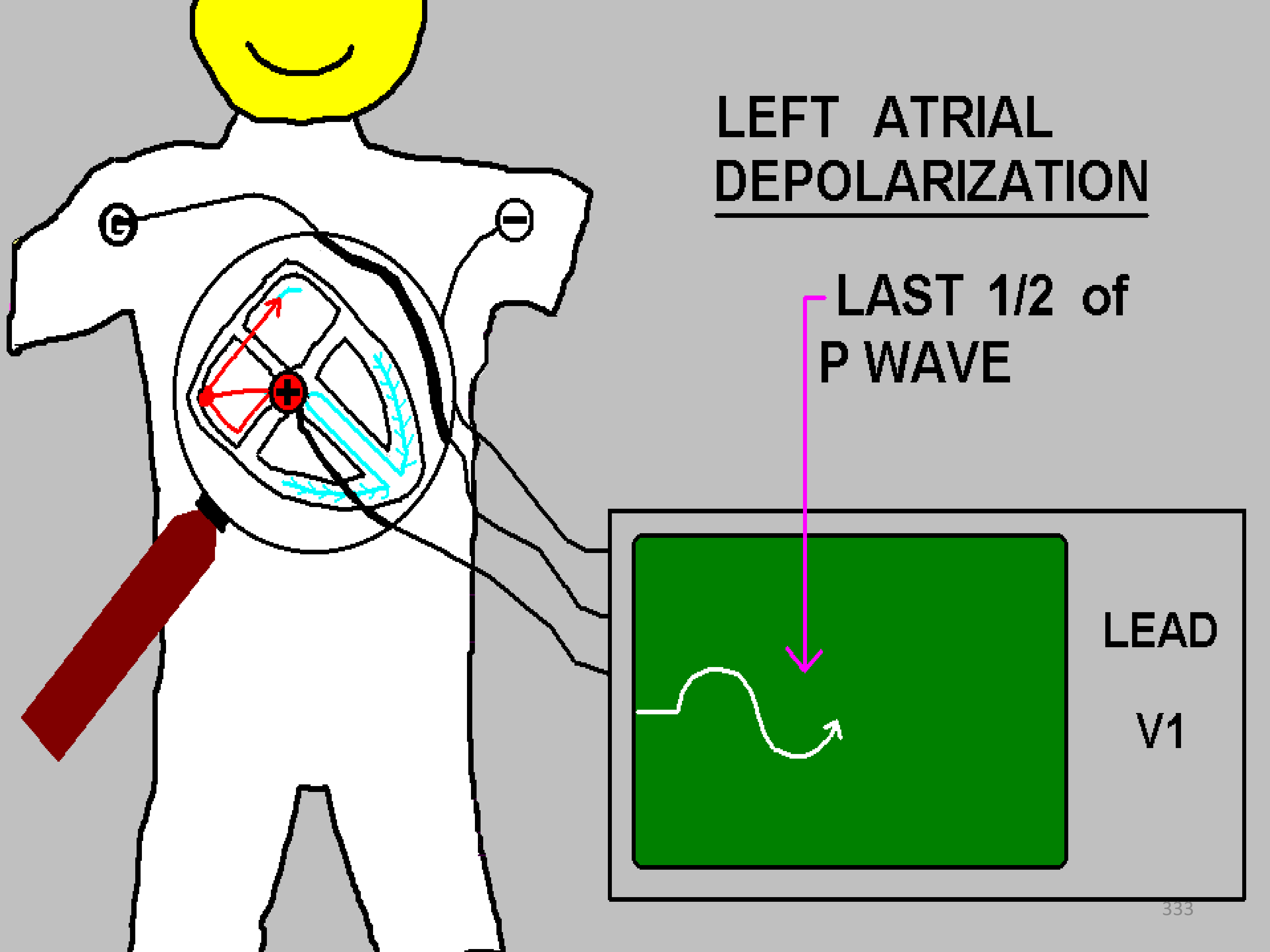
# THE P WAVE

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





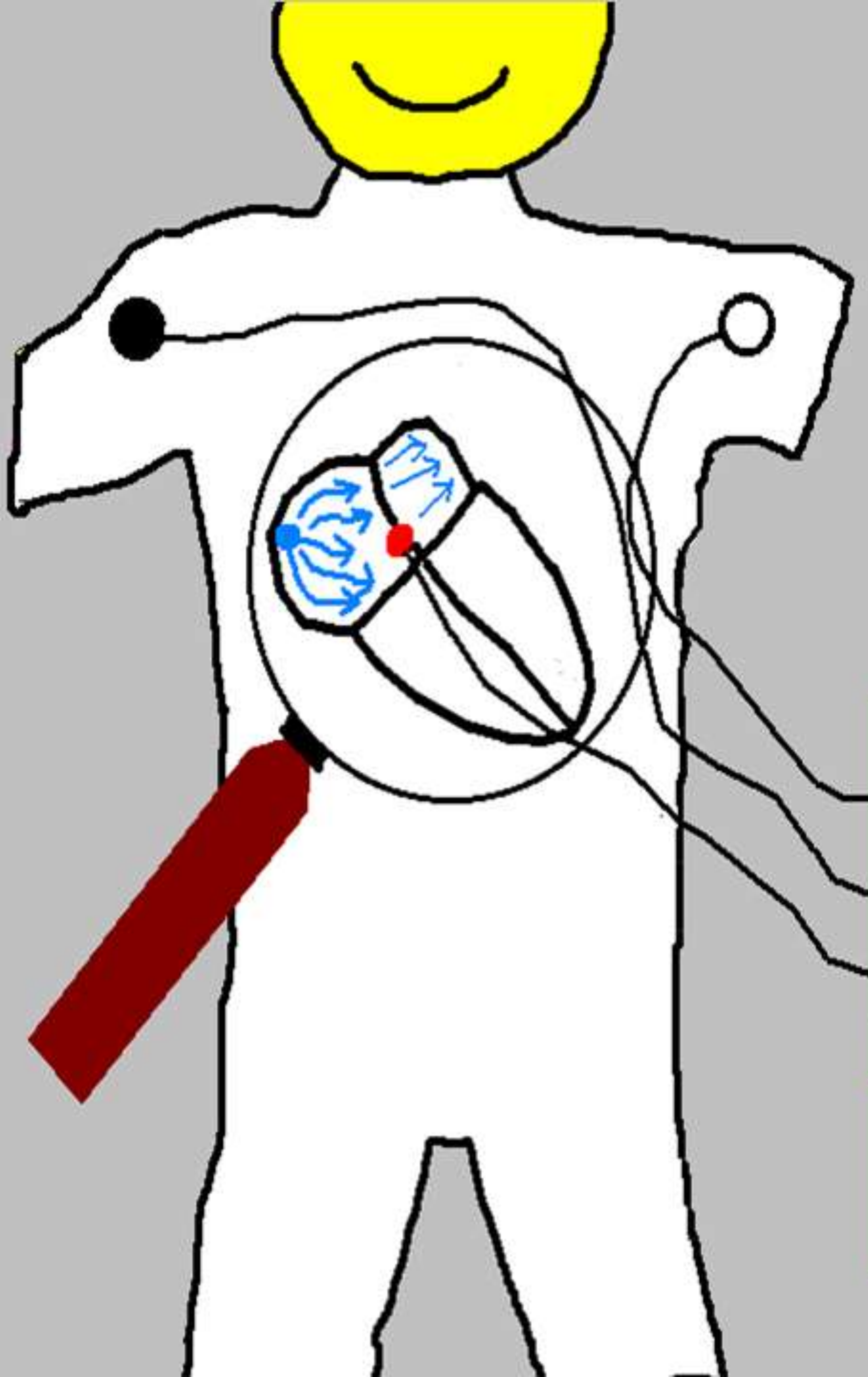
RIGHT ATRIAL
DEPOLARIZATION
FIRST 1/2 of
P WAVE
G
LEAD
V1


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

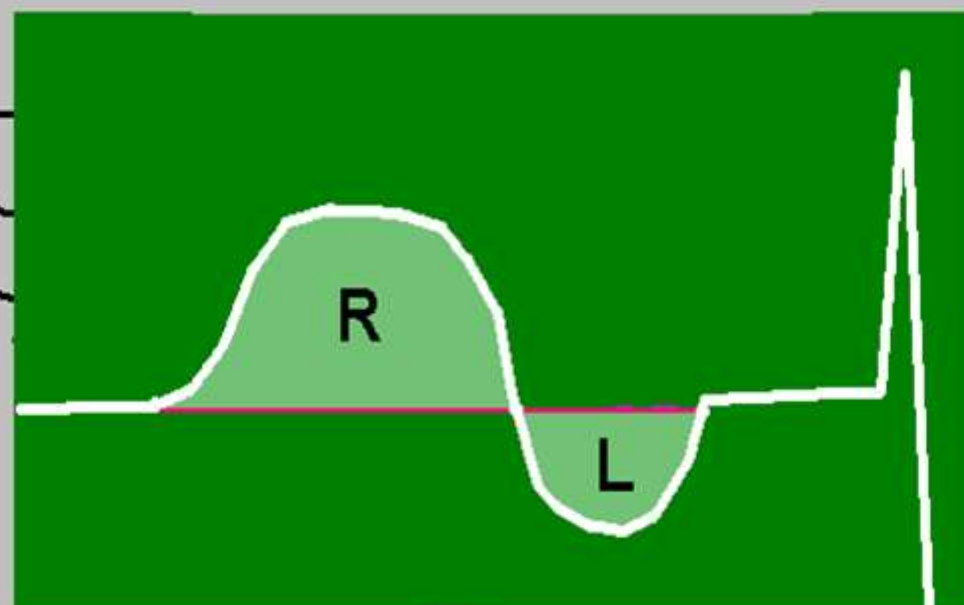
# Evaluate P Wave for Atrial Hypertrophy

- Evaluate amplitude and duration in Lead II
- If the P wave it "too tall (>2mm) or too long (>2.5mm)" in Lead II, ***then go to lead V1*** to evaluate P wave.
- In Lead V1, if the first half (positive deflection) of the P wave is LARGER than the second half (negative deflection) it suggests RIGHT ATRIAL HYPERTROPHY (RAH).

# RIGHT ATRIAL ENLARGEMENT



## P-WAVE IN V1



02-DEC-1998 00:24:45 ST. JOSEPH'S HOSPITAL-ER ROUTINE RETRIEVAL

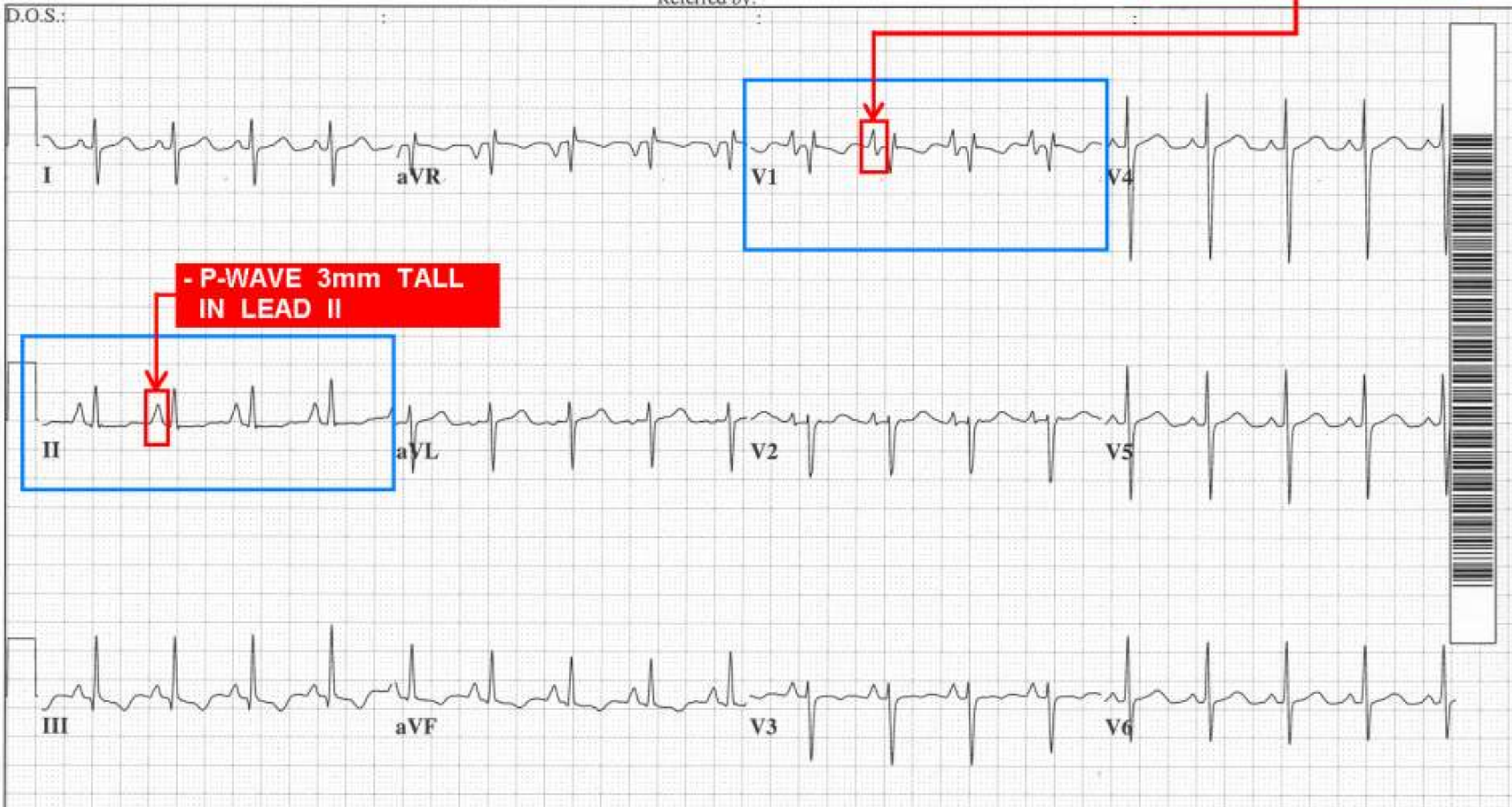
| | | | | |
|---|---|---|---|---|
| 29 yr | | Vent. rate | 107 | BPM |
| Male | Black | PR interval | 132 | ms |
| | | QRS duration | 80 | ms |
| Room:ER | | QT/QTc | 310/413 | ms |
| Loc:3 | Option:28 | P-R-T axes | 67 105 | -32 |

Sinus tachycardia
Right atrial enlargement
Rightward axis
Pulmonary disease pattern
RSR' or QR pattern in V1 suggests right ventricular
T wave abnormality, consider inferior ischemia
Abnormal ECG
When compared with ECG of 01-OCT-1998 21:45
T wave inversion more evident in Inferior leads ...

Referred by:

**EKG CLASS #WR03446043**

**- POSITIVE DEFLECTION TALLER (more dominant) IN LEAD V1**

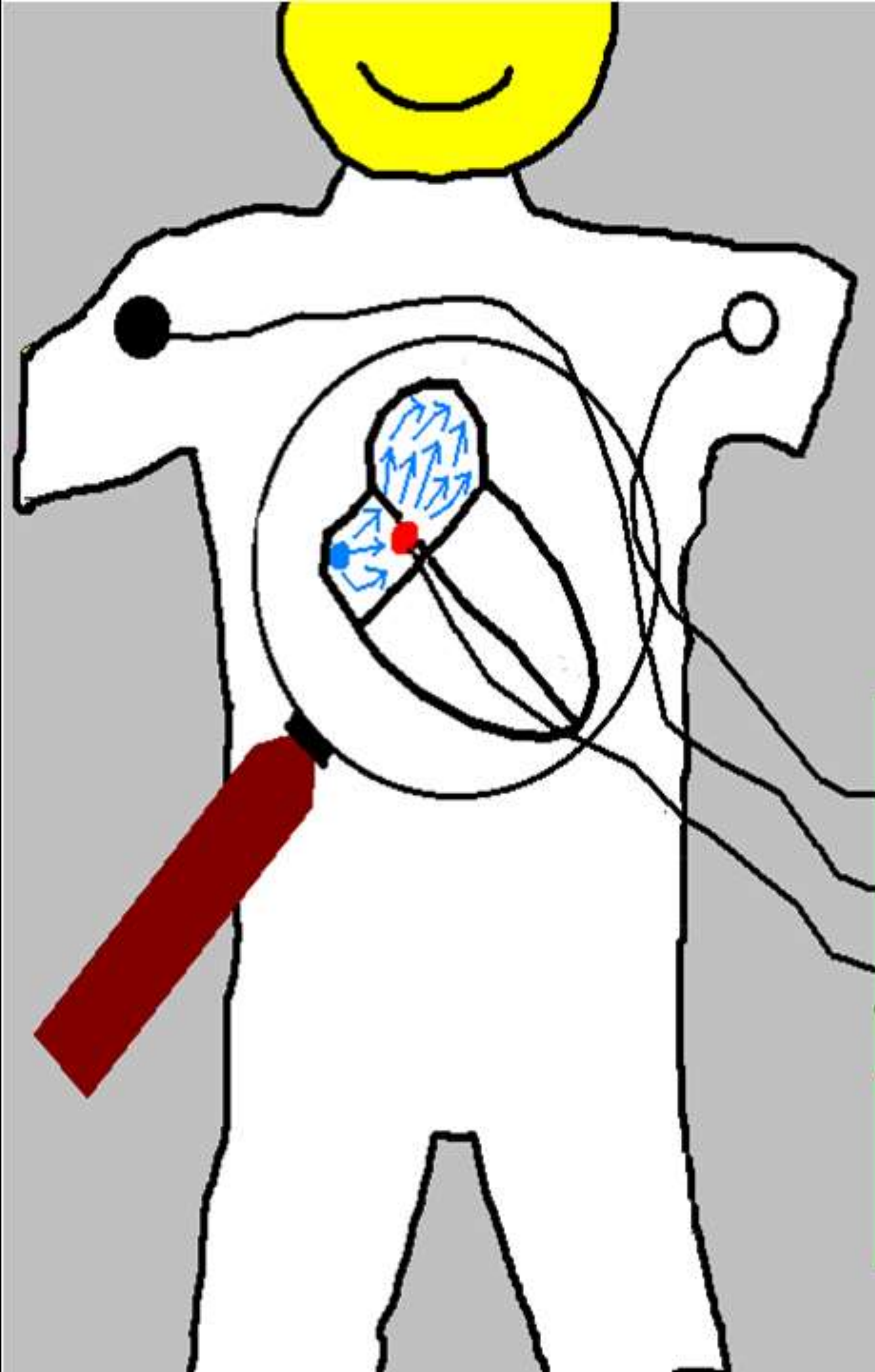



25mm/s 10mm/mV 40Hz 005C 12SL 4 CID: 13

EID:17 EDT: 07:28 02-DEC-1998 ORDER:

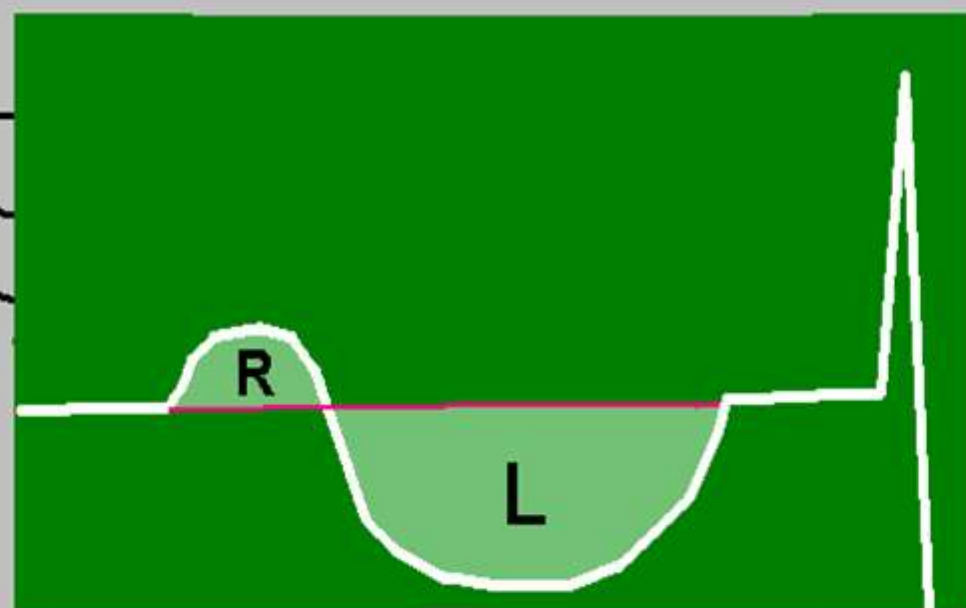
# Evaluate P Wave for Atrial  Hypertrophy

- Evaluate amplitude and duration in Lead II
- If the P wave it “too tall (>2mm) or too long (>2.5mm)” in Lead II,  ***then go to lead V1***  to evaluate P wave.
- In Lead V1, if the first half (positive deflection) of the P wave is LARGER than the second half (negative deflection) it suggests RAH.  If the second half (negative deflection) is larger, it suggests LEFT ATRIAL HYPERTROPY (LAH).



# LEFT ATRIAL ENLARGEMENT

## P-WAVE IN V1



01–MAY–1998 03:09:15 ST. JOSEPH'S HOSPITAL–ER ROUTINE RETRIEVAL

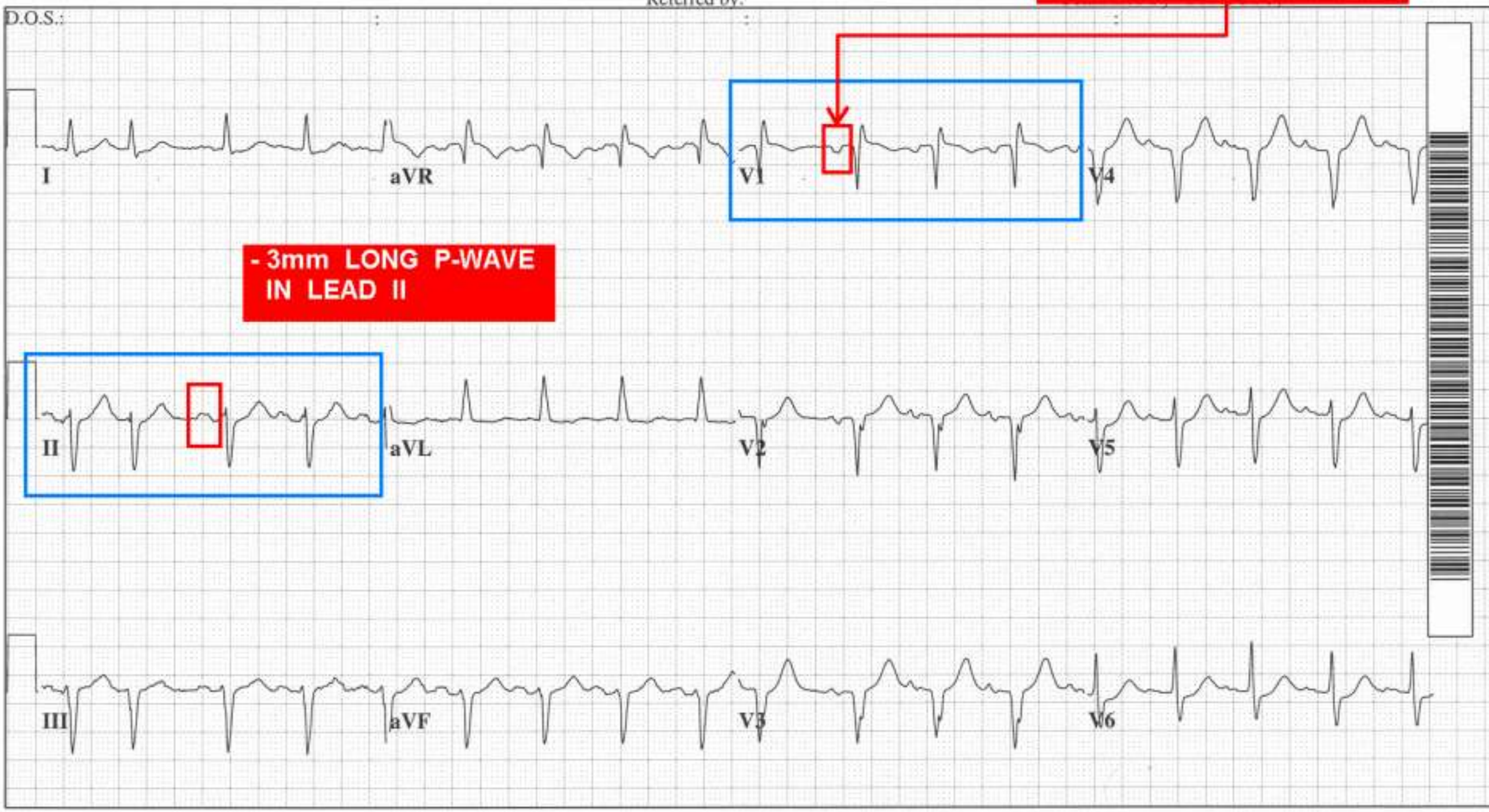
| | | | | |
|---|---|---|---|---|
| 77 yr | | Vent. rate | 106 | BPM |
| Male | Caucasian | PR interval | 170 | ms |
| | | QRS duration | 104 | ms |
| Room:S 1 | | QT/QTc | 374/496 | ms |
| Loc:3 | Option:10 | P–R–T axes | 67 –66 | 70 |

Sinus tachycardia with occasional Premature supraventricular complexes
Left atrial enlargement
Left axis deviation
Incomplete right bundle branch block
Anteroseptal infarct , age undetermined
Abnormal ECG
No previous ECGs available

**EKG CLASS #WR03651849**

**- NEGATIVE DEFLECTION P-WAVE IN LEAD V1**

Referred by:

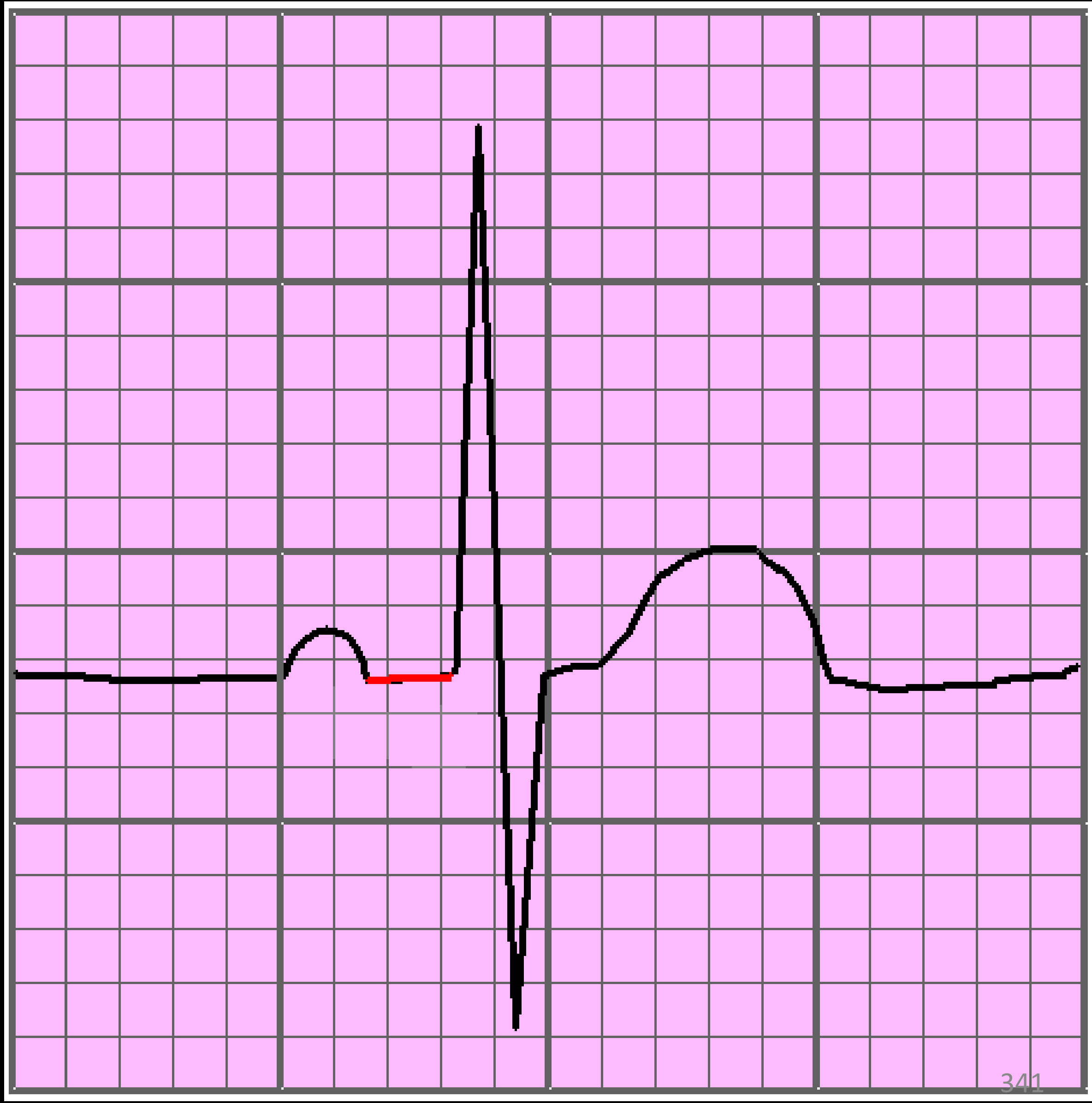



25mm/s 10mm/mV 40Hz 005C 12SL 4 CID: 11

EID:17 EDT: 14:12 02–MAY–1998 ORDER:

# THE P-R SEGMENT

SHOULD RETURN TO THE ISO-ELECTRIC LINE.



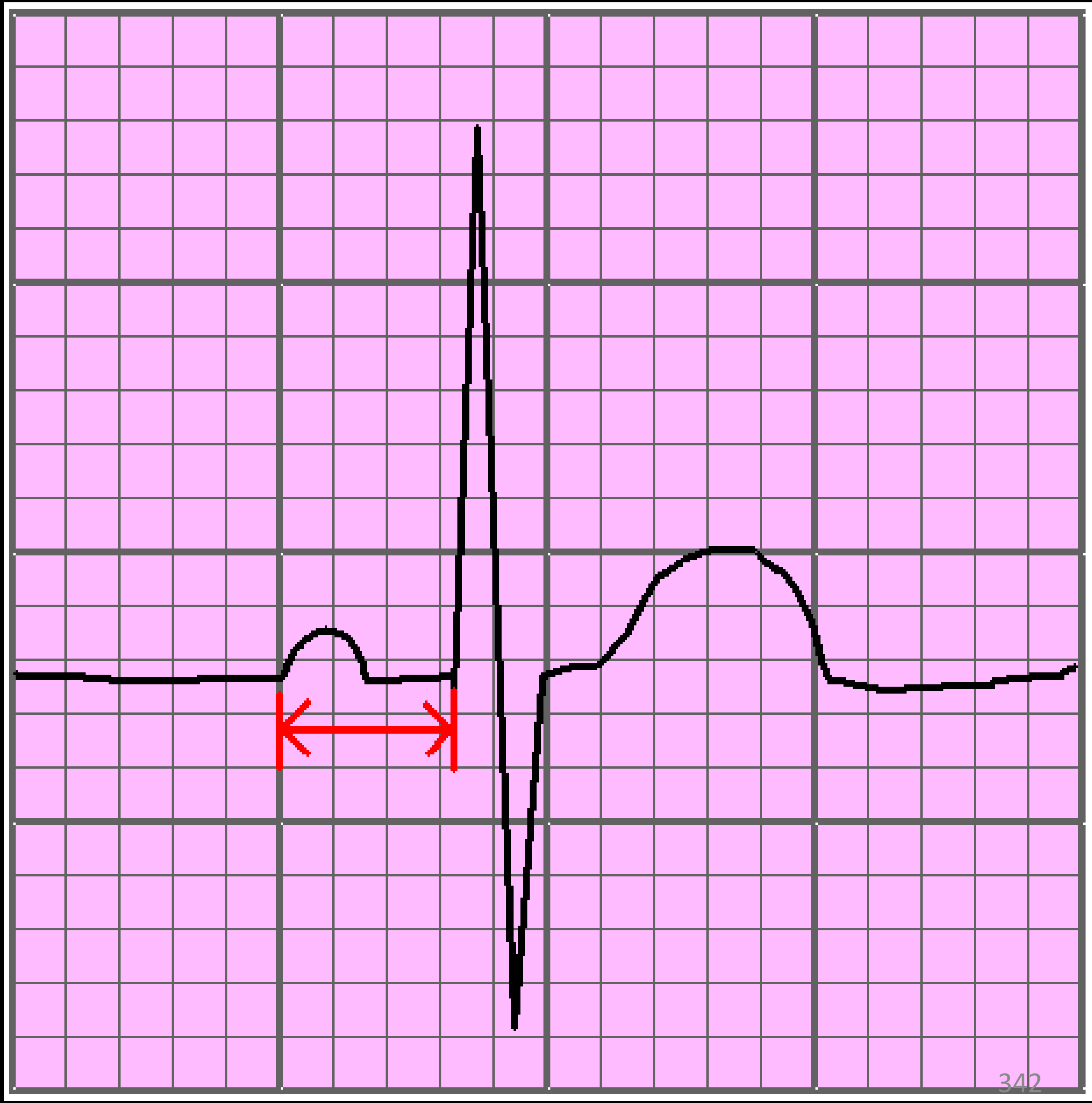
# NORMAL P-R INTERVAL

.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

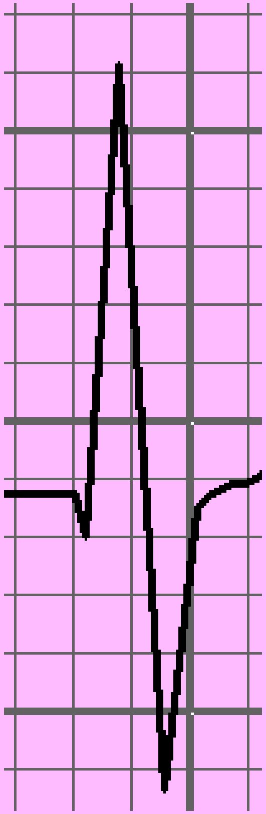
GREATER THAN 200 mSEC

THINK:

- HEART BLOCK

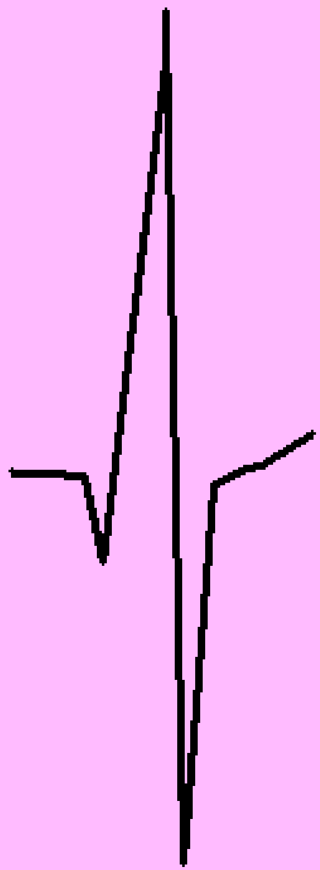
# THE QRS COMPLEX

- 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

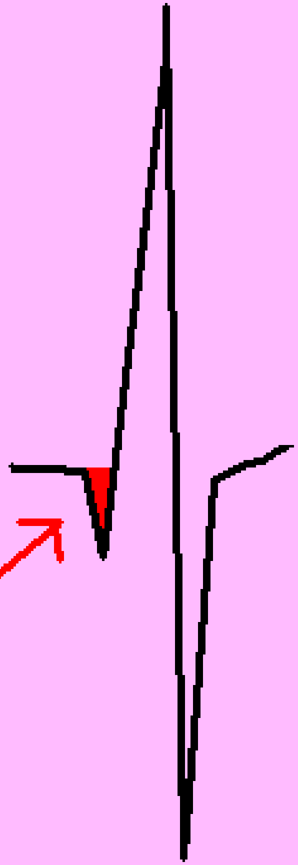
THIS QRS COMPLEX CONSISTS OF 3 DEFLECTIONS . . . .



# THE QRS COMPLEX

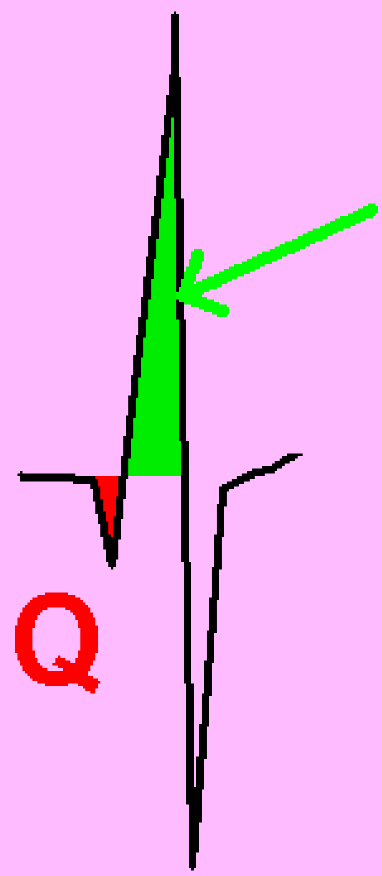
THIS QRS COMPLEX CONSISTS OF 3 DEFLECTIONS . . . .

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



# THE QRS COMPLEX

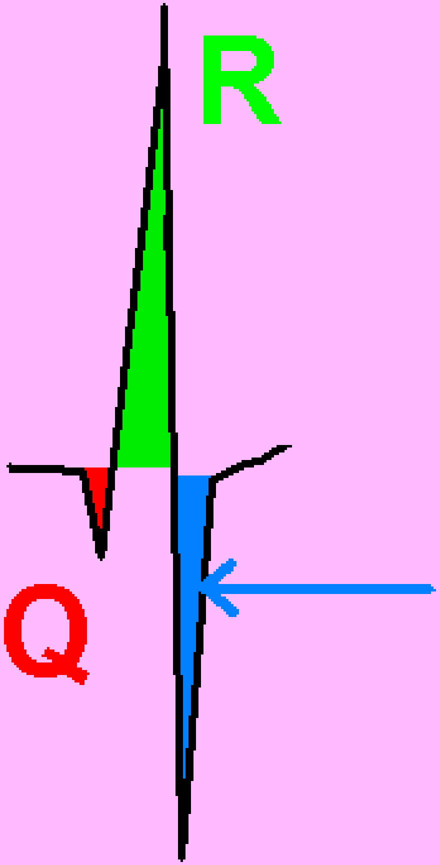
THIS QRS COMPLEX CONSISTS OF 3 DEFLECTIONS . . . .




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

# THE QRS COMPLEX

THIS QRS COMPLEX CONSISTS OF 3 DEFLECTIONS . . . .

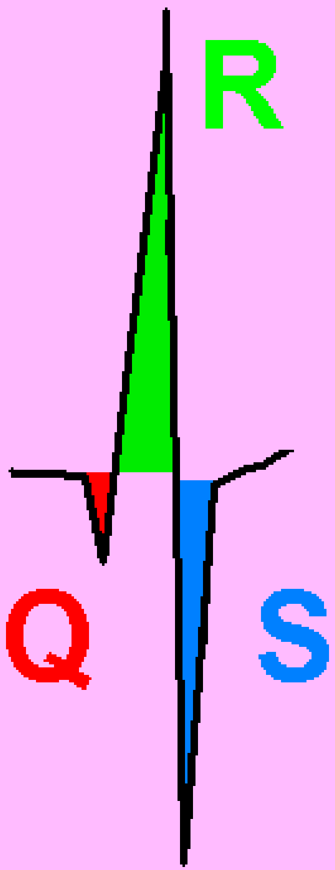



A NEGATIVE DEFLECTION AFTER THE R WAVE IS CALLED THE " S " WAVE

# THE QRS COMPLEX

THIS QRS COMPLEX CONSISTS OF 3 DEFLECTIONS . . . .

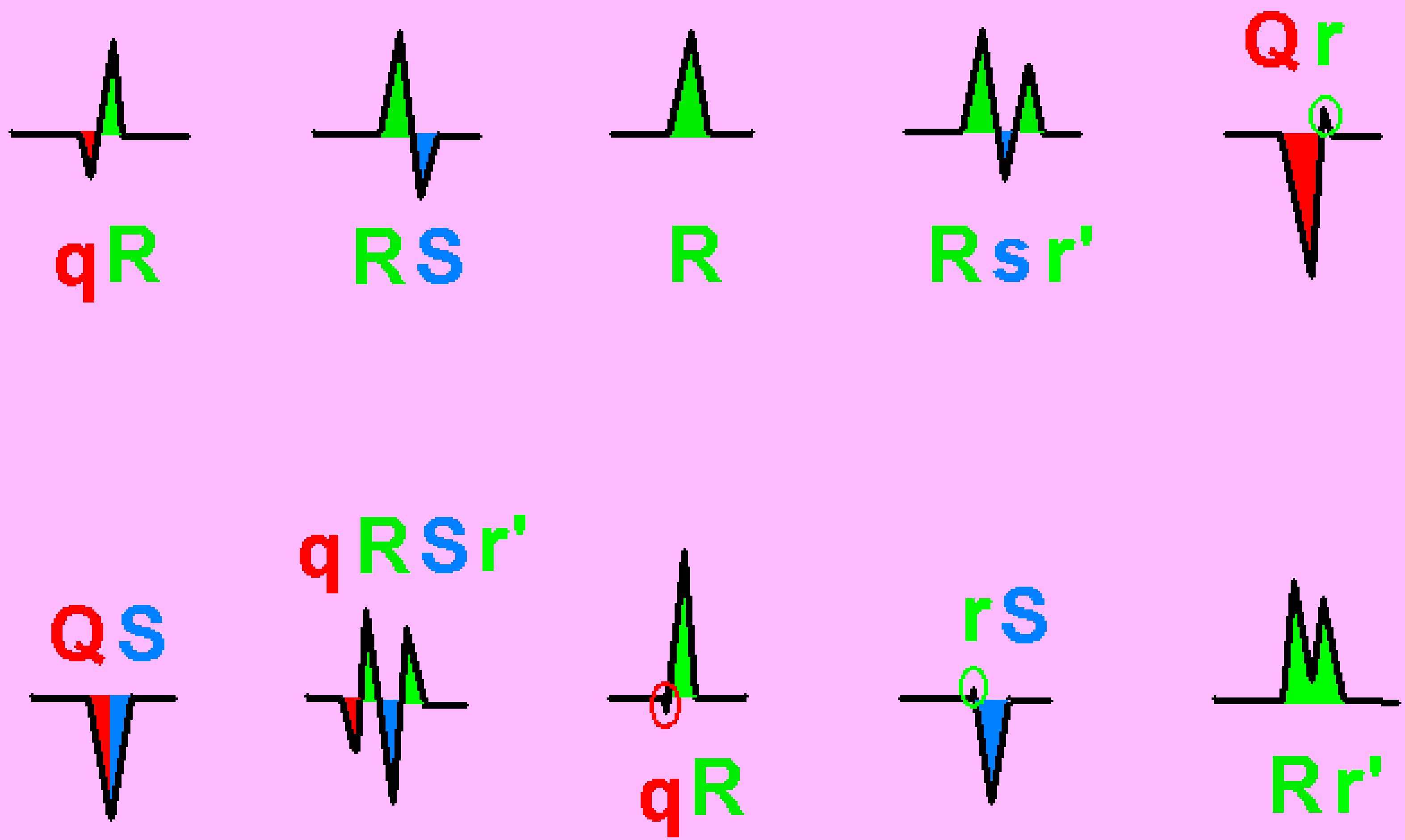
AND IS THE <u>ONLY</u> TRUE "QRS" COMPLEX




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:**

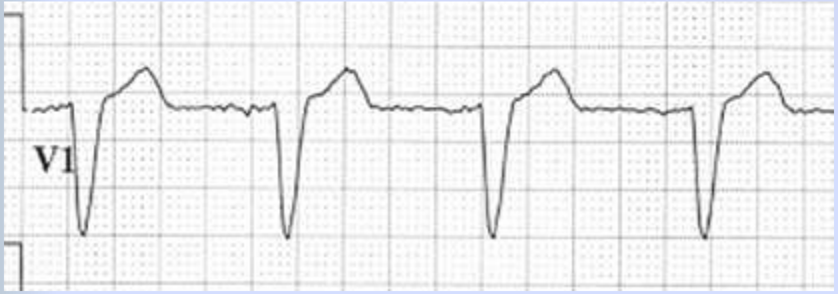
- BUNDLE BRANCH BLOCK
- VENTRICULAR COMPEX (ES)
- PACED RHYTHM
- L VENTRICULAR HYPERTROPHY
- ELECTROLYTE IMBAL. ( ↑$K^+$ ↓$Ca^{++}$ )
- DELTA WAVE (PRE-EXCITATION)

# When the QRS is WIDE (> 3mm):

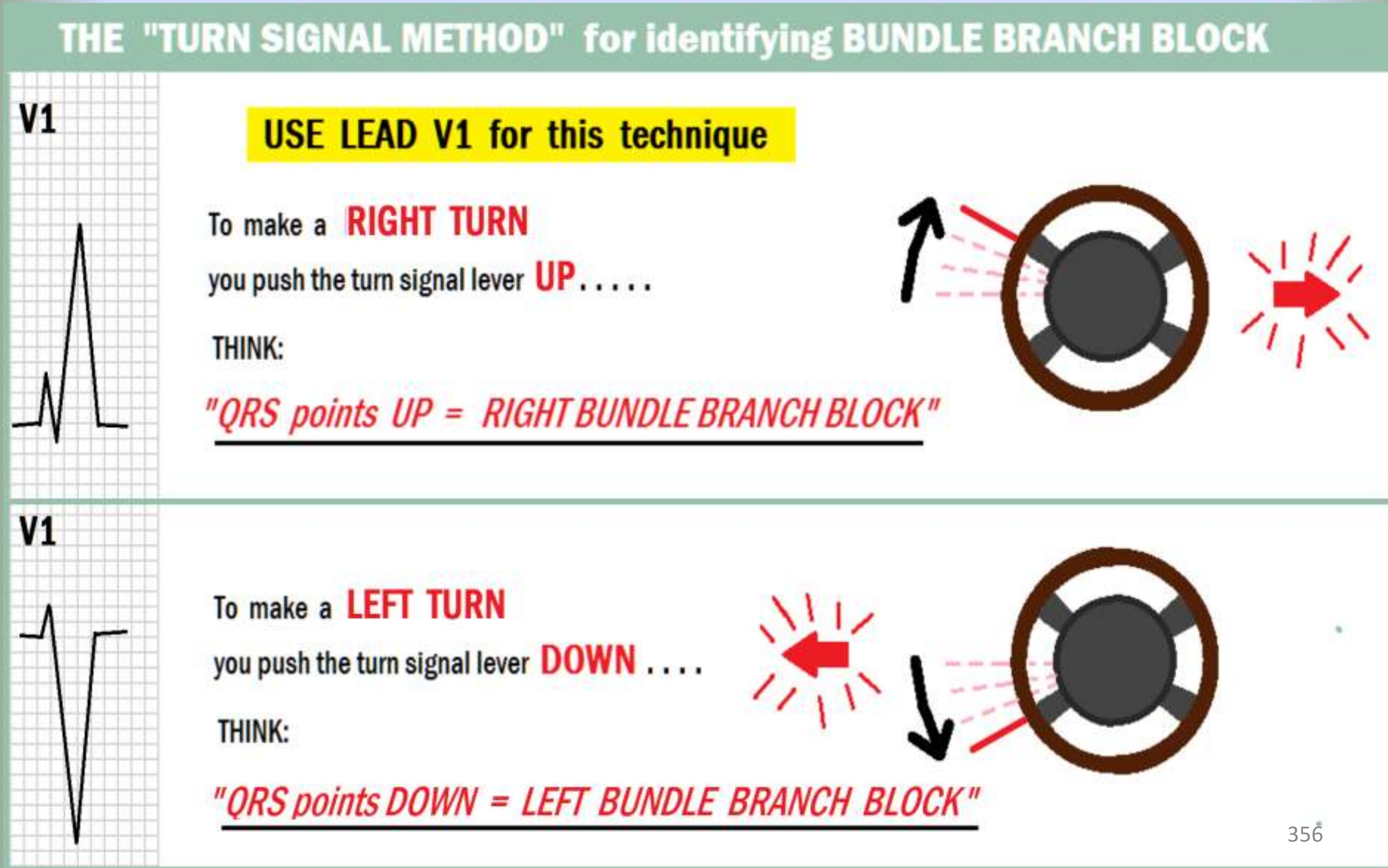
- If you KNOW the Rhythm is originating ABOVE the Ventricles (such as NSR or any Supraventricular Rhythm) – you should determine if the QRS has a RIGHT or LEFT Bundle Branch Block morphology.

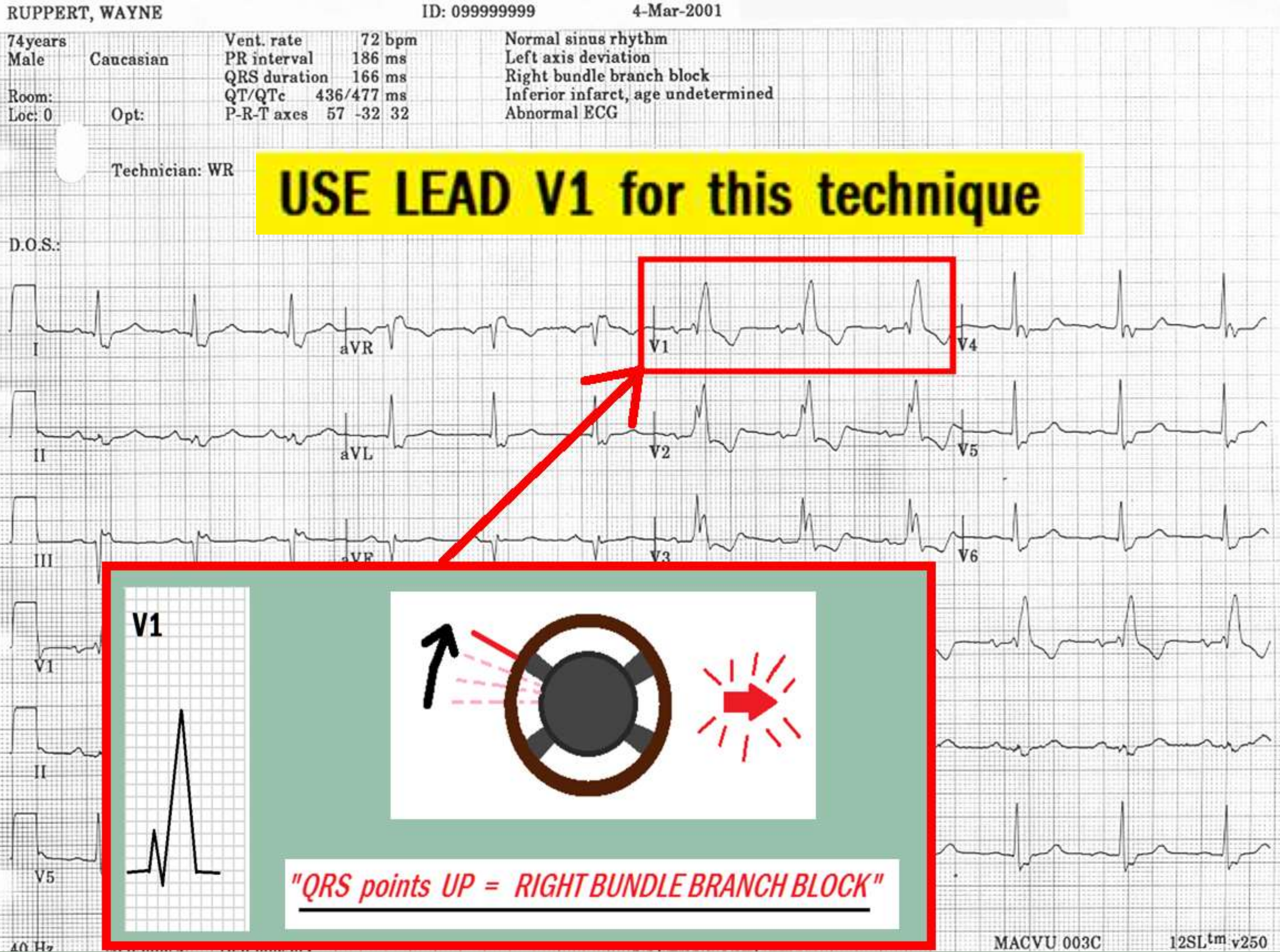
# Normal Sinus and Other "Supraventricular Rhythms" with WIDE QRS ( > 120 ms )

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

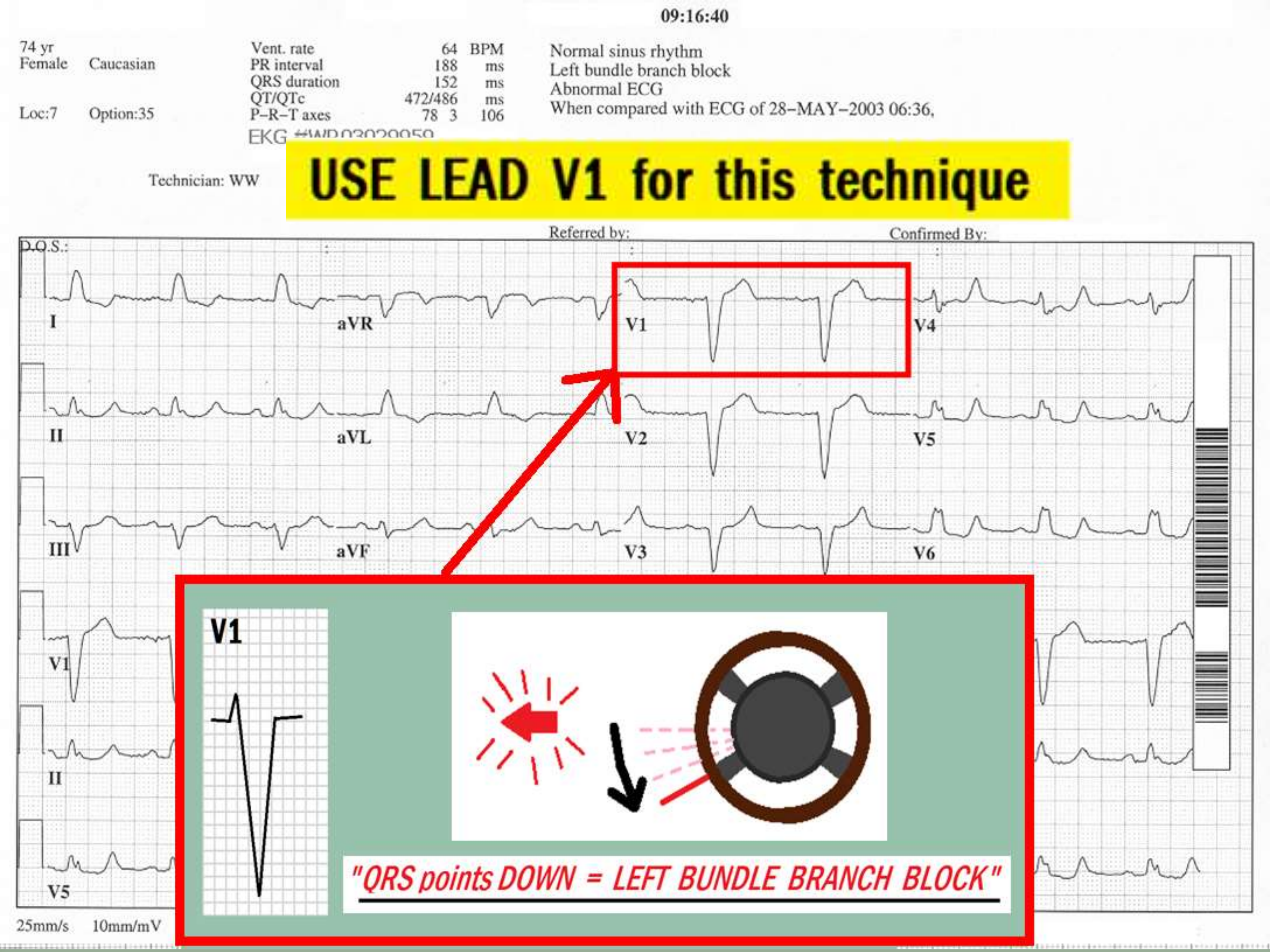



# Simple “Turn Signal Method” . . .





RUPPERT, WAYNE
ID: 099999999
4-Mar-2001
74years
Male Caucasian
Room:
Loc: 0 Opt:
Vent. rate 72 bpm
PR interval 186 ms
QRS duration 166 ms
QT/QTc 436/477 ms
P-R-T axes 57 -32 32
Normal sinus rhythm
Left axis deviation
Right bundle branch block
Inferior infarct, age undetermined
Abnormal ECG
Technician: WR
USE LEAD V1 for this technique
D.O.S.:
I
aVR
V1
V4
II
aVL
V2
V5
III
V3
V6
V1
II
V5
V1
"QRS points UP = RIGHT BUNDLE BRANCH BLOCK"
40 Hz
MACVU 003C
12SLtm v250



09:16:40
74 yr
Female Caucasian
Loc:7 Option:35
Vent. rate 64 BPM
PR interval 188 ms
QRS duration 152 ms
QT/QTc 472/486 ms
P-R-T axes 78 3 106
Normal sinus rhythm
Left bundle branch block
Abnormal ECG
When compared with ECG of 28-MAY-2003 06:36,
Technician: WW
USE LEAD V1 for this technique
Referred by:
Confirmed By:
D.O.S.:
I
aVR
V1
V4
II
aVL
V2
V5
III
aVF
V3
V6
V1
II
V5
25mm/s 10mm/mV
V1
"QRS points DOWN = LEFT BUNDLE BRANCH BLOCK"

*More on Determining Right – vs – Left Bundle Branch Block in Session 2.*

# When the QRS is WIDE (> 3mm):

- If you KNOW the Rhythm is originating ABOVE the Ventricles ( such as NSR or any Supraventricular Rhythm) – you should determine if the QRS has a RIGHT or LEFT Bundle Branch Block morphology.
- **If you SUSPECT the rhythm is VENTRICULAR in origin, then EVALUATE THE "NADIR" . . . .**

# THE QRS COMPLEX

## Point of NADIR

Measurement from BEGINNING OF QRS COMPLEX to the TIP of the DOMINANT WAVEFORM of the complex in LEAD V1 or V6.

## WHY ? ?

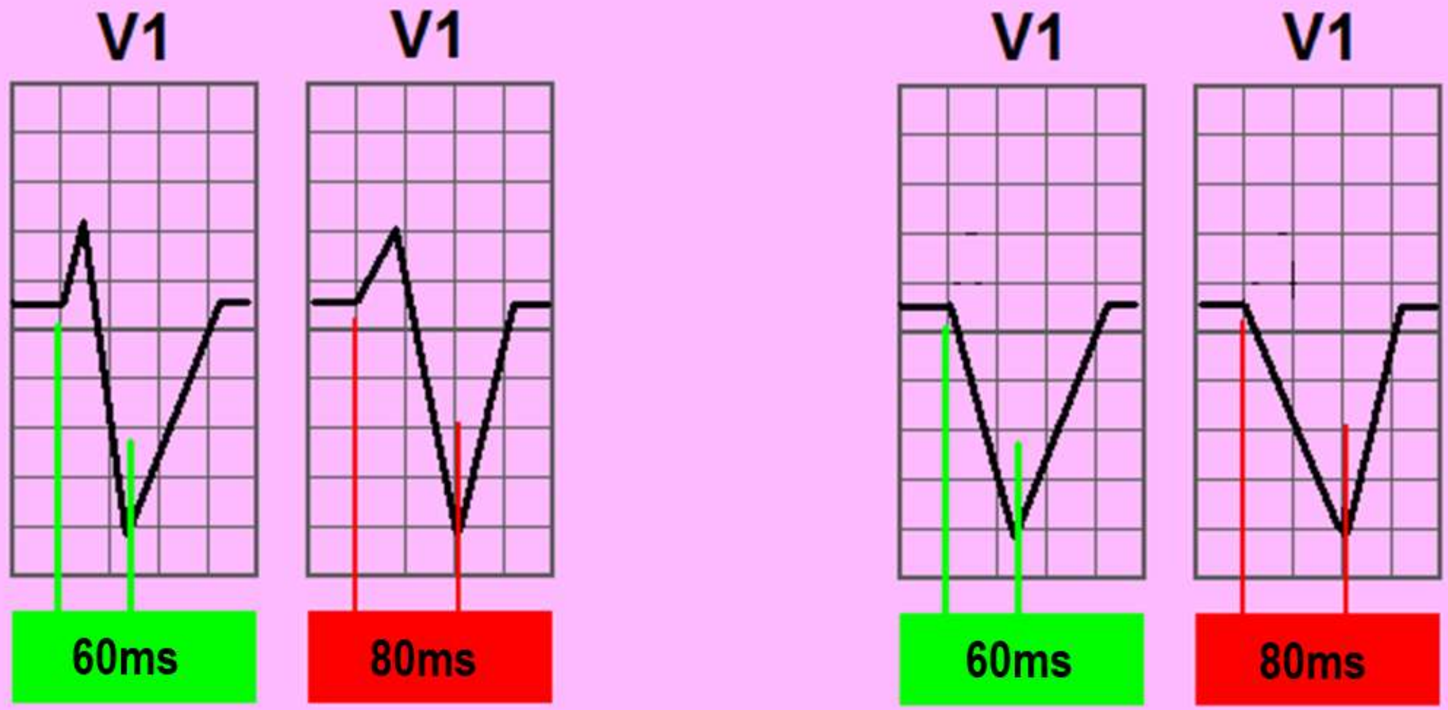
It is one (good) clue to help us discern VENTRICULAR beats vs. SUPRA-VENTRICULAR beats with abberancy.

# THE QRS COMPLEX

*How ??

-- Supraventricular favors < 70ms

-- Ventricular favors > 70ms




* Marriott, Henry J.L. -- a measurement of 70ms or greater from the beginning of the QRS to the peak of the R wave or nadir of the S wave suggestive of rhythms of Ventricular origin.

# 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

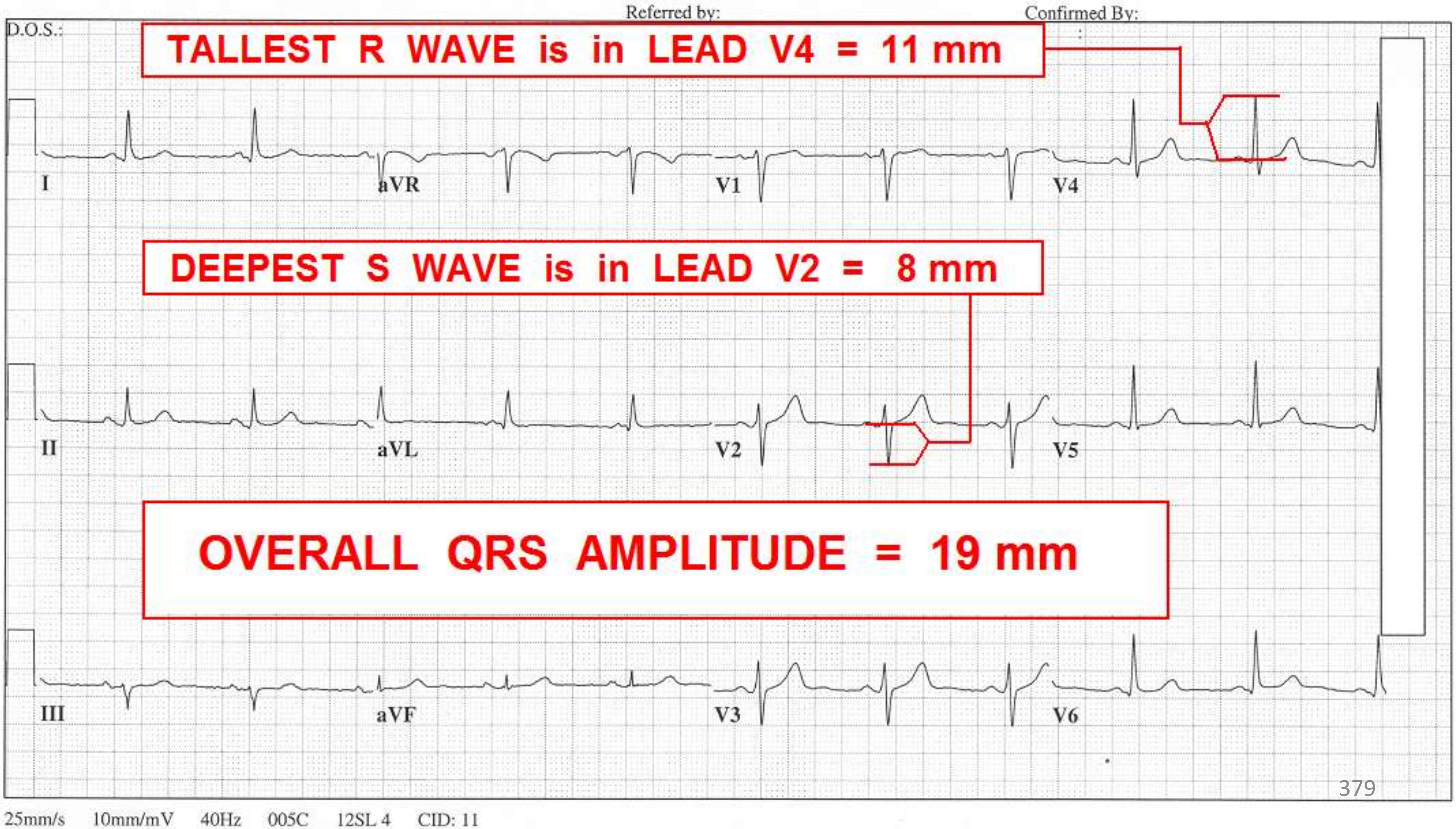
# THE QRS COMPLEX

## 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 ! . . . . . .

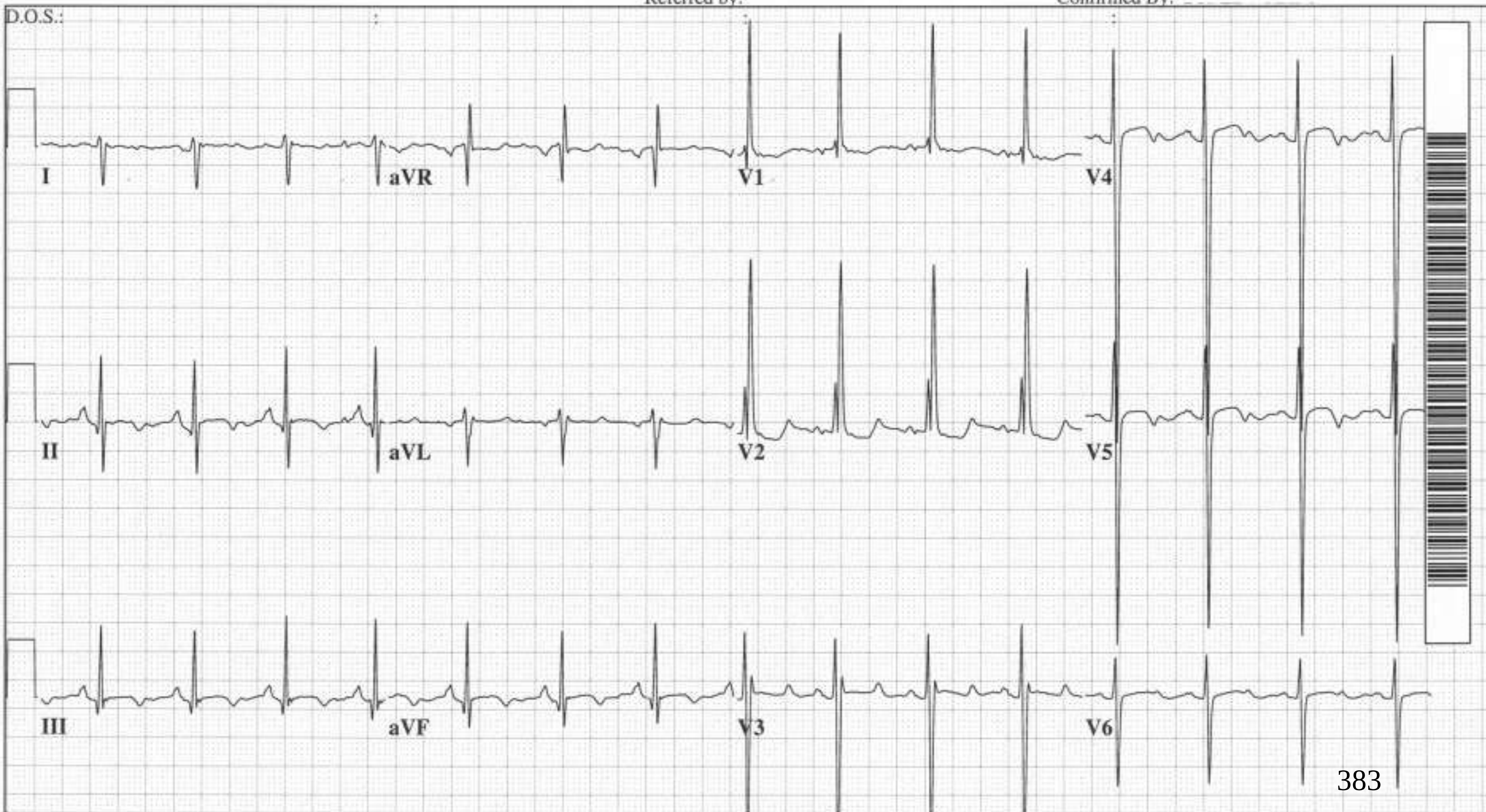
14–JUL–1997 14:30:58 ST. JOSEPH'S HOSPITAL–ER ROUTINE RETRIEVAL

| | | | | |
|---|---|---|---|---|
| 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
Male Caucasian

Room:ER S3
Loc:3 Option:18

| | | |
|---|---|---|
| Vent. rate | 100 | BPM |
| PR interval | 198 | ms |
| QRS duration | 186 | ms |
| QT/QTc | 380/490 | ms |
| 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:




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

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

Page 1 of 1

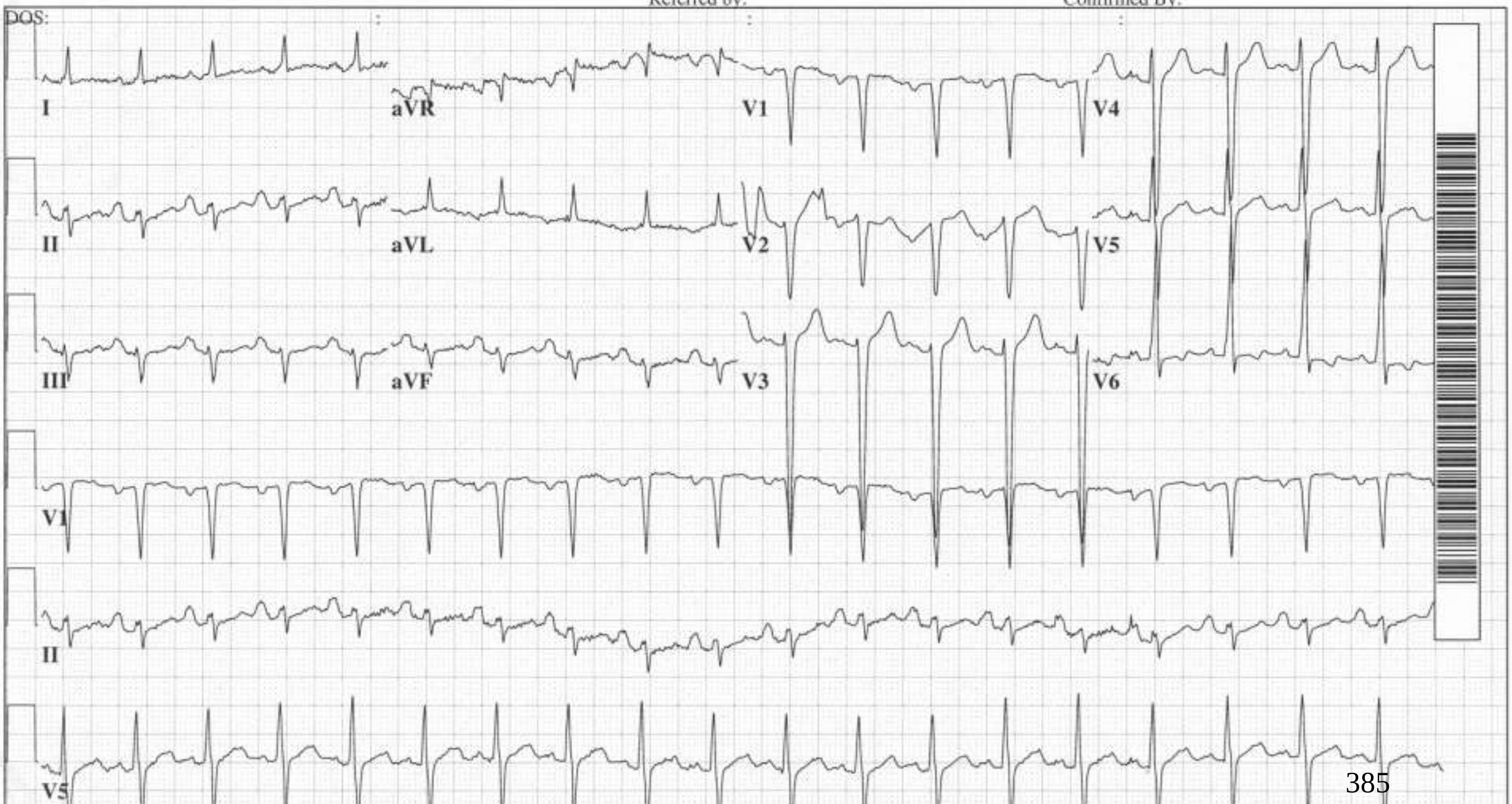
18–NOV–2002 02:15:46 ST. JOSEPH'S HOSPITAL–ER 1ST PREVIOUS

| | | | | |
|---|---|---|---|---|
| 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 |

**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

**EKG CLASS #WR03896717**

Referred by: Confirmed By:






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

Page 1 of 1

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

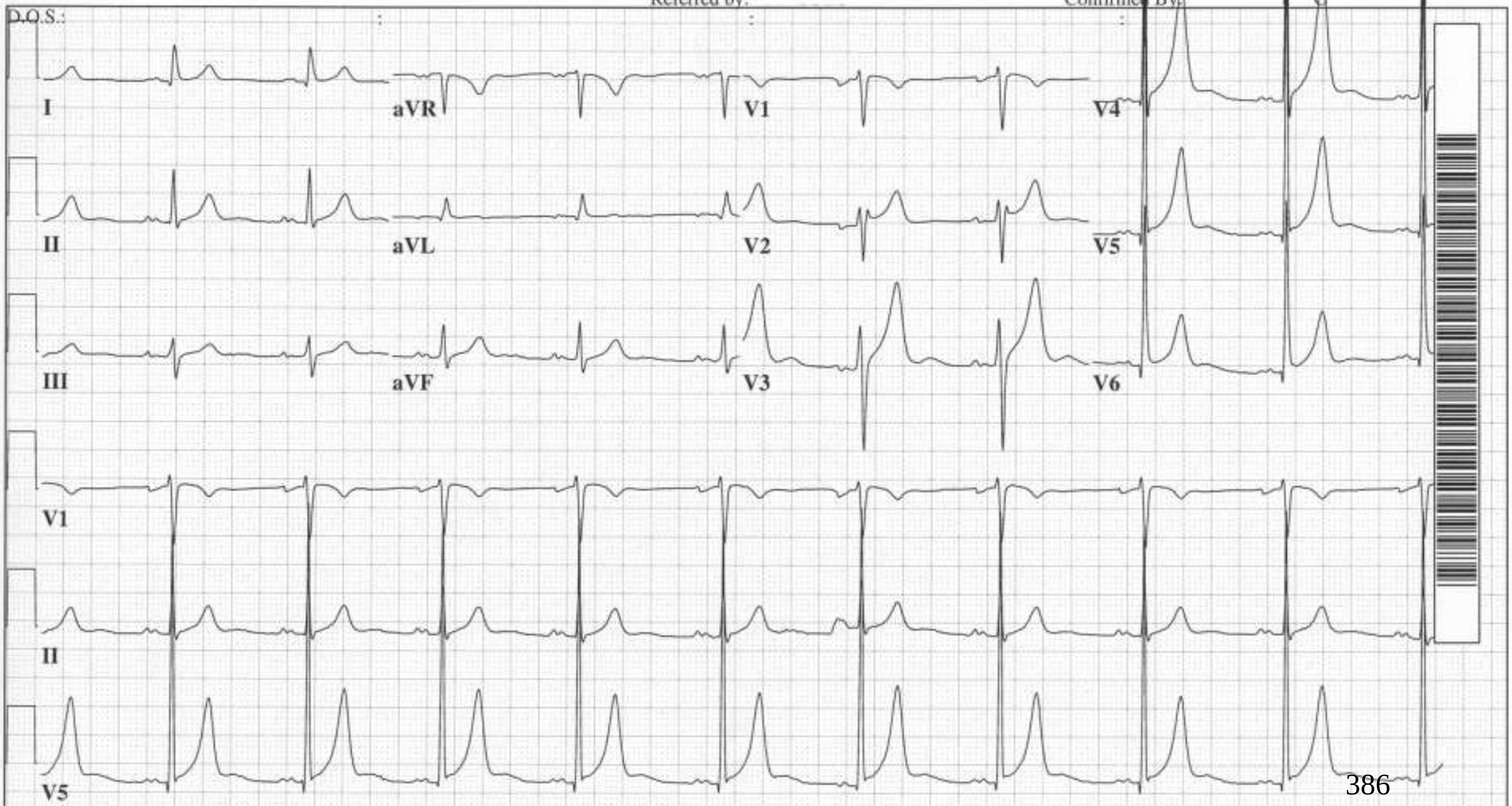
| | | | | | |
|---|---|---|---|---|---|
| 61 yr | | Vent. rate | 60 | | BPM |
| Male | Black | PR interval | 176 | | ms |
| | | QRS duration | 90 | | ms |
| | | QT/QTc | 400/400 | | ms |
| Loc:7 | Option:35 | P–R–T axes | 62 | 33 | 60 |

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:

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

**CRITERIA FOR MINIMUM AMPLITUDE:**

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 | | Vent. rate | 132 | BPM |
| Female | Black | PR interval | 154 | ms |
| | | QRS duration | 76 | ms |
| Room:ATL | | QT/QTc | 282/417 | ms |
| Loc:3 | Option:23 | 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 |
| P–R–T axes | 51 | 17 | −80 |

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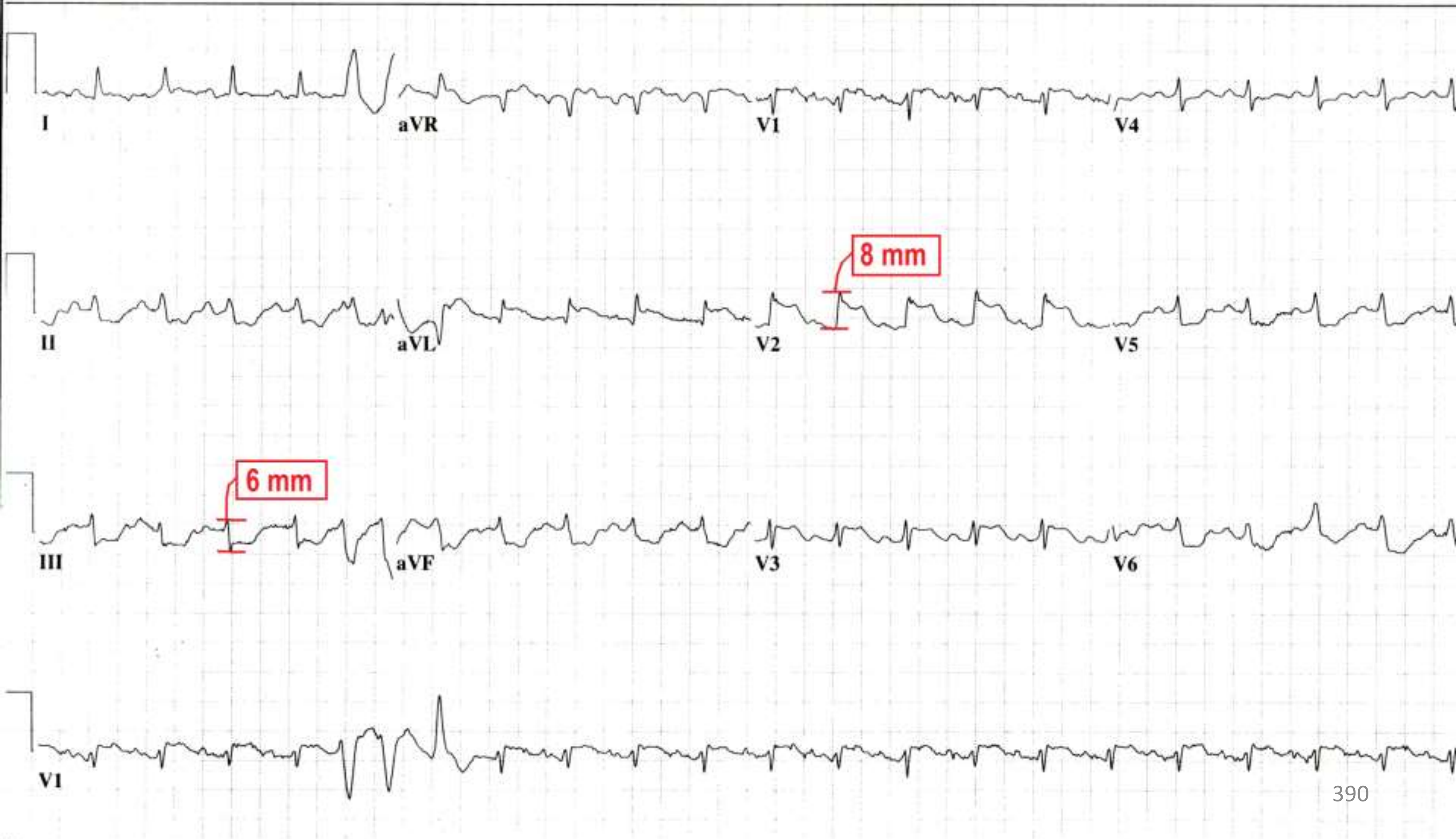
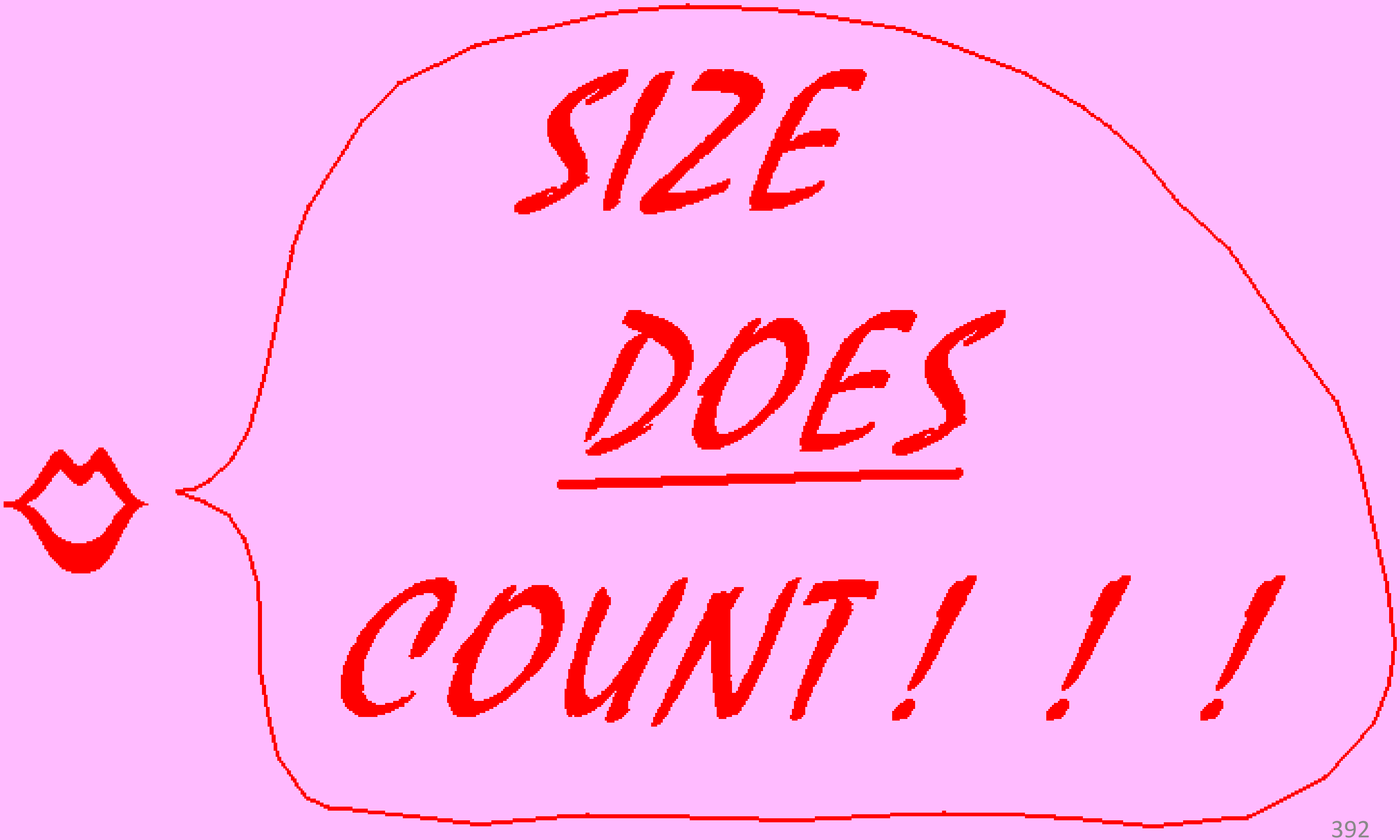
*** Age and gender specific ECG analysis ***
Sinus tachycardia with occasional , and consecutive
Premature ventricular complexes
Low voltage QRS
ST elevation consider anterolateral injury or acute infarct
*** ** ** ** * ACUTE MI ** ** ** **
Abnormal ECG
No previous ECGs available



# • Q WAVES •

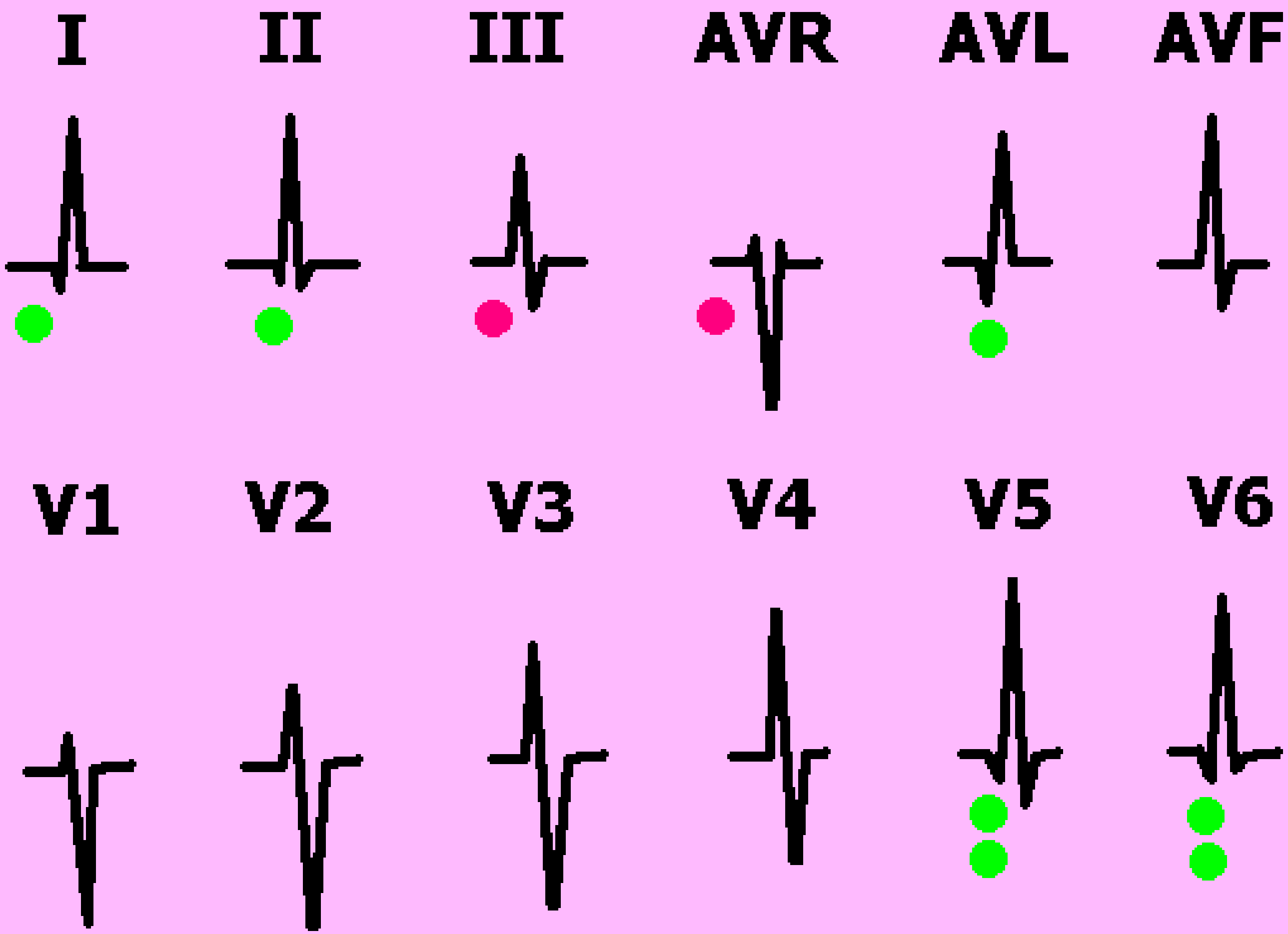
| | |
|---|---|
| **Normal Q Waves** | caused by depolarization of the intraventricular septum |
| **Abnormal Q Waves -** | caused by:<br>• necrosis ( old infarction )<br>• hypertrophy |

# 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

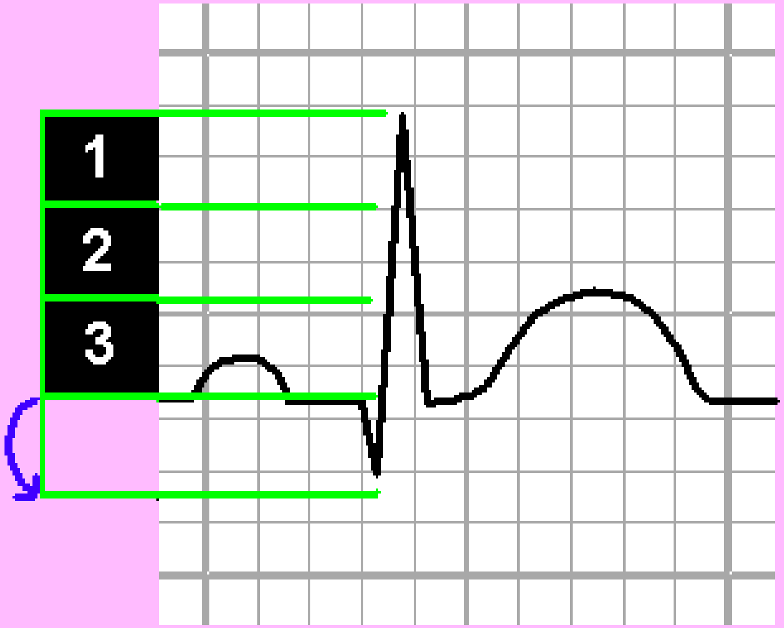
# THE QRS COMPLEX

## GENERAL RULES FOR NORMAL Q WAVES - WIDTH

LESS THAN .40 ( 1 mm ) WIDE

# THE QRS COMPLEX

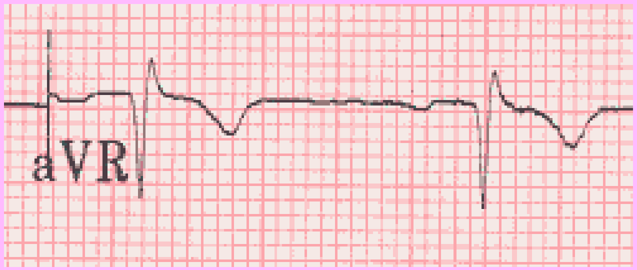
## GENERAL RULES FOR NORMAL Q WAVES - HEIGHT



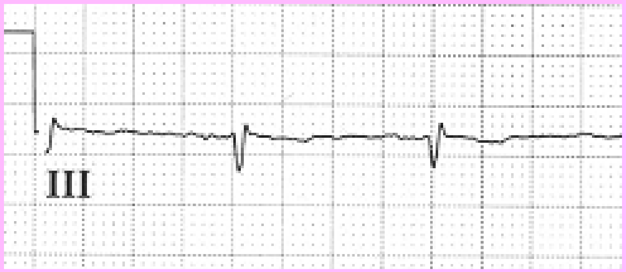

☞ LESS THAN 1/3 THE HEIGHT OF THE <u>R WAVE</u>

# THE QRS COMPLEX

## NORMAL Q WAVES
## EXCEPTIONS TO THE RULES




LEAD AVR



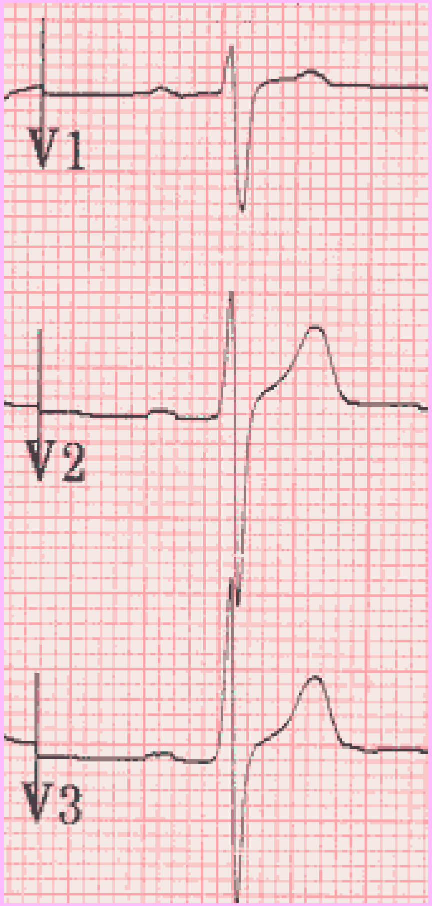

LEAD III

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

# NORMAL ST - T WAVES

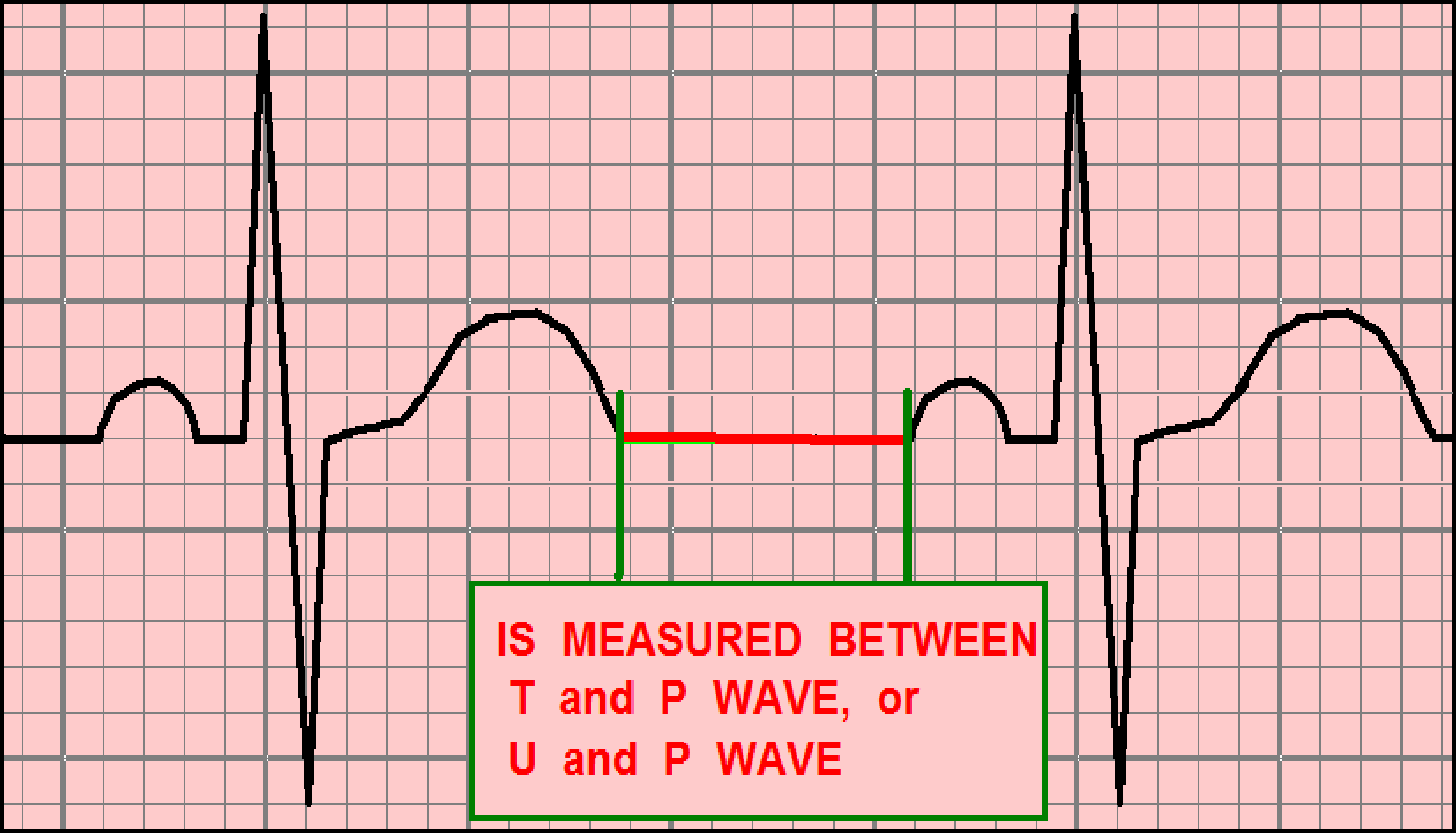
- WHEN QRS WIDTH IS NORMAL ( < 120 ms )


## ASSESS:

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

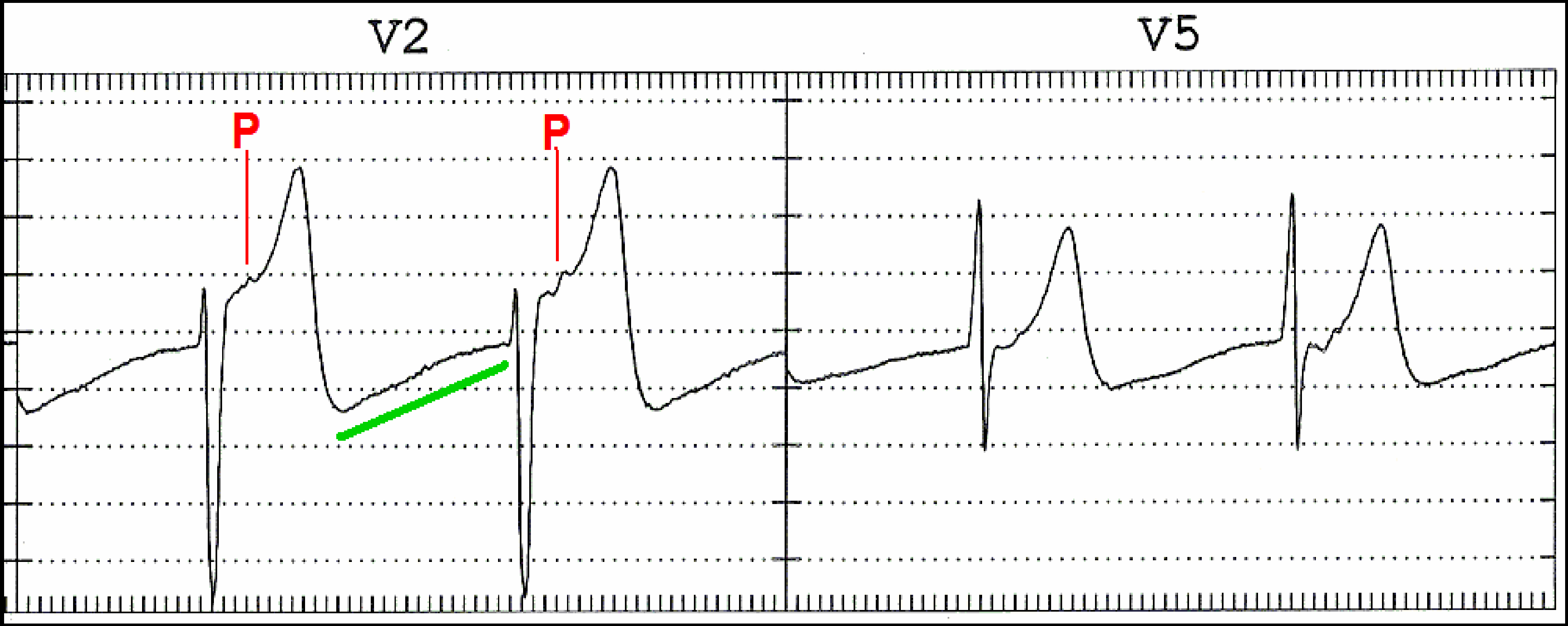
☞ *in EVERY LEAD EXCEPT aVR ! !*

# THE ISOELECTRIC LINE



# THE ISOELECTRIC LINE

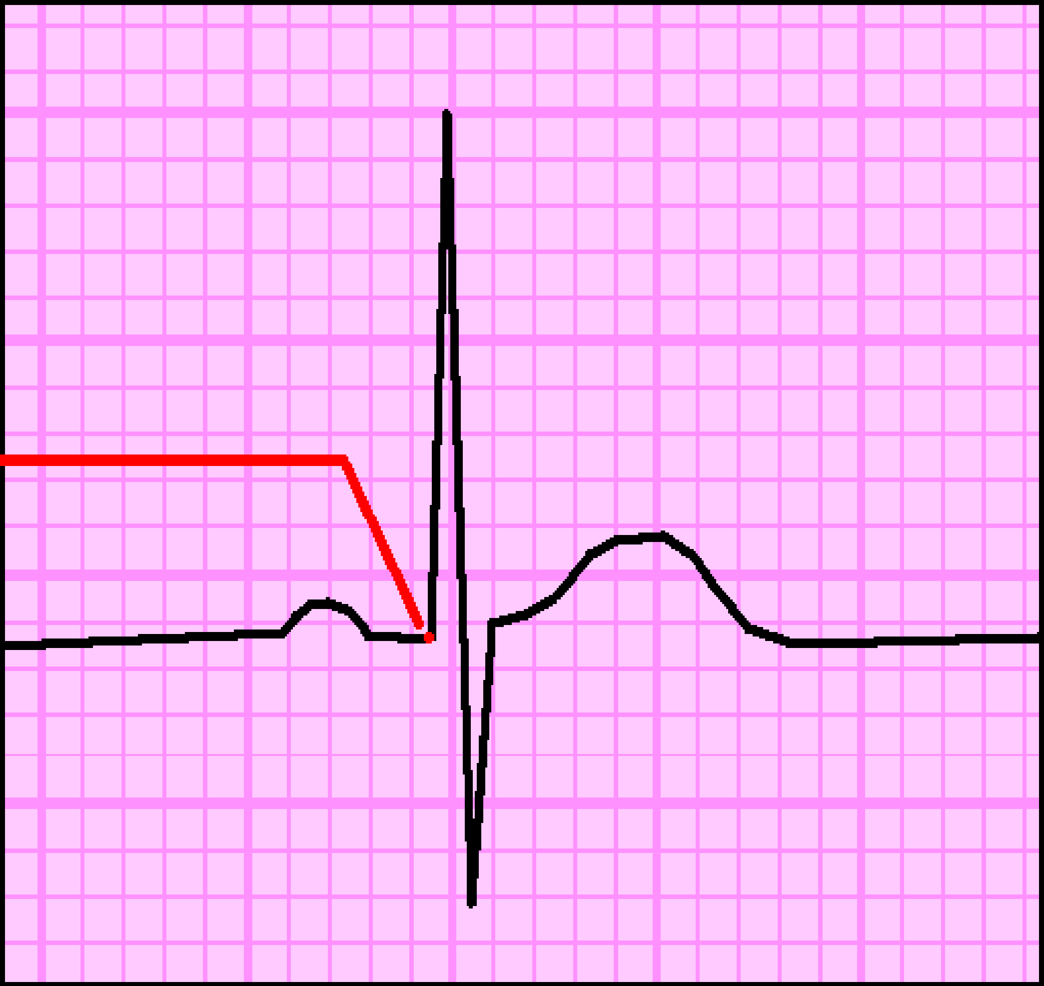
EKG from 13 y/o girl in ACCELERATED JUNCTIONAL RHYTHM.
note: upsloping T-P interval, and P buried in T waves.



# THE P-Q JUNCTION

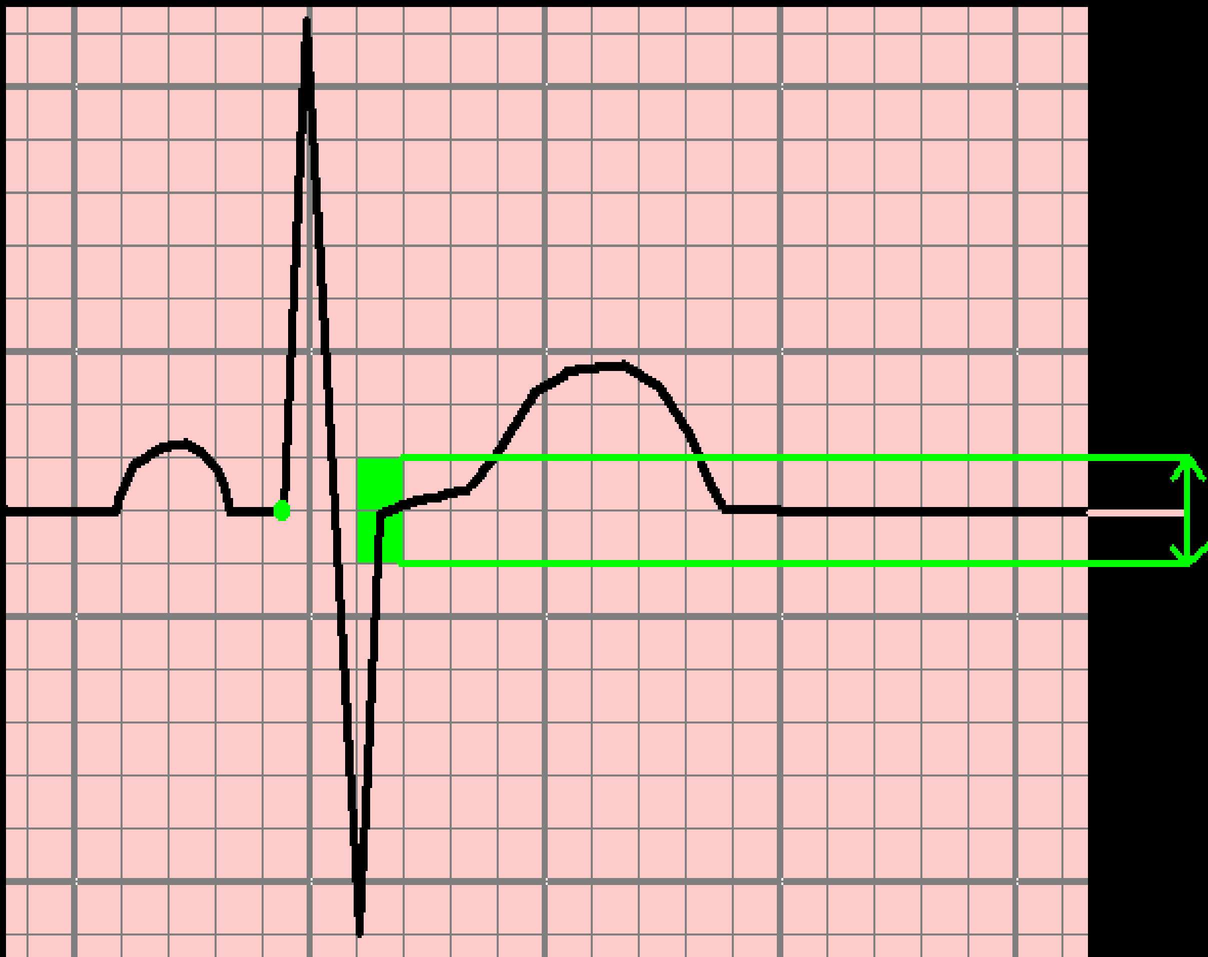
. . . . is the POINT where the P-R SEGMENT ends and the QRS COMPLEX BEGINS.

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 . .

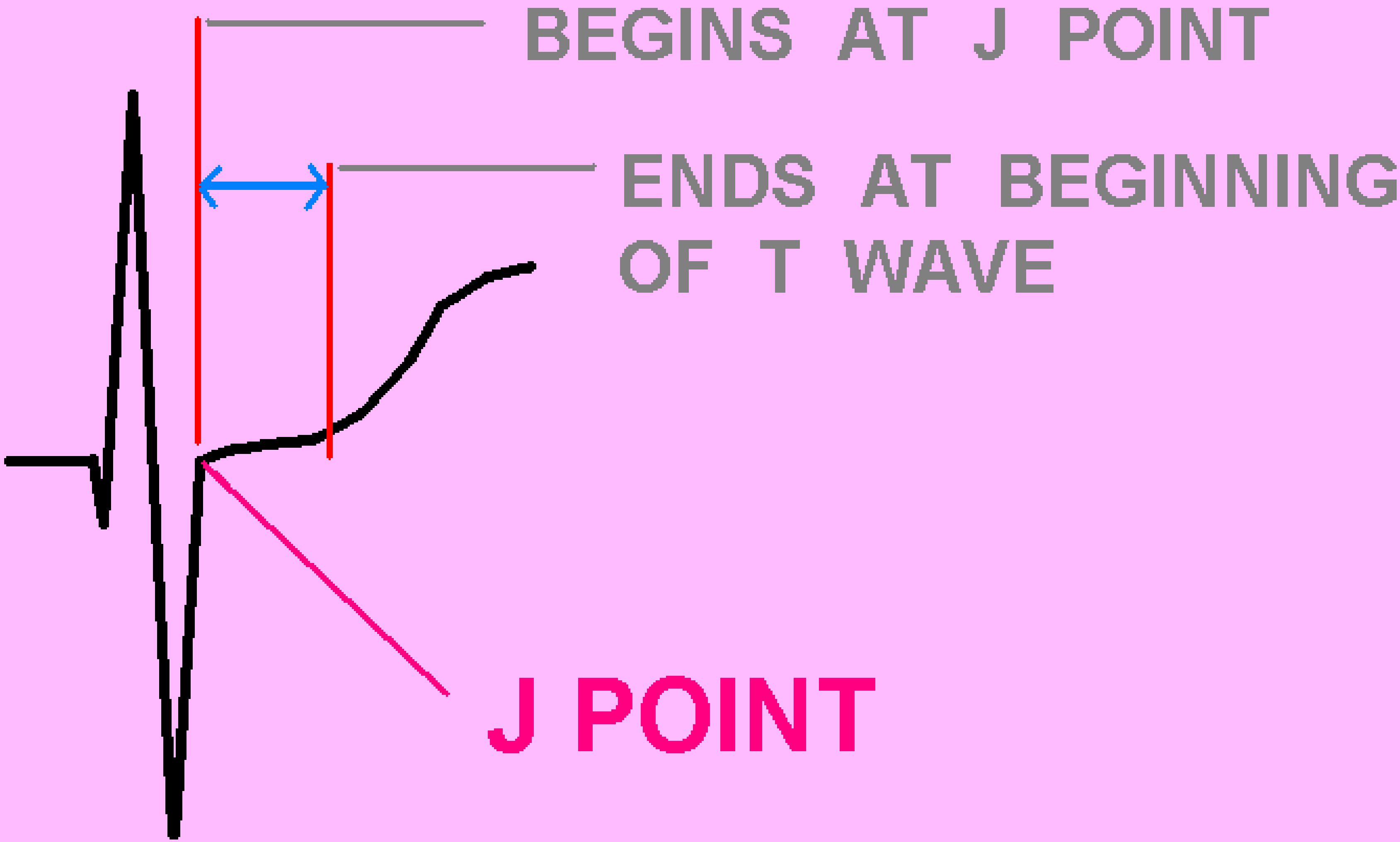


WITHIN 1 mm ABOVE

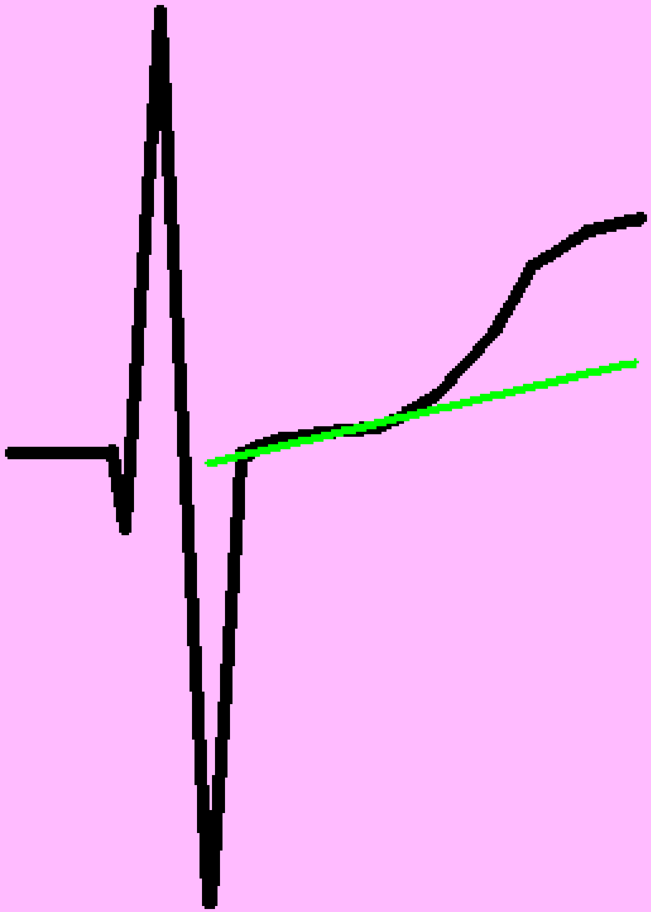
OR

BELOW THE P-Q JUNCTION

# THE S-T SEGMENT

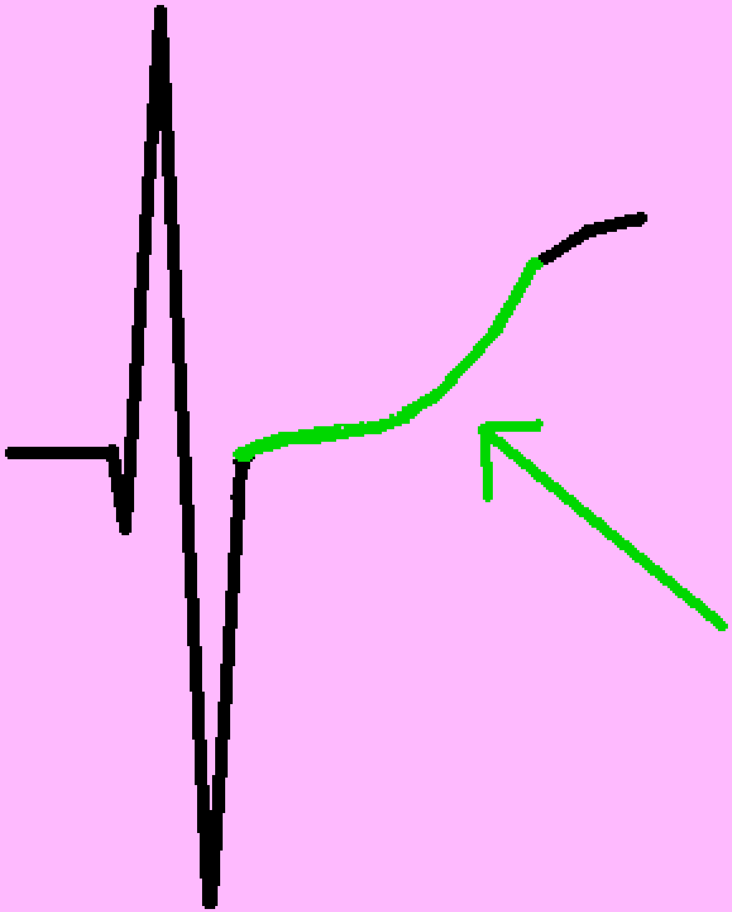


# THE S-T SEGMENT



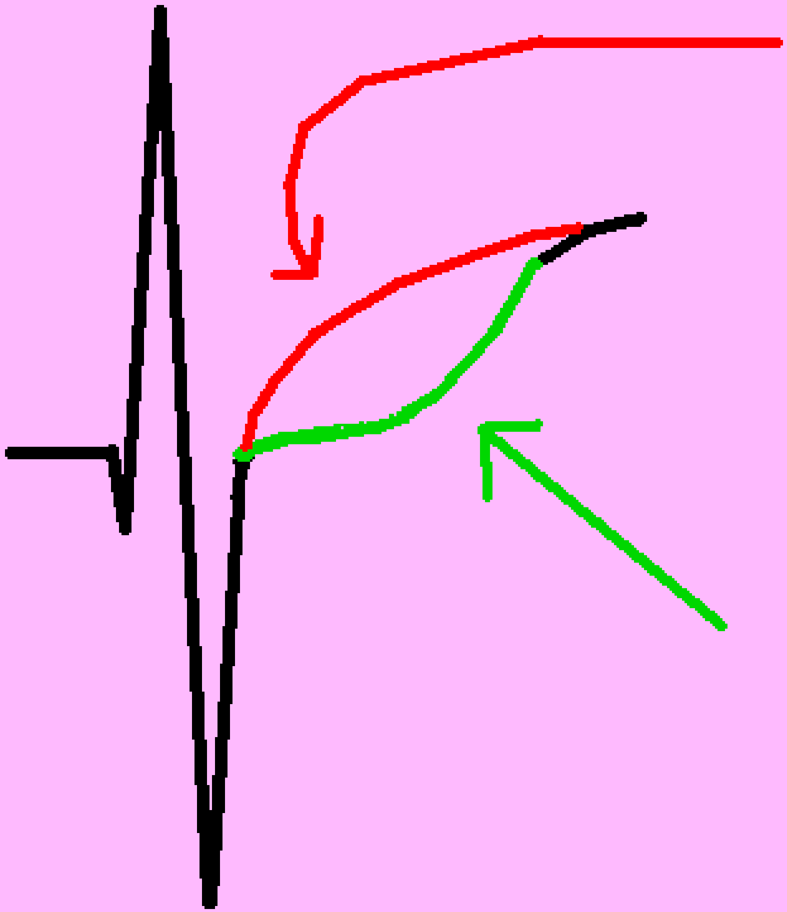
SHOULD HAVE
A "SLIGHT POSITIVE"
INCLINATION

# THE S-T SEGMENT



SHOULD BE "CONCAVE" IN SHAPE . . .

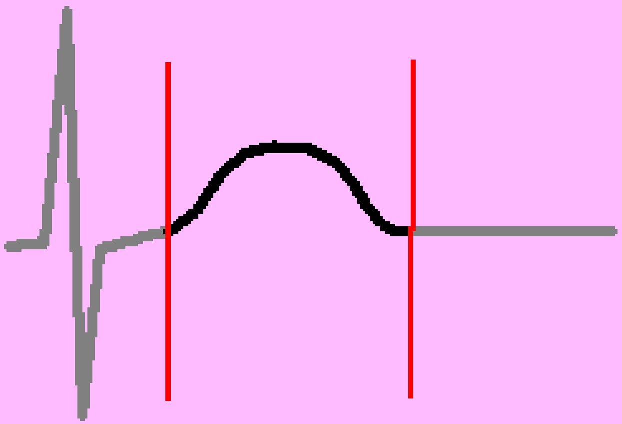
# THE S-T SEGMENT



AS OPPOSED TO
"CONVEX" IN
SHAPE

SHOULD BE
"CONCAVE" IN
SHAPE . . .

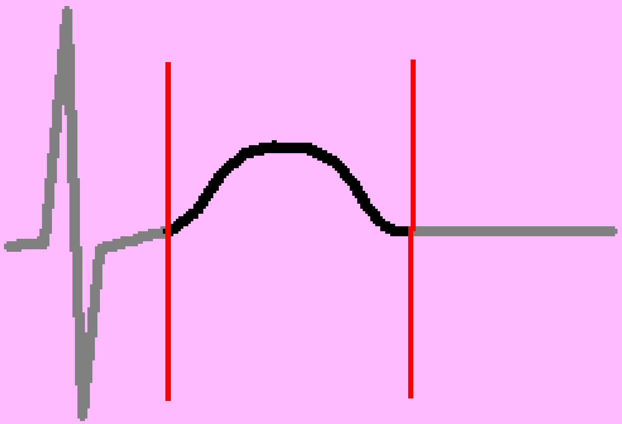
# THE T WAVE



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

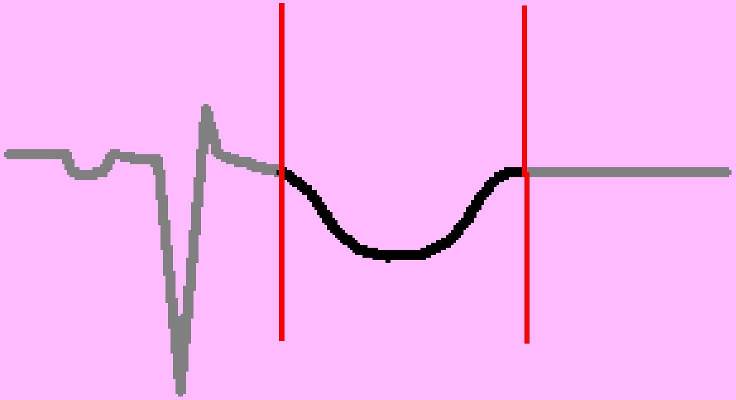
- SHOULD BE SYMMETRICAL

# THE T WAVE



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

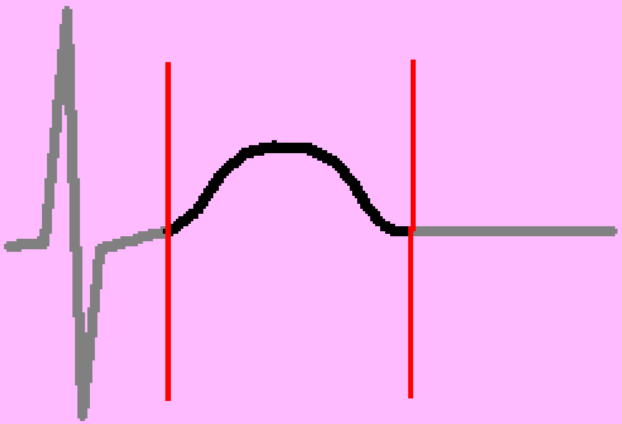
# THE T WAVE



# LEAD AVR

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

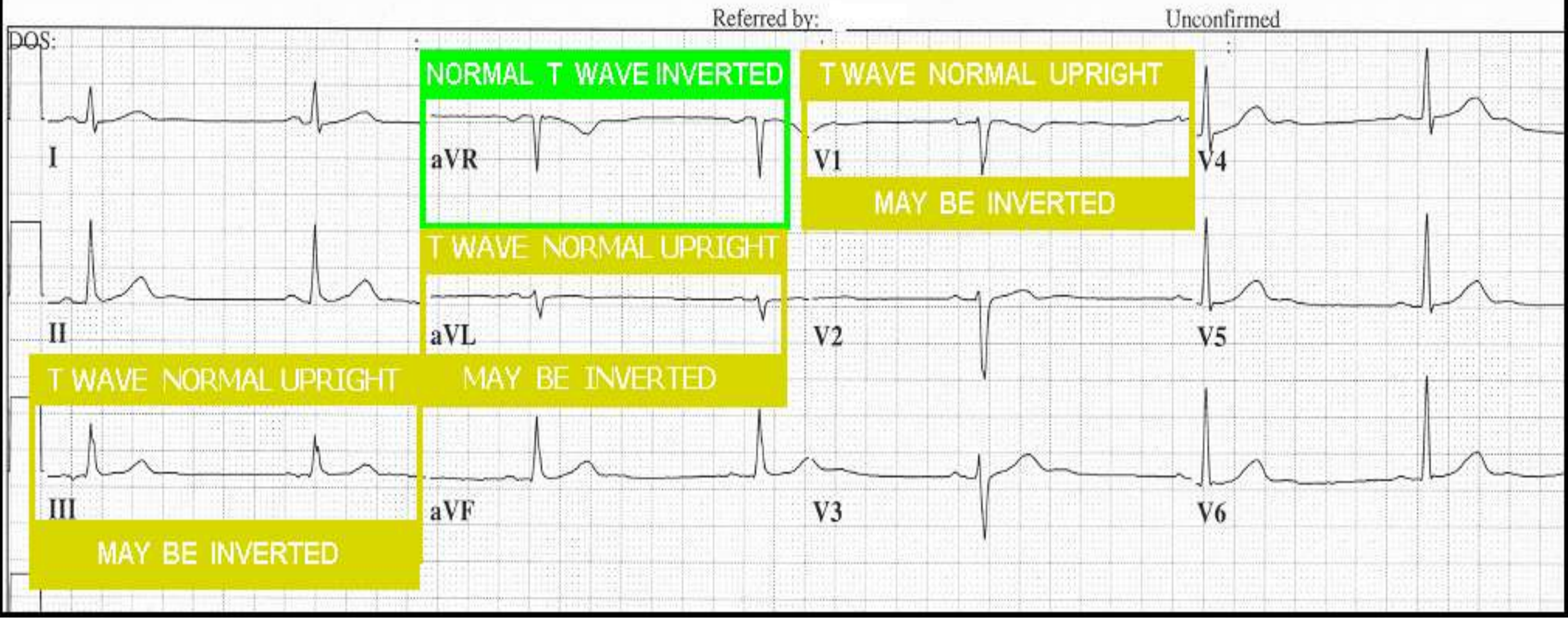
# THE T WAVE



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

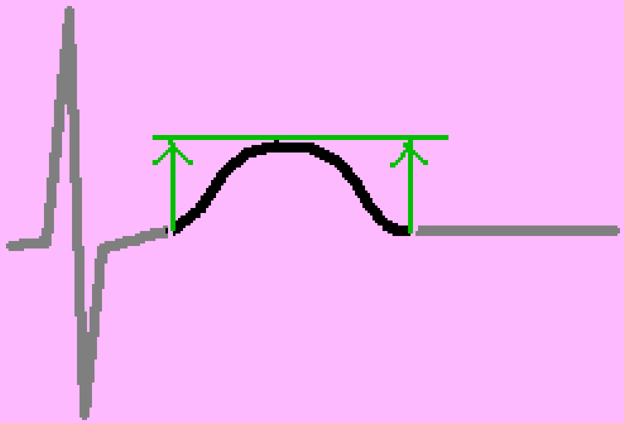
- SHOULD BE SYMMETRICAL
- SHOULD BE UPRIGHT IN ALL LEADS, EXCEPT AVR
- MAY BE INVERTED IN LEADS I, III, and V1

# Leads where the T WAVE may be INVERTED:




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

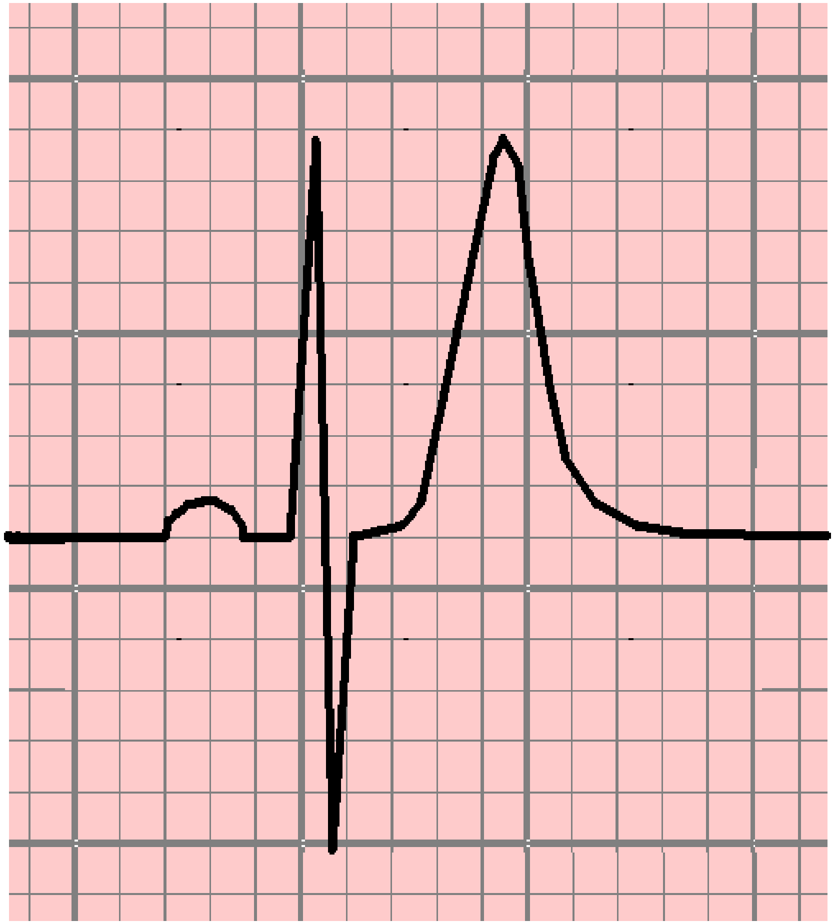
# THE T WAVE



## 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:

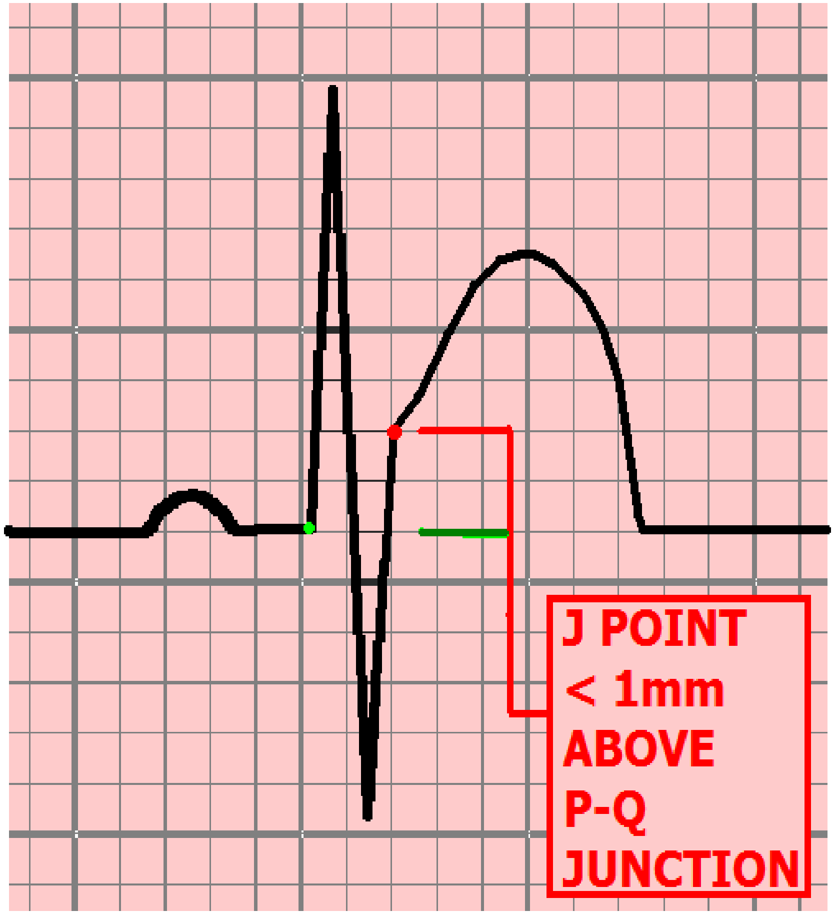


CONDITION:

- **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.

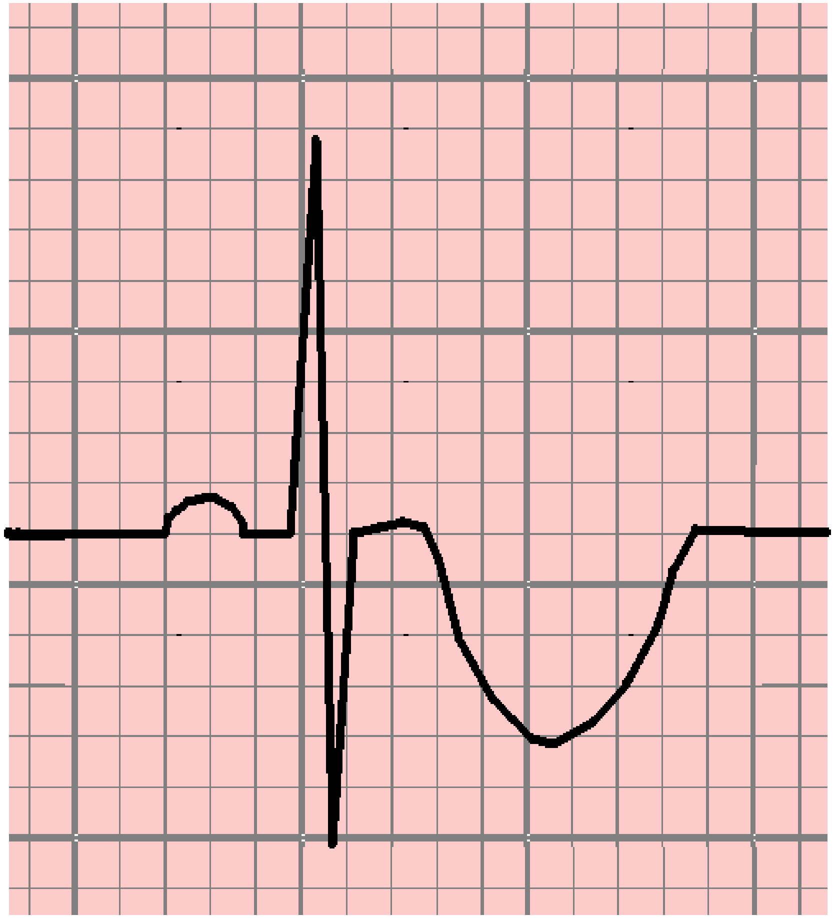
ON THE NEXT PAGE IN YOUR BOOK ARE SOME EXAMPLES OF THE ABOVE CONDITIONS

# 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:



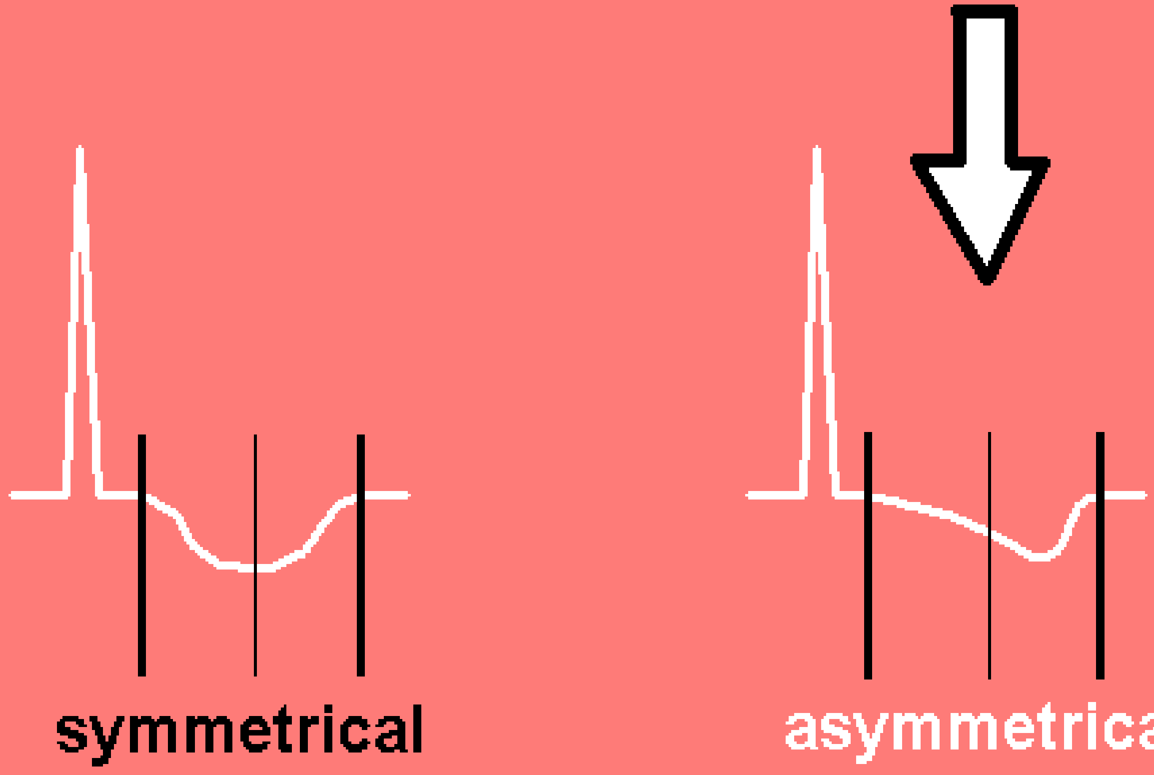
CONDITION:

- 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

# CHAMBER ENLARGEMENT

## VENTRICULAR STRAIN PATTERNS

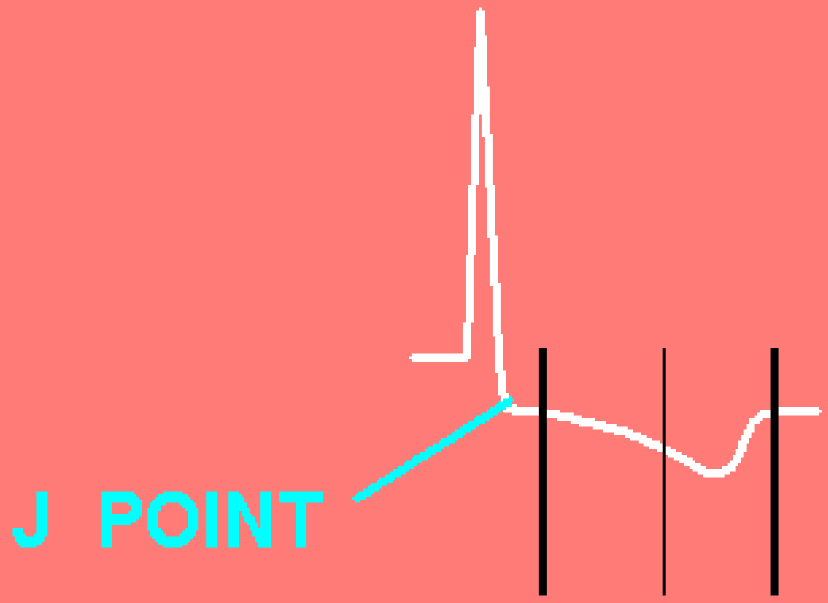
☞ T-WAVES ARE INVERTED and ASYMMETRICAL



# CHAMBER ENLARGEMENT

## VENTRICULAR STRAIN PATTERNS

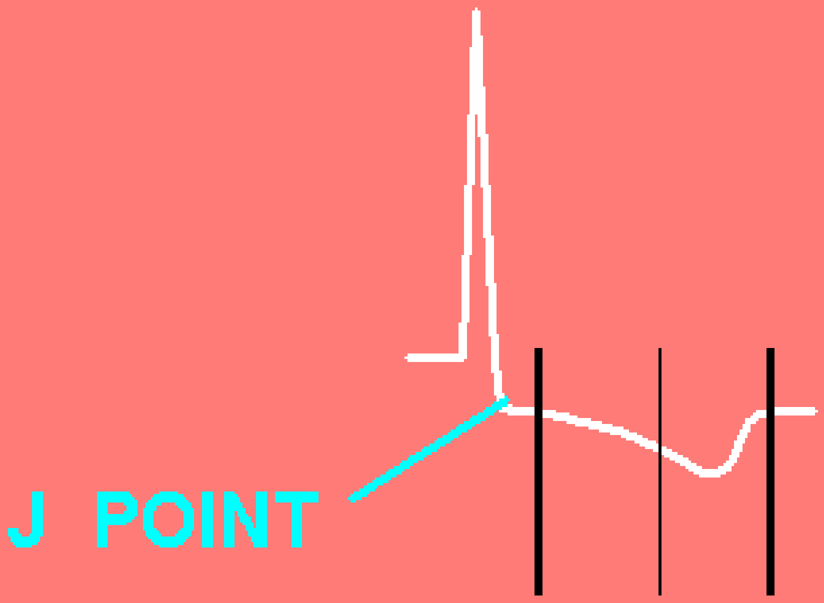
- T WAVES ARE INVERTED AND ASMMETRICAL
- THERE MAY BE S-T SEGMENT DEPRESSION



# CHAMBER ENLARGEMENT

## VENTRICULAR STRAIN PATTERNS

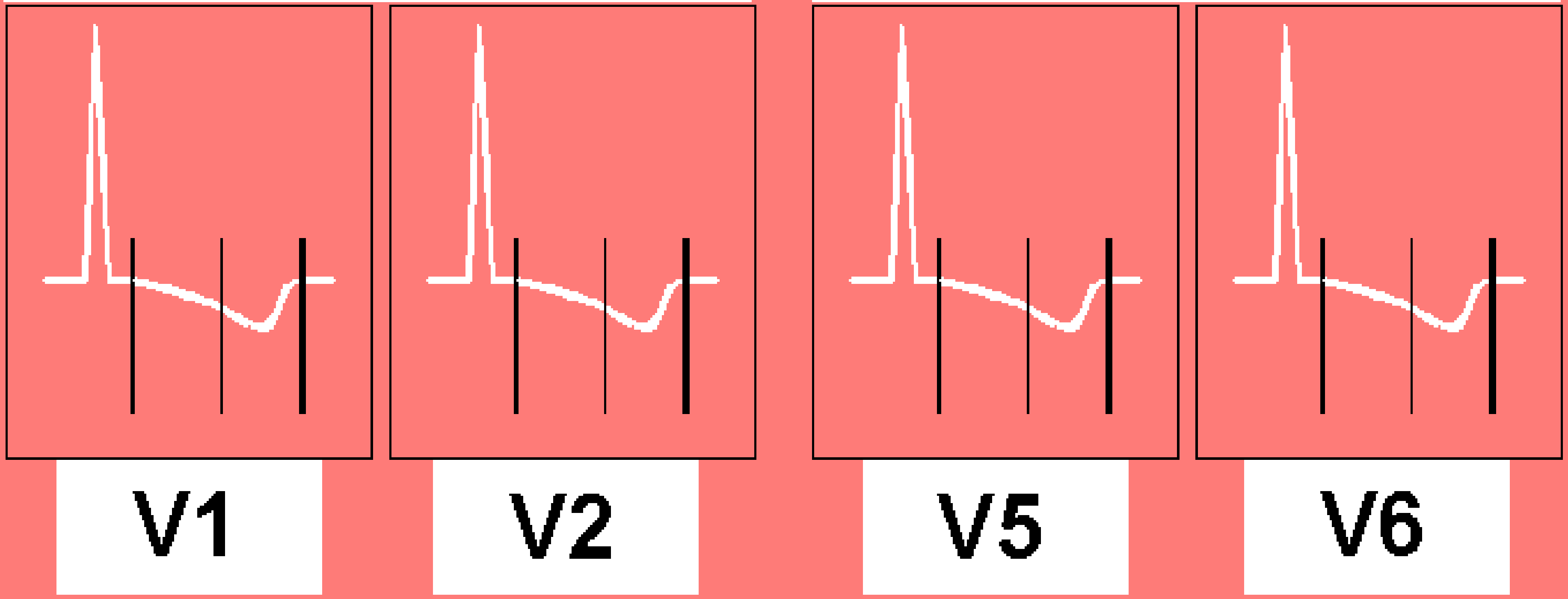
STRAIN PATTERNS ARE INDICATIVE OF SYSTOLIC OVERLOAD -- THE VENTRICLES HAVING TO OVERCOME GREAT FORCE TO EXPEL BLOOD.



# CHAMBER ENLARGEMENT

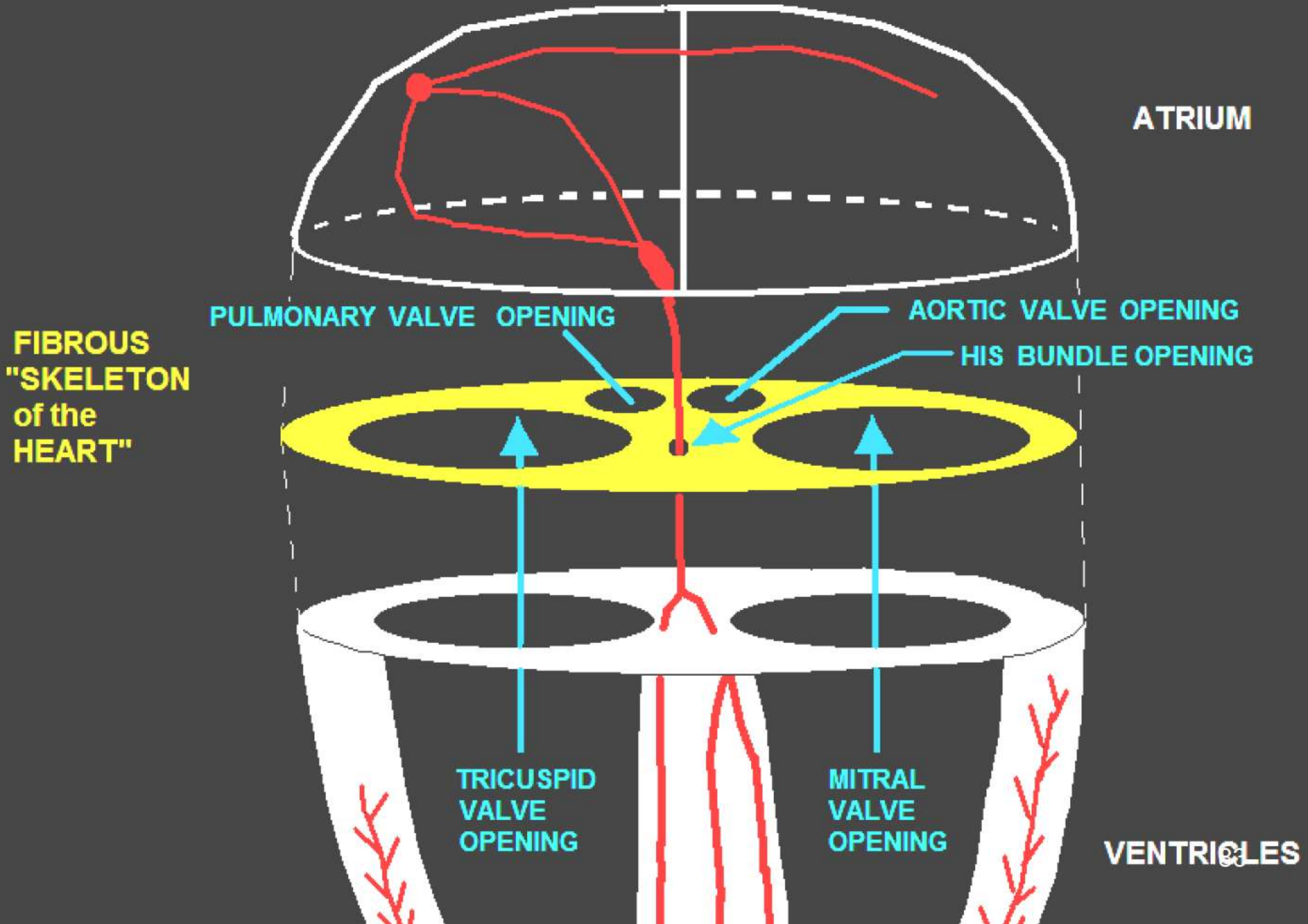
## VENTRICULAR STRAIN PATTERNS

| RVH | | LVH | |
|---|---|---|---|




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

# THE "SKELETON OF THE HEART"

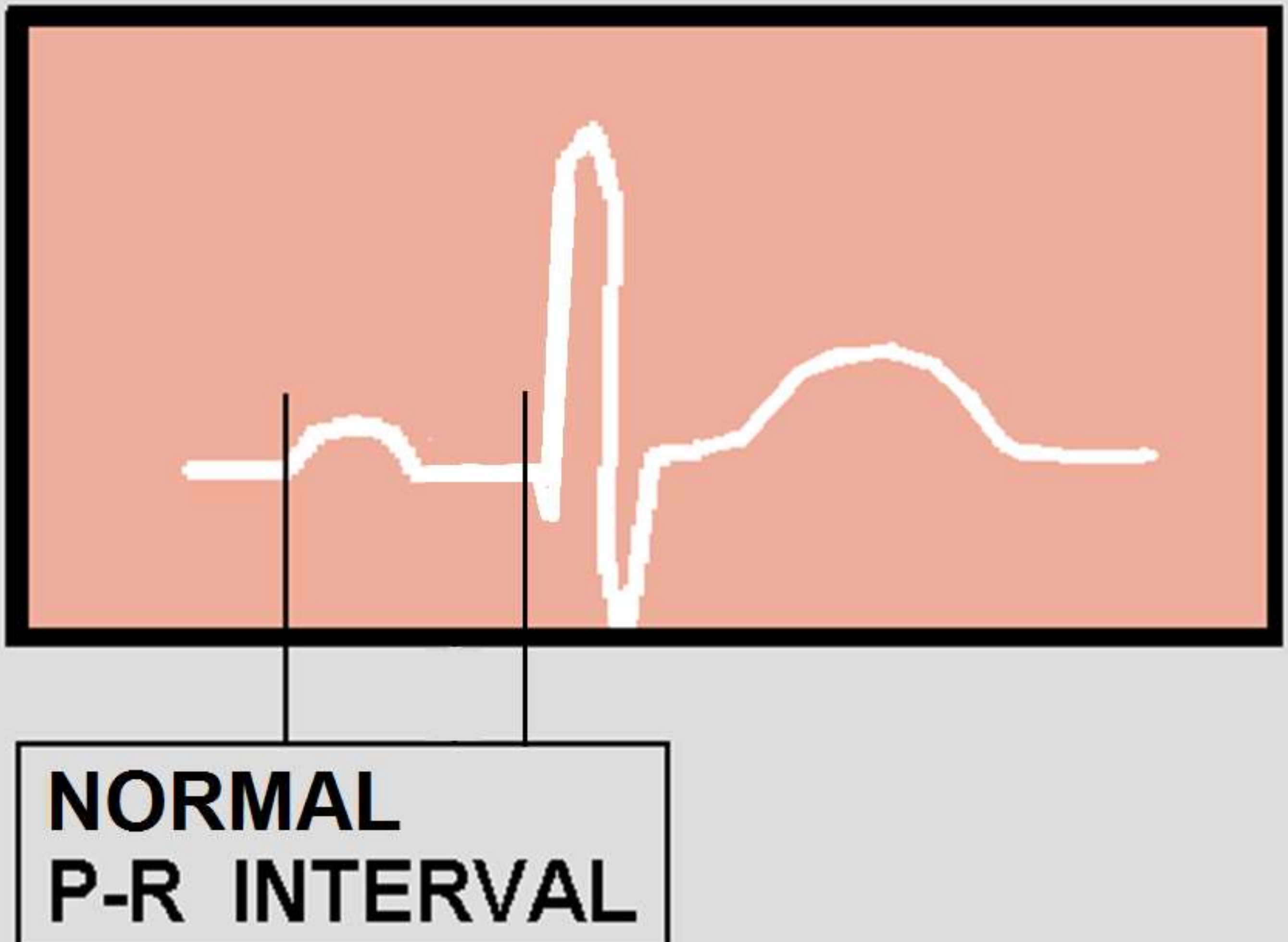


# Fibrous Skeleton of the Heart…

- Rarely taught ….. But it's so important to understanding cardiac function and ECGs…..
- It's a disk-shaped structure separating the atrium from the ventricles.
- Secures the heart valves.
- Acts as an electrical insulator, blocks electrical current………
- **An abnormal hole (BYPASS TRACT) allows current to "leak" between atrium and ventricles**

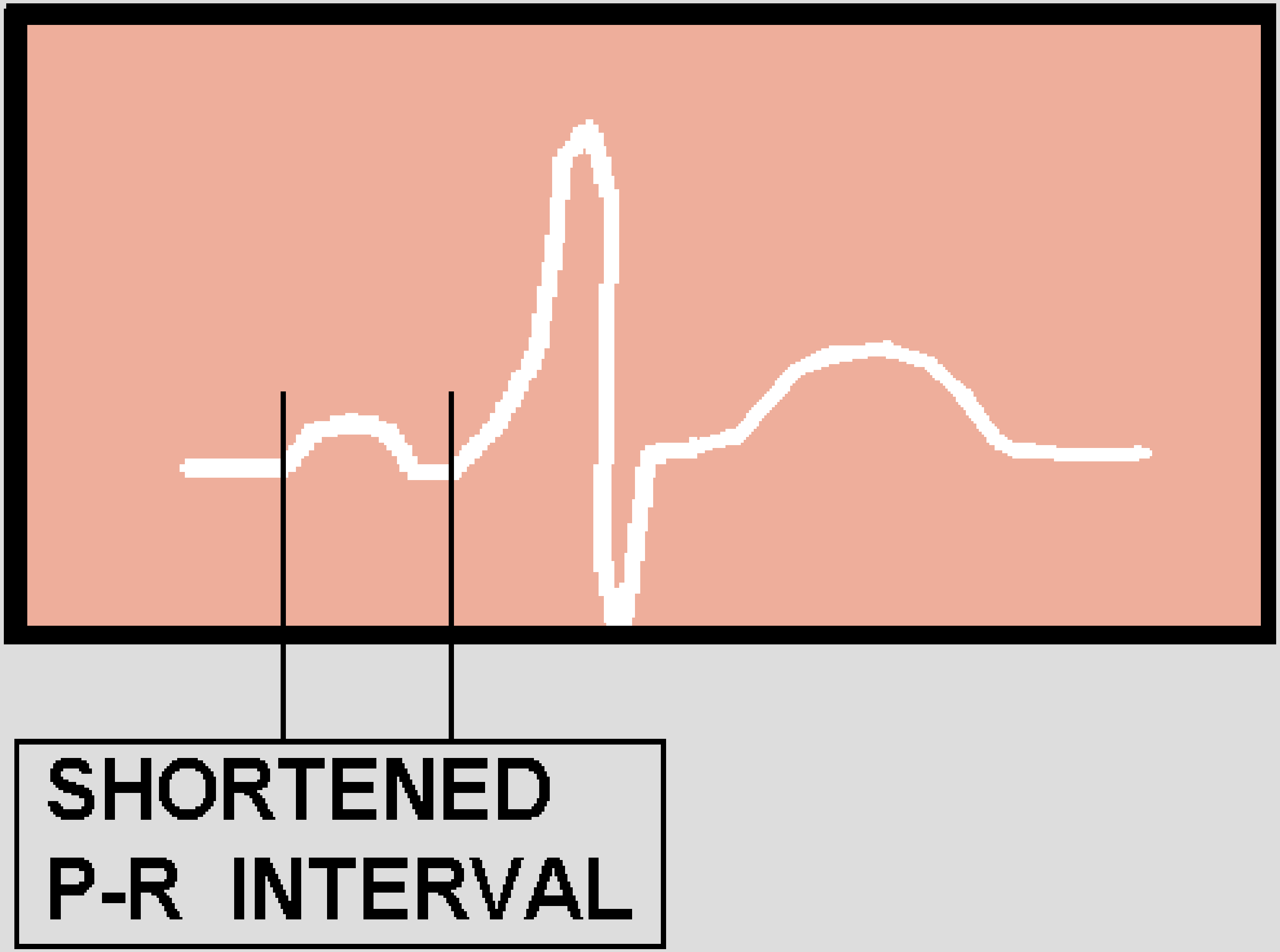
# WOLFF-PARKINSON-WHITE

## THE NORMAL ECG . . . .



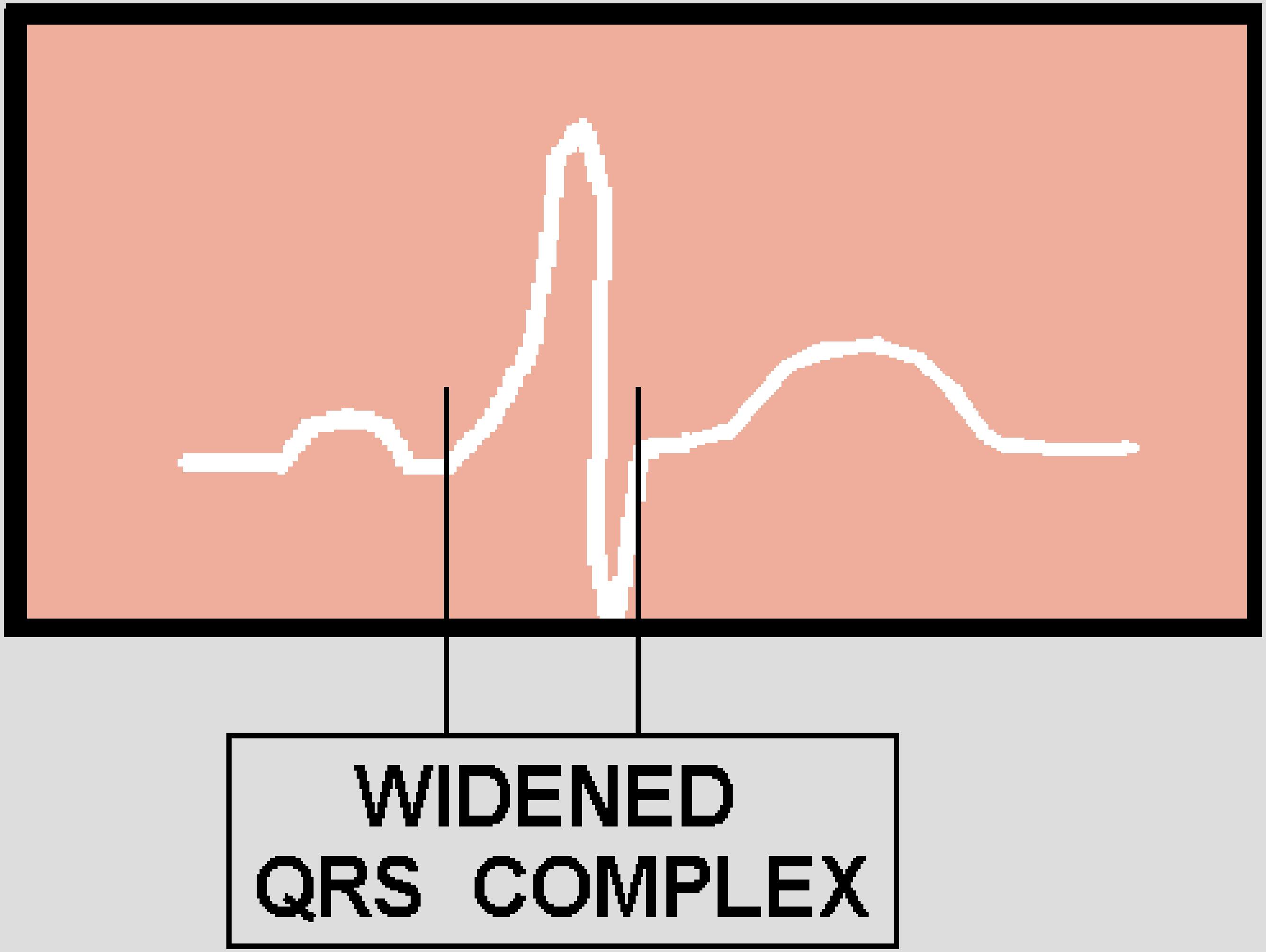
# WOLFF-PARKINSON-WHITE

## EKG CHARACTERISTICS



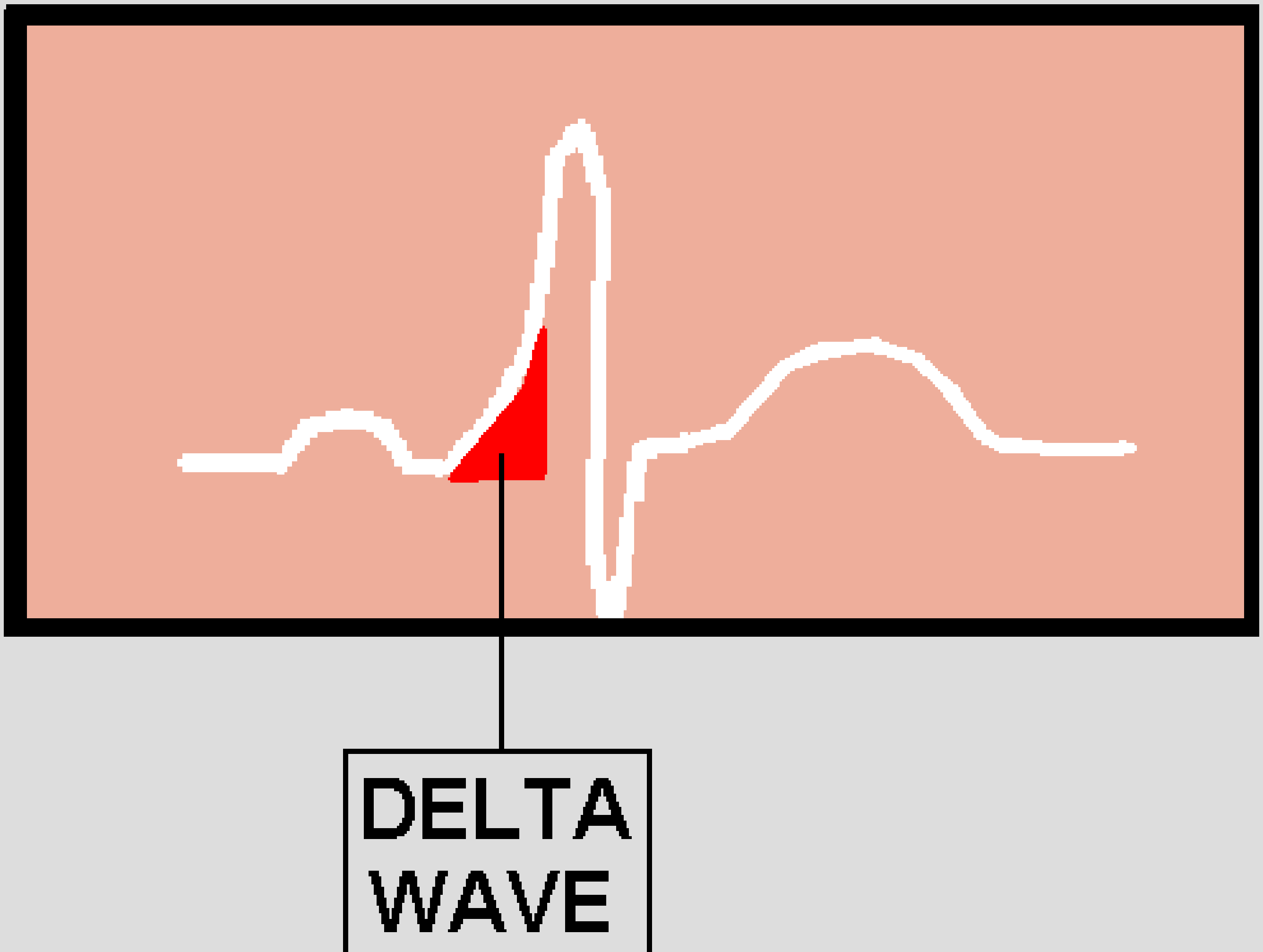
# WOLFF-PARKINSON-WHITE

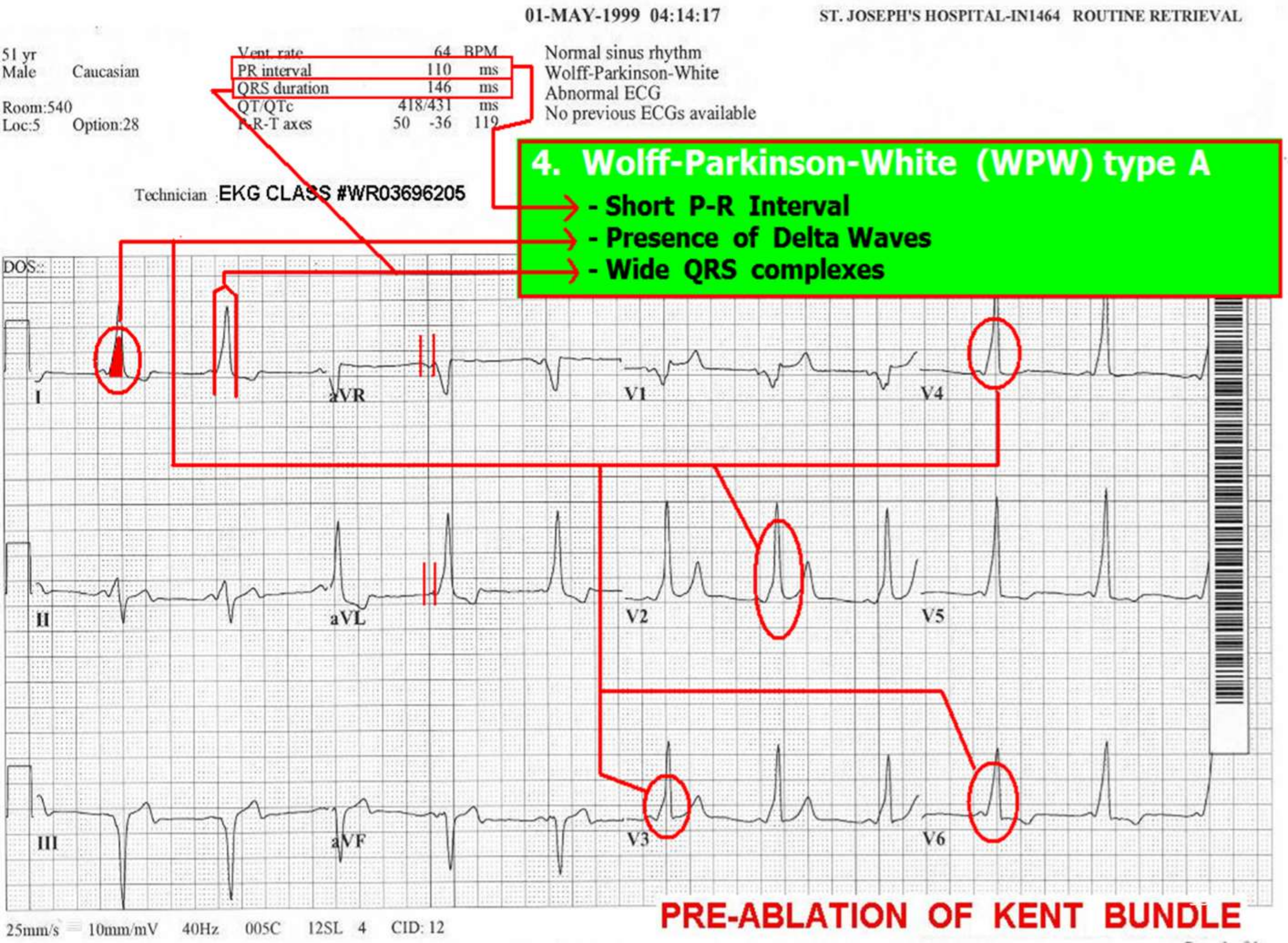
## EKG CHARACTERISTICS



# 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

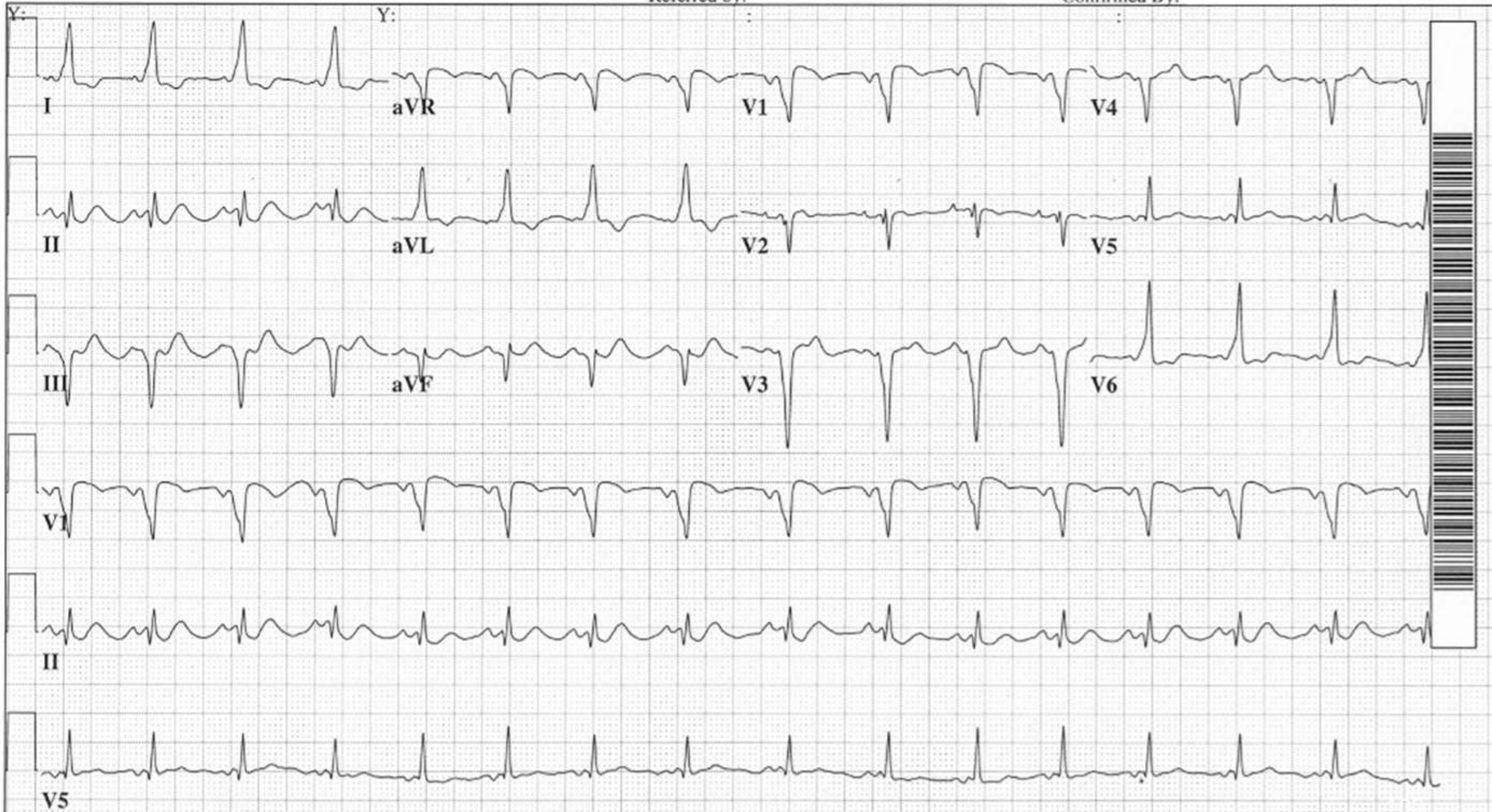
| | | |
|---|---|---|
| Vent. rate | 92 | BPM |
| PR interval | 112 | ms |
| QRS duration | 118 | ms |
| QT/QTc | 356/440 | ms |
| P–R–T axes | 59 –22 | 107 |

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

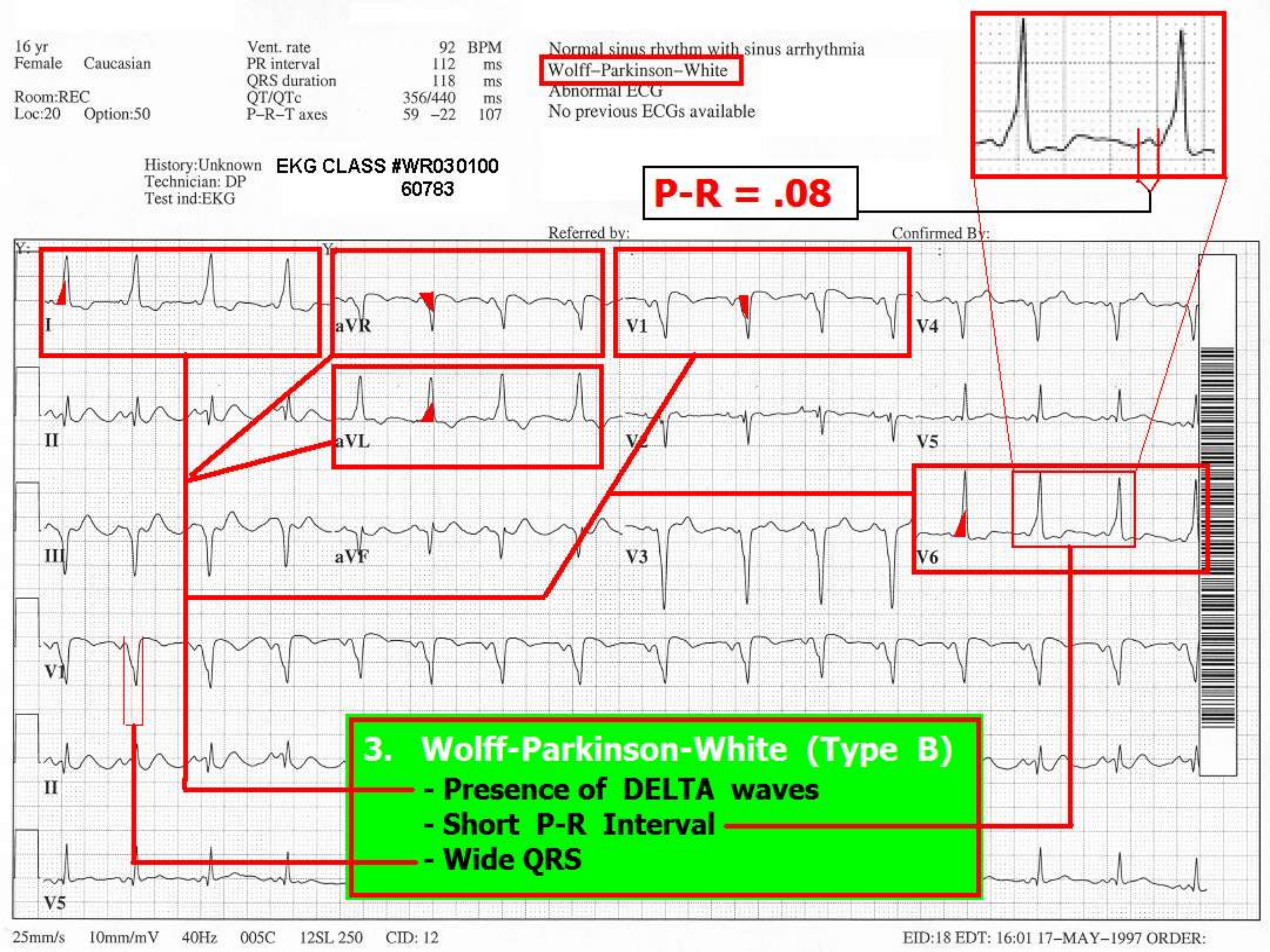
History:Unknown
Technician: DP
Test ind:EKG

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:

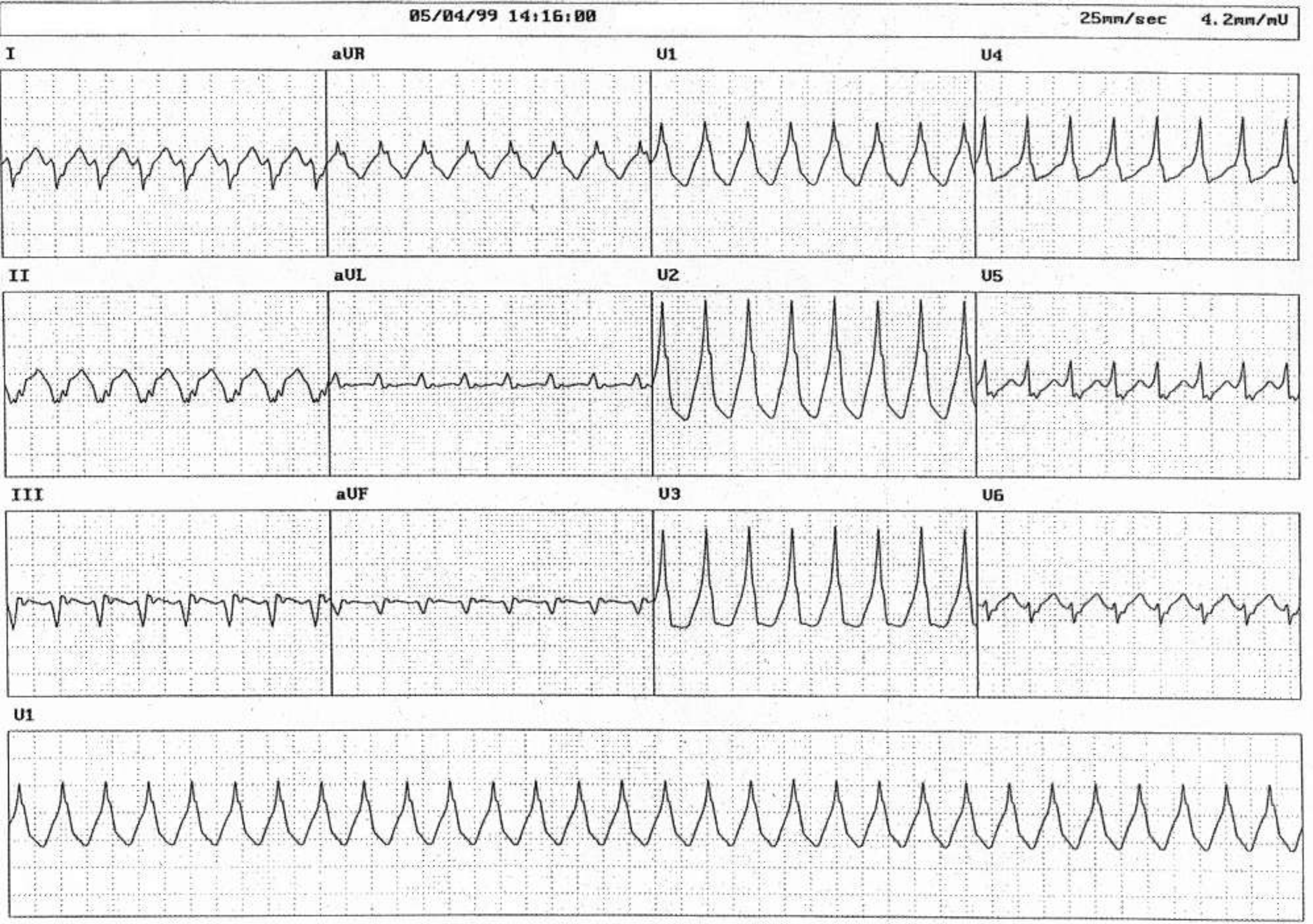


16 yr
Female Caucasian
Room:REC
Loc:20 Option:50
Vent. rate 92 BPM
PR interval 112 ms
QRS duration 118 ms
QT/QTc 356/440 ms
P-R-T axes 59 -22 107
Normal sinus rhythm with sinus arrhythmia
Wolff-Parkinson-White
Abnormal ECG
No previous ECGs available
History:Unknown
Technician: DP
Test ind:EKG
EKG CLASS #WR030100
60783
P-R = .08
Referred by:
Confirmed By:
I
aVR
V1
V4
II
aVL
V2
V5
III
aVF
V3
V6
V1
II
V5
3. Wolff-Parkinson-White (Type B)
- Presence of DELTA waves
- Short P-R Interval
- Wide QRS
25mm/s 10mm/mV 40Hz 005C 12SL 250 CID: 12
EID:18 EDT: 16:01 17-MAY-1997 ORDER:

W-P-W patients often experience Tachycardias:

- Narrow QRS Tachycardia (SVT)
- Wide QRS Tachycardia (mimics V-Tach.

The same patient can present with narrow QRS SVT, and at another time, Wide QRS Tachycardia ……..




ST. JOSEPH'S HOSPITAL W-P-W DOUBLE BY-PASS TRACT

**Patients with Wolff-Parkinson-White:**

- **Typically Pediatric / Young Adult**
- **May not know they have it**
- **May experience episodes of “palpitations” or “Very Fast Heartbeat.”**

**W-P-W may CAUSE A-fib with RVR. Patients may present with symptoms of “palpitations,” “heart racing,” “light-headedness,” or “passing out” . . . . . .**

**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 | WIDE QRS TACHYCARDIA – POSSIBLE VT |
| Male | Caucasian | PR interval | * | ms | Right bundle branch block PATTERN |
| | | QRS duration | 148 | ms | Abnormal ECG |
| Room:OP | | QT/QTc | 284/491 | ms | |
| Loc:8 | Option:16 | P–R–T axes | * –77 | 103 | |

Med: Unknown

Referred by: Confirmed By:


NOTE IRREGULARITY OF RHYTHM – (SUGGESTIVE OF AFIB)

LOOK FOR DELTA WAVES

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.***

**37 y/o male**

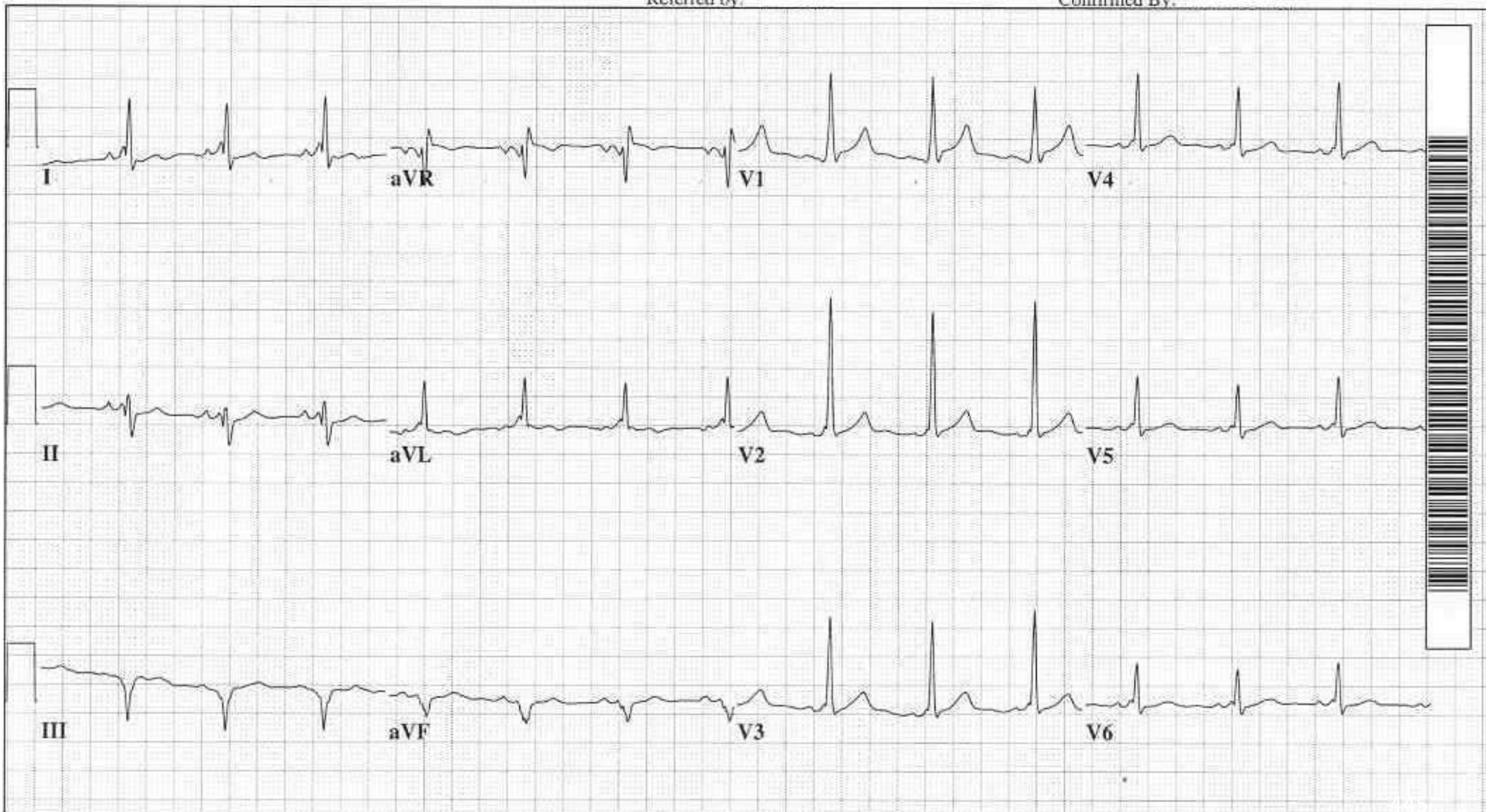
**After the patient was defibrillated, sinus rhythm with good perfusion was restored.**

**A 12 Lead EKG obtained revealed . . . . .**

ST. JOSEPH'S HOSPITAL- ROUTINE RETRIEVAL

| | | | | | | |
|---|---|---|---|---|---|---|
| 37 yr | | Vent. rate | 82 | | BPM | Normal sinus rhythm |
| Male | Caucasian | PR interval | 132 | | ms | Ventricular pre–excitation, WPW pattern type A |
| | | QRS duration | 128 | | ms | Abnormal ECG |
| Room:OP | | QT/QTc | 392/458 | | ms | |
| Loc:8 | Option:19 | P–R–T axes | 77 | –44 | 154 | |

Referred by: Confirmed By:




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

ST. JOSEPH'S HOSPITAL-

| | | | | | |
|---|---|---|---|---|---|
| 37 yr | | Vent. rate | 180 | BPM | WIDE QRS TACHYCARDIA – POSSIBLE VT |
| Male | Caucasian | PR interval | * | ms | Right bundle branch block PATTERN |
| | | QRS duration | 148 | ms | Abnormal ECG |
| Room:OP | | QT/QTc | 284/491 | ms | |
| Loc:8 | Option:16 | P-R-T axes | * −77 | 103 | |

Med: Unknown

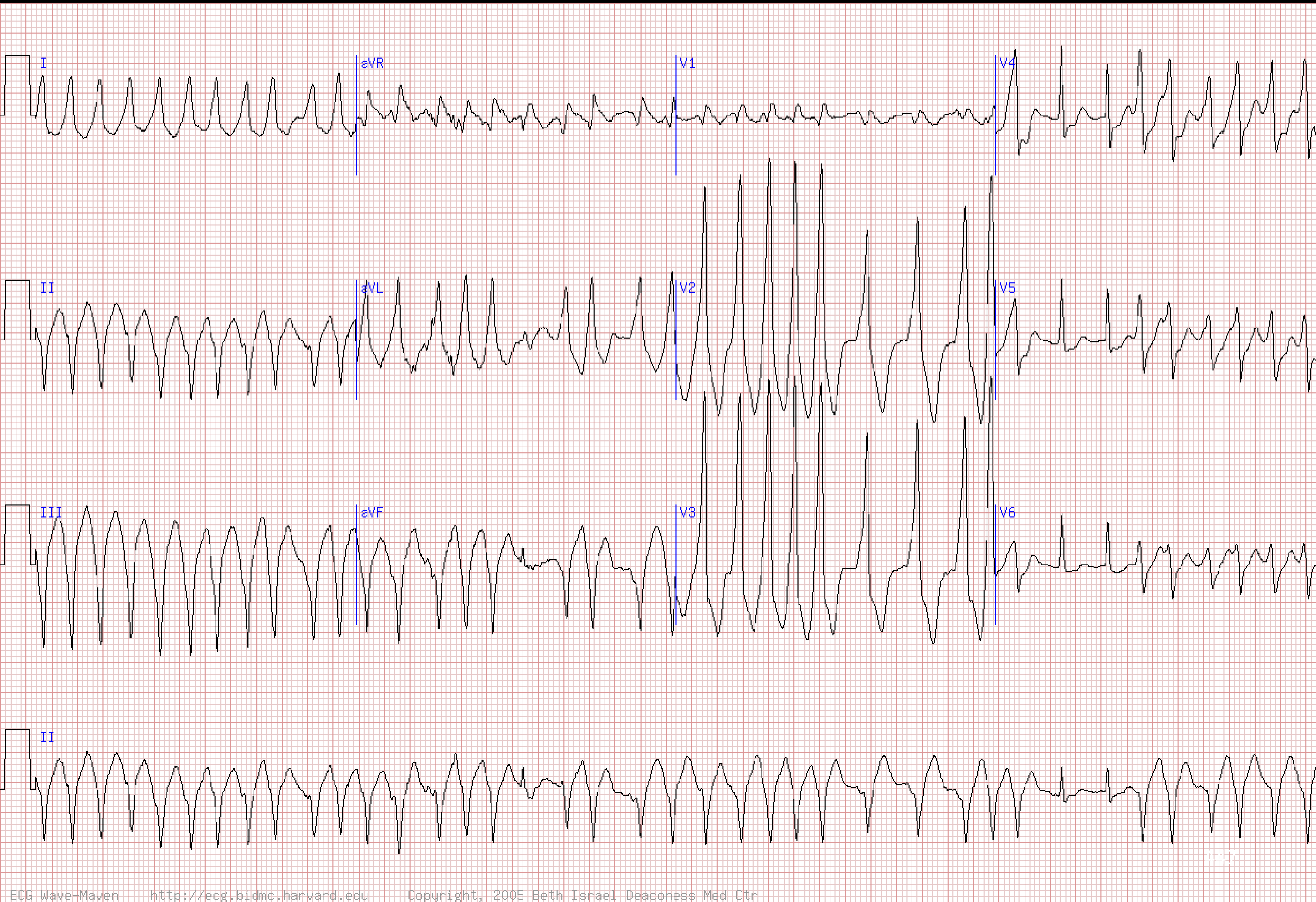
Referred by: Confirmed By:


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

-NOTE IRREGULARITY OF RHYTHM - (SUGGESTIVE of A-FIB)

-LOOK FOR DELTA WAVES

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

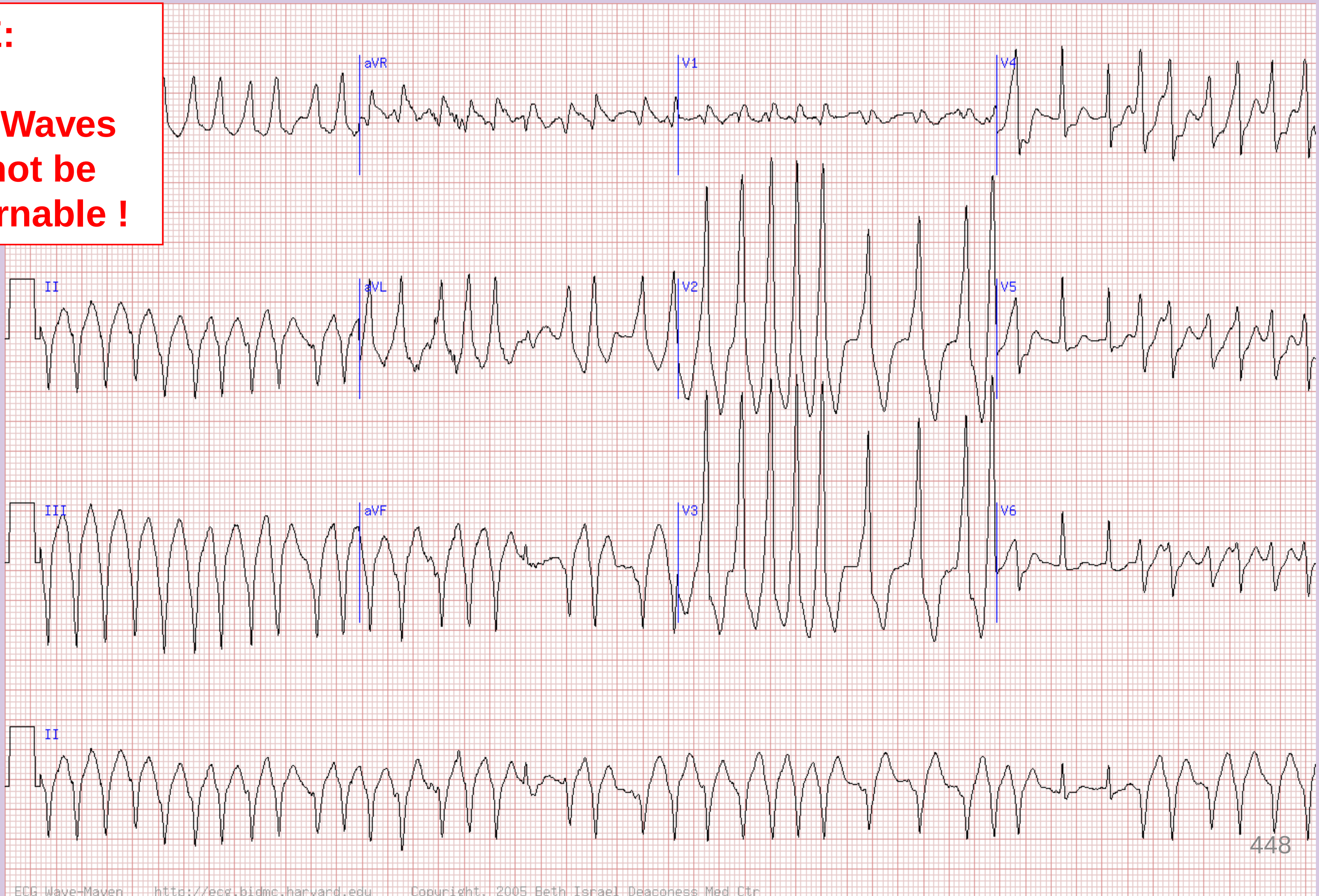


# CHARACTERISTICS of W-P-W with Afib & RVR:

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

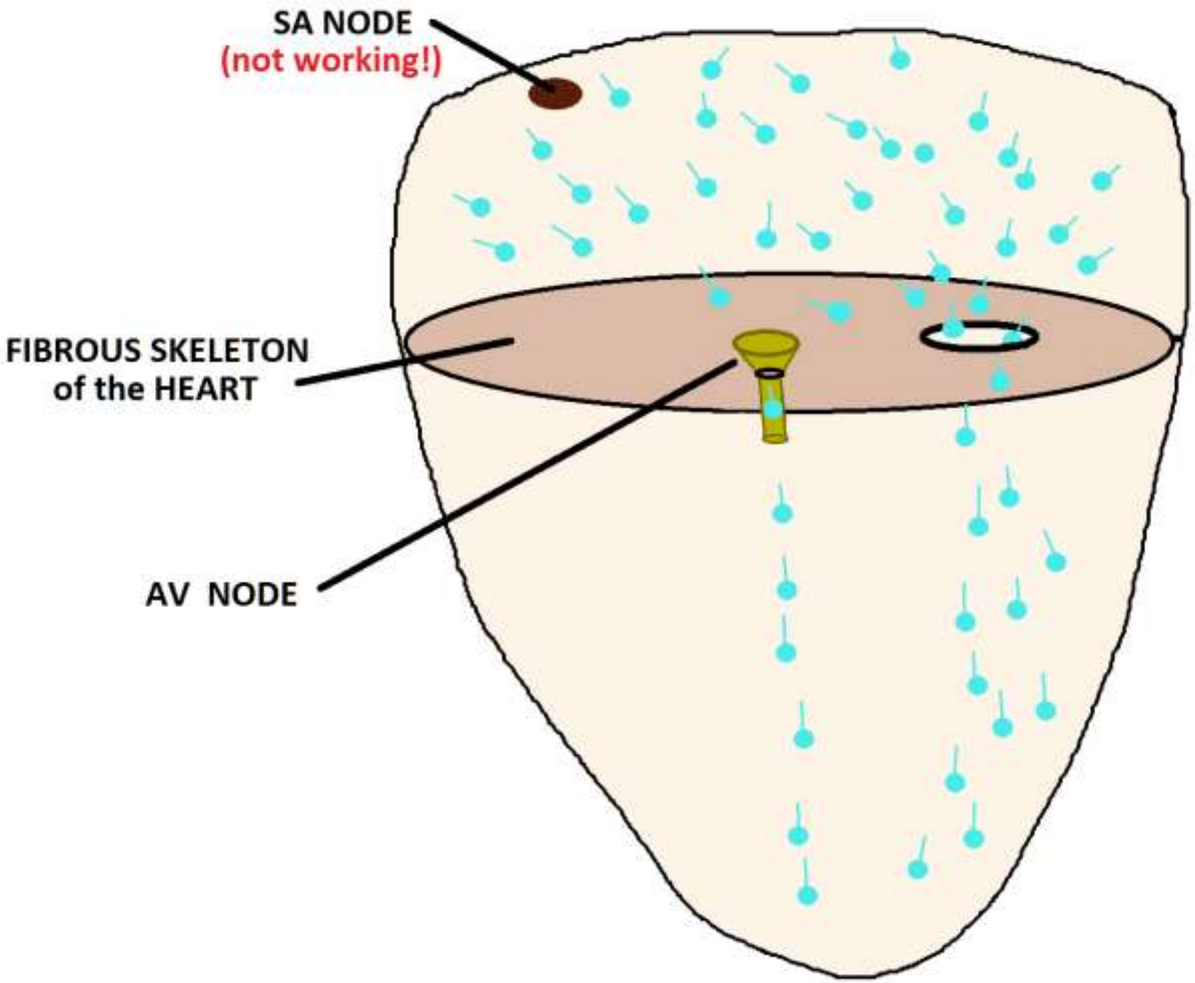
NOTE:

Delta Waves may not be discernable !



***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 )***

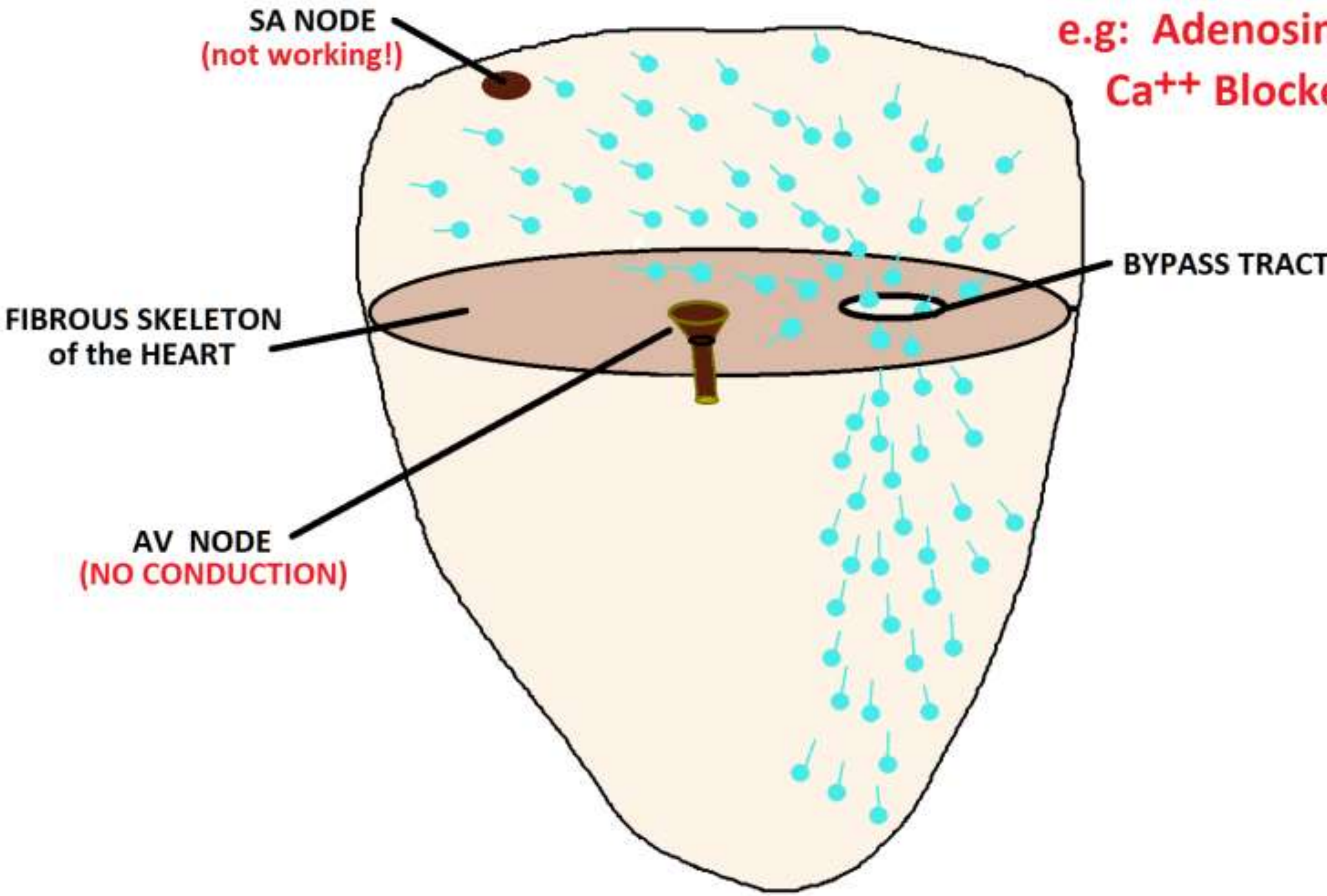
# Atrial Fibrillation with Wolff-Parkinson White

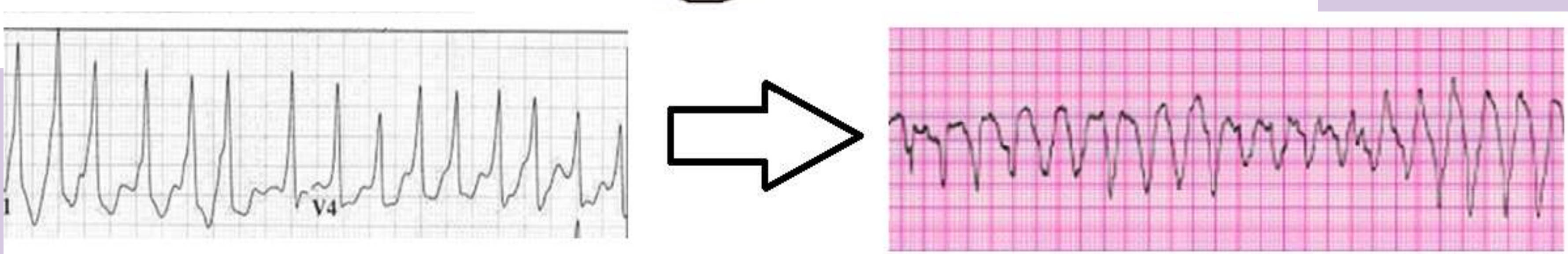


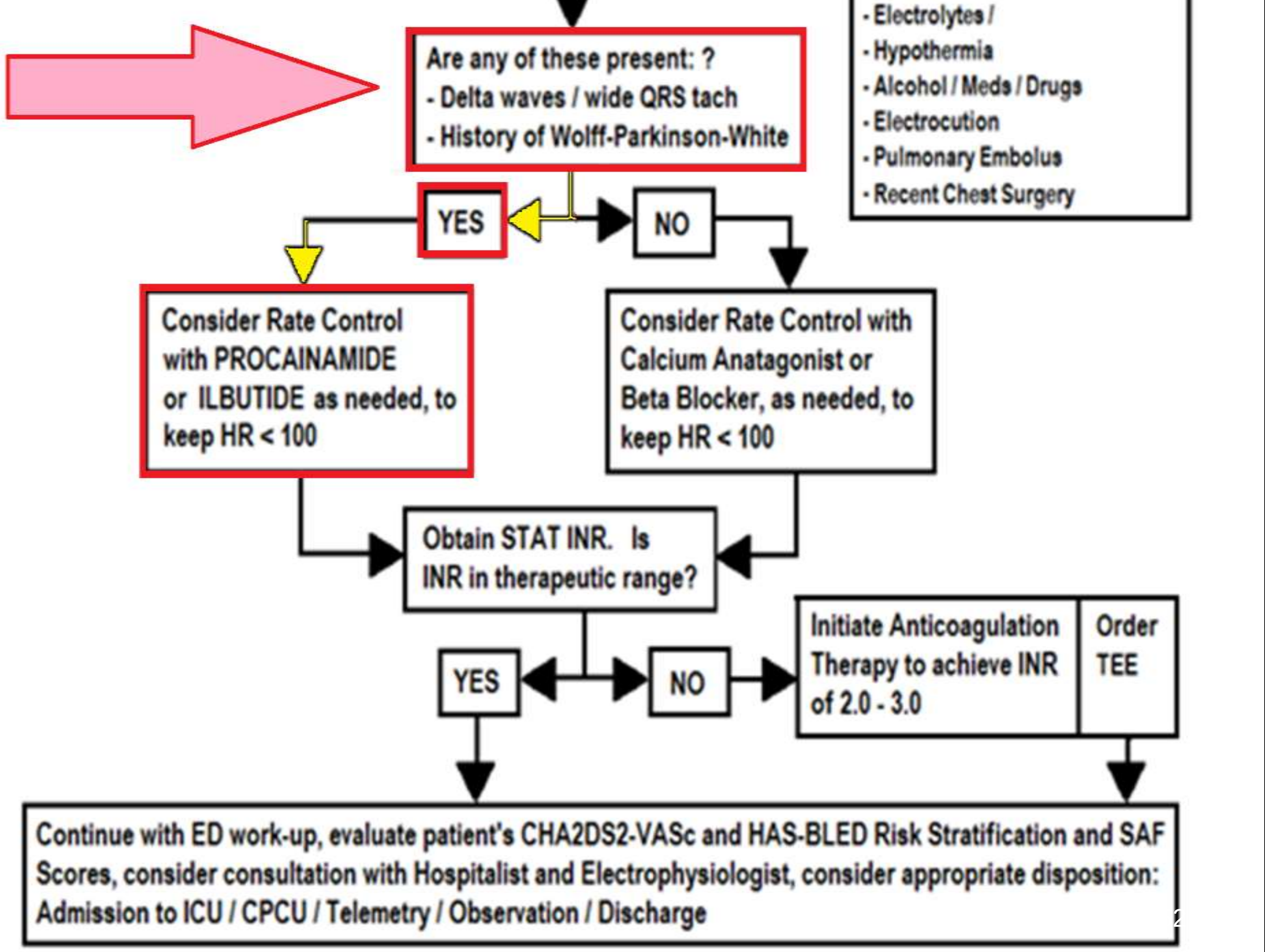

# Atrial Fibrillation with Wolff-Parkinson White

with AV NODAL BLOCKING AGENTS

e.g: Adenosine, $Ca^{++}$ Blockers




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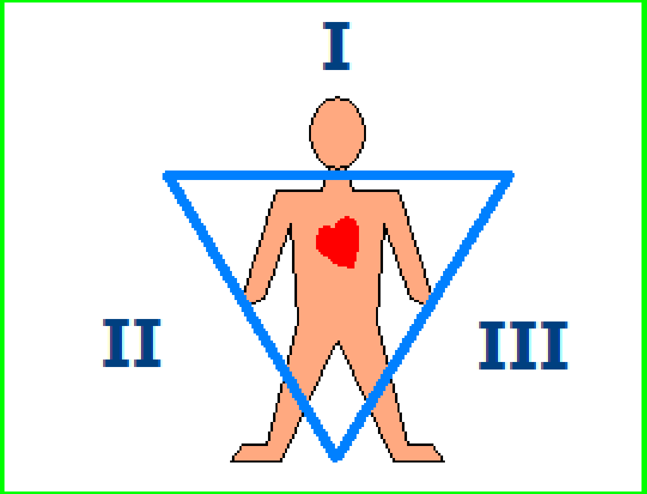
  - ~~ADENOSINE 6-12 (only if REGULAR)~~
  - PROCAINAMIDE (20-50mg/min)
  - ~~AMIODARONE (150 over 10min + 1mg/ min INFUSION~~

# ☞ EVALUATE THE AXIS IN BOTH PLANES

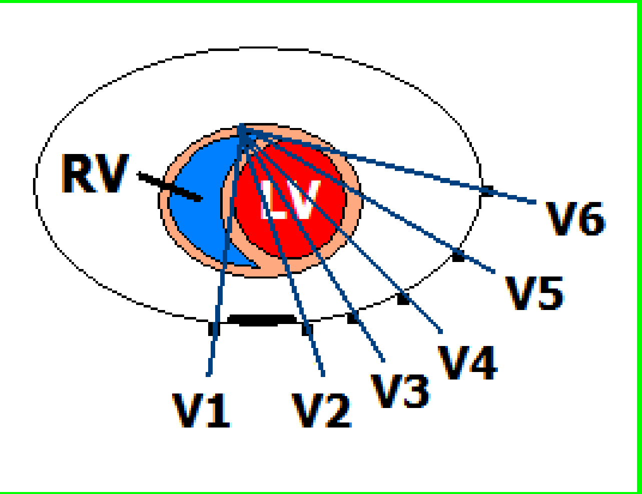
- **VERTICAL**

  **" AXIS DEVIATION "**

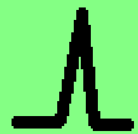
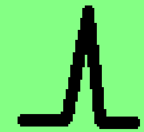
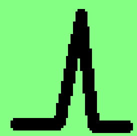



- **HORIZONTAL**

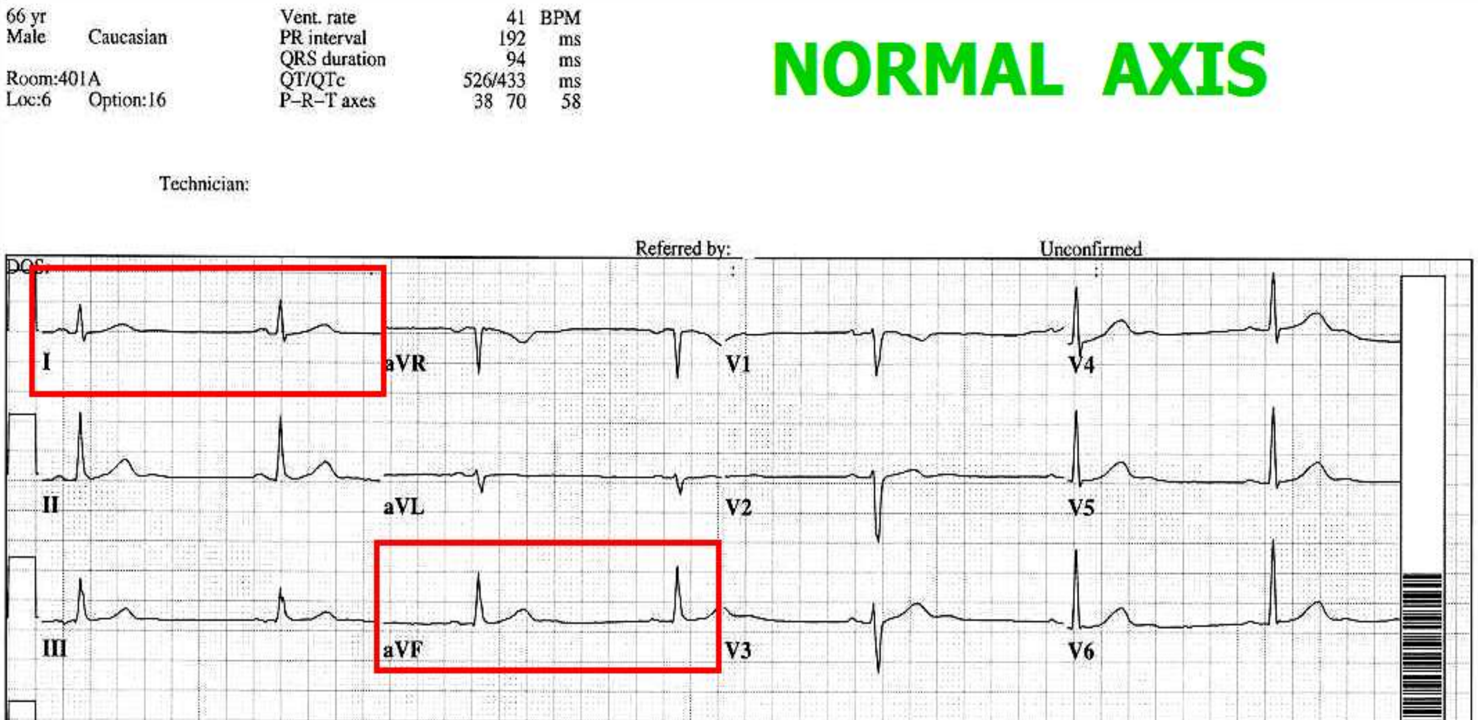
  **" AXIS ROTATION "**

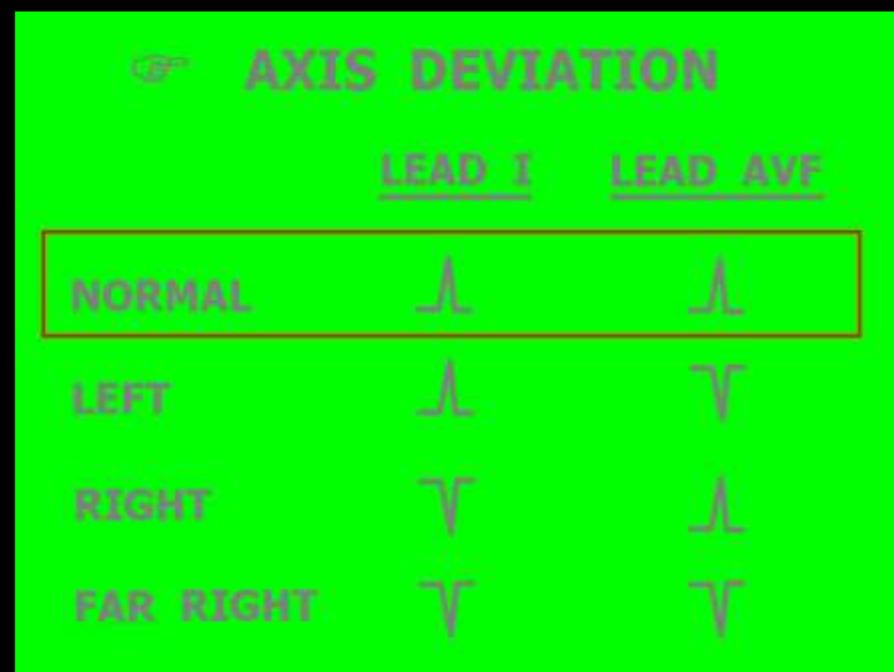


# AXIS DEVIATION

| | LEAD I | LEAD AVF |
|---|---|---|
| NORMAL |  |  |
| LEFT |  |  |
| RIGHT |  |  |
| FAR RIGHT |  |  |

# NORMAL AXIS


66 yr
Male Caucasian
Room:401A
Loc:6 Option:16
Vent. rate 41 BPM
PR interval 192 ms
QRS duration 94 ms
QT/QTc 526/433 ms
P-R-T axes 38 70 58
Technician:
Referred by:
Unconfirmed
I
aVR
V1
V4
II
aVL
V2
V5
III
aVF
V3
V6

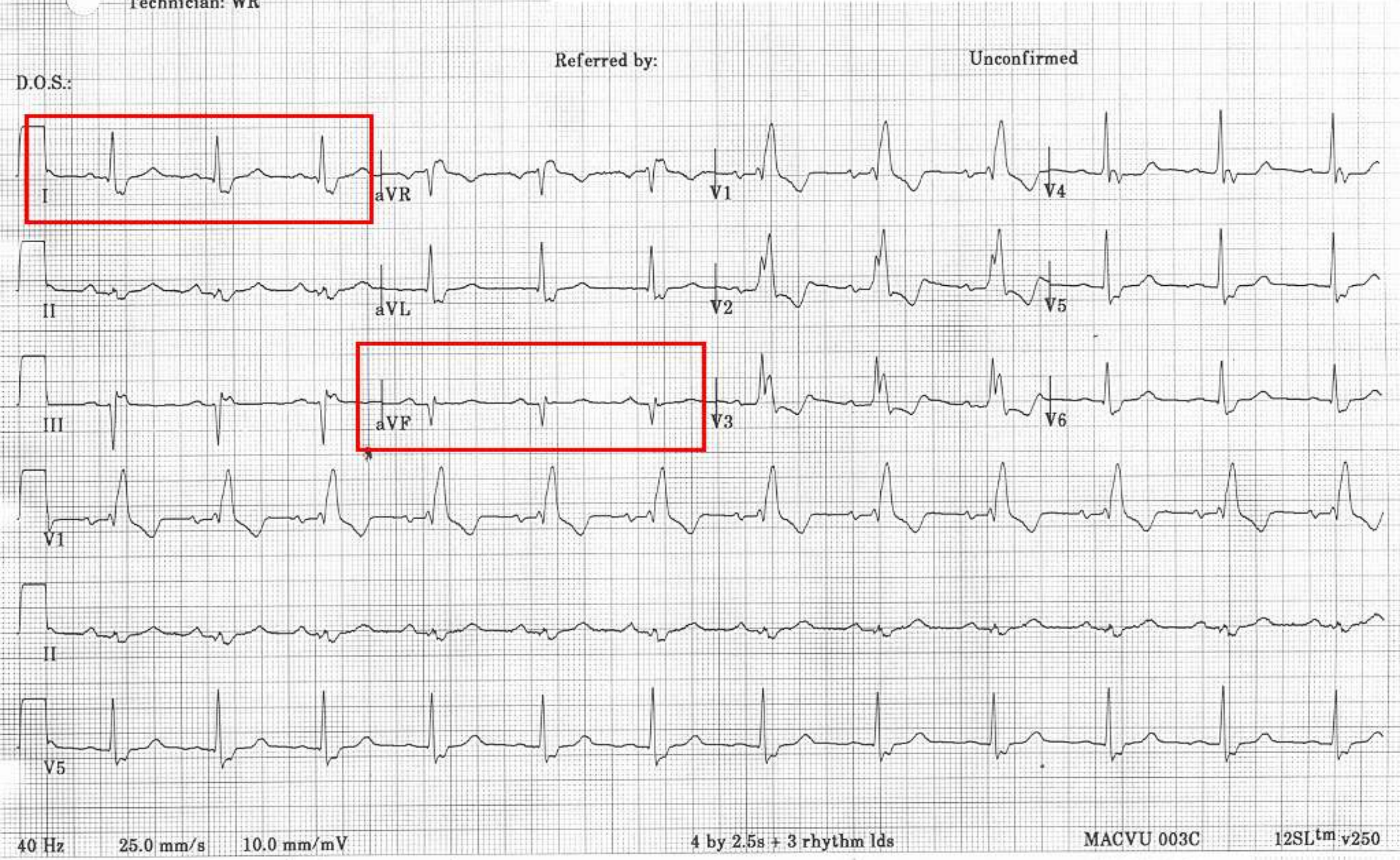

AXIS DEVIATION
LEAD I
LEAD AVF
NORMAL
LEFT
RIGHT
FAR RIGHT

RUPPERT, WAYNE ID: 099999999 4-Mar-2001 19:44:52

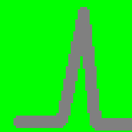
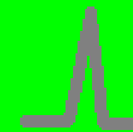
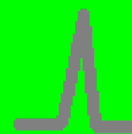
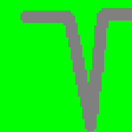
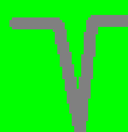
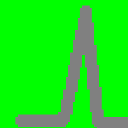
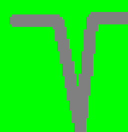
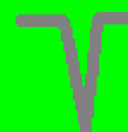
74years
Male Caucasian
Room:
Loc: 0 Opt:
Technician: WR

Vent. rate 72 bpm
PR interval 186 ms
QRS duration 166 ms
QT/QTc 436/477 ms
P-R-T axes 57 -32 32

# What is the AXIS of this EKG ?



# ☞ AXIS DEVIATION

| | LEAD I | LEAD AVF |
|---|---|---|
| NORMAL |  |  |
| LEFT |  |  |
| RIGHT |  |  |
| FAR RIGHT |  |  |

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

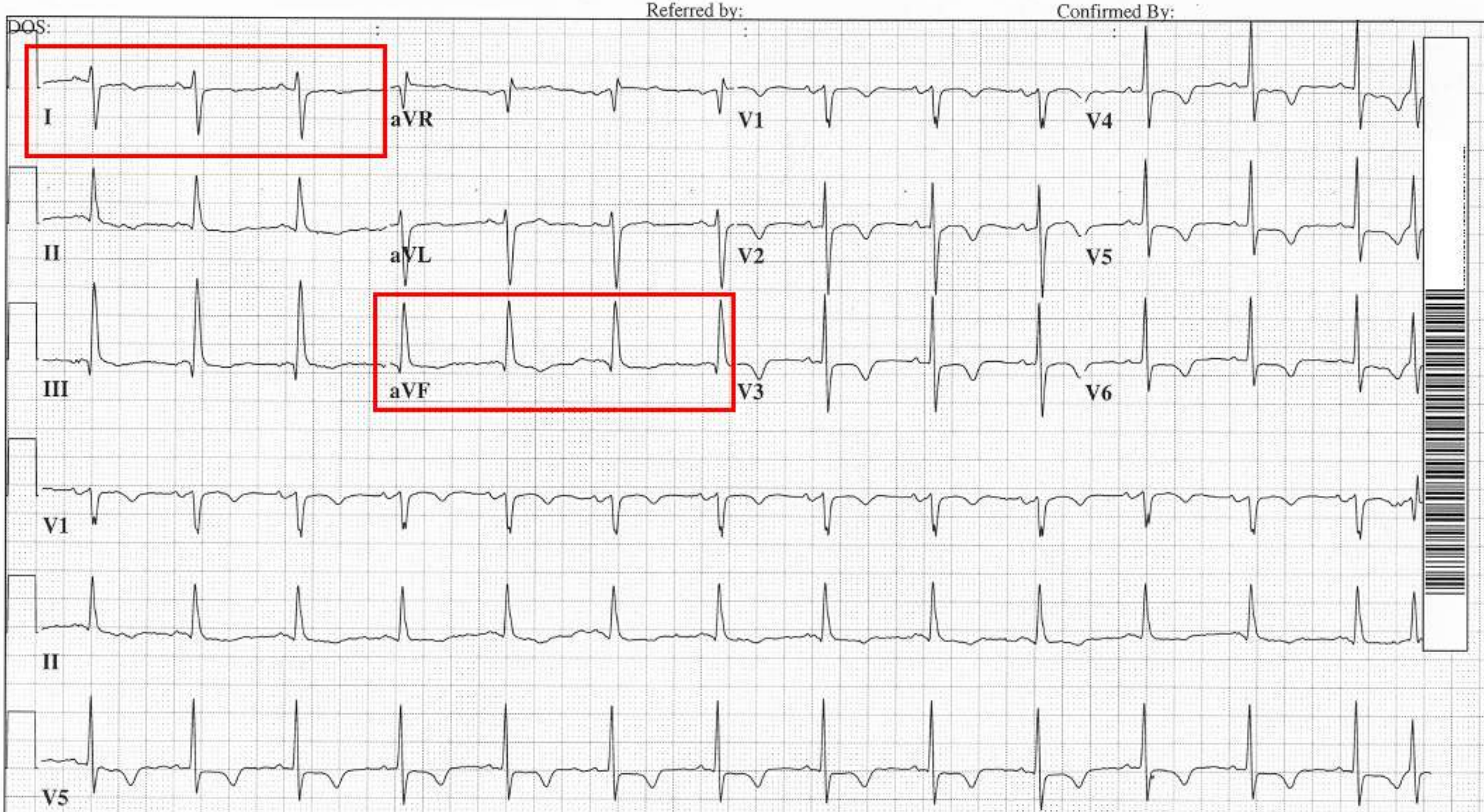
Room:303A
Loc:6 Option:11

| | | |
|---|---|---|
| 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 ?**

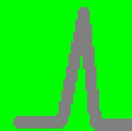
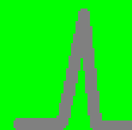
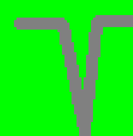
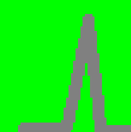
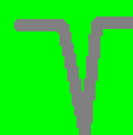
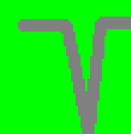
Technician: EKG CLASS CODE
WR03899892

Referred by: Confirmed By:




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

# ☞ AXIS DEVIATION

| | LEAD I | LEAD AVF |
|---|---|---|
| NORMAL |  |  |
| LEFT |  |  |
| RIGHT |  |  |
| FAR RIGHT |  |  |

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 |

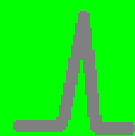
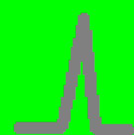
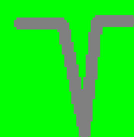
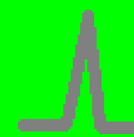
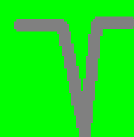
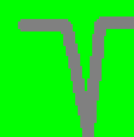
EKG CLASS CODE #WR03611255

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 |  |  |

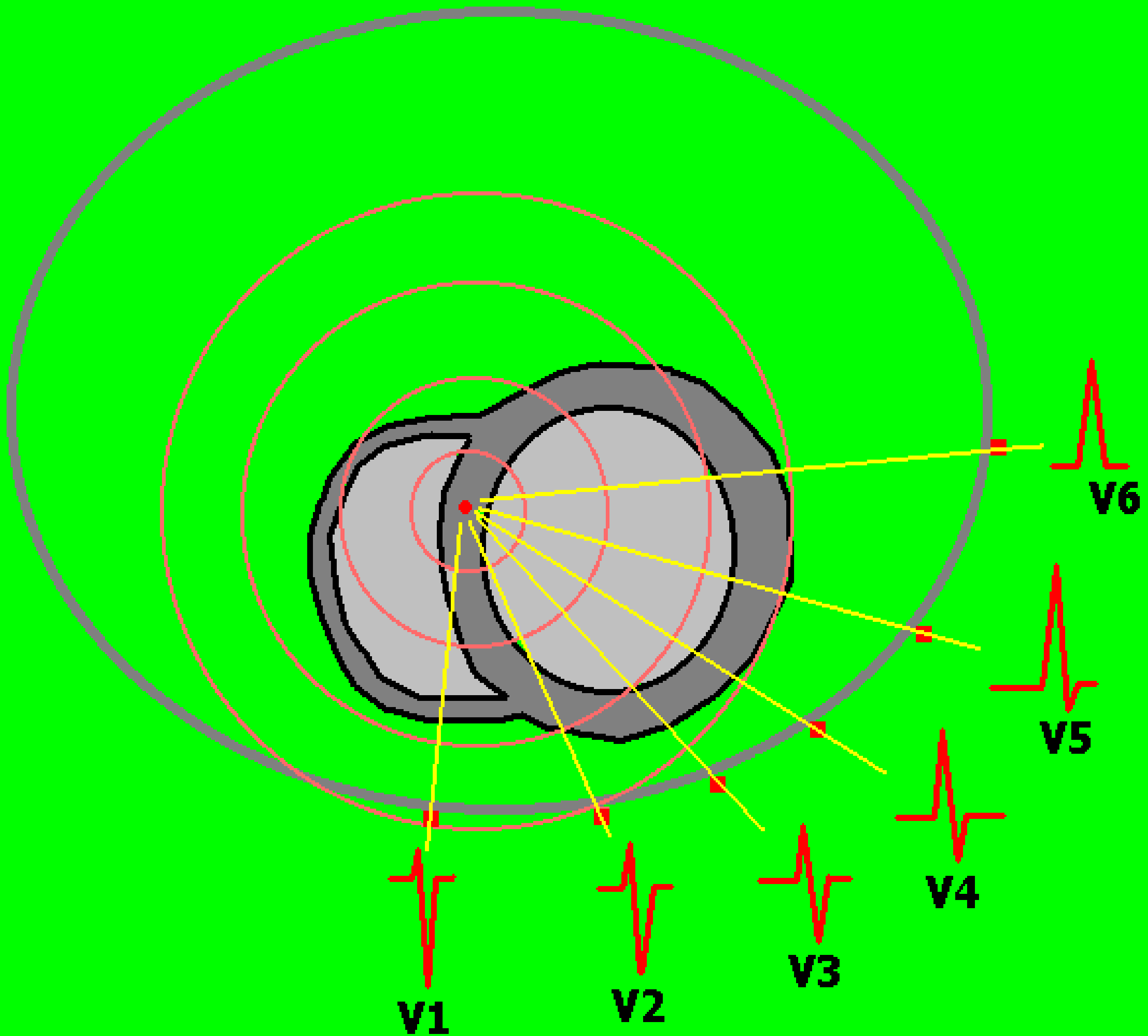
COMMON CONDITIONS WHICH *MAY* CAUSE

## ( NO-MAN'S LAND AXIS )

# FAR RIGHT AXIS DEVIATION:

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

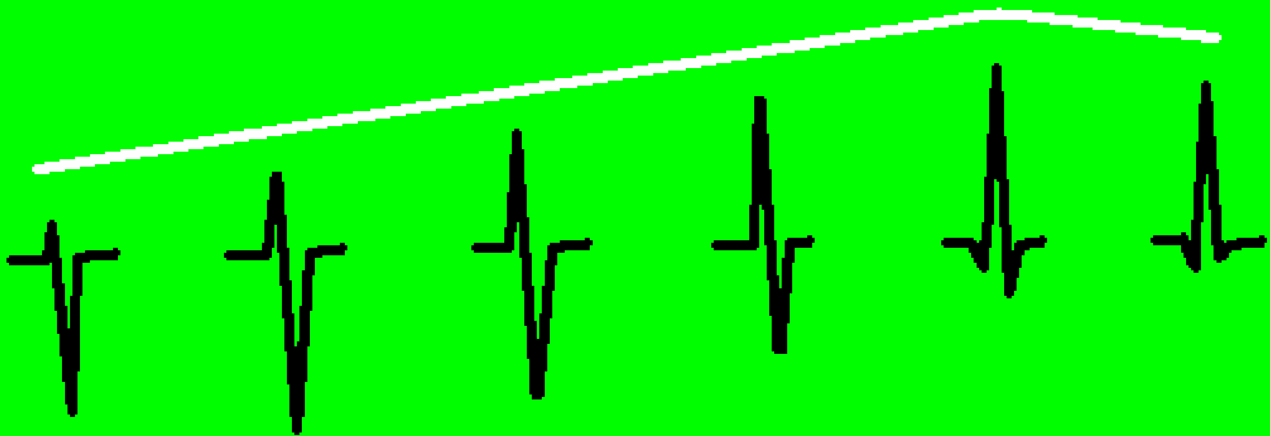
# AXIS ROTATION



# ASSESSING AXIS ROTATION:

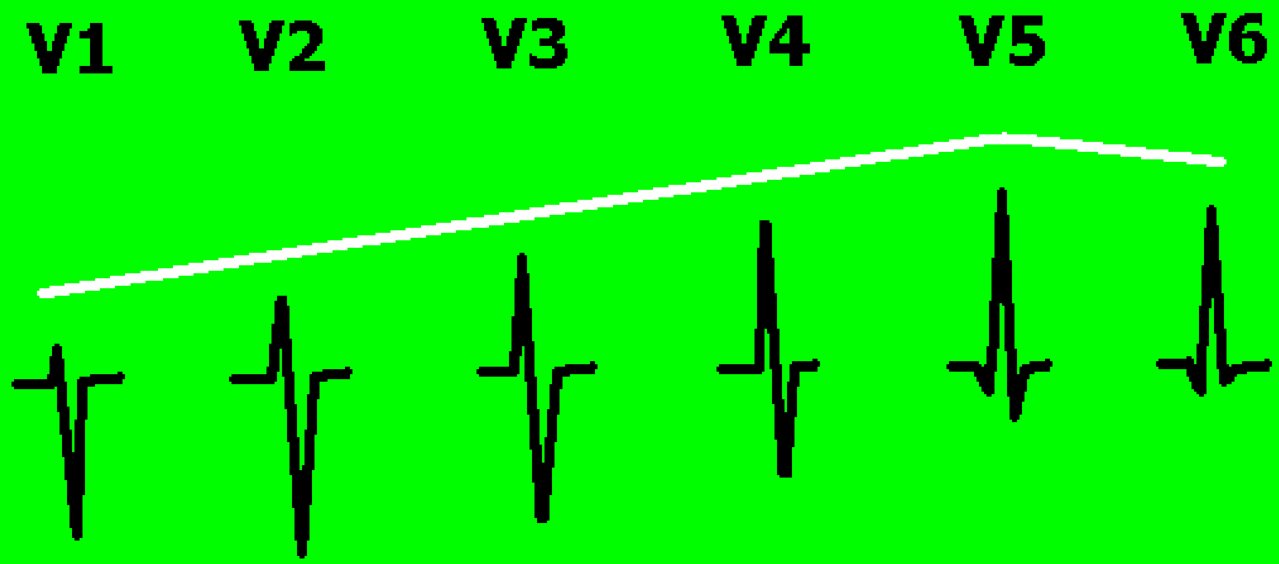
V1 V2 V3 V4 V5 V6

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

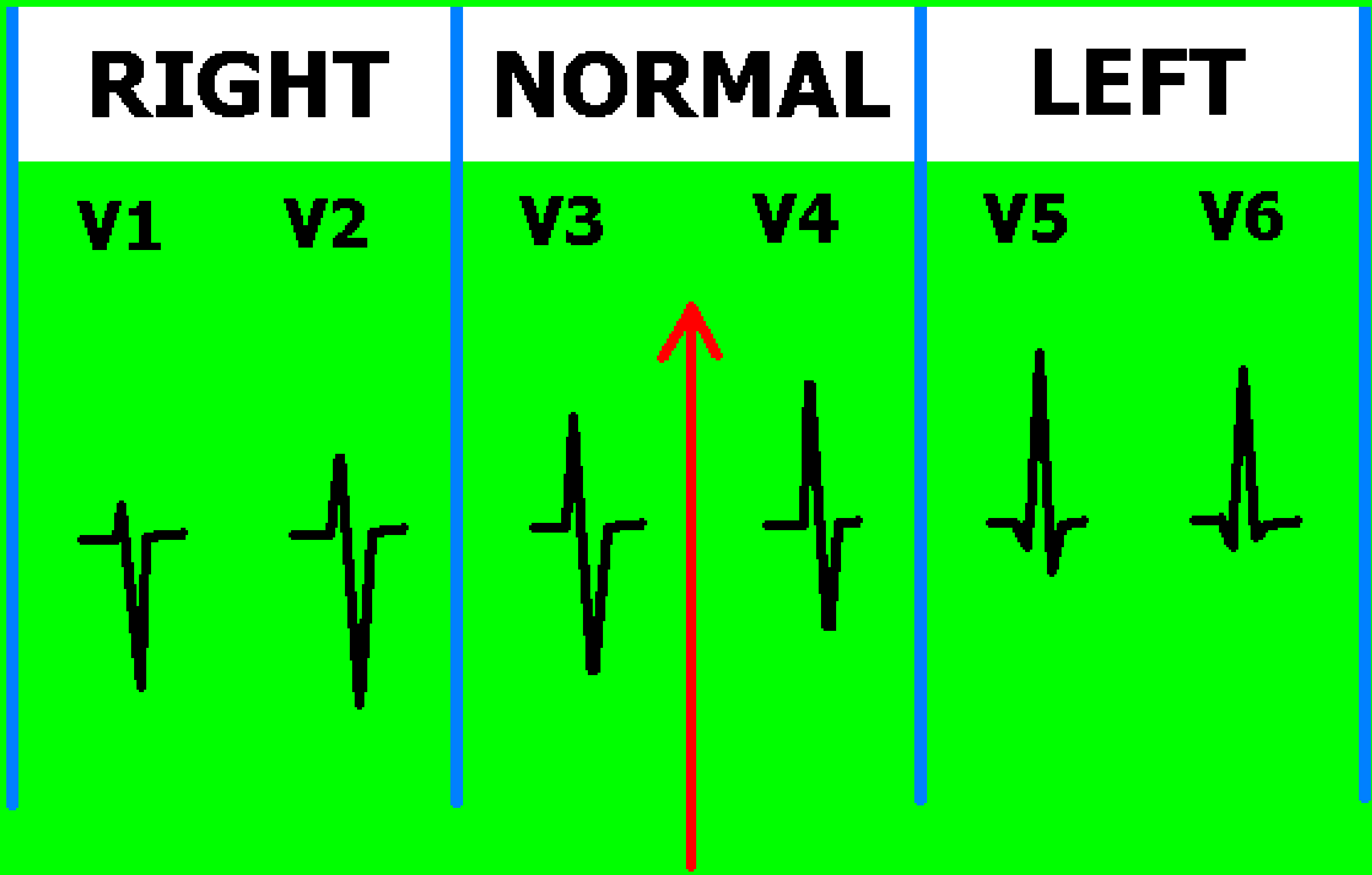
OCCURS IN THE LEAD WHERE THE QRS IS THE MOST **BIPHASIC**

AXIS ROTATION

# IMPORTANT TRANSITION RULE

**"Transition shifts TOWARD HYPERTROPHY and AWAY FROM NECROSIS."**

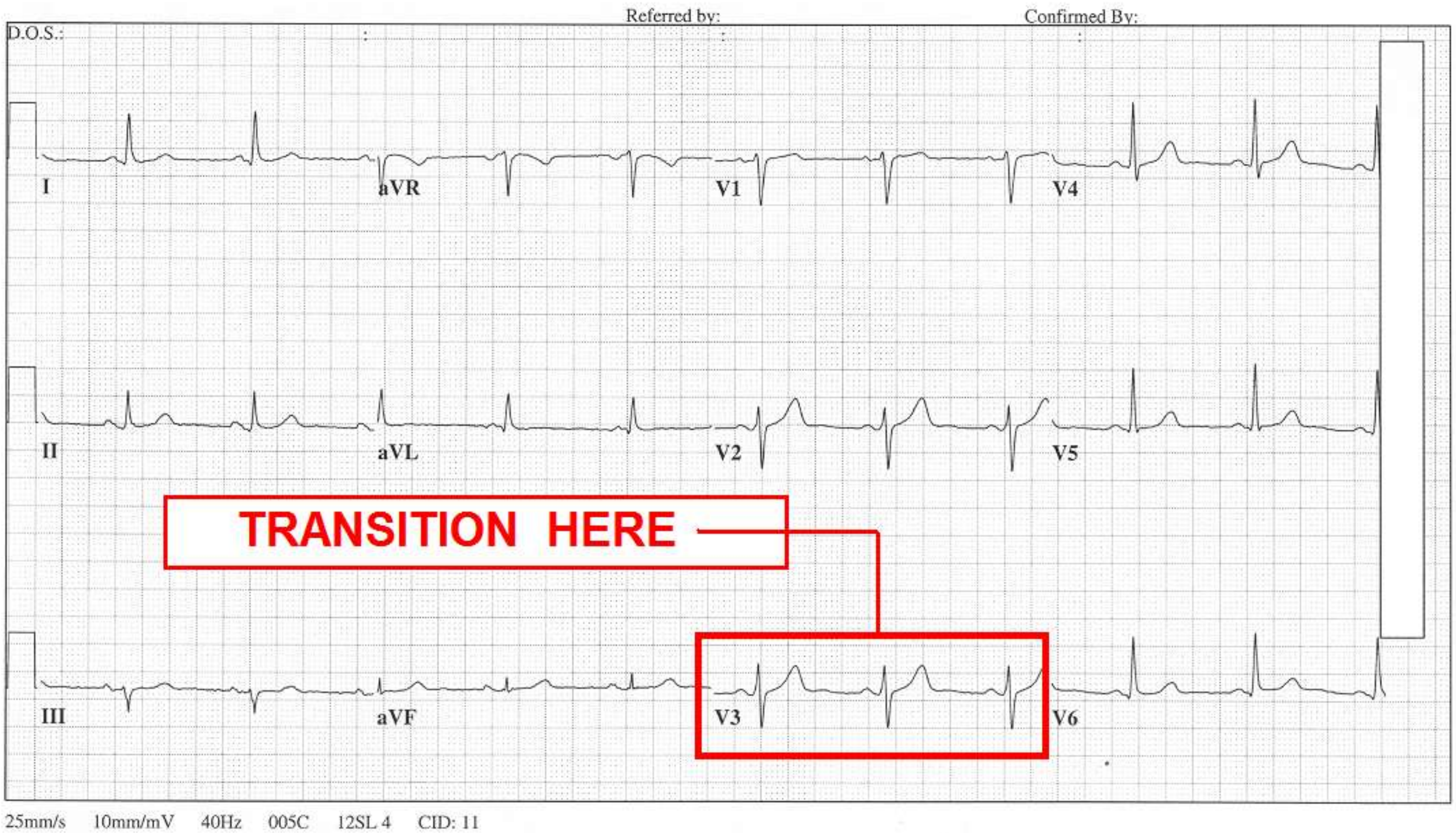
# AXIS ROTATION



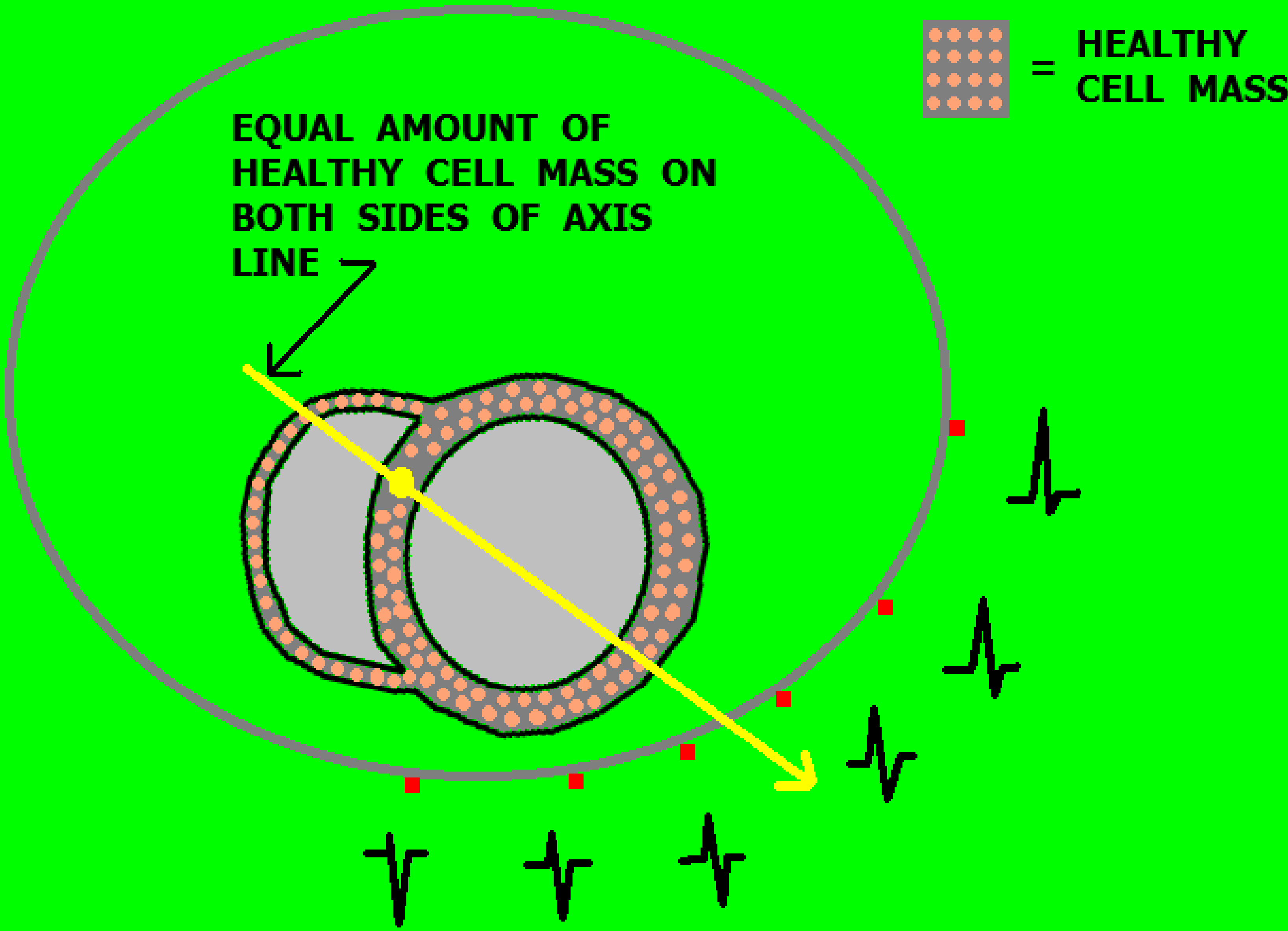

TRANSITION SHOULD
OCCUR IN LEADS V3 or V4

# NORMAL TRANSITION

## IS BETWEEN LEADS V3 and V4



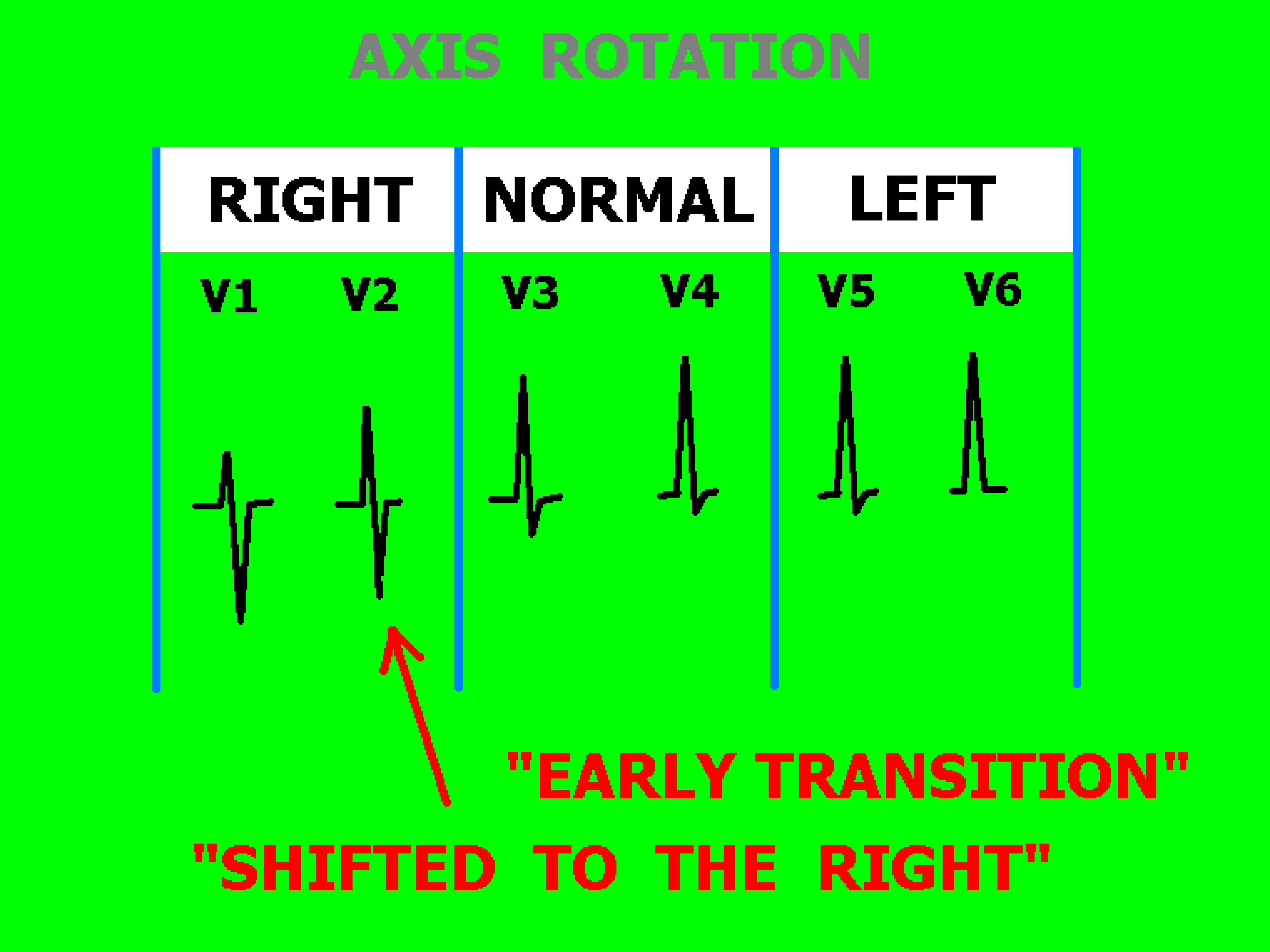
# NORMAL TRANSITION



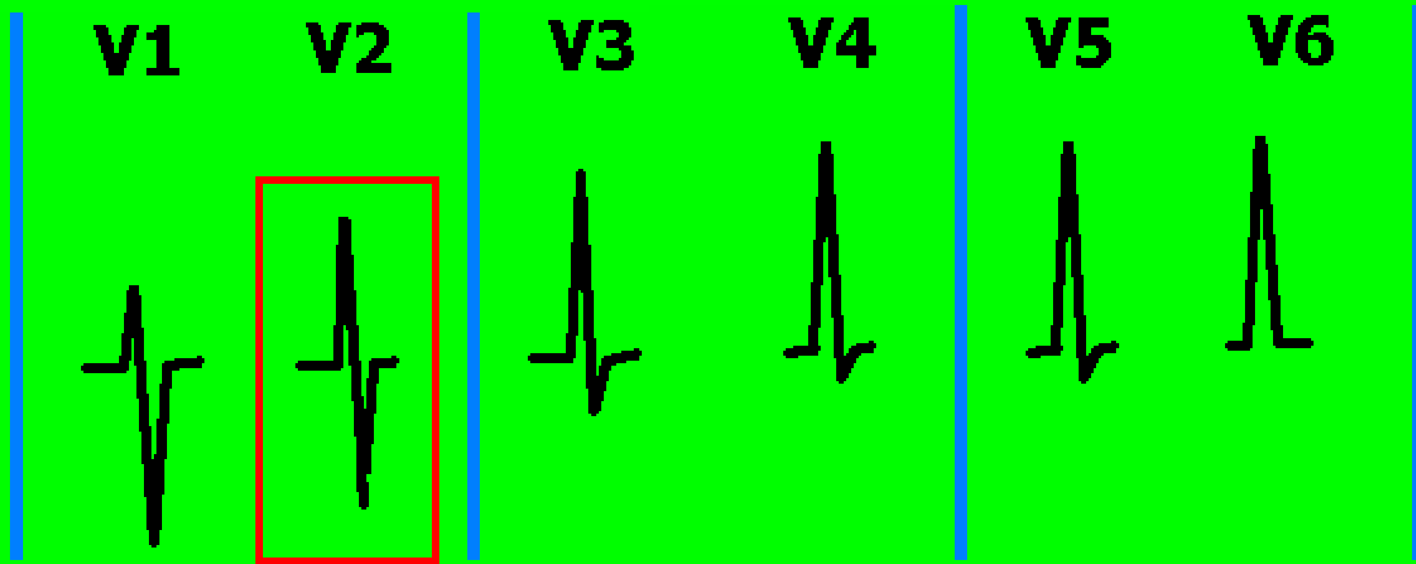
# ASSESSING AXIS ROTATION:

## IMPORTANT NOTES:

- As with all EKG-made DIAGNOSES, you must consider the TOTALITY of the PATIENT'S PRESENTATION. This includes the PATIENT'S CLINICAL PRESENTATION, RISK FACTOR PROFILE, and your INDEX OF SUSPICION.
- Validate all EKG-suspected DIAGNOSES with Additional, MORE ACCURATE diagnostic testing, e.g.: CARDIAC ECHO, CARDIAC CATHERIZATION, ELECTROPHYSIOLOGIC TESTING, MRI, etc.


AXIS ROTATION
RIGHT
NORMAL
LEFT
V1
V2
V3
V4
V5
V6
"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

RUPPERT, WAYNE ID: 099999999 4-Mar-2001 19:44:52 ST JOSEPHS HOSPITAL

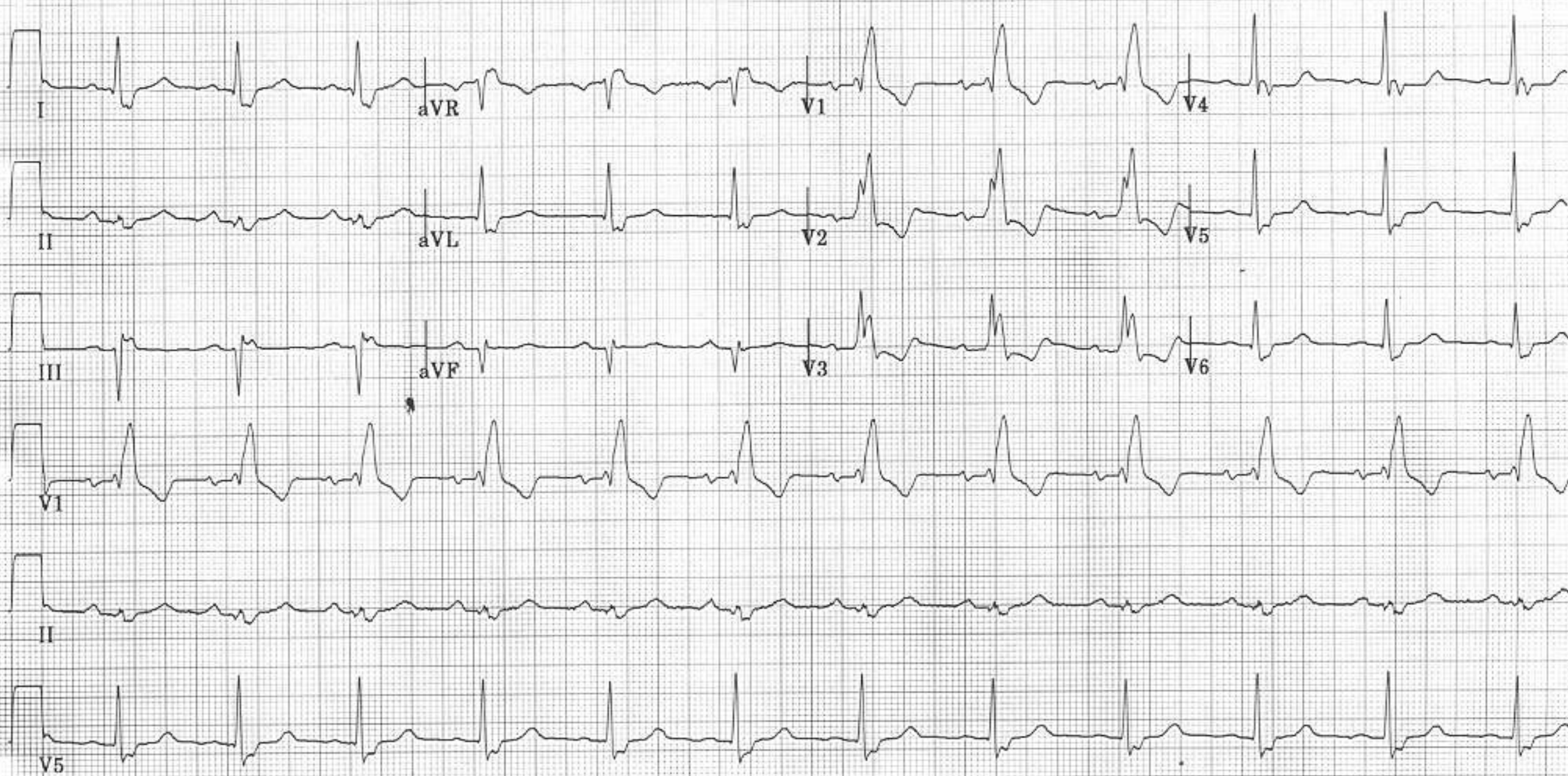
| | | | |
|---|---|---|---|
| 74years | | Vent. rate | 72 bpm |
| Male | Caucasian | PR interval | 186 ms |
| | | QRS duration | 166 ms |
| Room: | | QT/QTc | 436/477 ms |
| Loc: 0 | Opt: | P-R-T axes | 57 -32 32 |

Technician: WR

**What is the cause of EARLY TRANSITION in this EKG? -- Use the list of COMMON CAUSES OF EARLY TRANSITION to rule out different causes . . .**

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

# 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

# COMMON CAUSES OF EARLY TRANSITION

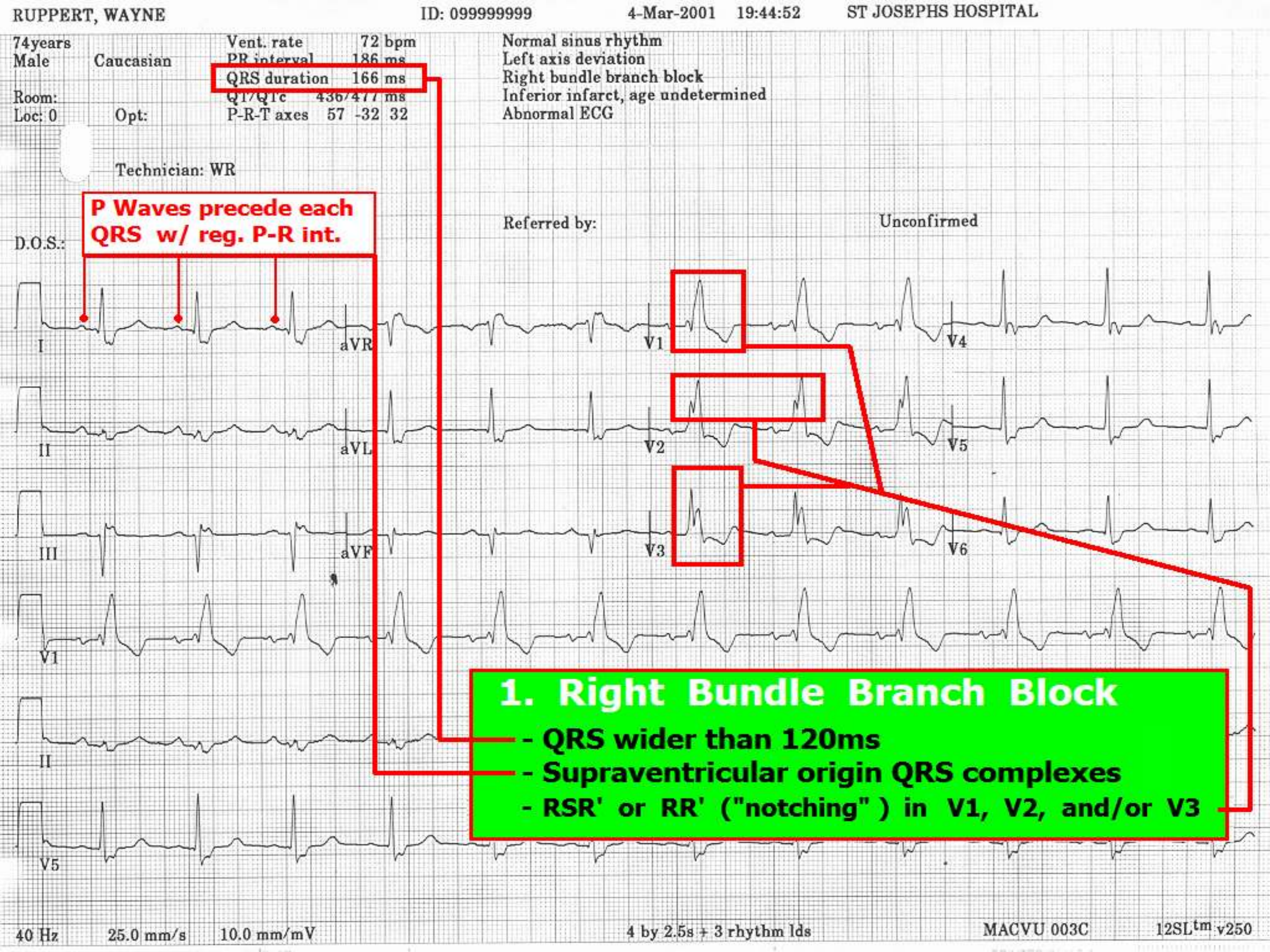
## ....SOME HELPFUL CLUES:

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~~



RUPPERT, WAYNE
ID: 099999999
4-Mar-2001 19:44:52
ST JOSEPHS HOSPITAL
74years
Male Caucasian
Room:
Loc: 0 Opt:
Vent. rate 72 bpm
PR interval 186 ms
QRS duration 166 ms
QT/QTc 436/477 ms
P-R-T axes 57 -32 32
Normal sinus rhythm
Left axis deviation
Right bundle branch block
Inferior infarct, age undetermined
Abnormal ECG
Technician: WR
P Waves precede each QRS w/ reg. P-R int.
Referred by:
Unconfirmed
D.O.S.:
I
aVR
V1
V4
II
aVL
V2
V5
III
aVF
V3
V6
V1
II
V5
1. Right Bundle Branch Block
- QRS wider than 120ms
- Supraventricular origin QRS complexes
- RSR' or RR' ("notching" ) in V1, V2, and/or V3
40 Hz
25.0 mm/s
10.0 mm/mV
4 by 2.5s + 3 rhythm lds
MACVU 003C
12SLtm v250

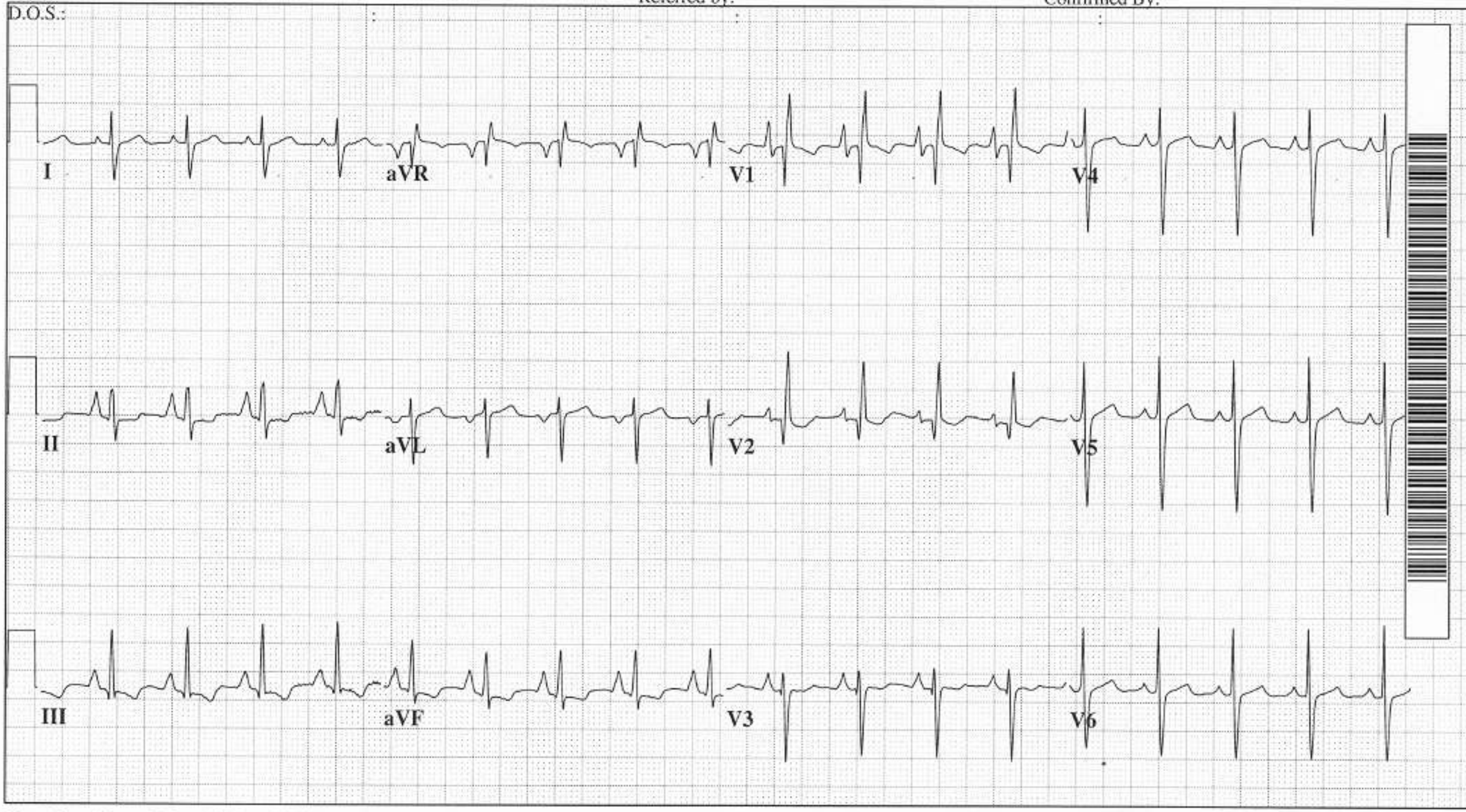
15–MAR–2000 10:29:05 ST. JOSEPH'S HOSPITAL–ER ROUTINE RETRIEVAL

| | | | | |
|---|---|---|---|---|
| 31 yr | | Vent. rate | 109 | BPM |
| Male | Black | PR interval | 122 | ms |
| | | QRS duration | 84 | ms |
| Room:ER | | QT/QTc | 296/398 | ms |
| Loc:3 | Option:16 | P–R–T axes | 79 117 | –27 |

Technician: EKG CLASS #WR03446043

**What is the cause of EARLY TRANSITION in this EKG ?**

Referred by: Confirmed By:




25mm/s 10mm/mV 40Hz 005C 12SL 4 CID: 13

EID:17 EDT: 08:56 20–MAR–2000 ORDER:

# 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

# 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)

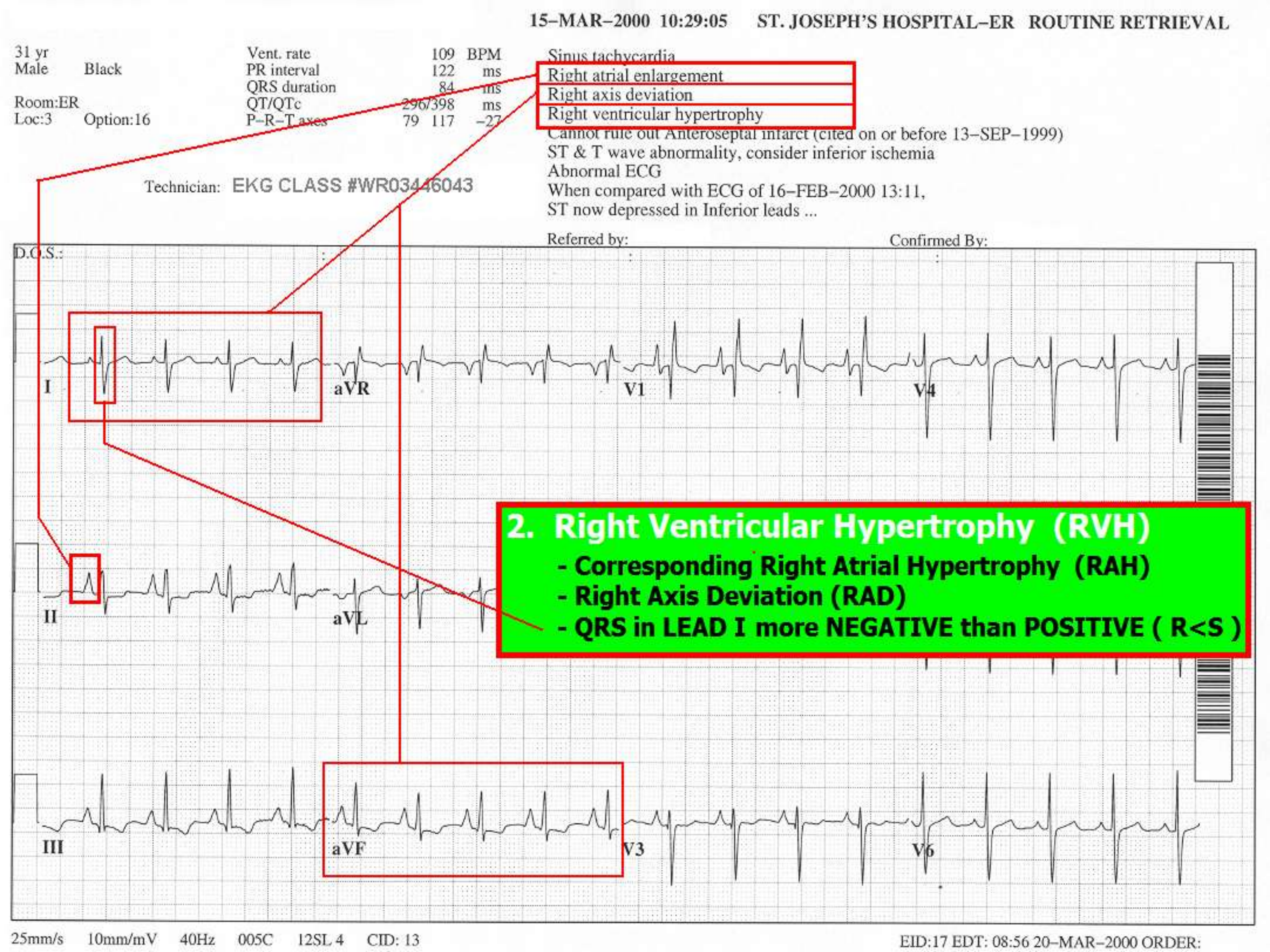
- Corresponding Right Atrial Hypertrophy (RAH)
- Right Axis Deviation (RAD)
- QRS in LEAD I more NEGATIVE than POSITIVE ( R<S )

~~3. Old Posterior Wall MI~~

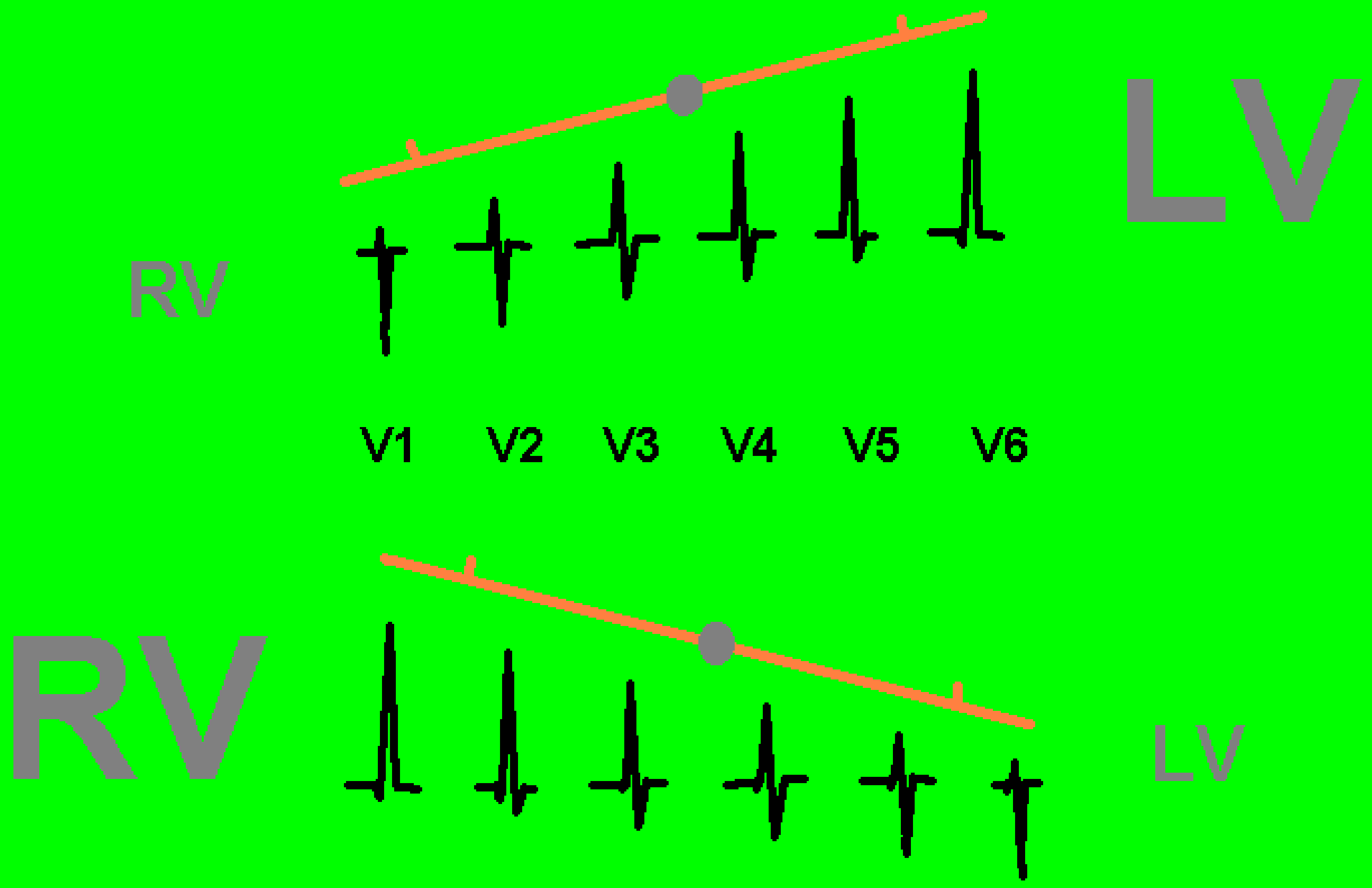
- ~~Usually accompanied by OLD INFERIOR WALL MI~~
- ~~Does NOT abnormally widen the QRS complex~~

~~4. Wolff-Parkinson-White (WPW) type A~~

- ~~Short P-R Interval~~
- ~~Presence of Delta Waves~~
- ~~Wide QRS complexes~~


15–MAR–2000 10:29:05 ST. JOSEPH'S HOSPITAL–ER ROUTINE RETRIEVAL
31 yr
Male Black
Room:ER
Loc:3 Option:16
Vent. rate 109 BPM
PR interval 122 ms
QRS duration 84 ms
QT/QTc 296/398 ms
P–R–T axes 79 117 –27
Technician: EKG CLASS #WR03446043
Sinus tachycardia
Right atrial enlargement
Right axis deviation
Right ventricular hypertrophy
Cannot rule out Anteroseptal infarct (cited on or before 13–SEP–1999)
ST & T wave abnormality, consider inferior ischemia
Abnormal ECG
When compared with ECG of 16–FEB–2000 13:11,
ST now depressed in Inferior leads ...
Referred by:
Confirmed By:
D.O.S.:
I
aVR
V1
V4
II
aVL
III
aVF
V3
V6
2. Right Ventricular Hypertrophy (RVH)
- Corresponding Right Atrial Hypertrophy (RAH)
- Right Axis Deviation (RAD)
- QRS in LEAD I more NEGATIVE than POSITIVE ( R<S )
25mm/s 10mm/mV 40Hz 005C 12SL 4 CID: 13
EID:17 EDT: 08:56 20–MAR–2000 ORDER:

# "SEE-SAW EFFECT" of RVH on R WAVE PROGRESSION



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

17 yr
Male Black

Room:ER
Loc:3 Option:16

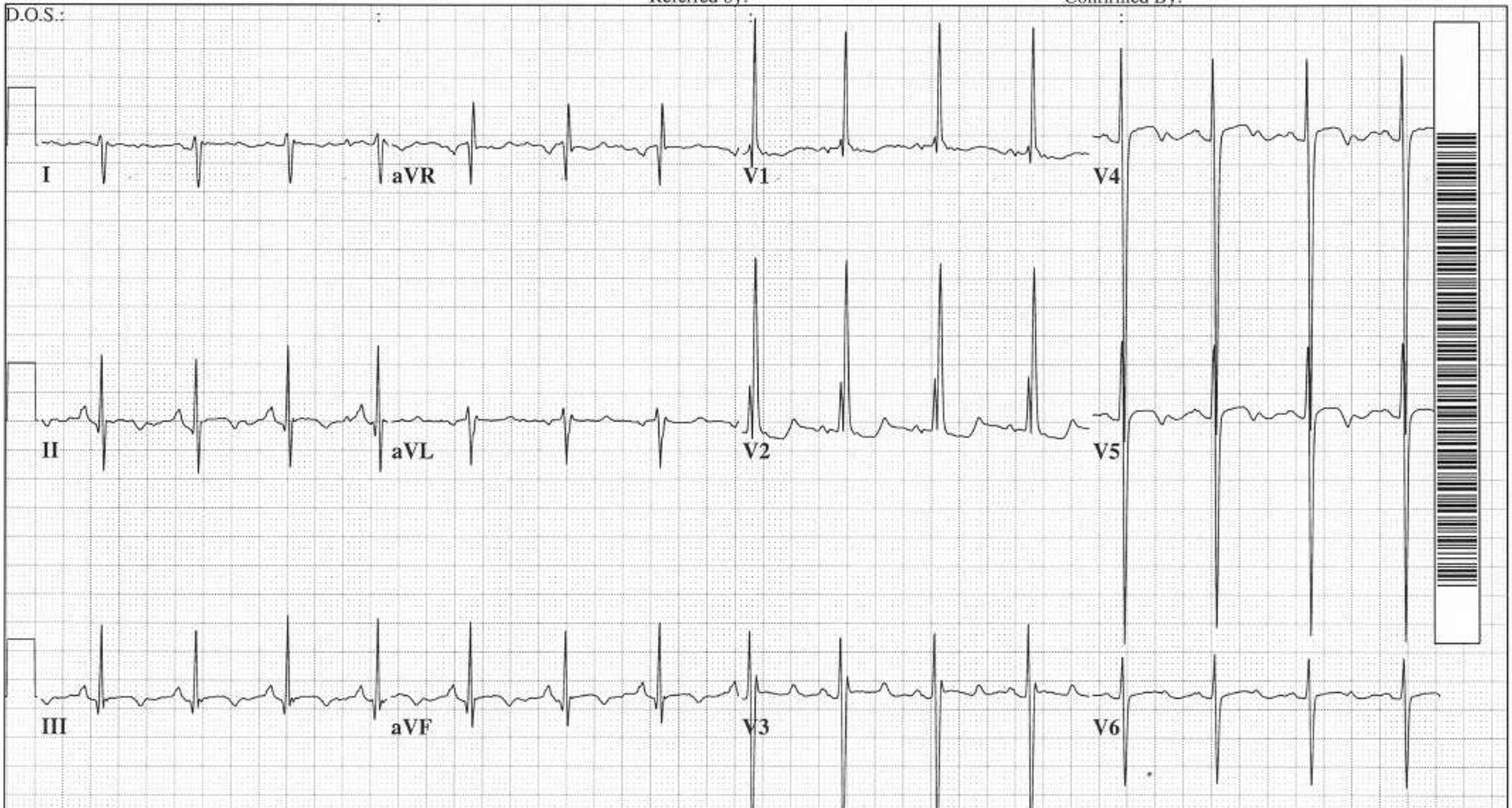
| | | | |
|---|---|---|---|
| Vent. rate | 90 | | BPM |
| PR interval | 136 | | ms |
| QRS duration | 94 | | ms |
| QT/QTc | 378/462 | | ms |
| P–R–T axes | 77 | 123 | 58 |

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

Technician: EKG CLASS #WR03616941

Referred by: Confirmed By:

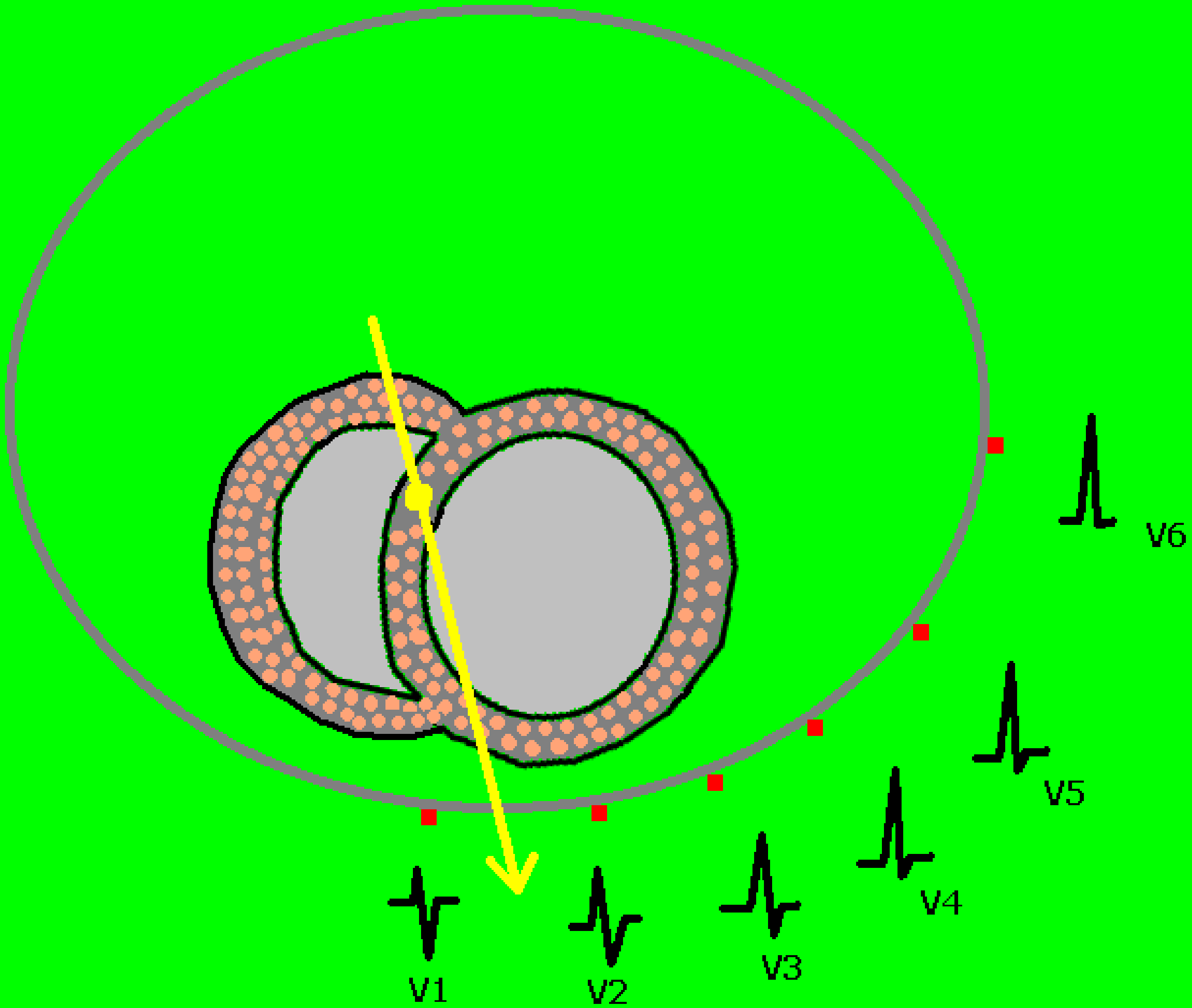
D.O.S.:




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

EID:11 EDT: 17:04 15–JUL–1997 ORDER:

# RIGHT VENTRICULAR HYPERTROPHY



Male Caucasian

Room:CCU3
Loc:1 Option:1

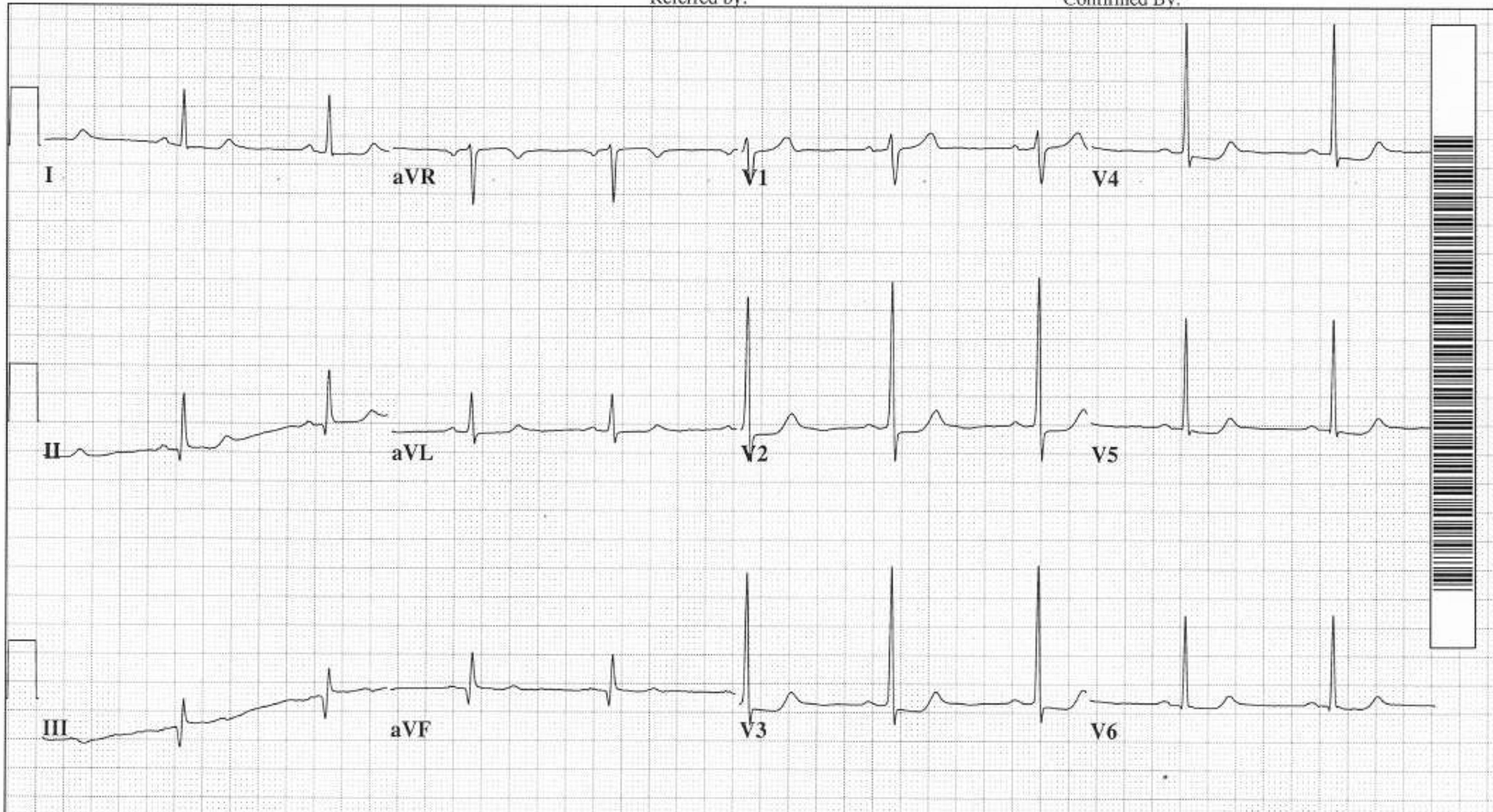
| | | |
|---|---|---|
| Vent. rate | 58 | BPM |
| PR interval | 168 | ms |
| QRS duration | 84 | ms |
| QT/QTc | 424/416 | ms |
| P–R–T axes | 18 28 | 29 |

# What is the cause of EARLY TRANSITION in this EKG ?

Technician ID: EKG CLASS #WR03602216

Med: Unknown

Referred by: Confirmed By:




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

EID:18 EDT: 21:53 06–MAY–1997 ORDER:

# 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

# 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~~

Male Caucasian

Room:CCU3

Loc:1 Option:1

| | | |
|---|---|---|
| Vent. rate | 58 | BPM |
| PR interval | 168 | ms |
| QRS duration | 84 | ms |
| QT/QTc | 424/416 | ms |
| P–R–T axes | 18 28 | 29 |

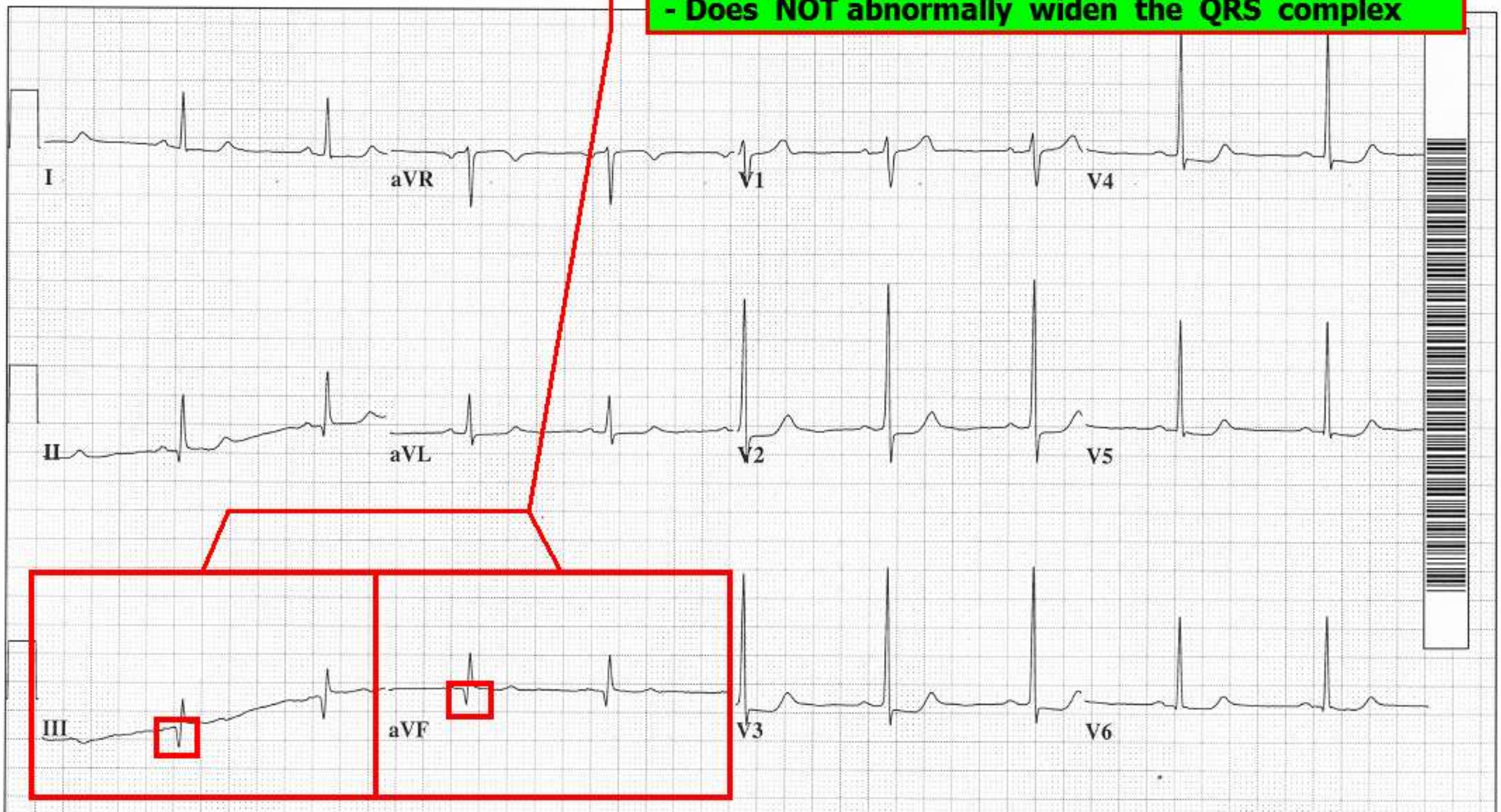
Sinus bradycardia
Inferior–posterior infarct (cited on or before 27–APR–1997)
Abnormal ECG
When compared with ECG of 30–APR–1997 13:39,
No significant change was found

Technician ID: EKG CLASS #WR03602216

Med: Unknown

**Old Posterior Wall MI**

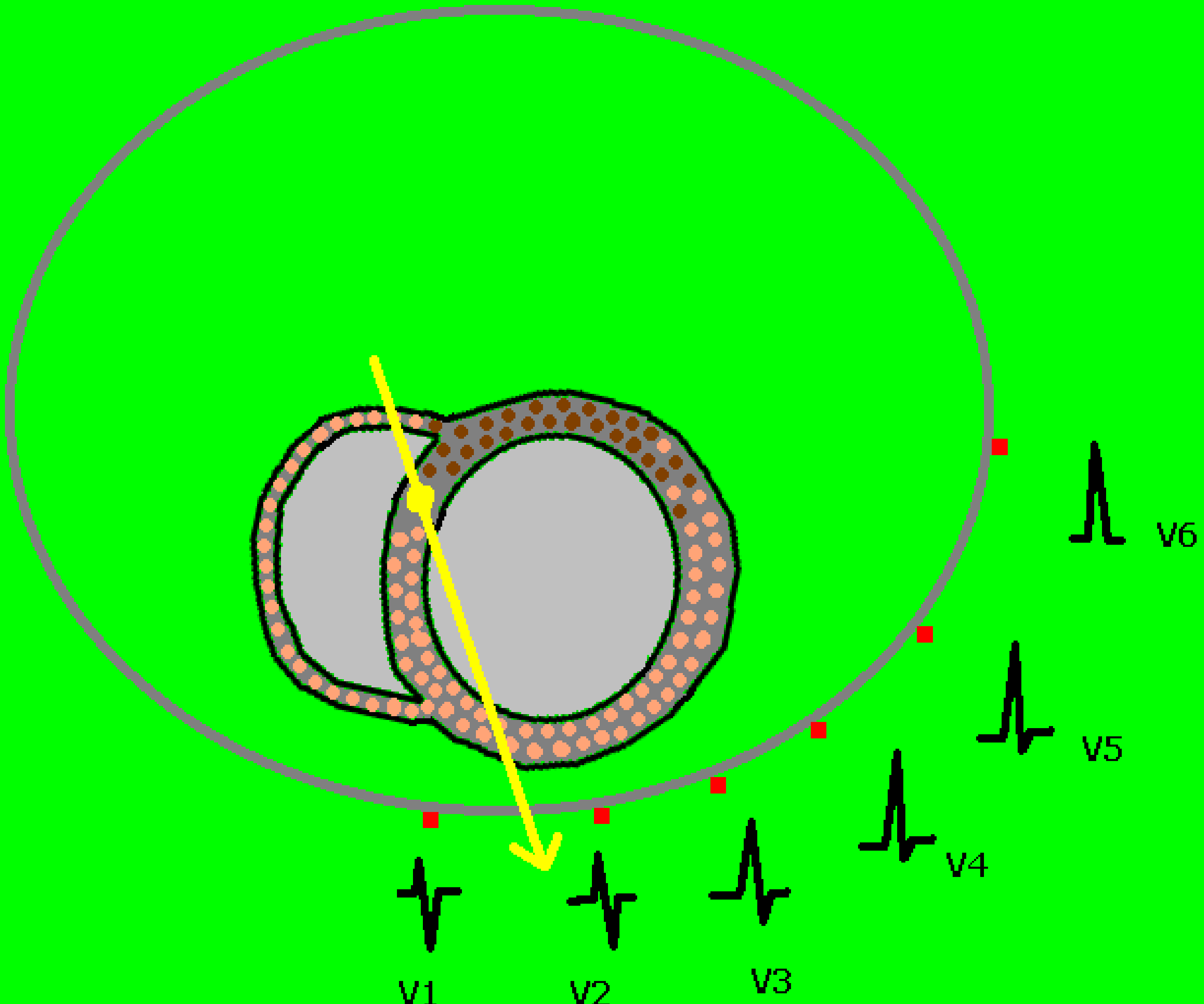
**→ Usually accompanied by OLD INFERIOR WALL MI**
**- Does NOT abnormally widen the QRS complex**




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

EID:18 EDT: 21:53 06–MAY–1997 ORDER:

# OLD POSTERIOR WALL M.I.



01-MAY- 04:14:17

51 yr
Male Caucasian

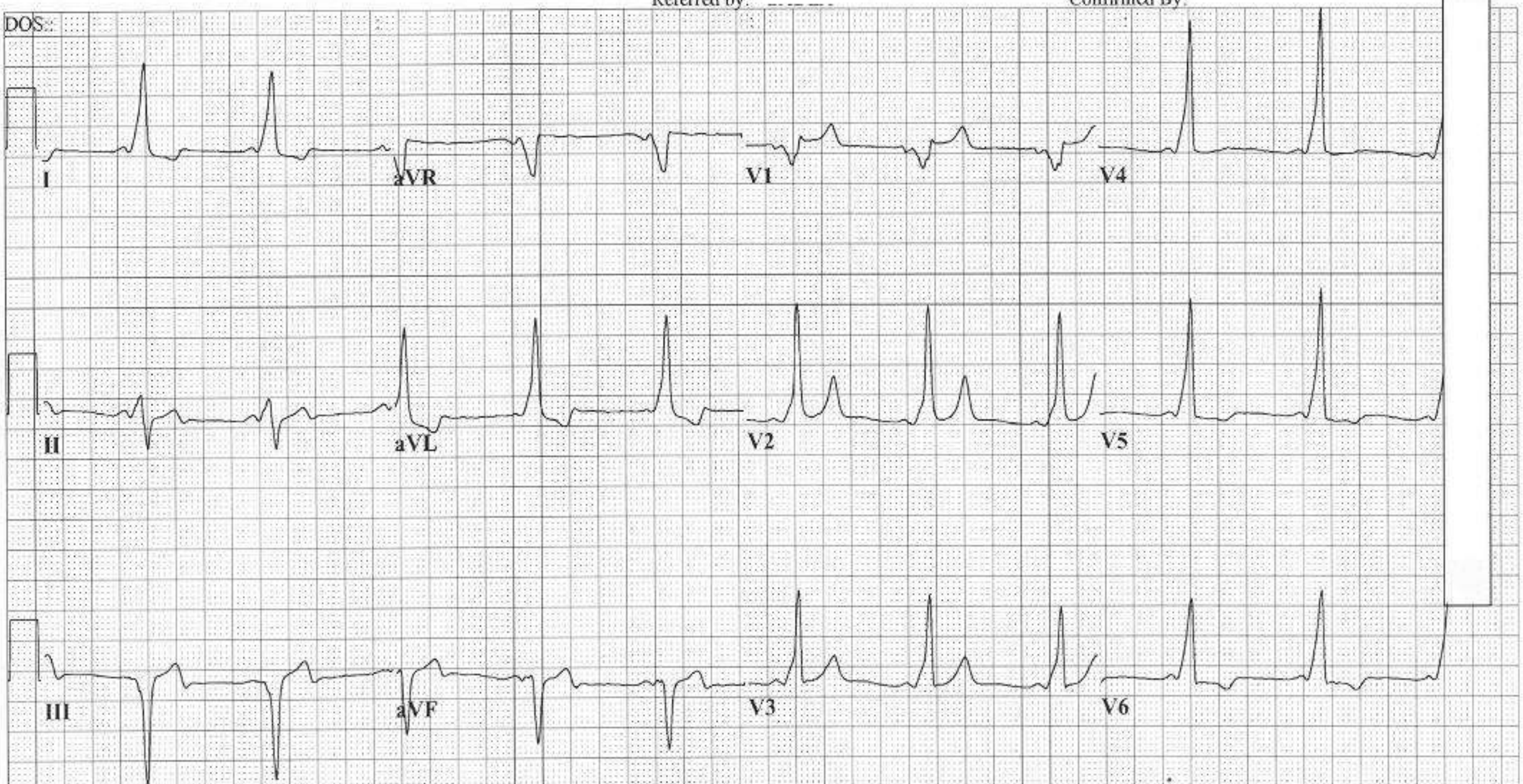
Room:540
Loc:5 Option:28

| | | |
|---|---|---|
| Vent. rate | 64 | BPM |
| PR interval | 110 | ms |
| QRS duration | 146 | ms |
| QT/QTc | 418/431 | ms |
| P-R-T axes | 50 -36 | 119 |

**What is the cause of EARLY TRANSITION in this EKG ?**

Technician EKG CLASS #WR03696205

Referred by: Confirmed By:




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

EID:17 EDT: 08:49 01-MAY-1999 ORDER:

# 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

# 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)~~

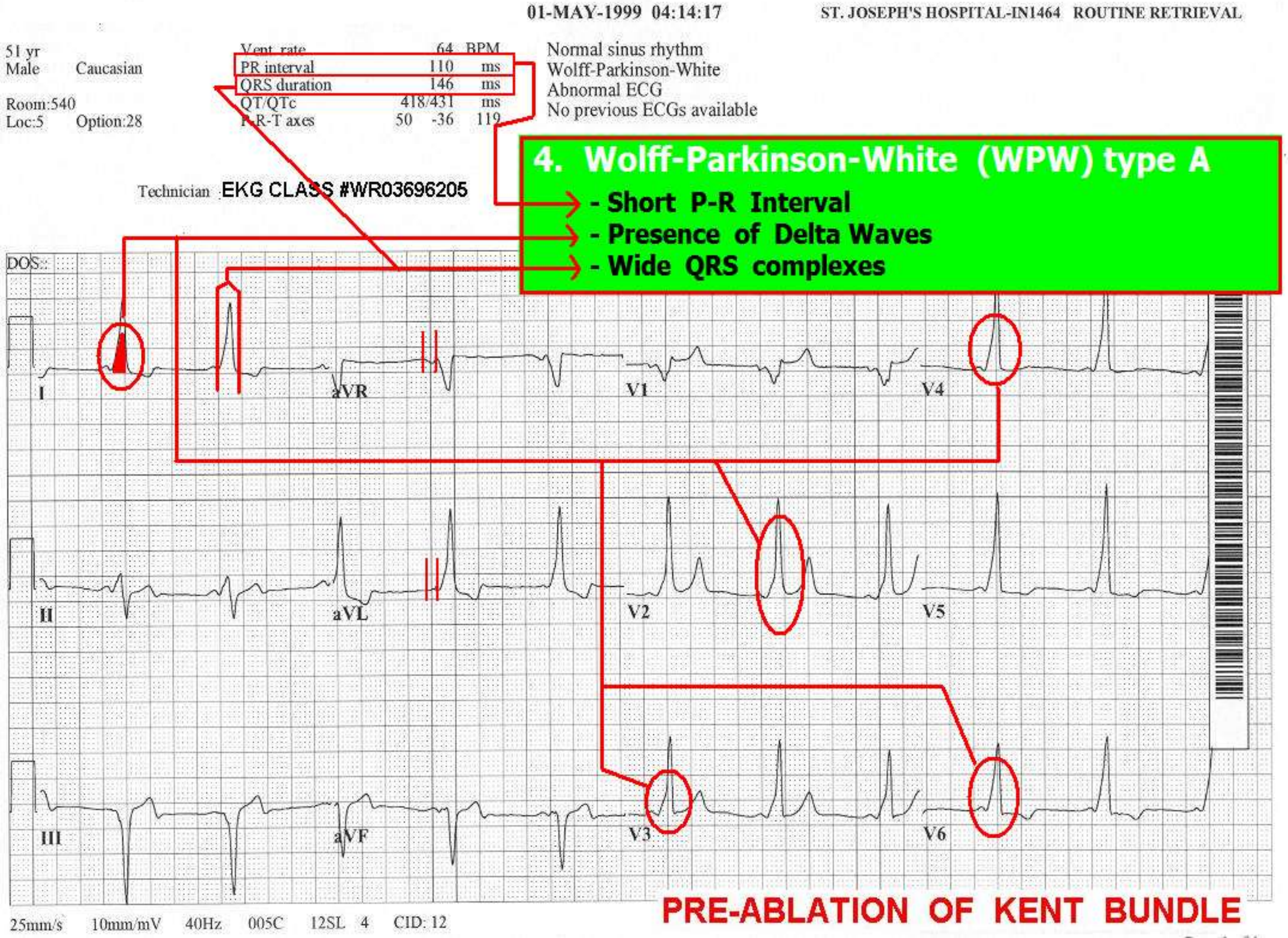
- ~~Corresponding Right Atrial Hypertrophy (RAH)~~
- ~~Right Axis Deviation (RAD)~~
- ~~QRS in LEAD I more NEGATIVE than POSITIVE ( R<S )~~

~~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


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

04-MAY-1999 04:47:41 ST. JOSEPH'S HOSPITAL-IN1464 ROUTINE RETRIEVAL

51 yr
Male Caucasian

Room:426
Loc:5 Option:28

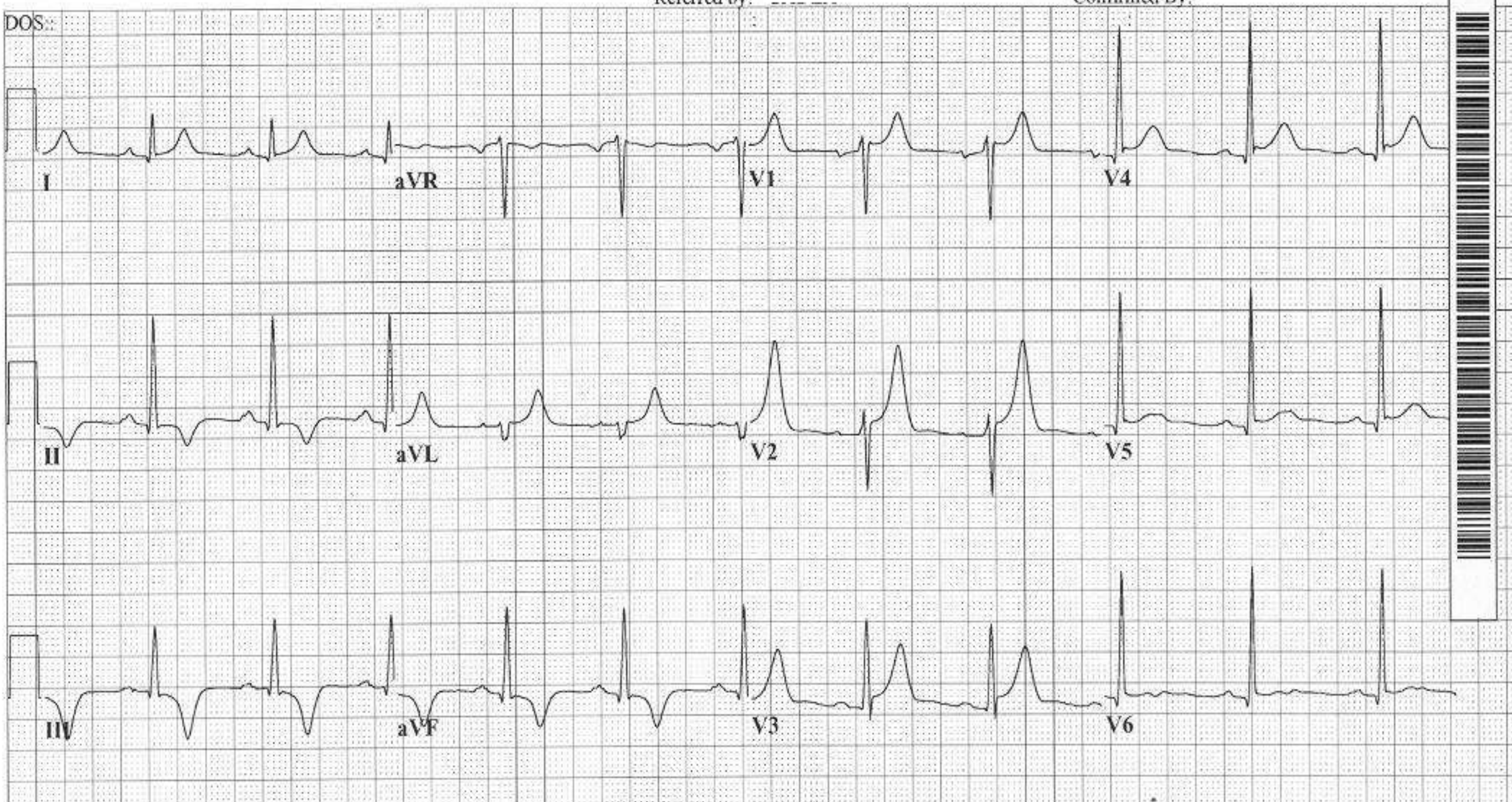
| | | |
|---|---|---|
| Vent. rate | 69 | BPM |
| PR interval | 184 | ms |
| QRS duration | 88 | ms |
| QT/QTc | 392/420 | ms |
| P-R-T axes | 60 69 | -50 |

Normal sinus rhythm
Marked T wave abnormality, consider inferior ischemia
Abnormal ECG
When compared with ECG of 01-MAY-1999 21:36,
Wolff-Parkinson-White is no longer Present

**POST-ABLATION OF KENT BUNDLE**

Technician: EKG CLASS #WR03696205

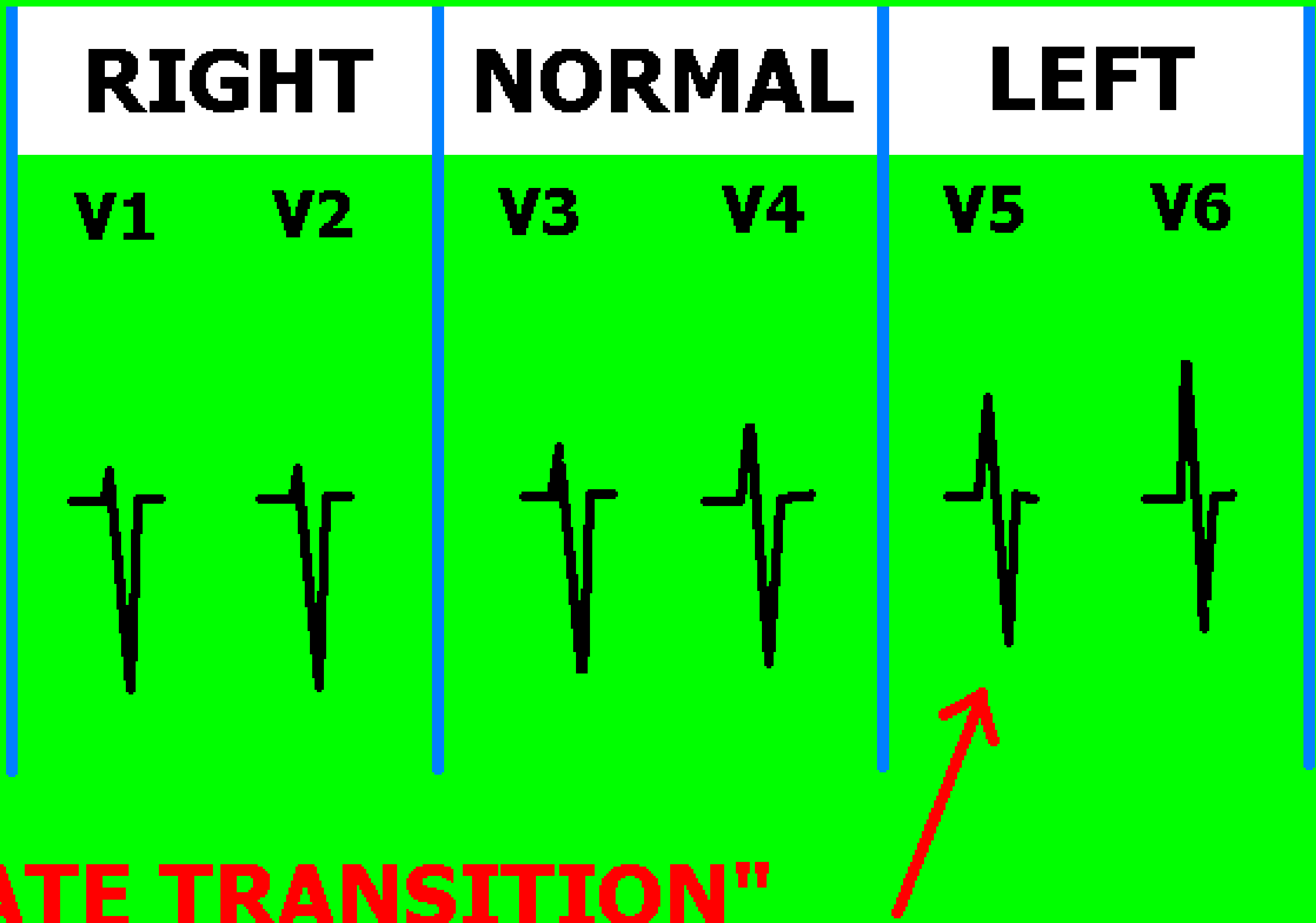
Referred by: Confirmed By:




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

EID:17 EDT: 09:08 04-MAY-1999 ORDER:

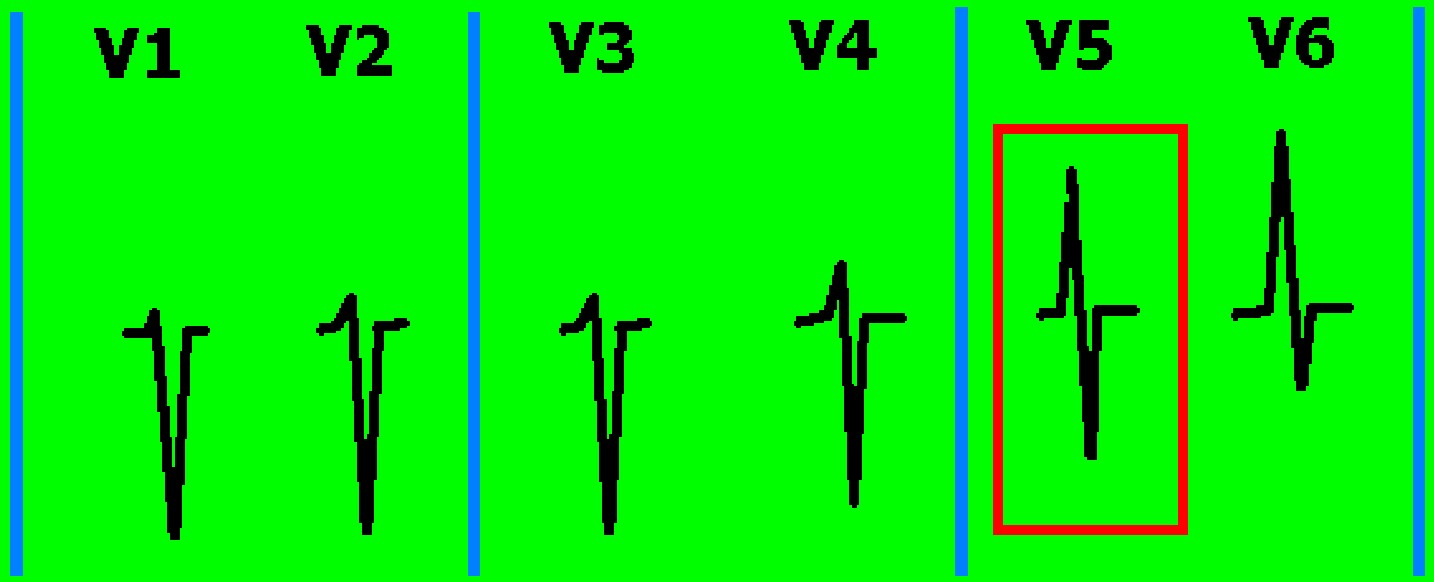
# AXIS ROTATION




"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 )

28–MAR–1997 05:46:00

91 yr
Female Caucasian

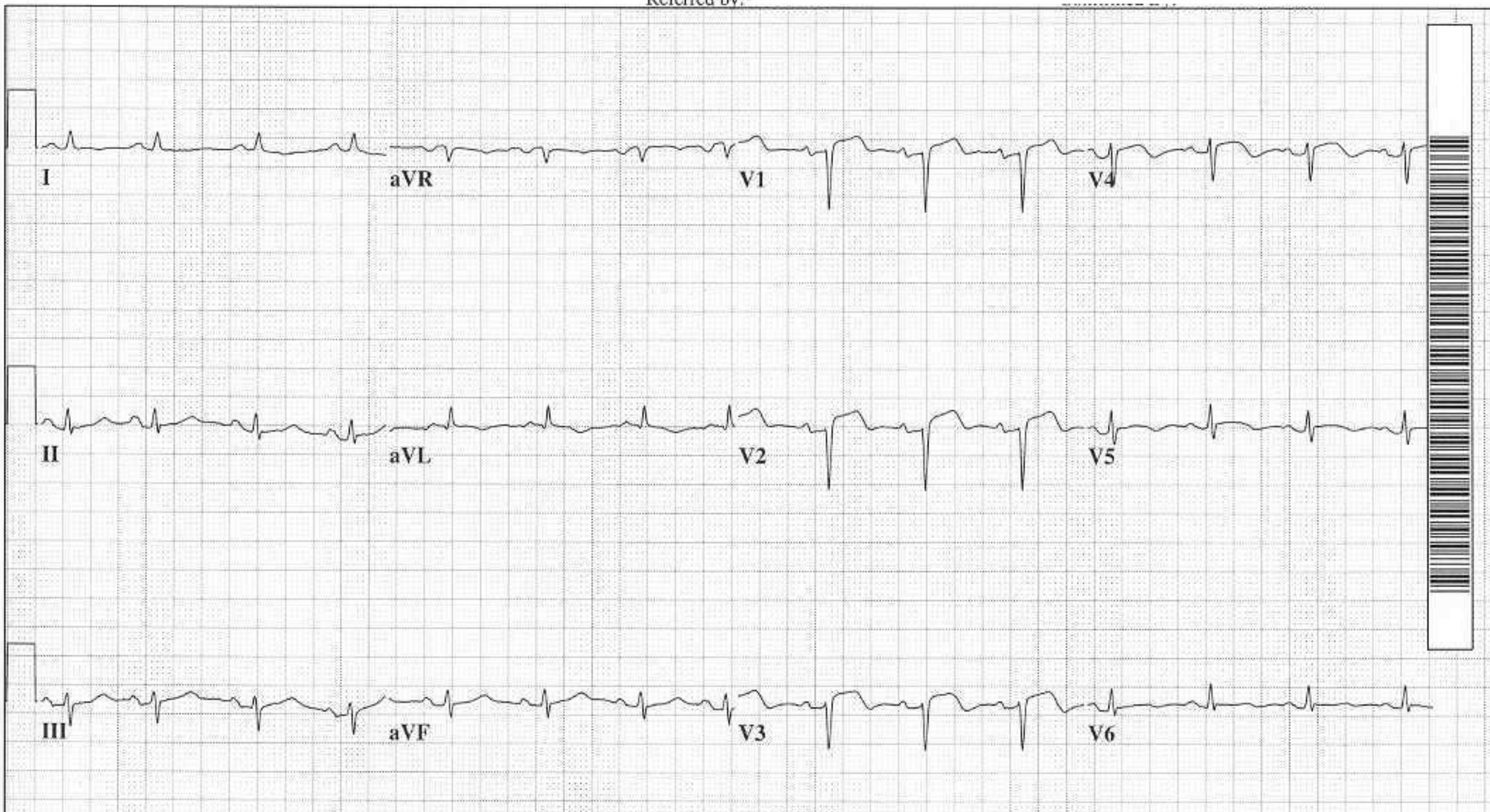
Room:3
Loc:1 Option:1

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

Technician ID: EKG CLASS # WR03110848

**What is the cause of LATE TRANSITION in this EKG ?**

Referred by:




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

EID:16 EDT: 11:25 30–MAR–1997 ORDER:

# 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 )

# COMMON CAUSES OF LATE TRANSITION

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

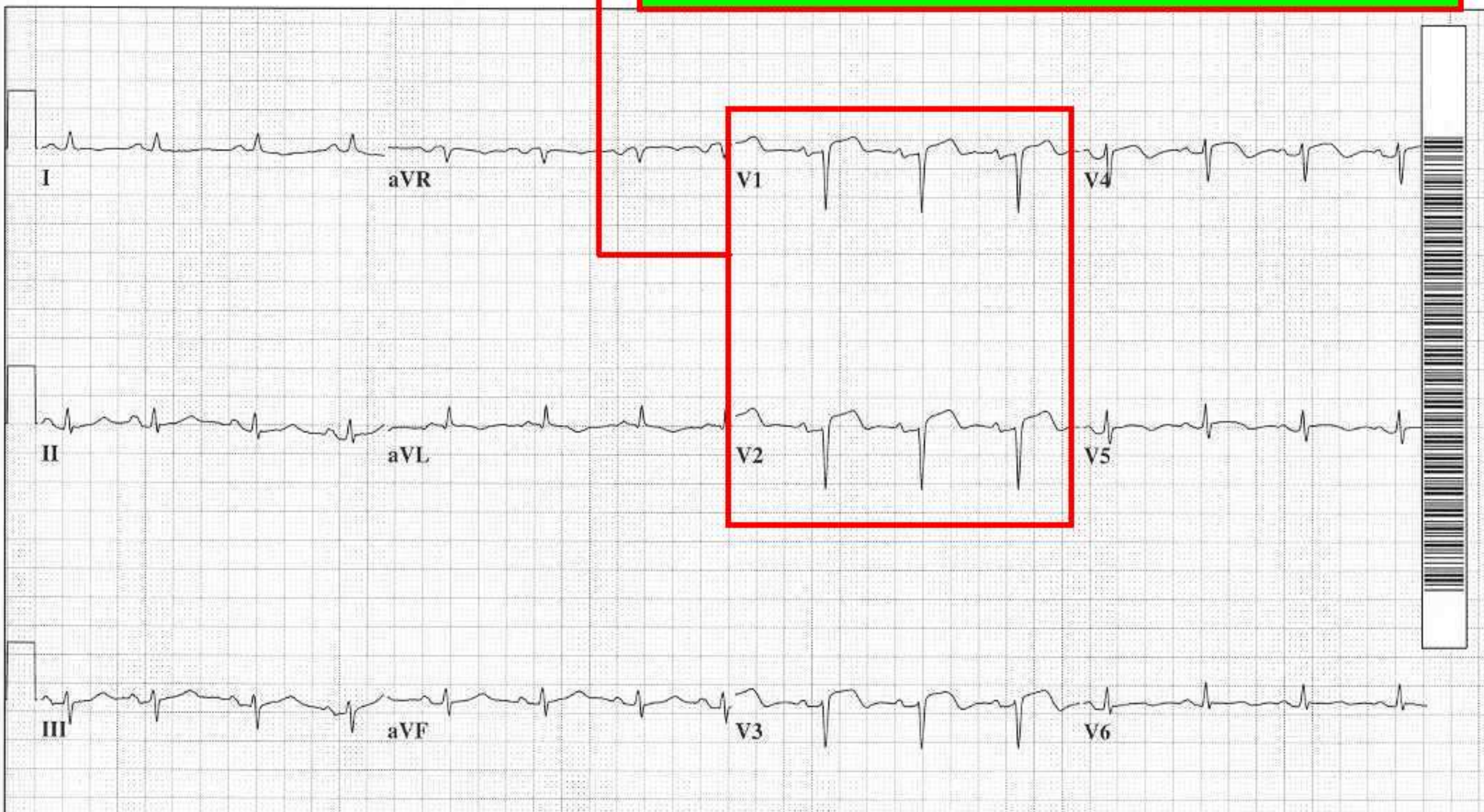
1. **Old Anterior MI**
   - Q Waves in V1, V2, and /or V3
   - Other causes of LATE TRANSITION ruled out
2. **Left Bundle Branch Bock ( LBBB )**
   - Supraventricular Rhythm
   - QRS wider than 120 ms ( .12 sec )
   - RsR' or RR' ("notching") in V5 and/or V6
3. **Left Ventricular Hypertrophy ( LVH )**
   - 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 )

| | | | | | |
|---|---|---|---|---|---|
| 91 yr | | Vent. rate | 87 | BPM | |
| Female | Caucasian | PR interval | 156 | ms | |
| | | QRS duration * | 80 | ms | |
| Room:3 | | QT/QTc | 332/399 | ms | |
| Loc:1 | Option:1 | P-R-T axes | 45 4 | 96 | |

Normal sinus rhythm
Possible Anterior infarct (cited on or before 27-MAR-1997)
Abnormal ECG

Technician ID: EKG CLASS # WR03110848

**Old Anterior MI**
**- Q waves in V1, V2, V3 and/or V4**
**- other causes of LATE TRANSITION ruled out**




25mm/s 10mm/mV 100Hz 005C 12SL 4 CID: 5 EID:16 EDT: 11:25 30-MAR-1997 ORDER:

27–MAR–1991 13:29:00 ST. JOSEPH'S HOSPITAL–IN 65+ ROUTINE RETRIEVAL

85 yr
Female Caucasian

Room:715A
Loc:6 Option:19

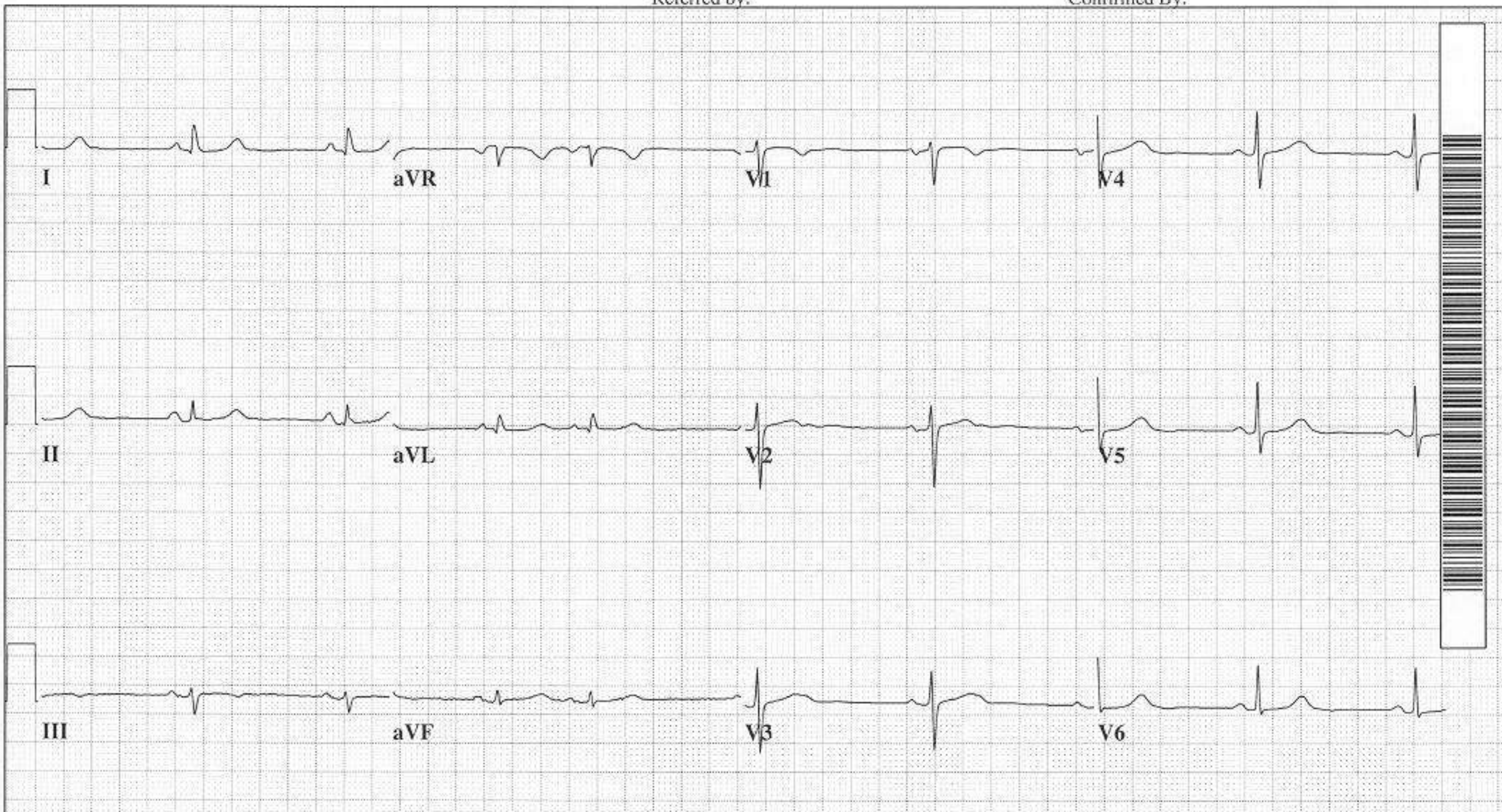
| | | |
|---|---|---|
| Vent. rate | 55 | BPM |
| PR interval | 152 | ms |
| QRS duration | 76 | ms |
| QT/QTc | 432/413 | ms |
| P–R–T axes | 40 14 | 34 |

Sinus bradycardia with occasional Premature supraventricular complexes
Otherwise normal ECG

EKG CLASS # WR03110848

**PRE-INFARCTION EKG**

Referred by: Confirmed By:




25mm/s 10mm/mV 40Hz 005C 12SL 68 CID: 0 EID:Cnvrtd EDT: ORDER:

27–MAR–1997 12:42:11 ST. JOSEPH'S HOSPITAL–ER ROUTINE RETRIEVAL

| | | | | |
|---|---|---|---|---|
| 91 yr | | Vent. rate | 100 | BPM |
| Female | Caucasian | PR interval | 166 | ms |
| | | QRS duration | 80 | ms |
| Room:ER | | QT/QTc | 360/464 | ms |
| Loc:3 | Option:17 | P–R–T axes | 52 –38 | 70 |

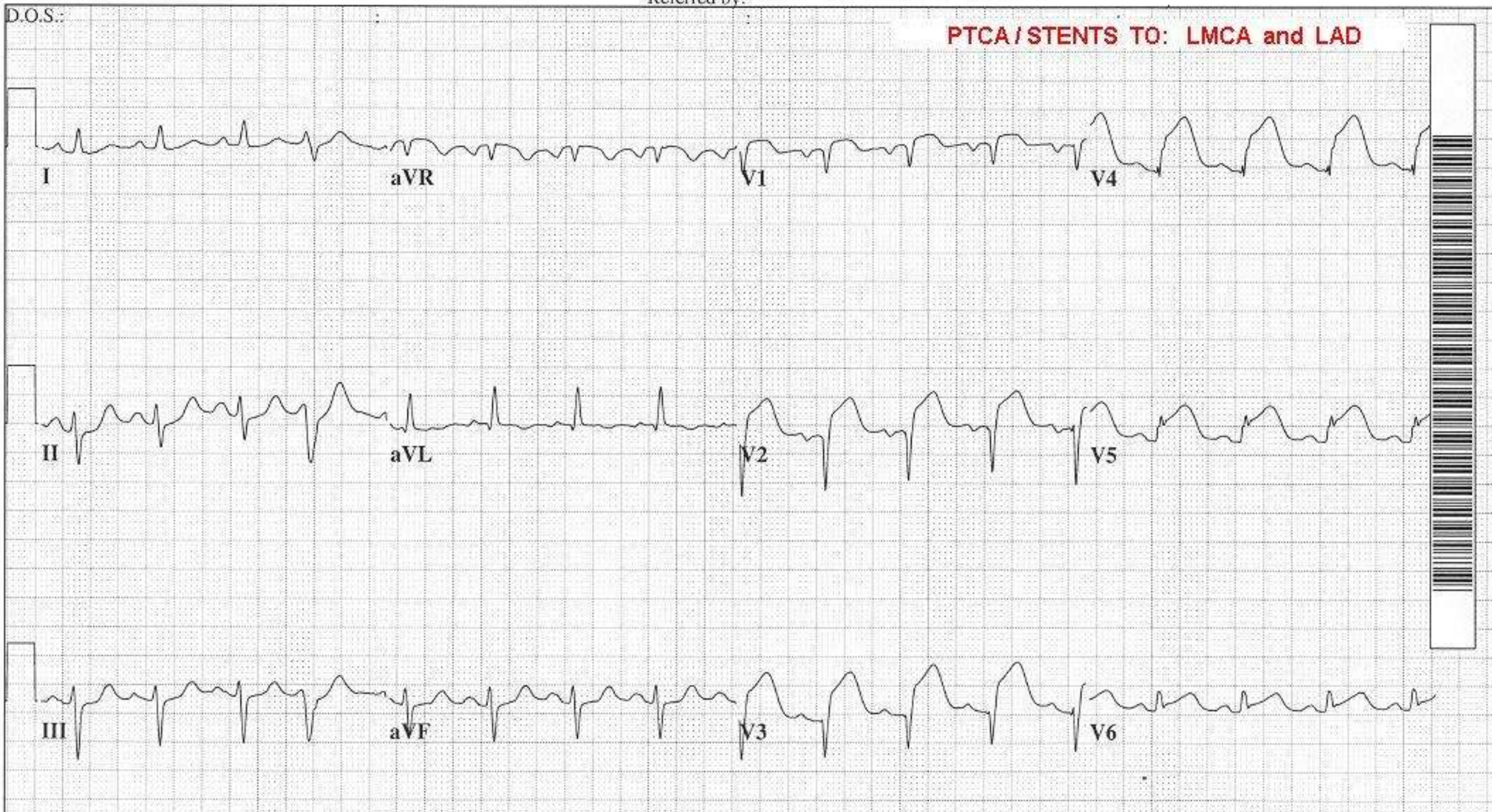
Technician: EKG CLASS# WR03110848

Normal sinus rhythm with frequent , and consecutive Premature ventricular and fusion complexes
Left atrial enlargement
Left axis deviation
Septal infarct , possibly acute
Anterolateral injury pattern
** ** ** ** * ACUTE MI * ** ** ** **
Abnormal ECG
When compared with ECG of 27–MAR–1991 13:29,

Referred by:

SUDDEN ONSET CHEST PAIN
-WAITED "SEVERAL HOURS" BEFORE SEEKING HELP
-ER - DIRECTLY TO CATH LAB

CPK: 2,471
CK/MB: 483
CK INDEX: 14




25mm/s 10mm/mV 40Hz 005C 12SL 4 CID: 1

EID:13 EDT: 18:31 28–MAR–1997 ORDER:

28–MAR–1997 05:46:00 ST. JOSEPH'S HOSPITAL–CCU ROUTINE RETRIEVAL

91 yr
Female Caucasian

Room:3
Loc:1 Option:1

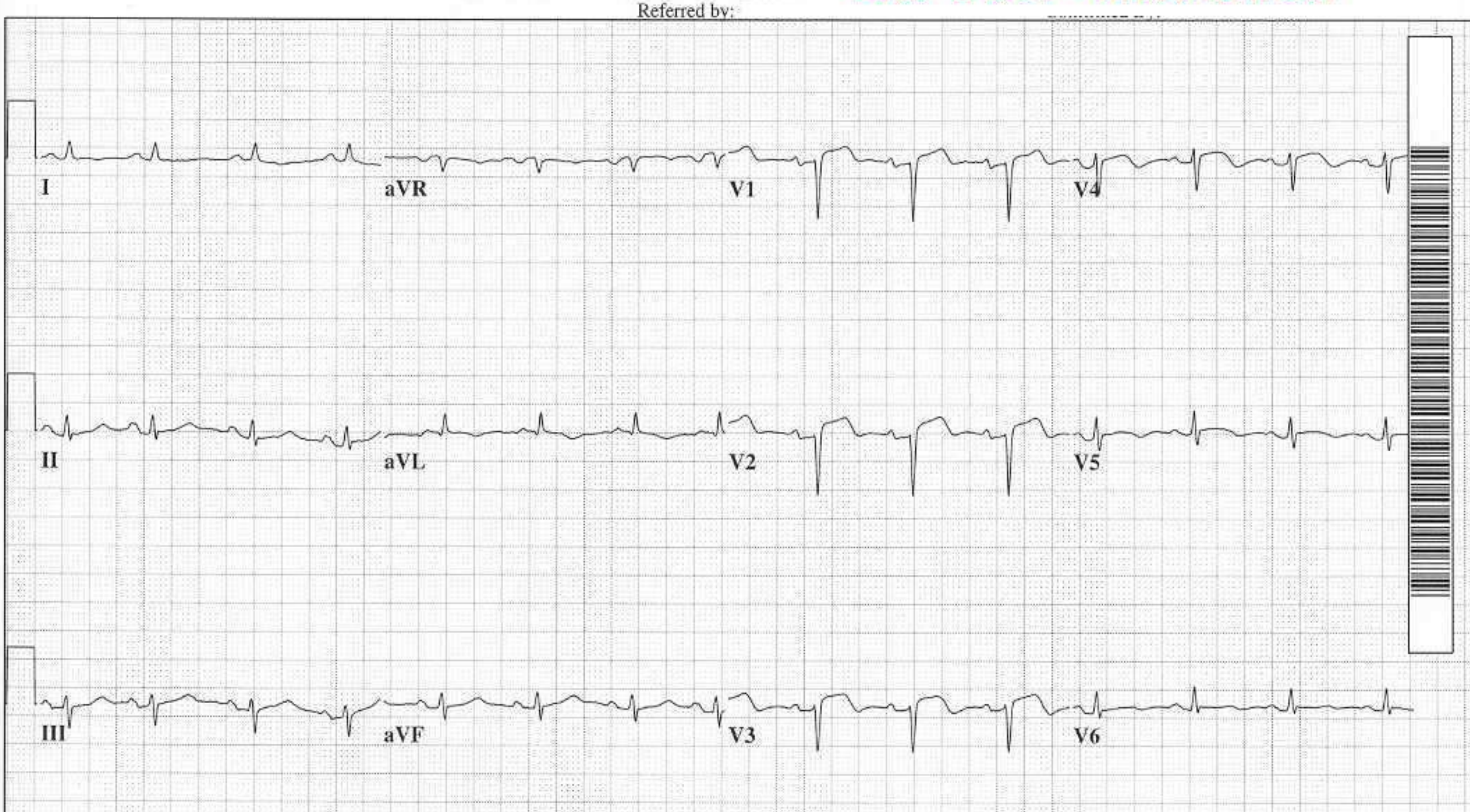
| | | |
|---|---|---|
| Vent. rate | 87 | BPM |
| PR interval | 156 | ms |
| QRS duration * | 80 | ms |
| QT/QTc | 332/399 | ms |
| P–R–T axes | 45 4 | 96 |

Technician ID: EKG CLASS # WR03110848

Normal sinus rhythm
Possible Anterior infarct (cited on or before 27–MAR–1997)
Abnormal ECG
When compared with ECG of 27–MAR–1997 16:26 (UNCONFIRMED),
QRS duration has decreased
Questionable change in initial forces of Anteroseptal leads
Non–specific change in ST segment in Lateral leads
QT has shortened

**EKG POST - INFARCTION**

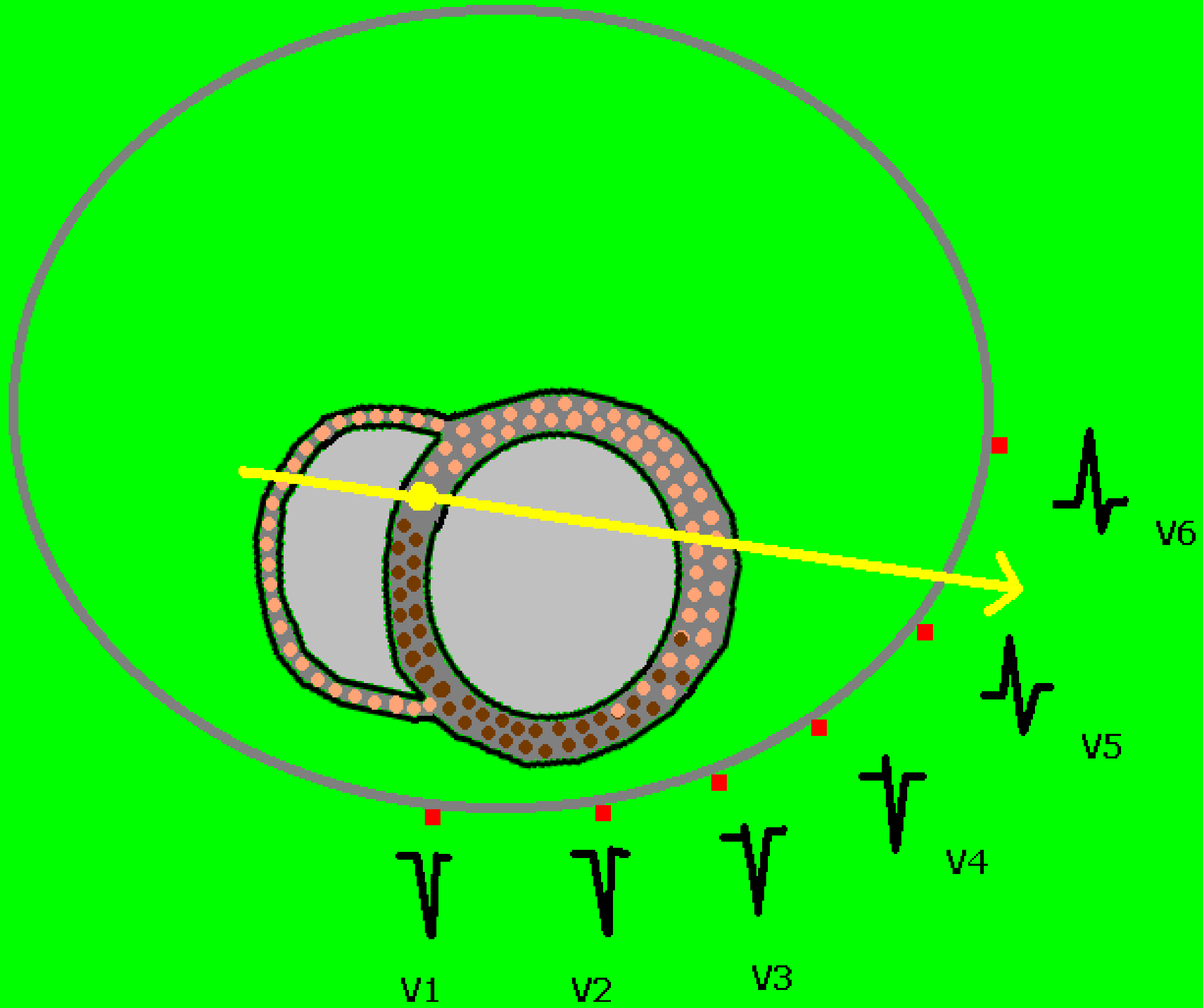
Referred by:




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

EID:16 EDT: 11:25 30–MAR–1997 ORDER:

# OLD ANTERIOR-SEPTAL WALL M.I.



## COMMON CAUSES OF LATE TRANSITION

....SOME HELPFUL CLUES:

- **When you have an EKG with LATE TRANSITION, which has NO OBVIOUS CAUSE . . .**

**Supect OLD ANTERIOR MI !**

- OBTAIN A THOROUGH PATIENT HISTORY
- OBTAIN COPIES OF OLD EKGs, IF AVAILABLE

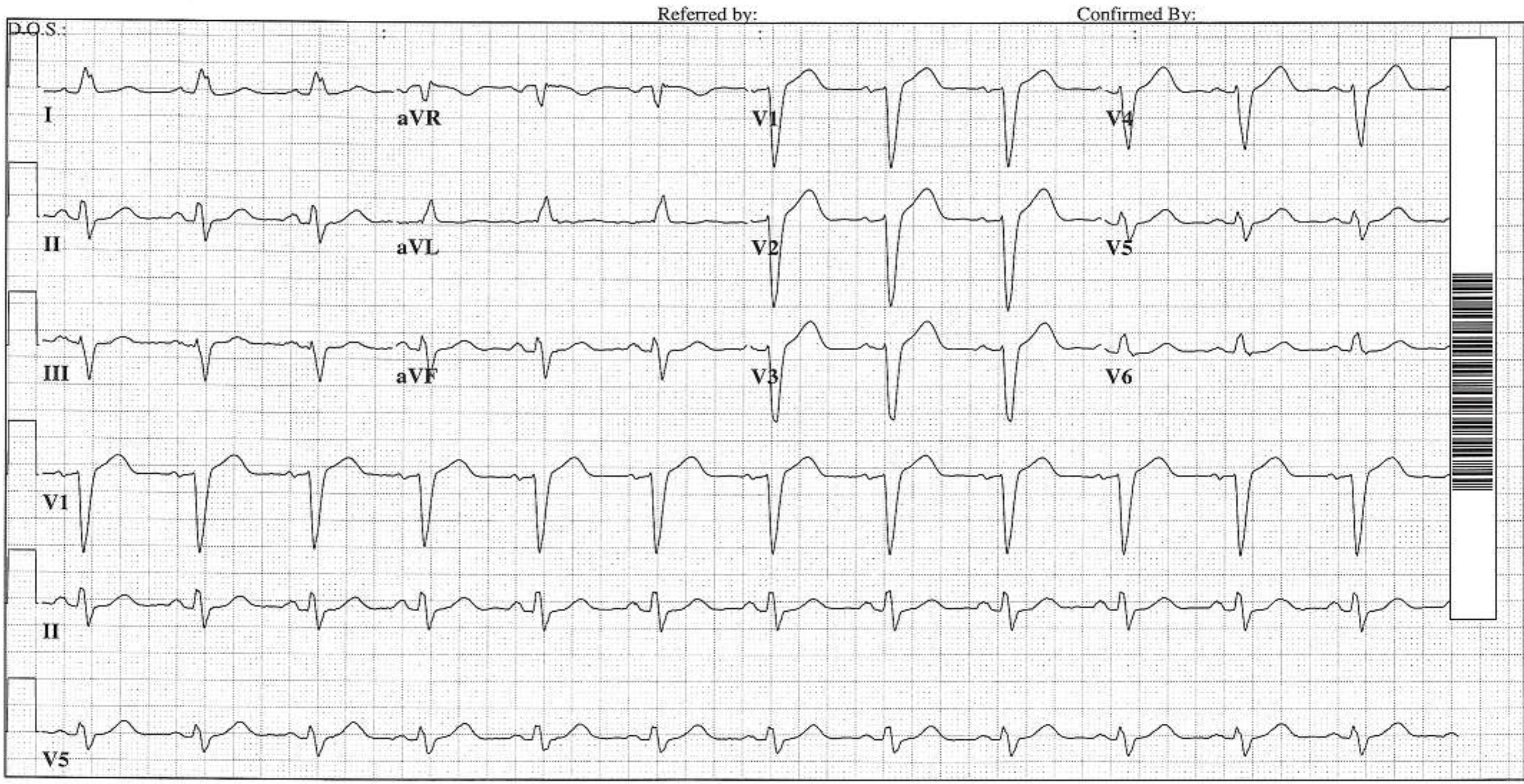
11:36:49

74 yr
Female Caucasian

Loc:7 Option:35

| | | |
|---|---|---|
| Vent. rate | 73 | BPM |
| PR interval | 160 | ms |
| QRS duration | 134 | ms |
| QT/QTc | 450/495 | ms |
| P–R–T axes | 67 −33 | 62 |

**What is the cause of LATE TRANSITION in this EKG ?**



# COMMON CAUSES OF LATE TRANSITION

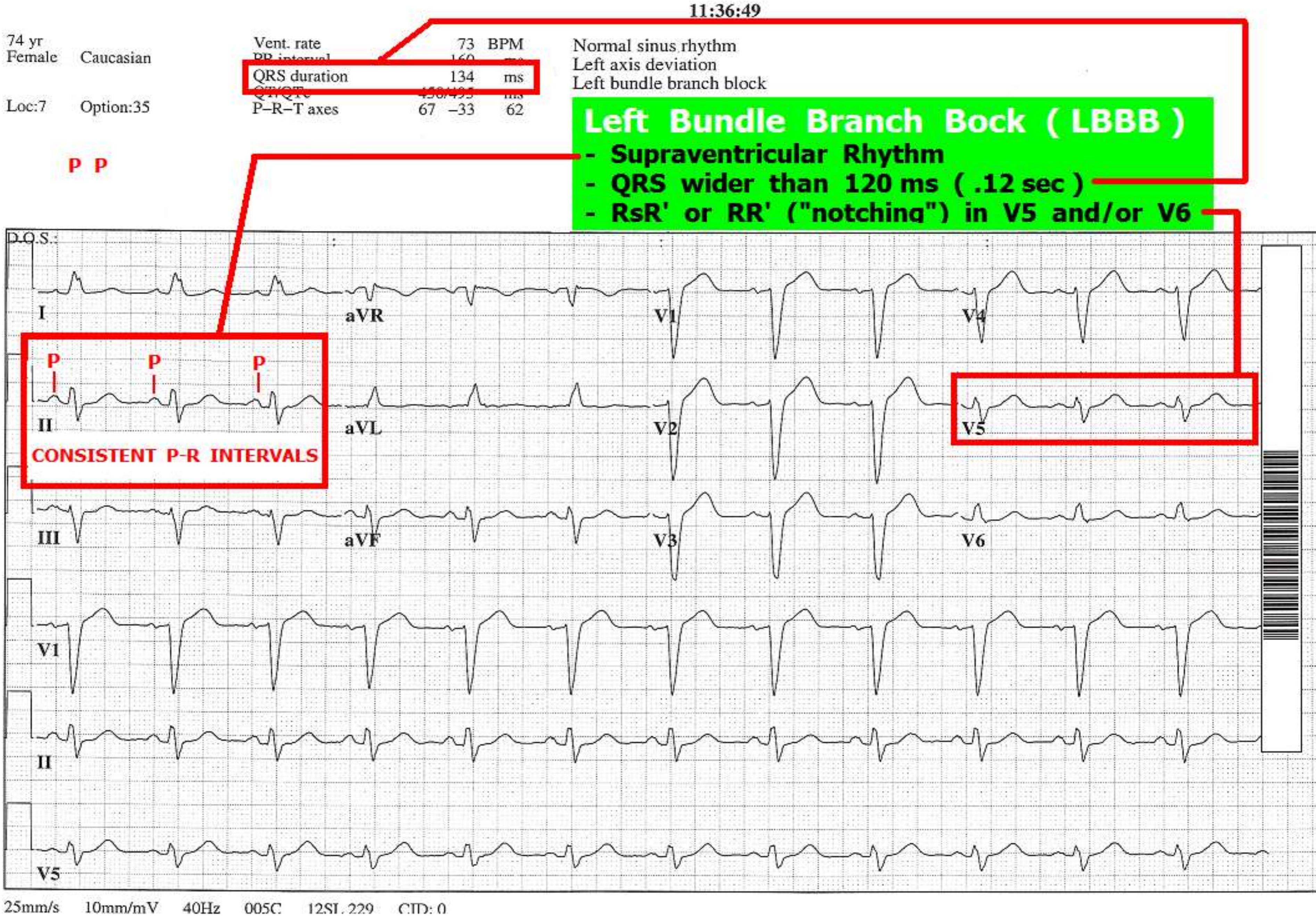
## ....WITH SOME *COMMON* HELPFUL CLUES:

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 )

# 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 )



11:36:49
74 yr
Female
Caucasian
Loc:7
Option:35
Vent. rate 73 BPM
QRS duration 134 ms
P–R–T axes 67 –33 62
Normal sinus rhythm
Left axis deviation
Left bundle branch block
Left Bundle Branch Bock ( LBBB )
- Supraventricular Rhythm
- QRS wider than 120 ms ( .12 sec )
- RsR' or RR' ("notching") in V5 and/or V6
P P
P P P
CONSISTENT P-R INTERVALS
I
aVR
V1
V4
II
aVL
V2
V5
III
aVF
V3
V6
V1
II
V5
25mm/s 10mm/mV 40Hz 005C 12SL 229 CID: 0

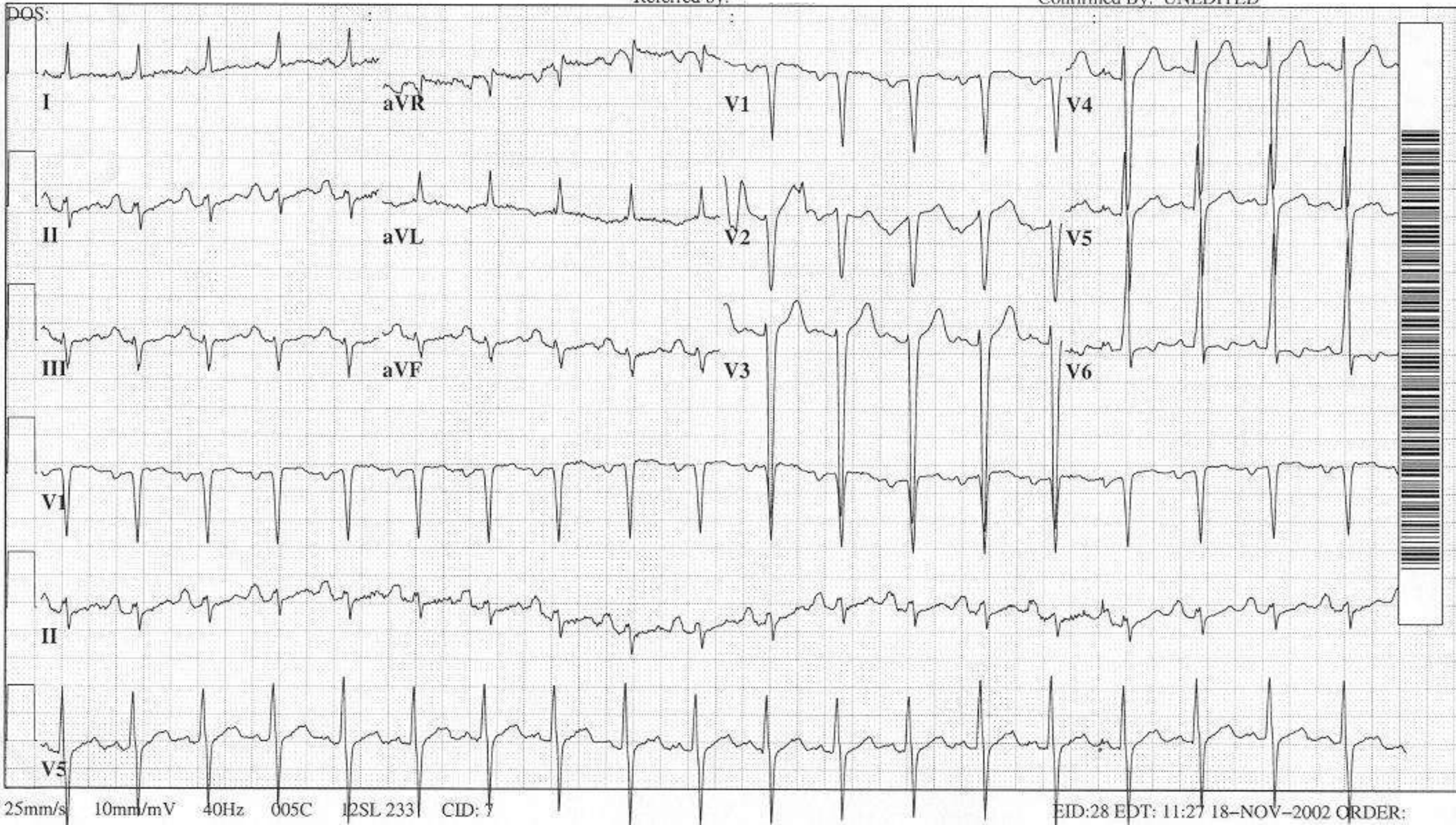
| | | | | | |
|---|---|---|---|---|---|
| 53 yr | | Vent. rate | 115 | BPM | |
| Male | Black | PR interval | 160 | ms | |
| | | QRS duration | 92 | ms | |
| Room:ER | | QT/QTc | 316/437 | ms | |
| Loc:3 | Option:23 | P–R–T axes | 76 –39 | 59 | |

EKG CLASS #WR03896717

**What is the cause of LATE TRANSITION in this EKG ?**

Referred by:

Confirmed By: UNEDITED



# COMMON CAUSES OF LATE TRANSITION

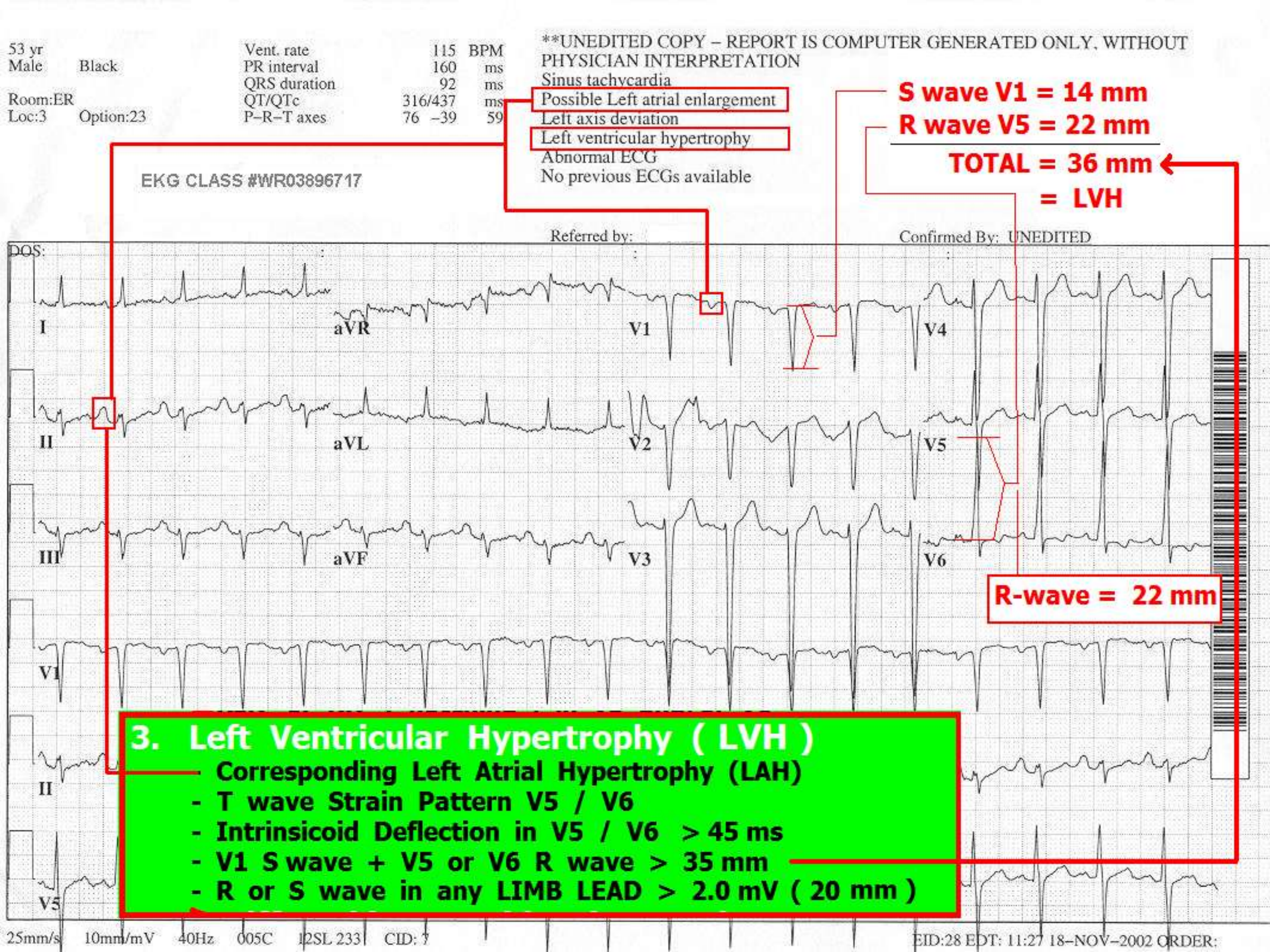
## ....WITH SOME *COMMON* HELPFUL CLUES:

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 )

# COMMON CAUSES OF LATE TRANSITION

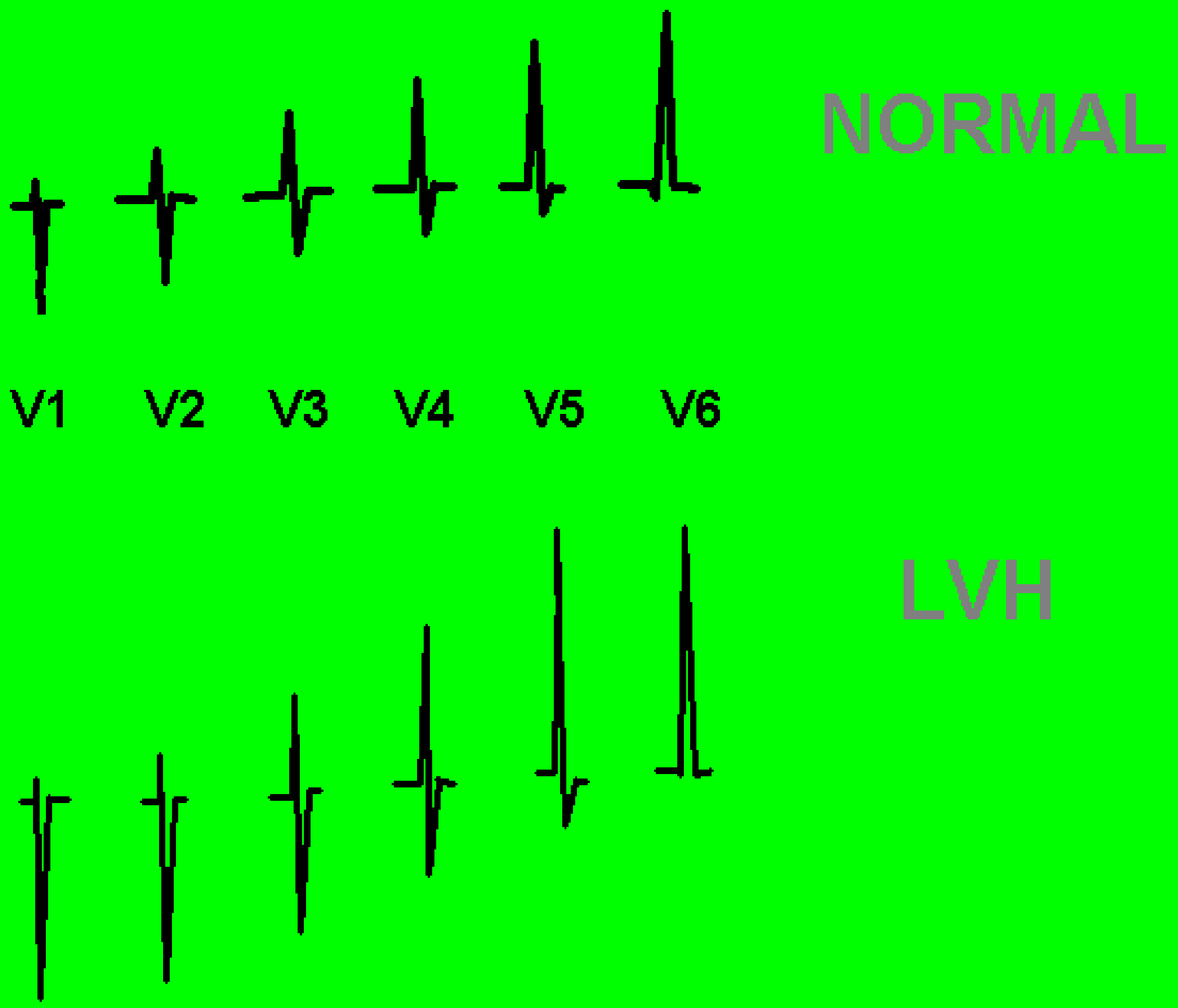
## ....WITH SOME *COMMON* HELPFUL CLUES:

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 )~~



53 yr
Male Black
Room:ER
Loc:3 Option:23
Vent. rate 115 BPM
PR interval 160 ms
QRS duration 92 ms
QT/QTc 316/437 ms
P-R-T axes 76 -39 59
**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
EKG CLASS #WR03896717
S wave V1 = 14 mm
R wave V5 = 22 mm
TOTAL = 36 mm
= LVH
Referred by:
Confirmed By: UNEDITED
DOS:
I
aVR
V1
V4
II
aVL
V2
V5
III
aVF
V3
V6
R-wave = 22 mm
V1
II
V5
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 )
25mm/s 10mm/mV 40Hz 005C 12SL 233 CID: 7
EID:28 EDT: 11:27 18-NOV-2002 ORDER:

# "EXAGGERATED" QRS SIZE in V leads FROM LEFT VENTRICULAR HYPERTROPHY



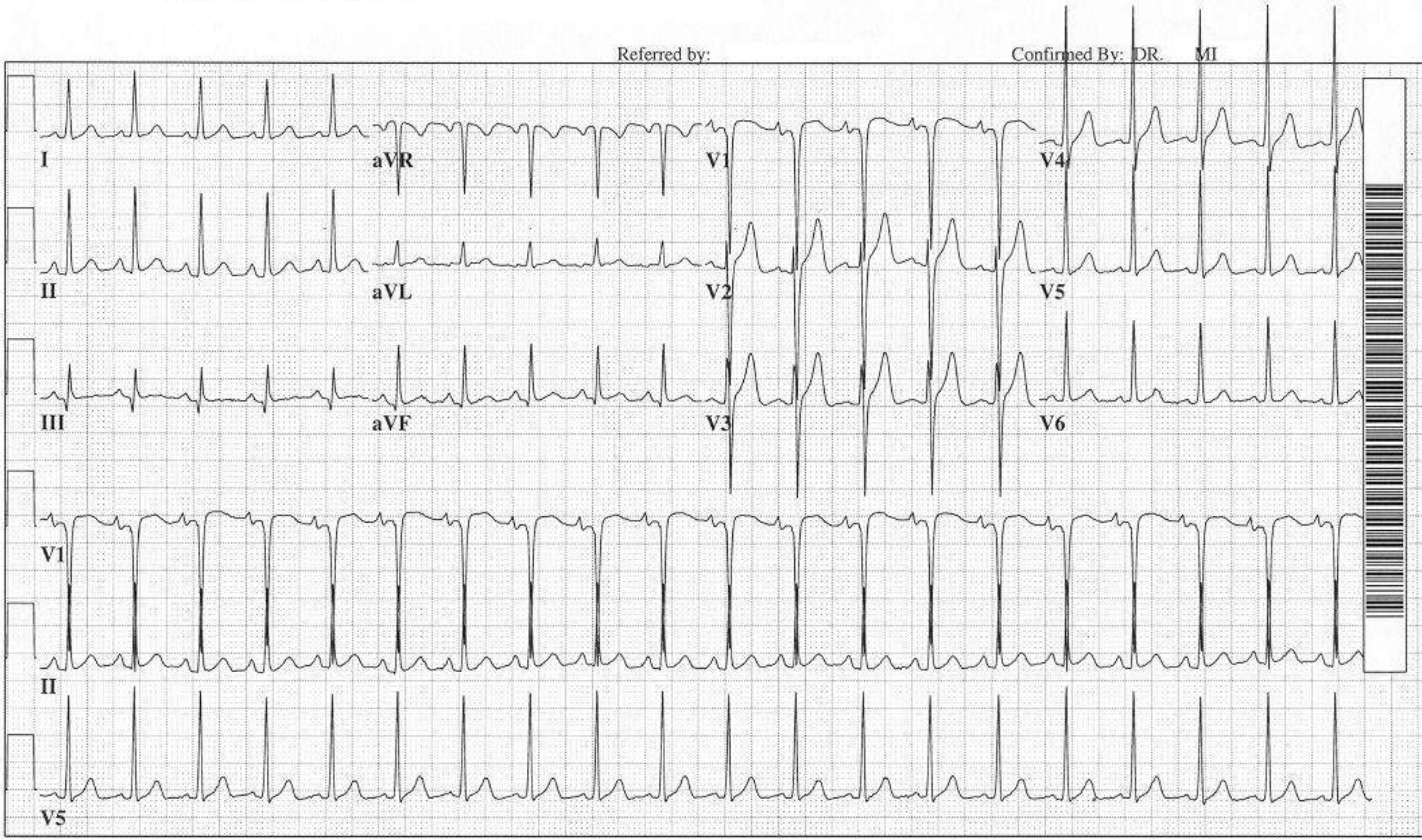
19–JUN–1995 22:39:00 ST. JOSEPH'S HOSPITAL–TCHD ROUTINE RETRIEVAL

| | | | | |
|---|---|---|---|---|
| 26 yr | | Vent. rate | 119 | BPM |
| Male | Black | PR interval | 126 | ms |
| | | QRS duration | 78 | ms |
| Room:703A | | QT/QTc | 282/397 | ms |
| Loc:8 | Option:25 | P–R–T axes | 68 46 | 41 |

Sinus tachycardia
Minimal voltage criteria for LVH, may be normal variant
Borderline ECG

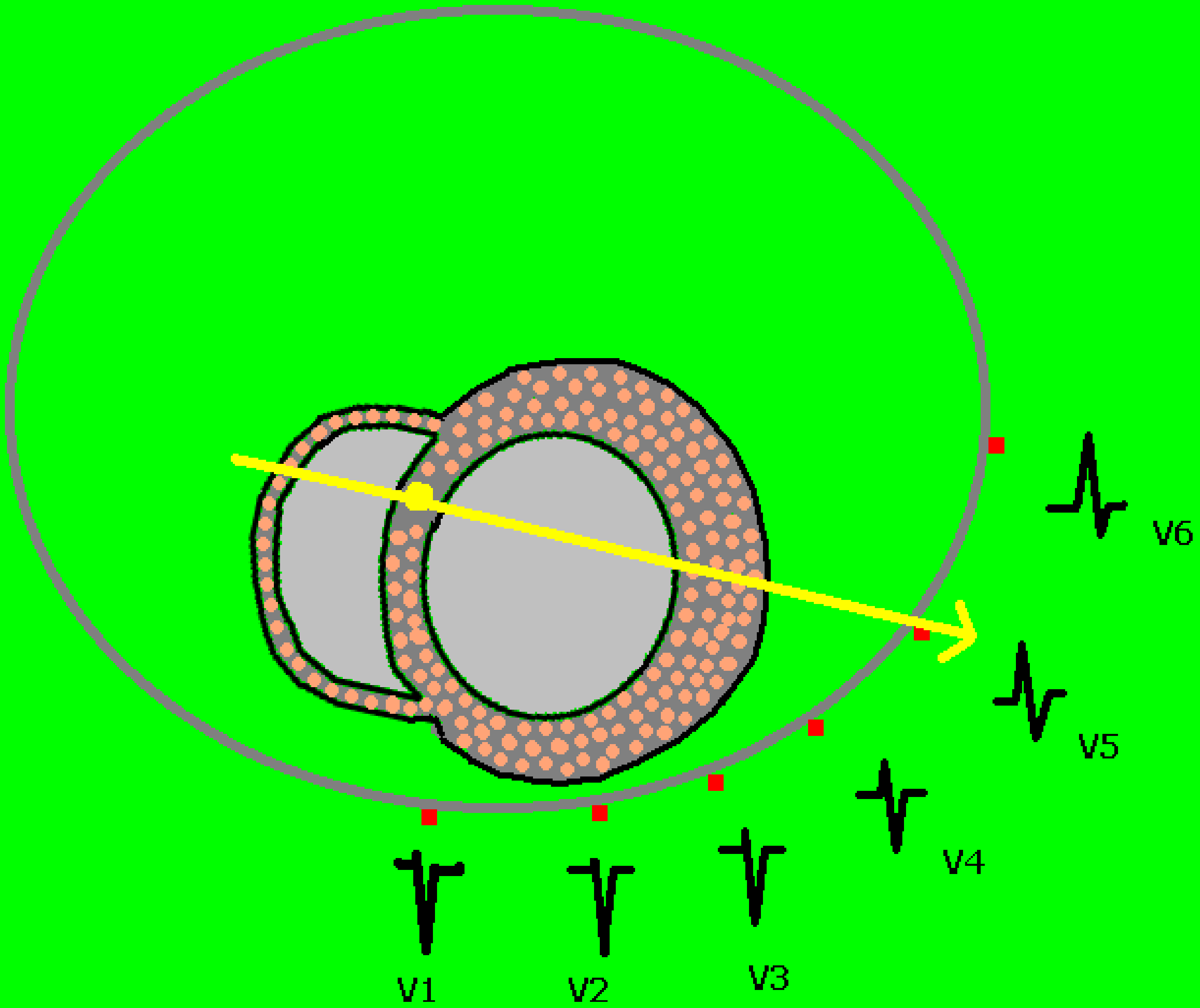
EKG CLASS #WR03446043

Referred by: Confirmed By: DR. MI




25mm/s 10mm/mV 40Hz 005C 12SL 250 CID: 0 EID:Cnvrtd EDT: ORDER:

# LEFT VENTRICULAR HYPERTROPHY



16 yr
Female Caucasian

Room:REC
Loc:20 Option:50

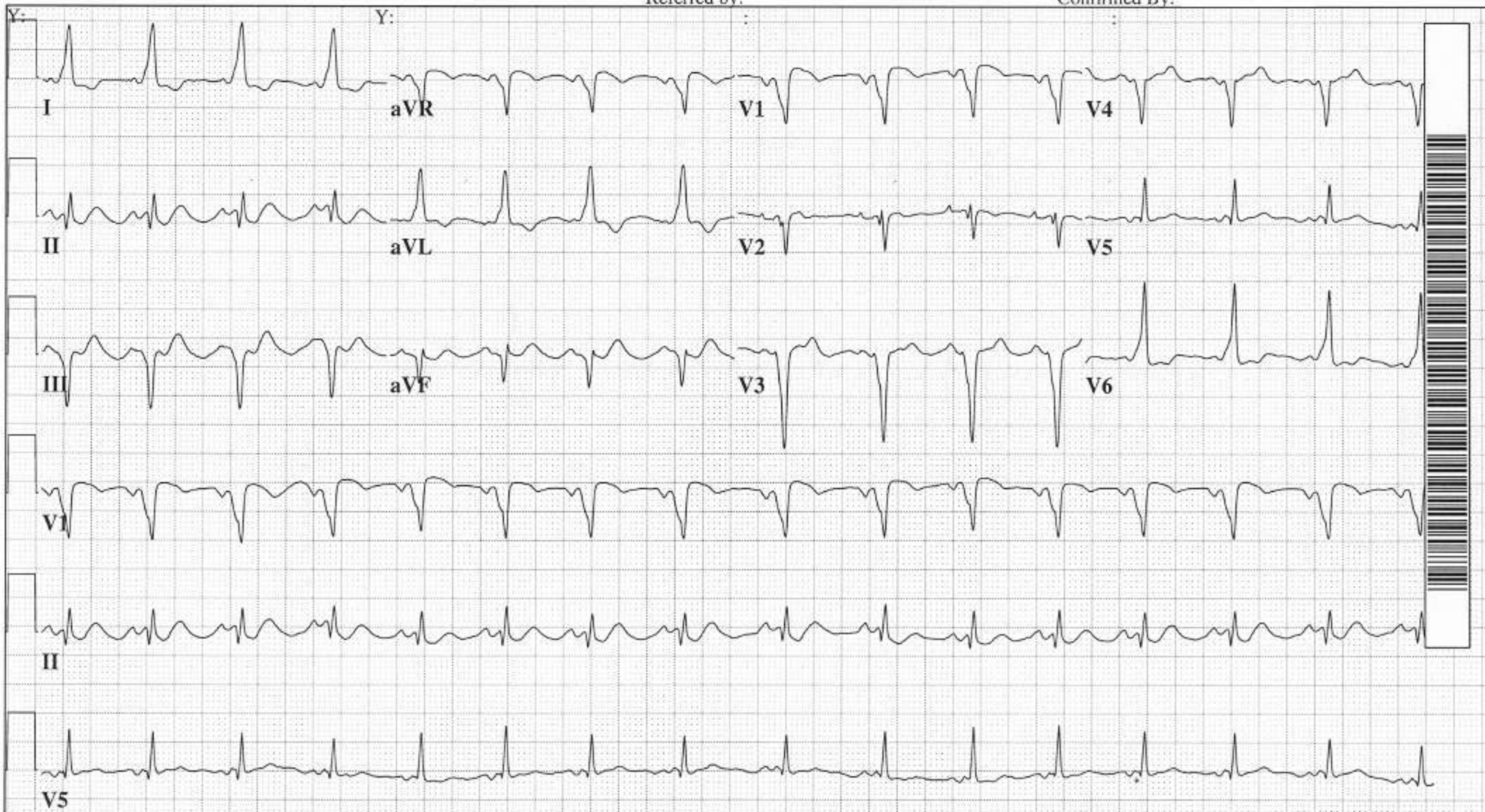
| | | |
|---|---|---|
| Vent. rate | 92 | BPM |
| PR interval | 112 | ms |
| QRS duration | 118 | ms |
| QT/QTc | 356/440 | ms |
| P–R–T axes | 59 –22 | 107 |

History:Unknown
Technician: DP
Test ind:EKG

EKG CLASS #WR030100
60783

**what is the cause of LATE TRANSITION on this EKG ?**

Referred by: Confirmed By:




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

# COMMON CAUSES OF LATE TRANSITION

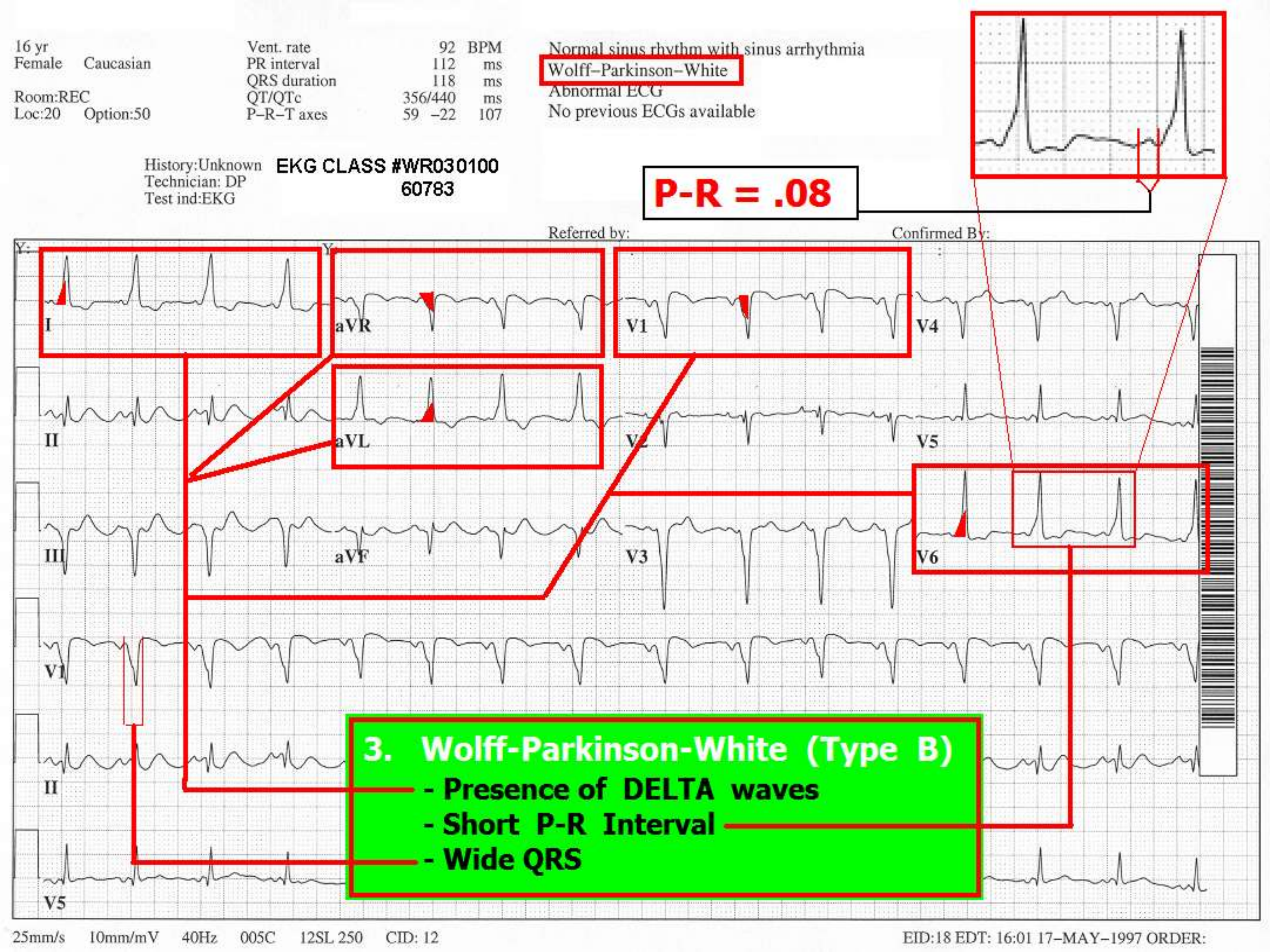
## ....WITH SOME *COMMON* HELPFUL CLUES:

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 )

# 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 )


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
Wolff–Parkinson–White
Abnormal ECG
No previous ECGs available
History:Unknown
Technician: DP
Test ind:EKG
EKG CLASS #WR030100
60783
P-R = .08
Referred by:
Confirmed By:
I
aVR
V1
V4
II
aVL
V2
V5
III
aVF
V3
V6
V1
II
V5
3. Wolff-Parkinson-White (Type B)
- Presence of DELTA waves
- Short P-R Interval
- Wide QRS
25mm/s 10mm/mV 40Hz 005C 12SL 250 CID: 12
EID:18 EDT: 16:01 17–MAY–1997 ORDER:

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