Blocks, Infarcts, and Killers:
"Advanced Basic" EKGs

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INTERSERVICE PHYSICIAN ASSISTANT PROGRAM
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INTEGRITY PERSISTENCE ATTITUDE PROFESSIONALISM
ARMY NAVY AIR FORCE COAST GUARD


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Objectives

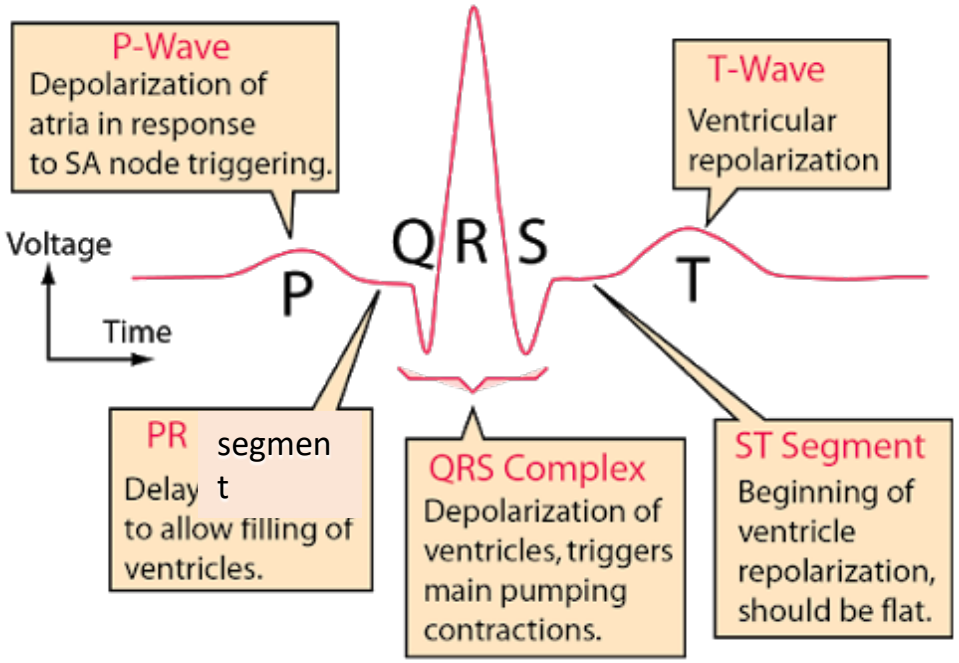
- Review of anatomy and physiology
- Blocks
- Ischemia / injury / infarction
- Killer EKGs


CAUTION
THIS MACHINE
HAS NO BRAIN
USE YOUR OWN

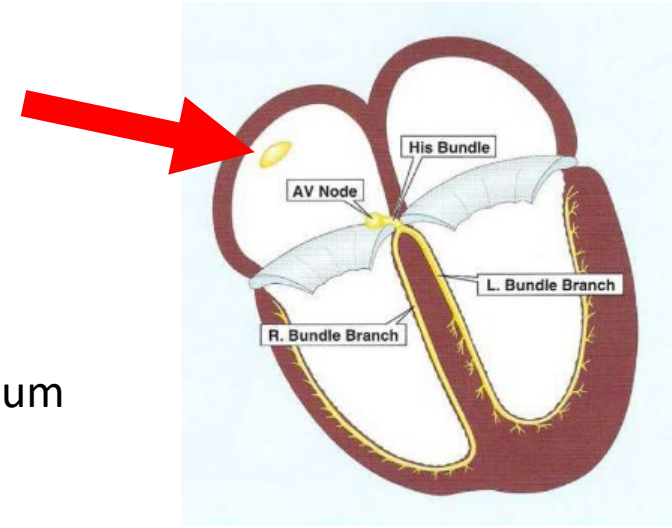
Anatomy and Cardiac Electrophysiology

- Cells signal to each other via electricity
  - Heart muscle cells are negatively polarized at rest
  - When DEPOLARIZED cells become POSITIVELY charged then myocytes (“heart muscle cells”) contract
  - Cell to cell contraction of depolarization is carried by Na+ ions
  - REPOLARIZATION is the cell returning to its resting negative state
- Myocyte depolarization → muscle contraction

The EKG and Depolarizations/Repolarization

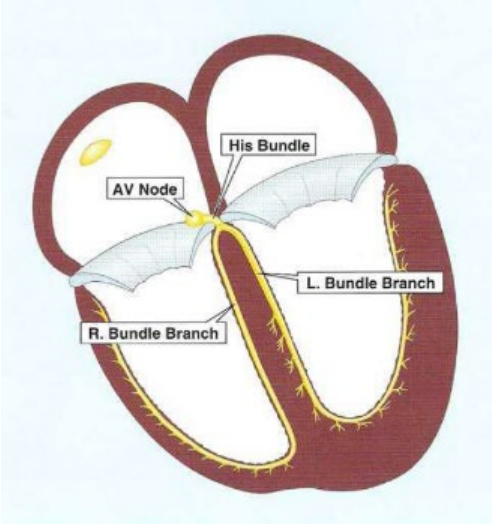


The SA Node and Conduction



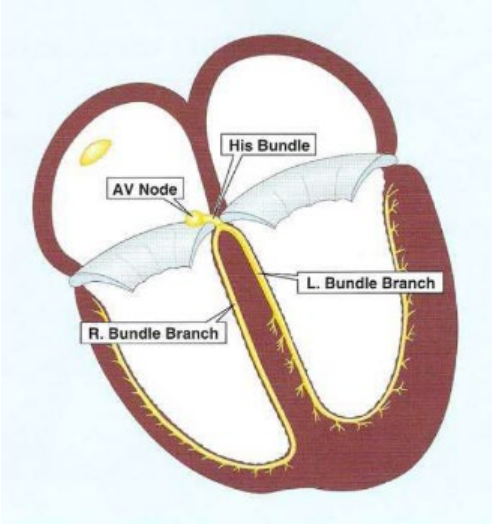
- The DOMINANT pacemaker
  - Located in the upper posterior wall of the right atrium
  - Automaticity → the ability to generate repeated depolarization

The AV Node and Conduction



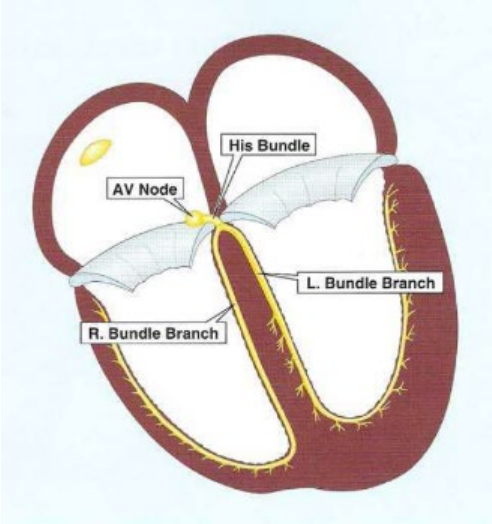
- Depolarization continues down until it hits the **AV valves** (both the tricuspid and mitral)
- The **AV node** sits between the **AV valves** and is the ONLY electrical connection between the atria and the ventricles!
- The **AV valves (tricuspid and mitral)** are also the gatekeepers of blood preventing backflow of blood into the atria during contraction

The AV Node and Conduction



- A pause occurs at the AV node as a result of slowed conduction after atrial depolarization
- This allows for blood to COMPLETELY empty from the atria into the ventricles
- Slowed conduction is a result of Ca++ movement instead of Na+ movement

Beyond the AV Node



- Conduction rapidly then goes through the ventricular conduction system
  - His Bundle →
  - Left and right bundle branches →
  - Terminates at purkinje fibers

Objectives

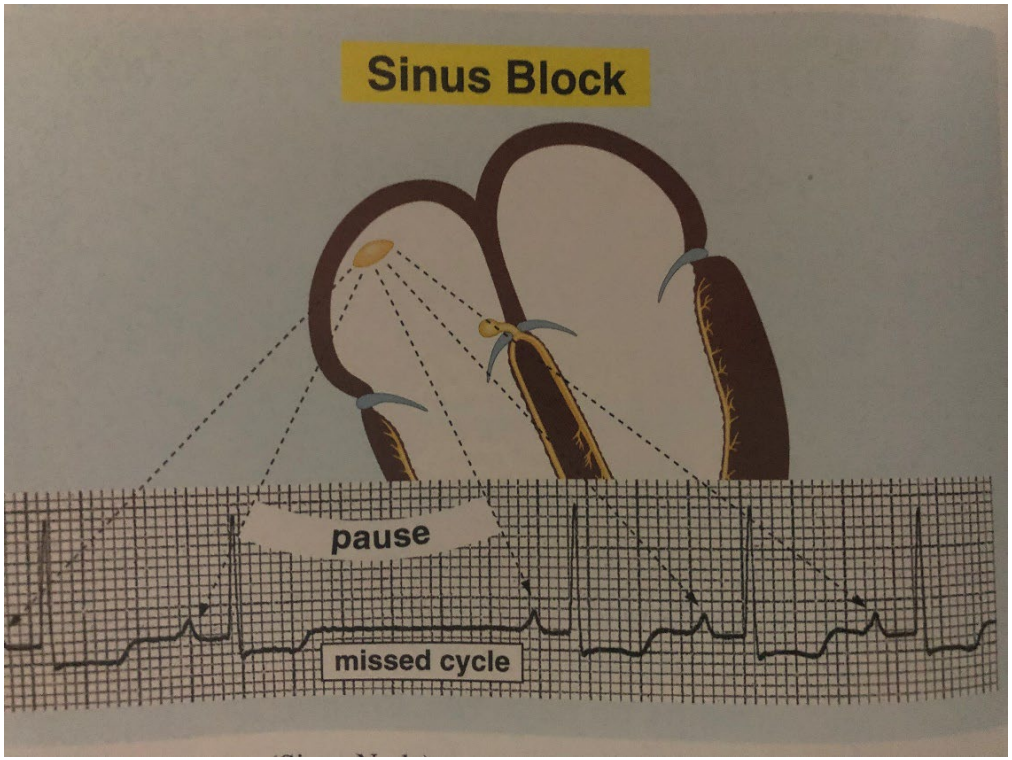
- Review of anatomy and physiology
- Blocks

Types of Blocks

- Sinus blocks
- AV blocks
- Bundle Branch Blocks
- Hemiblocks

Sinus Block

- Sick SA node stops pacing for at least one single cycle
  - Results in escape beat or escape rhythm
    - If an escape beat, then SA node goes back to functioning normally (AKA ONLY one cycle)

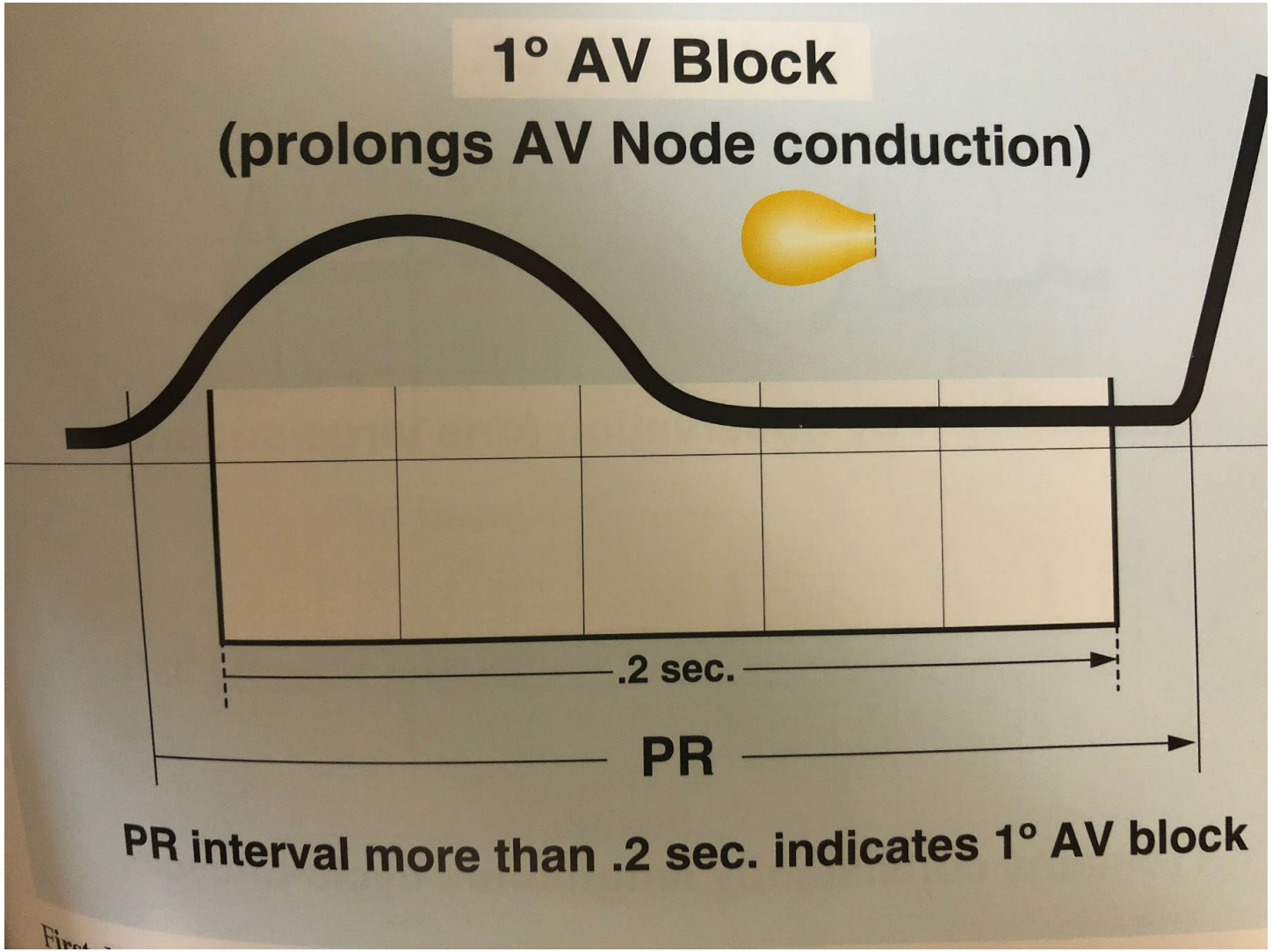


AV Blocks

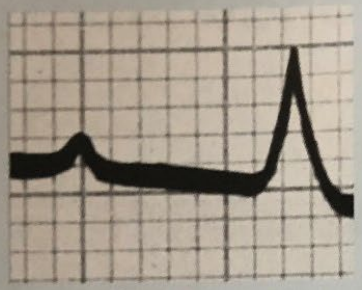
- Three types:
  - First degree
  - Second degree
  - Third degree
- Either limited or eliminated conduction through the AV node
- Any hindrance through the AV node will result in a long PR segment

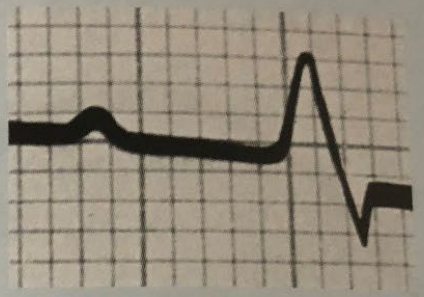
First Degree AV Block

- Slowed conduction through the AV node
- Results in a longer PR interval (NOT PR segment!)
- Remember:
  - Normal PR interval <0.2 seconds (or one BIG box)
- If the PR interval is bigger than a big box, then it's a first degree AV block


1° AV Block
(prolongs AV Node conduction)
.2 sec.
PR
PR interval more than .2 sec. indicates 1° AV block

1° AV Block



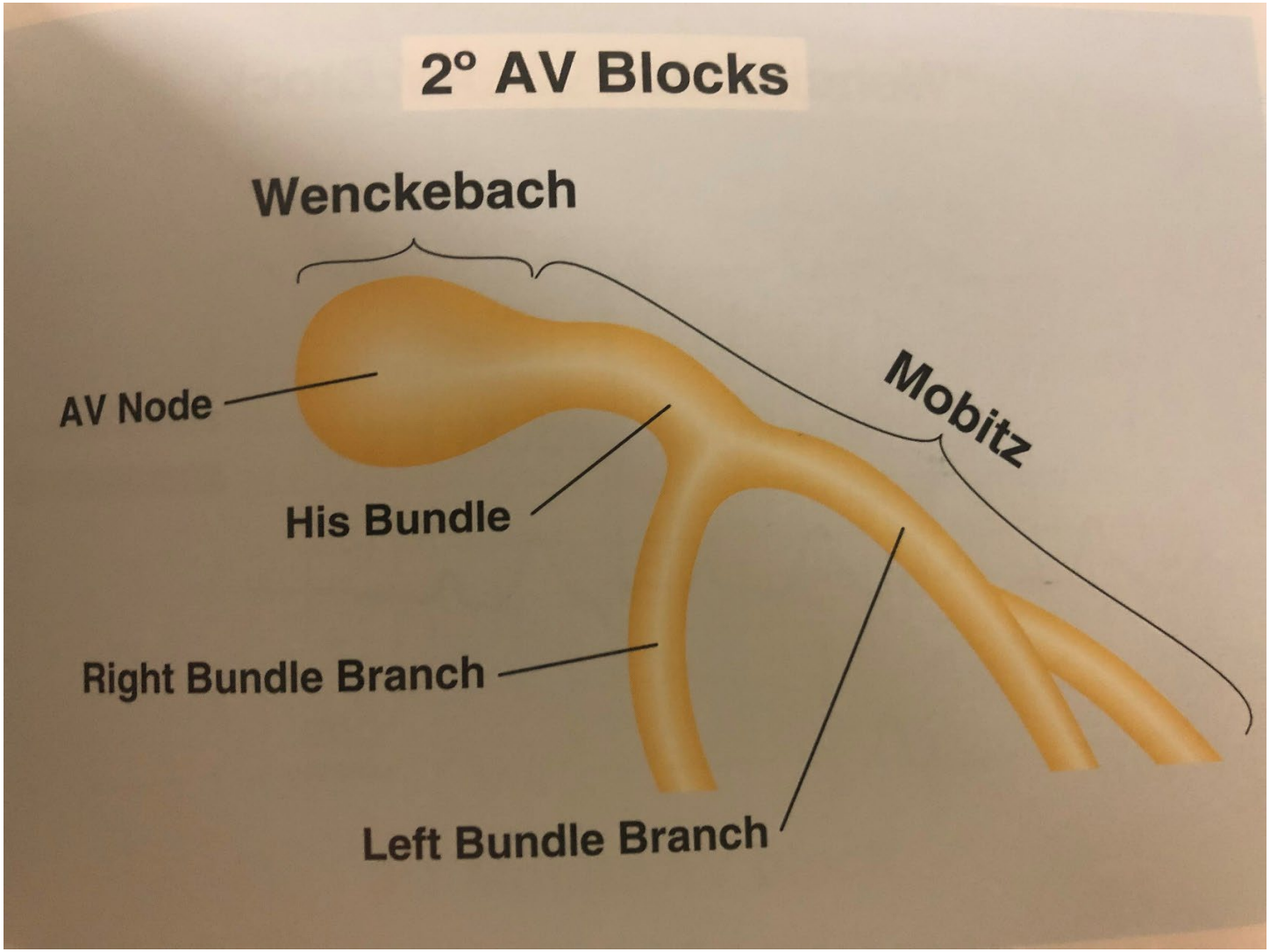


"Measure" PR by observation (one large square).

PR remains consistently lengthened cycle-to-cycle.

Second Degree AV Block

- AV node only transmits some conduction
  - Results in some P waves with no following QRS complex (remember conduction route again!)
- Originates in the AV node and below the AV node
- Two types:
  - Type I (Wenckebach)
  - Type II (Mobitz)


2° AV Blocks
Wenckebach
Mobitz
AV Node
His Bundle
Right Bundle Branch
Left Bundle Branch

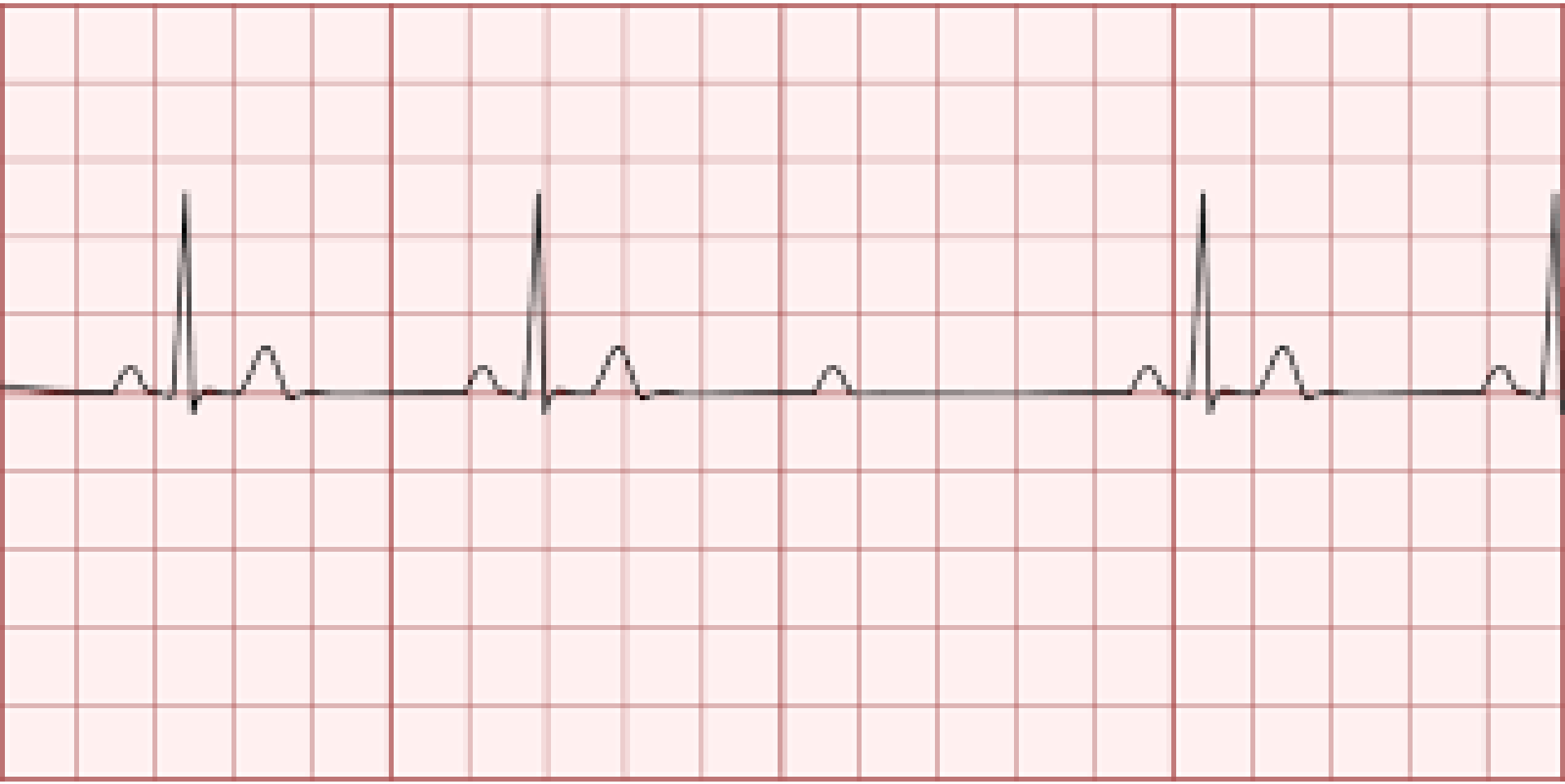
Second Degree Type I (Wenckebach)

- Problem is at the AV node
- Progressively longer PR interval with every cycle
  - “Longer, longer until it drops, now you’ve got a Wenckebach”
- Finally reaches a point when the P wave is not conducted through and results in no ventricular depolarization or QRS (AKA dropped beat)
- Consistent P:QRS ratio throughout
  - For example: 3 beats, then a drop

Second Degree AV Block Mobitz Type I (wenckebach)

Second Degree AV Block (Mobitz)

- Originates **below** the AV node
- Repeated atrial depolarization blocked before finally transmitting a signal to the ventricles
- Typically in a 2:1 or 3:1 block pattern



Third Degree AV Block

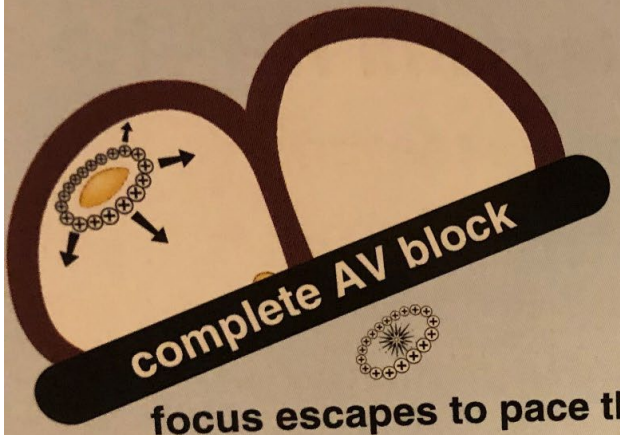
- Complete block between the atria and the ventricle
- Block can be at the AV node, His Bundle, or the Branches
  - Can determine by the QRS and the rate
- SA node still fires but a ventricular escape rhythm exists

Third Degree AV Block

- Essentially, the atria are working separately than the ventricles and both functioning without knowing what the other is doing

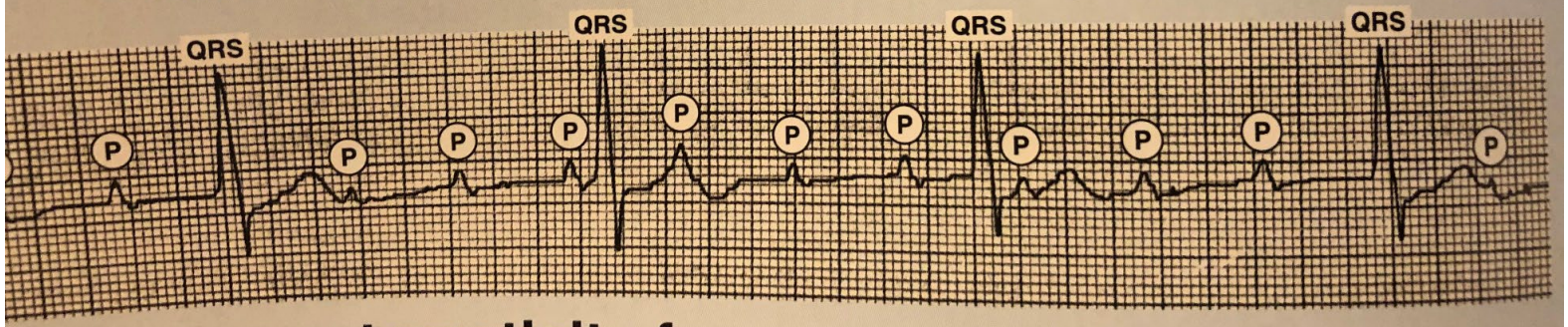
- Stokes-Adams Syndrome: syncope with a Third Degree AV Block

Complete (3°) AV Block



When the conduction of supraventricular depolarizations to the ventricles is totally blocked...

focus escapes to pace the ventricles

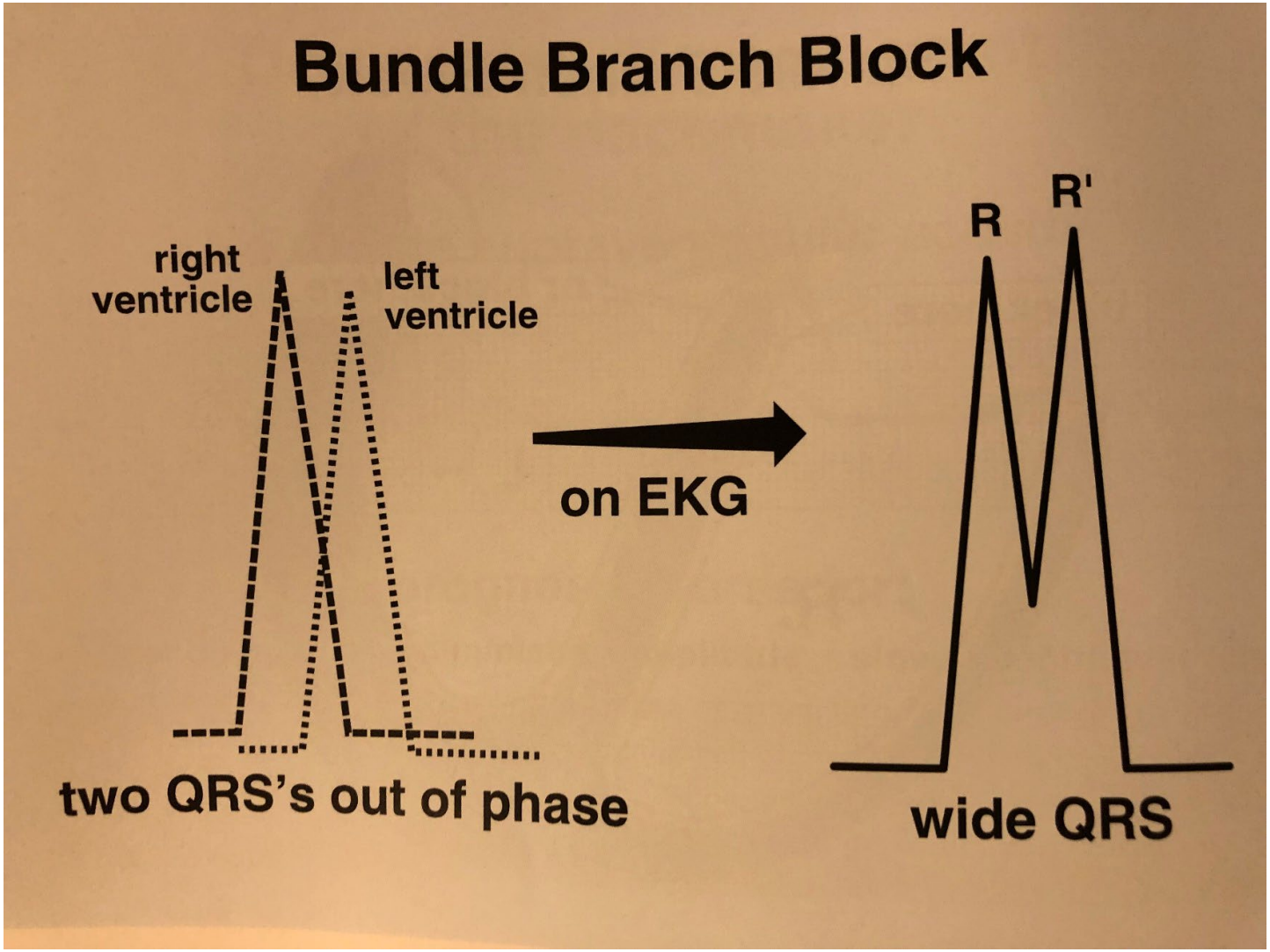


an automaticity focus escapes to pace the ventricles at its inherent rate.

Bundle Branch Block

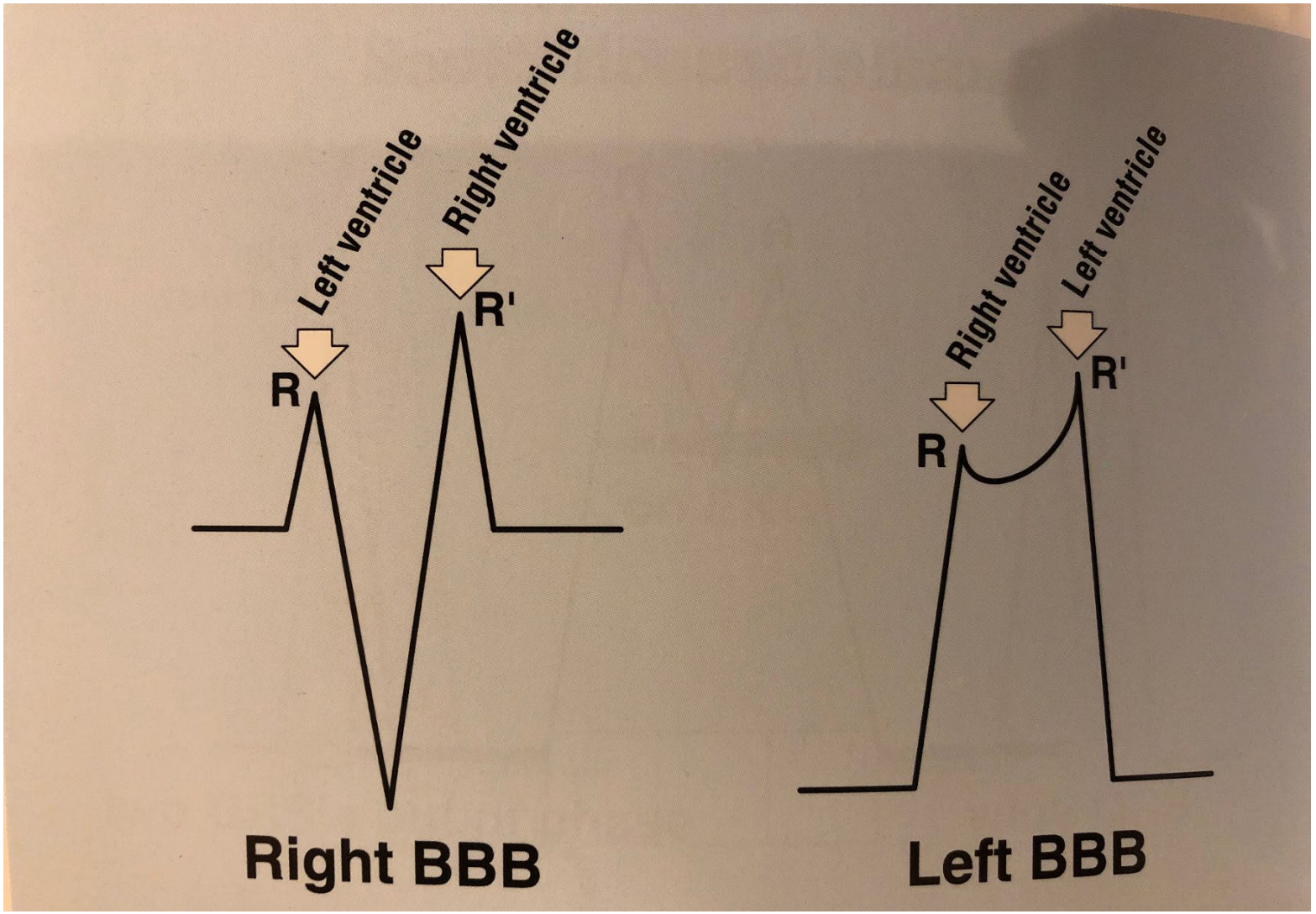
- Normally, depolarization between the ventricles should happen simultaneously
- Ventricular depolarization=QRS complex (remember?)
- With a BBB, one depolarizes later than the other
  - Result?
    - Two QRS complexes represented in one HUGE QRS complex
  - The second upward deflection is an R’

Bundle Branch Block

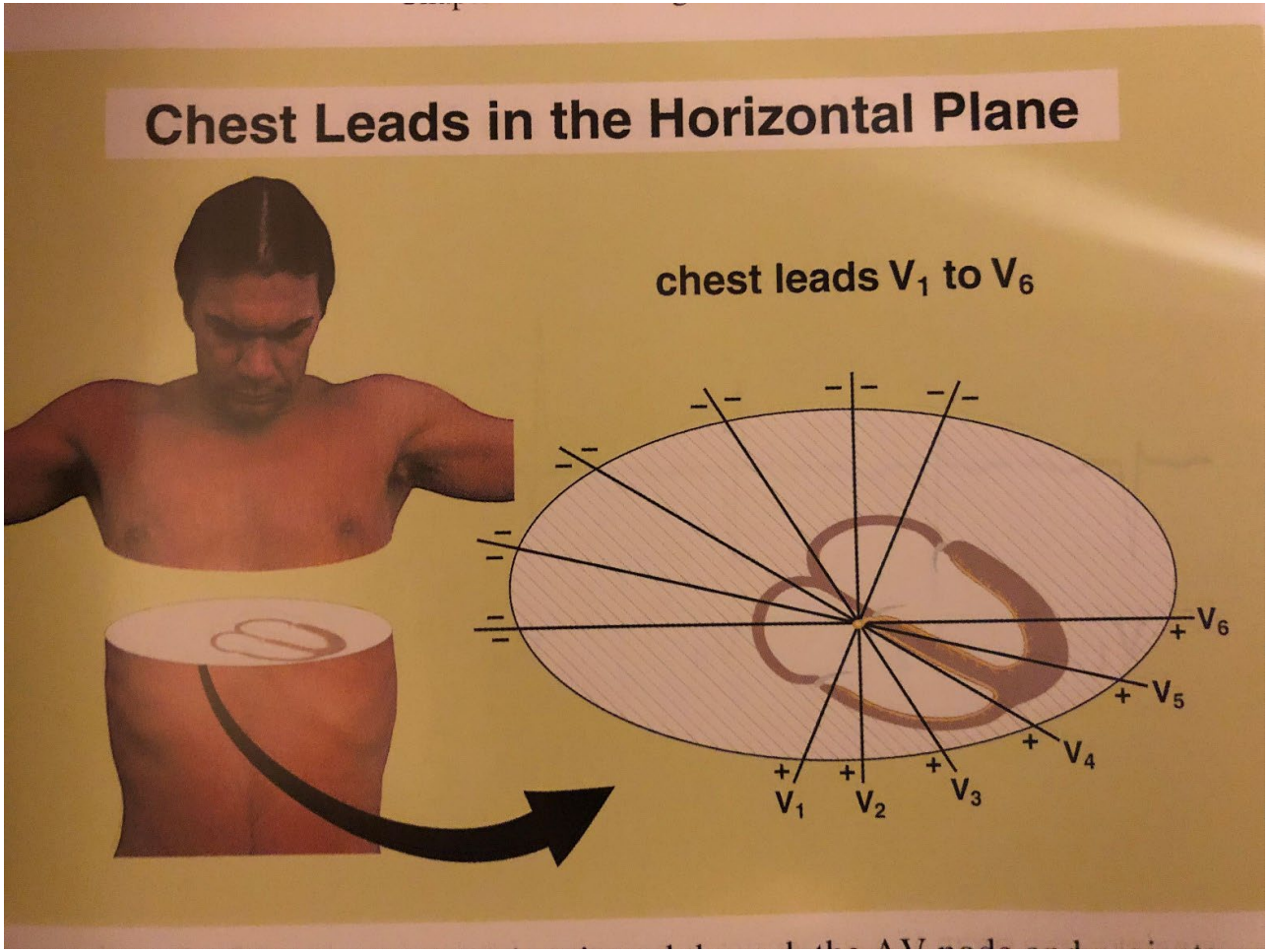


Bundle Branch Block

- Normal QRS is <0.12 seconds
- A BBB has a QRS >0.12 seconds (or 3 small boxes)
- Two types
  - Right BBB
    - LEFT ventricle depolarizes first, then the RIGHT
  - Left BBB
    - RIGHT ventricle depolarizes first, then the LEFT

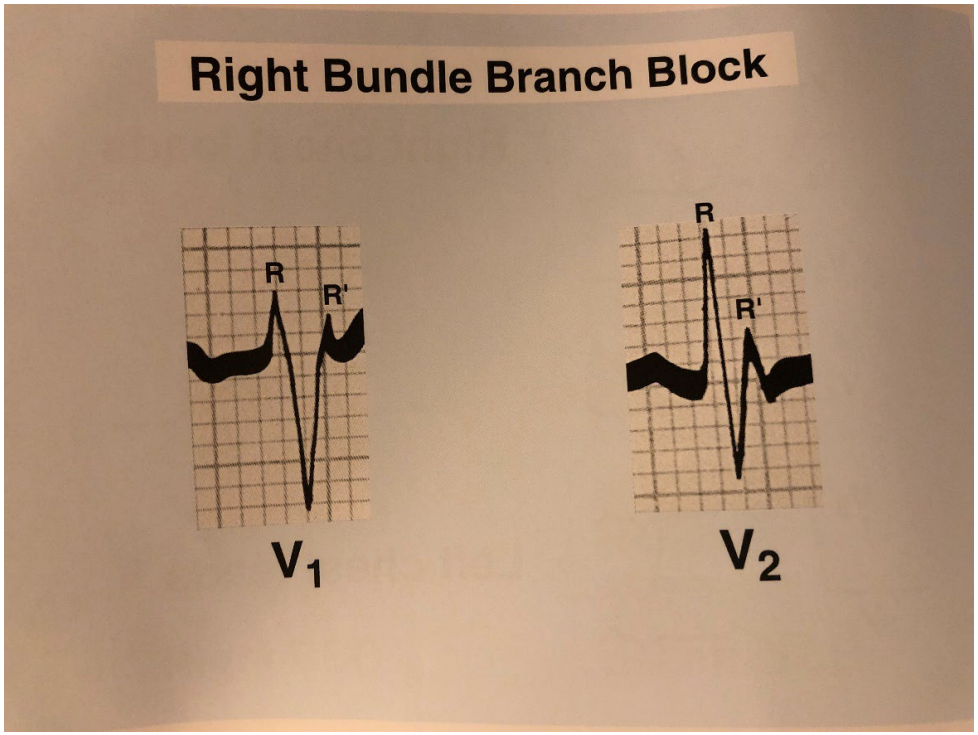

Left ventricle
Right ventricle
R
R'
Right BBB
Right ventricle
Left ventricle
R
R'
Left BBB

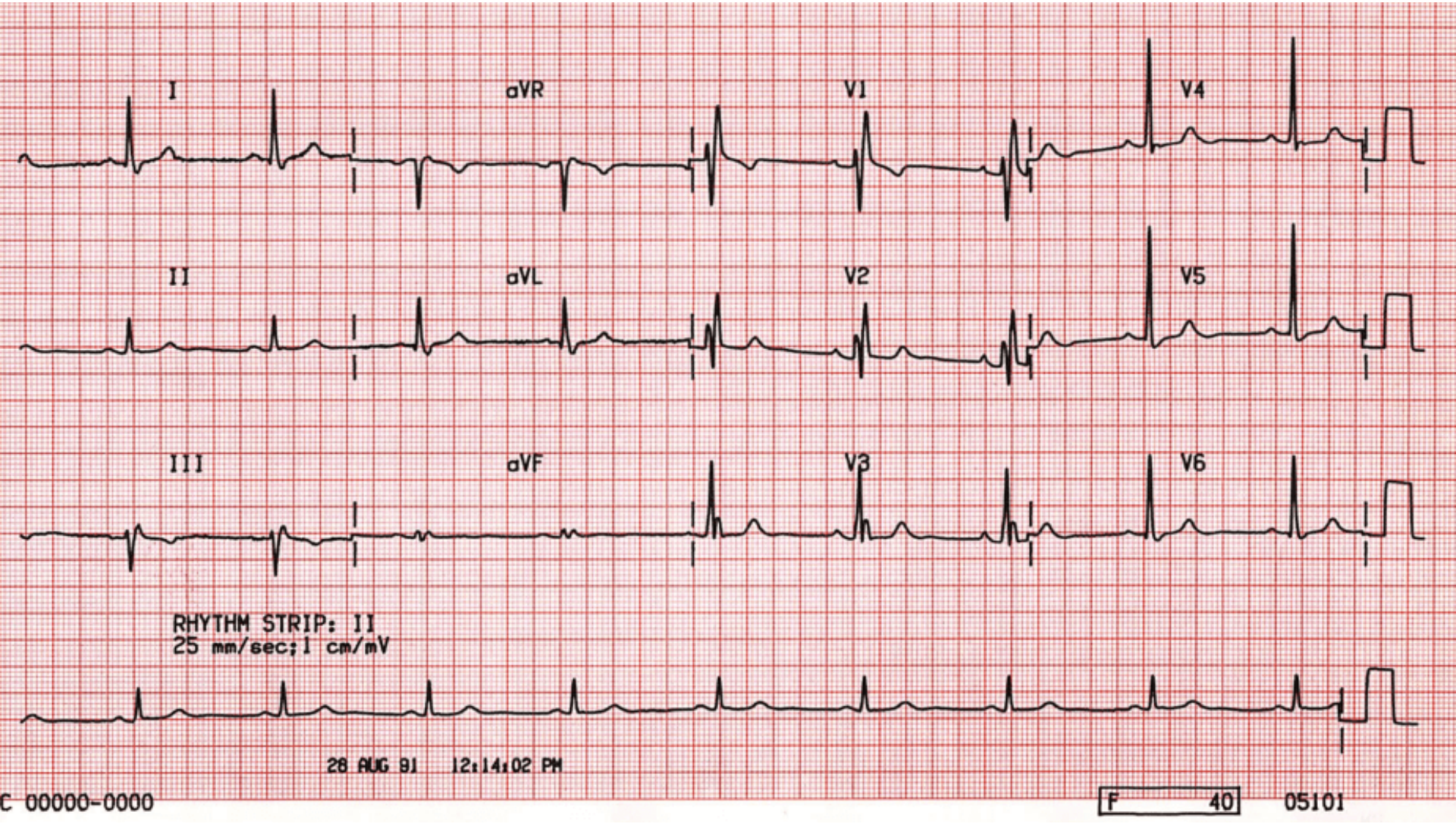
Remember…


Chest Leads in the Horizontal Plane
chest leads V1 to V6
V1
V2
V3
V4
V5
V6

Right Bundle Branch Block

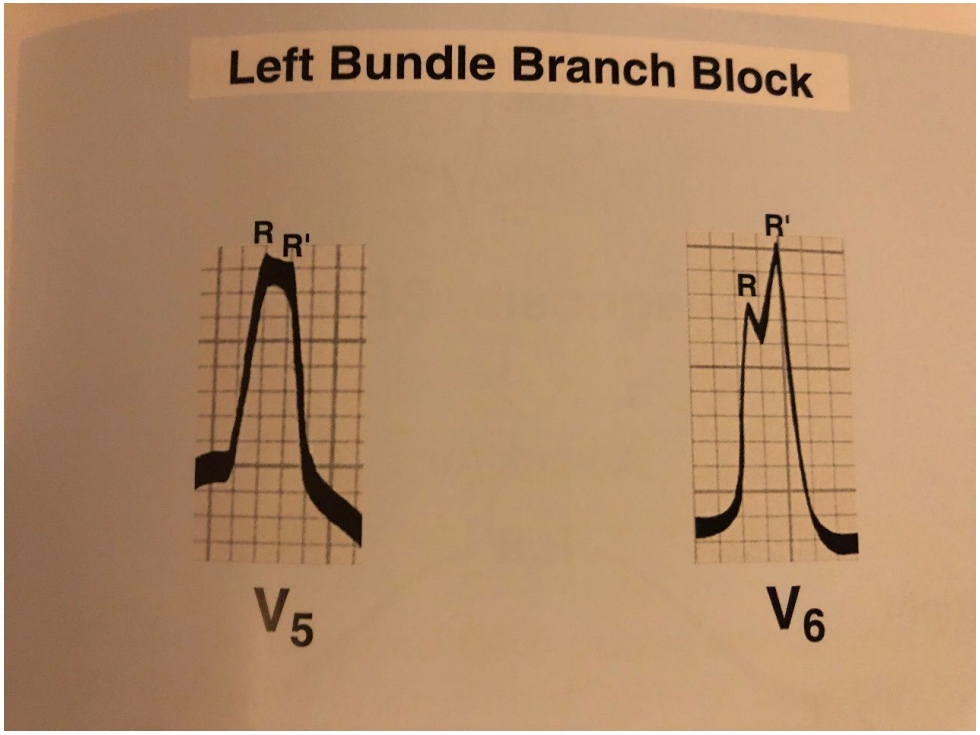
- You see RBBB in the right sided leads V1 and V2
- RR’ QRS has “rabbit ears” appearance (RaBBit)

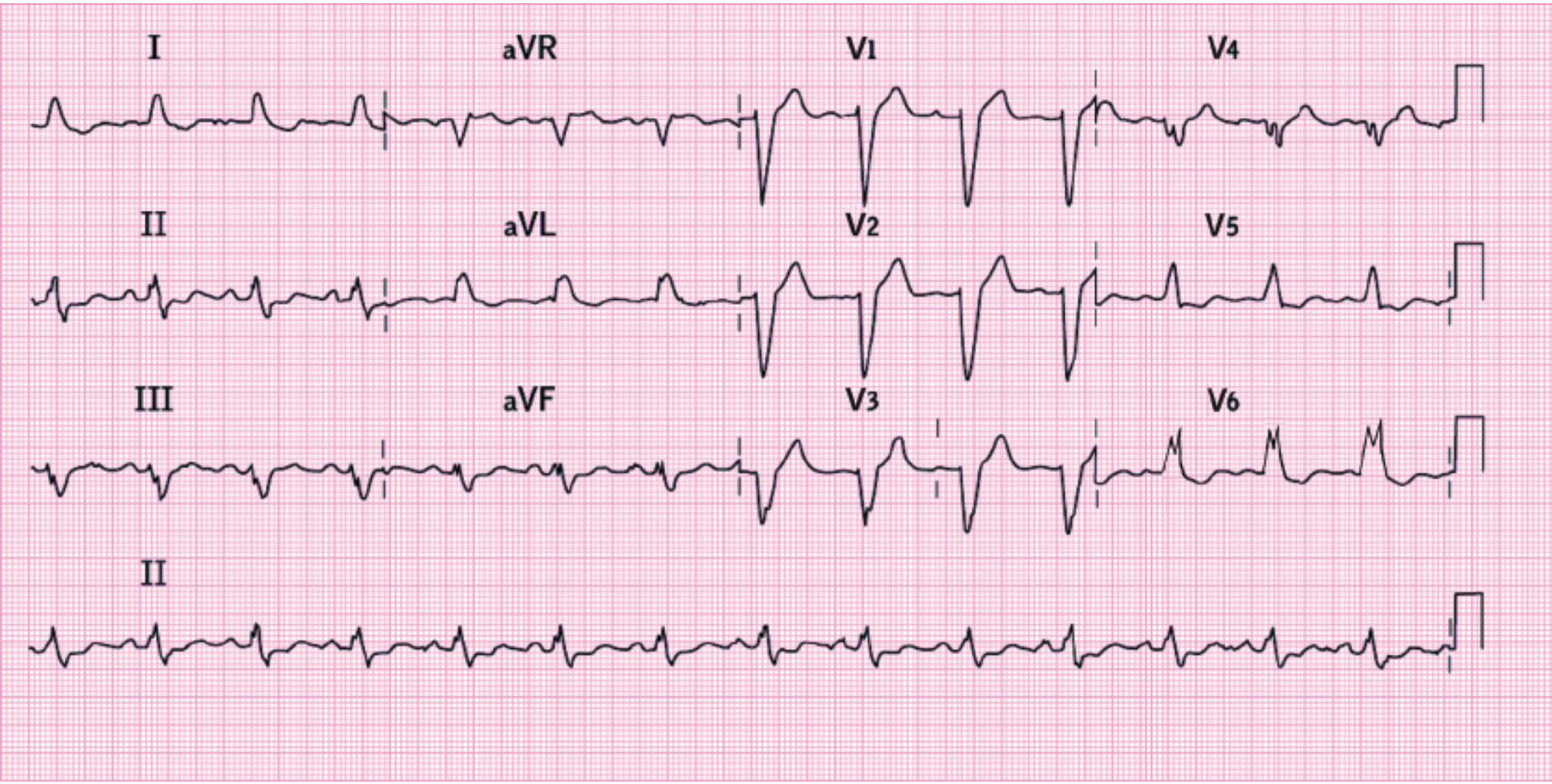



I
aVR
V1
V4
II
aVL
V2
V5
III
aVF
V3
V6
RHYTHM STRIP: II
25 mm/sec; 1 cm/mV
28 AUG 91 12:14:02 PM
C 00000-0000
F 40
05101

Left Bundle Branch Block

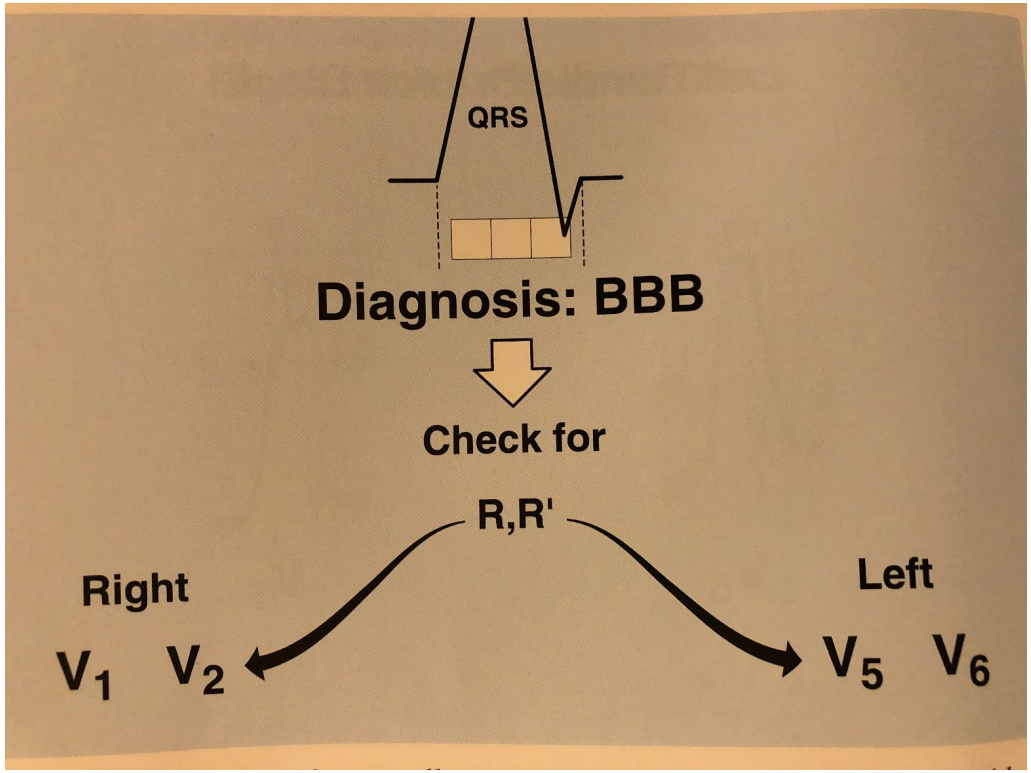
- Will see LBBB on the left sided leads V5 and V6
- May have an RR’ or a more monolithic appearance



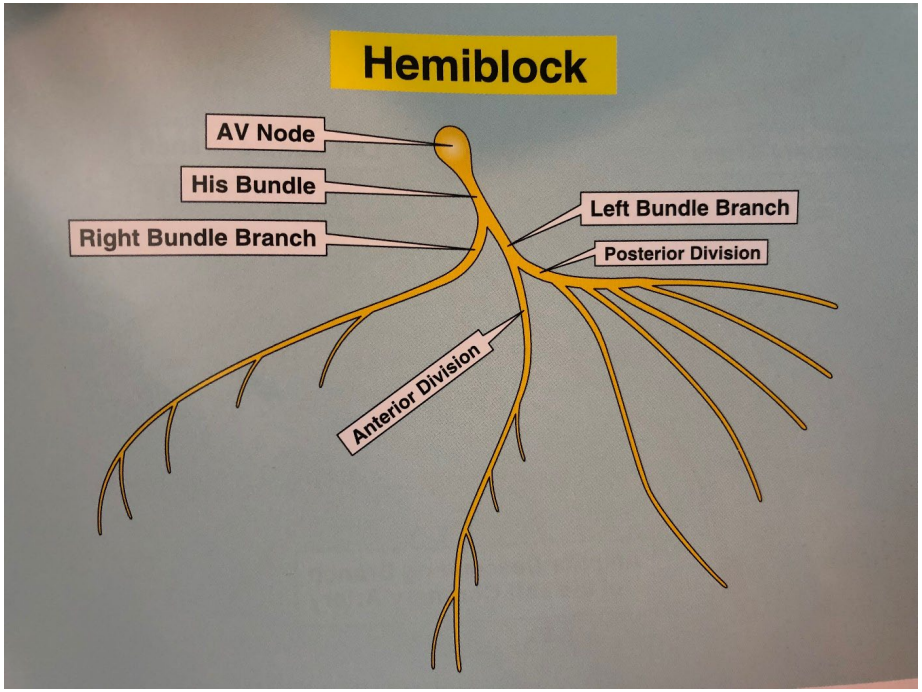

I
aVR
V1
V4
II
aVL
V2
V5
III
aVF
V3
V6
II

Practice Practice Practice

- Look for patterns
  - When looking at the EKG:
    - Is the QRS widened?
      - RR’ in V1 and V2? RBBB
      - RR’ in V5 and V6? LBBB



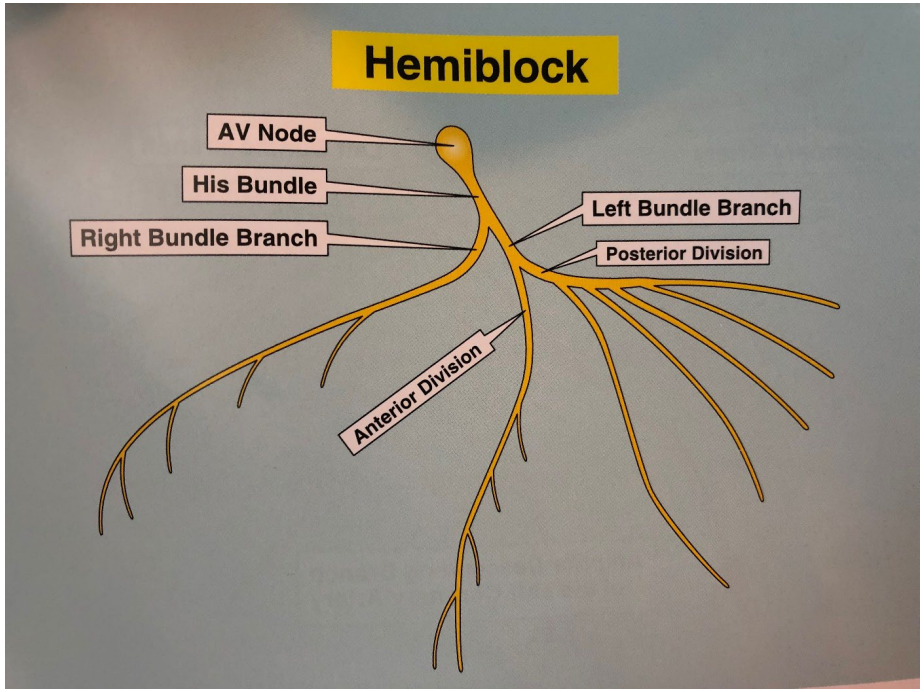
The Left Bundle Branch… a Review



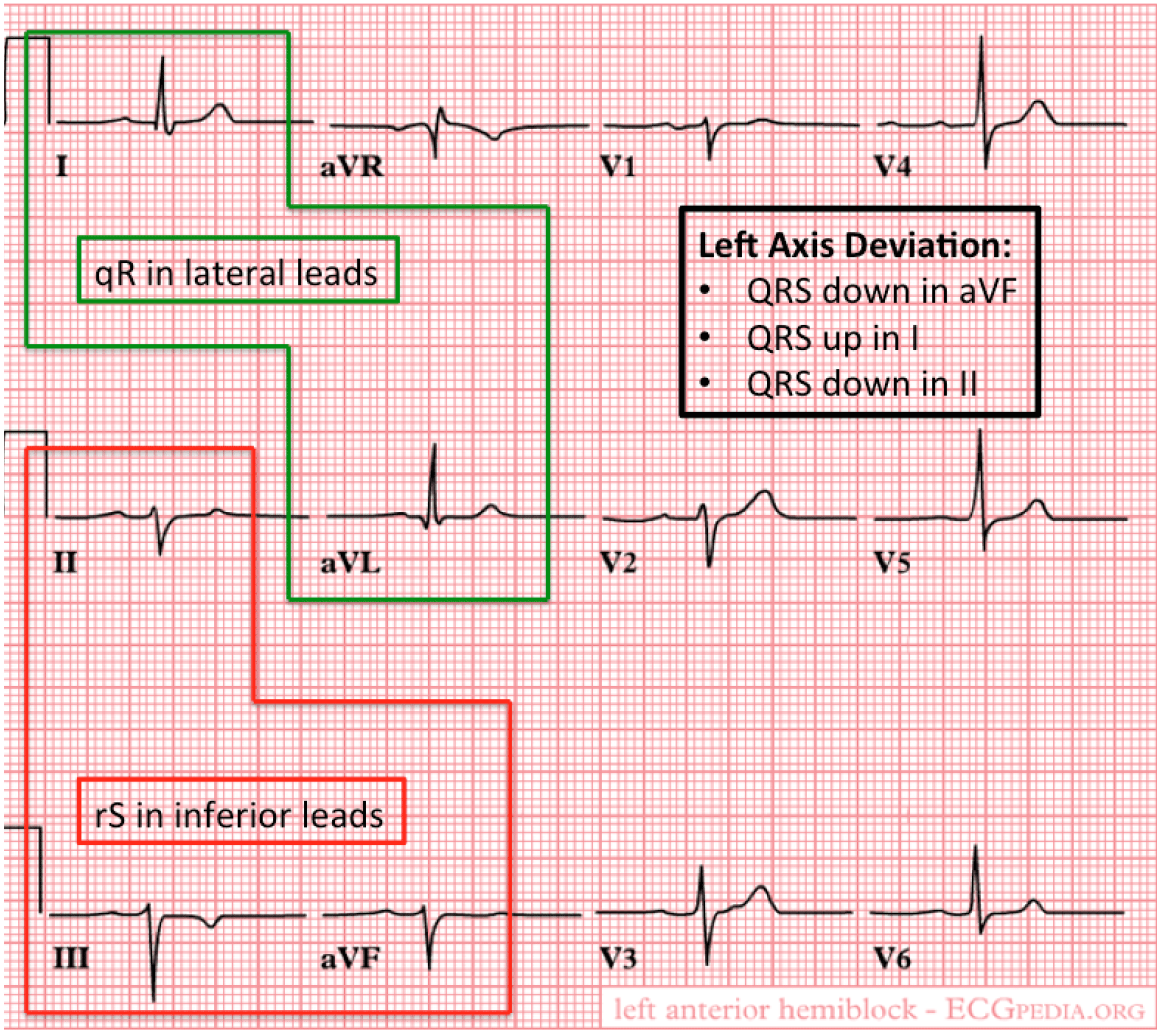
- Divides again after the His Bundle splits into the right and left bundle branches
- This creates an anterior fascicular branch and a posterior fascicular branch
- These two branches depolarize in opposite directions
  - Depolarization should occur at the same time

Depolarization of Anterior and Posterior Fascicles

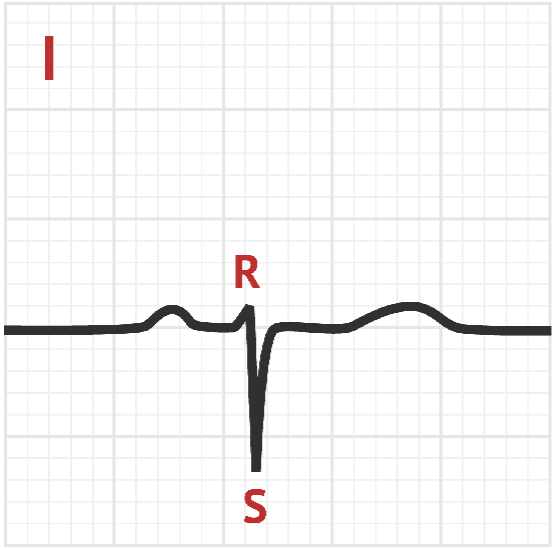
- Left Posterior Fascicle depolarizes posteriorly and inferiorly
- Left Anterior Fascicle depolarizes anteriorly and superiorly

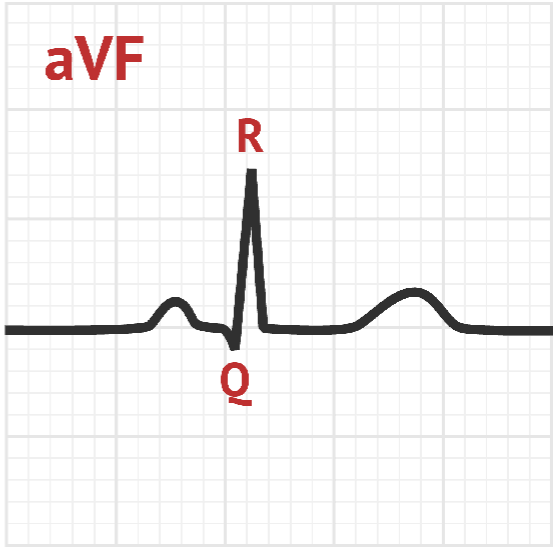


Left Anterior Fascicular Block



Left Posterior Fascicular Block





Okay, Let's Simplify

Left Anterior Fascicular Block (lead I)

Small r with deep S (rS) in inferior leads (aka II, III, aVF)

Small q with tall R (qR) in I and aVL

Left Posterior Fascicular Block (aVF)

Small r with deep S (rS) in I and aVL

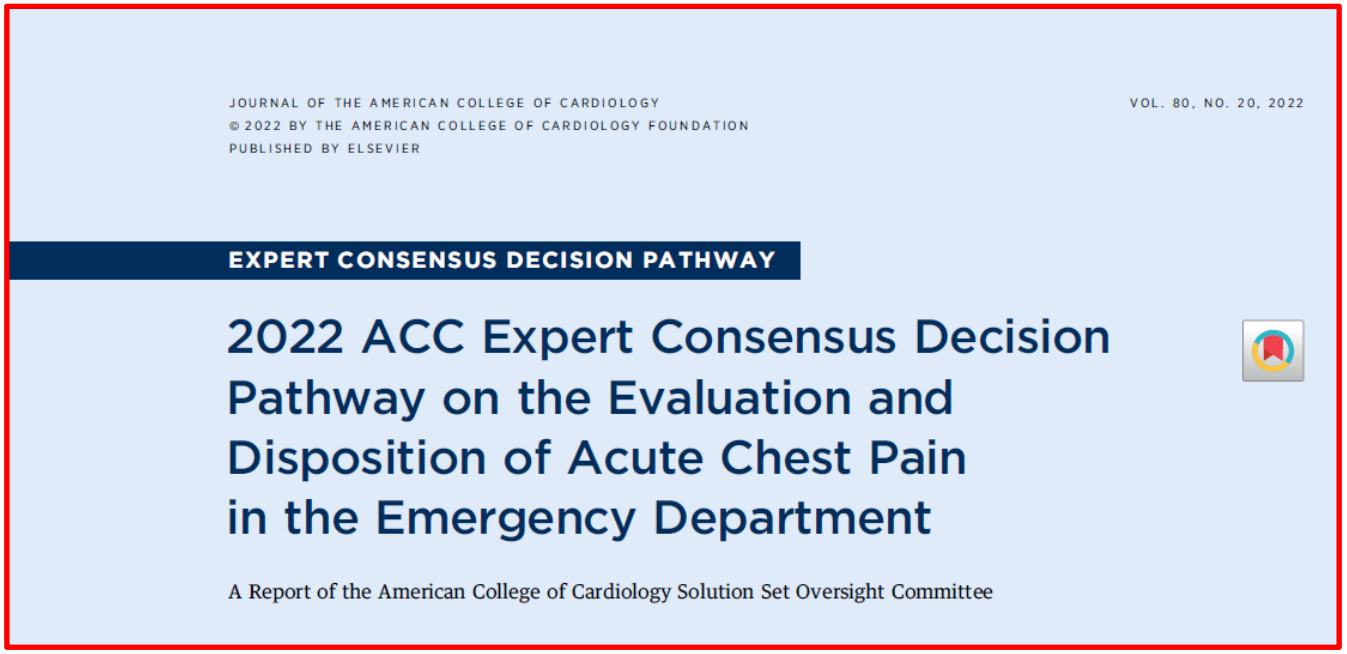
Small q with tall R in inferior leads (aka II, III, aVF)

In the end, best to recognize flipped QRS in these groupings, look up the meaning, and then look for accompanying right bundle branch block – "bifascicular block"

Objectives

- Review of anatomy and physiology
- Blocks
- Ischemia / injury / infarction

2022 Chest Pain Pathway for the ED



JOURNAL OF THE AMERICAN COLLEGE OF CARDIOLOGY
VOL. 80, NO. 20, 2022

PUBLISHED BY ELSEVIER

EXPERT CONSENSUS DECISION PATHWAY

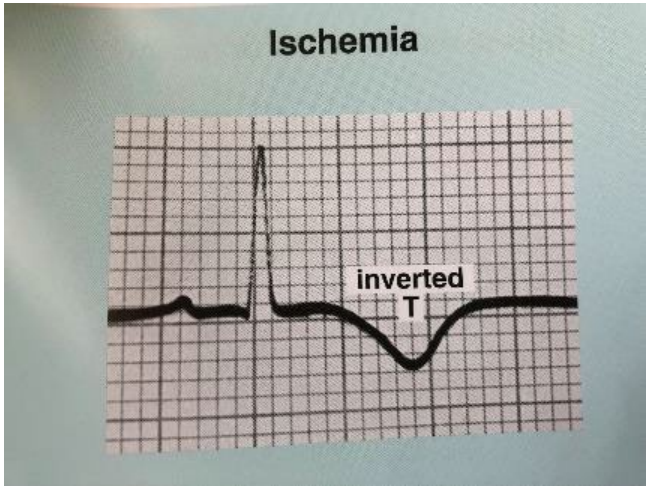
2022 ACC Expert Consensus Decision Pathway on the Evaluation and Disposition of Acute Chest Pain in the Emergency Department

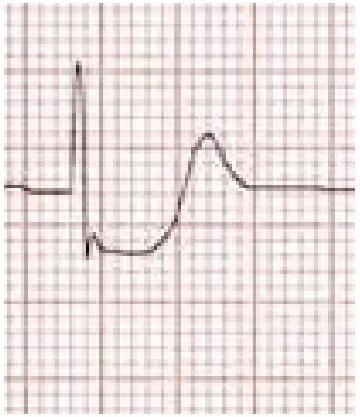
A Report of the American College of Cardiology Solution Set Oversight Committee

https://doi.org/10.1016/j.jacc.2022.08.750

Understand the Terminology

- Ischemia: insufficient myocardial perfusion
  - Reversible and represented by T wave changes and often by ST depression
- Injury: elevation of cardiac troponin, often from inadequate perfusion





Injury

- Usually a result of thrombus formation from a dislodged piece of plaque

- EKG can show hyperacute T waves
  - Peak within 30 minutes
  - Height of the T waves correlates with acuteness of injury
  - However, height is not as important as width and size relative to QRS complex

- No cellular death YET!

A Normal T-waves

Normal T wave
Smooth transition from ST-segment to T wave. T wave is slightly asymmetric with a steeper downslope.

Normal variant
Large, asymmetric T wave with broad base. Often in conjunction with slight J point elevation in leads V2-V4.

B Large T-waves

Hyperkalemia
Large, symmetric, pointed with short base.

Hyperacute T wave
can be seen in transmural ischemia. High, broad based, symmetric, not pointed. Almost always seen in conjunction with ST-segment elevation.

Injury

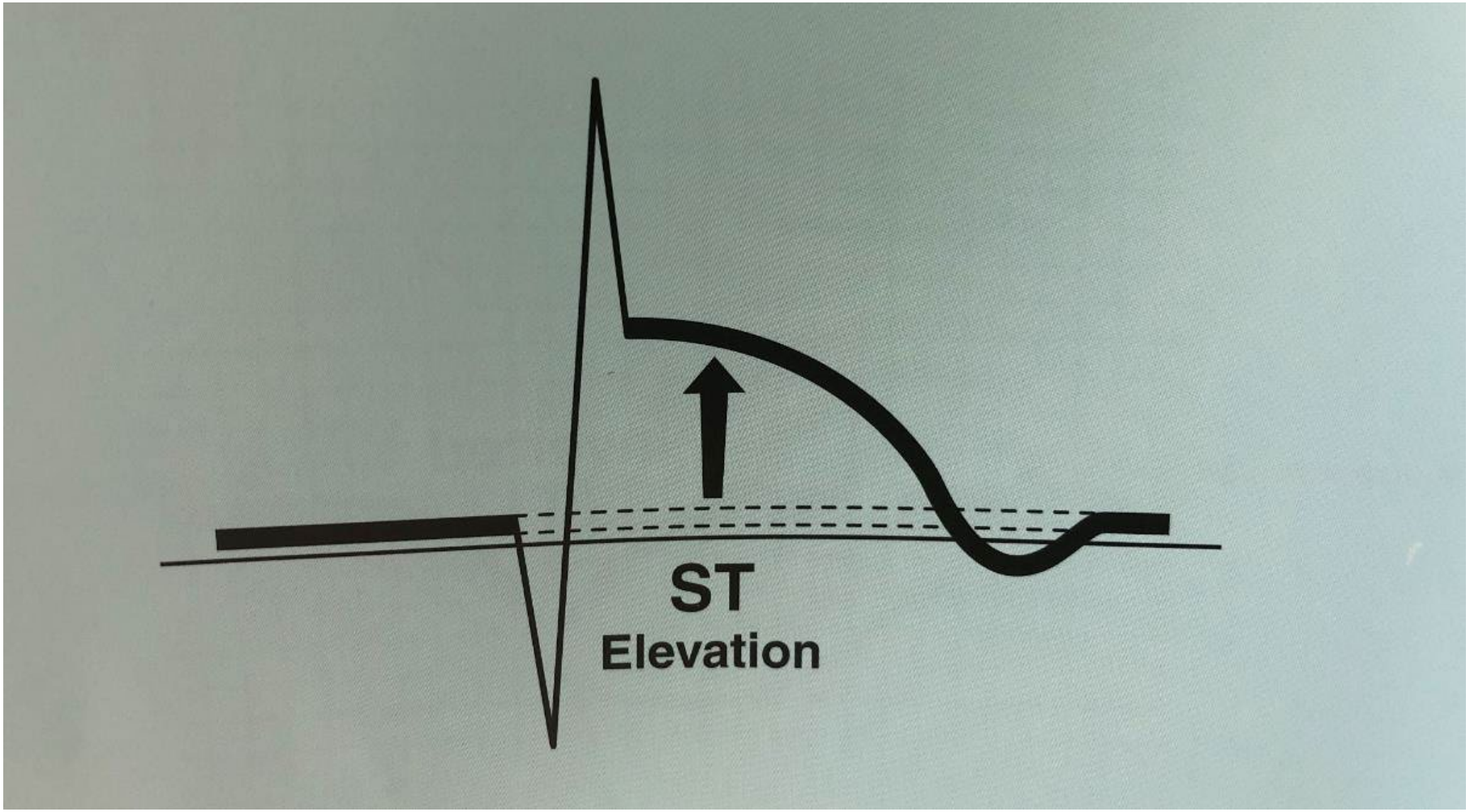
- As occlusion lasts longer, T waves remain hyperacute and the ST segment deviates

- ST segment elevation
  - Represents myocardium at risk for irreversible infarction
  - Also called the current of injury

- STEMI
  - ST segment elevation of at least 1 mm in 2 or more contiguous leads

ST Segment

- Ischemia changes ion movement and cell ion permeability
- Subendocardial ischemia
  - ST segment axis shifts AWAY from the affected ventricle
  - Ischemia then is represented with ST segment depression
- Transmural ischemia
  - ST segment axis shifts towards the affected area
  - Transmural ischemia then is represented by ST segment elevation


ST
Elevation

ST Segment Elevation Criteria

- STEMI
  - >1 mm elevation in 2 or more contiguous limb leads or V4-V6
  - >2mm elevation in 2 or more precordial leads V1-V3
  - >1mm **depression** in 2 or more precordial leads V1-V3 (posterior MI)
- Shape of the ST segment will change from concave to convex
- ST segment will normalize in 12-72 hours

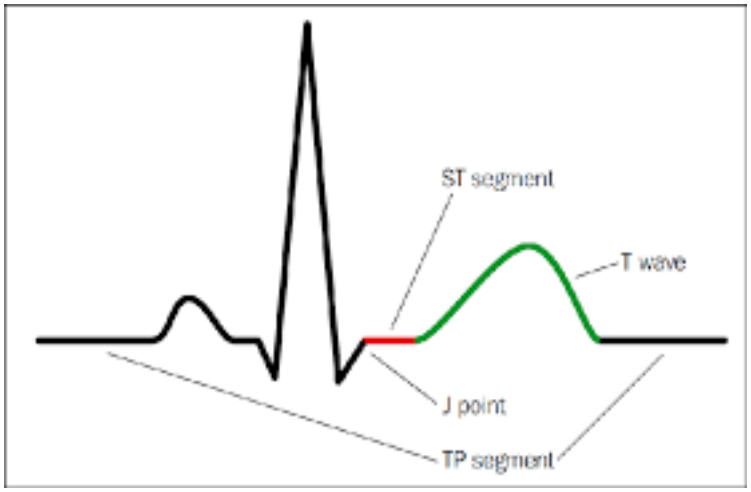
Caveat to ST Segment Elevation

- There are other causes other than STEMI!
  - Benign early repolarization
  - Pericarditis
  - Left ventricular aneurysm
  - Printzmetal's Angina
  - Bundle branch blocks

Let's look at the J point to understand some of these better

The J Point

- The J point is the transition from the QRS to the ST segment
- Compare it to the TP segment in order to look for deviation
- In acute MI, looking for a severe angle

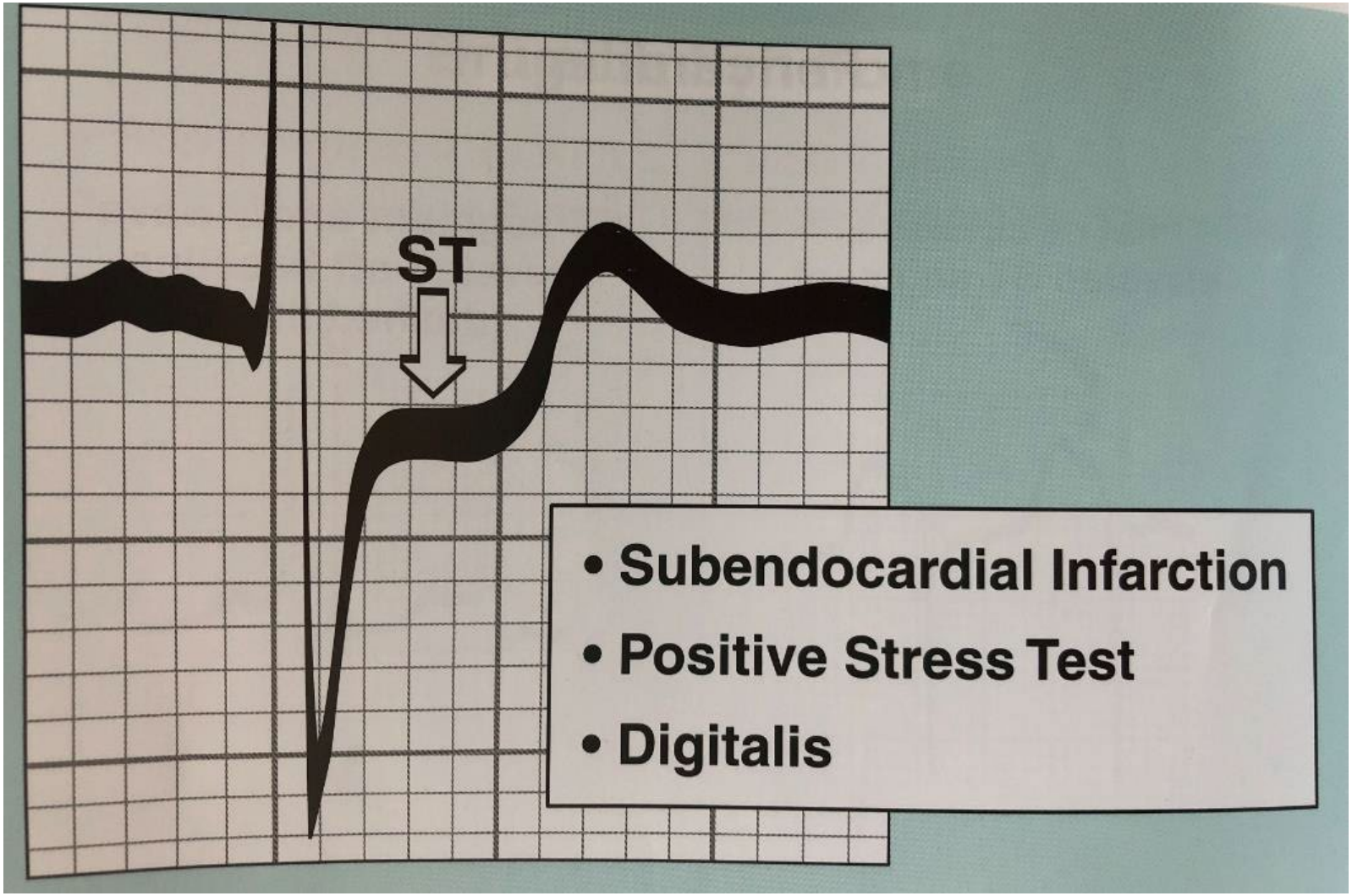


ST Segment Depression

- Causes
  - Posterior STEMI
  - Reciprocal changes in STEMI
  - NSTEMI/unstable angina
  - Subendocardial ischemia

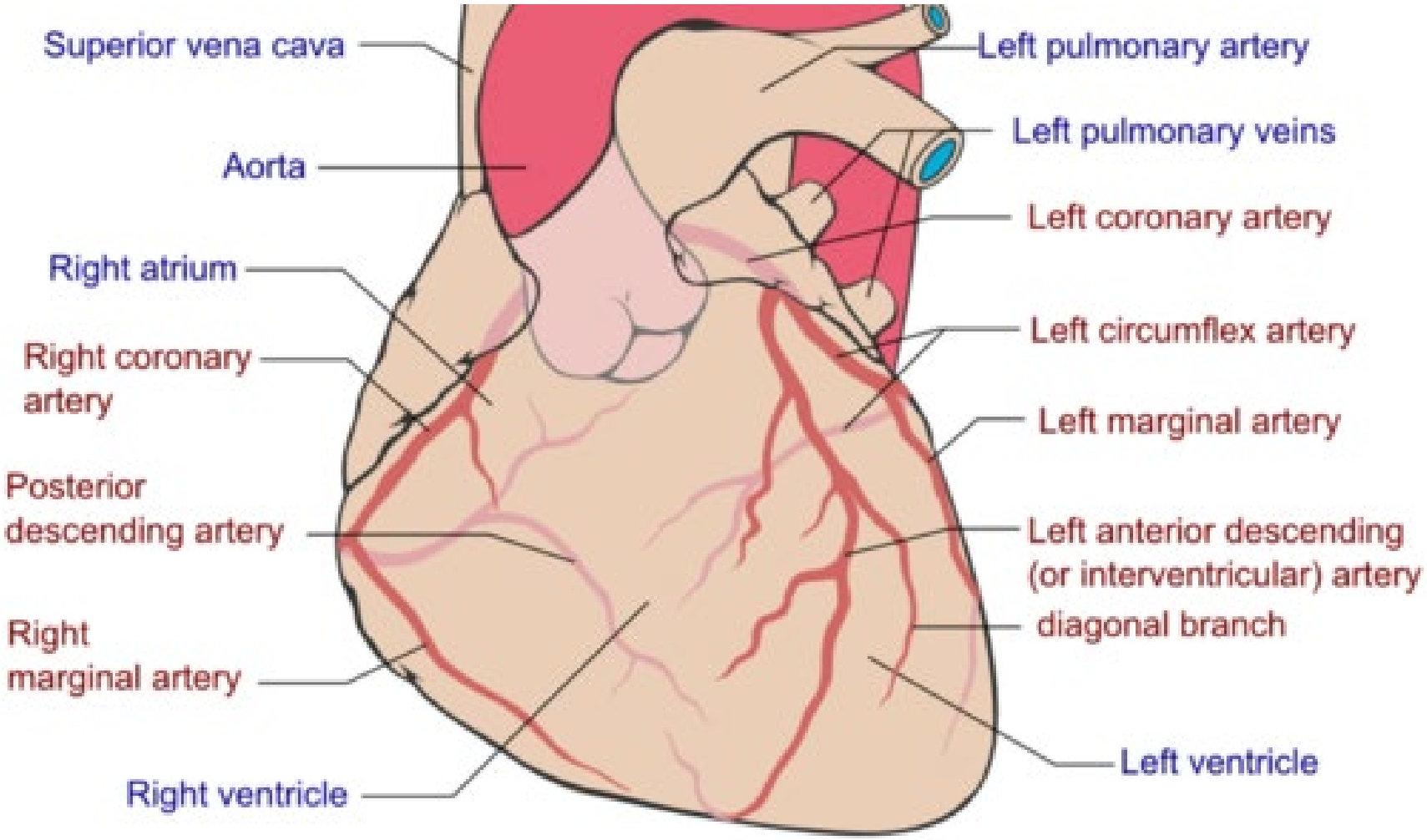
- If you see ST segment depression of 2+ mm in 3 or more leads, there is a high probability of elevated cardiac enzymes

- Reciprocal changes improves the likelihood of STEMI


ST
• Subendocardial Infarction
• Positive Stress Test
• Digitalis

Another Quick Review of Coronary Anatomy

- Left and right coronary arteries arise from the aorta
- LCA divides into the circumflex and anterior descending
- RCA divides into the marginal and posterior descending


Superior vena cava
Aorta
Right atrium
Right coronary artery
Posterior descending artery
Right marginal artery
Right ventricle
Left pulmonary artery
Left pulmonary veins
Left coronary artery
Left circumflex artery
Left marginal artery
Left anterior descending (or interventricular) artery
diagonal branch
Left ventricle

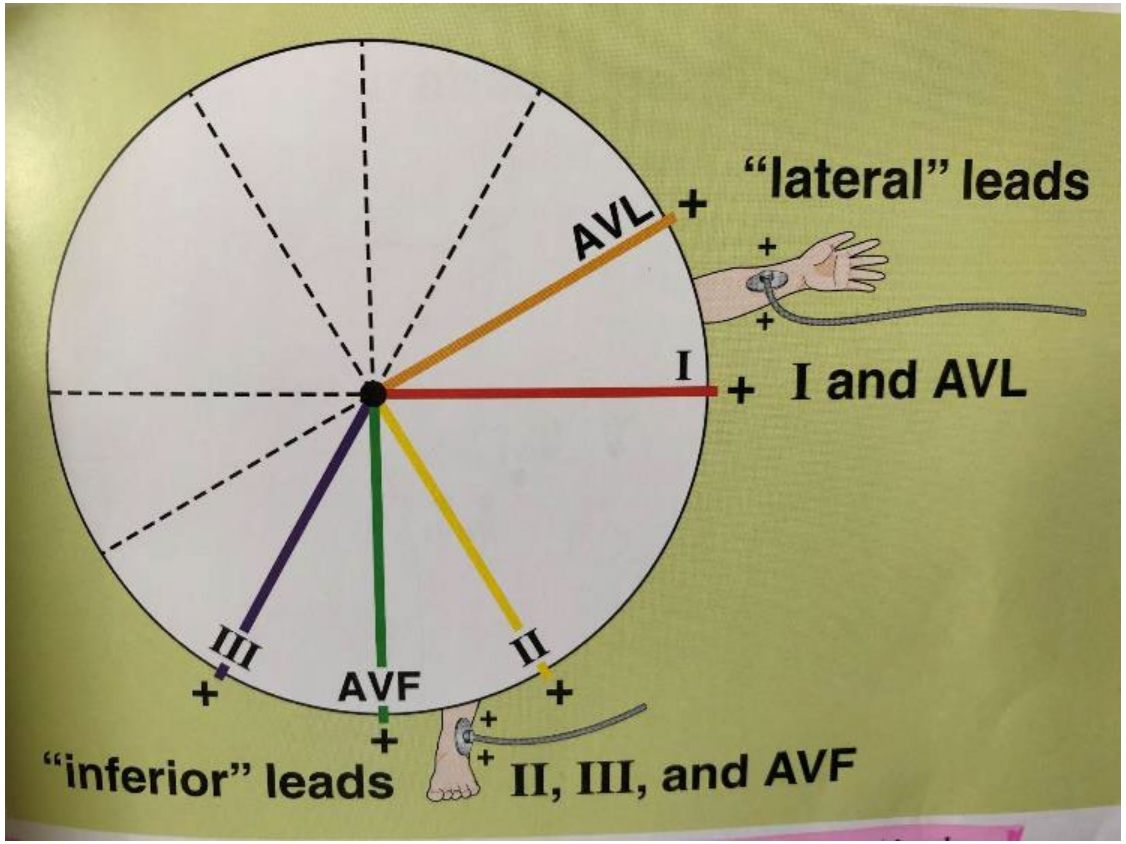
Coronary Circulation

- RCA supplies the SA node, AV node, and His Bundle
- LAD supplies the anterior and septal region of the left ventricle and the septum
- Left circumflex supplies the lateral wall of the left ventricle and left atria
- RCA supplies the right ventricle and posterior left ventricle

Put It All Together

- Now we've reviewed what leads represent the various areas of the heart and what vessels supply which areas of the heart
- We also know what to look for on EKG for ischemia and injury
- Let's look at the different types of MI!

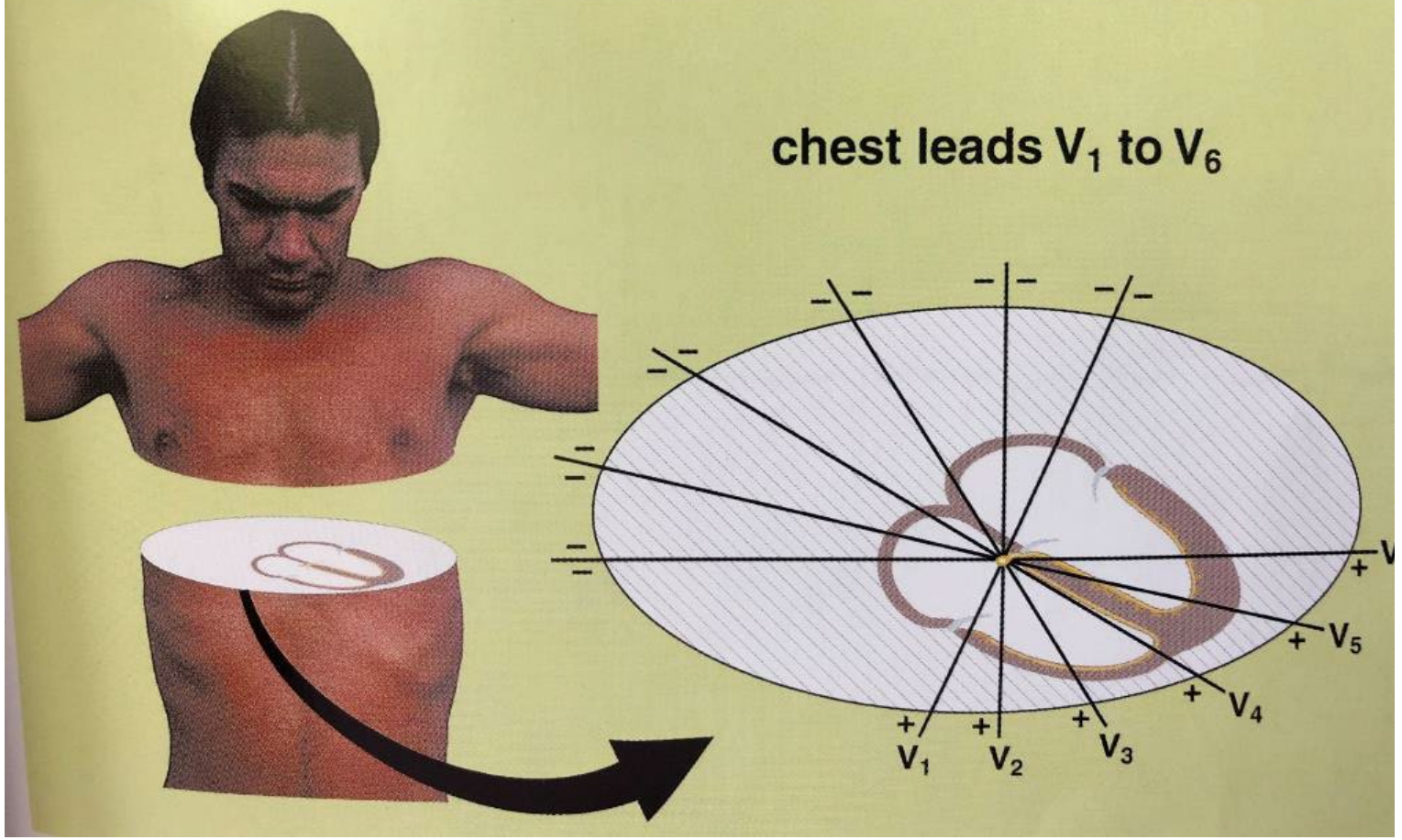
Let's Go Back



Lateral leads: I and aVL

Inferior Leads: II, III, aVF

Chest Leads in the Horizontal Plane



Types of MI

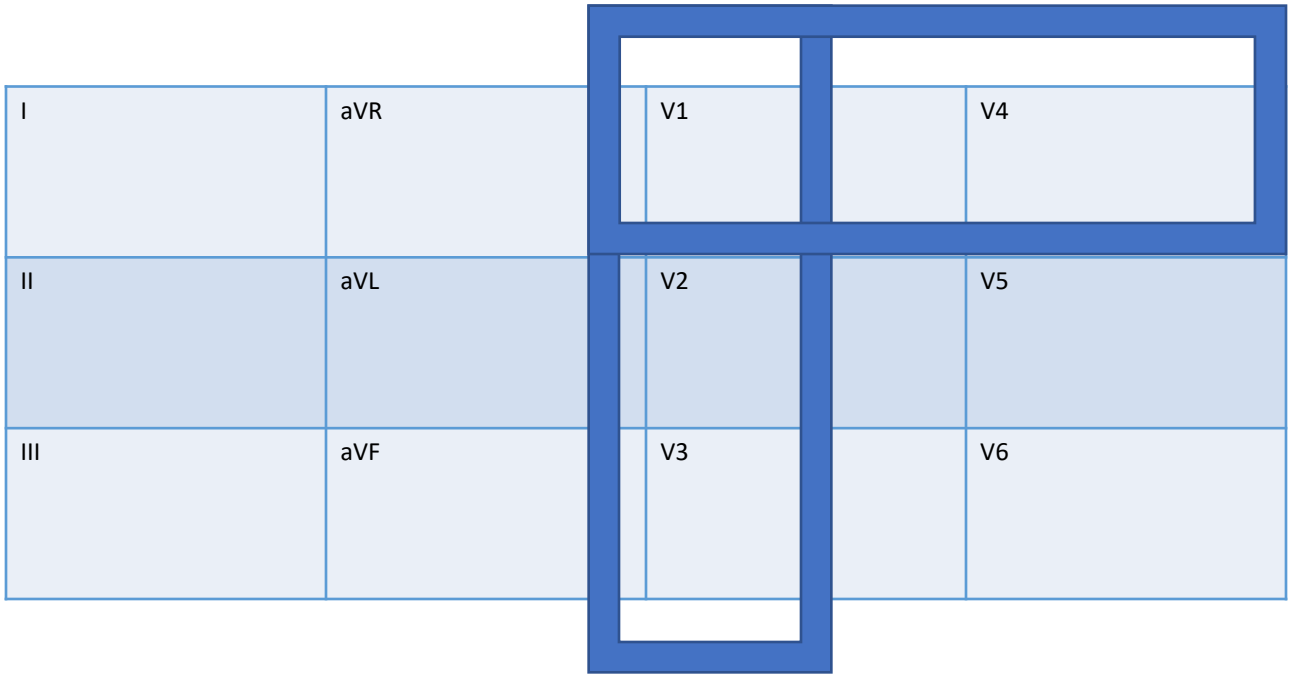
- Anterior
- Lateral
- Inferior
- Posterior
- Right ventricular

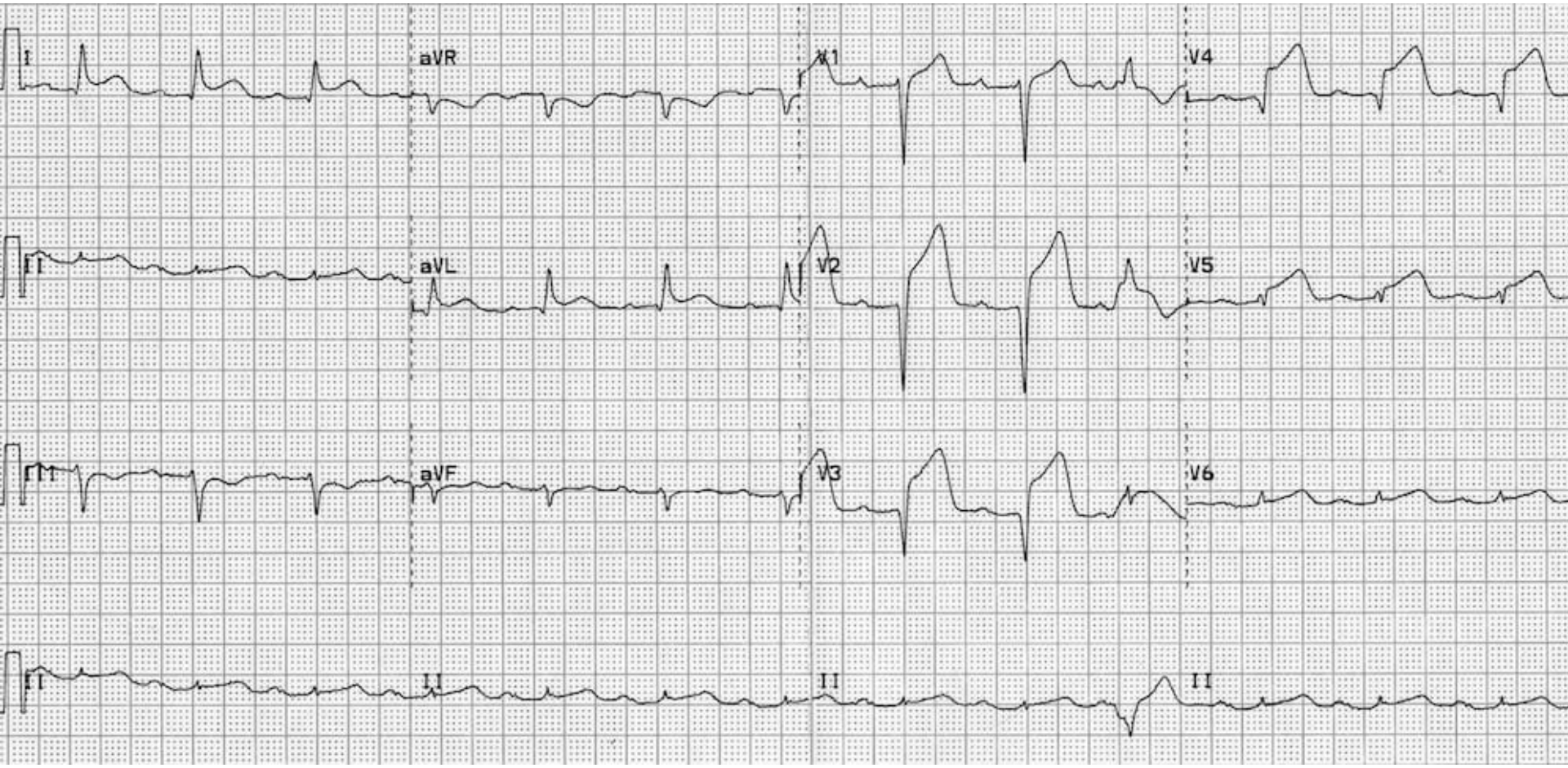
Summary

Coronary Artery	EKG Location	MI Term
Left anterior descending	V1-V4	Anterior
Left circumflex	I, aVL, V5-V6	Lateral
Right coronary	II, III, aVF	Inferior
Posterior descending (branch from right coronary in 70% / branch from left circumflex in 10% / from both in 20%)	V1-V3 (ST depression)	Posterior
Posterior descending (branch from right coronary in 85%)	V4R	Right ventricular

Anterior MI

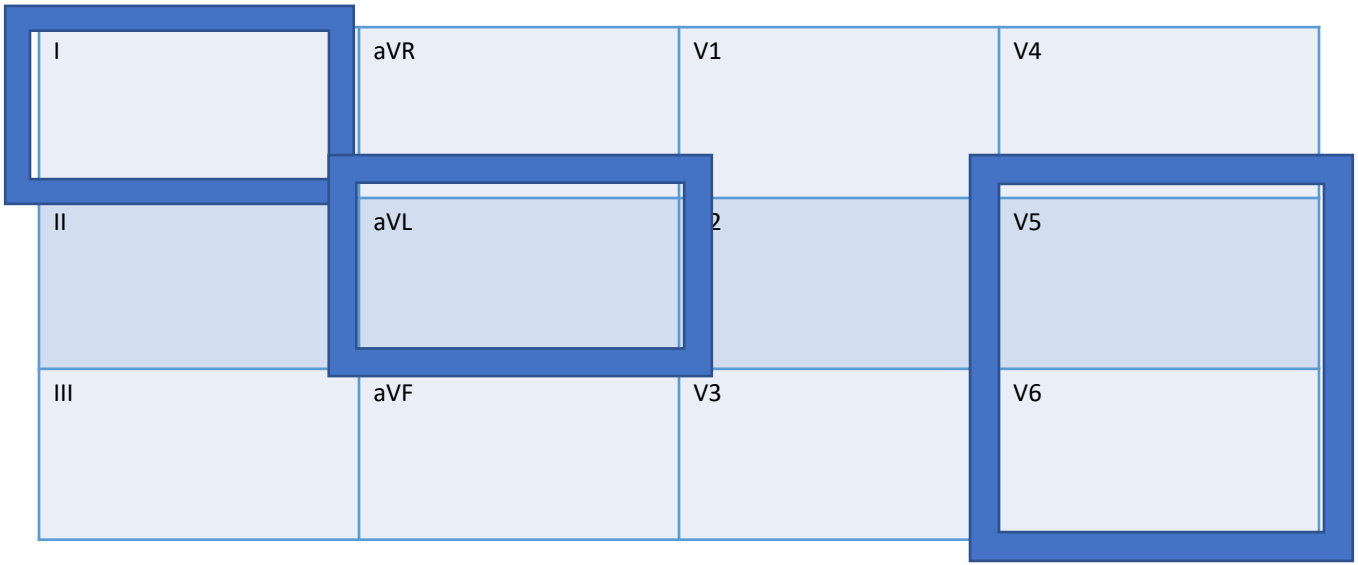
- LAD
- V1-V3

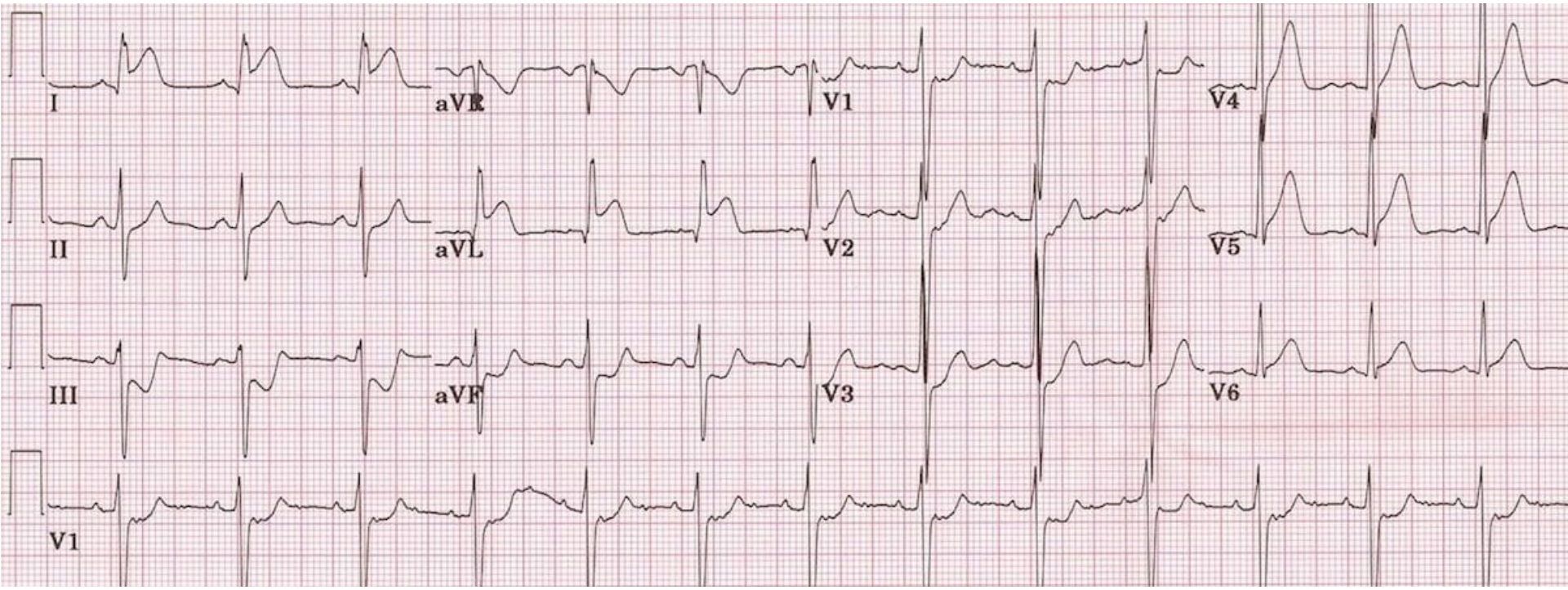



I
aVR
V1
V4
II
aVL
V2
V5
III
aVF
V3
V6
II
II
II
II

Lateral MI

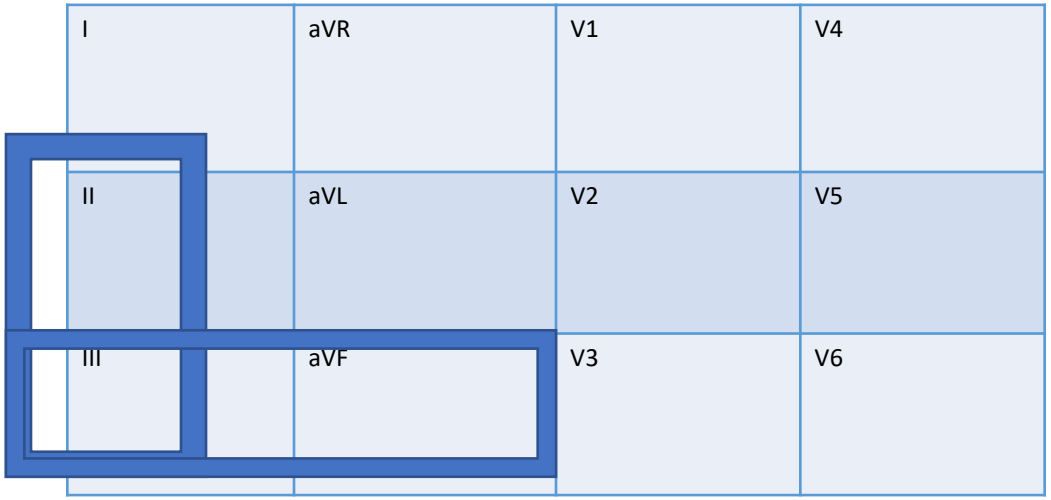
- Left circumflex
- I, aVL, V5-V6

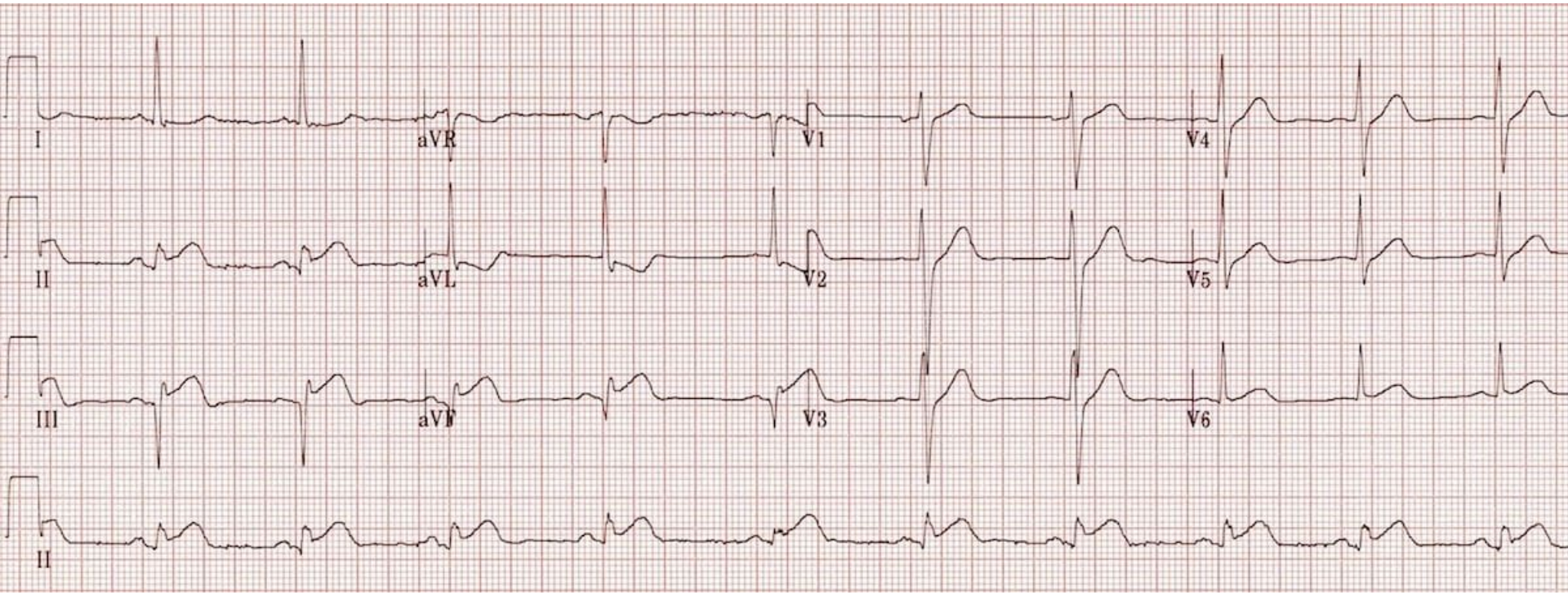



I
aVR
V1
V4
II
aVL
V2
V5
III
aVF
V3
V6
V1

Inferior MI

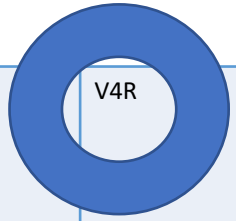
- II, III, aVF
- If you see an inferior MI, look for a right ventricular MI
- Should you give nitro?



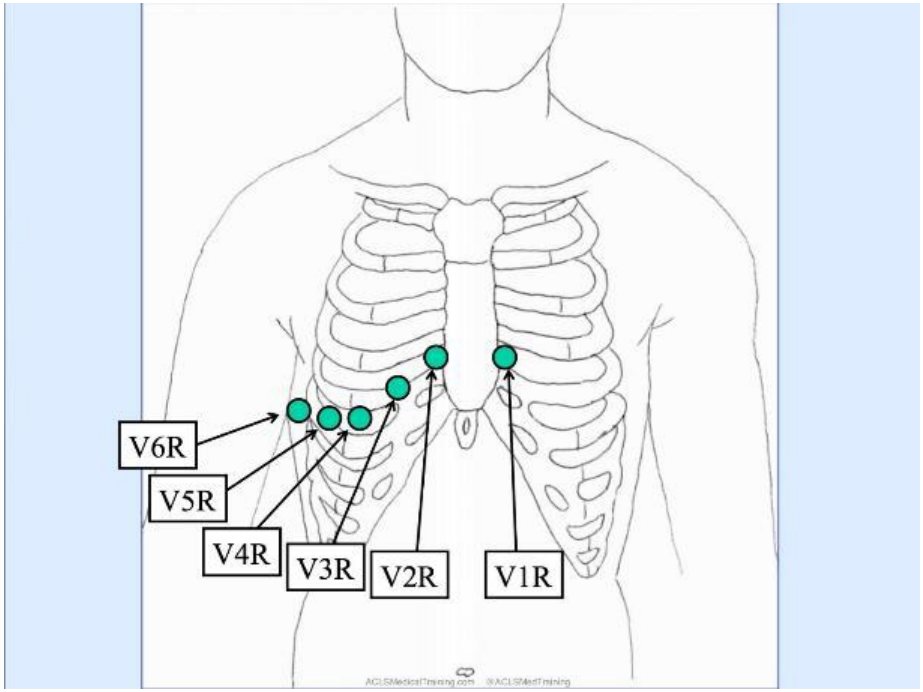

I
aVR
V1
V4
II
aVL
V2
V5
III
aVF
V3
V6
II

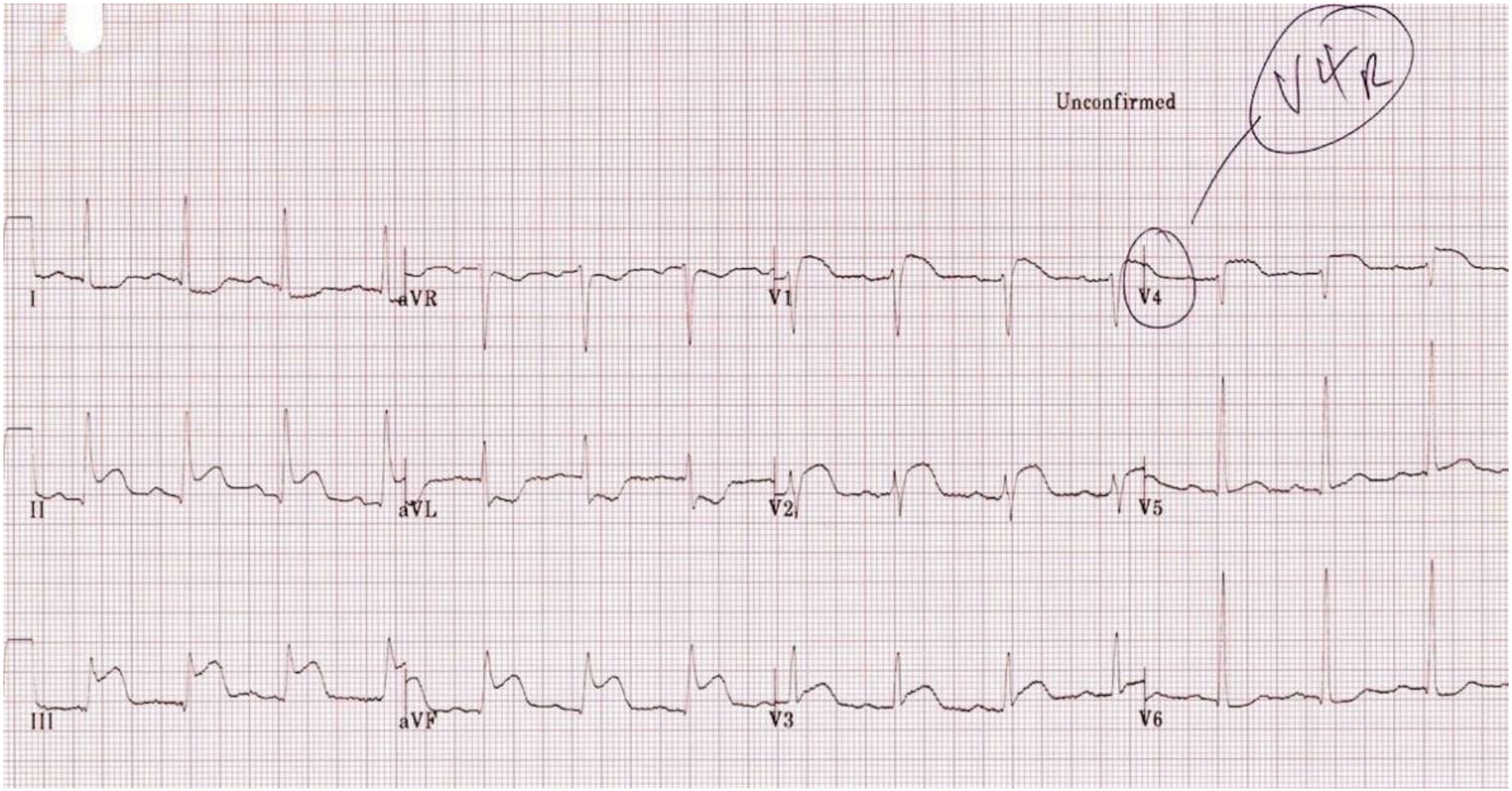
Right ventricular MI

- Present in approximately ¼ of inferior Mis
- Usually posterior descending artery
- V1R-V6R, V4R
- Right sided EKG



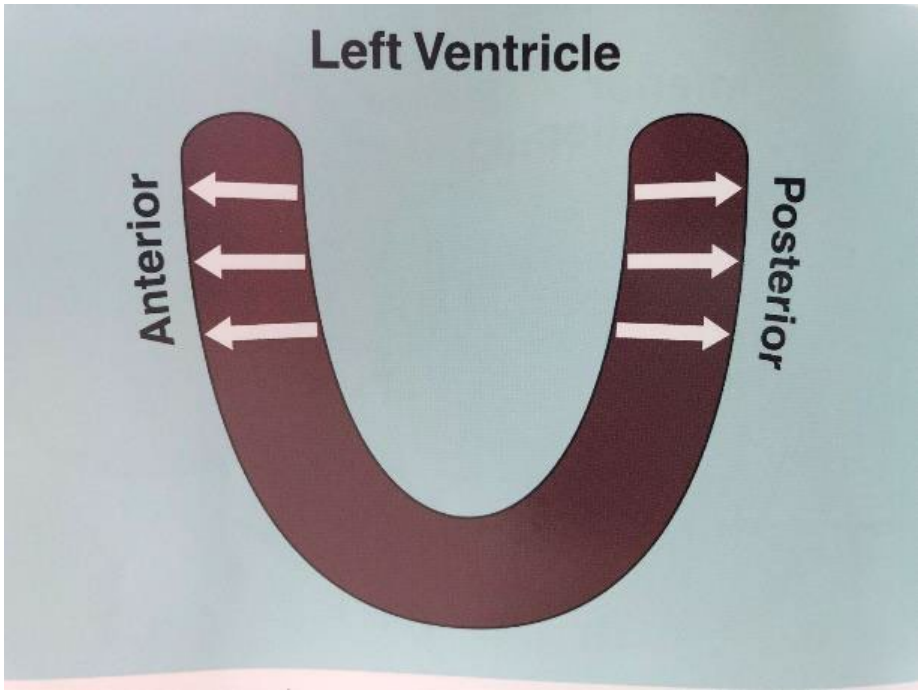
I	aVR	V1R	V4R
II	aVL	V2R	V5R
III	aVF	V3R	V6R


V6R
V5R
V4R
V3R
V2R
V1R



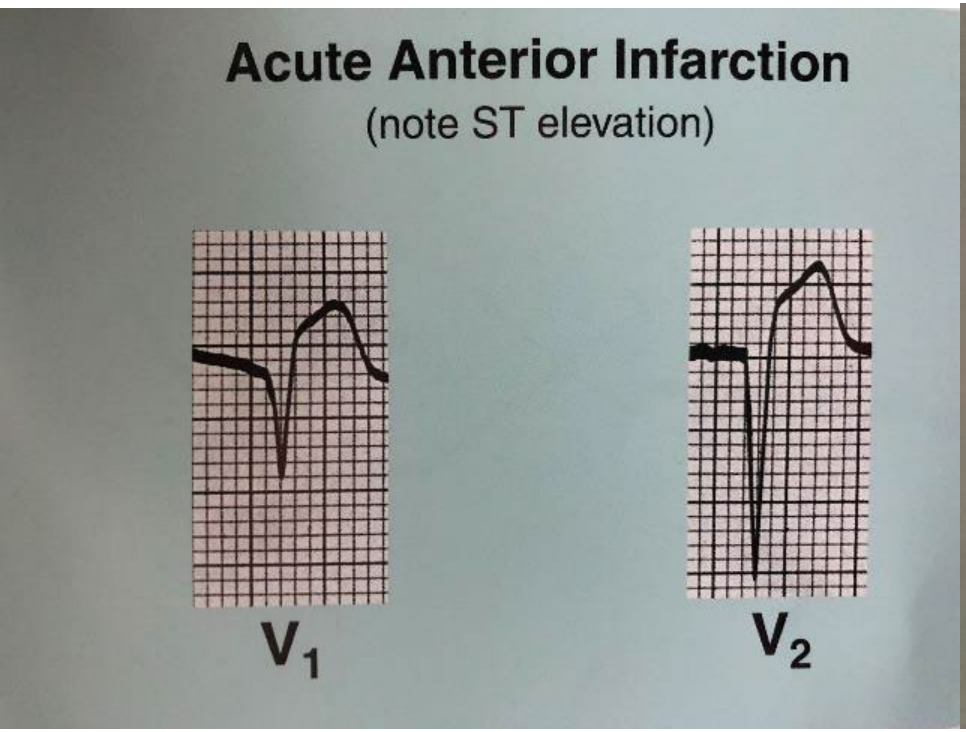
What else do you see?

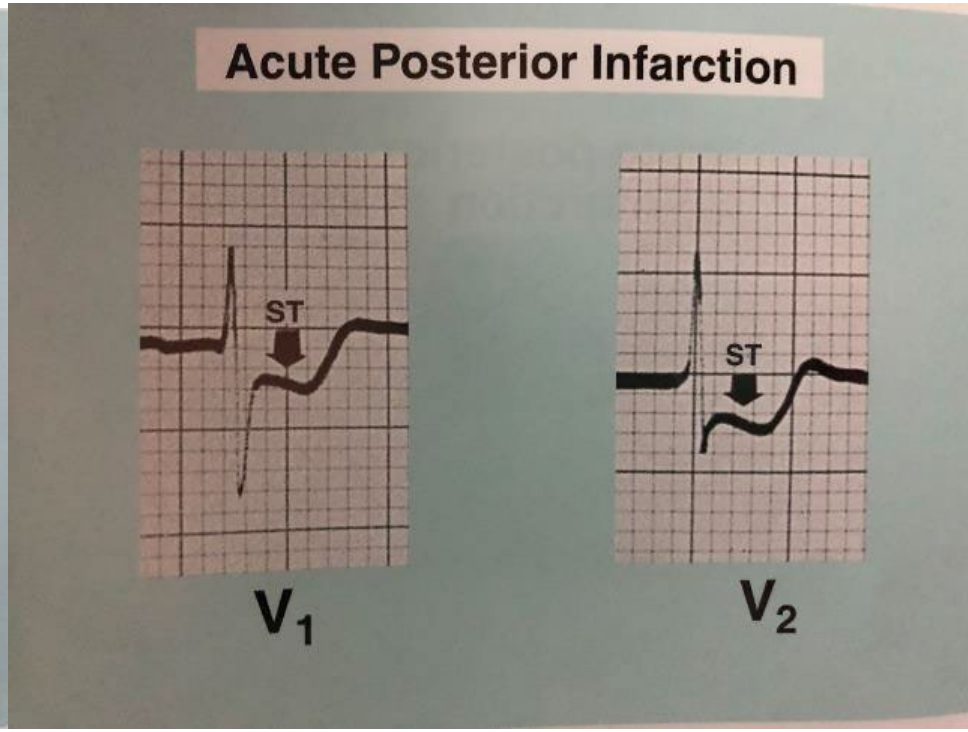
Left Ventricular Depolarization



- The anterior and posterior wall of the left ventricle depolarize in opposite directions

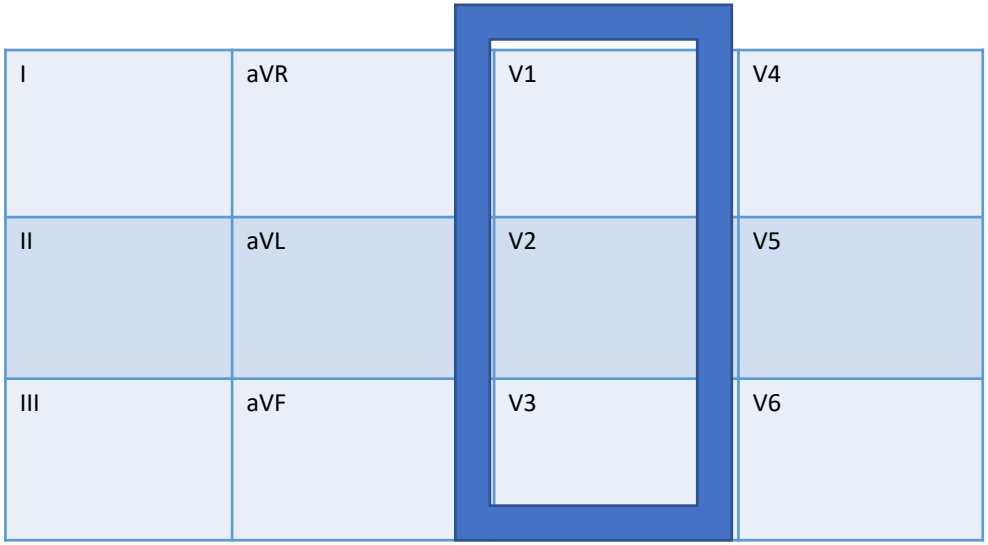
Left Ventricular MI Types





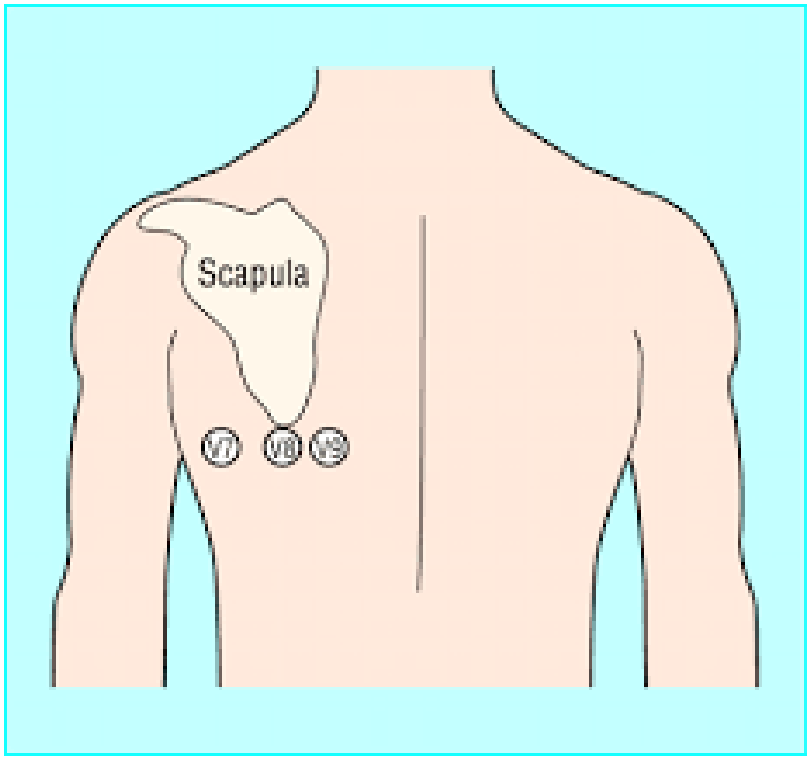
Posterior MI

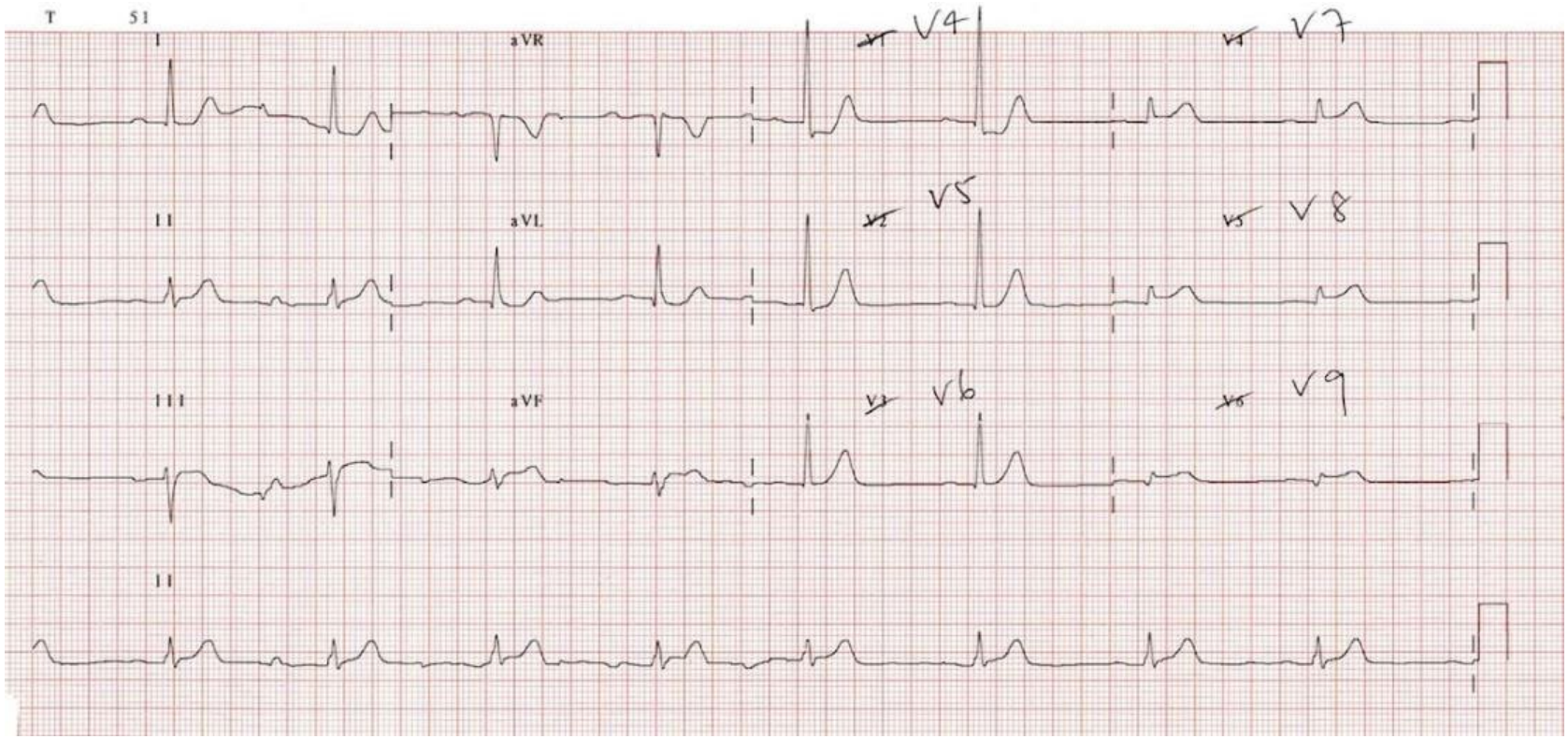
- Left Circumflex and/or Posterior Descending branch from Right Main
- ST **Depression** in V1-V3
- Very small percentage of MIs
- Look at posterior leads to confirm



Posterior MI

- If you see depression, do V7-V9



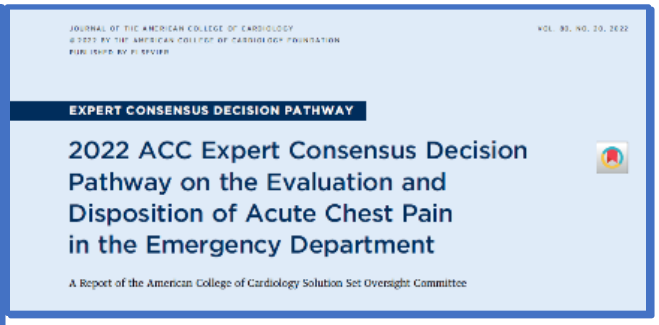

T 51
I
aVR
~~V1~~ V4
~~V4~~ V7
II
aVL
~~V2~~ V5
~~V5~~ V8
III
aVF
~~V3~~ V6
~~V6~~ V9
II

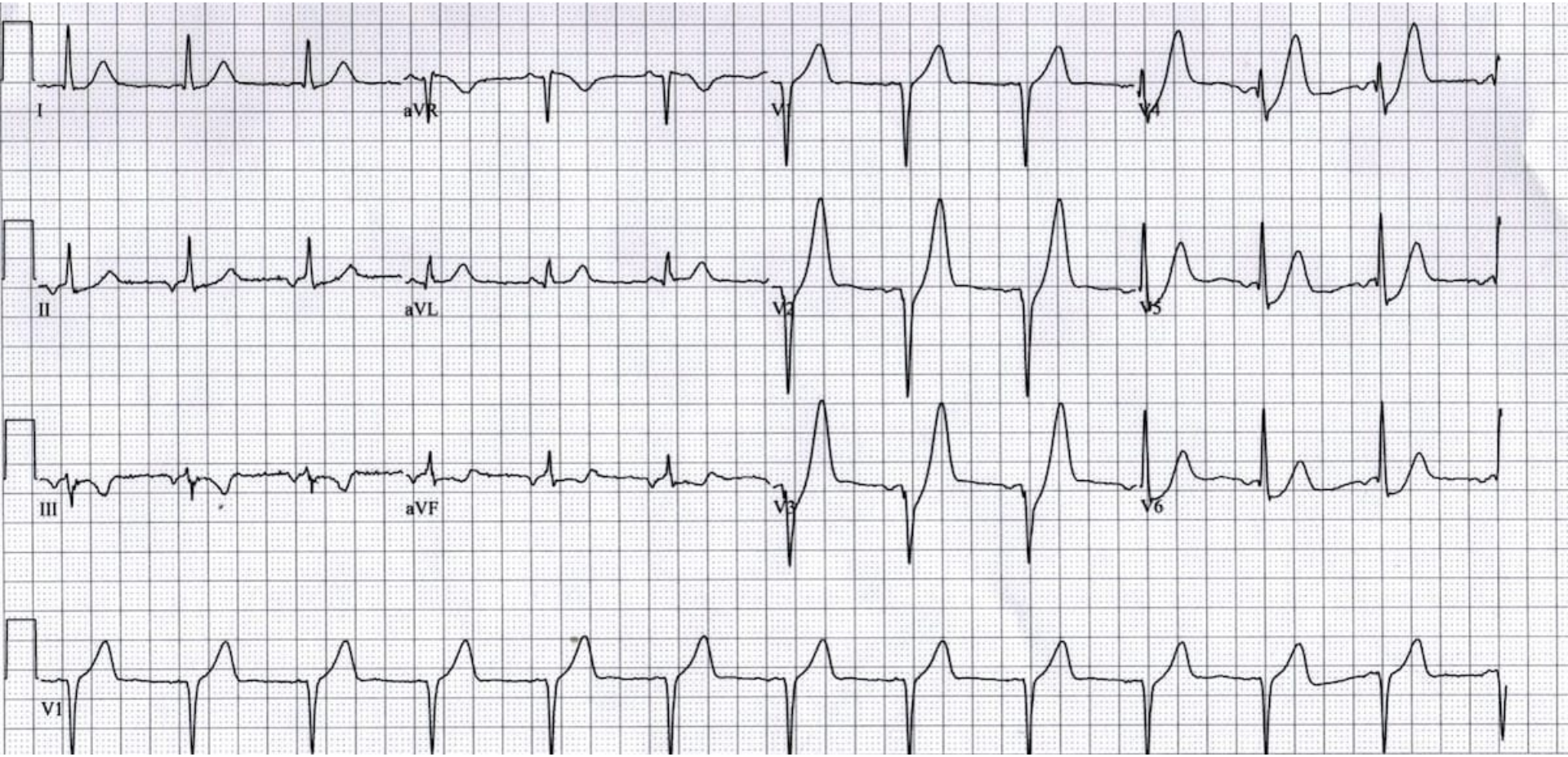
KEY TAKE HOMES

- Anterior: V1-V3
- Lateral: I, aVL, V5-V6
- Inferior: II, III, aVF
- If you see an inferior MI, look for a right ventricular MI
- Posterior: ST depression in V1-V3; do posterior leads

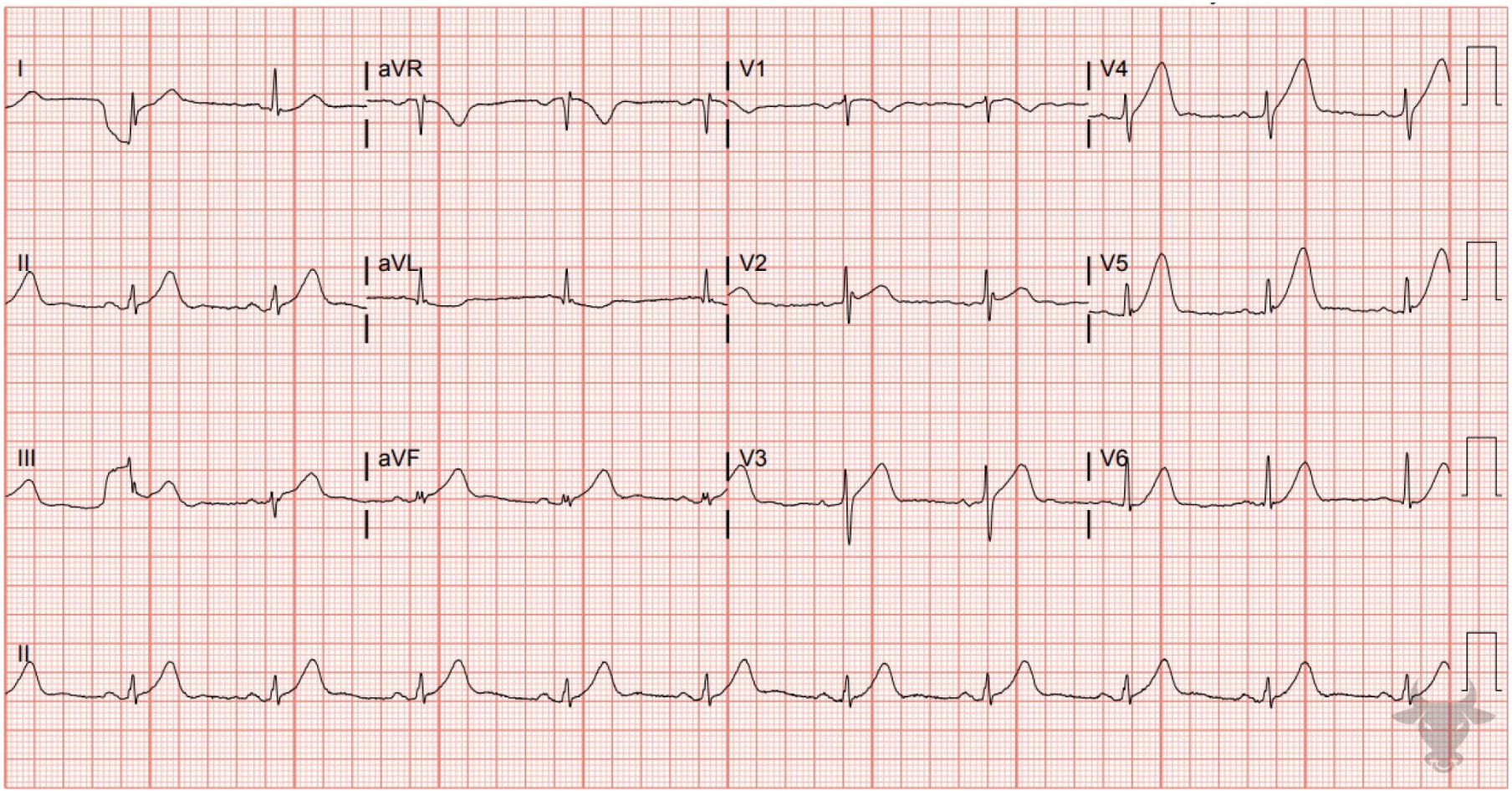
STEMI Equivalents

Posterior STEMI
Left bundle branch block or ventricular paced rhythm with Sgarbossa Criteria
Left bundle branch block or ventricular paced rhythm with Smith-modified Sgarbossa Criteria
De Winter Sign
Hyperacute T waves





De Winter Sign	■ Tall, prominent, symmetrical T waves arising from upsloping ST-segment depression >1 mm at the J-point in the precordial leads ■ 0.5-1 mm ST-segment elevation may be seen in lead aVR



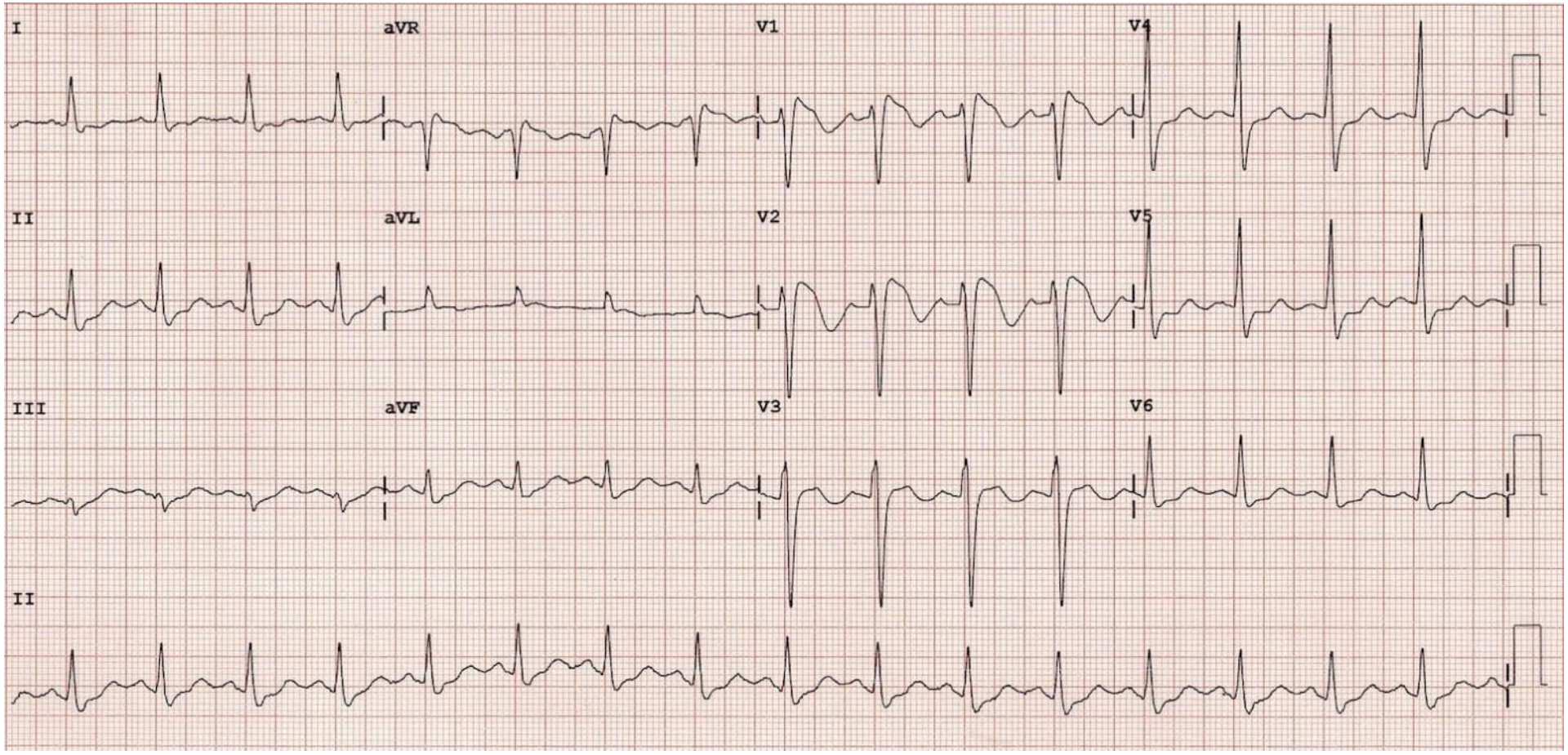
Hyperacute T waves	Broad, asymmetric, peaked T waves may be seen early in STEMI Serial ECGs over very short intervals are useful to assess for progression to STEMI

Objectives

- Review of anatomy and physiology
- Blocks
- Ischemia / injury / infarction
- Killer EKGs

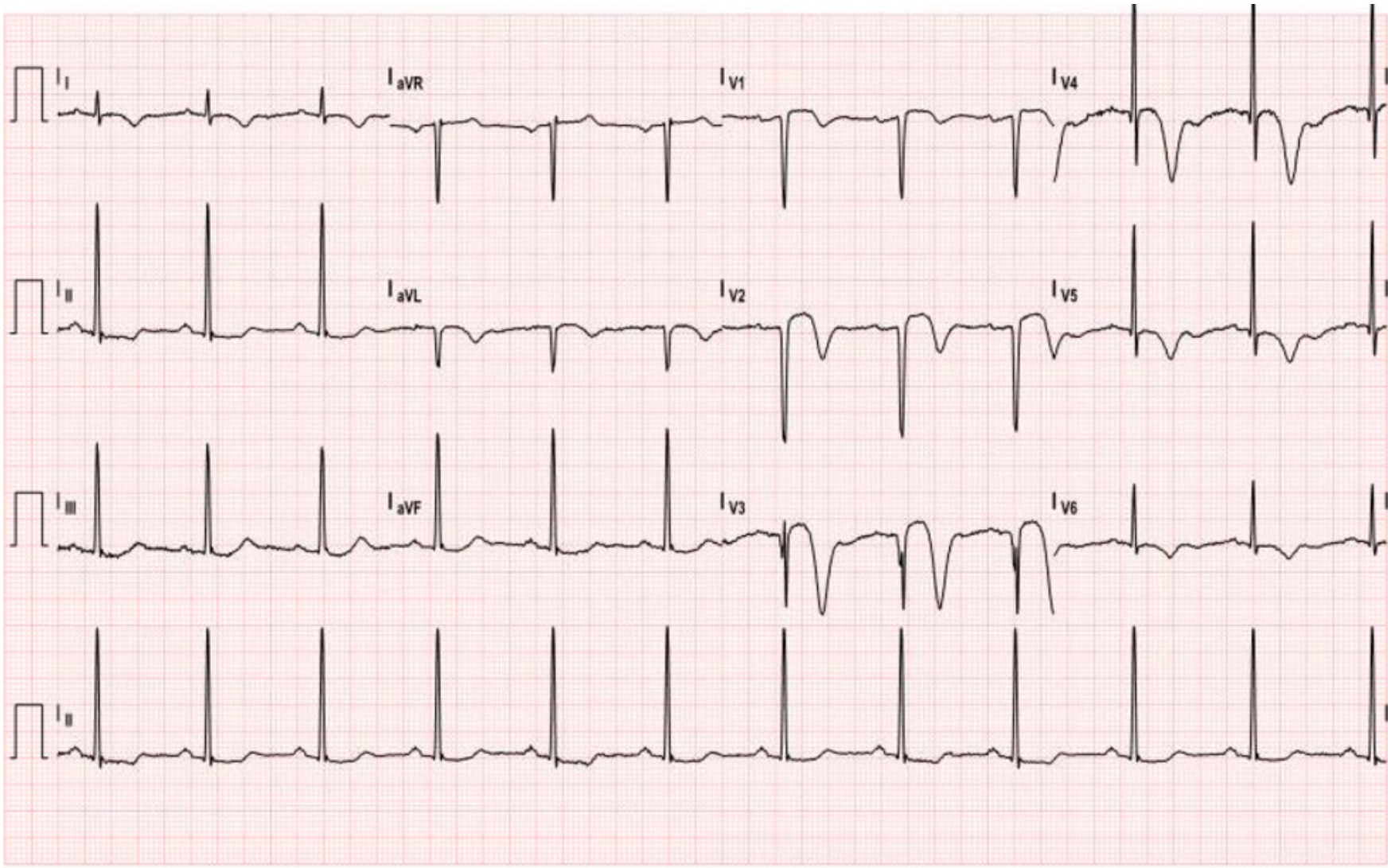
Brugada Syndrome

- Inherited arrhythmia
- High incidence of sudden cardiac death
- Most common in Asian men
- Makes patient more disposed to episodes of vtach
- EKG shows: RBBB with ST elevation in V1-V3


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

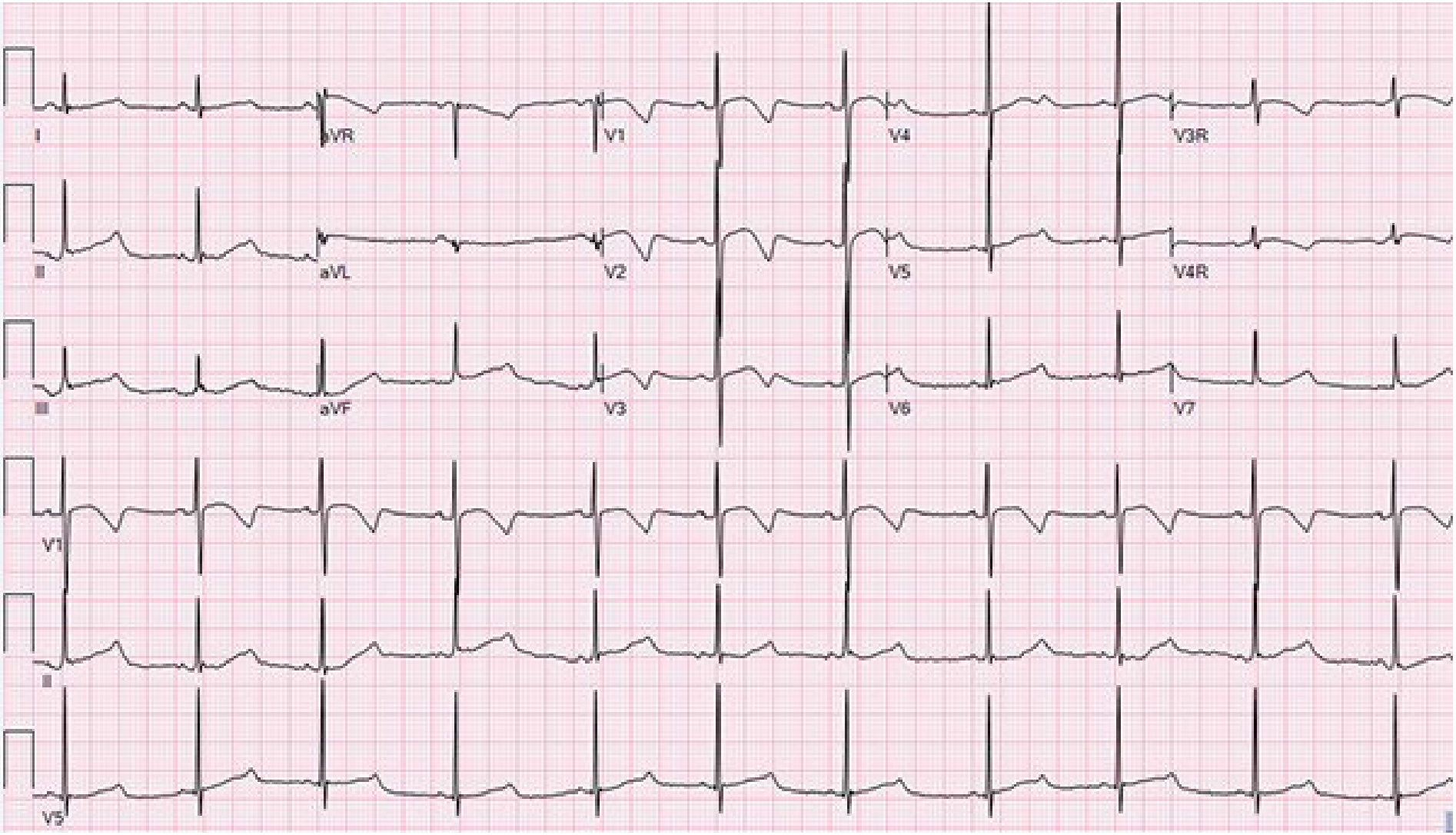
Wellens Syndrome

- Associated with critical stenosis of LAD… aka badness
- EKG shows: severe TWI in V2-V4


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

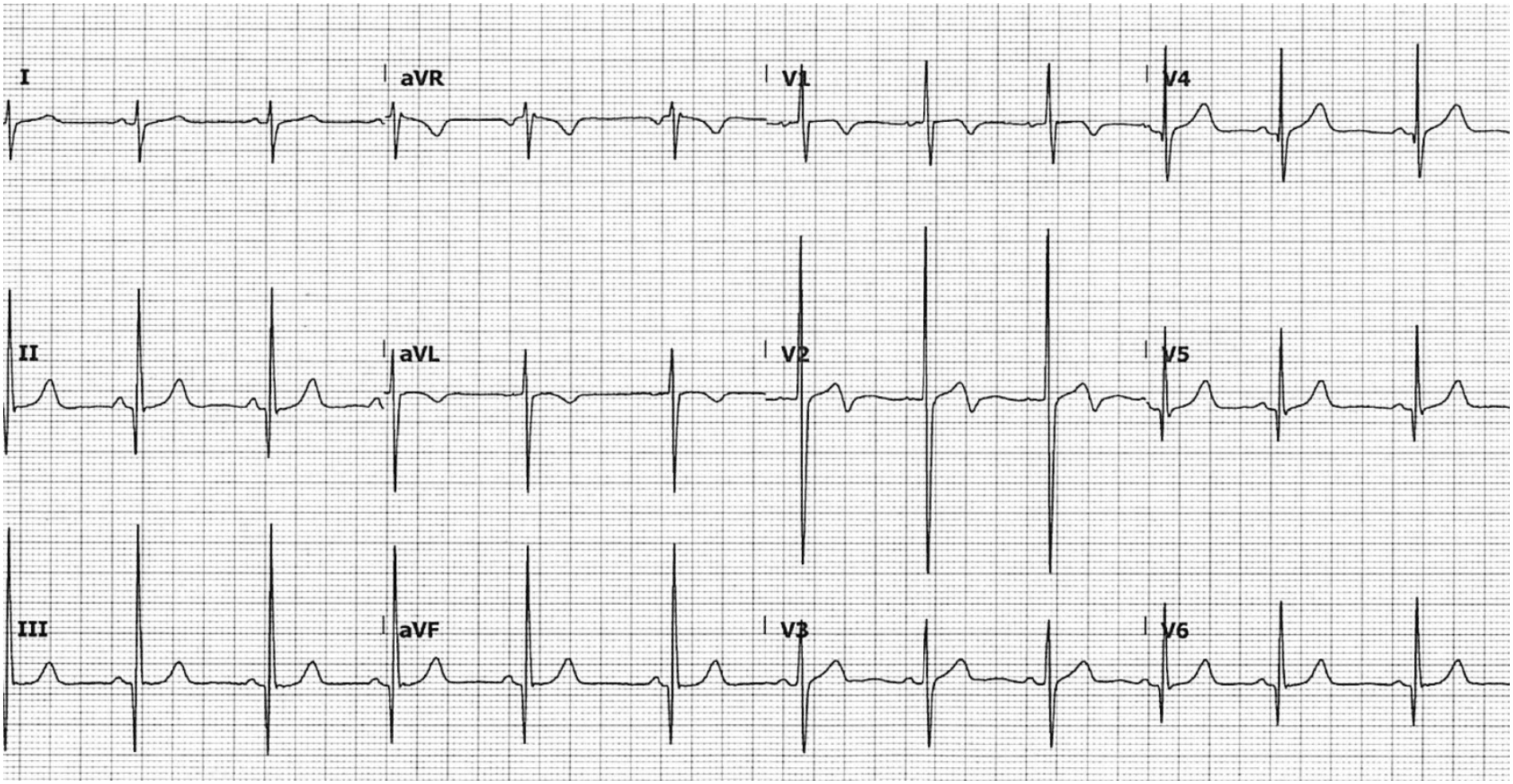
Long QT

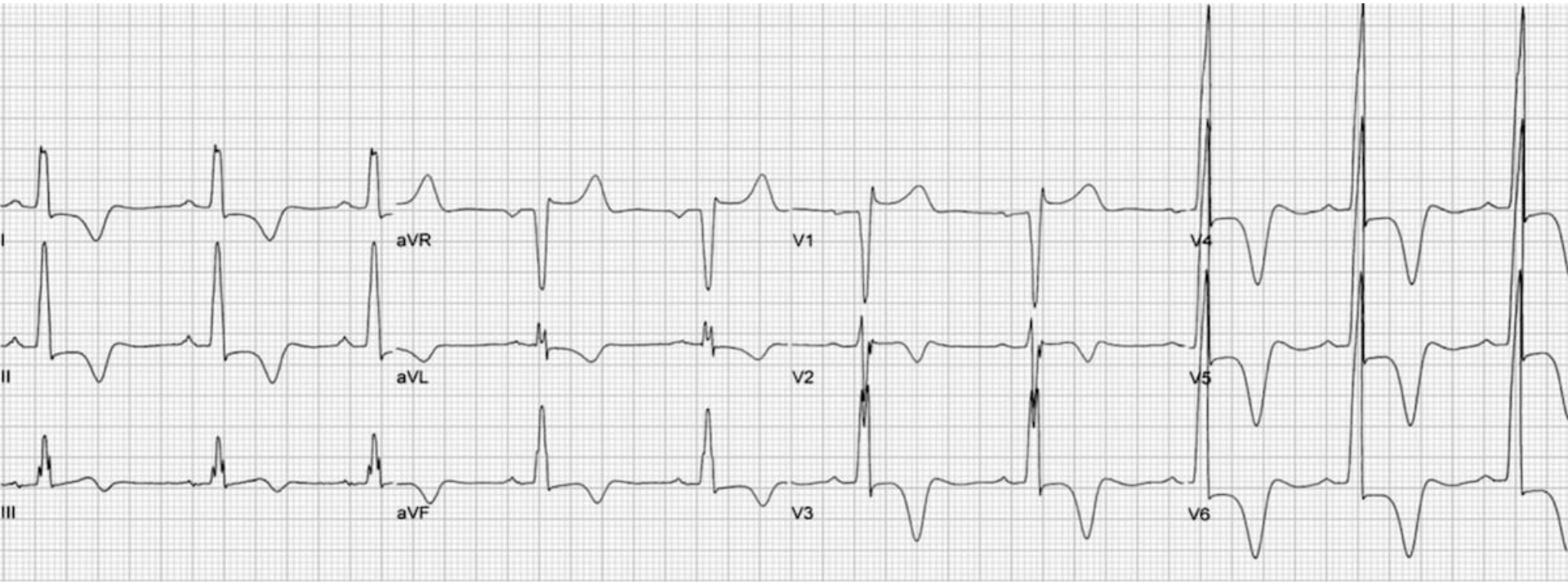
- Higher risk of sudden cardiac death
  - Usually results from torsades de pointes or v-tach
- Always measure QTc
  - QTc= QT/ square root of the RR interval
- Abnormal if the QTc >440 msec
- Most serious when QTc ≥500 msec


I
aVR
V1
V4
V3R
II
aVL
V2
V5
V4R
III
aVF
V3
V6
V7
V1
II
V5

Hypertrophic Cardiomyopathy

- Isolated left ventricular hypertrophy
- Patients present with
  - Chest pain symptoms
  - Exertional syncope
  - Always think about this in the young athlete who passes out
- Normal EKG in 5-10% of patients
- EKG shows:
  - LAD, LVH, increased QRS voltage, dagger Q wave, strain pattern


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


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

Objectives

- Review of anatomy and physiology
- Blocks
- Ischemia / injury / infarction
- Killer EKGs

Questions?

(Before some final slides)

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2view.fireside.fm

Parting Thoughts

- PR interval, QRS complexes are critical to understanding blocks
- ST-elevation MIs and equivalents map out to the affected area
- Beyond MIs, there are other critical EKG patterns associated with high morbidity and mortality that we must know
- Must thoroughly know “normal” to detect abnormal

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