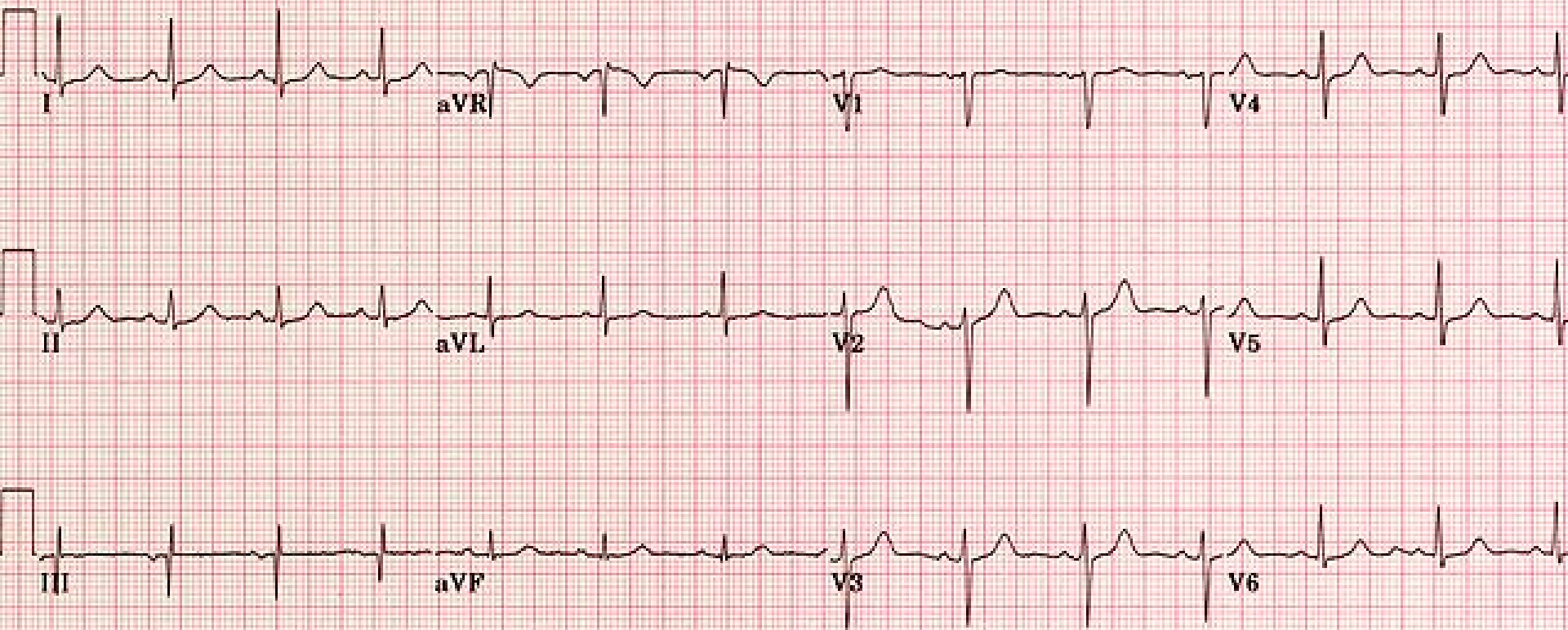


A Systematic Approach to the 12 Lead EKG

Emily Caldwell, MSN ACNP-BC

Normal EKG



Overview

- Heart Rate
- Rhythm
- Intervals
- Axis
- Voltage
- R Wave Progression
- Q Wave
- ST Segments
- T waves
- Device Involvement



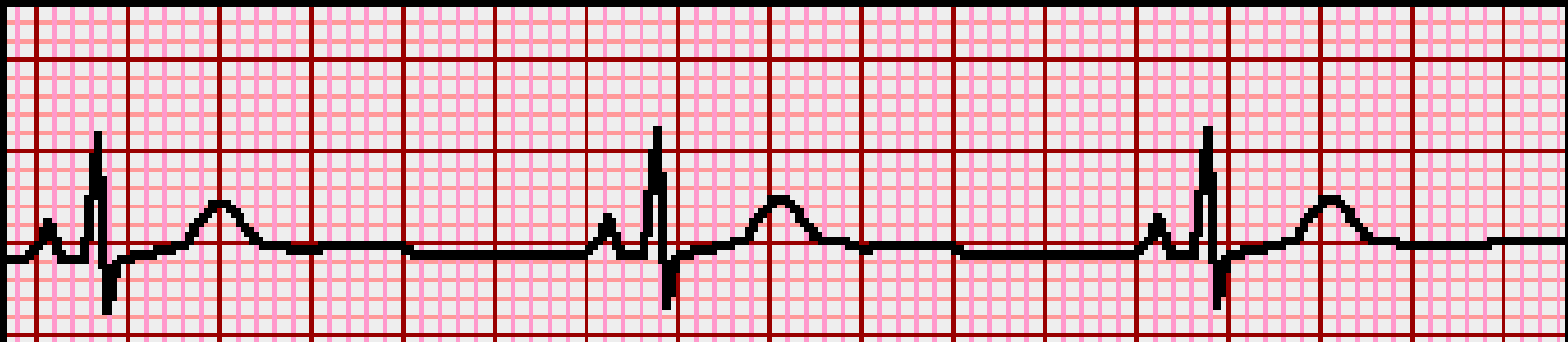
1 large box = 5mm = 0.2 sec

1 small box = 1mm = 0.04sec

Heart Rate

- Rule of 300- Divide 300 by the number of boxes between each QRS = rate

Number of big boxes	Rate
1	300
2	150
3	100
4	75
5	60
6	50



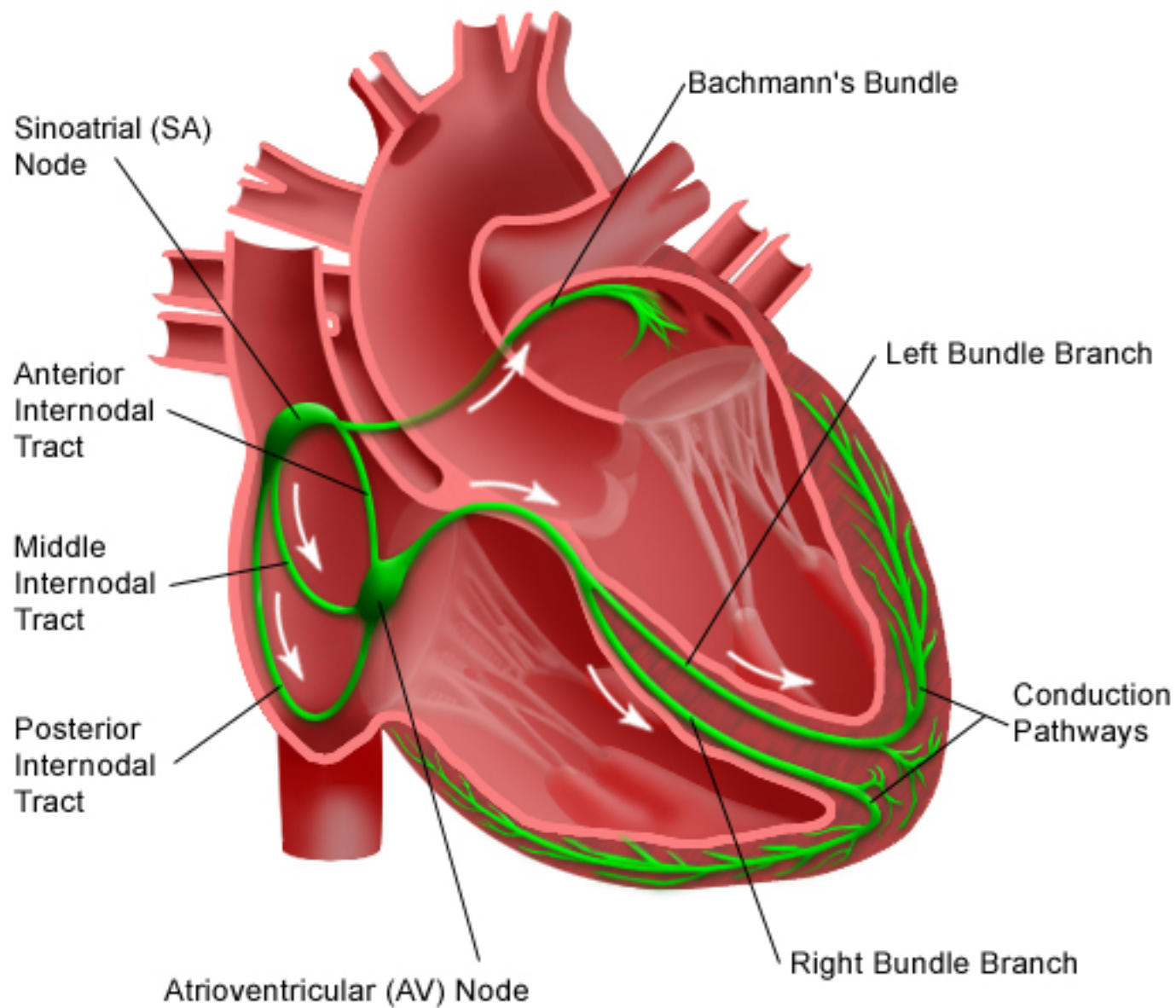
Rhythm

- P:QRS relationship
 - P:QRS = 1
 - P:QRS < 1
 - No P waves (or many)
- Heart Rate
- RR regularity
- P wave morphology
- PR interval
- QRS width

P wave morphology

- Normal P wave duration 80-110 msec
- Upright in I, II, and aVF; upright or biphasic in III, aVL, V1, V2. Small notching may be present.
- Normal amplitude: Limb leads $< 2.5\text{mm}$ and V1 positive deflection $< 1.5\text{mm}$ and negative deflection $< 1\text{mm}$
- Atrial enlargement- look at leads II, V1 and V2
 - RAE- tall, upright P waves $>$ normal (p-pulmonale)
 - LAE- terminal negative portion of the P wave in V1 $\geq 1\text{ mm}$ deep and 40 msec wide and notched P wave with a duration $\geq 120\text{msec}$ in II, III, aVF (p-mitrale)

Electrical System of the Heart

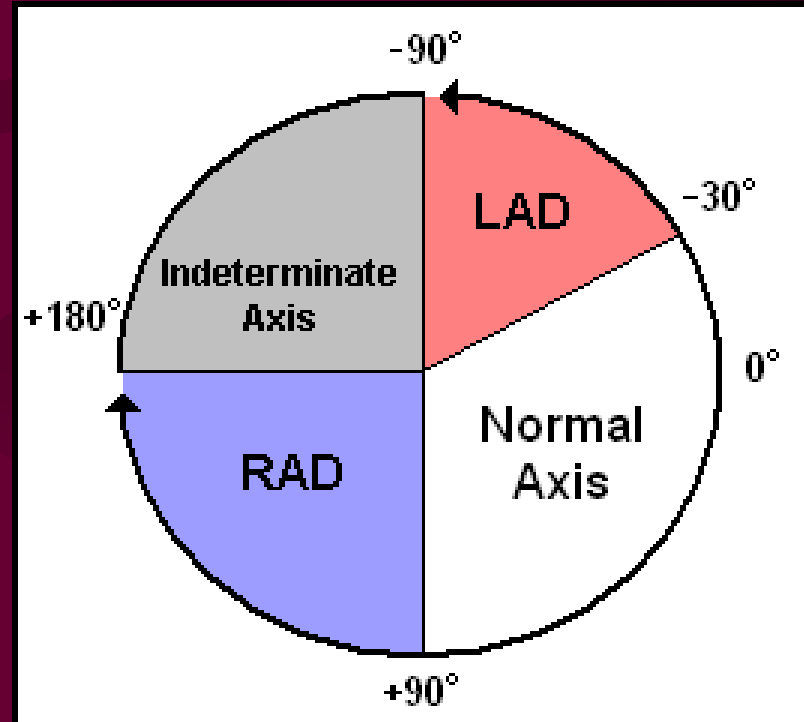


Intervals

- PR: 0.12-0.20 seconds
- QRS: < 0.10 seconds
 - Distinguish between moderate prolongation 0.10-0.12 and **marked** prolongation 0.12 secs when establishing a differential diagnosis
- Only report QTc- corrects for heart rate
 - Bazett's Formula $QT_B = \frac{QT}{\sqrt{RR}}$
- QTc: 0.35-0.43 seconds for heart rates of 60-100 BPM

QRS Axis

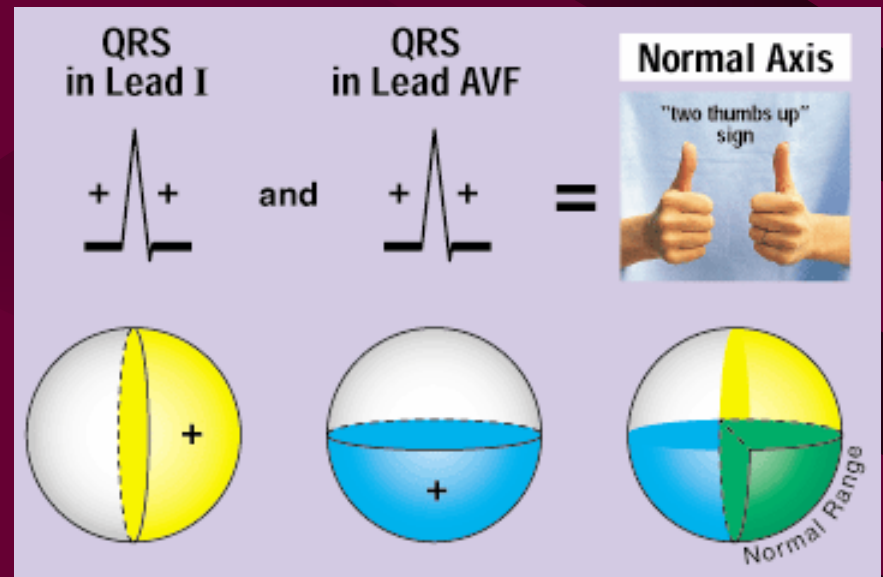
- Represents the major vector of ventricular activation- overall direction of the heart's activity
- Axis of -30 to $+90$ degrees is normal
- Consider the differential- early clues- once axis is identified



The Quadrant Approach

- QRS up in I and up in aVF = Normal

		Lead aVF	
		Positive	Negative
Lead I	Positive	Normal Axis	LAD
	Negative	RAD	Indeterminate Axis



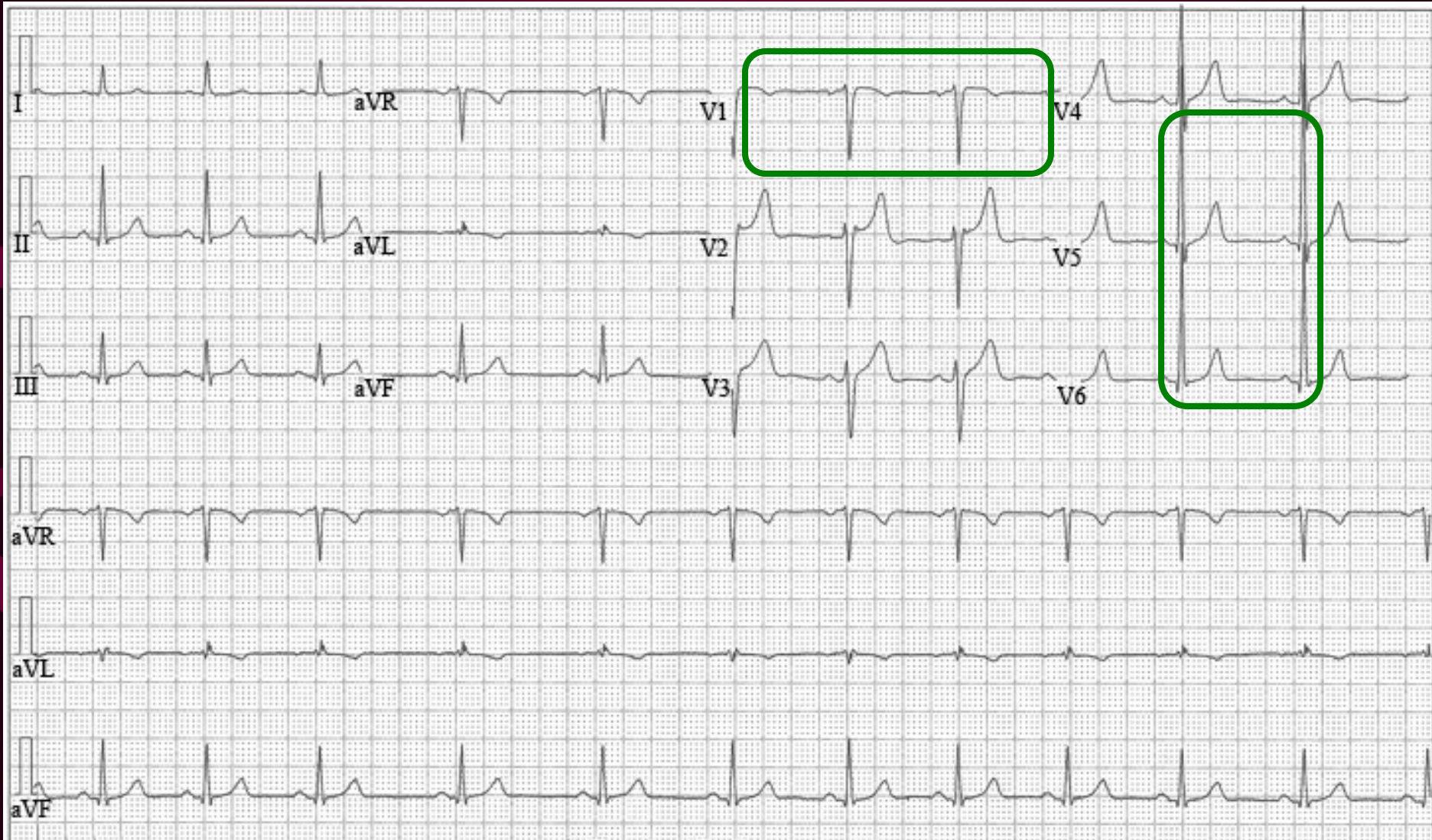
QRS Voltage

- Measurement: from baseline to the peak of the R wave or S wave
 - Normal voltage
 - Low voltage: Total QRS (R +S) < 5 mm in all **limb** leads and < 10 mm in all **precordial** leads
 - Increased voltage
 - LVH
 - RVH

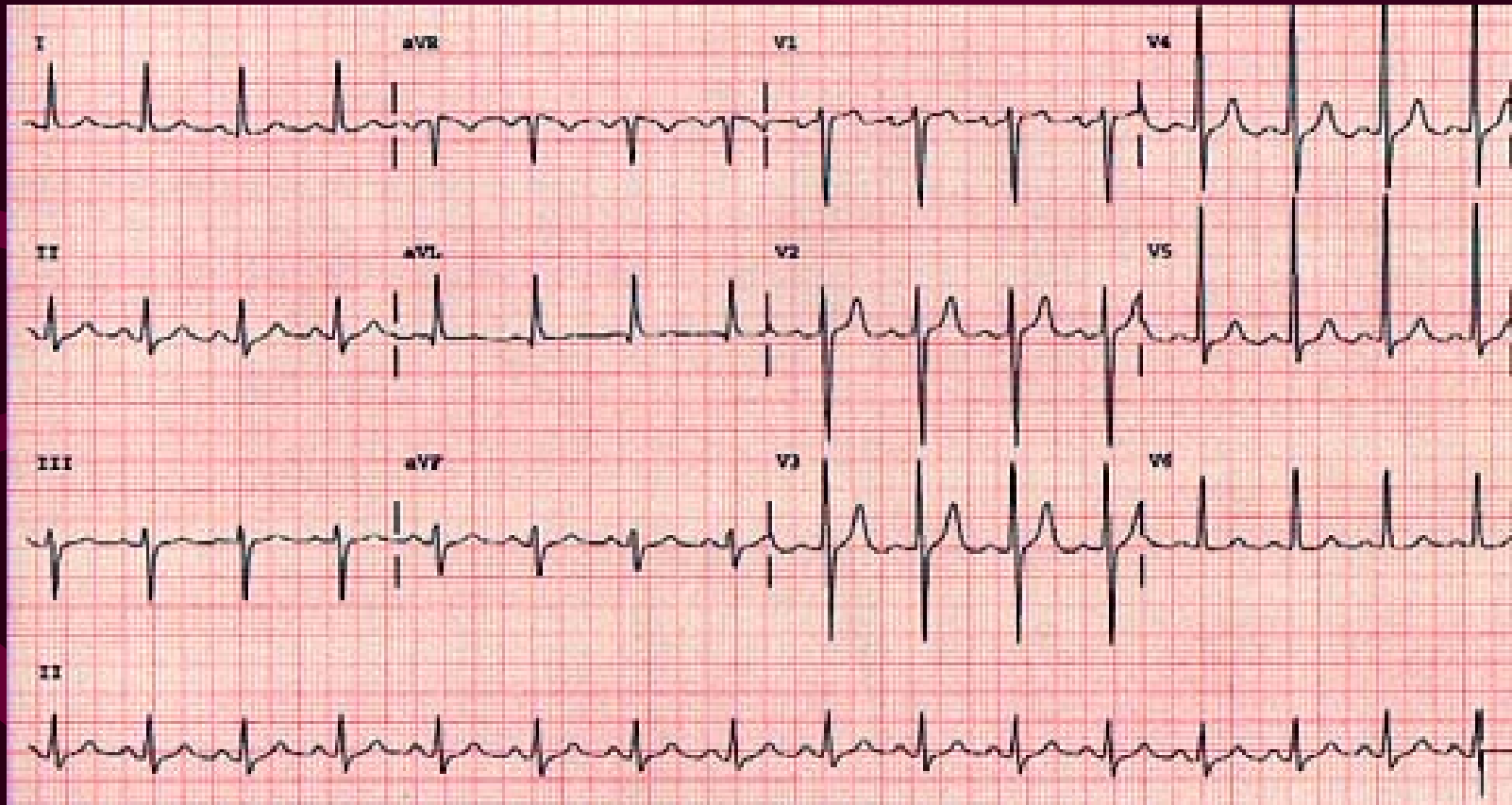
LVH

- Precordial Leads (one or more)
 - R wave in V5 or V6 + S wave in V1
 - > 35mm if age >40
 - > 40mm if age 30-40
 - > 60mm if age 16-30
 - Max R wave + S wave in precordial leads > 45 mm
 - R wave in V5 > 26mm
 - R wave in V6 >20mm
- Also Limb Lead criteria

Left Ventricular Hypertrophy



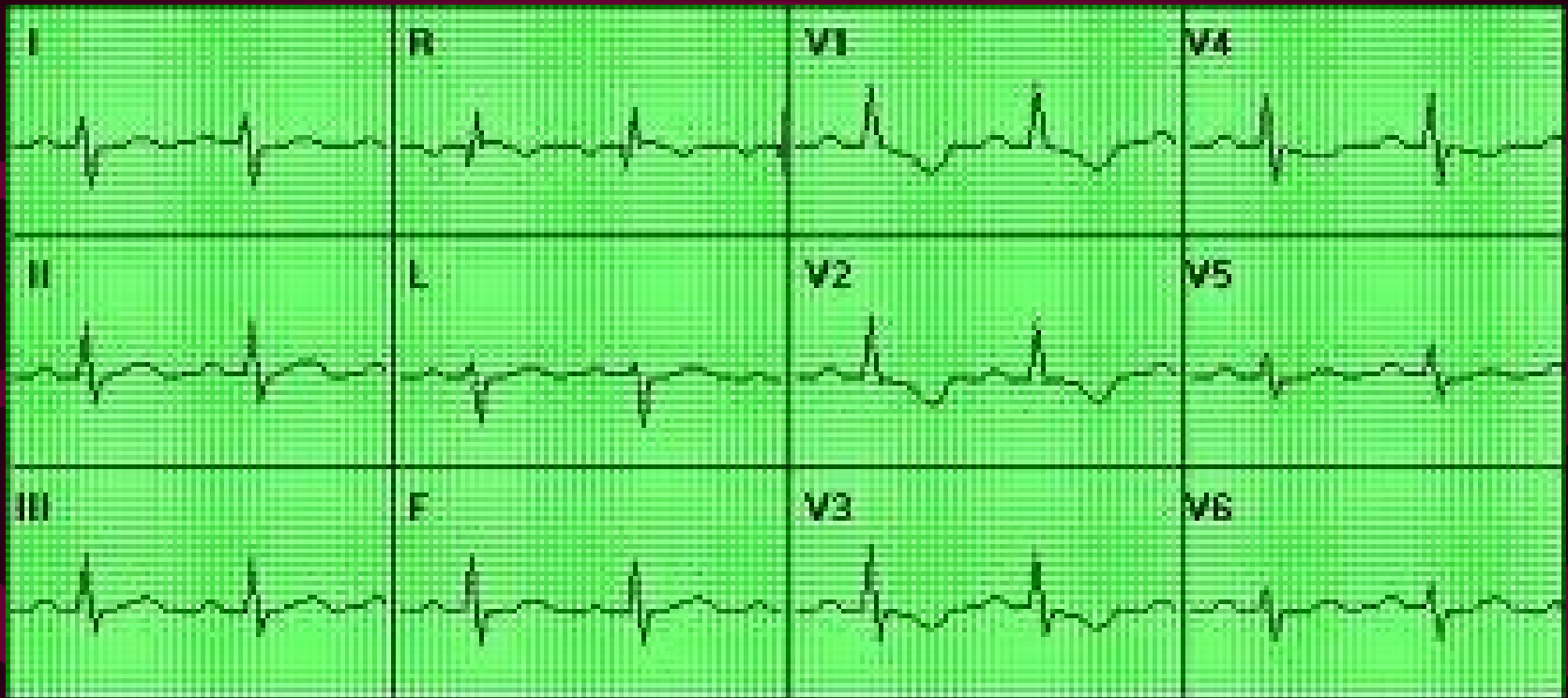
LVH



RVH

- Right axis deviation with mean QRS axis $\geq 100^\circ$
- Dominant R wave:
 - R wave in V1 ≥ 7 mm
 - rSR' in V1 with R' > 10 mm
 - qR complex in V1
- Secondary ST-T changes in right precordial leads
- RAE is common

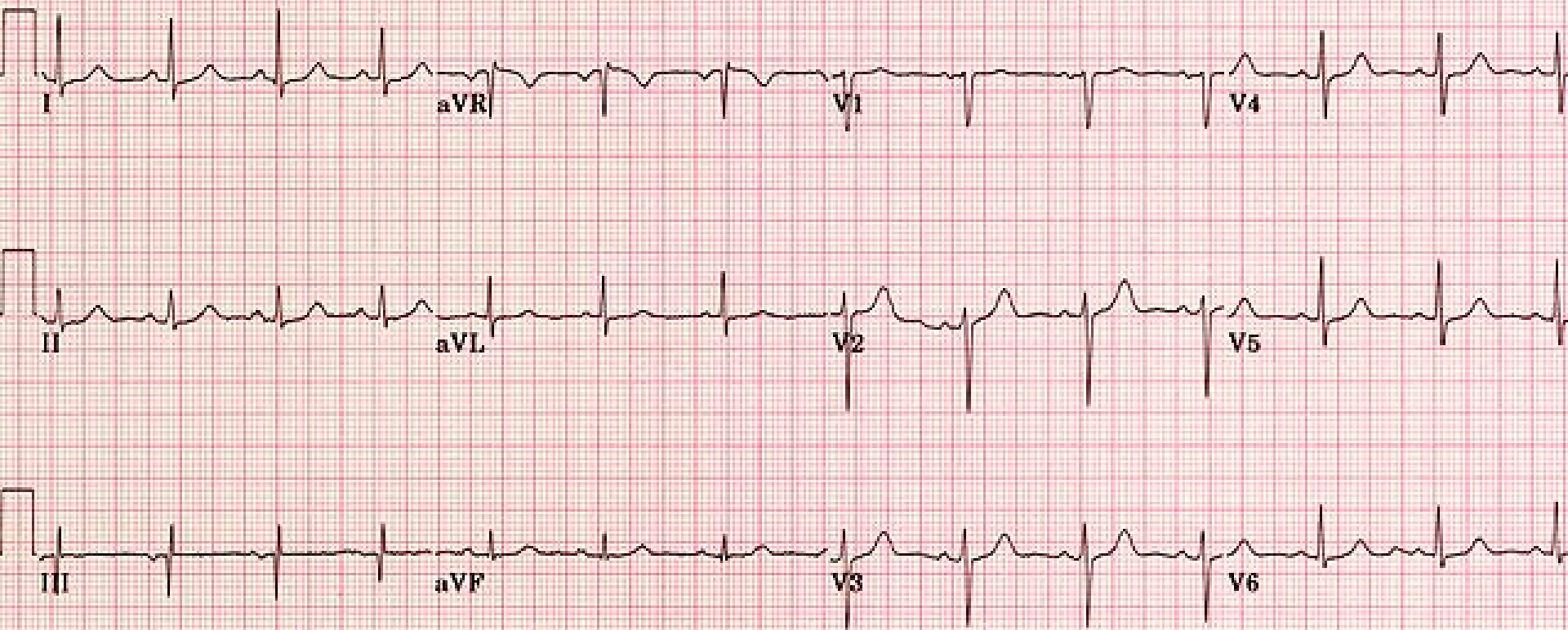
RVH



R Wave Progression

- Determine the precordial transition zone (R/S = 1)
- Normal: transition zone = V2-V4
- Poor RWP: transition zone = V5-V6
- Early/Reverse RWP: Decreasing R wave amplitude across the precordial leads

Normal EKG



Implanted Cardiac Devices

- Final step if not already identified with rhythm- Is Pacing Present?
- Identify pacing spikes
- EKG rarely identifies a defibrillator
 - Patient history
 - Device interrogation

Implanted Cardiac Devices

- Pacemakers
- Implanted Cardioverter Defibrillators-
ICDs
- BiVentricular (BiV) Pacemakers and ICDs
- Implanted Loop Recorders
 - *cannot be detected on EKG

Concepts in Pacing

- 4 Major Functions of a Pacemaker
 - Stimulate cardiac depolarization
 - Sense intrinsic cardiac function
 - Respond to increased metabolic demand by providing rate responsive pacing
 - Provide diagnostic information stored by the pacemaker

Concepts in Pacing

- Types
 - Single Chamber +/- ICD
 - Dual Chamber +/- ICD
 - Dual Chamber Biventricular (3 chambers) +/- ICD
- Problems
 - Loss of Capture
 - Non-sensing
 - Loss of Pacing Artifact

Concepts in Pacing

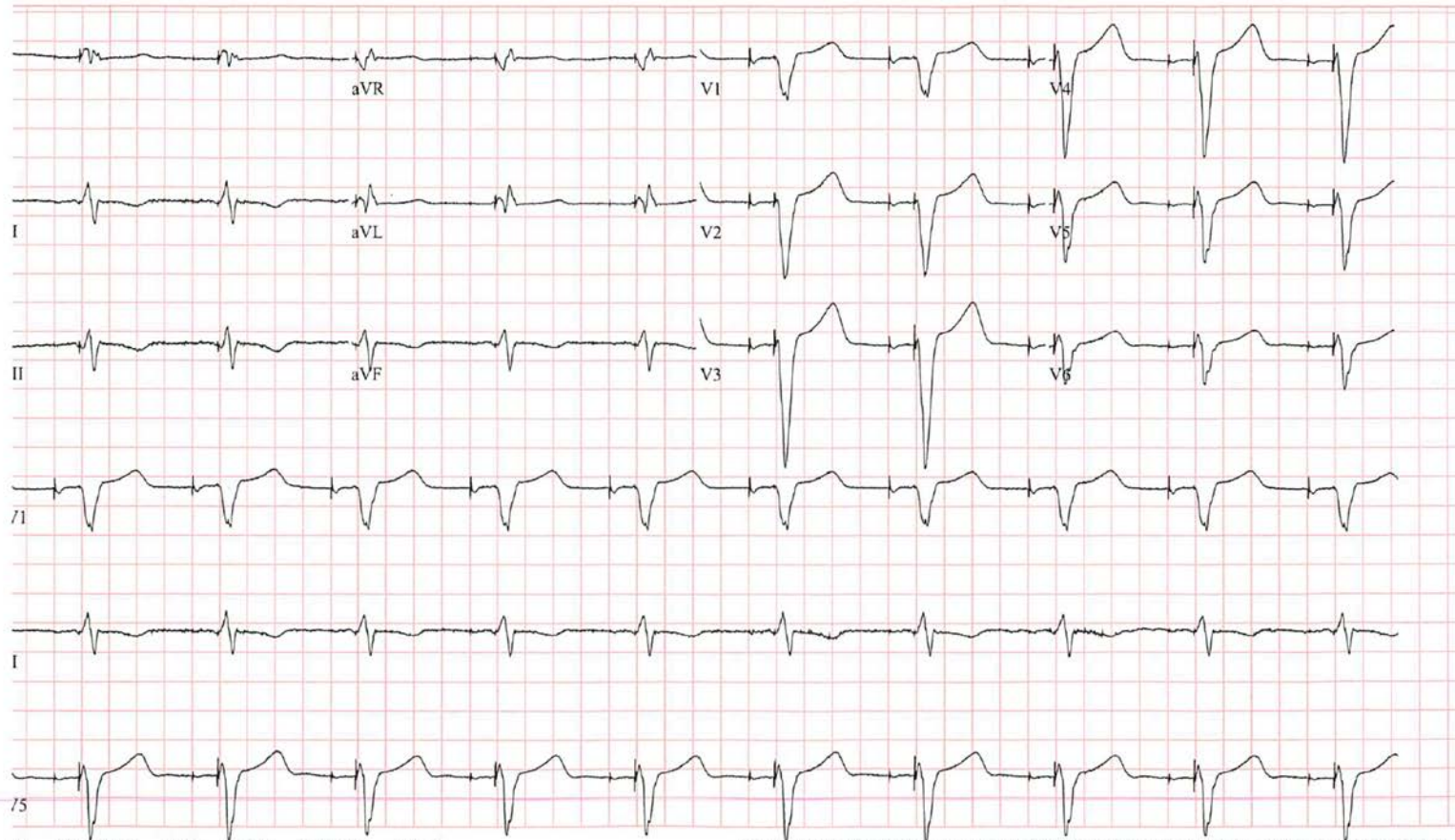
- Pacemaker “spike”
 - Configuration of the lead
 - Unipolar = Large spike
 - Bipolar = Small spike

21-JUN-2013 18:35:11

JG-1943 (69 yr)
Black
0lb
338

Vent. rate	60	BPM
PR interval	172	ms
QRS duration	176	ms
QT/QTc	552/552	ms
P-R-T axes	* -63	-65

AV SEQUENTIAL OR DUAL CHAMBER ELECTRONIC PACEMAKER
WHEN COMPARED WITH ECG OF 20-JUN-2013 19:55,
SIGNIFICANT CHANGES HAVE OCCURRED
Confirmed by [REDACTED] on 6/22/2013 11:08:00 AM



v/s 10mm/mV 150Hz 7.0.2 12SL 241 CID: 5

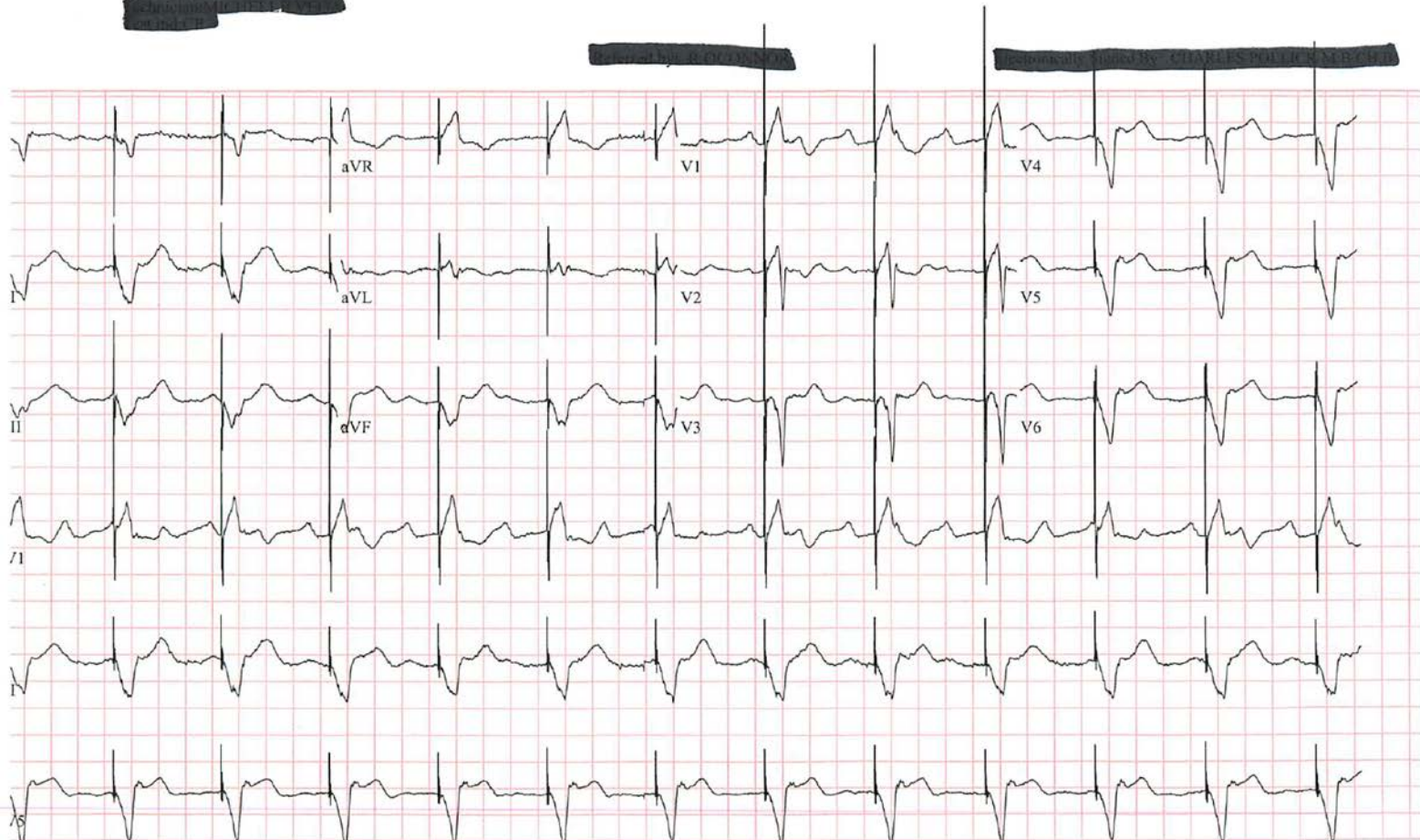
SID: M821668 EID:106 EDT: 11:08 22-JUN-2013 ORDER: 0621-0063 ACCOUNT: V00015535412

03-MAY-2009 17:23:10

B-1947 (62 yr)
Caucasian
0lb
423

Vent. rate	75	BPM
PR interval	*	ms
QRS duration	192	ms
QT/QTc	478/533	ms
P-R-T axes	* 167	79

ELECTRONIC VENTRICULAR PACEMAKER
WHEN COMPARED WITH ECG OF 15-APR-2009 06:22,
VENT. RATE HAS INCREASED BY 4 BPM
Confirmed by [REDACTED] (106) on 5/4/2009 7:11:29 PM



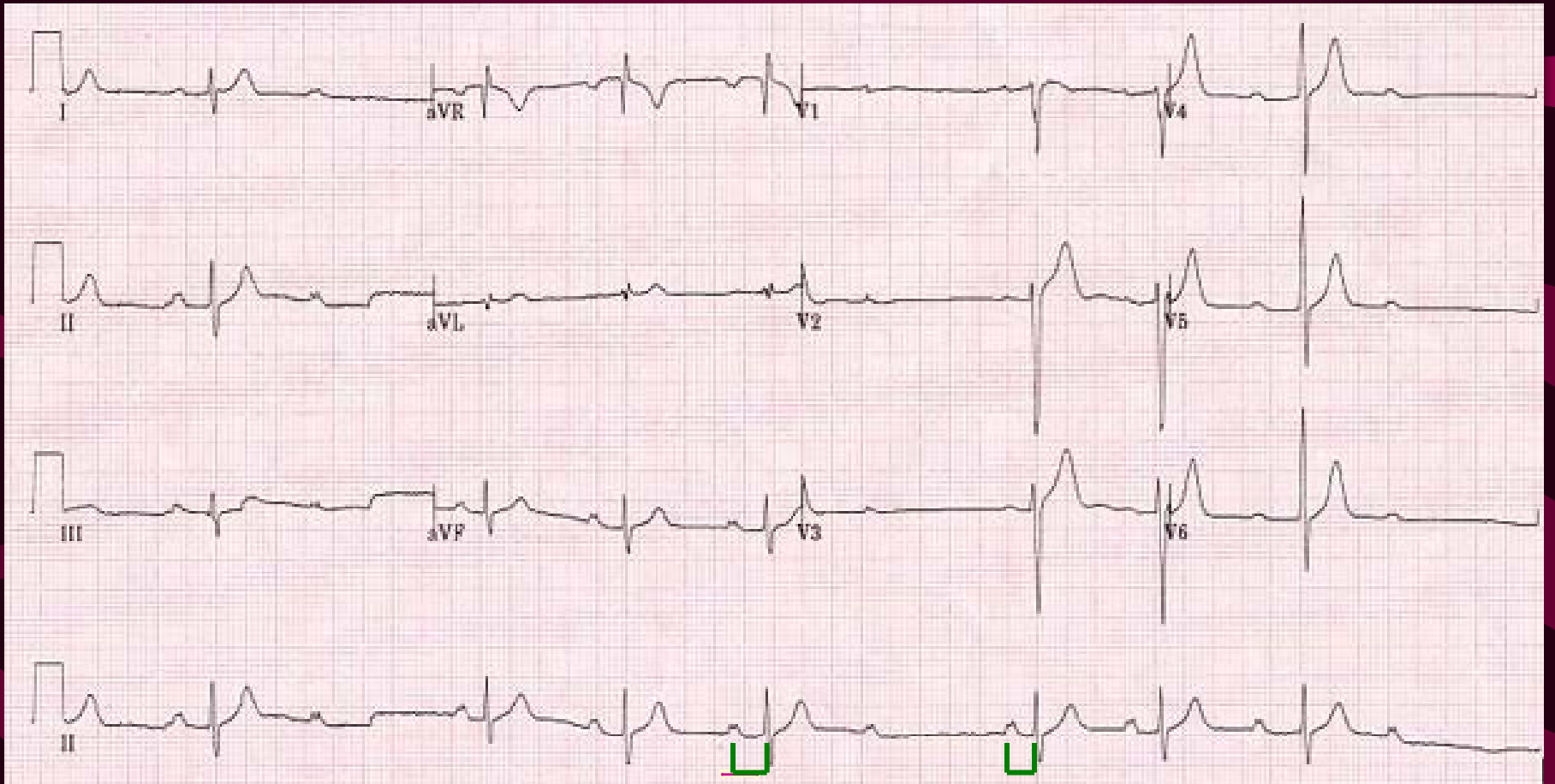
1/s 10mm/mV 150Hz 7.0.2 12SL 237 CID: 4

SID: M296125 EID:106 EDT: 19:11 04-MAY-2009 ORDER: 0503-0031 ACCOUNT: V00011306636

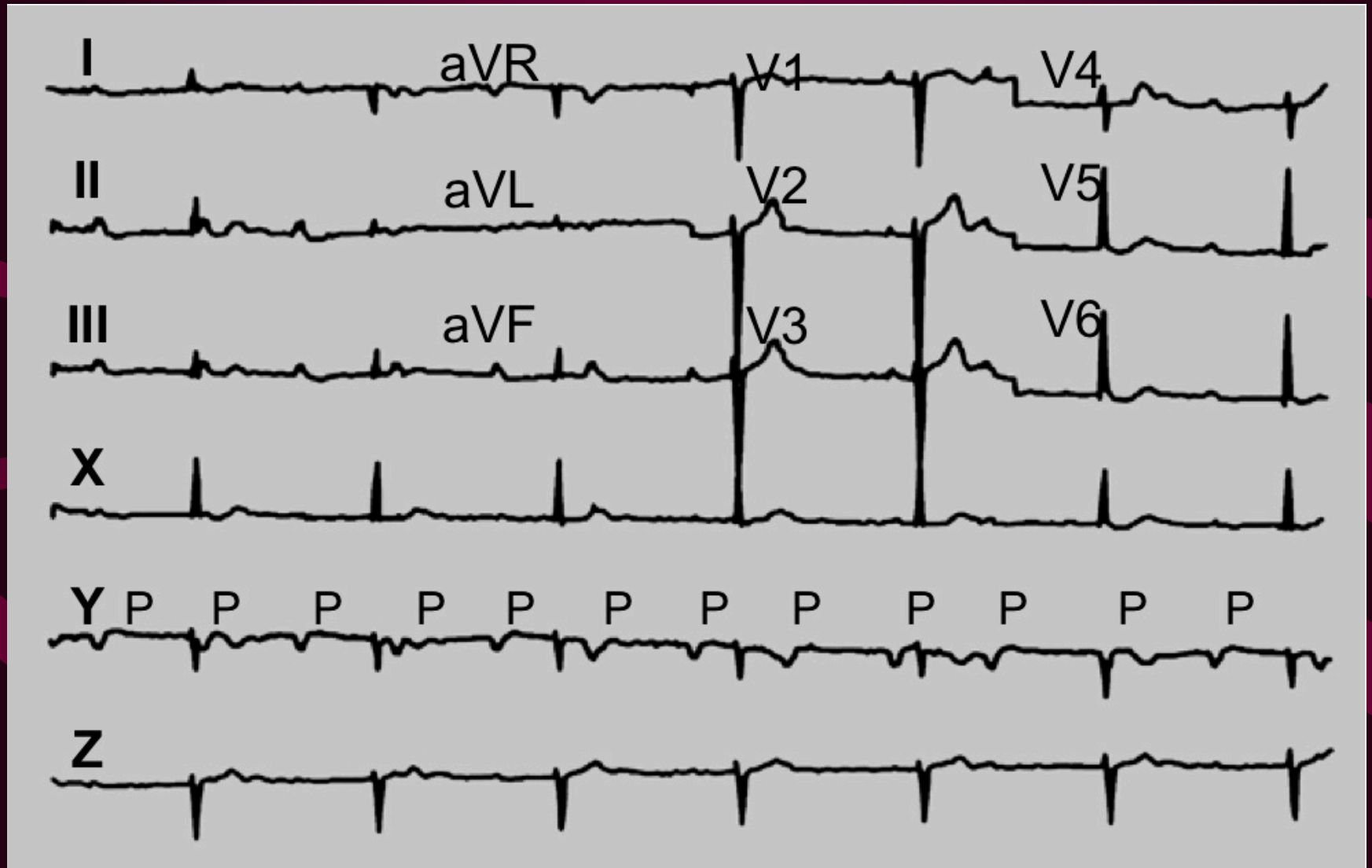
Heart Blocks on EKG

Classification of AV Blocks

- First Degree
 - PR interval fixed, >0.2 sec
- Second Degree
 - Type I (Wenckebach/Mobitz I)
 - PR gradually lengthened, then drop QRS
 - Type II (Mobitz II)
 - PR fixed, QRS drops randomly
- High degree AV Block
 - Momentary absence of conduction for several seconds
- Third Degree, Complete Heart Block
 - PR and QRS dissociated



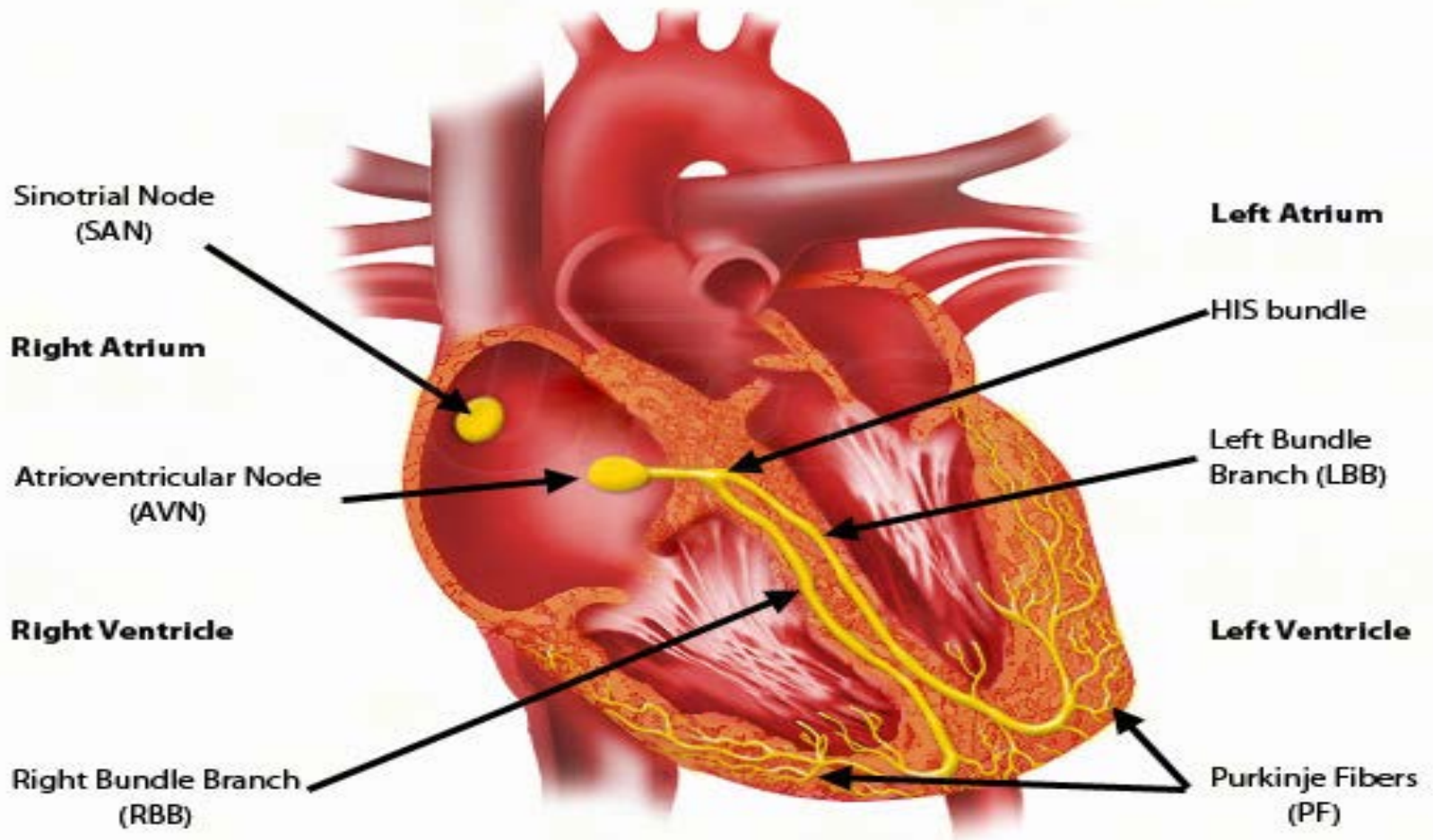
82 yo woman presents with fatigue



QRS duration

- Right Bundle Branch Block
- Left Bundle Branch Block
- If QRS duration is 120msec but waveform is not typical of RBBB or LBBB, diagnosis is intraventricular conduction delay

Cardiac Conduction system



Bundle Branch Blocks

- An obstruction in the transmission of impulses through one of the branches, either the left or the right, of the bundle of His
- A bundle branch block alone is not significant and requires no treatment
 - Understanding causes: MI, many types of heart disease. *Is it new?*

Bundle Branch Blocks- When is it Significant?

- A bundle branch block complicated by a 1st, 2nd, or 3rd degree AV block or by a fascicular block, especially when associated with an acute MI

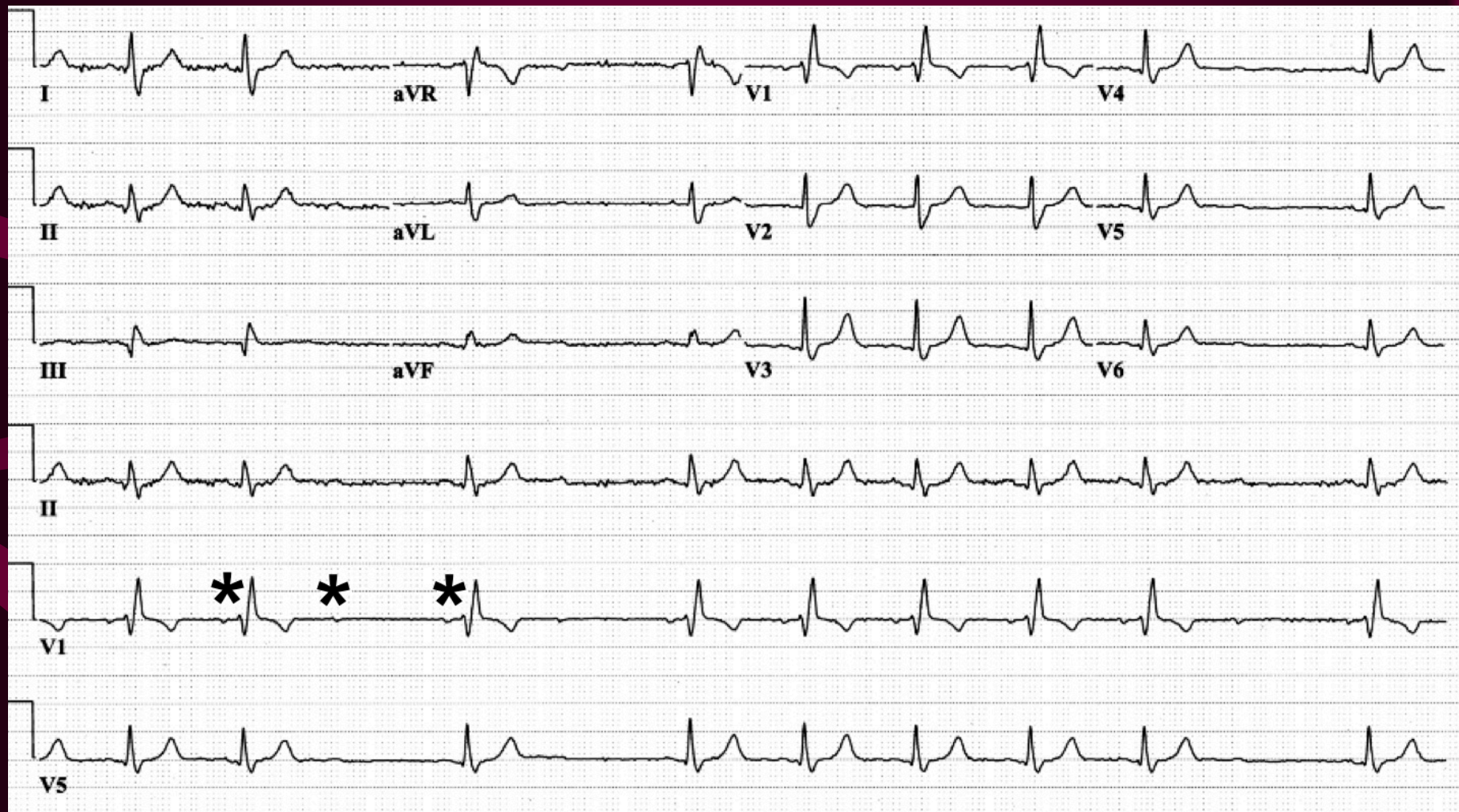
Fascicular Blocks (Hemiblocks)

- A fascicle is a bundle of Purkinje fibers – any main division of the ventricular conduction system is a fascicle
- There are 3 fascicles in the ventricular conduction system:
 - the Right Bundle Branch
 - the Anterior Division of the Left Bundle Branch
 - the Posterior Division of the Left Bundle Branch.

Right Bundle Branch Block

- QRS \geq 120 msec
- Secondary R wave (R') in V1 and V2 (rsR' or rSR')
- Delayed onset of intrinsicoid deflection in V1 and V2
- Secondary ST and T wave changes in V1 and V2
- Wide slurred S wave in I, V5, V6

75 year old man



LAFB- Left Anterior Fascicular Block

- Left axis deviation
 - With no other responsible factors to explain it
- qR complex (or an R wave) in leads I and aVL
- rS complex in lead III
- Normal or slightly prolonged QRS duration

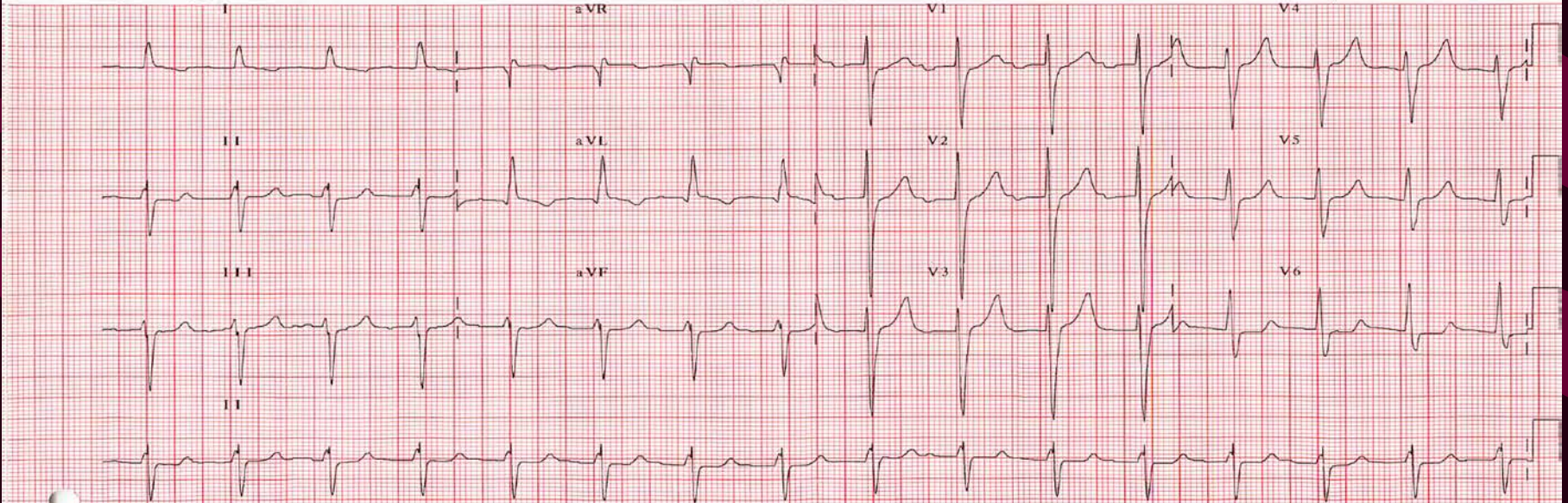
LAFB

Rate 93 . SINUS OR ECTOPIC ATRIAL RHYTHM, RATE 93.....P axis (135,-45) or indeterminate
PR 178 . LEFT ANTERIOR FASCICULAR BLOCK.....axis(240,-40), I:40 inf
QRSD 112 . PROBABLE LEFT VENTRICULAR HYPERTROPHY.....LVH voltage with LAA or LAD
QT 381
QTc 474

--Axis--
P 233
QRS -52
T 120

- ABNORMAL ECG -

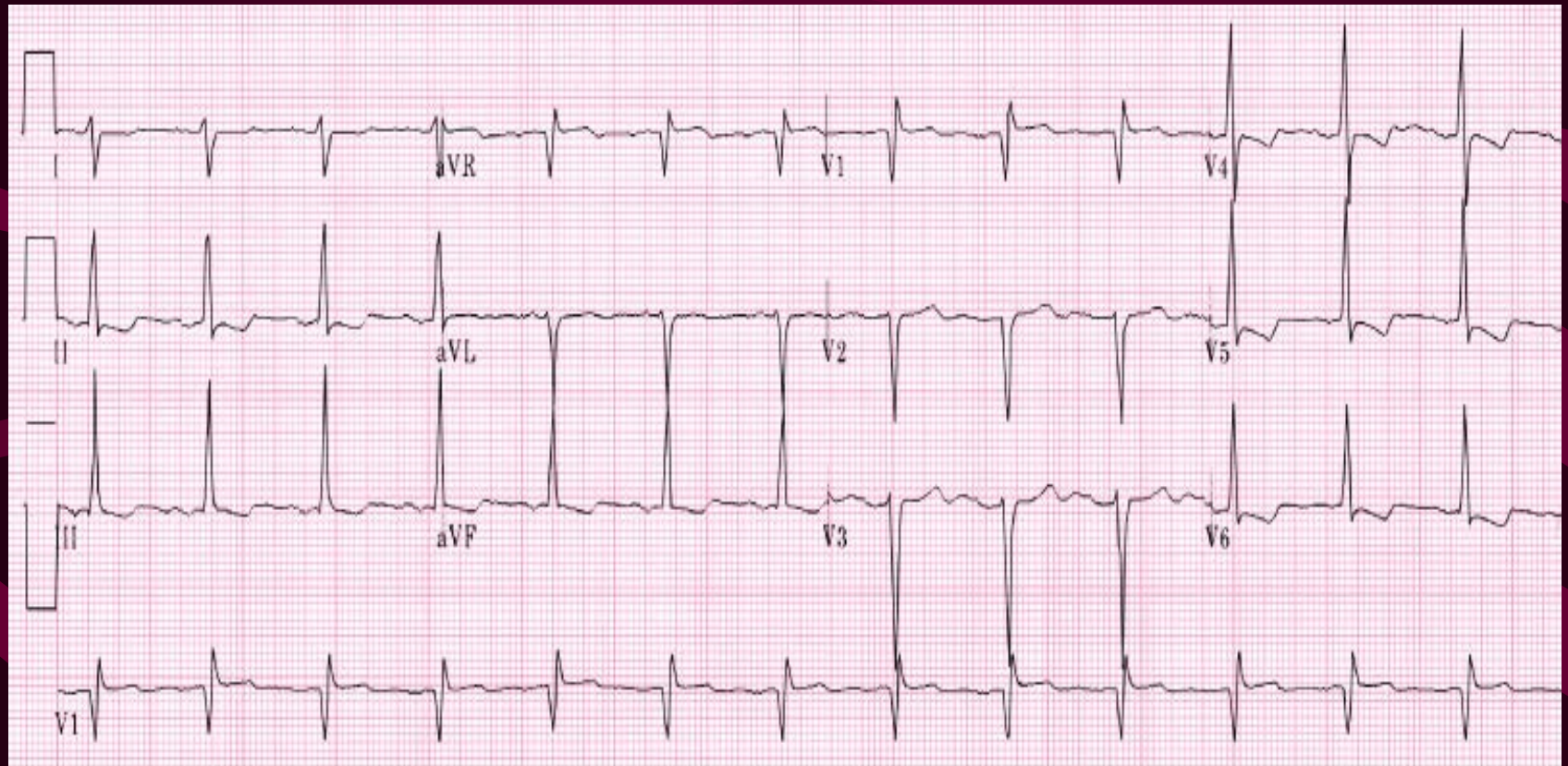
Unconfirmed diagnosis.



LPFB- Left Posterior Fascicular Block

- Right axis deviation
 - With no other responsible factors to explain it
- Normal or slightly prolonged QRS duration
- rS complex in I and aVL
- Tall R wave II, III and aVF

LPFB



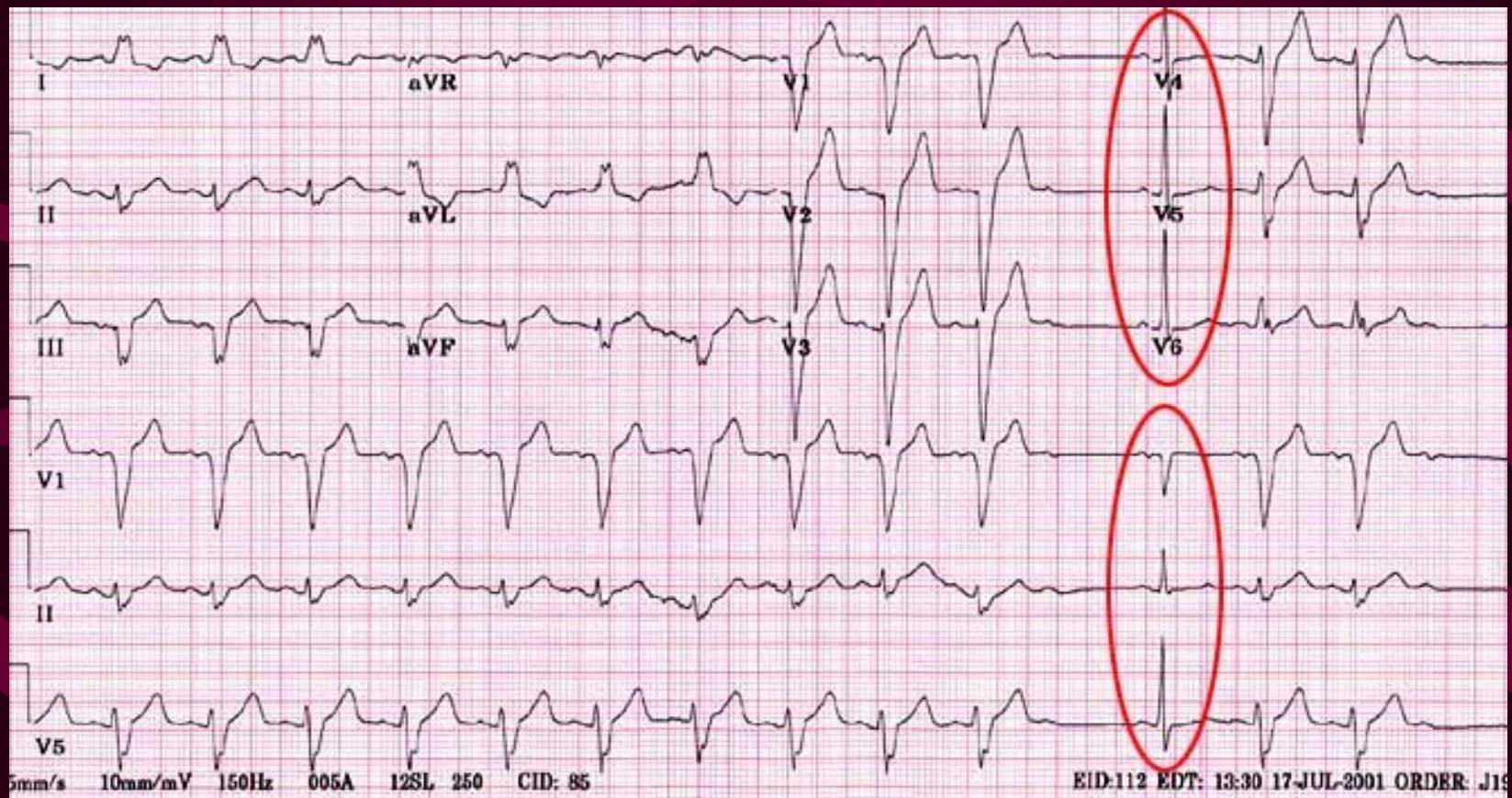
Source: Knoop KJ, Stack LB, Storrow AB, Thurman RJ: *The Atlas of Emergency Medicine, 3rd Edition*: <http://www.accessmedicine.com>

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Left Bundle Branch Block

- Prolonged QRS duration ≥ 120 msec
- Delayed onset of intrinsicoid deflection in V5 and V6
- Broad monophasic R waves in I, V5 and V6 that are usually notched or slurred
- Secondary ST and T wave changes opposite in direction to the major QRS deflection
- rS or QS complex in right precordial leads

LBBB



Nonspecific intraventricular conduction delay/disturbance

- QRS \geq 110msec but morphology does not meet criteria for RBBB/LBBB
- Seen with:
 - Antiarrhythmic drug toxicity (esp. IA and IC agents)
 - Hyperkalemia
 - LVH
 - WPW
 - Hypothermia
 - Severe metabolic disturbances

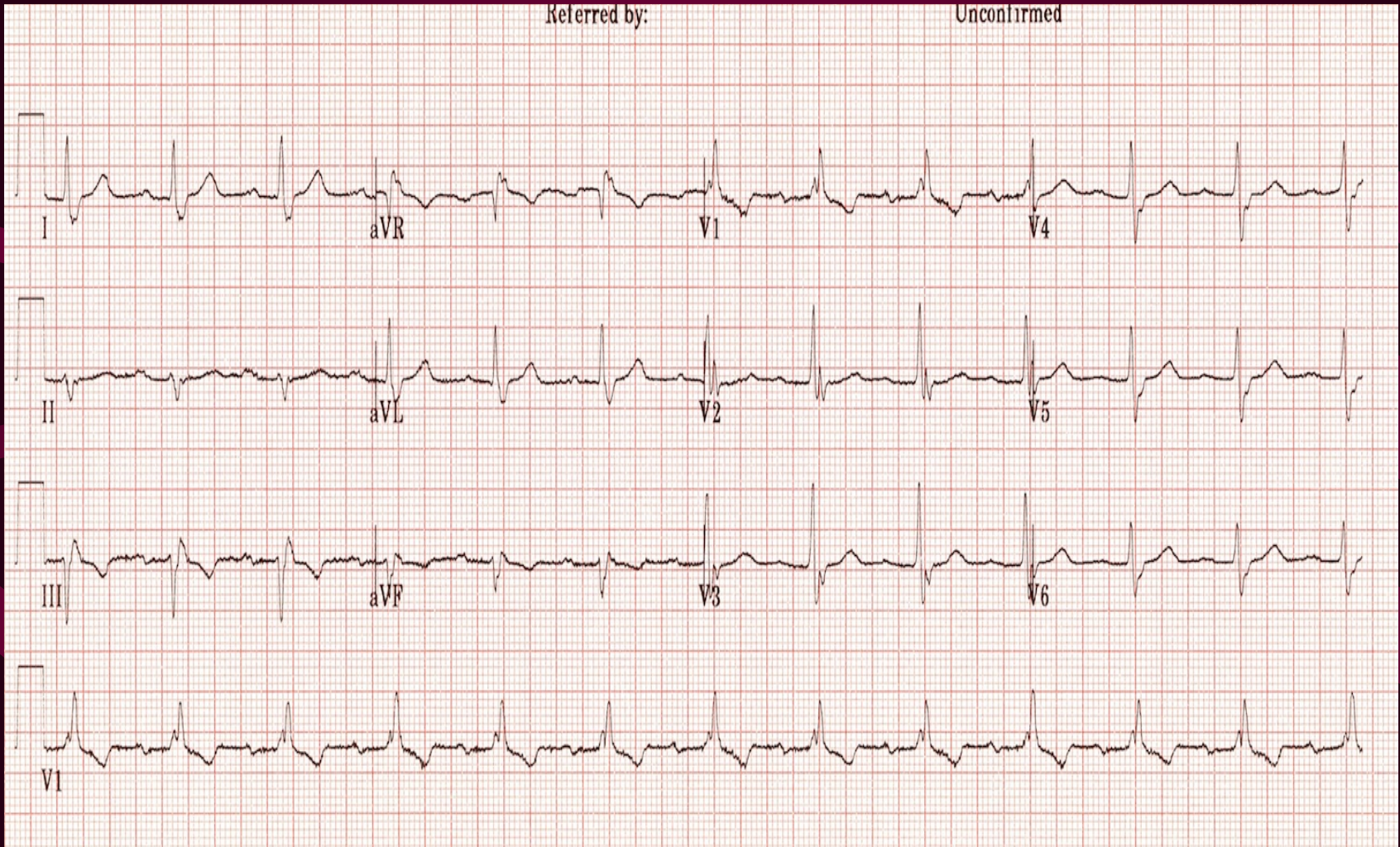
Trifascicular Block

- 1st Degree AV Block
- RBBB
- LAFB or LPFB
- Cardiology referral
 - Is the prolonged PRi due to AV node disease or diffuse distal conduction system disease? only an EP study can differentiate
 - Treatment = Pacemaker, especially if symptomatic

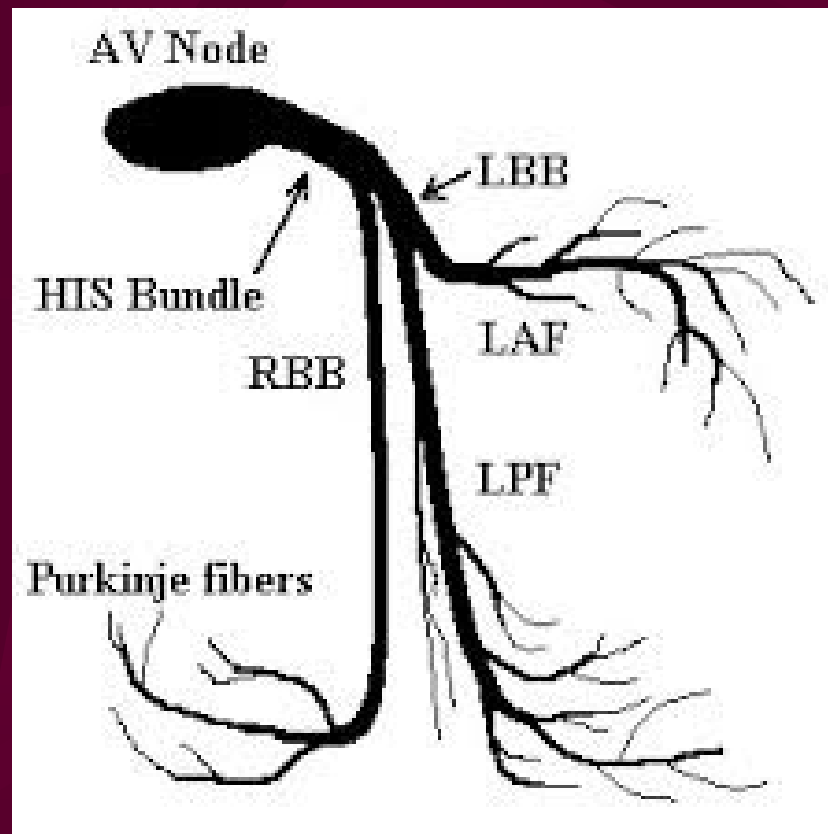
Trifascicular Block

Referred by:

Unconfirmed



Where is the Block?

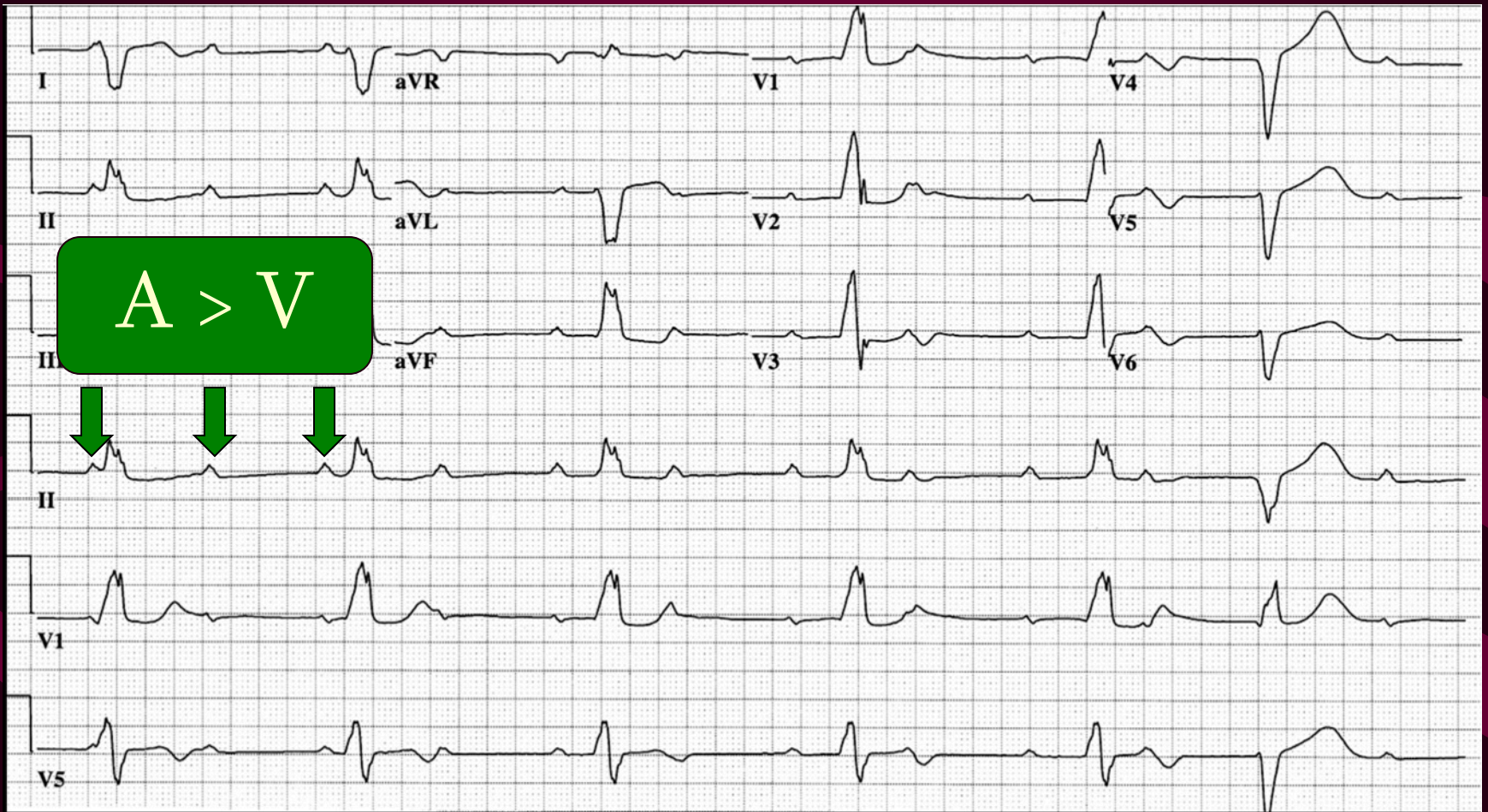


25mm / sec 10mm / mV

Mobitz II



60 yo man with lightheadedness



Overview

- Heart Rate
- Rhythm
- Intervals
- Axis
- Voltage
- R Wave Progression
- Q Wave
- ST Segments
- T waves
- Device Involvement