ECG THE BASICS

By Dr Tilahun Jiru

outline

- Introduction to ECG
- Normal ECG
- Reading ECG
- Rate, Rhythm, Axis, Hypertrophy
- Common Electrolyte abnormality ECG finding

What is an EKG?

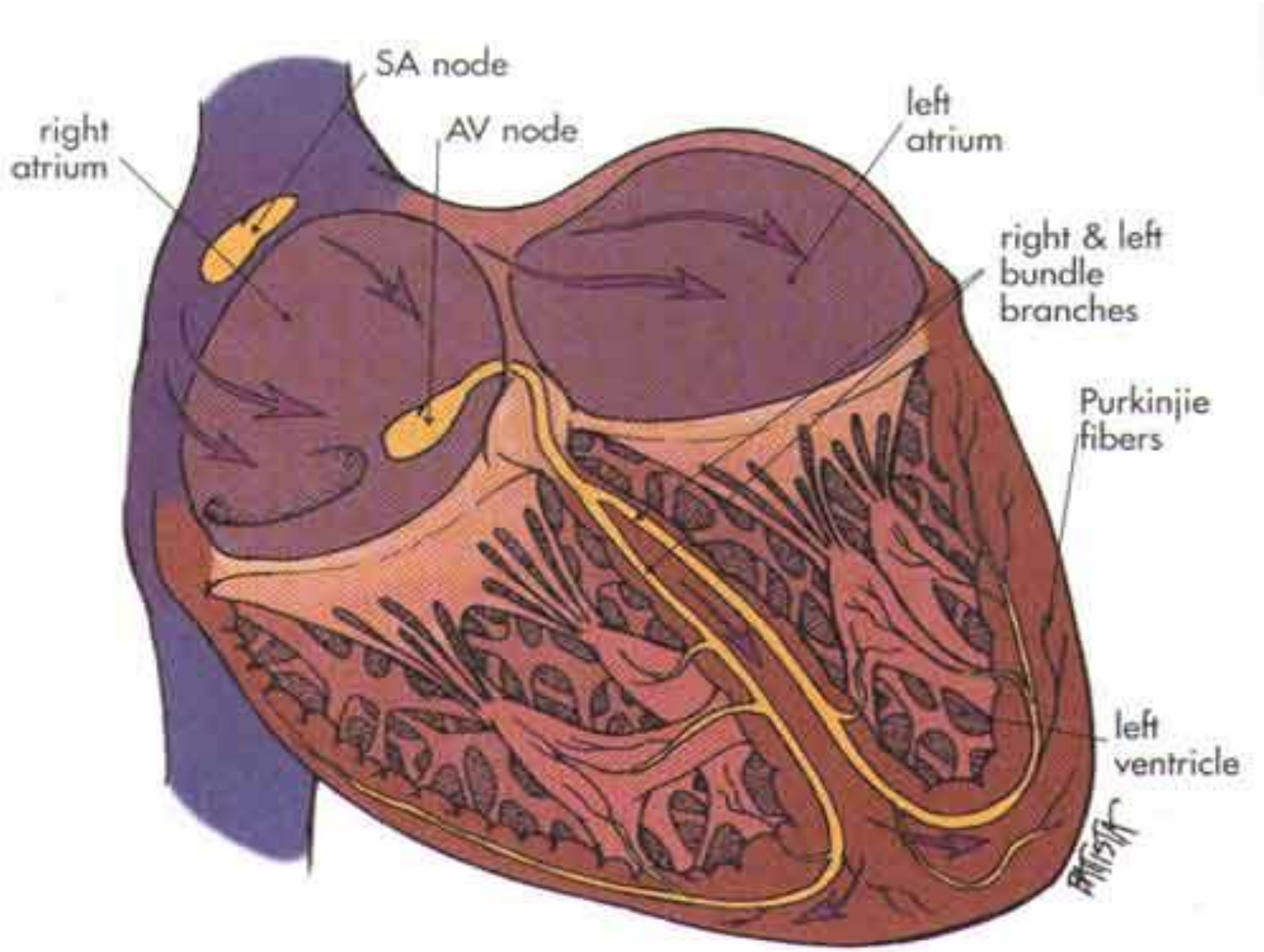
- An EKG is a method of measuring, displaying and recording the electrical activity of a heart

- Electrical stimuli is amplified to create a "rhythm strip" by a machine that consistently produces representations of the heart's electrical activity

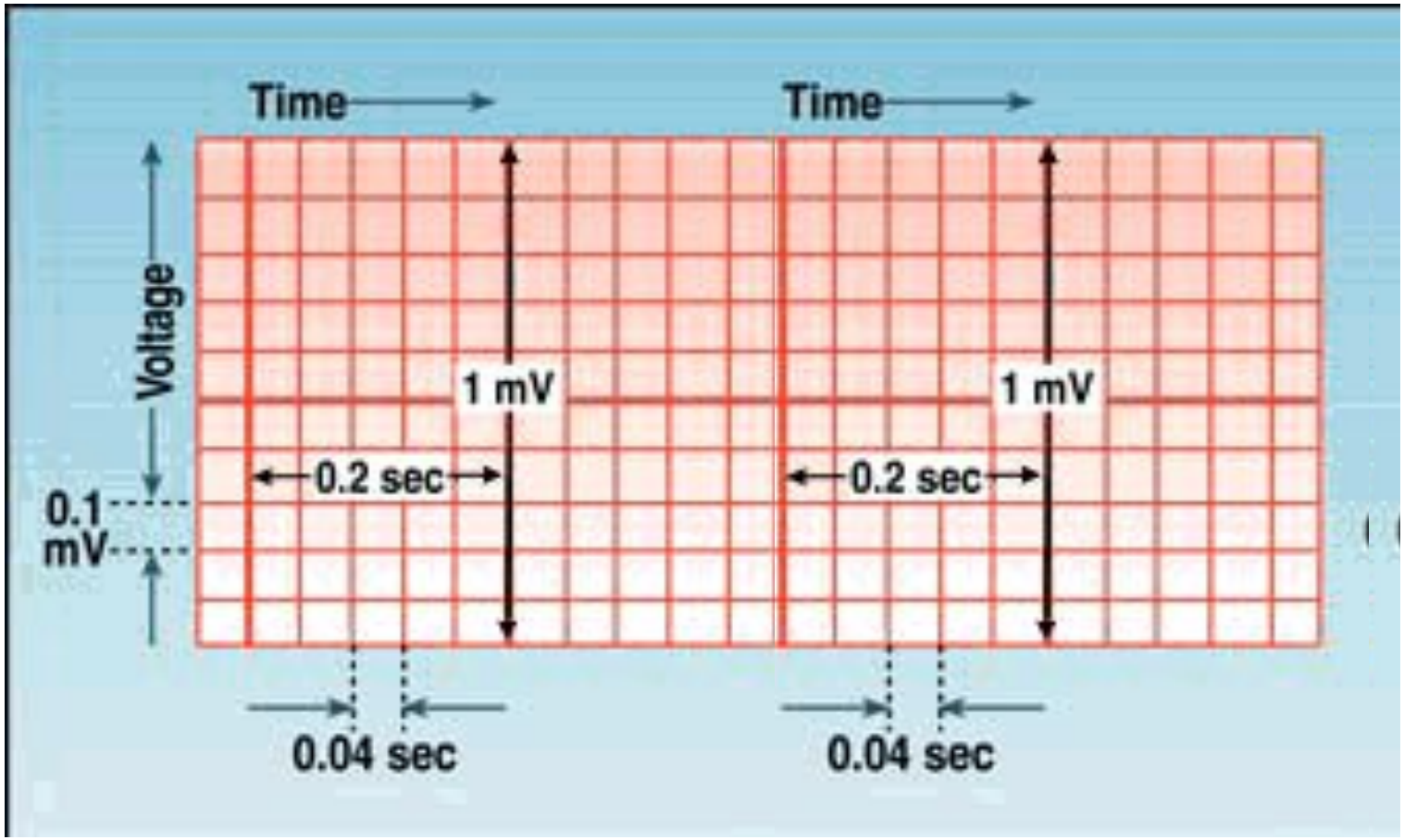
What types of pathology can we identify and study from EKGs?

- Arrhythmias
- Myocardial ischemia and infarction
- Pericarditis
- Chamber hypertrophy
- Electrolyte disturbances (i.e. hyperkalemia, hypokalemia)
- Drug toxicity (i.e. digoxin and drugs which prolong the QT interval)

Electrical System of Heart



ECG Graph Paper



Y- Axis Amplitude in mill volts

X- Axis time in seconds

ECG Complex

P wave

PR Interval

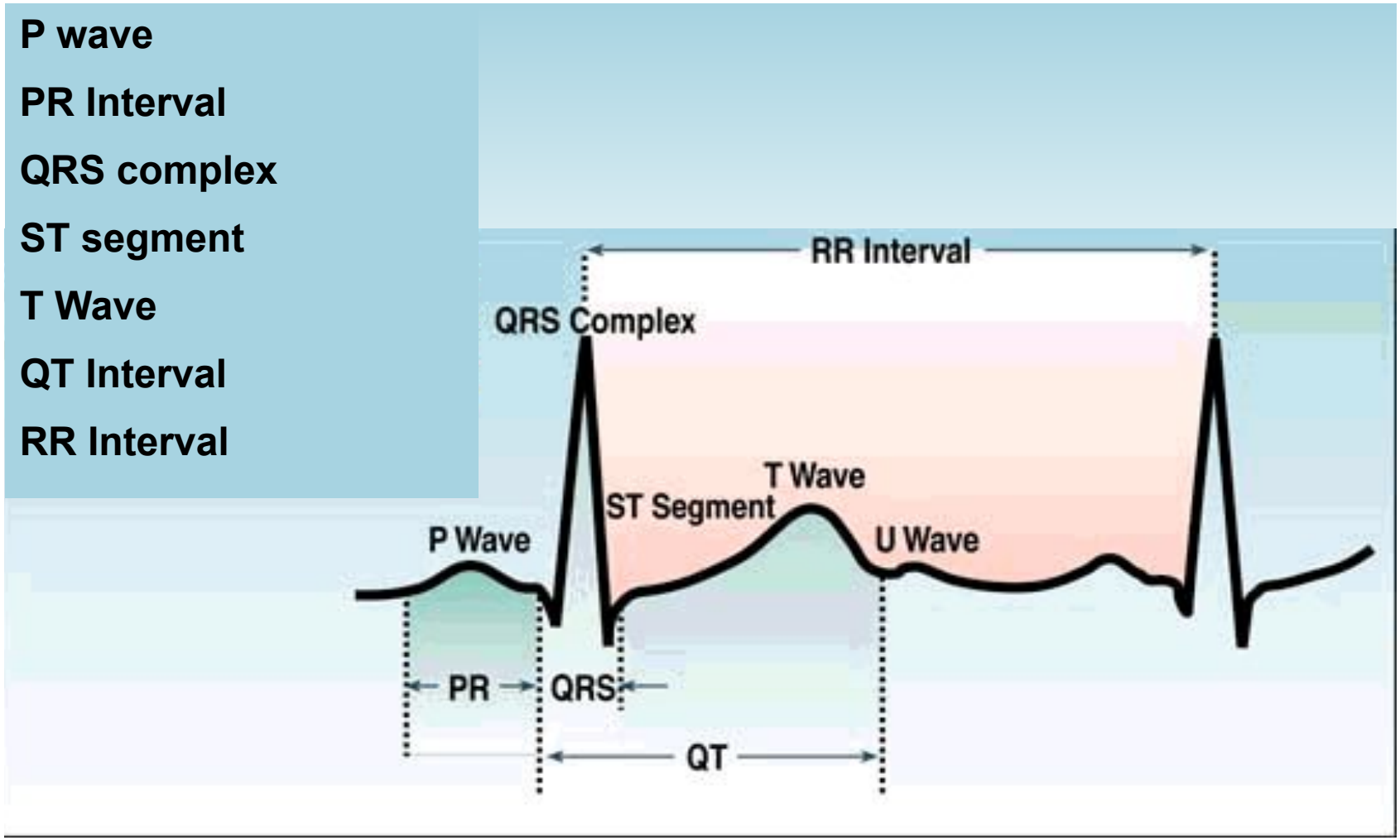
QRS complex

ST segment

T Wave

QT Interval

RR Interval



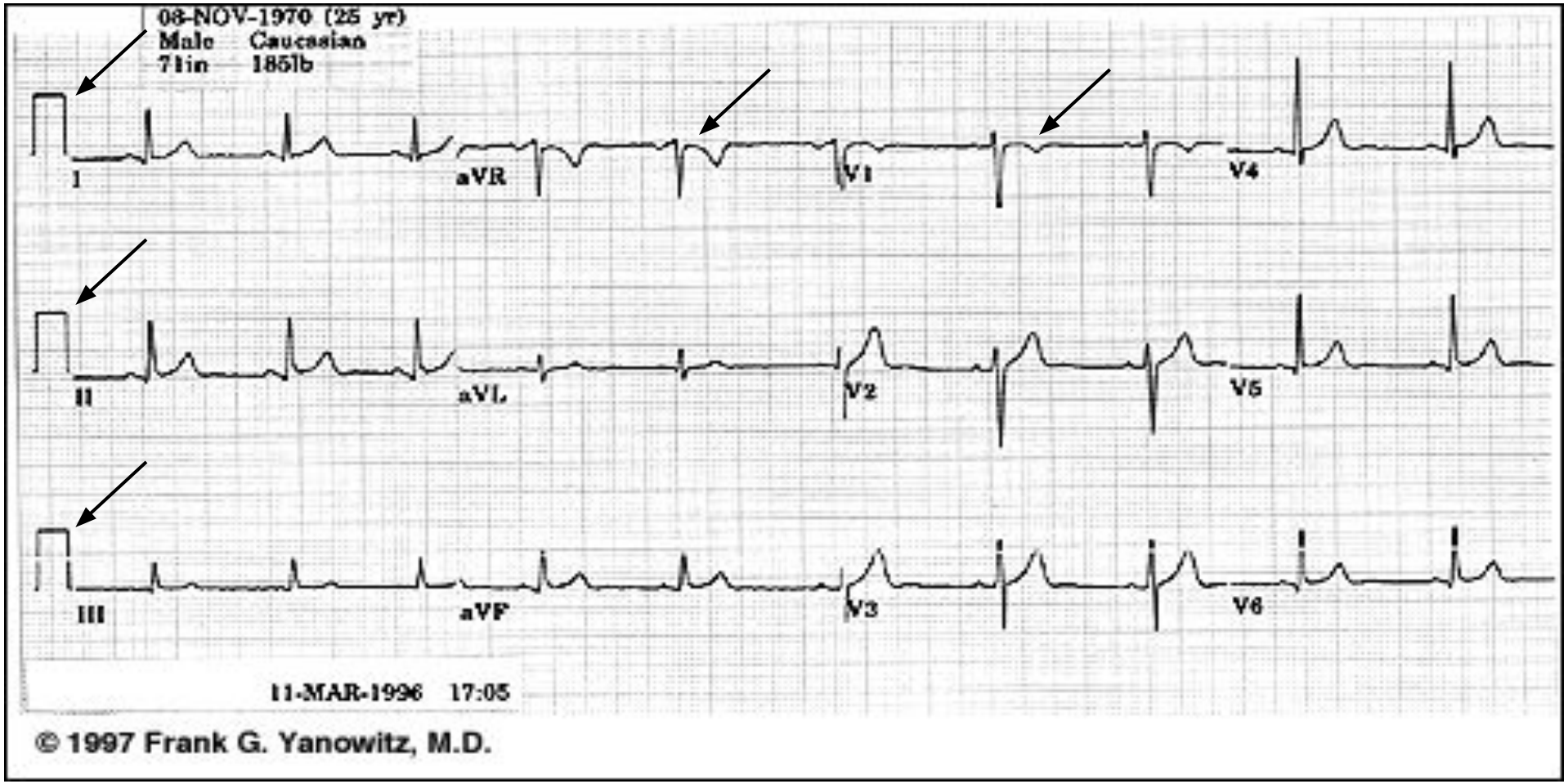
ECG Complex

- P Wave is Atrial contraction – Normal 0.12 sec
- PR interval is from the beginning of P wave to the beginning of QRS – Normal up to 0.2 sec
- QRS is Ventricular contraction –Normal 0.12 sec
- ST segment – Normal Isoelectic (electric silence)
- QT Interval – From the beginning of QRS to the end of T wave – Normal – 0.40 sec

Let us Identify the waves

- Q wave – Septal = < 3 mm, < 0.04 sec (1 small box)
- R wave – Ventricular contraction < 15 mm
- S wave – complimentary to R < 15 mm
- ST segment – Isoelectric – decides our fate
- T wave – ventricular repolarization – friend of ST
- TP segment – ventricular relaxation – shortened in tachycardia

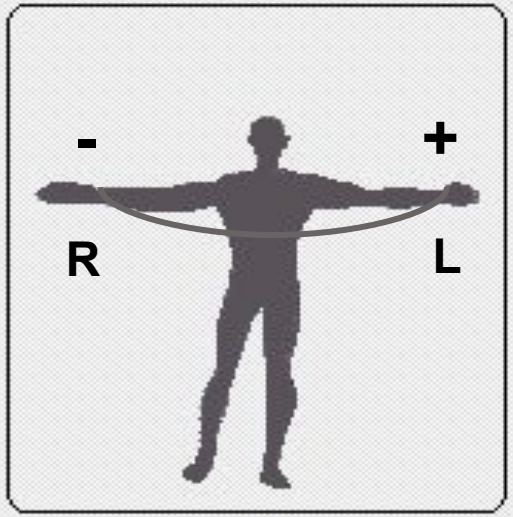
Normal ECG


08-NOV-1970 (25 yr)
Male Caucasian
71in 185lb
I
aVR
V1
V4
II
aVL
V2
V5
III
aVF
V3
V6
11-MAR-1996 17:05
© 1997 Frank G. Yanowitz, M.D.

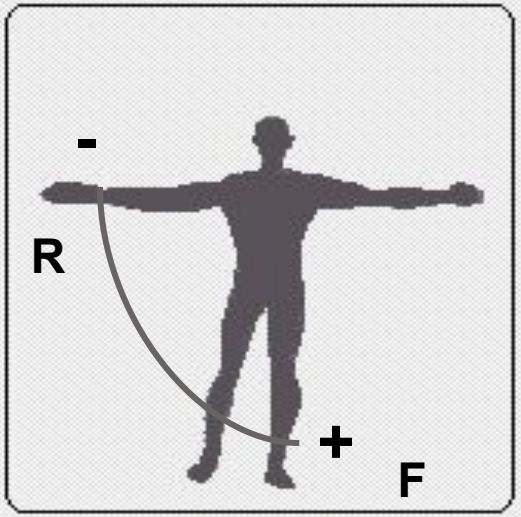
ECG Leads

- Standard ECG is recorded in 12 leads
- Six Limb leads – L1, L2, L3, aVR, aVL, aVF
- Six Chest Leads – V1 V2 V3 V4 V5 and V6
- L1, L2 and L3 are called bipolar leads
- L1 between LA and RA
- L2 between LF and RA
- L3 between LF and LA

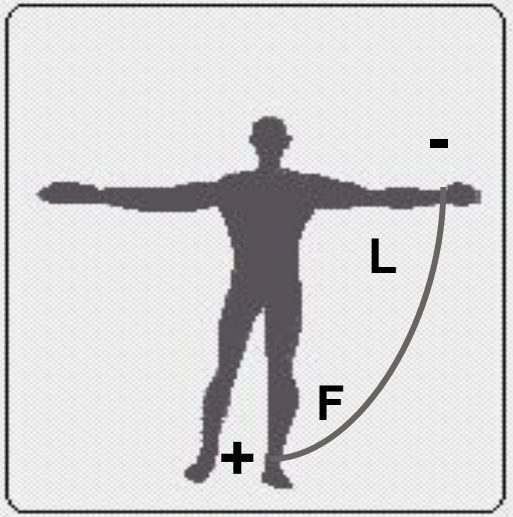
ECG Bipolar Limb Leads



Lead I

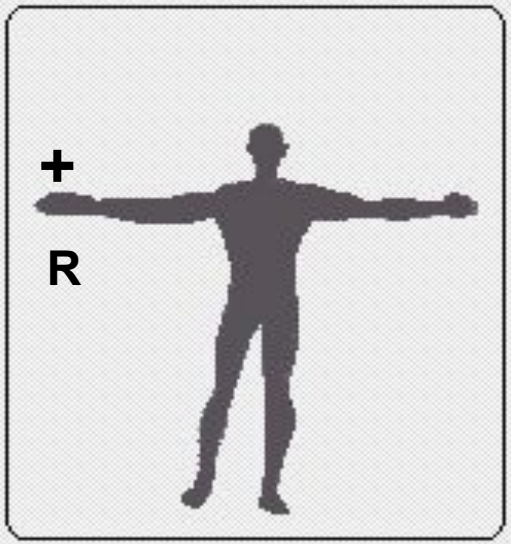


Lead II

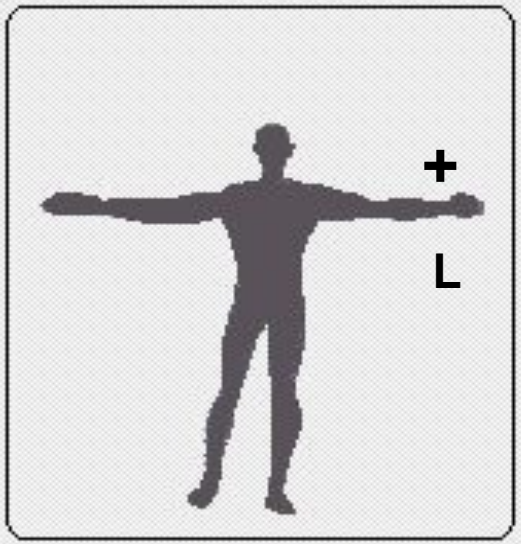


Lead III

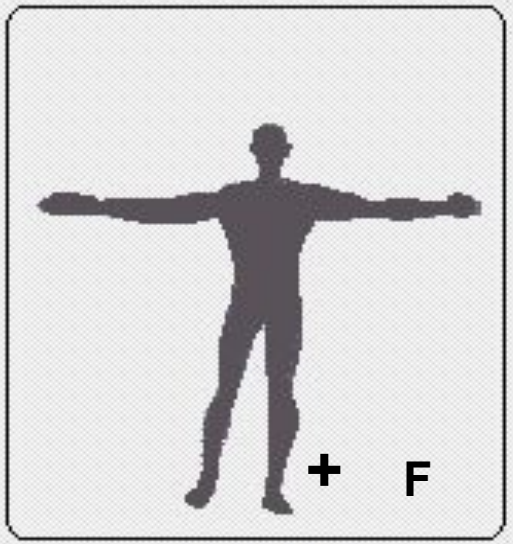
ECG Unipolar Limb Leads



Lead aVR

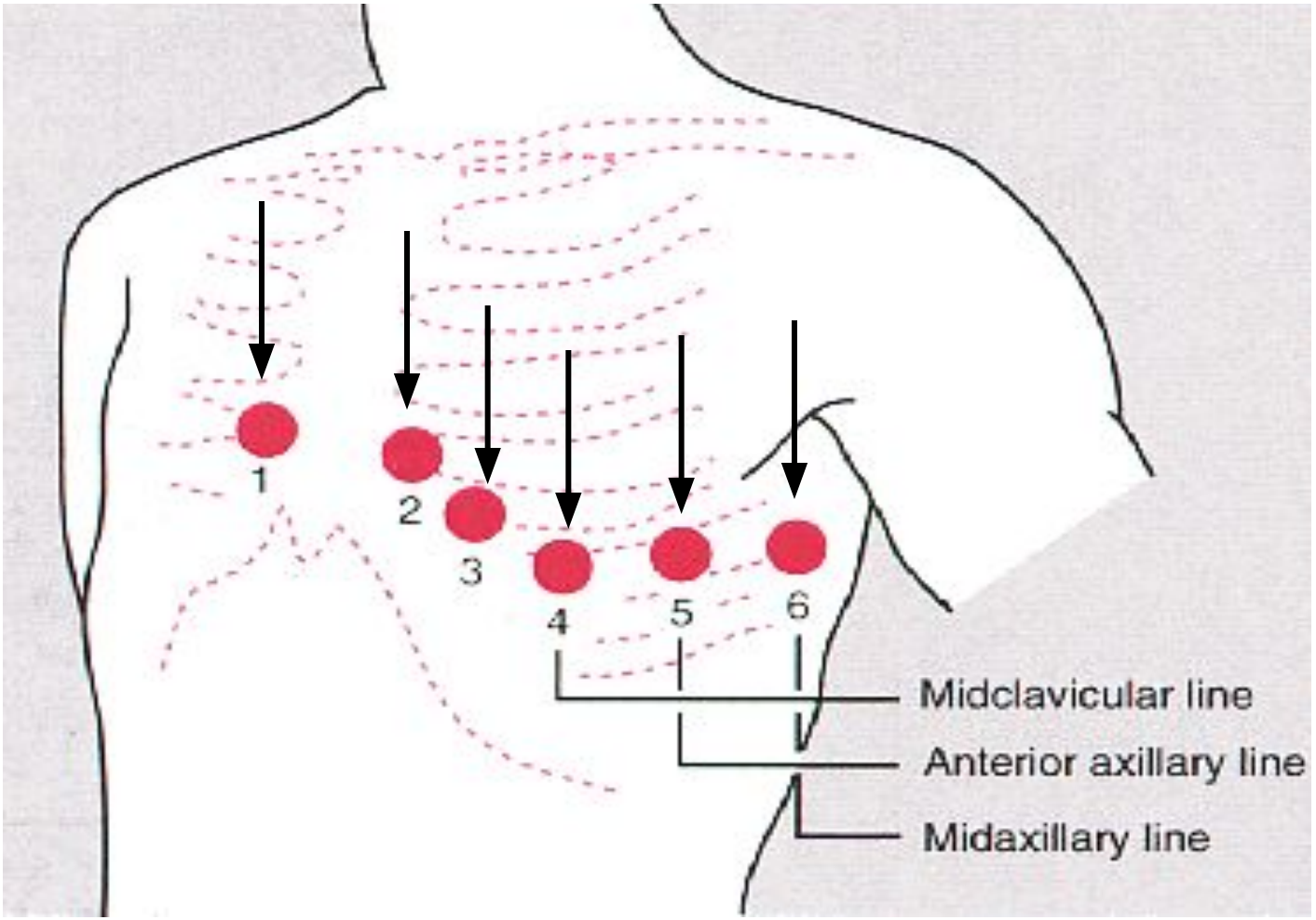


Lead aVL



Lead aVF

ECG Chest Leads

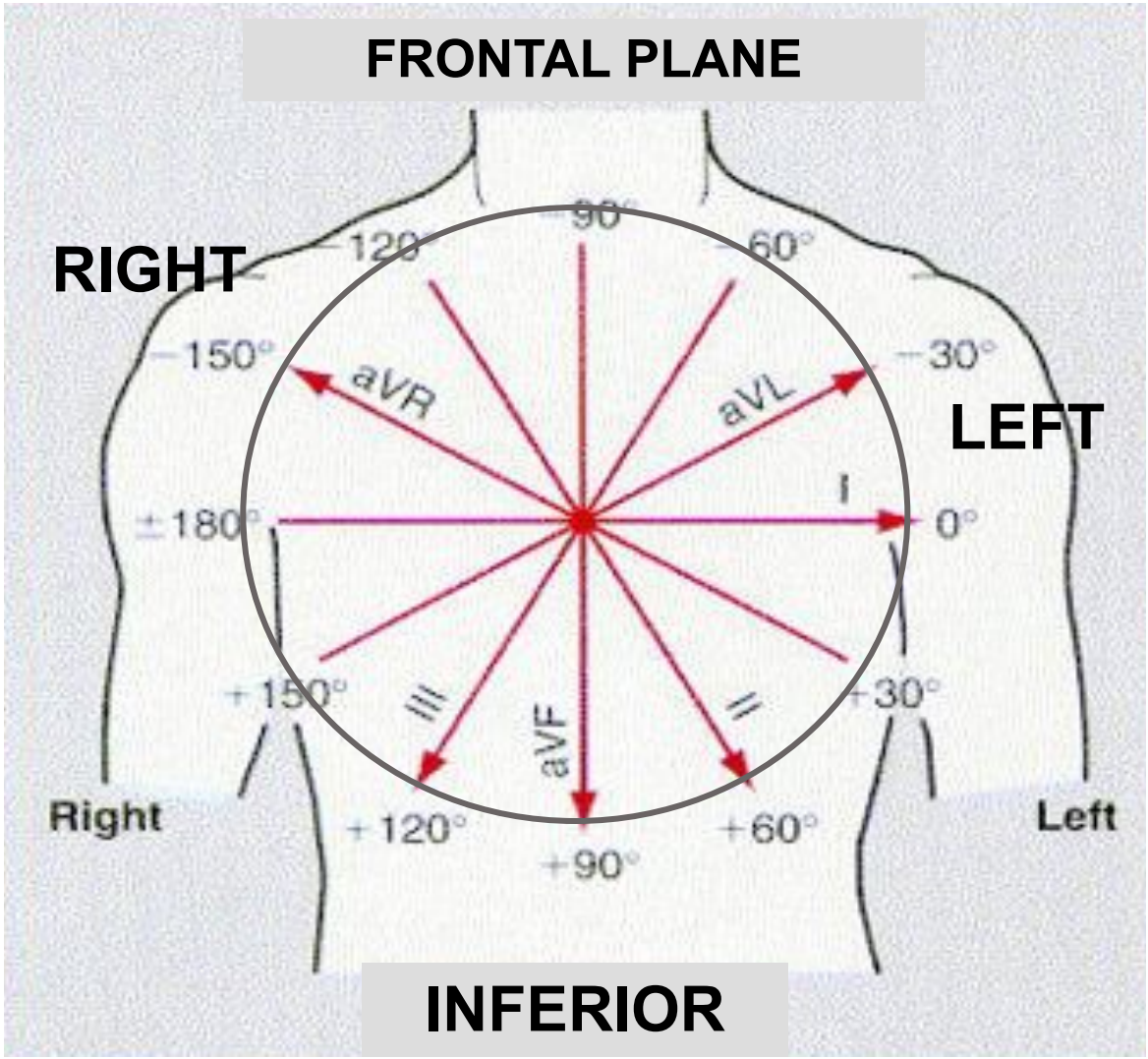


ECG Chest Leads

Precardial (chest) Lead Position

- V1 Fourth ICS, right sternal border
- V2 Fourth ICS, left sternal border
- V3 Equidistant between V2 and V4
- V4 Fifth ICS, left Mid clavicular Line
- V5 Fifth ICS Left anterior axillary line
- V6 Fifth ICS Left mid

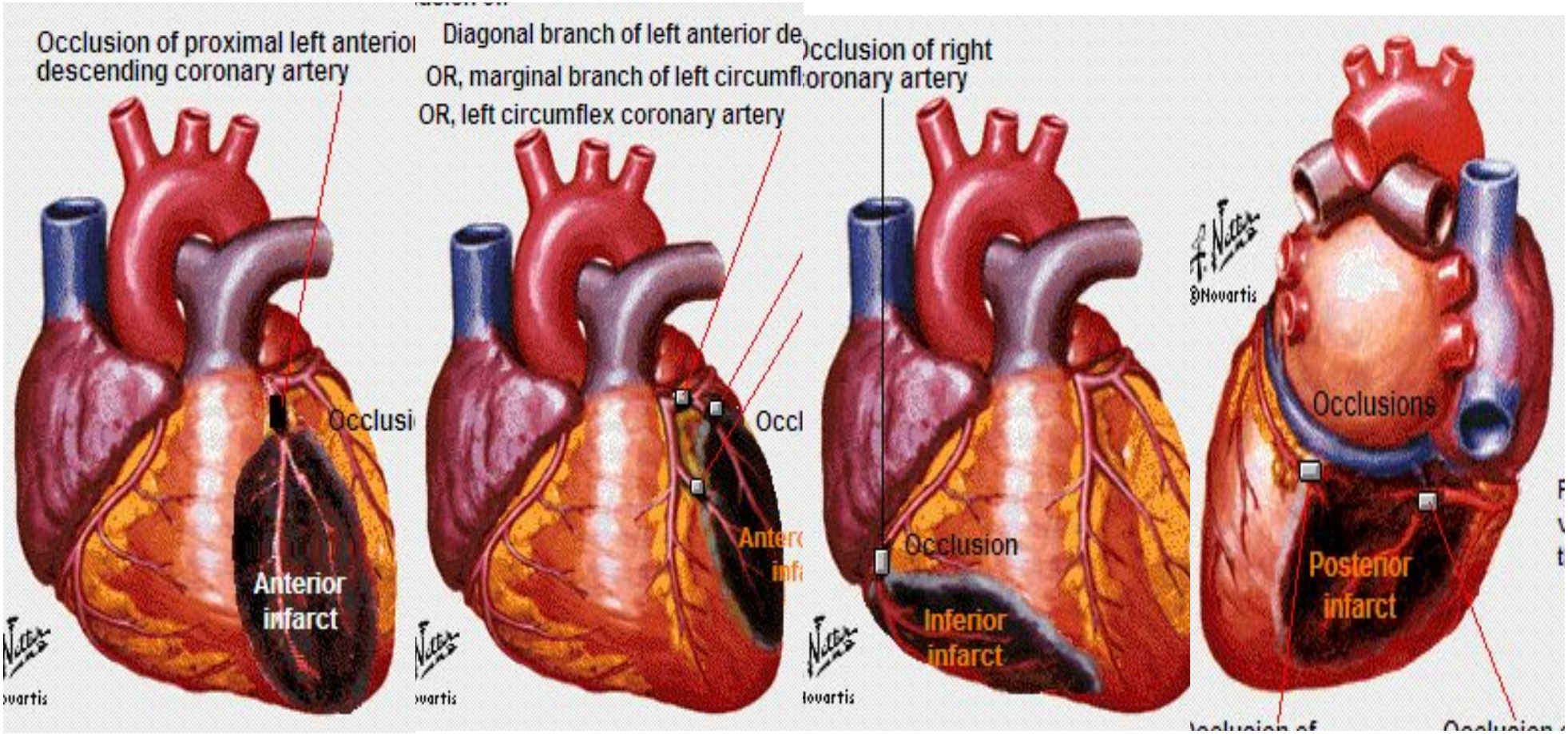
The Six Limb Leads



The 12 Camera Photography

- aVR is horizontal Rt. sided camera (cavitary lead)
- Lateral Leads – L1, aVL, V5 and V6
- Septal Leads – V1 and V2
- Anterior Leads – V3 and V4
- Anterio-lateral leads – V3, V4, V5, V6, L1 and aVL

To record Rt side events like RV infarcation we need right side lead like V4R to V6R



ANTERIOR	LATERAL	INFERIOR	POSTERIOR
LAD	LAD or LCx	RCA	RCA + LCx
V1, V2, V3, V4	V5, V6, L1, aVL	L2, L3, aVF	V1, V2 Mirror

How do you read ECG?

1. Rhythm
2. Rate
3. Regularity
4. Axis
5. Waves, segments and interval
6. Chamber enlargement

Begin to recognize Rhythm

Step 1- Are there P wave
Step 2- Are there QRS wave
Step 3- Are P waves and QRS waves related?

Determine Heart rate

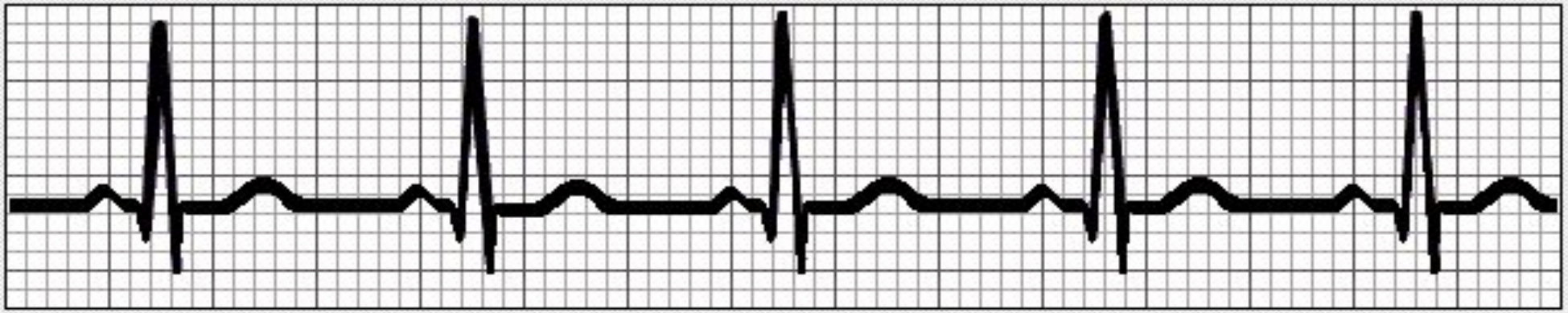
1. Rule of 300--- for regular rhythm

300/number of large box or 1500/number of small box

2. Rule of 10 second--for irregular rhythms.

As most EKGs record 10 seconds of rhythm per page, one can simply count the number of beats present on the EKG and multiply by 6 to get the number of beats per 60 seconds.

What is the Heart Rate ?



What is the heart rate shown in the tracing above?

- ☐ 50/minute
- ☐ 75/minute
- ☐ 100/minute
- ☐ 83/minute

Answer on next slide

What is the heart rate?

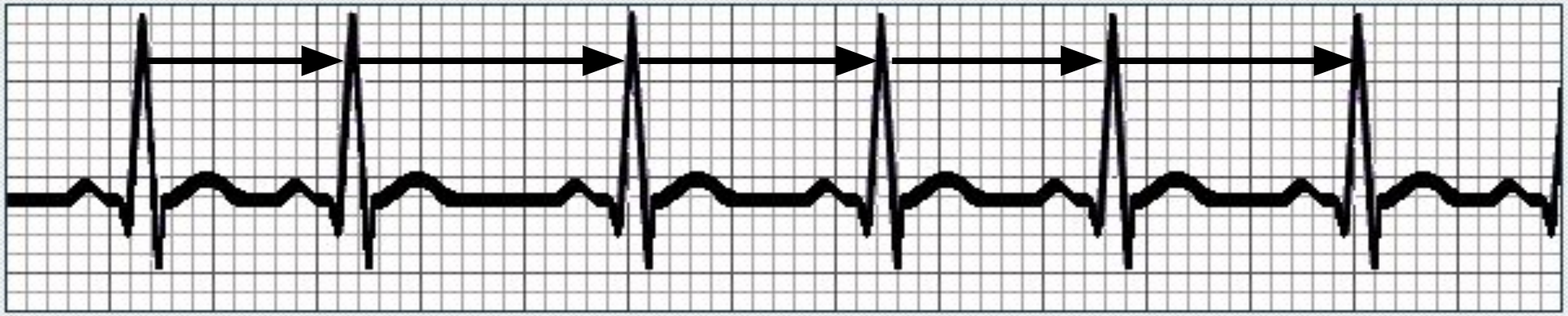
(300 / ~ 4) = ~ 75 bpm

What is the heart rate?

The Alan E. Lindsay ECG Learning Center ; http://medstat.med.utah.edu/kw/ecg/

33 x 6 = 198 bpm

What is the Heart Rate ?

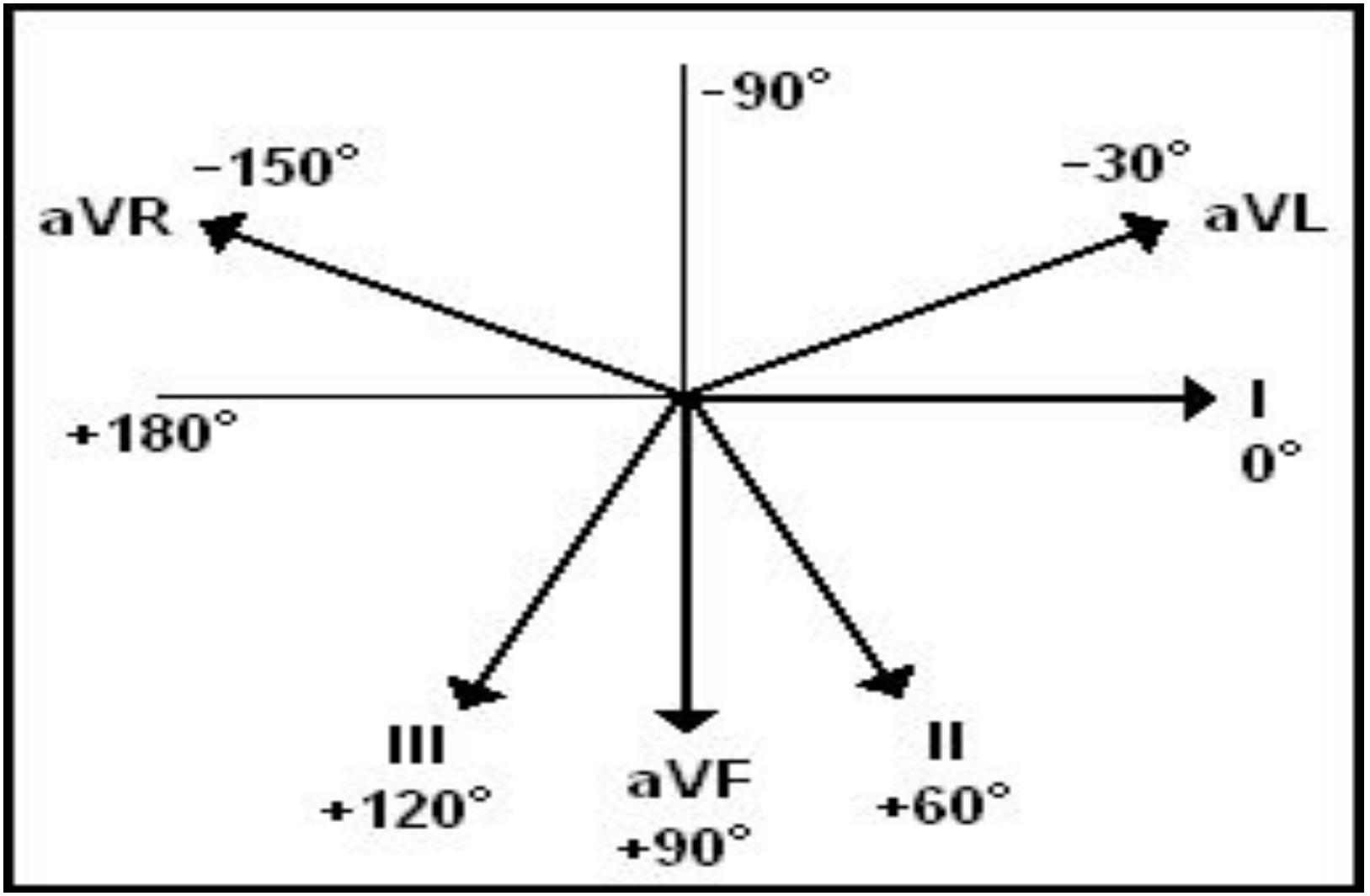


What is the heart rate shown in the tracing above?

- ☐ Approximately 67/minute
- ☐ Approximately 75/minute
- ☐ About 98/minute
- ☐ None of the above. It has an irregular rhythm.

Answer on next slide

Determining Axis



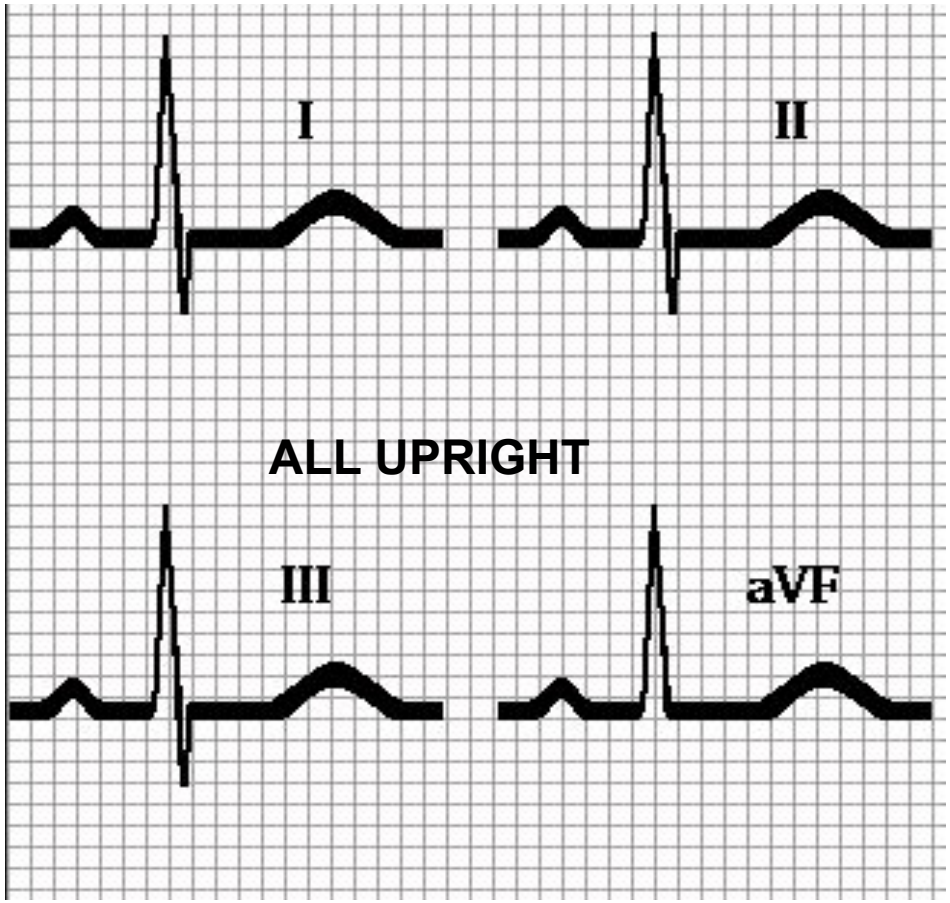
Axis

- The QRS electrical (vector) axis can have 4 directions
- Normal Axis - when it is downward and to the left – southeast quadrant – from -30 to +90 degrees
- Right Axis – when it is downward and to the right – southwest quadrant – from +90 to 180 degrees
- Left Axis – when it is upward and to the left – Northeast quadrant –from -30 to -90 degrees
- Indeterminate Axis – when it is upward & to the right – Northwest quadrant – from -90 to +180

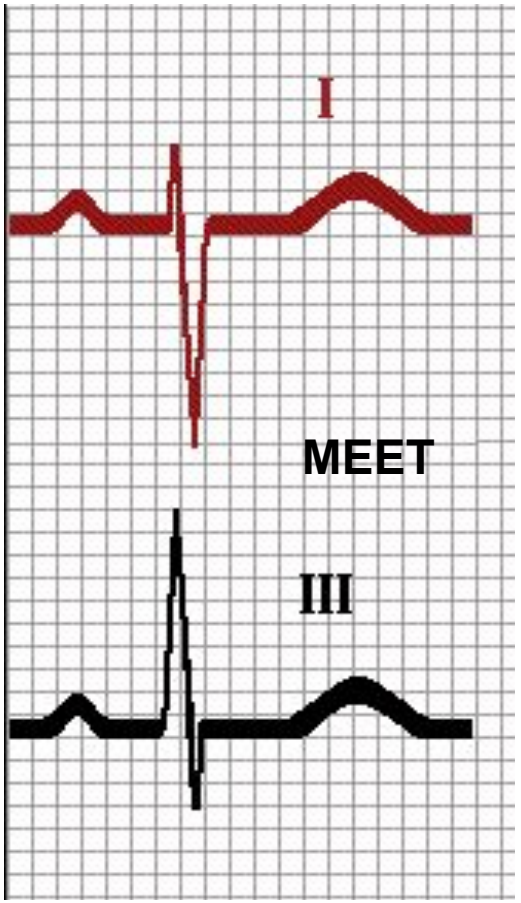
Calculating the cardiac axis

	Normal axis	Right axis deviation	Left axis deviation
Lead I	Positive	Negative	Positive
Lead II	Positive	Positive or negative	Negative
Lead III	Positive or negative	Positive	Negative

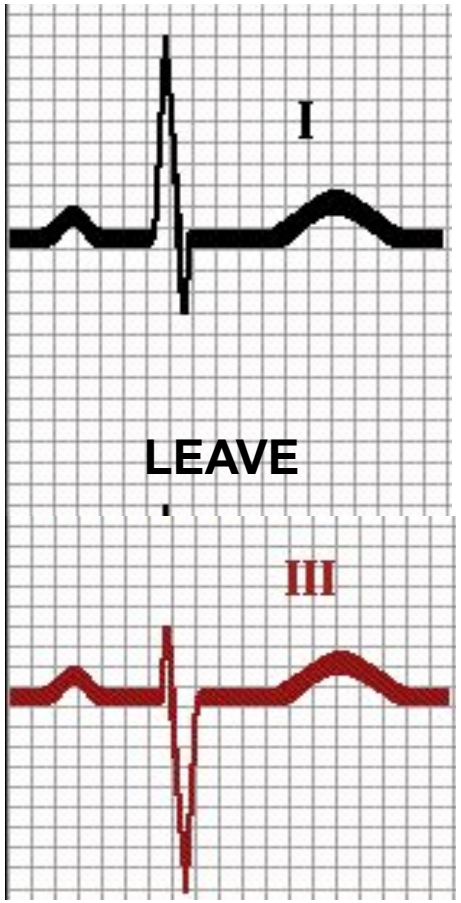
Axis Determination



NORMAL

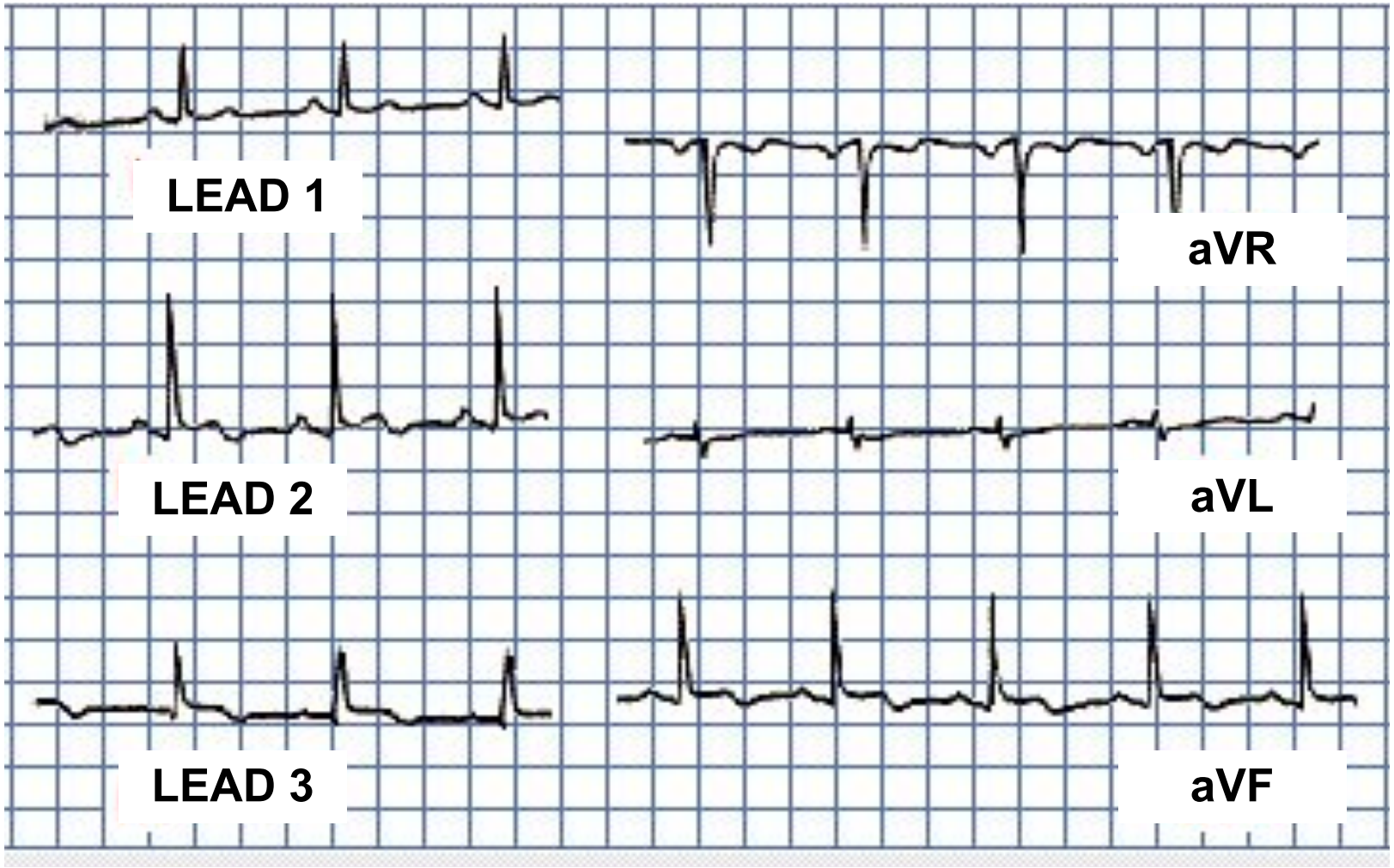


RIGHT

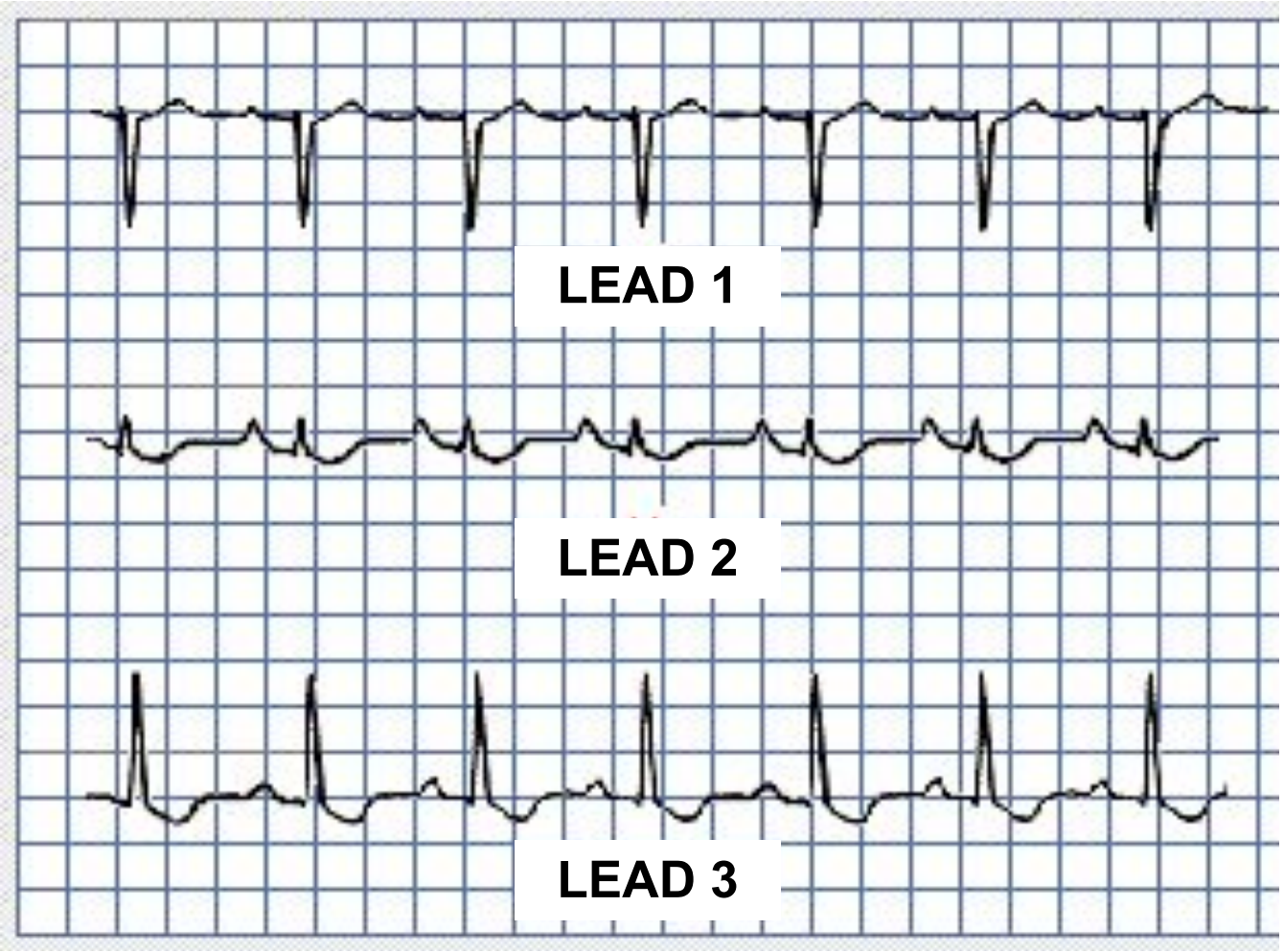


LEFT

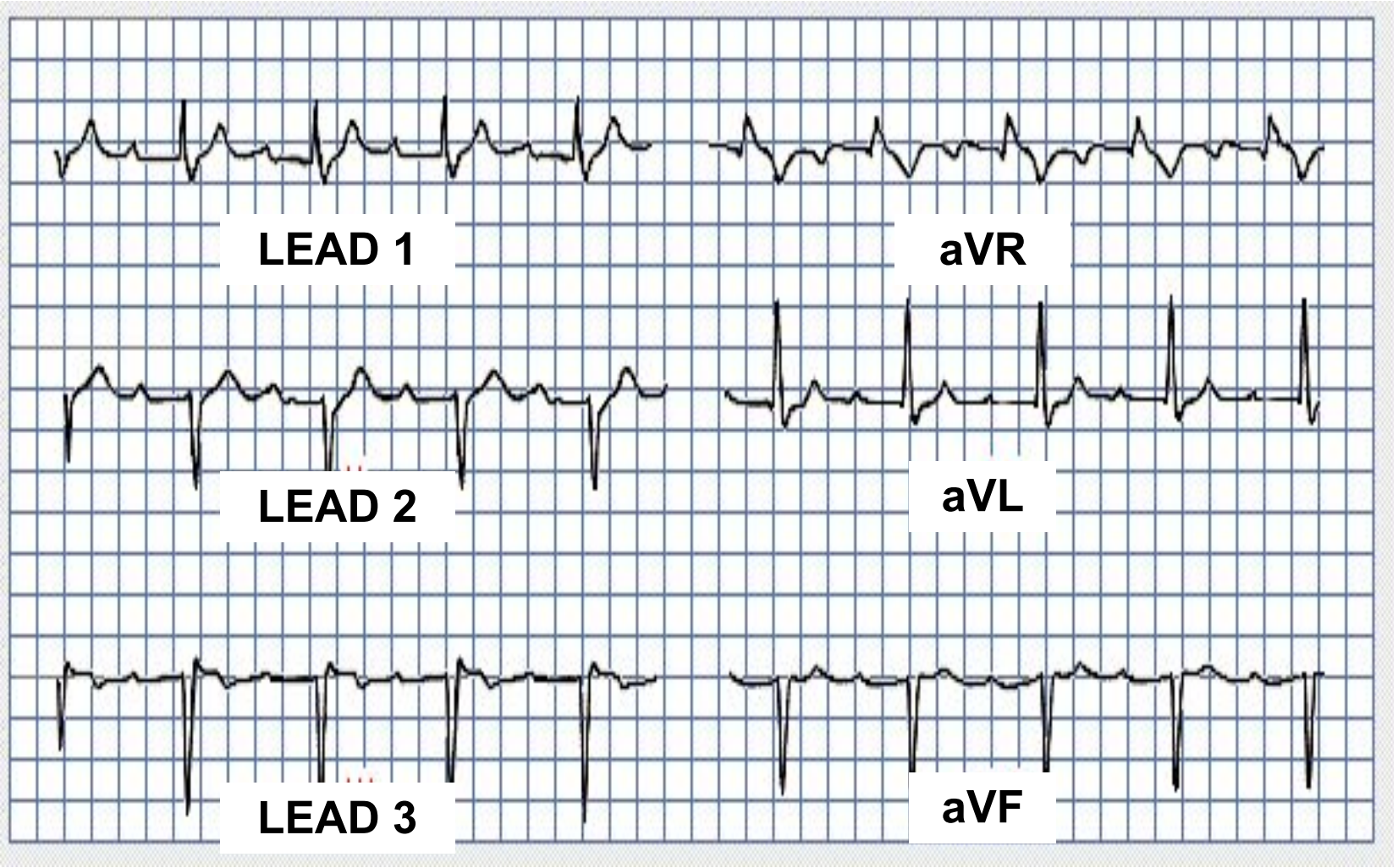
What is the Axis ?



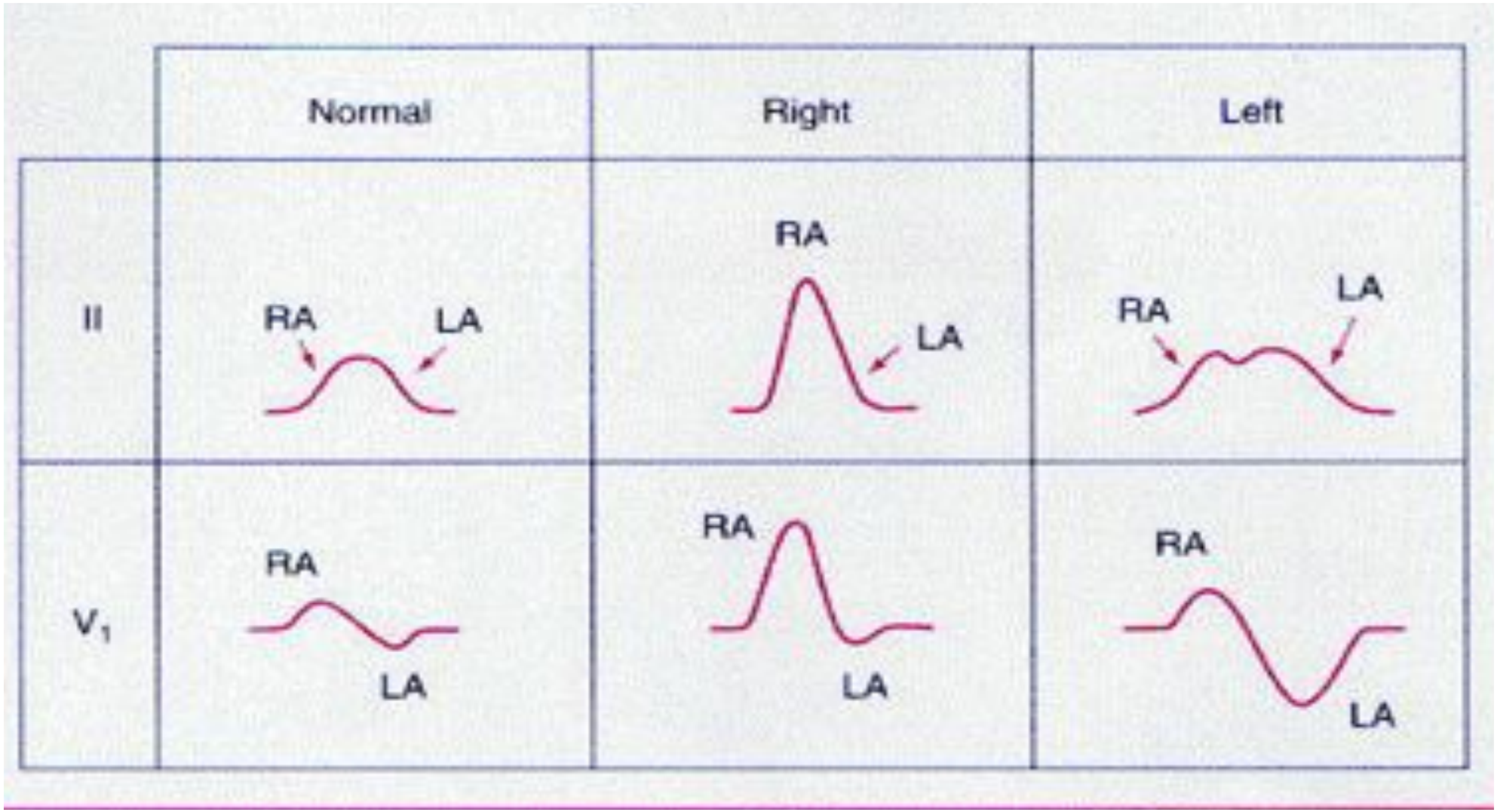
What is the Axis ?



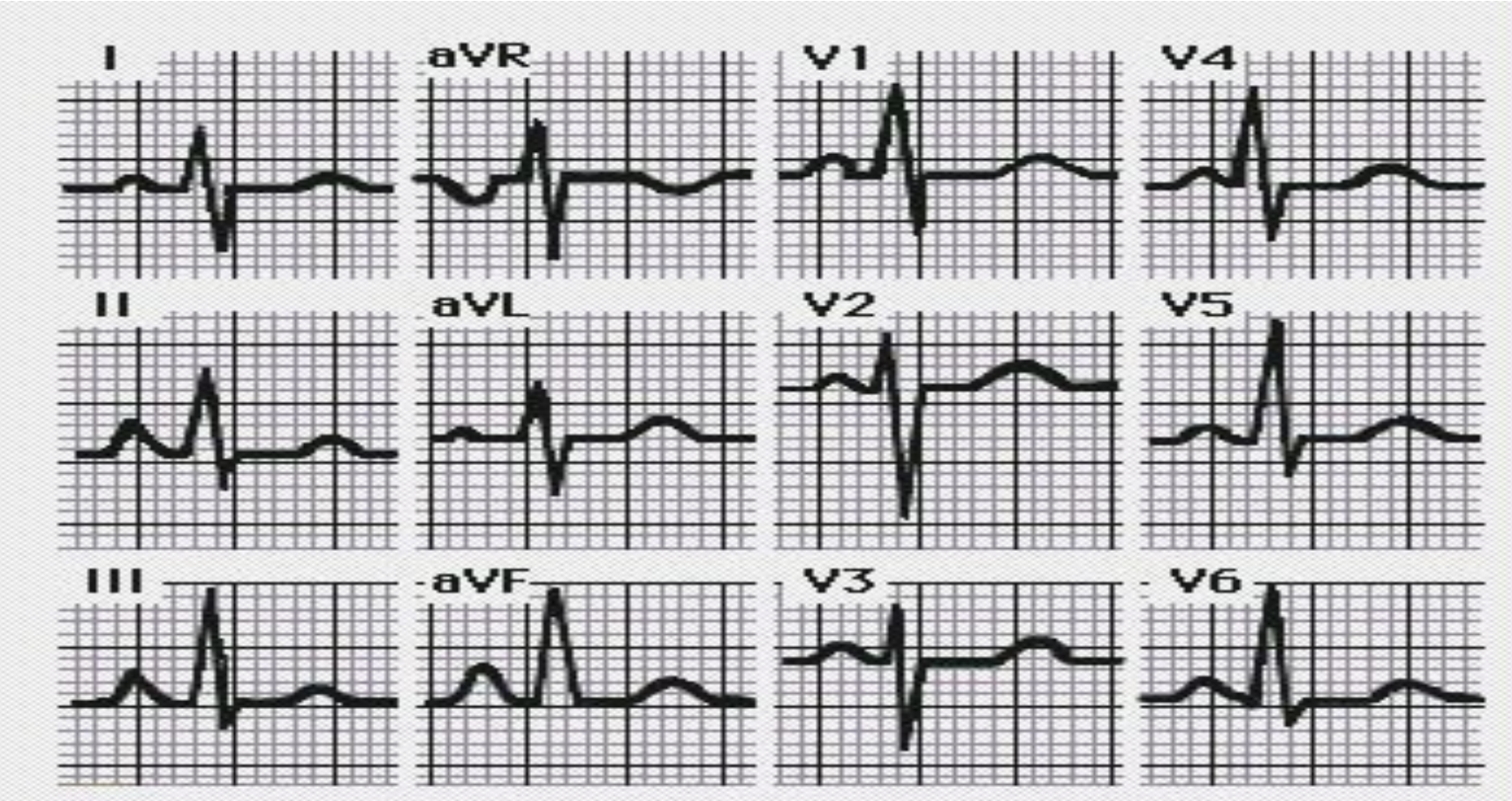
What is the Axis ?



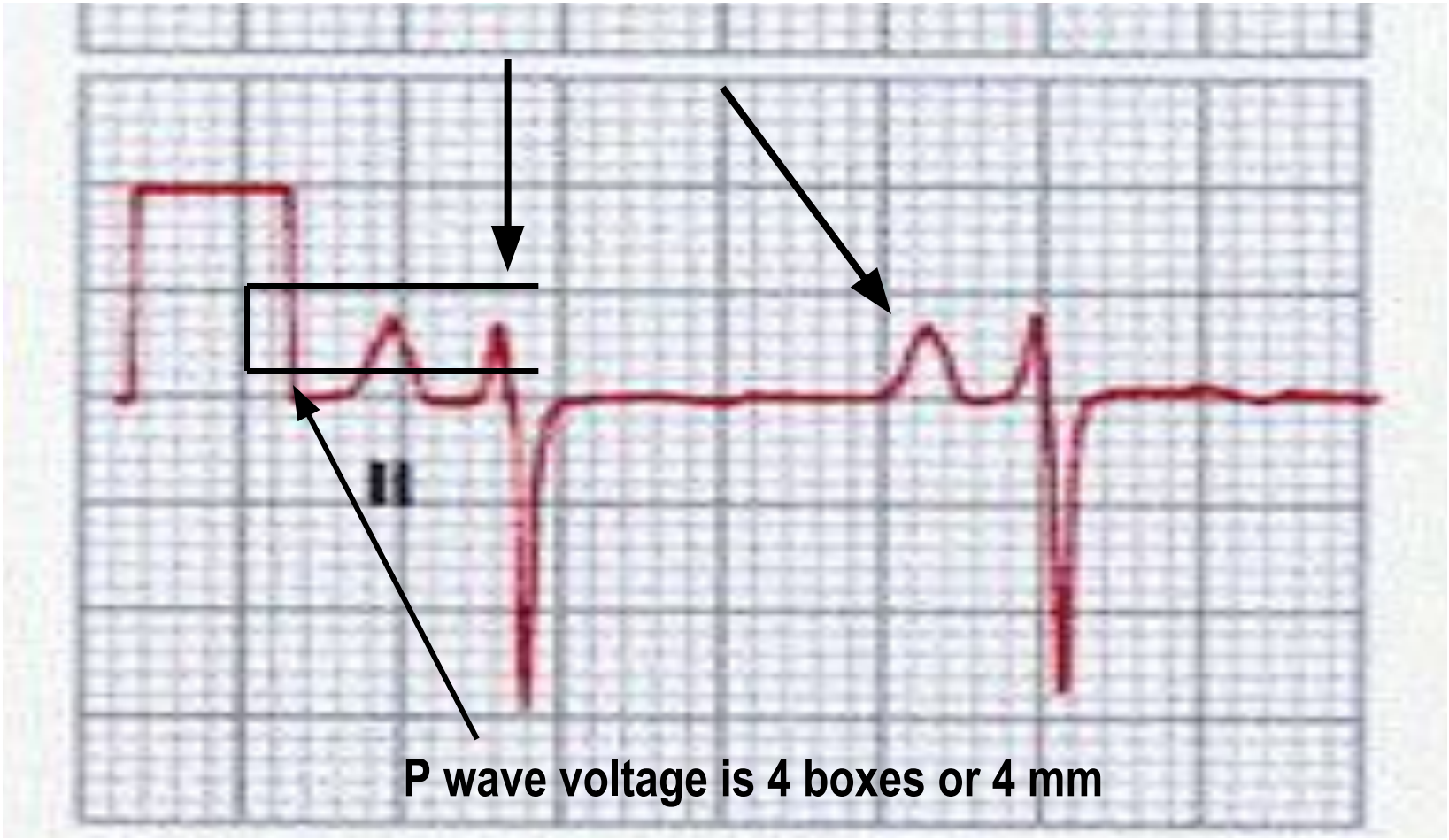
Atrial Waves



Right Atrial Enlargement



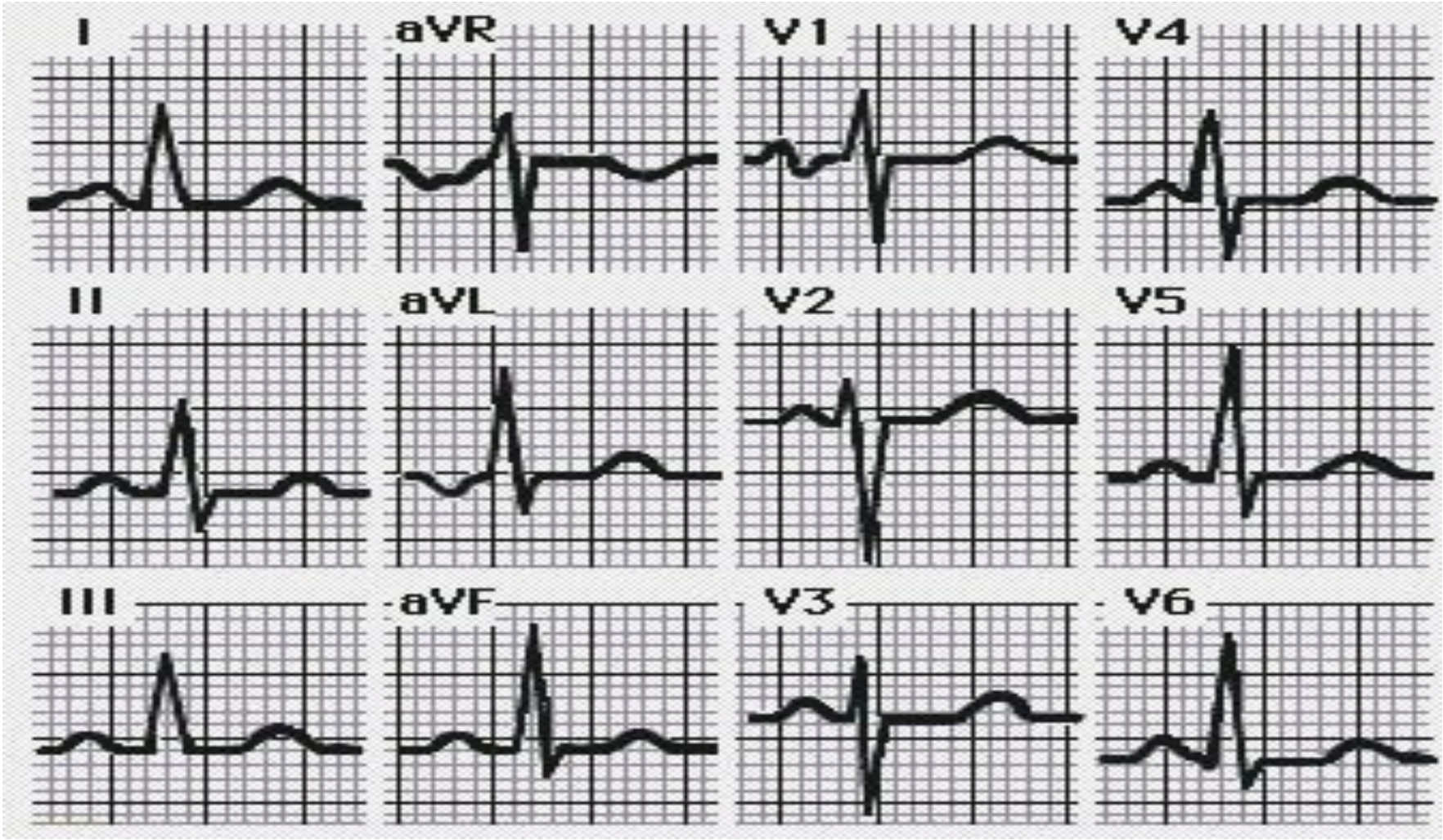
Right Atrial Enlargement



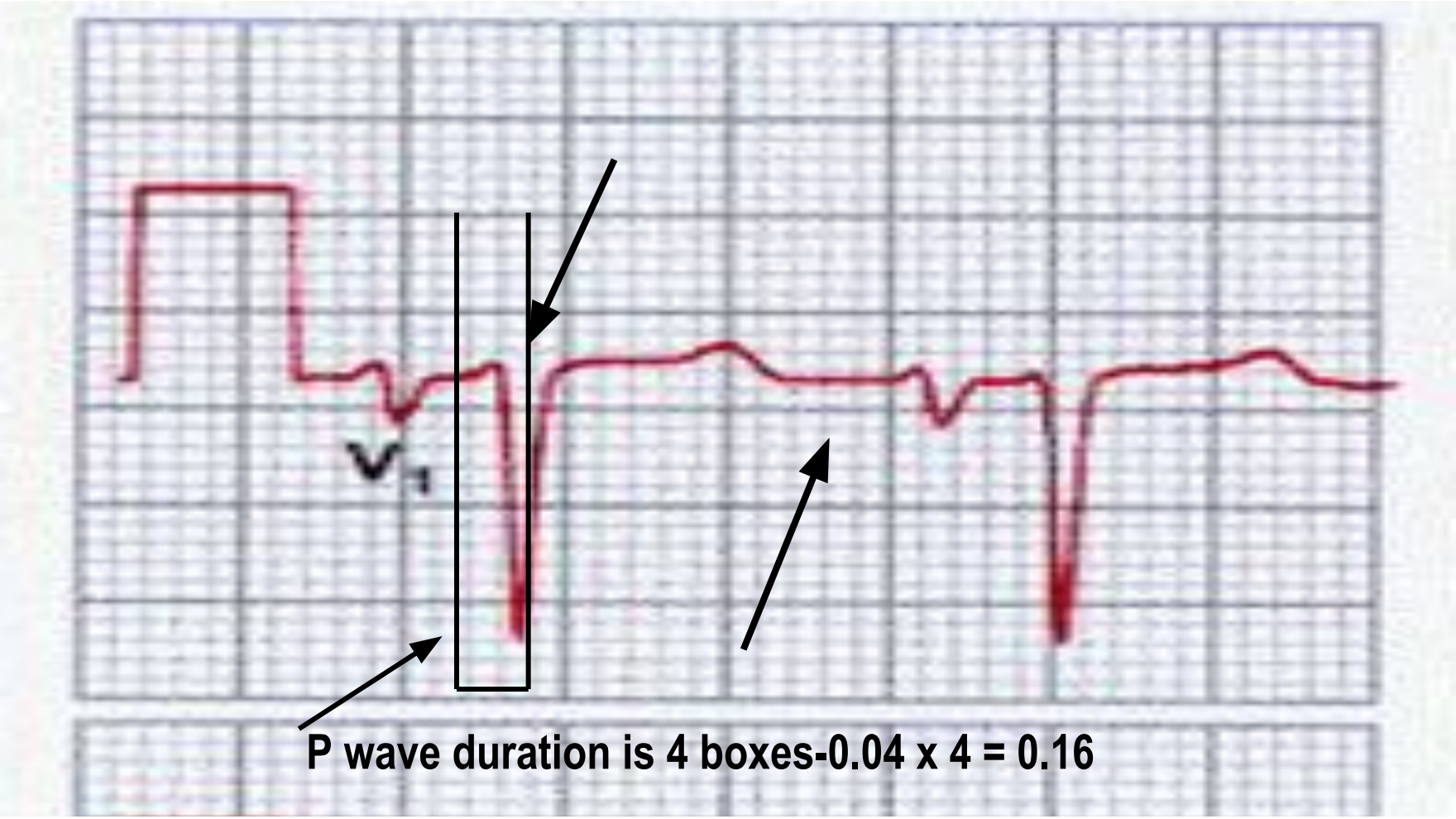
Right Atrial Enlargement

- Always examine Lead 2 for RAE
- Tall Peaked P Waves, Arrow head P waves
- Amplitude is 4 mm (0.4 mV) - abnormal
- DDX
  - Pulmonary Hypertension, Mitral Stenosis
  - Tricuspid Stenosis, Regurgitation
  - Pulmonary Valvular Stenosis
  - Pulmonary Embolism
  - Atrial Septal Defect with L to R shunt

Left Atrial Enlargement



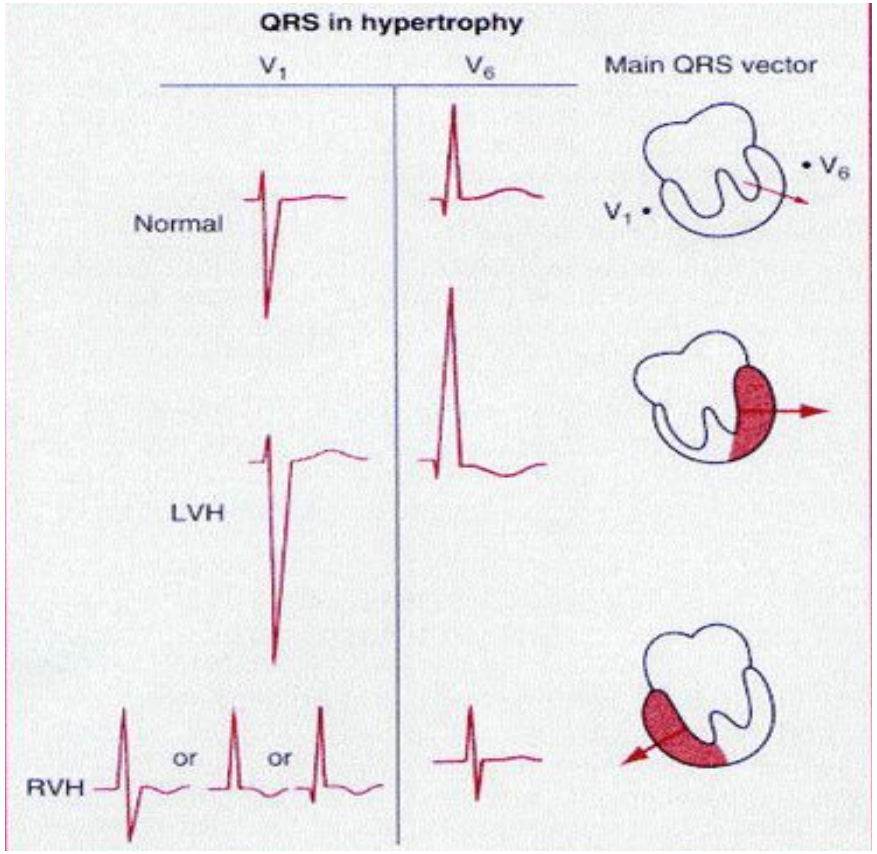
Left Atrial Enlargement



Left Atrial Enlargement

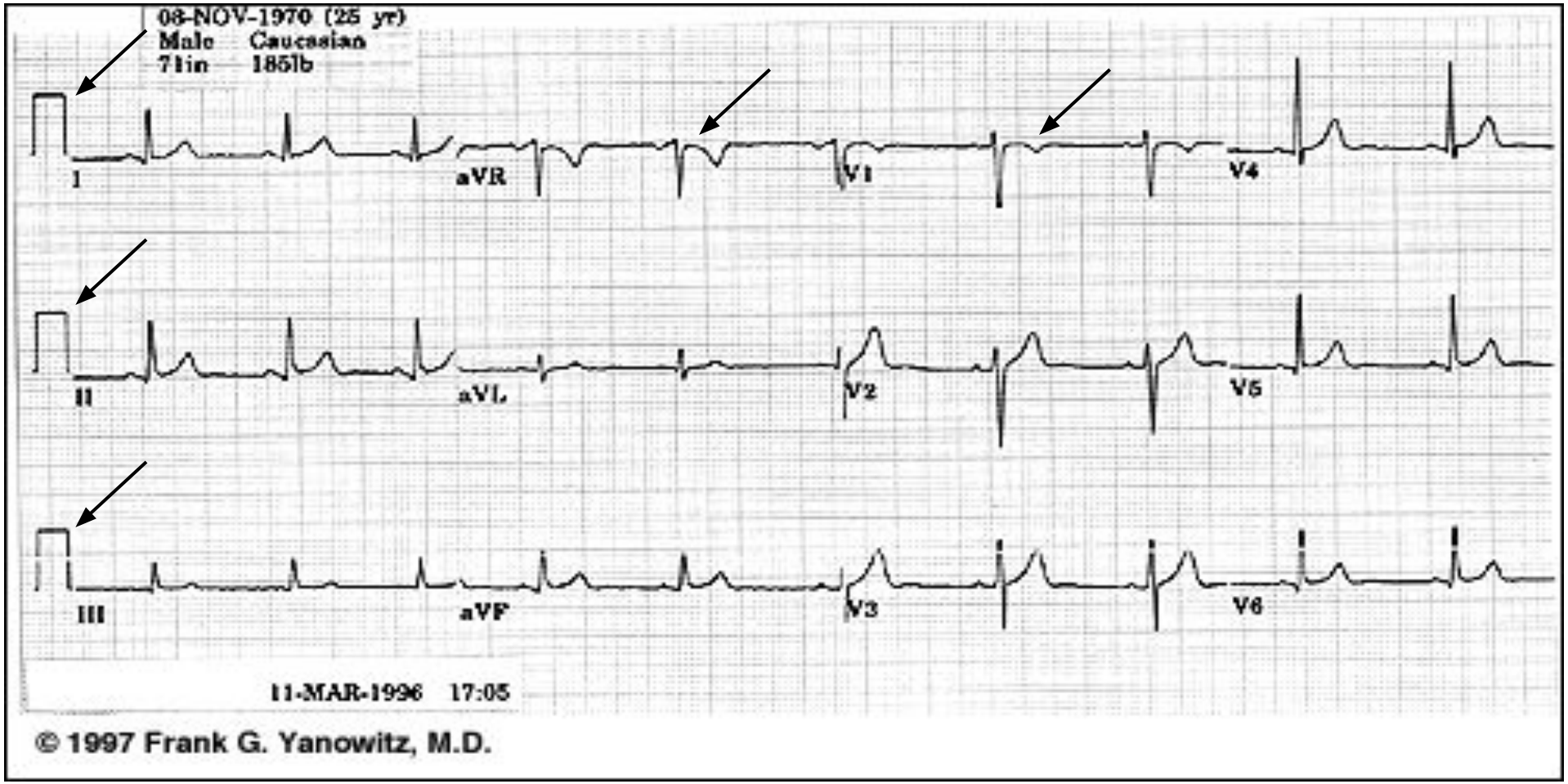
- Always examine V 1 and Lead 1 for LAE
- Biphasic P Waves, Prolonged P waves
- P wave 0.16 sec, ↑ Downward component
- DDX
  - Systemic Hypertension, MS and or MR
  - Aortic Stenosis and Regurgitation
  - Left ventricular hypertrophy with dysfunction
  - Atrial Septal Defect with R to L shunt

Ventricular Hypertrophy

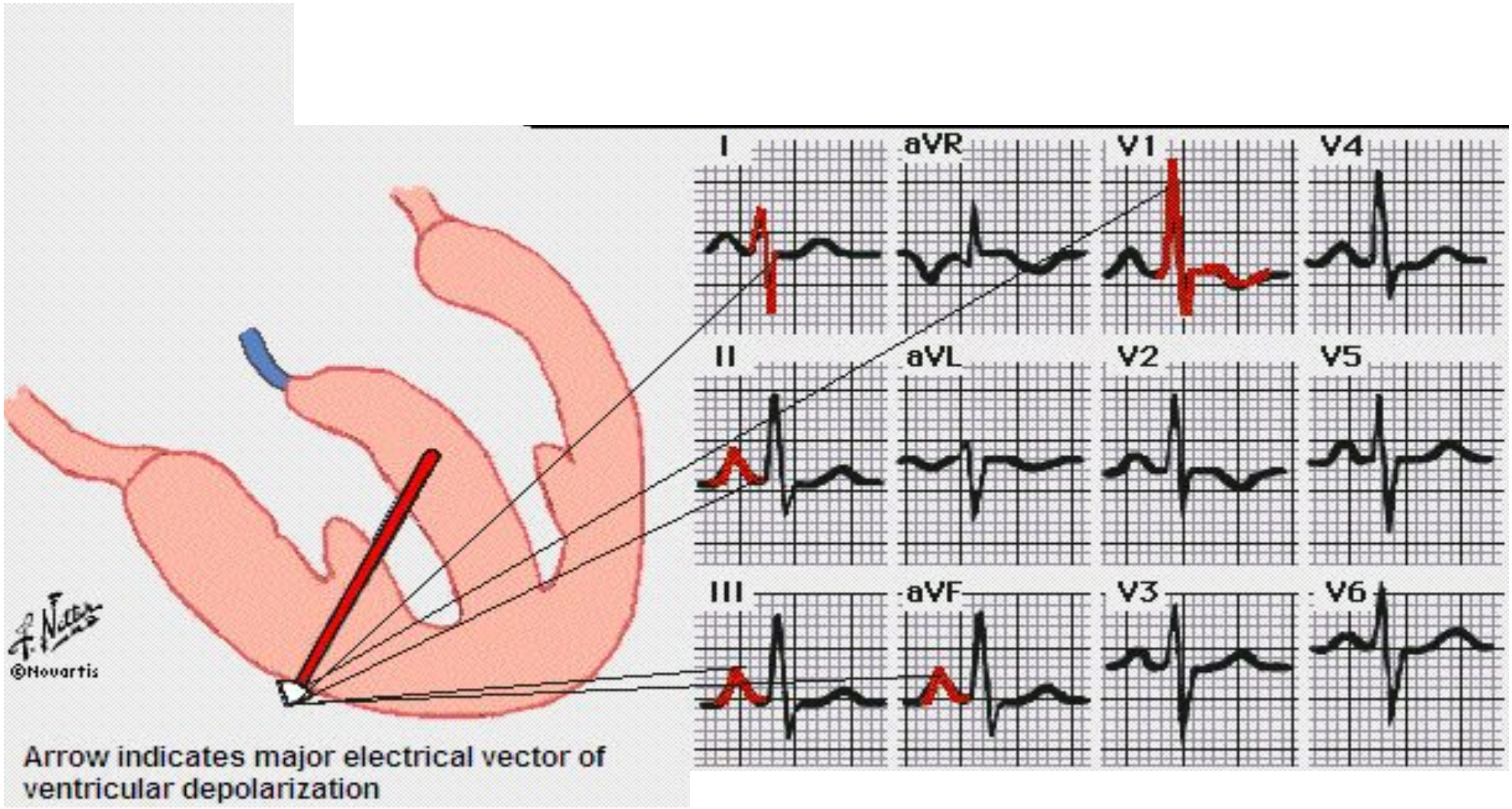


- Ventricular Muscle Hypertrophy
- QRS voltages in V1 and V6, L 1 and aVL
- We may have to record to ½ standardization
- T wave changes opposite to QRS direction
- Associated Axis shifts
- Associated Atrial hypertrophy

Normal ECG


08-NOV-1970 (25 yr)
Male Caucasian
71in 185lb
I
aVR
V1
V4
II
aVL
V2
V5
III
aVF
V3
V6
11-MAR-1996 17:05
© 1997 Frank G. Yanowitz, M.D.

Right Ventricular Hypertrophy

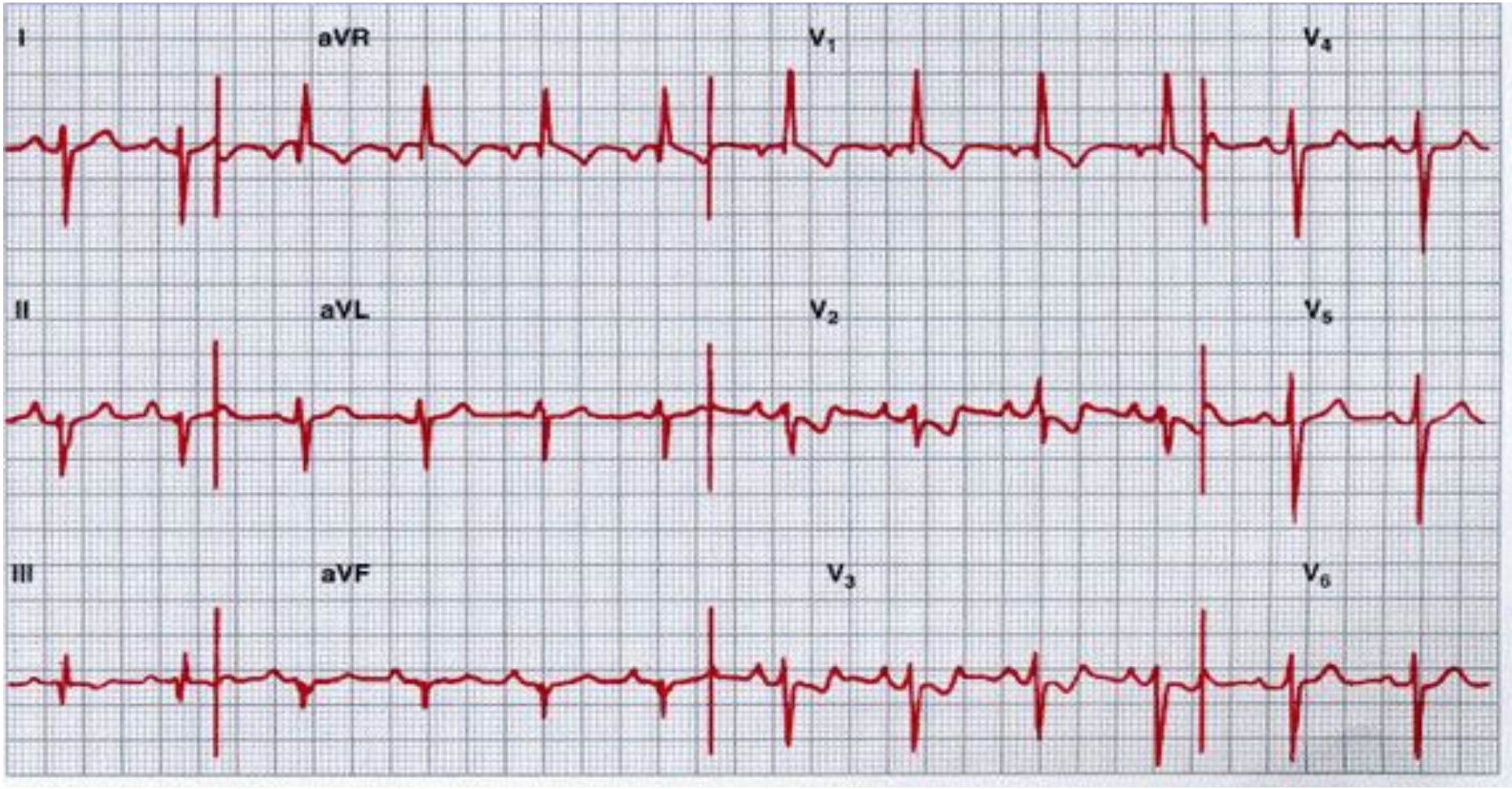


Right Ventricular Hypertrophy

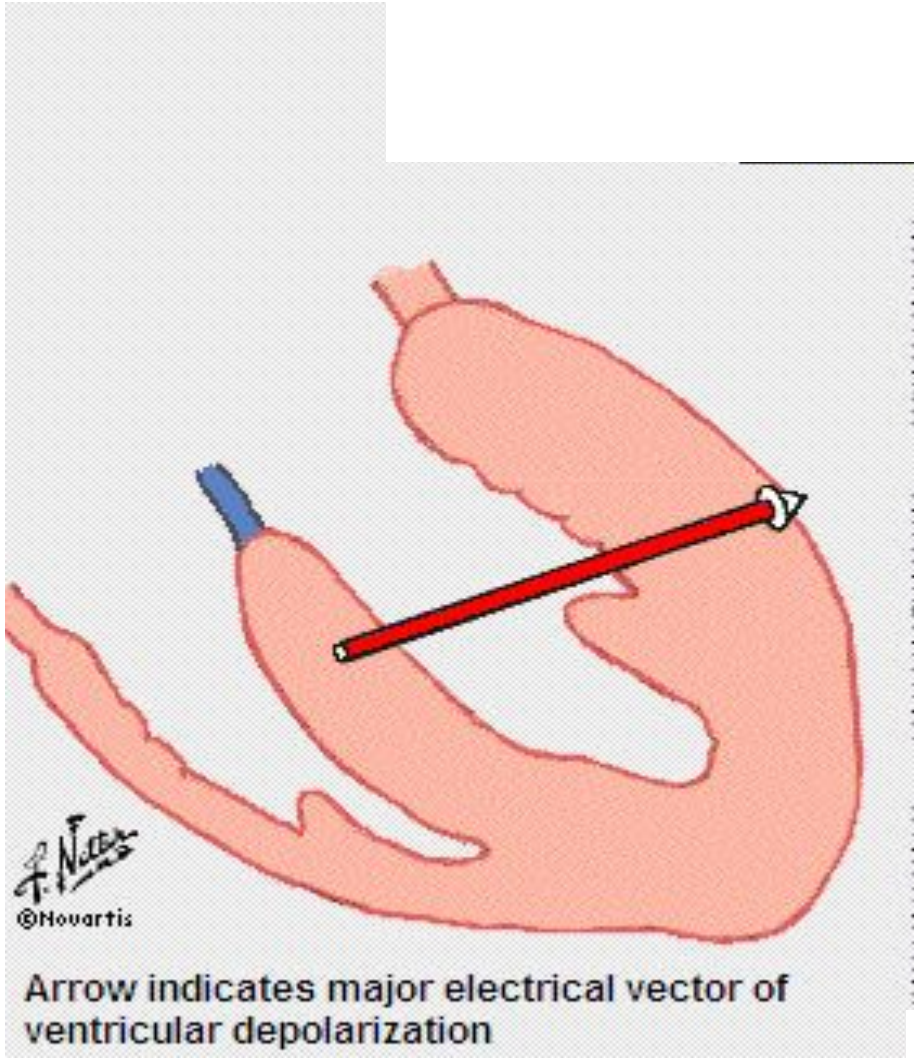
- Tall R in V1 with R >> S, or R/S ratio > 1
- Deep S waves in V4, V5 and V6

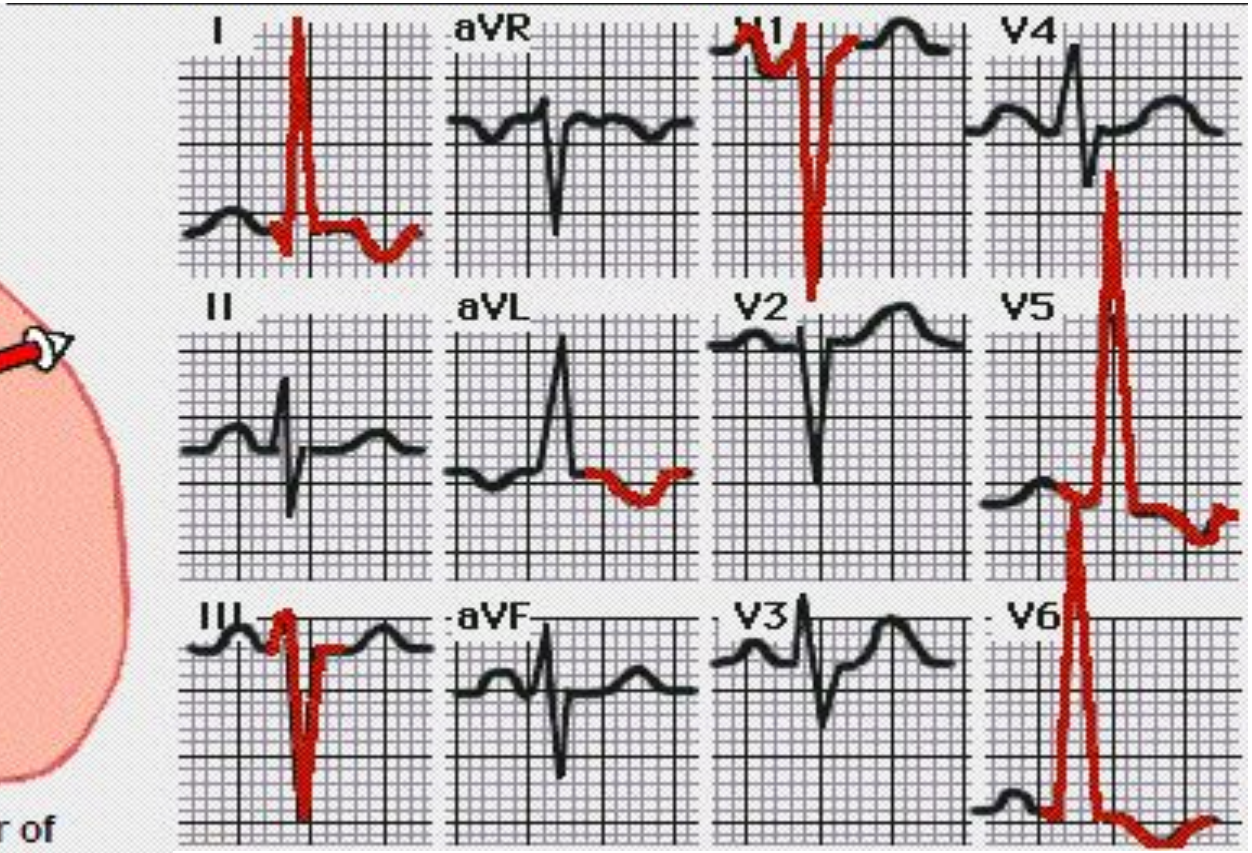
- The DD is RVH, Posterior MI, Anti-clock wise rotation of Heart
- Associated Right Axis Deviation, RAE
- Deep T inversions in V1, V2 and V3

Is there any hypertrophy ?



Left Ventricular Hypertrophy





Causes and Criteria of LVH

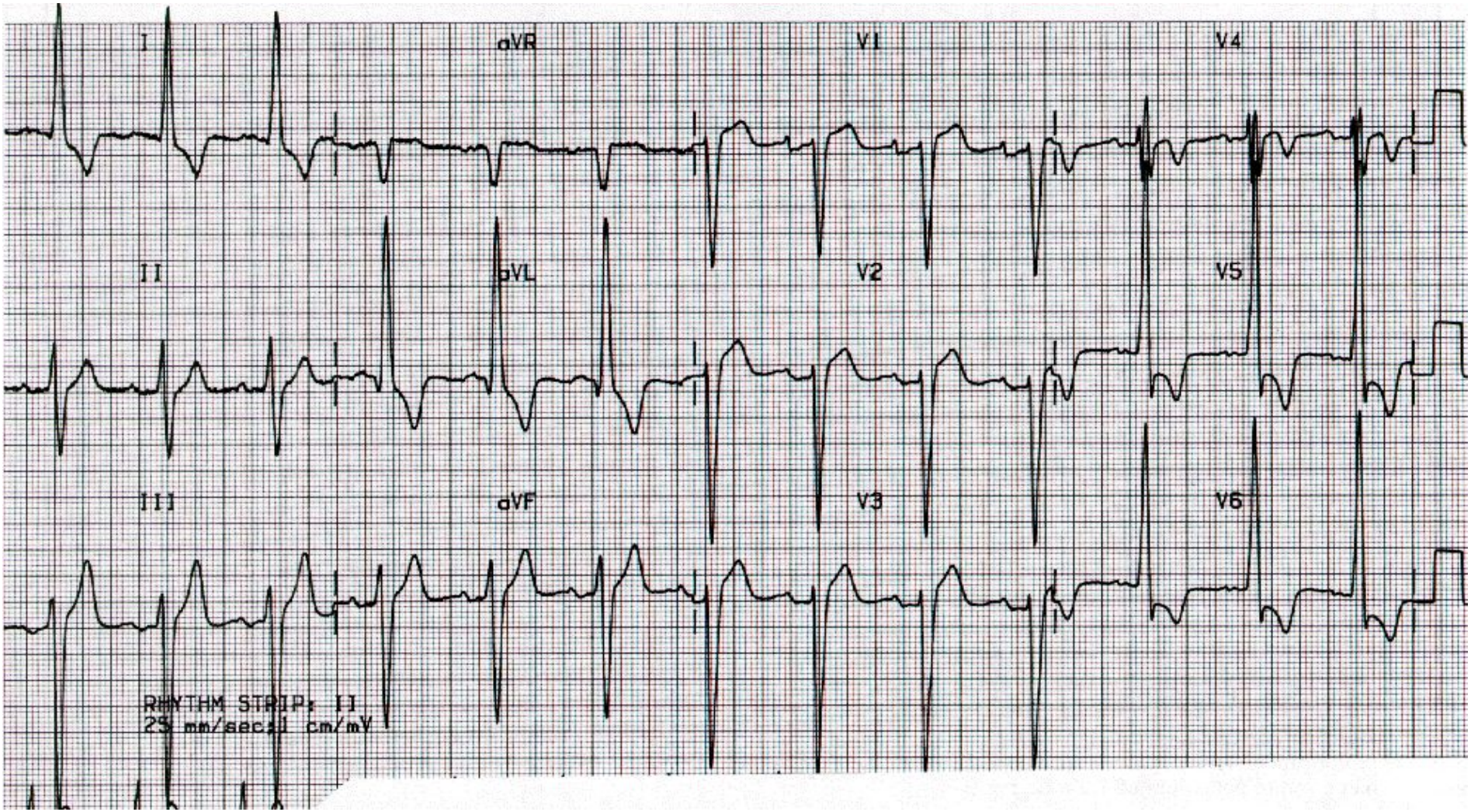
Causes of LVH

- Pressure overload - Systemic Hypertension, Aortic Stenosis
- Volume overload - AR or MR - dilated cardiomyopathy
- VSD - cause both right & left ventricular volume overload
- Hypertrophic cardiomyopathy – No pressure or volume overload

Criteria of LVH

- High QRS voltages in limb leads
- S in V1 + R in V5 > 35 mm
- R in Lead I + S in Lead III > 25 mm or
- R in aVL > 11 mm or S V3 + R aVL > 24 ♂, > 20 ♀
- Deep symmetric T inversion in V4, V5 & V6
- QRS duration > 0.09 sec, Associated Left Axis Deviation, LAE

What is in this ECG ?



Effect of electrolyte on cardiac rhythm

- The normal state of cardiac cell membrne polirization is dependent upon the maintenance of a normal ionic balance across the membrane

Common electroyte responsible for cardiac arrhythmias

- Potassium
- Magnesium
- Calcium

Hyperkalemia

- Is vital for regulating the normal electrical activity of the heart.
- increased potassium reduces myocardial excitability with depression of both pacemaker and conducting tissues resulting in bradycardia and conduction blocks and then arrest

ECG feature of hyperkalemia includes the following

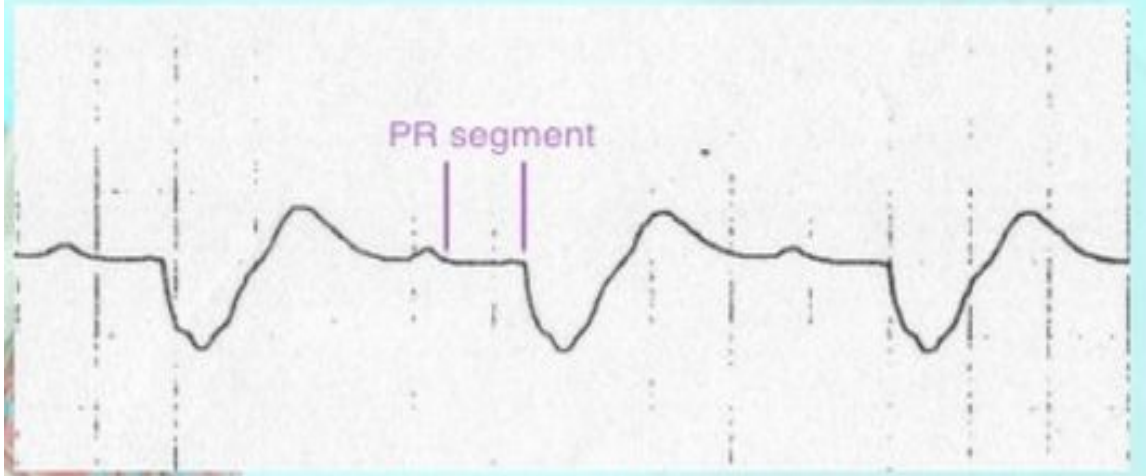
Peaked tall T wave

Flat P wave

Wide QRS

Short QT

Peaked T waves in Hyperkalemia



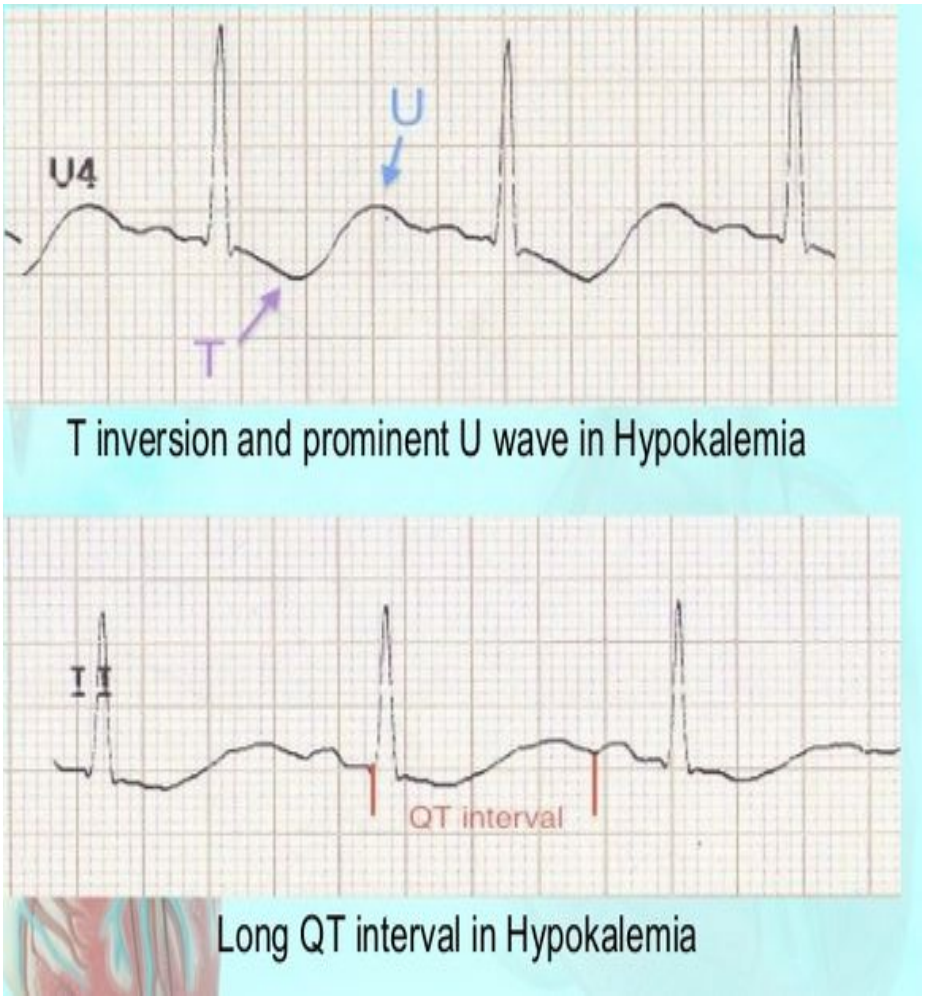
Prolonged PR segment in Hyperkalemia

Hypokalemia

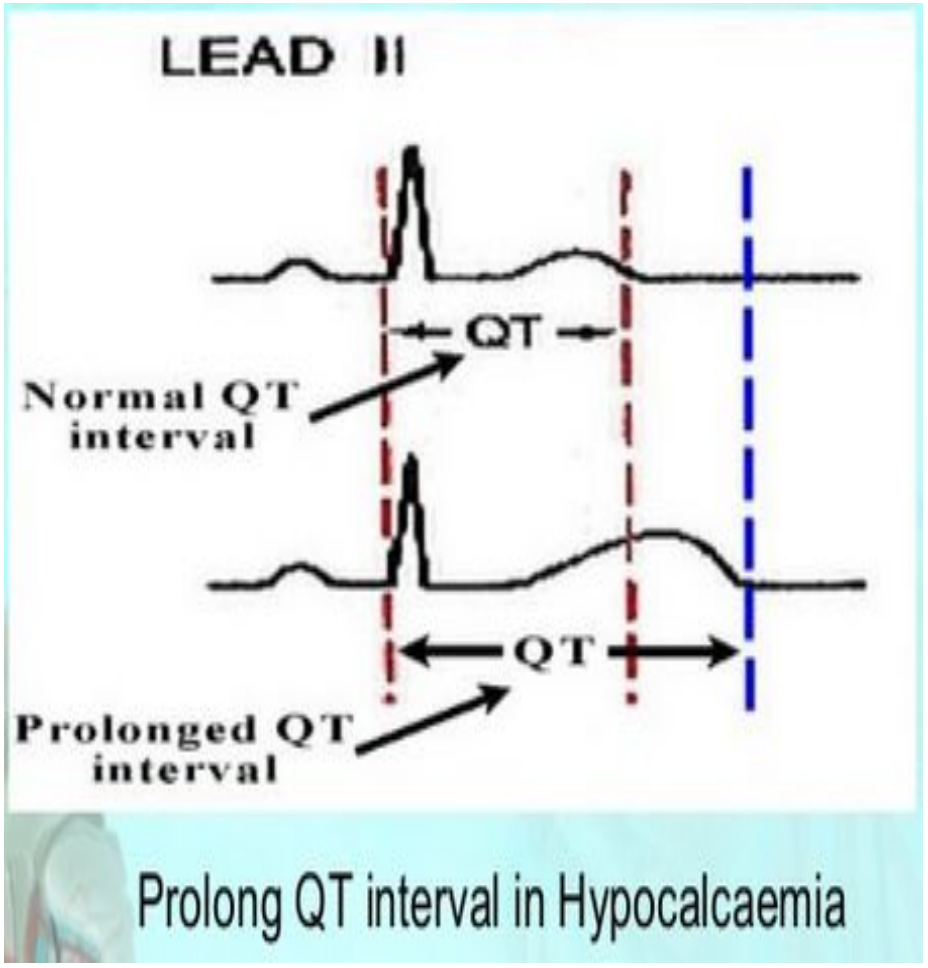
- Decreased potassium causes myocardial hyper excitability with the potential to develop re-entrant arrthymias

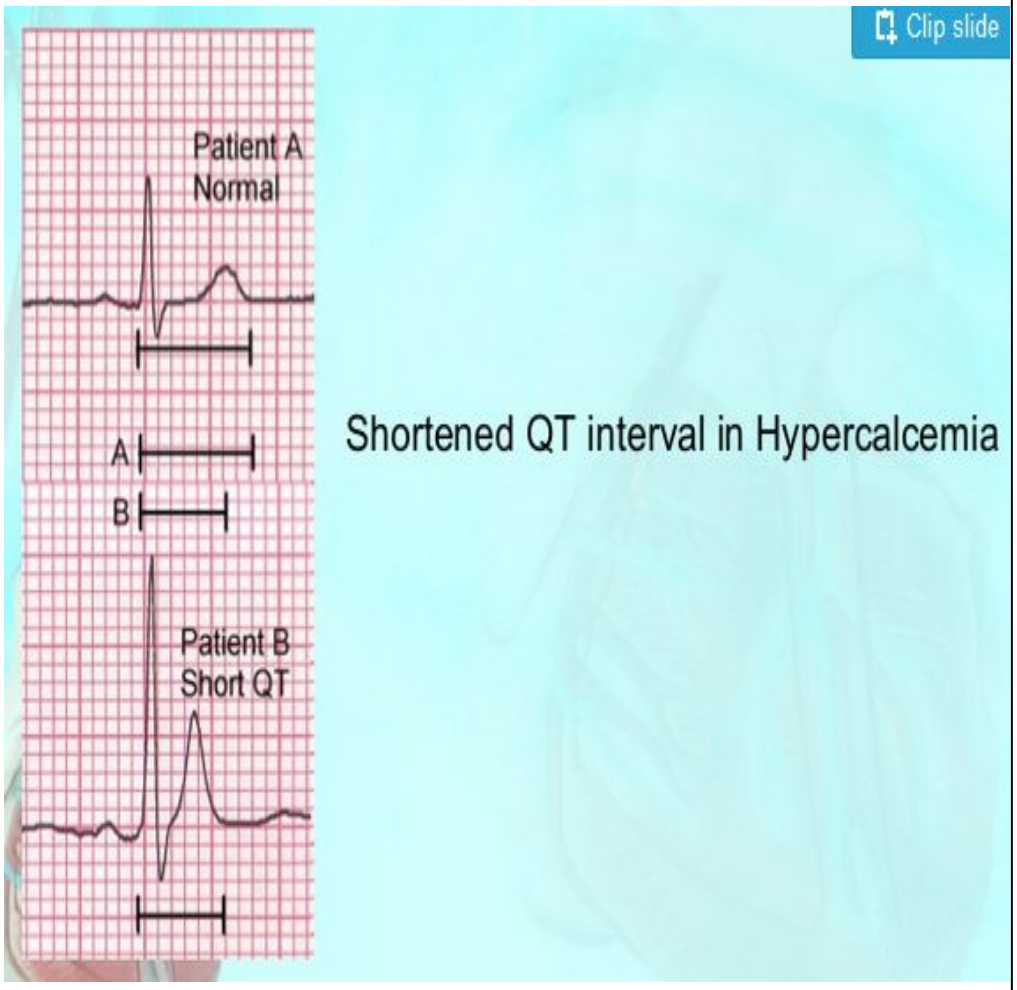
ECG features of hypokalemia

- Prolonged PR interval
- QT prolonged and T wave is flat or inverted
- ST segment is depressed
- U wave



Calcium


LEAD II
QT
Normal QT interval
QT
Prolonged QT interval
Prolong QT interval in Hypocalcaemia


Clip slide
Patient A
Normal
A
B
Patient B
Short QT
Shortened QT interval in Hypercalcemia

Magnesium

THANK YOU