Revised & Reviewed by: Abdulaziz & Bahammam
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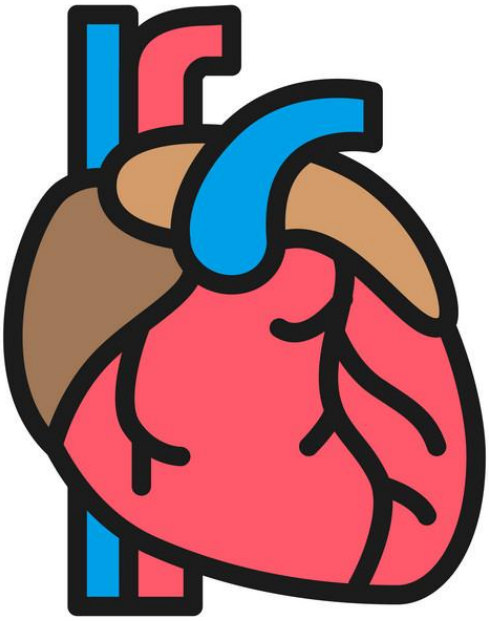
MED441
KING SAUD UNIVERSITY



Cardiovascular

OSPE

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Electrocardiography

What is ECG?

Definition:	Equipment	Function
ECG=electro+cardio+graphy. -Is the process of recording the electrical activity of the heart over a period of time using electrodes placed over chest wall - The algebraic sum of all the electrical potentials of the heart recorded from the body surface	▪ECG recording machine(electrocardiograph). ▪ ECG graph paper. ▪ Disposable ECG electrodes. ▪ Alcohol Swabs And Gauze.	1. Assessment of the **electrical** and **muscular** function of the heart 2. Detection Of Heart **Rate** 3. Detection Of Heart **Rhythm** 4. Detection Of The Heart's **Orientation** 5. Presence of **ischemia or infarction** the heart along with its **location** and **extent** 6. Detection Of **Electrolyte Imbalance**(hypocalcemia and hypercalcemia) 7. Detection Of **Drug Toxicity**

What's a lead?

-A lead is a pair of electrodes joined together record the potential difference between two electrodes.
-Each lead looks at heart from a **different angle** so as to locate an abnormality in the heart that can be detected by ECG.

How many leads ?

There Are 12 Standard Leads To Record ECG.
-Out of 12 leads:
6 are limb leads and 6 chest leads:
- **3 bipolar limb leads(Leads I,II and III)**
- **3 Unipolar Limb Leads(aVR,aVL and aVF),**
- **6 Unipolar Chest Leads**

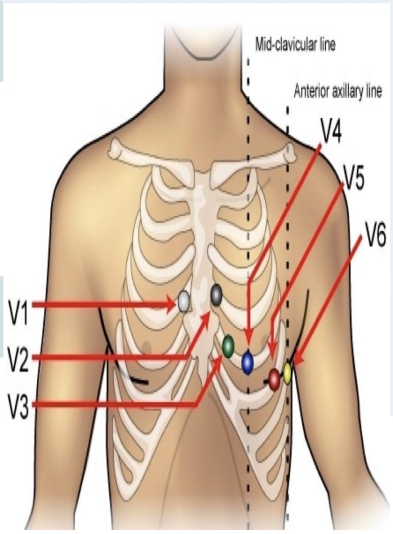
Planes

➔ Limb leads forms frontal plane
➔ Chest leads form the horizontal plane

	Types of leads	Limb leads	Chest leads
Bipolar	A bipolar lead records the potential difference between two active electrodes	**I,II,III** **Standard limb leads**	
Unipolar	Unipolar lead records the potential of one active electrode as compared to the other inactive electrodes,as it provides resistance to the inactive electrodes making their potential zero.	**aVR, aVL, aVF** **"Details Next slide"**	**V1-V6** **"Details Next slide"**

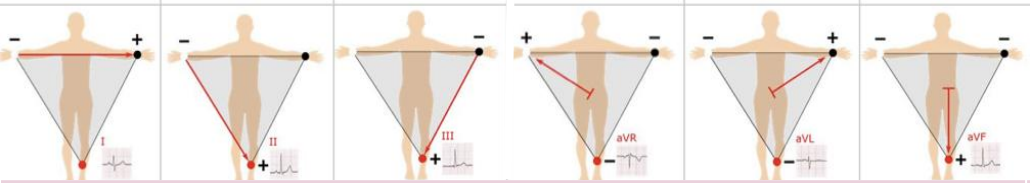
Chest Leads

V1	V2	V3
Placed in the **4th** intercostal space,**right** of the sternum	Placed in the **4th** intercostal space,**left** of the sternum	Placed between **V2** & **V4**
V4	**V5**	**V6**
Placed in the **5th** intercostal space,& mid-clavicular line	Placed in the anterior axillary line horizontal to **V4**	Placed in the mid-axillary line horizontal to **V5**



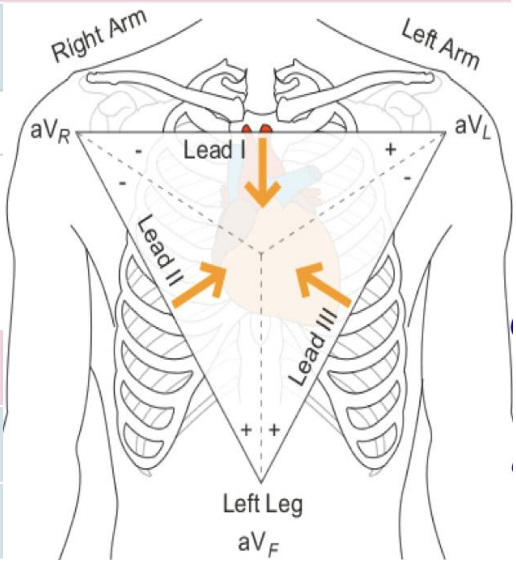
Limb Leads

Bipolar			Unipolar		
Lead I	**lead II**	**lead III**	**aVR**	**aVL**	**aVF**



4 electrodes placed on:	
Left arm	Right arm
Left leg	Right leg (ground)

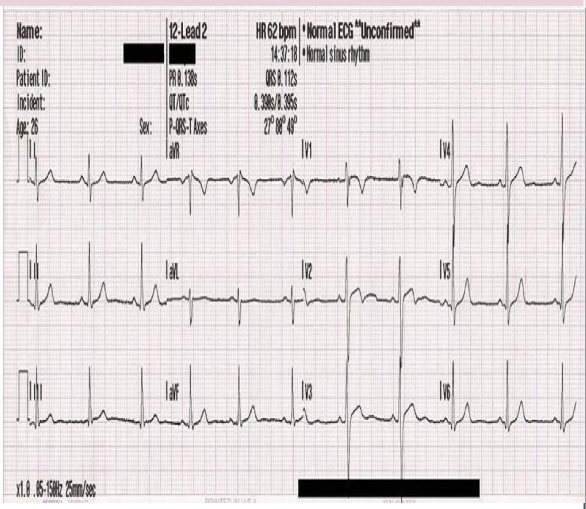
Einthoven's triangle



ECG trace

An ECG trace will be recorded.
You should know how to analyze The Trace For The Following parameters:

1. Calculate The Heart rate Of The Subject.
2. Comment On The Rhythm Of The Heart.
3. Name the waves & intervals & calculate their duration.
4. Calculate The Cardiac Axis.



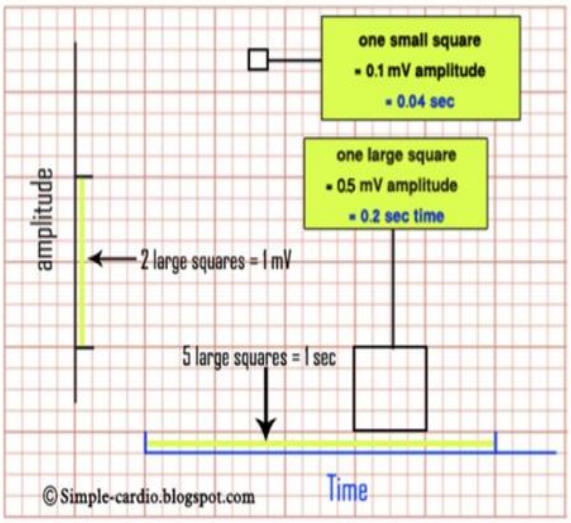
ECG paper calibration:

The paper runs at a standard speed of 25mm/sec.
The ECG is recorded on graph paper divided into large and small squares(boxes).

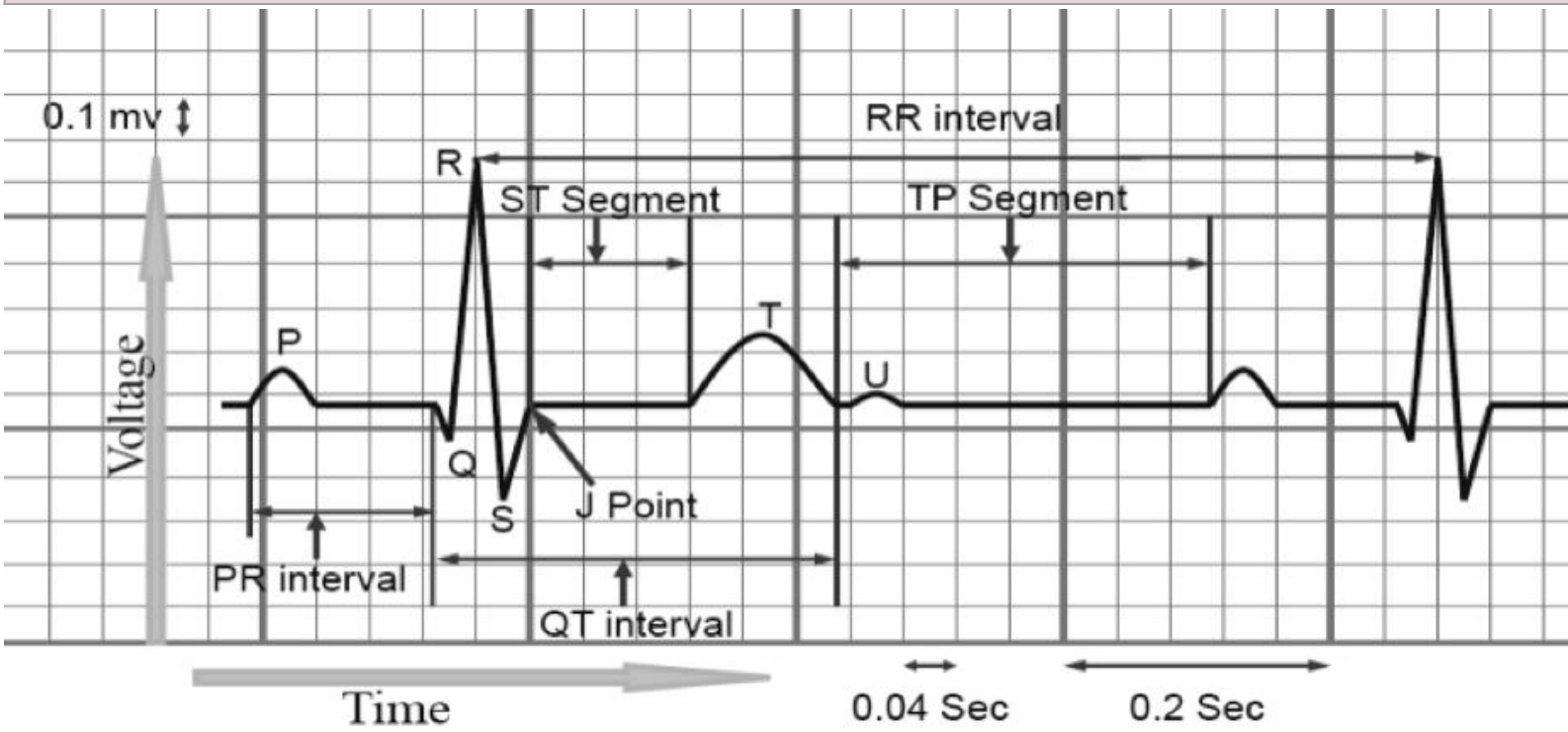
1. Each small box is 1 mm in length.
2. Five small boxes make one large box.
3. The horizontal axis denotes time (seconds)
4. The vertical axis denotes voltage(mv).

This means that :

- **Horizontally** :
  small box=0.04 seconds
  large box=0.2seconds (0.04s x 5 small squares)
- **Vertically**:
  10mm=1mv.



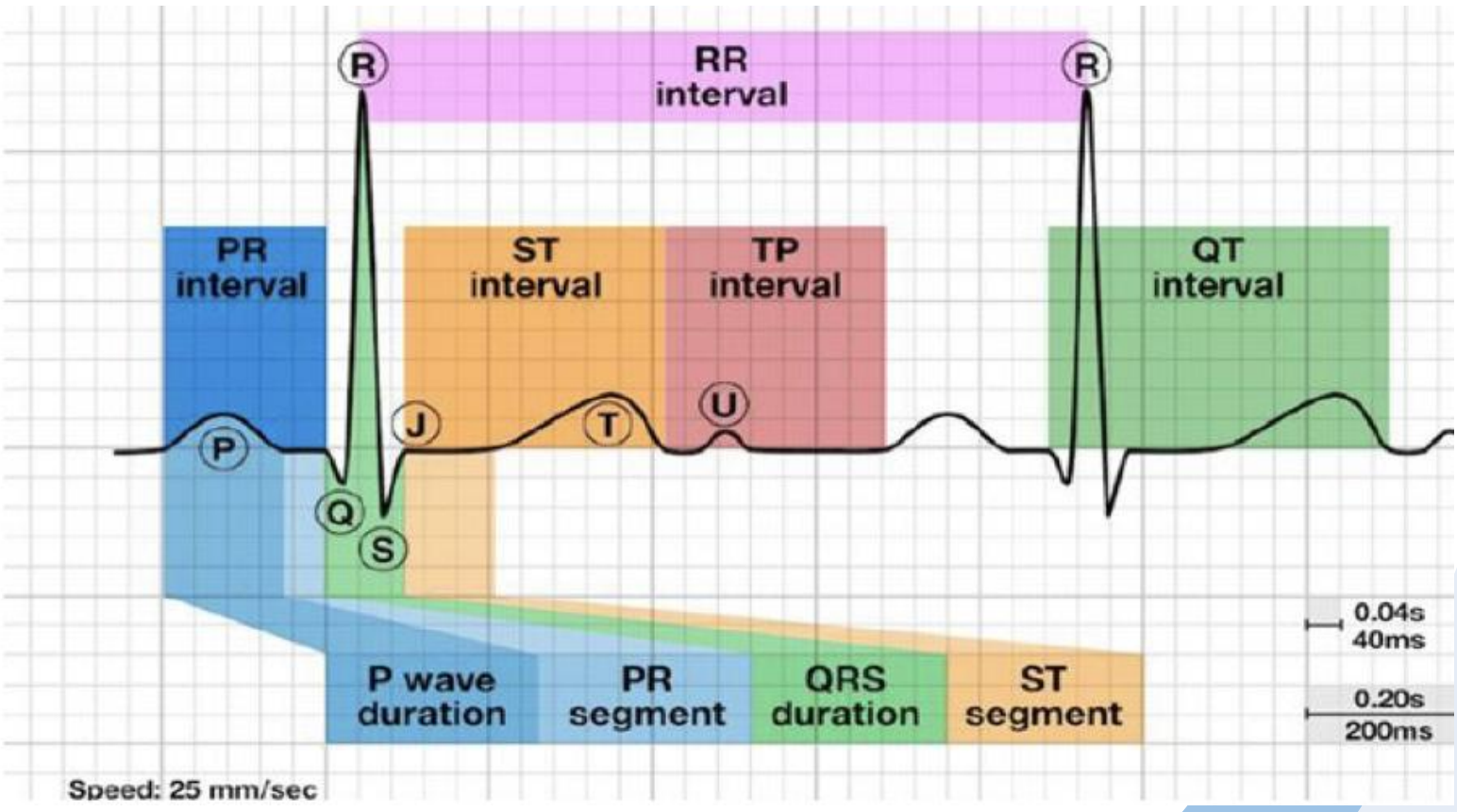
ECG waves and intervals:



ECG waves and intervals:

Wave	Phenomenon
P wave	Atrial depolarization
QRS complex	Ventricular depolarization
T wave	Ventricular repolarization
U wave	Papillary muscle repolarization

Interval	Measurement	Normal duration	Abnormalities
PR interval	From beginning of P wave to beginning of QRS complex	0.12-0.2s (3-5 small squares)	**Prolonged**: in 1st degree heart block Shortened: WPW
QRS complex	From beginning of Qwave to the end of the S wave	Not more than 0.12s (3 small squares)	**Prolonged** : Rt & Lt Bundle Branch Block(BBB)
QT interval	From beginning of Q wave to the end of the T wave	0.36-0.44s (9-11 small squares)	**Prolonged** -**hypo**calcemia & - digoxin toxicity **Shortened** -**hyper**calcemia
ST interval	From end of S wave to the end of the T wave	0.28-0.36s (7-9 small squares)	
ST segment	From the end of the S wave to the beginning of the T wave	Normally isoelectric	ST segment **elevation**: -acute myocardiaL infarction -pericarditis **Depressed** in -coronary ischemia(angina) & -digoxin toxicity



Determination of heart rhythm

What is the heart rhythm? The heart rhythm refers to the regularity with which the heartbeats

How is it determined? Heart rhythm can be determined by observing the R-R intervals on the strip recording of the ECG.

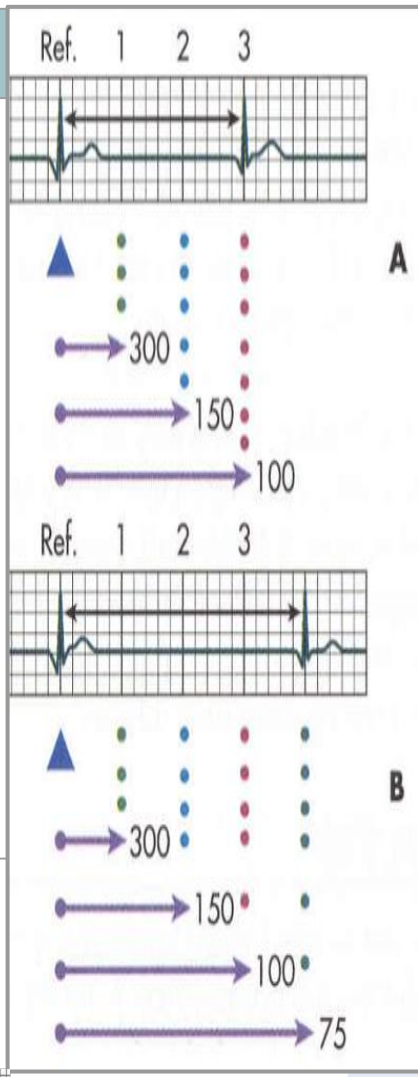
Normal heart rhythm: If the heartbeat regularly(R-R Interval Have The Same Duration) .

Arrhythmia: If the heart beats irregularly(RR interval have different duration) **Sinus Arrhythmia** Is a physiological arrhythmia as the heartbeats faster during inspiration and slower during expiration,due to the different firing rate of SA node during inspiration and expiration.

Determination of heart rate

Heart rate Calculation:

Regular Heart rhythm:	**Irregular heart rhythm**
You can use one of these two formulas:	1.count the number of QRS complexes in 30 large squares (which equals the number of QRS complexes in 6 seconds). *Remember 5 large square = 1 secs 2.Then multiply the number of QRS complexes counted in 6 seconds by 10 to get the number of QRS complexes in one minute i.e. the heart rate Example: Number or QRS complexes in 6 seconds= 7 So Number of QRS complexes in 1 min= 7 x 10 = 70beats/ min
$\frac{1500}{\text{Number of small squares between R} - \text{R}}$	
$\frac{300}{\text{Number of large squares between R} - \text{R}}$	



The normal range of HR is between 60-100 beats/min

- **Tachycardia:** above 100 beats / min
- **Bradycardia:** below 60 beats / min

regular heart rate:

Calculation of the cardiac axis

What is the electrical axis?

- The electrical axis is the average direction of the current flow in the heart during a cardiac cycle.
- The cardiac axis expressed as an angle and is measured in degrees.

Direction of spread:

- The depolarization wave normally spread through the ventricles in a direction from base of the heart to its apex.

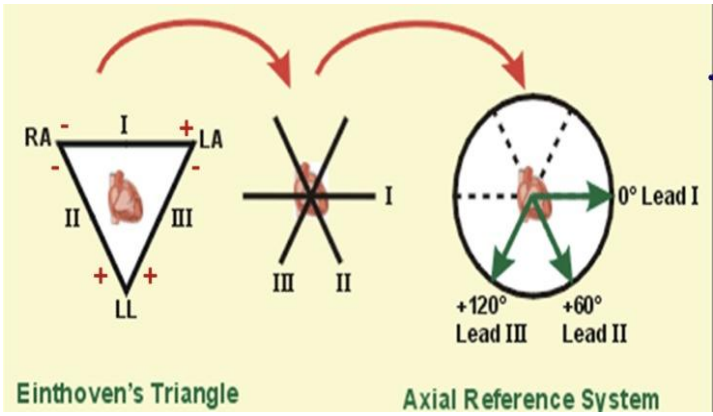
Lead 1:

- If limb leads are superimposed on each other,lead one will be looking at the heart from the left at an angle of 0°.
- This horizontal line Is considered reference or zero point.
- Any deviation below that line is expressed as positive number whereas deviations above the line are expressed as negative numbers.

Lead 2 & 3:

- Lead II is considered to be looking at the heart at an angle of+60°
- Lead III looks at the heart at +120°.

1.The normal cardiac axis
lies between **-30 to 90** degrees.
2.Left axis deviation (LAD)
Deviation of the cardiac axis to the left
(between -30 to -90) due to some pathological conditions
3.Right Axis Deviation(RAD).
Deviation Of The Cardiac Axis To The Right
(90 to 180) due to some pathological conditions
4.Extreme or right/left axis deviation
Beyond the above values

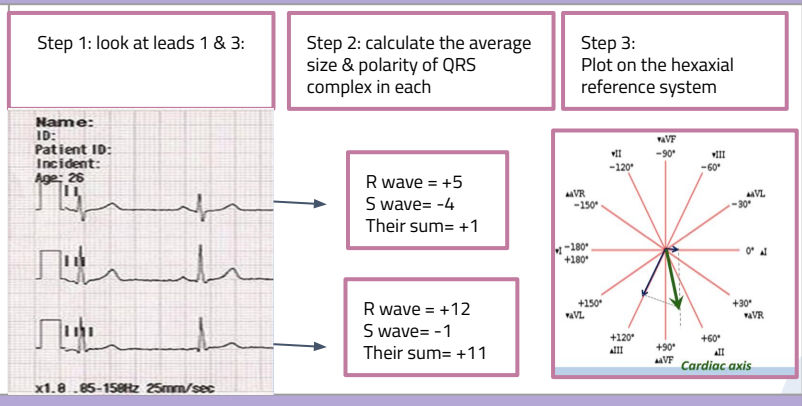


Determination of the cardiac axis

The accurate way

1. Look at leads I & III
2. Calculate the overall size & polarity of the QRS complex in each by subtracting the depth of S from the height of the R wave.
3. Construct a vector diagram & draw the sum of each lead on it.
4. Drop a perpendicular line from each arrow. From the point where they meet, Draw a line from that point to zero point and this will be the cardiac axis.

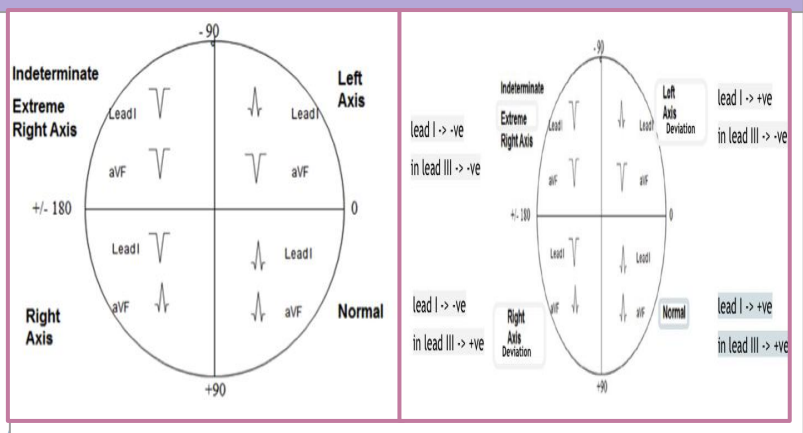
N.B : the height of the R wave & the depth of the S wave are both measure starting from the isoelectric line



Rule of thumb

applying the "rule of thumb" on the direction of QRS complex in leads I and III/aVF of the ECG

1. **Normal Cardiac axis :** QRS complex **positive** in both leads I and III
2. **Left axis deviation:** QRS complex is **positive in lead I** & **negative in lead III**
3. **Right axis deviation:** QRS complex is **negative lead I** & **positive lead III**
4. **Extreme axis deviation:** QRS complex is **negative in both leads I** & **III**



The carotid arterial pulse:

Carotid artery reflect the pressure of the left ventricle during cardiac cycle, So we use it to check ventricle function

Equipments:

Same equipment for JVP

Pulse transducer

Recorder
(biopac machine)

Examination bed

Procedure:

1. Ask the subject to lie quietly on the examination bed with head lifted at 45°.
2. Ask the subject to turn his head to the opposite side.
3. Feel the carotid arterial pulse on the medial side of the sternocleidomastoid muscle.
4. Apply the transducer over the carotid artery and connect it to the recorder

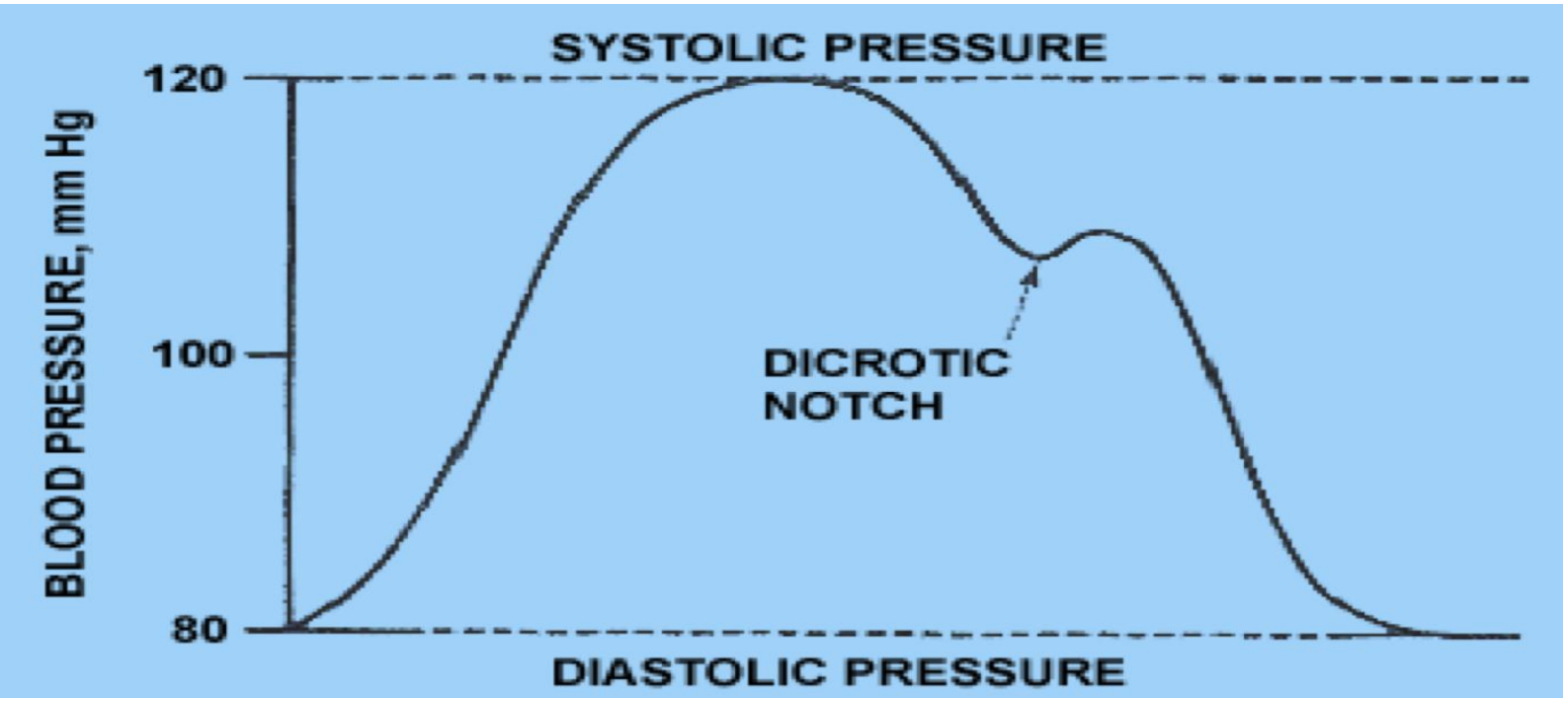
What happens?:

When blood is forced into the aorta during **ventricular systole,** two things happen:

1. Blood moves forward.
2. A pressure wave is set up which travels along the wall of arteries (faster than the flow of blood).

The pressure wave expands the arterial walls as it travels. The expansion of the **arterial wall is palpable as the pulse.**

The carotid arterial pulse:



The anacrotic limb (ana- means up)	The dicrotic notch or incisura	The dicrotic limb
-It is the **upward** deflection in the carotid arterial pulse tracing. - It represents **increasing pressure in the carotid artery** **When?** during the maximum ejection phase of ventricular systole. -In healthy individuals, the arterial pressure recorded at the peak of the anacrotic limb is 120 mmHg, i.e. systolic pressure.	-**Caused by:** the sudden closure of the aortic valve. **-Phonocardiogram:** It coincides with S 2 **-ECG:** occurs just after the T wave **When?** -It marks the beginning of ventricular diastole. - It occurs during the phase of diastole in the CAP tracing	It is the **descending** phase of the carotid arterial pulse tracing. - **Caused by** the decrease in carotid arterial pressure **When?** during ventricular diastole. - In healthy individuals, the lowest pressure recorded during this phase is about 80 mmHg due to the elastic recoil of the arterial wall.

Jugular Venous Pulse (JVP)

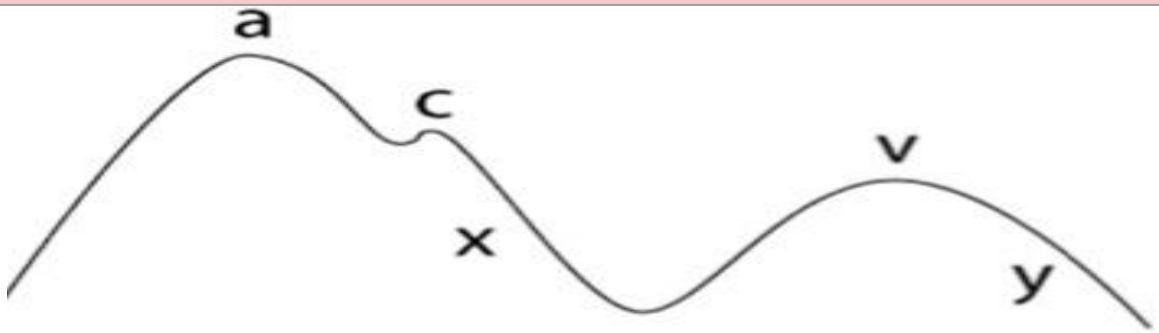
Procedure:

1. Position the subject at **45**° on a couch or bed so that the pulsation of the internal jugular vein can be visualized.
2. Ask the subject to perform a Valsalva maneuver (deep inspiration followed by a forced expiration against a closed glottis). As a result, the internal jugular vein becomes prominent.
3. Choose a position on the internal jugular vein away from the carotid artery.
4. Place the pulse transducer over the vein and keep it in position with a self-adhesive plaster and connect to the recorder.

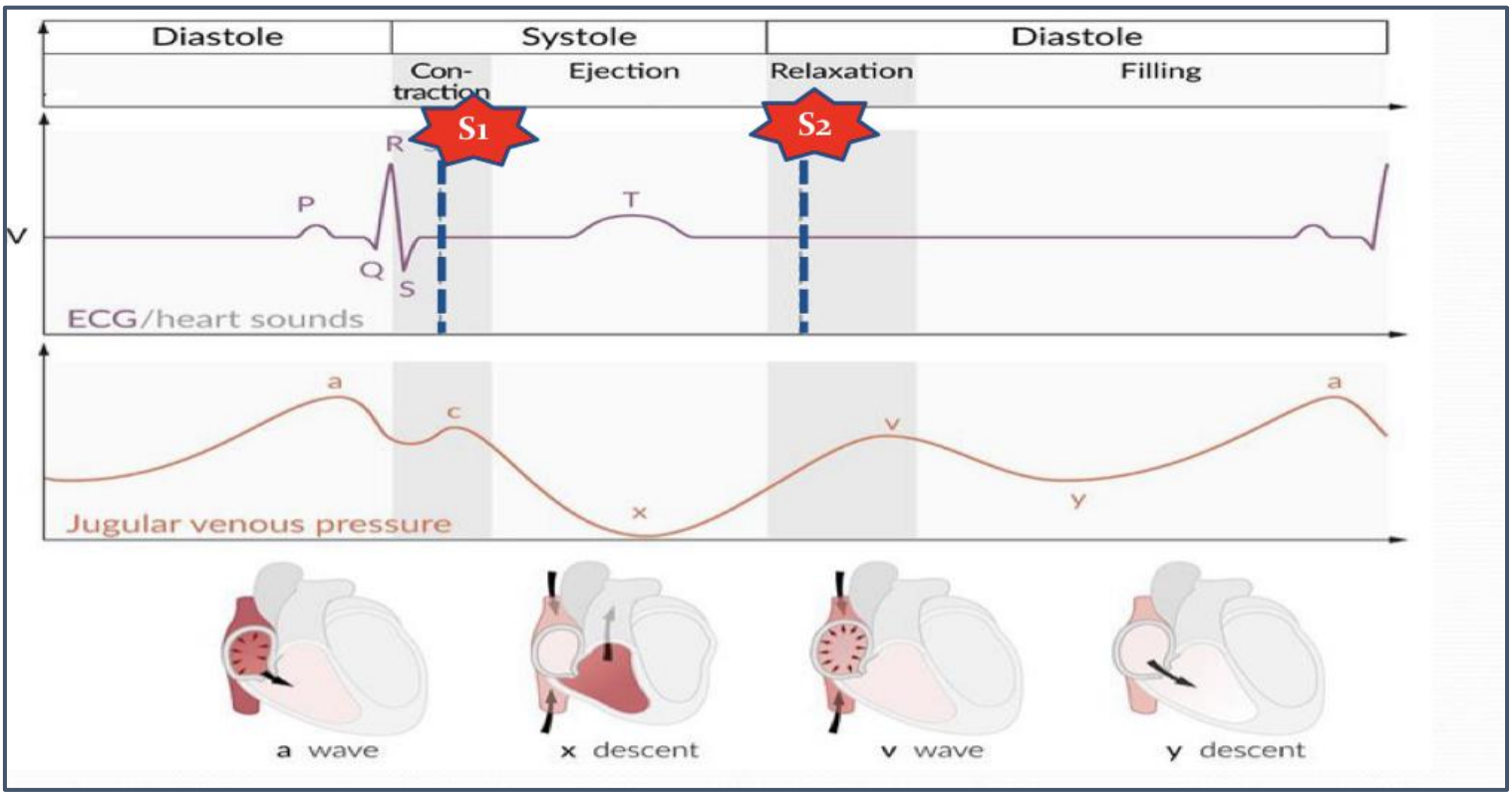
Why do we prefer internal jugular vein to record JVP?

Pressure changes in the right atrium are transmitted directly to the internal jugular vein as there are **no valves** between this vein and the right atrium.
The **external jugular vein cannot be relied upon** because this vessel:
- Has valves.
- May be obstructed by the fascial and muscular layers through which it passes.

Wave:	Physiologic event:
a wave	Increased right atrial pressure secondary to right atrial contraction occurring at the end of ventricular diastole.
c wave	Increased right atrial pressure caused by the bulging of tricuspid valve into the right atrium during isovolumetric ventricular contraction. Or due to transmitted carotid pulsations.
x descent	Decreased right atrial pressure due to downward displacement of tricuspid valve secondary to contraction of papillary muscles during ventricular systole.
v wave	It represents the increase in right atrial pressure as it fills with blood returning from the great veins against a closed tricuspid valve.
y descent	It represents the fall in right atrial pressure as blood flows out of the right atrium and into the right ventricle upon opening of the tricuspid valve

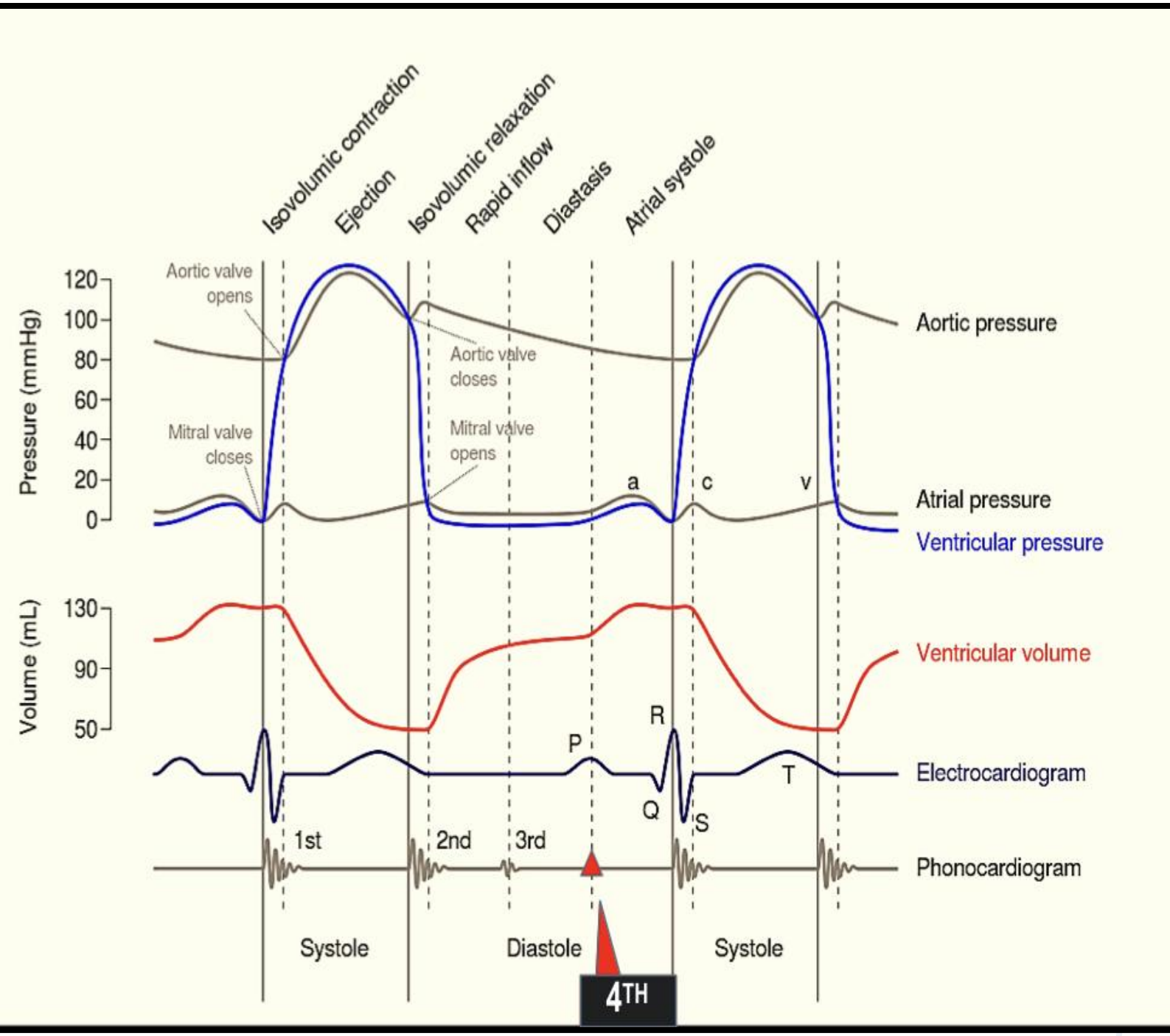


JVP & ECG:



Clinical application of JVP:

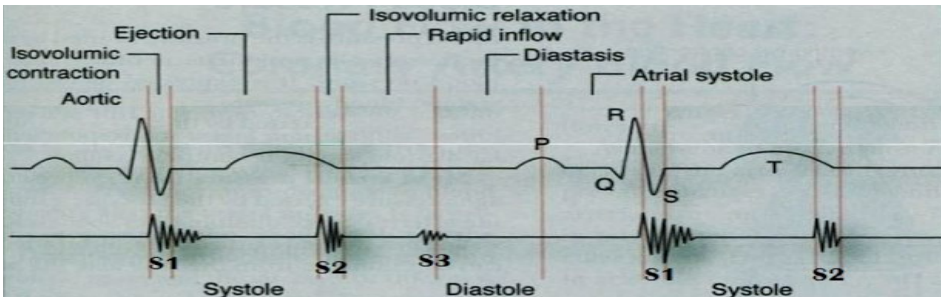
Clinical finding	Explanation	Possible causes:
Prominent 'a'wave	Signifies increased right atrial pressure	• Right heart failure • Tricuspid stenosis • Pulmonary stenosis • Pulmonary hypertension
Cannon 'a' wave	It occurs when the right atrial pressure becomes very high usually secondary to right atrial contraction against a closed tricuspid valve	• Atrial flutter wave • Third degree heart block (Complete heart block) • Ventricular Tachycardia
Absent 'a' wave	The right atrial pressure does not increase due to failure of proper contraction	• Atrial fibrillation
Large 'v' wave		• Tricuspid regurgitation


Isovolumic contraction
Ejection
Isovolumic relaxation
Rapid inflow
Diastasis
Atrial systole
Pressure (mmHg)
120
100
80
60
40
20
0
Aortic valve opens
Aortic valve closes
Mitral valve closes
Mitral valve opens
a
c
v
Aortic pressure
Atrial pressure
Ventricular pressure
Volume (mL)
130
90
50
Ventricular volume
R
P
T
Q
S
Electrocardiogram
1st
2nd
3rd
Phonocardiogram
Systole
Diastole
Systole
4TH

Heart sounds methods

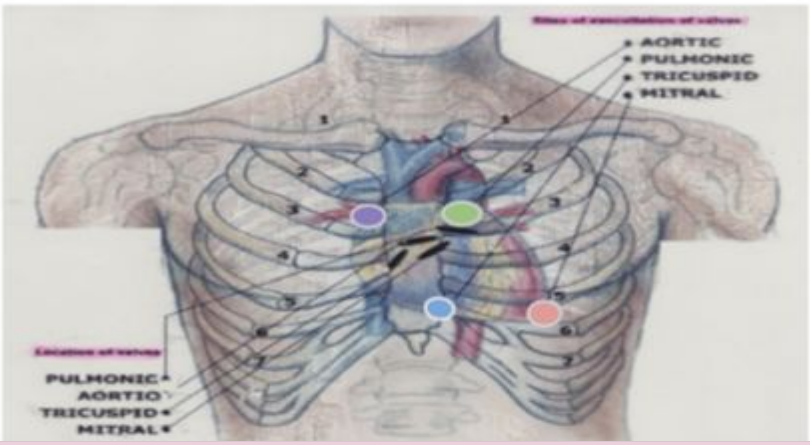
1- Phonocardiography

is the sensitive technique, by which a recording can be made of all four heart sounds by placing a transducer on specific areas of auscultation.



2- Auscultation

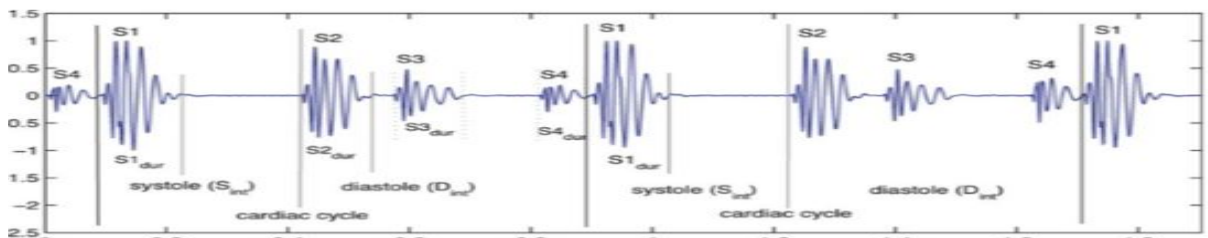
Using	Stethoscope
The position of the patient	• Supine • Left lateral • Sitting



Areas of auscultation			
Mitral area (apex)	Tricuspid area	Pulmonary area	Aortic area
Found in the left 5th intercostal space,approximately 1 cm medial to the mid-clavicular line.	Found just to the left of the lower border of the sternum.	Found in the left 2nd intercostal space at the sternal border.	Found in the right 2nd intercostal space at the sternal border.

Heart sounds

First heart sound (S1)	Second heart sound (S2)
It is always normal. It sounds as "lub".	It is always normal. It sounds as "dub".
usually prolonged, but dull in nature	usually short and sharp in nature
caused by the closure of AV valves.	caused by the closure of semilunar valves
best heard when auscultated at mitral and tricuspid areas.	best heard when auscultated at aortic and pulmonary areas.
occurs at the beginning of ventricular systole in relation to cardiac cycle.	occurs at the beginning of ventricular diastole in relation to cardiac cycle.
occurs just after QRS complex if we relate it to ECG	occurs just after T wave if we relate it to ECG
Frequency: 50-60 Hz	Frequency:80-90 Hz
Time: 0.15 sec	Time: 0.11 sec
Third heart sound (S3)	**Fourth heart sound (S4)**
may be heard normally in children, thin adults, and pregnant women or after exercise.	may be heard normally in older people.
caused by the striking of the blood to the wall of ventricles during rapid filling phase of ventricular diastole.	caused by the forceful contraction of atria.
best heard in mitral area (apex)	
occurs in the early diastole in relation to cardiac cycle (beginning of the middle third of diastole)	occurs just before the first heart sound during late diastole in relation to cardiac cycle.
Frequency: 20-30 Hz	Frequency: < 20 Hz
Time: 0.1 sec	



Splitting of S2

Physiologically	occurs during deep inspiration, as the chest wall expands and the intrathoracic pressure falls and this leads to an increase in the venous return into the right atrium
Reason	This inspiration- induced increase in venous return delays closure of the pulmonary valve causing the audible splitting of S
Sound	It is auscultated as “dub-dub” over the aortic or pulmonary areas during deep inspiration.

- This splitting can be appreciated only if the two components of the sound are separated by more than 0.2 sec.

Heart murmurs

Definition	Abnormal sounds produced due to abnormal flow of blood through abnormal heart valves e.g. stenosis or regurgitation.
Types	• Systolic murmurs • Diastolic murmurs • Continuous murmurs

Blood pressure

definition	The force exerted by the blood against any unit area of the vessel wall

Bl. Pressure 50mmHg:

Means that the force exerted is sufficient to push a column of mercury against gravity up to a level of 50 mmHg high.

Equipment

stethoscope

sphygmomanometer

bicycle and/or a treadmill

Measurement of arterial blood pressure	
1	The cuff size should be appropriate for the age and built of the subject.
2	The cuff must be applied snuggly (not too tight and not too loose) about 2.5 cm above the cubital fossa.
3	The free margin of the cuff should not be on the course of brachial artery
4	The manometer should be at the same level as the heart to exclude the effect of gravity while measuring the blood pressure.
5	Adequate amount of mercury in the bulb of the instrument.
6	The subject must be physically and mentally relaxed and in a comfortable environment.

Methods to calculate blood pressure	
Palpatory method	Auscultatory method
only gives an estimate of the **systolic** blood pressure	measures both **systolic** and **diastolic** blood pressures

BP category	Systolic BP		Diastolic BP
Normal	<120mmHg	and	<80mmHg
Elevated	120-129mmHg	and	<80mmHg
Hypertension stage 1	130-139mmHg	or	80-89mmHg
Hypertension stage 2	≥ 140mmHg	or	≥ 90mmHg
Hypertensive urgency	> 180mmHg	and/or	> 120mmHg
Hypertensive emergency	> 180mmHg + target organ damage	and/or	> 120mmHg + target organ damage

The korotkov sounds

- **These sounds are produced by turbulent flow in the constricted brachial artery.**

1. **Phase 1**
   The appearance of a clear tapping sound. This is the first sound that is heard and it represents the Systolic Pressure photos and Text.
2. **Phase 2**
   Blowing or swishing sounds.
3. **Phase 3**
   The sounds become sharper and crisper.
4. **Phase 4**
   An abrupt muffling of sounds.
5. **Phase 5**
   All sounds disappear. The point where the sound disappears is the diastolic blood pressure.

	Pulse pressure	Mean arterial blood pressure
Definition	It is the difference between systolic and diastolic blood pressures.	-It is the average blood pressure within the arteries during a whole cardiac cycle -The force responsible for maintaining a continuous forward flow of the blood in the circulation during the whole cardiac cycle.
Law	Pulse Pressure = Systolic – Diastolic pressure	M.A.B.P.= diastolic blood pressure + 1/3 pulse pressure
Pulse Pressure = Systolic – Diastolic pressure i.e. 120 – 80 = 40 mmHg.		
Example	120 – 80 = 40 mmHg.	-

BP changes with exercise

Conditions	Blood pressure
Before exercise	120/80 mmHg
After mild exercise	140/80 mmHg
After heavy exercise	160/60 mmHg

Factors affecting BP

1/ Diurnal variation

Blood pressure is lower in the morning.

2/ Age

blood pressure increase with age.
- At birth: 50/30 mm Hg
- Adult: 120/80 mm Hg
- Old age: 170/90 mm Hg

3/ Posture

In erect posture: the systolic falls a little but soon returns to normal by the compensatory mechanisms.

4/ Digestion

Systolic blood pressure rises by 6-8 mmHg after meals (1 hour).

5/ Exercise

Systolic blood pressure increase while diastolic blood pressure remains unchanged

6/ Emotions

-Increase blood pressure
- It drops during sleep and excessive hemorrhage.

7/ Temperature

Cold causes vasoconstriction so increase blood pressure due to increase peripheral resistance

8/ Sex

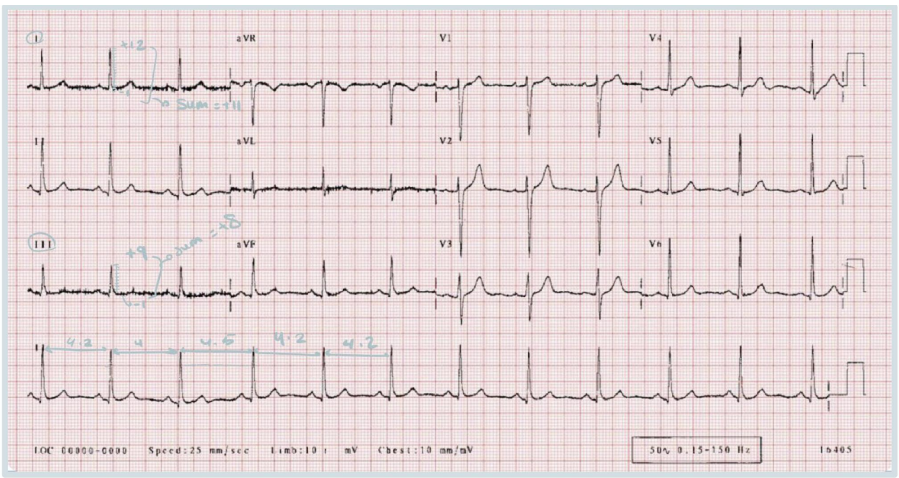
Blood pressure is lower in female until menopause

9/ Body build

Obesity increases blood pressure

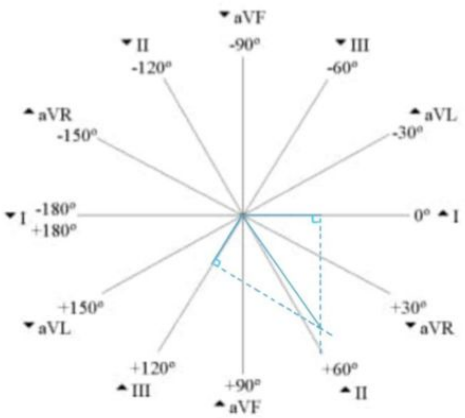
Handout question

Looking at the ECG tracing in Fig-17, answer the following questions;



A. Calculate the heart rate of the subject.

HR = 1500/no. SS —> = 1500/21 =71.43 beats/min
HR = 300/no. SL —> = 300/4.2 =71.43 beats/min



B .Comment on the rhythm of the heart.

Normal sinus rhythm

C.Name the waves and intervals and calculate their duration.

I. PR interval= 0.12-0.2 secs
II. ST interval= 0.28-0.36 secs
III. QT interval= 0.35-0.43 secs

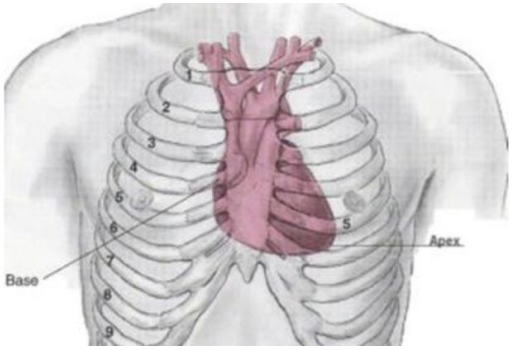
D.Calculate the cardiac axis.

56 degrees

e. What do you think of the ST segment?

ST segment is normal or isoelectric (not elevated or depressed)

Below is a picture of the chest. On the picture below shadow and label the precordial areas for heart sound auscultation, and answer the following questions;



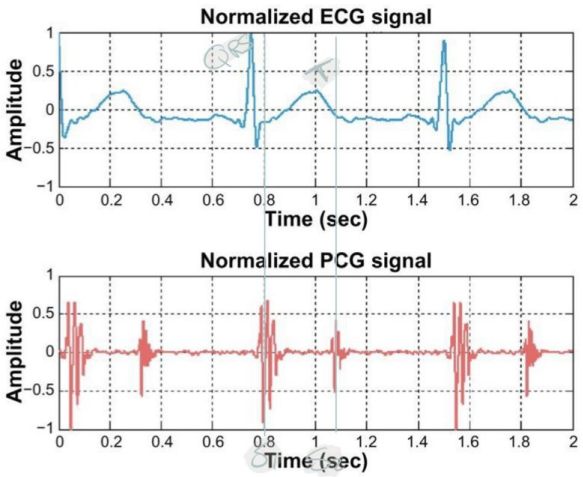
a. S1 is heard best in which area/s?

Mitral and tricuspid areas.

b. S2 is heard best in which area/s?

Aortic and pulmonary areas.

The tracing below, shows simultaneous recording of the ECG and the phonocardiogram (PCG). Using the knowledge acquired in the lab identify the following on the PCG tracing;



a. The first and second heart sounds.

S1 = occurs after QRS complex if we relate it to ECG

S2 = occurs after T wave if we relate it to ECG

b. Systole and diastole.

Systole = between the 1st and 2nd heart sounds

Diastole = between the 2nd and 1st heart sounds of next cycle

4- Why is the JVP recorded from the internal jugular vein rather than the external jugular vein?

Pressure change in right atrium are transmitted directly to the internal jugular vein as there are no valves between this vein and right atrium The external jugular vein cannot be relied upon because this vessel;

A) Has valves

B) May be obstructed by the fascial and muscular layers through which it passes

5- Explain how Korotkoff sounds are produced?

By turbulent flow in the constricted brachial

6- What is pulse pressure and how is it calculated?

It is the difference between systolic and diastolic blood pressures.

Pulse Pressure = Systolic – Diastolic pressure

7- What is mean arterial blood pressure? What is its significance? How is it calculated?

It's the average blood pressure within the arteries during a whole cardiac cycle. The force responsible for maintaining a continuous forward flow of the blood in the circulation during the whole cardiac cycle. M.A.B.P.= diastolic blood pressure + 1/3 pulse pressure

8- What are the effects of exercise on systolic and diastolic blood pressure? What happens to pulse pressure during exercise? Explain your answer.

Mild to moderate exercise = Systolic BP increase, Diastolic BP remains the same. Because of sympathetic stimulation, the cardiac output increases, which in turn increases the systolic BP, but no effect on diastolic BP. Severe exercise = Systolic BP increases, Diastolic BP decreases because of a net decrease in the total peripheral resistance due to the more vasodilatation effect on the arterioles supplying the exercising skeletal muscles than the vasoconstriction effect on the arterioles supplying the other tissues.

GOOD LUCK!!!

Special thanks to:
TEAM349

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