

4- Measurement of arterial blood pressure

Introduction:

The blood pressure means the force of blood exerted against the blood vessel wall. Arterial blood pressure (ABP) is one of essential parameters in cardiovascular physiology. In young adult human the ABP fluctuates between systolic levels of 120 mmHg, and a diastolic level of 70 mmHg. The ABP is written as systolic pressure over diastolic pressure (120/70 mmHg).

Systolic pressure is the maximum pressure exerted by the blood against the artery walls. It results when the ventricles contract. Normally, it measures 120 mm Hg.

Diastolic pressure is the lowest pressure in the artery. It results when the ventricles are relaxed and is usually around 80 mm Hg.

The mean blood pressure (MBP) is the average pressure throughout the cardiac cycle which equals to the diastolic blood pressure (DBP) plus one third of the **pulse pressure** (the difference between the systolic blood pressure and DBP).

$$\text{MBP} = \text{DBP} + \frac{1}{3} \text{Pulse pressure.}$$

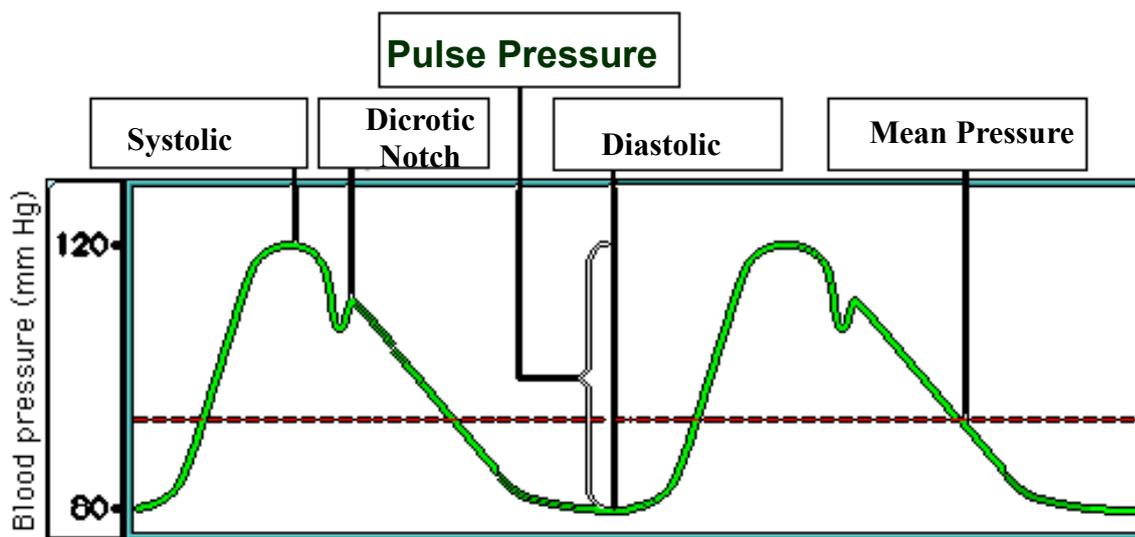


Figure (4-1): Blood pressure curve.

The ABP is the product of the cardiac output (COP) and peripheral resistance (PR). So increase in COP leads to increase the systolic blood pressure (SBP) whereas increase in PR leads to increase the DBP.

$$\text{Blood Pressure} = \text{Cardiac Output} \times \text{Peripheral Resistance}$$

Classification of blood pressure

Category	SBP	DBP
Normal	<120	<80
Prehypertension	121-139	81-89
Stage 1 hypertension	140-159	90-99
Stage 2 hypertension	≥160	≥100

There are two methods to measurement of ABP:

1- **Direct method**:- A cannula or needle filled with anticoagulant is inserted in artery. Then it is connected to the manometer.

2- **Indirect method**:

A- Palpatory method: The SBP can be determined by inflating an arm cuff and then letting the pressure fall and determining the pressure at which the radial pulse first becomes palpable.

B- Auscultatory method: It is standard method of taking a patient blood pressure by use technique developed by Korotkoff in 1905. The arterial pressure in human is routinely measured by this method by using instrument which is called a sphygmomanometer. Inflate the bag of instrument by means of a rubber squeeze bulb to pressure above the expected systolic pressure so no sound is heard with the stethoscope. The pressure in the cuff is then lowered slowly by open release valve. When the inflation pressure falls, the small spurt of blood escapes through the cuff and slight tapping sound heard. The pressure at which the sound is first heard (phase 1 of korotkoff sound) represents the systolic blood pressure (SBP). The sounds become louder, then dull, muffled and finally they disappear. The point at which the sound becomes muffled is taken as the diastolic pressure in pregnancy, children, and adult after exercise. This is also true in diseases such hyperthyroidism and aortic insufficiency. Diastolic pressure in resting adult correlates best with the pressure at which the sound disappears.

Korotkoff sounds are:-

- 1- Phase 1: tapping sound.
- 2- Phase 2: louder sound.
- 3- Phase 3: dull sound.
- 4- Phase 4: muffled sound.
- 5-Phase 5: disappeared sound.

The auscultatory method is accurate when used properly, because of the difficulty in determining exactly when the first beat is felt. Pressure by palpatory method is usually 2 – 5 mmHg. lower than those measured by the auscultatory method.

The number of precautions must be observed:-

- 1- **The cuff must be at heart level** to obtain a pressure that is uninfluenced by gravity (The blood pressure increase or decrease about 0.77 mmHg/cm above or below heart level).
- 2- **Using standard arm cuff** A cuff that is too small will produce a falsely high reading; one that is too large, a falsely low reading. The American Heart Association recommends comparing the cuff with subject arm. The length of bladder should be at least 80% of the arm circumference.
- 3- **Compare blood pressure in both arms**, when examining an individual for first time. Presences of difference between them indicate vascular obstruction.
- 4- Tell the subject not to talk during measurement of pressure.
- 5- A void using an arm with I.V, edema, injury or paralysis.
- 6- Smoking and drinking alcohol within last 15 minutes alter reading.
- 7- Pain, anxiety and discomfort give a falsely high pressure.

Normal value:- The average ABP in young adult is about 120/70 mmHg. In sitting or lying position at rest. The normal range is 100 – 140 / 60 – 90 mmHg. It falls at night and in women than in men. In healthy human both SBP and DBP rise with age. Exercise, anxiety and discomfort can lead to a transient rise in BP.

Physiological variation:-

- 1- Age: The ABP increase with age.
- 2- Sex: in women is slightly less than men.
- 3- It is more at evening and less in morning.
- 4- It is more after meal exercise and well-built person.
- 5- It is less in sleep and in lying position.

Sphygmomanometer:- See figure 4-2.

- 1- Graduated vertical limb which open to atmosphere. It has marking from 0 – 250 mmHg from below upward.
- 2- Rubber bag covered with linen cuff. **See figure 4-3.**
- 3- Rubber bulb with valve.
- 4- Release screw.
- 5- Mercury reservoir.
- 6- Rubber tubes.

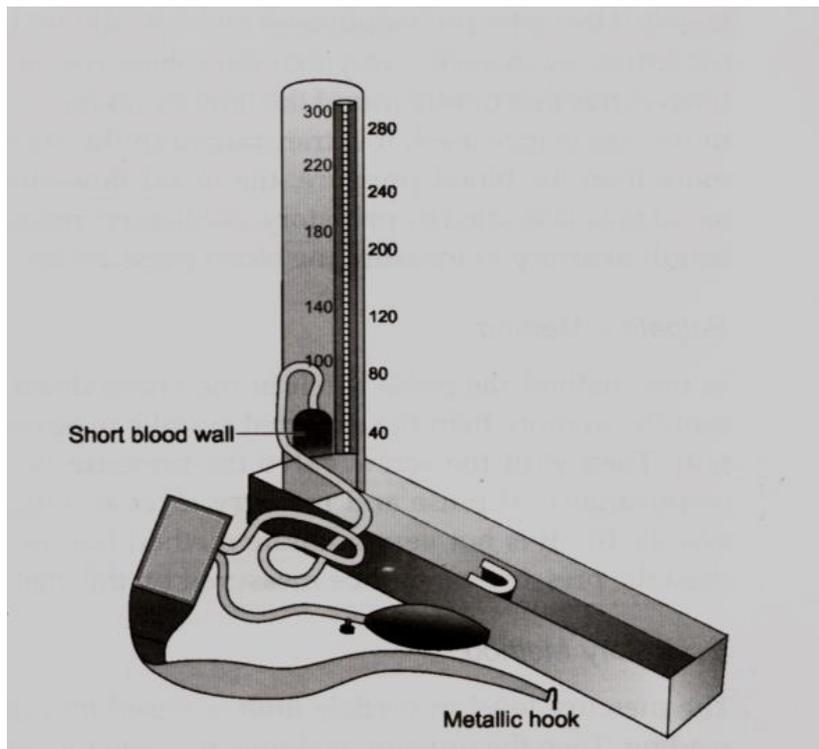


Figure (4-2): Sphygmomanometer.

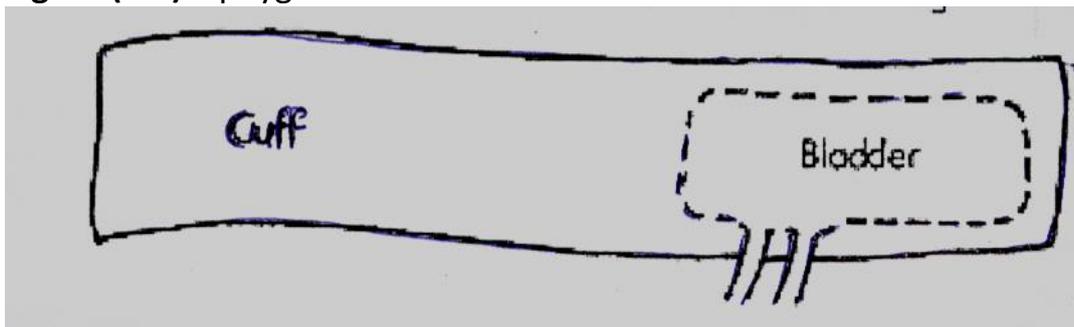


Figure (4-3): Rubber bag covered with linen cuff.

Objective:-

To measure the ABP in human beings.

Materials and instruments:-

- 1- Sphygmomanometer.
- 2- Stethoscope.
- 3- Subject.

Procedure figure 4-4:-

- 1- Subject should be relaxed, sitting or lying for five minutes.
- 2- Manometer is placed at level of observer's eyes.
- 3- All clothing should be removed from upper arm.
- 4- The arm of subject should be supported because failing of it causing isometric contraction which leads to false measurement.

- 5- Inflatable arm cuff is applied around the upper arm not too tightly, leaving one to two inches between the lower end and the cubital fossa, at level of heart.
- 6- Cuff is connected with a mercury or aneroid manometer.
- 7- The bell of stethoscope is placed slightly on the brachial artery. Don't put too much pressure on bell that may occlude arterial flow. Point ear pieces forward.
- 8- Cuff is inflated by a rubber squeeze bulb to pressure above expected SBP (no sound is heard) 20 to 30 mmHg. wait 15 – 30 seconds.
- 9- The pressure in the cuff is lowered slowly to hear soft sound by open release valve. So pressure falls at 2 -3 mmHg per second.
- 10- When the first sound (step 1 of Korotkoff's sound) is heard, the SBP is measured. Listen for the onset of at least two consecutive beats.
- 11- When the sound disappears, at this level DBP is measured in adult. In some conditions like pregnancy, exercise...etc we use muffling of sound (phase 4 of korotkoff's sound) for measurement of DBP.
- 12- Wait 1 - 2 minutes before repeating pressure on the same arm.

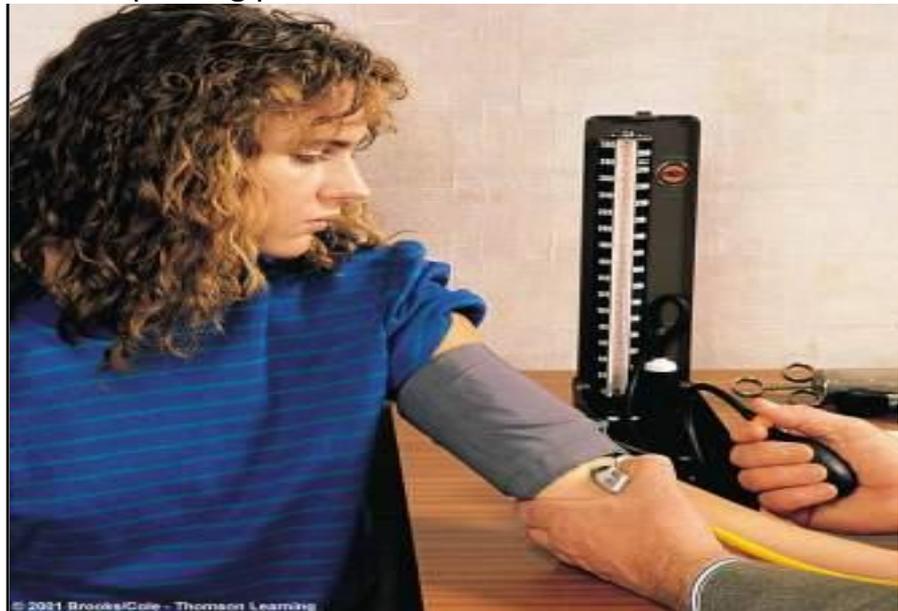


Figure 4-4: procedure of arterial blood pressure measurement