# Blood Pressure

The pressure generated by blood on the wall of arteries, vein, & capillaries is called Blood Pressure.

## Velocity & flow of Blood :-

** The mean velocity of blood in the proximal portion of aorta is 40 cm/sec.

The flow is phasic & velocity ranges from 120 cm/sec during systole to a -ve value at the time of the transient backflow before the aortic valve closes in diastole. In distal portion of the aorta & in the large arteries velocity is also greater in systole than it is in diastole.

However, the vessels are elastic, & forward flow is continuous because of the recoil during diastole of the vessel walls that have been stretched during systole. This recoil effect is sometimes called Windkessel effect & the vessels are called windkessel vessels in the honour of German scientist Windkessel who worked on elastic reservoir.

## Artial pressure :-

The pressure in Aorta, brachial and other large arteries in a young adult men rise to 120 mmHg (Systolic P.) & falls to a min^m 70 mmHg (Diastolic P.) during each heart cycle.

(P2)

Sy. Di.

* The arterial pressure is written as — 120/70 mm

* 1 mm Hg = 0.133 kPa

so in SI units → 16.0/9.3 kPa

* The Pulse Pr. = Syst − dia. P.

50 = 120 − 70

The pulse Pre = A between Sy. P & Dia Pr.

= 50 mmHg.

* Mean Pr. is the average pressure through the cardiac cycle. Because systole is shorter than diastole, the mean P. is slightly less than the value halfway between systolic & diastolic. It can be determined only by integrating the area of pressure curve. However, on average the mean P is equals to diastolic plus 1/3 of pulse pres.

Mean P ≅ Dia P + $\frac{1}{3}$ Pul P.

≅ 70 + $\frac{1}{3}$ × 50 = 70 + 17

≅ 70 + 17 = 87

The pressure falls very slightly in the large and medium sized arteries because their resistance to flow is small, but it falls rapidly in small arteries & arterioles, which are the main site of peripheral resistance against which heart pumps. The Mean P at the end of arterioles is 30–38 mm

Pulse P. — — — — — 5 mm

The magnitude of pressure drops along the arterioles, depending upon whether they are constricted or dilated.

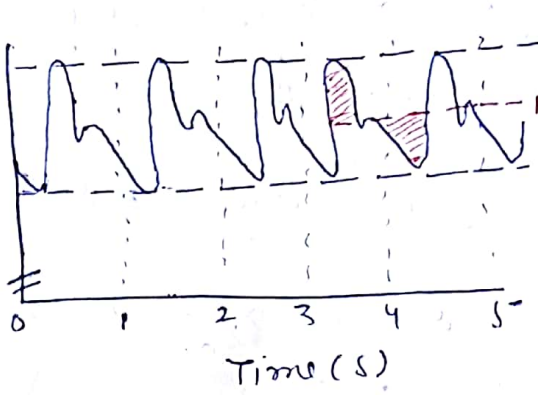


Fig - Brachial art. sy. P. curve of normal adult person showing the relation b/w sy. P, Di. P & M.P. The shaded area above the M.P. line is equal to shaded area below it.

**Effect of Gravity :-** The pressure shown normally in blood vessels are at heart level. The pressure in any vessel below heart level is increased and above heart level is decreased by the effect of gravity.

The magnitude of the gravitational effect (the product of the density of the blood, the acceleration due to gravity (980 cm/s) & the vertical distance above or below heart) is 0.77 mm Hg/cm at the density of normal blood.

Thus, in adult human in the upright position (when mean art. Pr. at heart level is 100 mm Hg), the mean P in large art. in the head (50 cm above heart) is 62 mmHg (100 − [0.77 × 50]) & the Pr. in large art. in the foot (105 cm below heart) is 180 mm Hg (100 + [0.77 × 105])

- The mean P. in large artery above 50 cm. Heart (head)

$$= (100 - [0.77 \times 50])$$
$$= 62 \text{ mmHg}$$

- The mean P in large artery below 105 cm heart (foot)

$$= (100 + [0.77 \times 105])$$
$$= 180 \text{ mmHg}$$

The effect of gravity is similar to and effect on cardiac output.

(104)

## Normal Arterial B.P. →

* The B.P. in the Brachial artery in young adu in sitting or lying position at rest is about 120/ 70

→ It is lower at night & women's than ♂.

* Since Arterial Pr = Cardiac output × peripheral resistance

Since Arterial P. is the product of Cardiac out & peripheral resistance, the affected, if both of these factors affected

* If cardiac out put increased → Systolic pressure increased
* If peripheral resistance increased → increased diastolic pressure

* In healthy humans both systolic & diastolic pressure increased with age. The An important cause of systolic pressure rise is decreased distensibility of the arteries at the same level of cardiac output, the systolic pr. is higher in old than in young ones. because there is less increase in the volume of the arterial system during systole to accommodate the same amount of blood

$\frac{1}{B.P}$ = distensibility of arteries (increased with age)

~~BP~~ = volume of arteries (~~increased~~ decreased with age)

* ~~Only~~ In 20% ~~to~~ patient the raise in B.P is due to nervousness hence called white coat hypertension. while in 80% it is due to real hypertension.

## Methods of measuring B.P :-

If a cannula is inserted into an artery, the arterial P. can be measured directly with a mercury ~~mo~~ manometer or a suitably calibrated strain gauge & an oscillograph arranged to write directly on a moving strip of paper. When an artery is tied off beyond the point at which the cannula is inserted, an end pressure is recorded. Flow of artery is interrupted, & all the kinetic energy of flow is converted into pressure energy

If a tube 'T' inserted into a vessel & the pressure is measured in the side arm of the tube, the recorded side pressure under condition where pressure drops due to is negligible is lower than end pressure by the Kinetic energy of flow. This is because in a tube (or blood vessel) the total energy (the sum of K.E of flow & pressure energy) is constant (Bernoulli principle)

It is noted that the pressure drops in any segment of arterial sy. is due to —

* Conversion of P.E into K.E
* resistance

The pressure drops due to energy lost in overcoming resistance is irreversible, since the energy is dissipated as heat; but the pressure drop due to conversion of P.E to K.E as a vessel narrows is reversed when vessel widens out again.

Bernoulli principle has a great significance in pathophysiology. Acc. to principle the greater the velocity of flow in a vessel, the lower the lateral pressure distending its walls. When a vessel is narrowed, the velocity of flow in narrowed portion increases & the distending pressure decreases

Therefore, when a vessel is narrowed by pathologic process (such as an arteriosler plaque, the lateral pressure at the constrict decreased & narrowing tend to maintai it self.

Flow of velocity in vessels $\propto \frac{1}{\text{lateral Pressure in a}}$

② Auscultatory method:-

The human B.P. normally recorded auscultatory method.

In this, an inflatable cuff (Riva-Rocc cuff) attached to a mercury manometer (sphygmomanometer) is wrapped around arm & a stethoscope is placed over the brachial artery at the elbow. The cuff is rapidly inflated until the pressure in it is well above the expected systolic pressure in the brachial artery. The artery is occluded by the cuff, & no sound is heard with stethoscope. The pressure in cuff is then lowered slowly. At the point at which systolic pressure in the artery just exceeds the cuff pressure a spurt of blood passes through each heartbeat a tapping sound is heard at brachial artery of elbow.

The cuff pressure at which the sounds are heard first is the systolic pressure.

The sounds become louder, then dull & muffled; finally in most individuals

they disappear. These are sounds of Korotkow & the pressure at which sound disappears is called diastolic pressure.

However, in adults after exercise & in children, hyperthyroidism & aortic insufficiency person the diastolic pressure is measured best with the pressure at which sounds become muffled.

The sounds of Korotkow are produced by turbulent flow in brachial artery. The streamline flow in the unconstricted artery is silent, but when the artery is narrowed, the velocity of flow through the constriction exceeds the critical velocity & turbulent flow results.

precautions:-

* The cuff must be at heart level. to obtain a pressure that is uninfluenced by gravity.
* The B.P. in the thighs can be measured with the cuff around the thigh and stethoscope over the popliteal artery. But it is not best because there is more tissue between cuff & & the artery & ~~press~~ pressure is falsely high. same thing is true ~~pres~~ brachial artery B.P. measured in obese arm person, because the blanket of fat dissipates some of cuff P.

In both situations, accurate pressure can be obtained by using a cuff that is wider than the standard arm cuff.

* Compare the B.P. in both arms when examining the person for first time. Major difference between the pressure on the 2 sides indicate the presence of vascular obstruction.