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17/MHS01/310

200L

PHS 201 ASSIGNMENT

MEDICINE AND SURGERY

1. **Discuss the long term regulation of mean arterial blood pressure.**
2. **Write short notes on the following:**
   a) **Pulmonary circulation**
   b) **Circle of Willis**
   c) **Splanchic circulation**
   d) **Coronary circulation**
   e) **Cutaneous circulation**
3. **Discuss the cardiovascular adjustment that occurs during exercise.**

1a) Mean arterial blood pressure is the average pressure existing in the arteries. It is not the arithmetic mean of systolic and diastolic pressures. It is the diastolic pressure plus one third of pulse pressure. Arterial blood pressure varies even under physiological conditions. However, immediately it is brought back to normal level because of the presence of well-organized regulatory mechanisms in the body. The body has four regulatory mechanisms to maintain the blood pressure within normal limits. They are; **nervous mechanism or short term regulatory mechanism, renal mechanism or long term regulatory mechanism, hormonal mechanism and local mechanism.**

- **Renal mechanism or long term regulation:** kidneys play an important role in the long term regulation of arterial blood pressure. Kidneys regulate arterial blood pressure by two ways: **by regulation of ECF volume** and **through renin-angiotensin mechanism.**

By regulation of extracellular fluid (ECF) volume: when blood pressure increases, kidneys excrete large amounts of water and salt, particularly sodium, by means of **pressure diuresis** and pressure natriuresis. Pressure diuresis is the excretion of large quantities of water in urine because of increased blood pressure. Pressure natriuresis is the excretion of large quantity of sodium in urine. Because of **diuresis** and **natriuresis,** there is a decrease in ECF volume and blood volume, which brings the arterial blood pressure back to normal level. When blood pressure decreases, the reabsorption of water from renal tubules is increased. This increases ECF volume, blood volume and cardiac output, restoring blood pressure.

Through renin-angiotensin mechanism: when blood pressure and ECF volume decrease, renin secretion from kidneys is increased. It converts angiotensinogen into angiotensin I, which is converted into angiotensin II by ACE (angiotensin-converting enzyme). Angiotensin II causes constriction of arterioles in the body so that the peripheral resistance is increased and blood pressure rises. Angiotensin II causes constriction of afferent arterioles in kidneys, so that glomerular filtration reduces, resulting in increased ECF volume which increases blood pressure to normal level. Also simultaneously, angiotensin II stimulates the adrenal cortex to secrete aldosterone. This hormone increases reabsorption of sodium from renal tubules. Sodium reabsorption is followed by water reabsorption, resulting in increased ECF volume and blood volume. It increases the blood pressure to normal level.

2a) **Pulmonary circulation:** this is the portion of the circulatory system which carried deoxygenated blood away from the right ventricle, to the lungs, and returns oxygenated blood to the left atrium and ventricle of the heart. Deoxygenated blood leaves the heart, goes to the lungs, and then reenters the heart. Deoxygenated blood leaves through the pulmonary artery. From the right atrium , the blood is pumped through the tricuspid valve into the right ventricle. Blood is then pumped from the right ventricle through the pulmonary valve and into the main pulmonary artery. Pulmonary circulation.

b) **Circle of Willis:** this is a circulatory anastomosis that supplies blood to the brain and surrounding structures. It is named after Thomas Willis (1621-1675), an English physician. The circle of Willis is a part of the cerebral circulation and is composed of the anterior cerebral artery, anterior communicating artery, internal carotid artery, posterior cerebral artery and the posterior communicating artery. The arrangement of the brain's arteries in the circle of Willis creates redundancy for collateral circulation in the cerebral circulation.

c) **Splanchic circulation:** it is also known as visceral circulation and constitutes three portions. These three portions are:

- Mesenteric circulation supplying blood to the GI tract.
- Splenic circulation supplying blood to spleen.
- Hepatic circulation supplying blood to liver.

A unique feature of the splanchic circulation is that the blood from mesenteric bed and spleen forms a major amount of blood flowing to liver. Blood flows to the liver from the GI tract and spleen through the portal system.

- **Mesenteric circulation**: blood flow is regulated by four factors. These include;
    - Local autoregulation which is the primary factor regulating blood flow.
    - Activity of Gastrointestinal Tract: contraction of its wall reduces blood flow due to compression of blood vessels. Relaxation increases blood flow because compression is removed.
    - Nervous factors: it is regulated by sympathetic nerve fibers. Increase in sympathetic activity constrict the mesenteric blood vessels, causing more blood to be diverted to the heart, skeletal muscles etc.
    - Chemical Functions-Functional Hyperemia: increase in mesenteric blood flow immediately after food intake.
- **Splenic circulation:** the spleen is the main reservoir for blood. Blood is stored in **splenic venous sinuses** and **splenic pulp,** which are lined with **reticuloendothelial cells.**
- **Hepatic circulation:** the liver receives blood from the hepatic artery and the portal vein. Blood flow to liver is regulated by; systemic blood pressure, splenic contraction, movements of intestine, chemical factors (excess carbon dioxide, lack of oxygen etc.) and nervous factors.

d) **Coronary circulation**: this is the circulation of blood through blood vessels of the heart muscles (myocardium). It is responsible for functional blood supply to the heart muscle itself. The right coronary artery supplies the whole of the right ventricle and posterior portion of left ventricle. While the left coronary supplies the anterior and lateral parts of the left ventricle. Coronary arteries divide and subdivide into smaller branches. Smaller branches are called **epicardial arteries** which give rise to other smaller branches called **final arteries or intramural vessels.**

The **coronary sinus** is the larger vein that drains 75% of total coronary flow. It drains blood from the left side of the heart and opens into the right atrium near the tricuspid valve.

Anterior coronary veins drain blood from the right side of the heart and open directly into the right atrium.

Thebesian veins drain deoxygenated blood from myocardium directly into the concerned chamber.

Normal blood flow through coronary circulation is about 200 mL/min. it forms 4% of cardiac output and is about 65-70 mL/min/100g of cardiac muscle. Coronary circulation is regulated by the following factors; need for oxygen, metabolic factors, coronary perfusion pressure and nervous factors.

e.) **Cutaneous circulation:** cutaneous blood flow supplies nutrition to the skin and regulates the body temperature by heat loss. The architecture of cutaneous blood vessels is formed in the following manner; **arterioles** arising from the smaller arteries reach the base of **papillae of dermis.** The arterioles turn horizontally and give rise to **meta-arterioles. Capillary loops** arise from the meta-arterioles. Arterial limb of the loop ascends vertically in the papillae and turns to form a venous limb, which descends downward. Few venous limbs unite to form the **collecting venule.** Collecting venules anastomose with one another to form the **subpapillary venous plexus.** These run horizontally beneath the bases of papillae and drain into **deeper veins.** Under normal conditions, the blood flow to the skin is about 250 mL/sq. m/min. When the body temperature increases, cutaneous blood flow increases up to 2,800mL/sq. m/min because of cutaneous vasodilation. Cutaneous blood flow is regulated mainly by body temperature. The hypothalamus plays an important role in regulating cutaneous blood flow. When the body temperature increases, the hypothalamus is activated. The hypothalamus causes cutaneous vasodilation by acting through medullary vasomotor center. Blood flow increases in the skin which causes the loss of heat from the body through sweat. When temperature is low, vasoconstriction occurs in the skin which causes the blood flow to the skin to decrease and prevent heat loss from the skin.

3. During exercise, there is an increase in metabolic needs of body tissues, particularly the muscles. There are two types of exercise; dynamic and static exercise. **Dynamic exercise** primarily involves the **isotonic muscular contraction.** It keeps the joints and muscles moving. Examples are swimming, cycling, walking, etc. It involves **external work** which is the shortening of muscle fibers against load. The heart rate, force of contraction, cardiac output and systolic blood pressure.

Static exercise involves **isometric muscular contraction** without movement of joints. Examples include pushing heavy objects. It does not involve **external work.** Increase of heart rate, force of contraction, cardiac output, systolic blood pressure and diastolic blood pressure increase as a result.

- **Aerobic exercise:** involves activities with lower intensity, which are performed for long periods. The energy is obtained by utilizing nutrients in the presence of oxygen, hence the name. At the beginning, the body obtains energy by burning glycogen stored in the liver. After exhaustion of stored glycogen (about 20 minutes in), the body starts burning fat. Body fat is converted into glucose, which is utilized for energy. Examples include; jogging, running, swimming, cycling, skating, etc.
- **Anaerobic exercise:** involves exertion for short periods followed by periods of rest. It uses the muscles at high intensity and a high rate of work for a short period. The body obtains energy by burning glycogen stored in the muscles without oxygen, hence the name. Burning glycogen without oxygen liberates lactic acid. Accumulation of lactic acid leads to fatigue, hence, this kind of exercise cannot be performed for a long period of time. Anaerobic exercise helps to increase muscle strength. Examples include; pull-ups, push-ups, weightlifting, sprinting, etc.

Cardiovascular and other changes in the body depend on the severity of the exercise. Exercise is divided into three types based on severity. They are

- **Mild exercise:** very simple form of exercise like slow walking. Little or no change occurs in cardiovascular system.
- **Moderate exercise:** does not involve strenuous muscular activity. Exhaustion does not occur at the end. Examples; fast walking and slow running.
- **Severe exercise:** involves strenuous muscular activity. Severity can be maintained only for short durations. Example; fast running for a distance of 400 meters. Complete exhaustion occurs at the end.

Some effects of exercise on the cardiovascular system include:

- **On blood:** mild hypoxia developed during exercise stimulates the juxtaglomerular apparatus to secrete erythropoietin. It stimulates the bone marrow and causes release of red blood cells.
- **On blood volume:** more heat is produced during exercise and the thermoregulatory system is activated which causes secretion of large amount of sweat. This leads to fluid loss, reduced blood volume, hemoconcentration and sometimes, dehydration.
- **On heart rate:** heart rate increases during exercise. In moderate exercise, heart rate increases to 180 beats per minute while in severe muscular exercise, it reaches 240 to 260 beats per minute.
- **On cardiac output:** it increases up to 20 L/min in moderate exercise and 35 L/min during severe exercise. Increase in cardiac output is directly proportional to the increase in the amount of oxygen consumed during exercise.
- **On venous return:** venous return increases remarkably during exercise because of muscle pump, respiratory pump and splanchic vasoconstriction.

- **On blood flow to skeletal muscles:** the amount of blood flowing to skeletal muscles increases greatly during exercise.
- **On blood pressure:** during moderate isotonic exercise, systolic blood pressure is increased. This is due to increase in heart rate and stroke volume. Diastolic blood pressure is not altered because peripheral resistance is not affected during moderate isotonic exercise. Blood pressure falls slightly below resting level after exercise. It however returns to resting level quickly as soon as the metabolic end products are removed from muscles.