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COURSE TITLE: MEDICAL PHYSIOLOGY

COURSE CODE: PHY 201

ASSIGNMENT

1. Discuss the long-term regulation of mean arterial blood pressure.

Firstly, mean arterial blood pressure (MAP) is the average blood pressure existing in the arteries. Mathematically,

$$\text{MAP} = \text{Diastolic pressure} + \frac{1}{3} \text{ pulse pressure}$$

Where;

$$\text{Pulse pressure} = \text{systolic BP} - \text{diastolic BP}$$

Note that; systolic BP = 110-140mmHg

$$\text{Diastolic BP} = 60-80\text{mmHg}$$

$$\text{Pulse pressure} = 40-50\text{mmHg}$$

The regulation of arterial blood pressure is done in four ways namely;

- Short-term regulatory or neural mechanism
- Long-term regulatory or renal mechanism.
- Hormonal regulatory mechanism.
- Local mechanism or local control.

Focusing on the long-term regulation; From the term “renal” regulation, it is understood that the kidney plays an important role in the long-term regulation of blood pressure. The renal mechanism operates when there is a slow alteration in blood pressure in several days/ months/ years time making the nervous mechanism to the altered pressure and loose its sensitivity for the changes therefore it cannot regulate the pressure anymore. Therefore it is termed “long-term regulation” . Kidneys regulate blood pressure in two ways:

- Regulation of ECF volume.
- Through renin-angiotensin mechanism.

Regulation of ECF volume

When the blood pressure increases, kidneys excrete large amount of water and salt particularly sodium by means of pressure diuresis (excretion of large quantity of water in urine due to increased BP) and pressure natriuresis (excretion of large quantity of sodium in urine). Due to diuresis and natriuresis, there is an ECF volume and blood volume which brings the arterial blood pressure back to normal. When blood pressure decreases. The reabsorption from renal tubules is increased which in turn increases ECF volume, blood volume and cardiac output resulting in the restoration of blood pressure.

Through renin-angiotensin mechanism

When blood pressure and ECF volume decreases, renin secretion from kidney is increased. It converts angiotensinogen into angiotensin I which is then converted into angiotensin II by ACE (angiotensin converting enzyme).

Actions of angiotensin II are;

- It causes constriction of arterioles in the body so that the peripheral resistance is increased and BP rises to normal level.
- It stimulates the adrenal cortex to secrete aldosterone (hormone that increases reabsorption of sodium from renal tubules). Sodium reabsorption is followed by water reabsorption resulting in increased ECF volume and blood volume which increases BP to normal level.

2. Write short notes on the following

a) PULMONARY CIRCULATION

This is the circulation between the heart and the lungs. It is blood circulation through the lungs. It consists of the right heart, pulmonary arteries, capillaries and veins. Deoxygenated blood flows into the lungs via the pulmonary arteries from the right ventricle while oxygenated blood flows into the left atrium via the pulmonary vein. Blood is pumped from the right ventricle to the lungs through the pulmonary artery. Exchange of gases occur between blood and aveoli of the lungs at the pulmonary capillaries. Thus, the left side of the heart contains oxygenated or arterial blood and the right side of the heart contains deoxygenated or venous blood. Pressure in pulmonary circulation is lower than that of systemic circulation thus also termed as “lesser circulation”.

b) CIRCLE OF WILLIS

It is the joining area of several arteries of the bottom/inferior side of the brain. Here, the internal carotid arteries branch into smaller arteries that supply oxygenated blood to over 80% of the cerebrum. It is formed by two groups of arteries; the internal carotid artery and the 2 vertebral arteries. These arteries provide the anterior and posterior circulation of the brain respectively. It is essential for brain functioning since it is the structure of the brain that is mostly sensitive to hypoxia.

c) SPLANCHNIC CIRCULATION

It is the circulation consisting of blood supply to the viscera(gastrointestinal tract, liver, spleen and pancreas). It constitutes three portions;

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

Unique factors of splanchnic circulation is that blood from mesenteric bed and spleen forms major amount of blood flowing to the liver through the portal system.

d) CORONARY CIRCULATION

It is the circulation of blood in the blood vessels that supply the heart muscle (myocardium). Coronary arteries supply oxygenated blood to the heart muscle and cardiacvein drain away blood once it has been deoxygenated. This circulation is of major importance to the entire body even the level of consciousness of the brain from moment to moment. Interruptions of coronary circulation quickly cause heart attacks in which the heart muscle is damaged by oxygen starvation.

e) CUTANEOUS CIRCULATION

It is the circulation and blood supply of the skin. The skin is not a very metabolically active tissue and has relatively small energy

requirements so its supply is different from that of other tissues. The cutaneous ensures heat exchange between the body and the environment.

3. Discuss the cardiovascular adjustment that occurs during exercise.

The integrated response to severe exercise involves fourfold to fivefold increases in cardiac output, which are due primarily to increases in cardiac rate and to a lesser extent to augmentation of stroke volume. The increase in stroke volume is partly due to an increase in end-diastolic cardiac size (Frank-Starling mechanism) and secondarily due to a reduction in end-systolic cardiac size. The full role of the Frank-Starling mechanism is masked by the concomitant tachycardia. The reduction in end-systolic dimensions can be related to increased contractility, mediated by beta adrenergic stimulation. Beta adrenergic blockade prevents the inotropic response, the decrease in end-systolic dimensions, and approximately 50% of the tachycardia of exercise. The enhanced cardiac output is distributed preferentially to the exercising muscles including the heart. Blood flow to the heart increases fourfold to fivefold as well, mainly reflecting the augmented metabolic requirements of the myocardium due to near maximal increases in cardiac rate and contractility. Blood flow to the inactive viscera (e.g., kidney and gastrointestinal tract) is maintained during severe exercise in the normal dog. It is suggested that local autoregulatory mechanisms are responsible for maintained visceral flow in the face of neural and hormonal autonomic drive, which acts to constrict renal and mesenteric vessels and to reduce blood flow. However, in the presence of circulatory impairment, where oxygen delivery to the

exercising muscles is impaired as occurs to complete heart block where normal heart rate increases during exercise are prevented, or in congestive right heart failure, where normal stroke volume increases during exercise are impaired, or in the presence of severe anaemia, where oxygen-carrying capacity of the blood is limited, visceral blood flows are reduced drastically and blood is diverted to the exercising musculature. Thus, visceral flow is normally maintained during severe exercise as long as all other compensatory mechanisms remain intact. However, when any other compensatory mechanism is disrupted (even the elimination of splenic reserve in the dog), reduction and diversion of visceral flow occur.