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DEPARTMENT: 200 LEVEL MBBS

COURSE: PHYSIOLOGY

1. LONG-TERM REGULATION OF MEAN ARTERIAL BLOOD PRESSURE

Kidneys play an important role in the long-term regulation of arterial blood pressure. When blood pressure alters slowly in several days/months/years, the nervous mechanism adapts to the altered pressure and loses the sensitivity for the changes. In such conditions, the renal mechanism operates efficiently to regulate the blood pressure. The kidney regulates blood pressure by two ways;

i. BY REGULATION OF EXTRACELLULAR FLUID VOLUME: When the 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 quantity of water in urine because of increased blood pressure. Even a slight increase in blood pressure doubles the water excretion. 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 in turn brings the arterial blood pressure back to normal level.
   When blood pressure decreases, the reabsorption of water from renal tubules is increased. This in turn increases ECF volume, blood volume and cardiac output, resulting in restoration of blood pressure.

ii. THROUGH RENIN-ANGIOTENSIN MECHANISM: When blood pressure and ECF volume decrease, renin secretion from kidneys (through juxtaglomerular cells) is increased. Juxtaglomerular apparatus is a specialized organ situated near the glomerulus of each nephron. When renin is released into the blood, it acts on angiotensinogen, which is created and released by the liver, and it becomes angiotensin I. Angiotensin Converting Enzyme (ACE) is secreted from the lungs and converts angiotensin I to angiotensin II.
   Action of angiotensin II
   - It causes constriction of arterioles in the body so that the peripheral resistance is increased and blood pressure rises. In addition, angiotensin II causes constriction of afferent arterioles in kidneys, so that glomerular filtration reduces. This results in retention of water and salts, increases ECF volume to normal level. This in turn increases the blood pressure to normal level.

- 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.

Angiotensin III and IV also increase blood pressure and stimulate adrenal cortex to secrete aldosterone.

2.

a. PULMONARY CIRCULATION: Pulmonary circulation is otherwise known as lesser circulation. It is the portion of the circulatory system which carries deoxygenated blood away from the right ventricle to the lungs, and returns oxygenated blood to the left atrium and ventricle of the heart. Blood is pumped from right ventricle to lungs through pulmonary artery. Exchange of gases occurs between blood and alveoli of the lungs at pulmonary capillaries. Oxygenated blood returns to l left atrium through the pulmonary veins.
b. CIRCLE OF WILLIS: The Circle of Willis (Circulus Arteriosus Cerebri) is an anastomotic system of arteries that sits at the base of the brain. It is the joining area of several arteries at the bottom (inferior) side of the brain. At the circle of Willis, the internal carotid arteries branch into smaller arteries that supply oxygenated blood to over 80% of the cerebrum. It helps blood flow from both the front and back sections of the brain. The circle of Willis gets its name from the physician Thomas Willis, who described this part of the anatomy in 1664.
c. SPLANCHNIC CIRCULATION: Also called mesenteric circulation. The splanchnic circulation consists of the blood supply to the gastrointestinal tract, liver, spleen, and pancreas. It consists of two large capillary beds partially in series. The small splanchnic arterial branches supply the capillary beds, and then the efferent venous blood flows into the PV. The splanchnic circulation receives over 25% of the cardiac output and contains a similar percentage of the total blood volume under normal conditions.
d. CORONARY CIRCULATION: Coronary circulation 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 cardiac veins drain away the blood once it has been deoxygenated. The circulation is of major importance not only to its tissues but to the entire body.
e. CUTANEOUS CIRCULATION: The cutaneous circulation is the circulation and blood supply of the skin. The cutaneous circulation ensures heat exchange between the body and the environment. Some of the circulating blood volume in the skin will flow through arteriovenous anastomoses (AVAs) instead of capillaries. These serve a role in temperature regulation.

3. CARDIOVASCULAR ADJUSTMENT THAT OCCURS DURING EXERCISE
During exercise, there is an increase in metabolic needs of body tissues, particularly the muscles. Various adjustments in the body during exercise are aimed at: supply of various metabolic requisites like nutrients and oxygen to muscles and other tissues involved in exercise and prevention of increase in body temperature. During exercise, there are adjustments in;
    a. Heart rate: Heart rate increases during exercise because of impulses from cerebral cortex to medullary centers, which reduces vagal tone i.e. vagal withdrawal. In moderate exercise, the heart rate increases to 180 beats per minutes. In severe muscular exercise, it reaches 240 to 260 beats per minute. Even the thought of exercise or preparation for exercise increases the heart rate. Four factors increase heart rate; impulses from prioreceptors, increased carbon dioxide tension, rise in body temperature and secretion of circulated catecholamines.
    b. Cardiac output: Cardiac output increases up to 20L/min in moderate exercise and up to 35L/min during severe exercise. Increase in cardiac output is directly proportional to the increase in the amount of oxygen consumed during exercise. It also increases because of heart rate and stroke volume.
    c. Blood pressure: During moderate isotonic exercise, the systolic pressure is increased due to increase in heart rate and stroke volume. Diastolic pressure is not altered because peripheral resistance is not affected during moderate isotonic exercise. In severe exercise involving isotonic muscular contraction, the systolic pressure enormously increases but the diastolic pressure decreases. Decrease in diastolic pressure is because of the decrease in peripheral resistance. This is due to vasodilation caused by metabolites. During exercise involving isometric contraction, the peripheral resistance increases. So the diastolic pressure also increases along with systolic pressure.
    d. Venous return: Venous return increases remarkably during exercise because of muscle pump, respiratory pump and splanchnic vasoconstriction.
    e. 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. Increased carbon dioxide content in blood decreases the pH of blood.
    f. Blood volume: More heat is produced during exercise and the thermoregulatory system is activated. This in turn, causes secretion of large amount of sweat leading to fluid loss, reduced blood volume, hemoconcentration and severe exercise leads to even dehydration.
    g. Blood flow to skeletal muscle: There is a great increase in the amount of blood flowing to skeletal muscles during exercise. In resting condition, the blood supply to the skeletal muscles is 3 to 4mL/100g of the muscle per minute. It increases up to 60 to 80mL in moderate exercise and up to 90 to 120mL in severe exercise.

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