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Physiology assignment

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

There are several physiological mechanisms that regulate blood pressure in the long term, the first which is the renin-angiotensin-aldosterone system (RAAS)

Renin-angiotensin-aldosterone system

When blood pressure and ECF volume decreases, renin secretion from kidneys is increased. It converts angiotensinogen into angiotensin I. this is converted angiotensin II by ACE (angiotensin-converting enzyme). Angiotensin II acts in two ways to restore the blood pressure:

1. 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 to normal level. This in turn increases the blood pressure to normal level.
2. 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 blood pressure to normal level

angiotensin III & IV also increase the blood pressure and stimulate adrenal cortex to secrete aldosterone

Secondly **by regulation ECF volume**

When blood pressure increases, kidney 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.

2) **Write short note on the following**

A) Pulmonary circulation: refers to the portion of the cardiovascular system that carries deoxygenated blood away from the heart, towards the alveoli of the lungs to undergo gas exchange, and then return oxygenated blood back to the heart. Deoxygenated blood leaves the right ventricle of the heart through the pulmonary valve and enters the pulmonary trunk. This divides into the right and left pulmonary arteries.

In the lungs the arteries divide further into very fine capillaries at the alveoli, allowing gas exchange to take place. Oxygen diffuses from the alveoli into the pulmonary capillaries while carbon dioxide diffuses from the capillaries into the alveoli. This newly oxygenated blood leaves the lungs through the pulmonary veins to the left atrium of the heart, completing the pulmonary cycle. The blood is then distributed around the body via the systemic circulation

B) Circle of willis: is an important junction of arteries at the base of the brain. The structure encircles the middle area of the brain including the stalk of the pituitary gland and other important structures. Two arteries called the carotid arteries, supply blood to the brain. They run along either side of the neck and lead directly to the circle of willis. Each carotid artery branches into an internal and external carotid artery. The internal carotid artery then branches into the cerebral arteries. This structure allows all of the blood from the two internal carotid arteries to pass through the circle of willis. The structure of the circle of willis includes:

- Left and right internal carotid arteries
- Left and right anterior cerebral arteries
- Left and right posterior cerebral arteries
- Left and right communicating arteries
- Basilar artery
- Anterior communicating artery

The circle of willis is critical, as it is the meeting point of many important arteries supplying blood to the brain. The internal carotid arteries branch off from here into smaller arteries, which deliver much of the brain's blood supply.

C) Splanchnic circulation: It comprises the gastric, small intestine, colonic, pancreatic, hepatic and splenic circulations. They are arranged in parallel and fed by the celiac artery and the superior and inferior mesenteric arteries.

The resistance arterioles are the primary determinant of vascular resistance in the splanchnic circulation. Neuronal control of the mesenteric circulation is almost entirely sympathetic in origin. The parasympathetic fibres from the vagi have little effect on the blood flow. Overall splanchnic blood flow requires about 25% of cardiac output. The splanchnic venous capacitance reservoir contains about one-third of the body's total blood volume. The sympathetic postganglionic fibres cause arteriolar vasoconstriction and decreases splanchnic perfusion. Sympathetic stimulations also contract the smooth muscles of the capacitance veins in the splanchnic circulation and may expel a large volume of pooled blood from the splanchnic into the systemic circulation. Auto regulation in the splanchnic circulation is less marked than in the cerebral, cardiac or renal circulations. The response is present, however, and serves to restore blood follow to areas suffering hyoperfusion because of an acute reduction in perfusion pressure. The splanchnic circulation also responds to reduced perfusion pressure by redistribution of blood flow within individual organs. The liver is unique in that it has both an arterial and a venous afferent blood supply and in the resting adults the liver receives blood via the hepatic artery and portal circulation.

D) Coronary circulation: It is part of the systemic circulatory system that supplies blood to and provides drainage from the tissues of the heart. In the human heart, two coronary arteries arises from the aorta just beyond the semilunar valves; during diastole, the increased aortic pressure above the valves forces blood into the coronary arteries and thence into the musculature of the heart. Deoxygenated blood is returned to the chambers of the heart via coronary veins; most of these converge to form the coronary venous sinus, which drains into the right atrium.

Obstruction of a coronary artery depriving the heart tissue of oxygen rich blood, leads to death of part of the heart muscle (myocardial infarction) in severe cases, and total heart failure and death may ensue.

E) Cutaneous circulation: It is the circulation and blood supply of the skin. The skin is not a very metabolic active tissue and has relatively small energy requirements, so its blood supply is different to that of other tissues.

Some of the circulating blood volume in the skin will flow through arteriovenous anastomoses (AVAs) instead of capillaries. AVAs serve a role in temperature regulation.

3) discuss the cardiovascular adjustment that occurs during exercise

- On blood: mild hypoxia developed during exercise stimulates juxtaglomerular apparatus to secrete erythropoietin.it stimulates the bone marrow and causes release of red blood cells. Increased carbon dioxide content in blood reduces pH of blood
- On heart rate: heart rate increases during exercise. Even the thought of exercise increases the heart rate because of impulses from cerebral cortex to medullary centers, which reduces vagal tone. In moderate exercise the heart rate increases to 180 beats/minute and in severe exercise it reaches 240-260 beats/minute.
- On cardiac output: cardiac output increases up to 20 L/minute in moderate exercise and up to 35 L/minute 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 splanchnic vasoconstriction
- On 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 etc.
- On blood flow to skeletal muscles: 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 3-4 mL/100g of the muscle/minute. It increases up to 60 to 80mL in moderate exercise and up to 90 to 120 mL in severe exercise.
- On blood pressure: during moderate isotonic exercise, the systolic pressure is increased. It is 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. Decrease in peripheral resistance is due to vasodilation caused by metabolites.