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MATRIC NUMBER: 18/MHS01/068

LEVEL: 200

COLLEGE: MEDICINE AND HEALTH SCIENCES

DEPARTMENT: MEDICINE AND SURGERY

COURSE CODE: PHS 201

COURSE TITLE: PHYSIOLOGY

1. DISCUSS THE LONG TERM REGULATION OF MEAN ARTERIAL BLOOD PRESSURE

The body's blood pressure is a measure of the pressures within the cardiovascular system during the pumping cycle of the heart. It is influenced by a vast number of variables, and can alter in either direction for various reasons. There is individual variation in blood pressures and can change throughout the day depending on activity. In each cardiac cycle arterial blood pressure fluctuates between diastolic and systolic pressure. However, the body behaves from day to day as if it regulated the mean arterial blood pressure, which is the average between diastolic and systolic pressures. Arterial pressure is continuously monitored by various sensors located in the body. Mean arterial pressure is regulated by changes in cardiac output and systemic vascular resistance. Whenever arterial pressure varies from normal, multiple reflex responses are initiated, which cause the adjustments in cardiac output, and total peripheral resistance needed to return arterial pressure to its normal value. There are two basic mechanisms for regulating blood pressure; short term mechanisms, which regulate blood vessel diameter, heart rate and contractility and long term mechanisms, which regulate blood volume.

There are several physiological mechanisms that regulate blood pressure in the long term, the first of which is the **renin-angiotensin-aldosterone system (RAAS)**. RAAS consists of renin, which is a peptide hormone released by the kidney. It is released in response to sympathetic stimulation or reduced sodium-chloride delivery to the distal convoluted tubule or decreased blood flow to the kidney. Renin facilitates the conversion of angiotensinogen to angiotensin I which is then converted to angiotensin II using **angiotensin converting enzyme (ACE)**. Angiotensin II is a potent vasoconstrictor. It acts directly on the kidney to increase sodium resorption in the proximal convoluted tubule. Angiotensin II also promotes release of aldosterone. ACE also breaks down a substance called bradykinin which is a potent vasodilator. Aldosterone promotes salt and water retention by acting at the distal convoluted tubule to increase expression of epithelial sodium channels. More sodium collects in the kidney tissue and water then follows by osmosis. This results in decreased water excretion and therefore increased blood volume and thus blood pressure.

The second mechanism by which blood pressure is regulated is release of **Anti Diuretic Hormone (ADH)** from the hypothalamus in response to thirst or an increased plasma polarity. ADH stimulates sodium reabsorption from the thick ascending limb of the loop of Henle. This increases water reabsorption thus increasing plasma volume and decreasing osmolarity. Other factors that can affect long-term regulation of blood pressure are natriuretic peptides. These include; **atrial natriuretic peptides (ANP)** and prostaglandins.

2a. PULMONARY CIRCULATION

The pulmonary circulation is the system of blood vessels that forms a closed circuit between the heart and the lungs. The term pulmonary circulation is readily paired and contrasted with the systemic circulation. The vessels of the pulmonary circulation are the pulmonary arteries and the pulmonary veins. The pulmonary circuit begins with the right ventricle, which pumps deoxygenated blood through the pulmonary artery. This artery divides above the heart into two branches, to the right and the left lungs where the arteries further subdivide into smaller and smaller branches until the capillaries in the pulmonary air sacs (alveoli) are reached. In the capillaries the blood takes up oxygen from the air sacs and releases carbon dioxide. It then flows into larger and larger vessels until the pulmonary veins (usually four in number, each serving a whole lobe of the lung) are reached. The pulmonary veins open into the left atrium of the heart, thereby pumping oxygenated blood into it.

2b. CIRCLE OF WILLIS

The circle of Willis is an anastomotic system or junction of several important arteries that sits at the base of the brain. It encircles the stalk of the pituitary gland and provides important communications between the blood supply of the brain and its surrounding structures. Two arteries called the carotid arteries, supply blood to the braid. 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 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.

2c. SPLANCHNIC CIRCULATION

Splanchnic circulation describes blood flow to the abdominal gastrointestinal organs including the stomach, liver, spleen, pancreas, small intestine, and large intestine. It comprises three major branches of the abdominal aorta; the coeliac artery, superior mesenteric artery and inferior mesenteric artery. The hepatic portal circulation delivers the majority of the blood flow to the liver. The blood flow of the splanchnic circulation originates from the celiac, superior mesenteric and inferior mesenteric arteries and is distributed to all abdominal viscera. The splanchnic circulation receives over 25% of the cardiac output and contains a similar percentage of the total blood volume under normal conditions. Thus, the splanchnic circulation can act as a site of regulation of distribution of cardiac output and also as a blood reservoir.

2d. CORONARY CIRCULATION

This is the circulation of blood in the blood vessels that supply the heart muscle (myocardium). Coronary arteries arise from the aorta, just beyond the semi-lunar 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. Because the rest of the body and most especially the brain, needs a steady supply of oxygenated blood that is free of all but the slightest interruptions, the heart is required to function continuously. Coronary circulation is tightly controlled by a combination of hydrodynamic influences (arterial perfusion pressure, extravascular compressive forces, flow characteristics of the blood), myogenic, neuronal, humoral, local metabolic and endothelium derived factors. These mechanisms regulate total coronary resistance and thus, coronary blood flow.

2e. CUTANEOUS CIRCULATION

The cutaneous circulation is the circulation and the blood supply of the skin. The cutaneous tissue has a relatively low metabolic activity compared to other tissues and organs and has relatively small energy requirements, so its blood supply is different to that of other tissues. Therefore, under normal conditions, circulation to the skin makes up about 4% of the total cardiac output. However, cutaneous circulation plays an important role in the regulation of core body temperature. Some of the circulating blood volume in the skin will flow through **arteriovenous anastomoses (AVAs)** instead of capillaries. AVAs serve a role in temperature control. AVAs are low resistance connections between the small arteries and small veins that supply and drain the skin. These allow the shunt of blood directly into the venous plexus of the skin without it passing through capillaries. Since AVAs contain no capillary section, they are not involved in transport of nutrients to/from the tissues, but instead play a major role in temperature regulation.

3. DISCUSS THE CARDIOVASCULAR ADJUSTMENT THAT OCCURS DURING EXERCISE

During exercise, mechanisms controlling the cardiovascular apparatus operate to provide adequate oxygen to fulfil metabolic demand of exercising muscles and to guarantee metabolic end-products wash-out. During exercise **cardiac output (CO)** increases to provide the flow needed to serve the contracting skeletal muscles. Yet, by resetting the operating point for the baroreceptors, vasodilation is regulated to make blood pressure stable or to increase during exercise. Such a balance between CO and total peripheral resistance would be considered to be governed by an interplay between the autonomic influence on the heart, vasodilatory substances released from the working muscles and sympathetic mediated vasoconstriction, including active skeletal muscles. The central nervous system and especially neural feedback from contracting muscles, are important for the blood pressure response to exercise. Blood flow to the heart would also increase fourfold to fivefold as well. An increase in pulse pressure would also occur.