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DEPARTMENT: MEDCINE AND SURGERY

COURSE: PHYSIOLOGY

ASSIGNMENT

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

Answer

Renin-Angiotensin-Aldosterone System (RAAS)

Renin is a peptide hormone released by the granular cells of the juxtaglomerular apparatus in the kidney. It is released in response to:

- Sympathetic stiulation
- Reduced sodium-chloride delivery to the distal convoluted tubule
- Decreased blood flow to the kidney

Renin facilitates the conversion of angiotensinogen to angiotensin 1 which id then converted to angiotensin 2 using angiotensin-converting enzyme (ACE). Angiotensin 2 is a potent vasoconstrictor. It acts directly on the kidney to improve sodium reabsorption in the proximal convoluted tubule. Sodium is absorbed via the sodium-hydrogen exchanger, angiotensin 2 also promotes the release of aldosterone. ACE also breaks down a substance called bradykinin which is a potent vasodilator. Therefore the breakdown of bradykinin potentiates the overall constricting effect . Aldosterone promotes salt and water retention by acting at the distal convoluted tubule to increase the expression of epithelial sodium channels. Further mote aldosterone increases the activity of the basolateral sodium-pottasium ATP-ase, thus increasing electrochemical gradient for movement of sodium ions. More sodium collects in the kidney tissue and water then flows by osmosis. This resuts in decreased water ex retion nad therefore increased blood volume and thus blood pressure.

Other mechanisms by which blood pressure is regulated are the;

- ✓ Regulated release of Anti Duiretic Hormone (ADH) from the OVLT of the hypothalamus in response to thirst or an increased plasma osmolarity.
- ✓ Natriuretic peptides.

2. Write short notes on the following;

- Pulmonary circulation: Pulmonary circulation is the system of transportation that shunts de-oxygenated blood from the heart to the lungs to be re-saturated with oxygen before being dispersed into systemic circulatiom. De-oxygented blood from the lower half of the body enters the heart from the inferior vena-cava while de-oxygenated blood from the suoerior half of the body enters the heart via the superior vena-cava. Both the superior vena-cava and inferior vena-cava empty blood into the right atrium. Blood flows through thr tricuspid valve into the right ventricle. It then flows through the pulmonic valve into the pulmonary artery before being delivered to the lungs. While in the lungs,blood diverges into numerous pulmonary capillaries where it releases carbin dioxide and is replenished with oxygen, the blood is transported via the pulmonary vein into the left atrium which pumps blood through the mitral valve and into the left ventricle. With a powerful

contration, the left ventricle expels oxygen-rich blood through the aortic valve and into the aorta: ths is the beginning of systemic circulation.

- Circle of willis: The circle of willis encircles the stalk of the pitituary gland and provides important communications between the blood supply of the fore-brain and the hind brain. The circle of willis begins to form when the right and left internal carotid artery (ICA) enters the cranial cavity and each one divides into two main branches: the Anterior Cerebral Artery (ACA) and middle cerebral artery(MCA). The anterior cerebral ateries are then unitd and blood can blood can cross flow by anterior communicating artery (ACOM). The ACAs supply most midline portions of the frontal lobes and superior medial parietal lobes. The MCAs supply most of the lateral surface of the hemisphere, except the superior portion of the parietal lobe (via ACA) and the inferior portion of the temporal lobe and occipital lobe. The ACAs, ACOM, and MCAs form the anterior half, better known as the anterior cerebral circulation. Posteriorly, the basilar artery(BA), formed by the left and right vertebral arteries branches into left and right posterior cerebral artery(PCA), forming the posterior circulation. The PCAs mostly supply blood to the occipital lobe and inferior portion of the temporal lobe.

- Splanchnic circulation:The splanchnic circulation comprises the gastric, small intestinal, 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 fibers from the vagi have little effect on 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 fibers cause arteriolar vasoconstriction and decrease splanchnic perfusion. Sympathetic stimulation also contracts the smooth muscle of the capacitance veins in the splanchnic circulation, and may expel a large volume of pooled blood from the splanchnic into the systemic circulation. Autoregulation 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 hypoperfusion because of an acute reduction in perfusion pressure. The splanchnic circulation also responds to reduced perfusion pressure by the redistribution of blood flow within individual organs. For example, in hypovolemic shock perfusion usually favors the mucosa of the gut at the expense of the muscularis mucosa.The liver is unique in that it has both an arterial and a venous afferent blood supply. In the resting adult the liver receives approximately 500 mL min of blood via the hepatic artery and a further 1300 mL min from the portal circulation.

- Coronary circulation:Coronary circulation, 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 arise 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.The heart normally extracts 70 to 75 percent of the available oxygen from the blood in coronary circulation, which is much more than the amount extracted by other organs from their circulations—e.g., 40 percent by resting skeletal muscle and 20 percent by the liver. 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.

- Cutaneous circulation: The cutaneous circulation 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 blood supply is different to that of other tissues.Some of the circulating blood volume in the skin will flow through will flow through arteriovenous anastomoses (AVAs) instead of capillaries. AVAs serve a role in temperature regulation. 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. Describe the cardiovascular adjustment that occurs during exercise.

Answer

The integrated response to servere exericse 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 four-fold 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 anemia, 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.