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CLASS: 200 LEVEL

COURSE: CARDIOVASCULAR PHSYIOLOGY

1. Long-term regulation of mean arteria blood pressure: This occurs within minutes to days. It involves adjusting total blood volume by restoring normal salt and water balance through mechanisms that regulate urine output and thirst. It is regulated by hormonal control. 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: Renin is a peptide hormone released by the granular cells of the juxtaglomerular apparatus in the kidney. It is released in response to the sympathetic stimulation, reduced sodium-chloride delivery to the distal convoluted tubule, and 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 reabsorption in the proximal convoluted tubule. Sodium is reabsorbed via the sodium-hydrogen exchanger. Angiotensin II also promotes release of aldosterone.

The second way in which blood pressure is regulated is release of Anti-Diuretic Hormone from the OVLT of the hypothalamus in response to thirst or an increased plasma osmolality.

These hormones conserve blood volume. Increases water and sodium reabsorption in kidneys.

1. Pulmonary circulation: Pulmonary circulation moves blood between the heart and the lungs. It transports deoxygenated blood to the lungs to absorb oxygen and release carbon dioxide. The oxygenated blood then flows back to the heart. The right ventricle pumps blood into the pulmonary artery (or trunk), which divides into the right and left pulmonary arteries, one going to each lung. Within the lungs each artery branches extensively into smaller arteries and arterioles, then to capillaries. The pulmonary capillaries surround the alveoli of the lungs; it is here that exchanges of oxygen and carbon dioxide take place. The capillaries unite to form venules, which merge into veins, and ﬁnally into the two pulmonary veins from each lung that return blood to the left atrium. This oxygenated blood will then travel through the systemic circulation. (Notice that the pulmonary veins contain oxygenated blood; these are the only veins that carry blood with a high oxygen content. The blood in systemic veins has a low oxygen content; it is systemic arteries that carry oxygenated blood.)

Circle of Willis: Some of the arteries in the head contribute to an important arterial anastomosis, the circle of Willis (or cerebral arterial circle), which is a “circle” of arteries around the pituitary gland. The arteries which supply blood to the brain are derived from two internal carotid arteries and the basilar artery (formed by union of the right and left vertebral arteries). Branches of the internal carotid arteries and of basilar artery anastomose on the inferior surface of the brain to form the circulus arteriosus (circle of Willis). The circle of Willis is thus basically a free anastomoses between the two internal carotid arteries and the two vertebral arteries which equalize pressure on the arteries of the two sides. In this way, the circulus arteriosus allows blood that enters by either internal carotid or vertebral artery to be distributed to any part of both cerebral hemispheres. Six large arteries taking part in the formation of circle of Willis supply by their central and cortical branches to the brain substance.

Splanchnic circulation: Splanchnic circulation includes the combined vascular beds of the intestines, pancreas, spleen and liver. The main vessels which constitute the splanchnic circulation are:

Arteries supplying the blood to the intestines, pancreas, spleen and liver include:

* Coeliac trunk is about 1 cm long and after arising from the abdominal aorta it divides into three main branches the left gastric artery hepatic artery and splenic artery,
* Superior mesenteric artery.
* Inferior mesenteric artery.

Hepatic portal system is formed by the veins draining blood from the abdominal part of the gastrointestinal tract (GIT). The veins comprising the hepatic portal system end in the portal vein. The portal vein supplies the blood collected from GIT to the liver by its right and left branches. Hepatic veins are terminal parts of an elaborate venous tree that permeates the liver. The hepatic veins emerging from the liver tissue end in the inferior vena cava.

Characteristics of this circulation include:

* During rest the abdominal GIT, viscera and liver receive about 1500 mL blood per minute (about 30% of cardiac output) via coeliac, superior mesenteric and inferior mesenteric arteries.
* If the entire GIT become simultaneously active, the splanchnic blood flow would have increased to about 4.0 L/ min. However, since during digestion and absorption, the GIT is sequentially activated, the maximum circulation is about 3.0 L/min.
* The unique feature of the splanchnic circulation is that the venous blood from GIT viscera is not directly carried to the heart through systemic veins, but is carried to the liver forming hepatic portal system. The splanchnic circulation is considered to consist of three parts: Intestinal (mesenteric) circulation, Splenic circulation and Hepatic circulation.

Coronary circulation: Coronary blood vessels include:

Coronary arteries

Two coronary arteries (right and left) arise from the root of ascending aorta and supply blood to the myocardium. Right coronary artery supplies blood to the right ventricle, the right atrium, the posterior part of left ventricle, the posterior part of interventricular septum and major portion of the conducting system of heart including SA node.

Left coronary artery supplies blood mainly to the anterior part of left ventricle, left atrium, anterior part of the interventricular septum and a part of the left branch of bundle of His.

Normally, the coronary arteries appear to function as end arteries. However, the presence of an arterial plaque or occlusion allows the anastomoses present between vessels to become functional. These anastomoses are of two types: Cardiac anastomoses and extra cardiac anastomoses.

Coronary veins

Coronary sinus is a wide vein about 2 cm long, which drains most of the venous blood from the myocardium (mainly left ventricle) into the right atrium. Its tributaries are the great cardiac vein, the small cardiac vein, the posterior vein of left ventricle and the oblique vein of left ventricle. Anterior cardiac vein draining venous blood mainly from the right ventricle opens directly into the right atrium.

Thebesian veins and coronary-luminal vessels (connections between the coronary vessels and the lumen of heart) constitute the deep venous system. These vessels drain only less than 10% of the venous blood from the myocardium directly into the various cardiac chambers, contributing to an anatomic shunt effect. The coronary luminal connections carry a larger proportion of the flow in the right ventricle than in the left ventricle.

CORONARY BLOOD FLOW: CHARACTERISTIC FEATURES

Normal coronary blood flow and oxygen demand

A continuous flow of blood to the heart is essential to maintain an adequate supply of O2 and nutrients. Normal coronary blood flow at rest is about 250 mL (70 mL/100 g tissue/min), i.e. about 5% of the resting cardiac output (5 L). Three to six-fold increase in the coronary blood flow may occur during exercise.

Oxygen consumption by the myocardium is very high (8 mL/min/100 g at rest). Because of this, even at rest 70–80% of the oxygen is extracted from each unit of the coronary blood as compared to the whole body (average of 25%) oxygen extraction at rest. The increased oxygen demand of the myocardium during exercise is met with by almost total (nearly 100%) extraction of oxygen and by manifold increase in the coronary blood flow.

Cutaneous circulation: The cutaneous circulation is the circulation and blood supply to 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. Cutaneous blood vessels include: cutaneous arterioles, meta arteriole, cutaneous capillaries, venules-extensive sub papillary venous plexus, arteriovenous anastomosis-in distal parts of extremities. Features of this circulation include: blood flow and skin colour, regional variations, exposure, regulation of body temperature.

1. Cardiovascular adjustment that occurs during exercise: there is an increase in Sino atrial node during exercise. This occurs because an information has been sent from the cortex of the brain to the cardiac accelerator centre in the medulla. As a result of this information, a sympathetic discharge occurs thereby stimulating the SA node. Stimulation of this node hinders the activities of the parasympathetic nerve to the heart. This withdrawal causes an increase in heart rate. An increase in sympathetic nerve activity to the heart will cause an increase in heart rate and stroke volume. This increase in sympathetic nerve is a result of the exercise. Due to an increase in heart rate and stroke volume, there is an increase in cardiac output. Chemobaro receptors will sense this change. Cardiac conductivity is increased, impulse from SA node is sent to atrial muscles atrioventricular node through the intermodal pathway. This increase in cardiac conductivity facilitates increase in cardiac contractility. Cardiac pressure increases with increased cardiac output which enhances blood flow. This enhanced blood flow is needed during exercise to enable enough blood reach the skeletal muscle and skin.