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COLLEGE/DEPARTMENT: MHS/MBBS

COURSE: PHYSIOLOGY

ASSIGNMENT

1. Discuss the long-term regulation of Mean Arterial Blood Pressure

Mean arterial pressure (MAP) is a critical hemodynamic factor. The absence of proper regulation of MAP can have important pathophysiological consequences. Low MAP can cause inadequate blood flow to organs, syncope, and shock. On the other hand, elevated MAP contributes to increased oxygen demand by the heart, ventricular remodeling, vascular injury, end organ damage, and stroke. The arterial baroreflex system is a key controller of MAP and is a complex system. It can be considered in its entirety as an integrative physiological system or in terms of its regulated component parts.

Mean arterial pressure is regulated by changes in cardiac output and systemic vascular resistance.

1. The long-term level of arterial pressure is dependent on the relationship between arterial pressure and the urinary output of salt and water, which, in turn, is affected by a number of factors, including renal sympathetic nerve activity (RSNA). In the present brief review, we consider the mechanisms within the brain that can influence RSNA, focusing particularly on hypothalamic mechanisms.

2. The paraventricular nucleus (PVN) in the hypothalamus has major direct and indirect connections with the sympathetic outflow and there is now considerable evidence that tonic activation of the PVN sympathetic pathway contributes to the sustained increased level of RSNA that occurs in conditions such as heart failure and neurogenic hypertension. The tonic activity of PVN sympathetic neurons, in turn, depends upon the balance of excitatory and inhibitory inputs. A number of neurotransmitters and neuromodulators are involved in these tonic excitatory and inhibitory effects, including glutamate, GABA, angiotensin II and nitric oxide.

3. The dorsomedial hypothalamic nucleus (DMH) also exerts a powerful influence over sympathetic activity, including RSNA, via synapses with sympathetic nuclei in the medulla and, possibly, also other brainstem regions. The DMH sympathetic pathway is an important component of the phasic sympathoexcitatory responses associated with acute stress, but there is no evidence that it is an important component of the central pathways that produce long-term changes in arterial pressure. Nevertheless, it is possible that repeated episodic activation of this pathway could lead to vascular hypertrophy and, thus, sustained changes in vascular resistance and arterial pressure.

4. Recent studies have reactivated the old debate concerning the possible role of the baroreceptor reflex in the long-term regulation of sympathetic activity. Therefore, central

resetting of the baroreceptor-sympathetic reflex may be an important component of the mechanisms causing sustained changes in RSNA. However, little is known about the cellular mechanisms that could cause such resetting.

2. Write Short Notes on The Following:

a. Pulmonary Circulation

The pulmonary circulation 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.[1] 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 trunk splits into the right and left pulmonary arteries. These arteries transport the deoxygenated blood to arterioles and capillary beds in the lungs. There, carbon dioxide is released and oxygen is absorbed. Oxygenated blood then passes from the capillary beds through venules into the pulmonary veins.

It begins on the right ventricle and ends on the left atrium. In the pulmonary circuit, blood takes up oxygen in the lungs.

The pulmonary circulation loop is virtually bypassed in fetal circulation. The fetal lungs are collapsed, and blood passes from the right atrium directly into the left atrium through the foramen ovale: an open conduit between the paired atria, or through the ductus arteriosus: a shunt between the pulmonary artery and the aorta. When the lungs expand at birth, the pulmonary pressure drops and blood is drawn from the right atrium into the right ventricle and through the pulmonary circuit. Over the course of several months, the foramen ovale closes, leaving a shallow depression known as the fossa ovalis.

Clinical Significance

A number of medical conditions can affect the pulmonary circulation.

* Pulmonary hypertension describes an increase in resistance in the pulmonary arteries
* Pulmonary embolus is a blood clot, usually from a deep vein thrombosis that has lodged in the pulmonary vasculature. It can cause difficulty breathing or chest pain, is usually diagnosed through a CT pulmonary angiography or V/Q scan, and is often treated with anticoagulants such as heparin and warfarin.
* Cardiac shunt is an unnatural connection between parts of the heart that leads to blood flow that bypasses the lungs.
* Vascular resistance
* Pulmonary shunt

b. Circle of Willis

The circle of Willis, or the circulus arteriosus, is formed by the anastomosis of the two internal carotid arteries with the two vertebral arteries. The anterior communicating, anterior cerebral, internal carotid, posterior communicating, posterior cerebral, and basilar arteries are all part of the circle of Willis The Circle of Willis 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.

The circle of Willis (CoW) is an anatomical structure that provides an anastomotic connection between the anterior and posterior circulations, providing collateral flow to affected brain regions in the event of arterial incompetency.

The circle of Willis acts to provide collateral blood flow between the anterior and posterior circulations of the brain, protecting against ischemia in the event of vessel disease or damage in one or more areas.
The circle of Willis describes the ring of blood vessels in the base of the brain that connects the main intracerebral blood vessels. It is incomplete in most individuals, although wide variations exist. Saccular aneurysms, the most common type of aneurysm, originate in and around the circle of Willis at the branching points of blood vessels. Aneurysms also occur more commonly in association with anomalies of the circle of Willis. For example, atresia of one proximal anterior cerebral artery may be associated with an aneurysm on the opposite, or dominant, anterior cerebral artery. The most common sites are the anterior communicating, posterior communicating, and middle cerebral arteries, depending on the particular study population. The anterior circulation is defined as those vessels supplied by the internal carotid arteries, whereas the posterior circulation describes those vessels supplied by the vertebral arteries. Approximately 85–90% of aneurysms occur in the anterior circulation, whereas only 10–15% occur in the posterior circulation.

c.Splanchnic Circulation
The circle of Willis acts to provide collateral blood flow between the anterior and posterior circulations of the brain, protecting against ischemia in the event of vessel disease or damage in one or more areas.

c. Splanchnic Circulation
The splanchnic circulation is composed of the blood flow originating 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. Multiple regulatory pathways are involved in the distribution of the splanchnic circulation. 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.

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. 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. Therefore its circulation is of major importance not only to its own tissues but to the entire body and even the level of consciousness of the brain from moment to moment. Interruptions of coronary circulation quickly cause heart attacks (myocardial infarctions), in which the heart muscle is damaged by oxygen starvation. Such interruptions are usually caused by ischemic heart disease (coronary artery disease) and sometimes by embolism from other causes like obstruction in blood flow through vessels.

BRANCHES
The following are the named branches of the coronary circulation in a right-dominant heart:
* Aorta
    * Left coronary artery / Left main coronary artery (LMCA)
        * Left circumflex artery (LCX)
            * Obtuse marginal artery (OM1)
            * Obtuse marginal artery (OM2)
        * Left anterior descending artery (LAD)
            * Diagonal artery (DA1)
            * Diagonal artery (DA2)
            * Right coronary artery (RCA)
        * Atrioventricular nodal branch
        * Right marginal artery
        * Posterior descending artery
        * Posteriolateral artery
        * Posteriolateral artery

e. 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.
Cutaneous circulation supplies nutrients to the skin and also regulates body temperature by heat loss.
Under normal conditions the blood flow to the skin is about 250 mL/sq m/min, but when there's an increase in body temperature cutaneous blood flow increases up to 2800 mL/sq m/min because of cutaneous vasodilation.
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. In this article we shall consider the different adaptations of the cutaneous circulation, and its role in body temperature control.
The cutaneous tissue has a relatively low metabolic activity compared to others tissues and organs. 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. Here we will cover systemic and local thermoregulation along with the skins response to injury.

3. Discuss the cardiovascular adjustment that occurs during exercise.
The integrated response to severe exercise 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 fourfold 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 anaemia, 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.