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18/MHS01/086

MEDICINE AND SURGERY

200 LEVEL

PHYSIOLOGY

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

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. 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. 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. 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. 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.

b) 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 encircles the stalk of the pituitary gland and provides important communications between the blood supply of the forebrain and hindbrain.

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.
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.
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.
f) Some of the circulating blood volume in the skin will flow through will flow through arteriovenous anastomoses (AVAs) instead of capillaries.

3. Discuss the cardiovascular adjustment that occurs during exercise

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 arterial baroreceptors, vasodilatation 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 (CNS), and especially neural feedback from contracting muscles, are important for the blood pressure response to exercise. Acceleration of the heart is governed by central command, whereas a blood-borne substance may contribute to the maintained elevation of heart rate (HR). Even in the absence of influence from CNS and neural feedback from working muscles, a tight coupling between CO and whole body oxygen uptake ($\dot{V}o_2$) is maintained.