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Pathophysiology of Pain

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Annotation: Pain sensitivity depends on the interaction of nociceptive and antinociceptive mechanisms, which can weaken or enhance each other. These mechanisms are part of one functional system, which results in maintaining the integrity of body tissues. Normal functioning of this system is possible while maintaining the activity of both interacting parts. The state of hyperalgesia can develop as a result of both an increase in the activity of nociceptive mechanisms and a suppression of the activity of antinociceptive mechanisms. A decrease in pain thresholds during the formation of a reaction of alertness and fear contributes to the detection of stimuli that are dangerous to the body. Increasing pain thresholds during emotions of rage and aggression expands the body's capabilities in the formation of active defensive behavior.

Key words: pathophysiology, pain, classification, components of the pain reaction.

Relevance. The most common reason for patients seeking medical help, including when pain relief is required, is pain. According to the National Scientific and Practical Society of Emergency Medical Care, in Russia the number of patients seeking emergency medical care with complaints of pain of various origins has increased by 25% in recent years. According to statistical analysis by the International Association for the Study of Pain (IASP, 2011), acute pain accounts for approximately 70% of emergency room complaints. Over the centuries of pain research, researchers have given different definitions of pain. These formulations in one way or another covered different aspects and manifestations of the pain syndrome. The ancient Greeks called pain the "watchdog of health," thus emphasizing the positive protective function of pain. A "negative" definition of pain was given by N. Kassil: "Pain is an unpleasant, oppressive, sometimes unbearable sensation that occurs mainly with super-strong or destructive effects on the human body and animals." PC. Anokhin considered pain as "a unique mental state of a person, determined by the totality of physiological processes in the central nervous system, brought to life by some super-strong or destructive stimulus." K.V. Sudakov defined pain as follows: "From the position of the theory of functional systems, pain is an integrative function of the body, which mobilizes the body and its various functional systems for protection against harmful factors and includes such components as consciousness, memory, motivation, vegetative, somatic, behavioral reactions, emotions". According to L.V. Kalyuzhny, "pain as an integrative function of the body is a negative biological need responsible for the formation of a functional system for maintaining homeostasis." The International Association for the Study of Pain (IASP) in 1994 summarized the concept of pain: "Pain is an unpleasant sensation and emotional experience arising in connection with the actual or potential threat of tissue damage or depicted in terms of such damage." Thus, pain in modern algology is considered as a multicomponent integrative reaction of the body to damage or the representation of such damage. Depending on the pathogenetic, etiological, temporary, clinical and other signs, there are different classifications of pain. Based on the

presence or absence of a damaging factor, pain is divided into physical and psychogenic. Psychogenic pain occurs without any apparent connection with any damage and is often a consequence of a depressive state. Physical pain in origin is divided into somatogenic, resulting from activation of nociceptors during injury, inflammation, ischemia or tissue stretching, and neurogenic, associated with dysfunction of the peripheral and central nervous systems. According to time parameters, acute and chronic pain are distinguished. Acute pain is new, "recent", which is inextricably linked with the damage that caused it; as a rule, it is a symptom of some disease. Such pain disappears when the damaging factor is eliminated. Acute pain, in turn, is divided into epicritic - "fast", localized, physiological, as well as protopathic - "slow", with variable intensity, poorly localized. Chronic pain often acquires the status of an independent disease; it is characterized by duration; The cause of this type of pain in some cases may not be determined. In neurophysiology, pain is usually divided into nociceptive (as a result of damage to pain-sensitive structures) and non-nociceptive (neuropathic and psychogenic). Nociceptive pain is somatic and visceral, and neuropathic pain is central and peripheral. Based on the relationship between the area of pain localization and the location of the painful process, local, projection, radiating, referred and phantom pain are distinguished. Local pain is localized at the site of the pathological process; projection ones are felt along the course and at the periphery of the nerve when irritated in its proximal section; pain in the area of innervation of one branch in the presence of a focus of irritation in the area of innervation of another branch of the same nerve is called radiating; referred pain occurs in areas of the skin innervated from the same segment of the spinal cord as the internal organs where the lesion is located. Interneurons of the spinal cord, on which excitations from internal organs and skin areas converge, are responsible for reflected pain. Painful excitation that occurs in an internal organ activates a common interneuron, and from it excitation spreads along the same pathways as during skin irritation. Phantom (deafferentation, or central) pain appears after amputation or deafferentation of a limb. They are associated with the presence of persistent foci of excitation in the nociceptive structures of the central nervous system (CNS), which is usually accompanied by a deficiency of inhibitory processes. Entering the cerebral cortex, excitation from the excitation generator (pain nerve center) is perceived as prolonged, continuous and excruciating pain. Based on topical lesions in clinical algology, a whole range of pains with a specific localization are distinguished: headaches, back pain, joint pain, etc. In particular, the term "headaches" includes >15 isolated nosological forms. The presence of these classifications illustrates the complexity and diversity of the aspect of pain, and also indicates the unity of the anatomical, physiological, psychological and social components, each of which, in turn, consists of a number of components. Pain occurs both with damaging effects on free nerve endings - nociceptors, and with strong stimulation of receptors of a different modality in conditions of sensitization (increased sensitivity) of the latter. There are different classifications of nociceptors based on the specific modality of action, the ability to respond only to certain or different nociceptive stimuli, membership in thin myelinated and non-myelinated fibers, and localization in tissues. The generalized classification includes 4 main groups of nociceptors: mechanoreceptors, thermoreceptors, chemoreceptors and polymodal receptors. Some mechanoreceptors of the skin - Paccini corpuscles, Merkel discs, etc. - with superthreshold excitation acquire the properties of multimodal nociceptors. Mechanical and temperature nociceptors respond with excitation to mechanical influences and temperature changes, respectively. Information from these receptors is transmitted to the central nervous system via fast-conducting A-delta fibers. Activation of pain chemoreceptors occurs as a result of exposure to algogenic biochemical factors (algogens); excitation from receptors of this type is transmitted mainly through slow C-fibers. Algogens acting

on chemoreceptors are divided into tissue (serotonin, histamine, acetylcholine, some prostaglandins, K+, H+), plasma (bradykinin, kallidin) and released from nerve endings (substance P, neurokinin A, calcitonin gene-related peptide). From a physiological point of view, pain is a sensory modality, like hearing, taste, and vision. The pain sensory system has all the morphofunctional characteristics of classical sensory systems: a specific receptor apparatus, a conductive part with subcortical sections, cortical projection and associative areas, as well as a complex of structures that regulate the activity of systems for perceiving and conducting pain information - the antinociceptive system. The modern theory of pain, based on data from foreign and domestic researchers, postulates the presence of specific pain receptors, specific afferent pathways and specific brain structures that form the sensation of pain and the corresponding reactions of the body. According to this theory, pain occurs due to the predominance of the activity of the nociceptive system over the antinociceptive system, which is constantly functioning in a healthy body. The pain system performs a signaling function, which consists in the perception, analysis and synthesis of information about the violation of such vital body constants necessary for normal functioning as the integrity of the integumentary membranes and a certain level of oxidative processes in tissues. Currently, there are different approaches to assessing pain sensitivity. In human observations, subjective and objective methods are used for such studies. The first are based on the patient's assessment of the severity of his pain, which is achieved using questionnaires or various scales. Objective methods for determining pain sensitivity (algometry) include: • mechanoalgometry – determination of the amount of pressure exerted on the skin, which is accompanied by the occurrence of pain; • thermoalgometry – measurement of the temperature necessary for the sensation of pain to occur when an area of skin is exposed to light, laser or infrared radiation, touch of a hot object, etc.; • chemoalgometry – assessment of the minimum concentration and volume of algogen solution with various methods of dosage administration (orally, subcutaneously, intramuscularly, etc.) that cause pain; • electroalgometry – study of the magnitudes of current or voltage (electrical stimulation) necessary to cause the sensation of pain.

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