



Focus on the Sensory Nervous System in Pain Diagnosis and Treatment

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Abstract

Pain affects many physiological functions, and the diagnosis and treatment of chronic pain are relatively complicated. A group of Chinese pain physicians engaged in the field of chronic pain for a long time recommended that evaluating the sensory nervous system based on clinical findings and looking for locations of pain generators, including the sensory nerve endings, the conductive pain pathways, and the brain, are conducive to accurate diagnosis and appropriate treatment targeted at the causes of pain.

Keywords

Sensory nervous system, Pain, Diagnosis, Treatment

Pain is an Unpleasant Sensation and Emotional Response of the Brain to the Actual or Potential Tissue Injury or Abnormal Stimuli within the Body [1]

The cerebral cortex is the advanced center of the human body to feel pain, and any stimuli, only when conducted to the brain, can stimulate corresponding uncomfortable and painful responses. The vast majority of known causes of pain are associated with various factors of the body, including inflammation, space occupying, variability, immunity, hypoxia or scarring, as well as possible psychosocial factors, such as depression. Pain represents a signal of injury of the body with physical motion and or visceral autonomic nervous responses as well as complex physical and psychological activity experience. Moderate to severe pain significantly interferes with human behavior, thinking, sleep, immunity and mental illness, and induces autonomic and endocrine responses, such as contracted blood vessels, elevated blood glucose or even myocardial infarction. "Chronic pain" as a symptom or a disease [2], refers to unhealed pain that has persisted for more than one month [3]. Since significant anatomical and pathological changes have occurred in the tissues at the site of injury, the

symptoms and treatment can be complex and may significantly interfere with patients' sleep, life, and work. The incidence of chronic pain is high and its service demands are enormous [4]. Many studies have shown that the etiology of chronic pain is specifically related to the pathological changes of brain structure and function [5,6]. In 2011, IASP revised the definition of neuropathic pain from "pain caused by the primary injury or dysfunction of the peripheral or central nervous system or transient disorder" [7] to "pain caused by injury or diseases of the somatosensory system", which clearly puts forward that the somatosensory nervous system is at the core of neuropathic pain.

The clinically widely recognized "3-classification method of pain" [8,9] is based on the abnormal stimuli or injured anatomical and physiological changes in the sensory nervous system, including "nociceptive pain" in the sensory nerve endings receptors, "neuropathic pain" in cells or fibers in the sensory nerve transmission pathways, and "psychogenic pain" at the cortical level. The characteristics of pain is that the three major structures in the sensory nervous system receive the nociceptive stimuli, respectively, and transmit them to the brain, which perceive the location, nature and degree of pain. Many dictionaries have cited "sensory nerves" or "special nerves" to annotate pain [10-13], and many experts also learned in clinic practice that the sensory nervous system is the core underlying the mechanism of the pathogenesis of pain [14-17].

Pain is also associated with feelings, emotions, cognition and social composition [18]. Humans are typical social animals, which creates complex needs for competitions and cooperation. The social environment determines people's thoughts, emotion, and feelings of pain. The ability of individuals to recognize and differentiate pain is significant and it can come from experience in attention, memory, and use of speech,

including perceptions of internal physical events, the past, current, and anticipated environments, and how to use words to describe pain. The unique experience of each individual and the changes in physiology and psychology determine and affect the feelings and emotions of pain. Pain is often magnified when individuals speak of their pain, even in absence of substantial physical injuries, and is most commonly associated with sleep disturbance. Some people may have abnormally excited foci in the cerebral cortex; they feel pain in specific locations of their body while physical examination can be completely normal, which is known as “somatization disorder”. Some somatic traumatic stimuli make the brain feel comfortable or a sensation which cannot be called pain but satisfaction, such as some sadists who feel happy about physical damage.

Pain Caused by Inflammation and Ischemia in Sensory Neurons and Their Axons Can Be Severe and Debilitating

It is often described as needle pricking-, lightning- and knife incising-like pain in a pattern of epilepsy in its innervated area, and numbness occurs when the sensory nerves are damaged. In peripheral nerve injury, the sensory, motor and sympathetic nerves can be involved concurrently. Muscle weakness occurs when the motor nerves are compromised in situations such as compression of the sciatic nerve by the piriformis contracture, compression of the ventral nerve roots by disc herniation, and severe diabetic neuropathy. Motor nerve injury may cause glial cells to undergo chemical or morphological reactions leading to functional changes in sensory neurons and interneurons in the spinal cord or brainstem. The sensory neurons in the dorsal root ganglion or the spinal cord couple with sympathetic nerves, leading to hypersensitive pain from the sensory nerves [19] in situations such as post-amputation neuralgia and complex regional neuralgia [20-22].

Stimulation of the Sensory Nerve Endings often Causes Local Pain

When local tissues, including all soft tissues, such as the skin, mucous membranes, skeletal muscles, smooth muscles, fascia, epithelium and periosteum, suffer from inflammation or injury, the nociceptors distributed in these tissues are stimulated. Inflammatory signals are transmitted from the sensory nerves to the brain, leading to pain sensation in the stimulated area in situations such as bruising, burn, arthritis, myofascial pain, pharyngitis, appendicitis. The physiological function of pain sensation serves as warning and protective role for the body and is also called “physiological pain”. Prolonged muscle contraction or paralysis may lead to ischemia and hypoxia, and stimulate the sensory nerve endings to produce local pain. When the sensory nerve branch-

es next to the fascia are stimulated, referred pain may occur.

Chronic pain may have multifactorial or combinatory causes which are often less well understood. Identifying the location and cause of the somatosensory nerve injury/lesion/disease is critical to develop appropriate diagnosis and treatment plans for better outcomes. With regard to the diagnosis of pain, it is important to be familiar with the anatomical and physiological aspects of the sensory nervous system and pay special attention to patients’ history, physical examination, and diagnostic tests including imaging and electrophysiological tests. The duration of pain helps to differentiate acute from chronic pain, while the descriptive nature of pain may suggest the location and nature of specific nerve involvement (peripheral nerve endings, nerve fibers, or involvement of the sympathetic nerves). “Mixed pain” refers to situations where two or more types of pains are involved. In principle, treating the cause of the pain is the best treatment. Since pain often involves multiple causes and mechanisms, it is often necessary to use multimodal and interdisciplinary approaches to management. Localization and understanding the nature of pain is a critical skill to master for better outcomes. Paying attention to the psychosocial aspect of pain is also important to patient-centered care. For example, the low back pain is the pain caused by compression of posterior branch of the spinal nerve [23]. The clinical manifestations include turning pain, a posture pain, nocturnal pain, morning stiffness, load pain or other symptoms. Based on physical examination, infrared thermal imaging and MRI examination, the doctors could determine the locations of the posterior branch (transverse interfascial myofascial, intervertebral foramen, etc.) and the causes (intervertebral disc stimulation, vertebral inflammation or endplate inflammation, intraspinal or posterior peritoneal disease, etc.). Therefore, using myofascial electrothermal acupuncture or radiofrequency to release the muscle fascia of the compression nerve [24], or using the intervertebral foramen to release the posterior occlusion of the spinal nerve [25] to remove the sources of compression nerve which caused low back pain was the best way to treat pain.

Summary

The sensory nervous systems are distributed throughout the body, and are at the core of pain. With respect to diagnosis and treatment of pain, clinicians should pay attention to the location, nature and characteristics of pain and use them as clues, and search for the location or cause of the actual or potential abnormal tissue stimuli or injury along the sensory nervous system. Multidisciplinary and multimodal treatments are often required in complex cases.

Conflicts of Interest

The authors report no conflicts of interest in this work.

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