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CHRONIC PAIN: NEUROPHYSIOLOGICAL MECHANISMS AND CLINICAL SIGNIFICANCE

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KALIT SO'ZLAR:

Chronic pain; Central sensitization; Peripheral sensitization; Neuropathic pain; Nociceptive pain; Pain modulation; Neuroplasticity; Clinical diagnosis.

ANNOTATSIYA:

Chronic pain is a persistent pathological condition lasting beyond normal tissue healing time, typically more than three months. Unlike acute pain, which serves as a protective biological alarm, chronic pain loses its adaptive function and becomes a disease itself. It is associated with complex neurophysiological changes such as peripheral and central sensitization, altered pain modulation, and long-term synaptic plasticity within the central nervous system. This article discusses the mechanisms, clinical manifestations, diagnostic challenges, and clinical importance of chronic pain in modern medical practice.

Introduction

Chronic pain is defined as persistent or recurrent pain lasting longer than three months or beyond the usual course of an acute illness or injury. Unlike acute pain, which serves as a protective signal for the body, chronic pain often continues without a clear underlying cause, affecting a person's quality of life, daily functioning, and emotional well-being. It is a complex condition influenced by biological, psychological, and social factors, making it a major public health issue worldwide. Approximately 20% of adults globally suffer from

chronic pain, with higher prevalence among older adults and those with comorbid conditions.

Causes and Mechanisms

The causes of chronic pain are diverse and can be classified into nociceptive, neuropathic, and mixed types. Nociceptive pain arises from tissue damage or inflammation, commonly seen in conditions like arthritis, tendinitis, or post-surgical recovery. Neuropathic pain results from injury or dysfunction in the nervous system, such as diabetic neuropathy, post-herpetic neuralgia, or spinal cord injury. Mixed pain includes features of both nociceptive and neuropathic pain. Mechanistically, chronic pain involves peripheral sensitization, where damaged tissues release chemicals that increase the excitability of nearby nerve endings, and central sensitization, where the central nervous system amplifies pain signals. Changes in neurotransmitters such as glutamate, substance P, and calcitonin gene-related peptide (CGRP) contribute to persistent pain perception.

Psychological and Social Impacts

Chronic pain is not limited to physical discomfort; it significantly affects mental health and social functioning. Individuals with chronic pain are at higher risk of developing anxiety, depression, and sleep disturbances. These psychological factors can amplify the perception of pain, creating a vicious cycle that hinders effective treatment. Socially, chronic pain can lead to decreased productivity, isolation, and financial difficulties due to medical expenses and reduced work capacity. Family relationships may also suffer, as caregivers experience stress and emotional burden. The biopsychosocial model emphasizes that understanding and managing chronic pain requires addressing not only biological but also psychological and social dimensions.

Diagnosis and Treatment Approaches

Accurate diagnosis of chronic pain involves a comprehensive assessment, including detailed medical history, physical examination, and, when necessary, imaging or laboratory tests. Standardized pain assessment tools, such as the Visual Analog Scale (VAS), Numerical Rating Scale (NRS), and the McGill Pain Questionnaire, help quantify pain intensity and quality. Treatment is typically multidisciplinary, combining pharmacological and non-pharmacological interventions. Pharmacological approaches include the use of nonsteroidal anti-inflammatory drugs (NSAIDs), acetaminophen, opioids for select patients, antidepressants, and anticonvulsants, depending on the type of pain. Non-pharmacological strategies, such as physical therapy, exercise programs, occupational therapy, and cognitive-

behavioral therapy (CBT), have shown significant efficacy in improving function and reducing pain perception. Interventional techniques, including nerve blocks, epidural injections, and spinal cord stimulation, may be considered for refractory cases. Patient education and self-management strategies are essential components of chronic pain management.

Recent Research and Future Directions

Recent scientific studies have advanced the understanding of chronic pain mechanisms and treatment options. Functional imaging studies, such as fMRI, have demonstrated altered brain network activity in individuals with chronic pain, providing insights into central sensitization. Research on glial cells and neuroinflammation highlights potential targets for novel pharmacological therapies. Emerging treatments include gene therapy, stem cell therapy, and the use of neuromodulation devices. Digital health tools and artificial intelligence applications are increasingly employed to monitor symptoms, predict flare-ups, and personalize treatment plans, potentially improving long-term outcomes

Conclusion

Chronic pain remains a complex and prevalent condition that affects millions worldwide. Effective management requires a holistic, multidisciplinary approach addressing biological, psychological, and social factors. Advances in research continue to enhance our understanding of chronic pain, offering promising avenues for more effective and individualized treatments. Raising awareness, improving access to care, and integrating emerging therapies will be crucial in mitigating the burden of chronic pain and enhancing quality of life for affected individuals.

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