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Neuropathic Pain

FACT SHEET

How the Brain and Spinal Cord Can Contribute to Pain: Central Mechanisms of Neuropathic Pain

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Neuropathic pain is a type of pain that arises from damage to the nervous system. Read An Overview of Neuropathic Pain and Its Impact (https://www.iasp-pain.org/resources/fact-sheets/an-overview-of-neuropathic-pain-and-its-impact/) for a detailed description. This fact sheet explains how damage to the central nervous system (the brain and the spinal cord) can cause neuropathic pain.

The role of the brain and spinal cord in pain

Normally, pain is felt when the body detects something harmful, such as intense heat, pressure, or injury. Special nerve endings called nociceptors send information about danger, threat, and harm via electrical signals through nerves to the spinal cord. In this fact sheet, we will refer to those as "danger signals". Those signals travel to the brain, which works to understand what is happening, resulting in the feeling of pain[8,10].

Different areas of the brain have their own unique roles in creating the feeling of pain. Some areas of the brain direct information to other parts, some help identify where the pain is felt, how strong it is, and what it feels like. Others process emotions, shaping how pain makes us feel, including discomfort, distress, or fear. Still other parts help interpret what the pain means and decide how we should respond, such as by moving away from danger or protecting the injured area[10,13].

Information does not only travel to the brain. The brain also sends signals to the spinal cord. This can increase or decrease the intensity of the danger signals. Certain brain areas can also release chemicals that help quiet danger signals and keep the system balanced[10,13].

In neuropathic pain, this system can change. When nerves, the spinal cord, or the brain are injured, they may produce abnormally strong signals. This can trigger lasting changes in how the brain and spinal cord process pain[5,9].

Danger signals can continue even after healing has occurred. Pain may appear without a clear cause, may be triggered by things that would not normally hurt, or may feel much stronger than expected[8,13]. Read How Damage to Nerves Throughout the Body (Peripheral Nerves) Causes Pain (https://www.iasp-pain.org/resources/fact-sheets/how-damage-to-nerves-throughout-the-body-peripheral-nerves-causes-pain/) for more information.

Turning up the volume: "Central Sensitization"

One of the main changes in neuropathic pain is called "central sensitization". This is where the brain and spinal cord become abnormally sensitive to information about threat or damage. When this happens, nerves react too strongly to incoming signals. Sometimes they can even react when there is no injury to the body. Over time, this sensitivity can build up. Even light or harmless signals may begin to feel painful[5,9]. Like a music player with the volume control knob stuck at "high."

These changes can be long-lasting and may become stronger over time[9,12]. This helps explain why neuropathic pain can persist[8,13]. But importantly, these changes can sometimes be reversed, and things can return to normal.

Changes in nerve and immune cells

After a nerve injury, chemical signals can strengthen the links between nerve cells (i.e., neurons). In addition, small electrical "gates" in nerve cells, called ion channels, can change how they work. These changes can make nerves more active and cause sudden bursts of danger signals[6,20].

Other cells in the nervous system also play an important role. Two important types are microglia and astrocytes. Microglia act like the brain's clean-up and defense cells. Astrocytes are star-shaped helper cells that help nerve cells communicate. When the nervous system detects signs of injury, microglia and astrocytes become active and release chemicals that help with repairs. However, these same chemicals can also make nearby nerve cells more sensitive[3,11,21].

Changes in the brain

In a healthy nervous system, the brain helps control pain by sending signals to the spinal cord that act like a natural "brake" on danger signals. However, in neuropathic pain, the brain's ability to quiet danger signals becomes weaker[10,13,22]. Chemical signals in the nervous system also begin to change. Some that normally reduce pain stop working, while others increase danger signals. This upsets the balance, making it harder for the brain to control pain[10].

Over time, long-lasting danger signals can also change the structure and activity of the brain itself. Brain scans show changes in areas involved in pain processing, which normally help regulate danger signals. The brain's "map" of the body can also change after nerve injury, which may make painful areas seem larger or more sensitive[2,17]. Pain can also affect brain regions that process emotions and memory. As a result, pain may feel more distressing and harder to control[1,2].

There are many factors that can raise or lower the risk of persistent neuropathic pain. Some are related to the pain itself, such as its severity or whether it affects more than one part of the body. Others are linked to the person, including age, sex, body weight, and other health conditions[14,15].

Evidence from research suggests that low levels of physical activity, poor sleep, unhealthy diet, smoking, and alcohol use may influence how the brain and spinal cord respond to injury and disease and can increase the risk of developing persistent pain[4,16].

Not just biology: the importance of psychological and social factors

Psychological factors such as depression and anxiety can increase the risk of developing persistent pain. What we believe and expect about our pain can also make it feel more intense and more difficult to manage[14,18]. This does not mean neuropathic pain is "all in your head" - these factors can contribute to increased nervous system sensitivity.

Psychosocial factors can also influence pain. These include stressful life events, work-related factors, lack of social support, and life experiences such as injury or abuse. These factors can affect our emotional and mental health[14,15]. Together with biological factors, they can influence the risk of developing persistent pain[7,19].

In summary, injury to nerves can cause a range of changes in how the brain and spinal cord function, which can cause or contribute to neuropathic pain. Understanding these processes may help researchers develop new treatments for neuropathic pain.

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