Neuro-anatomy of Pain

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Abstract

Most pain information begins at simple, naked nerve endings called nociceptors that form a functional pain unit with nearby tissue capillaries and mast cells. Tissue injury causes these nerve terminals to depolarize, an event that is propagated along the entire afferent fiber eventuating in sensory impulses reaching the spinal cord. This firing of primary afferent fibers at the site of tissue injury causes axonal release of vesicles containing neuropeptides such as substance P, which acts in an autocrine and paracrine manner to sensitize the nociceptor and increase its rate of firing. Primary fibers travel from the periphery to the dorsal horn where they synapse on secondary neurons and interneurons. When activated, interneurons exert inhibitory influences on further pain signal trafficking. Efferent supraspinal influences, in turn, determine the activity of interneurons by releasing a variety of neurotransmitter substances, thus resulting in a high degree of modulation of nociception within the dorsal horn. Pain, however, is a highly complex and subjective experience that is not linearly related to the nociceptive input. In fact, nociceptive information processing and consequent pain perception is subject to significant pro- and anti-nociceptive modulations. These modulations can be initiated reflexively or by contextual manipulations of the pain experience including cognitive and emotional factors. The so-called descending pain modulatory network involving predominantly medial and frontal cortical areas, in combination with specific subcortical and brain stem nuclei appears to be one key system for the endogenous modulation of pain. Furthermore, recent findings from functional and anatomical neuroimaging support the notion that an altered interaction of pro- and anti-nociceptive mechanisms may contribute to the development or maintenance of chronic pain states. Research on the involved circuitry and implemented mechanisms is a major focus of contemporary neuroscientific research in the field of pain and should provide new insights to prevent and treat chronic pain states.