

Neuroanatomy relevant to clinical manifestation on migraine

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Neuroanatomy defines the ballpark in which we think when trying to understand, diagnose and treat central nervous system disorders such as migraine. Migraine can be triggered by environmental events such as flickering lights, loud noise and certain odors, as well as behavioral events that lead to deviation from homeostasis (these will not be covered in my lecture). Migraine can also be triggered by intracerebral events such as aura, intracranial events such as subdural hematoma, and extracranial events such as mild trauma to the head. When the headache eventually commenced, it can be perceived as throbbing, referred to periorbital or occipital areas, and described as being felt inside the head (exploding), outside the head (imploding) or behind the eye (ocular). Peripheral neuroanatomy, different courses of pain fibers that innervate intra- and extra-cranial structures, and their convergence in the spinal trigeminal nucleus provide a neural substrate for the different triggering mechanisms and the unique headache perception (slides 1-14).

When lasting over many hours, migraine may also be associated with cephalic allodynia (the clinical manifestation of sensitization that develops in central trigeminovascular neurons located in the spinal trigeminal nucleus), irritability, anger, anxiety, fear, low-energy, depression, yawning, frequent urination, teary eyes, loss of appetite, nausea and sleep disturbances. The neural substrate of these symptoms can include a direct nociceptive pathway that originates in 2nd-order trigeminovascular neurons and terminates in a variety of hypothalamic and telencephalic nuclei involved in the regulation of these affective, behavioral and autonomic functions.

The pathophysiology of migraine is likely to involve acute and chronic functional and anatomical changes in the activity of thalamic and cortical neurons that mediate extra-cephalic allodynia, photophobia and other visual perception abnormalities, phonophobia, osmophobia and other olfactory perception abnormalities, fine-tuning of pain processing based on information gained through previous experience with this recurrent disorder, cortical excitability, motor clumsiness, decreased cognitive functions, and transient retrograde amnesia. Allowing us to conceptualize how such symptoms are generated by the migraine are direct nociceptive projections of trigeminovascular thalamic neurons to different layers of cortical areas such as the visual, auditory and olfactory cortices, the so-called 'pain matrix' which include the primary and secondary somatosensory cortices and the insula, and the motor, retrosplenial and parietal association cortices.

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Dr. Burstein is an NIH-funded translational researcher who works on the pathophysiology of neural pathways that underlie migraine pain. These neural pathways include networks of neurons that carry pain signals from peripheral structures to the spinal cord and from there, to brain areas that regulate pain perception, sensitivity to light, mood, appetite, hormonal secretion, autonomic reflexes, and sleep.