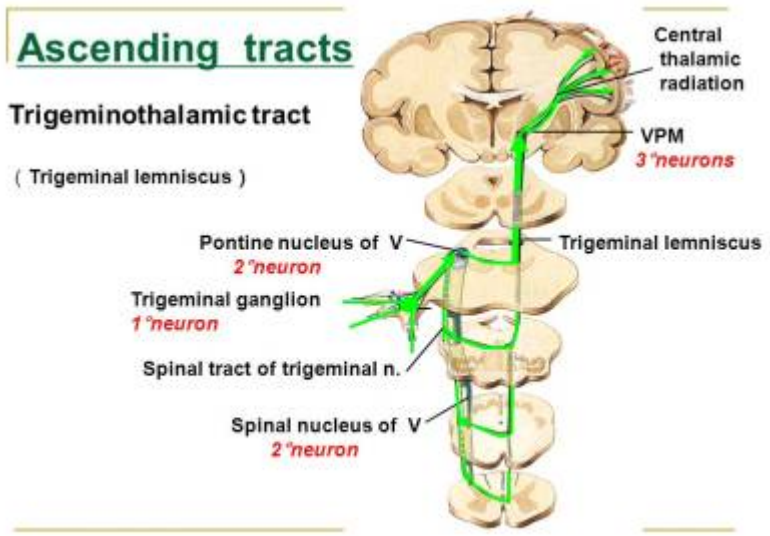
Trigeminal lemniscus



The trigeminal lemniscus, also called the trigeminothalamic tract, is a part of the brain that conveys tactile, pain, and temperature impulses from the skin of the face, the mucous membranes of the nasal and oral cavities, and the eye, as well as proprioceptive information from the facial and masticatory muscles.

The trigeminal lemniscus is composed of second order neuronal axons in the brainstem. It carries sensory information from the trigeminal system to the ventral posteromedial nucleus of the thalamus.

This tract was historically considered a cephalic division of the medial lemniscus due to the close proximity of the two ascending tracts.

Like the dorsal column medial lemniscus (DCLM) system, the trigeminal lemniscus carries tactile and proprioceptive sensations. However, the trigeminal lemniscus also carries pain and temperature sensations from the contralateral orofacial region, just as the spinothalamic pathway carries these sensations from the contralateral body. Thus, the trigeminal lemniscus of the head is functionally analogous to both the DCLM and spinothalamic systems of the body.

The anterior trigeminothalamic tract (or ventral trigeminothalamic tract) serves as a proprioception, touch, and vibration pathway from the face, head and neck (the facial equivalent of the DCML). After receiving input from Meissner's and Pacinian corpuscles, first order neurons (of the trigeminal nucleus) enter the pons and synapse in the principal sensory trigeminal nucleus. Axons of the second order neurons cross the midline and terminate in the ventral posteromedial nucleus of the thalamus (as opposed to the ventral posterolateral nucleus, as in the DCML) to mediate conscious sensation of proprioception, touch, and vibration from the face, head, and neck. The third order neuron in the thalamus then connects to the sensory cortex of the postcentral gyrus.

Classic anatomical atlases depict a contralateral hemispheral representation of each side of the face.

However, a bilateral projection of each hemiface was hypothesized, based on animal studies that showed the coexistence of an additional trigeminothalamic tract sprouting from the trigeminal principal sensory nucleus that ascends ipsilaterally.

A study of Henssen et al. from the Department of Anatomy, Department of Anesthesiology, Pain and Palliative Care, Donders Institute for Brain, Cognition and Behavior, Radboud University Medical Center, Department of Neurosurgery, Radboud University Medical Center, Nijmegen, The Netherlands, Department of Clinical Neurosciences, Wellcome Centre for Integrative Neuroimaging, FMRIB, University of Oxford, Nuffield, UK, Institute of Neuroscience and Medicine (INM-1), Research Centre Jülich, Jülich, Germany, Department of Clinical Genomics and Biochemistry and Molecular Biology, Mayo Clinic, Rochester, USA, aimed to provide an anatomical substrate for the hypothesized bilateral projection. Three post-mortem human brainstems were scanned for anatomical and diffusion magnetic resonance imaging at 11.7T. The trigeminal tracts were delineated in each brainstem using track density imaging (TDI) and tractography. To evaluate the reconstructed tracts, the same brainstems were sectioned for polarized light imaging (PLI). Anatomical 11.7T MRI shows a dispersion of the trigeminal tract (tt) into a ventral and dorsal portion. This bifurcation was also seen on the TDI maps, tractography results and PLI images of all three specimens. Referring to a similar anatomic feature in primate brains, the dorsal and ventral tracts were named the dorsal and ventral trigeminothalamic tract (dtt and vtt), respectively. This study shows that both the dtt and vtt are present in humans, indicating that each hemiface has a bilateral projection, although the functional relevance of these tracts cannot be determined by the present anatomical study. If both tracts convey noxious stimuli, this could open up new insights into and treatments for orofacial pain in patients [1)].

1)
Henssen DJHA, Mollink J, Kurt E, van Dongen R, Bartels RHMA, Gräßel D, Kozicz T, Axer M, Van Cappellen van Walsum AM. Ex vivo visualization of the trigeminal pathways in the human brainstem using 11.7T diffusion MRI combined with microscopy polarized light imaging. Brain Struct Funct. 2018 Oct 6. doi: 10.1007/s00429-018-1767-1. [Epub ahead of print] PubMed PMID: 30293214.