Neurobiology presentation

The receptors, first, second and third order neurons and their terminal fields of the medial lemniscus system

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The dorsal column–medial lemniscus pathway (DCML) is a sensory pathway. It contains first, second and third order neurons. The first order neurons are situated in the dorsal root ganglion of the spine and they carry signals from receptors to the gracile and cuneate nuclei in the brainstem, where they terminate.The receptors producing the initial signals are various mechanoreceptors in the skin. These can be Meissner’s corpuscle – rapidly adapting light touch receptor -, Pacinian corpuscle – rapidly adapting high frequency vibrations receptor also found inside joints -, root hair plexus – rapidly adapting crude touch and pressure receptors -, Ruffini corpuscle – slowly adapting strech receptor also found inside joints -, Merkel-Ranvier cells – slowly adapting light touch receptors. The receptors can also be from joints or muscles providing proprioceptive sense. In this case the receptors can be golgi tendons or muscle spindles. The mechanoreceptors in the skin define receptive fields, this is the area that can be sensed by that specific receptor. Individual sensory neurons of cortical areas also have receptive fields, in this case it is defined by all receptor signals arriving to them, by the union of the individual receptive fields of receptors. Here these regions can be symmetric bilateral as well. Where precise sense is needed the receptive fields are smaller, for example on the hand, while on other body parts they can be larger.

The second order neurons travel from the nucleus gracilis and nucleus cuneatus in a curved path towards the medial part of the brainstem, here the axonbundles are called internal arcuate fibers. At the level of the inferior olivary nucleus these fibers decussate and form the medial lemniscus. The word lemniscus has latin and greek origin and means ribbon, this implies the flat shape of this nerve bundle. These fibers terminate after the pons and midbrain on the ventral posterior nucleus of the thalamus or VPL.

The third order neurons travel from here through the internal capsule towards the primary somatosensory cortex of the cerebral cortex where they terminate. This area is also called as the Brodmann areas 3, 1 and 2 or as postcentral gyrus. Here the signals from lower regions end up in the medial part, while signals from upper regions are positioned laterally. There are overlaps between these regions. The surface size of these regions do not mirror the size of skin which the receptors cover but rather their density. For examlpe the torso has a relatively small surface reserved for it on the postcentral gyrus, but the hands and fingers have a significant amount. The homonculi modell show these relations.

Damaging this pathway will lead to loss of fine touch sensation, recognition of textures and patterns, balance and sense of vibration in the affected regions. If the lesion happens in the dorsal column the deficits will happen ipsilaterally, if it is before the decussation it will lead to contralateral deficits. The Romberg test checks a persons balance with closed eyes and failing it could mean that the medial lemniscus system is damaged.