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sulcus, and laterally by the ventrolateral sulcus. The lateral funiculus is limited ventrally and dorsally by the ventral and dorsal sulci and dorsolateral sulci. The posterior funiculus is located lateral to the dorsal median sulcus, and medial the dorsolateral sulcus. The dorsal funiculus is particularly unique in that it can be subdivided into two fasciculi. The gracile fasciculus (fasciculus gracilis) is closer to the dorsal median sulcus, while the cuneate fasciculus (fasciculus cuneatus) is closer to the dorsolateral sulcus. Owing to the fact that there is a somatotopic arrangement of this funiculus, both fasciculi may not be present at all spinal levels. However, when they are both present, they are separated from each other by the dorsal intermediate sulcus. Cross-sectional analysis of the spinal cord is a really tricky topic, so don't fret if you don't get it straight away! Use our spinal cord diagrams and quizzes to practice until you're feeling confident. It is important to understand the jargon associated with the spinal cord tracts in order to appreciate the anatomy and physiology associated with the tracts. The tracts are described according to the funiculus within which they are located. Additionally, a more precise location can be given based on the proximity of the tract to the midline. These descriptions are used in conjunction with the name of the tract to aid in localizing the neuronal pathway. The prefix spino- indicates that the tract is originating within the spinal tract. Therefore, the lateral spinothalamic tract refers to a cluster of nerve fibers traveling within the lateral funiculus of the spinal cord, which originated within the cord and will terminate within the thalamus. In contrast, the bundle of fibers known as the rubrospinal tract originates from the red nucleus of the midbrain and travels to the spinal cord. However, the reader should bear in mind that although the tracts are described as being confined to a particular region, there is significant overlap of the tracts in real life; so they may not always obey the prescribed classification systems. Overview of the pyramidal tracts (ventral view) The white matter of the spinal cord contains a mixture of ascending (sensory or afferent) and descending (motor or efferent) tracts. These tracts are bilaterally paired structures; some of which may cross the midline (decussate) at different levels to relay information to the side of the body, or from the side of the brain, on the side opposite to the point of origin. An example of this is the corticospinal tract, where fibers originating from the left cerebral cortex decussate at the level of the pyramids in the caudal medulla oblongata to supply muscles of the right side of the body. Growing up, the impression was given that there were only five senses that humans can detect. These were sight, smell, sound, taste, and touch. However, it is clear that touch can be further expanded to include pain, thermal changes, pressure, light (crude) touch, vibration, two-point discrimination, and proprioception. Sight, sound, smell, and taste are special afferent stimuli that are conveyed through their respective cranial nerves. However, the other tactile modalities are transmitted through the ascending tracts of the spinal cord. There are eight known ascending tracts conveying a variety of sensory stimuli that are discussed below. Recognition of these stimuli is provided by a variety of mechanoreceptors distributed throughout the body. These mechanoreceptors are free nerve endings that are responsive to several types of stimuli. They include: Pacinian corpuscles (for vibration and pressure sensation) Meissner's corpuscles (light touch) Merkel's discs (pressure receptors) Golgi tendons (for proprioception) joint receptors nociceptors (for noxious stimuli) muscle spindles (stretch receptors) Lateral spinothalamic tract Cutaneous sensory receptors transmit painful and varying thermal stimuli through the dorsal nerve root. The fibers then synapse the dorsal horn of the grey matter. The fibers of the second-order neurons decussate to the contralateral side and ascend in the lateral spinothalamic tract. These fibers pass through the medulla oblongata, posterior part of the pons, and enter the tegmentum of the midbrain. The lateral spinothalamic tract components then synapse on third-order neurons in the thalamus. As the stimuli for pain and temperature changes are processed here, they pass this information through the posterior limb of the internal capsule, through the corona radiata to reach the postcentral gyrus (Brodmann 3, 1, 2). Ventral (anterior) spinothalamic tract Cutaneous mechanoreceptors that are sensitive to crude (non-discriminative) touch and pressure changes transmit stimuli through the dorsal root ganglion. They synapse in the substantia gelatinosa (Rexed II) after ascending or descending for one or two segments in the posterolateral tract of Lissauer. Subsequent fibers pass to the other side via the anterior grey commissure to emerge in the anterior funiculus. Here, the fibers form the ventral (anterior) spinothalamic tract and ascend through the medulla oblongata alongside the lateral spinothalamic and spinotectal tracts. Like the lateral spinothalamic tract, the ventral spinothalamic tract also synapses on neurons in the thalamus. The remainder of the course of the third-order neurons of this tract is analogous to that of the lateral spinothalamic tract. Dorsal column: Medial lemniscus pathway and cuneocerebellar tracts Numerous cutaneous receptors detect and transmit sensory modalities such as light (discriminative) touch, vibration sense, proprioception, and two-point discrimination. Proprioception refers to the brain's ability to discern the actual spatial location of each part of the body. Two-point discrimination refers to the accuracy with which one can detect that a part of the body is being touched and that two relatively close points are being simultaneously stimulated. The receptors send impulses through the dorsal root ganglion and directly into the dorsal funiculus to form the dorsal column. The fibers split to form short descending and long ascending fibers that participate in local reflex arcs. This allows unconscious efferent intervention in cases where a stimulus (i.e. overextension of a limb) becomes harmful. Most of the long ascending fibers go on to form the fasciculus gracilis (throughout the length of the spinal cord) and the fasciculus cuneatus (at and above the level of the sixth thoracic vertebra). Both sets of fibers travel ipsilaterally, with the gracile fasciculus carrying stimuli from the lower limbs and lower six thoracic segments (T7 - T12) and the cuneate fasciculus conveying stimuli from the upper 6 (T1 - T6) and all of the cervical vertebrae. They each terminate at their respective nucleus (gracile and cuneate) within the medulla oblongata. The second order neurons produce the internal arcuate fibers that pass contralaterally through the sensory decussation, to form the medial lemniscus pathway. The fibers continue towards the thalamus and then to Brodmann's areas 3, 1, 2. Of note, the fibers arising from the cuneate nucleus form the posterior external arcuate fibers that travel through the inferior cerebellar peduncle, to enter the cerebellum. This is known as the cuneocerebellar tract, which carries joint position and proprioception to the cerebellum. Ventral (anterior) spinocerebellar The mechanoreceptors carry sensory information from the upper and lower limbs and trunk to the dorsal root ganglion of the eighth cervical through to the third lumbar (C8 - L3) segments. They enter the dorsal grey horn and synapse on the nucleus dorsalis (Clarke's nucleus). Note that Clarke's nucleus is only found between C8 - L3. Therefore fibers arising above or below that level will travel through the dorsal white column until they arrive at the nearest level. Not all the fibers of this tract continue toward the cerebellum on the same side. Only a minority of fibers will continue in the ipsilateral lateral funiculus, while the majority of the fibers will decussate to form the ventral spinocerebellar tract of the contralateral lateral funiculus. Both tracts will ascend through the medulla oblongata, and access the cerebellar cortex by their respective superior cerebellar peduncle. However, it has been theorized that the majority of the contralateral fibers travel through the middle cerebellar peduncle, to cross back to the original side. Dorsal (posterior) spinocerebellar The dorsal spinocerebellar tract also carries unconscious proprioception to the cerebellum but from the lower limbs and trunk. Like the ventral spinocerebellar tract, this information is relayed to Clarke's nucleus after passing through the dorsal root ganglion. Dorsal spinocerebellar tract (axial view) However, unlike the ventral counterpart, axons of the second-order neurons from Clarke's nucleus pertaining to this tract enter the posterolateral aspect of the ipsilateral lateral funiculus. As it forms the dorsal spinocerebellar tract, the fibers ascend to the medulla oblongata and enter the inferior cerebellar peduncle. They then integrate with the mossy fibers of the rostral and caudal cerebellar vermis. Muscular contraction against a relatively fixed skeletal system is the principal feature of the musculoskeletal system that facilitates locomotion. However, muscle fibers are dependent on action potentials generated by the spinal motor neurons of the anterior grey horn in order to produce a movement. Both conscious and unconscious regulation of these lower motor neurons of the anterior grey horn is achieved by numerous upper motor neuron pathways that originate above the level of tells (i.e. cerebral cortex, cerebellum, etc.). The actions of the upper motor neurons provide stimulatory and inhibitory modulation of the activity of the anterior horn cells, and by extension, the activity of the motor system. Unlike the sensory pathways, where the first-order neurons were at the level of the spinal cord and the third-order neurons were in the brain, the motor system has first-order neurons within the brain and third-order neurons at the anterior grey column. Corticospinal tracts The large pyramidal cells of the lamina pyramidalis interna (the internal pyramidal layer; 5th histological layer) of the cerebral cortex are the first-order neurons of the corticospinal tract. While the majority of fibers arise from the precentral regions (Brodmann's areas 4, and 6), the postcentral gyrus also contributes to its formation as well. However, those arising from the postcentral gyrus do not contribute to motor regulation. Only the motor component of the corticospinal tract will participate in regulating voluntary movement. Also, note that there is a somatotopic arrangement of the corticospinal tract that is best understood by reviewing the motor homunculus. The corticospinal tract travels in the opposite direction to the terminal parts of the spinothalamic and medial lemniscus tracts. It leaves the cortex through the corona radiata and internal capsule before passing through the basis pedunculi. Importantly, it forms the great pyramidal decussation in the caudal aspect of the medulla oblongata, where a majority of the fibers cross to the opposite side. As a result, fibers originating in the right hemisphere will travel in the left lateral funiculus, as the lateral corticospinal tract. The few fibers that did not decussate continue caudally in the ventral funiculus as the ventral (anterior) corticospinal tract. While the lateral corticospinal tract synapses in the anterior grey horn of all spinal segments along the length of the spinal cord, the ventral corticospinal tract only regulates the proximal thoracic and cervical segments. Vestibulospinal tract The vestibular nuclei are chiefly responsible for processing special afferent signals from the semicircular canal system of the inner ear , via the vestibular division of the vestibulocochlear nerve (CN VIII). It uses this information (in addition to visual and cerebellar cues) to determine the spatial relationship of the body to its environment. The lateral vestibular nucleus sends out ipsilateral efferent fibers called the vestibulospinal tract. As they continue into the anterior funiculus, they eventually synapse on the ventral grey horn cells. The effect of this innervation is to inhibit flexor and promote extensor, muscle activity to maintain balance. Vestibulospinal tract (axial view) Rubrospinal tract At the level of the superior colliculus in the tegmentum of the midbrain is a bilaterally paired set of oval nuclei known as the red nucleus. The nucleus itself is under continuous regulation by corticobulbar and cerebellorubral pathways. As the fibers emerge from the nucleus, they decussate to form the rubrospinal tract. These fibers eventually enter the lateral funiculus, where they integrate with the reflex cells of the anterior grey horn. Therefore, the rubrospinal tract indirectly carries regulatory signals from the cerebrum and cerebellum to inhibit extensor and promote flexor, muscle activity. Rubrospinal tract (axial view) Reticulospinal tracts Also originating at the red nucleus, the reticular formation is a diverse tract that runs along the pontomedullary axis. The reticular formation - which principally deals with arousal and maintaining consciousness - forms synapses on nuclei whose fibers that will become the reticulospinal tracts. There are pontine and medullary divisions of this tract; which also have components that decussate, as well as those that continue ipsilaterally. The reticulospinal tracts eventually provide regulatory impulses to the spinal reflex centers and voluntary movement. It has been noted that the pontine reticulospinal tract gives rise to the ventral reticulospinal tract in the ventral funiculus, while the medullary reticulospinal tract descends in the lateral funiculus to form the lateral reticulospinal tract. Tectospinal tract Very often individuals respond by jumping away from an object that unexpectedly moves or is perceived as hazardous at the time. This response is mitigated partly by the tectospinal tract. Visual impulses passing through the optic tract gains access to the superior colliculus. The majority of these fibers readily decussate to join the medial longitudinal fasciculus shortly after leaving the superior colliculus. The fibers of the tectospinal tract then enter the ventral funiculus (close to the ventral median sulcus), before terminating in the anterior grey horn of the proximal cervical segments. They integrate with the reflex centers to produce the postural movements in response to visual stimuli. To finish up your learning, take a deeper look at some of the specific white matter tracts or take a quiz on all the tracts and nuclei covered in this article! Just to recap the ascending spinal tracts: Lateral spinothalamic carries pain and thermal stimuli. Ventral spinothalamic is responsible for pressure and crude touch sensations. Dorsal column is the area of vibration sensation, proprioception, and two-point discrimination. Spinocerebellar tracts (anterior and posterior divisions) conduct unconscious stimuli for proprioception in joints and muscles. Cuneocerebellar carries the same information as the spinocerebellar tracts. Other ascending tracts in the spinal cord that are discussed in more detail in other articles include: Spinotectal serves an accessory pathway for tactile, painful, and thermal stimuli to reach the midbrain. Spinoreticular integrates the stimuli from the muscles and joints into the reticular formation. Spino-olivary is an accessory pathway that carries additional information to the cerebellum. In summary, the descending tracts of the spinal cord are: Lateral and ventral (anterior) corticospinal tracts deal with voluntary, discrete, skilled motor activities. Lateral and ventral (anterior) reticulospinal tracts provide excitatory or inhibitory regulation of voluntary movements and reflexes Rubrospinal tract promotes flexor and inhibit extensor muscle activity Vestibulospinal tract promotes extensor and inhibit flexor muscle activity. It also supports balance and posture. Tectospinal tracts facilitate postural movements arising from visual stimuli. Although the corticobulbar tract is a descending pathway, it terminates on the cranial nerve nuclei, which are located in the midbrain and brainstem. All content published on Kenhub is reviewed by medical and anatomy experts. The information we provide is grounded on academic literature and peer-reviewed research. Kenhub does not provide medical advice. You can learn more about our content creation and review standards by reading our content quality guidelines. References: Kiernan, J. A, Murray Llewellyn Barr, and Nagalingam Rajakumar: Barr's The Human Nervous System. 10th ed. Philadelphia: Wolters Kluwer Health/Lippincott Williams & Wilkins. Moore, Keith L et al. The Developing Human. 9th ed., Elsevier-Saunders, 2013. Sadler, T. W, and Jan Langman. Langman's Medical Embryology. 12th ed., Philadelphia, PA, Lippincott Williams & Wilkins, 2012 Snell, Richard S. Clinical Neuroanatomy: 7th ed. Philadelphia: Wolters Kluwer Health/Lippincott Williams & Wilkins, 2010. Illustrators: Structure of the spinal cord (coronal view) - Rebecca Betts Cross-sectional view of the spinal cord - Paul Kim Overview of the pyramidal tracts (ventral view) - Paul Kim Post central gyrus (coronal view) - Paul Kim Anterior spinocerebellar tract (axial view) - Paul Kim Dorsal spinocerebellar tract (axial view) - Paul Kim Vestibulospinal tract (axial view) - Paul Kim Rubrospinal tract (axial view) - Paul Kim Tectospinal tract (axial view) - Paul Kim