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# PYRAMIDAL TRACKT

**O.O. Doroshenko**
*Ivano-Frankivsk National Medical University*

**I. Scientific-methodical ground of theme.** The pyramidal tract, also known as the corticospinal tract, is an important part of the central nervous system. It is responsible for all voluntary movements made by the body. Damage to this tract can lead to a number of problems, including paralysis, muscle weakness, loss of muscle control, and tremors. Although there is much about the control of voluntary movement that is still unknown.

**II. Educational aim of lecture.** The main purpose of the lecture is a comprehensive enlightenment of principles of structure of the pyramidal nervous system and especially the nature of conditioned movements of the human body.

**III. The purposes of development of the person.** Young neurologists can diagnose well nervous system disease only having a thorough knowledge of the topical anatomy of the brain.

**IV. Plan of The Lecture**

**1. General Principles**
**2. Corticospinal and corticobulbar system.**
**3. Anatomy.**
**4. Tracts**
**5. Control of Axial & Distal Muscles**
**6. Disturbances in Motor Power**
**7. Types of Paralysis or Paresis Based on Location**
**8. Literature.**

## 1. GENERAL PRINCIPLES

Motion is a fundamental property of most animal life. In the simple unicellular animals, motion and locomotion depend upon the contractility of protoplasm and the action of accessory organs such as cilia, flagella, etc. The lowest multicellular animals possess rudimentary neuromuscular mechanisms; in higher forms, motion is based upon the transmission of impulses from a receptor through an afferent neuron and ganglion cell to muscle. This same principle is found in the reflex arc of higher animals, including humans, in whom the anterior spinal cord has developed into a central regulating mechanism, the brain, which is concerned with initiating and integrating movements.

The patterns of voluntary activity are planned within the brain, and the commands are sent to the muscles primarily via the corticospinal and corticobulbar system. Posture is continually adjusted not only before but also during movement by posture-regulating systems. Movement is smoothed and coordinated by the medial and intermediate portions of the cerebellum (the spinocerebellum) and its connections. The basal ganglia and the lateral portions of the cerebellum (neocerebellum) are part of a feedback circuit to the premotor and motor cortex that is concerned with planning and organizing voluntary movement.

## 2. CORTICOSPINAL & CORTICOBULBAR SYSTEM

### *ANATOMY*

The cortical areas from which the corticospinal and corticobulbar system originates are generally held to be those where stimulation produces prompt discrete movement. The best known is the motor cortex in the precentral gyrus. However, there is a supplementary motor area on and above the superior bank of the cingulate sulcus on the medial side of the hemisphere that reaches to the premotor cortex on the lateral surface of the brain.

Motor responses are also produced by stimulation of somatic sensory area 1 in the postcentral gyrus and by stimulation of somatic sensory area II in the wall of the sylvian fissure. These observations fit with the fact that 30% of the fibers making up the corticospinal and corticobulbar tracts come from the motor cortex but 30% come from the premotor cortex and 40% from the parietal lobe, especially the somatic sensory area.

The various parts of the body are represented in the precentral gyrus, with the feet at the top of the gyrus and the face at the bottom. The facial area is represented bilaterally, but the rest of the representation is unilateral, the cortical motor area controlling the musculature on the opposite side of the body. The cortical representation of each body part is proportionate in size to the skill with which the part is used in fine, voluntary movement. The areas involved in speech and hand movements are especially large in the cortex; use of the pharynx, lips, and tongue to form words and of the fingers and apposable thumbs to manipulate the environment are activities in which humans are especially skilled. The cells in the cortical motor areas are arranged in columns. The cells in each column receive fairly extensive sensor input from the peripheral area in which they produce movement, providing the basis for feedback control of movement. Some of this input may be direct, and some is relayed from somatic sensory area I in the postcentral gyrus.

### 3. Tracts

The corticospinal tract originates as the axons of pyramidal neurons in layer V of (mainly) primary motor cortex. In general, the farther the axon has to go, the larger the neuron. In the precentral gyrus there are some especially large neurons, visible even at low magnification. These neurons are called Betz cells, and were once thought to be the sole source of the corticospinal tract. We now know that they are only a subset of the pyramidal neurons which make up the tract. Once the axons leave the pyramidal cells, they enter the white matter just below layer VI. Every gyrus in the brain has this core of white matter, which contains all of the axons entering or exiting the gyrus. Deeper into the brain, all of these slips of white matter coalesce to form one large body of axons, the corona radiata, "radiating crown".

As you get still deeper into the hemispheres, the corona radiata dives into the deep nuclei of the brain, the caudate and putamen, splitting them in two. At this point, all of these axons are called the *internal capsule.* The internal capsule is a major two-way highway, and very vulnerable to strokes. Sensory information travels up it on the way from the thalamus to the cortex, and motor information travels through on the way down to the spine. In the horizontal sections at the beginning of the course, the internal capsule has an anterior and posterior limb. The motor and somatosensory information travels through the *posterior limb.*

If you were to follow horizontal sections down through the brain, at around the level where the midbrain begins, you would see the internal capsule coalesce into a tight bundle to exit the cerebral hemispheres. At this point the axons are called the cerebral peduncles, or the "stalks" of the cerebrum. The peduncles make up the floor of the midbrain, and contain all of the descending axons going to the brainstem or spine. The peduncles, unlike the internal capsule, are largely one-way; most of the axons in them are heading south. The ascending, sensory axons take other routes to get to the thalamus.

Once midbrain gives way to pons, two things happen to the peduncles. One, many of the axons from cortex were actually headed for the pons (the “corticopontine” fibers, of course), so they get off and synapse. Two, the remaining corticospinal axons get a little fragmented in the pons, so they are no longer visible as a nice tight bundle. They can be seen as several smaller bundles, though.

In the medulla, the fibers come together again as the pyramids. The pyramids were actually named as landmarks on the surface of the brainstem - on a human brainstem you can clearly see them as two ridges running down the ventral midline. The pyramids run the entire length of the medulla, large uninterrupted axon tracts on the ventral surface. At the very caudal-most end of the medulla, right about at the point where you have to start calling it cervical spinal cord, the fibers in the pyramids cross. The crossing event is called the *decussation of the pyramids.*

The nerve fibres that cross the midline in the medullary pyramids and form the lateral cortico-spinal tract make up about 80% of the fibres in the corticospinal pathway. The remaining 20% make up the anterior or ventral corticospinal tract, which does not cross the midline until the level at which it synapses with motor neurons. In addition, this tract contains corticospinal neurons that end on the same side of the body. The ventral pathway, which is the oldest phylogenetically, ends primarily on inter-neurons. These inter-neurons synapse on neurons in the medial portion of the ventral horn that control axial and proximal limb muscles. Conversely, the lateral cortico-spinal pathway innervates lateral neurons in the ventral horn that are concerned with distal limb muscles and hence with skilled movements. In humans, the neurons of this phylogenetically new system end directly on the lateral motor neurons.

The *corticobulbar (or corticonuclear) tract* is a white matter pathway connecting the cerebral cortex to the brainstem (the term “bulbar” referring to the brainstem). The ‘bulb’ is an archaic term for the medulla oblongata. The muscles of the face, head and neck are controlled by the corticobulbar system, which terminates on motor neurons within brainstem motor nuclei. This is in contrast to the corticospinal tract, which connects the cerebral cortex to spinal motor neurons, and controls movement of the torso, upper and lower limbs. The corticobulbar tract innervates cranial motor nuclei bilaterally with the exception of the lower facial nucleus which is innervated contralaterally. Among those nuclei that are bilaterally innervated a slightly stronger connection contralaterally than ipsilaterally is observed.

**4. Control of Axial & Distal Muscles**

Another theme that is important in motor control is that in the brainstem and spinal cord, medial or ventral pathways and neurons are concerned with the control of muscles of the trunk and proximal portions of the limbs, whereas lateral pathways are concerned with the control of muscles in the distal portions of the limbs. The axial muscles are concerned with postural adjustments and gross movements, whereas the distal limb muscles are those that mediate fine, skilled movements. Thus, for example, the neurons in the medial portion of the ventral horn innervate the proximal limb muscles, particularly the flexors, whereas the lateral ventral horn neurons innervate the distal limb muscles. Similarly, the ventral corticospinal tract and the medial descending paths from the brain stem (the testospinal, reticulo-spinal, and vestibulospinal tracts) are concerned with adjustments of proximal muscles and posture, whereas the lateral corticospinal tract and the rubrospinal tract are concerned with distal limb muscles and, particularly in the case of the lateral corticospinal tract, with skilled voluntary movements. Phylogenetically, the medial pathways are old, whereas the lateral pathways are new.

**5. DISTURBANCES IN MOTOR POWER**

Motor disturbances include weakness and paralysis, which may result from lesions of the voluntary motor pathways or of the muscles themselves. Impaired motor functioning may result from involvement of muscle, myoneural junction, peripheral nerve, or CNS.

**The lower motor neuron** (final common path-way) consists of a cell body located in the anterior gray column of the spinal cord or brain stem and an axon passing by way of the peripheral nerves to the motor end-plates of the muscles. It is the essential motor cell concerned with skeletal activity. It is called the “final common pathway” because it is acted upon by the corticospinal, rubrospinal, olivospinal, vestibulospinal, reticulospinal, and tectospinal tracts as well as by intersegmental and intrasegmental reflex neurons and because it is the ultimate pathway through which neural impulses reach the muscle.

Lesions of the lower motor neurons may be located in the cells of the ventral gray column of the spinal cord or brain stem or in their axons, which constitute the ventral roots of the spinal nerves or the cranial nerves. Lesions may result from trauma, toxins, infections, vascular disorders, degenerative processes, neoplasms, or congenital malformations. Signs of lower motor neuron lesions include flaccid paralysis of the involved muscles, muscle atrophy (with degeneration of muscle fibers), and reaction of degeneration (10-14 days after injury). Reflexes of the involved muscle are diminished or absent, and no pathologic reflexes are obtainable.

The upper motor neuron conveys impulses from the motor area of the cerebrum and is essential to voluntary muscular activity. It is the nerve cell of the motor cortex with its process that passes through the internal capsule, brain stem, and spinal cord by way of the corticobulbar or corticospinal tract to the lower motor neuron.

Lesions of the upper motor neuron may be located in the cerebral cortex, the internal capsule, the cerebral peduncles, the brain stem, or the spinal cord. Signs of upper motor neuron lesions include spastic paralysis or paresis of the involved muscles, little or no muscle atrophy (probably atrophy dis-use), and hyperactive deep reflexes, diminished or absent superficial reflexes, and pathologic reflexes and signs.

**6. Types of Paralysis or Paresis Based on Location**

**Hemiplegia** is a spastic or flaccid paralysis of one side of the body and extremities limited by the median line in front and in back.

**Monoplegia** is a paralysis of one extremity only.

**Diplegia** is a paralysis of any 2 corresponding extremities, usually both lower ex-tremities (but may be both upper). **Paraplegia** is a symmetric paralysis of both lower extremities.

**Quadriplegia**, or **tetraplegia**, is a paralysis of all 4 extremities.

Hemiplegia alternans (crossed paralysis) is a paralysis of one or more ipsilateral cranial nerves and contralateral paralysis of the arm and leg.

**7. Literature**

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