Motor system

The **motor system** controls muscle activity (ensures an upright position, work, food intake, communication). Purposeful movement is coordinated by a greater number of muscle groups at the same time. All sections of the CNS participate in motor control.

The activity of the motor system is:

1. **Involuntary** (stereotypical, fast) and we evoke it with a stimulus
2. **Free**

During movement, a combination of both types occurs.

Corticospinal pathway

Corticospinal tract (pyramidal) begins in the primary and secondary motor cortex (gyrus precentralis, superior frontal gyrus and parietal landscape). Pyramidal and extrapyramidal pathways lead from them, the pyramidal pathway itself from Betz cells forms only a smaller part. The **Tractus corticospinalis** runs from the capsula interna (end brain, cerebral cortex), most of the fibers cross in the **decussatio pyramidorum** (lower part of the medulla oblongata) and continue in the contralateral lateral cords spinal cord. A brain lesion in the region of the pathway causes paralysis of the muscles on the contralateral side. 75% of the fibers end on interneurons (the interface of the anterior and posterior horns) and 25% of the fibers end on motoneurons (the anterior horns of the spinal cord).

Motor unit

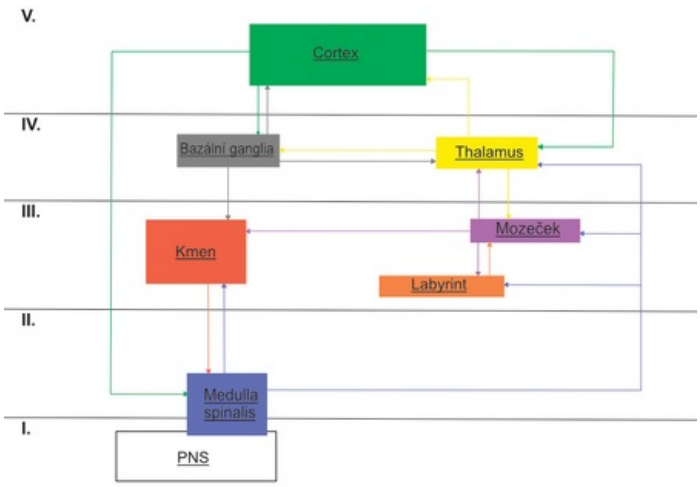
The **Motor Unit** is the basis of the motor system. It is a set of muscle fibers innervated by one motoneuron, and at the same time it is the smallest component that can be independently activated. Axon of a motoneuron branches after entering a muscle, its terminal fiber innervates one muscle fiber at a time. A synapse is formed - neuromuscular plate. Motor units represent the peripheral motoneuron.

Motion Control Principle

Motion control takes place on several levels.

1. Spinal cord
2. Brain stem
3. Cerebellum
4. Basal ganglia
5. Cerebral cortex

Mutual coordination of agonists, antagonists and synergists is essential. The main role of proprioception is to inform the center about probable movement. The basic impulse to free movement goes through the corticospinal pathway, the control of intensity is in the presence of proprioceptive reflexes. The receptors are **muscle spindle** (activated during muscle stretch, agonist facilitation and antagonist inhibition) and **Golgi tendon bodies** (inhibit agonists and facilitate antagonists). The feedback function is that the result of an activity affects the increase or decrease of the given activity



Hierarchy of motor control

Spinal motor circuit

At the level of the spinal cord, in the anterior corners of the spinal cord

- α-motoneurons – large neurons of the anterior horns of the spinal cord, where the corticospinal pathway ends and the motor unit begins
- γ-motoneurons – small neurons of the anterior horns of the spinal cord, innervate muscle spindles

When the spindle is stretched, the excitations facilitate the direct collateral activity of the own α-motoneuron (agonist) and inhibit the antagonist collaterally (via an interneuron). Muscle contraction is caused by a direct stimulus from α-motoneurons, or indirectly reflexively via γ-motoneurons

Principles of motor coordination

- Reciprocal innervation – the opposite effect on the motoneurons of antagonistic muscles
- Negative feedback – upon its activation, the interneuron releases the inhibitory transmitter and inhibits its own motoneuron
- The principle of the superiority of higher sections of the CNS - more perfect control of movement
- The principle of the final common pathway - all influences causing muscle contraction are applied by α-motoneurons

Functional unit of the nervous system (reflex)

Determined by the reflex arc, consists of 5 parts: receptor, afferent pathway, center, efferent pathway and effector

- **Monosynaptic spinal reflexes** (proprioceptive, myotactic, stretching) - the impulse is transferred to the α-motoneurons of the same muscle
- **Polysynaptic spinal reflexes** (exteroceptive) - arises from the activation of a different number of interneurons, when sensitive receptors in the skin are irritated

Muscle tone

Degree of resistance during passive movement in the joint

- Reflexively maintained muscle tension
- The cause is the low-frequency excitatory activity of α-motoneurons
- It results from the bombardment of AP(action potentials) coming from higher levels of the CNS and afferent fibers of somatosensory receptors

Lesions

In the case of central and peripheral motoneuron lesions, a movement disorder appears (slight muscle strength, clumsiness, loss of active movement - partial or complete)

- Light lesion - frustrating
- Partial movement disorder - paresis
- Monoparesis – one limb is affected
- Hemiparesis – one half of the body is affected
- Paraparesis – the lower limbs are affected
- Triparesis – impairment of three limbs
- Quadriparesis – impairment of all limbs
- Complete movement disorder - plegia (disappearing lesion syndrome)

Symptomatology

Momentum

- Central lesion – several muscle groups are damaged

  on the upper limbs, extension of the fingers, elbow and abduction in the shoulder are more affected
  flexion in the hip, knee and dorsiflexion of the leg is affected on the lower limbs

- Peripheral lesion – corresponds to a disorder of respective innervation areas

Myotatic reflexes

- Central lesion - increased reflexes due to spasticity
- Peripheral lesions – reduced or extinguished reflexes

Muscle tone

- Central lesion (spastic) - hypertonia, in the acute phase - pseudoweak paresis
- Peripheral lesion (weak) – hypotonia, atonia

Rigidity – basal ganglia lesions, agonist and antagonist hypertonia, α-motoneuron hyperactivity

Trophics

Interruption of the influence of motoneurons of the anterior horns of the spinal cord - muscle atrophy

- Central lesion – trophic level is normal
- Peripheral lesion – damage to any part of the motor unit results in muscle atrophy

Pathological polysynaptic reflexes (spastic phenomena)

Manifestation of central lesions positive spastic pyramidal phenomenon (Babinsky reflex – inversion of the cutaneous plantar reflex)

Fasciculation

Manifestation of peripheral disorders of spontaneous contraction of groups of muscle fibers

Fibrillation

Manifestation of peripheral involvement - spontaneous contractions of one muscle fiber (not visible, only on EMG)

Links

Related Articles

- Basal ganglia
- Tractus corticospinalis

References

- AMBLER, Zdeněk. *Fundamentals of Neurology.* 6. edition. Galen, 2006. pp. 66-67. ISBN 80-7262-433-4.