Nerve regulation of breathing

Control mechanisms

Breathing is controlled by two separate neural mechanisms. One of them is responsible for free breathing, the other for its automaticity.

Control of voluntary breathing

Free breathing is controlled from the cerebral cortex. The descending pathways of the *tractus cortico-spinalis* send impulses to the respiratory motoneurons. Thanks to free breathing, we can hold our breath for a limited period of time, change the frequency of breathing and its depth.

Breath automation control

The second mechanism is breathing automatics. It is located in the medulla oblongata and pons Varoli. Its efferent pathway passes through the white matter of the spinal cord between the lateral and ventral corticospinal tracts. The axons of the neurons providing inspiration terminate at motoneurons of the n. phrenicus located in segments C3-C5 and motoneurons controlling the external intercostal muscles in segments Th1-Th7. Fibers associated with expiration terminate on motoneurons of the internal intercostal muscles.

Respiratory neurons

Respiratory neurons are of two types. I-neurons send impulses in the inspiration, E-neurons act in the exspiration. During resting respiration, expiration is passive, so E-neurons are silent. Expiratory neurons are inhibited by the activation of inspiratory neurons and vice versa. This reciprocal innervation is primarily dependent on the activity of descending pathways. Impulses in these pathways stimulate agonists and inhibit antagonists.

Nuclei of respiratory neurons

According to their position, the nuclei of respiratory neurons can be divided into two groups. The dorsal group is located in the ncl. tractus solitarii. The ventral group occupies the ncl. ambiguus and ncl. retroambiguus. In the dorsal group we find mainly I-neurons. Some of them have monosynaptic connections with motoneurons of the phrenic nerve. The ventral group has E-neurons at its caudal end, I-neurons in the middle region and E-neurons again at the rostral end. The rostral neurons are probably responsible for the inhibition of I-neurons during expiration.

The effect of medulla oblongata

Thus, the main components of the basic respiratory rhythm generator responsible for automatic breathing are located in the medulla oblongata, since spontaneous breathing persists even after the brainstem is severed at the inferior border of pons. After the trunk is severed below the medulla oblongata, respiration stops completely. Rhythmic respiration is probably triggered by a small group of synaptically connected pacemaker cells located bilaterally in the medulla oblongata between the ncl. ambiguus and the lateral ncl. reticularis.

The effect of pons and the vagus nerve

The rhythmic activity of respiratory neurons in the medulla oblongata, although spontaneous, is influenced by pons neurons and vagal afferentation from receptors in the airways and lungs.

Pons Varoli

In pons we find an area known as the pneumotaxic centre containing neurons-I, E and neurons active in both phases of respiration. The pneumotaxic center is superior to the vagus and also has a dampening function on the apneustic center. By increasing the partial pressure of carbon dioxide in the arterial blood and the activity of the apneustic center, it leads to an influence on the inspiratory center, which sends excitations through the spinal pathways to motoneurons in the anterior horns of the cervical and thoracic spinal cord. This results in inspiration. Meanwhile, the respiratory centre also sends impulses to the pneumotaxic centre, which depresses the apneustic centre. As soon as the apneustic centre ceases to activate the respiratory centre, passive expiration follows.

Nervus vagus

The effect of the vagus is that when the lungs are expanded during inspiration, it causes impulses in the afferent fibers of the vagus, and these impulses inhibit inspiratory discharges. Therefore, the depth of inspiration is increased after vagotomy.

Links

Used literature

- TROJAN, Stanislav, et al. *Lékařská fyziologie.* 4., přeprac. a uprav edition. Grada Publishing, a.s, 2003. 772 pp. ISBN 80-247-0512-5.

- GANONG, William F.. *Přehled lékařské fysiologie.* 1. vyd. edition. H & H, 1993. 681 pp. ISBN 8085787369.