Effects of electric current

From the point of view of the effect of electric current, three types of effects can be distinguished:

- **Electrolytic effects** are related to electrochemical processes during the passage of electric current through tissues.
- **Irritant effects** are related to affecting the activity of excitable tissues, i.e. nerves and muscles.
- **Thermal effects** are related to the release of Joule heat when a current passes through a conductive medium.

Direct current

Irritant effects

The irritating effects are manifested when the current changes, so they are particularly pronounced when the current is switched on and off. Spasmodic contraction of the muscles when the current is connected can lead to unusual movements and thus be one of the causes of secondary injuries.

Thermal effects

The thermal effects of electric current depend on the intensity of the current flowing. Since the skin is a relatively poor conductor, high currents do not flow through the body at low voltages and the thermal effects are only small. As voltage increases and skin resistance decreases (e.g. wetting, electrode puncture, or skin damage), thermal effects may become more important.

Alternating low-frequency current (up to 500 Hz)

Electrolytic effects

Electrolytic effects are usually negligible because the rapid change in electrode polarity prevents the accumulation of electrochemical reaction products below the electrode. They come into consideration as an accompanying damage mechanism at very low frequencies and relatively high current intensities.

Irritant effects

Irritating effects dominate at low frequencies, the highest sensitivity is at a frequency of around 100 Hz. The passage of such a current through the heart is especially critical (e.g. hand-to-hand connection), when fatal fibrillation can be relatively easily induced. The reason for the higher risk is, among other things, that the heart is not equally sensitive during the entire cardiac revolution, thus persistent irritation increases the probability of intervention in the sensitive period.

The irritating effects of low-frequency currents are used therapeutically in a number of areas of medicine, e.g. when stimulating the activity of the heart (pacemaker) or when stimulating certain areas of the brain in the therapy of Parkinson's disease.

Thermal effects

The thermal effects depend on the intensity. Because of their persistent irritant effects, they are not usually used directly in medicine.

Alternating high-frequency current

Electrolytic effects

They do not apply at high frequencies.

Irritant effects

They recede with increasing frequency and practically disappear at frequencies in the tens of kHz.

Thermal effects

They dominate at lower frequencies. They are used therapeutically to warm up tissues.

At high frequencies, the so-called skin effect is manifested, when the electric current flows practically only on the surface of the conductor, with increasing distance from the surface of the conductor, the current density decreases very quickly.

Rheobase, chronaxy

The irritability of tissues can be expressed using two quantities - rheobase and chronaxy. These quantities belong to the important characteristics of excitable tissues and make it possible to determine the relationship between the intensity and duration of the stimulus that causes a response (action potential, irritation). In a typical experimental setup, excitable tissue is stimulated with a right-angle current pulse of selectable amplitude and duration.

Rheobase

Rheobase is the smallest stimulus intensity capable of evoking a response (action potential). When stimulated by, for example, a current with an intensity lower than the rheobase, the response will not be elicited. The physical dimension of the rheobase corresponds to the physical dimension of the stimulus, i.e. usually an electric current.

Chronaxy

Chronaxia is the smallest pulse duration required to elicit a response at a pulse amplitude equal to twice the rheobase. The physical dimension of chronaxia is time.

Links

Related articles

- Electrical current
- Effects of electric current on the organism

Literature

- BENEŠ, Jiří. *Základy lékařské biofyziky.* 3. edition. Karolinum, 2011. ISBN 9788024620343.
- NAVRÁTIL, Leoš – ROSINA, Jozef, et al. *Medicínská biofyzika.* 1. edition. Grada, 2005. ISBN 80-247-1152-4.