Cryosurgery

Cryosurgery is a method of treatment that uses the freezing of tissue at an extremely low temperature (cryodestruction) with a device called a ``cryokautery. In order to achieve the maximum effect, some basic prerequisites must be met during the intervention, such as a high freezing rate (the object must be frozen to a temperature below −20 °C at a rate greater than 200 K/min) and a subsequent slow thawing with a rate lower than 10 ;Caraway seeds.

Principle

The principle is that by rapidly cooling the tissue to a temperature lower than -25 °C with its subsequent slow thawing, we can reliably achieve its necrotization. In the process of necrotization, several biophysical factors acting synergistically on the cell are applied.

Cryocautery (cryopistol)

- Intracellular crystals formed by severe freezing cause irreversible lesions and changes in electrolyte concentration. These then cause denaturation of the phospholipids of the cell membrane.
- Large, previously formed water crystals grow (at the expense of small ones) in such a way that they exceed the size of the cell and tear it apart → a reliable - mechanical 100% destruction of the pathological tissue occurs, while the surrounding healthy tissue remains almost undamaged.
- Thermal shock.
- The formation of extracellular crystals leads to cellular dehydration by osmosis through the cell membrane, which causes an increase in the concentration of intracellular electrolytes to toxic levels.
- Mechanical damage cell membranes.
- Changes in the vascular system that lead to the so-called cryothrombosis of capillaries:
  - Low temperatures cause vasomotor alteration.
  - Interstitial edema promotes a slowing of circulation and an increase in vascular permeability.
  - Changes in the endothelium of blood vessels cause the destruction of blood elements and enable the fixation of a thrombus on the vessel wall.

Course of treatment

After self-freezing and subsequent thawing, the formation and separation of necrosis occurs. Necrotization of cryalized tissue usually takes 48 hours. After this time, the necrotic masses begin to separate and are eliminated from the body. The necrosis separation stage usually lasts about one week and is then replaced by the granulation stage, when the lesion created by cryalization is filled with granulation tissue. The granulation stage can last up to three weeks, or even longer depending on the size of the defect. The entire process concludes with the epithelization stage, which seamlessly follows on from the previous stage. It is possible to speed up the treatment, especially in the stage of separation of necrosis by means of enzyme therapy. Granulation can be supported by massaging the healing tissue, e.g. with a stream of flowing lukewarm water.

Signs of cell cryodestruction

1. Analgesic effect;
2. partial preservation cartilage;
3. preservation of antigenic material for possible immune reaction;
4. reliable necrotization of soft tissues;
5. thrombolysis capillary;
6. reversible anesthesia of peripheral nerves;
7. larger vessels remain undamaged - after thawing, blood circulation in them is fully restored without negative consequences;
8. the mineral base of the bones remains unchanged.

Usage

Cryosurgery is used in such cases, the treatment of which is very complicated and the use of classical surgery very difficult. Nevertheless, it brings with it many limitations, both biological and technical, which is why today it is used in a relatively limited way, only in a few *oncological indications*. Currently, cryosurgery is used especially in the case of **skin tumors**, the removal of which seems to be simpler and more acceptable in this way. Cryosurgery can also be applied to tumors that generally grow through the skin, which can either be largely reduced or, in some

cases, even completely removed. Furthermore, these procedures are used to ""open hollow organs"" to which there is relatively good access, such as, for example, trachea, bronchi, urinary tract (here in currently they use rather other methods) or the rectal part of the large intestine (treatment of hemorrhoids etc.).

Operation progress

Criteria

Freezing at the highest possible speed, realistically preferably around 200 K/min, reaching a critical temperature of at least −25 °C in the entire volume of destroyed tissue, slow thawing at a speed of around 10 K/min. If the tissue were frozen too slowly, the cells would dehydrate and they might survive the process. This would then be followed by recurrence and, in the case of malignant tumors, metastasis. On the other hand, the subsequent heating back to body temperature must be as slow as possible, so that the method of recrystallization of the frozen cells can (mechanically) destroy the pathological tissue, cell by cell. Large, previously formed water crystals grow (at the expense of small ones) in such a way that they exceed the size of the cell and tear it apart - thus reliable mechanical 100% destruction of the pathological tissue occurs, while the surrounding healthy tissue remains almost undamaged.

Custom Operations

1. Applying the surgical tip of the cryocautery to the surface of the pathological tissue.
2. Starting the freezing system – this is followed by rapid subcooling of the surgical tip and thus gradual freezing of the contacted tissue area. The depth of cryodestruction depends on the exposure time.
3. Switching the system to heating. Defrosting can take 1 to 4 minutes depending on the situation.
4. This completes the actual operation. It is advisable to leave the treated area free.

Postoperative course

Significant edema develops within 48 hours. Over the course of a few days, the necrosis is demarcated and subsequently separated, followed by gradual granulation and epithelization of the emerging defect, and within 2–6 weeks, depending on the extent of the lesion, complete healing usually occurs with a fine scar.

Benefits

Cryosurgery has many advantages, including relatively little pain, which makes it possible to operate with local anesthesia, or even completely without anesthesia, then limited or zero bleeding, easy procedure, favorable reaction of the immune system, if necessary, the possibility of repeating the procedure, the possibility of combination with other treatment methods, after scarring a very good cosmetic effect is achieved, without unwanted side effects.

Disadvantages

The main disadvantages are the longer time required and the high cost of the equipment. All contraindications are considered rather relative. Melanomas are considered unsuitable for cryalization, but recently there are more authors who say the opposite. Special caution is required when freezing the end parts of the limbs, where freezing can cause circular edema and severe circulatory failure with subsequent necrosis of the entire distal part of the limb.

Working materials

Among the cooling media, liquid nitrogen is currently used mainly, which has the most suitable properties for cryotherapy and with which the lowest temperatures can be achieved. Nitrogen must be transported and stored in a Dewar vessel where it will last for several days.

Devices that work with liquid nitrogen, so-called cryokauters, are commonly available on our market. Czech-made cryocauters in particular occupy one of the leading places in the world. The devices of the new generation are controlled by microprocessors, they are autonomous - they are not connected to a nitrogen bomb and it is possible to actively control the heating speed. Their cryoprobes, which are used for self-freezing, have replaceable tips that can be chosen according to the shape and nature of the crystallized lesion. For surface lesions and smaller tumors, the so-called "passive ends" are suitable, which are only applied to the frozen surface. They are usually made of aluminumu. To ensure a more perfect contact with the tissue, we coat them with an intact gel before cryalization. For tumors of larger dimensions, it is advisable to use "active ends", which are equipped with small channels, leading the nitrogen to the freezing surface. The freezing surface of these ends can be equipped with spikes, which are used to penetrate directly into the interior of the tumor, thereby achieving significantly lower temperatures not only on the surface, but also inside the tumor. The active terminals are made of copper and their surface is gold-plated.

Links

Related Articles

- Cryotherapy
- Effects of extreme temperatures on living organisms

External links

- Cryosurgery (Czech Wikipedia)
- Cryosurgery (English Wikipedia)
- Cryosurgical removal of penile warts - video (https://www.youtube.com/watch?v=zi0Oo5Bd_8c)

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