Low-intensity electromagnetic fields in cardiac surgery

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SUMMARY

This article is devoted to a review of the literature on the study of the effect of low-intensity electromagnetic fields on biological objects. The effects obtained with the use of low-intensity electromagnetic fields will make it possible to correct the biochemical parameters of blood and biological media, accelerate the processes of regeneration of the myocardium and blood vessels, and reduce the pharmacological load on the patient's body. Possible mechanisms of action are considered, as well as ways of using bioresonance technologies in cardiac surgery.

Key words: low-intensity electromagnetic fields, regeneration,myocardial ischemia, bioresonance.

RESUME

In this article we review the influence of low level electromagnetic fields to biological objects. The received effects give us the opportunity to correct biochemical indexes of blood and biological fluids, to make the regeneration of myocardium and vessels faster, to make the pharmacological strain less. We reviewed such aspects as mechanisms of action and the way of administration bioresinance technology in cardio surgery practice.

Keywords: low level electromagnetic fields, regeneration, myocardial ischemia, bioresonance.

During the treatment of patients with cardiovascular diseases, the clinician is faced with the problems of postoperative recovery, which include both wound healing processes and the normalization of endothelial function and autoregulation of the body.

With the development of technologies, methods of treating patients with diseases of the cardiovascular system are being improved. Achieving good results is based on an understanding of the fundamental processes occurring in the human body. In the study of these processes, researchers have long since moved from studying the interaction of organs and systems to studying the processes occurring at the cellular and sometimes molecular level. In living tissues, we find alternating fields, as well as combinations of electric and electromagnetic fields, which are most often in the range of low-frequency electromagnetic fields [1–4]. These fields are formed as due to the movement of ions through the cellular

membrane, and in the course of biochemical processes occurring in the cell itself and in its structural units. When studying the frequency characteristics of endogenous electromagnetic fields using an oscilloscope, it seems that electromagnetic noise is being recorded, but a more detailed study of the frequency characteristics reveals that these oscillations are different from electromagnetic noise interference and are the sum of different waves, each of which has a unique frequency [5] ...

Thus, ionic currents are not just physiological signals of standard metabolism or the classical membrane potential, but a specific and useful signal of key processes starting with the development of the embryo and ending with wound healing in adults [1, 2].

The study of the energy processes taking place in cells has created the prerequisites for the creation of a large number of methods for influencing the energy potential of the cell in order to achieve a therapeutic effect.

Possible principles of therapeutic actionConsiderable attention is paid to the study of the interaction of low-intensity electromagnetic fields (EMF) and biological objects. Describing low-intensity electromagnetic fields, we can say that they do not have enough energy to break molecular bonds: for example, they do not directly destroy DNA. In addition, they are non-invasive, not ionizing radiation and do not even have a warming effect on tissues and cells [6]. Thus, the effect of low-intensity electromagnetic fields is not associated with the transfer of field energy, but with the transfer of information.

The mechanism of action of low-intensity electromagnetic fields is not yet fully understood. At the moment, it is believed that the effect of electromagnetic fields on the cell is their effect on ion dynamics (Ca^{2+} and H^{+} and associated ion pumps, as well as voltage sensors) and their effect on small signaling molecules [7, 8]. It is important to understand that low-intensity EMFs induce physiological effects in specific parametric windows, for example, 8-60 Hz and low amplitudes [9]. If we consider the size of the cell, then the thickness of the cell membrane (10 nm) with a difference of 0.1 V correlates with the field strength of 106-107 V / m. The cell membrane, therefore, is a natural filter of external electromagnetic fields, EMFs outside the biological window must have a high intensity in order to have a direct effect on the internal components of the cell, however, the tension sufficient for cell penetration will cause its destruction [1].

Resonance and coherence are the factors that induce strong effects at low thresholds. Conservative calculations indicate that 1 mV induced membrane potential can be detected in 10 ms with fewer than 108 ion channels matched. Thus, a high intensity electromagnetic field is not required. According to Persinger, even a weak electromagnetic field is effective for targeted resonance [10, 11].

However, the effect of low-intensity fields does not end with the effect only on ion dynamics, these fields, having a high penetrating

ability, they also interact with genetic material. The effect of low-intensity electromagnetic fields on gene expression and, consequently, on the stimulation of the synthesis of various biological compounds and cell proliferation has been noted [12, 13]. If necessary, you can get the opposite effect - inhibition of the synthesis of certain substances, a decrease in proliferation [14, 15]. According to some authors, DNA synthesis is stimulated by the interaction of low-intensity, low-frequency electromagnetic fields and electrons in the DNA structure, which leads to the separation of base pairs, thereby initiating the synthesis of new double helices [12]. The combination of cell technologies and therapy with low-intensity, low-frequency electromagnetic fields made it possible to achieve controlled differentiation of stem cells [7].

Prerequisites for the introduction of low-intensity EMF in cardiac surgery

The effects caused by low-intensity electromagnetic fields, in particular, bioresonance therapy (BRT), have found application in various fields of medicine. By acting on biological objects, it was possible to accelerate the processes of wound healing [1, 7, 16–23]. This is especially important in patients with cardiovascular pathology who have undergone surgical treatment. In this group of patients, while taking medications, such as diuretics and Ca-channel inhibitors, there may be a slowdown in the regeneration processes [1].

The impact of low-intensity electromagnetic fields (BRT) on the myocardium subjected to ischemia contributed to the preservation of the viability of the tissues of the heart muscle [22-24].

According to the results of our experimental studies, it was revealed that the effect of a low-intensity, low-frequency electromagnetic field with specified characteristics (BRT) is able to stimulate the regeneration of myocardial areas damaged due to acute ischemia. At the same time, the dynamics of the level of cardiomarkers in the blood is different from the control group. The dynamics of these markers was not the same in different experimental groups, however, there was mainly a decrease in the level of the studied enzymes in comparison with the control group [22-24].

Our experimental studies give the right to believe that using BRT, we can not only reduce the infarction zone, but also shorten the recovery period of the damaged area of the myocardium [22].

The combination of low-intensity electromagnetic fields and stem cell therapy can also improve long-term results of treatment in patients with coronary heart disease [7].

Experiments have shown that exposure to low-intensity EMFs of certain characteristics can increase the threshold of permissible load in patients with coronary artery disease during the thread-mil test [25].

The effect produced by BRT on microhemodynamics makes it possible to use this instrument for the correction of various hemodynamic disorders [26]. Moreover, active NO synthesis in response to EMF therapy with specified characteristics can be widely used in diseases

cardiovascular system [26, 27].

EMF also has a positive effect on the processes of tissue revascularization. Thus, in the experiment, it was noted that EMTs cause the formation of tubular structures and proliferation of endothelial cells in vivo, while biochemical analysis revealed an increase in the content of fibroblast growth factor B-2 (FGF-2), as well as an increase in other growth factors (angiopoietin-2 , thrombopoietin and epidermal growth factor) [28].

Strengthening of angiogenesis at the site of injury, accelerated healing of fractures with the use of low-intensity, low-frequency EMF was also noted in works on osteogenesis [29].

Selecting the desired frequency allows you to control the level of metabolism in the body, changing such indicators as body weight, blood glucose levels, and the level of fatty acids [30]. The choice of the optimal amplitude-frequency parameters made it possible to use low-frequency electromagnetic fields for antibacterial therapy and stimulation of the immune response [31, 32].

The accumulated experience and the conducted studies of low-intensity electromagnetic fields allow us to talk about the possibility of introducing such a technique into cardiac surgery practice. Surgical treatment using a heart-lung machine, an abundance of medications taken by patients with diseases of the cardiovascular system has both positive and negative sides. However, this approach is a necessary measure. With the use of low-intensity electromagnetic fields, it will be possible to correct the pharmacological load, start the processes of regeneration and restoration of the body.

Conclusion

Analysis literature data and results, carried out us experimental research, gives the right to assert that low-intensity electromagnetic fields will find a worthy place in a cardiac surgery clinic.

The effects obtained with this type of therapy will help to correct the biochemical parameters of blood and biological media, accelerate the processes of regeneration of the myocardium and blood vessels, and reduce the pharmacological load on the patient's body. The use of therapy with low-intensity electromagnetic fields in combination with other technologies, such as cell engineering, will make it possible to obtain a more pronounced result in stem cell therapy and myocardial revascularization processes. The effects of low-intensity EMF on osteogenesis will make it possible to more effectively combat such complications as sternal instability in patients after sternotomy.

Further research in this direction will allow a more complete study of the mechanism of action of EmFs on the human body in various pathological conditions and will enable a wider introduction of the use of EmFs in cardiac surgery practice.

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