REPORT

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Use of physical factors of electromagnetic nature for decreasing complications in respiratory and cardiovascular systems in patients after surgical treatment of lung cancer

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Abstract

Surgical treatment of lung cancer is associated with a high risk of postoperative complications in cardiovascular and respiratory systems. Studied is the ability to prevent the postoperative complications in respiratory and cardiovascular system when exposed to ultra low frequency magnetic field in the given category of patients. To achieve this aim 126 patients, operated for lung cancer, have been exposed to ultra low frequency magnetotherapy on the brain occipital area during the early postoperative period. The Spectr-2 device for broad range magnetotherapy has served as an electromagnetic field source. Demonstrated is almost a two times decrease in a total number of postoperative complications as compared with the patients not subjected to the treatment. It has been established that using the electromagnetic nature factors leads to normalization in respiratory and cardiovascular activity and prevents development of many severe complications such as pulmonary embolism, acute myocardial infarction, disturbed cerebral circulation.

Keywords

Lung cancer, Magnetotherapy, Postoperative complications

Imprint

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Introduction

Lung cancer remains one of the most important medical and socio-economic problems in Russia and major developed countries. Nowadays surgical treatment is the main method giving hope for prolongation and improvement of life quality for lung cancer patients. Total number of complications and postoperative lethality in surgical treatment of lung cancer has always been considered high, and nowadays the frequency and probability of their development remain quite variable and depend on many factors. It is stated that in some cases an operative ablation of malignant tumor may cause acute stimulation of metastatic process due to traumatism of such operations [1–2]. This phenomenon is based on a number of mechanisms. The most important of them are stressor reactions which determine the nonspecific basis of pathology and aggressive treatment methods [2–3]. The correction of the mechanisms underlying pathological stress reaction may prevent the stimulation of metastasis, as well as reduce the probability of complications development in cardiovascular and respiratory systems and improve the results of tumor patients surgical treatment.

The phenomenon of anti-stressor effect of a weak ultra low frequency magnetic field (ULF MF) is established and becomes more and more applied in experimental oncology clinical practice. [4, 5, 11, 12]. When the specially developed ULF MF modes influence the brain hypothalamic area (CNS), the anti-stressor reactions are formed. These reactions elevate the general resistance of the organism including antitumor resistance [6–10].

The aim of the present paper is to study the ability to prevent the postoperative complications in respiratory and cardiovascular system when exposed to ULF MF during early postoperative period in lung cancer patients.

Materials and methods

At the RRIO thoracic surgery department analyzed are the data on 702 lung cancer patients after surgical treatment over a period of 7 years (1996–2003). 126 patients have been exposed to the ULF MF mag-

Table 1 Volume and frequency of operations, performed in the surgical treatment group and at postoperative MT

Operation volume	Operation (n=574)		Operation + MT (n=126)	
	absolute unit	%	absolute unit	%
Pneumonectomies	293	51,04±2,9	62	49,2±4,5
extended	188	64,2±2,0	42	67,7±5,9
combined	73	24,7±2,5	16	25,8±5,6
Lobectomy and bilobectomy	185	32,1±1,8	38	30,2±4,1
Economic resections	41	7,1±1,1	9	8,6±2,7
Trial thoracotomy	55	9,5±1,2	17	13,4±3,0

Table 2. Distribution of patients depending on the concomitant diseases in the surgical treatment group and at postoperative MT

Pathology	Operation (n=574)		Operation + MT (n=126)	
	absolute unit	%	absolute unit	%
Cardiac ishemic disease	174	30,3±1,9	47	37,3±4,3
Hypertensive disease	129	22,5±1,7	29	23,0±3,7
Chronic bronchitis	396	69,0±1,9	94	74,6±3,9
Pneumosclerosis	137	23,9±1,8	28	22,2±3,7
Silicosis	29	5,1±0,9	9	7,1±2,3
Gastritis, peptic ulcer disease	74	12,9±1,4	23	18,3±3,4
Diabetes	56	9,8±1,5	11	8,7±2,5
Obliterative disease vessels	42	7,3±1,1	9	7,1±2,3
Varicose vein disease	29	5,1±0,9	7	5,6±2,0
Other	149	25,9±1,8	35	27,8±4,0
Total	1215	211,8	292	231,7

netotherapy on the brain occipital area during the postoperative period. The Spectr-2 device with microprocessor control of induction, frequency and exposure for broad range magnetotherapy has served as a source for electromagnetic fields in order to protect the organism from the operational stress action. The central ULF MF exposure (on a head) in accordance with the presence of locus of a high magneto receptivity of the signal in occipital area [6] has been carried out. ULF MF has been applied every day starting from the second day after surgery according to the developed program of a sequential one session long increase in frequency of magnetic field in the range of endogenous brain frequency rhythms within the framework of the following mode: 0.03 Hz – 5 min; 0,3 Hz – 3 min; 9 Hz – 1 min, with a fixed magnetic field (MF) intensity. The initial MF intensity has been 5 mT, and then it has been gradually reduced with intervals of 2–3 days to 0.8 mT taking into account the exponential law with transition coefficient equal to 0.7 for maintaining the stable adaptation anti-stressor reactions. Patients not exposed to the magnetic field (574 individuals) have been a reference group. Comparing these groups of patients we have studied the immediate results (complications, postoperative lethality) of the surgical treatment. In both groups male subjects prevail, the mean age is practically the same: 54.8 and 56.5 years. The patients have been distributed similarly according to the tumor process stage in both the 1st and the reference group. The volume of surgical interventions, including extended, combined, economic and test operations, has been the same in these groups. The quantity of performed pneumonectomies has prevailed (Table 1).

In the compared groups the patients with an evident concomitant pathology, mostly chronic lung and car-

Table 3. Complications and lethality in lung cancer patients under the ULF MF postoperative exposure as compared to the surgical treatment

Complications	Form of treatment			
	Surgical treatment (n=574)		Surgical treatment + MT (n=126)	
	осложнения	умерли	осложнения	умерли
Wound abscess	33 (5,7)	–	6 (4,7)	–
Bronhus suture failure	23 (4,0)	5 (0,9)	4 (3,2)	1 (0,8)
Emphysema	19 (3,3)	2 (0,3)	4 (3,2)	1 (0,8)
after pneumonectomy	15 (2,6)	2 (0,3)	3 (2,4)	1 (0,8)
after lobectomy	4 (0,7)	–	1 (0,8)	–
Residual cavity after	13 (2,3)	–	3 (2,4)	–
Pericarditis	3 (0,5)	–	–	–
Mediastinitis	3 (0,5)	–	–	–
Pneumonia	15 (2,6)	3 (0,5)	2 (1,6)	1 (0,8)
Cardiovascular insufficiency	31 (5,4%)	11 (1,9)	2 (1,6)	1 (0,8)
PATE	12 (2,1)	12 (2,1)	–	–
Myocardial infarction	5 (0,9)	2 (0,3)	–	–
Disorder of cerebral circulation	3 (0,5)	2 (0,3)	–	–
Other thrombogenic complications	7 (1,2)	3 (0,5)	–	–
Postoperative hemorrhage	5 (0,9)	1 (0,2)	1 (0,8)	–
Stress surgical complications	7 (1,2)	1 (0,2)	–	–
ulcerative hemorrhage	5 (0,9)	1 (0,2)	–	–
perforated ulcer	2 (0,35)	–	–	–
Acute retention of urine	1 (0,2)	–	1 (0,8)	–
Intenstinal distention	17 (3,0)	–	2 (1,6)	–
Total	197 (34,3±2,0)	42 (7,3)	25 (19,9±3,5)	4 (3,2)

diac ischemic disease have been observed with the same frequency (Table 2).

The adaptation reactions have been identified according to the blood formula signal indices. The leucocytes cell composition has been defined by calculating 200 cells in Romanovsky-Giemsa-stained blood smears. The level of lymphocytes taking into account the content of eosinophils, monocytes and a total number of leucocytes as a reaction tension criterion has served as a signal criterion for the adaptation reaction.

Results and discussions

The analysis has demonstrated that in the group of postoperative exposure to alternating magnetic field observed is almost a two times decrease in a total number of postoperative complications as compared with the patients not subjected to such a treatment after operation (19,9 ± 3,5 % and 34,3 ± 2,0 %, respectively). Differences in the structure of complications in these compared groups have also been observed (Table 3). Noted has been the absence of complications related to the coagulability increase in the ULF MF postoperative exposure patients, i.e. no cases of pulmonary embolism (PE), myocardial infarction, cerebral circulation violation have been observed, whereas in the reference group after surgical treatment the total number of these complications has been 3.5 % (20 patients). Besides, in 7 patients (1.2 %) other thrombogenic complications such as superior vena cava and aortic abdominal thrombosis have been observed.

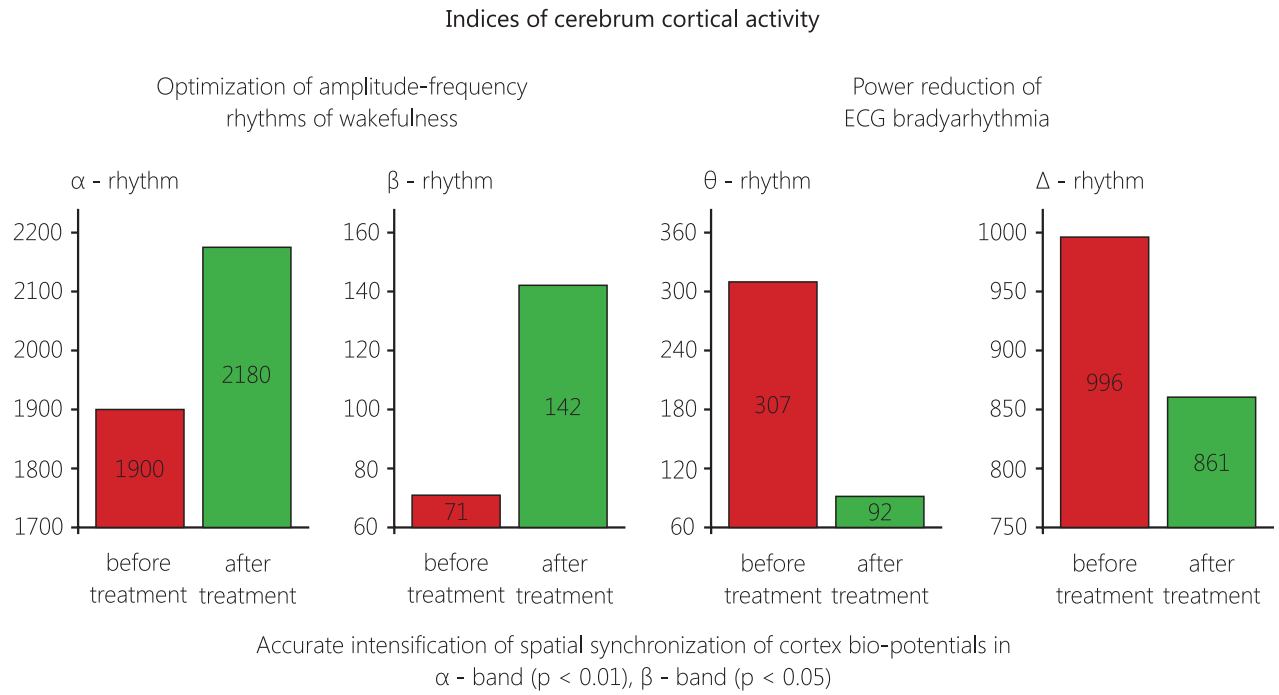

Fig. 1. Some poly-system factors identifying possibility for increasing the non-specific and anti-tumor resistance

In lung cancer patients after surgical interventions quite often observed are the complications immediately related to the stressor action of the surgical operation itself. These are gastric and intestinal bleeding, perforated stomach and duodenal ulcers. The accompanying ULF MF-therapy preventive effect has been manifested in the following form. Firstly, in the group of postoperative ULF MF exposure patients such complications have not appeared, though 23 patients in anamnesis had stomach and intestinal diseases, namely gastritis, stomach and duodenal ulcer.

Secondly, in the group of postoperative magnetotherapy observed has been a decrease in the number of postoperative pneumonia and cardiovascular complications from 2.6 % to 1.6 % and 5.4 % to 1.6 %, respectively.

Thirdly, the most significant result has been a more than 2 times decrease in the postoperative lethality in patients exposed to magnetotherapy as compared to the patients not exposed to it (3.2 and 7.3 %). It is logical to assume that decrease in lethality has been caused by the absence or reduction of a number of many above mentioned complications as well as improvement in their treatment results.

To control the mechanisms of lung cancer accompanying therapy the functional activity indicators of central nervous system (CNS), endocrine and immune systems has been studied. These indicators serve as physiological correlates for the ULF MF therapeutic action. In brain cortex stabilization of indicators of biopotentials spatial synchronization for alpha-and beta-rhythm ranges has been noted. Typical for oncology patients negative dynamics of slow-wave processes capacity has been 3.6 times reduced after conducting the poly-frequency therapy, that denotes direct correlation with a decrease in the oncology patients vegetative lability (Fig. 1).

Actually, according to the hormonal indicators, as opposed to the reference, the increased level of cortisol and adrenalin has normalized. The reduced melatonin-forming function of epiphysis and activity of thyroid glands and gonads have been restored (Fig. 2).

The cellular immunity indicators have normalized at the same time. The T-lymphocytes percentage has grown due to the helper-inductor cells which express marker CD4+ and the mitogen response of T- and B-cells to phytohemagglutinin (PHA) and lipopolysaccharide (LPS).

The adaptation reaction structure has been studied in lung cancer patients before the operation, as well as on day 1, 7 and 14 after the operation in the group of patients subjected to surgical treatment only (26 individuals) and exposed to the ULF MF after the operation (25 individuals) (Fig. 3).

Comparison of the initial adaptation reaction structure in the reference group patients has demonstrated that on day 1 after the operation the frequency of the acute stress development has 10 times increased, and the chronic stress has 6.5 times increased. The stressor reaction part has been 88.5 %, that is adequate to high traumatism of surgical intervention inducing the stressor effect. Despite the increased term of post-

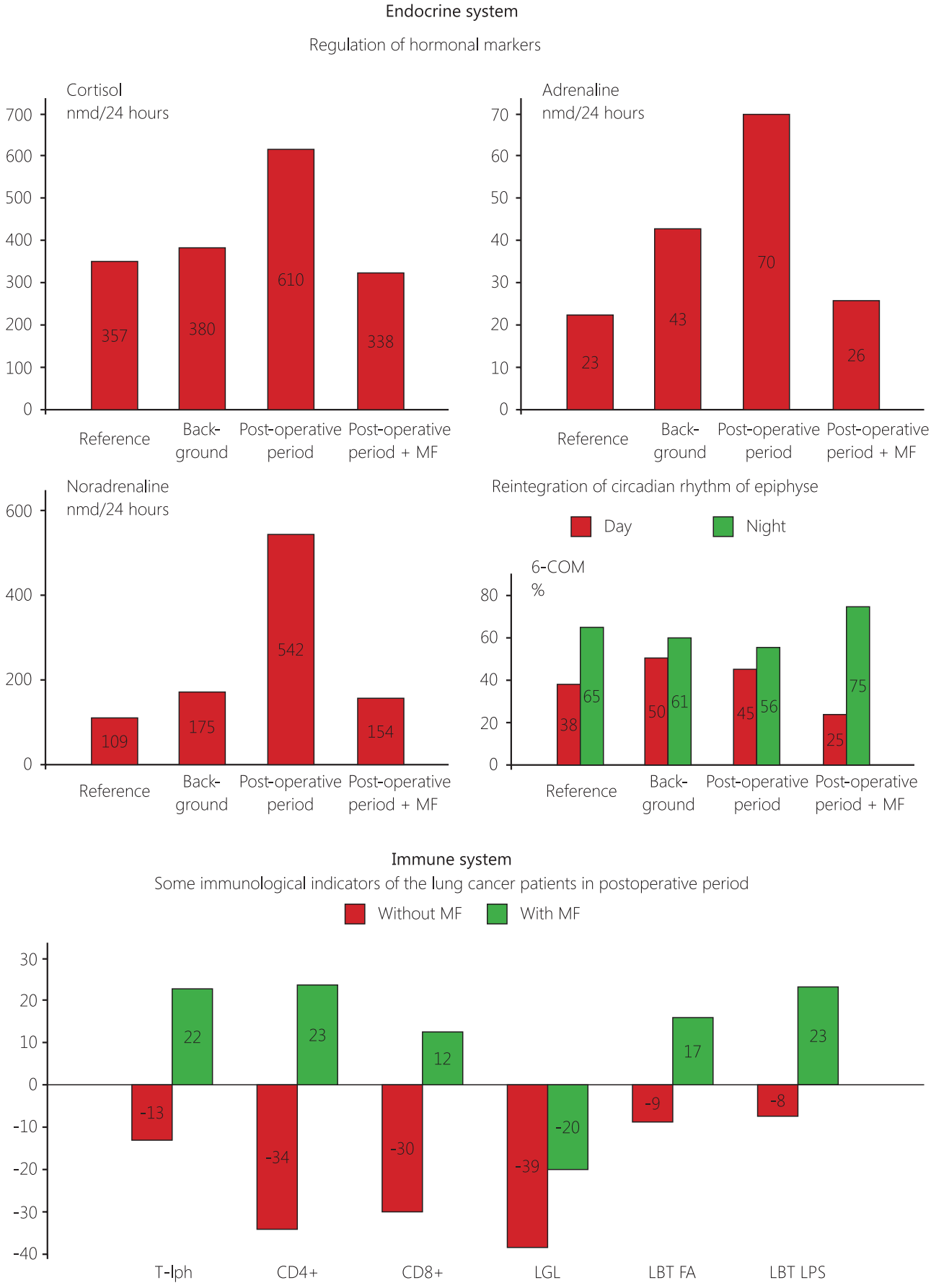

Fig. 2. Some indicators of the neuroendocrine and immune systems activity in the compared groups of lung cancer patients (reference, initial state, treatment with and without the ULF MF)

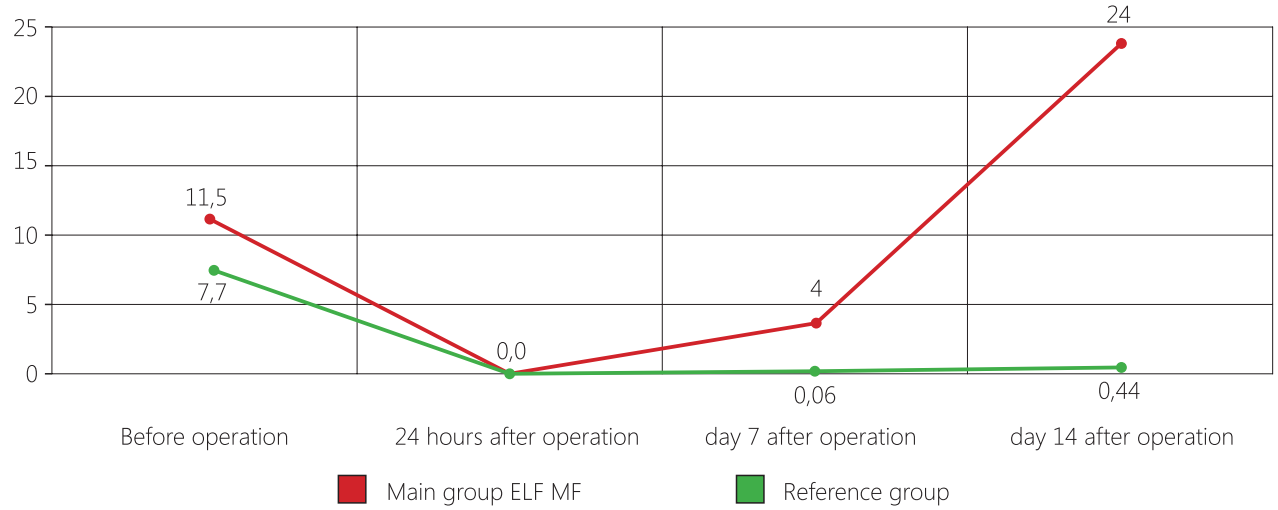

Fig. 3. Change in correlation of adaptation reactions in lung cancer patients at different stages of treatment

operative period, on day 7 after the operation in this group of patients the state of protective-compensatory mechanisms has not altered, they have remained suppressed due to dominance of chronic stress. Two weeks after the operation the frequency of the chronic stress occurrence has reduced by 19.3 % but still remained quite high (69.2 %). It can be explained by a prolonged transition from the acute form of this reaction into the chronic dominant one, as well as a rather low level of anti-stressor reactions.

The identification of the adaptation reactions by leukogram in the main group of the lung cancer patients has detected that a day after the surgical intervention the adaptive transition dynamics has been similar to the reference. This similarity consisted in total development of stress, which occupied 96 % of all the reaction structure. However, on day 7 after the operation, as opposed to the reference group where the above stressor dynamics of adaptive rearrangements remained, in the main group the acute stress development frequency reduced by 9 times, and the chronic stress development frequency reduced by 3.8 times as a result of the stressor reactions transition to the anti-stressor. On day 14 of the postoperative period in the group of patients exposed to the ULF MF formation of stable anti-stressor reactions has already been observed. The frequency of stress identification in the general structure of adaptive response has reduced by 17.3 times. The coefficient of correlation between the anti-stressor reaction and stress, as a reflection of the integral bioadaptive potential of the organism as a whole, has increased. Thus, the reliable intergroup differences in the frequency of the anti-stressor reaction development and the coefficient of correlation between the anti-stressor reactions and stress in identical terms of investigation indicate the evident regulatory type of the ULF MF exposures on the organism integral systems. These systems form the physiological archetype of the adaptive response aimed at increasing the active resistance, thus contributing to functional rehabilitation of lung cancer patients subjected to a traumatic surgical intervention.

Conclusions

The analysis of immediate surgical treatment results has demonstrated that the ULF MF application during the postoperative period allows reducing the total number of postoperative complications and lethality, eliminating the development of various severe postoperative complications in respiratory and cardiovascular system such as pulmonary embolism, acute myocardial infarction, cerebral circulation violation. The ULF MF application enables improving the course of postoperative period accelerating the process of patients' rehabilitation due to correction of the adaptive reaction mechanisms and nonspecific resistance increase.

Statement on ethical issues

Research involving people and/or animals is in full compliance with current national and international ethical standards.

Conflict of interest

None declared.

Author contributions

The authors read the ICMJE criteria for authorship and approved the final manuscript.

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