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No. 11

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MORPHOLOGICAL FEATURES AND SOME CONCEPTS OF MECHANISM OF BIOLOGICAL ACTION OF MAGNETIC FIELDS

Moscow ARKHIV PATOLOGII in Russian Vol 44, No 12, Dec 82 (manuscript received 13 Apr 82) pp 3-11

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/Text/ Scientific and technical progress has raised a number of urgent general biological problems to a new level. The problem of biological activity of magnetic fields is one of them. The effect of magnetic fields on living systems at present does not evoke any doubts and the ever more intensive utilization of electromagnetic energy in the national economy and in daily life evokes great interest on the part of researchers in various aspects of magnetobiology.

A high sensitivity of various biological objects to magnetic fields has been established. Their evolution took place under conditions of the geomagnetic field, which brought about a certain dependence of living processes on this environmental factor. A higher biological activity of alternating and, especially, pulsed magnetic fields as compared with constant magnetic fields has been shown /62, 64, 65, 68, 70 and 72/. Numerous biotropic parameters of magnetic fields have been clarified. Such are the field's intensity, its gradient, sense of the vector and exposition; for alternating magnetic fields, in addition to this, frequency; for pulsed magnetic fields, pulse frequency, form and duty ratio. The parametric differences of magnetic fields form the basis for their varying biological activity. In one case the biological effect can be caused primarily by the intensity of the magnetic field and in another, by its space-time characteristic.

The period of confusion brought about by the instability and contradictory nature of results of magnetobiological experiments is now over for magnetobiologists. From the moment when the dependence of the response on the functional state of the biological object, characteristic of the magnetic field and exposition was established, it became clear why under the effect of the same magnetic field it was possible to obtain different results and, on the other hand, the same results with the use of different magnetic fields.

On the whole, modern Soviet and foreign literature on magnetobiology no longer raises the question of the positive or negative effect of magnetic fields on biological objects. It is now well known that under specific conditions the positive effect of the magnetic field (for example, stimulation of a function) can change to a negative effect (inhibition of a function, dystrophy, necrobiosis and necrosis) with an increase in the object's exposition in the magnetic field or the latter's intensity, change in the functional state and reactivity of the biological object in time and so forth /29, 37, 39, 48, 49, 56, 65-68, 76 and 82/. Numerous proofs of the phase nature of the response of biological objects to the effect of magnetic fields have been obtained /60, 66 and 71/. There are also grounds for assuming that the magnetic field is one of many nonspecific factors causing general adaptive reactions of the organism /15, 66 and 67/. Varying the "dose" of the magnetic field (intensity and exposition), it is possible to cause (or maintain) a certain adaptive reaction in the organism /21 and 68/. It has also been established that during small expositions (minutes) magnetic fields of average intensities (tens and hundreds of oersteds) can have a beneficial effect on the organism in a number of pathological states, which at present is ever more widely utilized in magnetotherapy ("Primeneniye Magnitnykh Poley v Klinike" /Application of Magnetic Fields in Clinical Medicine/, Kuybyshev, 1976; "Klinicheskoye Primeneniye Magnitnykh Poley" /Clinical Application of Magnetic Fields/, Izhevsk, 1977; "Primeneniye Magnitnykh Poley v Klinicheskoy Meditsine i Eksperimente" /Application of Magnetic Fields in Clinical Medicine and in Experiments/, Kuybyshev, 1979). At the same time, with a much longer exposition (hours, days and longer), a big intensity (thousands of oersteds) or a complex space-time characteristic (magnetic "storms") magnetic fields are capable of producing significant morphological and even pathological changes in the organism. The disclosure of morphological changes under the effect of magnetic fields is one of the proofs of their distinct effect on biological objects. It should be stressed, however, that the disclosed dose-effect dependence is by no means always linear and often is more complex. In this connection it is appropriate to mention works which discuss the levels of reaction of the organism to magnetic fields and offer coefficients for a change from one level of reaction to another /21/.

The problem of participation of nervous and endocrine systems in the formation of the response of the entire organism to the magnetic effect is solved unequivocally in the fundamental investigations of a number of authors /66, 68 and 70-72/. Even under a short-term effect the magnetic field is capable of producing significant morphological changes in the tissues of the indicated systems. For example, a 3-minute effect of a constant magnetic field of an intensity of 200 to 300 Oe on the head of a rabbit produced an increase in the number of astrocytes and micro- and oligodendroglia of the sensomotor region of the cerebral cortex. These changes intensified with an increase in exposition, being combined with hyperplasia and hypertrophy of bodies and processes of the indicated cells /2 and 72/. The priority and greater manifestation of the reaction of the glia as compared with neurons /2, 51, 70 and 72/, which in the opinion of a number of authors is of protective-adaptive significance /70 and 72/, is the characteristic of the response of the central nervous system to magnetic fields. However, with an increase in exposition (60 to 70 hours) productive-dystrophic changes in the neuroglia in combination with dystrophic disturbances in nerve cells appear /72/. At the same time, a varying sensitivity of neurons of different sections of the central nervous system to the effect of magnetic fields is noted /50 and 51/. The nature of morphological changes in the central nervous system under the effect of magnetic fields does not depend on the field's characteristic, but their manifestation and time of appearance are determined by the intensity, frequency, length of effect and other features of applied magnetic fields /50, 51 and 72/. This feature is also noted at the ultrastructural level. Along with a high sensitivity of the mitochondria, endoplasmic reticulum and other organoids of nerve cells to magnetic fields the dependence of the effect's manifestation on the field's intensity and type (an alternating magnetic field is more active than a constant magnetic field) and on the length of exposition has been shown /27/.

Magnetic fields can produce both reactive and pathological changes in peripheral nerve conductors and endings /4, 25 and 74/. The dissimilar reaction of various structures of the peripheral nervous system to magnetic fields is noteworthy /4 and 74/. This is connected with their dissimilar functional state at the moment of effect /25/. Such a dependence of the magnetobiological effect on the functional state of the biological object is one of the most important general patterns of the biological action of magnetic fields /45, 55 and 56/.

Key importance in the formation of the organism's response to magnetic fields is attached to hypothalamic centers, which are initially activated under the effect of magnetic fields /66 to 68/. This is followed by an intensified output of tropic hormones stimulating the function of adrenal /37/, thyroid /49/ and sexual glands /67/. Biochemical investigations on rats have disclosed the activation of all the links of sympathetic-adrenal and hypophysial-adrenal systems during the early period (8 to 15 minutes) of effect of an alternating magnetic field of a frequency of 50 Hz and an intensity of 200 Oe. An increase in the content of 11-OCS, adrenalin, noradrenalin, testosterone, general and immunoreactive insulin and thyroxin is noted in the blood /38 and 67/. Morphological signs of hyperfunction of the thyroid gland in experimental animals have been detected under the effect of pulsed /29/, alternating /49 and 68/ and constant magnetic fields /83/. Ultrastructural changes in the adenohypophysis of experimental animals under the effect of magnetic fields also point to a change in the functional state of gonado-, thyro- and adrenocorticotropic cells /42/.

All these data make it possible to state that a system reaction of internal secretion glands directed toward an increase in the organism's resistance develops during the first minutes of the field's effect /67/. However, with an increase in exposition the picture changes. The phase of activation of the function of the endocrine system gives way to its inhibition /48, 67 and 76/. Morphological adaptive reconstructions followed by pathological changes appear. For example, the effect of an alternating magnetic field of 50 Hz, 200 Oe, for 7 days produced a dilatation of fascicular and reticular zones and adenomatous proliferations of the adrenal cortex in rats /32/. A prolonged (for more than 20 days) general effect of a constant magnetic field of 7,000 Oe was accompanied by the appearance in the adrenal glands of white mice of atypical figures of mitosis and microsections of necrobiosis of cortical layer cells and of perivascular edema and lysis of individual cells of the cerebral layer. A pulsed magnetic field of 1,200 Oe produced similar and even more pronounced changes during a shorter exposition /65/. Hemodynamic disorders and dystrophic changes in the cells of adrenal glands and the hypophysis have also been noted under the effect of a low-intensity magnetic field, but with a very complex space-time characteristic of the magnetic "storm" type /39/. The data on a change in insular activity /18 and 67/ are confirmed by heretofore few morphological investigations of the pancreas, which have disclosed changes in the quantitative ratio of A- and B-cells, as well as dystrophic and necrobiotic changes in the cells of the parenchyma of the gland /10/.

Ovaries are less sensitive to the effect of magnetic fields than testes /64/, which, apparently, is connected with the characteristics of the structure and function of these organs. Such pronounced changes can appear in testes during prolonged expositions under the effect of magnetic fields that this gave reason to refer to them as "shock" organs /22, 64 and 65/. An exceptionally severe affection of testes ("magnetic sterilization") in white mice under the effect of an alternating magnetic field of 50 Hz, 680 Oe, is described /20/. During the first hours after a 6½-hour stay of white mice in an alternating magnetic field of 50 Hz, 200 Oe, hemodynamic disorders and interstitial edema appear, the cytoarchitectonics of the spermatogenic epithelium is disturbed and dystrophic, necrobiotic and necrotic changes combined with an inhibition of spermatogenesis and with the appearance of binuclear cells occur. After 2 hours the content of RNA is lowered, acid lipids are accumulated, the activity of oxidation-reduction enzymes is inhibited, the content of amino acids decreases and DNA synthesis, especially in spermatogonia, changes /62, 77 and 78/. All this occurs against the background of a pronounced inhibition of the hormonal function of testicles /67/. A gradual normalization of the picture in testes is observed by the 30th day after the effect of an alternating magnetic field. Under the effect of a pulsed magnetic field changes develop even earlier and are more pronounced and longer. A constant magnetic field in contrast to an alternating and a pulsed magnetic field produces mild and less diffuse changes /62, 67, 77 and 78/. However, pronounced morphological and histochemical signs of disturbance in spermatogenesis in rats were observed under a prolonged intermittent (4 months, 4 hours daily) effect of a constant magnetic field of 200 and 400 Oe /28/. Thus, as in other organs, in testes constant, alternating and pulsed magnetic fields produce changes close in nature, but differing in the degree of manifestation /67/. In ovaries even a prolonged effect of a magnetic field does not produce significant disturbances. For example, only a circulatory disturbance and limited dystrophic changes were noted in the ovaries of rats staying in a constant magnetic field of 400 Oe for 1 month /61/. Very limited necrobiotic changes in the follicular epithelium and ova also appeared in guinea pigs under the effect of an alternating magnetic field of 50 Hz, 200 Oe /22, 64 and 65/. An electron microscopic study of the ova of rats subjected to the effect of an alternating magnetic field of 230 Oe under intermittent conditions (10 days, 30 minutes daily) did not disclose any disturbances in the ultrastructure of the granulosa /31/. Apparently, this characteristic of the reaction of ovaries to magnetic fields is due to the absence in them of intensive processes of cell reproduction inherent in testes, as well as to other structural, functional and metabolic characteristics.

The reaction of the cardiovascular system to magnetic fields seems very complex, because, in fact, it is an integrative response both to the direct effect of magnetic fields on the contractile myocardium and on the conducting and vegetative nervous systems of the heart, as well as to the reflex effects of magnetic fields on the heart and vessels.

A high sensitivity of the conducting system of the heart to magnetic fields is shown on an isolated heart of a frog /9 and 36/. A low-frequency pulsed modulated electromagnetic field of a frequency of 2 and 5 Hz with a flux density power of 5 mW/cm^2 causes a complete arrest of the isolated heart after 30 seconds. Sinus action with a resumption of atrioventricular contractions can be restored 5 to 10 minutes after the cardiac arrest by means of a magnetic field of the same frequency, but with a flux density power of 30 mW/cm^2 /9/. A constant magnetic field of an intensity of 2,000 to 2,300 Oe causes an increase and of 6,000 to 9,000 Oe, a decrease in systoles and even a complete cardiac arrest during the first minute of effect /36/. Furthermore, the magnetic field is able to change, on the one hand, the state of the cholinergic structures of the heart and, on the other, the functional readiness of the myocardium with respect to acetylcholine. The results of effect of a constant magnetic field of 1,000 Oe on an isolated heart of a frog for 40 to 50 minutes point to this. In this case an increase in the free fraction of acetylcholine-like substances and a decrease in the activity of cholinesterase, as well as the appearance of steadily alternating periods of asystolia with periods of restoration of contractions of the ventricles of the heart in response to the introduction not only of liminal, but of subliminal, acetylcholine concentrations into the perfusate, were observed /24/. Finally, the effect of the magnetic field on the vegetative nervous system of the heart is clearly detected under a separate effect on the head and chest region. A repeated effect of an alternating magnetic field of 50 Hz, 400 Oe, on the region of a rabbit's head is accompanied by an increase in both direct and reflex parasympathetic effects on the heart, whereas the same effect on the region of the animals' chest is characterized by the weakening of direct and unchangeability of reflex parasympathetic effects /43/.

Pathomorphological changes in the cardiovascular system under the effect of magnetic fields are characterized by the development of a general circulatory disorder with a disturbance in microcirculation /22, 53, 64-66 and 73/, change in the vascular tone /1/, increase in permeability with the development of diapedetic hemorrhages, plasma saturation of vascular walls, perivascular and interstitial edema /50/ and dystrophic and even destructive changes in the elements of vascular walls /51/. Dystrophic changes and even micronecroses, as well as round cell infiltrates in the stroma, appear in the myocardium at different times depending on the type of field, intensity and exposition /41 and 66/. The occurring changes can be subjected to a reverse development during 20 days and longer after the effect is terminated /66/. Data obtained during a study of the hydrational capacity of surviving tissues and showing that the myocardium has a greater sensitivity to magnetic fields than the brain, liver, stomach and skeletal muscle also point to the high sensitivity of the heart to magnetic fields /35/. All the above-mentioned data explain to a significant degree the well known fact that the number of heart failures, including with a fatal outcome, sharply increases during the period of natural magnetic "storms" /11, 23, 40, 76 and 89/.

Initial changes in the liver and gastrointestinal tract occurring under the effect of a brief (1 to 7 hours) effect of magnetic fields of weak and average intensities (from 20 to 7,000 Oe) are considered by a number of authors compensatory and are characterized by the appearance of hepatocytes with two and three nuclei, increase in the number of mitoses and swelling of Kupffer's cells /19, 22, 79 and 80/. An increase in the proliferative pool and in the mitotic activity of enterocytes and an accelerated transposition of the latter from the crypts to the apices of villi are noted in the small intestine /63/. In the liver during an early period an increase in the amount of RNA and a rise in the activity of succinate dehydrogenase and of acid and alkaline phosphatases are determined /18/, the content of glycogen /7 and 80/ and the state of the metabolic stock of amino acids /34/ are changed and DNA synthesis is stimulated /16/. The amount of RNA in the cytoplasm of erythrocytes increases and nucleoli acquire a pronounced pyroninophilia /63/. The dynamics of further changes is characterized by the appearance and progression (with an increase in exposition or in the field's intensity) of hemodynamic disorders and of dystrophic, necrobiotic and necrotic processes in liver /8, 39 and 75/ and intestine /63/ cells. The effect of magnetic fields on the liver is manifested early at the ultrastructural level. A swelling of mitochondria and an increase in their permeability are noted /81/, the dynamics of their "aging" is changed and the intensity of respiration is lowered /30/. With an increase in exposition changes in the granular endoplasmic reticulum of hepatocytes appear. They consist in a dilatation of canals and cisterns, a decrease in the number of ribosomes connected with membranes and an increase in the number of free ribosomes /13/. Depending on the exposition of animals in magnetic fields the chemiluminescence of liver homogenates changes in a phase manner, which points to a change in the processes of peroxide oxidation of lipids and concentration of free radicals /26/.

A disturbance in lympho- and hemodynamics, which occurs during an early period of effect and, subsequently, is accompanied by edema of lungs and of the kidney stroma and numerous hemorrhages, is the common feature of "magnetic" pathological changes in kidneys and lungs /22, 64 and 65/. Furthermore, the effect of an alternating and a pulsed magnetic field is characterized by the appearance of sections of emphysema and dystelectases in lungs /3 and 22/. Dystrophic changes progressing with an increase in exposition up to necrobiosis and necrosis of the most loaded cellular structures also appear /22 and 81/.

A number of investigations performed on cell cultures are devoted to the study of the characteristics of a direct effect of magnetic fields on the cell. There is quite a vast literature on the biological activity of constant and alternating magnetic fields with respect to cells in culture. The stimulating /86, 87, 89, 92, 94 and 96/ and inhibiting /36, 85, 87, 88 and 91/ effect of magnetic fields on cells is discussed. There are data on the effect of magnetic fields on cell respiration /93/ and mitosis /52, 86 and 87/. However, an overall morphofunctional evaluation of the effect of magnetic fields on cell culture has not been given up till now. The problem of the effect of pulsed magnetic fields on cell culture has not been illuminated at all in the literature.

According to our data the nature of the response of culture cells to magnetic fields depends on their functional state /55 and 56/. The effect of a pulsed electromagnetic field on chick embryo fibroblast culture cells at different phases of the chick's development gives different and even opposite results. A statistically significant shortening of the latent growth phase and the culture's earlier transition to the logarithmic phase occur under the effect of a pulsed electromagnetic field. A pronounced effect of a pulsed electromagnetic field stimulating the mitotic activity of cells is observed under the effect on the culture at the logarithmic phase. It is not a question of a passive accumulation of mitoses as a result of their inhibition at a specific phase, but of a true increase in mitotic activity, which is confirmed by the appropriate indicators of correlation of mitosis phases. The mitotic activity of cells under the effect of a pulsed electromagnetic field on the culture at the stationary growth phase hardly differs from control. The result of the effect of a pulsed electromagnetic field on cells at the degenerative phase of development of the chick embryo fibroblast culture is different. In this case a decrease in mitotic activity to zero sharper than in control and a more rapid withering away of the culture are noted /56/. Under the effect of a pulsed electromagnetic field on the culture at the logarithmic growth phase the duration of the mitotic cycle calculated according to the percent of labeled mitoses was 4 hours shorter than in the control culture. Cells undergo the DNA synthesis period (S-period) more rapidly. At the same time, the presynthetic (G-1) period was the most shortened. This indicates that under the effect of a pulsed electromagnetic field processes prepared for DNA synthesis are completed more rapidly.

The increase in the number of pathological mitoses is the characteristic feature of the effect of a pulsed electromagnetic field on the chick embryo fibroblast culture at logarithmic and stationary growth phases /60/. Phase (different from control) changes in both mitotic activity /54 and 58/ and in the sizes of nuclei /60/ are noted under the continuous effect of a pulsed electromagnetic field on the cell culture during the entire period of its existence. The increase in mitotic activity combined with the functional swelling of nuclei during an early (up to 30 hours) period of effect then gives way to its sharp decrease and to a functional shriveling of nuclei. The gradual increase in the area of nuclei of experimental culture cells against the background of a progressive decrease in mitotic activity, which ensues after a certain period of stabilization, points to their dystrophic swelling in connection with the negative effect of a pulsed electromagnetic field on the culture under a prolonged and continuous effect /59/. A morphological investigation of the culture has disclosed a number of characteristics indicating that the properties of the cell surface, on which the contact inhibition of division, adhesive properties of cells and their capacity for motion depend, change under the effect of a pulsed electromagnetic field /57 and 60/. The presented data point to a pronounced direct effect of a pulsed electromagnetic field on cells. As we have established, the nature of the response depends on their functional state.

Thus, morphological investigations convincingly confirm the biological activity of magnetic fields both at the organism and cell level. However, the problem of the mechanism of biological action of magnetic fields as yet is by no means resolved completely. Physicists, chemists and biologists understand it differently /17/. In our opinion, the following components can be singled out in the mechanism of biological action: 1) mechanism of initial interaction of the magnetic field with the substance of the biological object; 2) mechanism of reception by the biological object of the results of the magnetic field effect; 3) mechanism of response of the biological object to the effect of the magnetic field.

In the last few years many mechanisms of the initial effect of pulsed magnetic fields have become well known owing to the studies performed at the Institute of Chemical Physics of the USSR Academy of Sciences and at the Institute of Chemical Kinetics and Combustion of the Siberian Department of the USSR Academy of Sciences.

It has turned out that despite thermal motion even weak magnetic fields through magnetic and spin effects can affect the kinetics (direction and rate) of chemical reactions, recombination reactions and any reactions with the participation of radicals with unpaired electrons, which possess angular momentums and magnetic moments /6, 14, 17, 46 and 69/. In connection with this processes subject to the effect of magnetic fields can include electron transfer through the cytochrome chain and in Krebs' cycle, oxidative phosphorylation reactions, many enzymatic processes of transformation of free radicals in carcinogenesis and so forth. Thus, by means of this (we will call it quantum-biochemical) mechanism of universal interaction of the magnetic field with the biological substrate it is possible to touch upon the initial mechanisms of vital activity, whose change evokes a response of the living system directed toward a correction of occurring changes, that is, maintenance of homeostasis.

Homeostatic mechanisms, which have been observed at various levels of organization of living systems (from the subcellular to the organism level), are based on the law of intermittent activity of functioning structures /33/ and compensatory-adaptive changes in the rhythm and intensity of biosynthetic processes /47/. The alternate functioning of structures enables the living system over wide limits to level the effect of the magnetic field, transforming it into a discrete field with respect to individual structures /33/, thereby greatly lowering the degree of the factor's unfavorable effect. As has been pointed out above, there is a direct dependence between the functional state of the object (organoids, cells, organ and so forth) and the manifestation of the biological action of the magnetic field with the development of changes in maximally loaded structures /45, 56 and 81/. If the functional state of the biological object ensures the possibility of restoring its ultrastructures during the time of their relative rest, homeostasis can be limited to this. Otherwise, the rhythm of restoration of structures through an increase in the intensity of biosynthetic processes changes /47/. Owing to this, the living system can adapt itself not only to the effect of a constant, but also of an alternating and even a pulsed, magnetic field through the "assimilation" of the rhythm of the existing stimulus /47/, as, for example, this occurs under the effect of a pulsed electromagnetic field on the logarithmic phase of growth of the chick embryo fibroblast culture /56/. These changes in synthetic processes can explain the biochemical, histochemical and other features noted by many researchers in cells and tissues under the effect of magnetic fields /7, 16, 19, 30, 34, 41, 63, 66 and 82/.

If, however, the functional capabilities of the living system are unable to ensure an adequate intensity of restoration of structures, the latter are subject to "wear," dystrophy and destruction, as we have observed under the effect of a pulsed electromagnetic field on the degenerative phase of development of the chick embryo fibroblast culture /56/. An increase in the functional activity of cells or tissues can be ensured by the mobilization of additional structures from those available, as well as through their hyperplasia /47/. This thesis is confirmed by the early proliferative and hypertrophic changes in the glia in the central nervous system, which are considered compensatory /2 and 72/, proliferation of the intestinal epithelium /63/ and increase in the mitotic activity of cells in the culture /55, 56 and 60/ under the effect of the magnetic field. Thus, a systematic performance by the living system of the indicated homeostatic reactions at different levels (molecular and ultrastructural, cellular, tissue, organ and so forth) forms the morphofunctional substrate characterizing the response of biological objects to the effect of magnetic fields. The development of pathological changes under the effect of magnetic fields points to the insufficiency of homeostatic mechanisms. Of course, all these homeostatic reactions in higher organisms are performed with the participation of nervous and endocrine systems, which themselves are noted for a high sensitivity to magnetic fields (see above). That is why a local effect of the magnetic field on the organism differs from a general effect and the very reaction of the organism to the magnetic field is extremely individualized. This must be taken into consideration in magnetotherapy, which has become ever more widespread in recent years.

Thus, the stay of the biological object in the magnetic field is characterized, first, by the inevitable interaction of the magnetic field with the biological substrate and, second, by the response of the biological object to the effects produced by the field. However, before the living system begins the response directed toward the elimination of the consequences of the magnetic field effect, it must "sense" that something occurred in it, that is, between the effect of the magnetic field on the biological substrate and the response there is the necessary process of reception by the living system of a signal about the changes occurring in it. Without such a signal the living system has no need to change something in the state of dynamic equilibrium in which it usually stays. The perception by the living system of a signal about the changes occurring in it under the effect of the magnetic field is understood by us as the reception of the result of the field's effect (it is not a question of a specific reception of the magnetic field itself). This problem has not been worked out at all in magnetobiology.

It seems to us that the mechanisms of this reception are closely connected with the mechanisms of the initial effect of the magnetic field and are at the atomic-molecular (physicochemical) level. A change in the rate or direction of chemical reactions can be perceived by the elementary living system, for example, the cell, as a signal about a change in homeostasis and the need to correct it.

Despite careful research a special universal magnetoperceiving "instrument" has not been detected in biological objects up till now /67/. At the same time, all living systems, regardless of the level of their organization, are sensitive to the effect of the magnetic field. This universal magnetosensitivity points to the possibility of perception of the magnetic field effect both by the living system as a whole and by its individual parts on the basis of the quantum-biochemical mechanism of its initial effect.

The existence of a certain latent period in the organism's response to the magnetic effect /72/ points to the "accumulation" of the results of the initial effect sufficient for its reception. The need for the "accumulation" of the effect and for the transformation of quantity into quality is dictated by the fact that intermolecular interactions are of the nature of probability, that is, not all the molecules that have come in contact enter into a chemical interaction with each other. The magnetic field, orienting molecules, affecting singlet-triplet transitions and the process of recombination of radicals /6, 14 and 69/ and so forth, only increases the probability of a specific interaction. This effect must acquire the value critical for perception. In this case the transformation of quantity into quality forms the basis for the reception of the result of the magnetic field effect. Attention must be drawn to the fact that the initial effect of the magnetic field on the biological substrate, the reception of the result of this effect and the initial responses of the living system to the magnetic field can be carried out at the most elementary (atomic-molecular) level. This circumstance stresses their close interconnection and the need for an inclusion into the mechanism of biological action of the magnetic field as its three components.

Conclusion

An analysis of the literature data and of our own investigations conducted both at the organism and cell level points to a high sensitivity of biological objects to magnetic fields. The response of living systems to the effect of magnetic fields is characterized by a clear dependence of its nature on the system's functional state. The manifestation of the biological action of the magnetic field depends on the field's biotropic parameters. The biological action of the magnetic field is not distinguished by a specific set of morphological changes. The degree of the latter in different tissues is not the same and is determined by the characteristics of their metabolism, structure and function. At early stages morphofunctional changes occurring under the effect of the magnetic field represent the result of adaptive reconstructions for the purpose of maintenance of homeostasis. In our opinion, the mechanism of biological action of the magnetic field consists of the initial quantum-biochemical interaction of the magnetic field with the biological substrate, the reception by the living system of the result of the magnetic field effect and the response to this effect.

BIBLIOGRAPHY

1. Abramovich-Polyakov, D. K. and Krakovskaya, S. P., in the book "Primeneniye magnitnykh poley v klinike" /Application of Magnetic Fields in Clinical Medicine/, Kuybyshev, 1979, pp 237-239.

2. Aleksandrovskaya, M. M. and Kholodov, Yu. A., DOKL. AN SSSR, 1966, Vol 170, p 482.

3. Amosova, V. V., Vladislavleva, N. A. and Osipenko, P. I., in the book "Vsesoyuznoye soveshchaniye po izucheniyu vliyaniya magnitnykh poley na biologicheskiye ob"yekty. 2-ye. Materialy" /All-Union Conference on the Study of the Effect of Magnetic Fields on Biological Objects. 2nd. Materials/, Moscow, 1969, pp 35-39.

4. Anufriyeva, T. V., "Morfologiya kozhi morskikh svinok podvernutykh vozdeystviyu peremennogo magnitnogo polya" /Morphology of Skin of Guinea Pigs Subjected to the Effect of an Alternating Magnetic Field/, author's abstract of her candidate's dissertation, Novosibirsk, 1977.

5. Aristarkhov, V. M. and Piruzyan, L. A., in the book "Klinicheskoye primeneniye magnitnykh poley" /Clinical Application of Magnetic Fields/, Izhevsk, 1977, pp 5-6.

6. Aristarkhov, V. M., Piruzyan, L. A. and Tsybyshev, V. P., in the book "Reaktsiya biologicheskikh sistem na magnitnyye polya" /Reaction of Biological Systems to Magnetic Fields/, Moscow, 1978, pp 6-25.

7. Afanas'yev, Yu. I. and Murnikov, V. T., in the book "Vliyaniye magnitnykh poley na biologicheskiye ob"yekty" /Effect of Magnetic Fields on Biological Objects/, Kaliningrad, 1975, pp 210-211.

8. Afrikanova, L. A., Ibid, pp 209-210.

9. Ban'kov, V. I., Ibid, pp 106-107.

10. Belousova, L. I., in the book "Magnitnoye pole v meditsine" /Magnetic Field in Medicine/, Frunze, 1974, pp 144-145.

11. Bil'dyukevich, A. L., Valeyeva, L. S. and Akhmerov, U. Sh., in the book "Primeneniye magnitnykh poley v klinicheskoy meditsine i eksperimente" /Application of Magnetic Fields in Clinical Medicine and in Experiments/, Kuybyshev, 1979, pp 19-21.

12. Bordyushkov, Yu. N., Gashnikova, L. I. and Kvakina, Ye. B., in the book "Gigiyenicheskaya otsenka magnitnykh poley" /Hygienic Evaluation of Magnetic Fields/, Moscow, 1972, pp 48-52.

13. Borsegyan, L. Kh., Finakova, G. V., Romanova, G. V. et al., in the book "Vliyaniye magnitnykh poley na biologicheskiye ob"yekty," Kaliningrad, 1975, p 144.

14. Buchachenko, A. L., Sagdeyev, R. Z. and Salikhov, K. M., "Magnitnyye i spinovyye effekty v khimicheskikh reaktsiyakh" /Magnetic and Spin Effects in Chemical Reactions/, Novosibirsk, 1973.

15. Vasil'yev, N. V., Shternberg, I. B. and Boginich, L. F., in the book "Vliyaniye magnitnykh poley na biologicheskiye ob"yekty," Moscow, 1971, pp 108-123.

16. Vashurina, S. A., in the book "Primeneniye magnitnykh poley v klinicheskoy meditsine i eksperimente," Kuybyshev, 1979, pp 157-159.

17. "Vvedeniye v elektromagnitnuyu biologiyu," /Introduction to Electromagnetic Biology/, Tomsk, 1979.

18. Voloshina, E. I. and Kolesova, N. I., in the book "Primeneniye magnitnykh poley v klinicheskoy meditsine i eksperimente," Kuybyshev, 1979, pp 156-157.

19. Galantyuk, S. I., in the book "Primeneniye magnitnykh poley v klinike," Kuybyshev, 1976, pp 167-169.

20. Garganeyev, G. P., in the book "Gigiyenicheskaya otsenka magnitnykh poley," Moscow, 1972, pp 27-30.

21. Garkavi, L. Kh., Kvakina, Ye. B. and Ukolova, M. A., "Adaptatsionnyye reaktsii i rezistentnost' organizma" /Adaptive Reactions and Resistance of the Organism/, second edition, Rostov-on-Don, 1979.

22. Gorshenina, T. I., "Morfologicheskaya kharakteristika izmeneniy vyzvannykh magnitnym polem v eksperimente" /Morphological Characteristic of Changes Produced by the Magnetic Field in Experiments/, author's abstract of his candidate's dissertation, Tomsk, 1965.

23. Dubrov, A. P., "Geomagnitnoye pole i zhizn'" /Geomagnetic Field and Life/, Leningrad, 1974.

24. Zhdanova, N. F. and Nuzhnyy, V. P., in the book "Vliyaniye magnitnykh poley na biologicheskiye ob"yekty," Kaliningrad, 1975, pp 128-129.

25. Zagrebin, A. M. and Chuchkov, V. M., in the book "Primeneniye magnitnykh poley v klinicheskoy meditsine i eksperimente," Kuybyshev, 1979, pp 172-174.

26. Ivanov, V. V., Ibid, p 176.

27. Ir'yanov, Yu. M., "Deystviye magnitnogo polya na nervnuyu tkan'" /Effect of the Magnetic Field on the Nerve Tissue/, author's dissertation of his candidate's dissertation, Perm', 1971.

28. Kalibernyy, V. V. and Kuligin, A. G., in the book "Vliyaniye magnitnykh poley na biologicheskiye ob"yekty," Kaliningrad, 1975, pp 149-150.

29. Katola, V. M., Pirogov, A. B., Chertov, A. D. et al., in the book "Primeneniye magnitnykh poley v klinicheskoy meditsine i eksperimente," Kuybyshev, 1979, pp 181-182.

30. Kolodub, Yu. A. and Sinitsa, I. N., in the book "Vliyaniye magnitnykh poley na biologicheskiye ob"yekty," Kaliningrad, 1975, p 153.

31. Korzhova, V. V. and Kostenko, A. I., in the book "Gigiyenicheskaya otsenka magnitnykh poley," Moscow, 1972, pp 71-73.

32. Kraft, L. A. and Kamneva, T. G., in the book "Zhivyye sistemy v elektromagnitnykh polyakh" /Living Systems in Electromagnetic Fields/, Tomsk, 1979, pp 7-11.

33. Kryzhanovskiy, G. N., in the book "Biologicheskiye ritmy v mekhanizmakh kompensatsii narushennykh funktsiy" /Biological Rhythms in Mechanisms of Compensation of Disturbed Functions/, Moscow, 1973, pp 20-34.

34. Lekhan, I. G., in the book "Vliyaniye magnitnykh poley na biologicheskiye ob"yekty," Kaliningrad, 1975, pp 221-222.

35. Madiyevskiy, Yu. M. and Volozh, Yu. G., in the book "Vsesoyuznoye soveshchaniye po izucheniyu vliyaniya magnitnykh poley na biologicheskiye ob"yekty. 2-ye. Materialy," Moscow, 1969, pp 146-148.

36. Meshcheryakov, F. A. and Meshcheryakov, A. F., in the book "Vliyaniye magnitnykh poley na biologicheskiye ob"yekty," Kaliningrad, 1975, pp 212-213.

37. Moroz, V. V., Ibid, pp 122-123.

38. Moroz, V. V., in the book "Primeneniye magnitnykh poley v klinicheskoy meditsine i eksperimente," Kuybyshev, 1979, pp 195-196.

39. Muzalevskaya, N. I., "Fiziologicheskiye proyavleniya deystviya magnitnogo polya maloy napryazhennosti v diapazone sverkhnizkikh chastot" /Physiological Manifestations of the Effect of a Low-Intensity Magnetic Field Over an Extremely Low Frequency Range," author's abstract of her candidate's dissertation, Leningrad, 1978.

40. Nikberg, I. I., Piven', I. D., Ryvkin, B. A. et al., in the book "Gigiyena naselennykh mest" /Hygiene of Settlements/, Kiev, 1977, issue 16, pp 10-14.

41. Ordina, O. M., in the book "Zhivyye sistemy v elektromagnitnykh polyakh," Tomsk, 1979, issue 2, pp 12-14.

42. Ostrovskaya, I. S. and Timchenko, A. N., in the book "Vliyaniye magnitnykh poley na biologicheskiye ob"yekty," Kaliningrad, 1975, p 142.

43. Padalko, V. V., Losev, N. I., Berlin, Yu. V. et al., Ibid, p 105.

44. Pryadchenko, Z. Ye., in the book "Nauchnaya konf. molodykh uchenykh-morfologov Moskvy. 1-ya. Materialy" /Scientific Conference of Young Morphological Scientists in Moscow. 1st. Materials/, Moscow, 1976, pp 156-159.

45. Rassadin, A. M., "Zavisimost' morfologicheskikh izmeneniy v organakh ot ikh funktsional'nogo sostoyaniya v moment deystviya elektromagnitnogo polya" /Dependence of Morphological Changes in Organs on Their Functional State at the Moment of Effect of the Electromagnetic Field/, candidate's dissertation, Tomsk, 1965.

46. Sagdeyev, R. Z., Salikhov, K. M. and Molin, Yu. N., USPEKHI KHIMII, 1977, Vol 46, No 4, pp 569-601.

47. Sarkisov, D. S., Pal'tsyn, A. A. and Vtyurin, B. V., "Prisposobitel'naya Perestroyka Bioritmov" /Adaptive Reconstruction of Biorhythms/, Moscow, 1975.

48. Sakharova, S. A., in the book "Vliyaniye magnitnykh poley na biologicheskiye ob"yekty," Kaliningrad, 1975, pp 134-135.

49. Serebrov, V. Yu., "Vliyaniye peremennogo magnitnogo polya i antigena na funktsional'noye sostoyaniye shchitovidnoy zhelezy i nekotoryye metabolicheskiye zven'ya chuvstvitel'nyye k tireoidnym gormonam"/Effect of the Alternating Magnetic Field and Antigen on the Functional State of the Thyroid Gland and Some Metabolic Links Sensitive to Thyroid Hormones," candidate's dissertation, Tomsk, 1979.

50. Soldatova, L. P., in the book "Magnitnoye pole v meditsine," Frunze, 1974, pp 45-47.

51. Soldatova, L. P., in the book "Zhivyye sistemy v elektromagnitnykh polyakh," Tomsk, 1979, issue 2, pp 24-27.

52. Strekova, V. Yu., in the book "Problemy kosmicheskoy biologii" /Problems of Space Biology/, Moscow, 1973, Vol 18, pp 200-204.

53. Surganova, S. F., Demetskiy, A. M., Popova, L. I. et al., in the book "Primeneniye magnitnykh poley v klinicheskoy meditsine i eksperimente," Kuybyshev, 1979, pp 215-217.

54. Taranov, S. V., in the book "Razrabotka i prakticheskoye primeneniye ëlektronnykh uskoriteley" /Development and Practical Application of Electron Accelerators/, Tomsk, 1972, pp 208-209.

55. Taranov, S. V., in the book "Vliyaniye magnitnykh poley na biologicheskiye ob"yekty," Kaliningrad, 1975, pp 62-63.

56. Taranov, S. V., in the book "Materialy teoreticheskoy i klinicheskoy meditsiny" /Materials of Theoretical and Clinical Medicine/, Tomsk, 1975, issue 5, pp 25-27.

57. Taranov, S. V., Ibid, pp 28-29.

58. Taranov, S. V., in the book "Aktual'nyye voprosy meditsinskoy magnitobiologii" /Urgent Problems in Medical Magnetobiology/, Saransk, 1977, p 45.

59. Taranov, S. V., in the book "Molodyye uchenyye i spetsialisty--narodnomu khozyaystvu" /Young Scientists and Specialists for the National Economy/, Tomsk, 1977, pp 20-22.

60. Taranov, S. V., in the book "Primeneniye magnitnykh poley v klinicheskoy meditsine i eksperimente," Kuybyshev, 1979, pp 217-219.

61. Tarakhovskiy, M. L., Samborskaya, Ye. P. and Zadorozhnaya, T. D., in the book "Gigiyenicheskaya otsenka magnitnykh poley," Moscow, 1972, pp 77-79.

62. Tikhonova, N. M. and Shchepetil'nikova, A. I., in the book "Primeneniye magnitnykh poley v klinicheskoy meditsine i eksperimente," Kuybyshev, 1979, pp 219-221.

63. Tikhonova, N. M., Yel'kina, A. V. and Shchepetil'nikova, A. I., in the book "Zhivyye sistemy v elektromagnitnykh polyakh," Tomsk, 1979, issue 2, pp 33-34.

64. Toroptsev, I. V., ARKH. PAT., 1968, issue 3, p 3.

65. Toroptsev, I. V., Garganeyev, G. P., Gorshenina, T. I. et al., in the book "Vliyaniye magnitnykh poley na biologicheskiye ob"yekty," Moscow, 1971, pp 98-107.

66. Udintsev, N. A. and Kanskaya, N. V., "Vliyaniye magnitnykh poley na serdtse" /Effect of Magnetic Fields on the Heart/, Tomsk, 1977.

67. Udintsev, N. A. and Khlynin, S. M., "Vliyaniye magnitnykh poley na semenniki" /Effect of Magnetic Fields on Testes/, Tomsk, 1980.

68. Ukolova, M. A. and Kvakina, Ye. B., in the book "Vliyaniye magnitnykh poley na biologicheskiye ob"yekty," Moscow, 1971, pp 147-164.

69. Frankevich, Ye. L., "Khimiya i zhizn'" /Chemistry and Life/, 1980, issue 6, pp 9-14.

70. Kholodov, Yu. A., "Vliyaniye elektromagnitnykh i magnitnykh poley na tsentral'nuyu nervnuyu sistemu" /Effect of Electromagnetic and Magnetic Fields on the Central Nervous System/, Moscow, 1966.

71. Kholodov, Yu. A., in the book "Vliyaniye magnitnykh poley na biologicheskiye ob"yekty," Moscow, 1971, pp 124-146.

72. Kholodov, Yu. A., "Reaktsii nervnoy sistemy na elektromagnitnyye polya" /Reactions of the Nervous System to Electromagnetic Fields/, Moscow, 1975.

73. Chuchkov, V. M. and Zagrebin, A. M., in the book "Primeneniye magnitnykh poley v klinicheskoy meditsine i eksperimente," Kuybyshev, 1979, pp 237-239.

74. Shishova, L. I., Ibid, pp 239-241.

75. Shust, I. V., Kostinik, I. M. and Galantyuk, S. I., in the book "Vliyaniye magnitnykh poley na biologicheskiye ob"yekty," Kaliningrad, 1975, p 145.

76. Shushakov, A. P., Panov, T. N. and Novikova, K. F., "Trudy Leningrad. ob-va yestestvoispytateley" /Works of the Leningrad Society of Naturalists/, 1971, Vol 76, issue 1, pp 59-61.

77. Shchepetil'nikova, A. I., in the book "Magnitnoye pole v meditsine," Frunze, 1974, pp 162-164.

78. Shchepetil'nikova, A. I., in the book "Vliyaniye magnitnykh poley na biologicheskiye ob"yekty," Kaliningrad, 1975, p 143.

79. Yukov, O. S., in the book "Vsesoyuznoye soveshcheniye po izucheniyu vliyaniya magnitnykh poley na biologicheskiye ob"yekty. 2-ye. Materialy," Moscow, 1969, pp 262-263.

80. Yukov, O. S., in the book "Vliyaniye magnitnykh poley na biologicheskiye ob"yekty," Kaliningrad, 1975, pp 214-215.

81. Yashina, L. N., "Morfologicheskiye i gistokhimicheskiye issledovaniya vliyaniya impul'snogo elektromagnitnogo polya nizkoy chastoty (magnitnaya sostavlyayushchaya) v eksperimente na zhivotnykh" /Morphological and Histochemical Investigations of the Effect of a Low-Frequency Pulsed Electromagnetic Field (Magnetic Component) in an Experiment on Animals/, author's abstract of his candidate's dissertation, Khar'kov, 1973.

82. Yashina, L. N., in the book "Vliyaniye magnitnykh poley na biologicheskiye ob"yekty," Kaliningrad, 1975, pp 123-124.

83. Barbieri, M., Valentini, A. F., Zini, Q. et al., ATTI ACAD. NAZ. LINCEI; REND. CL. SCI FIS. MAT. NATUR, Ser. III, 1971, Vol 49, pp 153-161.

84. "Biological Effects of Magnetic Fields," Ed. M. Barnothy, New York, 1964, Vol 1.

85. Butler, B. C. and Dean, W. W., AM. J. MED. ELECTRON., 1964, Vol 3, pp 123-125.

86. Delorenzi, E., BOLL. SOC. ITAL. BIOL. SPER., 1935, Vol 10, pp 702-704.

87. Delorenzi, E. and Angela, G. G., ARCH. SCI. MED., 1961, Vol 112, pp 501-509.

88. D. Souza L., Reno, V. R., Nutini, L. G. et al., in "Biological Effects of Magnetic Fields," New York, 1969, Vol 2, pp 53-60.

89. Israeli, E., Karni, Z., Schur, L. et al., ISRAEL J. MED. SCI., 1971, Vol 7, pp 463-468.

90. Knox, E. C., Armstrong, E., Lancashire, R. et al., NATURE, 1979, Vol 281, pp 564-565.

91. Mulay, J. L. and Mulay, L. N., Ibid, 1961, Vol 190, pp 1019-1019.

92. Perakis, N., ACTA ANAT., 1947, Vol 4, pp 225-228.

93. Pereira, M. R., Nutini, L. G., Fardon, J. C. et al., PROC. SOC. EXP. BIOL. (N.Y.), 1967, Vol 124, pp 573-576.

94. Pumper, R. W. and Barnothy, J. M., in "International Biomagnetic Symposium. 3. Proceedings," Chicago, 1966, pp 53-55.

95. Sutherland, R. M., Marton, P. J., MacDonald, J. C. F. et al., PHYSIOL. CHEM. PHYSICS, 1978, Vol 10, pp 125-131.

96. Valentinuzzi, M., Ferraresi, R. W. and Vazquez, T., EXPERIENTIA, 1966, Vol 22, pp 312-312.

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EFFECT OF RESOLVING MAGNETIC FIELD SOURCES ON SEVERAL BLOOD INDICATORS WITH A CAROTID ARTERY AUTOVENOUS CRAFT

Minsk ZDRAVOOKHRANENIYE BELORUSSII in Russian No 4, Apr 83 (manuscript received 8 Jul 82) pp 56-57

[Article by G. V. Lud, assistant, Professor A. M. Demetskiy; Docent Ye. N. Medvedskiy, M. V. Pyshenko, senior scientific associate and A. A. Chirkin, senior scientific associate; Department of Operative Surgery and Topographical Anatomy (Professor A. M. Demetskiy, director), Central Scientific Research Laboratory (E. S. Pitkevich, senior scientific associate, director) of the Vitebsk Medical Institute]

[Text] Sources for artificial magnetic fields have been developed; there are devices of various designs and elastic magnets. They make it possible to have a sufficiently effective influence on organs and tissues located near the surface.

A resolving artificial magnetic field source on a base of collagen sponge has been developed at the Department of Operative Surgery and Topographical Anatomy of the Vitebsk Medical Institute in conjunction with the Laboratory for the Study and Application of Collagen in Medicine under Moscow Medical Institute No 1. This source can be implanted at any depth, and therefore can be used directly on any organ or tissue. With time it is subject to resolution and therefore does not require additional surgical intervention to remove it from the body.

Experimental testing of the effectiveness of the resolving artificial magnetic source was conducted with an operation involving a carotid artery autovenous graft.

Materials and Methods

Three series of experiments were conducted on 28 dogs. The first and second series were the controls. In the first series an autovenous graft was applied to the animals' carotid arteries; in the second series during the operation after the suturing of the autovenous transplant, a strip of collagen sponge measuring 1 x 2 cm was attached; it had the same composition as the resolving magnetic field source but it was nonmagnetic. The third series consisted of affixing a strip containing the magnetic field source to the autovenous transplant.

The autovenous graft on the carotid artery was applied under intravenous Nembutal anesthetic. The autovenous transplant 1.5 cm in length, taken from the right femoral vein, was attached to an imperfection in the common carotid artery. No medication treatment was applied in the post-operative period.

The animals used in the experiment were examined before the operation, and then after 1, 3, 7, 15, and 30 days. The morphological composition and coagulation properties of the peripheral blood were studied. The coagulation function was evaluated from thromboelastograms and biochemical coagulogram data, which included a determination of the blood clotting time; plasma recalcification time; plasma tolerance to heparin; prothrombin, heparin, and thrombin times; fibrinogen A and B; fibrinolysis; and a thrombotest. The blood was analyzed for histamine, serotonin, malonic dialdehyde, glucose, 11-OCS content, and the potassium and sodium in the plasma and erythrocytes was assayed. The results obtained were compared to the original data and data from the other series of tests.

Results

In the first series of experiments, the following changes were observed in the peripheral blood over the course of 1-3 days: the ESR---increased by a factor of 7 ($p<0.05$); leucocytosis with a shift to the left was noted; the number of lymphocytes decreased to one-half the original level; and the number of thrombocytes decreased to one-fifth the original level. By the seventh day the number of leucocytes and the leucocytic formula returned to the norm. Beginning on the third day after the operation the erythrocyte content in the peripheral blood gradually declined and after 1 month it was 75 percent of the original level ($p<0.05$). By this time there was an additional 35 percent decrease in the number of lymphocytes ($p<0.05$).

In the second series of experiments, during the first days following the operation there was also an increase in the ESR-- and in the number of leucocytes; a 30 percent decrease in the number of thrombocytes; but the lymphocyte content showed almost no change, and the decrease in the number of erythrocytes was less than significant (up to 82 percent of the original level).

In the third series, it was only during the first 24 hours that leucocytosis was observed and there was a reduction in the number of lymphocytes to one-half the original level ($p<0.05$). In the following periods the morphological composition of the peripheral blood did not undergo any substantial changes. The decrease in the number of erythrocytes was not significant (there was a 10 percent decrease).

A comparison of the thromboelastogram and biochemical coagulogram data showed that the operation attaching an autovenous graft to the carotid artery caused an acceleration in the blood coagulation process. Hypercoagulation developed primarily during the first and third phases of hemostasis. Beginning in the first 24 hours there was a 40 percent increase ($p<0.05$) in the level of fibrinogen B in the blood, which characterizes an increased coagulation capacity; there was a 1.5-fold increase in fibrinogen A, which is connected to the development of the inflammatory response. Over the course of the second post-operative week, the maximum hypercoagulation was observed. The thromboelastogram showed shortening of the longitudinal parameters: r, t, s, t; and a 35 percent increase in the coagulation and hypercoagulation indexes ($p<0.05$). A biochemical analysis of hemostasis revealed a decrease in blood coagulation time to one-half the original level; a 46 percent decrease in the heparin time; an increase in plasma tolerance to heparin; and a decrease in the fibrinolytic activity of the blood. By the end of 1 month the parameters of hemostasis returned to close to normal, with a remaining increased plasma tolerance to heparin, and a significantly shorter r indicator on the thromboelastogram, which characterizes the length of the first and second phases of hemostasis.

In the second series of experiments the changes in the blood's clotting activity showed the same trend as in the first series and occurred during the same observation periods.

In the third series, in which resolving magnetic field sources were implanted in the animals, over the course of the first 2 weeks a decrease in plasma tolerance to heparin to one-half to four-tenths the original level was observed; there was also a two-fold increase in the heparin time. On the third day an increase (of 83 percent) was noted in the content of fibrinogen A in the blood ($p<0.05$).

An analysis of the changes in the blood levels of histamine, serotonin, electrolytes, malonic dialdehyde, glucose and 11-mineralocorticoid showed that in the first series on the first and third days after the operation the level of histamine increased 3-fold ($p<0.05$); the level of malonic dialdehyde increased by a factor of 1.5; and the electrolyte content of the plasma decreased slightly, as did the number of erythrocytes. On the fifteenth and thirtieth days there was a 32-36 percent decrease in in the sodium content of the erythrocytes ($p<0.05$). Moderate hyperglycemia was also observed. The level of histamine in the blood was restored to the original level, and the level of serotonin decreased to 77 percent of the original level.

In the second series on the first and third days a 3-3.5-fold increase in the histamine content was observed ($p<0.05$); there was also an accumulation of potassium in the erythrocytes. During the second week the content of potassium and sodium in the erythrocytes decreased by 47-53 percent; the histamine level remained high; and the serotonin level decreased to four-tenths the original level ($p<0.05$). Starting on the fifteenth day and continuing to the end of the month, the same changes were observed as occurred in the first series: low sodium content in the erythrocytes; low malonic dialdehyde levels in the blood; insignificant hyperglycemia; and increased potassium levels in the plasma.

In the third series on the first and third days there was a 2-fold increase in the histamine content ($p<0.05$); and the level of sodium in the plasma decreased to 74 percent of the original level ($p<0.05$). During the course of the second week following the operation, the histamine level dropped to one-third the original level and the serotonin level rose by 30 percent. There was a simultaneous increase in the glucose and 11-OCS levels. On the fifteenth and thirtieth days there was a decrease in the malonic dialdehyde level to one-fourth the original level, with concurrent hyperglycemia.

Discussion

An analysis of the results obtained and a comparison of the data from the three series of experiments make it possible to distinguish definite stages in the body's response to the operation.

During the first stage (1 to 3 days) an inflammatory process developed in response to the surgical trauma, accompanied by leucocytosis with a shift to the left, an increase in ESR, and an increase in the fibrinogen A and histamine levels. In both control series of experiments, signs of increased blood clotting activity appeared: there was a decrease in the clotting time and heparin time; an increase in plasma tolerance to heparin; an increase in the fibrinogen B level; the thromboelastogram showed shortened longitudinal parameters; the coagulation and hypercoagulation indexes increased. In the third series of experiments the decrease in plasma tolerance to heparin and the increase in blood clotting time and heparin time characterize a certain slowing down of the blood clotting process.

During the second stage (7-15 days) the inflammatory response died down, there was normalization of the morphological composition of the peripheral blood and the histamine content. In the control series there were parallel decreases in the number of erythrocytes and their sodium content; with the implantation of the nonmagnetic collagen sponge there was also a decrease in the potassium content; pronounced hypercoagulation developed. There were substantial differences in the second stage with the implantation of the resolving magnetic field source. The blood clotting activity in these cases was normal or even somewhat reduced. The serotonin content was higher than that of histamine, with a significant decrease in the level of the latter. The moderate hyperglycemia and increase in the 11-OCS level offer evidence of activation of adrenal cortex activity. The level of sodium in the plasma decreased without an increase in its level in erythrocytes. The totality of changes of this type is defined as an intensification of the organism's defense responses.

Characteristic of the third, restorative stage (15-30 days) are insignificant hyperglycemia, decreased peroxide formation, a gradual decrease in the number of erythrocytes, especially in the first control series, and a simultaneous decrease in their sodium level. By the end of 1 month, the parameters of hemostasis were almost restored to the original levels in the control series. In the third series the morphological and biochemical compositions, as well as the blood clotting activity did not differ from the pre-operation levels.

Conclusions

1. With an autovenous graft to the carotid artery, the body's response is characterized by changes in the morphological and biochemical compositions of the peripheral blood and hypercoagulation.

2. Implantation of a resolving magnetic field source in an autovenous transplant prevents the increase in blood clotting activity and helps strengthen the body's defense mechanisms.

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FREQUENCY OF DISEASES OF DIGESTIVE ORGANS IN PEOPLE WORKING UNDER CONDITIONS OF COMBINED EFFECT OF LEAD AND SHF-RANGE ELECTROMAGNETIC ENERGY

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/Text/ Energy of radio frequencies of nonthermogenic intensity in combination with other factors in the industrial environment, in particular with lead vapor--a complex characteristic for the radio engineering industry--has been widely used in the last few years. Individual data on diseases in people working under conditions of an isolated effect of electromagnetic energy or lead are encountered in the literature. With regard to data on their combined effect, at present this information is absent.

We studied the frequency of diseases of digestive organs at two radio electronic industry plants, where four shops were examined by the continuous file method. All those examined were divided into four groups depending on working conditions: first, people working under conditions of an isolated effect of shf-range electromagnetic energy; second, people working under conditions of a combined effect of lead and shf-range electromagnetic energy; third, people working under conditions of an isolated effect of lead; fourth, a control group, where workers have no contact with harmful industrial factors. In the last few years the concentration of lead at work places has not exceeded the maximum permissible concentration, while 10 to 15 years ago it reached 0.01-0.03 mg/m^3. The level of effect of shf-range electromagnetic energy was more often within the standards, but periodically, especially during the last days of the month, slightly exceeded the maximum permissible concentration.

In all we examined 1,670 workers at plant No 1 and 577 workers at plant No 2. In addition to a dynamic study of the state of health according to ambulatory inspection data, a study was made of the filled out questionnaires of 245 workers at plant No 1, which made it possible to become thoroughly familiar with the anamnestic data of those examined concerning mainly changes in digestive organs. The answers were evaluated according to a five-point system. In practice, complaints were most often noted in those examined who were over 40 years old and had a length of service of more than 10 years. When the groups were compared, it was possible to note that workers of the third group (contact with lead vapor) made complaints most often and those examined having contact with an isolated effect of shf-range electromagnetic energy, least often.

Workers of the first group more often noted a decrease in appetite and air and spoiled food eructation in themselves. In this group a lowered acidity of stomach contents in workers with a length of service of more than 10 years was detected in 10.8 percent of the cases and gastric and duodenal ulcer, in 2.8 percent of the cases.

Such complaints as a disturbance in swallowing and a poor tolerance for meat and fatty food were encountered in people working under conditions of a combined effect of lead and shf-range electromagnetic energy more often than in other groups. Pains in the right hypochondrium and the epigastric region intensifying during a physical load, unpleasant emotions and travel in public transport facilities, a feeling of heaviness in the epigastric region, flatus, abdominal distention, an increase in appetite, dryness and bitter taste in the mouth, nausea, constipation and the need to be constantly on a diet were most often observed in people working under conditions of an isolated effect of lead. Thus, the questionnaires proposed by us make it possible to improve the diagnosis of gastrointestinal diseases under clinical conditions and, especially, under conditions of medicosanitary plant units, in particular in people with a short length of service, who, basically, do not make complaints during preventive examinations.

The frequency of diseases of digestive organs was analyzed through the study of workers' ambulatory charts during the entire period of work, as well as through examination under ambulatory conditions. The frequency of chronic gastritis, chronic cholecystitis and functional diseases of the nervous system is higher in people working under conditions of an isolated effect of shf-range electromagnetic energy. At the same time, people with a length of service of more than 10 years are sick more often.

A similar dependence of the frequency of diseases of digestive organs on the length of service was observed in those examined connected both with an isolated effect of lead and with a combined effect of shf-range electromagnetic energy and lead. However, the highest frequency of chronic gastritis, chronic colitis and diseases of the peripheral nervous system was among people working under conditions of an isolated effect of lead and the lowest, among people subjected to an isolated effect of shf-range electromagnetic energy. An increase in the number of cases of combination of several nosological forms when the length of service was extended was characteristic for the three groups. In particular, diseases of digestive organs were often combined with pathology of the nervous system. The certain difference in the frequency of gastrointestinal pathology in workers in similar occupations at the two plants is connected with the higher level of effect of shf-range electromagnetic energy at plant No 2 and the higher concentration of lead at the work places of this enterprise.

The data obtained on the frequency of diseases of digestive organs in workers under conditions of an isolated effect of shf-range electromagnetic energy correspond to the data presented by T. V. Kalyada et al. and L. V. Makarova. When comparing the frequency of diseases in people working under conditions of an isolated effect of the above-enumerated factors and their combination with the frequency of diseases in those examined in other occupations, it can be noted that pathology of digestive organs is encountered less often in them than in people working under conditions of effect of nitro compounds (A. I. Kleyner) and under conditions of a combined effect of carbon disulfide and the neuroemotional factor (G. G. Lysina and A. O. Navakatikyan), but more often than in workers in agricultural occupations (Ye. P. Krasnyuk).

The data obtained by us make it possible to conclude that pathology of the gastrointestinal tract is observed more often in people working under conditions of an isolated effect of lead than in people working under conditions of effect of shf-range electromagnetic energy and functional disorders of the nervous system are noted more often in people connected with an isolated effect of shf-range electromagnetic energy. The circumstance that under a combined effect of the above-indicated factors pathology of digestive organs was encountered slightly less often than under an isolated effect of lead could be explained by the fact that in the first case contact with lead vapor accounted for up to 30 or 40 percent of the work time, while during the remaining 60 to 70 percent of the time workers had contact with shf-range electromagnetic energy, which had a smaller effect on digestive organs than lead.

A change in gastric secretion of the hypoacid type was observed more often in people working under conditions of an isolated effect of shf-range electromagnetic energy and of the hyperacid type, in people working under conditions of lead effect, which indicates that shf-range electromagnetic energy inhibits gastric secretion, while lead has a stimulating effect on parietal cells. The latter leads to an increase in acidity during the first years of work. However, with age and length of service exhaustion of the functions of parietal cells sets in and hypoacid gastritis is quite often encountered in those examined with a length of service of more than 10 years under conditions of lead effect.

An early detection of functional changes in the gastrointestinal tract and liver makes it possible to promptly apply a number of therapeutic and preventive measures promoting improvement in workers' health, prevention of the development of chronic diseases and, as a result, decrease in morbidity.

BIBLIOGRAPHY

1. Kalyada, T. V., Nikitina, V. N., Kunina, V. V. et al., in the book "Voprosy gigiyeny truda v radioelektronnoy promyshlennosti" /Problems of Labor Hygiene in the Radio Electronic Industry/, Moscow, 1977, pp 69-77.

2. Kleyner, A. I., "Sostoyaniye glavnykh pishchevaritel'nykh zhelez pri vozdeystvii nekotorykh proizvodstvennykh faktorov" /State of Main Digestive Glands Under the Effect of Some Industrial Factors/, author's abstract of his doctoral dissertation, Kharkov, 1970.

3. Krasnyuk, Ye. P., in the book "Gigiyena truda" /Labor Hygiene/, Kiev, 1975, Issue 11, pp 43-45.

4. Makarova, L. V., in the book "Fizicheskiye faktory proizvodstvennoy sredy i ikh vliyaniye na sostoyaniye zdorov'ya rabotayushchikh" /Physical Factors in the Industrial Environment and Their Effect on the State of Workers' Health/, Moscow, 1973, pp 72-77.

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NATURE OF MORPHOFUNCTIONAL RENAL CHANGES IN RESPONSE TO SHF FIELD-HYPOXIA COMBINATION

Kiev VRACHEBNOYE DELO in Russian No 1, Jan 83 (manuscript received 22 Mar 82) pp 112-115

[Article by V.S. Belokrinitskiy and A.N. Grin', Laboratory of Biological and Hygienic Research, Kiev Scientific Research Institute of General and Communal Hygiene imeni A.N. Marzeyev]

[Text] In recent years considerable attention has been accorded to the combined effects of various environmental factors on the body. This is due to the fact that man's activities may place him at risk of exposure to several environmental factors simultaneously. Studies of the effects of such factors on the human organism have both a theoretical and a practical significance. An appreciation of such effects and their mechanisms of action will provide the physician with a rational scientific basis for rendering medical assistance.

The present communication represents a continuation of our work on the effects of UHF fields and hypoxia on the body [V.S. Belokrinitskiy and A.N. Grin', 1975; A.N. Grin', 1976; A.N. Grin', 1977; V.S. Belokrinitskiy and A.N. Grin', 1977; V.S. Belokrinitskiy, 1977].

The objective of the present paper is to delineate the nature and extent of morphofunctional changes in the kidney on exposure to a combination of UHF field and hypoxia, in relation to dosage, multiplicity of exposure, and the duration of hypoxia and the time of examination.

The experimental studies lasted for several months. The studies were undertaken on 283 120-210 g albino rats; the animals were divided into four experimental and four control groups. The first experimental group consisted of 29 rats exposed to 50 $\mu W/cm^2$ SHF field for 7 h for 10 days; during the last exposure they were also subjected to hypoxia. The second group of 16 rats was exposed to 50 $\mu W/cm^2$ SHF field for 7 h for 10 days and, a month later, were subjected to hypoxia. A third group of 32 rats was exposed to a 500 $\mu W/cm^2$ SHF field for 7 h and then to hypoxia. Finally, a fourth group of 27 rats was exposed to a 500 $\mu W/cm^2$ SHF field for 7 h and a month later to hypoxia.

A fifth group consisted of 48 rats that were not subjected to the SHF field or hypoxia. A sixth group (37 rats) was exposed to 50 μW/cm^2 SHF field for 7 h per day for 10 days; a seventh group (42 rats) was exposed to a 500 μW/cm^2 SHF field for 7 h. An eight group (52 rats) was subjected to hypoxia: the animals were 'elevated' in a pressure chamber to an 'altitude' of 8000 m for 20 min. The hypoxic conditions for this group were reproduced for the first, second, third, and fourth groups. The animals were irradiated by means of a LUCh-58 instrument (12.6 cm wavelength) used in therapy in a shielded chamber with dosimetric controls.

Assessment of morphofunctional changes in the kidney was based on the following indicators: general structural (architectonic) state of the renal tissue and its elements, histochemical characteristics of the cells and nephron segments (Schick reaction, Brache and Feulgen reactions, reaction for lipids, and histochemical analysis of oxidative-reductive enzymes--SDH, MDH, LDH, G6PDH), diuresis, specific gravity and biochemical composition of the urine (pH, i.e., concentration of free hydrogen ions, titratable acidity, presence and concentration of sugar, protein, and chlorides). Diuresis and the absolute quantity were calculated per 100 g of body weight, while titratable acidity was calculated per 100 cm^3 of urine. Histochemical analysis of the enzymes was carried out as proposed by E. Pearce [1962], and the results were evaluated as suggested by I.D. Shperling and I.F. Gusakova [1972]. The physicochemical characteristics of the urine were determined prior to exposure and 1, 2, 3, 4, 5, 10, 15, 20, and 25 days thereafter; the morphological and histochemical studies were conducted at the end of the experiment and 30 and 60 days into the recovery period.

In the general evaluation of results consideration was given to the histochemical and structural changes in the nephron in conjunction with overall renal function (quantity and chemical composition of the urine).

The results showed that the effects of a SHF-field-hypoxia combination differed from those obtained with these factors acting individually. These differences depend largely on the SHF field dose, its multiplicity and the time at which the animals were subjected to hypoxia. They also depend on the time at which the morphological and physiological indicators of the kidneys were examined in the course of the experiment, although the changes as a rule followed the same pattern.

In group 1 animals diuresis fell by 36% (from 5.30 to 3.40 cm^3) one day after SHF field-hypoxic exposure, while in 'pure' hypoxia (group 8) diuresis decreased by 53%, and in the SHF field animals (group 6) by 15%. In group 2 diuresis fell by 22.6% (same SHF field dose as in group 1, but subjected to hypoxia a month later). In group 1 animals normal levels of urine production were observed in 10 days, in group 2 animals in five to six days, and in the 'pure' hypoxia group in 14-15 days.

Chloride concentration in group 1 animals decreased by 30.4%, in group 2 rats by 21.7%, and by 61.9% in the 'pure' hypoxia group; an insignificant decrease occurred in the 'pure' SHF field groups at equivalent doses (groups 6 and 7). The same pattern applied to determinations of total sodium chloride.

In group 1 animals this indicator decreased by 50%, in group 2 by 33.3%, and in group 8 by 80%.

Much more pronounced changes in the indicators of diuresis, electrolyte excretion, and aciduria occurred after exposure to a combination of high dose SHF field (500 $\mu W/cm^2$) and hypoxia.

For example, group 3 animals sustained a sharp elevation of pH into the alkaline side (up to 9.50), while in group 8 ("pure" hypoxia) pH showed a weak acid shift (to 6.5). Titratable acidity in group 3 decreased by 63.2%. Normalization of these indicators was seen by the 20th day in group 3 animals and by the 10th day in group 4 animals, while in group 7 (500 $\mu W/cm^2$ SHF field for 7 h) background levels did not prevail until 25 days after irradiation.

In group 3 animals the chloride concentration and the absolute quantity of chlorides fell by 56.5 and 83.3%, respectively, a day after exposure to high dose SHF field and hypoxia; this was almost twice as great as in group 1 (low dose SHF field and hypoxia) and 5.4% lower than in group 8 ("pure" hypoxia). In group 4 animals these indicators showed less change than in group 3 animals, but were greater than those observed in group 2 animals. Recovery of these indicators was observed after 20 and 10 days, respectively. There was a marked increase in the specific gravity of urine of group 3 and 4 animals; furthermore, in distinction to group 4, group 3 presented with marked proteinuria which approached 0.528% and exceeded more than two-fold that seen in groups 7 and 8, i.e., that prevailing when SHF (500 $\mu W/cm^2$ for 7 h) and hypoxia acted separately. Elevation of the urinary specific gravity and proteinuria in group 3 persisted for 10-15 days after exposure to the SHF-hypoxia combination.

Changes in diuresis and the physicochemical characteristics of the urine were in good agreement with alterations in the histochemical indicators and tissue and cellular changes in nephron structure of the experimental animals.

For example, immediately after separate exposure to the SHF field and hypoxia, as well as after their combined effects, commonly employed pathomorphologic methods (hematoxylin-eosin staining, Van Gieson's staining, etc.) revealed variable degrees of vasodilatation and endothelial breakdown, perivascular and pericellular infiltrations, hemorrhage, swelling, partial de-epithelialization along the nephron, and other changes. These changes occurred alongside changes in histochemical indicators: decreased cellular content of glycogen, changes in DNA and RNA concentration, and appearance of neutral fat droplets which accompanied enhanced activity of oxidative-reductive enzymes in group 1, 2, 3, 4, 6, 7, and 8 animals, in comparison with the control animals.

Morphological changes in the experimental animals were essentially identical. However, the severity and extent of such alterations differed from group to group along the course of the nephron. The most pronounced changes were encountered in groups exposed to high dose SHF field (500 $\mu W/cm^2$ for 7 h; group 7), hypoxia (group 8), and animals exposed to combinations in which hypoxia immediately followed SHF irradiation (group 3). In these animals the renal dystrophic processes involved hydropic changes and hemorrhage, lesions which were not evident in the other groups. This was ascribed to the acute nature of exposure which did not allow for compensatory and adaptive mechanisms to come into play and alleviate the effects of these factors on the basis of their strength and frequency.

Histochemical changes and alterations in the cellular structure of the nephron and the kidney as a whole were significantly less severe in the animals that had been exposed for 10 days to low dose SHF field (group 6), those subjected to hypoxia immediately after a 10 day period of exposure to low dose SHF (group 1), and especially in those animals that, after 10 days of low dose SHF, were subjected to hypoxia a month later (group 2) in comparison with animals in groups 7, 8, 3, or 4. It is presumed that the low dose SHF field exposure stimulated certain compensatory and adaptive mechanisms which enhance the resistance of the animals against extreme factors and resulted in milder pathologic manifestations. Furthermore, these mechanisms became entrenched and stabilized in the time elapsing between the termination of irradiation and subsequent challenge, as indicated by the data derived from groups 1 and 3 in comparison with groups 2 and 4.

Normalization of the morphologic changes in the various groups was also variable. Histochemical features and the cellular structure of the nephron showed rapid recovery in groups 2 and 4. Recovery was much slower in groups 1, 3, and especially 7 and 8. A number of factors (fine-droplet fatty infiltration, elevated SDH and MDH activities, etc.) failed to show reversibility even after two months had elapsed since exposure.

Certain conclusions can be reached on the basis of the morphofunctional renal changes induced by combinations of various doses of SHF field and hypoxia, taking into consideration the time of exposure. Water-electrolyte metabolism and other metabolic features (carbohydrate, lipid and protein metabolism) which influence the histochemical findings and nephron structure were found to be highly susceptible to the effects of SHF and hypoxia. The metabolic alterations were more pronounced with hypoxia; a combination of the factors induced more moderate changes. The quantitative and certain qualitative morphological and biochemical changes (proteinuria, glucosuria, glycogen, RNA, DNA, and lipid content of nephron cells, enzyme activities, and even renal tissue architectonics) are in direct proportion to the SHF field dose, the numbers of exposure, and the time of hypoxia in combined exposures.

Preliminary irradiation with low dose SHF (50 or 500 $\mu W/cm^2$) alleviates the effects of acute hypoxic hypoxia, whether exposure to the latter takes place immediately after irradiation or a month later. Alleviation is more pronounced if the exposure to hypoxia occurs after ten irradiations with a low dose SHF field (50 $\mu W/cm^2$ for 7 h), especially if a month elapses between the last irradiation and hypoxia.

Under the experimental conditions employed here the combined effects of the SHF field and hypoxia, as evaluated in terms of morphofunctional renal changes, were reversible. However, more than two months are required for complete normalization of all the histochemical and structural aberrations in the cells of the nephron, while complete recovery of the excretory function is seen within 10-30 days of exposure.

BIBLIOGRAPHY

Belokrinitskiy, V.S., "Morphological and histochemical changes in compensatory adaptation during oxygen deficiency", FIZIOL. ZHURNAL AN USSR, Vol 23, No 4, 1977, pp 504-515.

Belokrinitskiy, V.S. and GRIN', A.N., "Effects of SHF electromagnetic field on metabolism and renal function", 10th Meeting of the Ukrainian Physiological Society, Naukova Dumka, Kiev, 1977, pp 25-26.

Belokrinitskiy, V.S. and Grin', A.N., "Effects of hypoxic hypoxia on structural and functional renal changes", FIZIOL. ZHURNAL AN USSR, Vol 21, No 6, 1975, pp 787-793.

Grin', A.N., "Effects of low doses of SHF electromagnetic waves on certain indicators of renal function and water-electrolyte metabolism", VRACH, DELO, No 10, 1976, pp 130-131.

Grin', A.N., "Age-related changes in renal function and water-electrolyte metabolism in UHF-irradiated rats", 10th Meeting of the Ukrainian Physiological Society, Naukova Dumka, Kiev, 1977, pp 96-97.

Grin', A.N., "Effects of certain physical factors on indicators of water-electrolyte metabolism", VRACH. DELO, No 12, 1976, pp 116-117.

Pearce, E.,"Histochemistry", Izd. Inostr. Lit., Moscow, 1962, 962.pp.

Rudnev, M.I., Nozdrachev, S.I., Belokrinitskiy, V.S. and Grin', A.N., "Functional and morphological changes in animals during acute hypoxic hypoxia", in:"Oxybiotic and anoxybiotic processes in experimental and clinical pathology", Naukova Dumka, Kiev, 1975, pp 183-184.

Shperling, I.D. and Gusakova, I.F., "Evaluation of histochemical manifestations of redox enzymes in the myocardium by means of nitroblue tetrazolium", ARKH. PATOL., Vol 34, No 10, 1972, pp 81-85.

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MANUAL THERAPY

Moscow SOVETSKAYA ROSSIYA in Russian 6 Apr 83 p 4

[Article by V. Ivanchenko, candidate of medical sciences: "Treatment Without Drugs--Medical Talks"]

[Text] There is a large flow of letters to the editor on medical topics. There are particularly frequent questions about new, highly effective, non-drug methods of treatment that are being introduced in recent years. For example, readers T. Baklanov from Chita, V. Kuz'mina from Novorossiysk and others asked us to tell about the method of manual therapy.

The history of development of this method goes far back into the past, when people began to use various methods of massage. It was gradually learned that special manipulations of the bones could set fractures and result in speedy bone fusion. Procedures were found that eliminated pain and inflammatory processes in the spine, muscles and joints. In Russia, such people, who handed down their skills from generation to generation, were called "bone-setters." Incidentally, among them were two relatives of M. V. Lomonosov. They even received cash prizes from the government for their unselfish therapeutic work. At first glance, it would appear that this is already history. However, I was recently in Abkhazia on a business trip, where I had the opportunity to see the remarkable results of treatment of fractures by one of the local old timers. He is, in a way, the last of the Mohicans. Having no medical education, such people cannot submit their techniques to official testing. Physicians are taught such techniques, but with scientific validation, at institutes in France, England, the United States and Canada.

In our country, methods are used of manual therapy ("manu" which translates into "hand"), which are popular in socialist countries, particularly Czechoslovakia. For example, physicians in Kazan demonstrated that the rapid analgesic effect of manual therapy is related to removal of tension from the muscles near the spine and unblocking of joints: a bedridden patient experiences immediate relief and freedom of motion. Manual therapy has a great future. But one cannot consider it miraculous, and it can only be used in conjunction with other therapy.

Readers K. Rep'yev from Lipetsk and M. Mubaryakov from Orenburg had heard about the curative effect of permanent magnets, but do not know whether they can make and use them on their own. There is an unequivocal answer: magnetotherapy is administered only when prescribed and under the supervision of a physician. Permanent magnets used for therapeutic purposes are divided into two groups: magnetophores and magnetotrons. The former are already in use in clinical practice, and they have anti-inflammation, analgesic, anti-edema and vasodilating action. Magnetotrons, which were developed by V. S. Patrasenko, head of the magnetotron laboratory at the "Magnit" Industrial Association in Novocherkassk, are even more promising.

For the time being, magnetotherapy is being introduced slowly, because of the conservative attitude toward it on the part of medical scientists. This is understandable: untested magnets are used too often for self-treatment. I had occasion to see magnetic boots, chairs, pillows and even beds designed by home-grown specialists. One aged inventor even wears a magnetic ... hat, in the belief that this prolongs his life. It turns out that he had read about the experiments of Rostov scientists under the guidance of Prof L. Kh. Garkavi: they discovered in an experiment that magnetic fields have rejuvenating effects. But one cannot extrapolate experiments on animals immediately to man! Such ventures often harm serious science, discrediting magnetotherapy and labeling it as a panacea.

In this respect, the effect of magnetic sand is interesting. At one of the beaches on the Black Sea coast of the Caucasus, there is a place with such a natural magnetic anomaly. The local sand, discovered in the vacation season, has a therapeutic effect on the body. For example, walking barefoot becomes a sort of magnetic massage for the feet, with a reflex effect on viscera. The scientists of Tbilisi, who conducted a study, confirmed the positive effect. At the same time, spending too much time on such a magnetic beach could impair arterial pressure, blood clotting and cause headaches. Consequently, thoughtless use of magnets is hazardous to health, for excessive exposure to a magnetic field is even more harmful than too little, and only a physician can find the happy medium....

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UPDATE ON MAGNETOTHERAPY

Moscow SOVETSKAYA ROSSIYA in Russian 3 Jul 83 p 2

[Article by V. Ivanchenko, candidate of medical sciences: "Magnetic Storms Are Not Frightening--Follow-up on an Article in SOVETSKAYA ROSSIYA"]

[Text] After publication of the item, "Treatment Without Drugs" (6 April 1983), many letters were sent to the editor, in which the readers asked for a continuation of the conversation about the achievements and prospects of the new method of treatment, magnetotherapy. Today we are continuing our talk on this topic. The nation's first magnetotherapy department is functioning in Sochi, in the Sanatorium imeni S. M. Kirov. This is a unique department. We are impressed by the permanent magnets of different shapes and sizes. Probably only here is there a complete set of magnetic clothing--starting with slippers and ending with a magnetic beret. "How effective is your treatment?" I asked Ye. V. Utekhin, doctor of medical sciences, who heads the department. Instead of an answer, he hands me a notebook with patients' comments:

"After treatment with magnetic applicators, pain disappeared from my joints, and I returned home without a cane" (G. Blagoslavskiy, Achinsk, Krasnoyarsk Kray). "For many years I had insomnia and could not fall asleep without sedatives. Now I sleep well, and even my memory improved" (R. Kreysina, Kum-Dag, Turkmen SSR).

Yes, Yevgeniy Vasil'yevich Utekhin is the founder and spirit of this department. He is a highly qualified scientist who has authored more than 100 scientific works; expressly he was the initiator of a combined [complex] approach to magnetotherapy. Obviously, my first question was about whether there was any exaggeration in the comments of those who regained their health.

"I think not," Yevgeniy Vasil'yevich began. "A magnetic field has an effect on the entire body and individual organs. Delivery of blood to them improves, smooth muscle spasms are removed, there is intensification of regeneration, phagocytosis and membrane permeability; an anti-inflammation and analgesic effect is obtained. This explains the good therapeutic response, even in the case of severe glaucoma complicated by myopia."

The innovative combined approach distinguishes all of the work of this scientist. Under his guidance, wards with a compensating electromagnetic unit have been set up in the department, for the first time in our country. When there is an increase in intensity of earth's magnetic field, a telegram is sent from the Scientific Research Institute of Applied Geophysics (Moscow): "A magnetic storm has started." This means that one must place magneto-sensitive patients in these wards. Electric current of the required polarity is delivered automatically there, and it maintains a close to normal level of magnetic field. Then the patients do not have to fear about any flare on the sun. Future plans include development of "immunity" to magnetic storms.

In this sanatorium, magnetotherapy is used to treat patients with osteochondrosis of the spine, atherosclerosis and endarteritis of the extremities. To demonstrate this graphically, Yevgeniy Vasil'yevich pointed to a mound of sand on a table: "Now let us dissolve [resorb] it." After several minutes of exposure to a variable magnetic field the mound disintegrates before our eyes. Evidently, a similar process at a somewhat slower pace occurs in the body in magnetotherapy for "salt depositing" processes.

As for atherosclerosis, it is, to put it graphically, scum on the wall of a vessel. And we know that magnetized water prevents formation of scum [scale] on pipes. Perhaps magnetized blood does the same thing? There are many questions. One thing is clear, the clinical response is evident. "Magnetic" iodobromide and salt water baths have earned a good name for themselves. In the future, there will be testing of a magnetic track for therapeutic running and walking, magnetic toothbrushes for prevention of periodontosis, massage in a magnetic field and other methods. Recently, the scientists of Sochi reported at an All-Union conference in Pushchino-na-Oke on the results of studying man's sensitivity to magnetism. This inspired enormous interest. It was found that most people are moderately and mildly sensitive to magnetic fields. They are called magnetostable. But some have high magnetosensitivity. For this reason they can feel a change in the weather because of change in earth's magnetic field. The efficacy of magnetotherapy for them is also particularly high. There are virtually no people who do not respond at all to magnetic field therapy.

Not only patients, but physicians visit the sanatorium. Several seminars have been held there. People are glad to share their experience. It is not in vain that professors and scientists from medical and scientific research institutes in Moscow, Kuybyshev, Kazan, Saratov, Omsk and other cities visited Sochi.

Of course, by far not all of the capabilities of the new method have been discovered. There is an interesting search ahead.

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