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DIENCEPHALIC DISORDERS IN PERSONS EXPOSED TO THE PROTRACTED EFFECT OF A SUPERHIGH-FREQUENCY (SHF) ELECTROMAGNETIC FIELD

[Following is a translation of an article by V. N. Gur'yev, Order of Lenin Academy of Military Medicine imeni S. M. Kirov, in the Russian-language publication Ekspertiza trudosposobnosti i trudoustroystvo pri nervnykh i psikhicheskikh zabolevaniyakh (Work Fitness Expertise and Work Arrangements in Nervous Mental Diseases), edited by Docent P. A. Makkaveyskiy, Vol XVIII, Works of the Leningrad Scientific Research Institute of Work Fitness Expertise and Occupational Guidance of the Disabled Ministry of Social Security RSFSR, No XVIII, Leningrad, 1965, pages 121-127.]

For several years now we have been observing more than 300 persons who were exposed to protracted superhigh-frequency (SHF) electromagnetic radiation with an intensity ranging from 70 to 200 microwatts/cm<sup>2</sup> for 6 hours a day. Nervous disorders in the form of neurasthenia or neurocirculatory dystonia have been noted in 158. Autonomic disorders are regularly associated with nervous diseases caused by chronic SHF radiation. They intensify with time and more or less pronounced dysfunction results.

Persons with diencephalic disorders present a great variety of complaints (Table 1) matched by numerous autonomic-vascular, metabolic-endocrine, trophic, and other symptoms.

Table 1

Complaints of Patients with Diencephalic Disorders

(1)	Жалобы	Число больных	%
(1)		(2)	
(3)	Общая слабость, утомляемость . . . . .	63	41,4
(4)	Вспыльчивость, раздражительность . . . . .	68	44,7
(5)	Тяжесть в голове, головные боли . . . . .	67	48,8
(6)	Головокружения . . . . .	23	14,7
(7)	Нарушение сна . . . . .	56	35,4
(8)	Ухудшение памяти и внимания . . . . .	36	22,8
(9)	Боли в области сердца . . . . .	53	33,5
(10)	Потливость, сальность кожи . . . . .	64	40,5
(11)	Трофические расстройства . . . . .	44	28,0
(12)	Эндокринные расстройства . . . . .	54	31,1
(13)	Нарушение питания . . . . .	40	25,3

1 - Complaints; 2 - Number of patients; 3 - General weakness, ready fatigability; 4 - Irritability; 5 - Heaviness in head, headaches; 6 - Vertigo; 7 - Impaired sleep; 8 - Poor memory and inattentiveness; 9 - Pain in heart region; 10 - Hidrosis, greasiness of skin; 11 - Trophic disorders; 12 - Endocrine disorders; 13 - Impaired nutrition

Autonomic-vascular symptoms include vasomotor disturbances, bradycardia, tachycardia, hypertrophy, cardiac changes, hidrosis, etc. (Table 2).

Table 2

Commonest Clinical Symptoms of Patients with Diencephalic Disorders

	Клинические симптомы (1)	Число больных (2)	%
(3)	<i>I. Вегетативно-сосудистые симптомы</i>		
(4)	Вазомоторные расстройства . . . . .	70	44,3
(5)	Брадикардия . . . . .	25	15,8
(6)	Тахикардия . . . . .	16	10,1
(7)	Гипотония . . . . .	76	48,1
(8)	Гипертония . . . . .	23	14,5
(9)	Изменения со стороны сердца . . . . .	40	25,3
(10)	Потливость, сальность кожи . . . . .	64	40,5
(11)	Нарушения дермографизма . . . . .	48	30,4
(12)	Пиломоторный рефлекс . . . . .	36	22,8
(13)	Пошатывание при закрытых глазах, тремор конечностей . . . . .	74	47,7
(14)	<i>II. Обменно-эндокринные симптомы</i>		
(15)	Нарушение питания, потеря веса, ожирение . .	40	25,3
(16)	Эндокринные расстройства (импотенция, бесплодие, увеличение щитовидной железы) . . . . .	54	34,1
(17)	<i>III. Расстройства сна (сонливость днем и бессонница) . . . . .</i>	56	35,4
(18)	<i>IV. Трофические расстройства (выпадение волос, кожный зуд, боли в суставах, ломкость ногтей и др.) . . . . .</i>	44	28,0
(19)	<i>V. Нарушение терморегуляции . . . . .</i>	4	2,5
(20)	<i>VI. Эмоционально-психические расстройства . .</i>	7	4,4
(21)	<i>VII. Дизэнцефальные кризы . . . . .</i>	15	10

1 - Clinical symptoms; 2 - Number of patients; 3 - I. Autonomic-vascular symptoms; 4 - Vasomotor disturbances; 5 - Bradycardia; 6 - Tachycardia; 7 - Hypotension; 8 - Hypertension; 9 - Cardiac changes; 10 - Hidrosis, greasiness of skin; 11 - Impairment of dermatographia; 12 - Pilomotor reflex; 13 - Tottering with eyes closed, tremor of extremities; 14 - II. Metabolic-endocrine symptoms; 15 - Impairment of nutrition, loss of weight, adiposis; 16 - Endocrine disorders (impotence, infertility, enlargement of thyroid gland); 17 - III. Sleep disorders (daytime sleepiness and insomnia); 18 - Trophic disorders (loss of hair, pruritus, pain in joints, brittleness of nails, etc.); 19 - V. Impairment of thermoregulation; 20 - Emotional-mental disturbances; 21 - Diencephalic crises

Metabolic-endocrine symptoms are manifested in impairment of fat metabolism (adiposis, exhaustion) and water-salt metabolism (thirst), poor appetite or anorexia, less commonly in unendurable hunger (2 patients). The relative significance of the symptoms is shown in Table 2.

Some symptoms are produced by functional changes in the gonads and thyroid. Females suffer disturbances of the menstrual cycle while males become impotent and lose sexual desire.

A variety of disturbances of thermoregulation were noted in 26 persons in the form of slight equalization of axillary and rectal temperatures (isothermia), lower rectal than axillary temperature (thermal inversion). Twelve suffered change in Shcherbak's thermoregulating reflex. Some could not tolerate an abrupt change in the ambient temperature or exposure to sunlight.

Disturbances of sleep and wakefulness were noted in 56 patients as reflected in hypersomnia, sometimes with disruption of the sleep rhythm. Other patients suffered from insomnia.

Trophic disorders (44 patients) were generally vague - changes in skin coloring, pruritus, local edema, early loss of hair.

Emotional and mental changes were in the form of asthenic-neurotic reactions and hypochondria.

Examination of the animal nervous system revealed micro-organic symptoms in many patients (Table 3).

Table 3

Symptoms of Involvement of the Animal Nervous System

Симптомы (1)	Число больных (2)	%
(3) Нарушения черепно-мозговой иннервации (анизокория, миез, разница глазных щелей, вялость зрачковых реакций и др.) . . . . .	17	10,8
(4) Изменения рефлекторной сферы (повышение, вялость) . . . . .	29	18,3
(5) Повышение механической возбудимости мышц	5	3,1

1 - Symptoms; 2 - Number of patients;  
 3 - Impairment of cranial innervation (anisocoria, miosis, difference in orbital fissures, sluggishness of pupillary reactions, etc.);  
 4 - Changes in reflexes (increase, sluggishness); 5 - Increase in mechanical excitability of muscles

Dysfunction of the cranial nerves was reflected in anisocoria, miosis, asymmetry of the orbital fissures, increase in or sluggishness of tendon reflexes. There were no gross reflex or sensory disturbances.

Cardiovascular disorders were in the form of a tendency toward hypotension and bradycardia and, in subsequent examinations, hypertension and tachycardia were frequently observed. Some patients had widened heart margins, dull sounds, EKG changes in the form of muscular impairment.

The above findings testify to the variety of clinical symptoms that may result from impairment of the central vegetative parts of the diencephalic region.

In accordance with the generally accepted classification of diencephalic lesions, we believe that the disorders noted can be ascribed to the autonomic-cardiac form with endocrine disturbances on the basis of the complaints and symptoms presented.

The fact that the disease follows a chronic course and that the changes are reversible shows that they are functional in nature. However, the discovery of microsymptoms suggests the presence of organic changes in the diencephalon. The presence of certain symptoms and syndromes in a number of patients with pronounced neuroendocrine disorders makes it possible to localize quite definitely the pathological changes in various nuclei of the hypothalamus.

It is noteworthy that the clinical picture was characterized by several syndromes, implying broad localization of the pathological process mainly in the central portions of the hypothalamus and a relationship between the resultant disorders and the anterior and posterior portions of the hypothalamus.

Diencephalic crises are a peculiar manifestation of diencephalic disturbances. We observed patients in whom autonomic paroxysms were combined with a variety of autonomic symptoms. Moreover, their EEGs showed changes indicative of decreased biological activity of the cortical cells. In patient V. the EEG changes showed the presence of epileptic activity. Thus, diencephalic crises can be regarded as a manifestation of involvement of the diencephalic region in the form of a diencephalic syndrome.

Fifteen of our patients had this form of the disease. Attacks and autonomic-vascular dysfunction were among the most prominent of the symptoms. They also suffered from metabolic-endocrine disorders. Emotional and mental disturbances were quite pronounced, especially during attacks.

Attacks occurred with pronounced autonomic-vascular disorders, but without loss of consciousness, more or less as follows. While the patient was feeling good, he suddenly felt a darkening in the eyes, dizziness, and muscular weakness. Constricting pain appeared in the heart region. An attack lasted 1-2 minutes and ended in profuse perspiration. Improvement set in gradually, but general weakness and heaviness in the head persisted a long time.

Diencephalic attacks usually developed after working with SHF machines, with considerable intensity of radiation, and they could occur several times a month. They even occurred when the person was away from work. In patient V., for example, attacks, associated with motor restlessness (arms, legs, lower jaw twitched), occurred at night during sleep. He could not be awakened. He felt pain in the arms and legs for a month thereafter. A neurological examination failed to reveal the focal symptoms of nervous system involvement.

The similarity of such diencephalic crises and their connection with work conditions are worth noting. For example, M. had attacks while working with a SHF machine. He would suddenly have an accelerated heart beat, his breathing became labored, convulsive twitchings appeared in the legs, and marked weakness and hidrosis followed. He was unable to perform his work satisfactorily for a week.

Some attacks were mild. I., for example, would suddenly feel as though he were struck in the back of the head, had a fever. He would turn red, perspire profusely, have arm tremors, speak disjointedly, stammer. Improvement set in after 1-3 minutes.

Other patients suddenly became dizzy, weak, pale, and felt as though their heart had stopped beating. This condition lasted 1-2 minutes and ended in hidrosis. General weakness and heaviness in the head persisted after a diencephalic crisis.

These diencephalic crises occurred against a background of marked autonomic disturbances, "storms". The following case is illustrative of the autonomic disturbances and diencephalic attacks resulting from exposure to a SHF field.

S., born in 1929, was a radar technician with 10 years' experience. After 5 years he developed signs of moderate autonomic dystonia. His condition deteriorated thereafter. Besides symptoms of pronounced neurasthenia with autonomic and endocrine disorders after intense exposure to SHF, he began to have sudden attacks of severe muscular weakness accompanied by tachycardia, constricting pain in the heart region, dryness in the throat, and hidrosis. The attacks lasted 2-3 minutes after which he felt weak and apathetic for several hours.

The development of autonomic symptoms can be judged from the predominance of tone in one of the parts of the autonomic nervous system during a diencephalic crisis, a fact of importance in pathogenetic therapy. For example, our patients' attacks began with symptoms indicative of increased tone of the parasympathetic nervous system.

We believe that all the manifestations of diencephalic disorders in our patients can be ascribed to the fact that the process is localized in the hypothalamus.

Diencephalic crises are apparently very similar to the autonomic-vascular form of hypothalamic impairment. This identification is tentative, although it is supported by the distinguishing features and peculiarities noted above.

It is reasonable to assume that the main pathological process after prolonged exposure to a SHF electromagnetic field is localized mainly in the central and posterior portions of the hypothalamus, while the neurodynamic disorders are more widespread, apparently due to involvement of other divisions of the central nervous system.

The results of our observations are in agreement with some data obtained in studies of diencephalic epilepsy by Ye. F. Davidenskova-Kul'kova (1959) and A. Ya. Mints (1958) but of another etiology (infection, cranial trauma, insolation, etc.).

In summary, persons exposed to an electromagnetic field for a long time may develop pronounced autonomic symptoms accompanied by diencephalic crises. The nature and intensity of the autonomic disorders vary with the intensity and duration of exposure to the SHF field and with the individual. The changes are functional and tend to disappear after appropriate treatment and transfer to other kinds of work.

Our findings indicate that persons exposed to SHF radiation need not suffer permanent disability provided that physicians utilize the preventive measures available.

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