

Treatment of occupational neurosensory deafness by transcranial electrostimulation therapy

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Workers in leading occupations (assemblers, electric welders, woodcutters, mechanics, and so on) employed in construction, repair and utilization of nuclear submarines are exposed to a set of harmful industrial factors of which the main one is noise. The noise level exceeds the LPL (80 dBA) for practically the whole of the working shift: the equivalent noise level for workers of different occupations varies from 86 to 125 dBA and naturally leads to hearing damage [1 and others]. The specific weight of occupational deafness in the structure of occupational morbidity of the Nuclear Shipbuilding Centre varies, depending on the occupation, from 10 to 45%.

Occupational neurosensory deafness (OND) of different degrees of severity arises, as a rule, for a length of service of more than 10 years but is occasionally found for a service length of from 5 to 10 years and in individual workers with enhanced individual sensitivity to noise, after 2 to 4 years [1].

A reduction in noise down to admissible levels by technical means under the conditions of existing technology is unfortunately impossible and the ear plugs used give insufficient protection of the organ of hearing against noise. Therefore the means of choice can be treatment of OND. However, the drug and general physiotherapy treatment methods used are not sufficiently effective.

In the last decade several electrostimulation (ES) methods were

proposed for the treatment of chronic neurosensory deafness of non-occupational genesis: transcranial, endaural, promontorial and so on. According to the data of different authors, the effect from treatment by the different ES methods varies within wide limits – from 6 to 75%.

The present work is a first investigation devoted to the validation and assessment of the effectiveness of the treatment of OND patients by the transcranial electrostimulation method - TES therapy.

In the selection of electrostimulation method for OND treatment a comparison was made of the effectiveness of the methods indicated. This suggested that transcranial electrostimulation can show sufficient effectiveness in OND treatment. It was assumed that the main healing effect might be connected with an enhancement of the excretion in urine of endorphin and other opioid peptides under the action of the TES [2, 7]. It has been shown in recent years that opioid peptides have an analgesic effect and are involved in the regulation of the central hemodynamics (improving the oxygen supply to the brain), in reparation, stress and immune reaction processes and so on [2, 6, 7]. On the basis of the fact that the synthetic opioid neuropeptide that is used - delargin - had a positive effect in neurosensory deafness [8] the suggestion was made of the possibility of obtaining a similar effect by the stimulation of endogenic neuropeptides by means of the electric

Exposure to noise leads to hearing damage, the development of occupational neurosensory deafness and occupationally caused disturbances of the overall state of health. The use of transcranial electrostimulation therapy promotes improvement of the hearing function and the state of health of the workers.

Neighbours protest booming cannons in blueberry farmers' field

People living within earshot of blueberry farms in British Columbia's Fraser Valley region want farmers to stop using cannons to protect their fields. They've started picketing because they can't stand the frequent gunshot-like blasts that are supposed to scare away blueberry-picking birds. "I came here for the peace and quiet. And for fifteen years it was like that," said Iver Lee, one of the founding members of Ban the Cannons, a group formed last June. Lee said the propane cannons - which are set up on rotating tripods and are timed to go off every three or four minutes - wake him up at dawn "with a loud thud" and keep firing until evening. "We live in a modern environmentally sensitive society now," said Lee. "We feel that farming should be socially responsible." But Abbotsford blueberry farmer Rajjinder Lally, who uses 20 cannons to protect his berry farm, said groups like Ban the Cannons must face the reality of living in farm country. "I don't think those people are right," said Lally, who has been using the cannons for 21 years. "When they move from town to a rural area the people don't know what farming is like. Farmers have a right to farm." Ban the Cannons can't ask the city of Abbotsford for help to get rid of the devices because provincial right-to-farm legislation protects farmers against conflicts with their non-farming neighbours. The Farm Practices Protection Act exempts farmers from nuisance legal action and municipal noise and odour bylaws.

action of the transcranial electroanalgesia type. This was confirmed by the results of treatment of patients by this method [5, 7].

The transcranial electrostimulation method - TES therapy - and its instrumental realization were developed in the I.P. Pavlov Institute of Physiology of the Russian Academy of Sciences under the supervision of Prof. V.P. Lebedev. The "Transair" apparatus has the approval of the Ministry of Health of the Russian Federation for widespread application and is certified by a Government Standard.

Noise, which is an occupational stressor factor, leads, as a result of the disturbances of the nervous regulation and the vascular supply, to an increase in the frequency of cases of arterial hypertonia [4], ulceration, ulcerous colitis [3] and so on. In occupational deafness the changes are mainly of the nature of functional disorders in the form of vegeto-vascular dysfunction, neurocirculatory dystonia. Patients have headaches, vertigo, palpitations, increased sweating, and objective changes are manifested in severe red dermographism, a reduction or increase in arterial pressure, and the development of vegetative disorders (acrocyanosis, sweating and so on.)

Since the TES therapy method together with its healing effect in non-occupational neurosensory deafness has been successfully used in the treatment of many syndromes and diseases (depression, increased fatigability, reduction in working ability, migraine attacks, headaches, hypertonic disease of stages I, II, hypertonia, vegeto-vascular dystonia, etc.), the following main objectives of the study were formulated:

- to assess the effect of TES therapy on the state of the hearing function in occupational neurosensory deafness of various degrees of severity;

- to assess the effect of TES therapy on the general state of health of workers with OND exposed to the action of intense noise.

Materials and methods.

For the examination and treatment we selected 125 men with different degrees of loss of hearing: 48 with signs of the action of noise on the organ of hearing (0 degree); 26 with a slight degree (degree I), and 32 with a moderate degree of OND (degree III). The length of service under exposure to noise was from 6 years 3 months to 38 years 8 months. There were 22 men with up to 20 years of service, 74 from 20 to 29, and 29 with more than 30 years. The age of the patients varied from 27 years 4 months to 59 years 2 months. There were 9 men aged less than 40 years, 70 from 40 to 49, and 46 aged 50 and older.

For the study we developed a programme involving examination by a therapist, an otolaryngologist, and an audiometric technician, the noting of active complaints, measurement of arterial pressure, taking of the pulse, study of vegetative and vegeto-vascular disturbances; a study of the state of the hearing function; perception of whispered and spoken speech in both ears and also by means of tonal threshold audiometry (AD-28 audiometer, Denmark). The assessment of the hearing function was carried out in accordance with GOST 124062-78.

The treatment was carried out over three courses: one course was received by 125 patients, two by 106 workers and three by 83 men. The interval between the first and second courses was 7 months and that between the second and third - 4 months.

Each course of treatment consisted of 10 sessions carried out each day in the industrial medical-prophylactic facility with release of the patients from work involving exposure to noise for the period of the treatment (11

days); the length of a session was 30 min.

The assessment of the effectiveness of the treatment in terms of the state of hearing and the general state of health was made by comparison of the results of an examination after the treatment with the data before treatment. The results obtained were subjected to statistical analysis: the probability of the zero hypothesis was taken as the significant difference ($p < 0.05$).

The essence of the TES therapy method consisted in the action through the covering of the skull of a rectangular pulse of current via frontal and rectomastoidal electrodes. We used the action of asymmetric bipolar pulses with a frequency of 77 Hz, duration 3.5 ms, strength of not more than 1-1.5 mA, generated by the "Transair-01B" apparatus. The treatment was given in

the sitting position, with a comfortable pose. Before the treatment the electrodes, the external surfaces of the equipment and the skin covering in the place where the electrodes were fixed were disinfected. The electrodes (rectomastoidal and frontal) were put in place on the head and were checked to make sure there was no hair or wires under the liners. In order to reduce the natural anxiety of the patient, the doctor explained the treatment method before the procedure was started.

After the first course of treatment there was an improvement in 11 out of the 125 patients in hearing in the speech frequency region, which led to change in the degree of deafness in the sense of an improvement by one degree: in 3 people with the signs of the effect of noise on the organ of hearing there was normalization; 5

Table 1. Characteristics of the general state of health of OND Patients After Treatment by TES Therapy under Dynamic Observation (frequency of occurrence, %)

		After courses of treatment			
Complaints and indicators		Before treatment	1st course	2nd course	3rd course
Complaints	Headaches	59.2 ± 4.4	33.6 ± 4.2****	28.5 ± 4.4***	25.5 ± 4.5****
	Vertigo	27.2 ± 3.9	9.6 ± 2.6****	10.4 ± 3.0*	11.3 ± 3.5***
	Palpitations	24.8 ± 3.9	7.2 ± 2.3****	4.7 ± 2.1****	6.0 ± 2.6****
	Pain in the region of the heart	23.2 ± 3.8	10.4 ± 2.7***	8.5 ± 2.7***	8.5 ± 3.1***
	Increased fatigability	62.4 ± 4.3	20.8 ± 3.6****	26.4 ± 4.3****	27.7 ± 4.9****
	Reduction in the working ability	51.2 ± 4.5	16.8 ± 3.4****	21.7 ± 4.0****	18.1 ± 4.3****
	Increased irritability	48.0 ± 4.5	17.6 ± 3.4****	21.7 ± 4.0****	22.9 ± 4.6****
	Insomnia	36.8 ± 4.3	15.2 ± 3.2****	14.2 ± 3.4****	15.7 ± 4.0****
	Increased sweating	35.3 ± 4.3	21.6 ± 3.7**	12.3 ± 3.2****	20.5 ± 4.5**
	Chilliness of the arms	56.8 ± 4.4	40.0 ± 4.4**	45.3 ± 4.9*	38.6 ± 5.4**
	Parasthesia in the arms	55.2 ± 4.2	36.8 ± 4.3***	36.6 ± 4.7**	38.6 ± 5.4*
	Pains in the arms	60.0 ± 4.5	40.8 ± 4.4****	45.3 ± 4.9**	37.3 ± 5.3****
	Cramp in the gastrocnemius	41.6 ± 4.4	20.0 ± 3.6****	26.6 ± 4.3***	24.1 ± 4.7***
	Pains in the lumbus	57.6 ± 4.4	32.0 ± 4.2****	31.1 ± 4.5****	37.3 ± 5.3***
	Stomach pains	12.8 ± 3.0	3.3 ± 1.6***	3.8 ± 1.9***	3.6 ± 2.1**
	Dyspeptic disturbances	24.4 ± 3.9	11.2 ± 2.9***	8.5 ± 2.7****	6.6 ± 2.7****
	Increased SAP (> 140 mm st. Hg)	48.2 ± 5.5	43.4 ± 5.5	27.7 ± 4.9***	22.9 ± 4.6****
	Increased DAP (>90 mm st. Hg)	28.9 ± 5.0	24.1 ± 4.7	21.7 ± 4.6*	13.3 ± 3.7**
	Mottleness of the hands	45.8 ± 5.5	39.8 ± 5.4	26.5 ± 4.9**	25.3 ± 4.8***
Indicators	Hyperhydrosis of the palms	66.3 ± 9.1	48.2 ± 5.5	39.8 ± 5.4**	38.6 ± 5.4**
	Tremor in the fingers of the extended hands	41.0 ± 5.4	34.9 ± 5.3	24.1 ± 4.7*	25.3 ± 4.8*

4) Notes: 1) The significance of differences in the occurrence of the complaints and indicators after the TES therapy courses compared with the data before treatment is: * - $p < 0.05$; ** - $p < 0.02$; *** - $p < 0.01$; **** - $p < 0.002$. 2) SAP and DAP are the systolic and diastolic arterial pressures.

men from the group with a slight degree of OND moved to the group of “signs of the effects of noise on the organ of hearing”, and in 3 patients with a moderate degree of OND we diagnosed a slight degree of the loss of hearing.

After the second course of treatment an improvement in hearing by one degree occurred 2.4 times more often than with the first course.

The three courses of TES therapy were carried out on the 83 patients, who received the first, second and third courses. We found that in approximately half of the patients (43.4%) there was significant and stable improvement in hearing after the treatment. This made it possible to change the severity of the OND by one degree of improvement, mainly after the second course of treatment. As a result of the TES therapy, the hearing was normalized in 35.5% of people with signs of the action of noise on the organ of hearing. In all patients in 100% of cases of slight degree of OND the following diagnosis was found after three courses of treatment: signs of the action of noise on the organ of hearing, i.e. preclinical degree of OND; and in 43.5% of patients with a moderate degree of reduction in hearing we determined a slight degree of deafness. No positive effect was found in patients with a significant degree of OND even after three courses of treatment.

A slight deterioration in hearing after 7 months after the first course of treatment and a stabilisation over the 4 months in the period between the second and third courses indicate the repeated courses of treatment by the TES therapy method should be made at intervals of 3-4 months.

The level of the overall state of health of the workers before the treatment was extremely low. All the workers complained of their state of health; more than a half of them had raised figures of arterial pressure and

vegetative and vegeto-vascular dystonia (see table 1).

The treatment of OND patients by TES therapy had a clear positive effect on the overall state of health. Even after the first course of treatment there was a 1.5 - 3 reduction in complaints of headaches, vertigo, palpitations, pains in the region of the heart, enhanced fatigability, reduction in working ability, increased irritability, insomnia, pains in the arms, pains in the lumbus, cramps in the gastrocnemius, parasthesia in the arms, chilliness in the arms, increased sweating, stomach pains, and dyspeptic disorders ($p < 0.02-0.002$).

In addition to the improvement in the subjective state of health, we found a reduction in the number of people with enhanced systolic and diastolic arterial pressure figures (SAP and DAP), a decrease in the number of people with mottleness of the hands and the trunk, hyperhydrosis of the palms and feet, general hyperhydrosis, tremor of the fingers of the outstretched hands and other vegetative and vegeto-vascular disorders.

Conclusions

1) The use of TES therapy reduces the levels of occupational damage to hearing in reversible stages: signs of the action of noise on the organ of hearing, OND of slight and moderate degree of severity in workers under conditions of intense noise without change in their occupational activity. 2) The use of TES therapy in addition with the improvement in hearing show an obvious positive effect on the general state of health of the workers despite the constant exposure to not only noise but also the whole complex of occupational hazards typical of the leading occupations in the nuclear ship construction industry. 3) The use of TES therapy is an economically advantageous, non-drug, method of

treatment which does not have the side effects typical of drugs. 4) The Transair apparatus, providing the TES therapy, should be included as essential means of treatment in medico-sanitary departments and occupational pathology centres for patients with OND.

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Contingent on the passage into legislation of the Aeroacoustics Research and Development Revitalization Act of 2002 (introduced in the Senate) a number of initiatives have been proposed including, Section 101,

Environmental aircraft research and development initiative.

"Not later than 10 years after the date of enactment of this Act, the NASA Administrator shall develop and demonstrate, in a relevant environment, technologies that result in the following commercial aircraft performance characteristics:

(1) **NOISE** – Noise levels on takeoff and on airport approach and landing that do not exceed ambient noise levels in the

absence of flight operations in the vicinity of airports from which such commercial aircraft would normally operate."

Rotorcraft research and development initiative.

"(a) **OBJECTIVE** – Not later than 10 years after the date of enactment of this Act, the NASA Administrator shall develop and demonstrate, in a relevant environment, technologies that result in rotorcraft with the following improvements compared to rotorcraft operating on the date of enactment of this Act:

- (1) 80 percent reduction in noise levels on takeoff and on approach and landing as perceived by a human observer
- (2) Factor of 10 percent reduction in vibration."