EEG And Reg Indicators In Workers With Varying Degrees Of Professional Hearing Loss

Nasretdinova M.T.

Samarkand State Medical University, Republic of Uzbekistan, Samarkand

ABSTRACT

Introduction The auditory zone of the cerebral cortex is the first to react to noise exposure, giving rise to subsequent changes in other parts of the sound analyzer. Clinical and experimental observations also indicate a close relationship between disorders of cerebral hemodynamics and bioelectric activity of the brain in various diseases.

The aim of the study was to study the indicators of bioelectric activity of the brain and cerebral hemodynamics according to EEG and REG data in persons exposed to prolonged exposure to industrial noise.

Materials and methods 102 people aged 23 to 55 years old working in industrial noise conditions were examined. Bipolar rheoencephalography was used to study the state of cerebral hemodynamics. Statistical processing of the research results was carried out. The electroencephalogram was recorded in a sound-absorbing chamber in the sitting position of the subject using a 14-channel electroencephalograph.

Results The structure of hemodynamics in workers of "noise" professions was heterogeneous. As the auditory function deteriorated, the hemodynamic parameters also changed. The increase in vascular tone was also indicated by the indicators of the dicrotic index. Those working in noise conditions, even with normal hearing, have persistent foci of arousal in the cortical structures of the brain.

Conclusions A decrease in the amplitude of the a-rhythm in the temporal and occipital regions of the brain as hearing deteriorates in workers confirms the presence of changes in the cortical structures of the brain.

Keywords: Noise Exposure, Electroencephalography, Cerebral Hemodynamics, FUNG, Photostimulation

Relevance

In a number of experimental studies it was noted that the auditory cortical zone of the brain first reacts to noise exposure, giving impetus to subsequent changes in other parts of the sound analyzer (1-5). B. M. Sagalovich and coauthors in the study of electroencephalographic parameters in workers "noise" professions with normal hearing and initial manifestations of auditory disorders first established that under the influence of industrial noise first occur functional disorders in the central nervous system, in particular in the central parts of the sound analyzer.

According to L. N. Shkarinov, I. B. Evdokimova, Dieroff on the results of our own research, in cerebral hemodynamics in workers "noise" occupations are marked significant shifts, which can not but affect the bioelectrical activity of the brain. Clinical and experimental observations also indicate a close relationship between cerebral hemodynamic disorders and bioelectrical activity of the brain in various diseases (1,2).

Therefore, it was expedient to **study** the indicators of bioelectrical activity of the brain and cerebral hemodynamics according to EEG and REG in persons exposed to prolonged

exposure to industrial noise. Such studies have not been conducted before.

Materials of the study We examined 102 people aged from 23 to 55 years, working in industrial noise conditions. None of them had somatic, endocrine, psychiatric and nervous diseases in their anamnesis. The control group consisted of 20 persons who were not exposed to noise. According to the data of threshold, supra-threshold and speech audiometry, depending on the degree of hearing function impairment, the workers were divided into 4 groups. The 1st group included 22 people with normal hearing, the 2nd group included 30 examinees with initial signs of occupational hearing loss in the form of localized reduction of hearing acuity up to 30 dB at 4000 Hz, less often - 2000-3000 Hz, the 3rd group - hearing acuity up to 30 dB at 4000 Hz, less often - 2000-3000 Hz, the 3rd group -recruitment. Thresholds of perception of air- and bone-conducted sounds at frequencies 3000-8000 Hz were in them within 45-60 dB. The 4th group included 29 persons with a pronounced degree of auditory disorders, in which there was an increase in the thresholds of perception of air and bone-conducted sounds on the entire fine scale, mainly in the area of 3000-8000 Hz (more than 60 dB), as well as the presence of FUNG phenomena.

To investigate the state of cerebral hemodynamics we used bipolar rheoencephalography (REG) in fronto-mastoidal (F-M) and occipito-mastoidal (O-M) leads. REG was recorded on electroencephalograph of "Bioscript" company (GDR) using rheographic attachment 4RG-1M and rheographic attachment 4RG-1M.

We quantitatively analyzed the common REG parameters: the time of the ascending part of the wave (a) in seconds, the ratio of anacrotes to the duration of the whole wave (~) in percent, dicrotic (DCI) and diastolic (DCI) indices in percent, rheographic index (Ri) and REG wave amplitude (A) in ohms. Statistical processing of the research results was carried out. The electroencephalogram was recorded in a sound-absorbing chamber in a sitting position with a 14-channel electroencephalograph EEG-4214 (Nixon company). Before recording, a 10-minute adaptation of the patient to the study conditions was performed. Biopotentials were withdrawn monopolarly according to the scheme "10-20" recommended by the International Federation of EEG Society. They were recorded in temporal (11-15 and 12-16) and (11-9 and 12-10) occipital leads. Background EEG recording was performed, as well as EEG with functional loads (reaction to solid light, phostimulation with frequency 6,8, 10, 12, 14, 16, 18 and 10 Hz in equal time intervals - 10 s, as well as three-minute hyperventilation). In addition to visual assessment, quantitative analysis of some EEG parameters, in particular, the average amplitude in microvolts of a-waves, the value of the latent period of a-rhythm depression on solid light in seconds, and the degree of assimilation of the imposed rhythms during photostimulation was performed. According to the severity of assimilation of the latter, we distinguished four degrees: high (6-20 Hz), medium (6-14 Hz), low (8-12 Hz), and areactive (4.5). At the same time EEG results were recorded on paper and saved on the basis of EEG spectral analysis. The parameters were analyzed in the frequency range of 0.5-32.0 Hz. We obtained a histogram of the spectrum, calculated by adding the power of each spectrum, placed by harmonic analysis in Fourier series. Power distribution of each spectrum was determined for 6 channels (3 sub-bands for each channel - 0,5-7,5, 8,0-13,5, 14,0-32,0 Hz). Quantitative characterization of spectral power in the specified frequency ranges was presented in digital form in percent.

The conducted studies showed that the percentage of a-rhythm for temporal and occipital leads prevails in the control) (Table 1).

Table 1

The average values of REG indicators in the carotid and vertebral-basilar systems in people who do not work in noise conditions (control group), and workers in "noise" professions with normal hearing and various disorders

REG indicators in different leads	The studied indicators for workers of various groups				
	control	1	2	3	4
F—м	0,1'2±0,006	0,11±0,003	0,12±0,002	0,12±0,003	0,15±0,004
О—м	0,11 ±0,002	0,11 ±0,004	0,13±0,002	0,12±0,003	0,15±0,005
F—м	0,71±0,01	0,72±0,01	0,71±0,008	0,73 ±0,013	0,72±0,021
О —м	0,71±0,01	0,71 ±0,01	0,72±0,008	0,73±0,011	0,72±0,023
F—м	13,2 ± 0,36	13,2±0,36	13,8±0,23	13,3±0,24	15,1±0,51
О—м	14,1±0,47	13,7±0,47	13,7 ±0,57	13,9 ± 0,38	14,8±0,42
F—м	81,7±2,05	811,7±2,00	83,2 ±0,76	82,8±0,78	85,6±0,62
О—м	83,5±0,73	81,5±1,00	82,5 ±0,45	82,6 ±0,74	86,4±0,52
F—м	52,8±4,43	56,9 ±1,47	70,1 ± 1,21	72,8±1,37	78,1 ± 1,34
О—м	59,4±1,31	58,3± 1,43	68,5±1,13	71,6±1,63	80,1 ± 1,75
F—м	53,3±1,43	68,3 ±1,41	72,1 ±1,37	74,3±1,23	78,7±1,42
О—м	52,8±2,15	67,2±1,21	69,2±1,43	72,8±1,24	79,3±1,38
F—м	1,2±0,03	1,4±0,03	1,4±0,03	1,3±0,03	1,1±0,04
О—м	1,0 ±0,04	1,2±0,04	1,1±0,03	1,2±0,03	0,72±0,03

However, already in normal-hearing persons (group 1), working under noise exposure conditions, there was a slight decrease in the pro-percentage content of the a-rhythm and an increase in the 0-rhythm compared to those in the control group. At the same time such decrease for temporal lead was unreliable (1=0.96), and for occipital lead - reliable (1=2.24). As for 0-waves, both at temporal (1=2,18) and occipital (1=3,10) leads there was a reliable increase of id (for the control group - 18,3± ±1,8% in temporal and 14,4±2,3% - in occipital leads, and for the workers of the 1st group - 28,1±4,1% and 26,4±3,1% respectively). Deterioration of hearing in workers of "noise" occupations is accompanied by even more pronounced redistribution of the content of rhythms in EEG waves. At the same time there is a significant decrease in the percentage content of a-rhythm and an increase in 0-rhythm both in temporal and occipital leads in all four groups compared to that in the control group. All this indicates the activation of excitation processes in the cortical structures of the brain in workers of "noise" professions. Such phenomena are already revealed in the persons of the 1st group, i.e. with normal hearing. The average statistical parameters of a-rhythm amplitude in occipital and temporal leads also decrease as the auditory function decreases in workers of "noise" professions. If in group 1 the amplitude of a-rhythm in temporal lead was 36,5± ±4,0 μV, and in occipital lead 43,5±7,5 μV, then in group 2 and 3 (with initial and moderate hearing impairment without FUNG phenomena) it was equal to 30±3, 5 and 37,5±6,5 μV, as well as 26±4,5 μV and 28±4,5 μV, and in patients of the 4th group (with pronounced decrease of auditory function and FUNG phenomena) - 20± ±3,0 μV and 24,0±4,5 μV. The differences in the amplitude of "-activity for all groups compared to the control group are reliable (except for those in the occipital lead in the 1st and 2nd groups).

Consequently, as hearing decreases in workers of "noise" professions, depressed

electrical activity of the brain is observed, lengthening of the latent period of depression of "-activity on eye opening in temporal and occipital leads. Thus, if this latent period in the control group amounted to 0.10±0.01 s, then in workers of "noise" professions of the 4th group (with pronounced hearing impairment and presence of FUNG) it significantly lengthened to 0.16±0.02 s (1 = 2.68).

The degree of assimilation of the imposed rhythms during photostimulation in the control group workers in both leads was good, in the 1st and 2nd groups - average, in the 3rd group - low, in the 4th group - absent. At photo-stimulation and hyperventilation sharp waves and peaks were also registered, especially in temporal and occipital regions. Consequently, objective signs of disturbances in the cortical structures of the brain in persons of "noise" occupations were revealed.

An increase in the percentage composition of slow waves in occipital and, especially, in temporal leads in the examined persons of all groups in comparison with that in the control group was also noted. Thus, slow waves in temporal leads in normal-hearing persons (control group) amounted to 10.1 ±3.4%, and in workers of the 4th group (with pronounced hearing impairment and FUNG phenomena) they increased twice (21.6±4.2%, 1 = 2.15). The increase in the percentage of slow waves in workers of "noise" professions indicates the presence of changes in the functional state of subcortical brain structures (6-10).

According to the data of rheoencephalography the following results were obtained. Rheoencephalograms recorded from fronto-mastoidal and occipito-mastoidal leads in the control group were characterized by constancy of the curve shape and regular alternation of co-relevant phases of the cardiac cycle. The REG wave had a rather fast, steep rise and slow descent, a rather high amplitude, a sharp apex, and a well-defined dicrotic tooth located in the middle of the descending part of the curve. Rheoencephalographic waves were very stable with respect to the isoline, and respiratory waves were insignificantly expressed. The quantitative parameters of the REG curve were also within the normal range (Table1).

The data of the table show that the structure of hemodynamics in workers of "noise" occupations was heterogeneous. As the auditory function deteriorated, hemodynamic parameters also changed. The tone of cerebral vessels increased, as evidenced by the increase in the duration of anacrota of the REG wave (a) in both hemispheric and occipital leads. In workers of the 2nd group this index was 0.13± ±0.002 s, and in the 3rd group - decreased to 0.12±0.003 s, probably due to the mobilization of adaptive properties of the sound analyzer. However, in the future, as hearing decreased, the duration of anacrotha gradually increased and in the 4th group (with pronounced hearing impairment and FUNG phenomena) it reached 0,15±0,004 s.

The increase of vascular tone was also evidenced by dicrotic index (DIC). Thus, in group 1 with normal hearing it was equal to 56.9±1.47% in fronto-mastoidal and 58.3±1.43% in occipito-mastoidal leads, i.e. it was practically within the physiological norm, but as the hearing function deteriorated it increased and in group 4 workers it reached 78.1±1.34% in the carotid and 80.1±1.75% in the vertebral-basilar system.

Disturbances of venous circulation to the greatest extent were observed in the persons of group 4, as evidenced by the increased diastolic index (DI) equal to 78,1 ±1,42% in hemispheric and 79,3 ± 1,38% - in occipital leads. Changes were also observed in cerebral blood flow in the system of vertebral arteries. The rheographic index was within the normal range in the 1st, 2nd and 3rd groups, and in the 4th group - reduced (0.72 ± 0.03) (11-15).

Conclusions Workers working in noise conditions, even with normal hearing, have persistent foci of excitation in the cortical structures of the brain, which may be one of the first signs of pathological effects of noise on the central parts of the nervous system. Decrease of a-rhythm amplitude in temporal and occipital regions of the brain as the workers' hearing deteriorates confirms the presence of changes in the cortical structures of the brain. The most significant shifts in the EEG and REG parameters

were revealed in the examined with pronounced hearing loss and signs of FUNG. The study of the state of cerebral vessels and its bioelectrical activity will contribute to the disclosure of the pathogenesis of professional hearing loss and the development of optimal measures for the treatment and prevention of these disorders.

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