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TEMPORAL CHARACTERISTICS OF THE ACOUSTIC REFLEXES OF THE INTRA-AURAL MUSCLES IN "NOISE" WORKERS WITH NORMAL HEARING AS WELL AS WITH INITIAL AND PRONOUNCED HEARING IMPAIRMENT

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Summary: The author presents the data on the rise and fall times of intraaural muscular acoustic reflex in the noise-exposed workers depending on their functional state. In workers with practically normal hearing there was a difference in duration of these periods (fall and rise) in presence of a 10-dB tonal perception difference in 4000 to 8000 Hz range. Considerable lengthening of both periods was revealed in the workers with a marked impairment of the hearing function. This may be explained by fatigue processes development in the neuromuscular system of the hearing organ.

Key words: Noise, pure-tone audiometry, auditory reflexes.

Some authors consider the acoustic reflex of the intra-aural muscles (ARIM) as a natural protective property of the hearing organ, which reflexively arises in response to the impact of high-intensity sound stimuli and leads to a change in the acoustic impedance of the sound-conducting system of the middle ear, and as a consequence - to a violation of the conditions of sound conduction (1,3,5). However, it is difficult to get a clear picture of the role of this phenomenon in the process of natural biological protection of the pre-cochlear organ from the effects of high-intensity sound stimuli based on published works.

A detailed study of the acoustic reflex of the intra-aural muscles, in particular its temporal characteristics, was carried out by L.N. Butenko of normal-hearing individuals. T.V. Shidlovskaya et al. presented the results of determining the temporal characteristics of the ARIM in workers of "noise" occupations, but they concerned only the latent period and the time of active aftereffect of the ARIM.

We conducted a study of the rise time, action and decline of the acoustic reflex of the intra-aural muscles in workers in "noise" occupations with normal hearing, elements of impaired sound perception and its pronounced reduction. To determine these parameters, ARIM recordings were made in 40 persons working in conditions of intensive industrial noise exposure, and in 10 persons with normal hearing function, not exposed to noise (control group). The ears of the control group were within normal limits, they had no history of neurological diseases.

Recording of the acoustic reflex of the intra-aural muscles was carried out using an impedance meter by "Amplaid" (Italy) with simultaneous transfer of data to magnetic media and their subsequent reproduction on paper using a self-recording device.

The threshold of ARIM occurrence measured by the impedance method was taken as the sound pressure level required to detect the smallest recorded value of impedance change.

When determining the temporal parameters of ARIM, the sound pressure level was 10 dB above the threshold of occurrence, the time of action of the acoustic stimulus was 1000 ms, stimulating frequencies were 500, 1000, 4000 Hz.

During ARIM registration, the acoustic stimulus was applied ipsi- and contralaterally to the ear under study, in accordance with which the ipsi- and contralateral acoustic reflex was recorded. Mathematical statistics methods were used to process the obtained data.All examined workers of "noise" professions were subdivided into 3 groups. The 1st group included persons with full perception of tones on the whole fine scale under study (125-8000 Hz), with normal values of speech

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audiometry and thresholds of differentiation (TD) of sound strength in the area of 500, 2000 and 4000 Hz at an intensity of 20 dB above the threshold. Workers with elements of sound perception disorders, whose hearing thresholds for tones in the range of 125-3000 Hz were within the normal range, and in the range of 4000--8000 Hz at 10-15 dB higher, constituted the 2nd group. Speech audiometry and sound force PD were within the normal range. The 3rd group included persons with pronounced hearing impairment, who had increased thresholds of 100% intelligibility of the verbal test by G.I. Greenberg and D.I. Zinder and 50% intelligibility of the numerals test by E.M. Kharshak, as well as relatively lower thresholds of sound force differentiation in the area of 2000 and 4000 Hz.

The analysis of the above parameters of the temporal characteristics of ARIM revealed coincidence or insignificant differences in the values of all the studied parameters at normal hearing both in workers of "noise" professions and in those who did not work in noise.

A sharp decrease in the duration of the ARIM rise time at ipsilateral stimulation with a sound frequency of 500 Hz was observed in group 2. The ARIM rise time in them amounted to 94±9.4 ms (Fig. 1). In group 1, this index was equal to 158.7±14.7 ms. The same dependence was observed in contralateral stimulation. Thus, in workers of the 2nd group the ARIM rise time amounted to 102.0± 18.5 ms, and in the 1st group - 182.5± 21.0 ms. In group 3 workers, the ARIM rise time was 185.7±38.4 ms and 146.6±39.0 ms during ipsi- and contralateral stimulation, respectively.

Consequently, the average statistical parameters of ARIM action time at ipsi- and contralateral stimulation in persons of "noise" professions with pronounced hearing loss undergo insignificant changes in comparison with those in normal-hearing persons working in noise. They are expressed in some decrease of its duration at all stimulating frequencies.

Deterioration of auditory function in workers of "noise" occupations is accompanied by an increase in the decline time of the acoustic reflex of the intra-aural muscles at all stimulating frequencies at ipsi- and contralateral presentation of the stimulating signal. Thus, at ipsilateral stimulation the ARIM decline time in the 1st group was equal to 226,0±23,2 ms, 2nd - 252,28±29,7 ms and 3rd - 365,71±31,3 ms at the signal frequency of 1000 Hz, and at contralateral stimulation with sounds of the same frequency - 240,6±20,7; 285,5±33,1 and 323,3±27,4 ms, respectively (Fig. 1,2).

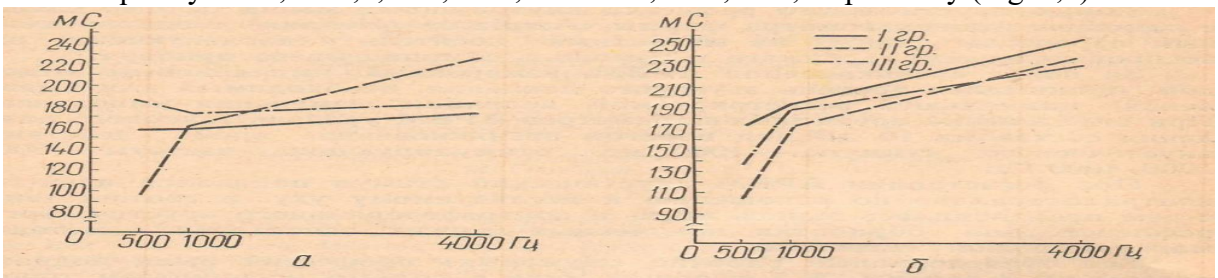

Рис. 1. Среднестатистические показатели времени нарастания АРВМ у лиц «шумовых» профессий в зависимости от состояния у них слуховой функции: а — ипсилатеральная стимуляция; б — контралатеральная стимуляция.

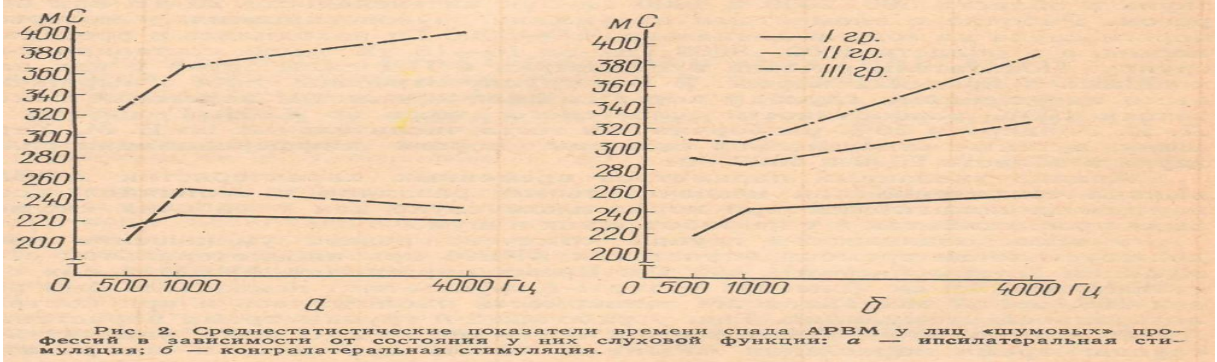

Рис. 2. Среднестатистические показатели времени спада АРВМ у лиц «шумовых» профессий в зависимости от состояния у них слуховой функции: а — ипсилатеральная стимуляция; б — контралатеральная стимуляция.

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As a result of statistical processing of data on the temporal characteristics of the acoustic reflex of the intra-aural muscles, it was revealed that the impact of noise on the hearing organ can cause physiological shifts in the functioning of the sound-conducting apparatus of the middle ear, in particular, there is a change in the duration of the rise and fall time of the acoustic reflex of the intra-aural muscles. Thus, as hearing decreases in persons with "noisy" occupations, the rise time of the ARIM at first significantly decreases, and then increases. As hearing deteriorates, the time of ARIM decline tends to increase.

This character of change in the time of ARIM increase may indicate the inclusion of compensatory mechanisms at the first stage in the process of protection of the hearing organ from noise exposure, which is manifested in its decrease. Further exposure to high noise levels weakens the activity of compensatory defense mechanisms, which is expressed in the fatigue of the neuro-reflex apparatus of the middle ear, manifested by an increase in the duration of ARIM build-up.

There is some difference in the indices of the temporal characteristics of the acoustic reflex of the intra-aural muscles at ipsi- and contralateral stimulation of it - at ipsilateral stimulation the phenomena of fatigue are expressed to a certain and significant degree. This can be explained by the fact that at contralateral stimulation the direct impact of the sound wave on the sound-conducting apparatus of the middle ear is absent, as a result of which the changes in the temporal parameters of the ARIM are less pronounced. In addition, the specificity of the contralateral acoustic reflex arc, which influences the studied temporal parameters, should be taken into account.

Thus, the study of temporal parameters of the acoustic reflex of intra-aural muscles in persons of "noise" occupations revealed that even with practically normal hearing, some of them have signs of noise influence on the sound analyzer, which is manifested by a sharp decrease in the ARIM rise time when stimulated by 500 Hz sounds, as well as by an increase in the ARIM fall time at all stimulating frequencies. With the progression of occupational hearing loss in workers, the rise and fall time of ARIM becomes longer, which indicates the developing fatigue of the neuromuscular apparatus of the sound analyzer. The results of the conducted research can be useful in solving the issues of occupational selection and vocational guidance.

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