

THE EFFECT OF PROLONGED PAIN ON THE COURSE OF DARK ADAPTATION BY THE OPTIC ANALYZER

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Numerous investigations [2, 3, 5, 7] have shown that pain causes major changes in the organism. The expression "reaction of an organism to pain" signifies to us the sum of the processes occurring at the different levels of the nervous system and affecting the entire life activity of the organism.

An analysis of the organism's mechanisms of adaptation to pain would seem most important. One of the routes by which this question can be resolved is via a study of the analyzers during pain, which would elucidate certain aspects of the interactivity within the afferent systems. The greatest portion of the work in this area has been done on the optic analyzer. In association with a transient pain stimulus, investigations have been carried out on the light sensitivity of the dark-adapted eye [4], electroexcitability [8], the adequate optic chronaxis, electroretinograms and electroencephalograms of the optic zone of the cortex [1].

L. T. Zagorul'ko, A. V. Lebedinskii, and Ya. P. Turtsaeva [4] observed an elevation in the light sensitivity of the dark-adapted eye under the influence of painful stimuli, which the authors regarded as an example of a favorable mechanism for the organism, promoting orientation at a moment of danger. P. P. Lazarev [5] noted that with weak pain sensations, the light sensitivity rose to a maximum, but with maximally strong pains it fell.

In the majority of investigations, the stimulus was only of transient nature, and the results obtained in this case might be relatively far removed from the picture observed in association with pains caused by prolonged pathological processes. Exceptions include the work on electrosensitivity and the adequate sensitivity of the dark-adapted eye in cases of sciatica [7], and also the investigation on the electrosensitivity of the eye in association with osteomyelitis [3]. In addition, a marked lowering of light sensitivity was noted [5] before and during the onset of migraine.

The purpose of this work was to elucidate the effect of prolonged pain on the course of dark-adaptation by the optic analyzer.

EXPERIMENTAL METHOD

We studied hospitalized patients, suffering from lumbosacral radiculitis [32], funiculitis [6], plexalgias [8], as well as 14 individuals with post-operative pain, gastric ulcer, or obliterative endarteritis.

The basic investigations were carried out on patients in the age range of 18-50 years, with normal visual field, reliable light sensitivity and visual acuity corrected within the range of from -1.5 to +1.0 diopter. The work was performed on an adaptometer of the ADM model, essentially during the autumn-winter period. The artifact of seasonal fluctuations in light sensitivity was excluded by parallel control investigations, using basically healthy individuals. The study was done strictly at the same time of day — from 5:00 to 7:00 P.M. The curve of adaptation was constructed according to the method prescribed by the manufacturers of the adaptometer. Following preliminary light adaptation for 10 min, using illumination of the internal surface of the adaptometer sphere of 1250 apostilbs, we determined the rise in light sensitivity over the course of one hour. A figure of constant area served as the test object.

After every 5 minutes we recorded the threshold of light sensitivity for the right and left eye. Each determination was verified three times, and a mean of the three results taken. The investigation was performed in complete

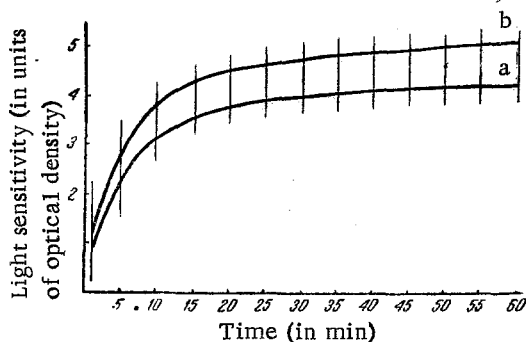


Fig. 1. Average changes in the adaptation curves of patients with prolonged pain (a) and essentially healthy individuals (b).

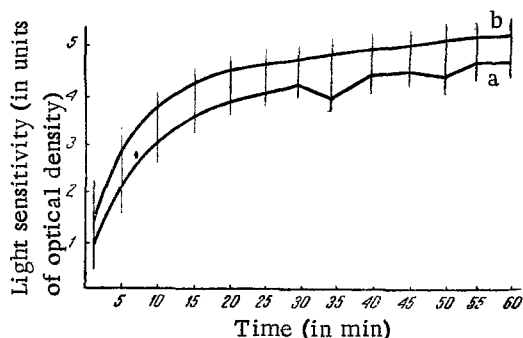


Fig. 2. Adaptation curves in patient L., before (a) and after (b) treatment for lumbo-sacral radiculitis.

In cases where the patient was not experiencing constant pain, but only complained of periodically occurring pain, we did not observe deviations from the norm in the adaptation curve.

Repeat tests with patients who, following treatment, ceased to experience pain (4) or obtained considerable alleviation (5), showed an elevation of the light sensitivity by 5-12% in comparison with the starting level.

As an example, we have shown the two adaptation curves of patient L., 28 years old, before and after a two month course of therapy for lumbo-sacral radiculitis (Fig. 2).

The mechanism of the change observed appears to be rather complex, and requires further study. It is clear that during prolonged pain mechanisms function which are markedly different from those seen with pain of short duration. This is indicated, first, by the total lowering of light sensitivity of the optic analyzer, and second, by the presence of negative fluctuations in the light sensitivity following supplementary pain stimuli.

It would be interesting to determine the moment in the course of prolonged pain stimulation when the effect of an initial elevation in light sensitivity [4] changes to the drop which we observed.

Most likely, the elevation in the threshold of light sensitivity occurs as a result of weakening of the cortical light sensitive components, due to overflow inhibition into the cortex arising during prolonged pain [3, 5, 7]. Along with this, some portion of the cortex is doubtlessly excited, since pain serves as an active and completely specific sensation. It is difficult to say whether or not the focus of excitation coincides with the projection. It may be postulated that this focus of congested excitation, supported by an inflow of painful afferent impulses, negatively induces the remaining portions of the cortex, which in turn has an induction relationship with the subcortex. However, this hypothesis by no means excludes participation of neurotrophic and hormonal influences in the mechanism of the above effect, as well as thalamic induction and effects from the reticular formation. It should be noted that the obtained results are in agreement with the data on changes in light sensitivity and the optic adequate chronaxis shown in the works of the P. O. Makarov school [6].

darkness and quiet. To avoid problems related to a consecutive visual image, the subject of the investigation was instructed to signal at the first sensation of light. The sensitivity threshold was expressed in units of optical density:

$$D = \lg \frac{I_0}{I},$$

where D = optical density, I_0 = the intensity of light falling on the light filter and Aubert diaphragm, and I = the intensity of light in the sphere. The obtained data were recorded in the form of an adaptation curve, and were analyzed statistically.

Control experiments were carried out on 36 essentially healthy individuals of varying age, using the same procedure.

The results of the control experiments agreed with the normal zone proposed by the manufacturers of the apparatus.

EXPERIMENTAL RESULTS

As can be seen from Fig. 1, with prolonged pain the light sensitivity of the optic analyzer fell markedly (by an average of 15-18%) throughout the full course of the curve, with a standard difference between the experimental and control values ($T \geq 3$) sufficiently high, and increasing with time. We did not observe constant asymmetries in the dependence of the pain focus to the cortex on the afferent projection. In a number of cases (approximately 40%), we observed a fluctuation in light sensitivity (0.3-0.6 unit of optical density), exceeding the error limits of the experiment.

It is interesting to note that subjectively, these drops in light sensitivity corresponded to spontaneous pain sensations, compounded upon the constant background level of pain.

We suggest that in certain cases the drop in light sensitivity and prolongation of the adequate optic chronaxis are nonspecific, and related to the appearance of a focus of congested excitation in the cortex.

SUMMARY

A study was made of the effect produced by chronic pain on the course of dark adaptation of the visual analyzer. Sixty persons with pain syndromes of various origin were subjected to examination. Investigation was carried out with the aid of an adaptometer of the ADM model; the light sensitivity thresholds were expressed in optic density units. Comparison of the data obtained with the results of 36 control experiments demonstrated that in prolonged pain the light sensitivity of the visual analyzer decreased along the whole course of adaptation curve by 15-18% of the normal value. A rise in the light sensitivity, gradually reaching the normal values, was noted after elimination of the pain. No deviations from the normal were revealed in cases with periodic transitory sensations of pain.

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All abbreviations of periodicals in the above bibliography are letter-by-letter transliterations of the abbreviations as given in the original Russian journal. *Some or all of this periodical literature may well be available in English translation.* A complete list of the cover-to-cover English translations appears at the back of this issue.
