Restoration of Hemispherical Symmetry of Cerebral Bioelectric Activity in Patients with Asthenoneurotic Syndrome by Bioacoustic Correction Method

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The distribution of EEG oscillation periods in healthy volunteers is symmetrical in the right and left hemispheres. Patients with functional brain disorders showed asymmetrical structure of EEG. The course of acoustic EEG-controlled biological feedback decreases the asymmetry to a level characteristic of healthy individuals.

Key Words: *electroencephalogram; biological feedback; hemispherical asymmetry*

Normal brain is characterized by symmetry in electrical activity of the right and left hemispheres [3,5,7,8]. Various organic damages to the brain, bipolar disorders, and schizophrenia disturb the symmetry of bioelectric activity (BEA) in the homologous subdivisions of cerebral hemispheres [1,5,7,8]. By contrast, no deviation in cerebral BEA symmetry was detected in neuroses and some other functional brain disorders [2,3]. Since quantitative assessment of the relationships between cerebral hemispheres is usually performed with the help of cross-correlation and coherent analyses or by hemispherical asymmetry of various EEG indices, it is a common practice to use short epochs (seconds), when EEG is non-stationary [5,7]. At the same time, to reveal the disturbances in BEA symmetry during functional brain disorders, it is expedient to use longer periods of analysis. To this end, we compared the symmetry of cerebral BEA in healthy subjects and in patients with some neurological diseases using a periodometric analysis, which allows to ignore non-stationary character of EEG and to assess cerebral BEA during long-term periods.

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MATERIALS AND METHODS

The study was carried out on 11 healthy volunteers and 28 patients (23 men and 16 women at the age of 19-61 years) with functional disturbances (asthenoneurotic, neurotic, and depressive states). Psychophysiological treatment included a course of acoustic EEG-controlled biological feedback (EEG-BFB) [4]. The procedures consisted of sessions of audition of the current sound BEA presentation of patient's own brain. The functional state of patients and volunteers was assessed subjectively and on the basis of feeling-activity-mood (FAM) test, Spilberger—Hanin and Lusher tests. The complete course of procedures consisted of 5-7 sessions. EEG from the right and left hemispheres was recorded during entire session of acoustic EEG-BFB (mean duration 30 min) with digitization frequency of 256 Hz via differential electrodes placed on the forehead and occiput (the reference electrode was placed on the vertex). EEG was analyzed after preliminary band filtration in the frequency range of 4-30 Hz. The whole EEG fragment record during single session was subjected to periodometric analysis. The distribution of EEG oscillation periods in the right and left hemispheres were assessed. The differences were characterized by the sum of absolute values of the differ-

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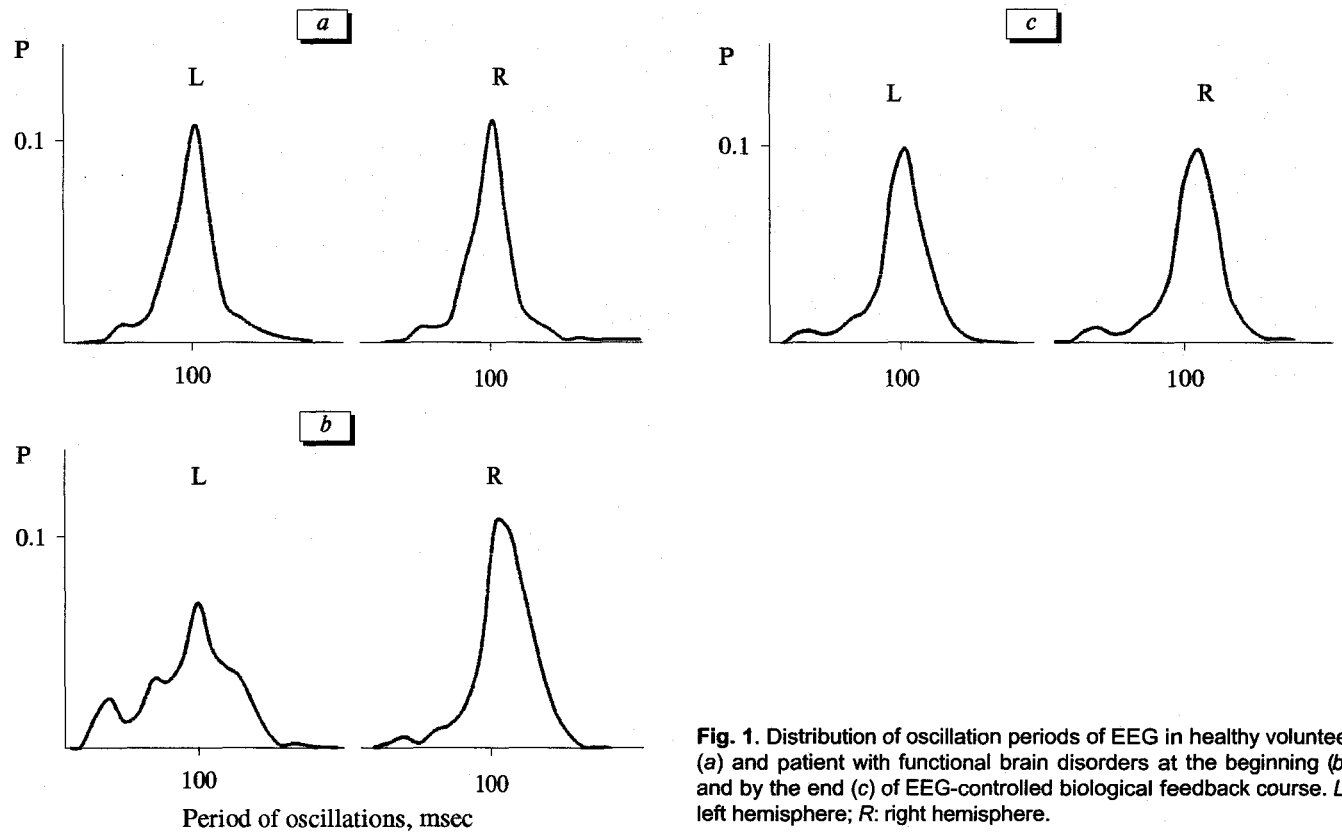

Fig. 1. Distribution of oscillation periods of EEG in healthy volunteer (*a*) and patient with functional brain disorders at the beginning (*b*) and by the end (*c*) of EEG-controlled biological feedback course. *L*: left hemisphere; *R*: right hemisphere.

ence in probability (P) between 4-msec bins in the range of α-, β-, and θ-rhythms.

RESULTS

In healthy volunteers, the structures of BEA in the right and left hemisphere were similar (Fig. 1, *a*). The parameter P corresponding to differential distribution of EEG periods in the right and left hemisphere was 0.093±0.018, while the mean number of oscillations for each analyzed EEG fragment was about 15,000. The maximum asymmetry was observed in the α-rhythm range: P_α was 0.038±0.011, which attests to its predominance in the examined group. For β- and θ-ranges P were 0.024±0.01 and 0.032±0.008, respectively.

In patients with functional brain disorders asymmetry of the distribution of EEG oscillation periods was higher than in the control: P was 0.182±0.127 in the whole period range, which significantly surpasses the control values ($p<0.01$ compared to healthy volunteers, Fig. 1, *b*). The greatest difference was observed in the α-range (P_α=0.072±0.047), while in β- and θ-range 0.054±0.048 and 0.045±0.019.

The course of acoustic EEG-BFB improved the state of the patients: it decreased reactive anxiety according to Spilberger—Hanin, normalized feeling, activity, and improved mood score assessed by FAM test. Moderation of anxiety was accompanied by normalization of vegetative coefficient and index of compliance to autogenous norm according to Lusher. In addition, complaint of headache, insomnia, fatigue, and erritability decreased in number or completely disappeared. It is important that this improvement was accompanied by a decrease in cerebral BEA asymmetry (Fig. 1, *c*). Periodometric analysis carried out at the end of acoustic EEG-BFB course showed that the difference of EEG oscillation period distribution between cerebral hemispheres significantly decreased to 0.113± 0.062 ($p<0.01$). Distribution asymmetry decreased from 0.197±0.105 to 0.099±0.035 ($p<0.01$) in 21 of 28 patients, tended to increase from 0.108±0.013 to 0.150±0.023 in 3 patients ($p>0.05$), and remained unchanged in 4 patients. The most pronounced changes were observed in the α- and β-ranges: P_α decreased from 0.081±0.050 to 0.040±0.018 ($p<0.01$) and P_β from 0.062±0.053 to 0.027±0.017 ($p<0.01$). By contrast, less pronounced changes (from 0.049±0.020 to 0.032±0.011) were observed in the θ-range. We revealed no age- or sex-related differences.

Thus, periodometric analysis of long epochs revealed significant differences in the distribution of EEG oscillation periods between healthy volunteers and patients with functional brain disorders. The latter demonstrated more asymmetrical distribution of EEG oscillation periods between the right and left hemispheres in comparison with healthy controls.

Acoustic EEG-BFB procedures improved the state of patients and decreased hemispherical asymmetry of EEG structure to a level characteristic of healthy subjects.

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