Characteristics of Spontaneous Bioelectrical Activity of the Brain in Women with Normal Gestation and Gestosis

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Pregnant women were examined during I, II, and III trimesters in order to detect EEG correlations of gestation dominant in health and threatened abortion. Single uncomplicated pregnancy was characterized by predominant activation in the central and temporal areas contralateral to the location of the placenta. Threatened abortion was associated with inversion of interhemispheric asymmetry of activation with respect to the placenta location.

Key Words: *electroencephalogram; interhemispheric asymmetry; gestation dominant; threatened abortion*

According to modern concepts, a new functional system mother—placenta—fetus (FSMPF) forms during gestation. This system enables integration of regulatory mechanisms of the mother and fetus [1,2,7,8]. Introduction of a systemic approach into perinatology characterizes a qualitatively new step in the development of this science: from discussion of individual mechanisms to studies of integration of various systems. The term "system" suggests the existence of the centroperipheral integration. According to modern concepts, the higher integrative centers of MPFFS are dominating constellation of nerve centers in the limbico-diencephalic structures or gestation dominant [1, 4,6,8], which determines not only visceral, but also behavioral reactions of the maternal organism during pregnancy.

Our model is based on the data on asymmetry of mechanisms of centroperipheral integration of MPFFS [5,7,11,15]. The characteristics of bioelectrical activity of the brain reflect activity of brain systems responsible for adaptation and regulatory mechanisms of various reactions and states at different levels of CNS. On the other hand, the results of EEG examinations of pregnant women with normal and complicated pregnancy are contradictory [3,9,10,12-14] and, what is more important, the encephalographic parameters in these studies are not analyzed in comparison with the direction of morphofunctional asymmetry of the fetoplacental complex. Here we studied bioelectrical activity of the brain in normal pregnancy and threatened abortion.

MATERIALS AND METHODS

A total of 230 pregnant women aged 18-31 years were examined at the Institute of Obstetrics and Pediatrics (Rostov-on-Don). Ultrasonic scanning, obstetrical and gynecological examinations, recording and analysis of bioelectrical activity of the brain were carried out at weeks 10-12, 23-24, and 35-36.

EEG recording and spectral analysis were carried out on an Encephalan 131-01 complex. Total bioelectrical activity of the brain was recorded in a monopolar mode by the 10-20 scheme in symmetrical frontal, temporal, central, parietal, and occipital areas. The reference electrode was placed on the ear lobes. EEG was recorded at rest with closed and open eyes for 4-6 min (digitization at 150 Hz, total frequency band 0.1-30 Hz). Visualization of the information and selection

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of artifact-free EEG fragments (five 6-sec EEG epochs) were carried out using a special software. Power spectra for selected epochs were calculated using Fourier transform algorithm for 19 channels in the main EEG rhythm bands. In addition, the mean amplitude, dominating frequency, index of each rhythm, and coefficients of interhemispheric asymmetry (C_{IHA}) were calculated for the main rhythms of each woman in each pair of leads.

$$C_{IHA}=(PR-PL)/(PR+PL)\times 100\%,$$

where PR and PL are α-rhythm powers from the right and left hemisphere.

Analysis of EEG data was carried out using Statistica 4.3 software with ANOVA bifactorial analysis of dispersions with consideration for the side of the placental location and the threat of abortion.

The location of the placenta was determined by ultrasonic scanning (Toshiba SAA 340-A). We found pronounced hypertrophy of the myometrium in the majority of women at weeks 10-12 of gestation. This sign was easily controlled in the saggittal plane conditionally imaged through the bottom of the uterus and cervix. Taking into consideration the effects of estrogen and progesterone on the myometrium we conclude that the development of retroplacental myometrial hypertrophy can be used as a reliable morphofunctional criterion of placenta formation. In questionable cases we relied on this criterion when determining placenta lateralization during I trimester. The thickness of the placenta to the right and left from the saggittal plane was evaluated during the II and III trimesters; 1.5-2-fold thickening of the placenta on one side indicated its lateralization.

Based on clinical and ultrasonic data, the women were divided into two groups: group 1 (n=72) included women without risk of threatened abortion during the entire gestation and group 2 (n=46) with threatened abortion confirmed at all stages of examination. Spectral EEG values and coefficients of interhemispheric asymmetry were averaged for each group. The significance of differences between the mean group values was evaluated using Student's t test.

RESULTS

Dispersion analysis revealed significant combined effect of two factors, placenta position and threat of abortion, on the interhemispheric asymmetry of α-rhythm in the central and temporal leads irrespective of the stage of recording (Table 1).

During weeks 35-36 in women without gestation disorders and right-side and ambivalent position of the placenta we observed pronounced bilateral asymmetry with predominating EEG α-rhythm power in the right hemisphere, especially in the temporal and central areas (Fig. 1, *a*, *b*). In women with threatened abortion and similar placenta location EEG α-rhythm power spectrum were higher in the left hemisphere. In women with left-side position of the placenta mirror relationships were observed (Fig. 1, *c*).

In EEG of group 1 women α-rhythm with maximum values in the parietooccipital leads predominated. The main rhythm was sinusoidal, modulated with an amplitude of 40-60 μV and frequency of 9.0-10.5 Hz, and was characterized by high degree of regularity, absence of hypersynchronization, and good or slightly changed voltage gradient. EEG topography in these women was characterized by clear-cut bilateral asymmetry in all cortical areas. Spectral power of α-rhythm was 65.4±12.3 μV^2. In 5 women of this group EEG was desynchronized with α-rhythm power of 25-30 μV^2 and the absence of regional differences. EEG was relatively stable during all three trimesters in this group.

The risk group (group 2) was heterogeneous by EEG characteristics and could be subdivided into 3 subgroups. In subgroup 1 (n=26) EEG was characterized by regular α-rhythm with amplitude <150 μV and with bilateral asymmetry; in 40% cases the maximum α-activity was shifted towards the parietocentral area. Spectral power of α-rhythm was high (105.0±20.5 μV^2). Subgroup 2 (n=15) consisted of women without interhemispheric asymmetry. EEG of these women showed leveled regional differences both in the presence of high activation and in α-rhythm-synchronized EEG. Subgroup 3 included 5 women in whose epileptiform activity (spikes, acute waves, discharges, *etc.*) occupied more than 40% EEG records.

Pronounced slow activity in the θ-rhythm band (especially in central areas — up to 25%), not surpassing the dominant rhythm by its amplitude, was observed in group 2 women (risk of abortion). In addition, low-frequency (up to 20 Hz) high-amplitude (up to 30 μV) β-activity essentially increased in symmetrical frontal areas in 70% women at late terms (36 week) of gestation.

TABLE 1. Bifactorial Dispersion Analysis of the Effects of Placental Lateralization and Risk of Abortion on Interhemispheric Asymmetry Coefficients of EEG α-Rhythm in Temporal and Central Leads

C_{IHA}	Fisher's test (F)	Significance (P)
Fronto-temporal areas	9.35	0.0012
Medium temporal	22.44	0.0009
Posterior temporal	10.58	0.0007
Central	10.08	0.0006

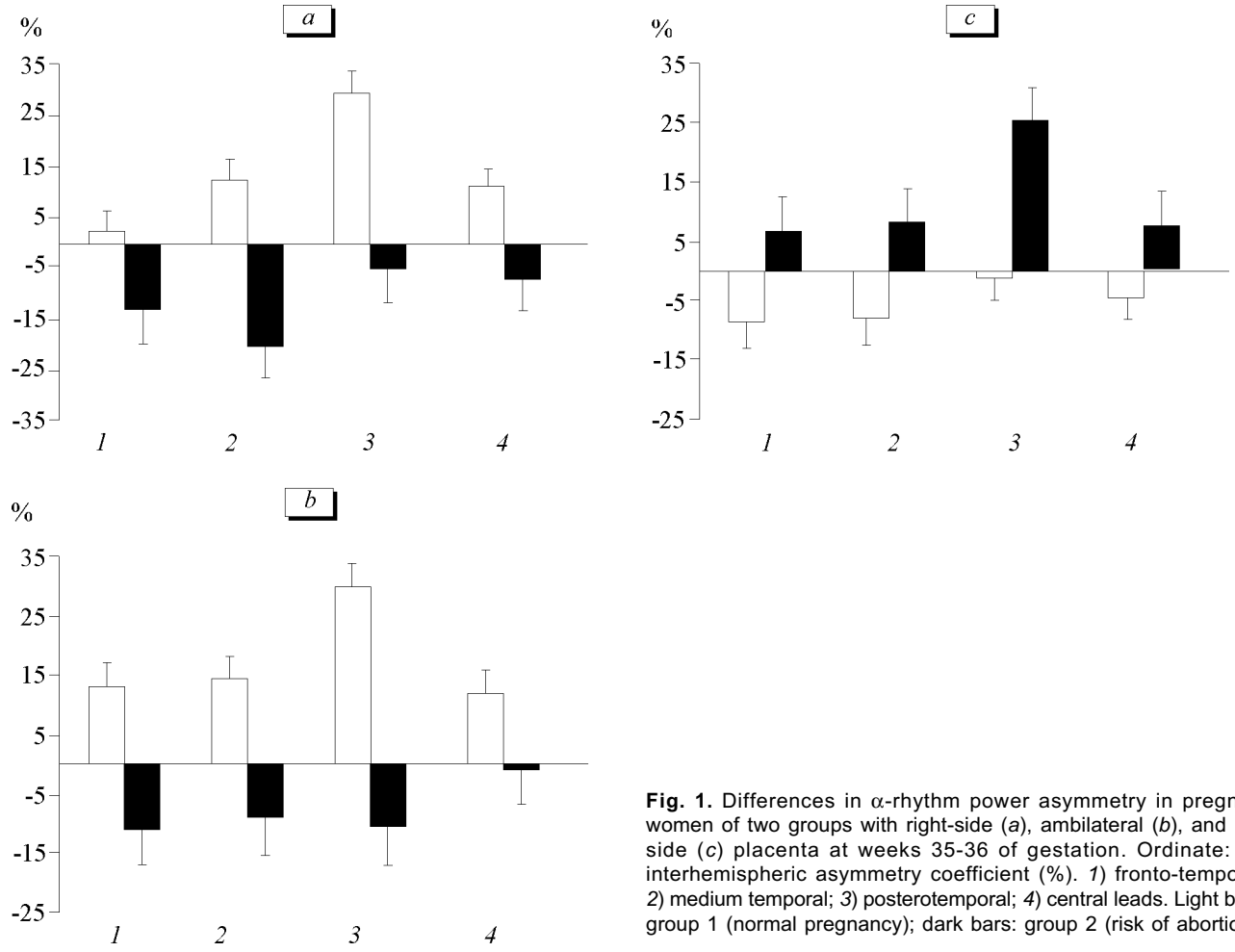

Fig. 1. Differences in α-rhythm power asymmetry in pregnant women of two groups with right-side (*a*), ambilateral (*b*), and left-side (*c*) placenta at weeks 35-36 of gestation. Ordinate: C_a: interhemispheric asymmetry coefficient (%). *1*) fronto-temporal; *2*) medium temporal; *3*) posterotemporal; *4*) central leads. Light bars: group 1 (normal pregnancy); dark bars: group 2 (risk of abortion).

In the context of modern electrophysiological notions, functionally more active hemisphere or brain area (higher activation level) is characterized by lower α-frequency power. In uncomplicated spontaneous pregnancy activation predominated in the temporal and central areas of the left hemisphere in women with ambilateral and right-side placenta. By contrast, higher level of activation of the temporal and central cortical compartments in the right hemisphere was detected in pregnant women with similar lateralization of the placenta and signs of threatened abortion. Mirror relationships were observed in women with left-side localization of the placenta: right-sided cortical activation of the temporal areas was associated with favorable course of gestation; higher activation of the left hemisphere and the absence of significant asymmetry in this sign were associated with threatened abortion. Hence, spontaneous bioelectrical activity of the brain in pregnant women is a very sensitive indicator of normal or abnormal gestation. The study of the mechanisms of central regulation of gestation processes can supplement the armory of methods for prediction and diagnosis of obstetrical and gynecological diseases.

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