MOTOR RESPONSES AND CARDIAC ACTIVITY OF THE FETUS AT THE END OF FULL-TERM PREGNANCY AND DURING LABOR

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Two forms of motor responses (MR) were identified in the fetus: jerky and prolonged motor activity. At the end of full-term pregnancy, periodic vagal bradycardia developed immediately before and after the MR. During MR the heart rate is increased, on account of increased activity of the sympathetic centers of the heart. During labor MR developed during the pains when the volume of blood in the uterus is reduced. MR during pains and the associated increased fetal heart rate gave rise to smaller changes in the blood volume in the uterus. Performance of MR is considered to be aimed at compensating the fetal hypoxemia which arises periodically at the end of pregnancy and, in particular during pains.

KEY WORDS: fetal motor responses; cardiac activity; pregnancy; labor.

Together with respiratory movements, activity of the skeletal muscles of the fetus helps to increase the velocity of the fetal circulation and is a factor inducing excess anabolism, thereby promoting growth and development [1, 2, 4].

Previous investigations have shown that fetuses of animal and man exhibit two types of extensor activity: jerky (JMA) and prolonged (PMA) motor activity [5–7].

The paper examines the relationship between motor responses (MR), the character of the fetal cardiac activity, and the volume of blood in the uterus at the end of pregnancy and during labor.

EXPERIMENTAL METHOD

Experiments were carried out on 18 women at the end of full-term pregnancy and on 5 women in labor. The ECG and phonocardiogram (PCG) of the fetus were recorded on the ÉKP-02 electrocardiograph. The electrodes were applied to the mother's anterior abdominal wall. Parallel with recording of the fetal ECG and PCG, the blood volume of the uterus was estimated by means of a high-frequency electroplethysmograph and the uterine contractions were recorded by external mechanohysterotraphy (using strain gauges glued to a laminated spring and disk electrodes). The strain gauges were connected to the input of the TA-5 amplifier and the electrodes were connected by coaxial leads to a high-frequency electroplethysmograph. The outputs of the amplifier and electroplethysmograph were connected in turn to an N-320/5 five-channel recorder.

To analyze the fetal cardiac activity the duration of the cardiac cycle (R–R interval), of electromechanical systole (the interval from the Q wave to the beginning of the second sound), and of electromechanical diastole (the interval between the beginning of the second sound and the Q wave) were recorded. The basis for analysis of the results was that with an increase in tone of the vagal centers of the heart the duration

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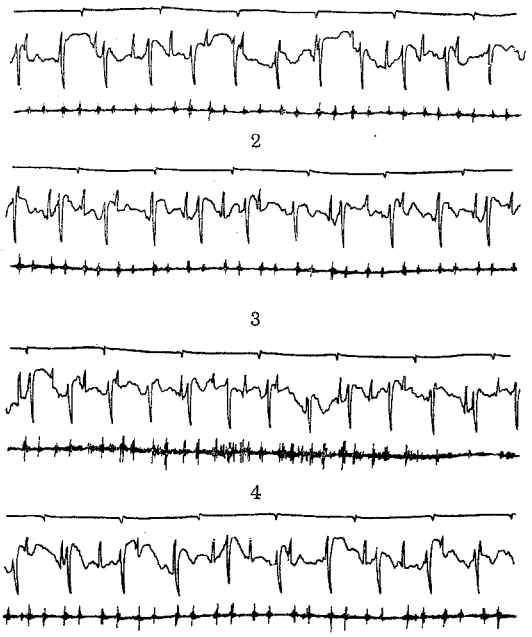

Fig. 1. ECG and PCG of fetus during PMA: 1) initial state; 2) immediately before PMA; 3) during PMA; 4) in recovery period after PMA. From top to bottom: time marker, ECG, PCG.

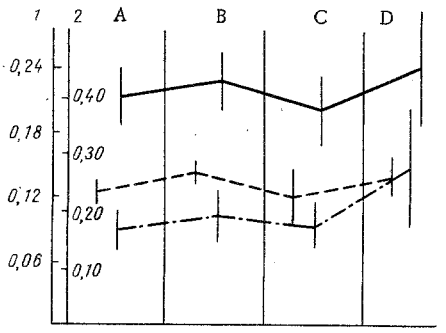

Fig. 2. Changes in parameters of cardiac activity during PMA: A) initial state; B) immediately before PMA; C) during PMA; D) in recovery period after PMA. Continuous line shows changes in duration of cardiac cycle; broken line shows changes in duration of diastole; line of dots and dashes shows changes in duration of systole. Ordinate: 1) standard deviation; 2) absolute value of phases of cardiac activity.

of the R–R interval and its standard deviation (σ) increased chiefly on account of an increase in the duration of diastole and its σ; with an increase in tone of the sympathetic centers of the heart, changes in the R–R interval are due to a change in the duration of systole and of its σ [3, 5]. At least 100 fetal cardiac cycles and at least 10–15 labor pains were analyzed in each case.

EXPERIMENTAL RESULTS

JMA is identified on the PCG as paroxysmal waves of high amplitude and short duration (the mother notices the jerky character of the fetal movements). During PMA prolonged changes took place in the fetal MR and PCG (the mother notices the longer fetal movements) (Fig. 1).

The fetal heart rate slowed a little immediately before JMA and PMA, but during the movements it increased, and in the recovery period the heart rate reached its lowest level. The increase of the R–R interval and its σ was associated with the increase in the duration of diastole and its σ, and as has already been stated, this was due to the appearance of tone of the vagal centers of the heart. With an increase in the heart rate the change in σ was connected with an increase in σ for the duration of systole. This is evidence of an increase in the tone of the sympathetic centers of the heart (Fig. 2).

The appearance of tone of the vagal centers of the heart immediately before MR was probably due to hypoxemia, which acts as a stimulus to the chemoreceptors of the carotid sinus and cardioaortic zones [6, 7]. Afferent impulses from the chemoreceptors evidently not only increase the tone of the vagal centers of the heart, but also lead to the appearance of JMA and PMA. MR in fact appeared during pains, when the blood

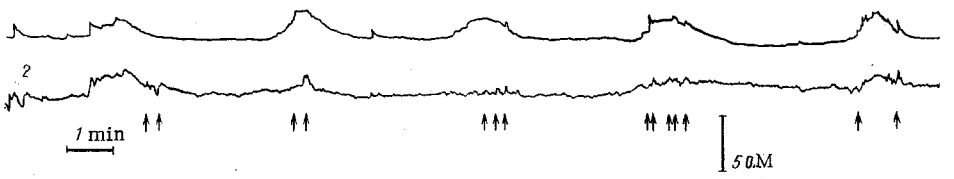

Fig. 3. Mechanogram (1) and electroplethysmogram (2) of the uterus during pains. Arrows indicate fetal motor responses.

volume of the uterus was reduced (Fig. 3) and fetal hypoxemia evidently developed. Meanwhile the blood volume of the uterus fell by a smaller amount during active fetal MR than during weak MR. This may indicate that the MR are aimed at increasing the velocity of the fetal circulation, increasing the blood flow through the capillaries of the placenta and, as a result, reducing fetal hypoxemia.

MR arising as a result of fetal hypoxemia thus lead to changes in fetal heart activity that contribute to the correction of the periodic hypoxemia.

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