EFFECT OF OVARIAN HORMONES ON RECEPTORS OF THE PREGNANT UTERUS

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In the early periods of pregnancy progesterone lowers the intensity of information received from the uterine receptors, but in the late stages of pregnancy it has no appreciable effect. Injection of folliculin in the late periods of pregnancy causes premature delivery, after which the intensity of the afferent flow of impulses from the uterine receptors is 7-8 times greater than after spontaneous delivery and 3-4 times greater than in control animals before delivery.

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After injection of estrogens into animals in the phase of diestrus or after castration the flow of impulses s from the uterine receptors increases sharply [2, 7, 8] and, as a result of this, the activity of various systems of the body is modified [5, 6]. In pregnancy the flow of afferent impulses is also increased, but its intensity depends on activity of the fetuses [1, 8].

The object of the present investigation was to determine, first, whether estrone and progesterone have any effect on information received from the uterine receptors of the pregnant animal, second, whether under these circumstances the response of the uterine receptors to stimuli arising from the fetuses is modified, and third, if such changes do take place, to discover whether they depend on the stage of pregnancy at which the hormones are injected. The experiments were carried out on cats, in which the physiological role of the ovarian hormones and their quantitative relationships at the various stages of pregnancy are close to those in women [9].

EXPERIMENTAL METHOD

Experiments were carried out on cats at the beginning and end of pregnancy, and also after castration. Folliculin was injected once or twice, intramuscularly, in a dose of between 3000 and 20,000 i.u., and progesterone in doses of between 4 and 25 mg. The acute experiments on the animals began 2-5 days after the beginning of administration of the preparation.

Activity of the uterine receptors was judged from the intensity of the flow of afferent impulses in the pelvic nerves, the recording electrodes being placed on the nerve close to the vertebral column. So as to be able to compare the activity of the uterine receptors with that of receptors of other organs (the urinary bladder, for example), the recording electrodes were also applied to the nerve trunk close to its point of emergence from the wall of the urinary bladder. The method of detecting and recording the potentials of the afferent impulses was described previously [8]:

EXPERIMENTAL RESULTS

Experiments were carried out on 27 pregnant and 9 castrated cats. Progesterone was injected into 19 pregnant females: in 6 animals pregnancy was in an early stage (weight of fetuses 2-10 g) and in 13 in late stages (weight of fetuses 55-140 g); folliculin was injected into 6 animals in the late stages of pregnancy. The results of previously described observations on pregnant animals not receiving hormones served as control [8]. These experiments showed that in the early and late stages of pregnancy the background intensity of afferent impulses flowing along the pelvic nerve does not differ significantly (Figs. 1c and 2b): the amplitude of the spike potentials does not exceed 30 μV and their frequency 30/sec. Immediately after tying the umbilical cords of the fetuses, the flow of impulses from the uterine receptors usually increases in intensity momentarily, diminishing again after 1 min.

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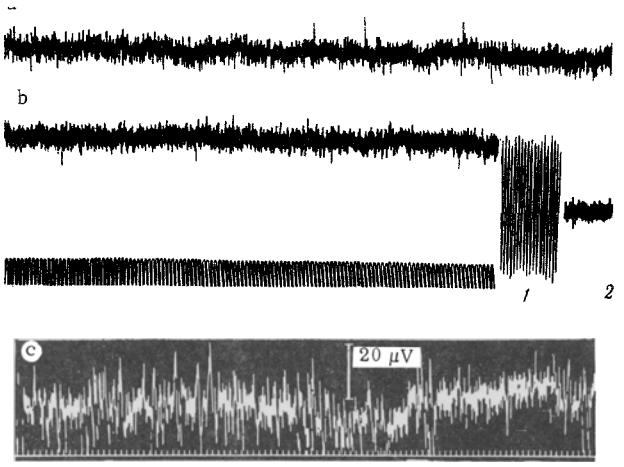

Fig. 1. Flow of afferent impulses along pelvic nerves of cats at various periods of pregnancy (mean weight of fetuses 2 g). a) background impulse activity; b) activity 1 min after tying umbilical cords of fetuses in a cat receiving 7.5 mg progesterone; c) background impulse activity in a cat not receiving progesterone. Here and in Figs. 2 and 3: 1) calibration 20 μV, 2) instrumental noise; time marker 0.02 sec.

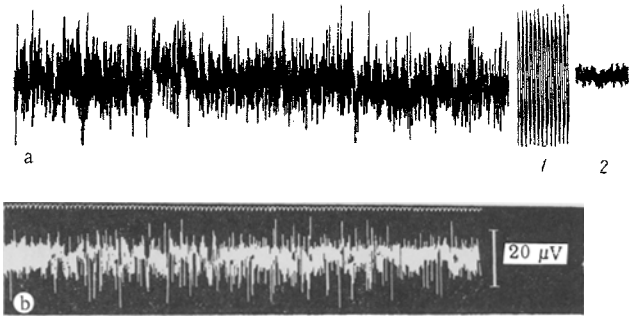

Fig. 2. Background afferent impulse activity in pelvic nerves of cats at end of pregnancy. a) impulse activity two days after injection of 5 mg progesterone (weight of fetuses 120 g each); b) impulse activity in cat not receiving progesterone (weight of fetuses 95 g each).

Progesterone caused changes (compared with the control) in the background afferent activity of the uterine receptors only when injected in the early stages of pregnancy: in 5 of the 6 animals only weak impulse activity was recorded in the pelvic nerves (Fig. 1a), and in one animal the activity was high (potentials up to 54 μV in amplitude and 60/sec in frequency). Against the background of weak afferent activity, ligation of the umbilical cords of the fetuses had no effect (Fig. 1b), i.e., in contrast to the control experiments, in this case the maternal organism did not received immediate information that the blood flow along the umbilicus had stopped.

When progesterone was injected in the late stages of pregnancy, no significant changes in afferent activity in the pelvic nerves compared with the control (at the same stages) were observed (Fig. 2): impulses were generated in volleys with an amplitude of 27.1 ± 0.3 μV and a frequency of 42.6 ± 1.1/sec. After removal of the fetuses into an incision made in the uterine cornu impulse activity rose and fell 1-2 min after ligation of the fetal cords. Analysis of the frequency of afferent impulses recorded from the trunk of the pelvic nerve (close to the spine) confirms these observations. For example, in an experiment on April 19, 1966 (weight of fetuses 105 g; 15 mg progesterone injected during two days) the background frequency of the activity was 17.4 ± 0.71, after withdrawal of the fetuses it rose to 42.6 ± 1.12, during the 20 sec after tying the umbilical cords it was 42.8 ± 2.93, and 1 min after tying it was 30.8 ± 1.16. The frequency of the impulse activity after stopping the blood flow along the umbilicus fell because of a decrease in activity of the uterine receptors and not as a result of drying of the nerve on the electrodes, because if the receptors of the urinary bladder were stimulated (by stretching the organ) instead of the uterine receptors, the flow of afferent impulses in the same nerve increased to the same degree as at the beginning of the experiment.

Delivery began in 3 of the 5 females after injection of folliculin; 24 h after the induced deliveries very high afferent activity was recorded in the pelvic nerves (Fig. 3a): the amplitude of the potentials reached 90 μV and the frequency 80/sec. Impulses were generated in groups over a period of 2-6 sec; in the interval between the groups single impulses of lower amplitude were formed. Activity as high as this was never observed during the 24 h after spontaneous delivery at term (Fig. 3b). In 2 females in which delivery did not begin after injection of folliculin, the background flow of afferent impulses along the pelvic nerves was of the same order as in the control animals.

In the castrated animals no changes in the low background activity of the uterine receptors was observed after injection of progesterone in any experiment.

Impulse activity from the receptors of the urinary bladder showed no change from the control in the pregnant and castrated females after injection of folliculin and progesterone.

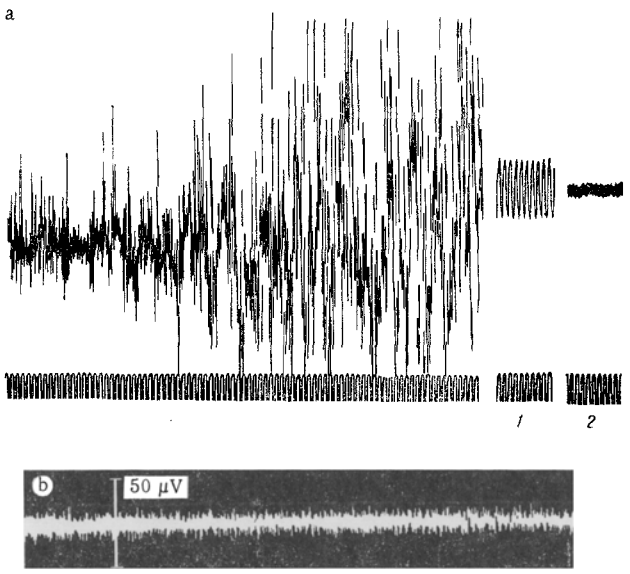

Fig. 3. Flow of afferent impulses along pelvic nerves of cats 20 h after delivery. a) After delivery induced by injection of 3000 i.u. folliculin; b) after spontaneous delivery.

During pregnancy the level of sex hormones in the maternal organism is high, yet nevertheless their injection in comparatively small doses gives rise to a complex series of changes notably in activity of the uterine receptors. These changes depend both on the stage of pregnancy and on the nature of the hormone. In the early periods of pregnancy progesterone lowered the intensity of information received from the uterine receptors and weakened their responses to changes in activity of the fetuses, while at the end of pregnancy it had no appreciable effect on these processes. It is interesting to note that in the late stages of pregnancy the reaction of the uterine muscles of rats to a disturbance of the state of the fetus is unchanged after injection of progesterone [3]. At the end of pregnancy in cats, as in other animals [4, 9], folliculin induces premature delivery. After such a delivery, the impulse activity generated by the uterine receptors and flowing along the pelvic nerves is very high: the amplitude and frequency of the impulses are 3-4 times greater than after spontaneous delivery and twice as great as during pregnancy. Folliculin acts in the same way on the muscle of the uterus [4].

The same selectivity in the action of ovarian hormones on uterine receptors is observed in pregnant females as in nonpregnant animals: the background activity of the uterine receptors is modified, but activity of the receptors of the urinary bladder (background and evoked) remains as before. Comparison of the results described in this paper with those published in the literature suggests that a direct relationship exists between the activity of the uterine receptors and the contractile activity of its muscles.

LITERATURE CITED

1. N. L. Garmasheva and E. F. Kryzhanovskaya-Kaplun, Fiziol. Zh. SSSR, No. 12, 1463 (1960).
2. N. L. Garmasheva, The Placental Circulation [in Russian], Leningrad (1967).
3. S. E. Drizgalovich, in: Reflex Reactions in the Physiology and Pathology of the Female Organism [in Russian], Leningrad (1952), p. 56.
4. S. E. Drizgalovich-Egorova, in: The Pathophysiology of Intrauterine Development [in Russian], Leningrad (1959), p. 80.
5. V. Ya. Katinas, Unconditioned and Conditioned Salivatory Reflexes in Dogs During Pregnancy, Author's Abstract of Candidate Dissertation, Leningrad (1956).
6. E. F. Kryzhanovskaya, Effect of Differences in the Concentration of Ovarian Hormones in the Body on Uterine Chemoreception, Author's Abstract of Candidate Dissertation, Leningrad (1954).
7. E. F. Kryzhanovskaya, Fiziol. Zh. SSSR, No. 1, 106 (1964).
8. E. F. Kryzhanovskaya-Kaplun, Fiziol. Zh. SSSR, No. 10, 1226 (1967).
9. R. Courrier and G. Gros, C. R. Soc. Biol., 120, 8 (1935).