

ELECTROHYSTEROGRAPHY BASED ON RECORDING FAST UTERINE POTENTIALS IN WOMEN

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Fast electrical activity of the myometrium was studied in women during pregnancy and childbirth. Action potentials (APs) were recorded from the cervix uteri by means of vacuum electrodes of an original design. APs recorded from the cervix were shown to reflect the electrical activity of the uterus as a whole. Electrohysterography based on recording fast APs can be used to detect changes of tone, even in the absence of visible uterine contractions.

KEY WORDS: uterine contractions; electrohysterography; electromyography.

The study of electrical activity of the uterus in women is aimed at satisfying the need of the clinician for an accurate method of estimating myometrial function capable of detecting initial changes in the state of the uterine muscle and providing data for the obstetrician in charge of the case.

So far in most clinical investigations the slow component of the uterine action potential (AP) has been recorded and analyzed [6, 9-11, 13, 14, 17, 18]. The information provided by the fast component of the AP as an indicator of myometrial functions in clinical practice has still received little study [6, 7], although it is known that spike activity is connected with the onset of the contraction of the smooth muscle. It might be expected that the analysis of this activity would provide information on changes in the state of the myometrium even in the absence of contractions.

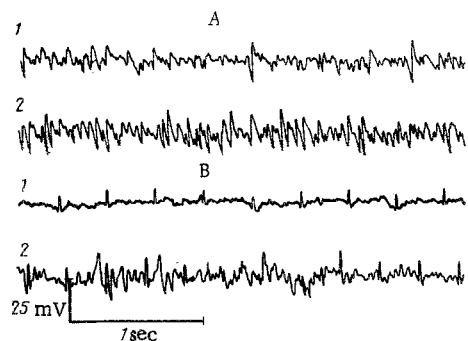


Fig. 1. First stage of normal labor at term. Fast myometrial APs recorded from the cervix and upper segment of the uterus, before and during contraction: A) recorded directly from the cervix uteri; B) abdominal recording from the upper segment of the uterus; 1) before, 2) during contraction recorded in the upper segment of the uterus.

The starting point for our approach to the study of the spike activity of the human uterus was based on experimental data in the literature [2, 4, 5, 11, 15]. Simultaneous recording of APs and contractions of the uterus in healthy unanesthetized rabbits gave the following results. A high degree of correlation exists between uterine contractions and the frequency of the fast potentials; with a sharp increase in the uterine tone the mean frequency and coefficient of variation of the frequency decrease sharply; during treatment with steroid and other hormones the electrical activity of the myometrium changes much sooner than the character of the uterine contractions.

The object of this investigation was to record fast APs directly from the cervix and indirectly through the

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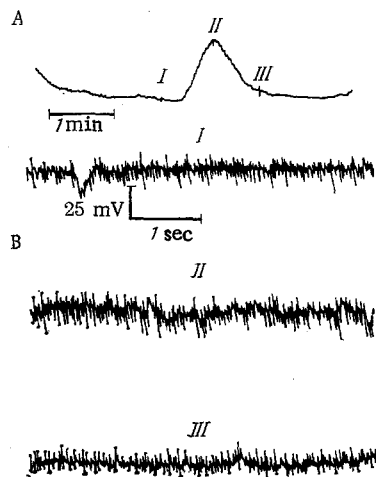


Fig. 2

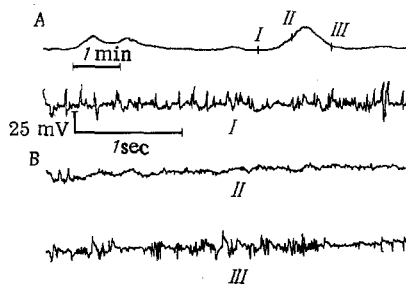


Fig. 3

Fig. 2. First stage of normal labor at term. Increase in frequency and amplitude of myometrial APs during the growth of a contraction wave. APs recorded from cervix uteri, contractions recorded in upper segment. A) mechanohysterogram; B) electrohysterogram; I, II, III) corresponding cuts of electro- and mechanohysterograms.

Fig. 3. Threatened abortion at the 37th week of pregnancy. Decrease in frequency and amplitude of myometrial APs at the height of contraction with a hypertonic uterus. APs recorded from surface of abdomen in region of upper segment of uterus, where contractions also were recorded: A) mechanohysterogram; B) electrohysterogram; I, II, III) corresponding cuts of electro- and mechanohysterograms.

abdominal wall from the body of the uterus, to compare the electrical and mechanical activities of the uterus, and to compare the electrohysterograms recorded in women during normal labor, during threatened abortion, and in postmaturity.

EXPERIMENTAL METHOD

Bipolar electrodes, with an interelectrode distance of 3 cm, were fixed to the cervix by means of a vacuum; electroencephalographic cup electrodes (diameter 8 mm) were used for the abdominal recording and were placed on the skin in the midline of the abdomen in the region of the superior and middle segments of the uterus. Potentials were recorded on a loop oscillograph or polygraph (Galileo). Although some information is lost by ink recording, the electrohysterograms thus obtained can be used to judge the dynamics of myometrial electrical activity. Simultaneously with the electrohysterogram the uterine contractions and fetal heart beat were recorded by means of a cardiotocograph. In some observations the uterine tone was measured by means of Uflyand's electromyotonometer [8]. The subjects were kept in a screened cubicle.

Electrohysterograms were recorded in 30 pregnant women (in four during normal pregnancy at 39-40 weeks, in eight during the first stage of normal labor, in four during threatened abortion, in six in the first stage of premature labor at the 30th-38th week of pregnancy, and in eight during postmaturity at 42-43 weeks).

It was much more difficult to record the APs from the uterus through the abdominal wall than from the cervix, for considerably more artefacts arise as a result of the maternal respiration, contraction of the abdominal wall, and the maternal and fetal heart beat, although in undernourished women with a broad aponeurosis of the abdominal muscle, good recordings could be obtained even by the abdominal method (Fig. 1B).

EXPERIMENTAL RESULTS

APs recorded from the cervix reflected the activity of the uterus as a whole. This is shown by the following facts: during the development of a contraction recorded in the upper segment of the uterus the

electrical activity of the upper segment and of the cervix uteri changed at the same time and in the same direction; in every case during recording of a contraction in the body of the uterus the frequency and amplitude of the APs recorded from the cervix uteri also changed (Fig. 1). The APs recorded from the cervix uteri evidently represented the "integral value of the electrical potential generated by all cells of the given muscle" [1], by all the myometrial cells.

Close correlation was found between the electrohysterogram and the mechanohysterogram. During normal labor at term the frequency and amplitude of the APs increased parallel with the contraction wave. Between the contractions the frequency and amplitude of the PAs decreased considerably (Fig. 2).

Different relations between the electrical and mechanical activity of the myometrium were observed in two of the six women during premature labor: at the height of contraction the electrical activity of their myometrium was not increased, but sharply reduced, the APs disappeared, and they reappeared at the end of the contraction (Fig. 3). The tone of the uterus in these women reached 60-65 units at the height of the contraction, compared with 40-50 units in the other subjects examined. Disappearance of the APs at the height of the contraction was probably due to the excessively high tone (firmness, elasticity) of the uterine muscle at this period. Similar changes were observed previously under experimental conditions: after the injection of adrenalin or acetylcholine into rabbits the uterine tone rose sharply and the APs disappeared [12].

In postmaturity the electrohysterogram in every case was of the same type: APs were absent or single spikes of low amplitude were recorded.

The functional state of the myometrium can thus be estimated more accurately from the intensity of its electrical activity than from the data of mechanohysterography. Changes in tone (firmness, elasticity) of the uterus often are not reflected in the mechanohysterogram, but they are clearly revealed on the electrohysterogram: disappearance of the APs or a sharp decrease in their amplitude and frequency is observed during the excessive increase in tone of the myometrium.

Another important factor is that during electrohysterography based on recording the fast APs, pulse counters and integrators can be used, so that the myometrial activity can be estimated quantitatively at once, which is much more difficult to do if the slow component of the AP generated by the myometrium is recorded.

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