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Changes in Electromyographic Activity of the Cervix after Stimulation of Labour with Oxytocin[1]

Marjan Pajntar, Drago Rudel

University Department of Obstetrics and Gynecology, and Faculty of Electrical Engineering and Computing, University, Ljubljana, Yugoslavia

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Abstract. The electrical activity of the cervix can be measured during labour. The influence of oxytocin on electromyographic (EMG) activity of the cervical musculature was studied in 80 primiparous women after induction of labor. The highest electrical activity registered at the time of uterine contraction and between two contractions was used for analysis. The basic pattern of oxytocin-produced changes in muscular contractions in the cervix observed via EMG activity is that of the activity increasing with contractions of the uterine corpus and diminishing between contractions. The effect of oxytocin on cervical musculature is different in ripe and unripe cervices.

Introduction

The role of smooth cervical muscle in the human has not been sufficiently explored. It is unreasonable to presume it would not be found there if it did not have some function [1]. Our own previous studies [2, 3] have shown that the electromyographic (EMG) activity of the smooth musculature in the cervix can be measured. This musculature was found to contract actively, sometimes differently in the longitudinal and circular directions. Since EMG is a good indicator of muscle activity, we wanted to explore whether there are any changes of cervical muscular activity after administration of oxytocin both in ripe and unripe cervices.

Materials and Methods

The study involved 80 primiparous women coming to the delivery room for induction of programmed labour. After admission to the delivery room, an estimation of cervical ripeness according to the Bishop [4] scores and an amniotomy were performed; a catheter for measuring intra-uterine pressure was inserted and an ECG electrode was attached to the infant's head to monitor the fetal heart rate. Within 30 min after the amniotomy an oxytocin solution (Syntocinon) was administered by the drip method at a dose of 6.75 mEq/min. The duration of the latent and the active phases of labour was registered.

Besides this routine procedure, EMG activity of the cervix was recorded simultaneously with intra-uterine pressure. Two spiral needle EMG electrodes were attached to the cervix for bipolar, differential detection of signals of the EMG activity in the circular direction, with a reference electrode placed on the woman's thigh. The procedure is described more in detail in our earlier reports [2].

In all 80 women, the EMG paper recordings were analysed. In figure 1 a typical EMG paper recording is presented. The upper trace relates to the electrical activity of the cervical muscle. The intensity of the signals is expressed in microvolts. Peak-to-peak values of the highest electrical activity (the largest amplitudes) at the time of uterine contractions (time mark AC) and between two contractions (time mark BC) were estimated. Samples were taken 15 min after amniotomy (15 min before oxytocin administration), 30 and 60 min after oxytocin administration. The results were classified into two subgroups: group 1 – unripe cervices (Bishop score ≤ 6), and group 2 – ripe cervices (Bishop score ≥ 7). The differences between the arithmetic mean values of the greatest measured amplitudes (in microvolts) were assessed by the t test for small dependent samples, small independent samples and populations with abnormal distribution.

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Results

Description of the Groups

Group 1 (Bishop ≤ 6; mean = 4.47, SD = 1.26) consisted of 45 cases, and group 2 (Bishop ≥ 7; mean = 8.43, SD = 1.38) of 35 cases. With regard to cervical ripeness, estimated according to the Bishop scores, the two groups were found to differ at a level of statistical significance ($p = 0.001$). Statistically significant differences were also found in the duration of individual phases of labour. The group of primiparae with unripe cervices had significantly longer latent (mean = 3.73:0.91 h, SD = 3.38:1.45, $p = 0.000$) and active phases (mean = 3.96:3.10 h, SD = 1.30:3.43, $p = 0.033$) at the onset of labour, which resulted also in a longer first stage of labour (mean = 7.67:4.06 h, SD = 2.15:4.05, $p = 0.000$) compared to group 2.

Intrapartal Changes in EMG and Differences between the Two Groups

Measurements of the maximal peak to peak amplitudes in paper recordings of EMG yielded the following results:

In group 1 uterine contractions (AC) were accompanied by relatively high amplitudes of electrical activity in the initial stage of labour (15 min before oxytocin), followed by a decrease at 30 min after oxytocin administration, before increasing significantly again at 60 min ($p = 0.000$). On the other hand, the relatively high BC amplitudes tend to diminish slightly after oxytocin administration (fig. 2, table 1).

In group 2, amplitudes of electrical activity at AC were initially relatively smaller, but they were increased significantly by 30 min ($p = 0.023$), and at 60 min they were even higher ($p = 0.000$). The BC amplitudes, which were relatively low before oxytocin administration, decreased even further at a statistically significant rate ($p = 0.037$) by 30 min (fig. 3, table 1).

The magnitude of AC amplitudes in groups 1 and 2 did not differ significantly, but that of BC amplitudes did. In group 2, these amplitudes were significantly smaller ($p = 0.012$ at 30 min and $p = 0.048$ at 60 min).

The amplitude ratio between AC/BC levels proved to be an interesting parameter in estimating the electrical activity. In group 1, the index values in the beginning of labour were small (fig. 4), increasing significantly ($p = 0.006$) at 60 min. In group 2, however, there was a significant increase of index values ($p = 0.017$) at 30 min. At 60 min after oxytocin administration, it was even higher ($p = 0.001$). In group 2 the pre- versus post-oxytocin index ratio at 60 min was greater than in group 1.

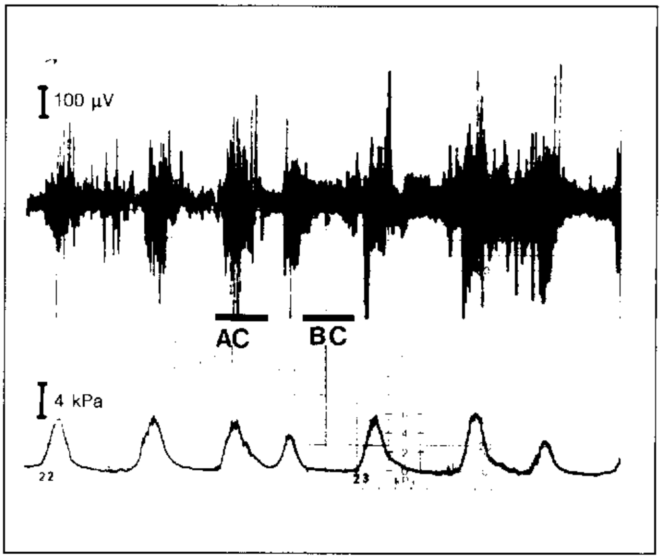

Fig. 1. Cervical EMG activity (upper trace) and intrauterine pressure (lower trace) in a primiparous patient.

Table 1. Mean values of amplitudes (µV) at 3 selected points of time and significance of intragroup and intergroup differences (unripe versus ripe cervices)

			Before oxytocin	30 min after oxytocin	60 min after oxytocin
Bishop ≤ 6	AC	M	201.5[1]	275.3	453.1[1]
		SD	217.7	143.3	249.4
	BC	M	201.5	158.7[2]	181.2[3]
		SD	170.5	141.7	163.2
Ratio		M	2.0[4]	2.6[5]	4.2[4,5]
		SD	1.9	2.0	4.4
Bishop ≥ 7	AC	M	244.4[6,7]	350.0[6]	433.2[7]
		SD	191.3	229.7	308.8
	BC	M	137.8[8]	92.0[2,8]	115.0[3]
		SD	128.9	60.1	116.9
Ratio		M	2.4[9,10]	5.2[9]	5.2[10]
		SD	1.9	5.9	4.1

Ratio = AC/BC.
1 $p < 0.000$ (intragroup).
2 $p < 0.012$ (intergroup).
3 $p < 0.048$ (intergroup).
4 $p < 0.006$ (intragroup).
5 $p < 0.010$ (intragroup).
6 $p < 0.023$ (intragroup).
7 $p < 0.000$ (intragroup).
8 $p < 0.037$ (intragroup).
9 $p < 0.017$ (intragroup).
10 $p < 0.001$ (intragroup).

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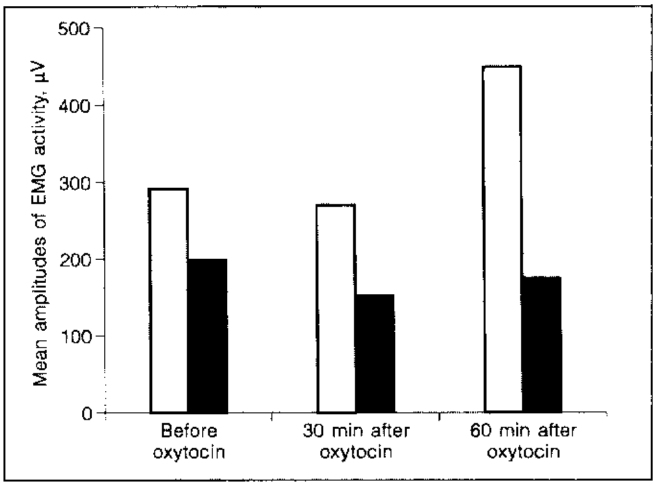

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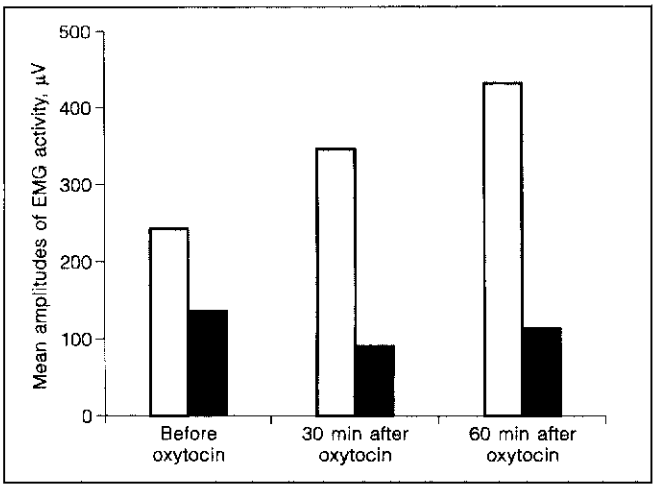

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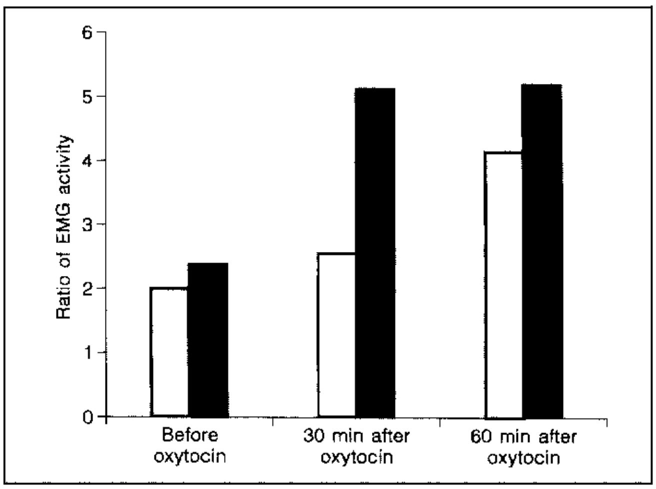

Fig. 2. EMG activity in unripe cervices after oxytocin (n = 45). □ = AC; ■ = BC.

Fig. 3. EMG activity in ripe cervices after oxytocin (n = 35). □ = AC; ■ = BC.

Fig. 4. Comparison of EMG activity between unripe (□) and ripe (■) cervices after oxytocin.

Discussion

The EMG is a complex electrical pattern arising from active muscle. Its amplitude is heavily influenced by several factors, among them: type of electrodes, recording electrode arrangement, the distance between them, electrode distance to the recorded muscle fibres, fibre distribution (number of muscle fibres sensed by electrodes) as well as the number of active motor units (MUs) that are firing, and their frequency of discharge. Higher frequency of discharge results in higher intensity of muscle fibre contraction. Contraction of the whole muscle is a consequence of the interaction of several muscle fibres. Since the EMG signal, as picked up in our measurements, actually reflects the superimposition of the simultaneous discharges of many MUs, the EMG amplitude increases with the intensity of muscle contraction. The discharge pattern generated by such a recording does not retain the shape of the individual MU activity.

Our assumption was that the methods of signal conditioning and acquisition were more or less identical in the majority of the cases. With a good electrode fixation in the cervix, we tended to keep the position of the electrodes stable during the first 90 min after the onset of the labour. In view of the electrode arrangement, our intergroup analyses may be more reliable than the intergroup comparisons.

The following comment on the results obtained is based on our hypothesis that longitudinally arranged muscular fibres are active during contractions of the uterine corpus and thus contribute to cervical dilatation, while circularly arranged fibres contract also between contractions, causing resistance in dilation of the cervical canal. We are, however, aware of a certain prevalence of longitudinal electrical activity in the cervix during labour, therefore we picked up the maximal possible quantity of muscular activity running in the circular direction [Pajntar et al., 1987, 1988].

Oxytocin administered after amniotomy appears to have an important influence on the muscular activity in the cervix. Changes in cervical muscular activity as a result of stimulation by oxytocin are different at a contraction (AC) or between contractions (BC). It seems that oxytocin does not have an identical effect on longitudinal and circular fibres. Another possible explanation for this difference in response may be their different innervation (parasympathetic versus sympathetic). The influence of oxytocin on the cervical musculature is different in ripe and unripe cervices.

The basic pattern of oxytocin-produced changes in muscular contractions observed via EMG activity is that of the activity increasing with contractions of the uterine corpus and diminishing between contractions. In unripe cervices, the AC EMG activity in the cervix increases only at 60 min after oxytocin administration, while in ripe cervices the increase begins immediately. Between contractions, under the influence of oxytocin the EMG activity decreases. In unripe cervices the decrease is less pronounced, while in ripe cervices it is considerable. The EMG activity at BC time mark is significantly smaller in ripe than in unripe cervices.

Cervical dilatation in ripe cervices is significantly faster than in unripe cervices, and may thus also be a sequel to increased activity of cervical musculature during corpus contraction and inactivity of the musculature between contractions. Good dilatation of the cervix in the initial stage of labour appears to depend on the ratio between the AC and BC EMG activities. The higher the index, the faster the dilatation and vice versa, the lower the index, the slower the dilatation. Or in terms of our hypothesis, strong contractions of the longitudinally running fibres of the cervical musculature can in the case of weak contractions of the circularly running musculature contribute to the faster cervical dilatation. On the other hand, strong activity of the circularly running fibres, manifested between contractions, impedes cervical dilatation. The influence of oxytocin on these two musculatures with different innervation (parasympathetic and sympathetic, respectively) is probably different. It stimulates the activity of longitudinally running fibres and relaxes the circularly running musculature. Thus oxytocin plays a role also in active dilatation of the cervix during labour.

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Prof. Marjan Pajntar
University Department of Obstetrics and Gynecology
Slajmerjeva 3
Ljubljana (Yugoslavia)