ELSEVIER SCIENCE IRELAND

European Journal of Obstetrics & Gynecology and Reproductive Biology 55 (1994) 9–12

OBSTETRICS GYNECOLOGY

The smooth muscles of the cervix in labour

M. Pajntar

University Medical Centre, Department of Obstetrics and Gynecology, Šlajmerjeva 3, 61000 Ljubljana, Slovenia

1. Introduction

The opinion that the cervix is passive during labour and that its dilatation is due to contraction of the uterine corpus has lately been contested by a number of new findings. It is now generally accepted that the uterine cervix plays an active role during pregnancy and labour and that dilatation and effacement also depend on an active process within the cervix. In the opinion of numerous authors the latter pertain to biochemical and structural changes in the connective tissue of the cervix. The muscular component is supposed by some authors not to be sufficient to have any important role in this process. But in Danforth's opinion it is unreasonable to presume it would be found here if it were not to have some function [1]. Actual counts of smooth muscle fibres have not been made, but examinations of many specimens suggest that, at most, the smooth muscle accounts for 10–15% of the normal cervical tissue. In occasional cases the smooth muscle content may be as high as 40% or 45%; occasionally there is virtually no smooth muscle to be found [2]. The smooth muscle of the myometrium extends along the periphery of the supravaginal portion of the cervix. It divides into two layers, of which one follows the vaginal reflection and the other continues for a short distance at the periphery of the portio vaginalis. In addition to these two systems, smooth muscle fibres are scattered sparsely and at random throughout the cervical tissue, in the opinion of some authors, without any uniform pattern, some longitudinal or circular in the inner part of the cervix and others, in a spiral pattern as a grouping of corporeal muscle fibres [1,3].

2. The role of the cervix during pregnancy and labour

The role of the cervix during pregnancy is to remain closed and retain the conceptus, while during labour it should dilate and retract. Following this concept the role of the smooth muscles in the cervix would be understandable: namely that by their contractions they contribute to the closing of the cervical canal during pregnancy, while in the course of labour they dilate, or through a different kind of contraction actively participate in the dilatation and retraction of the cervix (Fig. 1). For this role to be achieved the smooth muscles lying more or less in a circular pattern in the cervix should in pregnancy contract satisfactorily and act independently of the uterine corpus. The smooth muscles of the cervix in ewes contract vigorously, even late in gestation and with the approach of parturition. The cervical and uterine smooth muscles appear to act independently in this mammal, possibly reflecting their independent functioning [4].

3. Activity of cervical muscles

In humans, in the opinion of some authors, the cervix is constricting, constricting rhythmically and constricting independently of the corpus [2,5,6].

The strips of the uterine cervix in advanced pregnancy demonstrate spontaneous activity when mounted in organ baths. The most frequently encountered pattern

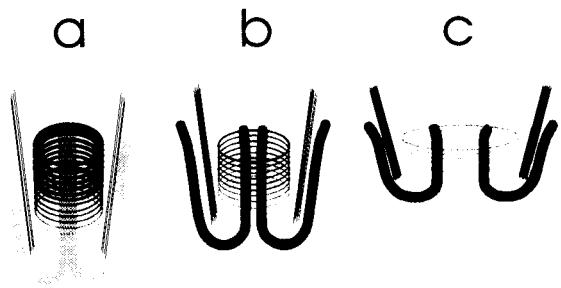

Fig. 1. Schematic of longitudinal and circular/spiral smooth muscle fibres in the cervix (hypothesis): (a) pregnancy, (b) ripening, (c) labour.

0028-2243/94/$07.00
SSDI 0028-2243(93)01760-Q

of contractile activity is high frequency — short duration. Prostaglandins PGE_2, PGI_2 and 6-keto-$PGF_{1\alpha}$ have an inhibitory effect on the muscular activity. The inhibitory effect of PGs on the cervical muscle activity may promote cervical dilatation and retraction [7]. Oxytocin stimulates contractions of cervical tissue in term pregnant women except in some in which an inhibitory effect is observed [8].

The activity of contractions of the smooth muscles of the cervix can be investigated mechanically or electrophysiologically. More than 80 years have elapsed since the first electrophysiological experiments on the uterus. Modern techniques and electronics provide precise and ample measurements, which were unimaginable until recently, and mathematical analyses of practically unsurveyable quantities of data.

4. Our investigation

Our team has been investigating the electrophysiology of the uterus, corpus and cervix since 1980. We are using surface Ag-AgCl disc electrodes for bipolar registration of the electrical activity of the uterine corpus and adapted spiral fetal scalp electrodes for bipolar registration of the cervical electrical activity. The electrodes for registration of the electromyographic (EMG) activity of the uterine corpus are fixed on the abdominal wall, the electrodes for registration of the cervical EMG activity are inserted directly in cervical tissue from the vaginal side. A miniature three-channel differential preamplifier was designed to amplify low-amplitude EMG signals with a fixed gain of 1000 and a bandwidth up to 5 kHz (3 dB). The EMG is further amplified by a three-channel galvanically isolated amplifier with adjustable gain, adjustable DC level, and a built-in low-pass filter (5 Hz) to exclude signals originating from striated muscles. The signals are recorded by a chart recorder and for further processing sampled and stored in a computer. Root mean square (RMS) and median frequency (MF) values are calculated every 5 s (MF from a power spectrum of 1-min overlapping windows). We have found that RMS is more useful for the evaluation of EMG activity than other measurements of rough electrical signals. rms is a quantitative measure of EMG intensity [9].

5. Results

5.1. Parity

In principle, the intensity of the cervical electrical activity decreases with parity. Even in a patient who is para 2 with an extremely unripe cervix, EMG activity was observed similar to that found in primiparous patients with unripe cervices. In most secundiparous patients, however, the electrical activity of the cervix bears more resemblance to that characteristic of primiparous women with ripe cervices. In triparous and multiparous women the activity is lower. As a rule, the amplitudes of individual bursts in multiparous women are much lower [10].

5.2. Ripeness of the cervix

In rough EMG records we find the following. In unripe cervices in induced labour (amniotomy and oxytocin) strong permanent activity in the beginning of the latent phase of cervical dilatation, sometimes without any noticeable contractions of the uterine corpus. This activity is subsequently grouped into increasingly pronounced bursts, which are usually synchronized with uterine contractions, but occasionally also appear between two contractions. In this period the activity is stronger than later in the active phase of dilatation. In riper cervices the initial activity is smaller and grouped into bursts, which occur in synchronization with uterine contractions but occasionally somewhat earlier or later. In the active phase of cervical dilatation the activity appears to be grouped in bursts, usually in synchronization with uterine contractions and persisting throughout a contraction. The intensity changes in the course of labour. These changes are not always correlated to the intensity of uterine contractions [10]. The statistical analysis of the RMS of cervical activity, detected transversally, in induced labour of primiparae has shown that after amniotomy and after oxytocin stimulation, the activity of smooth muscle is significantly greater in unripe cervices (Bishop 4 and less) than in more ripe cervices (Bishop 4–9). The RMS value is in statistically significant positive correlation with the length of the latent phase. In contrast, intrauterine pres-

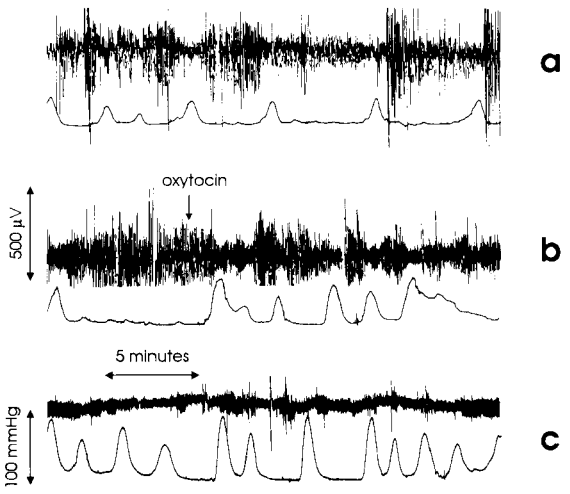

Fig. 2. EMG of the cervix (upper trace) and intrauterine pressure (lower trace): (a) before oxytocin application, (b) at oxytocin application, (c) after oxytocin application.

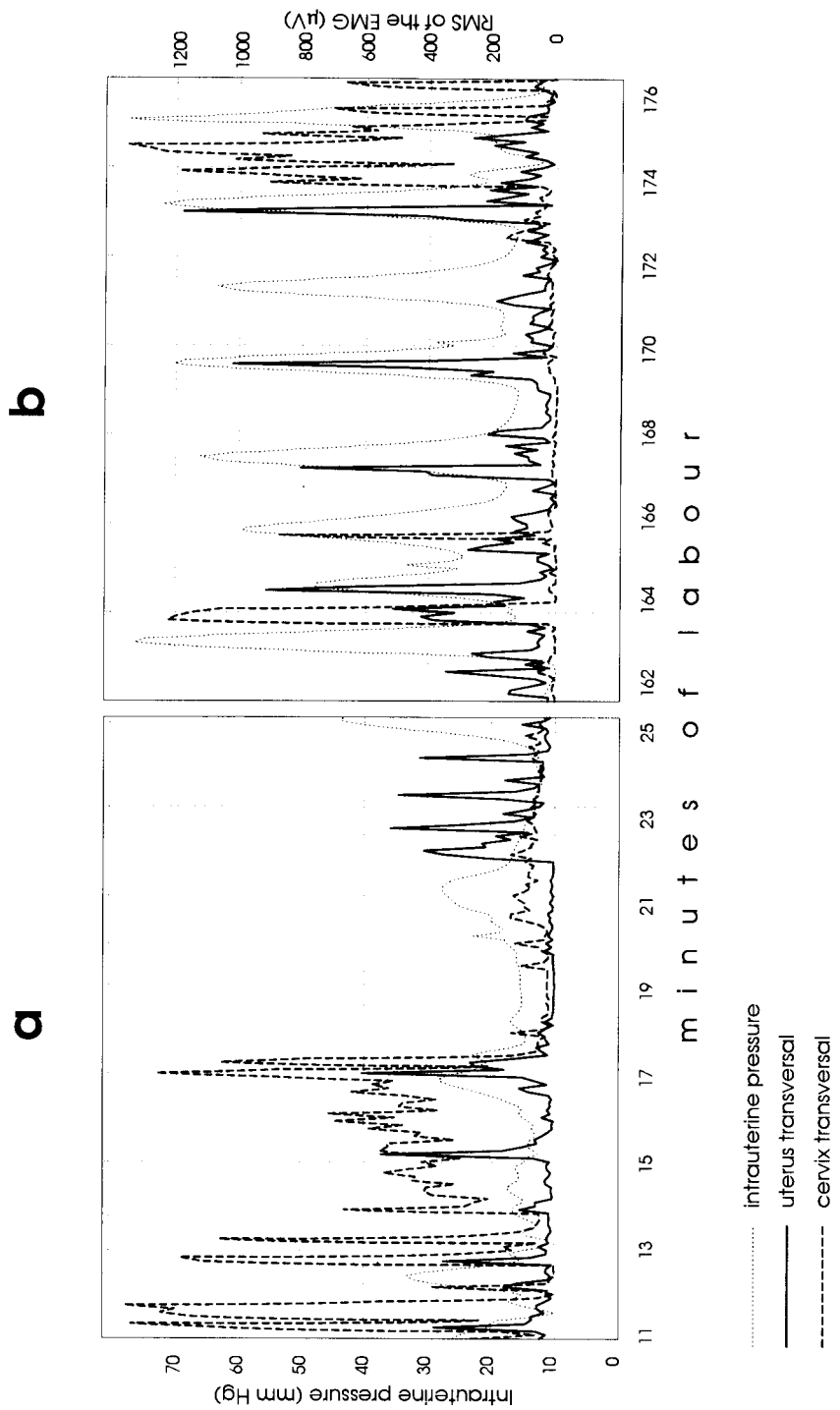

Fig. 3. Intrauterine pressure, RMS of the cervix (transversal measurement) and RMS of the lower uterine segment (transversal measurement): (a) latent phase of labour, (b) active phase of labour.

sure is in significant negative correlation with the length of the latent phase of labour (Pajntar M, Verdenik I, unpublished data). After the oxytocin application the EMG activity in the cervix increases with contractions of the uterine corpus and diminishes between contractions [11]. In some cases overall activity is diminished after oxytocin application (Fig. 2). All these findings suggest the importance of the activity of the smooth muscle in the cervix, especially in unripe cervices at the onset of labour, and show a role different to that of intrauterine pressure and/or contractions of the uterine corpus.

5.3. Two-lead registration of cervical EMG activity

In trying to find the characteristics of the activity of longitudinal and circular muscle fibres we have found the cervical EMG activity, measured both longitudinally and transversally, to be similar in many cases. When calculating the angle between the maximal EMG activity and the longitudinal axis of the cervical canal we have found it to range between 40° and 50°, which supports the theory of spirally running muscle fibres in the cervix. However, in some cases the EMG activity detected from the two leads differs in many ways. Usually the EMG activity detected transversally at the onset of labour is greater than that detected longitudinally, while as the labour progresses the latter becomes greater. These findings suggest that at the onset of induced labour, especially in unripe cervices, the smooth muscles (circular and/or spiral fibres) are more active and contribute to the closing of the cervical canal (unpublished results).

5.4. EMG activity of the cervix and uterine corpus

The EMG activity of the cervix was compared with the one of the fundus of the uterine corpus (longitudinal measurement), and with the one of the lower part of the corpus (longitudinal and transversal measurement). After amniotomy the electrical activity in unripe cervices is usually greater than in the fundus of the corpus, whereas in the case of ripe cervices the situation is reversed. As the labour progresses, especially in the active phase of dilatation, the proportion between the two changes independently of the intensity of contractions. The EMG activities in the cervix and in the fundus of the uterine corpus occur in groups of bursts, which in most cases are synchronized, both with each other and with uterine contractions. In a few cases, however, the distribution of bursts along the time scale in the cervix is entirely different from that in the fundus of the uterine corpus [10]. On the comparison of the RMS in the cervix (transversal measurement) and in the lower part of the uterine corpus (transversal and longitudinal measurement) we have found that the activity of all three observed parameters is constantly changing, especially in the latent phase of labour. It is different in both intensity and time of occurrence. It is most different at the onset of induced labour, while greater similarities have been found in the active phase of labour, mainly when approaching the end of cervical dilatation. Usually the electrical activity, measured transversally, is most vigorous in the lower uterine segment, followed by the intensity in the lower uterine segment measured longitudinally, and the weakest activity, measured transversally, is found in the cervix. In individual cases electrical activity is most vigorous in the cervix. In these cases the excitation is found to run in the direction from the cervix to the uterus (Fig. 3).

The smooth muscles of the cervix at the end of pregnancy and during labour are active and act in some way independently of the uterine corpus. This is in our opinion an important factor in the furthering knowledge of pregnancy and labour.

6. References

1 Danforth DN. The distribution and functional activity of the cervical musculature. Am J Obst Gynec 1954; 68: 1261–1271.

2 Danforth DN. The morphology of the human cervix. In: Pitkin RM, Scott JR, Ulmsten U, Ueland K, eds. Clinical Obstetrics and Gynecology. No. 1, vol. 26. Philadelphia: Harper & Raw, 1983: 7–13.

3 Hughesdon PE. The fibromuscular structure of the cervix. J Obstet Gynaecol Br Emp 1952; 59: 763–776.

4 Stys Sj, Clewell WH, Meschia G. Changes in cervical compliance at parturition independent of uterine activity. Am J Obstet Gynecol 1978; 130: 414–418.

5 Nixon WXW. Uterine action, normal and abnormal. Am J Obstet Gynecol 1951; 62; 964–984.

6 Theobald GW. Endocrine Control of Uterine Innervation. London: Butterworth, 1973; 366.

7 Bryman I, Sahni S, Norstrom A, Lindblom B. Influence of prostaglandins on contractility of the isolated human cervical muscle. Obstet Gynecol 1984; 63: 280–284.

8 Bryman I, Norstrom A, Lindblom B. Influence of neurohypophyseal hormones on human cervical smooth muscle contractility in vitro. Obstet Gynecol 1990; 75: 240–243.

9 Pajntar M, Verdenik I, Rudel D, Valentinčič B. Registration and analysis of cervical EMG during labour. In: Proceedings, IV International Symposium on Biomedical Engineering. Peniscola, 1991; 97–98.

10 Pajntar M, Roskar E, Rudel D. Electromyographic observations on human cervix during labor. Am J Obstet Gynecol 1987; 156: 691–697.

11 Pajntar M, Rudel D. Changes in electromyographic activity of the cervix after stimulation of labour with oxytocin. Gynecol Obstet Invest 1991; 31: 204–207.