IN-VIVO ELECTRICAL STIMULATION OF UTERINE SMOOTH MUSCLES IN SHEEP

D.Rudel

University of Ljubljana, Faculty of Medicine, Institute of Biomedical Informatics
Clinical Centre, Department of Obstetrics&Gynaecology
Vrazov trg 2, SI-1000 LJUBLJANA, SLOVENIA
drago.rudel@mf.uni-lj.si

Abstract: **An animal model was established for in-vivo studies of the EMG responses of a parturient uterine smooth muscle tissue to electrical stimuli. Five normally gravid sheep were fitted with implanted electrodes to register EMG signals and electrical stimulation. EMG signals were detected at the cervix and at the gravid horn. Spontaneous EMG activity was registered simultaneously with EMG responses to electrical stimulation. Different electrical stimulation parameters and protocols were tested.**

Direct EMG responses to electrical stimuli detected at the stimulation site were hindered by long lasting artifacts. No significant changes in the EMG activity at the horn were registered due to excitation at the distant cervical region and vice-versa. EMG responses registered during control measurements following each electrical stimulation session show an increase in the EMG signal amplitude (RMS) and a change in the signal frequency contents (increased MF and shift in PDS).

Keywords: **uterus, sheep, EMG, electrical stimulation, pregnancy**

Introduction

It is of extreme importance to clinical practice in obstetrics to be aware of pathologic uterine activity in abnormal pregnancy and labour. The activity of uterine smooth muscle could be studied also by electromyographic methods [1,2,3,4].

In-vitro histological investigations based on smooth muscle strips taken from an animal and/or human uterine fundus and the cervix enabled characterisation of basic electrical properties of uterine smooth muscle cells and bundles [5,6,7]. Further investigations of smooth muscle strip properties characterised the responses of an isolated muscle tissue of the human cervix to electrical stimulation [5,7,8,9,10,11] and/or an animal [12] myometrium to electrical stimulation.

The question arises of whether uterine EMG activity could be elicited *in-vivo* by an external electrical stimulus. No reports have been found so far on in-vivo electrical stimulation of pregnant uterine corpus or the cervix neither in sheep nor in humans.

We investigated the hypothesis that the EMG activity of uterine smooth muscle tissue could be elicited in-vivo in sheep by applying electrical stimuli to the tissue. As a consequence, uterine mechanical activity should increased. We speculated that the knowledge obtained could be implemented in humans to influence the process of ripening of the cervix during delivery [4 Rudel] and, in contrast, for testing the efficiency of drugs prescribed in cases of a threatened pre-term labour to diminished undesired uterine mechanical activity.

Materials and Methods

For ethical reasons in-vivo measurements were done in five multipara parturient sheep instead of on pregnant women. Each animal was fitted with a pair of stimulating/EMG detecting electrodes surgically placed on the sheep uterus: a pair on the horn and the other on the sheep cervix. The electrode wires were led percutaneously to connections with stimulation/registration equipment. During the measurements the animals were freely moving in a stall.

Four measurement protocols were tested where stimulation parameters and stimulation/EMG detection sites varied. Only one protocol gave positive results.

The sheep's cervical region smooth muscle tissue was electrically stimulated for a period of 20 minutes each day for five consecutive sessions. EMG activity was recorded during control measurements at the cervix and at the uterine horn using the same electrodes as for stimulation. Control measurements were made prior to each stimulation session. They lasted for 20 minutes before and for one-hour after each stimulation session. EMG activity was analysed in time, frequency and time-frequency domain. The elicited EMG signal pattern was characterised in terms of the EMG signal Root Mean Square (RMS), Median Frequency (MF) and Power Density Spectrum (PDS).

Results

There was an increase in EMG signal amplitude measured at the sheep cervix in the control measurement following electrical stimulation as compared to the EMG before stimulation. The increase was due to an activity (average MF = 1.2 Hz) superimposed on an EMG low-frequency signal (average MF = 0.1 Hz). The increased activity diminished in amplitude to the level of spontaneous activity within one-hour period. Results

of paired T-test and Wilcoxon test showed that the increase in cervical EMG RMS was statistically significant.

A considerable change was noticed in the average MF which increased from 0.25 Hz before to 0.44 Hz after electrical stimulation. MF decreased to the end of the control measurement to 0.36 Hz. Average EMG PDS of some selected (containing no artifacts) time intervals lasting from 1 to 5 minutes showed that the majority of the EMG signal contents was distributed in the frequency range from 0.03 Hz to 0.5 Hz. Some PDS had also separated high frequency components grouped around 1.1 Hz and/or 1.9 Hz.

EMG signal detected at the sheep horn remained almost unaffected due to electrical excitation of the cervix. There was no significant change noticed neither in RMF nor in MF.

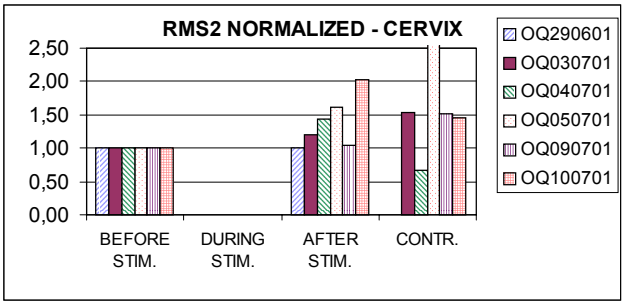

Figure 1: Normalised changes in average EMG signal amplitude (RMS) in EMG derived from the cervix.

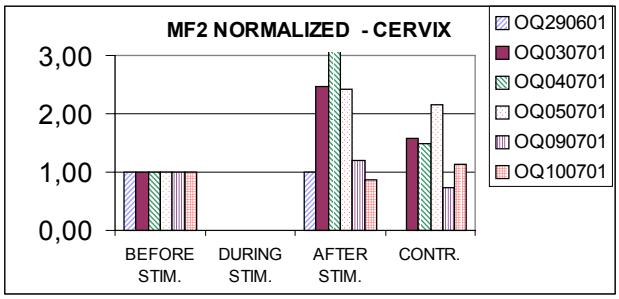

Figure 2: Normalised changes in average median frequency (MF) in EMG derived from the cervix.

Discussion

We believe this is the first report of an *in-vivo* stimulation of pregnant uterine smooth muscle tissue in a sheep. We confirmed our expectation that the stimulated smooth muscle tissue would respond to electrical stimulation by an increase in EMG activity. With the equipment available registration of in-vivo EMG responses was only possible after excitation by electrical stimuli was accomplished. At the stimulation site changes were reflected in higher EMG RMS values and as an increase of an average MF value. On average the increased EMG activity diminished to 150% of its spontaneous level within one-hour period. There were no significant changes in EMG detected at the electrode pair on the sheep horn being distant to the stimulation site at the cervix.

Conclusions

The established animal model reflects changes in the uterine EMG activity registered at the cervix. We consider it to be a suitable tool for objective assessment of changes in EMG activity of a parturient uterine smooth muscle tissue. By using the model tests of efficiency of drugs being prescribed to pregnant women in routine obstetrics practice are possible. This would be particularly essential for drugs being prescribed in cases of a threatened pre-term labour to diminished undesired uterine mechanical activity and in cases where ripening of the cervix at labour is to be achieved by medicaments.

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