ELECTROMYOGRAPHY OF THE PREGNANT UTERUS IN HUMANS AND SHEEP

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Abstract:
The aim of the investigation was to off-line compare parameters of uterine EMG signals recorded during pregnancy in humans and sheep.
Uterine corpus EMG recording sessions were performed in humans and in sheep. Sixty-five women underwent uterine corpus EMG recording sessions using abdominal surface skin electrodes. Six sheep underwent multiple EMG recording sessions using implanted electrodes. RMS and MF values were calculated from EMG signals. According to the different origins of EMG signals, RMS values were normalised (nRMS).
Differences between human and sheep EMG signals were assessed by comparing both parameters of EMG signals in different periods of pregnancy.
The trends of nRMS values approaching EDD are similar for both groups; they show a similar average increase. MF values are different. In the human group they show a slight average decrease while in the sheep group they show a slight increase with approaching EDD.
EMG activity in humans and sheep is similar in parameter nRMS and different in parameter MF.
Keywords: **uterus, human, sheep, electromyography, pregnancy**

Introduction

The activity of the human uterus during pregnancy is still not fully understood. This is partly due to the limitations on observing the activity through the entire course of pregnancy in humans. However, it would probably be possible to conclude much on human uterine activity by observing the uterine activity in other mammals.

The electromyographic (EMG) signal is considered to be a measure of smooth muscle cells activity [1]. To characterise EMG activity in different stages of pregnant and non-pregnant uteruses, uterine EMG activity has been investigated in humans [2,3,7] and animals[4-7] over the last few decades.

The purpose of this study was to compare the EMG signals of a human and sheep pregnant uteruses and to find similarities or dissimilarities in EMG parameters. The comparison would enable conclusions on the behaviour of human uterine EMG activity by observing uterine EMG activity in sheep.

Materials and Methods

Human study population. Study participants were adult normally pregnant women. On inclusion in the study they were between 23 5/7 to 39 6/7 weeks pregnant, all with one foetus.

Human EMG measurements. The EMG activity of the uterine corpus was detected using a non-invasive surface measuring technique. Two abdominal surface skin Ag-AgCl disc electrodes, 5mm in diameter, were attached transversally approximately 5cm above the symphysis. The inter-electrode distance was 7cm. A flat metal (Sn) reference electrode ($10cm^2$) was placed on the thigh. All participants voluntarily underwent from one to three 30 minute EMG recording sessions. A total of 155 uterine EMG recordings from 65 pregnant women were used.

Sheep study population. adult (3–7 years of age) normally pregnant sheep were included. All were multiparas, four with one foetus and two with two foetuses. On inclusion in the study they were between 50 to 100 days pregnant (gestation period in sheep is 140–159 days [8]). They were allowed to move freely in a box-stall (3m x 3m).

Sheep EMG measurements. One pair of active and one reference electrode were surgically implanted on the uterine surface under general anaesthetic. The electrodes were square shaped (3mm edge), made of 0.2mm thick platinum ribbon, unilaterally covered with silicon and mechanically attached to 70cm long multistrand stainless steel wire. The two electrodes were implanted in the middle of the pregnant horn in the transversal direction, approximately 6cm apart. The reference electrode was implanted in the middle of the uterus in the direction of the cervix, approximately 7cm from each electrode. After implantation and recovery from surgery, sheep was allowed to rest for at least two weeks for the uterus to stabilise.

During the recordings EMG signal preamplifier was connected to the measuring equipment via a flexible cable which was elastically attached to the ceiling.

All sheep underwent ca. 60 minute EMG recording sessions twice per day at the same time in the morning and in the evening until labour. A total of 354 uterine EMG recordings from 6 sheep was used.

Equal EMG data acquisition set-up was used for EMG recordings in a human and in sheep. Amplified and low-pass filtered EMG signals were digitised in real time by a PC-based 8-channel 12-bit A/D converter

using custom-made data acquisition software. The sampling frequency was 20Hz.

All EMG signals included were preprocessed to exclude artefacts and to remove the linear signal trend. The signals were then digitally filtered by a band-pass filter (from 0.08 to 4Hz). Signals were divided into one-minute time intervals.

For each one-minute interval for each EMG signal a root mean square (RMS) was calculated. RMS values were normalised: (nRMS).

In the frequency domain for each one-minute interval median frequency (MF) values were determined from power spectra densities. From one-minute MF values an average MF value for each EMG signal was calculated. A fast Fourier transform algorithm was used.

All calculated parameters were classified according to time of measurement as compared to estimated date of delivery (EDD).

Results

Values of nRMS and MF parameters in different periods of pregnancy for a human and sheep are presented as scatter diagrams in Figure 1 and Figure 2.

In the two groups nRMS values increase with approaching EDD in a similar way. On the other hand, trends of MF values with approaching EDD are different between the groups. In the human group MF values show a slight average decrease with approaching EDD while in the sheep group they show a slight increase with approaching EDD. Absolute average MF values are lower in the sheep group than in the human group.

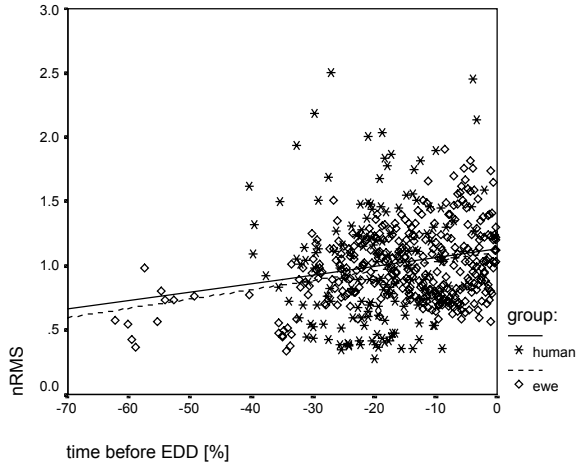

Figure 1: nRMS values before EDD with linear regression lines for humans and sheep respectively.

Discussion

To prove similarities between human and sheep EMG signals we compared EMG parameters nRMS and MF. We found both similarities and differences in the observed EMG parameters. The amplitude of smooth muscle activity (nRMS) during pregnancy is significantly stronger in a human than in sheep. The EMG activity increases in both groups with approaching labour and is similar in a human and sheep at the end of pregnancy.

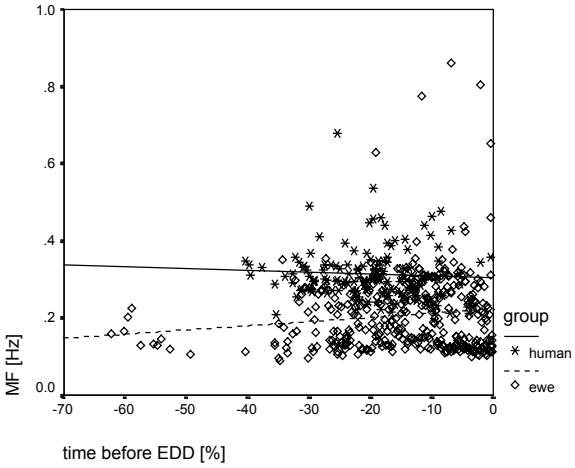

Figure 2: MF values before EDD with linear regression lines for humans and sheep respectively.

Conclusions

The nRMS parameter, describing EMG activity, has similar values in a human and sheep during pregnancy. The main differences between the observed groups exist in the MF parameter values.

REFERENCES

[1] T Kawarabayashi, "Electrophysiology of the human myometrium", in *The uterus*, T. Chard and G. Grudzinskas, Eds., Cambridge: Cambridge University Press, 1994, pp. 148-172.

[2] C Buhimschi, MB Boyle and RE Garfield, "Electrical activity of the human uterus during pregnancy as recorded from the abdominal surface", Obstet Gynecol 1997, vol. 90, pp. 102-111.

[3] M Pajntar, B Leskošek, D Rudel, I Verdenik, "Contribution of cervical smooth muscle activity to the duration of latent and active phases of labour", Br J Obstet Gynaecol 2001, vol. 108 pp. 533-538.

[4] R Garcia-Villar, PL Toutain, Y Ruckebusch, "Pattern of electrical activity of the ovine uterus and cervix from mating to parturition", J Reprod Fertil 1984, vol. 72, pp. 143-152.

[5] MHT Troedsson, AOG Wistrom, IKM Liu, M Ing, J Pascoe, M Thurmond, "Registration of myometrial activity using multiple site electromyography in cycle mares", J Reprod Fertil 1993, vol. 99, pp. 299-306.

[6] C Buhimschi, MB Boyle, GR Saade, RE Garfield, "Uterine activity during pregnancy and labor assessed by simultaneous recordings from the myometrium and abdominal surface in the rat", Am J Obstet Gynecol 1998, vol. 178, pp. 811-822.

[7] D Devedeux, C Marque, S Mansour, G Germain, J Duchene, "Uterine electromyography: A critical review", Am J Obstet Gynecol 1993, vol. 169, pp. 1636-1653.

[8] ESE Hafez, "Reproduction in farm animals", 6th edition, Philadelphia: Lea&Febiger, 1993.