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Predicting parturition in the ewe from the pattern of uterine motility

J. E. WOLFF AND P. M. DOBBIE

Ruakura Animal Research Station
Ministry of Agriculture and Fisheries, Hamilton

ABSTRACT

Mature ewes, 110 to 125 days pregnant, had catheters surgically implanted into maternal and foetal blood vessels and electrodes sutured to the myometrium. Electromyographic (EMG) signals were amplified, rectified, integrated and recorded. Between 2 and 12 days before parturition, the EMG pattern comprised bursts of activity that lasted 6.3 ± 1.5 (SD) min interspersed with periods of quietness that lasted 30 ± 13 min. Some 5 to 24 hours before delivery, a change in the EMG signal was noticeable with shorter, more frequent bursts of activity and a rise in the fraction of time occupied by activity from ~ 0.1 to > 0.2. During labour this fraction rose to ~ 0.5 with regular 1 to 2 min bursts of activity interspersed with short (~ 1 min) periods of rest. Thus the EMG can indicate impending delivery of the catheterised lamb. Surgical intervention produced a negligible reduction in gestation length from 147 ± 2 to 146 ± 1 days but a serious reduction in birth weight from 4.6 ± 0.8 to 3.7 ± 0.6 kg.

INTRODUCTION

The observation by Meschia *et al.* (1980) that the sheep placenta was an avid consumer of both glucose and oxygen has focussed attention on the causes and consequences of such high rates of metabolism. One issue that we are investigating is whether high or low rates of metabolism are good or bad for foetal growth and development. Our approach is to look for variations in neonatal vigour that might be related to the placental metabolism of glucose or oxygen.

Making both observations in the same experimental unit poses some challenges. Firstly the ewe and her foetus must be surgically prepared with catheters in the uterine and umbilical circulations for measurements of blood flow and the arteriovenous differences of metabolites. Secondly, the vigour of the newborn lamb must be challenged and measured in a reproducible manner after it has matured in response to the increased level of circulating cortisol at the end of gestation. Thirdly the placental tissues must be recovered and weighed before they autolyse and separate from the uterus. To meet these requirements we had to use a physical method for predicting the onset of labour so that the lamb could be delivered by Caesarian section and the placenta recovered intact.

The electromyographic (EMG) activity was selected for evaluation because Harding *et al.* (1982) and Krishnamurti *et al.* (1982) have shown pronounced changes in the EMG pattern during the 48 hours preceding parturition. Here we describe the progress made in predicting parturition from the EMG recording.

MATERIALS AND METHODS

Mature Romney crossbred, Perendale or Coopworth ewes had their oestrous cycles synchronised with intravaginal devices containing progesterone and were mated to the ram at about monthly intervals between December and July. They grazed on pasture until brought indoors at 100 to 120 days of gestation when they were fed a pelleted ration of lucerne and barley meal. Pregnancy was confirmed by X-ray at 80 to 100 days of gestation. Approximately half of the ewes were operated upon for placement of catheters in various foetal and maternal blood vessels and in the amniotic cavity using methods previously described (Wilkening *et al.*, 1982). After closing the uterine incision, electrodes were sutured into the myometrium at 2 sites — one was on the body of the uterus about 15 cm from the cervix and on the greater curvature of the pregnant uterine horn, the other was on the flexure of the pregnant uterine horn.

Various techniques such as those described by Titchen (1979) and Krishnamurti *et al.* (1982) were used for fabricating and placing the electrodes but only in a few instances were good recordings produced through to delivery. Our most successful method has been to feed four 1.5 m lengths of braided stainless steel electrode wire (Type AS632, Cooner Wire Co., Chatsworth, California) into a 0.9 m length of 1.00×2.00 mm polyvinylchloride catheter tubing. Electrode wires were tied in pairs around a 15 mm length of vinyl catheter tubing, the insulation stripped from a 10 mm length of each wire 5 mm distal to the knot and the shaft of a 22 g hypodermic needle crimped on to the free end. Each set of electrodes was sterilised in ethylene oxide. At surgery, the hypodermic needles with wires attached were passed from the serosal surface through a fold of the myometrium 3 to 4 mm apart. The free ends were tied to the myometrium 10 to 20 mm from the point of egress and the surplus wire trimmed. The arrangement is shown in Fig. 1. The electrode wires were exteriorised with the catheters and stored in a vinyl pouch attached to the skin over the ewe's flank with steel pins. One to 7 days after surgery the electrodes were connected to the input of a Universal AC/DC amplifier (Model no 13-4615-55, Gould Instruments, Cleveland, Ohio) with gain set for a full scale reading of 50, 100 or 250 μvolts (depending on the strength of the EMG signal) and the filters set at 3 and 100 Hz.

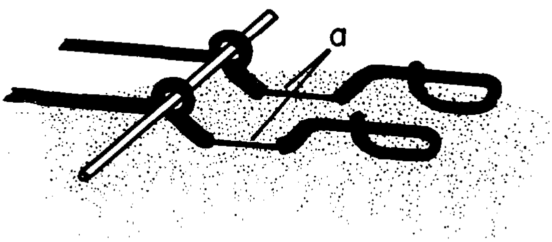

FIG. 1 Placement of recording electrodes in the myometrium. The fluorocarbon insulation has only been stripped from a 10 mm length of each wire at (a).

The output was recorded on a Rikadenki 2 pen chart recorder at speeds of either 0.33 or 2 cm/min and also passed to a Gould Integrator Amplifier (Model no 13-4615-70) where the biphasic EMG signal was rectified and summed for 1 second intervals. These values were also displayed on the second channel of the chart recorder and used for calculation of a myoelectrical index or fraction of time occupied by activity as described by Krishnamuriti *et al.* (1982). On 1 occasion, these values were digitised, displayed on the VDU of an Apple II microcomputer and stored on disk.

RESULTS AND DISCUSSION

Gestation lengths for the 13 operated and 22 unoperated ewes averaged 146 ± 1 (SD) and 147 ± 2 days respectively. This difference is statistically significant ($P < 0.05$ by a one-tailed t test) but cannot, by itself, be expected to have any detrimental effect upon maturation of the foetus that occurs mainly during the last week of gestation (Liggins *et al.*, 1973; Liggins, 1976). The observation is supported by the fact that virtually all of the lambs were born alive without assistance and needed no help to seek or obtain colostrum. The exception was a breech presentation that died during delivery. A comparison of birth weights, however, shows that lambs from the operated ewes weighed 3.7 ± 0.6 kg whereas those from the unoperated group were 4.6 ± 0.8 kg. This difference is statistically highly significant and indicates that still more attention must be given to surgical technique before the results of metabolic studies are unequivocally applied to the normally growing lamb.

The EMG activity we have recorded is generally similar to that reported by Harding *et al.* (1982). Between 1 week after operation and 2 days before parturition the average interval between EMG bursts was 30 ± 13 min while the average length of a burst was 6.3 ± 1.5 min. By comparison, Harding *et al.* (1982) found that the average EMG was 7.2 min long with an average interval of 47 min. We have not observed any consistent difference in the recordings obtained from the 2 sites.

Often on the day before parturition a change in the pattern has become evident. The EMG bursts were shorter and the interval decreased. In some ewes the myoelectrical index increased from <0.1 to ~0.2. These changes continued until the ewe was in labour when the bursts were about 1 to 2 min in length and well separated by quiet intervals of about 1 min. The myoelectrical index was then ~0.5. After delivery, the periodicity of the pattern gradually lengthened and by 3 days was similar to the pattern described for 3 days or more before parturition.

For the purposes of our experiment, we are satisfied that routine monitoring of the EMG from the pregnant uterus is a feasible method for learning when the ewe is close to parturition. On 3 counts, the technique is clearly superior to the measurement of intra-uterine pressure changes. These latter recordings show a shift in baseline whenever the ewe lies down or stands up and all contractions of the abdominal musculature are faithfully recorded as artifacts. Irregularities such as these are easily filtered out by the human eye but introduce major difficulties if a microcomputer is used to log the data and keep track of each animal. A third reason is that Harding *et al.* (1982) have shown that a change in EMG pattern clearly precedes the changes in intra-uterine pressure that mark a transition from a gentle squeezing of the foetus (Δ P 3 to 10 mm Hg) during each EMG burst before parturition to the much larger forces required for delivery (Δ P 20 to 40 mm Hg).

Initially we had hoped from the published work of Krishnamurti *et al.* (1982) that it would be possible to predict the time of parturition from the changing pattern of the EMG and deliver the foetus some 12 to 24 hours earlier. Our experiences indicate that this degree of precision is unlikely to be obtained. Instead, we will use the technique to warn us that the ewe is close to term. Only when the EMG pattern typical of labour is established will we deliver the lamb to challenge its neonatal vigour. Such a procedure will also permit the labour-induced rise of epinephrine to enhance maturation of the Type II cells in the lung that are responsible for lecithin synthesis and surfactant release, so necessary for lungs of the newborn to attain maximal compliance (Phillipe, 1983).

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REFERENCES

Harding R.; Poore E. R.; Bailey A.; Thorburn G. D.; Jansen C. A. M. Nathanielsz P. W. 1982. Electromyographic activity of the nonpregnant and pregnant sheep uterus. *American journal of obstetrics and gynecology* **142:** 448-457.

Krishnamurti C. R.; Kitts D. D.; Kitts W. D.; Tompkins J. G. 1982. Myoelectrical changes in the uterus of the sheep around parturition. *Journal of reproduction and fertility* **64:** 59-67.

Liggins C. G. 1976. Adrenocortical-related maturational events in the fetus. *American journal of obstetrics and gynecology* **126:** 931-939.

Liggins C. G.; Fairclough R. J.; Grieves S. A.; Kendall J. Z.; Knox B. S. 1973. The mechanism of parturition in the ewe. *Recent progress in hormone research* **29:** 111-159.

Meschia G.; Battaglia F. C.; Hay W. W.; Sparks J. W. 1980. Utilization of substrates by the ovine placenta in vivo. *Federation proceedings* **39:** 245-249.

Titchen D. A. 1979. Diaphragmatic and oesophageal activity in regurgitation in sheep: an electromyographic study. *Journal of physiology (London)* **292:** 381-390.

Wilkening R. B.; Anderson S.; Martensson L.; Meschia G. 1982. Placental transfer as a function of uterine blood flow. *American journal of physiology* **242:** H429-H436.