Prediction of parturition and dystocia in dairy and beef cattle

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Initiation of parturition

Parturition is a process initiated by the fetus and is dependent on the hypothalamus-pituitary-adrenal (HPA) axis. As parturition approaches, fetal stress activates the fetal HPA axis. Corticotrophin releasing factor (CRF) is secreted by the hypothalamus and CRF stimulates the release of adrenocorticotrophic hormone (ACTH) from the anterior pituitary gland, which in turn causes the release of cortisol from the fetal adrenal cortex. The increase in fetal plasma cortisol concentration is followed by an increase in maternal cortisol due to the activation of the HPA axis of the dam as a response to the pain and stress of labor. It is important to note that although fetal plasma cortisol concentration is high, only a very small amount of fetal cortisol crosses over into the maternal circulation.

Predicting parturition

The accurate prediction of parturition in dairy cattle is important in primiparous cattle as they are at increased risk of dystocia. Predicting the time of parturition permits focused monitoring of prepartum cattle and consequently reduces dystocia related morbidity and mortality to the dam and calf. Many factors have been shown to statistically predict parturition within 12-24 hours, but the practical use of these predictors remains limited. Factors shown to have some predictive ability include increased plasma cortisol concentration, decreased plasma progesterone concentration, decreased rectal and vaginal temperature, decreased feed intake and rumination rate, relaxation of the sacrosciatic ligament, filling of the teats and udder, presence of a bloody vaginal discharge, increased restlessness of the cow, and increased frequency of lying bouts and tail raises.

The maternal plasma cortisol concentration starts to increase 25-32 h before parturition in cattle, peaks immediately at the time of delivery, and rapidly decreases within 1 h after parturition. Parturition is a stressful and traumatic event; cattle that are carrying twins have higher plasma cortisol concentrations on the day of calving than cattle carrying a single calf, and cattle requiring assistance at parturition due to dystocia have higher plasma cortisol concentrations than cattle with unassisted deliveries. Hypercortisolemia results in hyperglycemia due to increased gluconeogenesis and decreased glucose utilization, and plasma glucose concentration is increased around parturition in response to the increased plasma
cortisol concentration. Blood glucose concentrations can be easily and rapidly measured cow-side using a point of care device.

We have evaluated the predictive ability of changes in rectal temperature, sacrosciatic ligament relaxation, plasma progesterone concentration, and blood glucose concentration as indicators of parturition within 12 and 24 hours in 36 primiparous and 73 multiparous Holstein-Friesians. Changes in rectal temperature were measured using a GLA M700 digital thermometer (GLA Agricultural Electronics). Relaxation of the sacrosciatic ligament was quantified by placing two rulers on the caudodorsal aspect of the pelvis perpendicularly to each other and measuring the maximal distance from one ruler to the sacrosciatic ligament. The plasma progesterone concentration was measured in duplicate using an ELISA that has been validated for cattle (Ovuchek Plasma, Biovet). Measurements and samples were obtained daily between 8 and 10am. Data was analyzed using repeated measures ANOVA and P < 0.05 was significant.

The mean rectal temperature in primiparous and multiparous cattle at 24 hours before parturition declined by 0.6°F and 0.5°F respectively, compared to values 24 hours previously. The mean amount of sacrosciatic ligament relaxation in primiparous and multiparous cattle at 24 hours before parturition was 4.5 mm and 3.7 mm, respectively, compared to values 24 hours previously. Mean plasma progesterone concentrations in primiparous and multiparous cattle at 24 hours before parturition decreased by 2.9 ng/mL and 2.5 ng/mL respectively, compared to values 24 hours previously. The optimal cutpoint for predicting parturition within 12 h in primiparous cattle was plasma [glucose] > 82 mg/dL (area under the ROC curve = 0.82; Se = 0.71; Sp = 0.84). The optimal cutpoint for predicting parturition within 12 h in multiparous cattle was plasma [glucose] > 72 mg/dL (area under the ROC curve = 0.83; Se = 0.74; Sp = 0.89).

We concluded that all four parameters have clinical utility as predictors of parturition in dairy cattle. Predictive utility can be increased by using equations derived using logistic regression but this decreases the practicality of using a single index to predict parturition within 12 and 24 hours.

**Predicting dystocia**

Dystocia remains a major problem in the dairy industry as it increases cow and calf mortality, decreases milk yield, delays uterine involution, and decreases reproductive performance, ultimately resulting in substantial financial loss. Fetopelvic disproportion is the most common cause of dystocia in dairy cattle, and primiparous animals have a higher incidence of fetopelvic disparity and dystocia than multiparous dairy cattle because of their smaller stature and late maturation of pelvic dimensions. However, an accurate test for dystocia in cattle will be challenging to develop because of the large number of factors that can result in dystocia, including calf presentation, position, posture, and sex, dam body condition score, and gestation length. Environmental factors, including season, nutrition and overall general management, are also important factors that influence the occurrence of dystocia.

Calf birth weight, particularly from first-calving heifers, as well as morphologic measurements of the dam such as thoracic circumference, height at the withers, and body weight are
positively associated with the incidence of dystocia in dairy cattle. Calf birth weight is also positively associated with morphologic measurements of the calf, including thoracic circumference, height at the withers or sacrococcygeal region, front hoof circumference, and circumference of the carpus, tarsus, or fetlock. Of these calf morphologic measurements, front hoof circumference is easily measured during stage II of parturition and consequently has the greatest clinical potential to predict calf birth weight and therefore the likelihood of dystocia. Linear equations have been developed for beef calves relating calf birth weight (kg) to the circumference of the front hoof at the coronary band (cm), such that: weight = 4.96 × circumference – 51.4 for heifer calves; and weight = 3.63 × circumference – 29.4 for bull and heifer calves. A commercially available tape measure, calibrated using the first equation, accurately predicted body weight in Holstein-Friesian and Jersey calves weighing between 31 and 45 kg.

The clinical utility of using maternal intrapelvic dimensions to predict dystocia remains controversial in beef cattle and has been minimally investigated in dairy cattle. Intrapelvic dimensions are most commonly measured in beef heifers before the start of the breeding season or during the first and second trimester when palpation per rectum is used for pregnancy diagnosis. Heifers with exceptionally small intrapelvic dimensions for their body weight or abnormal intrapelvic shape are culled or mated to “easy-calving” bulls because of their increased risk of dystocia. The ability of intrapelvic measurements measured at breeding time or early in gestation to accurately predict dystocia in beef heifers is questionable because extrapolation of intrapelvic dimensions obtained during first service or the first or second trimester leads to unacceptably high 95% confidence intervals for the predicted intrapelvic dimensions at parturition and failed to accurately predict dystocia in primiparous beef cattle.

Measurement of calf front hoof circumference, maternal intrapelvic area and selected morphometric dimensions in late gestation, and an estimate of the dam’s body weight are predictive of calving difficulty score in dairy cattle and beef cattle. The ratio of calf front hoof circumference to maternal intrapelvic area or width also has clinical utility to predict dystocia in dairy cattle, as these ratios directly reflect the magnitude of fetopelvic disproportion which is the most common cause of dystocia in cattle.

**Pelvimetry in the immediate antepartum period**

We examined the clinical utility of measuring calf front hoof circumference, maternal intrapelvic area, and selected morphometric values in predicting dystocia in dairy cattle. An observational study using a convenience sample of 103 late gestation Holstein-Friesian heifers and cows was used for the study. Intrapelvic height and width of the dam were measured using a pelvimeter and the intrapelvic area was calculated. Calf front hoof circumference and birth weight were also measured. Data were analyzed using Spearman’s correlation coefficient (rs), Mann-Whitney U test, and binary or ordered logistic regression. P<0.05 was considered significant.
The calving difficulty score (on a scale of 1 to 5) was greater in heifers (median, 3.0) than cows (median, 1.0). Median intrapelvic area immediately before parturition was smaller in heifers (268 cm²) than cows (332 cm²), whereas front hoof circumference and birth weight of the calf were similar in both groups. Calving difficulty score was positively associated with calf birth weight in heifers ($r_s = 0.39$) and cows ($r_s = 0.24$). Binary logistic regression using both dam and calf data indicated that the ratio of front hoof circumference of the calf to the maternal intrapelvic area provided the best predictor of dystocia (calving difficulty score = 4 or 5), with $Se = 0.50$ and $Sp = 0.93$ at the optimal cutpoint for the ratio (> 0.068 cm/cm²).

Our results suggest that measurement of pelvic area as close to parturition as possible (such as when late gestation dairy cattle are moved from the dry pen to the calving pen) is helpful in identifying heifers and cows at increased risk for dystocia. These animals would therefore be observed more frequently to ensure that parturition is progressing satisfactorily. Our results also suggest that determining the front hoof circumference of the fetus at the onset of Stage 2 of parturition provides additional information regarding the risk of dystocia in dairy cattle, and that knowledge of both the dam’s pelvic area and fetal front hoof circumference will facilitate optimal management of parturition. In particular, these measurements quantify the likelihood of severe dystocia, and permit the veterinarian and producer to collectively agree on proceeding with vaginal delivery, fetotomy if the fetus is believed to be dead, or cesarian section.

Clinical outcome of cesarian section in beef cattle

Evaluation of heifers and cows during stage 1 or stage 2 of parturition may indicate that vaginal delivery was not possible. Consequently, we were interested in characterizing the signalment, clinical signs, reproductive history, surgical management, and outcomes of beef cattle undergoing cesarean section because of dystocia. We meet these goals by conducting a retrospective case series involving 173 beef cattle admitted to the teaching hospital during a 10-year period that underwent cesarean section because of dystocia. The medical records were reviewed and information retrieved including cattle signalment; reproductive history; cause of dystocia; anesthetic protocol; surgical management; number, sex, and body weight of calves delivered (alive or dead); perioperative treatment; duration of hospitalization; and discharge status. The producers received a questionnaire regarding postoperative fertility.

Overall mortality rate for calves was high, with 36% (62/165) of the calves delivered dead or dying within 24 hours after cesarean section. The mortality rate was higher for female versus male calves and for calves from dams with signs of labor for ≥ 3 hours before hospital admission. Overall mortality rate for dams was low, with only 10 of 161 (6%) failing to survive for at least 21 days after hospital discharge. Postoperative fertility was acceptable, with 75% (44/59) of dams that were rebred after cesarean section giving birth to at least 1 live calf. We concluded that cesarean section was a clinically useful method for resolving dystocia in beef
cattle, providing a high dam survival rate and an acceptable postoperative fertility rate. Beef cattle producers should seek veterinary assistance whenever clinical signs of dystocia are evident, preferably within 3 hours after the start of stage 2 of parturition.

Recommended references


