SYNCHRONIZATION OF PARTURITION IN BEEF CATTLE WITH PROSTAGLANDIN AND DEXAMETHASONE[a]

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ABSTRACT

The effectiveness of dexamethasone and prostaglandin in combination for induction and synchronization of parturition in cattle was evaluated in 100 pregnant Angus, Hereford, Charolais and Simmental cows. Cows were distributed equally by breed, day of gestation and cow age to one of three treatments: 1) Control, 2) Dexamethasone (25 mg) plus prostaglandin $F_{2\alpha}$ (25 mg) or 3) Dexamethasone (25 mg) plus fenprostalene (1 mg). Hormones were administered simultaneously from 275 to 283 d of gestation. Gestation length at calving for control cows differed significantly ($P < 0.01$) among breeds: Angus, 278.5 $\pm$ 0.9; Hereford, 283.1 $\pm$ 1.1; Charolais, 283.2 $\pm$ 1.5; and Simmental, 285.4 $\pm$ 1.2 d. For hormone-treated cows, 80% of the calves were born between 30 and 46 h after the hormone injections; overall mean was 37.6 $\pm$ 1.1 h. Calving response did not differ ($P > 0.1$) between cows treated with prostaglandin $F_{2\alpha}$ versus fenprostalene (36.5 $\pm$ 1.6 vs 38.6 $\pm$ 1.6 h) or among cow age, day of gestation, or breed. Also, duration of labor, calving difficulty and calf viability did not differ between calves born at an induced or spontaneous parturition. The incidence of placenta retained for >24 h was higher for induced than spontaneous parturition (21.0 vs 0.0%), but it did not differ ($P > 0.1$) between cows treated with prostaglandin $F_{2\alpha}$ or fenprostalene (19.2 vs 22.6%). An acceptable degree of synchrony of parturition was attained by the administration of prostaglandin $F_{2\alpha}$ or fenprostalene in combination with dexamethasone. The higher incidence of retained placenta in treated than control cows did not affect subsequent fertility. The longer biological half-life for fenprostalene than for prostaglandin $F_{2\alpha}$ provided no improvement in increasing synchrony of parturition or decreasing frequency of retained placenta.

Key words: induced parturition, dexamethasone, prostaglandin, beef cattle.

INTRODUCTION

The opportunity to schedule and synchronize parturition in a herd of beef cattle with known gestation lengths has tremendous economic appli-

[a]Mention of companies or commercial products does not imply recommendation or endorsement by the U.S. Department of Agriculture over others not mentioned.
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cation because of more efficient utilization of manpower, fewer obstetrical complications and decreased neonatal calf mortality (1). It is well documented that parturition can be induced within the last 3 wk of pregnancy in the cow by glucocorticoid treatments (2-5). However, the application of glucocorticoid-induced parturition in beef and dairy cattle management has been inhibited by unacceptably high incidences of retained placenta and large among-cow variation in response time ranging up to several days (5). Preliminary results from the administration of dexamethasone in combination with prostaglandin $F_{2\alpha}$ to cows within 5 d of the estimated parturition date resulted in excellent synchronization of parturition within a small group of cows and a low incidence of retained placenta. Thus, the objective of this study was to evaluate the effectiveness of dexamethasone in combination with prostaglandin $F_{2\alpha}$ to regulate and synchronize parturition in a beef cow herd, and at a later stage of gestation than previously studied. Because prostaglandin $F_{2\alpha}$ has a short biological half-life, response to a longer-acting prostaglandin analogue (fenprostalene) was also evaluated.

MATERIALS AND METHODS

Trial 1

The trial utilized 100 pregnant Angus (n = 24), Hereford (n = 28), Charolais (n = 18) and Simmental (n = 19) cows ranging in age from 2 to 9 yr and bred to sires of their respective breeds at a synchronized estrus. Within age and breed, cows were assigned randomly to one of the following three treatments: Group 1, control; Group 2, dexamethasone (25 mg) plus prostaglandin $F_{2\alpha}$ (25 mg); or Group 3, dexamethasone (25 mg) plus fenprostalene (1 mg). The dexamethasone[c] and either prostaglandin $F_{2\alpha}$[d] or fenprostalene[e] were injected simultaneously intramuscularly or subcutaneously between 275 and 283 d of gestation with an equal distribution of cows across the 9-d period. Five cows assigned to Group 2 and one cow assigned to Group 3 calved before treatment and were not included in the data analysis. Control and treated cows were managed and handled together, confined to the same calving area and monitored continuously for signs of labor throughout the trial. A calving difficulty score and calf vigor score were assigned to each cow and calf, respectively, at parturition. The scoring system for calving difficulty was 1 = calved unassisted; 2 = little difficulty, assisted by hand pull; 3 = little difficulty, assisted by mechanical calf puller; 4 = slight difficulty using a mechanical calf puller, no injury to cow or calf; 5 = moderate difficulty using a mechanical calf puller, minor injury to cow or calf; 6 = major difficulty using a mechanical calf puller, severe hiplock and >30-min delivery; 7 = caesarean birth. Calf vigor was scored as 0 = calf dead at birth; 1 = calf weak and listless; 2 = calf lacked vigor; 3 = calf with average vigor; and 4 = calf very lively immediately after birth.

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[c]Veterinary Research, Porterville, CA.
[d]Lutalyse®, Upjohn Co., Kalamazoo, MI.
[e]Bovilene®, Diamond Laboratories Inc., Des Moines, IA.

Presence of the placenta 24 h after calf delivery was diagnosed as retained and the cow received a solution[f] of penicillin G procaine (200,000 units/ml) and dihydrostreptomycin sulfate (0.25 gm/ml) intramuscularly at a daily dosage of 4.4 ml/100 kg body weight, 8 mg of estradiol cypionate[g] intramuscularly every 5 d, and two intrauterine Cap-Tabs® tablets[h] every 2 d until expulsion of the placenta. No stressful manual removal of the placenta was attempted.

The Angus, Hereford and Simmental cows were subsequently exposed to fertile bulls for 60 d starting at about 60 d postpartum. Pregnancy rate was determined 60 d after the end of the breeding period.

Data recorded for each cow were treatment group, calving difficulty score, calf birth weight and vigor score and time of occurrance for the following events: hormone injections, appearance of placenta, appearance of fetal feet, expulsion of calf, calf first stood, calf first nursed and expulsion of placenta. Eight cows gave birth to twins and insufficient data were obtained on three additional cows; therefore, data for 11 cows were excluded from the analyses.

Data were analyzed by least-squares analysis with treatment, breed and parity (first vs multiple) as main effects and interactions. Cows without or with a retained placenta were given a score of 0 or 1, respectively. Simple correlations were calculated among measured variables adjusted for breed and parity effects.

Trial 2

Thirty-three pregnant recipient cows from three consecutive days of embryo transfer were injected intramuscularly with 25 mg of dexamethasone and 25 mg of prostaglandin $F_{2\alpha}$ as described in Trial 1, 3 d before the estimated parturition date based on the predominate breed of the fetus. Breeds of the recipient cows were Hereford and Charolais; fetuses were Charolais, Gelbvieh, Holstein, Pinzgauer and Simmental crossbreds. Time of hormone injection and of calf and placental expulsion were recorded. Cows with the placenta retained for >24 h were treated as in Trial 1.

RESULTS

Parturition occurred in pregnant beef cows 36.5 ± 1.8 h after treatment with dexamethasone and prostaglandin $F_{2\alpha}$ in combination or 38.6 ± 1.6 h after treatment with dexamethasone and fenprostalene in combination (Table 1); response time for parturition did not differ ($P > 0.05$) between the two hormone treatments. The mean response time was about 8 h shorter in Trial 2 (Table 5) than in Trial 1 (28.6 ± 1.3 vs 36.5 ± 1.4 h for cows treated with dexamethasone and prostaglandin $F_{2\alpha}$ in combination. In comparison, calving of the control cows occurred over a 9- to 10-d period within a breed of cattle, whereas duration of

[f]Vetycil-AS®, John D. Copanos, Inc., Baltimore, MD.
[g]ECP®, Upjohn Co., Kalamazoo, MI.
[h]Fort Dodge Laboratories, Inc., Fort Dodge, IA.

Table 1. Influence of induced parturition on labor and incidence of retained placenta (Trial 1)

Response	Control	Dexamethasone + Lutalyse	Dexamethasone + Bovilene
No. of cows	32	26	31
Gestation length at calving (d)	282.7 ± 0.6[a]	280.7 ± 0.7	280.6 ± 0.6
Interval from hormone injection to calf expulsion (h)	82.4 ± 15.6	36.5 ± 1.8	38.6 ± 1.6
Range (h)	-66.0 to 239.0	14.0 to 52.5	21.8 to 59.8
Percentage calving within a range of ± 6 h of the mean	6.5	73.1	71.1
Percentage calving within a range of ± 12 h of the mean	12.9	92.6	89.7
Interval from appearance of placenta to calf expulsion (h)	1.32 ± 0.20	1.65 ± 0.22	1.28 ± 0.20
Interval from appearance of calf's feet to expulsion (h)	0.46 ± 0.13	0.83 ± 0.15	0.62 ± 0.13
Incidence of retained placenta at			
12 h (%)	3.0	42.3	32.3
24 h (%)	0.0	19.2	22.6

[a]Means ± SEM.

Table 2. Influence of induced parturition on calf viability (Trial 1)

Response	Treatment		
	Control	Dexamethasone + Lutalyse	Dexamethasone + Bovilene
No. of cows	32	26	31
Calf birth weight	37.7 ± 0.8[a]	36.2 ± 0.8	37.0 ± 0.8
Calving difficulty score[b]	1.4 ± 0.2	1.7 ± 0.2	1.2 ± 0.2
Calf vigor score[c]	3.5 ± 0.1	3.3 ± 0.1	3.5 ± 0.1
Interval from birth to			
Calf first stood (h)	1.37 ± 0.32	1.57 ± 0.36	1.55 ± 0.33
Calf first nursed (h)	1.69 ± 0.38	2.29 ± 0.43	2.24 ± 0.39

[a]Means ± SEM.
[b]1 = calved unassisted; 2 = assist given by hand; 3 = assist with mechanical calf puller, little difficulty; 4 = assist with mechanical puller, slight difficulty, no injury to cow or calf; 5 = assist with mechanical puller, moderate difficulty, minor injury; 6 = assist with mechanical puller, major difficulty; 7 = caesarean birth.

[c]0 = calf died at birth; 1 = calf weak and listless; 2 = lacked vigor; 3 = average vigor; and 4 = calf very lively immediately after birth.

Table 3. Breed effects on gestation length, parturition, and calf birth weight and viability (Trial 1)

Trait	Breed of Cow: Hereford	Angus	Charolais	Simmental
No. of cows	28	24	18	19
Gestation length at parturition (d)				
Control cows	283.3 ± 1.3^{a}	279.6 ± 1.1^{b}	283.2 ± 1.6	285.7 ± 1.4^{c}
Treated cows	280.8 ± 0.8	279.8 ± 0.9	280.9 ± 1.0	281.3 ± 1.0
Interval from hormone injection to calf expulsion (h)	36.2 ± 2.1	37.0 ± 2.3	36.6 ± 2.6	42.6 ± 2.3
Calving difficulty score	1.3 ± 0.2^{d}	1.1 ± 0.2^{d}	1.3 ± 0.2^{d}	2.0 ± 0.2^{e}
Calf birth weight (kg)	34.6 ± 0.9^{b}	32.9 ± 0.9^{b}	42.9 ± 1.1^{c}	41.9 ± 1.0^{c}
Calf vigor score	3.5 ± 0.1^{d}	3.8 ± 0.2^{b}	3.5 ± 0.2^{d}	2.9 ± 0.2^{ce}
Interval from birth to				
calf first stood (h)	1.26 ± 0.33^{b}	0.58 ± 0.36^{b}	1.60 ± 0.42^{d}	2.83 ± 0.41^{ce}
calf first nursed (h)	1.67 ± 0.40^{b}	1.09 ± 0.43^{b}	2.11 ± 0.49^{d}	3.72 ± 0.48^{ce}
Incidence of retained placenta in induced cows at				
12 h (%)	39.3	16.7	11.1	26.3
24 h (%)	17.9	16.7	0.0	15.8

[a]Means_+ SEM.
[bc]Means within a row differ ($P < 0.01$).
[de]Means within a row differ ($P < 0.05$).

the calving period for all breeds combined was 14.3 d. A comparison between spontaneous and induced parturitions (Tables 1 and 2) indicated that induction of parturition 1 to 10 d before the expected calving date did not affect ($P > 0.05$) calf birth weight (37.7 ± 1.1 vs 36.6 ± 0.9 kg), calving difficulty score (1.4 ± 0.2 vs 1.4 ± 0.1), calf vigor score (3.5 ± 0.1 vs 3.4 ± 0.1), and length of time from appearance of placenta (1.32 ± 0.20 vs 1.44 ± 0.14 h) or fetal feet (0.46 ± 0.13 vs 0.71 ± 0.09 h) to calf expulsion, or from calf expulsion to calf first stood (1.37 ± 0.32 vs 1.56 ± 0.24 h) and first nursed (1.69 ± 0.38 vs 2.26 ± 0.29 h). Breed of dam and parity did not affect ($P > 0.05$) the induction of parturition as measured by the length of time from injection of hormones, appearance of placenta or appearance of fetal feet to expulsion of calf. Correlations between day of gestation at hormone treatment and interval from hormone injection to calf expulsion ($r = -0.07$), calf birth weight ($r = -0.05$), calving difficulty score ($r = -0.05$), calf vigor score ($r = +0.04$), interval from birth until calf first stood ($r = -0.11$), or interval from birth until calf first nursed ($r = -0.12$) were not significant ($P > 0.05$); thus, induction of parturition and neonatal calf viability were not influenced by gestational length. Interactions among variables were not significant ($P > 0.05$).

Table 4. Effects of parity on parturition, retained placenta and calf birth weight and viability (Trial 1)

Trait	First parity	Multiple parities
No. of cows	27	62
Gestation length at parturition (d)		
Control cows	283.1 ± 1.2[a]	281.3 ± 0.7
Treated cows	281.0 ± 0.8	280.5 ± 0.6
Interval from hormone injection to parturition (h)	36.2 ± 2.1	39.1 ± 1.5
Birth weight (lb)	31.6 ± 0.9[b]	34.8 ± 0.6[c]
Calving difficulty score	1.6 ± 0.2	1.3 ± 0.1
Calf vigor score	3.3 ± 0.2	3.6 ± 0.1
Interval from birth to		
Calf first stood (h)	1.90 ± 0.28[b]	0.85 ± 0.18[c]
Calf first nursed (h)	2.67 ± 0.31[b]	1.13 ± 0.20[c]
Incidence retained placenta at		
12 h (%)	37.0	19.4
24 h (%)	18.5	9.1

[a]Means ± SEM.
[bc]Means within a row differ ($P < 0.01$).

The more vigorous calves (higher vigor score) stood and nursed sooner after birth resulting in a significant ($P < 0.01$) negative correlation between calf vigor score and length of time from birth until calf first stood ($r = -0.76$) or first nursed ($r = -0.79$). Calves from cows with a longer interval from hormone injection to calving were slower to stand ($r = 0.30$, $P < 0.05$) and nurse ($r = 0.28$, $P < 0.05$) after birth. Interval from hormone injection to calving was not correlated significantly ($P > 0.05$) with birth weight ($r = -0.22$) or calving difficulty ($r = 0.25$).

Calf birth weight and vitality were affected ($P < 0.01$) by both breed (Table 3) and parity (Table 4). Charolais and Simmental calves were significantly ($P < 0.01$) heavier at birth than Angus and Hereford calves, and calves from multiparous cows had a heavier ($P < 0.01$) birth weight than calves from primiparous cows. Simmental calves were weaker at birth than Angus ($P < 0.01$), Hereford ($P < 0.05$) and Charolais ($P < 0.05$) calves, as measured by a lower vigor score and longer intervals from birth until the calf first stood and first nursed (Table 3). Lengths of time from birth until the calf first stood and first nursed were also longer ($P < 0.05$) for calves from primiparous cows than for calves from multiparous cows. Also, Simmental cows had more ($P < 0.05$) calving difficulty than cows from the three other breeds.

Cows with an induced parturition had a higher ($P < 0.01$) incidence of retained placenta than cows with a spontaneous parturition at both 12 (36.8 vs 3.0%) and 24 (21.0 vs 0.0%) h postpartum (Table 1). The incidence of retained placenta did not differ ($P > 0.05$) between cows receiving prostaglandin $F_{2}\alpha$ or fenprostalene. There was a trend for primiparous cows to have a higher incidence of retained placenta than multiparous cows (Table 4).

Subsequent fertility was not affected ($P > 0.05$) by premature induction of parturition. Pregnancy rate was 88.5% for control cows and 88.6% for treated cows, whereas the interval between calvings was 390.0 ± 3.0 d for control cows and 390.7 ± 3.3 and 394.2 ± 3.2 d for cows treated with dexamethasone and prostaglandin $F_{2}\alpha$ or fenprostalene, respectively.

Table 5. Influence of induced parturition on labor and incidence of retained placenta (Trial 2)

Trait	Dexamethasone + Lutalyse
No. of cows	33
Gestation length (d)	284
Interval from hormone injection to calf expulsion (h)	28.6
Range (h)	13.0 - 44.5
Percentage calving within a range of ± 6 h of the mean	81.3
Percentage calving within a range of ± 12 h of the mean	90.6
Incidence of retained placenta at 24 h (%)	15.2

DISCUSSION

Synchronization of parturition was achieved with the administration of 25 mg of dexamethasone and either 25 mg of prostaglandin $F_{2}\alpha$ or 1 mg of fenprostalene 2 to 10 d before the expected calving date. In both Trial 1 and 2, 90% of the hormone-treated cows calved within a 24-h period, all 90 hormone-treated cows in the two trials calved between 13 and 60 h after hormone treatment, a period of less than 48 h. In contrast, the time interval from birth of the first to the last calf for control cows was 343 h, a relatively short calving interval for a herd as the control cows were bred at a synchronized estrus. The degree of synchrony for parturition achieved with these hormone treatments is similar to, or narrower than, the ranges reported for dexamethasone alone or in combination with estrogen (1,3,4,6,7), and is narrower than the ranges reported for prostaglandin $F_{2}\alpha$ (8,9) and flumethazone alone (5,10) or in combination with estrogen. Also, the time interval from hormone injection to calf expulsion was shorter in the present study than has been reported previously. Differences in response time among studies and trials may be caused by differences in gestation length of the cows at treatment (3); cows in our study had longer gestation lengths than cows in most of the previous studies. However, the correlation between gestation length and interval from hormone injection to calf expulsion was small in Trial 1, and differences in response time have been found among herds at this Research Center (unpublished data). Conversely, dexamethasone and prostaglandin in combination (present study) may have a synergistic action on regression of the corpus luteum and initiation of parturition in comparison to glucocorticoids or prostaglandin $F_{2}\alpha$ alone (10).

Duration of labor and calf viability did not differ between treatment or from controls. Intervals between appearance of placenta or fetal feet to expulsion of the calf; and from time of calf expulsion to time calf first stood or first nursed were equal to (5), or longer (11) than, intervals reported previously. Differences among breeds in calf vitality ($P < 0.01$) were noted (Table 2), and along with differences in gestation length, may account for discrepancies among studies. In general, calf vitality does not appear to be reduced when parturition is induced within 10 d of the expected calving date (10).

Contrary to previous studies (1,3,9), birth weight of the calves born to induced parturitions did not differ ($P > 0.05$) from calves born at spontaneous parturitions. Absence of a treatment effect on calf birth weight may be because parturition was induced within 10 d of the expected parturition date or because of differences in fetal growth pattern among breeds of cattle (1).

Induction of parturition resulted in a higher incidence of retained placenta than associated with spontaneous parturitions. The incidence of retained placenta at 24 h postcalving (18.9%, Trials 1 and 2 combined) is lower than the incidence attained with dexamethasone, flumethasone or prostaglandin alone or in combination with estrogen (3,5,7-10,12), except for one study in beef cows treated with dexamethasone and estradiol benzoate combined (4). A longer gestation length and a lower incidence of retained placenta in beef than dairy cattle may have contributed to the lower incidence in this study. Conversely, circulating concentrations of prostaglandin $F_{2}\alpha$ increase within 2 d prior to spontaneous parturition, and it has been suggested that release of the fetal membranes is associated with villi production of prostaglandin $F_{2}\alpha$ (13), whereas dexamethasone inhibits uterine production of prostaglandins (14). Thus, the administration of prostaglandins in conjunction with dexamethasone may mimic the endogenous release of $PGF_{2}\alpha$ at parturition and enhance the release of fetal membranes, reducing the incidence of retained placenta. There was no evidence of decreased rebreeding associated with the retained placenta.

Although the degree of synchrony for parturition attained with the described hormone treatments was not perfect, having 90% of the cows in a synchronized herd (approximately the same gestation length) calve within 24 h or being able to schedule when a cow will calve makes it feasible to monitor a small herd of cows continuously and provide immediate obstetrical assistance during calving, resulting in increased neonatal calf survival and effective utilization of manpower. These methods are especially applicable for increasing neonatal survival of economically valuable calves (e.g., embryo transfer calves), and decreasing calving difficulty and neonatal calf mortality in cows with extended gestation lengths. Parturition can be induced in cattle as early as 265 d of gestation; however, induction of parturition 5 to 10 d before the expected calving date appears to result in fewer adverse side effects for both the cow and calf and a shorter and narrower response time. The shorter gestation length for Angus calves resulted in several Angus cows calving before treatment, indicating the necessity for scheduling induction of parturition based on gestation length for the calf genotype. Except for some inconvenience, the higher incidence of retained placenta for induced than spontaneous parturitions is not a major deterrent to the application of induced parturition.

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