Induction of early post-calving ovulation and oestrus in suckled beef cows

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ABSTRACT

The aim of this study was to compare the efficacy of exogenous progesterone, either without or with a single injection of gonadotrophin releasing hormone (GnRH), at initiating early post-calving ovulatory and oestrous activity. Six d after the first post-partum follicle had attained dominance cows were allocated to either an untreated control group; treated with a progesterone-impregnated CIDR® device for 5 d; or treated with a progesterone-impregnated CIDR® device for 5 d plus 250 mg GnRH given 30 h later. The mean (± s.e.) interval from calving to first ovulation was longer ($P<0.001$) in untreated cows (47 ± 6) compared with CIDR-treated cows either with GnRH (32 ± 4) or without GnRH (27 ± 1). Similarly, the interval from calving to first oestrus was longer in untreated cows, 73 ± 10 days compared with 57 ± 6 and 36 ± 6 respectively, ($P<0.01$). These results demonstrate that the interval to first ovulation and to first oestrus can be reduced in suckled cows.

Keywords: beef cow; ovary; dominant follicle; post-partum; anoestrus; progesterone; GnRH; CIDR.

INTRODUCTION

The post-partum anoestrous interval (PPAI) in cows is characterised by the absence of behavioural oestrous activity. It is generally acknowledged that suckling as opposed to milking extends this period (see Williams, 1990 for a recent review of suckling anoestrum, also Short *et al.*, 1990). Although oestrus may not occur for some weeks after calving, it is clear that significant follicle activity continues to occur on the ovary from soon after calving (dairy cows: Savio *et al.*, 1990 a & b; beef cows Murphy *et al.*, 1990; McMillan *et al.*, 1993). The key feature of this activity is that one follicle from a cohort of 5-10 follicles grows at a faster rate by suppressing the grow of its cohorts. This dominant follicle (DF) has a life of about 10 days following which time it regresses and is replaced by another DF. This process continues until a DF ovulates. First oestrus may accompany this ovulation but it is more usual for cyclic oestrous activity to commence some 7-10 days after first ovulation (see Lishman and Inskeep, 1991 for a recent review).

In single-suckled beef cows, workers in Ireland showed that 3-4 cycles of DF turnover occur before first ovulation (Murphy *et al.*, 1990). This contrasted with other work in well-fed milked dairy cows which showed that usually the first but some times the second or third DF normally ovulates (Rajamahendran and Taylor, 1990; Savio *et al.*, 1990 a). It was thus clear that continued DF turnover *prior to* first ovulation was the major reason for the longer PPAI in suckled compared with milked cows.

Any treatment which induces ovulation of an early DF could be expected to shorten the PPAI. Exogenous progesterone as well as exogenous GnRH treatment can induce ovulation early in the post partum period in cows (beef cows: Webb *et al.*, 1977, Crowe et al., 1993; dairy cows: Peters *et al.*, 1985), but the proportion of cows responding can be highly variable (10-80%). Some of this variability could be explained by the stage of the DF turnover cycle, and therefore DF responsiveness, at the time of commencing treatment.

A recent modelling analysis has shown that the optimum PPAI with respect to maximising calving percentage, at least in the single-suckled Angus herd studied, was between 60 and 70 days (Pleasants *et al.*, 1991). An extension of the PPAI from 70 to 90 days was associated with a 13 percentage unit reduction (range 5% to 20% between years). These analyses clearly highlight the problem associated with extending the PPAI beyond the optimum. However, Pleasants and colleagues did not model PPAI below 60 days.

The aims of the current study were 1. to determine if the treatment of early post-partum suckling beef cows with exogenous progesterone, either with or without GnRH, at known stages of the DF turnover cycle could initiate early oestrus and ovulation, and 2. to model the effect of a mean PPAI interval of 35 compared with 60 days on herd fertility and cow weaning performance.

MATERIALS AND METHODS

1. Induction of early oestrus and ovulation

Calving and ovarian DF monitoring

A herd of 40 Hereford x Friesian beef cows which calved between 22 August and 19 October, 1993 (mean calving date 21 September) were run together at Ruakura from about 6 weeks prior to the start of calving. Calving date was recorded and within 7 days of calving, the ovaries of each cows were examined per rectum using ultrasound (Aloka 210, 7.5 Mhz probe) to determine the size of the single largest follicle. Ovarian examinations were carried out on alternate days until the largest follicle attained a diameter estimated to be ≥ 10 mm (Ginther, 1993). These follicles were termed DF. Calves remained with the cows throughout the study and were only separated to facilitate ultrasound examinations.

Oestrous detection

Cows were observed daily for signs of oestrus from the start of ultrasound observations. All cows were tail-painted weekly from 12 days after the first DF was identified and the

date of paint loss or observed standing oestrus was recorded as the date of oestrus. Tailpainting coincided with the cessation of progesterone treatment. No cows had ovulated or shown oestrus by this time. Oestrous monitoring continued until the first coincident oestrus and ovulation or until the end of the study on 1/12/93.

Experimental treatments

The cows were allocated on a stratified live weight basis (mean 6 weeks pre-calving liveweight = 498 kg) within age (3 years vs older) and calving date to one of 3 treatment groups once a DF had been observed: untreated controls; progesterone-only treated for 5 days from 6 days after the first DF was observed; and progesterone-treated for 5 days from 6 days after the first DF was observed and 250 μg of GnRH (Fertagyl, Intervet, NZ) given 30 h after the end of progesterone supplementation. The original allocations resulted in 13, 12 and 15 cows in each of the 3 treatment groups. The treatment protocols were expected to initiate ovulation of the second post-partum DF. In all cows, ovarian monitoring continued until the first coincident oestrus and ovulation or until 1/12/93 when the study was terminated. Cows ranged from 42 to 100 days post-partum by this stage.

Progesterone was administered via an intra-vaginal CIDR® device. A 5 day CIDR® treatment appears to be sufficient to 'prime' neural centres associated with oestrous behaviour (McDougall *et al.*, 1992). In addition, the duration of progesterone treatment was expected to initiate a corpus luteum (CL) of normal rather than short duration (ie the exogenous progesterone is expected to overcome the 'short cycle' phenomenon characteristic of the first ovulation in post-partum cows). The exogenous GnRH was expected to initiate ovulation in at least 90% of treated cows (Crowe *et al.*, 1993).

Differences were compared using Student's t-test and contingency table analysis (Chi-square) for continuous and binomial data respectively.

2. Modelling the effect on herd fertility of PPAI intervals of 35 and 60 days

The calving distribution and calving date-PPAI regression data from Pleasants *et al.*, 1991 were used. Furthermore, we incorporated into our analysis the finding that in both 2 year old and mature suckling traditional (Angus) as well as dairy x beef (Hereford x Friesian) breeding cows, fertility is higher in heifers and cows with more oestrous cycles *before* first mating with an entire bull (Pleasants and McCall, 1993). This phenomenon is apparently real as it has been reported in other studies (dairy cattle: Macmillan and Clayton, 1980; Angus: Pleasants and Barton, 1992).

A spreadsheet was constructed which used the mean calving distribution reported by Pleasants *et al.*, 1991 and the overall mean regression of PPAI on calving date of -0.35 to calculate the day of first post-partum oestrus. A mean PPAI of 35 and 60 days were compared using a standard deviation of 3 days in both cases (Pleasants and Barton, 1992). Calving dates were grouped into 7 batches of 10 days each and each cow in each batch was assumed to have an equal opportunity of calving on each day for her batch. To this date we added intervals of 21 days to determine dates of second and subsequent oestrous activity. The start of entire bull mating was set constant. Thus, knowledge of calving date, date of first post-partum oestrus, date at start of entire mating and fertility at each mating, as well as weaning date and mean calf growth rate enabled us to calculate the herd calving rate, mean conception (and therefore calving) date and mean calf weaning weight for the next season. The effect of an entire mating duration of 3, 6 and 9 weeks were compared. Calves were assumed to have been weaned at the same age.

RESULTS

Two cows, both in the control group, had incomplete records and have been excluded from further analysis.

1. Ovarian and oestrous activity

All cows initiated growth of a DF within 3 weeks of calving and the mean interval from calving to attainment of a DF was similar in the 3 groups (Table 1). Compared with untreated control cows, calving to first ovulation intervals were reduced by 2-3 weeks in CIDR®- and CIDR® + GnRH-treated cows respectively (47 vs 27 and 32 days, $P<0.001$). In a similar manner, compared with untreated control cows, treatment reduced the interval between attainment of the 1st DF and ovulation by about 2 weeks in CIDR®- and CIDR® + GnRH-treated cows respectively (34 vs 15 vs 15 days, $P<0.001$), although 2 cows in the later group which clearly did not ovulate in response to GnRH treatment are excluded. These 2 cows had intervals of 29 and 57 days.

Of the untreated control cows, 82% (9/11) ovulated during the study compared with 87% (13/15) and 100% (12/12) of CIDR®- and CIDR® + GnRH-treated cows respectively (NS). In the CIDR® treated group of cows, 13/13 ovulated within a few days of the withdrawal of progesterone, but only 10/12 CIDR® + GnRH-treated cows did so. The remaining 2 cows ovulated 18 and 45 days after withdrawal of progesterone.

TABLE 1: Intervals from calving to 1st DF, 1st ovulation, 1st DF to 1st ovulation, and to 1st oestrus in untreated control cows and cows treated with a CIDR®-only or CIDR® + GnRH.

Interval d	Untreated Control	CIDR® Only	CIDR® + GnRH
Calving to 1st DF			
Mean	12.5	13.1	12.8
SEM	1.11	1.15	1.2
Range	7-19	7-23	9-21
Calving to 1st Ovulation			
Mean	47	27	32*
SEM	6.3	0.98	3.6
Range	27-80	22-24	23-68
1st DF to 1st Ovulation			
Mean	34	15	15**
SEM	6.3	0.16	0.23
Range	12-69	14-16	14-16
Calving to 1st Oestrus			
Mean	73	36	57
SEM	9.9	6.1	5.9
Range	46-98	21-63	46-66

* Includes 2 cows with intervals of 40 and 68 days.
** Excludes 2 cows with intervals of 29 and 57 days

Forty five percent (5/11) untreated control cows exhibited oestrus during the study compared with 47% (7/15) and 25% (3/12) of CIDR®- and CIDR® + GnRH-treated cows respectively (NS). However, no untreated cows exhibited coincident first oestrus and ovulation compared with only 4/13 and 1/12 CIDR®- and CIDR® + GnRH-treated cows respectively (NS).

2. Modelling effects of 35 vs 60 day PPAI

The modelling analysis indicated that 53%, 47% and 0% of cows would have exhibited 0, 1 or 2 periods of oestrous activity prior to the start of mating in a herd with a mean PPAI of 60 days. Comparable values for a herd with a mean PPAI of only 35 days were 2%, 37% and 61%.

With a 9 week mating duration, differences in herd pregnancy rate, mean conception date (and therefore mean calving date) and the total weight of calf weaned per cow were similar under the 2 scenarios examined (less than 3% difference in calf weaning weight per cow) (Table 2). Even with a 6 week mating duration differences were about 6% in favour of the herd with a shorter PPAI. However, it is note worthy that the same weight of calf weaned per cow could be achieved with a 6 week mating duration for the herd with a PPAI of 35 days compared with a 9 week duration for the other herd. It was not until a very short duration of only 3 weeks was used in the model did large differences in herd performance favour the herd with a shorter PPAI. Under these conditions a 26% advantage favoured the herd with a shorter PPAI.

TABLE 2: Effect of 35 and 60 day post-partum intervals on herd pregnancy rate, mean conception date and calf production/cow for a mating duration of either 3, 6 or 9 weeks.

	35 Day Mean PPAI Mating Duration			60 Day Mean PPAI Mating Duration		
	3 weeks	6 weeks	9 weeks	3 weeks	6 weeks	9 weeks
Herd Pregnancy Rate %	82	95	99	66	91	98
Mean Conception Date*	10	14	16	10	16	19
Total Weight Calf weaned/cow joined (kg)	182	208	214	145	196	208

* Days from start of entire joining

DISCUSSION

A key outcome of this study was that a short duration of treatment with exogenous progesterone was sufficient to induce ovulation of an early post-partum follicle in the majority of suckled cows. Ultrasonic monitoring of the DF present at the withdrawal of exogenous progesterone indicated that ovulation occurred within 96 h. Thus, early post-partum DF are clearly capable of ovulating, provided an appropriate hormonal environment can be initiated and maintained. Spontaneous ovulation of early post-partum DF is common in well-fed dairy cows (Savio *et al.*, 1990 a). Other workers have shown that the first DF in suckled beef cows can be induced to ovulate following a single injection of GnRH (Roche *et al.*, 1992). However, this appears to be the first report of exogenous progesterone-induced ovulation of a DF early in the post-partum period in suckled beef cows. It is clear from the present study that the inclusion of GnRH did little to improve the ovulatory response of the cows. This suggests that a short duration treatment with progesterone alone was sufficient to drive a LH profile capable of inducing ovulation.

It was expected that the 5 day period of progesterone priming would be sufficient to induce behavioural oestrus in suckled cows as this treatment has been successful in milked dairy cows (S. McDougall, pers comm). However, this treatment was only partially effective since only 20% (5/25) of the progesterone-treated suckled cows had a coincident first oestrus and ovulation. Compared with the milked dairy cow, the suckled beef cow may require a longer period of progesterone priming. The high incidence of oestrus and fertility following AI in anoestrous suckled Angus cows treated for 8-10 days with a progesterone-impregnated CIDR® device is consistent with this proposition (A.M. Day, unpublished results).

The results of the modelling analysis showed that no cows would be first mated by the entire bull at their third oestrus if the mean herd PPAI was 60 days. In contrast, almost two-thirds would be first mated at their third oestrus if mean herd PPAI was only 35 days. The consequences of this for subsequent herd fertility and calf production was largely dependent on the duration of the entire mating period. With a mating period of 9 weeks (probably the industry norm), there was little advantage in calf production per cow accruing to the herd with the shorter PPAI. This occurred because herd fertility was near maximum when PPAI was 60 days. Furthermore, differences between herds in the mean date of conception were small (3 days). The net effect was a 3% increase in calf production per cow to the herd with a 35 day PPAI. Although the advantage was doubled when the mating duration was 6 weeks, it was not until a mating duration of 3 weeks was used that the advantage to the earlier cycling herd become large. The major factor contributing to this advantage was higher herd fertility (82 vs 66% conception rate).

In summary, the results from the field trial demonstrate that it is possible to initiate a high incidence of ovulatory activity early in the post-partum period of suckled beef cows by using progesterone for 5 days. However, this treatment is inadequate at inducing a coincident oestrus and early ovulation. Other studies suggest that either a longer period of progesterone treatment may be required and/or that exogenous oestrogen at 24 h after progesterone withdrawal may be necessary to induce a coincident oestrus-ovulation response. The outcomes from the modelling analysis highlight the impact of mating duration on the likely benefit from initiating earlier post-partum cyclic activity. Furthermore, the results indicate that the same level of calf production per cow can be achieved with a shorter duration of mating in herds with a shorter PPAI, by about 1 day/day. Accordingly, the same level of calf production was produced by the herd with a 35 day PPAI when mated for only 6 weeks as compared with 9 weeks in the herd with a 60 day PPAI.

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