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POSTPARTUM ANOESTRUM

IN THE PASTURE GRAZED

NEW ZEALAND DAIRY COW

SCOTT McDOUGALL

1994

**Postpartum Anoestrus in the Pasture Grazed New
Zealand Dairy Cow**

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Scott McDougall

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Abstract

Postpartum anoestrus (PPA) is that period following parturition before ovulatory ovarian cycles have been re-established. This period lasts 20 to 30 days in normal, well-fed dairy cattle. To achieve an average interval between calvings of 365 days so that calving continues to occur at an appropriate time of the year, cows must resume cyclic activity, display behavioural oestrus, be mated and conceive by 83 days postpartum. An extended period of PPA compromises achievement of this target. Extended periods of PPA may result from either a failure to resume ovulations (anovulatory anoestrus) or a failure of expression or detection of behavioural oestrus (non-detection of oestrus).

The study population for this thesis was drawn from the research herds of the Dairying Research Corporation, Hamilton and from commercial herds from the Waikato region around Hamilton.

All herds calved seasonally between July and September and were milked twice daily. First calving occurred at approximately 2 years of age (i.e. heifers) and thereafter at 365 d intervals. Nutrition was predominantly from ryegrass/white clover pasture. The 10 year average rainfall of the distribution 1230 mm with higher rainfall in spring than summer. Average daily temperature ranges from a low of 8-9 °C in July to a maximum of 18.3 °C in January.

It was demonstrated that primiparous cattle had a longer PPA (40.2 vs. 27.2 ± 6.2 days for 2 year old and older cows, mean \pm SED, respectively) and that Friesians had longer PPA intervals than Jerseys (39.3 ± 3.1 vs. 27.9 ± 2.7 days, respectively). Increasing the stocking rate resulted in an increased PPA interval (30.2 ± 2.8 vs. 27.1 ± 2.9 days, for high and low stocking rates, respectively). Body condition score (1 = thin, 10 = fat) at calving was inversely related to the PPA interval (regression slope = -7.9 days, $P < 0.05$). Cows that had not commenced cycling 1 week before the planned start of mating (PSM) had lower condition scores (-0.3 ± 0.1), smaller total ovarian mass (-1.3 ± 0.2 , arbitrary units), higher serum urea concentrations (0.31 ± 0.16 mmol/L) and lower blood glucose concentrations (-0.14 ± 0.06 mmol/L) than cows which had ovulated by this time. Significant differences in the proportion of cows not detected in oestrus and anovulatory anoestrus were demonstrated among the 8 farms studied. These data indicate that age, breed, stocking rate, body condition score and between farm factors influenced the PPA interval.

Large ovarian follicles (>9 mm) were present by 10.3 (\pm 0.7) days postpartum and regular turnover of follicles occurred in the ovaries of all cows examined by daily transrectal ultrasound. An average of 4.2 (\pm 0.6) large follicles appeared before the first ovulation which occurred at 43.4 (\pm 5.3) days postpartum. The largest follicle in anovulatory cows had lower intrafollicular concentrations of oestradiol (E_2), testosterone (T) and progesterone (P_4) than in cycling cows when ovariectomy occurred at approximately 60 days postpartum (47 vs. 372 ± 2.1 ng/ml; 1.4 vs. 10.0 ± 2.3 ng/ml, and 7.8 vs. 16.0 ± 1.8 ng/ml for E_2 , T and P_4 , respectively). However, there were no differences in the diameters, the number of granulosa cells or the rates of growth of the largest follicles between the anovulatory and cycling cows.

A luteinising hormone (LH) surge and ovulation was induced in 10 of 10 and 9 of 10 anovulatory heifers, respectively, following treatment with 250 μ g of gonadotrophin releasing hormone (GnRH) when the largest follicle was >10 mm in diameter and growing, at 3 to 4 weeks postpartum. Sufficient GnRH receptors and releasable LH must have been present in the pituitary and the largest follicle must have been sufficiently mature to ovulate in response to the LH surge. However, only 3 of 9 ovulating heifers continued to ovulate beyond the first, short (<10 day) cycle.

Oestradiol treatment (0.5 mg i.m.) of PPA cows when either a small, growing follicle (5 to 9 mm) or a large plateau follicle (>10 and \pm 1 mm for 72 h) was present on the ovary resulted in 8 of 15 and 5 of 15 cows having an LH surge and ovulating, respectively. This illustrates that the E_2 positive feedback mechanism, a prerequisite for ovulation in a normal oestrous cycle, failed in nearly half of these PPA cows.

PPA cows had a lower LH pulse frequency and a higher LH pulse amplitude but similar mean LH concentration before and 3 and 10 days after ovariectomy compared to cyclic cows when ovariectomy occurred approximately 60 days postpartum. The LH parameters increased by a similar amount in the PPA and the cycling cows following ovariectomy. Exogenous E_2 treatment at 10 days post-ovariectomy resulted in a significant decrease in LH pulse frequency and an increase in LH pulse amplitude in the PPA but not the cycling cows. The GnRH pulse generator in the PPA cows appears to be suppressed by both ovarian and extra-ovarian factors. Additionally, hypersensitivity to negative E_2 feedback on LH pulse frequency was observed. Undernutrition and low body condition score have been hypothesised as contributing to increased negative E_2 feedback in cattle.

Treatment of anovulatory cows with P₄ for 5 days at 2 to 3 weeks postpartum resulted in a significant shortening of the intervals from calving to first ovulation, calving to first oestrus and calving to conception (30.7 ± 0.4 vs. 34.2 ± 1.0 , 35.8 ± 2.6 vs. 40.0 ± 1.8 and 85.0 ± 3.0 vs. 93.4 ± 2.3 days, respectively, $P < 0.05$) when compared with herdmates. Progesterone treatment produced a 'priming' effect, as the duration of the first postpartum luteal phase (9.5 ± 0.4 vs. 5.6 ± 0.9 days) and the proportion of cows detected in oestrus at the first postpartum ovulation (83.3 vs. 37.0, $P < 0.05$) were both increased.

Treatment of anovulatory cows for 7 days with P₄ and 400 i.u. of equine chorionic gonadotrophin (eCG) increased the probability of first service and conception occurring, compared to untreated cows. Low body condition score at the time of treatment reduced the probability of first service and conception, but the increase in probability of first service or conception following P₄ and eCG treatment was the same among cows with either low or medium body condition score.

Supplementation of a white clover/ryegrass pasture diet with pasture silage did not alter the intervals from calving to first ovulation, calving to first oestrus or calving to conception when compared with control cows fed pasture only. Silage supplementation did reduce first service conception rate (37.5% vs. 53.3%, $P = 0.09$).

The proportion of cows not in oestrus by the date of the planned start of mating varied among herds possibly due to differences in the age structure, breed and nutritional management. Further research is required to identify management and animal factors associated with an unacceptably high proportion of the herd not detected in oestrus by this date. Failure of the E₂ positive feedback mechanism, low LH pulse frequency and low intrafollicular steroid concentrations were identified in PPA cows. Increased sensitivity of the E₂ negative feedback mechanisms due to depleted body fat reserves and/or poor postpartum nutrition associated with prolonged periods of negative energy balance postpartum may be the major mechanism for extended PPA. An understanding of the control of GnRH and LH release from the hypothalamus and pituitary respectively, will be required before the patho-physiology of PPA can be fully understood. Treatment of anovulatory cows either early (2 to 3 weeks) postpartum or immediately before the planned start of mating shortened PPA intervals. The mechanisms appear to involve a 'priming' effect on expression of behavioural oestrus and on the length of the first luteal phase.

This thesis increases the understanding of the factors that influence the PPA interval, the endocrinology of PPA and the treatment of PPA cows.

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List of Publications Arising from this Thesis

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Submitted:

McDougall S, Macmillan KL and Williamson NB The effect of estradiol on release of Luteinizing Hormone and the ovulatory response at two stages of follicular development in the postpartum cow *Biology of Reproduction*

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Conference proceedings:

Macmillan KL, McDougall S, Taufa VK and Day AM (1994) Ovulation and oestrus among dairy cows with anovulatory anoestrus following progesterone treatment *Australian Society for Reproductive Biology* **26** 74

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Abbreviations

AA	Anovulatory anoestrus
BOH	β -hydroxy-butyrate
BSA	Bovine serum albumin
C_con	Calving to conception interval (days)
C_h1	Calving to first oestrus interval (days)
CI	Confidence interval(s)
CL	Corpus luteum
C_ovnl	Calving to first ovulation interval (days)
C_s1	Calving to first service interval (days)
CS	Body condition score
DF	Dominant follicle
DMD	Dry matter disappearance
DMI	Dry matter intake (kg/cow/day)
E ₂	Oestradiol 17- β
eCG	Equine chorionic gonadotrophin
EDTA	Ethylenediamine tetraacetate
EV	Oestradiol valerate
FSH	Follicle Stimulating Hormone
GH	Growth Hormone
GnRH	Gonadotrophin Releasing Hormone
h	hours
H-P-O	Hypothalamic-pituitary-ovarian
i.m.	intramuscular
i.v.	intravenous
IGF	Insulin-like Growth Factor
IGFBP	Insulin-like Growth Factor Binding Proteins
LH	Luteinising Hormone
MPA	Medroxyprogesterone acetate
NDO	Not detected in oestrus
NEB	Negative energy balance
NEFA	Non Esterified Fatty acids
ODB	Oestradiol benzoate
P ₄	Progesterone

PBS	Phosphate buffered saline
PGF _{2α}	Prostaglandin F _{2α}
PP	Postpartum
PPA	Postpartum anoestrus
PSC	Planned start of calving
PSM	Planned start of mating
PSM-7	7 days before the planned start of mating
PSM_con	Planned start of mating to conception
PSM_s1	Planned start of mating to first service
RIA	Radioimmunoassay
s.c.	Subcutaneous
s/c	Services/successful conception
sem	Standard error of the mean
SED	Standard error of the difference
SR	Stocking rate
T	Testosterone
TT4	Total thyroxine