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BRIEF COMMUNICATION

Effects of induced parturition on mammary function

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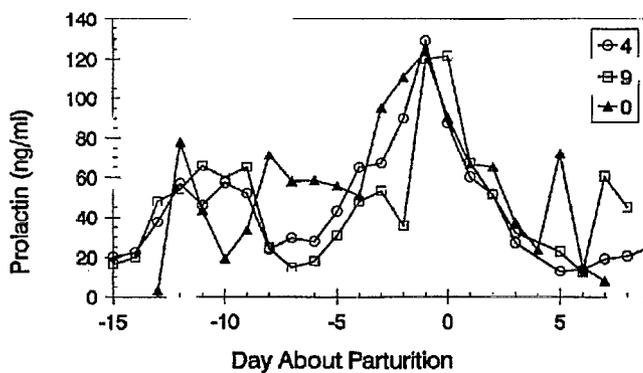
Keywords: Induced calving; mammary; parturition; colostrum; dairy cows.

Induction of parturition is a common dairy management practice in New Zealand. It has been estimated that approximately 10% of cows are induced to calve prematurely (Macmillan *et al.*, 1990). In terms of mammary development and function, premature induction of parturition effectively reduces gestation length, thereby depriving the gland of a period thought to be critical to development and differentiation. In spite of this, lactation after induced calving appears remarkably normal in terms of milk yield and composition (Bailey *et al.*, 1973; Beardsley *et al.*, 1974; Welch *et al.*, 1979). However, one aspect of mammary function that may be adversely affected by induced parturition is colostrum formation. Bailey *et al.* (1973) reported a significantly higher incidence of subnormal blood immunoglobulin levels in premature calves from induced dams compared to control calves. They estimated that nearly half of the variation in the calf's plasma immunoglobulin concentrations was due to the immunoglobulin content of their dam's colostrum. Our objective was to compare indices of colostrum formation and mammary function in cows induced to calve 9 or 4 weeks prematurely, or at full-term.

Multiparous dairy cows were induced to calve nine (n=8) or four (n=9) weeks prior to expected calving; or calved at term (n=5). Calving was induced with dexamethasone isonicotinate (21mg; im) 12 days prior to the target calving date. Cows that failed to show signs of impending calving also received an injection of prostaglandin F2a (0.5mg; im) 10 days later. Blood samples were collected daily from -14 to +6 days relative to calving to determine plasma concentrations of immunoglobulin G1 (IgG1), alpha-lactalbumin, and prolactin as indicators of colostrogenesis, lactogenesis and hormonal shifts associated with calving, respectively. Concentrations of alpha-lactalbumin and prolactin were determined by RIA and IgG1 by ELISA. Data were subjected to split-plot analysis of variance using SAS.

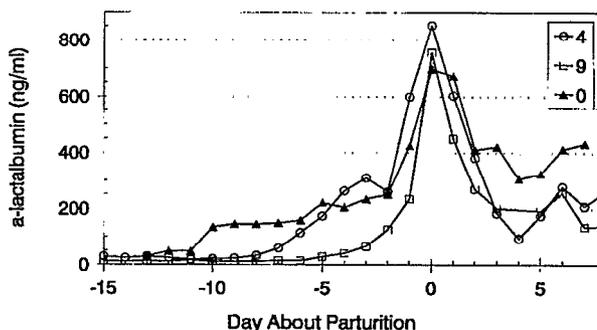
The overall mean (averaged over the entire sampling period) concentration of prolactin in plasma did not differ among induced and normally-calving cows (P=0.63; Figure 1). Across treatment groups, there was a highly significant effect of day relative to parturition (P<0.0001) arising from the typical (Guy *et al.*, 1994b) periparturient peak in prolactin concentrations. The treatment by day interaction was not significant (P=0.31), indicating that temporal changes in prolactin concentrations were similar among induced and control cows.

FIGURE 1: Mean concentrations of prolactin in plasma of cows induced to calve 4, or 9 weeks prematurely, or calving normally at term (0). The effect of time was significant (P<0.0001).



The effect of induction on overall mean concentration of alpha-lactalbumin in plasma approached significance (P=0.08; Figure 2). Concentrations averaged 144 ± 27, 233 ± 16, and 278 ± 27ng/ml in cows calving 9, 4 or 0 weeks prematurely, respectively. Similar to prolactin, alpha-lactalbumin concentrations differed over time relative to calving (P<0.0001), exhibiting the characteristic rise, acute peak at parturition, and rapid subsequent decline post-calving reported previously in cows (McFadden *et al.*, 1987; Guy *et al.*, 1994a,b). Effects of treatment and time did not interact (P=0.91), indicating that the general pattern of change in concentration over time was similar among groups. It is evident from Figure 2 that treatment differences were related to the timing of the onset of the initial increase in alpha-lactalbumin concentrations. Interestingly, this initial increase was apparently driven

FIGURE 2: Mean concentrations of alpha-lactalbumin in plasma of cows induced to calve 4, or 9 weeks prematurely, or calving normally at term (0). Treatment (P<0.08) and time (P<0.0001) effects were significant.

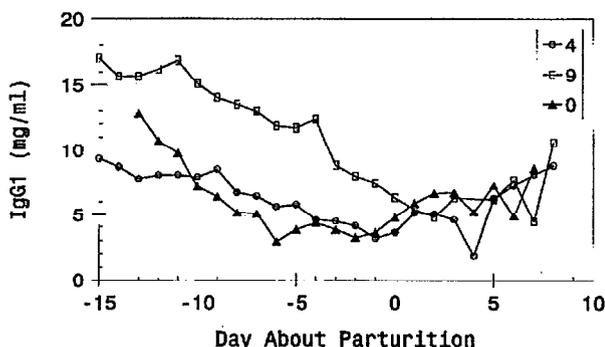


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by time of gestation rather than time relative to calving, whereas the larger, acute peak in concentration was clearly associated with calving.

Plasma concentrations of IgG1 differed over time ($P < 0.0001$; Figure 3). In general, IgG1 concentrations declined initially, plateaued, then began to increase toward initial levels. This pattern, in particular the marked decline in IgG1 prior to calving, which is considered to represent depletion of IgG1 from blood as it is rapidly transported into the mammary secretions, is a hallmark of colostrum formation (Guy *et al.*, 1994a,b) and indicates that all groups underwent colostrogenesis. However, overall mean concentration of IgG1 differed between groups ($P < 0.01$) averaging 10.6 ± 0.2 , 6.1 ± 0.2 , and 5.9 ± 0.3 mg/ml in cows calving 9, 4 or 0 weeks prematurely, respectively. Moreover, the interaction of treatment and time was highly significant ($P < 0.0001$) indicating that time trends differed among treatment groups.

FIGURE 3: Mean concentrations of immunoglobulin G1 in plasma of cows induced to calve 4, or 9 weeks prematurely, or calving normally at term (0). The effects of treatment ($P < 0.01$), time ($P < 0.0001$), and their interaction ($P < 0.0001$) were significant.



In general, reducing gestation length by inducing parturition 9 or 4 weeks prematurely did not markedly alter the pattern of changes in prolactin, alpha-lactalbumin, and IgG1

concentrations normally observed during the periparturient period. However, the alpha-lactalbumin and IgG1 profiles we observed suggest that the timing of the onset of these changes was affected. Although colostral IgG1 concentration was not determined in the present study, the observed decline in plasma levels suggests that the low IgG1 concentration in colostrum of induced cows reported by others (Bailey *et al.*, 1973) may be due to a limited duration of colostrogenesis, rather than a defect in the ability of the mammary gland to concentrate IgG1 into secretion. The rapidity of response and normalcy of mammary function in cows induced to calve up to 9 weeks prematurely is remarkable and has important implications to understanding mammary function: We must either question current dogma on the importance of mammary development during late pregnancy, or hypothesise a substantial capacity for compensatory growth and accelerated development of the mammary gland.

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