Occurrence and effects of sub-clinical hypocalcaemia in dairy cows

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ABSTRACT

Research has shown some dairy cows show temporary falls in plasma calcium concentration during the first six weeks of lactation. By monitoring plasma calcium concentrations in 58 dairy cows in 4 herds for 42 days postpartum it was found that 33% showed at least one episode of a fall in plasma calcium concentration to <1.9 mmol/l. The mean plasma calcium concentration of these cows during this period was 2.15 mmol/l compared to 2.60 mmol/l for those cows which maintained plasma calcium concentrations above 2.10 mmol/l for six weeks and 2.35 mmol/l for another group which maintained plasma calcium concentration above 1.9 mmol/l but not always above 2.1 mmol/l. These mean calcium concentrations differed significantly (P<0.001) among the three groups and between sampling days after calving. There was no significant association between herd and distribution of cows in each group and age of cow was not significantly correlated with plasma calcium concentration on days 7, 9, 19, 29 and 42 after calving or with the overall mean concentrations. Sub-clinical hypocalcaemia may commonly occur in early lactation and have significant effects on production and reproduction in dairy cows.

Keywords Dairy, cattle, hypocalcaemia.

INTRODUCTION

Hypocalcaemia without paresis was first reported by Mayer *et al.* in 1966 and has long been observed by practising veterinarians in dairy cows in the first two months of lactation. Recently Hove (1986) in Norway has reported that some 50 percent of a group of 28 cows were calcium cyclers in the first six weeks of lactation and showed falls in serum calcium to below a normal value of 2.18 mmol/l (low level of the 99 percent confidence interval for normal plasma calcium concentrations in the lactating cow) at around 10, 19 and 28 days after calving.

Induction of hypocalcaemia in cows and sheep by the slow infusion of Na_2EDTA has shown that there is a significant linear relationship between plasma calcium concentration in dairy cows and amplitude (P<0.01) and rate (P<0.01) of rumen contractions and amplitude (P<0.1 >0.05) and rate (P<0.05) of abomasal concentrations over the range of plasma calcium concentrations of from 0.5 - 2.5 mmol/l (Daniel, 1983). Similar research has also shown that there are significant linear relationships between plasma calcium concentrations and cardiac output, stroke volume, right ventricular work and arterial blood pressure in cows. These parameters are reduced by 34%, 33%, 25% and 39% respectively when plasma calcium concentration falls by 1 mmol/l (Daniel and Moodie, 1978; Barzanji and Daniel, 1988).

These results suggest that even with falls of plasma calcium concentration of from 2.2 to 1.7 mmol/l there can be a marked depression of gut motility and circulatory function. Such depression could affect the productive capacity of the cow.

Mulei (1989) investigated the relationship between calving to conception interval (C - C) and mean concentrations and changes in concentration with time, in certain blood parameters during the 8 week period after calving. The parameters measured weekly were haemoglobin, red cell count, leucocyte count, plasma albumen, globulin, calcium, magnesium, sodium, potassium, glucose, inorganic phosphorus, red cell potassium, red cell sodium and red cell magnesium concentrations. Where a parameter (either change with time or overall mean value) was significantly correlated (P<0.05 or occasionally P<0.1 >0.05 if it had suspected value to the equation) with C - C interval it was utilised in a stepwise multiple regression analysis to determine the most important variables contributing to C - C (dependent variable). The final regression equation was:

C - C = 98.6 + (Glucose x -34.8) + (Albumen x -42.7) + (Globulin x 49.9) + (Calcium x -42.0).
R^2 = 0.65 for the equation.

Where:

Glucose is the mean plasma glucose concentration over 8 weeks post-partum.
Albumen is the regression on time over eight weeks post-partum.
Globulin is the mean plasma globulin concentration over 8 weeks post-partum.
Calcium is the mean plasma concentration over 8 weeks post-partum.

The partial regressions for globulin and calcium were significant (P<0.01 and 0.05) and the standardised regression coefficients were as follows:

Glucose = -0.226
Albumen = -0.188
Globulin = 0.436
Calcium = -0.296

Thus, mean globulin and calcium concentrations were the most important variables in the equation.

These results suggest that mean plasma calcium concentration in the first 8 weeks of lactation is a factor influencing C - C either by affecting the rate of uterine involution and/or the onset of first oestrus or the number of services per conception.

MATERIALS AND METHODS

Four dairy herds in South East Queensland were chosen on the basis of access and owner willingness to co-operate to determine whether calcium cycling occurred. Three herds contained pure Holstein-Friesian cows and the fourth herd contained Illawarra cows. These herds were year round calving herds with mean daily milk yields of from 15 - 20 litres per cow. These herds were normally grazed improved tropical grass pasture during the summer/autumn period and irrigated rye grass or rye grass/clover pasture in winter. Lactating cows were usually supplemented with 1.5 - 2.5 kg of a grain concentrate supplement at each milking.

Blood samples were collected from a total of 58 cows over a period of 12 months. The distribution was 19, 16, 16, and 7 cows from each of the 4 herds. For ease of visitation and collection, a small group (3 or 4) of cows in each herd and calving at a similar time, were sequentially sampled at 6-12, 14, 16, 18-21, 23, 25, 27-30, 33, 36, 39 and 42 days after calving before another group was commenced. Blood was collected from the ventral coccygeal vein into collection vials containing lithium heparin. Plasma was separated off and stored at -10°C until analysis. Plasma calcium was estimated by atomic absorption spectroscopy.

On the basis of the concentrations of calcium the 58 cows were divided into 3 groups as follows:

Group I contained those cows which maintained plasma calcium concentration >2.10 mmol/l;

Group II contained those cows which maintained plasma calcium >1.91 mmol/l but not always >2.10 mmol/l;

Group III contained those cows which could not maintain plasma calcium concentrations >1.91 mmol/l during that period.

Chi square analysis was used to test whether distribution of cows in the 3 groups was independent of herd and correlation analysis was used to determine whether age of cows was related to overall mean plasma calcium concentration (mean of 23 samplings) or on concentrations on 5 selected days after calving (days 7, 9, 19, 29 and 42).

Analysis of variance was used to determine the significance of differences between mean plasma calcium concentration in Groups I, II and III and to determine the effects of days after calving within each group.

RESULTS AND DISCUSSION

The daily mean values for these three groups between days 6 and 42 after calving are shown in Figure 1. The overall mean plasma calcium concentrations were: Group I = 2.59 mmol/l, Group II = 2.35 mmol/l and Group III = 2.15 mmol/l and these differed significantly between groups (P<0.001) and between sampling dates (P<0.05). The group *by* sampling date interaction was

not significant. Group I maintained acceptable plasma calcium concentrations throughout the 6 weeks, whilst Group III showed large numbers of values below Hove's (1986) lower limit of normal of 2.18 mmol/l and 12 out of 21 cows in Group III had values <1.75 mmol/l on at least one occasion during the 6 week period. There was no significant association between herd and the distribution of cows in each group and age of cow was not significantly correlated with plasma calcium concentration on any of the selected days after calving or on overall mean concentration for the period.

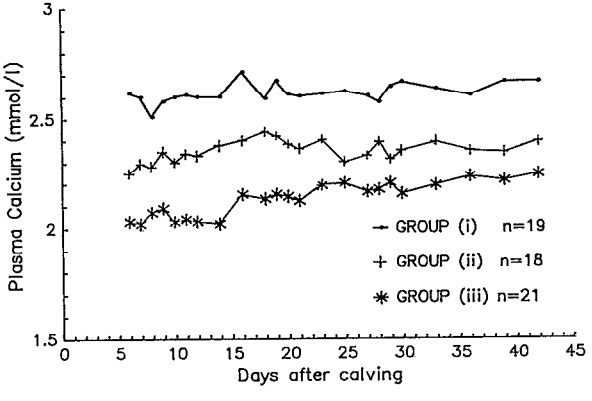

FIG 1 Trends in mean plasma calcium concentrations after calving in three groups of dairy cows. Group (i) all maintained plasma calcium concentration >2.10 mmol/l. Group (ii) all maintained plasma calcium >1.91 mmol/l but not always >2.10 mmol/l. Group (iii) were unable to continuously maintain plasma calcium >1.91 mmol/l.

The results show that a significant number of cows in our dairy herds are calcium cyclers whose plasma calcium concentrations fall during the first six weeks after calving to concentrations in which alimentary tract motility is reduced and circulatory efficiency impaired. There is likely to be a reduced blood supply to organs including the alimentary tract, mammary gland and uterus and a reduction of motility of the alimentary tract and contractility of the uterus (Silve and Noakes, 1984) when a degree of hypocalcaemia exists. It can thus be postulated that cows in Group III with one or two bouts of moderate hypocalcaemia will suffer these effects from time to time. This may be sufficient to affect production and fertility but wider studies with greater numbers of cows are required to substantiate these hypotheses.

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