

The Effects of 1α -OH Cholecalciferol on Calcium, Magnesium and Phosphorus Metabolism in Dairy Heifers, and its Potential Value for the Prevention of Milk Fever

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Vitamin D₃ (cholecalciferol) has been used for many years for the prevention of milk fever in dairy cattle (Seekles *et al.*, 1958) because it increases both the absorption of calcium and phosphorus from the diet and the mobilisation of these elements from bone. However, it acts slowly, and must therefore be administered at least 3 days before calving — a difficult period to judge accurately. 1α -OH cholecalciferol (1α -OH D₃) is a readily synthesised analogue of the physiologically active metabolites of cholecalciferol (Holick *et al.*, 1973) which stimulates the absorption of dietary calcium more quickly than cholecalciferol itself, and thus may be more useful for the prevention or treatment of milk fever.

We have studied (i) the effects of 1α -OH D₃ on calcium, magnesium and phosphorus metabolism in dairy heifers, and (ii) its effectiveness in preventing the post-parturient hypocalcaemia and hypophosphataemia which occur normally in dairy cows.

Methods and Results

(i) 1α -OH D₃ was administered intramuscularly to groups of 4 pregnant heifers at dose rates of 0.5, 1.0 or 2.5 μ g/kg body weight in either sesame oil or propylene glycol. After administration of 1α -OH D₃ in sesame oil the concentrations of calcium and phosphorus in plasma increased more rapidly than after doses of cholecalciferol. The first response occurred after 24 h, the peak after 3-4 days and increased concentrations were maintained for up to 13 days. After administration in propylene glycol (Fig. 1) increases in plasma calcium and phosphorus concentrations occurred after only 12 h, peak concentrations were reached after 2-3 days

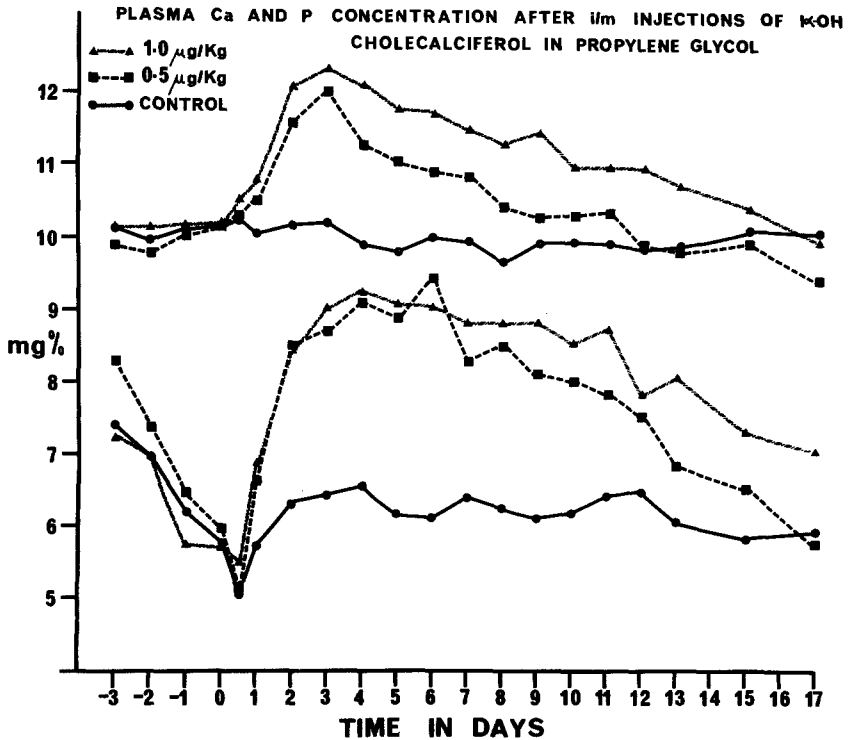


Fig. 1. The mean concentrations (mg/100 ml) of calcium (upper 3 lines) and inorganic phosphorus (lower 3 lines) in the plasma of groups of 4 dairy heifers, during the 3 days before and the 17 days after the intramuscular injection of $1\alpha\text{-OH D}_3$ in propylene glycol at dose rates of $0.5\mu\text{g}/\text{kg}$ body weight (■ ——— ■) and $1.0\mu\text{g}/\text{kg}$ body weight (▲ ——— ▲), or of propylene glycol alone (● ——— ●)

and increased concentrations were maintained for up to 12 days. The larger doses tended to prolong the duration of the increases in plasma calcium and phosphorus concentrations but peak concentrations were similar at all dose levels.

Appetite was depressed by about 8% and 20% during the thirteen days following the administration of 1.0 and $2.5\mu\text{g}$ $1\alpha\text{-OH D}_3/\text{kg}$ body weight respectively, the greatest decreases coinciding with the greatest increases in plasma calcium and phosphorus concentrations. At the same time there were small decreases in plasma magnesium concentration, but no other indications of toxicity. The calcium and phosphorus balances of the heifers receiving 1.0 and $2.5\mu\text{g}$ $1\alpha\text{-OH D}_3/\text{kg}$ increased by approximately $4\text{g}/\text{day}$.

(ii) $250\mu\text{g}$ $1\alpha\text{-OH D}_3$ was administered intramuscularly to 10 cows having their third or subsequent calf within 2 h after parturition. Nine similar cows were used as controls. Post-parturient hypocalcaemia (Fig. 2) and hypophosphataemia were considerably less severe in the treated cows than in the control cows.

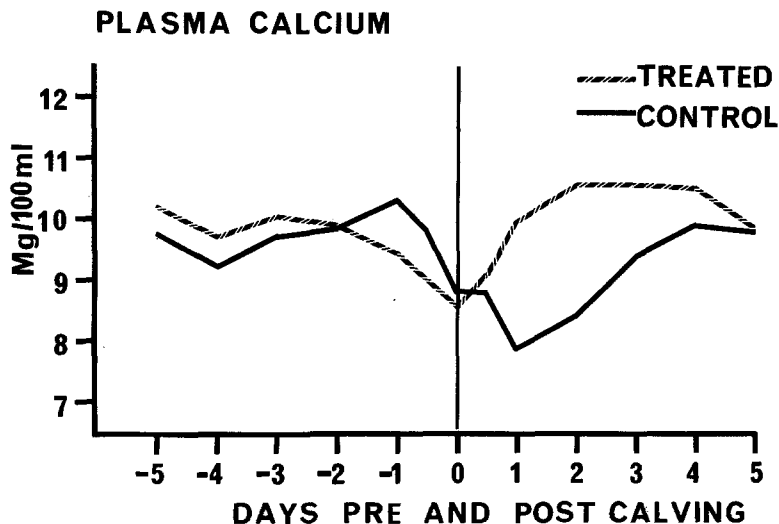


Fig. 2. The mean plasma concentrations of calcium in 9 cows treated with $250\mu\text{g}$ $1\alpha\text{-OH D}_3$ at calving, and 10 control cows, during the 5 days before and the 5 days after calving

Discussion

The first series of experiments indicates that increases in plasma calcium and inorganic phosphorus concentration were probably due to increased retention of calcium and phosphorus from the diet. Moreover $0.5\mu\text{g}$ $1\alpha\text{-OH D}_3/\text{kg}$ body weight increased plasma calcium and phosphorus concentrations to a similar extent, and did so more rapidly, than 10^7 units of vitamin D_3 (equivalent to approximately 0.5 mg/kg body weight), administered to dry cows (Manston, 1969).

The second experiment shows that the same dose of $1\alpha\text{-OH D}_3$ administered shortly after calving, rather than 2-3 days before, significantly reduced the post-parturient hypocalcaemia and hypophosphataemia which occur in dairy cows.

The results of both experiments suggest that $1\alpha\text{-OH D}_3$ is potentially valuable for the prevention or treatment of milk fever.

References

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