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THE EFFECT OF DIETARY CALCIUM ON INDICATORS OF BONE TURNOVER IN BROODMARES

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Introduction

Preliminary studies in our laboratory have found that serum ICTP, an indicator of bone turnover, is increased shortly after foaling. This increase may indicate that mares mobilize bone mineral during lactation. In addition, Glade (1993) reported that estimated metacarpal bone breaking strength decreased in lactating mares fed a diet containing the recommended NRC (1989) levels of calcium and phosphorus. In that study, bone breaking strength rebounded after weaning. This study was conducted to determine whether dietary calcium and phosphorus concentration would affect indicators of bone turnover in mares during late lactation and after weaning.

Materials and Methods

The study used 12 mares (average age 10 ± 4.8 y) split into two groups (control and high-calcium). Groups were balanced for age and parity. The study was initiated at 2.5 mo of lactation and lasted for 16 wk. Foals were weaned at 4.5 mo of lactation. Mares were kept on cool-season grass pastures and were fed a concentrate containing 0.6% Ca and 0.5% P (DM basis). When pasture availability declined, mares were offered timothy hay (0.5% Ca, 0.4% P, DM basis). The high-calcium group was fed the same as the control except dicalcium phosphate was added to the concentrate to increase total estimated calcium intake to 150% of the control group while maintaining a balanced calcium to phosphorus ratio. All mares were fed the concentrate at 1% of body weight until the sixth week of the study. At that time concentrate intake was reduced to 0.8% of body weight. During the seventh week, concentrate intake was reduced to 0.7% of body weight, and in the final week before weaning, the concentrate intake was reduced to 0.6% of body weight. At weaning, concentrate intake was dropped to 0.3% of body weight.

Collection of Data

Body weights were obtained every 14 d and blood samples were collected every 28 d for the duration of the study. Milk samples were collected every 28 d for the first 56 d. Calcium concentrations of milk and serum were determined using atomic absorption spectrophotometry. The serum was analyzed for osteocalcin, a protein that is a marker for bone formation, and ICTP, a type I carboxy-terminal pyridinoline crosslink telopeptide that is a marker for bone resorption. Serum ICTP was measured using a radioimmunoassay (DiaSorin, Stillwater, MN). Serum osteocalcin was determined using an enzyme-linked immunosorbent assay (ELISA) (Quidel, San Diego, CA). All samples were assayed in duplicate using the supplied set of standards along with a high and low control that had been previously analyzed in our laboratory.

Results

Calcium concentration in milk decreased over time ($P < 0.005$) with an average concentration of 593.0 ± 77.6 µg/g at 2.5 mo and 476.2 ± 113.6 µg/g at 4.5 mo. Milk calcium concentration was not affected by diet. Total daily milk production was not measured, but average daily gain of foals from mares fed the high-calcium diet ± 1.01 (0.2 kg) was not different from average daily gain of foals from mares in the control group ± 0.97 (0.08 kg). Calcium concentration in serum averaged 105.6 ± 11.2 mg/L at the beginning of the study (2.5 mo of lactation) and 109.6 ± 10.4 mg/L at the end of the study (2.0 mo after weaning). There was no effect of diet or time on serum calcium concentration. Serum ICTP concentration decreased over time ($P < 0.05$) from an average concentration of 3.82 ± 0.84 µg/L at the beginning of the study (2.5 mo of lactation) to 3.17 ± 0.60 µg/L at the end of the study (2.0 mo after weaning). Osteocalcin concentration in serum was 17.23 ± 3.88 ng/L at the beginning of the study (2.5 mo of lactation) and 16.16 ± 3.33 ng/L at the end of the study (2.0 mo after weaning) and was not affected by time ($P > 0.10$). There was no effect of diet on serum osteocalcin or serum ICTP concentration.

Discussion

Estimated calcium intakes for 500-kg mares through the first 5 wk of the study were 58 g of Ca and 46 g of P for the control diet, and 86 g of Ca and 71 g of P for the high-calcium diet. The NRC (1989) recommends 56 g of Ca and 36 g of P for 500-kg mares in early lactation. There was no effect of diet on milk calcium, serum ICTP, or serum osteocalcin, suggesting that these variables are not responsive to dietary calcium or phosphorus at levels above the NRC (1989) recommendations. Average milk calcium concentration in this study was 548.1 (104.2 µg/g, which is lower than the value of 800 (µ/g used in the NRC (1989) to calculate calcium requirements of mares in late lactation. If the NRC (1989) overestimates the calcium concentration in

milk during late lactation, it is possible that the calcium requirement in late lactation is also overestimated. Serum ICTP concentrations decreased with time suggesting that mares mobilized less bone mineral in later lactation and after weaning. However, serum osteocalcin concentrations did not change over time suggesting that the rate at which bone mineral is deposited remained constant. Further research is needed to define changes in bone turnover in pregnant and lactating mares.

References

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