PARATHYROID HORMONE SECRETION IN HYPOMAGNESEMIC SHEEP FED ON A LOW MAGNESIUM AND HIGH POTASSIUM DIET

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Introdction

Hypomagnesemic tetany (grass tetany) is a metabolic disorder of ruminants resulting from low serum magnesium levels which occurs primarily in early spring during periods of rapid forage growth. Tetany prone grasses are sometimes characterized by low magnesium (Mg) and high potassium (K) contents. Low Mg intake and reduced absorption of Mg by excess K consumption could result in the development to hypomagnesemia.

Experimentally induced Mg deficiency is often accompanied by hypocalcemia in cattle and sheep. Hypomagnesemia in ruminants has been shown to be associated with an impaired ability to mobilize calcium (Ca) into the blood (Terashima et al., 1988). The process of Ca mobilization is regulated mainly by parathyroid hormone (PTH). Therefore, an impaired Ca mobilization in hypomagnesemic animals would be due to insufficient secretion of the hormone. However, little information is available on biologically active PTH secretion in hypomagnesemic ruminants.

The present experiment was designed to determine PTH secretion in hypomagnesemic sheep fed on a low Mg/high K diet.

Materials and Methods

Four sheep weighing about 36 kg were used in the present experiment. A basal semi-purified diet mainly consisted of corn starch, corn cobs, dextrose, wood cellulose and soy protein to provide a low Mg diet. The control (0.24% Mg-0.61% K) and low Mg/high K (0.05% Mg-3.45% K) diets were prepared by adding 0.33% MgO and 5.40% KCl to the basal semi-purified diet respectively. Each diet was provided to meet the daily metabolizable energy requirements for sheep once daily. Water was provided *ad libitum*. All sheep were kept in metabolism crates and subjected to each diet treatment for two weeks. To stimulate PTH secretion in the animals, temporary hypocalcemia induced by the intravenous infusion of 2% disodium ethylene diamine tetraacetate (EDTA) solution. An EDTA infusion of 0.26 mmol/kg body weight was performed for 60 min on the last day of each diet treatment period. Blood samples were taken at 0, 30, 60, 90, 120 and 180 min during and after the EDTA infusion. Plasma samples were analyzed for Mg, total Ca and K by atomic absorption spectrophotometry; for ionized Ca using an ionic meter (Sera-250, Horiba Ltd. Japan); for PTH by double binding radioimmunoassay (INS-PTH radioimmunoassay kit, Nichols Insutitute, USA). The ability of parathyroid gland to secrete PTH in the control and low Mg/high diet-fed sheep were evaluated by the ratio of increased PTH to decreased ionized Ca concentrations during the EDTA infusion period. All parameters were analyzed by a paired t-test to determine significant diet effects.

Results and Discussion

Plasma Mg levels (1.2 mg/100 ml) of the animals fed on the low Mg/high K diet were significantly lower ($P < .01$) than those (3.3 mg/100 ml) of the control diet-fed sheep on the last day of each diet period. There were no significant differences in plasma total Ca and K concentrations between the diet treatment. Hypomagnesemia in the animals on the low Mg/high K diet may be induced by low Mg intake and reduced Mg absorption from the gastrointestinal tract due to dietary excess K.

Mean ionized Ca concentrations (1.19 mmol/l) prior to the EDTA infusion in hypomagnesemic sheep fed the low Mg/high K diet were higher ($p < .01$) than those (1.03 mmol/l) of the control sheep. The mean maximum decrease in ionized Ca concentration (ΔCa) during the infusion of EDTA in the hypomagnesemic sheep was higher ($P < .05$) than those of the control as shown in table 2. These results suggest that hypomagnese-

TABLE 1. CHANGES IN PLASMA PTH CONCENTRATION IN SHEEP FED THE CONTROL OR LOW Mg/HIGH K DIET DURING AND AFTER THE INFUSION OF EDTA SOLUTION (pg/ml)

Diet	Time (min) after the EDTA infusion					
	0	30	60	90	120	180
Control	23.6 ±3.1	29.0 ±2.1	29.6[a] ±2.7	26.0 ±1.5	26.0 ±2.3	25.8 ±2.5
Low Mg/High K	20.3 ±4.3	24.2 ±3.8	24.6[b] ±3.0	22.8 ±4.2	23.0 ±4.0	22.1 ±4.6

* Each value represents the mean ± SE of four sheep.
[a,b]Means with unlike superscripts in the same column differ ($P < .05$).

TABLE 2. MAXIMUM DECREASE IN IONIZED Ca (ΔCa) AND INCREASE IN PTH [ΔPTH] CONCENTRATIONS DURING THE EDTA INFUSION PERIOD IN SHEEP FED THE CONTROL OR LOW Mg/HIGH K DIET.

Diet	ΔCa	ΔPTH	ΔPTH/ΔCa
	−(mmol/l)−	−(pg/ml)−	
Control	0.47±0.03[a]	6.88±1.06[a]	14.4±1.5[c]
Low Mg/High K	0.53±0.03[b]	5.10±1.16[b]	9.7±2.1[d]

* Each value represents the mean ± SE of four sheep.
[a,b,c,d]Means with unlike superscripts in the same column differ (a,b $P < .05$; c,d $P < .01$).

mic sheep appeared to have reduced Ca mobilization compared to the control sheep.

Plasma PTH concentrations prior to the infusion of EDTA in hypomagnesemic sheep tended to be lower than those of the control sheep (table 1). In both groups, plasma PTH concentrations increased during the infusion of EDTA and showed the highest values at 30-60 min after the initiation of EDTA infusion. The mean maximum increase in plasma PTH concentrations (ΔPTH) during the infusion of EDTA in hypomagnesemic sheep was lower ($P < .05$) than those of the control sheep (table 2). The ratio of ΔPTH to ΔCa during the EDTA infusion period, which could evaluate the ability of parathyroid gland to secrete PTH, was significantly lower ($P < .01$) in hypomagnesemic sheep than in the control sheep. These results indicated that hypomagnesemic sheep induced by feeding the low Mg/high K diet had less PTH secretion in response to temporary hypocalcemia. Therefore, the impaired Ca mobilization of hypomagnesemic sheep fed on the low Mg/high K diet could be responsible for the reduced PTH secretion.

(Key Words: Hypomagnesemia, Parathyroid Hormone, Ca Mobilization)

Literature Cited

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