

Relationship between BCAA and blood pH in diarrheic calves

K. Tsukano,¹ DVM; K. Suzuki,¹ DVM, PhD; Y. Nishi,¹ DVM; S. Sarashina,² DVM, MS

¹The School of Veterinary Medicine, Rakuno Gakuen University, 582 Midorimachi, Bunkyo-dai, Ebetsu, Hokkaido, 069-8501 Japan

²NOSAI-Minami Agricultural Mutual Relief Association, 25-16 Misugityo, Yakumo, Futami-gun, Hokkaido, 049-3114, JAPAN

Introduction

Neonatal diarrhea leads to overall loss of not only electrolytes and water, but also decreases carbohydrates, lipids, and amino acids in calves. The mean fecal fat content was higher in calves with diarrhea than in healthy calves, and the mean caloric intake from milk was decreased by 31% in diarrheic calves compared with that in healthy calves. The negative energy balance continues during the diarrhea period. In addition, diarrheic calves fall into metabolic acidosis. Several studies have demonstrated that metabolic acidosis activates the catabolism of proteins and oxidation of branched-chain amino acids (BCAA) in muscle. If plasma amino acid profiles of diarrheic calves are similar with those in human with acidemia, more energy may be required for diarrheic calves with acidemia. However, intravenous nutrition for diarrheic calves with proteolysis-induced acidemia is poorly understood. The aim of this study was to investigate the relationship between acid-base status and plasma BCAA concentration in calves with diarrhea. This data may be useful for intravenous nutrition, especially with amino acid solutions, in calves with diarrhea.

Materials and Methods

Thirty-four Holstein calves 11.0 ± 5.9 days of age were enrolled in this study. Ten of 34 calves exhibited clinical signs of diarrhea, severe acidemia, and metabolic acidosis (severe group: pH 7.04 ± 0.11 , BE -17.4 ± 4.5) on the basis of blood gas analysis (i-STAT 1, USA). Seven of 34 calves exhibited clinical signs of diarrhea, mild acidemia and metabolic acidosis (mild group: pH 7.29 ± 0.06 , BE 0.0 ± 5.2) on the basis of blood gas analysis. The other 17 calves did not exhibit acidemia or metabolic acidosis (pH 7.41 ± 0.02 , BE 11.2 ± 3.5) on the basis of blood gas analysis. Single blood samples were collected by jugular venipuncture from all calves. The whole blood samples were analyzed for BHBA concentrations by an automatic analyzer (Precision Xceed, Abbott Lab., IL, USA). Then, free amino acid concentrations in plasma were measured by a HPLC method using a commercial amino acid

analysis kit (EZ: faast, Shimadzu, Kyoto, Japan) and automated amino acid analysis system (The Shimadzu Prominence and LCMS-2020, Shimadzu). We calculated the total amino acids (TAA: essential amino acid + non-essential amino acid), and BCAA (valine + leucine + isoleucine). Measured dependent variables were compared among groups using one-way ANOVA followed by Tukey's HSD test. The relationships of blood pH concentrations with plasma concentrations of TAA, BCAA, and BHBA were evaluated by Spearman's rank test. Data were described as mean \pm standard deviation. The significance level was $P < 0.05$.

Results

The values of plasma TAA, leucine, and isoleucine were significantly higher in the severe group compared with those of the other groups. The plasma concentration of BCAA was also significantly higher in the severe group compared with those of the other groups. In addition, the plasma concentrations of TAA ($r = -0.40$, $P < 0.05$) and BCAA ($r = -0.41$, $P < 0.05$) were significantly and negatively correlated with blood pH. The values of plasma BHBA in severe, mild, and control groups were 0.19 ± 0.07 , 0.10 ± 0.00 , and 0.03 ± 0.04 mM, respectively. The values of BHBA in the severe group were significantly higher ($P < 0.01$) than those of the other groups. In addition, BHBA ($r = -0.72$, $P < 0.001$) was significantly and negatively correlated with blood pH.

Significance

Even if calves fell into negative energy balance and quantity of total amino acids in the body was reduced, plasma TAA and BCAA were increased by severe acidemia. It is important for inhibition of proteolysis to correct acidemia in diarrheic calves. Supplying amino acids to diarrheic calves with metabolic acidosis is important as well. As calves with metabolic acidosis have an increased plasma BCAA concentration due to hyper-metabolic states of proteolysis, amino acid solutions containing low concentrations of BCAA may be useful to gradually correct the negative nitrogen balance.