The Effect of Diarrhea on the Glutamine Requirements of the Calf Gut

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Glutamine has been categorized as a nonessential amino acid. This classification implies that glutamine can be synthesized by body cells in adequate quantities from other amino acids. Thus, it was not considered necessary to include glutamine in nutritional formulas. Recently, it has been suggested that glutamine might be beneficial in the regeneration of the damaged gut. Investigations in laboratory animals have demonstrated that glutamine-enriched diets improve gut healing and reduce the loss of gut defense mechanism. As a result it has been suggested that glutamine is a conditionally essential dietary nutrient, which is required when the gut is damaged, rather than a nonessential amino acid. Studies in man and animals provide firm evidence that glutamine is readily metabolized after its intravenous administration. The results also indicate a safe and efficient use of glutamine-enriched diets in humans.

The effects of glutamine-enriched diet on scours has not been fully studied but it is likely to stimulate gut healing. The purpose of our study was to determine the requirements of diseased gut for glutamine. We measured the net intestinal glutamine uptake in the healthy and scouring state using an arteriovenous difference technique. Eight male Holstein calves were acquired from local dairy farms that have a low incidence of neonatal scours. All calves were obtained within a week of age and fed colostrum (5% of the body weight at birth). The femoral artery, jugular vein, mesenteric vein and the portal vein were cannulated. These catheters were used to measure blood flow and gut uptake of glutamine. All surgery were performed aseptically. Calves were allowed at least five days to recover from surgery in order to regain normal food intake.

Glutamine-enriched infusions were performed at increasing concentrations of [A]= 0, [B]= 100 , [C]= 200 and [D]= 400 mmol/h on days 6, 8, 10, and 12 after surgery. Presamples were collected at -20, -10 and 0 min. Glutamine infusions of [B], [C] and [D] were performed over an hour. Sterilized solutions were infused using a volumetric infusion pump (Imed 980®). The infusion of glutamine was commenced and blood samples were collected at 10 min intervals from 40 to 60 min. Blood flow in the portal vein was measured using a continuous dye dilution technique; sodium p-aminohippurate (PAH) was infused as a 3% solution at a nominal rate of 0.30 mL/min using a constant-infusion pump. Euthanasia were performed on all calves by day 12. On day 5, four calves presented scours caused by coronavirus. The other four calves were used as controls. Glutamine-enriched infusions were performed again on all diarrheic calves every other day as previously described from day 6 to day 12.

The intestinal glutamine uptake was calculated from the following equation:

$$\text{Intestinal uptake } (\text{mmol.kg}^{-0.75}.\text{h}^{-1}) = [\text{IF X } (P_G\text{-}F_G) \text{ X } (1\text{-PCV})]/\text{BW}^{0.75}$$

where IF is the blood flow in the gut, in liters per hour. P_G and F_G are blood glutamine concentrations, millimoles per liter, in portal vein and femoral artery respectively. BW is metabolic body weight, $\text{kg}^{0.75}$. This equation assumes that packed cell volume is the same in portal and arterial vessels.

In our studies arteriovenous differences for glutamine across the gut were too small to be detected. When glutamine is oxidized by the gut, the nitrogen in this amino acid is released as ammonia. Therefore, we measured the ammonia content in the blood entering and leaving the gut in two control calves. Ammonia production by the gut increased with glutamine infusion (ammonia AV differences pre glutamine infusion [A]= 6 μmol/L; ammonia AV differences post glutamine infusion [D]= 139 μmol/L). The increased ammonia production during glutamine infusion is likely to be coming from glutamine degradation. Therefore, we believe that our enzymatic assay to measure plasma glutamine concentration was too insensitive to reliably detect the low levels of intestinal glutamine uptake. Preliminary work using high-performance liquid chromatography (HPLC) suggested this technique would be a more accurate way of determining glutamine concentration than spectrophotometry. The method gave good recovery results (94.5%). We are investigating the sensitivity of the method and believe that this method holds promise for further studies of gut glutamine metabolism.