Intestinal Adaption Following 70 % Small Bowel Resection in the Horse

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Summary

In summary, ponies maintained on a steady-state or short-interval feeding program following 70 % distal small bowel resection did nod develop a malabsorptive syndrome, as indicated by their clinical status, and serum total protein values. In-vivo D-xylose absorption studies showed a progressive decrease in total absorptive capacity of the bowel following resection, however, the D-xylose absorption test can be affected by changes in gastric emptying, intestinal transit time, gut microflora, and the metabolic status of the animal. We are currently attempting to overcome these variables by modifying the test through the addition of 3-0-methyl glucose. Absorption of 3-0-methyl glucose is much less impeded by intestinal diseases, and the compound is not metabolized by the liver. Morphometric studies indicated that compensatory structural adaptive changes occurred in both the small and large bowel, however, adaptation does not appear to include the acquisition or expression of amino acid transport mechanisms in the large bowel. In-vitro nutrient absorption studies showed an increase in L-alanine absorption/cm² small intestine at 1 month post-resection, but not at 6 months. Absorption/cm² serose may underestimate the absorptive capacity of the small bowel following resection if, due to a compensatory increase in villus size, there are less absorptive villi/cm² serosa. In order to assess this, studies are underway to determine absorption on a per villus basis.
(Note: A manuscript describing part of the work presented here was been submitted for publication in the American Journal of Veterinary Research.)

Adaptation nach Resektion von 70 Prozent des Dünndarms beim Pferd

Kleinpferde, die nach einer Resektion von 70 Prozent des Dünndarms in regelmäßigen, kurzen Abständen gefüttert wurden, entwickelten keine Symptome einer Malabsorption, Allgemeinbefinden und Serumproteingehalte blieben unverändert. D-Xylose-Absorptionstests zeigten eine progressive Verminderung der totalen absorptiven Kapazität des Darms nach der Resektion. Der D-Xylose-Absorptionstest kann jedoch von der Magenentleerung, Passagezeit im Dünndarm, der Darmflora und der Stoffwechsellage des Tieres erheblich beeinflußt werden. Daher wird augenblicklich versucht, diese Schwierigkeiten durch Verwendung von 3-0-Methylglucose zu umgehen, da die Absorption dieser Substanz durch intestinale Erkrankungen weniger behindert und sie in der Leber nicht umgesetzt wird. Morphometrische Untersuchungen der Dünn- und Dickdarmmucosa zeigen kompensatorische Veränderungen. Die Adaptationsmechanismen erstrecken sich jedoch nicht auf die Ausbildung eines Aminosäurentransports im Dickdarm. In-vitro-Absorptionsstudien ergaben einen Anstieg der L-Alanin-Absorption pro Quadratzentimeter Dünndarm nach 1, jedoch nicht nach 6 Monaten nach der Resektion. Da bei In-vitro-Absorptionstests pro Flächeneinheit Serosa die absorptive Kapazität des Dünndarms unterschätzt werden kann, wenn wegen kompensatorischer Vergrößerung der Zotten weniger absorbierende Zotten pro Flächeneinheit vorhanden sind, werden neue methodische Ansätze erprobt.
Fußnote: Teile dieser Arbeit sind Gegenstand eines Manuskripts, das zur Publikation im American Journal of Veterinary Research eingereicht ist.

Extended Abstract

Resection of > 40 % of the equine small intestine is reported to induce malabsorption, weight loss, diarrhea, liver disease, and ultimately death. We studied the influence of a short-interval feeding program on the postoperative clinical course in ponies after 70 % distal small bowel resection for periods of one and six months. We also investigated the functional and structural adaptive changes which occur in the equine small and large bowel following 70 % distal small bowel resection.

Ponies were maintained on an automatic feeding system which delivered 1/8 the maintenance pelleted ration every three hours. Prior to surgery, and each month thereafter for the duration of the study, a D-xylose absorption test was performed on each pony, and blood was collected for a CBC and serum chemistry panel. Ponies were euthanatized at either 1 or 6 months after surgery. In-vitro absorption studies were performed on the small bowel, cecum, and right ventral colon utilizing Ussing chambers to determine absorption of sodium, 3-0-methyl glucose, L-alanine, and L-methionine. Complete necropsies were performed on each animal; tissues were collected for histologic examination and morphometric analyses of gut mucosa.

Ponies remained bright and alert, and had feces of normal consistency throughout the six month study. Though ponies lost 5 % of their preoperative body weight by week 5, they regained the weight by week 10, and then continued to gain weight at a rate comparable to control ponies for the remainder of the study. The initial weight loss was attributable to loss of intestinal mass at surgery, and decreased feed intake. Mean total protein and albumin values for resection ponies decreased 18 % by week 5 after surgery, but returned to preoperative levels by week 16. Serum alkaline phosphatase levels for resection ponies doubled by week 10, and gradually returned to control animal values by the end of the six month study.

At one month after surgery, mean peak D-xylose absorption for resection ponies was 41 % that of control ponies. D-xylose absorption decreased over time in resection animals, and was only 15 % that of controls at the end of the six month study. In-vitro absorption studies showed signi-

ficantly greater absorption of L-alanine/cm^2 small intestine in the one month resection group (n = 6) compared to the six month resection group (n = 6; p < .02), and a trend toward greater absorption than controls (n = 6; p < .06). Morphometric studies performed with light microscopy indicated that, compared to controls, resection ponies had a significant increase in small intestinal crypt depth at 1 and 6 month following surgery (p < .03). There was a trend toward increased villus height and 3-dimensional surface area at 1 and 6 months.
Evaluation of the cecal mucosa revealed significant increases in 2-dimensional mucosal surface area (p < .004), and crypt depth (1 mo-p < .008, 6 mos.-p < .04) for the 1 and 6 month resection groups compared to controls. In-vitro amino acid absorption studies performed 6 months after surgery (n = 6), showed no net absorption of L-alanine or L-methionine in the cecum or right ventral colon of either control or resection ponies.

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