Hemodynamics in the Normal and Laminitic Bovine Digit

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Introduction

Bovine laminitis is of great economic importance to the dairy and beef industry. Lameness from laminitis and its sequella results in loss of milk production, decreased weight gain, culling of animals and extra labor. Similar to horses, the digital pathology is thought to occur due to vascular derangements in the digital microvasculature leading to ischemia in the digital laminae. Digital hemodynamics in the horse have been well documented. Although most literature describing bovine laminitis is based on clinical cases or extrapolations from equine laminitis research, the bovid undergoes a different clinical course of disease, with a more mild chronic laminitis process being more common than the acute disease process routinely observed at the onset of equine laminitis. Therefore, hemodynamic data specific to the normal laminitic bovine foot is needed. The present study compared digital hemodynamics between normal and laminitic steers in early stages of laminitis.

Material and Methods

Eleven healthy steers (600-770 lb; 300-350 kg) were randomly divided into control and grain overload animals. Using a protocol that consistently results in clinical signs of laminitis, five steers were administered a grain mixture (wheat, barley, oats mixed 1:1 with water) at 3.5% of their body weight. Control animals (n=6) were administered water only. All animals were anesthetized either after a decrease of at least 50% in the central venous pressure (laminitic steers) or 6-8 hours after water administration (control steers). A pump-perfused extracorporeal digital preparation was used to evaluate digital hemodynamics. Heparin was injected (500 IU/kg IV) immediately before cannulation of vessels. Digital bloodflow (Qb) was determined by timed collection of venous blood samples in a graduated cylinder. Digital arterial and venous blood pressures were recorded by pressure transducers connected to a physiograph. Capillary pressure (Pc) was determined by using a described venous occlusion technique. Total vascular resistance (TVR) and pre- and post-capillary resistance (Ra and Rv) and ratios were calculated.

Results and Conclusions

Capillary pressures and post-capillary resistance were significantly higher ($p<0.05$) in the digital microvasculature of the grain overload steers compared to the control steers. Similar results have been previously documented in black walnut and carbohydrate laminitic models in horses. The increase in capillary pressure and post-capillary resistance facilitates transvascular movement of fluid and an increase in tissue pressure. In contrast to equine studies, no significant difference was noted in precapillary resistance, pre- to post-capillary resistance ratio, or digital bloodflow between control and grain overload steers. Overall, digital bloodflow in steers appeared to be less compared to horses, whereas capillary resistance was higher in steers. In conclusion, the differences in hemodynamic changes observed in the bovine digit when compared to the equid may account for the differences in clinical presentation seen in the two species.