Cryotherapy Reduced the Severity of Laminitis Evaluated 7 Days After Induction With Oligofructose

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Cryotherapy using circulating 1°C water and applied to all four limbs markedly reduced the severity of clinical and histological laminitis after experimental induction with oligofructose. The authors recommend the use of distal-limb cryotherapy for the prevention of laminitis in horses clinically at risk. Authors’ address: Australian Equine Laminitis Research Unit, School of Veterinary Science, Faculty of Natural Resources, Agriculture, and Veterinary Science, The University of Queensland, St. Lucia, Queensland 4072, Australia; e-mail: vaneps@vet.upenn.edu (van Eps). © 2006 AAEP.

1. Introduction

A previous study showed a reduction in acute laminitis severity when cryotherapy was applied to a single limb for 48 h during the developmental phase. It was unclear from that study whether laminitis could still have developed after cessation of cryotherapy at 48 h. The current study was designed to investigate the effect of cryotherapy applied to all four limbs for an extended period (72 h) after experimental induction of laminitis. Clinical and histological evaluation for laminitis was performed 7 days after experimental induction.

2. Materials and Methods

Eighteen Standardbred horses (14 geldings and 4 mares) with normal feet and no lameness were randomly allocated into three groups. Six horses served as cryotherapy controls (CC group). The remaining 12 horses received a laminitis-induction dose of oligofructose (OF) using the previously described method. Six of these horses (OFCT group) had cryotherapy treatment for 72 h after the induction dose. The remaining six horses (OFC group) had no cryotherapy treatment. All horses were euthanized by overdose with barbiturate 7 days after the OF-induction dose or the initial application of cryotherapy.

For cryotherapy application, the horses were placed in a wooden bath housed within stocks. An attached refrigeration pump continuously circulated water at 1°C. The water level was maintained just below the carpus. Internal hoof temperature, bath temperature, and ambient temperature were logged continuously for the initial 72-h period. After the initial 72-h period, the horses were evaluated for lameness twice daily. Before euthanasia, the lameness examinations were recorded on video and subsequently, scored by six blinded evaluators using a modified lameness-grading system. After euthanasia, samples of the dorsal lamellae were sectioned, stained, and examined using light microscopy. Lamellar architecture and total epidermal lamellar (TEL) length (measured from the bases of the primary epidermal lamellae to
the secondary epidermal lamellar tips) were recorded.

The median lameness scores of the OFC and OFCT groups were compared using Mann Whitney analysis. The TEL lengths for the front feet of each horse were combined, and the means were compared using an independent t-test. A significance level of \( p < 0.05 \) was used. The experiments were conducted according to the guidelines approved by the University of Queensland Animal Experimentation Ethics Committee.

3. Results

All horses in the CC group tolerated the cryotherapy well. Internal hoof temperature ranged from 1.8 to 3.6°C for the majority of the 72-h application period; however, intermittent periods of increased internal hoof temperature (\( \leq 12°C \)) were noted in four of the CC horses. Moderate distal-limb edema developed by 72 h and resolved by 7 days. Mild lameness was observed at the trot in one horse from the CC group at 7 days. Lamellar histopathology was normal in all feet from the CC horses.

All horses in the OFC group developed the moderate to severe lameness characteristic of laminitis, and it persisted until 7 days. Each horse was treated with phenylbutazone\(^a\) (4 mg/kg, q 12 h, IV) to alleviate laminitis pain. All OFC horses had lameness detectable at the walk before euthanasia. All horses in the OFC group had lamellar histopathological changes consistent with chronic laminitis. Sections of the front feet of each OFC horse showed circular “islands” of epidermal basal cells, which seemed to be unattached to the parent primary epidermal lamellae, instead of normal secondary epidermal lamellae.

Internal hoof temperatures of the OFCT group were similar to that of the CC group for the majority of the 72-h application period. All OFCT horses were judged sound after removal from the bath for the 7-day observation period. After video analysis and blinded grading, three horses in the OFCT group were deemed to be mildly lame at the trot (one of these was also judged to be lame at the walk on the turn). Two horses were judged to be sound, and one horse was scored between sound and mildly lame at the trot. Lamellar histopathology revealed no secondary epidermal lamellar “islands.” Lamellar architecture was almost normal with mild elongation and pointing of secondary epidermal lamellar tips evident in some of the feet.

The median lameness scores at 7 days were significantly less in the OFCT group compared with the OFC group (\( p < 0.05 \)). The mean TEL length was significantly less (\( p < 0.05 \)) in the OFCT group (3448 ± 81 \( \mu \)m) compared with that of the OFC group (4372 ± 267 \( \mu \)m).

4. Discussion

Continuous distal limb cryotherapy, applied during the developmental phase, markedly reduced the severity of clinical and histopathological laminitis after induction with OF. Immersion in 1°C water effectively reduced internal hoof temperature to a level comparable with that of ice and water in previous studies.\(^1,2\) The optimal or minimum temperature required for laminitis prevention has not been established. It is, however, logical that the minimum lamellar temperature achievable without damaging the tissue will result in a maximal reduction in lamellar metabolism, inflammation, and perfusion; subsequently, this will cause the most potent effect.

This study showed that cryotherapy can have a preventative effect when applied throughout the developmental period. This period did not exceed 72 h in the experimentally induced carbohydrate overload, but it may be longer and more variable in association with other conditions (clinical enterocolitis, metritis, pleuropneumonia, etc.).\(^3\) Constant application of cryotherapy during the entire developmental period is desirable; however, this would be difficult to achieve in clinical cases because of the lack of clinical or laboratory markers showing this phase. Until such biomarkers are available, clinical experience alone must be used to identify horses at high risk of developing laminitis. Cessation of cryotherapy can be based on the resolution of the primary disease.

Various methods exist for the application of distal-limb cryotherapy in horses.\(^3\) It seems to be important to cool the limbs to a proximal level of at least the mid-cannon region to cool arterial blood and achieve appropriate lamellar temperatures. Cold-water immersion using the system described here is an effective technique for continuous cryotherapy application; however, the horse must be confined to stocks and must remain standing for the entire application period. The authors are currently investigating a lightweight membrane system that would allow ambulation and recumbency in clinical cases.

This project was funded by a grant from the Rural Industries Research and Development Corporation (RIRDC) of Australia. The authors are grateful to the Animal Health Foundation of Missouri for their continuing financial support.

References and Footnote


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