In Vivo Evaluation of Extracorporeal Shock Wave Therapy for Collagenase Induced Suspensory Ligament Desmitis

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Extracorporeal shock wave therapy improved the rate of healing of collagenase-induced suspensory ligament desmitis in horses, as measured by ultrasonographic imaging. Extracorporeal shock wave therapy resulted in a statistically significant decrease in lesion area and improved fiber alignment and echogenicity of the ligament in treated ligaments when compared with control ligaments. Authors' address: Department of Veterinary Clinical Sciences, College of Veterinary Medicine, Ames, IA 50010-1250.

1. Introduction

Suspensory ligament desmitis is a common disease causing primary and compensatory lameness in the equine athlete. The disease can cause long-term lameness, restricting the horse's ability to perform at the level of competition achieved before the onset of lameness. Current medical treatment options include confinement and rest, controlled exercise protocols, intralesional injections, corticosteroid therapy, anti-inflammatory therapy, bone marrow injection, and corrective shoeing.[1,2] However, none of these methods consistently result in a satisfactory outcome.

Extracorporeal shock wave therapy (ESWT) is being used for the treatment of equine musculoskeletal diseases.[3–5] Recent studies have demonstrated that shock waves induce neovascularization at the tendon-bone junction, which in turn relieves pain and improves tissue regeneration and repair.[6] ESWT was also found to have a positive effect on the concentration of transforming growth factor-beta 1, which has a chemotactic and mitogenic effect on osteoblastic cells.[7] ESWT is a minimally invasive, safe method for the treatment of insertional tenopathy in humans.[8]

Initial clinical experiences with ESWT indicate that this therapy may be a beneficial treatment for suspensory ligament desmitis. Follow-up evaluation at 6 mo or more revealed improvement in lameness with a corresponding improvement in ultrasonographic appearance in six of seven horses in which suspensory desmitis was treated with ESWT.[9] These results are similar to those of other investigators that found seven of eight horses with >90-day follow-up to have a decreased lameness.[10]

The objective of this study is to evaluate the effectiveness of ESWT on collagenase induced suspensory desmitis.

2. Materials and Methods

Four horses with a mean age of 7.25 yr (range, 3–12 yr) and mean weight of 430 kg (range, 383–473 kg) with ultrasonographically normal suspensory liga-

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ments were used for the study. Lesions were induced in both forelimb proximal suspensory ligaments, 12-cm distal to the accessory carpal bone with 4000 IU collagenase.[a] The horses were ultrasonographically evaluated weekly for 3 wks, at which time the lesions seemed stable in size and appearance. At this time, ESWT was initiated. In each horse, one suspensory ligament served as an untreated control and one was treated with a focused shock wave generator[b] at 0.13 mJ/mm^2 three times at 3-wk intervals. Five hundred pulses were administered from the palmar aspect of the limb with a 35-mm probe and 500 more from palmar-lateral and palmar-medial with a 5-mm probe for a total of 1500 pulses. The size and appearance of the baseline lesions were recorded ultrasonographically 3 wk post-induction and re-evaluated at 3-wk intervals to the completion of the project at 15 wks. Recording of the ultrasonographic appearance of the suspensory ligament was done at five sites at 2-cm intervals, starting at the proximal attachment. The image analysis software in the ultrasound system[c] was used to measure the cross-sectional area of the ligament, defect, and percent lesions (%Les). A fiber alignment score (FAS) and echogenicity score (EchoS) were given at each 2-cm interval. A scoring system as described for superficial digital flexor tendon lesions was used.[11] The FAS was as follows: 0 = 75–100% parallel fiber alignment, 1 = 50–75% parallel fiber alignment, 2 = 25–50% parallel fiber alignment, and 3 = 0–25% parallel fiber alignment. The EchoS was as follows: 0 = normal or near normal, 1 = mostly echogenic, 2 = 50% anechoic and 50% echogenic, and 3 = mostly anechoic. The sum of the %Les, FAS, and EchoS from each of the five sites in each ligament made the total percent lesion (t%Les), total FAS (tFAS), and total EchoS (tEchoS).

Statistical analysis was performed on six outcome variables: %Les, FAS, and EchoS at the site of the greatest percent lesion in each ligament and t%Les, tFAS, and tEchoS for each ligament. Each variable was determined once for each suspensory ligament at five time points; therefore, the data are repeated measures. The baseline measurement was the measurement obtained the day treatment was started. To test the difference between treatment and control groups for each of the six variables, two methods of analysis were used. The FAS and EchoS are ordinal scores (0–3), which may not satisfy assumptions required for continuous data analysis methods. Instead, each ligament's score over time was summarized by the slope coefficient of a linear regression (FAS or EchoS versus time). The slope coefficient represents the trend of the variable for each horse over time. The resulting summaries (four slope coefficients per group) are used in t tests to compare FAS and EchoS for treatment and control. The tFAS and tEchoS variables are sums of FAS and EchoS over the five sites measured in the ligament. The possible range of the totals (0–15) is sufficient to treat these as continuous variables. The %Les and t%Les are continuous variables. Multiple analysis of covariance (MANCOVA) was used to compare treatment and control groups for continuous variables. MANCOVA accounts for within-subject correlation across time and controls for differences in baseline data across groups.[12] For each variable, the time $\times$ group interaction was not significant after controlling for baseline to assess the group effect directly. A $p \leq 0.05$ was considered significant.

3. Results

The treated group had statistically significantly ($p < 0.05$) lower means for tFAS, tEcho, and t%Les than the control group. The %Les is significantly lower in the treated group than the controls. The FAS was not statistically significant between treatment and control ($p = 0.0584$), but the treatment group had a lower average slope (-0.45, 0.1) than the control group (-0.1, 0.1). Therefore, the FAS scores for the treatment group were decreasing faster than for the control group. The EchoS was not statistically significant ($p = 0.8$) between treatment and control. For tFAS, the average difference (control $-$ treatment) over the groups is 2.6; for tEchoS, the difference is 2.28; and for t%Les, the difference is 31.58%.

4. Discussion

The collagenase model has previously been used for the evaluation of tendon healing in the horse.[13,14] This model provides a controlled mechanism for paired comparisons that decrease the number of animals needed for the study. Whereas it is possible that naturally occurring suspensory ligament desmitis may respond differently, the results of this study seem similar to results seen in clinical cases.

These results indicate that the lesions treated with ESWT healed significantly faster, as determined by ultrasonography, than the controls. Ultimately, the important factor is returning the horses with suspensory ligament desmitis to the previous level of activity without recurrence of the disease. This study did not evaluate long-term return to function. However, ESWT is a non-invasive mechanism that seems to stimulate healing of suspensory ligament desmitis and should be considered before resorting to more invasive treatment. Further investigations and clinical evaluations will be needed to assess long-term outcome.

A major problem in clinical cases of suspensory desmitis is the horse that remains chronically lame with lesions that seem to be slow healing. In this study, therapy was initiated 3 wk after induction of the lesion. This study indicates that ESWT decreased the %Les, t%Les, tFAS, and tEchoS faster than the control limbs when treatment is initiated early. Though a direct relationship cannot be implied, the author feels that the response seems similar to more chronic clinical cases.

The treatment protocol used in this study was the same as the author (S.M.) uses in clinical cases. This study used three treatments at 3-wk intervals, with 1500 pulses per treatment at an energy setting of 0.13 mJ/mm^2. It is well known that ESWT is dose-dependent.[15,16] Low energy and a low number of pulses may have no effect, whereas excessive energy or pulses may be detrimental. It is possible that refinement of the technique could result in improved healing.

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References and Footnotes

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[a]Collagenase C1639, Sigma Chemical Co., St. Louis, MO 63178.
[b]Equitron®, High Medical Technologies, Lengwil, Switzerland CH7584.
[c]Falco 100®, Pie Medical USA, Indianapolis, IN 46250.