Extracorporeal Shock Wave Therapy for Treatment of Navicular Syndrome

Scott McClure, DVM, PhD; Richard B. Evans, PhD; Kristina G. Miles, DVM; Eric L. Reinertson, DVM, MS; Jan F. Hawkins, DVM; and Clifford M. Honnas, DVM

Extracorporeal shock wave therapy was effective in decreasing the lameness associated with navicular syndrome in 81% of the horses as determined by an unmasked evaluator and in 56% of the horses with masked evaluators. Extracorporeal shock wave therapy provided a non-invasive, effective mechanism to decrease the lameness associated with navicular syndrome. There were no complications associated with the procedure. Horses that responded to treatment did not regress in the year after treatment. Authors' addresses: Department of Veterinary Clinical Sciences, (McClure, Miles, Reinertson) and Department of Veterinary Diagnostic and Production Animal Medicine (Evans), College of Veterinary Medicine, Ames, IA 50010-1250; Department of Veterinary Clinical Sciences, School of Veterinary Medicine, Purdue University, West Lafayette, IN 47907-1250 (Hawkins); and Department of Large Animal Medicine and Surgery, College of Veterinary Medicine, Texas A&M University, College Station, TX 77843-4475 (Honnas).

1. Introduction

Navicular syndrome is a common cause of chronic lameness in horses.[1] The exact etiology of navicular syndrome is unknown. Mechanisms of disease onset proposed include bone remodeling, ischemia, and chronic bursitis.[1] Resultant degenerative changes of the navicular bone include enlargement of the distal border synovial invaginations, cystic lesions of the medullary cavity, flexor cortex and fibrocartilage erosion and fibrillation, and enthesopathy of the impar and collateral sesamoidean ligaments.[1,2]

Multiple treatments for navicular syndrome have been explored, including hemorheologics, anti-inflammatories, corrective shoeing, and intra-bursal and intra-articular medications.[1,3] Inferior check ligament desmotomy and navicular suspensory ligament desmotomy have also been explored.[1,3,4] In refractory cases, palmar digital neurectomy has been used to alleviate pain for variable periods of time.

Extracorporeal shock wave therapy (ESWT) uses pressure waves generated in a fluid medium that can be focused at the site to be treated.[5] Shock waves have been shown to stimulate bone remodeling and increase blood flow to bone–ligament junctions.[6] The mechanisms by which these changes occur is unknown, but in vitro studies on the influence of bone cells have shown an increase in cytokines and cellular division after treatment with shock waves.[7,8]

The objective of this study is to report on the clinic effectiveness of ESWT for treatment of navicular syndrome in horses.

NOTES

2. Materials and Methods

Case records of horses that were diagnosed with navicular syndrome and treated with ESWT from June 1999 to August 2001 were evaluated for this study. All of the horses were diagnosed with navicular syndrome by a referring veterinarian, and the diagnosis was reconfirmed by a complete lameness examination using regional and intra-articular anesthesia, hoof tester evaluation, flexion tests, and radiographs. Signalment, limbs affected, and lameness grades were recorded. All lameness evaluations were completed on a hard surface. When evaluated in a circle, they were lunged or trotted in hand in a circle ~8 m (24 ft) in diameter.

Each navicular bone involved was treated by an electrohydraulic shock wave generator[a] while the horses were under general anesthesia in lateral recumbency. Fluoroscopic guidance was used to focus the ESWT at the appropriate location. Each navicular bone was administered at a total of 2000 pulses (1000 pulses through the frog and 1000 through the heel) at 0.89 mJ/mm^2. After treatment, horses were stall rested for 1 wk and then limited to hand walking and ground work for an additional 5 wk before resuming full work. Phenylbutazone was used as needed for its anti-inflammatory and analgesic properties for ~1 wk after treatment.

Horses were discharged with directions to maintain shoeing as was done before treatment. To the authors' knowledge, no additional treatments for the navicular syndrome were given to these horses, and none of the horses were given phenylbutazone before the 6-mo re-check examination. A follow-up examination was performed 6 mo after treatment. Further follow-up information was obtained by repeated clinical evaluation of the horse and by telephone and personal interview with the owner or trainer.

Outcome was evaluated three ways: (1) unmasked veterinary evaluation, (2) client perception of lameness, and (3) masked evaluation of video tapes taken before and 6 mo after treatment.

Unmasked outcome consisted of the lameness scores given to the horse by a veterinarian when trotted in hand and when circled each direction before and 6 mo after treatment. Clients were asked after 6 mo if the horse was better, the same, or worse. For clients with horses that were available after 12 mo, they were asked if the horse was better, the same, or worse since the 6-mo evaluation.

Video clips of each horse were obtained before treatment and 6 mo after treatment when trotted as described above. The video clips were randomly mixed on a tape, and three reviewers not associated with the study assigned lameness grades. Reviewers were given a written description of the clinical signs associated with each lameness grade and a videotape of horses not in this study as examples of each lameness grade to assure reviewers has similar objectives. A single lameness grade was assigned to the limb showing the greatest degree of lameness when trotted at hand in a straight line on a hard surface. Separate grades were also assigned to each inside forelimb when circled both left and right at a trot on a hard surface. When the lameness was identified on the outside leg, the leg inside the circle was given a grade of 0. Lameness was graded from 0 to 5 using a modified AAEP scale.[9]

A series of radiographs was taken of each foot for evaluation of the navicular region before and 6 mo after treatment for the 16 horses with follow-up. A radiologist blinded as to outcome or pre- or post-treatment evaluated the radiographs and scored them from 0 = normal to 3 = dramatic changes for medullary sclerosis, distal border synovial invaginations, flexor cortex erosions, abaxial margins, medullary cysts, and the deep digital flexor tendon.

For the unmasked evaluation, matched-pair t-tests were used to test the effect of the ESWT. A negative difference indicates that there is an improvement (decrease) in lameness. Outcome as assessed by owner/trainer is described categorically.

For video analysis, the objects of inference are the average difference in lameness scores when trotted in a straight line and the lameness scores of the most lame leg when trotted in a circle with that leg inside the circle, with the goal of showing that, on average, there is an improvement in lameness from pre-intervention to post-intervention. First, each horse's pre- and post- intervention scores were summarized across graders using the average of the three scores. Then the difference score for each horse was calculated using post-intervention average minus the pre-intervention average, so that negative difference scores indicate an improvement in lameness. When using the difference, the within-horse repeated measures effect is removed. Finally, pair-wise t-tests were used to compare the average difference with zero (no treatment effect). Observer agreement was measured with kappa, which adjusts the proportion of observed agreement by accounting for chance agreement.[10] A kappa to evaluate observer agreement was calculated for each pair of observers (3), pre- and post- treatment (2) for lameness when trotted in a straight line, and the worst leg inside the circle (2), resulting in 12 kappas.

To evaluate the radiographs, a paired t-test was done to compare the sum of the score for each foot between the pre- and post- treatment radiographs. The sum of the radiograph scores from the pre-treatment radiographs was compared to the outcome of lameness as assessed by the three graders for both the at hand and circling scores by determining if the correlation was significantly different from zero.

3. Results

Unmasked Evaluation

Thirty-four horses were treated for navicular syndrome during this period. Twenty-seven were available for follow-up veterinary examination 6 mo later, and 27 owners reported on their horses at 6 mo. At 12 mo, 19 clients reported on their horses. There were four additional horses that had undergone a palmar digital neurectomy after 6 mo that were excluded from the 12-mo report.

The 27 horses included 11 Quarter horses, 5 Thoroughbreds, 4 Paint Horses, 4 warmbloods, 2 Appaloosas, and 1 American Saddlebred. The median age was 12 yr, and the range was from 3 to 20 yr. There were seven horses used for pleasure and trail riding, six shown in rail classes, five shown for jumping, four used for barrel racing, and one cutting horse. All but three of the horses had undergone conservative treatments including shoeing, isoxsuprine, non-steroidal anti-inflammatories, and intra-articular injections. These horses had a median reported duration of clinical signs of 12 mo with a range for 2 wk to 10 yr.

Four of these horses had unilateral lameness, and an additional six required the more lame leg to be blocked to show lameness when circled toward the less lame leg. Because of difficulty in assessing the limb that was less affected and to prevent interaction of the response of one forelimb and not the opposite, all data reported are for the forelimb for the most lame leg at initial presentation. Therefore, the 27 horses had 27 limbs evaluated for response.

The mean ± SEM lameness grade at hand pre-treatment was 1.9 ± 0.18, and the worst limb inside the circle was 2.5 ± 0.13. This compared to post-treatment scores of 1.1 ± 0.18 and 1.6 ± 0.21, respectively. When trotted in a straight line, 1 horse improved three lameness grades, 2 horses improved two grades, 19 horses improved one grade, and 5 did not change, resulting in 22 of 27 (81%) improved. When evaluated in a circle, 2 horses increased one grade, 6 did not change, 10 improved one grade, 8 improved two grades, and 1 improved three grades; therefore, 19 of 27 (70%) improved. The decrease in lameness was significant for both trotted in hand (t ratio = −5.07; $p \leq 0.0001$) and when trotted in a circle (t ratio = −4.49; $p = 0.0001$).

After 6 mo, the owners reported that 22 horses improved (81%), 4 remained the same, and 1 horse got worse. Four of the horses underwent palmar digital neurectomy after the 6-mo re-check. Of these four horses, two had improved one lameness grade but were not able to compete, one did not improve, and one had an increased lameness score. After the 6-mo re-check, 6 horses were lost to follow-up, 2 were lame for other reasons, and 4 horses underwent neurectomy, leaving 16 horses being followed at 1 yr. None of these horses was reported to have increased lameness associated with navicular syndrome during the 6- to 12-mo time period.

Masked Evaluation

In the 16 horses that had acceptable videotaped evaluations before and 6 mo after treatment, there were six quarter horses, three Paint Horses, three Thoroughbreds, two warm bloods, one Appaloosa, and one American Saddlebred. The median age of the horses was 13 yr (range, 3–17 yr). There were five horses used for pleasure and trail riding, three each for jumping and dressage, two horses shown in rail work competition, two used in western speed events, and one used for cutting. The horses had been diagnosed with navicular syndrome by a veterinarian a median of 12 mo (range, 2 wk–36 mo) before treatment.

On initial examination, lameness grades ranged from 0 to 3 when trotted in a straight line on a hard surface. The lameness scores for the forelimb on the inside when circled ranged from 1 to 4. Post-treatment scores ranged from 0 to 3 in a straight line and 0 to 4 when circled. The mean lameness grade for horses trotting in a straight line decreased 0.7 between pre- and post-treatment and 0.9 for the most lame leg when evaluated inside the circle. When trotted in a straight line, 9 of the 16 horses (56%) improved, 2 were judged to have no change, and 5 had progression of the disease. Similarly, when evaluated in a circle, 9 of 16 (56%) improved, 1 had no change, and 4 had regressed. When trotted in a straight line, the average difference was −0.23 ($p = 0.22$), and for worst leg inside the circle, the average difference was −0.31 ($p = 0.17$). Eleven of the 16 horses (69%) had returned to their intended level of activity at the 6-mo re-check, 3 were used for a decreased level of activity, and 2 returned for palmar digital neurectomies at the 6-mo re-check. The kappas ranged from 0.32 to 0.6, indicating a fair to moderate observer agreement.

Radiographic Evaluation

There was no significant change in the radiographic scores between pre- and post-treatment ($p = 0.54$). The mean radiographic score pre-treatment was 3.5 compared with 3.75 at 6 mo after treatment. There was no significant relationship between pre-treatment radiographic score and outcome for lameness evaluation by the three masked graders for trotting at hand ($r^2 = 0.019$, $p = 0.92$) or in a circle ($r^2 = -0.23$, $p = 0.26$).

4. Discussion

The decreased lameness in these horses is encouraging because many of these horses had been chronically lame and most been unresponsive to previous conventional treatments. The results of the unmasked and masked evaluations do not match perfectly. This can occur for multiple reasons in addition to bias. An observer that has seen the same horse previously may be able to identify that the horse is improved, resulting in a decreased lameness score. In masked evaluation, the reviewers could not make a direct comparison between pre- and post-treatment. Second, the videotape does not permit a thorough evaluation of all aspects of a lameness exam, such as resistance of the horse to trot on a hard surface, degrees of head motion, and stride length, as well as the sound of the feet striking the pavement. The data could have been improved by force plate or kinematic analysis. The number of horses with complete videotape examinations was less (16 versus 27), which also decreased the likelihood of identifying a significant difference in the masked evaluation.

The unmasked evaluation showed a significant improvement, and the masked evaluation clearly indicated a trend toward improvement. The results could be better than what was found with this study for two reasons. First, additional treatments, including joint injections, the use of non-steroidal anti-inflammatory drugs, and further shoeing modifications, were not pursued. Second, many of the horses that did not return for a 6-mo re-check exam were reported to be doing well. One of the biggest problems associated with clinical studies is obtaining appropriate follow-up information. Nine of the 16 horses that did not return for follow-up were reported by the owner and/or referring veterinarian to be improved and 5 of 5 that were in competition before treatment had returned to competition. The remaining four horses were being used for pleasure and met the owners' expectations.

The use of blinded evaluators for reviewing videoclips of lame horses can remove much of the subjectivity of an unmasked evaluator. However, differences between reviewers and small sample sizes can make obtaining statistical significance difficult. An important point in evaluating data is that when data are at one end of the scale, such as a lameness grade of 0, they have a higher chance of being scored worse than it actually is. Therefore post-treatment data that shows an improvement will tend to gravitate back toward the middle of the scale. Efforts to standardize the scoring by using a training tape with the criteria should help to eliminate inter-observer variations. Ultimately, further studies including objective data such as gait analysis systems are indicated.

The mechanism associated with decreased lameness is unknown. There has been a direct analgesic effect reported with ESWT; however, it is reported to last only a few days.[8] A similar finding of decreased pain with few radiographic changes has been identified in humans with heel spurs.[8] Similar to this study, patients that became pain-free remained so. There were no untreated controls used in this study. While it is possible that there could be spontaneous improvement in some horses, the duration and severity of the disease in these horses makes it unlikely.

A proposed mechanism for the alleviation of pain and lameness is that neovascularization decreases the avascular necrosis. ESWT has been shown to stimulate neovascularization of the bone tendon junction that could occur in the navicular bone and impar and collateral sesamoidean ligaments.[6] Studies of navicular bone blood supply indicate that ischemia and increased intra-osseous pressure contribute to the changes seen with navicular syndrome.[11,12] Additionally, bone remodeling stimulated by ESWT may allow healing of the degenerative changes associated with navicular syndrome.

The results of this study indicate that ESWT should be considered as a viable non-invasive mechanism to navicular syndrome in horses. Further evaluations of response to treatment including gait analysis systems are needed. Studies that identify the mechanism that leads to the decrease in lameness may allow a more effective treatment plan and potentially a mechanism to prevent lameness associated with navicular syndrome in the future.

References and Footnote

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[a]Orthowave, Medical Technologies & Services, Konstanz, Germany.