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Original Research

Effects of Low-Level Laser Therapy and Chiropractic Care on Back Pain in Quarter Horses

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A B S T R A C T

Low-level laser therapy has been used clinically to treat musculoskeletal pain; however, there is limited evidence available to support its use in treating back pain in horses. The objective of this study was to evaluate the clinical effectiveness of low-level laser therapy and chiropractic care in treating thoracolumbar pain in competitive western performance horses. The subjects included 61 Quarter Horses actively involved in national western performance competitions judged to have back pain. A randomized, clinical trial was conducted by assigning affected horses to either laser therapy, chiropractic, or combined laser and chiropractic treatment groups. Outcome parameters included a visual analog scale (VAS) of perceived back pain and dysfunction and detailed spinal examinations evaluating pain, muscle tone, and stiffness. Mechanical nociceptive thresholds were measured along the dorsal trunk and values were compared before and after treatment. Repeated measures with post-hoc analysis were used to assess treatment group differences. Low-level laser therapy, as applied in this study, produced significant reductions in back pain, epaxial muscle hypertonicity, and trunk stiffness. Combined laser therapy and chiropractic care produced similar reductions, with additional significant decreases in the severity of epaxial muscle hypertonicity and trunk stiffness. Chiropractic treatment by itself did not produce any significant changes in back pain, muscle hypertonicity, or trunk stiffness; however, there were improvements in trunk and pelvic flexion reflexes. The combination of laser therapy and chiropractic care seemed to provide additive effects in treating back pain and trunk stiffness that were not present with chiropractic treatment alone. The results of this study support the concept that a multimodal approach of laser therapy and chiropractic care is beneficial in treating back pain in horses involved in active competition.

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1. Introduction

Back pain is a common cause of poor performance in athletic horses and is often related to biomechanical compensations for limb lameness, overuse injuries, ill-fitting saddles, or underlying spinal pathology [1–3]. Treatment options for horses with acute back pain generally include NSAIDs, hand walking, or rest. The treatment of chronic back pain and stiffness in horses reported in controlled, clinical trials suggests that chiropractic care and acupuncture are effective management options [4–6]. Chiropractic care is characterized by the application of low-amplitude, high-velocity forces to specific soft tissue or bony landmarks with the intent of improving spinal flexibility and reducing pain and epaxial muscle hypertonicity [7]. Two randomized, controlled clinical trials using pressure algometry to assess mechanical nociceptive thresholds (MNTs) in the thoracolumbar region have demonstrated that both manual and instrument-assisted chiropractic treatment can reduce back pain (or increase MNTs) in horses [8,9]. Chiropractic treatment has also shown positive benefits in increasing passive trunk mobility (i.e., flexibility) [5,10] and active trunk mobility with improved pelvic symmetry. Additional studies show effects of chiropractic in altering muscle activity [11] and reducing longissimus muscle tone based on

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measures of tissue compliance and electromyographic activity [12]. A study comparing spinal mobilization to manipulation in horses reported that a single session of chiropractic treatment induced a 15% increase in displacement and a 20% increase in tolerance to manually applied force, compared to mobilization [10]. Repeated chiropractic treatment applied once a week for 3 weeks produced an increase of 40% in displacement, 20% increase in applied force, and 7% increase in stiffness [5]. These findings support the theory that a series of chiropractic treatments may be more effective than a single treatment session in reducing back pain.

Medical lasers are used at high intensity for surgical applications and at low intensity (i.e., low-level) for the delivery and nonthermal absorption of photons within cells. Laser therapy is characterized by using coherent light of different wavelengths that preferentially penetrate the skin and underlying soft tissues to activate cellular and molecular mechanisms. Medical applications of low-level laser therapy in humans often include pain management and treatment of wounds and soft tissue injuries [13]. Photoradiation by low-level laser therapy can modulate inflammatory pain by reducing harmful cytokines (e.g., PGE2, IL-1 beta, TNF alpha), neutrophil cell influx, and the formation of edema and hemorrhage in a dose-dependent manner [14]. Clinically, there are contradictory reported effects in the treatment of human neck or back pain using low-level laser therapy: no difference from placebo laser treatments [15]; moderate, short-term effects [16]; or significant pain reduction immediately after treatment for acute neck pain and for up to 22 weeks in patients with chronic neck pain [17]. Several animal studies have compared laser therapy and NSAIDs and have reported that the optimal application and dosage of photoradiation are equally effective compared to NSAIDs [14]. Effective low-level laser therapy requires knowledge of key parameters such as wavelength, total radiant power (i.e., laser classification), radiant exposure (J/cm^2), exposure duration (seconds), treatment area (cm^2), and total radiant energy delivered (J per treatment session) [18]. In equine practice, low-level laser therapy is typically used to improve tissue healing and for pain management [19]. Prior studies have evaluated the depth of laser penetration [20] and energy absorption [21] in equine tendons and the efficacy of treating chronic back pain with laser acupuncture [22]. Currently, there are no controlled, clinical trials evaluating the effectiveness of low-level laser for addressing back pain in horses. The objective of this study is to determine the individual and combined effects of laser therapy and chiropractic care on subjective and objective measures of back pain and spinal dysfunction in Western Performance horses actively competing at national horse shows. Our hypotheses were that low-level laser therapy would provide the most effective treatment and that positive synergist effects would be noted with combined laser and chiropractic treatment.

2. Materials and Methods

2.1. Horses

A sample population of Quarter Horses that were actively participating in national western performance competitions were used for this study. All horses were judged for soundness during in-hand gait evaluation by two examiners (J.R.D., D.D.F.) prior to enrollment into the study. Inclusion criteria was based on horses with back pain or poor performance attributed to spinal dysfunction (e.g., stiffness, weakness). Horses with concurrent low-grade limb lameness ($\leq$2/5 AAEP scale) were also included if back pain was judged to be the most clinically relevant issue affecting performance. Owners or trainers signed an informed consent prior to their horse's inclusion in the project and a brief performance history and any current medications or treatments were recorded.

All horses underwent spinal evaluation by a single examiner (P.T.M.) who was blinded to treatment groups. While there was an attempt to randomly assign horses to treatment groups, not all horses were randomly assigned due to the inability to apply manual forces (i.e., chiropractic treatment) and owner or trainer's preconceived notions about the safety or efficacy of either laser therapy or chiropractic use in their horse. Therefore, horses were assigned to one of the three treatment groups based on clinical criteria and client preferences, which consisted of either laser therapy, or chiropractic treatment, or combined laser and chiropractic treatment. All treatments were provided by a single examiner (K.K.H.) who was not blinded to the results of the spinal examinations as clinical findings were used to guide the applied treatments. Owners and trainers were not blinded to the applied treatment. Spinal examination and treatments were provided free of charge to owners and trainers in exchange for allowing access to horses for three consecutive evaluation and treatment sessions over 3–5 days. All protocols were approved by the Institutional Animal Care and Use Committee at Colorado State University.

2.2. Visual Analog Scale (VAS)

Owners and trainers were asked to score the overall severity of their horse's back pain based on a VAS that was numbered from 0 to 10, with 0 representing the best case (e.g., no pain) and 10 representing the worst case (e.g., worse possible pain). A VAS was also used for examining the veterinarian's perception of the global severity of back pain and the overall quality of spinal and pelvic function. The owner VAS was recorded prior to spinal evaluation; whereas the veterinarian VASs were recorded after spinal evaluation as a global assessment of back pain and function.

2.3. Spinal Examination

Detailed spinal evaluations of the trunk and pelvis were completed on each horse at baseline (Day 0) and prior to any applied treatments. The number of affected thoracolumbar and sacral vertebral segments and the severity (i.e., absent, mild, moderate, severe, and unable to examine) of epaxial muscle pain and hypertonicity and segmental trunk stiffness in lateral bending were recorded (Online Supplemental Material). Firm digital pressure was used to identify painful sites over thoracolumbar (T4-L6) and sacral (S2-S5) spinous processes and to localize epaxial muscle pain and tone within the thoracolumbar and gluteal regions (T4-S5). Trunk stiffness was identified using low-amplitude lateral spinal oscillations applied segmentally at each thoracolumbar (T10-L6) vertebral level [23]. Left–right asymmetries in the prevalence and severity of the spinal examination findings were recorded.

2.4. Induced Spinal and Pelvic Reflexes

Spinal and pelvic responses to applied digital stimulation were used to assess active spinal mobility, coordination, and core strength. Graded responses to applied truncal stimulation were scored based on the quality (e.g., absent, controlled, jerky, avoidance), amplitude (in cm), and the ability to statically hold the induced postures (in seconds) (Online Supplemental Material). Digital stimulation was applied along the ventral midline over the sternum or cranial portion of the linea alba to induce elevation of the cranial thoracic region. Bilateral digital stimulation at the lateral tail head was used to induce a combined reflex of pelvic flexion and trunk elevation (i.e., kyphosis). The response to firm lateral compression of the tubera sacralia was scored based on the presence of a pain avoidance response and unilateral or bilateral unlocking of the stifles. Applied axial traction to the tail was used to theoretically assess core stability and neuromuscular coupling of the lumbosacral region.

2.5. Mechanical Nociceptive Thresholds

A pressure algometer (Model FPK 40, Wagner Instruments, Greenwich, CT) with a calibrated range from 0 to 60 kg/cm^2 was used to quantify MNTs using previously described techniques [9,24]. MNTs were recorded at baseline and after spinal evaluation, but before any applied treatments. MNT values were recorded 10 cm lateral to the dorsal midline at seven bilateral sites along the epaxial musculature of the trunk and pelvis at the T2, T6, T13, T17, L2, L6, and S2 vertebral levels [8]. Left−right differences at each vertebral level were assessed and regional MNT values were calculated from summed MNT values at bilateral sites within the cranial (T2, T6), middle (T13, T17, L2), and caudal (L6, S2) regions of the thoracolumbar spine to assess potential effects of saddle fit and rider across trunk regions.

2.6. Applied Laser and Chiropractic Treatments

Low-level laser therapy (SpectraVET PRO2 control unit and 810-3000 L-MULTI laser probe, SpectraVET Inc, Coeymans Hollow, NY) was applied topically to local sites of back pain. The laser probe contained four 810 nm laser diodes spaced 15 mm apart in a square array that produced a total optical output power of 3 W. The four laser beams were projected as separate 0.4 cm^2 rectangular spots with a power density per spot of 1.9 W/cm^2. Most horses had short hair coats for show purposes, so the dorsal trunk was only brushed clean to help maximized laser penetration [20]. The probe was placed in firm contact with the skin and held stationary at each site for 50 seconds, which produced 150 J of total energy delivered to the treatment site and an energy density of 94 J/cm^2. Each treatment session consisted of the irradiation of between 5 and 10 sites based on clinical findings of back pain and avoidance to applied manual pressure, which covered a total area of 400−800 cm^2 and produced a total energy dose of 750−1,500 J per treatment session.

Chiropractic treatment was applied to areas of pain and stiffness within the thoracolumbar and sacral regions using previously described techniques [10]. A high-velocity, low-amplitude (HVLA) manual thrust was applied to affected vertebral segments using a reinforced hypothenar contact and a body-centered, body-drop technique [25]. The HVLA thrusts were directed dorsolateral to ventromedial (at a 45° angle to the horizontal plane) with a segmental contact near the spinous process with the goal of increasing extension and lateral bending within the adjacent vertebral segments. If horses did not tolerate the applied chiropractic treatment, then truncal stretching, spinal mobilization, and the use of a spring-loaded, mechanical-force instrument (Activator [Activator Methods International, Ltd, Phoenix, AZ]) were used as more conservative forms of manual therapy in these acute back pain patients [9,10].

In the combined laser and chiropractic treatment group, laser therapy was applied first to areas of epaxial muscle pain and chiropractic treatment was then applied to vertebral segments with residual pain and stiffness. All treatments were applied in a consistent manner by the same investigator (KKH) and subjective responses to treatment (i.e., poor, fair, good, and excellent) were recorded.

2.7. Statistical Analysis

We hypothesized that low-level laser therapy would significantly reduce signs of acute back pain, compared to chiropractic care. Additionally, we hypothesized that combined laser therapy and chiropractic care would produce synergistic effects and provide the largest improvements in outcome measures. A mixed-model, repeated measures analysis (SAS Proc Mixed) with post-hoc comparisons of means by Tukey's HSD ($P \leq .05$) for each response variable was used to assess treatment group differences in the back pain and spinal dysfunction parameters. "Treatment" was used as the between-subjects factor and "Session" was used as the within-subjects factor. Treatment*session was used as an interaction variable in the model. A random effect for horse (nested within treatment) was used to account for repeated measures. Chi-squared analysis was completed on categorical data for select outcome variables. Paired t-tests were used to assess left−right differences in the spinal examination findings and MNT values. Spearman rank correlations were assessed between the owner and veterinarian VAS for global assessments of back pain and the quantitative measures of local back pain using summed MNT values within horses.

3. Results

3.1. Horses

A sample of 61 Quarter Horses, aged 8.7 ± 3.7 years, which included 3 stallions, 45 geldings, and 13 mares, were enrolled into the study from four national Quarter Horse shows. All horses actively participated in athletic competitions in Western Performance (68%) or English (32%) events and were enrolled into the study due to the presence of back pain or poor performance attributed to spinal dysfunction (e.g., stiffness, weakness). Of the 61 enrolled horses, 13 horses only had baseline data collected and 14 horses only had data from two evaluation sessions; therefore, these 27 horses were excluded from further analysis (Table 1). Final data analyses to evaluate treatment effects were completed on the remaining 34 of 61 horses, which had three complete evaluation sessions.

3.2. Concurrent Medical Treatment

There were no significant differences between treatment groups in the overall prevalence of anti-inflammatories ($P = .17$), spinal or sacroiliac joint injections ($P = .36$), intra-articular joint injections ($P = .56$), or other concurrent medical treatments ($P = .22$) used to address acute back pain or limb lameness issues during the course of the study. The time course of concurrent medical treatments was not a significant factor within treatment groups.

3.3. Applied Laser and Chiropractic Treatments

There was no significant difference in the total number of applied laser treatments within the laser and the combined treatment groups across spinal regions ($P = .66$) (Table 2). Similarly, there was no significant difference in the total number of applied chiropractic treatments within the chiropractic and the combined treatment groups across spinal regions ($P = .70$). The combined laser and chiropractic group received a comparable number of laser and chiropractic treatments as was applied in the respective individual treatment groups, which provided similar dosages of laser therapy and chiropractic care across the three treatment groups.

Chiropractic treatment was attempted in 42 horses within the chiropractic and the combined treatment groups; however, 8 (19%)

Table 1
Distribution of the total number of horses within treatment groups indicating subject dropout across the three sessions.

Session	Laser Therapy	Chiropractic Care	Combined Therapy	Total Number
1	20	19	22	61
2	17	15	16	48
3	11	12	11	34

horses did not allow the application of HVLA thrusts due to excessive pain or avoidance behaviors. In these horses, isometric stretching (n = 6; 14%), spinal mobilization with lower applied forces (n = 8; 19%), or mechanical treatment with an activator (n = 6; 14%) was used in place of the HVLA manual thrusts. For the successfully applied manual treatments, the immediate posttreatment reduction in pain, muscle hypertonicity, and stiffness was subjectively judged by the treating veterinarian (KKH) to be fair in 7 (17%) horses and good in 18 (43%) horses.

Overall, a higher proportion of laser therapy was applied within the thoracic spinal region and a higher proportion of chiropractic treatment was applied within the lumbar region (Fig. 1). Laser treatment had a bimodal vertebral level distribution with the highest prevalence of application at the T9-T13 and L4-L6 vertebral levels. Chiropractic treatment had the higher prevalence of application beginning at T8 with a gradual continued increase toward the sacral apex (S5). The number of applied laser treatments across sessions was higher within the laser group, compared to the combined treatment group (Table 3). The number of applied treatments across sessions was not significantly different ($P > .27$) between the chiropractic and combined treatment group, which provided equal dosages between groups.

3.4. Visual Analog Scale (VAS)

At baseline, the owner-derived VAS was significantly higher (i.e., increased back pain) for the laser therapy group (5.6 ± 1.8), compared to the chiropractic group (3.5 ± 1.9; $P = .05$) (Table 4). In all three treatment groups, the owner VAS scores decreased (i.e., reduced back pain) across sessions; however, the changes were not significant (all $P > .20$). There were significant group differences in veterinarian-derived VAS scores for back pain severity at baseline, where the chiropractic group had significantly lower VAS compared to the other two treatment groups ($P < .01$). At session #2, the veterinarian-derived VAS scores for the laser and chiropractic groups remained significantly different ($P = .03$) with lower VAS within the chiropractic group. There was a significant decrease in veterinarian-derived VAS of back pain severity from baseline to session #3 within the laser therapy group ($P = .01$), but not the other groups. For veterinarian-derived VAS of overall spinal and pelvic function, the laser therapy group had a significant increase (i.e., improved function) from baseline to session #3 ($P = .05$), which was not present in the other groups. There were significant negative correlations between quantitative measures of local back pain (i.e., summed MNT values) and VAS for global back pain from both owners ($P = .01$; $r = -0.26$) and the assessing veterinarian ($P = <.01$; $r = -0.62$).

3.5. Spinal Evaluation

Epaxial muscle pain had the highest prevalence (n = 1,723 affected vertebral levels) of the spinal evaluation outcome measures and the vertebral distribution peaked at the T15-L6 vertebral levels (Fig. 2). Trunk stiffness was identified at 956 vertebral levels and also peaked at T15-L6 vertebral levels. Interestingly, muscle hypertonicity was identified at 796 vertebral levels but subjectively, was not as closely linked to the prevalence of epaxial muscle pain as expected.

The chiropractic group had a significantly lower prevalence and less severe grade of epaxial muscle pain at baseline, compared to the other two treatment groups (Table 5). There was a nonsignificant decrease in the prevalence of epaxial muscle pain across sessions in both the laser (−14%; $P = .12$) and combined therapy groups (−18%; $P = .29$) and a corresponding nonsignificant increase (23%; $P = .30$) in muscle pain within the chiropractic group. There was a significant decrease in the severity of epaxial muscle pain in the laser therapy group from baseline to session #3 (−41%; $P < .01$). Within the combined therapy group, there was also a significance decrease in muscle pain severity from baseline to session #2 (−23%; $P = .02$).

At baseline, the chiropractic group had significantly fewer vertebral levels (3.2 ± 5.2) affected with epaxial muscle hypertonicity, compared to the laser therapy group (8.9 ± 6.7; $P = .04$) (Table 6). There were significant decreases from baseline in the total number of vertebral levels with epaxial muscle hypertonicity within the laser (−34%; $P = .04$) and combined therapy (−66%; $P = .03$) groups. Within the combined therapy group, there was also a significant difference in the severity of epaxial muscle hypertonicity from baseline to session #3 (−55%; $P = .02$).

There were no significant differences in the number of thoracolumbar intervertebral levels affected with lateral bending stiffness across treatment groups ($P = .35$); however, there was an 83% ($P = .42$) increase in the number of affected vertebral levels with stiffness in the chiropractic treatment group from baseline to session #3 (Table 7). In the combined therapy group, there was a significant decrease in the severity of trunk stiffness from baseline to session #3 (−54%; $P = .03$).

Table 2
Distribution of the number of applied treatments across spinal regions within individual (laser or chiropractic) and combined laser and chiropractic treatment groups.

Applied Treatment	Spinal Region				
	Thoracic	Lumbar	Sacral	Total	
Laser group	170	128	80	378	
Laser within combined therapy group	162	147	64	373	$X^2 = 0.88$, $P = .66$
Chiropractic group	102	157	51	310	
Chiropractic within combined therapy group	115	168	40	323	$X^2 = 0.71$, $P = .70$

Chi-squared statistics reflect comparisons between laser and combined laser therapy and between chiropractic and combined chiropractic treatment.

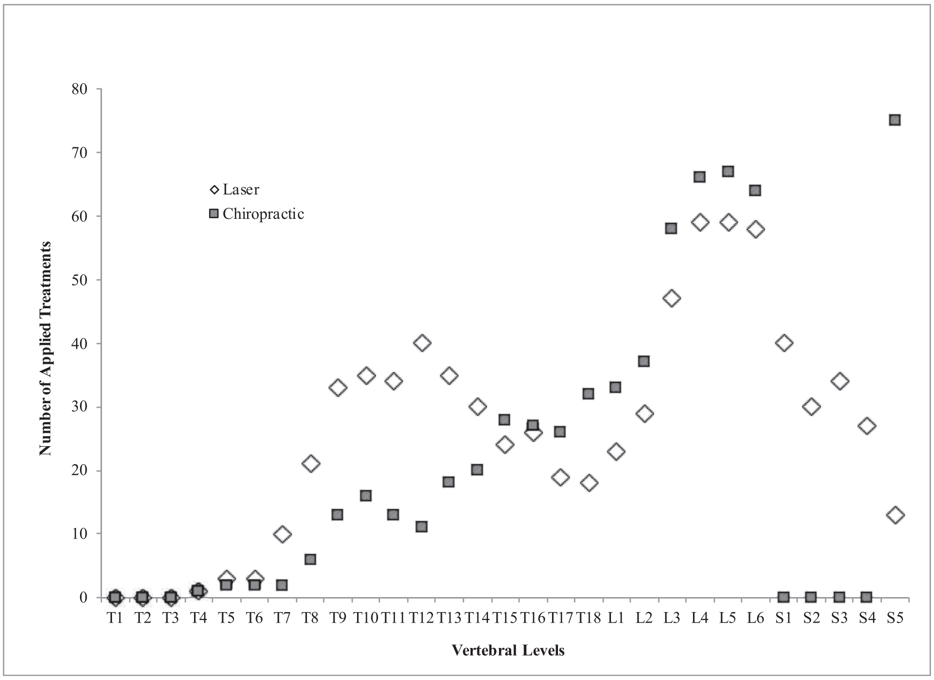

Fig. 1. Vertebral distribution of the total number of applied laser (n = 751) and chiropractic (n = 617) treatments. T = Thoracic, L = Lumbar, and S = Sacral vertebral levels.

The combined therapy group had a lower, but not significantly different (P = .07), number of painful spinous processes after treatment, compared to baseline. There were no significant changes in the severity of spinous process pain between treatment groups (P = .24) or across sessions (P = .29). Surprisingly, the prevalence of spinous process pain was quite low, compared to epaxial muscle pain or hypertonicity (Fig. 2).

3.6. Induced Spinal and Pelvic Reflexes

There were no significant treatment group differences at baseline or in the grades of induced sternal elevation reflex across sessions. The chiropractic treatment group had beneficial effects of significantly increased trunk flexion (28%; P = .02) and pelvic flexion (28%; P = .03) scores from baseline to session #3 (Table 8). There were no significant treatment effects on the ability to resist axial traction applied to the tail (P = .47) or the response to tubera sacralia compression (P = .29).

3.7. Mechanical Nociceptive Thresholds

There was a significant treatment group effect across all three trunk regions (i.e., cranial, middle, caudal) where the chiropractic group had significantly higher regional MNT values (i.e., less pain), compared to both the laser and combined therapy groups. There were no significant changes in regional MNT values across sessions (all P > .30). The percent change in pooled MNT values across all sites from baseline to the third treatment session reported as mean (minimum and maximum) was −4.5% (−49.3 to 27.3) in the laser therapy group, 2.3% (−41.3 to 25.4) with chiropractic treatment, and −3.9% (−57.9 to 30.0) in the combined therapy group.

There was a significant laser and chiropractic treatment group difference (P = .01) in pooled MNT values from baseline to the third treatment session, but no significant percent changes for the laser therapy (P = .47) or chiropractic (P = .28) groups.

4. Discussion

Low-level laser therapy, as applied in this study, produced significant reductions in back pain (−41%), epaxial muscle hypertonicity (−34%), and trunk stiffness (−45%) as evaluated with subjective pain scores and changes in spinal evaluation findings. Combined laser therapy and chiropractic care produced similar significant reductions in back pain, epaxial muscle hypertonicity, and trunk stiffness. Interestingly, chiropractic treatment by itself did not produce any significant changes in measures of back pain (−13%), muscle hypertonicity (+17%) or trunk stiffness (−18%); however, there were significant improvements in thoracic (+28%) and pelvic flexion (+28%) reflexes. The combination of laser therapy and chiropractic care provided some additive effects in treating back pain (+41%) and trunk stiffness (+44%) that were not present with chiropractic care alone.

The majority of low-level laser therapy studies in horses have investigated wound healing [26–28] and effects on tendons [20,29],

Table 3
Number of applied treatments per session within individual (laser or chiropractic) and combined laser and chiropractic treatment groups (Mean ± SD).

Applied Treatment	Session #1	Session #2	Session #3
Laser group	11.5 ± 2.8	11.0 ± 3.0	9.3 ± 3.3
Laser within combined therapy group	9.5 ± 3.4	7.9 ± 3.2[a]	5.4 ± 2.2[a]
Chiropractic group	8.1 ± 1.5	8.0 ± 1.9	8.3 ± 2.1
Chiropractic within combined therapy group	9.5 ± 4.6	7.3 ± 3.7	7.8 ± 3.7

[a] Within rows, values differ significantly (P < .05) from session #1 (baseline) values.

Table 4
Owner and veterinarian-derived visual analog scales (VAS) for overall back pain severity (0 = No pain; 10 = Worst possible pain) and for overall spinal and pelvic function (0 = No function; 10 = Best possible function). Mean ± SD (Percent change from baseline).

Treatment group	Owner VAS for Back Pain Severity		
	Baseline	Session #2	Session #3
Laser	5.6 ± 1.8[b]	4.8 ± 2.3 (−14%)	4.0 ± 2.1 (−29%)
Chiropractic	3.5 ± 1.9[a]	3.3 ± 1.9 (−6%)	2.5 ± 1.5 (−29%)
Combined therapy	4.1 ± 1.4[a,b]	3.4 ± 2.2 (−17%)	3.3 ± 1.6 (−20%)
	Veterinarian VAS for Back Pain Severity		
Laser	7.4 ± 1.8[b,*]	6.2 ± 2.3[b] (−16%)	5.3 ± 2.5[‡] (−28%)
Chiropractic	4.2 ± 2.1[a]	4.1 ± 2.6[a] (−2%)	4.3 ± 2.5 (2%)
Combined therapy	6.7 ± 2.1[b]	5.8 ± 2.4[a,b] (−13%)	6.1 ± 1.1 (−9%)
	Veterinarian VAS for Spinal and Pelvic Function		
Laser	5.9 ± 2.1[*]	6.8 ± 1.7 (15%)	6.8 ± 1.8[‡] (15%)
Chiropractic	6.7 ± 2.1	7.4 ± 1.3 (10%)	7.5 ± 2.4 (12%)
Combined therapy	6.2 ± 2.3	6.9 ± 1.7 (11%)	6.6 ± 2.2 (6%)

[a,b] Within columns (between treatment groups), values with different superscript letters differ significantly ($P < .05$).
[*,‡] Within rows (within a treatment group), values differ significantly ($P < .05$) from baseline values.

which report equivocal clinical results. In humans, laser therapy has shown beneficial effects in reducing acute and chronic neck pain [17,30]; however, the evidence is less supportive for treating low back pain [31–33]. Low-level laser stimulation over acupuncture points has been reported to be effective for treating chronic back pain in horses [22,34]. This is the first clinical, controlled study to assess the efficacy of laser therapy in treating back pain and spinal dysfunction in horses during active competition.

The analgesic effects of low-level laser therapy appear to be facilitated by slowed conduction velocity and reduced action potentials in peripheral nerves and inhibition of proinflammatory mediators [35]. In our study, the wavelength and treatment protocol for laser therapy was recommended by the manufacturer to address back pain in horses. The focus of this study was to apply laser therapy over regions of back pain and muscle hypertonicity, which likely involved the deep epaxial musculature versus the overlying skin or superficial thoracolumbar fascia. The biggest challenge in applying laser therapy is determining how much irradiation is being delivered to the desired tissues at a certain depth. The inhibitory effects of overlying hair and skin and the depth of tissue penetration needed to reach most structures are often critical limiting factors in photon delivery to injured tissues [21,36,37]. None of the horses in this study were clipped or shaved as they were all actively engaged in show events. Additional in-vitro studies are needed to characterize depth of penetration in varying thicknesses of epaxial musculature [20,38].

One of the primary risks of laser therapy is superficial tissue heating and thermal injury [39–41]. In our study, a few dark-colored horses did respond with local skin twitching and cutaneous trunci reflexes if the laser probe was held in a static position.

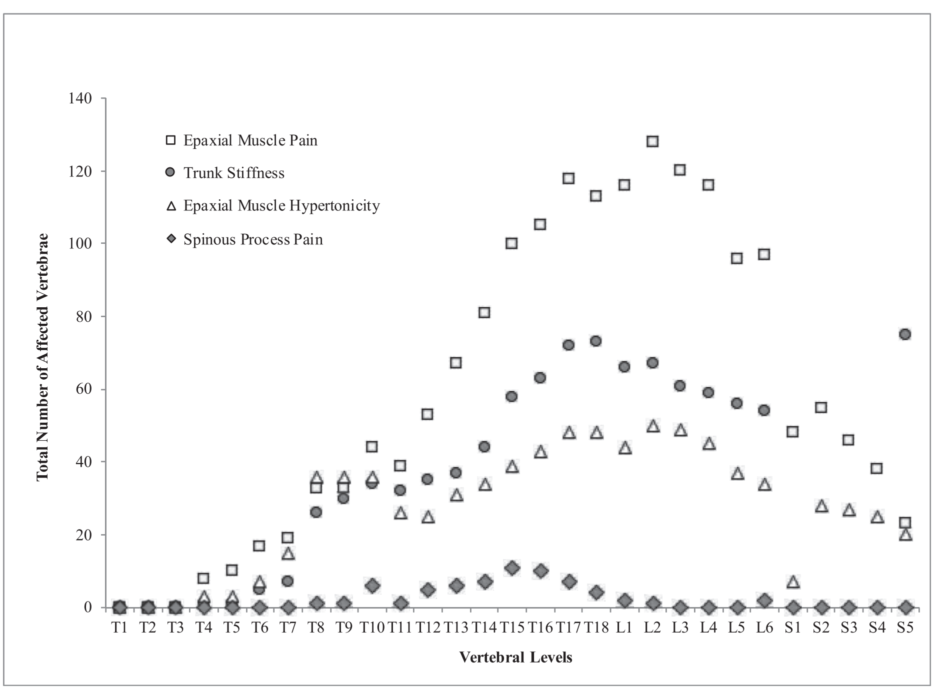

Fig. 2. Vertebral distribution of thoracolumbar epaxial muscle pain, trunk stiffness, epaxial muscle hypertonicity, and spinous process pain. T = Thoracic, L = Lumbar, and S = Sacral vertebral levels.

Table 5
Number of affected thoracolumbar vertebral levels (from T4-L6; n = 21 total) and severity of thoracolumbar epaxial muscle pain (0 = Absent, 1 = Mild, 2 = Moderate, 3 = Severe) within treatment groups across sessions. Mean ± SD (Percent change from baseline).

Treatment group	Number of Affected Vertebral Levels		
	Baseline	Session #2	Session #3
Laser	13.4 ± 6.3^{b}	12.9 ± 4.6^{b} (−4%)	11.5 ± 5.2 (−14%)
Chiropractic	7.7 ± 3.8^{a}	8.8 ± 5.3^{a} (14%)	9.5 ± 6.4 (23%)
Combined therapy	12.9 ± 4.5^{b}	12.4 ± 5.9^{b} (−4%)	10.6 ± 5.8 (−18%)
	Severity of Epaxial Muscle Pain		
Laser	$2.2 \pm 0.7^{b,*}$	$2.0 \pm 0.7^{b,*}$ (−9%)	$1.3 \pm 0.6^{‡}$ (−41%)
Chiropractic	1.5 ± 0.6^{a}	1.2 ± 0.7^{a} (−20%)	1.3 ± 0.9 (−13%)
Combined therapy	$2.2 \pm 0.8^{b,*}$	$1.7 \pm 0.8^{a,b,‡}$ (−23%)	$1.9 \pm 0.5^{*,‡}$ (−14%)

[a,b] Within columns (between treatment groups), values with different superscript letters differ significantly ($P < .05$).
[*,‡] Within rows (within a treatment group), values differ significantly ($P < .05$) from baseline values.

For these horses, the probe was moved in small circular pattern covering the area of approximately four probe head sizes. A similar approach is typically used with the application of continuous therapeutic ultrasound to prevent thermal injuries. One black horse did have two slightly raised areas of pitting edema the day following laser therapy when the probe was held in a static position. The cyclic movement of the probe did seem to help reduce local thermal effects; however, the cyclic motion also likely dispersed the laser irradiation over a larger area, which effectively reduced local tissue dosages. The laser treatment dose was conservative to avoid complications in actively competing horses, which could contribute to the limited improvement seen with laser therapy. Further refinement of laser therapy protocols may provide greater treatment effects while mitigating potential complications.

We did not use a negative control (i.e., no applied treatment) in this study as all horse owners and trainers expected some form of active treatment for their horses to reduce pain and to improve performance during these competition events. We included chiropractic care as a positive control in this study as there is a general body of evidence supporting its efficacy for treating chronic back pain and trunk stiffness in horses; however, it was unknown what specific effects chiropractic treatment might have on acute back pain [5,9,10,42]. As this was a competitive event, complete veterinary records were not typically available to assess the chronicity of the back pain; therefore, we had to rely on owner–trainer reports of the onset and severity of the perceived back problems in conjunction with clinical findings (e.g., heat, swelling, or severe epaxial muscle pain) to judge if the individual horse had acute or chronic back pain. Prior studies show increased pain immediately following chiropractic treatment in horses with subsequent reductions in nociceptive thresholds [8,9]. Chiropractic treatment was not tolerated in 19% horses due to excessive pain or avoidance behaviors; however, less invasive forms of manual therapy such as stretching, spinal mobilization, and mechanical treatment were tolerated in this population of horses with acute back pain. The applied forces may have aggravated acute back pain and muscle hypertonicity in this study; however, there were no lasting adverse effects noted in any of the applied therapies across groups. Despite having less severe muscle pain and fewer affected sites at baseline, chiropractic treatment was not very effective in decreasing back pain in this population of horses. The inability to provide consistent chiropractic care to all horses and the ongoing, intense exercise requirements associated with competition settings may have substantially limited the therapeutic effects of chiropractic treatment in this study. The immediate posttreatment response to chiropractic treatment was judged to be good in only 43% of horses, which suggests that other forms of therapy may be better tolerated or indicated in horses with acute back pain. The chiropractic treatment group did have significant increases in trunk and pelvic flexion reflexes, which might be interpreted as improved neuromuscular coupling and core stability. Further studies are needed to validate the use of spinal reflexes in predicting overall spinal health and performance in horses.

The percent change in pooled MNT values across all sites from baseline to the third treatment session in this study was nonsignificant, but the values were consistently lower (i.e., less pain relief) and more variable than reported MNT values in a previous study evaluating the effects of massage therapy and chiropractic treatment in horses actively involved in dressage and jumping [9]. In the previous study, the Day 3 percent change in pooled MNT values for chiropractic treatment was 11.1% (−10.4 to 19.0), compared to 2.3% (−41.3 to 25.4) in the current study. The large variation in MNT values measured in the current study likely reflects altered nociception associated with acute back pain and may

Table 6
Number of affected thoracolumbar vertebral levels (from T4-L6; n = 21 total) and severity of thoracolumbar of epaxial muscle hypertonicity (0 = Absent, 1 = Mild, 2 = Moderate, 3 = Severe) within treatment groups across sessions.

Treatment group	Number of Affected Vertebral Levels		
	Baseline	Session #2	Session #3
Laser	$8.9 \pm 6.7^{b,*}$	$4.9 \pm 6.7^{‡}$ (−45%)	$5.9 \pm 6.0^{‡}$ (−34%)
Chiropractic	3.2 ± 5.2^{a}	4.3 ± 5.9 (34%)	3.1 ± 4.0 (−3%)
Combined therapy	$6.2 \pm 4.9^{a,b,*}$	$4.4 \pm 4.8^{*,‡}$ (−29%)	$2.1 \pm 3.8^{‡}$ (−66%)
	Severity of Epaxial Muscle Hypertonicity		
Laser	1.0 ± 0.9	0.9 ± 1.0 (−10%)	0.8 ± 0.8 (−20%)
Chiropractic	0.6 ± 1.0	0.6 ± 0.8 (0%)	0.7 ± 0.9 (17%)
Combined therapy	$1.1 \pm 0.7^{*}$	$0.9 \pm 0.8^{*,‡}$ (−11%)	$0.5 \pm 0.7^{‡}$ (−55%)

[a,b] Within columns (between treatment groups), values with different superscript letters differ significantly ($P < .05$).
[*,‡] Within rows (within a treatment group), values differ significantly ($P < .05$) from baseline values.

Table 7
Number of affected thoracolumbar vertebral levels (from T4-L6; n = 21 total) and severity of trunk stiffness in lateral bending (0 = Absent, 1 = Mild, 2 = Moderate, 3 = Severe) within treatment groups across sessions.

Treatment group	Number of Affected Vertebral Levels		
	Baseline	Session #2	Session #3
Laser	5.9 ± 6.0	5.8 ± 7.4 (−2%)	5.5 ± 5.9 (−7%)
Chiropractic	4.1 ± 4.8	4.2 ± 5.6 (2%)	7.5 ± 7.6 (83%)
Combined therapy	5.1 ± 5.4	5.9 ± 6.6 (16%)	3.9 ± 5.4 (−24%)
	Severity of Trunk Stiffness		
Laser	1.2 ± 0.9	0.8 ± 0.9 (−33%)	0.9 ± 0.8 (−25%)
Chiropractic	1.1 ± 0.7	0.8 ± 0.8 (−27%)	0.9 ± 1.1 (−18%)
Combined therapy	1.3 ± 1.2*	1.1 ± 1.1*,‡ (−15%)	0.5 ± 0.7‡ (−54%)

*,‡ Within rows (within a treatment group), values differ significantly ($P < .05$) from baseline values.

capture individual responses to the various applied therapies and exercise demands [43]. In humans, MNT values in acute back pain patients have increased variability compared to normative MNT values [44,45].

VAS scores were used to evaluate the global or overall perception of thoracolumbar discomfort. There were significant associations found between summed MNT values and VAS; however, the correlation was poor for owners ($r = -0.26$) versus the assessing veterinarian ($r = -0.62$). Owners tended to underestimate the severity of back pain in horses compared to the other qualitative and quantitative measures of back pain used in this study. The ideal measure of back pain and dysfunction would be the assignment of a single, accurate and repeatable value. We incorporated a wide range of both qualitative and quantitative parameters in an effort to better capture the baseline status and to evaluate response to therapy in this population of actively competing horses. Epaxial muscle pain was the most common clinical finding across horses, which likely influenced the assigned VAS by both owners and the veterinarian.

We selected Quarter Horses in national competitions for use in this study as they provided the most uniform, readily accessible, large population of horses ridden under similar conditions that likely had a high prevalence of comparable types and severity of back pain. These horses are often ridden frequently and for long durations over the course of several days to meet show schedule and competition requirements. Access to a comparable sample of horses with back pain was judged not to be feasible in a routine clinical or university setting. The study was designed to have equal numbers of horses randomized to each treatment group: however, formal randomization procedures were not consistently possible as group assignment was influenced by the presence of severe epaxial muscle pain that prevented application of any manual forces or the owner or trainer's preconceived notions about laser or chiropractic use or efficacy in their individual horse. We had to be mindful of owner or trainer treatment preferences as they wanted the best possible treatment for their horses that were actively competing. These factors likely contributed to horses with more severe or wide-spread back pain being overrepresented within the laser and combined therapy groups.

There was a 44% dropout rate in this study as only 34 of 61 horses were used in the final data analysis. This rate was higher than we anticipated and was primarily related to owner and veterinary concerns of providing the best medical care possible for horses with a busy competition schedules and less importance placed on enrollment for three sessions over 3–5 days, as was required by our study design. Some horses were withdrawn from our study due to limb lameness with diagnostic and therapeutic needs that prevented continued enrollment. Other horses developed colic or respiratory issues than needed primary medical attention and treatment. Additional horses were removed from the final analysis that had a high prevalence of concurrent medications for addressing limb lameness or acute back pain issues. Finally, it was not possible to enroll all horses at the beginning of the horse shows; therefore, for those horses enrolled in the middle or later portions of the shows, it was not always possible to conduct three consecutive spinal evaluation sessions.

5. Conclusions

Low-level laser therapy produced significant reductions in back pain and trunk stiffness in a sample population of Quarter Horses involved in active competition. Chiropractic treatment alone did not produce any significant changes in back pain or trunk stiffness. The combination of laser therapy and chiropractic care provided some additive effects in treating back pain and trunk stiffness. These results support the concept that a multimodal approach is beneficial in treating acute back pain in a sports medicine setting.

Table 8
Grade of trunk flexion and pelvic flexion reflexes (0 = Absent, 1 = Mild, 2 = Moderate, 3 = Strong, 4 = Excellent) within treatment groups and across sessions.

Treatment group	Grade of Trunk Flexion Reflex		
	Baseline	Session #2	Session #3
Laser	2.4 ± 1.2	2.6 ± 0.8 (8%)	2.9 ± 0.7 (21%)
Chiropractic	2.5 ± 1.0*	2.7 ± 1.3 (8%)	3.2 ± 1.1‡ (28%)
Combined therapy	2.5 ± 1.2	2.9 ± 0.9 (16%)	2.8 ± 1.3 (12%)
	Grade of Pelvic Flexion Reflex		
Laser	2.5 ± 1.1	2.9 ± 0.7 (16%)	3.0 ± 0.9 (20%)
Chiropractic	2.5 ± 0.8*	3.0 ± 1.1 (20%)	3.2 ± 1.1‡ (28%)
Combined therapy	2.6 ± 1.3	2.9 ± 0.8 (12%)	2.5 ± 1.4 (−4%)

*,‡ Within rows (within a treatment group), values differ significantly ($P < .05$) from baseline values.

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Supplementary data

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