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The effects of chiropractic, massage and phenylbutazone on spinal mechanical nociceptive thresholds in horses without clinical signs

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Summary

Reasons for performing study: **Common methods used to treat back problems in horses need to be assessed objectively.**

Objectives: **To measure spinal mechanical nociceptive thresholds (MNTs) and evaluate the effects of chiropractic, massage and phenylbutazone, compared with active and inactive control groups.**

Methods: **Baseline MNTs at 7 sites within the thoracolumbar and sacral regions were measured in 38 healthy mature horses exhibiting no clinical signs of lumbar pain. Horses were assigned to one of 3 treatment groups: instrument-assisted chiropractic treatment, therapeutic massage and phenylbutazone; or 2 control groups: ridden exercise (active control) or routine paddock turnout with no ridden exercise (inactive control). MNT measurements were repeated at 1, 3 and 7 days post treatment. The percentage change from baseline MNT values was calculated within groups.**

Results: **On Day 7, the median MNT had increased by 27, 12 and 8% in the chiropractic, massage and phenylbutazone groups, respectively. MNT changes of <1% were seen within the active and inactive control groups.**

Conclusions: **Chiropractic treatment and massage therapy increased spinal MNTs within horses not exhibiting signs of lumbar pain.**

Potential relevance: **Pressure algometry provides an objective tool to evaluate the effects of commonly used, but currently unproven treatment modalities on spinal MNTs. Future studies need to evaluate combined treatment effects and longer-term MNT changes in horses with documented back pain.**

Introduction

Back problems are a common cause of poor performance and reduced jumping ability in athletic horses (Jeffcott and Haussler 2004). In horses with perceived back problems, clinical examination is often used to determine the presence and location of pain, but identification and localisation is often subjective. Pressure algometry has been used to measure mechanical nociceptive thresholds (MNTs) objectively within the axial skeleton (Haussler and Erb 2006a), and to quantify both bony and soft tissue pain (Haussler and Erb 2006b). Pressure algometry measures the minimum amount of pressure that produces a pain response; low MNTs are indicative of increased pain (Fischer 1986). Localisation of pain to affected tissues and quantitative pain assessment could potentially improve diagnosis and therapeutic management of horses with back pain.

Commonly prescribed treatments for chronic thoracolumbar pain in horses include stall rest, anti-inflammatory drugs and complementary therapies (Marks 1999). Unfortunately, most back pain treatments have not been evaluated in controlled, clinical trails for efficacy in reducing pain or musculoskeletal dysfunction (Jeffcott and Haussler 2004). Stall confinement or rest have been long advocated as the most effective remedies for treating back problems in horses (Jeffcott 1979). The rationale for prescribing rest is that the hiatus from athletic activities or ridden exercise removes any continued insult to the injured tissues, which allows the affected structures to heal and reduces the likelihood of chronic pain development. In man, there is no scientific evidence to support the use of bed rest for treating back pain and prolonged bed rest is detrimental to spinal health (Waddell *et al*. 1997). Similar studies investigating the efficacy of enforced rest for treatment of thoracolumbar pain are lacking in veterinary medicine.

Phenylbutazone is often the drug of choice for treating pain associated with various musculoskeletal disorders and is often prescribed for acute back pain, with mixed results (Jeffcott 1979). In one controlled clinical trial evaluating the efficacy of phenylbutazone for treating chronic thoracolumbar pain, the drug was not significantly different from a saline control (Xie *et al*. 2005). Chiropractic treatment and therapeutic massage are also commonly used for treating back pain in horses, although controlled clinical studies are limited (Haussler and Erb 2003; McBride *et al*. 2004). Chiropractic treatments, characterised by high-velocity, low-amplitude (HVLA) thrusts, can be applied either manually or with mechanical instruments with the intent of

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reducing pain and promoting spinal mobility (Maigne and Vautravers 2003). Mechanically-assisted chiropractic devices have been developed to control precisely the velocity, force and direction of an applied HVLA thrust to produce a safe, reliable and controlled force. In man, both manual and mechanical methods appear equally effective in reducing pain (Wood *et al*. 2001; Shearar *et al*. 2005). In horses, manually applied thrusts to the thoracolumbar spine have been reported to induce spinal mobility (Haussler *et al*. 1999), reduce spinal motion asymmetries (Faber *et al*. 2003), and reduce pain (Haussler and Erb 2003). Similar studies using mechanically-assisted chiropractic devices are lacking in horses. Massage therapy is defined as the manual manipulation of soft tissues for the purpose of promoting health and well-being (Holey and Cook 2003). In horses, therapeutic massage has not been objectively evaluated for their potential effects on spinal MNTs. The objective of this study was therefore to compare the effects of 3 common treatment methods on spinal MNTs in horses that were not exhibiting clinical signs of back pain.

Materials and methods

Horses

Forty horses without current histories of back problems from 4 separate farms within the same geographical region were used in this study. Horses without clinical signs of back pain were used due to the difficulty of acquiring a large population of horses with similar causes or gradations of back pain. Our hypothesis was that low-grade or subclinical back discomfort and inflammation was probably present from the physical demands of consistent ridden exercise. All horses were evaluated for lameness during in-hand gait evaluation by the local veterinarian and 2 horses were excluded because of lameness. The remaining 38 horses included 26 castrated males and 12 females age (mean ± s.d.) 11 ± 5 years (range 4–22 years), bodyweight 503 ± 44 kg (range 386–567 kg) and height at withers 1.64 ± 0.10 m (range 1.49–1.78 m). Breeds included 19 Warmbloods or Warmblood crosses, 9 Quarter Horses, 3 Thoroughbreds, 3 Friesians or Friesian crosses, 2 Paints, one Mustang and one Arabian. Athletic activities included dressage (n = 21), jumping (n = 6), Western reining or pleasure (n = 3), 3-day eventing (n = 1), and not actively ridden (n = 7).

Mechanical nociceptive thresholds

All horses were restrained quietly in stocks with crossties. A pressure algometer (Model FPK 60)[1] with a 1 cm^2 rubber plunger tip and a calibrated range 0–30 kg/cm^2 was used by a single examiner (K.A.S.) to determine MNTs using previously described techniques (Haussler and Erb 2006a). Pressure was applied perpendicular to predetermined anatomical landmarks at approximately 10 $kg/cm^2/s$ over 2–3 s until a local avoidance reaction was noted. Pressure was stopped and the corresponding MNT value recorded. The examiner did not view the readings during the application of pressure to limit potential bias. Three consecutive measurements at 3–4 s intervals were recorded at each site.

MNT values were recorded approximately 8–10 cm lateral to the dorsal midline at 7 bilateral sites along the epaxial musculature of the trunk. The underlying muscles included the thoracic portion of the rhomboideus muscle at the T3 vertebral level, the thoracic *spinalis* at T9, the thoracic *longissimus* at T13 and T18 and the middle gluteal muscle at the L3, L6 and S2 vertebral levels. To provide consistent localisation between measurement sessions, sites were marked by a wax marker. A fixed-order protocol was used to reduce between-subject variability. All landmarks were tested in a cranial-to-caudal order along the left and then right sides.

Repeatability

To assess adaptation or sensitisation, the 3 consecutive measurements at each site were evaluated for patterns of sequential increases (i.e. adaptation) or sequential decreases (i.e. sensitisation) or no change or consistent pattern. The prevalence of the 3 patterns was recorded within each treatment group (across all sites and horses) on each day. The median of the 3 consecutive measurements at each site was used as the site-specific MNT for that horse. Left and right measurements were compared to determine whether bilateral MNTs could be pooled into a combined value for each site. The ranges of 3 consecutive measurements at each site were recorded and mean range interpreted as a measure of overall instrument repeatability.

Treatment groups

An attempt was made to randomise all horses systematically to the 5 different groups; however, owners of 8 (21%) horses refused to have their horses allocated to the chiropractic or phenylbutazone groups. Therefore, these 8 horses were assigned randomly to one of the other 3 active exercise groups. All horses remained in active, ridden exercise throughout the study, except for 7 retired broodmares and horses that were out of work and paddock confined (inactive control group). A second control group (active control; n = 8) included actively ridden horses without any form of treatment.

On Day 0, the chiropractic group (n = 8) received HVLA thrusts provided by a spring-loaded, mechanical-force instrument (Activator II Adjusting Instrument)[2]. The hand-held instrument produces a very short duration (<5 ms) impulsive-type force that was applied to the articular processes of the cervical vertebrae, dorsal spinous processes of the thoracolumbar and sacral vertebrae, and the *tubera sacrale* by an American Veterinary Chiropractor Association (AVCA) certified veterinarian with 11 years of equine chiropractic experience. Treatment sites were selected, based on bony and soft tissue palpation for localised regions of vertebral stiffness based on spinal mobilisation and palpable areas of muscle hypertonicity or a localised pain response. The number of vertebral sites treated varied per individual horse, range 2–10 per side, with 9–17 total sites treated per horse. Within vertebral regions across horses, 19 sites were treated within the cervical region, 25 sites within the wither region, 26 within the caudal thoracic, 22 within the lumbar, 3 within the sacrum, and 4 over the *tubera sacralia*. Each treatment site was treated with one HVLA impulse from the instrument.

On Day 0, the massage group (n = 8) had manually-applied treatment (i.e. effleurage and petrissage) to all bilateral epaxial musculature of the cervical, thoracolumbar and sacral regions and the proximal thoracic and pelvic limb musculature. Particular emphasis was focused on areas of muscle hypertonicity or myofascial pain. Manual pressure was initially applied lightly and then progressively increased over the course of the session. The number and size of muscular sites treated varied between horses,

depending on the presence and severity of muscle hypertonicity. Horses were treated by an Equissage certified equine sports massage therapist with 12 years of equine massage experience. Each massage session lasted 35–45 min. The phenylbutazone group (n = 7) was given phenylbutazone paste (Equipalazone)[3] (1 g/227 kg bwt) orally, b.i.d. for 7 days. MNTs were repeated one day after initiation of treatments (i.e. Day 1) and at 3 and 7 days post treatment. The percentage change from baseline MNT values was calculated within each group over time.

Statistical analyses

Data were assessed for normality using Komolgorov-Smirnov tests. Ninety-one percent (256/280) of variables had a normal distribution; therefore, parametric statistical tests were used. Paired *t* tests (2-tailed) were used for left-right comparisons and within-horse changes over time. Treatment group differences in age, bodyweight, wither height, and MNTs were assessed by ANOVA using Tukey's HSD (alpha = 0.05) for *post hoc* comparison of means. Differences in pattern distributions of 3 consecutive measurements by treatment group were evaluated with Chi-squared tests ($P \leq 0.05$), as were differences in sex (female vs. gelding), breed (Warmblood vs. non-Warmblood), and use (dressage vs. nondressage) by treatment group. Associations between increased MNTs and treatment sites within the chiropractic and massage groups were also assessed using Chi-squared tests.

Results

Age, sex, breed, use, bodyweight and height at withers did not differ among treatment groups. The distribution of patterns of 3 consecutive measurements did not differ among treatment groups on Day 0. Twenty percent of 3 consecutive measurements increased sequentially, whereas 13% decreased and 67% had no change or consistent pattern. Mean range of 3 consecutive measurements was 1.6 kg/cm^2 (minimum range 0.7 kg/cm^2; maximum range 2.9 kg/cm^2). Mean left-to-right difference was 0.4 kg/cm^2 (range 0.0–1.2 kg/cm^2). On Day 0, left-right differences were not significant in 33 of 35 (94%) sites. At 2 sites with significant left-right differences, the MNT difference was <1.5 kg/cm^2, which was within the measurement error of the instrument for 3 consecutive measurements. Therefore, all left-right MNTs were pooled into a combined value for each site.

Baseline MNT values within the inactive control group were lower than, although not significantly different from, most sites in other groups (Table 1). On Day 0, MNT values did not differ according to treatment group, except at the T13 and L6 vertebral sites. Within most groups, MNTs were highest at the S2 vertebral sites. At Day 1, the overall median MNT increased 7.9% from baseline within the massage group, compared to overall MNT values of ± 1.0% or significantly decreased MNT values at individual sites within most other groups (Fig 1). The phenylbutazone group had the largest overall decrease in MNT values at -8.5%. On Day 1, MNT values caudal to T9 differed significantly between the massage and inactive control groups (Table 1). Compared to baseline, MNT values on Day 3 were significantly decreased at T13 in the phenylbutazone group and were increased, though not significantly, in the chiropractic and massage groups (Fig 2). At Day 7, MNT values within the chiropractic and massage groups were significantly higher than baseline values at sites caudal to T9 and T13, respectively

TABLE 1: Pooled mean (s.d.) MNT values (in kg/cm^2) at thoracolumbar sites within the treatment groups at Days 0, 1, 3, and 7

Day	Site	Inactive control (n = 7)	Active control (n = 8)	Phenylbutazone (n = 7)	Massage (n = 8)	Chiropractic (n = 8)	ANOVA P values
Day 0	T3	8.1 (1.6)	9.3 (2.0)	10.2 (1.9)	10.7 (2.4)	10.6 (2.0)	0.06
	T9	8.6 (2.3)	8.8 (2.0)	10.3 (2.3)	10.2 (2.3)	10.3 (1.3)	0.26
	T13	7.7 (1.1)^{b}	9.5 (2.2)^{a,b}	11.4 (2.2)^{a}	10.2 (2.1)^{a,b}	10.6 (2.3)^{a}	0.01
	T18	8.4 (1.9)	10.1 (2.4)	10.9 (1.6)	10.6 (1.9)	11.4 (2.3)	0.06
	L3	7.8 (2.3)	9.7 (2.1)	10.8 (2.0)	10.5 (1.9)	10.5 (2.3)	0.05
	L6	7.6 (2.1)^{b}	10.0 (2.4)^{a,b}	11.1 (2.6)^{a}	10.5 (2.2)^{a,b}	10.4 (2.2)^{a,b}	0.04
	S2	8.4 (1.6)	10.6 (2.5)	11.3 (2.6)	11.3 (2.5)	11.9 (3.0)	0.09
Day 1	T3	8.1 (1.7)	9.3 (1.8)	9.7 (1.1)	10.5 (2.6)	9.7 (1.9)	0.09
	T9	8.2 (2.0)	8.9 (2.1)	9.9 (1.8)	10.1 (2.4)	9.2 (1.3)	0.28
	T13	7.8 (1.4)^{b}	9.4 (2.2)^{a,b}	9.5 (1.6)^{a,b}	11.2 (1.7)^{a}	10.3 (1.7)^{a}	0.00
	T18	8.0 (1.6)^{b}	10.1 (2.3)^{a,b}	9.4 (1.7)^{a,b}	11.3 (2.3)^{a}	10.5 (2.1)^{a,b}	0.02
	L3	7.9 (1.9)^{b}	9.9 (2.2)^{a,b}	9.8 (2.2)^{a,b}	11.2 (2.2)^{a}	10.4 (2.1)^{a,b}	0.05
	L6	7.9 (1.9)^{b}	10.0 (2.4)^{a,b}	9.7 (2.6)^{a,b}	12.3 (3.0)^{a}	10.7 (2.1)^{a,b}	0.00
	S2	8.3 (2.1)^{b}	10.5 (2.5)^{a,b}	10.9 (2.6)^{a,b}	12.1 (2.7)^{a}	11.6 (2.4)^{a}	0.02
Day 3	T3	8.0 (1.7)	9.3 (2.0)	9.1 (2.2)	10.1 (1.7)	9.4 (1.9)	0.27
	T9	8.4 (1.8)	8.9 (2.1)	9.2 (2.2)	9.9 (1.7)	9.9 (0.8)	0.31
	T13	8.3 (1.5)^{b}	9.5 (2.1)^{a,b}	9.8 (2.2)^{a,b}	10.8 (1.7)^{a,b}	11.6 (2.0)^{a}	0.01
	T18	8.3 (1.7)^{b}	10.2 (2.4)^{a,b}	10.1 (1.7)^{a,b}	11.1 (2.2)^{a}	11.7 (1.7)^{a}	0.02
	L3	8.1 (2.0)^{b}	9.8 (2.3)^{a,b}	10.1 (2.0)^{a,b}	11.2 (2.5)^{a}	11.5 (1.7)^{a}	0.02
	L6	8.1 (2.0)^{b}	9.9 (2.5)^{a,b}	10.8 (1.7)^{a,b}	11.8 (2.2)^{a}	11.9 (2.3)^{a}	0.01
	S2	8.3 (2.0)^{b}	10.6 (2.5)^{a,b}	11.0 (1.7)^{a,b}	13.3 (3.4)^{a}	13.0 (2.3)^{a}	0.00
Day 7	T3	8.1 (1.4)	9.2 (1.9)	9.4 (1.5)	9.0 (1.0)	10.1 (1.5)	0.10
	T9	8.1 (1.8)^{b}	8.9 (2.0)^{a,b}	10.2 (2.0)^{a,b}	9.6 (1.1)^{a,b}	10.8 (1.7)^{a}	0.03
	T13	7.9 (1.6)	9.4 (2.3)	11.2 (2.2)	11.0 (1.4)	13.5 (2.7)	0.15
	T18	8.1 (1.8)^{c}	10.0 (2.4)^{b,c}	11.8 (2.0)^{a,b}	11.7 (2.1)^{a,b}	13.4 (2.7)^{a}	0.00
	L3	8.0 (2.0)^{c}	9.9 (2.2)^{b,c}	11.5 (2.2)^{a,b}	12.0 (2.4)^{a,b}	13.7 (1.7)^{a}	0.00
	L6	7.8 (2.1)^{c}	10.2 (2.4)^{b,c}	12.3 (2.5)^{a,b}	12.2 (1.9)^{a,b}	14.7 (2.6)^{a}	0.00
	S2	8.2 (2.2)^{c}	10.5 (2.5)^{b,c}	12.7 (2.8)^{a,b}	13.8 (3.4)^{a,b}	15.5 (2.3)^{a}	0.00

$^{a\text{-}c}$ Within days, values with different superscript letters within a row indicate significant ($P \leq 0.05$) differences between treatment groups using Tukey's HSD.

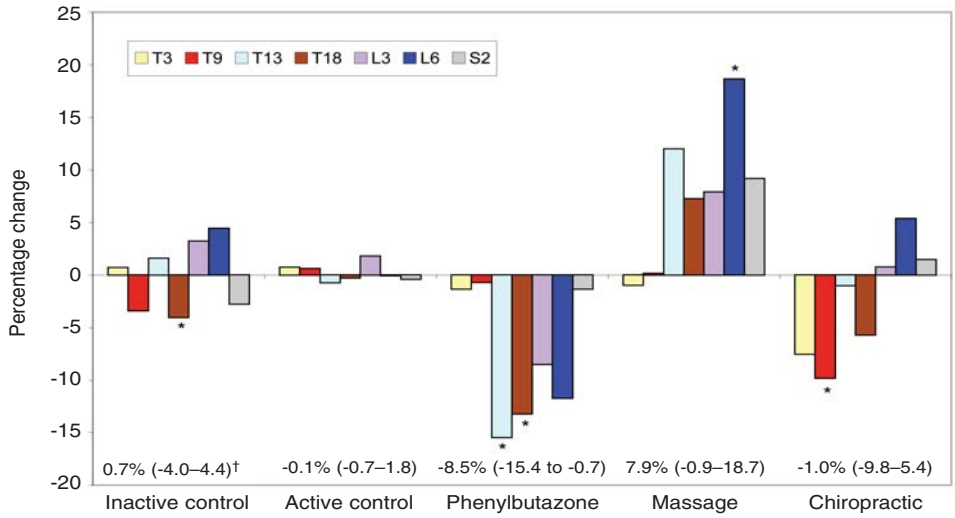

*Fig 1: Percentage change in pooled MNT values at vertebral sites within treatment groups at Day 1. *Values are significantly (P≤0.05) different from baseline values. †Overall group median (range).*

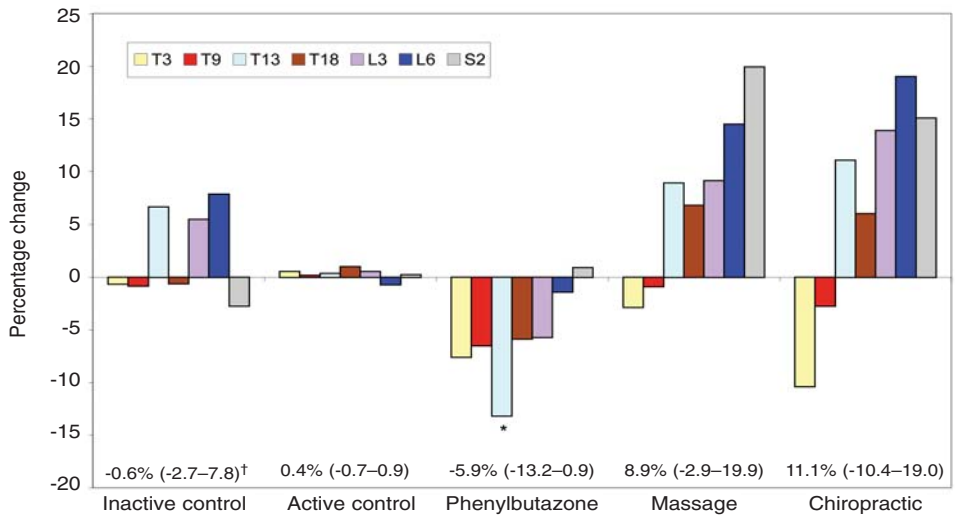

*Fig 2: Percentage change in pooled MNT values at vertebral sites within treatment groups at Day 3. *Values are significantly (P≤0.05) different from baseline values. †Overall group median (range).*

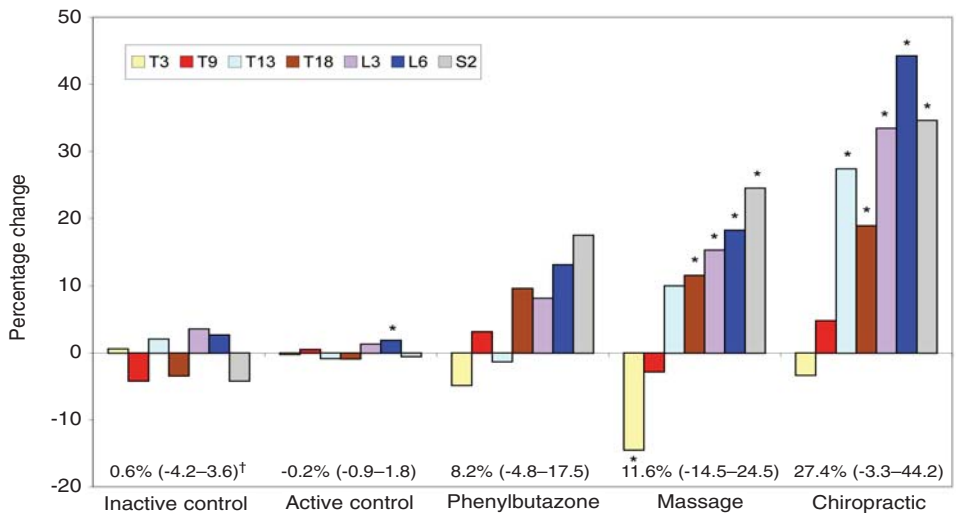

*Fig 3: Percentage change in pooled MNT values at vertebral sites within treatment groups at Day 7. *Values are significantly (P≤0.05) different from baseline values. †Overall group median (range).*

(Fig 3). In treated horses, the caudal-most vertebral sites had the largest MNT increases. Increased MNT values were not associated with sites of chiropractic or massage treatment. On Day 7, MNTs in the chiropractic group at sites T18 to S2 were significantly higher than in both control groups, but not significantly different from the phenylbutazone or massage groups (Table 1). Consistent changes over time were not evident in the 2 control groups (Table 2).

Discussion

Instrument-assisted chiropractic treatment and therapeutic massage were effective at producing significant antinociceptive changes within the caudal vertebral column from baseline to Day 7. Whether MNT changes are clinically important is not known; however, the ability and time-course of different treatment modalities significantly to change MNT values was judged clinically relevant. Decreased MNTs on Day 1 within the chiropractic group are presumably due to mechanical irritation of soft tissues or articular structures. In contrast, an immediate though nonsignificant increase in MNTs occurred in the massage group at Day 1 with gradually increasing MNTs noted at Days 3 and 7. These findings suggest that mechanisms of action other than endorphin release are responsible for MNT increases. If endogenous opiate systems were solely responsible for the increasing MNTs, then immediate but short-lived increases would be expected (McCarthy *et al*. 1993; Goldfarb and Jamurtas 1997). Chiropractic and massage probably produce systemic effects via several different mechanisms of action, including biomechanical, physiological, neurological and psychological mechanisms (Weerapong *et al*. 2005). Pain and MNTs may be influenced by all of these mechanisms; however, to explain longer-term therapeutic effects, central reflex mechanisms, such as ascending and descending pain-modulating spinal cord pathways via activation of mechanosensitive afferents, must be considered (Pickar 2002; Boal and Gillette 2004). Although the chiropractic instrument used in this study was tuned optimally for the biomechanical properties and mass of human vertebrae (Keller *et al*. 1999), it was capable of delivering an impulse with enough force to stimulate afferent pathways and nociceptive mechanisms in horses.

In man, the beneficial effects of massage are reported to be more psychological than physiological (Field 1998). Induced mental relaxation and reduced anxiety may increase tolerance to further, less comfortable treatment (Goats 1994). In the present study, the single massage treatment produced progressive increases in the overall median MNT over 7 days, which could have been due a reduction in anxiety. Reduced heart rates and positive behaviour responses (i.e. relaxation) have been recorded in horses treated with massage (McBride *et al*. 2004). Significant changes occurred when massage was applied to specified regions of the axial skeleton; the authors concluded that massage applied at allogrooming sites (i.e. mid-neck and withers) caused the largest physiological and behavioural effects, compared to nonpreferred sites at the forearm or thigh (McBride *et al*. 2004). In the present study, the massage group had larger MNTs increases within the caudal thoracolumbar spine compared to the wither region and appendicular sites were not evaluated.

Treatment of thoracolumbar pain with NSAIDs is usually disappointing. Many horses are referred for in-depth evaluation of back pain because of the lack of response to phenylbutazone or other NSAID treatment (Denoix and Dyson 2003). Phenylbutazone is efficacious as an analgesic in the presence of

TABLE 2: Pooled mean (s.d.) MNT values (in kg/cm^2) organised by treatment sites and days within the different groups

Site	Day	Inactive control (n = 7)	Active control (n = 8)	Phenylbutazone (n = 7)	Massage (n = 8)	Chiropractic (n = 8)
T3	0	8.1 (1.6)	9.3 (2.0)	10.2 (1.9)	10.7 (2.4)	10.6 (2.0)
	1	8.1 (1.7)	9.3 (1.8)	9.7 (1.1)	10.5 (2.6)	9.7 (1.9)
	3	8.0 (1.7)	9.3 (2.0)	9.1 (2.2)	10.1 (1.7)	9.4 (1.9)
	7	8.1 (1.4)	9.2 (1.9)	9.4 (1.5)	9.0 (1.0)*	10.1 (1.5)
T9	0	8.6 (2.3)	8.8 (2.0)	10.3 (2.3)	10.2 (2.3)	10.3 (1.3)
	1	8.2 (2.0)	8.9 (2.1)	9.9 (1.8)	10.1 (2.4)	9.2 (1.3)*
	3	8.4 (1.8)	8.9 (2.1)	9.2 (2.2)	9.9 (1.7)	9.9 (0.8)
	7	8.1 (1.8)	8.9 (2.0)	10.2 (2.0)	9.6 (1.1)	10.8 (1.7)
T13	0	7.7 (1.1)	9.5 (2.2)	11.4 (2.2)	10.2 (2.1)	10.6 (2.3)
	1	7.8 (1.4)	9.4 (2.2)	9.5 (1.6)*	11.2 (1.7)	10.3 (1.7)
	3	8.3 (1.5)	9.5 (2.1)	9.8 (2.2)*	10.8 (1.7)	11.6 (2.0)
	7	7.9 (1.6)	9.4 (2.3)	11.2 (2.2)	11.0 (1.4)	13.5 (2.7)*
T18	0	8.4 (1.9)	10.1 (2.4)	10.9 (1.6)	10.6 (1.9)	11.4 (2.3)
	1	8.0 (1.6)*	10.1 (2.3)	9.4 (1.7)*	11.3 (2.3)	10.5 (2.1)
	3	8.3 (1.7)	10.2 (2.4)	10.1 (1.7)	11.1 (2.2)	11.7 (1.7)
	7	8.1 (1.8)	10.0 (2.4)	11.8 (2.0)	11.7 (2.1)*	13.4 (2.7)*
L3	0	7.8 (2.3)	9.7 (2.1)	10.8 (2.0)	10.5 (1.9)	10.5 (2.3)
	1	7.9 (1.9)	9.9 (2.2)	9.8 (2.2)	11.2 (2.2)	10.4 (2.1)
	3	8.1 (2.0)	9.8 (2.3)	10.1 (2.0)	11.2 (2.5)	11.5 (1.7)
	7	8.0 (2.0)	9.9 (2.2)	11.5 (2.2)	12.0 (2.4)*	13.7 (1.7)*
L6	0	7.6 (2.1)	10.0 (2.4)	11.1 (2.6)	10.5 (2.2)	10.4 (2.2)
	1	7.9 (1.9)	10.0 (2.4)	9.7 (2.6)	12.3 (3.0)*	10.7 (2.1)
	3	8.1 (2.0)	9.9 (2.5)	10.8 (1.7)	11.8 (2.2)	11.9 (2.3)
	7	7.8 (2.1)	10.2 (2.4)*	12.3 (2.5)	12.2 (1.9)*	14.7 (2.6)*
S2	0	8.4 (1.6)	10.6 (2.5)	11.3 (2.6)	11.3 (2.5)	11.9 (3.0)
	1	8.3 (2.1)	10.5 (2.5)	10.9 (2.6)	12.1 (2.7)	11.6 (2.4)
	3	8.3 (2.0)	10.6 (2.5)	11.0 (1.7)	13.3 (3.4)	13.0 (2.3)
	7	8.2 (2.2)	10.5 (2.5)	12.7 (2.8)	13.8 (3.4)*	15.5 (2.3)*

*Within sites and groups, values within a column indicate significant (P≤0.05) differences from baseline values.

inflammation, but has no effect on pain perception in noninflamed tissues (Tobin *et al*. 1986). It was anticipated that NSAID administration would progressively increase the MNTs from baseline values over time based on our initial hypothesis that low-grade or subclinical back discomfort and inflammation was probably present in the ridden horses. Instead, significantly decreased MNTs were found at Days 1 and 3 and no overall positive MNT changes until Day 7. The authors cannot provide a reasonable explanation for the reduced MNTs within the phenylbutazone group at Days 1 and 3. Phenylbutazone is a nonselective NSAID with analgesic effects mediated by blocking cyclooxygenase, resulting in decreased prostaglandin production at the peripheral sites of inflammation and at the spinal level (Tobin *et al*. 1986). A direct spinal analgesic effect occurs because of activation of spinal glutamate and substance P receptors (Malmberg and Yaksh 1992). These spinal mechanisms may have contributed to the delayed MNT increases at Day 7 within the phenylbutazone group.

Assessment of any form of therapy for back injuries is difficult because of the tendency for spontaneous recovery (Jeffcott 1979). However, in the current study, treatment modalities increased spinal MNTs, compared to both control groups. Horses with nonridden exercise have lower MNTs than ridden horses (Haussler and Erb 2006a). In the current study, the inactive control group had MNTs that were between 28% and 42% lower than MNTs in the ridden horses. The mechanism for this difference is unknown but may be related to stimulation of endogenous β-endorphins during exercise (Goldfarb and Jamurtas 1997; Mehl *et al*. 2000). The MNT values within the active control group did not increase over time, indicating good repeatability of MNT measurements, lack of adaptation to the procedure and selection of an optimal control group for comparison with treatment groups.

Past recommendations for acute thoracolumbar injuries included stall rest with gradual return to work after the acute pain subsided (Jeffcott 1979). Recent recommendations for the rehabilitation of equine back problems are to "remove pain and make the horse as comfortable, as soon as possible, to allow it to be exercised to avoid further muscle loss and to promote muscle function and strength" (Denoix and Dyson 2003). The adverse effects of prolonged immobilisation on musculoskeletal health have been well documented (van Harreveld *et al*. 2002). In man, prolonged rest and avoidance of activity increases the duration and severity of back pain (Waddell *et al*. 1997). The effect of stall rest and controlled exercise on documented thoracolumbar pain in horses needs to be further evaluated.

A limitation of the current study was that horses without clinical signs were used; therefore, the effects of treatment or paddock confinement on back pain could not be directly evaluated. Nevertheless, chiropractic and therapeutic massage examiners were able to identify areas of discomfort and muscle hypertonicity to treat within their respective groups. The changes in spinal MNTs due to the different treatment modalities may not be directly applicable to horses with naturally occurring back pain. The presence of additional pain mediators and possible different mechanisms of action and responses to treatment would be expected. Treatments were individualised for each horse rather than using a standard treatment protocol for all horses. This caused treatment inconsistency between horses and therefore increased variability within groups. However, areas of perceived discomfort or hypertonicity were treated in order to optimise the potential therapeutic effects within each individual horse. Other study limitations included lack of random treatment group assignment for some horses, small sample size and resulting low statistical power on Days 1 and 3, and nonmasking of the examiner to treatment group assignments, which may have altered the results in some undetermined manner.

At Day 7, consistent cranial-to-caudal gradients of changes in MNT values were noted within the 3 treatment groups, but not in the 2 control groups. It is possible that currently undefined spinal mechanisms are responsible for these regional MNT differences. The cranial-to-caudal gradation in baseline MNT values is similar to a prior study measuring MNTs at the same thoracolumbar sites (Haussler and Erb 2006a). However, the amplitude of the MNT values in the current study were 20–51% lower than previously reported. Amplitude differences are probably due to variations in interexaminer repeatability and inexperience in using the pressure algometer (Antonaci *et al*. 1998). A slower or constant rate of pressure application may produce more precise MNTs measurements (List *et al*. 1991; Möller *et al*. 1998). In the current study, the mean range of 3 consecutive measurements was 1.6 kg/cm^2, which was higher than the 1.0 kg/cm^2 reported previously for the axial skeleton (Haussler and Erb 2006a). Lack of uniformity in identifying an endpoint during measurements or inconsistent rate of pressure application can reduce repeatability, but can be improved with training (Kosek *et al*. 1993).

Single treatments of either chiropractic or therapeutic massage significantly increased MNTs within the caudal vertebral column at 7 days post treatment. Pressure algometry provides an objective tool to evaluate the affects of commonly used, but currently unproven treatment modalities on spinal MNTs. The physiological effects of chiropractic treatment and therapeutic massage on nociceptive modulation needs further research. Longer-term studies are needed to compare these and other modalities for treatment of equine back pain, both individually and in combination to assess possible synergistic effects.

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Manufacturers' addresses

[1]Wagner Instruments Inc., Greenwich, Connecticut, USA.
[2]Activator Methods International, Ltd., Phoenix, Arizona, USA.
[3]Burns Veterinary Supply, Inc., Westbury, New York, USA.

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