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The effect percussive therapy on equine thoracic profile, mechanical nociceptive thresholds, spinal and limb kinematics and gait symmetry.

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Abstract

Therapeutic devices are increasingly used by therapists and horse owners. Percussive therapy (PCT) has been shown to effect blood flow, tissue oxygenation, increase range of motion (ROM) and improve recovery in humans. The aims of this study were to investigate the immediate effects of PCT on horses. Using a within-subjects randomised blinded cross-over design, twelve polo horses in training received two 12-minute PCT sessions to the major muscle groups, with the device on or off, 24-hours apart.

Pre- and post-intervention or sham sessions epaxial muscle mechanical nociceptive thresholds (MNT) and thoracic (T) profile dimensions were measured. Each horse performed four in-hand trot passes where spinal kinematics and gait symmetry were measured with inertial measurement units, plus stride length was analysed via 2D video recordings.

There were no significant differences between MNT measures. Within the sham group, thoracic profile was significantly different pre and post at T18 (mean change -0.48 cm ± 1.03; p = 0.003) and in the intervention group, there was a significant difference between the pre and post at T13 (mean change = -0.76cm ± 1.35). There was no significant difference in stride length or gait symmetry at the poll, withers, and pelvis but differences in T6, T13, L3 and sacrum ROM in the sham group and T6 and T18 in the intervention group were seen.

Overall, the application of PCT did not result in MNT or stride length changes in the intervention group when compared to the sham scenario although there were minor changes to thoracolumbar profile and spinal ROM. Further research assessing walk kinematics, ridden horse performance are recommended, along with assessing different PCT applications and other variables such as blood flow and neurophysiological responses that affect behaviour.

Keywords: Therapy, massage, vibration, horse

1. Introduction

Therapeutic devices are increasingly used by therapists and are also accessible to horse owners. These devices include vibration therapy units that deliver vibration to the tissues of the body using electromechanical oscillation. Cycloidal Vibration Therapy (CVT) is an example of application across three-dimensional axes (Niagra Equissage, 2024) and during percussive therapy (PCT) vibration is transferred to the body on a singular axis applying compressions with different frequencies (García-Sillero *et al.*, 2021). As horses commonly acquire musculoskeletal conditions which can affect performance negatively (Haussler *et al.*, 2007), desire for these devices to be supportive is strong, which may result in a positive bias, or placebo effect. Whilst use of vibration therapy is established in humans, with positive outcomes related to neural and/or muscular (re)conditioning (Souron *et al.*, 2017), strength and range of motion (Germann *et al.*, 2018), and pain perception and posture (Iodice *et al*., 2019) there is a paucity of evidence on physiological or biomechanical responses in horses. Gaining insight into the effects of home-use, therapeutic devices in horses will provide veterinarians, therapists, and owners with objective information on whether such devices will benefit horses, therefore having welfare and economic implications on horse and owner, respectively.

Cycloidal vibration therapy, a form of mechanical massage, applied directly to a horse via units placed over a horse's back and hindquarters in non-lame horses, resulted in positive effects according to Mackechnie-Guire *et al*., (2018). Thoracolumbar musculature dimensions were immediately increased and during gait, changes were observed in vertical range of motion at the wither, and mediolateral range of motion at the 13th thoracic vertebra (Mackechnie-Guire *et al*., 2018). More recently, PCT devices, for example the Theragun Pro 4th Generation (Therabody Internation Ltd, 4910 Merrifield Road Dallas, Texas, USA) have been developed, which allow for large compressive forces to be applied compared to typical local vibration devices, and these devices can sequentially be applied to major muscle groups in all regions of the body. However, they are similar to other forms of vibration in terms of the frequency of movement of the attachment head of the device, which causes the tissues to oscillate around an equilibrium point.

To date in humans, PCT has been shown to elicit the same physiological responses as vibration therapy in terms of increased blood flow, oxygenation of the tissue, increased range of motion and improved recovery, however these effects are reported to be larger and longer lasting in comparison to vibration therapy (García-Sillero *et al*., 2021; Kujala *et al*., 2019; Sams *et al.*, 2023). As similar musculoskeletal responses have been seen in humans and equines, for example following dynamic exercises to increase deep stabilising muscle cross sectional area (Hides *et al*., 1996; Stubbs *et al*., 2011) as well as vibration therapy interventions (Mackechnie-Guire *et al*., 2018), it could be inferred that similar responses would be observed following PCT. This study was designed to test the effects of PCT, currently un-studied in horses, despite anecdotal reports of benefit. If effective, this device may be beneficial both pre-competition and for recovery and rehabilitation. In addition, the authors sought to examine if there were any short-term effects of PCT that could affect performance negatively.

The aims of this study were to examine the immediate effects of the PCT, with a controlled method assessing for effects from the device and limiting confounding variables, aiming to investigate the devices effects thoracolumbar muscle profile, spinal kinematics, movement symmetry, stride length and mechanical nociception in horses.

2. Material and Methods

This study used pre- and post-intervention data collection, in a within-subjects randomised blinded cross-over design of treatment intervention and sham treatment. All data was collected by a member of the team, a veterinary physiotherapist (GT), who remained blinded to the therapy throughout. Horses were randomly assigned into groups; the intervention group received a preset protocol with the PCT device (Theragun Pro 4th Generation), and the sham group did not receive the therapy (the PCT device was placed onto the horse, but the percussive vibration setting was switched off). The PCT device was placed against the skin and moved over the major superficial muscle groups of the horse's body in turn for 30 seconds each, working caudally (*muscularis(m) rhomboideus, subclavius/supraspinatus, serratus ventralis cervicis, infraspinatus/deltoideus, pectoralis superficialis, triceps, spinalis dorsi/longissimus dorsi, gluteus medius, biceps femoris/quadriceps and semimembranosus*), starting on the left, then switching to the right, taking 12 minutes in total. Moderate pressure was applied via the PCT device to the muscle origin, then gliding up and down along the muscle belly from the origin to the insertion, with constant pressure at all times, in the direction of the muscle fibres. To ensure the pressure applied was the same on every horse, the device display, and the associated smart phone app that the device was synced to via Bluetooth ®, was monitored to ensure consistency (Therabody, 2020). This method follows the protocol prescribed by the manufacturer for pre-exercise use. There was a 24-hour wash-out period, and each horse received the alternative treatment, either intervention or sham, on the second day of data collection.

The behaviour of the horses was monitored by an independent, but non-blinded, experienced equine handler during the application of the PCT device for the intervention and the sham periods. The Equine Discomfort Ethogram was used, according to the categories of: limb and body movements; head, neck, mouth and lip movements; attention to an area; ear and tail movements; and overall demeanour (Torcivia and McDonnell, 2021), supported by observation of facial expressions (Dalla Costa *et al.*, 2016; Gleerup *et al*., 2015). If a horse was seen to express these behaviours the application of the PCT was to be ceased. The handler also monitored for positive behaviours such as leaning into the PCT application, leg resting, relaxation of the lip and lowering of the head (McBride *et al*., 2004).

Horse selection

A convenience sample of twelve clinically normal polo ponies, with reduced heterogeneity of management, which met the inclusion and exclusion criteria were selected as subjects. The inclusion criteria were that gait assessed by a Veterinary Surgeon prior to data collection during a straight-line hard-surface assessment was deemed <1/5 AAEP grading scale; were currently in routine ridden exercise but not exercised on either day of data collection; a veterinary physiotherapy assessment deemed them suitable for application of the percussive device and ≤2/5 on the palpation score for any superficial musculature (Merrifield-Jones *et al*., 2019). Horses were excluded if: they scored ≥2/5 (AAEP scale) during the veterinary assessment; had current back pain and/or epaxial hypertonicity as assessed by a veterinary physiotherapist (defined as an average of > grade 2/5 on the palpation score (Merrifield-Jones *et al*., 2019)); had an injury or any history of back related injury/ disease/ surgery or had received analgesics in the last 7 days prior to start of study or anytime during study.

Thoracic profile measurements

Thoracic musculature dimensions were measured with a flexible curve ruler (FCR) before and after the percussive therapy following a previously published measurement protocol (Greve and Dyson, 2014; Mackechnie-Guire *et al*., 2018), at the levels T10, T13 and T18 identified by palpation of the spinous process and by palpation of the ribs. The midpoint of FCR was positioned on the dorsal midline of the dorsal spinous processes and shaped around the horse's dorsum. Tippex was used to mark the points on the thoracic region to ensure accuracy of each FCR measurement. Data from the FCR was collected by drawing outlines of the resulting FCR form on A2 paper and a new FCR was used for each day of data collection. Thoracic profile width was measured on the FCR traces at 3cm, 10cm and 15cm depths from the dorsal midline.

Mechanical nociceptive thresholds (MNT)

For both intervention and sham treatments, a pressure algometer (FDX50; Wagner Instruments, CT, USA) was used pre- and post-treatments to analyse MNT.

Testing was located to the mid muscle belly of splenius at the level of the third cervical vertebra, mid *rhomboideus* muscle belly, *m.brachiocephalicus* overlying the sixth cervical transverse process, caudal *trapezius* and longissimus muscles, 10 cm lateral to T8, T18 and L3 dorsal spinous processes, midpoint of the line between the *tubera coxae* and *sacrale* in the *m.gluteus medius* muscle and the midpoint between the *tubera ischii* and *sacrale* for *m.biceps femoris* (Haussler and Erb, 2006). The test location was marked using tippex 9 cm from to the dorsal spinous which remained in place throughout treatment and data collection to ensure test-retest location reliability (Merrifield-Jones *et al*., 2019). Three repeats of MNT were taken at each location, pre and post intervention or sham treatment.

Kinematic measurements

To measure spinal kinematics and gait symmetry, eight wireless inertial measurement units (IMUs; Equigait Xsens, 100 Hz) were applied by the same trained technician. The units stayed in place during the sham and active treatment periods and were re-applied on day two, on locations marked with tippex. Horses underwent a dynamic assessment consisting of four in hand passes at trot on a 2mx25m straight line, hard surface. IMUs were applied with the horse standing square over the poll, withers, thoracic vertebrae (T)13, T18, Lumbar (L)3, on the midline between *tubera sacrale* and on the left and right *tubera coxae* using double sided adhesive tape (Pfau *et al*., 2020; Warner *et al*., 2010). For each sensor, dorsoventral, craniocaudal and mediolateral displacement range of motion (ROM), roll, pitch, yaw rotations were quantified (Pfau *et al.* 2017). Symmetry values were calculated using previously defined methods and differences in the minima (MinDiff), maxima (MaxDiff), upward range (UpDiff) were calculated at the poll, withers and pelvis, as well as hip hike differences (HHD).

A 2d video camera (iPad 9th Gen) was placed the centre of the experimental tract (a straight 2mx25m area) using a free-standing tripod. Horses were presented in trot (2.8 ± 0.2 m/s), in a halter by the same handler. Each subject performed four in hand passes, individual subject speed was recorded using speed gates and kept within ±0.2 m/s for each pass, to reduce variations attributed to velocity changes (Khumsap *et al*., 2002). Using an object of known scale within the video frame, stride length was analysed post -hoc using Kinovea (version 1.2) open-source software to ascertain if there are any differences pre and post the intervention and sham groups. One stride was defined as the right hindlimb going through one full cycle of motion from initial hoof impact to the next hoof impact.

Data Analysis

Statistical analyses, performed in SPSS (ver. 26, IBM, Armonk, USA) were used to investigate differences between the intervention and sham application pre- and post- intervention. Normality distribution was assessed with the Shapiro-Wilk test and appropriate tests applied. The repeated MNT were evaluated with a Related-Samples Friedman's Two-Way Analysis of Variance and post-hoc pairwise tests with the Bonferroni correction applied. FCR data were tested with related-samples Wilcoxen Signed Rank tests and significant values further assessed using Cohen's *d* effect size calculations. IMU data variables were analysed using Paired T-tests and an alpha level of $p = 0.05$ was defined for the statistical significance of all the tests.

3. Results

Thoracic Profile

Within the sham group, thoracic profile was significantly different pre and post at the spinal level T18, summed total change at depths 3cm, 10cm and 15cm (mean change -0.48 cm ± 1.03; $p = 0.003$). In the intervention group, there was a significant difference between the pre and post at spinal T13 summed total change at 3cm, 10cm and 15cm (mean change = -0.76cm ± 1.35; p<0.001). There were no other significant differences between the spinal locations or groups.

Table 1: Mean difference in the Pre and Post measures of thoracic (T) profile at a depth of 3cm, 10cm and 15cm at spinal levels T10, T13 and T18, reported in cm ± standard deviation for the sham and intervention groups.

Location	Sham	Intervention
T10_3cm	0.2±0.5	0.1±0.9
T10_10cm	0.2±0.9	0.2±2.7
T10_15cm	0.1±1.1	-0.1±2.3
T13_3cm	0.2±0.9	-0.9±0.8
T13_10cm	0.3±1.4	-0.3±1.2
T13_15cm	0.4±1.2	-1.1±1.7
T18_3cm	0.4±-0.7	0.4±1.1
T18_10cm	-0.4±1.3	0.1±1.1
T18_15cm	-0.6±0.9	-0.7±2.7

Mechanical nociceptive thresholds

There a was no significant difference in the pre and post mean MNT levels at for the nine locations tested in the sham or intervention groups (p>0.05) (Figure 1). When assessing for differences in the three repeated MNT measures, there were significant differences between the first and third repeats on the left side pre-sham (p=0.043), the first and second MNT measures on the left pre-intervention (p=0.032) and post intervention (p=0.018). However, there were no significant differences between repeated measures for all other pre- or post- sham or intervention MNT measured.

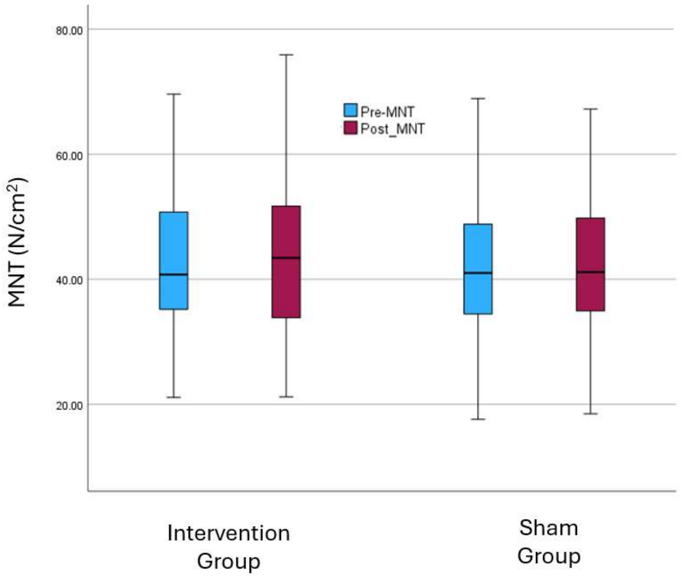

Figure 1: Average Mechanical Nociceptive Threshold (MNT) values, measured pre and post session for the intervention and sham groups, summed for the nine locations on the left and right side (mid muscle belly of *m.splenius* at the level of the third cervical vertebra, mid *rhomboideus* muscle belly, *m.brachiocephalicus* overlying the sixth cervical transverse process, caudal *m.trapezius* and *m.longissimus* muscles, 10 cm lateral to T8, T18 and L3 dorsal spinous processes, midpoint of the line

between the *tubera coxae* and *sacrale* in the *m.gluteus medius* muscle and the midpoint between the *tubera ischii* and *sacrale* for *m.biceps femoris*).

Kinematic measurements

In the sham group, there were significant differences in the IMU measurements before and after the sham period; at T6, dorsoventral ROM reduced (p=0.030; *d* = 0.761) and roll ROM increased (p = 0.029; *d* = -0.768); at T13 dorsoventral ROM reduced (p=0.046; *d* = 0.686) and pitch ROM increased (p= 0.047; *d* = 0.686). At L3 craniocaudal ROM reduced (p= 0.034; *d* = 0.738), roll ROM reduced (p= 0.011; *d* = 0.935) and pitch ROM reduced (p=0.025; *d* = 0.794). Over the sacrum, dorsoventral ROM reduced (p= 0.042; *d* = 0.703), however there were no significant differences at the poll or T18 IMU displacement values (table 2).

In the intervention group, there was no significant difference in the displacement values at the poll, at T13, at L3 or over the sacrum. At the T6 pitch ROM increased (p=0.047; *d* = 0.646) and at T18 craniocaudal ROM reduced (p = 0.013; *d* = 0.851) (table 2).

Table 2: Kinematic data collected via inertial motion sensors (IMU) during trot, pre and post sham and intervention group (mean± SD) (T = thoracic, L = lumbar, DV = dorsoventral, ROM = range of motion, CC = cranial-caudal, * = indicates significant values)

Spinal Level	IMU Parameter	Sham Group			Intervention Group		
		Pre	Post	P value	Pre	post	P Value
T6	DV ROM (mm)	58.8±8.4	57.3±8.3	0.03*	63.3 9.2	60.8±6.7	0.255
T6	Roll ROM (°)	23.1±3.8	24.4±3.8	0.029*	29.2 8.9	30.2±8.7	0.485
T6	Pitch ROM (°)	8.6±2.3	8.6±2.7	0.249	9.4 2.6	10.2±2.5	0.047*
T13	DV ROM (mm)	74.5±9.4	73.7±9.1	0.046*	72.0 21.9	75.5±7.0	0.591
T13	Pitch ROM (°)	5.9±1.7	6.5±2.2	0.047*	6.6 1.7	8.1±4.0	0.224
T18	CC ROM (mm)	19.3±3.1	19.5±3.9	1.000	20.1 3.5	19.6±3.5	0.013*
L3	CC ROM (mm)	18.3±2.6	17.2±3.1	0.034*	18.3 3.2	17.6±2.6	0.400
L3	Roll ROM (°)	18.9±3.7	18.1±3.5	0.011*	19.4 4.4	19.1±4.1	0.350
L3	Pitch ROM (°)	4.1±0.8	4.9±0.7	0,025*	4.4 0.7	4.5±1.0	0.653
Sacrum	DV ROM (mm)	77.3±9.8	75.6±10.8	0.042*	79.7 9.7	77.5±7.2	0.318

When assessing gait symmetry for all measures of poll, withers, and pelvis MinDiff, MaxDiff, UpDiff, and HHD in the sham or intervention groups there were no significant differences (table 3). For the six horses that received the intervention on day 1, there were no significant differences between variables when the post-intervention measures were tested against the pre-sham measures on day 2. One set of data collected for the sham group post-intervention measures was lost before analysis.

Table 3: Kinematic data collected via inertial motion sensors (IMU) during trot, pre and post with combined data for sham and intervention groups (cm) (W = withers, Pel = Pelvis, MnD = difference between the two minima in vertical displacement, MxD = difference between the two maxima in vertical displacement, ROM = Range of Motion, UpD = the upwards difference between the two vertical movement amplitudes, HHD = Hip Hike difference, negative values represent direction to the left and positive values represent direction to the right).

	N	Minimum	Maximum	Mean	Standard Deviation
PRE_Poll_MnD	24	-30.0	17.0	-3.9	12.0
PRE_Poll_MxD	24	-17.0	19.0	0.6	8.0
PRE_Poll_UpD	24	-34.0	33.0	-3.3	16.9
PRE_Poll_ROM	24	50.0	85.0	66.2	9.5
PRE_W_MnD	24	-15.0	7.0	-2.1	5.3
PRE_W_MxD	24	-17.0	11.0	-1.1	6.4
PRE_W_UpD	24	-22.0	11.0	-2.7	7.3
PRE_W_ROM	24	47.0	88.0	60.8	10.0
PRE_Pel_MnD	24	-15.0	4.0	-4.4	4.7
PRE_Pel_MxD	24	-7.0	30.0	0.333	8.1
PRE_Pel_UpD	24	-18.0	32.0	-4.0	10.7
PRE_Pel_ROM	24	56.0	91.0	73.5	9.2
PRE_HHD	24	-17.0	30.0	-5.1	10.8
POST_Poll_MnD	23	-46.0	19.0	-3.2	14.7
POST_Poll_MxD	23	-15.0	16.0	1.6	8.1
POST_Poll_UpD	23	-37.0	38.0	0.130	18.1
POST_Poll_ROM	23	45.0	91.0	66.3	10.9
POST_W_MnD	23	-12.0	6.0	-2.3	5.0
POST_W_MxD	23	-17.0	10.0	-1.4	5.6
POST_W_UpD	23	-18.0	9.0	-3.7	6.5
POST_W_ROM	23	46.0	72.0	58.3	7.7
POST_Pel_MnD	23	-15.0	9.0	-4.3	5.5
POST_Pel_MxD	23	-10.0	21.0	-1.1	6.7
POST_Pel_UpD	23	-16.0	21.0	-4.3	9.2
POST_Pel_ROM	23	56.0	89.0	72.522	8.6596
POST_HHD	23	-26.0	27.0	-4.652	13.2033

Stride length

There was no significant difference in the stride length of the sham group pre (mean = 280±26cm) and post (mean = 283±21cm) measures (mean change = -3±17cm; p=0.522) or in the intervention group for pre (mean = 280±28cm) and post (mean = 277±25cm) measures (mean change = 1±17cm; p=0.795).

4. Discussion

The twelve-minute protocol of intervention with the PCT device did not demonstrate consistent significant effects when compared to the sham group. The significant changes seen in the FCR measurements were small and had a low effect size, suggesting minimal clinical effect. There were significant changes in the spinal motion at T6 (increased pitch ROM) and at T18 (reduced craniocaudal ROM) in the intervention group, however there were also significant pre vs post differences in ROM in the sham group. These differences suggest that the effect was not due to the application of PCT, but the variance in repeated measures, similar to those seen in thoroughbreds in training where higher asymmetry values demonstrated higher variance on daily repeated measures (Sepulveda Caviedes *et al.*, 2018).

The horses were accepted to be included in the trial based on visual analysis of their gait, however the results of the intervention may have been influenced by gait asymmetry that was not identified in this initial screening process. When assessing 25 racehorses for lameness, poor to fair agreement between observers was noted. Asymmetry values from IMU data were considered to have adequate specificity and sensitivity when compared to visual assessment at >14.5mm (poll MinDiff) and >7.5mm (pelvis MinDiff) (Pfau *et al.*, 2020). These values are higher than previously published guideline values for working polo horses, which were MinDiff and MaxDiff (<-6 mm or>+6 mm) for poll movement and (<-3 mm or >+3 mm) for pelvic movement (McCracken *et al.*, 2012; Pfau *et al;.*, 2016). In our study a proportion of horses had asymmetry values that exceeded these thresholds and it is unknown whether different results would have been found in horses that have lower asymmetry values or those in training for different disciplines with functional requirements that differ to a polo horse, such as racehorses or showjumpers.

Positively, the results show that there were no negative effects of treatment which is important as PCT devices are being sold to owners, however we only evaluated one device that reports pressure applied to the operator. There are alternative PCT devices available on the market to owners that do not have this feedback. In addition, the operator applying the PCT in this trial was experienced in the use of the device and monitored the horse for signs of discomfort or pain according to the ethogram scales assessing facial expression and equine discomfort (Dalla Costa *et al.*, 2016; Gleerup *et al.*, 2015; Torcivia and McDonell, 2021).

Wither scratching has been suggested to contribute to a more relaxed behavioural response compared with neck patting in horse standing under saddle (Thorbergson *et al.*, 2016) and in horses undergoing massage, heart rate and positive behaviours were seen during application at the withers (McBride *et al.*, 2004). Both studies suggest that horses lowering the head, during these tactile stimuli, was a sign of relaxation but currently there is no research into equine behaviours during PCT, which an alternative form of tactile stimuli. The observers noted a high frequency of horses lowering their heads during the PCT intervention during this study. Therefore, an investigation into behavioural and physiological markers during PCT is warranted as relaxation is a commonly sought outcome of therapeutic interventions for scenarios such isolation of veterinary procedures (McBride *et al.*, 2004).

The horses on this study were assessed by a veterinary surgeon prior to inclusion and deemed not to have back pain and accordingly the results of MNT testing in both the sham and intervention groups did not show change between before and after the application of the PCT device. In MNT testing, pain reduces the threshold at which a horse will demonstrate a behavioural response to the application of the PA. Muscle tone, which is maintained through the myotatic spinal reflex was not measured in isolation via the PA, however manipulative therapy has been shown to immediately significantly decrease muscle tone (Wakeling *et al*., 2006). Using a tissue indenter as used in the study by Wakeling *et al*. (2006) may have shown differences in reactive muscle contractions after intervention. Palpation by hand could have been an alternative method of assessment as local hypertonicity is a marker used by manual therapists to assess for spinal dysfunction (Fryer *et al*., 2004), however reliability has only been assessed in one area on the equine epaxials to date (Merrifield-Jones *et al*., 2019).

The lack of negative effects and no adverse behavioural responses observed with anecdotal reports of positive behavioural effects suggest that further research into alternative PCT application methods, durations, repetitions, or longitudinal studies could be carried out with minimal concerns to the participants. A longer treatment or treatment repeated on multiple days may show different results. The vibration massage device used by Mackechnie-Guire *et al*., (2018) was applied for 20 minutes resulting in increased motion of the thoracic spine (wither vertical: pre 69.00 ± 8.77 mm, post 70.84 ± 8.79 mm, P = 0.04; T13 mediolateral: pre 26.45 ± 4.29 mm, post 29.27 ± 5.29 mm, P = .01). When examining these results for effect sizes, these changes (at the withers d = -0.21 and T13 d = -0.59) have low to medium effects (Fritz *et al*., 2012). When d values of 0.2 have been described as statistical and 0.5 as subtle (Fritz *et al*., 2012) it is important to consider clinical relevance and higher d values would give greater confidence in the effects of any intervention.

The absence of change of stride length may also be a due to treatment time being too short. Konrad *et al*. (2020) applied mechanical percussive treatment for five minutes on one set of muscles, the plantar flexors in the calf which significantly increased dorsiflexion range in human participants. If the same effects were to be seen in the horses in this study, treatment of the caudal thigh muscles would have resulted in greater hock flexion and potentially greater protraction during gait. The duration of application of the percussive therapy to these muscles was less than five minutes in total, therefore an extended application may be required for change in stride length. An additional measurement for future studies could be to measure intervention effects on stride length in walk. Hobson and Rudd (2022) demonstrated a 20cm walk stride length increase compared with a control group immediately after application of an electronic massage pad, however no comparison to trot or gait symmetry was included in their study.

5. Conclusion

Overall, the application of this PCT protocol did not result in mechanical nociceptive threshold or kinematic changes in the intervention group when compared to the control scenario although there were minor changes to thoracolumbar profile and spinal motion. Despite no short-term changes in most of the recorded measures there were no adverse effects on any of these variables and anecdotal reports of positive behavioural signs of relaxation during the PCT intervention were observed. Further research with different protocols, potentially assessing performance post-intervention in ridden horses, rather than only during in hand trot are suggested, along with assessing other variables such as blood flow and neurophysiological responses that affect behaviour.

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