

# Needle electromyographic activity of myofascial trigger points and control sites in equine cleidobrachialis muscle – an observational study

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## Abstract

**Background** Myofascial trigger points are commonly described in humans, and many studies have shown abnormal spontaneous electrical activity, spike activity and local twitch responses at these sites. Myofascial trigger points have only rarely been described in horses, and studies of their electrophysiological characteristics have not previously been published. The objective of this study was to explore the electromyographic (EMG) and other characteristics of myofascial trigger points in equine muscle, and to compare them with normal muscle tissue.

**Methods** Four horses with chronic pain signs and impaired performance were examined. They had previously been examined at the second author's practice, and showed signs compatible with the diagnosis of myofascial trigger points in their cleidobrachialis (brachiocephalic) muscle, ie localised tender spots in a taut band of skeletal muscle which produced a local twitch response on snapping palpation. They had therefore been selected for treatment with acupuncture. Needle EMG activity and twitch responses were recorded at 25 positions at the trigger point and at a nearby control point during the course of each horse's acupuncture treatment.

**Results** All subjects demonstrated objective signs of spontaneous electrical activity, spike activity and local twitch responses at the myofascial trigger point sites within taut bands. The frequency of these signs was significantly greater at myofascial trigger points than at control sites ( $P < 0.05$ ).

**Conclusion** Equine myofascial trigger points can be identified, and have similar objective signs and electrophysiological properties to those documented in human and rabbit skeletal muscle tissue. The important differences from findings in human studies are that referred pain patterns and the reproduction of pain profile cannot be determined in animals.

## Keywords

*Equine myofascial trigger points, myofascial pain syndrome, needle electromyography, local twitch response, taut bands, muscle pain, veterinary acupuncture.*

## Introduction

Myofascial pain syndrome (MPS) due to myofascial trigger points (MTrPs) is a common source of musculoskeletal pain in man.<sup>1-5</sup> An MTrP has been defined as a 'highly localised and hyperirritable spot in a palpable taut band of skeletal muscle fibres.'<sup>5-7</sup> The clinical findings from palpation described as associated with an MTrP are:<sup>2,5,7,8</sup>

1. A taut band (TB) of skeletal muscle with a point of exquisite tenderness to manual pressure
2. A transient contraction of the taut band, called a local twitch response (LTR), on mechanical stimulation, eg snapping palpation or dry needling of the MTrP
3. A characteristic pain referral pattern reported by the patient
4. The reproduction of the patient's usual pain upon noxious stimulation of the MTrP
5. Restricted range of motion due to the taut band and pain
6. Weakness of the affected muscles without atrophy.

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Gerwin et al reported on the difficulties in establishing consistent palpation findings, which requires skill in manual examination of muscle.<sup>8</sup> In their inter-rater reliability study, the LTR was found to be the most difficult feature to get good agreement, while agreement for reproduction of patient's pain was highest. Consistency in findings varied slightly for the different muscles examined which was suspected to be due to the relative palpation challenges and differences in palpation pressure.

There are considerable difficulties in extending this work to study MTrPs in horses: an animal cannot indicate referred or reproduced pain, and only a few muscles in the horse lend themselves to the palpation required to detect the TB or to elicit the LTR. Measuring the restricted range of motion and weakness would also present serious challenges in the horse. Currently, there are no references to MPS or MTrPs in mainstream veterinary texts pertaining to musculoskeletal disease.

Against a background of recent advances in understanding the neurophysiology of pain, studies of the electrophysiological properties of MTrPs have provided some support for their existence as a genuine clinical condition. Several studies have examined the electromyographic (EMG) activity at MTrPs in human subjects,<sup>2,9-14</sup> and in rabbits.<sup>1,15-18</sup> Hubbard and Berkoff reported needle EMG activity restricted to minute loci in MTrPs in human upper trapezius muscles.<sup>11</sup> This was characterised by intermittent high amplitude spikes of at least 200 $\mu$ V in amplitude occasionally reaching 700 $\mu$ V. In each case a control point 1cm from the MTrP showed only low amplitude baseline noise which averaged less than 10 $\mu$ V. By increasing the amplification of the EMG machine in a study of trigger spots (TrSs) in rabbit skeletal muscle, Simons and colleagues noticed that two types of wave form were observed:<sup>16</sup>

1. Low amplitude (maximum of 80 $\mu$ V peak to peak) noise-like component
2. Intermittent bursts of high amplitude spike activity as above.

The investigators in this study named the noise-like component spontaneous electrical activity (SEA) and subsequent studies have found that a combination of this and spike activity seem to be characteristic of minute sites (active loci) within MTrPs.<sup>13,14,16,18,19</sup>

In veterinary medicine, the presence and severity of pain cannot be verbally communicated by the

patient and is dependent on an assessment by the examining veterinarian or therapist. Ahern, in a discussion of the neuropathic pain potentials in the horse, noted this pain assessment is often highly subjective.<sup>20</sup> It seems likely that performance horses would suffer from MPS, but knowledge of trigger points and their role in pain is very limited among veterinarians. One of the authors has already noted that, when a horse is presented for 'poor performance syndrome', the conventional diagnostic work-up and interpretation often fails to recognise signs of myofascial pain and therefore appropriate treatment is often not offered.<sup>21</sup> Ridgway described 'diffuse myofascial syndromes' in horses with sore backs, muscle pain, tender acupuncture points and trigger points in the glutei, biceps femoris, the hamstring muscles, and the sternocephalic muscle. He proposed that stress, training rigors, and other immune system pressures were causative factors but did not offer any objective criteria to differentiate myofascial trigger points from muscle fibres described as fibrotic.<sup>22</sup>

Winjberg et al reviewed needle electromyography research in the normal horse and in neurogenic and myogenic disorders, and compared similar studies in human subjects.<sup>23</sup> Normal spontaneous activity (SA) at rest when the needle is placed near an end plate is described as 'end plate noise', with 10-50 $\mu$ V amplitude and 1-3 ms duration. Two forms of diseased spontaneous activity have been described: myogenic SA due to peripheral and/or muscle disease, which involves fibrillations, positive 'sharp' waves, or complex repetitive discharges; and neurogenic SA from peripheral and central nervous system disease. Fibrillation potentials and positive sharp waves were also noted incidentally in normal horses. Normative data for SA is lacking and its detection is considered very unspecific.<sup>23</sup> No needle EMG studies have described any investigation or consideration of the MTrP in the horse to date.

Janssens identified trigger points in 48 chronically lame dogs and described their locations and treatment. Nine trigger points involved the triceps, infraspinatus, quadriceps, pectineus, iliocostalis, peroneus longus, tensor fasciae latae, middle gluteal, semimembranosus, and semitendinosus muscles; the correlated acupoints were noted. The author described the trigger points as painful nodules occasionally found within a taut band in muscle which showed a

twitch response during dry needle treatments; the success rate in eliminating clinical signs after an average of three weekly treatments was 60%.<sup>24,25</sup> This publication introduced the concepts of MTrPs, taut bands and LTRs in veterinary practice based solely on palpation findings in lame dogs. Earlier, Simons and Stolov reported histological studies of a band-like hardness palpated in canine muscles which appeared to be caused by a circumscribed transient muscular contraction.<sup>26</sup> Thermographic studies of suspected equine MPS cases reported by the second author found no consistent correlation between focal hot spots and MTrPs, but some cases of suspected MPS had associated abnormal vasomotor tone over larger regions.<sup>27</sup>

This study aims to investigate whether the LTR seen in human MTrPs can be demonstrated in suspect MTrPs in equine skeletal muscle, to explore the electrophysiological properties of MTrPs in equine skeletal muscle, and to test whether LTR, SEA and spike activity occur more frequently at MTrPs than at control sites in muscle.

## Methods

### Horses

The study included four horses, all of which had been previously assessed for their suitability to receive acupuncture for chronic pain due to MPS by the second author, who is a certified veterinary acupuncturist (IVAS), an equine veterinary surgeon in private practice, and a past president of the Association of British Veterinary Acupuncturists (ABVA).

Horse 1, a 6 year old thoroughbred (TB) gelding in race training, was referred for total intolerance (violent bucking) to being saddled and ridden, with signs of hyperaesthesia and allodynia of the lower neck and girth. Horse 2, a 14 year old TB gelding retired from racing as a hack, had neck pain and intermittent front foot pain. Horse 3, an 8 year old TB gelding retired from racing two years earlier in poor general condition, had intermittent front foot lameness, impinging dorsal spinous processes from the 16th-18th thoracic vertebrae with tenderness in the paraspinal muscles of the neck and back. Horse 4, a 16 year old part TB gelding donated to the second author several years earlier, was retired from dressage and show jumping with a chronic right front foot injury with lameness, impinging dorsal spinous

processes of the 13th-18th thoracic vertebrae, and signs of chronic neck and back pain. Each horse demonstrated tender points in the cleidobrachialis division of the brachiocephalic muscle which fulfilled the following criteria:

1. Location within a taut band of muscle
2. A jump sign or other obvious sign of tenderness was elicited on manual palpation
3. An LTR was elicited on snapping palpation of the tender point.

These signs were necessary for the purpose of this study to confirm these sites as equine MTrPs and will be described in more detail in the next section. The distal brachiocephalic muscle is one of the few in the horse that can be palpated in the manner required to detect MTrPs.

Informed written consent was given by the owner of each horse before the study, which had ethical permission with certain imposed restrictions from the Royal Veterinary College. Three of the horses were inpatients and horse 3 was seen as a referral outpatient at the second author's equine veterinary clinic, where all the investigations took place.

### Identification of myofascial trigger point

The distal end of the cleidobrachialis division of the brachiocephalic muscle (Figure 1) was explored, using digital palpation, for a taut band;<sup>28</sup> that is, a band of muscle fibres that was clearly delineated and which felt firmer on palpation than surrounding muscle.<sup>29</sup> When identified, the taut band was palpated along its length for the most tender location, judged by the horse's movement away from digital pressure or showing obvious signs of discomfort. This site was then examined with 'snapping palpation' ie snapping the taut band briskly with one finger against the other across the direction of the fibres. When snapping palpation elicited a transient contraction of the muscle fibres within the taut band, an LTR, then the band was explored proximally and distally for the location where the most vigorous LTR could be produced.<sup>16,19</sup> Usually only one spot was exceptionally responsive to the stimulation and this was then identified as the MTrP.

For ethical reasons, no needles were inserted apart from those used for treatment. If the location of the MTrP corresponded to an acupuncture point that was appropriate for treatment, it was examined with an EMG needle. In all four horses, the MTrP

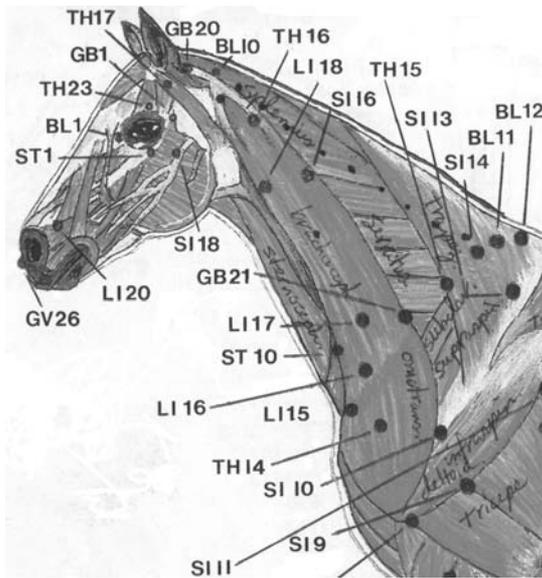


Figure 1 Acupuncture points on the head and neck of the horse following the transpositional system. An MTrP at LI16 in the cleidobrachialis muscle, was the site most frequently examined for needle electromyographic activity. Image reproduced with permission from an atlas by Peggy Fleming.

was found at the acupuncture points LI16 and LI17 using the 'transpositional' acupoints system. This system has been developed by equine acupuncturists in the West over the past 30 years by transposing the human acupuncture points onto the horse. The Chinese developed an equine acupoints system referred to as the 'traditional' equine acupoints which differs in many ways to the transpositional system. The traditional acupoints number only 176 and the Chinese did not describe channels (meridians) in animals. There is no equivalent traditional Chinese acupoint to LI16 in the horse, nor, indeed, is there an equivalent LI4 (Hegu) or many other of the frequently used human acupoints. The traditional equine back *shu* points ('association points') are placed in a different order to the human back *shu* points. The Western transpositional system is beset by numerous debates on their validity and the correct positioning of many important acupuncture points due to anatomical differences, notably in the extremities. These aspects of veterinary acupuncture can lead to confusion in standardisation and reporting as well as in issuing and interpreting ethical guidelines. The acupoint LI16 is often described by Western veterinary acupuncturists as variably located in an area of the

distal extent of the brachiocephalic muscle and is identified by palpation. In the authors' experience, it is a frequently tender region often with signs of one or more MTrPs. Traditionally, acupuncture also recognises *ah shi* points as tender sites which may be separate from the classical points, raising a discussion about what is meant by 'an acupuncture point'. In human studies, a high correlation between acupuncture points and MTrPs has been demonstrated by Melzack and Hong, allowing for 3cm flexibility in location.<sup>30,31</sup>

A second site was then chosen to be the control point. This also had to correspond to an acupuncture treatment point but had to be outside the taut band and show none of the above characteristics demonstrated by the MTrP. In three horses LI17 was chosen, which is located one cervical segment proximally from LI16. In one horse ST10 was chosen as there were signs of an active MTrP at LI17. All sites were examined bilaterally on each horse.

#### Electromyography analysis

A dual channel Medelec Synergy Note Book EMG system (Oxford Instruments Medical Ltd, Old Woking, Surrey, UK) was used to record electromyographic data. The EMG electrodes used were 50mm long bipolar concentric disposable needles. Each needle was 0.46mm diameter (26G) with a pick up area at the exposed conical tip of 0.34mm<sup>2</sup>. The gain was set to 50µV per division and the sweep speed to 50ms per division, providing a 500ms record per screen. Selected samples of SEA and spike activity (20 seconds duration) were recorded and saved for later analysis (Figure 2). The lower and upper frequency limits were set at 10Hz and 10kHz respectively.

#### Searching for electrical activity

The second author performed all the needling in this study. The EMG examination took place during the course of each horse's acupuncture treatment and no points were needled other than those which were already being needled for therapeutic reasons. Each horse was positioned in restraining stocks in order to keep it as quiet as possible (without the use of sedation) and therefore minimise movement and muscle activity during the examination.

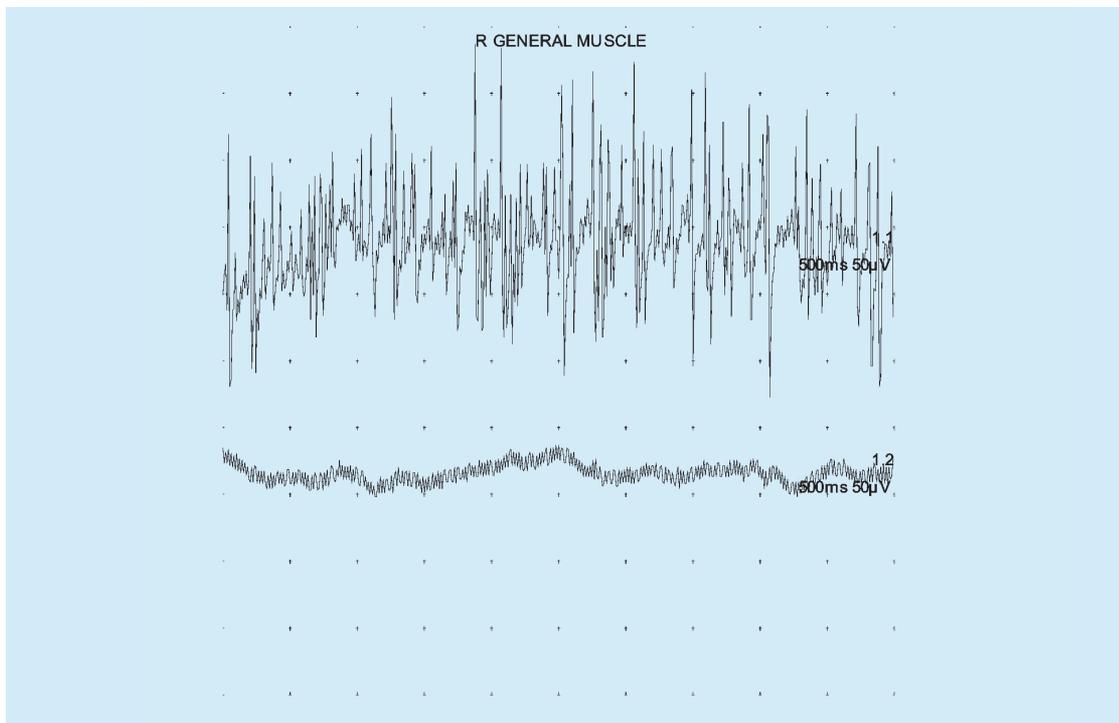
An indifferent electrode (earth) needle was inserted at the acupuncture point LU2, which lies in

**Table 1** Frequency of recorded spontaneous electrical activity (SEA), spike activity and local twitch response (LTR) at myofascial trigger points (MTrP) and control sites

		Number recorded at 25 locations			
		Left		Right	
		MTrP	Control	MTrP	Control
Horse 1	SEA	5	1	6	0
	Spike activity	5	3	3	1
	LTR	2	0	3	0
Horse 2	SEA	6	0	8	2
	Spike activity	6	1	8	2
	LTR	3	1	4	0
Horse 3	SEA	11	1	1	0
	Spike activity	3	1	1	0
	LTR	2	1	1	0
Horse 4	SEA	4	2	4	1
	Spike activity	4	2	10	2
	LTR	2	0	4	0

the proximal extent of the descending pectoral muscle where palpation revealed no evidence of taut bands. This point was consistently used as an adjacent, local treatment point as well as serving as the EMG earth site. The first needle electrode was connected to

channel one and was inserted into the site designated as the MTrP at LI16; the second was connected to channel two and served as the control site (acupoint LI17 or ST10) and the activity at each channel was recorded simultaneously.



**Figure 2** Typical electromyographic (EMG) recordings of end plate noise or spontaneous electrical activity (SEA) and spike activity during a local twitch response (LTR) at a myofascial trigger point (MTrP) (upper trace) and at a control, non-MTrP (lower trace) in the cleidobrachialis division of the equine brachiocephalic muscle.

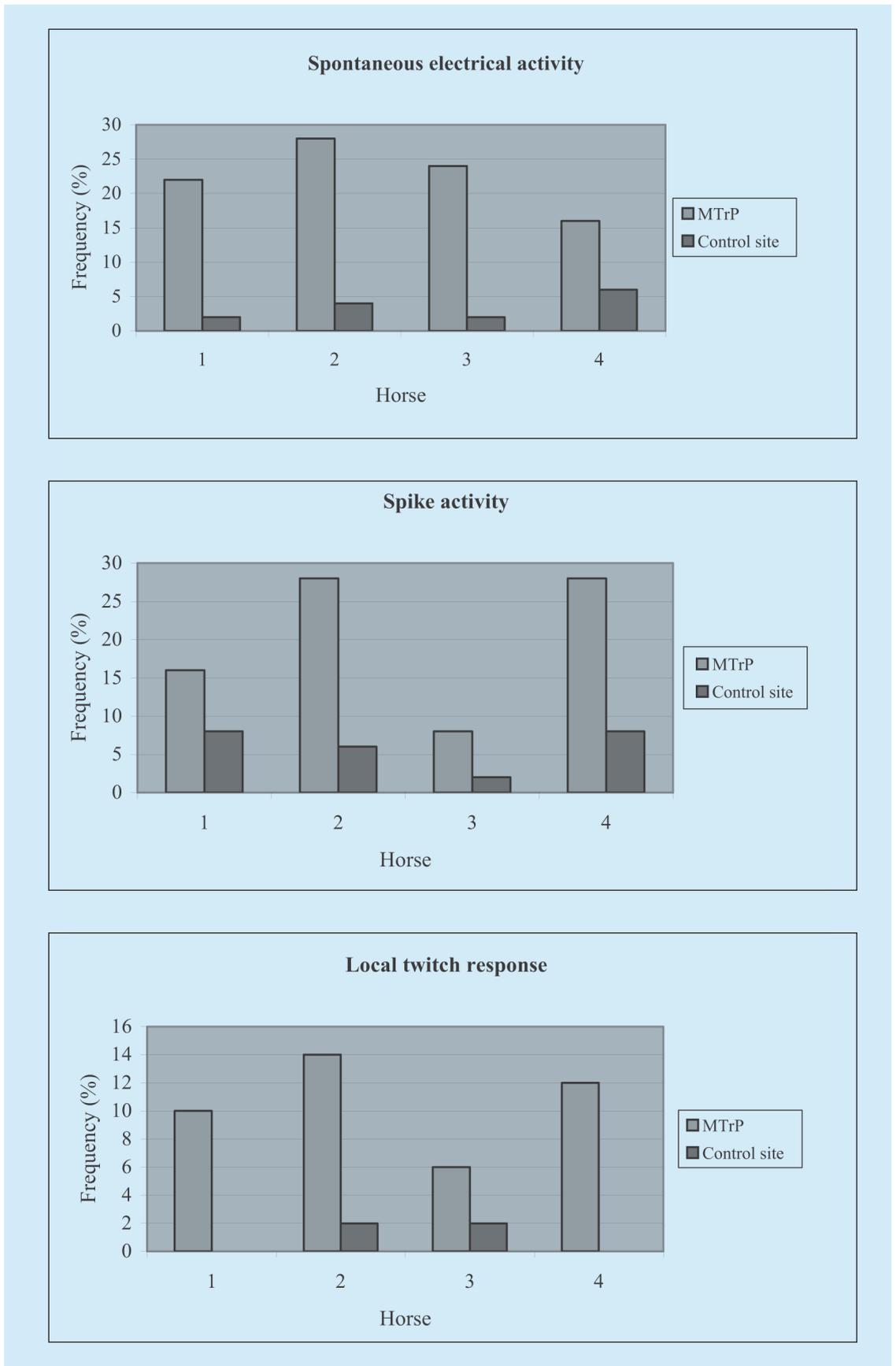


Figure 3 Frequency of spontaneous electrical activity (SEA), spike activity and local twitch response (LTR) at myofascial trigger points (MTRP) and control sites.

The search needle at the MTrP was used to explore this site for electrical activity by directing the needle in five directions (perpendicular, and at a 45 degree angle north, east, south and west) testing five depths roughly 1cm apart as previously described.<sup>14</sup> Therefore a total of 25 needle positions were examined at each MTrP. This procedure, although more standardised, mimics the second author's approach to dry needle treatments in searching for LTRs of secondary MTrPs near the primary MTrP and is well tolerated by most horses. The needle advances were made as slowly as possible by gently rotating the needle so as to minimise any insertional activity.<sup>16</sup> If insertional activity was seen then the needle was left in situ to allow the electrical activity to stabilise.

During the needling, the first author recorded manually how many of the 25 positions tested showed each of the following properties:

1. SEA: continuous electrical activity with an amplitude at least 10 $\mu$ V greater than the baseline shown at the control point and generally an amplitude of more than 20 $\mu$ V
2. Spike activity: at least 100 $\mu$ V in amplitude fitting the irregularly recurring pattern of those described in the literature<sup>19,33-35</sup>
3. LTRs within the taut band elicited during needling.

If SEA was found, the MTrP was considered to be an active locus.

The control site (LI17 or ST10) was then examined with the needle inserted there attached to channel 2, following the same procedure. The needle at the MTrP was left in an electrically quiet position to serve as the control needle.

#### Data analysis

For the purpose of the statistical analysis, the counts (ie the number of positive events recorded at 25 locations at each site) for SEA, spike activity and LTR from both sides were added together for each horse for both experimental and control conditions, since data from opposite sides were not considered to be independent. Data from all four horses were then combined, and were not normally distributed. Finally, counts at MTrP and control site were compared using a non-parametric test, the Wilcoxon sign test (one-tailed), with statistical significance set at  $P < 0.05$ .

#### Results

Samples of SEA and spike activity were recorded in order to analyse their typical electrical activity. Two types of waveforms were observed at the MTrPs: continuous low amplitude activity that sometimes reached an amplitude of 80 $\mu$ V peak to peak, and intermittent bursts of high amplitude spike activity of at least 100 $\mu$ V in amplitude and sometimes reaching 1000 $\mu$ V. The spikes were usually bipolar with an initial negative polarity and they lasted approximately 3-7ms. A typical example of the needle EMG activity recorded at MTrP and control sites during an LTR elicited during needle examination are shown in Figure 2. This MTrP shows continuous low amplitude (around 28 $\mu$ V) background noise (SEA) with intermittent bursts of spike activity ranging from 133-248 $\mu$ V. The EMG activity of the control site remained at a low amplitude of no greater than 16 $\mu$ V during this recording.

The counts recorded for SEA, spike activity and LTR for 25 positions on left and right sides of each horse are shown in Table 1. The frequency counts, expressed as percentages of the maximum possible scores (50) are presented graphically in Figure 3. The differences between the frequencies of occurrence of SEA, spike activity and LTR at the MTrPs and control sites were all significant ( $P < 0.05$ ).

#### Discussion

The horses included in this study clearly demonstrated three of the objective clinical signs which are reported by many authors as common clinical characteristics of MTrPs in human musculoskeletal medicine.<sup>3,5,36</sup> These included:

1. Palpable taut band of skeletal muscle
2. A spot of localised tenderness to manual pressure
3. An LTR within the taut band elicited by snapping palpation and needling.

It is not possible to identify the referred pain pattern or pain reproduction in animals, as in humans. However, as well as showing some important clinical similarities between equine and human MTrPs, this study demonstrated that the type of electrical activity found in MTrPs in the cleidobrachialis division of the equine brachiocephalic muscle was consistent with spontaneous electrical activity (SEA) found in MTrPs in human and rabbit studies.<sup>9-11,13-16</sup> This type of electrical activity was interpreted by some as

muscle spindle hyperactivity;<sup>11:18</sup> however, the EMG findings in this study are consistent with classical EMG studies of endplate activity,<sup>33-35</sup> which consists of two components:

1. Endplate noise which arises from miniature endplate potentials. This consists of frequently recurring, irregular, low amplitude, monophasic and initially negative potentials up to 80 $\mu$ V in size and of 1-2ms duration. This activity appears noise-like on the EMG recording and sounds like a seashell held to the ear<sup>33</sup>
2. Endplate spikes which are usually biphasic, initially negative and are 1-3ms in duration and range from 100-600 $\mu$ V in amplitude.<sup>32-34</sup>

The activity recorded at equine MTrPs in this study (Figure 2) has all of the characteristic features of endplate noise. It has been demonstrated in studies of rat muscle that normal endplate potentials could be converted to abnormal noise-like activity by applying mechanical stress to the endplate. Once it became abnormal this endplate noise remained abnormal.<sup>34</sup> The most likely explanation for a noise-like pattern arising at MTrPs is the excessive release of acetylcholine (ACh) which can be sufficient to reach the depolarisation threshold of the muscle membrane and can result in propagation of negative-positive potentials (NPPs).<sup>19</sup> This sustained depolarisation can produce contracture of sarcomeres and contribute to the formation of taut bands, is proposed in the 'Integrated trigger point hypothesis' by Travell and Simons.<sup>7</sup>

There was some EMG activity seen at the control sites measured in this study. This is not unusual and has been noted in previous studies of MTrPs in rabbits and humans.<sup>14:16</sup> The explanation given by Simons et al is that these loci found at control sites represent potential MTrPs that have not yet developed sufficient sensitisation to produce LTRs and that they occur in a taut band too small to be identified.<sup>16</sup> In horses there may well be taut bands which lie too deep to be found by palpation and it is possible that some of these were encountered at the control site. The fact that the control site was an acupuncture point may have also been relevant to the finding of occasional active loci and LTRs. In previous studies, Melzack and colleagues, and Hong have reported 71-75% correlation between acupuncture points and MTrPs.<sup>30:31</sup> In this study, acupuncture points were

used as the control sites in order to avoid unnecessary needling, and were checked carefully to ensure that there were none of the clinical signs of an MTrP. It would be interesting to compare EMG recordings from normal muscle tissue that is not an acupuncture point.

In this study, one important factor which could explain the background activity at control points is that the horses were standing and therefore their brachiocephalic muscle was continually active. In human studies the patient is usually lying down and is encouraged to relax the muscle being examined,<sup>14</sup> and in rabbit studies the subjects are anaesthetised.<sup>1:15:17</sup> If it were ethically acceptable, it might be interesting to see whether sedating horses would have any effect on the background activity at the control site which would influence the difference seen between this and the MTrP.

In a blinded study of EMG activity in the human infraspinatus muscle by Couppé et al, the amplitude was recorded in terms of root mean square (RMS) and although there was some endplate activity found at the control point the RMS values were significantly less than those recorded at the MTrP.<sup>14</sup> Although the technology was unavailable to measure the RMS values in this study, it was still noted that the amplitude of SEA at the active loci within an equine MTrP was at least 10 $\mu$ V greater than at the control site. These observations were made purely by reading the screen, but in future studies it would be useful to employ a system to enable more accurate measurements to be made.

Although the sample size was small, there was a significantly greater frequency in the occurrence of SEA and spike activity at equine MTrPs compared to control sites, suggesting that more active loci exist in an MTrP than at a control site in equine skeletal muscle. The activity often disappeared if the recording needle was advanced or withdrawn as little as a few millimetres, suggesting that active loci are probably no bigger than a few millimetres, as in human and rabbit studies.<sup>1:11:17</sup> In a study of MTrPs in rabbit skeletal muscle, SEA was observed in 100% of MTrPs examined but only 57% of control points, supporting the belief that these potentials are characteristic of minute active loci within MTrPs.<sup>16</sup>

There was a significantly greater number of LTRs produced during needle examination of the MTrP compared to the control site. These findings also

support the concept that a single MTrP contains a number of irritable active loci that are independently responsive to needle stimulation.<sup>2</sup> The fact that the equine LTR occurred specifically within the fibres of the taut band and showed characteristic EMG activity (Figure 2) would seem to indicate that the equine LTR is similar to that investigated in previous studies of human and rabbit MTrPs.<sup>1,2;19;29</sup>

The main criticism of this study is that there are too few subjects; however, some statistically significant results have been achieved even with such a low number. It would be interesting to repeat the study with a larger sample, which could allow the use of more sensitive tests such as analysis of variance (ANOVA). In addition, future studies should consider blinded examination of the MTrP and control site to avoid risks of operator bias.<sup>14</sup>

### Conclusion

The results of this study support the idea that MTrPs exist in equine skeletal muscle and that they show some of the objective signs that are found in humans. The needle EMG activity found at MTrPs in equine skeletal muscle consists of low amplitude noise-like activity, or SEA, and high amplitude spikes. The prevalence of SEA, spike activity and LTRs at MTrP sites was significantly greater than at control sites within equine skeletal muscle. This type of electrical activity is analogous to that found in similar studies of MTrPs in human and rabbit skeletal muscle. These sites might be responsive to acupuncture needling.

### Acknowledgements

The authors wish to acknowledge Andrew Bishop from Oxford Medical Instruments for providing the electromyographic equipment and technical assistance; Vicky Reis, practice nurse and owner of horse 2; the other horse owners who consented to this study; the staff at the Equine Veterinary Clinic.

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