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The effects of training aids on the *longissimus dorsi* in the equine back

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Abstract

This study aimed to determine whether training aids (side reins and a Pessoa) increased the use of the *longissimus dorsi* when horses are being lunged. Horses were lunged on a circle under four different conditions on the left and right reins in walk and trot, and electromyographic (EMG) and speed measurements were taken using surface EMG at T16 and GPS, respectively. The EMG intensity was substantially greater for the *longissimus dorsi* on the inside of the circle. Differences occurred in both the timing and the intensity of the EMG between the conditions. At walk, the EMG intensity was the greatest for the control condition and at trot the EMG intensity was the greatest for the control and Pessoa control conditions. It is concluded that the training aids of side reins and a Pessoa do not increase the use of the *longissimus dorsi* to stabilise the back.

Keywords: *longissimus dorsi*; lunge; training aid; EMG

Introduction

Disorders of the thoracolumbar spine exist in the form of soft tissue injuries, principally involving the *longissimus dorsi*[1]. All types and ages of horses can be affected where the muscle spasm can have a significant impact on performance. Rehabilitation of the longissimus is therefore very important to the equine.

The positive role of equine training aids has been reported for over 300 years, but their scientific value has never been tested. Training aids such as side reins appear to assist in the development of the dorsal muscles, including the *longissimus dorsi* that assists in stabilising the back[2]. Back stabilisation is achieved in conjunction with the abdominal muscles, which together act as a 'bow and string' resisting excess dorsal and ventral flexion of the spine[3]. Greater use of the hindlimbs is achieved when the horse has a low head position (where the poll is at the same level or below the level of the wither) and a wider head/neck angle[4]. This effect of lightness of the forehand and the engagement of the hindquarters, originating in a lively impulsion, is desired and follows the Federation Equestre Internationale Rules for Dressage[5]. In order to use the hindlimbs in this way, the horse must activate its dorsal and ventral muscles to stabilise the back against excessive flexion/extension, in addition to their function of stabilising lateral flexion and axial rotation. Side reins and the Pessoa training aid are training aids that aim to achieve this and so are used to develop these top line and abdominal muscles.

The purpose of this study was to measure changes in the activity of the *longissimus dorsi* when a horse was being lunged on a circle with no aids, with side reins and with a Pessoa during both walk and trot. We hypothesised that the electromyograms (EMG) in the *longissimus dorsi* activity at T16 increase when lunged in side reins and increase further when lunged in a Pessoa when compared with the control condition.

Materials and methods

Horses

Nine privately owned horses were studied (eight geldings, one mare; 7.8 ± 1.3 years; height at withers 1.61 ± 0.03 m, mean ± SEM). Examination by a veterinary surgeon confirmed that each horse was clinically free of lameness.

Data collection

Horses were lunged around a 15 m-diameter circle, marked with poles, in an outdoor school. Initially, each horse was lunged at walk and trot to determine its comfortable speed: a metronome was set to allow this speed to be repeated during testing and the speed was monitored using a global positioning system (Trine, Emtac, Byron, MN, USA) attached to an elasticised surcingle. Surface EMG were measured on the left and right *longissimus dorsi*, 9 cm from the midline at segment T16 using previously published methods[6]. The time of left forefoot contact was measured using an accelerometer attached to the hoof wall, and recorded with the EMG at 1000 Hz onto a palmtop computer mounted on the surcingle. All four limbs were bandaged.

EMG was initially recorded for 180 s of standing. EMG was measured in the (a) control condition with no aids followed by a randomised order of (b) side reins and (c) Pessoa training aid, Pessoa, which is a training system that encourages epaxial muscle development using a line around the quarters and two further adjustable side lines on pulleys. A middle position encourages the horse to stretch down and work from behind with an open head/neck angle and (d) control with only the back strap of the Pessoa on (Pessoa control). The training aids were fitted so that both aids opened the head/neck angle to the same amount and the Pessoa added the hindleg strap to increase hindleg engagement. The head/neck angle was created for each horse by having the horse's nose vertical when it reached the end of the length of the side reins or Pessoa. This was a natural position for the horse's neck and head and meant that the horse's poll was just above the withers. All the horses were accustomed to the side reins and only one (which was considered as being up to elementary dressage level) had not used the Pessoa prior to data collection. These experimental conditions were repeated for left and right reins at both walk and trot. For each trial, 180 s of data were collected.

Data analysis

The intensity of the EMG is an approximation to the power of the signal and was calculated after first removing ECG artefacts from the signal[6]. Around 100 strides were analysed for each trial. The mean intensity was calculated for each stride, and was classified as to whether it occurred from the *longissimus dorsi* on the inside or the outside of the lunge circle. The effects of horse, gait, condition and direction on the lunge speed were determined by ANOVA. The effects of horse and condition on the EMG intensity were calculated by ANOVA. Where significant ($P < 0.05$) effects were identified, they were characterised by *post hoc* Tukey tests.

Results

There was no significant effect of the condition on the walk or trot speeds, and these were 1.45 ± 0.04 and $3.28 \pm 0.11\,\mathrm{m\,s^{-1}}$ (mean ± SEM) for the walk and trot, respectively. At walk, there was a significant effect of the condition on the stride duration that reduced by 0.7, 0.7 and 1.2% for the Pessoa, side rein and Pessoa control, respectively. At trot, there was a significant effect of the condition on the stride duration that reduced by 2.3, 2.3 and 0.7% for the Pessoa, side rein and Pessoa control, respectively. A total of 7104 strides were analysed at walk, and 11,643 strides at trot. Bursts of EMG intensity were observed in both halves of the gait cycle for both walk and trot, and the intensity was substantially greater for the *longissimus dorsi* on the inside of the circle. Differences occurred in both the timing and the intensity of the EMG between the conditions (Fig. 1). At walk, the EMG intensity was the greatest for the control condition (Fig. 2a) and at trot the EMG intensity was the greatest for the control and Pessoa control conditions (Fig. 2b). The data did not support the hypothesis that the EMG from the *longissimus dorsi* at T16 lunged in side reins and a Pessoa would be greater that for the control condition.

Discussion

It has been generally accepted that the *longissimus dorsi* is used to stabilise the back since Strasser[3] proposed the 'bow and string theory'. This theory suggested that the forelimbs and hindlimbs–as well as the abdominal and axial muscles–were all involved in controlling trunk movement. The argument that a low head position and greater engagement of the hindlimbs is the best way to improve equine trunk muscle development goes back some 200 years. It is generally thought that the Pessoa system of ropes and pulleys encourages greater involvement of the *longissimus dorsi* and is useful for developing and maintaining muscle tone that can aid the horse to perform well at any level.

The results from this study have shown a substantial increase in the activity of the *longissimus dorsi* on the inside of a turn. The maximum EMG intensity on the inside can be two to three times greater than that on the outside *longissimus dorsi* (Fig. 1), and this results in a 20–30% increase in intensity when averaged across the whole stride (Fig. 2). These increases in EMG are associated with the greater lateral flexion required to turn, and are consistent with our previous reports of walking around a tight figure-eight course[6].

EMG increases with speed[7] and thus it was important to control this factor in order that we could be confident that differences in EMG between conditions

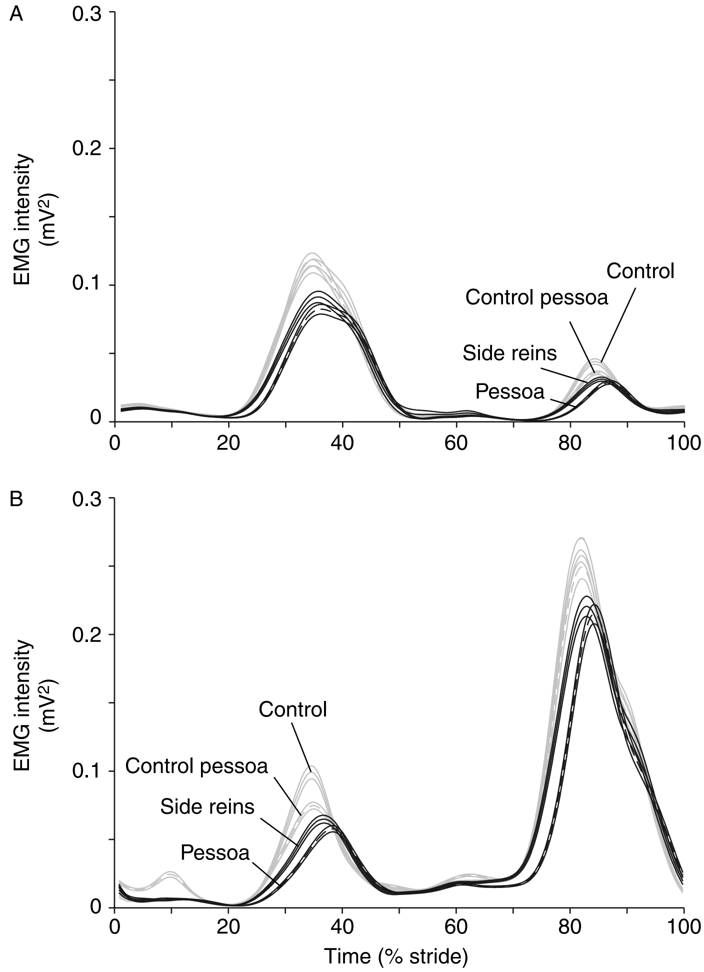

Fig. 1 EMG intensity at trot from the *longissimus dorsi* at T16 when using different training aids. Data show the mean ± SEM intensity for the EMG intensity for one horse for the right (A) and left (B) *longissimus dorsi* when trotting on a left rein. Time is shown as a proportion of the stride cycle that begins with the left forefoot contact. Control conditions are shown by the grey lines: control as solid and Pessoa control as dashed. Training aids are shown by the black lines: side reins as solid and Pessoa as dashed

were due to the condition and not the speed. Allowing natural speed to be chosen increases the standardisation of EMG patterns where data are more repeatable when the subject adopts its natural pace[8]. In this study, the lunger ensured the same speed by encouraging the horse from behind with the whip as required. At times, it was difficult to control the speed because the training aids cause the horse to shorten its stride with a shorter neck length[9]. The different head positions, from a wider head/neck angle in the control to a more closed one in the training aids conditions, may have affected the *longissimus dorsi* use and this is a factor that warrants further investigation.

This study showed the surprising result that the training aids did not promote the greatest activity in the *longissimus dorsi* (Fig. 2). During walking, the muscle activity was greatest during the control phase and lowest during the Pessoa control phase. These differences in activity may be because the swing of the free walk in the control meant more muscle activity was needed to brace against limb and head movement. It may be that a horse requires more longissimus activity to control a freely swinging walk than a shorter-striding collected walk, and this idea would be supported by the fact that the next lowest level of muscle activity is with the side reins and the next lowest again with the Pessoa. The horse is therefore using less longissimus activity as stride length is shorter (with the Pessoa) so less trunk control is needed. In trot, the *longissimus dorsi* muscle activity was the highest when using the Pessoa control condition. This opposite effect to the walk may again be due to hindlimb activity, but this time due to an increase in activity because of the faster gait and earlier

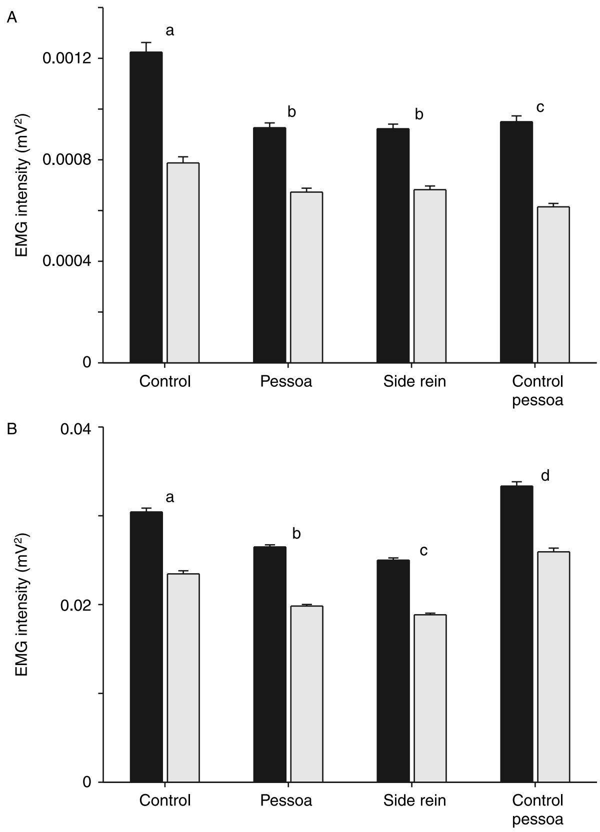

FIG. 2 EMG intensity at walk (A) and trot (B) from the two sides of the *longissimus dorsi* both with and without training aids. Bars show the mean ± SEM. EMG intensity from the *longissimus dorsi* on the inside of the lunge circle is shown in black and that from the outside in grey. Different letters denote significant differences between the conditions (*post hoc* Tukey tests from ANOVA)

feedback of the hock strap. The next level of muscle activity was in the control condition followed by the Pessoa and then side reins. Both walk and trot results indicate that the best way to increase the use of the *longissimus dorsi* may be to use fewer training aids rather than more. However, it should be remembered that we currently do not know the effect of training aids on the deeper muscles such as the *multifidus* that can also stabilise the back[10].

The EMG data show that the EMG in the *longissimus dorsi* is reduced with the training aids. It is possible that the training aids increase abdominal muscle activity, but this would need to be established in future. The results indicate that these training aids do not promote increased activity in the *longissimus dorsi* during training and rehabilitation and so it will be important to identify other methods to help strengthen the back of the injured or weak horse. The results do demonstrate, however, that the *longissimus dorsi* has greater activity when on the inside of a lunge circle and so it could be argued that simply lungeing a horse on a circle will help to promote activity in its *longissimus dorsi*. It remains to be seen whether such increases in *longissimus dorsi* activity are beneficial or not.

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References

1 Jeffcott L (1980). Disorders of the thoracolumber spine of the horse – a survey of 443 cases. *Equine Veterinary Journal* **12**(4): 197–210.

2 Rooney J (1982). The horse's back: biomechanics of lameness. *Equine Practice* **4**(2): 17–27.

3 Strasser H (1913).Textbook of muscle and joint mechanics *Lehrbuch der muskel- und gelenk-mechanik*. (cited by Slipjer, 1946 in Comparative biologic-anatomical investigation on the vertebral column and spinal musculature of mammals. *Proceedings of the Koninklijke Nederlandse Akademie van Wetenschappen (Tweed Sectie)* (**47**): 1–128) Berlin: Springer.

4 Roepstorff L, Johnston C, Drevemo S and Gustas P (2002). Influence of draw reins on ground reaction forces at the trot. *Equine Veterinary Journal Supplement* **34**: 349–352.

5 Anon (2003). Rules for dressage Federation Equestre Internationale (FEI), Avenue Mon Repos 24, PO Box 157, 1000 Lausanne 5, Switzerland.

6 Wakeling J, Barnett K, Price S and Nankervis K (2006). Effects of manipulative therapy on the longissimus dorsi in the equine back. *Equine and Comparative Exercise Physiology* **10**: 1–8.

7 Robert C, Valette JP, Pourcelot P, Audigie F and Denoix JM (2002). Effects of trotting speed on muscle activity and kinematics in saddlehorses. *Equine Veterinary Journal Supplement* **34**: 295–301.

8 Wootton M, Kadaba M and Cochran G (1990). Dynamic electromyography. II. Normal patterns during gait. *Journal of Orthopaedic Research* **8**(2): 259–265.

9 Holmstrom M, Fredricson I and Drevemo S (1995). Biokinematic effects of collection on the trotting gaits in the elite dressage horse. *Equine Veterinary Journal* **27**(4): 281–287.

10 Stubbs NC, Hodges PW, Jeffcott LB, Cowin G, Hodgson DR and McGowan CM (2006). Functional anatomy of the caudal thoracolumbar and lumbosacral spine in the horse. *Equine Veterinary Journal Supplement* **36**: 393–399.