Title: *(Use Normal style (Times New Roman 12). Only capitalise the first letter of the first word. No full stop at the end of the title)*

Electromyographic and kinematic evaluation of movement and muscle activity in horses with temporary forelimb lameness induction: a preliminary report

Summary: *(Your summary (Times New Roman 10) must use Body text style and must not be longer than this box)*

Application Understanding muscular adaptations could inform objective lameness-detection for early diagnosis/ treatment, ultimately serving to detect sub-clinical issues in supposed healthy horses and to reduce pain/ incapacity in lame horses.

Introduction The prevalence and impact of lameness on equine welfare has led to extensive research, which has biomechanically analysed lameness-related alterations in movement. Despite this, limited information is available about adaptive muscle activity that facilitates movement during lameness. Surface electromyography (sEMG) is a non-invasive method for quantifying muscle activity. However, no equine studies have employed sEMG to compare inherent and adaptive activity during non-lame and standardised lameness conditions, respectively. The aim of this preliminary study was to compare *Triceps Brachii* (TB) muscle activity in horses before and after induced forelimb (FL) lameness, using sEMG data.

Material and methods Six clinically non-lame horses (5 mares, 1 stallion, age: 7.0±3.7 years, height: 162.3±4.0 cm, body mass: 572.7±45.8 kg) were used. sEMG sensors (Delsys Trigno, Delsys Inc.) were attached bilaterally to locations above TB (long head), that were prepared by removing all hair and cleaning with isopropyl alcohol. Retro-reflective markers were attached to anatomical landmarks for quantitative lameness evaluation (QHorse, Qualisys AB) and gait event detection. sEMG (2000 Hz) and 3D kinematic (200 Hz) data were synchronously collected from horses during in-hand trot trials, conducted on a straight, hard surfaced runway before (baseline) and after FL lameness induction. Baseline data were initially collected, then temporary, mild FL lameness (2-3/5 AAEP Lameness Scale) was induced using mechanical bolt pressure, applied to the tip of the frog and monitored by qualified veterinarians (T.S., F.S.B.) using a modified horseshoe (Merkens and Schamhardt, 1988). Left and right FL lameness induction were randomised. Following data collection, the bolt/ sole pressure was removed and no horses showed adverse reactions to lameness inductions, or residual lameness. For stride segmentation, gait events were detected using kinematic data that were low-pass filtered (Butterworth 4th order, 10 Hz cut-off) and analysed in accordance with the methods described by Holt et al. (2017). To quantify lameness, MinDiff was calculated using poll vertical displacement data, where healthy horses exhibit MinDiff between -6 – 6mm and left and right FL lameness are exhibited as more positive and negative values, respectively (Rhodin et al. 2016). Raw sEMG signals were DC-offset removed, high-pass filtered (Butterworth 4th order, 40 Hz cut-off) (St. George et al., 2018), and full-wave rectified. Integrated EMG (iEMG) and average rectified value (ARV) were calculated using stride duration as temporal domain. To reduce inter-subject variability, iEMG and ARV from each horse were normalised to the maximum value observed for each limb (left/ right FL) across all strides from the baseline condition. Data from the "lame" and "non-lame" limb were grouped, according to the limb where lameness was induced. A 2x2 repeated measures ANOVA was used to compare muscle activity between limb (lame, non-lame) and condition (baseline, induced FL lameness). Post-hoc analyses using Bonferroni correction were performed where significant main effects were found.

Results Mean ± sd MinDiff were baseline:-1.8 ± 8.7 mm, left FL lameness induction:-55.3 ± 34.1 mm, right FL lameness: 56.8 ± 17.9 mm. Significant interactions between limb and condition were found for iEMG ($p<0.05$, $n^2=0.74$) and ARV ($p<0.05$, $n^2=0.75$). Post hoc analyses of iEMG and ARV data revealed muscle activity was significantly higher in the lame limb ($p<0.05$) and significantly lower in the non-lame limb ($p<0.01$) during the induced FL lameness condition.

Conclusion Preliminary findings reveal neuromuscular adaptations in TB during induced FL lameness. Significant increases in stance duration have been reported during FL lameness (Weishaupt et al. 2006). Therefore, significant increases in lame limb muscle activity may be due to prolonged stabilisation of the shoulder and elbow joints, as a compensatory mechanism of gait adaptation to lameness. Further investigations of additional muscles and chronic lameness cases are required to determine whether sEMG can provide a complimentary tool for objective lameness detection.

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