The Veterinary Journal 197 (2013) 245–252

Contents lists available at SciVerse ScienceDirect

The Veterinary Journal

journal homepage: www.elsevier.com/locate/tvjl

The effect of trotting speed on the evaluation of subtle lameness in horses

Sandra D. Starke [a,b,*], Kirsty J. Raistrick [a], Stephen A. May [a], Thilo Pfau [a,b]

[a] Department of Veterinary Clinical Sciences, The Royal Veterinary College, North Mymms, Hatfield AL9 7TA, UK
[b] Structure and Motion Laboratory, The Royal Veterinary College, North Mymms, Hatfield AL9 7TA, UK

ARTICLE INFO

Article history:
Accepted 1 March 2013

Keywords:
Horse
Lameness
Speed
Gait analysis
Trot

ABSTRACT

Equine lameness is a significant and challenging part of a veterinarian's workload, with subtle lameness inherently difficult to assess. This study investigated the influence of trotting speed on perceived and measured changes in movement asymmetry. Ten sound to mildly lame horses were trotted at a 'slow', 'preferred' and 'fast' speed on a hard surface, both on a straight line and in a circle on left and right reins. Video recordings of the horses were visually assessed by six experienced equine clinicians. Vertical movement of head, withers and pelvis was derived from inertial sensor data and several features calculated.

On the straight line, more horses were subjectively declared sound at higher speeds, whilst different objective asymmetry measures showed only slight and inconsistent changes. On the circle, speed had no significant effect on the subjective assessment, with an increase in objectively measured asymmetry at higher speeds possibly balanced by a decrease in sensitivity of the observers for this asymmetry. Horses visually examined for subtle lameness on the straight should therefore be evaluated at a slow speed. Trotting speed should be consistent on repeated occasions, especially during objective gait analysis on the circle, to avoid the interaction of treatment effects and speed effects.

Introduction

Lameness is the most frequent equine health issue, affecting approximately 11% of horses in the UK (Blue Cross, 2011). The associated cost, welfare and training implications have long been highlighted (Jeffcott et al., 1982; Kaneene et al., 1997; Vigre et al., 2002; Keegan, 2007; Dyson et al., 2008; Egenvall et al., 2009). Correctly detecting the onset of lameness is essential for early intervention, with treatment of lameness increasing the prospect of recovery (Ross et al., 1999). Although a controlled study in horses is currently lacking, early lameness detection and treatment in dairy cows resulted in reduced disease severity, fewer additional treatments and lower lameness prevalence compared to controls (Leach et al., 2012).

Despite the impact of lameness on the use and welfare of horses, subtle lameness is inherently difficult to quantify; visual assessment is often less sensitive than technology (McCracken et al., 2012) while being confounded by observer disagreement (Keegan et al., 1998, 2010) and bias (Arkell et al., 2006). Further, the human visual system has limitations in detecting changes (Holcombe, 2009) and the magnitude of perceivable asymmetry is likely restricted (Parkes et al., 2009).

Limited tools are available to the clinician for determining subtle gait irregularities in a clinical setting. Attaching visual aids such as white tape to both sides of the pelvis can help make subtle hind limb asymmetry more obvious to the eye (May and Wyn-Jones, 1987; Wyn-Jones, 1988). To exacerbate lameness, horses are commonly lunged on a hard and soft surface (Wyn-Jones, 1988; Baxter and Stashak, 2011; Ross, 2011a) and evaluated after provocation tests such as limb flexion (Wyn-Jones, 1988; Baxter and Stashak, 2011; Ross, 2011b). However, circling introduces speed and diameter-dependent movement adaptations and asymmetry even in sound horses (Clayton and Sha, 2006; Hobbs et al., 2011; Starke et al., 2012a; Pfau et al., 2012) and flexion tests are prone to 'false positives' (Wyn-Jones, 1988; Ramey, 1997; Verschooten and Verbeeck, 1997; Busschers and Van Weeren, 2001; Baxter and Stashak, 2011; Ross, 2011b; Starke et al., 2012c). Further tests such as ridden exercises (Baxter and Stashak, 2011; Ross, 2011a) can suffer from the influence of the rider on the gait (Wyn-Jones, 1988; Licka et al., 2004).

Trotting speed is one of the parameters that can vary, either intentionally or unintentionally, during the gait examination. Textbooks generally recommend to trot the horse 'as slowly as practical' (Baxter and Stashak, 2011), 'slow' (Wyn-Jones, 1988) or 'at a consistent speed, not too slow and too fast' (Ross, 2011a). While higher speeds often exacerbate prominent baseline lameness (Peham et al., 2000; Chateau et al., 2007), sound and subtly lame horses do not show this systematic change for moderate speed ranges (Peham et al., 1998, 2000; Halling Thomsen et al., 2010). However, since movement pattern inconsistency may cause disagreement between observers (Wren et al., 2005), consistency being greatest at the 'preferred' or faster speeds in horses on the

* Corresponding author at: Department of Veterinary Clinical Sciences, The Royal Veterinary College, North Mymms, Hatfield AL9 7TA, UK. Tel.: +44 1707 666425.
E-mail address: sstarke@rvc.ac.uk (S.D. Starke).

1090-0233/$ - see front matter © 2013 Elsevier Ltd. All rights reserved.
http://dx.doi.org/10.1016/j.tvjl.2013.03.006

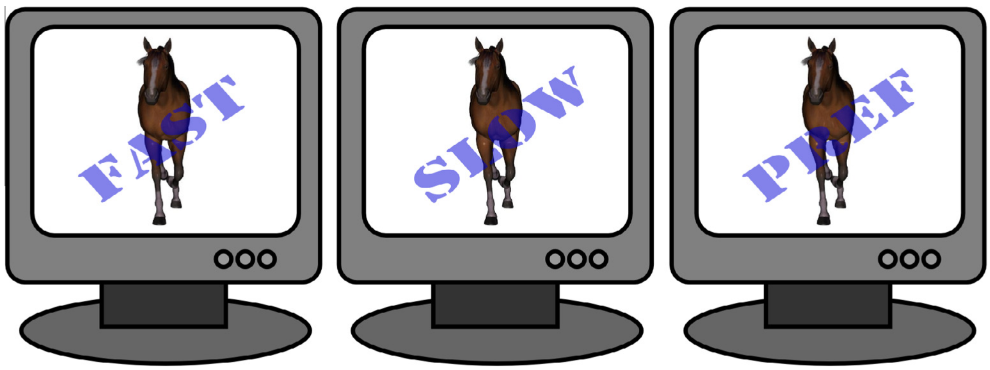

Fig. 1. Sketch of the monitor setup for subjective grading. Three adjacent monitors showed the same horse during 'slow', 'preferred' (pref) and 'fast' trot either in a straight line, on the left rein or on the right rein. The three clips were randomly distributed between the three monitors.

treadmill (Peham et al., 1998), it could be advisable to select a normal to fast trot when evaluating horses with subtle lameness. To date, this relationship has not been tested.

Trotting speed affects most movement features even in sound horses; examples are stride frequency/duration, stance time and stride length (Leach and Drevemo, 1991; Van Weeren et al., 1993; Clayton, 1994; McLaughlin et al., 1996; Galisteo et al., 1998), limb angles (Van Weeren et al., 1993; Clayton, 1994; Galisteo et al., 1998), trunk flexion angles (Robert et al., 2001), features of ground reaction force and impulse (Barr et al., 1995; McLaughlin et al., 1996; Dutto et al., 2004; Weishaupt et al., 2010) as well as muscle activation (Robert et al., 2002). While sound horses show a repeatable 'preferred' trotting speed when led by the same handler (Degueurce et al., 1997; Galisteo et al., 1998), lame horses tend to increase their speed after successful local analgesia or surgery (Peham et al., 2000). Especially when re-examining a horse after intrasynovial and perineural analgesia, treatment or prolonged time intervals, it is therefore crucial to keep the trotting speed consistent for reproducible results (Peham et al., 2000; Dyson, 2011; Ross, 2011a) and avoid the interaction of treatment effects and speed effects.

The aim of this study was to compare the effect of trotting speed on subjective lameness scores and objective measurements in a group of sound to mildly lame horses on the straight and circle.

Materials and methods

Horses and instrumentation

This study was granted approval by the Royal Veterinary College (RVC) Ethics Committee.

Ten unridden horses belonging to the RVC's teaching herd with a mean (SD) age of 9 (3) years, mean (SD) body mass of 483 (56) kg, mean (SD) height at the withers of 1.41 (0.12) m and mean (SD) height at the hip joint of 1.26 (0.17) m were used. Horses were instrumented with five MTx inertial sensors (Xsens). These were attached over withers, sacrum and left and right tuber coxae using custom built pouches and Animal Polster (Snøgg) and over the poll using a custom made Velcro (Kornbond) attachment. Sensor data were collected at 100 Hz per individual sensor channel and transmitted via Bluetooth from an Xbus unit (Xsens), attached to a surcingle, to a nearby laptop computer. A GPS logger (Trine II, BTGPS) sampled speed at 1 Hz. GPS data were downloaded (CruxLog software) after each session for further processing.

Data collection

Horses were trotted in a straight line (approximately 45 m) and in a circle on the left and right rein (radius approximately 5–6 m) in randomised order at their 'preferred' trotting speed as well as a 'slow' and 'fast' trot determined by the handler. The surface was hard and level throughout, coated with non-slip tarmac. Video recordings (Sony HDR-HC7) were taken during data collection.

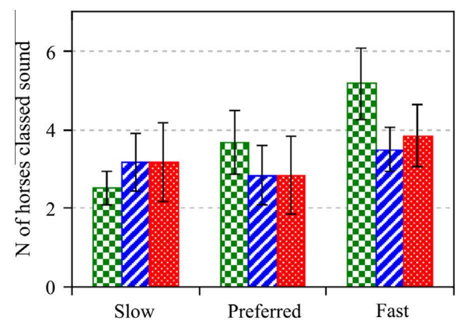

Fig. 2. Mean ± SEM number of horses declared sound at the three different trotting speed categories ('slow', 'preferred' and 'fast') across the six assessors. Green (checked), trot on a straight line; blue (striped), trot in a circle on the left rein; red (dotted), trot in a circle on the right rein.

Subjective assessment of lameness

For each horse, video clips showing the strides that matched objective analysis (see below) were created in Pinnacle Studio Pro (Pinnacle Systems). For each horse, three video series were created ('straight line', 'left rein' and 'right rein'). Each series contained three clips showing the horse trotting at the 'slow', 'preferred' and 'fast' speed (Fig. 1). The three clips of each series were randomly distributed between three adjacent, colour-calibrated (SpiderElite 3, Datacolour) 17 in. (43 cm) monitors (Dell, model E172FPt) and looped simultaneously using Windows Media Player (Microsoft). The order of the thirty video series was randomised per participant.

Six experienced veterinarians (on average 11.4 years of experience in assessing lameness, four participants having diplomate status) evaluated each video series for as long as desired, noting down the presence of lame limb(s) and the corresponding lameness score. The 11-point UK scale (Wyn-Jones, 1988; Dyson, 2011) ranging from 0 (sound) to 10 (non-weight bearing lame) was used for grading. After completion of the study, participants were asked to rank the difficulty in assessing lameness at the three speeds. The number of horses declared sound and the average assigned lameness scores to forelimbs and hind limbs during 'slow', 'preferred' and 'fast' trot were compared using a Friedman test (PASW Statistics 18; SPSS). Inter-observer agreement was calculated using the free marginal multirater kappa (Brennan and Prediger, 1981; Randolph, 2005; Warrens, 2010) using an online kappa (κ) calculator.[1]

Objective asymmetry quantification

Vertical (=aligned with gravity) acceleration of each inertial sensor was double-integrated and highpass filtered (cut-off frequency 1 Hz) to determine drift-free displacement (Pfau et al., 2005). Data were segmented into strides from early stance of the left hind limb (Starke et al., 2012b). Segmentation points were used to calculate stride frequency. For each horse, forty strides were used for trot in a straight line and 25 strides for trot on each rein.

The following measures (compare references below and see Starke et al., 2012a, for details) were calculated from the vertical displacement of each stride:

Symmetry indices (Uhlir et al., 1997):

[1] See: http://justusrandolph.net/kappa.