Equine Locomotion and Performance

Practical Assessment of Movement Symmetry in Horses: Use of Inertial Sensors during Clinical Lameness Exams

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Assessment of lameness is an everyday task for many veterinarians, it is an essential part of a prepurchase examination and the Royal College of Veterinary Surgeons (RCVS) has included it into the list if 'day one skills' for veterinary graduates. Recently, the first public National Equine Health Survey pioneered by the Blue Cross animal charity and supported by the British Equine Veterinary Association showed that lameness was the most common problem affecting 11% of the surveyed horses and lameness does not only compromise equine welfare and performance, but it also results in substantial financial costs to the equine industry.

Traditionally equine lameness is diagnosed by visual assessment combined with regional anaesthesia techniques (nerve blocks, joint blocks) in order to allow a targeted use of diagnostic imaging modalities to locate the source of the problem and subsequently recommend an appropriate treatment strategy. However, it has long been known that the gold standard for detection of lameness in horses, the human eye, is imperfect in its ability to accurately and repeatably detect the subtle movement symmetries that are observable in particular in mild hind limb lameness. It has been shown, that inter-observer variability is considerably influenced by experience (Keegan et al, 1998), that knowledge about administered regional anaesthesia techniques leads to intra-observer decision bias (Arkell et al, 2006), that the human visual system is limited in its ability to detect movement asymmetry (Parkes et al, 2009) and that the choice of scoring system influences inter-observer agreement (Channon et al, 2009, Hewetson et al, 2006). In particular for mild lameness, even very experienced observers often disagree about site and severity of the gait deficit (Keegan et al, 2010).

As a consequence, two types of biomechanical assessment techniques have been thoroughly investigated with respect to their appropriateness for detecting lameness: kinetic (force based) and kinematic (motion based) methods. In its simplest form, i.e. a unilateral deficit, lameness is characterised by movement asymmetry between the two stance phases of a pair of limbs. In more complicated cases, i.e. bi- or multilateral lameness, diagnostic techniques such as flexion tests, nerve or joint blocks or exercise on the lunge is utilised to amplify the effects and to induce detectable asymmetry.

Hence, kinematic methods (e.g. Buchner et al, 1996, Kramer et al, 2000) often aim to 'mimic' the visual exam performed by the clinician, and thus quantify one or several of the commonly used lameness (asymmetry) indicators - head nod, hip hike, fetlock drop or stride length to name a few (May and Wyn-Jones, 1987, Ross, Dyson, 2011).

Kinetic methods on the other hand allow for a more direct assessment of the source of the movement asymmetry - the forces acting on each limb during the stance phase (Weishaupt et al, 2004, 2006) and the location of the force under the hoof at different time points during stance (Williams et al, 1999).

Unfortunately, these highly accurate methods are based on 3D motion camera systems and/or force platforms, techniques that are in practice restricted to specialised gait laboratories often combined with treadmill exercise. In particular, assessing the horse under different conditions (e.g. on different surfaces or on the straight and on the lunge) requires the relocation and/or recalibration of these precision instruments. This is in practice prohibitive for the routine use in clinical lameness examinations.

Over recent years, the advent of miniaturised micro-electro-mechanical sensors (MEMS) and the improvement of range and bandwidth of wireless data transmission (e.g. bluetooth or WLAN) has resulted in the development of miniaturised inertial sensors that allow for an accurate assessment of linear and angular position, velocity and acceleration in 3D space (Pfau et al, 2005). We have successfully assessed locomotion of 'real-life' activities in horses (Parsons et al, 2008a,b, Pfau et al, 2006, Pfau et al, 2009, Robilliard et al, 2006, Starke et al, 2009). We and other research groups have recently concentrated on the practical assessment of lameness in horses (Church et al, 2009, Halling Thomsen et al, 2010, Keegan et al, 2004, Pfau et al, 2007, Walker et al, 2010a, Warner et al, 2010). At the Royal Veterinary College Equine Referral Hospital we now routinely employ our objective gait assessment system during clinical lameness exams in mildly lame horses to support our team of expert clinicians in the complex decision making process. The system comprises five inertial sensors mounted over strategic lameness related anatomical landmarks: poll, withers, sacrum and left and right tuber coxae. The sensors accurately quantify the vertical movement of lameness relevant anatomical landmarks during each stride and wirelessly transmit the data to a nearby laptop computer. The objective data then allow the calculation of published symmetry values and the comparison of these to published data for different groups of lame horses (e.g. Audigie et al, 2002, Uhlir et al, 1997).

Here we describe our inertial sensor system for practical and objective quantification of movement symmetry in horses and report results from recent on ongoing studies in different groups of sound and lame horses. The wireless unobtrusive nature of the system means that movement asymmetry of the horse can be easily assessed in different locations thus allowing objective assessment under conditions that are inherently difficult to assess with the traditional gait laboratory based techniques - e.g. on different surfaces, following nerve blocks or flexion tests (Walker et al, 2010b) and on the lunge (Starke et al, 2011). Through the collection of objective movement data from clinically relevant conditions the system will contribute to evidence based veterinary decision making, e.g. by collecting longitudinal data allowing to assess the efficacy of different treatment methods. In addition, the ease-of-use of the system together with the possible real-time feedback will be essential for the training of the lameness scoring skills of our veterinary graduates to accelerate their progress from novice to expert (Dreyfus and Dreyfus, 1986) and hence to improved welfare of the horse.

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