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Objective movement assessment
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Advances in wireless data transmission and miniaturisation of sensors have led to a ‘revival’ of gait analysis in horses which can now be performed outside the gait lab and provide quantitative measurements of a horse during the clinical lameness examination. Here we are giving an overview of inertial sensor based gait analysis, a technology providing freedom of movement to the horse and accurate and precise measurements in particular for upper body movement.

The 2 major indicators of front and hindlimb lameness are head nod [1] and hip hike [2]. In contrast to some other limb movement related parameters, these 2 upper body movement parameters are directly related to the biomechanical mechanism of providing weight support and propulsion. Hence they provide quantitative information using a limited number of asymmetry measurements readily comparable between exercises, such as during lungeing [3], after flexion [4,5] and diagnostic analgesia [6,7] and with rider [8].

In horses with movement symmetry values ‘within normal limits’ when trotted in-hand on the straight, the following movement adaptations have been reported on the lunge [3,9]: a mild increase in head downward movement during the outside front limb stance and a mildly increased movement amplitude of the inside tuber coxae. Due to the horses leaning into the circle (more so the faster they go and the smaller the circle) circle dependent asymmetries will be exacerbated. It is therefore paramount to control circle radius and speed when judging small circle dependent asymmetries (below the threshold of 25% of the human eye, [10]). When lungeing horses with induced lameness [11], compensatory movement adaptations mimicking an ipsilateral head asymmetry of almost the same magnitude as the primary induced pelvic movement asymmetry have been reported. On the lunge, horses with an induced forelimb lameness commonly show a mixed ipsilateral weightbearing and contralateral push-off hindlimb asymmetry, however resulting in only 20% of the primary induced head asymmetry. In particular on the lunge, a head nod may be related to an ipsilateral hindlimb problem.

Two studies [4,5] have quantified the effects of hindlimb flexion tests on pelvic movement asymmetry. Both report changes in pelvic movement for a positive flexion test reducing push-off with the flexed limb. Sensitivity and specificity compared to expert judgement was comparatively low [5] and may be explainable by high inter-horse variation [4]. Following flexion of the ‘unaffected’ limb, movement may be more symmetrical, effectively resulting in a bilateral lameness for a short time period. In general, movement asymmetry after an initial increase returns quickly to levels below the 25% threshold of human perception. Small changes in upper body movement symmetry related to diagnostic analgesia can be quantified with sensor-based systems. Quantifying head movement symmetry changes after anaesthesia of the palmar digital nerve or of the palmar digital nerve and its lateral branches [7] showed around 90% sensitivity and specificity for the quantified movement changes in comparison to expert categorisation into ‘positive’ or ‘negative’. Interestingly, negative blocks resulted in more asymmetrical movement while a minimal improvement by 0.2 mm should already be regarded as a positive effect. When investigating diagnostic analgesia in hindlimbs [6], the most sensitive parameters were related to either differences in weightbearing observed at the midline of the pelvis or to changes in movement amplitude differences between both tubera coxae. The latter is most sensitive when comparing upward movement of one tuber coxae during contralateral stance to its counterpart rather than comparing sheer movement amplitude.

Inertial measurement based gait analysis has allowed for quantification of a number of clinically relevant movement conditions. However, there is still much to investigate in particular in relation to lesion specific changes. Studies with clinically lame horses in relation to a confirmed diagnosis are needed to advance this field of research.

References