Systematic equine lameness localisation and the place of new technologies

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Introduction

Lameness is simply any alteration of the horse's gait, whether it's associated with pain or non-painful causes (e.g., neurological) related to the neck, vertebral column, withers, sacroiliac region, shoulders, hips, lower limbs, and hooves. The systematic evaluation of the lame horse is critical to making a correct diagnosis. The traditional approaches to the visual, physical and gait evaluations still have their place. Still, there are limitations, particularly concerning gait evaluation and the localisation of pain, that complicate the process of diagnosis. Further confusion can occur with the challenges of multi limb lameness and the daily variations in the severity of lameness. The goals of lameness examination are to identify lameness, and if present, the limb(s) affected and localise the lesion(s), make a diagnosis and treatment plan, provide a prognosis, and monitor recovery (Baxter *et al*., 2020). This presentation discusses these concepts and technological advances in lameness detection and localisation.

Lameness history

The horse's signalment and medical history may direct the focus of examination, but "pattern recognition" is not a substitute for a diagnostic approach. Key signalment features include breed, age, and occupation or use. Factors such as diet or dietary changes or changes in activity level may be important. For horses with a training schedule, training duration and any training changes may precipitate conditions causing lameness. Recent performance activities should be discussed. In some cases, this may direct the order of examination. For example, a young racehorse that has "pulled up" extremely lame after a race may be palpated and radiographed immediately as a screening test to rule out a fracture that could be exacerbated by gait evaluation. The onset of lameness, whether sudden or slowly progressive (i.e., chronic), is noted, any treatments given, and the horse's response should be queried. When was the horse last shod, and have there been any changes in shoeing? An open-ended enquiry of the perspectives and perceptions of the owner as rider, driver or trainer is often helpful.

Visual and physical assessment

Moving around the horse, its conformation, how it balances, and bears weight, wounds, scars, hair, or skin loss are noted. Horses with acute laminitis may adopt a sawhorse posture or be difficult to get to stand. The symmetry and musculature of the neck and back should be noted. The shoulders are examined for muscular symmetry and development, and the withers and limbs for symmetry in their contours, and an absence of any abnormal swellings. Similarly, the gluteal muscles are evaluated for development and symmetry; these may be poorly developed or asymmetric in chronic hind limb lameness. Each hoof pastern axis should be assessed, the balance of the hooves with each other, and the heel bulbs for each, as well as any wall defects are noted.

Advances in visual assessment: thermography

Digital thermography (DT) is a non-invasive imaging modality that provides a pictorial representation of heat emission patterns. Images are taken at a uniform distance from the patient, and when tissue is damaged, the change in perfusion may be detectable by DT. It should initially be performed prior to manipulation or exercise. DT is 10 times more sensitive to temperature change than touch. Repeated after exercise, it can detect asymmetry in thermal emission (e.g., saddle fit). The DT image is influenced by environmental conditions such as wind, sunlight, and humidity and requires an experienced operator to ensure valid images. It indicates a specific diagnosis in very few situations, and it is best used as a screening tool in conjunction with other imaging modalities (Soroko and Howell, 2018).

Palpation, manipulation, and closer inspection

This part of the examination is performed to identify sources of heat, pain and swelling (fluctuant, soft, firm or a combination thereof), range of motion and to facilitate closer inspection of the hooves. In busy practices this may occur after gait evaluation. However, important information may be missed if the incorrect limb is selected as the one most lame. After further noting hoof confirmation, the hoof testers are applied around the sole, across the frog, and across the heels noting any flinching, withdrawal, or postural changes in response. Careful palpation of the joints, bones and soft tissues of the limb requires detailed knowledge of anatomy. Pressure should be light at first to detect more subtle changes and then firmer. Comparison of left and right limbs is often helpful. In regions with multiple joints, each joint space should be palpated and manipulated. Limb manipulation usually requires lifting the limb and putting each region (e.g. fetlock) into flexion and extension, noting the range of motion (ROM), and the horse's behavioural response to these actions. Joints may also be gently stressed mediolaterally to assess joint stability. Changes in ROM may reflect acute changes, or chronic occupational adaptations (e.g. reduced fetlock ROM in jumpers). Palpation of the neck and cervical vertebrae, the back across the dorsal spinous processes, and either side of the spine can be used to identify protuberances, regions of muscle atrophy or tension, swelling and pain.

Advances in palpation: algometry

The localisation of thoracolumbar pain is challenging, and it is difficult to standardise the pressure applied during palpation. The algometer applies a standard pressure across a probe of known surface area (ideally 1 cm^2), to quantitatively determine the mechanical nociceptive threshold (i.e., pain) (Pogratz and Licka, 2017). Measurements are done on either side and along the back to allow for comparative localisation. The results may be influenced by sex, age, breed, and the operator, but the technique provides promise for standardising the pressure applied when palpating the equine back.

Gait evaluation

Traditional "subjective" gait evaluation when combined with flexion responses and regional anaesthesia, have been used for many years to direct imaging, diagnosis, and treatment. These techniques are more difficult to employ effectively with multiple limb lameness, multiple lesions within the same limb, or compensatory lameness. Horses are examined at the walk and trot (in a straight line and/or on a lunge line) and can be evaluated under saddle or at other less usual gaits (e.g., the tölte or pacing). The key features evaluated are asymmetry in movement and loadbearing, and changes in the range of motion. In the case of the distal limb there may be a change in the arc of the hoof and fetlock through the air, and/or the caudal and cranial phases of hoof placement. Although frequently observed in the frontal plane, these deviations may also occur lateromedially. Often the simplest deviations to recognise are a vertical drop in the head on the less affected forelimb (or a vertical elevation on the painful limb), or a drop or rise in the gluteal muscle mass in the case of the affected hindlimb. These changes may also be seen in horses that transfer their weight from the affected limb via the spinal column to the diagonal limb. There are many other subtle changes in movement recognised by experienced practitioners. The American Association of Equine Practitioners (AAEP) 6-point grading scheme is used to describe the severity of lameness, but some veterinarians use an 11-grade scale (Table 1). Ideally horses are examined on both firm and soft footing in a well-lit environment. The sound of concussion when the hoof strikes the ground surface may also be helpful in localising the most affected limb. Some horses that are excitable or difficult to calm sufficiently to observe their gait are aided with the help of mild sedation using xylazine (~100 150 mg IV/500 kg). Challenges in the repeatability of subjective gait evaluation and in the assessment of multiple limb problems have led to more objective assessment tools.

Advances in gait evaluation: kinetics

Ground reaction forces are generated when each hoof meets the ground during the stance phase of locomotion (Clayton and Hobbs, 2019). There is a close relationship between these forces and limb kinematics that varies with gait and lameness. When the hoof hits the ground, it moves forward and downward, resulting in rapid deceleration vertically and horizontally. The relationship between vertical and horizontal velocity changes with different gaits. The ground recreation forces are measured with a force plate, instrumented treadmill, or pressure mat. When the horse is lame, the peak forces for the lame limb are lower. Stationary force plates are precise and accurate with high repeatability, but they are not portable and require indoor installation. They are less suited for practice settings.

Advances in gait evaluation: kinematics

The measurement and study of movement is called kinematics. Kinematic techniques that are camera-based use multiple high-speed cameras to record limb (and rider) postings using a series of markers attached to the horse (and rider) (Keegan, 2007). The trajectories of the markers are analysed by computer algorithms to detect asymmetric movement between limbs. It is more sensitive than subjective veterinary evaluation. The setup of these systems requires a large area, is complex and time-consuming. Because of these limitations, they are used mostly for research.

Asymmetry in equine motion can be detected using inertial sensors affixed to the head, rump, and limb of the patient, in practice or academic setting (Keegan, 2007). The sensor data is transmitted wirelessly to the table held by the operator and converted into a chart of the vertical position relative to the round. Algorithms are available for forelimb and hindlimb lameness and different gaits. Lameness evaluation results are reported in a graphical display that depicts amplitude of impact and propulsion asymmetry in each stride. The horse can be evaluated trotting in a straight line, lunging at the trot, and trotting while ridden (Baxter *et al.*, 2020). Compensatory lameness can also be detected. This approach allows for a more precise quantitative approach to assessing the degree of lameness. This technique and the equipment are increasingly used in New Zealand practices.

Table 1. Grading scales for lameness evaluation

AAEP scale		United Kingdom scale	
Grade	Description	Grade	Description
0	Lameness not perceptible under any circumstances.	0	Not lame
1	Lameness is difficult to observe and is not consistently apparent, regardless of circumstances (e.g., under saddle, circling, inclines, hard surface, etc.).	1–2	Lameness hard to detect at walk or trot
2	Lameness is difficult to observe at a walk or when trotting in a straight line but consistently apparent under certain circumstances (e.g., ridden, circling, inclines, hard surface, etc.).	3–4	Lameness barely detectable at walk, easy to set at the trot
3	Lameness is consistently observable at a trot under all circumstances.	5–6	Lameness easily detectable at the walk
4	Lameness is obvious at a walk.	7–8	Hobbling at the walk, unwilling to trot
5	Lameness produces minimal weight bearing in motion and/or at rest or complete inability to move	9–10	Non-weight-bearing

Flexion tests

Flexion tests are used as part of subjective and objective lameness evaluation. The region is held in a stressed flexed or in an overextended position for a standard 30 or 60 seconds, and then the horse is trotted off. A positive response is recorded if there is an exacerbation in lameness after the first two or three steps. In the hindlimb, passive flexion occurs in all joints because of the reciprocal apparatus, despite attempts to localise to the digit or hock region. This also occurs to a lesser degree in the forelimb. It is almost impossible to isolate a single joint, meaning that this test is imprecise. Therefore, physical findings, gait evaluation and flexion test results are used to guide regional diagnostic analgesia for further localisation before diagnostic imaging.

Conclusion

Traditional approaches to lameness localisation remain useful. The subjective aspects of these evaluations are being challenged by emerging technologies that enhance our diagnostic abilities.

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