Clinical Diagnostics to Equine Back Pain

Subjects: Pathology

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Back pain is common in ridden horses. Back diseases in horses include Impinging Dorsal Spinous Processes, Ventral Spondylosis, Osteoarthritis of Articular Process, Intervertebral Discs Disease, Vertebral Fractures, Conformational Abnormalities, Desmopathy of the Supraspinous Ligament, Desmopathy of the Intraspinous Ligament, and Longissimus Muscle Strain. Back pain may also develop as a result of lameness (particularly hindlimb lameness). A poorly fitting saddle and an unbalanced rider are also considered important factors influencing the development of back pain in horses. The conventional diagnosis of equine back pain includes a clinical examination and diagnostic imaging examination using ultrasound, radiography, and thermography. Advanced diagnostic modalities of equine back pain involve the objectification of standard procedures through the use of algometers, a lameness locator, biometric mats, and the geometric morphometrics method. In addition to modern diagnostic methods, such as computed tomography and scintigraphy, advances in the diagnosis of equine back pain include the use of electromyography and functional electrical stimulation.

Keywords: back pain ; chronic pain ; horse ; electromyography (EMG)

1. Introduction

The equine industry has been continuously and intensively developing over the last few decades, presenting researchers and clinicians with increasing challenges to keep up with the demands of high-level horse sports as well as widespread leisure riding. The sport's increased popularity and widespread presence on social media have led to frequent criticism from audiences due to concerns about equine welfare. Modern conceptualizations of welfare issues associated with equestrian sports and leisure riding emphasize the great need for the early and effective recognition of any gait abnormalities or lameness to prevent injuries and chronic discomfort when ridden [1][2]. It is important to note that tack or rider-induced back pain, one of the significant causes of back diseases, is closely related to overloading the back during riding. Similar to how being overweight is considered to be a disease in human civilization, in the case of mainly leisure horse riding, it also becomes a contributing factor to diseases in equine civilization [3].

More than 47% of sport horses at normal work suffer from unrecognized lameness related to back pain [4]. Between 48% and 54% of horses in dressage, showjumping, and eventing show signs of back disease [5]. Similarly, 55% to 74% of leisure and riding school horses are severely affected by back disorders and riding school horses are twice as often affected with back pain than other working horses [6]. Finally, 85% of national hunt racehorses and 90% of flat racehorses exhibit clinical signs of back pain [5]. Therefore, back pain is considered one of the most common syndromes in ridden horses, responsible for chronic pain, poor performance, behavioral issues, impaired ability to work, or nonspecific lameness [7][8]. Experiencing chronic pain may cause changes in the horse's behavior and may also result in the development of additional diseases such as gastric ulcers [9][10]. The reduced accessibility of the affected back area, the need for using sophisticated clinical protocols and diagnostic modalities, and the necessary comprehensive experience of the clinician make an accurate identification of the primary pathology challenging [8][11].

Therefore, given the significant impact of back pain on horse performance, the use of advanced diagnostic modalities and functional therapies has become the desired direction of development in equine medicine.

2. Conventional Diagnostic Protocol of Equine Back Pain

Conventional diagnosis of equine back pain includes a clinical examination and diagnostic imaging examination using ultrasound, radiography, and thermography [8][11].

There are several published protocols for the clinical examination of horses for back problems [7][12][13][14]. Acquiring a good comprehensive history is crucial in all cases of back pain, as clinical symptoms are varied, multiple, and easily confusable with a number of other clinical problems. The next step is a complex clinical examination at rest, which needs to be carried out carefully, including the examination of the whole horse for other causes of lameness and loss of

performance problems. The inspection at rest includes observation and back palpation [15]. The initial inspection follows with the horse standing ‘four square’ on a flat hard surface to carry out a general appraisal of the conformation of its back, fore and hind limbs, as well as assessing its general condition and muscling. The assessment of the symmetry of the pelvis and hindquarter is extremely important in differentiating a pelvic or hindlimb problem. One of the most important parts of the clinical examination is palpation of the thoracolumbar spine. Spasm or guarding of any of the musculature of the thorax and lumbar regions may be part of a primary problem or an indicator of deeper pain [16]. The next step is a clinical examination in exercise. The horse should be watched in walk and trot in hand on a straight line, then on small and large circles on hard ground. Following the in-hand examination, the horse should be lunged in three gaits in both directions to aid in ruling out lameness. Subsequently, the saddle should be checked for a proper fit to the individual horse. Then, a clinical examination in walk and trot should be repeated under saddle. Observing the horse under saddle or in harness should also be part of a work-up for thoracolumbar problems, and stiffness or reluctance to bend in either direction can be reported by the rider. Flexion tests may also be performed. Horses with suspected back pain should always undergo a basic neurological examination to exclude a primary neurological problem as a cause of back pain or altered gait/lameness [17].

Ultrasonography (US) is most helpful in evaluating the SSL, ISL, muscles of the top line, as well as the spinous processes and facet joints of the thoracolumbar spine. With transducer frequencies between 2.5 and 7.5 MHz, most pathologies affecting soft tissues can be successfully diagnosed. Performing ultrasound in this region requires reliable knowledge about the anatomy of the muscles, tendons, ligaments, and joint surfaces [18]. When assessing in a strict median longitudinal and transverse plane, a great variability in the normal echogenic appearance of imaged structures should be considered. As the ligaments are elastic, hypoechoic areas may occur if the horse holds its head up, leading to the relaxation of the ligaments [19]. When examining the spinous processes, it should be kept in mind that the apices of Th3–Th7 vertebrae have separate centers of ossification and thus a roughened appearance. The remaining spinous processes have smooth surfaces. The interspinous space may be assessed between two adjacent spinous processes depending on their angulation. Placing a convex probe approximately 2–4 cm paramedian enables the evaluation of the left and right surfaces of the spinous processes for the presence of new bone formations or fractures [20]. The facet joints of the thoracolumbar spine are also evaluated in a transverse and longitudinal plane. The easiest way to identify the site of probe placement is the last rib, as it is easy to palpate and corresponds to the facet joint of Th17–Th18 vertebrae. Cranial and mid-thoracic facet joints are more difficult to identify as they are located much deeper. Once the facet joint of Th17–Th18 vertebrae has been localized, adjacent joints cranially and caudally are examined for left–right symmetry, width, and new bone formations [21][22].

Radiography (X-ray) is one of the fundamental diagnostic methods for assessing bony structures suspected of pathological changes. Most portable X-ray units can produce high-quality radiographs. Radiographs should be taken under sedation to reduce motion, and the horse should stand squarely on all four legs to avoid spine rotation. The use of radio-opaque markers helps correlate radiographic changes with specific locations on the horse. Key findings related to pathological changes in the thoracolumbar spine include impinging dorsal spinous processes, sclerosis, osteolysis, intra and periarticular remodeling, and vertebral fractures. Since the appearance of radiographic symptoms rarely corresponds with the degree of clinical signs, other functional diagnostic methods are essential to improve the accuracy of the diagnosis [23].

Infrared thermography (IRT) is an additional diagnostic method that detects the radiated power emitted from the body surface and provides data about surface temperature [24]. IRT imaging is performed non-contact using a thermal imaging camera. It is crucial to remove sand and dirt from the horse’s back and rump before imaging, preferably no later than 30 min before imaging, as the heat released during cleaning may affect the obtained image. The distance from which the horse is imaged, the emissivity of the thermal camera, and the method of image processing are also important considerations [25]. Basic image evaluation includes point, linear, or area measurement of minimum, maximum, and/or average temperature in the region of interest (ROI) corresponding to selected areas of the back [26][27][28]. However, modern analytical approaches, such as image texture analysis [29][30][31], image entropy analysis [32], and the application of a Pixel-Counting Protocol [33][34] are also available. The main disadvantage of IRT imaging is its low specificity due to the influence of factors such as the thickness of the skin and subcutaneous tissue [35], the length of the hair, external temperature [27][36], humidity of both the air and the horse’s body, and sunlight at the imaging location [25]. Since IRT is sensitive to various internal and external factors, it is commonly used for assessing the horse’s welfare [37], physiological response to effort [31], saddle fit [26][27], and the impact of rider–horse interaction, including matching [28] and the effect of bodyweight [30][32][38][39], rather than diagnosing back diseases.

3. Advanced Diagnostic Modalities of Equine Back Pain

3.1. Objectification of the Conventional Diagnosis Protocol

Some parts of this routine protocol for the conventional diagnosis of equine back pain are assessed subjectively. Therefore, methods for objectifying the diagnosis are needed. During a comprehensive clinical examination at rest, an algometer may be employed to render the inherently subjective back palpation more objective. The algometer is a small, hand-held tool used to assess the level of pressure a patient can tolerate in a specific area, known as the mechanical nociceptive threshold or pressure pain threshold of that area. Algometry enables the objective measurement of musculoskeletal pain thresholds [40][41] with acceptable repeatability [42]. This tool aids in localizing the pain site and comparing the response to treatment. However, further research is needed to fully realize the potential value of the algometer as a clinical tool in the diagnosis of back diseases. During a comprehensive clinical examination in walk and trot in hand, the Lameness Locator (LL, currently known as Equinosis Q) may be used to objectively confirm the presence or absence of lameness. The LL is a system of wireless inertial sensors positioned on the head poll, the pelvis, and the right front pastern. This tool provides results for the fore- and hindlimbs, categorizing lameness from mild to moderate/severe and aiding in the recognition of type, degree, and location of lameness [43]. With increasing awareness that trotting in hand may not be sufficient for diagnosing lameness and that horses can exhibit lameness when ridden, the examination protocol should always include the evaluation of horses under tack [44][45][46]. Therefore, a comprehensive clinical examination in walk and trot under saddle may be improved using the Biometric Mat (BM). The biometric mat is a tool that allows for the capture of the pressure distribution on the horse's back, assessing the complex interaction of forces between horse, saddle, and rider. As it can be used in a standing position, walk, and trot, the holistic effect of the rider's core strength, limb muscle strength, coordination, and balance on the horse's back may be assessed. Moreover, the biometric mat was used to determine the effect of the horse–rider interaction on the horse's welfare state [47], which can also be successfully reflected through the dorsal line posture using the Geometric Morphometrics (GM) method [6]. The GM method is a completely non-invasive analytical tool that allows for the quantification and comparison of the shape of a horse's dorsal line of the back based on regular visible light photos [34][48].

3.2. Advancements in the Diagnosis of Equine Back Pain

Modern diagnostic modalities such as nuclear scintigraphy or computed tomography are promising in diagnosing difficult cases; however, are expensive and not easily available to the general practitioner [49].

Despite the wide range of diagnostic modalities, pinpointing the exact cause of thoracolumbar pain in horses remains challenging. In humans, it has been confirmed that individuals with back pain exhibit early myoelectrical manifestations of muscle fatigue, and electromyography (EMG) serves as a useful tool for objective low back pain diagnosis. Muscle fibers are stimulated to contract by action potentials triggering depolarization and repolarization within individual muscle fibers, creating electromagnetic fields that can be measured by EMG. There are two methods of EMG: the first, needle EMG, is invasive and involves needle electrodes inserted into the muscles of interest, while the second, surface EMG (sEMG), uses electrodes applied to the extracellular skin surface above the muscles of interest. In recent research, only one group opted for the needle EMG technique to investigate the neuromuscular background of changes causing back pain [50], while all others focused on sEMG. The sEMG method has been employed to study back muscle activity during walk [51] and trot [52][53] as well as during jumping [54] and induced flexing [55]. Despite this research, the use of sEMG is still in its infancy in veterinary motion analysis. However, the application of modern devices is crucial to deeply understand many important aspects of this functional diagnostic modality. In IDSP, sEMG may be used to evaluate back and abdominal muscle weakness and malfunctioning nerve conduction, as unwillingness to bend a sore back is associated with weakness in these muscles and malfunctioning nerve conduction [38]. In OA, susceptibility to the development of the disease is supposed to be related to the biomechanics of this region, which involves lateral bending, axial rotation, and dorsoventral mobility [56]. As the activity of thoracolumbar muscles (m. longissimus dorsi and m. multifidus) is responsible for the mobility of this back segment, examining their function using sEMG seems to be a proper research direction in sound horses, those with clinical signs of OA, and during therapeutic exercises [57]. The assessment of m. longissimus electromyographic activity using sEMG should be performed at the level of the Th12 vertebra, where its maximum amplitude is concentrated [55][58]. The high maximum activity of the m. longissimus dorsi at Th12 could contribute to the development of muscle pain at this site [51]. In IVDD, sEMG would be a useful tool to determine the presence of a peripheral neurogenic component to muscle atrophy, as muscle atrophy may be mistakenly presumed to be associated with disuse [59]. In DSSL/DISL, the functional connection of the SSL and ISL with m. longissimus dorsi suggests that sEMG studies on this muscle could be helpful for confirming the clinical importance of diagnostic imaging signs as well as for the follow-up of treatment and rehabilitation [60]. In some desmopathies, altered collagen fiber alignment and arrangement of the ligamentous layers occur; therefore, it would be of clinical importance to confirm if the back muscles

that have a functional connection with the overlying ISL show an altered sEMG signal in affected horses [61]. However, all these hypotheses require confirmation in further studies.

Functional Electrical Stimulation (FES) is another advanced diagnostic modality that should be investigated for its clinical usefulness in equine back pain diagnosis. FES involves the painless electrical stimulation of a single muscle or a group of muscles to restore or improve their function. It has been used in humans to reverse muscle atrophy in patients after spinal cord injuries. FES has also been widely applied in the rehabilitation of various injuries in horses, as well as for overall performance enhancement [62]. In addition to its therapeutic use, FES can serve as a diagnostic tool over the thoracolumbar, lumbosacral, and cervical regions of the horse to detect dysfunction in muscles' neuromuscular control response. Observing the muscles' movement during FES stimulation allows for the assessment of their symmetry and range of motion. If an abnormal movement pattern, such as hypermobility, hypomobility, or postural sway, appears, the cause of this deviation is further examined. This approach helps localize the sites of dysfunction or pain, which can be thoroughly investigated using other diagnostic procedures. The stimulation of a painful area with FES causes repeatable and constant unwillingness to specific movements, serving as valuable diagnostic information [63].

Finally, both these modalities may be applied in supporting the functional exercises of the equine back and thus improve the prevention and treatment of equine back pain. It is crucial to include exercises for back stabilization during rehabilitation and training to prevent the recurrence of pain signs after back pain treatment. The dorsal line (topline) of the horse runs from the withers along the back down to the croup, with the m. longissimus dorsi being the main muscle unit. M. longissimus dorsi stabilize the spine, facilitate proper locomotion, and provide support to the saddle and rider. As the dorsal line is part of the active epaxial musculoskeletal system, its influence on horse performance is evident [64]. Some ground training with poles and the use of lunging aids, such as a chambon, rubber bands, side reins, and a Pessoa, have been recommended to improve back muscle action [28][34][57][65]. However, further research is needed to explore the increase in the ability of m. longissimus dorsi to stabilize the back after the use of lunging aids. Incorporating objective measurement modalities, as described above, into functional exercise monitoring will shed new light on the prevention and treatment of back pathology and the rehabilitation of horses with back pain.

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