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Pathophysiology, diagnosis and treatment of common causes of lameness

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Summary

Lameness is an abnormality of gait which can be caused by pain, loss of neuromuscular control, or a mechanical factor limiting normal movement. The cause of a lameness problem should be isolated by proper physical examination, flexion tests, and local anaesthesia. Routine imaging of areas of suspicion includes radiography, ultrasonography, and scintigraphy.
Joint disease is a common cause of lameness and may be due to degenerative joint disease and/or developmental orthopaedic disease, including osteochondrosis. Heritability and conformation both have important roles in the development of joint disease. Therapies for joint disease include rest, intraarticular injections, nonsteroidal antiinflammatory drugs, and arthroscopy, performed either for diagnostic and/or therapeutic purposes.
Thoroughbreds and nonracing performance horses more often have superficial digital flexor tendon problems and Standardbreds more often have suspensory ligament problems. Therapies for soft tissue injuries include rest, physical therapy, peritendinous sodium hyaluronate, and shoeing changes.
Considering the high level of wastage in the horse industry, prevention should receive more focus. Four important factors in prevention are heritability, conformation, dietary calcium, and proper training techniques.

keywords: horse, lameness, pain, musculoskeletal, orthopaedics

Pathologie, Diagnose und Behandlung häufiger Lahmheitsursachen

Lahmheit ist eine Abnormalität des Ganges, die verursacht werden kann durch Schmerz, Verlust der neuromuskulären Kontrolle oder durch einen mechanischen Faktor, der die normalen Bewegungsmöglichkeiten einschränkt. Die Ursache eines Lahmheitsproblems sollte durch gründliche klinische Untersuchung, Beugeproben und diagnostische Anästhesien festgestellt werden. Die routinemäßige Untersuchung verdächtiger Bereiche umfaßt Röntgen, Ultraschall und Szintigraphie.
Gelenkserkrankungen sind ein häufiger Grund für Lahmheiten, es kann sich um degenerative Gelenkserkrankungen und/oder entwicklungsbedingte orthopädische Probleme, eingeschlossen Osteochondrose, handeln. Erblichkeit und Exterieur spielen beide bedeutende Rollen bei der Entwicklung von Gelenkserkrankungen. Die Therapie umfaßt Ruhe, intraartikuläre Injektionen, nichtsteroidale Antiphlogistika und Arthroskopie, entweder zum Zweck der Diagnose oder der Therapie.
Vollblutpferde (Galopprennpferde) und Sportpferde leiden oft unter Problemen im Bereich der oberflächlichen Beugesehnen, wohingegen Trabrennpferde häufiger Probleme im Bereich des Fesselträgers haben. Die Therapie von Weichteilverletzungen besteht aus Ruhe, physikalischer Therapie, peritendinöser Injektion von Natriumhyaluronat und Änderung des Hufbeschlags.
Wenn man den hohen Anteil von Verschleiß im Pferdesport betrachtet, sollte der Prävention mehr Aufmerksamkeit geschenkt werden. Vier wichtige Faktoren für die Prävention sind Erblichkeit, Exterieur, Kalziumangebot im Futter und angemessenes Training

Schlüsselwörter: Pferd, Lahmheit, Schmerz, muskuloskeletal, Orthopädie

Introduction

Lameness is an abnormality of gait which can be caused by pain, loss of neuromuscular control, or a mechanical factor limiting normal movement. It is a problem in all types of horses but particularly in those used for competitive purposes. The more severe or intense the demands of exercise, the more likely the individual horse is to suffer from lameness.
Lameness which is considered relatively insignificant in other large animal species can be the cause of unsuccessful performance in horses. Two surveys have characterised the importance of lameness in racehorses. In a survey of young Thoroughbred racehorses, 53% were lame at some point during their racing careers from 2–4 years of age (*Jeffcott* et al. 1982). Of the training days that were lost to effective training over two racing seasons, *Rossdale* et al. (1985) found that 67.6% were due to lameness and 20.5% were due to respiratory disease.
The diagnosis of equine lameness is one of the most common yet most difficult tasks in practising veterinary medicine. Both the diversity of cases and the subtle level of lameness which can still affect the performance of the equine athlete contribute to the difficulty of lameness diagnosis.

History and signalment

Lameness is an abnormality of gait which can be caused by innumerable problems. It is merely a clinical sign and is not definitive of any one disease. In many cases, the aetiology may be multifactorial, thus rendering a simple classification as to a single cause impossible. Racehorses have more problems with high motion joints, ligaments, and tendons. Younger horses with joint effusion may have osteochondrosis. Older horses such as showhorses, jumpers, and dressage horses may be more likely to have problems with low motion joints of the distal limbs and feet. Regardless of age, breed, and use, a single horse may be afflicted with almost any locomotion disorder. This possibility cannot be overlooked in the diagnostic plan for any horse suffering from lameness.

Gait analysis

The use of high speed cinematography and computer analysis in equine gait analysis was first introduced over 20 years ago (*Fredricson* 1972). Other investigators have followed with similar studies, particularly with treadmill experiments, and more recently videotape has replaced the use of high speed film (*Fredricson* et al. 1983; *Leach* 1987; *Clayton* and *Barlow* 1989; *Back* et al. 1995). Despite the use of impressive and intricate films, videotape, and data analysis, the use of gait analysis continues to be primarily of research interest and not terribly practical for the field practitioner. This problem owes primarily to the lag time required to analyse data after images are captured on film or videotape, and secondarily to the cost of equipment for proper gait analysis. Continued attempts have been made to develop an instrument to more objectively take the place of the eye of the experienced equine practitioner. Force plates, pressure-sensitive mats, accelerometers (*Barrey* and *Desbrosse* 1996), and video cameras may be more useful for clinical detection of subtle lameness in the future.

Local nerve and intraarticular anaesthesia

Anaesthesia of local nerves and joints is a necessary part of most lameness examinations. When the practitioner suspects disease in a particular joint, intraarticular anaesthesia may definitively rule-in involvement of that joint by a positive response to being "blocked" in that joint. Intraarticular contrast radiography and/or dye studies have shown that injected anaesthetics may access areas of the joint which were previously thought to be inaccessible with a single local block. For instance, the tarsometatarsal joint block has been shown to extend to the distal intertarsal joint in approximately 30% of horses examined at postmortem (*Bell* et al. 1993). In other tarsometatarsal blocks, the injectate has been shown to extend distally along the flexor tendons. Distal interphalangeal joint (coffin joint) blocks may anaesthetise numerous structures (*Bowker* et al. 1996) and may make definitive diagnosis from a single block impossible without additional imaging. In all cases, the key to proper local anaesthesia is correct placement of the needle after appropriate antiseptic preparation of the site. The goal must be to perform the block with a single insertion of the needle.

Imaging

The combination of radiography with responses to local anaesthetics has enabled greater accuracy in diagnosis than use of visual examination alone. Radiographs of the suspected area should be taken after the lameness has been localised to a particular joint. Xeroradiography produces excellent images, particularly of stress fractures, but logistical support has been withdrawn from the marketplace by the manufacturer. Additionally, xeroradiography is associated with the danger of increased X-ray exposure.

The presence of joint space narrowing, osteophytes (periarticular), and bony reactions associated with origin or insertion of tendons, ligaments, or joint capsules (enthesophytes) should be assessed. Stress reactions may be indicated by sclerosis in the medullary cavity. Fissures may be difficult to detect since the X-ray beam must be parallel to the fissure to image it properly. Ultrasonography may be useful for examination of soft tissue structures such as tendons, ligaments, and joint capsules which are not easily imaged radiographically.

Scintigraphy is very sensitive because the images reflect the rate of bone turnover, or metabolic rate, in normal and abnormal bone. It can be used to localise lesions in areas which are overstressed, resulting in increased bone turnover. Metabolically-overactive areas are then usually radiographed for evidence of fissure, sclerosis, or osteoarthritis. Scintigraphy can also be a sensitive means of detection of navicular bone inflammation, pedal osteitis, traumatic arthritis, and early spavin (*Devous* and *Twardock* 1984).

Computerised tomography (CT) is used in some university referral centers, but standard human tables are built with sufficient strength to support only foals or small ponies, but not racehorses. Due to similar mechanical and technical problems, magnetic resonance imaging (MRI) has been studied primarily in equine cadavers, but units are being developed which should allow examination of the distal limb of the standing, sedated horse. The increased cost of these newer imaging technologies currently far outweighs the need for better images in the vast majority of equine lameness cases.

Joint Disease

Lameness is most commonly caused by joint disease which is most commonly caused by trauma (*Rose* 1977; *Todhunter* and *Lust* 1993). The two most common causes/effects of joint trauma are degenerative joint disease and developmental orthopaedic disease.

Degenerative joint disease

Degenerative joint disease (DJD) may be an increasing problem, possibly due to the increase in speed and intensity of training and racing of young horses which have not received adequate initial training. Age of the horse does seem to influence lameness in that many types of lamenesses seen in young horses do not occur in older and more mature horses (*Stashak* 1987). Some years ago in Norway, racing for 2-year-old trotters existed, but it became apparent that as few as 32% of the horses which started as 2-year-olds continued to race as 3-year-olds. Races based on closeness to an ideal time, rather than fastest-time-races, were then established for 2-year-olds. The driver who managed to get closest to the ideal time of 1:26–1:36 min/km won the prize money. In the first year after such racing was initiated for 2-year-olds, 3-year-old starters increased from 32% to 43%. In Sweden, the earnings of 7-year-olds who initially started as 2-year-olds were compared to those who started at 3–5 years of age. One hundred horses were randomly selected in each age group. Horses which started as 2-year-olds earned the most prize money and earned the most money per race. Horses born earlier in the spring earned more than horses born later in the year (*A. Lindholm*, personal communication). Subsequently, prize money for 2-year-old trotters in Scandinavia has not been terribly high, thus decreasing the incentive for younger horses to be pushed too hard. Clearly, more research about the training of younger versus older horses is needed to help to diminish injuries to each age group.

Developmental orthopaedic disease

Another common cause of joint disease is developmental orthopaedic disease (DOD). It has been detected radiographically in a surprisingly large proportion of the Standardbred population (*Birkeland* and *Haakenstad* 1968; *Birkeland* 1972; *Stromberg* and *Rejno* 1978; *Grondahl* 1991; *Grondahl* 1992). Upon radiographing the tarsocrural, metacarpo- and metatarsophalangeal joints of 753 yearling Standardbred trotters in Norway, *Grondahl* (1992) found that 43% had at least one DOD lesion. The clinical importance of many of these fragments is uncertain, since some horses with DOD lesions are asymptomatic. With a particular DOD lesion, the clinical importance has usually been associated with the location of the lesion and the severity of the radiographic changes present (*Trotter* and *McIlwraith* 1982; *Lindsell, Hilbert* and *McGill* 1983; *Hoppe* 1984). However, *Gaustad* (1995) examined 265 3-year-old Standardbred trotters with DOD and found that only 30% were sound, 52% were moderately lame, and 18% were severely lame. One must conclude from these data that DOD is a serious problem in Standardbred trotters in Scandinavia.

The most common DOD findings in Standardbreds are proximal palmar or plantar metacarpo- or metatarsophalangeal fragments (so-called "Birkeland fractures") and tarsocrural joint fragments (*Grondahl* 1992). It has long been debated as to whether or not these are osteochondrosis fragments or true fractures. Recent data have shown that proximal palmar/plantar lesions have more of the histological characteristics of fractures than of osteochondrosis lesions (*Nixon* and *Pool* 1995).

The benefits of surgical removal of DOD fragments remain unclear. Different studies have indicated that lame horses which have such fragments removed improve clinically after surgery (*Petterson* 1978; *Olson* 1983; *Houtto* 1991). Arthroscopy has been described as the surgical method of choice for fragment removal (*McIlwraith, Foerner* and *Davis* 1991). However, non-surgical treatment has been reported to result in sufficient clinical improvement to allow a return to athleticism in 47% of horses with DOD (*Rose, Sande* and *Rose* 1985).

Pathophysiology of joint disease

Degradation of articular cartilage probably begins simultaneously with the development of synovitis (*Greisen* 1982). Cartilage degradative products such as glycosaminoglycan subunits of proteoglycan molecules are produced in the synovial fluid and then diffuse into blood. Detection of these antigens in equine synovial fluid and blood by means of enzyme-linked immunosorbent assays (ELISAs) should facilitate early diagnosis and prognosis of degenerative joint disease (*Thonar* 1985). These antigens might also indicate the response of joint tissue to clinical intervention and might help to better define articular pathophysiology (*Hascall* and *Glant* 1987). The mechanisms of joint disease are being intensively studied with newer methodologies (*Prince* 1992; *Palmer* and *Bertone* 1994).

Joint treatment

Once disease has been localised to a particular joint, one must decide how to treat that joint to improve the horse's lameness and to return it to normal athletic function. The demands of competition dictate that the treatment should result in a short convalescence and should have a longlasting effect. Numerous intraarticular preparations have been used, with varying success. The use of intraarticular corticosteroid therapy in the horse was first documented in 1955 (*Wheat* 1955). Subsequently, sodium hyaluronate (*Rydell, Butler* and *Balazs* 1970), orgotein (*Ahlengaard* et al. 1978), dimethylsulfoxide (DMSO), synovial fluid transfer (*Rucker* and *Lindholm* 1981), and saline joint flushes (*Norrie* 1976) have been used (*Linblad* 1983). Polysulfated glycosaminoglycan (PSGAG) was used in the treatment of human osteoarthritis in the 1960's (*Escher* 1968) and was first described for use in horses as early as 1966 (*Kubitza* 1966). Today, PSGAG is used commonly intraarticularly (*Hamm* and *Jones* 1988) and perhaps more frequently intramuscularly (*Collins* 1989).

One alternative is simple rest with no intraarticular therapy. It is obviously relatively inexpensive, frequently used, and reportedly helpful. However, it may not be as efficacious as previously thought for certain conditions. *Gaustad* (1995) performed a study in 3- and 4-year-old Standardbreds with negative radiographs but with lameness localised to the distal tarsal joints (spavin). Rest alone yielded 12% recovery versus 46% for intraarticular injection of 2 ml of saline (negative control group) versus 67% when PSGAG or sodium hyaluronate were administered.

Nonsteroidal antiinflammatory drugs (NSAIDs) are commonly used to treat the pain associated with lameness of any cause. Frequently administered NSAIDs include phenylbutazone, flunixin meglumine, and ketoprofen (*Foreman, Grubb* and *Inoue* 1994). Dosages vary between studies, making direct comparisons of efficacy difficult between studies. Toxicity can result from oral, gastrointestinal, or colonic ulcers and/or renal effects.

Arthroscopy is a fourth alternative for joint treatment, particularly when intraarticular therapy has failed. Routine arthroscopic techniques have now been established for most equine joints. Arthroscopy can be used as a prognostic tool before other therapies are begun; if there is little to no normal joint cartilage remaining in the affected joint, there may be no point in pursuing intraarticular therapy or rest.

Tendon and ligament disease

High speed cinematography has documented that the superficial digital flexor tendon (SDFT) bears the load in the early part of the weight-bearing phase of each stride, before the load is spread to and shared by the deep digital flexor tendon (DDFT). The rate of increase in load-bearing is also greater in the SDFT. Conversely, in an extended trot (such as in Standardbred racing), the suspensory ligament (SL) is loaded preferentially in the initial part of the stance phase. These differences in functional loading of the palmar soft tissue supportive structures may explain the differences in incidence of SDFT and SL lesions in the different breeds, since Thoroughbreds more often have SDFT problems and Standardbreds more often have SL problems.
In the SDFT, the shortest filaments are in the middle of the tendon, where fibres usually are observed to tear causing a core lesion which is detectable ultrasonographically (*Goodship* et al. 1994). The narrowest portion of the tendon may not be the weakest. It has been shown that the number of fibres is crucial to tearing and that the narrowest portion of the tendon does not actually have the fewest number of fibres (*Riemersma* and *Scharmhardt* 1985). Diagnostic ultrasound has allowed better visualisation of lesions and better monitoring after therapy has been initiated.
Treatment of tendon injuries has varied greatly over the years, including firing and blistering, tendon splitting (*Asheim* 1964), proximal check ligament resection (*Bramlage* 1986), and peritendinous injection of sodium hyaluronate or PSGAG (*Gaughan, Nixon* and *Krook* 1991). Most recently, beta-aminoproprionitrile fumarate has shown promising results in inhibiting scar formation in initial trials (*Genovese* 1992). Shoeing with raised or lowered heels remains controversial (*Denoix* 1994). Physical therapy with cold, heat, massage, laser, therapeutic ultrasound, magnetic field therapy, and manual stretching has become increasingly popular and may have a place in the treatment regime if performed appropriately by skilled practitioners. Ultimately, however, the old adage "once a tendon problem, always a tendon problem" is still true.

Navicular disease

Navicular disease occurs more in some breeds than in others, but this may be due to the use of those breeds as riding horses, which tend to have a much higher incidence than racing horses. Two schools of thought exist as to the aetiology of navicular disease: vascular versus biomechanical. Interruption of blood flow to or from the navicular bone has been proposed as a contributing factor (*Colles* and *Hickman* 1977). Treatment for vascular compromise consists of giving the horse drugs such as warfarin or isoxsuprine to maintain patency of peripheral vessels and to decrease blood viscosity.
The biomechanical theory cites poor shoeing and poor foot conformation as inciting causes. Particular shapes of the navicular bone have been associated with increased incidence of disease (*Dik* and *van den Broek* 1995). If shoeing is corrected, such as through the use of egg bar shoes, then the disease may be reversible if there are no secondary changes in the bone or the flexor tendon. Cutting the collateral ligaments to the navicular bone has shown promising results in treatment (*Larsen* 1981), and may have its effect via cutting innervation to the navicular bone. In a comparative study of different treatments (rest, warfarin, isoxsuprine, collateral desmotomy, corrective shoeing with egg bar shoes), 75% of treated horses improved (*Wright* and *Douglas* 1993).

Lameness prevention

Many lamenesses recur despite the practitioner's best efforts to help the horse. Many therapies are, therefore, palliative, but not curative. One must conclude that the best treatment is prevention, but prevention remains poorly studied by the horse industry. Considerations in prevention of lameness problems include heritability, conformation, nutrition, and training.

Heritable conditions

To choose the right parents for a horse is important, because conformation is heritable. One example is the calculation (*Dolvik* and *Klementsdal* 1994) of an index for each Norwegian coldblood stallion for the heritability of its dorsoplamar carpal conformation ("back at the knee"). Standardbred DOD in the tarsocrural and metacarpo- and metatarsophalangeal joints has been shown to be heritable (*Grondahl* and *Dolvik* 1993). Because reactions to flexion tests have also been shown to be heritable (*Darenius* 1986), the presence of a sore joint should be considered in formulating breeding policies.

Conformation

Certain leg conformations have been shown to lead to more lamenesses (*Magnuson* and *Thafvelin* 1985). Undesirable leg conformation predisposes the individual horse to developing problems, and 11% of all injuries can be explained by poor leg conformation. Horses with sickle hocks have more problems than do those with more normal hock conformation. Horses which are "tied under at the knee" are 4–5 times more prone to tendon problems than those which are not, just as horses which are "back at the knee" are 4–5 times more prone to carpitis or osteochondral fractures than those which are not.

Dietary calcium

It has been shown that a suboptimal amount of dietary calcium can produce serious lameness problems in young growing horses (*Austbo* and *Dolvik* 1994). Pregnant mares fed just under the normal amount of calcium during and after pregnancy were compared with a control group in which normal amounts of calcium were fed. The diets were continued after the foals were weaned. Both groups of progeny were subsequently trained similarly by a professional trainer. The lower calcium group developed serious lameness problems when compared with the control group. Three low calcium horses actually fractured proximal sesamoid bones.

Proper training

To train a horse properly remains nearly an art to this day. The single biggest problem for the horse trainer is to keep horses injury-free. Different methods of training are assumed to influence lameness frequency (*Lindholm* 1990; *Gabel* 1993). Housing, handling, shoeing, tack and other equipment, and track or riding surface are other important factors to consider in preventing lameness. The rigors of racing schedules and the demands of owners often result in horses being hurried into racing before they are fully prepared (the concept that "we will race him into shape"). Another problem is that successful trainers jealously guard their training and feeding methodologies in order to maintain their competitive edge over their less successful counterparts. Even when better methods are known and established, there remains the problem of broadly disseminating the information to individual horse owners and breeders.

Conclusions

Lameness is a fact of life for horse owners, trainers, and veterinarians. Newer technologies have allowed better and earlier diagnosis, but prevention remains the more poorly studied of the means of decreasing the incidence of lameness. Carefully planned breeding should take into account not just fashionable breeding but also compatibility and heritability of conformation of both the sire and dam. Mares should be fed and monitored properly, as should young growing foals. Early training should be used to build bone and connective tissue strength without resulting in excessive loading resulting in unwelcome trauma and lameness. Proper shoeing is of particular importance once a horse's athletic career begins. When lameness occurs, early detection and correction will result in a more useful athlete for future use.

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