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Acute and Chronic Laminitis – An Overview

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Laminitis is usually classified by its duration and the morphological changes that have occurred. As such, developmental laminitis is the initial phase between the initial insult and the onset of clinical symptoms. Acute laminitis begins with the onset of clinical symptoms and is frequently cited as lasting until 72 hours after the onset of symptoms or the development of displacement of the distal phalanx, whichever is the sooner. If the distal phalanx does not displace after 72 hours, the disease enters the sub-acute phase. Chronic laminitis begins with the displacement of the distal phalanx regardless of whether the horse was in the acute or sub-acute phase of the disease. Chronic laminitis is further subdivided based on time and the amount of healing that has taken place. Early chronic laminitis is that phase immediately after the distal phalanx has displaced; the wall of the hoof capsule is grossly unchanged. This phase is succeeded by chronic active laminitis in which the distal phalanx remains unstable, but secondary changes in the hoof capsule are beginning to become evident. Chronic stable laminitis, as its name implies is that stage of the disease in which the deformed shape of the foot is accompanied by stability of the distal phalanx.

The classification of laminitis into phases is a convenience to enhance comprehension and assist in the diagnosis, treatment and prognosis of the disease, but the disease is a continuum. Horses tend to sequentially pass from one stage to the next on an unpredictable basis, and the boundaries between the stages are blurred. However, the continuum varies greatly between horses as they may take different entry points into the disease and different paths once affected.

Pathophysiology

The pathogenesis has yet to be clearly defined. Several mechanisms have been implicated over the last 30-40 years including dysfunction of the digital vasculature, a primary inflammatory response, toxin induced activation of metalloproteinases, and coagulopathy and thrombus formation. It is quite likely that all of these mechanisms may be involved in some manner. Recently, unequivocal evidence confirms an inflammatory response very early in the disease has before other changes are present, suggesting that the vascular changes, thrombi formation, and metalloproteinase degradation of the basement membrane are “downstream” events.

As the strength of the lamellae becomes decreased during the disease process, the capacity of the lamellae to maintain the position of the distal phalanx suspended within the hoof capsule decreases, the distal phalanx becomes unstable, and the distal phalanx displaces within the hoof capsule. The mechanical collapse of the lamellae can occur at any point around the circumference of the foot leading to different patterns of collapse. When the dorsal lamellae collapse, (dorsal) rotation ensues (Fig. 1), when all the lamellae appear to collapse...
simultaneously the distal phalanx displaces distally (Fig. 2), and when the lamellae on one side of the foot collapse, usually medial, unilateral distal displacement occurs (Fig. 3).

Following displacement of the distal phalanx, the newly developed cavity between the hoof capsule and distal phalanx fills with blood and necrotic material. The lamellae in the damaged area become hyperkeratotic and hyperplastic forming what is frequently referred to as a “lamellar wedge.” With healing, the distal phalanx may become progressively more stable within the hoof capsule, but frequently the hoof capsule becomes distorted and an abnormal relationship between the distal phalanx and hoof capsule and phalangeal axis persists. The outcome is dependent on several factors including the alignment of the dermal papillae of the coronary integument, the character of the lamellar wedge, the growth patterns of the capsule, the tension in the deep digital flexor tendon, and the pattern of weight-bearing.
Diagnosis and Assessment

The diagnosis of laminitis is usually straightforward. In horses with acute disease the diagnosis is made based on the characteristic gait, palpation of heat within the foot, increased digital pulses, and localization of pain with hoof testers. In horses with chronic disease, visual inspection of changes in the hoof capsule, palpation of the coronary band and radiographs provide additional information that allow the disease to be further characterized, characterization which, in conjunction with the clinical symptoms, is important in forming a prognosis and strategy for treatment. In rare instances, acute or sub-acute laminitis may present with sufficiently subtle symptoms to present a difficult diagnosis, though with time the symptoms are likely to become more classic.

Routine radiographic examination for the foot should include at least three views, a lateromedial, a dorsopalmar, and a dorsopalmar oblique. The lateromedial view is used to assess the position of the distal phalanx within the hoof capsule in the sagittal plane, the presence of gas within the wall and sole, and secondary changes to the distal phalanx. Of particular importance is the thickness of the sole, the angle of the solar margin of the distal phalanx to the ground, the degree of capsular rotation, and the vertical distance from the firm proximal border of the wall to the extensor process (Fig. 4). 3,4 The dorsopalmar view is used to assess the position of the distal phalanx in the hoof capsule in the frontal plane. Normally, the width of the distal interphalangeal joint space should be symmetrical, the articular surface of the distal phalanx approximately parallel to the ground, and the thickness of the medial and lateral walls adjacent equal. Marked tilting of the distal phalanx to one side accompanied by an increase in hoof width on the same side and narrowing of the distal interphalangeal joint on the opposite side are strongly suggestive of asymmetrical distal displacement (Fig. 5). Care should be taken to assess the positioning before determining this because tilting of the distal phalanx and asymmetry of the distal interphalangeal joint can be induced if the limb is not close to vertical. Venography has been used to assess perfusion of the digit. Decreased perfusion in the coronary, parietal, and subsolar vasculature have been associated with a decreased prognosis. 5

Figure 4. Radiograph of rotation. Radiograph a) shows rotation of the distal phalanx in relation to the other phalanges (solid black lines), rotation of the distal phalanx away from the hoof capsule (dotted white lines) and increased angle of the solar margin of the distal phalanx with the ground (dotted black line). Radiograph b) shows dramatically reduced thickness of tissues between the distal phalanx and the ground (double ended arrow) and the vertical distance from the coronary band to the extensor process (open triangles).
Medical Therapy

Medical therapy is aimed at preventing, limiting progression, and reversing the underlying pathophysiological processes and controlling pain by administering pharmacological agents. As such, the drugs used to affect the underlying pathophysiological processes are directed at the four mechanisms postulated to cause the disease. To counter vascular dysfunction in the digit, various vasodilators and rheologic agents have been used, and of these the most commonly used and likely to be beneficial is acepromazine. The main pharmacologic agents used to treat the inflammatory response in early laminitis are the non-steroidal anti-inflammatory drugs and DMSO, and because of the overlap between endotoxemia and inflammation, these non-steroidal anti-inflammatory drugs are also beneficial in horses with endotoxemia. Anti-endotoxin therapy is frequently used in horses that clinically appear to be endotoxic. Of these, endotoxin antiserum and polymixin B are most frequently used. Heparin and aspirin have both been used to treat coagulopathy and prevent thrombus formation in early laminitis. Unfortunately, no pharmacological agents are of proven benefit once the initiating events have occurred. Of all these agents, the most frequently used to treat uncomplicated laminitis are phenylbutazone, flunixin meglumine, DMSO, and acepromazine. However, many other drugs are used to treat diseases such as diarrhea, pleuropneumonia, and metritis that are commonly associated with the onset of laminitis, such as antibiotics, fluids, anti-endotoxin serum, and polymixin B.

The pharmacologic control of pain is an area that until recently has not received sufficient attention other than the traditional mainstay of non-steroidal anti-inflammatory drugs. More recently, interest in using other agents such as lidocaine and ketamine given as an intravenous infusion, narcotics either as a continuous rate infusion or epidural, and gabapentin has
developed. The use of these drugs to control pain must be paralleled by advances in assessing and monitoring pain.

Concurrent pituitary pars intermedia dysfunction and equine metabolic syndrome must be managed appropriately.

Supportive Care

The goals of supportive therapy shift during the course of the disease, though the principles used to achieve the goals remain remarkably similar. In the acute and subacute stages of the disease, the goals are to prevent displacement of the distal phalanx by attempting to stabilize the distal phalanx within the hoof capsule and to control pain. Immediately following distal displacement the goals are to limit additional displacement and control pain. As the disease progresses further and the distal phalanx becomes stable within the hoof capsule, the goals become realignment of the distal phalanx with the other phalanges and the ground, and realignment of the hoof capsule with the distal phalanx. Additionally, other complications of chronic laminitis must be managed.

The supportive care of horses with acute and chronic laminitis follows similar principles, however, there are differences in application. The distal phalanx is stabilized by reducing stress on the most severely affected lamellae and by decreasing the stresses within the lamellae associated with locomotion. This is achieved by moving the center of pressure, adjusting the distribution of pressure, and the rate at which the load is applied. The latter is accomplished by altering the contour of shoes or shoe-like devices to both diminish and smooth out the moment about the distal interphalangeal joint.

There are numerous ways to achieve these goals and many of them are interchangeable, and clinician preference is frequently based on past experience. In the early stages of the disease, devices applied to the feet to accomplish these goals tend to be temporary in nature so that they are easy to apply, adjust, and remove as circumstances change. This also allows rapid assessment of the effect of the intervention. Therefore, the most frequently used types of support are customized Styrofoam board (Fig. 6), moldable silicone putty (Fig. 7), and commercial cuff and wedge combinations, all of which can be taped in place.

Figure 6. Application of Styrofoam board to the ground surface of the foot.
There is a general assumption that the pain a horse is experiencing is related to both the stress in the lamellae, and the pressure on the sole distal to the distal phalanx. There may be other as yet unidentified sources of pain. Thus the effect of a treatment may be assessed by changes in comfort of the horse. By extension, it may be possible to glean information about the distribution of lamellar injury by observing a horse’s response to different treatments; this is particularly useful in horses with acute or subacute laminitis (in horses with chronic laminitis, the pattern of displacement provides you with similar information).

The center of pressure can be shifted by the use of extensions or wedges; the center of pressure moves towards the side of the extension or elevated side of the wedge. The distribution of pressure can be spread out over a greater area by changing the width of the shoe or by filling all or part of the space between the branches of the shoe with a material that contacts the sole and the ground; it can be done selectively to load one part of the sole and frog over other areas. Elastic/viscoelastic materials can extend the duration of loading to diminish the shock of contact with the ground.

Easing the moment about the distal interphalangeal joint is most important in the sagittal plane, the natural plane of motion of the distal interphalangeal joint, but to a lesser extent in the frontal and transverse planes in which collateromotion and rotation also occur within the joint. This is accomplished by rounding or beveling the outer rim of the shoe, or the addition of rails (Fig. 8). When a device is applied that covers the entire ground surface of the foot such as a wooden shoe (Figs. 9 and 10),\textsuperscript{10} then the entire ground surface can be modified to roll or bevel the margins on one or more sides, and can extend as far as needed towards the center of the device.

Other aspects of supportive care include ice therapy,\textsuperscript{11} limb wraps to control edema, and care of pressure sores. Additionally, appropriate nutritional support must be provided.
Figure 8. Left Image: The Natural Balance Shoe and Wedge Rails (Equine Digital Support System Inc.) Right Image: Shoe and rails used in conjunction with a silicone polymer to support the sole.

Figure 9. Left Image: Wooden shoe/Steward clog made from plywood and a plastic wedge pad. Right Image: Wooden Shoe after attachment with two screws and fiberglass tape.

Figure 10. Lateral and dorsopalmar radiographs showing the positioning of the shoe in relation to the distal phalanx.
Surgery

Deep digital flexor tenotomy is performed when the distal phalanx continues to rotate after all other measures to stabilize it have failed, there is persistent pain in horses with phalangeal rotation that does not respond to other treatment, or in horses that have developed a secondary contracture. Drainage of purulent material is performed as necessary, and is best achieved through the distal wall to preserve the integrity of the sole. Debridement of the distal phalanx must be undertaken with great caution and only in circumstances in which probing the distal aspect of the limb demonstrates exposure of the bone. This is because radiographic evidence of distal phalangeal lysis is far from diagnostic for septic pedal osteitis. Hoof wall resections and resections are techniques that have been used to improve the alignment of the wall with the distal phalanx.

Prognosis

The prognosis for horses with acute laminitis varies greatly with the severity of the initial disease and the ensuing progression of lamellar injury, displacement of the distal phalanx, and distortion of the hoof capsule. It is prudent to give a guarded prognosis regardless of the symptoms because of the propensity of the disease to recrudesce, but in horses with severe disruption of the lamellae with correspondingly severe clinical signs, the prognosis for survival must be poor. For those horses that have successfully progressed to chronic stable laminitis, the prognosis for survival is markedly better, and the severity of the secondary changes to the hoof capsule are likely to give an indication regarding the necessity for indefinite hoof care.

References

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