



Introduction

Laminitis, also called founder, is a severe pathology affecting the soft tissues of the equine hoof (lamellae). It is extremely painful and can end with the sport-career of an athletic horse or pony. Laminitis is frustrating for veterinarians because the knowledge of its pathophysiology is incomplete, it can affect one to four limbs but it more commonly affects hands¹.

Pathophysiology

Laminitis starts with early endothelial changes in lamellae, before it can see the lameness, it is called development stage. Histologically it can see neutrophils form aggregates with platelets and an important migration of neutrophils and monocytes from capillaries of dermis with activated systemic leukocytes producing oxygen free radicals. Also it observed an incremented expression of interleukins IL-1 and IL-10 in dermal tissue, further a substantially incremented expression of COX-2. All these changes are indicative of endothelial dysfunction and can be caused by several reasons including the predisposing factors: systemic inflammation caused by endotoxemia source gastrointestinal, respiratory or reproductive; metabolic anomalies like metabolic syndrome or obesity; severe trauma to a limb; hyperinsulinemia or insulin resistance common in obesity patients or hospitalized horses with stress and pain¹². Also hyperinsulinemia can produce an increased synthesis of endothelial endothelin (ET-1) which reduces the expression of nitric oxide in vascular tissue which leads to an intense venous vasoconstriction and facilitates the development of edema¹.

Basement membrane of lamellae is partly composed of collagen fibers IV and VII, physiologically metalloproteinases-2 and 9 digest them to facilitate hoof growth. But if this enzymes are hyperactivated like in laminitis they facilitate separation. This hyperactivity can be caused by exotoxin of *Streptococcus bovis* but activated neutrophils also generate metalloproteinase-9¹.

There are two basic stages of laminitis: acute and chronic. Acute laminitis is characterized by increased digital pulse, pain, lameness and stance narrow base². On the other hand chronic laminitis is considered when there is displacement of distal phalanx and it may be stable or not⁶.

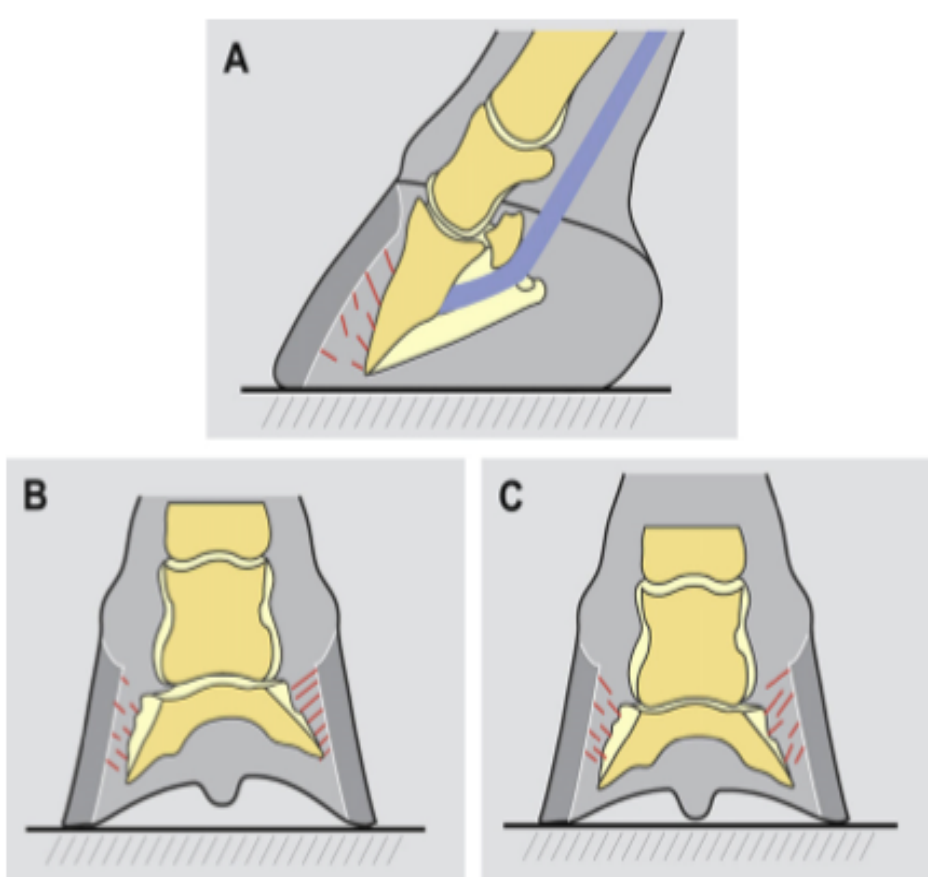


Figure 1 Types of displacement A) dorsal rotation, B) medial or lateral rotation, C) sinking⁶

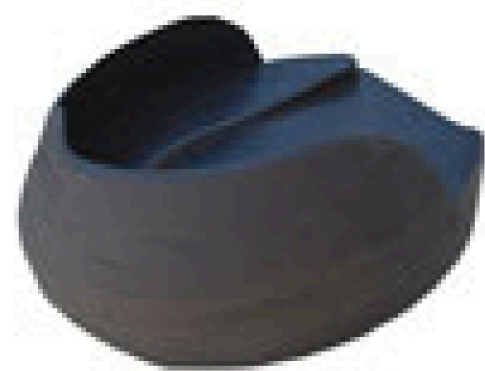


Figure 2: a cuff

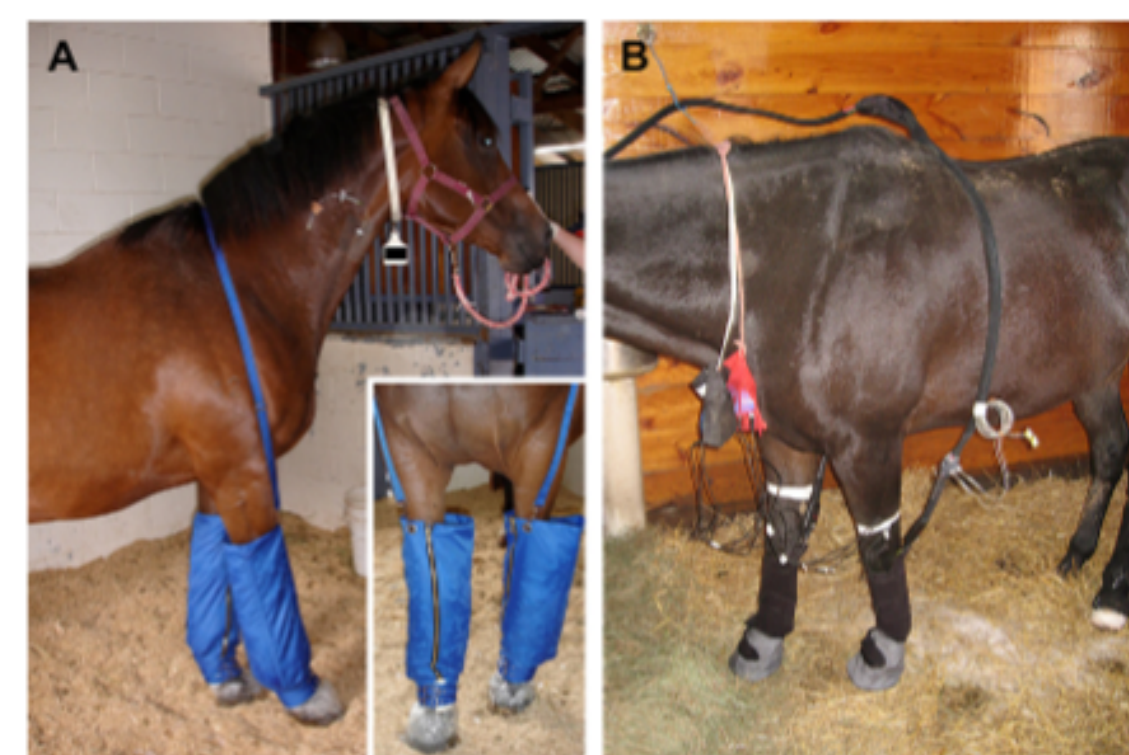


Figure 3: Cryotherapy systems¹³

Treatment: Acute laminitis

Support: the first step is to restrict the movement of the horse and keep it in a little stable with a deep sand bed preferably but a shaving bed can serve, to outline feet improving pedal circulation^{8,11}. Also it's important that horses are fed with good quality and low-carbohydrate food and water *ad libitum*¹¹. Horses need orthopedic support systems as casts, pads, cuffs, clogs or glued shoes, however by the weight distribution on the hoof with shoe would be more appropriate to draw them^{7,8,11}.

Analgesia: AINES like phenylbutazone or flunixin meglumine are indicated; opioids infusion with lidocaine, ketamine, detomidine and acepromazine for severe pain¹¹.

Specific drugs: pentoxifylline is antiinflammatory, antiendotoxic and improves distal flow by its rheological effect like isoxuprine and acepromazine^{4,11}. Polymyxin B for endotoxemia, retain circulating endotoxin¹¹. Matrix metalloproteinase inhibitors like doxycycline or marimastat are still under study^{4,11,14}.

Cryotherapy: Is therefore necessary to cool the hoof as the distal carpus/tarsus at 7-8°C on the hall of hoof during 72h and the return to normal temperature should be gradual. It's recommended to continue to cool down 24-48h after clinic resolution but it must stop for signs of infection^{4,13}. There are commercial systems of cryotherapy¹³.

Treatment: Chronic laminitis

It is imperative to carry out the medical, metabolic, environmental and dietary treatment together with the management of the foot.

Analgesia: It's recommended firocoxib, gabapentin for neuropathic pain and loco-regional infusions to control central and peripheral hyperalgesias².

Support: Hoofs are not aligned and overhead areas that do not regenerate are created, the mainstay of the treatment is to cut the hoof to realign distal phalanx. This process can be taken in many stages^{4,6}. There are too many types of horseshoes that can be used in this cases but they all have in common that they allow the hoof out in all directions, like wooden shoes. A block of wood is shaped to fit the hoof and attached with wood screws through the hoof one per quarter is used and finally the sole is filled with silicone¹⁰.

Surgical: tenotomy of the deep digital flexor tendon is only indicated in 3 cases: horses with progressive rotation of the distal phalanx, horses with persistent discomfort and slow or not growth of the sole or dorsal hoof wall and finally to correct severe deformities secondary to tension of tendon during treatment⁶. Resection of the hoof wall or coronary band is indicated to improve the growth rate of new hoof when other methods have failed or to debride drainage tracts⁴.

Stem cells: in study the use of autologous stem cell transplantation like regenerative therapy for laminitis¹⁴.

Maggot debridement: Due to tissue necrosis, infections are common and can lead to osteomyelitis, there are fly larvae that have proven beneficial⁵.

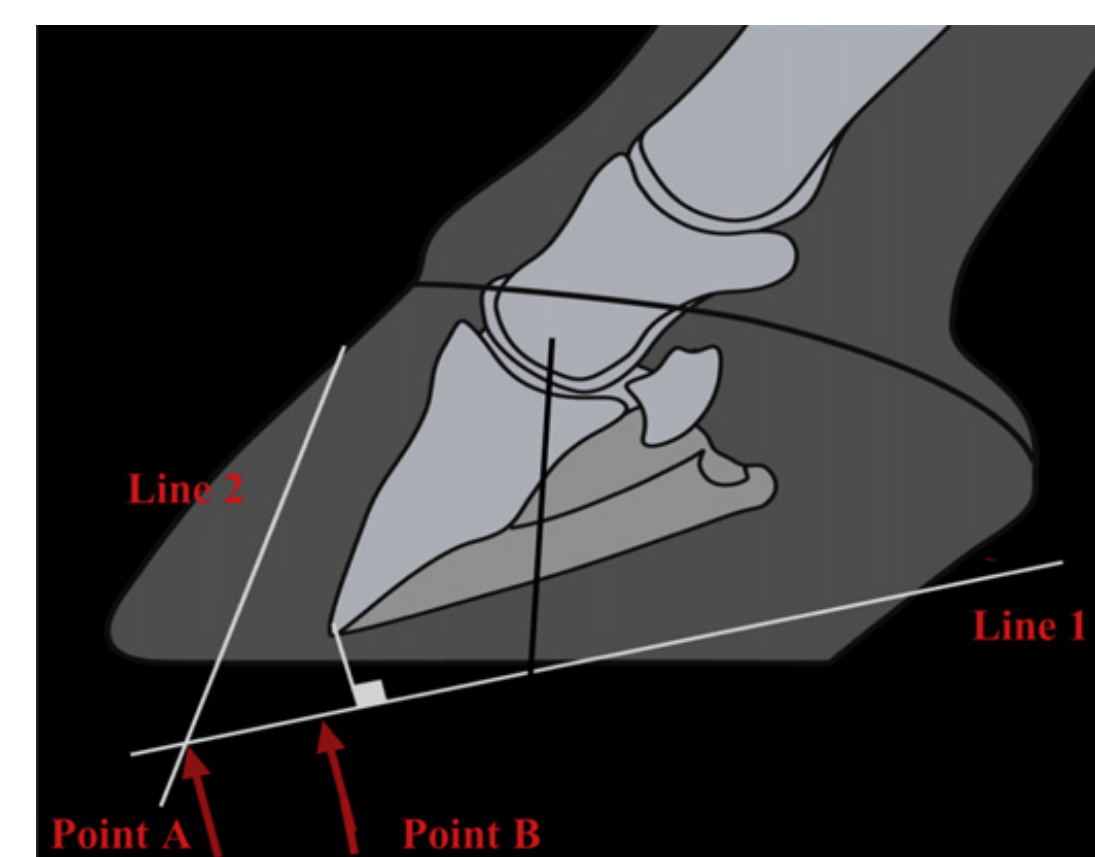


Figure 4: visual guide to cut the hoof⁶



Figure 5: A) 6 days, B) 6 weeks, C) 6 months after wall resection⁹

Figure 6: wooden shoe¹⁰

Prognosis

Identifying the stage of laminitis: acute, chronic or sinking is what provides greater diagnostic significance. The race has influence, Arabs and thoroughbreds are three times worse recovery, however there is no relationship with the degree of rotation³.

The most important determinant of prognosis in laminitis and one of the most difficult to quantify is the instability between the distal phalanx and the hoof wall. It has been observed that in the first 48 hours of laminitis, pain is well connected with the histological damage on the lamellae and this makes a good prediction of instability⁷.

Regarding the number of affected limbs: one hoof 33% of recovery, two hoofs 82% and four 62%, but in cases where there are a subjacent pathology the prognosis is worse³. If there is an imperfect cohesion of lamellae after an acute laminitis or sinking the prognosis for athletic performance is poor³. In all cases in which it had osteomyelitis horse was euthanized⁴.

It is important to consider in prognosis the purchasing power of the owner, the treatments are expensive and these animals must stand at least 8 months for the hoof wall grow back³.

Conclusion

Currently there are no controlled studies to confirm or compare the efficacy of the several treatments that are in use, nor any scientific proof that a treatment is more efficient than another⁷.

Despite it has been some progress in laminitis' research, the knowledge of its pathophysiology remains incomplete, missing gaps to fill. However no current studies that promise both therapeutic and preventive issues, need further investigation.

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