How to Construct and Apply Atraumatic Therapeutic Shoes to Treat Acute or Chronic Laminitis in the Horse  

M. L. Steward  
Shawnee Animal Hospital, Shawnee, OK, USA.

Abstract
An easy and safe therapeutic shoeing technique aids acute or chronic laminitic (foundered) horses by reducing mechanical forces and pain to the foot. This also helps to facilitate blood flow and soundness by providing static support to the third phalanx in a manner that is cost effective and requires a minimal amount of expertise. Success depends on the severity of vascular damage, amount of coffin bone sepsis and degeneration, proper shoeing technique and owner cooperation.

1. Introduction
Efforts to reduce mechanical forces and stabilize the distal phalanx are imperative to effective treatment of acute laminitis [1]. Properly designed and applied therapeutic shoes have aided in pain reduction. Additionally, they may also help to reduce or prevent the magnitude of permanent laminar damage and prevent further movement of the distal phalanx within the hoof capsule. It is also possible that they may aid in the improvement or reversal of deleterious digital or laminar hemodynamics. These are some of the goals of treatment a practitioner should implement into the treatment of acute laminitis [1] along with proper medical therapy.

Therapeutic shoeing of the painfully acute or chronic laminitis patient is often wrought with many obstacles including availability of qualified farriers, proper shoeing supplies, and many times, the lack of cooperation of the unruly or pained patient. It can be difficult to apply a set of therapeutic shoes to a horse suffering from painful laminitis, even with the aid of nerve blocks, tranquilizers, pain medication, and twitches. Overcoming the various problems faced by the veterinarian to properly care for a problem case and coordinating the personnel and patient involved can be frustrating. In my practice, the solution to some of these problems has been the rocker toe-rocker heel designed wooden shoe (Fig. 1). This shoe is applied with sole impression material to reduce mechanical forces in the hoof and to stabilize the distal phalanx, while also reducing pain. Pain reduction starts with the application of the shoe which does not employ painful hammering. While the horse stands on the shoe and the sole impression material, screws are inserted ventrally through the hoof wall and into the wooden shoe (Fig. 2).

Figure 1. The rocker toe-rocker heel design of the wooden shoe was actually designed from the shape of a plywood shoe worn by a foundered mare to protect a protruding, painful coffin bone. After wearing the wooden shoe for 3 mo, the "rocking horse" shoe design was evident on the immensely improved horse. - To view this image in full size go to the IVIS website at www.ivis.org . -

Figure 2. With the horse standing on the shoe, "Gold Deck" screws are screwed through the hoof wall in normal nail positions. The sole impression material (yellow) was held in place by the Vetrap (purple) until screws were inserted. The 0.75 in thick rubber sole (below the plywood) is an old stall mat. - To view this image in full size go to the IVIS website at www.ivis.org . -
2. Materials and Methods
The basic shoe is cut from standard 0.75 in plywood with a band, jig, or table saw using the outline of the hoof. This shoe can be used to stabilize a broken hoof wall or as an easily removed medicine plate/shoe combination for protecting a damaged hoof sole. Shoes of standard hoof sizes can be easily and quickly applied using wood screws (available at most hardware stores). These shoes can be modified to enhance digital breakover (moving breakover distally reduces the pull of the deep digital flexor tendon during locomotion). This feature allows the shoe to aid in the pain reduction of laminitic horses. Cutting a 45º angle across the front of the plywood shoe simply and easily moves the pivot point (breakover) back 0.75 in. Incorporating a square toe design to the shoe and bringing the front of the shoe within 1.5 in of the tip of the frog further enhances the mechanical breakover. Adding a second layer of plywood or rubber (laminated together using screws and an all-purpose glue) can further enhance breakover, because the 45º angle cut can be continued distally through the second layer (Fig. 3). This layered shoe can easily move digital breakover distally 1.5 in, without accounting for the square toe effect. The unusual thickness of the shoe helps the horse transfer weight to the rear limbs, which is a feature one notes in the classical "foundered" stance.

Figure 3. This radiograph shows the screws penetrating through the walls, sole impression material, and plywood and into the rubber base. The front and back of this "worn" shoe are angled to aid digital breakover and the efficiency of motion. The plywood and rubber are laminated together with screws and all-purpose glue. - To view this image in full size go to the IVIS website at www.ivis.org . -

The sole surface of the foot is cleaned and trimmed in a similar manner as a regular hoof trim, but one should try to leave as much sole over the tip of the coffin bone as practical. Radiographs, the lateral sulci of the frog, and the heels of the hoof are used as guidelines to try to realign the third phalanx and to spread the heels. EDSS Sole Impression Material [a] or Advance Cushion Support [b] is mixed and spread over the sole surface. The impression material is spread thinly over the painful toe region (unloading), and it is applied abundantly over the frog and heel regions (loading). The hoof is wrapped with Vetrap [c] or Elastikon [d] and immediately placed on the ground to bear weight. This pressure distributes the impression material over the sole regions in a flat plane, and the hoof wraps help contain the material (Fig. 4). This allows the impression material to gently and evenly spread the pressures exerted from the ground to the sole (and vice versa). This is very important, and it impacts the success of the system immensely. Care must be taken to fully support the frog but not to allow excessive pressure to be applied to the sole (especially the toe region); this may increase pain [1]. Generally, if the heels were lowered more than 0.25 in, a 2º or 3º wedge pad can be applied to help relieve the pull of the deep digital flexor tendon. A wedge pad should be added to the system if the horse displays discomfort when putting the heel down after trimming. The wedges are placed between the sole impression material and the shoe when the shoes are being applied.

Figure 4. This horse would walk on his toes to relieve some of the pull of the deep digital flexor tendon. The left shoe has been removed and shows how the right shoe is enabling the horse to "walk on his toes". Note that the left ankle is pulled forward, indicating that the horse wants to stand on the left toe as well (he did with the shoe on). The yellow sole impression material (noted on the right frog-bulb junction) was held in place by Vetrap until it "set up", forming a sole cushion that seems to aid in digital hemodynamics if applied properly. - To view this image in full size go to the IVIS website at www.ivis.org . -

When the sole impression material has "set up," pilot holes can be drilled into the hoof wall (Fig. 5) to facilitate screw placement. Screws (usually 1.625 in "GoldDeck" screws) can be started into the hoof wall in approximately the same location that a normal nail would occupy. When the shoe (and wedge pad, if used) is properly positioned under the foot, the screws can be inserted through the hoof wall, impression material, wedge pad, if used, and wooden shoe (Fig. 6). The widest part of the frog is the caudal boundary of the shoe, and the anterior part of the shoe is generally 1.5 in (or less) anterior to the tip of the frog. This placement and shoe outline is similar to the Natural Balance Shoe [e] design and placement. Screws should be tightened to hold the hoof firm without putting undue pressure onto the painful sole. If the screws are too tight, the horse will immediately show discomfort, and one can easily loosen the screw. A cordless drill or power screwdriver speeds the screw placement, decreasing application time. Different lengths of screws are kept on hand (1 - 3 in) to properly attach the different thickness systems.
Chronic laminitis cases usually display excessive toe growth, especially with substantial coffin bone rotation. The anterior hoof wall is rasped as much as practical (generally to the white line region) to achieve a normal appearing hoof on lateral profile. The anterior hoof wall is rasped to the white line region from below the coronary band to the sole (Fig. 7). This is possible because of the stabilization of the entire hoof wall using this system, and it should expose the elongated laminae just above the sole junction. This "opening of the laminae" allows an exit for relief of internal fluid buildup (septic or aseptic), which is common and oftentimes reoccurring in these cases. Antimicrobial hoof treatments such as Kopertox [f] should be applied to the exposed laminae to prevent ascending infections. Excessive toe growth mechanically pulls the heels forward, and often inward, resulting in severely contracted heels, especially when the toe wall rotates upward. Excessive toe growth probably causes impedance to hoof hemodynamics and biomechanical function and should be removed if possible.

When it has been determined that the shoe has been properly applied (i.e., most horses show immediate improvement of gait and obvious pain relief), 2 in fiberglass cast material [g], or hoof wall adhesive [h] can be applied to the hoof wall to insure long term stability (Fig. 8). The shoe should be included into the cast (or adhesive) to secure the system for extended periods of time (some cases have worn their shoes up to 3 mo without resetting). When applying the casting material (or adhesive), care must be taken not to trap exudates in the exposed laminar or solar abscesses that have not completely resolved. Different drainage-lavage systems can be incorporated into the cast or adhesive material to insure that unwanted fluid pressure does not complicate the healing process.

Should the sole be "dropped" from rotation of the third phalanx, the shoe can be routered out to relieve any possibility of painful sole pressure. Regular sole pads can also be cut to accommodate the dropped sole (Fig. 9). This will aid in the transfer of the sole toe pressure to the walls and frog-heel regions, and it will further stabilize the damaged hoof structure. Impression material is applied mainly to engage the frog and heel regions.
Figure 9. When the coffin bone rotates ventrally, the sole may "drop". The impression material may be cut out to compensate for the protruding sole, or sole pads can be cut out to form a "shim" to join the wall to the shoe without removing the vital protruding sole. This aids in digital wall and sole stabilization along with the use of the sole impression material. The threads of the screws allow wall stabilization without the shoe and wall being in direct contact. To view this image in full size go to the IVIS website at www.ivis.org.

Extra anti-inflammatory pain medications are prescribed for at least 3 days to offset any damage caused by trailering the horse to the hospital, trimming the hooves (changing hoof angles), and forcing exercise to evaluate gait and pain relief during the shoeing procedure.

3. Results
Variations of this therapeutic shoeing technique have been employed over the last 15 yr, and 64 cases of acute and chronic laminitis have been treated with this system. Six cases had coffin bones with greater than 15º of rotation, more than 10% of the tip of the bone deteriorated, and more than 1 yr in duration. These cases displayed some improvement in gait, decrease in pain (as evident by increased time standing and walking), increase in live sole thickness, and improvement in normal hoof appearance. Although their quality of life had improved, two of the six cases were euthanized for humane reasons, because their quality of life had not reached the accepted parameters. Four of these cases are currently being shod with square toed-rocker toed shoes and are pasture sound (able to walk without pain).

Eleven horses with Grade 5 lameness in two or more feet showed some improvement in gait and some pain relief after the therapeutic shoes were applied. Two were euthanized when venograms (combined with clinical signs and owners' wishes) suggested little chance of acceptable recovery (Fig. 10).

Figure 10. These radiographs (venograms) belong to a yearling colt. The colt suffered from acute laminitis post-colic surgery and was treated by two other veterinarians. A concerned farrier offered help and applied the wooden shoes to the front feet (upper radiograph) of this Grade 5 lame patient. Improvement was noted, but the right hind hoof (lower radiograph) showed signs of coronary band separation. Venograms and clinical signs revealed severely compromised laminar blood flow to the front feet and little hope for the hind foot. Euthanasia was advised. To view this image in full size go to the IVIS website at www.ivis.org.

Nine of these cases are recovering after spending 6 - 9 mo wearing this shoeing system. These horses had more than 10º coffin bone rotation. Shoes were removed, feet were therapeutically trimmed, and shoes were reset with new sole impression material when adequate sole growth required it (greater than 15 mm as measured on radiographs). The front of the toe wall is rasped into the white line region from the coronary band to the shoe (Fig. 11). This may help to relieve some of the pressure of laminar edema in the acute phase. Excessive toe growth (after the first mo of onset) is typical for these cases but was removed to facilitate healing. These 9 cases are currently sound and can return to light duty, but they have taken a minimum of 9 mo to gain adequate bone stabilization. Monthly hoof care was important to insure continued third phalanx realignment after the wooden shoes were removed. Therapeutic square toe-rocker toe metal shoes were applied when adequate sole growth was achieved and the hoof would accept hammering with a minimum of pain.

Figure 11. These before and after photos demonstrate the excessive toe growth that can occur between shoeings as well as the amount of anterior hoof wall that can be removed to realign the coffin bone. To view this image in full size go to the IVIS website at www.ivis.org.
The majority of cases (47) were chronic laminitis cases that had been ongoing from 3 - 14 mo. Ten of these cases had undergone extensive veterinary care elsewhere. These cases had less than 15º rotation and were Grade 2 - 4 lame (unless painful abscesses were present). Forty of these cases showed significant improvement of gait, were not as reluctant to walk as before treatment, and displayed significant pain relief immediately after shoeing (pain data collected from owner surveys). Seven of this group had painful abscesses in one foot and showed significant improvement on abscess resolution. Follow-up radiographs (taken when the patient was available) of 36 of 47 cases showed significant sole growth (greater than 10 mm in 45 days) (Fig. 12). These 36 cases, including two mules, two draft horses, and one donkey, have returned to useful soundness. Radiographs show derotation was successfully accomplished. Derotation is accomplished by trimming the heels to drop the back of the coffin bone to a normal angle and removing the front toe wall to discard the physical and mechanical template of distorted toe growth. Average time spent wearing the wooden shoes was 60 days with a range from 30 to 180 days. With the addition of the cast material or hoof adhesive, wooden shoes are being used for longer recovery periods because of the additional stability they provide. The screws alone will sometimes stress fracture when the horse becomes very active, and the shoes need to be replaced quickly if lost. If screws are used without exterior support, replacing the individual screws every 2 wk helps maintain screw strength, because they tend to rust rapidly (in some environments). Treatment was considered successful when the horse could trot soundly (in a straight line) and could accept nails on shoes with minimal objection. Continued long-term hoof care (with proper trimming) to derotate the third phalanx are incorporated into monthly farrier visits.

Figure 12. Sole growth was measured from the tip of the third phalanx to the sole surface on radiographs. This system increased sole growth compared with horses that wore regular shoes or no shoes. Some cases showed remarkable growth (> 10 mm/mo) of live sole. Note the broken screws. This Grade 5 lame horse became too active and broke the screws in the shoe. Fiberglass casting was added to the next pair of shoes to eliminate the need for screw maintenance. - To view this image in full size go to the IVIS website at www.ivis.org.

Four of the 47 cases were healing as expected and were released to the regular farrier. However, they experienced "farrier foundering" after being shod by uninformed farriers applying shoeing methods that put too much toe sole pressure on the damaged, recovering foot. These horses were walking soundly before shoeing and were displaying acute laminitis symptoms 24 h after improper shoeing. They were treated as acute laminitic cases, were placed back into the wooden shoe system, and had to undergo another recovery period. Eleven of these 47 cases were sold or the owner neglected the follow-up treatments.

Sole growth is measured using lateral radiographs of the third phalanx. The tip of the coffin bone is the site used to calculate sole depth. Follow-up radiographs are taken to calculate the increase in sole thickness (Fig. 13). Radiographs are used to reveal fluid pockets, bone deterioration, rotation or stabilization of the phalanx, and other information used to determine proper placement of digital breakover. In general, digital breakover should be placed behind the anterior line of the coffin bone as it is projected to the ground.

Figure 13. These radiographs showed the significant sole growth that occurred in 90 days (compare with Fig. 12). The right toe had a fluid pocket that was trimmed out with the excess sole. The horse was reshosed with a single layer of plywood, sole impression material, screws, and wall adhesive. This horse is now Grade 2 lame, which is a big improvement from the Grade 5 lameness only 9 mo earlier. - To view this image in full size go to the IVIS website at www.ivis.org.

4. Discussion

Horses affected with laminitis are often difficult to manage, even under the best of circumstances [2]. This is one condition that we, as veterinarians, sometimes have a difficult time trying to "do no harm" when we attempt to actively aid our patients. Typical therapeutic shoeing of a stabilized foot can cause additional injury to the fragile digit [2]. On the other hand, this shoeing system allows one to give biomechanical aid with a minimum of risk to the patient and personnel and simultaneously provide significant pain relief to the patient. The wooden "rocking horse shoe" seems to facilitate solar blood flow as evident by the substantial live sole growth that the hooves displayed on radiographs and during hoof trimming. Live sole growth seems to be a good indicator of internal hoof healing of laminitic horses. The layered plywood-rubber shoe (1.5 in tall) with a 45º toe angle moves digital breakover 1.5 in distally. The square toe design of the shoe typically moves breakover distally more than 0.5 in on an average horse. This gives up to a 50% mechanical advantage to an average hoof during locomotion. As a result, this significantly reduces the amount of painful force that the horse has to apply to the deep digital flexor tendon during propulsion. A chronic laminitic horse with
excessive toe growth can be biomechanically aided as much as 75% when the digital breakover is moved distally up to 5 in. Before foundering, this hoof may have been only 5 in in length.

The toe angle helps the especially pained patient to "walk on their toes," allowing the anterior surface of the coffin bone to remain perpendicular to the ground. This is another method in which the horse can help to disengage the pull of the deep digital flexor tendon (without a tenotomy). Critical cases will often walk with the sole surface of the shoe on concrete but will walk on the (front) toe angle (Fig. 12) on soft surfaces (pasture or lawn).

The flat midsurface of the shoe provides a stable surface for the horse to stand or walk on. Flat, even surfaces provide the horse with better therapeutic footing than uneven surfaces. The laminic foot needs to have the same considerations taken as a broken bone. It needs as much stabilization as possible, regardless of whether the horse is at walk or at rest.

The back (and front) of the shoe is sloped to enhance the efficiency of motion at a walk. The back slope is very beneficial when the horse stands up. The shoe allows the phalangeal and fetlock joints to remain "fixed," while the shoe "rocks" (similar to a rocking chair) as the horse stands up.

Edema formation is inevitable inside the hoof when the vasoconstrictive events of laminitis cascade. The hoof is highly predisposed to developing marked edema, which leads to the compression of the nutrient capillaries. This results in laminar ischemia, reduction of metabolic waste removal, and ultimately, laminar necrosis and degeneration [1]. Many tissues expand with edema, but the rigid nature of the hoof prevents expansion of the overall hoof capsule. Digital edema causes compression of the digital and laminar blood supplies and the lymphatic system. The rocking nature of the shoe, combined with the sole support system, may have a massaging effect on the internal hemodynamics, which may facilitate nutrient flow and waste product removal within the damaged hoof. This improvement of digital (and possibly lamellar) hemodynamics, combined with the biomechanical advantage of moving digital breakover distally, probably accounts for the significant permanent pain relief most of these cases experienced.

The horses are not tranquilized, nerve blocked, and rarely twitched when the shoes are applied. This allows excellent communication between the patient and doctor during and after the application of the shoes. Mistakes in application (usually too much sole pressure) generally are pointed out by the pained patient immediately, and thus, modifications can be made. Gait analysis can be made accurately and immediately, and adjustments can be made if necessary. Almost all horses positioned their front feet in a more normal stance immediately after shoes were applied. Walking (especially on soft ground) revealed more normal hoof placement and more fluid gaits. Most cases (for economic reasons) are shod at the hospital and sent home immediately. Within 1 h, most cases are diagnosed, radiographed, trimmed, shod, radiographed after shoeing, and evaluated for pain relief and gait improvement. Most cases are handled by one veterinarian, one vet tech, and the owner (holding the horse). Farriers are welcome and used when available. Grade 5 lame cases usually take longer and can be shod while lying down or with the use of a simple girth sling.

Most of the horses were of marginal economic value and received a minimal amount of therapy other than shoeing and daily medications such as phenylbutazone and isoxsuprine. Most horses were allowed pasture exercise, and only the Grade 5 lame cases were regularly provided stall bedding. Some of the cases would exercise more than their condition would tolerate, because the shoes reduced their pain much more rapidly than the actual stabilization healing had been completed. The resulting soreness was handled with pain medications and instructions to restrict the size of the paddock.

Laminitis often is a very devastating condition for the horse, the owner, the veterinarian, and the farrier. Treatment of this condition requires a team effort with a tremendous commitment from the owner. Our knowledge of this disease is growing so that we can better inform the owner of the exact medical condition from which the animal is suffering and provide affordable solutions to help relieve as much of the suffering as possible to their beloved companions.

Footnotes
[b] Advance Cushion Support, Nanric, PO Box 602, Versailles, KY 40383.
[c] Vetrap Bandaging Tape, 3M Animal Care Products, St Paul, MN 55144-1000.
[g] Vetcast, 3M Animal Health Care Products, St. Paul, MN 55144.
[h] Hoof Adhesive Equi-Thane Superfast, Vettec, Hoof Care Products, Oxnard, CA 93033.
References


All rights reserved. This document is available on-line at www.ivis.org. Document No. P0651.1103. This manuscript is reproduced in the IVIS website with the permission of the AAEP www.aaep.org