Take Home Message: It is possible to re-establish normal or near normal orientation of the distal phalanx within the hoof capsule and restore soundness in obese laminitic horses with specific trimming and dietary management.

Introduction: Veterinarians and farriers have struggled for ages with the treatment and management of laminitic horses. This paper describes the clinical presentation and outcome of four obese laminitic horses that were treated with a system that significantly increases soundness and restores the hoof capsule relationship to the distal phalanx to a normal or near normal relationship. The objective of this work was to document the changes, in soundness, body condition and radiographic parameters of the hoof in 4 laminitic horses treated with the Hoof Rehab system.

Materials and Methods:

Case Selection: Cases in this study were presented to the AUCVM hospital between September 2006 and April 2008 for lameness of suspected laminitis. The horses in this study each had abnormal body condition score (BCS) at presentation. A diagnosis of laminitis was confirmed based on clinical signs, and identification of rotation of the distal phalanx away from the dorsal hoof wall on lateral radiographs of the hoof. Venograms were performed if client consent for the additional cost was obtained (Cases 1 and 2) . Two of the four horses in this study had been experiencing clinical signs consistent with laminitis for more than 2 weeks at the time of presentation. Inclusion criteria for this group included; lack of significant boney remodeling of the distal phalanx, owner selection of the Hoof Rehab system, not switching to another hoof care system during the treatment period.

Hoof Care: The horses were treated using the methodology of Hoof Rehabilitation Specialist Pete Ramey as outlined in the articles at www.hoofrehab.com and the DVD series Under the Horse. The primary mechanical force working to separate the laminae was considered to be the weight of the horse combined with peripheral loading. The treatment was also guided by the concept that deep digital flexor tension cannot significantly oppose the laminae unless the toe wall is carrying the impact and/or breakover load. Any weight bearing by the hoof walls (with the exception of the heel
buttress) was significantly reduced and/or eliminated during the first 3 months of treatment.

The load carried by the hoof wall (and thus the laminae) was reduced at 3-6 week intervals by beveling the hoof wall, rendering it slightly passive to the sole. Lamellar wedge at the toe and quarters was also relieved from active pressure by beveling it at ground level; rendering it slightly passive to the sole.

The resulting [assumed] excess pressure on the sole was offset by one or more of the following methods of protection:

- Applying hoof boots$^{bc}$ with pads$^{b,d}$ and dental impression material$^{e,f}$ in the collateral sulci and under the frog.
- Casts$^a$ applied to cover the bottom of the foot with dental impression material$^{e,f}$ or pads$^b$ filling the solar concavity and collateral sulci.
- Glue-on hoof boots$^b$ with dental impression material$^{e,f}$ filling the solar concavity and collateral sulci.
- If a solar perforation or defect occurred or the sole under the tip of the distal phalanx was < 5mm, an air space was established under this region of sole by cutting material away from the hoof pad or impression material.
- Barefoot on yielding terrain including soft ground free of rocks and/or beds of 4” deep pea gravel (1/4 inch diameter stones) and/or 2” deep sand.

With each method used, the sole was protected while principles of axial loading were strictly applied.

Heel height was established subjectively using the following guiding principles:

- 10mm maximum change to heel height at one session
- Heels trimmed at a 5-10 degree positive slope from a plane parallel to the solar plane of P3
- Healthy (12mm) callused sole thickness always preserved
- Height and shape of the heels worked to prioritize caudal foot comfort and heel first impact
- Approximate, eventual target of positive 5 degree P3 solar angle to the ground plane

Turnout and daily in-hand exercise were encouraged when horses became Obel 1$^1$ and had a heel first landing in boots. Riding in padded hoof boots was encouraged when all of the following were achieved:

- When the horse became Obel 0 in padded boots
- When the proximal half (new growth) of the hoof wall became well connected as indicated by physical appearance of the hoof +/- radiographs. FIG 2
- When the sole exceeded 8mm thickness in all areas
- If the horse moved comfortably and all feet impacted heel first with the added weight of the rider

The following dietary restrictions were recommended for each case:
• Elimination of fruits, vegetables and other sweet or starchy treats
• Elimination of grains and/or processed feeds (excluding concentrated vitamin/mineral supplements)
• Elimination or restriction of live grasses
• Constant access to grass hay tested to 10% NSC or less
• Mineral supplementation provided to balance nutritional content of hay to meet NRC values for appropriate weight and work load of the horse.

Medication:

At the time of presentation, each horse was prescribed phenylbutazone at the dose of 2.2mg/kg q 12 h, PO. Phenylbutazone was administered at the dosages described to help maintain an Obel lameness score one less than at the time of presentation. The dose was reduced as quickly as possible to 2.2mg/kg q 24 h, PO. Phenylbutazone was discontinued when Obel score was 1 or 0. Some of the horses were also initially treated with acepromazine, 20 mg q 8-24 h, IM for 5 – 7 days.

Cases 1 and 2 presented solar perforations/defects at the distal tip of P3. The lesions were treated with saline lavage, strict hygiene and application of tetracycline and metronidazole powder under a bandage within the hoof boot. Case 2 was also treated with oxytetracycline, 6 mg/kg q 12 h, IV for 14 days.

Diet: A diet of free choice low starch hay (<12% NSC) and mineral supplement was recommended for each horse in the study.

Radiographs: Lateral radiographs of the front feet were taken of the horses on the first day of presentation, pre-treatment. The dorsal hoof wall, lateral heel and apex of the frog were marked with barium paste and the horses were positioned on blocks with a radiopaque marker in the top of the block as previously described. The hoof was placed in contact with the cassette. The primary beam was centered 1 cm above the block. Measurements of the relationship of the distal phalanx to the hoof capsule were made and recorded as previously described. Post-treatment lateral radiographs were repeated 7 – 13 months after presentation. Pre-treatment radiographs were compared to post-treatment radiographs.

Venograms: Venograms of Cases 1 and 2 were performed as previously described.

Lameness Evaluation: The Obel Laminitis Scoring system was utilized to evaluate lameness. The lameness was given an Obel Score by DRT or by the referring veterinarian on the day of the pre-treatment radiographs and then again at the time of post-treatment radiographs.

Body Condition Scoring: The horses were body condition scored by standard means pre and post- treatment. Body weights were not obtained because 3/4 of these horses were treated as ambulatory cases and were never in the vicinity of a scale.
Statistics: A statistical software package was used for data analysis (SPSS 17.0, SPPS Inc, Chicago, IL). Measurements taken for each forelimb before and after treatment were compared by the dependent sample t-statistic. For statistical analysis, the difference of dorsal hoof wall thickness (DDHWT) at the proximal and distal aspect of the distal phalanx was calculated (Redden). This difference reflects alterations to the hoof wall as a result of laminitis and decreasing values are found in improving patients. The ANOVA statistic for repeated measures was used to examine the data for statistically significant interactions of CE, palmar angle, degrees rotation, sole depth, difference between dorsal hoof wall thickness from proximal to distal, change in body condition score and Obel lameness score.

Results:

<table>
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<tr>
<th></th>
<th>Minimum</th>
<th>Maximum</th>
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Table 1

Descriptive information on the measurements taken at pre- and post-treatment examinations is given in Table 1.

The distance between coronary band and extensor process and sole depth thickness did not vary significantly between pre-treatment and post-treatment evaluations (p = 0.501 and 0.129, 95% CI for difference -2.186 - 4.061 and -5.634 – 0.884, respectively).

All horses were sound at post-treatment evaluation and a statistically significant reduction of Obel laminitis score was detected (p < 0.0001, 95% CI for difference 3.044 – 4.137)
A statistically significant reduction of palmar angle measurements when comparing both examinations was detected ($p = 0.001$, 95% CI for difference $2.404 – 6.596$).

The degrees of rotation at post-treatment evaluation were determined to be significantly smaller than those at pre-treatment ($p < 0.0001$, 95% CI for difference $4.904 – 10.846$).

The difference of the dorsal hoof wall thicknesses at the proximal and distal aspect of the distal phalanx (DDHWT) was found to be significantly reduced at post-treatment evaluation ($p = 0.002$, 95% CI for difference $1.977 – 5.523$).

Although there was no statistically significant change in sole depth in the study, the sole depth was increased or remained constant in each horse.

The body condition score of each horse in the study returned to normal during treatment.

Discussion:

The prognosis for laminitic horses has historically been based somewhat on the degrees of rotation of the distal phalanx away from the dorsal hoof wall. Horses with $> 11.5$ degrees rotation have previously been given a guarded prognosis. All of the horses in this study had $> 5$ degrees rotation and 2 of them were $> 11.5$ degrees yet each horse in this study returned to soundness and remains sound at the time of this writing.

The horses in this study had minimal to absent distal phalanx remodeling at the onset of treatment. Mild remodeling occurred during the course of treatment in one of the horses with $> 10$ degrees rotation (Case 2). This horse had more change on venogram than did Case 1. Case 2 also achieved less sole depth than did Case 1 with the more normal venogram.

The palmar angle or orientation of the distal phalanx to the ground was reduced in these horses. This system may prove to be an additional method of restoring distal phalanx alignment with the ground while maintaining horse comfort as has been previously described.

Although endocrinologic testing was not performed on these horses, it is likely that the causative factor for laminitis in these horses was equine metabolic syndrome due to their excessive body condition and the presence of regional fat deposition in the crest of the neck. Since none of these horses exhibited hirsutism it is unlikely that they suffered from pituitary dysfunction. Since each horse in the study attained a normal body condition during treatment, the success of this system may be dependent on owner compliance with dietary restriction and/or exercise.

Recent evidence has suggested that exercise decreases insulin resistance in obese horses. However, it is often contraindicated to exercise laminitic horses when they are in pain and the lamellar attachment of the hoof wall is compromised. The mechanics of this system adhere to axial loading principles removing the hoof wall from ground reaction force and making it passive during exercise. This is one of few laminitis treatment systems where exercise is recommended prior to complete recovery if the described criteria are met.

Obel grade score has been correlated to severity of lamellar destruction. The Obel grade score was significantly reduced in these horses who presented with Grade 3-4.
lameness. This indicates that it maybe possible to restore soundness and hoof alignment with the bone in some horses with significant lamellar disruption.

Although this study includes a very limited number of horses, the results indicate that further study of the application of this system is warranted. Three additional horses were treated with this system. They responded similarly, returned to soundness, yet were not included in this study because they were lost to radiographic follow-up. Additional cases are currently in progress.

Figure 1: Photograph of case 2 with new growth half-way to ground.  
Figure 2: Pre- and post- treatment radiographs of Case 1.  
Figure 3: Pre- and post-treatment radiographs of Case 2

a Under the Horse, DVD Series, Hoof Rehab Inc. Lakemont, GA 30552  
b Easy Boot Epics, Easycare Comfort Pads, Easy Boot Gloves, EasyCare Inc., Tucson, AZ, 85755  
c Soft Ride Boots, Soft-Ride Inc, Vermilion, OH 44089  
d wrestling mat pads, Rood and Riddle Equine Podiatry Center, Lexington, Ky 40511  
e Advanced Cushion Support, Nanric Inc, Lawrenceburg, KY 40342  
f EDSS Sole Support Impression Material, Hope for Soundness Inc., Penrose, CO 81240  
g Equicast, Equicast Inc, Aberdeen, NC 28315

References:


Figure 1: Case 2 with new uniform hoof growth half-way to ground
Figure 2: Case 1 – Left front pre-treatment

Figure 2: Case 1 – Left front post-treatment
Figure 2: Case 1 – Right front pre-treatment

Rotation 12°
CE = 14 mm
PA = 10
SD = 7.5 mm
HL = 21/28 mm

Figure 2: Case 1 – Right front post-treatment

Rotation 0°
CE = 9 mm
PA = 4
SD = 16 mm
HL = 20/20 mm
Figure 3: Case 2 – Left front – pre-treatment

Figure 3: Case 2 – Left front – post-treatment