A Case Study of Laminitis in Racehorses: Recovery from Prolapse of the Solar Corium

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The state of coffin bone displacement in a racehorse suffering from severe case of laminitis in right rear limb was monitored by conducting X-ray examination based on new indicators, and was treated with a method of shoeing combining 3 different therapeutic shoes together with sole protection materials, as well as rigorous correction of hoof shape and surgical treatment. As a result, the horse was cured after about 7 months of treatment.

Key words: racehorse, laminitis, prolapse of solar corium, lamellar wedge, therapeutic shoes

Laminitis has long been known as an intractable disease affecting horses. Laminitis has been attributed to disturbances in circulation caused by hyperemia in the hoof. Recently, however, its principle manifestation is thought to be ischemia of laminate regions (lamellar), and the various diseases caused by this are called laminitis [1–6].

Research on laminitis is in progress and its causes are being debated worldwide. The mechanism of occurrence of ischemia that selectively attacks laminated regions is still unknown, and no fundamental treatment has been established.

When a horse contracts laminitis, its laminated regions are destroyed by ischemia of unknown origin. Next, the coffin bone is pulled away from the hoof wall and its position gradually changes causing severe pain. It becomes displaced in a “rotational” or “sinking” displacement which leads to arc-shaped protruding due to the dropped sole. If the condition becomes further advanced, the coffin bone penetrates the sole (prolapse of the solar corium). Due to the unbearable pain, the affected horse is unable to support its body weight on the affected limb. Finally, it is unable to get up again, and sometimes end up in hoof loss, which the horse can no longer be treated and has to be euthanized.

We encountered a young racehorse suffering from severe laminitis with excessive displacement of the coffin bone, leading to prolapse of the solar corium. In this report, we will introduce the shoeing treatment with priority on reducing the displacement in the coffin bone, together with systematic treatment using drugs, based on newly established indicators for ascertaining the state of the disease which provided extremely good treatment results.

Background to the Occurrence of Laminitis

The affected racehorse was a superior two-year-old thoroughbred colt bred in the USA. It made its racing debut in autumn of its second year and won its first two races.

After winning its second race, the horse was put out to pasture for refreshment. There, it developed a suppurative disease on its left rear limb, and was treated by the attending veterinary practitioner. The pyosis was subsequently cured, but then it became difficult for the horse to bear weight on the other side, i.e. the right rear limb.

Since the condition was difficult to treat at the pasture farm, the affected horse was moved to the...
State of the Disease on Initial Diagnosis

Now the course of the present case will be explained in chronological sequence. The number of days indicates days elapsed after admission to the Racehorse Hospital.

At the start of the treatment, the sole was markedly swollen directly in front of the apex of the frog. There was a crescent-shaped perforation, and it was giving off an extremely unpleasant smell (Fig. 1).

To make an objective evaluation of the advance of the disease, radiography of the lateral view to observe the degree of displacement of the coffin bone was performed. The X-ray examination confirmed severe coffin bone displacement, a transparent image showing cavitation of the dorsal hoof wall (arrowhead), hyperplasia of the coffin bone (arrow), and decalcification of the sole border of the coffin bone (☆), while the front edge of the sole border of the coffin bone had grown out in a beak-like formation (※).

In the radiography of a normal hoof, the angles of the dorsal border of the hoof wall and the dorsal border of the coffin bone are parallel. In laminitis accompanied by rotation of the coffin bone, however, the front edge of the sole border of the coffin bone is displaced facing downwards (to the sole).

Therefore, the angle of inclination of the dorsal border of the coffin bone against the hoof-bearing surface becomes greater than that of the dorsal border of the hoof wall. Generally, when there is an intersecting angle differential of more than 10 degrees between the dorsal border of hoof wall and the dorsal border of the coffin bone, the prognosis is thought to be extremely bad [7].

In the radiography of the affected horse, the displacement of the coffin bone showed a differential of 15 degrees, leading to the judgment that this horse was unlikely to return to racing (Figs. 2, 3).

Drawing up Parameters for Shoeing Treatment and an Outline Thereof

Therapeutic shoeing was carried out by correcting the disfigured hoof wall and fitting therapeutic shoes. Vigorous correction of the hoof shape is essential since, in chronic cases of laminitis, the wall of the heel grows abnormally and the hoof becomes pumiced to compensate for damage to the dorsal hoof wall. Also,
The application of therapeutic shoes to ease the tractional force on the deep flexor tendon that causes displacement of the coffin bone is necessary.

For reliable therapeutic shoeing, the positional relationship between the coffin bone and the hoof capsule needs to be confirmed. Generally, the angle of the dorsal hoof wall against the dorsal hoof wall on radiography is taken as a guide [7, 8]. However, it is impossible to accurately assess the positional relationship between the dorsal hoof wall and the coffin bone in cases where the hoof wall has become disfigured and crevices or distortions (concaved changes) have occurred in the dorsal hoof wall, or cases in which pumiced hoof has developed. In the present case, the dorsal hoof wall was already disfigured, and it would not have been appropriate to use the dorsal hoof wall as a standard for calculating the displacement of the coffin bone. This was because, for reasons of the treatment, it was expected that the dorsal hoof wall would have to be filed, pared, or excised.

Therefore, the hoof-bearing surface was chosen as a standard locum instead of the dorsal hoof wall. The angle between the bottom of the coffin bone (sole side of the coffin bone) and the hoof-bearing surface was observed to measure the advance of rotational displacement of the coffin bone (Fig. 3).

Figure 4 shows the time course of correction of the coffin bone displacement and changes of hoof angle from the initial diagnosis until 209th day. On initial diagnosis, disfigurement of the hoof had already started, and the angle of the bottom of the coffin bone on the affected limb was 12 degrees. Since the angle of the coffin bone did not alter, the state of the disease was thought to have stabilized and on the 69th day, the angle of the coffin bone was corrected to 9 degrees by vigorously paring the heel. Thereafter, we gradually corrected the angle of the coffin bone while ascertaining the severity of the disease, until on the 209th day we managed to restore it to 0 degrees, the same as that of the healthy opposite limb. The hoof

![Fig. 3. Displacement of the coffin bone (same as Fig. 2). White line indicates the angle between the dorsal hoof wall and coffin bone. Red line indicates the angle between the bottom of the coffin bone and the hoof bearing surface.](image)

![Fig. 4. Changes of angle in displacement of the coffin bone and raised heel.](image)
The hoof angle was gradually adjusted using 3 different therapeutic shoes up to the 166th day after initial diagnosis (Fig. 5). All of these had the function of raising the heel, easing the tractional force of the deep flexor tendon, and providing smoother break over.

Adjustment of the hoof angle using these shoes gradually reduced the angle from 12 degrees on initial diagnosis to 9 degrees, and further to 5 degrees as the disease improved, until the shoes could be removed on the 166th day. Moreover, there was no deterioration in the state of the disease as a result of this treatment.

Until a few years ago, a heart-bar shoe was used for therapeutic shoeing in cases of laminitis. This shoe supported the frog with an iron bar linked at its center, and was expected to have the effect of reducing the displacement of the coffin bone. However, a sinking coffin bone and a hard shoe that supports it from below are prone to causing damage to the sensory parts of the hoof. Therefore, to replace this, a method of filling the sole with advance cushion support (ACS) has recently been tested [8]. Since the sole supports the horse’s body weight by maintaining an arch shape with a domed roof (fornix), all due caution was taken to prevent the loss of physiological functions of the sole when using ACS.

**Course of Treatment**

1st month after hospitalization

Antibiotics and anti-inflammatory analgesics were administered immediately after hospitalization, and external treatment was applied to the affected parts. The antibiotics were cefalotin sodium 10 g twice a day, and gentamicine sulfate 120 mg twice a day, injected intravenously. The anti-inflammatory analgesics were flunixin meglumine 415–830 mg each time injected intravenously, plus phenylbutazone 1,000–2,000 mg administered per orally. The antibiotics were administered continuously for about 1 month. They were stopped when it was confirmed that the perforation in the sole was cured, in conjunction with the results of blood tests. The anti-inflammatory analgesics, meanwhile, were administered in combination for one week, after which the state of the disease had improved. Then the flunixin meglumine was stopped, while the phenylbutazone continued to be administered once a day for one further month.

The therapeutic shoe used initially was a combination of a wedged bar shoe with open toe (Fig. 6, left) and ACS filling (Fig. 6, right). ACS was made easy to remove and refit in order to administer external treatment to the perforated part of the solar horn. Fig. 5 shows the state of these shoeing materials as seen from the contact surface. Since the angle of the bottom of the coffin bone was 12 degrees at initial diagnosis, the angle of the wedge was set to same angle.

The condition of shoeing was observed every day and irregular symptom such as elevation of the hoof wall temperature was not seen. Radiography was also performed once a week and no sign of deterioration was observed.

From 1 to 3 months of treatment

With the passage of 1 month after hospitalization, there was no further advance in the displacement of the coffin bone, and the condition had stabilized. The perforated area was covered with new granulation tissue, and the overwhelming odor had gone.

Since the affected horse was now able to move...
around freely in the stall, the therapeutic shoe used was changed to a different type. The new therapeutic shoe was a high heel rails shoe with open toe (Fig. 5, center), using two rails attached to the ground surface of the shoe along its longitudinal axis. This was designed to make the break over of the laminitis-affected hoof smoother to lateral direction. ACS was also used as a filler, as before.

After fitting the high heel rails shoe with open toe, the perforated area of the sole diminished further. The area became covered with a soft, fragile horn, which gradually hardened and increased the overall thickness of the sole. The horn from the swollen sole was therefore pared off.

As the condition of prolapse of the solar corium improved, the dorsal hoof wall became arc-shaped, the wall of the heel spread extensively, and aspects of so-called pumiced hoof became evident. Therefore, dorsal hoof wall was filed, the heel was extensively pared, and the hoof shape was corrected such that the sole side angle of the coffin bone was 8 degrees. Fig. 7-A shows the condition on the 92nd day after hospitalization.

From 3 to 4 months of treatment

After 3 months from the hospitalization, the horse was sufficiently able to bear weight on the affected limb, and its activity in the stall became more vigorous. The perforated area of the sole was completely sealed over with new horn, and it was judged that the horse had recovered from the prolapse of the solar corium. Therefore, all the hardened and thickened dead sole was excised.

After the excision, a wedged four points shoe (Fig. 5, right) was fitted in place of the high heel rails shoe with open toe, and was also filled with ACS. This shoe is designed to increase the stability of the coffin bone and its joints when bearing weight, and to make the break over smoother when walking. The toe of this shoe is formed in a horizontal bar shape, with a view to shifting the fulcrum of the break over towards the rear and make smoother break over. Also, due to the rocker-toe effect due to the narrow ground surface of branch, the load was reduced when the horse’s body moved laterally. Moreover, the hoof shape was corrected by removing yellow lamellar wedge, thought to be ectopic keratin, from a wide area and returning it to a more normal condition. Fig. 7-B shows the condition on the 134th day after hospitalization.

Furthermore, since the lamellar wedge is a locum favored by hoof mycosis, we continuously applied an antifungal ointment (miconazol nitrate) externally.

From 4 to 7 months of treatment

On the 166th day after hospitalization, which the state of the laminitis had settled down and the horse’s condition had stabilized, the lamellar wedge of the dorsal hoof wall was filed as far as possible and the heel excised. Then a four-point trim was carried out and the shoe was removed (Fig. 7-C).

Four-point trim is a method of trimming recommended by Dr. Redden in which 4 points for
bearing weight are created at the sole and the upward curvature created on the internal and external sides of the hoof. It is useful method to correct abnormal hoof shape and treating laminitis [8].

With the passage of 6 months after hospitalization, normal walking exercise was initiated.

Subsequently, we gradually excised the heel until the sole side angle of the coffin bone was horizontal, and corrected the position of the displaced coffin bone inside the hoof capsule.

By this stage, the affected horse could manage daily walking exercise of around 60 min. Moreover, since no lamining due to exercise or abnormality in the hoof was seen, the laminitis was judged to be cured, and the horse was once again allowed out to pasture on the 218th day after hospitalization. Fig. 7-D shows the condition on the day before discharge from the Hospital.

**Conclusions**

In our treatment of the present case, the angle of the bottom of the coffin bone against the hoof-bearing surface was used as an indicator for ascertaining the state of laminitis. In advance, we conducted X-ray examination on 50 hoofs from 25 racehorses aged between 2 and 7 years, and studied the respective angles of inclination. The average angle was $-0.07 \pm 1.9$ degrees, with no significant difference between right
and left limbs.

In the present case, based on above data, we were able to make objective evaluation of laminitis accompanied by severe disfigurement. Favorable treatment results were achieved by gradually correcting the bottom of the coffin bone of the hoof parallel to the hoof-bearing surface, using therapeutic shoes and other methods of treatment.

Dr. Redden suggests, with respect to therapeutic shoeing for laminitis, that in order to make smoother break over in cases of laminitis, the fulcrum of the break over should be taken back to just below the front edge of the coffin bone, the heel should be elevated and the tractional force of the deep flexor tendon on the coffin bone eased, while also the body weight should also be supported on the rear half of the hoof [8].

We were able to gradually correct the angle of the bottom of the coffin bone against the hoof-bearing surface using original indicator and 3 different therapeutic shoes. This method made the forward and lateral break over smoother, and stabilized the bearing weight on the heel which was thought to have led us to the favorable treatment results. Therefore, therapeutic shoes for laminitis must have function to reduce tractional force of the deep flexor tendon on the coffin bone and provide smoother break over. Also, as well as the simultaneous vigorous filing of the dorsal hoof wall and vigorous paring of the lamellar wedge, the application of ACS to the sole helped to reduce the displacement of the coffin bone. This result suggests application of ACS is essential when supporting perforated area.

Whatever the case, when treating such severe cases of laminitis, it is essential that veterinarians and horse shoers cooperate in implementing appropriate surgical treatment, while also applying therapeutic shoeing aimed at achieving dynamic effects.

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