Inside the Laminitic Foot

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Laminitis is a terrifying mystery to many horse owners, in part because in the early stages a horse with tremendous damage can look and act much like a mild case. A great deal of damage can occur even when the horse appears to have a favorable response to treatment.

What's going on inside that laminitic foot, and how do you tell if it's a really bad case?

To answer these questions, we'll take a look inside the laminitic foot using radiographs (X rays) and venograms, because understanding the mechanical changes that occur within these feet helps us understand how to treat laminitis more successfully.

Laminitis Basics

The job of the laminae is to hold the hoof wall onto the coffin bone. The "laminae" actually include two sets of leaflike laminae--one around the inside of the hoof wall and one around the face of the coffin bone. Together, these interlocking laminae provide a very secure, yet flexible anchor that keeps the coffin bone in place.

The deep digital flexor tendon (DDFT) is the antagonist (opposing force) of the laminae. It attaches at the bottom and rearward rim of the coffin bone and runs up the back of the leg, providing support and flexing the leg and fetlock/lower limb joints. When the foot is healthy, the laminae and DDFT work in harmony with each other.

Laminitis, whatever the cause, simply means inflammation of the laminae. When significant damage has occurred, their ability to anchor the coffin bone to the wall is compromised, throwing forces in the foot out of balance. This makes the foot unstable; the DDFT is the stronger force and can pull the bone away from the wall.

Every horse is affected differently by laminitis. The degree of structural damage laminitis causes depends on the intensity of the insult and the initial health of the foot. Most cases have minimal damage and will improve with various treatments. More severely damaged cases can initially present much like mild cases, but they don't improve without specific, aggressive treatment.

How do you tell the difference between a mild case and a potentially life-threatening one? Radiographs and venograms provide the information we need to develop a decisive treatment plan relative to the damage (more on these shortly).

Rotation's Out

The term rotation (diverging angle between the face of the coffin bone and the hoof wall) is often used to define laminitis. But the angle of rotation is no longer used by the author because it doesn't always occur! In classic sinker cases, the coffin bone can "sink" straight down through the sole with no sign of rotation. Also, rotation can be misinterpreted because other conditions, such as white line disease, can cause hoof capsule rotation.

Instead, look at soft tissue parameters--they offer much more reliable information that tells us what's really going on.
This image depicts the measurements Dr. Redden uses to evaluate and treat a laminitic horse: Sole depth, palmar angle, horn-lamellar zone, coronary-extensor process distance, and digital breakover.

**Measurements Are In**

Let's look at the parameters the author uses to define the precise position of the coffin bone within the hoof and its relationship to the ground. Becoming familiar with how these parameters function individually and together in a healthy foot can help show us the significance of any changes we see in one that is suffering from laminitis. A consistent, repeatable radiographic protocol ensures that each of these parameters can be measured accurately (suggested protocol: "Clinical and Radiographic Examination of the Equine Foot," see article #1457 at TheHorse.com).

Several of these parameters can be affected by a farrier's trim, so it's important to note when the horse was trimmed last when interpreting them.

**Horn-lamellar (HL) zone** denotes the perpendicular distance between the hoof wall and the coffin bone. It's measured in two places, just below the extensor process and at the apex. In most light breeds, the HL zone will be around 15/15 mm; the bone is relatively parallel to the wall. The HL zone is our first concern in all acute cases; if it continues to increase either uniformly or just at the toe, big trouble lies just ahead. A sinker may go from 15/15 mm to 20+/20+ mm within hours or days.

**Palmar angle (PA)** is the angle between the bottom of the coffin bone and the ground. The healthy palmar angle varies considerably from horse to horse and foot to foot. As heel growth increases, so does palmar angle (which is what happens in a club foot). Trimming the heel lowers the palmar angle, while acute capsular rotation increases the palmar angle.

**Sole depth (SD)** is the amount of sole beneath the apex of the coffin bone. At least 15 mm is required to adequately protect underlying sensitive structures. When the palmar angle increases as a result of HL zone swelling, sole depth decreases and compresses the sole. Trimming can also decrease sole depth.

**Coronary-extensor process (CE)** is the vertical distance between the top of the wall and the extensor process of the coffin bone. Baseline X rays (the first ones taken) will not be meaningful as the coronary-
extensor process varies from 0-15 mm in healthy feet; the value of this measurement is seen over time. If the coronary-extensor process increases and the sole thins, the bony column is sinking within the foot.

**Digital breakover (DB)** is the horizontal distance between the apex of the coffin bone and the breakover point (the forwardmost point of the foot or shoe touching the ground on a hard surface). Increasing palmar angle and decreasing digital breakover can significantly reduce tension in the DDFT and, subsequently, reduce tearing forces in the laminae.

Laminitis Emergency Treatment

**Day 1:**

1. Administer anti-inflammatory medication (Bute) in a therapeutic dose.
2. Treat the underlying disease (such as retained placenta, endotoxemia, etc.) if it is known.
3. Apply a device that will release tension on the deep digital flexor tendon (DDFT), making it soft and easily pushed back and forth with your thumb and finger (learn what this feels like). This requires a palmar angle (PA, the angle the bottom of the coffin bone makes with the ground, see description on page 62) of approximately 18-20°.
4. When a device is not readily available to create the 18-20° PA, use deep bedding to help facilitate a toe-down, heel-up, tendon pressure-reducing stance. Bed deep with dry sawdust or sand so the toes point downward in the material. If the horse stands on top of the sand, the PA is not 18° and the DDFT remains tight. Deep mud is okay, but the excessive moisture is tough on a foot, especially a weak one.
5. Take X rays and, preferably, a venogram. Both will serve as baselines. If the sole is very flat or bulged, leave the shoes on for the lateral X ray. In this case, apply an 18° PA device over the shoe. Without the shoe, your horse might be extremely lame.
6. Place the horse on strict stall rest.

**Day 3 or 4**

1. X ray the feet again and repeat the venogram.
2. Do not remove the 18° PA device. Taking it off for even a few seconds kicks the DDFT back in gear and causes very serious damage to the weakened laminae.
3. By Day 3 or 4 you will know precisely where the horse is headed. Radiographs likely will not reveal a significant change, but the venogram can reveal a large spectrum of response, from improved vascular perfusion to a tremendous loss of blood supply, even when the horse appears clinically improved, which calls for immediate aggressive treatment relative to the degree of vascular damage. Simply staying abreast of the vascular supply status opens the door to success that otherwise would not be available.

*Ric Redden, DVM, with Christy West*

**Radiograph Early and Often**

Depending on the horse to tell you if danger has passed can be a big mistake, as the physical signs of laminitis don't always match what's happening inside the foot. Some horses seem painful initially, get sounder, then crash with terrible pain six to eight weeks later. The best way to measure progress is by taking frequent radiographs and venograms.

Low-beam radiographs designed to show soft tissue should be made as soon as possible. The first films establish a baseline or starting point, so you can see and measure progress (or lack thereof) on subsequent
radiographs, rather than trying to guess how much better or worse the horse is by assessing a single set of X rays taken weeks or months into the disease.

**Blood Flow in the Foot**

Laminitis shuts down the blood supply to compromised areas of the foot. The primary treatment goal is to restore blood flow before tissue death and bone disease set in, so knowing the state of the blood supply is very important when identifying areas of damage and monitoring treatment success. A venogram (see below), which involves injecting contrast media into the foot below a tourniquet and taking a quick series of X rays, provides this information by illustrating the blood vessels in the foot.

Venograms clearly distinguish severely damaged cases from mild ones by showing where blood flow is compromised. They also help the practitioner and/or farrier monitor the efficiency of treatment by alerting them to serious blood flow alterations days to weeks before radiographic changes occur, and often weeks before the clinical picture indicates complications.

**Reversal Therapy**

Using simple mechanics to reverse the forces tearing the weakened laminae apart greatly enhances the healing environment. Significantly reducing DDFT tension helps equalize its force with that of the damaged, dying laminae, shutting down the mechanical process that's pulling the laminae apart.

**How does this work?** When DDFT tension is drastically reduced with a device that raises the palmar angle to 18-20° and decreases digital breakover, the apex of the coffin bone is no longer being drawn down into the sole. This reduces the tearing force pulling the laminae apart and allows better blood flow in the compressed, sensitive sole. When applied properly you should be able to feel the DDFT is now very soft and easy to move with your thumb and forefinger.

**What's a favorable response?** As stated earlier, improved soundness can be very misleading. To know without a doubt if a case is improving, measure parameters on radiographs and venograms taken every few days. Sole depth should increase in 10 to 15 days, horn-lamellar zone and coronary-extensor process measurements should stabilize, and palmar angle should not increase between evaluations.

Also, hoof growth should be noticeable at the coronary band, with growth rings that resemble those formed prior to onset. When growth doesn't occur, a venogram can help explain why, as growth is dependent on circulation.

Unfortunately, mechanical treatment can't fix all laminitis cases, even when optimum mechanics are employed at the onset. Surgically cutting the DDFT to eliminate its pull might be necessary. Proper realignment shoeing performed immediately prior to a tenotomy greatly enhances the healing environment and improves the success of this surgery.

**Why Lowering Heels is Bad**

The age-old treatment of removing the effects of laminitis (the long heel) actually pulls the DDFT tighter, increasing the forces that are responsible for the high heel and capsular rotation. This results in the apex of the coffin bone being pulled down even harder into the sensitive sole, compressing the sole's much-needed blood supply and increasing stress on the diseased laminae, which is the last thing they need.

If all that was needed was a rasp, laminitis would be very easy to treat and you probably wouldn't be reading this article.
Take-Home Message

Knowing what's going on inside a laminitic foot helps take the mystery out of evaluation and treatment, making this a logical, step-by-step process. Tracking laminitis progress and making treatment decisions based on radiographs and venograms gives you the best chance of beating this disease.

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