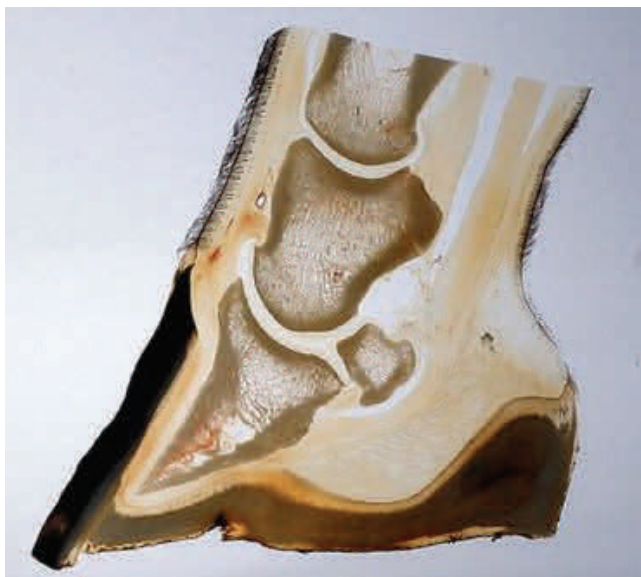




Founder

How does founder occur? In anatomy we learned that there is no space in the hoof capsule, it is a really tight situation. How can the coffin bone all of a sudden rotate away from the hoof wall? Well, it does **not** all of a sudden rotate away from the wall.



Rather the rotation happens gradually and is always the result of incorrect bone alignment, which means high heels and often high bars in connection with high heels. High heels result in a steep alignment of P2 and P1 and a rotated coffin bone. Now, unlike the conventional world, we talk about a rotated coffin bone when the coffin bone is out of its ground parallel position. That does not necessarily mean that the coffin bone is separated from the hoof wall. In a clubfoot for example, the coffin bone is rotated, but not separated from the hoof wall.

On the right we have an x-ray where the coffin bone is not ground parallel (rotated), but still attached to the wall.



So the coffin bone that is not ground parallel is rotated, but how does it separate from the hoof wall to be diagnosed as founder?



We name this process
"Progression of Rotation".

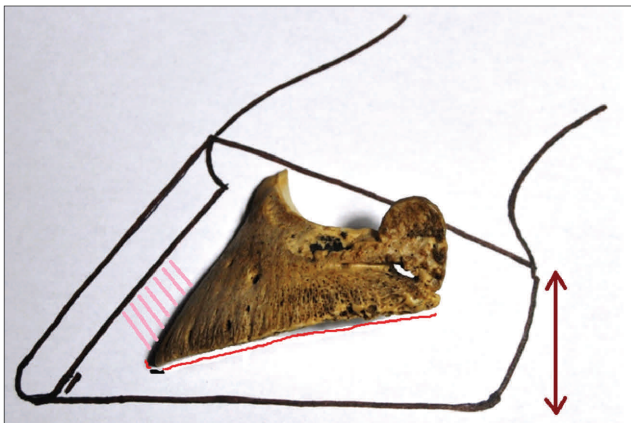
First the coffin bone is tightly connected to the hoof wall. The horse has high heels and a steep bone alignment. This situation puts a lot of pressure on the frontal laminar attachment. The pressure starts to stretch the lamellae and as they are under pressure with every step, they cannot regain their tightness.

As the coffin bone is rotated, the frontal distal border (tip of the coffin bone) now makes contact with the sole. To avoid this pressure, bone substance is removed from the frontal part of the coffin bone.

At the same time the circumflex artery, which nourishes the solar corium and is therefore responsible for sole production, is pinched partially or fully shut. So no sole or very little sole is produced in that area, and the coffin bone can sink a little deeper.

The pressure on the laminar connection still exists. As the coffin bone sinks and rotates further away from the wall, this scenario repeats itself: More bone is removed from pressure, less sole is produced, but at the same time the terminal papillae produce more white line to fill in the gap between wall and coffin bone. This is often referred to as the lamellar wedge.

In this sinking situation the sole corium is pushed together as well. As a result there is inferior horn production which can be seen in the area between the tip of the frog and the white line where the inferior horn is pushed together.





Since the coffin bone is now more or less standing on the sole instead of being tightly suspended by the lamellae, the pressure on the sole corium leads to less sole production and bruising.

The coffin bone has again more room and the tip slides more down and back, pushing the coffin joint (and therefore the extensor process) more and more forward. The pressure on the extensor process by the extensor tendon will eventually lead to changes in the extensor process as well.

The laminar connection becomes even more stretched, the tip of the coffin bone sinks deeper, the coffin bone "rotates" after it was already separated (the tight connection with the wall was already compromised).

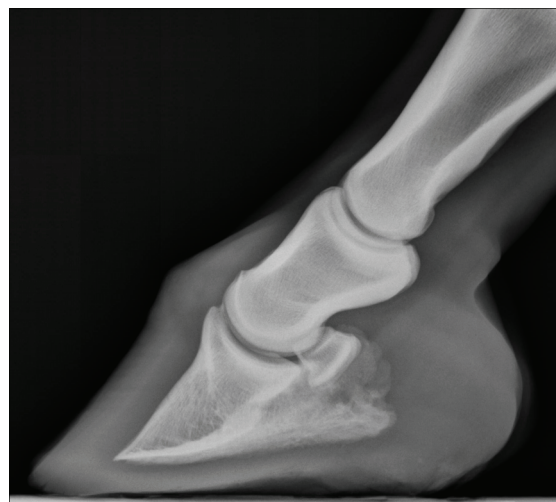
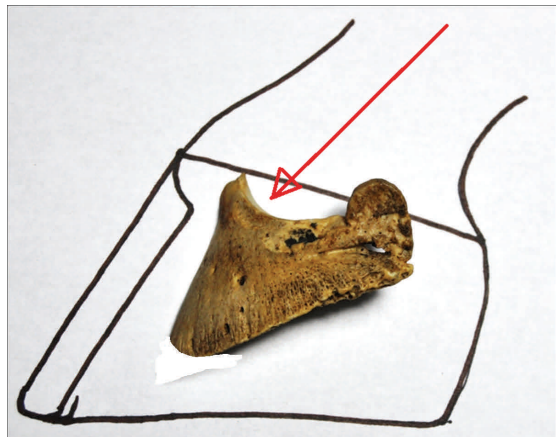
This cycle repeats itself and may be purely mechanical. The horse develops gradually a shorter stride, usually so gradual that the owner does not notice it. The question is if the shorter stride comes from the faulty bone alignment or actual pain. That is always hard to ascertain as horses try to hide the pain, have no sound for it and avoid being detected (by some predator) as a valid next meal. So far the **Progression of Rotation.**

Now, why was that important to know in all details?

Because it is possible to have rotation and even separation without clear "founder" signs. And while you will be trained to see all these problems without an x-ray, you need to understand that the "all-of-a-sudden" onset of founder has been a long time in the making.

It may be possible to see in a clear x-ray the beginning destruction of the tip of the coffin bone. But the destruction or change in bone has to be considerable (about 60%) in order to be visible in an x-ray.

In this picture the coffin bone has been restored to its ground parallel position, but the tip of the coffin bone is eroded from below and an exaggerated tip is visible.





If the horse is shod, the vaulted sole does not flex upon weight bearing. The coffin bone can only rotate slowly through the lack of sole growth under the tip of the coffin bone. As soon as the solar vault can flex through the removal of the shoe and trimming, the coffin bone will rotate immediately, because the laminar attachment is already compromised through the vibrations of the shoe (see picture). In this position the tip of the coffin bone has even more pressure and therefore bone substance will diminish very fast.



This development happens over many years, depending on how steep the hoof is, how much it deviates from the 30° hairline position, how much the horse moves and on which terrain he moves (concussive or non-concussive). The stretching of the lamellae is often connected with bruising and wound secretion. When trimming you may see red wound secretion in the white line.



When the frontal area of the lamellar connection becomes stretched and the coffin bone begins to rotate, the lamellar connection in the lateral areas becomes compromised as well. The lateral lamellae become stretched or twisted, depending on the tightness of the hoof capsule.

The horn tubules in the frontal area of the hoof become compressed, especially at the top of the coronet band (picture), as they are under constant pressure.





Separation of the coffin bone does not necessarily happen symmetrically either. Depending on the forces in the hoof the one or the other side may be more compromised.



Another asymmetric rotation with separation

Restoring compromised hooves like these takes more than just good trimming. As a hoof care provider you have to have a very clear picture where you want to trim to distribute the load of the bone column more evenly. You have to consider abrasion of the hoof wall on one side and accelerated growth through inflammation on the other side. You have to be clear what will rebuild the tissues.

In order to rebuild bone, you need tension on the existing bone, which may not occur without pain. In order to have the hoof rebuild a tight lamellar connection, you have to have the right nutrients available to the body (nutrition), you have to have the vitality of the horse at an optimum (absence of toxins and emotional stress) and you have to ensure that the lamellar connection does not receive any further mechanical stresses (vibrations through metal shoes or hard ground). The rehabilitation may not happen without abscessing (removal of necrotic tissue).

You have to be able to explain all these factors to the horse owner and win their cooperation through education.



One more time—how is it working, how does it happen?

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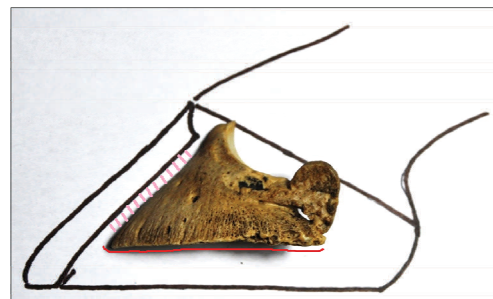
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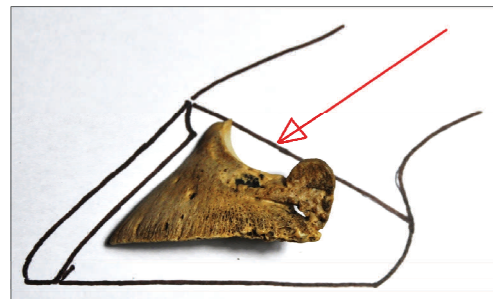
Ground parallel and parallel to the wall



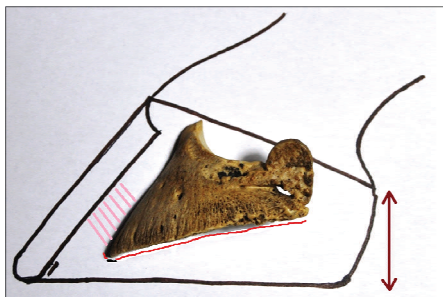
Tight laminar connection and the circumflex artery runs open around the distal end of the coffin bone.



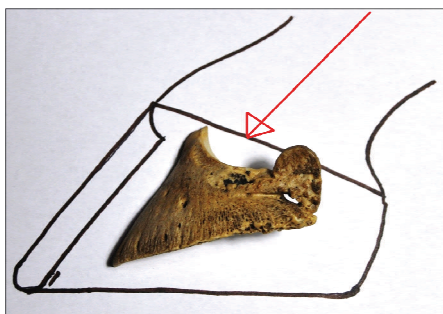
Upon weight bearing the pressure from the bone column, especially the short pastern bone, pushes in the middle of the coffin joint.



Slight rotation with separation



The laminar connection is really stretched, the high heels aggravates the situation, the circumflex artery is pinched shut at the tip, resulting in inferior horn production in that area.



Upon weight bearing the pressure from the bone column, especially the short pastern bone, pushes in more towards the extensor process, which aggravates the rotational force with every step.



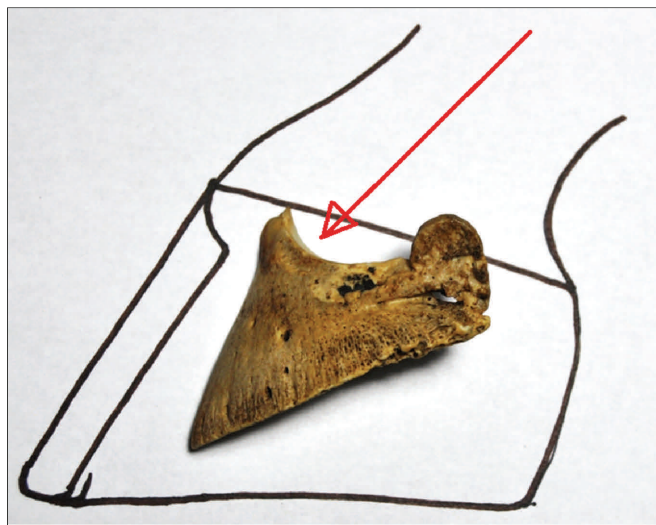
Severe rotation with separation



The laminar connection further stretched, the high heels shift all pressure towards the toe, the circumflex artery is pinched shut, destruction of the coffin bone tip is most likely.



Upon weight bearing the pressure from the bone column, especially the short pastern bone, pushes now mostly onto the extensor process.

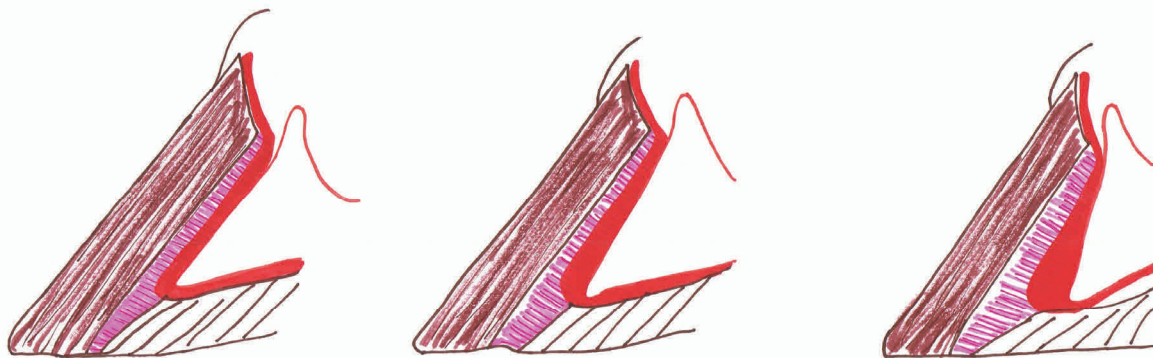




Rudolf Zierold DVM (Leipzig) did extensive research about the laminar connection in shod horses and came to the conclusion that in shod horses the destruction of the laminar corium is very comparable to the Raynaud syndrome so often seen in humans (Dentists, chainsaw operators, sledgehammer operators etc.): The fine capillaries are destroyed through vibrations from the end. In horses who show no lameness, the capillaries in the lamellar connection are destroyed through the vibration of the shoe. This in return leads to destruction of the lamellae (right)



Furthermore, in horses who move very little and have no (or very little) hoof mechanism, the quality of the connection between wall and coffin bone is less.





It also may happen in a hoof with rotation and separation that the white line has already closed again, giving a false impression of the situation.



Acute painful founder

You learned about the connection of the lamellae to the hoof wall, about rotation and separation and how separation happens slowly, over time. In these hooves lack of circulation does prevent the building of good horn substance and also prevents the supply of oxygen for the ATP production (nerve function). So the horse is rotated and separated and still somehow moving. Some horses move under these circumstances better than others, in general, they do not show too much of the already existing damage.

This begs the question: When does acute, painful founder happen?

Acute founder (rotation with separation) requires a trigger. This trigger leads to acute inflammation and this is then very painful - may the horse be barefoot or shod.

The cause is usually a change in the metabolism. That may be a high sugar content of spring pasture (or after the pasture has been freshly mowed). It may be a chemical wormer, vaccinations or injections of other pharmaceuticals. Changes in feed or a sudden protein overload also may be the culprit. Typical founder movement and stance. Look at the nostrils and the tightness in the shoulder and in the haunches.





Acute founder occurs in general after:

- 1.) Trauma - like road founder. Horse is used usually on soft ground, but all of a sudden excessively on hard ground
 - 2.) Toxins - any change in metabolism or blood chemistry. Poison (toxic plants, incorrect nutrition, excess protein, sudden changes in feed (see nutrition lecture), retained placenta membranes after foaling, causing bacterial toxicity. Drugs. The living organism often has severe problems dealing with chemical drugs (wormer, antibiotics, penicillin etc.)
 - 3.) Infections - rarely, but it happens. A "hot" nail in shoeing could cause such an infection, or a puncture wound that goes all the way to the corium. Other pathogens in the body may also trigger infection in the hoof.
 - 4.) If a horse has an injured leg or hoof, causing it to bear all weight on the opposite hoof.
 - 5.) Having Insulin Resistance
- A form of 'horse diabetes' called Equine Metabolic Syndrome or Cushing's

Symptoms

'Seedy Toe'

Less activity/reluctant to move

Reluctant to turn

Standing rocked back with hind feet under the body, and front feet stretched out

Hooves warmer than normal

Lying down more than normal

Depression

Blood in white line

Inflammation rings may be visible on the hoof wall

Pounding pulse in affected legs

Symptoms may be slight or severe

Painful response when pressure is applied to the sole

Every time there is an insult to the entire system of the horse, the weakest link (in this case the compromised hoof) will show the most reaction.



The veterinarian is usually only called after the horse is very painful, exhibiting typical symptoms of founder. He then may take radiographs and pronounce the horse as having foundered as a result of any of the above named causes. In reality the situation was a long time in the making. The addition of painful inflammation made the process "symptomatic". The "trigger" was just the proverbial straw that broke the camels back.

Should the acute trigger happen in a horse with correct hoof form, then the laminitis is still very painful, but after some movement and a few very uncomfortable days, the healing process will begin and the horse is usually after a few weeks fully usable again. See laminitis lecture.