

Understanding the Horse's Soles

8-16-05 Pete Ramey Copyright 2005

The sole of the foot is the most abused and misunderstood part of the domestic horse (with the possible exception of its digestive system). I've been guilty of it, too. As a horseshoer it always seemed necessary for me to routinely cut the sole at the toe, and in my early days as a barefoot trimmer I thought it was desirable to thin it at the back of the foot. When I began both professions, I was taught to view the sole as an idle passenger; trimming the hoof wall to certain parameters and then trimming or relieving the sole to match. Now I see the sole as the ultimate guide for hoof trimming; keeping the bars and walls 1/16 inch above the natural callused sole plane. (See the "Heel Height" article for exceptions.) When I think back on the past and compare it to my results now, I shudder at the comparison. My own learning curve has been a long one. I hope to shorten it for you, here.

It is a confusing subject, though. It can be difficult to distinguish between healthy sole that should be preserved, false sole that should be removed, shedding sole that needs to stay around as long as possible because the new sole underneath is immature, shedding sole that needs to be removed because fungal infection underneath is eating away at the new sole that is trying to grow, unsupported sole under flared walls that needs to have pressure relief..... The list goes on, and it seems the more you learn, the less you may understand what needs to be done. **Since the sole is the first line of defense between the horse and the ground, its proper management is crucial to soundness.** Luckily we have a very reliable guide. The seams between the sole and frog; the collateral grooves, are the most reliable and important guide we have for determining the needs of the foot. A full understanding of their significance and the information they offer will give you "x-ray vision" when you look at every hoof.

Let's start with the foundation. When viewed from the side, a naturally shaped hoof should have an arch from front to back much like the arch of your own foot. The coffin bone shapes the front half of the foot and in a standing horse, should thus mirror the front half of the arch, or be elevated slightly in the back. The lateral cartilages form the foundation for the back half of the foot, but with flexibility.

During normal locomotion, the horse loads the initial impact force on the more flexible back of the foot giving the horse an incredible ability to dissipate energy. Much like the rubber tires on your car, this flexibility immediately reduces the amount of shock that must be dissipated by the rest of the system.

As the foot reaches maximum load, the arch is pressed flat, giving a ground parallel orientation to the coffin bone and to the lateral cartilages. Then, the horse lifts the heels as the stride is completed, leaving the rigid front half of the foot the tremendous job of driving the horse forward.

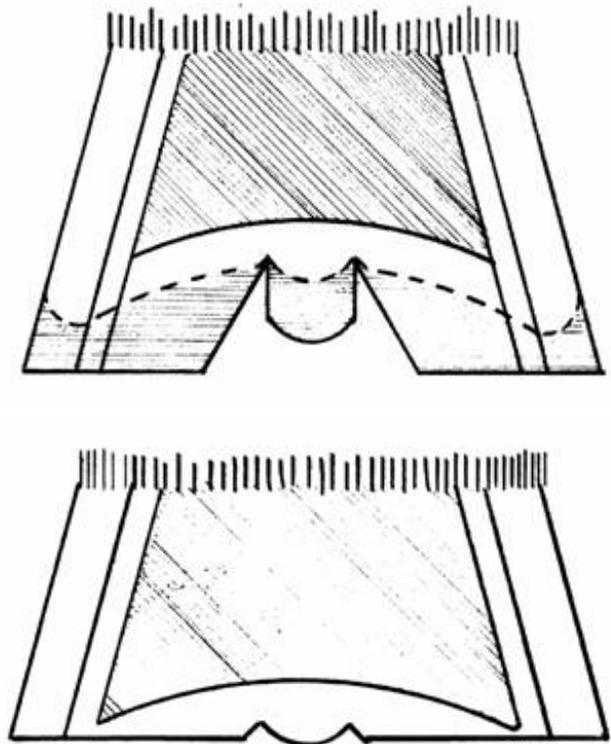


The underside of the coffin bone and the lateral cartilages are vaulted like a dome. Looking at this dome from the bottom gives you the impression you are looking into a bowl and the papillae that grow the sole of the horse are attached to and grow from this surface. According to measurements taken from wild hooves and healthy domestic hooves the sole should be $\frac{1}{2}$ to $\frac{3}{4}$ inch thick and uniformly cover the vaulted underside of the lateral cartilages and the coffin bone. This is not something we have to do for the horse. It will take this shape naturally if the horse gets plenty of movement on its bare hooves. We must allow this sole to callous into very dense material if it is to be expected to do its job of protecting the underside of the horse. Its surface area is huge when compared to that of the hoof wall's ground surface, so it is actually the sole that is bearing the lion share of the horse's weight (on any yielding surface, this is true, whether the hoof wall is $\frac{1}{8}$ inch shorter or $\frac{3}{8}$ inch longer than the sole).

The sole was designed for this, though, and does this job very well as long as humans don't come along and routinely thin it. Personally, I can run very comfortably on gravel while barefoot, but I know I could not even walk on grass if someone were constantly cutting the soles from my feet; even if they only did it in one tiny spot and left the rest of my callous intact. A broken bottle re-taught me this lesson on a recent family camping trip. I had plenty of calloused areas left on my feet, but the dime-sized area I lost made my own boots seem like "too little, too late". I was basically lame for a week, and a month later, I'm still not "gravel crunching" without my "hoof boots".

Soles of horses and humans can be regrown very quickly, but callused sole is another story. Callused sole is simply a huge amount of sole material packed into a thinner space. It takes time to build adequate callus. So should we just leave horse soles alone and let them callus and build at will? Usually, yes, it's just that simple. There are exceptions and this muddies the water, though. When a shoe has been on a horse or if it has been stall bound, the sole can build into thick layers. Domestic donkeys and minis tend to grow too much sole no matter how much they move on our soft pastures. Sub-solar abscessing can leave large false soles in its wake. Sometimes we do need to trim away this excess to allow hoof function and normal callusing of the real sole.

How do we tell the difference? How do we know when we have adequate thickness, excess thickness, or not enough? Easy. Nature gave us a trustworthy guide in the collateral grooves. If we learn to read them, we will never have to wonder what needs to be done or not done to the bottom of the foot. The very special thing about the collateral grooves is that they are very consistent in their depth to the underlying inner structures. If you cut the grooves deeper on a cadaver hoof, you'll find that it is about $\frac{1}{2}$ inch to the sensitive corium; whether the rest of the sole is too thick or too thin. This means that if a horse has too much sole, the collateral grooves will be too deep. If there is not enough sole thickness the collateral grooves will be too shallow. Only a sub-solar abscess can push the grooves farther from the coffin bone, and I have never seen or heard of a situation that brings them too close.

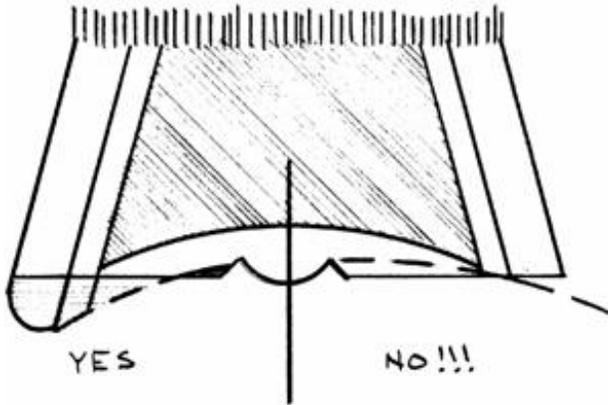


Above, are two "flat feet" with very different needs. The hoof on the left needs a "one-time" very aggressive trim, and the hoof on the right needs the entire bottom of the foot left completely alone. All we have to do is understand how deep the grooves are naturally, and we will immediately be able to tell if the inner structures are too close to the outdoors or too far away. This applies to the front of the foot and to the back. We can't put exact dimensions to this, because different coffin bones have different amounts of solar concavity, and of course it varies by hoof size. A little bit too much sole bothers horses far less than having too little, so I tend to begin by erring on the side of caution. Wild hooves and healthy domestic hooves with uniform sole thickness tend to have their collateral grooves (at the deepest part) about $\frac{3}{4}$ " off the ground at the apex of the frog, and about an inch off the ground toward the back (Near the termination of the bars). These measurements can be taken by laying a rasp across the foot and measuring down to the bottom of the groove.

If this measurement is $\frac{1}{4}$ " deep at the apex of the frog, you can very safely assume that there is not enough sole between the coffin bone, its sensitive corium, and the outdoors. It must be allowed to build. If this measurement is $1\frac{1}{2}$ " deep, you can very safely assume material could be removed. The same exact logic applies to the back of the foot as well.

These measurements are far more critical to the horse than toe length or heel height measurements. The coffin bone and lateral cartilages often descend into a lower position in the hoof capsule and this leaves a hoof capsule that is longer than natural. This is unhealthy, of course, but trimmers and farriers who ignore this fact and trim to heel or toe length dimensions add injury to injury by overexposing the nerves in the corium on the bottom of the foot. Thinning the sole tends to cause

the inner structures to move lower and lower, lengthening the overall hoof capsule. The flip side of this, is that allowing the sole to build and callus at optimum thickness drives the inner structures upward. The coronet moves down the skeleton, shortening the hoof capsule to natural proportions as the callus builds. The center and right pictures below show the natural sole thickness and concavity of a wild horse's foot.



In the picture above (top); you can see our goal when we are faced with a shallow collateral groove. The left side of the pictures show how we turn the flat foot with shallow collateral grooves into a concave foot with adequate sole thickness by building adequate sole thickness. The right side of the picture shows the common mistake of trying to carve out solar concavity; thinning an area that is already too thin. We will build solar concavity as we build sole thickness. Contrary to the way the picture must be drawn, the hoof generally does not lengthen during this process. The coffin bone and lateral cartilages are pushed upward as the sole builds, keeping the hoof capsule the same length or often dramatically shortening it.

If this process is only partially complete, you will see a flat spot adjacent to the white line and a concave shape to the area of live sole closer to the frog. This flat area reliably shows you where the sole is still too thin. It is very important to note that as the horse tries to build this natural sole thickness, it will often prioritize key areas where the sole thickness is needed the most. The result will be "lumps or bumps" on the flat area. Many trimmers routinely trim away these bumps; working against the horse's attempts to build adequate solar concavity. You must visualize the natural flow of the individual horse's solar concavity and determine if that flow goes all the way out to the white line, without going flat, anywhere. That lump may be the only correct spot on the whole foot. If it falls within the "imaginary bowl" of natural concavity, you should leave it and hope it spreads over the rest of the sole.



To visualize proper sole thickness using the collateral grooves, use the wild hooves or a healthy domestic hoof with adequate sole thickness. Think of the collateral groove as the bottom of a bowl, and natural solar concavity flows up and out from there. Anything sticking above this bowl should probably be removed. Any area below this bowl should be left alone and allowed to grow. Misunderstanding this is where people tend to hurt horses. Again, when the bowl isn't deep enough; there is not enough sole. There will be a flat spot in the sole in the outer perimeter touching the white line. You'll generally see the flow of the natural concavity making its way out from the frog, but then it will flatten out where it is too thin. Study the previous line drawings if this is still not crystal clear.

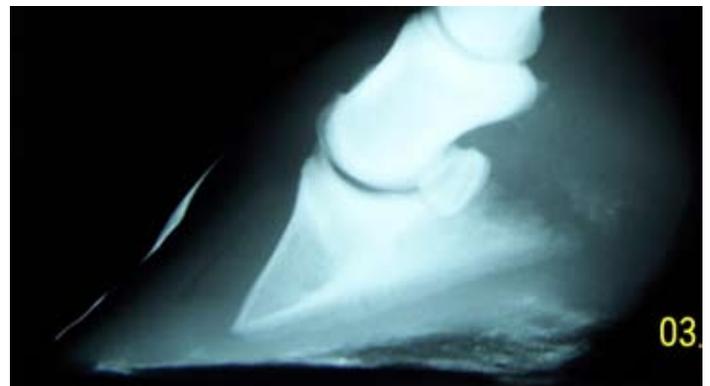
In the beginning, we don't know exactly how much concavity is needed by the individual horse, so we assume it should be 3/4 inch at the front and 1" deep at the back to be on the safe side. These measurements are toward the maximum you will commonly find, and always a good place to start. After we build some depth, the shape of the horse's natural solar concavity will start to emerge and we shift to trusting that shape.

The hoof above almost has complete sole thickness, but you can see a slight flattened area in the sole at the toe, indicating that a little more depth could be built there. Too many trimmers tend to cut concavity into this flat region, thinning an area that is already too thin. The result, again, is a flatter foot as the undermined coffin bone is free to migrate downward under the horse's weight. Concavity must be built up, and cannot be cut in. The solar concavity of the specimen above was never trimmed with a knife. This was a horse I owned, who died in a fence accident. The sole naturally callused itself in this shape when it reached adequate thickness. All I did was keep any dead, chalky sole from filling in during the off season.



In Jaime Jackson's wild hoof specimens (above), the collateral groove at the apex is only 1/2" deep within the solar concavity. If this were a domestic horse in our care we would know that natural sole thickness has been achieved because there is no flat spot adjacent to the white line at any part of the sole. This natural shape of the callused sole overrides our original 3/4 inch "starting guess", whether it turns out to be deeper or more shallow. If only these principles were more widely understood.....

I personally see more horses lamed by the farrier's rasp than by every other means combined. I would love to see a rasp designed to deliver a strong electric shock to its handler if it gets closer than 5/8 of an inch away from the bottom of any collateral groove for any reason. A hoof knife that shocks its handler if it gets closer than 5/8 inch away from a coffin bone or lateral cartilage would be nice as well. I would spend my very last dime; buying them and distributing them all over the world. There is no excuse for such a blatant misunderstanding of the foot. Most subsolar abscesses and EVERY coffin bone sole penetration I have ever seen came along in the wake of previous trimming away of the sole material under the coffin bone or lateral cartilages. This is a strong statement, I know, but painfully accurate.



The tip of P3 in the above radiograph was actually piercing the sole. The attending veterinarian diagnosed chronic laminitis, sole penetration and calcification of the lateral cartilages. The deep rasp marks and the huge flattened area were still visible in the sole in front of the frog! This work was done in preparation for a "corrective" shoe. The collateral groove depth at the apex was zero, and the groove depth at the back of the foot was 1-3/4". The conditions here should be immediately obvious to the educated naked eye, but I've seen this too

many hundreds of times to count. Why do so few notice? The above right radiograph was taken six months later. I simply allowed the horse to build adequate sole thickness under P3, grew in an attached toe wall, and kept the heels 1/16" above the sole. This restored 100% soundness and usability to the horse and melted most of the calcifications away..... In six months.

I try very hard not to point fingers at the previous farrier on cases like this. It would just come across as "putting down the competition" and I would probably spend my life as a witness in courtrooms or get beaten to death by an angry farrier, so I skillfully sidestep questions from owners about the real causes of these problems to keep peace. It makes my life easier, but I'll probably eventually go to hell for that dishonesty.

While barefoot trimmers are usually not guilty of sole abuse at the toe, many, of them are very guilty of having the same misunderstanding at the back of the foot. Like the coffin bone at the toe, the sensitive structures at the back of the foot can prolapse, or move downward relative to the coronet. Many trimmers try to get the heels and bars trimmed into "wild horse parameters" too quickly and thin the sole at the back of the foot. The results are sensitivity, sole bruising and then abscessing. The sole is designed to bear the horse, but only if it is well callused and naturally thick.



In the photos above, the left pictures are of the setup trim, and the right pictures are post-trim, four months later. The sole has built so much depth and concavity because it was completely left alone during this process. I was treating the horse for very thin soles and separated laminae. Notice that at the setup trim, the collateral groove at the apex of the frog is only about 1/8" deep and the sole in front of the frog goes flat. It should be obvious by this that the sole under P3 is very thin. Four months later, the sole has thickened, Placing the collateral groove 1/2 inch deep at the apex of the frog and solar concavity has built in to mirror the shape of the bone. All of the white line separation has grown out, with the exception of a small bit remaining at the toe.

Now look at the heels and bars. Early in my career, I would have viewed these bars as being "laid over" or bent, and trimmed bar and sole together to straighten them. Now, however, I see the flat area in the sole at the back of the foot as an indication that the sole is too thin. The bar is not laid over, but is chopped off too short because of this missing solar depth. Over the next four months, I simply let this sole build, keeping the bar and heel wall lowered to the height of the sole. When the sole built to adequate depth, the bars follow the resulting natural concavity and straighten themselves.

When I used to trim this concavity, rather than building it, my horses were less sound and their soles were much flatter. In four weeks time, the flat spot would return, and I would trim it again. Was I seeing success with hoof rehabilitation and with barefoot performance horses? Yes I was, but I had no idea at the time how much better things could be. Now, in hindsight, it's easy to see why.

Whether it is a shoer thinning the sole at the toe or a barefoot trimmer thinning the sole at the back of the foot, the result is sole sensitivity and bruising of the sole's live corium. This bruising often causes sub-solar abscesses to occur. Hoof managers must realize this because sole sensitivity and sub-solar abscesses in horses with adequate sole thickness and callus are about as common as white horses that won't roll in the mud. Using the collateral grooves as the guide will keep you out of this trouble.



The same working knowledge of the collateral grooves will also tell you when its time to get very aggressive with the sole. The collateral groove in the donkey hoof above is 1- 1/2" deep. We can very safely create the "natural bowl" of solar concavity, dramatically reducing this excess. In this case, I am keeping my nippers 3/4 inch away from the bottom of the collateral grooves at all times. After this one-time, large reduction, you should watch for the natural shape of the individual's callusing to emerge and trust that shape, rather than the "experienced guess" you started with. The collateral grooves at the back of this foot show you that the sensitive structures have migrated downward, and trimming these heels into "wild horse parameters" would actually cause you to make the grooves too shallow and even cut the lateral cartilages, in this particular case. The sole at the back of this foot must be preserved to drive them upward.



The pictures above demonstrate the information the collateral grooves have to offer. The left picture is before the setup trim. The horse was diagnosed with navicular disease and with a coffin bone rotation over 20 degrees. The right picture is the same hoof eight months later, and before a six week maintenance trim; sound and working for a living. The sole was not trimmed at any time during this process.

The collateral grooves at the setup trim are 1/16 inch deep at the apex of the frog and 1" deep at the back of the foot. The wide distance from the from the collateral groove at the back of the foot to the hairline shows that the lateral cartilages have migrated downward and these heels cannot be significantly lowered without thinning the sole and robbing the horse of necessary protection.

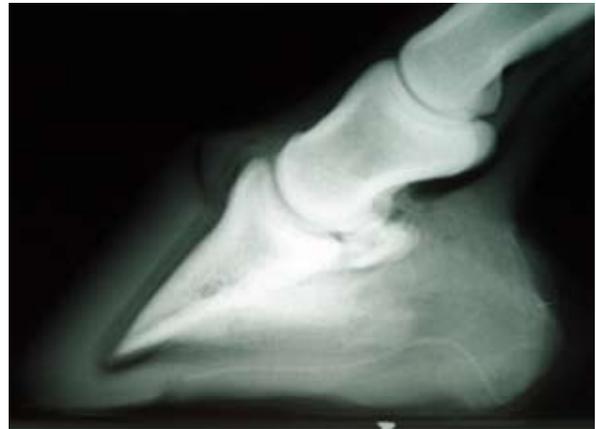
At the apex of the frog, the shallow groove and the flat area of sole in front show us that the coffin bone is very close to the great outdoors. In fact you can clearly see its imprint on the sole, and the unsupported sole and hoof wall stretched out in front. Using this information and judging the severely long hoof capsule, we know the coffin bone and lateral cartilages have migrated downward in the hoof capsule. If we cut the hoof into "natural parameters" we would trim the coffin bone itself; rasping the coffin bone is bad! :-)

Instead, I just trimmed the walls and bars to 1/16" longer than the healthy sole and relieved the pressure on the disconnected toe walls. Eight months later, the apex of the frog is buried nicely into 5/8" of solar concavity. The collateral groove at the back of the foot is 7/8" deep (after trimming the walls to 1/16" longer than the sole). There is adequate callused sole everywhere.

Additionally, this callused sole has driven the inner structures much higher in the hoof capsule; dramatically shortening the hoof. The toe wall is much shorter, and the collateral groove at the back of the foot is now above the hairline. In other words, the coronet and the rest of the hoof capsule has migrated over an inch down the skeleton, into a more natural position. The result is a naturally short heel and toe, with adequate solar concavity and thickness along the way. It was comfort, proper movement and the growth of a well attached hoof wall that shortened this hoof capsule; not the knife or rasp.

There have been too many methods and measurements applied to the hoof to possibly count. This may just sound like one more in a long list. I assure you though, that nothing is more important to the soundness and hoof function of the horse than natural sole thickness. If you doubt this, try rasping a little sole off of your own foot; just a little bit every four weeks will do the trick. Study the wild hooves and

get an image in your mind of the shape of the soles and particularly, the height of the collateral grooves from the ground. The wild hoof below has a wire placed in the bottom of the collateral groove to help you visualize this on the radiograph.



If you make sure your horses' collateral grooves are a natural height off the ground, you will be amazed by their soundness and by your own ability to fix and prevent hoof problems. Nature was kind to the horse to provide such an accurate guide for us to follow. As usual, we just need to learn to listen.



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