

Hoof cracks are a common occurrence in the feet of many domesticated horses, and they can range in severity from a minor blemish to a cause of serious lameness. Causative factors can vary widely, ranging from injury to imbalance of the foot. Generally speaking, minor hoof cracks are of little concern to the owner, farrier, and veterinarian, while serious cracks can compromise the horse's ability to perform. Of course, there is always the danger that a minor crack can turn into a severe one if it is not dealt with quickly.

Crucial to good hoof health and prevention of cracks is foot balance that allows the hoof to strike the ground evenly, says Lee McKinney, of Riverton, Wyo., who is currently celebrating her 25th anniversary as a farrier. (McKinney is a graduate of the Montana State Horseshoeing School in Bozeman and has written farrier articles for *Western Horseman*.)

"Many cracks are caused by imbalanced feet," she says. When that is believed to be the cause, the important thing is to deal with the root of the problem and get the foot back into proper balance.

"Sometimes it involves something as simple as trimming or rasping off flared out edges of hoof that have caused the foot to be out of balance, and sometimes it involves proper shoeing," she says.

Appropriate hoof care, or lack of it, can be a factor in the development of cracks, and once again McKinney believes balance is involved. Horses which are turned out to pasture in the winter with their feet neglected--especially if the shoes haven't been removed--are at risk, she says. These are horses which have chunks of hoof that break off while they are traveling over frozen ground or when a shoe is ripped free. Loss of a portion of the hoof causes the foot to be out of balance, and the end result can be cracks that might require months of recuperation once the foot is put back into proper balance through trimming and/or shoeing.

On the other end of the spectrum, says William Moyer, DVM, head of the Department of Large Animal Medicine and Surgery at Texas A&M University, are horses which have weak hooves that are prone to cracks and other injuries because they are treated too well.

"We have taken this animal that was designed to be in almost constant motion and have turned it into an apartment dweller," he says. "Bones need to be stressed by activity in order to grow strong. It's the same with the hooves. Many of today's horses walk and perform only on soft, cushioned surfaces. That does little to strengthen them. The hoof is dependent on forces or challenges. When they don't exist, there is no reason for it to grow strong."

Moyer brings more to the table concerning hoof health than acknowledged academic expertise. He grew up spending long hours in the saddle on a New Mexico ranch and has served as a veterinarian for 100-mile endurance races. In addition, he has been involved in a good deal of research involving equine bone development and repair of the hoof wall. A couple of years ago, he co-authored a book with Robert Sigafoos (Certified Journeyman Farrier at the New Bolton Center) titled *A Guide to Equine Hoof Repair*.

The equine selection process through the years has been a factor in hoof health of the domestic horse. Most horses in the wild have strong hooves that do not crack. One reason is that they travel over hard surfaces that wear their hooves down in a balanced fashion. Another reason involves survival of the fittest. Horses which suffered hoof cracks severe enough to cause lameness often were dinner for a predator. Thus, genes that tended to produce weak hooves were not passed on.

It is vastly different in the domestic world, where survival of the fittest is not an issue. If a horse has weak hooves that tend to crack, many owners simply turn to farriers and veterinarians for procedures--some of them sophisticated and costly--to solve the problem.

Before we get involved in a discussion on hoof cracks and various approaches to take in healing them, it would be helpful to take a brief look at the way in which nature has constructed the hoof. The abbreviated information that follows comes from a number of academic sources, including Moyer.

The Hoof

Hoof wall--The hoof wall is composed of three layers. The outer layer involves the periople and stratum tectorium. The periople, which functions much like the cuticle of a human fingernail, extends about three-fourths of an inch below the coronary band except at the heels, where it caps the bulbs of the heels. The stratum tectorium extends down to the bottom of the foot. It is a thin layer of horny scales that gives the glossy appearance to the outside of the wall below the periople. One of its tasks is to protect the wall from undue evaporation of moisture. The hoof wall is approximately 25% water. The middle layer comprises the bulk of the hoof wall and is the most dense portion. The inner layer is known as the laminar layer, which bears a multitude of primary and secondary laminae that attach the coffin bone to the inside of the hoof wall (sort of like Velcro).

Sole-- The structure of the sole is similar to that of the hoof wall. It appears that the sole is not designed to bear a lot of weight from the ground surface, but is designed to bear internal weight.

Frog--The frog is a wedge-shaped mass that occupies the angles bounded by the bars and the sole. The frog is 50% water and quite soft when compared to the hoof wall and sole. It acts as a shock absorber when the foot strikes the ground.

Sensitive structures--These structures inside the hoof wall are called sensitive for good reason: They contain so many blood vessels and nerve endings that any injury to them can cause pain and bleeding. We won't delve into a discussion as to what the structures are called or how they function. Suffice it say that nearly all inner structures in the horse's foot are elastic and spongy to some degree as part of the design to absorb concussion.

Coronary band--The coronary band is the sensitive, spongy area around the top of the hoof, which is the primary growth and nutritional source for the bulk of the hoof wall. Injuries to the coronary band are serious and can result in a permanent defect in the growth of the hoof wall.

Bones--The foot contains three bones. They are the lower end of the short pastern bone, the coffin bone, and the navicular bone. These bones are attached to the inner hoof wall by the Velcro-like laminae. Any injury or damage to them is a serious matter.

Tendons--Two key tendons are found within the foot. The extensor tendon attaches to the front of the coffin bone, and the deep digital flexor tendon attaches to the bottom of the coffin bone.

Concussion absorbers--The navicular bursa is a cushioning sac positioned between the deep digital flexor tendon and the flexor surface of the navicular bone; it helps reduce concussion on the navicular bone. Another of the inner structures that helps absorb concussion is the digital cushion, which is located between the bottom of the coffin bone, the deep digital flexor tendon, and the frog and sole. It is comprised of fibrous and fatty tissue that is very elastic. It is about the only inner structure that has few blood vessels and nerves. When it is compressed by the pastern bones and frog, it absorbs shock and cushions the bones.

When everything is working as Nature designed, the hoof is an anatomical thing of beauty. When something goes wrong, including cracks that sometimes admit infection-causing bacteria to the sensitive inner foot, it can become a disaster zone.

Defining Hoof Cracks

In their book, Moyer and Sigafos used the following categories for hoof cracks:

Location--Toe, quarter, heel, and bar.

Depth--Superficial or deep. Superficial cracks rarely result in lameness and often can be cleared up quickly. Deep cracks that reach all the way to the sensitive inner structures can cause intense pain and lameness. Deep cracks, in some instances, might require elaborate and costly treatment.

Length--Complete or incomplete. A complete crack would be one that runs from the coronary band to the ground surface. An incomplete crack would be shorter.

Origin--The crack either starts at the coronary band and travels down or starts at ground level and works up.

Fortunately, says McKinney, most of the hoof cracks she encounters fit into the superficial and incomplete categories and do not cause the horse pain. In many cases, she says, they can be treated by rebalancing the foot through proper trimming and application of a bar shoe.

For years, many farriers filed a deep groove above or below a crack in an effort to keep it from spreading. McKinney sees little value in that approach. "All you are accomplishing," she says, "is the destruction of hoof wall. You aren't going to stop the crack from spreading by filing a groove."

Just filing a groove became passé several years ago when farriers started using Dremel tools--akin to a dentist's drill, but larger--with which they can clean out the crack from bottom to top. Mustad Company recommends burning or drilling an inverted triangle into the top of ascending cracks to prevent further cracking. The key is to get down to the source of the crack, which rasping a groove often didn't do.

In addition to the more common vertical cracks, McKinney says, are horizontal cracks that occur at various locations on the hoof wall from the coronary band on down. Horizontal cracks, she says, often are the result of injury.

"I really don't worry much about those unless they are deep, because they will grow out," she says. "They can become a problem, though, when they get near the bottom of the foot and are right where a nail should go."

When that is the case, McKinney will use clips on the shoe to help stabilize it. In some cases glue-on shoes might be appropriate, she says.

While most of the cracks with which McKinney deals are of the superficial variety, there are cases where they are deeper and more severe, penetrating all the way to the sensitive inner structures.

"If there is blood or seepage," she says, "I call in a veterinarian, and we can work together as a team."

From that point, she says, it often becomes a matter of economics, with some of the procedures involving acrylic compounds and/or other expensive approaches.

"The owners have to decide how much they are willing to spend," she says.

One of the first reports on using acrylic compounds and a lacing technique within that compound was presented by Sigafoos at the 1995 AAEP Convention. In their book, Sigafoos and Moyer describe various techniques for healing cracks by using high-performance acrylic adhesives and a variety of structural engineering fabrics for reinforcement. All of the techniques have the same basic approach--clean out the crack with a Dremel tool, establish drainage if there is danger of infection, use acrylic adhesives to firmly bind to the hoof wall on either side of the crack, and overlay the whole thing with structural engineering fabrics for reinforcement. In some cases, lacing is installed within the fabric to help hold the crack together while it grows out. The variations in treatment protocol depend on location of the crack, and sometimes its depth.

One of the more sophisticated procedures for healing quarter cracks, described as a new approach, was discussed by Stephen E. O'Grady, BVSc, MRCVS, of Northern Virginia Equine Practice in The Plains, Va., at the 2001 AAEP meeting in San Diego, Calif. O'Grady described dealing with quarter cracks by combining the use of stainless steel wire and a strong structural fabric called spectra that resembles fiberglass (see photos on page 62).

"Quarter cracks are a common cause of foot lameness or decreased athletic performance in race and sport horses," O'Grady said in his introduction. "They typically originate at the coronary band and continue distally (downward). A true quarter crack is full-thickness and extends into the dermis of the hoof, often leading to instability, inflammation, and infection. Quarter cracks can be painful due to infection or instability caused by movement of the hoof wall posterior to (behind) the crack. The vertical movement of the heel bulb on the affected side further complicates this instability.

"Causes of quarter cracks may include trauma to the coronary band; pre-existing damage to the corium (the soft tissues between the sole of the hoof and coffin bone) from infection; abnormal hoof conformation, especially in the long toe, underrun heel; and focal foot imbalances, such as a sheared heel, short shoes, or an abnormal landing pattern when the foot strikes the ground."

To begin the repair work, O'Grady says, the quarter crack is explored and cleaned along its entire length using a Dremel tool. In some cases a drain is needed to help heal the crack.

Once the crack has been thoroughly prepared, two sets of paired 3/64-inch holes, 1/4 inch apart are drilled across from each other on either side of the crack. Stainless steel wire is threaded through the holes and tightened.

A polymethylmethacrylate (PMMA) composite is then mixed and a layer applied to the prepared area of the foot, completely filling the quarter crack. The spectra fabric is thoroughly impregnated with the PMMA composite and a section is placed over the prepared area, followed by another layer of composite. This procedure is repeated, O'Grady says, until three sections of fabric have been placed over the defect.

O'Grady had used the procedure on 25 horses at that time with positive results.

"This repair has produced consistent results when compared to previous methods used by this author, and there have been no reoccurrences reported following the repair," he wrote in the report that was published in the *2001 AAEP Proceedings*. "Horses treated in this manner become sound almost immediately, and are able to return to successful competition following the repair with no infection or bond failures being noted. Some of the cases presented with quarter cracks that had been previously repaired using only a composite. With these repairs, the crack had repeatedly ruptured at the coronary band, indicating instability of the repair."

Using prime preventive measures such as regular trimming and shoeing for better hoof balance can help prevent hoof cracks from forming, so your horse doesn't need these repair procedures.