2017 International Hoof-Care Summit Coverage

Hundreds of farriers and equine veterinarians from around the world gathered in Cincinnati, Ohio, Jan. 24-27 to talk hoof-care practices and innovations. The Horse was on the scene to cover some of the most practical of the more than 100 sessions, roundtables, and how-tos. Read on to find out what’s cutting-edge in the world of equine hoof care.

10 take-homes from the 14th annual edition of this equine foot-focused event

Trimming and Shoeing Techniques Can Affect How Horses Move

Farriers must understand biomechanics and the forces at work in a horse’s hooves to make appropriate trimming and shoeing decisions. Jenny Hagen, PhD, professor and researcher at Leipzig University’s Institute of Veterinary Anatomy, in Germany, explained how farriers can help horses move better using trimming and shoeing techniques.

A horse’s stride has two phases:
1. The nonweight-bearing swing phase; and
2. The stance phase, when the hoof is in contact with the ground.

Stance is further divided into three phases:
1. Landing, which starts with the initial ground contact;
2. Midstance, when the horse’s body is directly over the supporting limb and experiences the greatest ground reaction force (GRF,
which is exerted by the ground on the horse); and
3. Breakover, which is the process of the heels lifting off the ground, rolling over the toe, and the toe leaving the ground.

Hagen has been studying the horse’s stance phase because trimming and shoeing can affect the forces on the hoof and limb during this phase, and she wants to know exactly how.

Farriers can only impact the swing phase indirectly, she said.

“All biomechanics and all strains affecting tendons, ligaments, and joints have differences depending on the stage of the stance phase,” said Hagen, adding that the center of force (also referred to as center of pressure, where all forces become equal) also changes based on the phase.

In their recent study Hagen and colleagues collected data from 75 sound Warmbloods using an inexpensive mobile sensor system called Tekscan, which measures pressure across the various parts of the hoof. The resulting images and video revealed pressure distribution and hoof-ground contact in the stance phase, which could allow veterinarians and farriers to identify where hoof problems are located.

Hagen and her team discovered the following:

■ Initial contact How the hoof first impacted the ground varied greatly. The most common landing patterns were plane landing (all parts of the hoof contacting the ground simultaneously, which occurred in 35-42% of cases) and lateral landing (when the outer side of the hoof landed first, which happened in 35-40% of cases). Toe-first landings made up 15% of the cases. Medial (the inner side of the hoof landed first) and heel landings were 2% and 2-3% of the cases, respectively. She noted a weak correlation between initial contact and mediolateral (side-to-side) load distribution.

■ Mid stance The lateral hoof side was most affected by force during this phase.

■ Breakover This varied horse to horse, but more cases showed pressure on the lateral aspect of the toe than other parts of the hoof.

Effects of Trimming and Shoeing While trimming, a farrier tries to optimize the initial contact and hoof load during midstance and facilitate breakover, although it’s often difficult to improve all these aspects, said Hagen.

“If you would like to change the initial contact, gait pattern, or the stance phase of the horse, you need to aim specifically for it,” said Hagen. “You can’t just trim statically or geometrically (to the shape of the horse’s foot). You really have to check with the functional things like the walk and how the horse is moving.”

Changing how a hoof initially contacts the ground also often influences load distribution during the midstance phase, Hagen said. For each individual case, farriers must judge whether correcting the hoof’s initial contact toward a plane landing outweighs the disadvantage of an unequal loading during the midstance

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**OVERGROWN BARS**

**HOW FORM AFFECTS FUNCTION**

**CAUSE**
Lack of regular scheduled trimming and misconception of what the bars do.

**EFFECT**
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**SOLUTION**
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phase, when the strongest forces affect the limb, she added.

While farriers can trim to change the center of force more easily in the dorsopalmar (toward the heel) then mediolateral (middle) position, it’s difficult for them to change the location of the individual breakover in this manner.

Shoes’ Impact on Stride Farriers can also impact the horse’s stride by changing shoe weight, height, and surface. Each horse’s hoof-ground contact is different, and the effect of trimming and shoeing depends on posture and limb conformation, horse management, the stage of the stance phase, and manufacturing of the shoes.

“With the application of modified horseshoes, such as bar shoes, open toe shoes, or other surface modifications, specific regions of the hoof can be directly relieved to support the recovery of diseased parts of the hoof,” said Hagen. While farriers can apply modified horseshoes to adjust initial contact and facilitate breakover, they shouldn’t use them if the result is instability when the horse is in motion, especially with wedges, studs, or rocker shoes, Hagen said. She added that wedges put pressure on the heels, which can have negative long-term effects on hoof growth and shape, especially if a horse tends to have underrun heels. If a farrier needs to use wedges, Hagen recommended using long wedges made of soft material.

Hagen stressed that farriers shouldn’t rely on orthopedic shoes long-term. Just as people take antibiotics for a specified amount of time to treat a specific illness, a farrier only needs to use an orthopedic shoe temporarily to correct a specific problem. These shoes can affect pressure distribution on the hoof capsule, leading to shoeing intolerance or other problems, she cautioned.

Trimming’s Effects on Horse Hoof Morphology

Farriers use a wide range of trimming techniques to improve the health and structure of each equine foot and hoof capsule on which they work.

Brian Hampson, PhD, co-founder of the Australian Brumby Research Unit at the University of Queensland, in Australia, presented the results of a study in which he looked at the effects of four trimming models on hoof morphology (form and structure).

Study Overview Hampson evaluated 22 horses from the United States and Germany on which one of four trim types was performed over a 12-month period. His goal was to document morphologic changes associated with various barefoot hoof care models and to determine if hoof capsule changes occurred in relation to them. He also aimed to find out if the palmar soft-tissue volume within the foot changed over 12 months. He didn’t seek to determine if one trim method was better than another.

Dr. Brian Hampson documented hoof morphology changes, including heel bulb length, toe length, sole depth, and more, resulting from various trim methods.

(Trimming) should be based on a combination of measurement ‘guides’ and a good knowledge of the biological and biomechanical consequences of hoof length and angle changes.”

DR. BRIAN HAMPSON

Hampson’s research team analyzed data provided by four trimming schools that agreed to have farrier students trim horses every four to six weeks according to their taught trim method and share their results. Photos and radiographs were taken before and after each trim. The farriers/trimmers selected study horses with healthy, disease-free hooves they thought they could change. Each farrier started with hooves that had not been trimmed in the previous six weeks.

The Trimming Methods Hampson described the four schools’ trimming methods to the audience:

■ “Barefoot Hoof Orthopaedics (BHO)” from Dr. Konstanze Rasch of Germany: This technique doesn’t allow significant adjustments to the hoof wall from trimming underneath, because the belief is they stress the joints above, he said. Instead, the farrier thins the wall from the outside and lets the natural movement of the horse trim the hoof down.

■ “Natural Hoof Care” from Dr. Tina Gottwald of Germany: He said this method involves using a trim similar to those used for wild horses (the “mustang roll”) by rolling the hoof wall’s ground surface all the way around and taking it back to the white material/wet line.

■ “Pacific Hoof Care Practitioners (PHCP)” from Sossity Gargiulo of the United States: This method involves keeping the outer hoof wall tubules from interacting with the ground by using a trim similar to wild horse trims by rolling the hoof wall almost all the way back to the heel, he said.

■ “HoofPrint Method” from Cheryl Henderson of the United States: This trim creates a rocker toe and a thinner hoof wall.

Key Study Findings The study results confirmed that trimming can change hoof capsule morphology. Some changes
were positive, such as increased palmar ground support length and reduced toe length. Hampson's team viewed resulting reduced sole depth and excessive shortening of the toe as negative effects of trimming.

Hampson and colleagues found that hoof capsule changes might not align with each trimming school's philosophy or be as significant as each trim's advocate proposed. Finally, they found that palmar soft-tissue volume did not change relative to hoof capsule changes over the year-long study.

In his summary, Hampson described the importance of the hoof wall, especially at the toe and in the buttresses (in the back near the heels). "It's thick here (in the back) because the heels slam on the ground in the heel-strike in weight-bearing," he said. "In toe-off, there are large movement forces in the dorsal foot (the front hoof wall), so you need a lot of meat to absorb that shock."

Hampson said he's not a fan of the excessive mustang roll, which involves trimming the hoof wall into a rolled look all the way around the hoof so that the horse bears more weight on the inner hoof wall and the sole. He said it's not natural like many mustang roll fans promote. In his work with wild horses, he said he's never seen a wild horse's foot look like the mustang roll unless the horse was on the verge of death, traveling excessive mileage to survive drought conditions, or climbing rocky mountainous country to access feed.

"I don't see the point in cutting (the hoof wall) off, and I really haven't had anyone give me a good explanation for why that's done," he said. "I'm not convinced that's a natural horse's foot."

Additional Observations
He and the other researchers also found that:
■ None of the horses had perfectly symmetrical feet, and hoof morphology varied between horses;
■ No change occurred in distal phalanx (coffin bone) length, lamellar zone thickness (the distance between the laminae and the outer hoof wall), or sinker distance (the depth the coffin bone had sunk over time into the outer hoof). There was no change overall in heel bulb length, palmar angle (the angle the wings of the coffin bone make with the ground), dorsal hoof wall angle (the angle the outside of the hoof wall makes with the ground at the toe), and frog width in any group;
■ All the groups except BHO reduced the distance from the tip of the distal phalanx to the lamellar zone;
■ The horses had an average 20% reduction in sole depth (2.9 millimeters) with no difference between the four methods;
■ All but the BHO horses had an average...
26% reduction in toe length (range of 8% from one group to 40% from another);
■ Hoof length didn't change significantly, but PHCP achieved a 10-millimeter reduction while BHO achieved a 7-millimeter increase;
■ The horses' dorsal foot length decreased by 25% on average, while the BHO group experienced no reduction;
■ Mean palmar foot length increased by 8% (7 millimeters, with a range of 3-10 millimeters);
■ Heel angle (the one between the heel wall and the ground) increased by 2% on average (range of 5.8-degree reduction to 6.2-degree increase, with the increase not being significant);
■ Heel width was reduced by 6.3 millimeters on average (ranging from an 18-millimeter reduction to a 2-millimeter increase with the PHCP trim).
■ An overall 2.5-millimeter reduction occurred in foot width (9.8-millimeter reduction to a 7-millimeter increase) with the PHCP trim.
■ Horses experiencing the most aggressive toe trimming had the greatest reduction in foot length, the smallest increase in palmar foot length, a reduction in foot width, a 6-degree reduction in heel angle, and no change in heel width.

**Take-Home Message** Hampson emphasized that good hoof trimming isn't purely a science.

"Instead, it should be based on a combination of measurement ‘guides’ and a good knowledge of the biological and biomechanical consequences of hoof length and angle changes,” he said. “This is where art and science combine to produce the best results for the horse. Hoof care recipes work sometimes for some horses but will be detrimental for others.”

The study results give veterinarians, farriers, and horse owners more information with which to make educated decisions about hoof care, he said.

### Dealing With Hoof Capsule Distortion and Dysfunction

What do a dish, a crack, a flare, and a sheared heel have in common? All these problems are forms of hoof distortion.

"An undesirable shape change is a distortion,” which can lead to discomfort and lameness, said Scott Morrison, DVM, of Rood & Riddle Equine Hospital, in Lexington, Kentucky.

Morrison explained that hoof capsule distortion can have many causes:

■ Balance issues;
■ Shoeing;
■ Stress from certain types of work, such as repetitive speed training; and
■ Diseases, such as laminitis, white line disease, or canker.

**Early Hoof Morphology**

Managing hooves to prevent distortions starts at foaling. When horses are born, their hooves are almost perfectly symmetrical and covered with a soft deciduous (meaning it will eventually shed) material and have soft soles to protect the mare's birthing canal. Hooves harden after birth.

The typical newborn foal hoof is very contracted with underrun heels, which quickly shift back into the proper position, said Morrison. He also said it’s normal for foals to rock back on their heels, causing the toes to flip up slightly, and to be weak in the flexor tendons.

Hoof evaluation and care—within the first week of life—should begin with a minor trim, which the farrier should repeat every few weeks to help get the hoof surface completely on the ground.

“That juvenile period is really important for the digital cushion and the collateral cartilages and all those things to respond to stress and develop and mature in a way so they are strong enough when they become adults and athletes,” said Morrison, emphasizing the importance of getting the proper proportions on the foal’s foot.

Morrison said he often sees changes in the hoof capsule after a few months, as foals start to toe out naturally. But the capsule will become more symmetrical.

Newborn foals often have weak flexor tendons (right) and contracted, underrun heels (left) that correct naturally with age.
again as the foal ages. He advised farriers to evaluate foal feet carefully and observe how foals walk. When horses are young, farriery can help manipulate conformation for the better, at least until growth plates ossify (harden into bone), he said.

If a growing foal’s limbs become too crooked, Morrison intervenes with shoeing, using an extension to help straighten the limb by shifting the foot’s center of pressure. (This is the point at which the GRF acts upon the hoof.) He uses a pour-in pad to help support the sole to mimic the barefoot condition as much as possible.

Morrison said any outward limb rotation will usually self-correct as the foal grows into a yearling and his chest widens. “It’s normal for the foot to be loaded a little bit more medially than laterally, resulting in the medial wall being more vertical or straighter than the lateral wall,” he said.

Farriers might use heel plate shoes to rehabilitate severely compromised heel structures.

Shoeing and Trimming Basics The way the hoof interacts with the ground impacts the whole limb (even the entire body), especially the coffin joint and the navicular structures located at the back of the foot. Morrison emphasized that farriers need to understand the front half of the foot’s role in establishing traction and supporting various inner hoof structures.

Morrison likes to simulate the barefoot condition as much as possible in adults, as well, to minimize the effects of shoeing. He said farriers should be able to draw a line where the coffin bone is and then trim to the widest part of the foot, which is usually the center of rotation. Two-thirds of the coffin bone should be in front of the center of rotation and one-third behind.

He also recommended trimming the foot to create a positive palmar angle, ideally 2-5 degrees, which he considers within normal range. The center of rotation should line up with the geometric center of the weight-bearing surface of

Environmental Factors Affecting the Foot. Apply pour-in pads as a barrier to protect the foot from the elements.

Moisture softens the foot allowing for excess exfoliation, increased chances of thrush, foot expansion, and over hydration leading to abscesses.

Extreme cold or heat slows hoof wall growth.

Sole bruising and hoof wall chipping occur on hard, rocky terrain, and sandy terrain wears away sole.

Apply pour-in pads as a barrier to protect the foot from the elements.
the shoe. The ground surface of the heel should line up with the widest part of the frog, and there should be an adequate amount of sole depth, which varies based on the size of the horse’s hoof. Ideally, however, it should equal the width of the horn lamellar zone.

Morrison said the appropriate location of a horse’s breakover point—the forward-most point of the foot or shoe’s ground contact—is hotly debated. He suggested it be at the apex of the coffin bone, unless he is treating a horse with problems.

**Supporting Compromised Hooves** If a horse’s hoof capsule starts to distort due to imbalances, Morrison said he favors removing shoes when possible and letting the frog hit the ground, which stimulates hoof growth.

For horses with stressed feet that need axial (inner hoof wall) support, Morrison suggested various shoe types, heel plates, pour-in sole supports, or pads or decreasing shoe thickness to allow the frog ground contact.

He said the most popular way to provide support is with a straight bar shoe, which puts weight on the base of the frog and, thus, unloads the heels. Additional options include an egg bar shoe, which is designed to provide limb support; a heart bar, which has a “V” shape useful for supporting the frog while allowing thrust treatment; or a short heart bar, which is safer for speed horses.

Pour-in pads provide support by allowing the horse to weight his whole sole. A frog cradle is a safe way to support the base of the frog, he said. Farriers often use stabilizer plates on racehorses, but they can sometimes be difficult to clean out and can bruise the hoof bars (the inward folds of the hoof wall, located on either side of the frog).

Very compromised hooves are sore everywhere, making it difficult for farriers to provide any support, said Morrison. In these cases he applies a heel plate shoe with some dental impression putty and rolls the toe and the heel to make the horse more comfortable.

“You have to look at distortions and keep in mind why they are there and … try to respect the lower limb,” said Morrison. “In trying to change hoof capsule distortions, you also want to think about how you are going to change the mechanics of the whole lower limb.”

**Managing Severe White Line Disease**

White line disease is a bit of a misnomer as it doesn’t actually affect the white line along the bottom of the hoof wall. Rather, it’s a disease process that sets up within the inner nonpigmented section of the hoof wall, called the stratum medium, that can also erode into the stratum internum (where the sensitive laminae attach the hoof wall to the coffin bone). In severe cases, white line disease can damage the lamellar apparatus to the point that the horse develops laminitis.

Mike Steward, DVM, APF, of Shawnee, Oklahoma, described the intricacies of treating and shoeing horses with severe white line disease.

**Diagnosis** One of the big challenges in treating white line disease is that its cause is unknown. The disease process usually begins with separation of the hoof wall’s insensitive laminae from the
underlying sensitive laminae attached to the coffin bone. Bacteria, fungi, and dirt can then enter the space and cause infection, which is often difficult to treat due to its location and the lack of blood flow to this area.

Veterinarians typically diagnose white line disease by looking for abnormal wall separation or wall conformation, tapping the hoof wall to listen for a hollow sound, and applying hoof testers to the sole. A veterinarian or farrier can use a hoof knife to cut away the diseased part of the hoof wall to get a better idea of the extent of infection and separation. However, he said, radiography is a useful and less-invasive diagnostic tool.

Treatment Though it can take some time, treatment is relatively simple, said Steward. When dealing with these cases, he removes the dead hoof wall with a hoof knife, Dremel tool, or half-round nippers. This allows oxygen to reach anaerobic bacteria (which thrive without oxygen) that could be degrading the hoof wall. It also helps reduce stresses on the diseased hoof wall that are causing the separation. He emphasized the importance of cutting away the entire infected area. Then he said he usually applies a topical medication to treat the infection.

If the hoof wall defect is particularly large, Steward said he might mix powdered copper sulfate with impression material, place it within the defect for support, and wrap the foot with a cast. He added that some farriers also apply super glue to the cleaned lesions' edges to help seal them and prevent more damage.

Steward stressed the importance of stabilizing the hoof wall and coffin bone. If possible, he trims and rolls the affected toe and might then use a wedge pad or clog pads to help take some of the load off the diseased area. These wedging and breakover modifications can help reduce pressure on the deep digital flexor tendon, which is attached to the coffin bone, to help prevent (or relieve pain associated with) laminitis. Sometimes he applies ethylene-vinyl acetate (memory foam) to help lessen concussive forces on the foot, especially if the horse will be walking on hard ground or concrete.

Shoeing Farriers use various shoeing methods, depending on their knowledge of shoe mechanics and the individual

“"The toe soreness can be a result of the white line disease's damage to the lamellar apparatus, resulting in laminitis.”

DR. MIKE STEWARD

CAUDAL HEEL SYNDROME CAUSING PAIN

CAUSE Uneven loading of foot. Improper heel and toe placement.

EFFECT Narrowing of heels and frogs, improper toe landing and lameness.

SOLUTION Trim to proper heel and toe ratio. Increase weight bearing surface of the foot by moving heels back and support the sole with a pour-in pad.

RESULT Heel and toe ratio is in balance and the sole is supported. The heels are returned to their normal position and lameness is averted.
foot’s needs. For example, said Steward, they might apply a wide web shoe, a pad, and sole impression material to redistribute the horse’s weight to the back of the foot and protect the painful toe area.

“The toe soreness can be a result of the white line disease’s damage to the lamellar apparatus, resulting in laminitis,” said Steward.

Some of his favorite shoes for stabilizing the hoof and redistributing weight include heart bars, egg bars, square-toed shoes, and full roller motion shoes. In more severe cases, he might use a clog similar in design to that of the “outlaw shoe” for horses with laminitis.

“The concept of the wooden shoe (such as the eponymous Steward Clog) is utilizing mechanics in an orthotic (an artificial support) to alter the hoof’s engineering to enhance healing,” he said. “Stability and mobility are uniquely balanced in such a manner they allow the hoof to function in an optimum manner when normal. Altering one of these entities will inversely affect the other; and these are just two of many things that need to be considered when altering mechanics to enhance healing of white line or other hoof pathologies.”

If the foot requires more mobility, Steward recommended using a “taller” shoe to move the breakover point back. He cautioned that horses wearing tall shoes should be confined to spaces where they can’t move at speed, which can increase pressure and forces on the collateral ligaments and possibly cause injury.

Steward concluded that while farriers have many shoes to choose from when treating white line disease, they should select the one that meets the individual horse’s mechanical needs. The goal is to stabilize and protect the hoof and enhance healing.

The Relationship Between Hoof Deformation and Underrun Heels

Horse owners, veterinarians, and farriers alike know that preventing hoof problems is better than having to fix them. But when a hoof problem, such as underrun heels, does develop, it’s important for your horse’s health care team to be up-to-date on the latest research and treatment methods.

Peter Day, Dipl. WCF, farrier at the Royal Veterinary College, in Hertfordshire, U.K., and colleagues conducted a series of studies looking at the relationship between hoof deformation (a shock-absorbing mechanism—the natural change in the hoof capsule’s shape every time it’s loaded with the horse’s weight) and underrun heels. They compared the degree of deformation in hooves with and without underrun heels and evaluated the effects of carbon composite hoof wall patches on underrun heels.

Regardless of the term used—underrun heels; long-toe, low-heel; slung heels; or collapsed heels—this issue appears to occur more frequently in the front feet than the hind. For this reason, Day focused his research on only the front hooves. He said he considers heels to be underrun or collapsed when the heel angle is lower than the toe angle by about five degrees.

Underrun heels develop as the toe grows too long and the heels appear to grow forward rather than downward, becoming lower. This changes the forces acting on the foot’s structures—especially the deep digital flexor tendon that inserts on the coffin bone—making the navicular bone more vulnerable to injury.

Horses can be genetically predisposed to a low-heeled foot, so breeders should take this into consideration to avoid perpetuating the problem. Wear and tear on the predisposed hoof over time causes the horn tubules to bend and the heels to lower. This affects hoof deformation and blood supply to the foot.

Day described two theories behind hoof deformation:

1. Compression of the frog and the sole puts pressure on the foot’s cartilages and pushes them upward, causing the hoof to expand.
2. Forces going through the hoof wall’s laminar attachment are redirected as the middle phalanx (short pastern bone) lowers during the stance phase, pushing the hoof wall and the cartilage outward.

Day’s team performed a series of four research projects using cadaver limbs as well as live horses. They tested different hypotheses revolving around carbon composite patches’ effects on hooves. Results indicated that carbon composite patches applied to the hoof wall in horses with collapsed heels can improve horn tubule strength, circulation, and hoof deformation and shock absorption, offering farriers a practical application for preventing or treating collapsed heels.

Day performed his last trial in 12 front cadaver legs to determine whether hoof
deformation differed between horses with or without collapsed heels when artificially loaded at the equivalent of a fast trot. He found that overall deformation and foot spread was greater in feet without collapsed heels. In feet with collapsed heels, the medial heel showed significantly more proximodistal (from the inside outward) deformation. This confirmed their hypothesis that feet with collapsed heels have less heel deformation and, thus, reduced shock absorption, which can cause further foot problems.

**Treating the Problem**
Farriers’ support and treatment options for underrun heels include:

- Buttressing the heels
- Raising the heels
- A natural balance or barefoot trim
- Broad shoe
- Heart bar shoe
- Egg bar shoe
- Packers and pads

Treatment method often depends on the horse’s environment, so he encouraged farriers to ask owners about the footing the horse is living and working on. “Sometimes a particular shoe on a particular terrain might be exactly what you want,” said Day.

“At the moment, there is a lot of (research) going on in pads and packers and the effects they’re having,” he added. “A lot of that early work was done in the laboratory on cadaver material.” He says the preliminary results are exciting.

Because this abnormal hoof conformation ultimately contributes to a range of foot problems, such as navicular syndrome, chronic heel pain, bruising, coffin joint pain, lameness, and reduced performance, Day encouraged farriers to take control of the way a horse is shod. He advised keeping the horse on a set trimming and shoeing schedule, despite any owner resistance, so they can try to prevent problems rather than end up having to fix them.

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**INCREASE SOLE DEPTH FOR OPTIMAL HOOF HEALTH**

**CAUSE**
Over paring, wet environment causing over exfoliation, abrasive terrain.

**EFFECT**
Sensitivity to hard ground, sole bruising, thinning of the hoof wall, flattening of the sole.

**SOLUTION**
Apply pour-in pad material to minimize exfoliation and provide protection.

**RESULT**
Sole has time to regenerate itself and increase depth eliminating sole bruising and potentially resulting in thicker hoof wall.

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Physiology, Foot Morphology, and Health in Przewalski’s Horses

Researchers study feral and wild horses for a variety of reasons. For instance, they evaluate hoof health to better understand hoof conformation, disease, and lameness in domestic horses. Information gathered about hoof angles, wall thickness, laminitis incidents, and more all offer insight into keeping horses sound.

Hampson presented a study in which he looked at foot morphology and foot health in one herd of Przewalski’s horses.

A History of Domestication

Hampson began with a summary of the history of horses as different genetic branches separated into domestic horse breeds and wild horses, such as the Przewalski’s horse and the Tarpan. He also clarified that what we often think of as “wild horses,” such as mustangs and the Australian brumbies, aren’t really wild; they’re feral.

Horses were domesticated about 5,500 years ago, said Hampson, and were initially used for milk and meat. Researchers estimate humans started riding horses around 3,000 years ago.

At least 87 breeds have already gone extinct, Hampson said, and 25% of the remaining 900-plus breeds are endangered. Additionally, he said, modern horses don’t have as much genetic diversity as previous wild and ancient domestic populations.

What We’ve Learned From Przewalski’s Horses

In the 1960s, the Przewalski’s horse, which originated in Mongolia, came back from near extinction. Current numbers hover near 2,000 worldwide, thanks to careful breeding of 16 captive horses in the 1970s.

The Przewalski herd that Hampson studied lives on Europe’s largest steppe area, in Hungary. Researchers collect data on these horses, such as heart rate, body temperature, movement, grazing habits, diet, and location.

During the winter, researchers have learned, the herd goes into a torpor—their heart rates drop by 50%, body temperature by up to six degrees, and body mass by 20%. The herd stands for long periods, eating only one-third of their usual diet. The hooves are long and overgrown during this time and are trimmed naturally through movement come spring.

To learn more about the horses’ hooves and compare it to what researchers know about those of domestic and feral horses, Hampson studied the feet and blood work of 12 stallions and eight mares from the herd, aged 2 and 13 years. He collected radiographs, photographs, lamellar histology (samples for microscopic exam), and serum insulin concentrations.

He and his team found several differences in hoof shape and structure between Przewalski’s horse and feral/domestic horses:

- The dorsal hoof wall angle was around 57°, compared to brumbies at 55°;
- The heel angle was 42°, compared to brumbies at 45°;
- The coronary band angle (you guessed it … the angle the coronary band forms with the ground) was 21°, which is the same as brumbies.
- The palmar angle of the distal phalanx was 6.3°, whereas it was 5.7° in brumbies;
- The sinker distance was 7.7 millimeters, compared to 6 millimeters in small domestic horse breeds;
- The hoof wall thickness was 14.6 millimeters, similar to that found in brumbies and domestic horses;
- Three of the 20 had mild chronic laminitis but could walk;
- Nine of the 20 horses had “normal” feet;
- Of the 10 horses’ tissue samples, five showed changes normally associated with hyperinsulinemia (a condition in which there is excess insulin circulating in the blood relative to glucose); and
- Ten of the horses had low insulin levels (two of those were laminitic).

Hampson also shared that Lane Wallett, DVM, a veterinarian and paleontologist at the University of Florida, in Gainesville, studied equine fossils up to 3.5 million years old and discovered a 75% incidence of chronic laminitis (see TheHorse.com/33506).

Take-Home Message

Based on these findings, Hampson hypothesized all equids are vulnerable to this disease. Dr. Brian Hampson was surprised to find laminitis in Przewalski’s horses and hypothesized that all equids are vulnerable to this disease.
laminitis in the Przewalski’s horse,” he said. “We thought there might have been something that was different about that horse’s foot that protected it from laminitis. We thought that most likely we’ve changed the foot of the domestic horse over the last couple hundred years that has made it susceptible to laminitis, but that doesn’t seem to be the case. It’s always been there. Feral and wild horses aren’t exempt to these pathologies.”

**What Does Shoe Wear Reveal?**

Farriers and veterinarians came together in several Summit roundtable discussions to compare their experiences and offer advice to their peers. In one packed session, farriers discussed shoe wear, what it indicates about the horse, and what can slow it down. In addition, attendees reviewed how riding discipline and certain health conditions might impact shoe wear.

Adam Wynbrandt, APF, vice president of the American Association of Professional Farriers/International Association of Professional Farriers, moderated the session and said he’s personally seen shoe wear patterns herald upcoming health problems. He told the audience that as they gain more knowledge, they can tell more about the horse based on shoe wear.

Factors affecting shoe wear run the gamut and can include:
- Arena footing or turnout surface;
- Shoe material;
- Conformation and way of going;
- Ongoing medical problems;
- Shoe tightness; and
- Saddle fit, among others.

**Subtle Shifts?** It’s important for the farrier to ask the horse owner what he or she is doing with the horse and if anything has changed. For example, have there been changes in the horse’s or rider’s weight or rider’s skill level? Are other riders now riding the horse? These factors could cause horseshoes to start wearing differently than normal.

One attendee noted that if, historically, a horse has shown a wear pattern on one side of his shoes but then this stops, it could indicate that the owner might have changed something with the horse.

Another farrier said a horse he was shoeing had medial (toward the midline of the body) toe wear. It turns out the horse had hock problems, and once the veterinarian injected those joints, the medial toe wear pattern went away.

**What Lies Beneath** Farriers also discussed how footing affects shoe wear. For example, if a horse is ridden in an arena with newly added heavy sand, then steel shoes might start to show increased wear.

On the other hand, many agreed that chopped rubber footing is one of the easiest surfaces on shoes.

Another change that can cause a shift in shoe wear patterns is addition of stone dust or a similar material to a field or paddock to help deal with mud issues. The abrasive surface wears a shoe down faster than normal terrain would.

One farrier who favors using synthetic-material shoes said they wear similar to a steel shoe and provide the same type of information. He added that higher-density synthetic shoes wear quicker.

**Horse Factors** Regarding horses that show shoe wear changes, the farriers described how laminitic horses that recover or have had a recent setback might have unusual wear.

They talked about the differences among disciplines, such as how endurance horses wear shoes down very quickly and could need a reset after just one race. One solution for excessive wear is to use borium.

One farrier suggested adding weight to the shoe to reduce wear, because the horse will pick his feet up higher.

Often horses that are not engaging their hindquarters or conditioned for the type of work they are doing wear shoes faster. On the other hand, dressage horses, which must engage their hindquarters during work, tend to wear down their hind shoes faster and might need those shoes reset more often than horses in other disciplines.

One Standardbred racehorse farrier noted that he would trim a horse’s foot down on the side of increased wear because the horse was clearly off balance, but then occasionally he would trim the opposite side more to move the hoof’s...
forces placed on those important structures. On the horse’s feet aren’t even, neither are the markers on the dorsal hoof wall used proximal and distal (top and bottom) of the hoof. The team studied 34 shod and unshod horses that came to the clinic for routine examinations. Thirteen of the horses had even feet, and 21 had uneven feet. The team noted that animals with uneven feet typically retired earlier and that foot conformation or the differences in hoof loading patterns during movement and whether foot conformation or the difference between feet is more important in limb loading. Sarah Jane Hobbs, PhD, the research lead in equine biomechanics at the University of Central Lancashire, in England, presented her team’s study results. She worked alongside Willem Back, DVM, PhD, Dipl. ECVS, Cert. KNWvD, Spec. KNMvD, and his students from Utrecht University, in the Netherlands, and Sandra Nauwelaerts, PhD, from the University of Antwerp, in Belgium, on the project.

In previous studies, equine researchers found connections between uneven feet and pain avoidance as well as postural and loading preferences in standing horses. In one study of elite performance horses, researchers revealed that animals with uneven feet typically retired earlier than those with even feet. In Hobbs’ study, her team evaluated 34 shod and unshod horses that came into the clinic for routine examinations. Thirteen of the horses had even feet, while 21 had uneven feet. The team used proximal and distal (top and bottom) markers on the dorsal hoof wall to measure differences between left and right hoof wall angles in the front feet. They classified horses with a difference in hoof angle of more than 1.5 degrees as having uneven feet. They also labeled feet as flat (less than 50 degrees), medium (50-55 degrees), or upright (more than 55 degrees).

The researchers set up infrared three-dimensional motion analysis cameras for gait analysis along a corridor lined with rubber mats placed over a force platform.
They also placed a cluster of markers along each horse's cannon bone and long pastern bone and on various points along the hooves to collect kinematic data, which they analyzed with 3-D software. Handlers trotted the horses down the corridor so the researchers could evaluate forces at the ground and lower limb movement.

The team also measured the following conformational parameters to see which were better predictors of foot unevenness:
1. Hoof area;
2. Hoof width;
3. Heel height (unloaded);
4. Hoof angle;
5. Long pastern length;
6. Long pastern inclination;
7. Cannon bone length; and
8. Fetlock angle.

Findings

The team found that, of these parameters, hoof angle was the best predictor of uneven feet, followed by unloaded heel height. Hoof width was not a good predictor of uneven feet, Hobbs said. They also determined that the difference in hoof angle between the two front feet had a greater effect on the results than the hoof angle of each individual foot.

“Hoof angle was the best predictor of uneven feet, followed by unloaded heel height.”

DR. SARAH JANE HOBBS

When comparing front feet measurements in the uneven horses, Hobbs discovered several differences in movement patterns and forces produced at the ground: In the limb with the flatter foot, braking force produced when the hoof was in contact with the ground was greater than braking force in the limb with the steeper foot. In the middle of the stride, when the body sinks to its lowest point, the fetlock joint sunk lower and the vertical force was greater in the limb with the flatter foot compared to the limb with the steeper foot. The fetlock sunk lowest before the force reached its maximum.

After this, the horse starts to rise up and push forward, and the point where the horse stops braking and starts pushing forward happened later in the limb with the flat foot. This was not because the flatter foot was on the ground longer than the steeper foot, Hobbs said; both hooves spent the same amount of time on the ground.

Because the fetlock sinks more with the flatter foot and before the vertical force reaches its maximum, the limb is less stiff during loading. This corresponds to the ‘mechanical lameness’ that veterinarians describe at the walk, where the flatter foot’s fetlock joint visibly sinks more. Because we can’t see this in the trot, researchers have suggested that the condition is not associated with pain or pathology (disease). Hobbs’ measurements, however, suggest this might not be the case. The difference was not visible, but the alteration in stiffness and the difference in maximum force might indicate that underlying pathologies do exist. Researchers should be able to confirm this in future studies.

The fact that the hooves were in contact with the ground for the same amount of time was not surprising to the investigators, as they graded the horses as sound at the trot. The differences in the timing of the force measurements relate to how big those forces are and where they are acting on the limb and body while the foot is on the ground. So, in the flatter-footed limb the force vector (the invisible arrow coming out of the ground that describes the total force and its direction) is greater and points more toward the tail for a longer time, which suggests the rear of the limb is loaded longer during each step. As the force vector moves toward the nose (as the limb goes from braking to pushing) there is less time on the ground for this to happen, so pushing forward and breakover occur quicker in this limb. The opposite occurs in the limb with the steeper foot. These differences load the limb’s internal structures differently, which is likely to influence the integrity of the hoof and limb tissues and also exacerbate changes in foot shape.

Take-Home Message

Horses with uneven feet experience different loading patterns during locomotion, which might be partly responsible for changes in foot shape along with habitual asymmetrical standing postures. It’s important to monitor these horses’ hooves, as asymmetrical feet could lead to lameness and possibly early retirement.