Teams of veterinarians and farriers from around the country gathered at the fifth International Conference on Laminitis and Diseases of the Foot in Monterey, Calif., Sept. 17-18, 2010, to discuss the most cutting-edge information available for the fight to conquer laminitis. This devastating hoof disease is caused by an inflammation of the horse’s laminae—interlocking leaflike tissues attaching the hoof to the coffin bone. The exact causes, treatment, and prevention methods are varied and often elusive, but the presenters featured at the conference provided more insight on topics such as diagnostic testing, management strategies, and the importance of nutrition, exercise, and hoof care for the laminitic horse.

Following are synopses of some of the conference presentations. Longer versions of these articles can be found on TheHorse.com.

**Preventing Laminitis in At-Risk Horses**

Even though veterinarians and farriers are making progress in developing laminitis treatment techniques and researching the causes of laminitis, prevention is still the No. 1 defense. Bob Agne, DVM, an equine podiatrist at Rood & Riddle Equine Hospital, in Lexington, Ky., discussed how to recognize individuals that are at risk for laminitis and how to manage them to reduce the risk of the disease.
Several pre-existing conditions can put a horse at risk for laminitis, Agne reported. He noted risk factors and preventive treatments for each, but he cautioned that every case is different.

**Equine Metabolic Syndrome (EMS)**
- Typical clinical signs: Easy keepers; overweight horses with creasy necks and discreet subcutaneous fat deposits; and high insulin and glucose levels.
- Possible laminitis prevention protocols: Restricted carbohydrate intake, controlled exercise, limited grazing during long hours of sunshine and cool temperatures, levothyroxine supplementation (for weight loss), glucose and insulin testing in spring and fall to check blood for a hyperinsulinemic state (high levels of the hormone insulin that predispose horses to laminitis), and metformin (an anti-diabetic drug) administration if insulin levels rise above 100 uU/mL.

**Cushing's Disease**
- Typical clinical signs: Cushing's disease is caused by a slow-growing, noninvasive tumor in the pituitary gland and typically only occurs in horses over 13 years of age. Unfortunately, laminitis is often the first clinical sign, which makes prevention challenging. These horses also exhibit rough, excessively long hair coats and can have high circulating levels of adrenocorticotropic hormone (ACTH). Affected horses can also have high levels of blood insulin and glucose.
- Possible laminitis prevention protocols: Annual ACTH, insulin, and glucose tests for horses over 13; pergolide medication for horses with high ACTH and hyperinsulemia/hyperglycemia or for horses showing excess body hair and laminitis; diet, exercise, and grazing protocols as per EMS; and metformin in some cases.

**Prior Bouts of Laminitis**
- Typical clinical signs: a distorted hoof capsule, stretched white line, and abnormal foot radiographs showing coffin bone rotation.
- Possible laminitis prevention protocols: Identify and address cause of previous bout, shoe and trim to encourage growth of the sole, and remain vigilant for the earliest signs of recurring laminitis. Additionally, yearly foot radiographs can help identify any changes in the hoof.

**Foot Infection and/or Inflammation**
- Typical clinical signs: Lameness, swelling, draining tracts, heat, and increased digital pulse are evidence of inflammation that can compromise lamellar tissue.
- Possible laminitis prevention protocols: Radiograph feet with chronic draining abscesses or horses whose comfort level doesn’t improve in a few days after abscess drainage. A contrast study of the area of infection called a fistulogram can be used to determine the extent of the damage. Addressing abscesses promptly and treating severe ones aggressively are important for preventing lamellar failure. Finally, protecting the wound to avoid reinfection and using a wedge heel and rocker-toe shoeing will help to reduce stress on dorsal laminae.

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**We’ve got to do a better job in terms of managing carbohydrate nutrition in high-risk horses.**

**DR. RAY J. GEOR**

**Contralateral Limb Laminitis**
- Cause: A non-weight-bearing lameness results in an increased risk of laminitis in the opposite foot. This is caused by reduced blood flow within the foot that is forced to bear all of the weight.
- Possible laminitis prevention protocols: Treat the underlying cause of the initial lameness as quickly as possible; use material to help support the contralateral foot, especially the frog and sole region; remove the shoe if the foot is long, the shoe is inappropriate, and/or lameness is unlikely to improve quickly; and elevate the heel. Finally, monitoring the foot frequently by assessing digital pulses, coronary band health, and venograms are all important for preventing and detecting contralateral limb laminitis.

If laminitis does occur, early intervention can help you minimize the disease’s effects. The more owners learn to recognize the warning signs of laminitis, the more quickly the disease can be treated and damage to the laminae can be minimized.

Owners, veterinarians, and farriers need to communicate with each other, said Agne, especially since early laminitis signs can be benign or camouflaged by another concurrent lameness. Farriers can be especially helpful because they are in a position to notice changes in the hoof at every shoeing or trimming.

“It’s really a team effort in trying to prevent this disease,” said Agne.

**Understanding Nutritional Risks in Laminitic Horses**

We might be feeding our horses too well, at least as far as predisposing them to laminitis. Ray J. Geor, BVSc, PhD, Dipl. ACVIM, professor and chair of the Department of Large Animal Clinical Sciences at Michigan State University, spoke about controlling nutritional risks in pre- and post-laminitic horses.

“All of us recognize that horses evolved to consume roughage,” said Geor. “Despite the fact that we’re all well aware of that, we tend to feed horses somewhat differently. We often feed them starch-based meals (cereal grains and sweet feeds, for example) or allow them to graze ‘improved pastures’ that are rich in sugars.”

Pastures designed for dairy cattle, for example, have a much higher carbohydrate content than is ideal for horses. Overconsumption of these types of feeds can lead to laminitis, especially in horses and ponies with equine metabolic syndrome. Changes in pasture, like those that occur in spring and fall when the water-soluble carbohydrate (WSC) and starch contents rise, pose the greatest risk for an episode of laminitis.

Consumption of pasture rich in WSC can markedly disturb the microbial population of the horse’s hindgut and trigger events that lead to the development of laminitis. Yet not all horses turned out on WSC-rich pasture will develop laminitis. Geor explained that horses and ponies with features of EMS appear to be more susceptible to laminitis under these conditions. Clinical signs of EMS include obesity and/or regional accumulations of excessive fat (e.g., a creasy neck) and insulin resistance. In these animals, exaggerated increases in blood insulin after feeding might contribute to laminitis.

“So the first step in lowering risk for laminitis is to identify these high-risk animals before they become a proverbial ‘train wreck,’” said Geor. “Secondly, we’ve got to do a better job in terms of managing carbohydrate nutrition in these high-risk horses and ponies.”

Geor listed three key concepts related to risk of nutrition-related laminitis:

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1. Substantial flow of rapidly fermentable carbohydrates (i.e., starch and WSC) to the hindgut can occur with grain feeding and pasture grazing under certain conditions, leading to changes to and instability of the microbial community living in the hindgut. Reduction in the size of grain and grain-based meals and restricted pasture access at certain times of the year can help reduce diet-associated disturbances in hindgut function.

2. Dietary starches and WSC markedly affect blood-insulin responses, and equids with EMS tend to have exaggerated responses. Very high blood insulin is one factor that contributes to development of laminitis in EMS animals.

3. Seasonal factors can modify the risk for nutritionally associated laminitis through effects on appetite, adipose (fat tissue) mass, insulin sensitivity, and the dynamics of blood insulin.

Geor said researchers are just beginning to recognize these seasonal risks. “Horses and ponies are seasonal animals,” he said. “They’re designed to gain weight during the summer and into the fall and to lose weight during the winter. The question remains whether or not our modern management techniques interrupt that natural, seasonal cycle and contribute to obesity, which then contributes to insulin resistance.”

Geor speculated that insulin-resistant animals might lack the flexibility to adapt to changes in dietary conditions (e.g., seasonal changes in pastures), and this plays a role in their susceptibility to laminitis.

He concluded his talk with the take-home messages that carbohydrate nutrition is strongly linked to laminitis risk, and that strict management of carbohydrate nutrition is indicated for equids with an insulin-resistant phenotype (i.e., EMS).

Platelets Might Play Early Role in Laminitis

Laminitis begins well before clinical signs occur, at the cellular or even the molecular level, and addressing platelets might be a key to prevention or early treatment. Inflammation is central to most cases of laminitis, and Jamie Textor, DVM, Dipl. ACVS, an equine surgeon and PhD candidate at the University of California, Davis, discussed cellular events that happen before that inflammation manifests itself in clinical signs.

“Early on, we’re talking about cellular events,” Textor said. “That’s going to be the best opportunity we have to intervene, by understanding the cellular processes and trying to target some of them before they become a vicious cycle.”

The components of laminitic inflammation at the cellular level are neutrophils, platelets, and monocytes. Textor focused on platelets because research indicates that they are inflammatory cells, are very sensitive to endotoxins, and might be the first responders in laminitis.

When platelets activate, they aggregate or clot and then change shape radically. They also contain and release vasoconstrictors, and that restriction of blood flow in the foot could lead to laminitis.

Textor cited a 1998 study showing that inhibiting platelets prevented laminitis in experimental setups. Subsequent studies have confirmed that platelet aggregation is an early indicator of laminitis.

“We’ve got a triple threat here,” said Textor. “We’ve got our platelets activating early, probably the very first response. We’ve
got the neutrophils (a type of white blood cell) getting activated. They start interacting with the endothelium (lining of blood vessels) and start to go across it (into the laminae). After that time, laminar breakdown begins.”

Knowing this sequence of events might allow veterinarians to develop therapeutic strategies. “We could prevent these cells from ever getting to (the laminae) or ever being activated,” said Textor. “We could block the things that they deliver—we could prevent the vasoconstrictors from doing their thing. Lasty, maybe we could enhance the protective mechanisms that tissue might already have in place.”

**Chronic Laminitis Can Increase the Risk of Foot Infection**

Because laminitis compromises the equine foot so drastically, horses with the disease are more prone to foot infections and abscesses. Agne discussed how to diagnose and treat such infections.

The structural damage that results from laminitis restricts blood flow to the foot, which makes infection more difficult to fight. Agne said the stretched and scarred white line in laminitic horses is particularly susceptible to infection.

“The scar tissue is moist and lacks normal blood flow and, consequently, is a prime medium for bacterial growth and infection,” Agne said.

Hoof infections threaten normal horses as well and usually present with the typical signs of inflammation, Agne said, which include lameness, swelling, heat, draining tracts, increased digital pulse, and/or possible evidence of hoof injuries.

When diagnosing foot infections, said Agne, determine whether they are superficial or also involve deeper structures. That allows a veterinarian to prescribe the best treatment plan and give an accurate prognosis. If the infection involves the coffin and/or navicular bone, coffin joint, tendon sheath, collateral cartilages, and/or navicular bursa, the prognosis will be more guarded. Penetrating wounds (such as nail punctures) are particularly dangerous.

“Evidence of a penetrating wound always carries the possibility of deep infection,” said Agne. "Penetrating wounds, especially in the caudal (rear) portion of the foot, are medical emergencies. If they are left untreated for over 12 hours, the prognosis for a return to soundness decreases significantly."

When an object penetrates the foot, owners often ask their vets if they should remove the object.

"Usually what I tell people is if there is any chance that the object can cause further damage—be driven up into sensitive structures—take it out," Agne said. "If you're absolutely sure it's not going to cause any more damage, you can leave it in until the veterinarian gets there."

The goals for treating foot infections, Agne said, should be to debride any dead tissue, maintain drainage, apply antibiotic therapy, provide protection, support the surrounding healthy tissue, and protect the contralateral (opposite left/right) foot from laminitis.

Of course, as with all equine health concerns, prevention is the best option. To reduce the chances of a horse getting a hoof infection, an owner should keep the horse on a regular trimming and shoeing schedule, pay close attention to hoof health, and maintain a safe and healthy environment.

**Equine Metabolic Syndrome and Laminitis**

As noted in an earlier presentation, horses with EMS are at a higher risk for laminitis than the average horse. Thomas J. Divers, DVM, Dipl. ACVIM, ACVECC, professor and chief of Large Animal Medicine at Cornell University, spoke about the correlation between EMS and laminitis and discussed the management of these cases.

Genetics, diet, and exercise are the three factors that can best determine a horse’s risk for EMS. Those that develop EMS are usually five to 15 years old, obese, and easy keepers (horses and ponies that maintain or gain weight on a minimum amount of food), often with a cresty neck. Divers said that the fat in the middle of the neck might contain inflammatory mediators, which could lead to insulin resistance (a feature of EMS where the body doesn’t respond properly to insulin, which is responsible for controlling glucose levels, which provide energy to cells). However, he also said it is not yet known which comes first, the obesity or the insulin resistance.

Divers noted that EMS is more common in breeds that once thrived in harsh conditions. These include ponies, donkeys, domesticated mustangs, Morgans, Norwegian Fjords, Paso Finos, Peruvian Pasos, Arabians, Warmbloods, American Saddlebreds, Andalusians, Tennessee Walking Horses, and Quarter Horses.

While researchers don’t yet know why EMS horses develop laminitis, they have several theories.

“One of those is systemic inflammation triggered by episodes of carbohydrate overload in the lower GI tract,” said Divers. “Another possibility is insulin toxicity. It’s possible that insulin affects the normal mitosis (cell division) of the laminae during hoof growth or has a detrimental effect on blood flow to the laminae. It’s also possible that increased insulin has an adverse effect on glucose regulation within the cells.”

Divers said that many early changes in the laminae in EMS horses might go undetected clinically. However, endocrine
testing of at-risk individuals can allow veterinarians to catch many cases before structural damage to the laminae occurs, get a better prognosis by identifying/treating cases earlier, and monitor responses to treatment.

Obese horses with abnormal fat deposits should be tested for insulin sensitivity early, Divers said, perhaps in March of their 4-year-old year before the warming weather triggers growth of rich grass. For those with borderline results, test again in April after exposure to more rapid growth of grasses.

Restricting diet along with increasing exercise can usually help prevent EMS, even in susceptible horses. Divers said that levothyroxine (a thyroid hormone) is currently the best medical treatment for EMS if diet and exercise alone don’t work. Metformin has been shown to work, but he noted that its effects can be erratic.

A recent study on the prognoses of horses and ponies with EMS and laminitis showed that an animal with previous laminitis episodes might not develop as severe clinical signs in a subsequent episode. Divers noted, however, that their long-term prognoses after repeated bouts of laminitis was worse than that those with only a single episode, confirming the importance of early detection and treatment of EMS and associated laminitis.

**Understanding Cushing’s Can Help Treat Cushing’s-Related Laminitis**

Because horses afflicted with equine Cushing’s disease often develop laminitis, advances in diagnosis and treatment of Cushing’s can help veterinarians better prevent and/or treat the laminitis that stems from it, explained Nora Grenager, VMD, Dipl. ACVIM, of the Steinbeck Country Equine Clinic, in Salinas, Calif.

Horses with Cushing’s (pituitary pars intermedia dysfunction or PPID) have an eightfold decrease in levels of dopamine (a hormone and neurotransmitter) and its metabolites (breakdown products) compared with nonafflicted horses of the same age. Grenager reported that this is most likely due to localized oxidative stress and noted that evidence is lacking that this decrease is caused by systemic inflammation or systemic oxidative stress. Other, less likely factors that have not yet been well-evaluated could include toxins or pesticides, genetic predisposition, chronic inflammation or abnormal systemic metabolism, and a diet lacking enough selenium or protein.

Cushing’s horses are frequently insulin-resistant, a condition that also can be a factor in non-Cushing’s-related laminitis cases. A simple blood test can often identify horses with insulin resistance. Part of the problem with Cushing’s is that it can be difficult to diagnose early because horses can present widely divergent clinical signs.

“The ones where we need help are the ones where (the diagnosis) is not so clear,” Grenager said. “The bad news is that we don’t yet have a great test for those horses. That’s what researchers are working on.”

Grenager discussed common Cushing’s tests, particularly the dexamethasone suppression test (DST) and the resting endogenous ACTH test. Veterinarians usually employ these tests in an attempt to diagnose horses that don’t show dramatic clinical Cushing’s signs.

While the DST can be effective, it requires two veterinary visits and administration
of steroids (which can on occasion trigger laminitis in susceptible horses). It also can give early false negatives and show seasonal variations (meaning the horse's response to the test will vary with season; false positives are more likely to occur when testing in late summer and fall). A combined DST/thyrotropin-releasing stimulation test might show fewer false positives, but it is a 24-hour test that requires four blood samples.

The ACTH test, another effective test, requires only one veterinary visit and no steroids. Veterinarians must handle samples very carefully, collecting them in plastic tubes because ACTH binds to glass, and separating and freezing them quickly.

Grenager likes the newer dopplerone stimulation test because it is a safe test that doesn't take long and has been shown to be more effective year-round, avoiding the seasonal variations in test results. It is more expensive, however, and its reliability is not yet well-documented.

Regarding Cushing's treatments, Grenager noted that pergolide is the most effective treatment, but it can be expensive; cyproheptadine is less expensive yet not as effective. She said that more studies are needed on both medications, and on newer medications that work on Cushing's in humans and could potentially be explored for use in horses.

Veterinarians usually prescribe specific diet and exercise regimens for Cushing's horses, which can help minimize the risk of laminitis. Grenager also recommended good hoof and dental care, routine fecal egg count testing (to monitor for parasites), and body clipping if medication is not controlling the long hair coat. She advised watching for clinical signs and diagnosing and treating affected horses as soon as possible to avoid Cushing's-associated laminitis.

**Venograms Can Catch Laminitis Early**

Proper blood flow to the laminae of the hoof is critical at all times, but especially when a horse develops laminitis. Diagnostic techniques that can reveal how blood is flowing—or not—can help veterinarians catch laminitis early. Amy Rucker, DVM, of Midwest Equine in Columbia, Mo., discussed the importance of digital venograms in diagnosing and treating laminitis during the Sept. 17-18 Laminitis West Conference, in Monterey, Calif.

When performing a venogram, a veterinarian puts a tourniquet on the fetlock, injects a contrast dye into a vein below the fetlock, then radiographs the foot. The venogram shows how well the blood is flowing, which a normal radiograph (often called an X ray) cannot do, and helps the veterinarian identify any areas with compromised blood flow.

Veterinarians can get similar results with MRIs, but many do not have MRIs in their practice. MRIs also are much more expensive than venograms. Rucker explained that, with practice, any veterinarian with radiograph equipment can perform venograms, which can help them diagnose laminitis early.

To illustrate the importance of venograms, Rucker described a horse that showed no clinical or radiographic signs of laminitis. However, the venogram detailed a severe case that Rucker said would become a "sinker," where the coffin bone sinks down and can penetrate the sole of the foot.

"Venograms really help us follow our cases," Rucker said, adding that the venogram findings guide her choice of treatment for each case. "I also use the venograms to assess if they're responding to treatment."

During the conference Rucker spoke to both clinicians and horse owners. She gave the clinicians tips on how to perform venograms, while she explained to horse owners how venograms can help them, their veterinarians, and their farriers determine the best way to shoe a horse with laminitis.

"The most common error that I see with [veterinarians] that perform venograms is they don't get a tight enough tourniquet," Rucker said. "I apply it at the widest part of the fetlock."

She recommended that veterinarians initially practice on a horse with healthy feet to learn the procedure, recognize the errors that come with inexperience, and learn how to avoid them.

"When you first start to do the venograms, you're going to have a lot of artifacts (misleading findings) that are caused by [improper technique]." Rucker said.

**Managing Insulin Resistance Through Diet and Exercise**

Insulin-resistant horses are prone to laminitis, but owners and veterinarians can often successfully manage them through strict diet and exercise regimens. Geor outlined some of those regimens.

"We've got two opportunities for intervention," said Geor. "First, we've got animals that we know have had laminitis and also show evidence of obesity and insulin resistance (also called equine metabolic syndrome, or EMS). Second, we may identify a horse or pony with clinical features of EMS, even though laminitis has yet to be detected—in both situations, the goal is to manage the obesity and insulin resistance so that episodes of laminitis are avoided."

In designing a diet and exercise program, Geor first stressed the importance of a thorough baseline clinical assessment. That includes not only checking body weight and body condition score and blood-insulin levels, but also evaluating the horse's current feeding program, its level of physical activity, and whether or not it is sound for exercise.

Set realistic goals for weight loss and develop a monitoring plan. Geor indicated that weight loss of 0.7-0.8% of initial body weight per week over a three- to four-month period is a realistic target. However, he also emphasized that there is wide variation in response between animals, and this target might be a little ambitious for some horses and ponies. So, every horse should be treated individually, he noted, and it is often necessary to adjust the feeding and exercise program based on responses measured over the first four to six weeks of a weight-loss program.

For weight loss, Geor recommended that the horse have no access to grain, treats, or uncontrolled pasture grazing. Hay or the equivalent is the diet cornerstone, initially fed at about 1.2% of body weight a day. Decrease the caloric content by feeding hay that was harvested at late maturity. Hay can also be soaked to reduce
its sugar content. A ration balancer that provides essential vitamins and minerals can be fed along with the hay, typically no more than 1-1.5 pounds a day.

Although there isn’t much data available yet from studies evaluating the effects of exercise in obese, insulin-resistant horses, Geor said that exercise most likely helps these animals. He emphasized that an exercise program must be combined with dietary restriction. However, “starting an exercise program in a horse or pony that has had a recent episode of laminitis is tricky because there is a risk of causing more damage to the feet,” he noted. Your veterinarian needs to give the all-clear, and the horse must be monitored closely.

Lastly, Geor recommended increased turnout for confined horses in a large dry lot along with structured exercise. Begin with light exercise, perhaps 10-15 minutes a day, three to four days a week. Be sure the horse works on a good (forgiving) surface, and monitor his feet carefully. Then gradually increase the frequency and duration if he is comfortable.

In-Shoe Force Measurements Help Farriers Address Hoof Balance

The concept of a balanced foot can be subjective, but farriers are now using technological advances to take some of the guesswork out of the process. Patrick T. Reilly, chief of farrier services at the University of Pennsylvania’s New Bolton Center, discussed evaluating hoof balance with in-shoe force measurements.

After volunteering to participate in a study on how the human foot hits the ground, Reilly experimented with using similar technology to measure how the equine foot lands when the horse moves across the ground. Researchers have already used force plates built into floors to measure forces between the shoe and the ground, but Reilly wanted to examine forces between the shoe and the hoof.

“If we put a shoe on, I really want to know what the effect of that shoe is going to be,” said Reilly. “How is that going to change the tendencies of the horse to land, to load?”

By cutting an F-scan mobile in-shoe force measuring system (designed to measure forces between foot and footwear) to the shape of a horse’s hoof and placing it between the hoof and the shoe, Reilly examined what the shoe does to the hoof. In this way, he explained, “We could see what the different shoes were going to do for us.
How is an egg-bar shoe going to transmit force to the foot differently than, say, an open-heeled shoe? This could be very important information in the mechanical treatments of problems such as quarter cracks or navicular syndrome.

In one case study, Reilly and his team examined the right front foot of an 18-year-old Quarter Horse mare that was pasture sound. Given her conformation and the way she walked, Reilly and his colleagues expected the center of force to be on the medial (inner) side of the foot at the walk. What they discovered was that she actually put more weight on the lateral (outer) side of the foot while moving.

They also found that horses change the loading patterns on their feet depending on gait. This mare exerted 65% of the force on the medial side and 35% on the lateral side while standing still. At the walk, those percentages reversed to 34% on the medial side and 66% on the lateral side, and at the trot, they evened up to 50-50.

With further tests on different subjects, Reilly was able to examine how a horse’s stride alters with a rider aboard. For example, the load on the left and right front feet will change at the trot depending on what diagonal the rider is on (the forces are greater on the sitting side).

This type of testing allows Reilly to experiment with different types of shoeing and observe how they adjust a horse’s way of going and the stresses on his feet. The resulting information could prove invaluable not only in approaching farrier care for sound horses, but also for horses with suboptimal conformation or soundness issues.

Using Force Measurements to Help Shoe Laminitic Horses

Corrective shoeing for laminitis doesn’t always work, despite veterinarians’ and farriers’ best efforts, and it’s not always clear why a particular shoeing job isn’t successful. In-shoe force measurements, however, can show the effects of shoeing on the foot, allowing for timely adjustments and improved treatments. Reilly explained the advantages of taking these measurements in laminitic horses.

There are a variety of opinions on how best to treat each individual laminitic horse, but, Reilly said, “There are two things that we seem to agree on universally in our mechanical goals (for laminitis). One goal is that we want to take some strain off of that lamellar interface—we want to try to protect that interface. Secondly, we want to protect the dorsal sole on the surface of the foot (the sole nearest the toe area, which is an area frequently traumatized as a result of laminitis).”

Reilly demonstrated how he was able to document the mechanical effects of a particular corrective shoeing treatment on the hoof using force measurements. At New Bolton, he and his colleagues have treated many horses at risk for laminitis (such as those with a serious injury in one limb, potentially overloading its opposite) with convex (arched) solar support. The idea is that putty on the bottom of the foot can help reduce weight bearing by the hoof wall, potentially relieving strain on the compromised lamellar interface. Subsequent force measurements showed that such treatment achieved this goal.

When one of New Bolton’s research horses, a 34-year-old Morgan mare, developed laminitis, Reilly used force measurements to investigate three ways to manage the dorsal hoof wall: Leaving the distorted wall extending over the front of the shoe, squaring off the dorsal hoof that extended over the shoe at a 45-degree angle, and blending the hoof wall from the shoe up to the coronary band. While one might not think that it would matter what you do with wall that’s not touching the shoe or the ground, Reilly explained that removing this wall seems to affect the structural integrity of the hoof capsule, which can affect other parts of the hoof as well.

First Reilly measured the force on the dorsal solar surface when leaving the wall in place. After he squared off the toe, the force on the dorsal solar surface rose, and it rose again after Reilly removed most of the distorted hoof wall. This suggests there is a possible benefit to leaving this wall to keep the hoof capsule strong and able to withstand the weight bearing and mechanical forces associated with even limited movement.

In a similar yet opposite case, Reilly reinforced the outside of a weakened hoof with a hoof repair fabric, and force measurements showed that this reinforcement reduced dorsal solar force.

Reilly noted that another hot topic in shoeing laminitic horses is where to place breakover (the forwardmost point of ground contact when the hoof is on the ground). Breakover is often manipulated to adjust the speed the foot “breaks over” during movement, and the forces required to do so, potentially affecting tendon tension and stress on various areas of the hoof. Reilly conducted a study on six sound horses to see the effect of changing breakover location on dorsal solar forces at the walk and trot. Although the statistical analysis is incomplete, he found that while there might be beneficial aspects to moving the breakover point back, there can also be consequences.

“I continue to move the breakover point back aggressively (in laminitic horses to reduce stress on the weakened laminae at the toe),” said Reilly. “What I’m cautious of is to try to find ways to protect that sole when I do.”

Reilly gave conference attendees two take-home messages: Keep the weight off the dorsal sole as much as possible; and externally reinforcing the hoof wall can often help achieve this goal.

How Hoof-Wall Resections Can Help Laminitis Cases

When laminitis develops to the point that the hoof wall restricts blood supply to the laminae, causing further inflammation, a hoof-wall resection might be needed. Rucker spoke about when to perform resections and methods that give veterinarians the best chance for success.

In some laminitis cases the distal (lower) rim of the coffin bone becomes septic...
(infected) due to compromised blood flow and dying tissues. Rucker explained that fluid resulting from this can travel up the lamellar interface, breaking out at the coronary band. If initial treatment, usually a poultice, doesn't stop the process, the coronary band will swell and prolapse over the hoof wall. The wall then cuts into the swollen tissue, causing further inflammation and restricting blood supply to that tissue.

Performing a resection—literally taking off part or all of the hoof wall—just below the coronet can relieve the pressure on the laminae and thereby allow the critical blood circulation to be restored. With meticulous aftercare, the foot's underlying tissues can then repair.

“You don’t want to let these cases get away from you,” Rucker said. At the first sign of coronary prolapse, she reevaluates her treatment and makes shoeing adjustments to change the loading pattern within the laminitic foot (a deep digital flexor tenotomy might also be considered; for more information, see Webinar: Laminitis Diagnosis and Treatment). She also medicates the coronary band twice daily with a poultice. Most cases respond in two to three days (drainage and swelling quickly resolve), but nonresponsive cases might require resections.

Rucker noted the following aspects of her hoof wall resection technique:

- She removes the desired portion of the wall by cutting through it in a gentle arch/smiley face pattern, extending that past the coronary band prolapse and down below the affected tissue. She slowly pulls the wall off, easing apart the coronary papillae and lamellae.
- After removing the portion of the wall, she checks the remaining wall to make certain no sharp edges remain.
- She evaluates the coronary and lamellar tissues for degree of compromise. Mild cases will have some swelling, but when the lamellae are gently massaged they begin to bleed (indicating the circulation has returned). Cases with moderate damage have unhealthy-looking coronary and lamellar tissue and may require more aggressive treatments such as application of platelet-rich plasma. Cases with long-term or severe damage may have devitalized tissue at the coronary band or lamellae, and the affected portion of the coffin bone might be evident. Any exposed septic bone can be cut away and packed with antibiotic-impregnated beads.
Rucker cuts a piece of felt to the size and shape of the resected wall, soaks it in Betadine, and bandages it tightly over the defect to minimize swelling. The bandage is changed daily, and new areas of epithelialization (growth of cells over the resected area) should be evident within a week. The defect should begin to cornify (harden) within seven to 10 days and will eventually grow out as new hoof wall grows down from the coronary band. If treatment is successful, the white line of the new wall will be visually indistinguishable from that of a normal horse.

Aftercare, especially keeping the foot tightly bandaged, is critical, Rucker said, as is aggressively treating cases at the first sign of swelling or drainage from the coronary band. Waiting too long for resorption results in irreversible damage to the tissue. The wall may grow back, but only have a weak attachment to the underlying lamellae and coffin bone. In addition, the new wall itself may be disorganized and weak, lacking tubular horn if its growth center at the coronary band is damaged.

“As with all cases of laminitis, the key to success is immediate treatment,” she said. “Feet with minimal bone damage that can establish a strong bone-lamellar-wall attachment recover and return to soundness, but owners must be patient as it takes a year for the feet to regrow. Owners must also address the underlying cause of laminitis. In our area of the country, that is often obesity combined with insulin resistance.”

Rehabilitating Chronically Laminitic Feet

How veterinarians and farriers manage the chronically laminitic foot can often determine whether that horse can live a useful, relatively pain-free life. Agne discussed how discussed how the Rood & Riddle podiatry team approaches such cases.

Agne first assesses the foot, noting whether the coffin bone is stable within the hoof. His treatment goals are to:

■ Address the underlying cause of the laminitis, if known;
■ Reestablish vascular perfusion (healthy blood flow) to the dorsal solar corium (the inner tissues from which the sole grows) to encourage sole growth;
■ Encourage healthy wall growth from the entire coronary band;
■ Protect and unload lesions; and
■ Treat any infections.

Agne recommended using radiographs to help farriers determine the proper trim for such horses. While many different types of shoes have been found to help achieve the therapeutic goals, Agne said that the type of shoe isn’t as important as finding the proper trim and establishing good therapeutic mechanics.

“It’s good not to get married to one shoeing system,” Agne said. “I can’t tell you how many times I’ve had a horse go just above the cast to be sure they don’t get pinched or develop a lesion.

If a horse has severe rotation of the coffin bone, penetration or imminent penetration of the sole, and unrelenting pain that doesn’t respond to therapeutic shoeing, Agne said a deep digital tendon tenotomy (cutting the deep digital flexor tendon that attaches on the bottom of the coffin bone) might be the only option to pursue with that horse. He will usually take a series of venograms (special radiographs that show the blood flow in the foot) to help him make that decision and to help monitor progress afterward.

“Case selection is really important,” said Agne. “With a tenotomy, we’re loading the back part of the foot.” Horses that have a weak heel structure or show evidence of medial and/or lateral displacement of the coffin bone have a poorer prognosis than those that have robust heel structure and no evidence of coffin bone sinking.

Secondary complications of a tenotomy can include seromas (swelling due to localized collections of serum) in the sole or separated laminae, coronary band lesions as a result of coffin bone sinking, infections, flexor tendon contracture, and problems within the foot resulting from temporarily reduced stability of the coffin bone including navicular bone fractures and coffin joint subluxation. Thus, following up with correct derotation shoeing to properly support the foot is critical, Agne said, as well as closely monitoring the patient.

Applying Laminitis Research to Clinical Practice

Divers spoke about how veterinarians are putting the whole picture together to help treat and prevent laminitis cases. He explained three reasons why applying results of research to actual cases is difficult:

1. Laminitis has several different causes, including EMS, systemic inflammatory disease (SID), Cushing’s, corticosteroid use, and uneven weight-bearing.
2. With SID, two different models are used in research to induce laminitis (carbohydrate overload and black walnut extract). Some differences exist in the pathophysiology of the disease in each model.
3. There are different stages of laminitis, all with different pathophysiologic
findings, making it more difficult to study disease mechanisms and target treatment.

In treating horses with conditions that could lead to laminitis, Divers has two goals: treating the primary disease and inhibiting the laminitis disease process in the hoof. He begins by treating the whole horse to control sepsis. He then works on the foot to prevent laminitis or provide treatment during the earliest stages.

Non-steroidal anti-inflammatory drug (NSAID) use is well-documented in alleviating many clinical signs associated with SID, but Divers said NSAID use is not as well-documented for efficacy in directly preventing laminitis. He added that the type and dose of NSAID prescribed depends on the primary disease causing the laminitis and the stage of the laminitis.

Divers outlined several other commonly used treatments: vasomotor-modifying drugs (which act to dilate or contract blood vessels in the hoof), enzyme inhibitors (which can slow certain chemical reactions in the tissues), inhibitors of neutrophils and platelets (mediators of endothelial inflammation), and antioxidants. More research into the efficacy of these is required, he noted.

One treatment that has been shown to work well to prevent laminitis in at-risk horses is cryotherapy (cold therapy). Lowering the temperature of the foot might decrease laminar inflammation by inhibiting destructive enzyme activity and oxidative reactions. It also decreases laminar metabolism, thus decreasing oxygen and nutrient requirements. Lastly, it might also decrease the delivery of blood-borne toxins that can trigger enzymatic destruction of the laminae.

“The problem is, by what practical method can cryotherapy be applied,” said Divers, “and how long do we do continue it during a systemic disease?”

Divers recommends that in conjunction with other therapies, veterinarians should employ cryotherapy to ice the feet of horses with systemic inflammation and endotoxemia for 24 hours past the point where the horse shows a normal heart rate, digital pulses, rectal temperature, and neutrophil morphology.

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