The role of nutritional therapy in the treatment of Equine Cushing's syndrome and laminitis. (Equine Cushing's/Laminitis).

Alternative Medicine Review; 9/1/2001; Ward, Madalyn

Abstract

Equine Cushing's syndrome, a relatively common and complex condition, is difficult to treat with conventional medicine. Cushing's syndrome involves a hyperplasia or adenoma of the anterior pituitary gland. Biochemical alterations include increased endogenous cortisol, insulin resistance, elevated adrenocorticotrophic hormone, and decreased thyroid hormone levels. Symptoms include hirsutism with no loss of the winter coat in summer, refractory laminitis, weight problems (over- or underweight), polyuria/polydipsia (Pu/Pd), frequent infections, lowered immunity to intestinal parasites, decreased intestinal wall integrity, and infertility.

Laminitis (an inflammation of the laminae of the foot) is a common and often fatal complication of Cushing's syndrome that tends to be refractory to conventional treatment. One of the most common therapies is phenylbutazone, a non-steroidal anti-inflammatory drug (NSAID) known to cause significant changes in the permeability of the intestinal wall. Recent research has shown an intestinal bacterial exotoxin to be one of the triggering factors in laminitis. By removing phenylbutazone and healing the intestinal wall, laminitis becomes more responsive to treatment.

Good hoof-care combined with nutritional management and the application of other modalities, including acupuncture and Chinese and Western herbs, can complete the healing process. The successful treatment of equine Cushing's syndrome is one of the best examples of treating a disease using the holistic approach. While each case requires different combinations of modalities, the outcome is usually positive with individually selected treatments.

(Altern Med Rev 2001;6 (Suppl):S4-S16)

Introduction

Cushing's syndrome is a frequent diagnosis in horses. It has been prevalent in the horse population for many years, but has generally gone unrecognized, partly due to unreliable diagnostic tests. Symptoms of Cushing's -- including unexplained cases of laminitis occurring in the winter or early spring, or hirsutism in older horses -- will often have been present for many years. It is the belief of the authors, however, as well as others, that incidence of the syndrome is increasing and the condition is being seen in younger

horses.

Laminitis is one of the more frustrating complications of Cushing's syndrome to treat in equine practice. Chronic cases can take a significant amount of time and energy, yet nonetheless yield unsatisfactory results. Natural medicine provides another avenue of treatment to assist practitioners in dealing with both acute and chronic cases. One of the major factors in healing the laminitic horse is to support intestinal health and repair the basement membrane of the intestinal tract. Pollitt's landmark work has shown that a bacterial exotoxin -- Streptococcus bovis -- has the capability to cause lamellar separation at the basement membrane of laminae of the foot. This bacteria is present in the horse's hindgut and could be released through the basement membrane. Assuming the basement membrane of the intestinal tract can be strengthened through the use of natural medicine, then less exotoxin should be absorbed from the intestinal tract.

The goal in natural treatment of Cushing's and Cushing's-based laminitis is to provide nutritional support to prevent and reverse damage from circulating free radicals, prevent further damage, encourage healthy laminar attachments, and return the horse's metabolism to its proper balance. When managed correctly, with patience and attention to detail, most chronic cases can return to reasonable work. The authors believe that even the most unresponsive cases can often be managed and kept relatively comfortable without the use of drugs.

When treating laminitis with natural medicine, it is essential that each case be approached individually. Furthermore, using multiple supplements or treatment modalities without careful evaluation can be detrimental. Refractory cases may require multiple therapies; however, these therapies should not be used contemporaneously.

Pathophysiology of Cushing's Syndrome

It has been thought that the aging horse normally gets pituitary adenomas of the pars intermedia. (2,3) However, there are conflicting reports in the literature as to the prevalence of the true adenoma. Some sources believe hyperplasia of the pars intermedia occurs more frequently than an actual adenoma. (4,5) Although adenomas and hyperplasia result in similar sets of symptoms, the hyperplasia, being a functional disturbance rather than a tumor, may be easier to treat.

The pars intermedia contains melanotropes, cells that normally use dopamine to process beta-endorphin hormones. (3) In the horse with Cushing's, dopamine is not present, so the melanotropes also produce a small amount of corticotrophin which stimulates glucocorticoid production by the adrenal cortex. The normal negative feedback to decrease corticotropin production does not work since melanotropes in the pars intermedia do not have glucocorticoid receptors. (6) Therefore, corticotropin release continues endlessly. The pars distalis, which does have glucocorticoid receptors, decreases its production of corticotropin. Normally the hypothalamus coordinates the activity of the pituitary gland through the secretion of peptides and amines. (7,8)

What causes Cushing's to occur is not known. Is it just a hyperplasia of the pars intermedia, or is it from loss of dopaminergic control by the hypothalamus? If the former,

what is causing the hyperplasia? One theory is that chronic stress affects dopamine secretion by the hypothalamus, causing a loss of control of the intermediate lobe and leading to the development of hyperplasia. (7) The answers to these questions have yet to be determined.

Clinical Signs of Cushing's Syndrome

The most important diagnostic tools for identifying Cushing's as the underlying cause of laminitis are the history and clinical signs. The history needs to be both complete and extensive. A thorough physical examination may reveal some of the less obvious signs, such as poor teeth and reproductive problems. The clinical signs most commonly associated with equine Cushing's syndrome are hirsutism (long hair that does not shed in the summer), (9) refractory laminitis, weight problems (over- or underweight), lethargy/poor performance, polyuria/polydipsia (Pu/Pd), and hyperhydrosis (Table 1). (10) Some horses will exhibit numerous symptoms while others will have very few.

One of the most serious complications of Cushing's syndrome is laminitis, often with no apparent cause derivable from either the history or the examination. (9,11) Commonly, some of the most refractory cases of Cushing's-based laminitis occur in the winter, an otherwise uncommon season for typical cases of laminitis. Even the more common summer laminitis, which would appear to be caused by overeating of grass, can be quite refractory to treatment, especially when other clinical signs of Cushing's are present.

Many horses diagnosed with Cushing's are overweight and are very easy keepers, sometimes unable to eat more than a small amount of hay each day because they gain weight so rapidly. In some cases, a horse that was a previously easy keeper suddenly starts requiring more food to maintain body weight. The overweight horse generally has a cresty neck and fat pads in specific places. (2,9) The fat pads are generally behind the shoulder blades, on each side of the tail, and in the lumbar area. In addition, the fat on its body is often visibly lumpy. Some horses will maintain their fat pads despite obvious weight loss.

Diabetes accompanied by Pu/Pd (9,12) is observed occasionally. (2,5) Pu/Pd can also be caused by compression of the pars nervosa by the enlarging pars intermedia, resulting in a decrease in antidiuretic hormone production. (5)

Frequent infections of the skin or other organs occur, (2,6) probably due to hypercortisolemia and hyperglycemia. (10-12) It is well known that increased levels of cortisol are immunosuppressive, and that diabetics are prone to infections due to the high levels of sugar in their blood.

A sluggish thyroid gland or thyroid dysfunction is common in horses; yet it has been difficult to associate clinical signs with laboratory findings. (13) Some of the conditions previously attributed to thyroid problems, such as muscle soreness, are also part of Cushing's syndrome. (15)

Colic, (9) typically low grade and/or recurrent, as well as poor teeth with multiple dental abnormalities, have been reported as clinical signs associated with Cushing's syndrome.

(5) The connection between Cushing's and colic and poor teeth is unclear; however, they may be representative of the general breakdown of the system.

The literature also indicates these horses have lowered immunity to intestinal parasites. (5,7) It is the hypothesis of the authors that Cushing's-based laminitis may be associated with poor integrity of the gut wall, since there is evidence of colic and poor immune system function in Cushing's horses.

Chinese Clinical Signs

When studying this disease from the Chinese medical perspective, there are several diagnoses for Cushing's syndrome (Table 2), including kidney (KI) yang deficiency, vacuum heat due to yin deficiency, and qi-yin deficiency. Many of the symptoms fit the classic signs of kidney yang deficiency, such as sore back muscles, weakness, lassitude, increased clear urine, stocking up in the legs, and infertility. (16,17) Chronic illness from other sources can lead to KI yang deficiency. Retention of dampness from spleen deficiency can affect the kidneys by obstructing the movement of fluids. Old age can contribute to KI yang deficiency, which can in turn affect the digestive tract and produce diarrhea. (18)

Infertility occurs frequently in Cushing's, possibly due to a disturbance of gonadotropin secretion in conjunction with the disturbance of the pars intermedia function. (7) Examining the problem from a Chinese perspective, kidney yang deficiency can give rise to infertility problems.

When there is recurrent laminitis concurrent with polyuria and polydipsia the pattern fits a vacuum heat due to yin deficiency. In addition to the laminitis, some of these horses may have respiratory symptoms with either a dry cough or difficult breathing, gastric ulcerations with abdominal discomfort, and a weak, sore lumbar area. (18)

A qi-yin deficiency may manifest with some of the symptoms of yin deficiency listed above, but it may also have digestive symptoms with a loose stool, more fatigue, recurrent upper respiratory infections, and infertility. (18)

Laboratory Diagnosis

Supporting laboratory evaluations can be helpful but also inconclusive in the Cushing's patient. (2,5,8) In equine practice single blood samples are taken whenever the practitioner is at the farm, so there is little standardization of the timing of the samples. Many parameters examined have diurnal variations and may change due to stress or other factors, including the amount of exercise a horse has had before the blood is drawn. Elevated blood cortisol can indicate high stress levels; but is the high cortisol attributable to the Cushing's or has the Cushing's come from chronic stress affecting the feedback system in the pituitary gland? Therefore, cortisol as a single sample is apparently an inaccurate test for Cushing's syndrome. (10,15)

While resting insulin level, (19) ACTH, (10,19,20) and glucose are sometimes utilized, a more useful diagnostic test is the ACTH-stimulation test. (21) A low-dose dexamethasone

suppression test (LDDS) is perhaps the most often used; (4,10) however, the authors avoid using LDDS as it further stresses the adrenals. Some horses with Cushing's have insulin-resistant hyperglycemia, which can be identified with a single insulin and glucose sample or an insulin/glucose tolerance test. (6,19,22,23)

A thyroid panel can be performed, although the single-sample test usually used in equine practice provides minimal information on thyroid function and rarely proves helpful. The single-sample thyroid test does not provide a true picture of thyroid function, as there is significant variation in thyroid levels, even in normal horses. (13) Many practitioners have diagnosed a Cushing's case as hypothyroid and have treated the horse for that malady instead of Cushing's, often without much change. (14)

Some new laboratory profiles are being offered that combine tests taken at various times during the day. These may be more accurate in positively diagnosing Cushing's syndrome, but additional research needs to be performed before these tests can be considered more accurate than those already available.

While performing other laboratory tests, a complete blood count is advisable to examine immune system status. Many horses seen in the authors' practices have low white blood cell (WBC) counts. The neutrophil and lymphocyte counts vary, with one or both contributing to the low WBC count. A chemistry screen is also advisable since some of these horses have a variety of metabolic problems associated with their condition, including liver disease and chronic infections.

Insulin Resistance

Many Cushing's horses have elevated blood insulin levels, (15) without concurrently raised or lowered glucose levels. (15,22,24) A relatively new condition is being recognized in human medicine -- currently called syndrome X or insulin resistance syndrome. (25) Syndrome X is a group of symptoms related to insulin resistance or hyperinsulinemia. (26) This syndrome is characterized by an inability to transport glucose into cells. Insulin resistance occurs in as much as 25 percent of the non-diabetic population. (27) Cushing's syndrome in horses has some of the same characteristics as syndrome X. (15,25,26,28) While some of the specific symptoms are different, the general seriousness of the metabolic derangements is very similar. In insulin resistance, the cell wall insulin receptors cannot transport glucose effectively. (29,30)

People susceptible to syndrome X are frequently from a genetic type considered "thrifty," (31) or in horse terms, "easy keepers." (32,33) In this type of individual, horse or human, the body is very efficient at storing fat for times of need, and in fact, if fed less they often become more efficient in storing fat. In humans much of the fat stored from impaired glucose metabolism is distributed centrally, especially around the abdomen, whereas horses store their fat in specific places, including fat pads on their bodies and cresty necks.

Human treatment of syndrome X using natural medicine incorporates many of the nutrients and botanicals used when treating Cushing's horses. The permeability of the cell wall to insulin is enhanced and nutrients are provided to help insulin and glucose

pathways function more efficiently. (27)

Conventional Medical Treatment

The accepted drug therapy for Cushing's syndrome and its related complications is pergolide mesylate. (5,11) Pergolide is an expensive, type-2 dopaminergic-receptor agonist that works on the melanotrope cells in the pituitary gland. The drug replaces dopamine, so it is generally given for life. However, horses have been successfully removed from the drug in the authors' experiences and, while the drug does seem to help for a period of time, it does not appear to be a permanent cure.

Cyproheptadine is a serotonin antagonist drug that seems to be partially effective and less expensive; but there is no real scientific basis for its use, as serotonin does not play a role in Cushing's. Therefore, the rationale for its use is based on anecdotal evidence, and most horses that do respond only appear to benefit for one or two years. (5)

The standard treatment for laminitis, as well as many of the other complications associated with Cushing's syndrome, is nonsteroidal anti-inflammatory drugs (NSAIDs) to relieve pain and decrease inflammation. In cases of laminitis, very high doses are used when the horse is in extreme pain. Other drugs used in laminitis cases to alter the circulation or reduce swelling include DMSO, nitroglycerine patches, isoxuprine, and heparin. Since many of these horses have chronic infections, high doses or repeated courses of antibiotics are used.

Intestinal Permeability and Its Relationship to Laminitis

The effects and toxicity of NSAIDs have been extensively studied in horses as well as humans. (34) One recent equine necropsy study showed inflamed small and large intestinal walls after 12 days of phenylbutazone administration. (35) This study compared the toxicity of several NSAIDs -- phenylbutazone, flunixin, and ketoprofen. Phenylbutazone caused edema in the small intestine, and erosions and ulcers in the large intestine. Phenylbutazone toxicity studies found hypoproteinemia and suspected protein-losing enteropathies in a majority of the horses studied. (36-38) While gastric ulcers in horses are common, their presence may be due in part to the use of phenylbutazone.

Pollitt's recent work indicates the potential involvement of a leaky basement membrane in the intestinal wall as part of the pathophysiology of carbohydrate overload laminitis. A leaky basement membrane can allow Streptococcus bovis to enter the bloodstream. This exotoxin is capable of melting the basement membrane of the laminae in the foot by increasing the activity of metalloproteinase enzymes (MMPs). (1,39) MMP-enzyme activity occurs during tissue remodeling in normal bones, joints, endometrium, and metastasizing tumors. In an in vitro model developed by Pollit, MMP activation induced lamellar separation. (1) Pollit studied the effects of a number of possible triggers that would stimulate MMP activity in the basement membrane and the suspected exotoxin was the only one having any effect.

Research has been conducted in human medicine on the involvement of a leaky intestinal tract basement membrane in the pathophysiology of numerous diseases. (40,411) In the

leaky bowel the basement membrane allows large molecules to pass through the portal circulation into the liver and form immune complexes which are then distributed to the joints and other locations in the body. (40) Bacteria and bacterial by-products are known to leak through the basement membrane. (41) It has been demonstrated that a single dose of endotoxin can increase intestinal permeability in humans. (42)

Human studies have linked "leaky gut" to various diseases, including arthritis, which is significant since NSAIDs are commonly used to treat arthritis in both human and animal populations. (38) Many horses receive phenylbutazone on a daily basis for weeks, months, or even years, potentially contributing to increased intestinal permeability.

The implications of the research are that high doses of NSAIDs could be detrimental to intestinal wall integrity, thus contributing to laminitis. Preliminary results from a well-established, human functional medicine testing laboratory support the hypothesis of poor intestinal function in some of the Cushing's and laminitis horses (Harman, unpublished data). Consequently, the use of NSAIDs in treating laminitis should be questioned.

Clinically, in the authors' experiences, discontinuation of NSAIDs is one of the most important aspects of the success of holistic treatment for laminitis. Symptoms are usually worse for three to five days after removing the NSAIDs, causing the horse to lie down more, which can be alarming to the owner and attending veterinarian. However, this is better for the horse, since lying down takes pressure off the feet and allows antioxidants to work. When the horse feels better with natural medicine it is because the horse is better, not because the pain is masked by a drug.

Repairing the Gastrointestinal Tract

The integrity of the gastrointestinal system is vital to preventing formation and release of exotoxins into systemic circulation. The authors have adapted many treatments that have been used successfully in humans.

The most important first step is to stabilize the intestinal wall and restore the beneficial flora. Antibiotic use leads to unbalanced intestinal flora that contributes to leaky bowel syndrome. (43,44) Probiotics may restore pH and gut flora to a healthier environment. Beneficial bacteria such as Enterococcus faecium, Lactobacillus acidophilus, L. casei, Bifidobacterium bifidum, and Streptococcus faecium are indigenous to the equine digestive system. These bacteria help maintain proper pH levels in the system, (45,46) manufacture vitamins such as biotin, and digest fiber. Supplementation using a variety of equine probiotics should be considered.

Glutamine is an amino acid that is a primary fuel for the enterocytes of the small intestine. Glutamine levels are affected by any decrease in feed intake, as well as by any stress placed on the intestine, such as sepsis or endotoxemia. (47) Glutamine has been shown to reduce bacterial translocation across the gut wall, (48) and should be considered in any horse not eating properly, and in any horse where intestinal wall integrity may be questionable. Doses range from 10 to 35 gm per day, depending on the size of the horse.

Processed grains and hays can lose key ingredients during manufacturing, since pellets

and extruded feeds are made at high temperature. In some cases, a horse has difficulty digesting processed feed. In the authors' experiences, however, horses fed plain grains gain weight and are healthier. Some horses digest food better when digestive enzymes are added.

The Aphanizomenon flos-aquae strain of blue-green algae is high in chlorophyll and antioxidant nutrients such as beta-carotene. It may also contain active digestive enzymes to provide concentrated nutrition to help support healing, without placing additional stress on the digestive tract.

Aloe vera is an herb that has shown clinical efficacy in treating side effects of NSAIDs. Its anti-inflammatory effects are possibly from its inhibitory action on the arachidonic acid pathway via cyclooxygenase inhibition. (49) Studies on wound healing suggest Aloe vera modulates glycosaminoglycan levels in the wound, a factor that may enhance the healing of the basement membrane.

Slippery elm bark is another nutritional herb that protects and aids in healing the intestinal wall. Although it has a mucilaginous effect that would appear to soothe the intestinal wall, there is only anecdotal evidence to support its use. (50)

Nutritional Treatment of Laminitis

Nutritional support is critical in the laminitic horse and includes the basics of feed, water, and hay, as well as the addition of specific nutrients. The nutrients discussed below are those the authors have found clinically useful.

Feed

Once the digestive system is supported, high quality nutrients should be provided. The nutritional requirements for a horse with laminitis appear to be higher than for a normal horse. In the authors' experiences, a horse with Cushing's-based laminitis requires a high-fiber, low-carbohydrate diet. Wheat bran can be added as a source of fiber, taking care to keep the calcium:phosphorus ratio in balance in the overall diet (for most situations a 1.1:1 to 1.2:1 Ca:P ratio). Blue-green algae can be added to bran to provide amino acids and trace minerals. Grass or other lower protein hays can be given free choice. Some horses can tolerate an alfalfa/grass hay, especially if more protein is needed. Generally, alfalfa should not be used alone and should not be fed to the very overweight horse.

The feed should be low in sugar if the horse has signs of Cushing's syndrome with either altered insulin levels or diabetes. Sweet feeds should be avoided. In humans, increased insulin levels can begin in childhood. (51) Equine Cushing's may begin during a horse's younger years as well. Most prepared diets for foals and young growing horses are extremely high in sugar. Although the connection between feeding high sugar diets and Cushing's syndrome has not been proven in horses, there is a strong connection in humans between a high-sugar diet and insulin resistance. (52)

When evaluating the feeding program, treats being given should be examined. Many owners feed treats high in sugar, including large quantities of apples and carrots. Plain

corn (25%), barley (35%), and oats (45%) makes a simple, clean grain mixture without sugar. Some of these grains may not be available or useable in certain parts of the country, depending on harvest situations. Some horses react poorly to eating oats; if that appears to be the case, barley and corn together are sufficient.

Higher levels of protein (up to 14%) and calories may be needed in underweight horses, but should not be fed to normal or overweight horses. (53,54) Cushing's horses that are normal weight or underweight often do well on senior diets, which are higher in protein and fat. Many chronic laminitis horses lose weight due to the stress of walking in pain, and actually need increased amounts of feed. The practitioner often restricts feed in a laminitic horse; however, some horses need extra calories to maintain normal physiologic functions. Increased calories can be given as fats (vegetable oils or rice bran) and are well digested by most horses. Increasing total calories with oils may be preferable to using high-protein feeds and hays.

It is important to supply high-quality supplements to help these horses heal. Prepared foods do not have all the vitamins needed by a sick animal. However, formulated supplements which contain low-quality vitamins and added fillers may actually cause the horse's system to become more out of balance. Food-source vitamin-mineral supplements include blue-green algae, kelp, apple cider vinegar, carrots, and oranges. Several companies manufacture additive-free equine supplements.

Antioxidants

Coenzyme Q10 (CoQ10) is useful in reversing free radical damage secondary to sepsis from an endotoxin overload. This is thought to occur with CoQ10 acting as an oxygen free radical scavenger, thus stabilizing mitochondrial membranes, and by inhibiting the arachidonic acid metabolic pathway and the formation of inflammatory prostaglandins. (55) Clinically, CoQ10 seems to be one of the best antioxidants for use in laminitis cases. Pain decreases rapidly when COQ10 is used without concurrent NSAIDs. The therapeutic dose is 300-600 mg per day for the first two weeks; then the dose can be decreased slowly to a maintenance dose of 100 mg per day.

Vitamin C is an excellent antioxidant that can regulate the phagocytic process in endotoxic shock, mainly by decreasing free radical production. (56) Vitamin C is also an important nutrient for collagen production and provides immune system support. Doses range from 3-8 g per day. Horses tolerate these doses well with few cases of diarrhea or stomach irritation.

Other antioxidant nutrients that may be useful are vitamin E, superoxide dismutase (SOD), and dimethylglycine (DMG). These antioxidants are generally used by the authors in the more refractory cases.

Minerals

One of the most important aspects of a nutritional program for horses is the use of free-choice minerals with salt fed separately. Many laminitis horses eat large quantities of minerals for extended periods of time, indicating their need for minerals. A commercial

salt-mineral block contains about 94-percent salt, so a horse that does not crave salt will not consume the amount of minerals it needs. The authors have observed horses consuming large quantities of minerals when provided mineral supplementation with salt fed separately.

Several key minerals are needed to help a Cushing's horse with glucose metabolism. Magnesium affects insulin secretion and insulin's action in the cell. Magnesium also helps the cell be more flexible and permeable to insulin. (57) Chromium increases the cell's sensitivity to insulin binding and glucose uptake. Chromium has been shown to be effective in reducing fasting blood sugar levels. (58,59) Vanadium or vanadyl sulfate has actual insulin-like effects on glucose metabolism, (60) helping transport glucose into the cell. (61)

Methyl sulfonyl methane (MSM) is a source of organic sulfur, an important component of disulfide bonds in the laminae. Disulfide bonds are key to connecting the hoof wall to healthy lamina. (62) Sulfur may be an important nutrient for these horses and can be fed free-choice or by controlled supplementation.

Essential Fatty Acids

Essential fatty acids are needed to make the cell wall more sensitive to insulin. (63,64) Omega-3 fatty acids are especially deficient in the human diet and may be deficient in the equine diet. Most high-fat equine foods use an animal fat high in saturated fats rather than vegetable oils. Flax and hemp oil provide palatable omega-3 fatty acids to the horse, although fish oils have an even better fatty acid profile. (63)

Chinese Medicine

Chinese medicine, both acupuncture and Chinese herbs, may be used successfully. The Chinese herbal formulas used are Rhemannia 14 (kidney yang deficiency), Mai Men Dong San (vacuum heat due to yin deficiency), and Rhemannia 11 (qi-yin deficiency), or other custom-tailored formulas as needed. These should be used with a correct Chinese diagnosis and, although there is not a large amount of research currently to support their use and inclusion in this review, clinical results have been very encouraging.

Other Treatments

The authors have used several other forms of complementary medicine when treating Cushing's cases, including homeopathy and glandulars. Inclusion is based on anecdotal support from clinical practice. Research on these treatments for laminitis is warranted.

The use of cold baths to cool the hoof has at times been advocated. In light of Pollitt's research, cold should be used regularly in the first 48 hours, especially in known grain overload or toxic case situations. (1) Table 3 summarizes a comprehensive approach to Cushing's/ laminitis.

Hoof Care

Damage to the hoof in laminitis cases can be kept at a minimum by following these guidelines:

1. Do not use drugs to mask the pain. If pain is masked, the horse will continue to walk on the damaged lamina and cause additional damage. Natural antioxidants will allow healing without masking the pain. A horse with severe laminitis should lie down to take weight off of the damaged legs.

2. Provide deep sand-bedding if possible, or use styrofoam taped to the bottom of the hoof (e.g., 2-inch thick, blue builder's styrofoam). Washed river sand will best shift under the horse's weight, allowing the horse to stand in the most comfortable position. It will also shift under pressure points to keep pressure sores to a minimum. A horse with tight tendons will often stand with its toes buried in the sand and its heels elevated. The way the horse stands in sand is a good indication as to how the horse should be shoed.

3. Keep hooves soft and pliable. Because the horse with laminitis generally has swelling within the hoof capsule, attaining soft hooves which expand to relieve pressure is desirable. If the hoof becomes too hard, a poultice can be applied overnight. Using a rasp to thin the hoof at the toe will also give relief.

4. Shorten the toe to ease breakover by setting the shoe back. A long toe acts like a lever and causes more tearing of the hoof lamina. The natural balance approach to trimming the foot in line with the coffin bone, then raising the heels and slowly lowering them to relieve the tendon pull with special shoes can be extremely beneficial. Natural balance trimming must be done correctly in order to work. If the farrier does not understand the principles, more damage can result.

5. Encourage abscesses to drain. The authors recommend avoiding the treating of abscesses with systemic antibiotics or anti-inflammatory drugs. Drugs may temporarily suppress maturation of an abscess, thus allowing it to spread deeper into the foot. An abscess is nature's way of debriding dead tissue from the damaged laminae, so it is important the abscess is allowed to drain. Soaking in Epsom salts or applying poultices will encourage the abscess to mature and open to the outside of the hoof. Rasping the hoof wall thinly at the toe will give the abscess a place to drain.

6. Avoid shoeing procedures when the feet are extremely sore. Horses with acute episodes have very sore feet; pulling shoes and hammering will cause extreme pain. If the toes are long, carefully remove the shoes and bed in deep sand. Toes can be rasped back more easily if the hoof has been softened with a poultice. Several pads are available which can be taped on to provide frog support or raise the heels.

Environment Influences on Cushing's Syndrome

Many horses are kept in high-stress situations that contribute to adrenal stimulation and cortisol release. Competition horses are often traveling to shows two to four days a week, living in trailers and stalls with little, if any, turnout time, and with heavy use of NSAIDs during competitions. If it is possible to decrease environmental stress, the horse will benefit greatly. While many of these horses may be past their high-stress years, and the

current owner may not be showing heavily or keeping the horse in a high-stress environment, nonetheless Cushing's syndrome is still a factor. These horses are experiencing the effects of a previous lifetime of stress, excessive drug use, and poor nutrition.

Pasture turn-out time is very important; however, many horses cannot be on rich pasture feeding without exacerbating their symptoms. Clients should be encouraged not to fertilize their fields or mow and manage them too carefully. Natural fertilization with trace minerals is a good practice; although, if grass becomes too rich from good organic practices, an overweight horse will result. A few weeds (herbs) are welcome. For many horses a "fat pen" will need to be built; i.e., a small outside area with minimal grass so the horse can be out in the sunshine and near its stable mates, but not have too much grass.

Conclusion

Cushing's syndrome in horses is a complex condition requiring a multifaceted approach to both diagnosing and treating successfully. Refractory laminitis is the most serious symptom the practitioner must treat. Successful treatment of Cushing's and associated laminitis requires using a sound foundation of nutrition, specific supplements, and other therapies as indicated. Each horse must be evaluated and treated on an individual basis to achieve the best outcome.

Table 1. Clinical Signs Associated with Cushing's Syndrome

Hirsutism
Not shed out in the summer
Hyperhydrosis
Refractory laminitis
Winter laminitis
Weight problems (over- or underweight)
Sluggish thyroid glands
Insulin resistance
Thyroid dysfunction
Muscle soreness
Diabetes
Polyuria/polydipsia (Pu/Pd)
Collagen breakdown
Poor hair coat
Frequent infections of the skin or other organs
Colic
Poor teeth
Multiple dental abnormalities
Lowered immunity to intestinal parasites
Altered intestinal function laboratory tests
Decreased intestinal wall integrity
Infertility
Muscle wasting

Table 2. Chinese Diagnostic Patterns Seen in Cushing's Syndrome

Kidney Yang Deficiency
Vacuum Heat due to Yin Deficiency
Qi-Yin Deficiency

Table 3. Summary of Treatments for Cushing's/Laminitis

Repair the gastrointestinal tract
Correct the feeding program
Supplement with antioxidants
Correct mineral and essential fatty acid deficiencies
Determine Chinese medicine diagnosis and approach
Determine homeopathic prescription
Correct hoof care

References

(1.) Pollitt C. Equine laminitis: A revised pathophysiology. Proceedings Am Assoc Eq Pract 1999;45:188-192.

(2.) Boujon CE, Bestetti GE, Meier HP, et al. Equine pituitary adenoma: a functional and morphological study. J Comp Pathol 1993;109:163-178.

(3.) Millington WR, Dybdal NO, Dawson R Jr, et al. Equine Cushing's disease: differential regulation of beta-endorphin processing in tumors of the intermediate pituitary. Endocrinology 1988;123:1598-1604.

(4.) Dybdal NO, Hargreaves KM, Madigan JE, et al. Diagnostic testing for pituitary pars intermedia dysfunction in horses. J Am Vet Med Assoc 1994;204:627-632.

(5.) Dybdal NO. Pituitary pars intermedia dysfunction (equine Cushing's-like disease). In: Robinson NE, ed. Current Therapy in Equine Medicine. Philadelphia, PA: WB Saunders; 1997:499-503.

(6.) Orth DN, Holscher MA, Wilson MG, et al. Equine Cushing's disease: plasma immunoreactive proopiolipomelanocortin peptide and cortisol levels basally and in response to diagnostic tests. Endocrinology 1982;110:1430-1441.

(7.) Greco D, Stabenfeldt GH. Endocrinology. In: Cunningham JG, ed. Textbook of Veterinary Physiology, Philadelphia, PA: WB Saunders; 1997:385-403.

(8.) van der Kolk JH. Diseases of the pituitary gland, including hyperadrenocorticism. In: Watson TD, ed. Metabolic and Endocrine Problems of the Horse. Philadelphia, PA: WB Saunders; 1998:41-59.

(9.) van der Kolk JH, Kalsbeek HC, van Garderen E, et al. Equine pituitary neoplasia: a clinical report of 21 cases (1990-1992). Vet Rec 1993;133:594-597.

(10.) Hillyer MH, Taylor FGR, Mair TS, et al. Diagnosis of hyperadrenocorticism in the horse. Equine Vet Edu 1992;4:131-134.

(11.) Love S. Equine Cushing's disease. Br Vet J 1993;149:139-153.

(12.) Heinrichs M, Baumgartner W, Capen CC. Immunocytochemical demonstration of proopiomelanocortin-derived peptides in pituitary adenomas of the pars intermedia in horses. Vet Pathol 1990;27:419-425.

(13.) Sojka JE, Johnson MA, Bottoms GD. Serum triiiodothyronine, total thyroxine, and free thyroxine concentrations in horses. Am J Vet Res 1993;54:52-55.

(14.) Messer NT, Riddle WT, Traub-Dargatz JL, et al. Thyroid hormone levels in thoroughbred broodmares and their foals at parturition. Am Assoc Equine Pract Proced 1998;44:248-251.

(15.) Beech J, Garcia M. Hormonal response to thyrotropin-releasing hormone in healthy horses and in horses with pituitary adenoma. Am J Vet Res 1985;46:1941-1943.

(16.) Xie H. Traditional Chinese Veterinary Medicine. Beijing, China: Beijing Agricultural University Press; 1994:255-287.

(17.) Maciocia G. The Foundations of Chinese Medicine. New York, NY: Churchill Livingstone: 1989:253-254.

(18.) Xie S. Chinese veterinary herbal training notes. Chi Institute of Chinese Medicine. 2000;19,74-75.

(19.) Garcia MC, Beech J. Equine intravenous glucose tolerance test: glucose and insulin responses of healthy horses fed grain or hay and of horses with pituitary adenoma. Am J Vet Res 1986;47:570-572.

(20.) Auer DE, Wilson RG, Groenendyk S, Filippich LJ. Glucose metabolism in a pony mare with a tumour of the pituitary gland pars intermedia. Aust Vet J 1987;64:379-382.

(21.) Allen JR, Barbee DD, Crisman MV. Diagnosis of equine pituitary tumors by computed tomography -- Part 1. Compend Contin Educ Pract Vet 1988;10:1103-1106.

(22.) Baker JR, Ritchie HE. Diabetes mellitus in the horse: a case report and review of the literature. Equine Vet J 1974;6:7-11.

(23.) Loeb WF, Capen CC, Johnson LE. Adenomas of the pars intermedia associated with hyperglycemia and glycosuria in two horses. Cornell Vet 1966;56:623-639.

(24.) Reed SM. Pituitary adenomas: equine Cushing's syndrome. In: Reed SM, Bayly WM,

eds. Equine Internal Medicine. Philadelphia, PA: WB Saunders Company; 1998:912-915.

(25.) Zavaroni I, Bonini L, Fantuzzi M, et al. Hyperinsulinaemia, obesity and syndrome X. J Int Med 1994;235:51-56.

(26.) Bogardus C, Lillioja D, Mott DM, et al. Relationship between degree of obesity and in vivo insulin action in man. Am J Physiol 1985;248:E286-E291.

(27.) Reaven GM. Pathophysiology of insulin resistance in human disease. Physiol Rev 1995;75:473-486.

(28.) Reaven GM. Banting lecture 1988. Role of insulin resistance in human disease. Diabetes 1988;37:1595-1607.

(29.) Adamo M, LeRoith D, Simon J, Roth J. Effect of altered nutritional states on insulin receptors. Annu Rev Nutr 1988;8:149-166.

(30.) Cline GW, Peterson KF, Krssak M, et al. Impaired glucose transport as a cause of decreased insulin-stimulated muscle glycogen synthesis in type 2 diabetes. N Engl J Med 1999;341:240-246.

(31.) Neel JV. The "thrifty genotype" in 1998. Nutr Rev 1999;57:S2-S9.

(32.) Coffman JR, Colles CM. Insulin tolerance in laminitic ponies. Can J Comp Med 1983;47:347-351.

(33.) Jeffcott LB, Field JR, McLean JG, O'Dea K. Glucose tolerance and insulin sensitivity in ponies and Standardbred horses. Equine Vet J 1986;18:97-101.

(34.) Bjamason I, Williams P, Smethurst P, et al. Effect of non-steroidal anti-inflammatory drugs and prostaglandins on the permeability of the human small intestine. Gut. 1986;27:1292-1297.

(35.) MacAllister CG, Morgan SJ, Borne AT, Pollet RA. Comparison of adverse effects of phenylbutazone, flunixen meglumine, and ketoprofen in horses. J Am Vet Med Assoc 1993;202:71-77.

(36.) Lees P, Creed RF, Gerring EE, et al. Biochemical and haematological effects of phenylbutazone in horses. Equine Vet J 1983;15:158-167.

(37.) Snow DH, Bogan JA, Douglas TA, Thompson H. Phenylbutazone toxicity in ponies. Vet Rec 1979;105:26-30.

(38.) Snow DH, Douglas TA, Thompson H, et al. Phenylbutazone toxicosis in equidae: a biochemical and pathophysiological study. Am J Vet Res 1981;42:1754-1759.

(39.) Pollitt CC, Daradka M. Equine laminitis basement membrane pathology: loss of type IV collagen, type VII collagen and laminin immunostaining. Equine Vet J Suppl. 1998 Sep;

(26):139-144.

(40.) Inman RD. Antigens, the gastrointestinal tract, and arthritis. Rheum Dis Clin North Am 1991;17:309-321.

(41.) Wells CL, Jechoreck RP, Gillingham KJ. Relative contributions of host and microbial factors in bacterial translocation. Arch Surg 1991;126:247-252.

(42.) O'Dwyer ST, Michie HR, Ziegler TR, et al. A single dose of endotoxin increases intestinal permeability in healthy humans. Arch Surg 1988;123:1459-1464.

(43.) Darlington LG. Dietary therapy for arthritis. Rheum Dis Clin North Am 1991;17:273-285.

(44.) Schmidt MA, Smith LH, Sehnert, KW. Beyond Antibiotics. Berkley, CA: Noah Atlantic Books; 1993.

(45.) Clarke LL, Roberts MC, Argenzio RA. Feeding and digestive problems in horses. Physiologic responses to a concentrated meal. Vet Clin North Am Equine Pract 1990;6:433-450.

(46.) Moore JN, Garner HE, Berg JN, Sprouse RF. Intracecal endotoxin and lactate during the onset of equine laminitis: a preliminary report. Am J Vet Res 1979;40:722-723.

(47.) Souba WW, Herskowitz K, Klimberg VS, et al. The effects of sepsis and endotoxemia on gut glutamine metabolism. Ann Surg 1990;211:543-549.

(48.) Souba WW, Klimberg VS, Hautamaki RD, et al. Oral glutamine reduces bacterial translocation following abdominal radiation. J Surg Res 1990;48:1-5.

(49.) Vazquez B, Avila G, Segura D, Escalante B. Antiinflammatory activity of extracts from Aloe vera gel. J Ethnopharmacol 1996;55:69-75.

(50.) Physicians Desk Reference for Herbal Medicines. Montvale, NJ: Medical Economics Company; 1999:1196.

(51.) Barnard R, Ugianskis EJ, Martin DA, Inkeles SB. Role of diet and exercise in the management of hyperinsulinemia and associated atherosclerotic risk factors. Am J Cardiol 1992;69:440-444.

(52.) Garg A, Bantle JP, Henry RR, et al. Effects of varying carbohydrate content of diet in patients with non-insulin-dependent diabetes mellitus. JAMA 1994;271:1421-1428.

(53.) Glade MJ, et al. Dietary protein in excess of requirements inhibits renal calcium and phosphorus in young horses. Nutr Res Intern 1985;31:649-660.

(54.) Miller-Graber PA, Lawrence LM, Foreman JH, et al. Dietary protein level and energy metabolism during treadmill exercise in horses. J Nutr 1991;121:1462-1469.

(55.) Lelli JL, Drongowski RA, Gastman B, et al. Effects of coenzyme Q10 on the mediator cascade of sepsis. Circ Shock 1993;39:178-187.

(56.) Victor VV, Guayerbas N, Puerto M, et al. Ascorbic acid modulates in vitro the function of macrophages from mice with endotoxic shock. Immunopharmacology 2000;46:89-101.

(57.) Paolisso G, Sgambato S, Gambardella A, et al. Daily magnesium supplements improve glucose handling in elderly subjects. Am J Clin Nut 1992;55:1161-1167.

(58.) Linday LA. Trivalent chromium and the diabetes prevention program. Med Hypotheses 1997;49:47-49.

(59.) Evans GW, Bowman TD. Chromium picolinate increases membrane fluidity and rate of insulin internalization. J Inorg Biochem 1992;46:243-250.

(60.) French RJ, Jones PJ. Role of vanadium in nutrition: metabolism, essentiality and dietary considerations. Life Sci 1993;52:339-346.

(61.) Shechter Y, Li J, Meyerovitch J, et al. Insulin-like actions of vanadate are mediated in an insulin-receptor-independent manner via non-receptor protein tyrosine kinases and protein phosphotyrosine phosphatases. Mol Cell Biochem 1995; 153:39-47.

(62.) Grosenbaugh DA, Hood DM. Keratin and associated proteins of the equine hoof wall. Am J Vet Res 1992;53:1859-1863.

(63.) McCarty MF. Complementary measures for promoting insulin sensitivity in skeletal muscle. Med Hypotheses 1998;51:451-464.

(64.) Gerbi A, Maixent JM, Ansaldi JL, et al. Fish oil supplementation prevents diabetes-induced nerve conduction velocity and neuroanatomical changes in rats. J Nutr 1999;129:207-213.

Joyce Harman, DVM, CVA -- is owner of Harmany Equine Clinic, Ltd, in Washington, Virginia, a holistic equine practice incorporating acupuncture, chiropractic, homeopathy, herbs, nutrition, and saddle fitting. She is past president of the American Holistic Veterinary Medical Association.

Correspondence address: Harmany Equine Clinic, Ltd., Washington, VA 22747

Madalyn Ward, DVM, CVA -- graduated from Texan A & M University in 1980. She is certified in veterinary homeopathy, acupuncture, and chiropractic. She is owner of Bear Creek Veterinary Clinic in Austin, Texas.