Maintaining Soundness in the Performance Horse

Tracy A. Turner, DVM, MS, Dipl.ACVS
Anoka Equine Veterinary Services

Most horses have more than one problem, so it is advisable to examine the entire horse. After collecting the history, the examination should begin with observation of the horse from a short distance, noting any asymmetry (e.g., swelling, muscle atrophy) and the horse's general, conformation. Each limb should then be thoroughly examined, while bearing weight and while lifted and the neck and back carefully palpated. Important observations include swelling, pain, and altered range of motion.

GAIT EVALUATION

Gait evaluation should be performed on a firm, flat surface. Assessment of the horse’s gait is made at the walk and trot; "while the horse is moving toward, away from, and past, the examiner. The horse should also be observed while the horse is worked in a circle. Observations include gross and fine limb movements, foot strike and balance, as well as, length and height of foot flight, and abnormal head movements, (e.g., head bob) or excursions down a hill, worked on different, surfaces, and ridden or driven.

Manipulative Tests

Manipulative tests involve flexing a joint or applying pressure to a particular area (e.g., hoof, suspensory, apparatus) for about 30 seconds to 1 minute before releasing the limb and trotting the
horse for 20 to 30 yards. For accurate interpretation all four limbs should be evaluated, beginning with the least affected, or apparently normal limb(s).

**SERUM BIOCHEMISTRY Muscle Enzymes** Assessment of muscle disorders often involves measurement of serum activities of muscle-specific enzymes: creatine kinase a sensitive indicator of myonecrosis. Serum CK peaks within about 6 hours of muscle insult; its serum half-life is 1 to 2 days. Limited elevations may accompany training, transport, and strenuous exercise. Moderate to extreme elevations (sometimes >100,000 IU/L) can occur with exertional rhabdomyolysis or nutritional muscular dystrophy. If a delay of > 12 hours is anticipated before analysis, the serum sample should be frozen.

Muscle injuries are uncommonly documented as a cause of lameness in the horse. Fibrotic myopathy, stringhalt, and ruptured peroneus tertius are among the only muscle injuries reported in the horse (Turner 1987). These lamenesses are usually characterized by the resultant gait abnormalities. Other muscle problems such as stress tetany, synchronous diaphragmatic flutter, exhaustion, post exercise fatigue, tying-up (exertional rhabdomyolysis), and azoturia are regarded as specific physiologic disturbances (Hodgson 1985, Jones 1989). Muscle injuries frequently cause lameness in human athletes and racing greyhounds. Similar injuries therefore would be expected in the horse.

Factors which predispose to muscle strains include cold temperatures or impaired circulation to the muscle, local or generalized muscle fatigue, poor or insufficient training, and insufficient warm-up (Krejci 1979). Cold has been shown to increase muscle tension and cause circulatory disturbances. This phenomenon causes earlier muscle fatigue which can lead to uncoordinated muscle movement and strain. Fatigue predisposes to injury in two ways. First, muscle fatigue is a manifestation of general fatigue which affects those groups that are maximally loaded. As
muscles fatigue they decrease in performance and elasticity thus enhancing the likelihood of strain. Further general fatigue results in central nervous system incoordination of movement and predisposition to strain. Therefore, training must be designed to progressively increase the work load to develop the muscle groups, and to decrease early fatigue and permit rapid restoration of muscle function after exertion. Insufficient warm-up of muscles prior to exercise results in decreased circulation and lowered capacity to eliminate muscle waste products. Both these factors decrease the muscle's ability to sustain maximal performance.

The equine athlete is exposed to these predisposing factors on a routine basis. Hypothetically, if the horse suffers muscle strains, these injuries would most likely be manifested as lameness. The difficulty for the veterinarian is the positive diagnosis of these injuries. In human medicine, the athlete's description of the pain location is often the single most important factor in diagnosis (Krejci 1979). This diagnostic aid is obviously lacking in veterinary medicine. Many of these cases probably go undiagnosed in equine medicine because they cannot be confirmed by commonly used diagnostic methods such as radiographs and nerve blocks. As such, these lamenesses are most likely treated empirically with various combinations of rest, analgesics, and anti-inflammatory agents.

Thermography is the pictorial representation of the surface temperature of an object (Purohit 1980, Turner 1986). It is a non-invasive technique that measures emitted heat. A medical thermogram represents the surface temperatures of skin making thermography useful for the detection of inflammation. Although thermographic images measure only skin temperature, they
also reflect alterations in circulation of deeper tissues. This ability to non-invasively assess inflammatory change, makes thermography an ideal imaging tool to aid in the diagnosis of certain lameness conditions in the horse. The purpose of this paper is to describe the thermographic patterns associated with upper hindlimb lameness that could not be explained by joint or skeletal problems.

Records from 565 cases of upper limb lameness presented from 1986 through 1995 to the University of Florida, Rochester Equine Clinic, and the University of Minnesota were used to characterize the various thermographic patterns associated with upper hindlimb lameness not associated with joint or skeletal problems of the horse. The chief client complaint in each case was either lameness or gait abnormality. In each case, notations were made as to the horse's age, breed, sex, and use. The degree of lameness and limb(s) involved in each case were recorded. Lameness was evaluated on the AAEP grading system. Further information that was collected was the characterization of the horse's gait, response to flexion tests, areas of pain detected by palpation, thermographic abnormalities, diagnosis, and treatment. For the purposes of this manuscript only the thermographic results are presented with a summary of clinical signs. Three different types of thermographic cameras were used to collect the information: an Agema 870, an Inframetrics 520, and a Flir IQ325.

Thermographic lesions were defined as those with a one degree centigrade disparity in temperature. These disparities could consist of an increase or a decrease in temperature. Increases in temperature were suggestive of vasodilation associated with inflammation, whereas
decreases in temperature were indicative of either chronic scarring and reduced circulation or local edema, swelling, and vascular stasis due to severe inflammation.

On the basis of the thermographic and clinical findings, the horse's injury could be further categorized as one of three types of muscle injury: cranial thigh, caudal thigh, and croup region. The cranial thigh muscle injuries included injuries where the thermographic abnormality was over the quadriceps musculature, the caudal thigh myopathy which included those cases in which the primary thermographic abnormalities were located over the caudal thigh from the sacrum to the gaskin, and the croup myopathy which included cases shown thermographically to have inflammation involving the caudal loin, sacroiliac region, and hip.

In the upper hindlimb of the horse significant thermal changes were identified as either hot spots or cold spots, reflecting the presence or absence of swelling in the damaged tissue. The thermographic image was very useful in localizing the area of injury but did not characterize the specific nature or etiology of the injury. The most frequent hindlimb problems noted thermographically were noted over muscles. It is author's opinion that this may represent either muscle strains or muscle inflammation. In the cranial thigh, distinct hot spots were associated with the quadriceps musculature just proximal to the insertion on the patella. Many of the cases were presented for possible patella problems because of the prominence and slight lateral deviation of the patella. In each case, ultrasonography of the region of the "hot spot" revealed disruption of normal muscle fibers and varying sizes of hypoechogenicity typical of hemorrhage.
The caudal thigh thermography showed several common areas of abnormal heat: The most common was at the musculotendinous junction of the semitendinosus muscle. These horses typically presented with the hoof slap gait typical of fibrotic myopathy. Sonography of these cases revealed 2 different types of change, a hyperechogenicity thought to be early fibrosis and a disruption of normal muscle/tendon patterns with focal hypoechogenic areas suggesting tearing of the musculotendinous junction. A third area of abnormal thermal patterns was commonly seen in the caudal thigh, just caudal to the third trochanter of the femur directly over the biceps femoris. These horses typically presented with grade III/V lame or worse and there was intense pain associated with pressure over this region. The thermal changes noted were both a hot spot and an intense cold spot. We have not correlated any sonographic findings with this injury to date. However, this is the same region that has been noted on soft tissue scintigraphy and thought to be a site of focal muscle injury (Morris 1991).

The croup area injuries involved hot spots over the loin region, over the sacroiliac region, over the body of the gluteal muscle, and over the third trochanter. These horses usually presented with more subtle and more variable lameness. The owners/riders complained frequently that the horse was sore in their backs or stifles. The horses typically traveled short behind, had poor acceptance of the bit, and tended to move in a "hollow" manner. Many of the horses were not lame at the time of examination but did have a history of lameness of gait problems. The remainder of the horses were grade 1 to 3 of 5 lame. Horses affected by croup muscle pain were less lame than horses with caudal thigh myopathy. No consistent sonographic findings were found in these cases, however evidence of fasciitis was seen on muscle biopsy of one case.
Specific notations were made in the records as to gait abnormality. These notations included stiffness (loss of flexion), toe dragging, shortness of stride, hoof slap, and 'hip hike' or hitch. Horses with croup muscle pain were more likely to exhibit stiffness, toe dragging or short striding. The horses in the caudal thigh muscle injury group were more likely to show a 'hip hike' or hoof slap. The cranial thigh muscle injuries usually presented with an acute lameness of grade 3 of 5. The lameness usually improved within one week but each case was characterized by a prominent patella and outward rotation of the stifle.

Flexion of the hindlimbs rarely exacerbated the lameness in any of these cases. However, most horses did have a palpable area of pain over the muscles of the hindlimb. The area of pain corresponded to the abnormal area(s) noted during thermographic evaluation in about two-thirds of the cases. The horses were either not lame or were grade 1 lame were the least likely to show areas of palpable pain; thermography generally indicated the area of pain in 50% of these horses. Horses that were more lame were most likely to exhibit an area of palpable pain which corresponded to the thermographic lesion(s), correlated in over 90% of the cases.

Metabolic muscle diseases have been well described in the horse (Hodgson 1985, Jones 1989). The effects of these diseases on performance are well known. Generally, fatigue or metabolic disturbances have been the underlying cause of the muscle dysfunction (Jones 1989). These diseases can be documented by serum electrolyte and tissue enzyme disturbances, electromyography, and muscle biopsy (Hodgson). Muscle strain cannot be as easily diagnosed.
Serum levels of muscle enzymes will be elevated only if there has been actual tearing of muscle tissue; the extent of the enzyme elevation would depend on the amount of muscle tissue damage (Krejci 1979). The ability of electromyography to diagnose muscle strain has been equivocal in human medicine. These types of muscle injuries in the horse have rarely been described (Turner 1989). This is probably due to the difficulty in documenting the injury with objective data. However, there is no reason to believe that these types of injuries do not occur in the horse (Jeffcott 1981). Thermography may have its greatest clinical application in the assessment of individual muscle injuries which are difficult to diagnose (Turner 1989). Even though serum muscle enzyme elevation may non-specifically indicate muscle damage, the specific muscle or muscles damaged may be difficult to identify. Thermography offers two types of information important in the evaluation of muscle injury: first it can locate an area of inflammation associated with a muscle or muscle group; and second is that it illustrates atrophy well before it becomes apparent clinically.

Muscle inflammation will be most commonly seen thermographically as a "hot spot" in the skin directly overlying the affected muscle (Turner 1989). On a rare occasion, swelling and edema in the affected muscle will be severe enough to inhibit blood flow through the muscle. In this case the injured muscle will be seen thermographically as a "cold spot". Thermographic evaluation of muscle must be made from paired samples, that is comparison of the right and left sides. These comparison images should be nearly identical. Consistent variations from side to side would indicate muscle damage located at either the "hot" or "cold spot".
The most common cause of muscle inflammation is muscle strain (Krejci). A classification of first, second or third degree strain injuries, described in human athletes, has been applied to horses (Turner 1989). In this study we were able to discern three major areas of injury. One, the croup myopathy, involved inflammation over the areas of the longissimus lumborum m., gluteus medius m., gluteus profundus m., the sacroiliac joint, and the gluteal insertions on the greater trochanter and associated fascia. The analogous regions in man would constitute the lower back and hip. The second, the caudal thigh myopathy, involved the areas over the biceps femoris m., the semitendinosus m., the semimembranosus m., and their origins and their upper limb insertions and musculotendinous attachments. The third, the cranial thigh injury, constitutes damage to the quadriceps and tensor fascia lata.

A gluteal tendon lameness has been described in the horse; the major clinical sign was pain around the greater trochanter (Pearson 1986). There have been numerous reports of the effect of lumbar and sacroiliac pain leading to lameness (Jeffcott 1975, Jeffcott 1981, Jeffcott 1985). For the cases reported here we chose to place all these problems in one of three categories because, although physical examination revealed soft tissue pain and imaging of the areas by thermographic examination confirmed the location of lesion(s), these methods could not specifically identify the structures involved. Thermography only reflects problems of deeper tissues, i.e., it indicates the area of disease but does not reveal any information as to the nature of the organic damage. We grouped these problems together because of their close anatomical location and similar effects on the horse's gait (Dyce 1987).
Muscle injuries in the horse have been described as ranging from loss of performance to pain created by a particular movement to overt lameness (Meagher 1985). The wide range of degree of lameness in these cases supports this observation. The cases presented in this report indicate that the caudal thigh myopathy was more likely to cause severe lameness than the cranial thigh or croup muscle injuries. The caudal thigh muscles may be more likely to tear, and tears in this group of muscles have been documented (Turner 1984). Fibrotic myopathy, a condition of the horse that involves the semitendinosus muscle and occasionally the semimembranosus and biceps femoris muscles, is thought to originate from trauma to the musculotendinous junction. Another possible reason for the greater pain associated with these injuries is the complex actions of these muscles (Dyce 1987). This group of muscles extends the hip, flexes the stifle, and extends the hock. Because of the action of the horse's reciprocal apparatus all three functions cannot occur simultaneously unless muscle contraction is coordinated. Hypothetically, if an injury occurred, the horse should have pain each time the leg was extended because stifle extension would exert a direct opposing force on the caudal thigh muscles as they contract for hip and hock extension.

Pain on palpation was probably the single most important physical evidence of injury. Pain elicited by palpation should be repeatable, but care should be taken not to overdo palpation which may result in the horse "guarding" the injury and thus not responding. We found that firm pressure was more reliable than squeezing muscle masses when trying to differentiate pain from simple annoyance. Stress points have been described that help point to lesions of these muscles.
(Meagher 1985). Stress points are the points where the greatest stress produced by movement occurs.

Thermography was used in these cases as a diagnostic tool. In each case, information from thermography was important in the rendering of a diagnosis. Thermography has been shown to be a practical aid in the clinical evaluation of lameness. This modality specifically increases the accuracy of diagnosis by confirming inflammation in palpably sore areas and by showing the area to concentrate further diagnostic testing such as, sonography, radiography, or muscle biopsy. Clinically, thermography also improves therapy. Once the area of inflammation is determined physical therapy can be applied directly to that area. In this fashion therapeutic ultrasound, massage, or other treatment is applied more specifically to the inflamed area. Further, thermography can be used to monitor the resolution of the inflammatory process.

**Integrating Imaging in Diagnosing Equine Lameness**

There are several different methods of imaging the equine digit. Imaging is of utmost importance because it will provide pathologic and physiologic information necessary to treat the specific condition. Imaging can be divided into anatomic and physiologic imaging methods. Anatomic imaging modalities include radiology, ultrasonography, computer-aided tomography, and magnetic resonance imaging. Physiologic imaging modalities include scintigraphy and thermography.

Radiologic techniques are the most commonly used to evaluate the horse for lameness. Utilizing plain film radiography, it requires multiple projections to evaluate any area. Essentially the practitioner must attempt to draw conclusions about a three dimensional object utilizing 2
dimensional pictures. Occasionally it becomes necessary to utilize radiographic techniques that provide more information. Contrast radiography is one such technique that provides information about the articular cartilage and surfaces. It is of particular value in determining whether subchondral cysts communicate with the joint or in delineating a subcutaneous tract. Generally, 5 to 10 ml of contrast injected into the joint is adequate. Pathologic diagnoses are usually made by radiography in conjunction with clinical examination.

Ultrasonographic examination can be used to assess any soft tissue in the horse's body. The deeper the tissue that needs to be evaluated the lower wavelength probe needs to be used. The tissues are examined for changes in echogenicity. Changes in echogenicity correspond to changes in the tissue. Ultrasonography is most useful in the evaluation of tendons and ligaments but it also can be used to evaluate muscle and cartilage.

Magnetic resonance imaging and computer-aided tomography are both interesting and high detail anatomic imaging tools. However, at this time they are of little value to the practicing veterinarian but may help provide insight to researchers about the pathology.

Physiologic imaging techniques would be those techniques that provide the evaluator with an image that reflects physiologic processes. Unlike anatomical imaging that reflects structure, these images give insight into metabolism or circulation. Thermography and scintigraphy provide the examiner with the opportunity to examine the entire horse. When combined with a thorough clinical examination, these methods are extremely useful in identifying injuries that may have otherwise gone undetected.
Thermography is the pictorial representation of the surface temperature of an object. It is a non-invasive technique that measures emitted heat. A medical thermogram represents the surface temperatures of skin making thermography useful for the detection of inflammation. This ability to non-invasively assess inflammatory change, makes thermography an ideal imaging tool to aid in the diagnosis of certain lameness conditions in the horse. The circulatory pattern and the relative blood flow dictate the thermal pattern which is the basis for thermographic interpretation. The normal thermal pattern of any area can be predicted on the basis of its vascularity and surface contour. Skin overlying muscle is also subject to temperature increase during muscle activity. Injured or diseased tissues will invariably have an altered circulation. One of the cardinal signs of inflammation is heat which is due to increased circulation. Thermographically, the "hot spot" associated with the localized inflammation will generally be seen in the skin directly overlying the injury. However, diseased tissues may in fact have a reduced blood supply either due to swelling, thrombosis of vessels, or infarction of tissues. With such lesions the area of decreased heat is usually surrounded by increased thermal emissions, probably due to shunting of blood.

Scintigraphy utilizes polyphosphonate radiopharmaceuticals administered by intravenous injection and followed by measurement of the distribution of the pharmaceutical by a gamma camera. Concentrations of the pharmaceutical can be detected, as the polyphosphonates bind rapidly to exposed hydroxyapatite crystal. This is generally in areas where bone is actively remodelling. This is the basis of the bone scan but prior to this the distribution of the drug goes through two other phases. It is these phases that can be useful to evaluate soft tissue changes.
There are three phases, the vascular phase, the soft tissue phase, and the bone phase. The vascular phase or blood pool phase begins immediately after injection of the pharmaceutical. This phase is dependent on local variations in vascular supply. The most common clinical application for vascular phase scintigraphy is determination of patency of blood vessels. The second phase or soft tissue phase scintigraphy is performed while most of the pharmaceutical is in the extracellular fluid (ECF). This usually begins 1-2 minutes post pharmaceutical injection and lasts until significant uptake of the polyphosphosphate by bone, usually 1-2 hours. The distribution of the radiopharmaceutical during this phase is due to local blood flow, capillary density, capillary permeability and regional ECF volume. Because inflammation causes an increase in blood flow, capillary permeability and ECF volume, inflamed tissues accumulate high levels of radiopharmaceutical. This is the basic principle behind evaluation of soft tissue injuries by scintigraphy. The bone phase is the most useful in that the uptake of the radiopharmaceutical always increases around areas of increased remodelling or vascularity. Since injured bone is under going more rapid remodelling, this is the basis for using bone phase to detect injuries. Scintigraphy has been most useful for the detection of lesions in bone and ligaments. Scintigraphy has been particularly useful in the identification of enthesopathy (damage to the insertions of tendons and ligaments on bone).

The purpose of any lameness examination is to be able narrow the problem to a regional diagnosis. Once a regional diagnosis has been made it is possible to assess the area utilizing some type of anatomical imaging modality. Assessment of those anatomical changes serves as the basis for any pathologic diagnosis that may be made, as well as, being important in determining prognosis. For these purposes radiography and ultrasonography are complimentary. Radiography provides information regarding the boney tissues. Radiographs reflect change that has happened. Ultrasonography provides information about boney contour but more importantly provides insight to the soft tissues that connect bone or provide support. Sonography can give much better insight into the activity of a lesion. That is, is
the lesion active or not, do the soft tissues changes reflect an ongoing process or is it a chronic process. In addition, sonography can provide information about joint capsule, collateral ligaments, the consistitncy of joint fluid, and provide insight into the articular cartilage.

However, the pursuit of a regional diagnosis can be difficult. There are 3 instances where this can be frustrating. One, when diagnostic analgesia has failed to eliminate the lameness; two, when the lameness is too subtle to avail itself to diagnostic analgesic techniques, and three, when the patient is not amenable to handling or injection. In these cases, other methods must be used to evaluate the patient. This is where physiologic imaging modalities can be so useful. By providing insight into physiologic changes in the tissues, this can lead the examiner to evaluate those areas utilizing anatomic imaging methods.

Another area in lameness evaluation where imaging can be useful is in preventing injury. This requires the early detection of the physiologic change of injury. Although, the frequent use of an anatomical imaging modality can discover change in one region, physiologic imaging allows the assessment of the entire animal on a routine basis.

The utlization of imaging modalities in the diagnosis and treatment of equine lameness is absolutely necessary. This is the only reliable methods to assess the type and severity of the injury. In addition, the routine use of any method can provide insight into the stresses and strains of the athlete.

REFERENCES


