EVERY HOOF HAS A STORY

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Because hoof conformation is closely correlated to the forces applied to the equine foot, physical exam for lameness should begin by visually inspecting the foot. Because many horses not experiencing lameness have distorted hoof capsules it is important to distinguish between functionally sound feet and feet with hoof capsule distortion that is often associated with lameness. Constant observation of abnormal hooves may blind the clinician to hoof abnormalities that may affect soundness.

SYMMETRY

Digital asymmetry (laterality, high/low syndrome, mismatched feet, mild club foot) may be acquired as a consequence of decreased weight bearing caused by asymmetrical movement, asymmetrical tension of tendons, and pain. The relatively overloaded (i.e., initially more sound) foot acquires a shallower angle of the dorsal hoof wall, low or under-run heel and lower palmar angle as well as a larger circumference of the solar margin and a wider hoof. In the relatively underloaded limb, the foot becomes more upright and narrow with a higher palmar angle. Once acquired, this asymmetry may remain even after the original lameness has resolved. Resolving the asymmetry requires efforts toward restoring equality of load distribution between limbs. Although it is not always associated with lameness, asymmetry of the equine hoof should not be overlooked as an indication of previous, impending, or chronic lameness.

CORONARY BAND

Hair on the coronary band should lie flat against the hoof capsule; hair projecting horizontally may indicate excessive ground-reaction force on the associated hoof wall and may be correlated to pain within the foot. When viewing the foot from the side, a healthy coronary band should be nearly straight with only a mild proximally directed arch. The coronary band is dynamic, and its shape can be affected by chronic overloading. A coronary band with a proximally directed arch at the quarters is evidence of chronic overloading of the quarters. A coronary band that bends distally in the heel to become nearly vertical is an indication that the foot has poorly developed heels. Asymmetry of the height of the coronary band in the heel region on one side is commonly known as a “sheared heel”. The medial heel bulb/quarter is more commonly displaced proximally as it is more common for the foot to be offset laterally. This asymmetry of the heel region predisposes the horse to a spontaneous quarter crack on the side of the foot that has been displaced proximally. Sheared heels can be present without causing lameness.

The angle of the coronary band can be used to estimate the position of the distal phalanx within the hoof capsule. One study described the angle of the coronary band of apparently normal front feet to be 23.5 +/- 3 degrees. We believe that the angle of a normal coronary band is probably about 20-25 degrees relative to the ground. If the

coronary band angle is >30 degrees the horse is likely to have a negative palmar angle, and if the angle of the coronary band is >45 degrees, the horse undoubtedly has a negative palmar angle. At the other extreme, a coronary band parallel to ground Is indicative of a high palmar angle, which is often associated with a club foot or distal rotation of the distal phalanx. A hind foot with a negative solar angle (plantar angle) will have a growth ring pattern that is wider at the toe than at the heel and a line imagined along the coronary band slope and extended forward will strike the front leg above the carpus or even the chest or abdomen rather that at the carpus or below. A distally directed arch in the coronary band in the dorsal portion of the foot may indicate remodeling of distal phalanx.

The coronary band of a healthy hoof should feel thick and spongy and should have no evidence of a "ledge" where a finger can be placed behind the proximal aspect of the hoof capsule. A prominent ledge or depression in the coronary band indicates that the distal phalanx is located deeper than normal within the hoof capsule. Horses with this palpable abnormality at the dorsal aspect of the coronary band usually have excessive distance between the coronary band and the extensor process.

HOOF WALL

The normal healthy hoof wall should be smooth, have a light sheen, and be free of flares, cracks, and prominent growth rings. When growth of the wall becomes retarded as the result of uneven circulation, alterations in growth ring width are evident at the proximal margin of the hoof capsule. We believe that narrow growth rings in some areas indicate that circulation of the coronary corium has been decreased in that region. A region of the hoof with narrowed growth rings (suggesting altered/uneven circulation) has most likely been receiving excessive ground-reaction force because wall growth is generally inversely related to load. Narrow growth rings are commonly seen in the toe region of horses with chronic laminitis because the dorsal region of the corium is usually the area most poorly perfused; a result of compression of dorsal coronary corium, solar plexus, and dorsal laminar vessels caused by rotation of the distal phalanx. In our experience narrow growth rings are often found in the medial quarter of the forefeet of athletic horses presented for lameness evaluation. The coronary band of these horses is usually displaced proximally similar to the coronary band of horses with sheared heels and is likely caused by similar unequal distribution of vertical forces which may be accentuated by conformation or mediolateral imbalance. For horses with proximal displacement of the coronary band in either region lameness may resolve after administering only the medial portion of an abaxial sesamoid nerve block, suggesting that abnormally localized forces on the hoof wall may be a source of pain.

The presence of hoof wall flares or cracks are often caused by chronic, excessive overloading of the hoof wall in the region where these defects are found. Cracks in the quarter are more likely to be a cause of lameness than are cracks in other regions because the quarter is thinner than other regions, making a quarter crack more likely to involve the dermal layers of the hoof. Horizontal cracks are usually the result of a disruption of production of horn caused by coronary band trauma or when subsolar infection opens ("gravels out") at the coronary band. These cracks are seldom a cause of lameness.

FROG

The width of a healthy frog should equal 50 - 66% of its length. The frog of a healthy hoof has sufficient depth at its dorsal aspect to reach the bearing surface. If this portion of the frog does not engage the ground, fibrocartilage in the palmar portion of the foot develops poorly or atrophies. The central sulcus should be wide and shallow so that the index finger or ring finger fits easily into it. Contracture of the central sulcus is commonly observed. Contraction of the central sulcus can create an anaerobic environment that is ideal for development of thrush. When the frog tissue entrapped by the contracted sulcus becomes infected, the dermis at the deepest aspect of the sulcus often becomes eroded. The horse may exhibit lameness and show significant signs of pain when the sulcus is cleaned with a hoof pick. The pain caused by thrush in the central sulcus may cause some horses to land toe first to avoid loading the inflamed soft tissues of the heel. Landing toe-first may cause the heel to contract and atrophy more, perpetuating the infection and lameness. The relationship of the untrimmed frog to the sole indicates the position of the distal phalanx within the hoof capsule (i.e., the palmar angle). For instance, if the apex of the frog is deeply recessed and the frog appears to be angling toward the coronary band at the toe, the distal phalanx is probably similarly positioned, having a negative palmar angle.

COLLATERAL GROOVES

The depth of the collateral grooves may provide an accurate anatomical reference for predicting the relationship between the internal and external structures of the foot and the bearing surface because the depth of the collateral grooves is not altered by any method of hoof care, whereas the plane of the frog can be altered by a hoof knife. Foot structure that can be predicted based on characteristics of the collateral grooves includes: depth of sole, distance of the distal phalanx from the bearing surface, and the palmar/plantar angle. Based on dissection studies of the foot there appears to be a constant relationship between the collateral grooves and hoof conformation/structure. The collateral grooves apparently run parallel to and a fixed distance (10-11mm) from the solar surface of the distal phalanx in the dorsal half of the foot and the same distance from the collateral cartilages in the palmar half of the foot. In the healthy foot with adequate depth of sole, the collateral groove at the apex of the frog is 10 – 20 mm from the ground. This indicates that the distal phalanx is positioned an adequate distance from the ground, because the concave aspect of the distal phalanx is positioned 10-11 mm proximal to the deepest part of the collateral groove. We are currently conducting studies to validate these observations.

The orientation of the dorsal aspect (front half) of the collateral groove in relation to the ground plane parallels the position of the distal phalanx in the hoof capsule. Collateral grooves of some horses have a stair-step or undulating shape where the groove dips or curves to become substantially deeper in the heel region. We believe that collateral grooves that exhibit this type of conformation are an indication of poor development of the internal structures of the heel. A foot that has collateral grooves with this deep curvature in the heel region should be examined radiographically to confirm digital alignment and orientation of the distal phalanx to the ground (palmar angle). Horses with a negative palmar/plantar angle typically have a long toe-low heel conformation and a shallow digital cushion. In horses with this conformation, the combined thickness

of the frog and digital cushion is less than 2 inches and easily distracted heel bulbs. Although many lame horses with negative palmar/plantar angles do not block sound to the foot, this conformation in the hind feet may be associated with pain in the hock, suspensory ligament, gluteal and lumbar regions.

HEELS

During examination of the foot, the “heel base” of the hoof capsule, the collateral cartilages and the digital cushion should be evaluated. The “heel base” of the hoof capsule includes the hoof wall, the buttress, angle of the sole and the bars. The heel tubules should be straight and have an angle of incidence with the weight bearing surface similar to the tubules in the toe region. Ideally, the most palmar extent of the bearing surface of the heel tubules would be at the base of the frog and very near a vertical line drawn thru the middle of the third metacarpal/metatarsal bones. Many podiatrists describe under-run heels as those that are ≥5 degrees lower than the toe angle. Others have emphasized the relationship of the foot to the metacarpal/metatarsal bones when determining if the heels are under-run. He considered heels positioned well forward of the line drawn thru the middle of the third metacarpal/metatarsal bones to be under-run. Under-run heels that grow forward toward the widest part of the foot often collapse under the weight of the horse causing heel tubules to run nearly ground parallel. The bars and the angle of the sole may be crushed and deformed as a consequence of the severely under-run heel.

SOLE

The healthy sole tends to be callused and between 10 to 15 mm thick beneath the distal rim or tip of the distal phalanx. The sole must be at least 10 mm thick to protect the distal phalanx from trauma associated with impact. A ruler calibrated in millimeters can be placed within the collateral groove to measure the distance between the deepest part of the groove and the plane of the outer perimeter of the sole. We believe his measurement predicts the height at which the distal phalanx is suspended above the bearing surface of the foot and can be used to predict solar depth. It is not uncommon to find horses in which the depth of the collateral grooves measured at the apex of the frog is essentially zero millimeters from the ground (i.e., no space). Considering that the distal phalanx is concave, the sole of these horses becomes thinner from the apex of the frog peripherally toward the tip or distal rim of the distal phalanx. Flat soled horses that have zero collateral groove depth at the apex of the frog, generally have less than 7 mm of solar depth at the tip or distal rim of the distal phalanx. The distal rim of the distal phalanx is predisposed to trauma when the sole is less than 10mm. Feet with shallow collateral grooves are predisposed to solar bruising, subsolar infection, remodeling of the distal phalanx, and even rim fractures of the distal phalanx due to lack of solar depth and/or concavity of the sole. The opposite situation is true of feet with deep collateral grooves at the apex of the frog. These feet have sufficient solar depth and/or solar concavity to elevate and protect the distal phalanx from the trauma associated with impact. The ground surface should be approximately as wide as it is long. This creates a relative proportion from the front of the foot to the palmar aspect that is related to alignment of the center of articulation (of the distal interphalangeal joint) in the middle of the foot, or when shod, the middle of the shoe.