Hoof Balance in Equine Lameness

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Foot origin lameness remains a common cause of impaired performance in all classes of equine athletes. Proper hoof balance is important in minimizing development of foot lameness but remains a sometimes poorly understood concept and one on which veterinarians and farriers often have differing opinions. Some recent developments suggest that the frog and bars of the foot may serve a more important role in weight-bearing than was previously considered. Consequently, more foot practitioners now make efforts to incorporate those structures more effectively in weight-bearing, either for the barefoot or for the shod foot situation.

Medial lateral balance, dorsopalmar balance, and break-over are the cornerstones of proper foot balance. Proper attention to these aspects of balance allows the foot to break over easily and also ensures proper support to the heel region of the foot. Good foot balance probably exists if radiographs were taken of the foot and the distal border of the distal phalanx (P3) was parallel to the ground surface on a dorsopalmar projection. On a lateromedial projection, the caudal aspect of P3 should be 3 degrees to 5 degrees higher than the dorsal aspect.

Because radiographs are used only occasionally to help make trimming and shoeing decisions, farriers (and veterinarians) should learn to read external features of the foot that more accurately determine the location of P3 within the hoof capsule. They also need to make determinations on break-over based on external parameters of the foot and on how the foot lands during motion. When necessary, and in selected difficult cases, radiographs can be taken to help make some of these decisions. Determining the location of the live sole plane can help determine how much foot should be removed. This is an external reading that gives some idea of the depth of P3 and is a landmark for uniform trimming of the foot from medial to lateral.

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The true apex of the frog also is a mark of the live sole plane at the level of the frog apex. Determining depth of live sole at this level, along with live sole depth determination in both quarters, gives a farrier (and veterinarian) a visual impression of what depth of foot they are dealing with, relative to how much foot to remove in a uniform manner. The region of the apex of the frog also gives a good visual reference for foot-bearing surface proportions. With feet that "run forward," there is relatively more foot in front of the apex of the frog than behind this point, a situation that will usually result in lameness if not recognized and corrected. Veterinarians should become familiar with some of these reference points so they can work more closely with farriers in the restoration of problem feet.

FOOT PROPORTIONS

When viewed from the bottom, a point $^{1}/_{2}$ to $^{3}/_{4}$ inch behind the true apex of the frog marks the center of mass of the foot. The true apex of the frog is the point where, when trimmed down, the softer-textured frog meets the firmer tissue of the sole. As a general rule, approximately 66% to 75% of the bottom of the foot should lie caudal to the center of the mass of the foot, with the remainder lying forward of this point. This helps ensure that the frog and bars of the foot are more involved in weight-bearing. With feet that "run forward," more of the foot lies forward of this point. This usually means that break-over is much too far forward and that the heels are becoming stretched, compromised, and run under. It also means the frog and bars, which are designed to help dissipate energy of impact and loading over a larger surface area, participate minimally in this function.

HEEL-FIRST LANDING

A slight heel-first landing is commonly observed in feral horses and is often seen in sound domestic horses. Proprioceptors have been identified in the caudal aspect of the frog, and a heel-first landing may be a result of information generated from these receptors. Clinically, athletic horses with a good forward stride tend always to have a heel-first landing. A heel-first landing is easily detected from the side when the horse is at a walk. It is also

recognized with the horse moving directly toward the observer as the slight "toe flip" action the foot makes as the heel hits, followed by the toe.

When a heel-first landing is absent, and trimming and shoe application still result in a toe-first or flat foot landing, other approaches to foot care may be necessary. It may be required to use a wedge pad for one to several shoeings until a heel-first landing is reestablished. To ensure consistent engagement of the frog and bars, dental impression material is often placed between the frog and the pad. With this approach, a heel-first landing is often established immediately. Clinical judgment then determines how long this arrangement is required before returning to a more basic shoeing approach.

LIVE SOLE AND SOLE CALLUS (AT THE TOE)

Live sole refers to the waxyish, non-chalky-appearing tissue that is identified when the loose, chalky sole is exfoliated or removed. It can be identified just inside the hoof wall in the quarters to determine its depth in that region of the foot. It can also be identified at the true apex of the frog. Determination of depth in both areas, and recognition that the depth of P3 is the same distance from live sole in both areas, can be useful in helping to determine how much foot to remove, especially in distorted feet. The sole callus or sole ridge at the toe is the functional epidermal sole tissue that extends beyond the distal border of P3 at the toe. In most feet, it can be recognized as a raised area ahead of the apex of the frog and adjacent to the inside margin of the hoof wall.

This callus is considered to be supporting tissue for P3 and should not be removed. In a horse that has been barefoot, the sole callus is usually readily indentifiable, and its inner margin is where break-over occurs on the foot.

Again, identification of the live sole and sole callus at the toe helps determine how much can be removed from all areas of the foot. Although there are some minor variations in foot removal (depending on whether the horse will remain barefoot or be shod), recognition of these landmarks can be useful in foot preparation. This is particularly true when a foot has become distorted over a long period of time.

FLAT FOOT LANDING FOR MEDIOLATERAL BALANCE

Mediolateral balance is often evaluated by watching the foot land, with observers watching the horse move toward them. Generally, the foot should land flat side to side and not hit first on the medial or lateral wall. However, the conformation of some horses prevents the foot from landing in this manner. Most typically, this is the horse that toes out or has outward limb deviation or rotation. Many horses have only one limb with outward rotation, which means they may land flat side to side on one foot but land on the lateral wall or outside toe quarter region on the abnormally conformed side. Attempts to make such a foot land flat would be unsuccessful and should not be attempted. As P3 is a consistent distance (or depth) from the live sole plane both at the toe and the heel, reading the live sole plane, and trimming to the same level of sole plane all around the foot, helps determine when adequate hoof has been removed.

FUNCTION OF THE PALMAR ASPECT OF THE FOOT

The palmar aspect of the foot is functionally important for many reasons. In a healthy foot, it represents a large surface area for force (energy) dissipation. As previously mentioned, the palmar aspect of the frog has been shown to contain proprioceptors important for foot placement. Recent research has also identified an extensive vascular network within the ungual (collateral) cartilages in the heel region that is also thought to be important to hydraulically dissipating forces within the foot. A well-developed vascular network within the ungual cartilages is usually associated with thicker ungual cartilages and digital cushions that contain fibrocartilage, whereas poorly developed vascular networks are more often associated with thin ungual cartilages and digital cushions containing more fat and elastic tissue. The interaction of the frog, bars, digital cushion, and ungual cartilages is theorized to be the basis for considerable energy dissipation within the foot. Abnormalities of these anatomic structures may result in poor energy dissipation and development of chronic foot (heel) pain.

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