



## NO HOOF, NO HORSE, NO KIDDING!

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Why when you walk into your favorite tack store or feed store is there an entire section dedicated to pastes, paints, oils, ointments and polishes whose sole stated goal is to improve the survivability of the equine foot? Why do companies spend fortunes, and charge fortunes I might add, to create and market powders, pellets, granules and liquids aimed at curing, strengthening, rebuilding and growing impregnable hooves? Why do horse owners spend so much time and effort in nurturing and pampering the last few inches of the horse's leg, reading never ending magazine articles about the hoof, attending clinics about hoof care, reading blogs and even arguing about the best approach to care of the stubby little piece of anatomy? Why do people, such as myself, dedicate a large portion of their lives and careers to the study and care of the distal phalanx and it's surrounding tissues? In essence, **why the foot?**

The equine foot or hoof is the source of about ninety percent of all equine lameness. Not all hoof problems are seen by your veterinarian. Some foot lameness' are dealt with by the owners themselves or by the farrier that cares for the horse's feet on a regular basis. Yet still, problems of the foot provide us a fair share of lost riding hours and aggravation. While the foot itself is a complex system, perhaps the most complex portion of the equine locomotor system, the real reason for all of this concern is quite simple. The equine foot is the first line of defense against the rigors of the outside world.

Every stride, each footfall, the system at the far end of the equine leg provides several critical functions. The foot provides shock absorption to protect itself and the rest of the body from some of the accelerations and impacts involved in moving about in various types of terrain. In addition the foot acts as an interface for the horse to the ground, providing traction, durability and agility. Through an intricate system of both hard and soft tissues the foot also deals with the irregular and often challenging nature of the terrain that the horse has adapted so well to.

While the rest of the musculoskeletal system takes advantage of many levers and springs to endure locomotion, the hoof must rely on a compact and almost rigid structure. Note the phrase *almost* rigid. This is a critical modifier. Within the protective case of the hoof capsule there is cooperation between the bones, tendons, ligaments, soft tissues and even the blood itself, that allows the foot to survive and thrive. Even the hoof capsule is cleverly structured to allow for both strength and suppleness. The gross structure of the hoof capsule is made up of microtubules and a connecting matrix that allows for durability, self-regeneration and protection of the internal structures. Even when the capsule reaches a point of failure it will redirect the injury to avoid having the internal workings violated. The geometry of the capsule allows for flexibility, even though the substance of the capsule is quite rigid, while at the same time providing excellent traction in a variety of terrains.

There are multiple layers of the capsule. While the middle layer provides strength and flexibility, the outer most layer provides shelter in the form of moisture control. The inner layer of the hoof capsule, perhaps the most complex, provides the interface between the capsule and the bony structures of the distal limb. This inner layer, the laminae, is an intricate interface between the bone and the capsule. A complex tissue has evolved to join the rigid bone to the more flexible hoof capsule. This tissue serves many functions and is complex in both gross structure and physiology. The laminae, picture it as living Velcro®, is mechanically intricate with a complex blood supply and has the ability for the capsule to grow past the coffin bone within while providing a strong attachment to that same bone. If you were to sleep through most of this discussion it is critical that one concept be understood, in large part the coffin bone, and thus the weight of the horse, is **suspended** within the hoof capsule by the laminae, it is not a bone in an 'ashtray'. The laminae, in conjunction with a complex circulatory system are responsible for damping shock waves that might otherwise damage the bony structures within the hoof.

It is difficult to draw a clear line where the function of one component of the foot ends and another one takes over. Shock absorption, a major function of the foot, is managed by the hoof capsule, the soft tissue structures, the bone, the laminae and the circulatory system. The bones within the hoof capsule include the coffin bone or third phalanx, the navicular bone and the distal portion of the short pastern bone, the second phalanx. The coffin bone lends shape, support and a joint surface for the articulation of the foot. The porous nature of the bone is essential for circulatory and hydraulic function of the foot. The navicular bone, the smallest bone in the foot, is one fraught with pathology. This small bone is exposed to a variety of forces including direct compression, indirect compression, tension in multiple directions and friction. Given the magnitude of forces that are experienced by the navicular bone it is quite amazing that it survives at all. The navicular bone and its associated soft tissue structures are the portion of the foot that act most like the rest of the locomotor system. There are levers and tendons and ligaments that respond to the stresses of locomotion, much like what goes on in the other joints of the skeleton. Of course all this physics and mechanics goes on in a semi-rigid enclosure moving extremely rapidly and repeatedly beating itself against the ground.

Even the circulatory system cannot get away with performing only the relatively simple function of providing nutrients and oxygen to the critical tissues of the foot. Blood and the vasculature are also responsible for thermoregulation between the horse and the outside environment. In extremely cold environs there are shunts that direct blood flow away from the ice and snowbound hoof to aid in conserving core temperature. Blood is sent to the cold tissues only periodically to satisfy the reduced oxygen need of the hypothermic tissues of the foot. As if this wasn't enough to ask, the blood also acts in cooperation with the laminae, the digital cushion and the vessels and other soft tissues to make the foot either more rigid or to aid it in acting as a hydraulic shock absorber as required. As an added bonus the properly functioning foot has been said to act as an auxiliary system to the heart, helping to drive the blood back up the leg to return to core circulation as the horse moves about.

As a final task, the foot is also the structure, or more accurately, the system of structures, that is responsible for adapting the horse's limbs to the irregularities of terrain and movement. The limbs of the horse have evolved through millions of years to provide the horse with great speed and endurance while maintaining a high level of agility. In this quest for speed the limbs of the horse needed to shed mass and simplify. Lost was the ability of many smaller quadrupeds for pronation and supination of the distal limbs. The horse's legs could only extend and flex as the animal moves, leaving the foot to cope with the horse's adaptation to uneven terrain or lean angles when turning. The bones, ligaments and even the capsule, of the foot allow for this three dimensional movement. The interface of the distal joints, working in concert with the ligaments and tendons, is such that angular adaptations are allowed while increasing load, even asymmetrically applied, increases the stability of the joint.

If we can even begin to grasp the mechanical marvel that is the equine hoof, we will begin to understand that any modification that we force upon this structure will in many ways compromise it's function. As man has domesticated the horse and challenged the horse to perform new tasks we have attempted to adapt the foot to help it to endure greater stress. The more that we strive to understand the function of the foot, the greater our chances of providing the needed modifications without compromising the evolutionary changes that have made the foot so thoroughly capable.

