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ALE of the Equine Foot Reflection Answers

1. What does it mean to be sensitive or insensitive regarding the dermis and epidermis of the equine hoof?

Sensitive refers to the tissues that are vascularized and innervated. It involves all the corium, or dermis. Insensitive means it is free of any neurovasculature and refers to the epidermis. The junction between the two is visible as the white line and can be found between the hoof wall and the sole of the foot in an arc. It is easiest to visualize after a trim and is the location where nails that secure horseshoes are placed such that strong tissue is used, but it is also not painful or capable of injury that would result in bleeding.

2. What happens to the lateral cartilages as a horse ages? What are they referred to once this change occurs?

They often ossify later in life and are then referred to as side bones. This is considered a normal finding and is often seen on radiographs. They are not painful unless injury or trauma occurs, which can result in infection or a fracture.

3. What is the importance of the digital cushion?

The digital cushion acts as a shock absorber, protecting the distal bones, tendons and ligaments from concussive forces, it also returns some of the energy to “lift off” of the heel/“break over” of the toe and acts to compress the venous complex at the caudal aspect of the foot which pumps the blood proximally up the limb to return it to the heart.

4. What is the specific action of the common and long digital extensor *at each of the joints* included in this model? The superficial and deep digital flexors? Be specific.

The common (forelimb) and long (hindlimb) digital extensor attach distally at the extensor process on the proximal dorsal aspect of the distal phalanx and act to extend both the proximal and distal interphalangeal joints, thereby extending the entire digit. It also acts to hyperextend the fetlock, but that is proximal to today’s learning exercise. This action advances the hoof and prepares the hoof for weight bearing during ambulation. The superficial digital flexor attaches distally on the proximal aspect of the middle phalanx (P2), and therefore acts to flex the

proximal interphalangeal joint (as well as the fetlock). The deep digital flexor’s distal attachment is on the palmar or plantar surface of the proximal aspect of the distal phalanx. It acts to flex both the proximal and distal interphalangeal joints (as well as the fetlock). This action allows the foot to bear weight (anti-gravity), propel the horse forward while weight-bearing, and for the hoof to “break over” and be lifted as it is carried forward. Due to the extreme pressures on these tendons, there are suspensory ligaments (check ligaments) that help distribute some of the forces across the palmar/plantar aspects of the equine limb.

5. Is the SDF or the DDF responsible for rotation of the distal phalanx in cases of laminitis? How/why does that rotation occur? Be specific.

The only tendon that attaches in a position to pull the distal phalanx (P3) away from the hoof wall is the DDF. This can only occur when blood flow is disrupted due to inflammation. The basement membrane and sensitive laminae necrose due to lack of oxygen and nourishment/ cellular damage. Structural integrity is lost as the primary and secondary laminae die; the combined weight of the animal on the weakened laminae causes sinking of P3. As P3 loosens away from the insensitive wall, the DDF's pull rotates it away from the hoof wall. As P3 sinks, and rotates, it further compresses vasculature distally, and causes necrosis of the distal tip of P3 and the sole corium. If left unchecked, P3 rotates through the necrotic sole and the horse is considered foundered and would be euthanized.

6. Why is it important to be able to identify the various regions of the hoof?

Your ability to communicate effectively with colleagues, farriers and clients about their horse and their hooves depends upon a complete anatomic understanding. This knowledge also allows you to keep accurate medical records/chart locations of injury, defects and treatments.

7. What is unique about the laminae of the horse?

Equines are the only species that have both primary and secondary laminae. The arrangement of primary and secondary laminae in vertical folds, which interlock with the insensitive laminae along the entire arc of the foot, has an incredible amount of surface area, many, many times that of other ungulates. This allows the corium to attach to the hoof wall (via basement membrane) and suspend the weight of an entire horse on just four digits. Horses, therefore, can be incredibly agile, and fast with very large bodies utilizing this anatomic configuration.

8. How are impact forces mitigated in the equine foot?

The heel touches the ground first, and the frog, heel bulbs, and digital cushions are shock absorbers that mitigate the initial compression impact and return some of that energy when the foot lifts again. The hoof is rigid everywhere except for the heel. When the heel impacts the ground, the heel expands, the digital cushion and frog compress- these actions remove a lot of the impaction forces. The heel wall is constructed to be the weight bearing surface, where its reflection at the bar reinforces the hoof wall and defects some of the force of impact. The construction of the hoof wall is such that the intertubular horn acts as concrete and the tubular horn is the rebar (rebar more dense at the external edge/intertubular horn more dense internally) so that as the impact occurs the hoof absorbs a bit of the impact of the concussion and yet is strong enough to take the strain of pushing off with the toe and breaking over- the rigidity of the hoof wall provides traction and maximization of propulsion.

9. Inflammation in the laminae results in several deleterious results. Follow normal flow in and out of the equine foot using terminology above. What happens to that flow, in order, during the disease processes associated with laminitis. What role do the veins play in laminitis?

The arterial supply is collateral in the horse to the distal limb, via the medial and lateral plantar or palmar digital arteries. The veins (egress) usually follow the arteries (ingress) in the hoof. The digital

cushion acts as a venous pump with every footfall, where compression of the digital cushion occurs between the rigid hoof wall ventrally, lateral cartilages laterally and bones of the digit dorsally forcing venous blood proximally up the leg.

Venous outflow becomes compromised when soft tissues in the hoof swell because of inflammation. The hoof wall and bones/tendons are incompressible, so when parts of the corium swell, unpressurized veins are constricted, and flow becomes congested. Venous congestion causes back up of arterial blood, leading to further swelling, which leads to impaired arterial flow. This leads to death of the basement membrane/necrosis of laminar tissues, which results in the inability to support weight. Eventually this leads to sinking, detachment and rotation of the distal phalanx and ultimately founder and euthanasia.

The sinking and rotation of P3 further impact venous outflow, compounding the issue. Necrosis of tissues causes further inflammation/swelling compounding the issue. The resulting pain causes the horse to adjust their stance and stop moving, which changes compression of the digital cushion, impacting venous outflow, further compounding the problem, etc.