Nerves, Nerves, Nerves: Why Are They So Important to the Horse? (2015)

Robert M Bowker, VMD, PhD
Michigan State University, Department of Pathobiology and Diagnostic Investigation, College of Veterinary Medicine, East Lansing, Michigan, USA.

The equine foot is a neurosensory organ. Information is continuously received by the spinal cord and brain of the horse during movement as he perceives his environment during both flexion and extension of the distal limb. Sensory nerve receptors become activated prior to the foot impacting the ground via the fascia, a critically important but overlooked tissue that has a wealth of sensory nerve fibers and receptors, along with the ability to respond and adapt to the impacts that the foot receives during movement.

Traditional foot science and veterinary medicine has focused on pain sensation as we believe as it is believed to be mediating sensory information of the distal limb lameness. The foot and distal limb also have touch, vibratory, and light pressure receptors in these same regions, which inform the horse about his environment.

Dissections of cadaver feet have shown only a limited view of equine sensory innervations of the distal limb and do not take into consideration how they affect the live animal. The horse is really interested in the sensations other then pain exclusively, to know how he can begin to be comfortable when standing.

Notice where your horse stands in the barn yard. Does he stand on the cement or asphalt walkway when he is trying to relax? Probably not. When he does stand on cement, he is constantly shifting from one foot to the other one? That surface is very uncomfortable for him to stand on.

While some people believe this constant shifting of his weight from one foot to the other is a mechanism of pumping blood out of the foot, this notion is merely another one of those concepts of dogma — a belief with little to no factual information. Unlike humans, it is the equine veins that pump blood out of the foot in the horse. Veins in the horse’s leg actually pulsate.

Horses do not shift from one foot to the other foot when they are standing on a conformable or comfortable
surface. As an experiment, try standing in your stocking feet on the hardwood or linoleum floor in your kitchen without moving or shifting your weight. What happens after a few minutes? Are you beginning to feel uncomfortable? Does your entire mindset begin to change? Just a little? Most of us do have this experience as standing on hard surfaces results in a smaller surface area of foot contact, similar to the high heels that many women wear.

Does this ring a bell?

The smaller surface area results in higher pressures internally in the foot. Weight per surface area of loading is increased as the load on a surface is divided by the area of that surface to get the weight or pressure per surface area. Just pure biomechanics? In high heels or in sneakers, which will be more comfortable?

We come home and put on our fluffy slippers after a long day’s work. The slippers increase the surface area of loading while the texture of the slippers in turn increases blood perfusion within our feet and lower legs. This series of physiological events begin to change the way we perceive our persona and environment within our brains. We can begin to become more (relaxed and?) comfortable.

The same series of events are happening in the horse’s foot. With Doppler blood flow studies we have shown how different sensations of touch and warm water can affect the perfusion of the submersed foot as well as the opposite foot not being subjected to this touch and warm water. These effects are carried out by the sensory nerves to the opposite limb much the same way that acupuncture mediates similar effects.

Now as we return to the horse standing in the barnyard, when they are on a hard surface, they are constantly shifting from one foot to the next every few seconds (20 - 30+ seconds) They are uncomfortable! When they are standing on a more conformable surface — the sawdust and manure piles; the dirt paddock area; pea rock; grassy knoll — they do not shift their weight from foot to foot as frequently. The author has observed this for up to 12 - 15 minutes when they are on pea rock. (Bowker, Unpublished)

In a horse with painful acute or chronic laminitis and founder, nerves are stimulated from the new displacement of bone within the foot; they are constantly shifting their weight from foot to foot. To alleviate the pain, the horse must be made as comfortable as possible, as quickly as possible, via corrective trim and conformable surfaces. Initially, quite often we provide a towel or other cushion-like like surface for them to stand on. This towel increases the surface area a little but perhaps more importantly it alters the texture that the foot perceives. This in turn improves perfusion within the foot. Reducing the hoof wall as loading structure via trim and the use of softer pads are critical to make the horse more comfortable and to improve perfusion within the foot.

Pea rock (Figure 2), 4 or 5 inches deep (Figure 3), is a conformable, but supportive surface, and can be very effective in getting an acutely laminitic horse comfortable quickly. The pea rock and similar textured surfaces also improve tissue blood perfusion through the foot. The horses are able to walk and stand more comfortably, loading the foot more correctly, which is necessary for recovery.

The large number of sensory structures inside the foot, and the way in which horses use them, is under-appreciated. The various surfaces that are detected by the different sensory receptors actually cause changes in blood flow and opposite limb effects. Sensory nerves change the vasculature and tissue environments in such a way that changes are perceived psychologically as being more "comfortable"; this comfortable feeling is caused by the changes in blood flow through the tissues.

Figure 2. Depending on where you are, this stone may be called pea rock, pea stone or pea gravel. It should be 3/8ths inch, round, often called “washed”.
Not only are the sensory nerves throughout the horse’s foot, they are within the fascia, or loose connective tissues covering the distal limb. These sensory nerves are active not only while the foot impacts the ground, they are equally responsive and monitoring the distal limb while in flight, even before the foot hits the ground. This “pre-loading” engagement of the sensory receptors permits the foot and distal limb of the horse to begin to prepare for the loading events that are about to occur when the foot impacts the ground during movement. This “preparatory” phase “alerts” the vasculature and nervous system, the frog and most of the distal limb tissues and structures, prior to this loading impact. In other words the distal limb is “proactive” during locomotion rather than “reactive” or active after the fact of impacting the ground. If the later scenario were the normal sequence of events during movement, the horse would be tripping a lot or stumbling as the spinal cord reflexes and muscle contractions would always be “late”.

**SUMMARY**

Ongoing research is beginning to show how the equine foot is innervated and how any ground-contact will activate different sensory nerves and receptors, affect blood flow and comfort during gait and stance, in both normal stance and movements and in especially acute and chronic laminitis

**REFERENCES**

1 Bowker RM. NERVES, NERVES, NERVES: WHY ARE THEY SO IMPORTANT TO the HORSE? ECIR Group Inc. 2013 NO Laminitis! Proceedings, Jacksonville OR, USA.

2 Ibid.

3 Ibid.

---

This research was made possible by the generous support of the American Quarter Horse Association and the United States Equestrian Federation.