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Navicular syndrome: A different perspective

by Cristina Wilkins, Editor

This year’s Bowker Lectures began with a fascinating presentation titled ‘The Good Foot: The formation of chambers and micro vessels and the effects of vibration’ where, using navicular syndrome as a backdrop, Professor Robert Bowker presented his research findings and practical applications for providing the foot with the environment needed to develop and maintain a sound, functional structure.

Navicular syndrome

Navicular syndrome (sometimes termed navicular disease) is a common cause of forelimb lameness in horses aged between four and 15 years of age. An article published in Horses and People Magazine (which you can read here: http://goo.gl/qktvZC), explains that horses diagnosed with the condition usually have a history of a progressive and long-standing lameness, which may be present in one or both forelimbs. Although lameness can come on suddenly, the more common presentation is for a slower onset of clinical signs. Pain is located towards the back of the hoof, and this is why one of the characteristics of affected horses is to try and land the foot toe-first.

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Veterinarians commonly report visible changes to the navicular apparatus (see illustration), but there is much debate on the cause and why some horses develop navicular disease, whilst others do not. Many hypotheses have been proposed, but most theories have been shown to be non-causative. Two of the causal theories that have been largely discounted are that it is a vascular compromise (thrombosis or blockage of the blood flow in the area) or a degenerative ageing process.

Veterinarians agree that ‘long toe, low heeled’ horses appear to have a higher incidence of navicular changes and this has led to the theory that the condition...
Our view of Navicular syndrome is that it is an entire foot problem, rather than a problem specifically affecting or related to the navicular apparatus.

Our view is that, as most areas of the foot are subjected to the environmental stresses, the tissues within the foot will adapt and remodel to these stresses - either positively or negatively. During the early development and growth of the foot, positive forces promote adaptation that leads to a 'good foot': Negative forces result from our husbandry practices and excessive vibration, they hinder healthy tissue development and will eventually cause deterioration in other tissues, such as that seen in navicular horses.

is due to the exaggerated tension on the Deep Digital Flexor Tendon (DDFT), which runs over the back of the navicular bone and places more pressure on it. This, however, is often contradicted clinically, as affected horses will often have contracted heels and a more upright hoof conformation in the more lame foot than the less affected foot.

Caused and effect

Prof. Bowker has been dissecting and studying ‘navicular feet’ for two decades and, during this first lecture, provided his unique perspective on the root cause of the disease, which he sees as an entire foot problem; a degenerative process that starts in the frog, affects the internal tissues and ends in navicular bone pathology. He is searching for the cause by looking at the surrounding tissues.

“See changes in the frog three to five years before a horse develops navicular syndrome,” says Prof. Bowker to the delegates. “I see microscopic changes in the frog that gradually develop. My belief is that when you see changes in the navicular bone, the pathology is so far along, it is the tail end of the disease process and, if you can see changes in the front part of the frog (which I can see with ultrasound), then maybe we have to change the way we are shoeing and/or trimming; do something different. Our husbandry practices have to change because we are killing these horses fast.”

Swizzle sticks and car tyres

Prof. Bowker points to a slide of a section through the foot showing the coffin and pastern bones, navicular bone, the DDFT and other ligaments: “Underneath the navicular bone,” he continues. “There are a series of ligaments that were described 100 years ago, but most people have forgotten about.” (See images on Page 60.) “At the time of their initial description, this region of the frog was never looked at under the microscope, but I can show you that, between these ligaments, there is a ‘gazillion’ of tiny blood vessels. These vessels are all three to four microns and up to 100 microns in diameter (note that 1,000 microns equals 1 mm so they are, indeed, very small). They all have smooth muscle around them and, therefore, they are not capillaries. When I say there are a lot of these, there really are.”

This finding is at odds with established veterinary principles which, traditionally, consider the foot to have a relatively small blood supply. This may be explained due to microscopic size of this vasculature and the laboratory techniques used in preparing histological samples for researchers. Prof. Bowker explains that preserving these tiny vessels so they can be seen under the microscope requires specialised preparation techniques that take longer to achieve and are not standard.

Throughout the lecture, he emphasises these vessels are not capillaries - i.e. blood is flowing through them with two biophysical functions: energy dissipation and support of the horse, rather than just being there to feed the tissues. “Ligaments and myxoid tissues in the area do not require any significant blood supply,” he says. “So, why would the vessels be there? Why is all this blood flowing through the foot? It’s all blood flowing through the foot!” He insists that these vessels play the central role in dissipating the impact energy and vibration that is generated when the foot hits the ground.

“When the foot hits the ground (heel first), the impact and vibration energies radiate upwards through the heels and caudal foot. Impact energy cannot merely be ‘absorbed’ - it must be removed to prevent deleterious effects within the foot. The energies are transferred from the tissues to the flowing fluids in the many small vessels. This process removes the impact energies from the foot.”

“Think of swizzle sticks; (Prof. Bowker is referring to the common plastic drinking straws) they are very large tubes and they don’t really change the characteristics of fluid flowing through them. On the other hand, when you take that straw and you divide it into lots of smaller, very thin tubes, the resistance to fluid flow within one tube is very high, but the total resistance is very low. This is known in physics as Poiseuille’s Law.”

“Furthermore, the many small tubes provide a large surface area to remove energy. During this process, the impact energies are transferred from the heel tissues and lateral cartilage to the small blood vessels, thus removing the energies from the foot and, at the same time, dampening down the vibrations.”

“Another analogy,” continues Prof. Bowker. “Would be if you had a tube with cold water passing through it and you placed the tube in a hot water bath - energy from the hot bath would be transferred to the water passing through the tube. As a result, the temperature of the water in the tube would become warmer as it removes ‘hot energy’ from the bath. When you have a lot of these, they are able to remove much energy, as well as support the horse. It’s physics.”
To make it even clearer to the delegates, Prof. Bowker also compares these structures to the pneumatic tyre our cars ride on. The outside canvas (the tyre) equates to the ligaments and the blood vessels equate to the air in the tyre - they dissipate vibration and give the horse's chassis or bony column a smoother ride.

Prof. Bowker talks about the ‘good footed’ horse as one with healthy connective tissues that form secure chambers that protect the multitude of tiny vessels, to allow plenty of blood flow through the back of the foot to both support the horse and dissipate the vibration.

**Good and bad vibrations**

Prof. Bowker continues building the story that culminates in navicular syndrome. “What I want to show,” he says. “Is that horses that are riding on healthy feet are riding on these blood vessels and ligaments and, depending upon how the feet are trimmed or shod, the efficiency of the foot’s ability to dissipate energy and support may be compromised, so that not all of the impact energies are removed from the foot. As a result, the excess or “not removed” energies begin to affect the tissues within the foot.

“With navicular syndrome, the degeneration of the tissues by this excess energy has been significant, usually due to the long-term exposure of the foot to insults, to the point of clinical signs of lameness - the greater the vibration, the more you destroy the vessels, ligaments and connective tissues.”

Prof. Bowker goes on to explain that, in the human scientific literature, it is known that vibrations above 400 to 600 Hz cause blood vessels to constrict (the muscle in the wall of the blood vessels contracts and contain considerable amounts of collagen - the protein that yields gelatine.

Fibrocartilage is the stronger tissue, and is mainly found throughout the connective tissues of the lateral cartilage are slightly different; whiter in appearance and made of hyaline (transparent) cartilage and contain considerable amounts of collagen - the protein that yields gelatine.

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The functions of fibrocartilage are:

- **Support during stance (when the cuneate frog ligaments are under tension or being pulled)**
- **Protection of the microvasculature (by forming chambers, which act as conduits and enclosures for the vessels)**
- **Dissipation of energy: created energy on foot impact must be removed from the foot as it cannot be ‘magically absorbed’**

The cuneate frog and digital cushion are made of firm, yellowish fibrocartilage - a combination of fibrous and myxoid (mucinous in appearance) tissues.

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On the other hand, intrasosic vibrations are considered good for promoting blood flow and, therefore, movement that does not create excessive vibration has the potential to benefit the formation of healthy tissues.

Good and bad lateral cartilage

“I’ve shown before that the lateral cartilage of ‘navicular’ horses is quite thin,” says Prof. Bowker. At the level of the navicular bone, their lateral cartilage averages about 10% of the width of the foot and that’s a high number; the highest I’ve seen in navicular horses is 11% and most are 6-7% of the width of the foot.

“On the other hand, when you get these pretty good feet, the lateral cartilage is much thicker - about 25-35% of the width of the foot and they have a lot of vessels on the inside of that. That’s still true from what I published years ago. What happens with better feet is this tissue in the frog becomes more fibro-cartilaginous.”

Corn and cabbage

He continues: “15 years ago, I also published that the vessels always run inside the lateral cartilage.

At the time, I thought that the horses with bad feet (the ones that would later develop navicular disease) didn’t have an opportunity to develop good feet because they were not being stimulated properly. Now I realise what’s happening in these horses is the feet are starting to deteriorate in the early years of growth and development.

I have three-year-old racehorses and see significant changes in different parts of the foot. The foot hitting the ground creates vibration and, with a metal shoe or the hoof wall hitting a hard surface, the vibration is sky high. The lateral cartilage and the frogs start to deteriorate near the ground, the vessels start to deteriorate because of the vibration. This is why the pneumatic tyre is such a good analogy.

“When you go to navicular horses, the vessels get smaller and smaller and become constricted. When you learn that the vessels can remain constricted for days, you see how you get a progressive change to the tissues that depend on the blood being there to cushion and support the ligaments and bones, and dissipate the energy. The tissues change and turn to corn beef and cabbage - nothing that provides the horse with any support.

Most studies emphasise that the palmar hoof (the back part) is an important shock absorber because it is made of elastic, fat, connective and myxoid tissues, and an extensive microvasculature. Prof. Bowker remarks that, by its own nature, fibro-elastic tissue alone dissipates little energy, which is why he attributes this role to the blood that flows through many tiny blood vessels in the same area. Fluid that flows through very thin tubes does have the capacity to attenuate vibration.

Curse of the long toe

Add a long toe to reduced blood flow and degeneration of the palmar tissues and, according to Prof. Bowker, you quickly understand the damage seen in the navicular apparatus. He talks to the hoof care practitioners in the audience: “I am sure that most of the horses you come into contact with have long toes and that’s part of the problem.

“A long time ago, we did an experiment where we placed pressure sensitive tape between P2 (second phalanx) and P3 (coffin bone), between P2 and the navicular bone, as well as between the navicular bone and P3. We then simulated the posture typical of a broken back, a short or long toe, and we showed the pressures and forces are significantly higher between P2 and the navicular bone, and between the navicular bone and P3.

“Between P2 and P3, there is no change in stress. The stresses are where the navicular bone is because of the anatomy of the joint, which is an eccentric joint.”

Prof. Bowker gives delegates a quick anatomy lesson explaining the part of the joint that rides on the navicular bone is much larger, creating an eccentric joint and potential problems if the foot is not loaded properly. Most illustrations on the anatomy of this joint are based on a view where the bone is cut through the midline, where yes, P2 is shaped like a circle. When you go to one or the other side of the midline, the caudal bone surface of P2 is larger and this explains why a broken back axis significantly increases the pressure between these bones and stress on the navicular ligaments.

“In such a posture, the navicular bone and ligaments do not have an opportunity to relax or rest,” says Prof. Bowker. “The ligaments that suspend the navicular bone are under constant strain, constant stress and, over a period of time and in an effort to protect itself, the articular surface lays down tissue seen as tide marks - tredmarks are actually the formation of calcium within the joint cartilage.

“As a result, the joint loses its ability to dissipate energy, and causes pain as the excess vibration energy passes to the adjacent bones, ligaments and soft tissues. These effects are seen early on in the frog and then eventually in the navicular apparatus. These changes in the navicular bone are then seen in the radiographs in navicular horses.”

Conclusion

Prof. Bowker is adamant: “The crucial part is to reduce the vibration to the back of the foot. The frog has to make contact with the ground, the toe has to be kept short and the horse has to be provided with some sort of conformable surface, like sand or something that will conform to the shape of the foot and spread the load over the entire area.”

In other words, the horse has to be given the opportunity to ‘relax its feet’ or reduce the internal stresses. This, in particular, is the reason behind the principles now being applied by many horse owners of giving horses an area of deep pea gravel or river pebbles to rest on during the day, which Prof. Bowker equates to swapping your high heels for a pair of slippers, and of leaving the ‘dirt plug’ in the hoof or not cleaning the hoof out too regularly.

“Horses are not designed to walk on asphalt or cement on their hoof walls,” says he. “Even dry pasture will become hard and accentuate the vibration.”

As for the horses that are already compromised, Prof. Bowker says there is hope and that, given the opportunity, bad feet and navicular horses can adapt. This has a lot to do with the foot’s amazing ability to adapt, the wonders of the myxoid tissues contained in the frog and lateral cartilages, and of the massive numbers of blood vessels there. (Myxoid tissue are pre-stem cell tissues that have the ability to turn into the type of tissue the body requires, while the blood vessels have the ability to remove the impact energies away from the foot.)

It was a lot to take in one fascinating first session, but the picture got clearer throughout the two days as Prof. Bowker continued building the foot’s story over three more hour-long presentations. The common theme? Our care and management practices need to improve. Frog on the ground, conformable surfaces and keeping the toes short are now firmly etched into my memory! In a following issue, I will report on Prof. Bowker’s lecture on the sensory nerves and receptors in the horse’s foot.