CT in Equine Medicine: Another Revolution in Standing Resolution

Dr. Filip Vandenberghe is a partner and co-owner of the Bosdreef Equine Referral Hospital, based in Moerbeke-Waas in Belgium. Dr. Vandenberghe is an Equine Orthopedic Clinician and Associate of the European College of Veterinary Diagnostic Imaging. More than 15 years ago, he was a pioneer in the practical implementation of standing MRI in horses and is now considered a global expert in this field. In his daily work, Dr. Vandenberghe receives elite sports horses from all over the world. His focus is on detecting and managing mild pathology that can potentially limit the maximum performance of horses. In particular, the crossroads between orthopedics and neurology. With the installation of a new, Aquilion CT platform from Canon Medical last year, he is once again, leading a new revolution in equine diagnostic imaging.

Diagnostic imaging in veterinary medicine is, just as in human medicine, a discipline that is in permanent evolution. Technology that is introduced in humans quickly finds its way to the veterinary world. However, whereas humans all have a similar anatomy, the size and weight of animals differ widely. A veterinary radiologist working with horses faces two major challenges. Horses are tall and heavy, and they won't lay still on a table on command. It takes creativity and technology to adapt existing imaging modalities to be used in equine medicine, but once those tweaks are successfully made a whole new world of diagnostic capabilities opens up, and evolutions become revolutions.

The horse in diagnostic imaging

Horses have in a specific place in the veterinary world. Just like companion animals, such as dogs and cats, they have a high emotional value to their owners, and are part of the family. However, due to their use in all different equestrian disciplines, such as racing, show-jumping, dressage or reining, they also often have a very high financial and economic worth. The equestrian world has professionalized largely over the last decade, becoming a more solid industry with high financial interests. The value of the individual highly successful sports horse has increased enormously, to exceed multiple millions of euros. A high emotional or financial value of the individual animal implies a demand and need for state-of-the art veterinary medicine, including the most advanced diagnostic modalities. Whereas imaging was mainly limited to radiography and ultrasonography before the year 2000, MRI, CT and nuclear medicine are now part of the daily routine in a well-equipped equine hospital.

In contrast to companion animals, there's a certain hesitation in placing horses under general anesthesia for diagnostic purposes. Although very low, the risk of injury at recovery is present. Horses have to stand up when they come round from anesthetic. They cannot 'stay in bed' to recover. They are brought into a soft-padded recovery room and they are assisted with ropes when they rise. However, because of their 'flight behavior' they

can panic and injure themselves, and even break a limb in a worst-case scenario. As part of a good risk assessment, most of the diagnostic procedures involved in equine veterinary care are preferably performed on the standing horse under light sedation. If technology is adapted in such a way to be able to be performed on a standing horse, the case load increases enormously, and it revolutionizes our understanding of several pathologies.

Over 15 years ago, Bosdreef Hospital was one of the global pioneers working with an equine dedicated standing MRI system. Today, standing MRI has become the gold-standard in equine MRI. Today, we are working hard on the practicalities of performing standing high quality CT and setting the new standards in equine CT. Anatomical limitations or when an examination on the standing horse is not safe to the operators are two major reasons to put a horse under general anesthesia for a diagnostic procedure. Careful assessment of the potential risks to the horse or the operator, the diagnostic value of the obtained information, the ease of the procedure and the price, are essential in the case selection.

The platform and the gantry in a low position.

Horses are used in equestrian sports as true athletes. Modern equine sports medicine focuses strongly on prevention and early detection of injuries. As a consequence, diagnostic imaging has a strong focus on the musculoskeletal system.

Detailed imaging of bone, cartilage, ligaments, muscle and tendon requires, next to radiography and ultrasonography, the implementation of MRI and CT in the diagnostic work up of the sports horse.

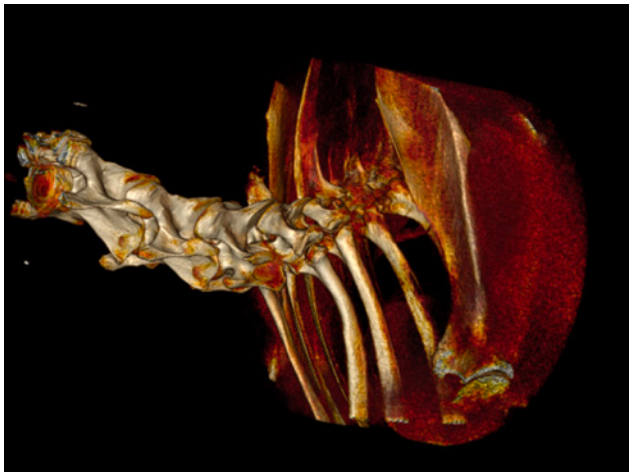
The platform and gantry in a high position to scan the head of the standing horse.

Positioning to scan the caudal neck and cranial thorax.

The horse and CT

For over 20 years, human CT devices have been used in equine medicine. To support the heavy weight of a horse, a dedicated large table is mounted over the original couch and the horse's limbs and head are scanned under general anesthesia. The possible volume to be imaged is limited to the size of the gantry. The development of large bore gantries in human imaging has allowed major progressions in equine imaging. It is now possible to scan more volume and, thus, different anatomical regions of the horse.

In a second phase of development of equine CT procedures, horses' heads were scanned standing. The horse is stood on a movable trolley, while under sedation. The trolley is located on the opposite side to the gantry, and connected to the original table coach. The horses head rests on the original table coach. As such, the horse is pulled or pushed through the gantry, while being scanned. To correct for the height of the standing horse, either the gantry is being placed on a higher fixed platform, or the trolley with the horse is sunk into the ground slightly with an elevator system. After some years, an update was made to this procedure by using sliding gantries. So the horse and trolley didn't have to move, but the gantry moved over the horse. A combination of both methods is still used in the majority of equine hospitals. Scanning under general anesthesia at one side of the gantry and scanning standing heads using the other side of the gantry.



3D reconstructed image of the caudal neck and cranial thorax.

In an attempt to image larger volumes in the standing horse, several cone beam systems have been introduced to the market with a gantry size of over one meter. Often a small field of view is obtained, and information is limited to bone with a relative low resolution. Similar systems mounted on robotic arms can image the distal limb of the standing horse, but resolution remains low. For a small selection of indications, and dependent on the case load, those systems might have their value, although technological advancements are still required.

Recently Qalibra and Canon Medical have brought a system to the equine market that serves many needs. A Canon Medical Aquilion Large Bore CT is mounted on a movable platform. The platform, with the gantry on it, can move up and down and back and forth. The platform is connected to the original moving system of the patient couch.

Scanning the equine stifle.

Sagittal reconstruction of a stifle showing contrast uptake in a medial meniscal tear.

While scanning the platform moves, and the gantry acts like a sliding gantry. The whole construction is mounted in a pit, so that the gantry can be positioned really low or very high. The platform allows high-quality imaging of the distal limb and the head and proximal neck in the standing horse. Under general anesthesia, any volume under 90 cm can be imaged. Essential to the set-up is that the horse is always in a safe position. The versatility of this system, in combination with the high-quality of the images obtained, will convince more hospitals, like Bosdreef, to install it and use CT on a daily basis. It will boost the use of CT in equine orthopedics and help us understand pathologies better, develop new treatments and improve our standards in high-quality care.

The distal limb

In over 70% of the cases of front limb lameness, the site of pathology is located in the distal limb. This means from the carpus down to the foot. The site of pain is localized to a specific region by diagnostic anesthesia. Standard imaging, like radiography and ultrasonography, often delivers the diagnosis, but more and more offen advanced imaging is required to diagnose or to better document the diagnosis. MRI and CT are of invaluable help in the foot especially, where the hoof-capsule limits the ultrasonographic examination options. Standing MRI has been in use for many years and continues to clarify a lot of pathologies encountered in sports horses.

"I believe this setup of gantry and platform will powerboost the use of CT in Equine Medicine."

Dr. Filip Vandenberghe , Bosdreef Equine Referral Hospital, Moerbeke-Waas, Belgium

Contrast CT of the DIP joint, acquired standing, showing a cartilage defect.

Scanning the distal limb standing.

Bone edema and soft tissue pathology are well-documented by MRI. With the implementation of standing high-quality CT in our hospital, we are now getting better at identifying subtle new bone formations, osteochondral fragmentation and hoof-capsule-related problems. The ease of use to perform contrast arthrography in the standing horse allows us to evaluate critically the integrity of the joint cartilage. No other previous system has delivered enough detail in the standing horse to pick up small cartilage erosions. With the speed and ease of the standing distal limb procedure, we believe CT imaging will over time partly or fully replace the radiographic studies of the distal limb.

The proximal limb

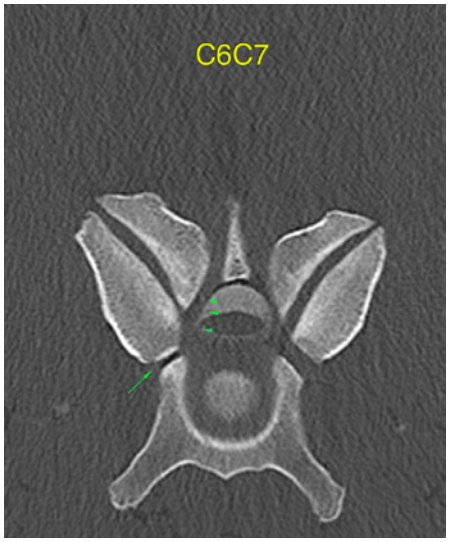
Imaging of proximal limbs always requires general anesthesia. Before the use of large bore gantries and moving platforms, imaging the more proximal regions was challenging and horses were literally squeezed into the gantry, in often very 'unphysiological' positions. Horses are heavy, and re-positioning a horse requires several people, and is often time consuming. In the new Qalibra system, the gantry can sink deep enough in the designated pit, and the horse can easily and safely be positioned on cushions on the ground. Easy positioning and short scan times reduce the time of general anesthesia and thus the risk on post-anesthetic complications.

The stifle is an especially interesting joint, for which 3D multi-slice imaging improves the diagnostic capabilities over radiography and ultrasonography. Open magnet low field MRI systems allow visualization of the equine stifle as well, but are often very time consuming. Stifle contrast CT is a fast procedure. The equine stifle is, like in another species, a complex joint that consists of several joint compartments, menisci and multiple ligaments. Just like knee trauma in human athletes, stifle injury in horses often implies damage to multiple structures, such as the medial menisci, the menisco-tibial ligament, or the cruciate ligament. Evaluation of the cartilage dictates the long-term prognosis. Contrast CT of the stifle on our hospital is mostly followed by an arthroscopy in the same general anesthesia.

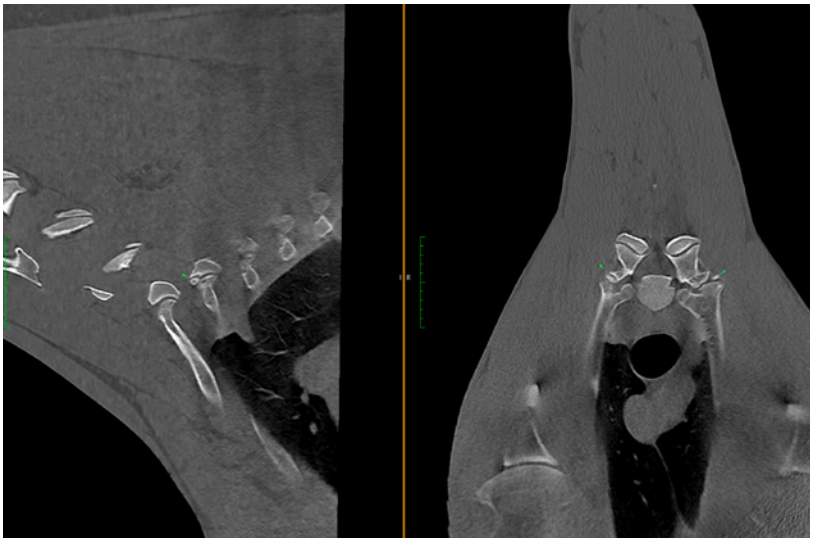
The neck

The neck of the horse is an anatomical region that has been neglected for many years in the diagnosis of performance issues. Nevertheless, it plays essential role in the biomechanics of the horse. Neck pathology can almost mimic any other pathology of the musculoskeletal system. A wide range of clinical signs can be directly or indirectly related to a reduced neck function. Horses can display stiff movement and become short gaited with a complete lack of hind limb propulsion, due to neck pain. In chronic cases, the behavior of the horse while being ridden can change, or they can even become very violent when certain exercises are asked of the horse. Arthropathies of the dorsal synovial facet joints often underpin neck pain. Soft tissue injury to the cranial neck (nuchal ligament origin, semispinalis tendinopathy, nuchal bursitis, etc.) can be diagnosed as well.

The presence of the spinal cord, spinal nerves and brachial plexus often explains neurological signs seen in combination with neck-related pathology. Congenital cervical vertebral malformation has been well-documented before as being a cause of spinal cord compression and ataxia, through diagnosis with (contrast-) radiography. The so-called 'wobblers'. Today, acquired ataxia caused by degenerative arthropathies in adult active athletes are diagnosed much more. Spinal cord compression is visible at the axial margin of the dorsal synovial facet joints, due to joint effusion, capsule thickening and osteophytosis.



Frontal reconstruction of a contrast myelogram of a caudal neck, showing massive enlargement of the articular processes of C7 with dorsolateral compression at the axial lining of the dorsal synovial joint and with stenosis of the intervertebral foramen left.



CT image of the cranial thorax showing large fragmentation of the costovertebral joints.

3D CT contrast-myelography has the potential to more exactly define the exact site of spinal cord compression, opening a broader window of treatment opportunities. Enlarged articular facets with ventral new bone formation might induce stenosis of the intervertebral foramen and potential dynamic impingement on the spinal nerves where they leave the vertebral canal. Neuropraxis of the nerve might induce paresis of the front line, with a reduced cranial phase of the stride, or even stumbling at work. Spinal nerves originating from the segments C5 up to T2 form the branchial plexus, being closely located ventral to the first thoracic vertebrae. From the plexus, the different nerves innervate the thoracic limb part. Today, we are able to image the whole neck and up to the fourth vertebral vertebra in any adult sports horse. All visualized pathology in the region, including the costovertebral joints, can affect the movement of the front limbs. CT is of invaluable help in unraveling the puzzle in between lameness originating from musculoskeletal pain and neurological dysfunction. In the forthcoming years, our knowledge and understanding of this common site of pathology will increase significantly, thanks to the new generation CT systems now available.

Scanning the equine head.

The head

For many years, CT of the equine head has been performed in the standing horse. The head is a complex and large structure, and interpretation of a radiographic examination of the head is difficult. Mild pathology might remain undiagnosed, going lost in the superposition of many structures in 2D imaging. Dental pathology, such as caries, pulpitis, fractures or diastema might directly affect the sinuses and cause infectious sinusitis. Bad tooth management can rapidly affect the welfare of the horse. CT examination assists in the early detection of dental disorders, sinus masses, ethmoid hematoma's or possible causes of head-shaking. Little by little, CT is replacing the use of a full radiographic study of the skull. //