Contrast Enhanced Computed Tomography for the diagnosis of foot pain in horses.

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Computed Tomography (CT scan or CAT scan) is a medical imaging modality based on X-ray technology used to generate a 3 dimensional image.
This modality of cross sectional imaging allows us to get a deeper understanding of the structure of the body part being imaged

Fig 1: Horse anesthetized positioned on the CT table with left front limb in the gantry at the New England Equine Medical and Surgical Center

Using CT scanning, a great deal of information invaluable to diagnosis and treatment is gained, and this has been traditionally used to evaluate complex fractures, sinus and dental problems, bone infections, bone cysts and to plan tumor removal.

More recently using a technique developed at the **University of California Davis**, the use of **contrast enhancement** in the horse's leg allows us to clearly identify and evaluate subtle soft tissue lesions within the foot with a sensitivity equal or greater than most MRIs.
This technique is only used at a few referral hospitals around the world (2 in the USA), and we are proud to be the first and only one to use it routinely on the East Coast.
This is done by delivering contrast medium directly into the blood vessel irrigating the limb via a catheter placed under ultrasound guidance and using a high power injector to deliver the contrast as the scanner is acquiring images.
The major advantage of Contrast Enhance CT compared to MRI is the ability, using intralesional injection techniques (using Platelet Rich plasma, stem cells…), **to target precisely** the site of the delivery using CT guidance (which is not possible with MRI).

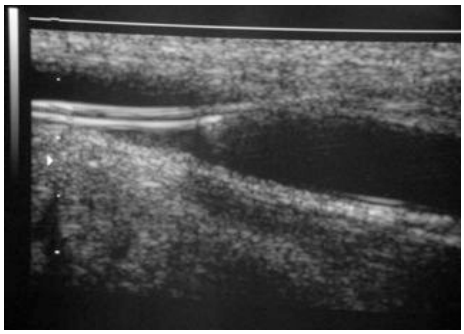

Fig 2 and 3: Catheter being placed under ultrasound guidance

Fig 4: Catheter being secure before optimal positioning of the limb using guiding laser beams

As case example, the horse seen on these pictures is a jumper with a history of left forelimb lameness. His lameness has been isolated to his foot as it resolved after palmar digital nerve anesthesia (nerve block). Without cross sectional imaging he would have been labeled as having “navicular disease”. Initially treated with corrective shoeing and coffin joint injections, he did not improve. Further blocks were performed at the New England Equine Medical and Surgical Center including digital flexor tendon sheath and navicular bursa blocks and results suggested a Deep Digital Flexor Tendon lesion within the foot. A contrast enhanced CT was advised and performed:

Fig 5: CT image without contrast.

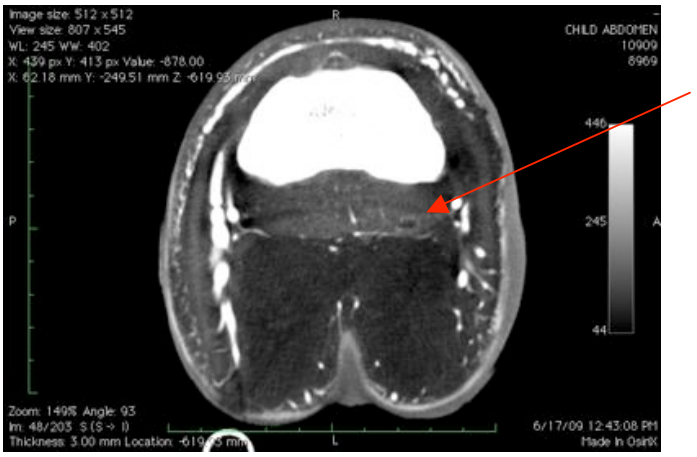

Fig 6: CT image with use of contrast enhancement: Note how obvious the small tear in the deep digital flexor tendon is (arrow)

Fig 7: Multiplanar reconstruction of the tendinous lesion showing its full extent (arrow)

Contrast Enhanced CT confirmed the suspected diagnosis, and allowed delivery of Platelet Rich Plasma (PRP) and stem cell rich bone marrow concentrate within the lesion to enhance ad speed up healing time

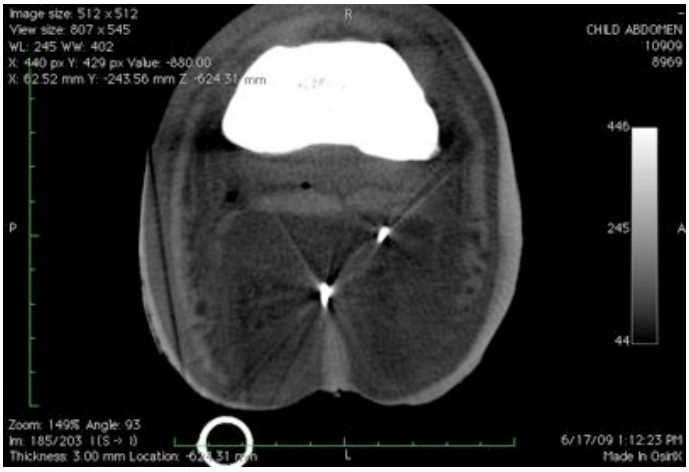

Fig 8: Needle being placed under CT guidance to allow precise delivery of healing enhancing agents

Clinicians at the New England Equine Medical and Surgical are pleased to offer this exciting diagnostic tool to our referring veterinarians and clients starting June 16th 2009.
CT scanning will be also very useful for evaluation of multiple other conditions including sinus problems, dental issues, fractures, bone infections, joint injuries, tumors, brain problems and neurologic problems.

Please do not hesitate to contact any of the NEEMSC clinicians with any questions regarding this new modality.

We are also excited to advertise that our **new Equine MRI** is now operational.

Please find attached:

1) The abstract of a study conducted by **Dr Omar Maher** and coworkers, Presented at the Annual *Symposium of the American College of Veterinary Surgeons* in 2007 on the **Use of Contrast Enhanced Computed Tomography for detection of deep digital flexor tendon lesion within the foot.**

2) The abstract of a study presented at the *Geneva Congress of Equine Medicine and Surgery*, in December 2007, by Dr Jack Snyder, **Dr Omar Maher** and Dr Sarah Puchalski on the **Diagnosis of soft tissue injuries of the foot using Contrast Enhanced Computed Tomography.**

DEEP DIGITAL FLEXOR TENDON INJURIES IN THE EQUINE FOOT

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The role and frequency of soft tissue injuries in horses with chronic palmar foot pain have become evident with the introduction and advent of cross sectional imaging of the horse's digit. Deep digital flexor tendon (DDFT) lesions are the most common soft tissue lesion in these horses and can be present as the only pathology or in conjunction with other osseous or soft tissue injuries.

Sport horses, particularly those used for jumping events (jumpers, hunters and three- day event horses), are the most commonly affected, although lesions are also occur relatively frequently in dressage, endurance and western performance horses and occasionally in pleasure horses. The typical history includes unilateral forelimb lameness that is alleviated by perineural anesthesia of the palmar digital nerves at the level of the heel bulbs (blocks to the foot). Often there has been a poor or temporary response to treatment with shoeing changes or medication of the distal interphalangeal joint or Navicular bursa.

Lameness severity ranges from 1 to 3 out of 5 on the AAEP lameness grading scale although occasional horses with very severe lesions present with a more severe lameness (4/5). Response to regional local anesthesia will differ slightly depending on the location of the tendon lesion within the digit. In our experience, this is especially true for palmar digital (PD) nerve anesthesia at the level of the heel bulbs and distal interphalangeal (DIP) joint anesthesia whereby the lameness may not completely resolve. More proximal injection of local anesthetic around the palmar digital nerves, at the level of the abaxial margins of the proximal sesamoid bones, will typically resolve the lameness. Digital flexor tendon sheath intra-thecal anesthesia will resolve or substantially improve the lameness with the exception of the insertional lesions where often only a partial improvement of the lameness is noted.

The clinical history and diagnostic anesthesia results will lead to a presumptive diagnosis of a soft tissue injury within the foot. In order to accurately assess the nature and extent of the injury diagnostic imaging must be employed. Routine diagnostics such as radiographs and ultrasound are useful in many cases. Radiographs commonly result yield negative results however a large number of lesions located proximal to the navicular bone can be reliably identified on ultrasound using a micro-convex probe positioned between the heel bulbs. Limitations to this technique are that the visible portion of the DDFT differs between horses depending on foot conformation and often only the proximal aspect of the lesion is visible so that documentation of the lesion's extent is not be possible. Moreover, ultrasound using this technique does not preclude the presence of another lesion more distal in the foot.

Advanced cross-sectional imaging modalities such as Magnetic Resonance Imaging (MRI) or Contrast Enhanced Computed Tomography (CECT) allow the visualization of the DDFT and its surrounding structures with a high reliability[1,2] and are therefore preferred. At UC Davis, both modalities (standing MRI and CECT) are available and can be used to compliment

each other; otherwise, CECT is preferred when a DDFT lesion is suspected as it allows therapeutic interventions (eg. CT guided intra-lesional injections).

Lesions of the deep digital flexor tendon are located (by order of frequency) in the distal pastern region (usually just proximal to the navicular bursa), at the level of insertion on the third phalanx or finally at the level of the navicular bone. Lesion types include dorsal fibrillation (typically at the level of the navicular bursa, with or without adhesions), lobe enlargement, core lesion and longitudinal splits[3].

A review of the medical records of horses recently diagnosed with DDFT lesions by means of CECT was performed. Sixty-one horses were identified. Other forms of cross-sectional imaging were used in their diagnosis including ultrasonography (30%), MRI (8%) or a combination of both (12%).

The lesions identified were located proximal to the navicular bone (43%), at the level of the navicular bursa (19%), at the level of the insertion onto the third phalanx (23%) or in a combination of proximal to navicular bone and insertion (11%) or finally combination of level of the navicular bursa and insertion (4%).

The DDFT tendon was the only lesion appreciated in 18% of the cases. Often accompanying lesions were identified including other soft tissue structures (27%) or bone (16%) or a combination of the two (39%).

Imaging characteristics included abnormal tendon density and contrast enhancement (32%), dorsal enhancement and fibrillation (28%), enlargement (9%), core lesions (21%), mineralization (5%) and also adhesions (5%).

Case management varies depending on lesion severity, location and the owners' wishes. In all cases, corrective shoeing and a 6 to 9 months rehabilitation program including periods of rest and controlled exercise are prescribed. In many cases intra-lesional injections are performed using CT guidance while the horse is under anesthesia, ultrasound or radiographic guidance while the horse is standing and sedated. Injections into the tendon are usually reserved for core lesions, longitudinal splits or enlarged DDFT lobes. The medications used in our hospital include bone marrow supernatant, fat derived mesenchymal stem cells, or platelet rich plasma. In cases where the predominant lesion involves either longitudinal splits or dorsal DDFT border fibrillation with or without adhesions debridement using tenoscopy or navicular bursoscopy[4] is performed. Acoustic shock wave therapy through a transcuneal approach is also used for treatment of DDFT insertion lesions.

1. Murray RC, Blunden TS, Schramme MC et al.:How does magnetic resonance imaging represent histologic findings in the equine digit? Vet Rad and Ultrasound 47:17-31, 2006
2. Puchalski SM, Snyder JR, Hornoff WJ et al.: Contrast enhanced computed tomography of the equine distal extremity. Proc Am Assoc Equine Pract 51: 389-397, 2005
3. Dyson SJ: Recent Developments in the Diagnosis of Foot Pain: What We Have Learned from Magnetic Resonance Imaging? Proc Am Assoc Equine Pract 50: ,2004
4. Smith MR, Wright IM, Smith RK: Endoscopic assessment and treatment of lesions of the deep digital flexor tendon in the navicular bursae of 20 lame horses. Equine Vet J 39:18-24, 2007

10th Geneva Congress of Equine Medicine and Surgery (Organization : Pierre A. Chuit, Founex; Dr Stephane Montavon, Avenches), Geneva (CH), 11-13 December 2007

DIAGNOSIS OF SOFT TISSUE INJURIES OF THE FOOT USING CONTRAST ENHANCED COMPUTED TOMOGRAPHY

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The role and frequency of soft tissue injuries in horses with chronic foot pain have become evident with the introduction and advent of cross sectional imaging of the horse's digit. Deep digital flexor tendon (DDFT) lesions are the most common soft tissue lesion in these horses followed by distal interphalangeal (DIP) collateral ligaments and impar ligament injuries. These lesions can be present as the only pathology or in conjunction with other osseous or soft tissue injuries.

Sport horses, particularly those used for jumping events (jumpers, hunters and three- day event horses), are the most commonly affected, although lesions are also occur relatively frequently in dressage, endurance and western performance horses and occasionally in pleasure horses. The typical history includes unilateral forelimb lameness that is alleviated at least partially by perineural anesthesia of the palmar digital nerves at the level of the heel bulbs. Often there has been a poor or temporary response to treatment with shoeing changes or medication of the distal interphalangeal joint or navicular bursa.

Lameness severity ranges from 1 to 3 out of 5 on the AAEP lameness grading scale although occasional horses with very severe lesions present with a more severe lameness (4/5). Response to regional local anesthesia will differ slightly depending on the location of the lesion within the digit. In our experience, this is especially true for palmar digital (PD) nerve anesthesia at the level of the heel bulbs and (DIP) joint anesthesia whereby the lameness may not completely resolve. More proximal injection of local anesthetic around the palmar digital nerves, at the level of the abaxial margins of the proximal sesamoid bones, will typically resolve the lameness. Digital flexor tendon sheath intra-thecal anesthesia will resolve or substantially improve the lameness caused by DDFT lesions with the exception of the DDFT insertional lesions where often only a partial improvement of the lameness is noted.

Horses with lesions of the collateral ligaments injuries will often not block to a DIP joint block

The clinical history and diagnostic anesthesia results will lead to a presumptive diagnosis of a soft tissue injury within the foot. In order to accurately assess the nature and extent of the injury diagnostic imaging must be employed. Routine diagnostics such as radiographs and ultrasound are useful in many cases. Radiographs commonly result yield negative results however a large number of lesions located proximal to the navicular bone can be reliably identified on ultrasound using a micro-convex probe positioned between the heel bulbs. Only the proximal aspect of the collateral ligaments of the DIP can be assessed ultrasonographically. Impar ligament injuries can be documented using transfurcal ultrasound, although this has not been reliable in our experience.

Advanced cross-sectional imaging modalities such as Magnetic Resonance Imaging (MRI) or Contrast Enhanced Computed Tomography (CECT) allow the visualization of the DDFT and its surrounding structures with a high reliability and are therefore preferred. At our institution, both modalities (standing MRI and CECT) are available and can be used to compliment each other; otherwise, CECT is preferred when a soft tissue lesion is suspected as it allows therapeutic interventions (eg. CT guided intra-lesional injections).

Lesions of the deep digital flexor tendon are located (by order of frequency) in the distal pastern region (usually just proximal to the navicular bursa), at the level of insertion on the third phalanx or finally at the level of the navicular bone. Lesion types include dorsal fibrillation

(typically at the level of the navicular bursa, with or without adhesions), lobe enlargement, core lesion and longitudinal splits.

Lesions of the collateral ligaments of the DIP occur at the origin or in the mid part of the ligament.

Imaging characteristics included abnormal tendon/ligament density and contrast enhancement, dorsal enhancement (DDFT) and fibrillation, enlargement, core lesions, mineralization and also adhesions.

Case management varies depending on lesion severity, location and the owners' wishes. In all cases, corrective shoeing and a 5 to 9 months rehabilitation program including periods of rest and controlled exercise are prescribed. In many cases intra-lesional injections are performed using CT guidance while the horse is under anesthesia, ultrasound or radiographic guidance while the horse is standing and sedated. Injections into the tendon/ligaments are usually reserved for core lesions, longitudinal splits or diffuse enlargement.

The medications used in our hospital include bone marrow supernatant, fat derived mesenchymal stem cells, cultured marrow derived mesenchymal stem cells, and platelet rich plasma. In cases where the predominant lesion involves either longitudinal splits or dorsal DDFT border fibrillation with or without adhesions debridement using tenoscopy or navicular bursoscopy is performed. Acoustic shock wave therapy and transcutaneoulsy for the origin of the DIP collareal liagement and through a transcuneal approach for treatment of DDFT insertion lesions and impar ligament lesions.