Incorporating computed tomography and positron emission tomography into equine practice.

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Cross-sectional imaging has made significant advancements in the last several years, allowing the versatile modalities to be adapted to equine practice. In the author's practice, computed tomography (CT) and positron emission tomography (PET) are frequently used to diagnose and manage pathological conditions resulting in lameness or poor performance.

The use of the modalities can be divided into diagnosis/prognostication, surgical treatment/planning, and monitoring response to therapy. Positron emission tomography is performed by injecting a radioactive compound specific to bone ^{18}F-sodium fluoride (NaF) or soft tissues utilizing glucose ^{18}F-fludeoxyglucose (FDG). The NaF molecules will bind to hydroxyapatite crystals in bone and reflect bone metabolic activity.[1] The FDG molecules are taken into cells via the glucose transporters.[2] Cells with increased metabolism will concentrate more FDG and appear brighter than other cells with regular metabolic activity. The detectors on the PET machine rotate around the distal limb and build a three-dimensional image with brighter areas of uptake corresponding to increased uptake of the radionucleotide. The author's practice utilizes NAF PET to diagnose distal limb bone injuries and FDG for soft tissue.[3–5] It has been very useful for diagnosing subchondral bone injuries and evaluating subchondral lucencies in the distal limb in both racehorses and sports horses, as well as various soft tissue injuries. Subchondral lucencies (SL) have been described in nearly every bone in the distal and proximal limb of multiple breeds, and subchondral bone injuries (SBI) have been associated with the development of osteoarthritis and lameness.[6–8] Positron emission tomography is utilized to aid in identifying and characterizing both SL and SBI. Lameness localized to the distal limb with minimal or equivocal findings on standard radiography and ultrasound undergo PET to rule in or out SBI or aid in determining if a visible SL has metabolic activity. Performance horses frequently have SL identified on the proximal first phalanx (P1) sagittal groove, or condyles, and the distal dorsal third metacarpal/tarsal (MC/T3) condyles. Computed tomography has also been employed by the author's practice for diagnosing pathological conditions of the distal limb, head, and cranial cervical spine standing and the upper limbs and axial skeleton under general anesthesia. It provides cross-sectional imaging and structural information and is often recommended when there is positive uptake on PET. The information gained on PET is generally metabolic or physiologic but does not give information on the structural integrity of the area of increased activity. Many horses with SL or SBI have structural abnormalities not observable on standard two-dimensional radiography. The CT findings help to prognosticate the injury and aid in determining treatment.

Computed tomography has long been utilized for surgical planning and guidance. In the author's practice, it is used to determine fracture configuration, plan for implant placement, and provide intra-operative monitoring and guidance. Many fractures occur in multiple planes or locations that are historically difficult to image in two dimensions. Preoperative planning with CT has been beneficial for third phalangeal fractures, complex fractures of the first and second phalanges, third metacarpus/tarsus, and carpal/tarsal joints. Intraoperatively, CT is employed to aid in placing screws in difficult-to-image subchondral bone lucencies and complex fractures.

Both CT and PET have also helped monitor injury. They are often repeated after treatment and rehabilitation to ensure the previous injury has healed or continues improving. Subchondral bone injuries have been documented to have decreased NAF uptake over time, which corresponds to bone healing. [9] Likewise, subchondral bone injuries and fractures will also show healing on CT over time, allowing recommendations for continued care or a return to exercise.

As with any new modality, clinical signs and imaging should be correlated to draw useful conclusions. As more practices and institutions incorporate cross-sectional imaging, the knowledge gained will continue to improve equine veterinarians' understanding of the disease processes and proper treatment.

1. Ahuja K, Sotoudeh H, Galgano SJ, et al. 18F-Sodium Fluoride PET: History, Technical Feasibility, Mechanism of Action, Normal Biodistribution, and Diagnostic Performance in Bone Metastasis Detection Compared with Other Imaging Modalities. *J Nucl Medicine Technology* 2020;48:9–16.

2. Basu S, Hess S, Braad P-EN, et al. The Basic Principles of FDG-PET/CT Imaging. *PET Clin* 2014;9:355–370.

3. Spriet M, Espinosa-Mur P, Cissell DD, et al. 18F-sodium fluoride positron emission tomography of the racing Thoroughbred fetlock: Validation and comparison with other imaging modalities in nine horses. *Equine Vet J* 2019;51:375–383.

4. Spriet M, Arndt S, Pige C, et al. Comparison of skeletal scintigraphy and standing 18F-NaF positron emission tomography for imaging of the fetlock in 33 Thoroughbred racehorses. *Vet Radiol Ultrasoun* 2023;64:123–130.

5. Spriet M, Edwards L, Arndt S, et al. Validation of a dedicated positron emission tomography scanner for imaging of the distal limb of standing horses. *Vet Radiol Ultrasoun* 2022;63:469–477.

6. Santschi EM. Equine subchondral lucencies: Knowledge from the medial femoral condyle. *Vet Surg* 2024;53:426–436.

7. Lesca H, Fairburn A, Sherlock C, et al. The use of advanced vs. conventional imaging modalities for the diagnosis of subchondral bone injuries. *Equine Vet Educ* 2022;34:443–448.

8. Cruz AM, Hurtig MB. Multiple Pathways to Osteoarthritis and Articular Fractures: Is Subchondral Bone the Culprit? *Veterinary Clinics of North America: Equine Practice* 2008;24:101–116.

9. Pye J, Spriet M, O'Brion J, et al. Longitudinal monitoring of fetlock lesions in Thoroughbred racehorses using standing 18F–sodium fluoride positron emission tomography. *Am J Vet Res* 2022;83.