# MUSCULOSKELETAL SCINTIGRAPHY IN HORSES

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#### INTRODUCTION

Equine scintigraphy was first used 40 years ago in Switzerland and has widespread use since its introduction. Scintigraphy in the horse is mainly utilised to evaluate the metabolic activity of bone and surrounding soft tissues in the investigation of orthopaedic issues. Radionuclide, usually technetium 99m bound to a bone seeking agent (diphosphonate- HDP or MDP) forms a radiopharmaceutical that is injected into the horse. Images are acquired using a gamma camera (Figure



Figure 1: Gamma camera acquiring images at Curragh Equine Diagnostics.

radiation emitted from the decay of the radionuclide. Areas of increased bone activity (ie. more osteoblasts) bind increased amounts of radiopharmaceutical, with a corresponding increase in radiation emission from this area. The amount of gamma rays emitted over the

1), which detects gamma

acquisition time are counted for each pixel of the camera acquisition area to create a corresponding image. The number of counts per pixel is translated into a two-dimensional image representing the amount of radiopharmaceutical uptake for a specific anatomical area, with regions of increased uptake viewed at proportionally greater intensity. Imaging at different time points post injection allows for imaging of vascular (0-2 minutes), soft tissue (15-30 minutes) and bone (1.5-3 hours) structures.

Scintigraphy offers a graphical representation of the physiological status of the musculoskeletal system, allowing for detection of pathological changes in metabolic activity of bone. These changes in physiological status can be detected earlier in the disease process and prior to the presence of any anatomical changes that may be detected on conventional imaging such as radiography and ultrasonography. Scintigraphy does not offer detailed anatomical information, however it can aid in directing the clinician toward focused use of additional diagnostic modalities, such as radiography, ultrasonography, MRI or CT as, and where appropriate. The ability of scintigraphy to be performed in the standing horse and to allow a full skeletal assessment offers advantages over other advanced diagnostic techniques such as MRI and CT, which are generally focused on a specific region of interest and limited to the distal limb, head and neck in the standing horse.

### **INDICATIONS FOR USE**

Scintigraphy generally constitutes part of a broader orthopaedic examination including the clinical examination, review of the case history and results of other diagnostic tests. Scintigraphy is useful in cases where:

- Diagnostic anaesthesia has not localised the lameness;
- Diagnostic anaesthesia cannot be safely performed due to dangerous behaviour;
- Intermittent or episodic lameness where interpretation of diagnostic anaesthesia is clinically unreliable;
- Severe lameness where a fracture is suspected;
- Lameness has been localised to an area and other imaging modalities have not detected pathology;
- Multi-limb lameness;
- Imaging of areas not easily penetrated by other imaging modalities including the upper limbs, axial spine and pelvis are required; and
- Screening of the entire skeleton in cases of unexplained poor performance.

#### IMAGE PROCESSING AND INTERPRETATION

Presently, clinicians have a good understanding of scintigraphy's diagnostic capabilities and limitations, the expected variations between horses of different ages and uses, of the predilection sites for injury, and the types of injuries diagnosed with specific sites of increased radiopharmaceutical uptake. The newer scintigraphy machines require minimal post acquisition processing to obtain an image of diagnostic quality, with digital systems providing motion corrected images (summated dynamic acquisitions) at the time of acquisition. 'Count stealing,' where a structure, typically bladder or a physis, can have such intense uptake that the remaining structures in the field of view are poorly visualised. This phenomenon can be easily corrected by cropping the offending structure from the image when processing to allow representation of the remaining



structures. Acquiring images dynamically over a set period of time, rather than a set number of counts, results in no loss of detail in images where cropping of structures that are count stealing is performed. Image interpretation can be subjective or objective. Some cases

Figure 2.



Figure 3: Profile analysis of the pelvis in a horse with a stress associated bone injury of the caudal aspect of the axial aspect of the right ilial wing.

have obvious pathology that requires no more than subjective analysis, however care must be taken not to miss pathology. Appropriate cropping and equilibration of image intensity is often all that is required. Objective measurements usually involve either region-of-interest measurements to quantify the number of counts per pixel (see Figure 2), or profile analysis to provide a graphical representation of radiopharmaceutical activity (Figure 3).

#### SCINTIGRAPHY IN THE RACEHORSE

Welfare of racehorses is, rightly, an issue at the forefront of racing, with increased focus from regulatory bodies and mounting media and public attention of late. While a significant amount of research efforts have been directed toward orthopaedic injuries in racehorses<sup>1</sup>, the use of scintigraphy at the individual horse level remains one of the most useful of diagnostic modalities in detecting bone pathology prior to complete fracture or catastrophic injury. Understanding that a significant proportion of catastrophic fractures in racehorses are the end point of cumulative stressassociated changes in the bone, and not the so called 'bad step' that is often blamed for such an injury, is fundamental into appreciating the usefulness of scintigraphy in detecting this pre-fracture pathology. Veterinarians and trainers have a significant role to play in selection of cases that warrant further investigation. This is not always an easy task and not every fracture in racehorses is going to be prevented by improved screening. As a profession and an industry, we should aim to be doing everything within our compass to minimise the occurrence of fractures in the race horse. It is only via thorough investigation of lameness cases will we improve our detection of these 'at-risk' individuals.

Stress-associated bone injury, stress fractures or pre-fracture pathology is commonly detected on scintigraphic examination of racehorses. Numerous studies have reported predilection sites in the racehorse, with lesions in the cannon, tibia, humerus and pelvis commonly seen (Figures 4-7). These sites are usually high on the list of differential diagnoses when dealing with acute onset moderate to marked lameness in the racehorse. Initial investigation of these cases usually involves nerve blocks (if the lameness is of an acceptable grade), screening radiographs of predilection sites, and if it is a hindlimb, transcutaneous ultrasonography of the pelvis, whereas a forelimb has ultrasonographic assessment of the proximal caudal aspect of the humerus and scapula. Negative findings on this initial investigation warrant a scintigraphic







Figure 5: Tibial stress fracture in the proximal caudal cortex of the left tibia.



Figure 6: Stress fracture in the distal diaphysis of the right humerus. Another predilection site in the humerus is the proximocaudal diaphysis.



Figure 7: Stress fracture of the left ilial wing of the pelvis. Note the relative increased uptake in the caudal aspect of the fracture line compared to more cranially. These fractures on the commonly originate from the caudal aspect and propagate cranially. Figure 4: Stress fracture in the palmar cortex of the distal condyle of the metacarpus. The fracture was not evident on flexed dorso-palmar radiographs of the fetlock at the time of presentation/scintigraphy (but was confirmed radiographically at sixweek re-assessment).

examination to determine whether there is any pathology present. Failure to detect significant pathology may allow the trainer to manage these cases in continued training without increased risk of catastrophic injury. In cases where stress fractures are diagnosed, repeat region-ofinterest scintigraphic examination can be performed and are useful to accurately determine the readiness for the individual to return to training exercise. When performing the image acquisition, tangential views of each region are acquired, in addition to specialist views such as flexed lateromedial of the fetlocks to separate the sesamoids and palmar/ plantar condyles of MC/ T3, or solar views of the feet where indicated. It is important that the examination involves complete assessment of associated musculoskeletal structures. For example, if only a forelimb lameness is being screened, the entirety of both forelimbs, neck and cranial thoracic structures should be

acquired. Conversely if a hindlimb lameness is



Figure 8: Dorsal 60 degree lateral oblique projection of the lumbar spine of a horse with acute onset right hind lameness. This horse has lumbar vertebral lamina stress fracture. This horse additionally had significant increased radiopharmaceutical uptake of many thoracic spinous processes.



Figure 9: An enostosis like lesion in mid to proximal tibia. There is a focal increased uptake evident in intramedullary bone on both lateromedial and caudocranial acquisitions.

being screened the thoracolumbar spine and ribs need to be included in this assessment (Figure. 8). Enostosis like lesions are detected with moderate frequency in the racehorse population (Figure 9). These lesions are usually located in medullary or enosteal bone. Enostosis like lesions can be variably associated with lameness with equally varying rates of association (23-71%) reported in the literature.<sup>2-5</sup> Radiographic changes (a focal area of increased radiodensity in the medullary/ enosteal region ) are frequently present when enostosis like lesions are detected on scintigraphy. These can frequently remain even once lameness has resolved and radiopharmaceutical uptake reduced.

## SCINTIGRAPHY IN THE NON-THOROUGHBRED

Scintigraphy in the nonthoroughbred sport or pleasure horse can be more challenging to determine causes of lameness where cases often present as subtle, low-grade, multi-limb lameness of chronic duration. Scintigraphic examination of sport horses has been reported to have a low

sensitivity and high specificity.<sup>6</sup> Frequently, multiple sites of increased radiopharmaceutical uptake are detected, however not all sites are diagnosed as a source of pain, yet reassuringly,

if the site is a source of pain, it is likely to have increased radiopharmaceutical uptake. These investigations are most rewarding when used in conjunction with complementary imaging modalities and diagnostic anesthesia where possible. The use of objective image assessment, such as region of interest studies on structures, for example the articular process joints in cases with reported back pain, can assist in determining the severity of disease.

In summary, scintigraphy is a very useful tool in our diagnostic armoury. It is the only imaging modality that allows a complete overview of physiological status of the equine skeleton. Whilst useful in assisting lameness diagnosis in all horses, scintigraphy has a particularly important role to play in improving racehorse welfare.

References available on request. All images provided by Curragh Equine Diagnostics.