DIAGNOSTIC VETERINARY IMAGING USING MICRO-IMAGING PLATFORMS

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Introduction

Introduction: Functional and anatomic imaging techniques such as positron emission (PET) and x-ray computer tomographies (CT), respectively, have revolutionized the practice of medicine by providing non-invasive methods to detect pathology and monitor the progression and regression of disease. PET imaging of ^{18}F-fluorodeoxy glucose (^{18}FDG) has provided a rapid and quantitative means of monitoring response to therapy that provides early feedback to the physician enabling expeditious changes in the therapeutic strategy to benefit the patient. These same advantages are also available to veterinarians who evaluate animal images acquired on human clinical CT, MRI, and PET scanners. Although the spatial resolution of these imaging platforms is adequate for diagnostic imaging of most companion animals, many smaller species such as birds, pocket pets, and small dogs and cats may benefit from higher resolution micro imaging.

Methods: We have utilized small animal imaging microCAT II, microPET P4 and Inveon tri-modality platforms to image unconventional small animals. The patients were generally anesthetized with isoflurane and image data acquired over ~ 10 min for CT or ~ 20 – 40 min for whole body PET imaging. Although limited by relatively small fields of view, as compared to clinical scanners, the sub-millimeter resolution affords unprecedented detail in the images.

Results: Here we present anatomic studies that include a male guinea pig with osteomyelitis; various wild or client-owned avian species with skeletal abnormalities including a peregrine falcon with a malaligned lower mandible and a cockatiel with a short, oblique, mid-diaphyseal femoral fracture; and a California King snake with a fibropapilloma.

Conclusion: These studies demonstrate the utility of small animal imaging platforms capable of sub-millimeter resolution for diagnostic veterinary imaging of small and exotic animals. Furthermore, we have demonstrated that CT imaging of large avian species using these small FOV platforms does not result in out-of-field-of-view artifacts.

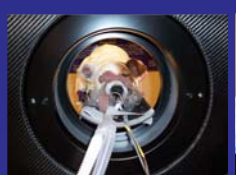
Micro-Imaging Hardware

Inveon SPECT/PET/CT scanner
SPECT resolution ~ 1.0 mm
PET resolution ~ 0.7 mm
CT resolution ~ 0.025 mm

ImTek SPECT/CT scanner
SPECT resolution ~ 1.5 mm
CT resolution ~ 0.05 mm

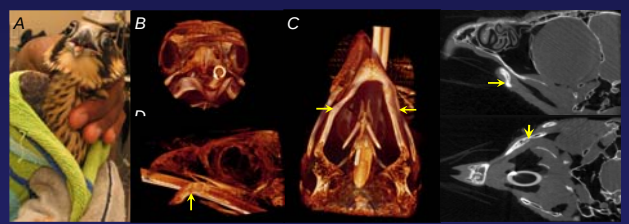
microPET P4 scanner
PET resolution ~ 2.5 mm

Practical Issues



1. Heavier or longer animals require increased support or lengthening of the imaging bed, respectively.
2. Anesthesia and intubation tubing as well as monitoring leads need to be managed.
3. Veterinary staff handle all the manipulations of the patient.
4. There is often significant out of FOV material when the microCT is used which variably affects the image quality.

Peregrine Falcon (*Falco peregrinus*): *microCT*



The falcon (*A*) was found in a parking garage in Atlanta, GA and brought to the University of Tennessee College of Veterinary Medicine for evaluation. The bird was found to have a malaligned lower mandible, but if the break was not completely healed it would be possible to reset the fracture and provide some relief to the bird, but this could not be assessed radiographically using conventional clinical CT imaging. Images of the head (*B-F*) were therefore collected using the microCAT II. 3D renderings (*B-C*) clearly delineated the malalignment. The planar sagittal (*E*) and coronal (*F*) images indicated the fracture had healed beyond reparation and no further clinical action was taken.

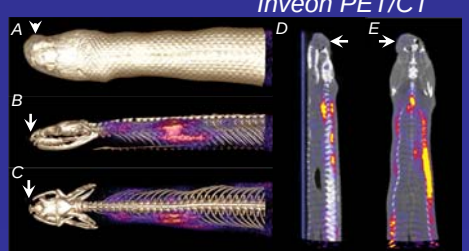
Cockatiel (*Nymphicus hollandicus*): *Inveon CT*

This 13 year old cockatiel was attached by a dog the day before presentation; he was unable to stand and hind limb and/or spinal trauma was suspected. The microCT study showed a normal spine, without evidence of fractures or luxations, and an oblique, severely overridden fracture of the mid-diaphysis of the left femur, with lateral displacement.

Guinea pig (***Cavia porcellus***): *Inveon CT*

This 2 year old male guinea pig had a chronic history of left lagophthalmos and partial left facial nerve paralysis. The microCT scan documents pronounced destruction of the occipital and temporal bone (arrows), thickening of the adjacent calvarium, and smooth thickening of the left tympanic bulla and left petrous temporal bone. Multiple osseous at the level of the cranial cavity were clearly identified. This findings are consistent with severe chronic left otitis media and interna with osteomyelitis/abscessation and invasion into the cranial vault.

California King Snake (***Lampropeltis getula californiae***): *Inveon PET/CT*

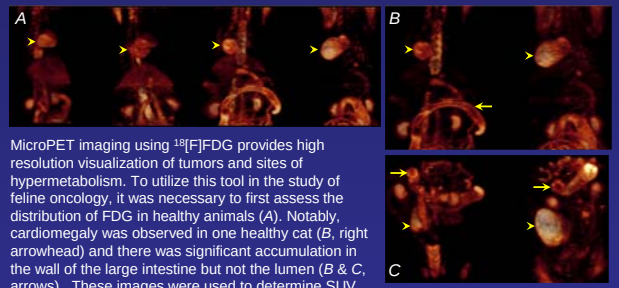


12-year old, female California king snake that presented for a 2 week history of the presence of a mass extending from the cranial aspect of the right eye to the rostrum. Cytologic evaluation of a biopsy suggested the mass was either fibroplasia or a well differentiated sarcoma. PET/CT imaging using ^{18}FDG revealed no hypermetabolic activity in the lesion. The patient did not respond well to intralesional carboplatin and was euthanized approximately three weeks later. The final diagnosis was a multicentric anaplastic sarcoma with pulmonary and renal metastases.

Amazon Parrot (*Amazona sp.*): *microCT*

The patient presented with paresis particularly in the lower limbs. Cardiac function was shown to be normal, therefore a spinal injury was suspected and the bird was referred for a microCT evaluation. Although the bird was ~ 400 g with an axial diameter greater than the CT FOV, images were acquired that were of diagnostic quality and excellent resolution. Beam-hardening artifacts were mild and due to the tracheal cartilage and grit in the gizzard. The lung architecture was readily imaged (*A*) as was a suspected abnormality in the lower vertebrae (arrows in *B-D*). These data indicated that relatively large avian species can readily be imaged using a microCT scanner with no loss of image resolution even with significant out of FOV material, presumably because of the low attenuation afforded by the feathers and bone.

Domestic Cat (*Felis catus*): *microPET*



MicroPET imaging using ^{18}[F]FDG provides high resolution visualization of tumors and sites of hypermetabolism. To utilize this tool in the study of feline oncology, it was necessary to first assess the distribution of FDG in healthy animals (*A*). Notably, cardiomegaly was observed in one healthy cat (*B*, right arrowhead) and there was significant accumulation in the wall of the large intestine but not the lumen (*B* & *C*, arrows). These images were used to determine SUV values for major organs in healthy animals.

Image Gallery: *microCT*

Screech Owl (*Megascops sp.*)

This bird was brought in with a suspected fractured mandible. CT imaging did not reveal any abnormalities.

Box turtle (*Terrapene carolina*)

The turtle was suspected of having a broken mandible. After CT imaging was clearly visible in both 3D and planar rendering.

Green Sunfish (*Lepomis cyanellus*)

Following the TVA Kingston Fossil Plant ash spill, fish were examined by CT to assess whether physical abnormalities had occurred. None were found.

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