

REVIEW ARTICLE

VETERINARY NUCLEAR MEDICINE.
SCINTIGRAPHICAL EXAMINATIONS – A REVIEW

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Abstract

Balogh L., G. Andócs, J. Thuróczy, T. Németh, J. Láng, K. Bodó, G. A. Jánoki: *Veterinary Nuclear Medicine. Scintigraphical examinations – a review.* Acta Vet. Brno 68, 1999: 231-239.

A review is presented of Veterinary Nuclear Medicine focusing on scintigraphical examinations. Most frequently applied clinical examination protocols are described, i.e. bone, thyroid, hepatic, renal, brain, cardiac and pulmonary scintigraphy, as well as oncological and inflammation scintigraphy, and miscellaneous scintigraphical examinations. Emphasis is placed on the types of procedures and the clinical information gained therefrom. No attempt is made to present or justify procedural details concerning instrumentation, radiopharmaceutical preparations, kinetic or radiation safety aspects. Detailed examinations are described following a schematic framework as: radiopharmaceuticals, examination protocol, indications and data evaluation, and illustrations. All the illustrations were taken between 1995 and 1999 from the data archive of the authors.

Veterinary nuclear medicine, scintigraphy, companion animals

Veterinary Nuclear Medicine procedures can be subdivided into two main categories: *isotope diagnostics* (called also *scintigraphy*) and *radiation (isotope) therapy* (Hightower 1986), similar to the situation in human medicine. In the present paper the focus is on the first category.

In isotope diagnostic procedures substances containing a radioactive label – the *radiopharmaceutical* are required. The label ideally is a gamma radiation-emitting isotope, has a short physical half-life, its chemical characteristics are suitable for stable labelling of different materials, and is economical as well. According to the above listed requirements the most frequently used isotope has recently been ^{99m}Technetium (^{99m}Tc) in both human and veterinary scintigraphical procedures. Radiopharmaceuticals are formulated in various physicochemical forms to deliver the radioactive atoms to particular parts of the living organism. Once localized, the gamma radiation emitted from the radiopharmaceutical will be available for external detection and measurement. Radiopharmaceuticals (there are more than 30 only in the Hungarian market) are applied parenterally or, less frequently, orally.

The primary equipment used for detection is the *gamma camera* (scintillation camera, Anger camera) attached to or built in a personal computer. Whole body and SPECT (single photon emission computer tomography) procedures need the most developed instrumentation, the so called *SPECT-camera*, where the detector can be moved by the computer to allow imagine three-dimensional distribution of radiopharmaceutical and

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a better sensitivity and resolution of picture quality. Figs 1 and 2 (Plate I) show a gamma camera and a whole body / SPECT camera at work.

There are many types of nuclear medicine procedures also in the everyday clinical work. The purpose of the present paper is to present an overview of veterinary scintigraphy to specialists working in the field of nuclear medicine or biomedical research, and to provide information helpful to veterinarians referring animal patients to nuclear medicine laboratories. Emphasis is placed on the types of procedures and the clinical information gained therefrom. No attempt is made to present or justify procedural details concerning instrumentation, radiopharmaceutical preparations, pharmacological kinetic or radiation safety aspects. Detailed examinations are described in each session following the schematic framework as: radiopharmaceuticals, examination protocol, indications and data evaluation, and illustrations.

Bone scintigraphy

Bone scintigraphy seems to be the most frequently performed veterinary nuclear medicine procedure (Devous and Twardock 1984; Lamb 1991; Chambers 1996). There are several commercially available radiopharmaceuticals, but, ^{99m}Tc methylene diphosphonate (^{99m}Tc MDP) is the most commonly used one. General injected dose ranges 10-20 Megabecquerel (MBq) / body weight in kg.

The skeletal scintigraphic examination can be divided into three imaging phases (3-phase bone scintigraphy) including: vascular phase or blood flow phase or nuclear angiogram (phase I), extracellular or soft tissue phase (phase II), and bone phase (phase III). Immediately (within one minute) after intravenous injection of a radiopharmaceutical the first phase imaging is showing larger blood vessels (both arteries and veins). The second phase takes 2-20 min after injection, and the images represent the radiopharmaceutical biodistribution in the extracellular fluid space of all body tissues after delivery via the vascular system. The third phase imaging begins 2-3 h after injection when the radiopharmaceutical localizes in bone on the 001 surface of the exposed hydroxyapatite crystals while the remaining radiopharmaceutical is excreted via the urinary tract. Not rarely single bone phase imagination is performed without the two earlier phases.

Phase I imaging is a sensitive test for loss of vascularity (e.g.: ischemic injury, degloving injuries, vascular infarction), and detecting acute inflammatory processes where significant local capillary recruitment has occurred (e.g. in acute localized cellulitis). Phase II imaging is useful in detecting and evaluating inflammatory diseases in soft tissues surrounding the skeleton (e.g. in tendon or ligament injuries, synovitis, myositis). Phase III imaging detects and evaluates acute or chronic bone disease that involves an increased rate of bone turnover (e.g. in complete or incomplete fractures, osteoarthritis, osteomyelitis, periosteal reactions, enthesopathies and primary or metastatic malignancies), and it also localizes dead bone tissue as a result of bone infarcts, sequestrum formation or previous trauma. Major advantage of bone scintigraphy versus radiological examination is that scintigraphy is able to detect abnormalities at a very early stage: a few hours after injury incomplete bone fractures can be detected scintigraphically while radiological abnormalities are detectable only after days. In summary, ^{99m}Tc MDP bone scintigraphy is a very sensitive but less specific method for examining the musculoskeletal system both in small animals and in horses.

Fig. 3 (Plate II) illustrates a whole body examination of a dog and Fig. 4 (Plate II) shows a horse examination.

Thyroid scintigraphy

Thyroid scintigraphy is one of the most common nuclear medicine applications in

veterinary medicine (Kintzer and Peterson 1991; Marks et al. 1994; Brawner 1996; Balogh et al. 1998). Recently sodium ^{99m}Tc -pertechnetate ($^{99m}\text{TcO}_4^-$) has been used more extensively for thyroid imaging than radioiodine because of its availability, low cost and radiation safety. Dosage is generally between 37 and 222 MBq for a cat or dog intravenously.

^{99m}Tc -pertechnetate localizes in the thyroid glands 20-30 min after application. Ventral and lateral aspects of the neck region are imaged routinely and additional ventral and lateral views of the neck and thorax should also be acquired to rule out ectopic tissue or tumor metastasis. Images are evaluated visually and quantitative analysis can be performed when the results of a patient are not clear. Quantitative analysis includes time – activity curves of the thyroid gland, activity ratios of the thyroid gland, salivary glands and background, and thyroid uptake of the injected dose.

Information obtained from thyroid scintigraphy is abundant. Morphological data (location, and size of thyroid lobes) are extremely important before surgical excision and evaluating response to therapy especially when suspected malignancy is diagnosed. Quantitative data such as time-activity curves, radionuclide uptake of the gland and calculated activity ratios (thyroid/salivary glands, thyroid/background) reveal very useful additional information for estimating the functional status of the thyroid glands.

In Fig. 5 (Plate III), there are typical ventral images of euthyroid and hypothyroid dogs, and a dog with thyroid malignancy as well as a hyperthyroid cat.

Hepatic scintigraphy

Considering the well-known liver multifunctionality, there are 3 main forms of hepatic scintigraphy in animals (Wolff et al. 1988; Koblik et al. 1990). Evaluating the *reticuloendothelial function* the ^{99m}Tc labelled colloids (e.g. sulphur colloid, serum albumin microaggregates) seem to be the radiopharmaceutical of choice. Due to their lipophilic characteristics, derivatives of iminodiacetic acids (^{99m}Tc IDAs) are available for *hepatobiliary scintigraphy*. *Portosystemic shunt scintigraphy* can be performed using different radiopharmaceuticals. Pararectally administered ^{99m}Tc -pertechnetate is the most frequently used one, whereas ^{123}I -iodoamphetamine and ^{201}Tl are much more expensive and ^{99m}Tc serum albumin macroaggregate needs ultrasonography guidance for the venipuncture of v. portae or v. lienalis.

Reticuloendothelial function scintigraphy by ^{99m}Tc labelled colloids means static imagination of the abdominal region where liver, spleen and bone marrow are visualized. The uptake mechanism is based on phagocytic activity of the RES-cells (in the liver – Kupffer's cells) and approximately 60 min after iv. injection the whole liver is visualized. Hepatobiliary scintigraphy can be performed by dynamic frame acquisition or static imaginations 2, 10, 15, 20, 25, 30, 45 and 60 min after the injection. The radiopharmaceutical is in normal cases in the liver parenchyma within 2 min, in the gall bladder between 2 and 20 min and thereafter it is excreted into the small intestines. Portosystemic shunt scintigraphy is always a rapid dynamic study. In parallel with the administration 3-4 seconds frame are acquired until 3-5 min while the radiopharmaceutical is passing through the v. portae into the liver and after capillarization into the heart.

Indications for reticuloendothelial scintigraphy are: evaluating hepatic and splenic morphology (size and shape) and hepatic or splenic masses of unknown origin (cyst, haematoma, abscess, tumor). Hepatobiliary scintigraphy holds morphological and functional information as well bile excretion function of hepatocytes, biliary tract patency, extrahepatic biliary obstructive lesions, acute or chronic cholecystitis. Portosystemic shunt scintigraphy is a very sensitive, non-invasive screening test for the presence of an pathological connection between portal and systemic veins. By this method it is possible to

quantify the magnitude of shunt flow in terms of a calculated shunt fraction and evaluate the efficacy of surgical intervention to occlude or to attenuate portosystemic shunts by calculating comparative post-operative shunt fraction values.

Fig. 6 (Plate III) illustrates hepatobiliary imaging of a healthy dog.

Renal scintigraphy

One of the earliest nuclear medicine applications in both veterinary (Twardock et al. 1991; Németh et al. 1998) and human fields is *renal morphologic imaging*. Radiopharmaceuticals used for this method are numerous; ^{99m}Tc-labelled diethylenetriaminepentaacetic acid (^{99m}Tc DTPA), glucoheptonate (^{99m}Tc GH), or more frequently dimercaptosuccinic acid (^{99m}Tc DMSA). Radiopharmaceuticals for *functional renal scintigraphy* can be divided into two groups: ^{99m}Tc-labelled mercaptoacetyltriglycine (^{99m}Tc MAG₃), ethylene dicystein complex (^{99m}Tc EC) and ¹²³I or ¹³¹I iodine labelled ortho-iodohippuric acid (¹²³I or ¹³¹I OIH) are filtered and excreted by tubular reabsorption while diethylenetriaminepentaacetic acid (^{99m}Tc DTPA) is excreted by glomerular filtration. Injected doses range 37-185 MBq/0.5-1 mL.

After intravenous injection of any of the above listed radiopharmaceuticals these will concentrate in the kidneys. Based on localization, mechanism pictures must be taken at different times after administration; for example a few minutes with ^{99m}Tc DTPA, and hours with ^{99m}Tc DMSA. Functional renal scintigraphy is always performed in dynamic studies when collecting pictures begins in parallel with the administration of radiopharmaceuticals. In the first minute 60 one-second frames are taken to examine the arterial blood flow of the kidneys and thereafter 20-30 second frames are taken until 20 min to evaluate renography. Around this time the radiopharmaceutical in healthy animals concentrates in the renal cortex, it is filtered into the renal medulla and excreted via the ureters into the urinary bladder.

Ultrasonography is a more frequently used method in the study of renal anatomy, location and individual size, as well as in suspected renal trauma, tumor, cysts, abscess or infection, morphological scintigraphy offers a real advantage. Morphological scintigraphy visualizes only a functioning kidney tissue and evaluates also the percent of renal function exerted by the right and the left kidneys. Functional renal scintigraphy allows to determine global and individual kidney glomerular filtration rates (GFRs) and effective renal plasma clearance (ERPF). Based on these functional data it is possible to evaluate the patient's response to treatment, to identify and determine the severity of even subclinical renal disease in an animal receiving nephrotoxic agents (such as cisplatin or aminoglycoside antibiotics). Although renal transplantation is a rarely used therapeutic method in the small animal practice, scintigraphy as a non-invasive, sensitive and specific method could be an excellent tool for evaluating the success (graft morphology, blood flow, functional and excretion mechanisms) of the operation.

Normal canine kidney morphology and function is presented in Fig. 7 (Plate IV).

Brain scintigraphy

There are a few conventional radiopharmaceuticals for planar brain scintigraphy: ^{99m}Tc-labelled diethylenetriaminepentaacetic acid (^{99m}Tc DTPA), glucoheptonate (^{99m}Tc GH), or ^{99m}Tc-labelled pertechnetate (^{99m}TcO₄⁻) which are available for veterinary purposes as well (Daniel et al. 1992; Dykes et al. 1994). Because of their higher prices ^{99m}Tc-labelled hexamethylpropyleneamine oxime (^{99m}Tc HM-PAO) and ethylcysteinyl dimer (^{99m}Tc ECD) are less frequently used substances in veterinary practice; however, both are very promising agents when brain SPECT examination is considered. Injected doses range 370-1110 MBq/0.5-2 mL.

Conventional (planar) brain scintigraphy is one of the most simply performable nuclear medicine applications. One to four hours after intravenous application of the radiopharmaceutical static imaging is performed around the head. Dorsal, lateral and caudal images are taken and pictures are evaluated visually. SPECT brain scintigraphy can be performed using conventional radiopharmaceuticals but ^{99m}Tc HM-PAO and ^{99m}Tc ECD yield a higher lesion to background ratio thereby picture quality will be better. These compounds readily enter the blood-brain barrier and are retained in the brain tissue and their distribution is fixed for hours. Within this time SPECT is available for cross-sectional imagination of the brain.

Indications for brain scintigraphy in veterinary medicine differ from human medicine. Suspected intracranial lesions such as tumors, cysts, hemorrhage, abscesses and trauma with head injury are the most frequent indications whereas seizures, cranial nerve disorders, epilepsy or behavioural changes are much less frequently examined in animals than in humans.

Fig. 8 (Plate V) illustrate static and SPECT examination of a dog brain.

Cardiac scintigraphy

Cardiac scintigraphy contains two main groups of nuclear procedures as myocardial imaging (perfusion and metabolic examinations) and functional scintigraphy (Koblik et al. 1987; Stockhof et al. 1990; Berry et al. 1993). Myocardial imagings require more expensive radiopharmaceutical background e.g.: ^{99m}Tc Technecium methoxy-isobutyl-isonitrile (^{99m}Tc MIBI or sestaMIBI), pyrophosphate (^{99m}Tc PYP), ^{201}Tl Thallium (^{201}Tl), ^{123}I labelled free fatty acids and other less frequently used radiopharmaceuticals. For functional scintigraphy radiopharmaceuticals of choice are ^{99m}Tc Technecium human serum albumin (^{99m}Tc HSA) or autologous red blood cells (^{99m}Tc PYP for in vitro or in vivo labelling). Injected doses change within a wide range between 74-370 MBq/dog or cat.

Although conventional planar examination of cardiac perfusion is nowadays a more widely used method there is an increase in the numbers of SPECT examinations in dogs as well in humans. Left lateral, ventral and sometimes left ventral oblique planar images are taken 20-60 minutes after radiopharmaceutical injection where acquisition parameters are 64 x 64 x 16 or 128 x 128 x 16 matrix size obtaining for a total 300 to 500 kcounts. SPECT examination is recommended to perform within three hours after radiopharmaceutical application. Parameters are similar to human studies, 180 degrees right lateral to left lateral with circular rotation of the detector around the ventral aspect of the thorax, 64 stops with around 30 seconds per stops. Filtered backprojection using Butterworth filter is used for image reconstruction. Functional examination such as ECG-gated radionuclide ventriculography and first pass radionuclide angiogram are very rapidly performable methods. ECG-gated study is performed after injecting blood pool agents and the image acquisition is synchronized by ECG R-R wave interval signals. First pass radionuclide angiogram starts in parallel with the bolus injection of radiopharmaceutical. The adequate acquisition parameters are 2-4 frames per second until 30-60 seconds.

Perfusion and metabolic cardiac scintigraphy are well accepted methods in signaling myocardial ischemia or infarction caused by coronary artery occlusion in human patients but they are only rarely employed in animals. Functional scintigraphy is much more frequently performed in the veterinary field as well: ECG-gated examination is available for examining and quantification of the left and right ventricular function with ejection fractions, ejection rate, filling rate and to assess the effects of chemotherapy agent (Adriamycin) or other drugs (digoxin) on myocardial function. First pass radionuclide

angiogram is giving yes or no answers to questions on congenital cardiac disease (right to left or left to right shunts) and it is able to quantify the severity of cardiac thoracic extracardiac left to right shunts.

Fig. 9 (Plate V) shows an ECG-gated radionuclide ventriculography in a healthy Beagle dog.

Pulmonary scintigraphy

Two types of pulmonary scintigraphy methods are known both in human and in veterinary medicine: *ventilation* and *perfusion* examinations (Amis et al. 1982; Harnagle et al. 1987). Radiopharmaceuticals of ventilation scintigraphy can be radioactive gases (^{133}Xe , $^{81\text{m}}\text{Kr}$) or radioaerosols ($^{99\text{m}}\text{Tc}$ DTPA, or HSA nano colloid). Practically $^{99\text{m}}\text{Tc}$ Technecium labelled human macroaggregated serum albumin ($^{99\text{m}}\text{Tc}$ MAA) is the alone radiopharmaceutical available for perfusion examinations. Injected doses range in both methods between 20-150 MBq/dog or cat and 555-740 MBq/horse.

Ventilation scintigraphy is performed immediately after gas or radioaerosol administration from a closed ventilation circuit. Static images are taken from ventral, dorsal and lateral aspects of the thorax using 128 (256) x 128 (256) x 16 (8) matrix sizes and 300-500 kcounts prerequisites. Much more rarely, mainly in dynamic studies on horses, it is also performed with 24 frames of 2-3 seconds each with the same matrix size as described earlier. Perfusion examination can be performed more simply; 2-5 minutes after radiopharmaceutical administration only static pictures are taken from dorsal, ventral, left and right lateral and left oblique aspects of the thorax, and radiopharmaceutical distribution is evaluated visually.

Ventilation studies in animals have been predominantly limited to research applications since it is difficult to have patient's cooperation. Perfusion examinations are much more frequently performed. They provide important information on blood perfusion of the lungs in pulmonary thromboembolism, in chronic obstructive pulmonary disease or where the disease occurs, the severity of lung symptoms in heart worm disease. In horses, suspected pulmonary thromboembolism and exercise-induced pulmonary hemorrhage are the two most common indications for perfusion scintigraphy.

Normal appearance of lung perfusion examination in a dog is shown in Figure 10 (Plate VI).

Oncological and inflammation scintigraphy

All of the listed scintigraphic procedures have the potential chance to detect oncological or inflammation processes in the examined organs but there are especially designed scintigraphical methods for detecting malignancies (Steyn and Ogilvie 1995; Balogh et al. 1997) and inflammation foci (Moon et al. 1989; Tucker et al. 1992). Radiopharmaceuticals used for oncological scintigraphy are $^{99\text{m}}\text{Tc}$ Technecium labelled methoxy-isobutyl-isonitrile ($^{99\text{m}}\text{Tc}$ MIBI or sestaMIBI), pentavalent dimercaptosuccinic acid ($^{99\text{m}}\text{Tc}$ DMSA(V)) and monoclonal antibodies ($^{99\text{m}}\text{Tc}$ MoAbs). There is a number of potentially available radiopharmaceuticals for inflammation scintigraphy, for example agents for autologous leukocyte labelling; $^{99\text{m}}\text{Tc}$ Technecium hexamethylpropyleneamine oxime ($^{99\text{m}}\text{Tc}$ HM-PAO), ^{111}In Indium oxine or tropolone, agents for the detection of increased blood flow and capillary permeability; $^{99\text{m}}\text{Tc}$ Technecium labelled human serum albumin ($^{99\text{m}}\text{Tc}$ HSA), immunoglobulins ($^{99\text{m}}\text{Tc}$ IgGs) and the most specific group, the monoclonal antibodies ($^{99\text{m}}\text{Tc}$ MoAbs). ^{67}Ga Gallium citrate is a sensitive but not specific radiopharmaceutical. It has been used both for oncological and inflammation scintigraphy. Injected activities range 100-740 MBq/a dog or cat.

Image acquisitions in oncological and inflammation scintigraphy are very similar and simple as well. Static imaging or whole body examinations are performed 2, 4, 6 hours or later after radiopharmaceutical application. Matrix sizes are 128 (256) x 128 (256) x 16 (8) in static pictures and 512 (256) x 512 (256) x 16 (8) in whole body pictures. Dorsal, ventral and left lateral view is taken from the body, and SPECT imagination can be performed when two-dimensional imaging is not satisfactory.

There is an increasing interest for the clinicians to detect inflammation processes and malignancies as early as possible, using a sensitive, specific and non-invasive method. Indications of inflammation scintigraphy are numerous in the veterinary practice as well. Examinations are carried out to identify or localize any inflammatory or septic focus in animals with known or suspected inflammatory disease such as septicemia or multi-system infections, inflammatory bowel diseases, osteomyelitis, septic arthritis, discospondylitis, rheumatoid arthritis. Further it is employed to evaluate surgical sites or implants in orthopedic patients, or to examine lesions identified radiographically or by ultrasonograph. Much less data are available concerning veterinary oncological scintigraphy, however ^{99m}Tc MIBI is found to be useful in canine malignant lymphoma and parathyroid adenoma, whereas to our knowledge no published information about ^{99m}Tc DMSA(V) exists.

Fig. 11 (Plate VI) illustrates ^{99m}Tc HM-PAO labelled autologous leukocyte scintigraphy in a dog with a sterile inflammation in the thigh muscle.

Miscellaneous scintigraphic examinations

The earlier listed detailed examinations are the most widely performed scintigraphical methods in the veterinary clinics, however, there are a few others used rather rarely. *Splenic sequestration scintigraphy* (Berry 1996) is used for evaluating size, shape and function of the spleen. *Bone marrow scintigraphy* is unique in sensitivity for detecting primary and metastatic malignancies in the skeletal system. *Lymphoscintigraphy* (Daniel and Bailey 1996) can be useful in evaluating primary or secondary lymphedema, and in determining the location of obstruction or leakage of lymphatic vessels and the presence of metastasis in lymph nodes. There are further scintigraphical methods for examining *gastrointestinal motility* (Voges et al. 1996), *mucociliary transport* (Whaley et al. 1987) in the airways, *sperm motility* (Balogh et al. 1995) in the female genital tract, *uterine clearance* (LeBlanc et al. 1994) in mares, or *bleeding detection* (Metcalf 1987) in body cavities and numerous others which hold scientific interest.

Discussion

Scintigraphy is a less known diagnostic imaging technique. Although it is similar to competitive methods such as radiography, ultrasound, endoscopy, there is one basic difference. By all the other methods only morphological objects can be visualized whereas scintigraphy has the advantage of the so-called physiological imaging. This means, that scintigraphy is able to visualize and quantitate the distribution of different materials in the living organism indicating the normal (physiological) or abnormal (diseased) processes of the object. That can be the basis of a sensitive, specific and non-invasive diagnostic method supporting the clinician's diagnosis. As a part of combined modality imaging systems, scintigraphy gives useful data for the medical and veterinary clinicians as well.

Scintigraphical procedures are performed in an increasing number in veterinary medicine. Veterinary clinicians who deal with this topic (scintigraphists) are grouped and organized in common associations with specialists in other imaging methods. In North America, the Society of Veterinary Nuclear Medicine as a part of the American College of Veterinary Radiology (SVNM/ACVR), and in Europe the European Association of Veterinary Diagnostic Imaging containing the Club of Scintigraphists is the organization of veterinary

specialists. The official journal is *Veterinary Radiology @ Ultrasound* containing in all bimonthly published issues one or more articles on this topic.

Although veterinary scintigraphy started only five years ago in Hungary, the conditions such as equipment, facilities, personal, and budgetary facilities are improving step by step and the authors believe that scintigraphy has its own place among diagnostic procedures in veterinary clinics.

Veterinární nukleární medicína. Scintigrafické vyšetřovací metody – přehled

Autoři předkládají přehled zabývající se veterinární nukleární medicínou zaměřenou na scintigrafická vyšetření. Jsou popsány nejčastěji používané vyšetřovací metody, tj. vyšetření kostí, štítné žlázy, jater, ledvin, mozku, dále scintigrafie srdce, plic, onkologických a zánětlivých indikací i některých speciálních vyšetření. Zdůrazněny jsou i klinické informace tímto vyšetřením získané. Autoři se nesnaží předložit či obhajovat detaily týkající se vybavení, používaných radiofarmak, průběhu vyšetření, indikací a hodnocení získaných výsledků či ilustrací. Dokumentace k přehledu byla získána v letech 1995 až 1999 a pochází z odborného archivu autorů.

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Plate I

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Fig. 1. A Beagle dog being imaged with a small field of view analogue gamma camera. The data analyzer computer coupled to the camera is not seen.



Fig. 2. SPECT camera in work. This equipment is available for whole body and cross-sectional imaging of radiopharmaceutical biodistribution.

Plate II

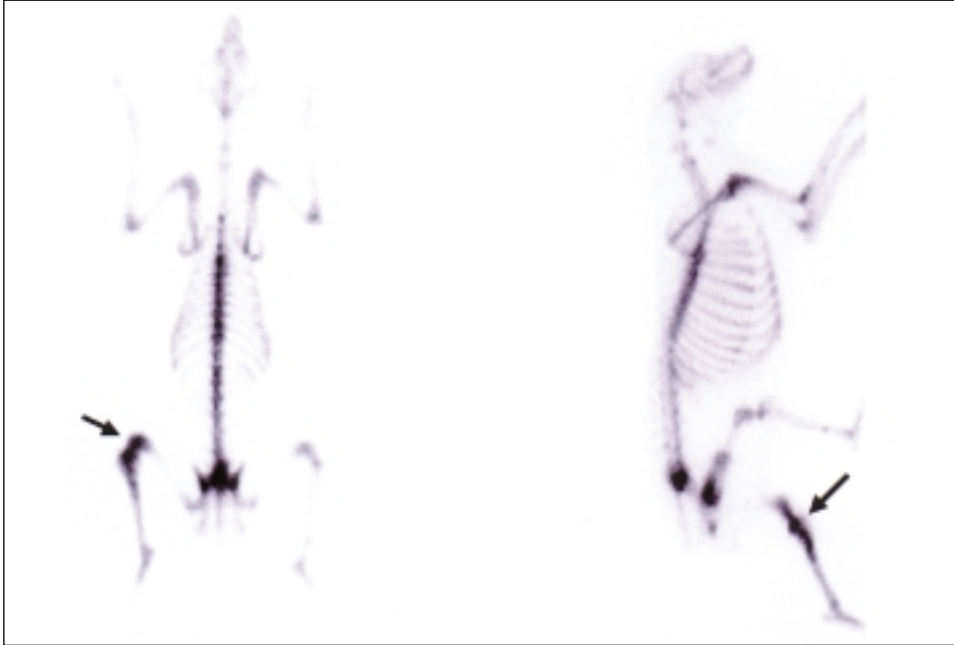


Fig. 3. Whole-body imaging of a dog having osteosarcoma. The dog was injected 370 MBq/0.5mL ^{99m}Tc MDP two hours before investigation. Notice the very clear radiopharmaceutical uptake in the left knee. No metastases are seen anywhere else in the body.

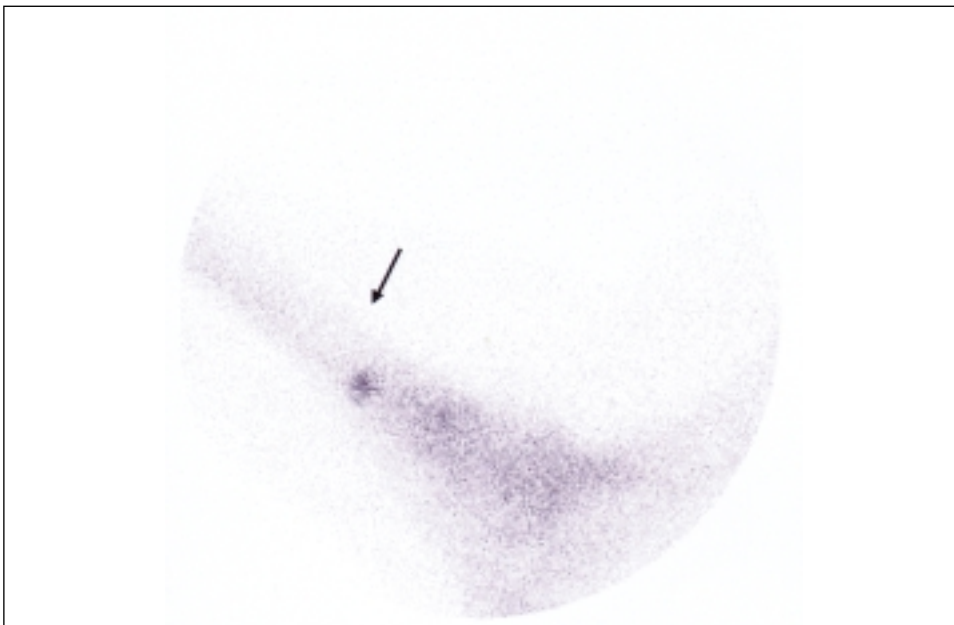


Fig. 4. Static picture of a horse forearm 3 hours after injection of 3 GBq/1.5mL ^{99m}Tc MDP. Notice the abnormal accumulation of radiopharmaceutical in the distal part of humerus (arrow) indicating an incomplete bone fracture.

Plate III

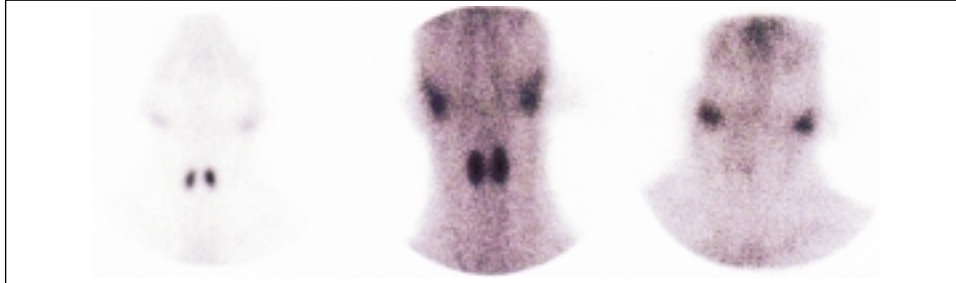


Fig. 5. Typical ventral images of an euthyroid, hyperthyroid and hypothyroid dog (from left to right) 20-30 minutes after 80-150 MBq/0.5-1.5mL ^{99m}Tc -pertechnetate application. Notice the differences between radiopharmaceutical concentration in thyroid glands.

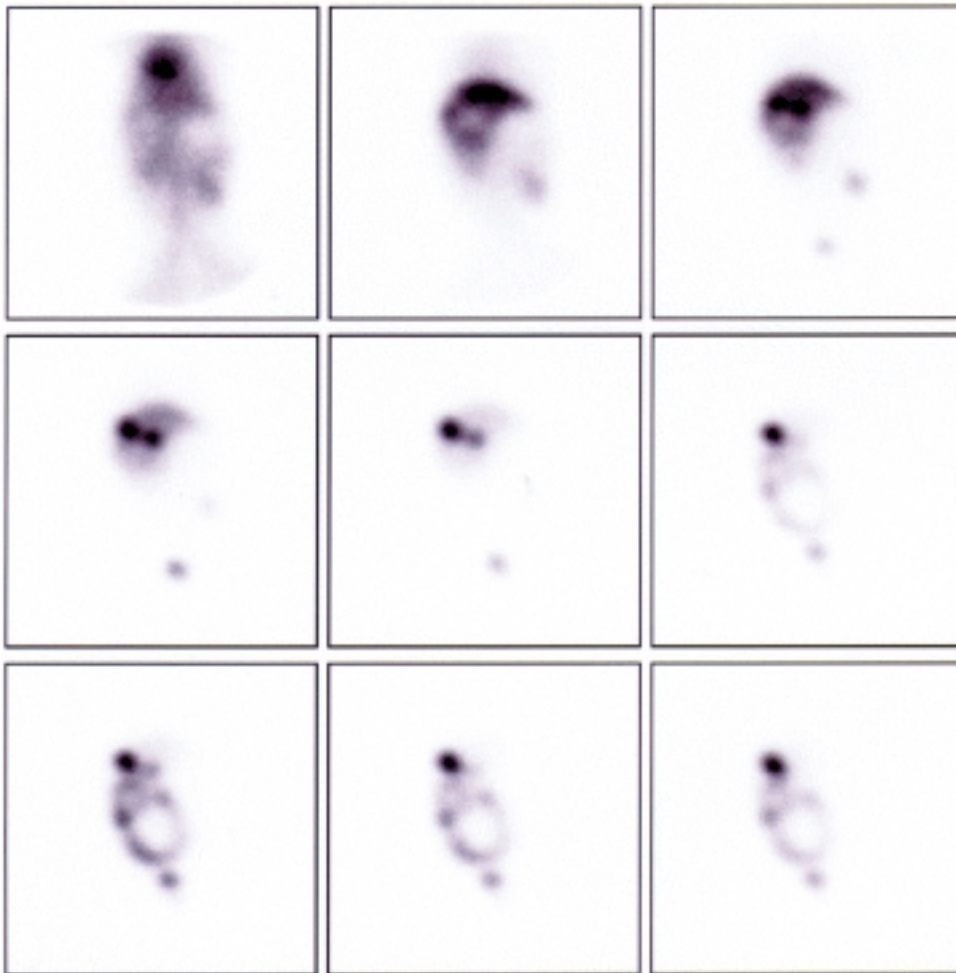


Fig. 6. Dynamic pictures of hepatobiliary scintigraphy in a healthy dog. After 80 MBq/1mL ^{99m}Tc BrIDA injection the radiopharmaceutical distributes in the whole body, concentrates in the liver parenchyma and is excreted through the gall bladder into the intestines.

Plate IV

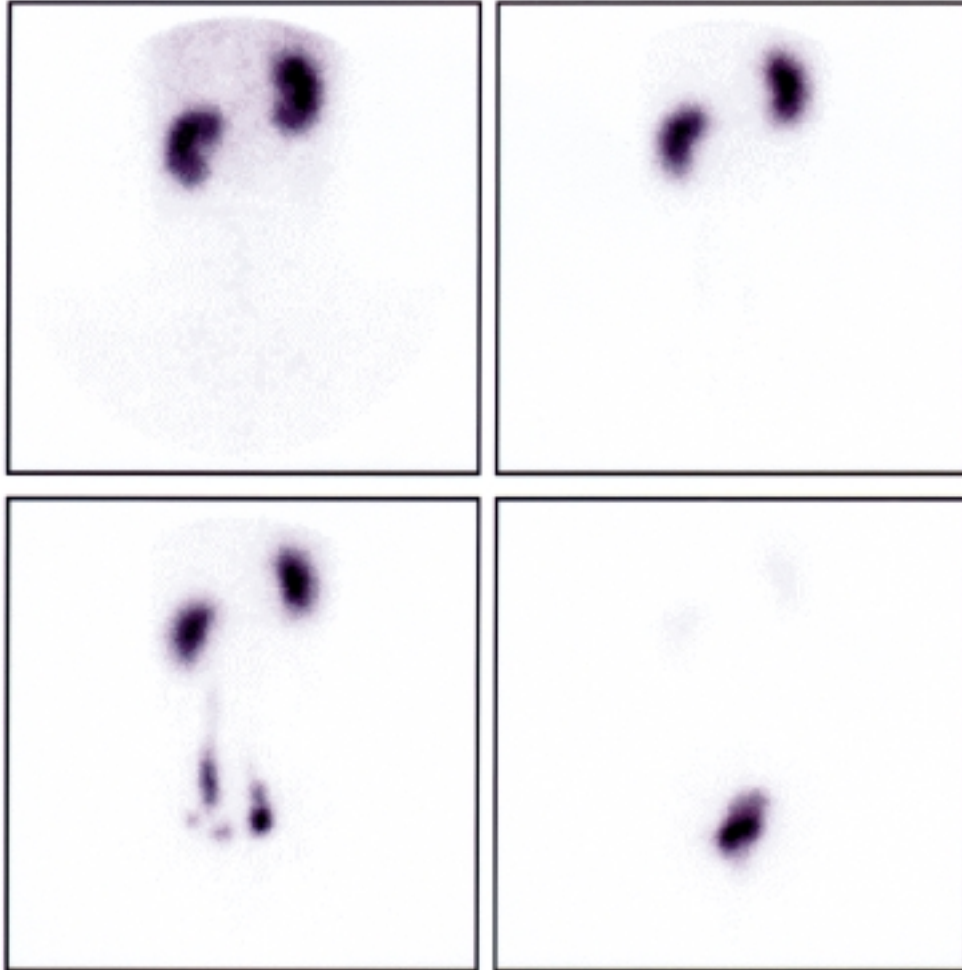


Fig. 7. Normal canine renogram after 110 MBq/0.5mL ^{99m}Tc DTPA injection. Radiopharmaceutical is concentrating in the kidneys and excreting through the ureters into urinary bladder.

Plate V

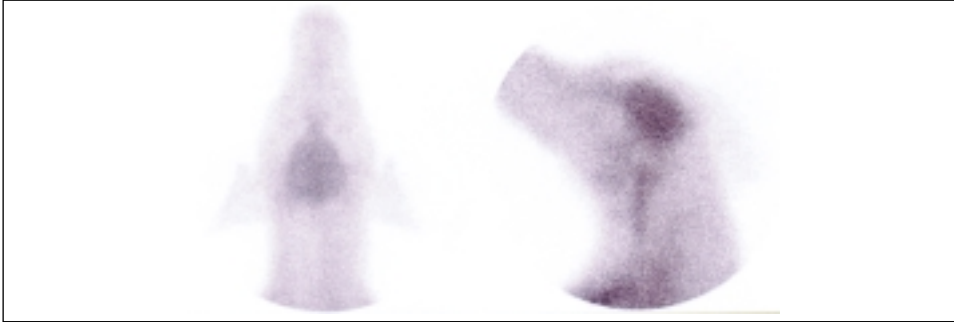


Fig. 8. Typical dorsal and left lateral brain perfusion imaging of a healthy dog sixty minutes after 200 MBq/1mL ^{99m}Tc HM-PAO application.

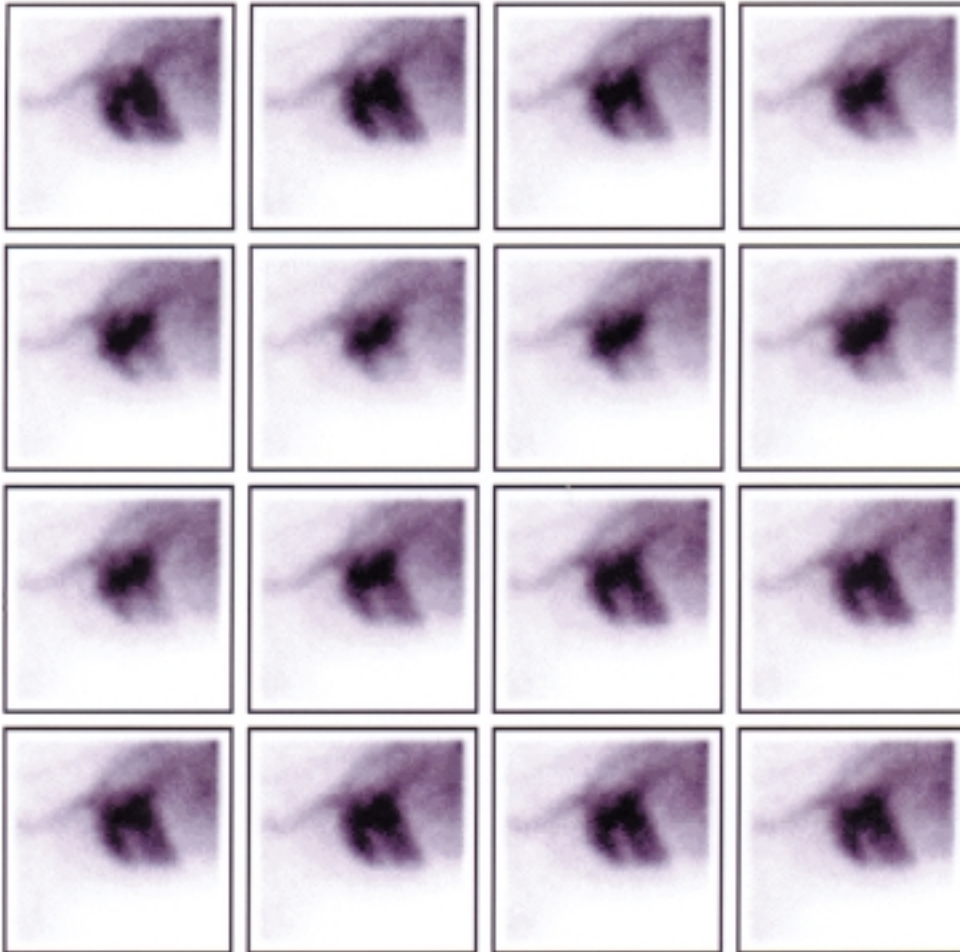


Fig. 9. ECG-gated radionuclide ventriculography of a healthy Beagle dog. Examination was carried out after 700 MBq ^{99m}Tc PYP labelled autologous red blood cells in a left lateral recumbency. Dynamic pictures show the motion of cardiac wall and volume changes of cardiac ventricles.

Plate VI

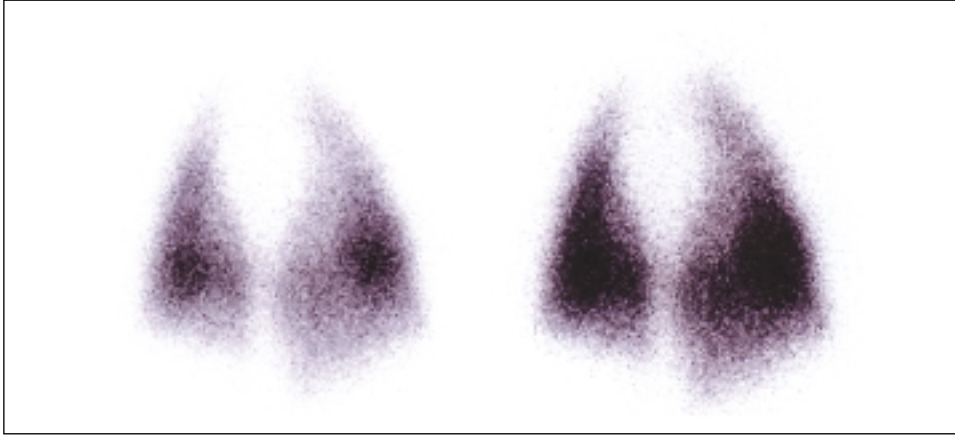


Fig. 10. Normal ventral and dorsal images of canine lung perfusion examination. 74 MBq/1mL ^{99m}Tc HSA macroaggregates were injected 10 minutes before investigation.

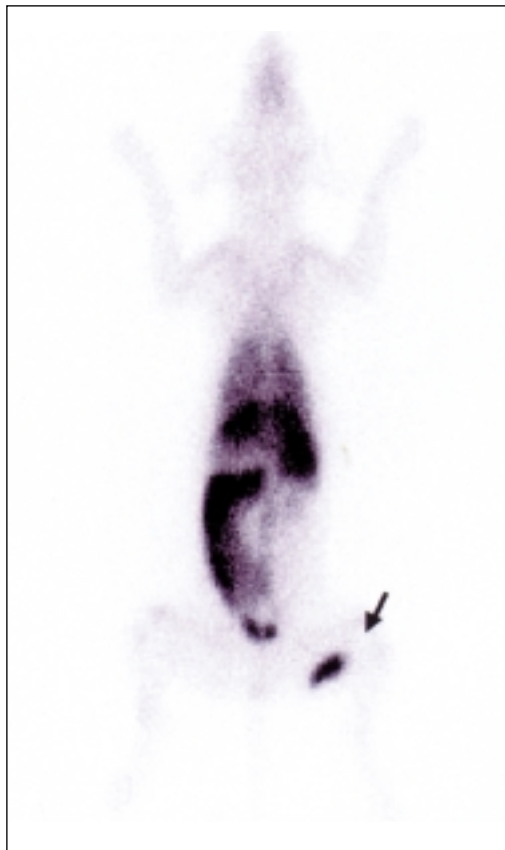


Fig. 11. Whole body imaging of artificially induced muscle infection (arrow) in a dog. 400 MBq ^{99m}Tc HM-PAO labelled autologous white blood cells were reinjected 2 hours before examination.