

International Journal of Advanced Biochemistry Research



ISSN Print: 2617-4693

ISSN Online: 2617-4707

NAAS Rating (2026): 5.29

IJABR 2026; 10(3): 980-986

www.biochemjournal.com

Received: 12-12-2025

Accepted: 16-01-2026

Deepti Netam

M.V.Sc. Scholar, Veterinary Surgery and Radiology, College of Veterinary Science and A. H., Anjora, Durg, Chhattisgarh, India

Rukmani Dewangan

Assistant Professor, Veterinary Surgery and Radiology, College of Veterinary Science and A. H., Anjora, Durg, Chhattisgarh, India

Mohindar Rawate

M.V.Sc. Scholar, Veterinary Gynaecology and Obstetrics, College of Veterinary Science and A. H., Anjora, Durg, Chhattisgarh, India

Shailendra Kanwar

M.V.Sc. Scholar, Veterinary Anatomy, College of Veterinary Science and A. H., Anjora, Durg, Chhattisgarh, India

Johnson Tandon

M.V.Sc. Scholar, Veterinary Medicine, College of Veterinary Science and A. H., Anjora, Durg, Chhattisgarh, India

Corresponding Author:

Deepti Netam

M.V.Sc. Scholar, Veterinary Surgery and Radiology, College of Veterinary Science and A. H., Anjora, Durg, Chhattisgarh, India

Scintigraphy in veterinary diagnostics: Clinical applications and future perspectives

Deepti Netam, Rukmani Dewangan, Mohindar Rawate, Shailendra Kanwar and Johnson Tandon

DOI: <https://www.doi.org/10.33545/26174693.2026.v10.i3l.8015>

Abstract

Scintigraphy is a prominent nuclear imaging technique in veterinary medicine that involves the systemic administration of radiopharmaceuticals to visualize physiological functions and assist in the diagnosis of various clinical conditions. Technetium-99m (^{99m}Tc), used either in its ionic form or labelled to specific pharmaceuticals, remains the most widely employed radionuclide due to its favourable physical and biological characteristics. The distribution of radiopharmaceuticals within the body is governed by physiological processes rather than disease specificity, enabling functional assessment of organs before structural alterations become apparent on conventional radiographic imaging. Gamma cameras and rectilinear scanners detect emitted gamma rays and convert them into electrical signals to generate diagnostic images. Scintigraphy is commonly applied in veterinary practice for bone evaluation, lung perfusion studies, thyroid imaging, and assessment of organ function. Owing to its high sensitivity and non-invasive nature, scintigraphy serves as a valuable adjunct to conventional imaging modalities. This narrative review highlights the principles, clinical applications, limitations, radiation safety considerations, and future perspectives of scintigraphy in veterinary medicine.

Keywords: Nuclear imaging, scintigraphy, radiopharmaceuticals, radioisotopes

Introduction

Nuclear energy has been employed for medical purposes for more than seven decades, with its applications evolving from basic diagnostic techniques to advanced molecular imaging modalities. The Society of Nuclear Medicine and Molecular Imaging (SNMMI) defines molecular imaging as the visualization, characterization, and measurement of normal and abnormal biological processes at the cellular or molecular level, rather than purely anatomical assessment. This approach supports both diagnostic and therapeutic applications, and recent developments in novel radioisotopes have led to the concept of theranostics, wherein different radionuclides are utilized for diagnosis and targeted therapy based on their emission characteristics (Ziesmann *et al.*, 2006) ^[23].

In veterinary medicine, the application of nuclear imaging parallels that of human medicine; however, its widespread use remains limited by high operational costs, stringent regulatory requirements, and the need for specialized infrastructure. As a result, the availability of nuclear imaging procedures in animals often reflects the level of technological development within a country (IAEA, 2021) ^[7]. Nevertheless, increasing attention toward advanced diagnostic approaches in both production and companion animals has contributed to a gradual expansion of nuclear imaging practices in veterinary healthcare over the past two decades (IAEA, 2021) ^[7]. Among the various nuclear imaging modalities, scintigraphy has emerged as the most commonly utilized technique in veterinary practice due to its ability to assess physiological function and detect abnormalities before structural changes become evident on conventional imaging. By employing gamma-emitting radiopharmaceuticals and specialized detection systems such as gamma cameras, scintigraphy provides valuable functional information that complements anatomical diagnostic methods. This narrative review focuses on scintigraphy in veterinary medicine, highlighting its principles, clinical applications, limitations, radiation safety considerations, and future perspectives.

Basic Principle of Scintigraphy

Scintigraphy is a nuclear imaging technique widely utilized in veterinary medicine for the assessment of organ function and the detection of pathological changes based on physiological activity. The technique involves the systemic administration of a radiopharmaceutical, most commonly technetium-99m ($Tc-99m$) labelled compounds, which localize in specific tissues according to underlying biological processes rather than structural alterations (Ziesmann *et al.*, 2006) [23]. Following intravenous administration, the radiopharmaceutical is transported via the bloodstream to target organs such as bone, thyroid, or kidneys, enabling functional evaluation of these tissues.

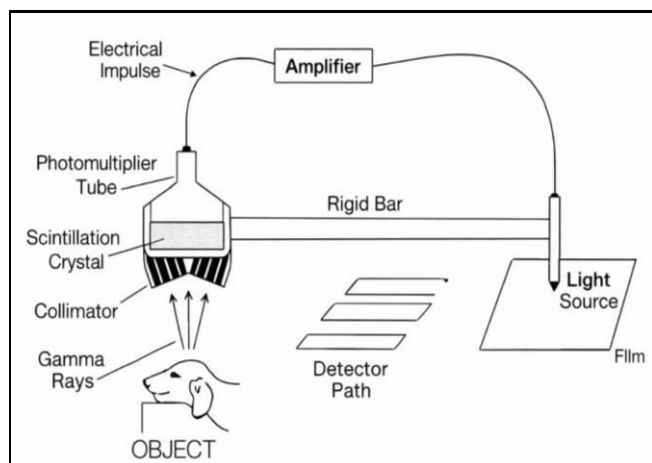


Fig 1. Illustrates a schematic representation of a rectilinear scanner. In this process, gamma rays emitted from the subject pass through a collimator, which selectively allows their entry before they interact with a scintillation crystal. This interaction generates flashes of light that are then converted into electrical signals by a photomultiplier tube. These signals are amplified and used to trigger a light source, which subsequently exposes the film. As the detector systematically moves over the subject, a rigid bar maintains the geometric alignment between the detector and the light source.

Once localized, the radioactive isotope undergoes decay with the emission of gamma photons that pass through body tissues and are detected by scintillation crystals within a gamma camera. The captured signals are processed electronically to generate planar or dynamic images that represent the spatial and temporal distribution of the tracer (Ziesmann *et al.*, 2006; Lattimer, 2019) [23, 12]. Unlike conventional radiographic techniques, in which radiation originates from the imaging equipment, scintigraphy relies on internally emitted radiation, rendering the patient a temporary radiation source until radioactive decay and biological excretion occur (Lattimer, 2019; Winter *et al.*, 2010) [12, 22].

Technetium-99m remains the radionuclide of choice for diagnostic scintigraphy due to its favourable physical characteristics, including a short half-life, optimal gamma emission energy, and versatility for labelling a wide range of pharmaceuticals. These properties contribute to adequate image quality while maintaining relatively low radiation exposure. Therapeutic radionuclides such as iodine-131 are used in selected clinical conditions, particularly feline hyperthyroidism; however, their longer half-life and radiation hazards necessitate stricter regulatory control and hospitalization protocols (Balogh *et al.*, 1999; Milardović, 2021) [1, 15].

The fundamental strength of scintigraphy lies in its high sensitivity for detecting alterations in tissue metabolism and perfusion, often allowing identification of disease processes before morphological changes become evident on radiography or ultrasonography. Static imaging provides information regarding organ size, shape, and tracer distribution, whereas dynamic studies enable quantitative evaluation of functional parameters such as renal perfusion and excretion (Ziesmann *et al.*, 2006; Spriet & Vandenberghe, 2024) [23, 18]. However, because radiopharmaceutical uptake reflects physiological activity rather than disease specificity, scintigraphic findings must be interpreted in conjunction with clinical signs and complementary imaging modalities to improve diagnostic accuracy.

Although diagnostic scintigraphy is generally considered safe due to the low administered radiation dose, appropriate precautions are essential to minimize environmental contamination and exposure of veterinary personnel and animal owners. Species-specific management practices are therefore required, including temporary isolation of large animals and post-procedural hygiene instructions for owners of small animals (Lattimer, 2019; Winter *et al.*, 2010) [12, 22]. Advances in detection systems, including SPECT and hybrid imaging technologies, continue to enhance image resolution and diagnostic confidence, further strengthening the clinical relevance of scintigraphy in modern veterinary practice (Srivastava *et al.*, 2017; Milardović, 2021) [19, 15].

Radionuclide

The use of radionuclide techniques in veterinary medicine began in the mid-1960s (Harris, 1968) [6], but their clinical application expanded slowly due to high costs, regulatory constraints, and limited infrastructure. Veterinary nuclear medicine primarily includes diagnostic procedures such as scintigraphy and selected therapeutic applications. Among these, scintigraphy remains the most commonly employed modality because it enables functional and physiological imaging, allowing early detection of abnormalities before structural changes become evident. Despite its proven diagnostic value, the wider adoption of radionuclide techniques in veterinary practice continues to be limited by logistical and institutional challenges (Balogh *et al.*, 1999) [1].

Radiopharmaceuticals

Radiopharmaceuticals form the foundation of scintigraphic imaging, as their biodistribution reflects underlying physiological and metabolic processes rather than structural alterations. Among available radionuclides, technetium-99m (^{99m}Tc) remains the radionuclide of choice in veterinary scintigraphy owing to its favourable physical characteristics, including an optimal half-life, suitable gamma emission energy, and ability to be labelled with a wide range of pharmaceutical compounds. These properties allow adequate image quality while maintaining relatively low radiation exposure. In contrast, iodine-131 is primarily reserved for therapeutic applications, as its longer half-life and particulate emissions limit its suitability for routine diagnostic imaging (Barber & Robert, 1983) [2].

The clinical value of scintigraphy is largely determined by the physiological mechanisms governing radiopharmaceutical localization. Processes such as active transport, adsorption to mineral matrices, capillary

blockade, phagocytosis, and compartmentalization enable organ-specific tracer accumulation in tissues including the thyroid gland, skeletal system, lungs, liver, and kidneys. This physiological targeting permits early identification of functional disturbances that may precede detectable anatomical changes.

Imaging protocols are therefore tailored to the pharmacokinetics of individual tracers, with acquisition timing selected to optimize target-to-background contrast. While these mechanisms contribute to the high sensitivity of scintigraphy, they also underscore its limited disease specificity, emphasizing the need for careful interpretation in conjunction with clinical findings and complementary imaging modalities.

Detectors

Scintillation detectors are fundamental to veterinary scintigraphy, as they enable detection and spatial mapping of gamma radiation emitted from administered radiopharmaceuticals. In clinical practice, these systems convert gamma photon interactions within a scintillation crystal into electrical signals that are subsequently processed to generate images representing tracer distribution within tissues.

Historically, rectilinear scanners were among the earliest detection systems used in veterinary nuclear medicine; however, their slow acquisition time and limited image resolution restricted their routine clinical application. In contrast, the development of gamma cameras, particularly Anger-type systems, significantly advanced scintigraphic imaging by allowing rapid, two-dimensional visualization of radiotracer distribution. Their ability to acquire dynamic and sequential images has made gamma cameras the preferred detector system in veterinary practice.



Fig 2: Displays a rectilinear scanner. The detector assembly (a) comprises a collimator, scintillation crystal, and photomultiplier tube. The rigid bar (b) links the detector to the light source, which is responsible for exposing the film inside the film holder (c).



Fig 3: Shows an Anger-type scintillation camera. The detector assembly (a) consists of a collimator, scintillation crystal, and an array of photomultiplier tubes. The console features a control panel (b), an output screen for photography (c), an output screen for recording on radiographic film (d), and a device for selecting the image format (e). Additionally, various collimators (f) are available for different imaging purposes.

The widespread adoption of gamma cameras is largely attributable to their improved temporal resolution, reduced need for prolonged restraint or anaesthesia, and compatibility with computer-assisted image processing. Unlike conventional radiographic modalities that primarily depict anatomical structures, scintillation-based imaging

emphasizes physiological and functional information, permitting quantitative assessment of organ perfusion, uptake, and excretion. These technological capabilities have enhanced the diagnostic reliability of scintigraphy and strengthened its role as a complementary modality within veterinary diagnostic imaging.

Table 1: Radiopharmaceuticals and radioisotopes used in scintigraphy for different organ scans

Organ Scanned	Radiopharmaceutical	Radioisotope	Mechanism of Localization	Species
Bone	Methylene diphosphonate (MDP) or Polyphosphates	Technetium-99m (Tc-99m)	Adsorption to hydroxyapatite in bone mineralization	Horses, Dogs
Lung (Perfusion scan)	Macroaggregated albumin (MAA)	Technetium-99m (Tc-99m)	Capillary blockade in pulmonary vasculature	Dogs
Thyroid	Pertechnetate (TcO ₄ ⁻) or Iodine-131	Technetium-99m (Tc-99m), Iodine-131	Active uptake by thyroid gland	Cats, Dogs
Liver (Portosystemic Shunt Scan)	Tc-99m Mebrofenin	Technetium-99m (Tc-99m)	Selective uptake by hepatocytes; blood flow tracing	Dogs
Kidneys (Renal Scan)	Tc-99m MAG3 (mercaptoacetyl triglycine), Tc-99m DTPA (diethylenetriaminepentaacetic acid)	Technetium-99m (Tc-99m)	Glomerular filtration (DTPA) or tubular secretion (MAG3)	Cats, Dogs
Brain	Tc-99m labeled compounds	Technetium-99m (Tc-99m)	Blood-brain barrier integrity assessment	Dogs
Heart (Cardiac Blood Pool Scan)	Labeled red blood cells	Technetium-99m (Tc-99m)	Retention in vascular compartment	Dogs

Clinical Applications of Scintigraphy

Scintigraphy represents an important functional imaging modality in veterinary medicine, offering diagnostic information based on tissue perfusion, metabolism, and physiological activity rather than structural appearance alone. Through the administration of gamma-emitting radiopharmaceuticals, most commonly technetium-99m-labelled compounds, scintigraphy enables visualization of organ function and metabolic alterations that may not be detectable using conventional radiographic techniques (Barber & Roberts, 1983; Milardović, 2021) [2, 15]. Owing to its high sensitivity, this modality is particularly valuable for the early detection of disease, assessment of organ function, and evaluation of complex clinical conditions across a range of species.

A. Bone Scintigraphy

Bone scintigraphy is among the most frequently utilized nuclear imaging procedures in veterinary medicine, primarily due to its high sensitivity for detecting alterations in skeletal metabolism (Chambers, 1996). The technique enables early identification of musculoskeletal disorders, including stress fractures, inflammatory conditions, and other bone pathologies, through the use of radiopharmaceuticals such as technetium-99m-labelled methylene diphosphonate (^{99m}Tc -MDP).

Three-phase bone scintigraphy, comprising vascular, soft tissue, and delayed bone phases, provides comprehensive evaluation of perfusion, inflammation, and bone turnover, thereby facilitating differentiation among conditions such as ischemic injury, cellulitis, osteoarthritis, and neoplastic involvement (Jorda & Matis, 2004; Schwarz *et al.*, 2004) [8, 17]. Owing to its ability to localize sites of increased metabolic activity, bone scintigraphy is particularly valuable in the investigation of lameness and joint disorders, especially in cases where conventional radiographic findings are inconclusive (Kippenes *et al.*, 1998) [10]. However, as increased radiotracer uptake is not disease-specific,

scintigraphic findings require correlation with clinical examination and complementary imaging modalities to achieve accurate diagnosis.



Fig 4: Depicts equine bone scintigraphy using a gamma camera. The image highlights the detector positioned near the horse's ribs, where it captures and registers radioactivity. (Source: Rossgdale Veterinary Surgeons, UK, 2021).



Fig 5: Equine bone scintigraphy. Note the detector closest to the left front foot, a region of interest for a spot view (Source: California Equine Orthopaedics, USA, 2021).

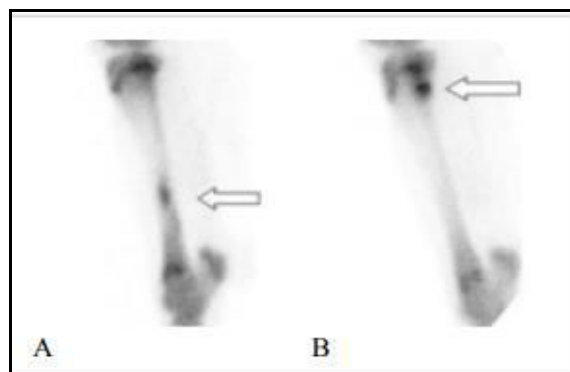


Fig 6: (A, B) Bone scan in horse (spot views). Tibial stress fractures are visualized as focal "hot spots" indicating fractures in a racehorse (arrows) (Source: Simpson, 2021)

B. Renal Scintigraphy

Renal scintigraphy plays an important role in the functional evaluation of the kidneys, enabling early detection of renal disorders such as nephritis, nephrolithiasis, and neoplastic conditions. Radiopharmaceuticals including technetium-99m labelled diethylenetriaminepenta-acetic acid (^{99m}Tc -DTPA) and dimercaptosuccinic acid (^{99m}Tc -DMSA) are commonly employed to assess parameters such as glomerular filtration rate and renal cortical function (Balogh *et al.*, 1999) [11].

A major clinical advantage of renal scintigraphy is its ability to provide separate functional assessment of each kidney, which is particularly valuable in unilateral renal disease and in pre-surgical decision-making. Additionally, scintigraphic evaluation allows monitoring of therapeutic response and early detection of nephrotoxic injury before irreversible structural damage becomes apparent (Meyer-Lindenberg *et al.*, 1996) [14]. Nevertheless, optimal interpretation requires integration with clinical findings and complementary imaging techniques to ensure accurate diagnosis.

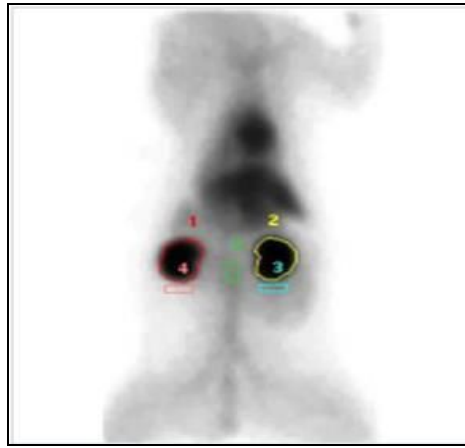


Fig 7: Renal scintigraphy in a cat imaged with Tc-99m-MAG3. Summed dynamic dorsal images show both kidneys as regions of interest (1,2) and backgrounds, including the aorta (rectangulars) (Source: Stock, *et al.*, 2016) ^[20].

C. Thyroid Scintigraphy

Commonly performed with ^{99m}Tc-pertechnetate, thyroid scintigraphy evaluates thyroid function and morphology in conditions like hyperthyroidism, thyroid carcinoma, and hypothyroidism. It aids in identifying ectopic tissue, planning surgeries, and monitoring therapy (Kintzer & Peterson, 1994; Branam *et al.*, 1982) ^[9, 3].

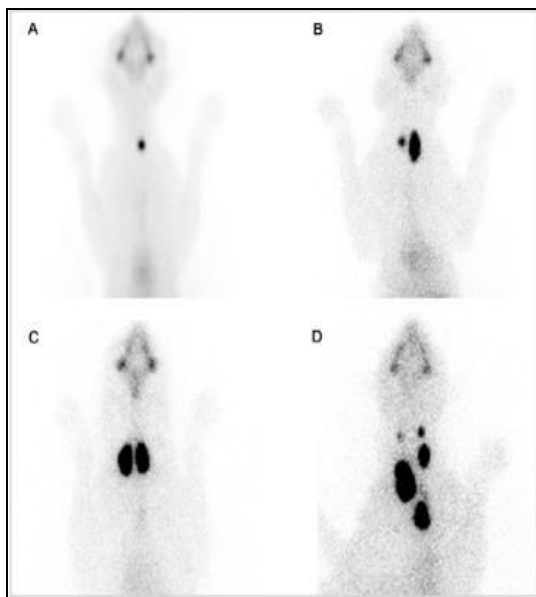


Fig 8: (A, B, C, D) Feline thyroid scan. Increased accumulation of Tc-99m pertechnetate as focal “hot spots” in four hyperthyroid cats (A) Increased accumulation in the left lobe (B) Asymmetrically increased accumulation in both lobes (C) Symmetrically increased accumulation in both lobes (D) Multifocal disease suggestive of ectopic thyroid tissue or metastases of the thyroid cancer (Source: Peterson and Broome, 2015) ^[16]

D. Hepatic Scintigraphy

Thyroid scintigraphy, most commonly performed using technetium-99m pertechnetate (^{99m}Tc-pertechnetate), is an established technique for evaluating both functional activity and morphological characteristics of the thyroid gland. It is widely used in the diagnosis and management of conditions such as hyperthyroidism, hypothyroidism, and thyroid neoplasia. Scintigraphic assessment facilitates identification of ectopic thyroid tissue, supports surgical planning, and enables monitoring of therapeutic response, particularly in feline hyperthyroidism (Kintzer & Peterson, 1994; Branam

et al., 1982) ^[9, 3]. Owing to its ability to quantify functional activity, thyroid scintigraphy remains an essential tool in endocrine evaluation where conventional imaging provides limited functional information.

E. Cardiac Scintigraphy

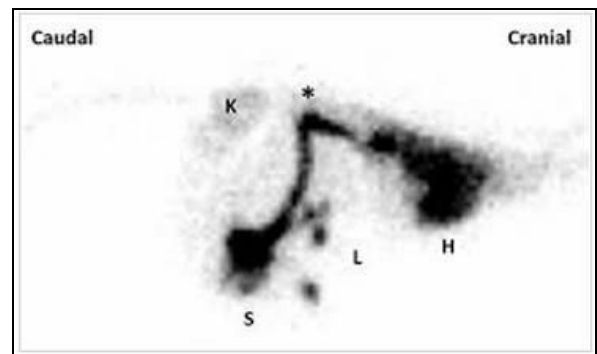


Fig 9: Shows a scintigraphic image of a portosystemic shunt in a dog. The image illustrates the flow of the isotope from the spleen (S) through a shunt vessel (asterisk) directly into the systemic circulation, reaching the heart (H) and kidney (K) while bypassing the liver (L) (Source: Tsai, 2021) ^[21].

Cardiac scintigraphy encompasses myocardial perfusion imaging and functional assessments such as radionuclide ventriculography, allowing evaluation of ventricular performance and cardiac dynamics. In veterinary practice, its application is primarily focused on the assessment of cardiac function, investigation of congenital abnormalities, and monitoring of pharmacological effects on the myocardium. Although myocardial ischemia detection is less commonly performed in animals, cardiac scintigraphy holds particular clinical value in the surveillance of cardiotoxicity associated with chemotherapeutic agents, such as doxorubicin (Adriamycin) (Balogh *et al.*, 1999) ^[1]. By providing quantitative functional information, this modality serves as a useful adjunct to conventional cardiac imaging techniques in selected clinical cases.

F. Lung Perfusion Scan

Lung perfusion scintigraphy utilizes technetium-99m-labelled macroaggregated albumin (^{99m}Tc-MAA), which becomes temporarily trapped within the pulmonary capillary bed following intravenous administration. This distribution allows assessment of regional pulmonary blood flow and

provides functional visualization of lung perfusion. The technique is particularly useful for identifying perfusion defects associated with pulmonary embolism, vascular abnormalities, and selected pulmonary disorders. In veterinary practice, lung scintigraphy has demonstrated clinical value in the detection of perfusion disturbances

resulting from parasitic-induced embolization in dogs (Barber & Roberts, 1983) ^[2]. As a functional imaging modality, it complements conventional thoracic imaging by revealing abnormalities that may not be apparent on structural examinations.

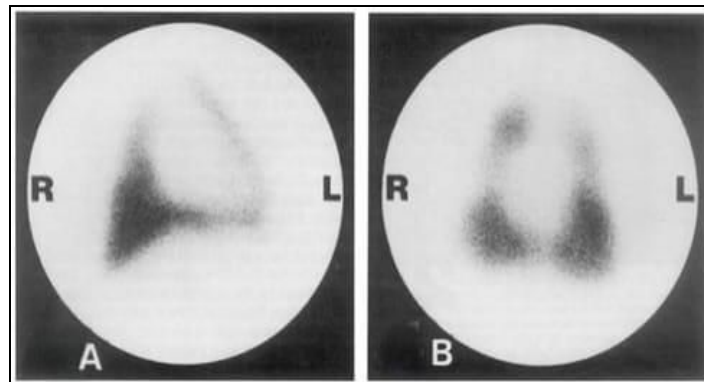


Fig 10: Presents perfusion lung scans using "Tc-MAA" in dogs, captured from ventral views. (A) Normal scan shows typical lung perfusion. (B) Abnormal scan reveals patchy regions with reduced activity in both lungs, attributed to pulmonary embolization caused by parasitic infection.

G. Lymphoscintigraphy

Lymphoscintigraphy is an emerging application of scintigraphy that enables functional assessment of lymphatic drainage and identification of sentinel or metastatic lymph nodes. Following peritumoral administration of radiopharmaceuticals, lymphatic pathways can be visualized, facilitating evaluation of tumour spread and regional lymph node involvement. This technique is gaining increasing importance in veterinary oncology, particularly for staging neoplastic diseases and guiding surgical planning (Barber & Roberts, 1983) ^[2]. By providing functional mapping of lymphatic flow, lymphoscintigraphy offers valuable information that complements conventional imaging modalities.

H. Brain Scan

Brain scintigraphy is based on the functional integrity of the blood-brain barrier, with radiopharmaceuticals accumulating in regions where this barrier is disrupted due to pathological processes such as tumours, trauma, or inflammatory lesions. Areas of abnormal tracer uptake appear as focal "hot spots," reflecting altered vascular permeability or metabolic activity. Although its use has declined with the advent of advanced cross-sectional imaging modalities, brain scintigraphy continues to provide functional information that may assist in the detection and localization of intracranial lesions in selected clinical cases (Barber & Roberts, 1983) ^[2]. When interpreted alongside clinical findings and anatomical imaging, it can contribute valuable supportive diagnostic insight in neurological disorders.

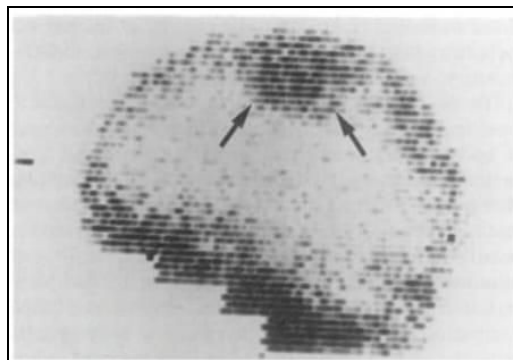


Fig 11: Presents a brain scan of a human, captured from a left lateral perspective using a rectilinear scanner. The highlighted region, marked by arrows, indicates heightened activity caused by a meningioma. This image was provided with the courtesy of Dr. James Barber from Cheyenne, Wyoming.

Radiation Hazards of Scintigraphy in Veterinary Practice

Scintigraphy involves the administration of radioactive materials and therefore presents potential radiation hazards in veterinary practice, primarily associated with diagnostic isotopes such as technetium-99m and therapeutic radionuclides including iodine-131 (Balogh *et al.*, 1999; Broome, 2006) ^[1, 4]. Following radiopharmaceutical administration, the animal temporarily becomes a source of

ionizing radiation, creating possible exposure risks for veterinary personnel, animal handlers, and owners through close contact and radioactive excretions (Ziesmann *et al.*, 2006; Lattimer, 2019) ^[23, 23].

To minimize these risks, international radiation safety guidelines emphasize strict adherence to standardized handling procedures, controlled patient management, and appropriate waste disposal. Recommendations issued by the International Atomic Energy Agency (IAEA) provide a

framework for safe clinical practice, including dose optimization, temporary patient isolation when required, and implementation of protective measures during imaging and post-procedural care (IAEA, 2021) [7]. The application of the ALARA (As Low As Reasonably Achievable) principle remains central to radiation protection, focusing on minimizing exposure time, maximizing distance, and using appropriate shielding.

Safe application of scintigraphy also depends on adequate professional training and institutional oversight. Specialized education in nuclear medicine, along with standardized operating protocols, plays a critical role in reducing occupational exposure and ensuring responsible use of radiopharmaceuticals. When appropriate safety measures are followed, diagnostic scintigraphy can be performed with minimal risk, supporting its continued clinical utility in veterinary medicine.

Conclusion

Scintigraphy has established itself as a valuable functional imaging modality in veterinary diagnostics, providing high sensitivity and physiological information that cannot be obtained through conventional anatomical imaging techniques. Its clinical utility is particularly evident in the evaluation of early-stage and complex disorders involving the skeletal system, thyroid gland, kidneys, and hepatobiliary system. Despite these advantages, the broader application of scintigraphy in veterinary practice remains constrained by high operational costs, specialized infrastructure requirements, and stringent regulatory guidelines governing the use of radioactive materials.

Ongoing technological advancements are expected to enhance the diagnostic potential of scintigraphy. The incorporation of hybrid imaging systems, such as SPECT/CT, has improved anatomical localization of functional abnormalities, thereby increasing diagnostic accuracy and clinical confidence. In addition, the growing interest in theragnostic approaches, combining diagnostic imaging with targeted radionuclide therapy offers promising opportunities for individualized disease management, particularly in veterinary oncology and chronic disorders. With continued professional training, improved accessibility, and institutional support, scintigraphy is likely to assume an expanded role in advanced veterinary diagnostic and therapeutic strategies.

References

- Balogh L, Andocs G, Thuroczy J, Németh T, Láng J, Bodo K, *et al.* Veterinary nuclear medicine: scintigraphical examinations-a review. *Acta Vet Brno.* 1999;68:231-239.
- Barber DL, Robert RE. Imaging: nuclear. *Am Coll Vet Radiol.* 1983;24(2):1-10.
- Branam JE, Leighton RL, Hornof WJ. Radioisotope imaging for the evaluation of thyroid neoplasia and hypothyroidism in a dog. *J Am Vet Med Assoc.* 1982;180:1077-1079.
- Broome MR. Thyroid scintigraphy in hyperthyroidism. *Clin Tech Small Anim Pract.* 2006;21(1):10-16.
- Chambers MD. Bone imaging: the diphosphonates. In: *Handbook of veterinary nuclear medicine.* Raleigh: North Carolina University; 1996. p.49-59.
- Harris AL. Radioisotope photoscanning in the dog. *Vet Med Small Anim Clin.* 1968;63:1038-1039.
- International Atomic Energy Agency. Radiation protection and safety in veterinary medicine. Safety Reports Series No.104. Vienna: IAEA; 2021.
- Jorda C, Matis U. Bone scintigraphy: an early indicator of disease or the last hope for a diagnosis? In: *Proceedings of the 12th European Society of Veterinary Orthopedics and Traumatology Congress;* 2004 Sep 10-12; Munich, Germany. p.1-8.
- Kintzer PP, Peterson ME. Nuclear medicine of the thyroid gland: scintigraphy and radioiodine therapy. *Vet Clin North Am Small Anim Pract.* 1994;24:587-605.
- Kippenes H, Johnston G. Diagnostic imaging of osteochondrosis. *Vet Clin North Am Small Anim Pract.* 1998;28:137-160.
- Koblik PD, Komtebedde J, Yen CK, Hornof WJ. Use of transcolonic technetium-99m pertechnetate as a screening test for portosystemic shunts in dogs. *J Am Vet Med Assoc.* 1990;196(6):925-930.
- Lattimer JC. Nuclear medicine imaging in animals: nuclear scintigraphy and positron emission tomography [Internet]. 2019 [cited 2021 Apr 28]. Available from: <https://www.msdsvetmanual.com/>
- Krzemiński M, Lass P, Teodorczyk J, Krajka J. Nuclear medicine applications in veterinary diagnostics. *Nucl Med Rev.* 2004;7(2):177-182.
- Meyer-Lindenberg A, Westhoff A, Wohlsein P, Nolte I. Validity of diagnostic methods for kidney function tests in the cat. *Tierarztl Prax.* 1996;24(4):395-401.
- Milardovic R. Veterinary nuclear medicine: a look into the future. *Veterinaria.* 2021;70(2):157-168.
- Peterson ME, Broome MR. Thyroid scintigraphy findings in 2096 cats with hyperthyroidism. *Vet Radiol Ultrasound.* 2015;56(1):84-95. doi:10.1111/vru.12165.
- Schwarz T, Johnson VS, Voute L, Sullivan M. Bone scintigraphy in the investigation of occult lameness in the dog. *J Small Anim Pract.* 2004;45:232-237.
- Spriet M, Vandenberghe F. Equine nuclear medicine in 2024: use and value of scintigraphy and PET in equine lameness diagnosis. *Animals.* 2024;14(17):2499.
- Srivastava M, Srivastava A, Singh SK, Tripathi A, Chaudhary AK, Panigrahi PN. Veterinary nuclear medicine: modern diagnostic approach in veterinary medicine. In: *National Symposium on Antimicrobial Resistance: Future Prospects in Human and Animal Health;* 2017. p.1-6.
- Stock E, Vanderperren K, Bosmans T, Dobbeleir A, Duchateau L, Hesta M, *et al.* Evaluation of feline renal perfusion with contrast-enhanced ultrasonography and scintigraphy. *PLoS One.* 2016;11(10):e0164488. doi:10.1371/journal.pone.0164488.
- Tsai S. Imaging of congenital portosystemic shunts [Internet]. 2021 [cited 2021 Apr 27]. Available from: <https://www.mspca.org/>
- Winter MD, Berry CR, Reese DJ. Nuclear scintigraphy in horses. *Compend Contin Educ Vet.* 2010;32(12):E5-E10.
- Ziesmann HA, O'Malley JP, Thrall JH. *Nuclear medicine: the requisites.* 3rd ed. St. Louis: Mosby; 2006