Nuclear scintigraphy

Thyroid scintigraphy is one of the most accurate ways to both quantitatively and qualitatively assess a suspect hyperthyroid cat. However, access to nuclear imaging equipment and the expertise needed to obtain a radioactive materials license typically limits the use of this diagnostic test to academic institutions. Scintigraphy uses a radioactive isotope injected into the bloodstream that then emits gamma rays detected by a device called a gamma camera. These isotopes can be specifically targeted to a wide variety of the body's tissues, including the thyroid. When evaluating feline patients with suspect hyperthyroid disease, scintigraphy allows us to determine unilateral vs. bilateral disease, check for metastatic disease and ectopic tissue, as well as evaluate efficacy of radioiodine therapy.

Which isotope to use?

When imaging the thyroid gland using scintigraphy, there are two radioisotopes that can be used. Iodine-123 is an available gamma emitter that mimics the uptake of non-radioactive iodine in the body, but its long half-life, higher gamma energy emission, and increased cost severely limits its use in veterinary medicine. The most common thyroid radiopharmaceutical is pertechnetate (TcO₄⁻) which is similar in size and charge to iodine, as well as readily available and inexpensive. This isotope is unique in that it is rapidly taken up by the follicular cells of the thyroid gland, causing it to concentrate in this specific organ, but not subsequently organified into thyroid gland products T₃ and T₄. This means that a pertechnetate thyroid scan can be performed as soon as 20 minutes after injection of the radiopharmaceutical, much quicker than if I-123 was used. Unlike pertechnetate, I-123 is organified by the thyroid, making it the isotope of choice when determining if a dose of I-131 will remain in the thyroid long enough for effective destruction of thyroid cells.
Factors affecting thyroid scintigraphy

Before we perform the scan there are a variety of factors that have the potential to either increase or decrease the uptake of pertechnetate by the thyroid. Taking a thorough history is key in identifying these factors so the results of the scintigraphic scan are not misinterpreted. The most common confounding factor we encounter at MSU is the use of methimazole. This drug blocks the production of T₃ and T₄, causing increased levels of thyroid stimulation hormone and subsequent increased uptake of both iodine and pertechnetate.⁴ Clinically, this means that cats must be off of methimazole for at least 10 days prior to scintigraphy as the increased uptake would result in an inaccurate scan.⁵

Performing the scan

The cat is first injected with a dose of 1-3 mCi (37-148MBq) of NaTcO₄. After 20 minutes, the cat is then heavily sedated and placed on the surface of the gamma camera. VD, left, and right lateral projections of the head and neck, as well as the thorax are obtained. Each projection takes approximately 1 minute to obtain. As the camera is ‘counting’ the number of gamma rays being emitted from the patient, heavy sedation is key to this study; any patient motion will result in a blurry, inaccurate image.

Common scintigraphic findings

Normal: The appearance of the normal feline thyroid scan is characterized by uniform distribution of radioactivity throughout both thyroid lobes (arrows). These should appear as elongated ovals, symmetrical in size and position in the central cervical region. The thyroid lobe margins should be smooth and regular with no ectopic tissue present. The zygomatic salivary gland is another organ that takes up and secretes pertechnetate in cats, and should also have uptake (arrowheads). There is lesser uptake in the parotid and mandibular glands. The ratio between either lobe of the thyroid and zygomatic salivary gland should be 1:1.⁶⁷

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- Factors affecting thyroid scintigraphy
  - Methimazole
  - Foods with high iodine content (seaweed, fish, offal)
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Abnormal: 4 patterns of abnormal uptake have been identified in cats. All are indicative of the presence of feline hyperthyroidism.

A – Unilateral increased uptake, with a suppressed contralateral lobe (normal tissue). This is the 2nd most common result of scintigraphy, seen in 32% of cats.

B – Bilateral, asymmetric uptake, indicating abnormal tissue in both thyroid lobes. This is seen in 52% of cats.

C – Bilateral, symmetric uptake. This is seen in 12% of cats.

D – Multifocal disease, indicating metastases, ectopic tissue, or both. This is the rarest result of scintigraphy, seen in 4% of cases.

98.5% of cats with a thyroid to salivary gland ratio of greater than 1.5 were confirmed to have hyperthyroidism on bloodwork, making this an ideal test for identifying cats with this disease.

References/additional resources