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Scintigraphic findings in 120 hyperthyroid cats

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The aim of this study was to characterise the scintigraphic findings in a large population of hyperthyroid cats in order to determine the location of thyroid pathology in newly diagnosed hyperthyroid cats and those that had previously undergone thyroidectomy. A specific aim was to identify the proportion of cats with ectopic hyperfunctional thyroid tissue and characterise the scintigraphic and clinical features of this subset of cats. Nearly one in five hyperthyroid cats was identified to have multiple areas of hyperfunctional thyroid tissue and/or intrathoracic hyperfunctional thyroid tissue where surgical thyroidectomy would not be curative. In addition, this study demonstrated that scintigraphy cannot reliably distinguish between thyroid carcinoma and adenoma. Owners should always be warned about the possibility of ectopic thyroid tissue before thyroidectomy is performed. In this study, intrathoracic hyperfunctional thyroid tissue and multiple areas of increased radionuclide uptake (IRU) were a common feature of benign thyroid disease and responded well to treatment with low dose radioiodine.

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Thyroid scintigraphy is a useful imaging modality that can assist in the diagnosis and further evaluation of feline hyperthyroidism.[1] The technique relies on selective uptake of a radionuclide by thyroid tissue. Pertechnetate ($^{99m}TcO_4$) is the radionuclide routinely used for this purpose. It has similar size and charge to iodine and is taken up by thyroid tissue. Furthermore, it is readily available, inexpensive and has a short half-life making it much safer to use than iodine isotopes.[1–4] Hyperthyroidism is diagnosed by the increased level of uptake of pertechnetate by the thyroid gland in comparison with salivary tissue.[5]

Thyroid scintigraphy also demonstrates the location of hyperfunctioning thyroidal tissue and is, therefore, useful in identifying ectopic thyroid tissue, which may be present anywhere from the base of the tongue caudally to within the thoracic cavity.[5,6] Scintigraphy can, therefore, assist with decisions regarding management of hyperthyroidism, in particular identifying patients where thyroidectomy would not be an appropriate treatment. In previous studies, intrathoracic thyroid tissue has been reported to occur in 8 –21% of hyperthyroid cats,[2,7–9] often being the result of one thyroid lobe descending into the thoracic cavity, rather than presence of additional areas of isotope uptake discrete from the two lobes of the thyroid gland. More detailed descriptions of scintigraphic features of cats with hyperfunctional ectopic thyroid tissue are lacking.

Scintigraphic imaging has also been described to aid in determination of malignancy and certain scintigraphic features of malignancy have been described.[2,4,10–12] However, these authors have frequently observed cats with ectopic hyperfunctional thyroid tissue, and cases with scintigraphic features of malignancy that appear to have benign thyroid disease.

Therefore, the aim of the present study was to characterise the scintigraphic findings in a large population of hyperthyroid cats in order to determine the

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location of thyroid pathology in newly diagnosed hyperthyroid cats and those that had previously undergone thyroidectomy. A specific aim was to identify the proportion of cats with ectopic thyroid tissue and characterise the scintigraphic and clinical features of the subset of cats.

Materials and methods

The database of the University of Bristol (UOB) Feline Centre was searched for cases of feline hyperthyroidism referred between 1994 and 2007. The sole inclusion criterion for the study was that a hyperthyroid cat should have good quality scintigraphic images available for review. Scintigraphic imaging is routinely performed on all hyperthyroid cats referred to UOB, in order to assist with treatment planning. One hundred and twenty cats were identified that met this criterion.

Details of signalment, physical abnormalities (in particular the presence of palpable goitre), whether previous thyroidectomy had been performed, reason for referral, treatment modality and response to treatment were recorded from case records where available.

Scintigraphy was preformed according to the following protocol: 37–111 MBq of sodium ^{99m}Tc-pertechnetate ($Na^{99m}TcO_4$) was injected intravenously. Using a Maxi Gamma Camera (General Electric, Horsholm, Denmark) with a low energy, general purpose parallel hole collimator, ventral, right and left lateral images of the cervical region and thorax were obtained 20 min after radionuclide injection. The cats were placed directly on the collimator using propofol sedation (Rapinovet; Schering-Plough Animal Health) to facilitate positioning. A 256 × 256 matrix was used, and each image was acquired for a total of 150,000 counts. The images were processed using dedicated nuclear medicine software (Micas X-plus Version 5.20, Bartec Medical Systems). Hyperfunctionality of thyroid tissue was measured by using the software to compare the count density obtained from thyroid and zygomatic-molar salivary regions of interest. All areas of hyperfunctional thyroid tissue were termed 'areas of increased radionuclide uptake (IRU)'.

Scintigraphic images from these 120 hyperthyroid cats were evaluated. The ventral images were used to identify the location of areas of IRU. A straight line was drawn between the points of the shoulders. Areas of IRU above this line were classified as being in the neck, areas of IRU on the line were classified as being at the level of the thoracic inlet, and areas of IRU below the line classified as being within the thorax (Fig 1). When a large area of IRU was present extending from the cervical area to the thorax (Fig 2), this was classified as IRU in the neck, thoracic inlet and thorax and a more detailed description describing the pattern of uptake was made.

The number and location of all areas of IRU were recorded, and the presence of ectopic radionuclide uptake was noted. Ectopic hyperfunctional thyroid

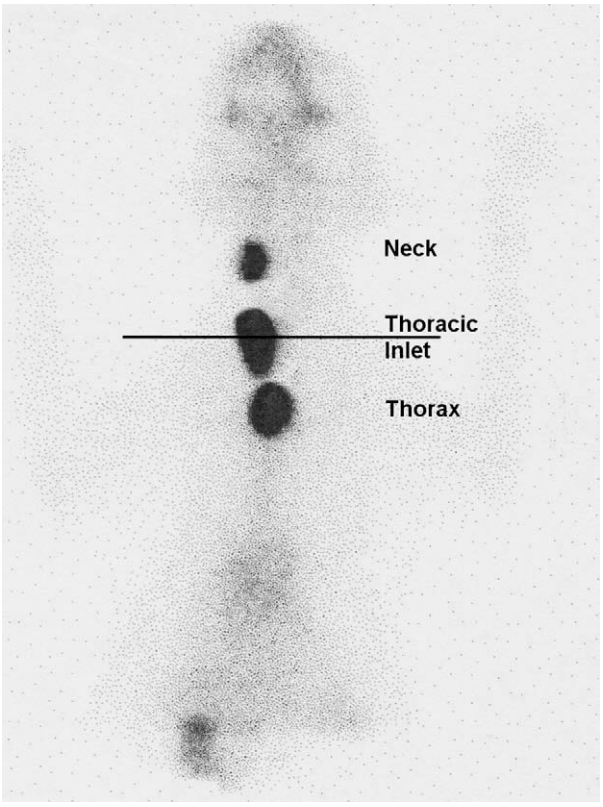

Fig 1. Scintigraphy scan, ventral view illustrating how the locations of areas of IRU were classified.

Fig 2. Scintigraphy scan, ventral view (Table 2; case 24) showing very extensive area of IRU involving both glands in cervical area extending into cranial thorax. In such cases that involved all three areas, the areas of IRU were described as being present in the neck, thoracic inlet and thorax and a more detailed description describing the pattern of uptake was made (Table 2). This thyroid gland had a very cystic appearance on ultrasound.

tissue was defined as uptake of radionuclide in more than two foci, and/or the presence of one or more areas of IRU located within the thorax.

Of particular interest was the subset of cats identified with ectopic hyperfunctional thyroid tissue. In these animals, an analysis was made of the reason for referral, whether the cat was newly diagnosed or had undergone previous surgery, whether the cat had palpable goitre and/or areas of IRU present in the neck and/or thoracic inlet, any histopathological findings, and the treatment and outcome. Scintigraphic images were also evaluated for similarities and differences between cats with carcinoma versus adenoma, and those that responded to radioiodine treatment versus those that did not. The referring veterinarian was contacted by telephone to obtain follow-up information about these cats with ectopic thyroid tissue. Details regarding recurrence of hyperthyroidism, development of any other illness and the time and reason for death or euthanasia were obtained.

In cases where thyroid histopathology had been performed ($n = 40$), the sections were reviewed on one occasion by a single pathologist (MJD) in order to verify the initial histopathological diagnosis and to determine whether any particular histopathological pattern might be associated with the presence of ectopic thyroid tissue.

Results

The age of the cats ranged from 6 to 18 years (mean 12 years). One hundred and fifteen cats were domestic shorthairs, three were domestic longhairs and two were Siamese. Sixty were neutered males, one was an entire male and 59 were neutered females.

The primary reason for referral was recorded for 51 of the 120 cases and included difficulty medicating (16 cases), owners interest in radioiodine treatment (10 cases), persistence or recurrence of hyperthyroidism following thyroidectomy (10 cases), inability to stabilise with medical management (five cases), difficulty medicating together with lack of palpable goitre (three cases), adverse effects of methimazole (three cases), presence of a very large palpable goitre (two cases) and treatment of thyroid carcinoma (two cases).

On evaluation of the scintigraphic scans, the number of areas of IRU ranged from 1 to 5 (mean 2), with 14 cats (12%) having more than two areas of IRU. Areas of IRU were located in the neck in 73 cats (61%), the thoracic inlet in 64 cats (53%) and the thorax in 26 cats (22%) (Table 1). The cats with areas of IRU in the thorax included 13 of the 14 cats that had more than two areas of IRU. The remaining cat with multiple areas of IRU had two in the neck and one in the thoracic inlet. Forty-four cats (37%) had areas of IRU in the neck only, 36 cats (30%) had areas of IRU in the thoracic inlet only, and nine cats (8%) had areas of IRU in the thorax only. Fifteen cats (13%) had areas of IRU in both the neck and thoracic inlet, five cats (4%) had areas of IRU in both the neck and thorax and three cats (3%) had areas of IRU in both the thoracic inlet and thorax. Nine cats (8%) had areas of IRU in all three locations (neck, thoracic inlet and thorax).

Eighty-six cats (72%) had palpable goitre on examination, of which 50 had areas of IRU in the neck and 51 in the thoracic inlet. There were, therefore, 20 cats with areas of IRU in the neck and 10 cats with areas of IRU in the thoracic inlet which were not palpable. Ten of the cats that did have a palpable nodule (12%) also had one or more areas of IRU in the thorax.

Twenty-eight cats (23%) had undergone previous thyroidectomy. Of these, 13 animals had previously undergone a single unilateral thyroidectomy (UT), three had undergone two unilateral thyroidectomies (one on each side) 8 months to 2 years apart, one had undergone three previous unilateral thyroidectomies (twice on one side and once on the other) approximately 1 year apart and one cat had undergone a previous bilateral thyroidectomy (BT). Two of these 18 cats had been reported to have remained persistently hyperthyroid following initial surgery and 11 of the cats were reported to have initially become euthyroid but had experienced recurrence of hyperthyroidism 6 weeks to 2 years later. The nature of the previous surgery was unrecorded in the remaining 10 cats. Of the cats that had previously undergone thyroidectomy, hyperfunctioning thyroid tissue was found unilaterally in the neck in six cats, unilaterally in the thoracic inlet in three cats, unilaterally in the thoracic inlet and/or neck and in the thorax in four cats, bilaterally in the neck and/or thoracic inlet in two cats, bilaterally in the neck and/or thoracic inlet and in the thorax in eight cats, and in the thorax alone in five cats. In total, ectopic hyperfunctional thyroid tissue was, therefore, present in 17 of the 28 cats (61%) that had previously undergone thyroidectomy.

Twenty-seven cats (23%) were found to have ectopic hyperfunctional thyroid tissue (Table 2). Twenty-six of these cats had intrathoracic areas of IRU, 13 of which also had more than two areas of IRU. One of the cats had three areas of IRU located in the neck and thoracic inlet. Of these 27 cats, 17 (63%) had undergone previous thyroidectomy. Twelve of these 17 animals had been referred for further investigation because of persistence or recurrence of hyperthyroidism following surgery. The remaining five of these 17 cats had been referred for treatment of a thyroid carcinoma (two cases), suspicion of a carcinoma (one case), owner's interest in radioiodine treatment (one case) and lack of response to radioiodine (one case). At least six of the cats that had undergone previous surgery only had a single UT, so presence of ectopic hyperfunctional thyroid tissue was not necessarily suspected, and 10 of the 27 cats (37%) with ectopic thyroid tissue had not had any previous surgery, having been referred as newly diagnosed hyperthyroid cats either because of owners specific interest in radioactive iodine treatment or difficulty in medicating the cats.

Table 1. Table showing number and locations of areas of IRU

Total number of areas of IRU	1	2	3	4	5
Total number of cats	60	46	8	4	2
Number of cats with area(s) IRU in neck	29	32	7	4	2
Number of cats with area(s) IRU in thoracic inlet	25	27	5	4	2
Number of cats with area(s) IRU in thorax	6	7	7	4	2

Following scintigraphic evaluation, 56 cats were treated with subcutaneously administered radioactive iodine. Anti-thyroid medication was withdrawn 2 weeks prior to radioactive iodine treatment. Fifty-one cats were treated with a single dose of 110 MBq (3 mCi, 'low dose (LD)'), and five cats were treated with a single dose of 1100 MBq (30 mCi, 'high dose (HD)'), either due to confirmed thyroid carcinoma (three cases) or because of a lack of response to a previous single treatment of LD iodine and suspected thyroid carcinoma (two cases). Figure 3 illustrates the scintigraphic scan of one of these cases. The cats treated with LD iodine included 14 of the cats with ectopic hyperfunctional thyroid tissue.

The majority of cats treated with LD radioiodine was euthyroid within 4 weeks post-treatment. In addition to the two cases that went on to receive HD radioiodine, two other cases were recorded as not responding to LD radioiodine. One cat had medium sized bilateral hotspots in the neck and then went on to have a BT; histopathology confirmed thyroid adenoma. The other case (Table 2; case 25) had a very extensive area of isotope uptake involving both glands in the neck and extending down the cervical region into the thorax (Fig 4). This cat also had thyroid biopsies confirming adenoma. The cat went on to be well stabilised with medical management. Three additional cases were also recorded that had not become euthyroid within the follow-up period, but thyroxine concentrations had significantly reduced. All of these cases had ectopic thyroid tissue (Table 2; cases 5, 7 and 11) and two (cases 7 and 11) had microscopically confirmed thyroid adenoma.

Only one of the cats treated with HD radioiodine did not become euthyroid; this was one of the confirmed carcinoma cases. A further cat (case 20) died shortly after treatment. Nineteen cats were treated with thyroidectomy, six cats were stabilised successfully with medical management and three cats received no further treatment for thyroid disease. Treatment modality in the remaining cases was not recorded. Further, follow-up information was only obtained for the cats with ectopic hyperfunctional thyroid tissue.

Histopathological examination of thyroid tissue was performed in 40 cases. Thirty cases were diagnosed with adenoma/adenomatous hyperplasia and 10 with carcinoma. Sections from all cats with carcinoma and 13 cats with adenoma were available for review. In all cases, there was agreement with the previous histological diagnosis. The cats identified with thyroid carcinomas have been previously described.[13]

Thyroid tissue from eight of the 26 cats with intrathoracic hyperfunctional thyroid tissue was examined microscopically. Two of these eight cats had thyroid carcinoma and six had adenoma/adenomatous hyperplasia (five of these also had more than two areas of IRU). The cat with three areas of IRU in the neck/thoracic inlet had adenomatous hyperplasia (case 27). Of the 18 cats that did not have histopathological assessment of thyroid tissue, at least a further seven cats became euthyroid following treatment with LD radioiodine (including two cats with more than two hotspots) and remained euthyroid with follow-up periods of 21 months to 4.5 years. A further four of these 18 cats, including two cats with more than two hotspots, were successfully controlled with medical management. The remaining seven cats either died (one from congestive heart failure (CHF), two from unknown cause) or were euthanased due to thyroid carcinoma and concurrent disease (one case), lost to follow-up (one case), became euthyroid following HD radioiodine administered due to suspected thyroid carcinoma (one case) or had not yet become euthyroid at the point of follow-up although T_4 was continuing to decrease (one case).

Many of the cats in this study identified as having intrathoracic hyperfunctional thyroid tissue were initially suspected to have thyroid carcinoma, particularly if there were very large and/or multiple and/or irregular areas of IRU (Fig 5). In addition, six further cases were initially suspected to have carcinoma. Two of these six cats had pulmonary masses evident on radiographs; both were subsequently diagnosed with thyroid adenoma on histology (one had a single area of IRU in the neck; the other had one area of IRU in the neck and one in the thoracic inlet). One cat had a mediastinal mass evident on radiographs (Fig 6); on ultrasonographic and cytological examinations this was found to be filled with acellular fluid. There was no uptake of technetium in the mediastinum (two areas of IRU in the neck only) and the cat became euthyroid following LD iodine treatment. A further cat had a single very large cervical thyroid mass that was confirmed to be thyroid adenoma on histopathology. The remaining two cats also had a large cervical mass which on scintigraphy had an irregular outline and very patchy appearance (eg, Fig 7); on histopathology one was found to be a cystic adenoma and the other adenomatous hyperplasia.

Discussion

The most appropriate treatment option for any individual hyperthyroid cat is determined by various factors, and the presence of multiple foci of abnormal

Table 2. Details of cats identified with ectopic hyperfunctional thyroid tissue

Case number	Number of hotspots			Additional features on imaging	Palpable nodule	Previous surgery	Reason for referral	Histopathology	Treatment	Outcome	Long-term follow-up
	Neck	TI	Thorax								
1	1		1	Mediastinal 1 cm diameter ST opacity on XR	Yes	R then L UT 2 years apart	Recurrence of hyperthyroidism	ND	LD radioiodine	Euthyroid within 4 weeks post treatment	Still alive and euthyroid 4.5 years post treatment
2		1	2		Yes	No	Owners interest in iodine treatment	ND	LD radioiodine	Euthyroid within 4 weeks post treatment	Lost to long-term follow-up
3	2	1	2		No	L then R UT	Recurrence of hyperthyroidism	ND	Carbimazole	Well controlled with medical management	Euthanased 5 months later with pancreatic neoplasia
4	2		1		Yes	UT	Recurrence of hyperthyroidism, large palpable goitre	ND	Carbimazole	Well controlled with medical management	Euthanased 10 months later for unknown reason; euthyroid at time of euthanasia
5	1	1	1	Very large thoracic area of IRU	Yes	No	Difficulty medicating	ND	LD radioiodine	T_4 reducing but not yet euthyroid after 4 weeks	Developed CHF, died 4 weeks post treatment
6		1	1	Mediastinal ST opacity on XR	No	UT	Carcinoma and concurrent disease	Carcinoma	No treatment	Severe concurrent cystitis and liver disease, euthanased at time of diagnosis	NA
7	1	1	2		Yes	BT	Recurrence of hyperthyroidism	Adenoma	LD radioiodine	Remained hyperthyroid, successfully controlled with carbimazole treatment	Euthanased 2.5 years later with renal failure

8			2		No	Yes	Recurrence of hyperthyroidism	ND	Carbimazole	Stabilised with medical management	Lost to follow-up
9	1		1		Yes	Yes	Recurrence of hyperthyroidism	Adenoma	Carbimazole	Stabilised with medical management	Lost to follow-up
10			1		No	Yes	Recurrence of hyperthyroidism	ND	Carbimazole	Stabilised with medical management	Lost to follow-up
11	3	1	1	On initial scintigraphy multiple areas of IRU in neck/TI/ thorax, raising suspicions of carcinoma. Scintigraphy repeated after removal of further nodules for histopathology	No	UT 3 months previously, further thyroid nodules removed when hyper-thyroid-ism recurred	Recurrence of hyperthyroidism and suspicion of carcinoma	Adenoma	LD radioiodine	T_4 significantly reduced 5 weeks post treatment but not yet euthyroid	Lost to follow-up
12	2		1	Clinician suspicious of carcinoma because of multiple areas of IRU	Yes	2 L UT	Recurrence of hyperthyroidism	2 Nodules removed − both adenoma	Methimazole	Well controlled with medical management	Developed laryngeal squamous cell carcinoma a few months later, time of euthanasia unknown
13			2	Large area of IRU extending from inside thoracic inlet to heart base, clinician suspicious of carcinoma	Yes	UT 4 years previously	Persistence of hyperthyroidism following thyroidectomy	Adenoma	Surgical biopsy for histopathology, followed by LD radioiodine	Became hypothyroid; stabilised with thyroxine	Euthyroid (still on thyroxine) 2 years later then lost to further follow-up
14			1		No	No	Not recorded	ND	LD radioiodine	Unknown	Lost to follow-up

(*continued on next page*)

Table 2. (*continued*)

Case number	Number of hotspots			Additional features on imaging	Palpable nodule	Previous surgery	Reason for referral	Histopathology	Treatment	Outcome	Long-term follow-up
	Neck	TI	Thorax								
15	2		1	Extremely large area of IRU within mediastinum, connected to bilateral areas of IRU in neck	Yes	No	Owners interest in iodine treatment	ND	No apparent response to LD radioiodine, then treated with HD radioiodine	Euthyroid within 10 weeks post treatment	Lost to follow-up
16			1		No	No	Poor response to methimazole	ND	LD radioiodine	Euthyroid within 4 weeks post treatment	Still alive and euthyroid 3 years post-treatment
17	2	1	1		Yes	No	Lack of response to LD radioiodine	ND, FNA suggestive of carcinoma	HD radioiodine	Euthyroid within 10 weeks post treatment, became hypothyroid	Still alive and hypothyroid (on thyroxine) 2.5 years later
18			2		No	No	Poor response to methimazole and no palpable thyroid	ND	LD radioiodine	Euthyroid within 4 weeks post treatment	Still alive and euthyroid 21 months post treatment
19			1		No	3 UT 1 year apart	Persistence of hyperthyroidism following 3rd thyroidectomy	ND	LD radioiodine	Euthyroid within 4 weeks post treatment	Still alive and euthyroid 27 months post treatment
20			1	Very large thoracic area of IRU	No	Yes	Recurrence of hyperthyroidism	ND, FNA suggestive of carcinoma	HD radioiodine	Died 2 weeks following treatment, cause unknown	NA
21	1	1	1	Widespread uptake of pertechnetate throughout pulmonary fields	Yes	UT	Treatment for carcinoma	Carcinoma	HD radioiodine	Euthyroid within 10 weeks post treatment	Remained euthyroid, euthanased 25 weeks post treatment due to pancytopenia (FIV positive)

22	1	1	1		Yes	UT	Difficulty medicating and owners interest in iodine treatment	ND	LD radioiodine	Euthyroid within 4 weeks post treatment	Lost to follow-up
23	1		1		Yes	UT 8 months previously	Recurrence of hyperthyroidism and very large goitre led to suspicion of carcinoma	ND	LD radioiodine	T_4 had reduced within 4 weeks post treatment but not euthyroid	5 Months post treatment still not euthyroid but T_4 continuing to decrease
24	2	1	1	Very extensive area IRU involving both glands in cervical area extending into cranial thorax cystic appearance on ultrasound	Yes	Yes	Poor response to medical treatment and large goitre suspicious of carcinoma	FNA suggestive of carcinoma, biopsy planned but died before performed	Methimazole	Euthanased due to development of CHF during investigations	NA
25	2	1	1	1 Large area IRU involving both glands, down cervical region into thorax	Yes	No	Poor response to methimazole, large goitre	Adenomatous hyperplasia	LD radioiodine	No reduction in T_4	Stabilised more easily on lower dose methimazole compared with pre-iodine, despite no reduction in T_4 with radioiodine alone. Alive and euthyroid 15 months post treatment
26			1		No	No	Difficulty medicating	ND	LD radioiodine	Euthyroid within 4 weeks post treatment	Still alive and euthyroid 7 months post treatment
27	2	1			Yes	No	Difficulty medicating	Adenomatous hyperplasia	Surgery	Euthyroid post surgery	Lost to follow-up

R = right sided, L = left sided, ND = not done, FNA = fine needle aspirate, NA = not applicable.

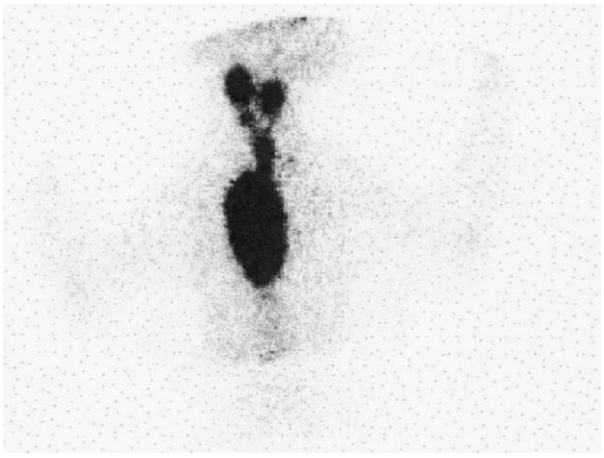

Fig 3. Scintigraphy scan, ventral view (Table 2; case 15) showing an extensive area of IRU involving both glands in the neck extending to a very large intrathoracic area of IRU. Histopathology was not performed in this case. The cat failed to respond to LD radioiodine but became euthyroid following HD radioiodine.

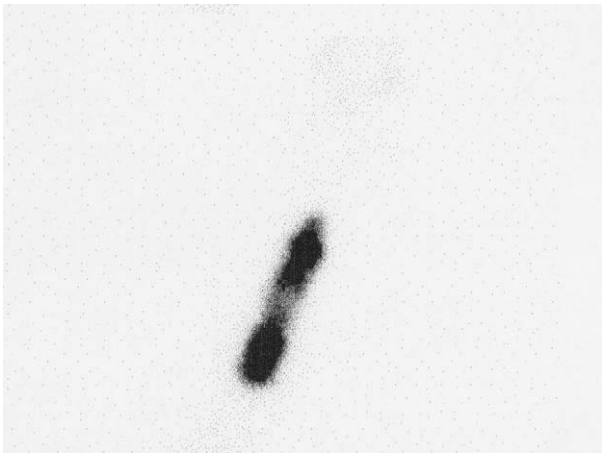

Fig 5. Scintigraphy scan, ventral view (Table 2; case 13) showing the presence of large irregular areas of IRU within the thorax. Biopsy of the mass revealed microscopical features consistent with an adenoma and the cat responded well to treatment with LD radioiodine.

thyroid tissue or ectopic thyroid tissue is an important consideration. The commonly used treatment options for feline hyperthyroidism are medical management with anti-thyroid drugs, surgical thyroidectomy and radioactive iodine treatment (^{131}I). Radioiodine treatment is often considered to be the best treatment option for many cats because it has the greatest potential to cure the disease with a single treatment, it is not dependent on the location of the hyperfunctional thyroid tissue, no general anaesthesia is required and there are minimal side effects.[2,14–16] However, in the United Kingdom there is relatively limited availability of this treatment modality and the major disadvantage is the necessity, for health and safety reasons, for a long period of hospitalisation in isolation facilities following administration of ^{131}I. Until recently the required isolation time at UOB was 5 weeks (now reduced to 3 weeks), which made radioactive iodine treatment less than ideal. For these reasons, thyroidectomy remains a common first choice of treatment for feline hyperthyroidism and is a useful treatment modality when there is no ectopic hyperfunctional thyroid tissue present. However, based on this study between 1/4 and 1/5 hyperthyroid cats have multiple areas of hyperfunctional thyroid tissue and/or

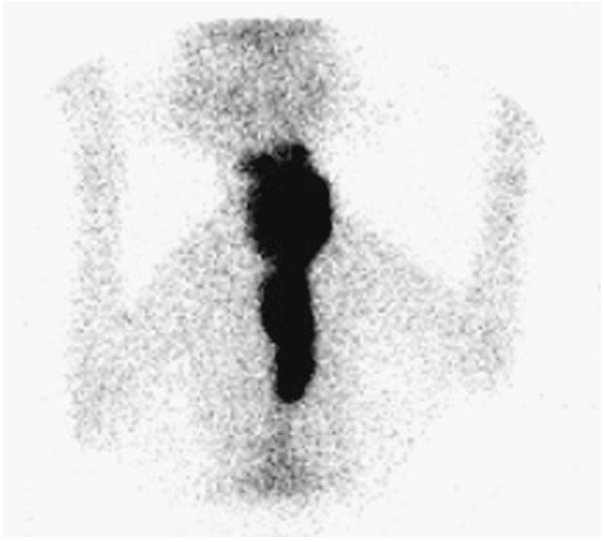

Fig 4. Scintigraphy scan, ventral view (Table 2; case 25) showing an extensive area of IRU involving both glands in the neck and extending down the cervical region into the thorax. Biopsies of the mass in the neck confirmed adenomatous hyperplasia. The cat only partially responded to LD radioiodine treatment and went on to be well stabilised with medical management.

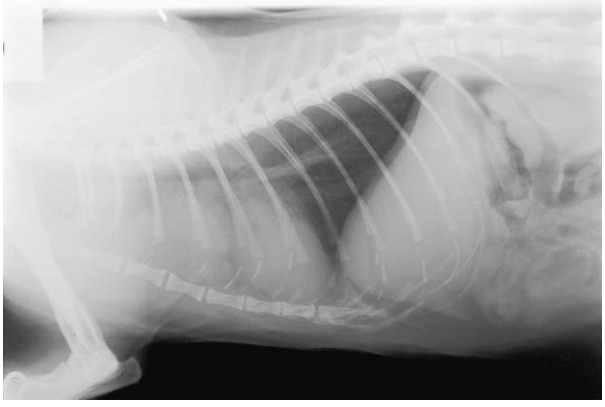

Fig 6. Thoracic radiograph demonstrating the appearance of a mediastinal cyst, which led to the suspicion of a thyroid carcinoma. However, there was no uptake of isotope in the thorax, and the cat responded fully to LD radioiodine.

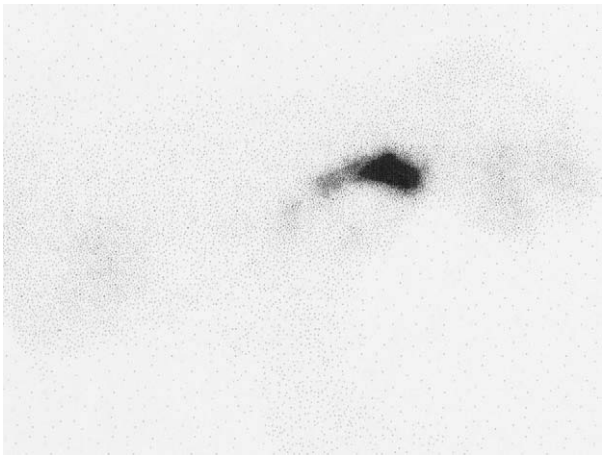

Fig 7. Scintigraphy scan, lateral view from a cat with a suspected carcinoma. An irregular outline and patchy appearance can be seen. This was diagnosed as a cystic adenoma on histopathological examination.

intrathoracic hyperfunctional thyroid tissue where surgical thyroidectomy would not be curative. Veterinary surgeons should, therefore, routinely warn owners about the possibility of ectopic thyroid tissue before thyroidectomy is performed. Particular consideration should be given to cats that have recurrence of hyperthyroidism following previous thyroid surgery, and those without palpable goitre. Sixty-eight percent of those cats in the present study which had recurrence of hyperthyroidism following thyroid surgery had ectopic hyperfunctional thyroid tissue.

The proportion of cats with palpable goitre was relatively low in this study (72%) compared with previous reports.[17] However, palpable goitre may have been underestimated as this was a retrospective study in which identification of this change was reliant upon annotation of the patient case records. Whilst lack of palpable goitre may increase suspicion of intrathoracic thyroid tissue, the presence of palpable goitre in a hyperthyroid cat does not exclude the possibility of additional ectopic thyroid tissue. In this study 12% of cats with a palpable goitre also had ectopic intrathoracic thyroid tissue.

In 97–99% of hyperthyroid cats thyroid pathology is benign, characterised histologically as adenomatous hyperplasia, adenoma or mutinodular adenoma. Thyroid carcinomas are recognised less frequently, with reported incidence of less than 3% of hyperthyroid cats.[2,8,17–19] It is important that thyroid carcinomas are distinguished as higher doses of radioisotope are required for successful radiotherapy.[2,20] Because malignant cells concentrate and retain ^{131}I less efficiently.[21]

It has been proposed that scintigraphic imaging may aid in determination of malignancy. Typical scintigraphic features of thyroid malignancy include distortion of the lobes, activity extending beyond the confines of the lobes, multiple foci of radionuclide uptake and uptake extending caudally or towards the thoracic inlet, multiple and extensive hotspots, a heterogeneous pattern of uptake with irregular, spiculated margins, linear multifocal patterns (suggestive of tumour extension along fascial planes) and uptake within the cranial mediastinum.[2,4,10,12,16] However, a recent retrospective review of 10 cases of feline thyroid carcinoma suggested that many cases did not display these typical scintigraphic findings.[13] Furthermore, multifocal and irregular uptake of radionuclide can occur in multinodular adenoma, cystic adenoma and cats that have had prior intracapsular thyroidectomy.[12] This finding was corroborated in the current study where many cats with benign disease had features such as multiple and extensive areas of IRU, areas of IRU in the mediastinum, heterogeneous uptake, irregular margins and distortion of the lobes. This suggests that although some scintigraphic features may increase the suspicion of malignancy, these are not definitive scintigraphic features that can reliably distinguish between malignant and benign thyroid disease.

It is not known why some of the cats in this series failed to respond clinically to administration of a single dose of 110 MBq (3 mCi) radioiodine. Radioactive iodine is considered to be a highly effective treatment for feline hyperthyroidism associated with benign thyroid pathology. It is however, recognised that up to 5–6% of cats require re-treatment;[21] the reported success rate after a single treatment is up to 94%.[14]

At the UOB a fixed dosing regime of 110 MBq (3 mCi) is used routinely for the treatment of benign thyroid disease, which is the median effective dose reported with individualised dosing methods.[4,8,14,15] However, it has been suggested that cats with extremely elevated thyroxine and cats with significantly larger volumes of hyperfunctional thyroid tissue as measured on scintigraphy, require higher doses of radioiodine.[8] Individualised dosing has been evaluated, attempting to take into consideration these factors, in addition to the biological half-life and thyroid uptake of iodine.[8,22] Other studies conclude that a fixed dose protocol of 148–185 MBq (4–5 mCi) is most appropriate for routine use.[15,23] Presence of large volumes of hyperfunctional thyroid tissue and/or marked thyrotoxicoxis may be the reason for a lack of response in some of the cats in this study. This was not a consistent finding as other cats with large volumes of hyperfunctional thyroid tissue did have a complete response, whilst another cat that had no response had only two small areas of pertechnetate uptake in the neck. The presence of thyroid carcinoma is another possibility in some cases where histopathology was not performed. As with this case, cats with thyroid carcinoma may respond very well to HD radioiodine.[2,13,20]

Another potential reason for the variation in response to a single LD of ^{131}I is that pertechnetate may not accurately reflect uptake or organification of ^{131}I and, therefore, may not reliably predict the response to ^{131}I.[2] It seems more likely that cats with ectopic tissue or very large volumes of abnormal tissue

have a higher risk of not responding to a single LD of ^{131}I, but owners should be warned prior to treatment that a lack of response is possible in a small number of cats, regardless of the scintigraphic findings.

In conclusion, the results of the present investigation indicate that the potential for the presence of ectopic thyroid tissue should be discussed with all owners of hyperthyroid cats prior to performing thyroidectomy. Furthermore, if hyperthyroidism recurs following thyroidectomy, scintigraphic evaluation should be seriously considered prior to performing a second surgical procedure. The identification of ectopic hyperfunctional thyroid tissue and/or multiple areas of IRU generally reflects the presence of benign thyroid disease and animals thus affected can respond well to treatment with LD radioiodine.

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