Thyroid Cysts in Cats: A Retrospective Study of 40 Cases

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Background: Thyroid cysts are rare in cats and poorly documented.

Objectives: To report distinguishing clinical features and treatment responses of cats with thyroid cysts.

Animals: Forty client-owned cats.

Methods: Retrospective review of medical records for cats with thyroid cysts confirmed by scintigraphy, ultrasound, magnetic resonance imaging, or necropsy at 4 referral centers between 2005 and 2016. Signalment, clinical findings, diagnostic testing, treatment, and outcome were recorded.

Results: Cats ranged in age from 8 to 20 years with no apparent breed or sex predilection. 37 of 40 (93%) cats were hyperthyroid (duration, 1–96 months). Clinical findings included palpable neck mass (40/40, 100%), weight loss (15/40, 38%), dysphagia (8/40, 20%), decreased appetite (5/40, 13%), and dyspnea (4/40, 10%). Cysts were classified as small (≤ 8 cm^3) in 16 (40%) and large (>8 cm^3) in 24 (60%) cats. Of 25 cats treated with radioiodine, hyperthyroidism resolved in 23 (92%), whereas thyroid cysts resolved in 12 (50%). Radioiodine treatment resolved small cysts in 8 of 13 (62%) cats and large cysts in 4 of 11 (36%) cats. Eight cats, including 2 euthyroid cats, underwent thyroid-cystectomy; 3 with bilateral thyroid involvement were euthanized postoperatively for hypocalcemia. Excised cystic thyroid masses were identified as cystadenoma (4) and carcinoma (4).

Conclusions and Clinical Importance: Thyroid cysts are encountered in hyperthyroid and euthyroid cats with benign and malignant thyroid tumors. Radioiodine treatment alone inconsistently resolved thyroid cysts. Thyroid-cystectomy could be considered in cats with unilateral thyroid disease or when symptomatic cysts persist despite successful radioiodine treatment of hyperthyroidism.

Key words: Cystadenoma; Feline; Hyperthyroidism; Thyroid carcinoma.

Thyroid cysts are infrequently observed and reported in cats, with only 6 cases reported in conjunction with functional[1,2] and nonfunctional thyroid tumors.[1,3,4] Depending on their size, thyroid cysts can be subclinical[2] or cause signs of dysphagia, regurgitation, cough, and laryngeal paralysis by compression of surrounding structures.[1,3,4] Rarely, death due to aspiration pneumonia after regurgitation has been reported.[2]

Fluid in the thyroid cyst typically is red-brown or serosanguinous, and cytologically compatible with hemorrhage or nonseptic inflammation.[1,2] Drainage of cyst fluid might temporarily alleviate clinical signs referable to compression of nearby tissues, but the fluid might re-accumulate.[1] Measurement of thyroid and parathyroid hormone concentrations on cyst fluid is reported to

Abbreviations:

^{131}I	radioiodine
CT	computed tomography
MRI	magnetic resonance imaging
T$_4$	thyroxine

help differentiate thyroid from parathyroid origin.[1] Advanced imaging such as ultrasound, computed tomography (CT), or magnetic resonance imaging (MRI) is also utilized to determine the source of cystic cervical masses.[1,2] To date, all published cases of palpably large thyroid cysts in cats in which histopathology was performed have identified only adenomas.[1–3] However, thyroid carcinomas can also exhibit cystic changes at necropsy.[5]

Ideal treatment options and long-term prognosis for cats with thyroid cysts have not been determined. Some have suggested that surgical resection is superior to radioiodine (^{131}I) therapy in hyperthyroid cats with thyroid cysts.[6] Successful unilateral surgical excision of thyroid cysts is reported in 3 cats.[1,3]

It is against this paucity of information that we sought to describe the clinical findings, diagnostic test results, and treatment responses of a series of cats with thyroid cysts.

Material and Methods

Case Selection

Medical records and imaging databases of the Cornell University Hospital for Animals, Animal Endocrine Clinic, Advanced Veterinary Medical Imaging, and Alamo Feline Health Center were searched to identify cats with thyroid cysts diagnosed between January 2005 and June 2016. Cysts were detected by

thyroid scintigraphy, cervical ultrasound, MRI, or necropsy. All thyroid scintiscans were reviewed by 1 investigator (MEP) to measure thyroid nodule (and cyst) volume using the equation for a spheroid ($V = 4/3 \ \pi a^2 c$), as previously described.[7] For cats that did not undergo thyroid scintigraphy, cyst volume was determined using the same method[7] from measurements obtained from other imaging modalities or at necropsy, or from the amount of fluid aspirated from the cyst. Cats were arbitrarily categorized as having either small cysts (≤ 8 cm^3) or large cysts (>8 cm^3) from parameters previously used to define thyroid size.[8]

Data obtained from review of medical records at time of thyroid cyst presentation included: age, sex, breed, thyroid status, clinical signs, physical examination findings, length of time since diagnosis of hyperthyroidism (if applicable), previous therapies for hyperthyroidism (if applicable), and results of imaging studies (scintigraphy, ultrasound, CT, MRI, or thoracic radiographs). Diagnosis of hyperthyroidism was based on compatible clinical features and serum thyroxine (T$_4$) concentrations above the upper reference interval limit for the laboratory utilized. Clinicopathologic findings from complete blood counts, serum biochemistry profiles, and urinalyses were recorded if obtained within 3 months of thyroid cyst diagnosis. Cyst fluid volume, appearance, cytologic findings, and cyst fluid T$_4$ concentrations were recorded. In cats that underwent radioiodine treatment, total ^{131}I dose and need for additional treatments were recorded. For cats that underwent surgery, histopathologic findings and complications after surgery were noted. Follow-up information determined resolution of hyperthyroidism and thyroid cysts. Cats that died or were euthanized were classified as dying secondary to their thyroid disease, other disease, or unknown reason.

Statistical Analyses

Most data are presented with descriptive and summary statistics (median, range, proportions). For select comparisons, such as cyst resolution by ^{131}I dose group (≤ 10 vs. >10 mCi), cyst resolution with ^{131}I by size of thyroid cyst, or incidence of treatment-induced hypothyroidism by ^{131}I dose group, a 2-tailed Fisher's exact test was used. A 2-tailed Mann-Whitney U-test was used for comparisons of ^{131}I dose between cats with large and small thyroid cysts. The nominal $\alpha = 0.05$ for all contrasts.

Results

Study Population

Forty cats with thyroid cysts from Cornell University Hospital for Animals (n = 5), Animal Endocrine Clinic (n = 16), Advanced Veterinary Medical Imaging (n = 15), and Alamo Feline Health Center (n = 4) were identified. Twenty-nine were domestic shorthair, 7 domestic longhair, 2 domestic medium-hair, and 1 each Maine Coon and Savannah. Cats had a median age of 13 years (range, 8–20 years) and consisted of 21 (52.5%) spayed females and 19 (47.5%) neutered males. Ninety-three percent (37/40) of cats were hyperthyroid; the 3 euthyroid cats had serum T$_4$ concentrations within the lower-half of the reference interval. Median time from initial diagnosis of hyperthyroidism to cyst recognition in 34 cats with available data was 23 months (range 1–96 months). During that interval, treatment for hyperthyroidism had been implemented in 29 of 37 cats. All 29 cats were treated with methimazole, of which 1 was also treated with radioiodine. Sixteen cats (40%) were classified as having small thyroid cysts,

whereas 24 (60%) were determined to have large cysts on the basis of measurements obtained by thyroid scintigraphy (32), cervical ultrasound (4), aspirated fluid volume (2), MRI (1), or necropsy (1). All euthyroid cats had large cysts, whereas hyperthyroid cats had small and large cysts (Table 1).

Clinical and Clinicopathologic Features

Owners or referring veterinarians most commonly noted a ventral neck mass (30/40; 75%). In fact, this was the only recorded concern in 18 of 40 (45%) cats and was identified on physical examination (Video S1) in all cats. Clinical signs at the time of cyst diagnosis were recorded in 21 of 40 cats. Those attributable to the compressive effect of the cervical mass included dysphagia (n = 8, 20%), decreased appetite (n = 5, 13%), dyspnea (n = 4, 10%), and dysphonia (n = 1, 3%). Most cats that exhibited dysphagia (6/8) or dyspnea (4/4) had large cysts (Table 1). One of the cats with a small thyroid cyst and dysphagia also had cranial mediastinal and pulmonary masses. Of the 4 cats with dyspnea, 2 exhibited inspiratory stridor whereas the respiratory pattern of the other cats was not further characterized. Other clinical features at the time of cyst diagnosis attributable to hyperthyroidism included polyphagia (n = 4, 10%), vomiting (n = 3, 8%), polydipsia/polyuria (n = 3, 8%), and tachycardia (n = 3, 8%). Clinical signs attributed to either hyperthyroidism or the compressive effects of the cyst (with resultant dysphagia or decreased appetite) included weight loss (n = 15, 38%) and muscle wasting (n = 11, 28%). One euthyroid cat with weight loss also had dysphagia attributable to a large thyroid cyst (Table 1).

Complete blood counts, serum biochemistry profiles, and urinalyses were completed in 34, 38, and 23 cats, respectively. Three cats were anemic (hematocrit, 14–26%, reference interval 29–48%); one of the anemic

Table 1. Characteristics of clinical manifestations of thyroid cysts in 40 cats.

Thyroid status Cyst size (Small: ≤ 8 cm^3 or Large: >8 cm^3)	Hyperthyroid (37)		Euthyroid (3)
	Small (16)	Large (21)	Large (3)
Clinical Presentation			
Dysphagia	2	5	1
Dyspnea	0	4	0
Weight Loss	6	8	1
Treatment			
Cyst resolution/cats treated with [131]I (all doses)	8/13	4/11	
Cyst resolution/cats treated with ≤ 10 mCi [131]I[a]	4/6	1/7	–
Cyst resolution/cats treated with >10 mCi [131]I[a]	4/7	3/4	–
Thyroid-Cystectomy	1	5	2
Thyroid Histopathology			
Cystadenoma	0	3	1
Carcinoma	1	2	1

[a]Multiply mCi by 37 to convert to MBq units for [131]I.

cats also demonstrated neutropenia and thrombocytopenia during methimazole treatment. Ten cats were azotemic (BUN, 37–50 mg/dL, reference interval 16–36 mg/dL) and 10 had mildly increased (2- to 3-fold) activity of liver-derived enzymes. Twelve cats had urine specific gravity <1.035, and 6 were proteinuric. Euthyroid cats had no clinicopathologic abnormalities.

Cyst fluid was aspirated in 22 cats. Median aspirated fluid volume in small cysts was 1.5 mL (range, 1–6 mL), whereas median volume in large cysts was 45 mL (range, 3–300 mL). The 3 mL volume obtained from the large cyst was a diagnostic sample; the next smallest volume aspirated was 12 mL. Fluid appearance, described in 15 cats, was red-brown (n = 7), serosanguinous (n = 5), or orange (n = 3). Cytologic evaluation was performed in 19 cats. The fluid was noninflammatory in 12 (of which 5 had a hemorrhagic component), inflammatory in 4, and neoplastic in 3 (carcinoma in 1 and epithelial tumor in 2). Median T_4 concentration in cyst fluid from 6 cats with hyperthyroidism was 4.4 μg/dL (2.1–11.7 μg/dL), 56.6 nmol/L (27.0–150.6 nmol/L). Concentration of T_4 within the cyst fluid showed no association with serum T_4 concentration (Fig 1).

Imaging Findings

Radiography was performed in 23 cats. Of these, ten cats had radiographs of both the cervical region and thorax, 3 cats had radiographs of the thorax only, and ten cats did not have images available for review. Radiographs were described as normal in 7 cats; radiographic findings in 16 cats included soft tissue opacity causing tracheal deviation or compression (n = 5;
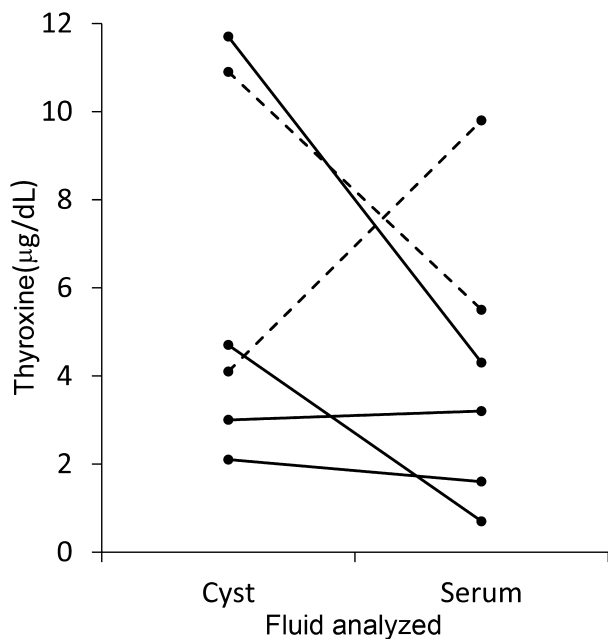
Fig 2), enlarged cardiac silhouette (n = 4), cranial mediastinal mass (n = 4), pleural effusion (n = 2), and mediastinal and pulmonary masses (n = 1).

Thirty-four cats underwent thyroid scintigraphy, with radionuclide uptake described as unilateral (n = 8), bilateral-symmetric (n = 5), bilateral-asymmetric (n = 14), and multifocal (n = 7). Twenty-nine cats had a single thyroid cyst, whereas 5 had multiple thyroid cysts. In cats with hyperthyroidism, cysts appeared as photopenic regions surrounded by hyperfunctional thyroid tissue (Fig 3).

Seventeen cats had cervical ultrasound examinations performed; 13 had sonographic evaluation in addition to scintigraphy, whereas 4 cats were diagnosed with thyroid cysts on cervical ultrasound examination alone. The cysts were characterized as thin-walled cavitations of the thyroid gland by anechoic fluid, mobile echoic debris, or both (Fig 4).

Two cats underwent CT, but both also had thyroid scintigraphy and cervical ultrasounds. One euthyroid cat underwent MRI as the sole imaging modality. One cat did not undergoing any advanced imaging, but was confirmed to have a thyroid cyst on necropsy.

Treatment and Outcome

Twenty-eight cats with hyperthyroidism and thyroid cysts underwent ^{131}I treatment (dose range, 2.8–30 mCi; 103.6–1110 MBq), with 14 cats receiving ≤10 mCi (370 MBq) and 14 receiving >10 mCi. Of the 28 cats treated with ^{131}I, 23 cats received doses >5 mCi (185 MBq). Cats with smaller cysts received a range of ^{131}I doses (median, 12.1 mCi; range, 2.8–30 mCi) similar to that of cats with large cysts (median, 13.8 mCi; range, 2–30 mCi) (P = .9). Hyperthyroidism resolved in 23 of 25 (92%) cats for which follow-up data were available, and 10 cats subsequently developed iatrogenic hypothyroidism requiring levothyroxine supplementation. Eight of the 12 (67%) cats treated with >10 mCi of ^{131}I developed hypothyroidism (as based on low serum total T_4 concentrations), compared to only 2 of 13 (15%) cats that were treated with ≤10 mCi. Cats

Fig 1. Thyroxine (T_4) concentration in thyroid cyst fluid compared to serum T_4 concentration in 6 cats with hyperthyroidism. Solid lines indicate cats receiving methimazole at time of T_4 determinations.

Fig 2. Lateral cervical and thoracic radiograph of cat with large thyroid cyst (arrow) displacing cervical structures.
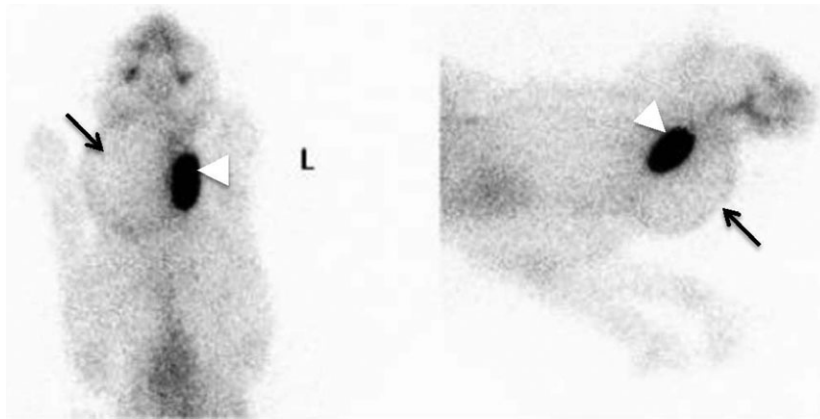
Fig 3. Images from thyroid scintigraphy on hyperthyroid cat with large thyroid cyst. Note the photopenic region of the cyst (arrow) and intense uptake of technetium in the hyperfunctional thyroid nodule (arrowhead).
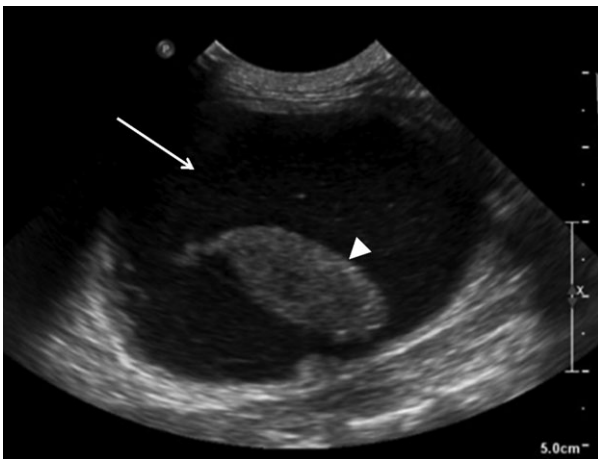

Fig 4. Ultrasound image of a large thyroid cyst in a cat. Note cystic fluid (arrow) and thyroid tissue (arrowhead).

Fig 5. Exposure of thyroid cyst in cat undergoing thyroid-cystectomy. Note the thin translucent wall of cyst.

receiving >10 mCi were more likely to become hypothyroid than cats receiving ≤10 mCi ($P = .015$).

Of 24 cats for which outcomes were available, 12 (50%) had thyroid cysts resolve within 6 months of ^{131}I therapy (Table 1). Four of these cats required repeated drainage for several months after ^{131}I treatment before their cysts fully resolved. Eight of the 13 (62%) small thyroid cysts resolved after ^{131}I treatment, whereas 4 of 11 (36%) large cysts resolved ($P = .4$). Of the 12 cats whose cysts resolved with ^{131}I, 5 of 12 (42%) were treated with ≤10 mCi and 7 of 12 (58%) were treated with >10 mCi (Table 1). In the 13 cats with small thyroid cysts, ^{131}I treatment resulted in resolution of cysts in 4 of 6 (67%) cats treated with ≤10 mCi and 4 of 7 (57%) cats treated with >10 mCi (Table 1, $P = 1.0$). For the 11 cats with large thyroid cysts, ^{131}I treatment resulted in resolution of cysts in 1 of 7 (14%) cats treated with ≤10 mCi and 3 of 4 (75%) cats treated with >10 mCi (Table 1; $P = .09$).

Three cats (2 given ≤10 mCi and 1 given >10 mCi ^{131}I) underwent thyroid-cystectomy after radioiodine treatment to remove residual thyroid cysts (Fig 5). The interval between radioiodine treatment and thyroid-cystectomy was 1 month in 2 cats, and 6 months in the remaining. All 3 cats had unilateral disease and none experienced complications after surgery or recurrence of cystic thyroid disease. Histopathologic findings disclosed thyroid carcinoma (2) and cystadenoma (1). Five cats underwent initial thyroid-cystectomy without [131]I. Of these, 2 cats were euthyroid, 2 were receiving methimazole for hyperthyroidism, and 1 was not receiving any treatment for hyperthyroidism. The 3 hyperthyroid cats that had bilateral thyroid-cystectomy developed severe hypocalcemia after surgery. In all 3 cases, owners declined managing this complication and elected euthanasia. The 2 euthyroid cats that underwent unilateral thyroid-cystectomy recovered without complication or recurrence of cystic thyroid disease. Histopathologic findings revealed thyroid carcinoma (2) and cystadenoma (3). Of the 3 hyperthyroid cats, 1 had thyroid carcinoma and 2 had thyroid cystadenomas. Of the 2 euthyroid cats, 1 had thyroid carcinoma and 1 had thyroid cystadenoma (Table 1).

Seven cats were not treated specifically for their cysts because of comorbidities (n = 3), severity of clinical signs associated with the compressive effects of the cyst (n = 2), selection of medical management of hyperthyroidism (n = 1), and unknown reasons (n = 1). Fifteen

cats died or were euthanized since diagnosis of thyroid cysts: 7 secondary to cystic thyroid disease, 6 to other diseases (cranial mediastinal mass [n = 2], metastatic hemangiosarcoma [n = 1], uremia [n = 1], pancreatitis, inflammatory bowel disease, and diabetes mellitus [n = 1], and congestive heart failure [n = 1]), and 2 to unknown causes.

Discussion

Our retrospective study describes the largest cohort of cats with thyroid cysts to date. Most cats with thyroid cysts were hyperthyroid, and most cats with clinical signs of dysphagia or dyspnea had large thyroid cysts. Treatment of hyperthyroidism with ^{131}I doses >10 mCi induced hypothyroidism more frequently than doses ≤10 mCi. Small thyroid cysts were no more likely to resolve after ^{131}I treatment than large cysts. Regardless of thyroid status, cysts were equally likely to be benign as malignant. Finally, T_4 concentrations in the cyst fluid were not reflective of serum T_4 concentrations.

The association of cysts with hyperthyroidism is not surprising. Median time from diagnosis of hyperthyroidism to recognition of the thyroid cyst was 23 months, suggesting that cysts occasionally develop with long-standing thyroid disease. Size, volume, and number of functional thyroid tumor nodules increase proportionally with disease duration in cats.[8] Although it is possible that the cats in our study represent a biased subset of severely affected cats presenting for ^{131}I therapy, clients often identified cysts in cats already diagnosed with hyperthyroidism and treated with methimazole or [131]I. Three euthyroid cats were referred for further evaluation because a large cervical mass was noted by the client and palpated by the primary clinician. Because thyroid palpation is a routine part of physical examinations in older cats, we would anticipate that most clinicians would be capable of identifying cervical masses and would likely refer these cats for further evaluation.

We arbitrarily categorized cats as having large (>8 cm³) or small (≤8 cm³) cysts (based on a previous study that used similar criteria to classify thyroid nodules) to see whether clinical signs, diagnostic test results, or treatment outcomes varied between the 2 groups. Clinical signs uniquely attributed to the thyroid cyst (dysphagia, dyspnea, and dysphonia) were more common in cats with large cysts. We suspect large thyroid cysts exert compressive effects on surrounding structures such as esophagus or trachea leading to these clinical signs. Other clinical signs of polyphagia, polyuria, polydipsia, and vomiting were attributed to hyperthyroidism. In all 40 cats, physical examination disclosed a palpable cervical mass. Although most other physical findings were ascribed to hyperthyroidism, weight loss and muscle wasting could be attributed to either hyperthyroidism or the dysphagia and poor appetite from the compressive effects of the cyst. Euthyroid cats only had clinical signs and physical findings referable to the cervical mass. In hyperthyroid cats, complete blood count,

serum biochemistry, and urinalysis abnormalities were consistent with those typically reported for the disease.[6] Azotemia in some cats was attributed to dehydration or concurrent chronic kidney disease. Anemia in 3 cats was ascribed to methimazole toxicosis (1 cat with concurrent neutropenia and thrombocytopenia), hemangiosarcoma (n = 1), and cranial mediastinal and pulmonary masses (n = 1).

In humans, thyroid nodules affect approximately 50% of the population, with 15–40% of the nodules being cystic.[9] Thyroglossal duct cysts are the most common congenital cause of cystic neck masses in children and young adults.[10] In adults, however, the majority of thyroid cysts arise from degenerating thyroid adenomas, with a smaller number attributed to malignant neoplasia such as papillary thyroid carcinoma.[9] Nodules that are predominantly cystic are more likely to be benign.[11] Similar to those findings, a previous report of thyroid cysts in cats associated them with benign thyroid adenomatous hyperplasia and thyroid cystadenoma.[1] Interestingly in our study, 50% of thyroid cysts examined histologically were malignant. However, the number of thyroid cysts undergoing histopathologic evaluation in our study was relatively small (8 cats). Most cystic thyroid nodules in humans are nonfunctional, although hyperfunctional thyroid nodules that have undergone hemorrhage or infarction can become cystic.[9] Disparate with those findings, most of the thyroid cysts in our population of cats were associated with hyperthyroidism.

Humans with thyroid cysts are frequently asymptomatic, but can exhibit clinical signs including neck pain, dysphagia, hoarseness, and dyspnea from upper airway obstruction, and Horner's syndrome.[9] In our study, dysphagia was reported in 20% of cats and dyspnea in 10%. Most cats that exhibited dysphagia or dyspnea had large cysts that seemingly compressed neighboring structures such as the esophagus and trachea.

Thyroid cysts in humans commonly contain hemorrhagic or serosanguinous fluid,[9] similar to the descriptions of fluid aspirated from the cysts in our study. In humans, thyroid hormones as well as other biochemical analytes such as acid phosphatase, aspartate aminotransferase, amylase, lactate dehydrogenase, and total bilirubin are increased in thyroid cyst fluid compared to serum.[12] Similarly, T_4 concentrations in thyroid cyst fluid in hyperthyroid cats are reported to be high.[6] In contrast, the T_4 concentrations in cyst fluid in 6 hyperthyroid cats in our study were variable and showed no clear association with the serum T_4 concentrations. Methimazole administration in 4 of the 6 cats might have affected these findings.

Thyroid scintigraphy, cervical ultrasound, CT, MRI, and fluid aspiration were utilized to identify size and number of thyroid cysts or confirm that a cervical neck mass was thyroid in origin. Thyroid scintigraphy allowed determination of the functional status of the thyroid tissue, and ultrasound, CT, and MRI permitted identification of the thyroid gland, adjacent vessels, and nearby lymph nodes. Cervical ultrasound also helped

guide percutaneous fluid collection from the cystic thyroid.[1]

Percutaneous drainage of the cyst as sole therapy results in high rates of recurrence in human patients.[13] Therefore, surgical excision is recommended for large cysts (>4 cm in diameter) or malignant cystic neoplasia.[14] Other therapeutic options include ethanol sclerotherapy,[14] radiofrequency ablation,[15] or interstitial laser photocoagulation.[16] In our study, most hyperthyroid cats with thyroid cysts (28/37; 76%) underwent treatment with [131]I. The majority of these cats (23/28; 82%) received >5 mCi ^{131}I likely reflecting the large size of the cystic thyroid masses. Despite receiving higher than traditional ^{131}I doses, hyperthyroidism resolved in only 92% of cats. Cats receiving >10 mCi were more likely to become hypothyroid. Thyroid cysts resolved in 50% of cats within 6 months of ^{131}I therapy. In some cats, the persisting cyst required intermittent drainage but ultimately stopped re-accumulating fluid. We found no statistical difference in the probability of cyst resolution with doses of [131]I >10 mCi or ≤10 mCi, likely because of the relatively small numbers of cats evaluated in each group.

Although surgical removal of thyroid cysts is the treatment of choice in humans, it has only been described in few cases in the veterinary literature.[1,3,4] In the study herein, thyroid-cystectomy was pursued in 3 cats in which ^{131}I treatment failed to resolve the thyroid cyst, and as first-line therapy in 2 euthyroid and 3 hyperthyroid cats. Thyroid-cystectomy was performed without complications in all cats with unilateral thyroid involvement. However, bilateral thyroid-cystectomy in the remaining 3 hyperthyroid cats was associated with severe hypocalcemia after surgery resulting in owner election of euthanasia. We suspect that the large size of the cysts distorted the normal anatomy of the thyroid glands making it difficult to adequately visualize and preserve the external parathyroid glands, resulting in peracute iatrogenic hypoparathyroidism. Hypocalcemia following bilateral thyroidectomy has been reported in 6–82% of cats, depending on the surgical method, and in most cases is mild and transient.[6] In a case series of dogs with bilateral thyroid carcinoma, hypocalcemia after surgery was observed in 11 of 15 (73%) despite efforts to preserve or re-implant the parathyroid glands.[17] Treatment of iatrogenic hypoparathyroidism should be anticipated in cats with large thyroid cysts undergoing bilateral thyroid-cystectomy.

Ethanol sclerotherapy is commonly performed in humans to treat thyroid cysts.[13] However, ethanol injection into thyroid nodules in hyperthyroid cats is associated with numerous risks including Horner's syndrome, dysphonia, laryngeal paralysis, and only transient resolution of the hyperthyroid state.[18,19] There are no reports of cats with thyroid cysts being treated with ethanol sclerotherapy, although it has been successfully used in the management of renal and hepatic cysts in cats.[20] Intracyst ethanol sclerotherapy could be a less invasive therapeutic option for thyroid cyst management in the cat and warrants further investigation.

Limitations of this study were those inherent in any retrospective study. Historical information was limited by completeness of the medical records. Diagnostic and treatment strategies were not standardized within or between institutions. Standardized prospective studies on a larger number of cases would be needed to determine the ideal treatment option for euthyroid and hyperthyroid cats with thyroid cysts. Unfortunately, the rarity of this disorder limits the feasibility of such clinical trials.

In conclusion, our study suggests that thyroid cysts appear to develop most often in cats with long-standing hyperthyroidism but can also occur rarely in cats with nonfunctional thyroid tumors. Benign and malignant functional and nonfunctional thyroid tumors were associated with cyst development. Most cats displaying dyspnea or dysphagia had large thyroid cysts. Thyroxine measurement on cyst fluid in hyperthyroid cats was unrelated to serum T_4 concentrations. Although ^{131}I was effective in treating hyperthyroidism, high doses were more likely to induce hypothyroidism without improving the rate of cure of large thyroid cysts. Some cysts resolved after ^{131}I treatment of hyperthyroidism, but other cysts persisted and required ongoing drainage or surgical removal. Thyroid-cystectomy was effective in resolving unilateral thyroid cysts. However, bilateral thyroid-cystectomy was associated with a high risk of iatrogenic hypocalcemia that should be considered with surgical planning.

Acknowledgments

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Supporting Information

Additional Supporting Information may be found online in the supporting information tab for this article:

Video S1. Palpation of a large thyroid cyst in a cat.