

Hyperthyroidism: clinical signs and physical examination findings

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Signalment

Hyperthyroidism is a common endocrine disorder of the senior cat affecting up to 10% of cats over 10 years of age.^{1,2} In fact, 95% of cats with hyperthyroidism are greater than 9 years old.³ Although the average age of cats with hyperthyroidism is 13 years, rarely cats as young as 8 months have been diagnosed.⁴ There is no breed or sex predisposition, but Siamese and Himalayan cats have lower risk of developing hyperthyroidism.^{1,5-7}

Clinical signs

Thyroid hormones regulate heat production and carbohydrate, protein, and lipid metabolism.^{8,9} With excessive secretion of thyroid hormones, there is an overall increase in metabolic rate and energy metabolism, with far-ranging effects on multiple organ systems. Clinical signs may vary from mild to severe depending on the duration and magnitude of increased thyroid hormone production.

There is no pathognomonic presentation for hyperthyroidism in cats, and indeed, the clinical picture has evolved over the last several decades. When hyperthyroidism was first recognized in the early 1980s (Fig. 10.1a), many cats presented with severe weight loss despite polyphagia, hyperactivity, and gastrointestinal tract disturbances (e.g., vomiting, diarrhea, voluminous stool).¹⁰⁻¹⁵ Often, electrocardiogram abnormalities and congestive heart failure were noted.^{12,16-18} Today, the frequency of those clinical findings has decreased (Table 10.1), and the most common clinical signs are mild-to-moderate weight loss with normal-to-increased appetite.¹⁹

TABLE 10.1. Clinical signs in cats with hyperthyroidism in 1984¹³ compared to 2016.¹⁹

Clinical signs	1984	2016
Weight loss	96%	92%
Increased appetite	77%	55%
Vomiting	49%	47%
Hyperactivity	68%	41%
Polyuria/polydipsia	53%	33%
Diarrhea/increased fecal volume	31%	21%

Suspecting hyperthyroidism in a cat can sometimes be challenging, as early or subtle signs of the disease may be dismissed as normal feline aging. Furthermore, cats may be misdiagnosed because hyperthyroidism can resemble many other diseases including diabetes mellitus, chronic kidney disease, liver disease, neoplasia, hyperadrenocorticism, exocrine pancreatic insufficiency, and gastrointestinal malabsorption associated with inflammatory bowel disease or alimentary lymphoma.^{2,20}

The prevalence of hyperthyroidism appears to have increased since its discovery in 1979 (see chapter 9), likely due to the widespread recognition of this disorder by veterinarians, advances in veterinary care leading to an overall increased population of elderly cats, and routine thyroid screening of middle-aged to older cats as part of annual health examinations.^{1,2,15,21} Thus, many cats now are being diagnosed at an early stage of their disease (Fig. 10.1b).



FIGURE 10.1. (a) Historical appearance of a cat with hyperthyroidism. Note the emaciation and severe loss of muscle mass. (b) Contemporary appearance of a cat with mild/early hyperthyroidism. Note that this cat's body and muscle condition are relatively normal.

Weight loss

Weight loss despite a normal-to-increased appetite remains the most common clinical sign in cats with hyperthyroidism (Table 10.1). Increased circulating thyroid hormones create a catabolic state with increased energy expenditure, increased lipolysis, and increased protein turnover leading to a loss of body weight associated with both reduced fat stores and lean body mass.^{8,9,22} As in human patients, muscle loss appears to be more profound than fat loss in cats with hyperthyroidism, and many cats diagnosed today will actually have a normal body condition score (BCS).¹⁹ In the early stages of the disease or with mild hyperthyroidism, weight loss may be mild. In fact, hyperthyroidism can be diagnosed in overweight and obese cats, with unintended weight loss incidentally discovered during routine annual health examinations.¹⁹



FIGURE 10.2. Cat with hyperthyroidism demonstrating extreme polyphagia. This cat is ingesting its fifth consecutive can of food for the day.

Change in appetite

Good to increased appetite

Most hyperthyroid cats have an increased appetite (Table 10.1). Some cats, particularly those with mild hyperthyroidism, may not have an obvious change in food consumption, but their owners still report their appetite as being good. Maintenance of a good to increased appetite often delays owners from seeking medical care for their cat, even in the presence of other clinical signs. More profoundly affected cats may exhibit behaviors such as begging for or stealing food, eating unusual dietary items (e.g., cake, pancake mix, bread), or consuming huge quantities of food (Fig. 10.2).¹⁰⁻¹⁴ Hyperthyroidism increases the basal metabolic rate, and polyphagia is an attempt to compensate for the increased energy expenditure by increasing calorie consumption. However, this effort is generally unsuccessful, with cats continuing to lose weight, particularly as the duration and severity of the cat's hyperthyroidism progresses.

Apathetic hyperthyroidism

Rarely, hyperthyroid cats may present with a decreased rather than a good to increased appetite.²³ These cats are often referred to as having “apathetic thyrotoxicosis”, particularly if their appetite improves after resolution of their severe hyperthyroidism.^{12,24} However, in most of these cats, a poor appetite actually reflects a co-morbidity that overrides the increase in appetite generally seen in hyperthyroid cats. Given that hyperthyroidism is a disease of aged cats, it is not unexpected that these cats may be afflicted with concurrent disease processes. In one study, non-renal co-morbidities were detected in 18% of hyperthyroid cats, with the most common being alimentary lymphoma and chronic enteropathy.²⁵

Additional co-morbidities that might contribute to reduced appetite include congestive heart failure, renal disease, pancreatitis, and other forms of neoplasia.^{23,25,26}

Gastrointestinal disturbances

Vomiting

Vomiting is reported in just under half of cats diagnosed with hyperthyroidism (Table 10.1). Owners often indicate that this occurs shortly after eating, leading to the suspicion that it is secondary to rapid over-eating.^{12,24} However, vomiting may also occur secondary to the direct effect of circulating thyroid hormone on the chemoreceptor trigger zone in the medulla.²⁷ Vomiting should resolve once euthyroidism has been restored. A cat that continues to vomit after effective treatment for hyperthyroidism should raise suspicion for an undiagnosed co-morbidity.^{23,25}

Diarrhea, increased fecal volume

Changes in defecation, mainly diarrhea and increased fecal volume, are less commonly seen in hyperthyroid cats than vomiting. These findings can result from intestinal hypermotility and malabsorption associated with the hyperthyroid state.²⁸ Some hyperthyroid cats will also develop steatorrhea.^{12,14} Maldigestion also may play a causative role in the diarrhea and weight loss, as reversible reduction in pancreatic exocrine secretion has been documented in humans with hyperthyroidism.²⁹ However, most hyperthyroid cats that present with moderate to severe diarrhea as one of their primary clinical signs have concurrent gastrointestinal disease (e.g., inflammatory bowel disease, alimentary lymphoma).²⁵

Neuromuscular signs

Cats with hyperthyroidism are frequently noted to be hyperactive, irritable, or restless (Table 10.1).³⁰ Thyroid hormones interact with the nervous system resulting in increased sympathetic drive that produces nervousness, irritability, and even delirium, stupor, or coma in rare human cases.³¹ In some cats, owners may report more “kitten-like” behavior (e.g., increased activity or playfulness) leading to misinterpretation of this clinical sign as a positive marker of health. Others state that their cats are anxious, vocalize more frequently, or aimlessly pace.^{10-12,14}

Aggressiveness; reduced tolerance for stress

Hyperactivity often manifests as increased aggressiveness or reduced tolerance for handling especially in the veterinary hospital. The stress of a car ride to the clinic, waiting in the reception area with barking dogs, and restraint during physical examination may result in respiratory distress (Fig. 10.3 and Video 10.1), weakness, and cardiac arrhythmias in some cats. This decreased ability to cope with stress must be considered during procedures.



VIDEO 10.1.

Video of a hyperthyroid cat exhibiting severe panting and respiratory distress during the physical examination.



FIGURE 10.3. Hyperthyroid cat exhibiting severe panting and respiratory distress during the physical examination.

Thyrotoxic seizures

Focal and generalized seizures have been reported in 0.3–9% of humans with thyrotoxicosis.³² High levels of circulating thyroid hormones increase the excitability in the brain and reduce the seizure threshold in susceptible individuals. The exact mechanisms are unclear, but hyperthyroidism increases cerebral blood flow and cerebral oxygen and glucose consumption, and it may alter the activities of sodium-potassium adenosine triphosphatase, severely altering sodium concentrations in neurons.³³ In addition, hypothalamic thyrotropin-releasing hormone (TRH) may act as an endogenous anticonvulsant,³⁴ and hyperthyroidism is expected to suppress the central nervous system levels of TRH. Both focal and generalized seizures characteristic of epilepsy have been rarely observed in hyperthyroid cats, with the seizures either lessening in severity or resolving with restoration of euthyroidism.³⁰ Rarely, hyperthyroid cats may present with acute focal neurologic deficits as a result of cerebrovascular accidents resulting from concurrent hypertension or cardiac disease.³⁰

Muscle weakness

Muscle weakness is commonly reported in human patients with hyperthyroidism as a result of proximal muscle paresis and atrophy.³⁵ Muscle biopsies may be normal or show nonspecific evidence of lipid infiltration, fiber atrophy, and nerve terminal damage. Signs of muscle weakness reported in hyperthyroid cats are rare but include generalized weakness, cervical ventroflexion, fatigue, muscle tremors, gait disturbance (e.g., ataxia, incoordination, inability to jump), muscle atrophy, breathlessness, and collapse (Fig. 10.4).^{10,12,30} Hypokalemia or thiamine deficiency may exacerbate signs of muscle weakness, particularly in cats exhibiting cervical ventroflexion.³⁶

Thyroid storm or crisis

Thyroid storm has been described in cats as a rare, but life-threatening complication of hyperthyroidism resulting from a rapid increase in serum thyroid hormone.³⁷ The term “thyroid storm”, as described in human medicine, is a clinical syndrome marked by exaggerated manifestations of thyrotoxicosis.^{38,39} Because of its high mortality, thyroid storm represents the most serious complication of hyperthyroidism in human patients. The diagnosis

is made clinically, based on a constellation of signs including high fever/hyperthermia, severe central nervous system signs ranging from marked agitation to obtundation and even coma, cardiovascular abnormalities, and multi-organ dysfunction.^{38,39} Although the term “thyroid storm” has been used to describe cats presenting with severe signs of hyperthyroidism,³⁷ none of these reported cats have developed high fever or marked hyperthermia, the classic clinical feature of thyroid storm in humans. Therefore, we prefer not to use the term thyroid storm to describe cats that present with, or develop signs of, severe thyrotoxicosis and instead favor the term “hyperthyroid crisis”.⁴⁰ Clinical signs of “hyperthyroid crisis” –which can be life threatening– include severe tachycardia (HR >300 bpm), tachypnea, panting, respiratory distress, profound weakness, cervical ventroflexion, or sudden blindness. Precipitating events may include abrupt removal of anti-thyroid medications, severe stress, or concurrent non-thyroidal illness. Clinicians should be aware that apparently stable hyperthyroid cats, especially those with severe, long-standing hyperthyroid disease, might deteriorate in the clinical setting with the stress of travel, handling, and diagnostic procedures.



FIGURE 10.4. Two cats with severe hyperthyroidism displaying generalized muscle weakness.

Increased thirst and urination

Polyuria and polydipsia appear to be decreasing in prevalence in hyperthyroid cats, presumably due to earlier recognition of the disease (Table 10.1).^{12,15,19} Cats with hyperthyroidism may exhibit change in drinking habits (such as drinking from dripping faucets or bath water) or urination (such as an increased number or size of clumps in the litter box). Increased thirst and urination in hyperthyroidism may develop as a consequence of the increased renal blood flow and glomerular filtration rate associated with excess thyroid hormones. Additionally, some cats with hyperthyroidism might develop primary polydipsia (compulsive water drinking).⁴¹

Concurrent renal insufficiency also contributes to the observed polyuria and polydipsia in many cats with hyperthyroidism and is likely the most common cause for increased thirst or urination. Because the glomerular filtration rate is increased with hyperthyroidism, cats with co-existing kidney disease may have normal serum markers of kidney function (i.e., blood urea nitrogen, creatinine, and symmetric dimethylarginine).⁴¹⁻⁴³ Masking of kidney dysfunction by the hyperthyroid state makes it difficult to determine if underlying renal insufficiency is causal for the polyuria, polydipsia, and reduction in urine specific gravity. Often, successful treatment of hyperthyroidism is required to determine if polyuria and polydipsia are due to the effect of increased thyroid hormones alone or associated with concurrent renal insufficiency (see chapter 12 on thyroid and kidney).^{41,42}

Respiratory signs

Respiratory signs, such as tachypnea, panting, or open-mouth breathing, are not uncommon in cats with hyperthyroidism, especially when stressed (Fig. 10.3 and Video 10.1).^{12,14} The cause of these signs is likely multifactorial, including heat intolerance, decreased ability to increase cardiac output in response to stress or exercise, increased production of carbon dioxide, and weakness of the respiratory muscles. Though rare in today's population of hyperthyroid cats, thyrotoxic congestive heart failure may result in pleural effusion or pulmonary edema, leading to respiratory distress.^{18,44}

Skin and hair coat changes

Cutaneous abnormalities are present in approximately 30% of cats with hyperthyroidism.⁴⁵ Common findings include excessive shedding, matting of hair, and increased rate of nail growth (Figs. 10.5 and 10.6).^{12,14} Focal or symmetric traumatic alopecia may be present due to cats pulling out patches of hair or excessive grooming, particularly of the ventral abdomen (Fig. 10.7).⁴⁶ Other cats may cease routine grooming habits leading to an unkempt appearance (Fig. 10.5).



FIGURE 10.5. Matted, unkempt haircoat in a long-haired cat with severe hyperthyroidism.



FIGURE 10.6. Nail changes (excessive nail growth) in feline hyperthyroidism. Note the long, thickened overgrown toenails, which may be more fragile than normal. These changes develop most commonly in cats with chronic and advanced hyperthyroidism.



FIGURE 10.7. (a) Hyperthyroid cat displaying excessive grooming of the ventral abdomen leading to traumatic alopecia (bald belly). (b) Cat with overgrooming of the lateral flank, leading to partial alopecia.

Physical examination

Physical examination findings in cats with hyperthyroidism vary based on disease duration and severity. The most common clinical features are palpable thyroid nodule(s) and muscle wasting (Table 10.2). A distinct effort should be made by veterinary personnel to track weights of feline patients at every office visit to detect subtle weight loss before it becomes physically noticeable. Hyperthyroidism should be considered in mature to geriatric cats in which weight loss is detected without specific intent or lifestyle changes.

Enlarged thyroid gland

In more than 90% of hyperthyroid cats, a cervical thyroid nodule can be palpated in one or both thyroid lobes (Table 10.2).^{1,47} In cats with long-standing disease, bilateral thyroid nodules are more common.³ Thyroid palpation is

TABLE 10.2. Physical examination findings in 462 cats with hyperthyroidism.¹⁹

Exam findings	Percentage
Palpable thyroid nodule	98%
Muscle wasting	77%
Thin body condition	35%
Tachycardia (≥ 240 bpm)	31%
Cardiac murmur	29%

non-invasive and inexpensive, and should be a routine part of the physical examination of all cats, particularly middle-aged to geriatric cats.⁴⁸ Two techniques can be utilized for thyroid gland palpation (Fig. 10.8).^{49,50} Both methods have very good within- and between-examiner agreement.⁴⁷

Classic palpation technique

The classic technique⁵⁰ places the cat in a sitting position. The neck of the cat is extended by tilting the head backward and tipping the nose upward towards the ceiling. The clinician's thumb and forefinger are placed on each side of the trachea and gently swept downwards from the larynx to the thoracic inlet along the jugular furrows (Fig. 10.8a and Video 10.2). Palpation of a mobile subcutaneous nodule or "blip" that slips under the fingertips determines the presence of a thyroid nodule.

Single finger palpation technique

The Norsworthy technique^{49,50} involves placing the cat in a standing position, with the clinician positioned directly behind the cat. To palpate the right thyroid lobe, the cat's head is held with the clinician's left hand and the chin elevated 45° horizontally and vertically (Fig. 10.8b and Video 10.3). The tip of the clinician's right index or middle finger is placed in the groove formed by the trachea and the right sternothyroideus muscle just below the larynx, then moved ventrally down the groove to the thoracic inlet. A characteristic "blip" can be felt if the thyroid gland is enlarged. The process is repeated in reverse for the cat's left thyroid lobe (Fig. 10.8c and Video 10.3).



FIGURE 10.8. Demonstration of two thyroid palpation techniques. (a) The “classic” palpation technique using thumb and index finger. (b) The single finger “Norsworthy technique” showing palpation of the right thyroid lobe. (c) The single finger technique showing palpation of the left thyroid lobe.



VIDEO 10.2.

Video of palpation of a unilateral (left-sided) thyroid nodule by the classic technique in a cat with hyperthyroidism.



VIDEO 10.3.

Video demonstration of single-finger palpation of bilateral thyroid nodules by the “Norsworthy technique” in a cat with hyperthyroidism.

Differential diagnosis of goiter

Thyroid palpation is a sensitive but poorly specific indicator of hyperthyroidism, as small thyroid nodules may occasionally be detected in euthyroid cats.^{51,52} This small goiter, commonly found in older cats, is generally due to mild or early adenomatous changes in thyroid tissue that are not yet hyper-functional but may progress to clinical hyperthyroidism over time. Larger nodules more likely reflect overt hyperthyroidism.^{50,52} However, other causes of cervical masses include lymphadenopathy, parathyroid tumor or cyst, salivary tumor or mucocele, carotid body tumor, branchial cleft cyst, thyroglossal duct cyst, and dermoid cyst.⁵³ Conversely, inability to palpate a cervical thyroid nodule does not eliminate a diagnosis of hyperthyroidism as gravitational forces may pull large thyroid tumors into the thoracic cavity.⁵⁴ Large thyroid tumor volume and location of thyroid tumors within the thoracic inlet or thorax are generally associated with longer disease duration and more severe hyperthyroidism.³

Huge thyroid masses

Occasionally, very large, fluctuant, or irregularly-shaped cervical masses may be found on physical examination in cats with thyroid cysts (Video 10.4),⁵³ thyroid carcinomas,⁵⁵ or SHIM-RAD tumors (defined as severe hyperthyroidism [serum $T_4 > 24 \mu\text{g/dl}$ ($>300 \text{ nmol/l}$)], huge thyroid tumor size or volume, intrathoracic tumor location, multifocal [≥ 3 nodules] distribution, and resistance to anti-thyroid drug treatment)³ (Fig. 10.9). Cats with large thyroid masses may exhibit dyspnea (particularly inspiratory stridor), dysphagia, or regurgitation secondary to compression of the larynx, pharynx, trachea, and esophagus.



VIDEO 10.4.

Video showing cervical palpation (using the classic technique) of a large thyroid cyst in a cat with long-standing hyperthyroidism.

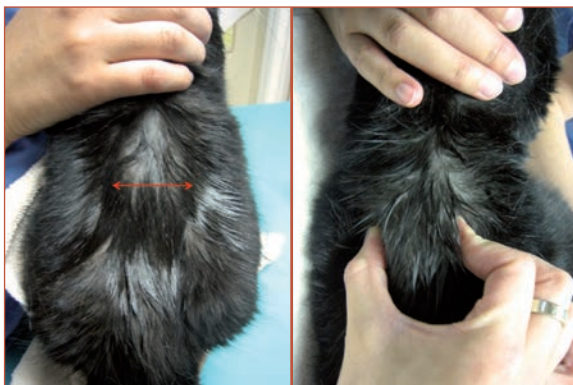


FIGURE 10.9. Thyroid palpation of a huge thyroid tumor in a 14-year-old, neutered male Domestic Shorthair cat with a 2.5-year history of hyperthyroidism, managed medically with methimazole. At time of initial diagnosis, the cat had a serum T_4 concentration of 6.6 $\mu\text{g/dl}$ (85 nmol/l) and was well controlled for the first year on low-dose methimazole (2.5 mg twice daily). Now the cat is poorly controlled and resistant to methimazole, with a serum T_4 concentration of 15.2 $\mu\text{g/dl}$ (195 nmol/l) despite having the methimazole dose increased to 15 mg per day.

Muscle wasting/Weight loss

Historically, most cats with hyperthyroidism present with very thin to emaciated body condition.¹⁰⁻¹⁴ However, in a recent study of 462 untreated hyperthyroid cats, only 35% were thin (low BCS) even though they weighed less than 1 to 2 years prior to their diagnosis.¹⁹ In fact, the majority of cats diagnosed with hyperthyroidism had an ideal BCS or were even overweight to obese.¹⁹

Based on the results of this study,¹⁹ weight loss in cats with hyperthyroidism appears to be predominantly caused by muscle wasting, rather than fat loss, especially in the early stages of the disease. The traditional BCS system assesses fat covering the ribs, abdominal tuck, and generalized fat deposits without assessing or evaluating muscle mass. The degree of muscle wasting can be evaluated by visualization and palpation of the spine, scapulae, skull, and wings of the ilia and classified as mild, moderate, or severe using the World Small Animal Veterinary Association (WSAVA) Muscle Condition Score chart (see chapter 41 for more information).⁵⁶

Despite muscle wasting in hyperthyroidism, owners seldom report that affected cats are weak or fatigue with physical activity. Rarely, cervical ventroflexion, generalized weakness, or gait disturbance (ataxia,

incoordination, inability to jump) can develop, especially with severe or long-standing hyperthyroidism (Fig. 10.4).^{10,12,30}

Cardiac abnormalities

Thyroid hormones alter cardiovascular function directly (by inotropic and chronotropic effects on the heart) and indirectly (through dilatory effects on peripheral vasculature).⁵⁷ As a result, cats with hyperthyroidism may develop changes in their heart consistent with a hypertrophic (or rarely a dilated) form of cardiomyopathy.^{44,57}

Tachycardia, murmurs, arrhythmias or gallop rhythms

Physical examination findings typically include tachycardia, with heart murmurs, arrhythmias or gallop rhythms detected less commonly. Tachycardia is due to a direct chronotropic effect of thyroid hormones on the heart as well as thyroid hormone potentiation of catecholamines on the heart. Murmurs are most often low grade (I-III/VI) and occur secondary to dynamic left or right ventricular outflow obstruction.⁴¹ The gallop rhythm is attributed to rapid ventricular filling. The presence of an arrhythmia warrants evaluation by electrocardiogram (ECG). Potential abnormalities on ECG include sinus tachycardia, increased R wave amplitude, and left anterior fascicular block; however, more serious abnormalities such as atrial and ventricular premature contractions, atrial and ventricular tachycardia, and atrioventricular block are less frequently identified.^{44,57}

Congestive heart failure

Prevalence of substantial cardiac derangements appears to be decreasing with earlier diagnosis and treatment of hyperthyroidism.^{57,58} If congestive heart failure does develop in hyperthyroid cats, clinical signs might include respiratory distress, anorexia, weak femoral pulses, and restrictive breathing pattern with pleural effusion.^{44,57} Should these signs be identified on physical examination, thoracic radiographs and echocardiogram are indicated to further characterize the nature and severity of potential cardiac disease. Almost all hyperthyroid cats that develop severe cardiac disease or failure today suffer from long-standing, poorly controlled thyrotoxicosis.²⁶

Hypertensive ocular lesions

Hyperthyroidism is an infrequent cause of systemic hypertension in cats. Several decades ago, hypertension was noted in up to 87% of cats with hyperthyroidism,⁵⁹ but this high prevalence was likely related to stress during blood pressure measurement. More recent studies estimate that only 10-25% of untreated hyperthyroid cats have systemic hypertension.⁶⁰⁻⁶² Approximately 25% of cats do develop systemic hypertension after successful treatment of hyperthyroidism, but this finding is not reliably linked to the unmasking of underlying kidney disease.^{61,62} The pathophysiology of hyperthyroid-associated hypertension remains poorly understood.

Systemic hypertension can cause target organ damage in tissues with rich arteriolar supply, particularly kidneys, eyes, myocardium, and brain. Hypertensive ocular changes are readily identified via direct or indirect fundoscopic retinal examination, and include retinal edema, hemorrhage, degeneration, or detachment.⁶² Severe ocular changes can lead to impaired vision, which can be assessed by the menace reflex and ability to track a moving object (such as a cotton ball), or challenging the cat to navigate obstacles in an unfamiliar room. Hyperthyroidism is not commonly implicated in hypertension-associated ocular disease, and most cats with hyperthyroidism do not develop overt retinopathy.^{63,64}

Co-morbidities

Attention should be paid to physical examination findings not readily explained by a diagnosis of hyperthyroidism. Given that hyperthyroidism is a disease of aged cats, it is not unexpected that these cats may be afflicted with concurrent disease processes.^{23,25,26}

In particular, small or irregularly shaped kidneys can increase suspicion of chronic kidney disease. Thickened intestinal loops or jejunal lymphadenopathy detected on abdominal palpation should raise concern for enteropathy. If co-existing disease is suspected, it is important to honestly discuss these concerns with cat owners so that they do not falsely assume that all of their cat's clinical signs will resolve with treatment of hyperthyroidism. Ultimately, hyperthyroidism must be effectively treated to determine to what degree the co-morbidity is contributing to the cat's clinical presentation.

Key facts

- The clinical picture of hyperthyroid cats has evolved from its initial recognition in the 1980s.
- The most common clinical signs remain weight loss and increased appetite.
- The most common physical examination findings are palpable thyroid nodule(s) and muscle loss.
- Muscle loss precedes fat loss in hyperthyroid cats, and hyperthyroidism may be diagnosed in cats with normal to increased body condition scores.
- Specific attention should be paid to palpation of the thyroid gland and muscle mass on routine physical examination, particularly in cats over 10 years of age, to detect subtle or early signs of hyperthyroidism.
- Gastrointestinal disease is the most common non-renal co-morbidity in hyperthyroid cats.

References

- Peterson M. Hyperthyroidism in cats: What's causing this epidemic of thyroid disease and can we prevent it? *J Feline Med Surg* 2012;14:804-818.
- Carney HC, Ward CR, Bailey SJ, et al. 2016 AAFP guidelines for the management of feline hyperthyroidism. *J Feline Med Surg* 2016;18:400-416.
- Peterson ME, Broome MR, Rishniw M. Prevalence and degree of thyroid pathology in hyperthyroid cats increases with disease duration: a cross-sectional analysis of 2096 cats referred for radioiodine therapy. *J Feline Med Surg* 2016;18:92-103.
- Gordon JM, Ehrhart EJ, Sisson DD, et al. Juvenile hyperthyroidism in a cat. *J Am Anim Hosp Assoc* 2003;39:67-71.
- Kass PH, Peterson ME, Levy J, et al. Evaluation of environmental, nutritional, and host factors in cats with hyperthyroidism. *J Vet Intern Med* 1999;13:323-329.
- Sabatino BR, Rohrbach BW, Armstrong PJ, et al. Amino acid, iodine, selenium, and coat color status among hyperthyroid, Siamese, and age-matched control cats. *J Vet Intern Med* 2013;27:1049-1055.
- Crossley VJ, Debnath A, Chang YM, et al. Breed, coat color, and hair length as risk factors for hyperthyroidism in cats. *J Vet Intern Med* 2017;31:1028-1034.
- Silva JE. Thyroid hormone control of thermogenesis and energy balance. *Thyroid* 1995;5:481-492.
- Mullur R, Liu YY, Brent GA. Thyroid hormone regulation of metabolism. *Physiol Rev* 2014;94:355-382.
- Holzworth J, Theran P, Carpenter JL, et al. Hyperthyroidism in the cat: ten cases. *J Am Vet Med Assoc* 1980;176:345-353.
- Hoenig M, Goldschmidt MH, Ferguson DC, et al. Toxic nodular goiter in the cat. *J Small Anim Pract* 1982;23:1-12.
- Peterson ME, Kintzer PP, Cavanagh PG, et al. Feline hyperthyroidism: pretreatment clinical and laboratory evaluation of 131 cases. *J Am Vet Med Assoc* 1983;183:103-110.
- Peterson ME. Feline hyperthyroidism. *Vet Clin North Am Small Anim Pract* 1984;14:809-826.
- Thoday KL, Mooney CT. Historical, clinical and laboratory features of 126 hyperthyroid cats. *Vet Rec* 1992;131:257-264.
- Broussard JD, Peterson ME, Fox PR. Changes in clinical and laboratory findings in cats with hyperthyroidism from 1983 to 1993. *J Am Vet Med Assoc* 1995;206:302-305.
- Peterson ME, Keene B, Ferguson DC, et al. Electrocardiographic findings in 45 cats with hyperthyroidism. *J Am Vet Med Assoc* 1982;180:934-937.
- Liu SK, Peterson ME, Fox PR. Hypertrophic cardiomyopathy and hyperthyroidism in the cat. *J Am Vet Med Assoc* 1984;185:52-57.
- Jacobs G, Hutson C, Dougherty J, et al. Congestive heart failure associated with hyperthyroidism in cats. *J Am Vet Med Assoc* 1986;188:52-56.
- Peterson ME, Castellano CA, Rishniw M. Evaluation of body weight, body condition, and muscle condition in cats with hyperthyroidism. *J Vet Intern Med* 2016;30:1780-1789.
- Peterson ME, Randolph JF, Mooney CT. Endocrine diseases. In: Sherding RG, ed. *The Cat: Diagnosis and Clinical Management*, 2nd ed. New York: Churchill Livingstone; 1994:1404-1506.
- Peterson ME. Animal models of disease: feline hyperthyroidism: an animal model for toxic nodular goiter. *J Endocrinol* 2014;223:T97-T114.
- Riis AL, Jorgensen JO, Gjedde S, et al. Whole body and forearm substrate metabolism in hyperthyroidism: evidence of increased basal muscle protein breakdown. *Am J Physiol Endocrinol Metab* 2005;288:E1067-1073.
- Nussbaum LK, Scavelli TD, Scavelli DM, et al. Abdominal ultrasound examination findings in 534 hyperthyroid cats referred for radioiodine treatment between 2007-2010. *J Vet Intern Med* 2015;29:1069-1073.
- Gunn-Moore D. Feline endocrinopathies. *Vet Clin North Am Small Anim Pract* 2005;35:171-210.
- Puig J, Cattin I, Seth M. Concurrent diseases in hyperthyroid cats undergoing assessment prior to radioiodine treatment. *J Feline Med Surg* 2015;17:537-542.
- Watson N, Murray JK, Fonfara S, et al. Clinicopathological features and comorbidities of cats with mild, moderate or severe hyperthyroidism: a radioiodine referral population. *J Feline Med Surg* 2018;in press (doi: 10.1177/1098612X18755925).
- Rosenthal FD, Jones C, Lewis SI. Thyrotoxic vomiting. *Br Med J* 1976;2:209-211.
- Papasouliotis K, Muir P, Gruffydd-Jones TJ, et al. Decreased oro-caecal transit time, as measured by the exhalation of hydrogen, in hyperthyroid cats. *Res Vet Sci* 1993;55:115-118.
- Wiley ZD, Lavigne ME, Liu KM, et al. The effect of hyperthyroidism on gastric emptying rates and pancreatic exocrine and biliary secretion in man. *Am J Dig Dis* 1978;23:1003-1008.
- Joseph RJ, Peterson ME. Review and comparison of neuromuscular and central nervous system manifestations of hyperthyroidism in cats and humans. *Progress in Veterinary Neurology* 1993;3:114-119.
- Wood-Allum CA, Shaw PJ. Thyroid disease and the nervous system. *Handb Clin Neurol* 2014;120:703-735.
- Song TJ, Kim SJ, Kim GS, et al. The prevalence of thyrotoxicosis-related seizures. *Thyroid* 2010;20:955-958.
- Hoffmann G, Dietzel ID. Thyroid hormone regulates excitability in central neurons from postnatal rats. *Neuroscience* 2004;125:369-379.
- Veronesi MC, Kubek DJ, Kubek MJ. Intranasal delivery of a thyrotropin-releasing hormone analog attenuates seizures in the amygdala-kindled rat. *Epilepsia* 2007;48:2280-2286.
- Olson BR, Klein I, Benner R, et al. Hyperthyroid myopathy and the response to treatment. *Thyroid* 1991;1:137-141.
- Nemzek JA, Kruger JM, Walshaw R, et al. Acute onset of hypokalemia and muscular weakness in four hyperthyroid cats. *J Am Vet Med Assoc* 1994;205:65-68.
- Ward CR. Feline thyroid storm. *Vet Clin North Am Small Anim Pract* 2007;37:745-754.

38. Chiha M, Samarasinghe S, Kabaker AS. Thyroid storm: an updated review. *J Intensive Care Med* 2015;30:131-140.
39. Angell TE, Lechner MG, Nguyen CT, et al. Clinical features and hospital outcomes in thyroid storm: a retrospective cohort study. *J Clin Endocrinol Metab* 2015;100:451-459.
40. Peterson ME. Thyroid storm: does this syndrome really exist in cats? *J Feline Med Surg* 2016;18:936-938.
41. Syme HM. Cardiovascular and renal manifestations of hyperthyroidism. *Vet Clin North Am Small Anim Pract* 2007;37:723-743.
42. Vaske HH, Schermerhorn T, Grauer GF. Effects of feline hyperthyroidism on kidney function: a review. *J Feline Med Surg* 2016;18:55-59.
43. Peterson ME, Varela FV, Rishniw M, et al. Evaluation of serum symmetric dimethylarginine concentration as a marker for masked chronic kidney disease in cats with hyperthyroidism. *J Vet Intern Med* 2018;32:295-304.
44. Fox PR, Broussard JD, Peterson ME. Hyperthyroidism and other high cardiac output states. In: Fox PR, Sisson D, Moise NS, eds. *Textbook of Canine and Feline Cardiology: Principles and Clinical Practice*, Second ed. Philadelphia: WB Saunders; 1999:781-793.
45. Miller WH, Griffin CE, Campbell KL. Endocrine and metabolic diseases. In: Miller WH, Glicksler, ed. *Muller and Kirk's Small Animal Dermatology*, 7th ed. St Louis, MO: Elsevier; 2013:512-553.
46. Vogelneust LJ. Skin as a marker of general feline health: Cutaneous manifestations of systemic disease. *J Feline Med Surg* 2017;19:948-960.
47. Paepe D, Smets P, van Hoek I, et al. Within- and between-examiner agreement for two thyroid palpation techniques in healthy and hyperthyroid cats. *J Feline Med Surg* 2008;10:558-565.
48. Paepe D, Verjans G, Duchateau L, et al. Routine health screening: findings in apparently healthy middle-aged and old cats. *J Feline Med Surg* 2013;15:8-19.
49. Norsworthy GD, Adams VJ, McElhaney MR, et al. Relationship between semi-quantitative thyroid palpation and total thyroxine concentration in cats with and without hyperthyroidism. *J Feline Med Surg* 2002;4:139-143.
50. Peterson ME. More Than Just T₄: Diagnostic testing for hyperthyroidism in cats. *J Feline Med Surg* 2013;15:765-777.
51. Ferguson D, Freeman R. Goiter in apparently euthyroid cats. In: August JR, ed. *Consultations in Feline Internal Medicine*, 5th ed. St. Louis: Elsevier Saunders; 2006:207-215.
52. Boretti FS, Sieber-Ruckstuhl NS, Gerber B, et al. Thyroid enlargement and its relationship to clinicopathological parameters and T₄ status in suspected hyperthyroid cats. *J Feline Med Surg* 2009;11:286-292.
53. Miller ML, Peterson ME, Randolph JF, et al. Thyroid cysts in cats: a retrospective study of 40 cases. *J Vet Intern Med* 2017;31:723-729.
54. Peterson ME, Broome MR. Thyroid scintigraphy findings in 2,096 cats with hyperthyroidism. *Vet Radiol Ultrasound* 2015;56:84-95.
55. Hibbert A, Gruffydd-Jones T, Barrett EL, et al. Feline thyroid carcinoma: diagnosis and response to high-dose radioactive iodine treatment. *J Feline Med Surg* 2009;11:116-124.
56. WSAVA Nutritional Assessment Guidelines Task Force Members. WSAVA nutritional assessment guidelines. *J Feline Med Surg* 2011;13:516-525.
57. Sangster JK, Panciera DL, Abbott JA. Cardiovascular effects of thyroid disease. *Compend Contin Educ Vet* 2013;35:E1-E10.
58. Fox PR, Peterson ME, Broussard JD. Electrocardiographic and radiographic changes in cats with hyperthyroidism: Comparison of populations evaluated during 1992-1993 vs. 1979-1982. *J Am Anim Hosp Assoc* 1999;35:27-31.
59. Kobayashi DL, Peterson ME, Graves TK, et al. Hypertension in cats with chronic renal failure or hyperthyroidism. *J Vet Intern Med* 1990;4:58-62.
60. Jepson RE. Feline systemic hypertension: Classification and pathogenesis. *J Feline Med Surg* 2011;13:25-34.
61. Williams TL, Elliott J, Syme HM. Renin-angiotensin-aldosterone system activity in hyperthyroid cats with and without concurrent hypertension. *J Vet Intern Med* 2013;27:522-529.
62. Taylor SS, Sparkes AH, Briscoe K, et al. ISFM consensus guidelines on the diagnosis and management of hypertension in cats. *J Feline Med Surg* 2017;19:288-303.
63. Maggio F, DeFrancesco TC, Atkins CE, et al. Ocular lesions associated with systemic hypertension in cats: 69 cases (1985-1998). *J Am Vet Med Assoc* 2000;217:695-702.
64. van der Woerd A, Peterson ME. Prevalence of ocular abnormalities in cats with hyperthyroidism. *J Vet Intern Med* 2000;14:202-203.