Results of excision of thymoma in cats and dogs: 20 cases (1984–2005)

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Objective—To provide long-term follow-up information for a series of dogs and cats with invasive and noninvasive thymomas treated by excision alone.

Design—Retrospective case series.

Animals—9 cats and 11 dogs with thymoma.

Procedures—Medical records were reviewed. The following factors were analyzed for their effect on prognosis: age of dog or cat, invasiveness of the tumor, percentage of lymphocytes in the mass (percentage lymphocyte composition) on histologic evaluation, and mitotic index of the mass.

Results—All patients were treated with excision of the tumor alone. Median overall survival time for the cats was 1,825 days, with a 1-year survival rate of 89% and a 3-year survival rate of 74%. Median overall survival time for the dogs was 790 days, with a 1-year survival rate of 64% and a 3-year survival rate of 42%. Recurrence of thymoma was observed in 2 cats and 1 dog, and a second surgery was performed in each, with subsequent survival times of 5, 3, and 4 years following the first surgery. Percentage lymphocyte composition of the mass was the only factor that was significantly correlated with survival time; animals with a high percentage of lymphocytes lived longer.

Conclusions and Clinical Relevance—Results of this study indicated that most cats and dogs with thymomas did well after excision. Even cats and dogs with invasive masses that survived the surgery and the few cats and dogs with recurrent thymomas or paraneoplastic syndromes had a good long-term outcome. Excision should be considered an effective treatment option for dogs and cats with thymomas. (J Am Vet Med Assoc 2008;232:1186–1192)

Thymomas are uncommon neoplasms of the cranial mediastinum; they are derived from thymic epithelial cells and have variable lymphocytic infiltration. They are considered to be one of the most common tumors of the cranial mediastinum in dogs and cats. Other differentials for mediastinal masses that must be considered include heart-based tumor, ectopic thyroid or parathyroid tumor, thymic branchial cyst, chemodectoma (aortic or carotid body tumors), metastatic neoplasia, granuloma, abscess, lipoma, teratoma, and schwannoma. It is important to differentiate between lymphoma and thymoma, as the therapeutic approach is different; lymphoma is treated medically, whereas surgery is the recommended treatment for thymoma. Paraneoplastic syndromes such as hypercalcemia, MG, polymyositis, dermatitis, arrhythmias, and other immune-mediated disease may worsen the prognosis in patients with thymoma and may not always resolve following removal of the mass. In some instances, paraneoplastic syndromes may develop after surgery.

Few clinical studies have been performed in which results of treatment in dogs and cats with thymoma were evaluated. More information is needed regarding results of treatment by excision alone. We hypothesized that complete excision of noninvasive thymomas in dogs and cats results in long-term survival, particularly if paraneoplastic syndromes are not present. The purpose of the study reported here was to provide long-term follow-up information for a series of cats and dogs with invasive and noninvasive thymomas treated by excision alone.

Materials and Methods

Case selection—Medical records of all dogs and cats with thymoma examined between 1984 and 2005 at The Ohio State Veterinary Teaching Hospital were reviewed. Criteria for inclusion in the study were as follows: excision of a thymoma, a diagnosis made on the basis of microscopic evaluation of excised specimens, and availability of histologic slides of the tumor for further evaluation by a pathologist.

Medical records review—Data obtained from the medical records included history; physical examination findings; results of clinicopathologic testing (including CBC, serum biochemical analysis, urinalysis, and cytologic examination of fine-needle aspirates or core biopsy specimens); findings on thoracic radiography, ultrasonography, and CT (when available); treatment; and outcome. Follow-up information was obtained by

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telephone contact with referring veterinarians and owners and by review of medical records at reevaluation of patient visits to the veterinary teaching hospital.

**Diagnostic evaluations**—For the purpose of this study, all available thoracic radiographs, computed tomograms, and ultrasonograms were reviewed by a board-certified radiologist (VFS). Histologic sections from each tumor were reviewed by a board-certified pathologist (SEW).

Percentage of lymphocytes in each mass (percent lymphocyte composition) was graded on a scale of 0 to 10 at 40X magnification on all sections available. A grade of 0 = no lymphocytes, 1 = > 0% to < 10% of the mass composed of lymphocytes, 2 = 10% to < 20% of the mass composed of lymphocytes, and so on until a grade of 10 in which ≥ 90% of the mass was composed of lymphocytes. Mitotic index of cells in each mass was also determined. The mean number of mitotic figures observed in 10 consecutive 40X fields was recorded for each thymoma. Fields with the least amount of lymphocyte infiltration were chosen for evaluation of mitotic index.

**Statistical analysis**—Survival curves were estimated by use of the Kaplan-Meier method for 2 endpoints of interest. For thymoma-specific survival, an event was defined as death resulting from the surgical procedure or progressive disease. Patients were considered censored if they were lost to follow-up or died of other causes. For overall survival, an event was defined as death resulting from any cause. Censoring only occurred if the patient was lost to follow-up. In an attempt to determine prognostic factors, univariable Cox proportional hazards models were fit for age of the dog or cat, invasiveness of the tumor (an invasive tumor was defined as one that was not encapsulated or was found to be adhered to surrounding tissues during dissection), percent lymphocyte composition of the mass on histologic evaluation, and mitotic index of the mass on histologic evaluation (dichotomized to 0 and > 0). The outcome of overall survival was used. No models were attempted for thymoma-specific survival because of the small number of events (deaths). For all analyses, a value of P < 0.05 was considered significant.

**Results**

**Signalment**—Nine cats and 11 dogs met the criteria for inclusion in the study. Seven cats were domestic shorthair cats, 1 was a Siamese, and 1 was a domestic longhair cat. Six cats were spayed females, and 3 were castrated males. Mean and median ages of cats were 11.7 and 12 years, respectively (range, 6 to 15 years). Four dogs were mixed breed, 2 were Dalmatians, 1 was an Airedale Terrier, 1 was a Labrador Retriever, 1 was an Akita, 1 was a Golden Retriever, and 1 was a Collie. Seven were spayed females, and 4 were castrated males. Mean and median ages of the dogs were 10.4 and 10.5 years, respectively (range, 5 to 15 years).

**Clinical signs and findings before surgery**—Clinical signs of cats included dyspnea (n = 6), coughing (4), anorexia (2), lethargy (2), vomiting (1), and regurgitation (1). Clinical signs of dogs included dyspnea (5), lethargy (5), dysphonia (4), coughing (3), anorexia (3), exercise intolerance (2), and regurgitation (2). Physical examination findings in cats included poor compressibility of the cranial portion of the thorax (6), muffled heart sounds (4), and absence of ventral bronchovesicular sounds (1). One cat had ventroflexion of the neck; low palpebral response; and, subsequently, MG. Physical examination findings in dogs included muffled heart sounds (7), tachypnea (3), and absence of ventral bronchovesicular sounds (2).

**Clinicopathologic findings**

Blood samples for CBC determinations and serum biochemical analyses were obtained from each dog and cat. One cat had eosinophilia (1.7 × 10⁶ cells/L), 1 had lymphocytosis (15.9 × 10⁹ cells/L), 1 had neutrophilia (22 × 10⁹ cells/L), and 1 had a low PCV (28%). Biochemical abnormalities in cats included high serum creatinine (n = 4 cats; range, 2.1 to 3.9 mg/dL; mean, 2.9 mg/dL), SUN (3; range, 37 to 49 mg/dL; mean, 43.3 mg/dL), and plasma protein (2; range, 8.1 to 9.1 g/dL; mean, 8.6 g/dL) concentrations and high serum creatinine kinase (1; 6,974 U/L) activity. Results of serologic testing for infection with FeLV and FIV by use of an ELISA were negative for all cats. One cat was tested for MG on the basis of clinical signs. An antibody titer of 37.4 nmol/L (reference value, < 0.3 nmol/L) against the acetylcholine receptor provided confirmation of MG in this cat.

Two dogs had neutrophilia (range, 20.0 × 10⁹ cells/L to 39.9 × 10⁹ cells/L; mean, 30.0 × 10⁹ cells/L), 1 had leukocytosis (42.4 × 10⁹ cells/L), and 1 had a low PCV (26%). Biochemical abnormalities in dogs included increased alkaline phosphatase activity (2; range, 271 to 617 U/L; mean, 444 U/L) and hypercalcemia (1; 19.1 mg/dL). The hypercalcemia was consistent with a diagnosis of hypercalcemia of malignancy confirmed by a high serum ionized calcium (2.4 mmol/L; reference range, 1.25 to 1.45 mmol/L) concentration, low serum parathyroid hormone (0.9 pmol/L; reference range, 2 to 13 pmol/L) concentration, and high serum parathyroid hormone-related protein (6.9 pmol/L; reference value, < 1.0 pmol/L) concentration.

Urinealysis results were available for 5 of 9 cats and 4 of 11 dogs. One cat had a specific gravity of 1.023, and 1 dog had a specific gravity of 1.021; the remainder of the cats and dogs had urinalysis results that were within reference range (specific gravity, 1.039 to 1.060).

**Diagnostic imaging**

Radiographic data were obtained by examining the radiology reports and reviewing the available radiographic images of the thorax. Radiographs from 6 dogs and 3 cats were available for review, and radiology reports were obtained from the medical records of the remaining patients. On lateral radiographic views of the thorax, a soft tissue opacity could be seen in the ventral aspect of the cranial mediastinum, causing caudal displacement of the cardiac silhouette and rostral displacement of the trachea in all patients. Radiographic findings were compatible with a large cranial mediastinal soft tissue mass. All radiographic images
of cranial mediastinal masses were reviewed, and the masses appeared lobulated. Upon review, masses in 2 of 3 cats and 2 of 6 dogs were poorly marginated. In addition, evidence of pleural effusion was observed in radiographs of 1 of 3 cats and in 5 of 6 dogs. No evidence of metastasis was detected in any radiographic images reviewed. Megasophasus was observed in the radiographs of the cat with MG, and no radiographic evidence of aspiration pneumonia was found for any cat or dog.

Ultrasonographic data were obtained by examining ultrasonographic reports and reviewing available video-taped examinations. Ultrasonography was performed in 4 cats and 7 dogs. Of 2 cats with ultrasonograms available for review, 1 cat had findings that were compatible with a single fluid-filled cavity in the mass, whereas the other cat had a mass that appeared primarily solid. Of 4 dogs with ultrasonograms available for review, 2 dogs had findings that were compatible with multiple fluid-filled cavities in the masses, whereas the other 2 dogs had masses that appeared primarily solid. Ultrasonographic evidence of pleural effusion was observed in 1 dog. Echocardiography was performed in 3 cats, which revealed a cranial mediastinal mass and cardiac values within reference range.

Non–contrast- and contrast-enhanced CT was performed in 4 dogs. Dogs were placed in sternal recumbency, and helical CT acquisitions were performed. Images were acquired by use of a standard algorithm. No evidence of metastasis, pleural effusion, or enlarged perihilar lymph nodes was observed on computed tomograms. Based on CT findings in 4 dogs, 3 dogs had tumors that appeared noninvasive, 3 had tumors that displaced surrounding vessels, and 1 had a tumor that appeared invasive and wrapped around surrounding vessels, including the cranial vena cava.

**Cytologic and histologic findings**

Ultrason-guided fine-needle aspiration of masses was performed before surgery in 7 of 9 cats and 9 of 11 dogs. All aspirates contained a mixed population of cell types, including lymphocytes (small, large, or both; 5 cats and 5 dogs), mast cells (3 cats and 4 dogs), neutrophils (3 cats and 3 dogs), mononuclear cells (4 cats and 1 dog), eosinophils (1 cat and 1 dog), epithelial cells (1 cat and 2 dogs), lymphoblasts (6 cats), mesenchymal cells (1 dog), and erythrocytes (4 cats and 1 dog). In 2 cats and 2 dogs, a presumptive diagnosis of thymoma could be made on the basis of established criteria of cell types found on cytologic examination.7,8 Specifically, aspirates indicative of thymoma contained many small lymphocytes, a mixed population of thymic epithelial cells, few eosinophils, and mast cells. A CT-guided fine-needle biopsy was performed in 2 dogs; findings on histologic examination of core biopsy specimens were diagnostic for thymoma for both dogs.

**Medical treatment**

One cat had received 4 treatments of chemotherapy (vincristine, cyclophosphamide, and prednisone) by the referring veterinarian prior to surgery on the basis of a presumptive diagnosis of lymphoma. The mass had slightly decreased in size after the second treatment, but did not decrease in size subsequent to that treatment. One cat was being treated with prednisone and pyridostigmine for MG prior to surgery.

**Surgical treatment and findings after surgery—**

Following induction of anesthesia, all cats and dogs were treated by excision of the thymoma. Tumor excision was performed twice in 2 cats and twice in 1 dog because of thymoma recurrence. Excision was performed via a median sternotomy in all 9 cats. For the 2 cats that had tumor excision performed twice, a median sternotomy was performed twice in 1 cat and a median sternotomy followed by a right third intercostal thoracotomy was performed in the other cat. A median sternotomy was performed in all 11 dogs, with a right third intercostal thoracotomy performed as a second surgery in 1 dog.

In cats, when considering the original and the recurrent tumors, 11 thymomas were removed from 9 cats. Four tumors were well encapsulated and were not adhered to surrounding structures. Seven tumors were found to be adhered to the pericardium and parietal pleura, with 2 of these tumors containing additional adhesions to surrounding vessels. Four of these 7 tumors were considered poorly encapsulated (1 of the masses was from a second surgery performed because of recurrence).

In dogs, when considering the original and recurrent tumors, 12 thymomas were removed from 11 dogs. Four tumors were well encapsulated and easily removed, and 8 tumors were adhered to the pericardium, surrounding vessels, and parietal pleura (1 of the masses was from a second surgery performed because of recurrence). Four of these 8 were adhered to surrounding lung lobes and required partial lobectomies. Additionally, removal of 1 of these 8 tumors required a venotomy of the caudal vena cava.

One cat and 3 dogs required debulking of the tumor because of invasiveness of the mass. In addition, debulking was performed on 1 cat with recurrent tumor at the time of the second surgery. Specimens of each tumor were submitted for histologic evaluation. Sternal lymph nodes were excised in 1 cat and 1 dog. All patients had thoracic drain tubes placed during surgery; 1 cat had an esophagostomy tube placed, and routine closure was performed on each incision.

**CytoLogic and histologic findings**

Histologic evaluation of all tissues obtained at surgery confirmed thymoma. Tumors were predominantly composed of round, oval, or spindle-shaped thymic epithelial cells. All tumors contained mature lymphocytes to various extents. Thymic corpuscles were observed in tumors from 1 cat and 3 dogs. Two cats and 2 dogs had tumors with dense fibrous capsules with fibrous trabeculae. Cystic masses were present in tumors of 1 cat and 1 dog, and mast cells were seen in tumors of 1 cat and 1 dog. A tumor from 1 dog had a few epithelial cells (clear cells) with nonstaining cytoplasm. Other rare findings were hemosiderosis, necrosis, cavitation, and hemorrhage located in tumors from dogs only. Mitotic figures were infrequent; only 1 tumor from a dog had > 10 mitotic figures/10 hpf (400X). In a cat and a dog from which sternal lymph nodes were resected, lymph nodes of the cat were free from metastases, whereas
lymph nodes of the dog contained clusters of neoplastic cells on histologic evaluation.

**Medical treatment**

No cat or dog received adjuvant chemotherapy or radiotherapy after surgery. The cat that had been treated with prednisone and pyridostigmine for MG prior to surgery continued this treatment after surgery.

**Outcome**—All cats and dogs that survived the immediate 24-hour postoperative period (89 cats and 8/11 dogs) were reevaluated by physical examination and thoracic radiography (cats, mean of 31 days, median of 16 days, and range of 8 to 120 days; dogs, mean of 41.5 days, median of 14 days, and range of 7 to 240 days). Following surgery, the hospital stay ranged from 3 to 5 days (8 cats, 1 for the second surgery; 8 dogs), 7 days (1 cat; 1 dog for the second surgery), and 12 days (1 dog). Further follow-up information concerning welfare and survival status of each dog and cat was obtained by telephone contact with referring veterinarians or owners or by examination of the medical record. Median follow-up time for dogs was 363 days (mean, 526), and median follow-up time for cats was 730 days (mean, 849).

Thymoma-specific survival and overall survival for dogs and cats were determined by use of the Kaplan-Meier method ([Figures 1 and 2](#)). Only 1 cat had a thymoma-specific event of death during surgery. Median overall survival time for cats was 1,825 days, with a 1-year survival probability of 0.889 (89% chance of survival) and a 3-year probability of 0.741 (74% chance of survival). Two cats died of unrelated causes, 1 cat had recurrence of a cranial mediastinal mass 2 years after the first surgery but died of chronic renal failure, and the second cat died of unrelated causes according to the referring veterinarian.

Median thymoma-specific survival time for dogs was 790 days, with a 1-year survival probability of 0.727 (73% chance of survival) and a 3-year survival probability of 0.485 (49% chance of survival). Median overall survival time for dogs was 790 days, with a 1-year survival probability of 0.636 (64% chance of survival) and a 3-year probability of 0.424 (42% chance of survival). One dog was euthanatized during surgery, and 2 dogs died within 24 hours of surgery. Two of the dogs that survived long-term died of other causes (1 was euthanatized because of a splenic mass, and 1 was euthanatized because of a low quality of life from arthritic problems). I died because of thymomas recurrence, 2 dogs were still alive, and 3 dogs were lost to follow-up. The dog with metastases to the sternal lymph nodes was known to survive for 2 years after surgery and was subsequently lost to follow-up.

One cat and 3 dogs had highly invasive masses in which only debulking of the tumor was possible. The cat underwent cardiac arrest during surgery and could not be resuscitated. One dog was euthanatized during surgery because of the invasiveness of the mass. Another dog died approximately 95% complete. The mass recurred 1 year after the first surgery. Debulking of the tumor was then performed, and excision was described as approximately 95% complete. The mass recurred 1 year later but was small. The owner opted not to treat the cat. The cat lived for 3 years after the first surgery and died of chronic renal failure.

In the dog that had tumor recurrence, a large well-encapsulated mass was removed and the thymoma-reacer.
curred 1 year later. The mass had invaded surrounding lung lobes, so the lungs were partially resected with the mass. Two years after the second surgery, the mass was again observed on thoracic radiographs. The owner opted not to treat the dog at this time. The dog lived for 4 years after the first surgery.

Prognostic factors—Of the factors analyzed (age, tumor invasiveness, percentage of lymphocytes in the mass [percent lymphocyte composition], and mitotic index), only the percent lymphocyte composition was significantly correlated with survival. In a survival model for percent lymphocyte composition in which data of cats and dogs were pooled, the hazard ratio for a 10% increase in lymphocytes was 0.65 (95% confidence interval, 0.46 to 0.91; \( P = 0.013 \)), indicating a 35% reduction in the death rate for a 10% increase in lymphocytes. In the same survival model with data from cats and dogs analyzed separately, results were similar to those of pooled data but were not significant.

Discussion

Excision is considered the definitive treatment for thymomas.\textsuperscript{4,9} Metastases are uncommon in humans (1% to 15%),\textsuperscript{10} although a higher rate of metastasis may be seen in invasive tumors.\textsuperscript{11,12} Although staging (stage I to IVB) of thymomas has been found to be helpful in human patients, given the retrospective nature of the study reported here, we were only able to determine invasiveness versus noninvasiveness of tumors, but the degree of infiltration was eminently subjective and surgeon dependent.

Cytologic examination may aid in the diagnosis of mediastinal masses, but distinguishing between the 2 most common causes of mediastinal masses, lymphoma and thymoma, can be difficult.\textsuperscript{1,13} In addition, the lymphoid component of the mass exfoliates more readily by aspiration or imprint techniques than do epithelial cells.\textsuperscript{5,7,14} In our study, cytologic examination was suggestive of thymoma in 2 of 6 cats and 2 of 11 dogs. Histologic evaluation of biopsy specimens does not always provide a definitive diagnosis.\textsuperscript{15} It has been reported that histologic evaluation of transthoracically obtained biopsy specimens can result in a definitive diagnosis in 50% of affected animals.\textsuperscript{2} In our study, CT-guided true-cut type biopsy specimens were obtained from 2 dogs; evaluation of these biopsy specimens resulted in a histopathologic diagnosis of thymoma.

Histologic evaluation of tumor specimens is the only way to definitively establish a diagnosis of thymoma, although these results are not likely to provide prognostic information.\textsuperscript{16} The degree of tumor invasiveness, as opposed to the histopathologic features of the mass, is considered the main determinant for prognosis in humans and dogs.\textsuperscript{12,17,18}

The role of advanced imaging, such as CT or magnetic resonance imaging, is to distinguish masses that are locally invasive from those that are space occupying for surgical planning purposes. Historically, CT has been the modality of choice for imaging the cranial mediastinum in humans.\textsuperscript{19} Computed tomography is considered to provide better information than survey radiographic images for determining the exact extent of mediastinal abnormalities.\textsuperscript{13,20} Computed tomography is also considered superior to ultrasonography when examining the surrounding vasculature because of the limitations and artifacts caused by air within the lungs.\textsuperscript{21} Currently, the ability to distinguish the degree of invasiveness in humans is considered better with magnetic resonance imaging than with CT.\textsuperscript{22} and magnetic resonance imaging may improve the staging and differentiation of thymoma.\textsuperscript{23}

In our study, CT was used in 4 dogs. One of these dogs had an invasive mass that wrapped around the vessels and displaced surrounding structures, which was verified in surgery. This mass was adhered to the pericardium, surrounding vessels, and lung lobes. However, the mass was surgically removed and thought to be completely excised. The other 3 dogs had masses that were considered noninvasive on the basis of CT evaluation. Two of the 3 masses were seen to be displacing surrounding structures. All 3 CT examinations revealed minimal vascularization and invasion, which corresponded with the encapsulated masses found in surgery. Therefore, in the study reported here, although the numbers were low, CT appeared to be helpful in determining the degree of invasiveness of thymomas. Our findings support the use of preoperative CT scans in patients with cranial mediastinal masses, although determining the resectability of a mass remains an intraoperative decision.

All cats and dogs in our study underwent a median sternotomy for adequate exposure and ease of tumor removal. Two of the 3 animals (1 cat and 1 dog) that had second surgeries underwent right third intercostal thoracotomy. This approach was used to avoid complications associated with subsequent adhesions after the first surgery.

The survival rate for animals with noninvasive, resectable thymomas is good, but the treatment for nonresectable thymomas has not yet been determined.\textsuperscript{9} Excision of invasive thymomas is believed to be unrewarding, as vital surrounding structures are involved and prognosis is not well defined.\textsuperscript{24} In humans with stage I noninvasive thymoma, the recurrence rate is 2%, whereas recurrence of the invasive forms (stage II to IV), believed resectable, is 20%.\textsuperscript{25,27}

In our study involving 23 thymomas (recurrent thymomas in 2 cats and 1 dog), thymomas recur ed with 0 of 4 noninvasive tumors of cats and 1 of 4 noninvasive tumors of dogs, 2 of 7 invasive tumors of cats, and 0 of 8 invasive tumors of dogs. In the study reported here, cats and dogs with invasive tumors appeared to have a high, immediate 24-hour postoperative mortality rate, but cats and dogs that survived surgery had a good prognosis. In previous reports,\textsuperscript{2,28} the prognosis for dogs with a noninvasive thymoma, without signs of megaesophagus, has been thought to be good, whereas signs of megaesophagus in association with an invasive thymoma carry a poor prognosis. Good results have been seen in cats treated for thymoma by excision alone.\textsuperscript{29} Results of our study reveal a 3-year overall survival rate of 74% for cats and 42% for dogs.

Thymoma can be associated with paraneoplastic syndromes in humans and animals, including MG,\textsuperscript{30-33} megaesophagus,\textsuperscript{1,33-35} hypercalcemia,\textsuperscript{1} polymyositis, exfoliative dermatitis,\textsuperscript{36,38} cranial vena cava
syndrome,\textsuperscript{39,40} nonthymic cancers, cytopenias, glomerulonephritis, systemic lupus erythematosus, rheumatoid arthritis, and thyroiditis.\textsuperscript{5,27,41,49} Forty percent of affected dogs have been shown to have associated autoimmune syndromes such as acquired MG, polymyositis, and immune-mediated skin diseases.\textsuperscript{30,30} The most common of these in humans and dogs is MG. In humans, MG occurs in 15% to 30% of humans with thymomas.\textsuperscript{31} In 2 studies,\textsuperscript{5,41} 14 of a total of 38 dogs with thymoma also had MG. Myasthenia gravis has also been found in cats with thymoma,\textsuperscript{48} and in 1 report, 2 of 12 cats with thymoma developed MG 1 to 2 weeks following surgery.\textsuperscript{20} Megaeosinophils is a common feature of MG potentially involving secondary aspiration pneumonia. Results of 1 study\textsuperscript{2} indicate that dogs with thymoma and megaeosinophils have a poor short-term survival time following thymectomy, with a median survival time of 4 days after surgery.

Only 1 of 9 cats and 1 of 11 dogs in our study had paraneoplastic syndromes, which is much lower than previously reported.\textsuperscript{3,11,20} One cat had MG as well as megaeosinophils. This cat, similar to results of most studies, developed MG prior to surgical removal of the thymoma, although MG has developed after thymectomy in humans.\textsuperscript{6,20} Myasthenia gravis did resolve in this cat after thymoma removal but occurred prior to thymoma recurrence. This cat was lost to follow-up 5.5 years after the first surgery. Hypercalcemia was observed in 1 dog in our study. This has been reported previously in dogs with thymomas,\textsuperscript{5,41,52,53} and may be caused by parathyroid hormone–related protein production by the thymoma.\textsuperscript{49} After surgery, the calcium concentration was again found to be high at the last recheck appointment. This dog lived for 26 months after surgery. Therefore, although the numbers are low, the cat and dog with paraneoplastic syndrome in our study had good long-term postoperative survival.

For incompletely resected or nonresectable tumors, other nonsurgical treatments have been suggested. Chemotherapy for the treatment of thymomas has been considered unrewarding, although most treatment protocols were designed for lymphoma, the supposed diagnosis at the time.\textsuperscript{3,4,3,51,55} Multimodality therapy combined with surgery and radiation therapy has been reported to be the most effective treatment for humans with incompletely resected tumors.\textsuperscript{50} Although not the emphasis of this retrospective study, when considering invasive thymomas, radiation therapy may be useful as either adjunctive or primary treatment.\textsuperscript{47,57,38}

Corticosteroids have been reported to induce remission or stabilize disease in thymomas in humans\textsuperscript{39,60} as well as in animals.\textsuperscript{3,4,47,37} Corticosteroids were given to 2 cats in our study. One cat had been given prednisone to help treat MG, and the other cat was suspected by the referring veterinarian to have lymphoma and received prednisone as part of a chemotherapy protocol, which was discontinued prior to surgical treatment.

Age of the animal, invasiveness of the tumor, percent lymphocyte composition of the mass on histologic evaluation, and mitotic index of the mass were factors analyzed in the study reported here for their effect on prognosis. Percent lymphocyte composition was the only factor that was significantly correlated with survival. Cats and dogs that had a high percentage of lymphocytes in their mass lived longer. This increased survival time in dogs with a lymphocyte-rich subtype of thymoma appears to correlate with a previous report\textsuperscript{9} on Kaplan-Meier analysis of dogs grouped by histologic tumor type.

In conclusion, the results of this study found that most cats and dogs with thymomas did well after excision. Cats and dogs with invasive masses had a higher mortality rate, but if they survived the surgery, they had a good long-term survival. The few cats and dogs with recurrent thymomas or paraneoplastic syndromes also had good long-term survival. Excision should be considered an effective treatment option for dogs and cats with thymomas.
27. Monroe WE, Roth JA. The thymus as part of the endocrine system. Compend Contin Educ Pract Vet 1986;8:24–32.