# Partial resection of the hyoid apparatus during surgical treatment of ectopic thyroid carcinomas in dogs: 5 cases (2011–2013)

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**Objective**—To assess perioperative findings and postoperative complications and outcomes in dogs that had ectopic thyroid carcinomas with invasion into the hyoid apparatus and underwent tumor excision with partial hyoidectomy.

**Design**—Retrospective case series.

**Animals**—5 client-owned dogs.

**Procedures**—Medical records of dogs that had an ectopic neuroendocrine tumor with invasion into the hyoid apparatus and underwent tumor excision with partial hyoidectomy were reviewed for information regarding perioperative and postoperative findings and outcome. During surgery in each case, the thyrohyoid and ceratohyoid or epihyoid bones (depending on degree of hyoid apparatus involvement) were sharply transected, allowing en bloc removal of the tumor. The ipsilateral cut ends of the thyrohyoid and ceratohyoid or epihyoid bones (depending on which was cut) were sutured together with polypropylene suture in a simple interrupted pattern.

**Results**—All partial hyoidectomy procedures were completed without surgical or anesthetic complications. All 5 dogs were able to eat and drink between 7 and 24 hours after surgery, with no signs of dysphagia, ptyalism, or abnormal tongue carriage. Follow-up information was obtained over a period of 173 to 587 days after surgery for all 5 dogs; 4 dogs were still alive at last follow-up. One dog was euthanized 587 days after surgery because of lethargy, inappetence, and hypercalcemia.

**Conclusions and Clinical Relevance**—From this limited series of cases, results suggested that partial resection of the hyoid apparatus during removal of ectopic thyroid carcinoma may be tolerated well and be associated with very good functional outcomes in dogs. (*J Am Vet Med Assoc* 2014;245:1319–1324)

Ectopic thyroid tissue is common in dogs, being present in nearly half of adult canine cadavers.[1] Ectopic tissue results from rapidly proliferating islets of the thyroid primordia, which separate from the main mass of developing tissue and become incorporated into the structures of the branchium and thorax.[2] Neoplasms of ectopic thyroid tissue are considered relatively rare in dogs, compared with other neoplasms, and such tumors develop in the thoracic cavity more commonly than in the cervical region.[3]

For dogs, resection of orthotopic thyroid carcinoma is the current standard of care, when determined to be feasible without excessive risk or long-term patient morbidity.[3,4] The notion that thyroid carcinomas in ectopic locations, such as at the base of the tongue, are not amenable to surgical removal exists both anecdotally and within the peer-reviewed veterinary medical literature.[5] Degree of invasion into surrounding structures and resultant loss of mobility of the primary tumor are often used to assess resectability.[4] Additional information obtained with the use of advanced 3-D imaging techniques, such as CT or MRI, allows further evaluation of tumor invasiveness and potential for surgical excision.[6] Because of their ectopic location, thyroid tumors in the cranial cervical region of the body may involve portions of the hyoid apparatus, resulting in relative tumor immobility and reluctance of surgeons to operate. This reluctance arises out of concerns regarding postoperative morbidity resulting from resection of anatomic structures involved with the tumor and leads to pursuit of alternative treatment options such as external beam radiation therapy.[3,4]

To the authors' knowledge, the only peer-reviewed publication that addresses resection of cervical ectopic thyroid tumors in dogs was a report by Lantz and Salisbury[7] published in 1989; the report described 3 dogs, all of which had tumor invasion into the hyoid apparatus. Given the paucity of information and the advances in perioperative patient management since publication of that report, the objective of the study reported here was to describe perioperative findings and postoperative complications and outcomes in dogs that had cervical ectopic thyroid carcinomas with invasion into the hyoid apparatus and underwent tumor excision and partial resection of the hyoid apparatus. A secondary objective

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was to describe a variation in the surgical technique for partial hyoidectomy in present use, compared with the historically described method.[7]

## Materials and Methods

**Case selection and medical records review**—The electronic surgical records of all client-owned dogs for the period 2011 to 2013 were searched for the word hyoid (partial or full word [case insensitive]), with all resultant surgery reports reviewed manually. Any dog undergoing surgery in which a portion of the hyoid apparatus was described as having been removed was included in the study. No further inclusion or exclusion criteria were applied. Medical records were reviewed, and information was extracted as follows: signalment, body weight, history, physical examination findings, preoperative clinicopathologic testing and imaging results, findings of cytologic or histologic evaluation of fine-needle aspirate samples or biopsy specimens before surgery, preoperative anesthetic protocol, surgery report and intraoperative findings or complications, postoperative complications and interventions, duration of hospitalization, histopathologic diagnosis, interval from surgery to time of last follow-up assessment, and outcome at last follow-up assessment.

**Anesthesia and preparation of dogs for surgery**—Anesthetic protocols varied according to the attending anesthesiologist but had many shared features. All dogs underwent premedication with an opioid administered IV or IM, with or without administration of a tranquilizer, followed by induction of anesthesia with propofol IV to effect and maintenance of anesthesia by administration of isoflurane in 100% $O_2$ via endotracheal tube. For all dogs, routine monitoring included serial measurements of $Spo_2$, rectal temperature, and direct or indirect arterial blood pressure; end-tidal capnography or blood gas analysis; and ECG. Each dog was positioned in dorsal recumbency with placement of a towel to slightly elevate and extend the neck; the thoracic limbs were secured in a caudal position. Hair along the ventral aspect of the neck was clipped from the mandibular symphysis to the level of the manubrium. A routine aseptic surgical preparation of the skin was performed.

**Surgical procedures**—A ventral midline cervical approach was performed centered over the mass, dividing the sternohyoid muscles on the midline. Marginal excision of the mass was performed in all dogs. A combination of sharp and blunt dissection was used to isolate the mass from surrounding structures, leaving its attachment to the hyoid apparatus. Care was taken not to damage the trachea, larynx, esophagus, or oropharyngeal mucosa. Identification and preservation of the hypoglossal and recurrent laryngeal nerves was attempted, but any branches incorporated into the tumor parenchyma were sharply transected. Surrounding musculature involved with the tumor was sharply transected approximately 1 to 2 mm from the mass, including various portions of the mylohyoid, geniohyoid, stylohyoid, genioglossus, styloglossus, hyoglossus, and thyrohyoid muscles as well as the root of the tongue in all dogs. A combination of bipolar electrocautery and placement of suture ligatures and metal surgical clips was used as needed to maintain hemostasis. Finally, the thyrohyoid and ceratohyoid or epihyoid (depending on degree of hyoid apparatus involvement) bones were sharply transected, allowing en bloc removal of the mass. The ipsilateral cut ends of the thyrohyoid and ceratohyoid or epihyoid (depending on which was cut in the preceding step) bones were sutured together with polypropylene suture[a,b] in a simple interrupted pattern (**Figure 1**). Muscle, subcutaneous tissue, and skin closures were performed in a routine manner. Minor deviations, such as placement of a drain, varied according to surgeon preference. All excised tumors were submitted for histologic examination.

**Outcome**—Clinical follow-up information was obtained by examination of the dog or telephone inter-

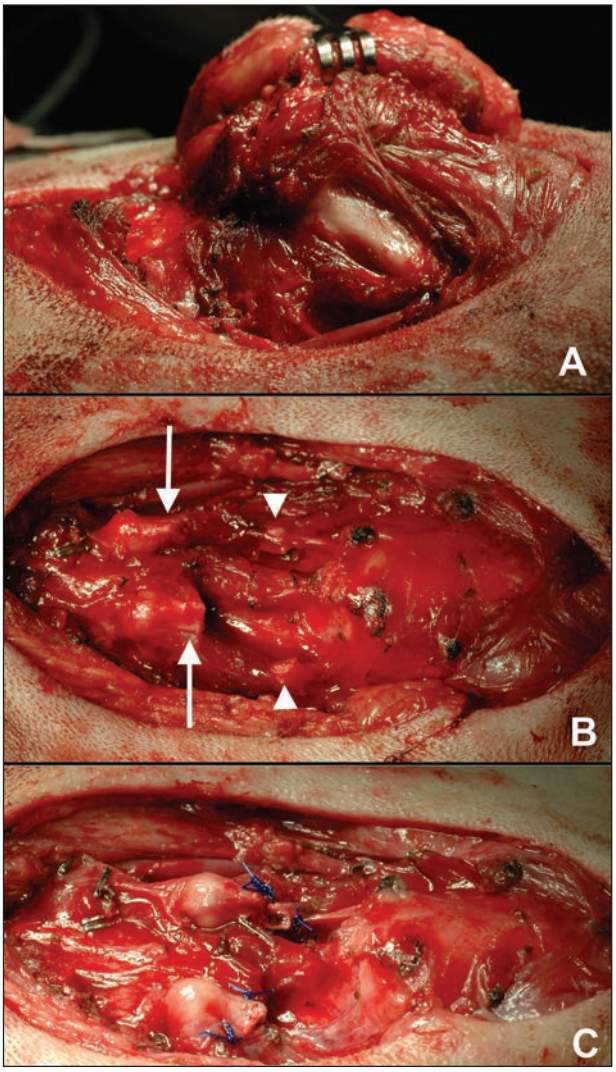


Figure 1—Intraoperative photographs of a 10-year-old neutered male Golden Retriever during removal of a cervical ectopic thyroid carcinoma and resection of the affected portions of the hyoid apparatus. The dog is in dorsal recumbency, with cranial to the left. A—Residual tumor attachments to the hyoid apparatus are visible after partial dissection of the ectopic thyroid carcinoma. B—Appearance of the surgical site after removal of the mass and en bloc partial hyoidectomy. Notice the cut ends of the ceratohyoid (arrows) and thyrohyoid (arrowheads) bones. C—Prior to closure of the surgical site, reconstruction of the hyoid apparatus is performed by suturing the cut ends of the thyrohyoid and ceratohyoid bones together.

view with the referring veterinarian or owner. Owners were asked whether their dog was still alive and whether there was recurrent local disease or development of metastatic disease, related clinical signs (eg, dysphagia, ptyalism, tongue function abnormality, dyspnea, stertor or stridor, and exercise intolerance), and any postoperative or ongoing adjuvant therapy.

## Results

From the medical records search, 5 dogs were identified for inclusion in the study. Each dog had undergone partial hyoidectomy during treatment of ectopic thyroid or neuroendocrine carcinoma. The signalment of these 5 dogs were as follows: an 8-year-old neutered male Welsh Corgi (dog 1), a 10-year-old neutered male Golden Retriever (dog 2), a 4.5-year-old spayed female Golden Retriever cross (dog 3), a 7-year-old neutered male Labrador Retriever (dog 4), and a 9-year-old neutered male German Shorthaired Pointer (dog 5). Body weights ranged from 17.8 to 41.0 kg (39.2 to 90.2 lb). The reason for evaluation in all cases was a palpable mass in the ventral cervical region, which had been detected 2 weeks to 5 months earlier. Physical examination revealed a firm, round, moderately to firmly fixed, ventral midline cervical mass (maximum diameter in all dogs, 4 to 6 cm), with no other remarkable abnormalities identified. Preoperative CBC and serum biochemical profile results were within reference limits for all dogs except 1 dog (dog 5), which had mild leukopenia (total WBC count, 4.57 × $10^3$ WBCs/µL; reference range, 6 × $10^3$ WBCs/µL to 17 × $10^3$ WBCs/µL). Total serum thyroxine concentration was evaluated in 3 dogs; results were within the reference range for 2 dogs and high for the other (dog 5; 4.56 µg/dL; reference range, 1.2 to 3.1 µg/dL).

Diagnostic testing included thoracic imaging (3-view thoracic radiography in 3 dogs [dogs 1, 3, and 4]; thoracic CT in 2 dogs [dogs 2 and 5]) and abdominal ultrasonography in 1 dog (dog 3); no major abnormalities were detected in any dog. The mass was assessed via CT in 4 dogs (dogs 1, 2, 4, and 5) and via ultrasonography in 1 dog (dog 3). The CT appearance of the tumors was similar in all 4 dogs and was described as a heterogeneously contrast-enhancing, soft tissue–attenuating, highly vascularized mass involving the basihyoid bone and variable lengths of the ceratohyoid, thyrohyoid, or epihyoid bones, with small and bilaterally symmetric orthotopic thyroid glands (**Figure 2**). Cervical ultrasonography in 1 dog (dog 3) revealed a heterogenous mass of mixed echogenicity with multiple small hyperechoic mineralizations. One dog (dog 2) also underwent nu-

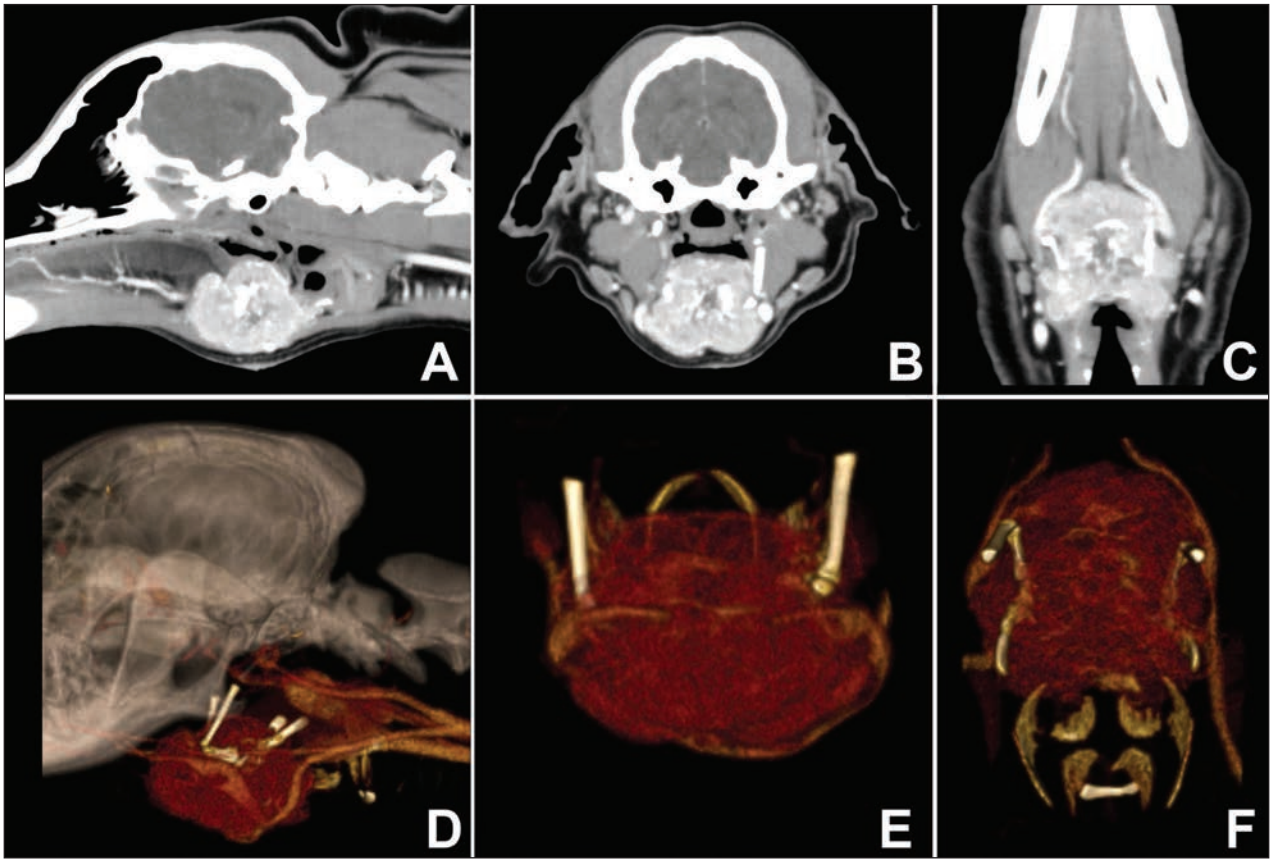


Figure 2—Computed tomographic images of an 8-year-old neutered male Welsh Corgi with an ectopic thyroid carcinoma that involved the hyoid apparatus viewed in the sagittal (A), axial (B), and dorsal (C) planes and paired 3-D reconstructed images from lateral (D), cranial (E), and dorsal (F) perspectives placed below their corresponding 2-D views to facilitate evaluation of hyoid apparatus involvement. Notice the markedly contrast-enhancing, highly vascularized mass involving the hyoid apparatus. Marked lysis of the basihyoid bone is evident in panel D. Skeletal structures have been removed from panels E and F to allow an unobstructed view of the tumor and involved bones of the hyoid apparatus.

clear scintigraphy with sodium pertechnetate Tc 99m, which revealed marked uptake of radionuclide by the ventral cervical mass (**Figure 3**).

Prior to surgery, samples of the tumor were collected via fine-needle aspiration for cytologic evaluation from 3 dogs (dogs 1, 3, and 5), and via incisional biopsy for histologic evaluation from 2 dogs (dogs 2 and 4). Cytologic and histopathologic findings were indicative of a tumor of neuroendocrine origin with features of malignancy in each case.

No anesthetic or surgical complications were encountered in any of the 5 cases. The size of polypropylene suture used for apposition of the cut ends of the ceratohyoid and thyrohyoid bones was either 2-0 or 3-0, depending on the size of the dog. One dog (dog 2) had temporary modified Rummel tourniquets placed around both carotid arteries during surgery, which were released on removal of the mass with no major hemorrhage. Another dog (dog 1) had an esophagostomy tube and closed-suction drain placed at the conclusion of surgery, both of which were removed within a 24-hour period because the dog regained an apparently normal appetite and there was no discharge via the drain. All 5 dogs were able to eat and drink apparently normally between 7 and 24 hours after surgery, with no signs of dysphagia, ptyalism, or abnormal tongue carriage. One dog (dog 2) had minor inspiratory stridor after recovery from anesthesia, which required no specific treatment and was noted to be nearly resolved by the next morning. Another dog (dog 4) had mild intermittent inspiratory stertor after recovery from anesthesia, which was not treated specifically and was noted to slowly improve over a period of approximately 12 months after surgery. None of the dogs developed aspiration pneumonia.

Following surgery, each dog received treatment with either hydromorphone hydrochloride (0.1 mg/kg [0.045 mg/lb], IV, q 4 to 6 h) or fentanyl citrate (2 to 5 µg/kg [0.91 to 2.27 µg/lb], IV [constant-rate infusion]) and supportive care (IV fluid therapy with crystalloid fluids) until discharge from the hospital 24 to 48 hours after surgery. Subsequently, each dog received analgesic treatment for a further 7 to 14 days. Each dog received tramadol hydrochloride (2 to 4 mg/kg [0.91 to 1.8 mg/lb], PO, q 8 h); additionally, 4 dogs (dogs 1, 2, 3, and 4) received carprofen (2.2 mg/kg [1.0 mg/lb], PO, q 12 h) and 1 dog (dog 5) received piroxicam (0.2 mg/kg [0.09 mg/lb], PO, q 24 h).

Histologic evaluation results for the excised tumors revealed thyroid carcinoma in 3 dogs (dogs 1, 2, and 5) and thyroid follicular carcinoma in 1 (dog 3). For 1 dog (dog 4), the diagnosis was recorded as a neuroendocrine tumor without further characterization.

Follow-up information was obtained at 173 to 587 days after surgery. Four dogs were alive at the time of last follow-up assessment. One dog (dog 4) was euthanized 587 days after surgery because of lethargy, inappetence, and hypercalcemia, for which the owner declined further diagnostic workup. Although recommended in several of the cases, adjuvant therapy was administered in only 1 case (dog 3); this dog received alternating administrations of toceranib phosphate (2.2 mg/kg, PO, q 48 h) and piroxicam (0.3 mg/kg [0.14 mg/lb], PO, q 48 h) for approximately 2 weeks prior to the owner discontinuing treatment without veterinary guidance. This dog was reevaluated 422 days after surgery for progressive respiratory noise and intermittent difficulty swallowing. No gross disease was detected via palpation of the cervical region, but thoracic radiography revealed pulmonary metastases and treatment with toceranib phosphate and piroxicam was restarted. One dog (dog 2) underwent recheck nuclear scintigraphy 7 months after surgery, which revealed no abnormal radionuclide accumulation in the neck or elsewhere in the body (Figure 3). The owners of that dog reported a change in pitch of the bark of the dog since surgery but no respiratory tract problems or exercise intolerance even with a highly active lifestyle. The remaining 2 dogs (dogs 1 and 5) had no follow-up diagnostic testing performed and were clinically normal 337 and 173 days after surgery, respectively.

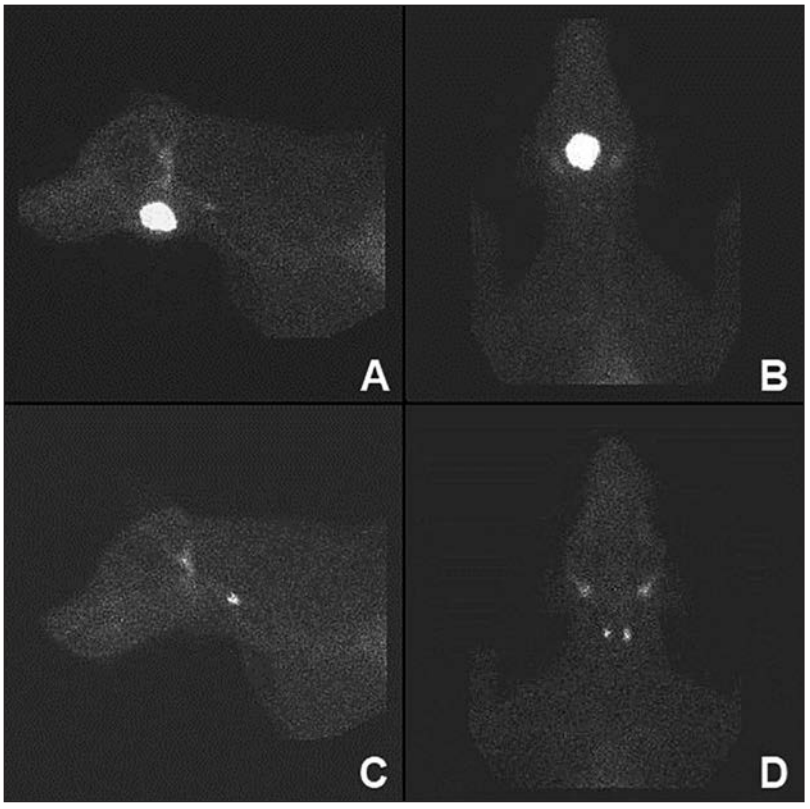


Figure 3—Lateral (A and C) and ventrodorsal (B and D) nuclear scintigraphic images of the same dog in Figure 1 obtained before (A and B) and 7 months after (C and D) surgical removal of the cervical ectopic thyroid carcinoma and en bloc partial hyoidectomy. Notice the marked uptake of sodium pertechnetate Tc 99m by the mass (A and B). After surgery, there was no abnormal radionuclide accumulation in the neck (C and D) or elsewhere in the body (not shown). The nonneoplastic thyroid glands are visible in the postoperative images.

## Discussion

In the present retrospective study, medical records of dogs that had cervical ectopic thyroid carcinomas with invasion into the hyoid apparatus and underwent tumor excision with partial resection of the hyoid apparatus were examined, and results suggested that tumor involvement of the hyoid apparatus is not a contraindication to surgery. Moreover, partial hyoidectomy appeared to be tolerated relatively well by the dogs. It is worth emphasizing that postoperative clinical function was considered excellent in all 5 dogs in this case series, even after extensive resection of the hyoid apparatus combined with removal of the root of the tongue. Within 24 hours after surgery, there was no evidence of dysphagia in any of the dogs, and all were apparently able to eat and drink normally. No respiratory signs developed after surgery in 3 dogs, and although mild, clinically nonimportant inspiratory stridor or stertor developed after surgery in 2 dogs, the problem resolved within 24 hours in one dog and over approximately 12 months in the other. These findings have clinical importance in that they may directly influence the judgment of surgeons on the resectability of tumors involving the hyoid apparatus.

To the authors' knowledge, there is only 1 related report in a peer-reviewed publication: an article by Lantz and Salisbury,[7] published in 1989, describing 3 dogs that underwent partial hyoidectomy during en bloc resection of ectopic thyroid carcinoma at the base of the tongue. Although other potential reasons for partial hyoidectomy may be encountered, the most common indication for the procedure in dogs appears to be treatment of ectopic thyroid neoplasms in the cranial cervical region. The primary distinction between the historical report[7] and the present case series centers on the development of postoperative complications; in the 3 dogs described previously, patient morbidity was increased, compared with findings in the dogs of this report. For the 3 dogs of the previous report,[7] postoperative complications included dysphagia, continuous ptyalism, and aspiration pneumonia. These problems were transient and self-limiting, with resolution of clinical signs by 3 days after surgery in 2 dogs and within 2 months after surgery in the other. Comparison of the surgical description in the previous report[7] and the present report yielded 2 possible explanations for this difference in postoperative function: in the treated dogs of the present report, placement of hyoid apparatus–stabilizing sutures may have contributed to improved pharyngeal function or attempts to minimize the amount of musculature resected for each tumor may have resulted in comparatively less surgical trauma. Tumors were removed via marginal excision (ie, 1- to 2-mm margin of normal tissue around the gross tumor) to reduce patient morbidity in the postoperative period. Resection of thyroid tumors must balance the benefits of local tumor control against surgically induced patient morbidity, and such marginal resections are typically recommended in orthotopic thyroid carcinomas as well.[3,4]

For the dogs of the present report, placement of hyoid apparatus-stabilizing polypropylene sutures, thereby connecting the cut ends of the epihyoid or ceratohyoid bones (depending on the amount of hyoid apparatus resected) to their ipsilateral thyrohyoid counterparts, was performed to potentially improve postoperative laryngeal and pharyngeal function. The hyoid apparatus provides a skeletal scaffold, supporting the tongue and upper vocal tract and larynx.[8] It allows for purposeful tongue movements during chewing, swallowing, and vocalization. Although not specifically evaluated, creation of discontinuity in the canine hyoid apparatus via excision of the basihyoid bone with variable portions of the thyrohyoid and epihyoid or ceratohyoid bones would be expected to have negative consequences for these functions. Placement of hyoid apparatus–stabilizing sutures was an attempt to ameliorate these potentially negative consequences of partial hyoidectomy. However, statements on the effectiveness and necessity of such suture placement cannot be made without further comparative investigation of dogs undergoing the same degree of hyoid resection with or without such placement of sutures.

Every attempt to preserve unaffected portions of the surrounding muscles (specifically, the styloglossus, genioglossus, and hyoepiglottic muscles) was made during treatment of the dogs of the present report, but tumor presence dictated the removal of any involved muscular portions. Because individual tumors likely varied in size and invasiveness, direct comparison between the report[7] describing 3 dogs that underwent partial hyoidectomy during en bloc resection of ectopic thyroid carcinoma at the base of the tongue and this report or among patients within a given report is difficult. Statements regarding tolerance of lingual muscle resection in dogs remain speculative beyond the factual observation that clinical function appears to be good to excellent, with some patients potentially requiring supportive care for a period of time after surgery.

Reports of the CT appearance of ectopic thyroid tumors are lacking, although in a recent study[6] of ultrasonographic, CT, and MRI findings in dogs with suspected thyroid carcinoma, 3 dogs had ectopic thyroid tumors. Two of those dogs had CT evidence of hyoid apparatus involvement, remarkably similar in appearance to the CT findings for the dogs of the present report. With increasing availability of advanced cross-sectional imaging techniques, such as CT or MRI, more detailed descriptions of the location of ectopic thyroid carcinomas and the involvement of surrounding structures are expected to expand on these initial observations.

The biological behavior of thyroid carcinomas is usually aggressive, with 25% to 80% of affected dogs developing metastatic disease.[3] Too few cases of ectopic thyroid carcinoma have been reported to accurately predict their metastatic potential, particularly those tumors associated with the hyoid apparatus. In a study[9] of 5 dogs with thoracic ectopic thyroid carcinoma, 1 had metastatic disease. Of 3 dogs with ectopic thyroid carcinoma at the base of the tongue, no dogs had evidence of metastatic disease at 9 months, 3 years, and 6 years.[7] With regard to orthotopic thyroid carcinoma, median survival time after thyroidectomy is > 3 years for dogs with freely moveable tumors, compared with 6 to 12 months for dogs with more invasive tumors.[10,11] For these reasons, adjuvant postoperative

treatment in the form of a combination of toceranib phosphate and piroxicam was elected by the owners of 1 dog (dog 3) in the present case series. Molecular targets of toceranib phosphate have recently been identified in thyroid carcinomas, and combination of that drug with piroxicam has been found to be safe when administered at standard dosages in dogs with a variety of tumor types including thyroid carcinoma.[12,13] One dog (dog 2) of the present report underwent recheck nuclear scintigraphy with sodium pertechnetate Tc 99m 7 months after surgery, which revealed resolution of any abnormal radionuclide signal and a lack of signal from distant sites in the body. However, metastatic tissue may not be identified via nuclear scintigraphy because of low-level uptake or obscuration by adjacent soft tissue structures.[14] Extrapolation from treatment recommendations for orthotopic thyroid carcinoma suggests that adjuvant postoperative treatment, such as administration of sodium iodide I 131 or external-beam radiation therapy, would yield a benefit for dogs with ectopic thyroid tumors involving the hyoid apparatus.[3,4]

External beam radiation therapy is used most commonly for dogs that have thyroid carcinomas with attachments to deeper cervical structures,[3] such as the dogs in the present study. Although not commonly performed, radioiodide treatment may offer distinct advantages over external beam radiotherapy such as the ability to target tumor tissue regardless of tumor location and the potential to administer sequential treatments in dogs that develop signs of tumor recurrence.[5,15] The decision to pursue these alternative treatments is often made on the basis of an assumption that surgical removal of tumors with deep attachments may create unacceptable patient morbidity in the postoperative period through damage or removal of vital structures.[4] The findings of the present study, along with those described in a previous report,[7] have suggested that veterinarians may consider surgical intervention in cases of ectopic thyroid tumors involving the ventral aspect of the hyoid apparatus without expecting unacceptable postoperative patient morbidity.

In the present study, the most common reason for partial resection of the hyoid apparatus in dogs was removal of ectopic thyroid carcinoma. The results suggested that such resections can be tolerated well and have very good functional outcomes. Larger, multicenter, prospective studies to evaluate this rare disease entity are required to further characterize the limits of resection and determine which patients may benefit from nonsurgical, or combined, forms of treatment.

a. Prolene suture, Ethicon Inc, Somerville, NJ.
b. Surgipro II suture, United States Surgical, Tyco Healthcare Group LP, Norwalk, Conn.

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