

Electrochemotherapy achieves high local control of lingual and tonsillar tumors in dogs and cats

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Objective

To describe local response, progression-free survival (PFS), and overall survival (OS) in dogs and cats with lingual or tonsillar tumors treated with electrochemotherapy (ECT) alone or combined with surgery.

Methods

Medical records were retrospectively reviewed for dogs and cats with a histologically or cytologically confirmed tumor of the tongue or tonsil treated with ECT alone or combined with surgery, with ≥ 1 posttreatment follow-up. Twenty-nine client-owned animals, 7 dogs and 7 cats with lingual tumors and 15 dogs with tonsillar tumors, were included. Response was assessed by modified Response Evaluation Criteria in Solid Tumors; PFS and OS were estimated by Kaplan-Meier analysis.

Results

In dogs with lingual tumors, the objective response rate (ORR) was 85.7% (complete response [CR], 71.4%); the median OS was 270 days, with 2 dogs alive at 980 and 1,090 days, and the median PFS was 263 days. In cats with lingual tumors, the ORR was 71.4% (CR, 57.1%), the median OS was 240 days, and all cats died, most of local progression; the median PFS was 215 days. In dogs with tonsillar tumors, the ORR was 80.0% (CR, 66.7%), the median OS was 240 days, and all dogs died, predominantly of pulmonary metastasis; the median PFS was 210 days.

Conclusions

ECT can provide high local response rates in dogs and cats with lingual tumors. In dogs with tonsillar tumors, even when high local response rates are achieved, patients die predominantly from distant metastasis, warranting a multimodal treatment approach.

Clinical Relevance

ECT achieved high local response rates in all groups. It appears most useful for function-preserving treatment for lingual tumors. The combination with surgery allows treatment of larger tumors than ECT alone. The survival of dogs with tonsillar tumors was limited by metastatic dissemination, supporting a multimodal approach.

Keywords: electroporation, oral tumors, tongue, squamous cell carcinoma, malignant melanoma

Oral tumors account for approximately 6% of all neoplasms in dogs and are the fourth most common type of canine cancer. The most frequently diagnosed malignant oral tumors include malignant melanoma, squamous cell carcinoma (SCC), and fibrosarcoma. Although less common in cats, oral tumors are also clinically important, with SCC

representing the predominant oral malignancy. Treatment is often challenging because complete surgical excision may be limited by the complex anatomy of the oral cavity and the need to preserve essential functions, such as prehension, mastication, swallowing, and grooming.^{1,2}

Among oral neoplasms, tumors involving the tongue and palatine tonsils present distinct clinical challenges. Lingual tumors are relatively uncommon and include SCC, malignant melanoma, sarcoma, mast cell tumor, and other less frequent histologic subtypes. Prognosis depends not only on histology but also on tumor location as rostral lingual tumors generally have lower metastatic potential and are

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more amenable to complete excision than tumors arising in the caudal tongue. In contrast, canine palatine tonsillar SCC is highly aggressive and is characterized by early regional lymph node involvement and frequent pulmonary metastasis, resulting in a poor prognosis despite local treatment. Large retrospective studies^{1,3} have reported median survival times ranging from 126 to 243 days for dogs with tonsillar carcinoma, with substantially longer survival observed only in patients without metastatic disease at diagnosis.

Current treatment options for oral tumors include surgery, radiation therapy, chemotherapy, cryotherapy, and immunotherapy or multimodal treatment depending on tumor type, location, and stage. Surgery remains the preferred treatment for many localized oral tumors; however, extensive glossectomy or resection of caudal oral structures may result in considerable functional morbidity. Radiation therapy provides an effective alternative in select patients but is not universally available and may be associated with significant cost, logistical limitations, and side effects. Consequently, less invasive local treatment modalities capable of preserving oral function are of increasing clinical interest.^{1,2}

Electrochemotherapy (ECT) combines the administration of a cytotoxic drug, most commonly bleomycin, with the application of short electric pulses that transiently increase cell membrane permeability, thereby enhancing intracellular drug uptake. Current veterinary guidelines support ECT as a safe and effective local ablative treatment for select superficial and oral tumors, particularly when surgery or radiation therapy is not feasible. Clinical studies have demonstrated high local response rates in canine oral malignant melanoma and nontonsillar oral SCC, especially in small tumors without bone involvement, while preserving surrounding tissues and minimizing treatment-related morbidity. Nevertheless, evidence specifically addressing tumors of the tongue and palatine tonsils remains scarce and is largely limited to small case series and isolated reports.²⁻⁴

Therefore, the objective of this retrospective case series was to describe treatment response, local tumor control, progression-free survival (PFS), and overall survival (OS) in dogs and cats with lingual and palatine tonsillar tumors treated with ECT either as a sole local treatment or in combination with cytoreductive surgery and adjuvant therapy.

Methods

This retrospective study involved review of medical records from client-owned animals treated as part of routine clinical care. Institutional Animal Care and Use Committee approval was not required. Written informed owner consent for treatment was obtained before all procedures.

Study design and case selection

A dual-center retrospective case series was conducted including dogs and cats with tumors involving the tongue (including the sublingual region) or palatine tonsil that were treated with ECT for local

tumor control either as a sole treatment modality or in combination with surgery and/or adjuvant therapy.

Data were retrospectively extracted from the medical records of all eligible patients that were treated from November 2015 through December 2025. For each animal, the following information was recorded: signalment (species, breed, sex, and age); tumor characteristics, including histologic diagnosis, tumor grade, and anatomic location; and treatment details, including the local treatment administered and whether concurrent chemotherapy was given. Outcome variables comprised local tumor response, local progression, PFS, OS, patient status (alive or dead) at the last follow-up, and, when applicable, the cause of death (categorized as local progression, metastatic disease, or a cause unrelated to the tumor). Local response was assessed using modified Response Evaluation Criteria in Solid Tumors, and survival times were calculated from the date of the first ECT session.

Dogs and cats were eligible for inclusion if they had a cytologically or histologically confirmed tumor involving the tongue (including the sublingual region) or the palatine tonsil, were treated with ECT for local tumor control (either as the sole local treatment modality or in combination with surgery and/or adjuvant therapy), and had at least 1 follow-up evaluation after treatment to allow assessment of local tumor response and outcome. Animals that did not meet the above criteria, as well as those with benign tumors, were excluded. The presence of metastatic disease was not considered an exclusion criterion. After application of these criteria, the lingual group comprised 14 patients (7 dogs and 7 cats), and the tonsillar group comprised 15 patients (all dogs). Because the 2 anatomic sites differ in biological behavior, results were analyzed and reported separately by site, with dogs and cats pooled within each group.

Pretreatment evaluation and clinical staging

All patients underwent a complete physical examination, with particular attention to the oral cavity and regional lymph nodes. A CBC and serum biochemical profile were performed in all patients. Tumor staging included cytologic evaluation of regional lymph nodes when accessible and thoracic imaging (thoracic radiography or CT) to assess for metastatic disease. Tumor stage was assigned according to the WHO Tumor, Node, Metastasis (TNM) classification for oral tumors when sufficient clinical and diagnostic information was available in the medical records.

ECT protocol

Electrochemotherapy was performed under general anesthesia according to current veterinary guidelines and standardized operating procedures for veterinary ECT.^{5,6}

Bleomycin (Bleocris 15; LKM or Hikma Pharmaceuticals) was administered IV as a bolus at a dose of 15,000 IU/m². Electric pulse delivery began 5 to 8 minutes after IV bleomycin administration using needle electrodes connected to a BIOTEX EPV 300 electroporator (BIOTEX SRL) or a CliniVet (IGEA).

The electrodes used were needle electrodes, consisting of 8 needles separated 4 mm from each other, and pulse configuration was eight 100- μ s-long pulses with a 1,000-V/cm voltage-to-distance ratio at 5,000 Hz.

Treatment planning was designed to ensure complete coverage of the tumor volume together with an appropriate margin of surrounding peritumoral tissue. In patients exhibiting partial response (PR) or local recurrence, additional ECT sessions were performed when tumoral relapse was observed.

Antiemetics and NSAIDs at appropriate doses according to the patient were administered for pain control after the procedure.

Surgical and adjuvant treatments

When complete surgical excision was not feasible but cytoreduction was achievable, partial or subtotal glossectomy or tonsillectomy and then ECT immediately after resection (surgery plus ECT protocol) was performed.

Based on histologic diagnosis and metastatic risk, select patients also received systemic or locoregional adjuvant therapy, including carboplatin, NSAIDs, immunotherapy, or lomustine, according to the attending clinician's judgment.

Response evaluation and outcome measures

Patients were reevaluated at scheduled follow-up (weekly for the first month, then monthly) visits by physical examination of the oral cavity. Tumor dimensions were measured using a digital caliper whenever feasible. In cases in which direct measurement was not possible or advanced imaging was clinically indicated and available, CT was used to assess tumor response. Clinical examination findings were integrated with imaging results when available. Retreatment was decided when a relapse or regrowth of a previously reduced lesion was observed.

Local tumor response was evaluated according to modified Response Evaluation Criteria in Solid Tumors and classified as complete response (CR), PR, stable disease, or progressive disease (PD). The objective response rate (ORR) was defined as the proportion of patients achieving either CR or PR.⁷ To assess side effects, the Veterinary Cooperative Oncology Group-Common Terminology Criteria for Adverse Events was used.

Clinical outcomes included OS, defined as the interval from treatment initiation until death from any cause, and PFS, defined as the interval from treatment initiation until documented local progression. Final patient status and cause of death were recorded and classified as tumor-related (local progression or metastatic disease) or unrelated to the neoplasm.

Statistical analysis

Continuous variables were summarized as medians and ranges (minimum to maximum) and categorical variables as absolute and relative frequencies. The analysis was descriptive. All histologic types were pooled within each group. Because feline and

canine oral tumors differ in biological behavior, lingual tumors were analyzed separately for dogs and cats; tonsillar tumors comprised dogs only. Overall survival and PFS were estimated by the Kaplan-Meier method, with animals alive at last follow-up censored at that date; because the 3 groups represent distinct populations, no between-group comparisons were performed. Analyses were conducted with the lifelines package for Python (version 3.12.3; Python Software Foundation). Survival times are expressed in days.

Because of the limited sample size and the marked heterogeneity of tumor histology and species, statistical analyses were considered primarily exploratory and descriptive.

Results

The study population comprised 29 client-owned animals distributed across 3 groups. The lingual tumor group in dogs included 7 animals with a median age of 11 years (range, 7 to 12 years), comprising 4 spayed females, 2 castrated males, and 1 intact male; represented breeds were Labrador Retriever ($n = 3$) and 1 each of mixed breed, Miniature Schnauzer, Goldendoodle, and Pomeranian. Histologic diagnoses in this group were SCC ($n = 4$) and 1 each of hemangiosarcoma, melanoma, and soft tissue sarcoma. The lingual tumor group in cats included 7 animals with a median age of 10 years (range, 7 to 15 years), comprising 5 castrated males and 2 spayed females; breeds were domestic shorthair ($n = 4$), mixed breed (2), and Siamese (1), and histologic diagnoses were SCC (5) and 1 each of soft tissue sarcoma and mast cell tumor. The tonsillar tumor group comprised 15 dogs with a median age of 11 years (range, 7 to 15 years), including 8 males (5 castrated, 3 intact) and 7 females (5 spayed, 2 intact); represented breeds included mixed breed ($n = 3$) and Poodle (2), with several other breeds represented by a single animal each. Histologic diagnoses in the tonsillar group were SCC ($n = 8$), melanoma (6), and soft tissue sarcoma (1). Tumor size was available for all 29 patients, whereas complete TNM staging was missing in 8 cases owing to the retrospective design, although the complete tumor-size data allow local response to be described for the entire cohort.

Lingual tumors

The lingual group comprised 14 patients (7 dogs and 7 cats); because of the distinct behavior of oral tumors between species, dogs and cats were analyzed separately (**Table 1**).

Lingual tumors in dogs

The 7 dogs had a median age of 11 years (range, 7 to 12) and a distribution of 4 females and 3 males. Histologic types were SCC in 4 dogs and 1 each of hemangiosarcoma, melanoma, and sarcoma. Three dogs received ECT alone, and 4 received ECT combined with surgery. A CR was achieved in 5 of 7 dogs (71.4%), a PR in 1 (14.3%), and PD in 1 (14.3%), for an ORR of 85.7%. Median OS was 270 days (range, 210 to 1,090), and median PFS was 263 days (range, 180

Table 1—Summary of clinicopathologic characteristics, treatments, and treatment outcomes.

Species	Location	Histology	TNM	Tumor size (cm)	Therapy	Neoadjuvant/ adjuvant therapy	ECT sessions	Local response	OS	PFS	Cause of death	Side effect grade
Canine	Tongue	SCC	T2/N0/M0	2	ECT	No	1	CR	980	980	Alive	I
Canine	Tongue	SCC	T2/N0/M0	2	Surgery + ECT	No	1	CR	210	210	Not related	II
Canine	Tongue	Hemangiosarcoma	T2/N0/M0	1 (multiple)	ECT	No	1	CR	1,090	1,090	Alive	II
Canine	Tongue	Melanoma	T2/N0/M0	1	Surgery + ECT	No	1	CR	210	180	Metastasis	I
Canine	Tongue	SCC	T2/N0/M0	1	Surgery + ECT	No	1	CR	690	690	Not related	I
Canine	Tongue	SCC		4	ECT	No	1	PR	270	263	Not related	I
Canine	Tongue	Sarcoma		1.1	Surgery + ECT	No	1	PD	215	180	Local progression	I
Feline	Tongue	Mast-cell tumor	T1/N0/M0	0.5 (multiple)	ECT	Lomustine	1	CR	430	430	Metastasis	II
Feline	Tongue	Sarcoma	T1/N0/M0	0.8	ECT	No	1	CR	765	750	Not related	I
Feline	Tongue	SCC	T1/N0/M0	1	ECT	No	1	PR	190	150	Local progression	I
Feline	Tongue	SCC		1	ECT	No	1	PD	150	130	Local progression	I
Feline	Tongue	SCC		1.1	ECT	No	1	CR	450	425	Local progression	I
Feline	Tongue	SCC		1	ECT	No	1	CR	240	215	Not related	I
Feline	Tongue	SCC		0.9	ECT	No	1	PD	180	165	Local progression	I
Canine	Tonsil	Melanoma metastasis in mandible	T2/N0/M0	1.5	Surgery + ECT	Carboplatin	1	CR	180	50	Metastasis	II
Canine	Tonsil	Melanoma	T2/N0/M0	1.6	Surgery + ECT	NSAIDs + carboplatin	1	CR	330	280	Metastasis	I
Canine	Tonsil	Melanoma metastasis in mandible	T2/N0/M0	1.8	Surgery + ECT	Immunotherapy	1	CR	650	580	Metastasis	I
Canine	Tonsil	SCC	T2/N1/M0	3.2	Surgery + ECT	No	1	PR	120	120	Metastasis	I
Canine	Tonsil	SCC	T3/N1/M0	3	Surgery + ECT	NSAIDs + carboplatin	1	CR	411	370	Metastasis	II
Canine	Tonsil	Melanoma	T2/N1/M0	2	Surgery + ECT	No	1	CR	390	360	Metastasis	II
Canine	Tonsil	SCC	T2/N0/M0	2	Surgery + ECT	Yes	1	CR	420	400	Metastasis	II
Canine	Tonsil	Sarcoma metastasis in mandible	T2/N0/M0	3	Surgery + ECT	No	1	CR	550	350	Local progression	I
Canine	Tonsil	SCC bilateral with vascular invasion	T2/N0/M0	3	Surgery + ECT	No	1	CR	210	210	Local progression	I
Canine	Tonsil	SCC compromising hyoids	T1/N1/M0	1 (bilateral)	Surgery + ECT	No	1	PD	45	45	Local progression	I
Canine	Tonsil	Melanoma con metastasis in tonsil N1 and M1	T1/N1/M0	1	Surgery + ECT	No	1	CR	50	50	Metastasis	II
Canine	Tonsil	Melanoma	T2/N1/M0	2	Surgery + ECT	Carboplatin	1	PR	150	140	Local progression	II
Canine	Tonsil	SCC	T3/N0/M0	3	ECT	Carboplatin	1	CR	255	165	Metastasis	I
Canine	Tonsil	SCC		1.2	Surgery + ECT	Pamidronate	1	PD	155	90	Local progression	I
Canine	Tonsil	SCC		1.6	ECT	Carboplatin	1	PD	240	210	Local progression	I

CR = Complete response. ECT = Electrochemotherapy. OS = Overall survival. PD = Progressive disease. PFS = Progression-free survival. PR = Partial response. SCC = Squamous cell carcinoma. TNM = Tumor, Node, Metastasis.

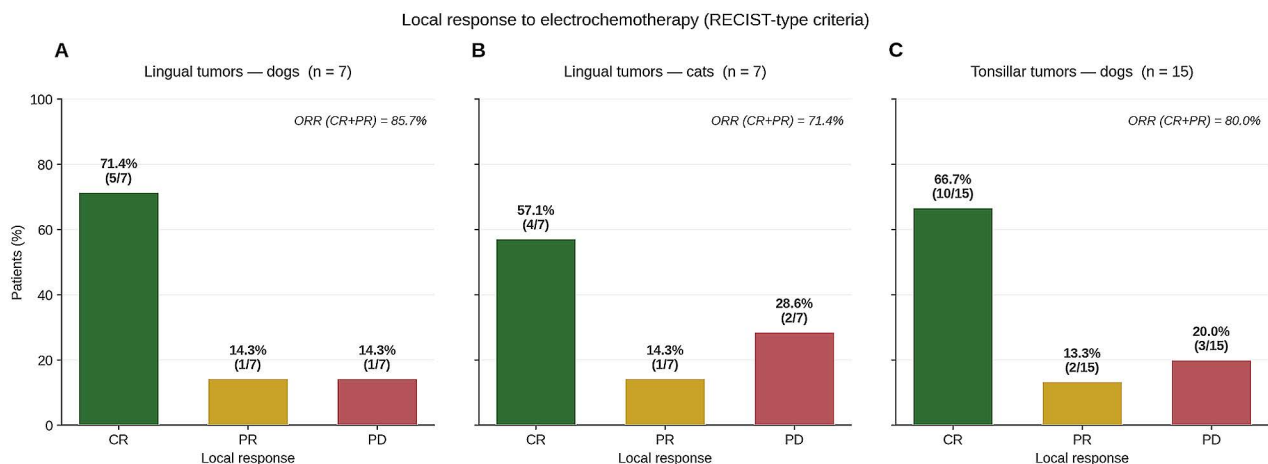


Figure 1—Local response rates in lingual and tonsillar tumors in each group of patients. CR = Complete response. ORR = Objective response rate. PD = Progressive disease. PR = Partial response. RECIST = Response Evaluation Criteria in Solid Tumors.

to 1,090); because 2 dogs remained alive at 980 and 1,090 days, the median OS underestimates the true value. Of the 5 deaths, 3 were attributable to causes unrelated to the tumor (**Figures 1 to 3**).

Lingual tumors in cats

The 7 cats had a median age of 10 years (range, 7 to 15) and a distribution of 2 females and 5 males. Histologic types were SCC in 5 cats and 1 each of

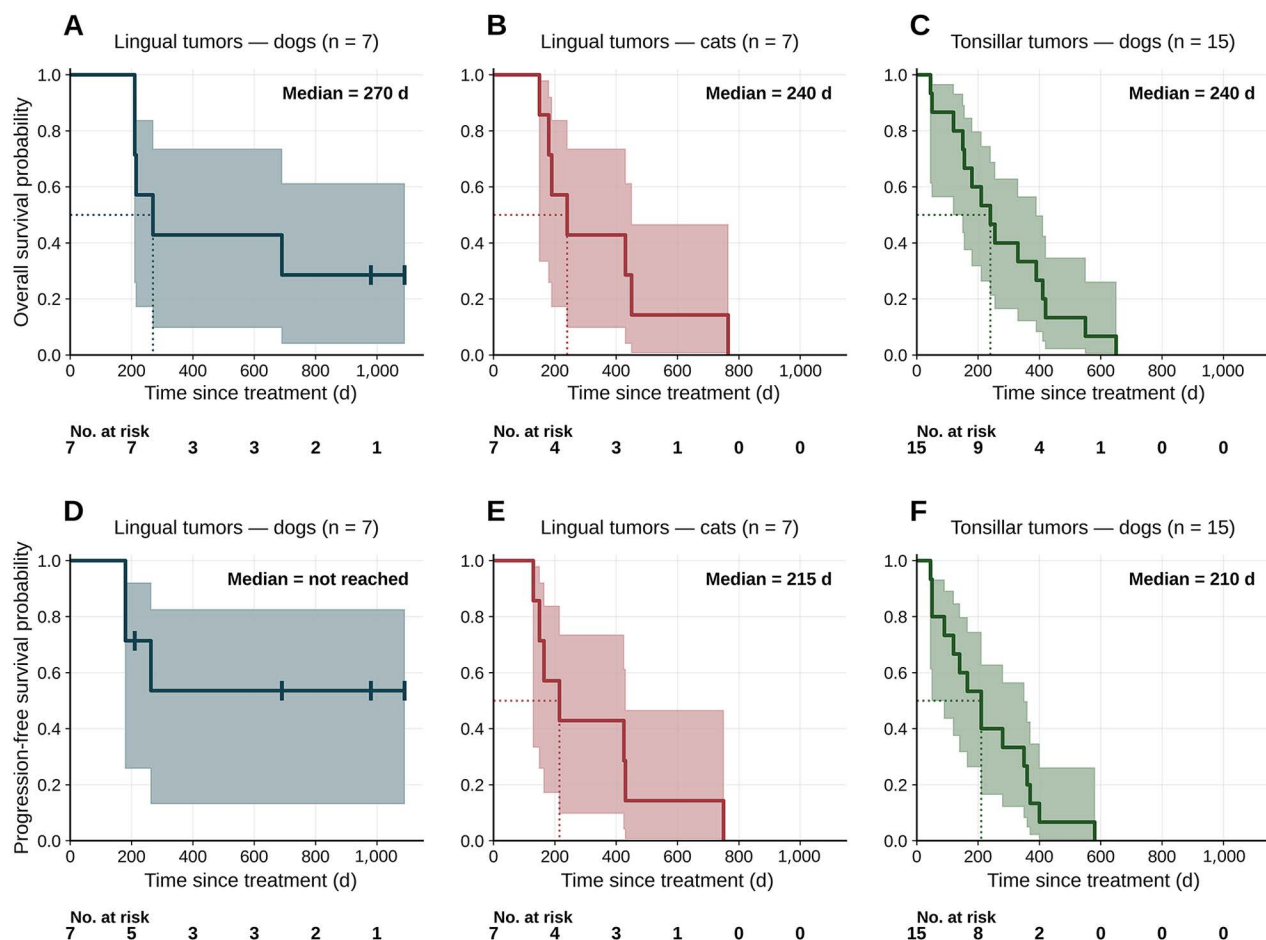


Figure 2—Kaplan-Meier curves of overall survival (A–C) and progression-free survival (D–F) following electrochemotherapy (ECT) for oral tumors. A and D—Lingual tumors in dogs (n = 7). B and E—Lingual tumors in cats (n = 7). C and F—Tonsillar tumors in dogs (n = 15). Tick marks indicate censored patients, shaded bands represent 95% CIs, and dotted lines indicate the median.

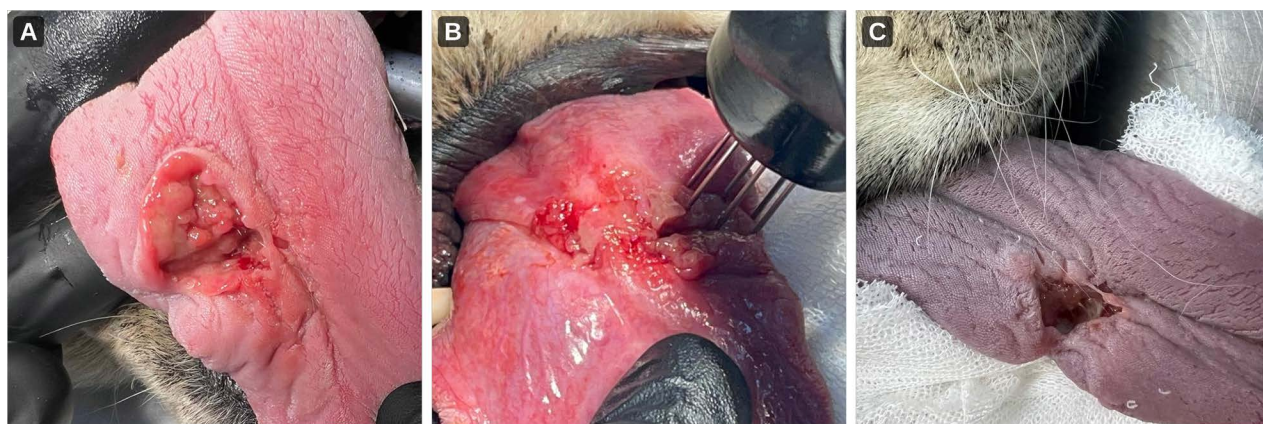


Figure 3—A canine patient with squamous cell carcinoma in the tongue. A—The patient at the moment of consultation. B—During ECT. C—Nine months after ECT the patient achieved a CR. It is worth noting that a defect is present in the tongue because the tumor compromised the whole thickness of the organ.

sarcoma and mast cell tumor. All 7 cats received ECT alone. A CR was achieved in 4 of 7 cats (57.1%), a PR in 1 (14.3%), and PD in 2 (28.6%), for an ORR of 71.4%. Median OS was 240 days (range, 150 to 765), and median PFS was 215 days (range, 130 to 750). All 7 cats died during follow-up, most of them of local progression (Figures 1 and 2 and **Figure 4**).

Tonsillar tumors

The tonsillar group comprised dogs only, with a median age of 11 years (range, 7 to 15) and a distribution of 7 females and 8 males. Diagnoses were SCC in 8 patients (53.3%); melanoma in 6 (40.0%), 2 of which were tonsillar metastases of a mandibular melanoma; and sarcoma in 1 (6.7%). Thirteen patients received surgery plus ECT, and 2 received ECT alone; 9 also received adjuvant therapy consisting of carboplatin, NSAIDs, immunotherapy, or combinations thereof.

Local tumor control was achieved in most patients: CR in 10 of 15 patients (66.7%), PR in 2 (13.3%), and PD in 3 (20.0%), with an ORR of 80.0%.

Survival was shorter than in the lingual group: median OS was 240 days (range, 45 to 650), and median PFS was 210 days (range, 45 to 580). All patients died during follow-up, predominantly of pulmonary metastatic disease (Figures 1 and 2 and **Figure 5**).

The side effects observed were minor in all cases, consisting of grade I to II localized reactions, such as bleeding, pain, mild erythema, slight edema, local discomfort, and superficial scabbing that resolved within 1 to 2 weeks. Pain was controlled with meloxicam (0.01 mg/kg/d) or firocoxib (5 mg/kg/d). In cases where surgery plus ECT was combined, 7 days of ciprofloxacin (10 mg/kg) plus metronidazole (30 to 40 mg/kg) was added.

A summary of the results is presented in Table 1.

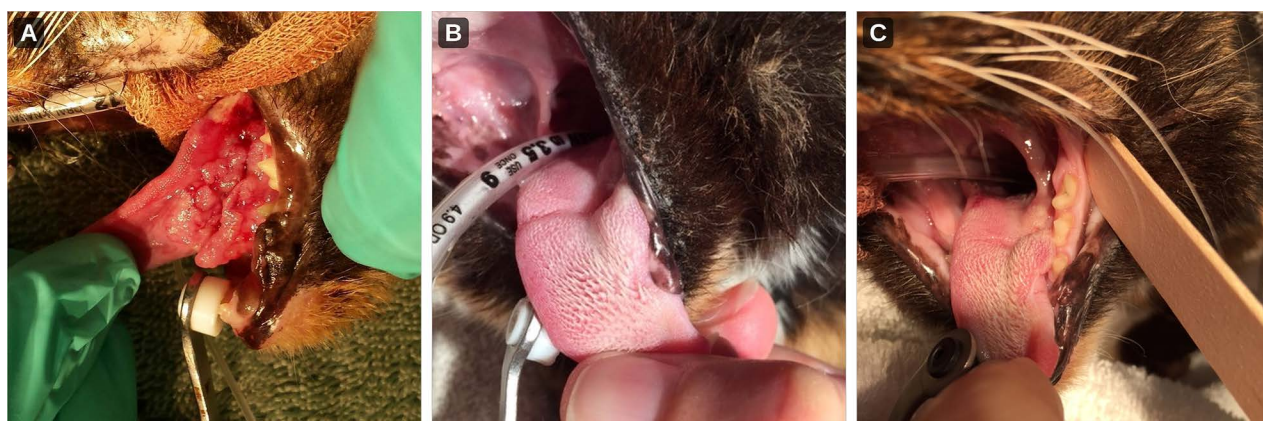


Figure 4—A lingual squamous cell carcinoma in a cat. A—Pretreatment appearance of the ulcerated lingual mass. B—Follow-up examination 4 months after ECT only showing a CR. C—Follow-up examination 6 months after treatment with no evidence of residual or recurrent disease and preservation of tongue structure and function.

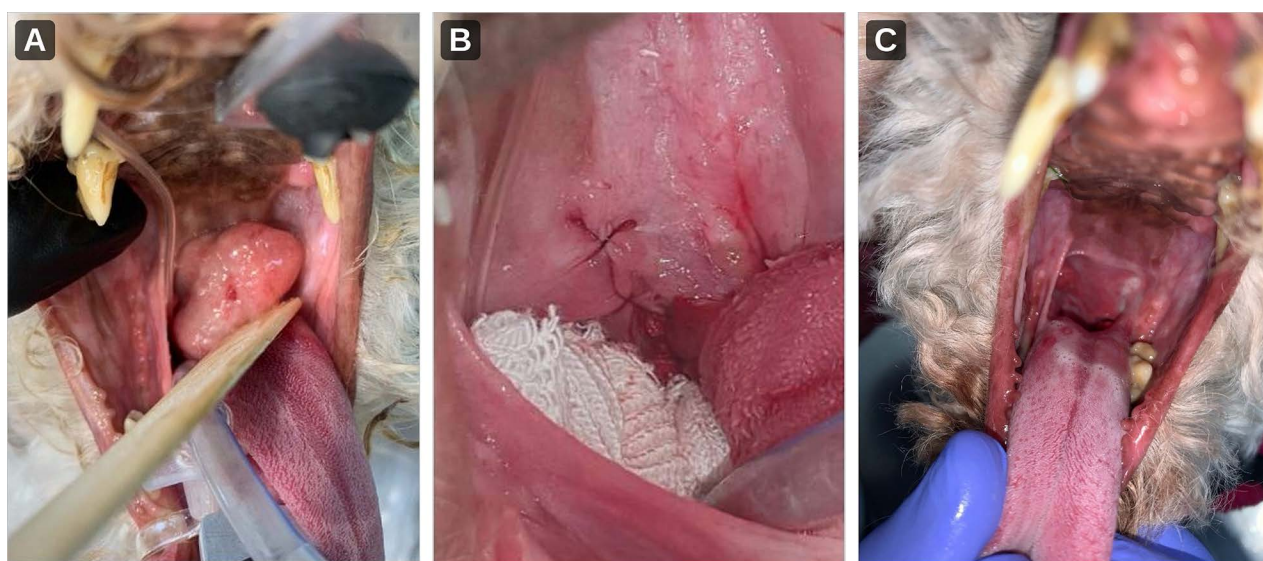


Figure 5—A tonsillar squamous cell carcinoma in a dog. A—Pretreatment appearance of the tonsillar mass. B—Immediate postoperative appearance following tonsillectomy and ECT showing the sutured surgical site. C—Follow-up examination showing a CR with no evidence of residual or recurrent disease at the treated site.

Discussion

This retrospective case series evaluated the clinical outcomes of ECT in dogs and cats with tumors involving 2 anatomically challenging oral locations: the tongue and palatine tonsil. Electrochemotherapy achieved a high rate of local tumor control in all 3 cohorts, with ORRs exceeding 70% in each cohort. However, long-term outcomes differed substantially according to tumor location and species. Animals with lingual tumors experienced prolonged survival and durable local disease control, whereas those with tonsillar tumors exhibited shorter survival despite similarly favorable local responses, likely reflecting the more aggressive metastatic behavior of tumors arising in the palatine tonsil. These findings suggest that, although ECT is highly effective for local disease management, long-term outcome is primarily determined by the biological behavior of the underlying tumor rather than by local treatment efficacy alone.

In dogs, the ORR of 85.7% (CR, 71.4%) was consistent with the 90.8% reported by Simčič et al³ for canine oral nontonsillar SCC treated with ECT, in which lesions smaller than 1 to 2 cm achieved CR without recurrence. The observed median OS of 270 days underestimates the true value because 2 dogs remained alive at 980 and 1,090 days at last follow-up; both of these long-term survivors, together with the finding that 3 of 5 deaths were unrelated to the tumor, support durable local control. These outcomes compare favorably with surgical series of canine lingual neoplasia from Culp et al,⁸ who reported a median survival of 216 days for SCC and 483 days overall in 97 dogs, and Syrcle et al⁹ reported 286 days for malignant lingual tumors. Taken together, these findings support ECT as an effective, function-preserving option for small canine lingual lesions.^{3,8,10}

Functional preservation represents an important advantage of ECT for lingual tumors. Partial or subtotal glossectomy may significantly impair prehension, mastication, grooming, and thermoregulation, particularly in cats and in dogs requiring extensive resections. Because ECT is minimally invasive and preserves normal tissue architecture, it offers an attractive alternative for patients in whom radical surgery would compromise oral function or quality of life.

In cats, the ORR was lower (71.4%; CR, 57.1%), with 2 of 7 patients showing PD and all cats ultimately dying, most of local progression. This is consistent with the recognized aggressiveness of feline oral SCC, particularly at lingual and sublingual sites, which carries a poorer functional and oncologic prognosis than the cutaneous or nasal planum presentations, in which ECT yields excellent responses (CR, 65% to 82%; ORR, approx 97%).¹¹⁻¹³ The contrast between the canine and feline lingual subgroups underscores the value of analyzing the 2 species separately and identifies feline oral SCC as the presentation least responsive to ECT in this series; multimodal approaches and earlier intervention on smaller lesions warrant investigation in this population.¹⁴

Notably, the best local responses were obtained in patients with tumors less than 1 cm in diameter (**Supplementary Figure S1**), whereas poorer

responses were seen in patients with more extensive disease. Moreover, even when a good local response was achieved in advanced cases, it was frequently followed by rapid relapse and, shortly thereafter, death of the patient.

Despite achieving a high ORR (80.0%; CR, 66.7%), confirming that the technique can control local disease even at a caudal, difficult-to-access site, dogs with tonsillar tumors had substantially shorter survival, with a median OS of 240 days. Most deaths resulted from metastatic disease, particularly pulmonary metastasis, whereas local progression accounted for only a small proportion of fatalities. These findings indicate that local tumor control was successfully achieved in most patients but was insufficient to overcome the aggressive metastatic behavior characteristic of tonsillar malignancies.

This figure exceeds the 126-day OS reported in the largest multicenter study (123 cases) by Treggiari et al¹⁵ and is comparable to the 243-day median reported by Grant and North,¹⁶ approaching the 381 days that Treggiari et al¹⁵ described for dogs without metastatic disease. The predominance of death from pulmonary metastasis is consistent with the high metastatic rate (42% to 87% nodal) reported for tonsillar SCC.^{16,17} The local failures (3 PD) occurred in advanced presentations (hyoid involvement in 1 case). The 6 melanomas had shorter OS outcomes (50 to 360 days) when compared with the SCC and sarcoma (45 to 550). Only 1 melanoma exceeded the OS of the melanoma group, surviving 580 days, which received immunotherapy.

Nearly half of the tonsillar cohort consisted of malignant melanomas, including 2 tonsillar metastases originating from mandibular melanomas and several dogs with advanced-stage disease (**Supplementary Figure S2**). These cases likely contributed to the relatively short survival times observed, consistent with previous reports⁴ describing median survivals of approximately 4.5 to 7.5 months in dogs with stage III or IV oral malignant melanoma treated with ECT.

Several of the longest-surviving dogs with tonsillar tumors received multimodal treatment combining surgery, ECT, and systemic therapy. Although no statistical comparisons were performed because of the limited sample size, this observation is consistent with previous studies^{15,16} identifying surgery, adjuvant chemotherapy, and NSAID administration as favorable prognostic factors for canine tonsillar carcinoma.

These findings reinforce the concept that ECT should be considered a local treatment modality within a multimodal therapeutic strategy rather than a replacement for systemic therapy. This approach may be particularly important for tumors with a high metastatic potential, such as tonsillar SCC and oral malignant melanoma. Emerging immunomodulatory strategies, including IL-2 and IL-12 gene electrotransfer combined with ECT, may further improve systemic disease control and represent promising avenues for future investigation.¹⁸

No cats were represented in the tonsillar group, consistent with the infrequent tonsillar origin of

feline oral SCC¹³ and possibly influenced by the referral patterns of the participating centers, so the tonsillar results apply only to dogs.

Several limitations should be considered when interpreting the results of this study. Its retrospective, dual-center design and relatively small sample size limited the ability to perform subgroup analyses or identify independent prognostic factors. The study population was heterogeneous with respect to species, histologic diagnosis, tumor stage, and adjuvant treatment, and both primary and metastatic tonsillar tumors were included. Complete TNM staging data were unavailable for 8 patients, precluding full stage stratification and limiting the interpretation of survival outcomes in relation to tumor stage. In addition, the absence of a control group prevented direct comparison of ECT with surgery or other treatment modalities.

Nevertheless, oral tumors involving the tongue and palatine tonsil are uncommon in veterinary practice, and published reports focusing specifically on these anatomical locations remain scarce. Consequently, this case series contributes clinically relevant information regarding the role of ECT in managing tumors arising in these challenging sites.

Taken together, these findings help define which patients are most likely to benefit from ECT. The best candidates are those with primary tumors, particularly SCC and melanoma, without local or distant progression, although ECT is also a valuable option for local management in patients with secondary (metastatic) disease because the anatomic location of these tumors frequently deteriorates quality of life through pain, partial obstruction, and bleeding, and effective local control can relieve these signs. As a sole modality, ECT represents a valuable option for the local treatment of lingual and tonsillar tumors when surgery is not feasible, particularly for small lesions up to approximately 3 cm in diameter, for which durable CRs can be achieved. When surgical resection is feasible, however, tumors larger than approximately 1 cm may benefit from a combined approach, with cytoreductive surgery followed by ECT applied to the surgical bed and margins. This approach may provide better local control than ECT alone. In tonsillar tumors, in particular, the combination of surgery and ECT may be especially useful for addressing surgically challenging or incomplete margins in this anatomically complex region. Because ECT is a locoregional treatment, it is most appropriate as a curative-intent option for animals without distant metastasis, whereas in patients with nodal or pulmonary spread, as was common in the tonsillar group, it is best regarded as a component of a multimodal plan, and feline lingual SCC, the least responsive presentation in this study, warrants particularly cautious case selection and early intervention on small lesions. Electrochemotherapy was generally well tolerated, and no serious or unexpected complications secondary to ECT were observed; the local effects noted were the expected transient inflammation, bleeding, and mild pain at the treated site, which did not compromise the patients' quality of life, with short-term symptomatic treatment provided after

the procedure in some cases, and when the tumor involved the full thickness of the tongue a tissue defect could remain after a CR. The procedure is performed under general anesthesia in a single session. Its tissue-sparing nature preserves oral function and avoids the morbidity of aggressive resection, such as extensive glossectomy or mandibulectomy, thereby supporting quality of life. For posttreatment support, we recommend analgesia during the peritreatment period and nutritional management with soft and semisolid diets during the first days after treatment. In this series, oral intake was preserved or recovered without the need for esophagostomy or other feeding tubes, and attention to oral hygiene and pain control further contributed to maintaining food intake and comfort.

Electrochemotherapy provided excellent local tumor control in both lingual and palatine tonsillar tumors. In dogs with lingual tumors, high response and prolonged survival were observed, with a substantial proportion of tumor-unrelated deaths, supporting ECT as an effective, function-preserving option for small lesions. In cats, lingual tumors (predominantly SCC) responded less favorably and all patients died, identifying feline oral SCC as the group in greatest need of improved or multimodal strategies. At the tonsil, despite good local response, survival was limited by metastatic dissemination, reinforcing the need to integrate ECT into a multimodal scheme that also targets systemic disease. Future directions could include evaluating mitotic rate, prospective trials, and a role for gene electrotransfer for immune stimulation. In addition, optimizing treatment protocols, combining surgery, ECT, and systemic therapy would be helpful in establishing the most effective treatment guidelines for these tumors and possibly other oral cancers.

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None reported.

Disclosures

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Artificial intelligence–assisted technology (Claude, Opus 4.5; Anthropic PBC) was used for 2 purposes: (1) language editing, to improve the English writing of author-drafted text without altering its scientific content, and (2) graphical preparation of the figures, to render the survival curves and response charts from data provided and verified by the authors and to assemble the clinical photograph panels from author-supplied images (cropping, rotation, scaling, and panel labeling only). No image content was generated, added, removed, or otherwise altered. The study data, the survival analyses, the assessment of local response, the interpretation of results, and the scientific content of the manuscript were produced entirely by the authors, who reviewed and approved all edited text and figures and take full responsibility for the accuracy and integrity of the content.

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Supplementary Materials

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