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WILEY

CLINICAL RESEARCH

Outcomes and clinical features associated with surgically excised canine salivary gland carcinoma: A multi-institutional, retrospective, Veterinary Society of Surgical Oncology study

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Abstract

Objective: The objective of this study was to describe the clinical features, prognostic factors, and outcomes in dogs with surgically treated salivary gland carcinoma.

Study design: Multi-institutional retrospective case series.

Animals: Seventy-two client-owned dogs from 16 institutions with surgically excised salivary gland carcinoma.

Methods: Medical records of dogs undergoing sialoadenectomy from January 1, 2000 to January 1, 2020 were reviewed for signalment, clinical signs, preoperative staging results, preoperative mass evaluation, complications, histopathologic diagnosis, local recurrence, metastatic disease, and survival times. Survival functions were estimated using the Kaplan-Meier estimator. Factors related to survival were individually tested using the log-rank test.

The results of this study were presented in abstract form during the Resident Forum at the Virtual ACVS Surgery Summit in October 2021.

Results: The overall median survival time (MST) associated with salivary carcinoma was 1886 days. Local recurrence occurred in 29/69 (42%) dogs with an overall disease-free interval (DFI) of 191 days. Metastatic disease occurred in 22/69 (31.9%) dogs, with an overall DFI of 299 days. Lymph node metastasis was present at the time of surgery in 11/38 (28.9%) dogs in which lymphadenectomy was performed at the time of surgery; these dogs had a shorter DFI at 98 days ($P = .03$) and MST at 248 days ($P < .001$).

Conclusion: The prognosis for dogs with salivary gland carcinoma treated surgically was more favorable than previously reported. Nodal metastasis was a negative prognostic factor for canine salivary gland carcinoma.

Clinical significance: Surgical intervention should be considered for dogs with salivary carcinoma.

1 | INTRODUCTION

Large-scale studies regarding outcomes for dogs with salivary gland carcinoma are limited. Multiple features surrounding the etiology of salivary gland neoplasia were described in the largest study to date (24 dogs).[1] In canine patients, most salivary gland neoplasia is malignant and of epithelial origin, and the most common primary tumor type is adenocarcinoma.[1] Other neoplasms, including fibrosarcoma,[2] lipoma,[3,4] extraskeletal osteosarcoma,[5] mast-cell tumor,[2] and lymphoma[6] have also been reported to occur in the salivary glands. The parotid salivary glands are reported as the most commonly affected in dogs.[1,6] Breed predisposition has not been shown but in a recent demographic study, poodle breeds trended towards significance.[7] The presence of a mass was the most common reason for presentation to a veterinarian; other clinical signs included halitosis and dysphagia.[1] The overall median survival time (MST) of the previously described population was 550 days, but the disease-free interval was not reported. At the time of diagnosis, lymph node metastasis was present in 17% of dogs, and distant metastasis was present in 8% of dogs.[1] The epidemiology and demographics of canine salivary gland neoplasia have been assessed based on pathology reports but patient outcomes were not evaluated.[2,7]

Surgery is often considered a primary treatment for local control of disease, in both veterinary and human medicine.[8,9] With advances in veterinary medicine, preoperative staging, operative techniques, and postoperative care over the past 20 years, re-evaluation of the outcomes of canine patients with salivary gland carcinoma is warranted. The objective of this study was to describe the clinical features, prognostic factors, and outcomes in dogs with surgically treated salivary gland carcinoma. We hypothesized that the MST would be longer than has been reported previously.

2 | MATERIALS AND METHODS

This was a multi-institutional, retrospective case series approved and organized through the Veterinary Society of Surgical Oncology list serv. Data from medical records for dogs with salivary gland carcinoma or adenocarcinoma from January 1, 2000, to January 1, 2020, were reviewed, and dogs treated surgically were included. Dogs presenting with recurrent disease without information from the previous surgery or those with incomplete medical records were excluded from the study.

Data collected for each dog included signalment, clinical signs, affected salivary glands, lymph node cytology or biopsy, imaging of the thorax, mass evaluation via cytology or incisional biopsy, surgery performed, and intraoperative and postoperative follow ups (complications, mass evaluation via histopathology, dates of local recurrence, metastatic disease, death, and cause of death). Adjuvant therapy, if administered, was also recorded. Cytology samples of the mass were categorized as "yes" or "no" based on the presence of neoplastic cells. Incisional biopsy samples were evaluated for concordance with the excisional biopsy. Lymph-node metastasis was determined based on cytologic or histopathologic confirmation of the presence of neoplastic cells. The diagnosis of lung metastasis was based on the presence of pulmonary nodules on thoracic imaging (radiography or computed tomography). Intraoperative and postoperative complications were recorded and defined as follows: intraoperative (from anesthetic induction to beginning of anesthetic recovery), perioperative (0-48 h), short-term postoperative (2-14 days), and long-term postoperative (greater than 14 days). Histopathologic diagnoses were as specific as possible; if the diagnosis was not specified beyond carcinoma or adenocarcinoma, it was categorized as such.

Minimum follow up was defined as presentation to a veterinarian at least 6 months after surgery, unless the patient died prior to the designated follow-up time. Dogs with less than 6 months of follow up were excluded from the study. Local recurrence was specified if it was confirmed based on cytology or histopathology and suspected based on palpation or imaging findings. Confirmed local recurrence was defined as cytological or histopathological confirmation of neoplasia at the previous surgical site.

Descriptive statistics for age and weight were reported as median and range. The overall disease-free interval (DFI) was defined as date of surgery to date of local recurrence or metastatic disease, whichever came first, and was recorded in days. The DFI was further evaluated individually for local recurrence and metastatic disease. Survival time (ST) was defined as date of surgery to date of death or euthanasia due to tumor-related causes and was recorded in days. Dogs that were alive at the time of the study or that died from disease unrelated to salivary carcinoma were censored from survival data. The DFI and ST were reported as medians and ranges. Survival functions were estimated using the Kaplan-Meier estimator. Factors related to survival were individually tested using the log-rank test and were considered statistically significant at $P < .05$. All analyses were performed in SAS 9.4 (SAS, Cary, North Carolina).

3 | RESULTS

Seventy-two dogs met the inclusion criteria for this study. The median age at presentation was 11 years (range, 2-16), and the median weight was 16 kg (range, 2.8-57.5). There were 27 (37.5%) spayed female dogs, 3 (4.2%) intact female dogs, 35 (48.6%) castrated male dogs, and 7 (9.7%) intact male dogs. Most dogs were mixed breed (17/72, 23.6%), but 38 specific breeds were represented as well (Table 1).

Clinical signs included: presence of a mass or swelling (58/72, 80.6%), presence of a salivary mucocele or ranula (3/72, 4.2%), exophthalmos (3/72, 4.2%), pain (3/72, 4.2%), hypersalivation (3/72, 4.2%), lethargy (3/72, 4.2%), retching or vomiting (3/72, 4.2%), weight loss (2/72, 2.8%), regurgitation (2/72, 2.8%), upper airway noise (2/72, 2.8%), coughing (2/72, 2.8%), dysphagia (1/72, 1.4%), and hemopytalism (1/72, 1.4%). The mass was identified incidentally by a veterinarian in 5/72 (6.9%) dogs.

Preoperative imaging of the thorax was performed in 63 dogs (63/72, 87.5%) via radiographs in 33 dogs, computed tomography (CT) in 23 dogs, and both modalities in 7 dogs. Of the dogs that had only radiographs performed, 28 dogs had 3 or more views, 10 had 2 views, and 2 had 1 view. Of the 12 dogs that had less than 3 views, 5 of those were followed by CT. Pulmonary

TABLE 1 Breed distribution for canine salivary gland carcinoma

Breed	Number of dogs
Mixed breed	17
Shih tzu	4
Beagle	3
Cavalier King Charles spaniel	3
English bulldog	3
Rhodesian ridgeback	3
Cocker spaniel	2
Miniature dachshund	2
Miniature poodle	2
Pembroke Welsh corgi	2
Shetland sheepdog	2
West Highland white terrier	2
Australian cattle dog	1
Basset hound	1
Bernese mountain dog	1
Bloodhound	1
Border collie	1
Boston terrier	1
Boxer	1
Chihuahua	1
Chinese shar-pei	1
Dogo Argentino	1
English springer spaniel	1
German shepherd	1
German shorthaired pointer	1
German spitz	1
Hovawart	1
Jack Russell terrier	1
Labrador retriever	1
Landseer	1
Miniature pinscher	1
Newfoundland	1
Pug	1
Siberian husky	1
Soft-coated wheaten terrier	1
Standard dachshund	1
Standard poodle	1
Toy poodle	1
Yorkshire terrier	1

nodules were identified in 5 dogs (5/64, 7.8%); nodules were diagnosed on radiographs in 1 dog and CT in 4 dogs.

Preoperative lymph node evaluation was performed via cytology in 24 (24/72, 33.3%) dogs and incisional biopsy in 1 (1/72, 1.4%) dog. Of these 25 dogs, lymph node metastasis was diagnosed in 7 (7/25, 28%) dogs (6 based on cytology and 1 based on the incisional biopsy). Preoperative cytology of the mass was performed in 47 dogs and was consistent with neoplasia in 27/47 (57.5%). An incisional biopsy of the mass was performed in 26 dogs. The incisional biopsy was diagnostic for an epithelial neoplastic process in 24/26 (92.3%) but was in complete concordance with the excisional biopsy in only 10/26 (38.4%).

Sialoadenectomy of the affected salivary gland was performed in all dogs. Affected glands included mandibular/sublingual (34/72, 54.2%), parotid (28/72, 38.9%), and zygomatic (5/72, 6.9%). Thirty-eight dogs had concurrent extirpation of 74 lymph nodes. The extirpated lymph nodes included the mandibular (36/74, 48.6%), medial retropharyngeal (28/74, 37.8%), superficial cervical (5/74, 6.8%), and parotid (3/74, 4.0%). One dog had a lateral retropharyngeal lymph node removed, and in another dog, the lymph node removed was not specified. Nine dogs had concurrent procedures including tonsillectomy (2/9), thyroidectomy (2/9), orbital exenteration (2/9), total ear canal ablation with lateral bulla osteotomy (1/9), marsupialization of a ranula (1/9), and salivary mucocele excision (1/9).

The intraoperative complication rate was 12.5% (9/72). The most common intraoperative complications were related to general anesthesia (4/9, 44.4%); these included hypotension, hypothermia, and regurgitation. The perioperative complication rate was 23.6% (17/72). The most common perioperative complications were facial nerve injury resulting in paresis or paralysis (7/72, 9.7%) and swelling or seroma formation (7/72, 9.7%). The \short-term postoperative complication rate was 35.7% (25/70). The most common short-term postoperative complication was swelling or seroma formation (15/70, 21.4%). The long-term postoperative complication rate was 13% (9/69). The most common long-term postoperative complication was facial nerve injury resulting in paresis or paralysis (3/69, 4.3%). Two patients died within the perioperative period, and 1 patient died within the short-term complication period (Table 2). Facial nerve injury only occurred when a parotid salivary mass was removed.

Histopathologic evaluation was performed for all dogs. For most dogs, the diagnosis was not specified beyond adenocarcinoma or carcinoma (Table 3). Criteria described in the histopathology reports included vascular invasion status (19/72, 26.4%), lymphatic invasion status (23/72, 31.9%), capsular invasion status (51/72, 70.8%), and margin status (58/72, 80.5%). Vascular invasion was present in 7 dogs (7/19, 36.8%), lymphatic invasion was present in 10 dogs (10/23,

TABLE 2 Complications of sialoadenectomy for canine salivary gland carcinoma

	No. of cases	Percentage
Intraoperative	9/72	12.5
Anesthetic complication (hypotension, hypothermia, regurgitation, etc.)	4/9	
Facial nerve transection[a]	2/9	
Linguofacial vein transection	1/9	
Tumor rupture	1/9	
Fracture of the hyoid apparatus	1/9	
Perioperative	17/72	23.6
Facial nerve injury (paresis or paralysis)[a]	7/17	
Seroma or swelling	7/17	
Regurgitation	2/17	
Death/euthanasia	2/17	
Short-term postoperative	25/70	35.7
Seroma or swelling	15/25	
Facial nerve injury (paresis or paralysis)[a]	5/25	
Surgical site infection or abscess	3/25	
Sialocele formation	2/25	
Cough	1/25	
Esophagitis	1/25	
Aural hematoma	1/25	
Necrosis of pinna	1/25	
Death/euthanasia	1/25	
Long-term postoperative	9/69	13.0
Facial nerve injury (paresis or paralysis)[a]	3/9	
Seroma or swelling	2/9	
Esophageal stricture	1/9	
Biting of the tongue (ipsilateral)	1/9	
Cough	1/9	
Ranula (contralateral)	1/9	
Cellulitis	1/9	

Note: The complications are defined as follows: intraoperative (from anesthetic induction to beginning of anesthetic recovery), perioperative (0-48 h), short-term postoperative (2-14 days), and long-term postoperative (greater than 14 days). The total number of cases in each complication group is further divided to distinguish the nature of the complication.
[a]Exclusive to cases of parotid sialoadenectomy.

TABLE 3 Histopathologic diagnosis as reported based on excisional biopsy

Diagnosis	No. of cases	Percentage
Adenocarcinoma, nos[a]	37	51.4
Carcinoma, nos[a]	17	23.6
Squamous cell carcinoma	3	4.2
Acinic cell carcinoma	2	2.8
Anaplastic carcinoma	2	2.8
Carcinoma ex pleomorphic adenoma	2	2.8
Carcinosarcoma	2	2.8
Mucoepidermoid carcinoma	2	2.8
Spindle cell carcinoma	2	2.8
Ductular carcinoma	1	1.4
Hepatoid-type carcinoma	1	1.4
Tubular adenocarcinoma	1	1.4

[a]Not otherwise specified.

43.5%), capsular invasion was present in 44 dogs (44/51, 86.3%). Margin status was complete in 31 dogs (31/58, 53.4%) and incomplete in 27 dogs (27/58, 46.6%). There was no correlation between vascular invasion and postoperative metastatic disease or lymphatic invasion and postoperative metastatic disease. Similarly, there was no correlation between capsular invasion and local recurrence or margin status and local recurrence. Thirty-eight (38/72, 52.8%) dogs had concurrent lymphadenectomy at the time of surgery. There was histopathologic evidence of metastatic disease to 1 or more lymph nodes in 11 (11/38, 28.9%) dogs. A total of 74 lymph nodes were removed, and histopathologic evidence of metastatic disease was present in 20 (20/74, 27.0%). Of the 30 dogs with lymphadenomegaly on CT scan, histopathology was performed in 18 (18/30, 60%) and was confirmed as metastatic in 9 (9/18, 50%). Of the 7 dogs diagnosed preoperatively with lymph node metastasis, 5 (5/7, 71.4%) were surgically excised, and 3 (3/5, 60%) were confirmed to be metastatic with histopathology.

Thirty-four dogs received adjuvant therapy following surgery. Chemotherapy alone was administered to 8 dogs (8/34, 23.5%), radiation therapy alone was administered to 10 dogs (10/34, 29.4%), and nonsteroidal anti-inflammatory drug (NSAID) therapy alone was administered to 4 dogs (4/34, 11.8%). Four (4/34, 11.8%) dogs had a combination of chemotherapy and NSAID therapy, 3 dogs (3/34, 8.8%) had a combination of chemotherapy and radiation therapy, 2 dogs (2/34, 5.9%) had a combination of radiation therapy and NSAID therapy. Two dogs (2/34, 5.9%) had a combination of chemotherapy, radiation therapy, and NSAID therapy. One patient received an autologous tumor vaccine (Torigen Pharmaceuticals, Farmington, Connecticut). Chemotherapy agents included carboplatin (10/34, 29.4%), doxorubicin (3/34, 8.8%), lomustine (1/34, 2.9%), gemcitabine (1/34, 2.9%), chlorambucil (1/34, 2.9%), and toceranib phosphate (7/34, 20.6%); some patients received a single agent whereas others received multiple. Drug protocols were at the discretion of the attending oncologist. The NSAIDs included piroxicam, meloxicam, carprofen, deracoxib, or firocoxib. Radiation therapy was administered via a linear accelerator in all dogs with the exception of a cobalt-60 source in 1 dog. The mean dose administered was 42 Gy.

The median follow-up time of patients surviving beyond the short-term complication period was 525.5 days (range, 37-3016). The overall DFI was 151 days (range, 24-806). Dogs with lymph node metastasis at the time of surgery had a shorter DFI ($P = .03$, 98 days with lymph node metastasis, 168.5 days without). Other factors that were evaluated but did not impact DFI included the salivary gland that was affected ($P = .39$), the age of the patient ($P = .54$), the type of adjuvant therapy ($P = .63$), or NSAID use ($P = .98$).There were 69 (69/72, 95.8%) dogs that survived beyond the short-term period. One dog died in the perioperative period due to respiratory arrest that was presumed to be secondary to iatrogenic intraoperative fracture of the hyoid apparatus. One dog was euthanized in the perioperative period due to poor prognosis associated with aspiration pneumonia and presumed secondary sepsis. One dog was euthanized within the short-term period due to progression of concurrent mesothelioma. Of the 69 dogs alive beyond the short-term period, local recurrence after surgery was confirmed via cytology or histopathology in 18 dogs (18/69, 26.1%) and suspected based on palpation or imaging in an additional 11 dogs (11/69, 15.9%). Data on follow-up therapy for dogs with confirmed or suspected local recurrence are included in Table 4. The DFI for local recurrence, including both confirmed and suspected recurrence, was 191 days. The DFI prior to confirmed local recurrence was 237 days, when dogs with suspected local recurrence were censored.

Metastatic disease after surgery occurred in 22 dogs (22/69, 31.9%) surviving long term; metastasis occurred to the lungs in 13 dogs (13/22, 59.1%), lymph nodes in 3 dogs (3/22, 13.6%), both lungs and lymph nodes in 2 dogs (2/22, 9.1%), and other locations in 5 dogs (22.7%). These 5 dogs had potential metastasis in the following locations: an intra-abdominal mass ($n = 1$), the left tonsil (for which a tonsillectomy was performed) (1), a liver mass (1), the spinous processes of L4 and L5 (1), and the liver, spleen, and adrenal gland (1). The excised tonsil had confirmed metastasis via histopathology, and cytology of the liver mass was consistent with epithelial

TABLE 4 Diagnosis and treatment for local recurrence of salivary gland carcinoma in both confirmed and suspected cases

	No. of cases
Confirmation of local recurrence	18/69
Fine needle aspirate with cytology	15/18
Excisional biopsy	2/18
Incisional biopsy	1/18
Treatment of confirmed local recurrence	
No management/quality of life only	8/18
Repeat surgical excision	5/18
Radiation therapy	3/18
Chemotherapy	2/18
Other medical management	4/18
Suspected local recurrence	11/69
Palpation of the surgical site	9/11
Computed tomography scan	2/11
Treatment of suspected local recurrence	
No management/quality of life only	6/11
Repeat surgical excision	1/11
Radiation therapy	0/11
Chemotherapy	2/11
Other medical management	2/11

Note: Local recurrence was specified if it was confirmed based on cytology or histopathology and suspected based on palpation or imaging findings. Confirmed local recurrence was defined as cytological or histopathological confirmation of neoplasia in the previous surgical site. This table includes both confirmed and suspected local recurrence in the dogs surviving beyond 14 days, and those are further distinguished based on method of diagnosis and treatment provided based on that diagnosis.

neoplasia. The other 3 locations were not evaluated beyond imaging. The median DFI prior to detection of metastatic disease was 299 days (range, 24-602).

Necropsy was performed in 3 dogs. One dog had local recurrence of left parotid salivary carcinoma and pulmonary nodules diagnosed prior to death, and on necropsy at 308 days postoperatively, there was histopathologic evidence of salivary carcinoma present in the left mandibular/sublingual salivary glands, lungs, left tonsil, and cervical fascia. One dog had local recurrence of left mandibular/sublingual salivary carcinoma diagnosed prior to death, and on necropsy at 506 days postoperatively, there was histopathologic evidence of salivary carcinoma present in the integument of head multifocally, lungs, left mandibular lymph node, and left adrenal gland. One dog did not have local recurrence or metastatic disease diagnosed prior to death, and on necropsy at 339 days postoperatively, there was no histopathologic evidence of salivary carcinoma present in any tissue.

The disease-specific MST was 1886 days (range, 85-2340), while the MST for all dogs included in the study was 498 days (range, 32-5086). Dogs with lymph node metastasis at the time of surgery had a shorter MST ($P < .001$, 248 days with lymph node metastasis, 2340 days without). Other factors evaluated that did not impact MST included which salivary gland was affected ($P = .11$), age of the patient ($P = .23$), and adjuvant therapy ($P = .91$). A separate analysis performed for NSAIDs as adjuvant therapy did not affect MST ($P = .12$). The survival rate when censored for death due to disease was 81.5% (35 dogs) at 1 year after surgery, 65.1% (22 dogs) at 2 years, and 61.5% (17 dogs) at 3 years.

4 | DISCUSSION

As hypothesized, the canine patients treated surgically for salivary carcinoma in the present study had a longer MST at 1886 days than the previously reported 550 days.[1] The previously reported MST was based on 24 dogs and may not have been completely representative of the disease process. Additionally, it was not stated in the previous report whether dogs were censored for MST analysis based on death due to disease. The noncensored MST, for the entire population of the current study, of 498 days was comparable to what was previously reported. This suggests that if censoring for disease-specific death had been previously performed in the population of 24 dogs, the MST may have been different. However, the MST of 1886 days as reported in the current study must be interpreted with caution, as inference testing could not be performed due to the number of dogs that were censored for death unrelated to salivary carcinoma or alive at the time of the study.

Lymph-node metastasis at the time of surgery was identified as a negative prognostic factor and was present in 28.9% of dogs at the time of surgery, which is higher than the 17% previously reported.[1] Although dogs in this study could not be staged according to the modified tumor node metastases (TNM) WHO system[1,10] due to the retrospective nature and lack of consistency with reports of tumor size, the presence of nodal metastasis classifies the dog as either stage III or stage IV. In the 2001 study, dogs classified as stage III or IV had a significantly shorter MST than stage I or II, similarly suggesting that lymph node metastasis impacts survival time.[1] Likewise, in the present study, DFI was shorter in dogs with lymph node metastasis diagnosed at the time of surgery ($P = .0005$). The impact of lymphadenectomy on survival times was unable to be determined due to the small number of dogs that underwent this procedure. Although selection of the

appropriate lymph node(s) to remove is beyond the scope of this discussion, sentinel lymph node mapping could be considered to minimize patient morbidity.

The most common clinical sign in this population of dogs was the presence of a mass or swelling. This is consistent with what has been previously reported for salivary gland carcinoma in dogs.[1] The role of cytology in the diagnostic process was evaluated because presence of a mass is the reason many owners will seek veterinary evaluation. Compared to the final excisional biopsy, 57.5% of dogs were diagnosed with a neoplastic process based on cytology of the mass. As such, salivary gland carcinoma cannot be ruled out cytologically. Furthermore, if a mass is not considered amenable to surgery, an incisional biopsy could be performed to guide recommendations for adjuvant therapy. Incisional biopsies are collected with the expectation that they are representative of the mass as a whole. In this population, the incisional biopsy was in complete concordance with the final excisional biopsy in 38.4% of dogs for which it was performed. As salivary gland carcinoma is more common in human medicine, the histologic differentiation of tumor types is more relevant in determining prognosis.[8] Given that 92.3% of incisional biopsies identified an epithelial neoplastic process, this method of diagnosis is likely to be acceptable for veterinary medicine as the individual histopathologic diagnoses are unable to be evaluated prognostically due to the rarity of the disease as a whole.

The most common complications associated with sialoadenectomy for salivary carcinoma in the present study were seroma formation and facial nerve injury, including both paresis and paralysis. A higher rate of wound-related complications was associated with the ventral approach for a mandibular and sublingual sialoadenectomy for salivary mucoceles.[11] One might infer that, with the dissection associated with mass removal, this may also be true for dogs with salivary carcinoma, particularly if concurrent lymphadenectomy warranting further dissection is performed. Facial nerve injury has been described as a complication of parotid sialoadenectomy for salivary mucocele in dogs,[12] as the facial nerve is intimately associated with the parotid salivary tissue. To minimize the risk of this complication, intraoperative visual contrast enhancement of the parotid salivary tissue (with or without a mass present) with methylene blue staining has been described with good success.[13] Although only 7 dogs were included in that report, none of the dogs experienced facial nerve injury or other complications.[13] Furthermore, most cases of iatrogenic facial nerve injury have been reported to resolve within 3 months postoperatively.[14] Given the retrospective nature of the present study, a standardized follow-up time was not performed for the remaining 3 dogs in the long-term complication period, and their ultimate outcome remains unknown. Two of those dogs were the same ones in which the facial nerve was transected for mass removal intraoperatively.

The rates of local recurrence and metastatic disease development following surgery for salivary gland carcinoma in dogs have not been reported previously. In the present study, the rate of local recurrence was 42%, including both confirmed and suspected recurrence, with an overall DFI of 191 days. The rate of local recurrence did not appear to be associated with capsular invasion or margin status for the dogs in which either variable was reported. Given the regional anatomy, surgical resection for salivary gland carcinoma is immediately extracapsular, which limits the interpretation of margin status. Similar to thyroid carcinoma, capsular invasion for dogs with salivary gland carcinoma does not seem to affect the rate of local recurrence.[15] Subsequently, the decision regarding adjuvant therapy should be based on clinical outcome rather than histologic reporting for margin status and capsular invasion. The overall metastatic rate was 31.9%, with an overall DFI of 299 days. The rate of metastasis did not appear to be associated with vascular or lymphatic invasion for the dogs in which either variable was reported. Similar to adrenocortical carcinoma, while the presence of vascular or lymphatic invasion may be concerning histologically, it does not appear to impact metastatic disease.[16] Clinicians should consider this information when planning for adjuvant therapy. However, the relationship of the histologic characteristics to local recurrence and metastatic disease may be impacted by the number of dogs for which this information was reported.

The mandibular and monostomatic sublingual salivary glands, joined by a common capsule,[17] were the most commonly affected glands in the present study. Previously, the parotid gland was reported as the most commonly affected in a cohort of 24 dogs, but the mandibular and monostomatic sublingual glands were classified separately rather than together in that study. Clinically, classifying these glands as 1 unit is more relevant, as the glands are intimately associated and therefore generally excised together.[9] In a more recent demographic study, the primary gland of origin was unable to be determined.[7] The lack of distinction of the affected gland is intriguing, as the affected gland in the present study was established for all dogs, but the methods of the demographic study did not describe how this was determined beyond a review of the medical record.

Adjuvant therapy was not shown to impact survival in this population. The chemotherapy agents used and radiation therapy doses and fractionation strategies had marked variability, limiting analysis and interpretation of individual modalities. The nonstandardized use of

adjuvant therapies meant that the findings of the current study should be interpreted with caution.

The limitations of this study pertain primarily to its retrospective nature, inducing selection bias and difficulty searching medical records. There may have been metastatic disease or local recurrence that was not reported. The methods of preoperative diagnostic evaluation and times for postoperative follow up were not standardized. Lymph node evaluation was not required either cytologically or histopathologically. Although this may have led to lymph-node metastasis being missed prior to surgery, the marked disparity between the survival times for dogs with lymph node metastasis and those without may indicate that most dogs were accurately represented. Despite having 72 cases included for this study, only 19 cases were included in the disease-specific DFI and MST reports. This detracts from the statistical power of the data, and the information should be interpreted with caution. Additional prospective studies are needed to provide a more accurate and more robust estimate of prognosis for canine salivary gland carcinoma. However, given the scarcity of these cases over the past 20 years, the feasibility of a prospective study should be considered.

In summary, the prognosis for dogs with salivary gland carcinoma treated surgically may be more favorable than previously reported. Subsequently, surgical intervention should be considered, when possible, with the understanding that local recurrence rates are particularly high for this neoplastic process and revision surgery may be indicated.

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CONFLICT OF INTEREST

The authors declare no conflicts of interest related to this report.

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