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Outcomes of eight cats with oral neoplasia treated with radical mandibulectomy

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Abstract

Objective: To report outcomes after radical mandibulectomy in cats.

Study design: Multi-institutional retrospective study.

Animals: Eight cats were included.

Methods: Medical records were searched for cats with confirmed oral neoplasia treated with radical mandibulectomy. Data collected included demographics, surgical procedure, histopathological diagnosis, postoperative management, and outcomes.

Results: Ages ranged from 8 to 17 years. All cats had 75% to 90% of the mandible removed and feeding tubes placed. Seven cats had squamous cell carcinoma, and one cat had a giant cell tumor. Six cats ate on their own postoperatively. Three cats had local recurrence and tumor-related died at 136 and 291 days. Six cats had no recurrence, with survival times of 156, 465, 608, and 1023 days, and two cats were still alive at 316 and 461 days after surgery. The three long-term survivors died of causes unrelated to oral neoplasia. One cat died at 156 days due to aspiration of food material. The overall estimated mean survival time was 712 days.

Conclusion: After radical mandibulectomy, independent food intake was achieved in 6 of eight cats, and four cats lived longer than one year.

Clinical significance: Radical mandibulectomy should be considered for the treatment of extensive oral neoplasia in cats. Successful long-term outcomes are possible with aggressive supportive care perioperatively.

1 | INTRODUCTION

Oral squamous cell carcinoma (SCC) is a locally aggressive, devastating disease in cats.[1,2] In some cases, the disease metastasizes to lymph nodes or distant sites.[3] In dogs, oral SCC is most often managed with wide surgical excision, with excellent results.[4] In cats, the disease is challenging because it is difficult to achieve clean margins in smaller patients.[5] Furthermore, reports in the literature and anecdotal evidence are limited but provide evidence that cats do not do as well as dogs with mandibulectomy.[5] Mandibulectomy is not routinely recommended in cats.[5] Northrup et al[5] reported outcomes in 42 cats after mandibulectomy. A high acute complication rate was reported in that study, and the authors recommended aggressive postoperative supportive care, including the placement of a feeding tube at the time of

Results of this study were presented in poster format at the Veterinary Society of Surgical Oncology Scientific Meeting; April 9-11, 2018; Maui, Hawaii and as an oral scientific abstract presentation at the ACVS Surgical Summit; October 24-27, 2018; Phoenix, Arizona.

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surgery.[5] Six cats in that study had >50% of both mandibles removed, and three of those six did not regain the ability to eat; five cats in total did not regain the ability to eat.[5]

Radiation has been pursued as an alternative to surgery for cats with oral SCC. Unfortunately, the results have not been promising, with reported median survival times of 92 to 174 days with various protocols, including stereotactic radiotherapy, palliative radiation, and postoperative radiation.[6-8] Surgical excision followed by radiation therapy for the treatment of mandibular SCC has also been described in cats with a reported mean survival time of 14 months.[9] Palliative treatment with nonsteroidal anti-inflammatory drugs has been advocated; the reported median survival time with this strategy was only 44 days.[10]

The authors have performed radical mandibulectomy in cats on several occasions, and our experiences have been different from those that have been reported, with some cats seeming to adjust well postoperatively and experiencing a good quality of life. The objective of this study was to report the presentation, diagnosis, and outcome of cats with mandibular neoplasia that were treated with radical mandibulectomy. We hypothesized that most cats would eat postoperatively and that long-term survival would be achieved in some cats with aggressive mandibular neoplasms.

2 | MATERIALS AND METHODS

This was a multi-institutional retrospective study (2012-2018) of cats with mandibular neoplasia treated with radical mandibulectomy. Radical mandibulectomy was defined as the removal of the entire anatomic compartment of the mandible[11-14] and > 50% of both of the mandibles. The case information recorded included signalment, clinical signs, preoperative treatments and staging, extent of tumor, surgical procedure, histopathology results, complications, outcome, and survival time. Evaluation of outcome included whether there was evidence of local disease recurrence or metastasis and when and whether the cats were able to maintain their nutritional requirements with oral feeding. Survival time was defined as the number of days from surgery until death or last contact. A Kaplan–Meier/log-rank analysis was performed in SPSS 24.0 (IBM, Armonk, New York) to estimate survival.

Cats were censored for survival when they died of non-tumor related causes or were still alive.

3 | RESULTS

Eight cats met the inclusion criteria. The median age was 12 years (8-17; Table 1). The most common presenting complaints were a mandibular mass or thickening of the mandible (n = 5), hyporexia (n = 4), ptyalism (n = 3),

TABLE 1 Signalment and outcome of cats treated with radical mandibulectomy

Cat No	Age, y	Breed	Sex	Year	Histopath	% Mandible removed	Surgical intent	Histopath margins	Surgical LN biopsy	Feeding tube	Eating PostOp	ST, d	Cause of death	Recurrence
1	17	DLH	MC	2014	SCC	75	Curative	Complete	BM: reactive	E-tube	Y, 14 d	465	Lymphoma	N
2	11	DSH	FS	2014	SCC	90	Curative	Complete but closest margin 2 mm	BM: reactive	E-tube	Y	608	Renal Failure	N
3	14	DLH	MC	2017	SCC	90	Palliative	Incomplete	BMR: metastasis to R mandibular and medial retropharyngeal lymph nodes	G-tube	Y, 1 mo	136	Recurrence	Y
4	13	DSH	FS	2014	SCC	75	Curative	Complete	…	E-tube	Y, 3 d	1023	Unresponsive, Euthanized	N
5	10	DSH	MC	2012	SCC	75	Curative	Incomplete	BM: negative	G-tube	N	291	Recurrence	Y
6	8	DSH	MC	2017	GCT	75	Curative	Complete	…	E-tube	Y, 11 d	461	Still alive	N
7	16	DSH	FS	2017	SCC	100	Curative	Complete	IM: negative	E-tube	N	156	Aspiration	N
8	9	NFC	MC	2018	SCC	75	Curative	Complete	BM: negative	E-tube	Y, 3 mo	316	Still alive	N

Abbreviations: …, no data available; BM, bilateral mandibular lymph nodes; BMR, bilateral mandibular and medial retropharyngeal lymph nodes; CM, contralateral mandibular lymph node; DLH, domestic long hair; DSH, domestic short hair; E-tube, esophagostomy tube; FS, female spayed; GCT, giant cell tumor; G-tube, gastrostomy tube; Histopath, histopathological; IM, ipsilateral mandibular lymph node; L, left; LN, lymph node; MC, male castrated; N, no; NFC, Norwegian forest cat; PostOp, postoperatively; R, right; SCC, squamous cell carcinoma; ST, survival time; Y, yes.

TABLE 2 Diagnostic work up and staging of cats treated with radical mandibulectomy

Case No	FNA mass	FNA LN	FNA LN cytology	Incisional biopsy	Imaging	Imaging description
1	…	BM	Lymphoid hyperplasia	SCC	CT	3.7 × 3.5 × 2.0-cm expansile mass involving the entire right mandible and extending over midline; the affected mandible has a severe moth-eaten to permeative lysis and irregular periosteal bone formation
2	Sarcoma	BM	Nondiagnostic	…	CT	3.3 × 2.9 × 2.5-cm mass along the ramus of the left mandible with severe osseous lysis
3	…	…	…	SCC	CT	3.3 × 2.8 × 4.3-cm aggressive, polyostotic right mandibular mass with invasion of the left mandible and extensive lysis of the bone at the level of the first premolar
4	…	BMR	Reactive	SCC	CT	Expansive, osteolytic mass within the right mandible was present, with soft tissue swelling and marked periosteal new bone formation along the rostral 4/5 of the mandible, combined with a lysis at the level of the mandibular symphysis, affecting the rostral left mandible as well
5	…	BM	IM: mast cells CM: reactive	Giant cell granuloma	MRI	Mass arising from the left mandible with bone lysis and irregular new bone formation; the mass extends from the rostral mandibular symphysis to the caudal aspect of the left mandible
6	Spindle cell proliferation	…	…	…	CT	Aggressive bone lesion of the mandible, characterized by a poorly marginated cortical expansion and partial lysis associated with a soft tissue swelling; the changes are noted bilaterally
7	SCC	…	…	…	CT	Extending rostrally from the distal root of 409 there is diffuse lysis of the body of the right mandible with severe lysis of the rostral portion of the left mandibular body extending to the alveolus of 304; there is marked irregular new bone located within the soft tissues at the level of and surrounding the lytic portions of the mandibular bodies, and there is a large, roughly ovoid rostral and ventral, contrast-enhancing soft tissue swelling with peripheral enhancement.
8	Nondiagnostic	BM	Reactive	Reactive bone, biopsied twice	CT	1.9 × 4.0-cm monostotic, aggressive, mixed osteolytic and proliferative, expansile bone lesion of the left mandible compatible with neoplasia

Abbreviations: …, no data available;; BM, bilateral mandibular lymph nodes; BMR, bilateral mandibular and medial retropharyngeal lymph nodes; CM, contralateral mandibular lymph node; CT, computed tomography; FNA, fine needle aspirate; IM, ipsilateral mandibular lymph node; LN, lymph node; SCC, squamous cell carcinoma.

halitosis (n = 3), mouth pain (n = 1), anorexia (n = 1), and lethargy (n = 1). All cats had a firm mandibular mass or swelling (n = 8) at physical examination. Other physical examination findings included mandibular instability (n = 2, cats No 2 and No 3), missing teeth (n = 1), and mandibular drift (n = 1).

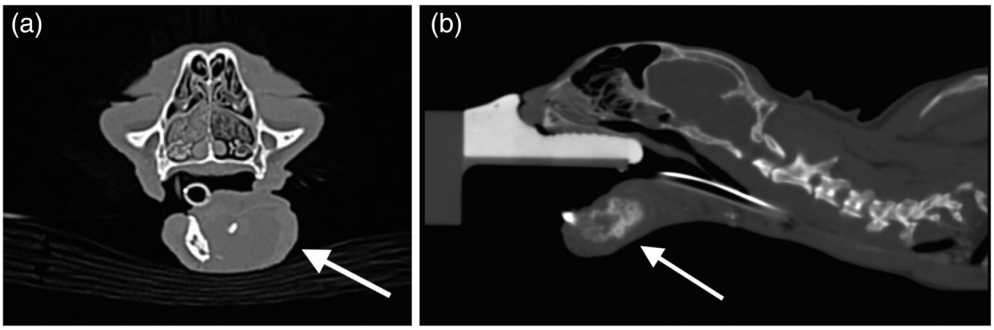

FIGURE 1 Axial (A) and sagittal (B) computed tomographic images of cat No 1. Note the extensive osteolysis and expansile lesion of the right mandible (arrow)

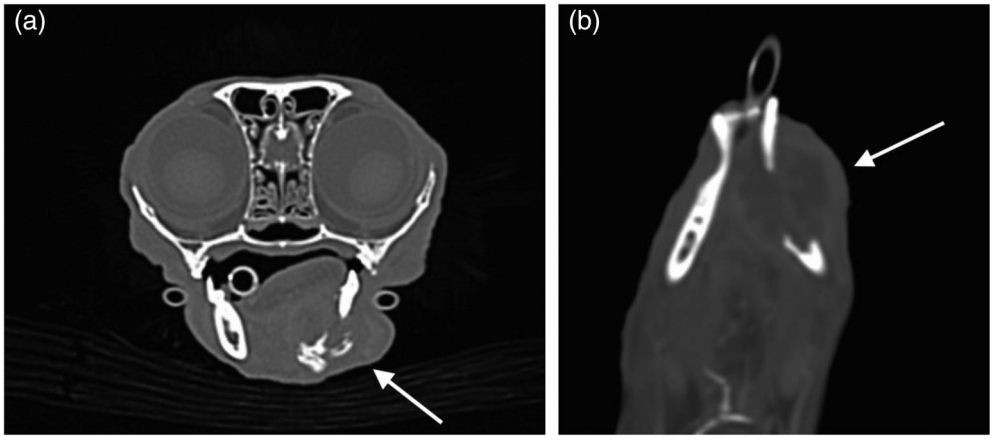

FIGURE 2 Axial (A) and coronal (B) computed tomographic images of cat No 2. Note the extensive osteolysis and expansile lesion of the right mandible (arrow)

3.1 | Diagnostics and staging

Lymph node aspirates were performed in five cases preoperatively (Table 2). The lymph nodes aspirated included mandibular lymph nodes bilaterally (n = 3), the mandibular and retropharyngeal lymph nodes bilaterally (n = 1), and the ipsilateral mandibular lymph node (n = 1). The cytology was either nondiagnostic or consistent with reactive lymph nodes in all cases except for cat No 5, which had evidence of mast cells in the ipsilateral mandibular lymph node, the clinical significance of which is unknown. The primary mass was aspirated for cytology in four cases and was consistent with a sarcoma (cat No 2), spindle cell proliferation with multinucleated cells and mild suppurative inflammation (cat No 6), SCC (cat No 7), and nondiagnostic (cat No 8).

A preoperative incisional biopsy was performed in six cats and was consistent with SCC in four cases (cats No 1, 3, 4, and 5), giant cell granuloma in one case (cat No 6), and reactive bone in one case (cat No 8). Biopsy was performed on two separate occasions in the case that was consistent with reactive bone.

Seven cats had preoperative computed tomography (CT) of the head and thorax, and one cat had an MRI and thoracic radiography. An expansile, osteolytic mass was noted in all cases of advanced imaging of the mandibular mass (Figures 1 and 2). All cats were considered free of pulmonary metastatic disease except for the cat in case No 8, which had an equivocal pulmonary lesion. In that case, there was an area of presumed atelectasis in the lung, but metastatic disease could not be ruled out. This cat had a treatment delay and repeat CT, and the noted lesion appeared to be resolving, so metastatic disease was considered unlikely.

3.2 | Preoperative treatment

One cat was treated with palliative radiation prior to surgery (case No 2). The initial treatment plan for this cat was palliative radiation, with 8 × 4 Gy given weekly. At the time of the third dose of radiation, the mass appeared to have progressed, and instability of the mandible was palpated. Radiation therapy was discontinued prior to administration of dose three. No other cats received neoadjuvant therapy prior to surgery.

3.3 | Surgical technique

3.3.1 | Mandibulectomy

Surgical approaches used to perform the mandibulectomy were a lateral, ventral, or combined approach (Figures 3-5, Table 1) The lateral approach was performed through caudal retraction of the lips or extension of the commissure up to the angular process via an incision through skin, buccinator muscle, and oral mucosa. The ventral approach consisted of a cutaneous incision on the ventral aspect of the mandible, followed by blunt and sharp dissection of the soft tissue structures around the disease area. For both approaches, mucosal incisions (buccal, gingival, and sublingual) were

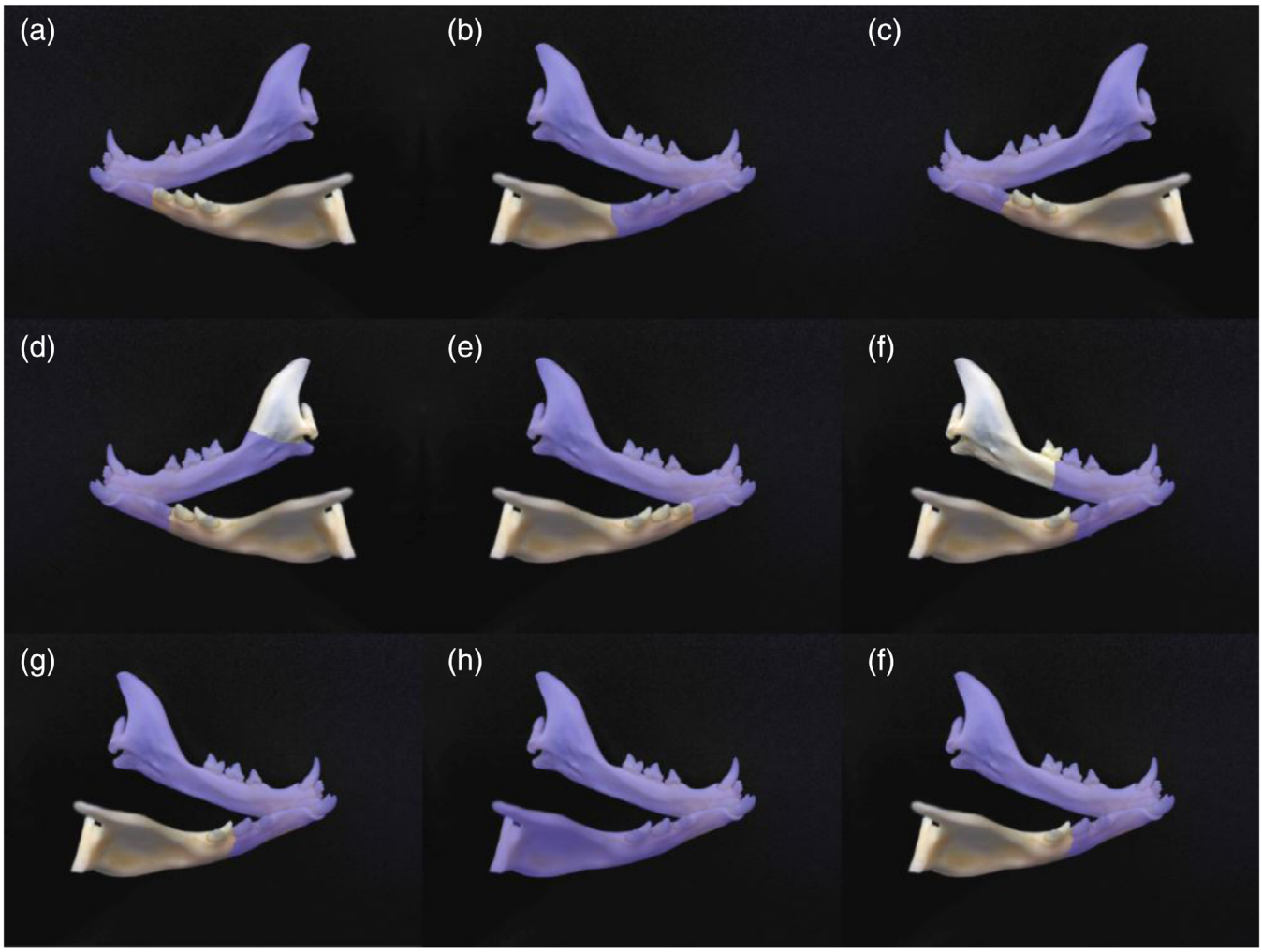

FIGURE 3 A, Cat No 1 right mandibulectomy and contralateral rostral mandibulectomy including 304. B, Cat No 2 left mandibulectomy and subtotal right mandibulectomy; the osteotomy was performed caudal to 409 C, Cat No 3 right mandibulectomy and subtotal left mandibulectomy with osteotomy caudal to the 307 D, Cat No 4 right subtotal mandibulectomy with only the mandibular body in situ, and left subtotal mandibulectomy with osteotomy caudal to including 307 E, Cat No 5 left total mandibulectomy and right subtotal mandibulectomy with the osteotomy caudal to 404. F, Cat No 6 bilateral subtotal mandibulectomy with osteotomies caudal to 308 and 408 G, Cat No 7 right mandibulectomy and left subtotal mandibulectomy with osteotomy caudal to 308. H, Cat No 7 had the remaining portion of the left mandible removed, resulting in a bilateral total mandibulectomy. I, Cat No 8 right total mandibulectomy and left subtotal mandibulectomy with the osteotomy just caudal to the 308

followed by transection of the mentalis, orbicularis oris, buccinator, mylohyoideus, geniohyoideus, genioglossus, masseter, digastricus, temporalis, and pterygoideus muscles, depending of the location and extension of the mandibular resection. Care were taken to minimize trauma to the lingual frenulum or sublingual and mandibular salivary ducts. Osteotomies were performed by using a combination of oscillating saw and mallet and osteotome (Figures 6-8). The vertical ramus was left in place to reduce, as much as possible, the morbidity associated with the procedure when margins were sufficient. One-centimeter margins were obtained when possible. The mandibular artery was ligated and cauterized or bone wax was applied to control hemorrhage. Closure was performed in one or two layers to accurately appose the labial, sublingual, and gingival mucosa. Mucosal flaps were elevated from the adjacent lip or cheek when possible. Sublingual mucosa was sutured directly to the skin in some cases because of extensive skin resection required to obtain adequate margins (Figures 9 and 10).

The intent of surgery was palliative in two cases and curative in six cases. In the two cases of palliative intent, wide margins were not achievable, and the mandibulectomy was a marginal excision. Both of the cats had palpable mandibular instability due to severe osteolysis and pathological fracture.

3.3.2 | Lymph node extirpation

Surgical approaches for removal of mandibular lymph nodes involved bilateral skin incision directly over the mandibular lymph nodes, cervical midline incision, or extension of the

FIGURE 4 Preoperative image of cat No 1. The cat is in dorsal recumbency. There is a large, firm mass of the ventral ramus of the mandible

FIGURE 5 Preoperative intraoral image of cat No 1. The cat is in dorsal recumbency. There is a large mass evident within the oral cavity of the right mandible

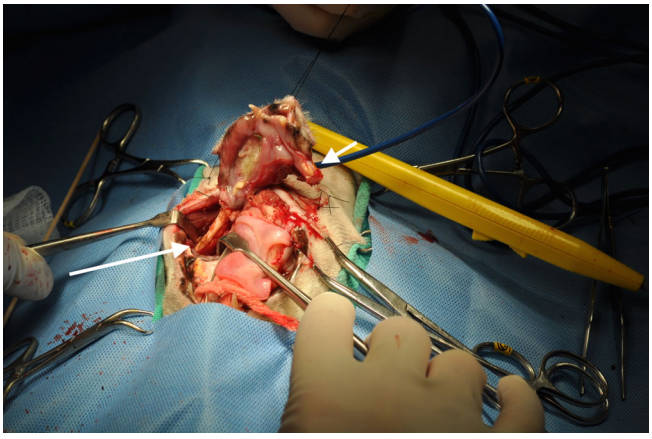

FIGURE 6 Intraoperative image of cat No 2. The cat is in dorsal recumbency. The left mandible and cranial portion of the right mandible is being removed. The mandibular body has been dissected from its attachments (long arrow) and the osteotomy in the right mandible is evident (short arrow)

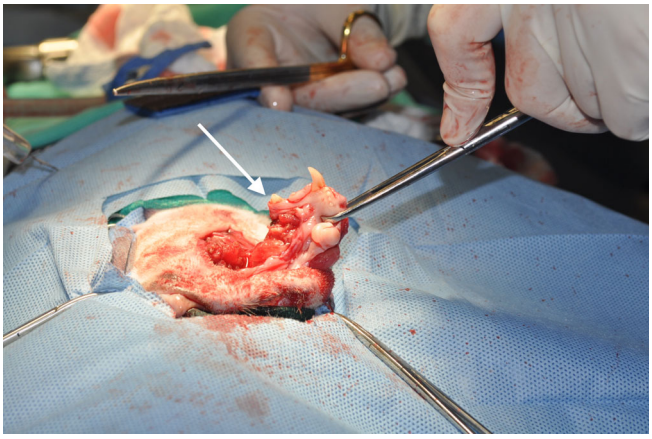

FIGURE 7 Intraoperative image of cat No 3. The rostral mandible is being grasped with Allis tissue forceps. The teeth in the right mandible are absent. An osteotomy has been performed in the left mandible

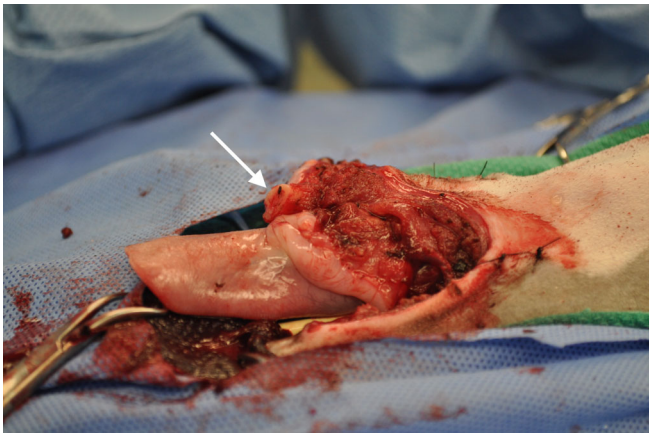

FIGURE 8 Intraoperative image of cat No 1 after total right mandibulectomy and subtotal left mandibulectomy. The cat is in dorsal recumbency. Note the cut edge of the left mandible at the osteotomy site (arrow)

skin incision used for mandibulectomy. When mandibular and retropharyngeal lymph nodes were removed bilaterally, the procedure with a cervical midline incision was performed as described by Green et al.[15] See Table 2 for information regarding the lymph nodes removed in each case.

3.4 | Perioperative management

Two cats required blood transfusion intraoperatively. Cat No 2 had a preoperative packed cell volume of 19.5%, which was addressed with a transfusion at the start of surgery because of anemia and anticipated blood loss. Cat No 5 lost a moderate amount of blood during surgery, prompting intraoperative blood transfusion.

Feeding tubes were placed in all cats during surgery (six esophageal and two gastric feeding tubes) for enteral

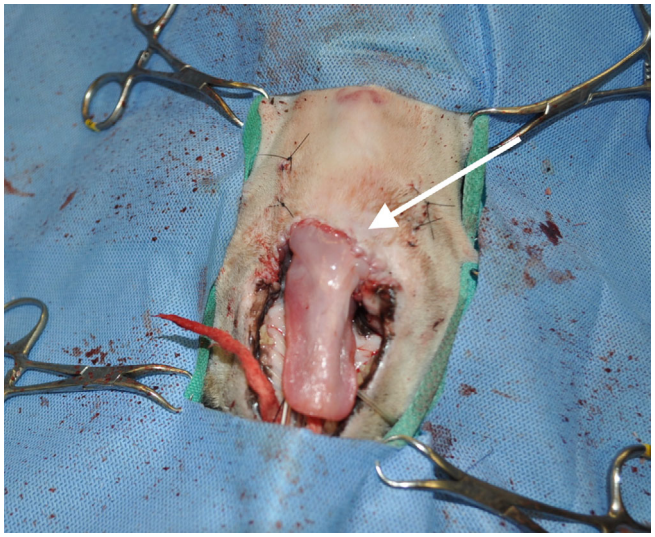

FIGURE 9 Intraoperative image of cat No 2 at the end of the procedure. The cat is in dorsal recumbency. Note that the skin that was previously overlying the mandible has been sutured directly to the mucosa of the ventral tongue (arrow)

FIGURE 10 Cat No 1, 14 days postoperatively

feeding. Postoperative treatment protocols varied, but all cats received intravenous fluids, perioperative antibiotics, and opioids (buprenorphine, fentanyl or sufentanyl) postoperatively. Meloxicam was administered postoperatively to control pain unless contraindicated. Cats were discharged with instructions for pain management and feeding tube management. Nutritional requirements were calculated, and instructions were provided to owners regarding the management of tube feedings. Cats were offered canned food orally, but tube feeding was continued until cats voluntarily ate enough to maintain their nutritional requirements.

One cat (No 5) was treated with postoperative radiation. Squamous cell carcinoma was diagnosed in this cat, with incomplete margins. The course of radiation was 10 × 4.8 Gy. No other cases received adjuvant radiation or chemotherapy for oral neoplasia. One cat (No 1) received chemotherapy for lymphoma that was diagnosed after the mandibulectomy.

3.5 | Histopathology

Seven cats had SCC, and one cat had a giant cell tumor of bone. Margins were considered complete in five cases, complete but within 2 mm in one case, and incomplete in two cases. Among the two incomplete cases, the surgical intent was palliative in one case and curative in the other. The case with narrow margins was treated with palliative intent. Surgical lymph node biopsies were performed in six cases and ranged from the removal of the ipsilateral mandibular lymph node to the removal of the mandibular and medial retropharyngeal lymph nodes bilaterally. The lymph nodes were negative for metastatic disease in five of six cases and positive for metastatic disease in one case (cat No 3). In cat No 3, the ipsilateral mandibular and medial retropharyngeal lymph nodes were positive for metastasis of SCC. See Table 1 for more complete information on the margins and histopathology for each case.

3.6 | Postoperative complications

Ten days postoperatively, cat No 4 had a 2 × 2-mm area of dehiscence over the mandibular osteotomy. This complication resolved with conservative treatment and extending the antibiotics (Clavamox; Zoetis, Parsippany, New Jersey) for an additional 7 days. A dehiscence over the osteotomy site of the left mandible 7 days after surgery in cat No 7 was managed by removing the remainder of the left mandible and temporomandibular joint (TMJ) disarticulation. This cat also developed a corneal ulcer and acute anterior chamber uveitis at day 13, responding to topical ocular medical therapy. Cat No 7 also experienced severe dryness of the rostral tongue. At day 40 postoperatively, the cat presented after self-trauma to the tongue with her hind feet. Two lacerations and nodular proliferation of the tongue were noted. This area was biopsied 61 days postoperatively and was consistent with extensive tongue ulceration with exposed, actively inflamed granulation tissue with no evidence of SCC.

3.7 | Nutrition

All cats were fed via a feeding tube until they consumed enough food orally to maintain their nutritional requirements. The time until these six cats were able to maintain nutritional requirements postoperatively was between 1 day and 12 weeks postoperatively (Table 1). Cat No 4 ate voluntarily 3 days postoperatively. However, the owners reported that the cat's lack of grooming and food on her haircoat decreased their social interaction with the cat. The owners felt that this negatively impacted the cat's quality of life. Cat No 5 was not

able to maintain his weight by oral feeding and was dependent on nutritional support via gastric tube until the time of death. Cat No 7 was never able to eat postoperatively, and was fed via esophageal tube (e-tube) until death. Cat No 8 experienced issues swallowing and appeared to have decreased saliva production postoperatively. The cat was also pawing at his mouth and gagging. Ten days postoperatively, the e-tube was exchanged for a smaller one, and the gabapentin that this cat had been receiving for pain control was tapered and discontinued because it has been reported to cause dry mouth in man.[16,17] One month postoperatively, the cat was vomiting and esophagitis was suspected. The cat stopped pawing at his mouth and was able to eat small amounts on his own. Two months postoperatively, he was eating 30% of his daily energy requirement on his own, and the rest was fed via e-tube. Three months postoperatively, he was eating 100% of his daily energy requirements on his own.

3.8 | Long term outcomes

Cat No 1 was euthanized 465 days postoperatively because of lymphoma. There was no evidence of recurrence of SCC at that time. Cat No 2 was euthanized because of renal failure 608 days postoperatively, with no evidence of recurrence. Cat No 3 developed mass recurrence and was euthanized 136 days postoperatively. Cat No 4 died of unknown causes 1023 days postoperatively. Cat No 5 developed a biopsy-confirmed recurrence under the tongue 17 weeks postoperatively and was euthanized 291 days postoperatively. Cat No 6 was still alive at the time of writing, 461 days post operatively. Cat No 7 was found dead 156 days postoperatively. At postmortem examination, copious ingesta was found in the larynx and trachea with severely edematous lungs, consistent with suffocation due to food aspiration. In addition, chronic ulcerative esophagitis was confirmed by histopathologic examination. This cat had been fed via e-tube since surgery. There was no evidence of recurrence of SCC. Cat No 8 was still alive at the time of writing, 316 days post operatively.

The margins were incomplete in the two cats with mass recurrence. In one cat, the surgery was considered palliative, and, in the other, the surgery was performed with curative intent. The margins were close (2 mm) in cat No 2, but there was no evidence of recurrence at the time of death (608 days).

At the time of writing, six cats were dead and two were still alive. The overall estimated survival time was 712 days. The median survival time was not reached. Four cats lived more than 1 year (Figure 11). Three cats died of reasons related to the tumor due to recurrence (n = 2) or aspiration of food material (n = 1). Three cats died of unrelated reasons, including lymphoma, renal failure, or unknown causes.

4 | DISCUSSION

We report eight cats with mandibular neoplasia treated with subtotal or total mandibulectomy. All cats had feeding tubes placed at the time of surgery. Six cats regained oral feeding between 3 days and 3 months postoperatively, two cats (No 5 and No 7) never regained the ability to take in their nutritional requirements by mouth. The estimated mean survival time was 712 days, with four cats living longer than 1 year. Two cats died of tumor-related causes (local recurrence in both cases), and one cat died of aspiration, which was likely associated with a complication of the feeding tube or a consequence of mandibulectomy. Successful outcomes are possible with subtotal or total mandibulectomy in cats with aggressive supportive care and should be considered as a treatment option.

The signalment, presenting complaints, and clinical findings reported here are in line with previous reports on cats with oral neoplasia.[5] Preoperative cytology of the primary

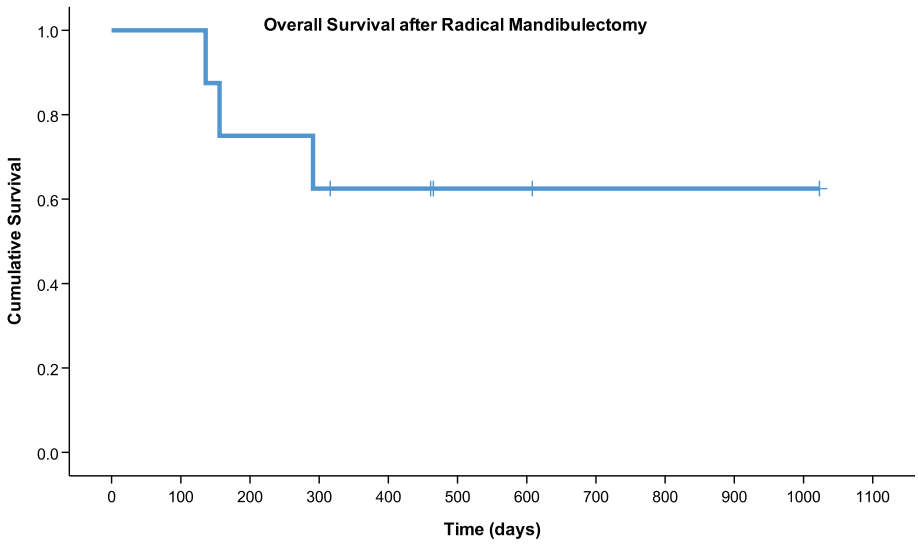

FIGURE 11 Kaplan–Meier curve for overall survival in cats with radical mandibulectomy

mass was performed in four cats and yielded an accurate diagnosis in only one case. In contrast, preoperative incisional biopsy was performed in six cats and yielded an accurate diagnosis in five of six cases. Preoperative imaging for staging included CT in seven cats and MRI in one cat. Computed tomography of the head and thorax seems advantageous compared with MRI because the thorax can be evaluated for metastatic disease on the same study. The authors also recommend an incisional biopsy for preoperative staging for mandibular masses in cats. In cat No 8, evaluation of the initial biopsy was consistent with a more benign process and was ultimately nondiagnostic despite an aggressive bone lesion revealed CT. In that case, the discordant biopsy and CT results delayed treatment. The presence of aggressive bone lesions should prompt consideration for neoplasia even if histopathological examination of biopsies is more suggestive of reactive bone; surgery should be considered in cats with a progressing aggressive bone lesion. Desmoplasia has been reported in human patients with SCC, consisting of new bone formation and reactive tissue that can be misinterpreted as benign disease.[18,19] Desmoplasia has been reported as a negative prognostic factor in humans with SCC.[18,19] Desmoplasia and small sample size may have contributed to the nondiagnostic presurgical biopsies in the cat reported in our study.

Mandibulectomy techniques vary with surgeon preference and extent of disease. The authors prefer a ventral approach to facilitate TMJ disarticulation and access to the mandibular artery as well as mandibular and retropharyngeal lymph nodes.[15] The technique for sampling lymph nodes varied in this study as well, with the ipsilateral mandibular lymph node, bilateral mandibular lymph node removal and the bilateral removal of mandibular and medial retropharyngeal lymph nodes being removed at the time of surgery. One cat in our series had histopathological evidence of metastatic disease in the ipsilateral mandibular and medial retropharyngeal lymph nodes. Current recommendations for lymph node sampling for oral neoplasia vary in veterinary medicine. Contralateral metastasis and metastasis to the medial retropharyngeal lymph nodes have recently been reported with oral neoplasia in dogs.[20] The same research group reported that CT was a poor predictor of lymph node metastasis, with common false positive and false negative results.[21] A ventral approach to the mandible allows bilateral removal of the mandibular and medial retropharyngeal lymph nodes without repositioning the animal.[15]

The intent of surgery was curative in six cats, and clean margins were achieved in five of six of these cases. Even with extensive tumors, clean margins are possible because of the compartmental resection of the mandible.[13] The intent of surgery was palliative in the two cats with mandibular instability due to osteolysis/pathological fracture. Margins were incomplete in one cat with recurrence. Margins were close in the other cat, with a good long-term outcome. None of the cats with clean margins of excision developed recurrence, and the long-term survivors in this study all had clean margins. Another important consideration in these cats is that removal of the primary bone tumor of the jaw will result in surgical palliation, even if long-term survival is not expected. Limiting the treatment of affected cats to palliative measures may be tempting because of concerns about postoperative function. Paradoxically, removal of the source of pain, infection, and/or impaired mastication associated with an extensive primary tumor of the mandible may improve quality of life and the cat's ability to eat.

Two cats required a blood transfusion intraoperatively, and two cats developed incisional dehiscence in the postoperative period. These complications are both expected and manageable with resection of oral tumors in dogs and cats.[22] Preoperative blood typing and the availability of blood for transfusion is recommended prior to mandibulectomy. All cats in this study had feeding tubes placed at the time of mandibulectomy. Feeding tube placement is recommended in all cases of mandibulectomy in cats because of the varying intervals between surgery and the willingness of cats to start eating on their own. This period varied from 3 days to 12 weeks in this study; one cat that never ate orally. Most cats in this study did eventually maintain their nutritional requirements orally, but owners must be warned that feeding tube support must be expected postoperatively and that this could be permanent. In the Northrup et al[5] study of mandibulectomies in 42 cats, 29 cats experienced anorexia in the postoperative period, but only 17 of 42 cats in that study had feeding tubes placed at the time of surgery. This may have led to some of the poor outcomes in that study and highlights the requirement for aggressive supportive care in cats undergoing mandibulectomy. These are often geriatric cats, just as in this case series, and it is important that they receive adequate nutrition to promote healing of their surgical sites.[23] Furthermore, even relatively short periods of anorexia may lead to hepatic lipidosis in cats.[24] Two cats (No 7 and No 8) displayed signs of oral pain for a prolonged period after surgery, such as pawing at the mouth, a dry tongue, and prolonged anorexia postoperatively. The extensive surgery and resulting alterations in the oral cavity may be poorly tolerated, resulting in long-term discomfort and anorexia in some cats. Some medications may also exacerbate oral dryness; gabapentin causes a dry mouth in approximately 30% of human patients.[16,17] Cat No 7 required long-term tube feeding and died due to aspiration of food material and ulcerative esophagitis. This complication was likely associated with the e-tube feeding. Vomiting has been reported as a complication of esophageal feeding tube placement in cats[25] but not aspiration and death. The ulcerative esophagitis may have affected esophageal motility and led to

regurgitation and aspiration after tube feeding. Alterations in the tongue base or pharynx secondary to mandibulectomy may also have contributed to the aspiration. The other cat (No 5) that did not regain the ability to take in its daily energy requirements by mouth received postoperative radiation therapy and developed local recurrence. Radiation therapy of oral neoplasia in cats is associated with mucositis, oral pain, and dysphagia.[26] Mucositis is reported to be one of the most common side effects of oral radiation therapy and is generally treated with feeding tube placement, pain medication, and antibiotics.[6,26,27] Although these side effects can be transient in most cases, a report on accelerated radiation therapy combined with cisplatin in 31 cats describes 25 cats receiving a feeding tube.[27] That report describes a median time of tube feeding dependence of 1 month (range, 2 weeks to 4 months), with four cats dependent on their feeding tube until death and one alive and tube feeding dependent at time of writing.[27] Pain from tumor recurrence or radiation therapy-induced mucositis may have been contributing factors to feeding tube dependence in this study. The remaining six cases did recover to the point of being able to sustain their body weight on their own and apprehend food and water by mouth. Some cats will require long-term assistance with grooming as well.

A limitation of our study is the small number of cases. Mandibulectomy is relatively uncommon in cats, largely because the current literature advises against it.[5,28] An additional limitation is the retrospective nature of the study. Body condition score and body weight were not measured consistently in these cases. The recommendation against mandibulectomy in cats is also based on a relatively small number of cases.[5] More studies are required to determine whether these cases can be successful with aggressive pain management and enteral feeding postoperatively. Our sample of eight cats is the largest cohort reported after radical mandibulectomy. Northrup et al[5] reported only six cats treated with radical mandibulectomy, of which 50% did not regain complete oral feeding.

The estimated mean survival time was 712 days, with four long term survivors. Death was attributed to local recurrence (2), aspiration of food material (1), and unrelated disease (3); two cats were still alive. The three long-term survivors were likely cured of their disease. Radical mandibulectomy to treat extensive oral neoplasia was not associated with a poor functional outcome or significant morbidity during the postoperative period in most cats in this study. Radical mandibulectomy should be considered in combination with postoperative aggressive pain control and feeding tube management as a treatment option for cats with extensive mandibular neoplasia. Cure is possible when clean surgical margins are obtained and cats tolerate the surgical procedure.

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CONFLICT OF INTEREST

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

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