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CLINICAL RESEARCH

WILEY

Intraoral approach for zygomatic sialoadenectomy in dogs: An anatomical study and three clinical cases

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Abstract

Objective: To describe an intraoral approach (IOA) for zygomatic sialadenectomy in dogs and to compare this surgical approach to a modified lateral orbitotomy approach (LOA).

Study design: Cadaveric study and short case series.

Sample population: Ten canine cadavers and three dogs with clinical disease.

Methods: Bilateral zygomatic sialoadenectomies were performed in six mesocephalic, two brachycephalic and two dolichocephalic cadavers, randomly assigned to IOA on one side and LOA on the contralateral side. Duration of surgery, ease of surgical stage scores (rated on 5-point Likert scale) and completeness of gland removal were recorded. Additionally, IOA was performed in three dogs with zygomatic salivary gland (ZSG) disease.

Results: Removal of the ZSG was complete in 8/10 and 10/10 dogs using the IOA and LOA, respectively. Surgery was faster with IOA (42.0 min; 33.5–49.6 min) than LOA (65.7 min; 54.9–76.4 min, $p = .005$). Ease of removal did not differ between approaches ($p = .091$). Diseased ZSGs were successfully removed in three dogs without intra- or short-term postoperative complications.

Conclusions: The intraoral approach described here was technically equally challenging but faster than the LOA. Its clinical use led to an uneventful surgery with excellent short-term outcome in three dogs.

Clinical relevance: The IOA provides an alternative approach for zygomatic sialoadenectomy in dogs with ZSG disease.

1 | INTRODUCTION

The canine salivary system consists of four major pairs of glands; the parotid, mandibular, sublingual, and zygomatic salivary glands (ZSG).[1] The ZSGs are located on the floor of orbit, ventral to the eye.[1] Salivary gland disease is uncommon in dogs, with a reported overall incidence lower than 0.17%.[2,3] Diseases of the salivary gland include mucocele, sialadenitis, sialadenosis, sialolithiasis, neoplasia, and infarction.[2,3] The mandibular and sublingual monostomatic glands are the most frequently affected while the ZSG is the least frequently involved in salivary gland disease.[4] Dogs with ZSG disease share

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clinical signs such as exophthalmos, periorbital edema and chemosis with other space occupying retrobulbar diseases.[2,4]

Zygomatic sialoadenectomy is considered a lengthy, relatively challenging procedure, mostly due to its anatomical location and current invasive approach, involving an osteotomy. Excision of the gland has been described mainly by a lateral orbitotomy and, uncommonly, by a ventral transconjunctival approach.[5–7] A modified lateral orbitotomy approach (LOA), with osteotomy of the zygomatic arch while preserving the insertion of the masseter muscle, is the currently recommended approach for orbital mass removal.[8] A dorsal and ventral approach to the zygomatic arch for zygomatic sialoadenectomy in canine cadavers have recently been described.[9]

Since the largest part of the ZSG lies ventral to the eye in the orbit, it was hypothesized that its removal via an intraoral approach (IOA) would be feasible. Intraoral drainage of retrobulbar abscesses in dogs is an established procedure, in which the oral mucosa caudomedial to the second maxillary molar tooth is incised and an instrument is bluntly inserted and advanced into the orbit.[5] We hypothesized that the proposed novel approach might offer several advantages compared to the LOA, including less need for tissue dissection, faster surgical procedure, less surgical scarring and minimal cosmetic impact. Furthermore, presumably, there would be a reduced risk of iatrogenic damage to the palpebral branch of the auriculopalpebral nerve and subsequent lagophthalmos, occasionally observed after LOA.[8] The aim of the study was to describe the IOA and compare it to the LOA for zygomatic sialoadenectomy in canine cadavers based on surgical time, difficulty level, and completeness of gland removal. Additionally, the short-term surgical outcome in three affected dogs undergoing IOA will be described.

2 | MATERIALS AND METHODS

2.1 | Cadaveric study

A cadaveric study was performed in 10 dogs, with different skull shape and size, euthanized for reasons unrelated to this study, and without evidence of any disease of, or trauma to, the head. The dogs were donated for use in this study with signed owner consent. All specimens were frozen and slowly thawed 48 hours prior to the study (24 h prior to catheterization). The day before the study, both major zygomatic papillae were catheterized using a 24-gauge peripheral intravenous catheter and methylene blue was injected until backflow was noted (corresponding to 0.1 ml, Figure 1A). The cadavers were refrigerated at 8°C until the study the next day. All dogs underwent a bilateral zygomatic sialadenectomy by the same person, a second-year surgical resident. In each cadaver, one of the ZSGs was removed by using an IOA while the LOA was performed at the contralateral side. A computerized random number generator (https://www.random.org/) was used to determine which technique was used at which side.

2.2 | Surgical outcome measures

A subjective score was designed, using a modified 5-point Likert scale,[10] to describe the ease for performing the different steps during the surgical approaches. It also evaluated the difficulty to isolate the gland and how difficult it was to judge if salivary gland removal was complete or not. In the modified 5-point Likert scale; the lower the score, the easier it was (Supplemental file). The surgical procedures were divided into three different stages; stage I (score range 0–12) from incision until observation of the ZSG; stage II (score range 0–20) from observation until removal of the ZSG; stage III (score range 0–8) from sialoadenectomy to reconstruction/closure of the wound. A stopwatch was used to record the time of each stage, and after each stage, the Likert scale was filled out. After bilateral zygomatic sialoadenectomy (one side IOA and contralateral side LOA), the alternative approach was performed (LOA at the side of IOA and IOA on the contralateral side) to evaluate whether or not glandular tissue was overlooked by the first approach. The injected methylene blue aided to help determine completeness of ZSG removal. The ZSGs were visually assessed, weighed and the volume calculated using the water displacement method. Briefly, it is a method used to measure the volume by measuring the volume of fluid displaced when the ZGS is submerged.

2.3 | Surgical technique

2.3.1 | Intraoral approach

Dogs were positioned in dorsal recumbency, with a cushion underneath the neck to position the hard palate in the horizontal plane. The mouth was kept open utilizing a rope tied to a surgical table frame. The zygomatic major papilla, located approximately 1 cm caudal to the parotid papilla on a ridge of mucosa at the level of the last maxillary molar tooth,[11] was identified. A 2.5 cm incision was made into the oral mucosa and muscular tissue overlying the rostral part of the pterygopalatine fossa, oriented in a 45° caudomedial to rostrolateral direction, ending

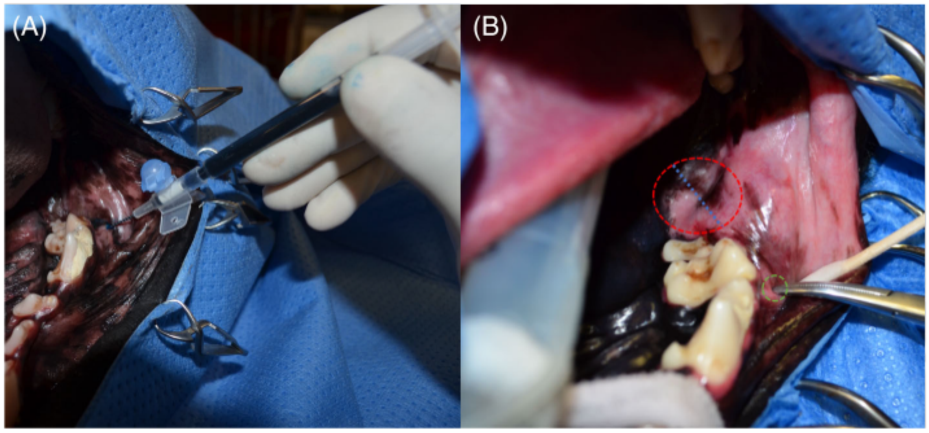

FIGURE 1 Intraoral landmarks. (A) The major zygomatic papillae, located caudal to the parotid salivary gland papilla on a ridge of mucosa at the level of the last maxillary molar tooth, catheterized using a 24-gage peripheral intravenous catheter and injected with methylene blue. (B) An illustration of the surgical incision into the oral mucosa and muscular tissue overlying the rostral part of the pterygopalatine fossa. Blue: surgical incision line; red: location of the zygomatic salivary gland; green: the major zygomatic papillae.

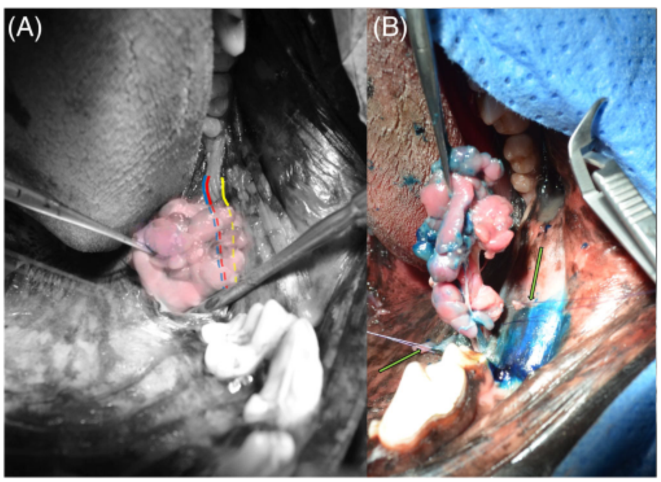

FIGURE 2 Intraoral zygomatic gland dissection. Intraoral approach for zygomatic sialoadenectomy in a dog cadaver. (A) The zygomatic salivary gland is grasped with an Allis tissue forceps and gentle traction is applied. (B) After gentle blunt dissection, the gland can be levered out with a periosteal elevator. Colored lines illustrate important neurovascular structures that one might encounter and need to be aware of. Red: branch of infraorbital artery; blue: deep facial vein; yellow: auriculotemporal nerve.

immediately caudal to the zygomatic major papilla (Figure 1B). At each side of the incision stay sutures were placed to retract the oral mucosa. The ventral edge of the salivary gland was freed carefully from the surrounding loose connective tissue by blunt dissection. An Allis tissue forceps was used to gently grasp the ZSG, and mild traction was applied in a rostroventral direction. The caudal extent of the ZSG was gently levered by inserting a periosteal elevator between the gland and the pterygopalatine fossa (Figure 2). Care was taken not to damage the deep facial vein, the auriculotemporal nerve and the branch of the infraorbital artery by performing gentle blunt dissection. Once the gland was completely freed from its surrounding tissue, the major salivary duct was transected close to the major zygomatic papilla and subsequently removed en bloc with the ZSG. The muscular tissue and the oral mucosa were closed in separate continuous layers using 4–0 poliglecaprone 25.

2.3.2 | Modified lateral orbitotomy approach

The LOA was performed with the dogs in lateral recumbency with a cushion under the nose to keep the zygomatic arch in a horizontal plane. The surgical technique was performed as previously described by Gilger et al.[8] Briefly, a curved skin incision was made 1 cm ventral to the lateral canthus, extending caudally over the dorsal rim of the zygomatic arch, ending just rostral at the base of the ear. Care was taken to avoid damaging the palpebral branch of the auriculopalpebral nerve and the dorsal buccal branch of the facial nerve, which lies subcutaneously and runs rostrodorsal to the zygomatic arch. The orbital ligament was transected at its midpoint and an incision was made in the temporal aponeurosis 5 mm dorsal to the zygomatic arch. Two holes were drilled through the zygomatic arch using a 0.8 mm K-wire on each side of the planned zygomatic osteotomy sites, approximately 3–5 mm apart. Two parallel zygomatic arch osteotomies were created with an oscillating saw, and the zygomatic arch was reflected ventrally, preserving the insertion of the masseter muscle. The ZSG was identified and freed by careful combined blunt dissection. The major salivary duct was ligated as close as possible to the major zygomatic papilla and transected. After sialadenectomy, the zygomatic arch was replaced and attached with 0.8 mm orthopedic cerclage wire. The orbital ligament was sutured using 3–0 polydioxanone prior to simple continuous closure of the subcutaneous tissue and the skin using 4–0 poliglecaprone 25.

2.4 | Statistical analysis

Statistical analyses were performed using SPSS Statistics 26 (IBM, Armonk, USA). Differences in weight and volume of the left and right ZSGs and differences in time needed to perform different steps for both approaches were evaluated by Wilcoxon signed rank tests. Differences in surgical stage scores between both approaches were analyzed using both Mann–Whitney U tests and Wilcoxon signed rank tests. p-values of $\leq .05$ were considered statistically significant.

2.5 | Clinical cases

Three dogs with zygomatic sialoadenopathy underwent sialoadenectomy using the IOA. All owners were informed of the possible risks and perioperative complications associated with the surgical procedure such as hemorrhage, wound dehiscence, and infection and signed an informed consent. All procedures were performed by an AVDC/EVDC, an ECVS diplomate or a resident under direct supervision of a diplomate.

2.5.1 | Case 1

A 6-year-old, 4.1 kg, female neutered Shih Tzu cross presented to the William R. Pritchard Veterinary Medical Teaching Hospital at UC Davis (UCD) for exophthalmos, conjunctivitis, blepharedema, chemosis and blepharospasm of the left eye. The dog was presented twice to the referring practice within the 3 days preceding the referral. A computed tomography (CT) scan was performed at the referral practice and a noncontrast enhancing, irregularly marginated, soft tissue structure dorsoventral and medial to the left globe was diagnosed. A copious amount of mucoid fluid was drained by aspiration resulting in a reduction of the extent of exophthalmos. A single injection of dexamethasone (dose unknown) was given in an attempt to decrease the chemosis. The dog was discharged with amoxicillin clavulanic acid (15 mg/kg, orally, every 12 h), artificial tears and ophthalmic ointment (neomycin/polymyxin B) alternating, every 4 hours. Two days later the dog returned to the referring veterinarian with recurrent clinical signs, a temporary partial tarsorrhaphy was performed on the left eye and the owner was referred to UCD.

The only abnormal finding on physical examination consisted of a firm swelling surrounding the left eye extending dorsally and caudally to the level of the left ear and ventrally to the left commissure of the lip. The remainder of the physical examination was unremarkable. The patient was anesthetized in order to explore the oral cavity. A raised firm swelling (1 cm × 2 cm × 1 cm), caudal to the second maxillary molar tooth and involving the left side of the soft palate, was noted (Figure 3A). In addition, moderate periodontal disease was noted with mild calculus build-up. Dental radiographs were performed and periapical lesions of the left first maxillary molar were identified. After dental scaling and polishing, the mouth was rinsed with 0.05% chlorhexidine gluconate solution and the dog prepared for a sialoadenectomy of the left ZSG using an IOA. Upon incision into the mucosa and muscular layer, a copious amount of viscous fluid drained from the surgical incision (Figure 3B). The undulating bulge in the oral cavity allowed for avoiding the important anatomical structures in that area. With the help of two stay sutures, the mucosa could further be retracted, further reducing the chance of damage to important structures and the eye. The "pocket" created by the fluid accumulation facilitated the dissection to remove the ZSG in one piece, which looked macroscopically normal and complete. The surgical time was 30 minutes.

2.5.2 | Case 2

An 11-year-old, 28.3 kg, male intact Border collie was presented to the Small Animal Teaching Hospital of Ghent University with chronic small intestinal diarrhea. On physical examination no abnormalities could be detected except for a moderately enlarged right mandibular lymph node. Fine needle aspiration of the lymph node yielded clusters of epithelial cells with light basophilic cytoplasm. The cells had malignant characteristics which included moderate anisokaryosis, anisocytosis, coarse chromatin, and the presence of multiple nucleoli. Computed tomography of the head, neck and thorax was performed and confirmed the presence of an enlarged right mandibular lymph node (1.3 cm × 1.5 cm × 2 cm) that showed rim enhancement after intravenous contrast injection. The lymph node was heterogeneous centrally with multiple small (<1 mm) hypoechoic cyst-like structures. Within the center of the left thyroid gland, a well-delineated 1.8 cm × 1.4 cm × 1.1 cm mass with a heterogeneous central part was seen. After the administration of intravenous contrast, clear rim enhancement was present.

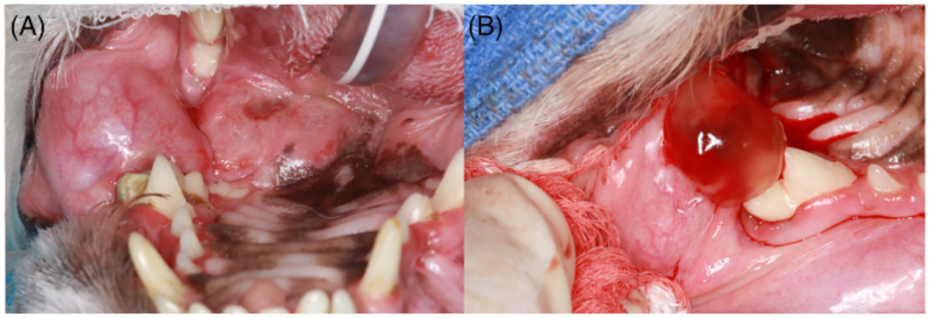

FIGURE 3 Left-sided zygomatic sialocele. (A) Note the raised firm swelling, caudal to the second maxillary molar tooth and involving the left side of the soft palate in this dog. (B) Viscous fluid drained from the surgical site upon incision.

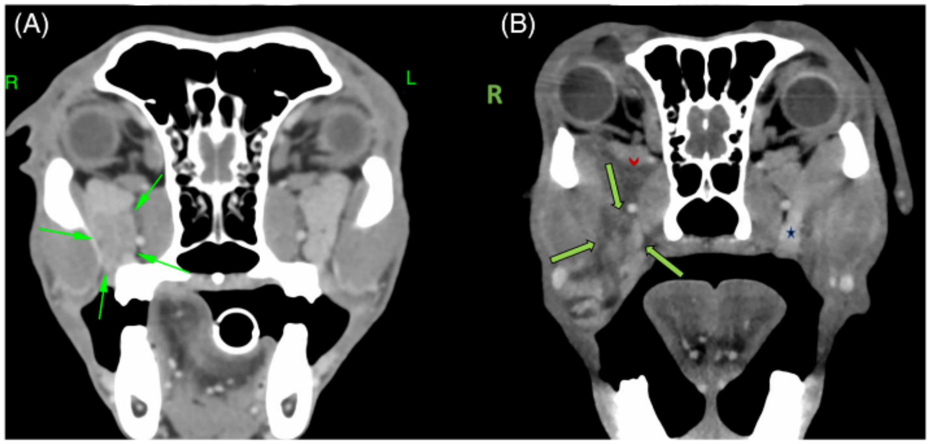

FIGURE 4 Transverse computed tomographic images. (A) Dog with a salivary gland carcinoma. The right zygomatic salivary gland (green arrows) is enlarged with contrast uptake. (B) Dog with a zygomatic sialocele. The right zygomatic salivary gland (green arrows) is displaced ventrally with moderate fluid accumulation in the right orbit (red arrowhead), primarily compatible with a sialocele. Note the left normal ZSG (black star).

Additionally, there was small 0.5 cm × 0.5 cm × 1 cm contrast enhancing mass present in the central to caudal part of the right ZSG (Figure 4A). A staged surgery was performed. During the first surgery, a left thyroidectomy and a right mandibular lymphadenectomy were performed. Three weeks later, an IOA was performed to remove the right ZSG, as described above. The surgery was uneventful and duration of surgery was 105 minutes.

2.5.3 | Case 3

A 5-year-old, 23 kg, female intact Belgian Malinois was referred to the Small Animal Teaching Hospital of Ghent University for further investigation and treatment of a retrobulbar mass with a progressively worsening exophthalmia of the right eye. The referring veterinarian aspirated and drained the mass intraorally lateral of last molar and a sialocele was suspected based on the aspirated fluid. On physical examination, the presence of exophthalmia of the right eye with a soft fluctuating mass just distal to right eye (1 cm × 1 cm × 1 cm) was noticed. On oral inspection, a fluctuating mass (3 cm × 2 cm × 1 cm) was felt at the level of the last molar of the right maxilla, at the location of the scar from the previous drainage site. A CT scan was performed and a moderate amount of amorphous fluid-attenuating, noncontrast enhancing material surrounding the right ZSG was diagnosed (Figure 4B). The fluid-attenuating material was causing a mild dorsolateral displacement of the right eye and a fluid filled pocket that bulged against the right lower eyelid. The right ZSG was rostroventrally displaced, caudal to the last molar tooth lying directly underneath the mucosa. The aberrant location of the gland made removal by the IOA relatively easy. Duration of surgery was 40 minutes.

3 | RESULTS

3.1 | Cadaveric study

Ten dogs of eight different breeds, of which six mesocephalic, two brachy- and two dolichocephalic dogs, (Dalmatian, Dogue de Bordeaux, English Bulldog, English Cocker Spaniel, German Shepherd, Jack Russell Terrier, Maltese and three mixed breed), were included with a median bodyweight of 24.2 kg (4.1–52.5 kg). The median weight of the ZSG was 5 g (1–8 g) and the median volume was 5 cm^3 (1–8 cm^3). No differences were found between the weight and volume of both ZSGs within dogs (p = 1.000 and p = .102, respectively).

Overall surgical time needed to complete zygomatic sialoadenectomy was shorter for the IOA compared to

TABLE 1 Median (range) surgical times in cadaveric dogs undergoing zygomatic sialoadenectomy with the intraoral approach (IOA) versus the modified lateral orbitotomy approach (LOA)

Procedure	Overall (min)	Stage I (min)	Stage II (min)	Stage III (min)
IOA	42.0 (33.5–49.6)	8.2 (6.0–10.6)	17.8 (14.2–25.4)	14.0 (12.2–15.8)
LOA	65.7 (54.9–76.4)	26.7 (22.5–35.0)	14.4 (11.0–16.3)	23.9 (19.2–27.4)
p-value	.005	.005	.007	.005

Note: The *p*-value represents the difference in time within dogs.
Abbreviations: Stage I, from incision until observation of the ZSG; Stage II, from observation until removal of the ZSG; Stage III, from sialoadenectomy to reconstruction/closure.

TABLE 2 Median (range) surgical ease scores based on a modified 5-point Likert scale in cadaveric dogs undergoing zygomatic sialoadenectomy with an intraoral approach (IOA) versus modified lateral orbitotomy approach (LOA)

Procedure	Overall (0–40)	Stage I (0–12)	Stage II (0–20)	Stage III (0–8)
IOA	12 (10–17)	2.5 (1–6)	8 (6–12)	1 (0–2)
LOA	13 (12–23)	3 (1–7)	6.5 (5–10)	4.5 (2–7)
p-value	.126	.614	.039	<.001

Note: The lower the score, the easier the technique. The *p*-value represents the difference between the median surgical ease scores.
Abbreviations: Stage I, from incision until observation of the ZSG; Stage II, from observation until removal of the ZSG; Stage III, from sialoadenectomy to reconstruction/closure of the incision wound.

the LOA (p = .005) (Table 1). Although stage I and III were faster when performing IOA (p = .005 and p = .005, respectively), removal of the ZSG itself was not faster when performing LOA at stage II (p = .007).

Although there was no difference between overall median surgical ease scores (p = .126), stage II was easier during LOA whereas IOA was easier during stage III (p = .039 and p = <.001, respectively) (Table 2). When surgical ease scores between IOA and LOA were compared within dogs, only stage III was more difficult when performing LOA compared to IOA (p = .091, p = .670, p = .064, p = .005, respectively for overall, stage I, stage II and stage III surgical ease scores).

The visibility during IOA was judged to be good (median score 1/4 [0–3/4]) during dissection in most dogs and the deep facial vein could always be identified. However, the dorsal buccal nerve and the branch of the infraorbital artery could only be identified post removal of the ZSG. In three cadaveric dogs, two brachycephalic (English Bulldog and Dogue de Bordeaux) and one mesocephalic (cross breed), it was difficult to determine whether all ZSG tissue was removed after performing the IOA. In two of these dogs, remnant ZSG tissue was observed. In one of these dogs, the gland could not be dissected in one piece, hindering the assessment whether the gland was completely removed based on macroscopic examination after IOA. In the second dog, the gland was judged to be intact but remnant tissue was noticed after performing an additional LOA at the end of the study.

The LOA, which offered better surgical overview and exposure, was also more invasive and time consuming. The deep facial vein could always be identified and, in 6/10 dogs, also the auriculopalpebral nerve, the dorsal buccal nerve and the branch of the infraorbital artery prior to removal of the ZSG was visualized. In addition, after LOA, it was found to be easy to assess whether all ZSG tissue was removed in seven dogs, whereas in the remaining three dogs it was feasible but difficult to determine whether all ZSG tissue was removed. Removal of the entire ZSG was successful in all specimens following LOA. In one dog, an iatrogenic defect in the oral mucosa occurred during the osteotomy of the zygomatic arch where the oscillating saw was incorrectly angled.

3.2 | Clinical cases

3.2.1 | Case 1

No intra- or postoperative complications were encountered. The dog was discharged two days after surgery with oral amoxicillin clavulanic acid (20 mg/kg, orally, every 12 h) and metronidazole (10 mg/kg, orally, every 12 h) for 14 days and meloxicam (0.1 mg/kg, orally, every 24 h) for five days. Histopathological diagnosis was severe neutrophilic and histiocytic sialadenitis. Follow-up examination 14 days after surgery revealed complete resolution of the exophthalmos, conjunctivitis, blepharedema, chemosis, and blepharospasm. The surgical incision healed without complications. The dog was doing well with no signs of recurrence four years after surgery based on owner telephone follow-up.

3.2.2 | Case 2

The next day, the dog was comfortable, ate and was discharged on amoxicillin clavulanic acid (12.5 mg/kg, orally every 12 h) and meloxicam (0.1 mg/kg, orally every 24 h) for five days. Histological diagnoses were a C-cell carcinoma of the thyroid gland and salivary gland carcinoma of the right ZSG with metastasis to the right mandibular lymph node. All surgical incisions healed without complications. The dog was started on chemotherapy with doxorubicin (in combination with promethazine [0.2–0.4 mg/kg IM] and dexamethasone [0.1–0.4 mg/kg IV]) and regular follow-up visits were performed. Eighteen months after the sialoadenectomy, local recurrence in the region of the sphenopalatine fossa was diagnosed during restaging, which prompted euthanasia 25 months postoperatively.

3.2.3 | Case 3

The dog was discharged the same day on carprofen (2 mg/kg, orally, every 12 h) for three days. During a telephone interview 30 days postoperatively, the owner reported that the dog was doing well and had been eating normally since being discharged. The exophthalmos and the mass effect underneath the eye disappeared completely shortly postoperatively.

4 | DISCUSSION

In this study, a novel and less invasive approach for canine zygomatic sialoadenectomy was evaluated in cadaveric specimens and three affected dogs with ZSG disease. The IOA for removal of the ZSG was relatively easy and the visibility was adequate during dissection in most dogs. During LOA a superior surgical overview and exposure of the ZSG was obtained, but this procedure was more invasive and time consuming. Our findings and results suggest several advantages of IOA: reduced surgical time compared to the modified LOA, no preoperative clipping was necessary and less tissue dissection was needed. IOA provided adequate exposure for ZSG while minimizing invasiveness of the approach. Complete extirpation of eight normal glands and near-complete removal of the remaining two ZSGs in cadaveric dogs was achieved. The novel IOA was straight forward with excellent clinical outcome in three affected dogs, without intraoperative or short-term postoperative complications. With this less invasive technique, the postoperative pain is expected to be lower than for LOA.

The authors found that the LOA in the brachycephalic skulls was the most challenging due to the thick zygomatic arch and, therefore, the advantage of the IOA technique was more distinct compared to the mesocephalic- and dolichocephalic skull conformations. However, it was in the brachycephalic dogs, in which there was ZSG tissue remaining in the cadavers via the IOA. For all breeds, once the ZSG was visualized, the removal of the gland was easier with LOA as landmarks such as the orbit of the eye and the infraorbital fat could be better visualized and increased the depth perception with a larger "window of sight". In the cadavers, differentiation between the ZSG and duct and surrounding structures was improved by methylene blue staining.

Sialoadenectomy of macroscopically normal ZSGs via IOA was technically successfully performed in all canine cadavers, except for two dogs in which one ZSG was torn during removal and the other case had remnant tissue left. This might have been due to loss of gland integrity after the defrosting process, as the capsule of the salivary gland is thin and poorly developed, thus being a friable structure.[12]

Compared to LOA, the IOA was a faster procedure and less invasive which reduces the risk of intraoperative and postoperative complications. In this small number of affected dogs, the morbidity of IOA was low; none of them had any complications. The clinical presentation and patient selection are important when choosing the most appropriate surgical approach for ZSG removal. In our study, zygomatic sialoadenectomy was particularly easy in the two dogs affected by non-neoplastic ZSG disease. In the first case, the ZSG was surrounded by the sialocele and, as such, dissection was barely needed whereas in case 3, the CT revealed rostroventral displacement of the affected ZSG, positioning it directly underneath the oral mucosa caudal to the last maxillary molar and thus immediately dorsal to the line of incision. A potential weakness of IOA includes the difficulty to ensure complete gland removal, which would be of paramount importance in case of neoplastic disease. Treatment for salivary gland neoplasia is primarily directed toward aggressive cytoreduction of gross disease, which, in previously reported dogs, was accomplished through complete zygomatic sialoadenectomy.[8,13] The reported median survival time of dogs affected by salivary gland neoplasia is 550 days after surgery combined with adjuvant treatment.[14] In case 2, despite the suspicion of a neoplastic process, the IOA approach was chosen as the tumor was relatively small and in the central to caudal part of the salivary gland tissue. More than one and a half years after removal of the primary tumor and the ipsilateral metastatic mandibular lymph node, a soft tissue mass was appreciated in the sphenopalatine fossa and the ipsilateral parotid lymph node was altered, indicating recurrence and progression of the disease.

Two of the affected dogs did receive postoperative oral antimicrobials, which, in retrospect, might not have been warranted as the oral tissue has excellent healing capacity and is particularly resistant to infection, presumably due to its vast blood supply and the antibacterial properties of saliva.[15,16] The authors therefore no longer recommend the use of postoperative antimicrobials and a short course of nonsteroidal anti-inflammatory drugs (NSAIDs) was adequate in our dogs for pain management postoperatively. The LOA, with an ostectomy of the zygomatic arch, would presumably result in higher postoperative pain scores. Although the oral mucosa undergoes the same steps in the healing process as the skin, it exhibits faster healing with minimal scarring. A human study showed oral mucosal wound healed 100% in 60 hours while the skin wound was less than 50% healed.[17] Without LOA and osteotomies of the zygomatic arch,[7,8] complications such as delayed bone union or osteomyelitis are completely prevented.[18] The IOA had minimal to no cosmetic impact and no Elizabethan collar was needed postoperatively.

Despite the positive outcome in our case series, more dogs are needed to provide more robust data on this novel approach. Nevertheless, zygomatic salivary disease is uncommon, which makes it challenging to recruit a large number of dogs in a timely fashion. As with any new procedure, there is a learning curve for performing a zygomatic sialoadenectomy via IOA. However, with careful blunt dissection, the procedure was relatively straight forward meaning that the learning curve is expected to be steeper than for the LOA. This was also the surgical resident's experience who was naïve to both techniques. Although injection of methylene blue has previously been used to describe parotid sialoadenectomy in cats and dogs,[19] the use of this technique as an objective measure of tissue visualization has not been validated to support its clinical value. However, it was the authors' opinion that it can be specifically useful in dogs with a neoplastic disease occurring for intraoperative visualization in comparison to a contrast sialography but not so useful in dogs with sialoceles due to the accumulation fluid and risk of leakage. Heinz body hemolytic anemia has been reported in cats with the use of methylene blue.[20] However, this is unlikely to happen if small dosages are used locally. Equally, two recent studies using methylene blue for lymph node mapping in 37 dogs reported no side effects.[21,22]

The current study has a few limitations, including the use of cadaveric specimens without ZSG disease. Cadavers cannot emulate in vivo variables such as bleeding, vessel and nerve damage, postoperative tissue swelling, suture reaction and degradation when suturing the muscular tissue and the oral mucosa within the confined space of the oral cavity. Yet, for the three affected dogs, these factors did not cause any issues. The procedure needs to be performed in more affected dogs to assess the number, type and severity of complications that can occur after this procedure. The limited sample size for both the cadaver and the affected dogs in the current study could have resulted in less biologic variation, such as size and conformation, which could affect the time of the surgical procedure as well as the difficulty score. However, this was mitigated by including dogs with different skull conformations and sizes, and we performed both procedures in each dog. Equally, the affected dogs consisted of both mesocephalic and brachycephalic breeds. All cadaveric surgeries were performed by a single surgical resident and the difficulty scores were subjectively evaluated, which could introduce bias. An additional disadvantage is that the small number of affected dogs did not allow us to draw a firm conclusion regarding the benefit of this technique. A randomized prospective study comparing different procedures would aid to determine which dogs might benefit from which approach. Comparison between IOA and the ventral non-ostectomy approach described by Dörner and colleagues would be interesting to further understand whether one is better or if they can complement each other.

To conclude, IOA is an appealing alternative to the more invasive LOA, in particular in dogs affected by zygomatic sialoceles. The indications for dogs with a neoplastic disease affecting the ZSG require more individual considerations.

AUTHOR CONTRIBUTIONS

Viitanen J, DVM, MRCVS: Contributed to the design of the study; performing the ex-vivo study, acquisition, analysis and interpretation of the data; drafting of the manuscript; and final approval to the manuscript. de Rooster H, DVM, MVM, PhD, Dip ECVS: Contributed to the design of the study; analysis and interpretation of the data; drafting of the manuscript; and final approval to the manuscript. Kitshoff AM, BVSc (Hons), MSc, Dip ECVS: Contributed to the design of the study; analysis and interpretation of the data; drafting of the manuscript; and final approval to the manuscript. Arzi B, DVM, Dip AVDC, Dip EVDC: Contributed to with; acquisition and interpretation of the data; drafting of the manuscript; and final approval to the manuscript. Devriendt N, DVM, PhD, Dip ECVS: Contributed to the design of the study; acquisition, analysis and interpretation of the data; drafting of the manuscript; and final approval to the manuscript.

CONFLICT OF INTEREST

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

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