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# Comparison of three surgical approaches for zygomatic sialoadenectomy in canine cadavers

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**Abstract**

**Objective:** To compare three surgical approaches for excision of the zygomatic gland in dogs.

**Study design:** Cadaveric study.

**Animals:** Cadavers of mesocephalic dogs (n = 20).

**Methods:** Each skull was assigned to a lateral approach with zygomatic arch ostectomy on the left (n = 20) and one approach without ostectomy on the right, ventral (n = 10) or dorsal (n = 10) to the zygomatic arch. Approaches were evaluated for surgical exposure (rated on a scale of 1-5 with one optimal exposure), tissue trauma, and completeness of gland removal. Glands from each side were weighed to compare as internal control.

**Results:** The ostectomy-based approach offered excellent surgical view and good exposure of the zygomatic gland but caused more tissue trauma. The dorsal nonostectomy approach did not allow complete zygomatic gland extraction in nine of the 10 dogs, whereas the ventral nonostectomy approach enabled complete extraction in all 10 dogs.

**Conclusion:** The ventral zygomatic approach allowed complete removal of the zygomatic gland, with good surgical overview, while reducing tissue trauma and preserving the zygomatic arch.

**Clinical significance:** The ventral nonostectomy approach should be considered as an alternative to excise the zygomatic gland in dogs.

## 1 | INTRODUCTION

Salivary gland diseases in dogs are rare and include sialadenitis, malignant neoplasia, and sialocele. Researchers in one study[1] that reviewed and categorized 160 canine salivary gland specimens that had undergone histological examination found that the most frequent pathologic findings were sialadenitis (28%), malignant neoplasia (26%), or sialocele (11%); 18% of the investigated glands had normal glandular tissue, 6% had salivary gland infarction, and 11% of the specimens had various degenerative or fibrotic lesions, ductal ectasia, sialolithiasis, edema, benign neoplasia, and secondary salivary involvement with systemic or cervical lymphosarcoma.[1] Most canine salivary gland tumors are malignant, with the most common type being adenocarcinoma.[2]

Among all salivary glands, the zygomatic gland is the least frequently involved in glandular diseases.[1] Because

of its ventral location within the orbit, the clinical signs of zygomatic gland disease vary but can include exophthalmia, protrusion of the nictitating membrane, orbital swelling, chemosis, and occasional pain when the mouth is opened or when hypersalivation occurs.[3-6] The affected dogs may also exhibit papilledema and globe deformation, with or without associated blindness.[4] The underlying cause of the glandular disease is mostly determined with cytological or histopathological examinations.[4,6,7-9] Removal of the zygomatic gland is the treatment of choice in most conditions.

Several surgical approaches to the zygomatic gland have been described in the literature.[10-14]

All techniques involve a lateral approach and ostectomy of the zygomatic arch to gain better lateral orbital exposure and to facilitate gland dissection. Despite the several modifications of this technique that have been described in recent decades,[10-18] surgery can be time consuming and invasive because ostectomy of the zygomatic arch is required. Transconjunctival and transpalpebral approaches to the zygomatic gland directly through the eyelid have also been described, but they are infrequently performed because of the limited surgical exposure and the inability to access or extirpate large masses.[14,16,18,19] Thus, a modified approach that would enable full exploration and removal of the zygomatic gland without ostectomy of the zygomatic arch would be of interest.

The objective of this study was to compare the suitability of three approaches for complete removal of the zygomatic gland by using the heads of 20 dog cadavers. The hypothesis was that elevation of the zygomatic arch would not be required to achieve complete excision of the zygomatic gland in normal cadavers.

## 2 | MATERIALS AND METHODS

### 2.1 | Materials

Skulls were harvested from client-owned dogs that had been euthanized for reasons unrelated to this study. The owners signed a consent form for permission to use the cadavers for teaching or research purposes when the animals were admitted to the hospital. Twenty cadavers of mesocephalic dogs with body weights ranging from 15 to 35 kg (mean, 24.8 ± 6.2) that had been euthanized because of disorders not related to the skull and deep-frozen immediately after euthanasia were included.

Only intact heads without obvious signs of illness or injury were included. The heads were thawed 1 day before the surgery. The lateral approach with ostectomy of the zygomatic arch as described by Bartoe et al[17] was selected as the control approach and performed on the left head side in all 20 cadavers. For comparison, two approaches without ostectomy were performed on the contralateral side (Figure 1). A ventral approach (incision at the ventral border of the zygomatic arch) was performed in dogs 1 through 10, and a dorsal approach (incision at the dorsal border of the zygomatic arch) was employed in dogs 11 through 20. The same surgeon (J.D.), who was experienced in head and neck surgery, performed all operations and conducted the grading of tissue trauma and surgical exposure.

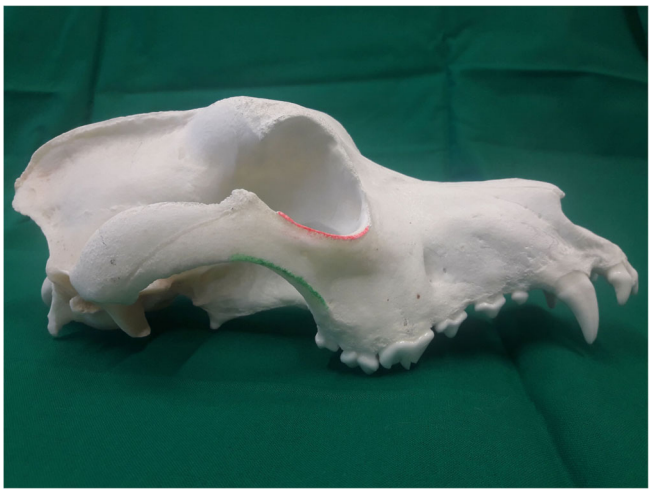

**FIGURE 1** Lateral view of a dog's skull (without mandible) illustrating position of dorsal (red line) and ventral (green line) approach

### 2.2 | Surgical methods

#### 2.2.1 | Ostectomy approach

In the ostectomy approach, the skin and aponeurosis of the temporalis muscle were incised along the dorsal margin of the zygomatic arch. Care was taken to avoid damaging the superficially running palpebral nerve and dorsal buccal branch of the facial nerve.[17] Both osteotomies were performed with a Liess wire saw (Kramp/Racek/Vienna/Austria); the cranial osteotomy was performed immediately behind the orbital ligament, and the caudal osteotomy was performed at the very distal end of the zygomatic arch. The orbital ligament was not transected. After ostectomy, the arch with the attached masseter muscle was folded ventrally, and the underlying structures, including the zygomatic gland, were exposed. The objective was to remove the entire intact gland after careful dissection. All remaining

glandular tissue was removed when the gland broke during the extraction.

### 2.2.2 | Ventral approach

The ventral approach was performed on the right side of the head in the first 10 dogs. A curved skin incision was made along the ventral border of the zygomatic arch. The masseter muscle had to be carefully severed from the rostral part of the zygomatic arch and flapped ventrally. Careful preparation was continued deeper until the zygomatic gland tissue was reached. After careful dissection, the zygomatic gland could be seen, covered across its surface by a branch of the deep facial vein. The exposed vein was easily secured with a thread loop, a Penrose drain, or anatomic forceps.

Dissection of the gland was performed underneath the vein proceeding in a dorsal direction. The most dorsal part of the zygomatic gland was covered by the arch but could be reached with curved mosquito clamps and dissected underneath the arch. At that point, the gland was only attached at its ventral margin by the excretory ducts, which had to be severed to remove the gland (Figure 2).

### 2.2.3 | Dorsal approach

For the dorsal approach, the first cut was made parallel to the lower eyelid along the dorsal margin of the zygomatic arch (ie, the ventral orbital rim). The very dorsal edge of the zygomatic gland, which was covered only by some subcutaneous tissue and was lying beneath the zygomatic arch, could be grabbed. The gland was held by an artery clamp and had to be prepared carefully under the arch and pulled dorsally. Dissection of the gland was conducted relatively blindly because the main portion of the gland was hidden beneath and medioventral to the zygomatic arch (Figure 3A-D).

For all three procedures, all parts of each removed gland were retained and placed on a gauze for weighing and further macroscopic comparison with the gland of the contralateral side of the same dog. The surgical overview was rated subjectively (1 to 5), and the amount of

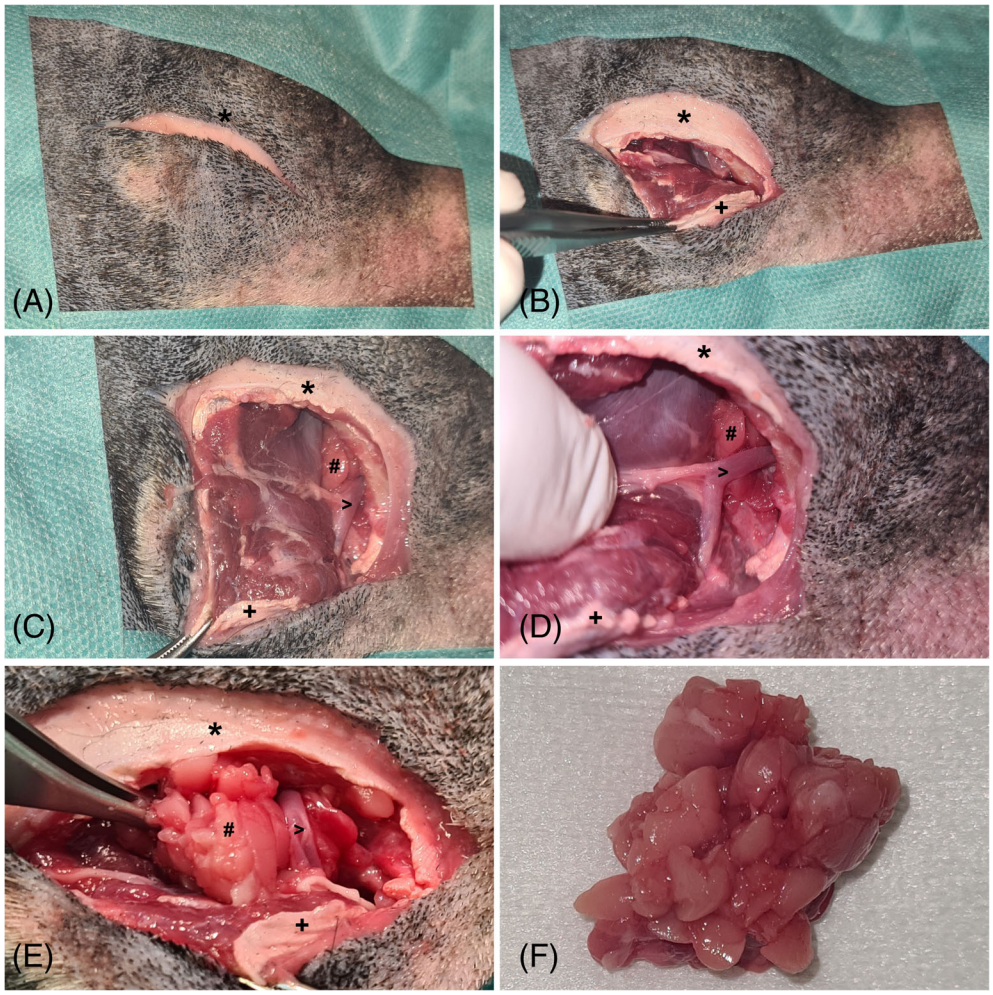


**FIGURE 2** Ventral approach, right side of the head. A, Curved skin incision along the ventral border of the zygomatic arch. B, Severing the aponeurosis of the masseteric muscle from the ventral border of the zygomatic arch and folding the muscle ventrally. C, Additional preparation in the depth; a branch of the deep facial vein is crossing the zygomatic gland. D, Detailed view of situs; the vein can serve as orientation aid and landmark because it is always situated on the surface of the gland. E, Careful dissection and extraction of the zygomatic gland underneath the vein. F, Zygomatic gland, completely extracted. *, zygomatic arch; +, aponeurosis of masseteric muscle; #, zygomatic gland; >, branch of the deep facial vein

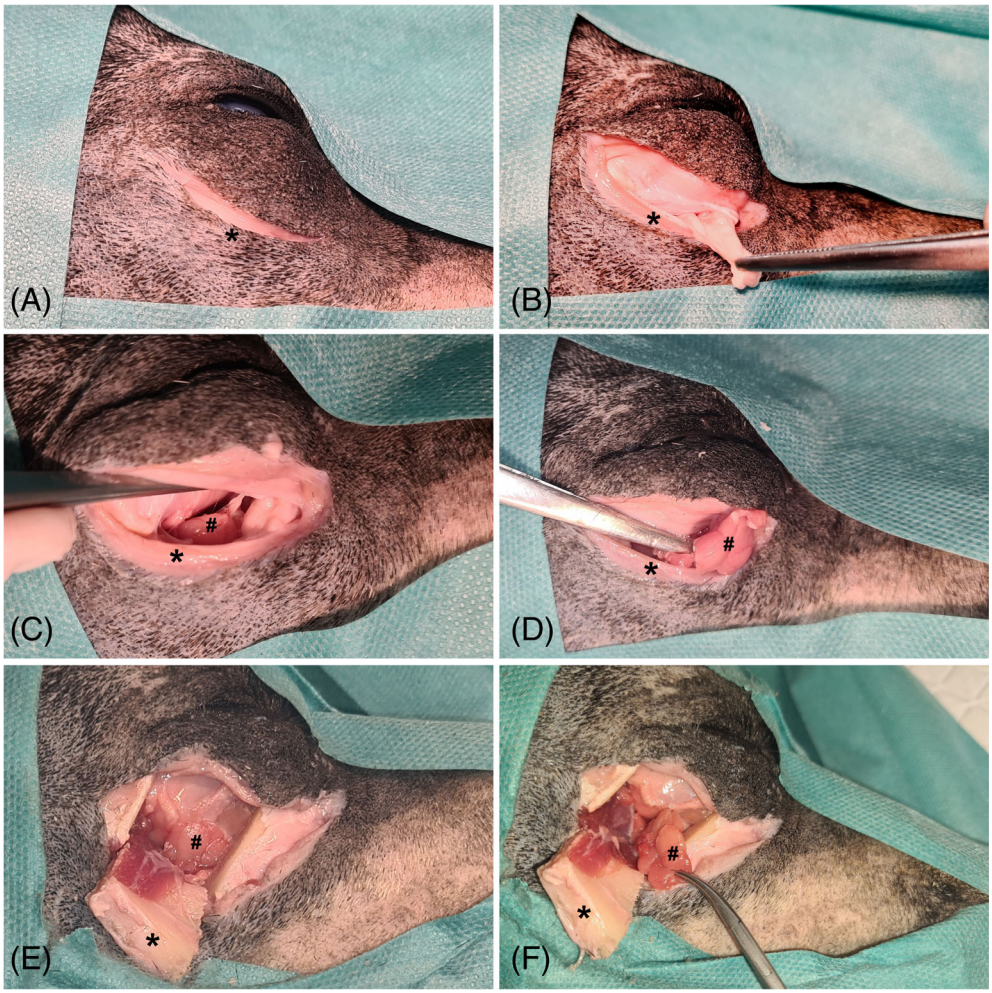


**FIGURE 3** Dorsal approach, right side of the head. A, Curved skin incision along the dorsal border of the zygomatic arch. B, Removing some subcutaneous fat to gain more exposure. C, The very tip of the gland can be seen under the dorsal border of the zygomatic arch. D, Careful dissection and extraction of the zygomatic gland under the zygomatic arch. E, After gland extraction, a part of the zygomatic arch was cut with a saw and folded ventrally to achieve better surgical exposure. The gland remnants, which were hidden under the zygomatic arch and could not be removed via primary extraction, can now be seen. F, Complete extraction of the zygomatic gland remnants after osteotomy. *, zygomatic arch; #, zygomatic gland

tissue trauma was noted. After extraction of the zygomatic gland without ostectomy on the right side of all 20 dogs, the zygomatic arch was then removed to achieve better surgical exposure, and dissection was performed to identify remnants of the zygomatic gland. If any remnants were found, they were also resected and weighed (Figure 3E,F). The weight of the gland remnants was added to the weight of the gland that had previously been removed from the same side.

## 2.3 | Evaluation of the outcomes

The ability to remove the gland completely, surgical exposure, and subjective amount of tissue trauma were evaluated and compared to the corresponding findings for the control side. After removal, the glands were inspected to assess their size and integrity and were weighed with a kitchen scale (with an accuracy of 0.5 g). After gland removal in the nonostectomy approach, the zygomatic arch was finally removed, and the surgical site was inspected for remnant glandular tissue. Gland remnants, when present, were also removed and weighed. The surgical exposure was subjectively evaluated on a scale from 1 to 5, with 1 indicating a perfect unrestricted view and sufficient space for an easy dissection and 5 indicating an insufficient view with the predominant part of the gland hidden by the zygomatic arch and dissection conducted blindly beneath the arch. Finally, the amount of tissue trauma was graded as "minimal" when cutting only through the skin; "moderate" when cutting through the skin and severing muscle from its bony attachment; and "maximal" when cutting through skin, muscle, and bone. Surgical exposure and tissue trauma were graded by a primary (ie, the surgeon [J.D.]) and a secondary (S.O.) investigator.

# 3 | RESULTS

The weight of the zygomatic glands, harvested from 20 mesocephalic dog cadavers, ranged from 3 to 6 g (mean, 4.6 ± 1). The size, structure, color, and weight of

the zygomatic gland differed among dogs but not between the two sides of the same dog.

The surgical view was graded as 1 in all cases when the ostectomy approach was performed on the left side, and the gland could be completely removed. However, preservation of gland integrity during the extraction could be accomplished in only eight cases (40%) because of the fragile consistency of the gland after the defrosting process. No remnants could be found in the orbit. The amount of tissue trauma was rated as maximal according to our scoring system because skin, muscle, and bone had to be cut in all dogs in which the ostectomy approach was performed.

The surgical view was diminished compared to the ostectomy approach on the contralateral side when the ventral approach was performed because the zygomatic arch partially covers the dorsal part of the gland. The surgical overview was graded as 2 in seven of 10 (70%) dogs and as 3 in three (30%) dogs. However, even when the arch constituted a barrier during dissection, the dorsal edge of the gland could be caught by using a curved mosquito clamp, and the gland could be carefully pulled out. The zygomatic gland was completely excised in all 10 cases (100%). In comparison to the gland extracted with the ostectomy approach, glands did not differ between weight and size. No gland remnants were found when the subsequent arch ostectomy was performed, providing evidence to confirming complete gland removal without ostectomy. The amount of tissue trauma was graded as moderate in all 10 dogs because the zygomatic arch remained intact, and only the masseter muscle had to be severed from the ventral border of the zygomatic arch.

In the dorsal approach, the surgical view was graded between 3 and 5; grade 3 in one (10%), grade 4 in five (50%), and grade 5 in four (40%) dogs. Dissecting the gland dorsally was difficult because most of the gland was covered by the zygomatic arch. The space for dissection was very narrow, and dissection had to be conducted blindly beneath the arch. The remaining gland could not be reached from dorsal after the greatest part of the gland was extracted.

Gland remnants were found in nine of 10 dogs when ostectomy was performed to inspect the surgical excision. The gland remnants were removed, weighed, and found to represent approximately one-third of the gland. Complete excision of the gland via the dorsal approach was not possible in 90% of the cadavers. The amount of tissue trauma in the dorsal approach was rated as minimal in all 10 dogs because only the skin had to be cut, and the muscles as well as the zygomatic arch remained intact.

Comparison of the three approaches revealed that surgical exposure was graded as 1 (20/20) for the ostectomy approach, as 2 (7/10) and 3 (3/10) for the ventral approach, and as 3 (1/10), 4 (5/10), and 5 (4/10) for the dorsal approach. Complete gland removal was possible in all ostectomy (20/20) and ventral (10/10) approach cases but in only one dorsal approach case.

No difference was noted between the ostectomy and ventral approaches in removing the entire gland. The gland was removed in toto in all attempts, unlike with the dorsal approach in which removal of the whole gland was successful in only one of 10 (10%) cases. The ostectomy approach offered the greatest surgical-view extent. Temporary elevation of a large portion of the zygomatic arch established a fairly large surgical field in which the zygomatic gland could be seen, dissected, and removed in a straightforward manner.

The surgical overview was subjectively better with the ventral approach, although the zygomatic arch remained intact with the ventral and dorsal approaches. Greater portions of the zygomatic gland were visible from the ventral approach, and dissection was still possible and successful. The surgical overview with the dorsal approach was rated between 3 and 5 because of difficulties in dissection that resulted in poor removal success.

With regard to tissue trauma, the dorsal approach was least invasive because only the skin had to be incised, and the bone (zygomatic arch) and the muscles (temporal/masseteric aponeurosis) remained intact. The ostectomy approach was the most invasive with maximal tissue trauma (skin, muscle, and bone), while the ventral approach had moderate tissue trauma (skin and muscle).

## 4 | DISCUSSION

The objective of this study was to describe two alternative and less invasive approaches for canine zygomatic gland removal and to compare these to the commonly used lateral approach with ostectomy. Our results provided evidence to confirm the hypothesis that an ostectomy-free approach to the zygomatic gland could also allow complete gland removal. Indeed, the ventral approach was found to allow sufficient surgical exposure and room for dissection for complete removal of the zygomatic gland without ostectomy of the zygomatic arch.

In our study, the lateral approach with ostectomy of the zygomatic arch, as described by Bartoe et al,[17] was performed as a standard procedure in all 20 cadavers on one side of the head, whereas the two alternative non-ostectomy methods were performed on the contralateral side in 10 dogs each. The removal accuracy was evaluated through comparison between the left and right sides. The sizes and integrity of the glands on the left and right sides were compared macroscopically,

and the glands were weighed. Because these methods were not sufficiently accurate, complete extirpation of the gland was confirmed after ostectomy of the ipsilateral zygomatic arch.

The next objective of the study was evaluation of the surgical exposure and the amount of tissue trauma. Specifically, we sought to evaluate whether the advantages of reducing tissue trauma with the two nonostectomy approaches outweighed the disadvantages of reduced surgical overview and lower space for dissection. Sufficient space for careful dissection was available in 100% of the attempts when the ventral approach was performed, although the zygomatic arch covered the dorsal portion of the zygomatic gland.

We expect that surgical duration would be longer with ostectomy and subsequent osteosynthesis, although we did not evaluate the surgical time in this study. A shorter surgery time reduces the risk of intraoperative and postoperative complications and infections. We also reasonably assume that longer and more profound postoperative pain management will be required after arch ostectomy. Without ostectomy, however, it is obvious that complications such as delayed bone union or osteomyelitis can be completely avoided.

A comparison of the ostectomy and dorsal approaches yielded significantly different results. While excision of the gland after ostectomy of the arch was 100% successful, in toto removal could be achieved in only 10% of dorsal attempts. The advantage did not outweigh the inefficient surgical overview, although tissue trauma was minimal (only cutting through the skin without impairing bone or muscles), which finally impeded the in toto excision of the zygomatic gland in 90% of cases. Here, approximately one-third of the gland could not be extracted by performing this approach in nine of 10 dogs. The ventromedial part of the gland remained in the surgical site and could be found only after arch ostectomy. These findings cannot be completely extrapolated to live dogs because living glandular tissue may not tear apart so easily. In one clinical case study, a dorsal approach enabled successful treatment of a zygomatic mucocele and necrotizing zygomatic sialadenitis.[19]

The remarkable difference in outcomes between the two nonostectomy approaches can be explained by the topographic location of the gland relative to the zygomatic arch at different horizontal levels. Approaching the gland from the ventral side of the zygomatic arch requires detachment of the masseter muscle from the ventral border of the arch but allows excellent visualization of the gland because only the dorsal third of the gland is covered by the zygomatic arch at this level of the skull. Thus, it was possible to properly dissect and extract the gland, although surgical exposure was somewhat impeded in the dorsal part of the operation field. In comparison, most of the gland is located beneath the arch and is therefore not easily accessible when the dorsal approach is performed. Approaching the gland from the dorsal side of the arch meant that only the very dorsal tip of the gland could be seen, and the remaining dissection down to the ventral end of the gland had to be conducted relatively blindly. While tissue trauma with this approach is considered minimal (only skin incision; no muscle or bone impairment is required), surgical exposure is also minimal, and the space for dissection is extremely narrow. As a result, uncontrolled damage to local vessels, such as the branches of the deep facial vein, and bleeding could subsequently occur.

In all three techniques, the tissue of the zygomatic gland was occasionally fragile and broke while extracting the gland. Gland fragility could be secondary to the freezing and thawing process because this is not commonly reported in live dogs. However, this does not negate the potential benefits of the ventral approach, which does not require performing zygomatic arch ostectomy.

In this study, all dogs belonged to mesocephalic breeds. The impact of dolichocephalic and brachycephalic skull confirmations and subsequent positioning of the zygomatic arch relative to the zygomatic gland and branches of the facial nerve, deep facial vein, and maxillary vein is unknown. Additional investigation on the impact of head conformation is required.

This study had several limitations. Perioperative variables, such as duration of anesthesia or bleeding, could not be evaluated because of the study's postmortem nature. Likewise, postoperative variables such as pain, postoperative swelling, hospital stay, time of recovery, and complications were not evaluated. Because alternating approaches between left and right were not considered in the study design, we could not evaluate the possible impact of laterality and handedness of the surgeon on the results relative to trauma and/or resection completeness. Finally, a major limitation was that all surgical approaches were performed in nondiseased and nonenlarged zygomatic glands. The extractability of an inflamed or neoplastic zygomatic gland with the ventral approach remains unknown.

The ostectomy approach offers excellent surgical overview and good exposure of the zygomatic gland, but it is the most invasive. With the dorsal approach, extraction of the entire gland was not possible in nine of 10 dogs; the most medioventral part remained within the cavity and could be excised only after zygomatic arch resection. Instead, the ventral approach could offer a true alternative for extraction of the zygomatic gland without the requirement for zygomatic arch ostectomy. The ventral approach offered sufficient zygomatic gland exposure

and room for dissection, allowing complete extraction of the gland in all examined dogs. Additional prospective clinical studies in dogs with zygomatic salivary gland disease and of varying skull types (dolichocephalic and brachycephalic) are required to confirm these preliminary cadaveric results.

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## AUTHOR CONTRIBUTIONS

J.D.: Conception of work, participation in study design, data collection and interpretation, performed surgeries, acted as investigator, drafting manuscript, manuscript composition, contributed to writing of manuscript, accountable for all aspects of the work, revision und final approval of the submitted manuscript. S.O.: Data collection and interpretation, cadaver organisation, acted as investigator, drafting manuscript, contributed to writing of manuscript, final approval of submitted manuscript. G. D.: Development of research question, conceptualization and design of study, methodology, supervision and counseling of the work, administration and accountable for all aspects of the work, revision und final approval of the submitted manuscript.

## CONFLICT OF INTEREST

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

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