T-shape versus circular shape: a retrospective evaluation of intraoperative and postoperative complications in a cohort of 142 dogs undergoing TECA-LBO for end-stage otitis

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OBJECTIVES: To report the impact of the surgical approach (T-shaped or circular incision) on intraoperative and postoperative complications associated with total ear canal ablation and lateral bulla osteotomy.

METHODS: Medical records of dogs that underwent total ear canal ablation and lateral bulla osteotomy with T-shaped or circular incisions between at 10 referral hospitals were retrospectively reviewed. Intraoperative and postoperative complications and follow-up were analyzed and compared between groups using Fisher's exact test for categorical data and the Mann-Whitney rank-sum test for numerical data, with $P<0.05$ considered significant.

RESULTS: One-hundred and forty-two dogs were included, totaling 156 surgeries: 84 were performed via circular incision (O-group), and 72 with a T-shaped incision (T-group). The groups were similar for sex (P=0.182) and bodyweight (P=0.836) distribution; the T-group was older at the time of surgery (P=0.019).

Intraoperative bleeding occurred in 13/156 (8%) dogs (11 O-group [7%], 2 T-group [1%]) more frequently in the O-group (P=0.03).

Postoperative complication rate was 38.6% (n=60): wound complications occurred in 31/156 (20%) dogs (8 O-group [5%], 23 T-group [15%]) more frequent in the T-group (P=<0.001); postoperative facial nerve neuropathy occurred in 31/156 (20%) dogs (22 O-group [14.1%], 9 T-group [5.8%]) associated with the O-group (P=0.045).

CLINICAL SIGNIFICANCE: Surgical preference may guide the choice between performing a T-shaped or circular incision during TECA-LBO. Circular incisions were associated with a higher incidence of intraoperative haemorrhage and postoperative facial nerve neuropathy, while T-shaped incisions may increase the risk of wound complications. Most complications in both groups were minor or self-limiting.

INTRODUCTION

The combination of total ear canal ablation (TECA) with lateral bulla osteotomy (LBO) currently represents the most effective treatment option for patients suffering end-stage ear disease unresponsive to medical management (Sharp, 1990). The presence of proliferative epithelial hyperplasia secondary to chronic inflammation is reported to be the primary indication for surgery in 59% to 85% of the patients (Sharp, 1990). Other indications for TECA-LBO include congenital anomalies, proliferative growths, aural tympanokeratoma, severe facial or aural trauma, neoplasia and para-aural abscessation (Saridomichelakis *et al.*, 2007).

Several complications have been reported in veterinary literature such as haemorrhage, nerve injuries, wound breakdown, chronic abscessation and fistulation, necrosis of the pinna, cosmetical alteration, and infection (Smeak, 2011; Coleman *et al.*, 2016).

Neurological signs associated with TECA-LBO include Horner's syndrome, vestibular signs and facial nerve paresis or paralysis. Of these, facial nerve neuropathy was most frequently encountered complication in dogs, with reports ranging from 13 to 48.9%, though it was rarely permanent and infrequently required intensive medical intervention (Seward 1958; Smeak, 2011; Spivack *et al.*, 2013).

The surgical technique was originally described with a T-shaped incision, which outlines the external meatus and projects the incision over the vertical ear canal, immediately ventral to the tragus, allowing further access to the horizontal portion of the ear canal and osseous auditory meatus (Beckman *et al.*, 1990; Smeak, 2011), however, many surgeons applied a modification of the technique consisting of a single circular incision outlining the auditory meatus, resulting in a smaller approach (Smeak 2012).

In dogs with erect ears and in cats, the loss of cartilage support at the base of the pinna can lead to cosmetic alterations, such as the ear failing to stand. To mitigate the risk of developing a floppy-ear appearance, other techniques were developed, such as the use of a single pedicle advancement flap and an inverted U-V shaped incision have been proposed. These approaches help preserve the structural integrity of the pinna and reduce the likelihood of ear collapse (Venker-van Haagen, 1983; McNabb *et al.*, 2004).

Although the topic is frequently discussed among surgeons, there is a lack of evidence supporting a difference in complication rate or outcomes based on the surgical approach for TECA-LBO. A search was conducted on June 15, 2024, using the keywords “TECA-LBO”, ”dog ear surgery”, ”surgical approach TECA”, “complication rate TECA”, across Google Scholar and PubMed databases; no studies were identified that had compared the impact of incision shape on surgical complications.

A limited operating window with consequent poor visualisation was believed to be one of the leading causes associated with iatrogenic damage of the major neuro-vascular structures (Smeak *et al.*, 1986; Smeak, 2011).

The aim of this study was to evaluate whether performing a circular or a T-shaped incision would affect the incidence of intraoperative and postoperative complications associated with total ear canal ablation. These authors hypothesised that there was no difference in intraoperative or postoperative complications and outcome between the two types of incision.

MATERIALS AND METHOD

Study design and inclusion criteria

Medical records from 10 referral centres were retrospectively reviewed to identify canine patients who underwent total ear canal ablation (TECA) and lateral bulla osteotomy (LBO) for end-stage otitis between March 2006 and February 2023.

Keyword used

Keywords used to retrieve cases were “Total ear canal ablation and lateral bulla osteotomy”, “TECA-LBO”, “end-stage otitis” and “ear surgery.” If the search function was not available in the medical record system, the investigator’s case log was searched instead.

Data extraction

Data collected included signalment (breed, gender, age, body weight), clinical presentation, diagnostic technique (computed tomography [CT], otoscopy, magnetic resonance image [MRI]), surgical technique, use of surgical drains, intraoperative and postoperative complications, culture and sensitivity results, histopathology reports and length of hospitalization. The surgical records were examined for each dog. Bilateral staged procedures were classified as such if the diagnosis of bilateral disease occurred at the time of presentation, but left and right TECA-LBOs were performed separately within any time frame.

Intraoperative complications were defined as complications occurring between skin incision and closure and recorded in the medical records at the time of surgery.

Short term follow-up was estimated < 30 days, medium term was between 30 days and one year, whilst long term follow-up was considered > one year. Follow-up was obtained by evaluating the medical records.

Postoperative complications were classified according to the Clavien-Dindo grading system: grade 1 included any deviation from a standard postoperative recovery that resolved with conservative measures or medical management, such as anti-inflammatory therapy. Grade 2 comprised complications requiring prolonged pharmacological treatment or blood transfusion. Grade 3 included complications necessitating surgical intervention or those with persistent clinical signs at long-term follow-up (>1 year). Grades 4 and 5 describe complications that lead to life-threatening complications and death of the patient respectively (Clavien *et al.,* 2009). Onset, duration, and severity of the complications were retrospectively extracted from the medical records.

Prophylactic antibiotic therapy was selected independently in each centre and retrieved from the medical records.

Surgical technique

TECA-LBO procedures were performed according to previously described techniques (Smeak, 1986; Beckman et al., 1990; Smeak, 2011; Smeak, 2012). In short, in the O-group, a circular incision through skin and cartilage was made over the external acoustic meatus, extending from just ventral to the tragus to the antihelix, cranially to the lateral crus of the helix, and caudally to the medial process of the antitragus (Figure 1). In the T-group, this circular skin incision was combined with a vertical extension beginning at the level of the tragus and extending ventrally over the vertical ear canal (Figure 2).

In both groups, blunt dissection of the subcutaneous tissue and auricular muscles exposed the vertical ear canal, enabling careful dissection of peri-cartilaginous tissue along the horizontal canal to the rim of the bony external auditory meatus. (Smeak, 1986; Beckman *et al.*, 1990). Following amputation of the ear canal, a lateral bulla osteotomy was performed in all dogs with the aid of rongeurs or high-speed burr (Mehrkens *et al.*, 2021; Smeak, 2012), and a sample was then acquired for culture and sensitivity test from the bulla following curettage and lavage with sterile saline.

Inclusion and exclusion criteria

Dogs were included in the study if they underwent TECA-LBO surgery for the treatment of end-stage otitis media/externa. Bilateral single session TECA- LBO was classified as such if the two stages of the procedure were performed under the same anaesthetic event; these dogs were excluded from the study.

Dogs that underwent TECA-LBO with a comprehensive clinical record with an available description of the surgical approach and a follow-up period of at least 14 days were included in the study. The selected cases were divided into two groups according to the shape of the incision: T-group (T- shaped skin incision) and O-group (circular skin incision). Dogs were excluded from the study if the leading reason for performing TECA-LBO was a revision surgery, a diagnosis of para-aural abscess or if the histopathological diagnosis was consistent with neoplastic disease. Dogs with preoperative clinical signs of facial nerve neuropathy, preoperative vestibular signs, with incomplete medical record or missing surgical report were excluded.

Data reporting and statistic

Using the above-mentioned criteria, data were recorded using a spreadsheet (Microsoft Excel 365, Microsoft Corporation, Redmond, WA).

Descriptive statistics were calculated between the O-group and the T-group in the period between surgery and the latest available follow-up (Microsoft Excel 365). All variables were tested to identify the association between the two groups and intraoperative and postoperative complications.

Intraoperative complications included in this study for evaluation were restricted to iatrogenic damage to the facial nerve and inner ear, and inadvertent laceration of the maxillary artery and vein, retroglenoid vein, internal and external carotid arteries. Postoperative complications included the development of facial nerve neuropathy, vestibular signs, wound complications, cosmetic alterations, pinna necrosis and para-aural abscess.

Categorical data were summarised as frequencies and percentages; significant associations were analysed using the exact Fisher test. Numerical variables were summarised with the median (and IQR); comparisons between two groups were performed with the Mann-Whitney rank-sum test for independent samples. All the analyses were performed using the open-source software R (R Studio), and a P value of less than 0.05 was considered statistically significant.

RESULTS

Study population

Clinical records of 310 client owned dogs were retrospectively reviewed. A total of 154 dogs were excluded for the following reasons: 35 due to a diagnosis of neoplasia, 27 because of incomplete medical records, 73 underwent a single-stage bilateral procedure, and 19 presented with preoperative facial nerve paralysis.

One-hundred and forty-two dogs met the inclusion criteria. Of these, 128 underwent unilateral TECA-LBO and 14 dogs underwent staged bilateral procedures. Each surgery was statistically evaluated singularly, accounting for a total of 156 TECA-LBO procedures (O-group 84/156; T-group 72/156).

Crossbreed dogs represented 15% (n=23) of the whole population, whilst French bulldog was the most represented brachycephalic breed 11% (n=17). The remainder of the breeds represented in the study were grouped in table 1.

A total of 26 dogs (17%), with even distribution between the two groups, were classified as extreme brachycephalic breeds according to the criteria previously established in other studies (O'Neill *et al.*, 2015; Banks *et al.*, 2023).

The population of this study included 98/156 (63%) male (51intact [33%] and 47 neutered [30%]) and 58/156 (37%) female dogs (17 intact [11%] and 41 neutered [26%]). Mean body weight was 22.5 kg (range 6-73). There was no difference in distribution between the two groups regarding sex (P=0.182) or body weight (P=0.836); the mean age at presentation varied between the two groups, with dogs in the T-group undergoing surgery at an older mean age of 7.9 years (range 2-16) compared to 6.4 years (range 1-13) in the O-group (P=0.019).

Short-term follow-up (median 18 days, range 14–30 days) was available for 142/156 (91%) dogs; medium-term follow-up (median 120 days, range 30–365 days) was available for 66/156 (42%) dogs, and long-term follow-up (median 812 days, range 367–2396 days) was available for 69/156 (44%) dogs. There was no significant difference in follow-up duration between the two groups.

Preoperative clinical findings

An ECVS diplomate was the primary surgeon in 99/156 (63.5%) cases (O-group [67/156, 43%]; T-group [32/156, 20%]), being overrepresented in the O-group (P=<0.001), while in 57/156 (36.5%) cases surgery was performed by surgical residents under direct supervision of an ECVS diplomate (O-group [17/156, 11%]; T-group [40/156, 26%]).

Eight/156 dogs (5%) presented with inability to fully open the mouth with no difference in distribution between the two groups (P=0.75).

Computed tomographic study was performed in a total of 102/142 (72%) dogs to investigate the clinical signs and paired with otoscopic evaluation in 28/142 (20%) and with MRI in one (0.7%) dog. Magnetic resonance imaging was performed in 17/142 (12%) dogs and completed with otoscopy in one (0.7%) dog.

Surgery was performed in 37/142 (26%) dogs following the sole otoscopic evaluation of the ear canal in cases of severe stenosis of the ear canal.

Surgery was performed in 37/142 (26%) dogs based solely on otoscopic evaluation, in cases where chronic disease and severe ear canal stenosis were present.

The most common findings on CT scans included varying degrees of ear canal stenosis, dystrophic mineralization of the ear canal, and erosive changes in the bulla, with evidence

of middle ear disease on the contralateral ear. On MRI, the most frequently observed findings were middle ear effusion and otitis interna.

Eighteen/156 dogs (11.5%) were previously diagnosed with skin disease of different aetiology. Four/156 cases (2.5%) were affected by a medically controlled endocrinopathy (diabetes [n=1], Cushing's syndrome [n=1], and hypothyroidism [n=2]).

Intraoperative findings

Of the 156 procedures, 84 (54%) were performed with a circular incision (O-group), and 72 (46%) with a T-shape incision.

One-hundred and twenty-eight dogs/156 (82%) underwent unilateral TECA-LBO (O-group [80/156, 51%]; T-group [62/156, 40%]). The remainder 14/156 (9%) dogs (O-group [4/156, 2.5%]; T-group [10/156, 6.5%]) underwent staged bilateral procedures. Surgery was performed on the right ear in 69/156 (44%) patients, and on the left ear in 87/156 (56%) dogs with no difference in distribution within the groups.

Each anaesthetic protocol was independently tailored by the anaesthetist in charge of the single case. Mean anaesthetic time was 168 minutes (range 90-320) (O-group 158 minutes [range 90-300 minutes]; T-group 191 minutes [range 95-320 minutes]), with the T-group associated with a longer anaesthetic time (P= 0.007).

Prophylactic antibiosis was performed with cefuroxime in 95/156 (60.9%) dogs (O-group [66/156, 42.3%]; T-group [29/156, 18.6%]), cefazolin in 45/156 (28.8%) dogs (O-group [18/156, 11.5%]; T-group [27/156, 17.3%]), and potentiated amoxicillin in 16/156 (10.2%) dogs (O-group [3/156, 1.9%]; T-group [13/156, 8.3%]).

Surgical time was 89 minutes (range 35-200) (O-group 79 minutes [range 35-175 minutes]; T-group 108 minutes [range 60-200 minutes]), where a longer surgical time was recorded in the T-group (P=<0.001).

Intraoperative complications occurred in 17/156 (11%) dogs, with a positive association with the circular incision (P=0.04).

The facial nerve was accidentally transected during the procedure in four/156 (2.5%) dogs, two (1%) in the O-group, and two (1.3%) in the T-group. This finding was not statistically significant (P=0.63).

Intraoperative bleeding occurred in 13/156 (8%) dogs, of which 11 (7%) in the O-group, and two (1%) in the T-group, with a statistically significant association observed between the circular shape and the occurrence of intraoperative blood vessel damage (P=0.03).

Most of the hemorrhages encountered in surgery 11/156 (7%) (O-group [9/156, 6%]; T-group [two/156, 1%]) were considered grade 1 complications whilst two/156 (1.3%) dogs, both belonging to the O-group, required blood transfusion and therefore considered grade 2 complications.

None of the dogs included in the study had surgical drains placed intraoperatively. Intraoperative complications were listed in the table 2.

Postoperative clinical findings and outcome

In the population of this study, 60/156 (38.6%) dogs suffered complications related to surgery, of which 30/156 (19.2%) in the O-group, and 36/156 (23.1%) in the T-group; with a positive association between T-shaped incision and postoperative complications (P=0.016).

Thirty-one/156 (20%) dogs developed facial nerve neuropathy post-operatively, where 22/156 (14.1%) dogs belonged to the O-group, and 9/156 (5.8%) to the T-group, with statistically significant association between the shape of the incision the development of facial nerve neuropathy (P=0.049).

Clinical signs resolved within the short-term follow-up period in the majority of dogs. Persistent clinical signs were documented in seven dogs, with follow-up available as long-term in four cases, and short-term in three cases (median 365 days; range 14–487 days). Five/156 (3.2%) dogs, all from the O-group, developed vestibular signs postoperatively (P=0.054); the clinical signs were recorded as mild consisting of the sole head tilt and resolved at the latest follow-up in all dogs.

Wound complications occurred in 31/156 (20%) dogs, eight/156 (5%) of which belonged to the O-group and 23/156 (15%) to the T-group, with a positive association between the T-shaped incision and the onset of postoperative wound-related complications (P=<0.001). Four/156 (2.6%) dogs (three in the T-group and one in the O-group) developed major wound dehiscence and one/156 (0.6%) dog in the T-group developed pinna necrosis requiring total pinnectomy, these cases were classified as grade 3 complications requiring revision surgery. The remaining complications included grade 1 events in 22/156 dogs (14.1%), consisting of self-limiting conditions such as seroma formation and partial wound dehiscence managed by secondary intention healing, and grade 2 complications in 4/156 dogs (2.6%) that required multiple courses of antibiotics due to persistent infection. Cosmetic alteration of the ear carriage was reported in 10/156 (6.4%) procedures, with four (2.6%) dogs in the O-group, and six (3.9%) in the T-group; with no statistically significant difference between the two groups (P=0.75).

A diagnosis of para-aural abscess was recorded in nine/156 (5.8%) dogs, five/156 (3.2%) in the O-group and four/156 (2.6%) in the T-group, (P=0.61). For these nine dogs, medium and long-term follow-up was available in three and six dogs respectively (median 495; range 150-1825 days).

Postoperative complications in relation to the shape of the incision were listed in the table 3 and 4.

Aftercare

The mean length of hospitalisation was 1.6 days (range 0-4) (O-group mean 1.6 days [range 1-4 days]; T-group mean 1.6 days [range 0-4 days]).

Histopathological evaluation of the ear canal was requested in 103/156 (66%) dogs, confirming the diagnosis of end-stage otitis.

Culture and sensitivity test was performed in 112/156 (72%) of the procedures. Samples harvested prior closure yielded a positive culture in 82/156 (53%) of the cases, whilst 30/156 (19%) samples were found negative for microbiological growth.

Of the positive cultures, 62/156 (40%) isolated a single microorganism, whilst two or more microorganisms were found in 20/156 (13%) of the samples. *Staphylococcus spp* were the most frequently encountered microorganisms accounting for 41/156 (26%) of the positive cultures. The remainder of the isolated microorganisms were *Pseudomonas* 25/156 (16%), *Proteus spp* 13/156 (8%), *Streptococcus spp* 8/156 (5%), *Escherichia coli* 7/156 (4%); the population of microorganisms is detailed in table 5.

Empirical antibiosis was started in 121/156 (77.6%) of the dogs (O-group [71/156, 45.5%]; T-group [50/156, 32%]).

Postoperative antibiotic therapy was changed according to the culture and sensitivity results in 50/156 (9.6%) dogs (O-group [24/156, 15%]; T-group [26/156, 16.6%]) and consisted in the use of a single antibiotic in 19/156 (12.2%) of the cases and in a combination of two antibiotics in 15/156 (9.6%) dogs (O-group [5/156, 3.2%]; T-group [10/156, 6.4%]). In seven/156 (4.5%) (O-group [3/156, 3.8%]; T-group [4/156, 2.5%]) dogs, the cultures showed a profile of antibiotic resistance.

Potentiated amoxicillin was the most prescribed antibiotic where an oral course was started in 49% of the dogs (n= 77/156), followed by cephalexin 26% (n= 41/156), marbofloxacin 17% (n= 26/156), enrofloxacin 2% (n= 3/156), amikacin 2% (n= 3/156), doxycycline 0.6% (n= 1/156).

Antibiotic treatment was prescribed for a mean of 13 days (range 5-37). No statistical difference in infection rate nor length of treatment was found in the two groups.

DISCUSSION

TECA-LBO has been considered a technically challenging procedure, requiring familiarity with the technique and a thorough understanding of the neurovascular structures surrounding the ear canal (Smeak, 1986; Sharp, 1990).

Iatrogenic injury to these structures has been proposed to result from restricted surgical access and limited intraoperative visualisation, and some authors have hypothesised that a T-shaped incision may offer a wider surgical field and improved exposure of the ear canal, thereby reducing the risk of neurovascular injury (Smeak, 2011). However, others authors have suggested that various modifications of the technique can be performed with comparable success rates (Lanz et al., 2004; Smeak, 2012).

Although frequently discussed among surgeons, the shape of the incision and its association with the incidence of surgical complication have not been evaluated yet, with surgeon preference driving the decision making.

In this study we examined the complication rate associated with TECA when comparing two different surgical approaches, a circular versus a T-shaped incision.

Our findings suggest that the shape of the surgical incision may play a role in the development of intraoperative and postoperative complications, with the circular incision more frequently associated with intraoperative vascular injury and postoperative facial nerve neuropathy, while the T-shaped incision may be linked to a higher occurrence of wound-related complications.

According to Smeak, intraoperative bleeding was a rarely reported complication occurring following accidental damage of the retroarticular vein, the external carotid artery, maxillary vein, or the internal carotid artery (Smeak, 2011).

In our population, intraoperative bleeding occurred in 13/156 (8%) dogs, 11 (7%) in the O-group, and two (1%) in the T-group, with a statistically significant association found between the O-group and the incidence of intraoperative bleeding (P=0.03).

These results supported the hypothesis that a more aggressive use of retractor devices may result in the alteration of the normal anatomical landmarks within the surgical field, leading to accidental vascular injury. Notably, all cases of major bleeding that required blood transfusion occurred in the O-group, suggesting that vessel control may have been more challenging in these cases, potentially due to limited exposure or altered tissue handling associated with this incision type, although surgeon experience and anatomical variation may also have contributed.

In our study 31/156 (20%) dogs were affected by facial nerve neuropathy following TECA-LBO, with a statistically significant but marginal association between the circular incision and facial nerve neuropathy (P=0.049).

This finding was in line with the current literature where it was reported between 13 and 48.9% (Spivack *et al.*, 2013; Chan *et al.*, 2020), but despite its frequency, intraoperative factors affecting the incidence of facial nerve damage are yet to be found, and individual surgical technique or patient-specific variables, may play a significant role (Spivack *et al.*, 2013; Chan *et al.*, 2020).

It is possible that a limited surgical approach necessitated more forceful use of retractor devices, which, combined with reduced visualization, may have contributed to iatrogenic facial nerve injury through compression or imprecise tissue handling, likely resulting in neuropraxia, with a transient interruption of nerve function and conduction without reaching complete axonal degeneration.

Spivack et al. (2013) reported that although facial nerve deficits occurred in 48.9% of dogs post-TECA-LBO, only 10.5% of these resulted in permanent clinical signs, with resolution taking up to 13 weeks in some cases; in the same study a minimum follow-up period of one year was used in that study to distinguish temporary from permanent deficits (Spivack *et al.,* 2013).

In our study, facial nerve deficits were still present in seven dogs at the latest follow-up. Long term follow-up suggested that at least four of these cases were likely to be permanent, however, for the remaining three dogs, where only short-term follow-up was available, it is possible that those deficits, although considered persistent at the time, might have resolved with a longer observation period.

Wound complications occurred in 31/156 (20%) of the cases, with a higher incidence recorded in the T-group (P=<0.001), where in five dogs revision surgery was required and these were therefore considered grade 3 complications, with no significant difference in distribution within the groups. The vast majority of wound complications appeared to be minor and were managed either medically or conservatively with no impact on the final outcome.

The authors' hypothesis was that the additional incision and consequent dissection of subcutaneous tissues and muscle required for the T-shaped approach along with the tension at the junction between the horizontal and vertical portions may compromise wound closure and increase the risk of dehiscence, breakdown, or infection, particularly if the skin edges are not perfectly apposed.

In our study, 9/156 (5.8%) dogs developed para-aural abscesses within a median follow-up time of 495 days (range: 150–1825 days), similarly to what was previously described.

The development of para-aural abscess was previously linked to incomplete removal of the epithelial lining following lateral bulla osteotomy, and the clinical signs were reported to develop in a period ranging from 3 to 24 months following TECA-LBO surgery (Holt *et al.*, 1996; Spivack *et al.*, 2013; Smeak, 2016).

For the population of this study, a long-term follow-up beyond one year was available in only 44% of cases, suggesting that para-aural abscesses may have been underreported, therefore, the true incidence of para-aural abscess formation in this cohort of dogs may have been higher than observed, highlighting the importance of extended postoperative monitoring in future studies.

The loss of support following the ablation of the external auditory meatus is a significant concern for owners of dogs with erect ears. In our study, 10 dogs developed an abnormal ear carriage, which appeared to be independent of the incision shape. However, due to the retrospective nature of this study, the severity of the cosmetic alteration in ear carriage could not be determined from the medical records.

Several surgical techniques have been described in the literature to preserve ear carriage in dogs with erect ears, to include the inverted U-V shaped incision, first proposed by Venker-van Haagen in 1983, in which a skin incision is performed from the intertragic incisure to the ventral limit of the vertical ear canal, and from the tragohelicine incisure to the same ventral point. Closure is achieved by folding the caudal part of the pinna forward and performing routine reconstruction resulting in a more rigid base (Venker-van Haagen, 1983). Alternatively, a ventrally based single-pedicle advancement flap has been described in cats to relieve tension and help preserve ear carriage (McNabb et al., 2004).

While these techniques offer alternative approaches to ear canal ablation, a direct comparison with the more commonly employed T-shaped and circular incisions regarding the incidence of complications is not currently possible due to the limited published evidence on this topic.

A positive association between length of anaesthetic time and the incidence of postoperative complications was previously reported by Beal et al in 2000 (Beal *et al.*, 2000).

In the current study, the T-group exhibited longer anaesthetic (P=0.007) and surgical (P=<0.001) times, and this group also included a higher proportion of residents in training. These findings may help explain the marginally higher rate of postoperative complications observed, possibly due to differences in surgical technique, tissue handling, and overall procedural efficiency associated with less experienced surgeons.

Samples for culture and sensitivity testing were acquired following curettage and lavage of the bulla with sterile saline to collect the most representative sample (Beckman *et al.*, 1990). Given the fact that TECA-LBO is considered a contaminated surgical procedure, in most cases empirical antibiotic prophylaxis was started before the results of the bacteriology became available, and the course of antibiotics was then either continued or suspended according to those results.

The authors of the present study restricted case selection on canine patients diagnosed with end-stage otitis as other indication for surgery, such as neoplasia, tympanokeratoma, severe ear trauma, or congenital abnormalities were reported to have a higher incidence of short- and long-term complications (Hardie *et al.*, 2008; Coleman *et al.*, 2016). These

conditions were therefore excluded to provide a more reliable comparison of complication rates specific to the surgical approach.

In the present study, statistical analysis revealed no significant differences between the two groups regarding sex (P=0.182) and bodyweight (P=0.836) distribution; however, it was noted that the T-group exhibited a greater average age when compared to the O-group (P=0.019). Despite this age disparity, we believe that this finding was unlikely to impact the overall conclusions of the study, as the primary outcomes were not influenced by age-related factors.

In most of the dogs in this study (72%), computed tomographic study was the preferred imaging modality to investigate the ear disease; this preference is primarily due to the CT ability to assess bony structures, such as detecting lysis of the tympanic bulla or petrosal temporal bone, which are common findings in conditions like cholesteatoma (Travetti *et al.*, 2010).

While MRI is considered superior to CT for the evaluation of the soft tissue components such as the membranous labyrinth, cerebrospinal fluid, and neural structures, allowing better differentiation between intra- and extracranial causes of cranial nerve deficits (Garosi *et al.*, 2003), it is generally reserved for cases with neurological signs that require more in-depth investigation due to its limited availability, longer anesthetic times, and higher costs (Dvir et al., 2000).

In 26% of dogs, video otoscopy alone was used as the sole imaging modality. In these cases, financial limitations may have influenced the decision to forgo advanced imaging such as CT or MRI. However, this is unlikely to have introduced significant surgical challenges, as the approach for dogs with end-stage otitis remains consistent regardless of imaging modality. While limited imaging may carry a theoretical risk of missing

concurrent pathology such as neoplasia, review of the complete medical records and histopathology findings revealed no cases where this impacted the surgical outcome or postoperative management.

The main limitation of this study remained its multi-institutional retrospective nature; this led to a higher variability in case management and to the inclusion of a larger number of clinicians, with different levels of experience.

Another important limitation of this study is the potential bias in the observed wound complication rate, which may be influenced by the fact that many dogs enrolled had likely received multiple courses of topical and/or systemic antibiotics prior to presentation. These previous treatments could have contributed to the development of multi-drug-resistant organisms or reduced the effectiveness of subsequent antibiotic therapy, thereby potentially impacting clinical outcomes.

The first 14 days were identified by Smeak in 2011 as the period with the highest incidence of postoperative complications, to include incisional complications, seroma formation, cellulitis, and neurological signs, ranging between 8 and 31% (Smeak, 2011).

Although in this study the patient's recovery was monitored for a minimum of 14 days after surgery, and therefore within our study period for all our patients, late-onset complications and recurrence might have potentially not been captured.

This represents a limitation of the study, as it may underestimate the full spectrum of postoperative complications; however, given the established pattern of complication timing, we believe this limitation is relatively minor in the context of the primary outcomes of the study.

In conclusion, performing TECA-LBO via a T-shaped incision, as originally described, appeared to be associated with a higher risk of wound complications, while the circular

incision was linked to a greater incidence of intraoperative bleeding and postoperative facial nerve neuropathy. The findings of this study suggested that the incision shape may have influenced the development of intraoperative and postoperative complications, although most were minor and self-limiting.

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CONFLICT OF INTEREST

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

Ethical approval. This work involved the use of non-experimental animals only (owned or unowned) and followed recognized high standards of individual veterinary clinical patient care. Ethical approval from a committee was not therefore needed.

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Figure Legends

Figure 1. A circular incision (O-group) is made around the external acoustic meatus, starting just below the tragus and extending cranially to the helix and caudally to the antitragus.

Figure 2. A T-shape incision (T- group) is made starting at the tragus, extending ventrally above the vertical ear canal

Table Legends

Table 1. Breeds

Table 2. Incidence of intraoperative complications in relation to the shape of the incision.

Table 3. Incidence of postoperative complications in relation to the shape of the incision.

Table 4. Wound complications.

Table 5. Isolated microorganisms.