Sialoceles occur when a defect in the wall of a major or, less commonly, minor salivary gland or duct results in extravasation and accumulation of saliva in the surrounding subcutaneous or submucosal tissues. Sialoceles occur when a defect in the wall of a major or, less commonly, minor salivary gland or duct results in extravasation and accumulation of saliva in the surrounding subcutaneous or submucosal tissues. The sublingual gland and duct are most commonly implicated in sialocele formation in dogs. While the etiology of sialoceles is idiopathic in most cases, other potential causes include trauma from dental procedures, prior abscess drainage, bite wounds, and choke chains as well as foreign bodies, neoplasia, dirofilariasis, sialoadenitis, and sialolithiasis.

Sialoadenectomy is the most definitive treatment for sublingual and mandibular sialoceles and is directed at complete removal of disrupted tissues. Sialoadenectomy is the most definitive treatment for sublingual and mandibular sialoceles and is directed at complete removal of disrupted tissues. Sialoadenectomy is the most definitive treatment for sublingual and mandibular sialoceles and is directed at complete removal of disrupted tissues. Sialoadenectomy is the most definitive treatment for sublingual and mandibular sialoceles and is directed at complete removal of disrupted tissues.

OBJECTIVE
To compare the long-term outcomes of a ventral versus lateral surgical approach for mandibular and sublingual sialoadenectomy in dogs with a unilateral sialocele.

ANIMALS
46 client-owned dogs.

PROCEDURES
Medical records of dogs that underwent unilateral sialoadenectomy between 1999 and 2019 were retrospectively reviewed, and information was collected regarding signalment, clinical signs, historical treatment, swelling location, diagnostic imaging findings, sialoadenectomy approach, adjunctive treatments, intraoperative complications, hospitalization time, postoperative complications, recurrence, and contralateral sialocele development.

RESULTS
There were no significant differences in incidences of intraoperative complications, recurrence, or postoperative complications between dogs in which a lateral versus ventral approach was used. Clinically important intraoperative complications included iatrogenic tears in the oral mucosa, ligature slippage from the duct end, hemorrhage, and possible lingual nerve transection. Surgical experience was associated with the likelihood that intraoperative complications would develop. Suspected recurrence was reported in 2 of 26 (8%) dogs that underwent a lateral approach and 2 of 12 (17%) dogs that underwent a ventral approach. Hospitalization time was significantly shorter with the lateral approach than with the ventral approach. Postoperative complications had a short-term onset and occurred in 4 of 25 (16%) dogs that underwent a lateral approach and 3 of 12 (25%) dogs that underwent a ventral approach. Age and presence of a pharyngeal sialocele were associated with development of postoperative complications.

CLINICAL RELEVANCE
Long-term outcomes for ventral and lateral approaches to sialoadenectomy were favorable and appeared to be comparable. Further prospective study into potential associations of sialoadenectomy approach, age, and pharyngeal sialoceles on outcome is needed.
Materials and Methods

Case selection criteria

Medical records of the Ontario Veterinary College Health Sciences Centre and the Veterinary Emergency Clinic and Referral Centre were searched to identify dogs in which a salivary mucocele had been diagnosed between January 1, 1999, and December 31, 2019. Only dogs treated by mandibular and sublingual sialoadenectomy with a ventral or lateral approach were included in the study. Dogs were excluded from the study if neither cytology or histopathology results were available or if results of these tests, diagnostic imaging findings, or intraoperative findings did not support the diagnosis of a sialocele. Dogs were also excluded if the reported sialoadenectomy approach deviated from the typical description in the literature.8,16 For instance if the ventral approach was performed without tunneling under the digastricus muscle.

Medical records review

Demographic data collected included species, breed, age, sex, and body weight at the time of sialoadenectomy. Clinical signs, duration of clinical signs at the time of diagnosis, unilateral or bilateral presentation, swelling location, previous surgical intervention, duration and type of medical management, and etiology were also recorded. Ranulas were classified as a sublingual swelling, as previously suggested.17 Preoperative diagnostic test results and clinical findings that were collected included gross appearance of aspirated fluid and results of cytologic analysis, bacterial culture and susceptibility testing, histopathology, radiography, CT, and focal ultrasonography, if applicable.

The surgical approach was at the attending surgeon’s discretion. Recorded surgical variables included approach, duration of surgery, side of sialoadenectomy, sialocele treatment method, adjunctive surgical procedures, and surgeon experience. Dogs were treated intraoperatively with ampicillin (19.1 to 25.4 mg/kg, IV) or cefazolin (20.7 to 30 mg/kg, IV), beginning 30 minutes prior to the first incision and continuing every 90 minutes thereafter.

In dogs with a ranula, the method of treatment was determined from the medical record. Ranula treatment was classified as untreated, incisional open drainage, incisional drainage with closure, and marsupialization. If a drain was placed, duration and type of drain placement were recorded.

Information on remarkable intraoperative findings and complications was recorded when noted in the medical record. Postoperative variables that were recorded consisted of recovery location, duration of hospitalization following surgery, and antimicrobials prescribed while the dog was in the hospital and at the time of discharge. Histopathologic findings and results of bacterial culture and susceptibility testing of samples collected intraoperatively were documented.

Outcome measures collected included type of and time to complications, recurrence, and development of a sialocele on the contralateral side. Postoperative complications included events in hospital and following discharge.18 Short-term postoperative complications were defined as complications that developed within 14 days after sialoadenectomy.19 Long-term postoperative complications were defined as complications that developed > 14 days after sialoadenectomy.19

Time to recurrence was defined as the number of days from surgery to diagnosis of a sialocele on the ipsilateral to the previous sialoadenectomy. If lateralization of the sialocele was unspecified, the sialocele was considered a recurrence unless sialoadenectomy on the contralateral side resulted in resolution.

Ventral approach to sialoadenectomy

For the ventral approach to sialoadenectomy, the patient was positioned in dorsal recumbency. The skin, subcutaneous tissues, and platysma were incised from the angle of the mandible caudally to the external jugular vein or from the caudal mandible cranially to the mid or rostral mandible. The fibrous capsule was incised and the mandibular and monostomatic sublingual salivary glands were identified and dissected free from their intra- or extracapsular attachments, and the sublingual salivary gland chain was exposed. The mylohyoid muscle was incised if necessary. Dissection was continued rostrally until the lingual branch of the trigeminal nerve and all glandular tissue were identified. The sublingual chain was passed deep to the digastricus muscle to facilitate dissection. The duct and gland complex was circumferentially ligated with monofilament suture at the level of the caruncle or lingual nerve and transected. The site was then lavaged with warm sterile saline (0.9% NaCl) solution. Deep fascial tissues were closed with absorbable monofilament suture in an

and the associated salivary gland.14,15 It has been proposed that improved rostral duct exposure may aid in complete removal of the affected tissue and reduce the incidence of recurrence.15 The traditional lateral approach to sialoadenectomy has been regarded as safer; however, rostral dissection is impeded by the digastricus muscle with this approach.14,15 In an experimental study on canine cadavers, polystomatic sublingual glandular tissue remained in all cases in which the traditional lateral approach was used. The ventral approach to sialoadenectomy involves tunneling under the digastricus muscle, which provides more extensive rostral dissection and duct excision, but its invasiveness risks trauma to the lingual artery, hypoglossal nerve, and lingual nerve, which lie in close proximity to the site.14,15

Although the efficacy of the ventral and lateral approaches for mandibular and sublingual sialoadenectomy have been individually reported, to our knowledge there have been no studies to date that have compared the 2 techniques. Therefore, the objectives of the study reported here were to evaluate the long-term outcomes of a ventral versus lateral surgical approach for mandibular and sublingual sialoadenectomy in dogs with a unilateral sialocele and to compare complication and recurrence rates.

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interrupted or simple continuous pattern. Subcutaneous tissues were closed with absorbable monofilament suture in a simple continuous pattern. Skin was closed with nonabsorbable monofilament suture in a cruciate pattern.

**Lateral approach to sialoadenectomy**

For the lateral approach to sialoadenectomy, the patient was positioned in lateral recumbency and a towel was placed under the neck to rotate the ventral aspect dorsally and stabilize the neck in an extended position. The skin, subcutaneous tissues, and platysma were incised from the angle of the mandible caudally to the external jugular vein. The fibrous capsule of the mandibular salivary gland was identified, and the mandibular and monostomatic sublingual salivary glands were separated from the capsule or dissected extracapsularly. Blood vessels on the dorsomedial aspect of the capsule were ligated with monofilament suture or cauterized. Dissection was continued rostrally until the lingual branch of the trigeminal nerve and all glandular tissue were identified. The duct and gland complex was circumferentially ligated with monofilament suture and transected. The site was then lavaged with warm sterile saline solution. Deep fascial tissues were closed with absorbable monofilament suture in a simple continuous pattern. Subcutaneous tissues were closed with absorbable monofilament suture in a cruciate pattern or with absorbable monofilament suture in an intradermal pattern.

**Outcome**

Information on outcome was obtained from the medical records and through a telephone or email survey of referring veterinarians or owners. The survey included questions on the presence of clinical signs associated with postoperative complications, recurrence of the sialocele, development of a contralateral sialocele, date of sialocele recurrence or new sialocele development, and any additional testing or treatment performed following the onset of clinical signs. If the dog was dead at the time of the survey, information on whether the cause of death was related to a sialocele or sialoadenectomy was collected. Owner interviews were not conducted for dogs > 12 years old at the time of the present study and dogs that were known to be dead. Dogs were considered lost to follow-up if the animal was not examined by a veterinarian or if the owner was not interviewed at least 6 months after sialoadenectomy.

**Statistical analysis**

The Shapiro-Wilk test was used to assess whether continuous variables were normally distributed. The Mann-Whitney U test was performed to compare nonparametric data such as age, weight, and duration of hospitalization between groups when dogs were grouped on the basis of sialoadenectomy approach (ventral vs lateral) and hospital (Ontario Veterinary College Health Sciences Centre vs Veterinary Emergency Clinic and Referral Centre). The Student t test was used to compare parametric data such as duration of drain placement between groups. The Fisher exact or χ² test was used to assess whether sialoadenectomy approach was associated with hospital and whether sialoadenectomy approach or hospital was associated with categorical variables, including sex, sialocele location, drain placement, and adjunctive treatment of ranulas. Univariate exact conditional logistic regression was performed to analyze for an association of independent variables with intraoperative complications, recurrence, and total number of postoperative complications. Dogs for which follow-up information obtained > 6 months postoperatively was not available were excluded from analyses of postoperative complications following discharge from the hospital.

Standard statistical software including SPSS Statistics for MacOS version 26.0 (IBM Corp) and SAS/STAT version 9.4 (SAS Institute Inc) was used for data analysis; all test assumptions were met. Values of P < 0.05 were considered significant. On the basis of data distribution, only a 1-sided P value could be calculated for some univariate logistic regression analyses. Two-tailed tests were performed in the remainder of cases.

**Results**

**Study population**

Fifty-seven dogs that underwent mandibular and sublingual sialoadenectomy between 1999 and 2019 were identified, but 11 of these dogs were excluded from the study. Reasons for exclusion included lack of laboratory testing that supported the diagnosis of a sialocele (n = 2); cytologic or histopathologic evidence of an abscess (2); histopathologic diagnosis of a suture granuloma (1), grade II soft tissue sarcoma (1), or suspected carcinoma (1); presence of bilateral disease (2); and use of a ventral approach without tunneling under the digastric muscle (2).

The remaining 46 dogs met the criteria for inclusion in the study (Table 1). Mixed-breed dogs (n = 13) were most common, followed by Australian Shepherds (4), Miniature and Toy Poodles (3), and Labrador Retrievers (3). Dogs from the private practice hospital were significantly (P = 0.020) older (median, 7 years) than dogs from the academic hospital (median, 4 years).

**Preoperative evaluation**

All dogs included in the study presented with a swelling (Table 1). A combination of swelling locations was observed in 8 of 46 (17%) dogs. Other presenting signs included decreased appetite (n = 7), dysphagia (6), ptyalism (4), oral bleeding (3), respiratory stertor (2), lethargy (1), rupture of the swelling (1), wheezing (1), gagging (1), coughing (1), inability to close the mouth (1), difficulty breathing (1), polydipsia (1), stomatitis (1), salivary gland enlargement (1), and fever (1). Time from onset of clinical signs to presentation to the referral hospital ranged from 1 day to 2.5 years.
Ten of 46 (22%) dogs had a history of trauma, which included dental extractions (n = 3), attack by another dog (2), running into a vehicle while carrying a frisbee (1), placement of premolar spacers on teeth 309 and 409 (1), rostral mandibulectomy caudal to teeth 306 and 406 performed with an oscillating saw for treatment of a gingival plasmacytoma (1), malignant melanoma excision from the lip commissure (1), and excision of a pharyngeal mass on the contralateral side through an oral approach, with a histopathologic diagnosis of sialoadenitis (1). In 2 of the 3 dogs, the side of dental extractions was ipsilateral to the sialocele, including 1 dog in which teeth 206 and 208 had been extracted 219 days prior to presentation for a sialocele on the contralateral side, but extractions ipsilateral to the sialocele (including teeth 402, 403, 405, and 411) had been previously performed at an unknown date. Information on the side of extraction was not recorded in the medical record for the remaining dog. Median time from a traumatic event to development of clinical signs or diagnosis of a sialocele was 180 days (range, 2 to 494 days) in the 7 of 10 dogs for which information was available. Four of 46 (9%) dogs had a history of a possible traumatic injury at an unspecified time prior to sialocele development. This included a history of chewing sticks (n = 2), prior choke collar training (1), and tarsal instability of unknown etiology (1).

Twenty-one of 46 (46%) dogs underwent focal ultrasonography of the cervical or sublingual region (Table 1). Findings included a fluid-filled pocket (n = 18), retropharyngeal or mandibular heterogeneous echotexture or lymphadenomegaly (11), sialolithiasis or mineralized sediment (2), enlargement (3) or reduction (1) in the size of the mandibular salivary gland ipsilateral to the sialocele, a nodule on the contralateral salivary gland (1), and a sublingual nodule (1). Ultrasonographic findings for 1 of 46 (2%) dogs were not documented. Five of 46 (11%) dogs underwent CT. All CT findings were consistent with a sublingual or cervical fluid-filled swelling or sialocele. A sublingual nodule was observed in 1 of 46 (2%) dogs. There was no evidence of underlying cause or other remarkable findings. In the dog that had previously undergone contralateral pharyngeal mass excision, CT performed 7 months preoperatively identified bilateral cystic pharyngeal lesions.

Fine-needle aspiration of the sialocele was performed in 41 of 46 (89%) dogs. Gross examination of the fluid was performed in 33 of the 41 (80%) dogs, and cytologic examination by a board-certified veterinary pathologist was performed in 29 of the 41 (71%) dogs. Findings from the fine-needle aspiration were consistent with a sialocele in 35 of the 41 (85%) dogs; findings were inconclusive in the remaining dogs. Incisional biopsy was performed in 2 of 46 (4%) dogs prior to sialoadenectomy, and results of histo-

### Table 1—Demographics and preoperative examination findings for 46 dogs with a unilateral sialocele undergoing sialoadenectomy with a lateral approach (n = 31) or a ventral approach involving tunneling under the digastricus muscle (15).

<table>
<thead>
<tr>
<th>Variables</th>
<th>Lateral approach</th>
<th>Ventral approach</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (y)</td>
<td>4.0 (0.4–14)</td>
<td>4 (0.9–12)</td>
<td>0.723</td>
</tr>
<tr>
<td>Sex and neuter status</td>
<td></td>
<td></td>
<td>0.299</td>
</tr>
<tr>
<td>Sexually intact male</td>
<td>5 (16)</td>
<td>0 (0)</td>
<td></td>
</tr>
<tr>
<td>Neutered male</td>
<td>11 (36)</td>
<td>8 (53)</td>
<td></td>
</tr>
<tr>
<td>Sexually intact female</td>
<td>2 (7)</td>
<td>0 (0)</td>
<td></td>
</tr>
<tr>
<td>Spayed female</td>
<td>13 (42)</td>
<td>7 (47)</td>
<td></td>
</tr>
<tr>
<td>Body weight (kg)</td>
<td>15 (3–45)</td>
<td>19.6 (3.3–40)</td>
<td>0.761</td>
</tr>
<tr>
<td>Sialocele lateralization a</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cervical</td>
<td>25 (81)</td>
<td>15 (100)</td>
<td>0.157</td>
</tr>
<tr>
<td>Pharyngeal</td>
<td>2 (7)</td>
<td>0 (0)</td>
<td>&gt; 0.999</td>
</tr>
<tr>
<td>Sublingual (ranula)</td>
<td>11 (36)</td>
<td>2 (13)</td>
<td>0.169</td>
</tr>
<tr>
<td>Sialocele lateralization a</td>
<td></td>
<td></td>
<td>0.587</td>
</tr>
<tr>
<td>Lateral</td>
<td>29 (94)</td>
<td>13 (87)</td>
<td></td>
</tr>
<tr>
<td>Midline</td>
<td>2 (7)</td>
<td>2 (13)</td>
<td></td>
</tr>
<tr>
<td>Affected side identified</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ultrasonography</td>
<td>9/11 (82)</td>
<td>7/10 (70)</td>
<td>1.000</td>
</tr>
<tr>
<td>CT</td>
<td>4/4 (100)</td>
<td>1/1 (100)</td>
<td>NA</td>
</tr>
<tr>
<td>Institution</td>
<td></td>
<td></td>
<td>0.004</td>
</tr>
<tr>
<td>Academic</td>
<td>23 (66)</td>
<td>15 (100)</td>
<td></td>
</tr>
<tr>
<td>Private</td>
<td>12 (34)</td>
<td>0 (0)</td>
<td></td>
</tr>
</tbody>
</table>

Data are given as median (range), number of dogs (percentage), or number of dogs with a positive result/number of dogs that underwent the procedure (percentage).

*Eight dogs had swellings in multiple locations.

NA = Not applicable.
logic examination were consistent with a sialocele in both cases.

**Surgical procedure**

At the time of surgery, a ranula that had not been previously observed was identified in 1 of 46 (2%) dogs and lateralization of a previously midline sialocele was identified in another dog (2%). Thirty-one of 46 (67%) dogs underwent sialoadenectomy through a lateral approach, and 15 of 46 (33%) dogs underwent sialoadenectomy through a ventral approach (Table 2). All surgical procedures were unilateral and performed by a diplomate of the American College of Veterinary Surgeons or a surgical resident under the supervision of a board-certified veterinary surgeon. The resident was the primary surgeon for 2 of the 15 (13%) dogs in which a ventral approach was used and 3 of the 31 (10%) dogs in which a lateral approach was used. The distribution of surgical approaches differed significantly ($P = 0.004$) between hospitals (Table 1). A drain was placed in 19 of 46 (41%) dogs. A closed suction drain was placed in 16 of 46 (35%) dogs and an open passive drain in 3 of 46 (7%) dogs. The drain was reported to be placed within the dead space created by removal of the salivary duct and gland complex in 10 of the 19 (53%) dogs; placement was not specified in the remaining dogs.

Nine of 13 (70%) dogs with a ranula had additional treatment for the ranula at the time of sialoadenectomy. Treatment included marsupialization ($n = 7$), ranula excision and closure (1), and incision with open drainage (1). Seven of 46 (15%) dogs had other procedures performed during the same general anesthetic episode as sialoadenectomy. These procedures included castration ($n = 2$), bilateral laryngeal saccullectomy (2), ipsilateral submandibular lymph node excisional biopsy (2), and perianal mass excision (1).

Intraoperative complications occurred in 5 of 31 (16%) dogs in which a lateral approach was used and in 5 of 15 (33%) dogs in which a ventral approach was used. Intraoperative complications in the lateral approach group included mandibular lymphadenectomy ($n = 1$), ligature slippage from the duct end (1), a tear in the mucosa during incisional drainage of a ranula (1), possible transection of the lingual nerve (1), and moderate hemorrhage from a blood vessel medial to the digastric muscle (1). Intraoperative complications in the ventral approach group included submandibular lymphadenectomy ($n = 4$; including a dog requiring lymphadenectomy owing to disruption of local blood supply to the lymph node, suspected to be the glandular branch of the facial artery) and creation of a defect in the oral mucosa during dissection (1). The intraoperative complication rate was not significantly ($P = 0.494$) different between surgical approaches. This remained the case when submandibular lymph node excision was excluded as a complication ($P = 0.937$). Surgeon experience was significantly ($P = 0.050$) associated with development of intraoperative complications when lymphadenectomy was included as a complication (Table 3).

Table 2—Intraoperative and postoperative findings for the dogs in Table 1.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Lateral approach</th>
<th>Ventral approach</th>
<th>$P$ value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Side of sialoadenectomy</td>
<td></td>
<td></td>
<td>0.754</td>
</tr>
<tr>
<td>Left</td>
<td>15/31 (48)</td>
<td>6/15 (40)</td>
<td></td>
</tr>
<tr>
<td>Right</td>
<td>16/31 (52)</td>
<td>9/15 (60)</td>
<td></td>
</tr>
<tr>
<td>Ranula treated</td>
<td>9/11 (82)</td>
<td>0/2 (0)</td>
<td>0.077</td>
</tr>
<tr>
<td>Drain placed</td>
<td>11/31 (35)</td>
<td>8/15 (53)</td>
<td>0.341</td>
</tr>
<tr>
<td>Time drain remained in place (h)</td>
<td>28 (9–66)</td>
<td>46.5 (22–70)</td>
<td>0.143</td>
</tr>
<tr>
<td>Hospitalization time (h)</td>
<td>27 (12–74)</td>
<td>44.5 (22–71)</td>
<td>0.047</td>
</tr>
<tr>
<td>Intraoperative complications</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>All</td>
<td>5/31 (16)</td>
<td>5/15 (33)</td>
<td>0.345</td>
</tr>
<tr>
<td>Excluding lymphadenectomy</td>
<td>4/31 (13)</td>
<td>1/15 (7)</td>
<td>0.937</td>
</tr>
<tr>
<td>Suspected recurrence</td>
<td>2/26 (8)</td>
<td>2/12 (25)</td>
<td>0.750</td>
</tr>
<tr>
<td>Postoperative complications</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>In hospital</td>
<td>2/25 (8)</td>
<td>1/15 (7)</td>
<td>&gt; 0.999</td>
</tr>
<tr>
<td>Following discharge</td>
<td>4/25 (16)</td>
<td>3/12 (25)</td>
<td>0.581</td>
</tr>
</tbody>
</table>

Data are given as median (range) or number of dogs with the variable of interest/total number of dogs (percentage).

Table 3—Association between primary surgeon experience and outcome for the dogs in Table 1.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Surgery resident</th>
<th>ACVS surgeon &lt; 5 years</th>
<th>ACVS surgeon ≥ 5 years</th>
<th>$P$ value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intraoperative complication ($n = 10$)</td>
<td>3</td>
<td>5</td>
<td>2</td>
<td>0.050</td>
</tr>
<tr>
<td>Intraoperative complication ($n = 5$)*</td>
<td>2</td>
<td>2</td>
<td>1</td>
<td>0.126</td>
</tr>
<tr>
<td>Suspected recurrence ($n = 4$)</td>
<td>1</td>
<td>0</td>
<td>3</td>
<td>0.102</td>
</tr>
<tr>
<td>Postoperative complication ($n = 7$)</td>
<td>0</td>
<td>4</td>
<td>3</td>
<td>0.645</td>
</tr>
</tbody>
</table>

Data represent number of dogs.

*Excludes dogs in which the intraoperative complication was mandibular lymphadenectomy.

ACVS = American College of Veterinary Surgeons.
Samples for bacterial culture and susceptibility testing were obtained intraoperatively in 14 of the 46 (30%) dogs. Actinomyces sp and Bergeyalla zoohelcum were cultured in 1 dog. This dog had a 2-day history of sublingual swelling after running into a vehicle while holding a frisbee in its mouth and had previous cytologic evidence of mild suppurrative inflammation without previous prior treatment. The remaining samples did not yield any bacterial growth.

Histopathology results were available for 42 (91%) dogs. Remarkable histopathologic findings, aside from those consistent with a sialocele, included sialoadenitis (n = 15), gland and duct ectasia (3), sialoliths (1), salivary epithelial dysplasia (1), and salivary gland atrophy (1).

**Postoperative care and outcome**

Information on in-hospital complications was available for 25 of 31 (81%) dogs in which a lateral approach was used and all 15 (100%) dogs in which a ventral approach was used. In-hospital postoperative complications occurred in 2 dogs in which a lateral approach was used, namely respiratory distress (n = 1) and development of a mild tremor and altered mentation and mild self-resolving hemorrhage from the incision site (1). Both of these dogs had originally presented with cervical and pharyngeal swelling. Postoperative diarrhea in 1 dog was deemed unrelated to sialoadenectomy and was not included as a complication. One dog in which a ventral approach was used developed moderate swelling around the incision site.

Sialoadenectomy approach was not significantly (P > 0.999) associated with development of in-hospital postoperative complications. Mean duration of drain placement was 38 hours (range, 9 to 70 hours). Duration of hospitalization was significantly (P = 0.047) shorter following the lateral approach (median, 27 hours) than following the ventral approach (median, 44.5 hours). In-hospital antimicrobials were administered in 18 of 40 (45%) dogs for which information was available. Twenty-six of 46 (57%) dogs were prescribed antimicrobials at the time of discharge from the hospital.

Information on postoperative complications following discharge was available for 37 of the 46 (80%) dogs, including 25 of 31 (81%) dogs that underwent a lateral approach and 12 of the 15 (80%) dogs that underwent a ventral approach. Median time to postoperative complications following discharge for all dogs was 8 days (range, 1 to 14 days).

Three of 12 (25%) dogs that underwent a ventral approach had short-term complications. Two dogs developed a seroma that resolved with drainage and supportive care, and 1 dog had polydipsia from the time of discharge that persisted until the time of follow-up.

Short-term postoperative complications following discharge occurred in 4 of 25 (16%) dogs that underwent a lateral approach. Two dogs had facial drooping or lower lip drooping and drooling ipsilateral to the side to surgery. The facial drooping was described by the owner to be present since the time of discharge and persisted until the dog died because of reasons unrelated to the sialocele 1,039 days after sialoadenectomy. The dog with lower lip drooping and drooling had these findings noted during a 14-day recheck examination, but they were not observed during a subsequent examination 49 days after surgery or thereafter by the referring veterinarian. One dog that had presented with pharyngeal and cervical swelling developed moderate swelling, lethargy, inappetence, staring into space, reluctance to open its mouth, stertor, and coughing 13 days after surgery. The dog was admitted to the hospital and treated with crystalloid fluids IV and buprenorphine for 2 days until clinical signs subsided. No complications were noted in the dog with suspected transection of the lingual nerve.

None of the dogs were euthanized for reasons related to the sialocele or sialoadenectomy. Sialoadenectomy approach was not significantly (P = 0.813) associated with the development of postoperative complications, but dogs with postoperative complications were significantly (P = 0.041) older than dogs without postoperative complications. For each year of age, the odds of developing a postoperative complication increased by 24% (OR, 1.24; 95% CI, 1.008 to 1.57; P = 0.041). Presence of a pharyngeal sialocele significantly (1-sided P = 0.032) increased the odds of having a postoperative complication (OR, 1.76; 95% CI, 1.34 to infinity).

Follow-up information regarding recurrence was available for 38 of the 46 (83%) dogs, including 26 of the 31 (84%) dogs in which a lateral approach was used and 12 of the 15 (80%) dogs in which a ventral approach was used. Median time to follow-up was 1,188 days (range, 194 to 3,579 days). Suspected recurrence of cervical (n = 1) and sublingual (1) sialoceles on the side ipsilateral to the sialoadenectomy occurred in 2 of the 26 (8%) dogs in which a lateral approach was used. Recurrence was suspected to have occurred in 2 of the 12 (17%) dogs in which a ventral approach was used. This included 1 dog with suspected recurrence of a cervical sialocele ipsilateral to the sialoadenectomy and 1 dog in which a cervical swelling with undetermined lateralization developed. Additional diagnostic testing and treatments were declined in all dogs with suspected recurrence. Median time to recurrence was 1,198 days (range, 847 to 1,649 days). The rate of suspected recurrence did not differ significantly (P = 0.750) between sialoadenectomy approaches.

Two of 37 (5%) dogs for which follow-up information was available had a contralateral sialocele develop 969 and 1,027 days postoperatively. Contralateral sialoadenectomy was performed 980 and 1,057 days postoperatively, respectively.

**Discussion**

To our knowledge, the present study represented the first attempt to assess clinical outcomes associated with ventral (with tunneling of the sublingual-mandibular salivary duct under the digastricus muscle) and lateral (without such tunneling) approaches for mandibular and sublingual sialoadenectomy in dogs with unilateral sialoceles. The ventral approach has previously been proposed to improve completeness of excision of the salivary gland complex for treatment of sialoceles. In contrast, our findings revealed no differences between approaches in regard to suspected recurrence and postoperative com-
plication rates. Most dogs in the present study had favorable postoperative outcomes with long-term resolution of clinical signs.

In the present study, 4 of 38 (11%) dogs were suspected to have had recurrence of a sialocele after undergoing sialoadenectomy, which was higher than recurrence rates reported previously.\textsuperscript{1,2,8,14,21} Sialoceles were suspected to have occurred in 2 of 26 (8%) dogs that underwent a lateral approach and in 2 of 12 (17%) dogs that underwent a ventral approach; however, these values were not significantly different. Also, the recurrence rate in the present study may have been artificially high because 1 dog classified as having a recurrence only had cervical swelling with undetermined lateralization, and similar cases have been excluded from previous analyses of recurrence rate.\textsuperscript{8} Because additional diagnostic testing or treatment was not provided for any of the dogs with suspected recurrence, it is possible that some of these dogs were misclassified.

Eleven of 46 (24%) dogs in our study had received treatment for a sialocele prior to presentation. Recurrence has been described to commonly occur following aspiration, drainage, or marsupialization of sialoceles because the underlying salivary chain defect persists with these techniques.\textsuperscript{7,8} Thus, sialoadenectomy is the preferred treatment for definitive resolution of sialoceles.\textsuperscript{8} It is possible that prior use of surgical methods could promote the formation of fibrous tissue, which would make subsequent visualization and dissection of the salivary chain more challenging.\textsuperscript{23} This could potentially have been a contributing factor for recurrence in 2 dogs that underwent ranula exploration with closure and swelling debridement with open incisional drainage prior to presentation.

Recurrence or persistence of sialoceles following sialoadenectomy is rare but has been described with underlying causes including excision of the mandibular lymph node instead of the salivary gland, removal of the unaffected salivary gland following inappropriate localization of the affected side, and rupture of the polystomatic salivary gland rostral to the site of excision.\textsuperscript{7,8,15} Published reports suggest that recurrence occurs predominantly within the first year after sialoadenectomy.\textsuperscript{8,22} By contrast, the median time to recurrence in our study was 3 years. It is possible that suspected recurrences that developed years after sialoadenectomy actually represented a contralateral sialocele with swelling along the midline.\textsuperscript{8} Glen\textsuperscript{1} reported bilateral sublingual gland or duct defects in 16% of cases. Certainly, the delayed presentation of a recurrent swelling could also be a result of slow accumulation of minute volumes of saliva from a minor quantity of residual secretory tissue containing a defect.\textsuperscript{2,3,7} The rate of sialocele development may be further attenuated by absorption of extravasated saliva by surrounding tissues.\textsuperscript{12} Where residual salivary tissue remains, development of a defect at a location independent of the initial rupture site could also be possible because sialography has previously demonstrated multiple defects within the same salivary chain.\textsuperscript{1}

A limitation of our study was the use of ultrasonography rather than CT in many of our cases. For the institutions that participated in the present study, ultrasonography was routinely used to evaluate the source of swelling when a sialocele was suspected. In contrast, because of the high cost of CT, this test was not considered mandatory prior to sialoadenectomy, and the decision of which side to treat was often based on the presence of a lateralized swelling, a history from the owner of lateralization in the early stages of disease, or ultrasonographic abnormalities of the salivary gland. Although this approach may not have been ideal, we would have expected recurrence to be almost immediate if the inappropriate gland had been removed,\textsuperscript{7,8,22} and this was not the case.

In the present study, recurrence was not significantly associated with the sialoadenectomy approach that was used. One possible explanation for this finding is that the site of extravasation in our population was more caudal than previously described so that the farther rostral dissection offered by the ventral approach did not confer the same benefits as suggested previously.\textsuperscript{7,8,21} Although the rostral polystomatic sublingual glandular tissue has been the most commonly implicated rupture site in the formation of sialoceles, resection to the level of the lingual nerve has been reported to be sufficient in most cases.\textsuperscript{11,24} Sialoadenectomy recurrence rates of < 3% have been described in previous studies.\textsuperscript{1,2,7,8,25} It is possible that our sample size was not large enough to detect the small proportion of dogs that would benefit from tunneling under the digastricus muscle. Variability in the level of duct transection within approach groups and variability in surgeon experience could also have made it more difficult for us to detect differences in outcomes between groups.

The lateral approach has been perceived to be safer than the ventral approach because dissection does not occur as close to neurovascular structures with the lateral approach.\textsuperscript{15} Conversely, visualization of anatomic structures may be improved with the ventral approach, which may be beneficial for less-experienced surgeons.\textsuperscript{15} In the present study, intraoperative complications were defined as described by Rosenthal et al\textsuperscript{20} as any adverse event that deviated from the ideal operative course from the time of skin incision to completion of skin closure. For our purposes, we extrapolated this to include elements of the surgical procedure that were not part of the standard description of the technique, such as removal of the mandibular lymph node. Iatrogenic tissue injury was the most common intraoperative complication in our study; however, in 9 of the 10 dogs with intraoperative complications, the complication necessitated only minimal or no changes in operative tactics. Disruption of the lymph node blood supply in 1 dog necessitated lymphadenectomy but had no further consequences for the patient. Although intraoperative complication rates did not vary significantly between the 2 approaches, there was a significant association with surgeon experience, which confounded these results.

Mandibular lymphadenectomy was the most frequently documented intraoperative complication in our study and occurred with both the lateral and ventral approaches. However, clinical consequences for affected patients were negligible. One potential explanation for the high incidence of mandibular lymphadenectomy may be deliberate removal of the lymph
node by the surgeon for ease of dissection or visualization; however, this was not documented in the medical records. This complication was not reported in previously published studies, except when the mandibular lymph node was mistaken for the salivary gland and inadvertently removed.\textsuperscript{2,7} Histopathologic analysis confirmed no such instances in our study population. In our experience, some surgeons may remove the mandibular lymph node routinely as part of the surgical approach to improve exposure; however, this was not part of the original surgical description and was considered a complication, as outlined by Rosenthal et al.\textsuperscript{24} Intraoperative complications were associated with the primary surgeon’s experience when lymphadenectomy was counted as a complication. Thus, performance of lymphadenectomy may also be related to the surgeon’s familiarity with the regional anatomy.

Although dissection with the lateral approach is not typically carried out close to neurovascular structures, use of this approach could hinder visualization and predispose inadvertent traumatic injury.\textsuperscript{15} Among the complications related to tissue injury with the lateral approach in the present study were hemorrhage from laceration of a vessel medial to the digastricus muscle (suspected to be the linguofacial vein), possible transection of the lingual nerve, and postoperative ipsilateral facial drooping. Facial nerve paresis has been previously described as a complication following parotidectomy for treatment of a parotid sialocele, but to our knowledge, this complication has not been reported following mandibular and sublingual sialoadenectomy in dogs.\textsuperscript{8,27} The lateral position of the ventral buccal nerve relative to the mandibular salivary gland could make it more susceptible to iatrogenic traumatic injury and postsurgical inflammatory neuropathy.\textsuperscript{2,28} In the ventral approach group, 1 dog sustained an oral mucosal tear. A similar injury was observed in a dog in the lateral approach group only during adjunctive ranula treatment. The extensive rostral exposure afforded with the ventral approach may increase the risk of damage to friable oral tissues. Thus, meticulous dissection may prove particularly beneficial when complete excision of salivary glandular tissue is attempted.\textsuperscript{8}

Owing to the potential for surgery times > 90 minutes, antimicrobials were routinely administered intraoperatively in our study population. Postoperatively, antimicrobial administration was continued, on the basis of surgeon preference, in 25 of the 46 (54%) dogs despite a lack of evidence of infection. Some dogs undergoing sialoadenectomy may develop seromas, as was the case for 2 dogs in the present study, and therefore may be at a higher risk of developing a postoperative infection.\textsuperscript{8,29}

Postoperative complications were defined as per Dindo et al\textsuperscript{10} as “any deviation from the normal postoperative course,” which did not include indication errors, failure to cure, and sequelae. All postoperative complications in both approach groups were self-limiting or mild and only short-term pharmacological treatment or drainage or no intervention was needed. Our analysis indicated that dogs with a pharyngeal sialocele were more likely to have postoperative complications; however, owing to the low number of cases, only a 1-sided $P$ value could be calculated. Both affected dogs developed respiratory stridor in the postoperative period. One dog had mild respiratory distress on recovery from anesthesia that improved with sedation and resolved over time, with the dog discharged 74 hours after surgery. The other dog had moderate pharyngeal swelling and reluctance to open its mouth at the 14-day recheck appointment. Space occupation within the oropharynx by the pharyngeal sialocele and pharyngeal edema from surgical inflammation are suspected incriminating factors of complications in dogs with pharyngeal sialoceles.\textsuperscript{1,13} Further research into the outcomes of pharyngeal sialoceles is needed.

Dogs in which the lateral approach was used had significantly shorter hospitalization times (median, 27 hours) than did dogs in which the ventral approach was used (median, 44.5 hours). A potential contributing factor could have been the higher percentage of dogs in which a drain was placed following the ventral approach versus the lateral approach, but a significant difference between groups was not detected. Increased rostral dissection and the dependent position of the incision with the ventral approach could result in increased dead space and fluid production, which may explain this finding.\textsuperscript{8} Other explanations could include potentially reduced pain with the lateral approach because of less-extensive dissection and differences in case management between hospitals and clinicians.

The signalement of dogs in the present study was comparable to that previously reported.\textsuperscript{1,2,7,8} Dogs that developed postoperative complications were older (median, 8 years) than those that did not (median, 4 years). To our knowledge, there are no previous reports that identify older age as a risk factor for complications in dogs undergoing sialoadenectomy, although this has been described for other surgical procedures.\textsuperscript{32–34} Preexisting covert comorbidities such as respiratory disease, neurologic disease, and age-related systemic illnesses could potentially explain the higher rate of postoperative complications in older dogs.\textsuperscript{32,35}

Limitations of our study arose primarily from its retrospective nature. Some medical records contained incomplete data for a number of variables of interest, particularly for early cases for which digital medical records were inaccessible. The rationale for selection of a particular sialoadenectomy approach, decision to pursue adjunctive treatment for ranulas, and extent of involvement of the surgical resident was often not disclosed in the surgical reports. Additionally, our study included cases from 2 referral institutions to increase the size of the study population, which introduced variability in surgical technique, experience, and case management that could have affected outcome measures. The discrepancy in the approach selection between institutions, which led to a low number of cases in which the ventral approach was used, was a limitation of the study. Biases inherent to the survey method, owner recollection, perceptions of clinical sign relevance or severity, and completeness of medical records may have also influenced data collected on our outcome measures.\textsuperscript{7,36–38}

In conclusion, our findings revealed favorable outcomes regardless of surgical approach in dogs.
undergoing sialoadenectomy. The more extensive duct dissection afforded by the ventral approach may benefit the small proportion of cases with rostral salivary duct defects; however, our results suggested that outcomes for the 2 approaches were comparable. Shorter hospitalization times were observed with the lateral versus the ventral approach, but the cause of this difference could not be determined. Limitations posed by this study's retrospective design warrant further prospective investigation on the effects of sialoadenectomy approach, age, and presence of pharyngeal sialoceles on long-term postoperative outcomes.

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