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Objective—To assess results of surgical correction of brachycephalic syndrome (including stenotic nares, elongated soft palate, and everted laryngeal saccules) in dogs and determine whether dogs with hypoplastic trachea have a less favorable long-term outcome.

Design—Retrospective case series.

Animals—62 dogs with brachycephalic syndrome.

Procedures—Medical records from 1991 to 2004 were reviewed for information regarding signalment, clinical signs, diagnosis, surgery, and long-term outcome. Surgical outcome was rated by owners as excellent, good, fair, or poor. Common abnormalities, treatments, and long-term outcomes among the 62 dogs were assessed.

Results—Predominantly affected breeds included English Bulldog, Pug, and Boston Terrier. Elongated soft palate was the most common abnormality (54/62 [87.1%] dogs); the most common combination of abnormalities was elongated soft palate, stenotic nares, and everted saccules (16/62 [25.8%] dogs). The English Bulldog was the most common breed for all abnormalities, including elongated soft palate (27/64 [50%] dogs), stenotic nares (14/36 [38.9%] dogs), everted saccules (20/36 [55.6%] dogs), hypoplastic trachea (7/13 [53.9%] dogs), and laryngeal collapse (2/5 [40%]). No dogs had everted saccules alone. Outcome did not differ between dogs undergoing staphylectomy by use of laser or scissor resection. Follow-up information was obtained for 34 dogs; 16 (47.1%) had an excellent outcome, and 16 (47.1%) had a good outcome. Overall treatment success rate was 94.2%, and overall mortality rate was 3.2%.

Conclusions and Clinical Relevance—Surgical treatment of brachycephalic syndrome in dogs appeared to be associated with a favorable long-term outcome, regardless of age, breed, specific diagnoses, or number and combinations of diagnoses. (J Am Vet Med Assoc 2007;230:1324–1328)

Brachycephalic syndrome is a combination of abnormalities of the upper respiratory tract in dogs that results in upper airway obstruction. The syndrome includes stenotic nares, elongated soft palate, everted laryngeal ventricles, laryngeal collapse, and hypoplastic trachea. Commonly affected breeds are the English Bulldog, Pug, and Boston Terrier. Affected dogs may have any combination of these disorders, which can cause varying degrees of upper airway compromise. Clinical signs include, but are not limited to, inspiratory stridor, exercise intolerance, gagging, regurgitation, vomiting, syncope, and dyspnea. These dogs are predisposed to respiratory distress and may require medical intervention on an emergency basis for severe dyspnea with resultant cyanosis and hyperthermia.

Treatment of dogs affected with brachycephalic syndrome involves a combination of medical and surgical management. Medical management includes weight loss, sedation (as needed [eg, via administration of acepromazine]), housing in a cool environment, and administration of anti-inflammatory medication. The components of the syndrome that are amenable to definitive surgical correction are stenotic nares, elongated soft palate, and everted laryngeal saccules.

The purpose of the study reported here was to assess results of surgical correction of brachycephalic syndrome (including stenotic nares, elongated soft palate, and everted laryngeal saccules) in dogs and determine whether dogs with hypoplastic trachea have a less favorable long-term outcome. Brachycephalic syndrome is a well-described entity, although to our knowledge, few studies have been performed to evaluate the results of surgical treatment. In 2 recent studies, cases of laryngeal collapse were reviewed, and in another, pathologic changes in the gastrointestinal tract were investigated in association with brachycephalic syndrome. The authors are aware of only 1 investigation to compare results of soft palate resection (staphylectomy) by use of a carbon dioxide laser with conventional methods involving scissor resection. In undertaking the present study, our hypotheses were that surgical treatment results in improvement of clinical signs in most affected dogs and that the presence of hypoplastic trachea has no effect on postoperative outcome.

Criteria for Selection of Cases

Medical records of dogs examined at The Ohio State University Veterinary Teaching Hospital and Med-Vet Associates Ltd, Columbus, Ohio, between 1991 and
All comparisons were done with χ2 test or a Fisher exact test. A value of P < 0.01 was used to determine significance because of the large number of tests performed, thereby reducing the odds of a type 1 error. Age was compared between groups of interest by use of a Wilcoxon rank sum test. Numbers of dogs of a specific breed that represented ≤ 5% of the total population were grouped together in an other-breed category. To compare diagnoses and surgical procedures with long-term results, the authors organized the data on the basis of the total number of each diagnoses or procedures (ie, if stenotic nares was the only abnormality, then diagnoses were equal to 1; if stenotic nares and elongated soft palate or soft palate and everted saccules were the detected abnormalities, diagnoses were equal to 2). Dogs in which hypoplastic trachea was diagnosed were investigated separately and compared with long-term outcome for other dogs.

Data analysis—All comparisons were done with either a χ2 test or a Fisher exact test. A value of P < 0.01 was used to determine significance because of the large number of tests performed, thereby reducing the odds of a type 1 error. Age was compared between groups of interest by use of a Wilcoxon rank sum test. Numbers of dogs of a specific breed that represented ≤ 5% of the total population were grouped together in an other-breed category. To compare diagnoses and surgical procedures with long-term results, the authors organized the data on the basis of the total number of each diagnoses or procedures (ie, if stenotic nares was the only abnormality, then diagnoses were equal to 1; if stenotic nares and elongated soft palate or soft palate and everted saccules were the detected abnormalities, diagnoses were equal to 2). Dogs in which hypoplastic trachea was diagnosed were investigated separately and compared with long-term outcome for other dogs.

Results

Signalment and clinical signs—The English Bulldog (27 [43.6%] dogs), Pug (13 [21.0%] dogs), and Boston Terrier (8 [12.9%] dogs) were the most common breeds among the 62 study dogs. Those 3 breeds comprised 77.4% of the dogs. Other breeds included 4 (6.5%) Pekingese; 2 (3.2%) each of Beagle, Bull Mastiff, French Bull Dog, and Pomeranian; and 1 (1.6%) each of Chow Chow and Shar Pei. In the study population, there were 41 (66.1%) male and 21 (33.9%) female dogs; 31 (50%) dogs were sexually intact males, and 12 (19.4%) were sexually intact females. Age of the dogs ranged from 2.5 months to 12 years (mean age, 3.1 years; median age, 1.5 years). Thirty (48.4%) dogs were ≤ 1 year old.

Stertor (snoring) was the most common clinical sign (36 [58.1%] dogs). Other clinical signs (in decreasing order) among the 63 dogs included exercise intolerance (21 [33.9%] dogs); dyspnea (18 [29.0%] dogs);
gagging, regurgitation, or vomiting (15 [24.2%] dogs); stridor (15 [24.2%] dogs); and syncope (8 [12.9%] dogs). There were no significant correlations between clinical signs and subsequent diagnosis.

Diagnoses and surgical procedures—Elongated soft palate was the most common abnormality (54 [87.1%] dogs). Stenotic nares and everted saccules were each diagnosed in 36 of 62 (58.1%) dogs. Mean number of abnormalities was 2.2 (range, 1 to 4). The maximum number of abnormalities in any 1 dog was 4. There were only 6 (9.7%) dogs with 4 abnormalities; 22 (35.5%) dogs had 3 abnormalities, 15 (24.2%) had 2 abnormalities, and 19 (30.6%) had 1 abnormality. The most common combination of abnormalities was elongated soft palate, stenotic nares, and everted saccules; this combination was identified in 16 (25.8%) dogs. Elongated soft palate alone was present in 15 (24.2%) dogs. Laryngeal collapse was present in 5 (8.1%) dogs.

Thirty-four dogs underwent thoracic radiography before surgery, and 13 of those dogs had hypoplastic trachea. Twelve of the 13 dogs that had a hypoplastic trachea had ≥3 abnormalities (ie, at least 2 other abnormalities). Hypoplastic trachea alone was not detected in any dog.

Of the 36 dogs with stenotic nares, 25 (69.4%) also had everted saccules and 25 (69.4%) had an elongated soft palate. Everted saccules were present in 26 of 28 dogs with 3 or 4 abnormalities and in 10 of 15 dogs with 2 abnormalities. Everted saccules alone was not diagnosed in any dog.

For each abnormality, English Bulldog was the most common breed, comprising 27 of 54 dogs with an elongated soft palate, 14 of 36 dogs with stenotic nares, 20 of 36 dogs with everted saccules, 7 of 13 dogs with hypoplastic trachea, and 2 of 5 dogs with laryngeal collapse. English Bulldogs were also the most common breed to have ≥3 abnormalities (19/28 [53.6%] dogs).

All abnormalities in the study dogs were surgically corrected, with the following exceptions: 2 dogs with everted saccules did not undergo sacculectomy, and 2 dogs with stenotic nares did not undergo rhinoplasty.

Long-term outcome—Follow-up information was available for 34 of the 62 dogs (Table 1). There were no significant differences in age, breed, sex, or number of abnormalities between dogs with or without follow-up information; therefore, those subpopulations were deemed to be similar. Of the 34 dogs for which follow-up information was available, 16 (47.1%) had an excellent outcome and 16 (47.1%) had a good outcome, regardless of the number of diagnoses. All 18 dogs with 1 or 2 diagnoses and 14 of 16 dogs with 3 or more diagnoses had a good or excellent outcome. Only 2 dogs with 3 or more diagnoses had fair or poor outcomes. Of the 16 dogs that were ≤1 year old, 11 had an excellent outcome and 4 had a good outcome. Conversely, of the 18 dogs that were >1 year old, 5 had an excellent outcome and 12 had a good outcome. There was no significant difference between the outcomes in these 2 groups.

Of the 2 dogs that had everted saccules and did not subsequently undergo sacculectomy, follow-up information was available for 1; outcome for this dog was considered excellent. There was no follow-up data for the 2 dogs with stenotic nares that did not subsequently undergo rhinoplasty.

There were no significant differences in the long-term outcome between breeds. There was no significant difference in outcome with regard to treatment institution. Hence, there was also no significant difference in the outcome of dogs having laser versus traditional staphylectomy. Outcome in dogs with or without concurrent hypoplastic trachea was not significantly different. Among the study dogs, the number of diagnoses or number of procedures did not significantly affect outcome.

Regarding complications, 1 dog required a temporary tracheostomy because of pharyngeal edema and 1 dog had rhinoplasty revision because of a suture reaction. There were no other complications reported in the medical records. Two (3.2%) dogs died prior to successful recovery from anesthesia, and the specific cause of death was unknown; a necropsy was not performed on either dog.

Table 1—Long-term outcome assessments* made by owners of 34 dogs with brachycephalic syndrome that underwent surgical treatment.

<table>
<thead>
<tr>
<th>Category</th>
<th>Excellent</th>
<th>Good</th>
<th>Fair</th>
<th>Poor</th>
<th>Total</th>
</tr>
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<tbody>
<tr>
<td>All dogs</td>
<td>16</td>
<td>16</td>
<td>1</td>
<td>1</td>
<td>34</td>
</tr>
<tr>
<td>Dogs with ≥3 abnormalities</td>
<td>7</td>
<td>7</td>
<td>1</td>
<td>1</td>
<td>16</td>
</tr>
<tr>
<td>Dogs with 2 abnormalities</td>
<td>4</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>7</td>
</tr>
<tr>
<td>Dogs with 1 abnormalities</td>
<td>5</td>
<td>6</td>
<td>0</td>
<td>0</td>
<td>11</td>
</tr>
<tr>
<td>Dogs with hypoplastic trachea</td>
<td>5</td>
<td>2</td>
<td>1</td>
<td>0</td>
<td>8</td>
</tr>
<tr>
<td>Dogs with laryngeal collapse</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>2</td>
</tr>
<tr>
<td>English Bulldog</td>
<td>8</td>
<td>6</td>
<td>1</td>
<td>1</td>
<td>16</td>
</tr>
<tr>
<td>Boston Terrier</td>
<td>2</td>
<td>2</td>
<td>0</td>
<td>0</td>
<td>4</td>
</tr>
<tr>
<td>Pug</td>
<td>3</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>6</td>
</tr>
<tr>
<td>Shih Tzu</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Other breeds</td>
<td>2</td>
<td>5</td>
<td>0</td>
<td>0</td>
<td>7</td>
</tr>
<tr>
<td>Dogs ≤1 year old</td>
<td>11</td>
<td>4</td>
<td>0</td>
<td>0</td>
<td>16</td>
</tr>
<tr>
<td>Dogs &gt;1 year old</td>
<td>5</td>
<td>12</td>
<td>0</td>
<td>1</td>
<td>18</td>
</tr>
</tbody>
</table>

*At >1 year after surgery, owners rated their dog’s surgical outcome as excellent (marked improvement in clinical signs with no restriction on physical activity), good (improvement in clinical signs with some limits on physical activity), fair (no improvement in clinical signs), or poor (severity of clinical signs increased after surgery).
Discussion

The English Bulldog, Pug, and Boston Terrier were the most common breeds represented in the present study. Within the study population of 62 dogs, mean age was 3.1 years and male dogs were more common than female dogs (ratio of 2:1). These data were not compared with the overall hospital populations; thus, it is not possible to say that any 1 breed was significantly overrepresented. These demographic results were similar to findings of previous studies, with the exception that the most common breed was the French Bulldog in 1 study from France and the King Charles Cavalier Spaniel in 1 study from Australia. The most common abnormalities detected in the dogs of the present study were also similar to those identified in dogs of other studies.

Brachycephalic dogs may have a variety of clinical signs, including inspiratory stertor (snoring) and stridor. Generally, stertorous breathing is associated with excessive tissue in the upper portion of the airway, such as an elongated soft palate, whereas stridor is usually associated with a narrowed or strictured upper airway, such as that caused by laryngeal collapse or paralysis. In our study, there was no significant association of clinical signs with diagnosis. Thus, although certain clinical signs are supportive of the various components of brachycephalic syndrome, definitive diagnosis can only be made on the basis of oropharyngeal examination findings.

In some of the dogs of the present study, gagging, retching, and vomiting were evident, which can result from a combination of factors. Excessive vagal stimulation associated with high upper airway pressure can stimulate a central invoked vomiting response. An elongated soft palate can cause gagging and retching because it extends caudal to the rima glottis, and there are several gastrointestinal tract disorders that commonly coincide with chronic respiratory compromise in dogs and in brachycephalic dogs in general. Poncet et al identified a significant association between severity of respiratory tract signs and pathologic changes in the gastrointestinal tract.

From the clinical experiences of the authors and others with dogs with brachycephalic syndrome, it has been thought that dogs with hypoplastic trachea may have a less favorable prognosis than those without. In 1 study, of 52 (85%) dogs with dyspnea for which a diagnosis of hypoplastic trachea was made, at least 1 other component of brachycephalic syndrome. Tracheal diameter was not associated with degree of dyspnea in that investigation. In our study, none of the dogs had a diagnosis of hypoplastic trachea alone; 12 of the 13 dogs with hypoplastic trachea had at least 2 other brachycephalic syndrome-associated diagnoses. This is not to imply that hypoplastic trachea is a secondary problem—it should be considered another independent component of brachycephalic syndrome. There was no significant difference in long-term outcome between dogs with hypoplastic trachea and dogs with an apparently normal tracheal diameter. This finding is supported by data reported recently by Pink et al. Despite a small sample size in that study, all of the dogs had tracheal hypoplasia and there was no apparent association of that condition with postoperative outcome. Because of our study's retrospective design, not all dogs underwent thoracic radiography during the preoperative evaluation; thus, the number of dogs with hypoplastic trachea may be underrepresented.

Laryngeal collapse was not a common finding in the dogs in the present study. Among the medical records initially considered for inclusion in our study, a diagnosis of laryngeal collapse was noted for 8 dogs; however, records of 4 dogs were excluded because the criteria for case selection were not met. Of the 4 dogs with laryngeal collapse that were included in the present study, 2 had a good or excellent outcome after surgical correction of their other abnormalities. The remaining 2 dogs were lost to follow-up. In the dogs in our study, laryngeal collapse was not surgically treated. Laryngeal collapse may be treated medically by means of weight loss, exercise restriction, and administration of drugs to reduce airway edema. In dogs with severe laryngeal collapse that do not respond to medical treatment, permanent tracheostomy can be considered.

Two recent publications regarding brachycephalic syndrome in dogs focus on laryngeal collapse. The method of grading the laryngeal collapse varies among these studies: used the system described by Leonard in 1960, whereas used an original mild-moderate-severe scale. It is important to note that grade 1 laryngeal collapse, as described by Leonard, represents eversion of the laryngeal saccules. Thus, we would expect mild or grade 1 collapse to respond favorably when upper airway negative pressure is reduced and saccules are removed. Contrary to the results of the present study, laryngeal collapse was identified in as many as 53% (34/64) of dogs with brachycephalic syndrome in another investigation, and long-term outcome was considered improved in 84% (41/46) of dogs with severe collapse. The results of that study offer support for an apparent palliative effect through reduction of upper airway negative pressure, even for dogs with severe laryngeal collapse.

The question of cause and effect in brachycephalic syndrome has not been definitively resolved by previous studies. It has been suggested that stenotic nares account for all airway changes causally, causing elongation of the soft palate and eversion of laryngeal saccules as a result of chronic increases in negative pressure in the oropharynx. Most (75%) of the total airway resistance (from nares to bronchioles) occurs in the nasal cavity. In the present study, 36 dogs had stenotic nares and of those, 25 (approx 70%) had an elongated palate and 25 (approx 70%) had everted saccules. Although a small percentage of dogs in our study had an elongated soft palate without stenotic nares, this finding supports the suggestion that stenotic nares may be a common Denominator in development of elongated palate and everted saccules. Previously, there has been an indication that stenotic nares have an impact on other diagnoses and postoperative outcome. However, the long-term outcome for the dogs of the present study was not associated with whether rhinoplasty was or was not performed.

Everted laryngeal saccules are thought to be secondary to chronic upper airway resistance.
with everted saccules included in the present study had at least 1 other abnormality; 26 of 28 (93%) dogs with 3 or 4 abnormalities had everted saccules. The findings of our study and those of recent investigations strongly support everted saccules and laryngeal collapse as secondary changes. Thus, as with laryngeal collapse, staphylectomy and nares repair may offer palliative effects. The authors have realized and caution others that not all saccules may require excision.

Laryngeal paralysis is not typically recognized as a component of brachycephalic syndrome. However, the authors have diagnosed laryngeal paralysis in brachycephalic dogs. Because of the retrospective nature of the present study, it was difficult to determine how many dogs were evaluated for laryngeal paralysis prior to surgery. Assessment of laryngeal function should be a routine part of complete upper airway evaluations.

Outcomes of 2 techniques for staphylectomy—sharp cut-and-sew resection and carbon dioxide laser resection—were compared in our study. The primary advantages of use of a carbon dioxide laser include minimal hemorrhage, swelling, and signs of postoperative pain and potential bactericidal properties of laser ablation. The laser coagulates small vessels as it cuts, seals lymphatic vessels, minimizes tissue handling and subsequent swelling, and decreases signs of postoperative pain by sealing nerve endings. Use of the laser reduces the duration of surgeries by more than half. Disadvantages of laser staphylectomy include the cost of the equipment and the potential safety hazards to those not familiar with laser use. Disadvantages of sharp cut-and-sew resection include hemorrhage and swelling. In our study, long-term outcome was similar regardless of the staphylectomy technique used. In a study in dogs by Davidson et al., results during the immediate period following laser and scissor resection were similar to those of our study, although long-term outcomes were not assessed.

Complications associated with surgical treatments of brachycephalic syndrome among the dogs of the present study were uncommon. Reported complications include marked pharyngeal edema and inflammation during the postoperative period, nasal regurgitation as a result of excessive soft palate resection, and aspiration pneumonia. Other less severe complications include dehiscence of nares repair, voice change because of excessive scaring following sacculectomy, and persistent upper airway noise. In our study, complications were limited to 1 dog that required a temporary tracheostomy because of pharyngeal edema and 1 dog that required a rhinoplasty revision because of a suture reaction. Compared with other investigations of brachycephalic syndrome in dogs, the mortality rate among the dogs of our study (3.2%) was the lowest, with the exception of a rate of 0% reported by Torrez and Hunt. The deaths in the present study occurred before successful recovery of the dogs from anesthesia (no necropsy information was available). The authors speculate that these deaths were a result of the high risk of anesthesia in brachycephalic dogs; because of severe upper airway obstruction, relative hypoxemia and increased vagal tone with or without subsequent bradyarrhythmias may develop, for example. We believe that improvements in surgical technique and perianesthetic management have contributed to lower mortality rates in more recent studies.

The results of our study have suggested that surgical correction of brachycephalic syndrome in dogs is associated with a favorable prognosis. Overall, the clinical status of 32 of 34 (94.1%) dogs was improved following surgery. These results were independent of age, breed, combination of diagnoses, and number of diagnoses and were similar following use of the laser and sharp resection techniques.

References