Brachycephalic airway obstructive syndrome in dogs: 90 cases (1991–2008)

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Objective—To determine the prevalence of individual anatomic components of brachycephalic airway obstructive syndrome (BAOS), including everted tonsils, and analyze the frequency with which each component occurs with 1 or more other components of BAOS in brachycephalic dogs.

Design—Retrospective case series.

Animals—90 dogs with BAOS.

Procedures—Medical records were reviewed for signalment, clinical signs at time of admission, historical and physical examination findings, BAOS components found on laryngoscopic examination of the pharynx and larynx, surgical procedures performed, and perioperative complications.

Results—English Bulldogs (55/90 [61%]), Pugs (19/90 [21%]), and Boston Terriers (8/90 [9%]) were the most common breeds with BAOS. The most common components of BAOS were elongated soft palate (85/90 [94%]), stenotic nares (69/90 [77%]), everted laryngeal saccules (59/90 [66%]), and everted tonsils (50/90 [56%]). Dogs most commonly had 3 or 4 components of BAOS, with the most common combination being stenotic nares, elongated soft palate, everted laryngeal saccules, and everted tonsils. Dogs with stenotic nares were significantly more likely to have everted laryngeal saccules (50/69 [72%]), and dogs with everted laryngeal saccules were significantly more likely to have everted tonsils (39/59 [66%]). Postoperative surgical complications occurred in 12% (10/83) of dogs that received corrective surgery. No specific BAOS component made dogs more likely to have complications.

Conclusions and Clinical Relevance—The prevalence of components of BAOS in brachycephalic dogs of this study differed from that reported previously, especially for everted tonsils. Thorough examination of the pharynx and larynx is necessary for detection of BAOS components. (*J Am Vet Med Assoc* 2010;237:1048–1051)

Brachycephalic dogs have unique upper respiratory anatomy that leads to upper airway obstruction. Compared with other breeds, brachycephalic dogs have a shortened skull resulting in a compressed nasal passage and altered pharyngeal anatomy.[1] Most brachycephalic dogs have a combination of compressed anatomy creating increased negative pressure on inspiration for adequate ventilation, leading to inflammation and stretching of pharyngeal tissues as well as obstruction. The primary anatomic components of BAOS are stenotic nares, elongated soft palate, and hypoplastic trachea, which create negative pressure within the airway because of increased respiratory effort, leading to additional secondary components. These include everted laryngeal saccules, laryngeal collapse, and everted tonsils, which further create airway turbulence and edematous pharyngeal tissue through increased respiratory efforts.[1–7]

Dogs with BAOS manifest various clinical signs, including stertorous breathing, loud snoring, coughing, gagging, syncope, collapse episodes, and difficulty eating.[2] These may occur at varying degrees of severity, from mild nasal airflow obstruction to severe signs of airway occlusion such as rapid inspiratory rates, pale or cyanotic mucous membranes, and abducted forelimbs. Acute signs can be exacerbated by patient obesity or stressful situations such as overheating, excitement, and exercise.[8] Extreme respiratory distress can be associated with difficulty ingesting food and uncoordinated swallowing, which may result in aspiration pneumonia and aerophagia. Gastrointestinal signs such as vomition and diarrhea can occur with extreme hyperthermia and aerophagia, and patients sometimes are evaluated for vomiting not associated with eating, which may be directly related to BAOS.[9–12]

In 1982, Harvey[3,4] reported the occurrence of the multiple anatomic components in a population of brachycephalic dogs, which included only those patients that were in need of surgical treatment. Harvey[3,4] found that stenotic nares were present in 51% of the

Abbreviations

BAOS	Brachycephalic airway obstructive syndrome
NPS	Stenotic nares, elongated soft palate, and everted laryngeal saccules
NPST	Stenotic nares, elongated soft palate, everted laryngeal saccules, and everted tonsils

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group, elongated soft palate in 100%, everted laryngeal saccules in 53%, laryngeal collapse in 31%, and everted laryngeal tonsils in 9%.

The American Kennel Club has recorded a substantial increase in the popularity of brachycephalic dogs; during the last decade, registration of Bulldogs, Miniature Bull Terriers, Bull Terriers, Staffordshire Bull Terriers, Bullmastiffs, and French Bulldogs has increased by 69%, 109%, 102%, 69%, 22%, and 476%, respectively.[13] This increase in dog registration is indicative of a growth in breeding these brachycephalic breeds, which may directly affect the prevalence of the individual anatomic components of BAOS.[13]

Findings in brachycephalic breeds have been commented on by investigators, including Lorinson et al[2] and Riecks et al,[5] who focused on postoperative outcomes after surgical treatment of BAOS in dogs. However, these investigators reported differing success rates for surgery in older versus younger dogs. Also, these studies included only dogs that had surgical intervention; therefore, a selection bias may have been present for the more severely affected dogs. In another study,[6] surgical prognosis in association with laryngeal collapse in dogs of Australia was evaluated. Again, only dogs that had surgical intervention were included, and this study[6] arguably involved a different genetic pool of patients than those in the United States. More recently, Ginn[7] detailed the prevalence of the anatomic components of BAOS in dogs and cats with nasopharyngeal turbinate disease. Case selection in that study[7] included only dogs and cats undergoing endoscopic assessment of the airway, as the prevalence of protruding nasal turbinates was being investigated. Although findings from all of these studies[2,5–7] have helped to gain a better understanding of BAOS, they may be biased toward animals more severely affected with BAOS or affected animals with specific traits.

It is probable that the occurrence of components of BAOS has changed since some of the early studies[1–4] were performed. More recent studies had a more narrowed focus on BAOS, with case selection limited to animals that underwent surgical intervention,[5,6] underwent nasal turbinate evaluation,[7] or had gastrointestinal disease.[10–12] However, to our knowledge, no recent studies have examined the prevalence of the individual components of BAOS in dogs without the use of narrow case selection criteria. Also, everted tonsils are usually not mentioned as a component of BAOS in dogs.[14–16] Therefore, the purposes of the study reported here were to determine the prevalence of the individual anatomic components of BAOS, including everted tonsils, and to analyze the frequency with which each component occurs with 1 or more other components of BAOS in a population of brachycephalic dogs that includes both surgical and nonsurgical cases.

Materials and Methods

Case selection—Medical records of the Mississippi State University College of Veterinary Medicine Animal Health Center were searched to identify all brachycephalic dogs admitted to the hospital between 1991 and 2008 with 1 or more of the following: stenotic nares, elongated soft palate, everted laryngeal saccules, everted tonsils, and hypoplastic trachea. Dogs may or may not have been surgically treated by nares resection, staphylectomy, laryngeal sacculectomy, or tonsillectomy. Data from dogs were included in the study if the dog underwent a laryngoscopic examination of the pharynx and larynx and at least 1 anatomic component of BAOS was observed.

Medical records review—Information obtained from the medical records included signalment, reason for evaluation, and historical and physical examination findings including stertor or stridor, dyspnea, respiratory distress, exercise or stress intolerance, gagging or coughing, vomiting, cyanosis, collapse, or hyperthermia. Dogs were categorized on the basis of age into 3 groups (ie, ≤ 1 year old, > 1 to ≤ 3 years old, and > 3 years old) as was done by Lorinson et al.[2] In addition, information was obtained from findings on laryngoscopic examination of the pharynx and larynx, indicating whether the patient had stenotic nares, elongated soft palate, everted laryngeal saccules, or everted tonsils and whether these conditions were surgically corrected. Other information included whether thoracic radiographs were obtained, whether the patient had a hypoplastic trachea, and whether intra- or postoperative complications developed and what they were.

Statistical analysis—Data collected from the medical records were tabulated, and percentages for each item were calculated. Mean ± SD values were determined for age and body weight of all dogs in the study population. One-way frequency and cross-tabulation tables and summary statistics were developed by use of a commercially available software program.[a] The Fisher exact test was used to test for associations between occurrences of the BAOS components: elongated soft palate, stenotic nares, everted laryngeal saccules, everted tonsils, and hypoplastic trachea. The χ^2 test was used to test for associations between BAOS component combinations, surgical correction, clinical signs at admission, age group, and complications. Values of $P \leq 0.05$ were considered significant.

Results

Ninety brachycephalic dogs met the inclusion criteria for the study. Mean ± SD age of the dogs was 3.1 ± 2.8 years. Of the 90 dogs, 34 (38%) were ≤ 1 year old, 30 (33%) were > 1 to ≤ 3 years old, and 26 (29%) were > 3 years old. Forty-seven (52%) were sexually intact males, 10 (11%) were neutered males, 17 (19%) were sexually intact females, and 16 (18%) were spayed females. Mean ± SD body weight was 18.64 ± 8.97 kg (41.00 ± 19.74 lb) with a range body weight of 3.41 to 44.09 kg (7.5 to 97 lb). There were 55 (61%) Bulldogs, 19 (21%) Pugs, 8 (9%) Boston Terriers, 4 (4%) French Bulldogs, 3 (3%) Boxers, and 1 (1%) Shih Tzu.

Of the 90 dogs, 62 (69%) had stertor or stridor, 55 (61%) were dyspneic, 48 (53%) had signs of respiratory distress, 43 (48%) had exercise or stress intolerance, 28 (31%) had episodes of gagging or coughing, 13 (14%) vomited, 12 (13%) were cyanotic, 5 (6%) had collapsed, and 4 (4%) were hyperthermic, as recorded in the medical record by the attending clinician. When examined for components of BAOS, 85 of the 90 (94%) dogs had an elongated soft palate, 69 (77%) had stenotic nares, 59 (66%) had everted laryngeal saccules, and 50 (56%) had everted tonsils. Thoracic radiography was performed for 41 dogs; of these, 16

Table 1—Number (%) of dogs out of a total of 90 with various numbers of components of BAOS (1 through 5) categorized by age group, clinical signs, and development of postoperative complications.

No. of BAOS components	Age (y)			Clinical sign					
	≤ 1	> 1 to ≤ 3	> 3	SS	D	R	E	G	PC
1 (9 dogs)	1/9 (11)	1/9 (11)	7/9 (78)	6/9 (67)	5/9 (56)	3/9 (33)	4/9 (44)	2/9 (22)	0/9 (0)
2 (16 dogs)	5/16 (31)	6/16 (38)	5/16 (31)	8/16 (50)	4/16 (25)	4/16 (25)	2/16 (13)	2/16 (13)	1/16 (6)
3 (29 dogs)	12/29 (41)	10/29 (34)	7/29 (24)	23/29 (79)	19/29 (66)	17/29 (59)	16/29 (55)	11/29 (38)	4/29 (14)
4 (29 dogs)	11/29 (38)	11/29 (38)	7/29 (24)	20/29 (70)	21/29 (72)	18/29 (62)	15/29 (52)	8/29 (28)	5/29 (17)
5 (7 dogs)	5/7 (71)	2/7 (29)	0/7 (0)	5/7 (71)	6/7 (86)	6/7 (86)	6/7 (86)	5/7 (71)	0/7 (0)

D = Dyspnea. E = Exercise or stress intolerance. G = Episodes of gagging or coughing. PC = Postoperative complication. R = Respiratory distress. SS = Stertor or stridor.

Table 2—Number (%) of dogs out of a total of 38 with the 2 most common combinations of BAOS components (NPST or NPS) categorized by age group, clinical signs, and development of postoperative complications.

Combination of BAOS components	Age (y)			Clinical sign					
	≤ 1	> 1 to ≤ 3	> 3	SS	D	R	E	G	PC
NPST (24 dogs)	7/24 (29)	11/24 (46)	6/24 (25)	15/24 (63)	17/24 (71)	13/24 (54)	12/24 (50)	6/24 (25)	4/24 (17)
NPS (14 dogs)	6/14 (43)	4/14 (29)	4/14 (29)	10/14 (71)	8/14 (57)	7/14 (50)	6/14 (43)	6/14 (43)	2/14 (14)

See Table 1 for key.

(39%) had radiographic evidence of a hypoplastic trachea. Fifty of the 90 (56%) dogs had both stenotic nares and everted laryngeal saccules. Dogs with stenotic nares were significantly (*P* = 0.01) more likely to have everted laryngeal saccules (50/69 [72%]). Thirty-nine of the 90 (43%) dogs had both everted laryngeal saccules and everted tonsils. Dogs with everted laryngeal saccules were significantly (*P* = 0.006) more likely to have everted tonsils (39/59 [66%]). There were no other significant ($P \geq 0.20$ for all other comparisons) associations among other BAOS components.

Eighty-three of the 90 (92%) dogs underwent some form of corrective BAOS surgery. A staphylectomy was performed in 78 of the 90 (87%) dogs, nares resection in 59 (66%), laryngeal sacculectomy in 56 (62%), tonsillectomy in 48 (53%), and arytenoid lateralization in 3 (3%). Four dogs developed intraoperative complications (hypotension [n = 2], tachycardia [1], and atrioventricular block [1]), while 10 dogs had postoperative complications (major [severe dyspnea or death; 4] or minor [excessive respiratory noise, dehiscence, or regurgitation; 6]).

Of the 5 recognized components of BAOS, 9 (10%) of the 90 dogs had 1 component, 16 (18%) had 2 components, 29 (32%) had 3 components, 29 (32%) had 4 components, and 7 (8%) had 5 components **(Table 1)**. Six of 7 dogs with 5 BAOS components had signs of respiratory distress, whereas only 4 of 16 dogs with 2 BAOS components had signs of respiratory distress.

The most common combinations of BAOS components observed were NPST in 24 (27%) of the 90 dogs and NPS in 14 (16%) dogs. For the 2 most common combinations of components, NPST and NPS, dogs were mostly in the middle and youngest age groups **(Table 2)**.

Discussion

Findings in this study concerning signalment and breeds of dogs with BAOS were similar to those reported previously.[2–13] The observed frequency of BAOS components in dogs of our study differs from findings of studies by Torrez and Hunt[6] and Ginn,[7] in which everted laryngeal saccules were observed more commonly than stenotic nares. Also, an increased prevalence of everted tonsils, compared with that observed by Harvey[3,4] and Lorinson et al,[2] was found in our study. This difference in findings among studies may reflect, in part, the nature of the study populations. Torrez and Hunt[6] included only dogs that were evaluated endoscopically, while Ginn[7] included only dogs that had undergone surgery. The higher incidence of everted tonsils observed in dogs of our study probably reflects an increased awareness of this potential finding during laryngoscopic examination of the pharynx and larynx.

The greater number of clinical signs observed in dogs with the combination of NPST, compared with that of dogs with the combination of NPS, may reflect the role of everted tonsils in BAOS or the increased awareness of its role in this syndrome by the surgeons performing examination of the pharynx and larynx. Everted tonsils were observed in 24 of 38 (63%) dogs of our study with the most common combination of BAOS components (ie, NPST or NPS). Most dogs with NPST (17/24 dogs) were in the 2 older age groups, compared with the number of dogs with NPS (8/14) that were in the 2 older age groups. These findings imply everted tonsils are likely to occur with continued airway strain in dogs generally over 1 year of age. Everted tonsils will detract from the available airway space and should be examined.

Surgical correction of BAOS components carries an anesthetic risk in the already respiratory-compromised patients, and proper pre- and postoperative measures should be taken. This study population had a low complication rate, with intraoperative complications occurring in only 5% (4/83) of dogs and postoperative complication occurring in only 12% (10/83) of dogs. No correlation between the number of BAOS components or patient age with risk of complications was determined. Of the 10 dogs with postoperative complications, only 1 was in the older age group. This may reflect the possibility that more severely affected dogs are evaluated at a younger age.

Limitations of our study include its retrospective nature; the possibility of incomplete information in the medical records, reflected by underreporting of complications and clinical signs; lack of a set protocol for patient evaluation; and the performance of laryngoscopic examination of the pharynx and larynx by different clinicians. All pertinent findings on laryngoscopic examination of the pharynx and larynx may not have been recorded, as the hospital does not have a uniform examination form for this evaluation. Also, results of statistical analysis in our study may be affected by the small number of affected dogs with complications, possibly leading to a type II error. Both referral and primary care patients were evaluated in this study; however, more referral than primary care patients were seen. Further studies are needed to determine the contribution of each component of BAOS to signs of clinical disease. Few radiographic images of the cervical and thoracic regions were taken for the evaluation of a hypoplastic trachea, so its true prevalence and involvement in complications may not be fully appreciated in this study population. Such radiographic evaluation would better standardize the assessment of brachycephalic patients as well as provide potential morphological information about the soft palate.

The difference in prevalence of the components of BAOS in this study, compared with that of previous studies,[1–7] may be explained, in part, by an increased popularity of selected brachycephalic breeds, the performance of a more focused examination of the pharynx and larynx, or regional influences in the United States. Everted tonsils may be a more frequent component of BAOS than previously thought. Although relatively infrequently observed, perioperative complications were seen in dogs of all age groups, suggesting care should be taken with every dog with BAOS.

a. FREQ procedure, SAS System for Windows, version 9.2, SAS Institute Inc, Cary, NC.

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