

## Brachycephalic Syndrome in Dogs - Endoscopic Findings in the Airways

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### ABSTRACT

**Background:** Brachycephalic dogs have several abnormalities in the airways, which generate clinical manifestations that impair the quality of life of these animals. Primary alterations promote airflow obstruction and increase intraluminal negative pressure, causing secondary alterations due to a cycle of inflammation with consequent obstruction. With the onset of inflammation and other alterations in the airways, clinical manifestations can be observed, such as snoring, reverse sneezing, coughing, dyspnea, cyanosis, syncope, and vomiting. Endoscopic examination of the airways allows visualization and diagnosis of morphological changes in these animals. This study aimed to evaluate the endoscopic findings of the airways and determine the quantitative and qualitative assessment of the severity of clinical manifestations in 14 dogs with brachycephalic syndrome (BS).

**Materials, Methods & Results:** Historical and anamnesis data and clinical, respiratory, and digestive manifestations were collected from the owners' reports. The clinical manifestations were classified as mild, moderate, or severe. All animals were subjected to endoscopy of the airways, and image findings were grouped according to the anatomical site where they were observed, then the abnormalities were correlated with the severity of the clinical manifestations. When comparing the frequency of endoscopic abnormalities with the severity of clinical manifestations, it is interesting to observe that animals with severe disease more frequently presented the following alterations: prolongation and thickening of the soft palate, laryngeal changes, presence of hyperemia, lymphoid hyperplasia and polyps in the nasopharynx, hypoplasia and presence of tracheal secretion and thickening of the dorsal tracheal muscle; bronchial collapse, hypoplasia of the main bronchi and bronchial hyperemia and the presence of aberrant nasal turbinates. Comparison between the means of nonparametric variables was performed using the Mann-Whitney test, with a 5% significance level.

**Discussion:** A higher frequency of French Bulldog dogs included in the study was observed, probably due to their greater popularity, although any brachycephalic dog may be affected by BS. Considering that nostril stenosis is a congenital alteration, which is usually diagnosed early, and since the animals included in the study were dogs referred for the rhinoplasty procedure the higher frequency of young dogs in the study was not surprising. The results revealed a significant difference in the endoscopic findings with the severity of the clinical manifestations in different variables, such as prolongation and thickening of the soft palate, eversion of the laryngeal saccules, presence of laryngeal inflammation and collapse, presence of polyps or lymphoid hyperplasia in the nasopharynx, thickening of the dorsal muscle of the trachea, polyps in the trachea and hypoplasia in addition to bronchial hyperemia. The larynx was the most affected anatomical site, with alterations present in 92.8% of the evaluated dogs. Based on these findings, it can be concluded that airway obstruction caused by primary alterations can cause secondary alterations, with consequent clinical manifestations in brachycephalic dogs it is possible to suggest that dogs with this syndrome may present severe manifestations of the disease, regardless of age. Furthermore, it can be concluded that in this study, dogs with BS had frequent laryngeal alterations and that alterations in the main bronchi were present in all animals with severe manifestations of the disease.

**Keywords:** airway obstruction, bronchial collapse, endoscopy, larynx.

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## INTRODUCTION

Brachycephalic dogs have become increasingly popular as companion animals, mainly because they are docile and require less space in their homes [7,8]. These dogs usually have brachycephalic syndrome (BS), in which several congenital anatomical changes lead to obstruction of the airways [18,20]. This obstruction resulted in resistance to airflow and increased intraluminal negative pressure, generating secondary changes that perpetuate the cycle of obstruction and soft tissue injury, aggravating respiratory symptoms [1,9].

The clinical manifestations involved can vary from mild to severe and can be exemplified as snoring, coughing, exercise intolerance, dyspnea at rest, cyanosis, and syncope [10,18]. In addition to impairing the quality of life of affected dogs, this can lead to death [24].

Primary and secondary changes can be identified using different diagnostic methods. On physical examination, it was possible to identify the presence and degree of nostril stenosis [3]. Imaging examinations can be used to diagnose other alterations [21]. Among these examinations, the most commonly used are radiographs of the cervical and thoracic regions, which can identify the presence of elongation and thickening of the soft palate and the occurrence of hypoplasia or tracheal collapse [22]. However, endoscopy of the airways allows the most accurate diagnosis of these alterations [3]. Through this examination, it is possible to visualize the entire extension of the airways to the region of the main bronchi, determining the presence and severity of each abnormality present, as an exam that encompasses the qualitative and quantitative evaluation of the obstructive processes [21,22].

This study aimed to evaluate the endoscopic findings in the airways and correlate them with clinical manifestations in brachycephalic dogs.

## MATERIALS AND METHODS

### *Local*

This study was conducted at the of the Cardiology and Respiratory Diseases Service (CRDS) of the Small Animal Veterinary Hospital of the Federal Rural University of Rio de Janeiro (UFRRJ), Seropédica.

### *Animals*

Brachycephalic dog breeds included in the study were selected from the clinical routine, aged  $\geq$

6 months, regardless of sex and reproductive status. In this study, only dogs with BS, who were referred for the rhinoplasty procedure, and their owners consented to respiratory endoscopy prior to the surgical procedure were included.

In addition to nostril stenosis, those who had clinical changes related to brachycephaly (snoring, dyspnea, cough, exercise intolerance, syncope, or apnea) were considered to have BS.

### *Clinical evaluation*

The clinical evaluation was initiated by obtaining the patient's history and anamnesis. Owners were asked about specific clinical aspects, such as coughing, sneezing, dyspnea at rest, cyanosis, syncope, and the presence of gastroenteric signs (flatulence, vomiting, and regurgitation).

Patients who showed changes in preoperative examination, such as blood count, liver serum biochemistry (aspartate aminotransferase, alanine aminotransferase, and alkaline phosphatase), and kidney (creatinine and urea), as well as changes in electrocardiographic or echocardiographic exams that contraindicate anesthesia, were not included.

### *Classification of groups*

After these stages, a physical examination was performed, and according to all clinical findings, animals classified with BS were grouped according to clinical signs as follows: severe signs (cyanosis, syncope, dyspnea at rest, or apnea), moderate signs (cough), and mild signs (signs other than those described, such as sneezing, snoring, and reverse sneezing).

### *Airway endoscopy*

For evaluation of the airways through endoscopy, the animals were sedated with pre-anesthetic medication [morphine<sup>1</sup> - 1 mg/kg/IM], and induction was performed with the patient in the operating room, and anesthetic propofol<sup>2</sup> [propofol - 3 mg/kg/EV] was administered intravenously, until loss of consciousness, palpebral, and mandibular reflexes. After induction, the patient was intubated, and anesthesia was maintained with 1.5% isoflurane [isoflurane<sup>3</sup> - dose-effect/inhalation]. The patient was then positioned in the sternal decubitus with the head slightly raised and placed on a support to start the airway endoscopy (AE). After anesthesia, the dogs were pre-oxygenated for 5 min and then extubated to introduce a fiber optic videoendoscopic probe<sup>4</sup>.

During AE, aspects, such as the color of the airways, areas of edema and mucosal irregularities, the presence and appearance of secretions, and the size and shape of the trachea and bronchi, were evaluated in the dorsoventral direction. The same parameters were evaluated using the retrograde rhinoscopy technique in the nasal cavity.

#### *Statistical analysis*

For quantitative variables, measures of central tendency (mean) and variation (standard deviation, variance, and coefficient of variation) were calculated, and for qualitative variables, absolute and relative frequencies were estimated using descriptive statistics. Comparisons between the means of nonparametric variables were performed using the Mann-Whitney U test. All analyses were performed using the SPSS 25.0 program<sup>5</sup>, and a probability level of 5% was considered.

### RESULTS

Fourteen dogs were included, of which 78.6% (11/14) were French Bulldogs and 21.4% (3/14) were pugs, with 50% (7/7) of the dogs being female and 50% (7/7) being male. The dogs were aged 5-60 months, with the age group distributed according to Table 1.

The clinical signs reported by the owners at the time of the clinical examination showed respiratory signs, and 56.2% (9/14) showed signs related to the gastrointestinal tract. Snoring was the most common alteration among respiratory signs in all dogs. The frequency of sneezing and coughing was the same, reported in 42.8% (6/14), and reverse sneezing was reported in 12.2% of dogs (2/14). More severe respiratory signs were observed less frequently in the study dogs, such as dyspnea at rest in 35.7% (5/14), cyanosis in 28.6% (4/14), and only one of the animals had apnea and syncope (7.1%) [Figure 1]. Among gastrointestinal signs, flatulence was the most frequent alteration present in 56.2% (9/14), followed by regurgitation in 21.4% (3/14) and vomiting in 12.2% (2/14) [Figure 2].

When the severity of the clinical manifestations was evaluated, 57.1% (8/14) of the animals had severe signs of the disease, 16.6% (2/14) had moderate signs, and 28.6% (4/14) had mild signs.

Regarding the AE findings, a significant difference was observed in relation to the endoscopic findings and the severity of the clinical signs presented in Table 2.

The larynx region was the most affected, with changes in this anatomical site present in 92.8% (13/14) of the dogs. The laryngeal alterations identified in these dogs were eversion of laryngeal saccules (92.8%; 13/14), laryngeal collapse and edema found concomitantly (35.7%; 5/14), and laryngeal polyps (7.1%; 1/14).

The presence of elongation of the soft palate was observed in 85.7% (12/14) of the dogs. Among these, only one animal (7.1%) [aged 8 months old] had thickening of the palate detected on endoscopic examination. Nasopharyngeal changes were observed in 42.8% (6/14) of dogs, with nasopharyngeal nodules occurring most frequently in 21.4% (3/14) of the animals, followed by lymphoid hyperplasia and polyps that occurred with the same frequency (14.2%; 2/14). The least frequent findings were the presence of mucus in the nasopharynx in one animal (7.1%) and hyperemia of the nasopharynx in one animal (7.1%).

Tracheal abnormalities were present in 64.2% of dogs (9/14). Tracheal hyperemia was the most frequent finding, occurring in 35.7% (5/14) of the animals. The presence of polyps and secretion was equally frequent in 28.6% (4/14) of the animals, and only 1 animal had both alterations concomitantly. Less frequent alterations, such as tracheal hypoplasia, were observed in 21.4% (3/14) of the dogs, and thickening of the dorsal tracheal muscle and tracheal collapse were observed with the same frequency in 14.2% (2/14) of the dogs.

Following evaluation of the tracheobronchial tree, 64.2% (9/14) of the animals were observed to have bronchial abnormalities, with bronchial collapse being the most frequent alteration (42.8%; 6/14). Other bronchial alterations were identified as hyperemia of the walls (28.6%; 4/14), bronchial stenosis (14.2%; 2/14), and bronchial hypoplasia (7.1%; 1/14). In all animals that had bronchial collapse, only the right bronchus was affected.

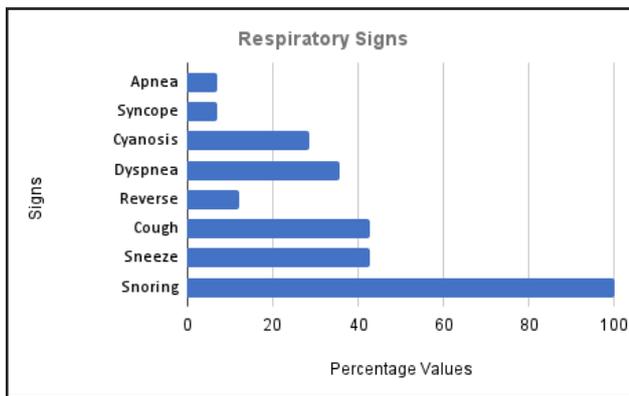
In the evaluation of the nasal cavity, the presence of aberrant turbinates was the most frequent alteration in the evaluation of the nasal cavity, occurring in 42.8% (6/14) of the dogs. Other alterations (35.7%; 5/14) were present at this anatomical site, and each abnormality (nodule, mucus, hyperemia, edema, and lymphoid hyperplasia) was identified in different animals.

When comparing the frequency of endoscopic abnormalities with the severity of clinical manifesta-

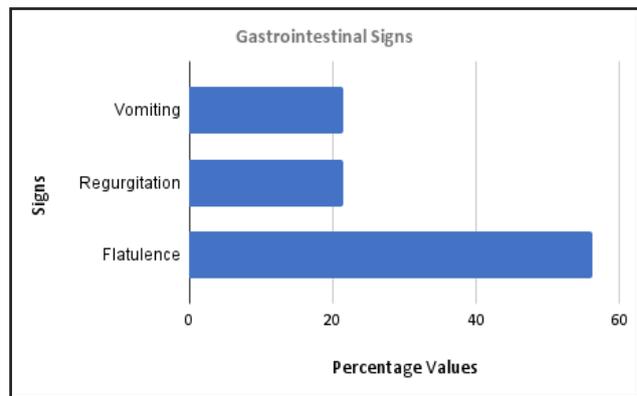
tions, it is interesting to observe that animals with severe disease more frequently presented the following alterations: prolongation and thickening of the soft palate, laryngeal changes, presence of hyperemia, lymphoid hyperplasia, and polyps in the nasopharynx; hypoplasia and presence of tracheal secretion and thickening of the dorsal tracheal muscle; bronchial collapse, hypoplasia of the main bronchi and bronchial hyperemia, and the presence of aberrant nasal turbinates (Table 3).

No alterations were observed when evaluating the frequency of endoscopic alterations in patients

with moderate manifestations. When analyzing the results obtained through AE in animals with mild manifestations, we observed a higher frequency of nodules and secretion in the nasopharynx, in addition to the presence of tracheal polyps. However, it is interesting that although few animals had collapse and tracheal hyperemia, both alterations presented the same frequency among animals with mild and severe signs.



**Figure 1.** Graphic illustration of the respiratory signs reported by the owners of the brachycephalic dogs included in the study, in percentage values. [Source: CRDS, 2018].



**Figure 2.** Graphic illustration of the gastrointestinal signs reported by the owners of the brachycephalic dogs included in the study, in percentage values. [Source: CRDS, 2018].

**Table 1.** Distribution according to breed, sex and age of the animals included in the study.

		FA (n)	FR (%)
Breed	Pug	3	21.4
	French bulldog	11	78.6
Sex	Males	7	50
	Females	7	50
Age	≤ 1 year	10	71.4
	> 1 year	4	28.6

FA: absolute frequency. FR: relative frequency.

**Table 2.** Statistical values refer to the comparison between endoscopic findings and the severity of clinical signs.

Variable	u	P-value
Soft palate extension	0.5	0.0404
Soft palate thickening	0	0.0248
Eversion of laryngeal sacculles	0	0.0248
Laryngeal edema	2.5	0.1914
Laryngeal collapse	2.5	0.1914
Nasopharyngeal polyps	0.5	0.0404
Lymphoid hyperplasia in nasopharynx	0	0.0248
Thickening of the dorsal trachea muscle	0.5	0.0404
Polyps in trachea	0	0.0248
Bronchial hypoplasia	0	0.0248
Bronchial hyperemia	0	0.0248

**Table 3.** Association between the endoscopic findings in the airways of brachycephalic dogs and severity of clinical manifestations.

Variable	n	Mild	Moderate	Severe
Total	14	4 (28.6%)	2 (14.3%)	8 (57.1%)
<b>SOFT PALATE ABNORMALITIES</b>	12	4 (33.3%)	2 (16.6%)	6 (50%)
Extension				
Yes	12	4 (33.3%)	2 (16.6%)	6 (50%)
No	2	2 (100%)	0	0
Thickening				
Yes	1	0 (0%)	0 (0%)	1 (100%)
No	13	4 (30.8%)	2 (15.4%)	7 (53.8%)
<b>LARYNX ABNORMALITIES</b>	13	4 (30.8%)	2 (15.4%)	7 (53.8%)
Eversion of laryngeal sacculles				
Yes	13	4 (30.8%)	2 (15.4%)	7 (53.8%)
No	1	1 (100%)	0	0
Laryngeal polyps				
Yes	1	0	0	1 (100%)
No	13	4 (30.8%)	2 (15.4%)	7 (53.8%)
Laryngeal edema and collapse				
Yes	5	0	1 (20%)	4 (80%)
No	9	4 (44.4%)	1 (11.1%)	4 (44.4%)
<b>NASOPHARYNX ABNORMALITIES</b>	6	2	1	3
Nodules in nasopharynx				
Yes	3	2 (66.7%)	1 (33.3%)	0
No	11	2 (18.2%)	1 (9.1%)	8 (72.7%)
Nasopharyngeal hyperemia				
Yes	1	0	0	1 (100%)
No	13	4 (30.8%)	2 (15.4%)	7 (53.8%)
Mucus in nasopharynx				
Yes	1	1 (100%)	0	0
No	13	3 (23.1%)	2 (15.4%)	8 (65.1%)
Lymphoid hyperplasia in nasopharynx				
Yes	2	0	0	2 (100%)
No	12	4 (33.3)	2 (16.7%)	6 (50%)
Nasopharyngeal polyps				
Yes	2	0	1 (50%)	1 (50%)
No	12	4 (33.3%)	1 (8.3%)	7 (58.3%)
<b>TRACHEA ABNORMALITIES</b>	9	3 (33.3%)	1 (11.1%)	4 (44.4%)
Trachea hypoplasia				
Yes	3	0	1 (33.3%)	2 (66.6%)
No	11	4 (36.4%)	2 (18.2%)	6 (54.5%)
Thickening of the dorsal trachea muscle				
Yes	2	0	1 (50%)	1 (50%)
No	12	4 (33.3%)	1 (8.3%)	7 (58.3%)
Tracheal hyperemia				
Yes	5	2 (40%)	1 (20%)	2 (40%)
No	9	2 (22.2%)	1 (11.1%)	6 (66.7%)

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(...continuation)

Variable	n	Mild	Moderate	Severe
Tracheal collapse				
Yes	2	1 (50%)	0	1 (50%)
No	12	3 (25%)	2 (16.7%)	7 (58.3%)
Tracheal polyps				
Yes	4	3 (75%)	0	1 (25%)
No	10	1 (10%)	2 (20%)	7 (70%)
Tracheal secretion				
Yes	4	1 (25%)	0	3 (75%)
No	10	3 (30%)	2 (20%)	5 (50%)
BRONCHIAL ABNORMALITIES	9	2 (22.2%)	0	7 (77.8%)
Bronchial collapse				
Yes	6	1 (16.7%)	0	5 (83.3%)
No	8	3 (37.5%)	2 (25%)	3 (37.5%)
Bronchial stenosis				
Yes	2	1 (50%)	0	1 (50%)
No	12	3 (25%)	2 (16.7%)	7 (58.3%)
Bronchial hypoplasia				
Yes	1	0	0	1 (100%)
No	13	4 (30.8%)	2 (15.4%)	7 (53.8%)
Bronchial hyperemia				
Yes	4	0	0	4 (100%)
No	10	4 (40%)	2 (20%)	4 (40%)
NASAL CAVITY ABNORMALITIES	5	1 (20%)	1 (20%)	3 (60%)
Aberrant nasal turbinates				
Yes	6	1 (16.7%)	1 (16.7%)	4 (66.6%)
No	8	3 (37.5%)	1 (12.5%)	4 (50%)

## DISCUSSION

A higher frequency of French Bulldog dogs included in the study was observed [8], probably due to their greater popularity, although any brachycephalic dog may be affected by BS [22,32].

Considering that nostril stenosis is a congenital alteration, which is usually diagnosed early, and since the animals included in the study were dogs referred for the rhinoplasty procedure [1,17], the higher frequency of young dogs in the study was not surprising.

The presence of respiratory signs in all animals showed that anatomical abnormalities resulting from BS affected the lives of the animals in the present study [28], regardless of their age. Therefore, this result suggests that the pathophysiological process of this syndrome begins with the birth of these animals. It is

important to note that most animals (56.2%) showed gastrointestinal signs, demonstrating that even young dogs can be affected by aerodigestive changes [11], as proven by the presence of these alterations in the dogs in the study.

The relationship between snoring and BS could be observed, as reported by all tutors, as it is an easily identifiable clinical sign [22]. The presence of this clinical sign suggests that upper airway obstruction is present, reinforcing the need to investigate an obstructive process and other abnormalities in the snoring animal [25]. Despite the high frequency of dogs with sneezes, this clinical manifestation may be related to the occurrence of allergic processes, which are largely justified by the increased exposure of brachycephalic dogs to domiciled environments with a diversity of

possible allergic agents, and not by the anatomical alterations found in BS [6]. However, this study did not investigate the possible environmental influences of sneezing.

The frequency of coughing shows that stimulation of receptors present at different sites in the airways occurs in dogs affected by BS, which may be related to the presence of chronic inflammation of the airway [10]. Reverse sneezing was seldom observed; however, many owners may confuse this manifestation with coughing, dyspnea, or even those who do not spend much of the day with their animals may not have witnessed such events, leaving them as a possibility of underestimating the animals [19].

Among the most severe signs, difficulty in capturing air (dyspnea) and distributing oxygen through the tissues (cyanosis) was observed in a few animals, suggesting that they have more severe anatomical alterations [1]. It is not possible to state that severe clinical signs are rare, since the number of animals included in the study was not representative of the total population of dogs with BS. Few animals had syncope and apnea, demonstrating that these manifestations may not have been observed by the tutors, depending on the moment they occurred [15].

When evaluating aerodigestive signs, flatulence was the most reported alteration, which is related to the occurrence of aerophagia by polypnea, and digestive alterations are common in brachycephalic dogs [34]. Although rarely reported by owners, episodes of vomiting and regurgitation reinforce reports of the predisposition of brachycephalic breeds to present gastrointestinal abnormalities in the literature [11]. The low frequency of these alterations may be related to the fact that the animals evaluated were young, since the gastrointestinal changes in BS are secondary to increased negative pressure in the upper airways and chronic aerophagia, leading to hiatal hernia and gastroesophageal reflux [24,32].

When classifying the clinical manifestations of the dogs in the study, more than half of the animals included had severe manifestations of BS, since at least one of the signs that were considered severe (syncope, cyanosis, dyspnea at rest) was observed in each of these animals [13,16]. Therefore, it is possible to believe that even in young animals, the disease can cause damage to the quality of life and even the risk of death [20,31].

In the dogs included in this study, laryngeal alterations were frequent, as found in one study conducted previously [4], allowing us to hypothesize that the increase in negative pressure generated by the stenosis of the nostrils in these dogs may have contributed to this finding [9]. This hypothesis can be reinforced by other respiratory and gastric clinical findings, in addition to endoscopic findings, which are common due to pressure changes [16]. The impact of the chronic obstructive process on the larynx can be observed by the significant presence of eversion of the laryngeal saccules in the study. Considering the low frequency of laryngeal collapse and edema in the region, and that laryngeal saccule eversion represents the initial stage of laryngeal collapse, it is believed that these findings may be related to the age group of the included animals, since most were under 1-year-old and that laryngeal collapse reflects a more severe and chronic stage [26,31]. Therefore, to better understand this finding, a comparative study of dogs with BS in different age groups is necessary.

Only one dog had laryngeal polyps; however, as the number of animals included was not representative, no conclusion can be drawn other than an occasional finding [33]. It is worth mentioning that the patient in question was the oldest among the animals in the study, again bringing up the possibility of involvement and late evolution [7].

The elongation of the soft palate was a significant finding in dogs in the present study, as described in most animals affected by BS. However, soft palate thickening was observed in only one animal, which presented severe symptoms of the disease, suggesting that this alteration may be secondary to the obstructive process [14]. Therefore, further studies with more appropriate methodologies are required [37].

The presence of polyps and lymphoid hyperplasia in the nasopharynx reinforces the findings of the present study on chronic tissue inflammation [2]. The presence of polyps can also be associated with a chronic obstructive process [30,35]. However, a study with a more representative population of brachycephalic dogs is necessary, as these findings may be related to neoplastic or infectious processes [12,31,38]. The occurrence of nodules was an incidental finding in dogs; however, without histopathological analysis to differentiate between inflammatory or neoplastic

processes, it is not possible to affirm the correlation of BS with its presence.

Although no evident relationship of in severity was observed, more than half of the dogs presented had some alterations in the trachea, between among congenital and acquired alterations [20,23,24]. This finding suggests that, in the dogs of the present study, BS may be the cause of tracheal alterations, as well as a consequence of these findings [5]. However, more comprehensive studies are needed. Tracheal hyperemia and the presence of evident mucus in the AE represent the presence of inflammation; however, both findings were not significantly present in the study animals [13,32]. Therefore, we believe that, despite inflammation being a perpetuating factor of clinical signs, this process did not worsen the clinical condition of the evaluated dogs [27,28].

Tracheal hypoplasia, although rare, was observed in dogs that presented severe symptoms, reinforcing that lumen reduction generates more severe signs than inflammation, as described in other studies [9,10]. Thickening of the trachea muscle was observed in only 2 animals with tracheal hyperemia. Although one study related the presence of dorsal tracheal muscle thickening to tracheal collapse, none of these 2 dogs had collapsed [39]. Therefore, it is possible to hypothesize that thickening may be an early sign of tracheal collapse. The tracheal collapse was observed in only 2 animals, suggesting that the genetic factors associated with the pathophysiology of this condition were not related to BS [5,27].

Regarding the clinical manifestation of the animals with collapse tracheal, there was mild symptomatology in a 5-month-old dog and severe in one of 36-month-old, suggesting that the clinical signs may be related to the age of the animal, since it usually manifests itself after 6 months [4,9]. The occurrence of tracheal polyps was an unexpected finding in study dogs, as they are not commonly reported in other studies. However, without histopathological analysis to rule out other causes, it is not possible to confirm the correlation of BS with its presence. An animal with tracheal hypoplasia showed severe signs of BS [35]. In this case, the severity is not surprising since this alteration decreases airflow and reduces blood oxygenation, leading to severe manifestations.

Bronchial collapse was the most frequent alteration in this region, with the right bronchus be-

ing the most affected in the present study [4]. This fact does not corroborate the data in the literature, in which the left bronchus is reported to be as the most affected [22]. This finding may be related to the small number of animals in the study, or, because other studies also refer to concomitant conditions, such as heart diseases that may can favor this collapse in the left bronchus. On the other hand mean while, 3 animals that presented had laryngeal collapse also presented bronchi collapse, that, and according to any authors [4,9], there is was a strong correlation between the occurrence of these 2 alterations. In the Animals in which bronchial hyperemia was observed, they also presented some degree of obstruction at this anatomical site [29]. Despite the unrepresentative number, it is known that the increase in resistance or change in the passage conformation imposed on the air flow causes inflammation [33]. Animals that presented had bronchus stenosis or hypoplasia were rarely observed in this study, and no correlation with severity could be hypothesized based on by the bias imposed by the sampling. However, the animal that presented with bronchus hypoplasia also presented with tracheal hypoplasia, suggesting that the 2 alterations could be related in this case.

The aberration of the nasal turbinate was an abnormality observed in a few animals (42.8%); however, it was more frequent compared to the data from the literature in which approximately 20% of brachycephalic dogs had this alteration [12]. We must consider that this divergence from previous studies may be related to the population sample [29]. However, it should be noted that the obstructive process imposed by the aberrant turbinate enforces resistance in the airflow through the nasal cavity, which justifies the presence of severe manifestations, such as dyspnea, observed in the study; however, as the patient also had stenosis of the nostril, it was not possible to attribute which of these mechanisms contributed the most to the clinical manifestation [36,37].

Other abnormalities observed in the nasal cavity were identified separately in different animals [6], and hyperemia, edema, hyperplasia, and the presence of secretion may be associated with inflammation in the region due to the obstructive process imposed by nostril stenosis or other causes [38], such as allergic processes.

It is interestingly, a that a 1-year-old French Bulldog, presented with severe manifestations of respiratory disease (cyanosis, dyspnea, and apnea), although no alteration was found on in AE [15]. Considering that the owner reported clinical signs were reported by the owner, it is believed that the absence of endoscopic findings reinforces the fact that many tutors confuse respiratory signs, being able to overestimate or underestimate overestimating or underestimating them [19]. Another fact to be considered is that all dogs had nostril stenosis, and if during agitation when seeing their owners, this animal may momentarily present tachypnea.

Despite the sample, it is interesting to observe that when evaluating endoscopic findings in patients with BS with severe manifestations, it is evident how the deleterious obstructive process of different segments of the airways impairs the quality of life of these dogs [30]. Meanwhile, the lack of signs that stand out in moderate cases and the findings of mild cases that appear to be occasional suggest, as described in another study [31], that the more barriers to the passage of airflow exist, the more serious the disease will be.

The present study presents a limitation of the sample number in addition to encompassing only 2 breeds, with a higher frequency of French Bulldog dogs [25]. Considering that the phenotypic variation of brachycephaly varies according to the breed, it is important to emphasize that these findings may be different from other brachycephalic dogs and that a study with a greater number of animals and greater breed diversity would be necessary for further conclusions.

## CONCLUSION

Despite the low sample number when evaluating the set of alterations in dogs with BS, it is possible to suggest that dogs with this syndrome may present severe manifestations of the disease, regardless of age.

Furthermore, it can be concluded that in this study, dogs with BS had frequent laryngeal alterations and that alterations in the main bronchi were present in all animals with severe manifestations of the disease.

Most of the findings of the clinical symptomatology reports were consistent with the findings of changes in the airways.

## MANUFACTURERS

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