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Current State of Knowledge

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Brachycephalic breeds are usually distinguished from others by their shortened skull due to an early ankylosis of the cartilages of its basis. In order to define more precisely the term Brachycephalic, different measurements have been used: A skull width/length ratio > 0.81, a face to skull ratio of 1.6 to 3.44 or a craniofacial angle <14° (angle between the base of the skull and the facial skull). Given these findings different breeds are usually recognized as Brachycephalic: Boston terrier, English and French Bulldog, Pugs, Pekinese, Shi-tsu, Cavalier King Charles. Some miniature breeds as Yorkshire Terriers, miniature Pinschers are also often included in this list. Upper respiratory syndrome has been described in Brachycephalic Dogs (BD). Clinical signs usually include snoring, inspiratory dyspnea, exercise intolerance and stridor, cyanosis or even syncopal episodes in more severe cases. These problems usually aggravate with stress, exercise or heat. Labored breathing is accompanied by overdilatation of the chest since a higher negative pressure tends to suck the abdomen into the thoracic cavity. The condition usually aggravates with age. Vomiting or saliva regurgitation are also frequently encountered.

**PARTICULARITIES OF BRACHYCEPHALIC DOGS**

**Anatomic particularities of upper airways**

Several anatomic abnormalities can be found in the Brachycephalic dogs. The cartilaginous skeleton of the external nares is usually shorter, thicker and medially displaced, secondarily obstructing the nostrils. Due to shortening of the skull, the size and shape of the conchae are modified, leading to potential intranasal stenosis. Whereas in dolichocephalic and mesocephalic breeds, the transition from hard to soft palate is usually caudal to the last molar, it is more caudally located in BD. Then, the soft palate which normally extends to the top of the epiglottis can extend up to 1 to 2 cm beyond and can readily be aspirated into the Rima Glottidis upon inspiration. On a radiographic examination (Fig. 1-1, 1-2) one can readily see that, in BD, the soft palate is not only overlong but also over-thick. In a number of BD, especially French and English Bulldogs the base of the tongue is also hyperplastic; the term macroglossia has usually been used to define this abnormality. Besides these findings other some tissue redundancies can be found, especially in the oro and naso-pharynx region.

The Rima Glottidis, narrowest airflow passage of the upper airways is formed by the paired arytenoid cartilages and the vocal folds. The laryngeal saccules or ventricles are located cranial to the vocal folds and cannot be seen on a normal dog. In many BD laryngeal ventricles can be seen protruding into the laryngeal lumen. Finally, due to an abnormal embryogenesis, the trachea of some Brachycephalic dogs (mainly English Bulldogs) is hypoplastic, which further decreases the air flow.

These anatomical anomalies are responsible for a multifocal obstruction of the upper-airways: The nostrils are obstructed by medially displaced nares, the naso-pharynx and the oro-pharynx are “blocked” between an hyperplastic tongue and an overthick soft palate, and the rima glottidis is obstructed by the overlong soft palate. These anatomic abnormalities have secondary functional consequences on laryngeal function.

**Pathophysiologic consequences**

Given their narrowed nostrils and nasal passages, Brachycephalic dogs must produce higher negative pressure to breathe properly. During inspiration the soft palate flutters into the rima glottidis and can even obstruct it. In some instances when negative pressure is high enough, it may exceed the natural resistance of the tissues, causing their collapse. This can be clinically observed on the nostrils but also on the larynx. The cuneiform and corniculate cartilages are drawn into the glottal opening following increased inspiratory efforts causing laryngeal collapse. In these cases an inspiratory stridor and even suffocation can be observed. In such patients the laryngeal ventricles are usually everted into the laryngeal lumen. Everted laryngeal ventricles and laryngeal collapse would be secondary events leading to even more severe respiratory compromise.

**Other findings in BD suffering from upper airway compromise**

Many owners describe signs of regurgitation or vomiting when their BD becomes excited or suffers of respiratory dis-
tress. In these instances signs of respiratory distress are usually relieved when the dog vomits or regurgitates large packs of "foam". In one study on 73 Brachycephalic dogs suffering from upper airway syndrome, respiratory and digestive signs were graded as minimal (grade 1), moderate (grade 2), or severe (grade 3) according to their frequency and severity. Respiratory signs were moderate in 20 dogs (27.4%) and severe in 51 (69.9%). Nineteen dogs (26%) were presented with grade 1 digestive disorders, 19 (26%) with grade 2, and 35 (48%) with grade 3. Among the 35 dogs with grade 3 digestive signs, 28 (80%) suffered of grade 3 respiratory disorders, 5 (14.3%) of grade 2 and 1 (5.7%) of grade 1. A correlation between gastric and respiratory signs severity was demonstrated (p=0.059).

**DIAGNOSIS**

Several steps should be undertaken in order to make an accurate diagnosis of Brachycephalic syndrome.

**History and clinical signs**

The history usually describes snoring and progressive exercise intolerance aggravated by warm temperature when the dog is 1 to 2 years old. Therefore, most owners become aware of the problem during the second summer of the dog’s life. Unfortunately, sneezing being considered as a normal respiratory feature of BD by most owners, breeders and even practitioners, no further diagnostic or therapeutic step is usually undertaken. With time, the condition worsens until signs of laryngeal collapse occur (inspiratory stridor). In these cases most owners spontaneously find a way to open their pets’ upper airways by opening the mouth and pulling the tongue forward. Concomitantly, vomiting or regurgitating food or saliva usually happens and this is also considered to be a normal feature of Brachycephalic Dogs in most owners’ and breeders’ mind.

**Radiographic examination**

Radiographic examination of the face can be used to assess the length and thickness of the soft palate. In many cases it can be observed that both oropharynx and nasopharynx are equally compressed by mucosal hyperplasia (figure 1-1, 1-2). Thoracic radiographs can be recommended in order to diagnose stenotic trachea, aspiration pneumonia and secondary right-sided heart failure.

**Endoscopy**

Given the common involvement of upper airways and upper gastrointestinal tract, endoscopy should be conducted as a basic diagnostic work-up.

Length and thickness of the soft palate are assessed and after removal of the endotracheal tube, the motion of the arytenoid cartilages and position of the ventricles are evaluated. In some cases, especially very small brachycephalic dogs (Pugs, Pekinese...) the arytenoid cartilages are flaccid and have a tendency to rotate inward into the laryngeal lumen. During the same procedure, upper Gastro-intestinal endoscopy is done: Esophagus, cardia, stomach, pylorus and duodenum are evaluated. Gastric and duodenal biopsies are recommended.

**Macroscopic and endoscopic findings**

Stenotic nares and soft palate hyperplasia are the two most common anomalies (respectively present in 50 to 85% and 96-100% of cases). Everted ventricles are usually found in 54-60% of the cases and although more rarely mentioned in the past, a moderate to severe laryngeal collapse was presented in 64% of the patients in a retrospective study.

Although many anatomic malformations of the gastrointestinal tract were often described in BD, some authors specifically studied digestive disorders in BD suf-
Gastro-intestinal and respiratory signs: a common pathophysiologic pathway

Gastro-oesophageal reflux associated with regurgitation and vomiting can contribute to upper oesophageal, pharyngeal and laryngeal inflammation. These phenomena have been documented experimentally in animals and clinically in infants. They can further contribute to upper respiratory problems. In turn, respiratory distress could stimulate the autonomous sympathetic nervous system which would slow gastric motility and increase the gastric emptying time. Furthermore, the dilated antrum would stimulate gastrin producing cells responsible for muscular hyperplasia. In a study in exercising racing horses the pressure over the lower-oesophageal sphincter has been shown to be related to the obstruction of upper respiratory tract. In human a high prevalence of hiatal hernia and gastro-oesophageal reflux has been demonstrated in asthma patients.

Finally, in the dog several cases of gastro-oesophageal diseases or hiatal hernia have been described associated to upper airways obstruction. The correlation between respiratory and digestive disorders suggests the influence of upper respiratory tract diseases on the gastro-oesophageal diseases, and vice versa.

The gastro-oesophageal disorders –ptyalism, regurgitation, vomiting, and reflux – can aggravate the respiratory sign by encumbering the pharyngeal region and stimulating persistent inflammation.

Conversely, the chronic respiratory depression promotes gastro-oesophageal reflux.

The close relation between respiratory and digestive problems is sustained by the fact that most of these animals “vomit” large packs of saliva when excited or stressed or in respiratory distress.

Medical treatment of gastro-oesophageal disease

In one study 29, the influence of upper airway surgical treatment on gastro-intestinal signs improvement has also been studied. In this study, when an inflammatory gastro-intestinal disease was observed endoscopically, a medical treatment, based on inhibition of hydrogen ion secretion (omeprazole 0.7 mg/kg per os every 24 hours) and prokinetic medication (cisapride 0.2 mg/kg per os every 8 hours), was recommended immediately after surgery. If distal oesophagitis was noted, an antacid was prescribed for 15 days (magnesium hydroxide, 1ml/kg after meals). Following histological results, medical treatment was adjusted for each case. For moderate to severe gastritis a two months course of treatment was recommended, including an inhibitor of hydrogen ion secretion (omeprazole, 0.7 mg/kg per os every 24 hours), a prokinetic (cisapride, 0.2 mg/kg per os every 8 hours), a surface protector (sucralfate, 1g per os every 12 hours apart from the meals). For severe gastritis and/or duodenitis with parietal fibrosis, the same treatment was advised for 3 months and corticosteroids were added (prednisolone starting at 0.5 mg/kg per os every 12 hours).

This study also suggests that after surgical treatment of upper airways and despite discontinuation of medical treatment in more than 80% of the cases, a clear improvement of upper gastro-intestinal tract disease was observed. In the cases where a control gastro-oesophageal endoscopy could be obtained 6 months after upper airway surgery, it always showed a complete resolution of the gastro-oesophageal endoscopic and histopathologic signs. These findings support the previous hypothesis of a common pathophysiologic pathway for upper respiratory and upper gastro-oesophageal disease in Brachycephalic dogs.

Surgical treatment

Nostrils

Several techniques of rhinoplasty have been developed. They all aim at opening the lateral wings of the nostrils. Removing this part actually increases the diameter and contributes to improvement of the nasal flow.
Elongated and hyperplastic soft palate

Current techniques for treatment of elongated soft palate involve section of the overlong part. Although the point of section has been recommended to be somewhere between the midpoint and the end of the tonsils, it is wise to cut it until the extremity of the soft palate hardly comes in contact with the tip of the epiglottis. A new technique of palatoplasty so-called “The folded flap palatoplasty” has been developed in order to address both the pharyngeal and the laryngeal obstruction. In this technique, not only the soft palate is shortened but is also made thinner. Figure 2-1, 2-2, 2-3

This technique achieves a marked reduction of the soft palate thickness, thereby relieving the nasopharynx and oropharynx from obstruction. Besides, the suture line is situated in the oral cavity and oropharynx, which lessens the obstructive potential of a possible postoperative oedema. Furthermore, the rostral situation of the suture line tends to tract and depress the caudal edge of the soft palate ventrally, which opens the nasopharynx. As with the conventional techniques, the soft palate is shortened and the laryngeal obstruction is also relieved.

Laryngeal disease: Should we treat it?

In one study, 64% (39/61) of the patients were presented with moderate to severe laryngeal collapse and 54% (33/61) with everted ventricles. Since it is postulated that laryngeal collapse and ventricular eversion are secondary events more likely due to increase respiratory depression, relief of proximal obstruction should alleviate signs of laryngeal collapse. This is actually observed clinically. In this study, only one dog out of 61 had to sustain laryngeal surgery (arytenoid lateralization) and one, an oral ventriculectomy. Although ventriculectomy has been recommended as treatment for ventricular eversion, it increases local inflammation and can result in laryngeal webbing. Its benefit in improving clinical signs has not yet been proven. On the opposite, in a retrospective study looking at dogs with ventricular eversion, the overall prognosis was better in those that did not sustain a ventriculectomy. Treating laryngeal collapse remains a challenging issue. In cases where clinical signs are not improved after rhinoplasty and palatoplasty, lateralization of one of the arytenoid cartilages can be attempted. This usually provides an adequate laryngeal opening in cases where the cartilage is stiff enough. In some cases the arytenoids cartilages are flaccid and have a tendency to invert into the laryngeal lumen. In our experience these cases do not respond favourably to lateralization. For those a permanent tracheostomy should be proposed.

PROGNOSIS

Following this overall medico-surgical protocol the prognosis 6 months after surgical treatment was graded as good in 22% and excellent in 67% of the cases. It compares favourably with previous studies conducted at the same institution not accounting for gastro-esophageal treatment.
CONCLUSION

In Brachycephalic breeds, anatomic anomalies of the upper respiratory tract, i.e. stenotic nares and overlong and overthick soft palate, progressively lead to further impairment of breathing due to progressive laryngeal compromise, i.e laryngeal collapse and ventricular eversion. In addition, gastro-esophageal disease can be found clinically, endoscopically and histologically in many BD suffering from upper airway impairment. In order to relieve the upper airway obstruction an early surgical treatment of the stenotic nares and of the overlong and overthick soft palate is recommended. A concurrent medical treatment of gastro-esophageal signs has also been shown to improve the overall prognosis.

REFERENCES


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