Retrospective Study on the Prevalence of Gastro-esophageal Reflux in Brachycephalic and Non-Brachycephalic Dogs Anesthetized for CT Examination

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SHORT COMMUNICATION

Abstract
Gastro-esophageal reflux is the return of gastric contents in the esophagus, phenomenon that can be identified in dogs under general anesthesia, but also in dogs without anesthesia, due to disorders of the distal esophageal sphincter. The aim of the present study was the comparative assessment of the incidence of gastro-esophageal reflux in brachycephalic and non-brachycephalic dogs. The medical records were evaluated for 98 dogs, presented with different pathologies of the spine. The animals were subjected to a standardized anesthetic protocol and CT scan. Following the analysis of the acquired CT images, it was found that gastro-esophageal reflux was present in 31 brachycephalic dogs (31/46; 67.39%) and in 9 non-brachycephalic dogs (9/52; 17.31%), respectively. There was an increased predisposition of the brachycephalic breeds regarding the occurrence of gastro-esophageal reflux, using identical anesthesia and positioning protocols.

Keywords: brachycephalic dogs; non-brachycephalic dogs; CT exam; gastro-esophageal reflux.

INTRODUCTION
Gastro-esophageal reflux (GER) represents the retrograde displacement of ingesta or fluid from the stomach to the esophagus (Reeve et al., 2017). Represents a complication commonly found in dogs under general anesthesia occasioned by medical imaging investigations or surgery, and can be life-threatening (Fernandez Alasia et al., 2021), but often overlooked in veterinary medicine (Lambertini et al., 2020). In addition, GER can also be found in non-anesthetized animals, following distal sphincter disorders (Poncit et al., 2005). Post-anesthetic esophagitis may be caused by peri- and/or intraoperative GER, and may in turn cause postoperative discomfort and esophageal stricture (Savvas et al., 2016; Shaver et al., 2017). The values of the incidence of GER in dogs under anesthesia register quite large variations, from 5% (Savvas et al., 2016) to 87.5% (Lambertini et al., 2020), and in dogs affected by brachycephalic obstructive airway syndrome the incidence of GER was 75% (Reeve et al., 2017). The appearance of GER in dogs can be influenced by several factors, such as the adverse effects of anesthetics on the motility of the cardia sphincter (Grimm et al., 2015), the age and size of the animal (Benimra et al., 2020), the positioning of the animal, pre-operative fasting, and increased negative intrathoracic pressure associated with increased inspiratory effort (Fernandez Alasia et al., 2021). The aim of the present study was to evaluate the incidence of GER in brachycephalic dogs compared to non-brachycephalic ones, without gastrointestinal pathologies and using the same anesthesia and positioning protocols.
MATERIALS AND METHODS
The medical records of brachycephalic and non-brachycephalic patients without gastrointestinal pathologies, who benefited from CT scan of the spine, during January 2020 – May 2021 were reviewed retrospectively, in order to detect possible cases of GER. Patient identification data, including breed, age, sex and body weight, were taken from medical records. Patients were divided into 2 groups according to signalment: the first group consisted of brachycephalic dogs, and the second group consisted of non-brachycephalic dogs. They were subjected to a fasting diet of at least 10 hours and water fasting of at least 2 hours before the procedure, according to previously established protocols (Jeff, 2013). The anesthetic protocol was identical for all dogs, using butorphanol in premedication at a dose of 0.2-0.3 mg/kg IV, midazolam 0.2-0.3 mg/kg IV, medetomidine 4-8 mcg/kg IV, followed by induction with propofol 1-6 mg/kg, intubation, maintenance with isoflurane and 100% oxygen, with their monitoring throughout the procedure (Jeff, 2013). CT scanning was performed using a General Electric Revolution machine (USA), and patients were placed in the dorsal recumbency position using radiolucent positioning devices. Plain and postcontrast transverse helical scans were performed to evaluate the spine (the data obtained are the subject of another study) and in addition, the esophago-gastric segment was followed.

Statistical analysis
A statistical analysis was performed using the statistical function of Microsoft Excel 2007. For all the calculated data, a 95% confidence interval was provided with an exact binomial test. A Chi-squared test was performed to compare the effect of weight, age and gender related to the absence or presence of GER on CT scan.

RESULTS AND DISCUSSIONS
Patients
Of the total number of patients included in the study, 46 were brachycephalic and 52 were non-brachycephalic. The first group was represented by 38 French bulldog, 5 English bulldog, 3 Pugs, of which 27 females aged between 2 and 5 years (median age was 3.29 years) and body weight between 8 and 20 kg (an average of 13.29 kg), and 19 males aged between 2 and 5.5 years (an average 3.52 years) and body weight 9-22 kg (an average 15.10 kg), respectively. The second group consisted of 52 non-brachycephalic dogs, including 37 Crossbreeds dogs and 15 purebred dogs (7 German shepherd, 4 Rottweiler, 4 Labrador), of which 29 females aged between 3 and 7 years (an average of 5.26 years) and body weight 10-31 kg (an average of 21 kg), and 23 males aged between 2 and 7.5 years (an average of 5.24 years) and body weight 9-35 kg (an average of 24.04 kg), respectively.

Gastroesophageal CT findings
Following the examination of CT scans, in 31 (31/46; 67.39%) brachycephalic patients, and 9 (9/52; 17.31%) non-brachycephalic patients, moderate dilation of the terminal segment of the esophagus was found, caused by the presence of fluid, gas or mixed content (Figures 1 and 2). According to previous studies, these changes are compatible with GER (Benzimra et al., 2020). Brachycephalic patients were represented by 13 males (13/46; 28.26%) aged between 3.5 and 5.5 years and weighing between 14 and 22 kg, and 18 females (18/46; 39.13%) aged between 3.5 and 5 years, and weighing between 12 and 20 kg, respectively. Non-brachycephalic patients were represented by 3 males (3/52; 5.77%) aged between 6.5 and 7.5 years, and weighing between 30 and 35 kg, and 6 females (6/52; 11.54%) aged between 5.5 and 7 years, and weighing between 27 and 31 kg, respectively.

Figure 1. CT images showing the appearance of the esophagus (white arrows) in brachycephalic patients: (a) without content; (b) with liquid; (c) with gas; (d) with mixed content.

From the obtained results it was found that GER was identified in both brachycephalic (67.39%) and non-
brachycephalic (17.31%) breeds, similar to those in the literature (Shaver et al., 2017). However, patients belonging to the brachycephalic breeds had a higher incidence compared to non-brachycephalic breeds these findings being consistent with previous studies (Conte et al., 2020). Following CT scans, it was found that the presence or absence of GER was correlated with the conformational type of the patients (brachycephalic and non-brachycephalic, p = 0.00059). Also, the presence or absence of GER on the CT scans was significantly correlated with age, gender and body weight status. It has been observed that gender is an influencing factor of GER appearance. The females, in both groups, were more susceptible to GER compared to males, and the calculated p-value was 0.0108 in brachycephalic group and 0.00266 in non-brachycephalic group, respectively. Moreover, a strict relationship could be observed between the occurrence of GER and the age of patients, but also their body weight. It was found that older patients (>3.5 years in brachycephalic, and >5.5 years in non-brachycephalic, respectively) and overweight patients (>12 kg in brachycephalic, and >27 kg in non-brachycephalic, respectively) were more affected.

![Figure 2. CT images showing the appearance of the esophagus (white arrows) in non-brachycephalic patients: (a) without content; (b) whit gas; (c) with liquid; (d) with mixed content.](image)

Although the animals included in this study benefited from fasting (10 hours for food and at least 2 hours for fluids, respectively) according to the protocol used, CT scans showed the appearance of GER, with a different composition. The appearance of distal esophageal sphincter relaxation is suspected to be the consequence of low gastric pH that would favor the retrograde movement of gastric contents in the esophagus (Benzimra et al., 2020), but in our study it was not possible to confirm this hypothesis. In the present study, GER was observed especially in brachycephalic breeds, and recent studies have shown that the esophageal hiatus has a greater opening to the brachycephalic breeds compared to the non-brachycephalic ones, being considered a primary (congenital) anatomical change (Conte et al., 2020), which would explain the prevalence of GER in these breeds. In addition, it has been reported that brachycephalic patients, who usually show respiratory signs, also suffer from esophageal abnormalities (Poncet et al., 2005), and esophageal hiatus abnormalities may promote GER (Conte et al., 2020). Also, previous studies have stipulated that higher body weight influences the retrograde movement of gastric contents in the esophagus (Benzimra et al., 2020), aspects found in the present study.

CONCLUSIONS

The present study highlights a higher predisposition of brachycephalic breeds compared to non-brachycephalic breeds regarding the occurrence of GER, using identical anesthesia and positioning protocols. The occurrence of GER on the CT scans was significantly influenced by the age, gender and body weight of the patients in both groups evaluated. Further extensive studies are required to monitor the effects of GER disease in dogs undergoing medical investigations and surgery in our clinic.

**Author Contributions:** VTL and IP performed CT scans; VTL and NT collected the data; NT designed and supervised the study; VTL and IP wrote the paper. All authors read and approved the final version.

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**Conflicts of Interest**

The authors declare that they do not have any conflict of interest.
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