

Evaluation of Gastroesophageal Reflux Disease and Related Alimentary Factors in Dogs and Their Owners

¹G. Meineri, ²P.G. Peiretti, ³N. Vitale, ⁴A. Vercelli and ⁵R. Ferraris

¹Dipartimento di Produzioni Animali, Epidemiologia ed Ecologia,
Università di Torino, Grugliasco (TO), Italy

²Istituto di Scienze delle Produzioni Alimentari, C.N.R., Grugliasco (TO), Italy

³Istituto Zooprofilattico Sperimentale del Piemonte, Liguria e Valle d'Aosta, Torino, Italy

⁴Ambulatorio Veterinario Associato, Torino, Italy

⁵Dipartimento di Gastroenterologia, Ospedale Mauriziano, Torino and IRCC, Candiolo, Italy

Abstract: This study was aimed at evaluating gastroesophageal reflux disease (GERD) in dogs and their owners and to establish the relationship with alimentary factors. Sixty dogs belonging to a veterinary clinic were evaluated together with their owners to investigate their alimentary habits. A dietary questionnaire was given to the dog owners to fill in. A logistic regression model was performed to study any association between diet and GERD symptoms. The results showed an endoscopic GERD presence of 20% in dogs similar to that found in humans. A relationship between diet and GERD symptoms and between GERD symptoms in the dogs and owners was also present. In spite of the limited sample size, the feasibility of the alimentary questionnaire here tested may be useful for further more extensive prospective studies.

Key words: Dog, owners, gastroesophageal reflux, alimentary factors, oesophagitis, food, foodstuffs, alimentary questionnaire

INTRODUCTION

Gastroesophageal reflux disease (GERD) consists of an abnormal passage of gastric juice from the stomach back to the oesophagus. It can cause severe complications such as oesophagitis and a precancerous lesion named Barrett's oesophagus (Morino *et al.*, 2003; Ferraris *et al.*, 2007). GERD has been studied in detail in man but less so in domestic animals. Among the predisposing factors, diet seems to play a role of primary importance (Sonnenberg and El-Serag, 1999; Pehl *et al.*, 1999). An exponential increase in the incidence of GERD in man and its complications has been found in the last 50 years in the western world. Adenocarcinoma of the oesophagus has exceeded squamous oesophageal cancer in frequency, though the latter was more common in the past and in eastern countries. Furthermore, it seems to have undergone the highest relative increase among all malignant cancers in man (Pera *et al.*, 1993). The possibility of the introduction of one or more alimentary substances into the human diet over the last few decades as a cause of the epidemiological and clinical changes relative to GERD is supposable (Franceschi, 1993).

Several studies have reported the presence of GERD in dogs; Barrett's oesophagus was in fact induced in experimental dogs (Kawaura *et al.*, 2001). No data are available on a possible recent increase in GERD in domestic animals similar to that reported in man (McMahon *et al.*, 2002).

The aim of the present study was to evaluate the presence of GERD in dogs and to establish the feasibility of an alimentary questionnaire in a preliminary study about the relationship between some alimentary substances and GERD symptoms in dogs and their owners.

MATERIALS AND METHODS

The study was carried out at the Ambulatori Veterinari Associati (Cso Traiano 99/D-Torino-Italy) Veterinary Clinic from 2003-2006. In order to evaluate the presence of GERD in dogs, an upper endoscopic examination was performed in a in twenty autoptic cases of presumably healthy dogs following their death from accidental causes and 80 consecutive *in vivo* cases. The endoscopic criteria for diagnosing oesophagitis and Barrett's oesophagus were used according to the

standard Savary-Miller classification (Savary and Miller, 1978). A case-control study was carried out in order to investigate the relationship between GERD and food and 30 dogs with and 30 without GERD symptoms were selected (Groups 1 and 2, respectively). All the cases were consecutively selected from among dogs that had been taken to a veterinary clinic and investigated for typical GERD symptoms. Among 50 dogs suffering from only symptomatic GERD, 30 were negative to the faecal test for *Helicobacter pylori* infection and these were included in the Group 1 study. Group 2 consisted of the first 30 cases without evidence of GERD symptoms and brought to the clinic because of skin, bone, eyes or gynecological disease or submitted to periodic vaccinations. Those dogs that presented internal medical pathologies or other gastrointestinal symptoms other than GERD, such as diarrhoea, known liver or pancreatic disease, inflammatory bowel disease or which had been submitted to abdominal surgery were excluded from the study. Only typical GERD symptoms (i.e. abundant salivation, regurgitation and acts of vomiting after meals), with or without accompanying respiratory symptoms, were considered for entry to the study. Figure 1 and 2 show data relative to the diet and GERD symptoms in dogs and owners, respectively. As far as the owners are concerned, the list of foods include the foodstuffs traditionally (FST) considered to cause GERD and the presence of foodstuffs and drinks in the diet such as: chocolate, cheese, tomato sauce, pizzas, mints, coke, spirits and coffee. As regards the owners' symptoms: heartburn, regurgitation, thoracic pain, swallowing difficulties, abundant salivation, vomiting after meals, persistent cough, asthmatic attacks, voice clearing, chronic laryngitis, respiratory difficulties (mainly during the night) and asthmatic attacks were registered. The examined schedules were filled in by the owners of the dogs in the veterinary surgery. To evaluate the relationship between alimentary habits and GERD in dogs and their owners were analyzed. Items from the questionnaire regarding alimentary habits and GERD symptoms. The type of diet of the dog (coded as: commercial food, home made or both), reflux-food in dogs (presence, or not, of foodstuffs causing reflux), presence of GERD symptoms in dogs, reflux-food in owners and presence of GERD symptoms in owners were considered. A primary screening test to identify any association between GERD and the considered factors was calculated with $2 \times K$ contingency tables using χ^2 analysis for categorical variables. The analysis was performed with the SAS® PROC FREQ procedure of the SAS software package.

Any collinearity between the type of diet, reflux-food and GERD symptoms in the dogs and in the owners was

Sex: M ☐ F ☐ Age ☐ Weight ☐ Ideal weight ☐ Breed ☐
 Brachiocephal ☐ Dolicocephal ☐
 Sterilisation Yes ☐ No ☐
 Number of puppies ☐
 Diet 1) Commercial food ☐ Dry foodstuff ☐ Moist foodstuff ☐
 2) Home made food ☐
 Are the following food and drinks present in the dog's diet?
 Chocolate ☐ Cheese ☐ Tomato concentrate ☐ Pizza ☐ Numbers of meals ☐
 Does the dog present any of these symptoms?

Symptoms	Presence	Presence daily	Presence weekly
Inappetence	Yes <input type="checkbox"/> No <input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Swallowing difficulties	Yes <input type="checkbox"/> No <input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Abundant salivation	Yes <input type="checkbox"/> No <input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Acts of swallowing after meals	Yes <input type="checkbox"/> No <input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Acts of vomiting after meals	Yes <input type="checkbox"/> No <input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Persistence cough	Yes <input type="checkbox"/> No <input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Asmatic attacks	Yes <input type="checkbox"/> No <input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Drinking after meal	Yes <input type="checkbox"/> No <input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Respirator difficulties (mainly during the night)	Yes <input type="checkbox"/> No <input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

Fig. 1: Comparative study on gastroesophageal reflux disease dog's data

Sex: M ☐ F ☐ Age ☐ Weight ☐ Ideal weight ☐ Breed ☐
 Environment: Rural ☐ Half-rural ☐ Urban ☐
 Physical activity: Yes ☐ No ☐
 Diet: Are the following food and drinks present in the dog's diet?
 Chocolate ☐ Cheese ☐ Tomato concentrate ☐ Pizza ☐ Coke ☐ Mint ☐
 Peppermints ☐ Mint chewing-gums ☐ Garlic ☐ Spirits ☐ Coffee ☐
 Numbers of meals ☐
 Do you smoke? No ☐ Yes ☐ <10 a day? ☐ >10 a day? ☐
 Does the dog present any of these symptoms?

Symptoms	Presence	Presence daily	Presence weekly	Presence monthly
Heartburn (and stomach acidity)	Yes <input type="checkbox"/> No <input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Regurgitation or dysphagia	Yes <input type="checkbox"/> No <input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Swallowing difficulties	Yes <input type="checkbox"/> No <input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Abundant salivation	Yes <input type="checkbox"/> No <input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Acts of vomiting after meals	Yes <input type="checkbox"/> No <input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Persistence cough	Yes <input type="checkbox"/> No <input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Asmatic attacks	Yes <input type="checkbox"/> No <input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Thoracic pain	Yes <input type="checkbox"/> No <input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Chronic laryngitis	Yes <input type="checkbox"/> No <input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Respirator difficulties (mainly during the night)	Yes <input type="checkbox"/> No <input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

Fig. 2: Comparative study on gastroesophageal reflux disease owner's data

also investigated and a stratified analysis, performed using a χ^2 Mantel-Haenszel Test, was used to evaluate the presence of confounding factors. A logistic regression model was carried out with SAS® PROC LOGISTIC to calculate OR (Odds ratio) adjusted for interaction. The likelihood ratio test was used to assess the overall significance of the model (two-tailed significance level $\alpha = 0.05$). The significance of each term in the model was tested using Wald's χ^2 . Estimated OR and 95% Wald's CI were obtained as measures of the predictor effect. The

Hosmer-Lemeshow test was performed to assess the goodness-of-fit of the model (Hosmer and Lemeshow, 1989).

RESULTS

Endoscopic signs of GERD i.e., oesophagitis or Barrett's oesophagus was found in 20 out of 100 endoscopic examinations indicating a 20% prevalence of this disease in the sampled dogs. This value is similar to the value reported in humans (Locke *et al.*, 1997). Data on sixty dogs and their owners was collected in the veterinary clinic. The elaborated alimentary questionnaire is shown in Fig. 1. All the forms were filled in by the owners in the waiting room before the examination. Only 14 owners out of 60 asked for an explanation before filling in the forms. The 30 dogs with GERD symptoms were examined using oesophageal endoscopy: 18 subjects showed esophagitis, but only one with associated Barrett esophagus and 11 dogs did not show any oesophageal lesions. Among the 30 symptomatic dogs (group 1): 7 subjects were assuming a homemade diet with FST considered to cause GERD, only one was eating a homemade diet without FST considered to cause GERD, 10 subjects were eating a mixed diet (homemade and commercial diet) with FST considered to cause GERD, 4 dogs were eating a mixed diet (homemade and commercial diet) without FST considered to cause reflux and 6 dogs were assuming only a commercial diet. Among the 30 asymptomatic dogs (group 2) taken to the veterinary clinic for other pathologies: 2 subjects were on a homemade diet with FST considered to cause GERD, 19 dogs were on a homemade diet without FST considered to cause GERD, only one dog was on a mixed diet (homemade and commercial diet) with FST considered to cause GERD, 7 dogs were eating a mixed diet (homemade and commercial diet) without FST considered to cause reflux and three were eating only a commercial diet. Among the owners of the thirty GERD symptomatic dogs: 4 owners did not present GERD symptoms in spite of eating Food Traditionally (FT) considered to cause GERD, 16 subjects had no GERD symptoms without eating FT considered to cause GERD, 9 owners had symptoms and were eating FT considered to cause GERD and two were symptomatic without eating FT considered to cause GERD. Among the owners of the thirty GERD asymptomatic dogs with reflux disease, 4 subjects were asymptomatic in spite of eating FT considered to cause GERD, 21 subjects were asymptomatic without eating FT considered to cause GERD, 3 subjects had symptoms and were eating FT considered to cause GERD and only one owner on a diet free of food that causes reflux was symptomatic to GERD.

Table 1: Type of diet in 60 sampled dogs

Diet type	Frequency	(%)
Homemade	29	48.33
Commercial	9	15.00
Mixed	22	36.67

Table 2: Principal symptoms in 30 GERD dogs

Symptoms	Frequency	(%)
Barrett	1	3.33
Oesophagitis	18	60.00
No lesions	11	36.67

Table 3: Presence of GERD symptoms in 60 owners

Symptoms in man	Frequency	(%)
No	45	75.00
Yes	15	25.00

Table 4: The use of refluxogen food for dogs

Reflux in dogs	Frequency	(%)
No	40	66.67
Yes	20	33.33

Table 5: Chi-square value and odds in the investigated variables

Variables	OR	χ^2	p-value
Type of diet		8.08	0.01
Commercial	0.23 (0.47-1.17)		
Homemade	3.59 (0.57-22.0)		
reflux-food		18.00	0.0001
presence	21.0 (4.78-104)		
GER symptoms			
in owners yes	3.76 (1.04-13.7)	4.28	0.03

Table 6: Risk analysis on 60 dogs for the presence of GERD symptoms

Risk factor	OR	95% CI
Presence of reflux food	35.5	5.9-61.2
Homemade vs commercial	0.3	0.04-1.7
Mixed vs commercial	0.06	0.01-0.4

Table 1-4 show the frequency of variables considered in the analysis. The principal type of diet in dogs was homemade (48%), but refluxogen food was present only in 33% of the sampled dogs; 60% of the sample showed oesophagitis. Twenty five percent of the owners had symptoms were and 38% of them had a reflux diet.

Sixty dogs were analyzed, 30 with GERD symptoms and 30 without. The χ^2 test showed an association between GERD symptoms in dogs and the type of diet, reflux food and GERD symptoms in the owners, as shown in Table 5. No association was found between GERD symptoms in dogs and the refluxogen diet in owners ($\chi^2 = 1.94$, $p = 0.12$). The data showed collinearity between GERD symptoms in owners and the type of diet ($\chi^2 = 8.94$, $p = 0.003$) and reflux-food ($\chi^2 = 10.01$, $p = 0.002$). The stratified GERD analysis for reflux by GERD owners showed similar OR results (19.12_{MH}-18.47_{logit}). The Breslow-day test for homogeneity of variance was not significant ($\chi^2 = 0.083$, $p = 0.78$). The stratified analysis of GERD for the commercial diet by GERD owners showed the same OR values (5.83_{MH}-5.83_{logit}). The final logistic regression model (likelihood ratio $\chi^2 = 18.18$, $df = 3$, $p < 0.003$)

included the type of diet (Wald's $\chi^2 = 8.52$, $df = 2$, $p < 0.01$) and the presence of reflux food (Wald's $\chi^2 = 15.3$, $df = 1$, $p < 0.001$). The Hosmer and Lemeshow test showed no evidence of poor fit ($\chi^2 = 9.3$, $df = 8$, $p = 0.32$) (Table 6).

DISCUSSION

An analysis of veterinary literature has shown that very little attention has been paid to GERD and related diseases. The lack of this information may be due to the rarity of this disease in the past and to a difficult and incorrect evaluation of symptoms in animals or to the limited use of endoscopy as a diagnostic tool. It in fact proved impossible to find any alimentary schedules on GERD disease in veterinary literature. More than 20-30% of the human population suffers from significant GERD symptoms (Locke *et al.*, 1997) and similar data has been reported in dogs (McMahon *et al.*, 2002). As recently reported (Mc Dougall *et al.*, 1996), GERD symptoms represent a serious clinical problem for human life because of their longstanding duration, the influence on nocturnal resting and the quality of the sufferers working and social life. GERD is related to diet in man (Franceschi, 1993) and as shown in this study, the same is found for animals. The availability and the experience of a hospital clinic devoted to GERD in humans (Ferraris *et al.*, 1997) made the clinical application of our schedule in veterinary practice easier. Although, limited in sample size, the present study shows a clear relationship between alimentary derangement and GERD related symptoms. As shown by the logistic regression and chi square test, the presence of refluxogen food in dog alimentation is highly correlated to GERD ($\chi^2 = 18$, $p = 0.0001$) and the probability of GERD in the presence of reflux food increased by 20 times (OR 35.5).

Homemade food is also correlated to GERD ($\chi^2 = 8.3$, $p = 0.0003$), but the data seems to show a protective action of homemade versus commercial food (OR 0.03). Food known to cause reflux in man was also used by some owners to feed their dogs. Furthermore, dogs suffering from suspected GERD symptoms were fed with home made food in addition to a standard commercial diet, but the data did not show any association, perhaps because of the limited size of the sample. Further studies in animals submitted to upper gastrointestinal endoscopy for GERD symptoms are needed in order to find a statistical correlation between diet and proved GERD in animals.

CONCLUSION

In spite of the limited sample size, our data show that GERD is present in dogs as in man in about 20% of the general population. As in man, it is strictly related to the type of diet. A dietary relationship between the owners and dogs suffering from the same symptoms further confirms the above hypothesis. Our recommendation is that the listed refluxogen foods in the 2 alimentary questionnaires do not have to be inserted in the dog diet to prevent GERD symptoms. The alimentary questionnaire that was drawn up, which is devoted to evaluating GERD in dogs, proved to be feasible, easy to complete during the time spent waiting for the visit and may be useful for further studies on GERD in animals.

Despite the limited number, our data seems to be relevant because this study is the first attempt to investigate the dog-owner relationship with regards this increasing pathology. More extensive and detailed evaluations of alimentary risk factors for GERD are necessary.

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