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Etiopathogenesis of Canine GDV: A Nutritionist's Interpretation of the Evidence

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Abstract

A definitive understanding of the etiopathogenesis of canine gastric dilatation-volvulus, also known as bloat, remains elusive. While commercial dry dog foods have been theorized as a causative factor, there is little evidence that the form or composition of food has a major influence on risk. Feeding the at-risk dog multiple times per day may have some preventive effect, but prophylactic gastropexy is likely to be most effective in managing risk.

Introduction

Gastric dilatation in dogs is characterized by the onset of rapid accumulation of gas or air in the stomach. This condition is often associated with gastric volvulus, i.e., a varying degree of malposition or torsion of the stomach in the abdominal cavity. Although it is thought that dilatation generally precedes volvulus, both gastric dilatation with and without volvulus are thought to be caused by the same underlying disease process. Most reports do not attempt to differentiate the two manifestations, but rather refer to them collectively as gastric dilatation-volvulus (GDV). Regardless, the increase in intragastric pressure as a result of accumulation of gas in the stomach can lead to gastric necrosis, decreased venous return, metabolic acidosis, cardiac arrhythmias, hypovolemia, disseminated intravascular coagulation, and cardiogenic shock. A case of GDV is most often fatal without urgent and aggressive therapy, usually with surgical correction of the torsion (if it exists), but in any case with a gastropexy to prevent recurrence. Even with medical intervention, short-term mortality rates reported in more recent papers range from 10 to 16%, and may be much higher when other procedures are performed concurrently (e.g., partial gastrectomy).[1,2]

GDV occurs predominantly in giant- and large-breed dogs, with the likelihood of a purebred show dog in either category developing GDV over its lifetime to be 22 and 24%, respectively (up to 42% in Great Danes).[3] The etiopathogenesis of GDV remains elusive, but by all accounts appears to be multifactorial in origin. Both dietary and nondietary factors have been implicated as contributing to the incidence of occurrence. Because the onset of GDV in an individual animal is infrequent and unpredictable, well-controlled studies to investigate the direct effect of a hypothesized causative factor on occurrence of GDV are difficult to conduct. As a result, most reports offer either epidemiological evidence of risk factors or results of studies looking at the effect on a presumed cause of GDV (e.g., delayed gastric emptying time). Although the effect of food and/or feeding is often the subject of study, few contributions to the literature have been offered by veterinary nutritionists.

Food-Related Risk Factors

Much effort has been spent in investigation of food as a potential cause of GDV, particularly with respect to type and composition of food. Early postulation was that dry dog food, especially those largely comprised of processed soy and cereal grains, was a primary factor in the etiopathogenesis of GDV.[4-6] The theory was that unlike the diet of wild or feral carnivores, whose diet would be high in animal protein and "animal roughage" (poorly digestible parts of carcasses such as bone, cartilage, fur, feathers, etc.), the modern extruded commercial diet was unsuitable for maintenance of optimum gastric structure and function. The high levels of fermentable carbohydrates characteristic of dry dog foods served as a substrate for gastric flora (including *Clostridium perfringens*), which could be responsible for the gas formation.

A study tested this hypothesis by comparing the feeding of commercial dry dog food versus a raw "meat and bone ration" to eight Irish Setter dogs either once or three times daily (2 X 2 Latin square design) for up to approximately two years.[6] One dog died approximately six months into the study and was replaced. The raw ration, intended to mimic the diet of wild carnivores, consisted of whole dressed, roughly chopped chicken, ground horse meat, whole apple, bran, and vitamins and minerals. No effects due to diet or frequency of feeding were seen on pentagastrin-induced gastric secretion. Postprandial serum gastrin levels increased in dogs fed once daily versus three times, but no effect of diet type was observed and all values remained within the normal range. Dogs eating commercial food once daily showed greater gastric dimensions post-feeding and greater stomach weight and larger residual food volume in the stomach two hours post-feeding at the termination of the study.

The authors postulated that once daily feeding of a commercial

dry dog food could cause GDV by virtue of repeated extension and eventual enlargement of the stomach, delaying normal emptying, and in combination with the rapidly fermentable carbohydrates in the food could account for the rapid production of gas in the stomach and onset of GDV. The dog that died six months into the study was in the commercial food/once daily group and did suffer GDV on multiple occasions before death, hence adding credence to this suggested etiopathogenesis. However, due to the small number of animals (two per group) and the high prevalence of GDV in the breed, it is difficult to conclude whether there was a true effect due to diet/frequency or whether it was just coincidence.

Subsequent work has shown that neither a higher prominence of soy and grain ingredients in dry dog food nor a higher percentage of metabolizable energy from carbohydrates influenced GDV risk.[7,8] Also, other work counters the contention that cereal-based dry diets result in a delay in gastric emptying, a theorized influencing factor in GDV. A study comparing effects of a canned meat-based diet with a dry cereal-based diet (either fed as is or with added water) failed to show a significant difference between groups with respect to patterns of gastrointestinal motility or half-time for gastric emptying.[9] Another study showed that movement of particulate markers from the stomach was slower in dogs fed a fortified all-meat wet food versus a cereal-based dry food moistened with evaporated milk.[10]

An Internet survey did find consumption of dry dog food to be associated with increased risk of GDV.[11] However, that risk was lowered with supplemental fish or eggs in the diet. A case-control study found inclusion of table scraps in an otherwise dry food diet also lowered the risk compared to dry food alone, but the effect of adding canned food or moistening the dry food was not significant.[12] A study of feeding practices in Irish Setters found that feeding a single food type, although not necessarily dry food, increased the risk of GDV.[13]

While one study found that the relative predominance of either animal-sourced protein ingredients or soy and cereal ingredients did not influence GDV risk, the presence of a fat or oil (animal or vegetable origin) listed among the first four ingredients (and associated higher metabolizable energy contribution from fat) was linked to a significant increased risk of GDV.[7] The authors hypothesized that a high-fat diet could delay gastric emptying compared to high-protein or -carbohydrate diets and contribute to the etiopathogenesis.

The inclusion of citric acid in dry dog foods was implicated as a risk factor for development of GDV, particularly if the food was moistened.[14] Citric acid is often used as a component in "natural" fat preservative systems. Regardless, this finding was reported on a preliminary basis only and did not appear in the finished paper as published, so its relevance appears moot.

In addition to food composition, food volume has been reported to be a factor in risk of GDV. Dogs fed a larger volume of food per meal expressed as a proportion of body weight had a higher risk, regardless of the number of meals fed daily (although the combination of large volume and once daily feeding further increased the risk).[8]

Food particle size also has been reported to have an effect. Large pieces of meat (greater than 30 mm in size) added to dry commercial kibble, canned meat-based foods or home-prepared foods appeared to decrease the risk of GDV, while added ground or small pieces of meat did not have that effect.[15] While the authors suggest that this decrease in risk may be due to a mechanical effect of large particles, the means by which this occurs was unclear. While large particles could theoretically slow the rate of consumption, food intake time (i.e., the time needed to finish a meal completely) was measured but not found to be a contributing risk factor in this study.

Feeding-Related Risk Factors

In addition to food type, the number of daily feedings also has been implicated in the etiopathogenesis of GDV.[6] Some studies have found a positive association between feeding one meal per day with increased risk of GDV,[12,13] while another failed to make that association.[15] Similarly, rapid eating behavior has been implicated as a factor in GDV.[12,16] However, other studies found no evidence of increased risk.[13,15]

Common advice for dogs at risk for GDV is to limit activity after eating. However, one study failed to find an associated risk.[15] In fact, playing with other dogs or "running the fence" after meals was associated with a decreased risk of GDV.[11]

Another common piece of advice to decrease the odds of GDV is to feed the dog with a raised feeding bowl, reportedly to minimize aerophagia. However, even with confounding taken into account (e.g., owners of high-risk dogs are more likely to implement this feeding management advice), using a raised bowl was found to increase, not decrease, risk.[16]

Other Risk Factors Not Related to Food or Feeding

Breeds identified with a predilection for GDV include (but certainly is not limited to): Great Danes, Irish Wolfhounds, Bloodhounds, Irish Setters, Akitas, and Standard Poodles.[3] In a report from New Zealand, the odds of a case of GDV presented to a veterinary office being a Huntaway (a large working farm dog) was 19 times higher than the odds of a control (trauma case) being a Huntaway.[7] "Deep-chested" dogs, i.e., those with a higher thoracic depth-to-width ratio, and those thin for their respective breed standard may be at greater risk.[3,16] There also may be a familial component, as dogs with a first-degree relative with a history of GDV (including a sire or dam, but especially a sibling or an offspring) are at increased risk.[16]

Age appears to be a factor, with odds of occurrence increasing over time.[11,13,15,16] Risk of GDV has been reported to be increased in males in one study[12] but intact females in another,[11] while

others reported no influence of gender or neuter status.[15,18]

Stress caused by kenneling, travel or other activities has been implicated with increased risk of GDV.[13,19] A "happy" personality as opposed to fearfulness or anxiety appears to decrease risk.[12]

The minimum and maximum daily atmospheric pressure on the day of a GDV event and the maximum pressure the day before the event were positively associated with the probability of an incident of GDV.[20] An increased incidence of GDV has been reported to occur during the spring in pet dogs,[11] during the summer in working farm dogs[17] and during the winter in military dogs.[21]

Conclusions

At this time, there appears to be a paucity of sound guidance for the veterinary nutritionist to offer in terms of management of risk of GDV in susceptible dogs via dietary manipulation. While early theories incriminated dry dog food containing highly fermentable carbohydrates as an etiologic factor, only modest evidence has surfaced to corroborate the premise that the form, ingredients or nutritional composition of the food have a significant impact on risk. In other words, there is little basis upon which to advise against the feeding of commercial dry foods containing grains or soy as a means to mitigate the risk of GDV. On the other hand, several reports suggest that adding "something" to a dry diet (e.g., fish, eggs, table scraps, large chunks of meat) could lower the risk. The mechanism by which use of these dietary additions would have an impact on risk is not understood. However, it is a relatively easy practice to implement, provided the added foods are not used in excess as to unbalance the total ration. The addition of a complete and balanced canned food to the dry diet would avoid the possibility of unbalancing the diet, but a lowering of risk by this practice has not been reported.

An ingredient/nutrient in dry dog foods that has been identified as a potential risk factor for GDV is fat. However, recommendations to avoid products that list fat or oil as a major ingredient and/or where fat is the major energy contributor appear contrary to other advice. For example, it also has been reported that lowering the volume of food fed per meal may have protective effects. The addition of fats to a dry food facilitates increased energy density of the food compared to protein or carbohydrates, so higher fat products generally allow for lower volumes to be fed. Also, addition of table scraps or other foods to a dry dog food often increases total fat content of the diet. Finally, a dog that is thin for its breed standard appears to be at greater risk for GDV. This condition normally would be addressed by increasing caloric intake, usually achieved by increasing dietary fat content.

If a lower energy density food is offered, the volume of food per meal also can be effectively reduced by increasing the number of meals per day. Although not all studies reported increased risk with once-a-day feeding, it is a repeated finding, so multiple daily feedings appear to be a prudent practice that is easy to implement. Reports on the effect of food intake time on risk of GDV are mixed. Food bowls designed to slow the rate of eating are available and would not appear contraindicated. On the other hand, feeding from raised bowls may actually increase risk.

Surgical rather than nutritional intervention may be key to effective prevention of GDV. In dogs that suffered an episode of GDV, gastropexy decreased the rate of recurrence from 54.5 to 4.3% and increased median survival time from 188 to 547 days.[22] Endoscopically assisted gastropexy is advocated as a safe and reliable means of prophylaxis in dogs at high risk for GDV.[23]

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