In dogs, GDV is characterized by gaseous distension of the stomach and rotation of the stomach around its long axis. This process is invariably associated with varying degrees of hypovolemic or septic shock, ventilation-perfusion mismatch, and myocardial dysfunction.

The clinical signs and medical and surgical management of GDV have been extensively described, but the etiopathogenesis of the condition is not fully understood. The pathogenesis of GDV in dogs appears to be multifactorial and influenced by a number of risk factors.

Retrospective epidemiological studies have identified the following risk factors for GDV: being a large or giant purebred dog, increasing age, increasing thoracic depth-to-width ratio, having a relative with a history of GDV, being male, being underweight, eating 1 meal daily, eating rapidly, having a fearful temperament, experiencing a stressful event in the 8 hours prior to the GDV episode, eating a diet containing small particles of food, and being prone to aerophagia. Two prospective cohort studies and 2 nested case-control studies evaluated further some of these risk factors.

Identification of risk factors implicated in a disease such as GDV is valuable when 1 or more of these factors can be eliminated, reduced, or modified. In the treatment of clinical cases at their practice, the authors have noted that a gFB was frequently detected during surgery to treat an episode of GDV in dogs, suggestive of a possible relationship between gFBs and development of GDV.

The purpose of the retrospective study reported here was to compare the incidence of gFBs in a group of dogs that underwent exploratory celiotomy for GDV with the incidence of gFBs in a control group of dogs (all dogs weighing \(\geq 30\) kg [66 lb] and older than 12 months of age) that underwent exploratory celiotomy.

### Objectives
- To evaluate whether the presence of a gastric foreign body (gFB) is a significant risk factor for gastric dilatation and volvulus (GDV) in dogs and to quantify the change in likelihood of developing GDV associated with the presence of a gFB.
- To evaluate whether the presence of a gastrointestinal foreign body (giFB) is a significant risk factor for gastrointestinal dilatation and volvulus (GI-DV).

### Design
- Retrospective case-control study.

### Animals
- 118 large- or giant-breed dogs treated surgically for an episode of GDV and 342 large- or giant-breed dogs (> 12 months old) that underwent abdominal surgery for reasons other than GDV.

### Procedures
- During exploratory celiotomy, all dogs underwent palpation and visual examination of the entire gastrointestinal tract. A foreign body was defined as nondigestible or slowly digestible material palpated during gastrointestinal tract examination that was causing clinical signs or was \(> 10\) cm in length or \(> 2\) cm in width.

### Results
- The incidence of gFBs was significantly higher in the group of dogs with GDV. The presence of a gFB, age, weight, and purebred status were significant risk factors for GDV. Odds ratios were calculated for gFB (OR, 4.920), age (OR, 1.157), weight (OR, 0.958) and purebred status (OR, 4.836).

### Conclusions and Clinical Relevance
- Gastric foreign body was found to be a significant risk factor for GDV in dogs. The study findings suggested that a large- or giant-breed dog with a gFB was approximately 5 times as likely to develop GDV as a similar dog with no gFB. Results indicated that there was a strong correlation between gFB and GDV in dogs. However, further cohort studies are needed to determine whether there is a causal relationship between the presence of a gFB and the development of GDV in dogs. (J Am Vet Med Assoc 2012;241:1190–1193)

### Abbreviations
- FB Foreign body
- GDV Gastric dilatation and volvulus
- gFB Gastric foreign body
- giFB Gastrointestinal foreign body
- iFB Intestinal foreign body
for reasons other than GDV, evaluate whether the presence of a gFB is a significant risk factor for GDV, and quantify the change in likelihood of developing GDV associated with the presence of a gFB. The null hypothesis was that there was no statistical correlation between presence of a gFB and GDV.

Materials and Methods

Medical records review—The medical records of all large- and giant-breed dogs that underwent exploratory celiotomy at the Lago Maggiore Veterinary Clinic between January 2002 and December 2005 were reviewed. The dogs were assigned to 1 of 2 groups: dogs with GDV (cases) or dogs without GDV (controls). For both groups, dogs were included in the study only when a thorough description of the visual and tactile examination of the entire gastrointestinal tract (cardia to rectum) was present in the surgical report.

Dogs with GDV were included in the study when the following criteria were met: admission to the Lago Maggiore Veterinary Clinic between January 2002 and December 2005 for surgical treatment of GDV, confirmation of the diagnosis during exploratory celiotomy, and complete medical record (including date of admission, diagnosis of GDV confirmed at surgery, breed, age, body weight, sex, neuter status, and a surgical report containing description of the gastrointestinal tract examination findings).

Control dogs were included in the study when the following criteria were met: admission to the Lago Maggiore Veterinary Clinic between January 2002 and December 2005, age > 12 months, weight ≥ 30 kg, exploratory celiotomy performed for reasons other than GDV, no history of GDV in the previous year, and complete medical record (including date of admission, reason for exploratory celiotomy, breed, age, body weight, sex, neuter status, and a surgical report containing description of the gastrointestinal tract examination findings).

For both groups, gFBs were defined as nondigestible or slowly digestible material palpated during gastrointestinal tract examination that was causing clinical signs or was > 10 cm in length or > 2 cm in width. For statistical calculations, all iFBs in the control group were considered gFBs. The same surgeon (LF) performed or supervised all the celiotomies during the study period.

Statistical analysis—From the clinical records, the following data were obtained and subjected to statistical analysis: presence of gFB, age, weight, sex, purebred status, and breed. A Pearson χ² test was performed with statistical software to compare the incidence of gFBs between the 2 groups. A multiple logistic regression analysis was conducted with statistical software to model the probability of GDV developing as a function of age, sex, body weight, breed, purebred status, or presence of a gFB as well as the interaction of these variables. In this model, the presence of GDV was considered a binary response variable. Age and weight were considered continuous variables. The presence of a gFB was considered a binary categorical variable. Continuous factors to be modeled were initially evaluated for multicolinearity by use of the variance inflation factor and tolerance options in the statistical software. Variance inflation factor and tolerance options were found to have appropriate values (< 10). The final model was created by generation of a full model including all terms and first-order interactions and then use of a backward elimination option to identify the most appropriate subset of independent variables. Model coefficients and their associated P values, ORs, and 95% confidence limits of those ORs were calculated by statistical software. Odds ratios represent the relative likelihood of GDV development for each of the specified variables; an OR > 1 represents an increased likelihood of disease. A value of P ≤ 0.05 was considered significant.

Results

All 118 dogs that underwent exploratory celiotomy to treat an episode of GDV at the Lago Maggiore Veterinary Clinic between 2002 and 2005 met the criteria for inclusion in the study. Of the 521 dogs that underwent exploratory celiotomy for reasons other than GDV at the Lago Maggiore Veterinary Clinic between 2002 and 2005, 342 met the criteria for inclusion in the control group. For the 118 dogs that underwent exploratory celiotomy for GDV, mean age was 8.1 years (median age, 8 years). Twelve (10.2%) dogs had a concurrent gFB detected via gastrointestinal tract palpation or visualization and confirmed during gastrotomy (via gastric lavage in 1 case). The mean and median ages for these 12 dogs were each 6.5 years. The FBs retrieved were classified as follows: bones (1 Great Dane, 1 Basset Hound, 1 crossbred dog, and 1 Rottweiler), stones (1 Dogue de Bordeaux and 1 Italian Hound), plastic material (1 Rottweiler and 1 Bernese Mountain Dog), baby toy (1 German Hound), stick (1 Briard), socks (1 German Shepherd Dog), and underpants (1 Great Dane). All the FBs were in the dogs’ stomachs.

For the 342 dogs that underwent exploratory celiotomy for reasons other than GDV, mean age was 6.9 years (median age, 7 years). The reasons for surgery among these dogs included abdominal neoplasia (n = 72), pertoni-tis (ie, gastroenteric origin, biliary peritonitis, urinary peritonitis, prostatic abscess, pancreatic abscess, or neoplasia [69]), penetrating abdominal wound (27), pyometra (22), organ biopsy (21), uroliths (renal, ureteral, bladder, or urethral [19]), urinary tract rupture (18), cesarean section (14), splenic torsion (13), traumatic abdominal rupture or abdominal hernia (13), diaphragmatic rupture (12), gFB (9), inguinal hernia (9), draining tract in the abdominal wall (8), intussusception (8), mesenteric volvulus (5), megacolon (2), and ectopic ureter (1).

Eleven (3.2%) control dogs had diagnosis of gFB confirmed via gastrointestinal tract palpation or visualization and during gastrotomy or enterotomy. The mean and median ages for these 11 dogs were each 3 years. A gFB was removed from 4 dogs and an iFB was removed from 7 dogs. The FBs retrieved were classified as follows: a stone (1 German Shepherd Dog [gFB]), 1 Italian Hound [iFB], 1 Irish Setter [gFB], and 1 Rottweiler [iFB]), 2 bones (1 Rottweiler [iFB]), infant pacifier (1 Doberman [iFB]), stockings (1 Labrador Retriever [iFB]), string (1 Labrador Retriever [iFB]), tennis ball (1 Labrador Retriever [gFB]), towel (1 German Shepherd Dog...
In those 2 dogs, the stones were removed because they were > 5 cm in diameter and were considered likely to cause obstruction. For statistical calculations, all iFBs in the control group were considered gFBs.

The incidence of gFBs in the group of dogs surgically treated for GDV was significantly (χ² test; P < 0.001) higher than the incidence of gFBs in the control group. The final statistical model identified the presence of a gFB (P < 0.001), age (P < 0.001), weight (P = 0.015), and purebred status (P < 0.001) as significant risk factors for development of GDV. Sex was not identified as a significant (P = 0.13) risk factor. Breed was excluded from the analysis because the numbers for each breed type were too low for statistical analysis.

Odds ratios were calculated for presence of a gFB (OR, 4.920), age (OR, 1.157), body weight (OR, 0.958), and purebred status (OR, 4.836) with regard to development of GDV in dogs. The OR obtained for gFB indicated that a large- or giant-breed dog with a gFB was 4.920 times as likely to develop GDV as was a similar dog without a gFB. In the dogs in the present study, on the basis of the 95% lower confidence limit, the presence of a gFB increased the likelihood of developing GDV by a minimum of 97.9%.

Another finding of the present study was that purebred status is a significant risk factor for GDV in dogs, as indicated by 4.836 times as likely to develop GDV as was a similar dog with no gFB. The presence of a gFB increased the likelihood of developing GDV by a minimum of 97.9%.

The identification of gFB as a significant risk factor for development of GDV in dogs may be useful to pet owners and veterinary surgeons for prevention of this devastating condition. When a gFB is detected as an incidental finding by a veterinary surgeon, a conservative approach is often adopted. Endoscopic or surgical removal is only recommended when clinical signs are likely to develop. The rationale behind this approach is that most gFBs will pass uneventfully through the gastrointestinal tract. In humans, at least 80% of gFBs that reach the stomach are eventually excreted; thus, a conservative approach is recommended.15,16

If a dog is predisposed to GDV, based on previously identified risk factors, the owner may be counseled on the increased chance of development of GDV if a concomitant gFB is present. Accordingly, endoscopic or surgical removal with or without gastropexy could be suggested to the owners as an alternative approach. If endoscopic removal of the gFB is achieved, gastropexy may be performed via an endoscopic-assisted,17 laparoscopic-assisted,18 or total laparoscopic technique.19 Furthermore, owners of dogs of predisposed breeds may be counseled to restrict possible access to foreign material to minimize the risk of GDV.

The pathophysiologic mechanism by which dogs with gFBs are predisposed to development of GDV was not evaluated in the present study. In the veterinary medical literature, there are several speculative theories. Gastric FBs are known to cause mechanical outflow obstruction,20 which may be acute or chronic as well as partial or total. Outflow obstruction leads to delayed gastric emptying21 and may cause subsequent gastric distension. The presence of a gFB is also reported to induce gastritis,22 which also results in delayed gastric emptying.21 Furthermore, vomiting may lead to aerophagia, which has been reported as predisposing dogs to development of GDV.23 The combination of these processes may lead to gastric distension, which has been detected prior to development of volvulus.1-3 Although these proposed pathophysiologic mechanisms are logical, their importance is speculative. Further elucidation of their role was beyond the scope of the present study but would be an ideal subject for further research.

Another finding of the present study was that purebred status is a significant risk factor for GDV in dogs, as indicated by results of a previous study.1 Increasing age was also a significant risk factor, corroborating findings in other reports.5,6,10,11

In the population of dogs weighing > 30 kg of the present study, another significant risk factor for development of...
Gastric dilatation-volvulus (GDV) was lower body weight. However, because the study dogs did not undergo body condition scoring, it was not possible to ascertain whether low body weight was associated with being underweight or being of a smaller stature or breed. Thin body condition was identified as a predisposing factor for GDV in a previous retrospective epidemiological study involving 202 dogs. In a prospective cohort study involving 1,634 dogs, thin body condition and a history of a major or chronic health problem during the first year after birth were confirmed as significantly associated with GDV in the univariate but not the multivariate analysis. Those authors speculated that poor body condition and a history of chronic health problems may not be causally related to GDV; these findings may represent additional clinical signs that develop secondary to an (hypothetical) underlying gastrointestinal pathological process that ultimately causes GDV. A possible association between GDV and inflammatory bowel disease was noted in a study of 23 dogs, and a possible association between GDV and high plasma gastrin immunoreactivity was evaluated in a study of 45 dogs. Some chronic gastrointestinal diseases that cause malabsorption can be associated with pica and giFB (e.g., exocrine pancreatic disease) in dogs. It would be interesting to further evaluate the associations between these pathological processes and GDV by performing prospective clinical studies.

In the control group in the present study, all iFBs were considered giFBs for statistical calculations. If the incidence of actual giFBs was compared between the 2 groups, the importance of gFB as a risk factor for GDV would have been even greater with a higher OR.

When multivariate regression is used and includes as many previously identified risk factors as possible, the likelihood of ascribing a risk factor to a known confounder is minimized. However, it was not possible to obtain information regarding feeding habits, diet composition, each dog’s temperament, or history of each dog’s relatives from the medical records available in the present study. It is possible that one of these variables would have altered the significance of gFB as a risk factor for development of GDV.

Another limitation of the present study was its retrospective nature. This limitation was partially overcome by the fact that all surgeries were performed or supervised by the same surgeon (LF). The same intrasurgical technique was used to evaluate the gastrointestinal tract in the 2 groups of dogs, and the same criteria were used to define giFBs for both groups. Despite the inherent limitations, results of the present study indicated a strong significant association between GDV and a concurrent gFB in dogs. To confirm this association, further studies with more powerful study designs are warranted; moreover, investigations of the potential pathophysiologic mechanisms may improve our understanding of the complex pathogenesis of this condition.

References