Prospective evaluation of laparoscopic-assisted gastropexy in dogs susceptible to gastric dilatation

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Objective—To determine long-term outcome associated with laparoscopic-assisted gastropexy in prevention of gastric dilatation-volvulus (GDV) in susceptible dogs and to evaluate use of laparoscopy to correct GDV.

Design—Prospective study.

Animals—25 client-owned large-breed dogs.

Procedure—23 dogs susceptible to GDV were referred as candidates for elective gastropexy. These dogs had a history of treatment for gastric dilatation, clinical signs of gastric dilatation, or family members with gastric dilatation. Laparoscopic-assisted gastropexy was performed. One year after surgery, abdominal ultrasonography was performed to evaluate the attachment of the stomach to the abdominal wall. Two dogs with GDV were also treated with laparoscopic-assisted derotation of the stomach and gastropexy.

Results—None of the dogs developed GDV during the year after gastropexy, and all 20 dogs examined ultrasonographically had an intact attachment. Another dog was euthanatized at 11.5 months for unrelated problems. Two dogs with GDV successfully underwent laparoscopic-assisted gastropexy after the stomach was repositioned.

Conclusions and Clinical Relevance—Laparoscopic-assisted gastropexy resulted in a persisting attachment between the stomach and abdominal wall, an absence of GDV development, and few complications. Dogs with a high probability for development of GDV should be considered candidates for minimally invasive gastropexy. Carefully selected dogs with GDV can be treated laparoscopically.

Gastric dilatation-volvulus (GDV) results in a frequently fatal emergency in large dogs. The mechanisms are only partially understood, but factors are thought to include overeating (frequently in a vigorous gulping manner), drinking a large amount of water, pica, postprandial activity and excitement, and delayed gastric emptying time. Many dogs developing acute GDV have previously had signs of gastric dilatation or subtle signs of gastrointestinal tract problems after eating. Mortality rate increases greatly when the stomach is dilated and has undergone volvulus.1-3 In a prospective series of 295 dogs undergoing surgery for GDV, 15% died.3 If dogs that were dead on arrival to the emergency room were included, the mortality rate increased to 26% of dogs with GDV. In contrast, only 1% of dogs with dilatation only, or with a nonconfirmed GDV, died. Results of a retrospective study4 of 137 dogs treated for GDV revealed that 13.3% died. Mortality rate was higher in a multipractice epidemiologic study of 1,934 dogs treated during the 1980s. Dogs with GDV died at a 33.3% rate.5 Large-breed (Akita, Bloodhound, Collie, Irish Setter, Rottweiler, Standard Poodle, and Weimaraner) and giant-breed (Great Dane, Irish Wolfhound, Newfoundland, and Saint Bernard) dogs were shown to have a 6% incidence of GDV with GDV accounting for 16% of all of the deaths in these breeds.6 Some dogs seem to inherit a predisposition for GDV, as there is an increased likelihood of GDV if a first-order relative (parent or sibling) has had GDV.7-10 Recurrence and death in dogs treated medically for GDV are reported as being between 7611 and 80%.12

Prevention of volvulus by a right-side gastropexy greatly reduces the probability that a dog with gastric dilatation will die.12 In a retrospective study of dogs treated medically for gastric dilatation, 68 of 103 dogs survived the initial treatment and were followed for 1 year. Fifty-nine (81%) died within a year of the initial treatment, resulting in the author’s conclusion that medical treatment alone does not produce favorable long-term results.13 In a series of 136 dogs that underwent surgery for GDV, only 4.3% of dogs treated with a gastropexy had recurrence, in contrast to 54.5% of dogs that did not have a gastropexy during their initial surgery. Dogs that had gastropexy had a median survival time of 547 days compared with 188 days for dogs not treated by gastropexy.4 Other authors have concluded that the risk for volvulus is greatly reduced by a gastropexy performed during surgery for GDV or as a prophylactic measure.2,8,12-14 A variety of laparotomy techniques (tube gastropexy, circumcostal gastropexy, incisional gastropexy, and belt-loop gastropexy) have been used to attach the pyloric antrum to the right abdominal wall, effectively preventing volvulus in approximately 93% of dogs.11-13,15-19 Although these dogs that have had gastropexy avoid GDV, they can develop gastric dilatation, and the owner must apply measures to reduce the likelihood. At least 3 gastropexy techniques have been reported in which all of the surgery is performed laparoscopically.20,21

We have recently developed a laparoscopic-assisted gastropexy technique.22-24 When performed in research dogs, laparoscopic-assisted gastropexy is quick, easy, and effective in producing a strong adhe-
ation.2 The purpose of the study presented here was to determine the usefulness and long-term outcome of laparoscopic-assisted gastropexy in the prevention of GDV in client-owned dogs that were susceptible to gastric dilatation. Following surgery, dogs were evaluated for 1 year to evaluate morbidity rate and whether this gastropexy technique resulted in a long-term attachment of the pyloric antrum to the body wall and GDV prevention.

Materials and Methods

Selection of dogs susceptible to gastric dilatation—Twenty-three client-owned large-breed dogs were selected for our study because of their propensity for GDV as indicated by a history of treatment for gastric dilatation, signs of gastric dilatation observed by the owner, or a family history of gastric dilatation. Owners signed a study consent form after being informed that gastric dilatation is a life-threatening condition, gastropexy is an elective procedure that reduces the likelihood of GDV, and measures to reduce the likelihood for gastric dilatation prevention must continue to be practiced. Historical questions were asked concerning gastric dilatation in terms of feeding, eating, and drinking habits, clinical signs (ie, nonproductive retching, abdominal pain, abdominal distention, pacing, and excessive salivation), family history, and previous treatments. A complete physical examination, CBC determination, serum biochemical analyses, and urinalysis were performed. Ten clinically normal dogs, which had not had a gastropexy, were used to evaluate the normal ultrasonographic appearance of the stomach in relation to the abdominal wall.

Surgical procedure—After evaluation, each dog was anesthetized by use of a protocol approved by the hospital anesthesiologists. During the laparoscopic-assisted gastropexy technique, laparoscopy was used to identify the pyloric antrum and retrieve it through the abdominal wall. The first 12-mm-diameter trocar for the laparoscopic telescope was placed 3 cm caudal to the umbilicus. During abdominal insufflation and observation, a second 12-mm-diameter trocar was placed lateral to the right margin of the rectus abdominus muscle and 3 cm caudal to the last rib. A laparoscopic Babcock forceps was used to grasp and withdraw the pyloric antrum through the paramedian trocar incision. The trocar site was extended and the pyloric antrum partially exteriorized. The seromuscular layer was incised down to the submucosa for 3 to 4 cm in a longitudinal direction, midway between the mesenteric and antimesenteric sides of the pyloric antrum. The cranially located seromuscular flap was sutured to the transversus abdominus muscle in the cranial portion of the extended trocar incision. This was repeated on the caudal side. The oblique muscles were closed over the gastropexy site, and the subcutaneous tissue and skin were closed in separate layers.

Postoperative evaluations—Dogs were evaluated at 1 week and 1 year after surgery. Dogs were examined at 1 week after surgery for suture removal, and the client was asked questions about feeding, eating and drinking habits, defecation, abdominal discomfort, and complications after surgery. Telephone calls were made at 1 and 6 months after surgery. Questions asked at 1, 6, and 12 months after surgery included whether the dogs had signs of gastric dilatation (ie, nonproductive retching, abdominal pain, abdominal distention, pacing, excessive salivation) or had received treatment for gastric dilatation. At the 1-year evaluation, a history in relation to GDV was obtained for each dog. Examinations included CBC determination, serum biochemical analyses, and abdominal ultrasonography. Ultrasonography was performed after the hair was clipped at the gastropexy site and acoustic coupling gel applied. The gastropexy site was examined ultrasonographically by use of a 7-MHz transducer (6 dogs), 10-MHz transducer (12), or a 12-MHz transducer (1). The location of the right gastric wall in relation to the abdominal wall and the appearance of the stomach wall and the abdominal wall at the gastropexy site were examined. These ultrasonographic findings were compared with those of 10 clinically normal dogs that had not had gastropexy.

Selection of dogs with GDV—The first dog included in our study with GDV was a 12-year-old spayed female Standard Poodle that was admitted to our emergency service because of GDV. The owner stated that 2 months previously, the dog had signs typical of gastric dilatation that resolved without veterinary care. Twelve hours previously, the dog had been treated at another emergency clinic for GDV, at which time it underwent gastric intubation and received IV administration of fluids and diazepam. The dog recovered and then relapsed. At admission to our hospital, the dog was lying on its side, had a pulse rate of 170 beats/min, and had radiographic evidence of GDV. Emergency treatment included IV administration of hydromorphone hydrochloride and diazepam to facilitate intubation of the stomach, IV administration of lactated Ringer’s solution and hetastarch to treat shock, SC administration of heparin, and antimicrobial treatment. An ECG was monitored at frequent intervals for arrhythmias by use of telemetry. Within 2 hours of initiation of resuscitation, anesthesia was induced with IV administration of etomidate and maintained with isoflurane. The dog was treated for GDV by use of laparoscopic-assisted gastropexy as already described. The 12-mm-diameter laparoscopic trocar was placed on the midline, approximately 3 cm caudal to the umbilicus by use of a Hasson technique. The stomach had redsented after removal of the gastric tube at the time of anesthetic induction and tracheal intubation. The stomach tube was replaced and the stomach deflated. Omentum covered the stomach, and a 180° volvulus was present. The second 12-mm-diameter trocar was placed at the site selected for attachment of the stomach to the abdominal wall (ie, lateral to the rectus abdominus and 3 cm caudal to the last rib on the right side). The laparoscopic Babcock forceps was used to retract the omentum from the stomach and then to grasp and reposi- tion the pyloric antrum and greater curvature of the stomach. A small area of ecchymosis on the greater curvature of the stomach and some hemorrhage in the area of the short gastric veins were observed. The remainder of the stomach and spleen was normal in appearance. The laparoscopic-assisted gastropexy was completed. The second dog included in our study with GDV was an 11-year-old female spayed German Shepherd Dog. The dog was admitted within 4 hours of initial signs of GDV, which included unsuccessful attempts to vomit. Initial examination and treatment for shock were similar to the first dog with GDV. Radiographic findings were typical of gastric volvulus. The spleen appeared markedly distended. Ultrasonography revealed that blood flowed in and out of the spleen. The stomach was intubated with difficulty following sedation with butorphanol and acepromazine maleate. This dog also appeared stable with a stomach distended with food, water, and air. It was elected to initiate correction of GDV by use of laparoscopic-assisted gastropexy with the option to convert to an open laparotomy if the stomach wall appeared diseased or the spleen appeared to be thrombosed. Anesthesia was induced by IV administration of diazepam and ketamine hydrochloride, followed by isoflurane gas for maintenance. Trocar placement and repositioning of the omentum and stomach were the same as in the first dog with GDV. The
spleen was markedly distended but otherwise appeared to have normal blood flow. Some free blood was found in the abdomen, but the stomach wall appeared to be well perfused. The laparoscopic-assisted gastropexy was completed.

Results

Twenty-three dogs underwent surgery and were followed for 1 to 3.5 years with a mean and median follow-up time of 14.9 and 13 months, respectively. All dogs were breeds with a high susceptibility for GDV. The 23 dogs included 10 Greater Swiss Mountain Dogs, 5 Great Danes, 2 German Shepherd Dogs, and 1 each of the following breeds: Golden Retriever, Irish Setter, Bullmastiff, Black and Tan Coonhound, Doberman Pinscher, and Akita. Mean (± SD) body weight was 46.7 ± 12.3 kg (102.7 ± 27.1 lb) with a range of 25.9 to 73.9 kg (57.0 to 167.0 lb). Mean age was 3.3 ± 2.2 years old with a range of 1 to 9 years old. The 10 clinically normal hound dogs, which were used to characterize the ultrasonographic appearance of the right abdominal wall and stomach, had a mean body weight of 22.6 ± 3.4 kg (49.7 ± 7.5 lb).

Nine of the 23 dogs had a history of gastric dilatation before hospital admission, and this was the primary motivation for the client to request gastropexy. A veterinarian had treated 6 of the 9 dogs with previous gastric dilatation as an emergency. The remaining 3 dogs were treated by their owners who had experience in treating other dogs for GDV and were able to perform gastric intubation. Four of the 9 dogs with a history of gastric dilatation also had a parent or sibling that had gastric dilatation. One dog developed gastric dilatation nearly every day. Six of the remaining 23 dogs had signs of gastrointestinal tract disease such as vomiting, abdominal pain, pacing, and transient gastric distention, which had not been treated. Three of the 23 dogs had no known history of gastric dilatation but did have first-order relatives that were affected. Only 5 of the 23 dogs did not have a history of gastric dilatation, signs of gastrointestinal tract disease, or a relative that had gastric dilatation. The owner of 1 of these dogs had had 2 Great Danes that died of GDV, but those dogs were unrelated to the current dog. A veterinary technician or a veterinarian owned 3 of the 5 dogs. The final dog was an aggressive Bullmastiff that weighed 75.9 kg (167 lb).

Morbidity rate associated with surgery—None of the dogs had substantial postoperative problems that could be attributed to surgery. The only complication was associated with delayed reactions that developed around the suture that attached the stomach to the abdominal wall. Five months after gastropexy, 1 dog had a small fistula at the gastropexy site. Reactions around the sutures in another dog were identified by use of ultrasonography at the 1-year evaluation. The client was not aware of an incisional problem in this dog, and only a small, firm subcutaneous nodule was apparent on palpation. Gastropexy sites were explored in both dogs and the sutures removed. Neither dog had further incisional problems or signs that the attachment between the stomach and the abdominal wall had failed.

Long-term efficacy—None of the dogs developed GDV or received veterinary care for gastric dilatation or other gastrointestinal tract problems during the monitored time, which lasted for up to 3.5 years after gastropexy. All dogs were followed for at least 12 months, except 1 dog that was euthanatized 11.5 months after surgery because of severe and sudden aggressiveness. This dog was necropsied and had a firm adhesion of the stomach to abdominal wall. This gastropexy site was 3 cm long and 4 cm caudal to the last rib. The mucosal layer was continuous over the gastropexy site. At least 12 of the 15 dogs that had a history of gastric dilatation or signs of gastrointestinal tract disease before gastropexy improved after gastropexy. One dog continued to have gastric dilatation 3 or 4 times per month, with clinical signs that were reported by the owner as resolving following metoclopramide treatment. Two dogs underwent surgery for splenic volvulus, at which time the emergency surgeon reported a firm adhesion between the stomach and the abdominal wall.

Figure 1—Transverse ultrasonographic image of the right cranial portion of the abdomen in a clinically normal dog. Notice the distance (0.3 cm) between the serosal margin of the body wall (uppermost cursor indicated by arrow) and the serosal surface of the stomach (lower cursor indicated by arrow). The normal layered appearance of the stomach wall and the serosal surface are clearly seen. Movement of the stomach wall was seen during real-time imaging. In Figures 1–3, dorsal is to the left and right is to the top.
Poodle recovered without clinically important complications. After surgery, the dog was treated in the intensive care area to administer fluids and monitor the dog’s ECG. The dog began eating on the day after surgery. Because of ventricular arrhythmias, which resulted in pulse deficits, the dog remained in the hospital for 48 hours before discharge to the client. The dog had regained an exercise routine of walking 2 miles daily with the owner by 1 week after surgery. The German Shepherd Dog steadily improved after surgery and was discharged 72 hours after surgery. The dog rapidly regained normal eating habits and activity level within 1 week after surgery.

**Discussion**

In our study, laparoscopic-assisted gastropexy was easily performed in client-owned dogs by one of the authors (CAR). Since the beginning of our study, residents have been performing this procedure in our hospital, and the technique has been taught in laboratories to many veterinarians, some with entry-level endoscopic surgery skills. The technique is relatively simple, as the antral incision and suture placement during gastropexy can be easily seen and performed in an open fashion. Because the attachment between the stomach and the abdominal wall can be viewed in the closed abdomen, this laparoscopic-assisted technique ensures that the pyloric antrum is not twisted in its attachment to the abdominal wall. On the basis of the 2 dogs that had reactions around the suture in our study, we have modified our suturing technique. It was believed that the nonabsorbable suture used for the initial traction sutures might have penetrated the gastric mucosa and lumen. Polydioxanone suture material is now used instead of polypropylene. In addition, we have discontinued including the initial traction sutures in the closure pattern. Care is taken to ensure that the suture is placed only into the seromuscular flap to further ensure that the lumen is not entered.

Results of epidemiologic studies of dogs that are susceptible to gastric dilatation provide criteria as to which dogs should receive gastropexy. The acute and unexpected onset of GDV in middle-aged or older dogs means that several years of an absence of clinical signs of gastrointestinal tract problems in dogs that are susceptible to gastric dilatation does not ensure that a dog will not develop GDV. Dogs in which gastropexy to prevent GDV is strongly indicated include those that have a history of gastric dilatation, have signs of gastrointestinal tract problems that are typical of dogs with gastric dilatation, or have a first-order relative that has had gastric dilatation. Other indications include a history of splenic volvulus and a chest shape that has a deep chest-to-width ratio. Results of a critical prospective study of 927 military working dogs revealed that 9.1% developed GDV and were removed from the working force. Considering that many working dogs include breeds that are known to be susceptible to gastric dilatation and that their occupation is stressful, gastropexy could preclude the loss of a valuable trained working dog. Military veterinarians have been trained and are currently routinely performing laparoscopic-assisted gastropexy in these working dogs.

Several gastropexy techniques have been developed for use during a laparotomy. The first widely used
technique was a tube gastropexy, which can be performed quickly during laparotomy for GDV treatment.\textsuperscript{[20]} Compared with other techniques, tube gastropexy breaking strength is relatively low,\textsuperscript{[21]} and volvulus recurs in 5 to 11% of dogs that undergo surgery.\textsuperscript{[22-24]} The tube is typically left in place for 1 week, and some dogs also develop septic peritonitis from tube gastropexy.\textsuperscript{[25]} New gastropexy techniques have been developed with the goals that they would be simple to perform, produce a permanent adhesion between the pyloric antrum and the right abdominal wall, not alter gastric function, and produce minimal complications.\textsuperscript{[26]}

A permanent adhesion requires that the mesothelium of the serosa and peritoneum is removed, cauterized, or incised at the interface of the stomach and body wall.\textsuperscript{[27]} The circumcostal technique provides a strong adhesion on the basis of findings in breaking-strength studies and results in a low GDV recurrence rate.\textsuperscript{[28-30]}

Infrequent complications include iatrogenic perforation of the gastric mucosa,\textsuperscript{[31]} pneumothorax, and rib fractures.\textsuperscript{[32]} The belt-loop and incisional gastropexy techniques produce strong adhesions with low recurrence rates for GDV.\textsuperscript{[14,15,19-21,33]}

Laparoscopic gastropexy techniques have been developed.\textsuperscript{[22,24]} These are performed by use of laparoscopic suturing or stapling techniques within the abdomen. Three trocars and a high degree of laparoscopic surgical skill are required. The adhesion between the stomach and abdominal wall resulting from these laparoscopic techniques fractures at lower breaking strengths than those of incisional and belt-loop gastropexy performed by laparotomy.\textsuperscript{[22]}

The laparoscopic-assisted technique described herein uses laparoscopy only to identify and grasp the pyloric antrum. Once the antrum is exteriorized, the gastric incision and gastropexy can be simply and quickly performed by an open technique. Mean (± SD) breaking strength, also reported as maximal tensile strength, for gastropexy specimens of such organs as liver, kidneys, pancreas, and the intestinal wall (full thickness). These techniques also require only entry-level endoscopic surgery skills. With the addition of 1 or 2 trocars, laparoscopic ovariohysterectomy, a more challenging procedure, also can be performed during the laparoscopic-assisted gastropexy.

To our knowledge, our report is the first of laparoscopic correction of GDV in clinically affected dogs. Dogs reported in this article were carefully selected on the basis of findings on the initial evaluation. A stomach tube could be passed to deflate the stomach, material coming from the tube did not indicate gross gastric hemorrhage, and the dogs were hemodynamically stable after fluid resuscitation. The Hasson technique permitted safe entry into the abdomen and insufflation with carbon dioxide.\textsuperscript{[34]} During the brief period following removal of the stomach tube during tracheal intubation of the first dog, the stomach redilated. The stomach tube was replaced during surgery so that the stomach deflated and derotated. We had previously performed prophylactic laparoscopic-assisted gastropexy in a dog in which the endotracheal tube had inadvertently been placed into the esophagus. The stomach had been inflated before the mistake was realized and the tube properly positioned into the trachea. The 180° clockwise volvulus was easily corrected by use of the Babcock forceps to derotate the pyloric antrum. With experience, it may be possible to perform surgery on other dogs with gastric dilatation when gastric intubation is difficult. The use of laparoscopy permits excellent viewing of most abdominal organs but does not permit palpation of the stomach. When laparoscopy is being performed in a dog with GDV, severe gastric wall injury and splenic thrombosis may be reasons to convert to an open procedure.

Documentation of a secure antral adhesion to the right abdominal wall is desired by many clients and is needed to validate efficacy of gastropexy procedures. We have used ultrasonography and contrast gastrograms.\textsuperscript{[22]} Distinct differences were found between the ultrasonographic appearance of the right abdominal wall in dogs that had gastropexy\textsuperscript{[32,35]} versus those that did not. Clinically normal dogs have a distinct separation of serosa of the pyloric antrum from that of the abdominal wall. In contrast to clinically normal dogs, the pyloric antrum moved in concert with the adjacent abdominal wall in dogs that had laparoscopic-assisted gastropexy. The last rib is frequently immediately over the gastropexy site, even though the surgical position was usually about 3 cm caudal to the rib. Gastrograms indicated that the pyloric antrum is near to, but not necessarily adhered to, the right abdominal wall. The greatest value of gastrograms was to document normal gastric emptying, a fact already confirmed with a good history that indicates normal gastric function.\textsuperscript{[22]}


\textsuperscript{[2]} Military Working Dog Veterinary Services, Lackland, Tex.

References


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