Evaluation of short- and long-term complications after endoscopically assisted gastropexy in dogs

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Objective—To determine short- and long-term complications in clinically normal dogs after endoscopically assisted gastropexy.

Design—Prospective case series.

Animals—24 dogs.

Procedures—Endoscopically assisted gastropexy was performed on each dog. Dogs were evaluated laparoscopically at 1 or 6 months after surgery to assess integrity of the gastropexy. Long-term outcome was determined via telephone conversations conducted with owners ≥ 1 year after surgery.

Results—Mean ± SD gastropexy length was 4.5 ± 0.9 cm, and mean duration of surgery was 22 ± 5 minutes. One dog had a partially rotated stomach at the time of insufflation, which was corrected by untwisting the stomach with Babcock forceps. Two dogs vomited within 4 weeks after surgery, but the vomiting resolved in both dogs. Four dogs had diarrhea within 4 weeks after surgery, which resolved without medical intervention. In all dogs, the gastropexy site was firmly adhered to the abdominal wall at the level of the pyloric antrum. Long-term follow-up information was available for 23 dogs, none of which had any episodes of gastric dilatation-volvulus a mean of 1.4 years after gastropexy.

Conclusions and Clinical Relevance—Endoscopically assisted gastropexy can be a simple, fast, safe, and reliable method for performing prophylactic gastropexy in dogs. At 1 and 6 months after gastropexy, adequate placement and adhesion of the gastropexy site to the body wall was confirmed. Such a procedure could maximize the benefits of minimally invasive surgery, such as decreases in morbidity rate and anesthetic time. This technique appeared to be suitable as an alternative to laparoscopic-assisted gastropexy. (*J Am Vet Med Assoc* 2010;236:177–182)

Despite advances in critical care and anesthetic monitoring and an increased awareness by owners of dogs predisposed to develop GDV, the condition continues to be associated with relatively high morbidity and mortality rates. In the past, mortality rates for dogs with GDV were approximately 50%[1–3]; however, mortality rates between 15% and 20% have been reported more recently.[4,5] For this reason, many veterinarians have begun to advocate prophylactic gastropexy for higher-risk patients.[6–13] The lifetime risk of certain dogs predisposed to develop GDV has been estimated to be between 4% and 37%.[7] These dogs include, but are not limited to, large- to giant-breed dogs (especially Great Danes), dogs with a first-degree relative that has had GDV, excessively anxious dogs, and inappropriately rapid eaters.[14–16] On the basis of inquiries about the number of prophylactic gastropexies performed by veterinarians in the geographic area surrounding the veterinary practice of the authors, we suspected that prophylactic gastropexy was not widely performed by veterinarians for a number of reasons, including lack of client and veterinarian education, cost, morbidity, and a perception of the invasiveness of the procedure. Presumably, similar reasons would contribute to a low frequency of prophylactic gastropexies being performed throughout the United States.

Abbreviation

GDV	Gastric dilatation-volvulus

Minimally invasive procedures continue to be introduced to the veterinary field and are gaining popularity among veterinary surgeons.[17–22] Although potentially challenging, these procedures are advantageous in humans in that they are associated with a decrease in incision size, decrease in the duration of hospitalization, decrease in morbidity, decrease in incisional complications, and improved cosmetic appearance, compared with results for conventional surgery.[22–24] Clearly, these advantages are magnified when performing a prophylactic procedure.

Currently, prophylactic gastropexies can be performed via an open approach or several techniques described elsewhere.[25–33] Each of these techniques requires a large incision and is widely considered a major surgical procedure as a result of the necessary large exposure and amount of time required to perform the surgery. Many owners and veterinarians consider such a procedure excessively invasive for a young healthy dog with an uncertain probability of developing GDV later in life.

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More recently, minimally invasive alternatives have been described and are gaining interest among veterinarians.[8–11] These include laparoscopic-assisted gastropexy, grid-approach gastropexy, and total laparoscopic gastropexy. The major drawback to these procedures is the need for expensive instruments for the laparoscopic technique, duration of the procedure, and possible increase in the risk of damaging other organs by use of the grid approach.[8–10,34,35] In another report[36] by our laboratory group, we described a technique for evaluating the feasibility of performing endoscopically assisted gastropexy. Such a procedure may have benefits similar to those of other minimally invasive procedures described for prophylactic gastropexy.

Briefly, endoscopic-assisted gastropexy involves insufflation of the stomach and concurrent use of endoscopy to provide surgeons with adequate visibility during percutaneous placement of stay sutures into the region of the pyloric antrum. The stay sutures are then pulled taut in an effort to place the stomach directly against the body wall. An incision between the stay sutures provides an approach to the pyloric antrum of the stomach. A gastropexy is then performed. The purpose of the study reported here was to evaluate the short- and long-term outcome for dogs in which endoscopically assisted gastropexy was performed to aid in the prevention of GDV.

Materials and Methods

Animals—Twenty-four client-owned dogs were selected for use in the study because of an increased risk for developing GDV, as determined on the basis of signalment or a family history of GDV. Dogs were not excluded on the basis of body weight, breed, age, or sex. For each dog, results of a serum biochemical analysis and CBC were assessed prior to inclusion in the study. Owners were charged a reduced fee for the endoscopically assisted gastropexy and were not charged a fee for the follow-up laparoscopic procedure. At the time of enrollment of their dogs, clients signed a consent form acknowledging the potential risks from the gastropexy and anesthesia as well as potential complications associated with the subsequent laparoscopic examination 1 or 6 months after the gastropexy. The study was approved by the Iowa State University Institutional Animal Care and Use Committee.

Surgical procedures—Food was withheld from each dog for 12 hours before anesthesia. Each dog was anesthetized in accordance with a protocol approved by the attending anesthesiologist. Briefly, dogs were premedicated with 1 or a combination of the following: butorphanol tartrate, hydromorphone, acepromazine maleate, or diazepam. Anesthesia was induced by administration of propofol or thiopental. Anesthesia was then maintained by administration of isoflurane in oxygen. Hair on the abdomen of each dog was clipped, and the abdomen was routinely prepared for surgery. Each dog was also placed on a recirculating warm water blanket to reduce the likelihood of it becoming hypothermic, and routine monitoring was performed throughout the procedure. Lactated Ringer's solution was administered IV at a rate of 10 mL/kg/h (4.5 mL/lb/h) during the procedure. All surgeries were performed by one of the authors (SBR).

Each dog was positioned in left oblique recumbency. The table was tilted (head upward) 30° from a horizontal plane such that the hind quarters were approximately 30° below the head. A videogastroscope[a] (insertion tube length, 103 cm; outer diameter, 8.6 mm) was passed through the mouth of each dog and advanced to the stomach. The stomach was then insufflated with room air until rugal folds were minimally visible and adequate distention was achieved. In a few dogs, the cervical portion of the esophagus was compressed by an assistant to help achieve gastric distention. To locate the anatomic site for location of the procedure, external compression across the body wall was performed by use of curved Rochester-Carmalt hemostatic forceps, with simultaneous viewing of the pyloric antrum via the endoscope. The stomach was briefly evaluated for evidence of gross pathological changes. Number 2 polypropylene suture[b] on a cutting needle (needle length, 76 mm) was passed through the right lateral aspect of the body wall immediately caudal to the 13th rib; the needle and suture were viewed endoscopically as they entered and exited the stomach at the level of the pyloric antrum (approx 2 to 3 cm proximal to the pylorus) before exiting the body wall again. The resulting stay suture incorporated approximately 2 cm of tissue. The suture was then pulled taut and temporarily secured in place with mosquito hemostats. An additional piece of suture was then inserted approximately 4 to 5 cm aborad from the initial suture in the region of the pyloric antrum.

An incision was made through the skin, subcutaneous tissues, and layers of the abdominal musculature between the 2 stay sutures; dissection of tissues was performed until the stomach was visible. Orientation of the incision differed but typically was perpendicular to the 13th rib. The abdominal musculature was incised sharply; the various muscles were not bluntly dissected in a grid manner. Hemostasis was achieved by application of manual pressure, use of curved hemostats, and ligation of larger vessels with 3-0 polydioxanone suture.[b] Two Gelpi self-retaining retractors were placed perpendicular to each other in the incision to allow better visibility. A longitudinal incision (approx 4 cm in length) was then made through the serosal and muscular layers of the pyloric antrum, as described elsewhere.[36]

For the purposes of the study, an adequate gastropexy was considered to be a minimum of 3 cm in length. Length of each gastropexy was measured to the nearest millimeter by use of the scale on a scalpel handle. The seromuscular layer was sutured to the transversus abdominis muscle by use of 2 separate continuous patterns with 0 polypropylene suture[b] (**Figure 1**). Suture bites through the seromuscular layer were initiated at least 1 cm from the cut edge. The external abdominal oblique muscle was then approximated with 2-0 polydioxanone suture[b] in a simple continuous pattern. Subcutaneous tissues were closed in a routine manner, and a simple continuous intradermal pattern with intermittent suturing to the underlying tissues was performed by use of 3-0 poliglecaprone 25.[b] Skin sutures were not inserted. Stay sutures were subsequently removed while the stomach was endoscopically evaluated and decompressed.

All dogs received hydromorphone (0.1 mg/kg [0.045 mg/lb], IV) immediately after completion of the

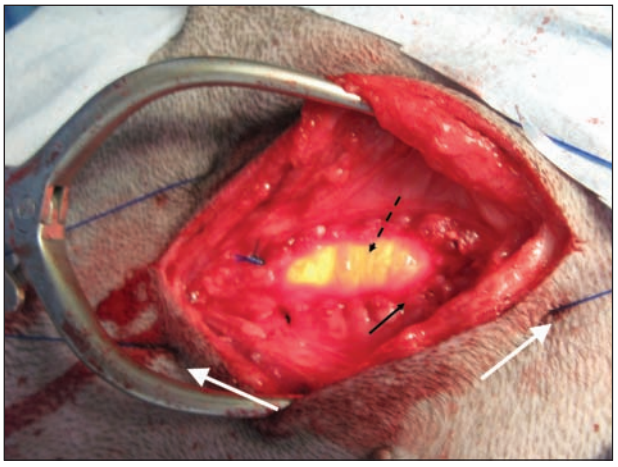

Figure 1—Photograph of the abdomen of a representative dog during endoscopically assisted gastropexy. The head of the dog is to the left. Stay sutures (white arrows) have been placed by use of an endoscope and are used to indicate the area for the abdominal incision. Notice the seromuscular layer that has been sutured to the transversus abdominis muscle (black arrow) and the stomach mucosa, which appears yellow because of illumination from the endoscope (dashed black arrow).

procedure and were subsequently administered tramadol (2 to 3 mg/kg [0.9 to 1.4 mg/lb], PO, q 8 h for 3 to 5 days, as necessary to alleviate pain). Dogs were hospitalized overnight after surgery to enable observation; dogs were discharged to owners the following day.

Postoperative laparoscopic evaluation—At the time of enrollment, the first 10 dogs were assigned to be laparoscopically evaluated 6 months after the endoscopically assisted gastropexy was performed, whereas the remaining dogs enrolled in the study were to be laparoscopically evaluated 1 month after the endoscopically assisted gastropexy procedure. Food was withheld from each dog for 12 hours before anesthesia. Each dog was anesthetized in accordance with a protocol approved by the attending anesthesiologist and maintained with isoflurane in oxygen. Hair on the abdomen was clipped, and the abdomen was routinely prepared for surgery. Each dog was also placed on a recirculating warm water blanket to reduce the risk of becoming hypothermic, and routine monitoring was performed throughout the procedure. Lactated Ringer's solution was administered IV at a rate of 10 mL/kg/h during the procedure.

Briefly, each dog was positioned in dorsal recumbency and a Veress needle was introduced approximately 1 to 2 cm caudal to the xiphoid. The abdomen was insufflated with carbon dioxide to a pressure of approximately 14 cm H_2O. After adequate insufflation was achieved, a 5-mm trocar-cannula was introduced on the right side of the abdomen approximately 2 cm cranial and lateral to the umbilicus. A 5-mm, 30° laparoscope[c] was introduced into the abdomen, and the abdominal cavity was briefly explored. The gastropexy site was laparoscopically evaluated to assess adequate placement and healing. Adjacent abdominal organs were assessed for inadvertent entrapment at the gastropexy site. A 5-mm port was then established on the left side of the abdomen approximately 2 cm cranial and lateral to the umbilicus. Laparoscopic Babcock forceps were introduced into the abdominal cavity and used to place firm traction on the adhesions that had formed between the abdominal wall and pyloric antrum. A 5-mm laparoscopic biopsy instrument was then used to obtain biopsy specimens from the interface between the body wall and stomach. Biopsy specimens were submitted for histologic examination.

Long-term postoperative evaluation—All owners were contacted via telephone at least 1 year after the gastropexy and asked to participate in a brief survey. Questions included specific details regarding subsequent episodes of GDV, any gastrointestinal signs after the surgery (eg, vomiting, diarrhea, or anorexia), client perception of signs of pain exhibited by the dogs, and client satisfaction associated with the cosmetic result. Overall scores for client satisfaction and pain were rated on a scale of 1 to 10, with a score of 10 being the most satisfied or the most pain, respectively. Owners were asked to recall the amount of pain and any potential complications, despite the prolonged interval since the prophylactic procedure was performed.

Statistical analysis—Mean, median, range, and SD values for duration of surgery, length of the gastropexy, and body weight were calculated. Additionally, mean, median, range, and SD values were calculated for the client survey of pain perception and client satisfaction.

Results

Animals—Prophylactic endoscopically assisted gastropexy was performed on 24 dogs. Follow-up monitoring was performed for 0.3 to 1.8 years (mean, 1.4 years; median, 1.5 years). Although all breeds were considered susceptible to developing GDV, breeds represented in the study included 10 Great Danes, 5 large mixed-breed dogs, 2 Boxers, 1 Irish Wolfhound, 1 French Bulldog, 1 Standard Poodle, 1 Mastiff, 1 Doberman Pinscher, 1 Bernese Mountain Dog, and 1 Giant Schnauzer. There were 6 sexually intact females, 3 spayed females, 4 sexually intact males, and 11 neutered males. Dogs ranged from 0.3 to 8.3 years of age (mean ± SD, 2.33 ± 1.9 years; median, 2.0 years) at the time of surgery. Mean body weight ranged from 12.5 to 79.1 kg (27.5 to 174.0 lb), with a mean of 41.5 ± 17.3 kg (91.3 ± 38.1 lb) and a median of 43.2 kg (95.0 lb). For all dogs, results of a serum biochemical analysis and CBC were within reference limits.

Surgical procedure—Mean ± SD duration of surgery for the 24 dogs ranged from 15 to 35 minutes (mean ± SD, 22 ± 5 minutes; median, 22 minutes). There were no major surgical or anesthetic complications encountered during the surgery. The approximate amount of time for introduction of the gastroscope into the stomach and achievement of adequate insufflation was 1 minute. Although intragastric pressure was not measured, there were no substantial changes in values for the monitored variables at the time of stomach insufflation. Gastropexy length ranged from 3.0 to 7.0 cm (mean, 4.5 ± 0.9 cm; median, 4.5 cm).

One dog had a partial rotation of the stomach on insufflation. This was detected by identifying the pylorus to the left of midline via percutaneous palpation of the pyloric antrum while viewing the stomach endoscopi-

cally. Stay sutures in this dog were placed at the proposed incision site, which corresponded to the body of the fundus as a result of the partial rotation. The abdomen was incised between the stay sutures. Once the stomach was visible, Babcock forceps were used to untwist the stomach until it was properly positioned for gastropexy. Proper positioning was confirmed endoscopically.

Postoperative laparoscopic evaluation—Laparoscopic examination was performed on 10 dogs at 1 month and 9 dogs at 6 months after the endoscopically assisted gastropexy. Five dogs were not laparoscopically evaluated because of owner noncompliance. All 19 dogs had a firm gastropexy at the level of the pyloric antrum. All dogs subjectively had adequate adhesion formation between the body wall and pyloric antrum, as determined on the basis of results when we attempted to pull the pyloric antrum away from the body wall (**Figure 2**). Results of histologic examination of biopsy specimens obtained laparoscopically from the gastropexy site were available for 9 dogs examined at 1 month and 9 dogs examined at 6 months after gastropexy. All biopsy specimens had mature granulation tissue, fibrous connective tissue, a tunica muscularis, or a combination of these 3 findings.

Long-term postoperative evaluation—The owners reported no complications associated with healing of the incision after the endoscopically assisted gastropexy. All dogs resumed typical activities within 1 week after surgery. Of the 24 dogs, follow-up information was available for 23. None of the dogs with follow-up monitoring had an episode of GDV after the gastropexy (range, 0.4 to 1.8 years; mean, 1.4 years; median, 1.5 years).

Two dogs vomited within 4 weeks after surgery; however, vomiting resolved in both dogs after administration of famotidine (0.5 mg/kg [0.23 mg/lb], PO, q 12 h for 7 days). Four dogs had diarrhea within 4 weeks after surgery; diarrhea in all dogs resolved without medical intervention. On a pain scale of 1 to 10 (10 indicated the most pain), owner-assigned pain score for the dogs after surgery ranged from 1 to 10 (mean ± SD, 4.2 ± 2.9; median, 4). Two owners believed the pain score was 10 immediately after discharge from our veterinary hospital. The 2 owners who believed that their dogs had excessive pain were asked to describe the signs of pain. One owner mentioned that his dog had always been sensitive to painful conditions and thus was not surprised that the dog whined after returning home. The other owner could not accurately recall the exact behavior of the dog to indicate pain, but he did remember that the dog had signs of excessive pain.

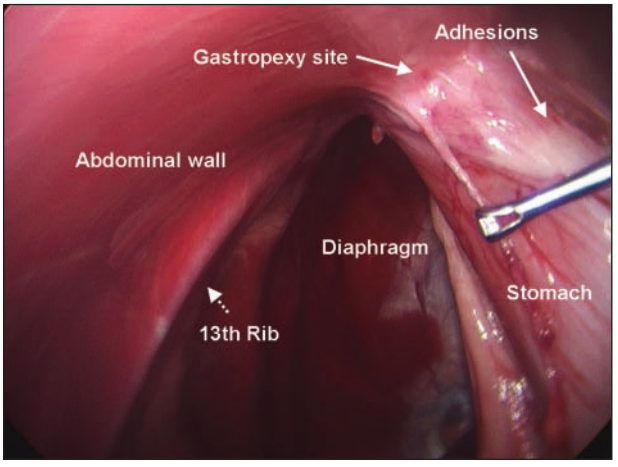

Figure 2—Laparoscopic view of the abdomen of a representative dog 1 month after endoscopically assisted gastropexy. Babcock forceps are used to place traction on the stomach, which reveals that a firm adhesion has developed between the site of the gastropexy (just caudal to the 13th rib) and the abdominal wall.

Twenty-two of 23 owners were satisfied with the cosmetic outcome of the surgery. On a scale of 1 to 10 (10 indicated the most satisfaction), owner satisfaction for the outcome of the procedure ranged from 7 to 10 (mean, 9.8; median, 10).

Discussion

The short- and long-term outcome for endoscopically assisted gastropexy in client-owned dogs was evaluated in the study reported here. In another study,[7] investigators reported that prophylactic gastropexy decreased the mortality rate associated with GDV in Great Danes, Irish Setters, Rottweilers, Standard Poodles, and Weimaraners. In the short-term period after surgery to correct GDV, mortality rates among dogs can reach 16% to 33%.[3,5,37,38] Issues associated with performing prophylactic gastropexy include invasiveness of the procedure, lifetime risk of an episode of GDV, and actual necessity of prophylactic surgery, and many owners are unaware of the procedure.[7–10,37,39,40] The procedure evaluated in our study was similar to laparoscopically assisted gastropexy.[8–10] The key difference was that the procedure performed in our study requires only 1 incision, which corresponds to the site of the gastropexy. Thus, our procedure was essentially the same as an incisional gastropexy.

Other investigators have evaluated the integrity of the adhesion between the stomach and body wall interface. The breaking strength of adhesions resulting from circumcostal, belt-loop, incisional gastropexy, and laparoscopically assisted gastropexy ranges from 60 to approximately 110 N, depending on the type of procedure and the interval between when the surgery is performed and the adhesion strength is tested.[10,13,27,35,41] We elected to not evaluate the strength of the adhesions because we believed it would not add substantial insights to the technique described. The ultimate load necessary to cause failure at the adhesion site of a laparoscopically assisted gastropexy has been described in detail.[10] Given the similarities between the procedures in that study and the study reported here, we assumed a similar mean ± SD failure load of 106.5 ± 45.6 N. Regardless, the strength of an adhesion required to prevent GDV is not known, and breaking strength has not been correlated with clinical efficacy (ie, a reduction in the incidence of GDV).[10]

In our study, we did not detect gross breakdown of adhesions during the laparoscopic evaluation 1 or 6 months after the surgery. At both of these time points, laparoscopic examination of the gastropexy site revealed no signs of failure. All dogs appeared to have a strong adhesion between the seromuscular layer of the stomach and the transversus abdominis muscle. We

were able to confirm correct anatomic positioning of the gastropexy in all dogs on which a laparoscopic examination was performed. Subjectively, there were no obvious differences in the appearance of the gastropexy at 1 and 6 months. Histologically, there were no findings indicative of failure or complications in adhesion formation between the seromuscular layer of the stomach and the transversus abdominis muscle.

Complications associated with traditional gastropexy procedures include rib fracture, dehiscence of the incision, sepsis, pneumothorax, and recurrence of gastric dilatation with or without volvulus.[13,26,28,30,40,42,43] Less invasive techniques have been described[8–10,13,34] that can be used to decrease the morbidity associated with gastropexy. On the basis of the results reported here, there were no major surgical complications encountered, no issues with healing of the incision or gastropexy site, and no failures identified at the time of postoperative laparoscopic examination. One dog did have partial rotation of the stomach at the time of surgery and required detorsion of the stomach for proper positioning of the gastropexy. This emphasizes the importance of having a surgeon who is comfortable with endoscopy and anatomy perform the procedure to avoid inadvertent placement of the gastropexy in an inappropriate position. Furthermore, certain complications, such as perforation of a loop of bowel or major organ at the time of percutaneous needle advancement into the stomach, can be envisioned. Needle breakage inside the abdomen is a potential complication, although the authors have not had this happen with the current selection of needles. On the basis of the limited number of dogs in this study, we did not encounter this complication, and we hope that adequate insufflation will make this complication an extremely rare event.

Regardless of potential complications, the technique used here may have an advantage over other less invasive techniques in that the instrumentation required may be more widely available because veterinarians may already be using the equipment for other procedures.[36] Another notable advantage is that the duration of surgery may be substantially less than for other prophylactic procedures, which have been reported to reach approximately 70 minutes of surgical time.[35] It is important to mention that practice and increased surgical efficiency can make it possible to perform all prophylactic procedures in similar surgical times.

After gastropexy, the dogs subjectively appeared to be comfortable and did not have signs of excessive pain while in our veterinary hospital. However, owner assessment of pain indicated that dogs may have signs of pain after discharge. We assumed that the pain associated with the procedure would be minimal and that tramadol would be sufficient to control this pain. We provided analgesic rescue if dogs were uncomfortable, but subjectively, we did not detect excessive pain while the dogs were hospitalized. On the basis of the owners' responses to the questionnaire, 2 dogs were classified as having extreme pain. However, these owners did not make the authors aware that their dogs had signs of extreme pain; therefore, no rescue analgesia was provided.

A shortcoming of the study is the retrospective nature of the questionnaire, which required owners to recall the amount of pain perceived by their dogs. This may have been overestimated or underestimated by the owners because of the time elapsed since the gastropexy. Although other minimally invasive procedures have been compared with traditional open procedures in regard to pain,[44,45] the authors are not aware of any specific studies on pain associated with a gastropexy technique. It would be interesting to perform a study to compare signs of pain associated with a variety of gastropexy techniques. Because this procedure is minimally invasive, we assume that pain associated with the procedure would be minimal, compared with that for other techniques.

Only 1 of 24 dogs was lost to follow-up monitoring. All gastropexy procedures were performed in dogs predisposed to episodes of GDV as a result of their breed, behavior, or genetics. Postsurgical monitoring was conducted for a mean of 1.4 years, and there were no episodes of GDV in the 23 dogs during that time. Other potential limitations of this study include the lack of a longer period (ie, lifetime of each dog) of follow-up monitoring, the small sample size, and lack of proof that the gastropexy will not fail sometime in the future.

On the basis of the results for the study reported here, we believe that when performed by a trained and experienced surgeon, an endoscopically assisted gastropexy is a safe, fast, reliable, and minimally invasive alternative to other currently available prophylactic procedures. Endoscopically assisted surgery in humans potentially maximizes the benefits associated with minimally invasive surgery, including a reduction in size of the incision, a decrease in postoperative pain and analgesic drug requirements, and a more rapid restoration of physiologic function of the intestinal tract.[46,47] Subsequent to the study, the authors have performed prophylactic endoscopically assisted gastropexy on a regular basis and have taught the procedure to other veterinary surgeons. We perceive that becoming proficient in the technique is most difficult for veterinary surgeons who have no experience with endoscopy, and we believe that most veterinary surgeons will be comfortable with the procedure after performing 4 or 5 surgeries. In our limited experience, we have found that the surgery is simple to perform in most dogs but we have infrequently encountered a dog in which it was difficult to achieve the appropriate position or to access the stomach caudal to the 13th rib, which contributes to the duration of the procedure as a result of the need to reposition the dog.

a. GIF-160 gastrointestinal videoscope, Olympus, Tuttlinger, Germany.
b. Ethicon, Somerville, NJ.
c. Stryker Endoscopy, San Jose, Calif.

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