Evaluation of a novel technique involving ultrasound-guided, temporary, percutaneous gastropexy and gastrostomy catheter placement for providing sustained gastric decompression in dogs with gastric dilatation-volvulus

W. Alexander Fox-Alvarez DVM, MS
J. Brad Case MS, DVM
Daniel D. Lewis MS, DVM
Ashley C. Joyce
Kirsten L. Cooke DVM
Beau Toskich MD

From the Department of Small Animal Clinical Sciences, College of Veterinary Medicine, University of Florida, Gainesville, FL 32608 (Fox-Alvarez, Case, Lewis, Joyce, Cooke); and the Department of Radiology-Vascular Interventional Radiology, Mayo Clinic, 4500 San Pablo Rd S, Jacksonville, FL 32224 (Toskich).

Address correspondence to Dr. Fox-Alvarez (walvarez@ufl.edu).

OBJECTIVE
To evaluate the feasibility of ultrasound-guided, temporary, percutaneous T-fastener gastropexy (TG) and gastrostomy catheter (GC) placement for providing sustained gastric decompression in dogs with acute gastric dilatation-volvulus (GDV) and to compare findings with those of trocarization.

ANIMALS
16 dogs with GDV.

PROCEDURES
Dogs were randomly assigned to undergo gastric decompression by means of percutaneous trocarization (trocar group; n = 8) or temporary TG and GC placement (TTG+GC group; 8) with ultrasound guidance. The gastric volvulus was then surgically corrected, and the decompression sites were examined. Outcomes were compared between groups.

RESULTS
The proportion of dogs with successful decompression did not differ significantly between the TTG+GC (6/8) and trocar (7/8) groups; median procedure duration was 3.3 and 3.7 minutes, respectively. After the failed attempts in the TTG+GC group, the procedure was modified to include ultrasound guidance during T-fastener placement. The decrease in intragastric pressure by 5 minutes after trocar or GC insertion was similar between groups. For dogs in the TTG+GC group, no significant difference in intragastric pressure was identified between 5 and 60 minutes after GC insertion. Complications included inadvertent splenic or jejunal placement in 2 dogs (TTG+GC group) and malpositioned and ineffective trocar placement in 1 dog (trocar group). All dogs survived for at least 2 weeks.

CONCLUSIONS AND CLINICAL RELEVANCE
Ultrasound-guided, temporary, percutaneous TG and GC placement was safe and effective at providing sustained gastric decompression in dogs with GDV, suggesting that this technique would be ideal for dogs in which surgical delays are anticipated or unavoidable. (J Am Vet Med Assoc 2019;255:1027–1034)

Gastric dilatation-volvulus is a life-threatening emergency characterized by gastric distention and malposition, most commonly affecting large- to giant-breed dogs.1–4 The rapid clinical decompensation of GDV patients occurs secondary to massive gastric distention, which impinges on normal diaphragmatic movement, compresses vital abdominal vasculature, and leads to a cascade of negative sequelae including hypovolemic shock, arrhythmia, electrolyte disturbances, visceral necrosis, and death.5–8 For this reason, rapid gastric decompression is a key component of preoperative stabilization for dogs with GDV.9,10

Gastric decompression is typically attempted on initial evaluation of dogs with GDV via orogastric intubation or percutaneous trocarization, which have reported success rates of 76% and 86%, respectively.11 However, these techniques provide only temporary decompression, and gastric dilatation can return as long as the volvulus persists.

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Conclusions and Clinical Relevance
Ultrasound-guided, temporary, percutaneous TG and GC placement was safe and effective at providing sustained gastric decompression in dogs with GDV, suggesting that this technique would be ideal for dogs in which surgical delays are anticipated or unavoidable. (J Am Vet Med Assoc 2019;255:1027–1034)

Abbreviations
GC  Gastrotomy catheter
GDV  Gastric dilatation-volvulus
IGP  Intragastric pressure
IQR  Interquartile (25th to 75th percentile) range
TG  T-fastener gastropexy

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We previously evaluated the efficacy of temporary TG and self-retaining GC placement for providing continuous gastric decompression in dogs with experimentally induced gastric dilatation. In that study, the technique was found to be minimally invasive and quick to perform (in < 4 minutes), and it successfully provided effective continuous gastric decompression without creating a gastric wound that required closure. The next logical progression in the investigation of this technique was to evaluate its performance and effectiveness in dogs with naturally occurring GDV.

The purpose of the study reported here was to evaluate and describe the use of a novel means of gastric decompression for dogs with naturally occurring GDV by means of ultrasound-guided, temporary, percutaneous TG and GC placement and to compare findings with those of standard ultrasound-guided gastric trocarization. We hypothesized that the novel decompression technique would be safe and that results would not differ significantly from those of trocarization, except that it would take more time to perform TG and GC placement and that the achieved gastric decompression would be sustained.

Materials and Methods

Dogs

Dogs brought to the emergency and critical care service at the University of Florida College of Veterinary Medicine with naturally occurring GDV were considered for inclusion in the study following owner consent. The GDV was diagnosed on the basis of clinical signs and results of abdominal radiography. An a priori sample size calculation (α = 0.05; β = 0.80) had been performed on the basis of previously reported data that indicated it would take a mean ± SD of 2.3 ± 1.5 minutes to achieve a 50% decrease in IGP. This calculation revealed that a total of 13 dogs would be necessary to detect a significant difference in decompression efficacy between groups when a 50% decrease in IGP was used as the threshold for successful decompression. Therefore, 16 dogs were selected for participation. The study protocol was approved by the University of Florida Veterinary Hospitals Research Review Committee and Institutional Animal Care and Use Committee (protocol No. 201508909).

Procedures

A random number generator was used to assign the next 16 dogs with GDV that met inclusion criteria to undergo gastric decompression by means of standard ultrasound-guided, percutaneous trocarization (trocar group; n = 8) or ultrasound-guided, temporary, percutaneous TG and GC placement (TTG+GC group; 8). On initial evaluation and diagnosis with GDV, all dogs were connected to a mobile anesthesia group; 8). On initial evaluation and diagnosis with GDV, all dogs were placed in 1 or both cephalic veins. Aggressive indirect blood pressure monitoring, and an IV catheter to provide continuous ECG recordings and gastric decompression would be sustained.

To perform TG and self-retaining GC placement for providing continuous ECG recordings and indirect blood pressure monitoring, and an IV catheter was placed in 1 or both cephalic veins. Aggressive IV fluid therapy was instituted and adjusted to the individual patient on the basis of cardiopulmonary readings, with the aim of achieving a heart rate of ≤ 140 beats/min and systolic arterial blood pressure of 100 mm Hg. Methadone (0.2 mg/kg [0.09 mg/lb]) was administered IV to all dogs to alleviate discomfort.

Dogs were then prepared for gastric decompression by clipping of hair from and aseptic preparation of the planned optimal site of entry for decompression, confirmation of that site via ultrasonography, and SC infusion of 1 mL of 2% lidocaine solution around the site. For dogs assigned to the trocar group, gastric decompression was performed by use of a 14-gauge over-the-needle catheter placed in an area of tympany in the dorsolateral abdominal region 1 to 3 cm caudal to the right 13th rib. The site was again ultrasonographically examined before the attending emergency clinician inserted the trocar (catheter). On initial placement, the trocar was attached to a device that had been calibrated prior to use in accordance with the manufacturer’s recommendations to measure and record IGP (0 minutes) and then held in place by the clinician while decompression occurred. This clinician was unaware of (blinded to) the IGP readings. Intragastric pressure measurements were recorded every 5 minutes until the trocar was removed, and the timing of this removal was chosen by the clinician on the basis of his or her subjective assessment of air flow through the trocar, the level of decompression achieved, and improvement of cardiopulmonary values. An IGP reading was obtained immediately prior to trocar removal.

Repeated trocarization was allowed at the clinician’s discretion when the gastric dilatation appeared to have recurred, patient discomfort appeared to have increased, or cardiopulmonary values had correspondingly worsened. Timing of the duration of this procedure began at initiation of local anesthesia and ended on removal of the trocar. Corrective surgery and gastroscopy were performed routinely on completion of data collection. Partial gastrectomy and splenectomy were performed when necessary as determined by the attending surgeon. The trocar placement site was evaluated at the gastric serosal surface during corrective surgery when it could be identified.

For dogs assigned to the TTG+GC group, the clinician performing gastric decompression wore sterile gloves while placing 3 T-fasteners percutaneously approximately 1.5 cm apart in a triangular orientation into the gastric lumen via the right dorsolateral abdominal region, in the same place as described for dogs in the trocar group (Figure 1; Supplementary Video S1, available at avmajournals.avma.org/doi/suppl/10.2460/javma.255.9.1027). The exact location of placement within this region was determined by ultrasound guidance and the subjective auditory pitch of tympany. Prior to placement, all T-fastener needles were attached to a 6-mL syringe containing 2 mL of sterile saline (0.9% NaCl) solution. After introduction of the T-fastener needle into the gastric lumen, the attached syringe plunger was drawn back to

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evaluate for the presence of air bubbles, which would indicate appropriate intragastric positioning, and the T-fasteners were deployed from the needle to perform a temporary gastropexy. In the center of the temporary gastropexy site, a 21-gauge needle was placed into the gastric lumen, into which a 0.018-inch, 60-cm guidewire was fed. The needle was removed over the guidewire, and a 5F introducer was placed over the guidewire to dilate the needle tract and then removed. Finally, a 5F self-retaining pigtail catheter was placed over the guidewire into the gastric lumen, the guidewire was removed, and the pigtail coil was formed, locked in place, and retracted to the gastric wall. Timing of the duration of this procedure began at initiation of local anesthesia and ended on completion of the procedure as indicated by locking the pigtail catheter. As for dogs in the trocar group, an immediate IGP measurement was recorded followed by readings every 5 minutes. If fluid was noted exiting the end of the catheter or gas efflux could not be detected subjectively, the catheter was flushed with 3 mL of sterile saline followed by 3 mL of room air prior to IGP measurement. The TG and GC were left in place to passively decompress the stomach for 60 minutes or until the time of surgical correction of the gastric volvulus. For no dog was surgery delayed to allow collection of 60 minutes of data beforehand.

The TG and GC were draped out of the surgical site, and prior to correction of the volvulus, a non-sterile surgical assistant unlocked and removed the pigtail catheter and then cut the T-fastener anchor sutures, releasing the temporary gastropexy. Corrective surgery and gastropexy were performed routinely following removal of these materials. Partial gastrectomy and splenectomy were performed when necessary as determined by the surgeon. The sites of the temporary TG and GC placement were evaluated at the gastric serosal surface during corrective surgery.

**Additional data collection**

Duration of clinical signs prior to gastric decompression was recorded for each dog. Outcome of each decompressive procedure was determined, with successful decompression defined as a lowering of IGP to ≤ 7 mm Hg. Complications noted during the decompression procedure or abdominal exploration during surgical correction of gastric volvulus were recorded.

**Statistical analysis**

Statistical software was used for all analyses. The Shapiro-Wilk test was used to assess continuous data (eg, age, body weight, IGP, and procedure duration) for normality of distribution. Because these data were nonnormally distributed, they are reported as median (IQR). The Wilcoxon signed rank test was used to compare repeated measurements such as IGP between and within the 2 treatment groups, and the Wilcoxon rank sum method was used to compare nonrepeated measurements between treatment groups. The Pearson $\chi^2$ test was used to compare categorical values such as success rates between treatment groups. For all comparisons, values of $P < 0.05$ were considered significant.

**Results**

**Animals**

The 16 dogs with GDV included 7 German Shepherd Dogs, 3 Great Danes, 1 Doberman Pinscher, 1 Giant Schnauzer, 1 Golden Retriever, 1 Greyhound,
1 Standard Poodle, and 1 Weimaraner. Nine dogs were neutered males, 6 were spayed females, and 1 was a sexually intact female. Median age was 8.0 years (IQR, 6.7 to 10.1 years), and median body weight was 34.3 kg (75.5 lb; IQR, 29.5 to 41.8 kg [64.9 to 92.0 lb]). The duration of clinical signs of GDV prior to initial evaluation ranged from 0.5 to 17 hours.

Median age of dogs in the trocar and TTG+GC groups was 7.4 years (IQR, 3.6 to 8.8 years) and 9.9 years (IQR, 7.3 to 11.0 years), respectively (P = 0.051); median body weight was 41.4 kg (91.1 lb; IQR, 31.4 to 49.5 kg [69.1 to 108.9 lb]) and 32.8 kg (72.2 lb; IQR, 29.0 to 34.8 kg [63.8 to 76.6 lb]), respectively (P = 0.07). Median duration of clinical signs prior to initial evaluation was 3.9 hours (IQR, 1.2 to 5.0 hours) and 2.3 hours (IQR, 1.5 to 4.4 hours), respectively (P = 0.92).

**Procedure**

Gastric access was successful in 14 dogs (8/8 in the trocar group and 6/8 in the TTG+GC group), and gastric decompression was successful in 13 dogs (7/8 and 6/8, respectively). Procedure duration and IGP data were summarized by group (Table 1). Median initial IGP for all 14 dogs in which gastric access was considered successful was 13.4 mm Hg (range, 4.2 to 20.2 mm Hg). All dogs had a significant decrease from the initial IGP measurement (on trocar or GC insertion [0 minutes]) to the final measurement (trocar group, P = 0.006; TTG+GC group, P = 0.002), and the magnitude of this decrease did not differ significantly (P = 0.70) between treatment groups. The decrease in IGP from the initial reading at 0 minutes to the second reading (≤ 5 minutes later) was significant in both groups (trocar group, P = 0.006; TTG+GC group, P = 0.02), and the magnitude of this decrease did not differ significantly (P = 0.37) between groups. In the TTG+GC group, no significant (P = 0.31) difference was identified between IGP measurements at 5 minutes and those at 60 minutes, suggesting that sustained decompression was achieved.

For 1 dog in the trocar group, the first attempt to decompress the stomach failed (inadvertent abdominocentesis) but was successful on the second attempt; therefore, that dog was considered to have had a successful outcome. For the 1 dog in the trocar group considered to have had an unsuccessful outcome, the first attempt to trocarize the stomach also failed (inadvertent abdominocentesis); however, although the second attempt was successful at entering the gastric lumen, the IGP failed to decrease to ≤ 7 mm Hg before the trocar was withdrawn. For both of these dogs, the recorded procedure duration encompassed both attempts; no evidence of trauma from the failed trocarization attempt was identified in either dog. Emergency clinicians did

### Table 1—Comparison of median (IQR) values of selected variables for client-owned dogs with GDV that underwent ultrasound-guided gastric decompression by means of percutaneous trocarization (n = 8) or temporary, percutaneous TTG plus GC placement (6).

<table>
<thead>
<tr>
<th>Variable</th>
<th>Trocar</th>
<th>TTG+GC</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Procedure duration (min)</td>
<td>3.3 (2.5–4.8)</td>
<td>3.7 (3.0–4.2)</td>
<td>0.52*</td>
</tr>
<tr>
<td>Initial IGP (mm Hg)</td>
<td>11.8 (9.6–18.6)</td>
<td>13.0 (10.9–15.4)</td>
<td>0.80†</td>
</tr>
<tr>
<td>Final IGP (mm Hg)</td>
<td>4.1 (2.4–5.2)</td>
<td>3.5 (3.0–4.1)</td>
<td>0.61†</td>
</tr>
</tbody>
</table>

*Comparison between groups performed with the Wilcoxon rank sum test. †Comparison between groups performed with the Wilcoxon signed rank test.
not elect to perform a second trocarization in any dog owing to returned gastric distention within the 1-hour preoperative study period.

The 2 failures in the TTG+GC group occurred early in the study (second and third dogs that underwent the procedure). In 1 dog, the decompression attempt failed when the spleen was inadvertently lacerated by the T-fasteners and 21-gauge needle. The T-fasteners went through the spleen and into the gastric lumen, as indicated by the presence of air bubbles in the syringe attached to the T-fasteners, and the guidewire could not be fed through the central 21-gauge needle because of the presence of the spleen. The procedure was abandoned, and the T-fastener anchor sutures were cut externally to release the spleen. No additional decompression methods were attempted. Surgical evaluation of the spleen revealed 4 small punctures 3 cm from the margin of the head of the spleen (Figure 2). Hemorrhage in this dog was minor and controlled with hemostatic gelatin foam. No splenectomy was performed. The procedural data were incomplete for this dog owing to the failure, and the dog was consequently excluded from data analysis.

For the second dog in the TTG+GC group in which decompression failed, the TG and GC were placed without any problems noted externally; however, they were placed into a loop of jejunum that was trapped between the distended stomach and body wall. Surgical exploration revealed that the GC and T-fasteners had been placed 5 mm away from the antimesenteric border of the loop of jejunum. The T-fastener anchor sutures were consequently cut, and the GC was removed to free the segment of jejunum. No evidence of leakage was detected from the 3 T-fastener or GC sites, and the affected jejunal segment appeared healthy (Figure 2). The area was wrapped in omentum, and the remainder of the surgery proceeded routinely.

For the first 3 dogs treated in the TTG+GC group, including these 2 dogs considered to have had a decompression failure, ultrasonography had been used solely to determine the location of the intended TG and GC sites, which were marked by SC local anesthetic administration. The T-fasteners were then placed blindly where the blebs of local anesthetic had been placed. For the remaining 5 dogs, the T-fasteners were placed under direct ultrasound guidance to ensure appropriate intragastric placement, resulting in successful decompression for all 5 dogs.

The sites of TG and GC placement were visually evaluated during subsequent surgery to correct the gastric volvulus in all 6 dogs in which decompression was considered successful, and none of these sites required suture closure or treatment (Figure 3). In all 6 dogs, the sites of TG and GC placement were located in the gastric midbody, 1 to 3 cm dorsal or ventral to the greater curvature of the stomach (Figure 4).

Splenectomy was also performed for 2 dogs in the trocar group after splenic thrombi were noted during surgery. Partial gastrectomy was performed for 1 dog in the TTG+GC group in which full-thickness necrosis was identified in a 7 X 5-cm portion of the fundus during surgery. In that dog, the TG and GC sites were approximately 10 cm away from this location in a healthy area of the gastric body and 2 cm ventral to the greater curvature of the stomach. All 16 dogs survived to discharge from the hospital and appeared to be doing well when examined 2 weeks after surgery for suture removal.

Figure 3—Photographs showing the external (A) and internal (B; arrow) appearance of the temporary TG and GC after placement as well as the sites of entry into the gastric wall after the T-fasteners (thin arrows) and catheter (thick arrow) have been removed (C). Notice that only mild serosal damage is evident.

Figure 4—Illustration showing the sites of temporary TG and GC placement in 6 dogs with GDV (each represented by an X) in which gastric decompression was considered successful. The sites on the ventral surface of the stomach are shown (black Xs), as is the 1 site on the dorsal surface of the stomach (white X). Sites were all within the gastric body, an uncommon location for gastric necrosis in dogs with GDV.
Discussion

Results of the present study supported the use of ultrasound-guided, temporary, percutaneous TG and self-retaining GC placement for gastric decompression in dogs with naturally occurring GDV. Both this approach and trocarization achieved successful gastric decompression in GDV patients, with temporary TG and GC placement having the added advantage of providing sustained decompression. The use of T-fasteners and a pigtail GC was important for preventing premature dislodgement of the GC and providing a continuous patent avenue for gas outflow.

T-fasteners consist of suture material attached to a metal T-bar, preloaded into a slotted 18-gauge needle that can be introduced percutaneously into the organ lumen and deployed. The needle can then be removed, leaving the suture and attached intraluminal T-bar for affixing the organ to the body wall. T-fasteners are used in human medicine to allow temporary fixation of an organ to the body wall, most often to facilitate safe tube placement into the gastrointestinal tract for feeding or decompression.15-17 The use of 3 T-fasteners for TG created a tented area around the GC tip to prevent the gastric wall from folding onto and obstructing the GC as the stomach decompressed. The TG also provides a means to replace the GC in the event of early dislodgement, although the locked pigtail catheter tip is intended to resist premature removal. Another benefit of the pigtail catheter is the 5 additional fenestrations protected within its curled tip, which reduce the risk of complete obstruction.

The 2 groups of dogs in the study reported here were similar with respect to age, body weight, and duration of clinical signs prior to initial evaluation, and their characteristics were similar in age, size, and breed to dogs in previous GDV studies.1,2,12,13,18,19 Consistent with findings in many other case series,4,12,20-22 of GDV in dogs, German Shepherd Dogs were common, comprising 7 of the 16 (44%) included dogs. A wide range in duration of clinical signs (0.5 to 17 hours) was also noted. Whether a longer duration of clinical signs prior to treatment of dogs with GDV is associated with a worse prognosis is unclear.12,15,19,23 The inconsistency in establishing a connection between these 2 factors is likely due to interpatient variability in the degree of gastric distention and the associated extent of cardiopulmonary and vascular compromise. The range in the initial degree of gastric distention and IGP in dogs in both groups of the present study was also wide (IGP, 4.2 to 20.2 mm Hg). It is reasonable to consider that the greater the increase in IGP and the longer its duration, the greater the amount of cardiovascular decompensation and hypoperfusion one might expect as well as the greater the blood lactate concentration. Although no association was investigated between duration of clinical signs and outcome in our study, the only dog that required partial gastrectomy had the longest duration of clinical signs (17 hours).

Both standard trocarization and temporary TG and GC placement were performed within a clinically feasible amount of time in the study reported here, and procedure durations did not differ significantly between groups. Dogs in the TTG+GC group had less variability (ie, a smaller IQR) in procedure duration than did dogs in the trocar group. This duration reflected the amount of time the emergency clinician was physically performing each procedure, rather than the amount of time required to achieve successful decompression. In the trocar group, procedure duration encompassed the time to perform the initial trocarization as well as any subsequent attempts in dogs with an initial failure and the period when the clinician held the trocar in place for decompression. In the TTG+GC group, procedure duration included only the time required to place the TG and GC because once these were in position, the clinician no longer needed to be present.

On comparison of the speed of gastric decompression between the trocar and TTG+GC groups, both groups had a significant decrease from initial IGP in ≤ 5 minutes, the extent of which was statistically similar. However, dogs in the trocar group had more rapid decompression than did dogs in the TTG+GC group, which was not surprising given that decompression began immediately after the trocar was inserted, whereas no meaningful decompression took place as the temporary TG was performed in preparation for GC placement. A self-retaining catheter design with a wide intraluminal footprint, such as a Foley, wingtip Malecot, or Pezzer catheter, may resist occlusion as gastric decompression occurs without requiring a TG. Use of such a catheter could simplify the reported technique and allow it to be performed faster; however, to the authors’ knowledge, no such catheter exists in a 5F size, and larger sizes may create gastric wounds that would require identification and closure.

Previously reported data regarding IGP in dogs with naturally occurring GDV are limited to a footnote in a single report in which the mean ± SD IGP for 20 dogs at initial evaluation was 22.9 ± 13.7 mm Hg. The median IGP at initial evaluation in the present study (13.4 mm Hg) was lower than this but within the same range of values. The lowest documented IGP in dogs associated with complete caval compression leading to diversion of venous return via the azygous vein was 20 mm Hg in an experimental angiographic study.24 The finding that all dogs in the present study survived the procedure and were doing well 2 weeks later could have been related to only 1 dog having an initial IGP > 20 mm Hg; therefore, most dogs likely retained at least some normal abdominal venous return. The physiologic range of IGP in healthy dogs is unknown; however, intra-abdominal pressure has been evaluated in healthy dogs in several studies.25-27 Whereas the results of those studies differed on the basis of measurement technique, in 1 study,27 intra-abdominal pressure measurements obtained by instillation of saline solution at a dose of 1 mL/kg cor-
related well with measurements obtained via laparoscopic insufflator. In that study, the mean resting intra-abdominal pressure in clinically normal dogs ranged from 5.81 to 7.06 mm Hg. On this basis, we defined a successful decompression for the present study as a lowering of IGP to ≤ 7 mm Hg because an IGP within the healthy physiologic range of intra-abdominal pressure would likely be of no consequence to abdominal structures.

Occasionally, some dogs in the TTG+GC group and 1 in the trocar group had IGP values that were slightly increased from the previous reading. This increase may have been due to contraction of abdominal musculature, a change in positioning during transport, or partial occlusion of the GC. For the dogs in the TTG+GC group, the higher IGP readings decreased once more after the GC was flushed with 3 mL of saline solution followed by 3 mL of air. In clinical situations, we would recommend this be performed every 15 minutes while the GC is in place or any time when the catheter subjectively seems to be occluded to ensure continued patency. Although IGP was not quantified immediately before surgery for dogs in the trocar group, surgeons subjectively noted greater gastric distention on abdominal exploration and required the use of orogastric intubation to facilitate derotation more often than for dogs in the TTG+GC group (data not shown).

A retrospective study of gastric decompression methods for dogs with GDV revealed success rates of 76% and 86% for orogastric intubation and gastric trocarization, respectively. The success rates in our study were similar to those findings and did not differ between treatment groups. Both treatment groups had 2 dogs in which the initial attempt at gastric decompression failed; however, 1 of the 2 dogs in the trocar group had a successful outcome on a second attempt. Apart from those in which gastric access was unsuccessful on the first attempt, no other dogs in the trocar group underwent repeated trocarization at the discretion of the emergency clinician. This may have been attributable to the brief period that the emergency clinician was triaging the dogs prior to anesthesia in our study (maximum of 1 hour), which did not reflect all clinical scenarios in which repeated trocarization may be indicated when gastric dilatation recurs.

Decompression for dogs in the TTG+GC group was attempted only once, and if failure was suspected, the procedure was abandoned out of concern for the unknown degree of trauma caused by GC misplacement. Given the outcomes observed for the 2 dogs with misplaced TG-GC units, we now expect such trauma would be minor. The TG-GC unit that was misplaced into the spleen caused mild hemorrhage from the placement sites that was controlled by direct pressure and a hemostatic gelatin sponge. The second misplaced TG-GC unit was placed into a loop of jejunum, again causing mild trauma that was treated with an omental wrap. In both situations, misplacement caused no further disease or damage requiring major surgical intervention. The 2 failures occurred early in the study, when ultrasound guidance was not part of the insertion technique. In the final 5 dogs treated in the TTG+GC group, the initial T-fastener was placed under direct ultrasound guidance to ensure appropriate intragastric placement. This small alteration to the technique appeared to prevent misplacement; therefore, we recommend use of direct ultrasound guidance when performing temporary TG and GC placement to prevent inadvertent damage to other abdominal structures.

In the aforementioned retrospective study of dogs with GDV, only 1 of 85 (1%) dogs treated by trocarization had evidence of inadvertent trauma to abdominal organs on abdominal exploration. In the present study, the trocars in 2 dogs were misplaced into the abdomen and in neither dog was the site of the aberrant puncture identified on abdominal exploration despite purposeful investigation. Given that finding, the retrospective nature of the other study, and how seldom a secondary clinical problem developed, we believe that the inadvertent trauma caused by misplacement of trocars occurs more frequently than has been reported but is likely underreported owing to the inconsequential injury caused by trocar needle puncture.

As shown in the preliminary study in which the temporary TG and GC procedure was evaluated in dogs with experimentally induced gastric dilatation, none of the placement sites in the stomach had evidence of clinically important trauma or a wound that required suture closure. One concern we had moving from this experimental setting to clinically affected dogs was whether the location of temporary TG and GC placement would be in sites known to be at a higher risk than others for gastric necrosis. Although gastric necrosis can occur anywhere in the stomach, the most commonly reported sites are the fundus and cardia. For all dogs in the TTG+GC group, the site of the TG-GC unit was within the gastric midbody, 1 to 3 cm dorsal or ventral to the greater curvature of the stomach, and away from the more common sites of gastric necrosis (Figure 4). Indeed, for the 1 patient in which partial gastrectomy was performed, the sites of temporary TG and GC placement were in a healthy area of the gastric body, approximately 10 cm away from a region of full-thickness fundic necrosis. Although the degree of gastric torsion can differ among GDV patients, the TG-GC unit was consistently placed in the gastric body of all dogs in the present study, suggesting placement in areas known to be at higher risk for gastric necrosis would be unlikely.

Overall, ultrasound-guided, temporary, percutaneous placement of a TG and self-retaining GC provided rapid, safe, effective, and sustained gastric decompression in dogs with naturally occurring GDV, with outcomes and procedure durations comparable with those achieved via standard gastric trocarization. We believe that the continuous decompression provided with the temporary TG and GC technique makes it ideal for situations in which surgical delays
are unavoidable. Additional research is warranted to compare objective measurements such as cardiopulmonary and clinicopathologic values as well as patterns in IGP over a longer duration and in a larger number of dogs and to further investigate the benefits of continuous gastric decompression over temporary methods in dogs with clinical GDV.

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Footnotes

a. SAF-T-PEXY, Kimberly Clark Medical, Roswell, Ga.

b. Mallinckrodt modification micropuncture introducer set, Cooke Medical, Bloomington, Ind.

c. Dawson-Mueller multipurpose drainage catheter, Cooke Medical, Bloomington, Ind.

d. Labquest 2 with gas pressure sensor, Vernier Software & Technology, Beaverton, Ore.

e. JMP, version 9.0.2, SAS Institute Inc, Cary, NC.

References


