

# Comparison of incisional gastropexy with and without addition of two full-thickness stomach to body wall sutures

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## OBJECTIVE

To compare complications between a modified incisional gastropexy (MIG) technique and standard incisional gastropexy (SIG).

## ANIMALS

347 client-owned dogs.

## PROCEDURES

Dogs that had undergone SIG or MIG from March 2005 through April 2019 were identified through a medical record search of the University of Missouri Veterinary Health Center. The MIG technique is identical to SIG except 2 additional simple interrupted sutures are added, 1 cranial and 1 caudal to the continuous suture line, going full thickness into the stomach to ensure engagement of submucosa. Medical record information was used to identify intraoperative, postoperative, and short-term complications, and telephone or email communication to pet owners and/or referring veterinarians was used to identify complications (short-term and long-term) after discontinuance of care at the University of Missouri Veterinary Health Center. Intraoperative, postoperative, short-term, and long-term complications were analyzed in aggregate within 6 matched groupings: (1) gastropexy for gastric dilatation-volvulus, (2) prophylactic gastropexy without other procedures, (3) gastropexy with ovariohysterectomy, (4) gastropexy with castration, (5) gastropexy with splenectomy, and (6) gastropexy with celiotomy other than splenectomy. Overall rates of complications potentially attributed to gastropexy were compared between SIG and MIG using the Fisher exact test. Overall rates of complications not attributed to gastropexy were compared between SIG and MIG using the  $\chi^2$  test.

## RESULTS

There were no significant differences in overall complication rates between SIG and MIG.

## CLINICAL RELEVANCE

Surgeons who feel that engagement of gastric submucosa is important for gastropexy success may use the MIG technique with minimal fear of complications. However, superiority of one technique over the other cannot be determined on the basis of this study.

**G**astropexy is performed during surgical correction of gastric dilatation-volvulus (GDV) or as a prophylactic procedure in at-risk patients to prevent GDV in dogs.<sup>1-7</sup> The objective of gastropexy is to create a permanent adhesion of the stomach to the right abdominal wall thereby eliminating the possibility of gastric volvulus. Multiple techniques have been employed to achieve this adhesion, including tube gastropexy, circumcostal gastropexy, and belt-loop gastropexy.<sup>1-4</sup> Currently, the most popular gastropexy technique is incisional gastropexy (IG)<sup>5-7</sup> whereby 1 incision is made through the right transversus abdominis muscle and a second incision is made in the pyloric antrum of the stomach through the seromuscular layers. Then, the 2 incisions are apposed with

a simple continuous suture pattern. The success of IG in preventing volvulus is high<sup>6-8</sup> but not 100%.<sup>8-11</sup> One study<sup>8</sup> reported 4.3% recurrence of GDV in cases that had gastropexies but did not specify which gastropexy technique was performed on each case of recurrence. Two studies at the same institution but during different time spans (2002 to 2005, and 2005 to 2008) reported specifically on IG and recorded GDV recurrences of 9.0% and 6.9%, respectively.<sup>10,11</sup>

The causes of the IG failure have not been elucidated, but a possible cause may be ineffective healing of the IG due to tension on the suture line. The submucosa is assumed to be the strongest layer of the stomach.<sup>12,13</sup> However, the submucosa is not engaged with suture in the standard IG technique.<sup>5-7</sup>

Modification of circumcostal gastropexy by incorporation of the stomach submucosa was proposed as an improvement of that gastropexy technique.<sup>13</sup> Similarly, engagement of the submucosa with IG might alleviate tension on the incision during healing and thereby eliminate failures. Such a modification performed at the University of Missouri Veterinary Health Center (VHC) involves the addition of 2 simple interrupted sutures from the stomach to the body wall, 1 cranial and 1 caudal to the continuous suture line. The additional sutures are placed full thickness into the stomach to ensure engagement of the submucosa. Whether this modification improves IG success has not been studied, and potential complications of this modification have not been reported. The objective of this retrospective study was to compare cases that received the modified IG procedure (MIG) to those with the standard IG procedure (SIG) to determine if there were detrimental effects associated with the MIG. We hypothesized that there would be no difference in complication rates between dogs with and without the IG modification. We also aimed to determine whether MIG offered better prevention of GDV than SIG if there were enough postgastropexy GDV occurrences to do so.

## Materials and Methods

Medical records from the University of Missouri VHC were searched from March 2005 through April 2019 to identify client-owned dogs in which IG was performed. Included in the study were medical records for dogs that had IG performed as part of GDV correction and those that had IG performed as a prophylactic procedure. Prophylactic gastropexy was defined as IG performed on dogs without GDV that were presented specifically for IG or dogs that were presented for abdominal surgery and the surgeon included IG as part of the procedures after determining that the dog was at risk for GDV on the basis of breed or body conformation. All prophylactic IG procedures were performed via celiotomy; gastropexies performed using laparoscopy were excluded from this study.

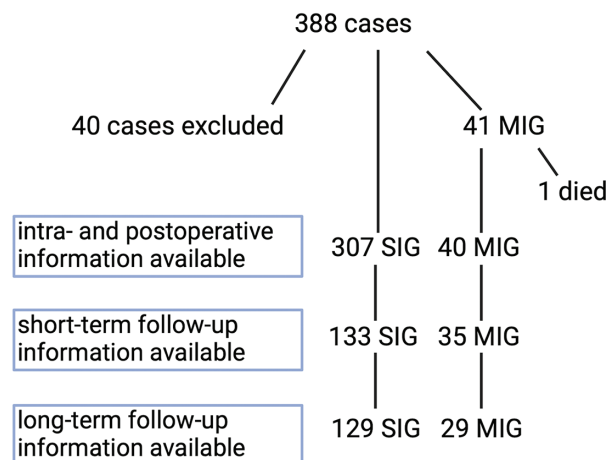
Cases were grouped on the basis of surgical method (either SIG or MIG). Surgery reports were reviewed to determine surgical method (SIG or MIG), record the suture material used for gastropexy, identify concurrent surgical procedures other than gastropexy, and identify intraoperative and postoperative complications. All complications, including comorbidities and complications unlikely to be due to gastropexy, were recorded, but obvious comorbidities were removed for statistical analyses. Anticipated potential complications related to gastropexy included right abdominal wall tenderness, hematemesis, suture-related infection or abscess, fistulous tract at gastropexy site, intestinal entrapment, and occurrence of GDV. Particular attention was given to search for evidence of suture-related complications. The following demographic data were also retrieved from the medical record: breed, gender (male, castrated male, female, spayed female),

and body weight to determine whether any of these factors might influence complications. Pet owner information was also recorded for the purpose of contacting for follow-up information.

Medical record information was used to evaluate intraoperative, postoperative, and short-term complications. Telephone follow-up or email to pet owners and/or referring veterinarians was used to identify complications (short-term and long-term) after patient discharge from the VHC. The postoperative follow-up period was defined as the time from completion of surgery to discharge from hospital. The short-term follow-up period was defined as the time from surgery to the time the dog returned to the VHC for suture removal. If the dog was not returned to the VHC for suture removal, short-term complication information was obtained during questioning about long-term complications. Long-term follow-up was defined as the time from suture removal to the latest medical information at the time study data collection was conducted (April 2021). To identify missing short-term complication information as well as long-term complications, an online survey was emailed and direct telephone calls were made to the pet owners or referring veterinarians. The survey was used to ascertain whether the dog was alive or deceased, whether there were complications related or unrelated to the gastropexy, whether the dog had recurrent gastric distention (bloating) episodes that did not require surgery, whether the dog had additional abdominal surgeries, whether the dog had a subsequent case of GDV for which surgery was recommended, and whether that surgery was performed or declined.

## Statistical analysis

Data were assembled in a spreadsheet, and dogs were assigned to different groups. Dogs were matched by primary surgical intervention and whether they had SIG or MIG. Six matched groupings were



**Figure 1**—Flow chart of case selection for dogs that had either a standard incisional gastropexy (SIG) or a modified incisional gastropexy (MIG) from March 2005 through April 2019. There were 40 cases initially excluded due to insufficient data in the medical records.

constructed: (1) gastropexy for GDV, (2) prophylactic gastropexy without other procedures, (3) gastropexy with ovariohysterectomy, (4) gastropexy with castration, (5) gastropexy with splenectomy, and (6) gastropexy with celiotomy other than splenectomy. Due to the low rate of complications within groupings and the small number of complications that could be potentially attributed to the gastropexy procedure, meaningful statistical compari-

sons could not be made and are thus not reported. For cases with complications that could potentially be attributed to the gastropexy procedure, the overall complication rates between SIG and MIG were compared using the Fisher exact test with significance set at  $P \leq .05$ . Similarly, overall rates of complications not attributed to the gastropexy procedure were compared between SIG and MIG using the  $\chi^2$  test with significance set at  $P \leq .05$ .

**Table 1**—Dog breeds or types that had either standard incisional gastropexy (SIG) or modified incisional gastropexy (MIG), including which breeds had complications potentially attributed to gastropexy.

Breed or type	No. of SIG cases	No. of MIG cases	Complication potentially attributed to gastropexy
Labrador Retriever	69	6	Fever of unknown origin (SIG) - postoperative period (1)
Great Dane	55	5	
German Shepherd Dog	34	5	
Mixed breed	32	5	Painful (SIG) - short-term (1)
Golden Retriever	14	0	
Standard Poodle	11	2	Regurgitation (SIG) - long-term (1); undescribed digestive issue (SIG) - long-term (1)
Unknown breed	11	1	
Mastiff	6	2	
Bloodhound	5	0	
Boxer	5	1	
Rottweiler	5	1	Regurgitation (SIG) - short-term (1)
Bernese Mountain Dog	5	1	
Doberman Pinscher	4	2	Celiotomy 2 mo after gastropexy unknown reason (MIG) - long-term (1)
Newfoundland	4	1	
Alaskan Malamute	3	0	
Belgian Malinois	3	0	
Golden Retriever-Poodle cross	3	0	
Greyhound	3	0	
Irish Wolfhound	3	0	
Saint Bernard	3	2	
Weimaraner	3	0	
American Staffordshire Terrier	2	0	
Australian Cattle Dog	2	0	
Chesapeake Bay Retriever	2	0	
Coonhound	2	0	
German Shorthaired Pointer	2	0	
Labrador mix	2	0	
Great Pyrenees	2	0	
Rhodesian Ridgeback	2	0	
Swiss Mountain Dog	2	0	
Basset Hound	1	0	
Bouvier des Flandres	1	0	
Cane Corso	1	0	
Collie	1	1	
Dalmatian	1	0	
Dogue de Bordeaux	1	0	
English Mastiff	1	0	
English Springer Spaniel	1	0	
Fila Brasileiro	1	0	
French Bulldog	1	1	
Great Pyrenees mix	1	0	
Hovawart	1	0	
Old English Sheepdog	1	0	
Pointer	1	0	
Pointer mix	1	0	
Poodle mix	1	0	
Shar Pei	1	0	
Siberian Husky	1	0	
Vizsla	1	0	
Akita	0	1	Mild inappetence and vomiting (MIG) - long-term (1)
Australian Shepherd	0	1	
Bulldog	0	1	
Chow	0	1	

## Results

On the basis of review of available medical records, there were 388 cases that had IG performed from March 2005 to April 2019. Of these cases, 40 did not have the IG method (SIG or MIG) indicated in the medical record, 307 had SIG (polypropylene,  $n = 22$ ; polydioxanone, 285) and 41 had MIG performed (polypropylene,  $n = 18$ ; polydioxanone, 23). One of the MIG cases was eliminated from the study because the dog died 5 hours after surgery for GDV due to deteriorating condition, and therefore this dog had no postoperative, short-term, or long-term data for comparison. Of the remaining 347 cases, 129 owners (SIG,  $n = 101$ ; MIG, 28) participated in the follow-up questionnaire by either online survey or telephone call. Intraoperative and postoperative data were available for all 307 SIG and 40 MIG cases. Short-term follow-up (SIG median follow-up period, 12 days; range, 1 to 36 days; MIG median follow-up period, 10 days; range, 3 to 18 days) was available for 133 SIG cases and 35 MIG cases. Long-term follow-up (SIG median follow-up period, 1,161 days; range, 58 to 4,648 days; MIG median follow-up period, 1,855 days; range, 832 to 3,723 days) was available for 129 SIG cases and 29 MIG cases (**Figure 1**). The median (range) body weights were 33.4 kg (5.7 to 86.6 kg) for SIG and 29.8 kg (9.6 to 75.8 kg) for MIG. There were 47 dog breeds represented (**Table 1**).

There were no occurrences of GDV in either group after SIG or MIG. There were 7 dogs that had complications potentially attributable to the gastropexy procedure; 5 were in the SIG group and 2 were in the MIG group ( $P = .407$ ; power 0.131). None of these 7 dogs had more than 1 complication that could be potentially attributed to the gastropexy procedure. During postoperative hospitalization, 1 SIG dog had a fever of unknown origin. On short-term follow-up, one SIG dog was painful for 3 days after surgery and another SIG dog experienced regurgitation for 2 days postoperatively; 1 MIG dog had decreased appetite and vomiting. On long-term follow-up, one SIG dog had frequent regurgitation and another SIG dog had an undescribed digestive issue; 1 MIG dog had an exploratory celiotomy

performed 2 months after gastropexy for gastroto-my and enterotomy for unknown reasons. The median (range) body weight for the 5 SIG dogs was 26.7 kg (23.5 to 36.8 kg); the 2 MIG dogs weighed 31.2 and 31.5 kg. All dogs that had complications potentially attributed to gastropexy had gastropexy performed with polydioxanone except for the MIG dog that had inappetence and vomiting at the short-term but not the long-term follow-up. There were 38 dogs that had complications not attributed to the gastropexy procedure (**Table 2**); 35 were in the SIG group and 3 were in the MIG group ( $P = .636$ ; power 0.076). Complications within matched groupings were too few for statistical analysis (**Supplementary Tables S1–S4**).

There were 11 dogs with comorbidities. One dog in the MIG group had intraoperative atrial fibrillation, and dilated cardiomyopathy was diagnosed at the short-term follow-up. Among the 11 dogs with comorbidities, short-term follow-up data were available for 10 dogs and long-term follow-up data were available for 7 dogs. None of these dogs experienced gastropexy-related complications, although 1 dog with hypertension and kidney disease required a feeding tube for 1 to 2 months to address trouble eating.

## Discussion

The primary objective of this study was to retrospectively compare perioperative and follow-up outcomes of dogs receiving 2 different gastropexy techniques (SIG and MIG) to determine whether there were detectable differences in complication rates between SIG and MIG groups. No statistically significant differences were detected in complication rates between dogs receiving SIG and dogs receiving MIG.

Incisional gastropexy is highly successful<sup>6–8</sup> and has been reported to reduce death due to GDV by 2.2-fold to 26.9-fold, depending on the breed of dog.<sup>14</sup> However, there are reports of GDV after IG.<sup>9–11</sup> The reason why GDV can occur after technically appropriate IG has not been determined, but 1 case report<sup>9</sup> suggests that stretching of the sutured body

**Table 2**—Complications not attributed to gastropexy procedure in 38 dogs that had a SIG or MIG.

Time of complication	Complications noted in 35 SIG cases	Complications noted in 3 MIG cases
Intraoperative	Hypotension (4) Minor blood loss (3) Ventricular premature contractions (1)	None
Postoperative	Prolonged anesthetic recovery (8) Aspiration pneumonia (2) Hypotension (1) Anxiety (1) Hypovolemia (1)	Minor incisional bleeding (1)* J-tube abscess (1)
Short-term follow-up	Seroma along incision (1)* Patient-induced trauma to incision (2)* Surgical site infection (5)* Prolonged recovery (1)	None
Long-term follow-up	Trouble eating, requiring a feeding tube for 1–2 mo (1) Gastric dilatation without volvulus (3) Seroma along incision (1)*	Gastric dilatation without volvulus (1)

\*Surgical site and incision refer to the abdominal incision for celiotomy, not the gastropexy site.

wall and stomach may occur during wound healing. The MIG was developed to support the sutured gastropexy tissues during healing and prevent stretching of those tissues. Theoretically, the 2 extra full-thickness simple interrupted sutures provide the necessary support to prevent tissue stretching because they engage the strongest layer of the stomach, the gastric submucosa.<sup>12,13</sup> While it is possible to engage the submucosa with suture without penetrating the gastric lumen, doing so runs the risk of missing the submucosa or not sufficiently engaging it, as has been suggested with colopexy failures.<sup>15</sup>

While published descriptions of SIG do not describe engagement of gastric submucosa, it is possible that some surgeons may incorporate submucosa during apposition of seromuscular layers to the body wall. Such information is difficult to obtain retrospectively from surgery reports, but common practice at the site of this study has been to not engage the submucosa with SIG. The lack of recurrence of GDV in the SIG cases questions the necessity of submucosal engagement. If lack of submucosal engagement is not the cause for reported SIG failures, the failure to form an adequate adhesion may be related to the body wall incision. It is possible that lack of full-thickness incision in the transversus abdominis muscle could result in an inadequate adhesion. Purposeful adhesion in dogs requires sufficient injury to the parietal peritoneum and serosa to cause tissue hypoxia and secure immobilization to allow capillary ingrowth.<sup>16</sup>

The absence of GDV after gastropexy in any of the cases in this study suggests that the full-thickness sutures in MIG may not be necessary. Had the MIG proven to be more successful than SIG or if the strength of MIG is pursued in other studies, knowledge of potential complications would be helpful. Therefore, potential complications of the full-thickness sutures of MIG were investigated. Anticipated surgical complications associated with MIG might be related to suture contact with the nonsterile gastric lumen, such as peritonitis, regional cellulitis, or gastric fistula. None of these complications were found in this study. Presence of suture in the gastric lumen could result in gastritis and associated clinical signs such as nausea and vomiting. Only 1 dog with MIG experienced vomiting on short-term follow-up and no MIG cases had vomiting reported on long-term follow-up, whereas 1 SIG dog had regurgitation for 2 days postoperatively and 1 SIG dog with kidney disease and hypertension had frequent regurgitation reported on long-term follow-up. Therefore, gastric irritation by the intraluminal placement of suture did not appear to be problematic.

The type of suture material could influence the success or complications of gastropexy. Polydioxanone and polypropylene are commonly used for gastropexy. Polypropylene might be preferred because gastropexies have been shown to have decreased strength during wound healing as collagen remodels.<sup>4</sup> The greatest decrease of gastropexy tensile strength occurs 21 to 50 days postoperatively.<sup>4</sup> While the strength of polydioxanone decreases by 31% after 42 days,<sup>17</sup> polypropylene retains tensile strength

indefinitely.<sup>18</sup> Furthermore, polypropylene might be preferred because collagen remodeling results in only 20% of final wound strength by 21 days.<sup>19</sup> However, polydioxanone was used in many cases in this study and no dogs subsequently developed GDV. One might argue against polypropylene because of its permanent presence in the stomach; however, there were no long-term complications in any of the dogs for which polypropylene was used.

Given the retrospective nature of this study, there were some limitations. Notably, there were no objective evaluations of gastropexy sites, such as imaging with ultrasound, that have been performed in prospective studies.<sup>20-22</sup> The long-term outcome relied on owner's memory with significant passage of time since the surgical procedure; therefore, some complications may have been forgotten. Only 129 of 347 (37.2%) owners participated in the follow-up questionnaire, and their responses could have been subject to selection bias. The low response rate limited the ability to identify short-term and long-term complications; therefore, complication rates could be higher than reported here. Results can also potentially be confounded by variation in case management at the discretion of attending veterinarians. All complications were recorded to avoid missing those associated with gastropexy, resulting in inclusion of complications that were not likely related specifically to the surgical technique. Some gastropexies were performed in conjunction with other procedures, making it difficult to know whether the gastropexy or the other procedure was to blame for complications. Separating the gastropexies into the 6 different surgical combinations for comparisons was performed to match procedures between SIG and MIG cases in an attempt to reduce the variability between groups. However, there were some matched groupings that provided insufficient numbers of cases for statistical comparison.

Comorbidities may not directly affect gastropexies, but they can affect patient outcome. Therefore, comorbidities were noted in this case series to see whether any case outcome was influenced by the comorbidity. Interestingly, all but one of the comorbidities occurred with SIG, probably because of the greater number of SIG cases compared to MIG. Long-term follow-up was traced back to each comorbidity, and no problems related to gastropexy were identified.

In conclusion, there were no occurrences of GDV after either SIG or MIG. There were no statistically significant differences in complication rates between SIG and MIG. As such, either SIG or MIG as described in this study may be useful for prevention of GDV. However, a prospective, randomized study comparing the biological strength of these 2 techniques and/or comparing recurrence of GDV as well as other technique-related outcomes would be needed to determine whether one technique has an advantage over the other (MIG vs SIG). Furthermore, investigation into the role of the body wall incision in success or failure of IG is warranted.

## Acknowledgments

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## Supplementary Materials

Supplementary materials are posted online at the journal website: [avmajournals.avma.org](http://avmajournals.avma.org)