A rapid and strong laparoscopic-assisted gastropexy in dogs

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Objective—To develop a technique for laparoscopic gastropexy in dogs and evaluate effects on stomach position and strength of the adhesion between the stomach and abdominal wall.

Animals—8 healthy dogs.

Procedure—Dogs were anesthetized, and the abdomen was insufflated with carbon dioxide. A laparoscope was placed through a cannula inserted on the abdominal midline caudal to the umbilicus. Babcock forceps placed through a cannula inserted lateral to the right margin of the rectus abdominus muscle were used to exteriorize the pyloric antrum, a longitudinal incision was made through the serosa and muscular layer of the pyloric antrum, and the seromuscular layer of the pyloric antrum was sutured to the transversus abdominus muscle. After surgery, positive-contrast gastrography was used to evaluate stomach position and the onset of gastric emptying, and ultrasonography was used to assess stomach wall activity and mobility. Dogs were euthanatized 1 month after surgery, and tensile strength of the adhesion was tested.

Results—In all dogs, stomach position and the onset of gastric emptying were normal 25 days after surgery, and the pyloric antrum was firmly attached to the abdominal wall 30 days after surgery. Mean ± SD ultimate load of the adhesion in tension was 106.5 ± 45.6 N.

Conclusions and Clinical Relevance—The laparoscopic gastropexy technique described in the present study could be performed quickly and easily by an experienced surgeon, resulted in a strong fibrous adhesion between the stomach and abdominal wall, and appeared to cause minimal stress to the dogs.

Materials and Methods

Dogs—Eight healthy male dogs weighing between 20 and 30 kg (mean ± SD, 25.2 ± 3.57 kg) were used in the study. For all dogs, results of a CBC, serum biochemical analyses, and urinalysis performed prior to inclusion in the study were normal. The study was performed with the approval and under the guidelines of the Institutional Laboratory Animal Care and Use Committee of the University of Georgia.

Surgical technique—Dogs were premedicated with atropine sulfate (0.04 mg/kg of body weight, IM) and acepromazine maleate (0.1 mg/kg, IM). Anesthesia was induced with thiopental sodium (12 mg/kg, IV) and maintained with halothane in oxygen. Dogs were placed on a warm-water recirculating blanket to reduce hypothermia, and routine monitoring was performed during anesthesia. Lactated Ringer's solution was given IV at a rate of 10 ml/kg/h. Following abdominal insufflation with carbon dioxide, positive-pressure ventilation was provided at a rate of 12 breaths/min, with a tidal volume of approximately 12 ml/kg; the inflation pressure during inspiration was < 25 cm water. Butorphanol (0.15 mg, IM, at the end of surgery and 12 hours later) was administered for analgesia.

For the laparoscopic-assisted gastropexy, a 10- to 12-mm-diameter trocar cannula was placed on the midline 2 to 3 cm caudal to the umbilicus, using the open (Hasson) technique. Retraction sutures of size 0 polydioxanone were placed on either side of the linea alba incision under sterile conditions. The linea alba was incised using a scalpel, and the stomach was exteriorized using Babcock forceps passed through the cannula into the abdomen. The seromuscular layer of the pyloric antrum was sutured to the transversus abdominis muscle. After surgery, positive-contrast gastrography was used to evaluate stomach position and the onset of gastric emptying, and ultrasonography was used to assess stomach wall activity and mobility. Dogs were euthanatized 1 month after surgery, and tensile strength of the adhesion was tested.

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longitudinal incision was made through the serosa and mus-

missures of the intended gastropexy site, and a 4-cm-long
polyethylene were placed 4 cm apart in the pyloric antrum at the com-
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and the fundus was positioned on the left side and dorsally.
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(10 ml/kg) via an orogastric tube. Stomach position was con-

tained in left lateral recumbency. Gastric motility and
position of the stomach wall in relation to the abdominal wall
were assessed.

Mechanical testing—Dogs were euthanatized 30 days
after surgery, and within 1 hour after euthanasia, the
strength of the adhesion site between the pyloric antrum
and abdominal wall was evaluated, using a mechanical test-
ing machine. The gastropexy site was removed in such a
way that portions of the stomach and apposing abdominal
wall remained, and these portions were cryolysed to cus-
tom-made clamps. Tissue at the site of fixation to the
cyroclamps was 1.5 to 6 cm wide. The clamps were placed
in the testing machine 5 to 10 cm apart, with the gastropexy
site centered between the fixation points. During testing,
the clamps were cooled with dry ice, but the gastropexy site
was maintained at approximately 21 °C, using a warm-
water-recirculating system. The gastropexy was loaded in
tension to failure. Maximum load was 448 N, with a sensi-
tivity of ± 1 N. Displacement velocity was 2.54 mm/min. A
graph of displacement versus load was recorded, and the
tissue was videotaped during loading.

Histologic evaluation—Following mechanical testing,
tissue from the gastropexy site was placed in neutral-buffered
10% formalin. Suture material was removed, and full-thick-
ness sections were trimmed from the adhesion site, routinely
processed, and embedded in paraffin. Section were stained
with H&E and Masson trichrome stains and examined histo-
logically. Adhesion sites were evaluated for the amount and
maturity of connective tissue (granulation vs dense collagen-
ous tissue), the amount of collagen, and the degree of
inflammation associated with or not associated with the
sutures.

Statistical analyses—Ultimate loads of the adhesions and
results of CBC were reported as mean ± SD. Cell counts before
and after laparoscopy were compared by use of one-way repeat-
ed-measures ANOVA. Significance was defined as P < 0.05.

Results

All dogs recovered from surgery without complications;
one vomited or had any signs of illness. For 4 dogs, results of CBC performed 3 days after surgery were indicative of a mild inflammatory response, consisting of mature neutrophilia without any immature neutrophils. For the other 4 dogs, results of CBC were unchanged from preoperative values. Mean WBC and segmented neutrophil counts increased significantly from 9,362 and 5,177 cells/µl, respectively, to 16,700 and 12,346 cells/µl 3 days after surgery. The highest total WBC count 3 days after surgery was 23,900 cells/µl. Results of CBC performed 7 days after surgery were normal for all dogs.

Positive-contrast gastrography 25 days after surgery indicated that stomach position and the onset of gastric emptying were normal in all dogs. Ultrasonographically, the stomach appeared to be adhered to the abdominal wall just caudal to the last rib in each dog, as evidenced by a lack of free movement of the stomach wall relative to the abdomi-
nal wall and a lack of distinction between the serosal surface of the stomach and the serosal surface of the abdominal wall. The stomach wall was thicker and more hypoechoic at the site of the attachment than elsewhere (Fig 3). Contractions of the pyloric antrum were seen in all dogs, but motility was absent at the site

Figure 1—Aerial view of a method for laparoscopic gastropexy in dogs. The primary surgeon is located on the dog’s right side with the monitor positioned opposite the surgical site so that it can be easily seen. Trocar cannulas are placed for the laparo-
scope (caudal to the umbilicus) and Babcock tissue forceps (right of the rectus abdominus and caudal to the last rib), which was used to grasp the antrum.

and were used to maintain a tight seal around the cannula. The peritoneal cavity was then distended with carbon dioxide, using an insufflator, and a 0° 10-mm-diameter laparo-
scope was placed through the cannula. The laparoscope was
connected to a camera and xenon light source. A second tro-
car cannula was placed lateral to the right margin of the rec-
tus abdominus muscle and 3 cm caudal to the last rib. Laparoscopic Babcock forceps were passed through this can-
ula and used to grasp the pyloric antrum midway between the greater and lesser curvatures, approximately 5 to 7 cm orad from the pylorus (Fig 2). The Babcock forceps were
removed from the abdomen along with the cannula, exter-
riorizing the pyloric antrum, and the incision in the abdomi-
nal musculature was extended parallel to the rib to a length
of 4 cm. Care was taken to avoid twisting the pyloric antrum
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sutured to the transversus abdominus muscle in a continu-
ous fashion with 2-0 polypropylene. The oblique muscles
were approximated with interrupted cruciate sutures of 2-0
polypropylene. The pyloric antrum was viewed laparosco-

cally to ensure that it was not twisted, and the laparoscope
and remaining cannula were removed. The cannula site was
covered with a single interrupted suture of size 0 polydiox-
anone in the external sheath of the rectus abdominis. Subcutaneous tissues and skin were closed routinely.

Postoperative monitoring—Complete blood counts were performed 3 and 7 days after surgery. Twenty-five days after surgery, positive-contrast gastrography was performed to assess stomach position and the onset of gastric emptying. Ventrodorsal and right lateral radiographic views were obtained after administration of a barium sulfate suspension (10 ml/kg) via an orogastric tube. Stomach position was con-
considered normal if the pylorus was positioned on the right side and the fundus was positioned on the left side and dorsally. Onset of gastric emptying was considered normal if barium was seen in the cranial part of the duodenum.

Ultrasonography of the gastropexy was also performed 25 days after surgery, using a 10 MHz transducer. Dogs were

positioned in left lateral recumbency. Gastric motility and
position of the stomach wall in relation to the abdominal wall
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All dogs recovered from surgery without complications; none vomited or had any signs of illness. For 4 dogs, results of CBC performed 3 days after surgery were indicative of a mild inflammatory response, consisting of mature neutrophilia without any immature neutrophils. For the other 4 dogs, results of CBC were unchanged from preoperative values. Mean WBC and segmented neutrophil counts increased significantly from 9,362 and 5,177 cells/µl, respectively, to 16,700 and 12,346 cells/µl 3 days after surgery. The highest total WBC count 3 days after surgery was 23,900 cells/µl. Results of CBC performed 7 days after surgery were normal for all dogs.

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of attachment. If a dog struggled during examination, the gastric wall at the adhesion site was pulled toward the abdominal wall.

At necropsy, mean ± SD length of the adhesion was 2.9 ± 0.56 cm. In all instances, the tissue failed at the gastropexy site during tension testing, and tissue distal to the gastropexy site remained attached to the clamps. Therefore, load data reflected the strength behavior of
operative and postoperative complications, and not interfere with gastric function, has minimal intra-wall in an anatomic position to prevent volvulus, does permanently attaches the stomach to the abdominal wall, and appeared to cause minimal stress to the dogs. The adhesion site had abundant fibroplasia extending from the submucosa of the stomach through the abdominal wall and infiltrating into the musculature of the stomach and abdominal wall. Regions of fibroplasia consisted predominantly of mature granulation tissue with moderate amounts of thin collagen fibers interspersed with lesser amounts of dense collagenous tissue composed of abundant thick collagen fibers. Fragmented suture material was surrounded by fibroplasia in 1 dog, in which a mild granulomatous inflammatory response surrounded fragmented suture material. Trichogranulomas and a few small foci of lymphocytes, plasma cells, and a few neutrophils were each seen in 1 dog. One dog had several large areas of pyogranulomatous inflammation that contained fragments of bone, and 1 dog had a resolving hematoma between the muscles of the abdominal wall.

Discussion

The laparoscopic gastropexy technique described in the present study could be performed quickly and easily by an experienced surgeon, resulted in a strong fibrous adhesion between the stomach and abdominal wall, and appeared to cause minimal stress to the dogs. Laparoscopic equipment and expertise were needed, but the extra-abdominal suturing simplified the procedure, compared with other laparoscopic gastropexy techniques that have been described.

Types of gastropexies performed through a laparotomy include incisional gastropexy, circumcostal gastropexy, belt-loop gastropexy, and tube gastropexy. The ideal gastropexy is simple and quick to perform, permanently attaches the stomach to the abdominal wall in an anatomic position to prevent volvulus, does not interfere with gastric function, has minimal intra-operative and postoperative complications, and requires minimal postoperative management. The Stamm technique for gastrostomy tube placement was modified in 1976 and advocated for use to prevent recurrence of volvulus in dogs undergoing surgery for treatment of GDV. Tube gastropexy has the advantage of providing a means for gastric decompression and drug administration; however, the tube must be maintained in place for at least 1 week after surgery, as premature tube removal can result in death. In addition, morbidity rates associated with tube gastropexy may be high because of tube-associated cellulitis and altered gastric myoelectric activity. Myoelectric function was found to be disrupted for 48 to 168 hours after experimental induction of GDV and tube gastrostomy, as well as after tube gastrostomy alone. Right-sided percutaneous endoscopic gastrostomy (PEG) tube placement has been attempted as a nonsurgical method of creating a permanent gastropexy. Unfortunately, in 1 study, only 4 of 7 dogs that underwent PEG tube placement had an adhesion between the stomach and abdominal wall 58 days later, and the tensile strength of this adhesion was approximately a third of that for the adhesions in 7 other dogs in which incisional gastropexy was done. In 2 studies of dogs with GDV that underwent tube gastrostomy, 4 of 76 (5%) and 3 of 24 (12%) had a recurrence. The adhesion can break down in dogs undergoing simple gastropexy or tube gastrostomy, allowing volvulus to recur.

Creating a permanent adhesion between the stomach and abdominal wall requires that the mesothelium of the serosa and peritoneum be removed, cauterized, or incised at the interface of the stomach and abdominal wall. Circumcostal gastropexy results in a very strong adhesion and is associated with a low rate of recurrence of GDV. In clinical studies, 1 of 30 (3%), 0 of 5, and 2 of 34 (6%) dogs had a recurrence after undergoing circumcostal gastrostomy during surgical correction of GDV. Complications in dogs undergoing circumcostal gastropexy have included peritonitis resulting from perforation of the stomach, iatrogenic pneumothorax, and inadvertent rib fracture. These problems are easily recognized and managed but are rare when the procedure is performed by experienced surgeons. A modified technique for circumcostal gastropexy has been described and is reported to be quicker to perform and easy enough to be done by a single person. This modification involved transecting the cartilaginous portion of the tenth or eleventh rib and passing the long portion of the rib through a seromuscular tunnel in the pyloric antrum. Recurrence rates are reportedly low in dogs undergoing belt-loop or incisional gastropexy, and these techniques do not have the potential for causing iatrogenic rib fracture or pneumothorax. Gastric dilatation-volvulus did not recur in any of 20 dogs followed up for 3 to 13 months or in 21 dogs followed up for 3 to 33 months after belt-loop gastropexy, and positive-contrast gastrography revealed normal peristaltic contractions in 14 dogs that underwent belt-loop gastropexy. Incisional gastropexy has also been used to produce a permanent fixation of the pyloric antrum to the abdominal wall. A simple gastropexy method
that involves incorporating a portion of the pyloric antrum when closing the midline abdominal incision has been used in Europe for many years. Although the recurrence rate was low in 61 dogs in which this procedure was performed, problems may be encountered if additional abdominal surgery must be performed in a dog that has undergone this type of incisional gastropexy because of adherence of the stomach to the abdominal midline.

The breaking strength of the adhesions produced with the laparoscopic gastropexy technique described in the present study (mean ± SD, 106.5 ± 45.6 N 30 days after surgery) was similar to strengths reported for adhesions resulting from circumcostal (100 N 21 days after surgery), belt-loop (109 N 50 days after surgery), and incisional gastropexies (60 N 21 days after surgery, 62 N 58 days after surgery, and 85 N 30 days after surgery) and higher than strengths reported for adhesions resulting from tube gastrostomy performed through a laparotomy (63 N 21 days after surgery) or by means of PEG tube placement (22.3 N 58 days after surgery). However, although in vitro testing suggested that the strength produced with the present technique was as strong or stronger than adhesions produced with other gastropexy techniques, the strength required to prevent gastric volvulus is not known, and breaking strength has not been correlated with clinical efficacy (i.e., a reduction in the rate of recurrence of volvulus).

The laparoscopic gastropexy technique described in the present report compares favorably with previously described laparoscopic techniques in terms of ease and strength of the gastropexy site. In addition, this technique required placement of only 2 trocar cannulas, compared with the 3 trocar cannulas required for previously described techniques. Breaking strength was greater than that reported following laparoscopic stapled gastropexy (45 N) and following a technique that involved laparoscopic dissection of a seromuscular flap for exit through the external and internal oblique muscles (77 N). Previously described laparoscopic techniques require laparoscopic dissection, and 2 of these techniques require laparoscopic stapling. Surgery times for these laparoscopic techniques also appeared to be longer than surgery times for procedures performed through a laparotomy.

References

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