Laparoscopic-assisted enterostomy tube placement and full-thickness biopsy of the jejunum with serosal patching in dogs

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Objective—To develop laparoscopic-assisted techniques for enterostomy feeding tube placement and full-thickness biopsy of the jejunum in dogs.

Animals—15 healthy dogs.

Procedure—Dogs were anesthetized, and positive pressure ventilation was provided. A trocar cannula for the laparoscope was inserted on the ventral midline caudal to the umbilicus. For enterostomy tube placement, a second trocar cannula was placed lateral to the right rectus abdominis muscle, and a Babcock forceps was used to grasp the duodenum and elevate it to the incision made for the cannula. The duodenum was sutured to the abdominal wall, and a feeding tube was inserted. For jejunal biopsy, a third trocar cannula was placed lateral to the left rectus abdominis muscle. A portion of jejunum was elevated to the incision for the second or third cannula, and a full-thickness biopsy specimen was obtained. A second specimen was obtained from another portion of jejunum, and retention sutures for the 2 biopsy sites were tied so that serosal surfaces of the biopsy sites were apposed to each other. Dogs were euthanatized 30 days after surgery.

Results—The enterostomy tube was properly positioned and functional in all 8 dogs that underwent laparoscopic-assisted enterostomy tube placement, and sufficient samples for histologic examination were obtained from all 7 dogs that underwent laparoscopic-assisted jejunal biopsy. None of the dogs had any identifiable problems after surgery.

Conclusions and Clinical Relevance—Results suggest that in dogs, laparoscopic-assisted procedures for enterostomy tube placement and jejunal biopsy are an acceptable alternative to procedures performed during a laparotomy. (Am J Vet Res 2002; 63:1313–1319)

A laparotomy has traditionally been required prior to surgical procedures involving the abdominal organs. More recently, however, laparoscopy has become an accepted and, sometimes, the preferred approach for such procedures, because surgical stress and postoperative recuperation time are reduced with laparoscopy, compared with laparotomy; gastrointestinal tract function (ie, myoelectric activity, intestinal motility, and transit time) returns to preoperative values more rapidly following laparoscopy; and recovery times are shorter following laparoscopy, resulting in lower hospitalization costs. A major disadvantage of laparoscopy, however, is the extensive training and experience needed for surgeons to become proficient with laparoscopic surgical procedures. For this reason, many more-involved procedures are performed as laparoscopic-assisted procedures, rather than as strict laparoscopic procedures. During laparoscopic-assisted surgery, a laparoscope is used to identify the abdominal organs. The appropriate organ is then elevated to or exteriorized through a small incision in the abdominal wall, and the necessary surgical procedures are performed in a traditional fashion with direct examination of the tissues. This approach reduces the trauma and time associated with opening and closing a large open abdominal incision and decreases the need for extensive intra-abdominal manipulation.

Two common small intestinal surgical procedures in dogs are placement of an enterostomy feeding tube and small intestinal biopsy. Enterostomy feeding tubes are critical for metabolic support of patients following abdominal surgery, especially patients with gastrointestinal tract or pancreatic disease. Small intestinal biopsy is essential to the diagnosis of many diseases in dogs, and although biopsy specimens can be obtained by means of endoscopy, such specimens often only contain mucosa. In dogs that do not require a laparotomy for other reasons, laparoscopic-assisted procedures for enterostomy tube placement and small intestinal biopsy could reduce stress and operative time. The purpose of the study reported here, therefore, was to develop laparoscopic-assisted techniques for enterostomy feeding tube placement and full-thickness biopsy of the jejunum with serosal patching in dogs.

Materials and Methods

The study protocol was approved by the University of Georgia Laboratory Animal Care and Use Committee. To reduce the number of dogs used for development of laparoscopic-assisted procedures, procedures described in the present report were performed during the same anesthetic episode that procedures used to develop laparoscopic-assisted procedures for gastropexy or cystopexy.

Animals—Eight healthy male dogs weighing between 20 and 30 kg (mean ± SD, 27.2 ± 3.57 kg) were used to develop procedures for laparoscopic-assisted enterostomy tube placement. Seven healthy female dogs weighing between 17.4 and 28 kg (mean ± SD, 21.4 ± 3.85 kg) were used to develop procedures for laparoscopic-assisted jejunal biopsy.
Anesthetic protocol—Dogs were premedicated with atropine (0.04 mg/kg, IM) and acepromazine (0.1 mg/kg, IM), and anesthesia was induced with thiopental sodium (12 mg/kg, IV) and maintained with halothane in oxygen. Dogs were placed on recirculating warm-water blankets to minimize hypothermia, and depth of anesthesia was monitored by evaluating reflexes, heart rate, and blood pressure every 5 minutes. Lactated Ringer's solution was given IV at a rate of 10 ml/kg/h. During laparoscopy and abdominal insufflation with carbon dioxide, positive pressure ventilation was provided (12 breaths/min; approx tidal volume, 12 ml/kg; peak inspiratory pressure, < 25 cm water). Butorphanol (0.15 mg, IM) was administered at the end of surgery and again 12 hours later.

Surgical procedures—Dogs were placed in dorsal recumbency. Sites for placement of the trocar cannulae were selected to provide good viewing with the laparoscope and appropriate grasping of the small intestine (Fig 1). One cannula (10- to 12-mm diameter) was placed on the ventral midline, 2 to 3 cm caudal to the umbilicus, by use of the open (Hasson) technique. During placement of this cannula, retraction sutures of size-0 polydioxanone were placed 1 to 2 cm lateral to the midline on both sides of the midline. These sutures were used to lift the body wall during cannula placement and were then used to maintain a tight seal around the cannula during abdominal insufflation. An insufflator was used to distend the peritoneal cavity with carbon dioxide, and a 10-mm laparoscope was placed through the cannula. The laparoscope was connected to a 3-chip camera and a 300-W xenon light source.

For the 8 dogs undergoing enterostomy tube placement, a second trocar cannula was placed lateral to the right rectus abdominis muscle in the midabdominal area (Fig 1A). A 10-mm laparoscopic Babcock forceps was used to grasp the duodenum at its midpoint and bring it up to the level of the incision made for cannula insertion (Fig 2A). The cannula and forceps were removed, and if necessary, the incision was lengthened with Metzenbaum scissors so that the antimesenteric aspect of the duodenum could be seen. The duodenum was sutured to the transversus abdominis muscle with 4 interrupted sutures of 2-0 polypropylene placed in a square (Fig 2B). A purse-string suture of 2-0 polypropylene was then placed in the middle of this square, and a 10-g 3-in catheter was inserted into the lumen of the duodenum through the middle of the purse-string suture. A 5-F feeding tube catheter was passed through the catheter (Fig 2C). The first purse-string suture was tightened, and a second was placed. The oblique abdominal muscles were closed over the enterostomy tube site, and the subcutaneous fat and skin were closed in separate layers. The catheter was secured to the abdomen.

For the 7 dogs undergoing jejunal biopsy, the first and second trocar cannulae were placed as described for the dogs undergoing enterostomy tube placement. A third trocar cannula was then placed lateral to the left rectus abdominis muscle, opposite the second cannula (Fig 1B). Laparoscopic Babcock forceps were inserted through the second and third cannulae and used in a hand-over-hand manner to examine the full length of the small intestine. A portion of the jejunum selected for biopsy was grasped with 1 of the Babcock forceps and brought up to the level of the incision made for insertion of the second or third cannula (Fig 3A).
The cannula and forceps were removed, and if necessary, the incision was lengthened with Metzenbaum scissors so that the antimesenteric aspect of the jejunum could be seen. Retention sutures of 2-0 polydioxanone were placed on both sides of the intended biopsy site (Fig 3B), and a full-thickness biopsy specimen was obtained. The biopsy specimen was taken in a transverse direction with respect to the long axis of the jejunum with a No. 11 scalpel blade. The biopsy site was closed with interrupted cruciate or simple interrupted sutures of 3-0 synthetic absorbable suture material; an attempt was made to invert the mucosa during closure of the biopsy site. The jejunum was replaced in the abdomen, and a second loop of jejunum was brought up to the level of the incision. Retention sutures were placed on both sides of the intended biopsy site, using the same strands of suture material used to place the retention sutures for the first biopsy site (Fig 3C). Care was taken to ensure that the retention sutures were placed in proper alignment and that the second biopsy site was at least 35 cm from the first biopsy site. The biopsy procedure was repeated, and just before the second loop of jejunum was returned to the peritoneal cavity, the retraction sutures were tied, apposing the 2 biopsy sites so that each site acted as a serosal patch for the other (Fig 3D).

Postoperative care and monitoring—A CBC was performed 3 and 7 days after surgery in dogs undergoing enterostomy tube placement. Seven days after enterostomy tube placement, 30 ml of liquid contrast material (10 ml of meglumine iothalamate diluted with 20 ml of sterile water) was instilled through the enterostomy tube, and abdominal radiographs were obtained. The enterostomy tube was then withdrawn. Dogs were followed up for 1 month after surgery and then euthanatized. At necropsy, the sites where the enterostomy tubes had been inserted or where the biopsy specimens had been obtained were examined. Specimens were obtained and submitted for histologic examination. Sections were stained with H&E and Masson trichrome stains and examined for amount and maturity of connective tissue (granulation tissue vs dense collagenous tissue) and amount of collagen deposition. Severity of inflammation associated and unassociated with suture material was evaluated.

Results
Both procedures were easy to perform, particularly enterostomy tube placement. Subjectively, laparoscopic-assisted enterostomy tube placement was easier than inserting an enterostomy tube during a laparotomy, particularly because the duodenum was secured to the abdominal wall prior to tube insertion, preventing the enterostomy tube from coming out of the duodenum during attachment of the duodenal to the abdominal wall. In addition, the laparoscopic-assisted procedure allowed traction to be placed on the duodenum during tube insertion, permitting the tube to easily be passed around the caudal flexure of the duodenum. In dogs undergoing enterostomy tube placement, the omentum typically had to be moved from the right to the left side of the abdomen. The duodenum could best be located by rotating dogs slightly so that the right side was uppermost.

All dogs recovered from surgery without complications. None of the dogs developed a fever, signs of lethargy, or signs of any illness after surgery, and none vomited. Results of CBC performed 3 days after enterostomy tube placement were reflective of a mild inflammatory response in 4 dogs and were unchanged, compared with preoperative CBC results, in the other
4. The inflammatory response consisted of mature neutrophilia with no evidence of immature neutrophils. Mean WBC and segmented neutrophil counts increased significantly from 9,362 and 5,177 cells/µl, respectively, before surgery to 16,700 and 12,346 cells/µl, respectively, 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. Injection of contrast medium into the enterostomy tube 7 days after surgery resulted in normal progression of contrast through the intestinal tract (Fig 4). None of the contrast medium was seen outside the intestinal lumen.

At necropsy, the enterostomy tube sites were firmly attached to the right abdominal wall in all 8 dogs. Histologically, abundant fibroplasia with moderate to abundant collagen deposition extended from the submucosa of the duodenum through the severed musculature of the body wall and into the subcutis, firmly adhering the duodenum to the body wall. In 5 dogs, the adhesion was composed of approximately equal amounts of granulation tissue and dense collagenous tissue, and in

Figure 3—Diagram of a method for laparoscopic-assisted jejunal biopsy in dogs. A—A Babcock forceps inserted through a cannula lateral to the left or right rectus abdominis muscle is used to elevate a portion of the jejunum to the abdominal wall. B—Retention sutures of 2-0 polydioxanone are placed on both sides of the intended biopsy site, and a full-thickness biopsy specimen is obtained. The biopsy site is closed with interrupted cruciate or simple interrupted sutures of 3-0 synthetic absorbable suture material. C—A second loop of jejunum is brought up to the level of the incision, and retention sutures are placed on both sides of the intended biopsy site, using the same strands of suture material used to place the retention sutures for the first biopsy site. D—The biopsy procedure is repeated, and just before the second loop of jejunum is returned to the peritoneal cavity, the retraction sutures are tied, apposing the 2 biopsy sites so that each site acts as a serosal patch for the other.
3, the adhesion was composed of predominantly granulation tissue. Suture material was seen in the area of the adhesion in all 8 dogs and was surrounded by fibroplasia in 2 dogs, purulent inflammation in 1, granulomatous inflammation in 1, and a combination of these in 3; no tissue reaction was seen surrounding the suture material in the remaining dog. Five dogs had evidence of inflammation not associated with suture material in the area of the adhesion. In 3 dogs, mild lymphoplasmacytic infiltration was seen, and in 1, purulent tracts surrounded by purulent granulation tissue extended from the duodenal mucosa to the subcutis. In a fifth dog, there were multiple pyogranulomatous foci containing small bits of hair and barium-like material.

One of the 7 dogs that underwent laparoscopic-assisted jejunal biopsy was adopted at the end of the study. In the remaining 6 dogs, the antimesenteric regions of the 2 jejunal biopsy sites were found to be firmly adhered to each other at the time of necropsy. There were no other loops of bowel adhered to the biopsy sites, nor was there any apparent local inflammatory response or problems with movement of ingesta through the intestines. Histologically, the jejunal biopsy sites in 5 of the dogs contained small to moderate amounts of fibrous connective tissue. The apposing sites were adhered serosa to serosa (1 dog), submucosa to submucosa (1), omentum to submucosa (1), and omentum to submucosa (3). The serosa-to-serosa adhesion had little collagen deposition, but the other adhesions were densely collagenous. In these areas of adhesion, pyogranulomatous inflammation and concentric fibrosis surrounded pieces of suture material used to close the full-thickness biopsy sites. In 5 dogs, dense collagenous connective tissue bridged the serosal surfaces of the 2 jejunal segments at the margins of the biopsy sites; omental fat typically covered this connective tissue bridge. Loose connective tissue and omentum bridged the serosal surfaces of the jejunal segments in the sixth dog. Pyogranulomatous inflammation and concentric fibrosis typically surrounded remnants of the retention sutures in the areas of bridging fibrosis.

None of the additional laparoscopic procedures had any apparent effect on the enterostomy tube sites or jejunal biopsy sites in the 14 dogs that underwent necropsy.

**Discussion**

Results of the present study suggest that in dogs, laparoscopic-assisted procedures for enterostomy tube placement and jejunal biopsy are an acceptable alternative to procedures performed during a laparotomy. The tube was properly positioned and functional in all 8 dogs that underwent laparoscopic-assisted enterostomy tube placement, and sufficient samples for histologic examination were obtained from all 7 dogs that underwent laparoscopic-assisted jejunal biopsy. None of the dogs had any identifiable problems after surgery. If considered necessary, the liver, kidneys, and pancreas could have been examined and biopsied with this laparoscopic-assisted approach before the intestinal surgery was performed.

In dogs with a functional stomach, gastrostomy tube feeding is an accepted method of providing nutritional support, because large volumes can be given at infrequent intervals and the tubes are generally large enough that standard canned foods mixed with water can be administered. In dogs without a functional stomach, however, enterostomy tube feeding is the best method of providing nutritional support. Enterostomy tube feeding requires sustained infusion of specially prepared commercial enteral diets, as feeding too great a volume too rapidly can result in intestinal overdistention with signs of vomiting, diarrhea, abdominal distention, and cramping. Diets used for enterostomy tube feeding must flow easily through the narrow tube and must be easily absorbed. Polymeric diets that are relatively isotonic and contain large molecular weight proteins, carbohydrates, and fats are most commonly used.
One of the most common indications for enterostomy tube feeding is acute pancreatitis, as acute pancreatitis induces a hypermetabolic state with increased caloric and nitrogen demands while reducing the ability of the gastrointestinal tract to meet these increased needs. Early alimentation improves the immune and nutritional status with few complications in affected dogs.

Insertion of enterostomy feeding tubes during laparotomy has been associated with low complication rates. For instance, in a study of 40 dogs and cats in which enterostomy tubes were inserted, 5 dogs and 2 cats had a total of 10 tube-related complications. These included focal cellulitis, tube dislodgement, and tube occlusion. Similarly, reported complication rates in people in which an enterostomy tube is placed during laparotomy range from 2 to 7%. On the other hand, complication rates following percutaneous endoscopic tube insertion reportedly are twice as high as rates following insertion during laparotomy. A limited laparotomy approach for placement of duodenostomy tubes in 7 dogs has been described. Complications included discomfort during tube placement, local cellulitis, and tube-site infection; however, all complications resolved, and tubes were functional for 2 to 28 days. In the present study, none of the dogs developed any tube-related complications. However, only a small number of dogs were included, and all dogs were healthy.

Intestinal biopsy is required to diagnose many intestinal diseases, especially those associated with persistent diarrhea and signs of malabsorption. In general, the least invasive method for intestinal biopsy is preferred, because many of these patients are hypoalbuminemic. Endoscopic biopsy of the stomach, duodenum, or colon may yield sufficient samples for a diagnosis; however, samples obtained with endoscopic biopsies typically are small and contain little or no submucosa, making it difficult to obtain an accurate diagnosis. In addition, endoscopy permits examination only of the mucosal surface, and in human patients, there is a poor correlation between the operative diagnosis made by the endoscopist and the histologic diagnosis made by means of histologic examination of endoscopic biopsy specimens. Laparotomy allows for excellent visual and tactile examination of the intestines and allows for collection of full-thickness biopsy specimens from all portions of the intestines. Laparoscopy, on the other hand, does not allow for tactile examination of the intestines, but does avoid the need for opening the abdominal wall, reduces splanchinic manipulation, thereby reducing stress, trauma, pain, and the likelihood of postoperative ileus, and reduces fluid and protein losses in patients with ascites, compared with laparotomy. In addition, as indicated in the present study, use of laparoscopic-assisted procedures allows for collection of full-thickness small intestinal biopsy samples.

Although we did not directly compare laparoscopy with laparotomy for jejunal biopsy in these research dogs, the laparoscopic-assisted approach in these research dogs can be subjectively compared with our clinical experiences of laparotomy. The time and trauma associated with making and closing an abdominal incision and the exposure trauma associated with laparotomy pads and retractors were avoided during laparoscopy. More experience is required to examine the entire small bowel during laparoscopy than during laparotomy with a generous incision. Two-dimensional visualization is much better during laparoscopy than laparotomy, but the intestines cannot bepalpated as when the abdomen is open. With both laparoscopy and laparotomy, care must be taken to avoid taking biopsy specimens from sites that were too close to each other when the sites are being apposed for serosal patching.

References