Subtotal Colectomy With Surgical Stapling Instruments Via a Trans-cecal Approach for Treatment of Acquired Megacolon in Cats

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Surgical stapling equipment was used to perform an end-to-end colonic anastomosis in 15 cats for the treatment of acquired megacolon. An end-to-end stapling device was passed to the anastomotic site by a trans-cecal approach. Subsequent closure of the cecal incision was accomplished with a thoracoabdominal stapling device. Two cats had hemorrhagic episodes immediately after surgery that required blood transfusions. All 15 cats have had good to excellent health after subtotal colectomy and colocolostomy performed using this stapling technique. Results of this study have demonstrated that "single surgical field" placement of the end-to-end stapling device has the primary advantage of simplicity and a lower chance of contamination compared with (dual field) rectal passage of similar devices. Closure of the cecal access incision is easily performed without reducing the diameter of the large intestinal lumen. The stapling technique provided an efficient and consistent method for anastomosis of the large bowel in cats.

A CQUIRED MEGACOLON in cats is diagnosed by a history of refractory constipation, abdominal palpation showing a firm distended colon and survey radiographs confirming colonic dilatation and impaction.1,2 It can be a result of colonic or rectal neoplasms, strictures, extraluminal masses, narrowing of the pelvic canal after trauma, or from neurologic3-5 or endocrine disease. When the cause of the colonic dilatation is not apparent, a tentative diagnosis of idiopathic megacolon is made. Early in the course of the disease affected cats may respond to stool softeners, laxatives, enemas, and dietary changes. As the disease progresses, however, medical therapy may be ineffective, and surgical intervention should be considered.

Subtotal colectomy for the treatment of acquired megacolon in cats has been reported.6-8 Surgical stapling techniques for performing end-to-end colocolostomy are described in the human literature for the treatment of colonic neoplasms, idiopathic megacolon, and congenital aganglionic megacolon.9-12 In dogs, stapling devices have been used experimentally to evaluate adhesion formation, bursting strength, and histopathology after end-to-end colonic anastomosis.13

In this report, we describe the use of stapling instruments to perform subtotal colectomy and end-to-end colonic anastomosis in 15 cats with acquired megacolon. The instrument used to perform the anastomosis is introduced through an incision in the cecum. The unique anatomic configuration of the feline cecum makes introduction of the device possible.14

Materials and Methods

Colocolostomy was performed with an end-to-end anastomosis stapling instrument* in 15 cats undergoing subtotal colectomy for treatment of megacolon. Six cats were treated at Tufts Veterinary School Foster Hospital for Small Animals, and nine cats were treated at Angell Memorial Animal Hospital, by one of two surgeons, between March 1990 and January 1992. Fourteen cats had idiopathic megacolon, and one cat developed megacolon after trauma and pelvic fracture malunion (Table 1).

All cats had a history of chronic constipation of 3 months to 10 years in duration and had been treated with

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* EEA®️, United States Surgical Corporation, Norwalk, Connecticut.
### TABLE 1. Clinical Data for 15 Cats with Acquired Megacolon (MC) Treated by Subtotal Colectomy with Stapling Instruments

<table>
<thead>
<tr>
<th>Case No.</th>
<th>Age/Gender/Breed</th>
<th>Duration of Signs (Mos)</th>
<th>History</th>
<th>Postoperative Complications</th>
<th>Long-term Results (No. Mos Followup)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>9 yr MC DSH</td>
<td>12</td>
<td>FeLV + diagnosed two years prior to surgery; occasional laxative therapy</td>
<td>Diarrhea, tenesmus for two weeks</td>
<td>Excellent (36)</td>
</tr>
<tr>
<td>2</td>
<td>5 yr MC Himalayan</td>
<td>24</td>
<td>Maintained using multiple laxatives and enemas</td>
<td>Rectal hemorrhage requiring transfusion; diarrhea for one month</td>
<td>Excellent (28)</td>
</tr>
<tr>
<td>3</td>
<td>7 yr MC DLH</td>
<td>72</td>
<td>Maintained using multiple laxatives and enemas; high fiber diet†; inappropriate defecation</td>
<td>Diarrhea, inappetence for two weeks; inappropriate defecation continued for six months</td>
<td>Excellent (24)</td>
</tr>
<tr>
<td>4</td>
<td>6 yr FS DSH</td>
<td>12</td>
<td>Maintained using laxatives, enemas, high fiber diet†</td>
<td>Diarrhea for 3–4 weeks</td>
<td>Excellent (22)</td>
</tr>
<tr>
<td>5</td>
<td>4 yr MC DSH</td>
<td>30</td>
<td>Deobstipated every 4–6 weeks; laxatives ineffective</td>
<td>Diarrhea for 2–3 weeks</td>
<td>Excellent (22)</td>
</tr>
<tr>
<td>6</td>
<td>7 yr MC DSH</td>
<td>36</td>
<td>Laxatives ineffective; frequent hospitalizations to deobstipate</td>
<td>Diarrhea, inappetence; dehydration for two weeks requiring subcutaneous fluids at home</td>
<td>Excellent (21)</td>
</tr>
<tr>
<td>7</td>
<td>14 yr MC Maine Coon cat</td>
<td>30</td>
<td>Multiple forms of laxatives and enemas</td>
<td>Diarrhea for 10–14 days</td>
<td>Excellent (21)</td>
</tr>
<tr>
<td>8</td>
<td>13 yr MC DLH</td>
<td>3</td>
<td>Collapsed pelvic fracture malunion three months prior to surgery</td>
<td>Diarrhea for one month</td>
<td>Excellent (21)</td>
</tr>
<tr>
<td>9</td>
<td>3 yr MC Himalayan</td>
<td>12</td>
<td>Partially responsive to laxatives</td>
<td>Shock, hemorrhage requiring transfusion; diarrhea two weeks</td>
<td>Excellent (19)</td>
</tr>
<tr>
<td>10</td>
<td>10 yr FS DLH</td>
<td>6</td>
<td>Owner unable to medicate cat or give special diets</td>
<td>Diarrhea, inappetence for two weeks</td>
<td>Excellent (18)</td>
</tr>
<tr>
<td>11</td>
<td>10 yr MC DLH</td>
<td>12</td>
<td>Infrequent laxative therapy</td>
<td>Diarrhea, inappetence for two weeks</td>
<td>Excellent (18)</td>
</tr>
<tr>
<td>12</td>
<td>7 yr MC DLH</td>
<td>18</td>
<td>Laxatives ineffective, enemas; chronic feline urologic syndrome</td>
<td>Diarrhea, tenesmus for 5–7 days</td>
<td>Excellent (16)</td>
</tr>
<tr>
<td>13</td>
<td>13 yr FS DSH</td>
<td>120</td>
<td>Chronic laxative therapy; chronic traumatic abdominal hernia (repaired at the time of subtotal colectomy)</td>
<td>Diarrhea for three weeks</td>
<td>Excellent (15)</td>
</tr>
<tr>
<td>14</td>
<td>10 mo FS DSH</td>
<td>6</td>
<td>Chronic medical therapy unrewarding</td>
<td>Diarrhea for 7–10 days</td>
<td>Excellent (15)</td>
</tr>
<tr>
<td>15</td>
<td>9 yr FS DSH</td>
<td>8</td>
<td>Owners unable to medicate</td>
<td>Diarrhea for 5–7 days</td>
<td>Excellent (14)</td>
</tr>
</tbody>
</table>

DSH = domesticated short-haired cat; DLH = domesticated long-haired cat; MC = male castrated; FS = female spayed.
† Prescription diet w/d, Hill's Pet Products, Topeka, Kansas.

A combination of laxatives, enemas, and dietary manipulations before surgery. Constipation had become intractable in all cats. Laboratory data obtained before surgery included a complete blood count and serum biochemical profile. Antibiotics were not administered, and the colon was not cleansed or otherwise prepared in any of the cats. The cats were anesthetized and the abdomen prepared for aseptic surgery. The abdomen was opened using a ventral midline celiotomy; after exploratory laparotomy,
Fig. 1. (A) Typical appearance of the distal gastrointestinal tract in feline idiopathic megacolon. (B) Segmental branches of the colic arterial blood supply have been clamped with metallic vascular clips and divided. Crushing (C = Carmalt) and atraumatic (D = Doyen) intestinal forceps are in place at the margins of the planned transection sites.

the distal small intestine, cecum, and colon were isolated with moistened laparotomy pads (Fig. 1A). Individual segmental short colic arterial branches of the ileocolic, middle colic, and left colic vessels were clamped with metallic vascular clips† and divided. The colon was compressed manually to move feces into the dilated colonic segment. Intestinal forceps were placed proximal and distal to the planned transection sites in the colon (Fig. 1B). A Furniss purse-string device‡ was placed at the proximal and distal limits of the colectomy site, 2 cm distal to the cecum and 2 to 3 cm proximal to the pelvic brim, and a purse-string suture was placed at both sites using 3-0 polyglactin 910§ on a 6 cm straight needle (Fig. 2). The colon was transected with a number 10 Bard Parker scalpel blade, using the Furniss purse-string instrument as a cutting template. After removal of the purse-string instrument, a 3 cm enterotomy was made on the antimesenteric surface of the cecum, and an ovoid sizer (Fig. 3A) lubricated with sterile water-soluble gel was introduced through the cecal incision and advanced to the proximal colonic margin. The ovoid sizers allowed assessment of bowel diameter for selection of appropriately sized staple cartridges and dilated the bowel to facilitate introduction of the end-to-end anastomosis instrument. In 13 cats, an end-to-end anastomosis stapler with a 25 mm cartridge was used, and in two cats a curved disposable end-to-end anastomosis 21 mm stapler was used (Fig. 3B).

The end-to-end anastomosis instrument was introduced through the trans-cecal access site into the bowel. The bowel ends were slipped over the cartridge and anvil and the individual purse-string sutures were tied. The bowel segments were compressed, and the handle was squeezed to fire the staples (Fig. 4). The stapler was rotated to allow it to slip past the staple line. After removal of the instrument, the stapled anastomosis was inspected.

The access site was closed with the thoracoabdominal instrument. Stay sutures placed at the cecal access site allowed accurate alignment of the tissues in the thoracoabdominal stapler. Staple cartridge placement was carefully examined to assure that the staples would penetrate the double thickness of the bowel wall. Firing of the thoracoabdominal stapler placed two staggered rows of stainless steel staples into the tissue. The instrument edge served as a cutting guide for a scalpel blade to remove the excised tissue. The stapled cecum was released, and the staple line was inspected to assure hemostasis (Fig. 5).

Surgical gloves and surgical instruments were changed after completion of the anastomosis because of contamination associated with performing the intestinal resection and anastomosis. The abdominal cavity was copiously lavaged with warm sterile saline solution and omentum was tacked over the surgical site with absorbable sutures. A three-layer abdominal closure was performed in all cats.

All cats were given lactated Ringer’s solution administered either subcutaneously or intravenously (15 mL/kg/day) for 2 to 4 days after surgery. All cats received butorphanol tartrate†† (0.2 to 0.4 mg/kg intravenously [IV] or intramuscularly [IM]) every 4 to 6 hours on the first postoperative day as needed to minimize pain. The cats were fed the day after surgery. Low-residue, highly aro-

† Surgiclip®, United States Surgical Corporation, Norwalk, Connecticut.
‡ Purse-string device, United States Surgical Corporation, Norwalk, Connecticut.
§ Vicryl®, Ethicon Inc., Somerville, New Jersey.
†† TA55®, United States Surgical Corporation, Norwalk, Connecticut.
† Torbugesic, 10 mg/mL, Fort Dodge Laboratories, Fort Dodge, Iowa.
mastic and palatable foods were given to encourage consumption. The cats were examined at suture removal and again, when possible, 1 to 6 months after surgery. If follow-up examination was not possible, the owners were contacted by telephone.

**Results**

Complications did not occur after surgery in 13 cats. Complications did occur immediately after surgery in cats 2 and 9. Cat 2 had profuse intrarectal bleeding that was presumed to originate from a short segmental colic artery at the anastomotic site. A blood transfusion and intravenous fluid therapy were administered, and the bleeding resolved within 24 hours. Cat 9 had a rapidly falling hematocrit and cardiovascular collapse, but the source of the blood loss could not be determined. This cat also responded to intravenous fluid therapy and blood transfusion and recovered.

All cats had diarrhea and tenesmus within 24 hours after surgery that lasted up to one month after surgery. Long-term complications related to the stapling technique were not observed in any of the cats. Follow-up physical examinations on nine cats (2 through 4, 9, 11 through 15) revealed generally healthy cats who had semiformal stool in the rectum and no discomfort on abdominal palpation. Physical examination was not obtained in six cats.
who were evaluated by telephone interviews with the owners (1, 5 through 8, 10); further episodes of constipation had not occurred in these cats. All owners reported that their cats were in good to excellent health at follow-up periods ranging from 14 to 36 months. The long-term results were judged excellent if (1) the cat produced a semiformed feces without tenesmus or hematochezia and had no further episodes of constipation, (2) physical examination showed no abnormalities, and (3) the owner reported the cat’s general quality of life to be improved. None of the cats required medication or special diets after surgery.

Discussion

The end-to-end anastomosis stapling instrument is a long, tubular instrument that can be used to perform an end-to-end anastomosis anywhere in the gastrointestinal tract.\textsuperscript{10,16} The procedure creates a true inverting anastomosis using a circumferential staggered double row of surgical stainless steel staples. The staples in the cartridge are bent against the anvil into a B-shape when fired, which provides a degree of hemostasis without collapsing the microcirculation because they allow blood flow in small vessels through the openings of the staple. These observations in horses\textsuperscript{17} and dogs\textsuperscript{18} also showed that the staggered double row configuration allows blood circulation between the individual staples (Fig. 6A and 6B). The instrument used in 13 cats in this study has cartridges with 31-, 28-, or 25-mm outer diameters and pro-
duce inner luminal diameters of 21, 18, or 15 mm, respectively. In most cats, the 25 mm staple cartridge is small enough for insertion into the colonic lumen. The caliber of the bowel can be determined by using ovoid sizers, which, when lubricated, can be gently inserted into the bowel before the cartridge is inserted (Fig. 3A). A completely disposable stapler featuring a 21 mm outer diameter also can be used (Fig. 3B).

In humans and in larger dogs, the end-to-end anastomosis stapler can be introduced through an adjacent natural orifice (e.g., the anus) or alternatively can be introduced through an access incision in the bowel either above or below the anastomotic site. The feline cecum is frequently dilated and flaccid in cats with idiopathic megacolon, facilitating introduction of the 25 mm end-to-end anastomosis instrument by the trans-cecal approach. If the cecal lumen is too small to accept this cartridge, the 21 mm disposable end-to-end anastomosis instrument may be used. Transanal introduction may be attempted, but most cats have a narrow anus and pelvic canal that will not accept even the 21 mm stapler. Cats with malunion of pelvic fractures are not appropriate candidates for stapled colonic anastomosis by a transanal approach. An assistant is required to manipulate instruments when transanal introduction is used, increasing the possibility of contamination. We believe that the trans-cecal approach is the simplest, safest route for introduction of the stapling device.

The feline cecum is a small conelike blind pouch at the proximal portion of the colon, and its lumen is contiguous with that of the ascending colon. Its anatomy differs from that of the canine cecum, which is sigmoid or cork-screw in shape because of peritoneal attachments to the ileum. The configuration of the feline cecum simplifies introduction of the instrument.

Colonic anastomoses heal in several stages. During the first seven days the inflammatory process is associated with increased collagenolysis and a decrease in strength at the anastomosis site. Thereafter, collagen synthesis is responsible for strengthening the anastomosis, and long-term collagen remodeling further increases its strength. Several studies in the human and veterinary literature have compared stapled and hand-sewn anastomoses. Stapled anastomoses have a higher bursting pressure than hand-sewn anastomosis during the early lag phase of healing, and dehiscence is more likely to occur during this phase when hand-sewn anastomosis is performed. After seven days, stapled anastomoses have a higher tensile strength than sutured anastomoses. The minimal inflammatory response to a stapled anastomosis results in superior wound strength and the double row of staples increases the mechanical strength of the site. The microvasculature is protected while assuring adequate holding power. A recent report using the end-to-end anastomosis stapler in the large bowel of pigs showed no significant differences during any phase of healing when compared with suture anastomosis.

Stapling can reduce intraoperative time in comparison with hand suturing. Surgical time “saved,” however, is proportional to (1) the surgeon’s skills in hand suturing or mechanical stapling and (2) the specific surgical procedure undertaken. The potential advantages of surgical stapling should be weighed against (1) the cost differential between staple cartridges and suture materials and (2) the potential savings associated with a reduction in anesthesia time.

Complications associated with the use of surgical staplers in the gastrointestinal tract include bleeding, problems in tissue approximation, leakage of the anastomosis, and instrument failure. The surgeon must be familiar with the instrumentation before using it in the operating room. When instrument failures occur, the staples will not properly engage in the tissues. In general, tissues that are not healthy should not be stapled. The positioning of the stapling equipment should be carefully assessed before firing the staples to assure accurate approximation of tissues. The frequency of leakage at the anastomosis site is similar when staple techniques are compared with conventional suturing. The anastomosis should be carefully inspected for leaks and reinforced with suture material before closing the abdomen. As a precaution, an omental patch should be placed around the anastomosis and cecal enterotomy.

Long-term complications associated with stapled anastomosis are unusual. Stenosis at the anastomosis site, functional defects at the stoma, and adhesions have been reported. Long-term complications were not noted in any of the 15 cats in this study. Although veterinary examination was not performed in six of 15 cats, telephone interviews with owners provided sufficiently reliable information regarding the cats’ ability to defecate without any further episodes of constipation.

Subtotal colectomy is a generally effective treatment for cats with acquired megacolon that is not responsive to medical therapy. Long-term results using the end-to-end anastomosis stapler are similar to previously reported techniques using more conventional methods. There are few reports that describe the use of the end-to-end anastomosis stapler to perform colonic anastomosis in small animal surgery. Based on this series of 15 cases, the end-to-end anastomosis stapling instrument can be used successfully to perform colonic anastomosis in cats with acquired megacolon.

References