intraluminal lavage and evacuation of the colon, and the other for extraluminal lavage, using warm water (37° C (98.6° F)).[199] If these are not available, stomach tubes, buckets, and pumps are used.

A full-thickness, 8- to 12-cm (3- to 5-inch) incision is made on the antimesenteric border of the pelvic flexure.[198] One hose is inserted and gently advanced into the colon, while the other is used to continuously lavage the serosal surface to prevent fecal contamination. During the evacuation procedure, it is useful to lift the colon and ensure that the underside is lavaged as well. With sterile technique, an assistant helps to feed the hose into the colon and massage its contents. Although a modified colon tray has been described to evacuate the colon, it is not deemed necessary by most surgeons.[200] At this time, if colonic evacuation is performed as part of the correction of a large colon torsion, an intestinal biopsy can be collected. Closure of pelvic flexure enterotomies is performed using 2-0 absorbable suture material in two layers: a simple-continuous seromuscular layer followed by a Lembert or a Cushing pattern.[201] The colon is rinsed thoroughly with sterile saline and replaced in the abdomen.

Enterotomies in the right dorsal or ventral colon are performed after the colon has been draped off from the main surgical field. In the ventral colon, enterotomies are performed between teniae, since the fibrous nature of the teniae precludes successful inversion during suturing. In the dorsal colon, the location of the enterotomy is not as critical. Enterotomies performed at these sites are more likely to suffer from postoperative luminal hemorrhage; a full-thickness closure (simple-continuous or Connell) is therefore performed on the first layer to achieve better hemostasis.[84] A Lembert or Cushing pattern is used as the second layer.

A modified Heineke-Mikulicz technique for pelvic flexure enterotomy closure has been described in two horses with extensive stricture of the large colon.[175] A longitudinal incision was centered over the stricture and closed using a transverse closure, effectively increasing the diameter of the colon at that site.

Large Colon Resection

Resection of the large colon is performed to remove full-thickness mural defects in the large colon. Causes include strangulation, infarction, thromboembolic disease, neoplasia, and scar tissue formation.[177,197,196,202-208]

Removal of 50% to 95% of the large colon has been described.[208-213] Techniques for resecting the large colon include resection and end-to-end anastomosis, and resection and side-to-side anastomosis. End-to-end procedures are performed to remove the colon up to 10 to 12 cm (4 to 5 inches) from the cecocolic ligament.[179] When resection of the colon closer to or proximal to the cecocolic ligament is required, a side-to-side technique is preferred because the end-to-end technique exerts too much tension on the anastomotic site, placing it at risk for dehiscence. In our experience, it is important to ensure that apposition of the colons in an end-to-end fashion is achieved without tension, and this requires that a substantial amount of colon remain distal to the cecocolic fold.

RESECTION AND END-TO-END ANASTOMOSIS

For a *resection and end-to-end anastomosis,* the colon is exteriorized on a colon tray and draped off; the cecum is replaced in the abdomen. All ingesta are massaged into the segment to be removed. If the colon is full, a pelvic flexure enterotomy is performed to evacuate the colon; care must be taken to remove all ingesta and water from the right dorsal and ventral colons to minimize contamination during the resection. For the resection, a site is chosen that is located in the healthy part of the colon (if possible) and that is easily held by the assistant surgeon without tension on the mesentery.[179] The colon is positioned to expose the right colic artery and the colic branch of the ileocolic artery within the mesocolon; the colonic vessels are isolated by blunt finger dissection and double-ligated using 1 polyglactin 910 (Figure 37-21). Alternatively, two double rows of staggered staples (TA-90 Premium) are applied across the mesocolon, followed by a third double-staggered row 4 cm distal. The mesocolon is transected between the proximal and distal staple lines. Hemostasis is verified and any bleeding vessels are ligated. The right ventral colon is transected in a line transverse to its long axis, whereas the dorsal colon is transected at a 30-degree angle to its long axis, with the antimesenteric border shorter so that the diameters of the colons are similar (Figure 37-22, *A*). In the original description of the procedure, a V-shaped stoma was then created between the mesenteric border of the dorsal and ventral colons using an inverting linear anastomotic instrument (GIA Premium 55) reinforced with a double-layer, simple-continuous pattern. This step was omitted in later descriptions of the procedure.[214] Starting at the mesenteric border and suturing from the lumen, the colons are apposed with a double-row, simple-continuous pattern using 0 polydioxanone or Vicryl. The second layer should be full thickness to achieve hemostasis (see Figure 37-22, *B*). Once the mesenteric portion of the anastomosis is completed, suturing is approached from the serosal side, and the colons are apposed using a double layer, starting with a Connell followed by a Lembert pattern (see Figure 37-22, *C*). The colon is lavaged and replaced in the abdomen.

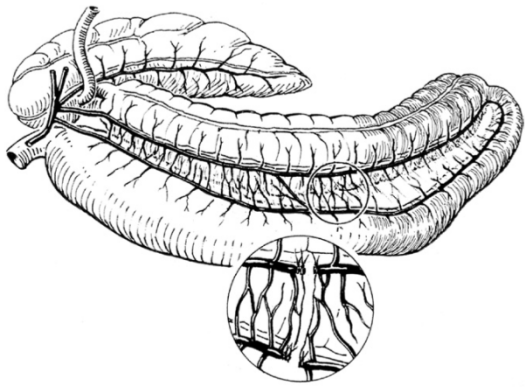

Figure 37-21. The ascending colon is placed on a colon tray with the vessels facing uppermost. The colonic vessels are isolated by blunt finger dissection and double- or triple-ligated before transection *(inset).*

SIDE-TO-SIDE ANASTOMOSIS AND RESECTION

For a *side-to-side anastomosis,* the site of resection is usually more proximal, at the cecocolic ligament or orad to it. The colon is exteriorized to the left of the horse on a colon tray and the colonic vasculature is transected as previously described. The

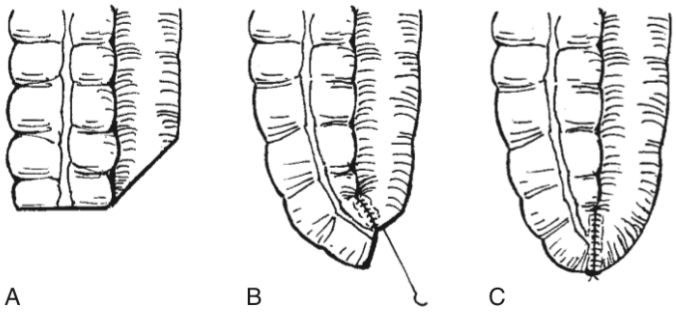

Figure 37-22. Amputation of the large colon. **A,** The right ventral colon is transected in a line transverse to its long axis, whereas the dorsal colon is transected at a 30-degree angle to its long axis. **B,** Starting at the mesenteric border, and suturing from the lumen, the colons are apposed with a double-row simple-continuous pattern using 0 polydioxanone or Vicryl. **C,** Once the mesenteric portion of the anastomosis is completed, suturing is approached from the serosal side, and the colons are apposed using a double-layer pattern, starting with a Connell and followed by a Lembert.

stoma is then created before the resection, taking advantage of the weight of the colons to facilitate exposure of the anastomotic site. The site for creating the stoma is identified, taking care to end it just proximal to colonic vessel ligation, so that a blind sac is not formed. A three-tier side-to-side stoma is created; the first layer apposes the seromuscular layers of the colons using 1 polyglactin 910 in a Lembert or Cushing layer for a length of 20 cm (8 inches) (Figure 37-23, *A*). A full-thickness incision is made in each colon and a full-thickness simple-continuous circumferential closure interrupted at 180 degrees is made to create the stoma (see Figure 37-23, *B* and *C*). The upper layer is subsequently apposed using a Cushing or Lembert pattern (see Figure 37-23, *D*). Alternatively, the stoma can be created using stapling instrumentation. This may minimize contamination, but it may not be possible if the colons are too thick and edematous as a result of the underlying disease process. For an adequate-size stoma, the stapling instrument is fired twice if the ILA-100 or the GIA-90 is used and three times if the GIA-55 is used (the staples for the GIA-55 are smaller). Staple lines should be oversewn. Once the staples have been applied, the down layer cannot be approached for oversewing. This layer should therefore be established first, before application of the stapling instrument. Once the stoma is created, the colons are resected, starting with the ventral colon, taking care to resect them at the site of colonic vessel ligation. The lumens are closed using a full-thickness simple-continuous or Connell pattern, and oversewn with a Lembert or Cushing pattern (Figure 37-24). The resected colons are lavaged and replaced in the abdomen. Although resection of the large colon has been reported using stapling instrumentation, this is usually not possible after correction of large colon torsion, since the intestinal edema and congestion do not allow proper closure of the instrument and adequate formation of the staples.

An early method of large colon resection has been described that uses a luminal approach to create the side-to-side anastomosis, followed by closing the ends of the colons.[211] The technique described earlier for resection and end-to-end anastomosis represents a modification of this technique.

Successful bypass of the right dorsal colon for the treatment of large colon volvulus has been described in one horse.[189] In that report, the large colon was judged to be nonviable after correction of a large colon volvulus. The right dorsal colon was transected as far distally as possible within the abdomen, using a TA-90 stapling instrument, and the suture line was partially oversewn. The right ventral colon was transected 10 cm (4 inches) from the cecocolic ligament, and an end-to-side anastomosis between the right ventral colon and the descending

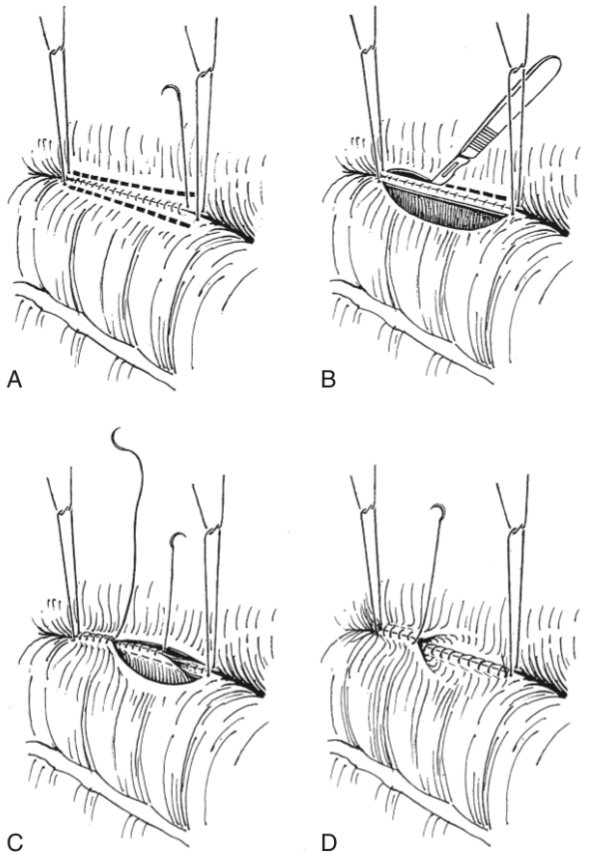

Figure 37-23. A hand-sutured side-to-side anastomosis of the ascending colon. **A,** Placement of stay sutures at either end of the intended stoma. Note that the anastomosis is performed with the diseased part of the colon still *in situ*. The seromuscular layers of the ventral and dorsal colons are apposed with a Lembert or Cushing pattern, using an absorbable suture material. **B,** A full-thickness incision is made in each colon, and a full-thickness simple-continuous circumferential closure, interrupted at 180 degrees, is made to create the stoma, shown in **(C). D,** The upper layer is then apposed using a Cushing or Lembert pattern.

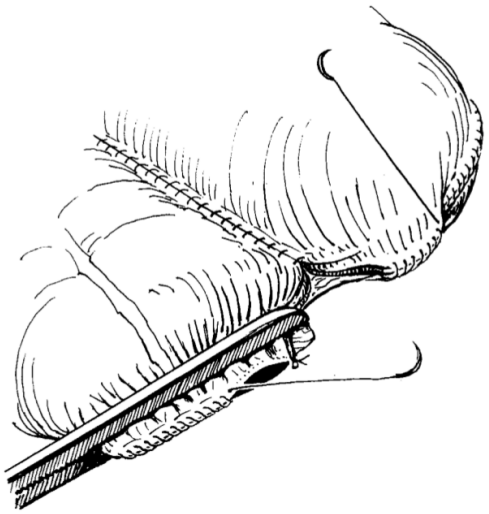

Figure 37-24. The amputated ends of the large colon are closed with a hand suture technique. Note that the amputation of the colon occurred next to the anastomosis site to prevent the formation of a blind end. The lumens are closed using a full-thickness simple-continuous or Connell pattern, oversewn with a Lembert or Cushing pattern.

colon was performed using a double-layer inverting pattern. Two mild episodes of colic and diarrhea for 1 week were the reported complications. In a similar fashion, anastomosis of the right ventral colon to the descending colon to bypass a nonfunctional descending colon anastomosis in a miniature pony was reported.[188] A two-layer hand-sewn end-to-side anastomosis was performed between the right ventral colon and the small colon. One episode of colic successfully treated with medical therapy was the only postoperative complication encountered in this case.

COMPLICATIONS

Complications from large colon resection are usually a result of the primary disease. They include persistent endotoxemia and peritonitis caused by continued bowel devitalization. This is because the site of torsion is usually at or proximal to the site of resection, so that some portion of compromised large colon cannot be removed. It is therefore essential for the surgeon to remove as much of the devitalized colon as possible. In our experience, this requires a side-to side resection at or proximal to the cecocolic fold. Even then, a segment of devitalized colon may remain in the abdomen, leading to subsequent complications. Most horses that succumb to endotoxemia and peritonitis do so within 3 to 7 days postoperatively after requiring considerable intensive care. In contrast, survivors see an improvement in clinical signs within 24 hours of the procedure.

Postoperative pain is common in horses after large colon resection. It is a painful procedure, even in normal horses. Administration of NSAIDs, lidocaine, and opiates can help alleviate the pain.

Signs of endotoxemia are common after large colon resection for large colon volvulus. Signs include fever, tachycardia, injected mucous membranes, dehydration, and hypoproteinemia. Signs of large colon ileus, such as distention, which can be quite severe, may also occur. Supportive care with fluids, plasma, and antiendotoxin modalities are important (see Chapter 2). Horses should be monitored for signs of postoperative hemorrhage, which is more prevalent with large colon procedures and occasionally requires a blood transfusion.

Postoperative diarrhea is commonly observed after large colon resection, because of mucosal damage or the reduced surface area available for fluid absorption, or both. The diarrhea is usually self-limiting and resolves within a few days if it is not of infectious origin. However, isolation procedures should be followed as dictated by hospital protocol, and infectious diseases should be ruled out.

Horses with successful resection of the large colon usually regain normal fecal consistency within 5 to 7 days. Because of the decreased surface area available for digestion and water absorption, these horses have increased water and phosphorus requirements and require a highly digestible diet.

PROGNOSIS

The prognosis after large colon resection depends on the reason for performing the resection, but the procedure does carry inherent risks, as demonstrated by a study where large colon resection performed in normal horses resulted in 3 of 10 horses dying directly as a result of the procedure.[209] In a group of horses having undergone large colon resection, there was a significant difference in short-term survival (discharged from the hospital) between horses with a nonstrangulating lesion (77.8%) compared to a strangulating lesion (47%), and horses that underwent a large colon resection for nonstrangulating lesions were 3.9 times more likely to survive.[183]

SMALL COLON

Anatomy

The transverse colon is the continuation of the right dorsal colon. It begins at the level of the 17th or 18th thoracic vertebra where the right dorsal colon narrows significantly in diameter as it turns medially.[1-2] The transverse colon is short and passes from right to left, cranial to the cranial mesenteric artery. It is connected dorsally to the pancreas, to the dorsal aspect of the abdominal cavity, and by a short transverse mesocolon to the root of the mesentery. These attachments prohibit visualization of the transverse colon during a celiotomy. To the left of the root of the mesentery, the transverse colon continues as the descending colon, also known as the small colon. The small colon occupies the left caudodorsal quadrant of the abdominal cavity. It is approximately 3.5 m long and maintains a 7- to 10-cm width throughout its entire length. It is suspended by a long descending mesocolon, which allows good surgical access to all but the most proximal and distal portions of its length. The descending mesocolon originates from the left surface of the root of the mesentery and continues caudad attached to the dorsal body wall until it turns into the mesorectum at the pelvic inlet.[1-2] The mesocolon often contains a significant amount of fat. The small colon is attached to the terminal duodenum by the duodenal colic fold, which is an important surgical landmark when exteriorizing the proximal jejunum. The small colon has two longitudinal muscular bands called teniae, one within the mesocolon and the other on the antimesenteric

Taken from Auer J, Stick J. Equine Surgery. 4th ed. W.B. Saunders; 2012.