
D. E. Freeman

College of Veterinary Medicine, University of Illinois, Urbana, IL, USA.

The purpose of this presentation is to cover some of the basic principles of abdominal and gastrointestinal tract surgery in horses and to describe techniques for different procedures. Although the emphasis will be on the techniques preferred by the author, others will be described.

The Abdominal Incision

The caudal ventral median celiotomy is the most popular approach because it is simple and allows access to most of the equine abdomen. This incision extends for 25 cm or more from a point 2.5 cm cranial to the umbilicus. A more cranial approach would also be indicated if preoperative information suggested a lesion in the cranial part of the abdomen, such as diaphragmatic hernia, gastroduodenal lesion, and renal and ureteral surgery in a foal. A more caudal incision is required for cesarean section, surgery of the bladder and umbilical components, and for access to lesions in the distal part of the small colon. Caudal incisions in male horses require a paramedian skin incision around the prepuce and reflection of the skin edge laterally to expose the body wall. Layers should not be undermined or separated during incision or closure, because this is traumatic, creates dead space, and could reduce blood flow to wound margins.

Closure of the Peritoneum -

The peritoneum does not need to be sutured as it is very thin and tears easily, even when the falciform ligament is used to appose the edges. One advantage to suturing the peritoneum is to exclude bowel from the field during closure of the linea alba and to reduce drainage and incisional swelling.

Linea Alba Closure – Suture Material -

Fibers of the linea alba run perpendicular to the direction of suture tension and this feature would appear to provide a strong closure of the ventral median incision (Trostle 1994; Trostle 1998). The linea alba is thicker and has greater breaking strength near the umbilicus than it has in the more cranial parts of the abdomen (Trostle 1994). The type of suture used and the method of closure are dictated by surgeons’ preferences, but absorbable material is unlikely to cause suture sinuses and form a persistent nidus for infection. If monofilament suture (polydioxanone and polyglyconate) is subjected to rough handling (bending, twisting, crimping, grasping in instruments or traction with edges of an instrument), the outer core can be damaged, and this decreases the strength of the suture. Polyglycolic acid or polygalactin-910 are absorbable sutures that have been treated with a lubricant to decrease tissue drag and increase ease of handling, but have poor knot security. Because polyglycolic acid and polygalactin-910 have poor knot security, they require at least 5 to 7 throws per knot. In general, knot security is inversely proportional to the memory and size of the suture material (Trostle 1994: Trostle 1998).

In a study on closure of equine cadaver linea alba, size 5 polyester (nonabsorbable) had a greater breaking strength and stiffness, followed in order by size 2 polyglycolic acid, size 3 polyglactin 910, size 2 polydioxanone, size 2 polypropylene, and size 2 nylon (Trostle 1994). However, polydioxanone has better mechanical performance after 28 days of implantation than polyglycolic acid (Campbell and Bailey 1992). Polyglycolic acid or polygalactin-910 sutures degrade by hydrolysis at a rate that is predictable, even in the face of infection, and these materials induce minimal foreign body reaction. In a recent retrospective study, polygalactin-910 sutures had an increased risk of incisional infections when compared with polydioxanone sutures (Honnas 1997). Multifilament suture can harbor bacteria and cause tissue drag.
Closure of the Linea Alba - Suture Patterns -
Numerous suture patterns that have been used to close the linea alba, including simple continuous (Turner et al. 1988), simple interrupted, near-far-far-near (NFFN), far-near-near-far (FNNF), cruciate, inverted cruciate, and mattress patterns (Freeman et al. 2002). A continuous suture pattern allows the biomechanical forces to be more evenly distributed over the entire incision line, is quicker to perform than interrupted patterns and is significantly stronger than the inverted cruciate pattern (Magee and Galuppo 1999). The continuous pattern also places less suture in the tissues and therefore should incite less foreign body reaction and reduce the risk of infection, compared with interrupted patterns (Freeman et al. 2002). Of course, breakage of the continuous suture would completely disrupt the closure.

In large horses (>700 kg), mares in advanced pregnancy, or after a second exploratory through a recent incision, approximately 3 - 5 retention sutures can be placed to give additional support a ventral median incision during recovery and the immediate postoperative period (Freeman et al. 2002). These are vertical mattress sutures with doubled # 2 nylon placed through polypropylene bolsters (as for secondary closure). The far bites include all layers and close bites are placed ≤2.5 cm from the skin edge and only through the skin and subcutaneous tissues.

Techniques and Principles -
Intraoperative decompression of distended or impacted bowel reduces postoperative strain on a suture line in the linea alba and reduces bowel protrusion into the incision so closure can be faster. To prevent inadvertent bowel puncture during each bite, the back end of a thumb forceps can be used as a backstop for the needle directed inwards. For the exit bite, the skin and subcutaneous tissue can be grasped with forceps and elevated to bring the linea edge into view. A visceral retainer or "fish" can also be placed to retain bowel from the suture line. Peritoneal fat should be excluded from the closure because it interferes with apposition of the linea alba.

The optimal tissue bite size for adult equine linea alba is 15 mm from the edge and sutures are placed about that distance apart (Trostle 1994: Trostle 1998). The incision edges should be pulled into snug apposition, but tissue should not be tied too tightly, because this will strangulate the edges and cause foci of incisional necrosis. Knots are the weakest points of a suture line (Trostle 1994: Trostle 1998). To improve knot security, use one and a half surgeon’s knots on the first throw followed by a surgeon’s knot on the second, and then a succession of single throws. The author prefers to start with a sliding half hitch that is tightened to produce a secure purchase before subsequent throws are placed (Freeman et al. 2002). Subsequent throws should be square knots to reduce slippage of the sliding half hitch. Continuous patterns in the linea alba can be ended by having surgeons on opposite sides of the horse starting at each end of the incision and meet in the middle to tie the long ends of the sutures together.

Skin Closure -
The subcutaneous or subcuticular tissues can be closed with a simple continuous pattern with 2 - 0 synthetic absorbable material. The author does not close the subcutaneous tissues in the belief that subcutaneous sutures add foreign material to the wound, serve as a nidus for infection, and retain the infection in the body wall and deeper sutures. Without subcutaneous sutures, drainage of an infected incision is easily established and healing does not seem to be adversely affected. The skin can be closed with a variety of patterns with staples, synthetic nonabsorbable or synthetic absorbable material. The author prefers polyglycolic acid size 2 - 0 or 3 - 0 in a simple continuous pattern, and this suture material is usually absorbed in 3 to 5 weeks, without any adverse effects on wound healing.

Incisional Dressing and Bandages -
A temporary water-impervious self-adhesive plastic drape (Steri Drape – 3M) applied at the end of surgery can reduce incisional contamination from dirt and debris in the recovery stall (Freeman et al. 2002). Incisional complications can also be reduced by keeping the recovery stall as clean and dry as possible, to reduce contamination of the incision and to prevent awkward falls that stress the incisional closure. Bandages are not used routinely in this clinic as they are expensive and require frequent changing, although they can reduce swelling and protect an infected incision. The abdominal bandage can be especially useful to protect the incision in a mare from contamination by a nursing foal and to protect an incision in the horse that has developed laminitis and tends to lie down.

Abdominal Exploration
If the lesion cannot be seen or palpated immediately, use a systematic approach, based on tracing from fixed or easily located segments to segments that cannot be exteriorized or readily identified (Fig. 1). Exteriorize the apex of the cecum, which is usually the first structure found, and
a. Follow this to the body and base of the cecum,
b. Follow the dorsal band of the cecum to the ileocecal fold and ileum (Fig. 1),
c. Follow the ileum [50 cm] to the jejunum [20 m] to the duodenocolic ligament [duodenum to proximal small colon],
d. Follow the lateral band of the cecum to the cecocolic fold and right ventral colon (Fig. 1), and
e. Follow the right ventral colon to the entire large colon [3 to 4 m].

Figure 1. Intraoperative exposure of large colon after correction of a displacement to show important anatomic landmarks used to orient and locate critical parts of the intestinal tract (cranial is to the right). Ce = cecum; RVC = right ventral colon; SF = sternal flexure; LVC = left ventral colon; LDC = left dorsal colon. The arrow points to the cecocolic fold and the arrowheads point to the ileocecal fold. - To view this image in full size go to the IVIS website at www.ivis.org.

Follow the caudal edge of the spleen (left abdominal wall) to the dorsal edge of the spleen, and then medially to the nephroplenic (renosplenic) ligament, and left kidney. In the pelvic inlet, palpate the inguinal rings, internal genitalia, bladder, and rectum. Follow the rectum to the small colon (3 to 4 m), transverse colon, and right dorsal colon. Palpate the stomach, pylorus, and duodenum (1 m), liver, and diaphragm. Follow the mesentery of small intestine to the cranial mesenteric artery and right kidney. To find the epiploic foramen, stand on the left side of the horse and insert the right hand through the most rostral commissure of the incision, and direct it with the arm at right angles to the incision along the right body wall. When the fingertips encounter the edge of the liver, trace the fingers medially along the visceral surface of the liver. Ignore the fissure separating the right lobe from the caudate lobe and draw the back of the fingertips along the caudate lobe until you encounter a 1 to 3 finger wide slit between the caudate lobe and the portal vein. This is the epiploic foramen and intestine usually passes through this from left to right.

The following segments of the adult horse's gastrointestinal tract cannot be exteriorized: any part of the stomach, the entire duodenum, first 25 to 30 cm of jejunum, distal 25 to 30 cm of ileum, ileocecal junction, transverse colon, base of cecum, cecocolic junction, terminal part of the right dorsal colon, and terminal part of the small colon.

**Surgical Techniques for Equine Small Intestine**

Survival rates after small intestinal surgery in horses are improving and there is an apparent decline in prevalence of postoperative ileus and adhesions (Vachon and Fischer 1995; Freeman et al. 2000). In equine small intestine, the surgeon determines viability as it relates to leaving in situ or resecting intestine that could be prone to adhesion formation. Clinical criteria of viability are serosal color, improvement in color after correction of the strangulation, presence or absence of mesenteric arterial pulses, and spontaneous motility or motility evoked by snapping a finger against the intestinal wall. Red discoloration and even some black patchiness or stripes in bowel, with a thick and edematous wall, do not always indicate necrosis. Bluish discoloration suggests arterial occlusion and a poorer prognosis for viability, especially if the affected area of bowel wall is thin. To avoid maldigestion after surgery, 4.5 m should be the minimum length of remaining small intestine in an adult horse (Vachon and Fischer 1995).

After the lesion has been corrected, the bowel is arranged in its correct orientation on the left side of the abdominal incision, and the extent of resection is defined. The mesentery is resected and closed and the bowel decompressed through the strangulated segment. A suture is used to gather the mesentery as it is incised and this suture is tied so only a short defect remains from the mesenteric stump to the bowel ends. Intraoperative decompression is recommended to reduce the risk of postoperative ileus and postoperative volvulus. Decompression is accomplished through the strangulated bowel after its mesentery has been incised to allow it to be mobilized far from the surgical field to drain into a container. Take care not to stretch and tear remaining mesenteric attachments. The alternative approach is to drain contents into the cecum, but this involves unnecessary handling of healthy bowel distal to a jejunojejunostomy, and also creates a full cecum that could complicate jejunoccecostomy and abdominal closure.

Strangulated bowel is removed along with approximately 30 cm or more of contiguous healthy intestine at each end. A large arcuate artery, as close as possible to its origin from the major mesenteric vessel, is left to supply the anastomosed ends. At least 5 to 10 cm of mesentery is left beyond the last major vessels and branches to prevent inadvertent vascular occlusion or puncture during final mesenteric closure. Penrose drains are applied at 30 to 45 cm from each side of the anastomosis site (Fig. 2). This technique prevents trauma to the critical area of the anastomosis and Penrose drains are less traumatic than Doyen clamps (Fig. 3).
Figure 2. Use of a Penrose drain to occlude the bowel at least 30 to 45 cm from the anastomosis and an angled S-shaped transection that creates a larger stoma. Compare with Figure 3. - To view this image in full size go to the IVIS website at www.ivis.org.

Figure 3. A popular method for using clamps to resect small intestine, with an angled line of transection at 60º to the mesentery (broken line). An alternative is to apply the crushing clamp (top clamp) at an angle and cut along the edge. The potential problems with these methods are an insufficiently large stoma and trauma from the Doyen clamp (bottom clamp) to bowel close to the anastomosis. - To view this image in full size go to the IVIS website at www.ivis.org.

In the author’s opinion, the size of the stoma is critical to the success of end-to-end jejunojejunostomy in horses, because even a small degree of stomal constriction can be poorly tolerated. Most reported cases of postoperative ileus in an end-to-end anastomoses in horses are the result of resistance to flow through the stoma. For an end-to-end anastomosis in a 450-kg horse, it should be possible for a surgeon that wears a size 7 1/2 glove to fit at least 3 fingers along the jejunal wall into the anastomosis. An S-shaped line of transection, cut with a curved Mayo scissors, eliminates sharp angles caused by the standard angled transection and increases the length of the apposed edges to produce a wide stoma (Fig. 2 and Fig. 3). Stay sutures are placed through the mesenteric and antimesenteric edges of both proximal and distal segments to align them and to maintain them at similar diameters throughout closure. With all handsewn anastomosis patterns, sutures must penetrate deep enough to incorporate the tough submucosal tissue. Regardless of anastomosis used, excessive inversion and stomal constriction must be avoided, and both are usually caused by overzealous attempts to obtain a leakproof seal. After the anastomosis is complete, the remaining mesenteric defect is closed with 3-0 PDS in a simple continuous pattern, taking care to avoid mesenteric vessels or shorten the mesentery at the anastomosis (Fig. 4).

One-layer Interrupted Lembert Pattern
An interrupted Lembert pattern has been used in equine jejenum (Freeman et al. 2000) with size 3-0 polydioxanone (size 4-0 for foal jejenum), bites 6 to 8 mm apart, 6 to 8 mm wide, and passing within less than 1 mm from the cut edge (Fig. 4). Each suture is tied snugly but should not strangulate or cut tissue. In one study, 15 of 16 horses (94%) with this anastomosis survived short-term, and no horse required a repeat celiotomy or developed postoperative ileus (Freeman et al. 2000). This anastomosis does eliminate the potential pursestring effect of some continuous patterns and each individual suture can be tightened sufficiently to achieve hemostasis as needed. Also, the interrupted pattern might allow some degree of stomal expansion that would be less likely with a continuous pattern. However, interrupted patterns tend to be slow and tedious and expose a considerable amount of suture material in the knot (Fig. 4), which could predispose to adhesions. Therefore, they might benefit from methods that can prevent focal adhesions to anastomoses, such as sodium carboxymethylcellulose and a hyaluronate membrane (Seprafilm, Genzyme Corporation, Cambridge, Mass, USA; Eggleston et al. 2001; Fig. 5). Continuous Patterns
A popular method for end-to-end anastomosis of equine small intestine is a two-layer anastomosis, with a simple continuous pattern for the submucosal/mucosal layer, followed by a continuous Lembert or Cushing pattern in the seromuscular layer (Eggleston et al. 2001). Mucosal and seromuscular rows are interrupted at the mesenteric and antimesenteric margins to
prevent a purse-string effect. Compared with the Lembert, the Cushing pattern is more likely to purse-string the bowel, but it causes less inversion and does expose less suture material to serosal surfaces, which could reduce the risk of adhesions. The contribution of a separate mucosal closure is questionable. A continuous full-thickness pattern, with careful prevention of mucosal protrusion, developed more perianastomotic adhesions than a two-layer inverting anastomosis (Eggleston et al. 2001). However, this anastomosis was faster and produced a significantly larger stomal diameter than the inverting technique, and the prevalence of adhesions could be reduced by covering with a bioresorbable membrane of hyaluronate and carboxymethylcellulose (Eggleston et al. 2001; Fig. 5). A continuous version of the Lembert pattern described above also works well and is faster than the interrupted pattern (Fig. 5).

**Stapled Jejunojejunostomy**

The major advantages of stapling instruments are speed, reduced tissue handling, improved tissue blood flow, minimal contamination, ease of application, a stoma of consistent and predictable size, and rapid healing without a potentially dangerous lag period. Disadvantages are expense, need for side-to-side application in adults, stomal constriction by healing of apposed raw edges at commisures of the stoma, and limitations by tissue thickness.

The proposed speed advantage of staples over handsewn anastomoses has not been confirmed in clinical use (Semevolos et al. 2002), possibly because time saved with an anastomosis might be only a minute fraction of the total surgery time. The time benefit might be lost in stapled jejunojejunalostomy in horses, because of the number of staple and suture lines required. If the staple lines are oversewn, the advantages of speed and reduced tissue handling are lost and the prevalence of adhesions is comparable to that with handsewn anastomoses in horses (Baxter et al. 1992). That staples reduce peritoneal contamination compared with handsewn anastomoses is questionable and not clinically relevant. Also, the risk of leakage in a staple line (Latimer et al. 1998) can be attributed to technical failures that are not easily recognized at surgery. A closed one-stage functional end-to-end stapled jejunojejunalostomy might be superior to other stapled anastomoses (Latimer et al. 1998).

**Jejunoileostomy**

If sufficient healthy ileum is available, jejunoileal anastomosis is an alternative to jejunocecal anastomosis that can be performed more quickly and preserves the ileocecal valve. This anastomosis has a tendency to obstruction and does not function as consistently as a jejunojejunalostomy (Freeman et al. 2000). However, a jejunoileal anastomosis has been performed successfully with a continuous suture pattern in the seromuscular layer that eliminated inversion obtained with other patterns (Loesch et al. 2002).

**Jejunocecal and Ileocecal Anastomoses**

Jejunocecal and ileocecal anastomoses can constitute 40% of all small intestinal anastomoses (Freeman et al. 2000) and can have a lower survival and more immediate postoperative complications than other types of anastomosis. The mesentery and small intestine are prepared as for a jejunojejunalostomy except that the ileum is transected and oversewn with a Parker-Kerr technique. As much cecum should be exteriorized as possible, and even large colon if necessary, to empty the abdomen and bring the ileum closer to the abdominal incision. Fluid from distended bowel is drained through the strangulated segment rather than drained into the cecum, as the latter would increase leakage of cecal contents during the anastomosis. The stoma should be created as close to the base of the cecum as possible (Fig. 6), midway between the dorsal band and the medial band, and with small intestine directed towards the base of the cecum (Fig. 6 and Fig. 7). An end-to-side or side-to-side pattern can be used, but the latter might have fewer postoperative complications. However, there is a tendency to make too large a stoma with a side-to-side anastomosis, which can cause stoma enlargement and obstruction later.

**Figure 6.** Completed handsewn side-to-side jejunocecalostomy, created as described in the text. Ce = cecum; Je = jejunum; cranial is to the right. The stoma is placed parallel to and between the medial and dorsal (white arrowhead) bands of the cecum and as much of the cecum as possible is exteriorized to place the anastomosis high on the cecal body, in this case almost level with the attachment of the cecocolic fold (arrow) to the right ventral colon. The black arrowheads mark the ends of the anastomosis, which appears rotated because it is close to the abdominal incision. - To view this image in full size go to the IVIS website at www.ivis.org.
Approximately 12 cm of the oversewn end of jejunum is attached to the selected area on the wall of the cecum, which can be elevated with stay sutures or Babcock forceps, with two interrupted stay sutures of 3-0 polydioxanone. Either a handsewn side-to-side method, GIA stapling instruments (Fig. 8), or the "cutting thread" technique can be used to make a 10-cm stoma. For handsewing techniques, the first row must appose the antimesenteric portion of the jejunum and the cecum approximately 5 to 10 mm away from the proposed site for the stoma. Failure to do this will place the stoma too close to the mesentery and the dorsal band of the cecum, and will rotate the jejunum so that it is kinked at the anastomosis. A continuous Cushing pattern is placed on the far side of the proposed line for 11 cm, and this is tied at each end. The jejunum and cecum are then incised within 5 mm of each end of that row and 5 mm parallel to it. The next row can be a full thickness simple continuous pattern that apposes the far edges of the cecum and jejunum. This layer can be tied at each end, and must be placed so that each end includes the commissures of the stoma. Failure to do this could result in gaps at these crucial points. This row is then completed in full thickness or Lembert fashion on the near side with a new strand of suture material. The near side is then oversewn with a continuous Cushing pattern.

Side-To-Side Jejunocecal/Ileocecal Anastomosis without Ileal Transection
If the ileum is obstructed by a tumor, muscular hypertrophy, or chronic intussusception, an incomplete bypass can be used, which means that the ileum is not transected. In horses with chronic intussusception, all attempts should be made to reduce the intussusception by gentle traction on the ileum and mild pressure through the cecal wall on the intussusceptum. In such cases, the ileum and jejunum are chronically dilated and thick-walled, which makes staple apposition very difficult. A side-to-side handsewn anastomosis is used as described above.

Surgical Techniques - Large Intestine
Large colon displacement can be corrected by recognizing the type of displacemen and by returning the bowel to its normal anatomical location (Fig. 1). To correct large colon volvulus, determine the direction of the twist, which usually causes the ventral colon to rotate in a medial and dorsal direction (clockwise as viewed from the back of the horse). Exteriorize as much colon as possible, place both arms deep in the abdomen, work with the bowel as close to the twist as possible, and use open, flat hands to manipulate the dorsal and ventral colons. From the surgeon’s perspective, working through the abdominal incision, the direction for derotation of large colon volvulus is clockwise in most cases. To prevent rupture of bowel during manipulation and exteriorization, the surgeon must not grab the wall with fingertips and should relieve distention if necessary by needle decompression (Fig. 9) or by an enterotomy (Fig. 10). The abdominal incision should be enlarged as needed to allow more room for manipulation of heavy bowel and to break the intraabdominal vacuum that holds the colon in place.

Surgical Techniques - Large Intestine
Figure 9. Gas decompression of the cecum with a 14 gauge needle tunneled between the seromuscular and mucosal layers for a distance before mucosal puncture, a technique that obviates the need for suture of the puncture site. - To view this image in full size go to the IVIS website at www.ivis.org . -
Decompression -
Gas decompression of distended colon is accomplished through a 14-gauge needle tunneled beneath the seromuscular layer and connected to a suction device (Fig. 9). Gas removal will facilitate abdominal access and intestinal manipulation, but an enterotomy might be needed if the bowel is distended and heavy with solid and liquid contents. A longitudinal enterotomy in the left ventral colon, close to the pelvic flexure, is also used to allow lumen irrigation with water delivered through a garden hose, to remove a solid impaction (Fig. 10). An enterotomy can also be used to remove an enterolith or other foreign material from the terminal portion of the right dorsal colon or transverse colon, after it has been massaged as close as possible to the pelvic flexure or into a segment of right dorsal colon that can be exteriorized.

Enterotomy -
Enterotomy is a dirty procedure that requires vigilance by all involved to prevent contamination, and is more likely to lead to incisional infection than to peritonitis. Methods to prevent adherence of intestinal contents to the serosa around the incision include almost constant lavage of the bowel with warm saline or precoating the proposed enterotomy site with sodium carboxymethylcellulose. The enterotomy is closed with a Lembert followed by a Cushing pattern, using 2-0 polydioxanone on a taper needle. This method exposes less suture material to the peritoneal cavity, and could thereby reduce risk of adhesions to foreign material; however, adhesions are very rare in the large colon.

An enterotomy might be required in the small colon to remove an impaction with food material or enterolith. If the impaction is focal and composed of dehydrated colon contents, it can be softened by injection of saline through an 18-gauge needle (Fig. 9) into the substance of the impaction. If an enterotomy is used, an incision in the antimesenteric taenia bleeds less than other parts of the wall and is easier to close. The enterotomy is closed with a Lembert followed by a Cushing pattern, taking care to cause minimal inversion and reduction of the lumen diameter (Fig. 11). A "high enema" can be used to relieve impaction of the small colon by passing a stomach tube through the anus and guiding it manually to the impaction to allow water infusion. This procedure can involve excessive colon handling in stubborn cases of long tubular impactions and this can lead to adhesions. Therefore, the author prefers an enterotomy.

Surgery of the Cecum -
Impaction is a common disease of the cecum and can lead to cecal rupture. The cause is unknown, but most cases in the USA are in hospitalized horses treated for an orthopedic disease and that have received a nonsteroidal anti-inflammatory drug and general anesthesia. Treatment can be entirely medical with laxatives, or surgical with a typhlotomy at the apex of cecum to relieve the impaction. A jejunocolic anastomosis (jejunum to right ventral colon) can be used to prevent recurrence of cecal impaction, because some horses might be prone to repeated episodes. This anastomosis can be a complete bypass (transection and oversewing the jejunum) or an incomplete bypass (no transection and the small intestine can empty through two routes). Cecocolic intussusception is very rare and can be a surgical challenge. Surgical treatment is determined by the degree of difficulty involved in correction and includes reduction only, with or without partial typhlectomy after reduction, colotomy in the right ventral colon, with or without partial typhlectomy to reduce the intussusception, and with or without partial typhlectomy after reduction. Despite the difficulty of the procedure, a successful outcome is likely if great care is taken to minimize intraoperative contamination (Martin et al. 1999).

Miscellaneous -
Resection of the small colon is required less frequently than for the small intestine, but pressure necrosis at the site of an
Impaction, strangulation by an enterolith or ovary, mesenteric avulsion, or volvulus are examples that require resection. The principles are the same as for the small intestine, except that the large colon might need to be emptied to reduce flow through the anastomosis, the mesenteric vessels require more attention because they are hard to locate in the thick mesenteric fat, and postoperative feeding might need to be delayed.

If a volvulus of the large colon requires resection, viable margins for anastomosis are not always accessible. Most resections are at the level of the cecocolic fold, which might leave some damaged right dorsal colon in the horse. However, resection can improve survival by reducing the surface area of damaged mucosa and thereby reducing the dose of endotoxin that can cross the colon wall. An additional advantage of resection is reduced risk of recurrent volvulus or other colon displacement. Various methods have been described, but the most popular are end-to-end and side-to-side anastomoses, and the latter can be handsewn, stapled, or a combination.

Colopexy is also used to prevent recurrent large colon volvulus or displacement, but can only be performed on healthy colon, and is usually reserved for the first recurrence (Hance 1997). There are concerns about the safety of this procedure, and recurrent displacement, colic, incisional sinuses, and colon rupture are recognized complications. Nephrosplenic ligament entrapment can be treated by an IV infusion of phenylephrine to reduce the size of the spleen and to facilitate dislodgement of bowel by rolling or by exercise (Johnston and Freeman 1997). These procedures reduce the need for surgery.

Rectal prolapse and prolapse of a variable portion of the small colon through the rectum can follow parturition or any other cause of straining in horses. Although most cases can be treated by reduction and retention of the prolapse, necrotic small colon should be amputated close to the level of the anus. The first step in this is to transfix the prolapse by long needles to retain it in place during segmental resection and anastomosis.

Postoperative Care

Postoperative procedures after colic surgery are to facilitate early return of normal gastrointestinal tract function and to prevent complications. Anything that stresses the abdominal incision, such as rectal examinations or any physical activity, should be avoided after surgery. A stomach tube is not placed in the author’s clinical but is passed as needed to decompress the stomach. Most horses can eat a very small handful of hay within 18 - 24 hours after most surgeries, again at 3- to 4-hour intervals, and the amount increased slowly to a full ration within 3 to 4 days. The process is delayed by 2 to 3 days in a horse that had small colon resection and anastomosis. Each horse receives potassium penicillin i.v. at 22,000 U/kg bwt every 6 hours and gentamicin at 6.6 mg/kg bwt i.v. every 24 hours for three days. Flunixin meglumine is given at 1.1 mg/kg bwt i.v. once or twice daily for two to three days after surgery, or as needed. Intravenous fluids are given at 1 to 2 L/hr to a 450-kg horse for the first 12 hours and the rate is adjusted for changes in PCV and total plasma protein during and after that interval. Specific prophylactic measures to prevent adhesions, reperfusion injury, and postoperative ileus (POI) are not used, and endotoxin antiserum is not given in the author’s clinic, except as needed after surgery for large colon volvulus. Prokinetic drugs are only used as needed.

Postoperative pain should be managed as the individual case dictates, but those cases that had a small intestinal disease and are refractory to analgesics and gastric decompression may warrant a second celiotomy. Postoperative rest involves 14 days in a stall, followed by another 14 days in a stall with handwalking exercise, and 30 days in a small paddock before work resumes, provided that incisional healing has been uncomplicated.

References


All rights reserved. This document is available on-line at www.ivis.org. Document No. P0733.1203.