DIFFICULT INTRAOPERATIVE DECISIONS DURING COLIC SURGERY
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Key Points
- Assessing intestinal viability remains one of our greatest challenges
- Clear and effective intraoperative client communication is imperative
- Adhesion prevention is superior to adhesion treatment
- Some situations will require additional incision support during closure

One of the first major surgeries many equine surgical residents will log as a primary surgeon will be an emergency colic surgery. Being adequately prepared for this challenge and able to make correct intraoperative decisions is imperative for successful case outcome. Arguably the two greatest challenges faced during colic surgery are assessing bowel viability, and overall patient survivability based on the lesion identified and the procedures required to correct the problem. Even experienced equine surgeons encounter moments of anxiety when making these two decisions. Adhesion prophylaxis and abdominal wall closure following repeat laparotomy are more straightforward issues to deal with, and will also be discussed.

Assessing Intestinal Viability:
Adequate blood supply is critical for successful healing of any anastomosis as inadequate postoperative circulation can lead to bowel ischemia and necrosis and ultimate anastomosis failure. Accurate and objective methods of assessing intestinal viability have not progressed significantly in the past 25 years since Freeman et al compared clinical judgment (53% accuracy), Doppler ultrasound (88% accuracy), and fluorescein fluorescence (53% accuracy) to predict intestinal viability in ponies. Assessing intestinal viability is still a major challenge for our human counterparts as well. In the human literature, a recent review paper written by Urbanavicius et al evaluates techniques available to assess intraoperative intestinal viability. In this review, the reported incidence of anastomotic leakage ranges between 1.2% and 19.2% with up to 32% of patients with an anastomotic leak dying from this postoperative complication.

Clinical assessment of bowel viability is currently the primary method used in equine abdominal surgery and is an important part of the assessment in the human operating theater as well. Bowel viability is usually estimated primarily by the color of the serosal surface, and if an enterotomy is being performed, mucosal surface color is also valuable. In addition, bowel peristalsis, visible and/or palpable pulsation of mesenteric arteries, and hemorrhage at the incised bowel margin help the surgeon subjectively assess bowel viability. This clinical assessment is subjective, and based on the experience of the surgeon. Studies have shown that clinical judgment in predicting intestinal viability is inadequate, yet an objective and accurate method of assessing bowel viability is still unavailable. Horgan and Gorey define the requirements of an ideal bowel viability test as: 1) The technique must have ready availability, preferably in every operating theater dealing with abdominal emergencies; 2) The necessary equipment must not be cumbersome or require specialized personnel; 3) The method must be accurate with a minimum of false negative results and, more importantly, few false positives; 4) The technique must be objective and reproducible; and 5) The method must be cost effective.
In the past 10 years, numerous techniques have been evaluated in human studies attempting to quantitatively assess intraoperative intestinal viability and there is no agreement as to which method is the most accurate and applicable. The most widely used methods are those reflecting oxygenation and perfusion measured by visible light spectrophotometry (VLS) and laser fluorescence angiography (LFA) respectively. Intestinal viability studies in the human field often involve colorectal cancer and colorectal anastomosis.

VLS is a technique used to assess bowel oxygenation by using shallow-penetrating visible light to measure hemoglobin oxygen saturation in small tissue volumes (denominated as StO₂). Visible light penetrates approximately 2mm into the tissue. The spectroscope or oximeter emits low-powered white light from a handheld or endoscopic probe placed near or on the bowel wall. The light penetrates and diffuses and reemerges colored according to the oxygenation level (StO₂). An important advantage of VLS is that it penetrates capillaries well, but not larger vessels. This results in a capillary-weighted measurement, which most closely correlates with tissue oxygen saturation. Drawbacks to VLS are first, that a specific level of StO₂ that leads to intestinal tissue ischemia has not been defined to date; second, there is no uniformity in StO₂ measurements as different algorithms are used by different oximetry systems for estimating StO₂; third, reproducibility of results can be affected by bile, stool or food within the intestine which can interfere with the passage of light when measurements are taken at the mucosa, and fourth, prices of oximetry systems are costly.

LFA has been validated for intestinal microcirculation assessment and the technique involves an intravenous injection of fluorescent dye (indocyanine green) and illumination of the bowel at the site of interest with a laser light. Digital videos of the fluorescence are recorded as a function of tissue perfusion. Clinical studies evaluating LFA have been promising with results showing that measurements by LFA led to extended resections of malperfused intestine in 14.2% of patients, avoiding leaving nonviable bowel in situ. The authors recommend the technique for routine use in clinical practice. This technique does have limitations in that the contents of the intestine can interfere with fluorescence and the limiting values of LFA representing irreversible necrosis are not yet defined.

Studies using VLS or LFA have not been published to date in the horse. Although these techniques are not universally accepted in human medicine as an ideal assessment of bowel viability, they are the most promising at this time. Further work needs to be done in the equine field so that the surgeon does not have to rely solely on clinical judgment, which has been proven to be inconsistent. Plasma lactate values have been looked at in horses with > 360 degree large colon volvulus to determine the relationship between plasma lactate concentration at admission and colonic viability. The results suggested a strong association between plasma lactate concentration at admission and outcome in this population of horses with plasma lactate concentrations < 6.0mmol/L at admission having a > 90% chance of survival whereas only 30% of horses with a plasma lactate > 7.0mmol/L survived. This information is useful for large colon volvulus cases, but further studies will need to be performed with other forms of colic to make it universally helpful.

Intraoperative Assessment and Client Communication:

The intraoperative assessment of the offending lesion during colic surgery and measures required to correct it are relatively straightforward in most instances. Difficulty arises however when trying to transfer that knowledge to the client while factoring in prognosis, likelihood of secondary complications, and cost. Clients are frequently feeling significant emotional stress at
this time, and their thought processes may be unclear. They will frequently look at the surgeon to make the decision for them. It is important to present the facts of the situation as clearly as possible and allow the client to make an informed decision regarding proceeding with surgery or electing euthanasia. Unfortunately in this economic climate, more and more clients are opting for humane euthanasia rather than pursuing surgical correction of complicated conditions that may result in elevated final invoices. Remembering the published AAEP guidelines regarding euthanasia of horses can be helpful and clients might find them useful when trying to make these decisions:

- A horse should not have to endure continuous or unmanageable pain from a condition that is chronic and incurable.
- A horse should not have to endure a medical or surgical condition that has a hopeless chance of survival.
- A horse should not have to remain alive if it has an unmanageable medical condition that renders it a hazard to itself or its handlers.
- A horse should not have to receive continuous analgesic medication for the relief of pain for the rest of its life.
- A horse should not have to endure a lifetime of continuous individual box stall confinement for prevention or relief of unmanageable pain or suffering.°

**Adhesion Prevention:**

Because treatment of adhesions after they have formed is unrewarding, expensive and associated with a poor prognosis for survival, an emphasis should be placed on prevention.° Good surgical technique (keeping the bowel moist, minimizing tissue handling, good hemostasis, minimal exposed suture, removal of damaged tissue, etc.) remains one of the most critical factors in minimizing adhesion formation. A recent retrospective study by Gorvy et al looked at adhesions in 99 horses undergoing repeat laparotomy, and found that although adhesions were the most common pathological finding at repeat laparotomy (32%), they do not appear to be related to the site of the primary lesion, resection, or endotoxemia. This is consistent with the hypothesis that surgical trauma is the most important stimulus in adhesion formation.°

There are numerous methods of preventing adhesions including, NSAID and antibiotics to avoid inflammation and infection, systemic postoperative heparin in attempt to ultimately block the conversion of fibrinogen to fibrin, postoperative prokinetic agents to avoid prolonged apposition of serosal or peritoneal surfaces, omentectomy to eliminate omental adhesions, tissue coating solutions to provide a lubricating barrier, and postoperative peritoneal lavage.° Which method or methods the surgeon chooses to utilize will likely be case and surgeon dependent.

**Situations requiring additional support during incisional closure:**

Many times the surgeon will be able to predict preoperatively when abdominal incision closure augmentation is warranted. This may include horses having a repeat laparotomy through a recent incision, mares in advanced pregnancy, large breed horses (>700 kg), or horses that have evidence of impending dehiscence in the early postoperative period necessitating incisional revision. Other times, the surgeon will decide during incisional closure that augmentation may be warranted based on tissue factors such as a thin linea alba or tearing of the external fascia of the rectus abdominus sheath.

If the decision is made that extra support is needed, 3 to 5 retention sutures can be placed using a vertical mattress pattern of 20 gauge stainless steel wire, or doubled # 2 nylon with stents.
to minimize focal tissue crushing. A handy source for the stents is to cut the suction tubing into 1.5-2cm sections. The vertical mattress pattern is placed such that the far bites are placed through all layers and the close bites are $\leq 2.5$ cm from the skin edge and only through the skin and subcutaneous tissues.\textsuperscript{12} The retention sutures are placed 8-10 cm apart and are placed prior to primary closure of the linea alba. These sutures are usually removed in the first postoperative week unless the integrity of the incision is suspected to be inadequate.