Intestinal Surgery; Why did it leak?

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Wound dehiscence of an intestinal anastomosis often leads to generalized bacterial peritonitis and subsequent death. Therefore, factors which negatively affect visceral healing are potentially of great clinical significance to the surgeon. Factors that cause intestinal anastomoses to leak include etiology of obstruction, failure to adequately identify ischemic tissue, improper suturing or stapling technique and factors that negatively effect wound healing such as sepsis, malnutrition and anti-neoplastic therapy.

Importance of tissue apposition

Direct approximation of the wound edge allows for optimum rapid healing characterized by primary intestinal wound healing. With good apposition rapid mucosal re-epithelialization and early formation of young well-vascularized collagen between the submucosa, muscularis and serosa occurs. **Figure 1:** example of an intestinal wound at 3 days postoperatively with using appositional sutures. Note the good alignment of the mucosa, submucosa and muscularis with a fibrin seal on the serosal surface. Other advantages of approximating patterns for intestinal anastomosis are: 1) lumen diameter is not compromised, 2) wound strength meets or exceeds everting or inverting wound strengths, and 3) adhesions are minimal. The crushing suture has been shown to cause more tissue ischemia directly at the suture line and its use is discouraged. **Figure 2:** example of an intestinal wound at 3 days postoperative with crushing sutures applied to the wound edges. Note the hemorrhage and necrosis within the muscularis and incomplete establishment of mucosal integrity.

Mucosal eversion or tissue overlap retards healing and should be avoided. Delayed fibrin seal formation, delayed mucosal re-epithelialization, increased mucocele formation, prolonged inflammatory response, and marked adhesion formation all characterize everted healing.

Eversion may initially widen the lumen diameter, but the prolonged inflammatory response usually narrows the lumen sometimes resulting in stenosis. **Figure 3:** example of an intestinal wound at 7 days reveals mucosal eversion and poor tissue apposition resulting in mucocele formation and reduced lumen diameter. Evertting anastomoses also have an increased tendency for leakage especially in the face of a septic abdomen and should never be used in the colon.
Inversion of the wound edge creates an internal cuff of tissue that reduces lumen diameter. Hemodynamic compromise of the inverted submucosa occurs resulting in mucosal edema and necrosis. After five days the internal cuff usually sloughs. Figure 4: example of an inverting anastomosis at 7 days revealing reduced lumen diameter at the anastomotic site. Inverting anastomoses are characterized by a rapid serosa to serosa seal and minimal adhesion formation. Because of their safety against leakage, inverting patterns may be the preferred technique for the colon.

**Suture material and pattern selection**

Both absorbable and non-absorbable suture materials have been used successfully for anastomosis. The braided nonabsorbable suture materials such as silk or Dacron may harbor bacteria create granulomatous inflammatory reaction or draining suture sinus. Monofilament non-absorbable sutures such as Nylon and polypropylene are safe in contaminated environments. However polypropylene has been associated with foreign body adherence in one case series.

Absorbable suture materials are usually used since the GI tract heals very rapidly and suture tensile strength is only needed for 2-3 weeks. Absorbable suture materials reported in the literature include chromic gut, polyglycolic acid (Dexon), polygalactin 910 (Vicryl), polydioxanone (PDS) and polyglyconate (Maxon) and poliglecaprone (Monocryl). Of these, surgical gut is not recommended for anastomosis because it is rapidly broken down by collagenase. Polygalactin 910 and polyglycolic acid are multifilament derivations of glycolic acid which retain good tensile strength for up to 28 days. Both sutures have good knot tying and handling characteristics with the exception of significant tissue drag. Vicryl is commonly used for intestinal anastomosis in Europe with good published success.

Polydioxanone (PDS) and polyglyconate (Maxon) are polyester monofilament suture materials which are also absorbed by hydrolysis and therefore are unaffected by contaminated environment. They maintain up to 40% of their original tensile strength after 3 weeks. Many surgeons are starting to use shorter acting monofilaments such as Monocryl or Biosyn for intestinal anastomosis. They have similar handling properties to PDS but its tensile strength are resorbed by within 10-21 days. The newer “Plus” sutures are impregnated with the antibacterial agent Tryclosan. Their efficacy in reducing infection in contaminated dermal wounds may foster an increased use in intestinal anastomosis.

Suture size, needle type and number of sutures are also important factors to consider. For cats, I use 4-0 suture on an RB1 needle. Usually 16-20 sutures are needed to complete the anastomosis. For small dogs I typically also use 4-0 suture on an RB1 needle whereas for larger dogs 3-0 suture on an SH needle is used and 20-24 sutures are needed to complete the anastomosis. After transection, the wound edges are trimmed to remove averted mucosa and suturing is begun at the mesenteric border. Sutures are then placed on the anti-mesenteric border, then at the 3 and 9 o’clock position before filling in the gaps.

I personally use a continuous suture pattern rather than interrupted pattern with the first suture being placed at the mesenteric border and the second at the antimesenteric border. Figure 5: with a continuous pattern the first suture is tied at the mesenteric border and the second at the antimesenteric border. On one side the pattern is
advanced from mesenteric to antimesenteric and on the opposite side from antimesenteric to mesenteric. The suture line is then tied to the remaining tag at the original knot to complete the anastomosis.

A rapid alternative to sutured anastomosis is the use of an Auto Suture 35 skin stapler with stainless skin staples (United States Surgical Corp., Norwalk, CT). After triangulating the intestine with three stay sutures, the skin stapler is used to place staples every 2-3 mm around the perimeter of the wound. These closures are more rapidly done than hand sewn anastomosis and have similar bursting strengths but mucosal eversion may occur between staples.

The GIA and TA auto staplers lay a double row of staples for security and when used in combination create a functional “end to end anastomosis”. The GIA portion of the anastomosis is inverted whereas the TA portion of the anastomosis is averted. Recent studies have shown that leakage rates are similar to hand sewn techniques but auto stapler usage significantly reduces surgical time.

Small intestinal resection is limited to 70% of its length in adult dogs and 80% in puppies. Beyond that short bowel syndrome with malabsorption, maldigestion and chronic diarrhea will result.

All anastomosis should be covered with a vascularized omental flap which is tacked in place. Omentum is useful in 1) restoring blood supply to a devascularized area, 2) facilitating lymphatic drainage, and 3) minimizing mucosal leakage and secondary peritonitis. The role of omentum is significant when one considers that in one study 90% mortality rates were seen with intestinal anastomoses after omental resection was performed in dogs. Free omental flaps are not as effective as pedicle omental flaps and may in fact lead to anastomosis failure.

After the anastomosis has been completed, the mesenteric defect is closed with a simple continuous pattern taking care not to include the mesenteric vessels within the sutures. The anastomosis is then covered with a pedicle of greater omentum. The omentum is critical to the successful healing of the intestinal wounds especially in patients with peritonitis. In one study, 9 of 10 dogs with experimentally induced peritonitis died after intestinal anastomosis whereas 10 out of 10 dogs survived when the omentum remained.

Serosal patching utilizes the antimesenteric surface of the small bowel to cover or buttress an adjacent area of questionable tissue viability or an area that cannot be reliably sutured. Jejunum is commonly used because its freely movable mesentery allows it to be mobile. The serosal patch provides mechanical stability and will help to induce and localize a fibrin seal over the questionable area.

**Why do anastomoses leak?**

Wound dehiscence of biopsy site, enterotomy or intestinal resection and anastomosis often leads to generalized bacterial peritonitis and subsequent death. Therefore factors which negatively affect visceral healing are potentially of great clinical significance to the surgeon. Factors that cause *intestinal anastomoses leakage* include the etiology of obstruction, failure to adequately identify ischemic tissue, improper suturing or stapling technique and factors that negatively affect wound healing such as sepsis, malnutrition and anti-neoplastic therapy. In a retrospective study of 115 cases of intestinal anastomosis in dogs and cats leakage occurred in 13 of 90 dogs but none of 25 cats. The incidence of postoperative complications was related more to the etiology of the cause of resection. Mortality was also higher in dogs needing intestinal surgery because of foreign body obstruction vs those secondary to neoplasia. In this study discriminant analysis indicated that dogs with preoperative
peritonitis, intestinal foreign body and serum albumin concentration ≤ 2.5 g/dl were most likely to have leakage of the intestinal wound.

The etiology of the anastomosis Tissue trauma, sepsis, burns, and major surgery induce major metabolic changes in small animal patients. With each of these stresses the animal's basic metabolic rate is accelerated and protein metabolism occurs, leading to a potential state of negative nitrogen balance. Protein-calorie malnutrition (PCM) occurs because of starvation, when a metabolic response to injury becomes prolonged, or with hypermetabolism secondary to sepsis. It takes only five to 10 days of anorexia to compromise the immune system and deplete the body's muscular and hepatic glycogen stores. When PCM is present cell mediated immunity is impaired, there is a high risk of infection, anemia and hypoproteinemia and impaired wound healing.

Caloric and protein depletion in animals has been shown to inhibit visceral healing, but only after a loss of 15 to 20 percent of body weight. Decreases in wound breaking strength are directly proportional to the carcass weight loss. It is estimated that 75 percent of animals with elective surgical wounds attain functional wound union during the period of negative nitrogen balance; however, extended PCM from muscle, visceral, or plasma tissue losses increases the risk for visceral wound disruption. Impaired visceral wound healing is due to both a prolonged lag phase of healing and diminished capacity for fibroplasia within the logarithmic phase. Malnutrition induces intestinal mucosal atrophy, reduced motility, increased incidence of ileus and the potential for bacterial translocation through the bowel wall, with resultant sepsis.

*Glucocorticoids* have a negative effect on wound healing when given in large doses prior to the third day after wounding. *NSAIDs* appear to affect the early inflammatory phase of wound healing or have a significant negative effect on visceral healing strength. *Radiation* therapy interferes with fibroblast mobilization, replication, and collagen synthesis as well as causing sclerosis of microvasculature, thereby reducing oxygenation at the wound site. Whenever possible, radiation therapy should be initiated after visceral wound healing is complete. The negative effects of cancer on wound healing appear to be secondary to nutritional deficiencies rather than direct tumor impairment on wound healing. Visceral wound healing may actually be mildly augmented owing to release growth factors by the neoplasm. *Effects of chemotherapeutic agents on visceral wound healing are variable*. Drugs such as vincristine, vinblastine and azathioprine seem to be safe when used in therapeutic doses. Drugs such as cyclophosphamide, methotrexate, 5-FU, and doxorubicin have been shown to delay wound healing in both experimental and clinical studies. *Cisplatin* appears to significantly impair intestinal wound healing in rats and should be used with caution after intestinal surgery.

**Effect of early feeding on intestinal healing**

Impaired wound healing due to nutritional causes may be ameliorated by feeding an enteral or parenteral diet that supplies energy needs in the form of fatty acids and sugars and provides essential amino acids. Feedings of high protein meals after injury can optimize conditions for normal visceral wound healing. Amino acids provided through enteral nutrition are utilized for the synthesis of structural proteins such as actin, myosin, collagen, and elastin.

Early if not immediate postoperative enteral feeding has been shown to have a positive influence on the healing rate of intestinal anastomosis in dogs. Bursting pressures and collagen levels of ileal and colorectal anastomosis were compared in Beagles fed elemental diets versus those fed only electrolyte and water for four days. The dogs fed elemental diets had nearly twice the bursting strengths of the control group and nearly double the amount of
both immature and mature collagen at the wound site. Total parenteral nutrition (TPN) does not appear to ameliorate the mucosal atrophy or increase collagen deposition as does enteral nutrition. In human studies, the incidence of septic complications was significantly lower in people fed between eight to 24 hours after surgery versus those maintained on TPN. Additionally early fed patients had a reduced incidence of postoperative ileus and reduced hospital stay.

REFERENCES