

**BASICS OF INTESTINAL SURGERY:
ANATOMY, PATHOPHYSIOLOGY, INSTRUMENTATION & SUTURING**

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ANATOMY

The small intestine extends from the pylorus to the caecum. The most fixed portion of the small bowel is the distal duodenum, due mostly to the duodenocolic ligamentous attachment to the descending colon. This anatomical landmark must be recognized to allow proper exploration of the small intestine. The jejunum is the major portion of the small Intestine with the ileum being only 6-20 centimeters in length in most small animals.

The major blood supply to the small intestine is from the cranial mesenteric artery. A portion of the proximal duodenum is supplied by the celiac artery and shares a source of blood (pancreaticoduodenal) with the right lobe of the pancreas.

The wall of the small intestine comprises the mucosa, submucosa, muscularis and the serosa. The submucosal layer provides blood vessels, lymphatics and nerves. Importantly, it is also the "holding" layer which must be included in any suturing technique that is used to re-appose tissue of the small intestine.

INSTRUMENTATION

Bowel surgery does not require major investment in instrumentation!

However some basic tools are essential and these include:

- Atraumatic (deBakey) thumb forceps
- Doyen bowel clamps
- Fine (Mayo) needle holders

- Diathermy
- Suction
- Laparotomy towels
- Fine (4/0) monofilament suture material

An extremely useful (but very expensive!) instrument that has recently become available is the Ligasure (Valleylab Inc®) system that permits rapid vascular coagulation of mesenteric vessels.

CHEMOPROPHYLAXIS

INTESTINAL VIABILITY

An assessment of bowel viability can be very difficult; bowel that appears normal during surgery may later become non-viable and cause failure of an anastomosis. The standard clinical criteria used for bowel viability assessment include:

- colour
- peristaltic motility
- arterial pulsations

When the amount of bowel to be resected is in question, then more should be removed. Evaluation of appearance and motility the blue-black colour and flaccid texture allows the surgeon a fair amount of accuracy when predicting bowel viability. Examples of this type of venous occlusion include intussusceptions, intestinal volvulus or strangulated hernias. Some techniques have been investigated to increase the accuracy of determining bowel viability with a view to eliminating unnecessary intestinal resection or the return of compromised bowel to the peritoneal cavity. These include:

- Doppler ultrasound
- Thermistor thermometry
- Intravenous fluorescein

However, investigations show that clinical examination is at least as effective as other techniques for assessing bowel viability.

PRINCIPLES OF INTESTINAL ANASTOMOSIS

Suture materials: today, most surgeons prefer to use a synthetic monofilament suture material that reduces frictional damage during suturing and limits the inflammatory reaction at the repair site.

Suture needles: classically, round bodied needles have been used to prevent tearing of the intestinal wall that occurs with cutting needles. In practice, this leads to poor penetration of the bowel wall and hence most surgeons prefer a taper-cut needle that avoids both problems.

Suture patterns: The type of suture pattern used for bowel incisions (enterotomy, end-to-end anastomosis) in the dog and cat is probably best limited to a simple approximating type of suture pattern - the simple interrupted appositional (SIA) type. The SIA is a non-crushing technique that causes less tissue ischemia at an anastomotic site for the first week. This method is technically simple and recommended for general use in all anastomoses in small animals. The crushing technique, although causing more ischaemia than the SIA, allows quicker regeneration of mucosa over the incision and less scar formation. Bursting pressure studies and histopathological evaluation of the crushing method and SIA techniques were similar. An alternate method would be the use of a continuous pattern. The continuous approximating suture pattern will cause less mucosal eversion and postoperative peritoneal adhesions than the interrupted patterns. It also produces precise apposition of the submucosal layer between sutures. Regardless of the suture pattern chosen for use in the intestine of the small animal, meticulous care is of paramount importance when placing sutures through this delicate tissue. Disruption of the vascular supply is probably the most common biological factor responsible for failure. Failures are almost always due to faulty surgical technique.

CORRECTION OF LUMINAL DISPARITY

Luminal disparity will sometimes accompany resection of bowel. Correction of almost all disparities can be accomplished by suture spacing techniques alone. Other techniques including: cutting the smaller diameter loop of bowel at an angle,

'fish mouthing', partial closure of the larger bowel opening or end-to-side or end-to-end are rarely if ever really necessary.

SEROSAL & OMENTAL PATCHING

The omentum is capable of sealing off infection, perforations and revascularizing compromised gut. The surgeon should take advantage of these characteristics in gastrointestinal surgery by using omentum to wrap an anastomotic site or an enterotomy incision. This helps protect against suture line failure by decreasing the possibility of leakage or infection and by bringing in an additional source of blood vessels.

The serosal surface of a loop of bowel can likewise be used to patch leaking areas of bowel or to reinforce suture lines involving stomach or bowel. It has been successfully employed in veterinary medicine in some animals where omental patching or wrapping had failed.

PATHOPHYSIOLOGY

OBSTRUCTION OF THE SMALL INTESTINE

Bowel obstruction in the dog or cat is the most common indication for surgical intervention involving the gastrointestinal tract.

The obstruction is classified as:

- simple (mechanical or functional)
- strangulated.

Simple obstructions can be:

- high (proximal) and involve the pylorus, duodenum and the proximal jejunum. A high obstruction is usually considered to be associated with higher mortality rates.
- low (distal) small bowel obstruction involves the lower one-half of jejunum and ileum.

The severity of the obstruction is further modified by whether it is a partial or complete obstruction. Causes of small bowel obstruction can be due to foreign

bodies, intussusceptions, tumours (lymphoma, annular adenocarcinoma), strictures, abscesses or rarely adhesions.

DISCRETE FOREIGN BODIES

Simple obstruction results in distension of the bowel proximal to the obstruction causing fluid and gas accumulation. The content of the fluid will depend upon the location of the obstruction.

High: If the obstruction is proximal to the pylorus, then hydrogen ion loss will likely predominate resulting in a metabolic alkalosis. Hypokalaemia often accompanies this acid-base disturbance. Vomiting due to obstructions below the pancreatic and biliary ducts will result in a much greater volume of fluid loss. This fluid will have a significant amount of bicarbonate ion present in it contributing to a metabolic acidotic state. Fluid loss can be rapid and severe due not only to vomiting but also to the inability of the fluid collecting proximal to the obstruction to pass distally into the intestine where absorption can take place. The fluid loss from vomiting and decreased absorption can result in clinical signs ranging from dehydration to hypovolaemic shock. The latter can result in metabolic acidosis due to lactic acidosis. The rise in intraluminal pressures associated with a high obstruction is minimal but the intramural pressure is great.

Low: obstructions involving the distal jejunum or ileum cause less severe systemic effects. Vomiting is an uncommon sign and when it occurs it is intermittent. Fluid and electrolyte loss is much less initially but if allowed to become chronic, these losses can become significant. Low bowel obstruction is not often associated with vomiting. If vomiting does occur, it is intermittent with fluid and electrolyte loss being minimal. If the obstruction persists for weeks, the animal will eventually become anorectic, lose weight, and eventually die from starvation. Distension of the intestinal wall is less severe in distal obstructions and as a result circulation of the affected portion of gut is not impeded.

The blood supply to the segment of intestine undergoing distension may be so severely compromised that blood is shunted away from intestinal capillaries and into arteriovenous anastomoses. Ulceration and pressure necrosis of the bowel can

also occur from the physical presence of a large foreign body. The result is hypoxia to the bowel, loss of viability, and increased permeability to toxins, including endotoxins. The duodenum is more sensitive to the circulatory changes associated with distension. Thus the need for earlier surgical intervention in a high obstruction is apparent when distension is a significant entity.

LINEAR FOREIGN BODIES

Linear intestinal foreign bodies may be seen in both the dog and cat. Thread and needle foreign bodies or strings are seen in the cat with greatest frequency. In one study, the mean age of cats with thread and needle foreign body was 2.7 years. In the vast majority of these cases, thread is most often found (90%) with a needle involved in less than 10% of the cases. The linear foreign body usually starts as a partial obstruction. Its continued presence in the bowel, however, can cause large sections of the bowel to become non-functional and essentially become completely obstructed. The pathogenesis of linear foreign body obstruction requires that the object become fixed somewhere cranial in the digestive tract (see diagram). The object is either looped around the base of the tongue or trapped at the pylorus. Normal smooth muscle contraction of the small intestine continues to propel the object aborally but due to its fixation, it will damage the mesenteric border of the bowel through which the string passes. Continuation of peristalsis against the pressure of the fixed linear object will eventually result in a perforation of the gut with leakage and peritonitis quickly following. When lacerations occur, mortality increases dramatically.

INTUSSUSCEPTION

Intussusception is an invagination of a portion of the gastrointestinal tract into a posterior or preceding segment of intestine. Intussusception occurs more frequently in the dog than the cat. This disease is most often seen in the young dog or cat and the location is usually near the ileocolic valve. It is thought to occur due to the vigorous contraction of a segment of intestine into the lumen of the adjacent relaxed

segment. The invaginated portion of intestine is called the intussusceptum and the portion into which this segment invaginates is called the intussusciens.

The blood supply to the intussuscepted piece of gut is compromised due to its inclusion in the invagination. Initially, venous occlusion is present resulting in edema of the bowel and, if prolonged, can eventually cause arterial occlusion and necrosis. Eventually, fibrinous adhesions can form making spontaneous or surgical reduction of the intussusception less likely.

STRANGULATION

Strangulation of the bowel is a much more severe form of obstruction. Luminal blockage as such is not always present, but the blood supply to a segment of bowel is severely compromised. Strangulation should always be considered in cases of suspected bowel obstruction when the clinical signs are more severe than those usually associated with a simple mechanical obstruction. Partial or total obstruction of the venous drainage of a segment of bowel is most often seen in cats related to intussusception or strangulated hernias. An intact arterial supply allows the intramural sequestration of blood and eventually bowel wall edema. Proximal to the strangulation, the bowel will distend and become filled with gas and fluid. The fluid in a strangulated obstruction will have a significant amount of blood in it. If the strangulation continues, the bowel wall will become nonviable and necrotic allowing the transmural migration of toxins and bacteria. Fluid and blood loss combined with the peritoneal absorption of these bacteria and toxic substances will eventually lead to hypovolaemia and endotoxic shock and death if left untreated.

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