

Surgical Management of Abdominal Trauma

Howard B. Seim III, DVM, DACVS
Colorado State University

OVERVIEW

Patients that sustain a traumatic injury severe enough to cause an abdominal hernia or patients that sustain penetrating abdominal wounds (i.e., gunshot, bite wounds) should have an exploratory laparotomy. After a review of general principles and techniques of abdominal surgery in cats and dogs, including the surgical techniques for ventral midline celiotomy, abdominal exploration, abdominal wall closure, and management of complications such as wound dehiscence, these proceedings outline the surgical management of traumatic abdominal wall hernias and peritonitis. Step by step descriptions of the surgical technique for repair of abdominal hernias are provided. For peritonitis, we will cover the indications and techniques for abdominocentesis, exploratory surgery, diagnostic abdominal lavage, and open abdominal drainage. In the lecture, case examples admitted to the author's critical care service will be used to illustrate the surgeons' decision making techniques. Video of clinical case material will be used to illustrate all techniques.

If you would like a copy of the video of this surgical procedure on DVD go to

www.videovet.org.

KEY FACTS

- The abdomen generally is explored by means of a ventral midline incision from xyphoid to pubis. In most animals the entire abdomen, including the inguinal areas and the caudal thorax, should be prepared for aseptic surgery to allow extension of the incision into the thoracic or pelvic cavities if necessary.
- Various techniques can be used to systematically explore the entire abdomen; every surgeon should develop a consistent pattern to ensure that the entire abdominal cavity and all structures are visualized and/or palpated in each animal.
- Complications of abdominal surgery, including dehiscence (incisional hernias), may occur if improper surgical technique is used. The most common cause of wound dehiscence in the early postoperative period results from the surgeon's inability to recognize the rectus sheath or not getting adequate bites in the collagen dense rectus sheath.
- Patients that sustain a traumatic injury severe enough to cause an abdominal hernia or patients that sustain penetrating abdominal wounds (i.e., gunshot, bite wounds) should have a xyphoid to pubis abdominal exploratory laparotomy.
- For most abdominal hernias, perform a ventral midline abdominal incision to allow the entire abdomen to be explored. Assess the extent of visceral herniation. Reduce the herniated contents and amputate or excise necrotic or devitalized tissue around the hernia. Close the muscle layers of the hernia with simple interrupted or simple continuous sutures.
- Abdominocentesis— the percutaneous removal of fluid from the abdominal cavity— usually is done for diagnostic purposes although it may occasionally be therapeutic. Indications include shock without apparent cause, undiagnosed disease with signs involving the abdominal cavity, suspicion of postoperative gastrointestinal dehiscence, blunt or penetrating abdominal injuries (i.e., gunshot wounds, dog bites, vehicular injury), and undiagnosed abdominal pain.
- Exploratory surgery is indicated when the cause of peritonitis cannot be determined or when bowel rupture, intestinal obstruction (e.g., bowel incarceration, neoplasia), or mesenteric avulsion is suspected.
- Although the practice of routinely lavaging the abdominal cavity of animals is controversial, lavage is always indicated with diffuse peritonitis. Lavage should be done with care in animals with localized peritonitis to avoid dissemination of infection.

- Open abdominal drainage is a useful technique for managing animals with peritonitis. Reported advantages include improvement in the patient's metabolic condition secondary to improved drainage, less formation of abdominal adhesions and abscesses, and access for repeated inspection and exploration of the abdomen. With this technique the abdomen is left open, and sterile wraps are placed around the wound.
- The prognosis for animals with generalized peritonitis is guarded; however, with proper and aggressive therapy, many survive. Some authors have suggested that the mortality rate approaches 50%. The mortality rates reported in animals with generalized peritonitis treated with open abdominal drainage have varied from 20% to 48%

GENERAL PRINCIPLES AND TECHNIQUES

Definitions

Celiotomy is a surgical incision into the abdominal cavity. The term **laparotomy** often is used synonymously, although it technically refers to a flank incision. A sudden onset of clinical signs referable to the abdominal cavity (e.g., abdominal distention, pain, vomiting) is called an **acute abdomen**.

Surgical Techniques

The abdomen generally is explored by means of a ventral midline incision from xyphoid to pubis. In most animals the entire abdomen, including the inguinal areas, and the caudal thorax should be prepared for aseptic surgery to allow extension of the incision into the thoracic or pelvic cavities if necessary.

Ventral Midline Celiotomy in Cats and Female Dogs

With the patient in dorsal recumbency, make a ventral midline skin incision beginning near the xiphoid process and extending caudally to the pubis. Sharply incise the subcutaneous tissues until the external fascia of the rectus abdominis muscle is exposed. Ligate or cauterize small subcutaneous bleeders and identify the linea alba. Tent the abdominal wall and make a sharp incision into the linea alba with a scalpel blade. Palpate the interior surface of the linea for adhesions. Use scissors to extend the incision cranially or caudally (or both) to near the extent of the skin incision. Digitally break down the attachments of one side of the falciform ligament to the body wall or excise it and remove it entirely if it interferes with visualization of cranial abdominal structures. Clamp the cranial end of the falciform ligament and ligate or cauterize bleeders before removing it.

Ventral Midline Celiotomy in Male Dogs

Patients undergoing exploratory laparotomy for abdominal trauma should have the prepuce and penis aseptically prepared for surgery and they should remain in the surgical field; particularly if lower urinary trauma is suspected. Make a ventral midline skin incision beginning at the xiphoid process and continuing caudally to the prepuce. Curve the incision to the left or right of the penis and prepuce and extend it to the level of the pubis. Incise the subcutaneous tissues and fibers of the preputialis muscle to the level of the rectus fascia in the same plane as the skin incision. Ligate or cauterize large branches of the caudal superficial epigastric artery and vein at the cranial aspect of the prepuce. Retract incised skin, prepuce and penis and subcutaneous tissues laterally to locate the linea alba and external fascia of the rectus abdominis muscle. Do not attempt to locate the caudal linea alba until subcutaneous tissues have been incised and the abdominal musculature fascia identified. Tent the abdominal wall and make a sharp incision into the linea alba with a scalpel blade. Palpate the interior surface of the linea for adhesions. Use scissors to extend the incision cranially or caudally (or both) to near the extent of the skin incision.

Abdominal Exploration

Systematically explore the entire abdomen. Various techniques may be used; however, every surgeon should develop a consistent pattern to ensure that the entire abdominal cavity and all structures are visualized and/or palpated in each animal.

Use moistened laparotomy sponges to protect tissues from drying during the procedure. If generalized infection is present or if diffuse intraoperative contamination has occurred, flush the abdomen with copious amounts of warmed, sterile saline solution with no additives (i.e., antiseptics or antibiotics). Remove the lavage fluid and blood and inspect the abdominal cavity before closure to ensure that all foreign material and surgical equipment have been removed. Perform a sponge count and compare it with the preoperative count to ensure that surgical sponges have not been left in the abdominal cavity.

Abdominal Wall Closure

The linea alba may be closed with a simple continuous (author's preference) or a simple interrupted suture pattern. The simple continuous technique does not increase the risk of dehiscence when properly performed (i.e., secure knots, appropriate suture material, adequate bites in the rectus sheath), and it allows for a rapid and more secure closure. Synthetic monofilament absorbable suture (Maxon, PDS) should be used for continuous suture patterns, and six to eight knots should be placed at each end of the incision line.

On each side of the incision, engage a 5 to 7 mm bite of white rectus sheath with each suture. Place sutures no further apart than 3 to 4 mm, depending on the animal's size. Tighten sutures sufficiently to appose but not enough to strangulate tissue, because sutures that strangulate tissue negatively affect wound healing. Incorporate full thickness bites of the abdominal wall in the sutures if the incision is midline (i.e., through the linea alba). If the incision is lateral to the linea alba and muscular tissue is exposed (i.e., paramedian incision), close the external rectus sheath without including muscle or peritoneum in the sutures. Close subcutaneous tissues with a simple continuous pattern of absorbable suture material and reappose the preputialis muscle fibers in the male dog. Use nonabsorbable sutures (simple interrupted or continuous appositional pattern) or stainless steel staples to close skin. Place skin sutures without tension.

Complications

Dehiscence (incisional hernias) may occur if improper surgical technique is used (see the above discussion). The most common cause of wound dehiscence in the early postoperative period results from the surgeon's inability to recognize the rectus sheath or not getting adequate bites in the rectus sheath. Bites should engage at least 5 to 7 mm or more depending upon patient size.

TRAUMATIC ABDOMINAL WALL HERNIAS

Definitions

External abdominal hernias are defects in the external wall of the abdomen that allow protrusion of abdominal contents; **internal abdominal hernias** are those that occur through a ring of tissue confined within the abdomen or thorax (i.e., diaphragmatic hernia, hiatal hernia). External abdominal hernias may involve the abdominal wall anywhere other than the umbilicus, inguinal ring, femoral canal, or scrotum.

Surgical Treatment

Patients that sustain a traumatic injury severe enough to cause an abdominal hernia or patients that sustain penetrating abdominal wounds (i.e., gunshot, bite wounds) should have a xyphoid to pubis abdominal exploratory laparotomy. All visceral structures should be carefully examined to signs of trauma (e.g., mesenteric rents, ruptured hollow viscous organs, avulsed kidney, ureteral damage). In addition, abdominal ceiliotomy approach facilitates abdominal hernia closure. Most abdominal hernias can be repaired by suturing torn muscle edges or apposing the disrupted abdominal wall edge to the pubis, ribs, or

adjacent fascia. In rare cases synthetic mesh must be used to repair the defect. Some hernias (i.e., intestinal strangulation, urinary obstruction, concurrent organ trauma) require emergency surgical correction. The extent of devitalized muscle may not be apparent initially, however, for patients in stable condition, delaying surgery until muscle damage can be accurately assessed facilitates surgical correction. The most common complications of surgery are hernia recurrence and wound infection. Abdominal hernias that occur secondary to bite wounds usually are contaminated; wound infection and dehiscence of the skin or hernial repair (or both) may occur. Mesh should not be placed in these hernias, hernial closure is performed during exploratory laparotomy, and the skin wounds should be left open to drain. Treatment of infected wounds includes cultures, drainage, antibiotics, and/or flushing.

Positioning

For ventral hernias the animal is placed in dorsal recumbency and the area around the hernia is prepared for aseptic surgery. Repair of ruptures of the cranial pubic ligament may be facilitated by placing the animal in dorsal recumbency with the rear limbs flexed and pulled cranially.

Surgical Techniques

Abdominal Hernias

For most abdominal hernias, perform a ventral midline abdominal incision to allow the entire abdomen to be explored. Assess the extent of visceral herniation. Reduce the herniated contents and amputate or excise necrotic or devitalized tissue around the hernia. Close the muscle layers of the hernia with simple interrupted or simple continuous sutures.

Cranial Pubic Ligament Hernias

Make a ventral midline skin incision and identify the ruptured tendon and its pubic insertion. Evaluate the inguinal rings and vascular lacuna; these hernias may extend into the femoral region as a result of rupture of the inguinal ligament. Reattach the free edge of the abdominal wall to the cranial pubic ligament with simple interrupted sutures. As an alternative, suture the tendon remnant to the muscle fascia and periosteum covering the pubis or anchor it to the pubis by drilling holes in the pubic bone through which sutures can be placed. If the hernia extends into the femoral region, it may be necessary to suture the body wall to the medial fascia of the adductor muscles. When doing so, take care to avoid damaging the femoral vessels or nerves.

Prognosis

The prognosis generally is good, and recurrence is uncommon. When recurrence occurs, it generally is noted within a few days of surgery. Most animals have excellent long-term results when appropriate techniques are used.

PERITONITIS

Definition

Primary generalized peritonitis refers to spontaneous inflammation of the peritoneum without any pre-existing intra-abdominal pathologic condition. **Secondary generalized peritonitis** occurs in conjunction with an intra-abdominal pathologic condition and may be further classified as infectious or noninfectious.

Surgical Treatment

Abdominocentesis (see below) is the percutaneous removal of fluid from the abdominal cavity, usually for diagnostic purposes, although it may occasionally be therapeutic. Indications include shock without apparent cause, undiagnosed disease with signs involving the abdominal cavity, suspicion of postoperative gastrointestinal dehiscence, blunt or penetrating abdominal injuries (i.e., gunshot wounds, dog bites, vehicular injury), and undiagnosed abdominal pain. A multifenestrated catheter should be used to enhance fluid

collection. Physical and radiographic examinations should precede abdominocentesis to rule out instances in which it may not be safe and to guide needle placement. Four-quadrant paracentesis may be performed if simple abdominocentesis is not successful in retrieving fluid. It is similar to simple abdominocentesis except that multiple abdominal sites are assessed by dividing the abdomen into four quadrants through the umbilicus and tapping each of these four areas. Diagnostic peritoneal lavage should be performed in animals suspected of having peritonitis if the above methods are unsuccessful in obtaining fluid for analysis.

Exploratory surgery is indicated when the cause of peritonitis cannot be determined or when bowel rupture, intestinal obstruction (e.g., bowel incarceration, neoplasia), or mesenteric avulsion is suspected. Serosal patching and plication reduce the incidence of intestinal leakage, dehiscence, or repeated intussusception. Animals that require surgery and that have peritonitis secondary to intestinal trauma (disruption of mesenteric blood supply, bowel perforation, chronic intussusception, foreign body) often are hypoproteinemic. The role that protein levels play in healing intestinal incisions is not well understood. However, most surgeons are concerned that hypoproteinemic patients may not heal as quickly as patients with normal protein levels, despite one study that showed similar complication rates among animals with normal protein levels and those that were hypoproteinemic and undergoing intestinal surgery. Most experimental evidence has shown that retardation of wound healing is not seen with moderate protein depletion but only with severe deficiencies (<1.5 to 2 g/dL).

Although the practice of lavaging the abdominal cavity of animals with peritonitis is controversial, lavage generally is indicated with diffuse peritonitis. Lavage should be done with care in animals with localized peritonitis to avoid dissemination of infection. When lavage is performed, as much of the fluid as possible should be removed because fluid inhibits the body's ability to fight off infection, probably by inhibiting neutrophil function. Historically, many different agents have been added to lavage fluids, especially antiseptics and antibiotics. Povidone-iodine is the most widely added antiseptic; however, its use may be contraindicated with established peritonitis. Furthermore, no beneficial effect of this agent has been shown in repeated experimental and clinical trials in animals. Although a great many antibiotics have been added to lavage fluids over the years, there is no substantial evidence that their addition is of any benefit to patients who are being treated with appropriate systemic antibiotics. Warmed sterile physiologic saline is the most appropriate lavage fluid.

Open abdominal drainage (OAD) is a useful technique for managing animals with peritonitis. Reported advantages include improvement in the patient's metabolic condition secondary to improved drainage, less formation of abdominal adhesions and abscesses, and access for repeated inspection and exploration of the abdomen. With this technique the abdomen is left open and sterile wraps are placed around the wound. The frequency of wrap changes depends on the amount of fluid drained and the amount of external soiling. Complications of open abdominal drainage include persistent fluid loss, hypoalbuminemia, weight loss, adhesion of abdominal viscera to the bandage, and contamination of the peritoneal cavity with cutaneous organisms.

There is evidence to suggest the use of Jackson Pratt drains are an efficient means of draining the peritoneal cavity for 2 to 4 days postoperatively. This technique allows the surgeon to perform a primary abdominal closure yet still provide abdominal drainage.

Positioning

For abdominocentesis and diagnostic lavage, the abdomen should be clipped and prepared aseptically. These procedures may be performed with the animal in lateral recumbency or standing.

Abdominocentesis

Insert an 18- or 20-gauge, 1½-inch plastic over-the-needle catheter (with added side holes) into the abdominal cavity at the most dependent part of the abdomen. Do not attach a syringe; instead allow the fluid to drip from the needle and collect in a sterile tube. If sufficient fluid is obtained, place it in a clot tube and an ethylenediamine tetraacetic acid (EDTA) tube, submit samples for aerobic and anaerobic culture, and make four to six smears for analysis. If fluid is not obtained, apply gentle suction using a 3-mL syringe.

It is difficult to puncture bowel by this method because mobile loops of bowel move away from the tip of the needle as it strikes them. Perforations created by a needle this size usually heal without complications. The major disadvantage of needle paracentesis is that it is insensitive to the presence of the small volumes of intraperitoneal fluid and thus a negative result can be meaningless. At least 5 to 6 mL of fluid per kilogram of body weight must be present in the abdominal cavity of dogs to obtain positive results in most cases using this technique.

Diagnostic Peritoneal Lavage

Make a 2-cm skin incision just caudal to the umbilicus and ligate any bleeders to avoid false-positive results. Spread loose subcutaneous tissues and make a small incision in the linea alba. Hold the edges of the incision with forceps while the peritoneal lavage catheter (Stylocath) without the trocar is inserted into the abdominal cavity. Direct the catheter caudally into the pelvis. With the catheter in place, apply gentle suction. If blood or fluid cannot be aspirated, connect the catheter to a bottle of warm sterile saline and infuse 20 mL/kg of fluid into the abdominal cavity. When the calculated volume of fluid has been delivered, roll the patient gently from side to side, place the bottle on the floor, vent it, and collect the fluid by gravity drainage. Do not be surprised if you do not retrieve all of the fluid, particularly in dehydrated animals.

Exploratory Laparotomy

Perform a ventral midline incision from the xiphoid process to the pubis. Obtain a sample of fluid for culture and analysis. Explore and inspect the entire abdomen. Find the source of infection and correct it. Break down adhesions that may hinder drainage. Lavage the abdomen with copious amounts of warm, sterile saline if the infection is generalized. Remove as much necrotic debris and fluid as possible. Close the abdomen routinely, place an abdominal drain, or perform open abdominal drainage.

Prognosis

The prognosis for animals with generalized peritonitis is guarded; however, with proper and aggressive therapy, many survive. Some authors have suggested that the mortality rate approaches 50%. The mortality rates reported in animals with generalized peritonitis treated with open abdominal drainage have varied from 20% to 48%.