Recognizing and Treating Ruptured Abdominal Organs

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The abdomen, its muscular wall, and the organs within it are prone to rupture as a result of trauma. Such rupture may then require surgical intervention. If part of the gastrointestinal tract is ruptured, it is best to perform the surgical intervention as soon as possible. However, if the rupture involves the abdominal wall or even a solid organ (e.g., the liver, spleen, or kidney) and is not causing life-threatening hemorrhage or entrapping other organs, delayed repair may be best, if repair is required at all.

In trauma cases, the order in which diagnostic and treatment activities should be performed depends on the *point in time*—i.e., how long ago the injury occurred. Also, it is sometimes necessary to deviate from ordinary routines to stabilize the patient.

Most animals presented for treatment after major trauma (e.g., after being hit by a car) have sustained some trauma to the abdomen. The veterinarian must decide whether the injury requires surgical intervention or whether it will require such intervention in the future. If so, when? Therefore the question of not only *whether* but *when* to perform surgery becomes critical in decision making in emergency medicine.

Most traumatized animals do not require abdominal exploration, but those that do should be considered high-risk patients. The clinician must decide whether exploratory laparotomy should be performed. To be effective, this decision-making process must be repeated at regular intervals as well as after the addition of each new piece of information. To be successful in emergency medicine, clinicians must be able to second-guess themselves and willing to change their minds if new data, or findings, are revealed.

Emergency treatment of trauma patients is dynamic, and clinicians have a critical responsibility to *be observant* and to use their observations in making decisions. Of course, diagnostic technology has advanced dramatically in recent years and sophisticated equipment has become increasingly available to small animal practitioners. Nevertheless, the observation of changes, not only in the laboratory data and radiologic images but also in the patient, remains of utmost importance. Heart rate, the color and refill of the mucous membranes, pain responses, alertness, amount of blood lost, and similar signs all need to be noted and used in making and reevaluating treatment decisions.

DIAGNOSTIC APPROACH

In cases of rupture of abdominal organs, the history can lead the clinician to the diagnosis and to recommendations for definitive treatment. Some basic questions can yield answers that reveal abdominal injuries, so little if any further diagnostic workup is necessary. Did you see the animal shot? How long was the knife? How high was the window from which the animal fell? Answers to questions focused on the injury are often very revealing.

The physical examination in cases of ruptured abdominal organs can be dramatic and lead to easy diagnosis, or it can be subtle. Abdominal trauma that causes organ rupture often involves multiple injuries. It may be necessary to clip the animal's haircoat to determine the full extent of the bruising, number of bite wounds, and the entrance and exit wounds of projectiles.

When palpating the abdomen for abnormalities, the veterinarian should also palpate the adjacent bones, including a rectal examination for pelvic fractures. If the trauma was severe enough to fracture the pelvis, the veterinarian should suspect major abdominal trauma.

Early in the evaluation of a trauma patient, the veterinarian should take blood samples for a complete blood count and routine chemistry panel. Not only do these tests enable the veterinarian to evaluate the major organs as well as the vascular system, the results of the initial tests can serve as a baseline for monitoring the patient's progress.

In cases of abdominal trauma, radiology is important. The thorax as well as the abdomen should be examined radiographically in these cases. Trauma severe enough to rupture abdominal organs is often associated with multiple injuries, including thoracic disease as well as fractures. Such radiographic find-

ings as free gas or fluid in the abdominal cavity, intestinal ileus, or lack of organ detail can help the veterinarian diagnose rupture of abdominal organs. Contrast studies of the gastrointestinal and especially the urinary tract can be invaluable as the case progresses.

Abdominal centesis, which involves tapping the abdomen with a needle in one or more quadrants, can be diagnostic, especially if bile, urine, intestinal contents, or free-flowing blood is removed. However, a negative abdominal aspirate does not rule out rupture of an abdominal organ.

The value of diagnostic peritoneal lavage has been well documented in the veterinary literature. If something in the history, physical examination, radiographic findings, and/or the progress of the patient suggests rupture of an abdominal organ but no rupture has yet been documented, then peritoneal lavage is an appropriate next step in the diagnostic evaluation. Diagnostic peritoneal lavage is best suited to finding fluids and small particles leaking from the gastrointestinal tract, biliary system, and the genitourinary tract. The fluid that is removed should be thoroughly tested.

Abdominal exploration is no substitute for an appropriate medical workup, but it is a valuable diagnostic and therapeutic option in cases of abdominal or intraabdominal rupture. The experiences of medical surgeons during wartime have led to the recommendation to explore the abdomen as soon as is reasonably possible in specific cases, such as penetrating wounds of the abdomen (whether from dog bites or bullet wounds), abdominal hernias with entrapped viscera, pneumoperitoneum not associated with external wounds, persistent severe abdominal pain, persistent hemorrhage, and peritonitis.

Abdominal exploration implies that the entire abdomen is explored. Trauma cases, in which multiple injuries to multiple systems are expected, require an incision enabling full exploration. The surgeon should take a well-organized approach to examining the abdomen and its contents—examining both by region and by organ system.

RUPTURED ORGANS

Spleen

The spleen, which is the most commonly ruptured organ requiring abdominal surgery, is often traumatized in dogs and cats but requires surgical intervention more often in dogs. If the animal can be stabilized despite abdominal bleeding that is caused by splenic trauma, then emergency abdominal surgery is not indicated. Exploration of the abdomen often demonstrates splenic tissue that had been torn in half or otherwise separated but has healed and is apparently functioning well.

Abdominal bleeding that cannot be controlled needs to be explored whether associated with trauma or not. Abdominal bleeding that is not associated with trauma is often associated with splenic tumor. In these cases, radiographs of the thorax and abdomen should be taken before surgery. If the thorax is full of metastatic lesions, then surgery is usually inadvisable. Ultrasonography is also valuable for evaluating the spleen and the liver before surgery if abdominal hemorrhage is believed to be associated with splenic tumor. Large ruptured splenic masses are often benign. A liver biopsy is recommended if the spleen is removed because of a tumor.

During splenectomy, the surgeon should always take care to protect the blood supply to the wall of the greater curvature of the stomach. This blood supply is provided by the short gastric arteries and veins and by vasculature shared with the pancreas.

Liver

Liver trauma is common, and small hepatic ruptures usually seal on their own. However, a liver rupture found during abdominal exploration can be supported with an omental covering. In cases of severe crush injury of the hepatic parenchyma, the damaged tissue must be removed. Surgery of the liver lobes always looks rough because the parenchyma is best managed by crushing the tissue along the line to be resected, isolating and ligating the vessels serving the tissue, and finally covering the raw, roughened remaining edge with omentum. If the damage to the liver is extensive, then local peritonitis should be anticipated and drainage to the outside established.

Biliary System

The gallbladder and the associated biliary drainage are seldom acutely ruptured except in cases of gunshot wounds. Bullets entering the abdomen are often funneled into the gallbladder. The biliary tree is most susceptible to crush-type injury, which does not result in bile leakage until the damaged tissue becomes necrotic. Thus the rupture may occur as long as a week after the initial trauma.

Whether the surgeon should remove a damaged gallbladder in trauma cases is always a dilemma. If the common bile duct is damaged, it is better to ligate the common duct (whose repair is associated with a high degree of failure) and use even a damaged gallbladder to direct the bile into the intestine (a cholecystoduodenostomy or cholecystojejunostemy). If the biliary tree is intact and viable, then the safest decision is to remove the gallbladder.

Pancreas

In cases of pancreatic rupture, pancreatic tissue that is avulsed from its vascular and ductal attachments should be removed. If possible, the central pancreatic duct of the remaining tissue should be ligated.

The right limb of the pancreas shares its blood supply with the descending duodenum. If the right limb is damaged, it is best to ligate the pancreatic ducts of the damaged tissue and drain the area to the outside with Penrose drains to help control the local peritonitis. Removal of the right limb is difficult and may devascularize the descending duodenum. Ligation of the pancreatic ducts will cause the ligated exocrine portion of the pancreas to atrophy.

Stomach

The stomach is seldom ruptured by direct abdominal trauma. However, it may rupture as a result of gastric torsion and gastric ulcers. In cases of stomach rupture, wide resection to healthy tissue is recommended. In cases of ruptured ulcer, biopsy of the gastric wall should always be performed.

When deciding where the stomach tissue is healthy, especially in cases of gastric torsion, the surgeon should assess the color of the serosal surface, not the mucosal surface. If the color of the serosal surface is improving and is warm to the touch, then it is viable. If the decision of where to resect the stomach is based on the mucosal surface, then too much of the stomach wall is removed. The stomach has an excellent blood supply, heals rapidly, and accommodates reduced capacity well.

Bowel

Rupture of the small intestine can result from external trauma (e.g., dog bites, bullet wounds, or evisceration) or from intestinal trauma associated with ingested foreign material (especially linear foreign bodies). If a short segment of small intestine is severely damaged, then resection and anastomosis is best. If an extensive length of small intestine is damaged, then the surgeon should attempt salvage by closing the ruptured wounds without debridement of damaged tissue edges, unless they are necrotic. Intestinal rupture is usually closed with synthetic absorbable suture material in a simple interrupted or continuous suture pattern. Using the omentum and the healthy serosal surface of associated intestine is helpful in attempting to ensure the formation of a good fibrin seal.

Colonic rupture, although rare, is often associated with a sharp fragment of fractured pelvis penetrating the distal colon. A colon puncture is best closed with a mattress suture pattern placed wide to the damaged wound edges. The sharp, contaminated fracture fragments are removed, and the abdominal soft tissues are protected from further damage by the pelvic fractures. The area is then drained to the outside.

Kidney and Ureter

Genitourinary ruptures present some different problems. Because of the kidney's retroperitoneal location under the lumbar vertebrae and its solid parenchyma surrounded with a firm capsule, the kidney is more likely to be crushed than ruptured, except in cases of gunshot wounds. Any renal capsular rupture can cause extensive retroperitoneal hemorrhage, which is difficult to diagnose but is usually self-limiting if the animal is treated for hypovolemia. Minor capsular tears are associated with severe bruising of the renal parenchyma but do not usually require nephrectomy. Severe deep, multiple fractures and punctures of the kidney are best treated with nephrectomy.

Kidneys are sometimes stripped out of their peritoneal beds and are found in the abdomen tethered to their vascular and ureteral attachments. Such kidneys should be repositioned and secured in their normal lumbar beds. When positioning the kidney, care should be taken to ensure that the vascular and urethral conduits are not twisted. Kidneys that have been totally avulsed from their vascular attachments seldom survive. If an avulsed kidney is found during exploration, it should be removed and its vascular stumps located and ligated.

If a ureter is avulsed at or near its attachment to the kidney, repair is difficult and often fails. If the other kidney is healthy, then nephrectomy should be considered. If the ureter is avulsed near its attachment to the bladder, then it should be reimplanted in the bladder and the distal ureteral stump ligated. The wall of the ureter can also be ruptured in association with blockage by a calculus, but it is seldom lacerated in association with trauma. If the integrity of the ureteral walls is interrupted, the associated calculi should be removed and the edges of the walls closed with fine-diameter absorbable suture material. A stent catheter in the ureter and exiting the urethra is recommended for 3 to 5 days after surgery.

Bladder and Urethra

Bladder ruptures are always of concern and sometimes pose a diagnostic challenge. Ruptures of the bladder and other portions of the urinary conduit need not be repaired with the same haste with which rupture of the gastrointestinal tract is approached. In cases of gastrointestinal rupture, rapid closure of the leaking area and decontamination of the abdomen are

critical. Urine in the abdomen is irritating and is deadly if allowed to accumulate over an extended period; if it is allowed to drain from the abdomen, however, the trauma patient can be fully stabilized before repair is initiated, thus also permitting more accurate diagnostic evaluation.

Diagnostic evaluation can often be accomplished by placing a urinary catheter through the urethra into the ruptured bladder and even on into the abdominal cavity. This catheter can initially be used to help diagnose the rupture with contrast materials and to collect fluid for laboratory analysis. The laboratory values of the fluid are compared with serum values. If a urethral catheter cannot be placed, then a caudal abdominal drain or drains can be placed to keep the urine draining to the outside. This gives the bladder tissue time to stabilize before surgical manipulation and decreases the difficulty of the repair.

The bladder and the urethra are both notorious for delayed rupture, most often associated with crushing pelvic fractures. As with injury to the biliary tree, the tissue can be crushed and rendered avascular but the conduit may remain intact for 3 or 4 days—until tissue necrosis results in leakage. To repair injury to the bladder or urethra, the surgeon must debride the necrotic tissue and approximate the healthy tissue. Absorbable suture material is used for repair of the bladder or urethra.

It is also possible for the bladder wall to be partially ruptured, causing it to bulge outward. This usually happens in the dome portion of the fundus near the diverticulum. If abdominal exploration or cystographic contrast studies reveal a partial rupture of the bladder wall, the surgeon should resect the damaged portion and reestablish the integrity of the bladder walls.

Urethral avulsion associated with abdominal trauma produces signs reminiscent of bladder rupture. Radiographic contrast studies are often required to confirm the presence of urethral avulsion and rule out bladder rupture. If the rupture occurs within the pelvic canal, the urine leakage usually travels caudally, draining into the distal perineum and caudal abdomen, causing extensive bruising and edema. Once again, if the urine can be directed from the bladder to the outside, the damaged urethral tissue is given time to stabilize, affording healthier tissue that is more suitable for the eventual surgical repair. The perineal and caudal ventral abdominal area where the urine has accumulated should be drained by multiple small incisions through the skin into the subcutaneous fatty tissue.

Urethral ruptures at or near the junction with the bladder usually drain urine into the abdomen. This rupture is often seen in castrated male dogs and occurs through the area of the atrophied prostate. All urethral ruptures should be closed over a urinary catheter that should remain in place for 3 to 5 days or until the animal is urinating around the catheter. It is important to visualize the white mucosal lining of the urethra to ensure that the sutures used to anastomose the urethral rupture penetrate the entire urethral wall. Absorbable sutures are recommended for the urethral repair.

Abdominal Wall

If a traumatic abdominal hernia has occurred and no other abdominal cavity trauma requires immediate surgery, then it is best to delay closure until the inflammation to the muscular wall tissue has stabilized—often within 5 to 10 days. If the patient with an abdominal hernia requires abdominal exploration for rupture of an organ, then closure should be attempted by approximating the tissue to restore function but not by accurate restoration if the tissue is too damaged to hold sutures.

SUPPORTIVE CARE

Peritonitis

In general, if local peritonitis is present or peritonitis is expected after surgery, the abdomen should be drained to the outside. This is usually accomplished with Penrose drains. General peritonitis that is caused by blood or urine can often be cleared sufficiently to permit abdominal closure if the peritoneum is flushed repeatedly. In contrast, septic or caustic peritonitis is treated by leaving a portion of the ventral abdominal incision open to permit continued drainage of the material and the associated peritoneal exudate. The open area of the abdominal incision is covered with sterile absorbent materials and changed as often as is required to prevent further contamination. The abdominal wall is closed as soon as the drainage of the abdominal fluids is clearing and reduced in volume.

Nutritional Support

In emergency medicine, and especially in the management of severe trauma, the clinician must grapple with immediately life-threatening problems. Thus it is often easy to put off thinking about the patient's eventual need for nutritional support. Nevertheless, nutritional support is important, perhaps essential, in the care of critically ill patients.

If the animal has sustained an injury severe enough to rupture an abdominal organ, it may have a combination of other problems that will cause extended debilitation and may necessitate further surgery. Before completing an emergency abdominal procedure, the surgeon should address what kind of support the pa-

tient may need in the immediate future. If the patient will need a gastric or intestinal feeding tube, the tube should be placed while the animal is still anesthetized. If the animal will require parenteral nutritional support, the appropriate catheter can be placed at the conclusion of the abdominal surgery.

CONCLUSION

Things happen quickly in emergency medicine, and it is important for each hospital or veterinarian who treats emergency cases to develop a plan for approaching the management of these cases. Advance preparation can help the clinician make decisions that are based on the best data that can be gathered and to take action to guide these cases to a successful conclusion. The decision-making process in emergency medicine involves three steps: plan, decide, and then act. Clear thinking and good decisions are particularly important in managing the serious, multiple injuries associated with rupture of abdominal organs.