Proceedings of the
European Veterinary Conference
Voorjaarsdagen

Amsterdam, the Netherlands
Apr. 23-25, 2009

Next Meeting:

Reprinted in IVIS with the permission of the Conference Organizers
http://www.ivis.org
Pericardial effusion (PE) is the most common pericardial disease in the dog but an uncommon cardiovascular disease. The etiology in 90% is neoplasia or idiopathic PE. PE occurs primarily in older large breed dogs. There seems to be a breed predisposition for Golden Retriever, German Shepherd dogs and St. Bernhard with Golden Retrievers over-represented in dogs with idiopathic PE. PE causes cardiac tamponade with decreased ventricular filling and cardiac output which can lead to right heart failure and cardiogenic shock. The diagnosis can be established with the help of clinical signs, physical examination, radiology, electrocardiography and echocardiography, considered as the “gold standard”. The first therapy is pericardiocentesis. The diagnostic value of pericardial fluid examination is limited. Cytology of the fluid can not distinguish between idiopathic and most neoplastic, but in cases of infectious pericarditis or lymphosarcoma it can be diagnostic.

Surgery

In cases of idiopathic PE pericardiocentesis can be the only treatment in 33–50% of affected dogs but in malignant effusion relapse can be expected in 100%. In case of relapse surgical management with subtotal or partial pericardectomy is advised. Pericardiectomy is considered to be curative in recurrent idiopathic PE and to be palliative in malignant PE. Thoracotomy is the conventional method of performing this procedure, which is associated with marked morbidity and mortality combined with prolonged hospitalization. Recently less invasive procedures as percutaneous balloon pericardiectomy or thoracoscopic partial pericardectomy has been described. Percutaneous balloon pericardiectomy is effective but less investigations are done, the procedure needs fluoroscopic guidance and no biopsy is collected. Thoracoscopic partial pericardiectomy offers the advantage of a minimal invasive surgical treatment with examination of the thorax, performing the pericardiectomy and gaining biopsy material.

Thoracoscopic partial pericardiectomy can be done with lateral approach and exclusion of the ipsilateral lung, but this includes a risk for shunting, reduced gas exchange and is not recommended in compromised animals. In the technique described here the procedure can be performed in dorsal recumbency without lung exclusion but mechanically ventilated. The first trocar has to be inserted transdiaphragmal parapyphoid on the left side. The trocar stays open to create an controlled open pneumothorax. After thoracoscopic control 2 separate instrumental portals at each side of the chest were introduced after determination of the optimal position. The pericardial sac has to be held with an endograsper and can be opened with an endoscissors. A window from about 4x5 cm should be cut out of the pericard using the endoscissors or bipolar cauterization. The piece of pericardium was should be removed through one of the instrumental portals. If only this procedure was done without damaging the lungs a chest tube is not necessary. Closure of the portal insertions should be performed in a routine manner. The thorax has to be evacuated by thoracocentesis until negative pressure is obtained.

Thoracoscopic pericardiectomy with transdiaphragmatic parapyphoid approach offers several advantages over pericardiectomy by thoracotomy including less postoperative pain, morbidity and mortality, faster recovery, shorter hospitalization length and improved cosmetic appearance. It can be performed without pulmonary exclusion and the associated risks.

References


**Management of Gastrointestinal Obstruction**
Catriona M. MacPhail, DVM, PhD, Diplomate ACVS
Colorado State University, Fort Collins, Colorado, USA
cmacphai@colostate.edu

**Gastrotomy**
Gastrotomy is a common procedure most often performed for removal of gastric foreign bodies. The procedure is facilitated with the placement of stay sutures at each end of the proposed incision. The body of the stomach is opened with a stab incision into the lumen in a relatively avascular area between the greater and lesser curvatures. The incision is continued with Metzenbaum scissors to create an opening large enough to remove the foreign material. Synthetic absorbable monofilament suture with a swaged-on taper needle is the material of choice for most gastrointestinal surgery. Regardless of the suture pattern, the common theme for all gastrointestinal surgery is inclusion of the submucosal layer in the closure. Full-thickness purchase of the tissue ensures that this holding layer is incorporated in the suture line. Specific options for gastrotomy closure include: two-layer continuous inverting pattern (Cushing followed by Lembert), single-layer simple interrupted pattern, or single-layer simple continuous pattern. For simple gastrotomy, the author prefers a single-layer simple continuous pattern with 3-0 monofilament absorbable suture. A two-layer pattern may be more appropriate if performing a partial gastrectomy or if there is a concern regarding tissue viability.

**Enterotomy / Enterectomy**
Although there are several significant differences in the healing properties of the small and large intestine, the same suturing principles apply regardless of the location of the foreign body within the gastrointestinal tract. Gentle tissue handling, adequate tissue purchase, use of appropriate suture material, and proper suture placement will ensure a secure closure. Luminal compromise is not usually an issue with simple enterotomies, however some surgeons prefer to routinely close longitudinal incisions transversely to avoid this problem altogether. Inverting patterns have been proposed to minimize mucosal eversion and the formation of adhesions. However, since adhesions are an infrequent problem in small animals and since luminal diameter would be decreased by inverting the tissue, this technique is not recommended. Options for simple enterotomy closure include: single-layer simple interrupted approximating pattern or single-layer simple continuous approximating pattern.[i] End-to-end intestinal anastomosis is most commonly performed following removal of nonviable tissue (enterectomy). Intestinal viability is based on assessment of subjective parameters such as color, thickness, arterial pulsation, capillary bleeding, and peristalsis. As with enterotomy closure, single-layer approximating patterns are preferred. Simple continuous patterns are faster and use less suture material, which is not only economical, but also decreases the amount of foreign material in the abdominal cavity.[ii] Tissue apposition is also thought to be better. The concern about creating a purse-string effect with a continuous pattern can be avoided if a modified simple continuous pattern is performed. In this technique, two suture lines are used, one originating at the mesenteric border and the other originating at the antimesenteric border. Good visualization of the mesenteric knot is imperative as this is the most common site for leakage. A single-layer full thickness continuous suture line is placed from the mesenteric knot to the stay suture at the antimesenteric knot with tissue purchases 2mm from the wound edge and 2 to 3 mm apart. This is repeated on the other side from the antimesenteric knot to the mesenteric knot. There is no difference in reported rates of dehiscence between animals with simple continuous anastomotic closures and animals with simple interrupted closures.

**Clinical Examples of gastrointestinal Obstruction**

**Foreign Bodies**
Focal gastrointestinal obstruction following ingestion of unusual items is common, particularly in young dogs and cats. Animals typically present with acute and protracted vomiting, and can be clinically dehydrated with severe electrolyte imbalances. Abdominal palpation is usually painful and on occasion the foreign object can be felt. Common locations for focal foreign bodies to become lodged include pylorus, caudal duodenal flexure, and ileocolic junction. Diagnosis is made from abdominal radiographs, which may show the foreign material if it is radiodense. Otherwise, obstruction is suspected based on the dilation of obstructed intestinal loops with air or fluid. Repeated abdominal radiographs, contrast studies, or ultrasonography may be necessary if the diagnosis is not apparent from the initial radiographic study. Gastrointestinal obstruction with linear material is a unique situation most commonly associated with cats. Foreign bodies such as string, thread, or cloth are ingested and become anchored typically at the base of...
the tongue or at the pylorus. Peristalsis advances the foreign body into the intestine. However, as a result of the anchor, the intestine will gather around the foreign body. This plication of the intestines may cause a complete or, more often, partial obstruction. Intestinal peristalsis continues against the fixed material and may lacerate the mucosa and cause perforations along the mesenteric border.

Abdominal palpation is frequently painful and may reveal a large mass of bundled intestines. Occasionally, careful oral examination may reveal the foreign material anchored around the base of the tongue. On abdominal radiographs, the appearance of 3 or more small, eccentrically located, luminal gas bubbles tapered at one or both ends was diagnostic for linear foreign body in one study.2 If the diagnosis is still uncertain, other imaging techniques such as upper gastrointestinal contrast studies or abdominal ultrasonography may be required. Ultrasonographic appearance of a linear foreign body is described as a central hyperechoic line with intestine plicated on either side. Contrast agents should be administered with caution as it has been reported that 16% of cats had intestinal perforation found at surgery.

Linear foreign bodies are considered surgical emergencies. Conservative management of linear foreign bodies has been reported. However, in that study 42% of cats that were initially managed medically ultimately went to surgery.3 Given that perforated intestine from the linear foreign body carries a 50% mortality rate, early surgical intervention is the treatment of choice.4 Multiple enterotomies are typically required for removal of linear foreign bodies. This allows for segmental removal of the material and minimizes the risk of iatrogenic perforation from too much traction. Depending on the extent of damage, intestinal resection and anastomosis may be indicated. Due to the mesenteric fat, perforations along the mesenteric border can be difficult to identify and to suture appropriately. This is the most common site for dehiscence following intestinal resection and anastomosis. In this scenario, resection and anastomosis may be preferable to primary closure of the site in the mesenteric border of the intestine. If peritonitis is present or if the sutured intestine is of questionable viability, omentization or serosal patching can be used to reinforce the site.

**Intussusception**

Gastrointestinal obstruction due to intussusception is an uncommon, but notable condition in the dog and cat. Intussusception occurs when a segment of intestine (intussusceptum) moves into the lumen of an adjoining segment (intussuscipiens). Intussusception has been reported at all levels of the gastrointestinal tract with ileocolic intussusceptions being most common. Causes have been attributed to intestinal parasitism, linear foreign bodies, previous abdominal surgery, and gastroenteritis, although often the cause is unknown. Diagnostic imaging is mostly used to confirm what is already suspected from abdominal palpation. The characteristic ultrasonographic appearance of an intussusception is a multilayered target-like image in the transverse plane and alternating hyperechoic and hypoechoic parallel lines in the longitudinal plane.

Surgical intervention is the treatment of choice for intussusception. At surgery, manual reduction of the intussusception should be gently attempted, but it is often not successful. If reduced, the involved intestine (or intussusceptum) is evaluated for perforations and viability. Intestinal resection and anastomosis is indicated when manual reduction fails or if the reduced tissue is devitalized. The resected segment should be submitted for histopathological evaluation to potentially identify the cause of the intussusception. Enteroplication (or enteroenteropexy) is recommended to prevent recurrence; however, complications may result from this procedure as well, so this procedure remains controversial.

Both intussusception recurrence and severe postoperative complications associated with enteroplication have been reported in the dog and cat.5,6

**Gastrointestinal Neoplasia**

Gastrointestinal tumors most commonly arise in the intestinal tract, with gastric and esophageal tumors occurring less frequently. Canine small intestinal malignant tumors include lymphoma, adenocarcinoma, and leiomyosarcoma, which all occur most frequently in the jejunum. The most common feline small intestinal neoplasms are adenocarcinoma and lymphoma.

Obstruction occurs more frequently with adenocarcinoma due to the annular ring of tissue that is formed by the tumor. Siamese cats are overrepresented accounting for 71% of all feline cases, but many canine breeds can be affected. Intestinal lymphoma can be either discrete or diffuse and the cats may be either FeLV positive or negative.

It is preferential to try to determine the kind of intestinal tumor before taking the dog or cat to surgery. Unless causing an obstruction, intestinal lymphoma is primarily treated with chemotherapy, not surgical excision. Abdominal ultrasound is an excellent diagnostic tool in this situation as the characteristics of the intesti-
n al mass can be determined, mesenteric lymph nodes can be evaluated, and fine-needle aspirates of the mass and lymph node can be performed. Cytology is fairly reliable for definitive diagnosis of lymphoma, however it is inconsistent for adenocarcinoma. Complete surgical resection is the treatment of choice for intestinal adenocarcinoma. Margins of 4 to 8 cm from each end of the mass are recommended. Metastatic surgical technique as well as reinforcement of surgical sites with omentum or serosal patching is essential, as wound healing may be delayed in these animals. The reasons for poor wound healing include microscopic disease at surgical margin, hypoproteinemia, cachexia, or general debilitation. If the mass is located in the colon, subtotal colectomy may be required for complete excision. Distal lesions may require pelvic osteotomy or a rectal pull-through technique for access. Wide surgical margins are felt to be essential in long-term control of colonic adenocarcinoma. Reported guidelines recommend 2.5 to 5.0 cm margins away from each end of the mass. The effect of adjunctive chemotherapy following surgical excision of intestinal adenocarcinoma is debatable. Diffuse gastrointestinal lymphoma is traditionally treated with chemotherapy alone, but solitary obstructive lesions require surgical resection. A full exploration of the abdominal cavity should be performed to look for evidence of metastasis, with particular attention to the omentum, mesenteric lymph nodes, and liver. Even without gross evidence of disease, routine biopsy of the liver and lymph nodes is ideal to document absence of microscopic metastasis. Identification of metastasis at the time of surgery is known to be a poor prognostic indicator of survival for both small and large intestinal neoplasia. Even with metastasis, surgical resection of the primary intestinal tumor may still be indicated as a palliative option to resolve the obstruction. Prognosis for intestinal neoplasia may depend on several factors: evidence of metastasis, histologic type and grade, and presence of neoplasia at surgical margins. A wide range of survival times for cats has been reported, with some cats with metastasis living many months. Following resection of small intestinal adenocarcinoma, dogs have been reported to have a median survival of 10 months. Canine leiomyosarcomas have a median survival over 1 year. Diffuse intestinal lymphoma has a worse prognosis than solitary lesions that can be resected.

References


GASTRIC DILATATION VOLVULUS SYNDROME
Catriona M. MacPhail, DVM, PhD, Diplomate ACVS Colorado State University, Fort Collins, Colorado, USA cmacphai@colostate.edu

Introduction
There is a wide spectrum of presentation of dogs with gastric dilatation volvulus syndrome (GDV). Astute and educated owners may pick up on subtle clinical signs such as mild abdominal distension and increased salivation. However, often the dog is not brought in until more overt signs are present. Diagnosis and emergency treatment of GDV are often performed based off of a high index of suspicion from signalment, presentation, and physical examination findings (i.e. a large or giant deep-chested dog with high anxiety and restlessness, non-productive retching and hypersalivation, signs of cardiovascular compromise, and abdominal distension or tympany).

Before the Surgery
To stabilize the animal, circulatory support is crucial. This is commonly initiated before attempts at gastric decompression. Crystalloid fluid therapy (90ml/kg) is instituted initially with baseline parameters checked after every quarter-dose. These parameters include heart rate, pulse quality, capillary refill time, packed cell volume, and total protein. Gastric decompression can be achieved through oro-gastric intubation or gastric trocharization. For orogastric intubation, a large bore gastric tube is selected and a length is measured from the dog’s nose to the last rib. A roll of 2” tape is placed in the dog’s mouth and the tube is gently passed through the tape roll and into the dog’s esophagus. Passage is facilitated by using a small amount of lubricant on the end of the tube. Changing the position of the dog can often help get the tube through the cardia into the stomach. Once in the stomach, the other end of the tube should be submerged in
Reprinted in IVIS with the permission of the Organizers

In anticipation of surgery, a minimum database should be performed. There are no classic findings on complete blood count and biochemical profile for dogs with GDV, but a stress leukogram, mildly elevated liver enzymes, and altered serum electrolytes are not uncommon findings. An activated clotting time could be performed prior to surgery as a baseline and to screen for possible DIC. More complete evaluation of clotting may be indicated in dogs that are unstable, have platelet counts less than 100,000, or have evidence of petechiae or ecchymosis. Serum lactate concentration has been evaluated as a preoperative predictor of mortality. Lactate levels > 6.0mmol/L have been associated with gastric necrosis and an increased mortality rate.

Diagnostic Imaging and ECG
Abdominal radiographs can be used to definitively diagnose GDV, but are often unnecessary. The decision to go to surgery is typically made based on a presumptive diagnosis from presentation and physical examination findings. If available, a preoperative electrocardiogram (ECG) should be obtained. ECG allows for easy monitoring of response to shock therapy as well as screening for preoperative arrhythmias. Ventricular arrhythmias most commonly occur in dogs with GDV 24 to 48 hours postoperatively. The presence of preoperative arrhythmias has been shown to be associated with an increased mortality rate.(1)

Surgery
In most abdominal surgeries, an exploratory should be performed first as a general assessment of the abdomen and to make sure other possible problems are not missed. This is often not possible in dogs with GDV as the stomach bloated and malpositioned. An exploratory is performed following derotation as this gives the stomach and spleen some time before assessing tissue viability. Subjective parameters are most reliable in assessing organ viability. These include color, thickness, peristalsis, arterial pulses, and capillary bleeding. Large splenic vessels can be palpated for the presence of a pulse or thrombosis. A necrotic stomach will rapidly lose the characteristic mucosal slip. If indicated, a splenectomy or partial gastrectomy should be performed. The decision to perform either of these procedures should not be taken lightly, as both have been shown to be associated with increased mortality.(1,2) Gastropexy is performed before closure to prevent recurrence. Recurrence rates following gastropexy range from 5-10% compared to an 80% recurrence rate without a gastropexy.(10) Belt-loop, incisional, or circumcostal gastropexy should be performed and the choice is often based on surgeon preference.

After the Surgery
Following surgery for GDV, dogs should be monitored for cardiac arrhythmias, DIC, sepsis, and other systemic complications. Gastric mucosal protectants and motility modifiers are often prescribed. Feeding is typically begun 12 to 24 hours postoperatively with small meals of a highly digestible bland diet. There are multiple causes of death for dogs with GDV including shock, DIC, sepsis, and cardiac dysfunction. Overall mortality for dogs with GDV is approximately 12 to 18%.(1-3) The effectiveness of prophylactic gastropexy in preventing an acute episode of GDV is unknown. Prophylactic gastropexy is most commonly performed by request of an owner who owns a high-risk breed dog or has had other dogs suffer or die from GDV. To avoid a large midline incision, prophylactic gastropexy can be also performed with laparoscopic guidance or through small grid incision on the right side of the animal.

References

Proceedings of the European Veterinary Conference - Voorjaarsdagen, 2009 - Amsterdam, Netherlands
CANINE LARYNGEAL PARALYSIS
Catriona M. MacPhail, DVM, PhD, Diplomate ACVS
Colorado State University, Fort Collins, Colorado, USA
cmacphai@colostate.edu

Introduction
Laryngeal paralysis is a relatively common condition particularly in older large breed dogs. Although diagnosis and treatment appear straightforward, there are many questions about laryngeal paralysis that remain unanswered. Controversy also exists regarding the long-term outcome following surgery. A recent large retrospective study performed at Colorado State University (CSU) found a higher postoperative complication rate than previously reported and it identified several risk factors that may increase surgical morbidity. This is in contrast to studies that describe good to excellent outcomes in 80 to 90% of dogs. Based on this discrepancy, we are continually examining the issues that surround the diagnosis and management of this disease.

Work-Up
The routine work-up for a dog suspected to have bilateral laryngeal paralysis includes physical exam, neurologic exam, CBC, biochemical profile, urinalysis, thoracic radiographs, thyroid function screening, laryngeal examination, ± esophagram, and ± cervical radiographs. Dogs should be thoroughly evaluated for possible underlying etiologies of laryngeal paralysis. Definitive diagnosis of laryngeal paralysis requires visual examination of larynx. Suspicion of this condition arises from the history of the dog as well as consistent clinical signs. Typically, a light plane of anesthesia is induced using intravenous thiopental, propofol, or ketamine / diazepam combination.

However, laryngeal examination is a poorly specific diagnostic test as false positives are common due to the influence of anesthetic agents on laryngeal function. Diagnosis may also be confused by the presence of paradoxical movement of the arytenoids resulting in a false negative result. In this situation the arytenoid cartilages move inward during inspiration due to negative pressure created in the trachea by breathing against a severe obstruction. The cartilages then return to their original position during the expiratory phase giving the impression of abduction. An assistant can state the stage of respiration during the examination to help distinguish normal from abnormal motion. Doxapram HCL (1mg/kg, IV) has been advocated for routine use during laryngeal examination to increase respiratory effort and intrinsic laryngeal motion.

Surgical Candidates
Dogs are often not severely clinical until they have bilateral laryngeal paresis or paralysis. Therefore, dogs with unilateral laryngeal dysfunction are not usually surgical candidates. For dogs with bilateral laryngeal paralysis, the decision to go to surgery is based on the quality of life of the dog, severity of clinical signs, and the time of the year. Warmer weather causes dogs to breathe harder with less physical exertion. Increased respiratory rate and effort against a fixed upper airway obstruction results in laryngeal cartilage swelling. This creates a vicious circle as the swelling increases the degree of obstruction, which increases the effort of respiration, which increases laryngeal swelling, and so forth.

Surgery
Unilateral arytenoid lateralization (UAL) is current technique of choice for most surgeons. Bilateral lateralization has been shown to result in unacceptable morbidity. Other techniques include partial laryngectomy (PL), castellated laryngofissure, and permanent tracheostomy. Differences in techniques do not appear to affect postoperative outcome. Griffiths et al examined the outcome of dogs treated with cricoarytenoid laryngoplasty versus those with thyroarytenoid lateralization. Cricoarytenoid lateralization resulted in 207% increase in the area of the rima glottis compared to 140% for dogs with thyroarytenoid lateralization. However, no difference was noted between techniques with regards to complication rate or short-term outcome, although cricoarytenoid laryngoplasty took significantly longer to perform. A similar study was performed by Demetriou et al, in which both procedures were found to results in good long-term clinical outcome.

The effect of the degree of suture tension and on the area of the rima glottis and degree of airflow has been recently evaluated in canine cadavers. It was found that low-tension suture (the suture was tied as tight as possible) resulted in a significant increase in the area not covered by the epiglottis in a closed position. These studies suggest the use of a low-tension suture in clinical cases for the potential reduction in the risk of postoperative aspiration pneumonia.

Post-Op Complications
For dogs at CSU that underwent UAL between 1985 and 1998, 19% developed postoperative aspiration pneumonia. Factors significantly associated with a higher risk of developing complications include preoperative aspiration pneumonia, megaesophagus, temporary tracheostomy use, and concurrent neoplastic disease. This finding was supported by an additional study in dogs with idiopathic laryngeal paralysis.
Diaphragmatic hernias can be congenital or traumatic in origin, and acute or chronic in duration. Animals with acute traumatic diaphragmatic hernias have typically sustained significant blunt vehicular trauma. The degree of respiratory compromise depends on the amount of abdominal viscera displacement and the presence and severity of other thoracic injuries. Animals may display respiratory distress, tachypnea, tachycardia, and cyanosis. Cardiac dysrhythmias are common due to the irritation of the heart by abdominal viscera. Animals with congenital or chronic diaphragmatic herniation may be asymptomatic or have only mild increases in respiratory rate and effort. The creation of an abdominal-thoracic pressure gradient across the diaphragm at the time of impact dictates the nature of the injury to the thorax. If abdominal pressure is greater than thoracic, a diaphragmatic tear results. Diaphragmatic tears typically occur through the muscular portion, which is the weakest part of the diaphragm. Abdominal organ displacement into the thoracic cavity depends on the location and size of the tear. Almost any organ can herniate, although the liver is the most frequent, followed by the small intestine, stomach, and spleen.

Diagnostic Imaging
Thoracic radiography may demonstrate obvious organ herniation in the thoracic cavity. Radiographic signs include loss of diaphragmatic outline and cardiac silhouette, displacement of lung fields, presence of gas filled visera, and pleural effusion. Effusion is usually associated with liver entrapment and venous occlusion. Abdominal radiographs may demonstrate cranial displacement of abdominal organs. Identification of stomach or intestines within the thoracic cavity makes the diagnosis of diaphragmatic hernia uncomplicated. However, if there is a large amount of pleural fluid or if the soft-tissue parenchymal organs are herniated the diagnosis of diaphragmatic hernia may be less obvious. Repeating radiographs following thoracocentesis may identify herniation that was not apparent before. Performing all radiographic views (right lateral, left lateral, ventrodorsal, and dorsoventral) may shift herniated visera and allow better visualization. Additional diagnostic imaging procedures can be used to aid confirmation of a diaphragmatic hernia. Unconventional radiographic imaging when compared with routine survey radiographs may provide valuable information. Such views include horizontal beam projection and standing ventrodorsal projections. Upper gastrointestinal positive contrast studies using orally administered barium sulfate will show the location of the stomach and intestines. Ultrasonography can also be used, although the diaphragm itself is not readily visualized even in normal animals. Rather, it is the interface between air-filled lung and hyperechoic liver that identifies the location of the diaphragm. A straightforward diagnosis occurs when there is identification of abdominal visera next to the cardiac silhouette. Positive contrast peritoneography can also be used if suspicion of diaphragmatic herniation is high, but cannot be confirmed from the previously described studies. Water-soluble iodinated contrast media is injected into the peritoneal cavity. Translocation of the contrast into the thoracic cavity confirms disruption of the diaphragm.

Surgery
Mortality associated with diaphragmatic hernia has been long thought to be higher when surgery is performed less than 24 hours or more than 1 year after injury. However, a more recent study did not find this to be the case. In general, anesthesia and surgery should

References

DIAPHRAGMATIC HERNIAS
Catrina M. MacPhail, DVM, PhD, Diplomate ACVS
Colorado State University, Fort Collins, Colorado, USA
cmacphai@colostate.edu
be delayed until the animal can be adequately stabilized. Stabilization includes shock therapy, oxygen supplementation, and antibiotic administration. However, emergency surgery is indicated if there is gastric herniation or if the animal’s respiratory status deteriorates. Gastric herniation is a surgical emergency because these animals are at risk for acute gastric distension, severe respiratory compromise, and death. The goals of surgery are to reduce the herniated organs back into the abdominal cavity, examine the organs for any vascular compromise or perforation, and repair the diaphragmatic defect. Occasionally the diaphragmatic tear needs to be enlarged or the incision extended cranially through the sternum to allow reduction of abdominal contents and improve visualization. Tears are sutured from dorsal to ventral using an absorbable or nonabsorbable monofilament suture in a simple continuous pattern. Use care when suturing near the caval, esophageal, or aortic foramina. If the diaphragm has been avulsed from its thoracic wall insertions, incorporate the ribs into the closure. Defects too large to close are rarely encountered; however, if faced with this situation autogenous flaps or synthetic implants may be used. Autogenous flaps include a sliding transverse abdominal muscle flap or an omental pedicle flap. Examples of synthetic materials include polypropylene mesh and silastic sheeting. Following repair of the diaphragm, air is removed from the thoracic cavity by needle thoracocentesis or placement of a thoracostomy tube.

Complications
The most serious complication associated with surgical repair of diaphragmatic hernias is re-expansion pulmonary edema, which follows rapid reinfation of atelectatic lungs. Although this is an uncommon complication, it most often occurs in cats with chronic herniation. Ways to prevent this complication is to avoid aggressive positive pressure lung expansion during anesthesia once the hernia has been reduced and to avoid aggressive removal of air through the thoracostomy tube in the postoperative period. The animal should be allowed to gradually reinfate their lungs on their own. Other less common complications include pneumothorax, hemothorax, liver lobe necrosis, gastrointestinal vascular compromise, and reherniation. If the animal survives for the first 12 to 24 hours after surgery, the prognosis is very good. Reported survival rates range from 80 to 90% following surgical correction. Deaths are usually due to concurrent injury or pulmonary edema.

References
2. Williams J, Leveille R, Myer CW. Imaging modalities used to con- firm diaphragmatic hernia in small animals. Compend Cont Educ Pract Vet 1998;20:1199

Surgical Management of Lower Urinary Tract Stones in Dogs
Catriona M. MacPhail, DVM, PhD, Diplomate ACVS
Colorado State University, Fort Collins, Colorado, USA
cmacphai@colostate.edu

Introduction
Cystotomy is a common surgical procedure in small animal surgery, most often performed for removal of uroliths. Surgery is indicated for stones that are not amenable to medical dissolution or those that are causing urinary obstruction.

Prior to cystotomy, stone retropulsion is sometimes required to move urethral stones into the urinary bladder. Under general anesthesia, the largest urinary catheter that can be placed is inserted until it abuts a urethral stone. Saline flush mixed with sterile lubricant is then flushed through the catheter with a fair degree of force. If the obstruction is not relieved, the proximal urethra can be occluded by a finger inserted in the rectum of the animal. The catheter is flushed, dilating the urethra.

Pressure on the proximal urethra is then released letting the stone be flushed into the urinary bladder. A lateral abdominal radiograph should be performed prior to surgery to confirm that all stones have been dislodged from the urethra. The catheter is left in place as the animal goes to surgery to prevent stones from falling back into the urethra.

Surgery
Following a routine caudal abdominal midline approach, the bladder is located and isolated from the rest of the abdomen with damp laparotomy sponges. Stay sutures are placed in the apex and neck of the bladder to facilitate cystotomy. A ventral incision in a relatively avascular area is typically performed to allow good visualization of the trigone and ureteral openings. A full-thickness sample of the bladder wall is taken for culture and histopathology. Calculi are removed from the bladder using forceps, spoon, or other smooth and blunt instruments. The stones are submitted for quantitative analysis in order to determine the need for postoperative medical management to prevent stone recurrence. A urethral catheter is passed several times, both normograde and retrograde, to make sure that no stones remain in the bladder neck or urethra. It has
been reported that stones are left behind in 10-20% of cases following cystotomy. The urinary bladder is unique in that it regains nearly 100% of its original tensile strength by 14 days. Therefore, synthetic absorbable suture material is most suitable for cystotomy closure. Monofilament suture is preferred as there is some concern that contact between urine and multifilament suture may lead to an increased rate of absorption or may promote urolith formation.(1) Nonabsorbable suture and staples are contraindicated in urinary bladder closure, as they are associated with the formation of urinary calculi. There are a number of suture patterns that can be used to close the urinary bladder. The surgical goals are to minimize tissue trauma, create a watertight seal, and avoid promotion of calculi formation. Options for cystotomy closure include:

- Single-layer simple continuous pattern
  - Simple continuous pattern in mucosa only, followed by,
    - Partial-thickness Lembert pattern
- Two-layer appositional continuous pattern
  - Partial thickness simple continuous pattern followed by,
    - Partial thickness Lembert pattern
- Two-layer inverting continuous pattern
  - Partial thickness Cushing pattern followed by,
    - Partial thickness Lembert pattern
- Partial thickness simple continuous pattern
- Two-layer inverting continuous pattern
  - Partial thickness Cushing pattern followed by,
    - Partial thickness Lembert pattern
- Single-layer simple interrupted pattern
- Single-layer simple continuous pattern

There is no difference in circular bursting wall tension of urinary bladders closed with single-layer simple interrupted appositional pattern versus a two-layer continuous inverting closure.(2) Luminal compromise may occur if two-layer inverting patterns are used in urinary bladders with severely thickened walls. A three-layer closure can be used if there is excessive hemorrhage from the bladder mucosa. In this technique, the mucosa is closed as a separate layer in a simple continuous appositional pattern (which attenuates the bleeding), followed by a two-layer inverting pattern in the seromuscular layers. The author typically performs a single-layer full-thickness simple continuous closure with 3-0 or 4-0 rapidly absorbable monofilament suture. Most surgical texts state that the lumen of the bladder should not be entered with suture material. Urinary calculi formation has been associated with multifilament absorbable suture, nonabsorbable suture, and metal staples, however there have been no studies assessing the lithogenic potential of the newer monofilament absorbable sutures. Full-thickness purchase of the bladder wall guarantees incorporation of the submucosal holding layer. Single layer partial-thickness closures of the urinary bladder that miss the submucosa may be inadequate for preventing urine leakage.

**Post-Op Care**
There is no special postoperative care required following cystotomy. Routine postoperative abdominal radiographs can be taken to confirm that all urethral and bladder stones have been removed. Owners should be warned to expect mild hematuria for 3 to 5 days post-operatively. Follow-up medical management should be based on results of stone analysis.

**References**

**TRAUMATIC UROABDOMEN**
Catriona M. MacPhail, DVM, PhD, Diplomate ACVS
Colorado State University, Fort Collins, Colorado, USA
cmacphai@colostate.edu

**Introduction**
Leakage of urine into the abdominal cavity is a common condition following vehicular trauma in small animals. Other causes of uroabdomen include rupture of the upper or lower urinary tract secondary to calculi obstruction or neoplasia, as well as iatrogenic injury. Early clinical signs of uroabdomen may be nonspecific. It is not uncommon for animals with uroabdomen to still have normal urination habits. As the condition progresses, owners may describe onset of severe lethargy, anorexia, vomiting, restlessness, or reluctance to lie down. Animals with severe abdominal pain may display a praying position. A fluid wave may sometimes be elicited on abdominal ballottement. Animals may also present in hypovolemic and/or septic shock with marked abdominal pain and abdominal distention. Signs of hypovolemic shock include pale, tacky mucous membranes, tachycardia, and weak peripheral pulses. These animals may have cardiac dysrhythmias, respiratory compromise, and altered mentation.

**Diagnosis**
Aside from standard laboratory evaluation, including complete blood count, biochemical profile, electrolyte panel, and urinalysis, an abdominocentesis should also...
be performed in animals thought to have uroabdomen. If fluid is balloted, a single midline tap may be done using a 20 gauge, 1-inch needle. Lesser amounts of abdominal fluid may require a four-quadrant abdominocentesis or diagnostic peritoneal lavage. The four-quadrant technique is usually performed with the animal standing or in lateral recumbency. The bladder is expressed to avoid inadvertent cystocentesis and the abdomen is clipped and antiseptically prepped. A 20 gauge, 1-inch needle is inserted into each quadrant: cranial and caudal to the umbilicus and on either side of midline. Fluid should be allowed to drip from the hub of the needle into an EDTA tube (purple top). In animals with uroabdomen, a diagnostic peritoneal lavage is seldom necessary, as fluid should be readily retrieved from the peritoneal cavity. Ultrasound may also be used to help locate pockets of fluid and avoid unintended injury of the abdominal viscera.

Collected fluid should be examined cytologically and protein quantitation and total nucleated cell count should also be performed. The hallmark diagnostic test for uroabdomen is measurement of the creatinine level in the abdominal fluid compared to the serum creatinine level. Fluid creatinine levels are typically 2 to 4 times higher than serum levels. Potassium can also be measured and compared between fluid and serum. Although urea is known to rapidly equilibrate between the abdominal fluid and blood due to the small size of the molecule, it is often markedly elevated in the abdominal fluid as well and can be measured quickly using dipstick measurement (Azostix®).

Patients diagnosed with uroabdomen are not surgical emergencies. Often these animals have significant electrolyte abnormalities and acid-base imbalances and should be stabilized over a 12 to 24 hour period before going to surgery. Stabilization includes intravenous fluid therapy, urethral catheterization, and peritoneal drainage. Drainage of the peritoneal cavity can be accomplished through insertion of a multifenestrated large-gauge catheter. This catheter can often be placed with only mild sedation and a local anesthetic block. Both the peritoneal drainage catheter and the urinary catheter should be connected to closed collection systems so that fluid losses can be quantitated and replaced. Thoracic radiographs and electrocardiography are also indicated in animals that have been involved in vehicular trauma. Electrocardiography is also indicated in animals with significantly elevated serum potassium.

**Surgery**

Uroabdomen secondary to a traumatic incident is often due to lacerations of the urinary bladder or proximal urethra. Damage to the upper urinary tract usually occurs secondary to urolith obstruction, penetrating abdominal wounds, or neoplasia. Contrast radiographic studies should be performed after stabilization but prior to surgery to identify the exact location of the tear. Positive-contrast cystourethrography is utilized for suspected lower urinary tract injuries, while an excretory urogram should be used if renal or ureter damage is suspected. Definitive surgical treatment is based on the site of urine leakage. Surgical repair of the bladder is most commonly indicated in animals with traumatic uroabdomen. While spontaneous closure of bladder tears have been reported, the treatment of choice is still surgical repair. The area of devitalized or necrotic tissue is excised and the bladder is closed using a single or double-layer continuous pattern with 3-0 or 4-0 absorbable suture.