INTRODUCTION:
Intestinal surgery is a common surgical procedure but it is one with significant morbidity or mortality if things go badly.

Gastrotomy:

Indications:
Gastrotomy is indicated for removal of gastric foreign bodies, resection of gastric lesions (ulcers or neoplastic disease) and as a technique for obtaining full-thickness gastric biopsies.

Procedure:
Ventral midline incision beginning at the xiphoid and extending at least 2/3 of the distance to the pubic brim. Isolate the stomach by placing stay sutures in the ventral wall of the stomach slightly further apart than the proposed incision. Use an 11 blade to make a stab incision and aspirate gastric contents. Extend ventral gastrotomy incision to desired length. Retrieve foreign body. Palpate extremes of the stomach lumen (should also do this prior to making gastrotomy incision). Carefully lavage the gastric lumen and aspirate gastric content or pass stomach tube to allow fluid to be removed. Routine closure.

Tips:
• Stay sutures will aid in the retraction of the stomach and will help maintain the elevation of the stomach, minimizing the risk of abdominal contamination.
• Engage submucosa to achieve a secure closure.
• Closure with one or two layers. Can use an inverting pattern (two layer) or simple appositional pattern.
• Small, monofilament absorbable suture (3/0 or 4/0); needle type matters (SH, RB or similar is ideal).

Intestinal biopsies / enterotomies:

Indications:
Intestinal biopsies are the most common request for surgical biopsies. Endoscopic biopsies are often not deep enough to be diagnostic and full-thickness biopsies are needed for histopathologic evaluation. For all intestinal biopsies, a few rules are applicable.

• Samples need to come from various portions of the intestinal tract. I normally obtain a duodenal, 1-2 jejunal and an ileal biopsy.
• Gastric biopsies are obtained only when specifically requested or if there are abnormal finding during the exploratory.
• Colonic biopsies are generally avoided due to the higher bacterial content and the less forgiving nature of colonic healing.
• Before incising the intestine for the biopsy, make sure you have isolated the segment to be biopsied with moistened laparotomy sponges. The lumen of the intestines needs to be occluded before incision to prevent expulsion of intestinal contents. This can be accomplished using 1) an assistant’s fingers [best option], 2) vascular clamps (e.g. ductus clamp) or a 3) Penrose drain. Other techniques may also be use but I avoid intestinal clamps. The use of rubber-clad (rubber sheathing) on any clamp used to occlude the intestines is to be avoided.
• Moistened gauze sponges are used to remove any ingesta that leaks from the incision and are discarded off the table.
• Surgeons should take care to avoid damaging or distorting biopsy samples. They should use needles or very gentle pressure with tissue forceps. Biopsies are placed directly into formalin containers, thus avoiding desiccation or being inadvertently discarded.
Obtain biopsies from the anti-mesenteric surface when possible. Most GI diseases are generalized and have the lowest risk of compromising the local vascular supply.

Procedure:
Several different techniques are available for taking intestinal biopsies. They will be described below.

The first technique is to incise the anti-mesenteric surface with an 11 blade and taking a small elliptical portion of the bowel. The second technique is to make a 6-8 mm longitudinal incision along the anti-mesenteric surface and then close the incision in a transverse fashion. This creates “dog-ears” at either end of the incision that are trimmed away with Metzenbaum scissors. This technique gives you two small, full-thickness biopsies.

Another technique uses a 4-6 mm dermal biopsy punch to create a circular biopsy in the anti-mesenteric surface. This is my primary technique at this time and I have seen few complications with it. The primary concern (complication) I worry about is inadvertent penetration of the mesenteric wall if the surgeon presses too hard on the punch while cutting through the anti-mesenteric surface. This laceration might not be noticed by the surgeon resulting in the leakage of GI contents. A second “issue” is that the punch may force the sample into the intestinal lumen. In most cases, a little gentle pressure forces the sample to re-surface and it can be lifted with your suture needle or tissue forceps. The final issue concerns the re-use of the biopsy punch. While these can be cleaned and re-sterilized, a punch that is re-used (and re-used and re-used) can become quite dull. Steam sterilization will dull the instrument faster than EtO sterilization and will also deform (melt) any of the disposable punches. A dull punch means less cutting and more pressure to force through the tissues. However, this problem is easily resolved, simply throw out the dull punch and getting a new one!

We have an on-going argument (concern) about the sample quality as it relates to histopathologic evaluation. We have received some feedback that the small biopsy punch biopsies have an irregular appearance on histopathology. This is probably due to the curling of the biopsy sample when placed in formalin and poor histologic processing. We frequently use a piece of a sterilization indicator and press the serosal side of the biopsy to this paper. It helps to minimize the curling and improves processing. Check with your regular histopathology laboratory for suggestions before incorporating this into your routine protocols.

Once the biopsy is complete, trim everted muscosa and close with several simple interrupted sutures. My preference is an absorbable, monofilament (i.e. 4/0 PDS) on a taper needle. I close the central portion first (longitudinal direction) and place additional sutures on either side until the incision is secure. We routinely check biopsy site closures by inserting a 25g needle into the intestinal lumen, occluding the intestines on each side of the incision and injecting saline into the lumen. Fill the lumen until it is moderately distended. If there is no leakage, you can feel comfortable about the closure. If a portion of the closed incision leaks, place another suture or remove and replace all the sutures are required. If the surgeon wants additional support, they can wrap the site with omentum or place a serosal patch over the enterotomy site. (See below)

Tips:
- Complications and concerns associated with intestinal biopsies include biopsy site dehiscence, peritoneal contamination and standard concerns associated with any abdominal surgical procedure. Biopsy site dehiscence should be a rare complication and is generally associated with inadequate closure of the biopsy site, failure to engage the submucosa in sutures apposing the biopsy incision, or the presence of severe intestinal disease.
- Hypoproteinemia and hypoalbuminemia have not been associated with increased risk of intestinal dehiscence after biopsy, although extra care is warranted in animals suffering from these conditions.
- Other factors, such as pre-existing intestinal or peritoneal disease, may create a higher risk for any individual animal.
- Many of the animal undergoing biopsy have been on immunosuppressive drugs for their underlying disease. This may have a negative impact on healing.
**Enterotomy:**

**Indications:**
- Removal of intestinal foreign bodies, intestinal biopsy and removal of focal neoplastic lesions.

**Procedure:**
- When performing an enterotomy, you can use the same suturing techniques that are used for a biopsy. A few pointer include:
  1. Choose your needle and suture material carefully. I prefer a small, taper point needle with a tight radius (SH or RB-1 needles) for intestinal sutures.
  2. Minimize tissue trauma to the wound edges. This is an especially common problem for inexperienced or infrequent surgeons. Excessive use of tissue forceps on the wound edges can slow healing and increase the risk of complication. Using an inappropriate (or dull needle) is likely to result in the surgeon having to exert more force to accomplish needle passage through the submucosa. Poor technique (i.e. not following the curvature of the needle during the tissue passage) is also detrimental.
  3. You can use a combination of suture patterns to help with closure. I normally use full-thickness, simple interrupted appositional sutures for my enterotomy closure; however, I might add a modified Gambee suture to aid with apposition if the interrupted sutures are not apposing tissues to my satisfaction.
  4. Again, trimming the everted mucosa is helpful in closing an enterotomy site. There is a lot of intestinal mucosa, and you may need to trim it several times. When trimming the mucosa, use the curvature of your Metzenbaum scissors to help. Place the concave surface of the scissors against the serosal surface of the intestines to help get a close trim.
  5. Transverse closure of a longitudinal incision helps to minimize narrowing of the intestinal lumen.

**Tips:**
- Temporary vascular occlusion can be accomplished with vascular forceps. I prefer these to Doyen clamps since the vascular forceps have a better occlusion pressure and are easier to manipulate. Straight ductus forceps are the easiest to use.
- A large (18-20 Fr) red rubber catheter can be used to help remove a linear foreign body through a single enterotomy incision. The linear foreign body is exposed through a proximal incision and is attached to the red rubber catheter. The catheter is fed into the intestinal lumen and then passed through the intestines until it can be retrieved from the anus. The linear foreign body will generally loosen from the intestinal wall and follow the catheter as it is milked down through the intestinal tract.

**Resection / anastomosis:**

**Indications:**
- Once you have determined the point of resection, you need to isolate the segment of diseased bowel. Pack off the bowel with moistened laparotomy sponges to prevent contamination from intestinal contents. Crushing and non-crushing clamps are placed on the bowel and the bowel is cut with approximately a 60 degree angle between the mesenteric and anti-mesenteric surfaces.

**Procedure:**
- There is normally a substantial amount of mucosal eversion from the edges of the resection. This mucosa can be trimmed aggressively to help make the apposition of the wound edges easier. (I normally trim one side and suture it. If the mucosa everts further, I continue to trim the mucosa back as required). The normal procedure for suturing a resection is to place a suture to appose the mesenteric surface (6:00); then you go to the anti-mesenteric surface and place a suture there (12:00). Then, split one side (place a suture at 3:00) and fill in between the sutures until that side is completely sutured. Roll the intestines and place a suture in the middle (9:00) and again, fill in between the sutures.

**Tips:**
- A few recommendations that I normally employ when performing intestinal surgery:
When placing the mesenteric suture to begin the anastomosis, I place 3-4 interrupted sutures on the mesenteric surface. I find this allows me to more accurately appose the edges especially in dogs or cats with a substantial amount of fat along the mesentery. I pre-place these sutures and then tie with the knots on the outside of the lumen.

I prefer using simple interrupted, appositional sutures for intestinal anastomosis. Normally these are placed in a full thickness manner. Care is taken to ensure the angle of penetration into the lumen is perpendicular to the intestinal wall. Other suture patterns can be used (simple continuous, modified Gambee suture) as preferred; but inverting patterns and crushing sutures are not recommended in small animals.

Inverting patterns are NOT typically used for small animal intestinal surgery. The need to have serosa-to-serosa contact for adequate healing is no longer accepted as true. Apposition of tissues layers results in more accurate and early restoration of the intestinal wall.

Once you are satisfied with the anastomosis, the mesenteric defect is closed. Take care to avoid damaging any of the mesenteric vessels as this could impair blood flow to the anastomosis, delaying healing and increasing the risk of dehiscence.

ADJUNCTIVE ABDOMINAL PROCEDURES:

1. **Pressure testing:**
   I teach all my students to “pressure check” their intestinal closures. The reason is simple, you can readily repair or supplement a sutured wound at the time of the procedure and hopefully minimize the potential for bowel leakage ... at least leakage due to poorly placed sutures.

   To pressure check your intestinal closure, take a 10-12 mL syringe and a 25g needle. Fill the syringe with saline and insert into the intestinal lumen. With your assistant gently occluding the intestinal on either side of the enterotomy incision, inject saline into the lumen; distending the intestine. Gently apply pressure and check for obvious or subtle leakage. If you are going to “pressure check” the intestinal closure, do not be afraid to be rather aggressive with the distention.

   If you notice leakage, re-evaluate your suture line. Look at the tissue apposition and then at the suture spacing. Place additional sutures as required to stop the leakage. Be careful to remove any clots or fibrin at the incision site; these materials can temporarily seal surgical sites; however, they will eventually release and then the surgical site may start to leak.

2. **Omental patch:**
   An omental patch is simply the process of wrapping the omentum over the completed surgical site. The omentum is felt to have a positive effect on the healing process since it has an excellent blood supply and is filled with lymphatics. The omentum can be tacked in place using a few fine, absorbable sutures or the omentum can simply be wrapped around. In reality, the omentum will probably find its way to the surgical incision on its own.

3. **Serosal patch:**
   A serosal patch is created when you suture the serosal surface of an organ over a surgical incision. It has been shown that the serosal patch creates a better seal than does an omental patch; in fact, histopathology demonstrated mucosal growth on the serosal patch.

4. **Antibiotic selection for intestinal surgery:**
   Antibiotics are controversial for intestinal surgery. If you are using antibiotics, they should be aimed at the most likely bacterial organisms. Using peri-operative antibiotics is a reasonable practice, but there is little reason to continue antibiotic therapy once the procedure is complete. Some veterinarians justify continuing antibiotic therapy by saying they want to prevent peritonitis in the case of incisional leakage. This is generally a misguided justification since antibiotics are not going to prevent an intestinal incision from leaking or magically plug a leaky bowel.
Diaphragmatic hernias occur when the integrity of the diaphragm is compromised. This allows abdominal organs to move into a position in front of the normal division between the abdominal and thoracic cavities. While this is most commonly the result of a traumatic event, congenital hernias, primarily pericardio-peritoneal hernias, can occur.

The clinical signs associated with a diaphragmatic hernia can range from no outward signs to immediately life-threatening respiratory compromise. Although this is a surgical condition, management options depend on the clinical condition of the animal as well as the suspected chronicity of the hernia.

Congenital diaphragmatic hernias are normally associated with a failure of the diaphragm to close leaving a communication between the pericardium and the peritoneal cavity.

Diagnosis
Since many animals with diaphragmatic hernias are asymptomatic at presentation, clinicians must maintain a high level of suspicion whenever a history of trauma exists. In other cases, a diaphragmatic hernia may be discovered during routine radiographic examination of the thorax or abdomen.

Animals with a history of blunt force trauma to the body should have thoracic radiographs to check for diaphragmatic hernia, pulmonary contusions and pneumothorax. This is especially important when sedation or general anesthesia is required for other injuries. Other reported signs suggestive of a diaphragmatic hernia include an apparent reduction or absence of abdominal viscera on palpation or radiography, a "wasp-waisted" appearance, the absence of gastro-intestinal noise on abdominal auscultation or the presence of GI noise on thoracic auscultation. Some animals may have respiratory or cardiac signs associated with a diaphragmatic hernia. Thus, a diaphragmatic hernia can complicate almost any differential list.

Diagnostic techniques used to confirm a diaphragmatic hernia are generally straightforward. Traumatic diaphragmatic hernias are routinely demonstrated on thoracic radiographs. With proper radiographic technique, there is a loss of the diaphragmatic silhouette with increased opacity in the thoracic cavity - primarily in the caudal thorax or on a single side. There may be a silhouetting of this opacity with the heart and, in some cases, there may be gas-filled intestinal segments in the thoracic cavity. Congenital hernias of the diaphragm, i.e. pericardio-peritoneal hernias, appear as an enlarged, globoid heart and a loss of diaphragmatic silhouette along the midline of the animal or a blending of the diaphragmatic silhouette with that of the heart. Rule-outs should include pleural effusion, pericardial effusion and cardiomegaly. Use of ultrasound or contrast radiography (peritoneogram, angiography or enteral contrast) is often required to distinguish between these radiographic causes of cardiomegaly.

When to do Surgery
Timing is important in the management of diaphragmatic hernias. There are only a few indications for immediate surgical intervention. Indeed, there are two peaks of increased mortality associated with diaphragmatic hernias: 1) those undergoing surgery immediately after the initiating trauma and 2) those animals with chronic, potentially incarcerated, hernias.

In the first situation, the increased mortality is probably due to the severity of the trauma and the challenges of performing anesthesia and surgery on a critical patient. I would suggest
Immediate surgery is only indicated in limited circumstances where the patient fails to respond to standard techniques for stabilization due to having a gas-distended organ, such as the stomach, in the thoracic cavity or the presence of another surgical condition requiring immediate intervention, such as intra-thoracic or intra-abdominal hemorrhage. My experience is consistent with the observation that there is a significant increase in mortality associated with immediate surgical intervention for diaphragmatic hernia.

For animals with chronic diaphragmatic hernias, there is another increase in operative mortality. This is associated with the presence of adhesions and devitalized or compromised tissues that may lead to re-perfusion injuries. Several special concerns and techniques for surgeons in this situation will be presented later in these notes.

My preferred patient is a stable, “non-shocky” animal that can be placed under anesthesia with confidence. Although the “stabilization period” could represent 2-7 days from the initial trauma, my preference is to repair these cases within the first few days after the accident (if there are not other contraindications to surgery). It is important to closely monitor the patient with a diaphragmatic hernia while awaiting surgery. Although I don’t consider a diaphragmatic hernia to be an emergency surgery, I try to perform surgery as soon as possible.

Surgery

All animals undergoing surgery for diaphragmatic hernia repair should have at least one intravenous catheter in place and should be receiving intravenous fluids during surgery. While crystalloids are normal, some patients may require plasma, synthetic colloids, blood (whole or packed cells) or hemoglobin based products. In cooperative patients, the initial clipping of the surgical site is performed before anesthesia induction. A wide, long clip is made because the incision may need to be extended depending on hernia size, chronicity and the organs that have herniated.

Surgical repair of diaphragmatic hernias begins with a ventral midline incision extending from the xiphoid to the pubis. Self-retaining abdominal retractors (Balfour type) are used to enhance exposure. The abdominal surface of the diaphragm is examined for the site of the hernia. Once the hernia has been identified, the herniated organs are gently returned to their normal position in the abdominal cavity. It is important to remember that the fastest and gentlest method of reducing herniated organs may be to enlarge the tear in the diaphragm. Placing excessive traction on herniated organs can result in significant direct damage to the incarcerated organ or create damage the organ’s vascular supply.

Once all the organs and tissues are restored to their normal position, the diaphragmatic defect is sutured. In long-standing hernias, the wound edges may need to be debrided to facilitate healing. Radial tears can be sutured using a simple continuous pattern or a Ford-interlocking pattern. The suture pattern is begun at the most dorsal (deepest) aspect of the tear. Care is taken to make sure that sutures don’t enter the large vessels transversing the diaphragm through the caval hiatus. As the tear is sutured, a mild amount of eversion may be encountered. Care must also be taken to ensure a complete closure at the ventral body wall. Circumferential diaphragmatic tears are sutured to the body wall using a similar technique. I employ circumcostal sutures to supplement the strength of the diaphragmatic repair when I am near a rib. Diaphragmatic hernias can be sutured with pretty much any suture material but I recommend using either a long lasting absorbable monofilament (polydioxanone or polyglyconate) or a non-absorbable monofilament (polypropylene or nylon).

The surgery is completed by re-examining the entire abdominal surface of the diaphragm (looking for other tears), performing a complete abdominal exploratory (to identify other lesions of consequence) and removing excessive air or fluid from the thoracic cavity. Normally, I avoid placing a thoracostomy tube and prefer to remove the air using a transdiaphragmatic aspiration technique. To accomplish this, we insert an 18g catheter through the diaphragm. The stylet is removed and an intravenous extension set with a three way stop-
cock is connected to the catheter. The stop-cock can be connected to a syringe or to a suction hose to remove air from the thoracic cavity and to restore the pressure differential. I normally place the catheter at the edge of the diaphragm so that the excursions of the diaphragm don’t result in the dislodgement of the catheter. In cases with excessive intrathoracic fluid, I try to make sure all the fluid is removed before beginning the diaphragmatic repair.

The inability to restore the normal concavity of the diaphragm after transdiaphragmatic aspiration should prompt another examination of the diaphragmatic surface. I have encountered situations where the diaphragm had more than 3 distinct areas of tearing. I place a thoracostomy tube only when there is a high risk of continued fluid or air accumulation within the thoracic cavity.

**Chronic Diaphragmatic Hernias**

Repairing a chronic diaphragmatic hernia may be easy or difficult. PLAN FOR A DIFFICULT SURGERY. The difference is based on the number and severity of adhesions present in the thoracic cavity and the state of the herniated organs. The surgeon must be prepared to extend the ventral midline incision cranially through the caudal portion of the sternum. The release of free oxygen radicals and other cytotoxic agents from ischemic tissues can result in patient death. Re-expansion pulmonary edema is a reported complication associated with aggressive re-expansion of atelectic lungs secondary to any chronic thoracic mass. Re-expansion edema compromises vascular integrity in the lungs resulting in severe pulmonary edema and a steadily decreasing ability to maintain normal tissue oxygenation. My experience with this condition suggests that mechanized ventilatory support offers the only hope in such a patient, with a very poor prognosis. Efforts to avoid aggressive re-expansion of collapsed lungs, allowing them to slowly re-expand after reduction of the herniated tissues, offers the best prognosis. Use of drugs to blunt the release of oxygen free radicals show some promise.

Restoring all herniated viscera to their normal location can make abdominal closure difficult because the abdominal cavity may have adapted to the absence of abdominal organs and is smaller. The appearance of the bowel should be monitored during closure to identify organ compromise. Furthermore, care must be taken to ensure bowel loops are not inadvertently incorporated when closing the lumen. In extreme cases, where it is felt that primary abdominal closure could result in abdominal organ compromise, delayed abdominal closure or the placement of polypropylene mesh in the abdominal wound could be performed.

**Practical Considerations for Surgery**

The first decision to be made is when to perform surgery on a patient who presents with a diaphragmatic hernia. Remember the two peaks of mortality and temper your enthusiasm to get into the OR with knowledge of the importance of stabilization.

The surgical skills required for most diaphragmatic hernia repairs are possessed by most veterinarians who perform routine abdominal exploratories. However, self-retaining abdominal retractors and some surgical assistance is needed. Other items such as long handled surgical instruments may make suturing in a deep chested, large breed dogs easier. In selected cases, prosthetic materials, such as polypropylene mesh, may be needed to repair the hernia.

Anesthesia can be challenging and may create the most stress for the surgeon. EVERYTHING must be ready for surgery before beginning premedications. I have had otherwise stable animals de-compensate after the administration of premedications or the induction of general anesthesia. Ventilatory support, mechanical or human, is required for diaphragmatic hernia repair.

All personnel should be ready to perform the procedure when premedications and induction agents are administered. Anesthesia requirements include gas anesthesia with a machine that permits manual or mechanical ventilation. Inspiratory pressures should not
exceed 15-20 cm of water since higher pressures can result in pulmonary barotrauma, especially to previously traumatized lung tissues. I recommend avoiding the use of acepromazine and thiobarbiturates in most cases since these can result in splenic enlargement and could further compromise respiration if the spleen is herniated into the thoracic cavity. Routine use of opioids provides additional analgesia and promotes deeper respiratory excursions post-operatively. The increased depth of respiration associated with adequate analgesia often neutralizes the potential respiratory depression attributed to opioid use.

Postoperative management is vital to successfully repairing a diaphragmatic hernia. There needs to be “round the clock” care for the first 24-48 hours after surgery, especially if a thoracostomy tube has been placed. Supplemental oxygen therapy can be accomplished with nasal O₂ administration via cannula or an oxygen cage. Consider this BEFORE the patient has recovered from anesthesia. The nasal cannula should be placed prior to anesthesia recovery. Early placement will prevent struggling with a dyspneic, agitated patient while trying to place the nasal oxygen cannula.
AURAL HEMATOMA:

Indication:
Aural hematomas form between the skin and cartilage of the pinna - most commonly on the ventral aspect. They may occur as small (segmental) hematomas or they may encompass the entire ventral aspect of the pinna.

Procedural options:
When considering various procedures for treating an aural hematoma, duration and size are the most important. Acute hematomas allow the veterinarian to consider the relatively non-invasive treatment options of aspiration or drainage. For aspiration of an aural hematoma, the key points are 1) patient sedation (light anesthesia), 2) careful surgical preparation of the aspiration site and 3) use of a large-gauge needle or butterfly catheter. Placement of “closed-drainage” systems for continued aspiration over 24-48 hours has been described using a modified butterfly catheter and Vacutainer® tubes. With this technique, the female connector is cut off of the butterfly catheter and the catheter tubing is fenestrated along ½ of its length. A stab incision is made at the base of the hematoma, accumulated blood is expressed and the fenestrated portion of the catheter is placed into the hematoma cavity. The exit site is closed with a purse-string suture and the catheter is secured with a finger-trap suture. The ear is bandaged to secure it in place and the needle end of the drain is placed into a 10mL Vacu-tainer® tube that is attached to the bandage. The vacuum within the tube provides gentle suction to pull fluid from the hematoma cavity. The tube is changed as required to maintain the vacuum. After a few days, the drain is removed. The ear bandage can be maintained for another 1-4 days.

For more chronic hematomas, incision to allow for removal of clots and fibrinous products is more appropriate. A slightly curved (S-shaped) linear incision is the classic technique for hematoma drainage. The incision is made over the entire length of the hematoma running along the long axis of the ventral pinna. The hematomas contents are expressed and the hematoma cavity is cleared of any remaining clots. Skin edges are NOT apposed - rather a gap is left to promote drainage (some surgeons remove a strip of skin along either side of the incision to allow for a tighter apposition of the skin to the underlying cartilage without apposing the wound edges). The ear can be bandaged (alone) or horizontal mattress sutures can be placed from the ventral surface to the dorsal surface and back (through & through sutures) Non-absorbable suture (2/0 -3/0 nylon or polypropylene; a straight needle makes this easier) is used and is tied loosely. Suture removal is performed in 14-21 days.

Recommended procedural description:
The modification I currently use is the Keyes Biopsy punch. Instead of a single incision, multiple punctate wounds are made over the hematoma and the adjacent area. After thoroughly fenestrating the pinna, I place interrupted sutures between the edges of the biopsy site into the underlying cartilage. These are normally done with either a small absorbable material (3/0 Monocryl) or a non-absorbable material. I maintain an over-the-head ear bandage for at least 4-7 days.

Comments / Tips:
• The underlying cause of the hematoma needs to be investigated. Make sure to be treating any pre-existing otitis.
• Poor preparation site - particularly combined with the use of intralesional steroids - can result in infection.
• If using “through & through” mattress sutures, make sure the suture orientation is parallel to the long axis of the pinna. Placing sutures perpendicular to the long axis may result in significant compromise of the vascular supply with subsequent pinna necrosis.
• I incorporate sutures across the entire pinna as I have chased hematomas long a pinna before.
VENTRAL BULLA OSTEOTOMY:
Indication:
Increased opacity of the middle ear (bulla) associated with infection or masses (inflammatory polyps or neoplasia).

Anatomy:
The ventral bulla is a thin, bulbous structure on the ventral aspect of the skull. It is a part of the middle ear and is separated from the external ear canal by the tympanic membrane. In the diseased state, the bulla loses its delicate radiographic appearance and can become thickened. The normal radiographic opacity of the bulla is air-filled but in disease states, it is frequently filled with soft tissue, mucoid material or fluid (sometimes distinguishable by the presence of a fluid line). In the cat, the bulla can be palpated when the head is extended while in most dog (and especially large, muscular dogs) the bulla can be challenging to locate.

Important anatomical structures include:
- hypoglossal nerve & lingual artery (both retracted medially)
- digastric muscle
- osseous promontory with sympathetic fiber tracts
- ventro-medial and dorso-lateral compartments in the feline bulla (separated by a thin osseous septum)

Procedure:
Once dissection has exposed the ventral aspect of the bulla, the thin bone is penetrated and the osteotomy is performed. A Steinmann pin (or a burr drill) can be used to create the initial entry into the bulla. I use a pin and complete the osteotomy with rongeurs. Bacterial cultures are obtained at the time of entry. Warm saline and suction [Frazer tip] is used to lavage and clear the bulla. Any tissue or debris is extracted and the epithelial lining of the bulla is removed through a combination of lavage, gentle curettage and suction. Care is taken to avoid damage to the sympathetic nerve fibers running along the osseous promontory in the dorso-medial portion of the bulla. Damage to these fibers can result in Horner’s syndrome or other signs of vestibular dysfunction. Fortunately, these signs are generally temporary.

Once the bulla is cleared of debris and the epithelial lining is removed, the cavity is lavaged with warm saline and suctioned dry. Closure is routine - although some surgeons place a Penrose drain in the bulla for 2-3 days to allow for additional drainage. I prefer fine, monofilament absorbable sutures in the deep layers and appositional skin sutures for skin closure. I cover drains with a light bandage.

Comments / Tips:
- It is important to remember the cat has a medial and lateral compartment to the bulla. During a ventral bulla osteotomy procedure, both compartments must be opened.
- Dogs and cats with a pre-existing head tilt may not have complete resolution of the abnormality. Most animals with no pre-existing head tilt which develop one immediately after surgery will have complete resolution after a few weeks.
- Feline inflammatory polyps may also be obstructing the oral cavity or soft palate. Check the oral cavity and the nasopharyngeal areas after surgery to make sure all tissue has been removed.

TOTAL EAR CANAL ABLATION:
Total ear canal ablation is one of the most rewarding procedures I perform. The reason is that in many cases, I am able to restore a relationship between an owner and their pet that has suffered months and often years of strain caused by the never-ending battle to maintain the health of the dog’s ears.

The surgery is pretty accurately described by its name, ”total ear canal ablation” but this designation alone neglects a vital portion of the procedure - a concurrent bulla osteotomy. The bulla osteotomy can
be performed from either a ventral or a lateral approach. The lateral is the most common since the removal of the ear canal given the surgeon direct access without an additional incision.

**Indications**

The primary indications for a total ear canal ablation - lateral bulla osteotomy (TECA-LOB) is a chronic, end-stage ear canal in the dog or cat. In most animals, this is represented by a thickened, inflamed ear canal with multiple (and often resistant) micro-organisms. The ear is painful and the interior is swollen and thickened from hyperplasia of the tissues. The aroma is terrible and may be encountered upon entering the examination room. The history for most dogs needing a TECA-LOB is long and convoluted. The list of treatments and efforts at controlling the infection / inflammation is often quite impressive.

**Important Anatomical Structures**

Anatomic review is very important with this surgery; a good surgical text and your anatomy book should be consulted before attempting this procedure. Review the location of the anatomical structures: maxillary artery, great auricular artery, superficial temporal artery, caudal and rostral auricular veins, parotid gland and facial nerve. Careful preparation will improve the chances of a complication-free surgical procedure.

**Surgical Procedure**

**Preparation:** Patients are placed in lateral recumbency with the head slightly elevated. The entire ear and the lateral surface of the head is clipped. The ear is cleaned as thoroughly as possible. Once this is complete, a dirty prep of the surgical area is performed and the patient is transferred to the operating room. Some surgeons like to hang the ear while others will fold the ear on the prepared surgical site. A sterile prep is completed and the surgical site is draped in a routine manner. The over -drape is incised to allow the pinna to be passed through. Although the pinna does not have to be exposed in this manner, I like to be able to manipulate the pinna during the procedure (this is why I have the entire pinna clipped and included in the prepped area).

Once the sterile field has been established, I use a "T" incision to begin the procedure. The base of the "T" extends 1-2 cm beyond the ventral aspect of the ear canal. The upper portion of the "T" curves around the base of the external opening to the ear canal. Expect brisk hemorrhage in most cases. Electrosurgery or another method of hemostasis will be most useful for a TECA-LOB surgery. Some authors like to begin their dissection with the mid-portion of the ear canal but I begin at the top and work my way down to the base of the ear. I incise around the external opening of the auditory canal. You must take care to correctly gauge the depth of your cut as you go around the medial aspect of the ear canal. If you incised too aggressively, you may go through the cartilage and through the lateral aspect of the pinna. While a small incision can be routinely repaired, a larger incision could result in compromise of the vascular supply to the pinna and cause necrosis of the pinna. Normally, I make a skin incision down to the cartilage and make the cartilage cut using cartilage scissors. In this manner, the depth of the cut can be better controlled. Once the external portion of the ear canal is freed from the pinna, I place a towel clamp across the opening to aid with traction.

**Canal resection:**

The first key to a successful total ear canal ablation surgery is to STAY CLOSE TO THE EAR CANAL. Once dissection extends beyond the initial opening, the surgeon should hug the external ear canal for the rest of the procedure. This technique will minimize the risk to those anatomical structures previously discussed. Continue the dissection in small segments, using sharp-sharp or Metzenbaum scissors or electrosurgery. My preference is sharp dissection. Make sure the tips of the scissors are turned so they roll around the ear canal. This will help maintain proximity to the ear canal during dissection.

Use a finger to probe and determine the position and depth to the skull. The caudal edge of the zygomatic arch and the temporal bone can be palpated on the medial aspect of the dissection. As the dissection continues, the surgical field shrinks, narrowing down to a smaller and smaller hole. As the junction of the auricular and annular cartilage, start looking for the facial nerve. As previously discussed, the facial nerve exits the skull through the stylomastoid foramen and courses ventrally to the external ear canal. It is the most susceptible to damage during dissection on the ventro-caudal aspect of the ear canal. Some surgeons always identify the facial nerve (find it and know why not to be); others don't hunt for the nerve if
Once I have identified the facial nerve, I begin the final dissection. I use a Freer periosteal elevator to aid with elevation of tissues from around the bulla. The combination of elevation and continued sharp dissection should allow the surgeon to complete the dissection of the external canal to the level of the external auditory meatus. Next, sever the ear canal from its bony attachment. This generally accomplished by cutting the canal with cartilage scissors direct in a caudo-ventral to cranio-dorsal direction which decreases the risk to the facial nerve. When the ear canal is calcified, severing the canal often requires significant effort. A few especially challenging ears canals require using a scalpel blade or even an osteotome or bone cutter.

After ear canal removal, clear any remaining cartilage from the external auditory meatus. This may require the use of the periosteal elevator and rongeurs. I gently elevating tissue in a ventro-caudal direction until the bulla is visualized; this aids during the bulla osteotomy that is the next step.

If you quit at this point, you can truthfully say that you have performed a TECA. However, you can also bet that you will still see problems because without a lateral bulla osteotomy, the job is not complete.

Lateral bulla osteotomy
For the lateral bulla osteotomy, I use an assortment of “Kerrison-type” laminectomy rongeurs. These rongeurs are a pistol-shaped with a narrow shaft and a relatively small bite and close by squeezing the pistol grip. Place the tip of the rongeur inside the edge of the external auditory meatus and slowly nibble away the ventral aspect of the opening. The ventral edge of the auditory meatus is quite thick and can be challenging to remove. This is why the laminectomy rongeurs are useful.

 Debate exists over the extent of the lateral bulla osteotomy. I advocate a large opening and generally take off most of the lateral aspect of the bulla. Next, the interior of the bulla must be cleared of all debris. A variety of ear curettes, with a “surgeon specific” bend, aid in the cleaning of the bulla. Other instruments, including DeBakey forceps, and a Freer elevator, can be used to aid with the removal of debris. Copious lavage is important and extremely useful in washing away debris and allowing remnants of tissue within the bulla to be visualized. The effort to clean out the bulla is controlled to prevent damage sensitive structures within the bulla. Excessively aggressive débridement is likely to result in damage to the sympathetic nerves in the bulla.

There is a “pearl” of inflammatory tissue located on the cranio-lateral aspect of the bulla. It hides behind the rim of the bulla and must be teased from this position. Once the bulla is cleared of inflammatory debris and epithelial lining, the surgeon should see the slightly dull, “bone” color of the underlying bone. In painting terms, it has a “matte” or “semi-gloss” appearance. If the interior of the bulla still appears glossy, then the epithelial lining has not been removed. This is often more difficult in less affected ears because chronic inflammation generally results in hypertrophy of the bulla lining.

Bacterial culture and sensitivity
I obtain bacterial cultures after clearing the bulla of debris and completing a copious lavage of the bulla. Previously, I obtained culture immediately after removing the ear canal but I found I was growing lots of different, really “ugly” bacteria. And furthermore, I found that the dogs did well with minimal antimicrobial therapy. I finally realized I was not interested in what used to be in the ear and the bulla but rather, I wanted to know what was going to be left at the end of surgery. This was what needed to be treated - not the bacteria that were now in the histopathology bucket. So, I recommend culturing immediately before closing and then I feel comfortable about having an accurate representation of the bacterial population of the surgical site. If I obtain a positive culture (and in some cases, the culture comes back NEGATIVE), then I recommend antibiotic therapy, based on the antibiotic sensitivity, for a minimum of 4-6 weeks.

Closure
Incision closure is routine. Again, the surgical site is lavaged with warm saline and aspirated dry. At this point, the surgeon has to decide if they want to place a drain in the surgical site. At one time I typically placed a Penrose drain after a TECA, but a study showed no greater incidence of post-operative
complications (seroma and infection) when the drain was omitted. I stopped drain placement and have been pleased with the results. If a drain is used, take care to avoid capturing it when closing the incision.

The surgical site is closed using a 3/0 or 4/0 absorbable suture material. The skin closure is performed with 2/0 - 3/0 non-absorbable suture in an interrupted pattern (I achieve better skin apposition with this closure), but skin staples or an intradermal pattern can be used.

Complications
The myriad of possible complications make the TECA-LOB surgery a challenging procedure. Complications will be discussed as either “immediate” or “delayed”. Owners should be given complete disclosure about the risk of complications. Surgeons who are inexperienced in performing this procedure should anticipate a higher complication rate than those seen by more experienced individuals. These complications should be discussed with clients when presenting a TECA-LOB as a treatment option (Table 1). Since this table consists of reported and encountered complications, individuals may have the misfortune of adding to the table from their own experience or from additional readings. (Next page)
### TABLE 1: TECA Complications to discuss with owners

<table>
<thead>
<tr>
<th>Immediate Complications</th>
<th>Associated with surgery or the immediate, post-surgical period, may be self-limiting, others can be life-threatening.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hemorrhage</td>
<td>From damage to either the caudal auricular artery or one of the auricular veins, often challenging to control since vessels tend to have oblique damage (i.e. tearing along the side of the vessel) and visualization in the diminutive surgical site (level of the bulla) is quickly obscured by hemorrhage. Don’t blindly grab for vessels, aspirate the site to remove the blood and use hemostatic agents. These, in combination with direct pressure and patience, offer best hope for easy control. In some situations, the best option may be packing the surgical site and temporarily closing the incision. Surgery is then completed 24-48 hours later.</td>
</tr>
<tr>
<td>Local cellulitis</td>
<td>Uncommon in our hands. Careful surgical preparation and copious lavage should minimize this. Keep drains, if used, covered. Warm compress the incision and change the bandage daily.</td>
</tr>
<tr>
<td>Facial Nerve Damage</td>
<td>Can be minor (temporary) or severe (inadvertent transection). Patients should always be evaluated for post-operative function. If the nerve was transected, repair can be attempted by suturing the epineurial sheath. While this will not insure healing and return of function in the future, it is the most practical alternative for most surgeons. Suturing the epineurial sheath is done with very fine, non-absorbable suture (8/0 nylon). Generally 6-8 sutures are sufficient to achieve apposition. Patients are managed with eye lubrication until the blink reflex returns or until the animal learns to retract the globe in order to have a passive closure of the eyelid.</td>
</tr>
<tr>
<td>Deafness</td>
<td>Considered a “complication” although I tell owners this is expected. Some dogs continue to respond. BAER can be performed before surgery to determine degree of pre-surgical deafness if owners are concerned.</td>
</tr>
<tr>
<td>Incision dehiscence</td>
<td>Not uncommon to see some dehiscence at the junction of the “T” incision. It is generally managed with “benign neglect” and routine incision care and allowed to granulate. More excessive dehiscence is most likely associated with surgical site infection.</td>
</tr>
<tr>
<td>Dyspnea</td>
<td>Post-operative complication which can be life threatening. The etiology is unknown but might involve inflammation (swelling) of laryngeal tissues or inadvertent disruption of laryngeal function, or unobserved regurgitation and aspiration.</td>
</tr>
<tr>
<td>Head tilt (vestibular nerve injury)</td>
<td>When present before surgery, it is likely to be permanent. If present after surgery, it will often resolve with time. May also see Horner’s syndrome with damage to nervous structures of the middle and inner ear. It is generally secondary to overzealous curettage of the bulla.</td>
</tr>
<tr>
<td>Pinna alterations</td>
<td>As discussed, it can cause necrosis of the pinna with damage to auricular vessels. Dogs &amp; cats with erect ears may have altered ear carriage after surgery.</td>
</tr>
<tr>
<td>Fistula / abscess formation</td>
<td>Can occur days to months after surgery. Swelling and then rupture of the abscess under pinna can occur. Typically it is responsive to antibiotics but reoccurs after antibiotics are discontinued. It is consistent with retention of contaminated tissues in or around the bulla and requires exploration of the surgical site and removal of the responsible tissues. If a second surgery is not curative, a ventral approach to the bulla is recommended.</td>
</tr>
</tbody>
</table>
Surgical Shorts –
Quick tips for specific procedures

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Introduction:
This lecture will present a number of short topics to help with management of surgical patients. These include:
- Performing a tracheostomy,
- How to create a simple wound diffusion catheter at the surgery table,
- A modified technique to surgically insert a gastrotomy tube.

Tracheostomy:

Developing a level of comfort in performing a tracheostomy is important for a clinician. Tracheostomies can be either emergent or planned surgeries. An emergency tracheostomy is performed when there is a severe upper respiratory tract obstruction. Situations demanding an emergent tracheostomy typically occur with little advance warning and in some circumstances must be performed under less than optimal conditions; i.e. an unstable patient in severe respiratory distress, at the cage-side or in the critical care unit, and with inadequate patient preparation. Planned tracheostomies are performed to provide an airway for patients prior to diagnostic or surgical procedures of the upper airway or oral cavity. Normally, there is the potential for severe airway obstruction or the need to have an alternative to orotracheal intubation.

Planned tracheostomies are performed under controlled, aseptic conditions. They offer the clinician an excellent opportunity to become familiar with the steps of performing a tracheostomy in a calm, minimally stressful environment.

Instruments for performing a tracheostomy include:
- Scalpel blade (10 or 15 blade) and handle,
- Needle holders,
- Suture scissors,
- Metzenbaum scissors,
- Mosquito hemostatic forceps (2) and,
- A small Gelpi retractor.

Suture materials include:
- a monofilament, non-absorbable (e.g. 2/0 Ethicon [nylon])
- and an absorbable monofilament suture (e.g. 3/0 or 4/0 Monocryl), and
- Umbilical tape.

The patient is placed in dorsal recumbency and a towel is placed under the neck to extend the head and flatten the ventral neck. In all but the most extreme circumstances, the neck is clipped, prepared and draped for aseptic surgery. The prepared area includes the cricoid cartilage and extends caudally to the thoracic inlet and laterally ½ the distance to dorsal midline.

The tracheostomy is begun by incising along the ventral midline of the neck. The incision is centered 3-5 tracheal rings below the cricoid cartilage and extends from the cricoid 5-10 cm towards the manubrium. The clinician is cautioned to avoid incising too deeply when making the skin incision; especially since it may tense when a tracheostomy is being performed.
After the initial incision, bleeding is controlled with hemostats or electrocautery. The subcutaneous tissues are separated and the sternohyoideious muscle identified. The muscle is split revealing the ventral surface of the trachea. Gelpi retractors are placed in the incision for retraction and improved visualization.

It is important to carefully place the Gelpi retractors so as to avoid unintentional injury to the esophagus, the vagosypathetic trunk, the jugular vein or the carotid artery. It is also important to avoid damaging these structures when incising into the trachea or during other portions of the procedure.

Once the extent of the trachea is visualized, the fascia covering the trachea is dissected away, exposing roughly 50% of the tracheal diameter. Excessive dissection does not improve visualization and increases the risk to adjacent structures and the potential of vascular compromise to the trachea.

Next, two stay sutures (2/0 monofilament nylon) are placed above and below the intended incision site and are tied as long loops (8-10 cm). These stay sutures aid manipulation of the tracheal stoma. Before this is done, you must check the location of the endotracheal tube (if one is in place) to avoid snagging the inflated cuff with the stay sutures. It may also be helpful to accentuate the curvature of the suture needle (i.e. bend it) before placing the stay sutures. This is especially true when using a flatter needle (3/8 curvature) normally associated with skin sutures. The stay sutures can pull the stoma apart when the changing or replacing the tracheostomy tube.

The actual tracheostomy can be performed by several different techniques. I routinely make a horizontal incision between tracheal rings 3-4 or 4-5. The incision extends roughly 40-50 % of the circumference of the trachea. Again, care is taken to avoid iatrogenic injury to structures on the sides of the trachea.

With the tracheal incision made, the endotracheal tube is withdrawn (Figure 8) and the tracheostomy tube is inserted. If additional anesthesia will be required, you can insert a regular cuffed, endotracheal tube. Replace this with a non-cuffed tube at the discontinuation of anesthesia.

Placing traction on the stay sutures will open the tracheal stoma for easy insertion of the tracheostomy tube.

I partially close the tracheostomy incision site with a few subcutaneous and skin sutures to decreases the size of the open wound. Use a non-adherent pad is cut to go around the tracheostomy tube and the neck is lightly bandaged. Make sure the bandage is secure. Avoid excessive bulk since a large or shifting bandage could obstruct the tracheostomy tube.

When choosing a tracheostomy tube, the tube should fill 50-60 % of the tracheal lumen. The tracheostomy tube is secured around the neck with umbilical tape or gauze to prevent dislodgement. A non-cuffed, double lumen tracheostomy tube (Shiley tube) is my choice for routine use. The double-lumen tube allows for easier management of the tracheostomy tube. The inner cannula is simply un-locked and removed from the outer cannula to permit cleaning. Since the outer cannula remains in place, there is minimal risk of respiratory distress and replacement of the inner cannula is simple. Unfortunately, double lumen tubes are not available in very small sizes. In these patients, I simply have two tracheostomy tubes that can be interchanged with one in place and one being cleaned and soaked in a mild antiseptic solution.

To change the tracheostomy tube for cleaning, any bandage material used to secure the tracheostomy tube is removed. Traction is applied to the stay sutures and the tube is withdrawn. The stoma site is quickly cleaned, being careful not to dislodge debris into the tracheal lumen. The replacement tube is inserted through the lumen and secured. Although it may seem self-evident, it is essential the tube be correctly inserted back into the tracheal lumen. Incorrect tube
placement can have devastating consequences. The fresh tube is once again secured to prevent it from dislodging.

If the tracheostomy tube is placed for mechanical ventilatory support, a cuffed tracheostomy tube is used. The cuff is inflated only enough to prevent leakage during positive pressure ventilation. Over-inflation of a tracheostomy tube cuff is one of the most common causes of tracheal stenosis in patients with long-term tracheostomies.

Final thoughts:

When finishing the tracheostomy, I sometimes place 1-3 horizontal mattress sutures through the sternohyoid muscles. These sutures are passed dorsally to the trachea and are tied to draw the sternohyoides muscles dorsal to the trachea. This elevates the ventral surface of the trachea toward the ventral surface of the neck. This reduces tension and minimizes soft tissues which could occlude the tracheostomy stoma. This step, although essential for a permanent tracheostomy, is not required for every temporary tracheostomy.

Soaker catheter:

A “soaker catheter” is simply a multi-fenestrated tube that is placed in the surgical wound before closure to allow for the infusion of local anesthetic into the surgical site. It is an excellent technique for augmenting other post-operative analgesia protocols.

The technique is called a “soaker catheter” because of the resemblance to the soaker hoses sold for use in landscaping applications and gardens. Commercial soaker catheters are available (Diffusion/Wound catheter; MILA international, Erlanger, KY) but they are simple to create. You can make soaker catheters ahead of time and re-sterilize them to have on hand or you can create them at the surgery table. To make a soaker catheter, we take a sterile, 3.5 Fr red rubber catheter. Determine the length you need to implant into the wound bed and then trim off the fenestrations at the distal end and heat seal the distal end. We attach a syringe and double check that the end is completely sealed before proceeding. Once the end has been sealed, numerous fenestrations are made - roughly 1 cm apart - through the catheter. Use the smallest needle possible for this since the size of the fenestrations will effect the overall delivery of local anesthetic throughout the wound bed. I prefer a 30g needle that you can find on an insulin syringe. Place the catheter on a sterile huck towel (or other soft surface that will allow penetration of the needle through both sides of the catheter without penetrating your table drape or dulling the needle) and pierce the catheter through and through every 1 – 1 ½ cm along the desired length. Take care not to extend the fenestrations beyond the exit point of the catheter. Again, infuse saline into the catheter and confirm that the soaker action is working.

Place the catheter in the wound bed and close routinely, but take care not to suture the catheter into the wound. As with any drain or tube, it is better to have the soaker hose exit the wound bed through a small stab incision adjacent to the primary incision. Secure the catheter with a finger trap (3/0 nylon suture) around the catheter making sure not to occlude the catheter with the finger trap. We normally infuse bupivicaine - diluted with saline - through a soaker hose and will begin this immediately after skin closure. We repeat the infusions every 6-8 hours and have maintained the catheters for 3 days. The catheter capped with an adaptor and a catheter cap. It should be bandaged to prevent premature removal and contamination. If you notice pain on infusion, or if you see increased inflammation at the surgical site, it is possible that there could be some infection or a foreign body reaction secondary to soaker catheter placement. Discontinue administration and check the site. Remove the catheter is you think it is causing problems.

Modified gastrostomy tube placement:

Introduction:

We are often asked to place a gastrostomy tube for supplemental, enteral nutrition in a surgical patient. Numerous techniques have been described for tube placement and this will describe a
technique brought by Dr. Jamie Bellah that we have modified and continue to use on a regular basis. It is a modification of the original PEG-tube (i.e. percutaneous, endoscopic-placed, gastrostomy tube).

**Equipment:**
2. Balfour retractor
3. Trocar chest tube; 8-12 Fr is adequate (Argyle Trocar; Medtronic)
4. Pezzer catheter (Bard)

**Procedure:**
We place stay sutures in the ventral aspect of the stomach wall. Pack off the stomach with moistened laparotomy sponges and elevate the stomach. A small (2-3 cm), full-thickness incision is made between the stay sutures. The trocar catheter is inserted into the gastric lumen and is forced through the gastric wall along the greater curvature in the fundic region of the stomach. The trocar is directed towards the left body wall.

An exit site is identified about 3-6 cm behind the last rib and located 1/3 to ½ the distance dorsally. The trocar is bluntly continued through the lateral body wall and exited through the skin (a small stab incision will allow the trocar to exit the skin). The overlying chest tube now extends from the gastrotomy incision through the gastric lumen, stomach wall and the body wall to exit the skin. The larger end of the Pezzer catheter is cut at an angle and the end is inserted firmly into the flared end of the chest tube. With the catheter firmly in place, the chest tube is drawn through the gastric lumen, stomach wall, the body wall and skin, dragging the Pezzer catheter behind.

Once the tip of the Pezzer catheter is drawn through the skin, it is secured with a clamp. The gastrostomy incision can now be closed (3/0 or 4/0 monofilament, absorbable). The stomach is sutured to the body wall – around the gastrostomy tube – making sure to securely appose the stomach wall to the body wall. I use an interlocking box suture pattern for this (see below). Care should also be taken to ensure you do not inadvertently suture the gastrostomy tube during placement of the sutures.

The catheter is pulled to secure the Pezzer tip against the stomach wall and it can be cut to the desired length and secured with a finger-trap suture. A light bandage can be used to cove the exit site.

**Why do I like this procedure?**
The short answer is this technique avoids potential complications and headaches I have encountered with other, more traditional techniques.
1. You are able to make a smaller gastrotomy incision for tube insertion.
2. You don’t have to try and force the gastrostomy tube through a larger incision and then close a surgical wound around a tube (violating the basic principle of not having drains or tubes exiting through incision sites as they increase the risk of wound dehiscence),
3. You use a sharp but non-cutting tip (trocar) to penetrate the stomach wall and the body wall. This action forces the tissue fibers apart rather than cutting them. This should result in less leakage around the tube and less risk of continued leakage if the tube is removed prematurely.
INTRODUCTION:
Gastric dilation and volvulus (GDV) is a commonly encountered emergency surgery in small animal practice. Clinical signs of GDV can vary dramatically - from the restless dog with mild abdominal distention to the moribund, septic dog with a ruptured stomach. Dogs with a clinically apparent GDV need to have immediate intervention to alleviate clinical distress and subsequent intervention to restore normal anatomic relationships and prevent reoccurrence of the condition.

Pre-surgical stabilization:
As with all emergent surgical conditions, taking some time to improving patient stability will generally result in better outcomes. Restoration of a more normal cardiovascular status - using fluid boluses of crystalloids, colloids and/or hypertonic saline - should be initiated. At the same time, gastric distention needs to be reduced by passage of an orogastric tube. I avoid gastrocentesis or trocharization except as a last resort. Under these circumstances, try to relieve the distention and THEN re-attempt passage of an orogastric tube.

Having said this, the idea of achieving “patient stability” before surgery is a challenging and ever-changing goal. The key is making appropriate interventions, close monitoring and subsequent evaluation of the patient’s condition. In some situations, patient status is not going to improve until you attempt surgery.

Surgery:
We try to begin by pre-clipping our patients to minimize the delay after induction of anesthesia. A wide surgical clip allowing for an incision from the xiphoid to the pubis is recommended. If you anticipate that you might need to place a drain, feeding tube, etc, clip and prepare for those as well.

A standard ventral midline incision is made to begin. Care is taken to avoid injuring (incising) the distended stomach or the spleen which may be directly beneath the linea alba. I routinely remove the falciform ligament but alternatively, it can be released to one side of the abdominal incision. Balfour retractors can be placed to aid with visualization and manipulation.

Evaluate the stomach. The omentum will be pulled over the exposed (ventral) surface of the stomach. The greater curvature may be discolored - from red to dark purple to purplish-grey. Residual gastric distention is removed through the manipulation of the orogastric tube or by direct gastrocentesis [we use a 16-18 g needle connected to the house vacuum system] to try and get the stomach as decompressed as possible. Once this is accomplished, the repositioning of the stomach is much easier.

Standing on the right side of the dog, locate the displaced pylorus. Typically, I run my hand down the left body wall (opposite from where I am standing) and locate the pylorus. Once I have the pylorus grasped [right hand], the remaining hand [left] presses down on the greater curvature of the stomach - pushing it dorsally - while the pylorus is pulled back toward the surgeon [ventrally and toward the right side]. Once the stomach has been rotated back into place, the omentum will resume its normal position. Palpate the esophagus ensure there is no obstruction or twist remaining (it has been reported that the stomach can rotate several times). The spleen may also need to be re-positioned.

Next the integrity of the stomach is evaluated. Options for managing the discolored stomach wall include: no-intervention, gastric wall invagination, partial gastrectomy (resection) or a second-look surgery.
The spleen is evaluated next. If the splenic parenchyma has evidence of thrombosis or necrosis, a decision must be made to perform a partial or total splenectomy. Although it was once considered routine to perform a splenectomy in dogs with GDV, it is not required in the majority of dogs with GDV.

Finally, a decision about performing a gastropexy must be made. It is NOT a requirement at this point as in rare circumstances; it might be in the patient’s interest to end the surgery quickly with the intent to perform a gastropexy in the (very) near future. In these situations, maintaining gastric decompression is vital. This would be a very uncommon option for us.

**Gastropexy:**
While most gastric surgery can be performed with a basic surgical pack, several other pieces of equipment can make the procedure go much smoother and easier.

Additional equipment needs:
- Balfour abdominal retractor
- Suction
- Electrosurgical unit
- Skin staples
- Additional towel clamps (small)
- Laparotomy sponges / sterile surgical towels
- #15 scalpel blade (for gastropexy incisions)

**Gastropexy techniques:**
There are actually more than half a dozen techniques reported for operative gastropexy. The most common options are presented below.

**Incisional**
Begin by creating a partial thickness incision on the ventral stomach wall (incising the serosa and muscularis layer; allowing the mucosa to bulge out). Make a corresponding incision in the body wall on the right side, incising through the transversus muscle. There may be some hemorrhage. Separate through the muscle layer to allow identification of the underlying muscles (internal abdominal oblique). Now, suture the edges of the gastric incision to the edge of the body wall incision. This can be accomplished using: 1) a single strand, simple continuous pattern tying the suture back to itself, 2) starting a strand and suturing the caudal aspect of the incision with a second strand to close the cranial incision, or 3) you could use a simple interrupted pattern to appose the edges.

Try to get good apposition between the wound beds. This techniques is relatively fast to perform and creates a reliable adhesion. Incisional gastropexy may be the simplest option for a lone surgeon to perform. I normally use 3/0 PDS on a SH needle, but any synthetic, absorbable suture should be adequate.

**Belt-loop**
Create the belt-loop (parallel vertical incisions roughly 15-20 mm apart) in the body wall through the transversus muscle. Bluntly dissect (scissors) to undermine the muscle and to connect the two incisions. Avoid placing the belt-loop incisions too far cranial where there might be inadvertent penetration of the diaphragm. Develop the “belt” on the stomach wall along the greater curvature of the stomach. I like to base my flap near the greater curvature. Incision placement is roughly 1/4 to 1/3 of the distance between the pylorus and the cardia. The “belt” consists of the gastric serosa and muscularis. The size of the flap should complement the size of the belt-loop. Avoid long thins flaps since there could be compromised blood flow and subsequent necrosis. The flap must be handled gently (stay sutures).

Pass the “belt” through the belt-loop by passing a hemostat through the belt-loop (cranial to
caudal) and grasping the stay suture that was placed in the gastric flap. Withdraw the hemostat pulling the suture through the belt-loop. Draw the bulk of the stomach over to the right body wall with your hand rather than pulling it over by pulling the gastric flap. The gastric flap passes through the "belt" in a caudal to cranial direction. After making sure the gastric flap is not rotated or kinked in any way, it is replaced on its original wound bed and secure with simple interrupted sutures (3/0 or 4/0 PDS) at the corners. Appose the remaining portions of the flap using interrupted or continuous sutures.

You might want to place 1-2 sutures along the edge of the abdominal wall "belt" to partially close this incision. Additionally, a couple of "safety" sutures can be placed between the stomach and body wall to help prevent tension on the flap while healing occurs. I especially like doing these sutures when I have a dogs with GDV that has a lot of gastric content which was not able to be removed via stomach tube.

Other techniques you might encounter include:

**Circumcostal**
This technique is similar to the belt-loop gastropexy since it uses a pedicle flap elevated from the ventral aspect of the stomach. The primary difference is that the gastric flap is passed around the rib instead of through a muscular tunnel. It may be easier to develop the flap on the lesser curvature and to pass the flap in a cranial to caudal direction.

**Rib-fracture**
A recently published technique based on the circumcostal gastropexy. Involves the fracture or cutting of the rib instead of dissecting around the rib. The 12th or 13th rib is cleared of muscular attachments. A bi-pedicile flap is elevated off the ventral surface of the stomach. The rib is cut and the exposed portion is inserted through the stomach flap. The rib is secured with a K-wire and cerclage wire to approximate the ends.

**Role of prophylactic gastropexy:**
Indications for prophylactic gastropexy break down in to two categories:
1. Owner requested - typically patients with a breed disposition to GDV, familial history of GDV, or previous owner experience with GDV.
2. Medically indicated - includes those animals where the veterinarian feels there is an increased risk of GDV due to the patient's medical condition. Examples include dogs with large abdominal masses after surgery (splenectomies) or dogs with history of gastric distention and areophagia.

Discussion of prophylactic gastropexy is appropriate with owners of predisposed breeds, especially those animals that become extremely agitated during hospitalization or boarding or those that are facing multiple anesthetic or sedative episodes.

Options for prophylactic gastropexy include:
1. Any of the different "standard" surgical procedures for creating a gastropexy (see previous discussion),
2. Laparoscope-assisted gastropexy, and
3. Laparoscopic gastropexy.

**Open gastropexy:**
I have frequently suggested to students that an open, prophylactic gastropexy is an excellent method of learning how to perform gastropexies in a more controlled environment (i.e. not in the middle of the night, with a critical GDV patient on the table). Some surgeons routinely offer open gastropexy in predisposed breeds anytime they are in the abdominal cavity. While I have not gone that far, if we have a dog that exhibits risks factors for GDV and is an appropriate breed, we will offer the procedure. When done in
conjunction with an OHE, gastropexy does require a more extensive incision. Owners need to be aware of this in advance. Alternatively, I have used a modification of the lap-assisted gastropexy through a limited caudal abdominal incision. With the proper instrumentation, this can be easily accomplished.

**Laparoscopic-assisted gastropexy:**
This is a technique where a laparoscope is used to identify the correct area of the stomach to pexy. This area is assessed via a small, paramedian incision on the right of mid-line. Laparoscopic graspers are used to grasp the pyloric atrium along the greater curvature and to elevate this portion of the stomach into the body wall incision. Once the desired portion of the gastric wall has been herniated through the body wall incision, the serosal and muscular layers of the stomach wall are incised. The gastric mucosa should not be incised; if the partial thickness gastrotomy incision is made too deep resulting in penetration through the mucosa, simply place an appropriate number of interrupted sutures in this layer to securely appose the mucosa and complete the gastropexy. The edges of the partial thickness incision is sutured to the incised transversus muscles created by the body wall incision. The body wall incision and the laparoscopic portals are closed using routine techniques. The body wall incision seems to have more swelling after this procedure. While this may cause some mild concern with owners, I have not encountered infection as a problem. The incision should calm after 7-10 days.

**Laparoscopic gastropexy:**
A laparoscopic (closed) gastropexy is performed completely with laparoscopic equipment. There is increased time and effort based on laparoscopic skills. Accomplished laparoscopic surgeons can use the incisional or belt-loop type techniques to accomplish this.
SURGICAL PROCEDURES OF THE UPPER URINARY SYSTEM
( kidney biopsy, ureteral by-pass & bladder surgery )

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ANATOMY

The kidney is secured in a protected position within the abdominal cavity and technically, it lies in the retroperitoneal space. Complete examination of the kidney requires careful dissection of the kidney from its retroperitoneal attachments. This will result in hemorrhage from vessels entering the capsule. These vessels are relatively few in the normal kidney but may increase in the diseased kidney. Ligation or fine electrocautery will allow for a relatively blood-free surgical field. Some procedures are possible without completely freeing up the kidney from its normal attachments, but if you do have to free the kidney completely, it is important to secure it back into position. Failure to secure the kidney could result in torsion of the renal vascular and subsequent loss of the kidney.

The renal artery branches off the aorta and feeds the kidney directly. Renal arteries frequently branch before entering the hilus of the kidney. The right renal artery is reported to branch more frequently than the left. In a few cases, there can be multiple branches off the aorta to the kidney but I have infrequently encountered these. You may encounter multiple branches from a single renal trunk, but these branches arise very close to the aorta. The renal arteries enter the hilus and branch to form the arcuate arteries at the corticomedullary junction. Damage to the arcuate arteries will cause substantial bleeding during renal surgery or biopsy. When encountered during surgery, these should be avoided, ligated or cauterized to limit hemorrhage. The renal veins drain into the gonadal vessels on the left and into the vena cava on the right.

While a flank approach can be used for renal surgery, especially biopsy, a ventral midline approach is more common. Adequate incision length is important to help with visualization of the entire urinary system.

No matter the type of renal surgery, active diuresis of the patient after the procedure is indicated. In addition to fluid support, opioid analgesics should be considered. I avoid the use of NSAIDs or alpha-2 agonists for post-operative analgesia after renal procedures.

RENAI BIOPSY:

Renal biopsies are important for both diagnostic and prognostic information relating to kidney disease. The cause of renal disease, its duration and potential reversibility can be determined from an adequate, appropriate renal biopsy. Persistent proteinuria requires a renal biopsy to differentiate glomerulonephritis from renal amyloidosis. Renal biopsy is vital in prognosticating causes of acute renal failure. Biopsies showing tubular damage without damage to the basement membrane should carry a more favorable prognosis and may encourage owners to seek aggressive, supportive therapies, such as hemodialysis. In a few circumstances, such as suspected renal lymphoma, a renal aspirate might provide the needed diagnostic information.

Considerations:
Renal biopsies can be problematic. At least 5 glomeruli are needed for a diagnosis. Pre-biopsy evaluation should include complete evaluation of renal parameters. Assessment of coagulation ability (i.e. buccal mucosal bleeding time, platelet counts) is especially important is the biopsy is being performed under indirect imaging.

The renal cortex is biopsied to avoid the major vessels, nerves and ureter in the renal hilus. This is accomplished by directing the biopsy needle along the long axis of the kidney. Clinicians should choose large “tru-cut” needles (14-16g). Smaller “tru-cut” needles (18g and smaller) may have less risk of complication but sample too few glomeruli for a confident histopathologic diagnosis. If there is concern, the biopsy can be performed under laparoscopic or direct visualization; thus allowing the surgeon to evaluate and control any post-biopsy hemorrhage.

Needle biopsies (aka “tru-cut” biopsies) are probably the most commonly performed. Needle biopsies can be obtained as 1) a blind, percutaneous procedure, 2) percutaneous with ultrasound guidance, 3) through a “key-hole incision”, 4) under laparoscopic guidance and 5) during exploratory surgery. Again, it is important to avoid the renal pelvis as this can create a tract into the renal pelvis. The result can be substantial urinary hemorrhage and possibly urinary obstruction. Incisional kidney biopsies can be obtained if large samples are needed; however, I seldom use incisional biopsies unless a nephrotomy has already been performed. If a renal biopsy is needed along with a nephrotomy, I simply take a thin slice off the incision edge before nephrotomy closure.

**CYSTOTOMY:**

*Surgical basics*

Use a ventral incision to gain access. Dorsal incisions were advocated at one point based on fears of adhesions to the abdominal incision; however, these adhesions are very uncommon in the dog and cat. A ventral incision makes exploration of the bladder easier; stones don’t fall into the urethral neck as much and it is easier to identify the ureteral openings.

The bladder is emptied using suction or a large syringe prior to incision. Samples are obtained for evaluation or culture and sensitivity. Stay sutures are placed (full thickness and often in a cruciate pattern) to help manipulate the bladder. I use three silk stay sutures with one placed at the apex and the others placed at points representing the halfway point of the subsequent incision. A moistened laparotomy sponge is placed under the bladder to absorb any blood or urine that might spill. A stab incision is made using an 11 blade and the incision is extended with the blade or with Metzenbaum scissors. Hemorrhage is typically brisk. Gentle aspiration is used to remove any residual urine from the bladder. Care should be taken to avoid irritation of the bladder mucosa with the suction tip. As the incision is extended, the surgeon must make sure to avoid the trigone area and the ureteral openings. Furthermore, care should be taken to avoid incising through the dorsal aspect of the bladder. If this occurs, a couple of well-placed sutures should repair the damage.

*Procedure:*

What is the best suture pattern for repair of the urinary bladder? The answer, of course, is the one that fits the situation. In my hands, I generally use a simple continuous suture pattern for routine urinary bladder closure. In certain circumstances, such as when I have a traumatized bladder with an irregular tear or neoplasia requiring resection, I may use a simple interrupted pattern (or a combination of the two). What makes the decision? The inherent qualities of the
different patterns. Specifically, simple interrupted sutures allow for better apposition of tissue layers and for easier closure of irregular wounds edges. A simple continuous suture will create a more water-tight incision line and is faster and potentially more economic. Evaluation of the incision and the bladder integrity should guide the selection of the suture pattern for the easiest and most secure closure.

I have grown un-concerned about whether or not my suture enters the bladder lumen. In fact, I take full-thickness bites to ensure the submucosa is incorporated in the incision closure. What about the suture being a nidus for infection or urinary calculi formation? I don’t worry about it. First, use monofilament, absorbable suture for closure (typically 4/0 PDS II or Monocryl). Next, place the animal on appropriate dietary management (probably the biggest advance in urinary management). I use antibiotics only if indicated by UA or culture results. Finally, the evidence suggests the bladder mucosa rapidly covers the suture resulting in minimal suture exposure to the urine within the lumen. In a few situations.

I have used a double layer closure - 5/0 Monocryl to close the mucosa and then 4/0 PDS to close the submucosa, muscularis and serosa. Inverting patterns (Cushing or Lembert) are seldom used in my cases, however, they should be considered in situations where your suture selection is limited to non-absorbable, braided or monofilament suture. Inverting suture patterns cause mild to moderate incisional inversion. This results in slower healing and a reduction in bladder volume.

**Cystopexy:**

Cystopexy, the intentional creation of an adhesion between the bladder and the body wall, can be a primary procedure but is generally used to support other procedures. These include placement of a temporary or permanent cystostomy catheter, perineal hernia repair, bladder advancement to allow for ureter re-implantation, and colopulsion suspension. Once the location for the pexy is determined, the peritoneal covering of the body wall and the bladder serosa are abraded or incised. The two raw surfaces are placed in apposition and sutured in place. I prefer to use an interlocking suture pattern or a double purse-string. For most incisions, I use a long-lasting monofilament suture but if I need permanent adhesions, I use a non-absorbable suture (polypropylene). Additional, supporting sutures are placed. Remember to double check for catheter patency or trapping surgical disposables or instruments between the bladder and the body wall. It is also helpful to release or remove your abdominal retractors before determining the location of your pexy site.

**Temporary or permanent cystostomy**

A cystostomy catheter is placed when temporary or long-term urinary diversion is required. This may be secondary to acute or chronic urethral obstruction (from neoplasia or calculi) or severe urethral trauma. It may be the best method of urinary diversion after urethral surgery, particularly when urethral catheterization might damage or disrupt the surgical site or the healing process. I have place temporary cystostomy catheters using human nephrostomy catheters in a few cases where urinary diversion was needed. This can be useful in animals requiring additional stabilization before a lengthy anesthesia and surgical episode. Placing a cystostomy catheter is similar to performing a cystopexy. The site is determined and a Foley catheter is passed into the abdominal cavity at that site. Place either an interlocking box or a double purse-string suture in the bladder wall. Make a stab incision into the bladder and insert the catheter into the lumen. Temporarily inflate the catheter bulb and again check the location
of the pexy. Tighten the interlocking box and secure the bladder against the body wall. If additional sutures are to be placed, advance the catheter into the center of the bladder to avoid puncturing the bulb when passing any additional sutures. Secure the catheter with a “finger-trap” suture on the outside and connect it to a closed collection system.

When pulling a temporary cystostomy catheter, the catheter can simply be pulled and the site bandaged. The wound will rapidly contract and granulate closed. While this is useful when we want to remove the catheter, it also means that if the catheter is prematurely dislodged, it must be replaced immediately or an additional surgery may be required to re-insert the catheter.

General considerations or “odds and ends

Avoid placing post-operative catheters in most of your urinary bladder patients. Instead, provide the patients with access to outside areas where they can urinate every 4-6 hours - possibly more if they require post-operative fluids. While catheters are appropriate for animals in some circumstances (e.g. immobile animal, questionable integrity of the bladder or bladder closure, need to monitor urine production) I find they normally complicate management, they are frequently removed by the patients and they certainly increase the risk of ascending urinary infections - possibly with a more challenging infectious organism. If you place a catheter, please make sure the catheter is handled using good aseptic technique and connected to a closed collection system. Open-ended catheters are simply highways for bacteria. Take care if you decide to place a urinary catheter after surgery. I have encountered several situations where a polypropylene catheter (and a red rubber catheter) transversed the urethra, entered the bladder and exited the bladder through the cystotomy incision. While it was effective in preventing the bladder from becoming excessively distended, it was not effective in directing the urine into the collection system and the urine ended up in the abdominal cavity.

It is typical for patients to have post-surgical hematuria. Normally, the hemorrhage is short lived - with the majority occurring immediately after surgery. Some hematuria will occur - especially at the end of micturation - but the frequency and the amount should steadily decrease. Severe post-surgical hemorrhage can occur if hemostasis was incomplete and a vessel is hemorrhaging into the bladder lumen. In rare situations, transfusion or re-operation may be required to control blood loss.
Introduction:
There are a number of conditions involving the upper respiratory tract in dogs and cats. My experience is that upper respiratory distress is more common in dogs. Cats seem to become dyspneic more commonly from conditions associated with pulmonary or thoracic pathology. Despite this, all the conditions presented here have been reported in cats.

Tracheal Collapse
Tracheal collapse is a progressive condition associated with small breed dogs that result in significant respiratory distress. It is primarily found in breeds such as Yorkshire terriers, toy poodles and Pomeranians. The cervical trachea is most commonly affected but the collapse can extend along the thoracic trachea down to and including the main stem bronchus.

Tracheal collapse is believed to be caused by chondrodysplasia or softening of the cartilage rings in the trachea resulting in a slow loss of structural integrity. This causes the trachea to deform, especially during inspiration, causing a decrease in the cross-sectional area of the tracheal lumen. The smaller lumen results in increased respiratory effort and decreased intralumenal pressures, placing even more stress on the cartilage. This constant stress is suspected to hasten the progressive nature of tracheal collapse.

Clinical signs associated with tracheal collapse include: coughing, stertorous breathing, exercise intolerance, heat intolerance and cyanosis. In severe cases, the condition may progress to complete respiratory arrest and collapse. Many dogs are unable to sleep comfortably due to difficulty breathing and consequently the owners are unable to rest.

Diagnosing tracheal collapse is straightforward. However, many clinicians have the tendency to make the diagnosis with minimal supportive evidence and, in doing so, may overlook other reasons for the clinical signs such as cardiac disease or a primary respiratory problem.

The first diagnostic step is to obtain thoracic and cervical radiographs. These are taken as both inspiratory and expiratory films because the trachea’s appearance changes based on the stage of respiration. During inspiration, the cervical trachea is compromised while the intrathoracic trachea may appear normal. Animals with intrathoracic collapse may exhibit the opposite situation during expiration. I have not seen a dog with a strictly intrathoracic collapse. Radiographs also help to rule out other disease states.

Since tracheal collapse is a dynamic process, fluoroscopic examination is extremely useful in making the diagnosis. During fluoroscopic examination, the actual changes in a patient’s trachea can be observed. In most situations, complete occlusion of the tracheal lumen can be seen.

My final (and definitive) diagnostic procedure is a tracheoscopic examination. This is accomplished with a small flexible endoscope (3 mm) or with a rigid arthroscope. Unlike the other diagnostic procedures, general anesthesia is required for visual examination. The scope is guided into the trachea and advanced until the tracheal bifurcation is seen. I find I have the best visualization while withdrawing the scope up the trachea.

Direct visualization of the tracheal lumen allows for the assignment of a grade to the disease. The standard scale for grading tracheal collapse is presented in table 1. I feel that the diagnosis of tracheal collapse is not complete until the tracheal lumen has been visualized.

<table>
<thead>
<tr>
<th>Grade Classification</th>
<th>% Tracheal Lumen Compromise</th>
</tr>
</thead>
<tbody>
<tr>
<td>Normal</td>
<td>&lt;10 %</td>
</tr>
<tr>
<td>Grade I</td>
<td>10 - 25 %</td>
</tr>
<tr>
<td>Grade II</td>
<td>25 - 50 %</td>
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<tr>
<td>Grade III</td>
<td>50 - 75 %</td>
</tr>
<tr>
<td>Grade IV</td>
<td>&gt;75 %</td>
</tr>
</tbody>
</table>

Medical management is accomplished by using combinations of medications to inhibit the cough reflex, open the airways and decrease tracheal inflammation. Specifically, I use albuterol elixir and a cough
suppressant (butorphanol or hydrocodone) for most cases. Opioid cough suppressants are the most effective and have the added benefit of causing mild sedation to relax the excited and stressed patient. Obese patients may greatly benefit from weight loss - enough that other more aggressive measures may not be required.

**SURGICAL OPTIONS:**

*Intraluminal Tracheal Stents - Our current preference:*

See attached pamphlet (below).

**Dorsal membrane plication**

Dorsal tracheal membrane (trachealis muscle) plication can be an effective method of holding the dorsal tracheal membrane so that it does not hang into the tracheal lumen. A ventral midline incision is made and the trachea is rotated, exposing the dorsal tracheal membrane. Grasping the dorsal tracheal membrane, mattress sutures (fine, non-absorbable, monofilament polypropylene suture material) are placed, evert the membrane out of the tracheal lumen. This is repeated along the length of the cervical trachea. A smaller, more rounded trachea results once with the obstructing membrane pulled out of the lumen. Long term studies have not demonstrated the effectiveness of tracheal plication but it may have a place in the management of grade 2 tracheal collapse where the primary airway obstruction is caused by dorsal tracheal membrane laxity.

**External ring placement**

External support a flaccid or malformed trachea is the most common technique used for surgical management of tracheal collapse. This generally takes the form of custom made polypropylene rings or spirals placed around the outside of the trachea. Each technique has positive and negative aspects, however, the techniques share a basic surgical approach.

The trachea is approached using a ventral cervical incision. I find elevating the head and neck with a towel helps maintain a level surgical field. An incision is made from the laryngeal cartilage to the thoracic inlet taking care to avoid entering the chest cavity. The sternohyoideus and sternocephalicus muscles are bluntly separated to exposure the ventral trachea. The recurrent laryngeal nerve, jugular vein, carotid artery and vagosympathetic trunk are each identified. Preservation of these structures during dissection and retraction is vital and will decrease complications. From this point on, the techniques differ based on the type of support that is needed.

Individual tracheal rings can be placed around the trachea. These rings are created from 3 cc syringe cases cut to widths of 7-10 mm. Six equally spaced holes are drilled through the ring to allow suture passage. The ring is cut over the 6th hole to allow it to be placed around the trachea. The ring is secured by sutures encircling a tracheal ring and passing through the pre-drilled holes in the prosthesis.

Avoid jugular venopuncture or catheters when preparing to perform tracheal surgery. Hematomas make nerve and vessel identification extremely difficult.

A spiral ring prosthesis is a 3mm wide polypropylene support created from a syringe case. Placement of the prosthesis involves the dissection of the left tracheal pedicle and perforation of the right tracheal pedicle as the prosthesis is placed along the length of the trachea. Dissection of the left pedicle allows retraction of the left recurrent laryngeal nerve. Care is taken to place the spiral on the inside of the right recurrent nerve as it is passed around the trachea. The tracheal blood supply is segmental and visible blood vessels are preserved. The spiral encircles the entire length of the cervical trachea into the thoracic inlet. Once in place, 4/0 polypropylene sutures are placed at 6:00 and 3:00 and 9:00 to pull the trachea out to the prosthesis. The sutures tags on the 3:00 sutures are left long and are used to rotate the trachea so that sutures can be placed through the dorsal tracheal membrane (12:00 position). All sutures go around the spiral ring prosthesis and enter the tracheal lumen with knots on the outside. After all sutures are placed, the surgical site is lavaged and closed in a routine manner.

Reports of tracheal necrosis followed the initial publication of the spiral ring prosthesis technique caused it to fall out of favor. Excessive dissection around the trachea to permit easy passage of the spiral ring disrupts the segmental blood supply and causes post-operative tracheal necrosis. Dissection of a single tracheal pedicle should maintain the blood supply thereby avoiding this complication. Nonetheless, I always warn owners about this potentially devastating complication.
Management:

After intervention, the patient goals are to maintain tissue oxygenation, manage pain, prevent excessive coughing and avoid infection. Prior to extubation, tracheal collapse patients should have a nasal oxygen cannula placed. Oxygen is given through the endotracheal tube until extubation and through the nasal cannula thereafter. Opioids are used for post-operative pain management. At the same time, opioids, especially butorphanol, are effective cough suppressants. I frequently continue butorphanol (0.1-0.4 mg/kg IV or IM every 4 hours) once the initial pain is well controlled. Tranquilization with a very low dose of acepromazine (0.02-0.05 mg/kg IV or IM) enhances the effect achieved with opioids and helps relieve anxiety. Oral administration of butorphanol or hydrocodone (Hycodan) can be continued throughout the post-operative period and may be required long term. Placement of a permanent prosthesis is an indication for peri-operative antibiotic administration. I use either a first generation cephalosporin (22 mg/kg IV at beginning of surgery and then every 90-120 minutes) or ampicillin (25 mg/kg IV at beginning of surgery and then every 90-120 minutes). If oral medication is warranted after surgery, I tend to use Clavamox at the standard dosages, every 8-12 hours. Alternatively, doxycycline can be used, especially if there is a concern about mycoplasma species.
SURGICAL PROCEDURES OF THE LOWER URINARY SYSTEM

(urethrotomy, urethrostomy & urethral prolapse)

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URETHRAL PROCEDURES

Some general comments about urethral surgery in dogs and cats. First, there is a significant amount of hemorrhage during urethral surgery. Persistent irrigation is the best way to maintain a clear surgical field since the use of electrosurgery and excessive blotting of blood with surgical gauze creates urethral trauma that could influence the final results of the procedure.

After surgery, it is important that the surgical site not be disturbed. A natural clot forms over the surgical site and everyone wants to wipe this off and clean the wound. With very few exceptions, I leave this natural bandage in place and avoid further irritation to the surgical site. It is also important that your patient awakes from anesthesia wearing an Elizabethan collar (or a similar device) to prevent self-mutilation of the surgical site. Finally, most urethral procedures will result in substantial post-surgical hemorrhage when the animal urinates. This is to be expected. Urethrotomy incisions - especially those healing by second intention - will bleed every time the animal urinates for 2-10 days after the procedure. This degree of post-operative hemorrhage may necessitate patient hospitalization during this time to minimize client concerns. Careful monitoring of the packed cell volume (or HCT) should be done in these patients, especially if they were anemic prior to surgery.

Urethral retropulsion

Retropulsion is accomplished with the patient under general anesthesia. Additional anesthesia can be accomplished using local anesthetics through local infusion up the urethra or through epidural placement of a short-acting anesthetic. Next, a well-lubricated catheter is placed in the urethra to the level of the obstruction. The type of catheter is left to the individual, but I find that a large bore, red rubber catheter works well although a stiffer, polypropylene catheter might work well in some cases. I find that a Foley-type catheter is not stiff enough to help dislodge the obstruction and the use of Foley balloon impairs my ability to advance the catheter.

An assistant dons a glove and places their finger in the rectum. Placing ventral pressure on the urethra will permit the urethra to be distented. The primary clinician infuses saline into the urethra (through the catheter), distending it. Ideally, this will result in some loosening of the obstructed stones. In a coordinated manner, the urethral pressure through the rectum is released and the catheter advanced. At this point, some of the stones should be retropulsed back up the urethra. It is seldom that a single effort at retropulsion relieves the obstruction. In fact, I find that I may have to do several attempts to free up the obstruction (if it is going to be relieved).

One important consideration, you can inadvertently infuse a great deal of saline during retropulsion and you must be careful to not over-distend the bladder; especially, if there was already a substantial amount of urine in the bladder. I always drain the urinary bladder after
relieving the obstruction and leave the catheter in place to prevent the retropulsed stones from returning to the urethra. If this works, then an urethrotomy incision can be avoided.

Urethrotomy

Most urethrotomy procedures in dogs are related to urinary obstruction from calculi that passed into the urethral but became obstructed at the os penis. If a single stone becomes obstructed, urine is still able to flow around it but as multiple stones begin to accumulate behind the primary stone, the flow becomes more and more diminished until obstruction is complete. Before committing to an urethrotomy incision to remove the obstruction, attempts should be made to retropulse the stones into the urinary bladder (see previous section).

If an urethrotomy incision is needed to remove an obstruction, it is normally performed over the proximal base of the os penis in the dog. Care must be taken to stay on the midline or excessive hemorrhage may be encountered if the incision strays into the cavernous tissues. Small, Gelpi-type retractors can be used to maintain the incision. The retractor penis muscle is identified and dissected free from the penis. It can be moved to the side. If a catheter is in place, it makes identification of the urethra much easier.

Urethrotomy closure can be accomplished through primary suture closure or by letting the urethrotomy incision heal by second intention. Primary suture closure require meticulous apposition of the mucosal edges to minimize stricture formation. A fine (5/0 or smaller), monofilament, non-absorbable suture is my preference. Poor apposition will result in granulation tissue formation and this can lead to stricture. I normally let urethrotomy incisions heal by second intention. The dog will urinate from the distal urethra and the urethrotomy incision for several days but I have never experienced urethral stricture after letting a dog heal by second intention.

Urethrostomy

Surgical considerations for canine scrotal urethrostomy

Urethrostomy in the dog is normally performed as a scrotal urethrostomy. In this location, the urethra is relatively superficial and the urethra is curving from a perineal position to the ventral abdomen thereby allowing gravity to help prevent urine scald or urine migration into the SQ tissues. Accurate apposition the urethral mucosa to the skin (thereby creating a “muco-cutaneous” junction) is essential to creating a permanent urethrostomy. Intact dogs undergoing permanent urethrostomy should be castrated and a scrotal ablation performed. Care is needed with the ablation to ensure there is enough skin to permit the creation of a tension-free muco-cutaneous junction.

Surgical considerations for feline perineal urethrostomy

Accurately apposing the urethral mucosa to the skin (thereby creating a “muco-cutaneous” junction) is essential to creating a permanent urethrostomy. Perineal is the accepted, standard location in cats. Complications are higher in dogs with this procedure. Castration and penile amputation. Dissect penis free up to the ischiocavernosus muscle. This is important since inadequate dissection promotes urethrostomy stricture formation. I still use the recommendation that you should be able to insert hemostats to box-lock; if not, need further dissection is needed. Once this is accomplished and then is not any tension causing retraction of the penis, the penis is amputated and the urethra is split on the dorsal aspect and sutured to the
skin. Again, creation of a “muco-cutaneous junction” is essential since granulation tissue promote stricture formation at the urethrostomy site.

**Urethral resection and anastomosis**

This is a relatively uncommon surgery in veterinary medicine. Most indications include urethral trauma, neoplasia (e.g. prostatic adenocarcinoma, transitional cell carcinoma), and iatrogenic injury. If urethral resection is being planned, it is essential to review the pertinent anatomy for nerves and vascular supply to the urethra and bladder. The surgical plan should include some technique for urinary diversion during healing. A cystostomy tube or a urethral catheter can be used.

This is a challenging surgery and adequate visualization is essential (magnification). Fine, monofilament suture, simple interrupted appositional is best for the anastomosis. It is important that there not be any tension across the anastomosis site. The resected edges are apposed with full-thickness bites. Suture the dorsal side first - knots on the outside of the lumen. Care must be taken to avoid inadvertently catching the far wall with your suture. Having a urethral catheter in place at the time of suturing may help this. A Foley catheter can be used to pull the bladder caudally toward the urethra. A contrast study can be used to evaluate the procedure and to check for healing. In most cases, I pull the catheters in 7-10 days. It is a good idea to re-check the urethra in 30-45 days to evaluate for stricture formation

**SALVAGE PROCEDURES**

**Temporary or permanent cystostomy**

A cystostomy catheter is placed when temporary or long-term urinary diversion is required. This may be secondary to acute or chronic urethral obstruction (from neoplasia or calculi) or severe urethral trauma. It may be the best method of urinary diversion after urethral surgery, particularly when urethral catheterization might damage or disrupt the surgical site or the healing process. I have place temporary cystostomy catheters using human nephrostomy catheters in a few cases where urinary diversion was needed. This can be useful in animals requiring additional stabilization before a lengthy anesthesia and surgical episode.

Placing a cystostomy catheter is similar to performing a cystopexy. The site is determined and a Foley catheter is passed into the abdominal cavity at that site. Place either an interlocking box or a double purse-string suture in the bladder wall. Make a stab incision into the bladder and insert the catheter into the lumen. Temporarily inflate the catheter bulb and again check the location of the -pexy. Tighten the interlocking box and secure the bladder against the body wall. If additional sutures are to be placed, advance the catheter into the center of the bladder to avoid puncturing the bulb when passing any additional sutures. Secure the catheter with a “finger-trap” suture on the outside and connect it to a closed collection system.

When pulling a temporary cystostomy catheter, the catheter can simply be pulled after deflation of the balloon and the site bandaged. The wound will rapidly contract and granulate closed. While this is useful when we want to remove the catheter, it also means that if the catheter is prematurely dislodged, it must be replaced immediately or an additional surgery may be required to re-insert the catheter.

**Transpelvic urethrostomy:**
This procedure has been promoted as an alternative for pre-pubic urethrostomy and even as an alternative for perineal urethrostomy. The procedure has been described; Bernarde A, Viguier E. Transplevical urethrostomy in 11 cats using an ischial ostectomy. Vet Surgery. 33:246-252, 2004.

Prepubic urethrostomy:

This procedure is used for failed urethrostomy patients. The procedure involves using an abdominal approach to transect the pelvic urethra and to re-locate the urethral stoma on the ventral body wall.

I normally dissect the urethra free as far into the pelvic canal as possible. Next ligate and transect the urethra. The urethra is then pulled through the body wall in location that does not 1) create any tension on the urethra or 2) impinge on the urethral lumen (creating a kink in the urethra). I like to suture the urethra to the body wall (non-penetrating, polypropylene sutures) as it exits. This takes the tension off the skin sutures as the urethral stoma heals. Some additional, careful dissection may be needed to reduce the inguinal fat pad in cats. I find reducing the amount of adipose tissue in the area helps minimize urine scalding from excessive skin folds.

Cats undergoing a pre-pubic urethrostomy should retain bladder control after the procedure. Otherwise, post-operative care is similar for all urethrostomy.

General considerations or “odds and ends”

Tissue Handling:

Handle the urinary tract gently. It is easily inflamed and rough handling results in greater post-surgical irritation (prompting clients to call frequently to report “FLUFFY is always squatting and straining). Use gentle lavage to remove hemorrhage, don’t wipe the mucosal surface. Take care with suction and avoid or minimize incisional manipulation with forceps or hemostats. Avoid excessive electrosurgical application along bladder incisions. “Pin-point’ application can be accomplished using forceps and the cautery wand. Excessive carbonization from electrosurgery delays healing and may promote granulation tissue formation.

Hematuria:

It is common for patients to have post-surgical hematuria. Normally, the hemorrhage is short lived - with the majority occurring immediately after surgery. Some hematuria will occur - especially at the end of micturition - but the frequency and the amount should steadily decrease. Severe post-surgical hemorrhage can occur if hemostasis was incomplete and a vessel is hemorrhaging into the bladder lumen. In rare situations, transfusion or re-operation may be required to control blood loss.

Suture materials

Many options exist for suturing the urinary system. My preference is a fine, monofilament, absorbable suture. This would include PDS II and Maxon. Monocryl is very strong but has a rapid absorption rate in the tissues and therefore should only be used in normal bladders where you would expect the healing to be rapid and complete in a short period of time.

Monofilament, non-absorbable sutures (polypropylene >> nylon) can be used in situations where the healing is expected to be delayed. In general, this is not a suture recommended for
urinary closure. Braided, absorbable sutures have mixed reviews for use in the urinary bladder. Vicryl is considered acceptable but Dexon is not recommended for use in the acidic environment of the bladder. Chromic gut has been used as well but is not currently recommended. This is in spite of a recent study that showed that gut had the least change in suture strength after being soaked in urine inoculated with *E. coli* bacteria. The reason for this is related to the mechanism of degradation for chromic gut sutures. The inflammatory reaction, specifically macrophages, are responsible for the break-down of chromic gut. The absence of macrophages from the test systems in this report would account for the minimal change in the strength of the suture material - even in inoculated urine. Braided, non-absorbable sutures can be used for external ligatures but should not be placed where they could enter a lumen or cause obstruction secondary to an inflammatory reaction.

Urinary surgery is “plumbing”. We have to clear obstructions and create a non-leaking access for fluid movement. This means gentle tissue handling, accurate tissue apposition and careful suture placement is required. The urethra typically heals quickly and completely when properly handled and apposed; however, the wound can dehisce when tissues are excessively traumatized or de-vascularized by the inciting injury or poor surgical technique.

**Catheters after urinary surgery?**

The need for placing urinary catheters are urethral surgery is controversial. In my practice, I don’t place in-dwelling urinary catheters as long as:

1) the patient is otherwise healthy and able to get up to urinate on a regular basis,
2) if I have a secure bladder closure,
3) if the hospitalization facility can assist frequent urination (24 hour care) and,
4) there is no medical reason to need to document the amount of urine being produced by the patient.

If a catheter is placed, then three important items are considered. First, passage of the catheter must not disrupt any incision or cause more damage to the injured areas. Next, urinary catheters must be placed using aseptic technique and secured to the patient. Finally, a closed collection system should be used for urine collection. It is important to remember that urinary catheters were shown to increase the risk of stricture formation if the catheter is creating too much irritation.