INTERVENTIONAL RADIOLOGY: Cases from the IR Service

Matthew W. Beal, DVM DACVECC
Michigan State University
College of Veterinary Medicine
bealmatt@cvm.msu.edu

Introduction:
Following the trends in human medicine, there is an ongoing effort to adapt and develop minimally invasive therapeutics for the management of various problems facing veterinary patients. Minimally invasive therapeutics offer the advantages of smaller incisions, decreased pain, shortened anesthesia times and shorter length-of-stay compared to traditional open surgical approaches. Currently in veterinary medicine, laparoscopy, thoracoscopy, minimally invasive orthopedics, endourology, interventional cardiology, and interventional radiology are meeting this demand.

Interventional radiology (IR) involves the use of contemporary imaging modalities to gain access to different structures in order to deliver materials for therapeutic purposes. IR techniques have been widely utilized in human medicine for the past 20-30 years to effect minimally invasive diagnostic and therapeutic outcomes. In veterinary medicine, IR is evolving out of various different specialty areas as different IR applications are identified to meet the needs of small (and large) animal patients. Applications of IR in veterinary medicine are just being realized. The purpose of these proceedings is to present applications of IR in veterinary medicine with an emphasis on applications of IR in Emergency / Critical Care Settings.

Equipment:
Many IR procedures require advanced imaging modalities. Fluoroscopy is a critical tool for performing most IR procedures. Ultrasound, endoscopy, and cross-sectional imaging modalities are also commonly utilized. In IR, an array of guide wires with various properties, catheters specifically adapted for individual procedures, stents composed of different materials and configurations, embolic coils, embolic particles, drainage devices, surgical glue, oils, chemotherapeutic agents, occlusion devices, balloons, etc. replace the standard surgical pack. Due to the variety of materials utilized in the management of various pathologic conditions, maintaining an inventory of IR disposables is critical, but also expensive. However, basic procedures including tracheal and urethral stent placement can be performed with a limited inventory.

Emergency and Critical Care Applications of IR:
Tracheal collapse: Tracheal collapse is a common affliction of small breed dogs. In the emergency setting, some dogs with acute respiratory embarrassment secondary to tracheal collapse require intubation and positive pressure ventilation when traditional measures to stabilize them fail (sedatives, oxygen therapy, corticosteroid therapy, and cough suppression). In this setting, attempts are generally made to extubate the dog while facilitating a slow recovery from anesthesia in an effort to minimize respiratory effort. When the patient is unable to be extubated, definitive care is necessary. Surgical management using prosthetic rings is a consideration, but tends to be invasive and is associated with a significant incidence of acute complications and limitations including but not limited to disruption of the tracheal blood supply, injury to the recurrent laryngeal nerve causing laryngeal paralysis, and the inability to access
the intrathoracic trachea. Placement of a tracheal stent is a technique that provides this patient population with a rapid, minimally invasive, and effective technique to restore the patency of the tracheal lumen. At the authors’ institution, approximately 10% of tracheal stents are placed in dogs that require intubation to relieve airway obstruction (and cannot be successfully extubated). Tracheal stent placement offers a very rapid, non-surgical (everything is done through the airway) treatment option for animals in this situation. The incidence of acute complications is extremely low when compared to prosthetic ring placement provided the stent is sized and deployed appropriately.

**Tracheobronchial Foreign Body Retrieval:** Large airway foreign bodies are rare in dogs and cats. When present, however, they most often cause manifestations of fixed airway obstruction. If the foreign object is mobile, dynamic airway obstruction may also result. Non-cardiogenic pulmonary edema may be a sequela. Traditionally, these obstructions are managed through tracheobronchoscopy coupled with grabbing instruments. However, in smaller animals, the bronchoscope may occupy the majority of the tracheal lumen and may not have a working channel or allow for utilization of instruments adjacent to the scope (due to the limited size of the trachea). This “crowding” of the trachea also often doesn’t allow for the presence of an endotracheal tube and as a consequence, maintenance of oxygen saturation and anesthesia is challenging.

Alternatively, with the aid of general anesthesia and fluoroscopic guidance, an endotracheal tube can be positioned just beyond the larynx. Using a bronchoscope adapter, a stone basket commonly utilized for endoscopic retrieval of uroliths may be passed down the endotracheal tube to “capture” the foreign body. Alternatively, various grabbing instruments may be utilized. Finally, a foley catheter passed beyond the foreign object and inflated and withdrawn slowly may help facilitate mobilizing the object proximally. The author has had the most success with the stone basket. Careful manipulation of instruments and the foreign object must be performed to minimize the chance of tracheal or laryngeal trauma. All the while, the anesthesia team can still administer ventilatory support via the bronchoscope adapter.

**Retrograde Bladder Access / Antegrade Urethral Access / Percutaneous Cystostomy:** Numerous clinical conditions necessitate placement of a urinary catheter in the critical care setting. However, on rare occasion, retrograde access using a urinary catheter is not possible due to urethral damage/disruption, very small patient size, complex anatomy, or the presence of a diverticulum(s) associated with prostatic neoplasia or infection. In this patient population, using fluoroscopic guidance, retrograde guide wire (0.035in standard stiffness, angled tip, hydrophilic guide wire) access to the bladder can be accomplished in some cases (with or without fluoroscopic guidance) and a urinary catheter can be placed over the guide wire. The angled tip of the guide wire allows it to be directed across areas of complex anatomy and regions of partial urethral disruption or stenosis.

In some instances, however, retrograde access with a urinary catheter or a guide wire is unsuccessful. In this patient population, antegrade urethral access is very often possible. The patient is sedated in lateral recumbency and the abdomen is clipped and prepared as if for surgery. The entire procedure is performed with the aid of fluoroscopic guidance. Cystocentesis is performed using an 18g catheter near the apex of the bladder. A small amount of urine is withdrawn and replaced with 5-10mL of sterile iodinated contrast agent (200-300mgI/mL) to help illustrate the bladder. Through this catheter, a 0.035in standard
stiffness, angled tip, hydrophilic guide wire is passed. The slight angle at the tip of the guide wire allows it to be directed. The guide wire is directed down the urethra. Most times, with the exception of complete urethral transection, the guide wire will traverse areas of the urethra that are damaged or disrupted, obstructed, and those that display complex anatomy and will be exteriorized at the level of the penis or vulva. A urinary catheter can then be placed retrograde over the guide wire and the guide wire removed. This technique is not expected to be useful in cats with urethral obstruction due to urethral plug or stones. Standard techniques for dislodging the plug/stone should be undertaken.

As an added measure of security, once guide wire access to the bladder is achieved, following serial dilation, a locking loop pigtail drainage catheter 6F-10F can be placed percutaneously over the guide wire and into the bladder as a percutaneous cystostomy tube.

**Malignant Urethral Obstruction:** Transitional cell carcinoma, prostatic carcinoma, and other intrapelvic neoplasia may result in urethral obstruction. Traditional therapy has been centered on diverting urine via surgical placement of a cystostomy tube while pursuing traditional tumor-directed therapies. Cystostomy tube placement requires surgery and requires significant owner maintenance for the duration of the pet’s life. In addition, complications including tube dislodgement and recurrent urinary tract infection are not uncommon.

Using IR techniques, an intraluminal self-expanding metallic urethral stent can be placed (non-surgically) via the vulva or penis to open the urethral lumen. Note that stents for this purpose are very different than those used for tracheal applications. Using fluoroscopy, the length and width of the obstruction can be very precisely measured and a stent of an appropriate length and width to span the obstruction chosen. The stent is deployed from a delivery system introduced via the urethral orifice. The entire procedure takes approximately 1 hour and is associated with little to no patient discomfort. Patients are able to urinate immediately after stent placement. The greatest complication of the procedure is incontinence (approximately 25%). Incontinence results from the stent spanning the urethral sphincter and at times, a significant portion of the urethra. With the symptom of the neoplastic condition palliated, chemotherapy, radiation therapy or other adjunctive treatments may be utilized to address the tumor directly.

**Nasojejunal (NJ) or Esophagojejunal (EJ) Tube Placement:** Enteral nutritional support is associated with decreased length of stay, fewer infective complications, and significant cost savings when compared to parenteral nutritional support in people with critical illness. Nasogastric and nasoesophageal tube placement is quick and the procedure is generally well-tolerated in small animal patients. However, many of these patients demonstrate nausea or vomiting associated with feeding into the stomach. Feeding distal to the stomach allows for the provision of enteral nutritional support in this patient population. Traditional surgical jejunostomy is invasive (requires surgery or laparoscopy) and is associated with significant complications including ostomy complications and septic peritonitis. We describe a technique also utilizing fluoroscopy in which a combination of a 4-5F Berenstein catheter and 0.035in 260cm hydrophilic, straight, flexible tip guide wire are utilized to gain guide wire access to the jejunum. Once this is achieved, a feeding tube is placed over the guide wire and sutured adjacent to the nasal planum. In our experience, ability to achieve transpyloric access is 100%. Ability to gain jejunal access is 84%. Oral migration is very rare. This technique has become “standard of care” in our service in patients with pancreatitis, septic peritonitis, and conditions
associated with protracted vomiting or gastric motility disorders. Using a similar technique, EJ tubes may also be placed.

**Percutaneous Nephrostomy Tube Placement / Ureteral Stent Placement:** Percutaneous nephrostomy may be performed for the stabilization of patients with ureteral obstruction allowing for diversion of urine while definitive diagnosis and treatment is undertaken for the underlying disease process. Ureteral obstruction most often results from stones, infection, and tumors of the bladder. The procedure is performed under a short anesthesia and eliminates the need for emergency surgery in these often critically-ill patients until a time when they are more stable and better surgical candidates. The nephrostomy tube may be transitioned to a ureteral stent (placed exclusively using image guidance or as a “hybrid” procedure involving both open surgery and image guidance) once the patient has been stabilized. Alternatively, it may serve as a bridge to surgical placement of a subcutaneous ureteral bypass (SUB) in animals in which the ureteral obstruction cannot be bypassed. If the patient with ureteral obstruction is stable, primary management with a ureteral stent or SUB may be undertaken.

**Peripherally Inserted Central Catheter (PICC):** PICC lines are optimally placed using fluoroscopic guidance, especially when the terminal location of the catheter is of significant importance such as in patients that are undergoing central venous pressure measurement.

**Drainages:** Miscellaneous drainages may be performed using image guidance. These include placement of drains for abdominal fluid accumulations, thoracic fluid accumulations, pericardial effusion, pancreatic fluid accumulations (pancreatic pseudocyst), etc.

**Management of Hemorrhage:** Some animals may present with hemorrhage that cannot be managed successfully using traditional techniques. Bland embolization of nasal hemorrhage, embolization of bleeding neoplastic lesions, and embolization of acute arterial hemorrhage due to trauma may be performed. These techniques require some degree of technical expertise.