Interventional radiology (IR) has been a mainstay of treatment in human medicine for many years. The goal of IR is to utilize imaging modalities such as ultrasound, radiography and fluoroscopy to perform minimally-invasive diagnostic and therapeutic procedures. Depending on the disease process, these procedures often allow for people and animals to have shorter hospital stays and minimal morbidity. Additionally, these procedures allow for improved access to certain body regions, and offer treatment options in cases that were previously deemed untreatable.

There are several current applications for IR in veterinary medicine in the treatment of both benign and malignant disease. In the following summary, several of the potential applications are outlined and some of the veterinary literature that has been published on IR techniques is discussed. As improvements are made in diagnostics and equipment, it is likely that the opportunities to utilize IR techniques will increase in companion animals thus altering the treatment regimens that have been historically pursued.

**Neoplastic Interventions**

• Malignant obstruction: Stents

  Obstruction resulting from neoplasia causes significant morbidity regardless of the location. The most common presentations of these obstructions are within the urethra, ureter, colon, trachea and blood vessels. These obstructions result in clinical signs that can only be alleviated by eliminating the obstruction. Descriptions of the use of stents to relieve these obstructions are limited to case reports and case series, but early results are promising. (Hume et al. 2006, Weisse et al. 2006, Culp et al. 2007, Schlicksup et al. 2009)

  Urethral obstruction is one of the most commonly encountered malignant obstructions in veterinary medicine. Bladder, urethra, and prostatic carcinoma causes obstruction of urine voiding with a resultant alteration in electrolyte balance that can be life-threatening. Placing a stent within the urethra can allow for voiding of urine and immediately improve the patient’s clinical status. This procedure is easily and quickly performed by someone experienced in stent placement. While this treatment will not alter the course of the primary disease process (eg. transitional cell carcinoma), it will alter the patient’s clinical course. After the placement of a stent, veterinary patients will often have a normal quality of life until metastatic disease is noted. Previously, a patient with poor treatment options for a complete urethral obstruction (serial cystocentesis, permanent urethral catheterization, and tube cystostomy) can now maintain a good quality of life while undergoing treatment of the primary tumor.
Similarly, with colonic, tracheal or vascular malignant obstruction, patients will be in a situation where euthanasia is likely the only option unless the obstruction is relieved. A stent can be placed to palliate the clinical signs associated with the obstruction. Placing the stent may allow for a normal quality of life in a previously severely affected patient.

**Intra-arterial chemotherapy**

Intra-arterial chemotherapy involves the administration of chemotherapy into the artery or arteries directly supplying a tumor. This allows for the tumor to receive the first pass of chemotherapy as opposed to being exposed to a filtered amount of chemotherapy as is seen when chemotherapy is given intravenously. Advantages of intra-arterial chemotherapy include increased intra-tumor concentration of a chemotherapeutic agent and potentially a decrease in chemotherapy-associated side effects.

Intra-arterial chemotherapy is commonly employed in human medicine for hepatic, bladder, thyroid, lung and breast tumors. As some chemotherapeutic agents are considered radio-sensitizers, intra-arterial chemotherapy may also have improved efficacy when given in conjunction with radiation therapy.

The use of intra-arterial chemotherapy in veterinary medicine has been described. (McCaw et al. 1988, Heidner et al. 1991, Withrow et al. 1993) Three studies have combined intra-arterial chemotherapy with radiation therapy in the treatment of canine osteosarcoma. (Heidner et al. 1991, Withrow et al. 1993) In these studies, the use of intra-arterial chemotherapy with radiation therapy improved tumor response to radiation therapy. Additionally, the combination of these two modalities prolonged survival in comparison to reported survival times for amputation alone.

Tumors in particular that may benefit from intra-arterial chemotherapy include bladder transitional cell carcinoma, thyroid carcinoma, prostatic carcinoma, feline vaccine-associated fibrosarcoma, and hepatocellular carcinoma. Whenever possible, surgery and/or radiation therapy is pursued when treating these above tumor types; however, location, size and owner opinion may preclude the use of surgery or radiation thus providing an opportunity to consider intra-arterial chemotherapy.

**Transarterial Embolization/Chemoembolization**

Transarterial embolization (TAE) and transarterial chemoembolization (TACE) involve the use of interventional radiologic techniques to deliver an embolic agent directly to a tumor; TACE delivers chemotherapy in addition to the embolic agent. TACE attacks the tumor on 2 fronts: 1) chemotherapy is administered directly into the tumoral arterial supply and 2) the blood supply to the tumor is embolized.

TACE is particularly attractive for the treatment of liver neoplasia due to the dual blood supply employed by the liver. More specifically, normal liver parenchyma is supplied primarily by the portal vein whereas liver tumors receive blood supply almost exclusively from the hepatic artery. Therefore, despite embolization of the hepatic arterial blood supply, sufficient blood supply to the normal liver remains intact via the portal vein. Canine hepatic neoplasia can result in significant morbidity. Hepatocellular carcinoma (HCC) is the most common form of primary hepatic neoplasia and occurs in 3 major morphologic forms: diffuse, nodular and massive. The massive form accounts for greater than 60% of HCC in dogs, and surgical resection is the treatment of choice, albeit, when possible. However, the other forms of HCC (nodular and diffuse) are generally not amendable to surgery, and massive forms of HCC that grow unchecked for a period of
time may present a dangerous surgical option by involving or invading surrounding structures or being positioned in an unfavorable location.

Veterinary literature documenting both TAE and TACE is limited. (Sun et al. 2002, Weisse et al. 2002, Cave et al. 2003, Marioni-Henry et al. 2007) The embolization of hepatocellular carcinoma, an osteosarcoma metastatic lesion and a canine fibrosarcoma have been attempted. In the above report evaluating HCC, one dog received TAE and 1 case dog received TACE.

Non-Neoplastic Interventions

• Tracheal collapse: Stents
   The most commonly reported IR technique in veterinary medicine is the placement of stents for the treatment of tracheal collapse. (Moritz et al. 2004, Culp et al. 2007, Sura et al. 2008) Medical management with oral medications is generally attempted first in the treatment of tracheal collapse, but this may not always be successful. Several procedures have been advocated when the medical management of tracheal collapse has failed and include surgery and stent placement within the trachea.

   Efficacy in the use of stents to treat tracheal collapse has been demonstrated in several studies. (Moritz et al. 2004, Sura et al. 2008) This procedure can be quickly performed by an experienced individual and allows, in most cases, immediate relief of clinical signs. However, long-term medical management is often necessary post-stent placement and owners should be well prepared for this fact when electing to pursue tracheal stenting. Additionally long-term outcomes have not been seen in a large number of cases and future studies should focus on improving case selection by evaluating outcomes of dogs that have received a tracheal stent.

• Intra-hepatic portosystemic shunts: Transvenous coil embolization
   During development in utero, inherent shunts are utilized in dogs and cats to allow for blood to bypass certain organs as they are developing. When these shunts do not undergo their natural closure, the result is potentially severe neurologic, gastrointestinal and urinary tract signs. These shunts cause significant morbidity that may include poor growth, mental depression, seizures and death. Treatment of these shunts is recommended in virtually all cases.

   Intra-hepatic shunts (shunts developing within the hepatic parenchyma) are particular difficult to treat due to their location. Surgery has been historically offered but morbidity associated with the procedure is considered high. An alternative option proposed is the delivery of an embolic agent (most commonly coils) to slowly and progressively close down a shunt allowing for diversion of the blood flow through normal vascular means.

   An IR procedure for the treatment of intra-hepatic shunts has been developed and is showing promise in the treatment of this difficult disease process. (Gonzalo-Orden et al. 2000, Leveille et al. 2003) While only a few reports have been documented, this procedure shows promise as a treatment option that offers lower morbidity with improved outcome.

• Ureteral obstruction: Stents
   Ureteral obstruction/stricture occurs in cats and dogs secondary to ureteral calculi, ureteral crystal accumulation, or ureteral blood clot formation. Traditionally, treatments to
relieve the obstruction have included aggressive fluid therapy, ureterotomy and/or ureteral reimplantation. Alternatively, a nephrostomy tube can be placed temporarily to prevent urine from being retained in the renal pelvis and causing kidney damage.

A relatively new technique called ureteral stenting, involving the placement of a tube extending from the renal pelvis to the bladder, has been developed. The stent can be passed through the ureter either with a combination of cystoscopy and fluoroscopy or surgery and fluoroscopy. The stent causes passive dilation of the ureter and allows for urine flow to continue from the kidney to the bladder. In most cases, the stent can be removed during a future procedure.

• Intravascular foreign body removal

One complication of intravascular catheterization includes breakage or dislodgement of a component or components of an intravascular catheter subsequently resulting in an intravascular foreign body. In human medicine, the removal of intravascular foreign bodies is considered mandatory. (Kidney et al. 1998) Complication rates as high as 71% have been reported in human cases and death has been reported in association with intravascular foreign bodies. (Richardson et al. 1974, Fisher et al. 1978)

Intravascular foreign bodies can potentially be removed via a minimally-invasive approach involving intravascular catheter and snare placement. A recent report documented the percutaneous removal of intravascular foreign bodies in 5 dogs, a goat and a horse. (Culp et al. 2008) All devices were successfully removed with the use of a snare that was controlled under fluoroscopic-guidance. (Culp et al. 2008)

References


