Interventional Medicine in Veterinary Patients
Targeted Therapy Using Wires, Balloons, Stents, Coils, and Devices

Brian A Scansen DVM, MS, Dipl. ACVIM (Cardiology)
Clinical Assistant Professor – Cardiology and Interventional Medicine
The Ohio State University Veterinary Hospital
Email: scansen.2@osu.edu

The development of minimally-invasive therapies to palliate or cure disease has accelerated in human medicine over the last three decades and at the forefront of this movement is the field of interventional medicine (or interventional radiology / IR). Nonexistent until the late 1960's, the term interventional radiology refers to a myriad of diagnostic and interventional modalities (**Figure 1**) developed to diagnose, palliate, or cure disease via the insertion of targeted treatments into the patient guided by imaging (X-ray, ultrasound, MRI, etc.). The most well-known of these therapies in human medicine is coronary angiography and angioplasty for heart disease; however, catheter-delivered therapy is employed in nearly all specialties of medicine with reduced risk, pain, and recovery time as compared to standard surgical techniques. It is principally within the last decade that such techniques have transferred to the care of animal species led by a public that demands the same high level of care for their pets as that afforded to human family members.

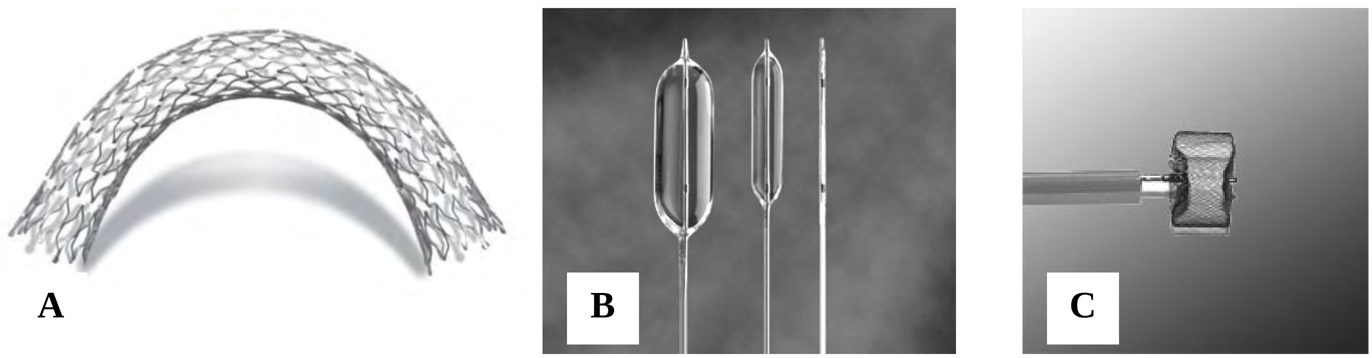

Figure 1. Devices used in interventional medicine. Nitinol self-expanding stent (A); balloon dilation catheter in varying stages of inflation (B); Amplatz vascular plug (C). *Images courtesy of Infiniti Medical, LLC.*

The benefits of minimally-invasive interventional techniques to veterinary patients are multiple. In addition to reduced pain, shorter recovery time and lessened risk, there are now interventional therapies available for conditions that previously had no good therapeutic options. Development of interventional techniques allows for greater collaboration with human medical colleagues and similarly fosters collaboration within veterinary medicine, with applications for all species in nearly all subspecialties. The following is a brief overview of the interventional therapies available as well as future opportunities and the role of such techniques in current veterinary practice.

Interventional Cardiology

Diagnostic cardiac catheterization has been employed since the mid-20th century to measure intracardiac pressures and delineate cardiac malformations. The therapeutic potential of cardiac catheterization has been employed more recently with the advent of endovascular cardiac pacing, balloon dilation of stenotic valves, and transcatheter closure of PDA (**Figure 2**). Veterinary patients with slow heart rates now receive the same pacemakers to control their heart rhythm as human patients; affording these dogs, cats, and horses a near normal life. Patients with congenital heart disease, such as puppies born with a malformed pulmonary valve or an abnormal vascular connection between the great vessels (PDA), can now have their disease treated and in many cases cured with a small incision in the neck or groin rather than with open-chest surgery. Rhythm disturbances that slow the performance of racing horses, such as atrial fibrillation, can now be converted to normal with an electric shock delivered via catheters inserted into the heart (**Figure 3**). Current devices under development for humans include catheter-delivered valve replacement as well as septal-occluding devices for patients born with a hole between the chambers of the heart (ASD or VSD). With the appropriate technology, such therapies should be transferable to veterinary patients providing a treatment for conditions that currently require open-heart surgery at substantial cost and high-risk.

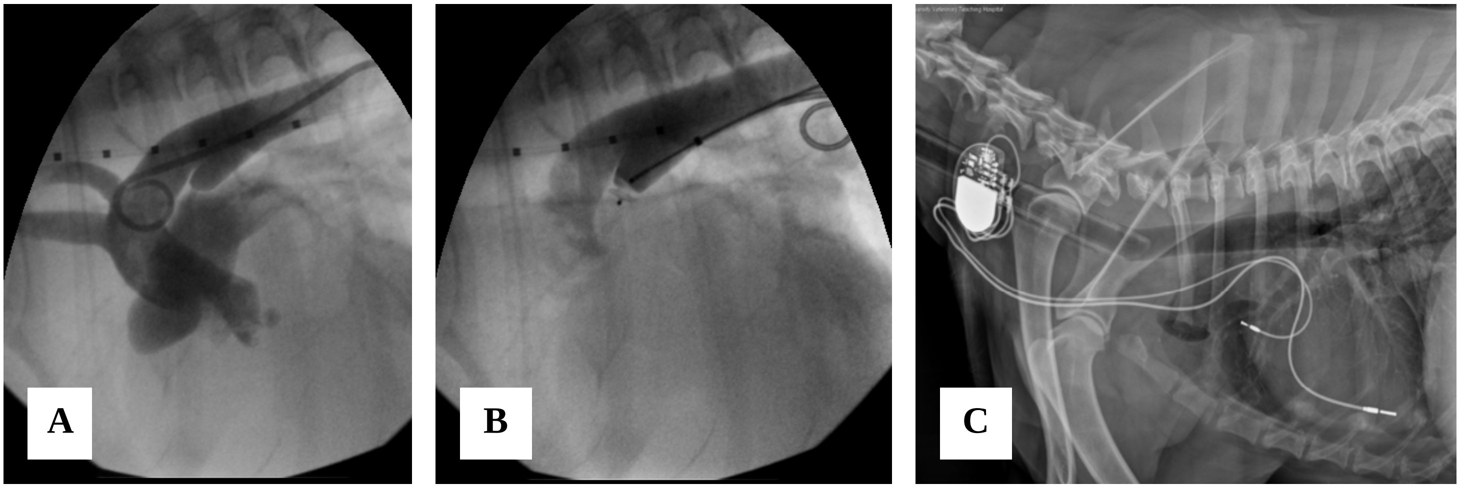

Figure 2. Cardiac interventions. A lateral angiogram with delineating a left-to-right shunting patent ductus arteriosus (A). The PDA is closed after placement of an Amplatz Canine Duct Occluder (B). Lateral radiograph of a dog with a dual chamber pacemaker with pacing leads in the right auricle and the apex of the right ventricle (C).

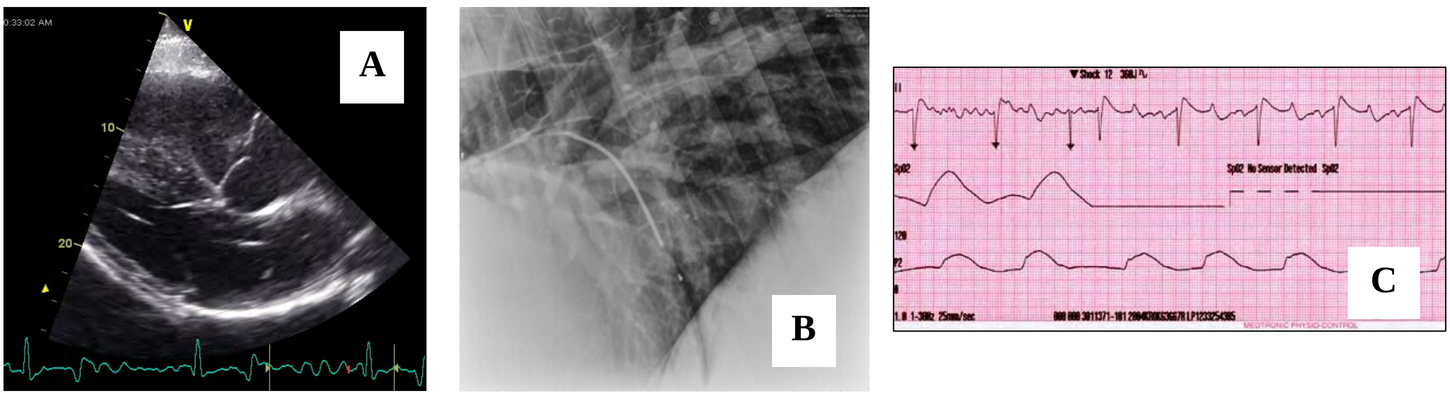

Figure 3. Equine intracardiac direct-current cardioversion. Catheters are placed via ultrasound-guidance into the right atrium and left pulmonary artery (A and B). A shock is then delivered to restore normal heart rhythm, as on this ECG (C).

Interventional Pulmonology

Tracheal collapse is a common affliction in older toy breed dogs, also occurs in the miniature horse, and results in signs of respiratory distress, severe coughing, and even death. Classic surgical techniques for tracheal collapse only benefit a small proportion of patients and are associated with moderate complication rates. The placement of endotracheal stents, though not without potential complication, can now be employed to open the diseased airway of these patients and provide palliation for patients with an otherwise devastating and incurable disease (**Figure 4**). Other interventional techniques that can be applied to the respiratory system include ballooning and stenting for nasopharyngeal stenosis and transbronchial lymph node biopsy to diagnose lung pathology or stage disease.

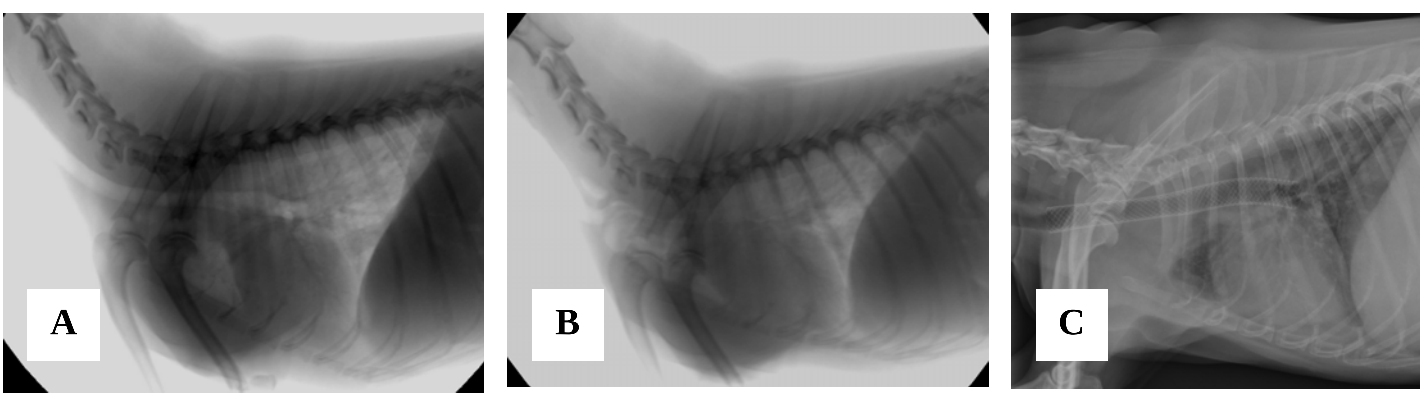

Figure 4. Tracheal collapse in a Schipperke. Normal tracheal lumen is present during inspiration (A), with severe collapse of the intrathoracic trachea noted during forced expiration (B). A woven Nitinol stent has been placed spanning the area of collapse (C).

Interventional Urology

Numerous interventions are available for patients with kidney and urinary disease. Dogs with cancer of the urethra and lower urinary tract can develop complete obstruction and classically require an external tube to be placed into the bladder for urinary diversion, with many associated complications. Now, a self-expanding stent can be placed, giving these patients a patent urethra and palliating their disease (**Figure 5**). Patients with stones in the ureter or kidney may be able to avoid surgery via percutaneous nephrostomy, ureteral stenting, and/or lithotripsy (using lasers or shock-wave therapy to break-up the stones). Patients with benign or malignant ureteral obstructions can also be stented via percutaneous nephrostomy (**Figure 6**). Similarly, patients with a tear in the ureter or urethra may be able to avoid complicated surgery by placing a ureteral or urethral stent and allowing the tear to heal over the stent.

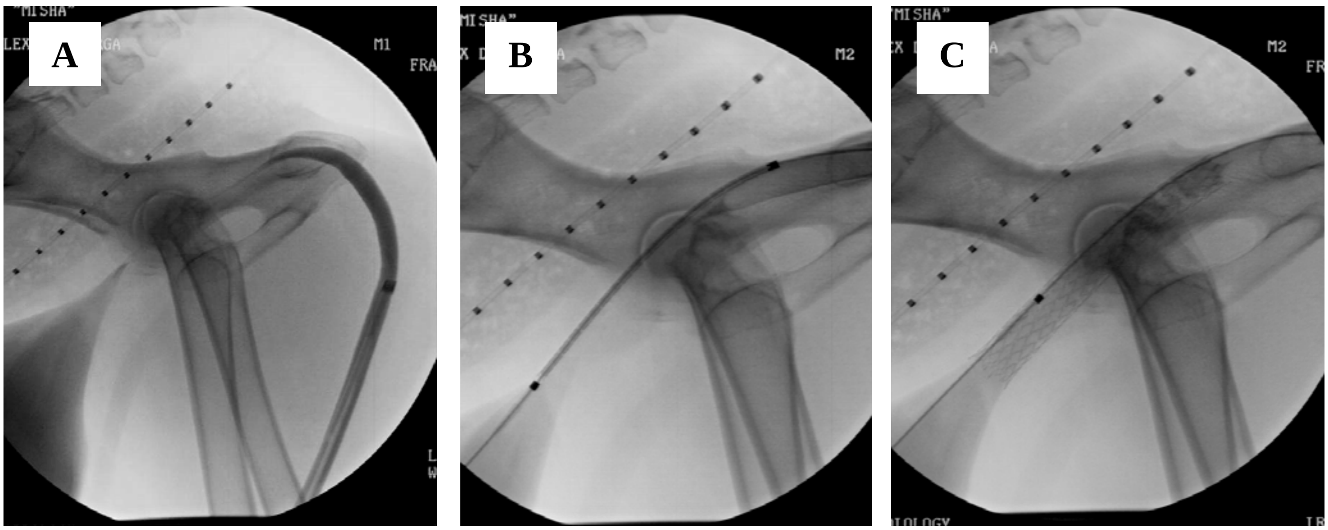

Figure 5. Urethral stenting. A cystourethrogram is performed (A). A glide wire is passed into the bladder and a laser-cut Nitinol self-expanding stent is placed across the area of constriction (B). After stent expansion the urethra is patent (C).

Figure 6. Transitional cell carcinoma in a dog causing left ureteral obstruction. Ultrasound images of the bladder show a large hyperechoic mass attached to the bladder wall (A) causing left ureteral obstruction and hydronephrosis of the left kidney (B). This case may benefit from a ureteral stent (C) in which the upper loop is placed under fluoroscopic guidance into the renal pelvis and the lower loop into the urinary bladder, bypassing the tumor and eliminating the ureteral obstruction and secondary renal impairment. *Ureteral stent image courtesy of Infiniti Medical, LLC.*

Vascular Interventions

Patients with arterio-venous malformations (usually in a limb, the liver, lungs or brain) are very difficult to manage surgically given the high potential for bleeding. Interventional techniques are now available to find the source of these vascular malformations and either deploy a device, particles, or inject polymerizing glue to occlude the abnormal vascular connections. Patients born with anomalous porto-caval connections within the liver (intrahepatic portosystemic shunts or IHPSS) often show signs of neurologic disease as the liver is unable to detoxify substances from the bloodstream. Surgery for IHPSS is associated with 10-30% mortality at the time of operation and is considered a difficult, high-risk procedure. Newer techniques to close these malformations with a stent and thrombogenic coils are associated with better outcomes at lower risk requiring only a small incision in the neck (**Figure 7**). Patients can often be discharged the following day, in contrast to surgery where intra- and post-operative complication rates can be high. Thromboembolic disease, such as acute pulmonary thromboembolism, may also be addressed with intervention, either through local fibrinolytic therapy or via mechanical thrombectomy. Lastly, intractable epistaxis (uncontrolled nose bleeds) can now be treated by occluding the offending artery via device or microparticles.

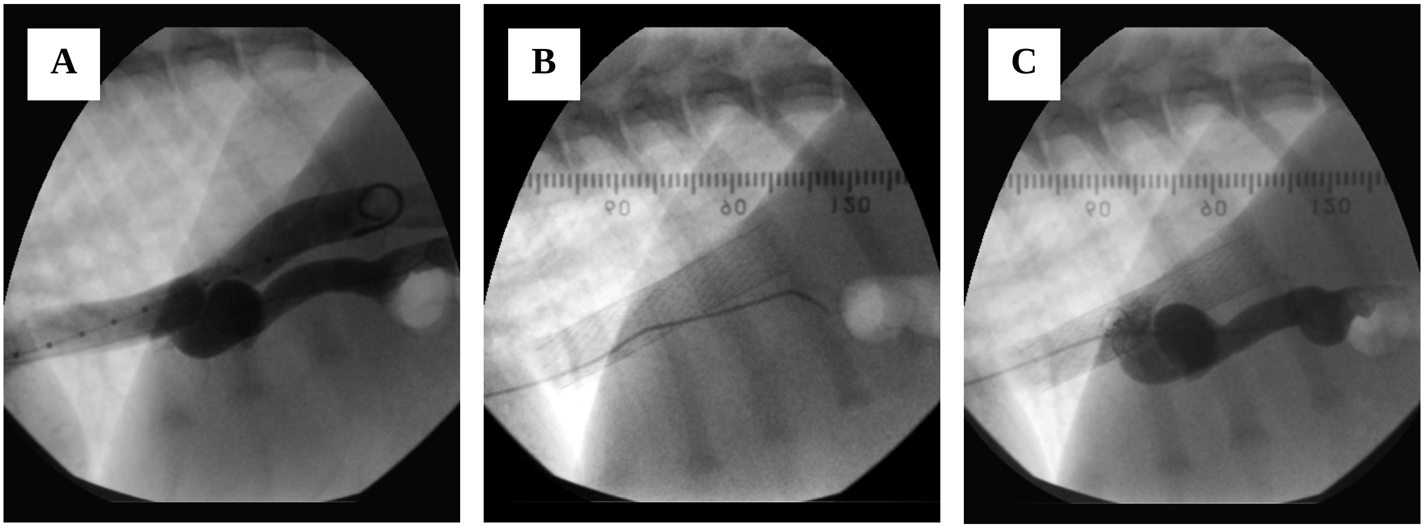

Figure 7. Intrahepatic portosystemic shunt closure by percutaneous transjugular coil embolization. Catheters are placed via the jugular vein into the caudal vena cava and portal vein (A). A stent is deployed across the mouth of the shunt (B) and thrombogenic coils are inserted to close the anomalous vascular connection (C).

Oncologic Interventions

Cancer is a common cause of illness, veterinary cost, and mortality in the older pet. While many surgical, chemotherapeutic, and radiation treatment options are available for animals with cancer, there remain many cases that do not respond or become refractory to conventional therapies. Direct catheter-delivered chemotherapy and particle embolization (occluding the blood supply to the tumor with microparticles) is frequently employed in human patients with nonresectable liver cancer and can now be performed in dogs and cats (**Figure 8**). Similar targeted therapy can be directed at other cancers as well. As described above for patients with urinary obstruction secondary to tumors, stents have been placed in patients with nonresectable colon cancer to alleviate obstruction and this may be considered elsewhere in the body as well. Radiofrequency ablation of metastatic disease is also now performed in humans and may be transferable to veterinary patients in the future.

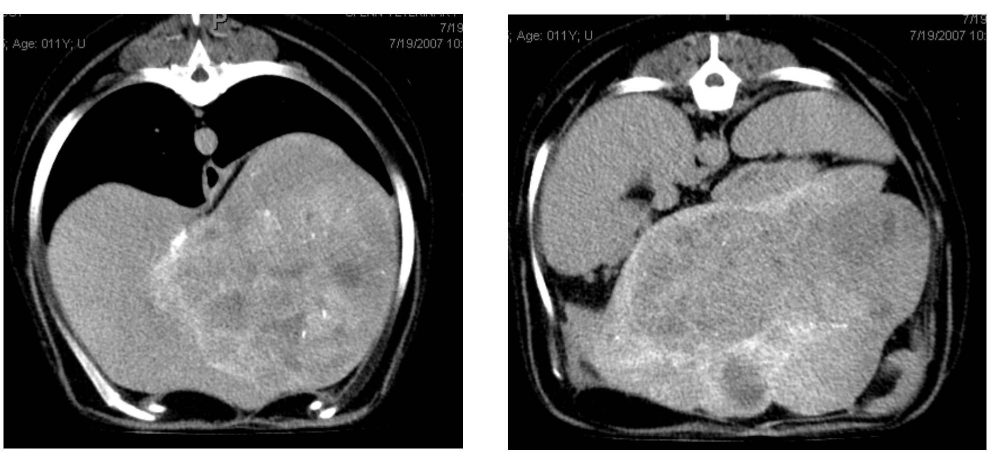

Figure 8. Bland particle embolization of a nonresectable hepatic adenoma. CT images of a non-resectable hepatic adenoma are shown after microparticles are delivered into the left hepatic artery to occlude the tumor's blood supply. *Images courtesy of C Weisse, Veterinary Hospital of the University of Pennsylvania.*

Gastrointestinal Interventions

Lastly, there are many IR applications for gastrointestinal and hepatobiliary disease in human medicine. These include esophageal balloons and stents to open benign or malignant strictures (**Figure 9**), stenting of biliary tract obstructions, transjugular liver biopsy (so that bleeding in these coagulopathic patients is directed into the vascular space), and biliary diversion techniques. All of these interventions can potentially be adopted in the veterinary field.

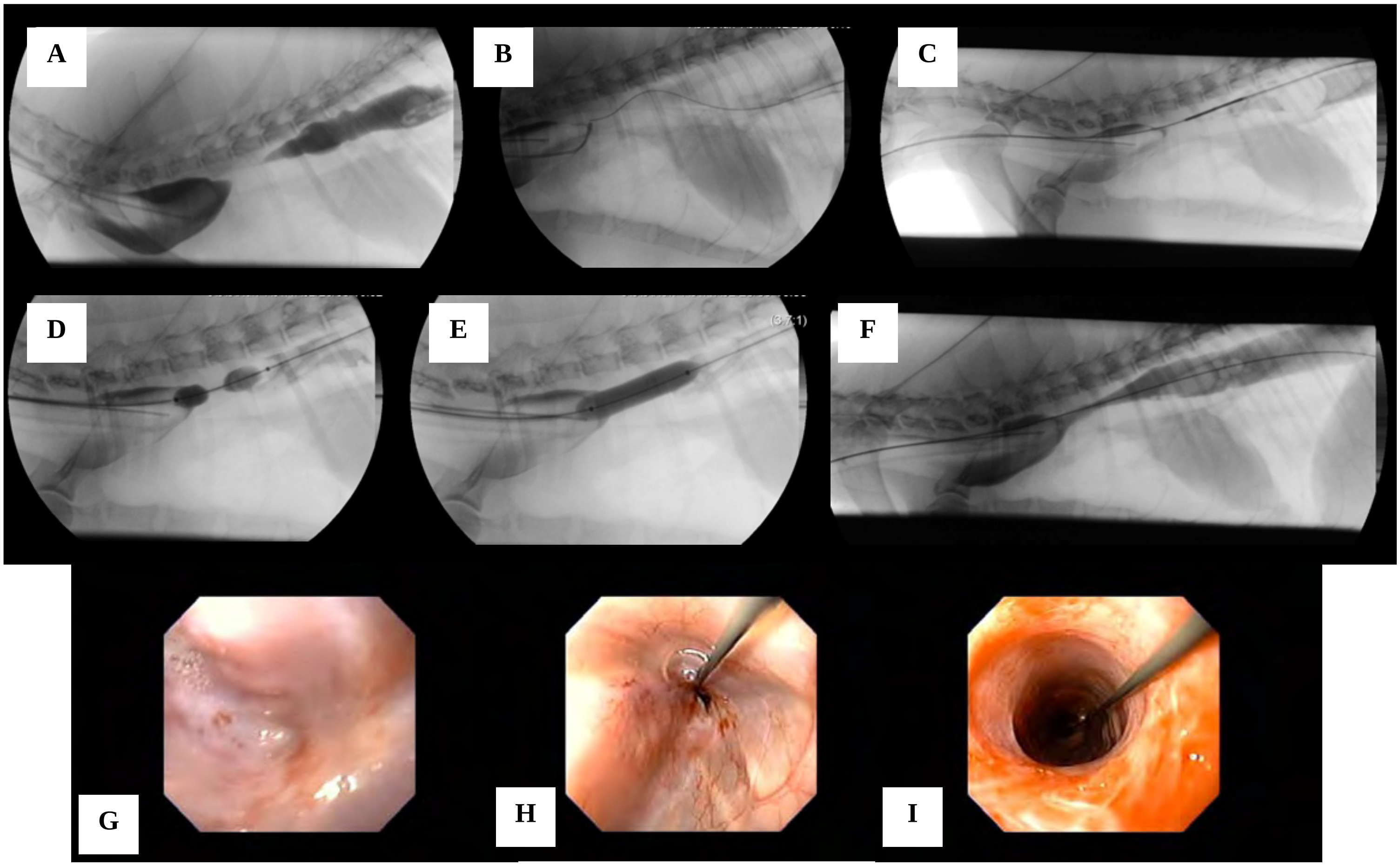

Figure 9. Feline esophageal stricture intervention. A complete stricture of the mid-thoracic esophagus is present on preliminary contrast study (A). A perforation in the stricture is made under fluoroscopic guidance using orad and trans-gastric guide wires B). The wire is brought across the stricture and a balloon catheter is advanced to dilate the stricture (C-E). Contrast now flows along the entire esophageal length (F). Endoscopic images in the same cat show the initial stricture (G), the wire across the stricture (H), and after successive balloon dilation (I).

Summary

Interventional medicine provides an exciting new frontier in the search for effective, minimally-invasive, and targeted therapies for our animal patients. The benefits as compared to standard surgical approaches may include reduced pain, shorter recovery time, lower mortality rate, and the ability to offer new options to patients that previously had none.

If you have a patient that may benefit from an interventional technique or simply to discuss this field of medicine in greater detail, please contact Dr. Brian Scansen at The Ohio State University at scansen.2@osu.edu or 614-292-3551.