Veterinary Interventional Endoscopy and Interventional Radiology: “When Minimum Interventions Mean Maximal Results.”

**What is: Interventional Radiology?**
- **IR** or **VIR** or Surgical Radiology
- Utilizes minimally-invasive image-guided procedures to diagnose and treat diseases in every organ system
- Using the least invasive techniques currently available
- Minimize risk, improve outcomes

**Interventional Endoscopy**
- IE: any endoscopic technique that spare patients unnecessary, major surgical procedures by diagnosing and treating conditions with minimally invasive endoscopic techniques
- Endoscopic interventions are performed of the urologic, gastrointestinal, respiratory, hepatobiliary systems

**Who are Human Interventionalists?**
- Urologists
- Radiologists
- Cardiologists
- Pediatricians
- Gastroenterologists
- Respiratory specialists
- Criticalists
- ………

**Why IR/IE in Veterinary Medicine?**
- Solutions
- Reduced mortality
- Eliminate/reduce morbidity
- Advance veterinary medicine

**WHO are Veterinary Interventionalists?**
- ACVIM- internists
- ACVS-surgeons
- ACVIM- cardiologists
- Oncologists
- Criticalists
- Radiologists…

**Why NOT?**
- Equipment
- Technical Abilities
- Ancillary Support

**Solutions**
- Reduced mortality
- Eliminate/reduce morbidity
- Advance veterinary medicine
**What has been and is being done?**

- PDA 1st
- Endoscopic Retrieval of FB
- Lithotripsy, basketing
- Endoluminal Stenting:
  - Tracheal, Urethral, Ureteral
- Balloon expansion
- Endovascular techniques: HPP, AVMs
- Epistaxis, IRH, Thrombolysis

**Veterinary IE procedures:**

**Urologic:**
- Ureteral stenting
- SUB placement
- Ectopic ureteral ablation
- Minimally invasive stone removal
- Urethral bulking agent injection
- Urethral stenting
- Endoscopic infusion for IRH

**Gastrointestinal:**
- Polypectomies
- Biliary stenting
- Colonic/esophageal stenting

**Respiratory:**
- Tracheal stenting
- NPS-balloon/stenting
- Tracheal mass/foreign body removal
- Carina/bronchus embolization

**Veterinary IR procedures:**

**Vascular Benign disease:**
- Percutaneous coiling of IHPSS
- Embolization of Hepatic AVM
- Embolization/coiling of PAVM
- Embolization: refractory epistaxis
- Thrombolysis
- Aortic stenting

**Interventional Oncology:**
- Chemoembolization
- Intra-arterial chemotherapy
- Cryotherapy
- Chemical/thermal ablation
- Caval stenting-transatrial stenting

**Ureteral Stenting**

**Who and How?**

- Cats, male dogs <5Kg: Sx
- Dogs: endoscopic/PC

- Feline ureteral obstructions (44 cats with 48 ureters)
  - 77% nephrolithiasis
  - 17% strictures, circumferential ureters, idiopathic
  - 32% UTI
  - 91% azotemic
  - 98% hydronephrosis
Surgery for Ureteral Obstructions

Management and Outcome of Cats with Ureteral Calculi:

~Academic institution with transplant experience~

31% peri-operative complications
18-39% mortality
Follow-up:
40% ureteral stone recurrence
85% nephrolithiasis at time of surgery
50% persistent azotemia
Improved outcome vs. medical management (8-17%)
Passed stone (8%)
Moved stone to partial obstruction (8.7%)

Feline Ureteral Stenting: Outcomes/Prognosis

Short-term:
Azotemia post stent
41% vs. 91% pre
Median: 2.4 mg/dL (vs. 4.6)
Procedure complications
Major 7%
Stranguria 2-20%
85% resolved 1-2 wks
Stentil responsive
Stentil present in 30%

Long-term:
Complications:
23% major
8% minor
Stent exchange in 20%
Survival (71% survival):
7% peri-op mortality - CHF
20% long-term mortality
2/9 from CKD
Other causes 7/9

Berent, Weisse, Bagley.

WHO?
Females dogs
Male dogs >7Kg

WHY?
Infected ureteroliths
Following endoscopic infusions for IRH
Post-ESWL

Predictors of outcome for cats with ureteral obstructions after interventions...
FMJS Horowitz et al. 2013

N: 41 cats
No prelim association with survival
All pelves decompressed
All creatinine improved
Hospital time assoc with creatinine, complications and post creat and potassium
Overall good survival times

Ureteral stenting: Outcomes

Survival time with stents (29 cats)
29% died; 7% peri-op; 22% post-op
2 due to renal failure/progression 11 months later
6 due to ureteral disease
3 due to CHF/SIRS
5-unrelated causes months/years later
MST:
Median >250 days
Range 15-1245 days (3.5 years)
No recurrences from stone disease (vs. 40% with sx)

Morbidity:
Peri-operative: 7% vs. 31% with sx
Mortality:
Peri-operative: 7% vs. 25% with sx ureterotomy
Successful 92%
Stent in long-term (>1245 days)

Procedure:
Cystoscopy
Guidewire, ureteral catheter
Suction and flush pelvic fluid
Place DPT ureteral stent over wire
Outcomes:
>5% need surgical conversion
Hospitalization 24-72 hours
Successful in nephrectomies/major surgery candidates
Renal architecture improves drastically at recheck

Endoscopic Ureteral Stenting

Interventional Renal sparing treatment for Pyonephrosis for Canine patients (13 cases). Kuntz, Berent, Weisse, Bagley, 2013

All septic, 70% thrombocytopenic

Procedure:
Cystoscopy
Guidewire, ureteral catheter
Suction and flush pelvic fluid
Place DPT ureteral stent over wire

Outcomes:
>5% need surgical conversion
Hospitalization 24-72 hours
Successful in nephrectomies/major surgery candidates
Renal architecture improves drastically at recheck

NEVER take out a kidney based on obstructed architecture!!

Endoscopic Ureteral Stenting
**SUB:** Subcutaneous Ureteral Bypass
- Alternative to stent
- >0.5cm renal pelvis
- Surgically placed
- Effective for any ureteral obstruction
- Port for sampling, flushing
- Minimal long-term data

**Complications:**
- Leakage around port: < 5%
  - No longer occurs with new device
- Obstruction: < 5%
  - Flush with saline: contrast
  - TPA if block with clot

**Outcomes:**
- 100% resolution of obstruction
- Reduced bladder irritation
- Need more long-term data
- Easy access to urinary system
- 15-20% complication rate

**POST-stent or SUB**
- Follow-up/monitoring:
  - Post procedure rechecks:
    - 1-2 wks, 1month, EVERY 3-6 mo
    - Clinical signs-
      - Medical management
      - Antibiotics
      - Anti-inflammatories
      - Antispasmodics
    - Renal values
    - Ultrasound/radiographs
    - Urine culture

**Ectopic Ureter Laser Ablation**
**Diagnosis:**
- YOUNG INCONTINENT dogs/cats
  - Cystoscopy- 100% diagnostic
  - CT, ultrasound NOT as accurate
  - Often have co-morbid abnormalities
    - Hydroureter/hydronephrosis
    - Vaginal membranes/dual vagina- 90%
    - USMI...
  - Incontinent

**Surgery vs. EULA:**
- Sx: extramural

**EULA Procedure and Outcomes**
  - 50% achieved continence with ablation alone
  - 77% achieved continence with additional therapies:
    - Medical management: PPA, DES
    - Transurethral bulking agent
    - Hydraulic occluder placement

**EULA: procedure**
Complications/Follow-up
- Urethral/ureteral tears
- Indwelling catheter
- Post-procedural bleeding
- Ureteral recanalization
- Inflammation
- Ureteral obstructions
- Continence score q2 weeks

Minimally Invasive Stone Removal: The who, what, how...
- VUH
- Stone basketing
- Lithotripsy
- PCCL
- ESWL
- PNL

Which procedure When?
- Female dogs:
  - <4mm: voiding urohydropropulsion (VUH)
  - >4mm: laser lithotripsy via cystoscopy
- Male dogs:
  - <3-5mm: VUH, laser lithotripsy (if >7Kg)
  - >3mm: PCCL, laser lithotripsy or cystotomy
- Female cats:
  - <3mm: VUH
  - >3mm: laser lithotripsy or PCCL or cystotomy
- Male cats:
  - PCCL or cystotomy
  - If PU can scope

Voiding Urethrohydropropulsion
- Under anesthesia
- 15min procedure
- <3mm male dogs, female cats
- <4mm female dogs
- Multiple stones
- Any type of stone

Stone Basketing
- Same size as VUH
- Male dogs >7Kg (need cystoscopy)
- All female dogs
- Female cats
- Urethral trauma
- No incision

Laser Lithotripsy
- Outcome:
  - 86.7% success: Females (100%) > Males (86.7%)
  - Shorter procedure for urethral vs. bladder calculi
- Complications:
  - Females (17.9%) vs. Male (13.3%)
  - Urethral swelling -> indwelling catheter
  - Laser-induced perforation bladder/urethra
  - Indwelling catheter vs. surgery
  - Post-procedural stricture formation
- Follow-up/Recurrence:
  - 51% recurrent stone formation
  - 19% recurrence rate at 1-2yr. follow up
**Laser Lithotripsy**
- Cystolitholapaxy: “look into the bladder to crush a stone”
- Polyp removal
- Why not?
  - Procedure time:
    - Males: median 140 mins (40-382)
    - Females: median 90 mins (35-330)
  - Lengthy procedure times
  - Urethral irritation

**ESWL: Extracorporeal SW Lithotripsy**
- Nephroliths: dogs
- Ureteroliths: dogs
- Not bladder stones- Fixed
- Renal damage
- Not all stones amenable
- Require ureteral stenting

**PCNL Procedure**
- PCNL: 4
- SENL: 6
- 9 dogs, 1 cat, 12 units
- Safe and Effective

**PCCL percutaneous cystolitholapaxy**
- 25-45 mins
- Dog/cat any size
- Any stone
- Urethral stone
- 100% stone removal
- 1-2 cm incision
- Discharge in 24 hrs
- $ = cystotomy
- Scope entire LUT
- Reduced recurrence?

**Endoscopic Assisted Nephrolithotomy**
- **ENDOSCOPIC NEPHROLITHOTOMY FOR NEPHROLITHIASIS IN DOGS**
  - Transvesicular percutaneous cystolitholapaxy as method of removing and urethroliths in dogs and cats. JAVMA Benner et al. 2012
  - Complicated nephroliths
    - Signs of flank pain/colic
    - Depression, fever, lethargy, anorexia, hematuria
    - A/CKD
    - 95% not clinical
  - Options: PCNL, ESWL, Surgical Nephrotomy
  - PCNL vs. SENL
    - 100% stone removal
    - Reduced renal damage

**Urethral Obstruction**
- Causes:
  - Neoplastic disease (intraluminal & extraluminal)
  - Transitional cell carcinoma, prostatic carcinoma, sarcoma
  - Benign disease
  - Cattle
  - Structure formation
  - Proliferative urethritis
- Treatment:
  - Cystotomy tube
  - Surgical debulking
  - CO2 laser ablation
  - Radiation therapy
  - Urethral stenting
Endoluminal Urethral Stenting

- Self-expanding Nitinol stent
- Fluoroscopy
- Deployed over wire
- 98-100% successful
- 25% Incontinent
- Stranguria
- Consider RT
- Ureteral stents
  - Chemotherapy increases MST

Idiopathic Benign Hematuria


- IRH: chronic URT bleeding
- Ruptured renal pelvic hemangiomas/angiomas the cause
- Benign but...anemia, ureteral and urethral obstruction(s)
- Endo-guided electrocautery or sclerotherapy replaced ureteronephrectomy

IRH: Endoscopic Sclerotherapy

Methods and Materials
- 2.5% povidone 1; and 2 sterile liquid 1% silver nitrate
- Ureteral stent placed

Results
- N=7 dogs sclerotherapy
- 5 unilateral, 1 bilateral
- 6 males and 1 female
- 6 yrs and 21kg
- Success in 6/9 units (~12 hours)
- 2 failed treatment
- Follow-up time was 5 mos

Conclusions
- Safe and effective
- 1st report in dogs
- Consider prior to nephrectomy
- Further investigation required

Gastrointestinal Interventions

- Polypectomies
- Biliary stenting endoscopically
- Esophageal balloon/stenting
- Colonic balloon/stenting

GIT Polypectomies


Now routinely recommended vs. surgery as effective, safe and minimally invasive.

Biliary Stenting/Diversion

Use of a nitinol stent to palliate a colorectal neoplastic obstruction in a dog

Endoluminal Tracheal Stenting
Nasopharyngeal stenosis balloon/stenting
Tracheal/bronchial mass removal
Respiratory Foreign body retrieval
Embolization for Chylothorax

Tracheal Collapse: Endoluminal Stenting
45.8% dogs requiring stents have BC
Warn owners the pet will continue to cough so aggressive medical therapy post-stent!

Antirivatives:
Narcotics
Butorphanol
Hycodan
Sedatives: Trazadone

NPS: Stenting

4 dogs & 3 cats
Success rate:
6/6 immediate resolution
5/6 resolution of clinical signs 12 to 28 mos. post stent placement
Complications:
1/6- Caudal positioning
2/6- Tissue ingrowth
Recommendations:
> 1 cm of caudal soft palate unstented
Complete membrane -> Covered stent
**Tracheal Pathology**
- Endoscopic snare for Mass
- Ballooning for Hemostasis
- Foreign body Retrieval

**Idiopathic Chylothorax**
- Medical: Corticosteroids/diuretics, Rutin (benzopyrone), Low fat diet
- Surgical/Thorascopic: TD ligation, Pericardecctomy, CC ablation
- Pleuroport Placement, Shunting....

**Chylothorax**
- TD: 40-47% Failure
- TD + CCA: 88% success
- TD + PC: 57-100%
- TD + CCA: 83% success
- TD + PD: 60% success
- Measured CVP: No increased CVPs before or after

**Thorascopic Treatment for Chylothorax in the dog**
- Minimally invasive treatment of idiopathic chylothorax in dogs by thorascopic thoracic duct ligation and subphrenic pericardecctomy:
  - N: 6 dogs
  - Successful in all

**Interventional Radiology**
Vascular Interventions for Benign disease:
- IHPSS
- HAVMs
- PAVMs
- Epistaxis

Interventional Oncology:
- Chemosembolization
- Intra-arterial chemotherapy
- Cryotherapy
- Chemical/Heat ablation
- Caval stenting/transarterial stenting

**IHPSS Intrahepatic Portosystemic shunts**
IHPSS:
- Intrahepatic direct communication between the portal system and the systemic venous drainage
- Bypassing of the liver sinusoids
  - Signalment:
    - Young, large and giant purebred
    - Encephalopathic (abnormal behavior), vomiting, diarrhea, poor growth, PUPD, anorexia, myxomatous face, soft haircoat
    - 30% have GIT hemorrhage
  - Diagnosis:
    - Typical BW, BA, UA
    - *Dual phase-CTA* is best to locate portovenous shunt entry
**IHPSS Treatment:**

- **Medical:**
  - Lactulose, antibiotics, low-protein, highly digestible diet, dairy/vegetable based protein, Keppra
  - LIFELONG omeprazole (1mg/kg every 12 hours)

- **Surgical:**
  - Ameroid constrictors, cellophane banding, ligation
  - Post-operative mortality 11-28% and complications 77%
  - Overall mortality 23-63.6%

**Percutaneous Transjugular Coil Embolization (PTCE):**
- <5% post-operative mortality
- <15% long-term mortality with life-long antacids
- Minimally invasive: can easily replace further coils

**Procedure:**
- Jugular access
- Access to portocaval shunt
- Caval stent
- Thrombogenic coils are placed

Weisse et al. JAVMA 2014;244:78-94. Endo-vascular evaluation and treatment of IHPSS 100 dogs.

**Hepatic Arteriovenous Malformations**
- Rare: multiple high-pressure A. to low-press V
- Congenital: dogs and cat
- HA communicates with PV via multiple shunting vessels
- Hepatofugal
- Extrahepatic shunts decompress

**Signalment:**
- Young dogs < 1 year, any breed
- 75% abdominal effusion
- GI signs, stunted growth
- Heart murmurs-20%
- Bruit or turbulence

**HAVM Treatments**

**Diagnosis:**
- AUS
- Dual-phase CTA

**Treatment and prognosis:**
- Medical
- Surgical
  - Long-term prognosis fair 38-55%
  - Glue embolization:
    - Survival 100%, with fair to good prognosis in 100%
    - Repeat embolizations
    - 75% medical management post-procedure or surgery

**Glue embolization:**
- Arterial access via femoral artery
- Catheterization of the hepatic (or other) arterial branch feeding the AVM.
- Cyanoacrylate glue and ethiodized oil
- Small incision over the femoral

**Epistaxis: Refractory**
- Benign disease:
  - Coagulation disorder
  - Thrombocytopenia
- Malignancy
- Intra-arterial catheterization
- Super-selection of sphenopalatine a.
  - Embolic bead delivery

**HAVM: Glue embolization**

**PTCE**

**Percutaneous Transjugular Coil Embolization for IHPSS**

**Procedure:**
- Jugular access
- Access to portocaval shunt
- Caval stent
- Thrombogenic coils are placed

**Photo Courtesy of Dr. C. Weisse, Animal Medical Center, NY**
**Interventional Oncology**
- Chemoembolization
- Intra-Arterial chemotherapy delivery
- Cryotherapy
- Heat/chemical ablation
- Caval stenting

**Chemoembolization**
Unresectable hepatic tumors
TACE-transarterial chemoembolization

**Candidates:**
- Typically HCC
- Hemoabdomen
- Progression
- Dual CTA

**Procedure:**
- Femoral A.
- Super select
- Local delivery
- 95% arterial
- Chemotherapy + beads + contrast +/- Embolization

**Chemoembolization: Outcomes**
- Post-procedural recovery:
  - Small groin incision
  - Kept overnight
- Preliminary data (per Dr. Chick Weisse):
  - Safe <10% non-target embolization
  - Altered architecture at recheck CT
  - 30% have reduction in size
  - Increased chemotherapy to liver
  - Reduced/undetectable chemo levels systemically
  - Subsequent surgical resection

**Intra-Arterial Chemotherapy**
- Any regional chemotherapy delivery
- Increased local concentration
- Reduced systemic concentration
- Prostatic neoplasia
- Hepatic masses
- Bladder neoplasia
- Minimal evidence at this time
- Further investigation required

**Cryotherapy**
- RT unresponsive
- Nasal masses
- Focal metastasis

**Caval Obstructions: Palliative Stenting**
- Budd-Chiari
- Schlieksup, Weisse, Berent, Solomon
- Effective Palliative treatment for dogs with BCS
Caval Obstructions: Palliative Stenting

- Percutaneous transjugular stenting for caval obstructions
- Small incision in jugular vein for caval access
- Placement of stent(s) across obstructive lesion
- Rapid resolution of signs of impaired venous drainage

Current Investigations and Future possibilities

- Stem cells for CKD and PLN
- IA delivery of radiosensitization agents
- Prostatic embolization
- Transjugular liver biopsy
- High frequency ultrasound prostatic neoplasia
- Endoscopic biliary decompression
- Heat/Chemical Ablation

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