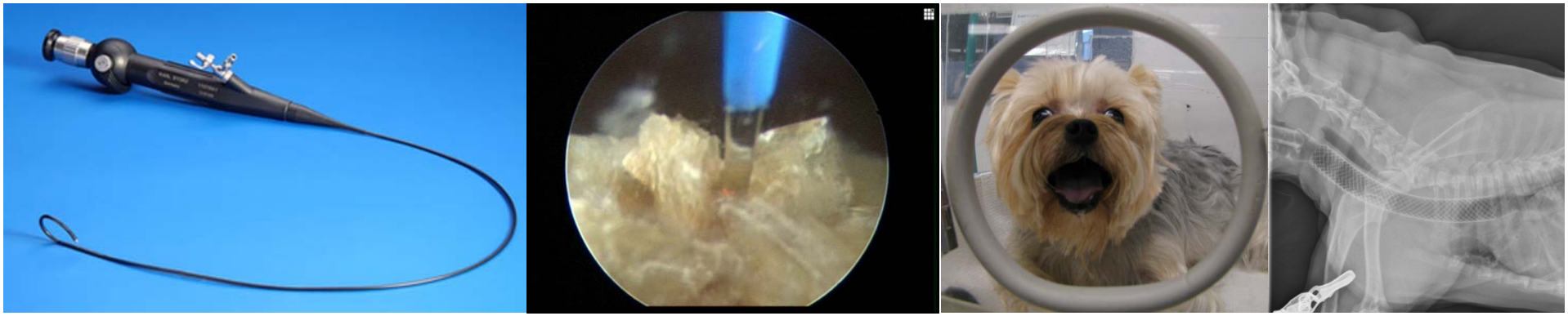
Cornell University Veterinary Specialists

Interventional Radiology and Interventional Endoscopy

Practical Applications for Veterinary Medicine



Megan Morgan, VMD, DACVIM
Marnin Forman, DVM, DACVIM

This lecture is sponsored by…

Outline

- **Background on Interventional Radiology (IR) and Interventional Endoscopy (IE)**
- **IR and IE in the treatment of Urolithiasis**
- **IR and IE in the treatment of Urinary incontinence**
- **IR and IE in the treatment of Tracheal collapse**
- **IR and IE in the treatment of Urinary obstructions**

IR and IE-Background

- What is Interventional Radiology (IR)?
  - A specialty that utilizes image guidance to perform minimally invasive procedures to diagnose and treat disease.

Thoracic radiograph of a patient with a tracheal stent

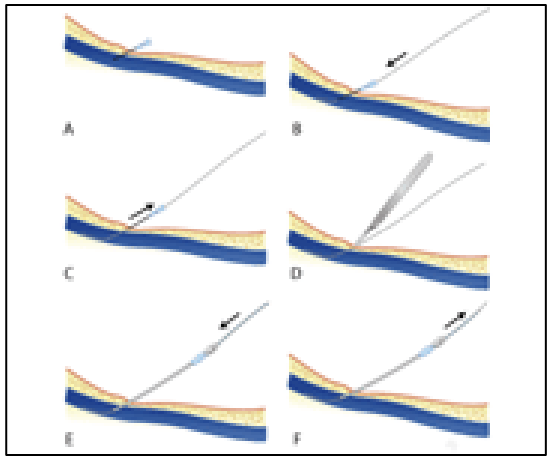
IR and IE-Background

- What is Interventional Endoscopy (IE)?
  - A specialty that utilizes endoscopic guidance to perform minimally invasive procedures to diagnose and treat disease.

Cystoscopic image of a patient with bilateral ectopic ureters

IR and IE-Background

- Image guidance tools
  - Fluoroscopy
  - Ultrasound
  - Digital radiography
  - CTA
  - MRA
- Minimally invasive access
  - Natural orifice
  - Seldinger technique



Seldinger Technique
http://www.accessmedicine.ca

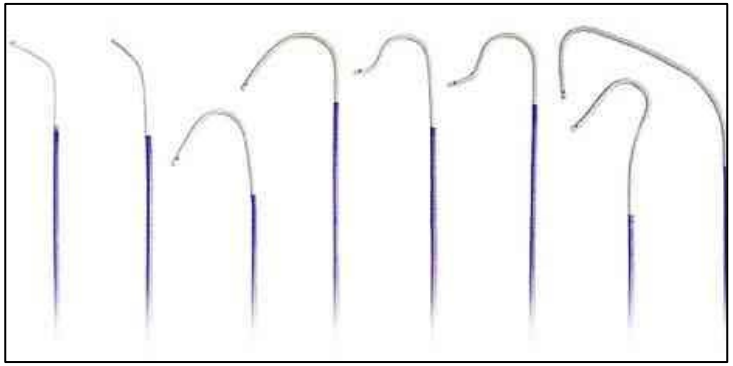
IR and IE-Background

- IR and IE goals
  - Palliation of clinical signs
  - Adjuvant therapy
  - Definitive treatment

Fluoroscopic image of a retrograde contrast urethrocystogram in a patient with urethral transitional cell carcinoma

IR and IE-Background

- IR and IE equipment
  - Guidewires
    - Most common sizes
      - –0.035 inch--fits through an 18 gauge needle
      - –0.018 inch--fits through a 22 gauge needle
      - –0.025 inch--fits through a 20 gauge needle
  - Specialized catheters
    - Categorized by the type of tip

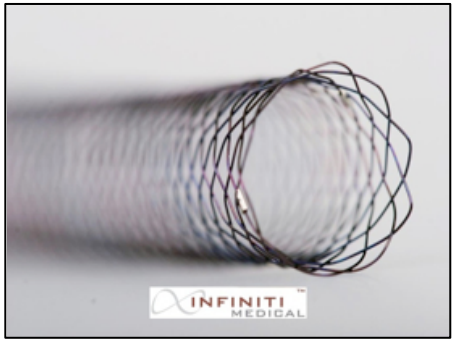


Vascular access catheters

IR and IE-Background

- IR and IE equipment
  - Sheaths
    - Sized by the size of the catheter accepted by the sheath
    - The actual diameter of the sheath is larger than the listed sheath size
  - Stents
    - Multiple material types
    - Wire mesh vs. laser cut
    - Balloon expandable vs. self expanding
    - Covered vs. uncovered

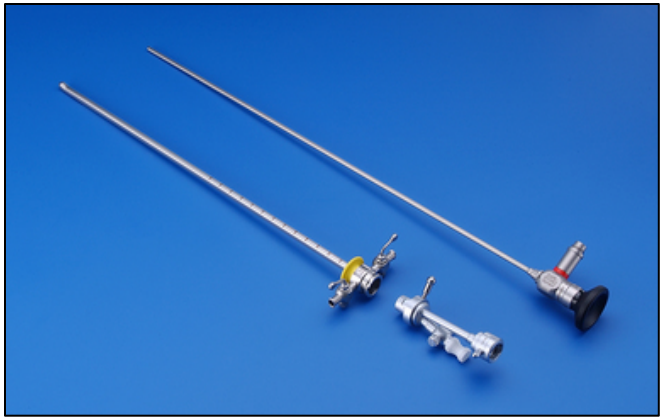
Vascular access sheath



Nitinol wire mesh tracheal stent

IR and IE-Background

- IR and IE equipment
  - Cystoscopes
    - Rigid cystoscopes for cystoscopy in females
    - Flexible cysto/ureteroscopes for cystoscopy in males

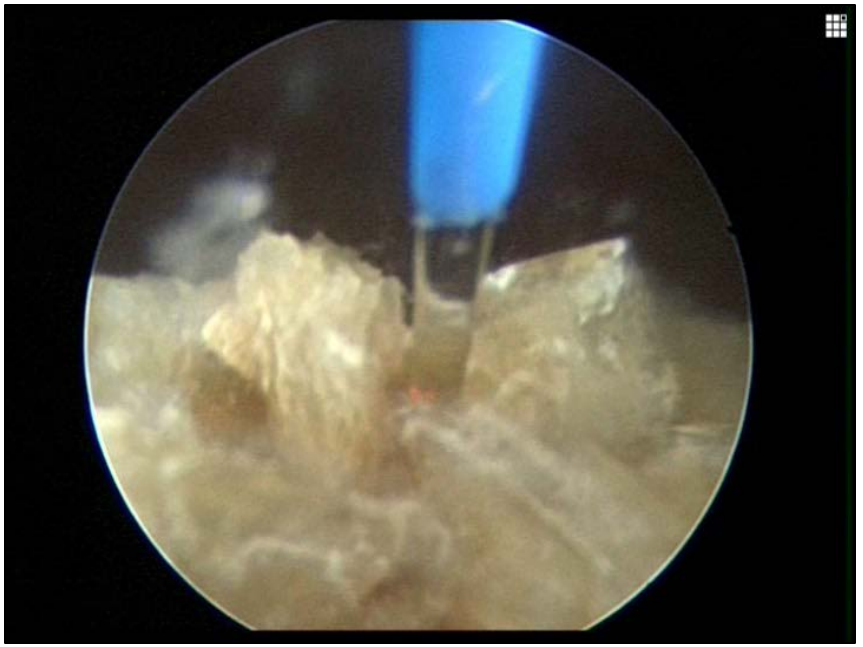


Karl Storz 2.7 mm diameter, 30 degree tip rigid cystoscope

Karl Storz 2.7 mm diameter flexible ureteroscope

IR and IE-Urolith management

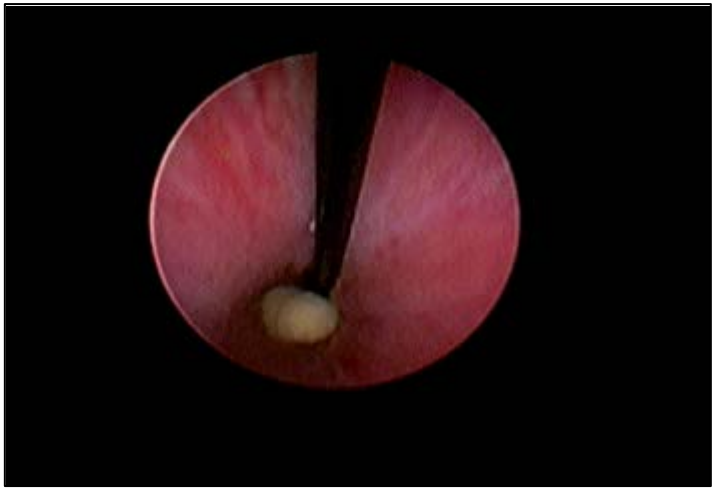
- Laser lithotripsy
  - Cystoscope is passed through the urethra to gain access to uroliths
  - Ho:YAG laser is used to break stones into fragments



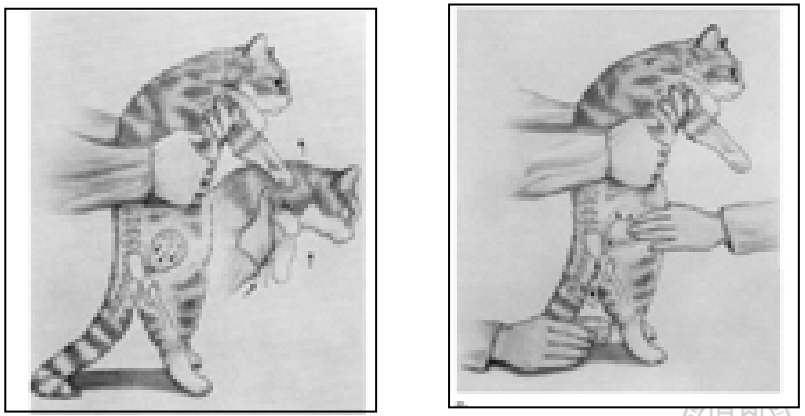
Ho:YAG laser lithotripsy of calcium oxalate stones in a female dog

IR and IE-Urolith Management

- Laser lithotripsy
  - Stone fragments are removed via stone basketing or voiding urohydropulsion



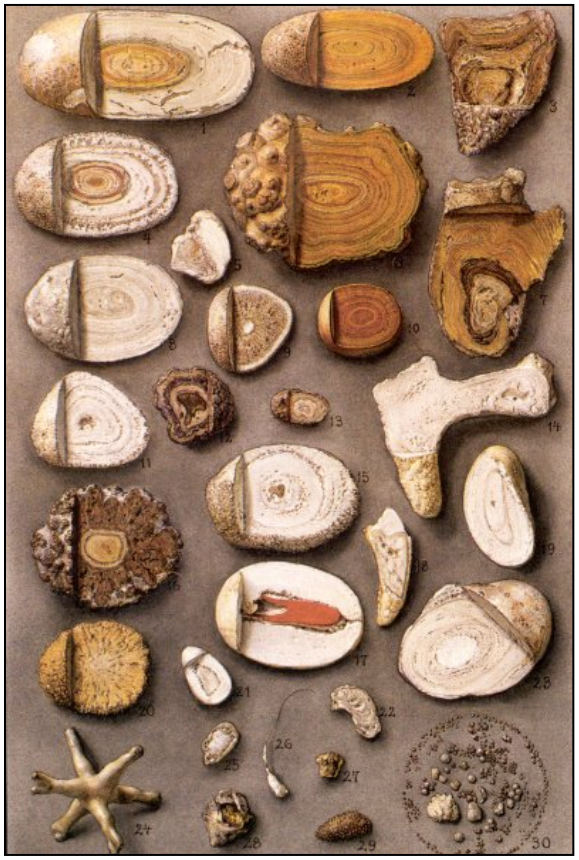
Stone basketing in a female dog



Voiding urohydropulsion in a cat

IR and IE-Urolith Management

- Laser Lithotripsy--Pros
  - Success rates are similar to those achieved with cystotomy (80%-85%)
  - Procedure is minimally invasive
  - Recovery is faster compared to cystotomy
  - Urethrolith management is easier compared to cystotomy
  - Less post-operative maintenance for clients



Cystic calculi

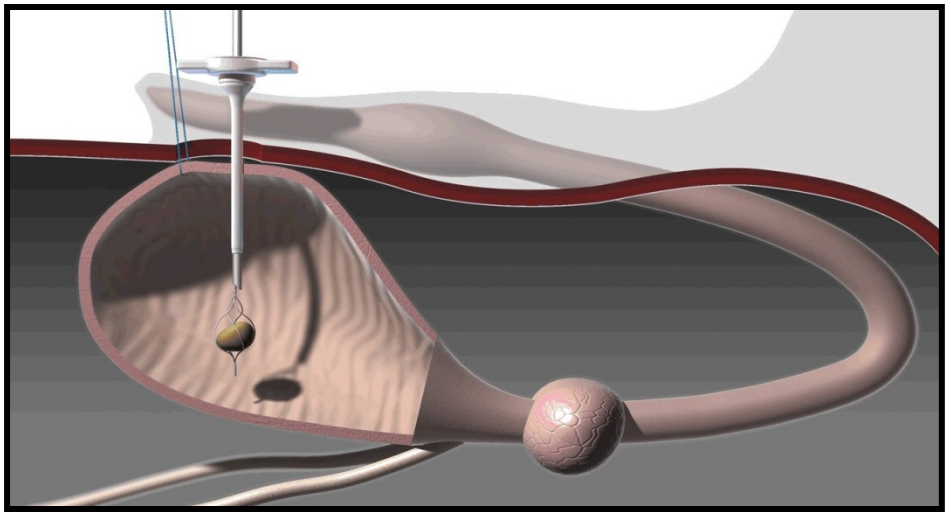
IR and IE-Urolith Management

- Laser Lithotripsy-Cons
  - Procedure can take longer than cystotomy, particularly in male patients (procedure times are similar in female patients), and in patients with large numbers of stones or very large stones.
  - Requires expensive equipment
  - Can cost more than cystotomy (facility dependent)

Fiber-optic flexible cysto/ureteroscope

IR and IE-Urolith Management

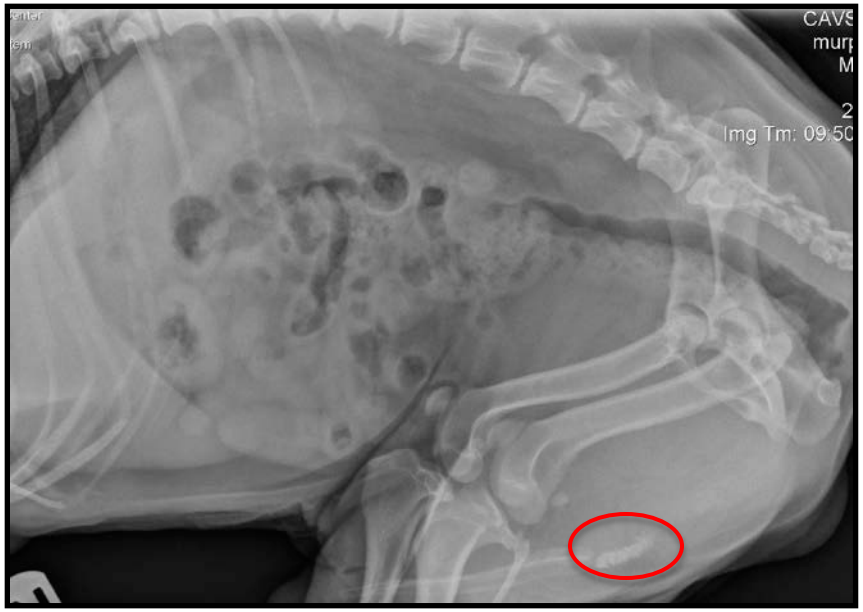
- Percutaneous Cystolithtomy (PCCL)
  - Antegrade access to urinary bladder is obtained through a laparoscopic port
  - Rigid cystoscope is used to access the urinary bladder
  - Flexible ureteroscope is used access the urethra



Percutaneous Cystolithotomy approach
Image courtesy of Allyson Berent, DVM, DACVIM

IR and IE-Urolith Management

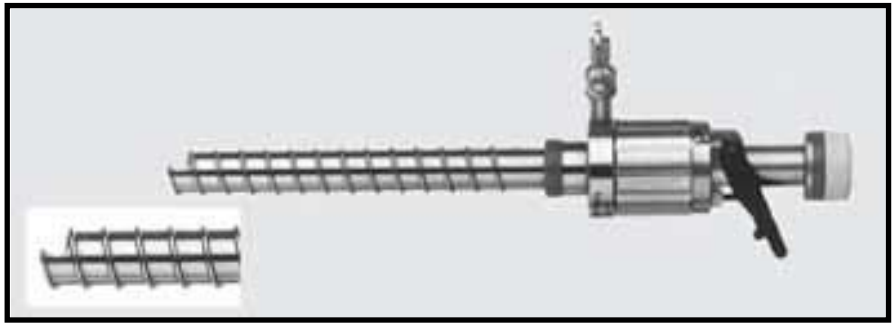
- PCCL-Pros
  - Enables easy access to urethroliths, even those which are proximal to a stricture
  - Faster than lithotripsy in male patients, especially those with large numbers of bladder stones
  - Excellent visualization of bladder and urethra result in minimal risk of leaving calculi behind
  - Procedure is minimally invasive
  - Very low complication rate
  - Rapid patient recovery



Multiple urethroliths in a male dog

IR and IE-Urolith Management

- PCCL-Cons
  - Not as minimally invasive as laser lithotripsy
  - Requires expensive equipment

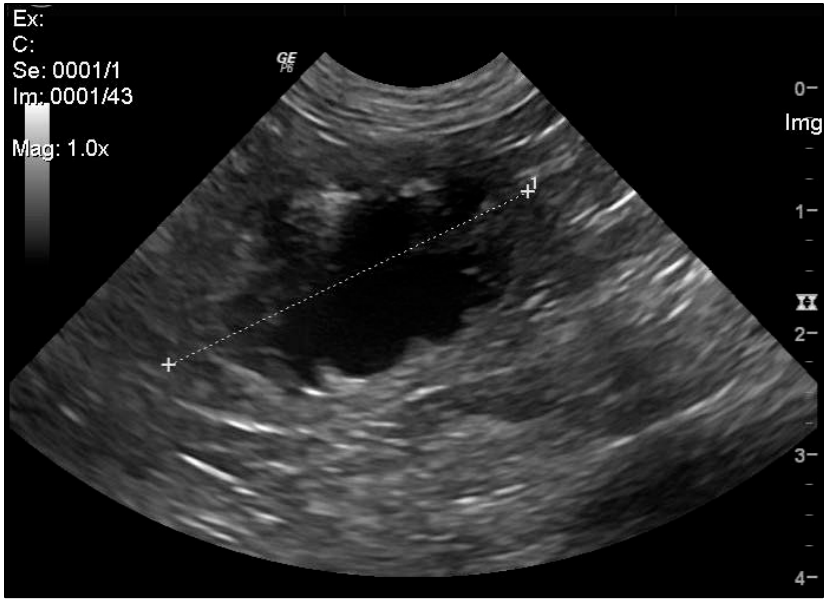


Karl Storz Ternamian Endotip Port

Karl Storz 2.7 mm diameter flexible ureteroscope

IR and IE-Urolith Management

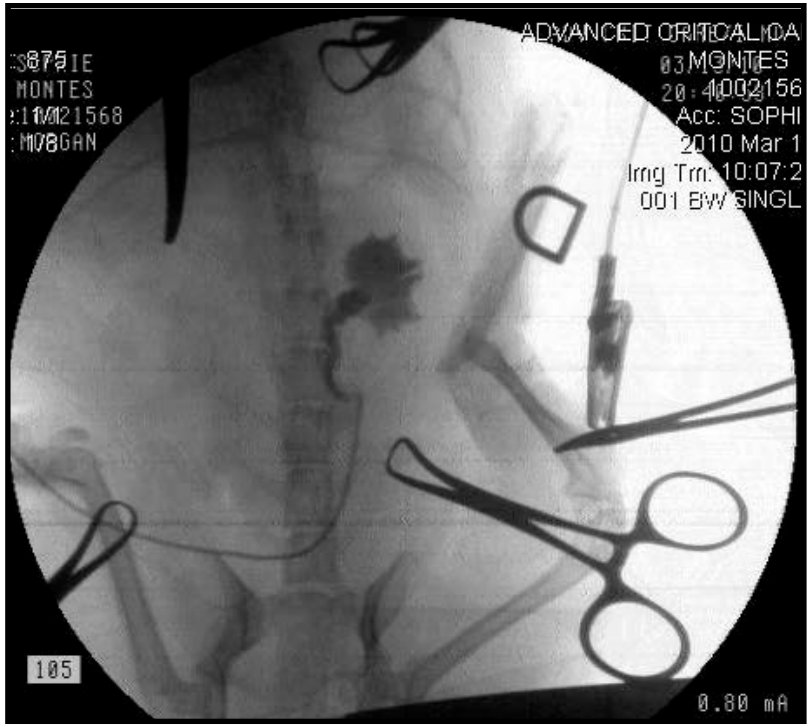
- Ureteral Stent Placement
  - Can be used to address ureteral obstruction secondary to ureterolithiasis, neoplasia, or stricture
  - Effect of ureteral obstruction on renal function:
    - 40% decline in renal function within 24 hours of obstruction
    - 80% decline in renal function within 2 weeks of obstruction
  - Effect of removing ureteral obstruction on renal function (study performed in non-azotemic cats)
    - If obstruction was removed within 5 days, full function returned immediately.
    - If obstruction was removed within 7 days, full function returned in 35 days.
    - If obstruction was removed in 15 days, full function returned in 530 days.



Hydronephrotic kidney caused by a ureteral obstruction

IR and IE-Urolith Management

- Ureteral Stent Placement techniques:
  - Cystoscopic guided placement—typically used in larger female dogs (>8 kg)
  - Percutaneous antegrade placement—used in dogs with TCC causing obstruction of the ureteral orifice(s)
  - Surgical retrograde placement—used in smaller dogs and cats with ureterolithiasis or ureteral stricture
  - Surgical antegrade placement—used in cats with ureterolithiasis or ureteral stricture, or in dogs with TCC causing obstruction of the ureteral orifice(s) (when percutaneous placement is unsuccessful)



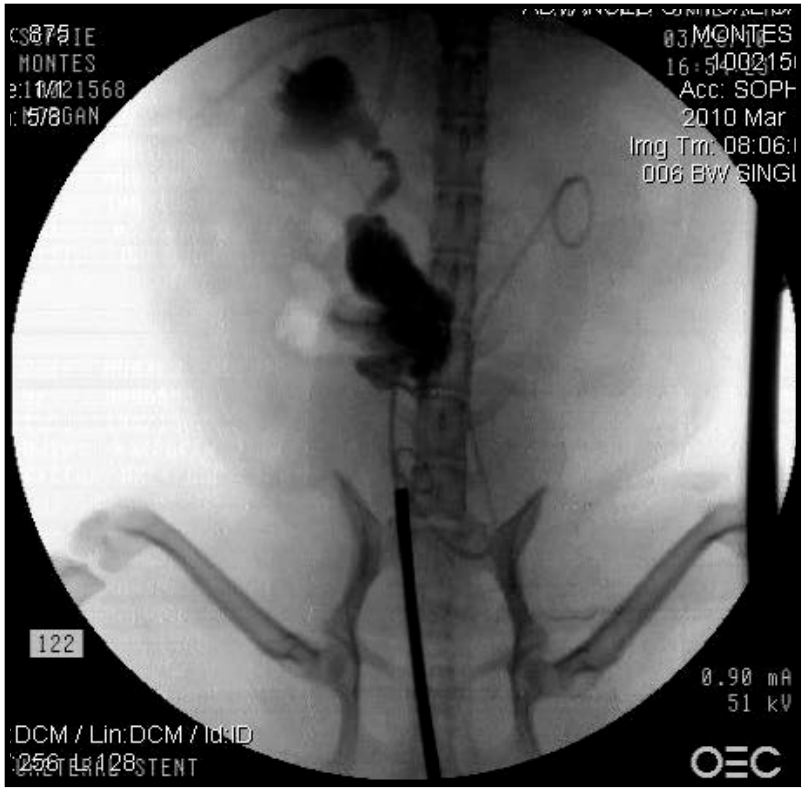
IR and IE-Urolith Management

- Ureteral Stents-Pros
  - Less likely to result in ureteral leakage or stricture compared with ureterotomy
  - Less invasive than ureterotomy or neoureterocystostomy
  - Successful in patients with multiple ureteroliths , which would have necessitated multiple ureterotomies
  - Decreased incidence of repeat obstruction in patients with concurrent ureterolithiasis and nephrolithasis
  - Long term palliation of ureteral obstruction in patients with TCC

Unilateral ureteral stent in a cat

IR and IE-Urolith Management

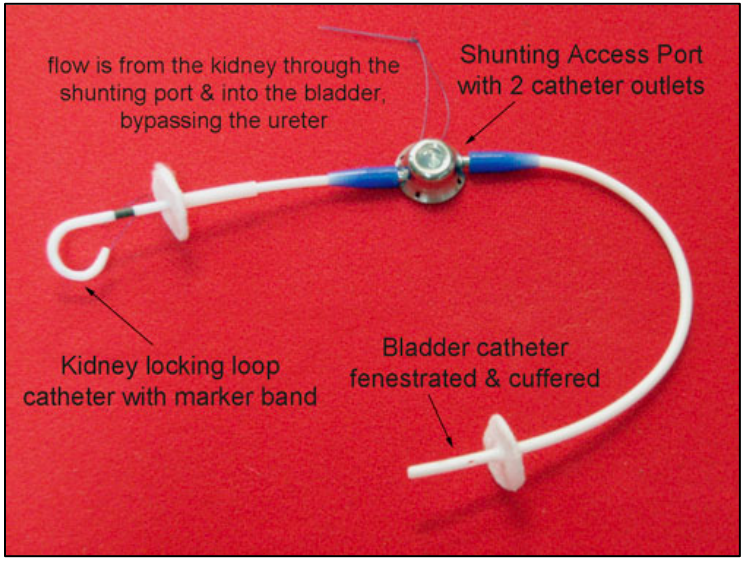
- Ureteral Stents-Cons
  - Cystitis and pollakiuria
  - Stent infection
  - Stent obstruction
  - Stent migration
  - Ureteral trauma during stent placement
  - Volume overload secondary to post-obstructive diuresis



Ureteral leakage following wire passage during ureteral stent placement

IR and IE-Urolith Management

- Subcutaneous Ureteral Bypass (SUB)
  - Enables relief of ureteral obstruction in patients with unsuccessful stent placement, or stent intolerance
  - Consists of a cystostomy tube, a nephrostomy tube, and a subcutaneous port connecting the cystostomy and nephrostomy tubes
  - Urine leakage at cystoscopy/nephrostomy tube sites or at subcutaneous port site is possible
  - Obstruction of cystostomy/nephrostomy tubes is possible



Subcutaneous ureteral bypass device
www.norfolkvetproducts.com/subsystem.html

IR and IE-Urinary Incontinence

- Causes of urinary incontinence in dogs and cats
  - **Urethral Sphincter Mechanism Incompetence (USMI)**
  - **Ureteral ectopia**
  - Neurological dysfunction
  - Intrapelvic bladder
  - Detrusor instability
  - Urovaginal and urethrorectal fistula
  - Vaginal or vestibular urine pooling
  - Urethral prolapse

IR and IE-Urinary Incontinence

- Urethral Sphincter Mechanism Incompetance
  - Most common cause of urinary incontinence in dogs
  - Affects 5.1-9.7% of all spayed female dogs
    - 12.5% of spayed female large breed dogs
  - 35% will not respond to estrogen supplementation
  - Diagnosis:
    - Exclusion of other causes of urinary incontinence
    - Urethral Pressure Profilometry (UPP)
      - Does not rule out multiple contributing factors

IR and IE-Urinary Incontinence

- USMI treatment-Submucosal Urethral Bulking Agent Injections
  - Performed using cystoscopic guidance
  - 68% complete resolution of incontinence (collagen)
  - 15% complete resolution with the addition of PPA
  - Average duration of continence—17 months
  - Deterioration of continence is common (40% of patients in one study), and occurs over the first 12 months after the procedure
  - Collagen is no longer on the market, necessitating the use of new bulking agents

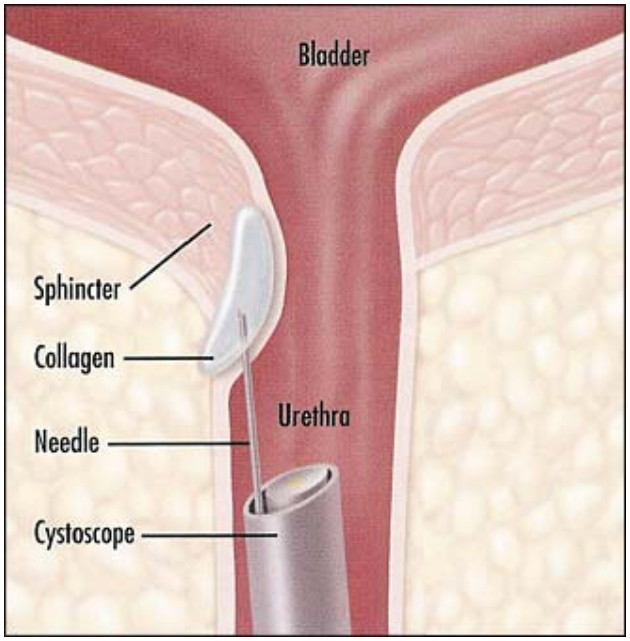
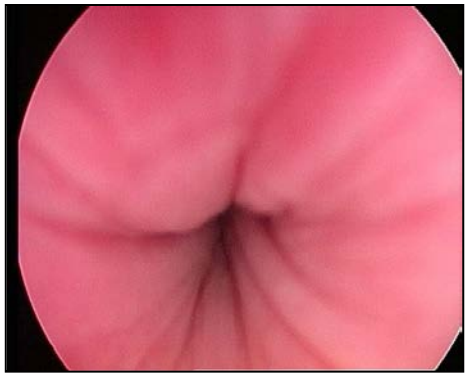
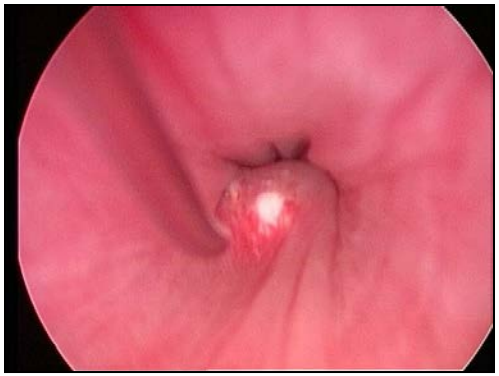


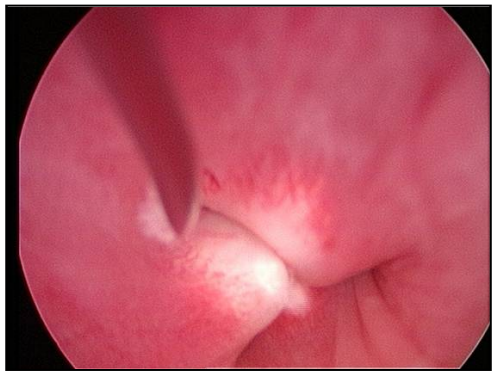
Diagram of technique for submucosal urethral bulking agent injections

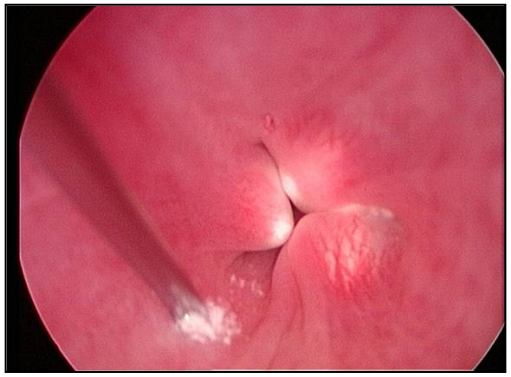
IR and IE-Urinary Incontinence

- USMI treatment-Submucosal Urethral Bulking Agent Injections



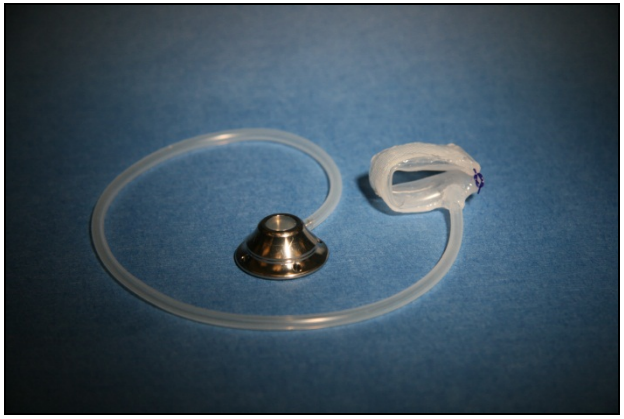






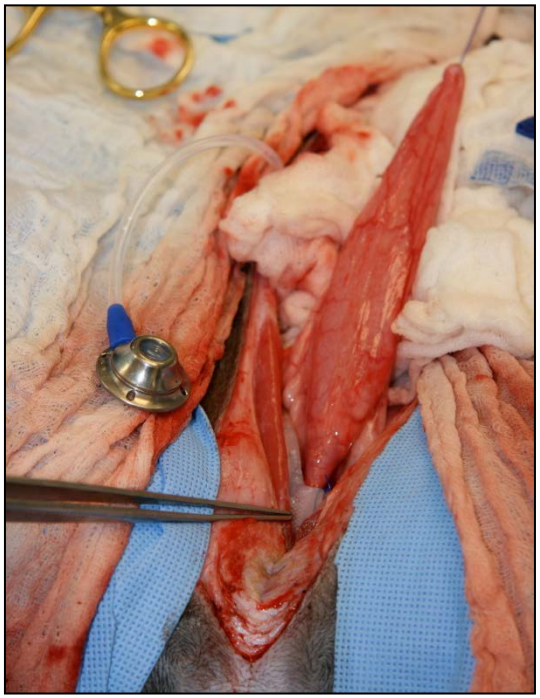
IR and IE-Urinary Incontinence

- USMI-Hydraulic Occluder or Artificial Urethral Sphincter Placement
  - Surgical approach to the treatment of USMI in dogs
  - Involves the placement of a silicone ring around the urethra in the region of the external urethral sphincter, which can then be inflated with saline in the future.
  - A subcutaneous port is then used for control of occluder injection.
  - In some cases, requires cystopexy in order to access the urethra (6/12 cases in a recent abstract).

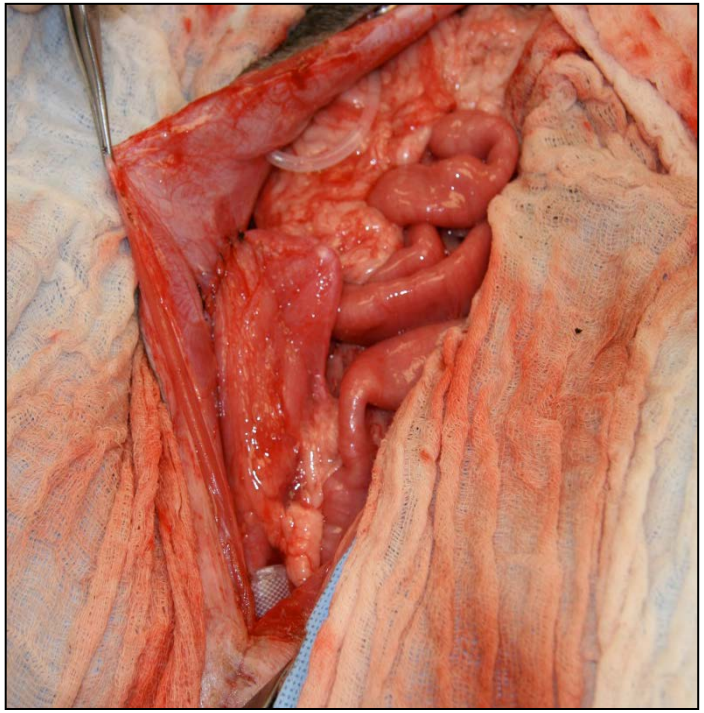


IR and IE-Urinary Incontinence

- Hydraulic Occluder/Artificial Urethral Sphincter



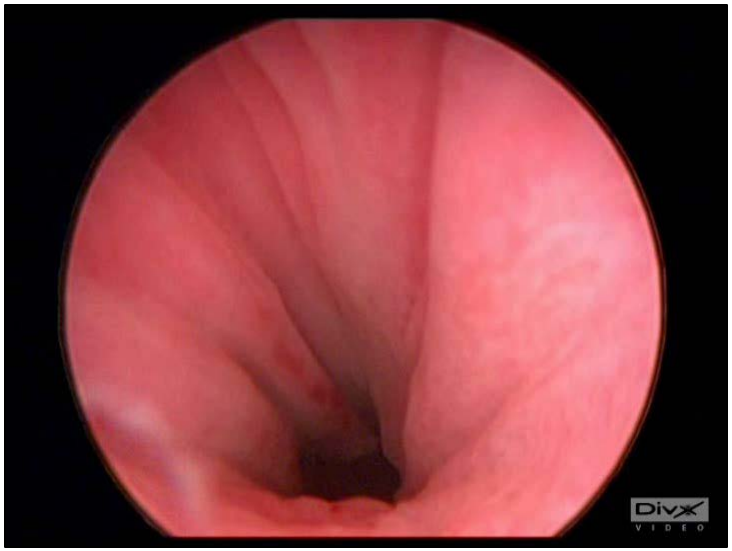
Artificial Urethral Sphincter encircling the proximal urethral of a dog



Cystopexy in a dog following artifical urethral sphincter placement

IR and IE-Urinary Incontinence

- Hydraulic Occluder/Artificial Urethral Sphincter—Follow up
  - Cystoscopy performed 6 weeks following occluder placement
  - Saline injections into subcutaneous port are performed every 2 weeks until continence is achieved



Cystoscopy during hydraulic occluder injection

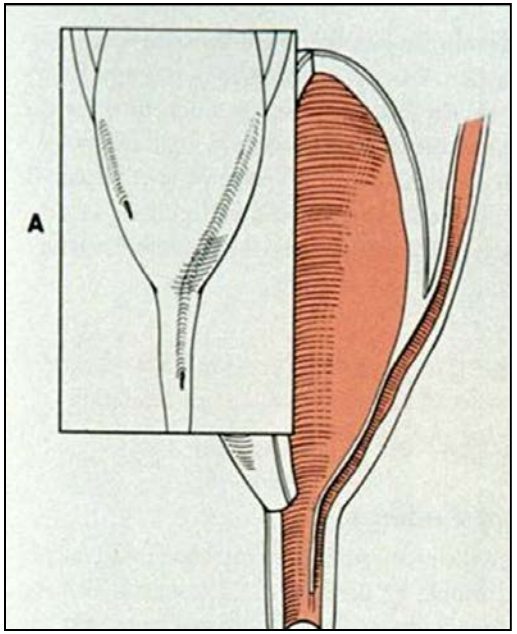
IR and IE-Urinary Incontinence

- Ectopic Ureters-Background
  - Etiology
    - Dysembryogenesis of the urinary tract, resulting in termination of the ureters in a site other than the trigone of the bladder
  - 95% are intramural
  - Often associated with multiple urinary tract anomalies
  - 64% of females with ectopic ureters will have concurrent UTI
  - Diagnosis:
    - IV urography
    - Positive contrast cystography
    - Ultrasound
    - Computed Tomography
    - **Cystoscopy**

Bilateral ectopic ureters in a dog

IR and IE-Urinary Incontinence

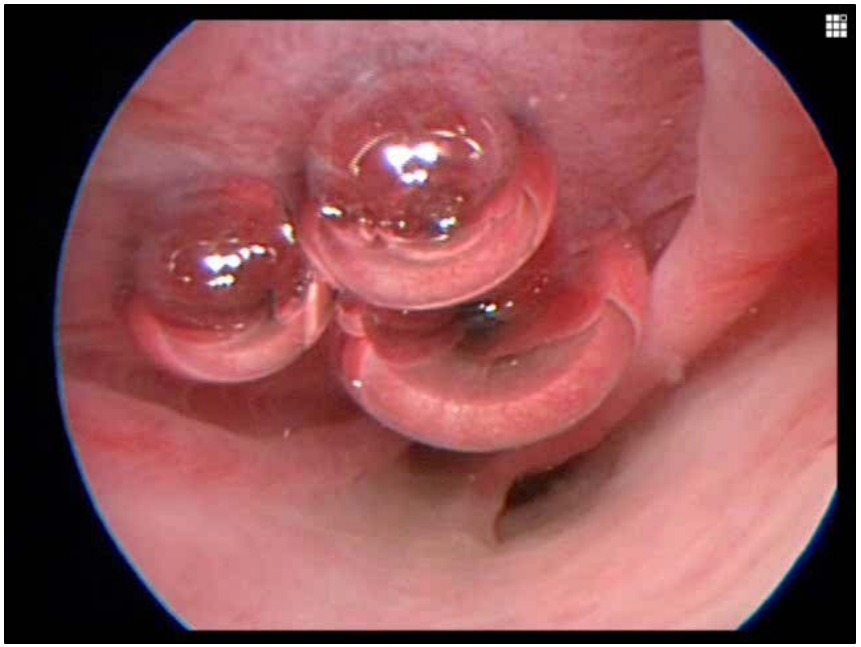
- Ectopic ureters-Treatment options
  - Surgery
    - Neoureterostomy
    - Neoureterocystostomy
  - Interventional endoscopy
    - Cystoscopic laser ablation



Drawing of an intramural ectopic ureter

IR and IE-Urinary Incontinence

- Ectopic Ureters-Cystoscopic guided laser ablation



Ectopic ureter laser ablation in a dog

IR and IE-Urinary Incontinence

- Cystoscopic guided laser ablation of ectopic ureters
  - Pros
    - Minimally invasive
    - Can be performed at the same time as diagnosis of the ectopic ureter
    - Success rates equal to or exceeding surgical success rates (50% completely continent)
    - Extremely low complication rate
  - Cons
    - Requires expensive equipment

Cystoscopy of a dog with bilateral ectopic ureters

Cornell University Veterinary Specialists

IR and IE for the treatment of Tracehobronchial Malacia & Urethral Obstruction

Case Based Approach

Marnin Forman, DVM, DACVIM

Joey 5 year old MC Yorkie

HISTORY

- **Honking coughing & gagging for 2 years initially mild if excited or drinking water**
- **Progressive 6 months prior to evaluation**
- **Treated with doxycycline, transiently better**
- **Then treated with hydrocodone**
- **Exercise intolerance for a few months**
- **Progressive dyspnea for 1 week**

Joey's Presentation

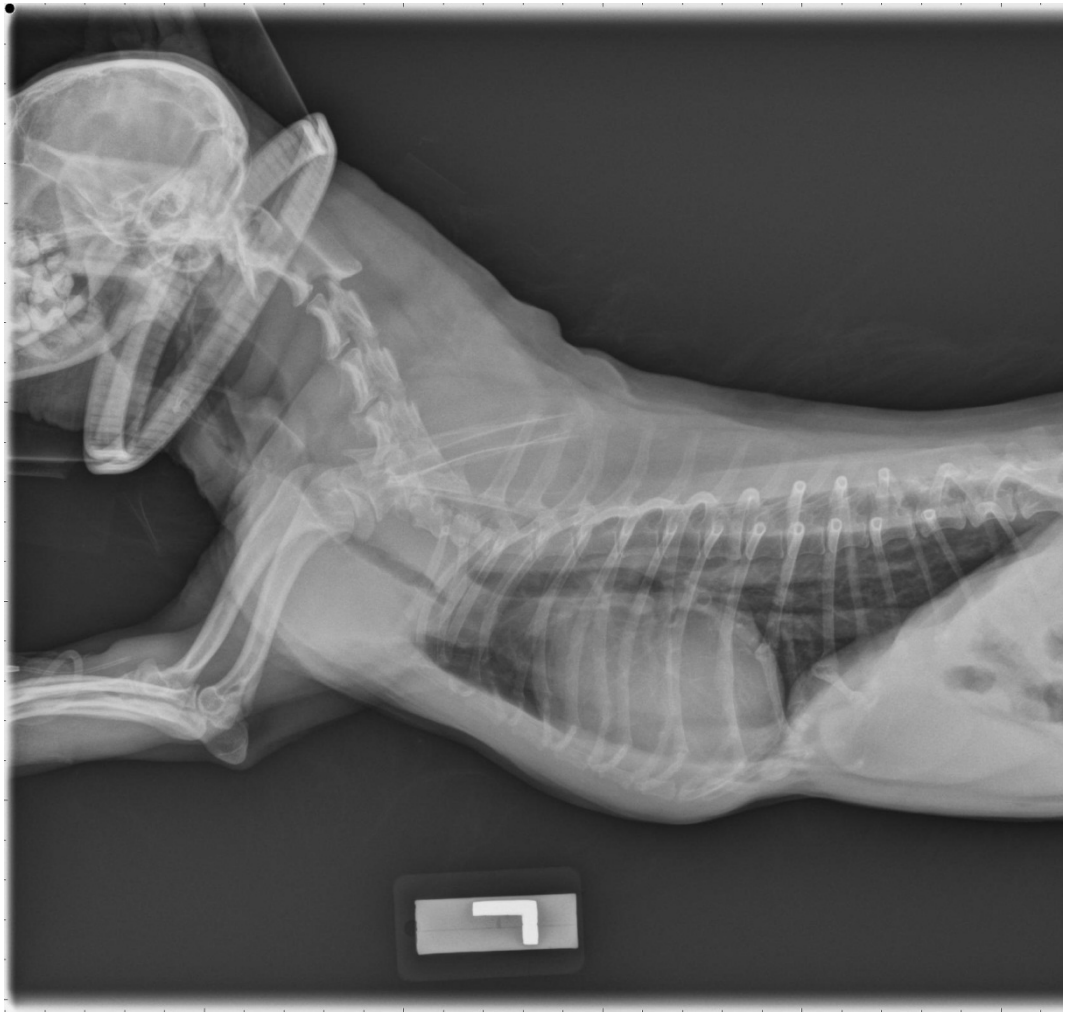
PHYSICAL EXAMINATION

- **Temp 102.8°F**
- **HR 120 bpm**
- **RR 80 bpm**
- **Weight 7 lbs (3.2 kgs)**
- **Cyanotic, dyspnea**
- **Intermittent coughing**
- **Overweight (BCS 7/9)**
- **Air filled stomach**

Joey’s Lateral Chest Radiograph

Diagnostic options for Collapsing Trachea

- **Signalment, clinical signs**
- **Chest radiographs**
  - **Inspiratory, expiratory ?**
  - **Center the beam at the shoulder**
- **Ultrasound**
- **Fluoroscopy**
- **Bronchoscopy**
  - **Fluid analysis**
  - **Culture**



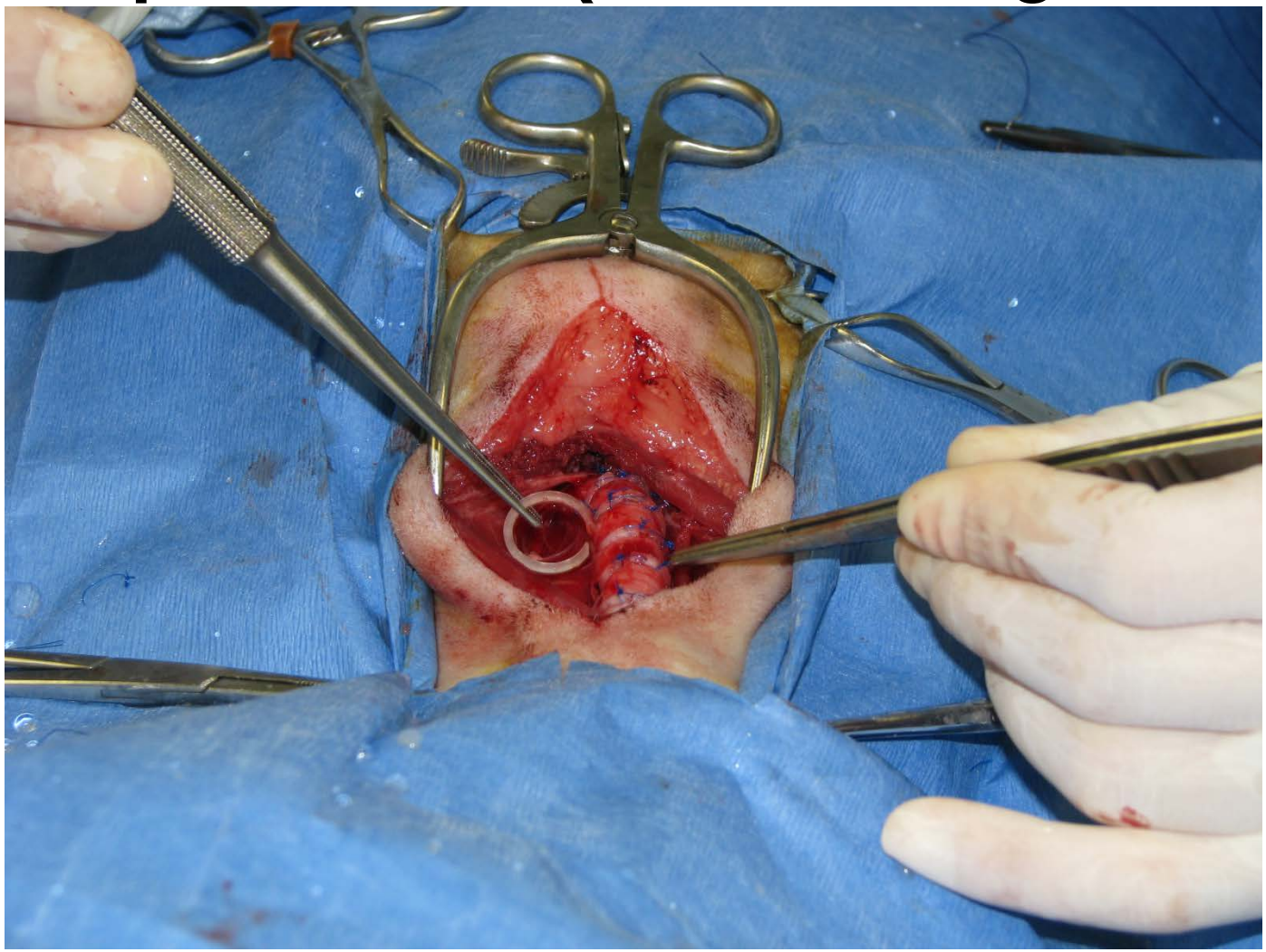
Treatment options for Collapsing Trachea

MEDICAL THERAPY

- **Acute setting**
  - **Sedation (butrophanol, acepromazine)**
  - **Antibiotics for secondary infection**
  - **Bronchodilator (terbutaline, theophylline)**
  - **Antinflammatory doses of steroids**
  - **Oxygen therapy**
- **Chronic setting**
  - **Cough suppressants [hydrocodone, Robitussin DM, Lomotil (Diphenoxylate and Atropine)]**
  - **Lasix?, antihistamines?**
  - **Weight loss, body harnesses**

Surgery for Collapsing Trachea

External prosthetics (tracheal rings or spiral)



External Prosthetics
Tracheal rings or spiral

- **Permits correction of cervical collapse**
- **Unrewarding with thoracic collapse**
- **Complications**
  - **Loosening or failure of implants**
  - **Infections**
  - **Laryngeal paralysis**
  - **Tracheal necrosis**
- **Techniques to limit complications**
  - **Modified dissection, preserve vascular supply**
  - **Arytenoid (s) lateralization**

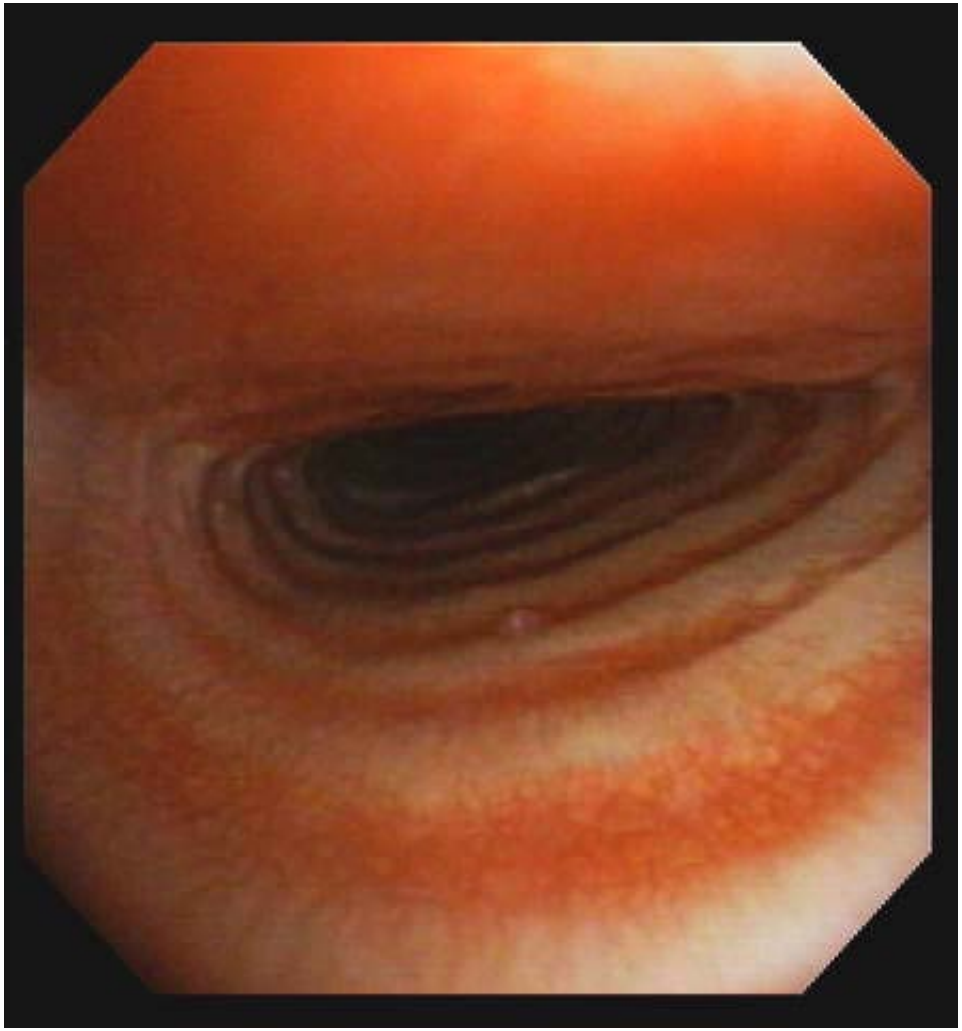
Intraluminal Tracheal Stenting

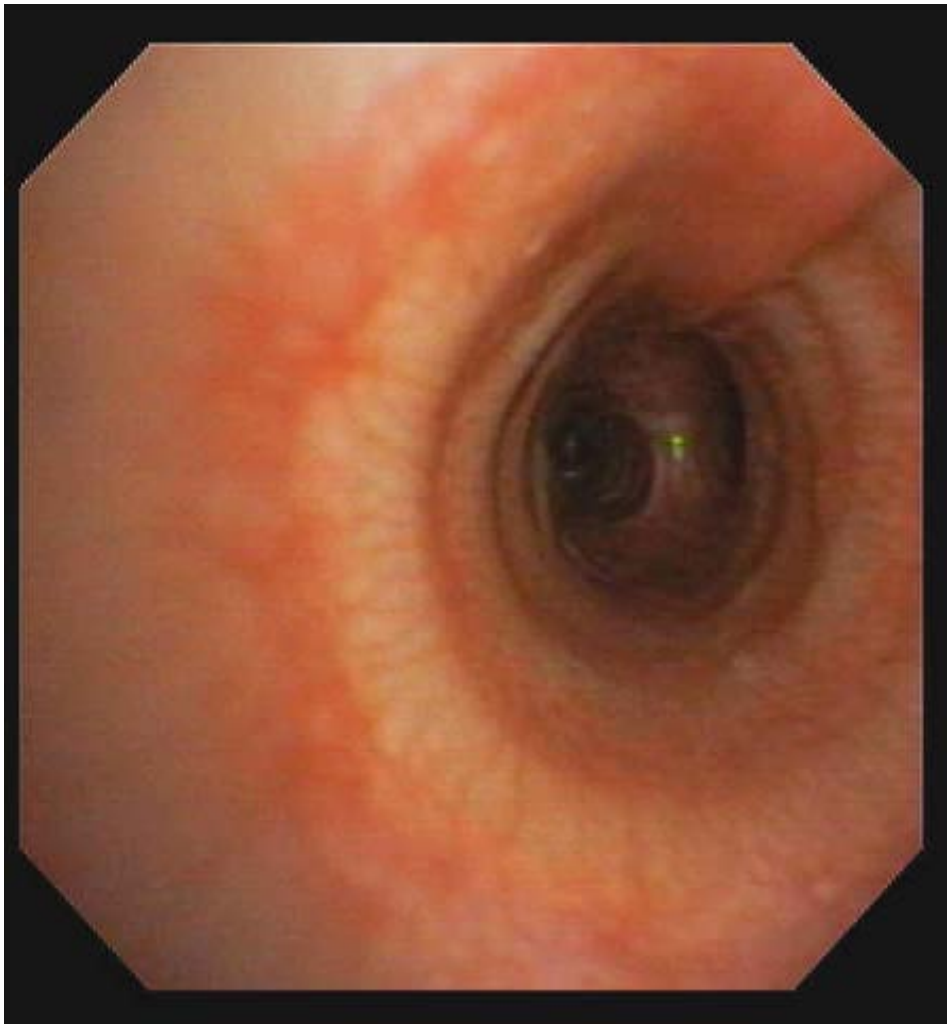
- **Correction of cervical & intrathoracic collapse - infrequent only cervical collapse**
- **Balloon-expandable stents, stainless steel mesh, self-expanding Nitinol stent**
- **Complications, range 10-42%**
  - **Pneumomediastinum, SQ emphysema**
  - **Excessive inflammatory tissue formation**
  - **Progressive tracheal or bronchial collapse**
  - **Stent shortening and less likely fracture**
  - **Continued coughing**
- **Techniques to limit complications**
  - **Newer stents, correct sizing, medical therapy**

Prognosis for Collapsing Trachea

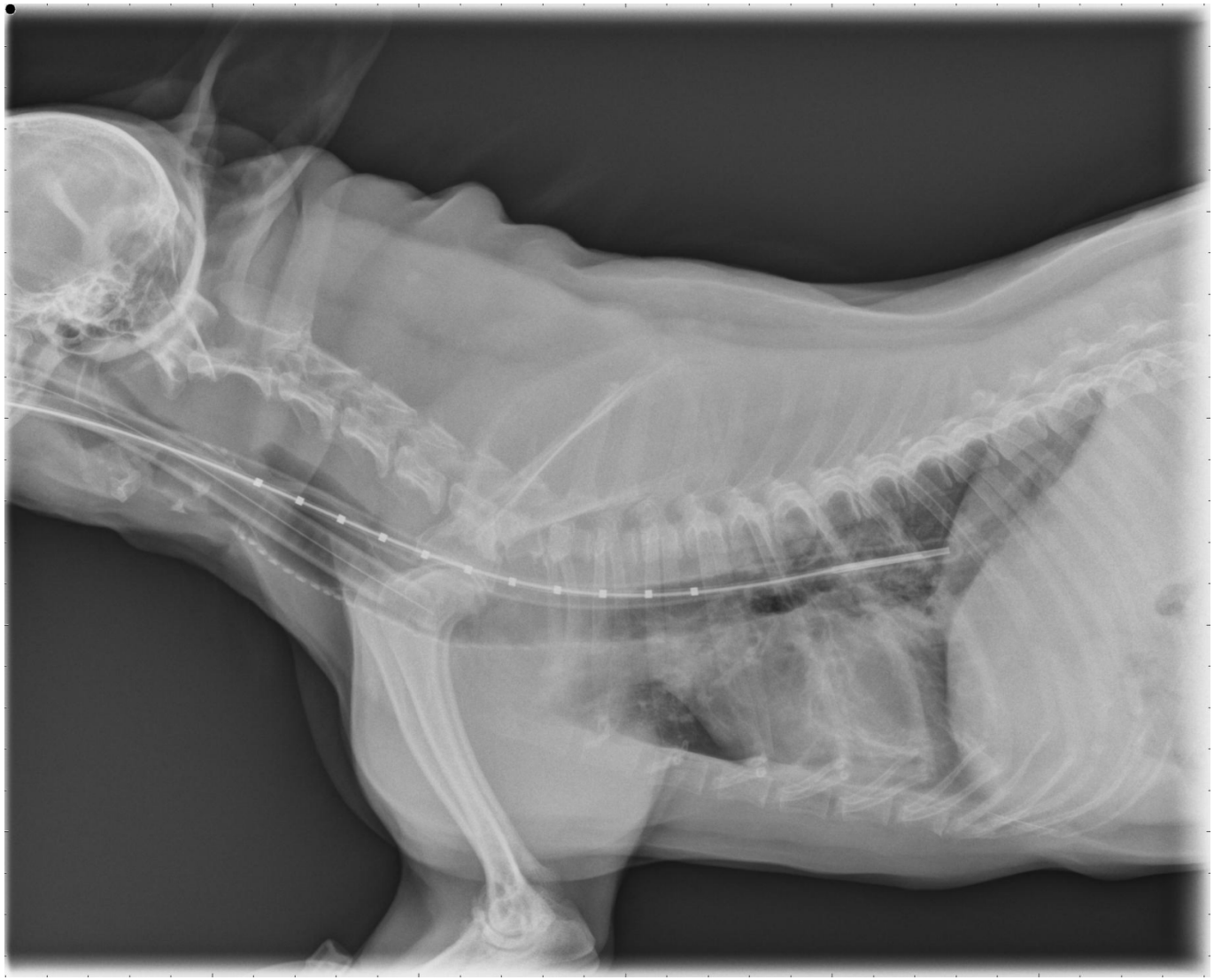
- **Medical**
  - **Beneficial for 71%, especially if mild collapse**
- **Surgery**
  - **75% - 85% of dogs improve**
  - **If > 6 years or laryngeal or bronchial disease more complications & poorer outcome**
  - **6% die perioperatively, 11% laryngeal paralysis, 19% require a tracheostomy, 23% died of respiratory problems**
- **Intraluminal Tracheal Stenting**
  - **90% - 95% are immediately improved**
  - **0-8% die perioperatively, 10-42% complications**

Joey’s Bronchoscopy

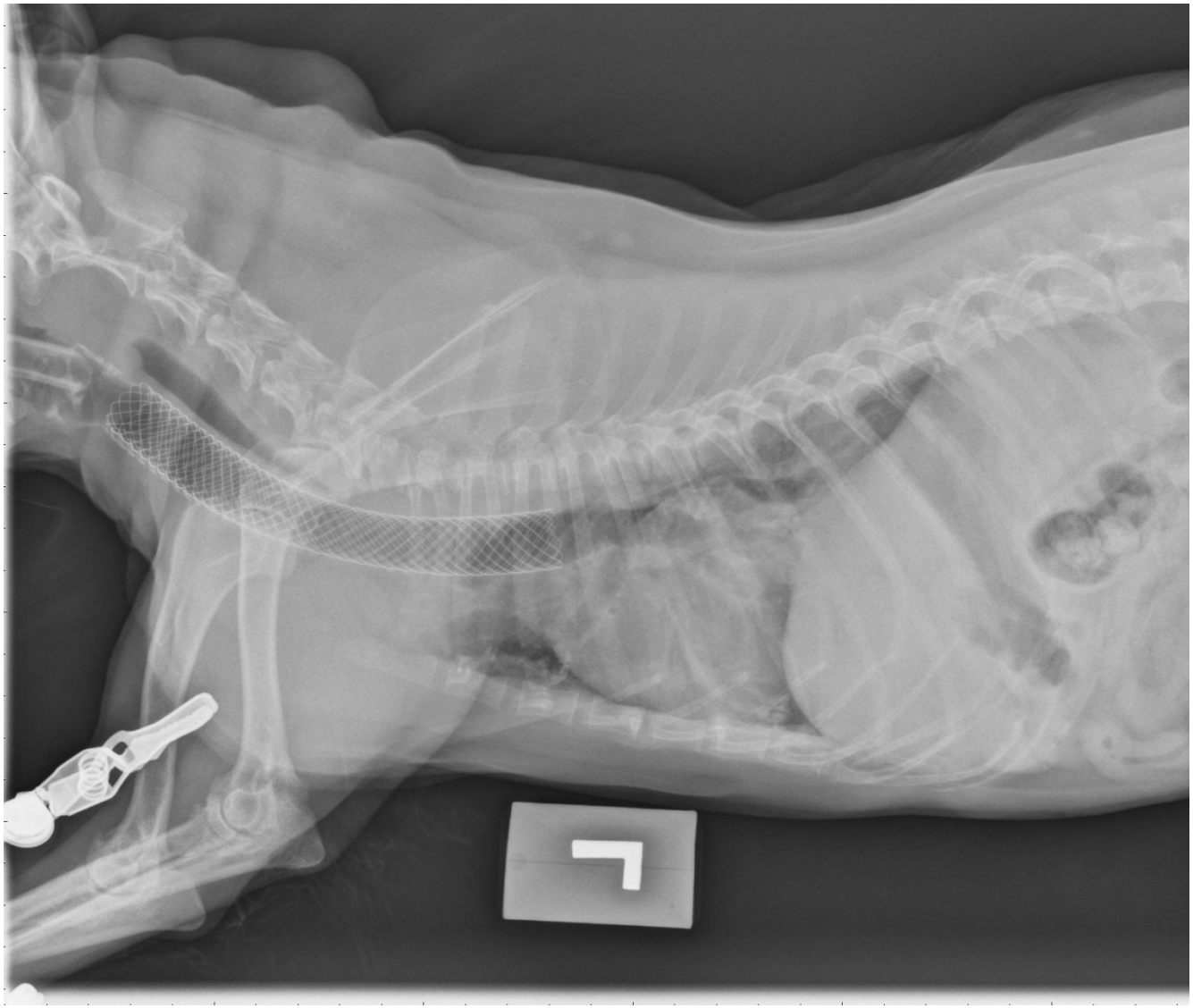




Joey’s Intraluminal Tracheal Stent Measurements



Joey's Intraluminal Tracheal Stent Post Placement Radiograph



Joey's Outcome

- **Post stent placement breathing comfortable, went home next day**
- **Medical therapy**
  - **Doxycycline for 3 weeks**
  - **Lomotil long term**
- **No further cyanotic events**
- **Exercised more?**
- **Still alive**

Bart 10 year old MI Labrador

HISTORY

- **Progressive stranguria and pollikuria for 2 weeks**
- **5 days of inability to urinate**
- **Straining to defecate**
- **Urinary catheter placed**
- **Prostatomegaly noted on PE & ultrasound**
- **FNA of prostate revealed carcinoma**
- **Treated with Baytril, Deramaxx**

Bart's Presentation

PHYSICAL EXAMINATION

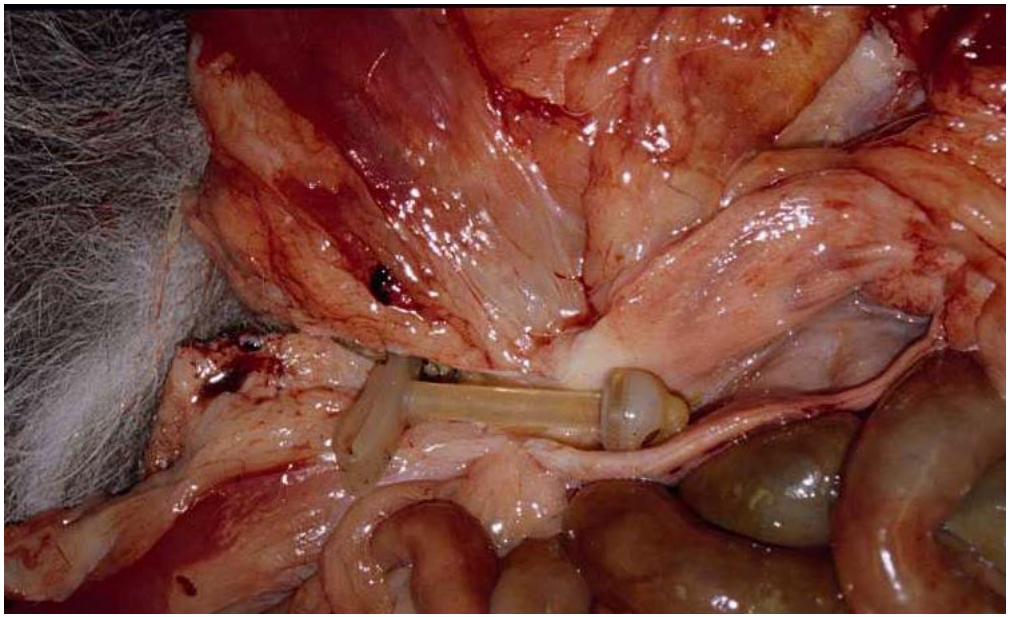
- **Temp 101.5°F**
- **HR 86 bpm**
- **RR Pant bpm**
- **Weight 85 lbs (38.8 kgs)**
- **Markedly enlarged, irregular prostate**
- **Closed foley urethral catheter**

Treatment options for Urethra Obstruction 2nd to Prostatic Cancer

- **Cancer directed therapies**
  - **Radiation therapy**
  - **Chemotherapy**
  - **Surgery**
- **Urethral directed therapies**
  - **Intermittent or indwelling urinary catheterization**
  - **Low profile cystostomy tubes**
  - **Transurethral stents**

Low profile Cystostomy tubes

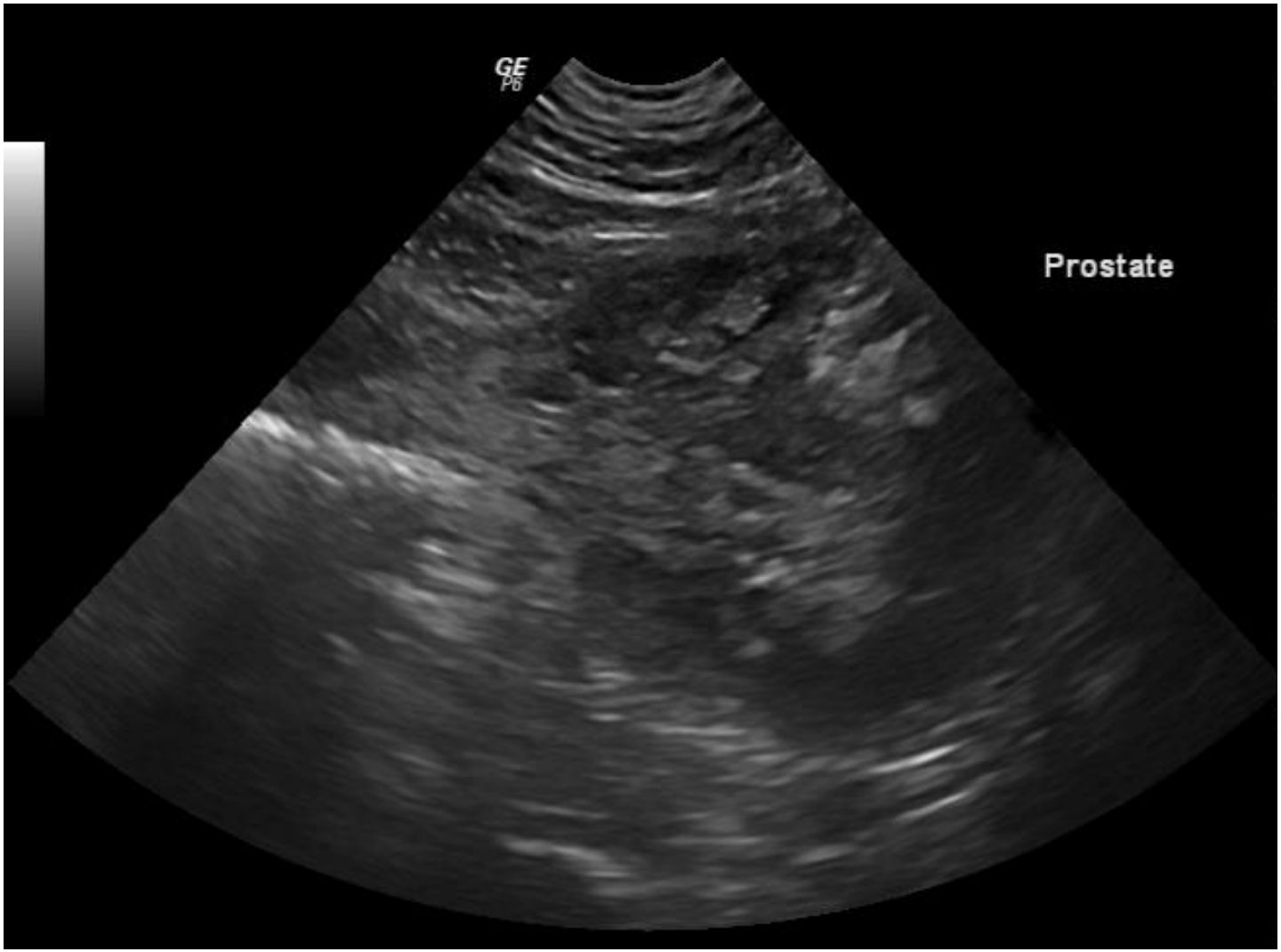
- **Complications**
  - **Chronic infections**
  - **Tube leakage**
  - **Dislodgement**
  - **Need for manual drainage**
  - **In 1 study, 49% has complications**



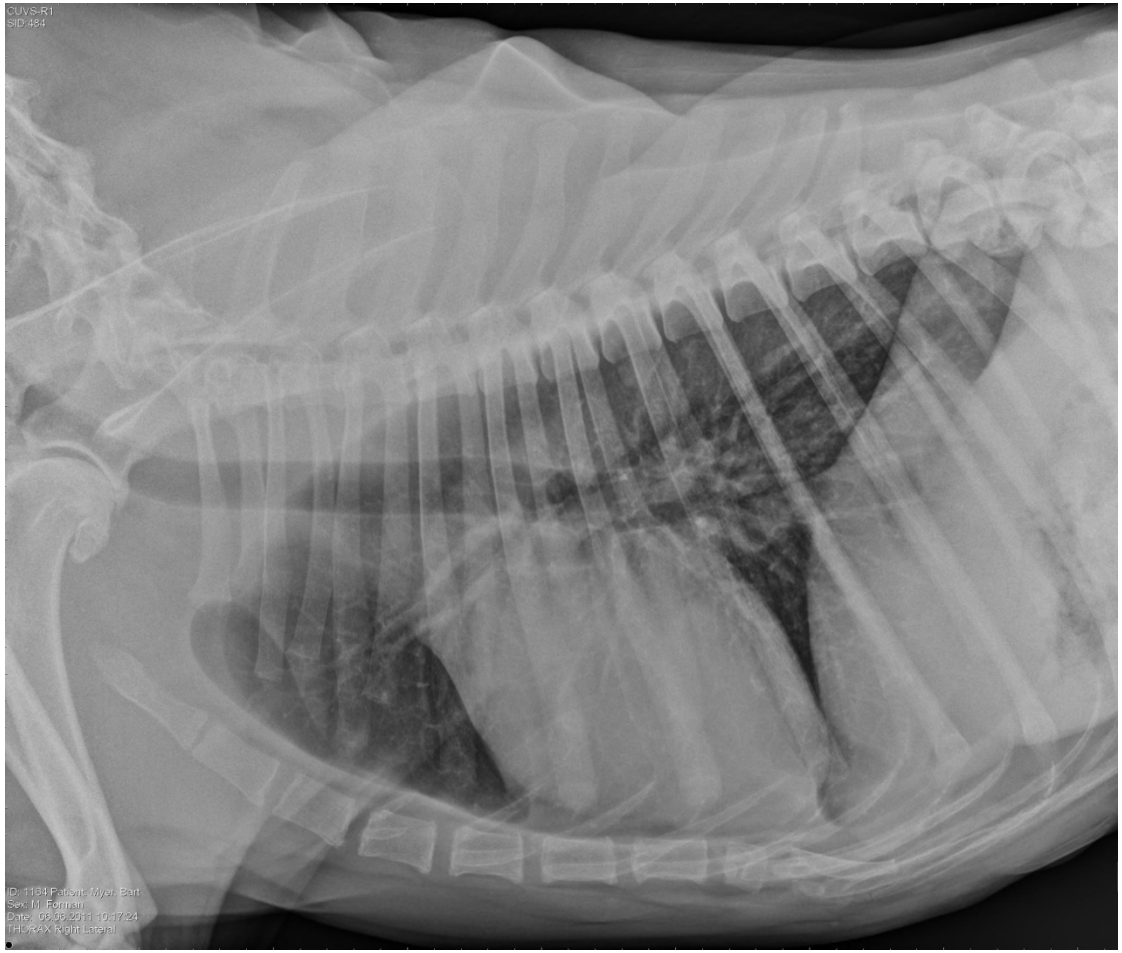
Transurethral stents

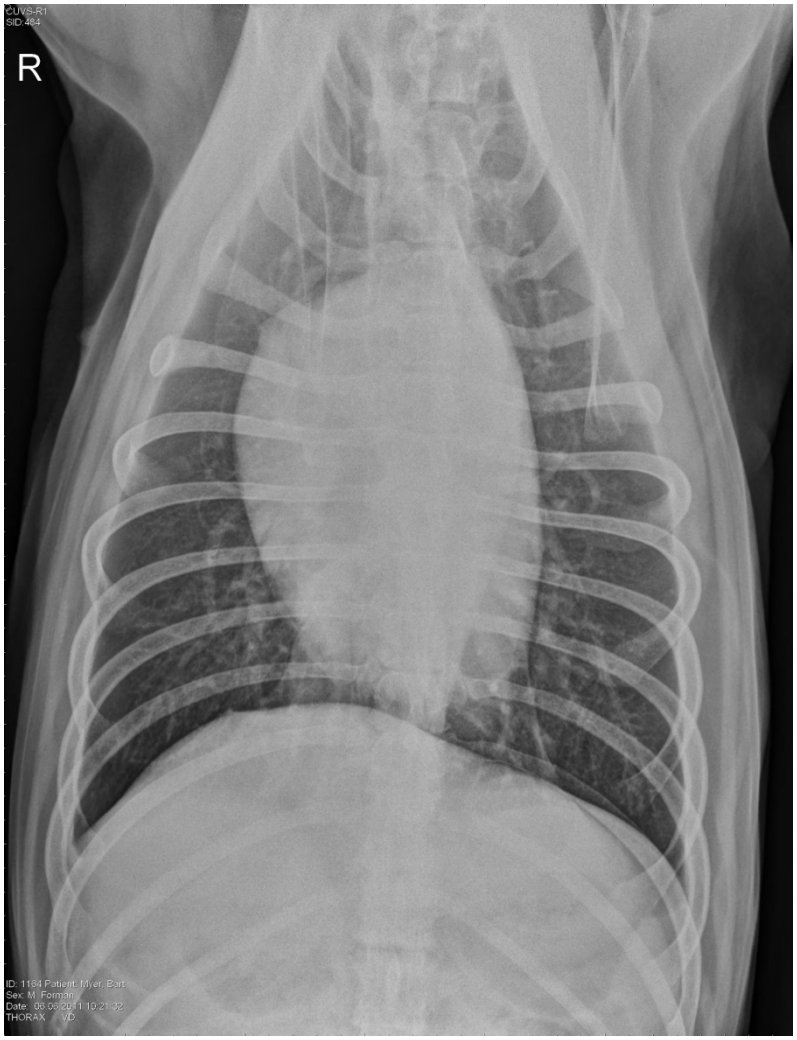
- **Balloon-expandable stents, self-expanding stainless metallic stents, self-expanding (laser cut) Nitinol stent**
- **Complications**
  - **Blood clots formation, urethral edema**
  - **Urinary incontinence**
  - **Progressive cancer (local, metastatic)**
  - **Stent fracture and not stent shortening**
  - **Palliative**
- **Techniques to limit complications**
  - **Primary cancer therapy (Radiation, chemotherapy)**

Bart’s ultrasound

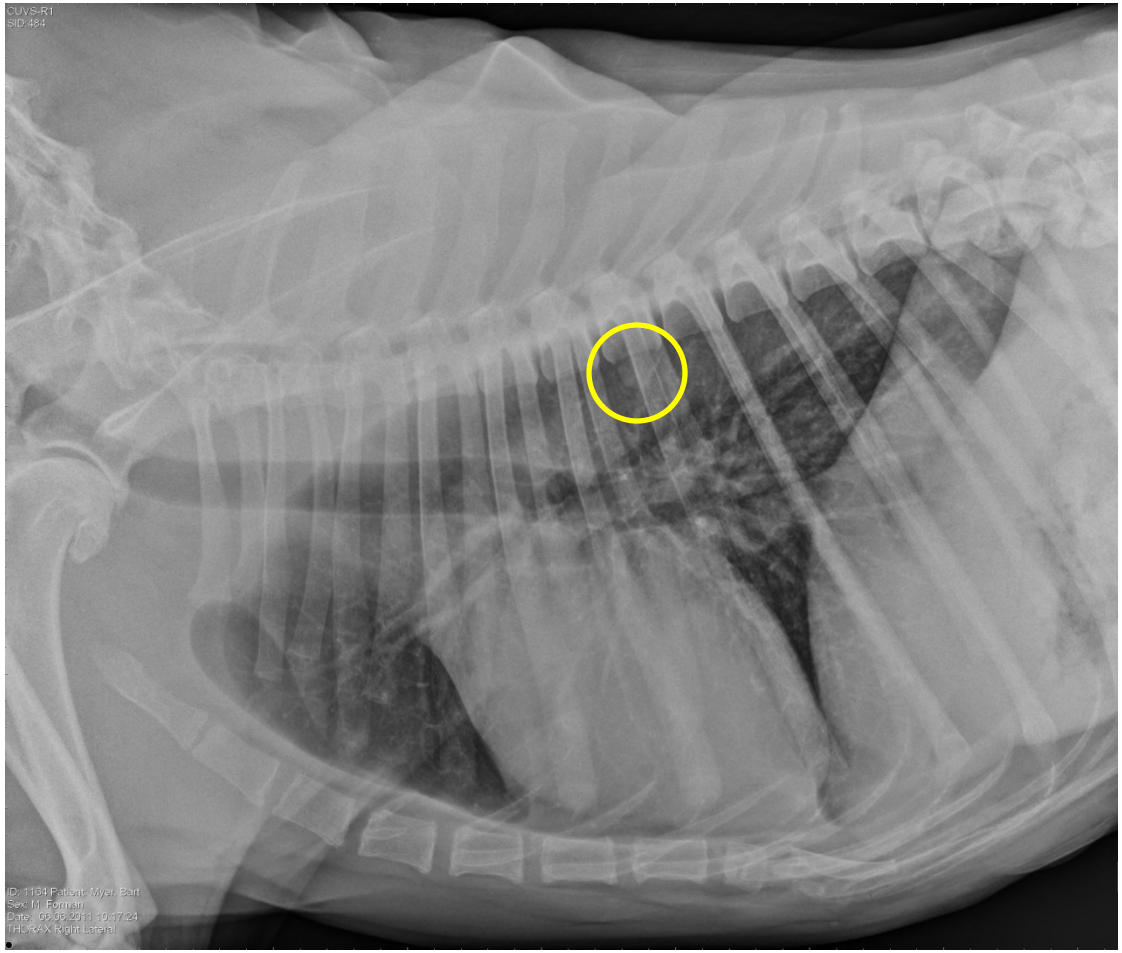


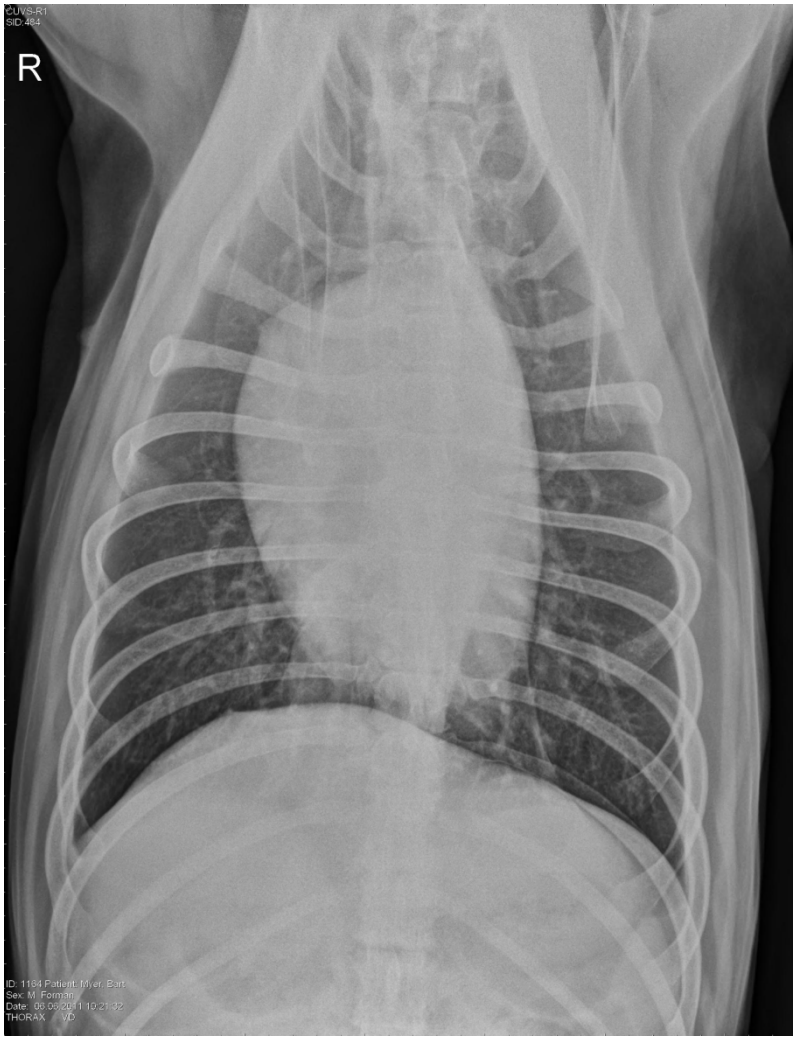
Bart's Chest Radiographs





Bart's Chest Radiographs

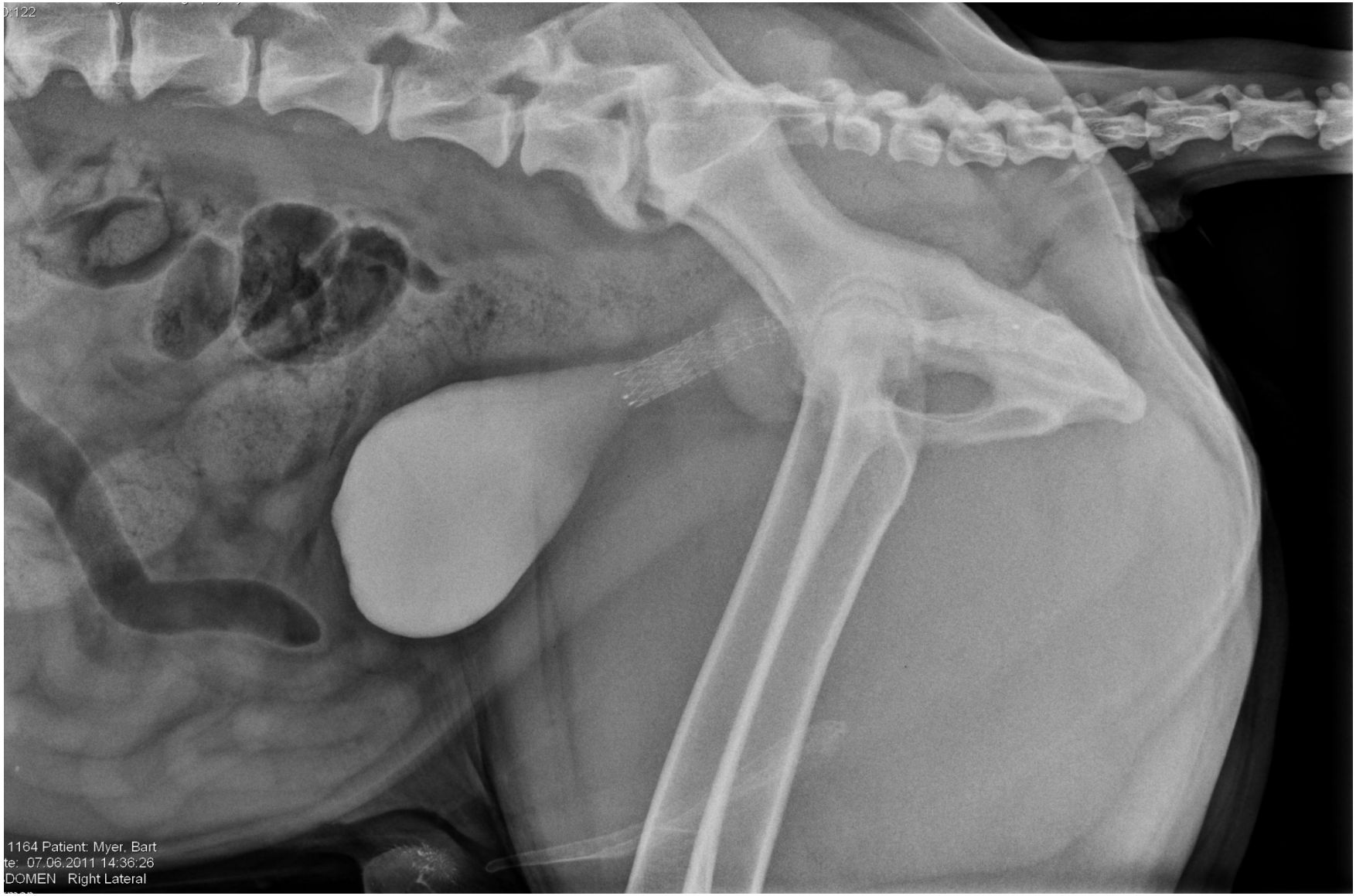




Bart’s Contrast Retrograde Urethrogram

Bart's Fluoroscopic Stent Placement

Bart’s Post Placement Radiographs



Bart's Outcome

- **Post stent urinating well, home next day**
- **Medical therapy**
  - **Lactulose, Deramaxx**
- **Chemotherapy**
  - **Carboplatin q 3 weeks**
- **Developed urinary incontinence**
  - **Controlled with phenylpropanolamine**
- **Progressive pulmonary metastatic disease**
  - **Noted 3 months later**
- **Stranguria, azotemia and then euthanasia**
  - **5 months post stent placement**

QUESTIONS

Megan Morgan
VMD, DACVIM
mmorgan@cuvs.org

Marnin Forman
DVM, DACVIM
mforman@cuvs.org