

# **Interventional Radiology & Cardiology**

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# **Interventional radiology**

- Image guided
- Minimally invasive procedures
- Using natural body orifices or blood vessels

# Advantages

- Less peri-operative pain
- Lower risk
  - Hemorrhage
  - Wound infection or breakdown
- Shorter hospitalization period
- Fewer unexpected costs for owner

# Interventional radiology

- Primary treatment
  - PDA, PS, IHPSS
- Adjuvant therapy
  - Intra-arterial chemotherapy
- Palliative therapy
  - Stent

# Interventional radiology - Devices



**PDA**

**(Patent Ductus Arteriosus)**

# **PDA – Natural history**

- **50% dead by one year old without treatment**
- Complication
  - Left heart dysfunction
  - Congestive heart failure
  - Arrhythmias
  - Pulmonary hypertension: leading to R-to-L shunt

# **PDA – Physical examination**

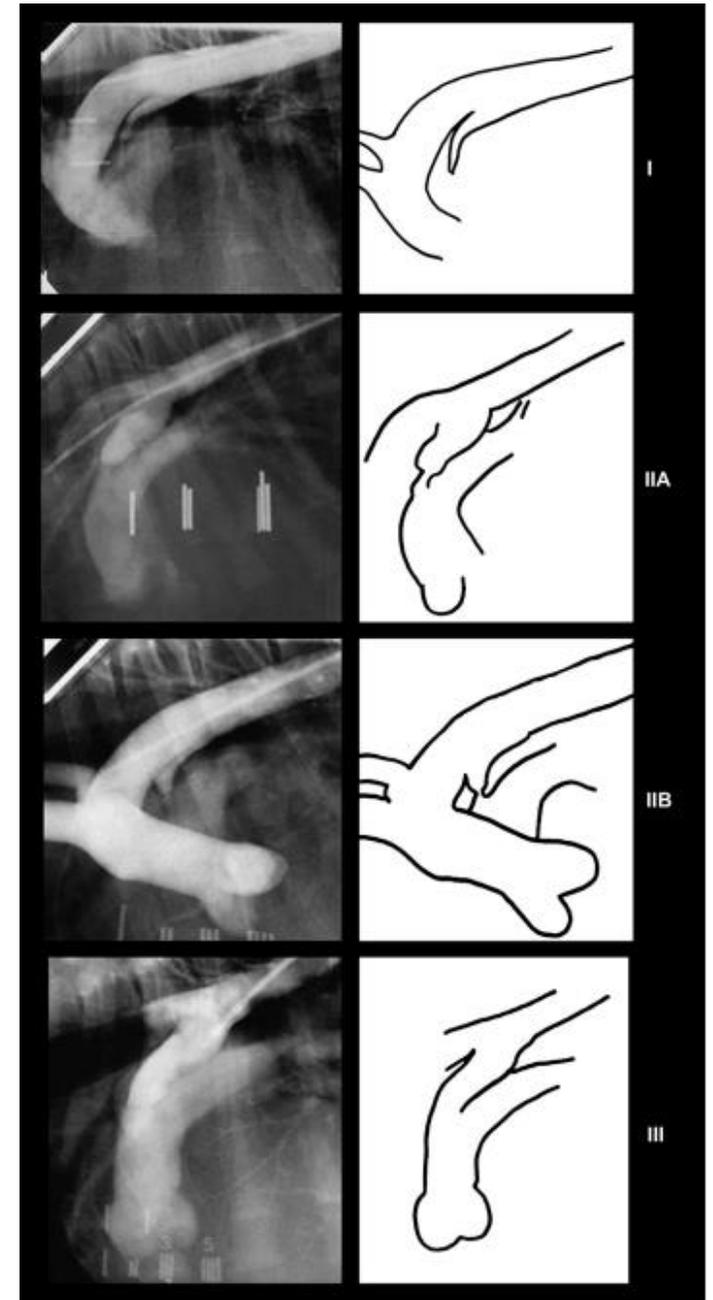
- Continuous cardiac murmur
- Bounding femoral pulse

# PDA – classification\*\*\*

## PDA classification in dogs

- Type I : small, tapering
- Type II : medium, funnel
  - IIa : PDA의 proximal portion의 직경이 일정
  - IIb : PDA의 proximal portion이 감소 (고깔 모양)
- Type III : large, no taper  
intervention 불가능

Angiographic classification of patent ductus arteriosus morphology in the dog<sup>☆</sup>

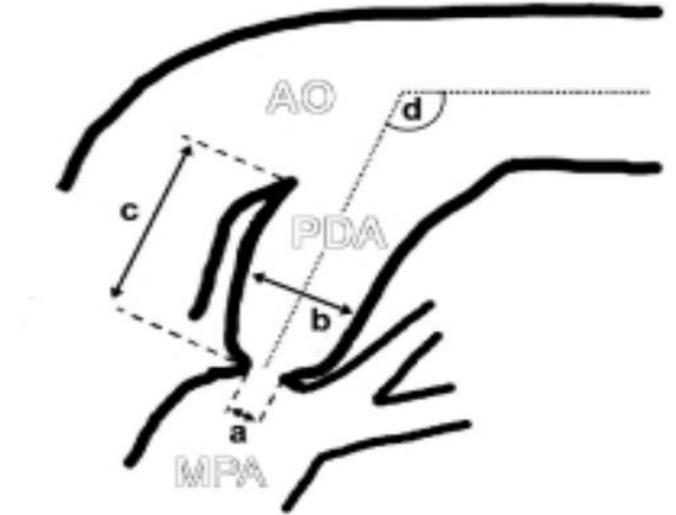


# **PDA – Diagnosis (Pre-op)\*\*\***

- **Transthoracic echocardiography**
- **Transesophageal echocardiography**
- **CT**
  
- Type 평가 정확하지 않을 수 있음, **Intra-operative Angiogram**

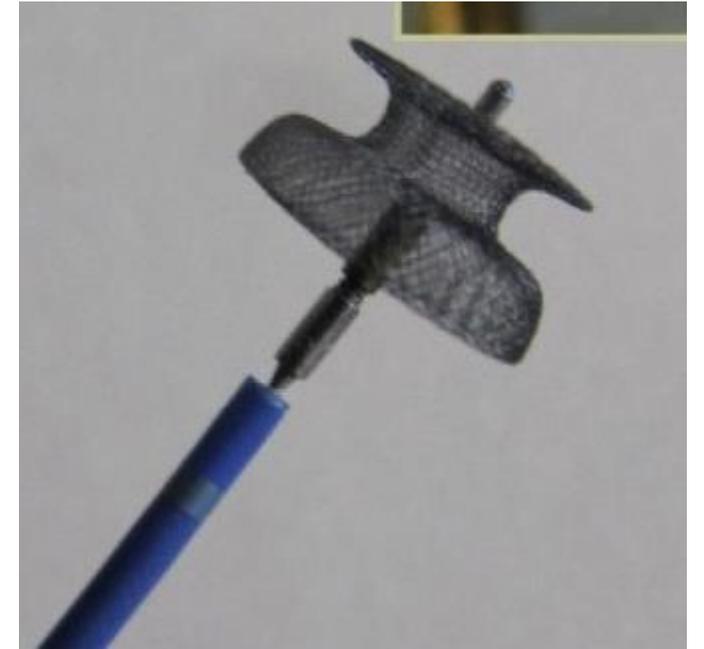
# PDA – Aim of Interventions

- Occlusion of the ductus
  - Or at least reduce ductal flow
  - >98% complete occlusion
- Minimally invasive approach using a peripheral artery (or vein)
  - Most often a femoral a.
- Reduce future risk of heart failure and cardiac death



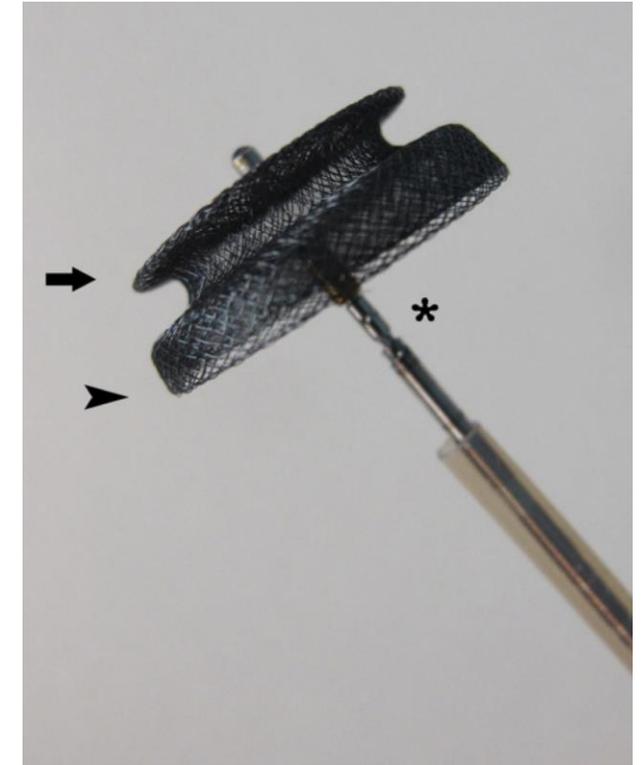
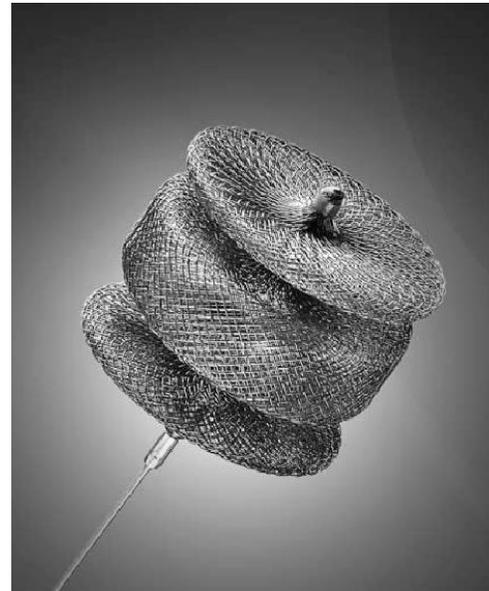
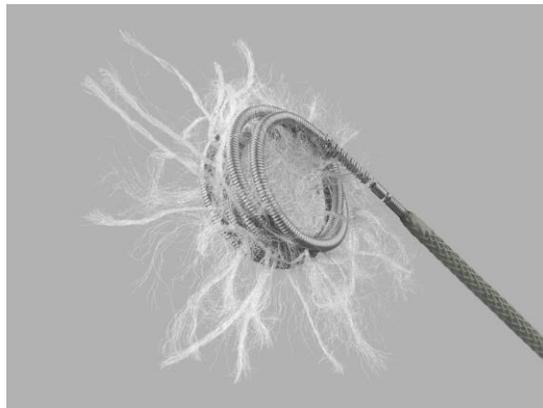
# PDA – Contraindications\*\*\*

- Tubular PDA – non-tapered
  - Cannot safely place ACDO
  - AVP2?...
  - Surgical ligation
- Patient systemically unwell – risk of infection
  - Sepsis
  - Immunosuppression
- Severe pulmonary hypertension
  - R-to-L shunt
  - PH non-responsive to sildenafil

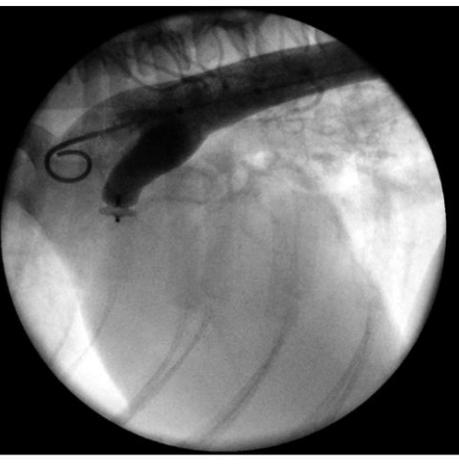
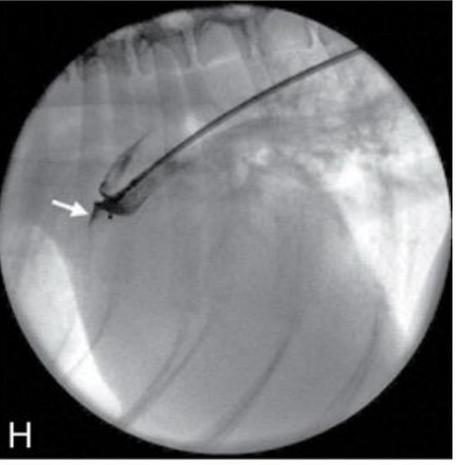
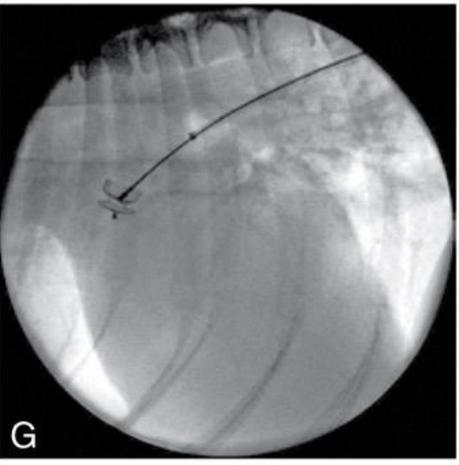
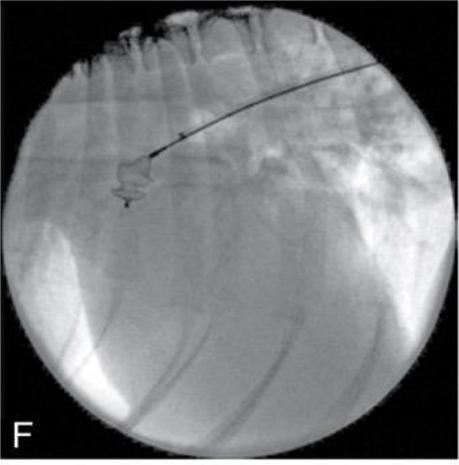
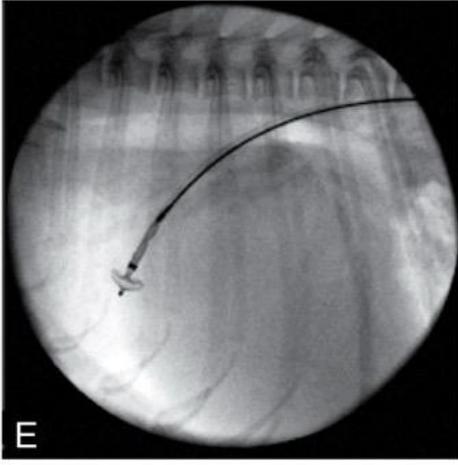
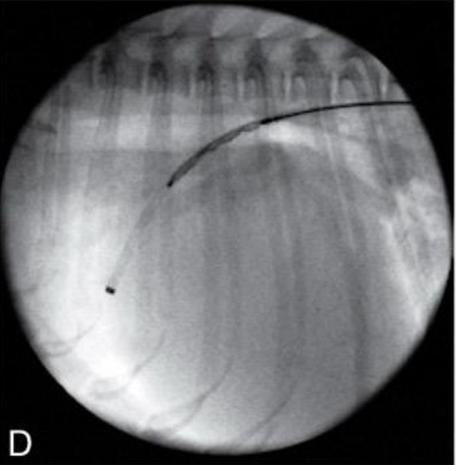
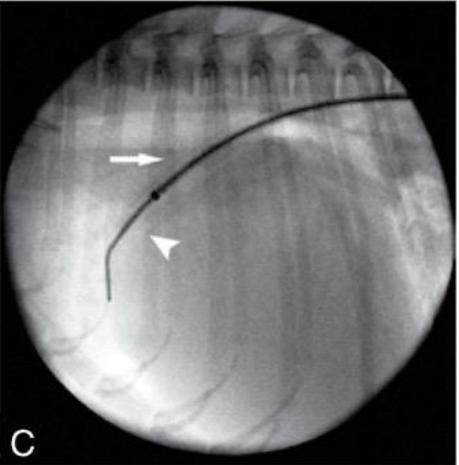
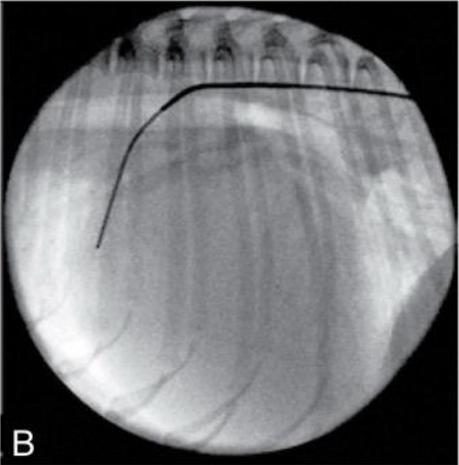
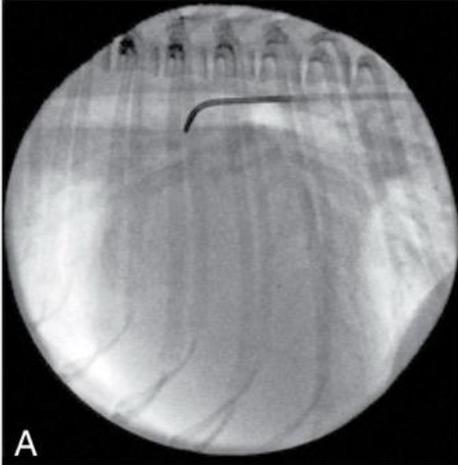


# PDA – Occlusion device

- Amplatz Canine Ductal Occluder (ACDO)
  - Best choice
  - Ostium diameter / Ampulla diameter
- Vascular plug (AVP2)
- Thrombogenic coil



# PDA – Occlusion device (ACDO)



# **PDA – Occlusion device\*\*\***

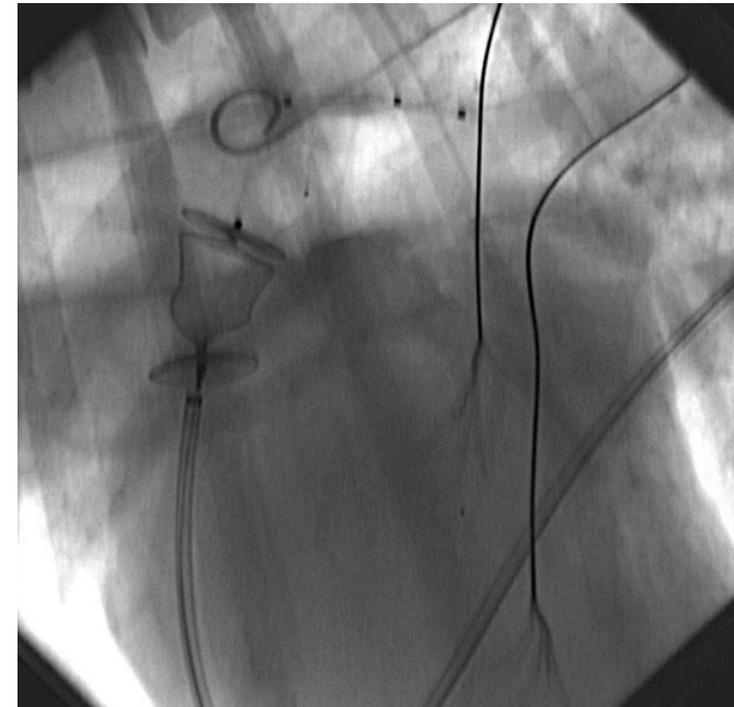
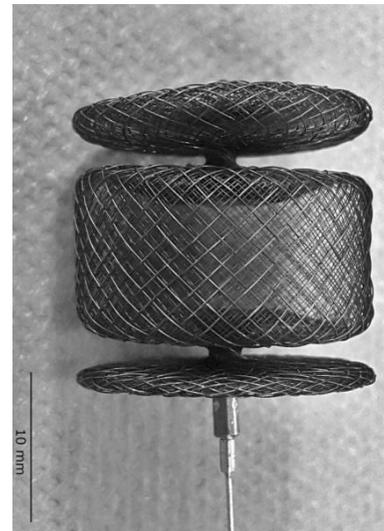
- **Only ACDO? Patient Size ! (Artery size, Ductus size)**
  - **Minimum delivery sheath size is 4F (3mm)**
    - over the wire
    - can use vascular sheath, but **minimum is 6F**
  - **2.5kg...**
- If small dog with a small PDA, an ACDO is possible
- Easier if larger dog
- Options for small dogs and cats
  - Transvenous plug (Amplatz type 2)
  - Coils (<1kg)
  - Surgical ligation

# PDA – Potential complication

- Hemorrhage from site of vascular access
- Contrast nephropathy (rare in dogs)
- Device loss / pulmonary embolism
- Bradycardia after PDA closure : common > Branham reflex (successful procedure)
- Lameness post-PDA closure – neuropathy
- Skin necrosis post-PDA closure
- Pain associated with surgical site
- Sudden death post-op
- Progressive systolic dysfunction

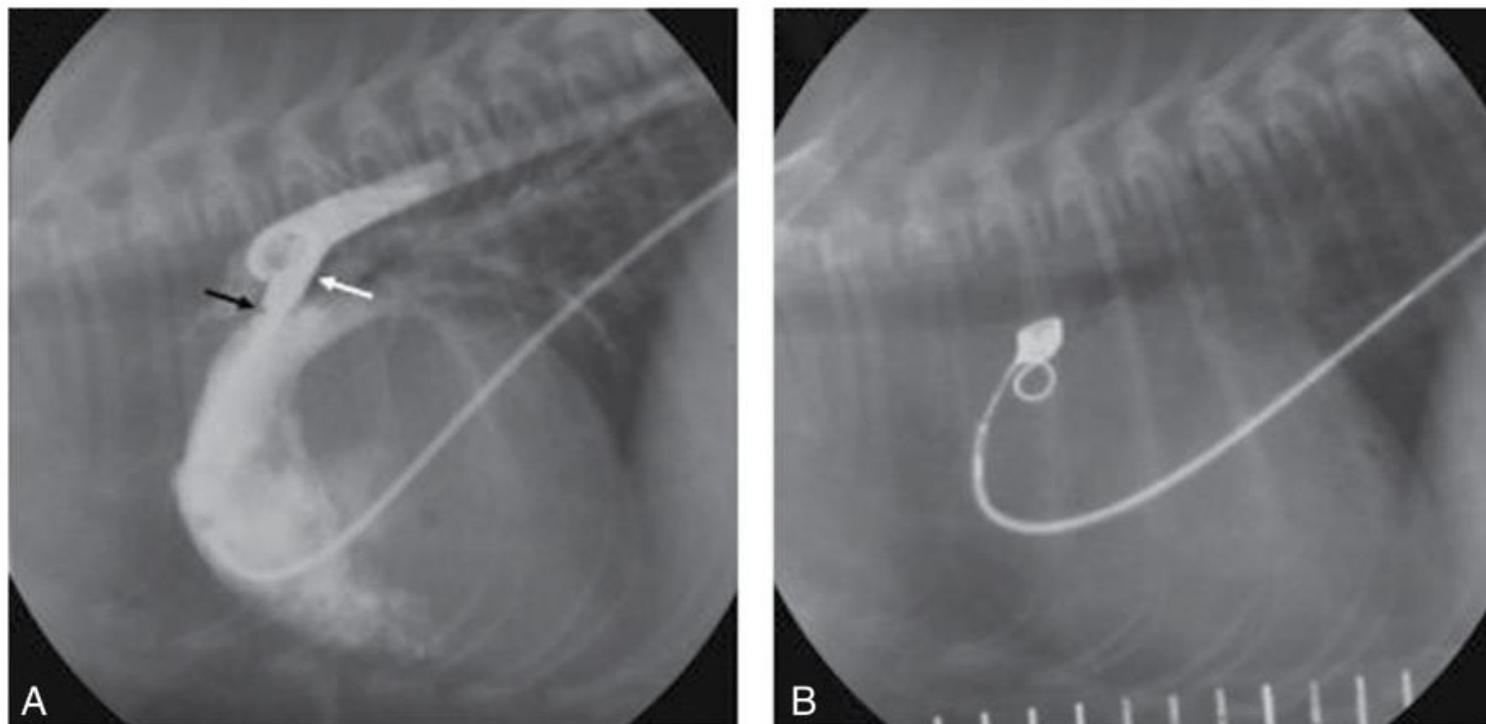
# PDA – Occlusion device (AVP-2)

- Similar size device to ACDO, but can be deployed transvenously
- Jugular vein
- Most small dogs down to 3.0kg – below that
  - smallest : 1.5kg for the transvenous route
  - Reports of 900g



# PDA – Occlusion device (coil)

## Transvenous coil



# PDA – Post-op and Aftercare

- Hospitalize 24hrs
  - Observation and Analgesia
- Antibiotics
- E-collar
  
- Sedate in recovery if too anxious or excitable
  - Acepromazine 5mcg/kg IV
  - Buprenorphine 0.02mg/kg IV

# PDA – Follow-up

## Follow-up

- Discharge at 24h post-op
  - Analgesic for 2-3days if painful
- Suture removal 10-14days
- Activity restriction 72hrs (some 28-days)
  - Delayed embolization is possible
- Advise owner regarding signs of complications
  - Embolization
  - Infection

# **PDA – Follow-up (4-8weeks re-examination)**

- Echocardiography to assess reverse remodeling
  - Device position can also be assessed
- Thoracic radiography or ultrasound to check device position
- No breeding

# **Pulmonic stenosis**

# **Pulmonic stenosis – morphology\*\*\***

- (1) dome-shaped valve with commissural fusion
  - (2) dysplastic and thickened valve (hypoplasia of leaflets)
  - (3) hypoplasia of the pulmonary annulus
- variable degrees

- **Type A : fusion of the pulmonary valve leaflets**
- **Type B : hypoplasia of the pulmonic annulus**
- **Mixed type**

# **Pulmonic stenosis - consequences**

## **1. Reduced right heart output**

- **Reduced pulmonary flow**
- **Reduced left heart inflow**
- **Reduced cardiac output**

## **2. Increased RV pressure**

- **Increased myocardial oxygen demand**
- **Relative myocardial hypoxia**
- **Fibrosis and ischemia in long-term**

### **\*Symptoms**

- **exercise intolerance, syncope, sudden cardiac death, congestive heart failure, cyanosis**

# **Pulmonic stenosis – Diagnosis\*\*\***

- **Echocardiography, Angiography, CT, MRI ...**
- **Transthoracic echocardiography with Doppler**
  - : **valve morphology**
  - : **annular size** > onset of systole (from right-parasternal short axis)  
or end-diastole, end-systole  
(during angiography)
  - : **severity of stenosis**

# Pulmonic stenosis - Diagnosis

- Where is main site of stenosis ?
  - Infundibular / valvular / supra-annular
- How much is valve leaflet fusion contributing to stenosis
- Valve thickening (redundant valve tissue)
- Hypoplastic annulus
  - : ratio of the aortic to pulmonary annular diameter :  $>1.2$
- Is there a significant supra-annular ridge?
- Circumpulmonary coronary
- What is the degree of dynamic stenosis in the RVOT?
  - : severe RV hypertrophy
- Tricuspid valve competence

# **Pulmonic stenosis – Classification\*\*\***

- Severity of stenosis
  - > **Based on pressure gradient across the valve**
    - **Mild** < 50mmHg
    - **Moderate** 50~80mmHg
    - **Severe** > 80mmHg
- Clinical signs in Severe, but possible in Moderate (not Mild)

# **Pulmonic stenosis – Tx : Aim of Interventions**

- Reduce pressure overload on the right heart
- Improve pulmonary flow and thus cardiac output
- Reduce current clinical sign
- Reduce risk of future clinical signs or cardiac death

# **Pulmonic stenosis – Tx : indication\*\*\***

- **Moderate stenosis w/ clinical sign**
- **Severe stenosis**

# Pulmonic stenosis – Medical Tx

## \*Medical Tx

### - Atenolol for 2~4 weeks prior to BPV

- 0.5mg/kg BID start > increasing 1.5mg/kg BID
- higher dose – severe dynamic obstruction below the valve (hypertrophy)

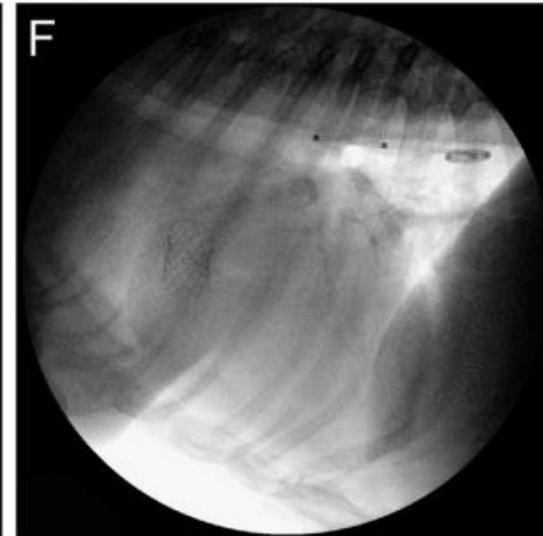
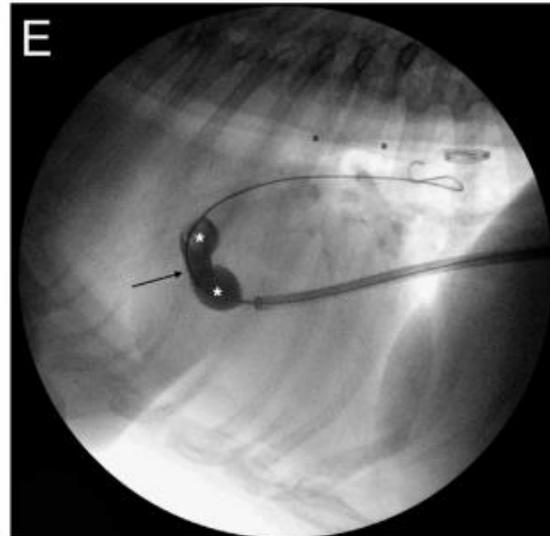
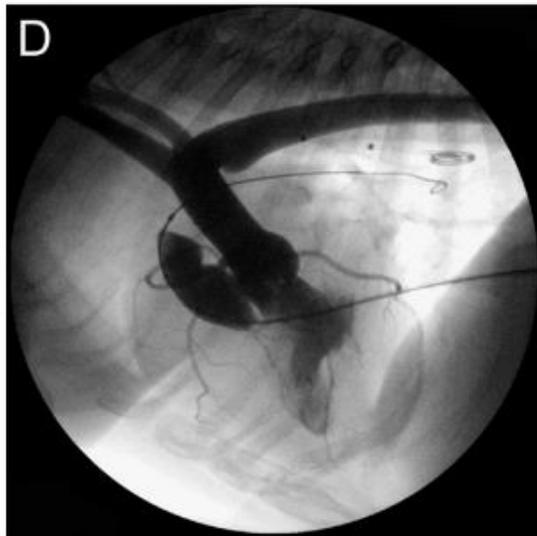
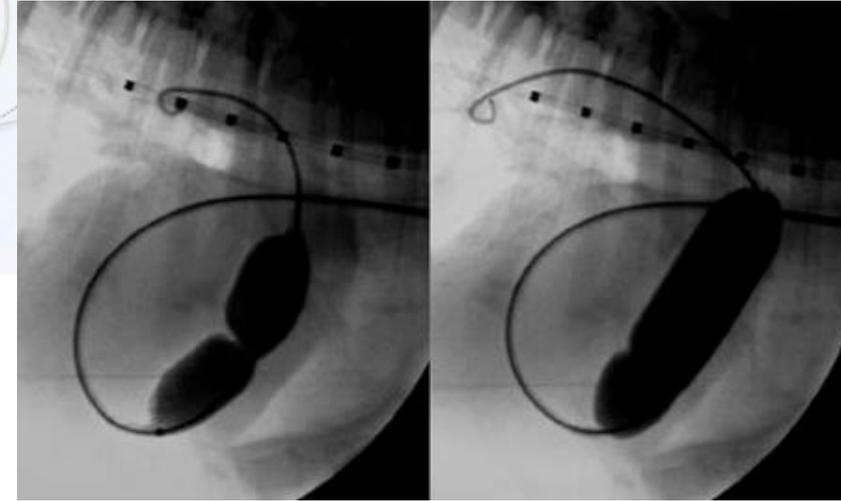
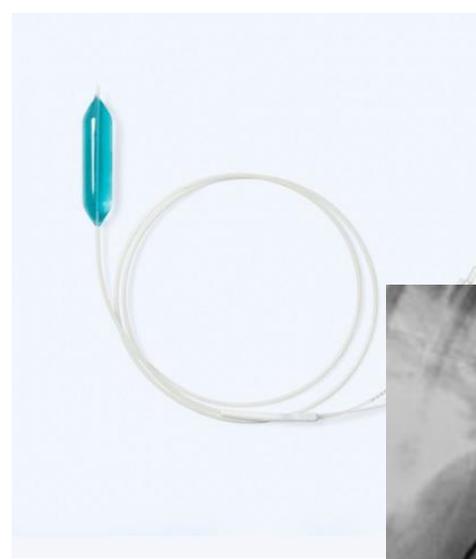
### - Wait for a few weeks in very young dogs

- somatic growth that reduce anesthetic risk
- for equipment : small vasculature and reduced RV lumen
  - over 2kg (<1kg 가능하지만)

# Pulmonic stenosis

## \*Treatment

- Balloon pulmonary valvuloplasty (BPV)
- Stent implantation



# Pulmonic stenosis – Balloon valvuloplasty (BPV)

## \*Complication

- Hemorrhage at vascular access site : 쉽게 조절됨
- Bursting balloon
  - Not often an issue, plastic may embolise
  - Can make removal more challenging – tricuspid valve damage
  - Don't suck back on balloon if it bursts : cardiac blood sample
- Ventricular arrhythmia
  - very common - boluses and up-titration of Lidocaine CRI if using
  - severe : balloon deflate and wait a minute and re-balloon

# Pulmonic stenosis – BPV : Recovery and after-care

- Sedate if excitable or stressed post-op
- Analgesia - buprenorphine 0.02mg/kg
- IV antibiotics : pre-op and q90mins
- Hospitalize 24hrs
- 48hr exercise restriction
  - Dynamic right ventricular outflow tract obstruction 있을 경우 더 오래 운동제한
- Educate on risks of hematoma and infection

# Pulmonic stenosis – BPV : Follow-up

- 24hr and 4~12 weeks and 12months
  - Echocardiography (dynamic obstruction 있는 경우 좀더 빨리 재진)
- Lifelong considerations
  - Not permitted to breed
  - Monitor for recurrence of clinical signs
  - 10-20% require repeat procedure
  - Adjust atenolol dose as required based on echo

# **Pulmonic stenosis – BPV : prognosis**

- **More than 50% reduction of pre-BPV pressure gradient**
- **Final gradient : 30-40mmHg**
- Restenosis : repeat BPV
- Pulmonary insufficiency
- Progressive right heart dilation
  - : cavitory effusion unlikely (moderate to severe TR)
- Residual stenosis
  - : mild to moderate – favorable
  - : severe – risk for cardiac complication

# **Pulmonic stenosis – Stent**

- **Circumpulmonary coronary artery**
- Significant fibrous tissue at sinotubular junction (supra-valvular stenosis?)
  - French bulldog
- **Mixed or Type B stenosis**
  - **balloon first > stent**
- **Previous balloon failure**

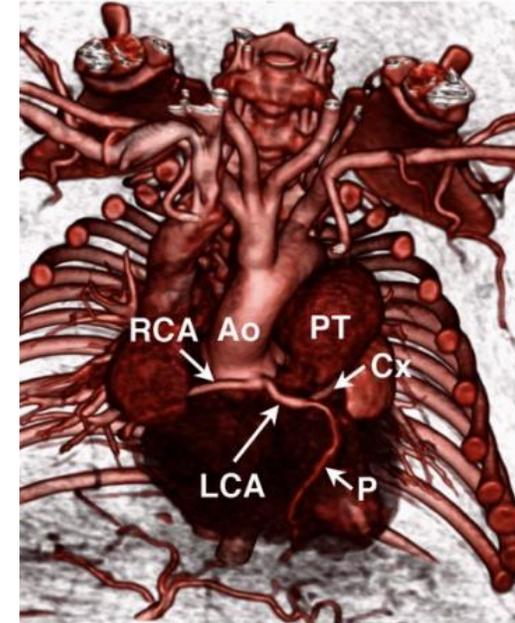
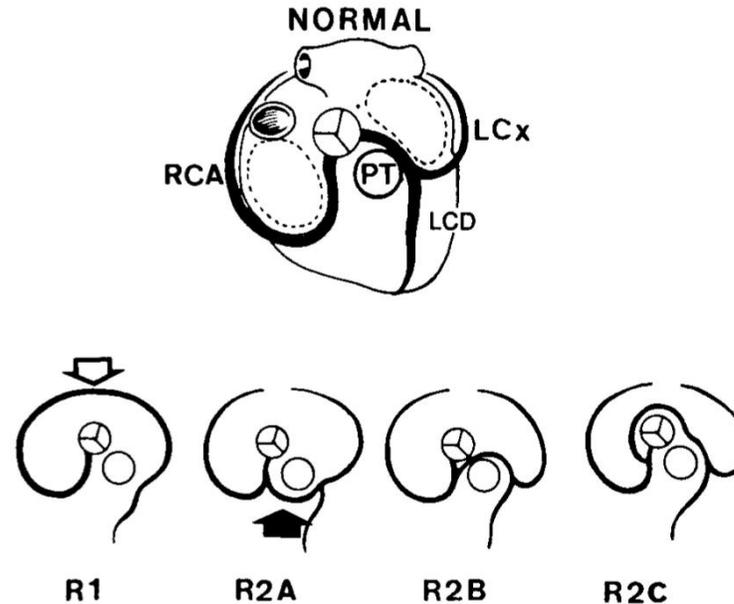
# Pulmonic stenosis – Stent : circumpulmonary coronary

## Coronary anomalies and PS

- Bulldog and Boxer type breeds
  - Not all individuals, but some

- One type may contribute to pulmonic stenosis

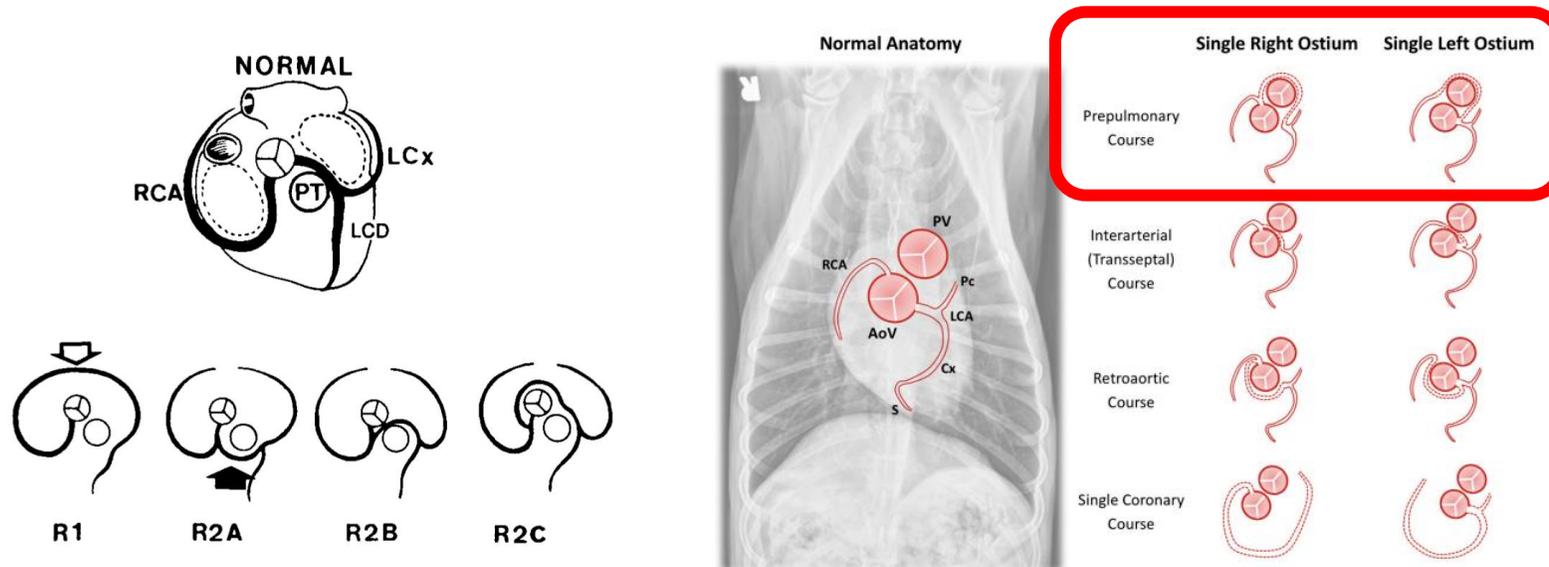
- Absolute contraindication to aggressive ballooning – consider a stent



# Pulmonic stenosis – Stent : circumpulmonary coronary

## Coronary artery anomalies

- Single coronary ostium - Brachycephalic dog breed에서 흔하게 나타남
- Balloon valvuloplasty를 할 때는 prepulmonary course가 중요함



Review

Coronary Artery Anomalies in Animals

# **Pulmonic stenosis – Stent : complications**

- Myocardial perforation
- Bleeding
- Arrhythmia (~50~90%)
- Thromboembolism
- Pulmonary artery dissection

# Pulmonic stenosis – Stent : post-op care

- Clopidogrel – start day 2 post-op / continue for 3-months
- Re-examine at 4-weeks, 6-months and then annually
- Complication
  - RV failure
  - Stent occlusion – usually gradual closure of proximal stent. Consider re-balloon
  - Granulation tissue?
  - Stent fracture – 되어도 증상 없는 경우가 대부분.

# **Intrahepatic PSS**

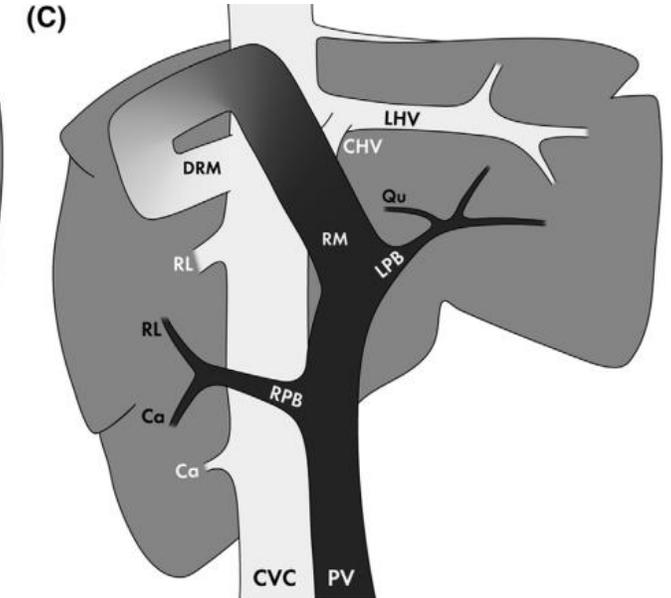
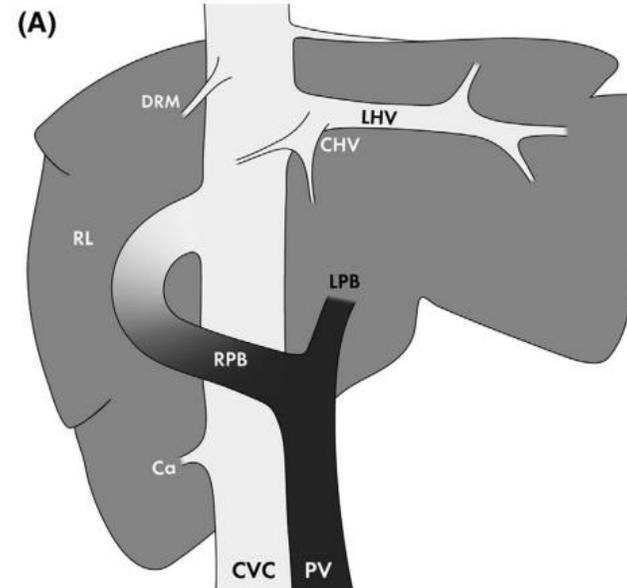
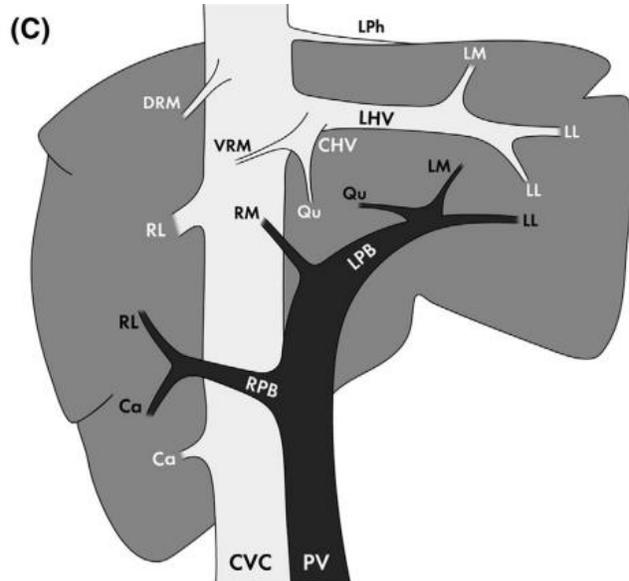
**: PTCE**

**( Percutaneous transvenous coil embolization )**

# Intrahepatic PSS

Canine intrahepatic portosystemic shunt insertion into the systemic circulation is commonly through primary hepatic veins as assessed with CT angiography

Intrahepatic PSS는 대부분 portal과 hepatic vein이 직접 연결되는 형태



# **Intrahepatic PSS – Aim of Interventions**

- **Partial or complete endovascular attenuation of IHPSS or EHPSS**
  - **Restore or improve portal perfusion**
  - **Ultimately maximize hepatic function**
- **Surgical Tx of IHPSS**
  - Peri-operative complication rates : 77%
  - Peri-operative mortality rates : up to 28%
  - Overall mortality rates rates : 64%
- **Similar clinical results**
- **Fewer peri-operative complications and mortalities**

# Intrahepatic PSS – Diagnosis

- Signalment / History
- Rectal examination
  - GI hemorrhage (GI ulceration – 15% of IHPSS)
- Blood analysis
- Radiography
- Ultrasound
- **CT angiography : Anatomy**

# Intrahepatic PSS – Medical management

- weeks to months
- Improve **body condition score**
- Resolve the clinical signs of **hepatic encephalopathy (HE)**
- Have time to grow to more closely achieve ultimate **patient size**
  - Prevent placing undersized implants
  - At least **5 months**
- Aggressively treat **GI ulceration**
  - w/ raising portal blood pressure : life threatening

# Intrahepatic PSS – Medical management

## Pre- and post-procedural medical management

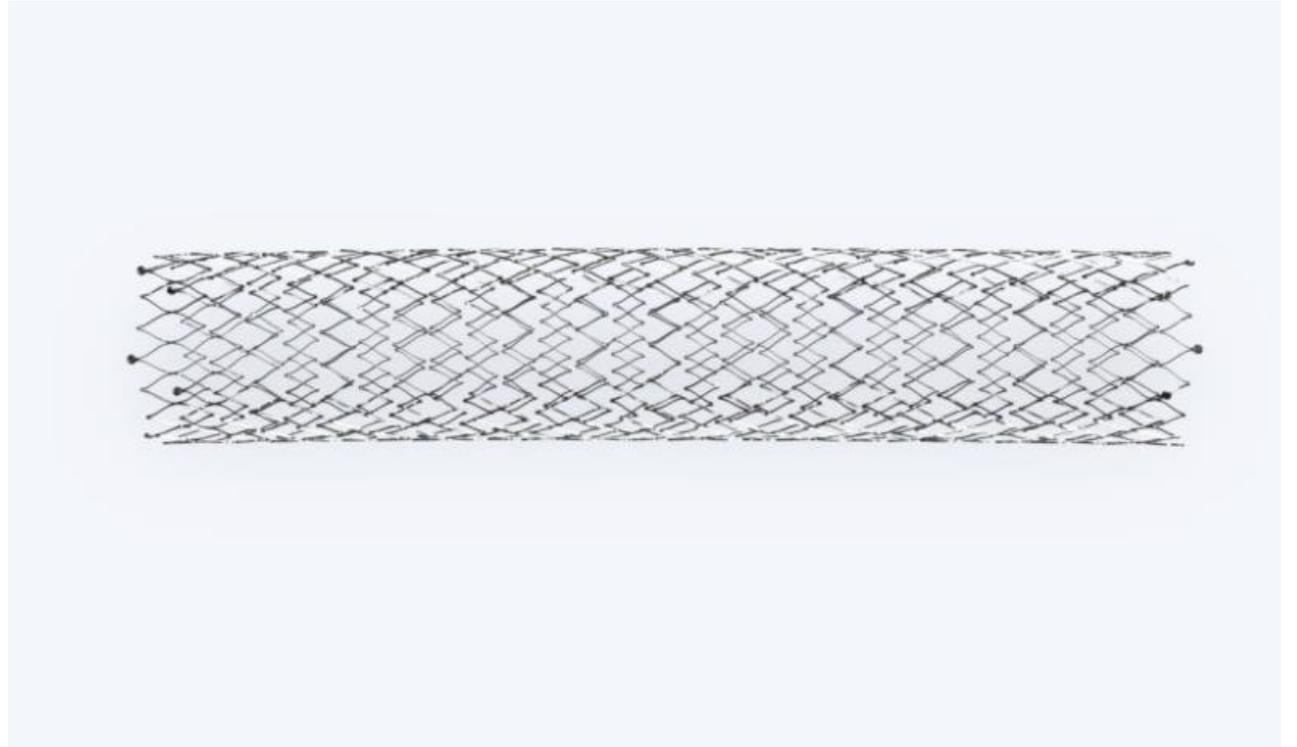
- Antibiotics - Metronidazole : 7.5mg/kg PO q12hr (pre and post)  
Cefazolin (intraoperative)
- Laxatives - Lactulose : 0.1-0.2ml/kg PO q8-12hr (soft but formed stools) (pre and post)
- Gastroprotendants - Omeprazole : 1mg/kg PO q12hr (pre and post) / Life-long
- Low-protein diet - Hills L/D, Royal Canin Hepatic LS (pre and post)
- Anticonvulsants - Dogs with persistent neurological dysfunction or Cats  
Levetiracetam (Keppra) : 40mg/kg at 0 and 2hr, then 20mg/kg q8hr (pre and post)
- Analgesics - Tramadol : 2-4mg/kg PO q8-12hr for 3days (post)

# Intrahepatic PSS – CT Angiography

## When possible, CT angiography is performed

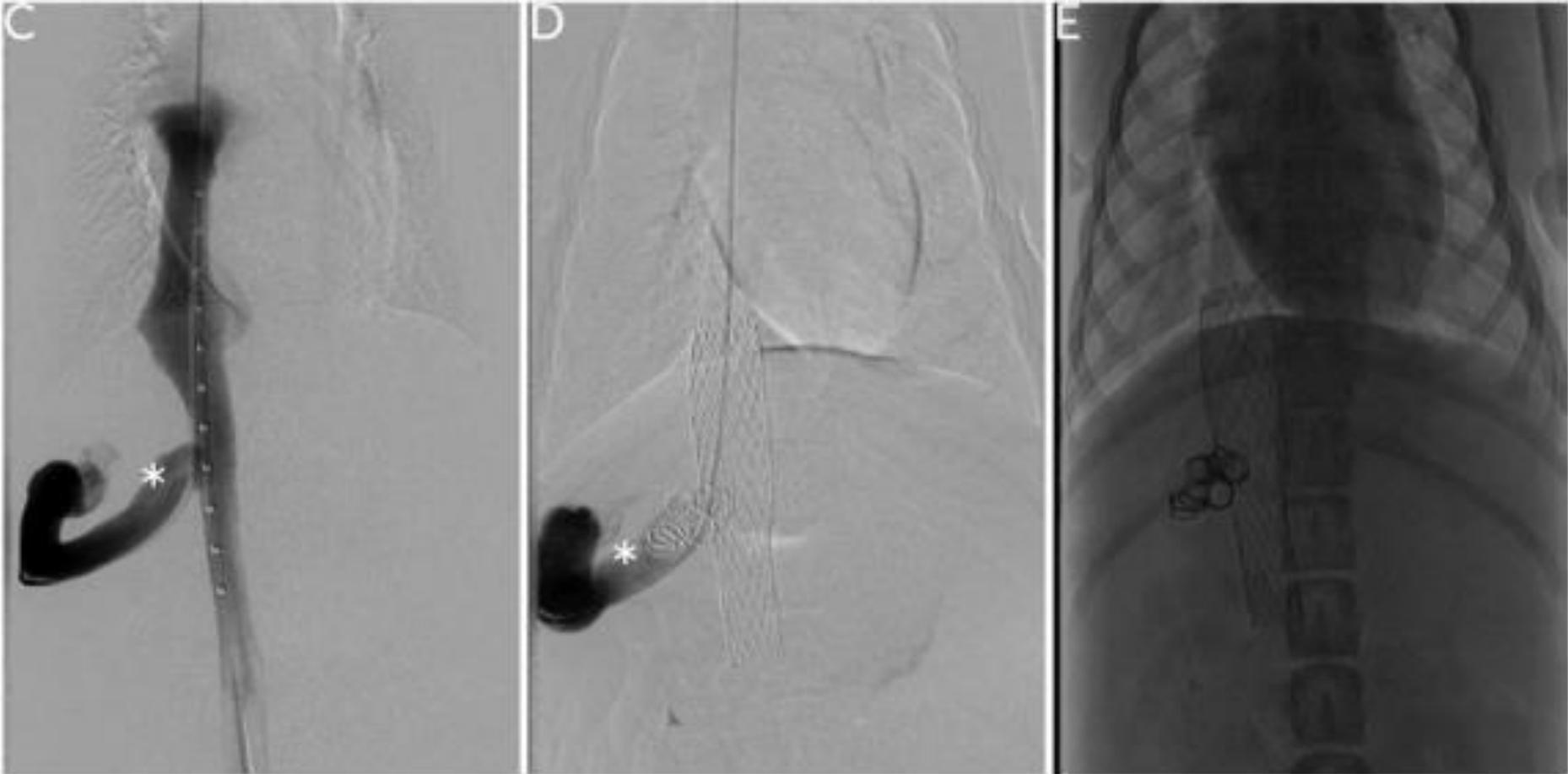
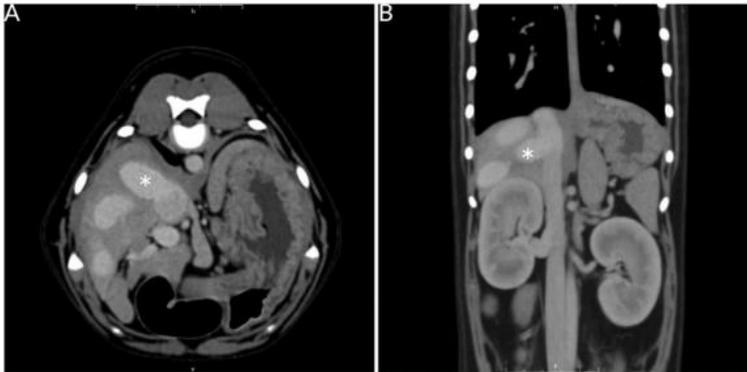
- **Separate** anesthetic episode
  - Shunt anatomy
  - Caval and shunt measurements
- 
- Performed as closely as possible to the time of the procedure
  - Accurate for the patient size

# Intrahepatic PSS – PTCE



# Intrahepatic PSS – PTCE

- Right jugular vein



# Intrahepatic PSS – PTCE

- Acute : physical obstruction
- Chronic : physical obstruction and clot (later fibrin)
- Be conservative!
  - Developed due to “unacceptable” surgical morbidity & mortality
  - Adding additional coils later is straightforward (post 6months)
- Systemic Pressure : PVP gradient  $> 5-10\text{mmHg}$

# Intrahepatic PSS – Post-op care

- Downsize vascular sheath 12Fr to 8Fr overnight. vs remove entirely
- CBC, chemistry follow day
- Routine postoperative monitoring
- No pain meds
- Attempt to avoid medications that further alter neurotransmission
- Discharge < 24hrs later (or 2 days)

# Intrahepatic PSS – Complications

## Major

- Portal hypertension (procedural, post-procedural)
- CNS dysfunction
- “Non-target embolization” – typically pulmonary
- Poor positioning of caval stent
- Abdominal hemorrhage (wire vessel puncture - not a problem in most cases)

## Minor

- Hemorrhage from access site

# Intrahepatic PSS – Expected Clinical Course

- Gradual weight gain
- Ongoing medical management x 2-4 weeks
  - Wean from antibiotics x 1 week
  - Wean from lactulose x 2 weeks
  - Wean from diet x 2-4 weeks
- Clinical signs, clinicopathologic evaluation dictate need for further intervention
  - Will bile acids normalize?
- Ongoing gastroprotectants d/t GI bleeding risk : life-long possible
- Failure to wean?
  - Ongoing shunting, multiple intrahepatic collaterals

**Trans-arterial  
Embolization (TAE)**

**Chemoembolization (TACE)**

# TAE / TACE

## Pillars of cancer treatment

- Medical
- Radiation
- Surgical
- **Interventional**
  - **Stenting** of malignant obstructions
  - **Locoregional therapies** : Transvascular / Ablation

# TAE / TACE

## Intra-arterial chemotherapy

- Super-selective catheterization utilizing fluoroscopic-guidance
- Can be combined with radiation therapy
- **Greater percentages of the chemotherapy will go directly to the tumoral supply**
- **Less exposure to the systemic circulation = less systemic side effects**

# **TAE / TACE – Principles**

## **Transarterial embolization (TAE)**

- Ischemic necrosis and cell death from hypoxia

## **Transarterial chemoembolization (TACE)**

- Cytotoxic drugs are concentrated in the tumor and embolization prevents wash-out

## **Response Goals**

- Only treatment available
- Pre-operative bleeding control
- Treat before definitive surgery

# **TAE / TACE – Indications**

**In veterinary medicine,**

- Liver neoplasia
- Nasal neoplasia
- Prostatic neoplasia

# TAE / TACE – Liver : Why are we doing it?\*\*\*

Liver : 80% HPV, 20% HA

Tumor : 15% HPV, 85% HA

- Solitary massive HCC
  - Surgical success (complete excision) = good prognosis
  - MST >3yrs, <5% surgical mortality, Metastasis rare
  - **Right-sided solitary HCC** : 40% surgical mortality / 10% dirty margin
- **Unresectable, diffuse or nodular HCC**

# **TAE / TACE – Liver : Indications\*\*\***

## **TAE**

- Debilitated patient
- Benign liver tumor
- Diffuse liver neoplasia resulting in hemorrhage
- Bleeding (emergency)
- Pre-operative therapy

## **TACE**

- Right-sided solitary HCC
- Close to Portal vein or CVC
- Nodular HCC or Diffuse HCC (non-resectable)
- Old age or Owner do not want laparotomy

# **TAE / TACE – Liver : Indications\*\*\***

## **Non-resectable tumor**

- Right-sided
- Close to PV, CVC / Invasion to PV, CVC
- Nodular or Diffuse tumor (2개 이상) > 각각

## **Pre-operative therapy**

**Hemorrhage – Tumor rupture/leakage : emergency**

**Client – 개복술에 대한 거부감 / 노령 및 기대수명이 짧은 경우**

# TAE / TACE – Liver : Patient Preparation\*\*\*

- **Tumor biopsy & staging (...FNA)**
- Full bloodwork screening (+ liver function test)
- Pelvic limb osteoarthritis
- **CT**
  - **Pre-surgical planning : tumor resectability**
  - **Primary feeding vessels**
- Premedication – antibiotics, anti-inflammatories, gastroprotectants, antiemetics, analgesics
  - **Anti-inflammatories**
    - Intraoperative : dexamethasone 0.01mg/kg IV once at induction
    - Postoperative : prednisone 1mg/kg/day PO x 5days
      - 0.5mg/kg/day PO x 5days
      - 0.5mg/kg/q2days PO x 5days

# **TAE / TACE – Liver : Complications\*\*\***

- Technically challenging
- Post-embolization syndrome (fever, nausea, pain / in 48~72hrs)
- Non-target embolization
  - Normal parenchyma
  - Run off into gastroduodenal a.
    - Cholecystitis
    - GB infarction, Biliary duct necrosis (w/ bile peritonitis)
- Liver necrosis / abscess formation
- Acute renal failure
- Hemoabdomen
- Septicemia

# **TAE / TACE – Liver : FU & Expected outcomes\*\*\***

- Chemotherapy side effects (more safe .vs IV chemotherapy)
- Radiography or CT
  - Tumor shrink (not more than 10-30% in size)
  - Tumor parenchyma cavitated – necrosis
- Discharged the following day
  - Post-embolization syndrome : minimize signs (opioid analgesia, NSAIDs, anti-emetic)
  - Limited activity / E-collar / Medication / Monitoring
- POD-7 and POD-14 : CBC
- Repeat TACE every 5-6 weeks
- Follow up CTA every 5-6 weeks

# **TAE / TACE – Nasal & Prostate**

## Nasal

- TAE : no use of chemotherapy due to skin necrosis
- Femoral a.

## Prostate

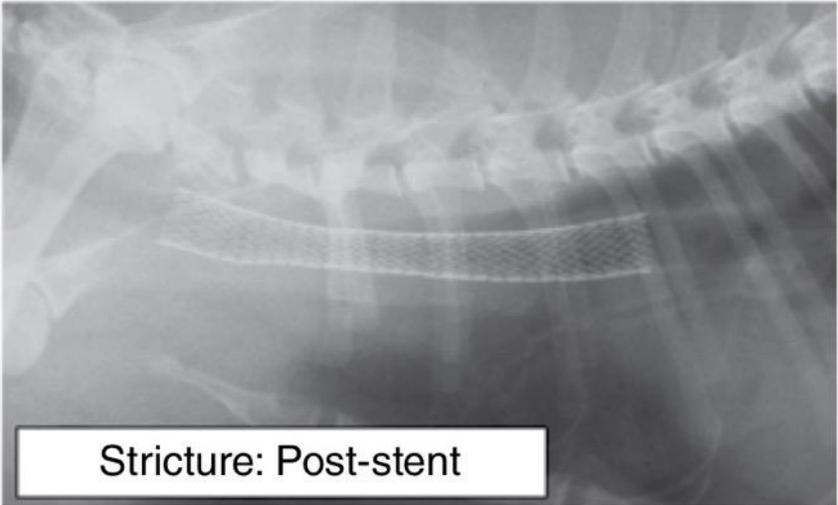
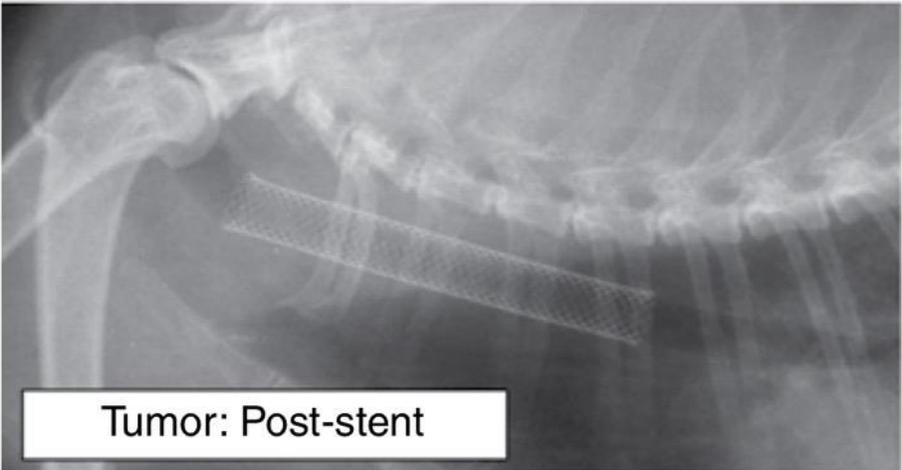
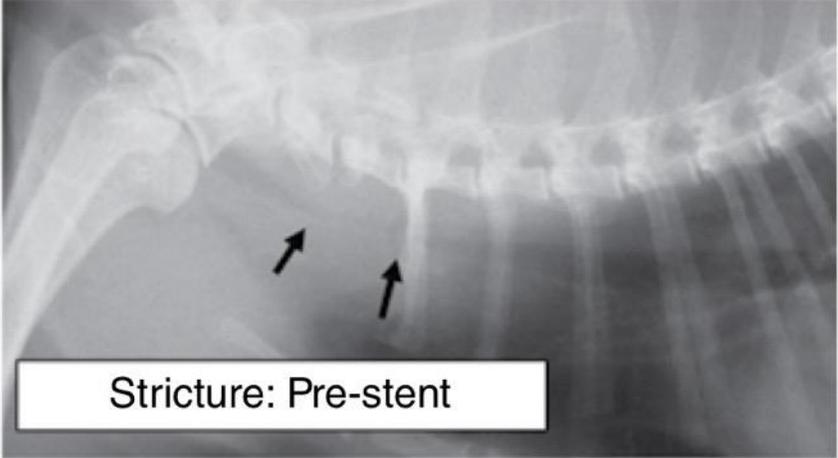
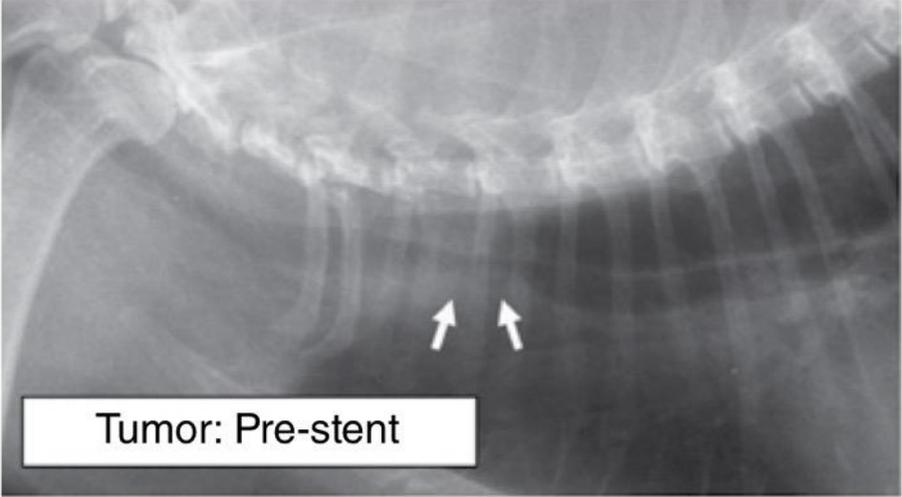
- Bilateral selection of prostatic a.
- Carotid a.

# **Tracheal stent**

# Tracheal Stent – Tracheal collapse

- Deficiency in the cartilage matrix of the trachea
  - Also bronchi and smaller airways
- Progressive, often over years
- Diagnosis : **dynamic fluoroscopy**
- **Clinical signs : Treatment decisions\*\*\*\*\***
  - 75% cases of chronic cough : **successfully managed medically**
  - **Dyspnea is more difficult to control medically**
    - Location of collapse determines clinical signs
    - Cervical = inspiratory effort / Intra-thoracic = expiratory effort

# Tracheal Stent – Stricture / Tumor



# **Tracheal Stent – Expectations (tell to client)\*\*\***

- **Palliative – not a cure**
  - **Ongoing cough, but should improve**
- **Disease may progress in time to affect lower airways**
- Clinical improvement in 75-90% cases
- Immediate complications rare
- Mortality rare
- Late complications
  - Progression of disease
  - Stent shortening and migration
  - Stent fracture
  - Granulation tissue / infection

# **Tracheal Stent – Emergency. Possible?\*\*\***

- Emergency cases
- Hard to recover from anesthesia if a stent is not placed immediately
- Owner are far more likely to opt for the procedure if done immediately
- One anesthesia event (faster, cheaper, safer)

**It's possible... May be... Size (rare)...**

# Tracheal Stent - Discharge

## Discharge medication

- Antibiotics
  - AMC 20mg/kg BID for 5days
- Anti-tussives
  - Codeine 1-2mg/kg BID-TID for 28days
  - Hydrocodone 0.25mg/kg BID-QID
- Tapering dose of Prednisolone
  - 2mg/kg/day for 5days
  - 1mg/kg/day for 5days
  - 0.5mg/kg/day for 5days
  - 0.5mg/kg alternate days for 5days
- +/- bronchodilator

# Tracheal Stent - Discharge

## Discharge instructions

- Harness walks only
- Expect a soft cough as dog adapts to the stent in position
- Avoid stress / over-excitement / over-heating
  
- Recheck in 2weeks – sooner depending on symptoms (radiographs)
- Recheck 3months, every 6months
  - dependent on response (radiographs +/- bronchoscopy)
- More frequent visits if symptoms warrant

# **Tracheal Stent – Frequently Asked Questions**

**Is bronchial collapse a contraindication to tracheal stenting?**

- **Bronchial collapse**
  - No. It's helpful
  - Poor prognostic sign
  - Persistent cough – treated aggressively with medical management
  - Bronchial stent

# **Tracheal Stent – Frequently Asked Questions**

**What are the common causes of a persistent cough or new cough post stent placement?**

- Compliance with medications?
- Adequate dose of medications?
- Progression of disease (bronchial or more trachea)?
- Co morbid conditions (cardiac, pneumonia, etc)?
- Stent fracture
- Stent migration

# Tracheal Stent – Frequently Asked Questions

## What should I tell clients about stent fractures?

- Fracture is a known risk of the procedure
- Risk has decreased over time with design improvements
- Dors generally respond well to placement of second stent
- Risk factors
  - Persistent cough
  - Excessive stent over-sizing

# **Urethral stent**

# Urethral Stent

- **Complete urethral obstruction**
  - Extreme discomfort
  - Life-threatening biochemical changes
- **Partial urethral obstruction w/ dysuria & incomplete bladder emptying (QOL)**

# Urethral Stent

**\*\*Urethral neoplasia – most common**

- Transitional Cell Carcinoma (TCC)
  - 15~50% metastasis
  - dysuria ~84%
  - **~10% complete urinary obstruction**
  - Local disease is the cause of death in up to 60%
  
- Prostatic Carcinoma
  - ~0.3% prevalence based on clinical findings
  - ~0.6% based on necropsy
  - Dysuria and urinary obstruction

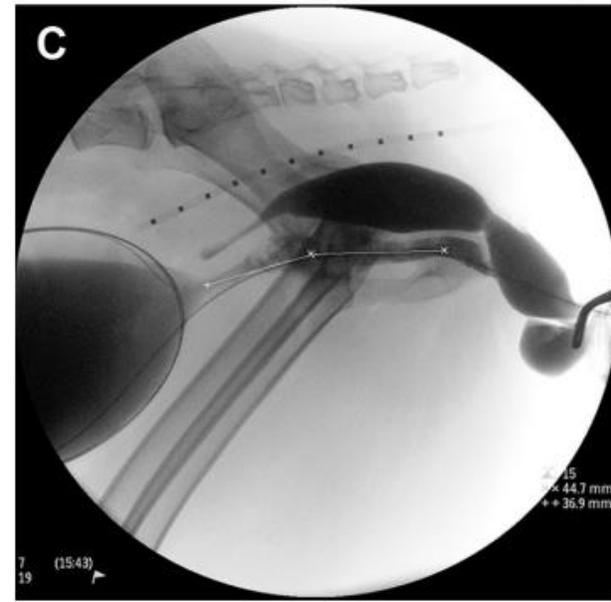
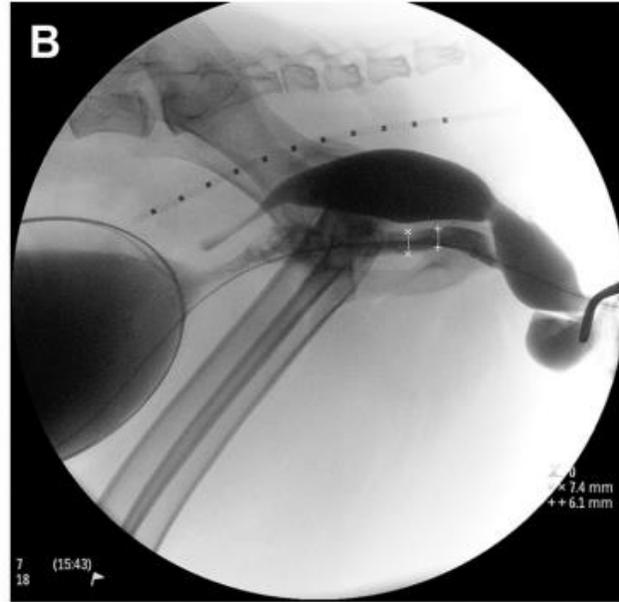
# Urethral Stent – Indications

- Urethral neoplasia – obstruction
  - TCC, prostatic carcinoma, leiomyoma 등
- External urethral compression
  - Metastatic intrapelvic lymphadenopathy
- Benign urethral obstruction
  - Strictures (pre- urethral damage (iatrogenic), pre- surgery)
  - Reflex dyssynergia
  - Proliferative urethritis

# Urethral Stent - Diagnosis

- Patient evaluation
- History taking
  - **Patient's voiding habits**
  - Stranguric
  - **vs tumor inflammation (post-voiding straining – empty bladder)**
  - vs tenesmus (prostatic tumor)
- Radiography
- **Ultrasonography : Ureteral involvement**
- CT : metastasis
- **Palliative**
- **Complete tumor staging is not required (not alter the decision for stenting)**

# Urethral stent



# Urethral Stent – Complications

- Stranguria
- Urination with pain (most tumor in triangular > stent in UB)
- Incontinence
  - 25% - severely incontinent
  - Male > female
- Hematuria
- Stent migration
- Re-obstruction due to continued tumor growth
  - Tumor ingrowth through the stent / ends of the stent / new tumor ..
  - Rare (less than 10%)
  - Repeat stenting

# Urethral Stent – Aftercare

- Do not urinary catheterization
  - Damage to stent
  - If need, by Fluoroscopy-guided
  - Avoid Foley catheter
- Generally, pain medication (-)

# Urethral Stent – Follow-up

- Discharged the day of procedure
- Antibiotics
  
- Urinary incontinence & persistent low-grade straining post-stenting
  - Improve in a week
  
- 1-2weeks after > oncology consultation
- NSAIDs & Chemotherapy (for MST)
- Patient evaluation (disease progression & subsequent ureteral obstruction)
  - incontinence (overflow) & progressive stranguria

# Urethral Stent – Follow-up

- Incontinence
  - More than a week, **phenylpropanolamine** consideration
- Chronic obstruction and UB enlargement
  - bladder atony possible
  - Bethanecol consideration

# Urethral Stent – Client Education

**Palliative** : only obstruction / tumor staging and progression

Straguria (inflammation or stent) > resolve

Hematuria

## **Incontinence**

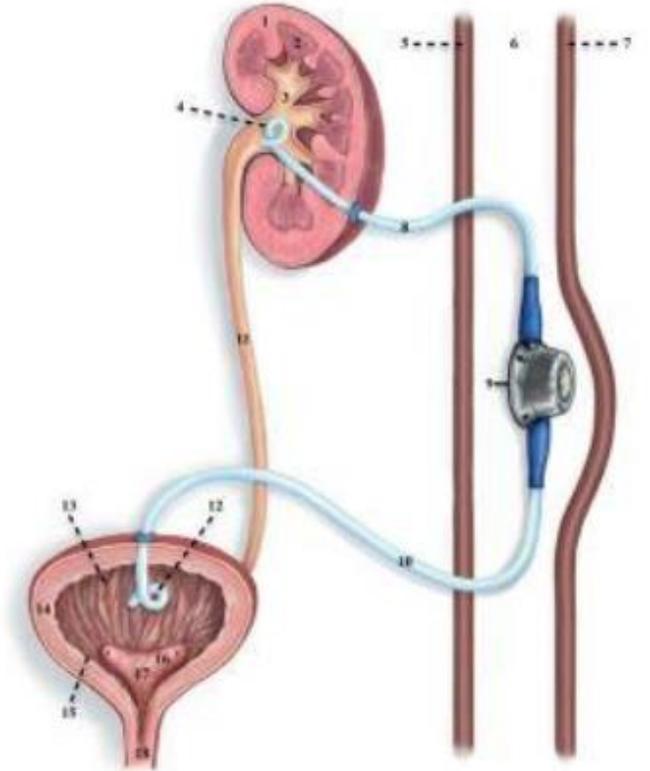
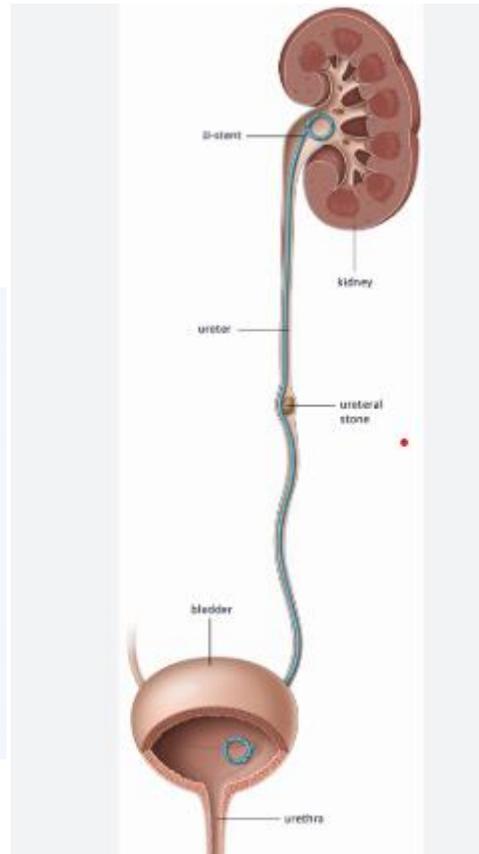
- risky (25~64%)
- Laser cut stent – cannot be removed
- 사전고지 및 보호자 인지 / 보호자가 이것을 감수할 수 없다고 한다면 다른 decompression 방식을 선택

**Ureteral stent**  
**SUB**

# Ureteral Stent / SUB – or Nephrectomy

It's worth trying (ureteral stent / SUB)

But, chronic – irreversible..



# **Ureteral Stent – Consequences of obstruction**

- Decreased renal blood flow
- Decreased in GFR ; reversible leading to irreversible loss of renal function
- Infection / Sepsis
- Systemic symptoms (pain, anorexia)

**Decompression is Essential!**

# Ureteral Stent – Pre-procedure

- Pre-operative imaging
  - X-ray, US, CT
- Laboratory exams
  - CBC, Coagulation profile, BUN, Crea, Urine culture
- Medications
  - Fluids, Antibiotics, Anti-hypertensives

# Ureteral Stent – Retrograde vs Antegrade

## Retrograde

- Open surgery to bladder
- Technically easiest
- Requires least equipment
- Fastest
- Can be used in cats/dogs regardless of size

## Antegrade

- Percutaneously, Open
- Least invasive
- Can be helpful when obstruction is at UVJ
- More equipment needed
- Can be more challenging

# Ureteral Stent – Common Findings Post Stenting

- Hematuria
  - Often of no clinical concern
  - More frequent with antegrade approach
  - Follow vitals and CBC
  - Most commonly resolves spontaneously
- Straining or frequent to void
  - Can be related to bladder irritation caused by stent
  - Self limited
  - May indicate need to use a shorter stent

# Ureteral Stent – vs SUB

	Stent	SUB
Causes passive dilation of ureter in wider ureteral diameter?	Yes	No
Complication: obstruction	Can be replaced	Cannot be replaced - SUB is glued into place
Complication: Leak / uroabdomen	Not a known complication	Potential 2 <sup>nd</sup> surgery required
Complication: recurring infection	Can be treated with antibiotics or stent can be removed / replaced if problematic	Cannot be replaced – glued into place Aggressive antibiotic treatment required

# Summary

- PDA, PS
- Intrahepatic PSS (PTCE)
- TAE, TACE
- Tracheal stent / Urethral stent / Ureteral stent / SUB
  
- **질환별로 Interventional Treatment의 Aim & Indication을 잘 이해하고,  
다른 치료방법들과 비교 및 혼합해서,  
환자를 위한 최선의 치료옵션의 한 일부로서 잘 활용해보자.**
  
- **치료적 효과, 보호자 만족도, 테크닉 : 생각보다 좋을지도??**

**Thank You**