Interventional Cardiology: Indications and Outcomes

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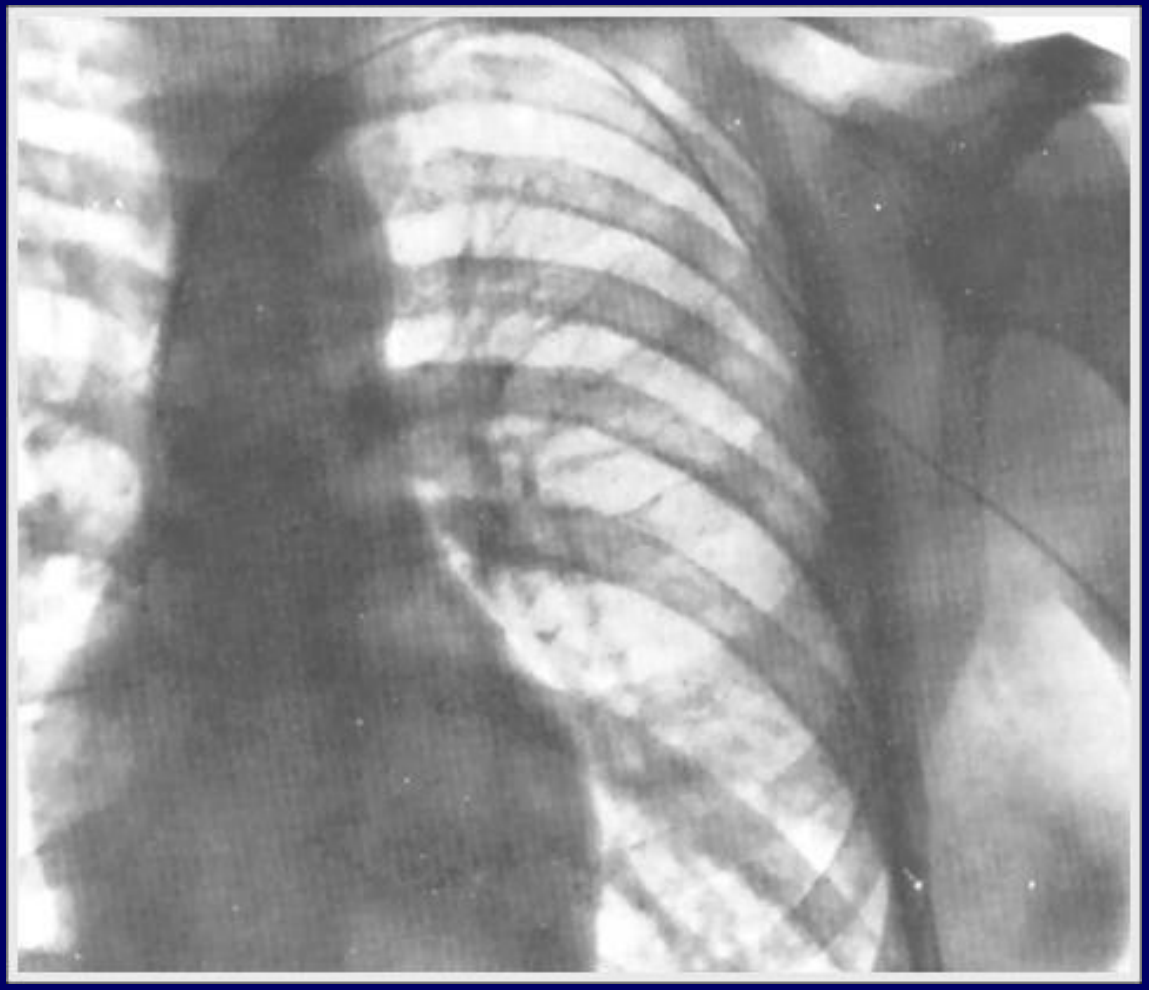
Historical Perspective

- 1844 Claude Bernard- Catheterized Equine Heart
  - Era of Cardiac Physiology Developed
    - Pressure Manometry
    - Fick Cardiac Output Method
- 1929 Werner Forssman- Catheterized First Human Heart
  - HIMSELF

Historical Perspective



Baim DS & Grossman W. Cardiac Catheterization, Angiography, & Intervention. 5th ed. 1996

Historical Perspective

- **Forssman's Goal**
- **1930-Klein 1st Use of Fick's Principle Clinically**
- **1947- Capillary Wedge Pressure Measurements**
- **1950- Left Heart Retrograde Catheterization**
- **1953- Seldinger Technique Described**
- 1967 Porstman 1st PDA Occlusion Attempt
- **1970- Swan-Ganz Balloon Catheter**
- **1977- First Angioplasty Performed**

Indications

- Decision to proceed
  - Benefits should outweigh risk
  - Success meets or exceeds other procedures
  - Cost effective
- Diagnostic Catheterization
  - Superseded by echocardiography
- Pre-surgical Screening
- Therapeutic Intervention
- Clinical Research

Importance TO YOU

- **Indications**
- **Availability**
- **Usefulness**
- **Limitations**
- **Inform owners of all available options**

Pacemaker Therapy

- **1968 –James Buchanan-1st reported clinical use in dogs.**
  - **Surgical placement of epicardial lead**
- **1985- Surgical implanted pacemaker in cats reported**
- **Late 1980's –Transvenous placement of endocardial leads reported**
  - **Darke and also by Sisson**

Pacemaker Indications

3rd Degree AV Block

Sick Sinus Syndrome

2nd Degree AV Block

Pacemaker Indications

3rd Degree AV Block

(29 cases)

Sick Sinus Syndrome

(42 cases)

2nd Degree AV Block

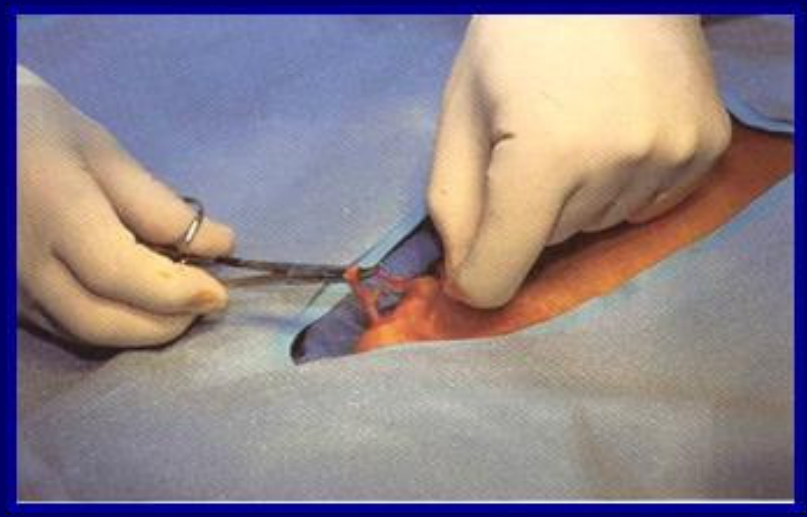
(8 cases)

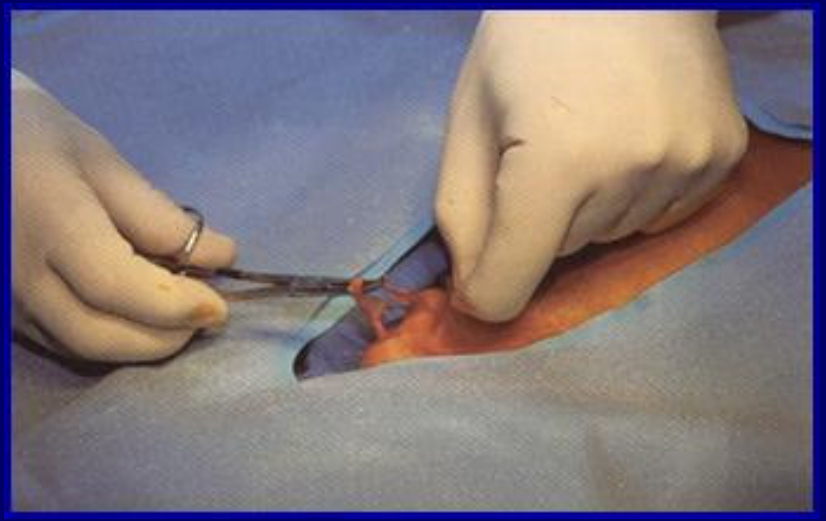
Pacemaker Indications

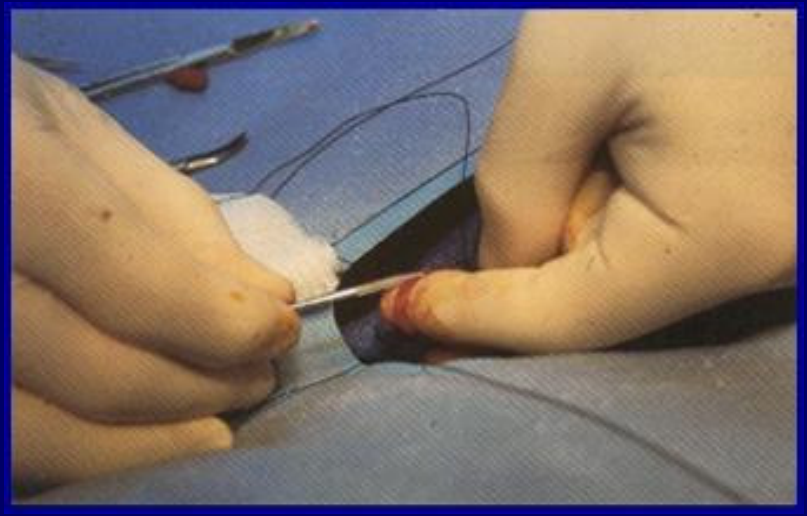
- **Other Bradyarrhythmias**
  - **Sinus arrest**
  - **Persistent atrial standstill**
- **Animals with documented ECG abnormalities & associated clinical signs**

Pacemaker Equipment

Pacemaker Placement

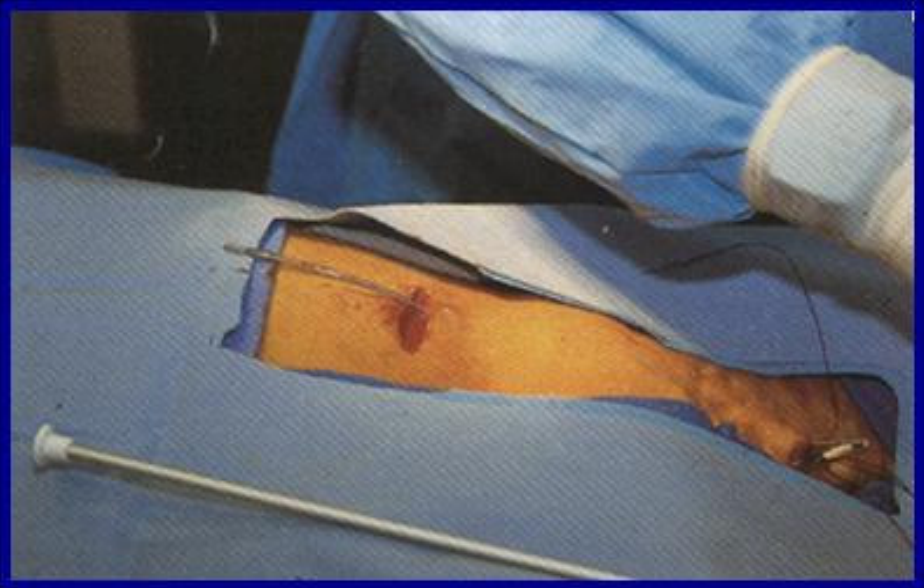


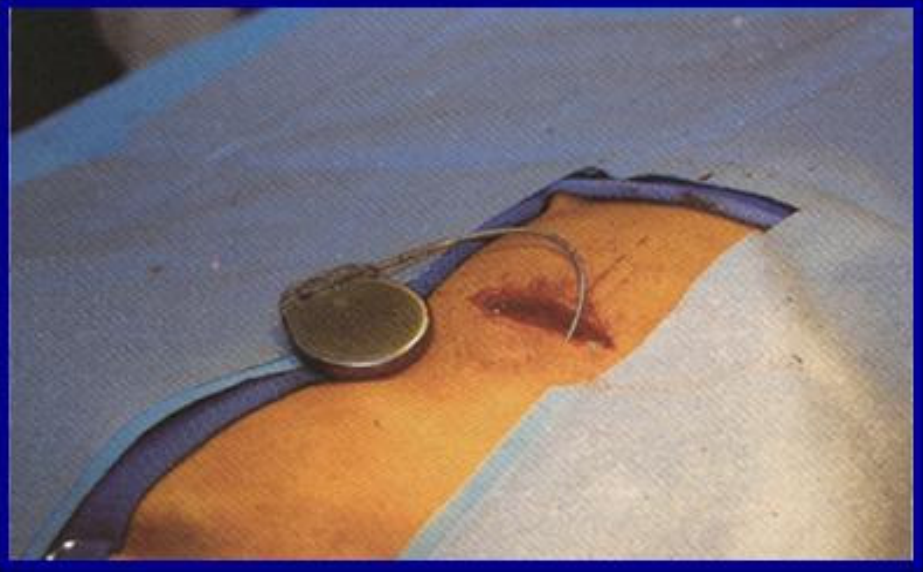




Kittleson et al Small Animal Cardiovascular Medicine. 1st ed 1998

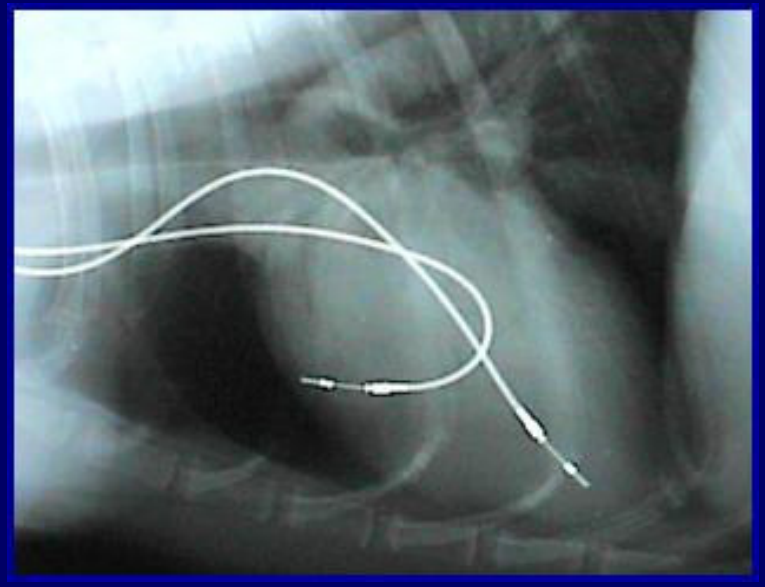
Pacemaker Placement





Kittleson et al Small Animal Cardiovascular Medicine. 1st ed 1998

Single Chamber System-VVI



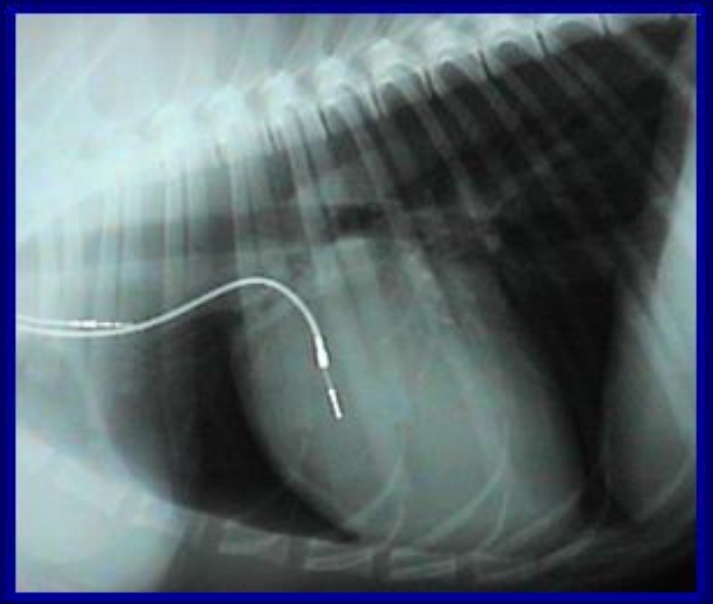
Dual Chamber System-DDD

Pacemaker Procedure

- 1.5 to 2 hour procedure length
- Patients monitored overnight
- Discharged following day
- Prophylactic antibiotics 7-10 days
- Patient Strictly Confined
  - 1 month
- Recheck in one month

Pacemaker Complications

- Complications
  - Seromas (4)
  - Lead Dislodgement (3)
  - Infection (1)
  - Arrhythmias (4)

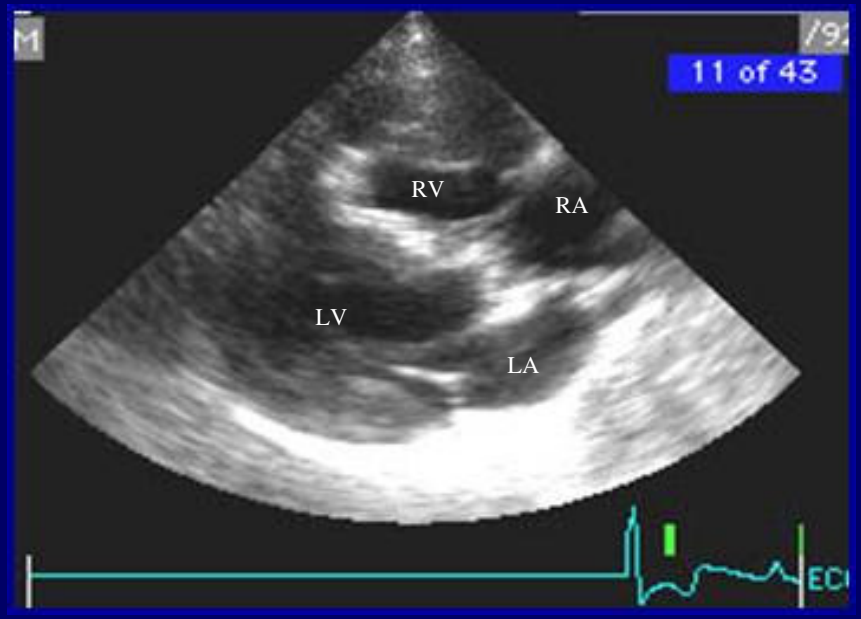


Balloon Valvuloplasty

- **Dilation of stenotic valves or vessels using balloon tipped catheter**

- **Treatment of choice to attempt to relieve cardiovascular obstructions associated with:**
  - **Pulmonic Stenosis**
  - **Subvalvular aortic stenosis**
  - **Tricuspid valve stenosis**
  - **Cor Triatriatum Dexter**

Disease	Pulmonic Stenosis	Subaortic Stenosis
Definition	Pulmonic valve malformation -Valve, above or below	Narrowing of LV outflow -Fibrous or fibromuscular
Signalment	English Bulldog, Beagle, Keeshond, Mastiff, Miniature Schnauzer, Pug	Boxers, Golden Retriever, German Shepherd, Rottweiller, Newfoundland
Physical Exam	Loud coarse systolic murmur left heart base 	Systolic murmur @ left heart base Weak femoral pulses
Pathology	Pressure overload to right ventricle Arrhythmias and syncope	Pressure overload to left ventricle Arrhythmias and syncope
Treatment	B-blockers Surgery Balloon Valvuloplasty	B-blockers Surgery Balloon dilation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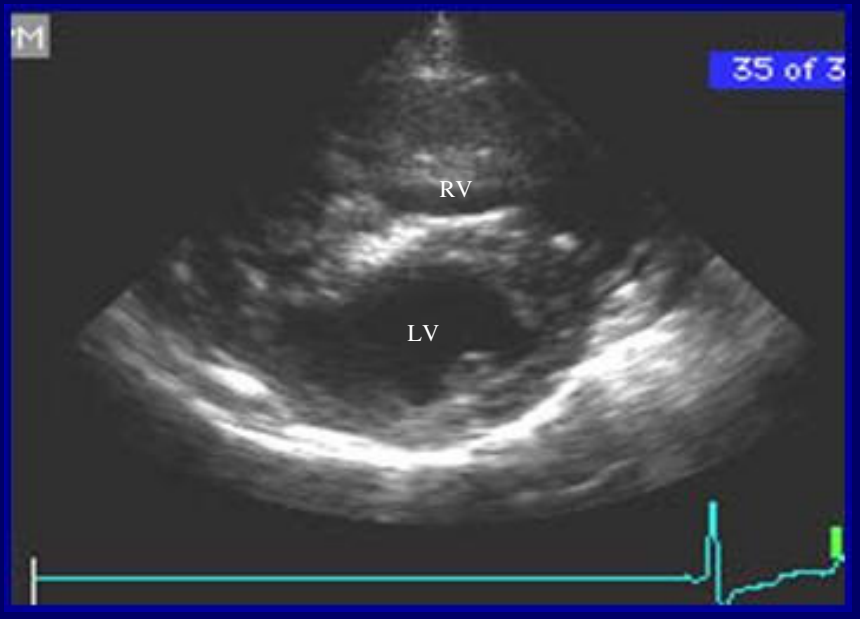
RV
RA
LV
LA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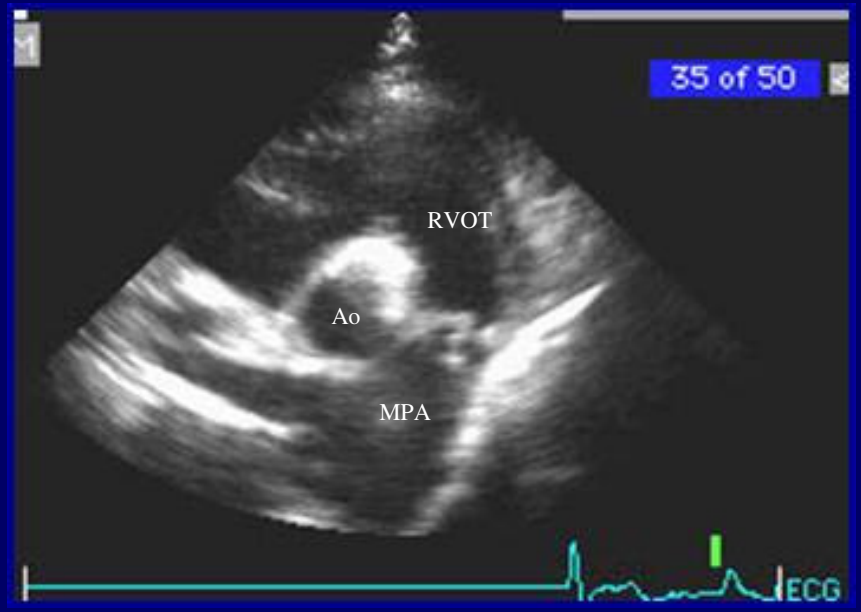
RV
LV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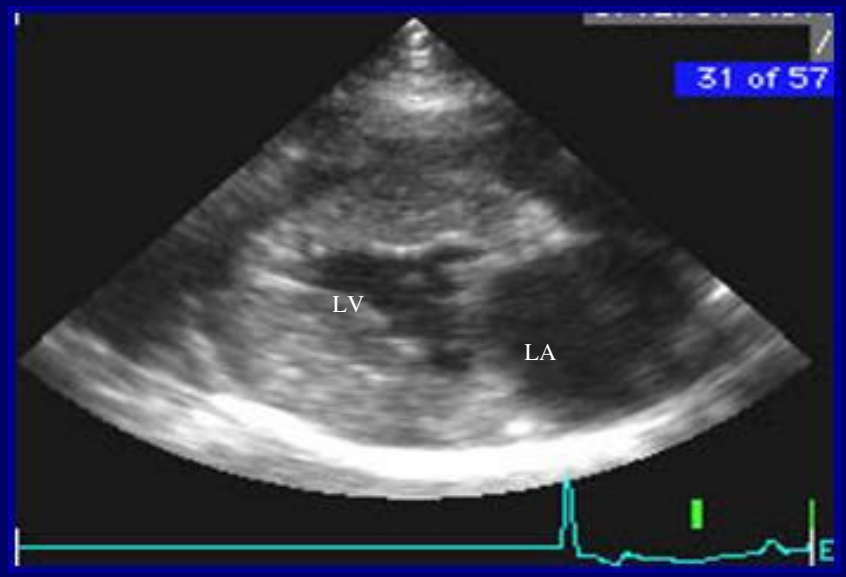
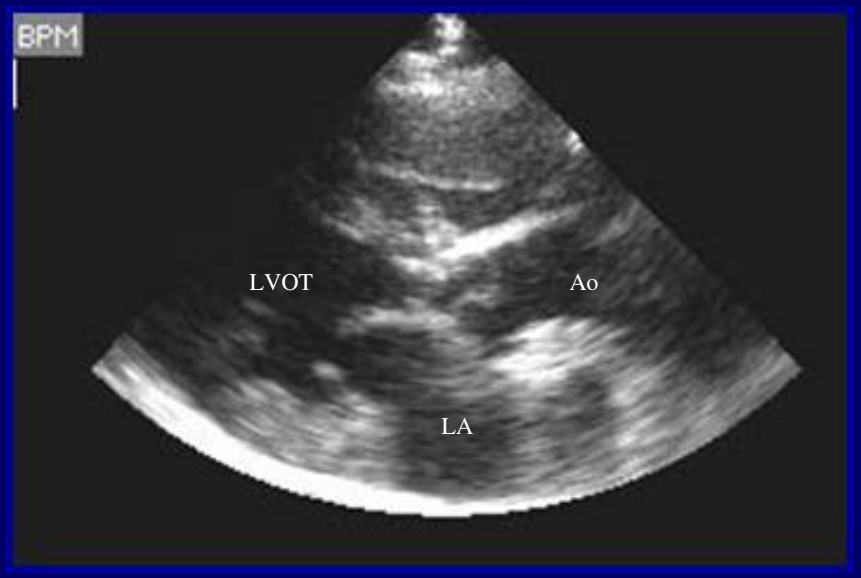
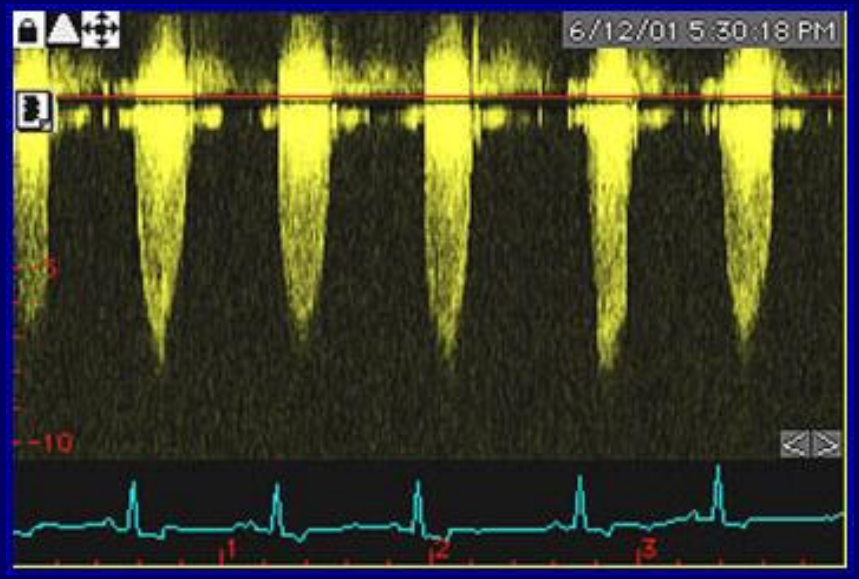
Subaortic Stenosis

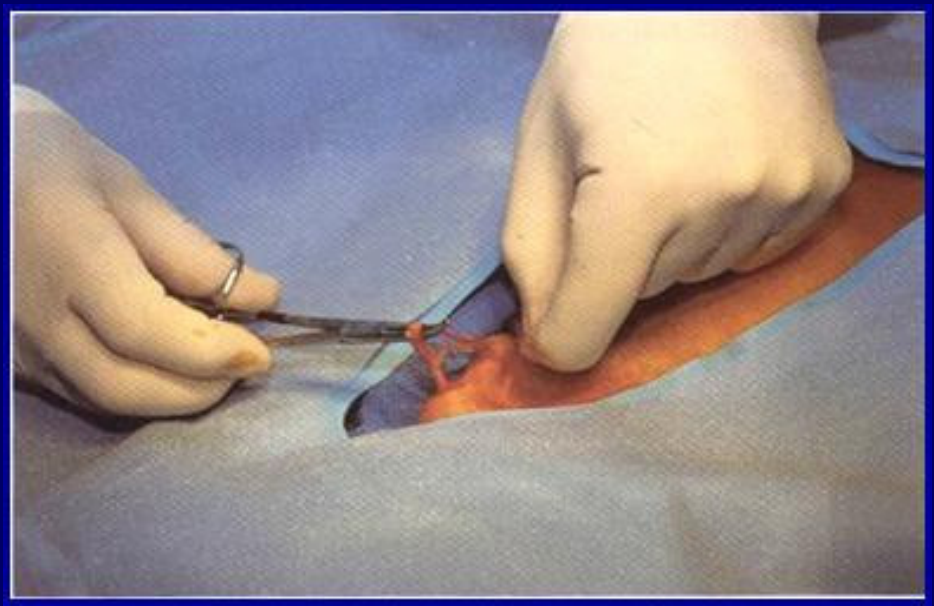


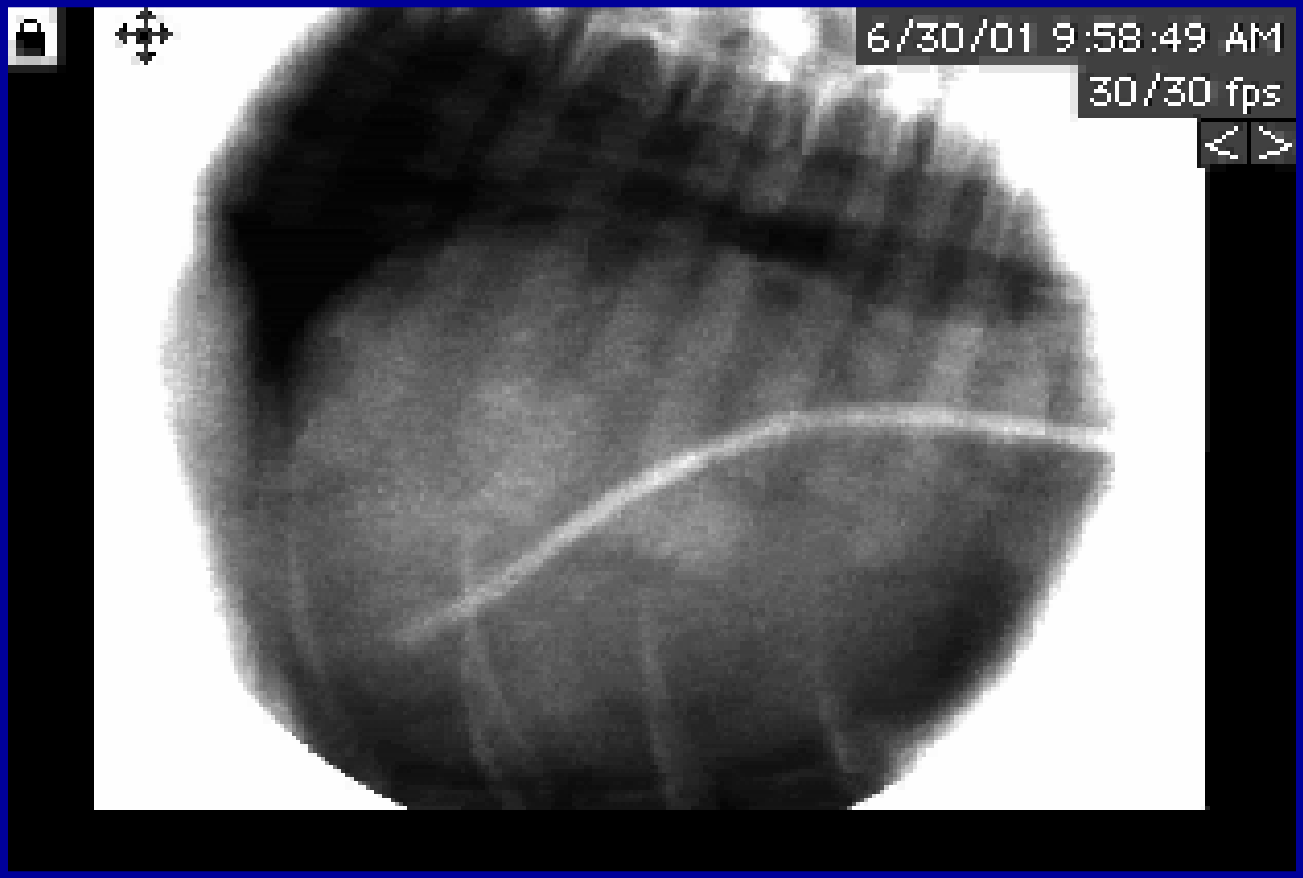




The Procedures

Pulmonic Stenosis

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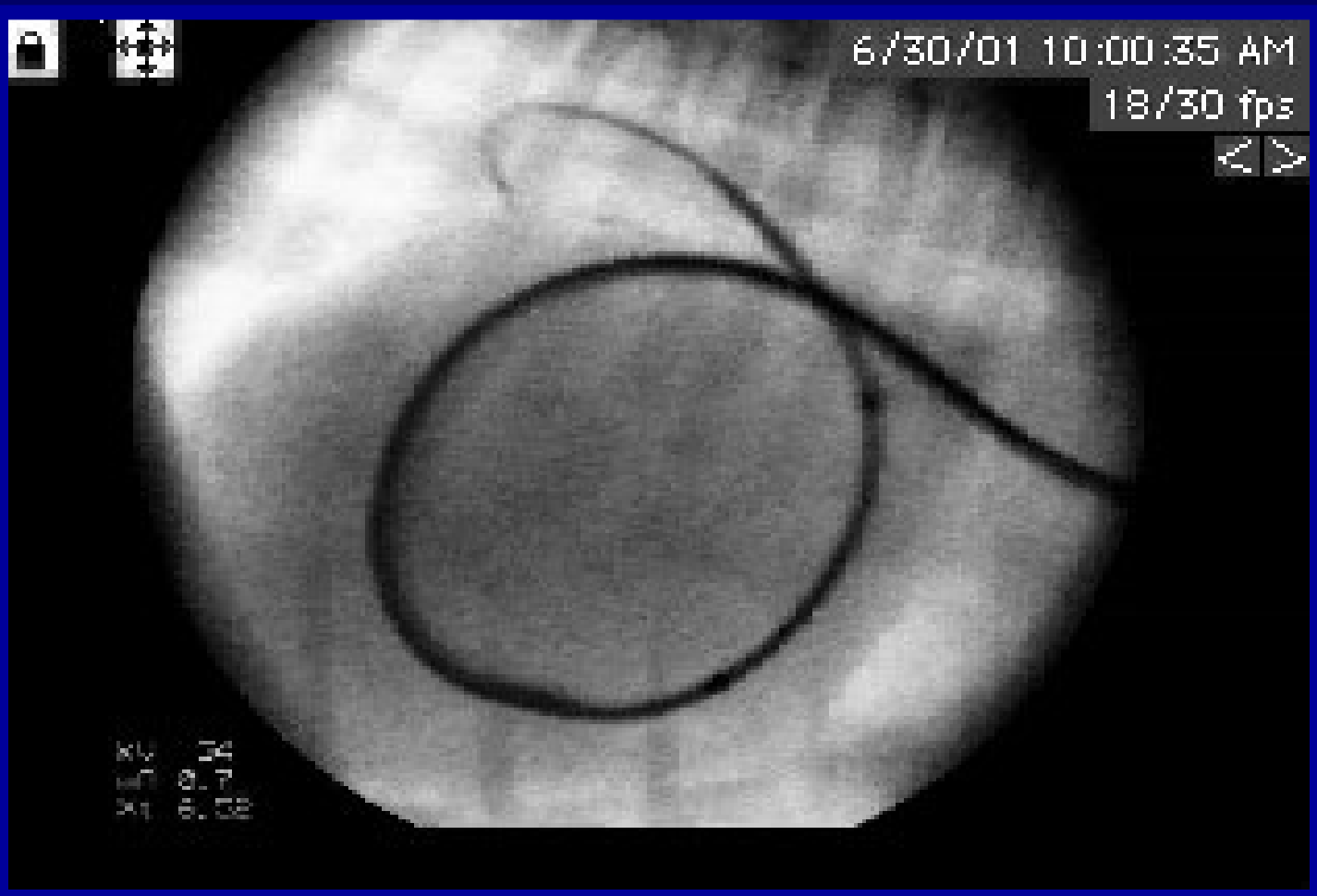
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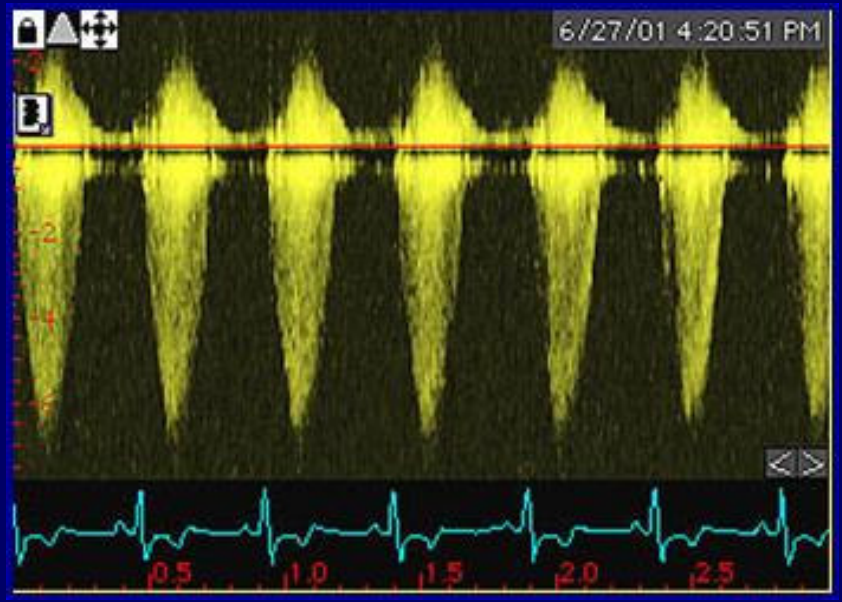
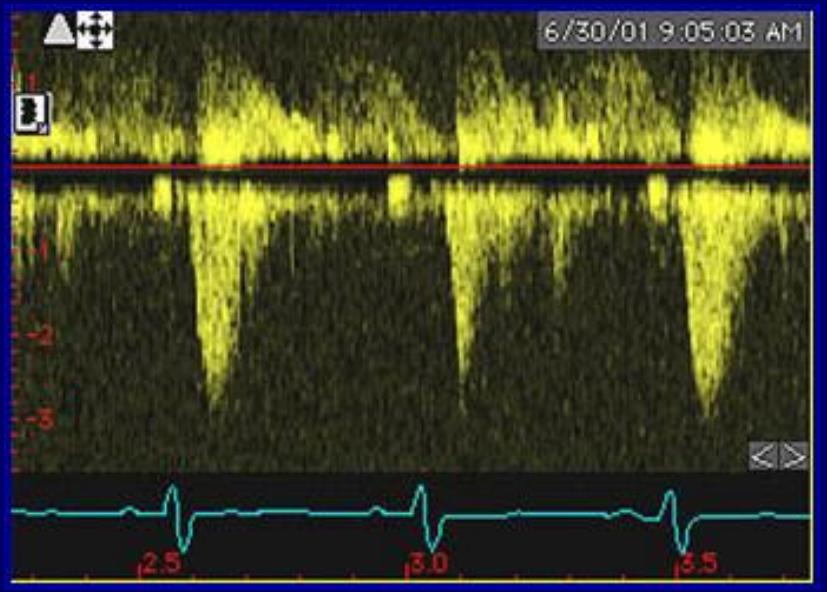
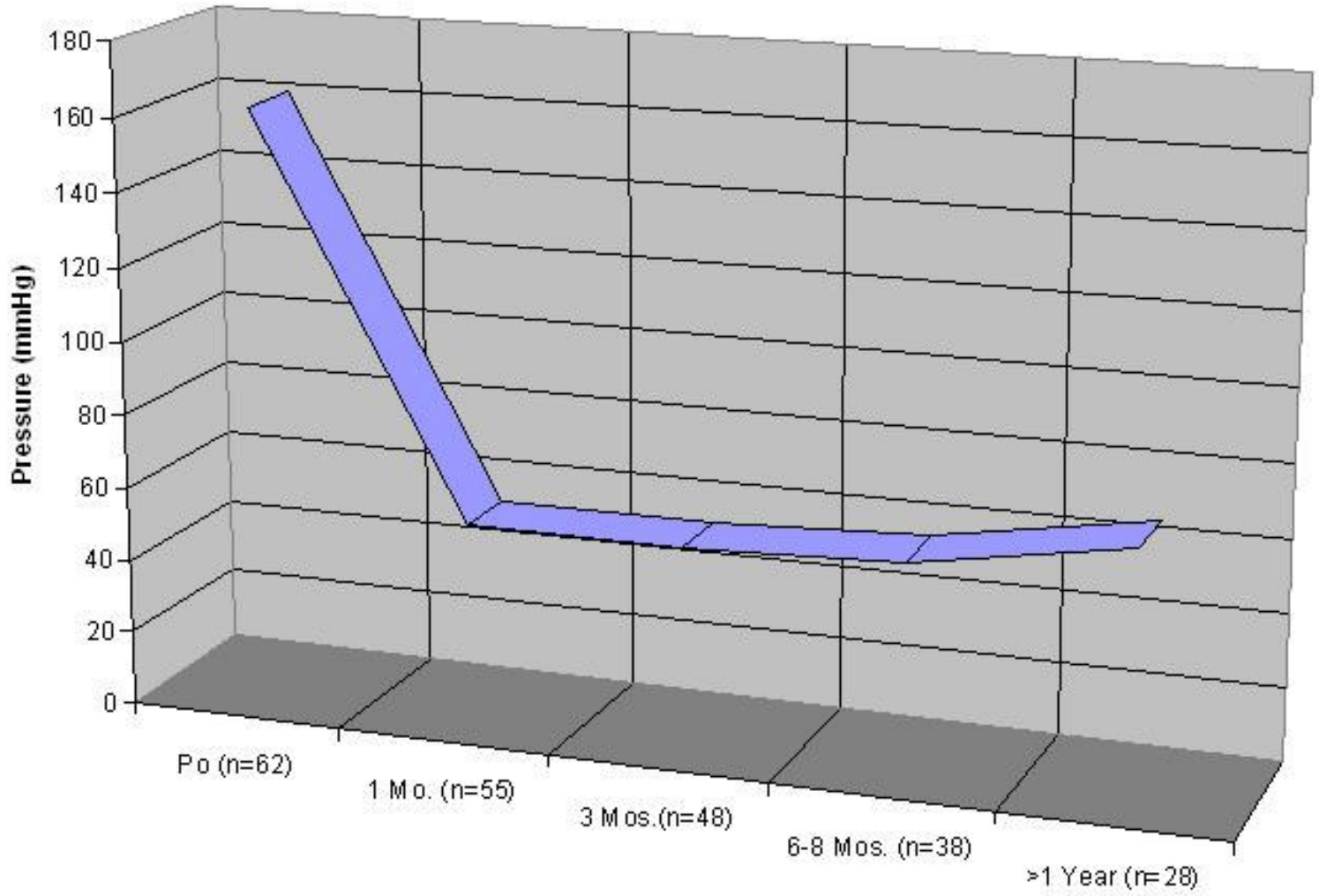
Pulmonic Stenosis

- **Post operatively patients monitored overnight**
- **Antibiotics 7-10 days**
- **Therapy with ß-blockers**
- **Echocardiogram performed next day**
- **Cost $1500-$1700 total bill w/o complications**





Avg. RV-PA Pressure Gradient



	Po (n=62)	1 Mo. (n=55)	3 Mos.(n=48)	6-8 Mos. (n=38)	>1 Year (n=28)
RV Pressures	161.4482353	54.03181818	54.121875	56.62666667	66.878125

Results

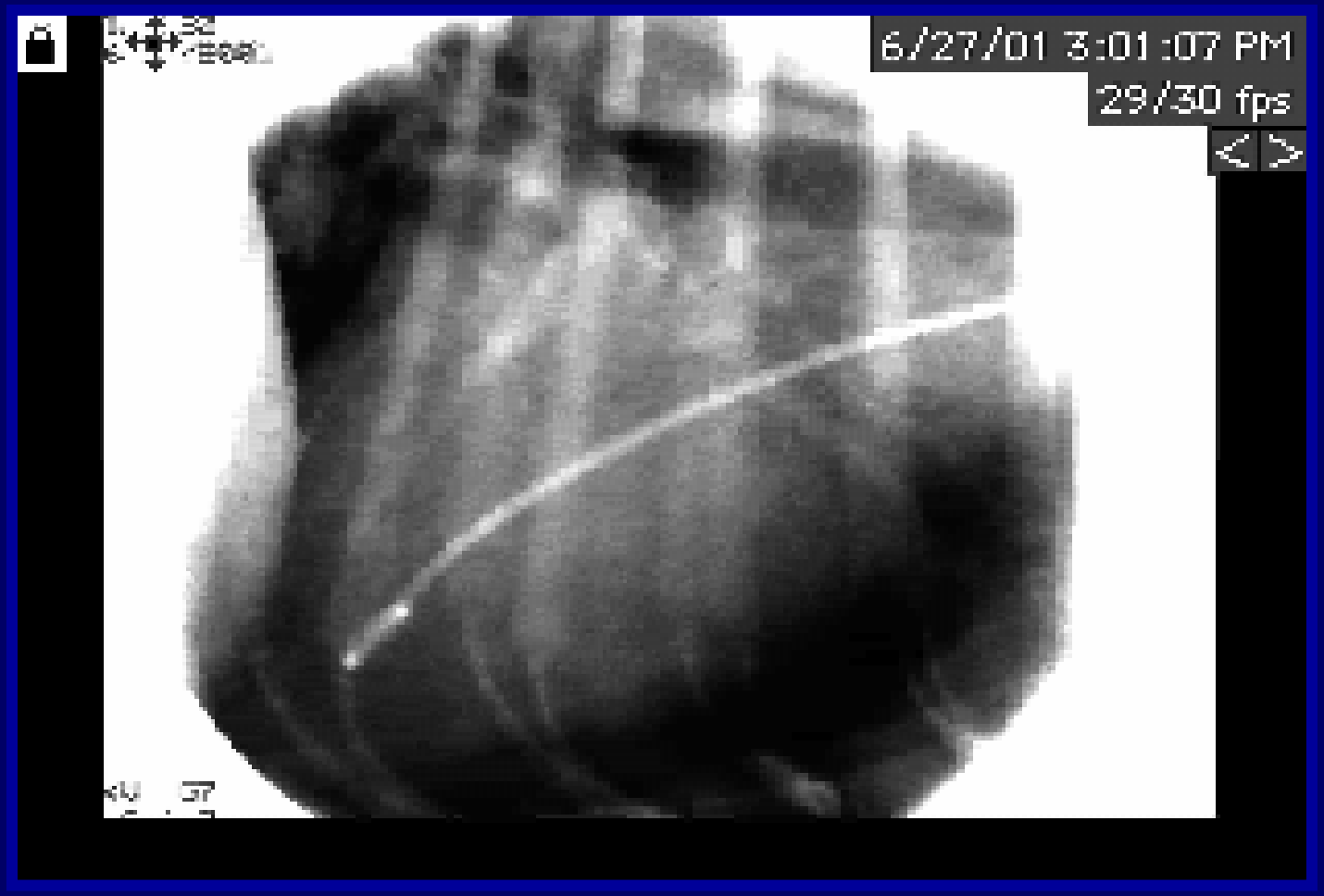
- Become TOC for this disease because of success
- 50% decrease in gradient across valve in 70% - 85% of dogs
- Purdue University Team Cardiology

# Cases Ballooned	**Gradient Pre op avg.**	**Gradient Post op avg. n=29**	**Gradient 1 month Post op avg. n=27**	**Complications**
62	192**mmHg**	73 **mmHg**	78 **mmHg**	3 deaths

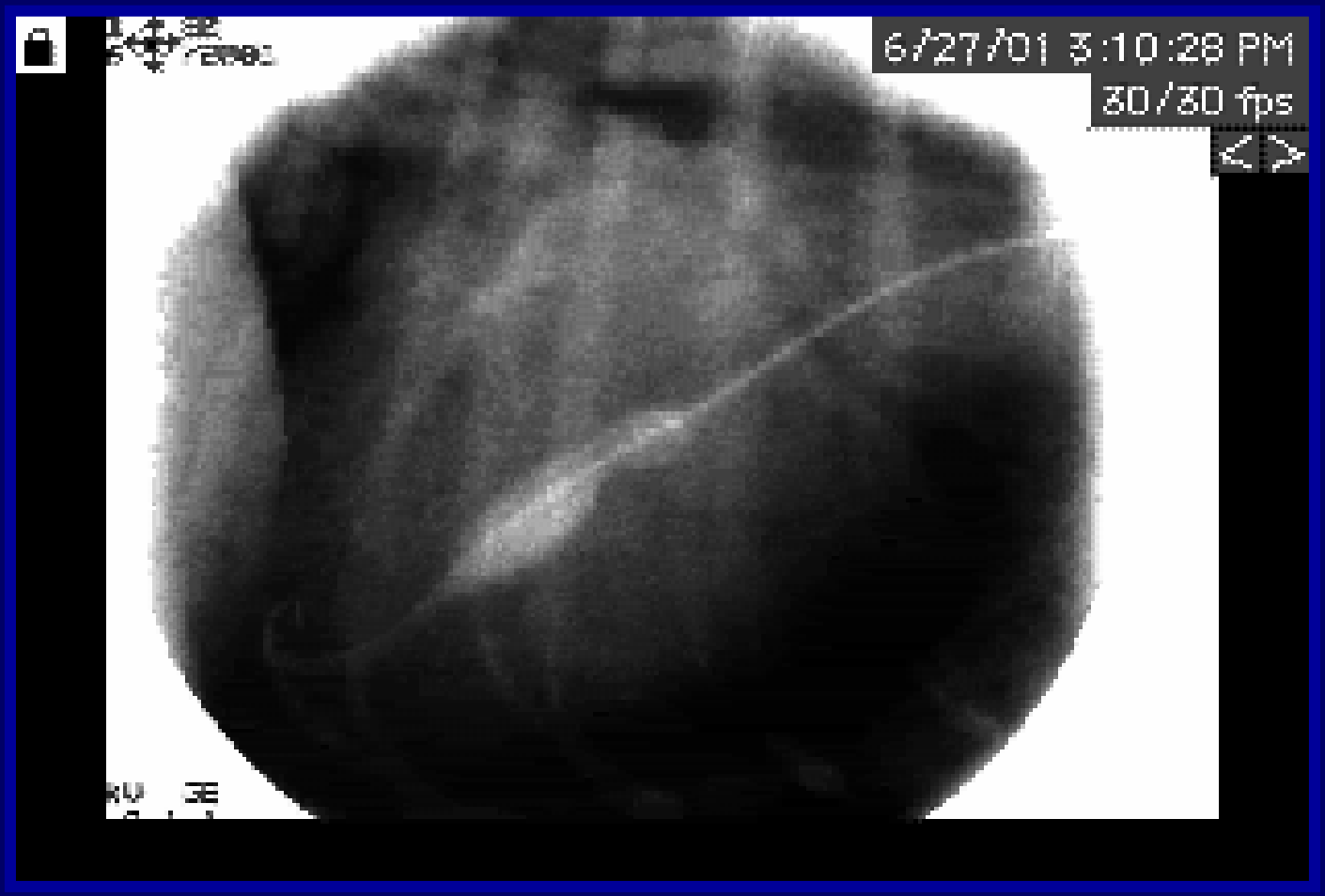
Subaortic Stenosis

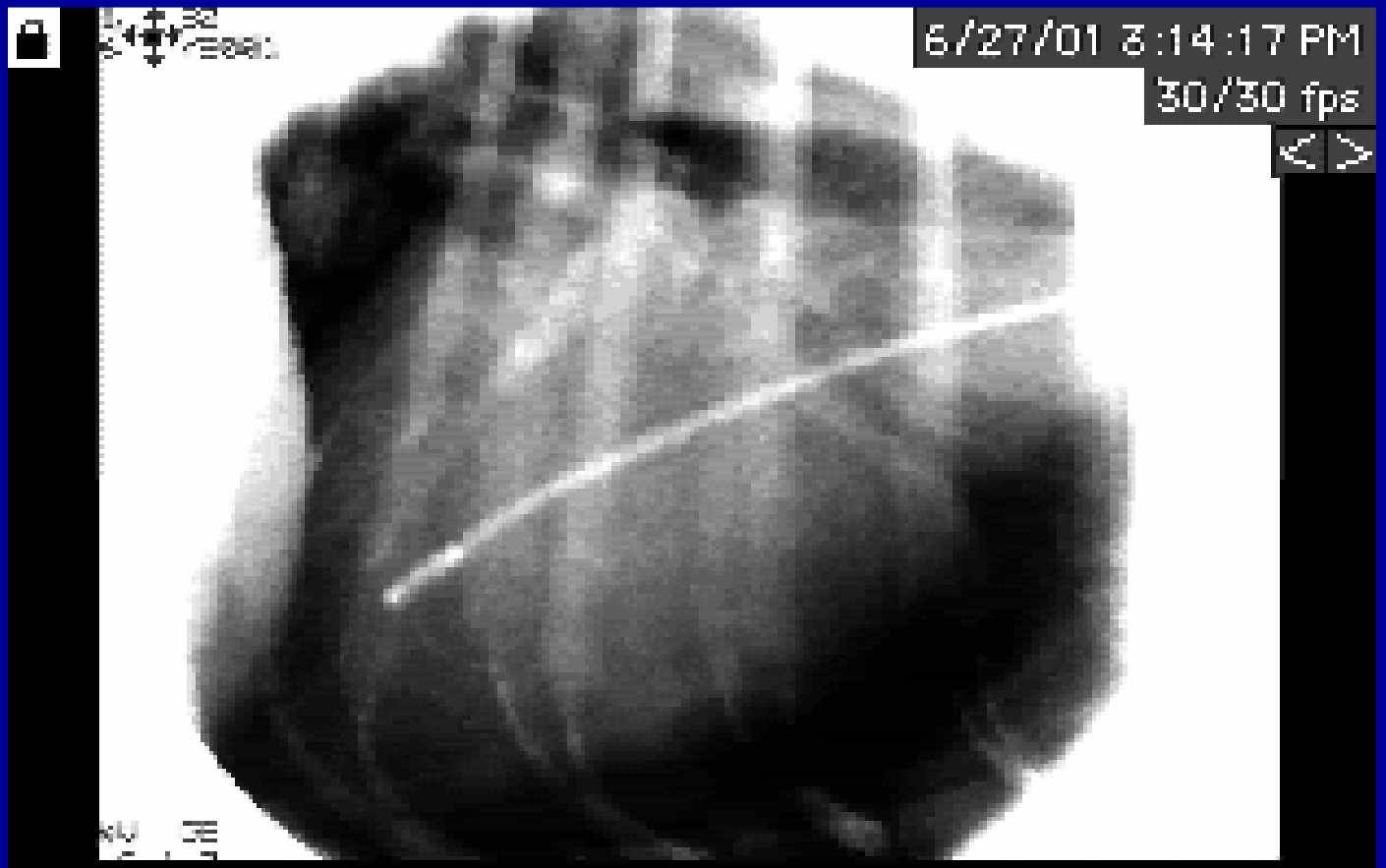
- **Balloon Dilation**
  - **Vascular cut-down to external carotid**
  - **Fluoroscopically guide catheters into LV**
  - **Measure pressure gradient**

Left Ventricle Angiogram



SAS Ballooning

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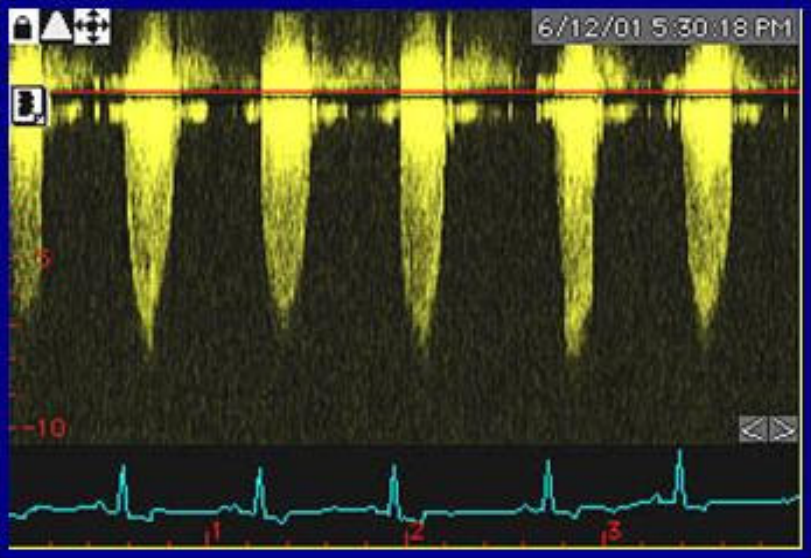
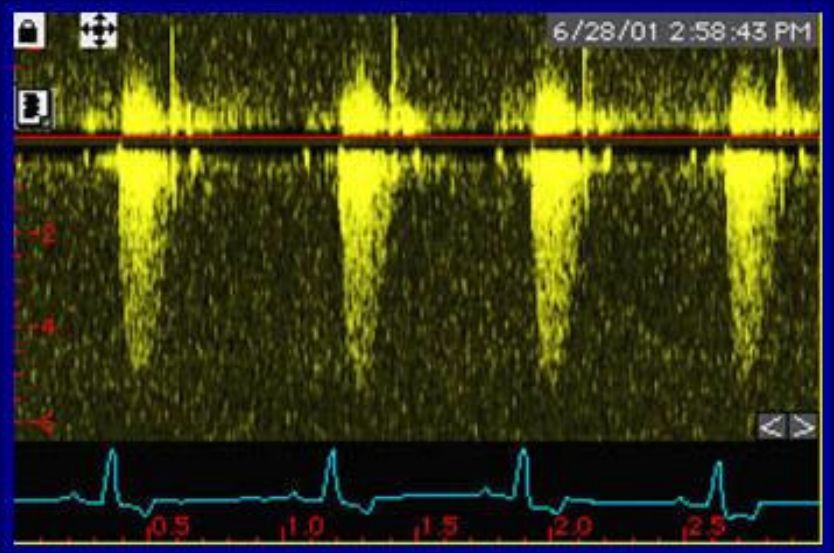
Subaortic Stenosis

- **Results**
  - **Initial decrease in gradient 30-60%, over 6 month period gradient may return**
  - **Purdue Team Cardiology**
    - **5 Cases, 3 Gradients :237mmHg to 92mmHg @ 1 month.**
      - **2 Died during procedure**





Transcatheter Shunt Occlusion

- **Human Medicine**
  - **Patent ductus arteriosus**
  - **Ventricular septal defects**
  - **Atrial septal defects**
  - **AV Fistulas**
- **Veterinary Medicine**
  - **Patent Ductus Arteriosus**
  - **AV Fistulas**
  - **Atrial Septal Defects**
  - **Portosystemic Shunts**

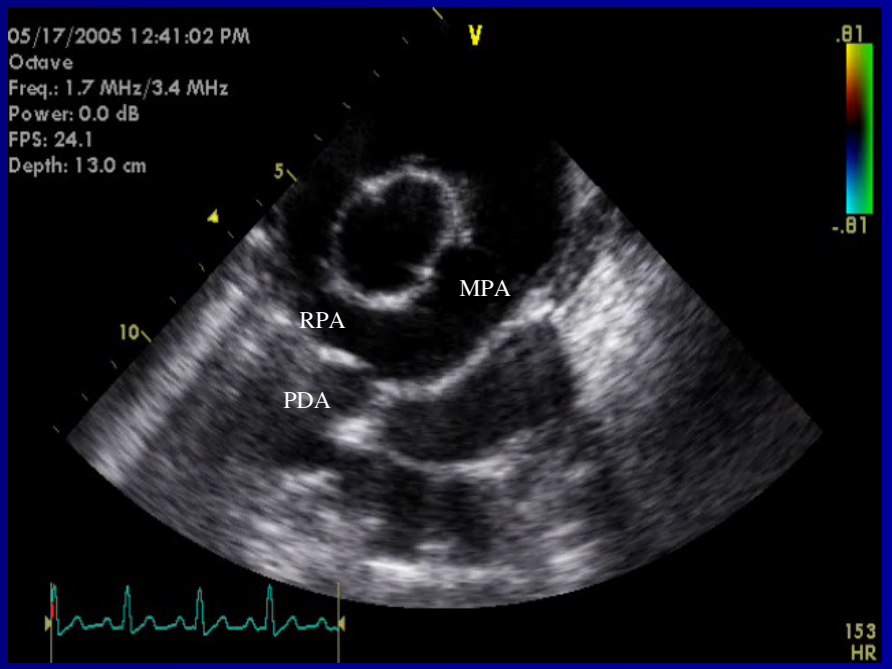
Patent Ductus Arteriosus

- **Most commonly diagnosed congenital disease in dogs**
- **Failure of the left sixth aortic arch to close**
  - **Shunts blood from aorta to pulmonary artery**
  - **Left sided volume overload and heart failure**
- **Poodles, German Shepherds, Collies, Pomeranians, Shetland Sheep dogs Maltese and Yorkshire terriers**

Patent Ductus Arteriosus

- **Physical Examination**
  - **Loud continuous murmur at the left heart base** 
  - **Hyperkinetic 'Bounding' femoral pulses**
  - **Animals may be stunted**
  - **May have signs of CHF**

Patent Ductus Arteriosus



Patent Ductus Arteriosus

- **Ductus must be closed**
  - **Excellent prognosis with closure**
  - **50% - 70% die within 1st year without**
  - **Actually 1st congenital defect to be closed surgery and by occlusion**
- **Surgery**
  - **Ligation - Excellent results**
  - **Requires thoracotomy**
    - **Increased cost and hospitalization**

PDA Transcatheter Closer

- Three main devices
  - Gianturco Embolization Coils
  - Amplatz Vascular Plug
  - Amplatz Canine PDA Device

Gianturco Embolization Coils

- **Double helix stainless-steel spring coils with Dacron strands attached**
- **1st Reported in 1995 (Miller et al)**
- **Dimensions**
  - **Wire diameter 0.018” to 0.052”**
  - **Outer (helical) diameter 3 - 25 mm**
  - **Coil Length- 3-25 cm**

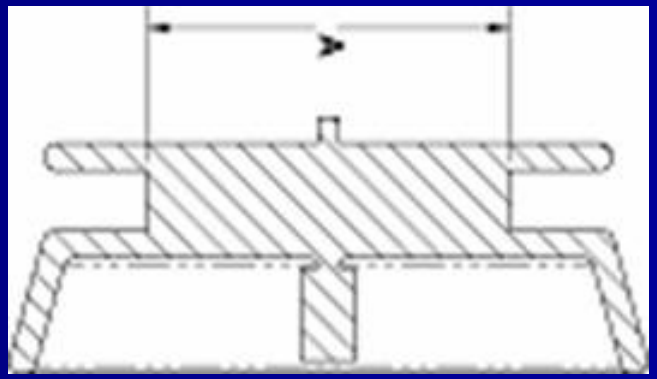
Amplatz Vascular Plug

- Self-expandable cylindrical device
  - Nitinol mesh
  - Threaded delivery cable
  - Repositionable
- Size range 4 – 16 mm
  - 5 Fr – smallest system
- Delivery
  - Transarterial or Transvenous

AGA Medical 2007

Amplatz Canine PDA Device

- Self-expanding
  - Nitinol mesh
  - Distal flat disk
  - Larger proximal cup
  - Threaded cable
  - Repositionable
- 3- 14 mm size
  - 5 Fr – smallest system
- Delivery
  - Transarterial



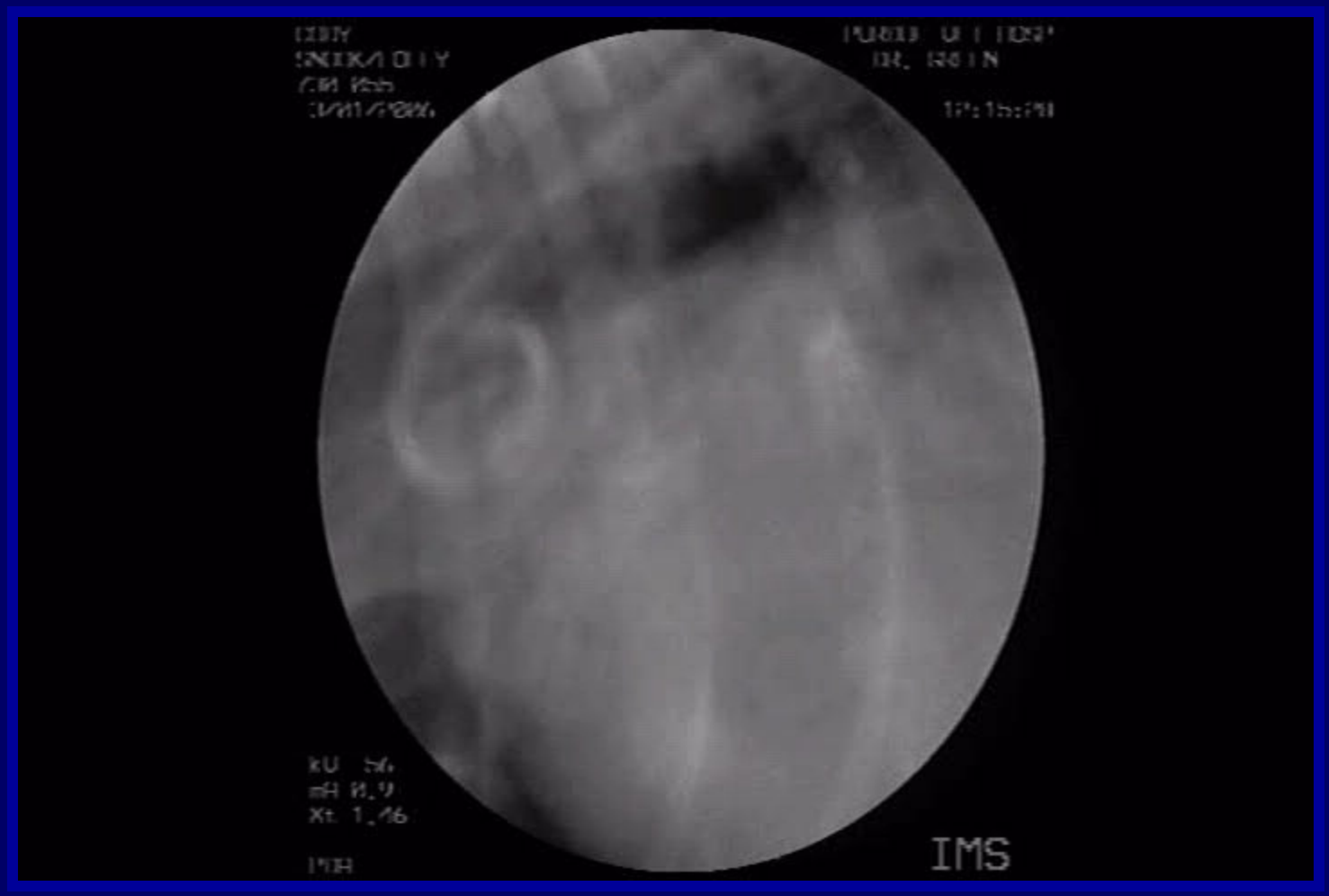
Infinintimedical.com 2007

Patent Ductus Arteriosus

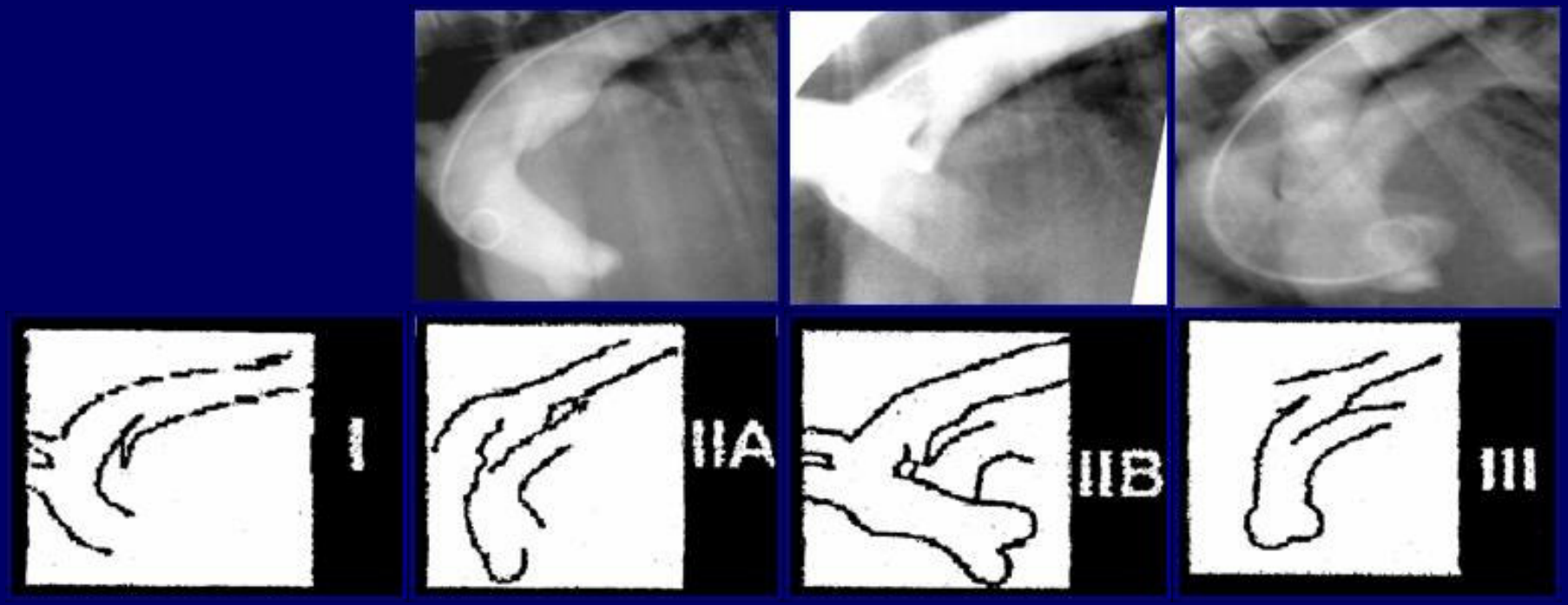
- **Delivered transarterial or transvenous routes**
  - **Introducer**

- **Delivery System**
  - **Modified Bioptome Technique**
    - **4-Fr pigtail**
    - **4-Fr CHB long sheath**
    - **3-Fr bioptome**

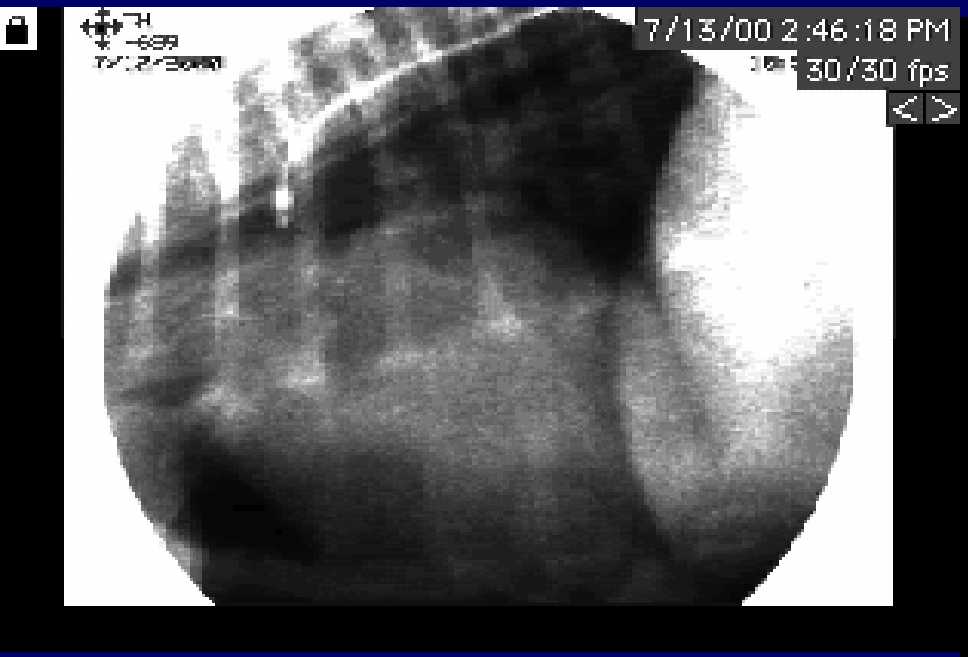
Aortogram



PDA Ductal Types



Miller et al. 1994 ACVIM Proceedings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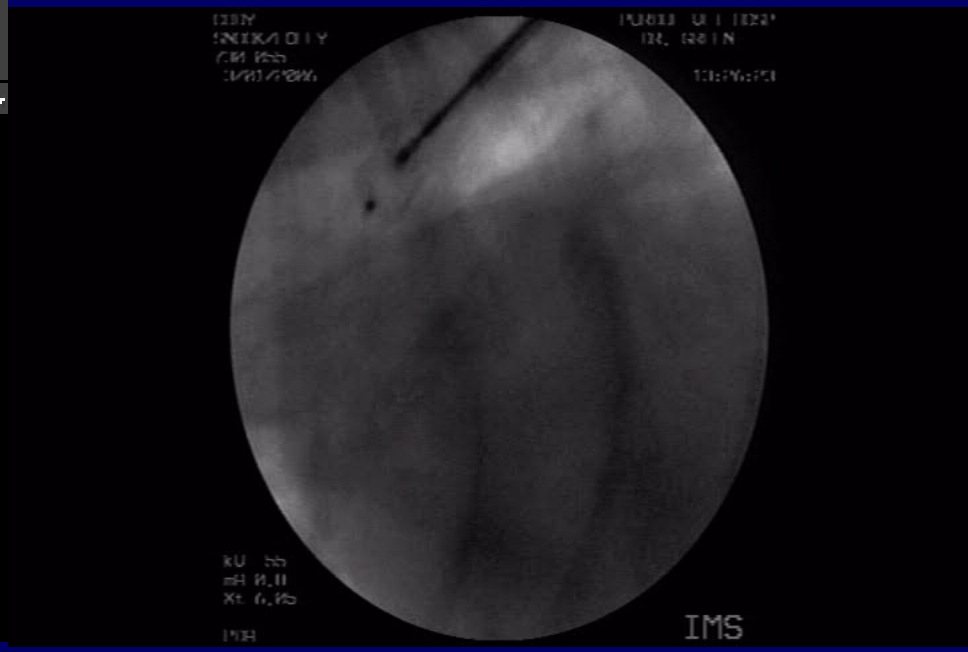
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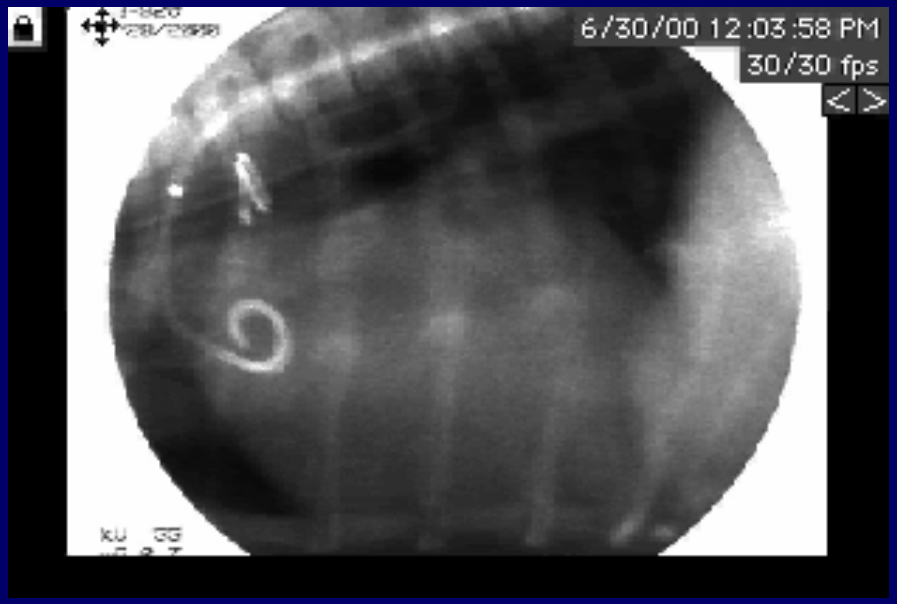
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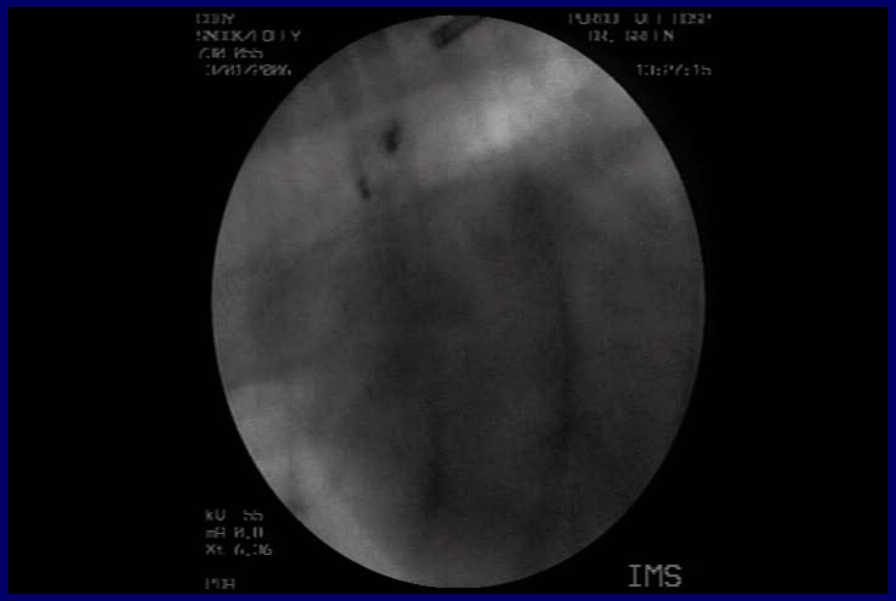
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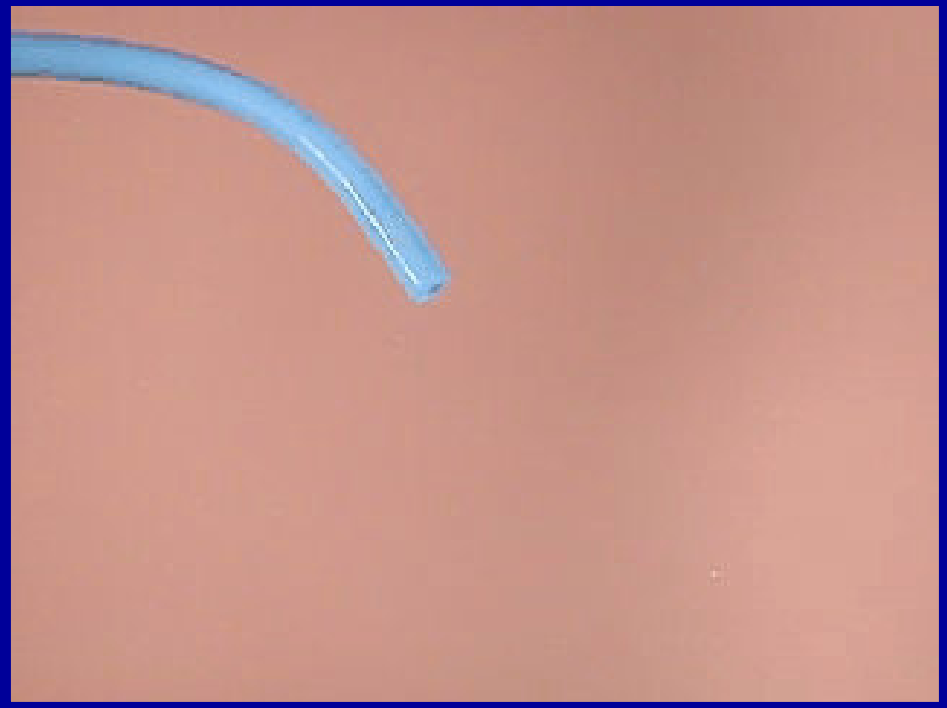
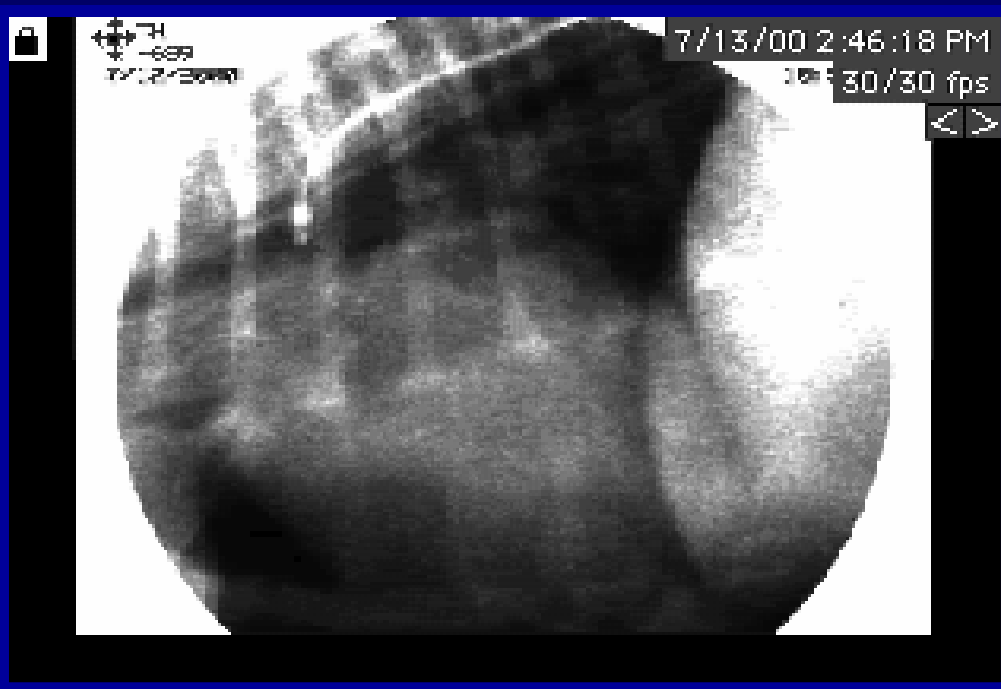
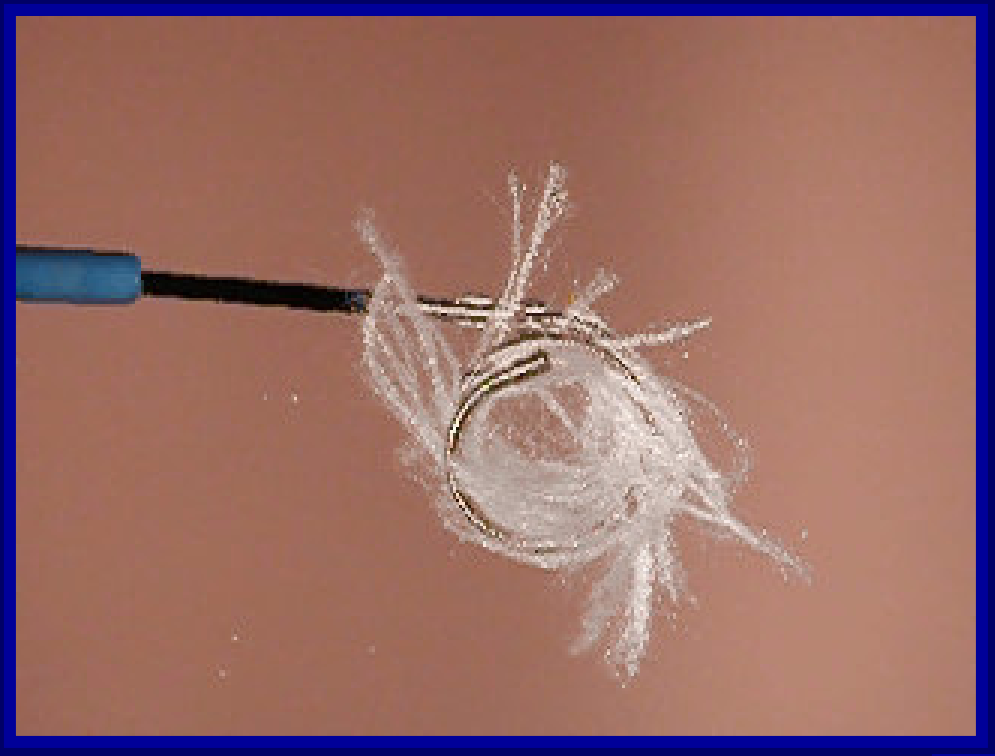
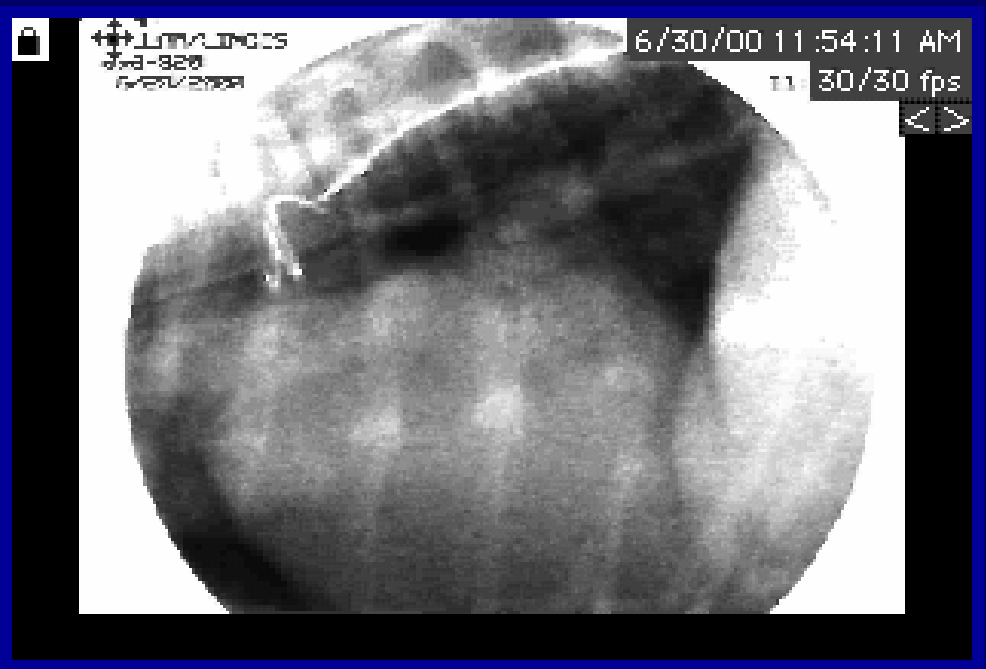
Coil Deployment



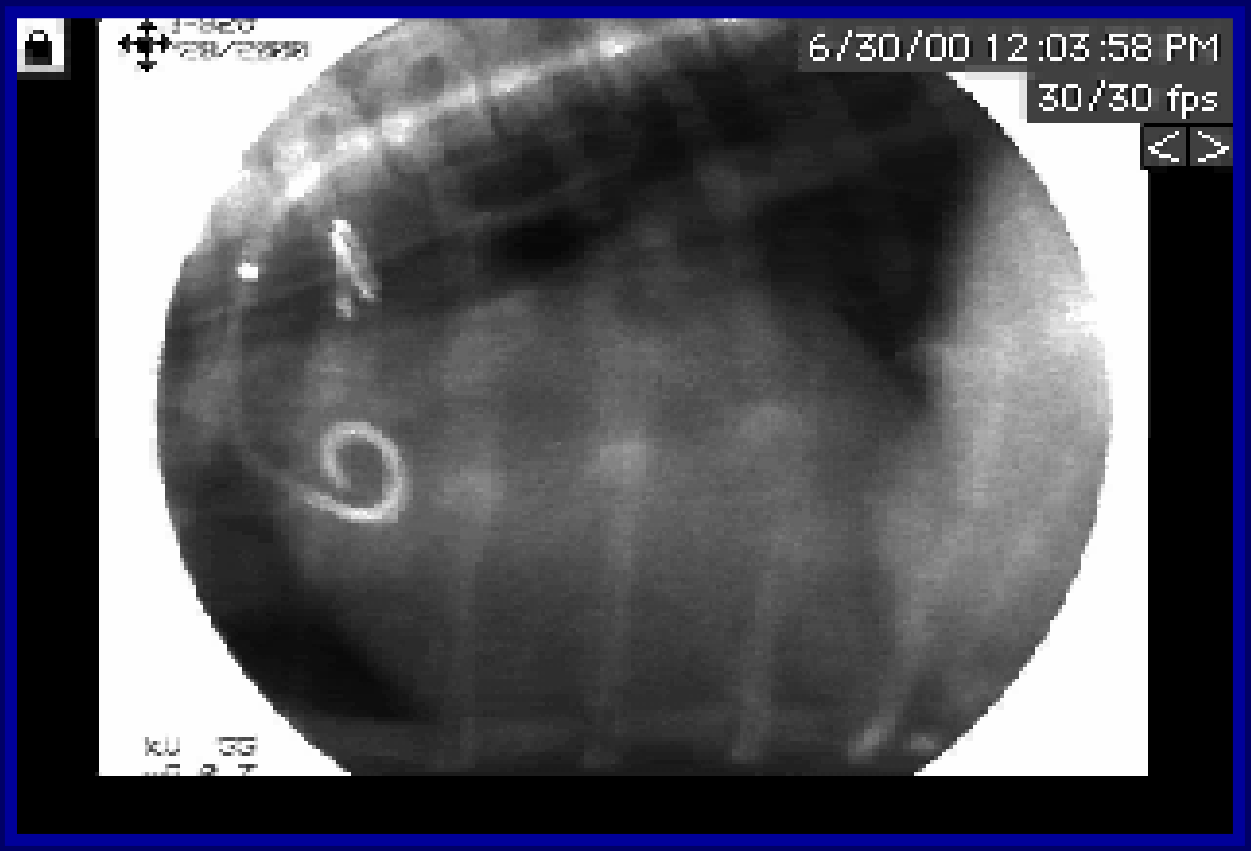




Coil Release

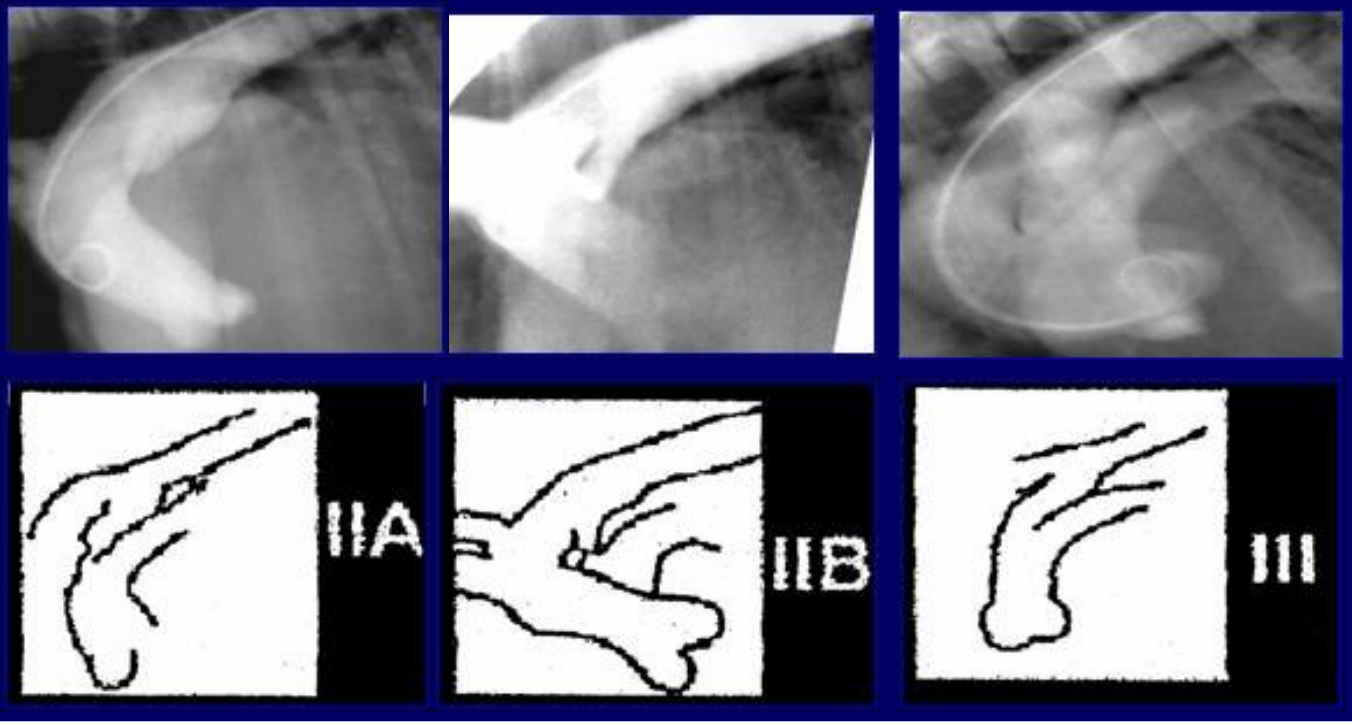


Post Coil Angiogram



PDA Post Operative

- Monitored overnight
- Echocardiogram
- Antibiotics 1 week
- Recheck in 1 month



# Cases	47	22	14
Coiled	43/47	20/21	5 (3)
Comp.	3-Sx, 4-PF 2-Deaths, 2- Emb.(1)	1-Sx, 1 PF 1 Death 3-Emb. (1)	3 hematoma 1 PF

Results

- **Fourteen Could Not Be Coiled**
  - **Nine with Type III Ductus**
  - **Four Too Small**
- **Persistent ductal flow**
- **Complications ~7-11%**
  - **Coil Embolism During Procedure**
  - **Hematoma**
  - **Duct Perforation**
  - **Death**
- **Cost ~$1000-1300**



# Cases	73 (2003)	22	5
Outcome	66/73	20/22	5/5
Complications	4-Sx, 6-PF 3-Deaths, 5- Emb.	2 – PF 1 spinner	None
Type III	▪3 of 5 ▪2 closed ▪Multiple coils	▪ 1 of 2 attempts ▪ 1 embolized	▪ Not attempted
Limitations	Patient size Ductal morph & size	Morphology?	Patient size Morphology?
Device Cost	~$50 - $350	~$400	~ $550

Limitations

- Large ductus
- Non restrictive ductal morphology
- Patient size*

Other Catheter Based Procedures

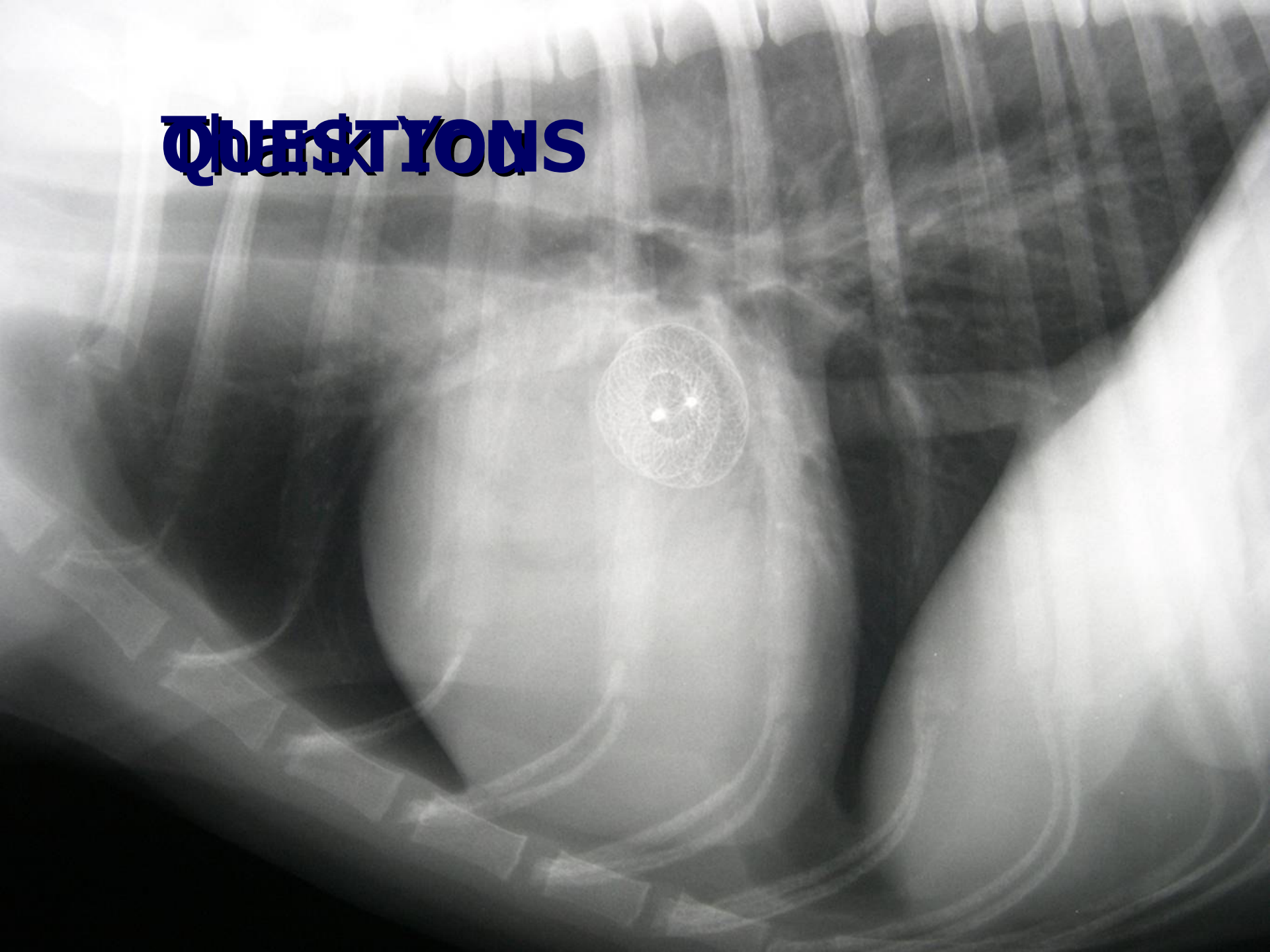
- Temporary cardiac pacing via the esophagus
- Balloon pericardectomy (7)
- Porto systemic shunt closure (3)
- Other uses for Occlusion Devices
  - Idiopathic hematuria (2 of 3)
  - Guttural pouch bleeding (1)
  - AV Fistulas (2)

Conclusion

- Interventional cardiac catheterization is less invasive and expensive than other therapeutic techniques
- Interventional cardiac catheterization continues to evolve as a part of this specialty in human and veterinary medicine alike

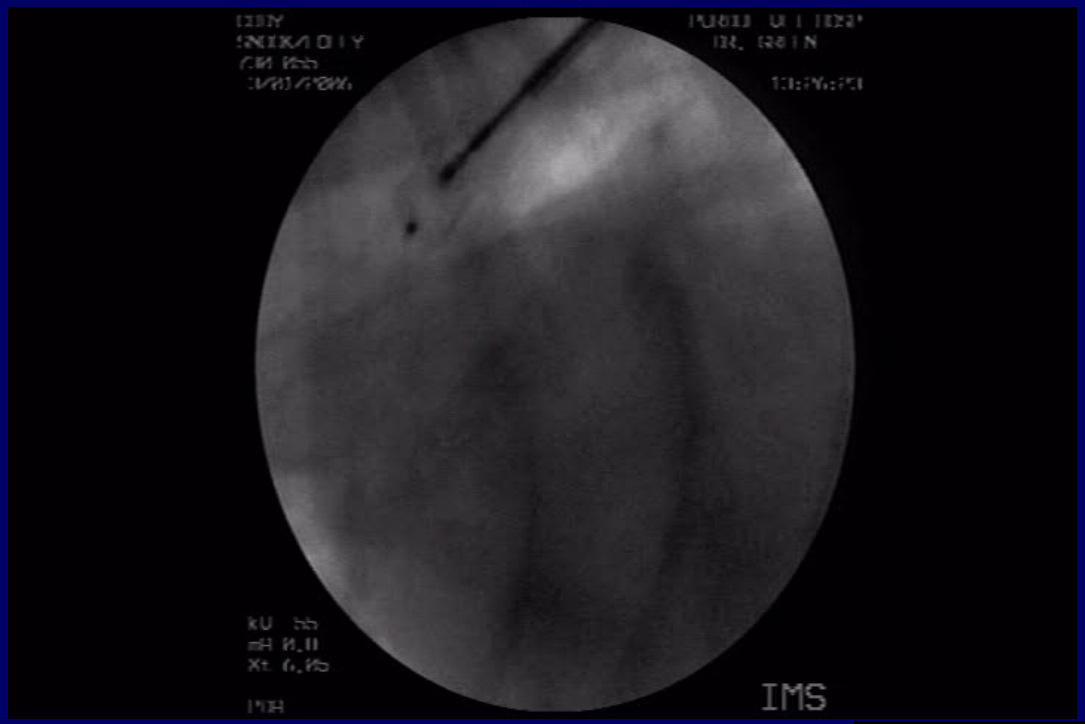
Conclusion

- Cardiovascular catheterization remains an integral part of cardiology despite its decline as a diagnostic tool
- It is important for you to know what new techniques are being used to treat advanced diseases

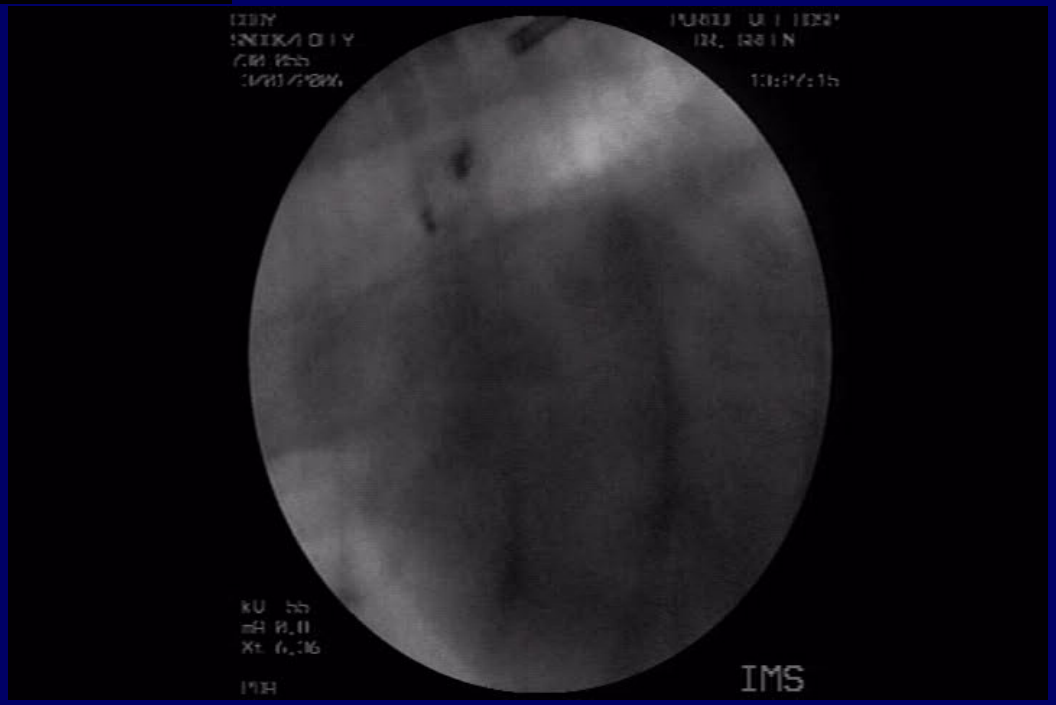

QUESTIONS

On the Horizon

- **Amplatzer Duct Occluder**
  - **Self-expandable mushroom shaped occluding device**
  - **Successful use in moderate to large PDA's**
  - **Modified for veterinary use**

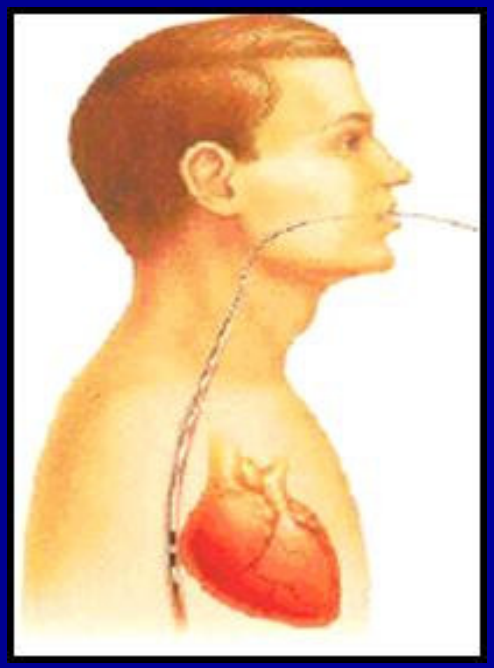


PLUG
Device

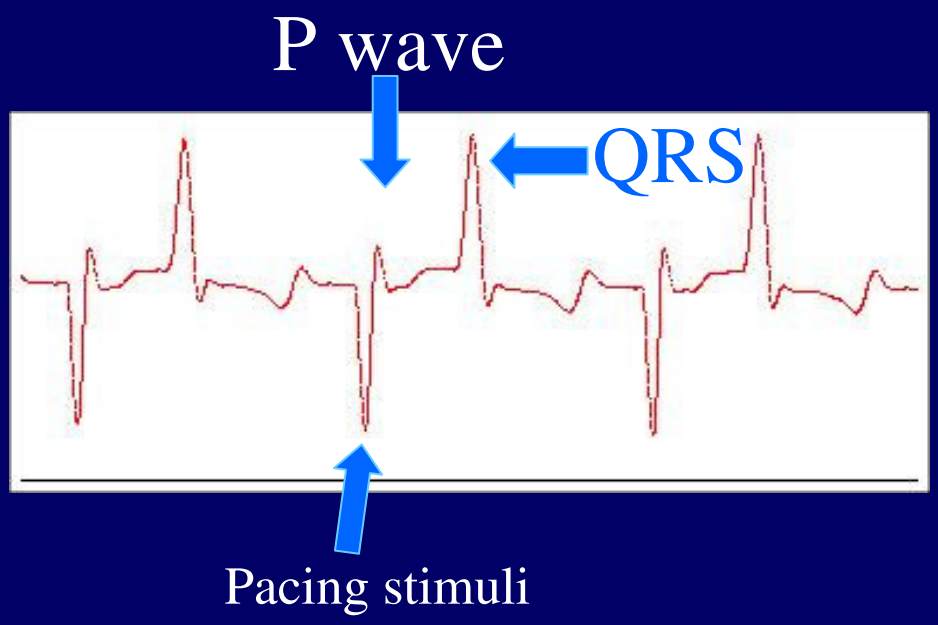


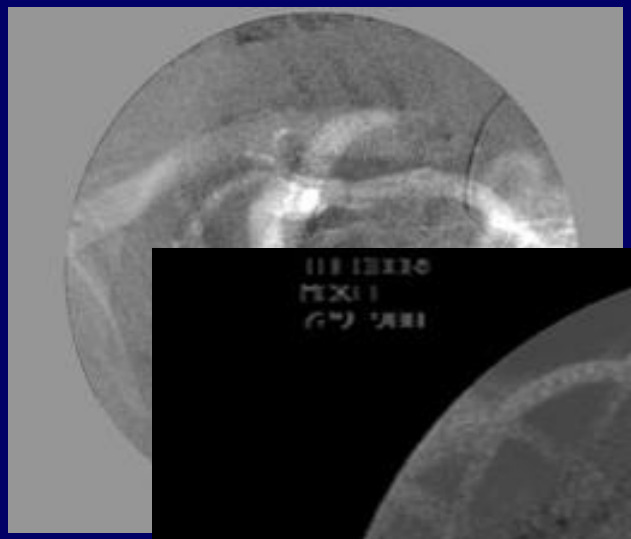
Trans-esophageal Pacing

- Gastro-esophageal Temporary Cardiac Pacing
- Electrophysiologic catheter inserted via nasoesophageal route
- Good preliminary effort
  - Captured atria
- Study to assess safety and efficacy



Trans-esophageal Pacing





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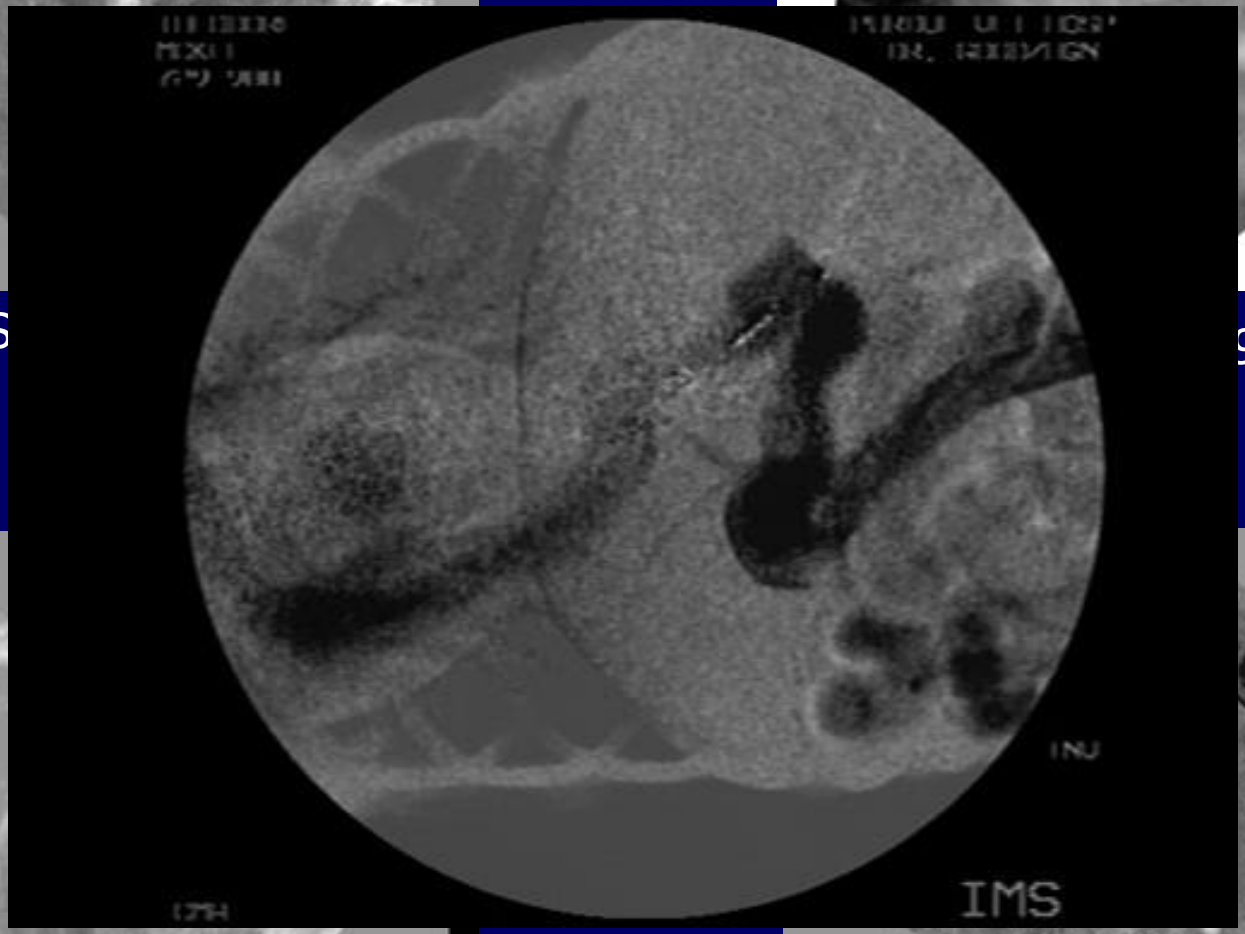
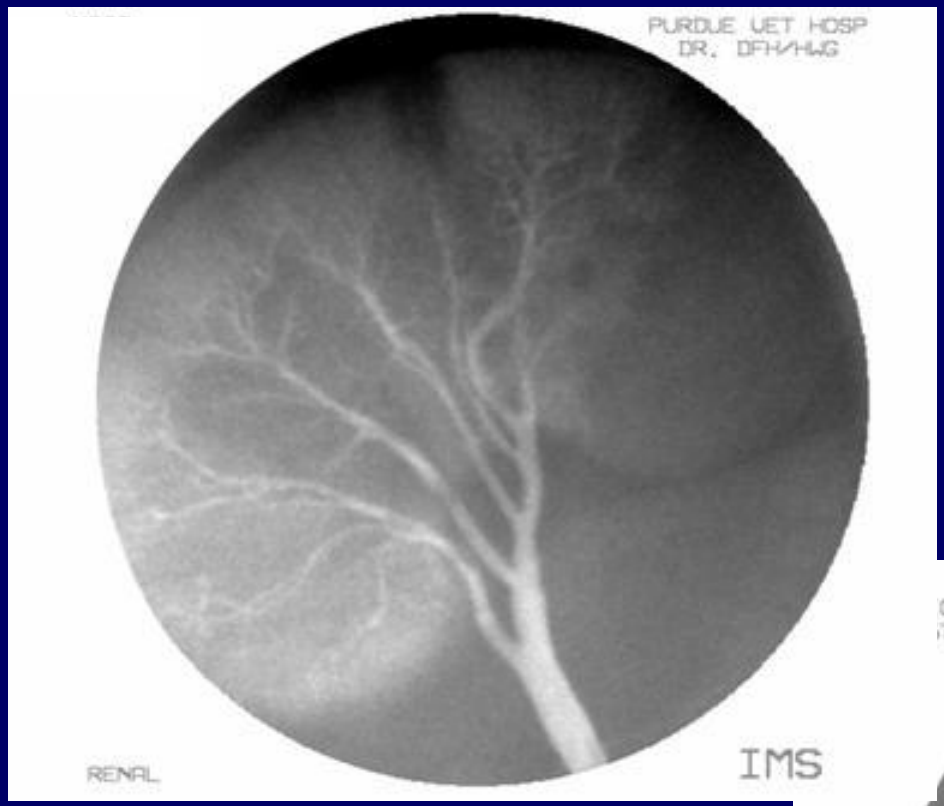


Porto-Azygous 10/91

Multiple Acquired 7/91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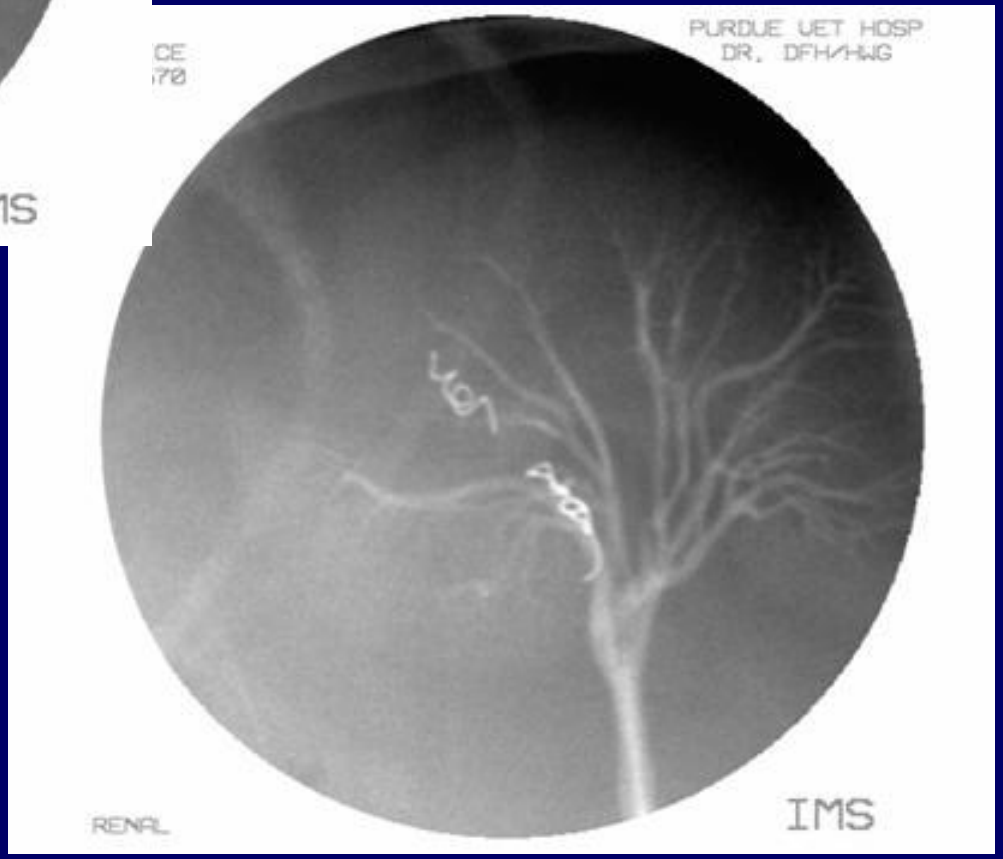
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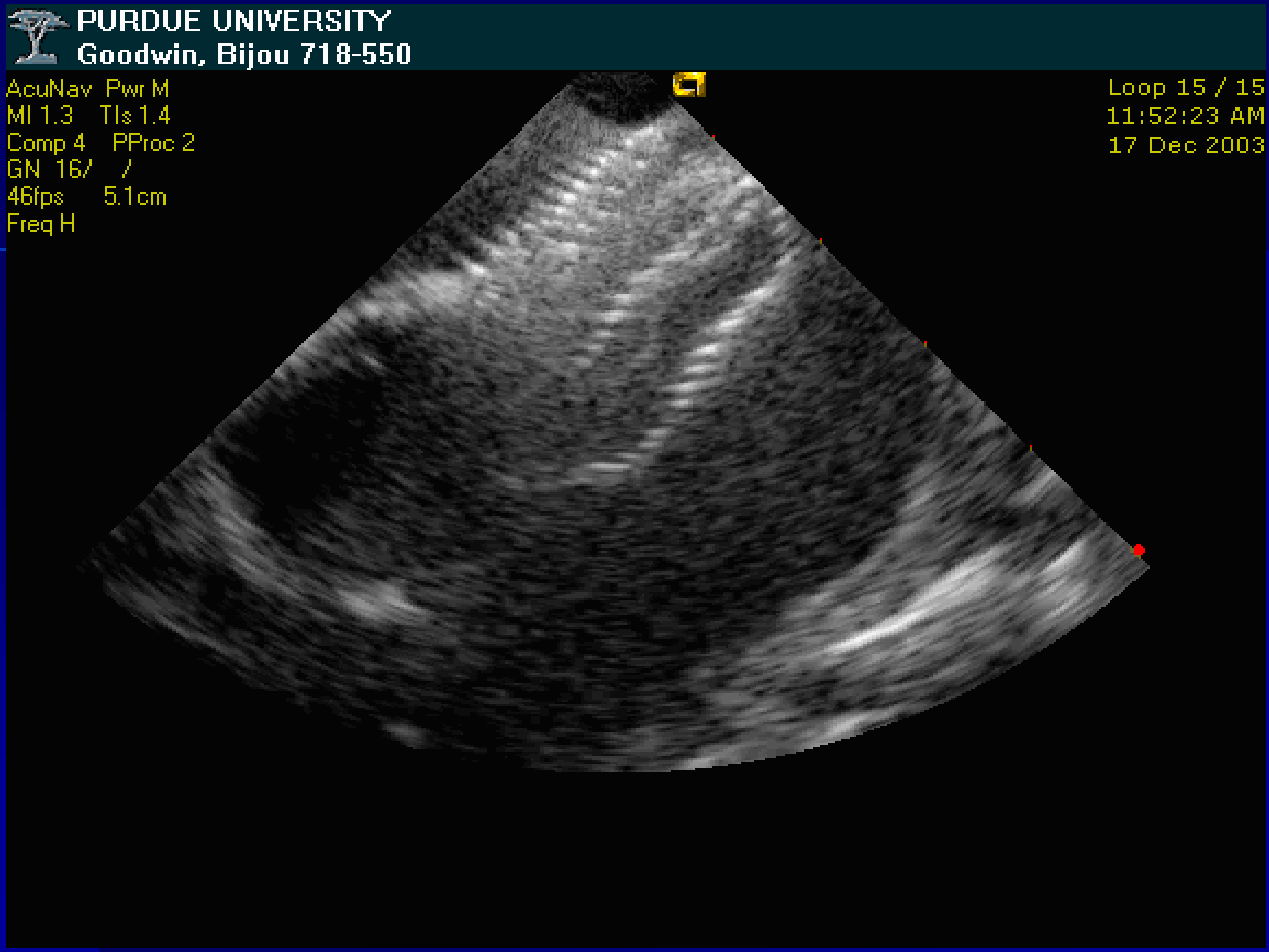
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