



Catheterization Laboratory Complications

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- Death
- Arrhythmia/ heart block
 - Surgical, poor hemodynamics, congenital, catheter induced
- Thromboembolic events/stroke
- Bleeding-hematoma, internal
- Infection
- Cardiovascular perforations, dissections, tears-
(vascular, cardiac, valves)

Overall, risks are very low

Complications related to specific interventions

- Complications related to the specific intervention planned
 - Valvuloplasty, angioplasty, devices
- Complications related to the known anatomy and physiology
 - Tet spell, ductal dependent lesions (pulmonary and systemic), PPH
- Complications related to age & size of patient
 - Premature and small infants-blood loss, hypoglycemia
 - Elderly-stroke, MI
 - Co-morbidities-diabetes, thrombophilic diseases, sickle cell disease, etc
- Technical/procedural/judgement errors

Complications we often overlook

- Allergic reactions
- Brachial plexus injury
 - muscular adolescents, adults
- Radiation injury
- Vascular injury-post cath
 - Smaller patients, larger sheaths
 - Most common complication related to cath
 - Most often catheter/sheath related-(10-15%)
 - Vascular obstructions did not necessarily result in clinical signs of symptoms

- Unpredictable cardiopulmonary lesions
 - HLHS
 - Coronary abnormalities
 - PA/IVS with RV dependent coronary flow

Treat each patient according to his/her unique cardiac anatomy and physiology...and ANTICIPATE!

- Dilated
- Critical AS/PS/COA
- “Sick” Fontane

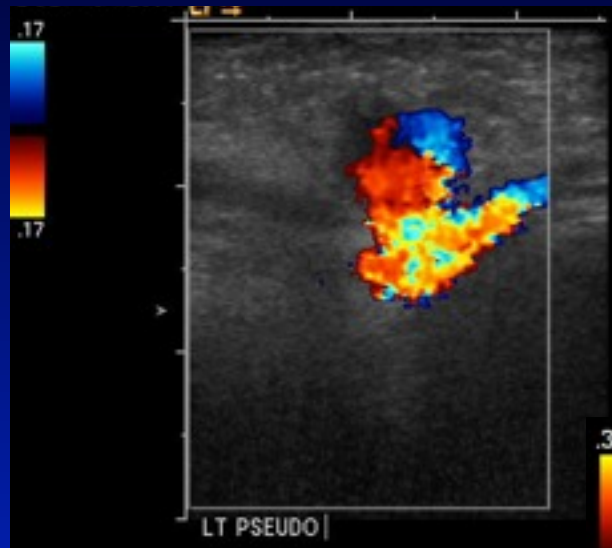
It's not over until it's over!!!

- Reactive pulmonary vascular bed
 - The premature infant or very sick patient
 - Valve dysfunction, small margin of error
- “Bad anatomy or physiology” (dysplastic valve, obstructed coronary artery, vascular spasms, PPH)

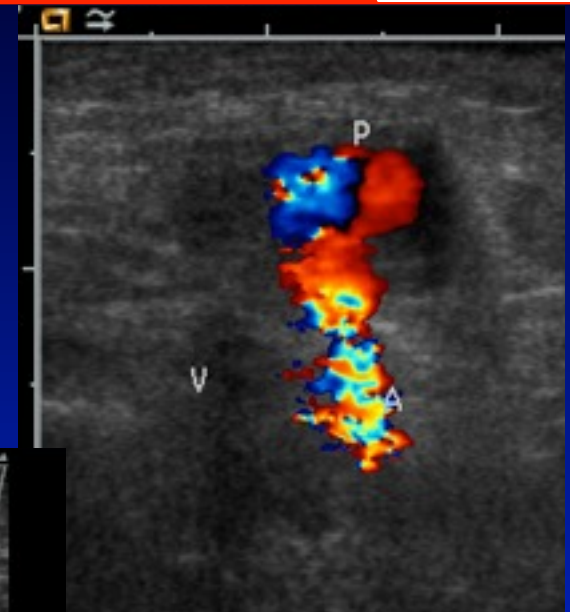
Post cath complications

- Extubation (airway, pulmonary hypertension)
- Oral intake (nausea, vomiting)
- Sheath insertion site (hematoma, bleeding, aneurysm, fistula)
- Extremity perfusion (pulses)
- Infection potential
- F/U for intervention (device position, residual lesions, thrombus, valve function)

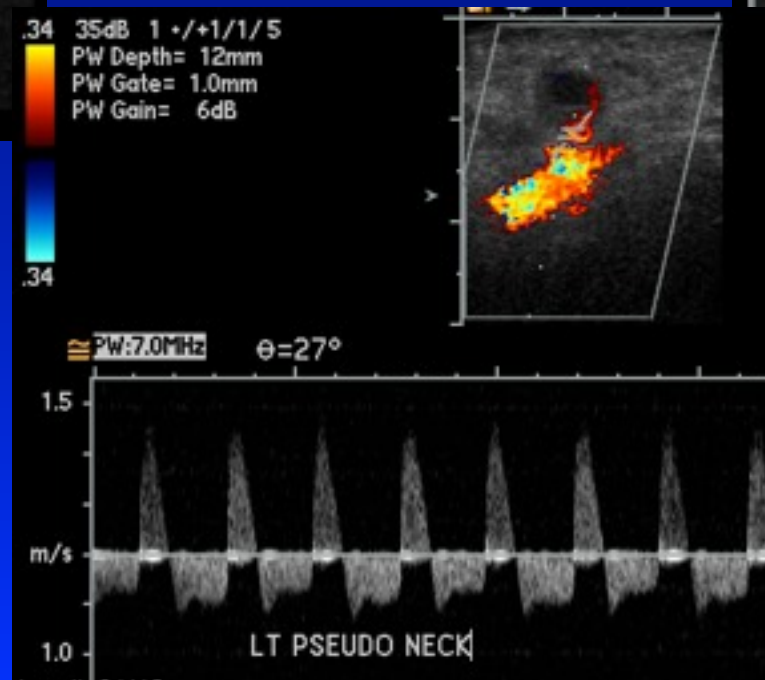
Left femoral artery pseudoaneurysm s/p cath



Long axis view

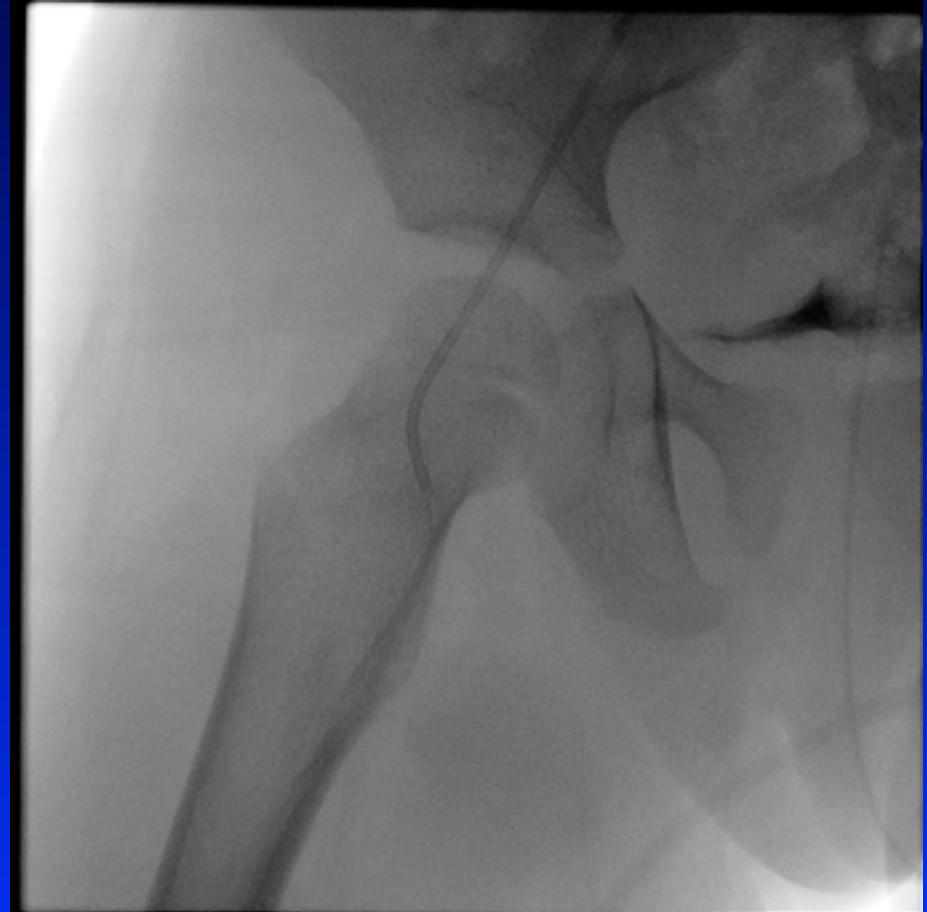
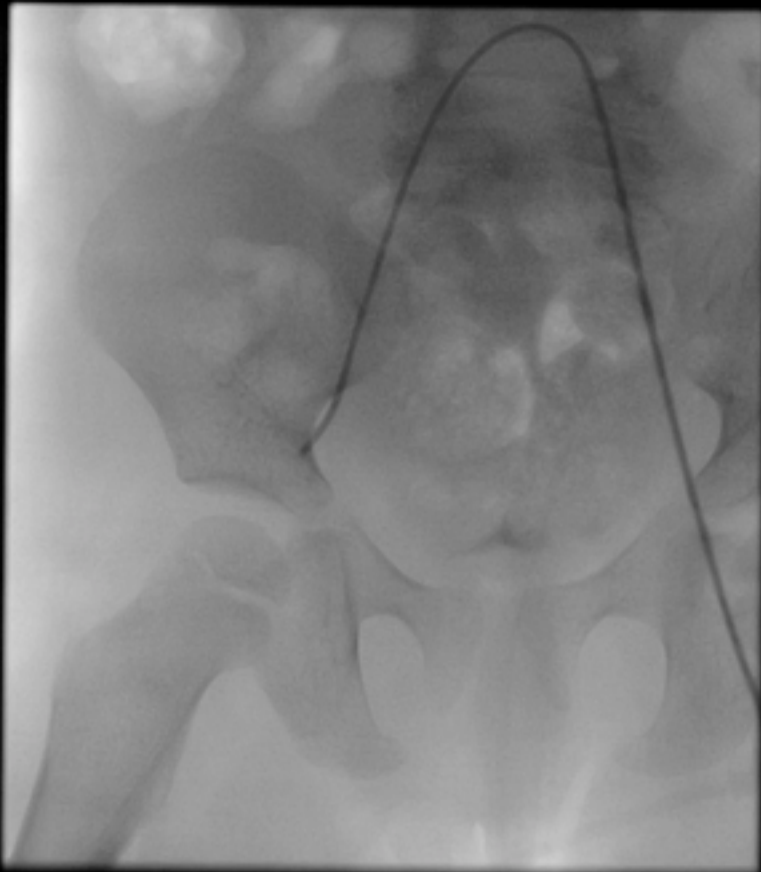


Transverse view

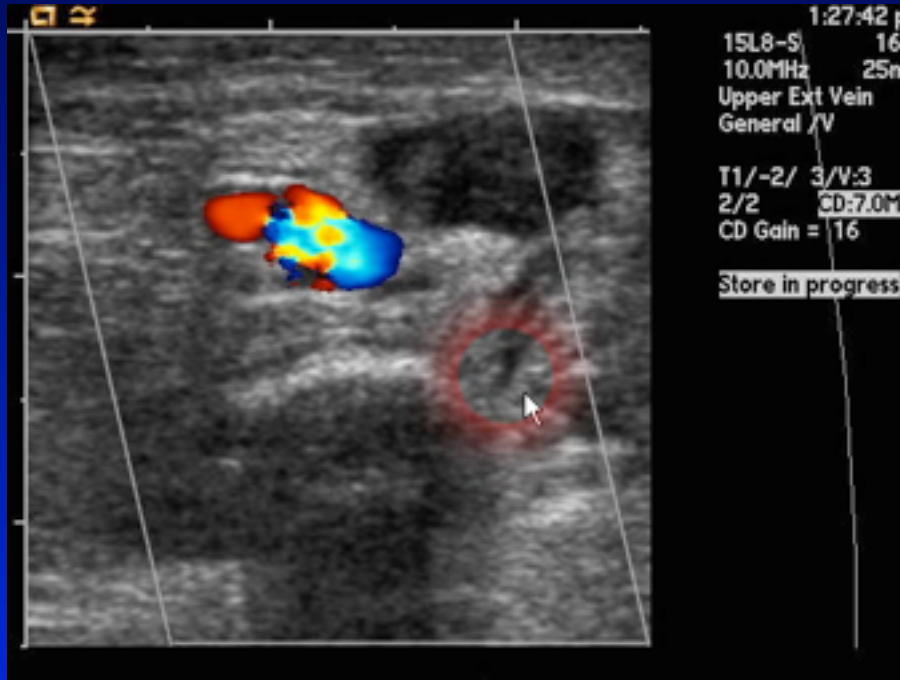


Diagnosis?

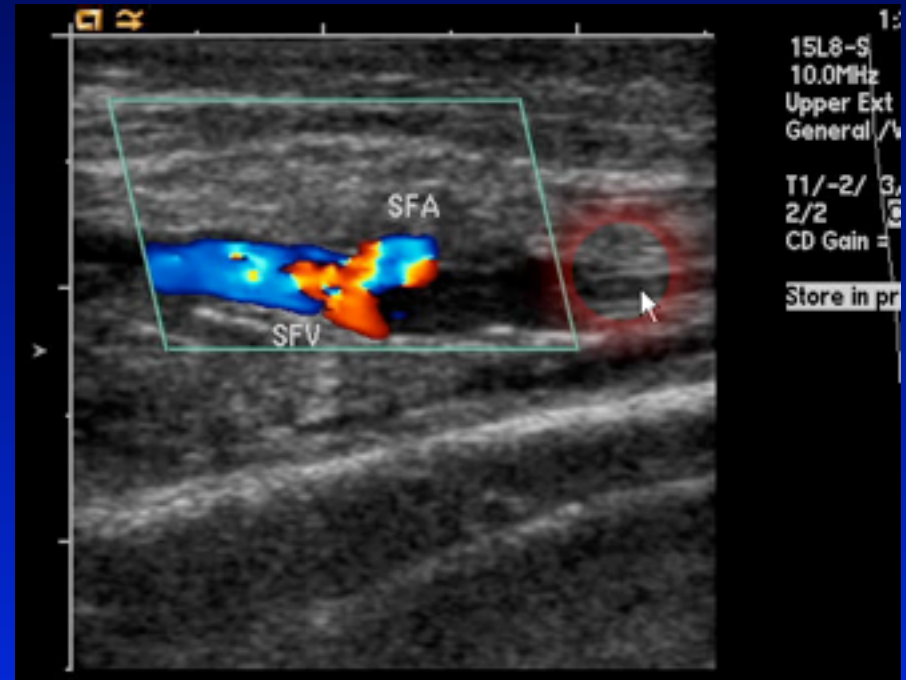
femoral arteriovenous fistula



Femoral AV fistula following femoral access

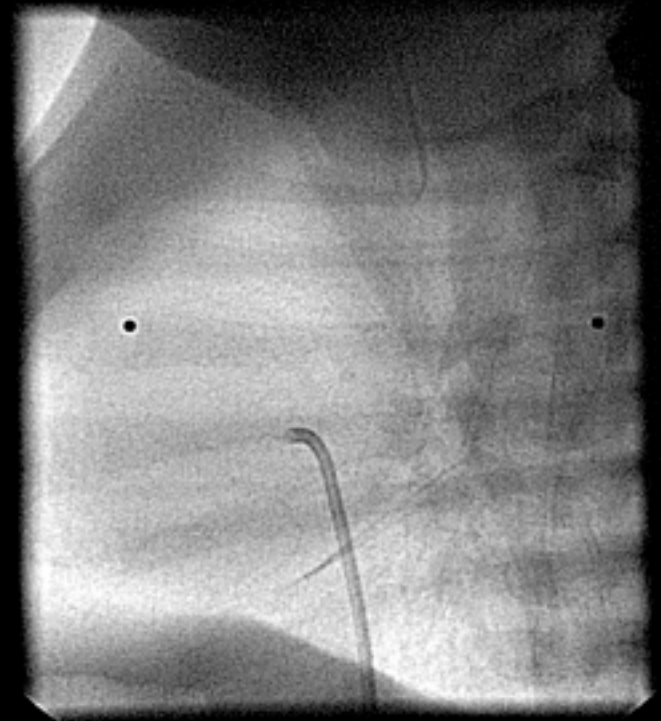
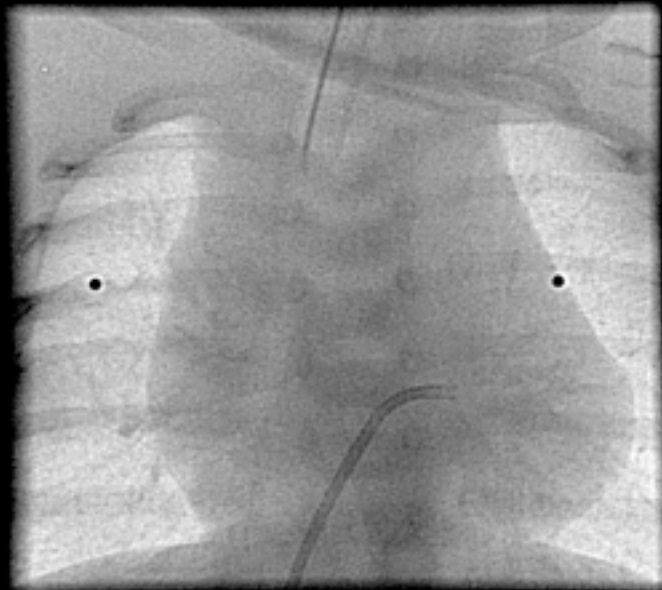


Transverse view



Long axis view

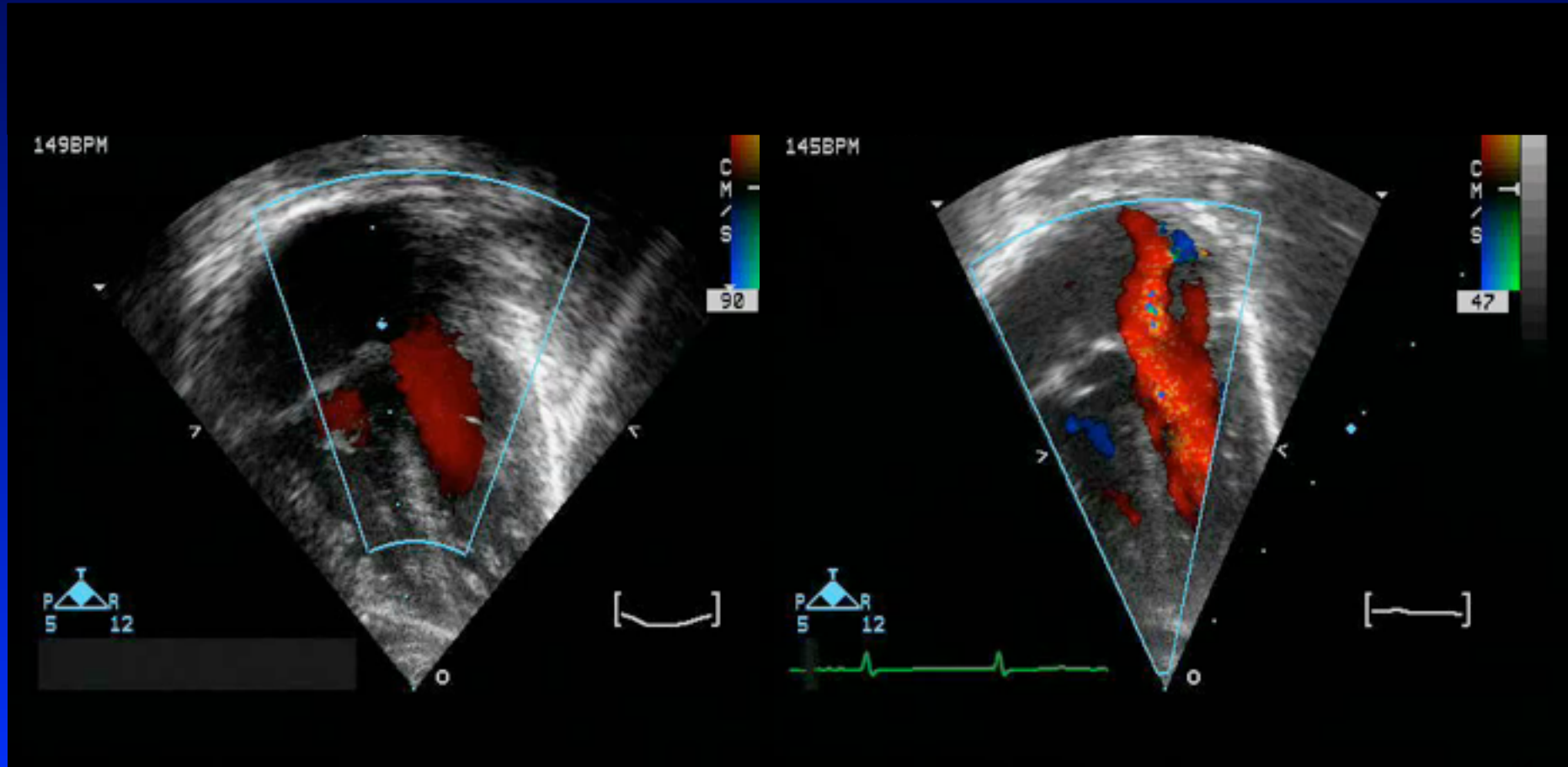
Neonate TOF: prograde left heart cath-aortogram for ductal stenting



Neonate TOF: prograde left heart cath-aortogram for ductal stenting

Pre

Post

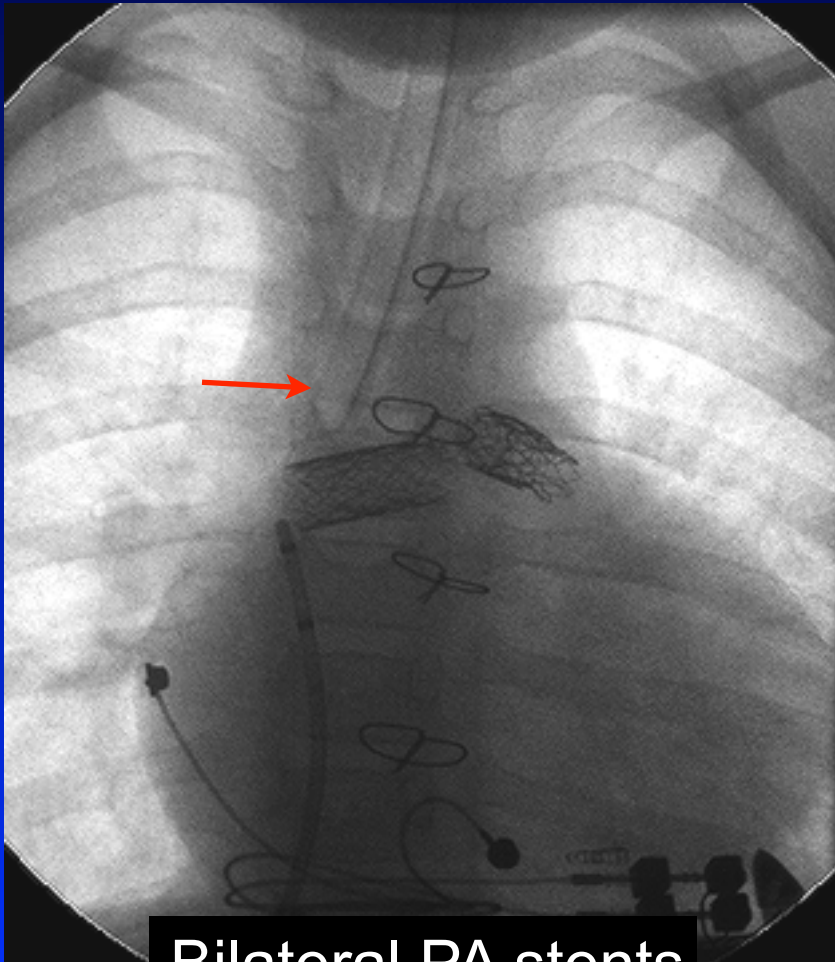


Some basic principles...

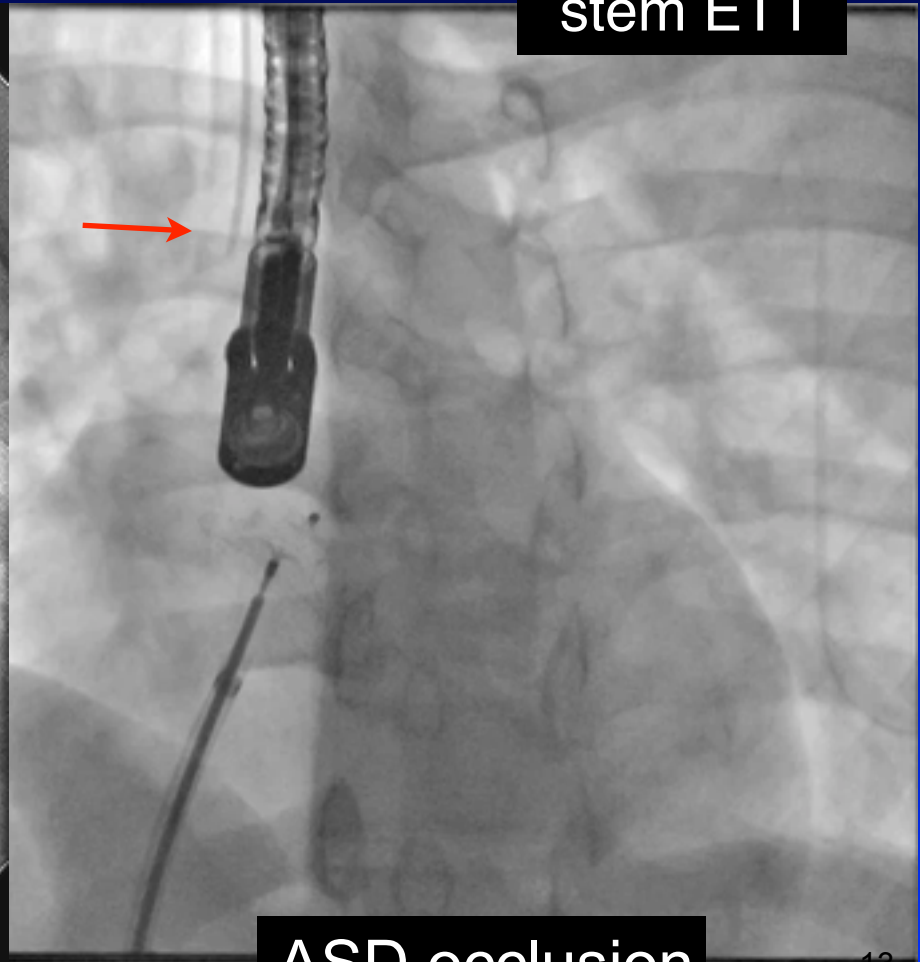
Most complications start w/ overlooking minor errors:

What's wrong with these pictures?

Right main
stem ETT



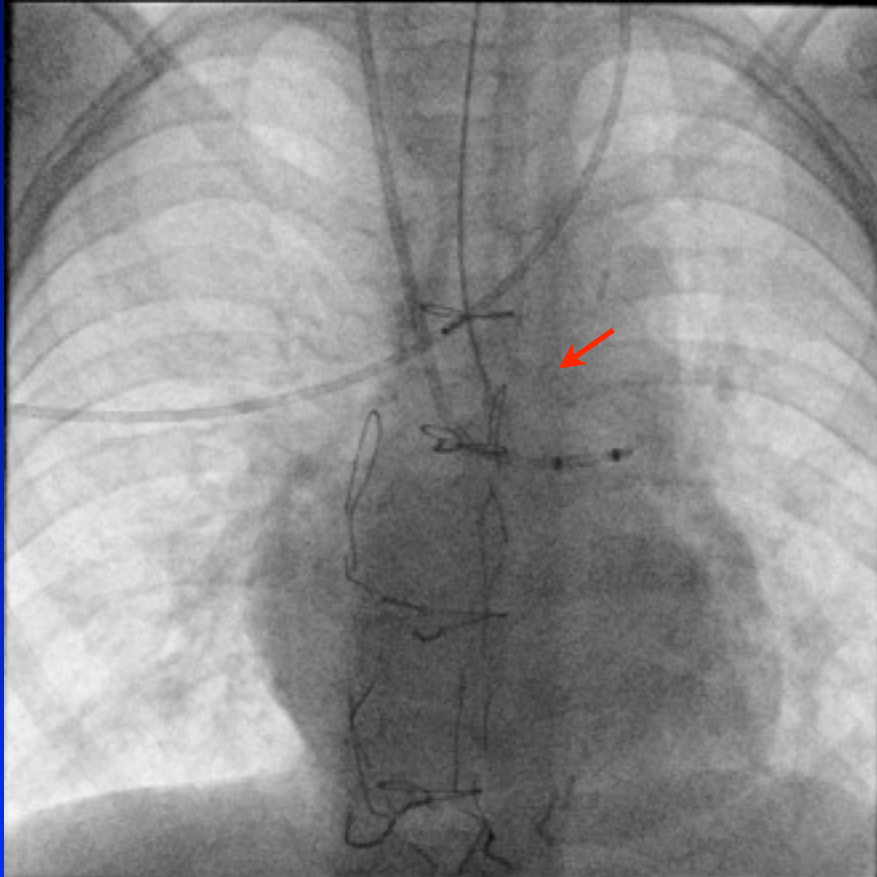
Bilateral PA stents



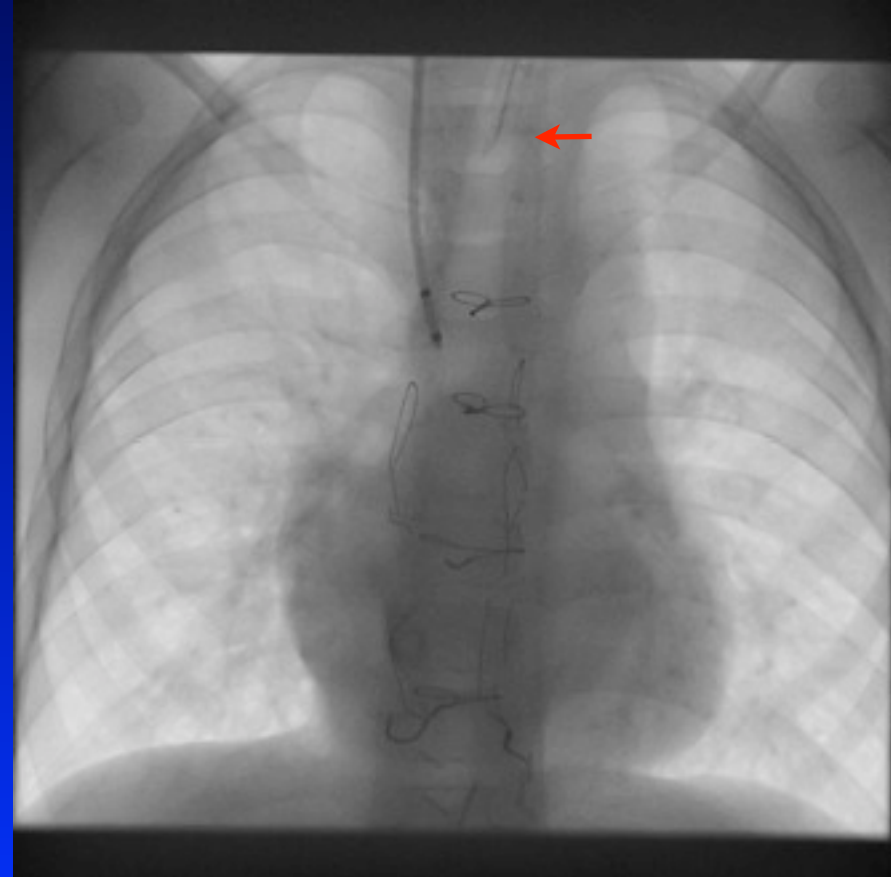
ASD occlusion

What's wrong with this picture?

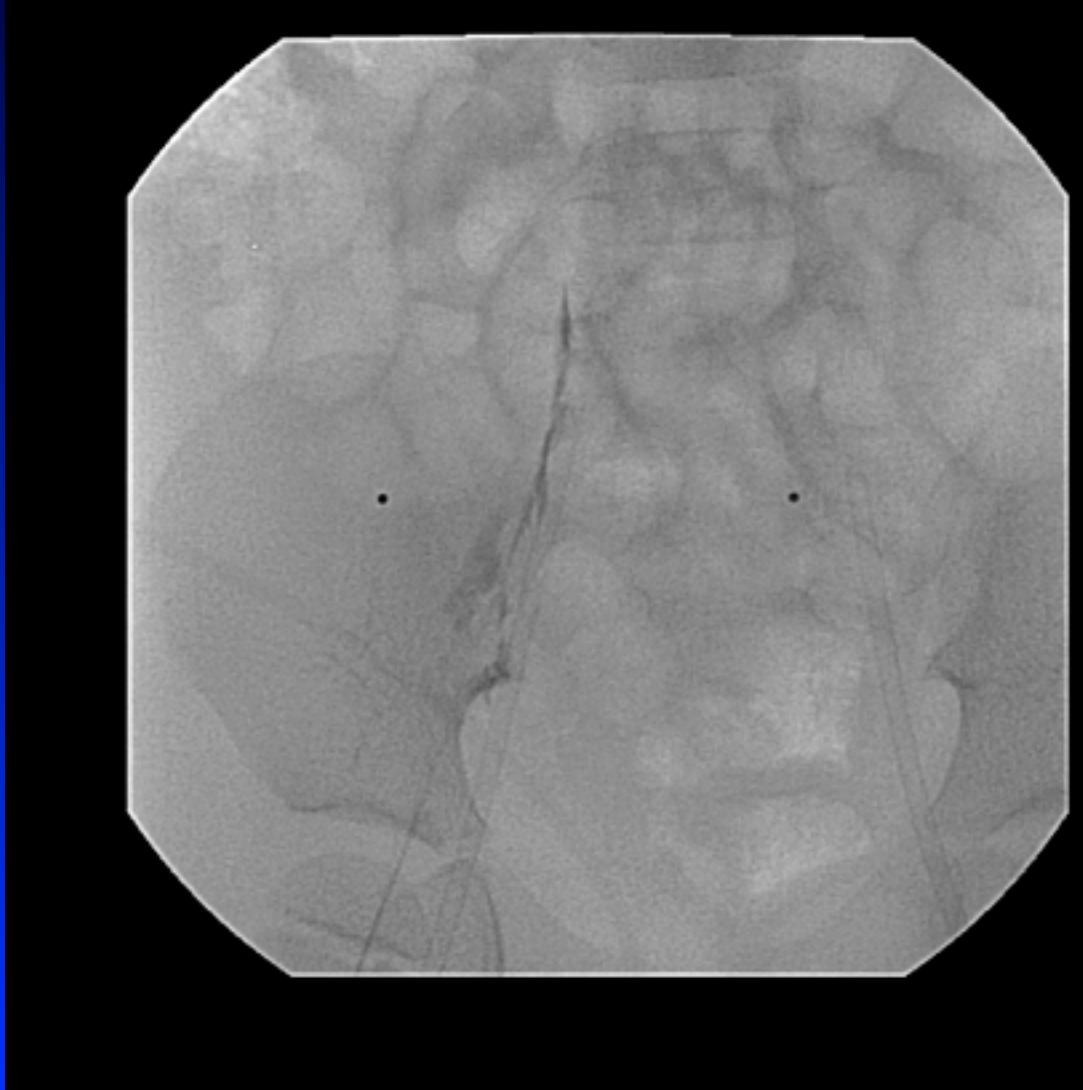
Left main
stem ETT



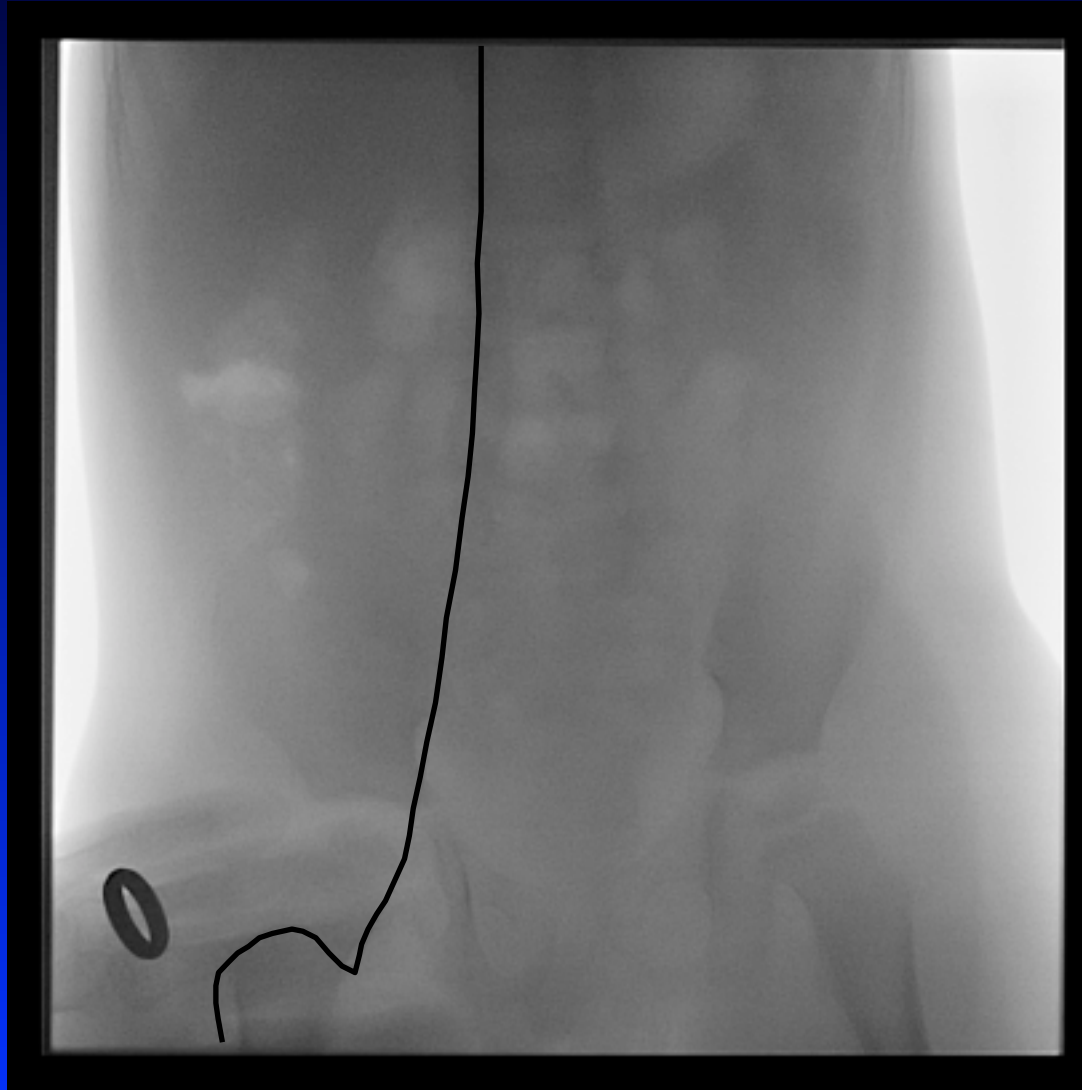
High ETT



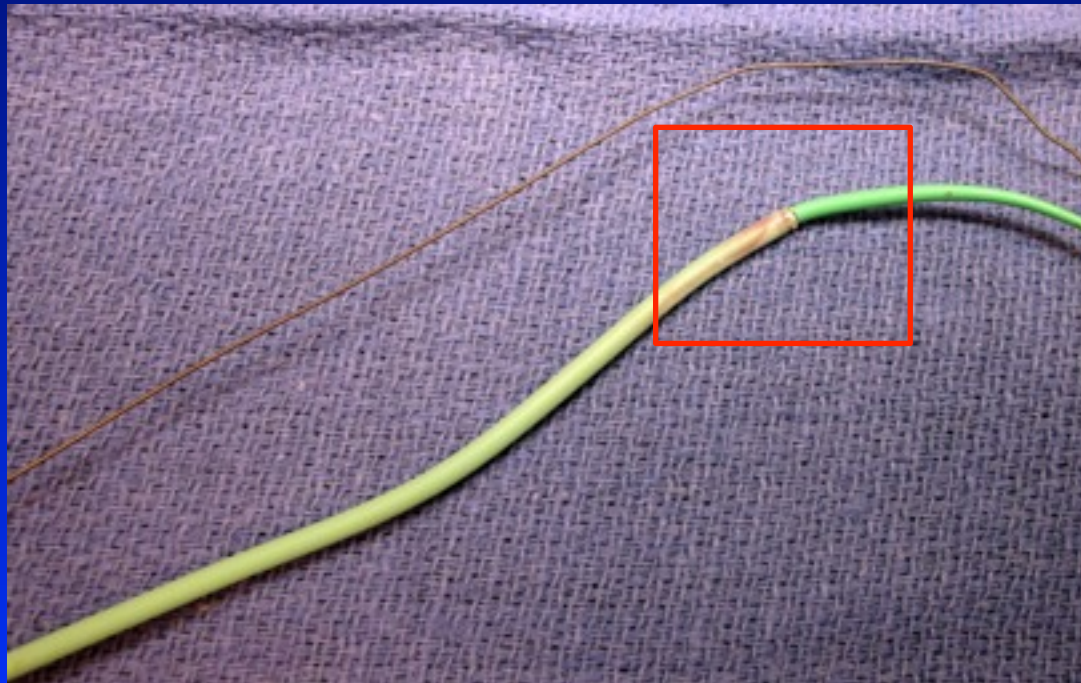
If wires don't go easily into the vessel, don't force it in!



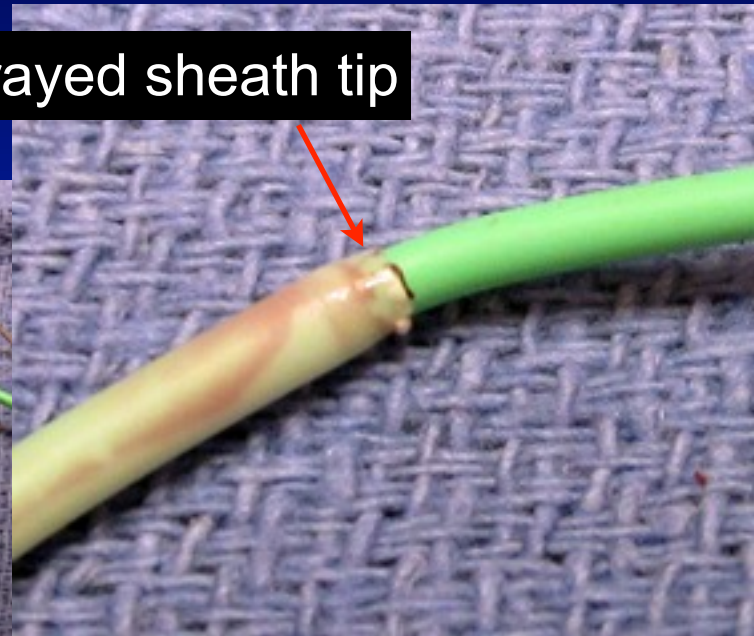
Wire in IVC...but unable to insert sheath into RFV



Wire and sheath bent out of shape during femoral access

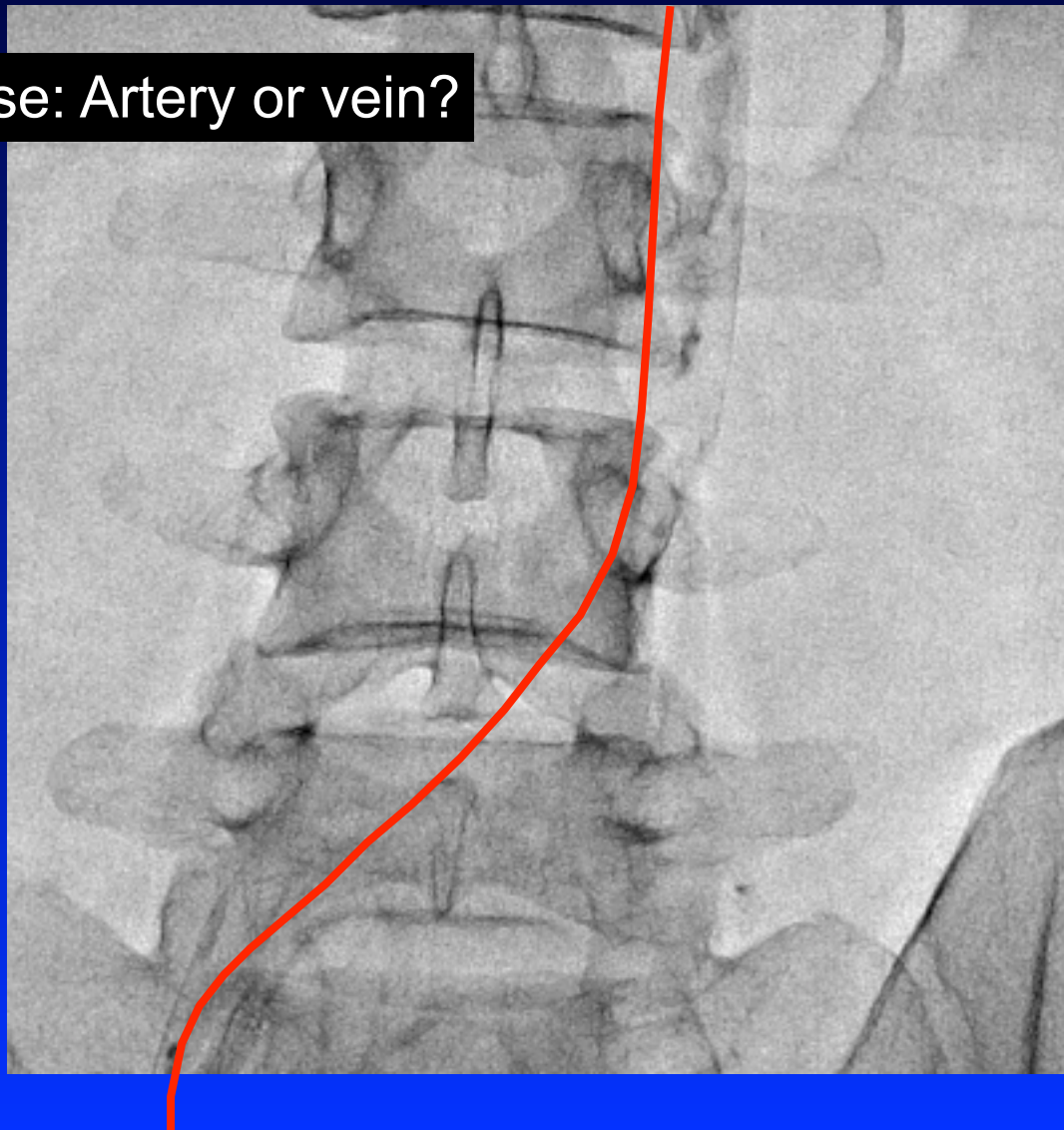


Frayed sheath tip

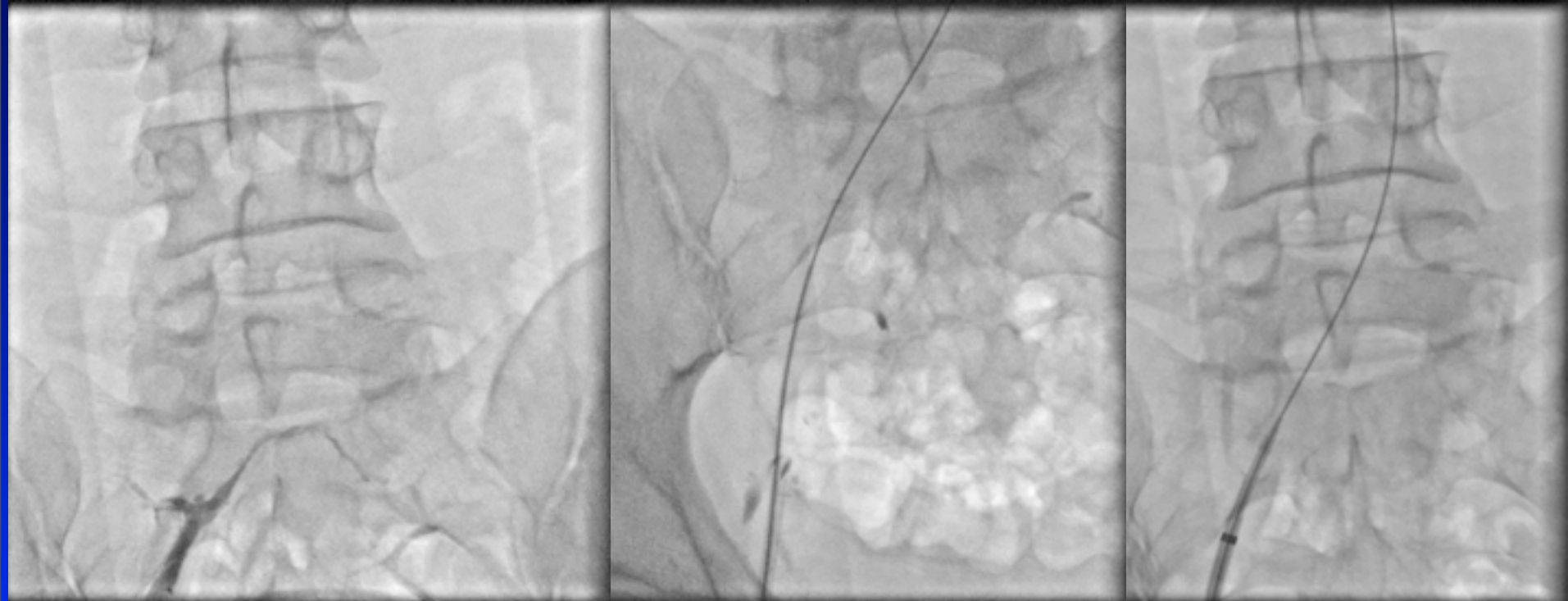


If wire/catheter course unusual: take a picture

Vascular course: Artery or vein?

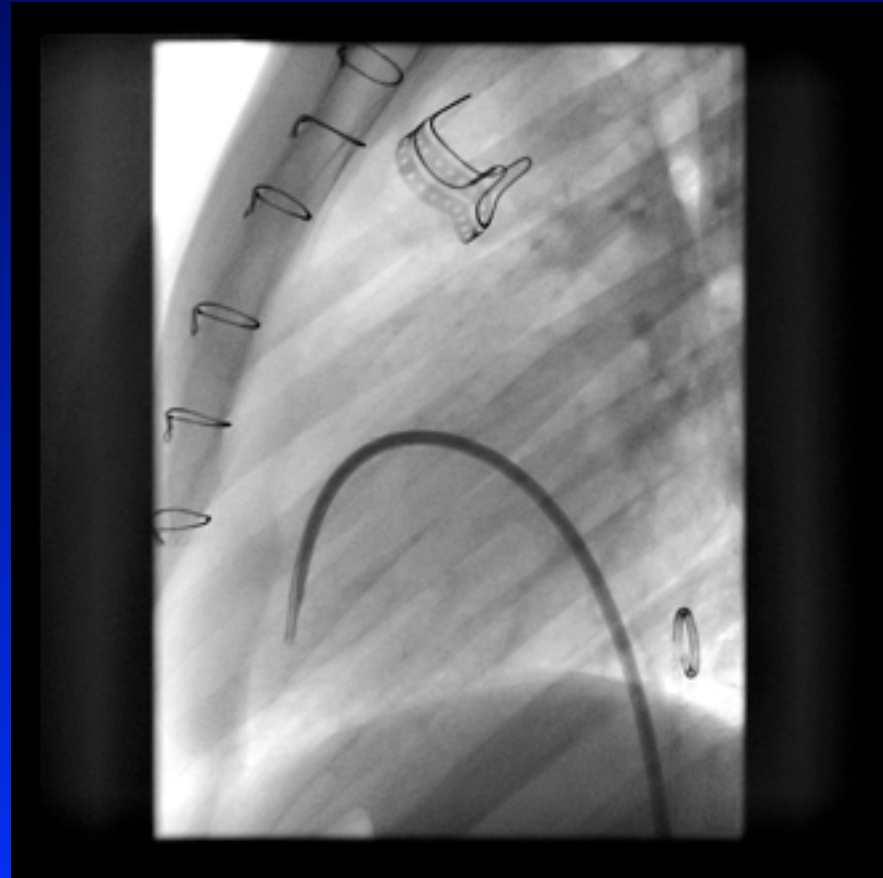
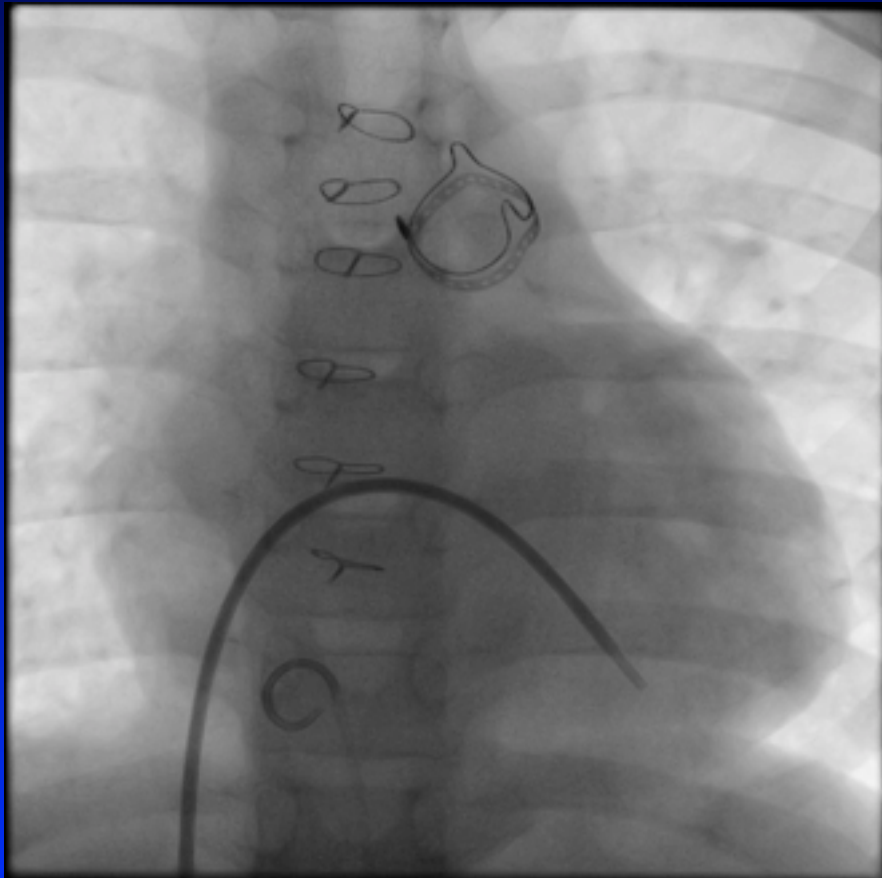


If difficulty advancing catheter/ wire, take a picture



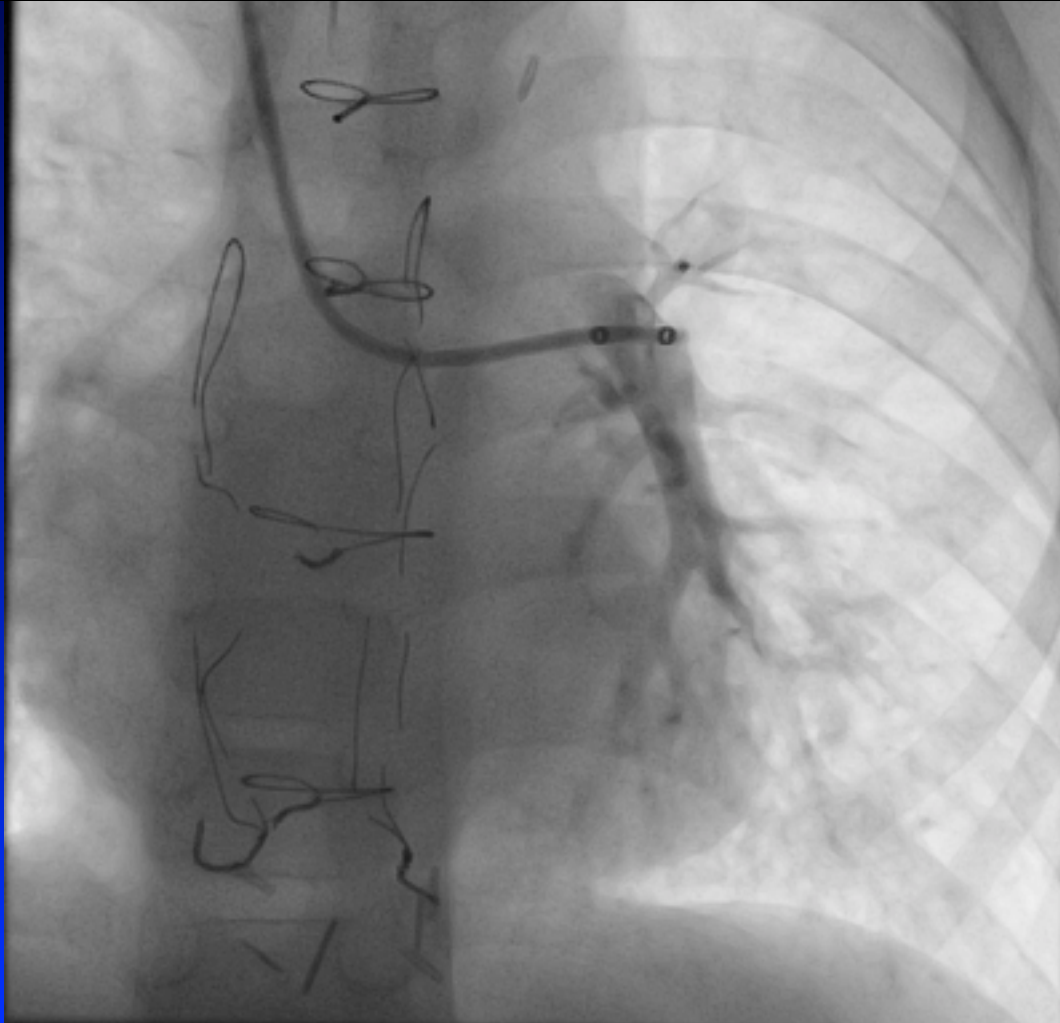
Avoid careless errors...

Connecting power injector to endhole catheter....

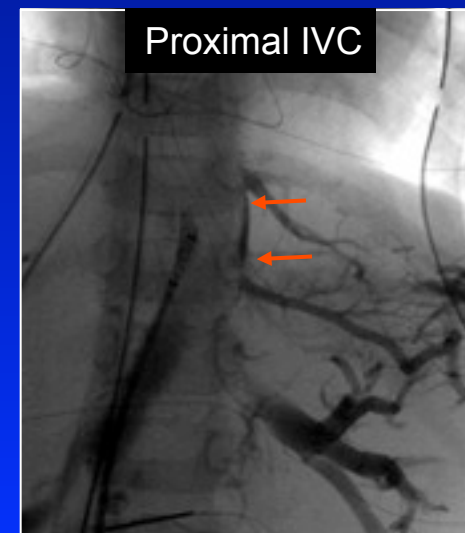
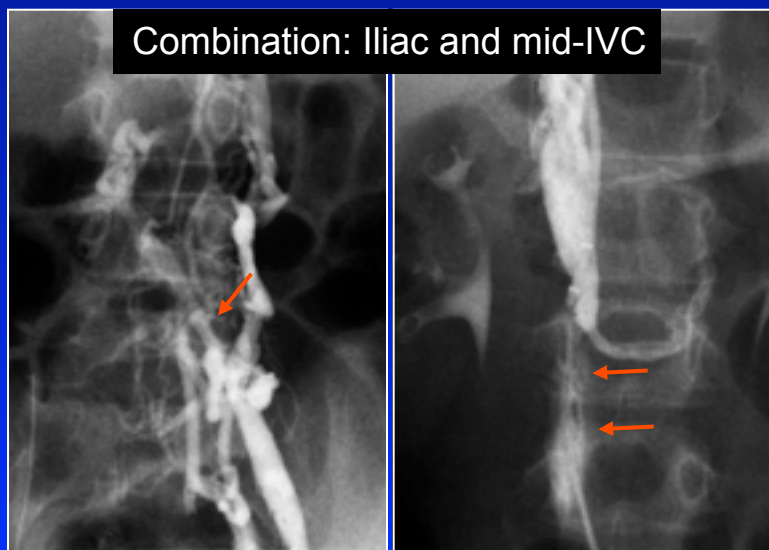
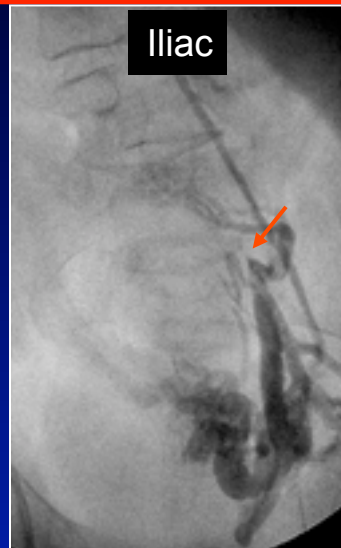
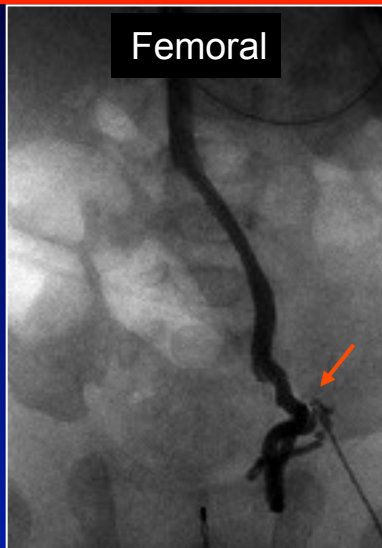


Avoid careless errors...

Leaving air in syringe for hand injection

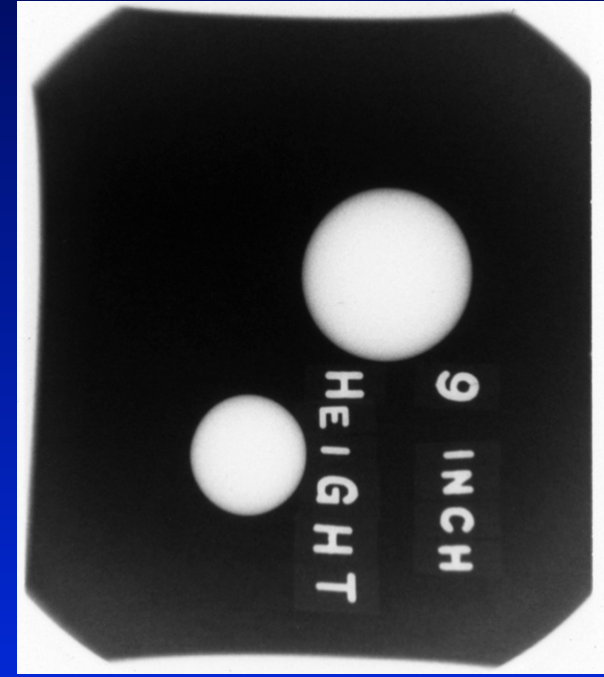
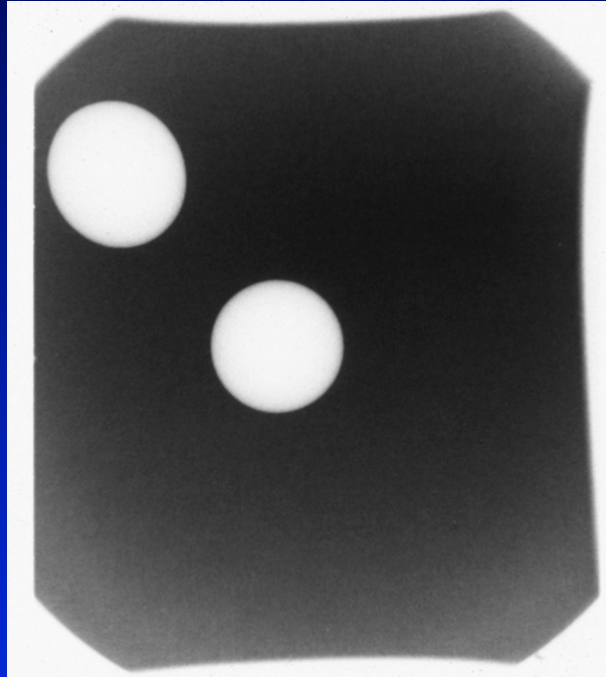
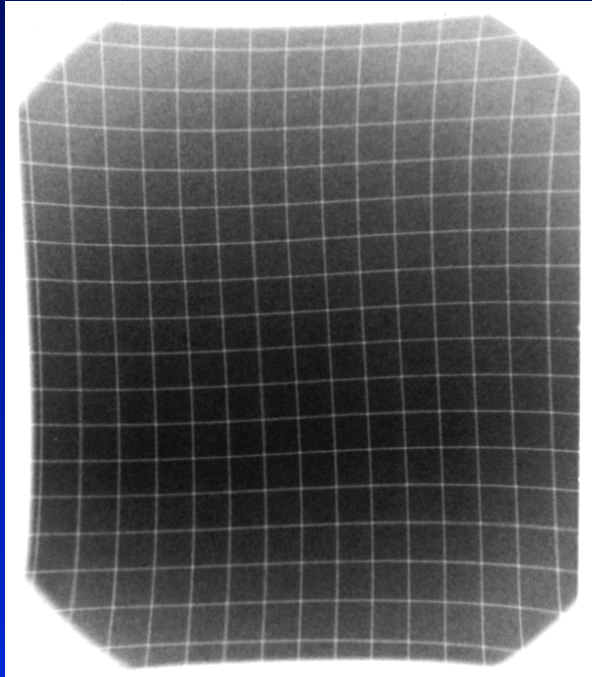


Post cath: Venous obstructions at various levels



Accurate imaging is crucial!

Center anatomy of interest to minimize image distortion

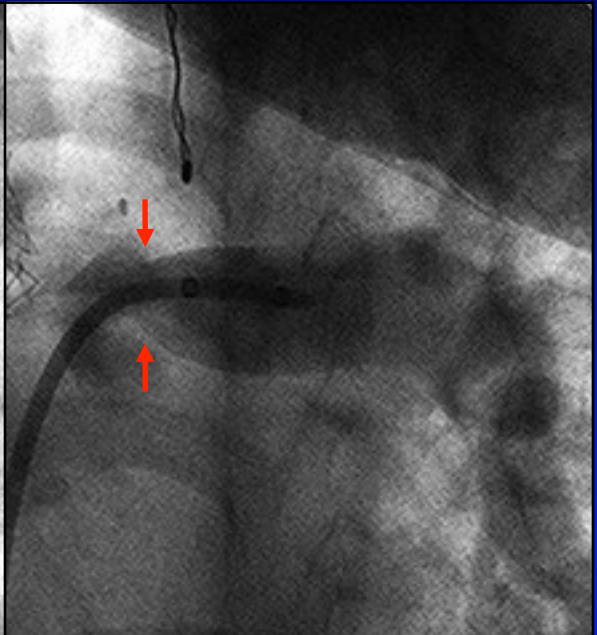
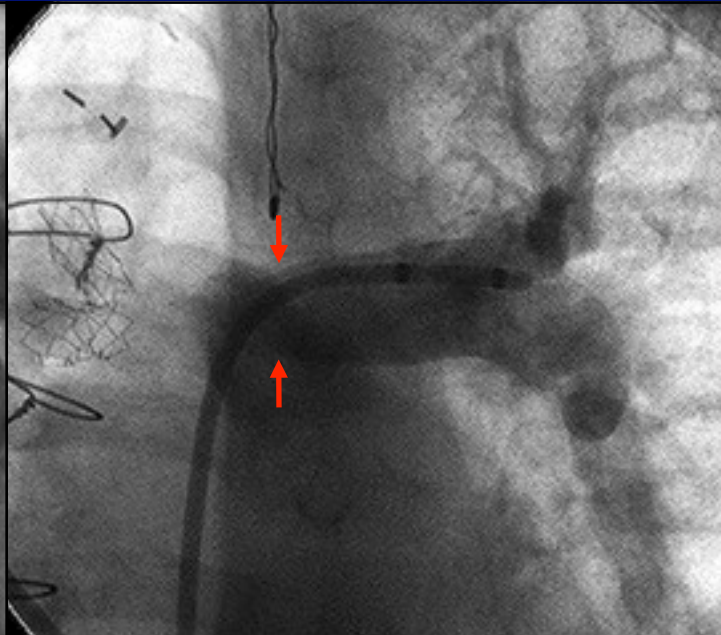
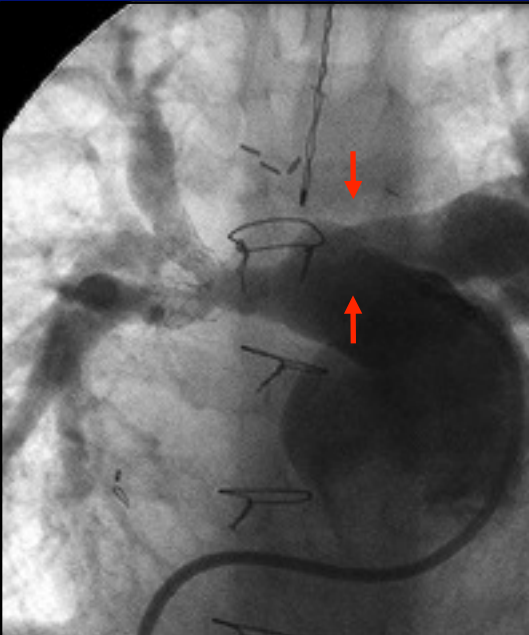


Orifice stenosis difficult to see: need multiple angulation views

AP

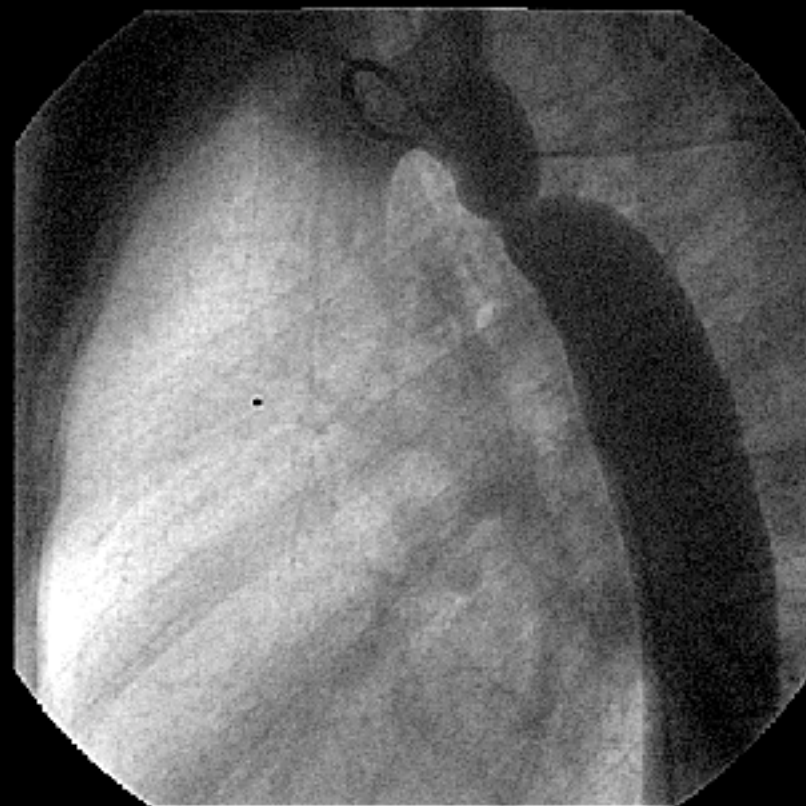
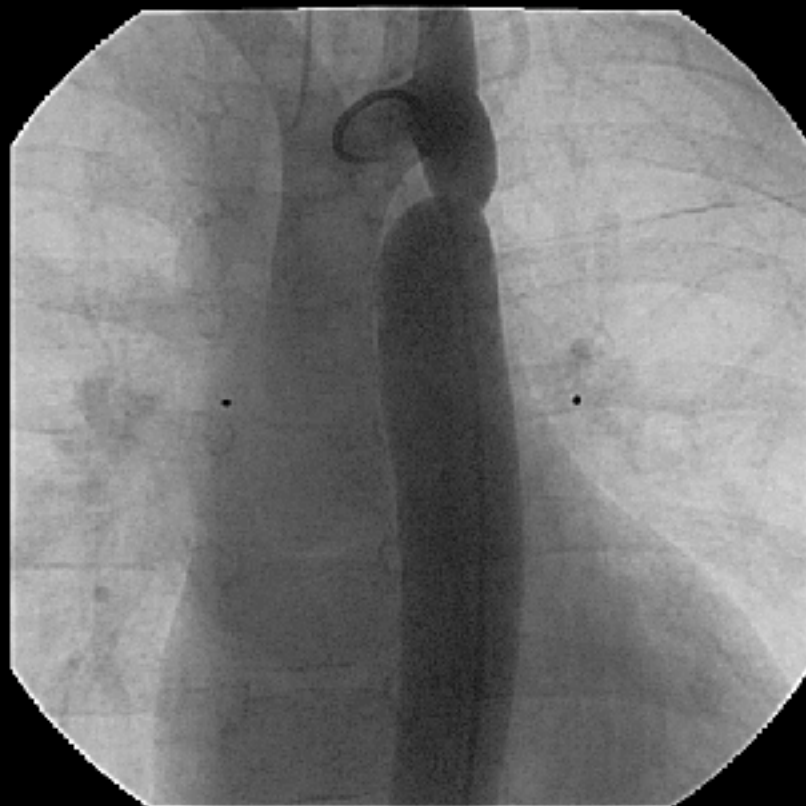
20° RAO/ 20° cranial
angulation

30° RAO/ 30° cranial
angulation

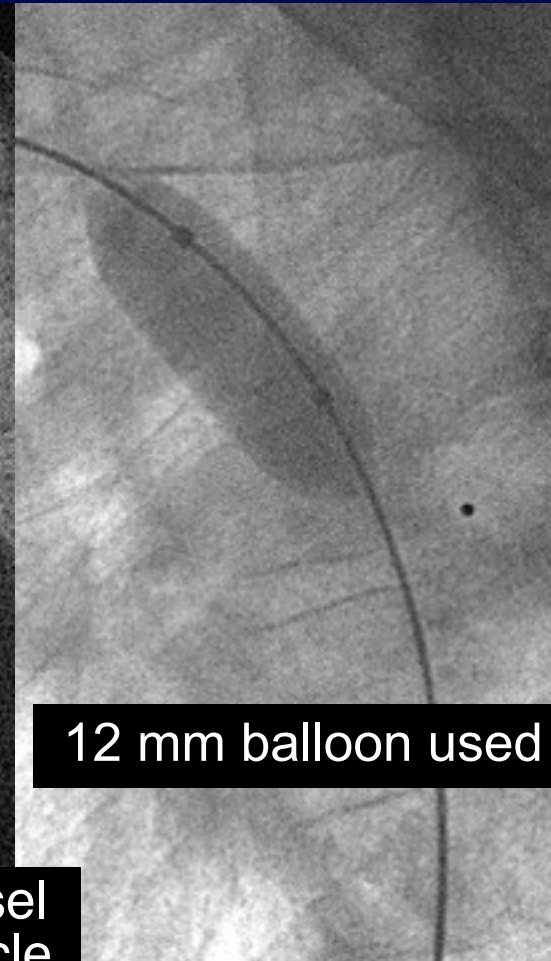
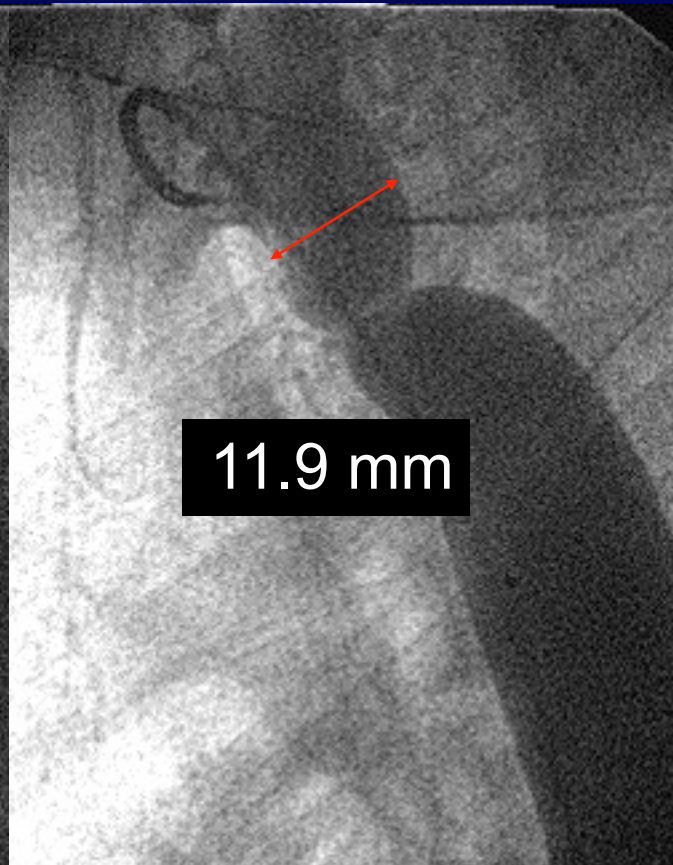
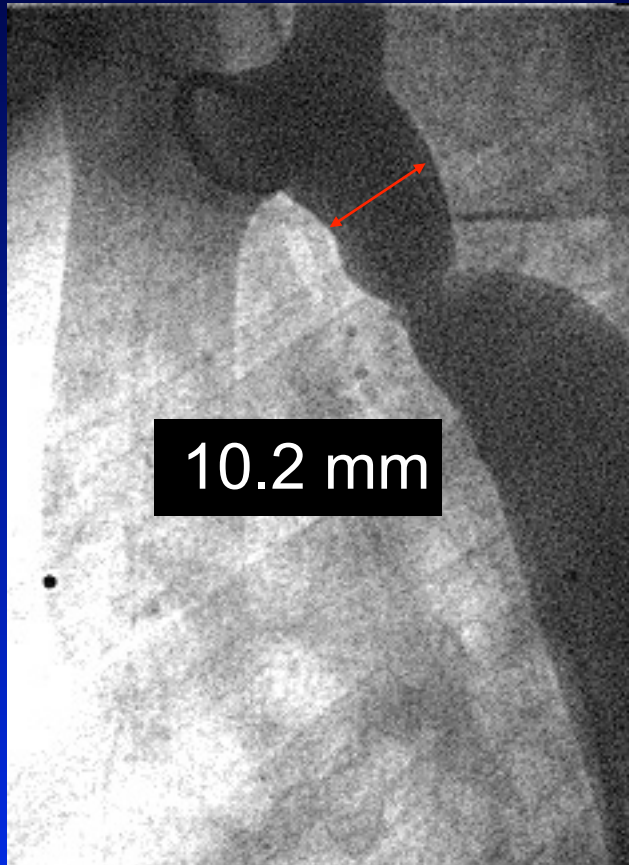


Essential accurate measurements

Discrete COA w/ mild distal arch narrowing



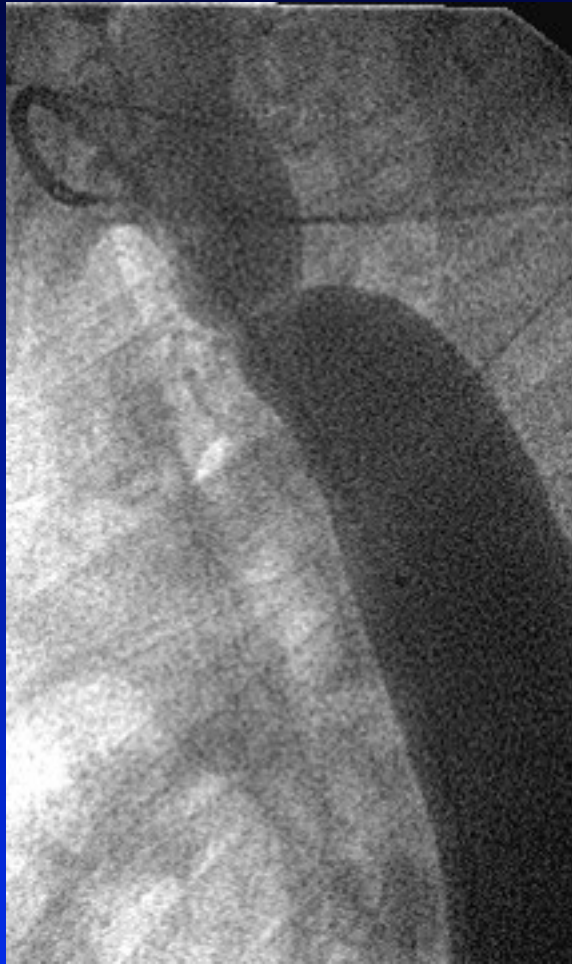
Aortic diameter changes with a pulsatile aorta



- Tempting to select frame with darkest contrast

- Measure the largest vessel diameter of the cardiac cycle

Comparison of aortograms



Pre-dilation



Post-dilation

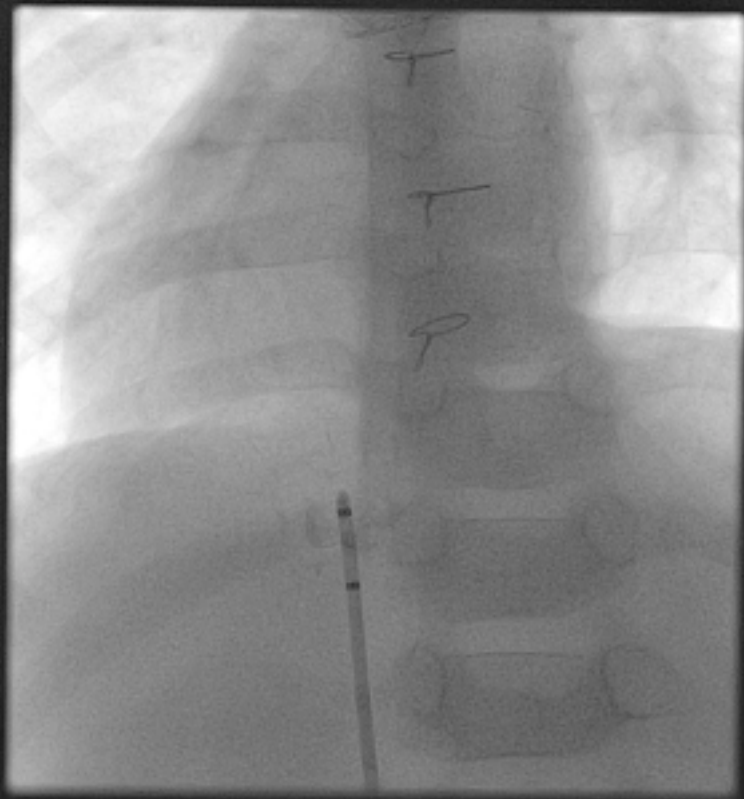


Post-stent
(MaxLD)

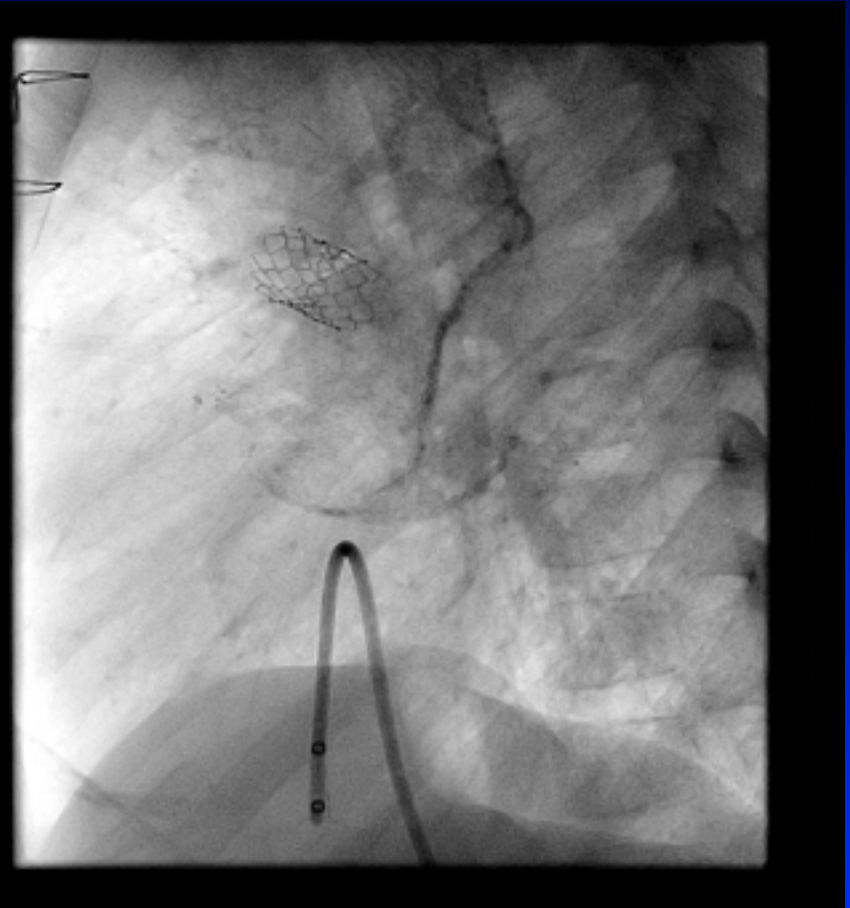
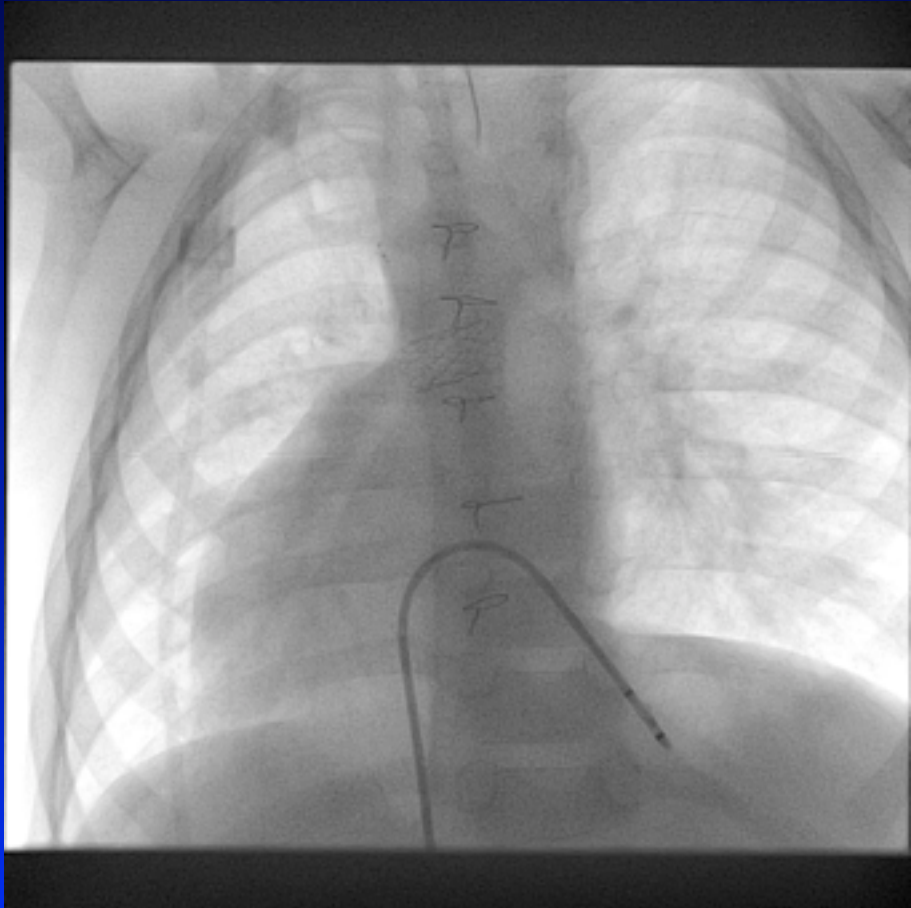
If you don't look for it, you won't find it!

- Have high index of suspicion
- Persistence to look for anomalies
- Selective injections

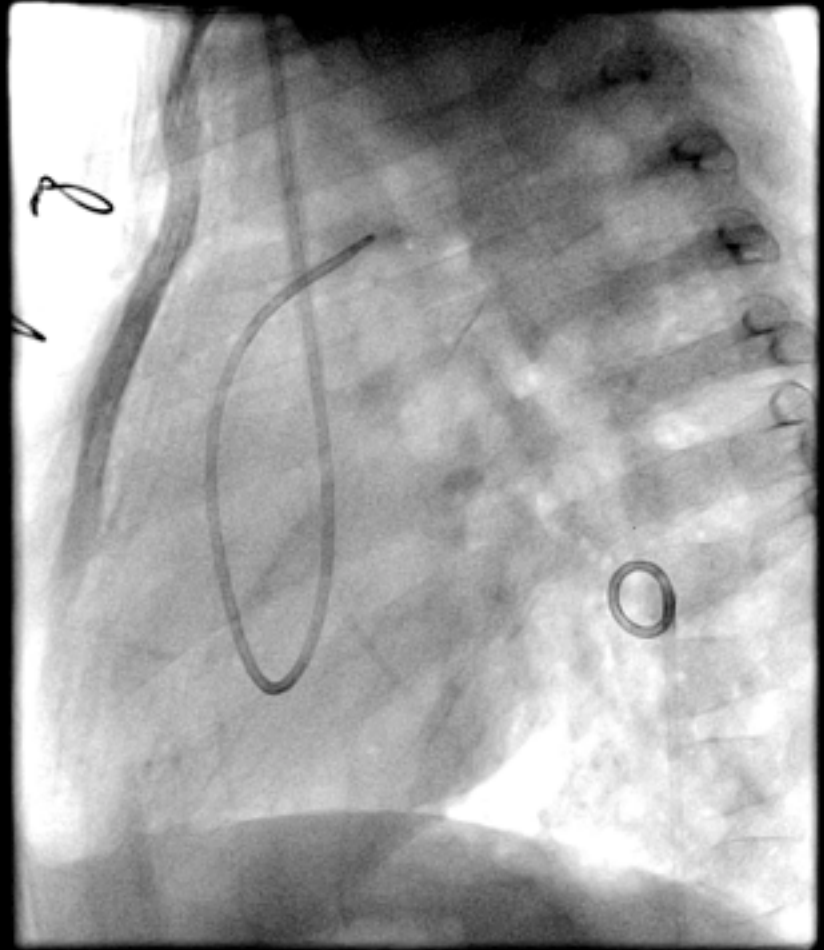
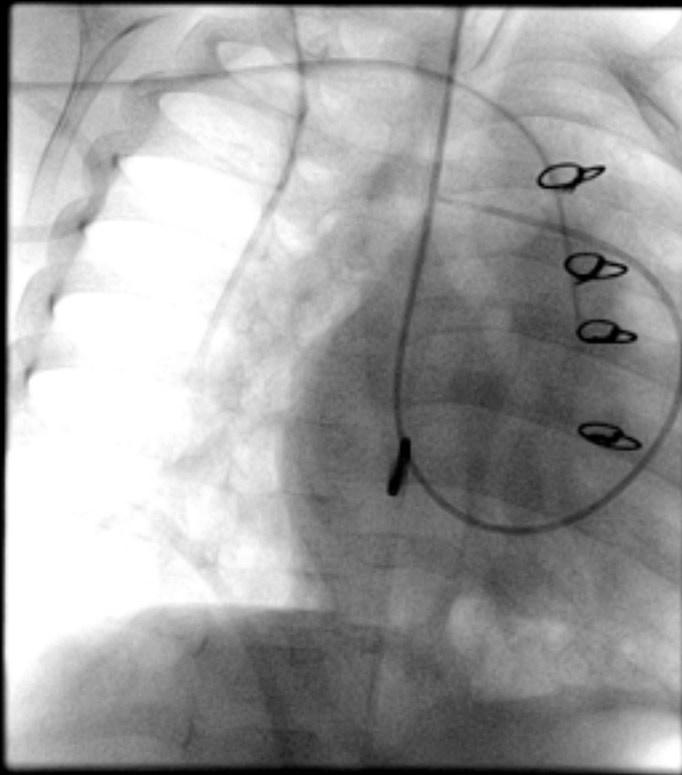
What's wrong with this angio?



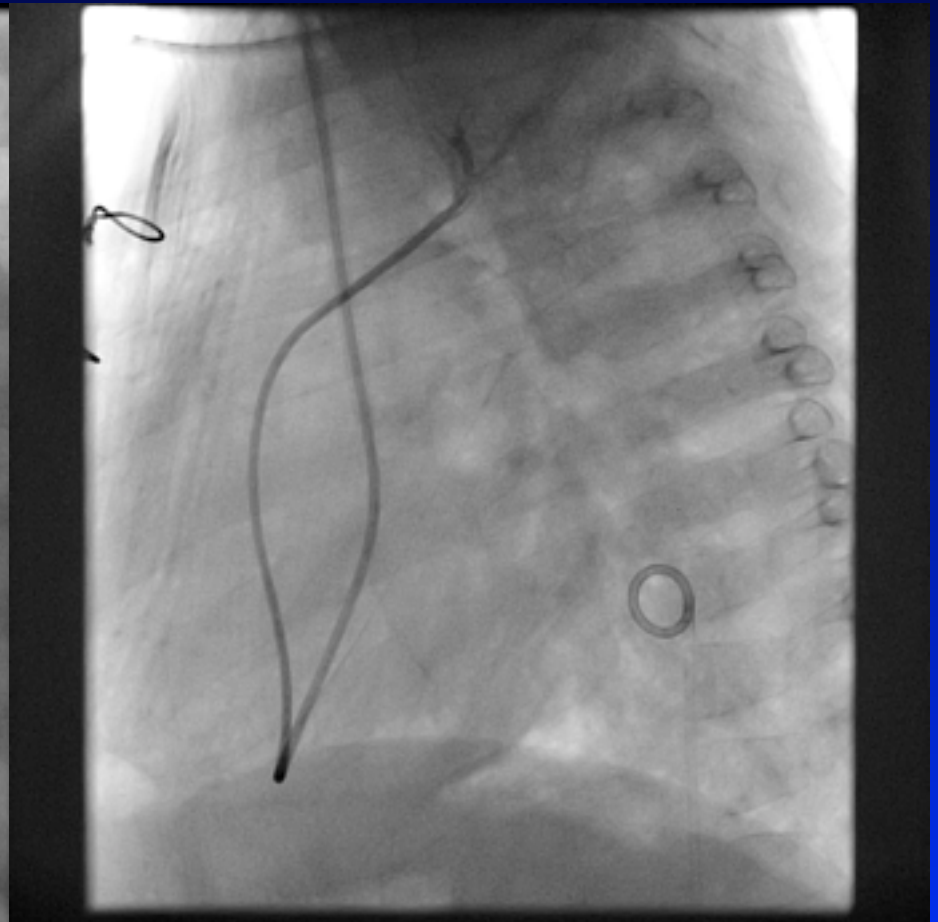
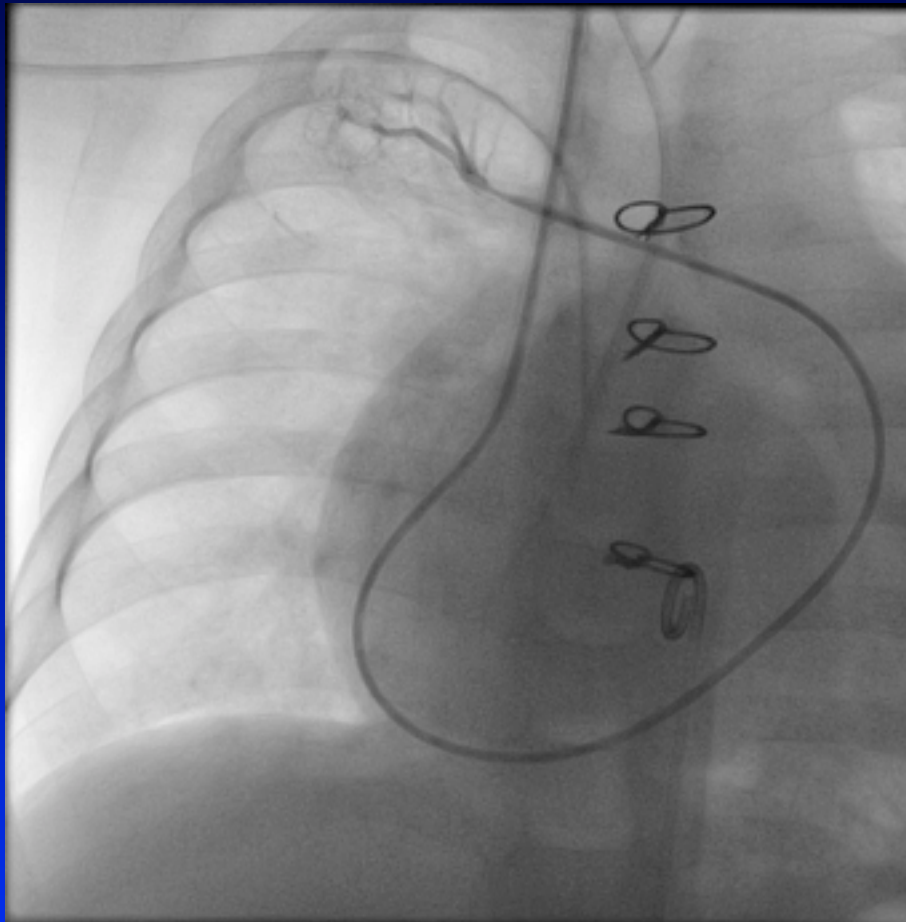
Left hepatic vein to LA



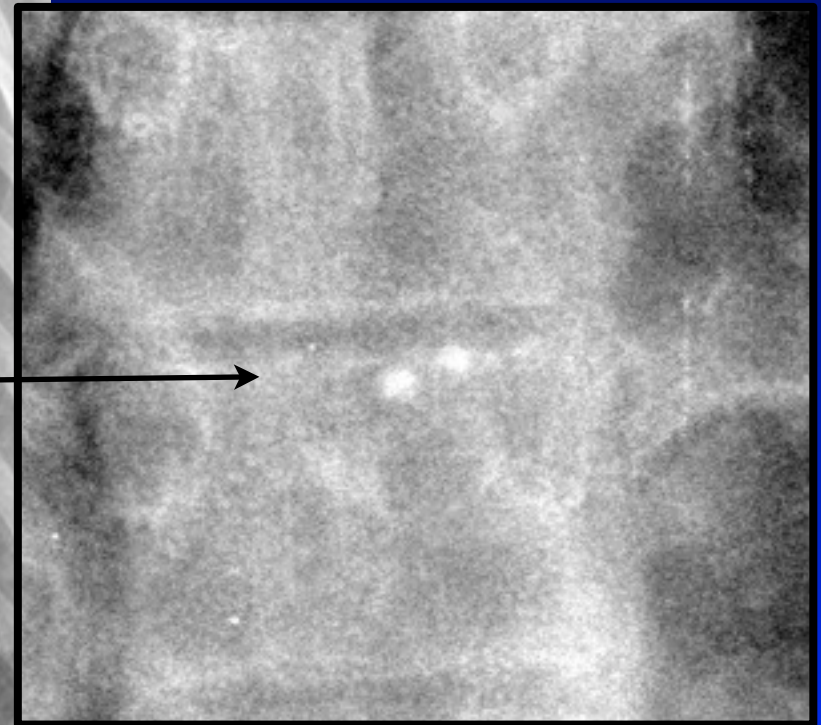
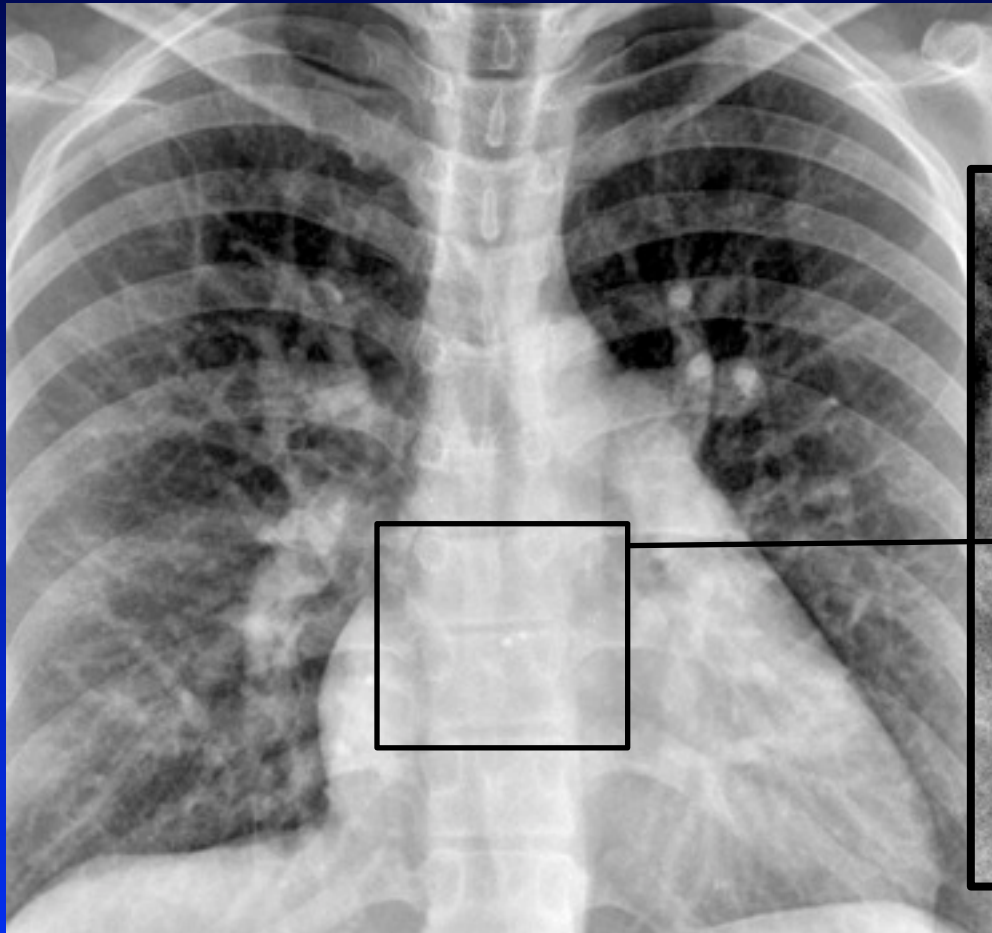
What's wrong with this picture?



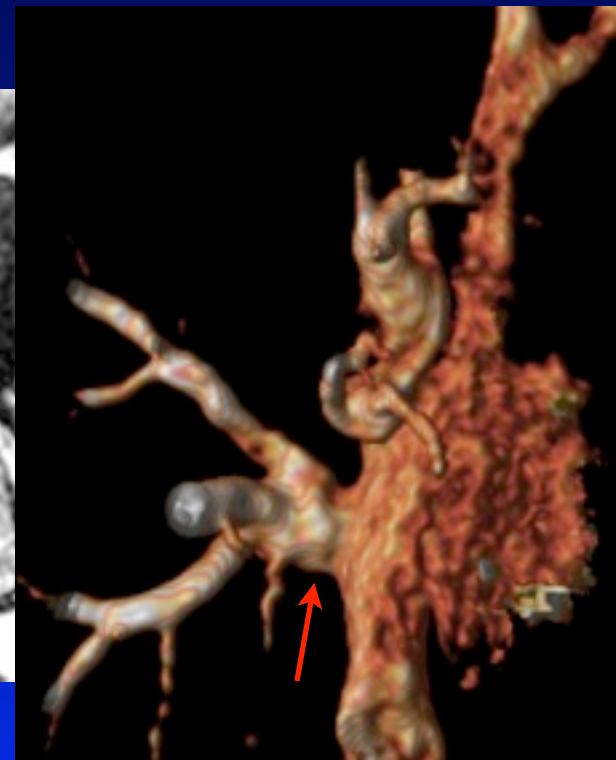
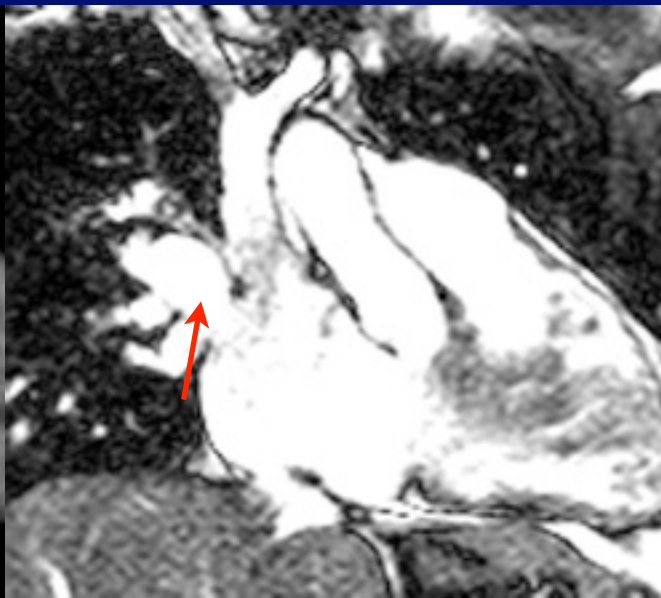
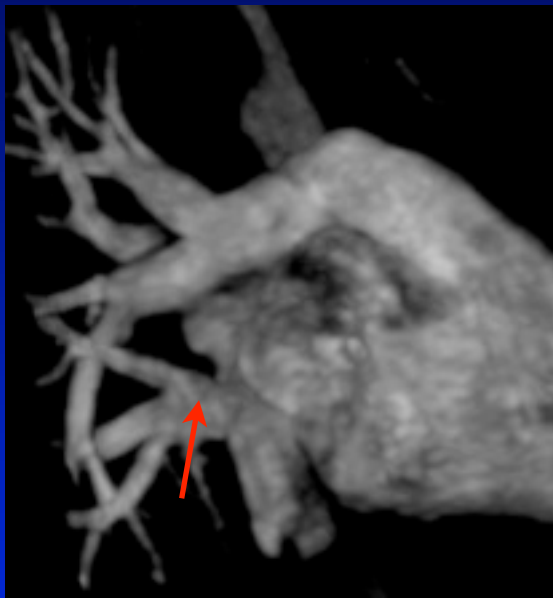
Right upper pulmonary vein stenosis



20 yo s/p ASD occlusion: CXR: Persistent cardiomegaly



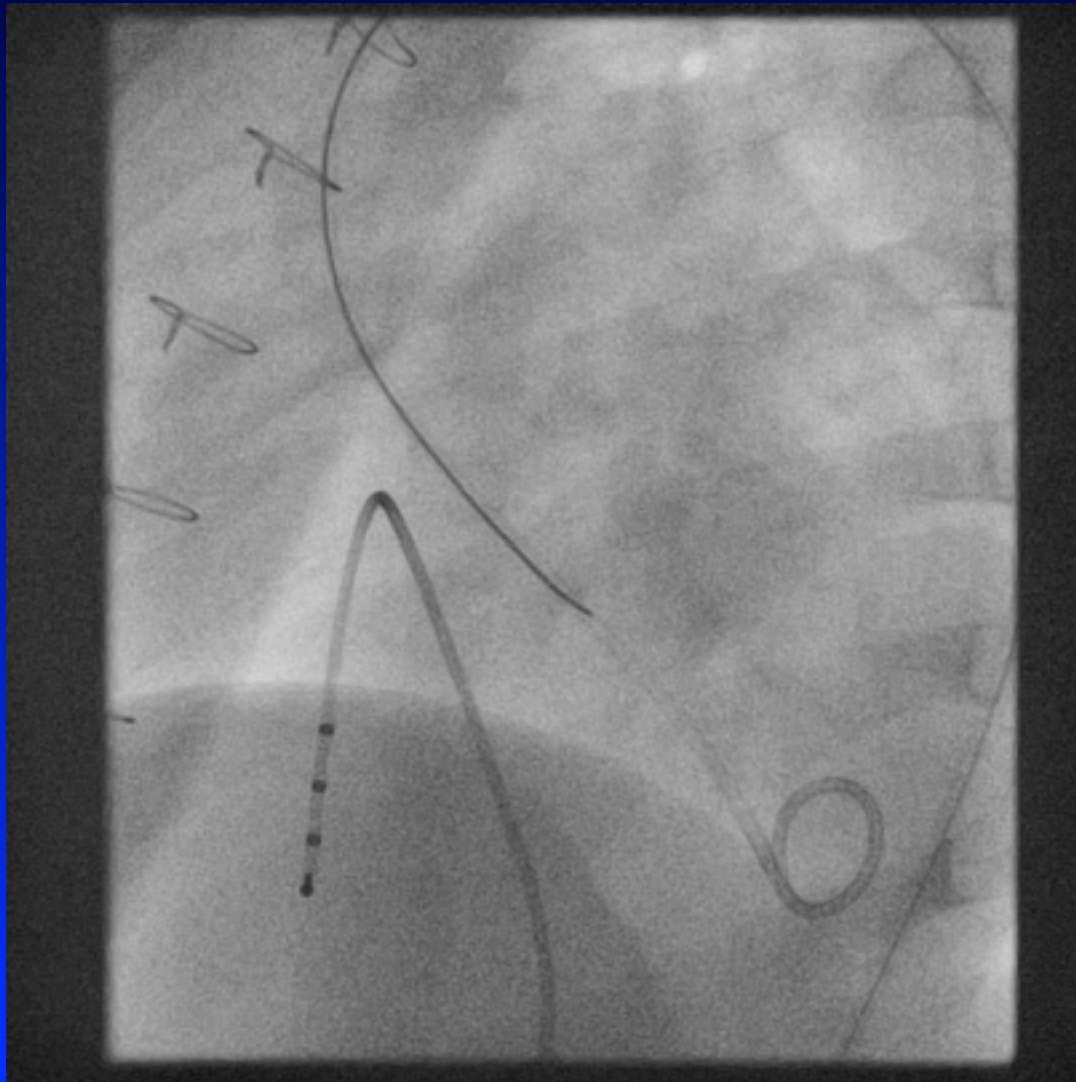
MRI shows...?



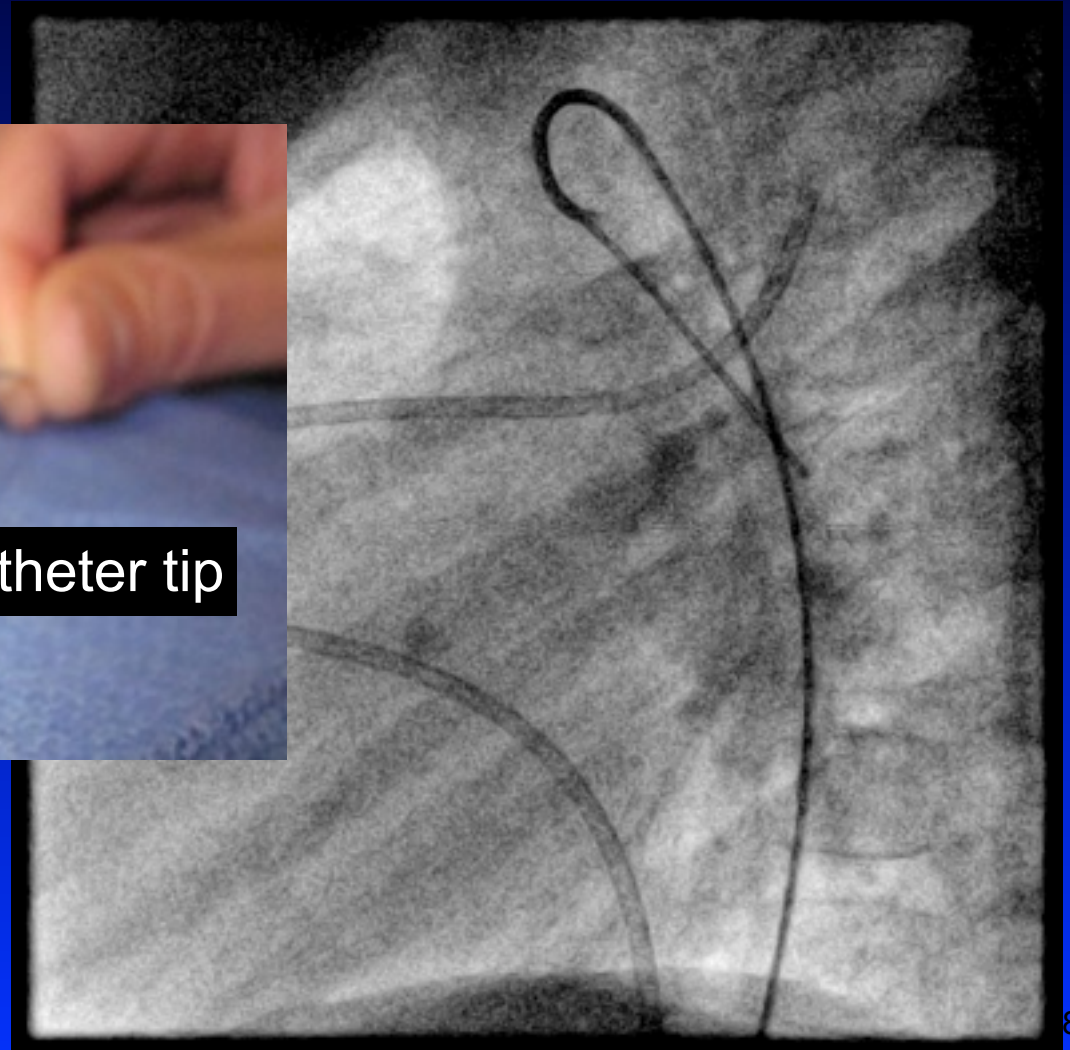
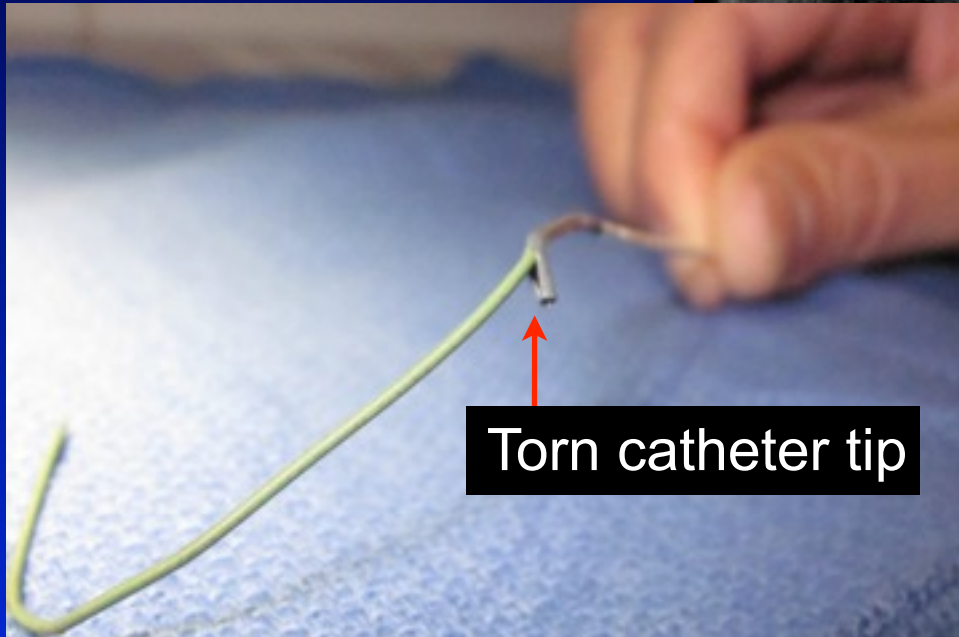
PAPVR of right lung

Pay attention to minor details...

What happened?

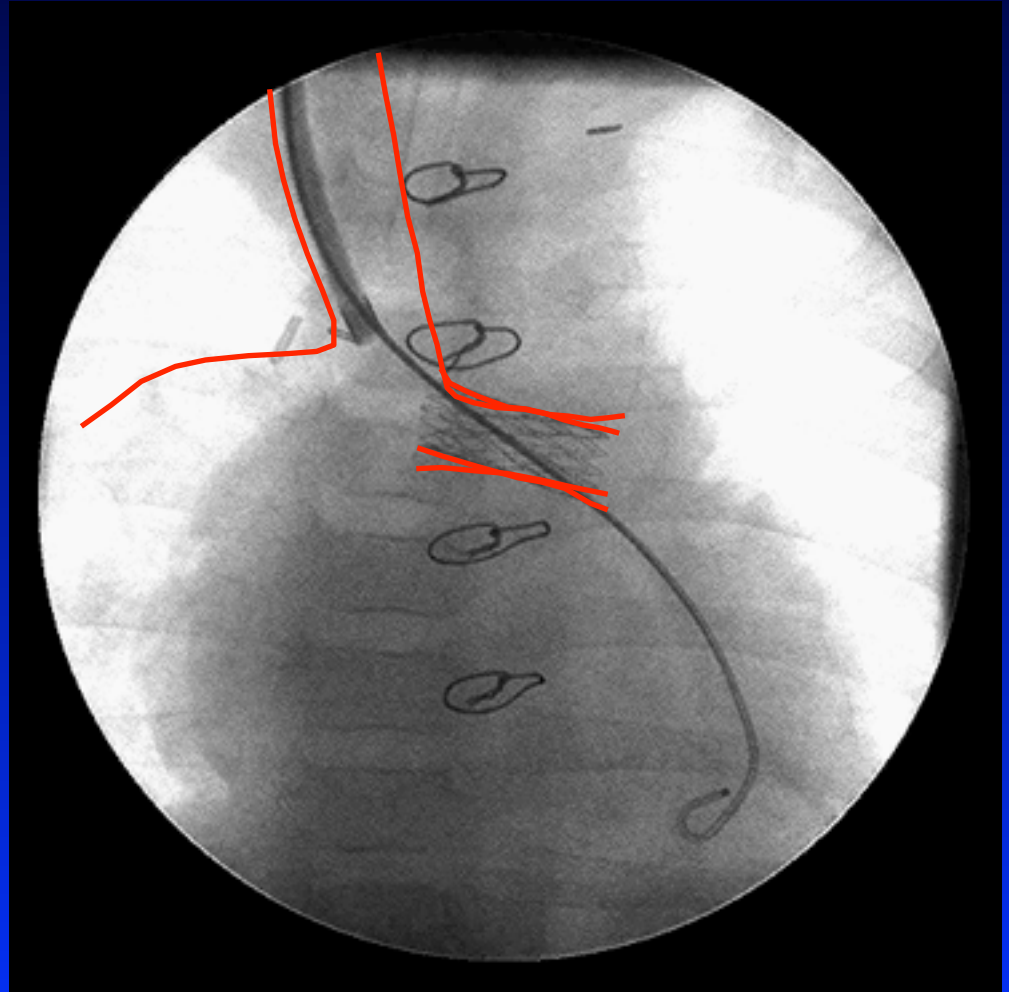
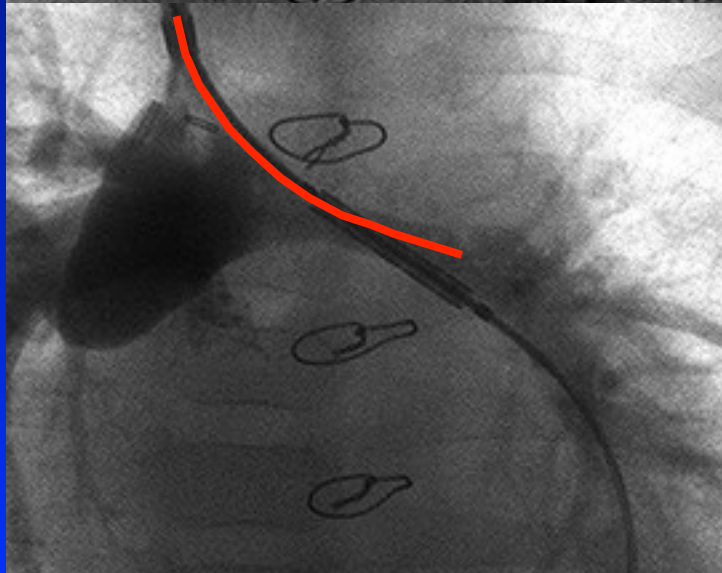
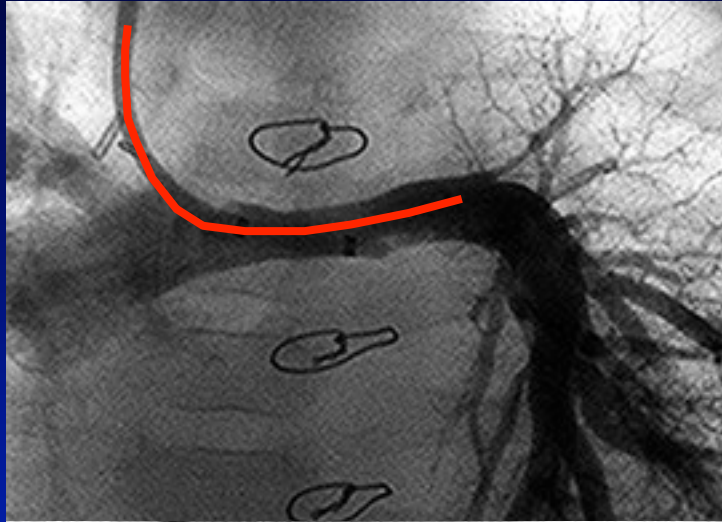


**Develop high tactile sense...
Advancing wire...unable to go around arch
What's wrong with this?**

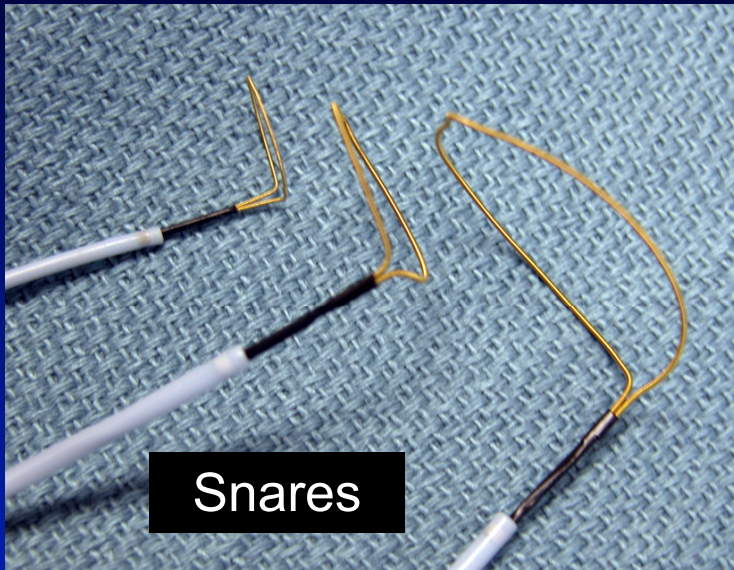


- **Wires**
 - Access vessels: floppy-tip / torquing wires
 - Stent delivery: stiff / exchange length wires
- **Do not compromise good wire position**
 - Stiff part of wire placed far beyond stenotic segment
 - PA- distal subsegmental pulmonary branches
 - COA- subclavian art / sinus of valsalva
 - Take your time to achieve good position
 - May need several exchanges with floppy, steerable wires and endhole catheters to get stiff exchange wire into position
 - Stiff wires can alter shape of vessel-know original angles before wire enters vessel

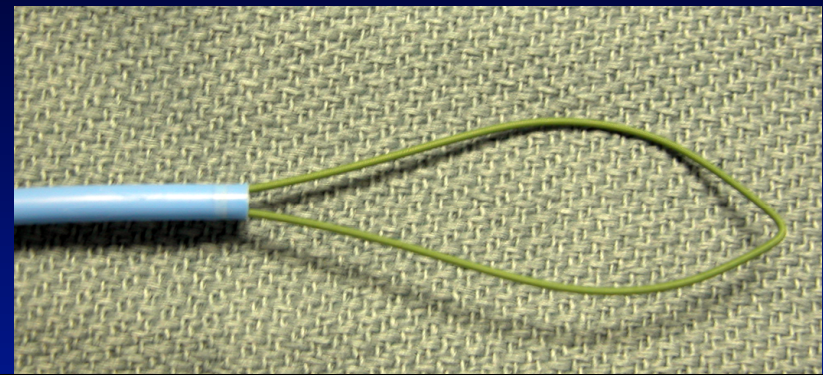
Effect of stiff wires of vessels



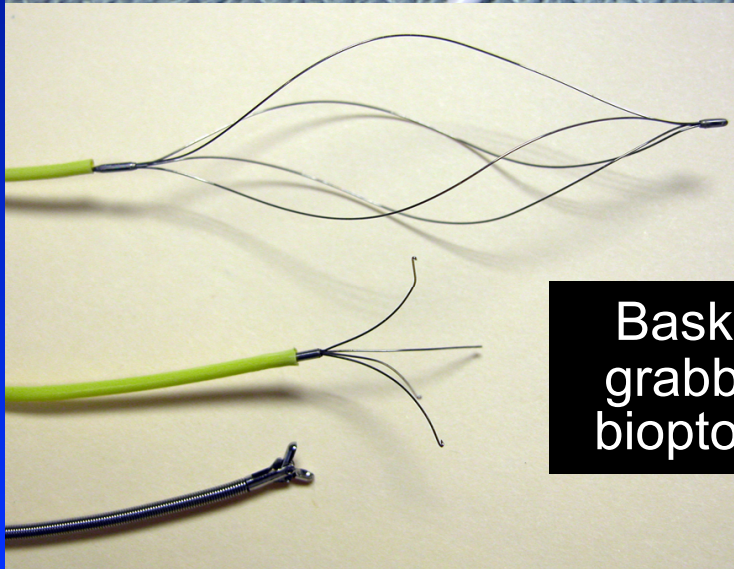
Have retrieval devices available



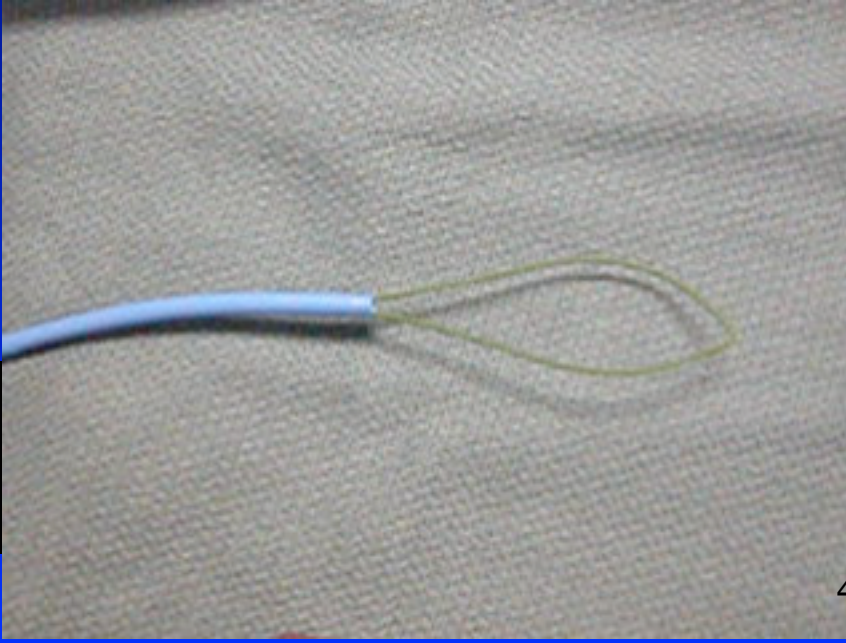
Snares



Makeshift snare for 180° angle

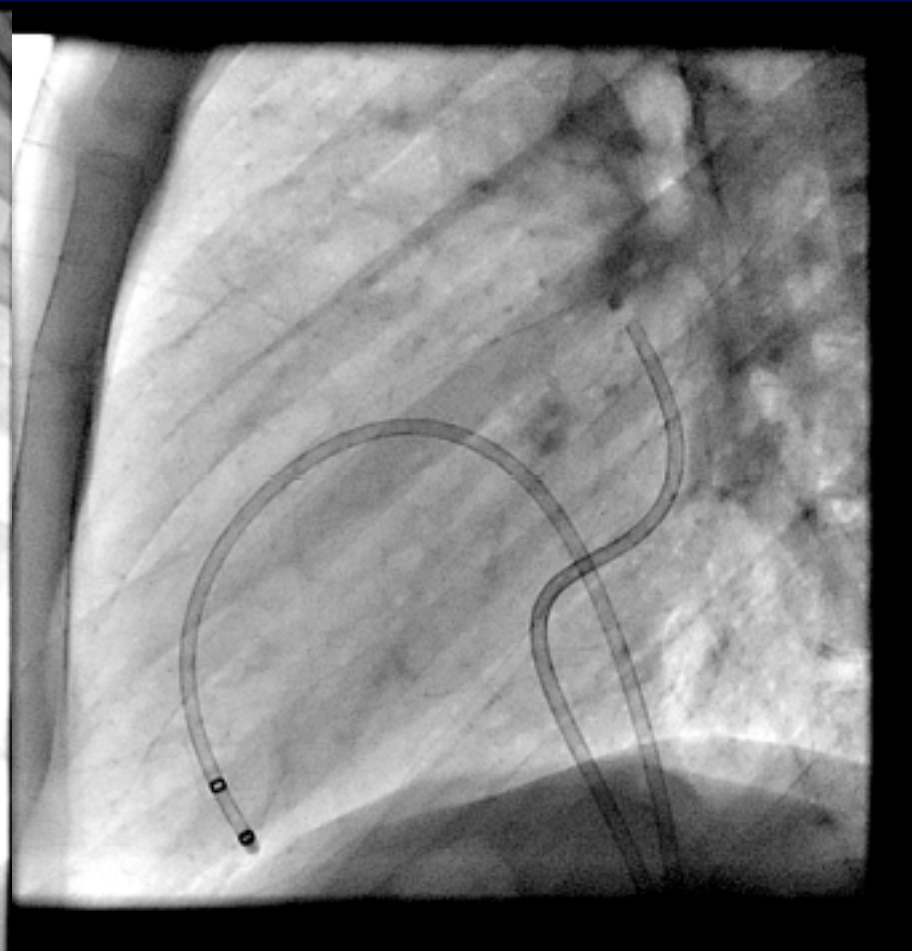
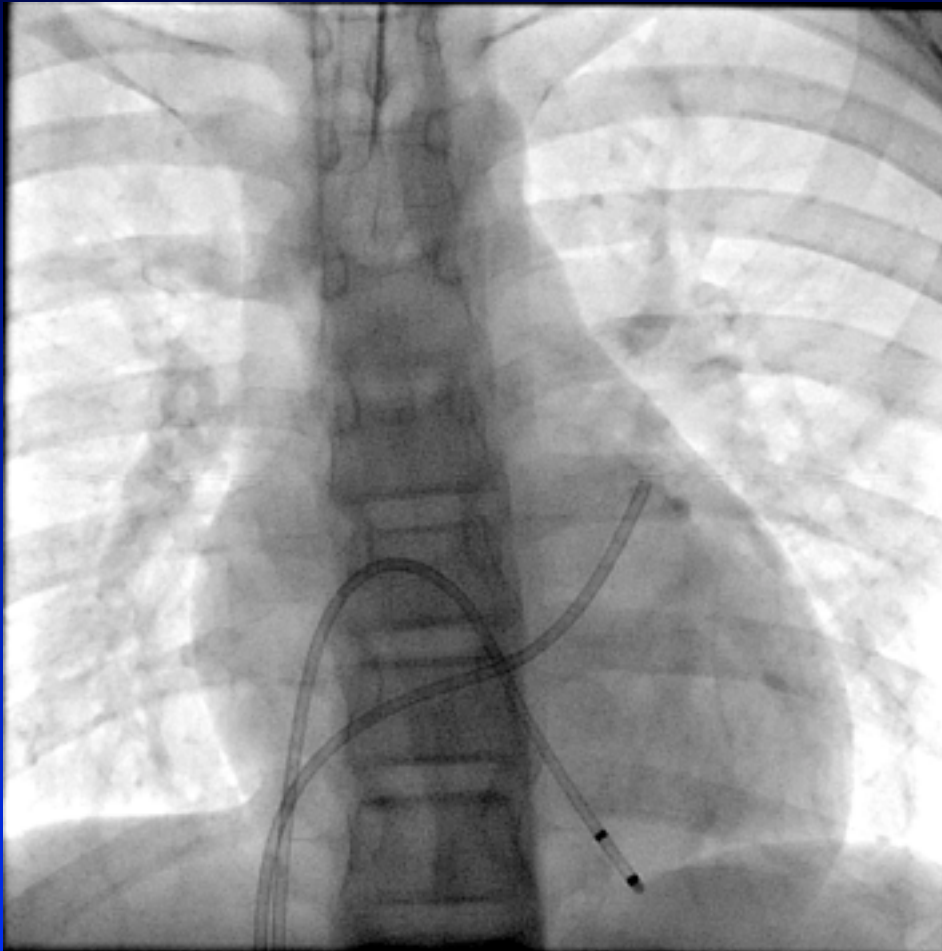


Baskets,
grabbers,
bioptomes

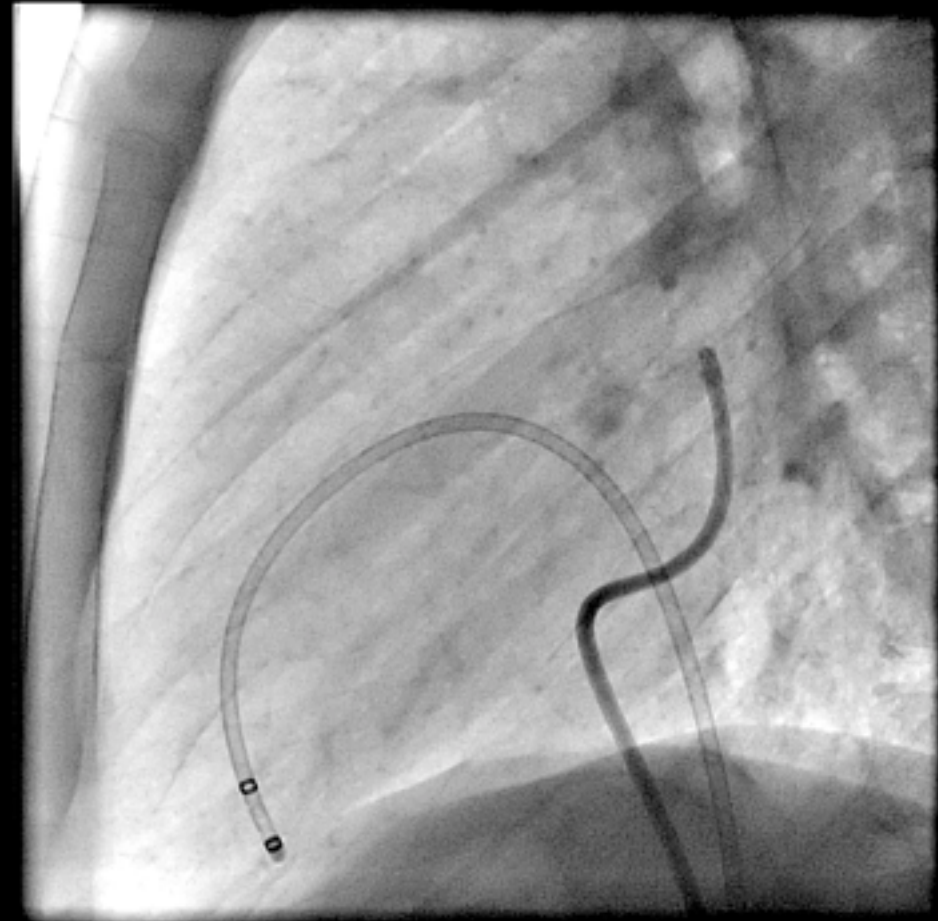
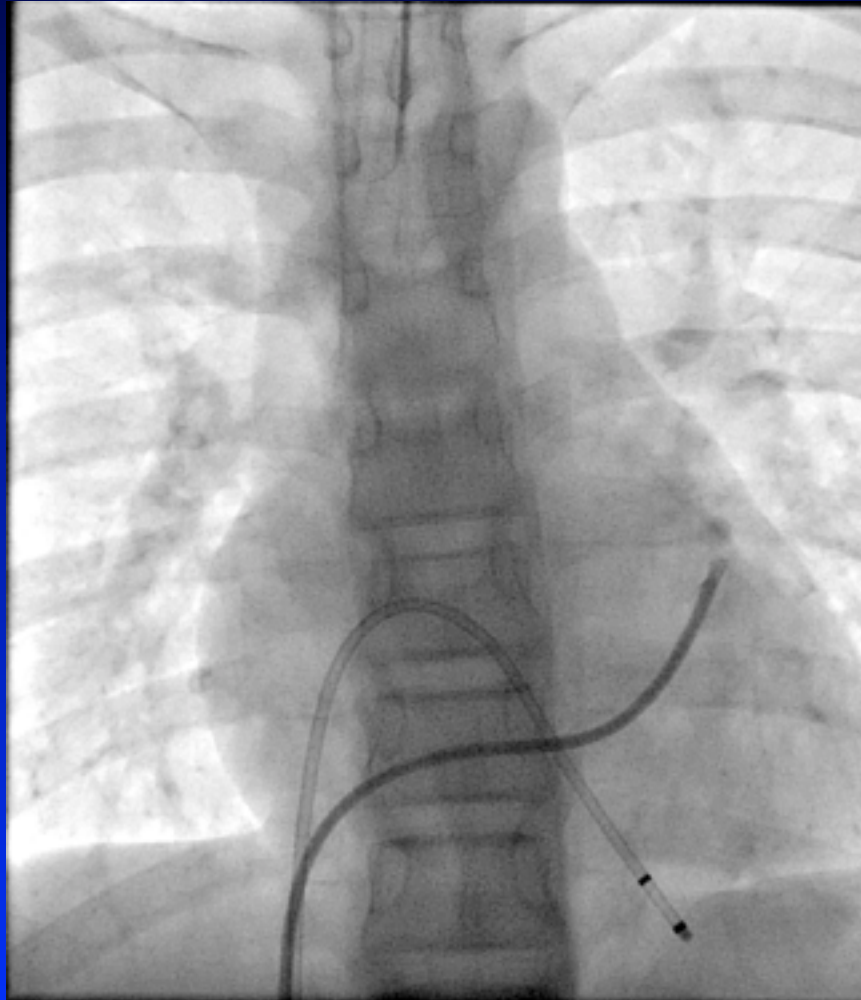


- Planning out cath strategy
- Recognize anatomic/physiology aberrations
- When moving a catheter, should have expectation of what it should do
 - When it doesn't perform to expectation, should have questions:
 - Inadequate catheter manipulation
 - Wrong catheter used
 - Anatomy-use more than one view
- Vital sign changes-listen for rhythm changes, saturation frequency
- Toggle eyes between fluoroscopy & hemodynamic monitors; biplane views

13 yo with valvar PS for dilation: Catheter course?

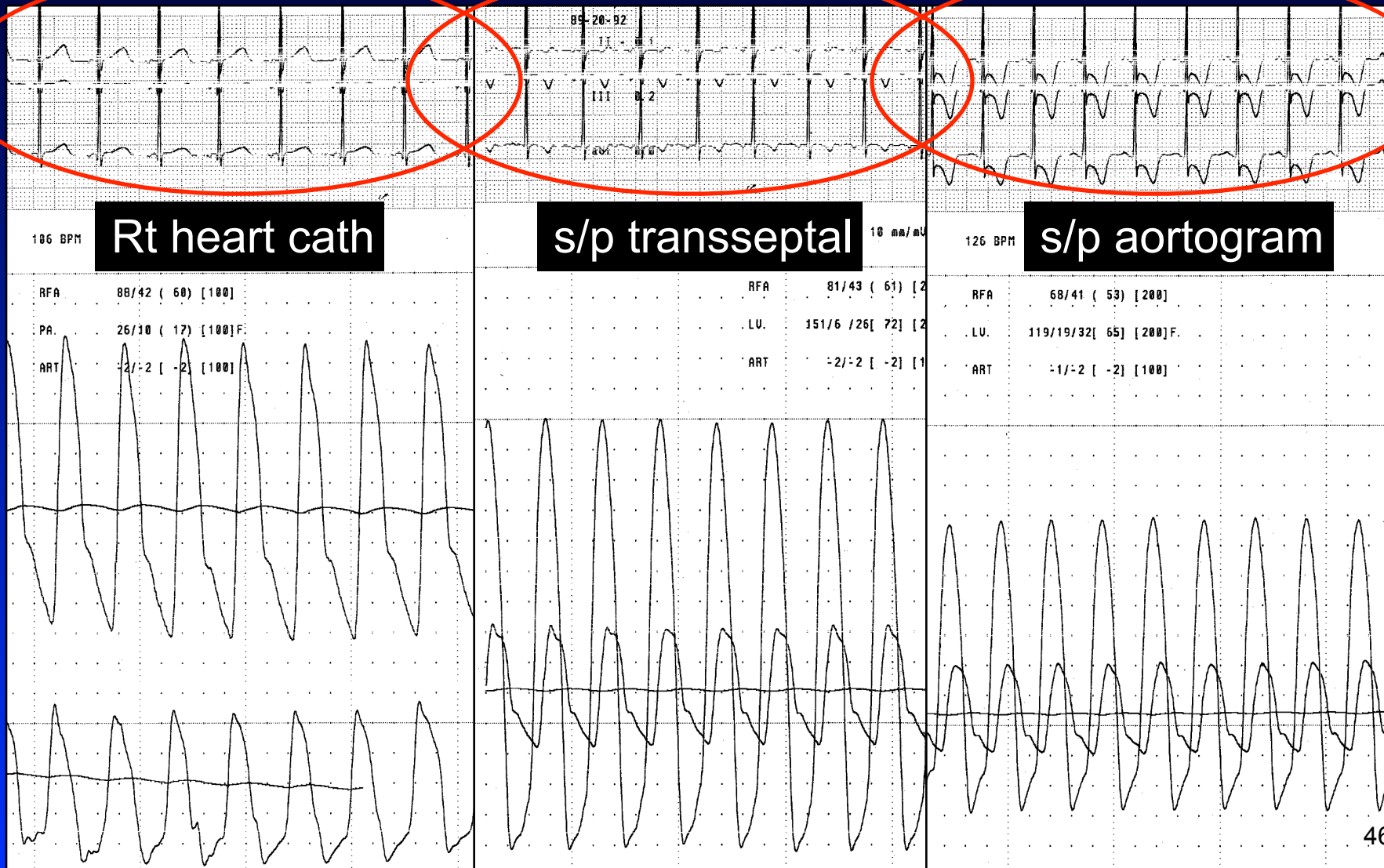


Catheter NOT in RVOT; Catheter in CS

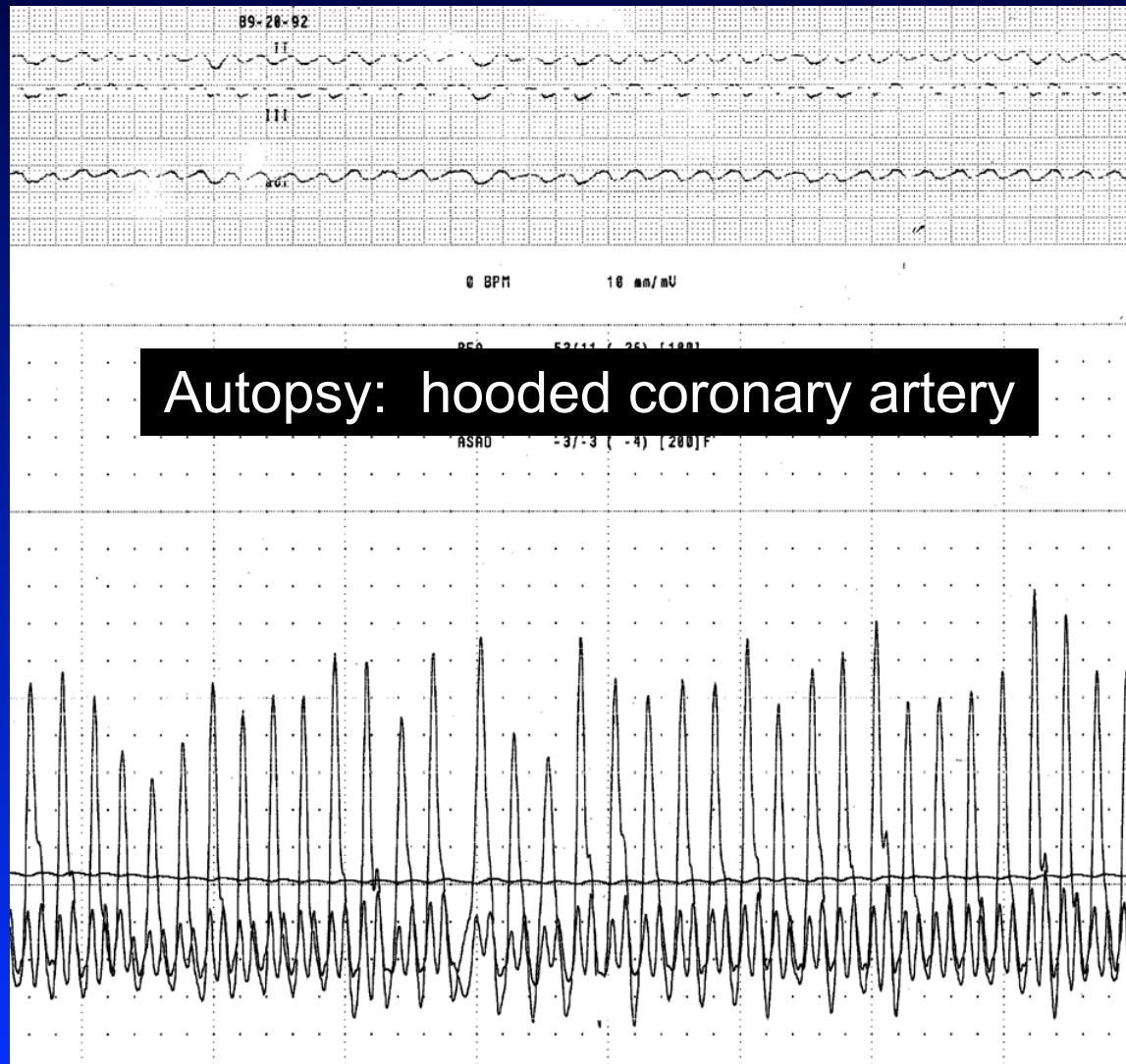


- Death
- Arrhythmia/ heart block
 - Surgical, poor hemodynamics, congenital, catheter induced
- Thromboembolic events/stroke
- Bleeding-hematoma, internal
- Infection
- Cardiovascular perforations, dissections, tears-(vascular, cardiac, valves)

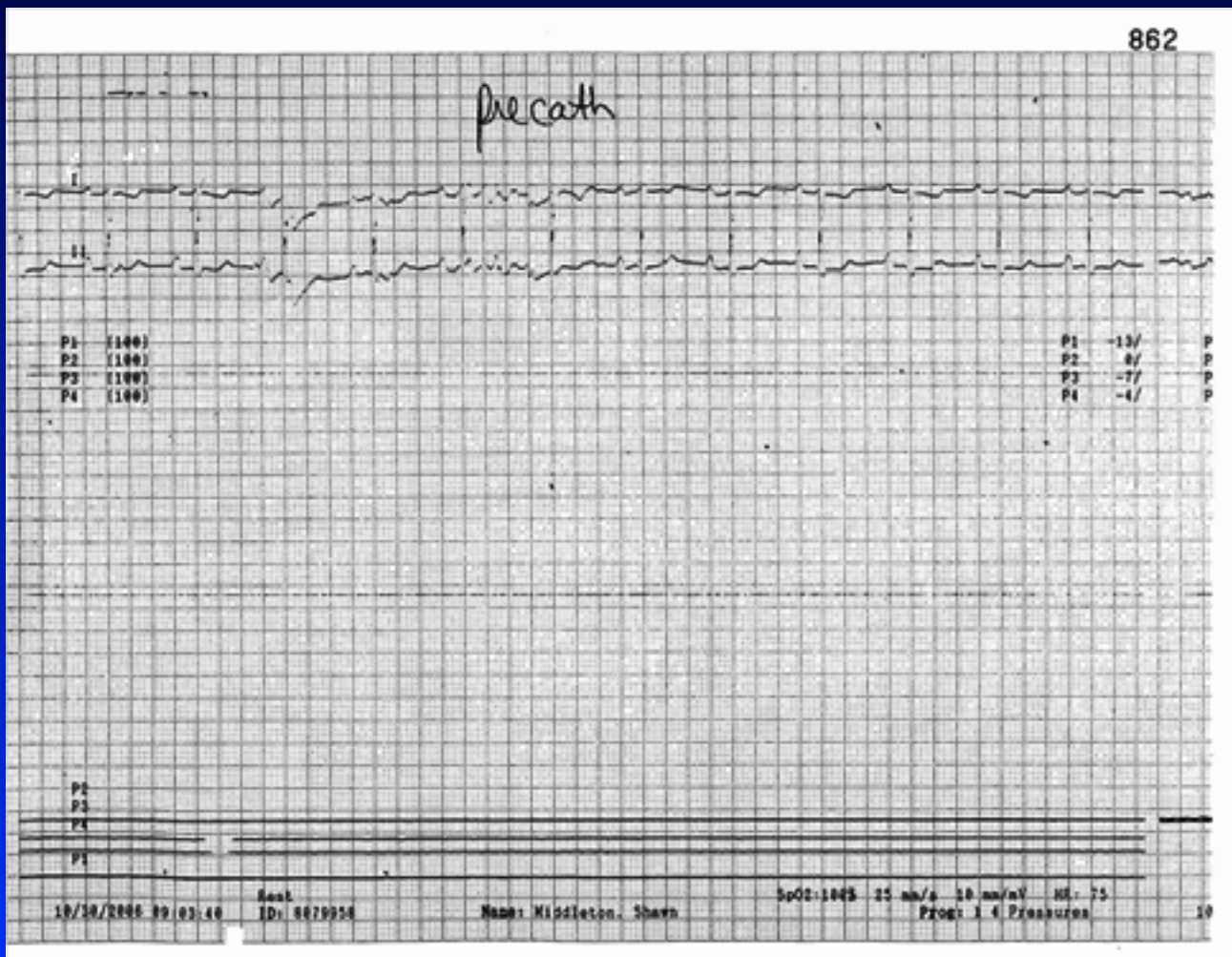
Severe AS for dilation: What's wrong?



Final rhythm....code called off.



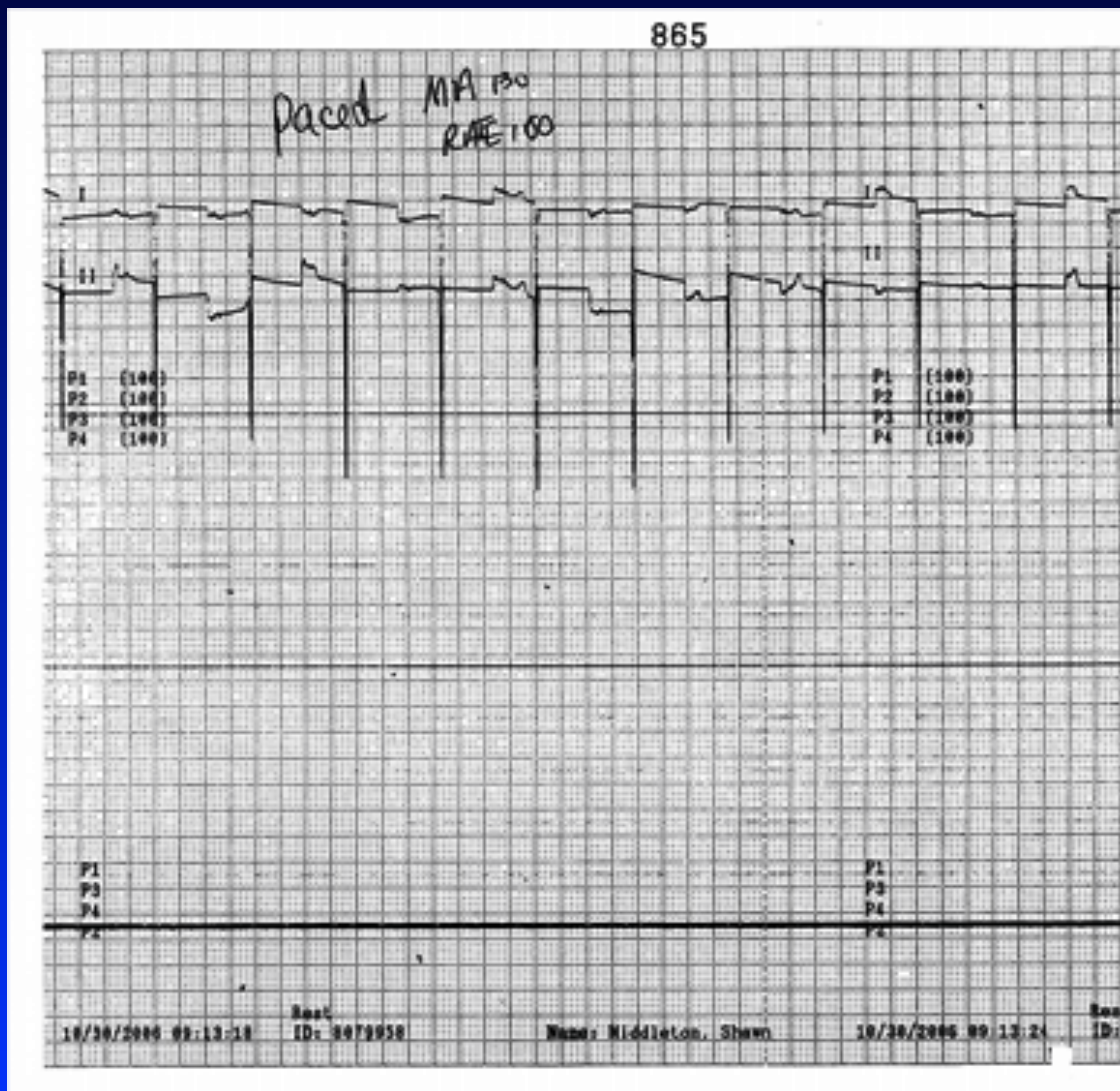
Fresh transplant for first time biopsy: pre-cath rhythm



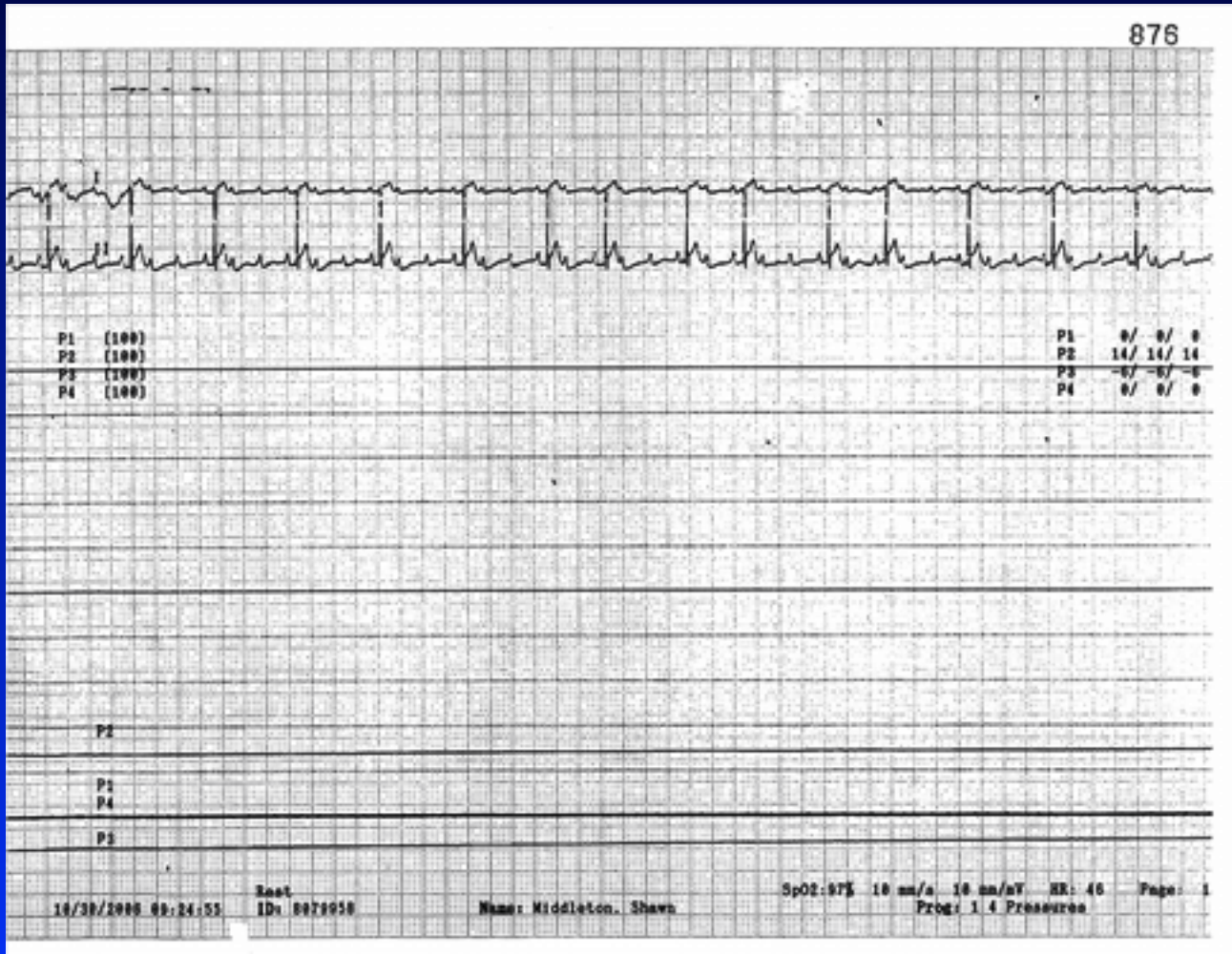
Post-intubation rhythm Diagnosis & management?



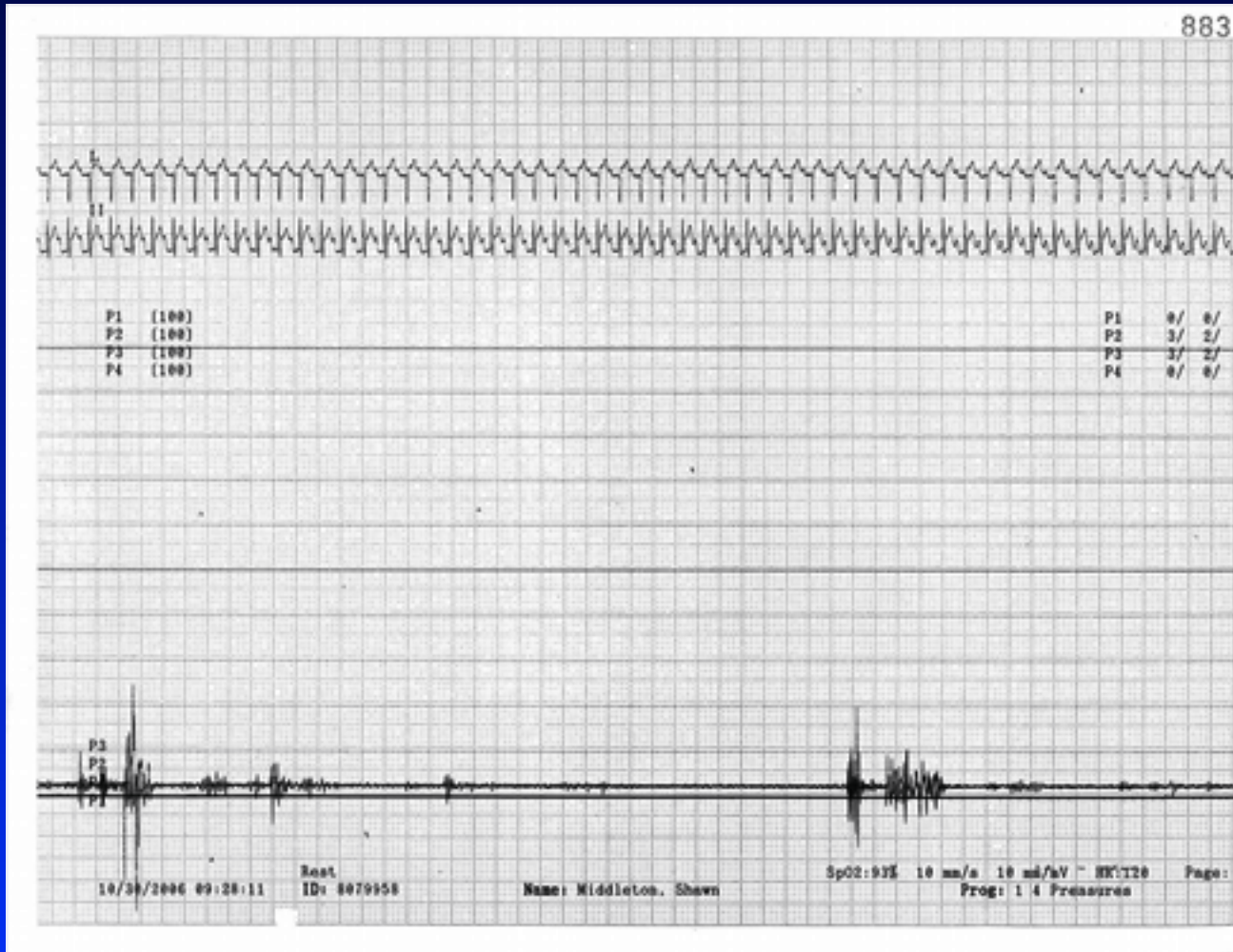
Paced



4:1 heart block

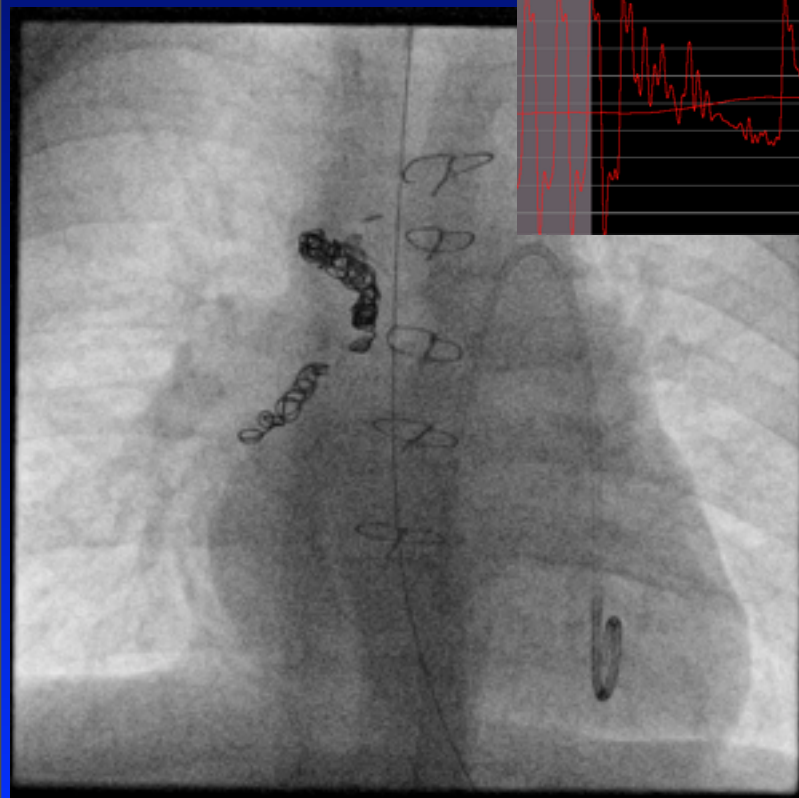
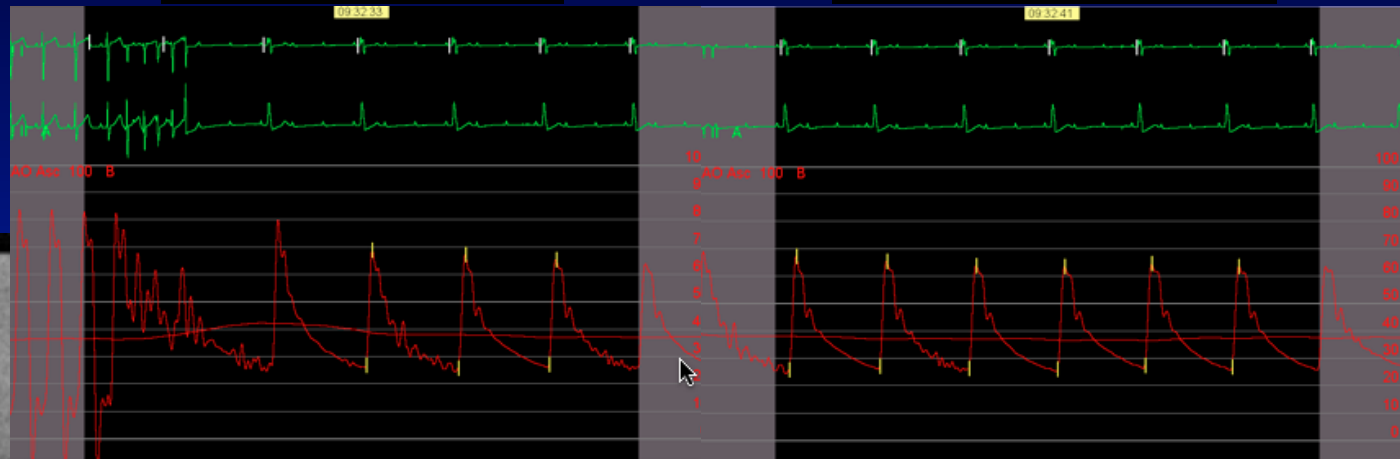


Recovery: proceed with biopsy

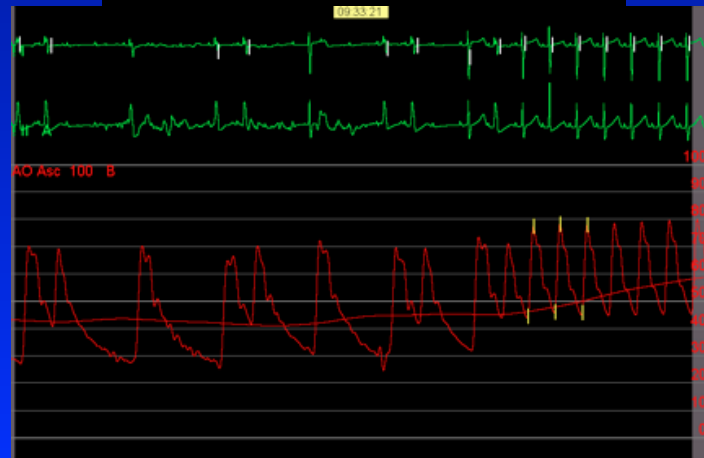


What's going on?

Treatment options?



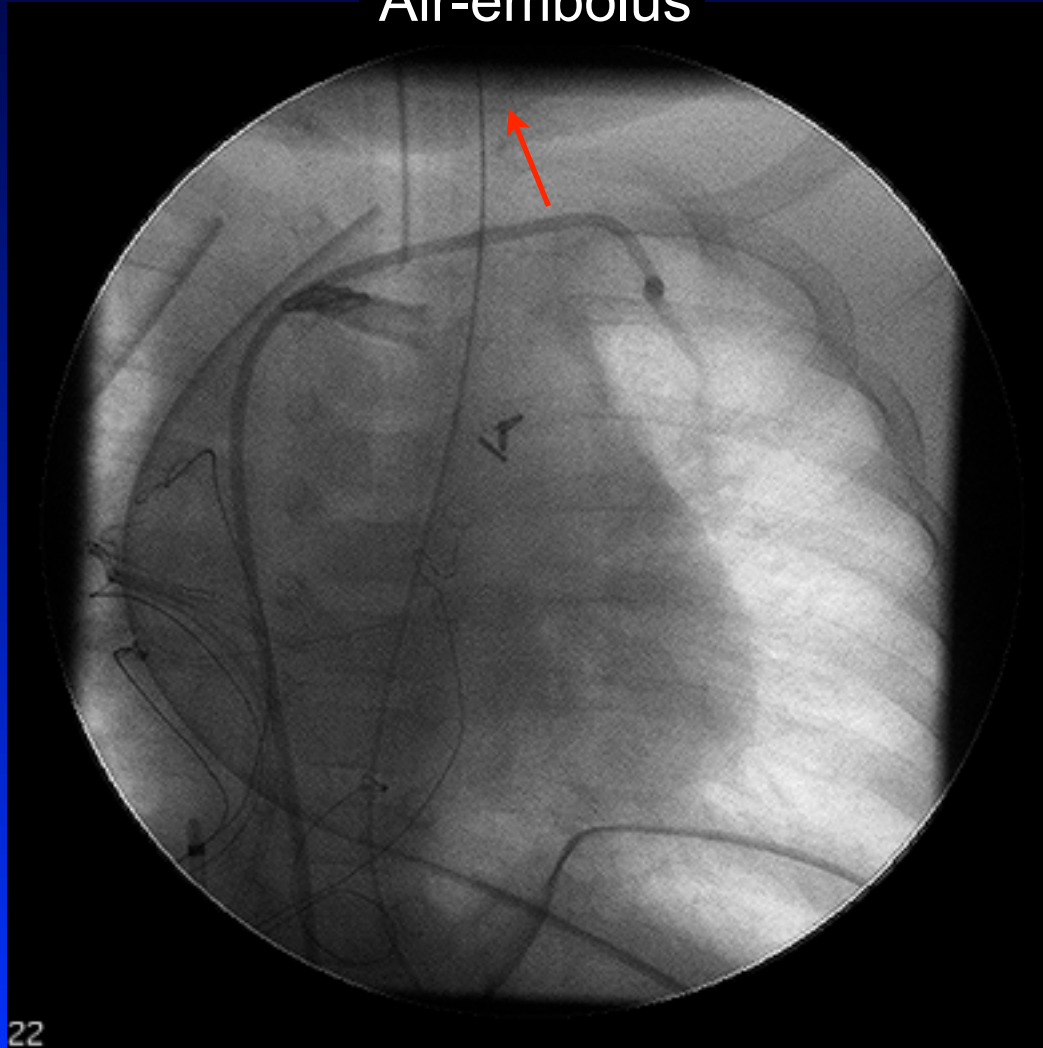
Recovery after 52 secs



- Death
- Arrhythmia/ heart block
 - Surgical, poor hemodynamics, congenital, catheter induced
- **Thromboembolic events/stroke**
- Bleeding-hematoma, internal
- Infection
- Cardiovascular perforations, dissections, tears-
(vascular, cardiac, valves)

End-hole catheter positioned over a wire: anticipated problem?

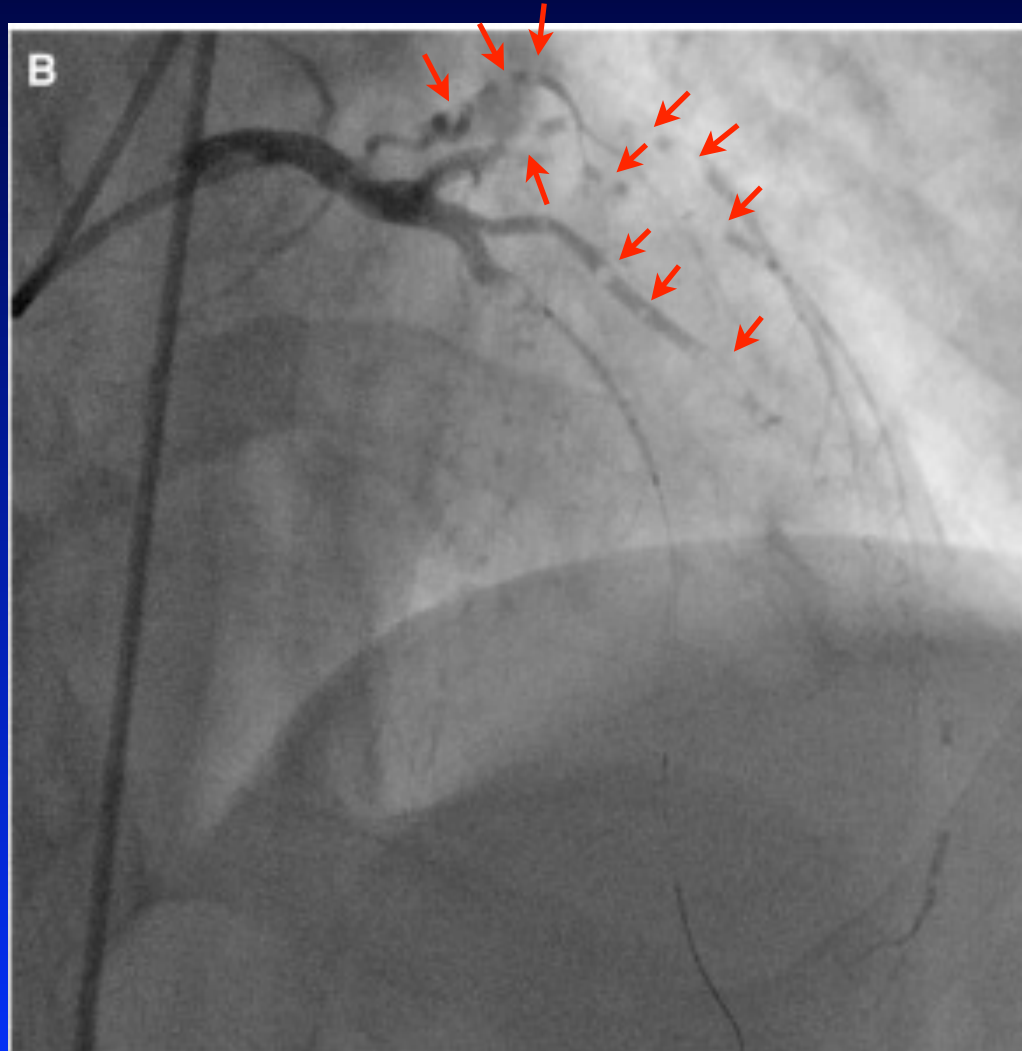
Air-embolus



22

55

What's wrong with this picture?

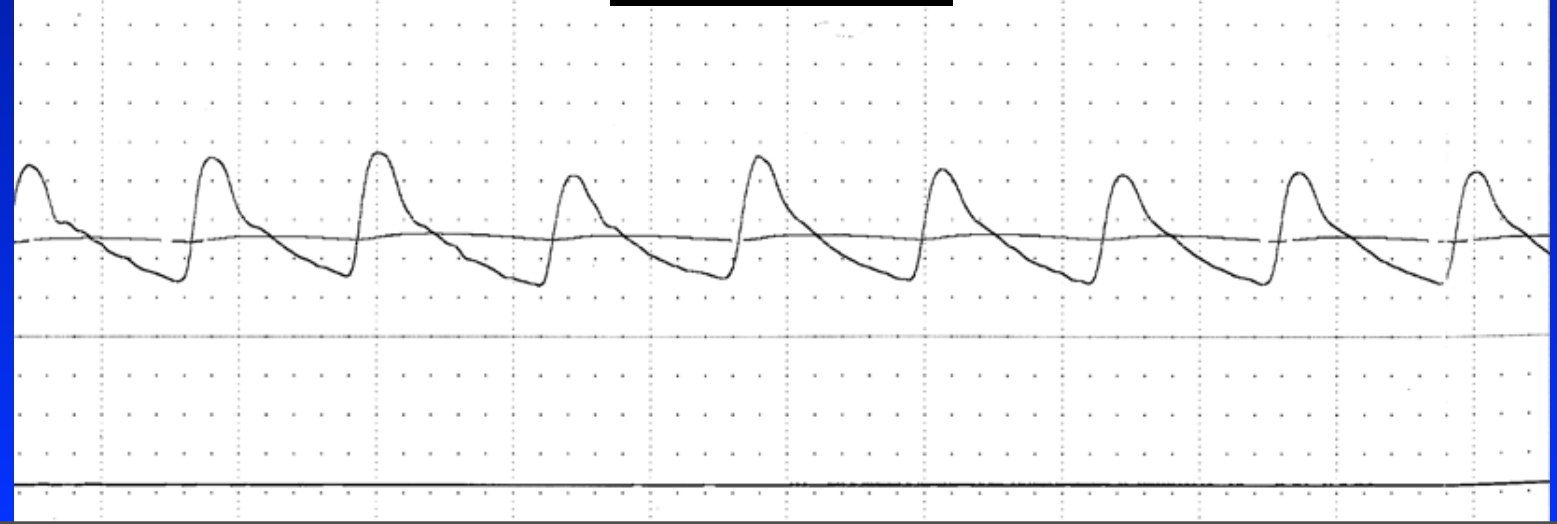


During ASD occlusion: Diagnosis and most likely cause?



RFA 45/31 (37) [100]F
LA. .6/6 (6) [100]F
FAIL

Air embolus

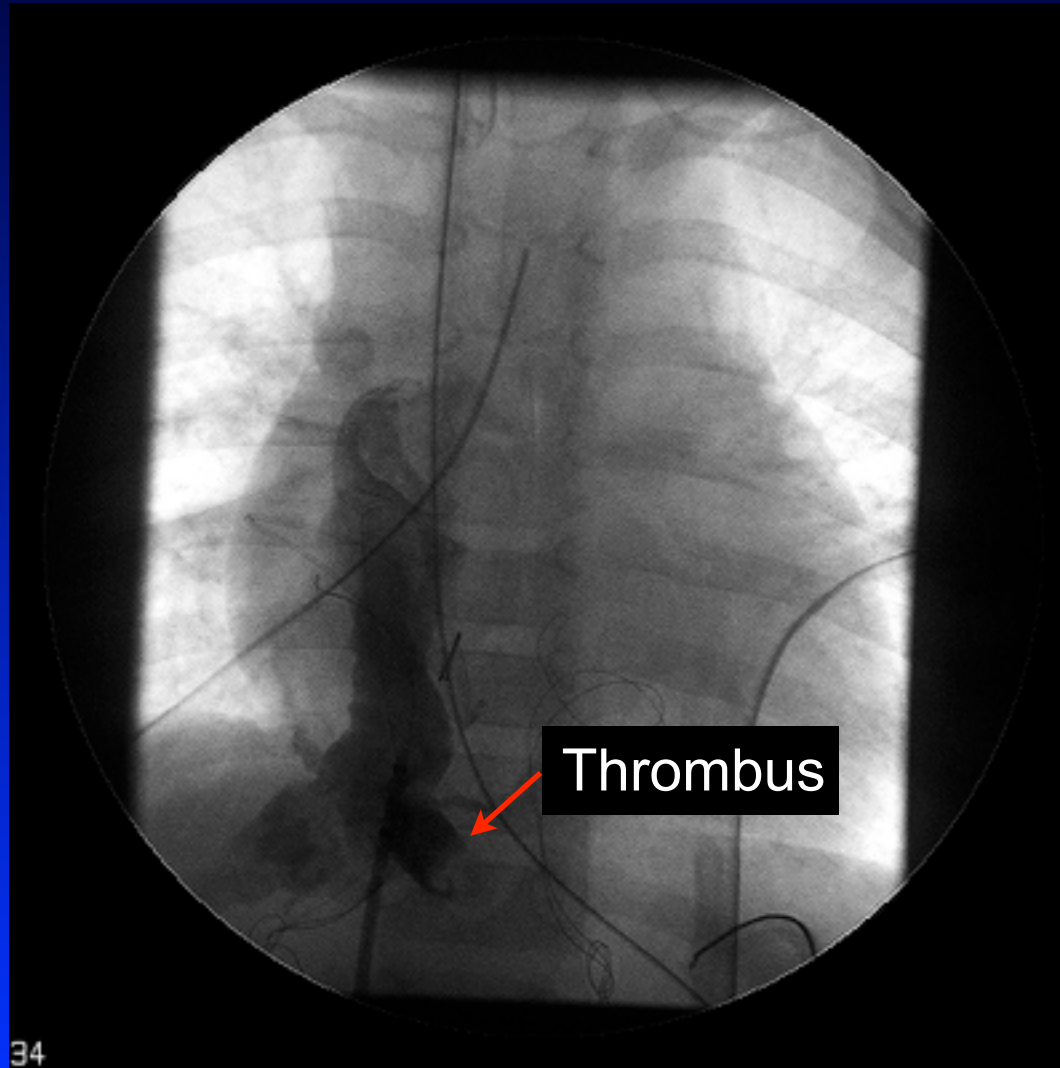


Thrombus-found in long sheath after ASD occlusion

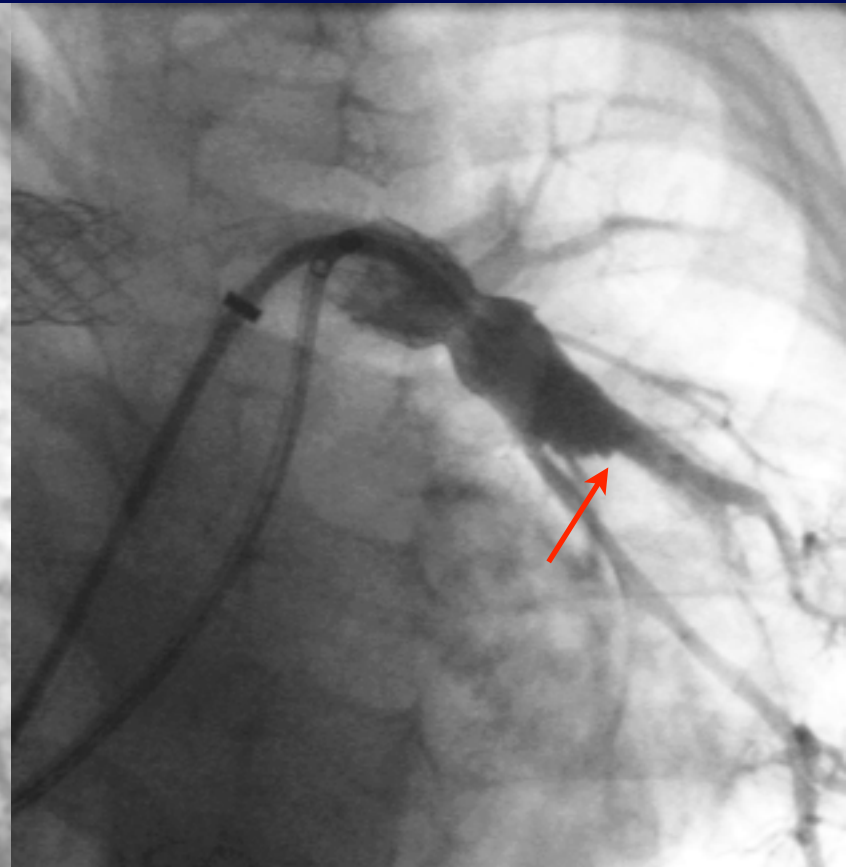


- Catheter/sheaths
- Stagnant flow (Fontan)
- Sites of intimal injury (stented sites)
- Prevention:
 - Avoid stasis (flush)
 - Anticipate
 - Heparin (ACT >220)
 - Avoid prolonged obstruction
 - Hydrate patient
 - Vigilance

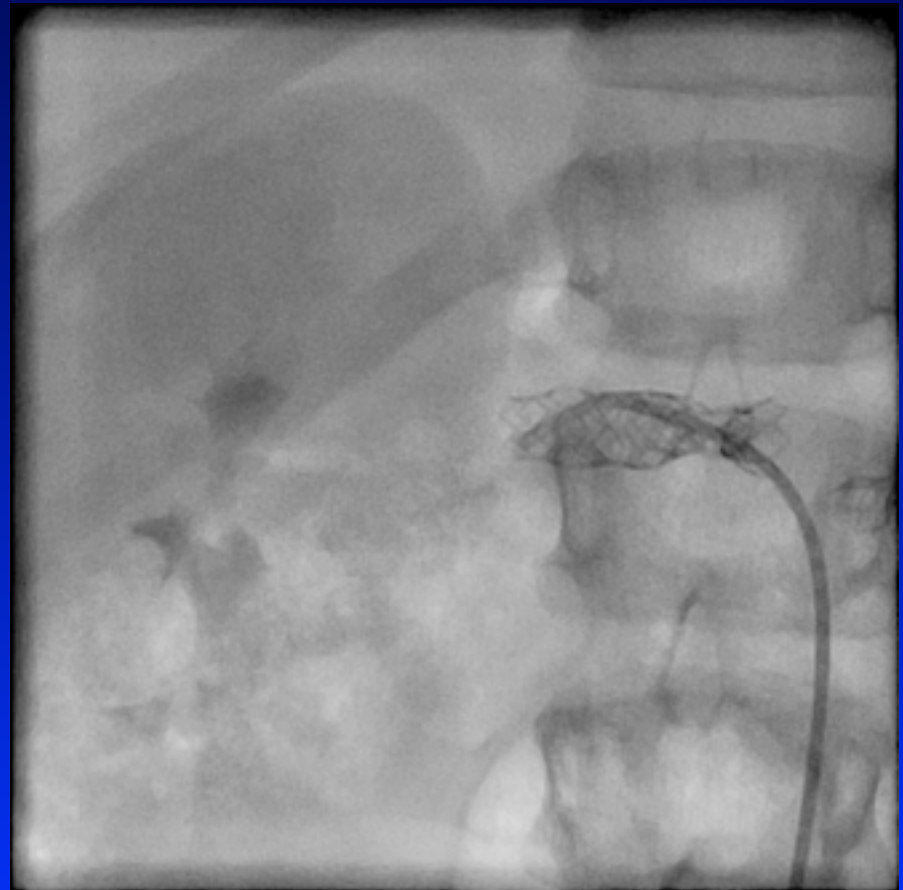
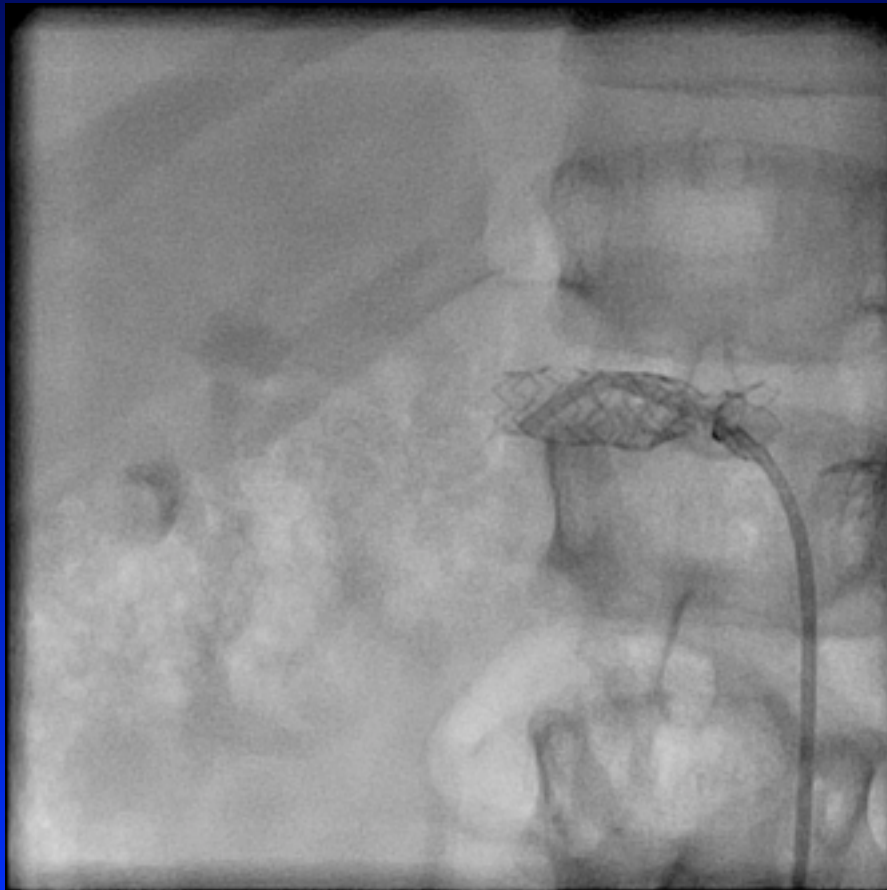
Evaluation of a failing Fontan: anticipated problem?



Technical success but inadequate heparinization with prolonged obstruction of distal flow from sheath during stent procedure

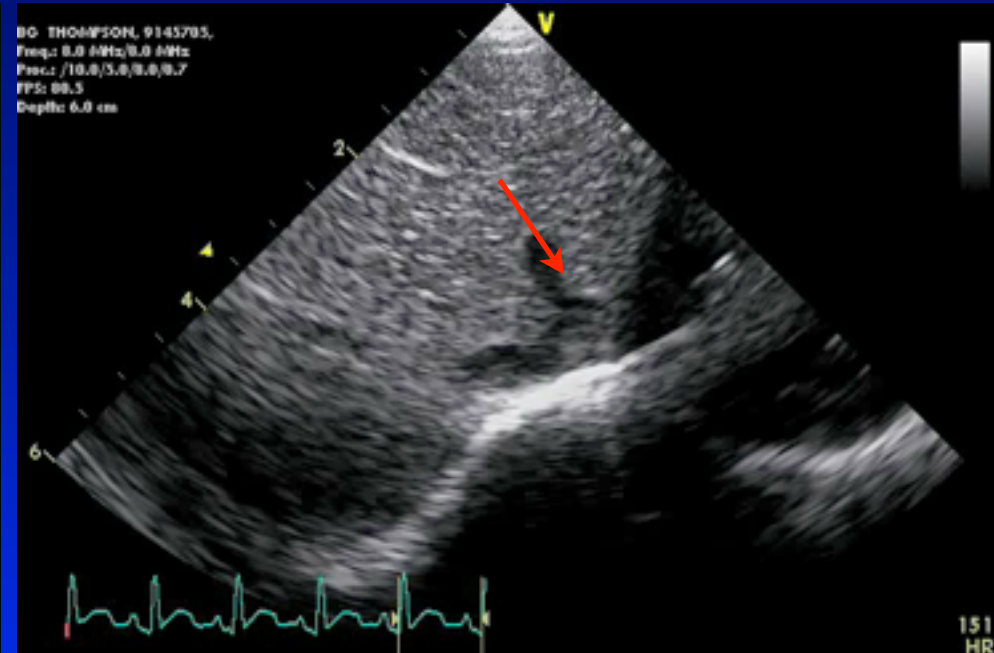
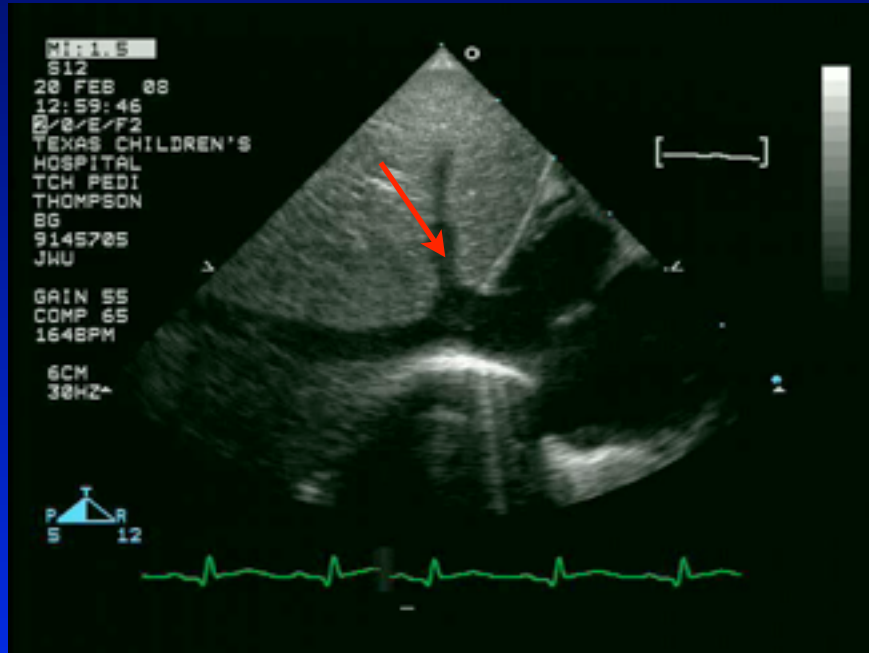


What's the problem?



- Death
- Arrhythmia/ heart block
 - Surgical, poor hemodynamics, congenital, catheter induced
- Thromboembolic events/stroke
- Bleeding-hematoma, internal
- **Infection**
- Cardiovascular perforations, dissections, tears-
(vascular, cardiac, valves)

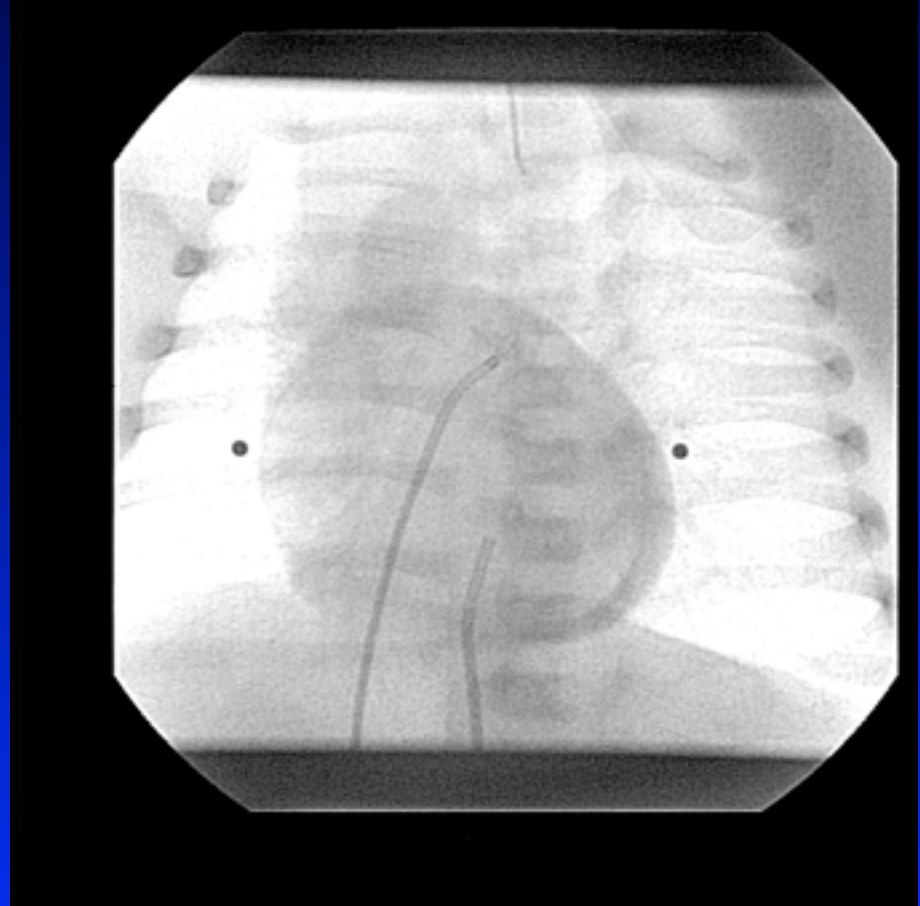
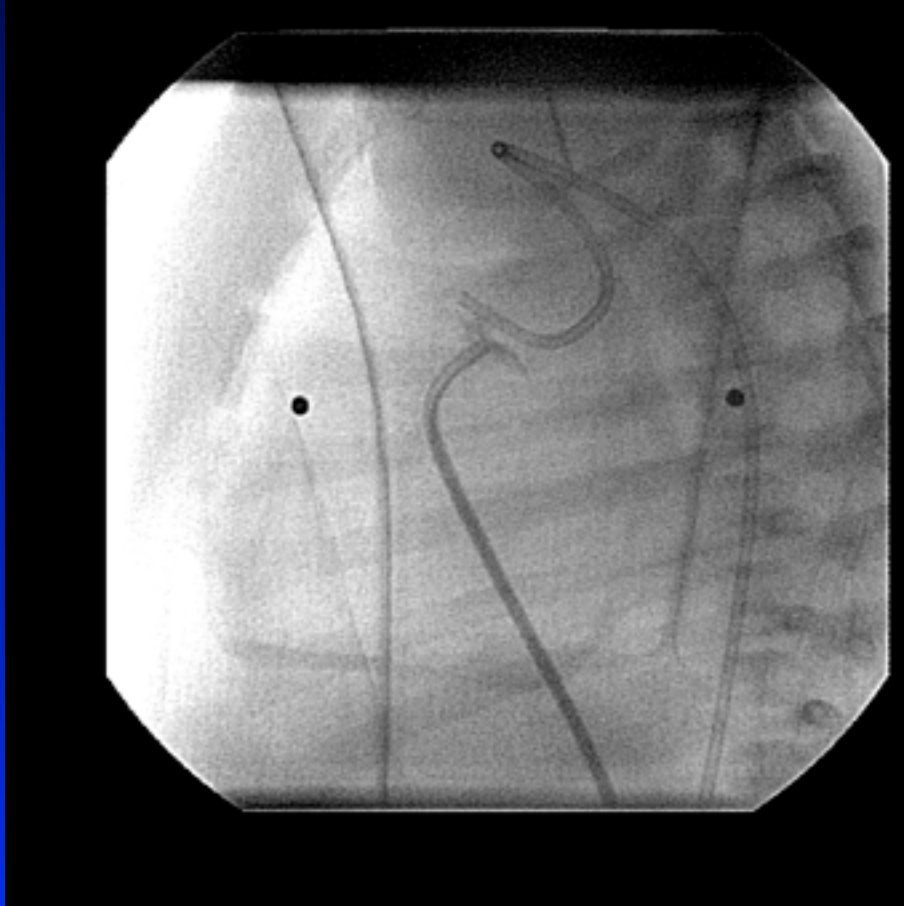
- Fever post cath: Diagnosis?
- Vegetation found in IVC near ductus venosus



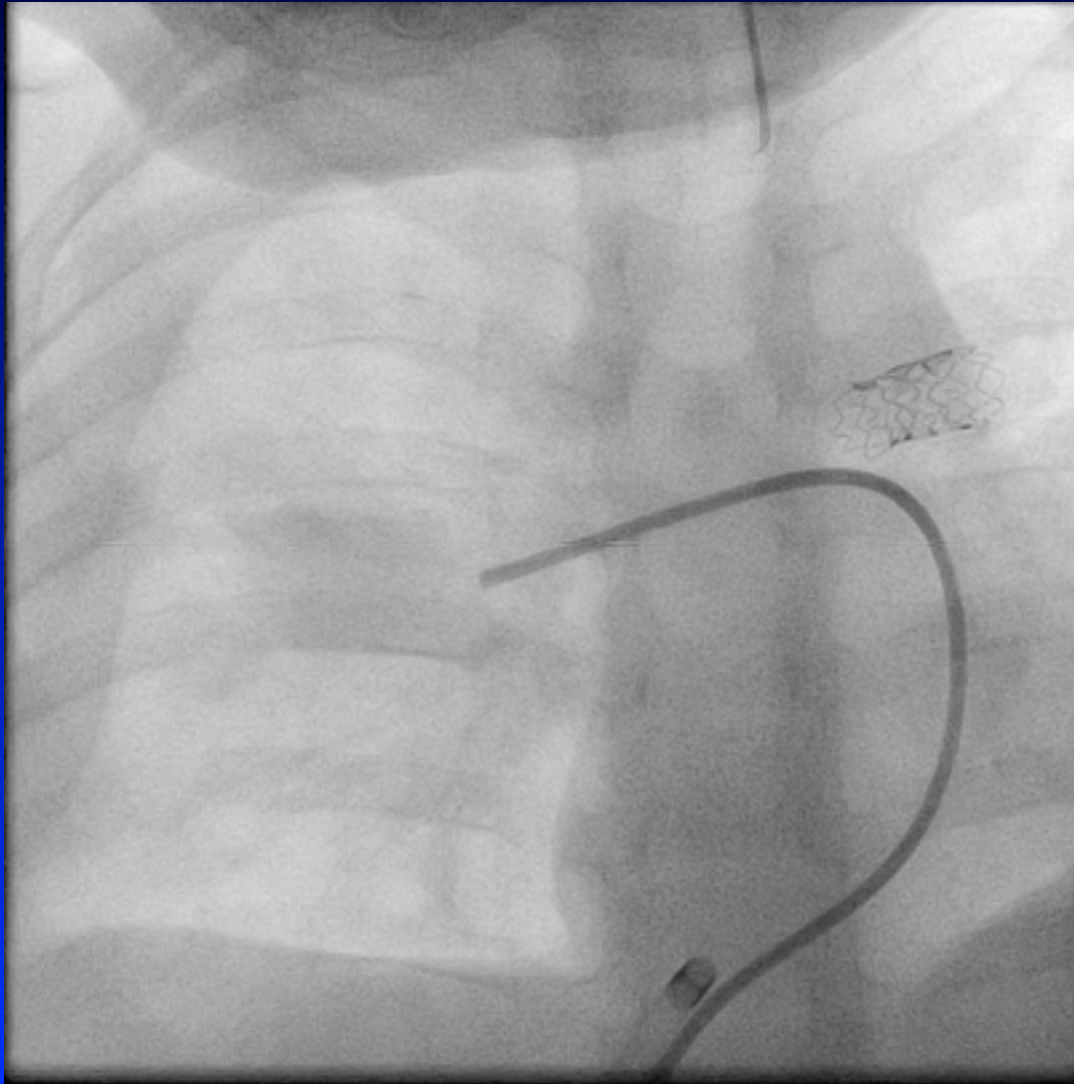
- Death
- Arrhythmia/ heart block
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- Bleeding-hematoma, internal
- Infection
- Cardiovascular perforations, dissections, tears-
(vascular, cardiac, valves)

- Know your anatomy
 - Be on guard:
 - When catheter/wire not in anticipated position
 - Resistance when pushing catheter/wire-tactile sensitivity
 - Neonates/post-op incision sites
 - Calcium
 - Take small hand injections to verify position
 - Biplane views , RVOT
- Stiff wires, transseptal needles, RF wires

Cardiac perforation- RF perforation of valvar PA



Uncontained dissection



Special considerations: Allergic reactions

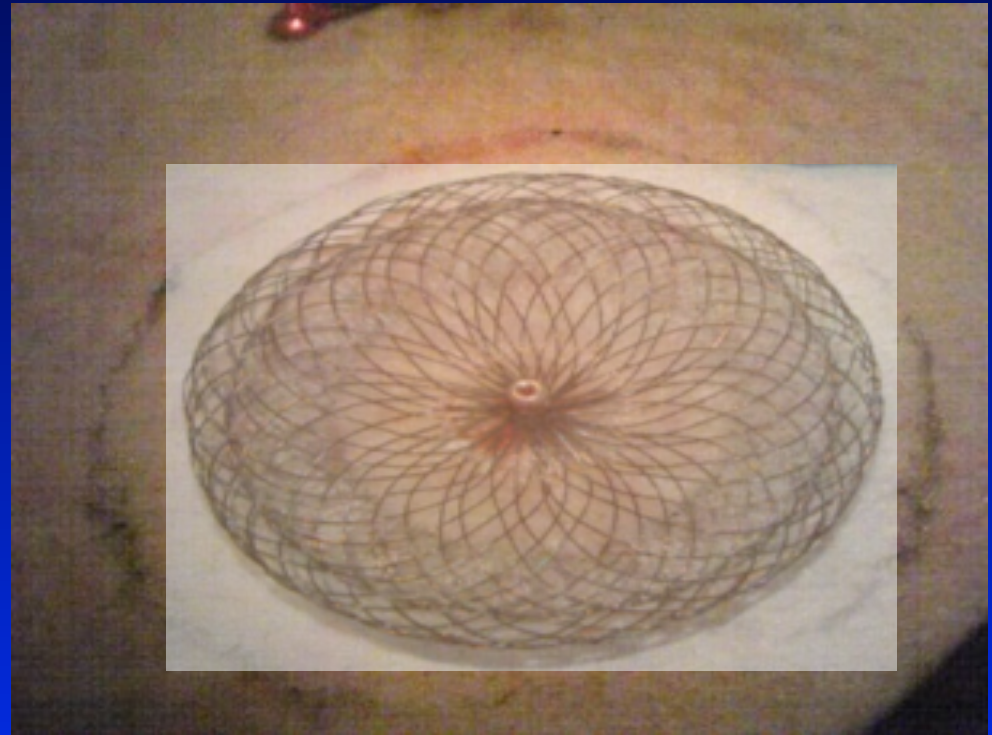
- Contrast-iodine
- Latex, tape
- Nickel-rare
- Renal injury from contrast
 - (classic teaching: 6 cc/kg max)

Diagnosis?

Tape allergy



Nickel allergy



Skin lesion noted day after Melody valve implant...diagnosis?



Syringe found under patient at end of case

- 2 previous PTCA procedures
- Patient weight 300 lbs
- 52 minutes fluoro time
- High dose fluoro mode
- Bi-plane imaging
- 6 weeks later:
 - “rash” develops

