

# Urgent Cath Intervention in the Interstage: Is 3DRA worth the risk?

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# Disclosures

None



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# Interstage Single Ventricle Patients

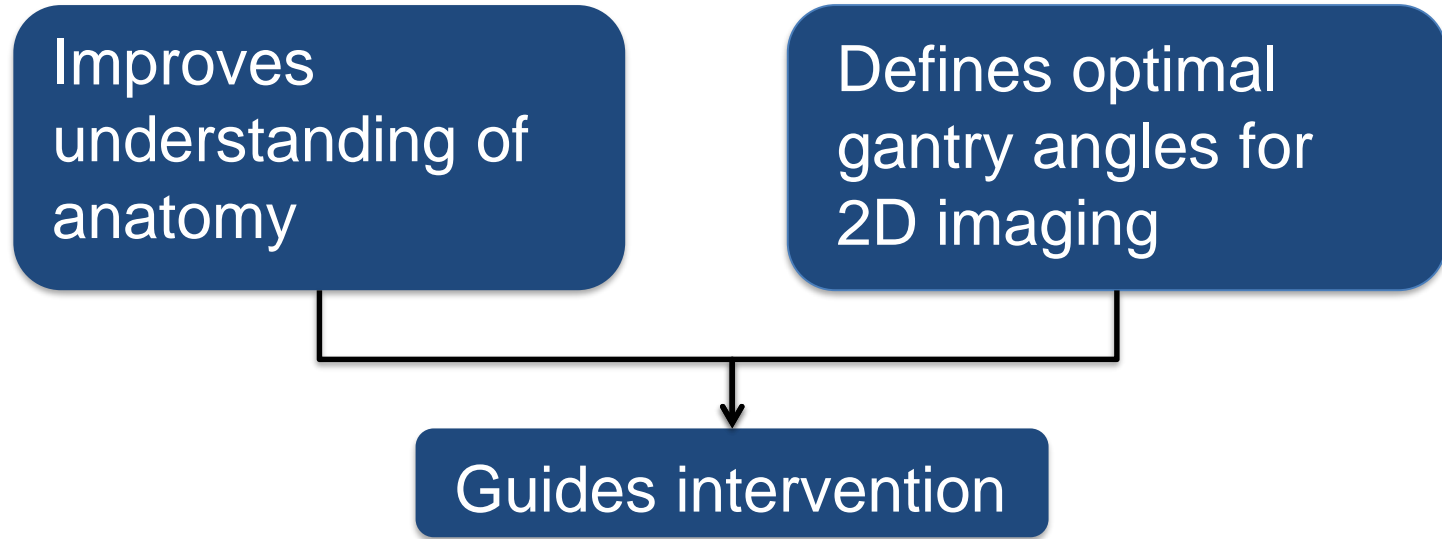
- Mortality 2-16%<sup>1</sup>
- Reinterventions
  - Rate 18-37%<sup>2</sup>
  - Improve systemic oxygenation
    - Increase pulmonary blood flow
    - Improve venous mixing
  - Improve systemic perfusion
  - Urgently performed

<sup>1</sup>Feinstein JA1, Benson DW, Dubin AM, et al. Hypoplastic left heart syndrome: current considerations and expectations. *J Am Coll Cardiol.* 2012 Jan 3;59.

<sup>2</sup>Galantowicz M, Cheatham JP, Phillips A, et al. Hybrid approach for hypoplastic left heart syndrome: intermediate results after the learning curve. *Ann Thorac Surg.* 2008 Jun;85(6):2063-70.



# Benefit of 3DRA



Does the benefit outweigh the risk?



# Catheterization RISK Score for Pediatrics (CRISP)

TABLE V. CRISP Score Point Assignment

Patient Clinical Characteristics	Points assigned
Age ( $X_2$ )	
>1 year	0
30 days–1 year	2 ✓
<30 days	2 ✓
Weight ( $X_3$ )	
>5kg	0 ✓
2.5–5 kg	2
<2.5 kg	2 ✓
Inotropic support ( $X_4$ )	
None	0 ✓
Yes-Stable	0
Yes-Unstable/ECMO	2 ✓
Systemic illness/organ failure ( $X_5$ )	
None	0 ✓
Medically controlled/1 organ failure	0
Uncontrolled/> 1 organ failure	3 ✓
Physiologic Category( $X_6$ )	
Category 1	0
Category 2	1 ✓
Category 3	4 ✓
Pre-Cath Diagnosis ( $X_9$ )	
Category 1	0
Category 2	2 ✓
Category 3	2 ✓
Procedure Category ( $X_{10}$ )	
Category 1	0 ✓
Category 2	1
Category 3	3 ✓
Procedure type ( $X_{11}$ )	
Diagnostic	0
Interventional	3 ✓
Hybrid	3 ✓

Incidence of severe adverse event for interstage single ventricle patient:

6.2% - 36.8%

Nykanen DG, Forbes TJ, Du W, et al. CRISP: Catheterization RISK score for Pediatrics: A Report from the Congenital Cardiac Interventional Study Consortium (CCISC). Catheter Cardiovasc Interv. 2016 Feb 1;87(2):302-9. doi: 10.1002/ccd.26300. Epub 2015 Nov 3.



# Barriers to 3DRA in Urgent Interstage Catheterizations

- Increased radiation dose
- Increased contrast dose
- Increased procedural time
- Additional vascular access
- Clinical decline with pacing

# 3DRA vs 2D Digital Angiography

**Table 3.** Patient Study and Control Group: Comparison of Radiation and Parameters to Perform Rotational and Bi-plane Imaging and Total Procedural Radiation

Radiation Parameters	3DRA Group, Median (IQR), n = 100	2DDA Group, Median (IQR), n = 100	P Value
Duration of single 3DRA/2DDA (seconds)	4.1	4.9 (3.8-6.2)	.12
DAP for a single 3DRA/2DDA (cGy/cm <sup>2</sup> )	278 (107-595)	241 (124-760)	.14
Indexed DAP for a single 3DRA/2DDA (cGy/cm <sup>2</sup> /m <sup>2</sup> )	237 (147-428)	218 (130-732)	.42
Effective dose by Monte Carlo simulation (mSv)	1.8 (1.2-2.8)	1.67 (1.08-3.7)	.22
Total procedural DAP (cGy/cm <sup>2</sup> )	3605 (1679-18 033)	3544 (1186-10 761)	.45
Total procedural indexed DAP (cGy/cm <sup>2</sup> /m <sup>2</sup> )	3348 (1885-9383)	3176 (1537-7778)	.48
Total procedural Air Kerma (mGy)	250 (146-816)	265 (121-531)	.21
Total procedural indexed Air Kerma (mGy/m <sup>2</sup> )	244 (170-578)	249 (174-500)	.79

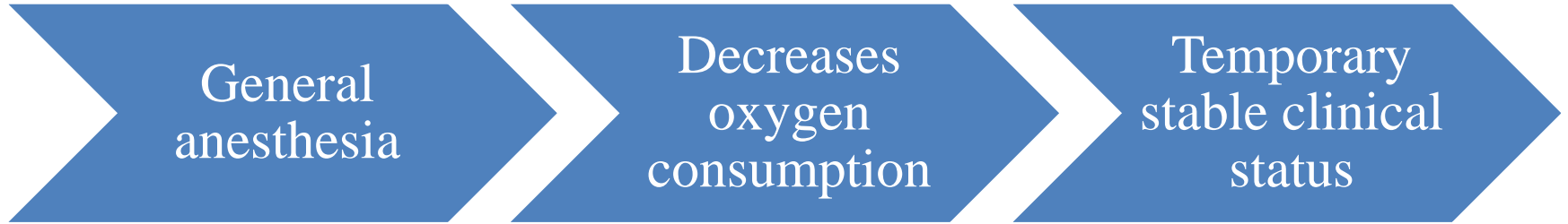
**Table 5.** Patient Study and Control Group: Comparison of Contrast Volumes and Other Procedural Data

Contrast and Procedural Data	3DRA Group, Median (IQR), n = 100	2DDA Group, Median (IQR), n = 100	P Value
Single 3DRA/2DDA contrast volume (mL/kg)	1.59 (1.0-1.9)	1.01 (0.5-1.2)	<.001
Total procedural contrast volume (mL/kg)	3.8 (2.9-5.3)	4 (2.5-5.2)	.494
Number of cine angiograms	7 (4-12)	11 (7-15)	<.001
Total fluoroscopy time (min)	30.8 (17-55)	42.3 (30-60)	.023
Length of procedure (min)	140 (110-207)	161 (135-217)	.106

Haddad L, Waller BR, Johnson J, et al.  
Radiation Protocol for Three-Dimensional Rotational  
Angiography to Limit  
Procedural Radiation Exposure in the Pediatric  
Cardiac Catheterization Lab. Congenit Heart Dis.  
2016 Apr 14. doi: 10.1111/chd.12356.

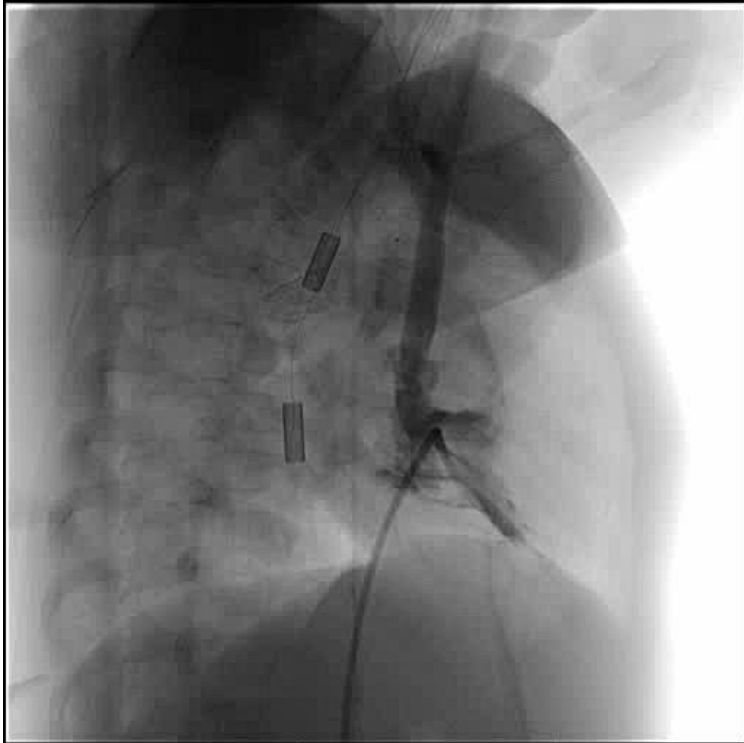


# Clinical Status





# Transesophageal Pacing



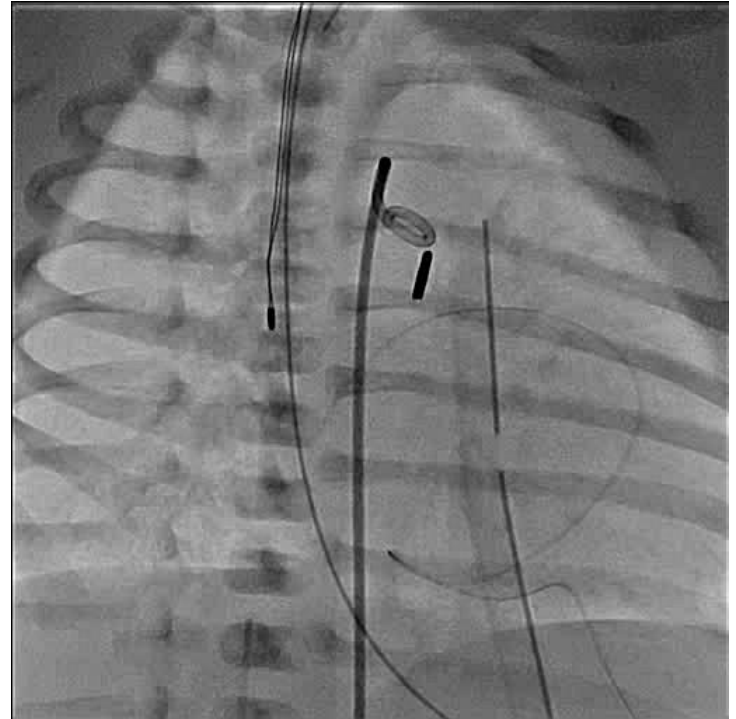
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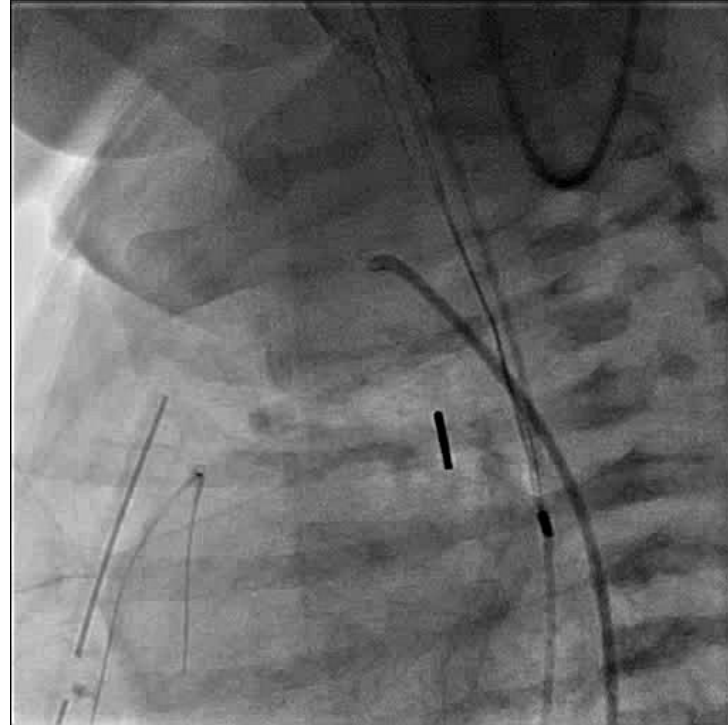
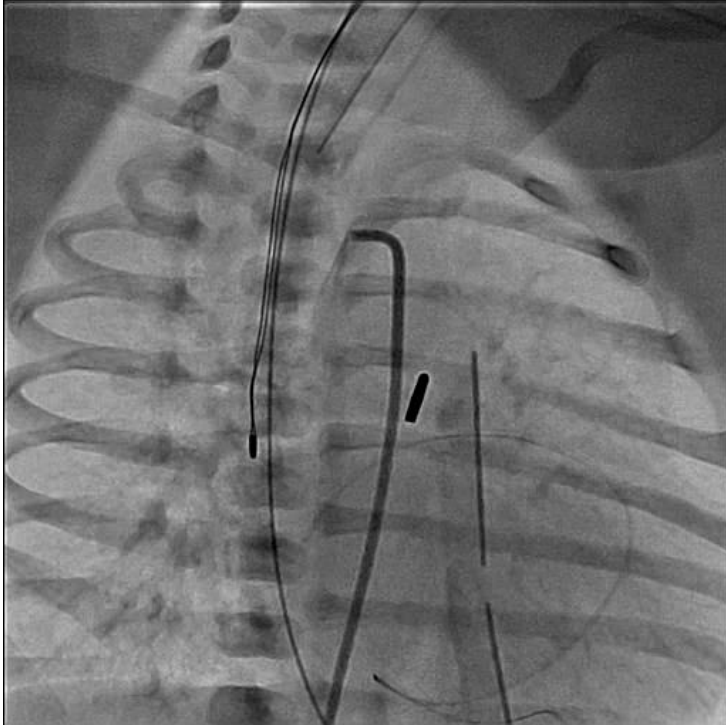
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# Case 1: Modified BT Shunt

- 1 week-old male
- PA/IVS, hypoplastic RV, RVDCC
- S/P placement of a 3.5 mm Gore-Tex modified BT shunt
- Severe post-operative cyanosis hours



# Selective Angiogram

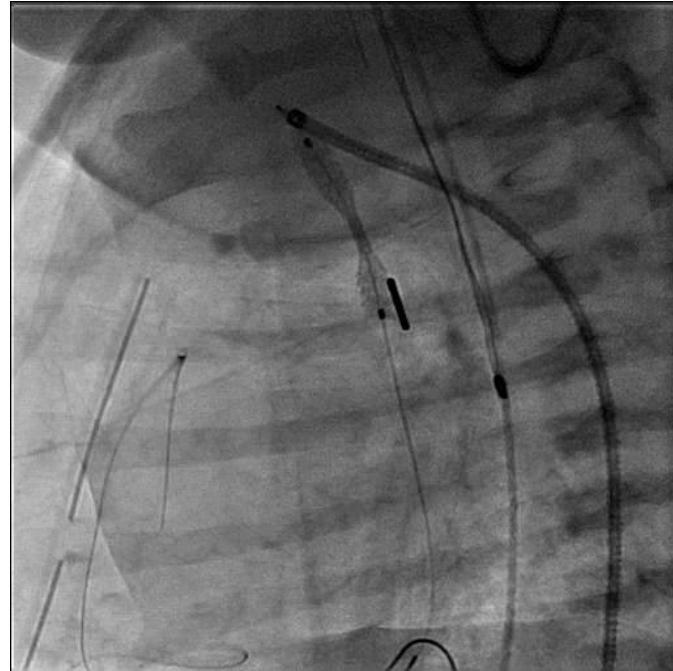
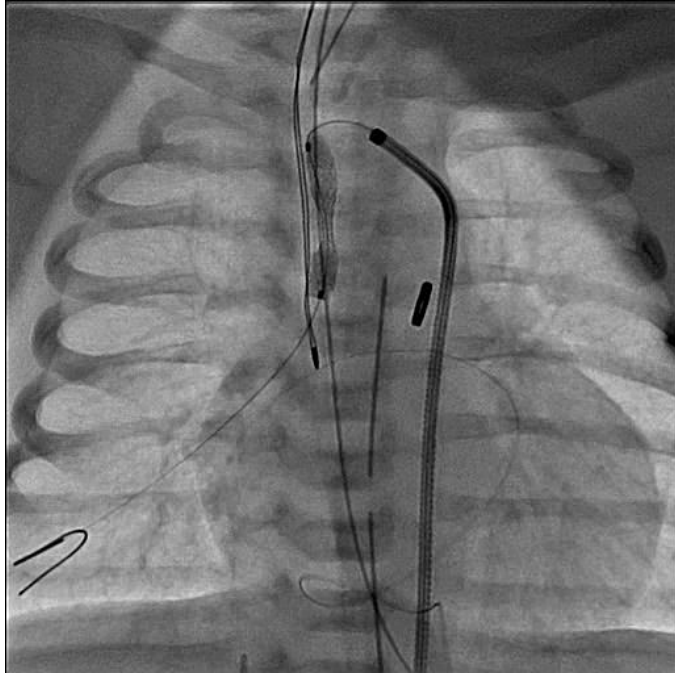


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# Implantation of a 3.5 mm x 18 mm Integrity Stent

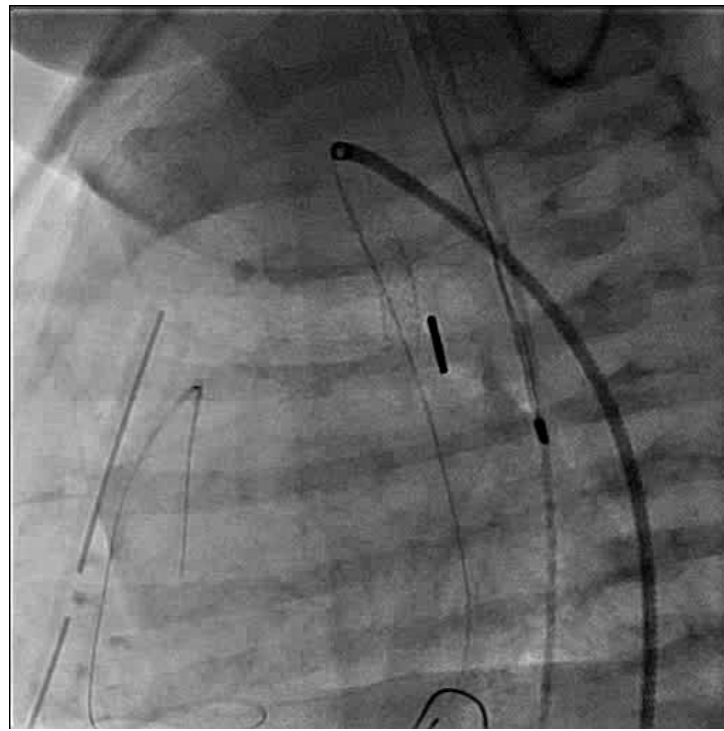
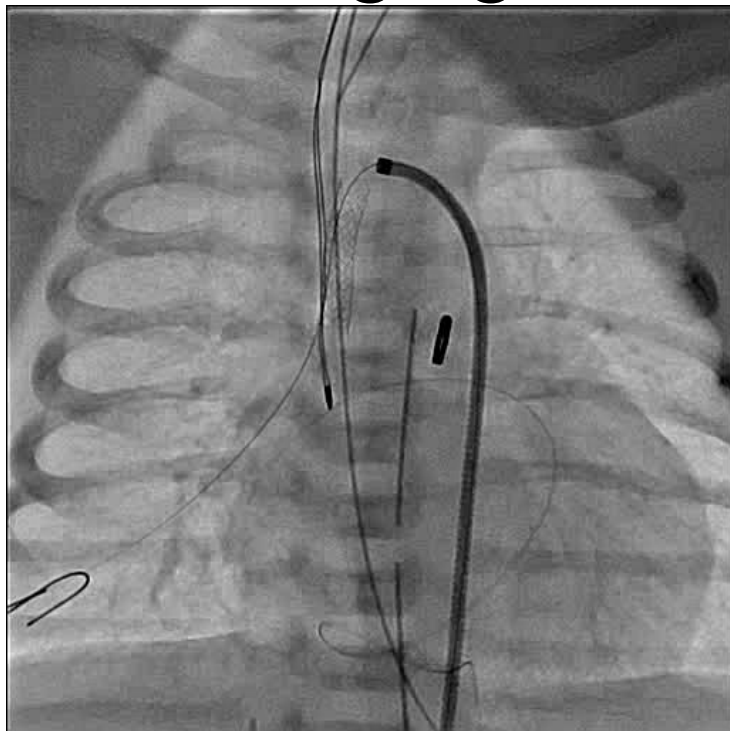


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# Final Angiogram



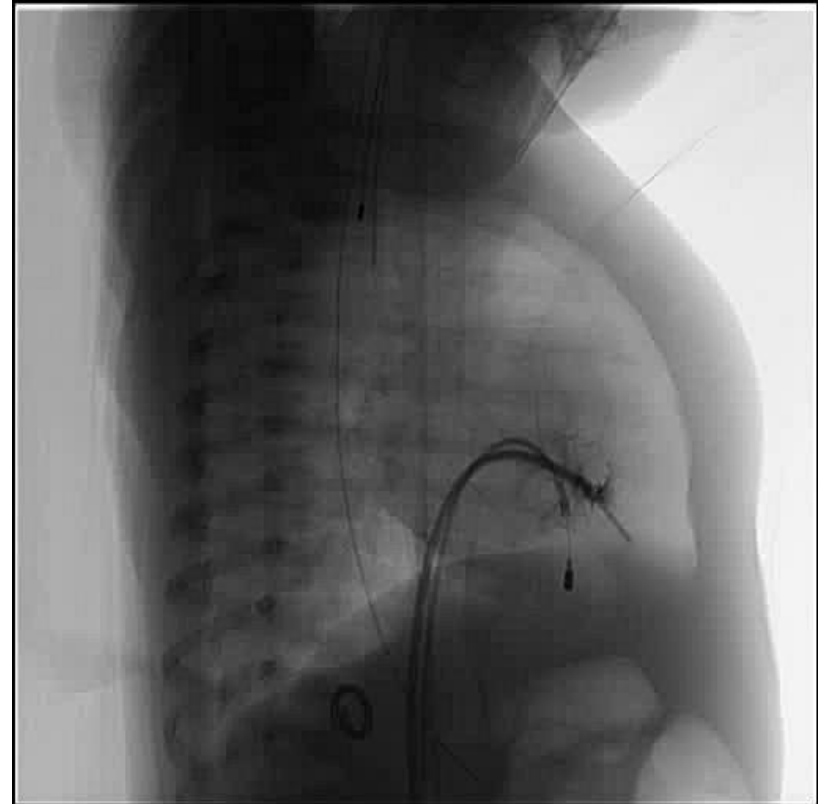
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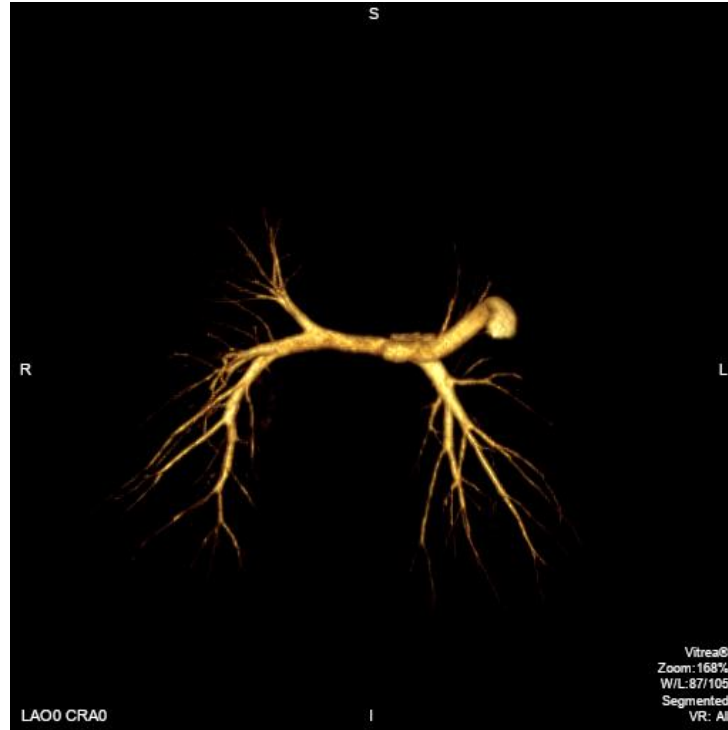
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# Case 2: Sano Shunt

- 1 month-old male
- HLHS (AS/MS) s/p Norwood operation with a 4 mm Gore-Tex Sano shunt
- Progressive cyanosis



# 3D Reconstruction

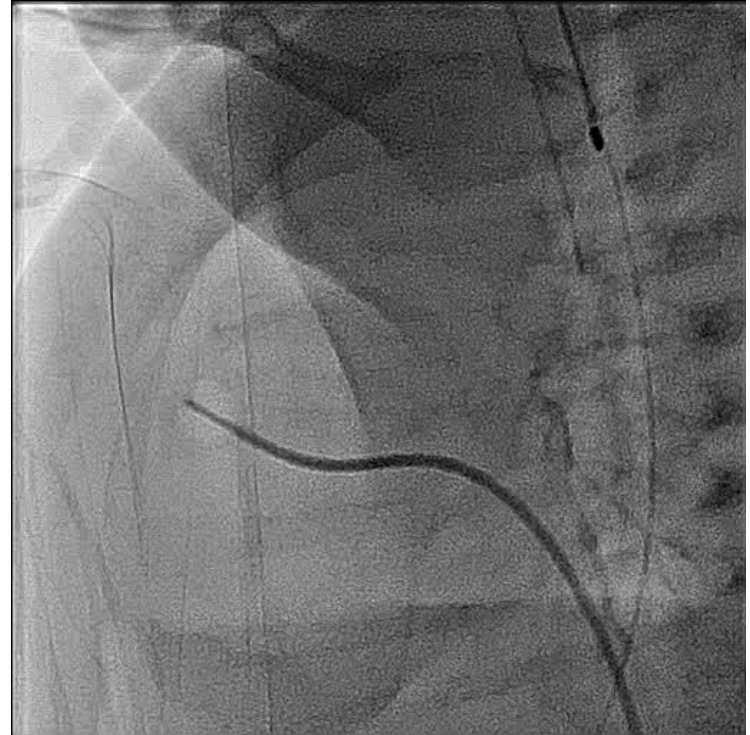
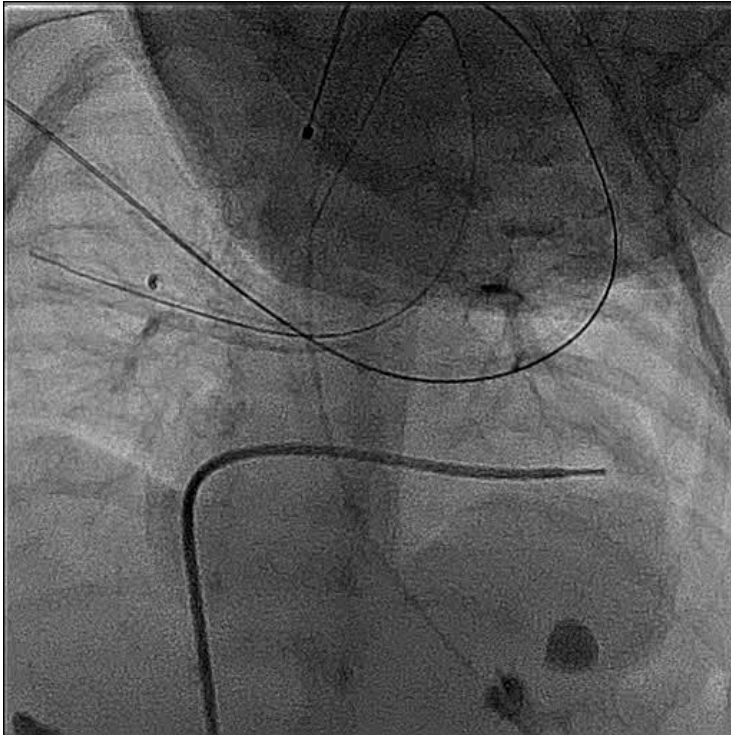


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# Sano Shunt Angiogram



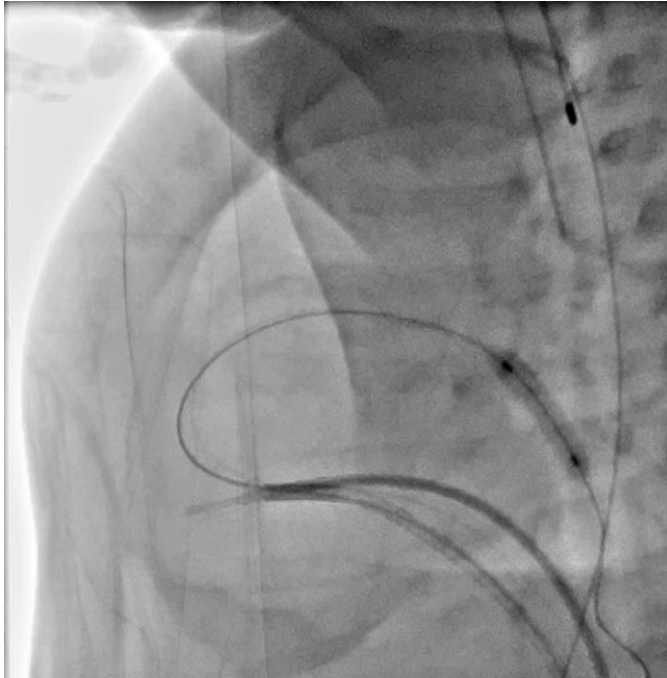
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# Balloon Angioplasty with 3.5 mm x 15 mm Quantum Maverick Balloon

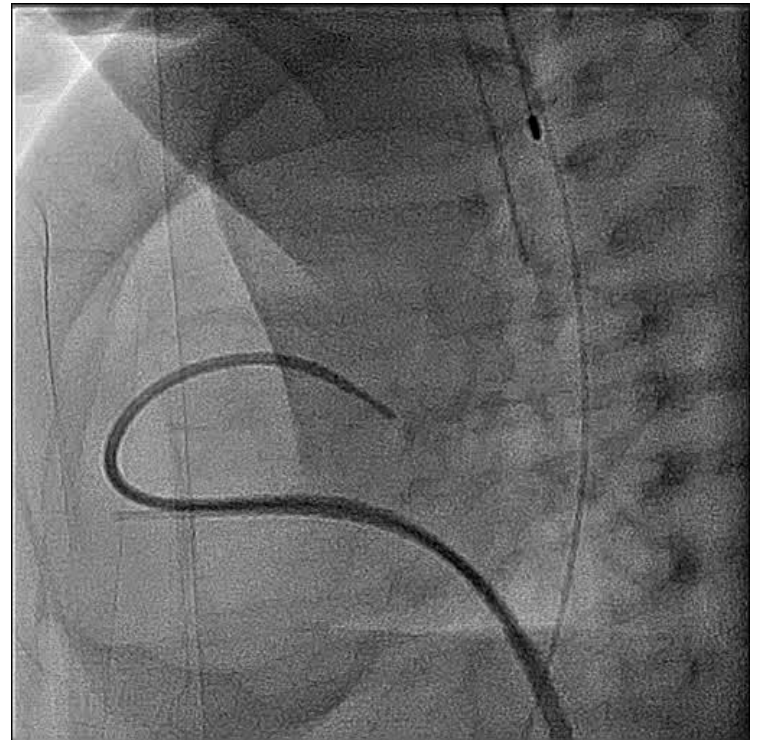
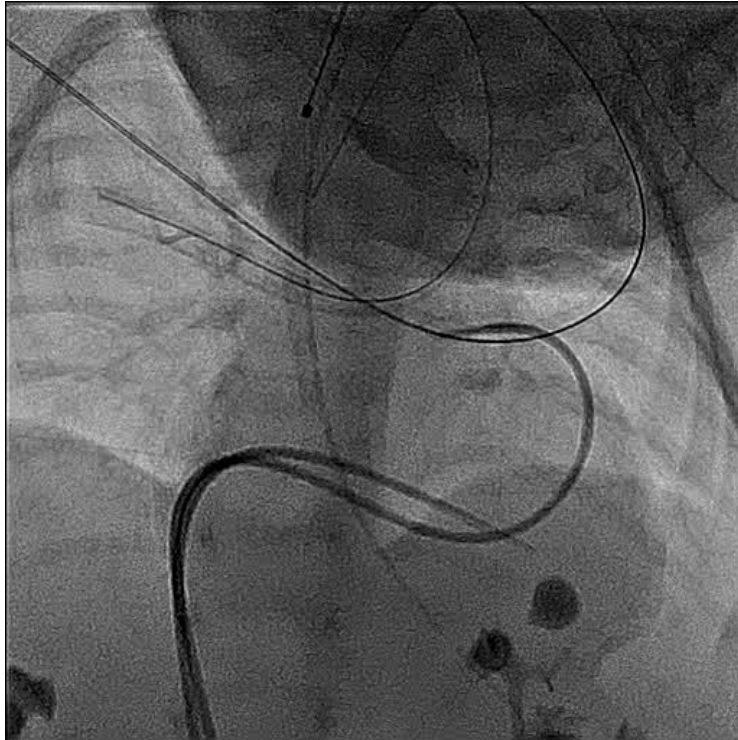


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# Post Procedural Angiogram



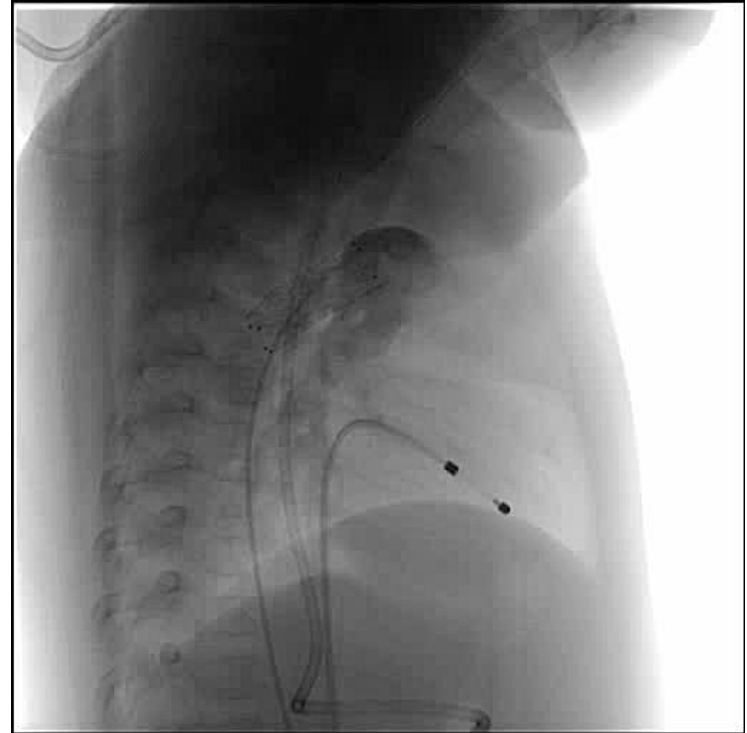
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# Case 3: Retrograde Aortic Arch Obstruction

- 3 month-old female
- HLHS (MA/AA)
- S/P Hybrid stage I palliation
- Echocardiogram revealed an increasing gradient across the retrograde aortic arch



# 3D Reconstruction

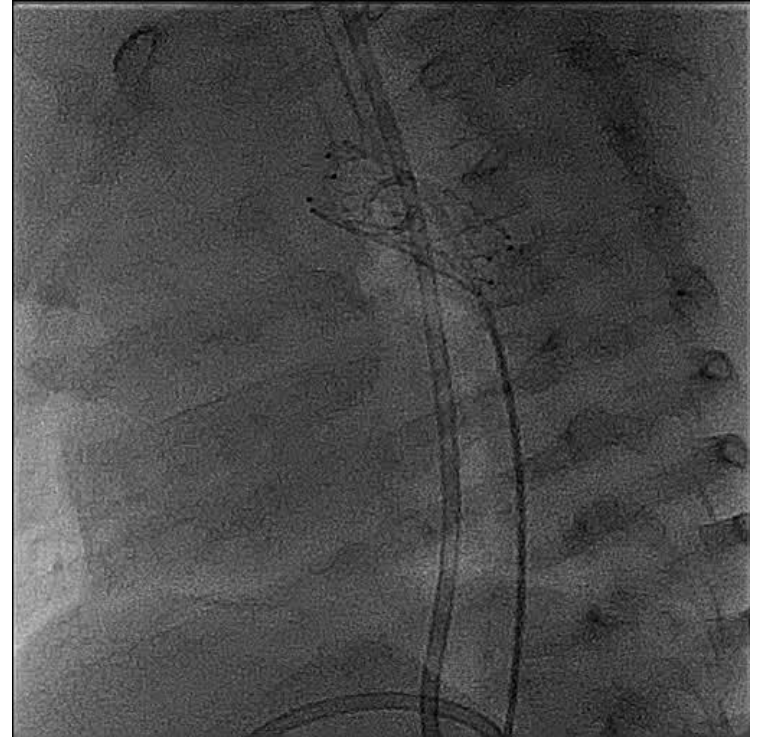
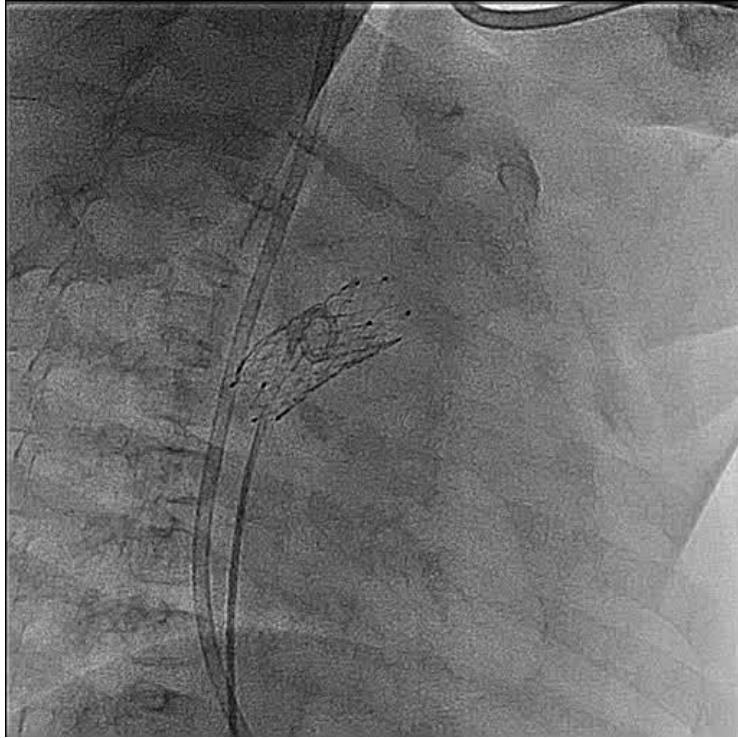


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# Retroaortic Arch Angiogram

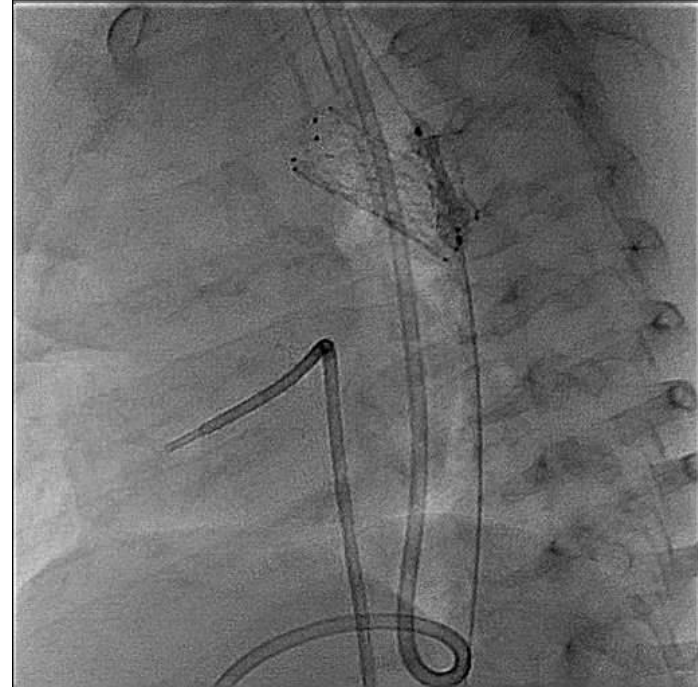
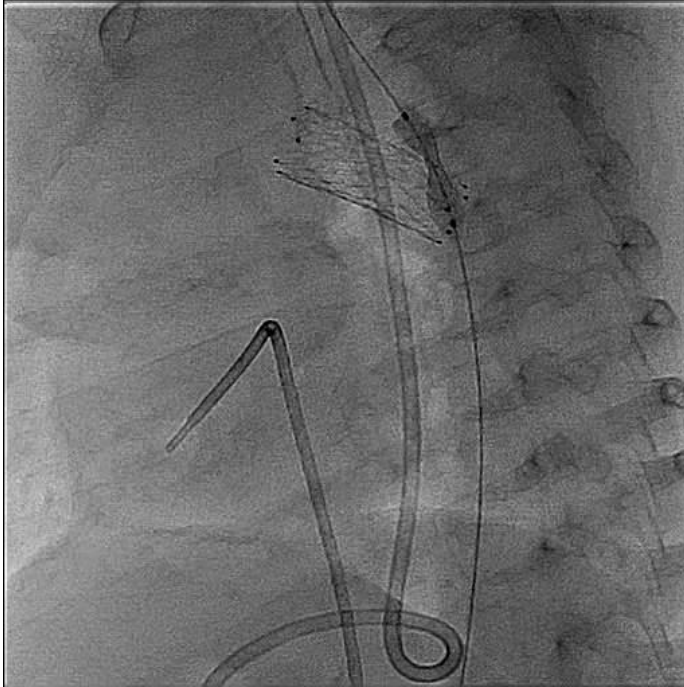


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# Implantation of 4.5 mm x 13 mm Multi-Link Ultra Coronary Stents (x2)

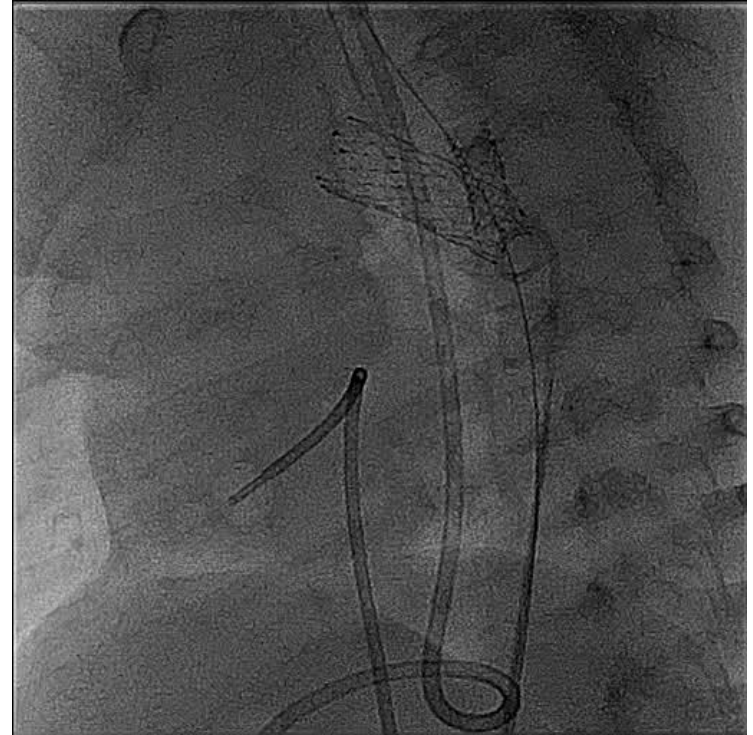
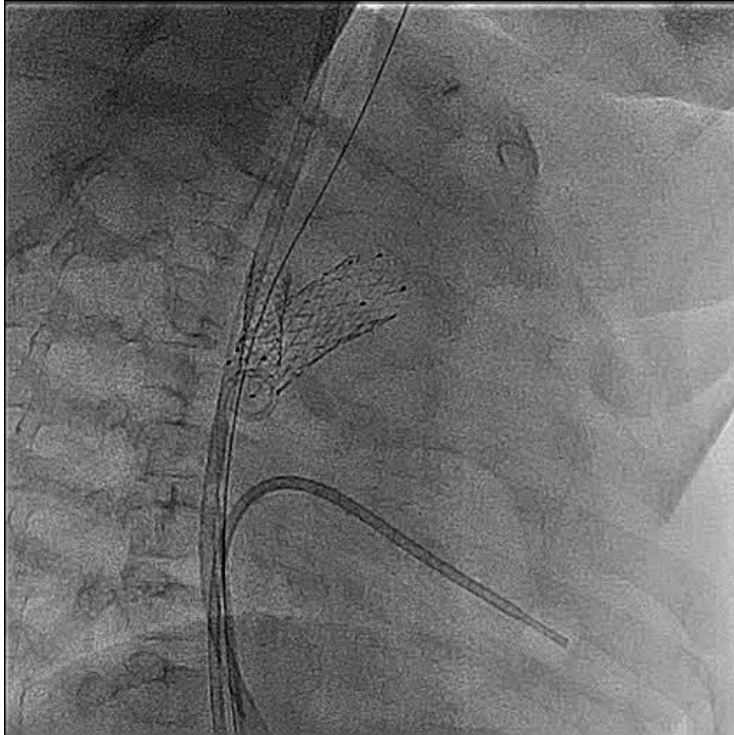


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# Post-Procedural Angiogram



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# Summary

- Interstage SV patients are at high risk for morbidity and SAE during cardiac catheterization
- Risk of 3DRA can be mitigated
- 3DRA guides intervention
- Use of 3DRA should be determined on an individual basis





# Is 3DRA Worth the Risk?

## **Yes:** Complex Anatomy

- Visualized in  $>2$  planes
- Optimal planes are unknown
- Adjacent to other anatomic structures

## **Examples**

- RV-PA conduit
- Pulmonary arteries
- Recoarctation
- Retrograde aortic arch

## **Maybe not:** Simple Anatomy

- Visualized in  $\leq 2$  known planes
- Distant from other anatomic structures

## **Examples**

- Shunts
- Stented PDA
- Atrial septum



# Thank You



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