Pediatric Cardiac CT

State of the art imaging with Dual Source technology

Daniel Kütting

University Hospital Bonn, Germany
Department of Diagnostic and Interventional Radiology
Chair: Prof. Dr. med. Ulrike Attenberger

Disclosures

Speakers Fee:

Philips Healthcare, Siemens Healthineers, AstraZeneca, Boehriner Ingelheim, GSK

Advisory Board:

Boehringer Ingelheim

- Tremendous growth in pediatric cardiac computed tomography imaging
- Fast scan times (0.27 to 0.35 seconds)
- Excellent spatial (0.5 mm) and temporal (63 ms) resolution
- Physiologic information
- 3-D post processing

- Complimentary to Echocardiography
- Excellent modality for emergent indications
- No to minimal sedation required
- Motion correction & Artifact reduction tools

Parameters	Echocardiography	Catheterization	Cardiac CT(A)
Invasiveness	No	Yes	No
Morbidity	No	Yes	Yes
Acoustic window limitation	Yes	No	No
Temporal resolution	Highest	High	Fair
Spatial resolution	Fair	Highest	High
3-D post-processing	Yes	Yes	Yes
Operator dependent	Yes	Yes	No
Acquisition time	Depends on operator	Long	Very short
Radiation exposure	No	Yes	Yes
Risks of contrast medium	No	Yes	Yes
Availability	Most	Least	Average

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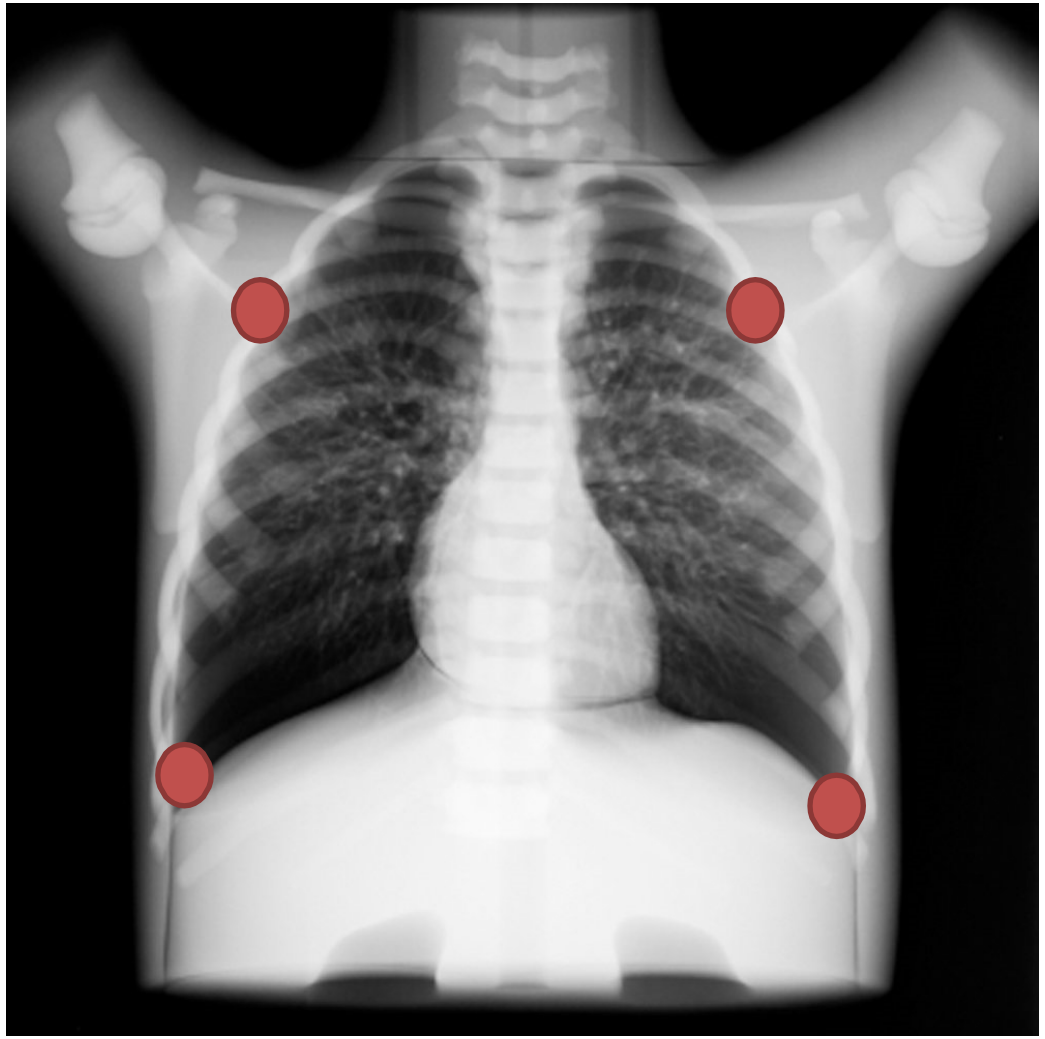
- Preparation
- Protocol selection
- Dose estimation

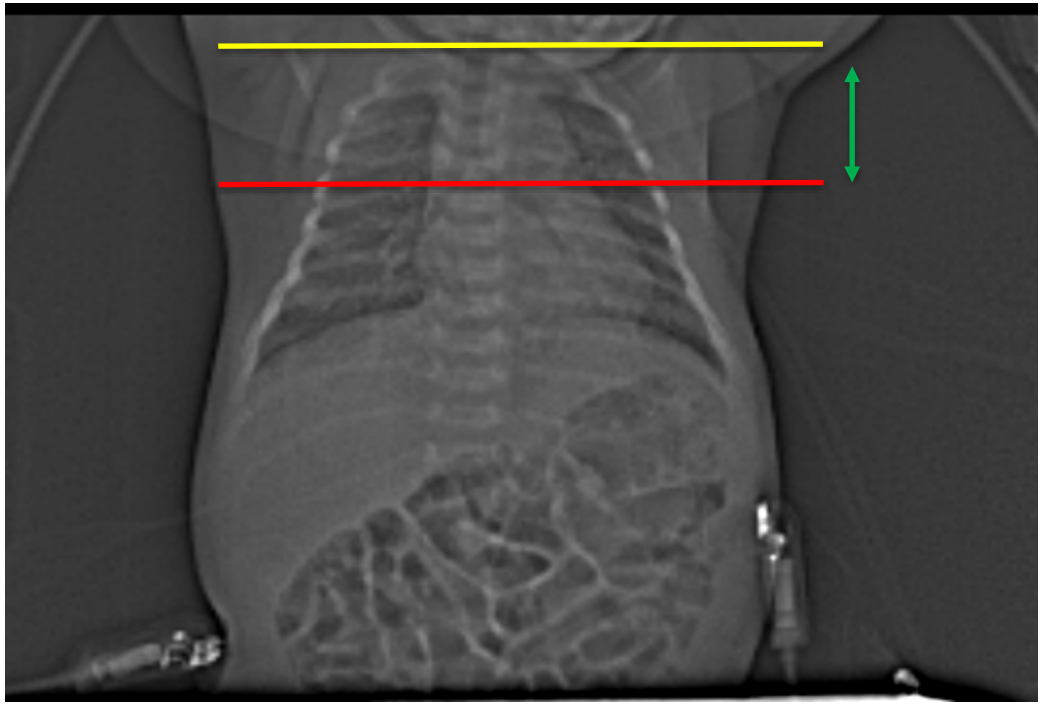
Positioning and ECG Leads



Kyoto Kagaku pediatriac thorax phantom

Preparation

- In heart rates below 70–75 beats per minute, optimum at 70% of the RR inter
- In faster heart rates imaging at end-systole (at 30–40% of the RR) superior



Goo et al. Pediatr Radiol 2019
Jin et al . Int J Cardiovasc Imaging 2010

Contrast agent

- iso-osmolar contrast agents (300–370 mg iodine/mL)
- 1.5–2 mL/kg diluted in saline (50-80%)

Scan timing

- Triggered vs. calculated start

Secinaro et al. Pediatr Radiol 2019

Protocol

▪ Prospective ECG-gating high pitch imaging	→ “working horse”
▪ Prospective ECG-gating (“step and shoot”) – single phase imaging or “padding” combined with low tube current imaging for functional assessment	→ Functional assessment and coronary imaging
▪ Retrospective ECG-gating	→ never

Temporal resolution

Vendor	Scanner model	X-ray source — detector design	Number of detector rows	Detector element *z*-dimension (mm)	Total detector *z*-axis coverage (mm)	Minimum gantry rotation time (ms)	Intrinsic TR (ms)	X-ray generator power (kW)
GE Healthcare, Chalfont St Giles, UK	Optima 660	Single	64	0.625	40	350	175	72
	Revolution HD/GSI	Single	64	0.625	40	350	175	107
	Revolution CT	Single	256	0.625	160	280	140	103
Philips Healthcare, Guildford, UK	Ingenuity	Single	64	0.625	40	420	210	80
	iCT Elite	Single	128	0.625	80	270	135	120
	IQon Spectral CT	Single	64	0.625	40	270	135	120
Siemens Healthcare, Frimley, UK	Somatom Definition Edge Stellar	Single	64	0.6	38.4	280	142	100
	Somatom Definition Flash Stellar	Dual	64	0.6	38.4	280	75	2 × 100
	Somatom Force	Dual	96	0.6	57.6	250	66	2 × 120
Toshiba Medical Systems, Crawley, UK	Aquilion PRIME[a]	Single	80	0.5	40	350	175	72
	Aquilion ONE	Single	320	0.5	160	350	175	72
	Aquilion ONE Vision	Single	320	0.5	160	275	137	100

Roefo 2019

DSCT	Age (y)	Effective dose (mSv)
Non-ECG-gated		
Ben Saad et al.	<1 y	0.5
Jin et al.	<5 y	0.74
Kanie et al	<6 y	1.3
High-pitch spiral ECG-triggered		
Kravchenko et al.	<1 y	0.24
Liu et al.	<5 y	0.41
Malone et al.	<20 y	0.98

Cases

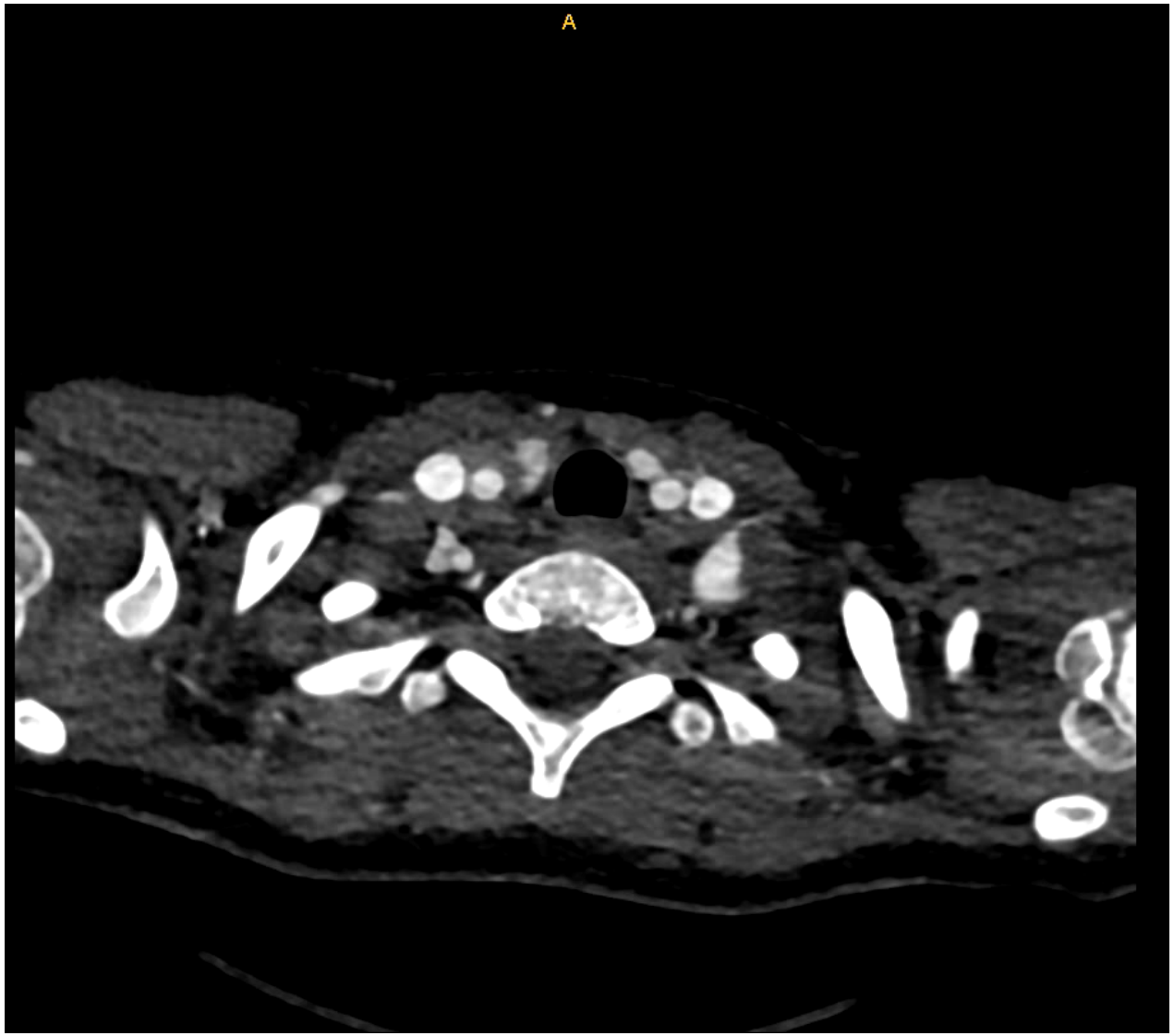
Evaluation of Pulmonary Arteries

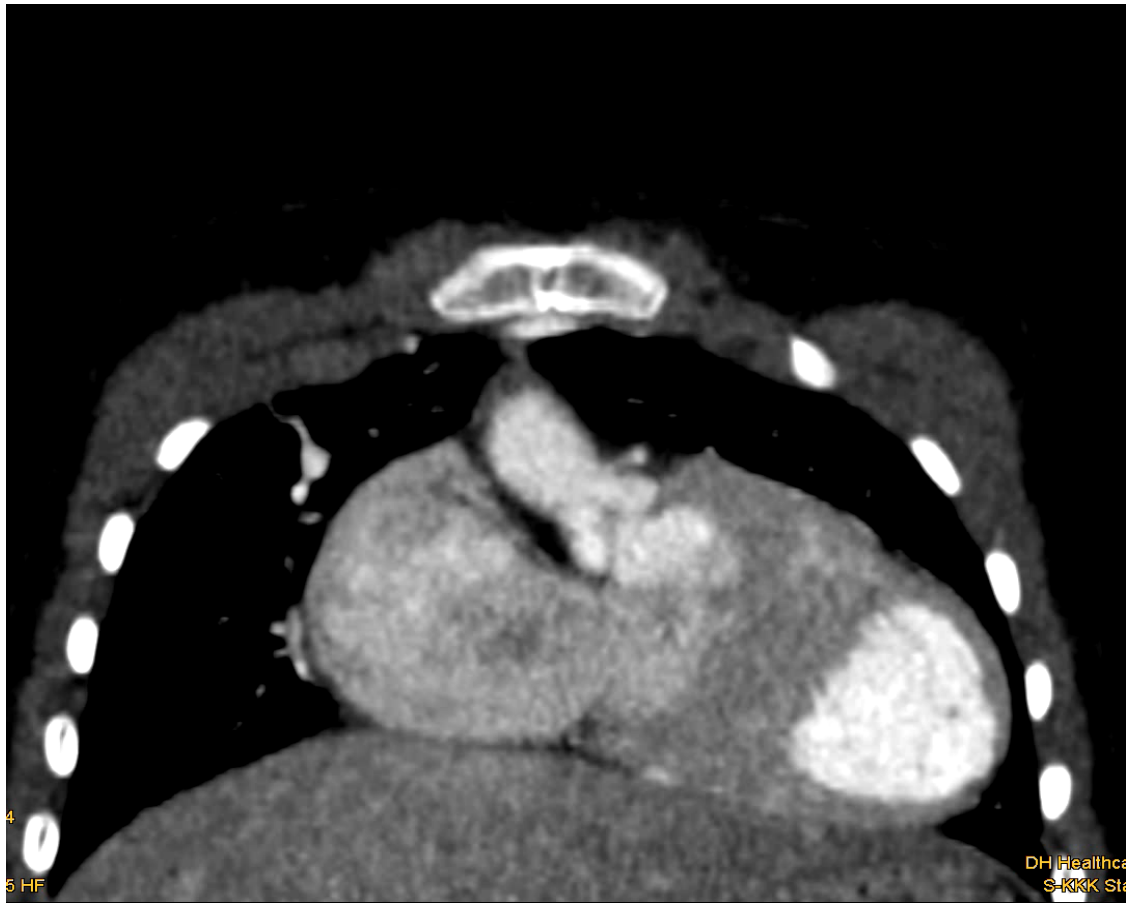
Pulmonary Atresia

- 5 year old girl
- pulmonary atresia
- hypoplasia of the central pulmonary arteries
- several MAPCAs
- before unifocalisation of MAPCAS

Prospective high pitch ECG-gated non triggered protocol

@ 126 BPM

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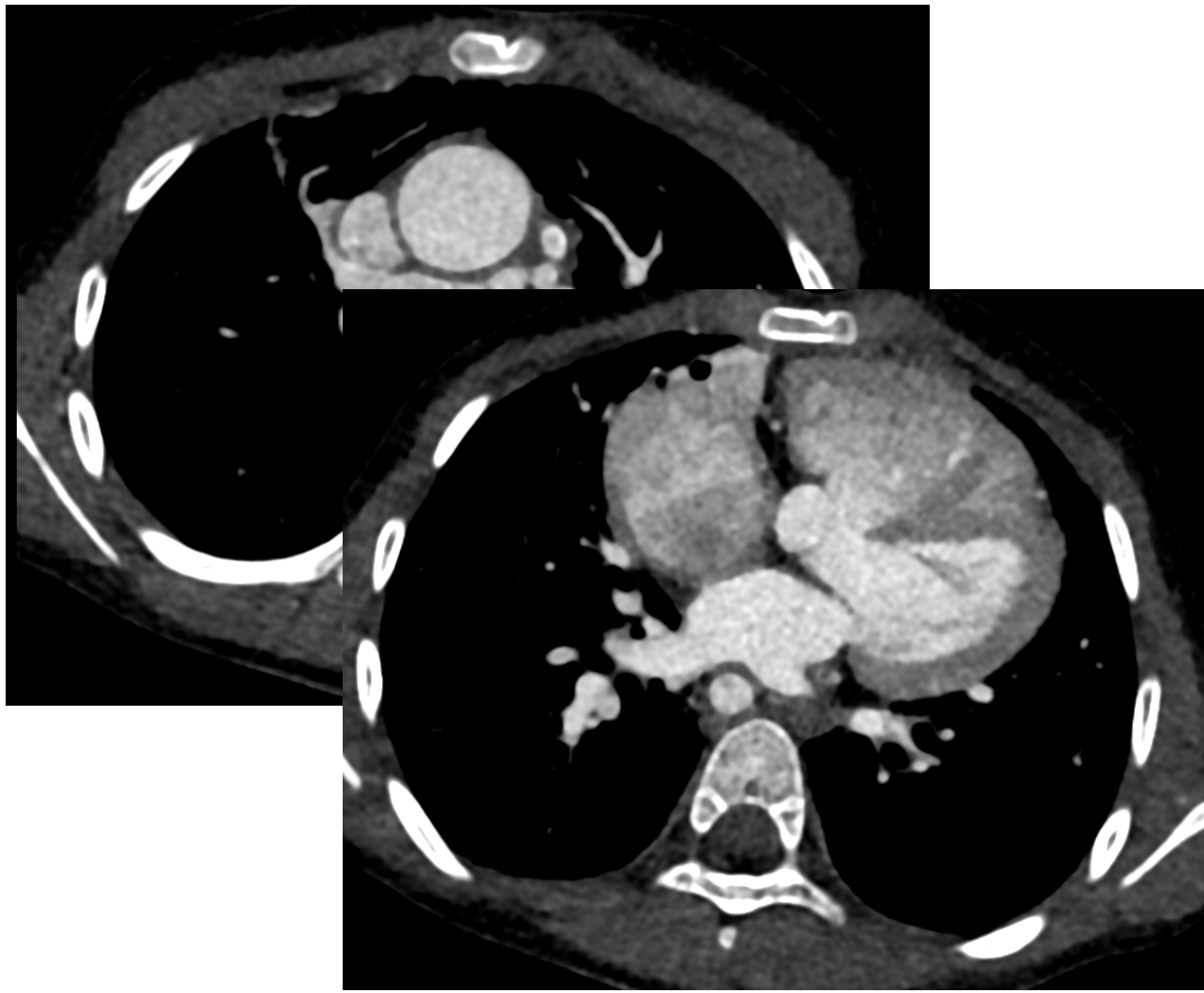


Radiation Dose:

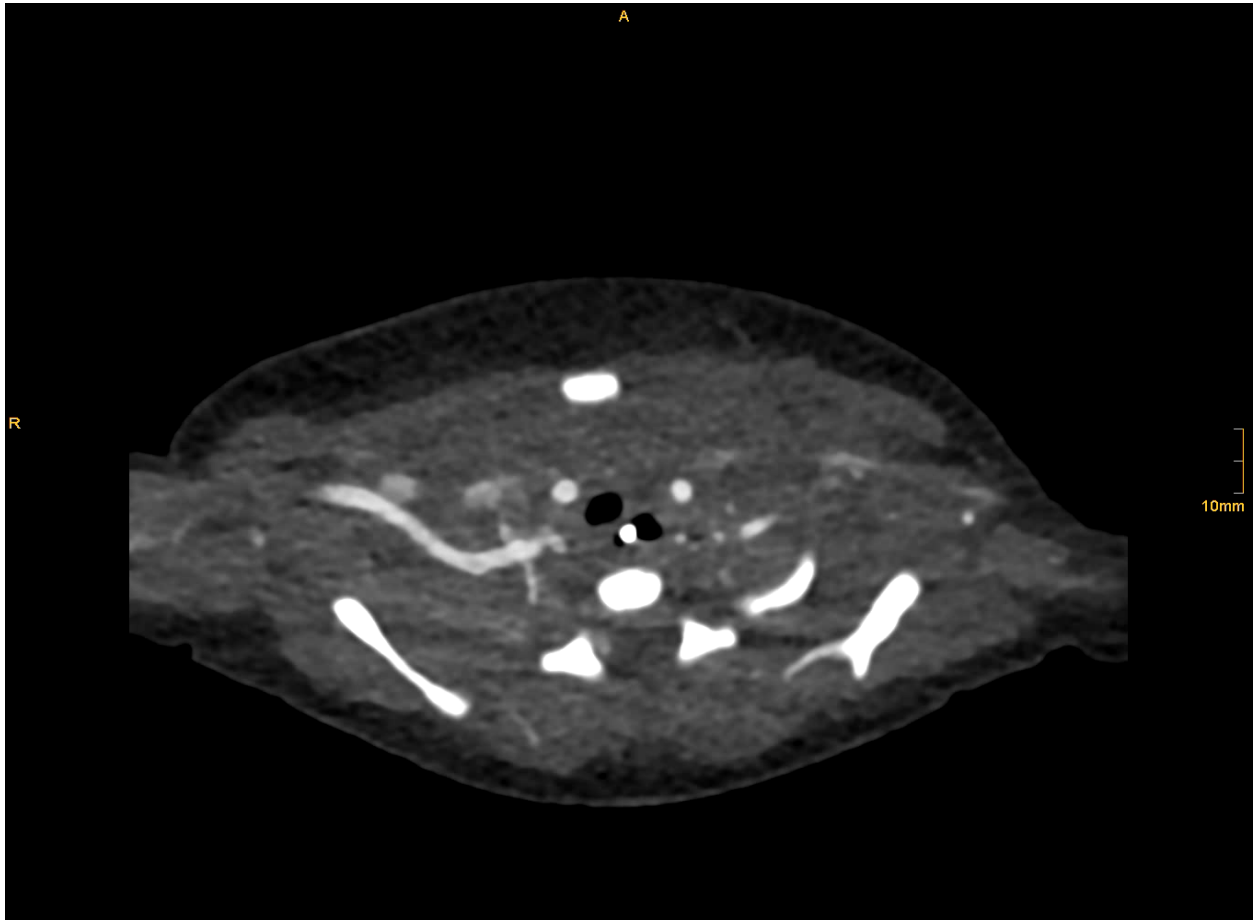
DLP:	9.1 mGycm
CTDI:	0.55 mGy
Effective D:	0.35 mSv

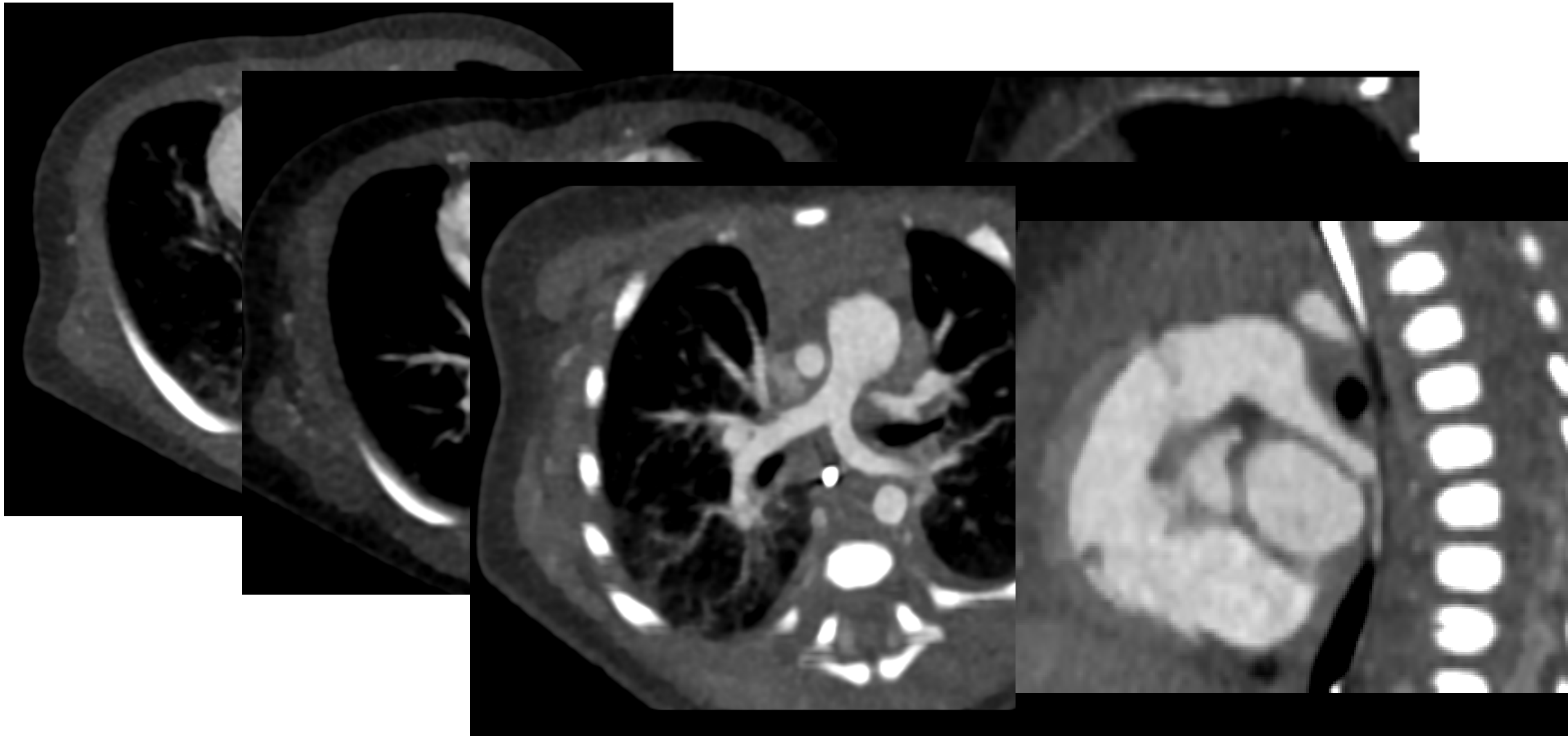
- 4 day old boy
- hypoplastic left heart
- Dysplastic mitral valve
- hypoplastic aortic arch
- ventricular septal defect
- partial left pulmonary sling

Cardiac and pulmonary anatomy?

Prospective high pitch ECG-gated non triggered protocol

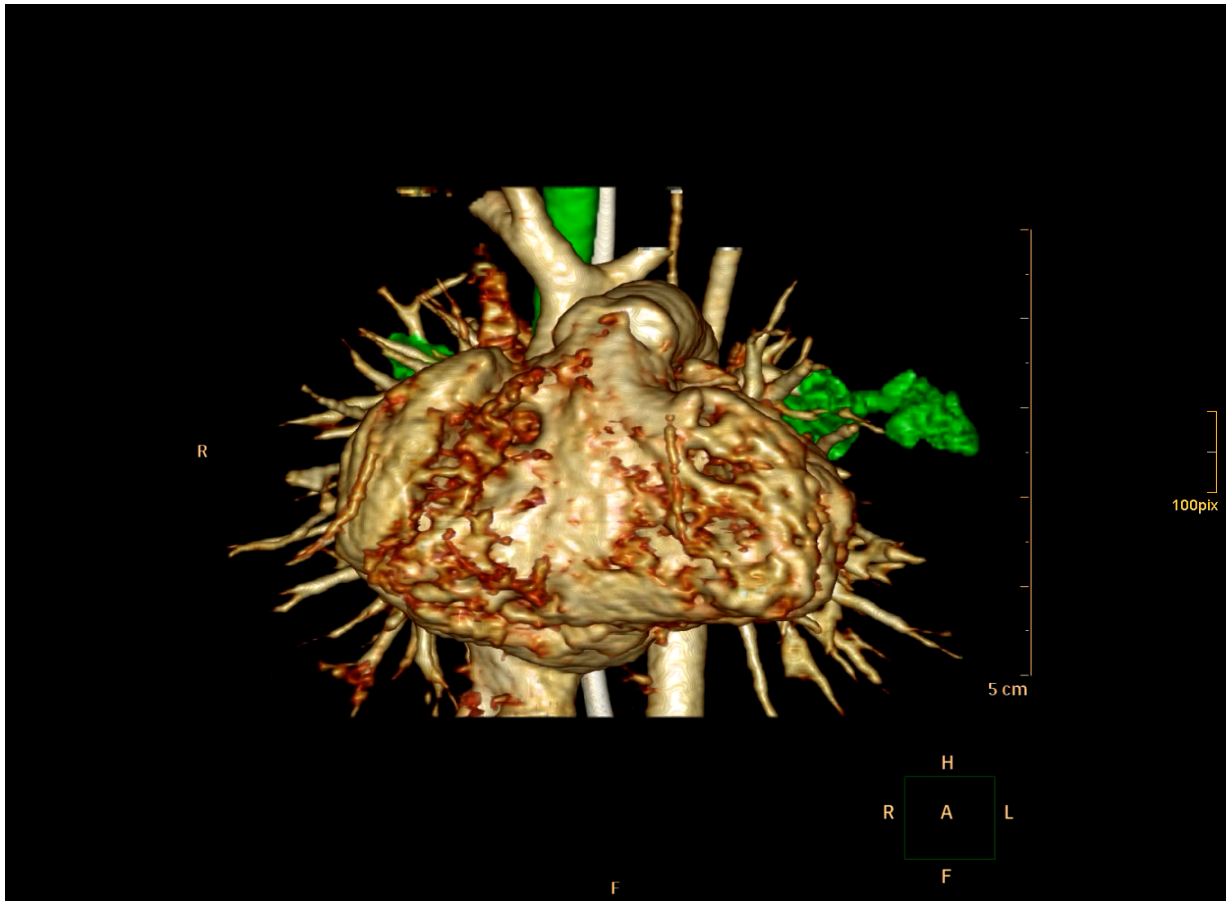
@ 142 BPM





Radiation Dose:

DLP:	2.5 mGycm
CTDI:	0.2 mGy
Effective D :	0.097 mSv



Evaluation of Pulmonary Veins

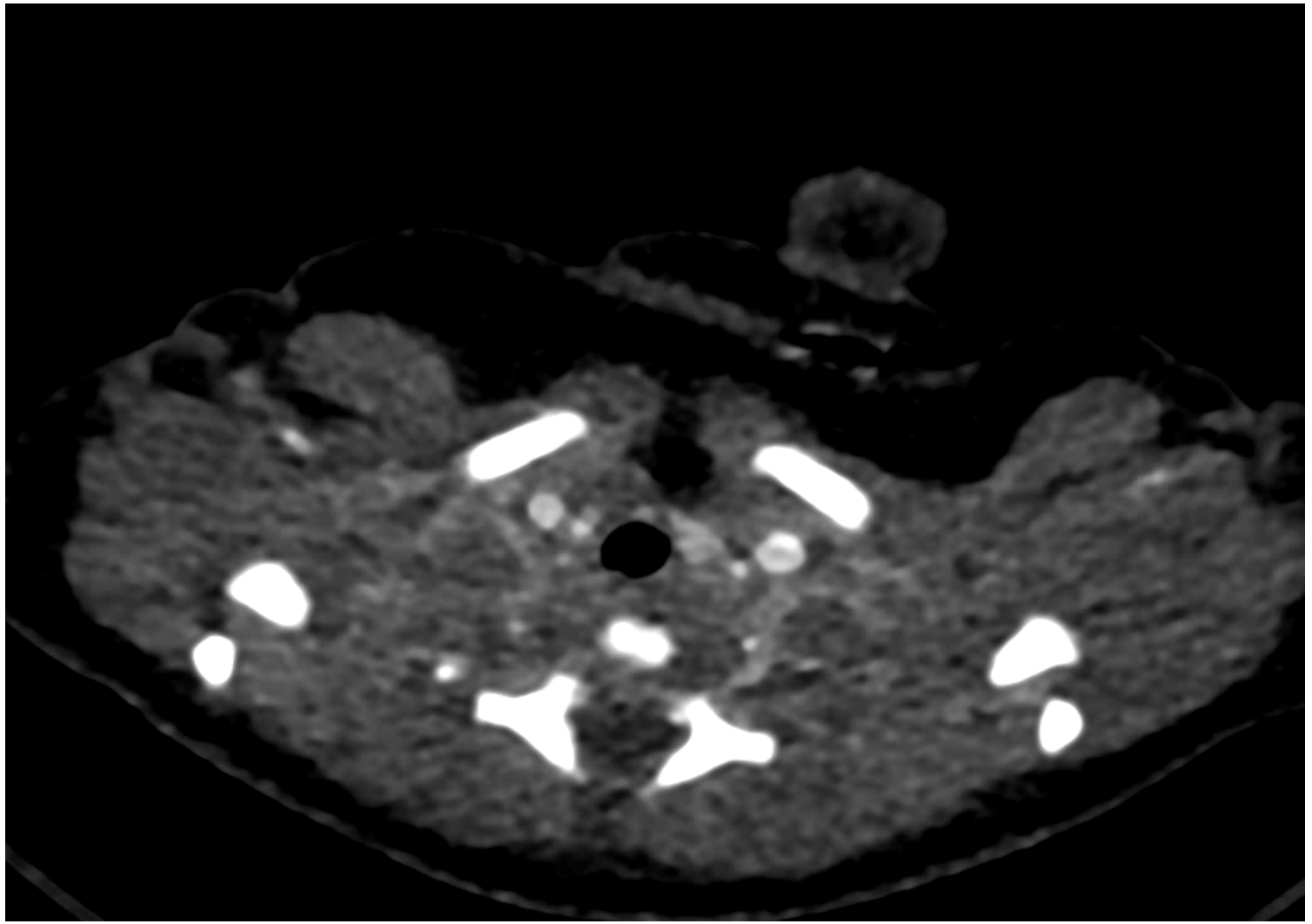
- 15 day old boy
- **TAPVD**
- partial AV-canal
- ASD II

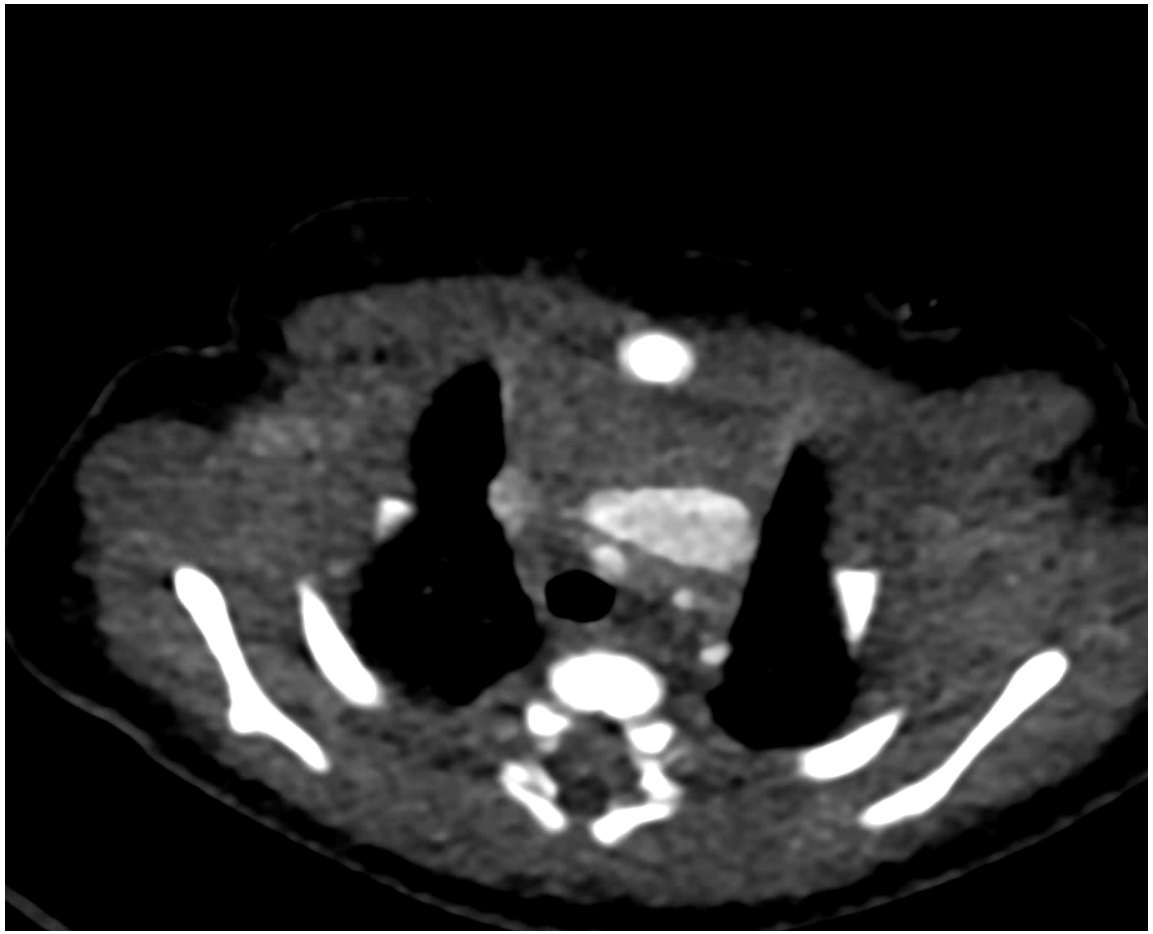
Venous Drainage?

Cardiac Anatomy?

Prospective high pitch ECG-gated non triggered protocol

@ 148 BPM





Radiation Dose:

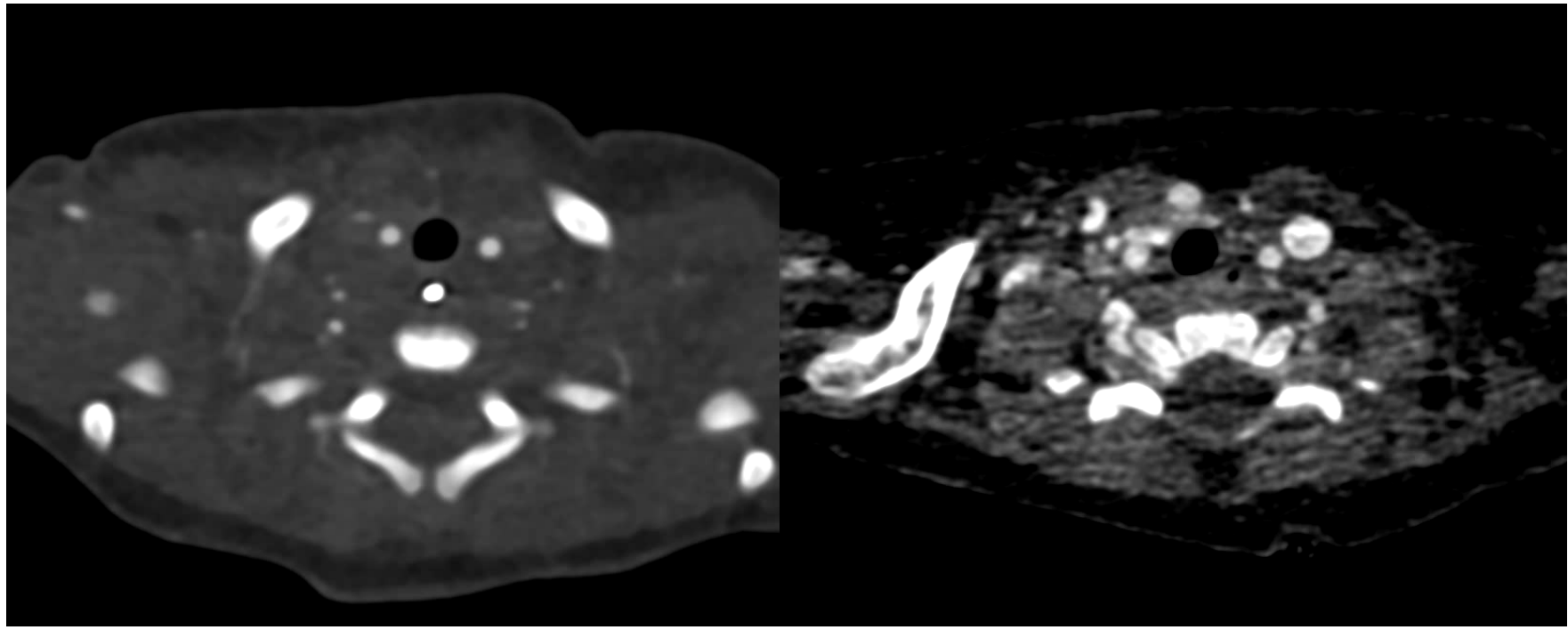
DLP:	3.1 mGycm
CTDI:	0.21 mGy
Effective D :	0.12 mSv

Post Surgical Assessment

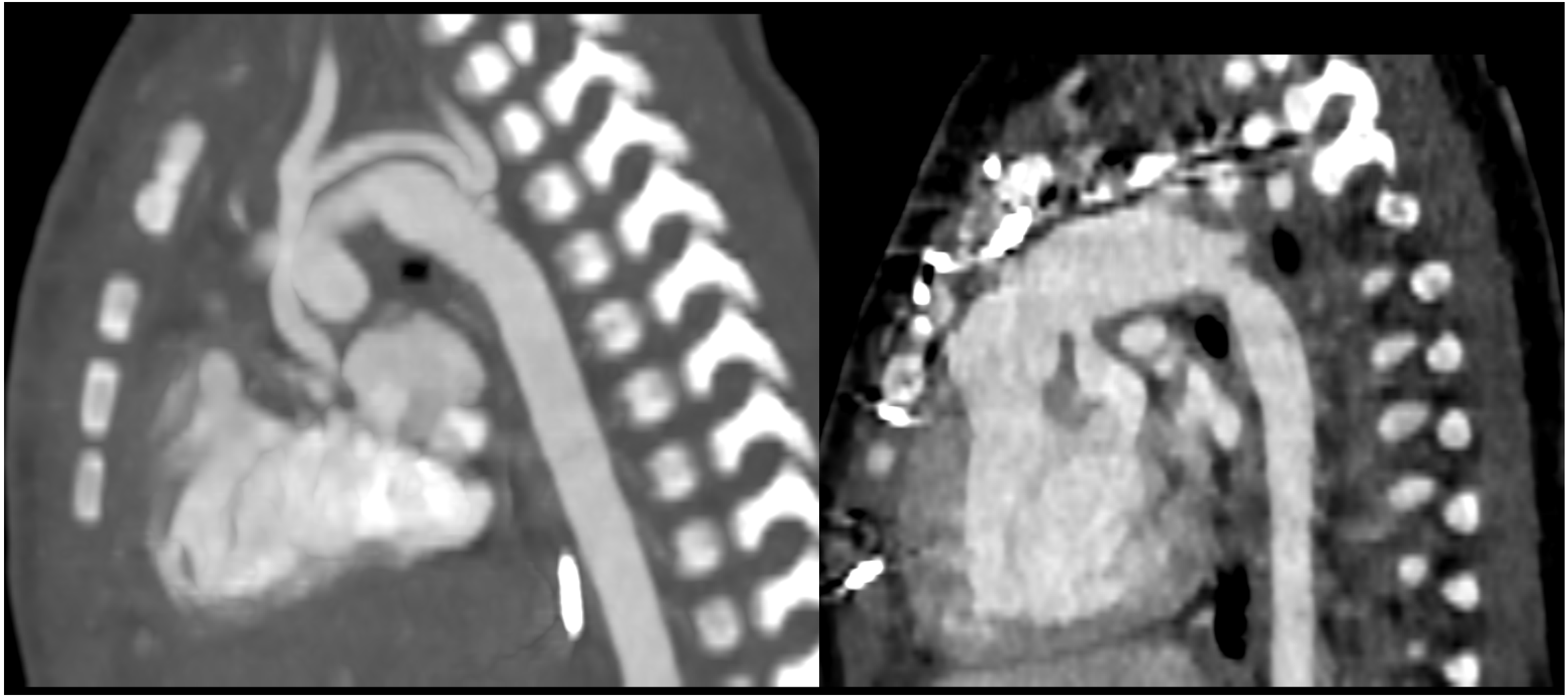
- 5 month old girl
- HLHC
- Isthmus Stenosis

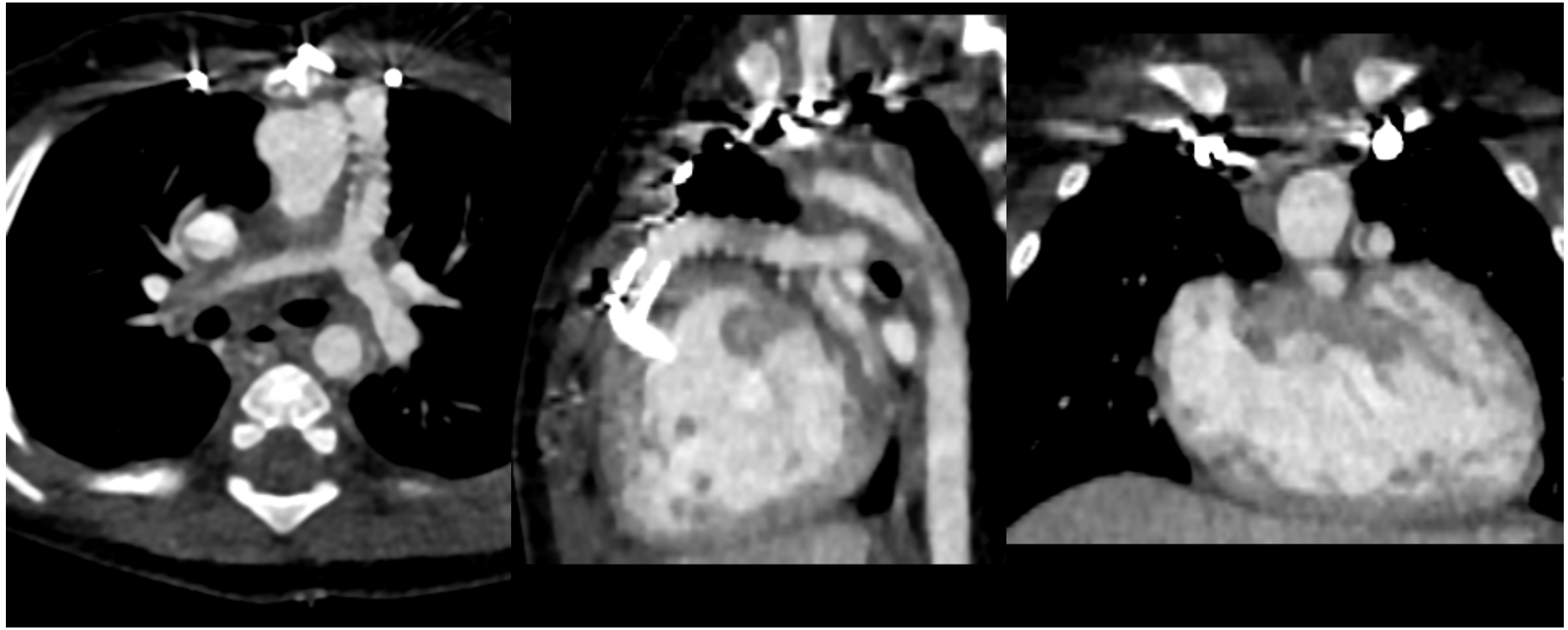
@ 131 BPM

@ 127 BPM



Prospective high pitch ECG-gated non triggered protocol





Radiation Dose:

DLP:	5.9 mGycm
CTDI:	0.42 mGy
Effective D :	0.23 mSv

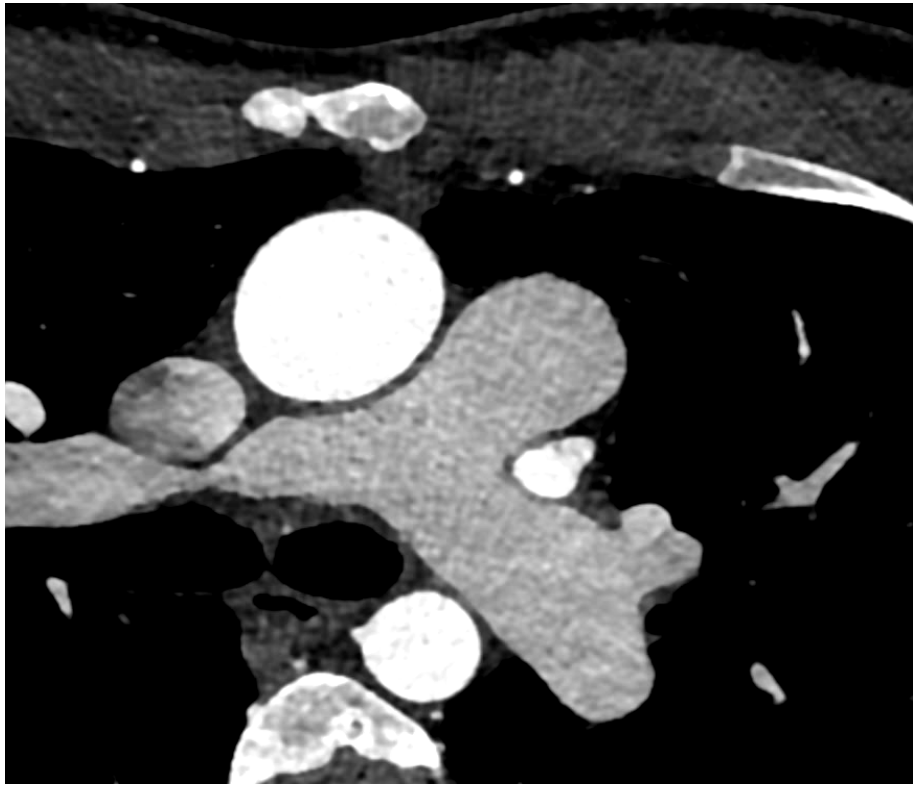
Coronary Artery Assessment

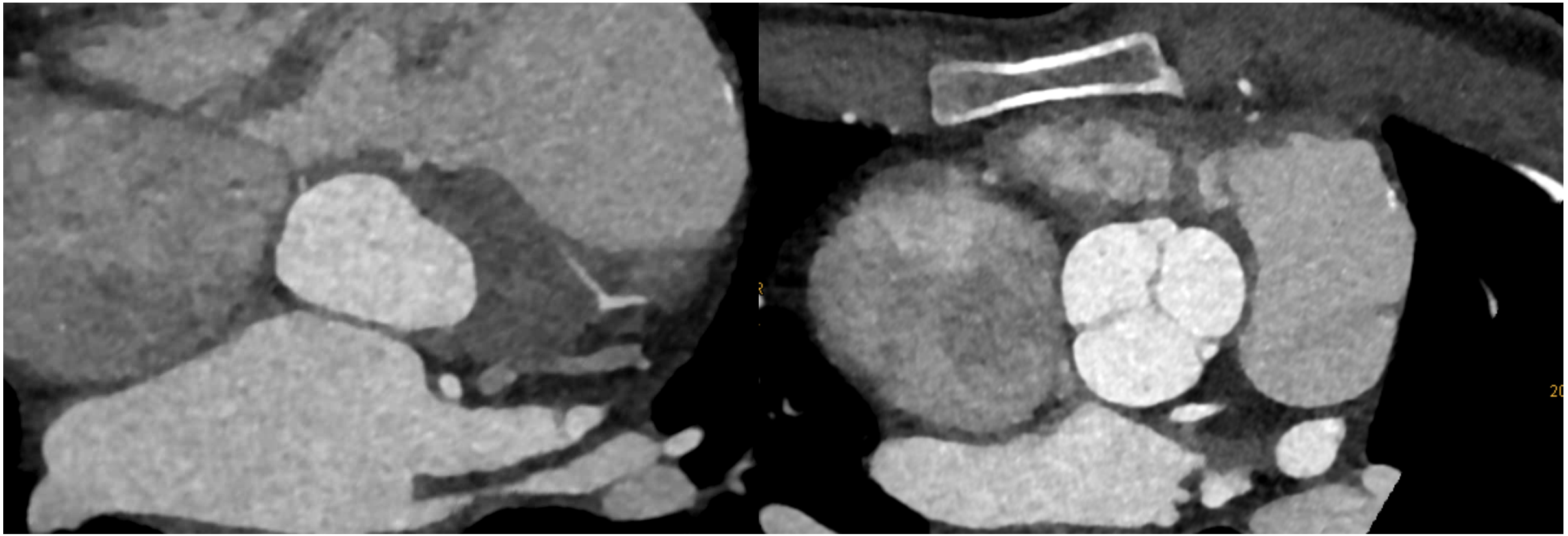
- 17 year old boy
- TOF
- Coronary situation unlcear
- LAD from RCA?

- Before RV-PA Conduit

Prospective high pitch ECG-gated triggered protocol

@ 71 BPM

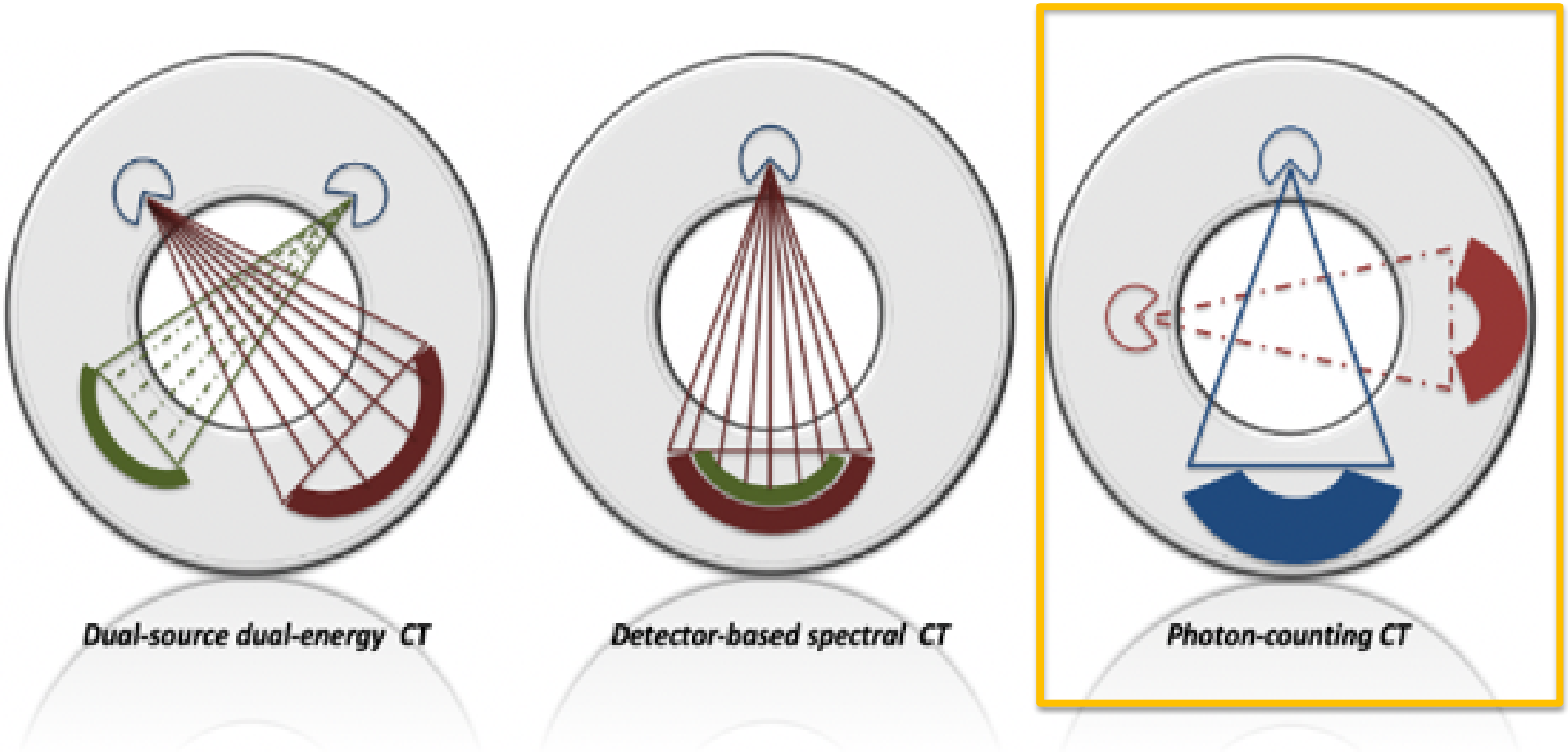




Radiation Dose:

DLP:	40.3 mGycm
CTDI:	1.86 mGy
Effective D :	0.7 mSv

Spectral Imaging



Prospects of Photon Counting CT Imaging

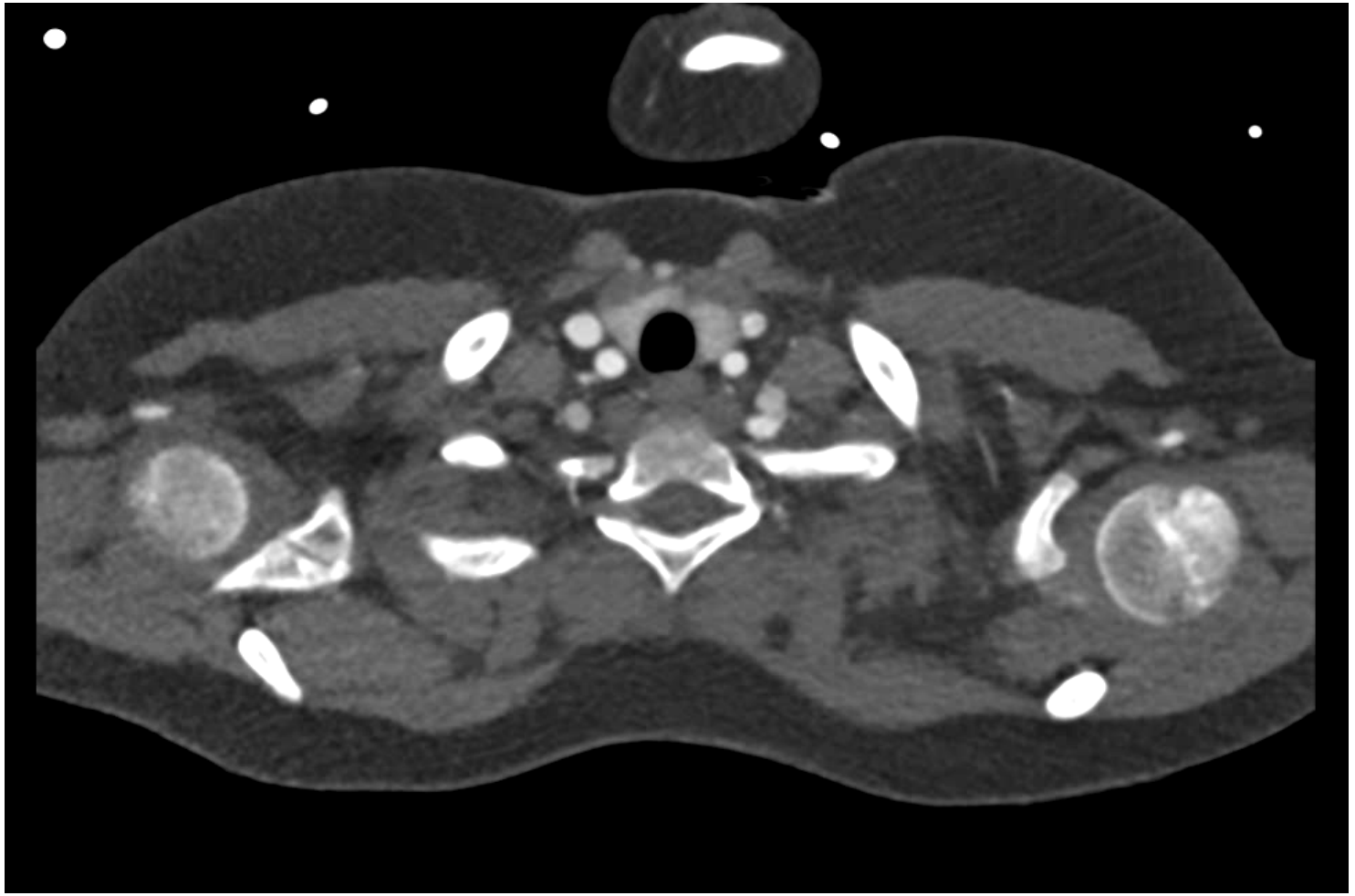
- Higher spatial resolution
- Higher iodine sensitivity
- Less radiation
- More options of image post-processing

- 11 year old boy
- ASO following dextro-TGA
- PAH

Reasons for PAH, collaterals?

Prospective high pitch ECG-gated non-triggered protocol

@ 98 BPM

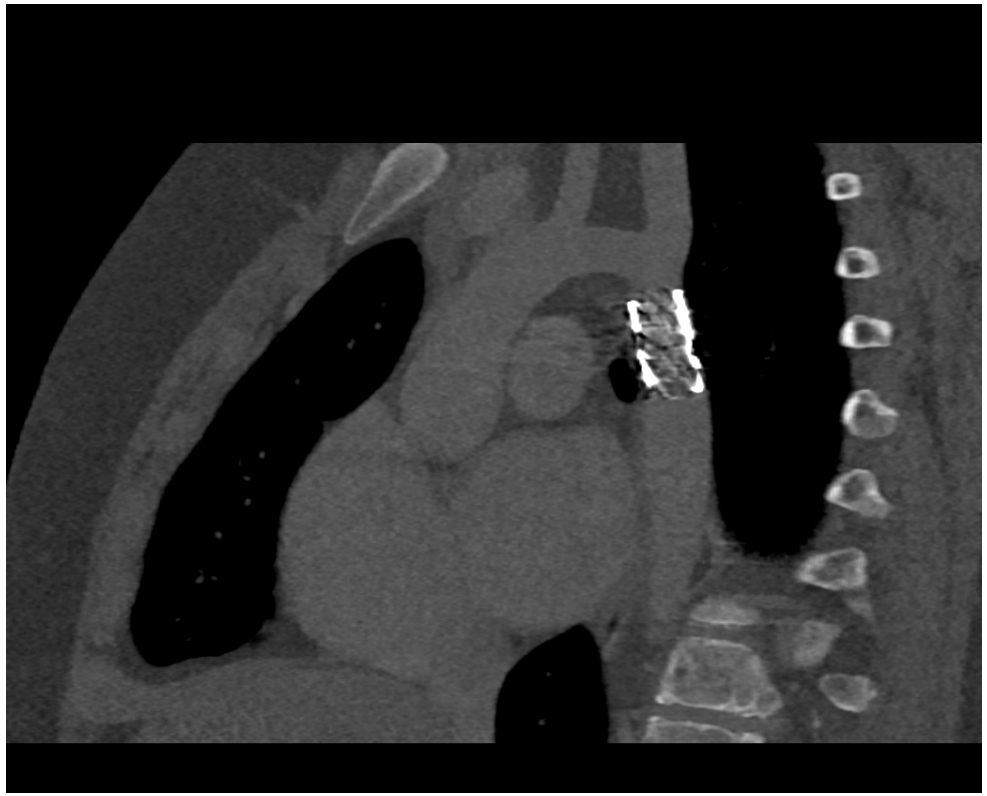


- 11 year old boy (71 kg)
- Aortic Isthmus Stenosis

Aortic aneurysm, Stent?

Prospective high pitch ECG-gated non-triggered protocol

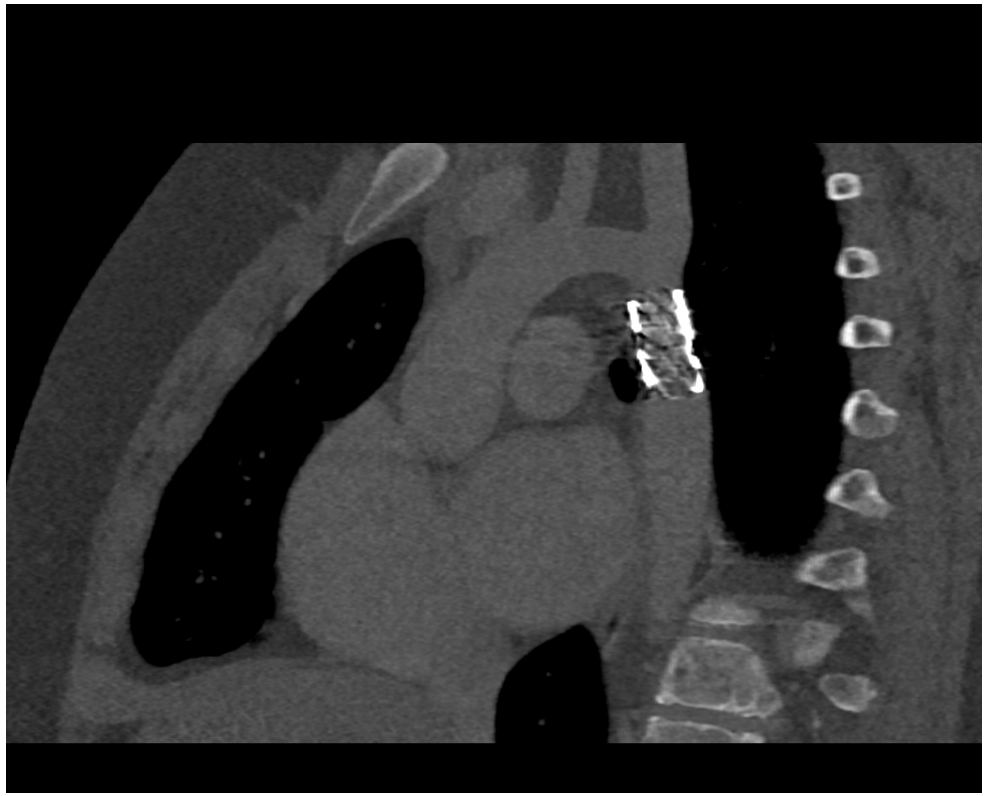
@ 87 BPM



35 ml Iodine

Radiation Dose:

DLP:	20.3 mGycm
CTDI:	0.96 mGy
Effective D :	0.38 mSv



Thank you for your attention

Weight (kg)	*k* factor[b]
≤3	0.039
>3–6	0.039
>6–9	0.026
>9–12	0.026
>12–15	0.018
>15–20	0.018
>20–30	0.013