



Referring Infants and Children for Cardiac Investigations – including High Dose Procedures

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Heart Disease in Infants and Children

- c.1% of all newborns have congenital heart problem
- Different from Adults
- Majority of conditions are structural (ASD, VSD, Coarctation, Tetralogy of Fallot, TGA etc)
- Minority are “acquired” (cardiomyopathy, myocarditis, Kawasaki Disease, endocarditis, rheumatic carditis, arrhythmias etc)
- >90% of infants born with CHD will survive into adulthood
- Increasingly significant burden on paediatric imaging facilities

Heart Disease in Infants and Children

Imaging Modalities

- Echocardiography – the primary imaging tool
- Chest X-Ray – of limited value
- **CT** – wide applications
- **Angiography** – historically the “gold-standard” imaging tool –
now, targeted imaging, often with interventional procedure
- **3-D Rotational angiography** – invasive but increasingly impressive image quality
- MRI – anatomy, tissue quality (scar, fatty deposition), function

Echocardiography

- Widely available technology
- Portable (bedside, echo lab, ICU, cath lab)
- Performed by paed cardiologist (consultant or fellow), cardiac physiologist and ?ANP (trained in echo)
- Excellent for precise intracardiac anatomy (structure, valves), good for function, poor beyond the proximal pulmonary arteries
- Usually 2D and colour flow (blood flow direction and stenoses)
- 3D has been disappointing
- No radiation

Heart Disease in Infants and Children

Echocardiography

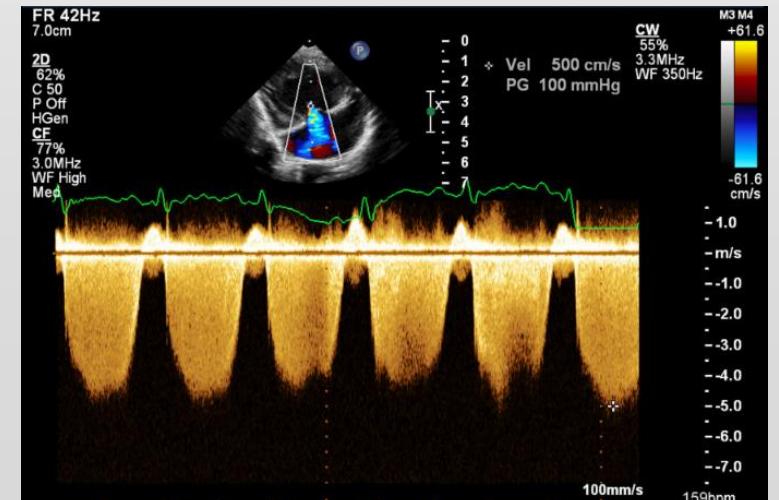
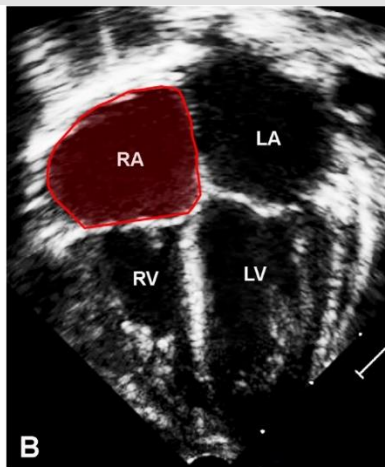
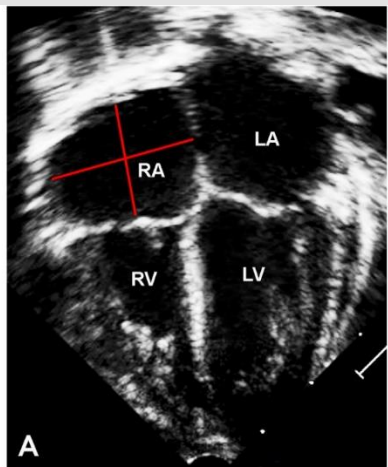
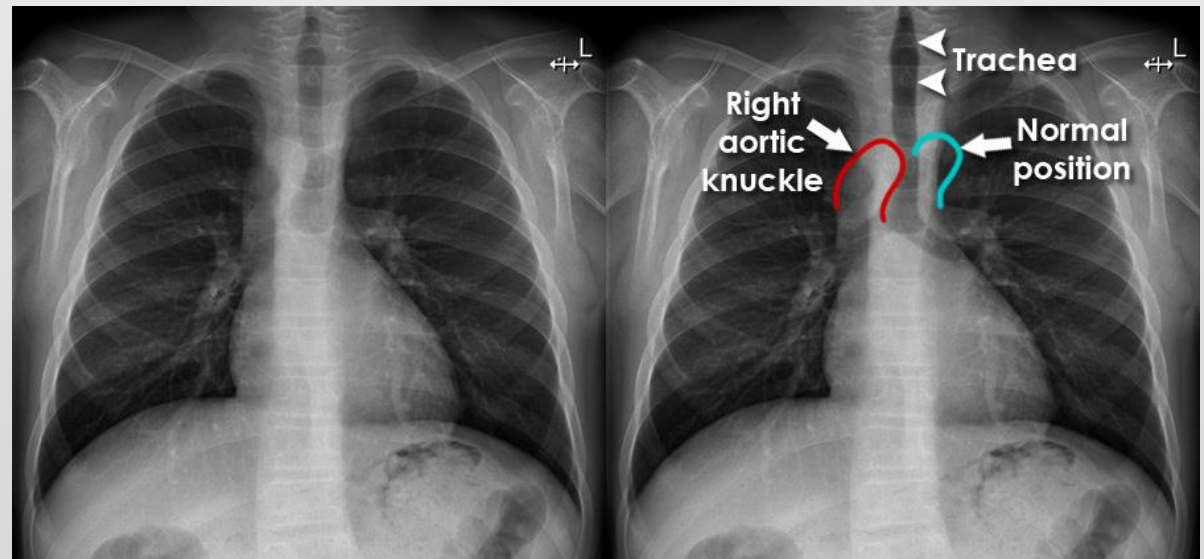


Figure 2. Apical 4-chamber view at ventricular end-systole showing (A) right atrial major-axis and minor-axis lengths and (B) right atrial area.

Heart Disease in Infants and Children

Chest X-Ray (CXR)

- Limited value
- Heart size/position
- Pulmonary vascularity
- Lung disease
- Atrial isomerism (heterotaxy)
- Aortic sidedness
- Quick, cheap
- Low dose (0.08mSv)

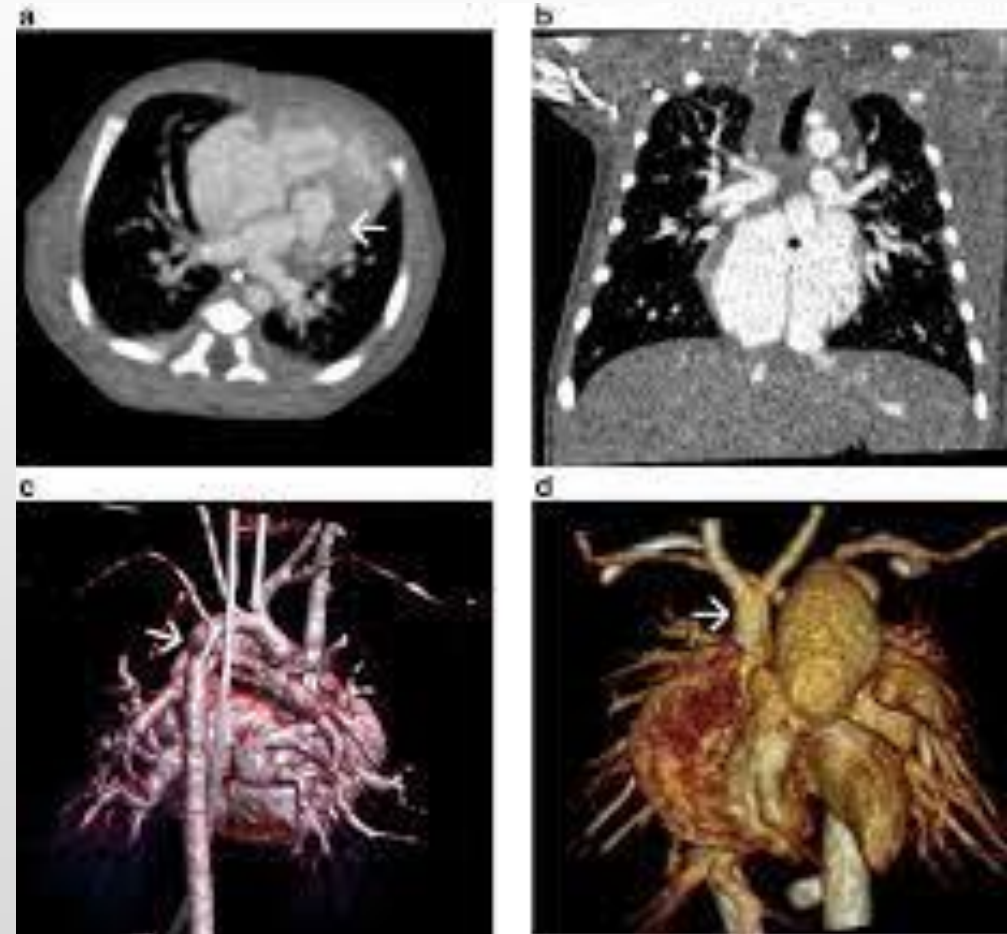
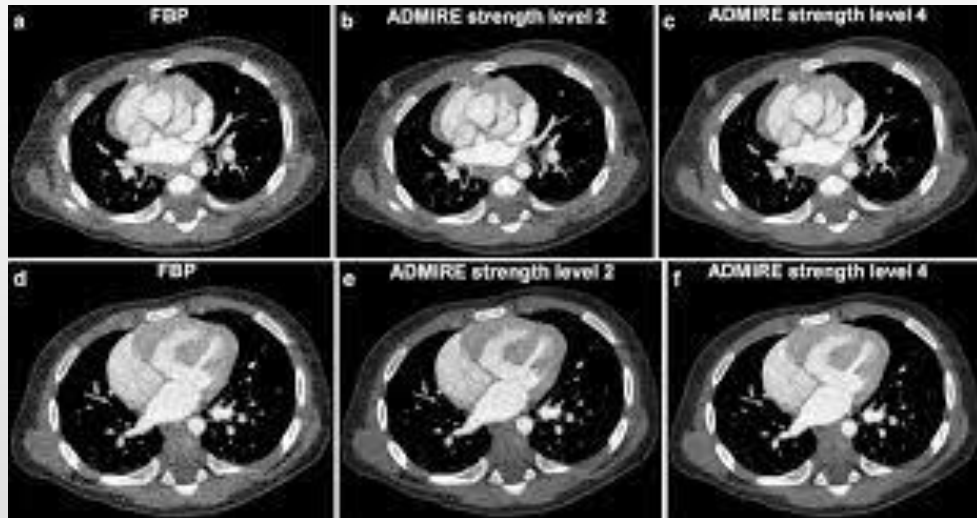


CT

- **Wide applications**
- **Multi-slice and CT angiography**
- **Improved image quality and post-processing complexity**
- **Good for heart size, relationship of heart and vessels to other mediastinal and bony structures**
- **Relatively quick**
- **Requires skill/training in image acquisition and post-processing**
- **Limited (machine) availability**
- **Higher dose radiation (2.7 - 6.6mSv)**

Heart Disease in Infants and Children

CT



Cardiac Catheterisation and Angiography

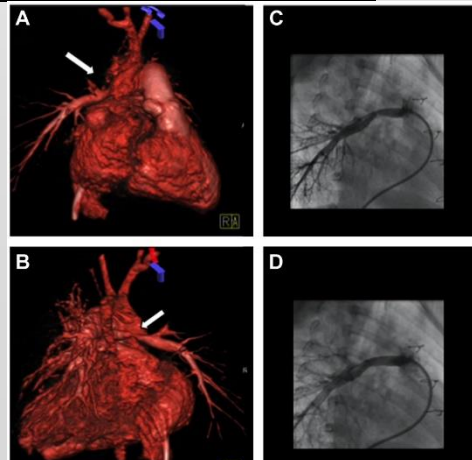
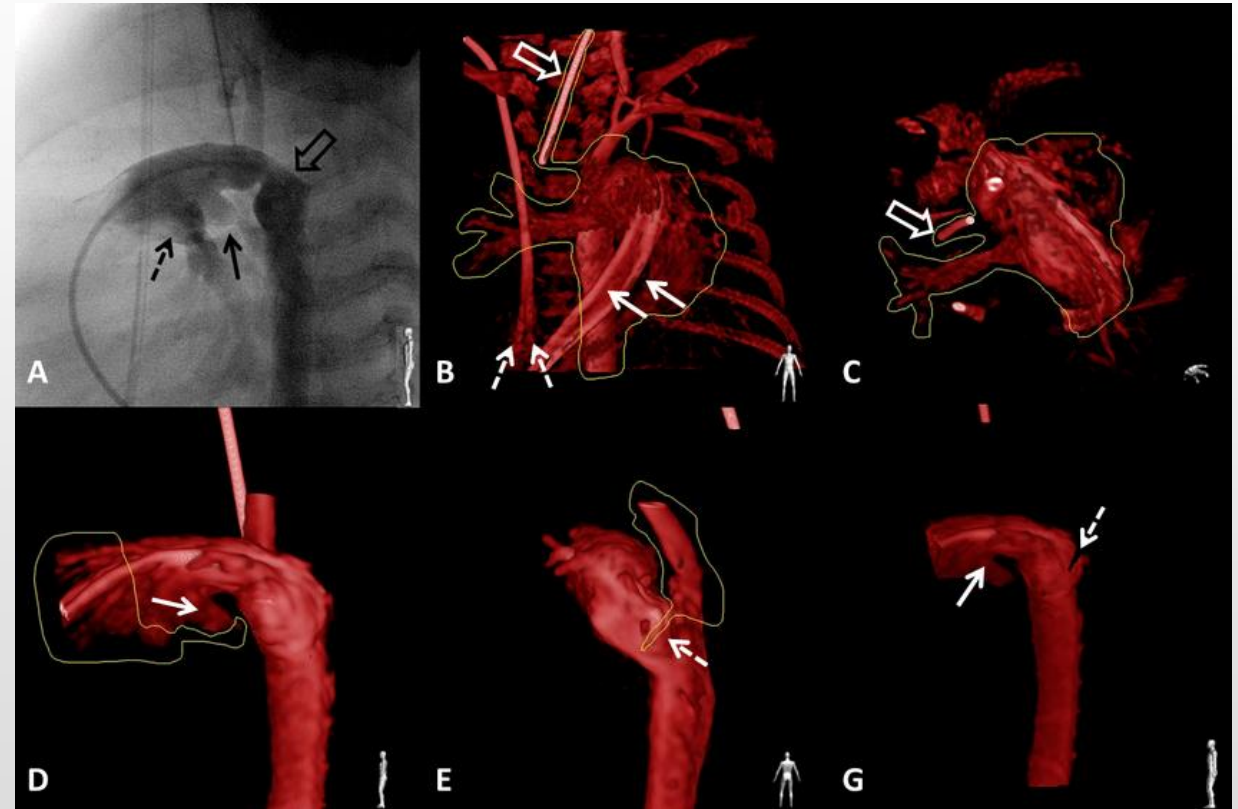
- Originally the gold standard in diagnosis
- Radio-opaque dye injected into the heart/blood vessels, while multiple X-Ray images (12/16/32 per sec) being taken
- Now, an adjunct to other modalities – and to aid interventional procedures
- Fluoroscopy (3-12 pulses per sec) – to aid catheter/device placement
- Angiography – better image quality – but higher radiation dose
- Typical radiation dose c.2-3 mSv (higher with complex interventional procedures)

3D Rotational Angiography

- Adjunct to conventional angiography
- X-Ray beam rotates around the patient
- Skilled post-processing required to obtain optimal images
- High quality, high definition images esp great vessels, 3D anatomy of the heart and mediastinal structures
- Significant aid in planning cardiac surgical and interventional catheter procedures
- High dose radiation but lower than conventional angiography
(3D Rotational = 1.5mSv Conventional angio = 2-3mSv)

Heart Disease in Infants and Children

3D Rotational Angiography

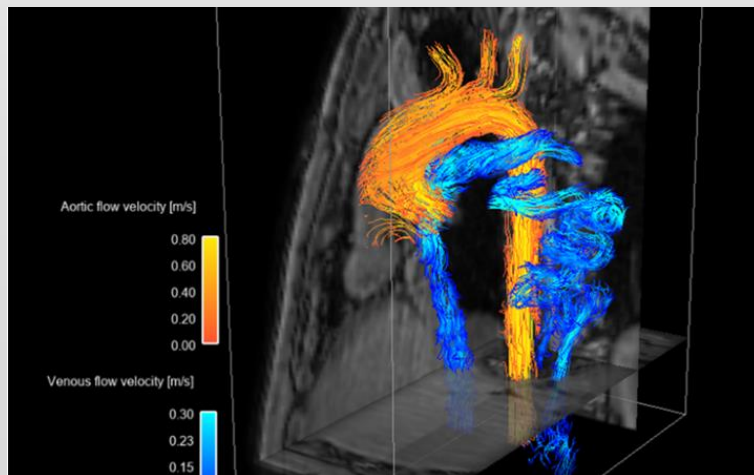
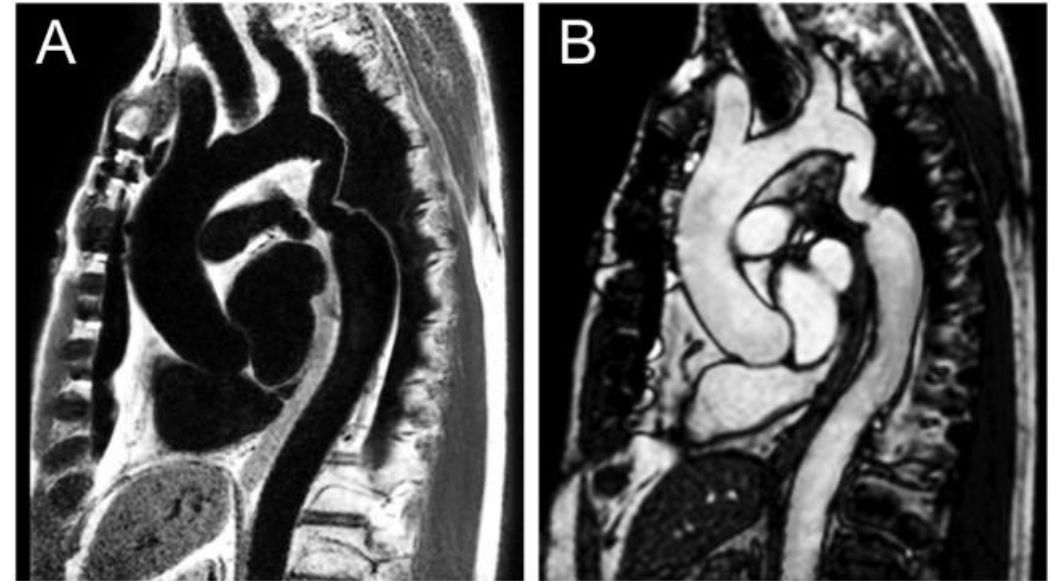
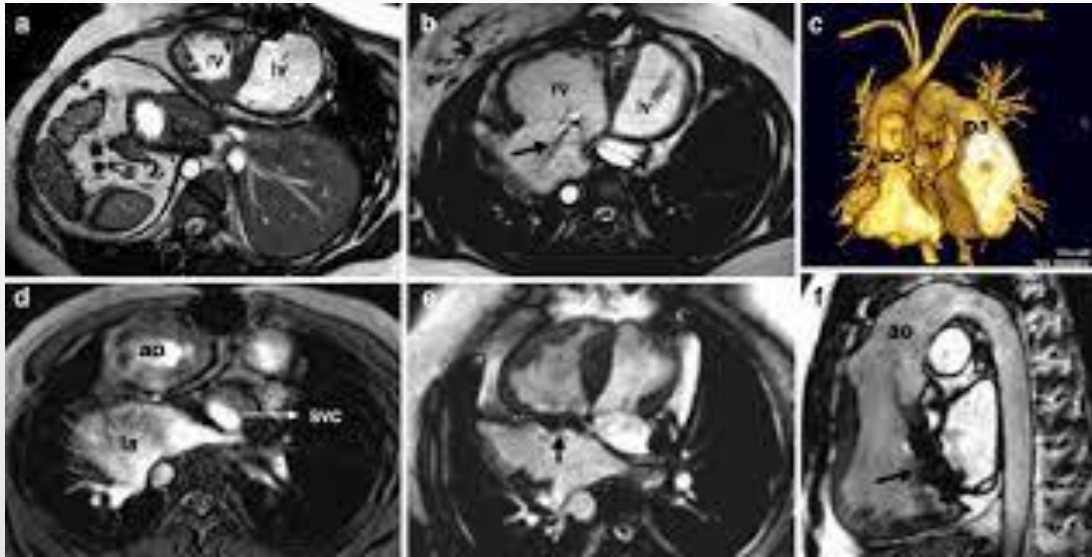


MRI

- High quality imaging of cardiac anatomy, vessels, mediastinum
- Anatomy, cardiac tissue characteristics, blood flow, cardiac output, valve regurgitation
- Expensive equipment (limited availability)
- Labour intensive (longer procedure, more likely to require sedation or general anaesthesia, post-processing highly skilled)
- Requires attendance of consultant paediatric cardiologist with specific training in MRI
- Metallic devices produce artefact
- No radiation

Heart Disease in Infants and Children

MRI



Necessary Requirements

- Investigation is clinically appropriate/necessary?
- Safest modality to obtain information?
- Has not already been done?
- Other imaging has been reviewed?
- Patient is well enough?
- Waiting list (for the procedure/investigation) is appropriate?
- Parents understand and agree?
- Clinical team understand and agree?
- Who will be responsible for obtaining and acting on the results?

What are the typical clinical scenarios – and who refers?

- **Cardiac Ward (inpatients)**

Referrals from: Medical team, ANPs, Cardiology CNSs, Senior
Senior nursing staff

- **Cardiology Outpatients:**

Referrals from: Medical team, ANPs, CNSs

- **Cardiology Day Ward:**

Referrals from: Medical team, ANPs, Cardiology CNSs

- **Joint Cardiac Conference (JCC):**

Referrals from: Medical team, ANPs, CNSs

Potential systemic deficiencies

- Duplication of referrals (esp CXR, occasionally CT): large team, poor communication, long lead in time to surgery or interventional procedure
- Inappropriate imaging modality: large team, new clinical staff
- Unnecessary investigation: (previous imaging not reviewed, information not required) – large team, new clinical staff, poor communication
- Results not acted upon: heavy clinical load, poor communication, change-over of NCHD staff

Role of the ANP

- **Specific training in Paediatric Cardiology**
- **Understand the indications, pros and cons of the various imaging modalities**
- **Provide continuity in clinical care, patient journey**
- **Attend all Joint Cardiac Conferences, ward rounds, OPDs**
- **Training in team work, communication**
- **Follow up results of investigations and appropriate communication with consultant, senior medical team member**
- **Undertake audit of practice (esp referral of patients for high dose radiological procedures)**

Conclusion

Before referring a child for a cardiac investigation (esp high dose radiological procedure)

- Know the patient
- Know the procedure
- Know why you are referring
- Discuss with senior team members
- Discuss with the family and patient
- Take responsibility for the result and onward communication

Thank You !