

## Update in neonatal cardiac MR Imaging

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## Indications for neonatal CMR

- Vessels
  - Arteries
    - Systemic – interrupted aortic arch, vascular rings
    - Pulmonary – anomalous, aorto-pulmonary collaterals, arterial duct
  - Veins
    - Systemic in isomerism
    - Pulmonary in isomerism and isolated TAPVC or PAPVC
- Ventricles
  - Borderline hypoplasia to determine single vs biventricular repair
  - Criss-cross heart
- Ventriculo-arterial connection
  - Complex double outlet right ventricle
- Haemodynamics
  - In CHD e.g. QP:QS, RPA:LPA
  - In premature infants
- Tumours

## Equipment and personnel

- 1.5T still more popular than 3T but artifacts with 3T can be overcome
- Phased array cardiac coil or MRI incubator
- Monitoring
- Feed and sleep – vacuum immobilizer
- Sedation – cardiac anesthesiology
- Warming blanket/warm air
- Dedicated MRI technologist
- Cardiac radiologist/imaging cardiologist
- Rapid prototyping 3D printer

## Sedation

- Feed and sleep
  - Reasonable option for stable infants with simple questions
  - Darken scan room, vacuum immobilizer, ear plugs
  - Withhold feed for 6 hours, repeat feed if wakes during scan
- Pharmacologic sedation
  - More reliable for more complex cases with longer scan times and when an apnea is required i.e. when high quality contrast enhanced angiography essential
  - For neonates with in parallel circulation cardiac anesthesiology recommended. MRI usually well tolerated but occasional need for some form of resuscitation

## Technique

- Aim is to define anatomy and characterize hemodynamics and ventricular function
- Achieved with a combination of static steady state free precession (SSFP or GRE), cine SSFP, phase contrast (PC) and contrast enhanced MR angiography (3D spoiled gradient echo). Delayed enhancement may be required to assess for possibility of endocardial fibroelastosis (inversion recovery SSFP with inversion time to null myocardium). T1W, T2W FSE for tumours

## Scan protocol

- Static non-gated SSFP surveys of whole thorax in 3 orthogonal planes
- PC AAO, MPA, RPA, LPA, DAO, SVC, AVV, pulmonary veins (non-breath hold 3 NEX)
- MRA +/- apnea
- Short axis cine SSFP (ventricular volumetry) +/- axial cine SSFP for anatomy
- +/- Ax & Cor T1W/T2W FSE for tumours
- +/- SAX DCE for EFE

## Parameters

- Cine imaging
  - High spatial resolution – in plane  $\sim 1\text{mm}^2$
  - Small FOV (20-26cm)
  - Slice thickness 3-5mm
  - Adjust temporal resolution for faster heart rates (fewer views per segment)
- MRA
  - matrix 256x160, FOV 220mm
  - Voxel size  $0.9 \times 1.1 \times 1.2 - 2.4\text{mm}^3$
  - Double dose gadolinium (0.2mmol/kg) manual injection – 8-10s with a saline chaser – bolus tracking, centric k-space filling
  - Repeat 10-20s acquisitions for arterial and venous phases
  - Dynamic imaging with advanced k-space filling techniques possible

## Borderline left ventricle assessment

- If valvar anatomy favourable an MRI for hemodynamic assessment may be helpful when deciding whether a small left ventricle is likely to be able to support the systemic circulation after ductal closure +/- arch repair
- A left ventricular end diastolic volume index of  $20\text{ ml/m}^2$  and ascending aortic flow of  $>1.8\text{ L/min/m}^2$  often used as lower limits for biventricular repair

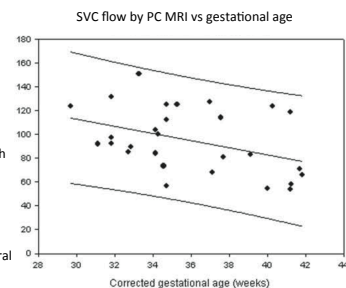
## New developments – 3D models

- Pediatric cardiac imaging research
- Using a conventional CE MRA acquired with timing to opacify relevant structures
- Segmentation software used to create a cast of the blood pool
- This converted to a mesh with cutaways to reveal structures interest
- Popular with cardiac surgeons for planning complex intraventricular repairs



## New development – preterm infants

- Neonatology research
- Ventricular volumetry
- Phase contrast
- 3T with incubator
- GA 30 weeks onwards
- Hemodynamic changes in the early neonatal period difficult to study but likely important with respect to clinical outcome and MRI more accurate than echocardiography for measuring cardiac output, systemic/cerebral perfusion



## Selected references

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