

MAGNETIC RESONANCE IMAGING

Background: Cardiac MRI is the gold standard for ventricular volume and function assessment providing reproducible and reliable measurements of both right and left ventricles

Indications: Indications for pediatric cardiac MRI include evaluation of both congenital and acquired cardiac conditions as well routine postoperative surveillance of anomalies following surgical correction or palliation. The cardiac MRI examination can be broken down into an evaluation of cardiovascular morphology, quantification of right and left ventricular function, quantification of intravascular flow or obstruction, and tissue discrimination (masses/ myocardial fibrosis). Each of these assessments involves dedicated sequences optimized for their individual role.

Risks and Benefits : Evaluation of ventricular function is performed with cine SSFP sequences that are optimized to provide excellent myocardial-blood pool differentiation. Images are obtained in various planes that are similar to those acquired on echo and include a 2-chamber plane (coronal oblique view demonstrating right/left atrium and accompanying ventricle), a 4-chamber plane (transverse oblique covering both atria and ventricles), short axis plane (sagittal oblique across right ventricle and left ventricle). Additional views, such as left and right outflow tract planes as well as aortic root planes (Fig. 2), may also be acquired depending on the pathology being evaluated. Cine 3D SSFP sequences are evolving which allow acquisition of the entire cardiac volume at multiple frames across the cardiac cycle which would enable a single SSFP acquisition which could be subsequently reconstructed along whichever plane is desired.

Tissue characterization can be performed with techniques such as first pass perfusion sequences, phase sensitive inversion recovery, T1 and T2 mapping. Administration of a

pharmacological stress agent such as adenosine or dobutamine (stress perfusion) can be utilized to elicit reversible ischemia. However, unlike in adults, stress perfusion in pediatrics is usually reserved for those patients clinically felt to be high risk for myocardial ischemia, such as those with coronary artery involvement in Kawasaki disease or in heart transplant patients with suspected coronary artery disease.

Flow evaluation is performed with cine phase contrast sequence. Flow sequences are used to assess stroke volumes and regurgitant fractions across the aortic and pulmonary valves. In addition, flow sequence can be used to measure the volume of systemic to pulmonary shunting, known as the Qp: Qs ratio where Qp is the volume of pulmonary blood flow and Qs is the volume of systemic blood flow. 4D phase contrast angiography is now widely available and allows acquisition of the entire mediastinal cardiovascular structures in a single acquisition. This allows interrogation of any vessel in any plane to be performed subsequently and the creation of tractography lines to demonstrate areas of disturbance to laminar flow.

Finally, contrast enhanced 3-D magnetic resonance angiography (MRA) also provides excellent morphological assessment of the thoracic and abdominal vasculature with time resolved techniques. Such techniques enable a fast acquisition that can be used to isolate the pulmonary and systemic arterial phases of contrast enhancement .

Gadolinium and other contrast agents and Nephrogenic Systemic Fibrosis

Limitations: The entire cardiac MRI examination including a morphological assessment, ventricular function and flow analysis is expected to take between 60 and 90 minutes. 3D and 4D flow and SSFP techniques are particularly time intensive, and expected to take 5-7 mins per sequence. However these have the potential benefits of decreasing the number of 2D sequences required.

Frequently general anesthesia or conscious sedation is necessary in the pediatric population. The spatial resolution with current techniques is less than that achieved with volume or dualsource MDCT however the temporal resolution is better. Finally MRI in patients with claustrophobia and non MRI compatible implantable devices/hardware is contraindicated.