Contrast enhanced MRA in the assessment of congenital heart disease in neonates and infants.

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Introduction
Cardiac MRI in the neonate and infant poses some technical challenges compared to imaging in the adult. Cardiac anatomy is much smaller, cardiac and respiratory rates are much higher and there is a significant variation in patient size. Patient compliance is also extremely limited for breath holding etc. Standard black blood T1 are prone to motion artifacts for the above reasons and only a limited number of slices may be acquired due to the short cardiac cycle. Contrast enhanced MRA (CE-MRA) has an established role in adults for the non invasive assessment of the thoracic aorta and great vessels but there is little published data on its use in the paediatric population. The purpose of this study was to use the same basic techniques of adult CE-MRA for the imaging of neonatal and infant congenital heart disease to try to improve the visualisation of small vascular structures and improve the diagnostic accuracy of cardiac MRI in these patients.

Methods
The setting for this study was a large specialist paediatric teaching hospital which was the national referral centre for paediatric cardiac surgery. Patients were recruited by referral from clinicians following initial assessment with echocardiography and where surgery or further assessment via conventional angiography was being considered. MR imaging was performed using a Philips Gyroscan ACS-NT 1.5 Tesla superconducting magnet with enhanced gradients (powertrak 6000). Due to the small subject size, imaging was performed using either a knee, neck or circular surface coil. ECG gating was used in all patients and breath holding for those patients imaged while under general anaesthesia. Imaging protocols included back blood imaging in 2 or 3 planes using either SE-EPI with or without respiratory gating or breath hold T1 TSE. Cine GRE sequences were also performed where appropriate. CE-MRA was performed using multiple dynamic T1-FFE acquisitions with mask subtraction in the coronal plane. Examinations were reported in conjunction with the cardiologist attending the patient. T1 black blood and CE-MRA sequences were compared for the accuracy of anatomy demonstrated.

Results
12 patients were recruited aged between 4 days old and 2.5 years old (mean 7.5 months, median 4 months). 8 patients were less than 1 year old. Indications included assessment of stridor and pre and post operative assessment of complex cardiac malformations. 8 patients were examined using GA and 4 patients free breathing. Oral sedation was not used. CE-MRA was performed using a bolus of gadolinium of 0.2-0.3mmol/kg giving total contrast volumes of between 1 and 3mls. Administration was by manual injection followed by saline flush. 1 data acquisition was acquired pre contrast to act as a mask followed by 3 acquisitions post contrast. Scan delay ranged between 5 and 10 seconds and acquisition times ranged between 6 and 15 seconds per acquisition. Effective slice thicknesses were between 2-3mm overcontiguous with between 20 and 40 slices per acquisition. TR ranged from 4.6 - 6ms and TE from 1.1 - 1.6ms. All examinations were well tolerated with no complications. Clinically useful information was gained in all cases. Normal vascular anatomy was confirmed in 4 cases. Pathology identified in the remaining cases included double aortic arch (figure 1) and anomalous arch vessels resulting in airway compression. 2 cases with abnormal anatomy went to surgery without the need for conventional angiography. It was felt that the vascular anatomy of the arch vessels and detailed intracardiac anatomy was more reliably visualised using CE-MRA due to thinner slice thicknesses, high vessel contrast and the ability to perform multi planar reformating.

Discussion
CE-MRA has been shown to be technically feasible in the neonate and young infant with no complications. In all cases clinical useful information was gained avoiding the need for conventional angiography in some cases. Initially patients were only examined under general anaesthesia with suspended respiration, but later patients in the study were examined during free breathing with only minimal artifacts occurring. We now use CE-MRA as a routine part of our cardiac MRI assessment protocol of neonates and infants as we find that the small vascular anatomy can be demonstrated more reliably than conventional T1 black blood sequences.

References