Congenital Heart Disease
Evaluation by Structural and Functional Magnetic Resonance Imaging

Thesis
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Of MD Degree in Radiodiagnosis

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Abstract

Cardiac MRI has become a clinically useful supplement to Echo and conventional x-ray angiography in the diagnostic work-up of patients with congenital heart disease.

The aim of this work is to evaluate the role of MR imaging in assessment of morphological (intra and extracardiac anatomy) and functional parameters (whenever possible) of congenital heart diseases.

The study was conducted on 40 patients including both pediatric (31 patients) and adult patients (9 patients). The patients were referred from the cardiology department, Kasr El Aini Hospital and the Children Hospital (Abu El Reesh), Cairo University. All patients were submitted to both echocardiographic examination and MRI study. Cardiac catheterization was performed in 13 cases.

Conventional spin echo, b-FFE/BH and CE-MRA were done for the patients. Ventricular volumes were calculated for a selected group of patients. MRI results were comparable to Echo and cardiac catheterization.

Key words: MRI-congenital heart disease-Functional MRI-Echocardiography-Cardiac cathetrization

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List of abbreviations

MRI	Magnetic resonance imaging
3D	3-Dimensional
CMRI	Cardiovascular magnetic resonance imaging
CHD	Congenital heart disease
CHDs	Congenital heart diseases
ECG	Electrocardiogram
A-V	Atrioventricular
VA	Ventriculoarterial
ASD	Atrial septal defect
VSD	Ventricular septal defect
PEAR	Phase encoded artifact reduction
FFE	Fast field echo
GRE	Gradient echo
SNR	Signal to noise ratio
IR-FSE	Inversion recovery fast spin echo
FSE	Fast spin echo
RV	Right ventricle
LV	Left ventricle
FFE-SENSE	Fast field echo sensitivity encoding
TR	Repitition time
TE	Echo time
SSFP	Steady state free precession
VEC	Velocity encoded cine
PA	Pulmonary artery
TEE	Transoesophageal echocardiography
TTE	Transthoracic echocardiography
CEMRA	Contrast enhanced magnetic resonance angiography
3D-GE	3-Dimensional gradient echo
3D-MRA	3-Dimensional magnetic resonance angiography
XMR	X-ray fluoroscopy, Magnetic resonance scanner
DIR-FSE	Double inversion recovery fast spin echo
ASO	Atrial septum occluder
LT	Left
RT	Right
RA	Right atrium

LA	Left atrium
IVC	Inferior vena cava
PV	Pulmonary vein
Ao	Aorta
RVOT	Right ventricle outflow tract
LVOT	Left ventricle outflow tract
HV	Hepatic vein
SVC	Superior vena cava
IVC	Inferior vena cava
TAPVC	Total anomalous pulmonary venous connection
TAPVD	Total anomalous pulmonary venous drainage
PAPVC	Partial anomalous pulmonary venous connection
PAPVR	Partial anomalous pulmonary venous return
APVD	Anomalous pulmonary venous drainage
TOF	Tetralogy of Fallot
TGA	Transposition of the great arteries
CCTGA	Congenitally corrected transposition of the great arteries
TR	Tricuspid regurge
PVS	Pulmonary valve stenosis
PS	Pulmonary stenosis
PR	Pulmonary regurge
fRV	Functional right ventricle
aRV	Atrialized right ventricle
PAs	Pulmonary arteries
LPA	Left pulmonary artery
RPA	Right pulmonary artery
APcol	Aorto pulmonary collateral
MPA	Main pulmonary artery
Desc Ao	Descending aorta
Asc Ao	Ascending aorta
PDA	Patent ductus arteriosus
AS	Aortic stenosis
SAS	Subaortic stenosis
b-FFE/BH	Balanced fast field echo/breath hold
b-FFE/NBH	Balanced fast field echo/non breath hold
MIP	Maximum intensity projection
FOV	Field of view
NSA	Number of signal averages
CTA	Computed tomography angiography
RV-PA	Right ventricle-Pulmonary artery

MAPCAS	Major aortopulmonary collateral arteries
CCD	Color coded Doppler
DILV	Double inlet left ventricle
DOLV	Double outlet left ventricle
PG	Pressure gradient
CCA	Common carotid artery
IVS	Interventricular septum
RVOTO	Right ventricle outflow tract obstruction
BT	Blalock-Taussig
DORV	Double outlet right ventricle
EDV	End diastolic volume
ESV	End systolic volume
EF	Ejection fraction
SV	Stroke volume
CO	Cardiac output
RT	Real time
3DE	3 dimensional echocardiography
PCI	Percutaneous coronary intervention
CABG	Coronary artery bypass grafting
Cath	Catheterization

Introduction
&
Aim of work

Introduction and Aim of the Work

Cardiac MRI has become a clinically useful supplement to ECHO and conventional x-ray angiography in the diagnostic work-up of patients with congenital heart disease. Three dimensional (3D) sequences are capable of depicting both intracardiac and extracardiac structures with high accuracy in adults and adolescents (Fenchel et al., 2006).

Cardiac magnetic resonance (CMR) of the pediatric patient involves a unique set of technical challenges beyond those encountered in adult imaging. Anatomical structures are smaller, demanding greater spatial resolution; heart rates are high, demanding greater temporal resolution; and patients may be sedated or uncooperative, rendering breath-hold imaging strategies useless. Despite these difficulties, CMR offers several advantages over other imaging modalities, including soft tissue contrast, lack of ionizing radiation, a capacity for true three-dimensional imaging, accurate flow quantification, and freely selectable imaging planes. These advantages and continued advances in MR hardware, software, and imaging techniques are bringing CMR into more widespread use in pediatric cardiology (Simonetti and Cook, 2006). Cardiac magnetic resonance is increasingly being used not only for the initial investigation of CHD but also as follow-up after surgery or catheter-guided intervention (Christian et al., 2007).

Echocardiography is currently used as the initial noninvasive imaging study for almost all patients with known or suspected CHD. MRI is unlikely to replace echocardiography as the first diagnostic procedure because of the portability, universal availability, and low cost. MRI can demonstrate cardiovascular anatomy without the limitation of acoustic windows or ultrasound penetration of the body. Therefore the morphology of some regions, such as the supracardiac region and the posterior aspect of the heart, can be