THE ROLE OF CARDIOVASCULAR MAGNETIC RESONANCE IMAGING IN THE DIAGNOSIS OF DIFFERENT CARDIOMYOPATHIES

Essay

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ABSTRACT

(Key Words: Cardiovascular Magnetic Resonance Imaging- CMR- Cardiomyopathies)

Cardiovascular magnetic resonance imaging (CMR) is able to diagnose and differentiate cardiomyopathies in a single study. The assessment of essential information such as alterations of myocardial and ventricular geometry and function is possible with a high degree of accuracy and reproducibility, thereby enabling the cardiologist to increase the safety of therapeutic decisions.

The aim of this study is to review the role of Cardiovascular magnetic resonance imaging in the diagnosis of different cardiomyopathies.

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List of Abbreviations

ACR	American College of Radiology
AD	Autosomal Dominant
AHA	American Heart Association
AO	Aorta
AR	Autosomal Recessive
ARVC	Arrhythmogenic Right Ventricular Cardiomyopathy
ARVD	Arrhythmogenic Right Ventricular Dysplasia
CAD	coronary artery disease
CEMRA	Contrast Enhanced Magnetic Resonance Angiography
CNR	Contrast-to-Noise Ratio
CP-MRA	Contrast Phase Magnetic Resonance Angiography
CT	Computed Tomography
CX	Circumflex Coronary a.
DCM	Dilated Cardiomayopathy
DE	Delayed-contrast Enhancement
DICOM	Digital Imaging and Communication in Medicine
ECD	Echo Color Doppler
ECG	Electrocardiography
EDV	End Diastolic Volume
EF	Ejection Fraction
EPI	Echo Planar Imaging
ESV	End Systolic Volume
FA	Flip Angle
FFE	Fast Field Echo

FGRE	Fast GRadient Echo
FIESTA	Fast Imaging Employing STeady –State Acquisition
FISP	Fast Imaging with Steady-state free Precession
FLASH	Fast Low Angle Shot
FOV	Field Of View
FS	Fat Suppression
FSE	Fast Spin Echo
FSE-IR	Fast Spin Echo – Inversion Recovery
Gd	Gadolinium
Gd-DTPA	Gadolinium-diethylenetriamine pentaacetic acid
GRASS	Gradient Recalled Acquisition in Steady State
GRE	Gradient Echo
HARP	Harmonic Analysis of Phase
HCM	Hypertrophic Cardiomyopathy
IR	Inversion Recovery
IR-GRE	Inversion-Recovery Gradient Echo
IR-GRE DE	Inversion-Recovery Gradient Echo Delayed Enhancement
IT	Inversion delay Time
IV	Innominate Vein
IVC	Inferior Vena Cava
LA	Left Atrium
LAD	Left Anterior Descending a.
LM	Left Main a.
LPA	Left Pulmonary Artery
LPV	Left Pulmonary Vein

LV	Left Ventricle
MIP	Maximum Intensity Projection
MPA	Main Pulmonary Artery
MR	Magnetic Resonance
MRA	Magnetic Resonance Angiography
MRI	Magnetic Resonance Imaging
NEX	Number of Excitations
PA	Pulmonary Artery
PC	Phase Contrast
PDP	Phase Difference Processing
PET	Positron Emission Tomography
PFR	Peak Filling Rate
PCr/ATP	Phospho Creatine/Adenosine Triphosphate
PVC-MRI	Phase Velocity Cine Magnetic Resonance Imaging
RA	Right Atrium
RC	Right Coronary
RCM	Restrictive Cardiomayopathy
RF	Radio Frequency
RIPV	Right Inferior Pulmonary Vein
ROI	Region Of Interest
RPA	Right Pulmonary Artery
RV	Right Ventricle
SVC	Superior Vena Cava
SE	Spin Echo
SENSE	SENSitivity Encoding techniques

SMASH	Simultaneous Acquisition of Spatial Harmonics
SNR	Signal-to-Noise Ratio
SOLVD	The Studies of Left Ventricular Dysfunction
SPECT	Single Photon Emission Computed Tomography
SPGR	SPoiled Gradient Echo
SPGR-ET	SPoiled Gradient Echo Train
SSFP	Steady State Free Precession (Fiesta, True FISP, Balanced Echo)
STIR	Short Time Inversion Recovery
SV	Stroke Volume
T1	Longitudinal relaxation time
T2	Transverse relaxation time
TA	Time of Acquisition
TE	Time to Echo
TI	Time of Inversion
TR	Time of Repetition
VENC	Velocity Encoding
WHO	World Health Organization
2D	Bi-dimensional
3D	Three-dimensional

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Introduction

Cardiomyopathies (CM) are a group of chronic progressive diseases in which the dominant feature is direct involvement of the heart muscle with cardiac dysfunction

Based on morphology, Physiology, and etiology they can be divided into four main types; restrictive, hypertrophic, Dilated, and arrhythmogenic right ventricular dysplasia (ARVD). The cardiomyopathies that do no fall into any of these categories are placed in the unclassified section.[1]

Current cardiovascular magnetic resonance (CMR) techniques have much to offer in the evaluation of cardiomyopathies. In most ways the promises made by the “one- stop shop” idea have been realized in this area of cardiac pathology. Magnetic resonance imagining’s abilities to combine high resolution imaging of the heart, viability imagining using delayed hyper enhancement imaging, tissue characterization and coronary angiography allowed patients with left ventricular (LV) dysfunction to be characterized completely in one non- invasive sitting.[2]

Restrictive Cardiomyopathy; Restrictive filling and reduced diastolic size of either or both ventricles with normal or near normal systolic function is idiopathic or associated with other disease (e.g. amyloidosis, endomyocardial disease)

Hypertrophic Cardiomyopathy; Left, and/ or right ventricular hypertrophy, often asymmetrical, which usually involves the interventricular septum, mutations in sarcoplasmic proteins caries the disease in many patients.

Dilated Cardiomyopathy; Dilatation and impaired contraction of the left or both ventricles caused by familial/ genetic, viral, and/ or immune, alcoholic/

toxic or unknown factors, or is associated with recognized cardiovascular disease.[2]

Arrhythmogenic Right Ventricular Dysplasia; Progressive fibrofatty replacement of the right, and to some degree left ventricular myocardium. Familial disease is common.[3]

Unclassified Cardiomyopathy; Disease that do not fit readily into any category, examples include ventricular non-compaction cardiomyopathy.[4]

Basic Cardiovascular Magnetic Resonance (CMR) are the same as those used for cardiac function study[3]. One approach is to follow the scout with axial T1 WI covering the heart and great vessels. These can be used to identify the left and right ventricle and provide for measurements of the left atrium, pulmonary arteries and thoracic aorta. Two-chamber (2-ch) and four chamber (4-ch) cine magnetic resonance imaging, preferably using breath-hold techniques are planned from the axial images. Short-axis images are then acquired, making sure to completely cover the ventricle from apex to base. Another approach is to use available fluoro or real-time CMR sequences to establish the geometry of the various needed sequences and then follow with diagnostic images.

The evaluation and management of patients who have heart failure and specific cardiomyopathies remains clinically challenging. Essential to the appropriate care of these patients is not only an understanding of the patient’s cardiac morphology and function but also identification of pathologic and modifiable substrate.[3]

Aim of the work

To review the role of magnetic resonance imaging in different cardiomyopathies.

Radiological Anatomy of the Heart by MRI

General Features Of The Heart

The heart is a mediastinal structure that lies within the pericardial sac, such that one-third of its bulk is to the right of the midline. The cardiac long axis has oblique orientation in relation to the sagittal plane of the body, with the base in right superior location and the apex extending anterior inferior and to the left in a position called levocardia.

The heart is formed by two atria and two ventricles, which are positioned around the central fibrous body. The atria are in posterior, superior and to the right location and the ventricles located anterior, inferior and to the left. Heart receives the systemic and pulmonary veins as they connect to the right and left atrium, respectively. The cardiac outlet is through the aorta and pulmonary artery.[5]

The cardiovascular system is composed of three segments: atria, ventricles, and great arteries. They are connected in a sequential manner.

Atrium joins the ventricles through the atrioventricular valves. The ventricles connect to the great arteries by the arterial valves.[6]

Cardiovascular magnetic resonance imaging (CMR) shows the cardiovascular morphology through a series of slices obtained from different planes.[7] The following are the standard planes used: (i) transverse axial (Fig.1.1b-m.), (ii) coronal (Fig.1.2b-g. and 1.6.), (iii) two-chamber long axis (Figs.1.3. and1.4.), (iv) four-chamber long axis (Fig.1.5.), (v) left ventricular outflow tract (Figs.1.6. and 1.7.), and (vi) short axis (Fig.1.8b-d.). Special plane sections are needed for visualizing specific areas of the heart, such as the aortic valve/right ventricular outlet view through the crista supraventncularis.[8]