Changes in Ventricular Structure and Function after Balloon Mitral Valvuloplasty

Magnetic Resonance Image Follow-up Study

A Thesis Submitted for Partial Fulfillment of Doctorate Degree of Cardiovascular Medicine

By

Amir Anwar Shaker Samaan

M.B.B.Ch, M.S.c

Supervised by

Wafaa El Aroussy, MD

Professor of Cardiovascular medicine, Cairo University

Karim Said, MD

Assistant Professor of Cardiovascular medicine, Cairo University

Sir. Magdi Habib Yacoub, FRS

Professor of Cardiothoracic Surgery, Imperial College, London

Faculty of Medicine

Cairo University

2016

Acknowledgments

In these few lines, I would like to express my deepest gratitude to ***Prof. Sir. Magdi Yacoub*** for his valuable guidance and meticulous supervision throughout the course of conducting this research.

Also I would like to show all my respect and gratefulness to ***Prof. Mohammed Eid Fawzy*** for his continuous guidance and support. He helped in the initiation of balloon mitral valvuloplasty service at Aswan Heart center and has always been a source of inspiration and encouragement for all of the team.

I am particularly indebted to ***Prof. Wafaa El Aroussy*** for her generous help and continuous support. She has always been welcoming, reassuring and encouraging.

Special thanks *to* ***Prof. Karim Said***, my mentor and role model, for his patience and valuable help in planning and conducting this research.

I would like also to thank my colleague; ***Dr. Mohamed Hassan*** for his contribution in conducting this research; helping in performing the cases and in completing the statistics.

Last but not least, I would like to present this work to my wife and my parents who supported me a lot and without them the completion of this work would have not been possible.

Abstract

Background: Prior studies have showed abnormal left ventricular (LV) function in patients with rheumatic mitral stenosis (MS). The pattern of LV remodeling after balloon mitral valvuloplasty (BMV) has not been well elucidated.

Purpose: To describe changes in global and regional LV myocardial function in patients with rheumatic MS using CMR 6 months and one year after successful BMV.

Methods: Thirty patients (median age 33 years, 22 women) with isolated rheumatic MS were studied. All patients had CMR before, 6 months and one year after successful BMV. The following parameters were studied: indexed LV end diastolic and end systolic volumes (LVEDVI and LVESVI respectively), ejection fraction (EF), LV torsion, and regional and global LV deformation (analyzed at 17 LV segments using myocardial tissue tagging). Late gadolinium enhancement was studied to look for any myocardial fibrosis.

Results:

At baseline, patients had median EF of 57 (range: 45-69) %, LVEDVI of 74 (44-111) ml/m^2 and LVESVI of 31 (14-57) ml/m^2 with absence of late gadolinium enhancement in all myocardial segments.

Six months following BMV, compared to pre-BMV study, all LV myocardial segments showed significant improvement in strain parameters with significant increase in global longitudinal LV peak systolic strain (-16.4 vs. -13.8, p <0.001), global circumferential peak systolic strain (-17.8 vs. -15.6, p=0.002), base-apex LV torsion (3.3° vs. 2.5° p<0.001) and base -mid LV torsion (3.6 vs. 2.3° p<0.001).

At one year follow up, compared to pre-BMV study, there was a trend towards a decrease in LVESVI (29 ml/m2, p=0.079) with a significant increase in LV EF (62 %, p<0.001). A further significant increase, compared to 6 months follow up studies, was noticed in global longitudinal peak systolic strain (-17.9 vs. -16.4, p=0.008), global circumferential peak systolic strain (-19.4 vs. -17.8 p=0.03), base-apex LV torsion (4.1° vs. 3.3°, p=0.05) and base-mid LV torsion (4.7 vs. 3.6, p=0.007).

Conclusions: Among patients with isolated rheumatic severe MS, successful BMV is associated with early and continuous improvement in regional and global LV systolic strain and torsional deformation parameters that is followed by a late improvement in EF.

Table of contents

List of tables

List of Figures

Abbreviations & Acronyms

AF: Atrial fibrillation

ARF: Acute rheumatic fever

ASD: Atrial Septal defect

BMV: Balloon Mitral Valvuloplasty

BNP: Brain Natriuretic Peptide

CMR: Cardiac Magnetic Resonance Imaging

EDV: End-diastolic volume

EDVI: End-diastolic volume index

ESV: End systolic volume

ESVI: End-systolic volume index

ESS: end-systolic wall stress

ET: Ejection time

FAC: Fractional Area Change ()

GLS: Global Longitudinal Strain

GCS: Global Circumferential Strain

HARP: Harmonic Phase

HIV: human immunodeficiency virus

ICT: Isovolumetric contraction time

IRT: Isovolumetric relaxation time

LA: Left atrium

LV: Left ventricle

LVEDP: Left ventricular end-diastolic pressure

LVEF: Left Ventricular Ejection Fraction

MS: Mitral stenosis

mPAP: mean Pulmonary Artery Pressure

MPI: Myocardial performance Index

MR: Mitral Regurgitation

MRI: Magnetic Resonance Imaging

MVA: mitral valve area

PAP: pulmonary artery pressure

PASP: Pulmonary Artery Systolic Pressure

PCWP: Pulmonary Capillary Wedge Pressure

PVR: Pulmonary Vascular Resistance

RHD: Rheumatic heart disease

RV: Right ventricle

RVEF: Right Ventricular Ejection Fraction

RVSP: Right Ventricular Systolic Pressure

SR: Strain rate

STE: Speckle Tracking Echocardiography

SWI: stroke work index

TAPSE: Tricuspid Annular Point Systolic Excursion

TB: Tuberculosis

TGF-β: Transforming Growth Factor -β

TR: Tricuspid Regurgitation

TDE: Tissue Doppler Echocardiography

TDI: Tissue Doppler Imaging

Vce: Velocity of the contractile element

WHO: World Health Organization

ROI: Region of Interest

Introduction

Introduction

Although the incidence of rheumatic fever and its complications have declined in developed countries, the disease is still a major health problem in many developing countries[1]. The mitral valve is the most commonly and severely affected by rheumatic process by stenosis and/or regurgitation[2]. It is estimated that up to 30 million schoolchildren and young adults have chronic rheumatic heart disease worldwide, and nearly a third of these have mitral stenosis[3].

Ventricular abnormalities in patients with mitral stenosis (MS) have been previously described in many studies. Impaired left ventricular (LV) systolic function has been reported in around 30% of patients with MS[4], and in those with apparently normal systolic function, underlying abnormal LV contractility has been described using novel techniques[5,6]. Several theories have been suggested to explain LV abnormalities in the presence of MS. Previous rheumatic process[7], reduced ventricular filling[8], increased afterload[8] and abnormal left - right ventricular interaction[9,10] have all been previously proposed as underlying mechanisms of LV systolic dysfunction seen in these patients.

Changes taking place in the LV following balloon mitral valvuloplasty (BMV) have been a subject of investigation over the past years. Different diagnostic tools including cardiac catheterization and angiocardiography[8], echocardiography[9], tissue Doppler imaging[11] and Speckle Tracking Imaging[12] were used earlier for description of LV changes after BMV. However, many of the available data and results are controversial and most of the previous studies focused only on the immediate or short term changes following BMV with only a few data available regarding mid or long term changes.

Right ventricular (RV) dysfunction has also been shown in patients with mitral stenosis[13]. Elevated RV after load due to increased pulmonary artery pressure was suggested to be the cause of the decline in RV systolic function in patients with MS[14]. This process may be exacerbated by significant tricuspid regurgitation due either to