

**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

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## 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<sup>2</sup> and LVESVI of 31 (14-57) ml/m<sup>2</sup> 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 ( $3.3^\circ$  vs.  $2.5^\circ$   $p < 0.001$ ) and base -mid LV torsion ( $3.6$  vs.  $2.3^\circ$   $p < 0.001$ ).

At one year follow up, compared to pre-BMV study, there was a trend towards a decrease in LVESVI (29 ml/m<sup>2</sup>,  $p = 0.079$ ) 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 ( $4.1^\circ$  vs.  $3.3^\circ$ ,  $p = 0.05$ ) 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.

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# 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- $\beta$ :** Transforming Growth Factor - $\beta$

**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<sup>1</sup>. The mitral valve is the most commonly and severely affected by rheumatic process by stenosis and/or regurgitation<sup>2</sup>. 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<sup>3</sup>.

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<sup>4</sup>, and in those with apparently normal systolic function, underlying abnormal LV contractility has been described using novel techniques<sup>5,6</sup>. Several theories have been suggested to explain LV abnormalities in the presence of MS. Previous rheumatic process<sup>7</sup>, reduced ventricular filling<sup>8</sup>, increased afterload<sup>8</sup> and abnormal left - right ventricular interaction<sup>9,10</sup> 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 angiocardiology<sup>8</sup>, echocardiography<sup>9</sup>, tissue Doppler imaging<sup>11</sup> and Speckle Tracking Imaging<sup>12</sup> 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<sup>13</sup>. 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<sup>14</sup>. This process may be exacerbated by significant tricuspid regurgitation due either to