Three Dimensional Echocardiography Navigation of the mitral valve in patients with left ventricular dysfunction and functional mitral regurgitation

THESIS

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Abstract

Purpose: to describe the detailed geometric changes in the mitral valve apparatus occurring in patients with left ventricular dysfunction and functional mitral regurgitation.

Methods: prospective study that included 40 patients who had left ventricular systolic dysfunction and functional mitral regurgitation of varying severity from June 2015 to June 2016 referred to the department of Cardiovascular Medicine Cairo University ; they were divided into two groups according to the coronary angiography (done at least within 30 days next to their enrollment): group 1: 25 patients (LV dysfunction is due ischemic cardiomyopathy) and group 2: 15 patients (LV dysfunction is due to idiopathic dilated cardiomyopathy).

We evaluated the different deformity indices of the mitral valve apparatus in these patients using 2D and 3D echocardiography with the new mitral valve navigation software, and compared the results between the two study groups.

Results: The effective regurgitant orifice area (EROA), as an index of mitral regurgitation severity, was positively correlated with mitral valve anteroposterior diameter, mitral valve annular 3 dimensional (3D) circumference, mitral valve annular 2 dimensional area, mitral valve annular 3D area, mitral valve anterior and posterior leaflet 3D area, mitral valve tenting volume and tenting height, and annular ellipsicity in the whole study population. The mitral annular area, anterolateral and posteromedial tethering showed a strong correlation with indices of left ventricular dysfunction. There was no significant relationship between mitral regurgitation severity indices and those of LV systolic dysfunction as measured by left ventricular ejection fraction.

Conclusion: Mitral valve navigation using 3D TEE provided us with detailed mapping of the geometric changes occurring in the mitral valve apparatus in patients with functional mitral regurgitation.

Key words of thesis:

1- Mitral valve navigation

2- Left ventricular systolic dysfunction

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List of abbreviations

2D	Two- Dimensional
3D	Three- Dimensional
A 4C	Apical 4 chamber view.
AML	Anterior mitral leaflet.
CRT	Cardiac resynchronization therapy.
CMR	Cardiac magnetic resonance imaging.
CW	Continuous wave
DCM	Dilated cardiomyopathy.
ECG	Electrocardiography
ECM	Endothelial mesenchymal differentiation
EMT	Extracellular matrix
EROA	Effective regurgitant orifice area.
FMR	Functional mitral regurgitation
LA	Left atrium
LV	Left ventricle
LVOT	Left ventricular outflow tract.
MA	Mitral annulus
MR	Mitral regurgitation.
MRI	Magnetic resonance imaging.
MRVol	Mitral regurgitation volume.
MVN	Mitral valve navigation
MVQ	Mitral valve quantification
PW	Pulsed wave
PISA	Proximal isovelocity surface area.
P_1, P_2, P_3	Posterior mitral leaflet scallops
PM	Papillary muscle
PML	Posterior mitral leaflet.
P SAX	Parasternal short axis view
TTE	Transthoracic echocardiography
TEE	Transeosophygeal echocardiography.
TVI	Time velocity integral
VC	Vena contracta.

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INTRODUCTION

Introduction

Functional Mitral regurgitation (FMR) develops in approximately 20% of the patients following acute myocardial infarction (MI) without papillary muscle (PM) rupture and 50% of those with congestive heart failure [(1-5)].

Due to the large number of patients with acute MI, the incidence of ischemic mitral regurgitation (MR) is also high. MR affects patients' prognosis, doubling mortality following myocardial infarction and heart failure [(1-4)].

While only severe MR due to organic lesions has been shown to affect prognosis, even mild ischemic MR can significantly affect survival [(3, 4)]. Therefore, ischemic MR presents a clinical problem, which requires established therapeutic strategies based on mechanistic understanding.

FMR is characterized mechanistically by incomplete mitral leaflet closure, namely displacement of the leaflet coaptation apically within the left ventricular cavity [(6)], involving a spectrum of anatomic abnormalities of both the left ventricle (LV) and papillary muscles (PMs). Post-infarct, outward displacement of PMs leads to stretching of the chordae tendinae and increased tethering forces on the mitral leaflets, which causes the apical coaptation and restricted closure. Annular dilatation may also contribute by stretching leaflets and causing incomplete closure. Accordingly, FMR is classified as type IIIb in the Carpentier classification [(7)].

In clinical practice, FMR varies widely despite the same degree of LV dysfunction. Therefore, evaluation of the LV shape and mitral geometry might help in the assessment of the mechanisms of FMR.

The complex pathophysiology of FMR makes a challenge for surgery. Optimal repair of functional mitral regurgitation (FMR) requires an understanding of its mechanisms and identification of the mitral valve geometric changes that occurred. Therefore, the use of multiple echocardiographic parameters to assess FMR severity and its major mechanism for planning therapeutic options may be expedient.

Recent two-dimensional (2D) and three-dimensional (3D) studies have examined the mechanisms of FMR. Three-dimensional echocardiography, with its higher spatial resolution, has been used to effectively quantitate the morpho-anatomic changes associated with FMR[8–14]. Specifically, it has demonstrated that changes in left ventricular shape rather than function cause shifts in annular-papillary muscle relationships leading to abnormal leaflet tension. Recently, 3D echocardiography also suggested that mitral valve leaflets may be elongated in response to the stress imposed by increased tethering caused by dilated cardiomyopathy or post myocardial infarction [8,12,13,15].

Development of novel approaches to understand mitral valve geometry by echocardiography may improve understanding of the mechanism, clinical trajectory, and reparability of ischemic mitral regurgitation.