"ATRIAL FIBRILLATION AND THROMBOEMBOLIC RISK- DEMOGRAPHIC, CLINICAL AND ECHOCARDIOGRAPHIC (TRANSTHORACIC vs TRANSOESOPHAGEAL) EVALUATION"

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CERTIFICATE

This is to certify that **Dr. ARUN.R**, Post graduate student [2010-2013] in the Department of Cardiology, Government General Hospital, Chennai & Madras Medical College, Chennai-600003, has done this Dissertation on **"ATRIAL FIBRILLATION AND THROMBOEMBOLIC RISK-DEMOGRAPHIC, CLINICAL AND ECHOCARDIOGRAPHIC (TRANSTHORACIC vs TRANSOESOPHAGEAL) EVALUATION**" under my guidance and supervision in partial fulfillment of the regulations laid down by The Tamil Nadu Dr. M.G.R Medical University, Chennai, for DM Cardiology –Branch II examination to be held in August, 2013.

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DECLARATION

I hereby solemnly declare that the dissertation titled **"ATRIAL FIBRILLATION AND THROMBOEMBOLIC RISK-DEMOGRAPHIC, CLINICAL AND ECHOCARDIOGRAPHIC (TRANSTHORACIC vs TRANSOESOPHAGEAL) EVALUATION**" was done by me at Department of Cardiology, Madras Medical College and Rajiv Gandhi Government General Hospital, Chennai-3 during 2012 under the guidance and supervision of my unit Chief Prof. Dr.V.E.DHANDAPANI, MD,DM.

The dissertation is submitted to the Tamilnadu Dr. M.G.R. Medical University towards the partial fulfillment of requirement for the award of D.M. (Branch-2) in Cardiology.

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“ATRIAL FIBRILLATION AND THROMBOEMBOLIC RISK- DEMOGRAPHIC, CLINICAL AND ECHOCARDIOGRAPHIC (TRANSTHORACIC vs TRANSOESOPHAGEAL) EVALUATION”

CONTENTS

Title of the abstract: **PREVALENCE AND ECHOCARDIOGRAPHIC ASSESSMENT OF MITRAL REGURGITATION INCLUDING 3D-EF [EJECTION FRACTION] ASSESSMENT IN ACUTE ST ELEVATION MYOCARDIAL INFARCTION**

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OBJECTIVES

This study intended to assess the prevalence of Mitral Regurgitation in patients of acute ST elevation Myocardial Infarction (STEMI) during index hospitalization and during 1 month follow up along with 3D EF assessment.

METHODS

119 consecutive patients with STEMI were assessed for mitral regurgitation using various quantitative echocardiographic parameters like jet width, vena contracta and PISA during index hospitalization as well as during 1 month follow up. Left ventricular ejection fraction was assessed by both Simpson's method as well as 3D echocardiography. All continuous variables are expressed as mean ± SD and categorical variables as number (percentages). Independent samples T test was used for comparative analysis of two continuous variables. Comparison of categorical variables was done using Chi square test. Pearson correlation coefficient was used to analyze the correlation between two continuous variables.

RESULTS

STEMI patients have 22.7% prevalence of MR at onset, which is more likely in older age group, diabetics and IWMI patients and independent of gender and left ventricle systolic dysfunction. Most commonly, ischaemic MR is of milder severity at onset which tends to persist in 15.7% of patients during follow up. Some patients may develop new MR later on depending on the LV remodeling. Modalities of revascularization doesn't influence the course of Mitral Regurgitation in short term follow up.2D EF estimation with a properly acquired good image is comparable to more precise 3D EF in STEMI patients.

INTRODUCTION

MR is a frequent complication of coronary artery disease. It was often under-rated because it is clinically silent, but with the use of echocardiography this complication is observed between 15%-20% after a myocardial infarction.[1] When compared with patients without MR, the patients with acute myocardial infarction and mitral regurgitation are older, more often in female and frequently have a history of previous ischaemic heart disease.[2] Its presence and degree have major prognostic implications and underscore the importance of its detection and quantification. Ischaemic mitral regurgitation can independently predict cardiovascular death with a relative risk of 2.[3] In a community trial, Bursi et al found that mitral regurgitation predicted heart failure as well as mortality among 1 month survivors independent of age, gender, ejection fraction, and Killip Class.[4] Even mild MR was shown to increase the mortality in SAVE trial (Survival and Ventricular Enlargement) [3] hence, detection and quantification of MR is crucial.

MR can be estimated by different techniques on echocardiography. Color flow imaging allows an easy visualization of MR, but was found to overestimate the MR.[5] Mccully et al demonstrated that the same jet area corresponds to smaller regurgitant volumes in functional MR as compared to organic MR.[5] Doppler echocardiography allows accurate assessment of regurgitant volume and effective regurgitant orifice and thus provide the tools to reliably

evaluate the prognosis and mechanism. Doppler methods are simple, fast, reproducible and proven to be more reliable bur sparsely applied in routine clinical evaluation. Current guidelines advocate quantification of MR by the measurement of vena contracta and proximal isovelocity surface area (PISA), the most recommended quantitative approach whenever feasible. The semi-quantitative evaluation should be abandoned.[6]

Echocardiography is the most common method to assess left ventricular systolic function. It can efficiently predict the outcome and help in determining the treatment modalities like CRT-D implantation etc. Routine 2D EF measurement has several limitations in AMI patients due to problems of foreshortening and geometric assumptions.3D echo LVEF is much more accurate especially in presence of regional wall-motion abnormalities as it does not have geometric assumptions and is found to have comparable with present day ‘‘gold standard’’ for systolic function , cardiac MRI .[7] It can automatically calculate ejection fraction and left ventricular mass using the automated software’s, and is therefore more reproducible. It is several folds accurate as compared to conventional echo.

As there is no data for prevalence of Mitral Regurgitation in Indian population, this study was undertaken. We evaluated the prevalence and degree of Mitral Regurgitation in the acute phase and after 1 month of STEMI.

AIMS AND OBJECTIVES

PRIMARY AIM

a. To study the following parameters in Acute ST Elevation Myocardial Infarction[STEMI] patients
    i. Prevalence of mitral regurgitation[MR] by echocardiography in acute STEMI and during 1 month follow up
    ii. 3D-EF(ejection fraction) assessment

SECONDARY AIM

a. Correlation of 2D-EF, 3D-EF and MR in STEMI patients

REVIEW OF THE LITERATURE

INTRODUCTION

Mitral regurgitation (MR) is defined as systolic retrograde flow from left ventricle (LV) to left atrium (LA) because of pressure gradient between the two chambers. [8] The term ischaemic MR does not necessarily imply the presence of true myocardial ischemia, it is in fact an abridgment, characterizing a clinical situation corresponding to chronic coronary artery disease with frequently a prior history of one or more myocardial infarctions leading to progressive global or regional pathological LV remodelling, usually in the absence of reversible ischaemia.[9]

Ischemic MR is a type of secondary/functional MR due to coronary artery disease. Secondary MR is defined as functional MR, due to LV remodelling by idiopathic cardiomyopathy or coronary artery disease.[8, 10] It is important to distinguish between primary MR due to organic disease of one or more components of the mitral valve apparatus and secondary MR which is not a valve disease, but represents the valvular consequences of a LV disease. There are however limitations in both terms: functional and ischemic. Indeed, recent studies have demonstrated evidence of structural changes in the mitral leaflets in response

to tethering on them by LV pathological remodelling. The leaflet adaptation includes enlargement and increased stiffness.[11]

PREVALENCE

MR is a frequent accompaniment of ischaemic heart disease. Clinical presentation is variable from silent to severe MR presenting with hemodynamic instability. It may be an incidental finding on echocardiography or catheterization .[3] Its importance was often underscored because of low murmur intensity but with the use of echocardiography, MR is observed between 15%-20% of patients with acute myocardial infarction.[1]Different investigators have found variable incidence of MR in acute MI with the help of different imaging modalities.Lehmann et al found 13 % incidence of mitral regurgitation early in the course of acute myocardial infarction with the help of contrast left ventriculography.[2] Tcheng et al reported incidence of post-infarction mitral regurgitation was to be 17.9% of patients within hours of infarction.[12] Indeed, when it is sought by doppler, MR has been reported to occur in up to 39% of patients with MI. [13,14] With the recent advances in non-invasive doppler echocardiography ,it is possible to accurately assess the regurgitant volume and effective regurgitant orifice. Old age, diabetes, past history of MI, severe CAD are more frequently associated with STEMI with

MR than patients with STEMI without MR.[2, 12, 15] Its presence and degree have major prognostic implications and mandates its detection and quantification.

PATHOPHYSIOLOGY

Normal mitral valve function depends on perfect delicate interplay between the mitral leaflets, the subvalvular- apparatus (which includes: chordae tendinae and papillary muscle), the mitral annulus, and the left ventricle. Pathophysiology of ischemic MR is perplexing. Myocardial damage and LV dysfunction usually precedes MR. Ischemic MR is characterized by normal leaflets and subvalvular apparatus and occurs due to restricted motion of the leaflets. According to the Carpentier's classification, ischaemic mitral regurgitation is classified as type 3. [16]

Given below is the classification based on motion of leaflet in relation to the mitral annular plane (figure 1)

1: normal leaflet motion. Perforation of the leaflet due to traumatic injury or endocarditits, or annular dilatation, which may cause left ventricular disease, is the cause of MR in type1.

2: excessive leaflet mobility accompanied by displacement of the free edge of one or both leaflets beyond the mitral annular plane into the left atrium, degenerative cardiac diseases may cause leaflet prolapse.

3: leaflet restriction. It is further subclassified into 2 varieties:

3a, where the restriction occurs throughout the cardiac cycle, i.e. both in systole and diastole due to shortening of the chordae and/or leaflet thickening such as in rheumatic disease,

3b, where the leaflet restriction is seen in systole only (usually the result of regional wall motion abnormalities seen in ischaemic mitral regurgitation).[16]

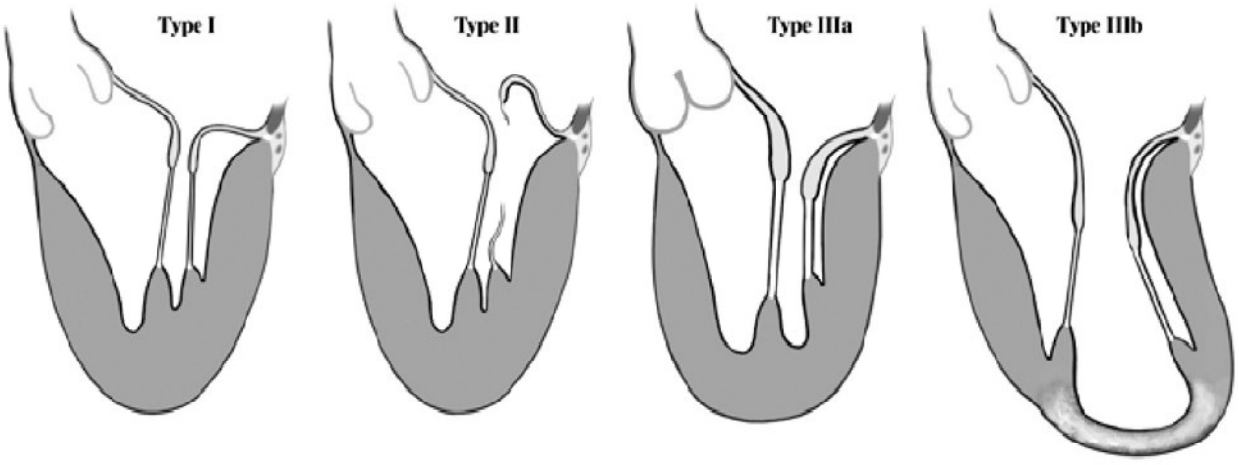

Figure 1: Carpentier's functional classification of Mitral Regurtitation[17]

Mitral Leaflet closure is mainly an intricate interplay between the forces of tethering and ventricular forces (figure 2, 3). Increase in tethering forces will not allow adequate closure of the mitral leaflets.[8, 18] The most frequent pattern seen is posterior infarction, more commonly trans mural, leading to local left ventricular pathological remodelling and thereby contributing to posterior, apical and lateral displacement of the posterior papillary muscle. As the papillary muscle extends non-extensible chordate to both the leaflets, its displacement results in a more apical tethering of the leaflets and their coaptation point, and a characteristic deformity of the anterior leaflet which is described as the 'seagull sign'.[8, 19] The tethering process produces the shape like that of a tent between the annular plane and the displaced leaflets. The tenting volume closely estimates the regurgitant orifice area.[8,20] Tenting area is asymmetric in case of posterior infarction and regional remodelling, predominates on the posterior leaflet close to the medial commissure. It is accompanied by decreased mobility of the posterior leaflet. In another subgroup of patients with previous anterior infarction or both anterior and posterior infarctions, LV dilatation is more global, LV is more spherical, both papillary muscles are displaced, the tenting area is symmetric, the regurgitant jet is central and the contribution of annular dilatation and flattening is more important.

Second important determinant is decrease in ventricular closing forces, includes altered systolic annular contraction ,LV dysfunction ,reduced synchronicity

between the two papillary muscles and global LV dyssynchrony, especially in basal segments.[8]Factors aggravating the mitral regurgitation are dilatation of the mitral annulus and the decrease in systolic annular contraction, but isolated annular dilatation does not create functional mitral regurgitation.[18]

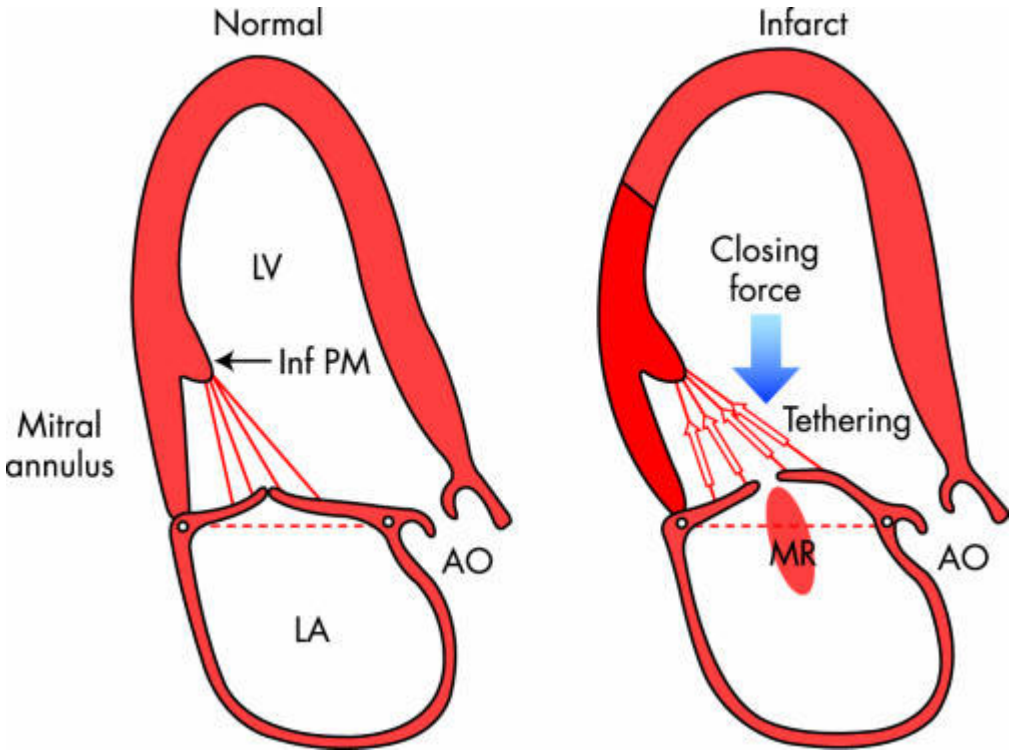

Figure 2: Left figure: Normal coaptation is seen. **Right figure**: tethering of leaflet due to papillary muscle displacement and annular dilatation

AO, aorta; Inf PM, inferior papillary muscle; LA, left atrium; LV, left ventricle; MR, mitral regurgitation.

(Reproduced from Levine RA, Hung J, Otsuji Y, et al. *Mechanistic insights into functional mitral regurgitation.* Curr Cardiol Rep 2002; 4:125–9)

Occasionally, leaflet prolapse can occur as a result of fibrotic elongation of papillary muscle which may be followed by an event such as myocardial infarction and this can result in MR. (Carpenters' Type 2).

The consequences of MR depend on the following underlying factors

a. Severity of regurgitation

b. LA compliance

c. LV-LA gradient (the driving force)

d. Duration of the lesion

Acute MR can occur secondary to two rare causes: rupture of a papillary muscles resulting from acute myocardial infarction and transient active ischemia leading to true ischemic MR. The rupture of a papillary muscle, more often in the location of head of the postero-medial papillary muscle, is a catastrophic complication of actual MI with a high mortality if emergency surgery is not done.[8, 21]

In majority of patients with chronic ischemic MR complicating left ventricular dysfunction and heart failure, LA is enlarged and has a greater compliance with

low driving force. The volume overload resulting from MR contributes to a vicious cycle : the more remodelling of left ventricle, the more severe MR begets MR, so greater the severity of MR, larger the volume overload on LV which finally leads to LV remodelling.LV becomes more and more dilated and spherical in accordance to laplace law, which further propentiates the MR. Despite a reduction in LV impedance, LV wall stress increases ,finally translating into LV dysfunction.[22] Chronic ischaemic MR finally leads to development of pulmonary arterial hypertension.

Another important feature of ischaemic MR is its dynamicity. [23] The degree of MR is best quantified by the effective regurgitant orifice (ERO) area. [24] The regurgitation area keeps on changing throughout the systole due to dynamic changes in transmitral pressure, though it is of lesser importance in mid-systole when compared to other phases of systole.[25,26] ERO is load dependent, therefore affected by daily activities. Another evidence of the dynamicity of ischaemic MR is a reduction of regurgitant volume related to a reverse LV remodelling obtained by appropriate medical treatment. [27] Dynamic nature of MR can be very well appreciated during an exercise doppler echocardiogram.[28] The degree of MR seen at rest is not related to exercise-induced changes in ERO area or regurtitant volume.[29] Exercise-induced changes are quite variable in different individuals.

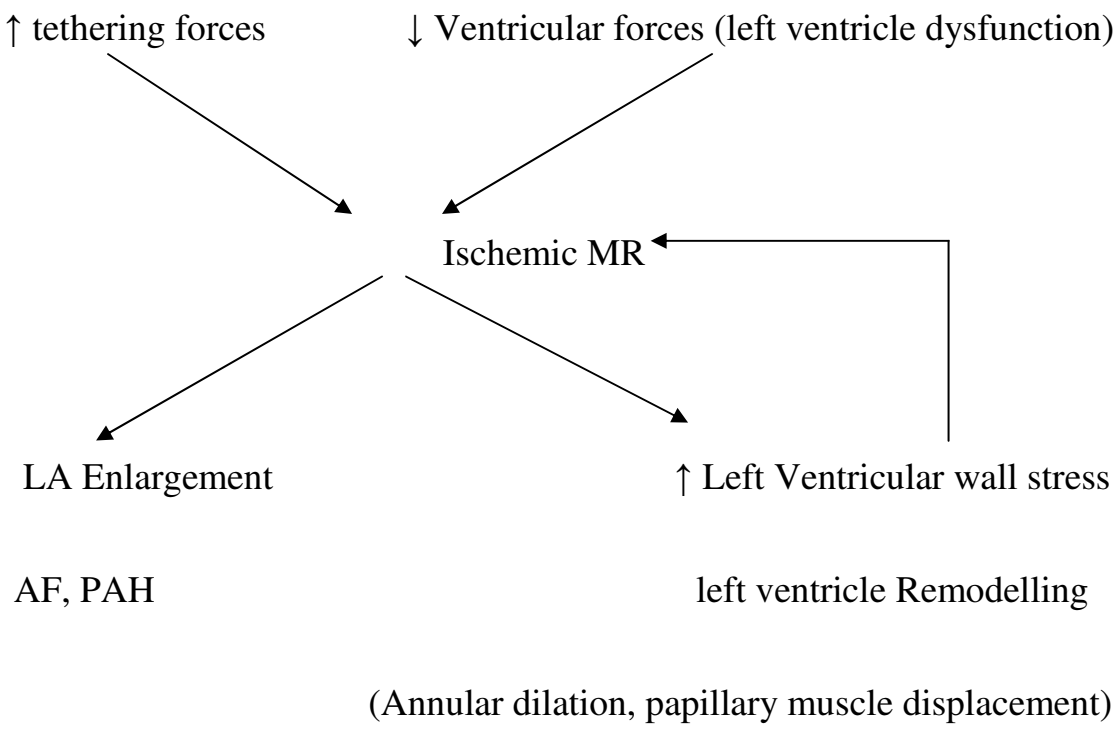

Figure 3: Pathophysiology of Ischaemic MR

In some individuals with moderate or severe MR at rest, a decrease in ERO area can be observed with exercise and usually results from contractile reserve of the LV, in particular of the postero-basal segment and/or a reduction in intra LV dyssynchrony.[30] Around 30% of these patients develop an increase in the severity of regurgitation and in systolic pulmonary artery pressure during exercise. The degree of exercise-induced increase or decrease in MR relates to changes in valve deformation, LV remodelling and papillary muscles synchronicity.

DIAGNOSIS AND QUANTIFICATION

Clinical examination in ischaemic MR may reveal a regurgitant murmur of low grade or may even be silent or inaudible .It is an insensitive method for ischaemic MR diagnosis due to subtle or near normal auscultatory findings in many patients. This can be explained from the fact that cardiac output is low, LV contractility is compromised and atrial pressure is high thereby they cause lower regurgitant volume, consequently low grade murmur in ischemic MR compared to organic MR. There is no correlation between intensity of murmur and severity of ischaemic MR.

The diagnosis of ischaemic MR is usually made by using imaging modalities like doppler echocardiography. Doppler echocardiography is a useful tool in diagnosis and is superior to other techniques like contrast ventriculography. Importance of doppler echocardiography in routine clinical practice is undisputed. Clinically subtle findings like low intensity murmurs should always lead to a careful echocardiographic examination.

Quantification of MR is also crucial. Echocardiography plays a key role not only in diagnosis of regurgitant lesion but also in the assessment of the mechanism and the severity of MR. It also has a role in determining treatment options as it helps in determining the feasibility of valve repair versus replacement.

Assessment of Mitral Regurgitation by echo can be (a) qualitative (b) quantitative.

QUALITATIVE METHODS

Colour flow imaging

Colour flow imaging is the most widely used method to assess MR severity echocardiographically .[32] This measurement is poorly reproducible and influenced by various factors. Though it allows an easy visualization of the regurgitation and frequency of MR, it has major limitations in assessing the severity of MR. [5, 33] It tends to overestimate the severity of regurgitation. It is generally assumed that with increasing MR, the size and extent of the regurgitant jet in LA is increased. Larger colour jets extending deep into LA represent greater severity of MR than small thin jets that appear just beyond the mitral leaflets. However, the jet size may be influenced by other factors such as technical and hemodynamic influences and therefore caution must be exercised in interpretation of jet severity based on jet size. For the same severity of MR , patients with increased LA pressure, enlarged LA or wall hugging eccentric jet may show smaller jets area when compared with normal LA pressure, size or with central jets.[6] In acute MR, even centrally directed jets may be misleadingly small. Nevertheless, a large eccentric jet adhering, swirling and reaching the posterior wall of the LA favours significant MR and

smaller thin jets appearing just beyond the mitral leaflets usually is an indicator of mild MR.

Continous Wave Doppler of MR jet

Continuous wave doppler of mitral regurgitation jet is another qualitative parameter which is used to measure the severity of mitral regurgitation. The signal intensity (jet density) of the CW envelope of the mitral regurgitant jet can be used as a qualitative indicator to mitral regurgitation severity. A dense triangular mitral regurgitation signal with a full envelope indicates severe mitral regurgitation than a faint signal. Truncated (notch) envelope with a triangular contour and an early peak velocity (blunt) indicates elevated LA pressure or a prominent regurgitant pressure wave in the LA due to severe MR. In case of eccentric mitral regurgitation; it may be difficult to record the full CW envelope of the jet, while the density may be used as indicator for assessing the severity.

SEMIQUANTITATIVE MEASURES

The semi-quantitative evaluation of regurgitant jet area should not be used.[6] It is recommended that these measures should only be used for diagnosing mitral regurgitation, and not to quantify the severity of MR. A more quantitative approach is recommended when more than a small central MR jet is seen.

Vena contracta width (VCW)

The vena contracta is the narrowest portion of the MR jet downstream from the orifice; it reflects the effective orifice area.[34-36] Whenever feasible measure the dimensions of vena contracta, which can help in quantification of MR. Using a careful probe angulation and adapted Nyquist limit (colour Doppler scale) (40–70 cm/s), the vena contracta is typically imaged in a view perpendicular to the commissural line (e.g. the parasternal long-axis or the apical four chamber view) to identify the neck or the narrowest portion of the jet. This narrowest doppler colour sector scan can be coupled with the zoom mode to improve resolution and for more accurate measurement (Figure 4). It is recommended that if possible averaged measurements over at least three beats should be taken and measurements should be taken from two orthogonal planes. A vena contracta, < 3 mm is considered as an indicator of mild MR whereas a width ≥7 mm defines severe Mitral Regurgitation, values in between 3 to 7 mm are ambiguous and need further confirmation by a more quantitative method.[6]

The concept of vena contracta is based on the assumption that the regurgitation orifice is almost circular, this assumption holds true in cases of organic MR but in functional MR the results may not be accurate as the orifice may be non circular and elongated along the mitral coaptation line. [37, 38] Thus, it could look narrow in four-chamber view and broad in two-chamber view. Conventional 2D colour

Doppler imaging does not provide appropriate orientation of 2D scan planes to obtain an accurate cross-sectional view of the vena contracta. The vena contracta can be classically well identified in both central and eccentric jets. In case of multiple MR jets, the respective widths of the vena contracta are not additive. Such characteristics may be better appreciated and measured on 3D echocardiography. In cases of functional MR, a mean vena contracta width (four- and two chamber views) has been shown to be better correlated with calculation done using the 3D vena contracta.[41] 3D echo assessment of the vena contracta is not used routinely and currently it is used for research purposes.

A mean value >8 mm on 2D echo has been reported to define severe MR for all aetiologies of MR including functional MR, though it needs confirmation in further studies.[39]

Pulmonary venous flow Doppler

It is an additional parameter for evaluation of MR severity. Normally, if there is no diastolic dysfunction in venous flow Doppler we get a positive systolic wave (S) which is followed by a smaller diastolic wave (D). As the severity of MR increases, there is a blunting of the S wave velocity. Systolic blunting or systolic flow reversal will be seen in moderate and severe MR respectively.

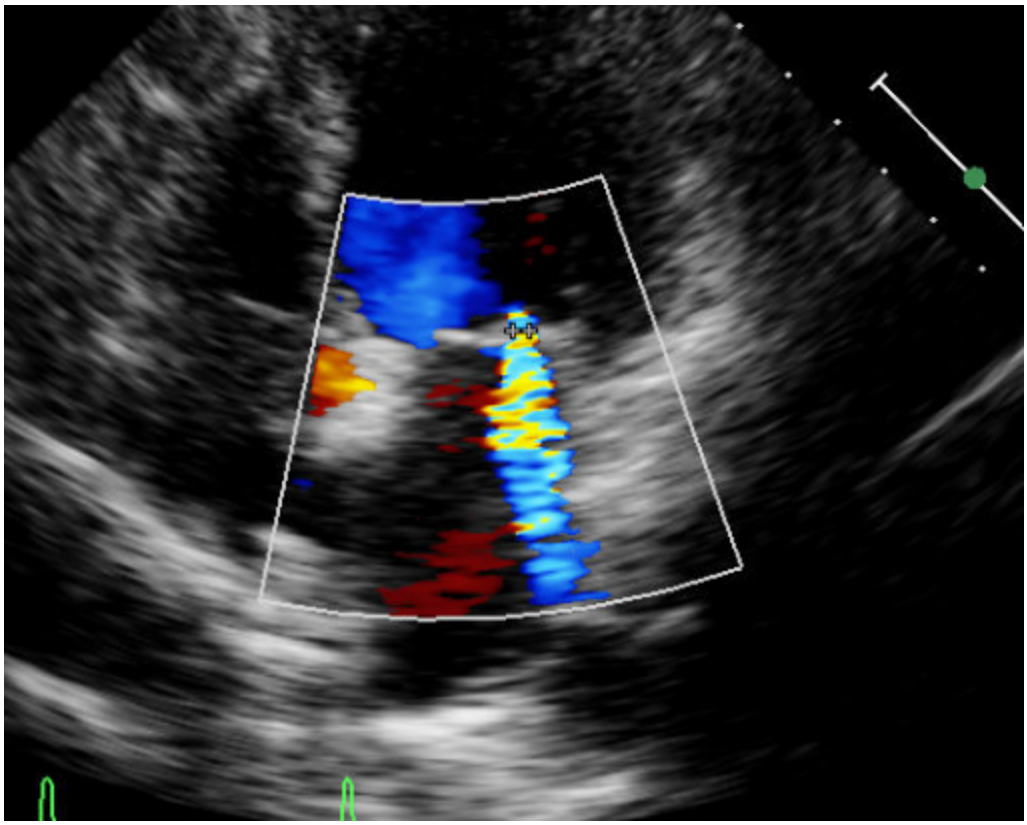

Figure 4. Measurement of Vena contracta width in Mitral Regurtiation.

QUANTITATIVE METHODS

Doppler volumetric method

Doppler volumetric method can calculate regurgitant volume by finding the difference between measured mitral and aortic stroke volume.[43].It can be inferred using 2D echocardiograph by calculation of LVEDV and LVESV which are calculated using biplane method of disks. [42] Same jet areas correspond to smaller RVol in ischemic MR than in organic mitral regurgitation. However, this method is

cumbersome and time consuming. It is not recommended as first line investigation for quantification of regurgitant volume.

Flow Convergence Method

Flow-convergence method is the most frequently quantitative method for estimation of MR in current practice.[44]It is based on law of conservation of flow; its basis lies in the modified form of continuity equation. It enables the measurement of ERO area and regurgitant volume with precision.[45] As the flow convergence is proximal to the regurgitant orifice it forms the basis of analysis.[46] The apical four-chamber view is classically recommended for enabling good visualization of the proximal isovelocity surface area (figure 5). However, in anterior mitral valve prolapse the calculation of PISA should be done in the parasternal long- or short-axis view. By lowering the image depth and reducing the Nyquist limit to 15–40 cm/s, flow velocity at a hemispheric surface proximal to regurgitant orifice can be determined.[6] The radius of the PISA is measured at mid-systole using the first aliasing. Regurgitant volume (R Vol) and effective regurgitant orifice area (EROA) are obtained using the standard formula.

Regurtitant flow = 2Π (radius of the flow convergence) ^{2} x aliasing velocity

ERO is the ratio of regurgitant flow /peak mitral regurgitant velocity

Regurtitant volume (RVol) is calculated as product of ERO and MR TVI.

Qualitatively, the presence of flow convergence at a Nyquist limit of 50–60 cm/s is an indicator to the presence of significant MR.[6]

Grading of organic MR [6]

	Mild	Moderate	Severe
EROA (mm2)	<20	20–29; 30–39	≥40
R Vol (mL)	<30	30–44; 45–59	≥60

Moderate regurgitation group can be further classified into 'mild-to-moderate' (EROA of 20–29 mm2, R Vol of 30–44 mL) and 'moderate-to-severe' (EROA of 30–39 mm2 or R Vol of 45–59 mL). In ischaemic MR, the thresholds of severity, which are of prognostic value, are 20 mm^2 and 30 mL, respectively.[47] EROA is the most robust parameter as it represents a marker of lesion severity. A large EROA can lead to large regurgitant kinetic energy (large R Vol) as well as to potential energy, with low R Vol but high LA pressure.

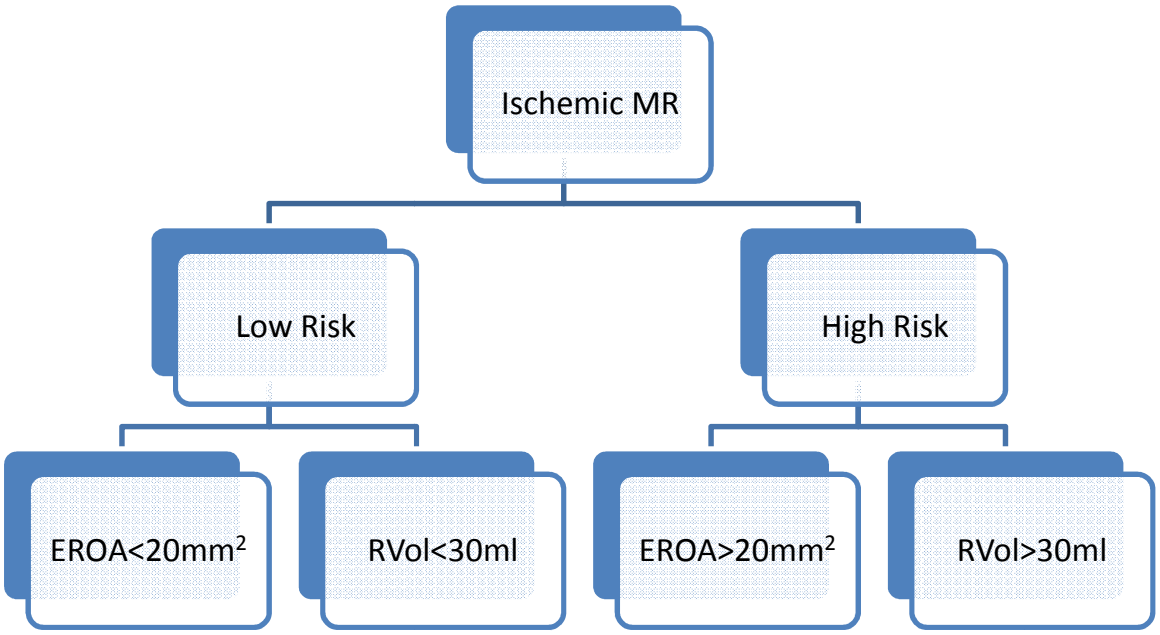

Figure 5: Ischaemic MR Grading [6, 48]

This method is simple, fast, and reproducible and has been validated by multiple investigators.[46; 49]It precisely calculates the RVol, which indicates the volume overload induced by MR, and the effective regurgitant orifice (ERO), which delineates the severity of anatomic lesion.

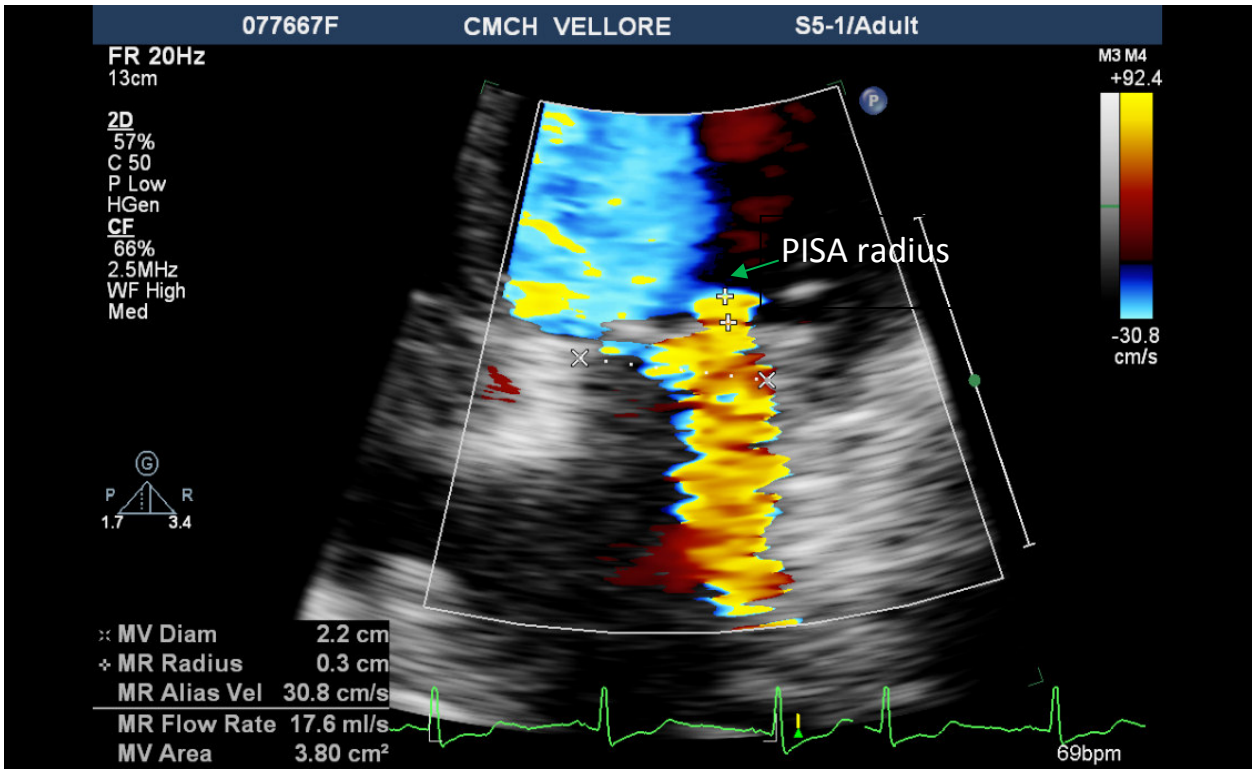

Figure 5. Determination of radius of proximal isovelocity surface area (PISA) in ischaemic Mitral Regurgitation.

There are several limitations of the proximal isovelocity surface area (PISA) approach. [8,46] First, the PISA radius changes during systole is larger in early and late systole, and smaller in midsystole when the LV pressure is maximal.[50] Ideally, the PISA radius should not be measured at only one time point, but averaged through systole. Second, for an accurate measurement, the flow convergence should be hemispheric. In cases of functional MR, the flow convergence—a three-dimensional structure—is frequently hemielliptic (Fig 6), implying an underestimated calculation of ERO and regurgitant volume, particularly when the

ratio of long-axis length to short-axis length of the 3D regurgitant orifice is >1.5. [38, 51-52]

Third, multiple jets can be present; the addition of several flow-convergence regions has not been validated. Fourth, it is more accurate for central jet. It may not hold for eccentric jets, several jets, or complex or elliptical regurgitant orifices. Practically, the geometry of the PISA varies based on the shape of the orifice and mitral valve leaflets surrounding the orifice.

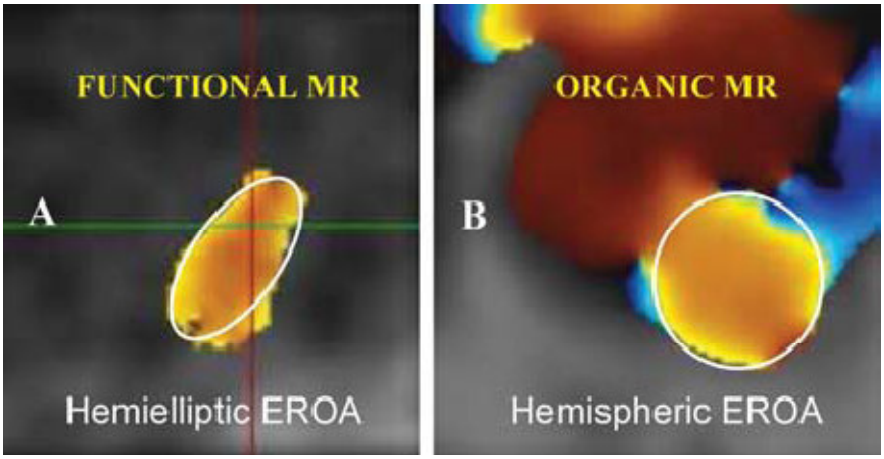

Figure 6: 3Dimensional shape of the convergence flow in (a) functional MR (b) organic MR

(Reproduced from EHJ guidelines for the assessment of the valvular regurgitation 2010)

Thus, practically, the most reliable calculation of regurgitant volume and ERO area is the averaging of the quantitative doppler and the PISA methods .However, this approach is time consuming.[8]

Invasive assessment

Mitral regurgitation could be assessed by invasive ventriculography. Some schools of thought have considered Left ventriculography as the reference methodology for assessment of mitral regurgitation. However this method of grading of MR is also subject to limitations and cannot thereby be considered gold standard because of influence of loading conditions affecting the MR severity.

Comparatively, Quantitative Doppler echocardiography is non invasive and also provides more objective data for grading and prognostic information about regurgitation than ventriculogram.[53]

PROGNOSIS

The presence of ischaemic MR is an important indicator for long term morbidity as well as mortality. It is an independent risk factor for the same. The presence of ischaemic MR may result from acute infarction resulting in regional left ventricular dilation and consequent loss of contractile mechanism or in some instances it may be a previously existing lesion which went undiagnosed. Several studies have clearly shown that ischaemic mitral regurgitation can predict cardiovascular

mortality independently.[2-4,8, 12, 54] Relative risk was found to be quite variable ranging from 1.48 - 7.5.[8] Worse long term prognosis was seen in patients presenting with non ST elevation myocardial infarction .[55] A community based study has also confirmed the prognostic importance of ischaemic MR among one month survivors of MI: its presence is associated with a three-fold increase in the risk of heart failure and a 1.6-fold increased risk of death at 5-year follow-up, independent of LV ejection fraction, Killip class, age and gender.[4,8] Barzilai et al found that AMI patients with a murmur suggestive of MR had a 12-month mortality of 36% compared with 15% for patients without an MR murmur. [56]SAVE study investigators also showed that mild MR was associated with high mortality. Greater the severity of mitral regurgitation, worser was the prognosis.[48] Even uncorrected mild MR, as well as moderate to severe ischaemic MR is found to be associated with higher mortality on long term. However, the severity of ischaemic MR tends to follow the severity of the LV dysfunction causing the MR; the worse the MR, the worse the LV functions. Till date, there are no studies to prove that ischaemic MR is a predictor of long term prognosis irrespective of severity of LV dysfunction present.[8] No studies have proved that correction of mitral regurgitation will mitigates the long term mortality independent of left ventricular systolic dysfunction[8]

Though small case series has shown that coronary revascularisation in acute MI has reduced the severity of MR in selected patients, it tend to persist in > 50% of patients of MI on follow up.[12] Therefore, even coronary revascularisation may not halt its progression during long term.

Prognosis is also found to be related to the dynamicity of component of ischaemic mitral regurgitation. A 5 fold increase in the relative risk of death with an exercise-induced increase of ≥13 mm2 of the ERO area was found.[8, 57] It is the best predictor of hospitalisation and cardiovascular morbidity as compared to severity of mitral regurgitation at rest. Its deleritious effects are related to several factors like sudden increase in R Vol (regurgitant volume) and with rapid QRS widening due to increases in ventricular wall stress leading to worsening LV dyssynchrony.[58]

In patients with LV systolic dysfunction, acute pulmonary oedema which may develop due to sudden worsening of dynamic MR leading to acute increase in left atrial pressures.[8, 59] Greater exercise-induced regurgitant volume and systolic pulmonary arterial pressure may cause exertional dyspnea.[60] Around 20% may have an improvement in the severity of ischaemic mitral regurgitation during exercise, who have a favourable long term prognosis. [57] This is thought to happen in patients with contractile reserve in posterior segment.[29]

MANAGEMENT

Numerous treatment options have been proposed but the treatment of ischaemic mitral regurgitation still remains a complex issue and needs further research and trials to find an ideal treatment modality with long term benefits. In current clinical approach at most places ring annuloplasty is preferred treatment modality. However, long term benefits of this technique remains obscured as it has no role in correction of local alteration due to left ventricular remodelling.

Medical Management

Standard anti-failure medications such as angiotensin-converting enzyme (ACEI) inhibitor or ARBs if the ACEI is not well tolerated), aldosterone antagonist and beta-blockers .[8, 61] It may help in alleviating the severity of mitral regurgitation by producing reverse left ventricular remodeling.[8, 62]

Cardiac resynchronization therapy

Though biventricular pacing per se is not an treatment modality for ischaemic mitral regurgitation, it is an indication to consider CRT in patients of ischemic MR with reduced left ventricular ejection fraction ,functional class III or more even with medical treatment and ecg showing QRS of more than 120 ms.[63] Cardiac resynchronization therapy resynchronize the papillary muscles and increase the closing force which helps in immediate reduction in MR.[8,64-65] There is further

more reduction in the severity of MR in long term that is after few weeks or months as it plays a role in LV reverse remodelling, through a reduction in tethering .It can also reduce dynamic MR.[66] Magnitude of MR induced by exercise attenuate significantly in parallel to reverse Left Ventricular remodelling over a period of three months and result in improved cardiopulmonary performance.[8, 67] Despite a reduction in the severity of MR, residual MR frequently persists. Immediate recurrence of MR has been seen post withdrawal of CRT due to dyssynchronization of the papillary muscles leads to. [68-70]

Percutaneous coronary revascularization

It may help in reducing the severity of mitral regurgitation at rest as well as during exertion in the subset where it is directly induced by ischaemia. .[8]

Surgical Management

Surgical approach for management of ischemic MR can only reduce its severity, not eliminate it completely. Coronary artery bypass grafting by itself is regarded insufficient in correction of MR. [71] Persistence of even little residual mitral regurgitation postoperatively has been shown to be associated with higher mortality [72] With the use of an undersized prosthetic (preferably two-sizes) ring [73], reduction in LV volume has been seen and even a small increase in LV ejection fraction has been documented , [74] but the long-term benefits could not be

proved.[75,76] Several studies have shown that long-term outcomes in terms of survival benefit or functional outcome is questionable by combined surgery. [75,77-78] In a recent randomized control trial it has been shown that mitral valve repair done along with CABG was associated with improvement of NYHA class, LVEF, and reduction in left ventricular diameter, left atrial size and PAP(pulmonary artery presence) .[79]It was not powered enough to analyse the effect on mortality . To conclude it may be said that fixing some valves may help, but it is difficult to identify which ones.[80] Recently published meta-analysis showed that mitral valve repair for ischaemic mitral regurgitation is associated with better survival compared with MVR (mitral valve replacement). [81]

The European Society of Cardiology guidelines recommend that patients with severe ischemic mitral regurgitation (ERO area ≥20 mm2) undergoing CABG should be treated by combined surgery (class I, level of evidence C). [8,82]Mitral valve repair may be considered in symptomatic patients with severe mitral regurgitation who cannot be revascularized is questionable (class IIb).[82] Mild mitral regurgitation should be managed conservatively. Due to the lacuna of well defined guidelines and evidence, the management of ischemic MR should be individualized. Assessment of myocardial viability, especially in region of posterior basal wall, inducible ischemia and the dynamic component of MR aids in decision making. Biphasic response or regional contractile reserve during stress

testing usually have exercise-induced reduction in mitral regurgitation, can be help decision making. Patients with exercise-induced increase in effective orifice area area ≥13 mm2 could be taken up for combined surgery. Severity of MR is always underestimated even with intra-operative TEE. Pharmacological measures like phenylepherine or rapid fluid challenge may be used to assess the ischaemic MR.[83] Parameters like grossly dilated left ventricle, multiple regurgitant jets , systolic sphericity index, wall motion score index, ESV(end-systolic volume), severe MR, >2.5 cm2 systolic tenting area, , large angle (≥45°) of the posterior leaflet, >1 cm distance between coaptation point and mitral annulus are recognized as predictors of bad outcome of procedures like mitral valve repair by annuloplasty .[84-86] Several adjunctive techniques have been proposed like chordal cutting, internal direct repositioning or external repositioning of the displaced papillary muscle.[8, 87] However, they are not yet clinically approved for routine management of ischaemic mitral regurgitation.

PERCUTANEOUS REAPIR

Percutaneous edge-to-edge Alfieri procedure has been used for the treatment of MR due to either ischaemic or organic cause. In it, the central parts of both mitral leaflets are apposed producing a double orifice.[8, 88] Many researchers have developed the devices which can be delivered in coronary sinus and reduce the

severity of mitral regurgitation by pushing the PML forward.[89-90] Long term effects of these devices needs to be studied.

FORTHCOIMG THERAPIES

Future targets like transplanting autologous myoblast has potential proven to cause localized LV reverse remodelling and appears to be a promising approach in decreasing ischaemic MR. More understanding of our concepts of leaflet adaptation in LV dysfunction can help us in developing potentially better therapies in future. [91]

3D EF Measurement in Myocardial Infarction

Echocardiography is the most common method to assess left ventricular systolic function. It can efficiently predict the outcome and help in determining the treatment modalities like CRT-D implantation etc. Routine 2D EF measurement has several limitations in AMI patients due to problems of foreshortening and geometric assumptions.3D echo LVEF is much more accurate especially in presence of regional wall-motion abnormalities as it does not have geometric assumptions and is found to have comparable with present day ‘‘gold standard’’ cardiac MRI .[(5)] It can automatically calculate ejection fraction and left ventricular mass using the automated softwares, and is therefore more reproducible. It is up to 3 times more accurate than 2DE LVEF.[7]

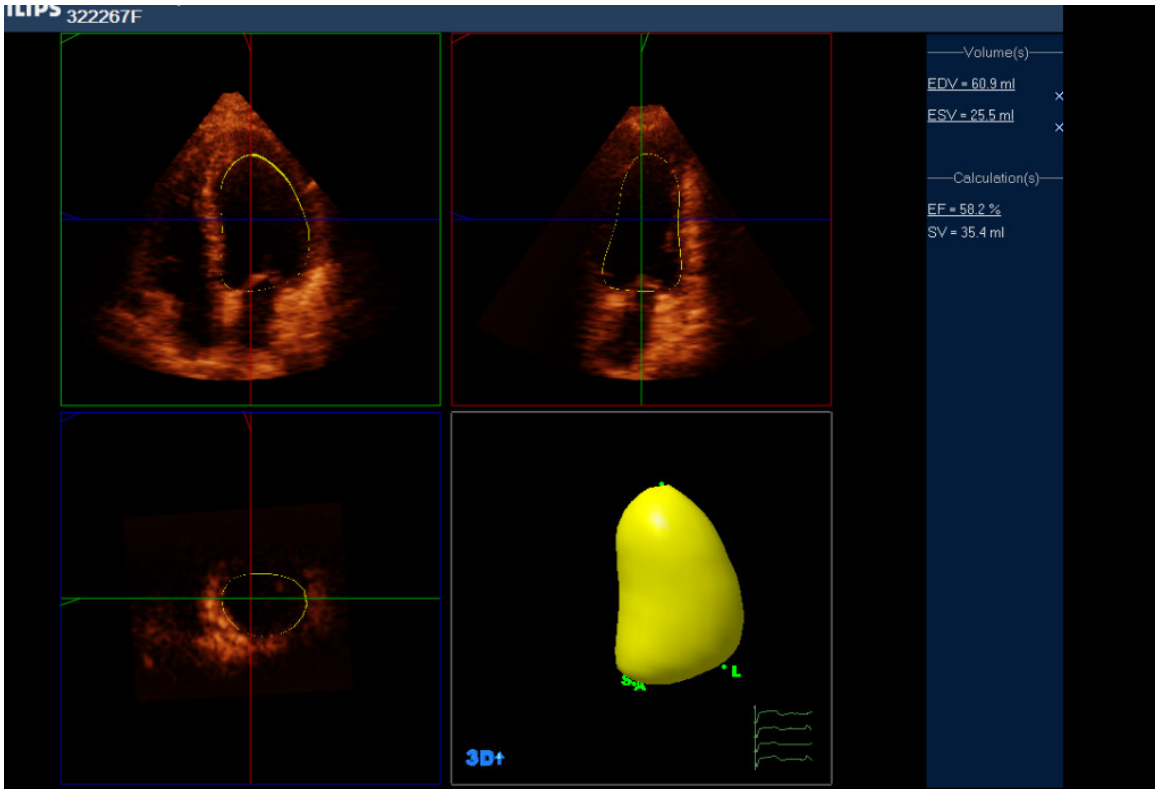

Figure 7.Measurement of 3D EF in echocardiography through Q lab analysis

DESIGN AND METHODOLOGY

Study Design:

This is a single centre prospective observational study done in the department of Cardiology, Christian Medical College (CMCH), Vellore.

SETTING

Study was done in the Cardiology department of Christian Medical College and Hospital, a tertiary care hospital in South India.119 consecutive patients with STEMI were assessed for mitral regurgitation using various echocardiographic parameters.

STUDY PARTICIPITANTS

Inclusion criteria:

All patients older than 18 yrs old, who sustained STEMI between September 2011 to August 2012.

Exclusion criteria:

Patients were excluded from the study if they had

1. Rheumatic heart disease
2. Persistent arrythmias
3. Known coronary artery disease(CAD)
4. Cardiogenic shock

5. Trivial MR

Methods:

1. Demographic and clinical profile of patients were collected were collected once they consented
2. All patients underwent echo once they were stable during index admission. Mitral regurgitation quantified using jet width[vena contracta], jet area and proximal isovelocity surface area(PISA) ,if central jet is present
3. Left ventricular ejection fraction were assessed by both Simpson's method as well as 3D echocardiography

STATISTICAL ANALYSIS

Statistical analysis was done using commercially available statistical software ('IBM SPSS software version 15', Illinois, Chicago). All continuous variables are expressed as mean ± SD and categorical variables are expressed as number (percentages). Independent samples T test was used for comparative analysis of two groups with a normally distributed continuous variables. Comparison of categorical variables was done using Chi square test. Pearson correlation coefficient was used to analyze the correlation between two continuous variables with a normal distribution. Comparative

analysis was performed by one way analysis of variance (ANOVA). A p value less than 0.05 was considered statistically significant for all test results.

RESULTS

1. STUDY PROFILE AND BASELINE CHARACTERISTICS

A total of 119 patients of STEMI were evaluated for ischaemic MR during the study period. Mean age of patients in the whole study population was 53.42 ± 11.47 years. Majority patients (57.1%) were found to be in the age group of 40-59 years, with least number was in >80 yrs (2.5%).10.9% patients were young, <40 years having MI. Number of males outnumber within each group.Ratio of Males: Female is 96:23. 31.9%(38) of the patients has type 2 diabetes mellitus,98.3%(117) of patients had dyslipidemia, 37.8(45) % of the patients had hypertension ,54.6% (65) were obese , 47.1%(56) were current smoker and 13.4%(16) had positive family history of coronary artery disease(CAD). On an average all patients were had at least 2 risk factors.

Baseline characteristics of both groups with Anterior wall MI (AWMI) and Inferior wall MI (IWMI) were comparable without any significant statistical difference except baseline 2D EF, which was higher in IWMI group (table 1). Patients presenting with AWMI were having slightly higher proportion of hypertension, though it was statistically insignificant.

Characteristic	**AWMI**	**IWMI**	**p value**
Age	52.30±11.11	54.58±11.81	.281
Male	47(78.3%)	49(83.1%)	.515
Female	13(21.7%)	10(16.9%)	.515
Diabetes	19(31.7%)	19(32.2%)	.85
Hypertension	27(45%)	18(30.5%)	.103
Smoking	29(48.3%)	27(45.8%)	.779
Dyslipidemia	59(98.3%)	58(98.3%)	.990
Obesity	35(58.3%)	30(53.1%)	.293
Positive Family History	10(16.7%)	6(10.2%)	.299
Baseline 2D EF	44.94+7.5	50.7+7.4	.000(significant)
Baseline 3D EF	45.42+8.5	46.96+8.6	.33

Table 1.Baseline characteristics of patients according to the type of STEMI

2. Prevalence of MR

27(22.7%) patients were found to have MR during index admission for MI (Figure 8), out of which 24(88.9%) had mild MR and 3(11.1%) had moderate MR based on quantitative measurements. None of the patients were found to have severe MR. Mean Vena contracta (VC) in mild and moderate MR patients at presentation were 2.91±0.94 and 3.54±0.25 respectively. Mean PISA radius, effective regurgitant orifice area (ERO) and regurgitation volume in mild MR patients at presentation were 0.315±0.08, 0.05±0.03 and 7.07±3.65 respectively (table 2).

MR	**VC(mm)**	**PISA radius(cm)**	**ERO(cm^2)**	**MR Volume(ml)**
MILD(n=24)	2.91±0.94	0.315±0.08	0.05±0.03	7.07±3.65
MODERATE(n=3)	3.54±0.25	0.44±0.06	0.10±0.06	30.33±7.77
AFTER 1 MONTH				
MILD(n=12)	2.97±0.55	0.38±0.81	0.05±0.03	6.9±3.17
MODERATE(n=2)	4.8±8.5	0.55±0.07	0.125±0.02	27±1.41

Table 2.Quantitative echocardiographic parameters of MR at presentation and after 1 month

Mean age of patients presenting with ischaemic MR at onset was 59.2 ± 10.82(figure 9), population includes 74.1% males (20) and 25.9 %(7) females. Majority of patients presenting with MR at admission were in the age group of 60-79 years (figure 9).Among the patients having MR at admission included 48.1%(13) type 2 diabetics, 100%(27) dyslipidemics, 33.3 % (9) hypertensive's, 44.4% (12) obese, 44.4 %(12) current smoker, 22.2%(6) had AWMI, 77.8%(21) had IWMI and none had a positive family history of coronary artery disease (CAD). Though there was trend towards females being more commonly associated with MR, it was found to be statistically insignificant (figure 10). None of the risk factors predicted of onset of MR in STEMI patients at admission and during follow up on statistical analysis except age, diabetes and site of STEMI(Table 3).IWMI patients were more likely to develop MR at presentation (table 3).Male gender was found to have higher prevalence of absence of MR during follow up.

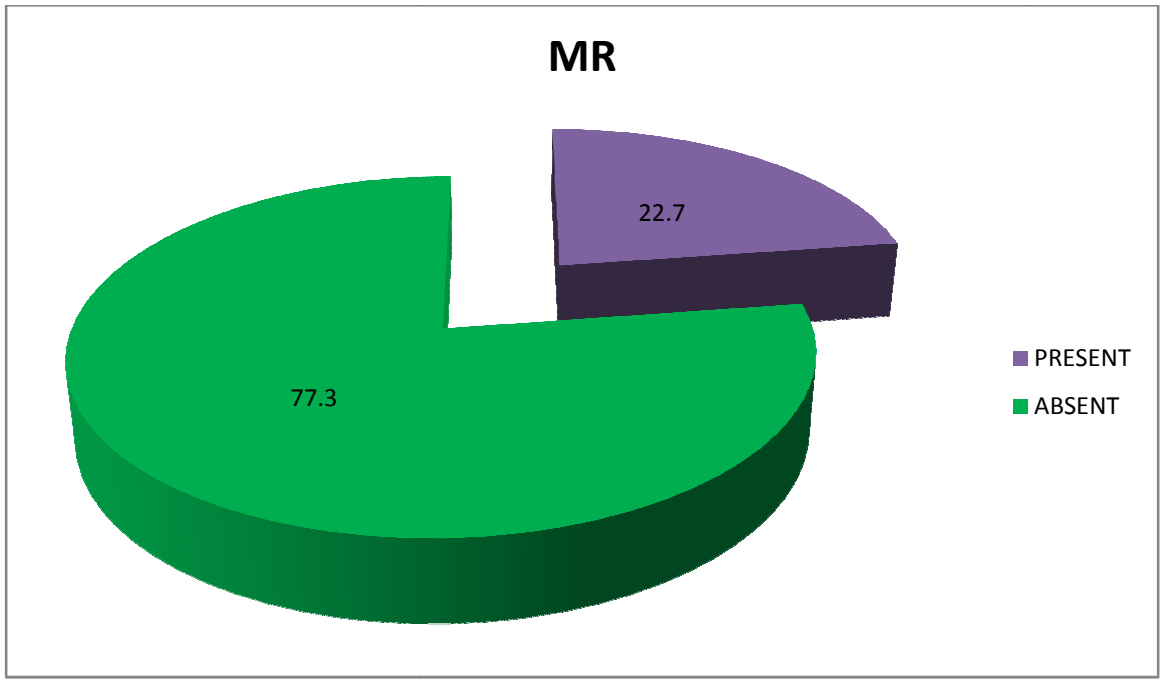

Figure 8.Prevalence of MR at admission

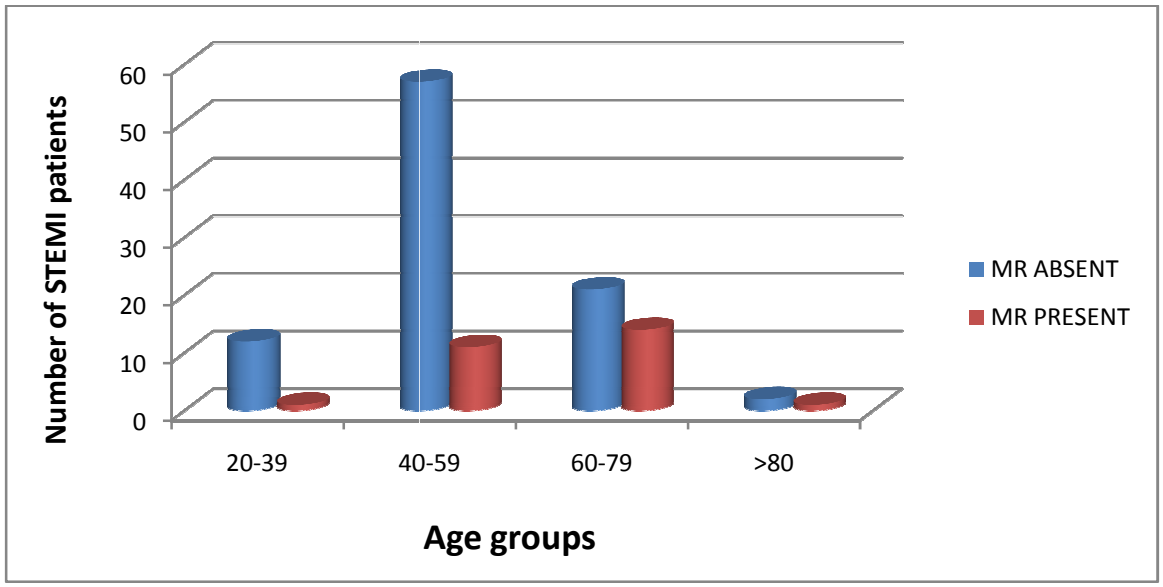

Figure 9.Prevalence of MR according to the age groups

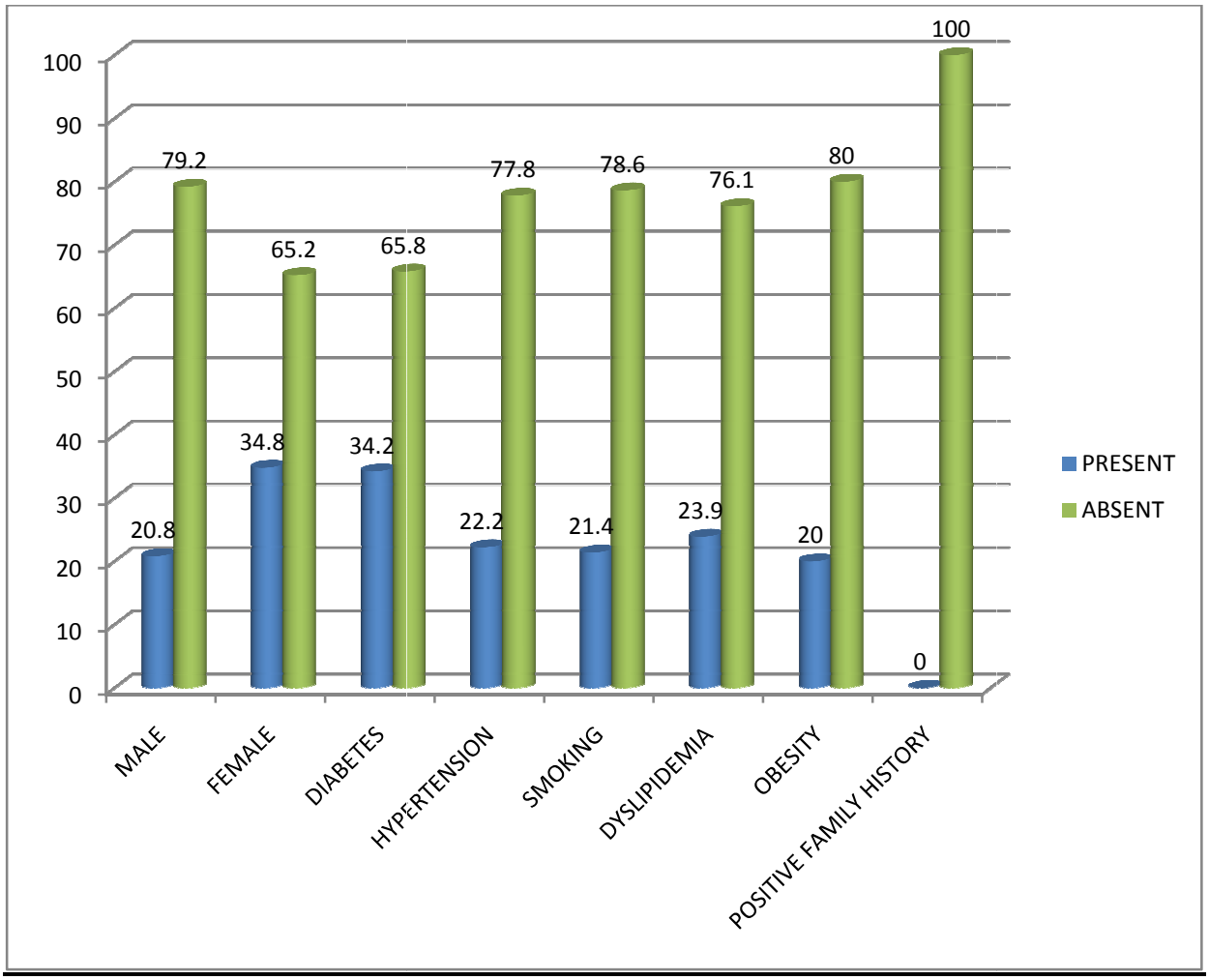

Figure 10.Proportion of baseline risk factors of patients with and without MR

During follow up after 1 month, MR was found to be present in 15.7% of patients despite a dropout of 30(25.2%) patients (figure 11).MR continue to persist in 10.1 %(9) patients with improvement in severity in 13.5 %(12) and new onset in 5.6 %(5) patients (figure 12).Among 14 patients who were having MR at follow up, 3(21.4%) had AWMI and 11(78.6%) had IWMI at baseline. None of the baseline characteristic was found to be predictor of mitral regurgitation during follow up

(table 3) excluding sex and site of STEMI.AWMI and males tend to have lesser prevalence of mitral regurgitation at follow up (table 4). IWMI patients continue to have higher incidence of Mitral Regurgitation which was persistent and also developed new onset MR, but it was not statistically significant (p-0.647).Females have higher prevalence of Mitral Regurgitation during follow up visit(table 3).None of the patients with positive family history had Mitral Regurgitation at onset. Development of MR in STEMI patients was not influenced by the treatment modality used (figure 13).

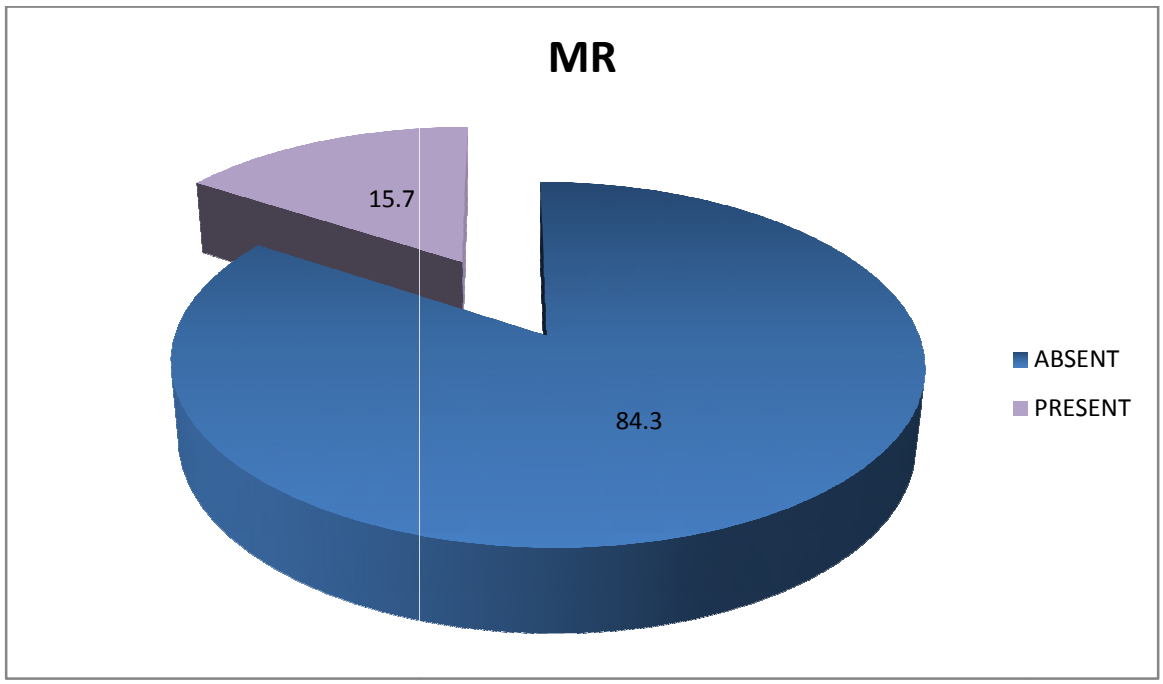

Figure 11.Prevalence of MR after 1 month

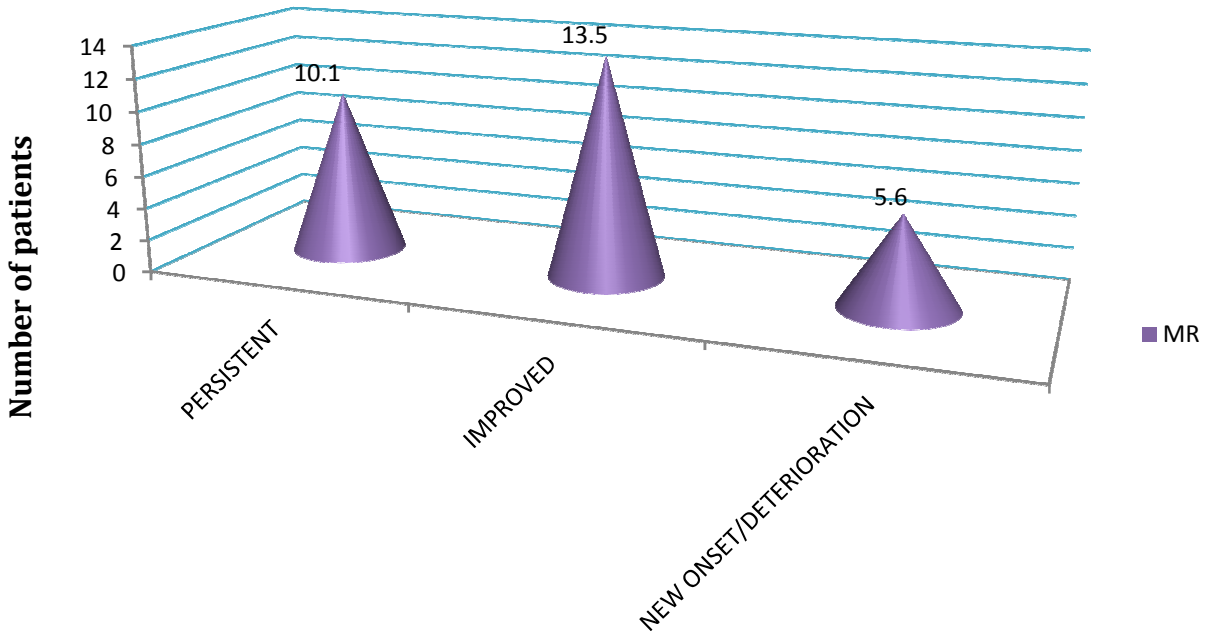

Figure 12.Profile of MR after 1 month

Proportion of patients having greater severity of MR after 1 month was found to be slightly higher, despite being reduction in absolute number of patients having moderate MR (figure 14).Initially, 3(11.1%) patients had moderate MR, but at 1 month, only 2 patients had moderate MR. IWMI patients were found to have higher prevalence of MR (figure 15).

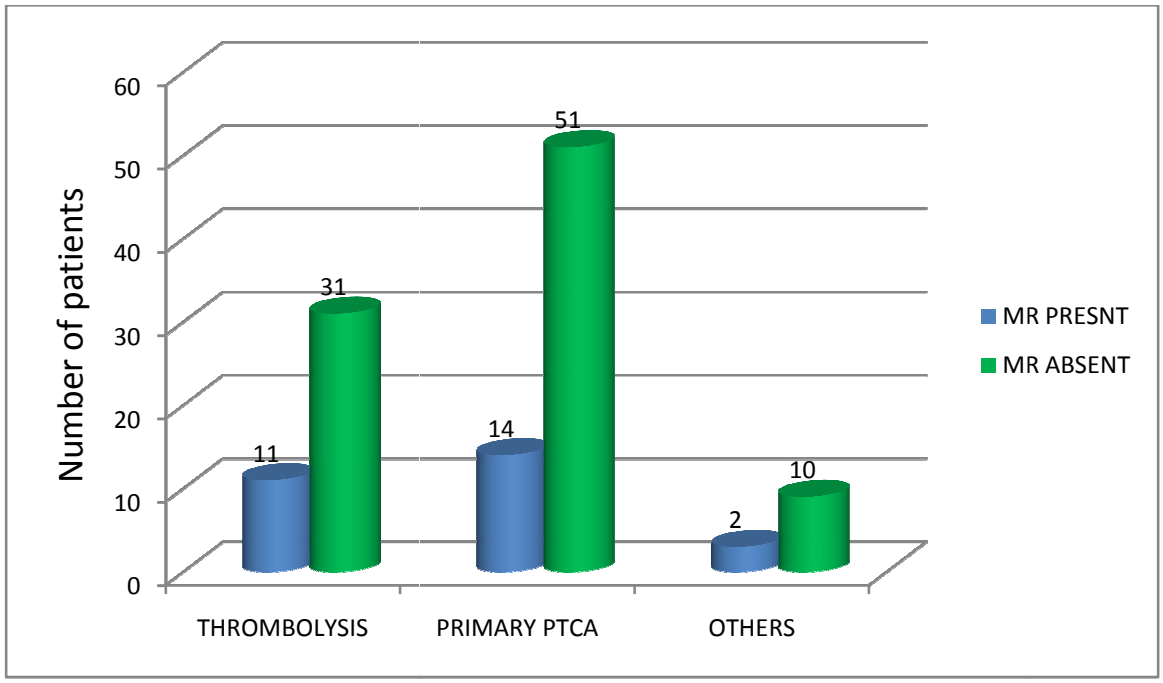

Figure 13.Prevalence of MR in relation to treatment strategies

Characteristic	**Baseline MR**	**p value**	**MR at 1 month**	**p value**
Age (yrs)				
Group 1 (20-39)	1(3.7)		2(14.3)	
Group 2 (40-59)	11(40.7)	0.024*	5(35.7)	0.132
Group 3 (60-79)	14(51.9)		7(50)	
Group 4 (≥ 80)	1(3.7)		0(0)	
Sex				
Male(96)	20(74.1)	0.323	9(64.3)	0.007*
Female(23)	7(25.9)		5(35.7)	

Site of STEMI AWMI(60) IWMI(59)	 6(22.2) 21(77.8)	0.001*	 3(21.4) 11(78.6)	0.03*
Diabetes(n=38)	13(48.1)	0.04*	5(35.7)	0.612
Hypertension(n=45)	9(33.3)	0.585	4(28.6)	0.615
Smoking(n=56)	12(44.4)	0.757	5(35.7)	0.210
Dyslipidemia(n=117)	27((100)	0.44	14(100)	0.539
Obesity(n=65)	12(44.4)	0.36	5(35.7)	0.257
Positive Family History(n=16)	0(0)	0.02*	1(7.1)	0.458
Baseline 2D EF	48.17±8.93	0.769	50.2±8.6	0.216
Baseline 3D EF	46.24±7.68		50.37±8.61	
Reperfusion modality Thrombolysis (n=45) Primary PCI (n=62) Miscc(n=12)	 11(40.7) 14(51.9) 2(7.4)	0.744	 8(57.1) 6(42.9) 0(0)	0.134

Table 3.Comparison of various variables with MR at onset and during follow up

*statistically significant

MR		Sex		Total	p value
		1(Male)	2(Female)		
Absent	Number of patients	69	7	76	
		(88.5%)	(58.3%)	84.4%	0.019*
Present	Number of patients	9	5	14	
		(11.5%)	(41.7%)	15.6%	
Total	Total no.	78	12	90	
	% within sex	100.0%	100.0%	100.0%	

Table 4. Association of sex with the prevalence of Mitral Regurgitation at 1 month

Severity	**Baseline MR**	**MR at FU**
Mild	24(88.9)	12(85.7)
Moderate	3(11.1)	2(14.2)
Severe	-	-

Figure 14.Prevalence of severity of MR at onset and after 1 month

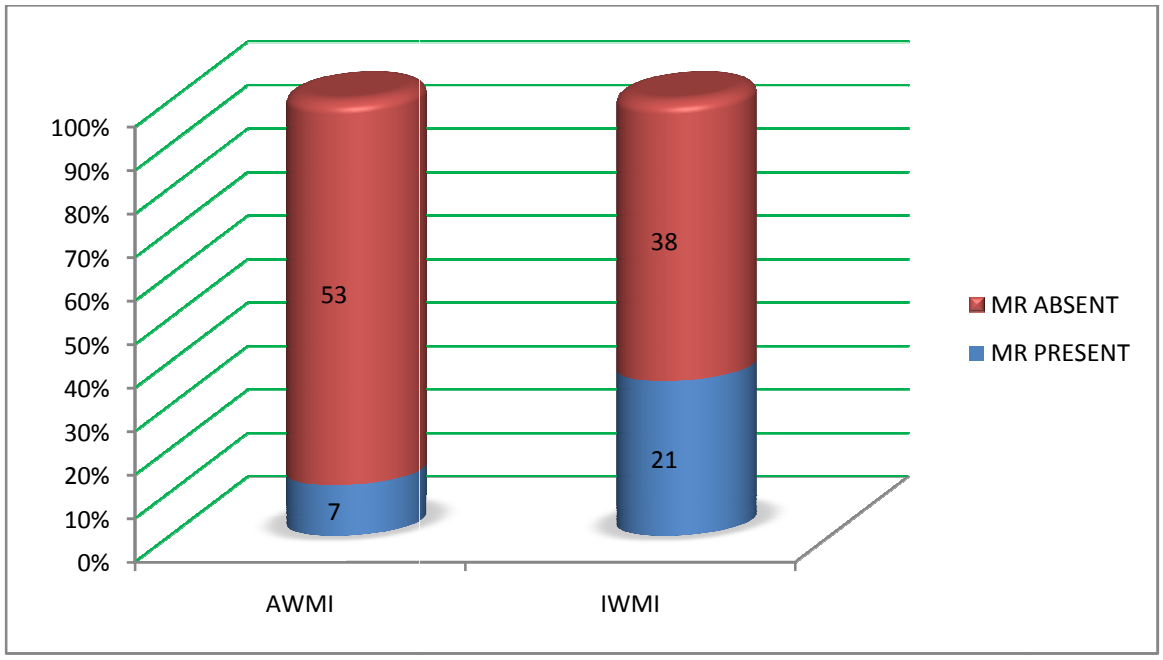

Figure 15.Prevalence of MR in relation to type of MI

3. Correlation among 2D and 3D EF in STEMI

Mean 2D EF in AWMI group at presentation was 44.94% ± 7.5% and in IWMI group was slightly higher 50.7% ± 7.4.4%.LV systolic functions was found to be better in IWMI patients on presentation. After 1 month, there was an increase in 2D EF by 6.9%(51.83±8.06) in AWMI group and negligible change in IWMI group (51.05±8.4).2D EF was found to strongly correlate with 3D EF at admission and during follow up irrespective of type of STEMI (table 5), though poor image quality was one of the hindering factor in some of the patients. Figure 14 shows the scatter plot displaying the distribution of 2D and 3D EF at baseline.

2D and 3D EF	Correlation coefficient, r	p (2 tailed)
At admission	0.525	0.01
At 1 month	0.609	0.01

Table 5.Correlations of 2D and 3D EF at admission and after 1 month

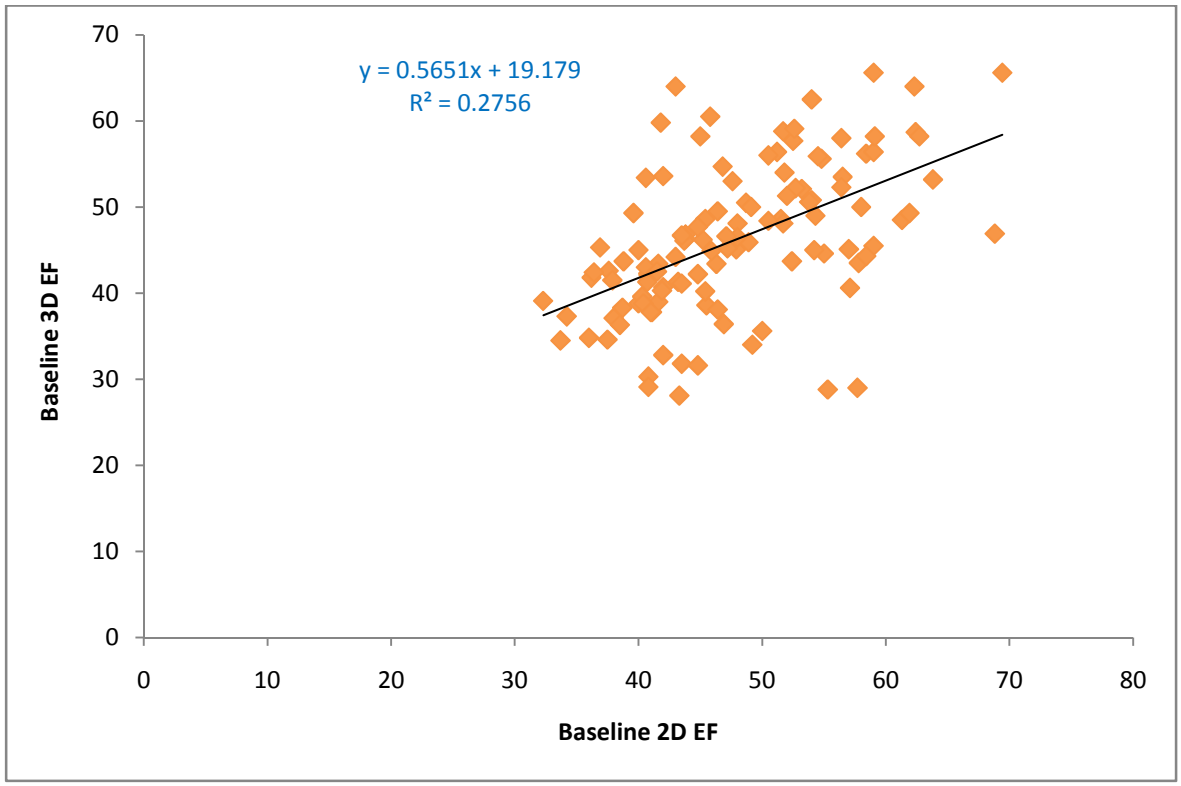

Figure 16.Scatter plot showing relationship of 2D-EF and 3D-EF at admission (Pearson correlation coefficient r, 0.525)

* Correlation is significant at the 0.01 level (2-tailed).

DISCUSSION

The present study is a prospective observational study which evaluated the prevalence of functional (ischaemic) mitral regurgitation in patients with STEMI at presentation and during 1 month of follow up. Mean age of patients was 53.42 ± 11.47 years with majority of them being males (83%). Most common age group was found to be 40-59 years (57.1%), with least patients in >80 yrs (2.5%).10.9% patients had MI in young (<40 years).Our results are found to be similar as observed in a large retrospective analysis by Brijesh et al[92] done in our institute. Most common risk factor was found to be dyslipidemia(98.3%) , followed by obesity(54.6%),smoking (47.1%),diabetes(31.9 %), hypertension (37.8%) and positive family history of coronary artery disease(13.4%). This data is different from create study where diabetics 34% had diabetes; 37.7% had hypertension; and 40.2% were smoker.[93] All patients were having multiple coronary risk factors.LV systolic function was found to be better in IWMI patients at presentation as lesser territory was compromised by ischaemia. Similar results were observed by Darbar et al and our findings are consistent with it.[94] With anterior infarction, the injury is exclusively in the left ventricle, whereas inferior infarction is associated with injury to both ventricles, causing less impairment of left ventricular function despite an equivalent overall myocardial insult. After 1 month, there was a trend in the increase in 2D EF by 6.9% in AWMI group due to revascularisation therapy.[95]

MR was found in 22.7% at presentation of STEMI in our study population, which is in accordance with older studies including angiographic ones (table 5). It was found to be higher in older age group, diabetics and IWMI patients at the onset, which was consistent with previous studies.[2, 12, 15] There was a trend toward an excess of women in the MR group, though it was not statistically significant due to under representation of females in present study. Similar data on the demographics of MR after AMI have been presented earlier by Lehmann, Tcheng, and Barzilai.[2, 12, 15] IWMI involves the posterior wall of LV leading to left ventricle remodelling and distortion. This result in apico-lateral as well as posterior displacement of papillary muscle, which in turn leads to apical displacement of mitral leaflet coaptation point, producing the ischaemic mitral regurgitation.[8] Mostly patients had mild MR and none had severe MR which is possibly due to exclusion of very sick patients like cardiogenic shock. During follow up after 1 month, MR was found to be in 15.7% of patients despite a dropout of 30(25.2%) patients. Some patients with MR tend to improve with the resolution of acute ischaemia due to revascularisation as well as favourable LV remodelling and improvement in LV systolic function, while some had deteriorated with worsening mitral regurgitation due to adverse left ventricular remodelling with passage of time after STEMI. Treatment modality used didn't influence the development of MR as shown earlier

by Tcheng JE et al. Acute reperfusion with thrombolysis or angioplasty did not reliably reverse valvular incompetence as seen in earlier observational studies.

None of the baseline risk factor except diabetes, territory involved and older age group ,can reliably predict the development of MR at onset and left ventricle systolic function, though this study was not powered enough to study those predictors. IWMI patients tend to have higher prevalence of MR during the STEMI as well as during follow up secondary to tethering effect on the mitral valve leaflet which may be a harbinger of chronic MR later on. Treatment modality didn't influence the severity of MR in STEMI patients.

Author	Year	No of patients	Modality used	Prevalence of MR (%)
Barzilai B et al[15]	1988	1480	Echo	39
Tcheng JE et al[12]	1992	1480	Echo	17.9
Lehmann KG et al[2]	1992	206	LV ventriculography	13
Gervasio A. Lamas et al[3]	1997	727	LV ventriculography	19.4
Present study	2013	119	Echo	22.7

2D EF was found to correlate linearly with 3D EF irrespective of type of STEMI. In a recently published metanalysis, Jennifer L. Dorosz et al[96] showed similar results. With EF, there is no difference in the bias between 3DE and 2DE, and the difference in the variance is modest (± 4.7%). Despite being subjected to errors due to foreshortening, poor endocardial definition, narrow echocardiographic windows, and assumptions about LV shape, it remains a ubiquitous tool for assessing LV size and systolic function in day to day clinical practise.

Although 3DE shows promise in providing the accessibility of echocardiography and the multi- planar imaging of CMR, this nascent technology still has limited spatial and temporal resolution compared with gold standard modality of CMR. Despite its limitations, 3DE may be superior to 2D techniques.

Our single centre study shades light on the prevalence of Mitral Regurgitation in acute STEMI in Indian population. MI is most prevalent in middle age persons with ischaemic Mitral Regurgitation in slightly older age group. Modalities of revascularisation (mechanical vs thrombolytic or medical treatment doesn't influence the course of Mitral Regurgitation in short term follow up. However, these findings need to be confirmed in larger study population MI.

STUDY LIMITATIONS

The main limitation of this study was smaller sample size, which was not powered enough to study the predictors of development of MR in STEMI patients. Moreover, females were underrepresented in the study group, which may have negated the gender effect on ischemic MR. Critically ill patients , cardiogenic shock etc were not included in whom ,there is a probability of having severe mechanical complications of STEMI like severe MR. There was a significant drop out during follow up, which may have influenced the statistical analysis.

Only echocardiographic LV systolic function measurements were used and were not compared with other imaging modalities like MRI, which is gold standard for determining EF in patients with regional wall motion abnormalities. Longer follow up periods are required for assessing the development of chronic ischaemic MR.

CONCLUSION

STEMI patients have 22.7% prevalence of MR at onset, which is more likely in older age group, diabetics and IWMI patients and independent of gender and left ventricle systolic dysfunction. Despite under-representation of females in our study population, they seem to carry higher risk of development of ischaemic Mitral Regurgitation in India. Most commonly, ischaemic MR is of milder severity at onset which tends to persist in 15.7% of patients during follow up. There is a significant association of development of ischaemic MR during acute STEMI with IWMI. Some patients may develop new MR later on depending on the LV remodelling. 2D EF estimation with a properly acquired good image is comparable to more precise 3D EF in STEMI patients.

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INFORMATION SHEET

Prevalence and Echocardiographic assessment of Mitral Regurgitation including 3D-EF [Ejection fraction] assessment in Acute ST Elevation Myocardial Infarction

1. This study is for research purpose and to study the prevalence and echocardiographic assessment of Mitral Regurgitation including 3D-EF [Ejection fraction] assessment in Acute ST Elevation Myocardial Infarction
2. Expected duration : 1 year
3. Description of the procedures – ECG and ECHO
4. No foreseeable risks or discomforts to the subject
5. No direct benefit to the subject
6. No alternative procedures available to the subject
7. Complete confidentiality of records identifying the subject will be maintained by Principal Investigator.
8. No compensation available to the subject in the event of a study – related injury
9. No anticipated prorated payment to the subject
10. No subjects responsibilities on participation
11. Subject's participation is voluntary, that the subject can withdraw from the study at any time and that refusal to participate will not involve any penalty or loss of benefits to which the subject is otherwise entitled
12. No apparent foreseeable circumstances under which the subject's participation may be terminated by the investigator without the subject's content.
13. No additional costs to the subject that may result from participation in the study
14. Subject can withdraw from the research and procedures at any time of study
15. There will be no consequences on subjects decision to withdraw from the research
16. Subject or subject's representative will be notified in a timely manner if significant new findings develop during the course of the research which may be affect the subject's willingness to continue participation will be provided
17. We are not involving pregnant women in our study

18.Approximate number of subjects enrolled in the study – 100 patients

STUDY PROFORMA

DATA ABSTRACTION FORM

DATE OF ENROLMENT: ENROLMENT NO. :

NAME: AGE: HOSPITAL NO.:

ADDRESS:

PHONE:

CLINICAL DIAGNOSIS: BMI:

HR:

BP:

CLINICAL CHARACTERISTICS	
AGE	
SEX	
DM	
SMOKING	
HTN	
ALCHOLISM	
DYSLIPIDEMIA	
OBESITY	
FAMILY HISTORY OF CAD	
REPERFUSION	
MI	

Age Group
20-39yrs 1
40-59yrs 2
60-79yrs 3
≥80yrs 4
SEX-1[MALE], 2[FEMALE]
RISK FACTOR-1(PRESENT)/2(ABSENT)
MI-1(AWMI)/2(IWMI)
REPERFUSION: 1 (THROMBOLYSIS)/2(PCI)/3(Miscellaneous)

MR SEVERITY:

	DURING HOSPITALISATION	AFTER 1 MONTH
JET AREA 1. PLAX 2. A4C		
VENA CONTRACTA (mm)		
PISA a. PISA radius(cm) b. EROA(cm2) c. Regurgitant volume(R vol)		
MR SEVERITY		

MR SEVERITY- 0[Absent], 1[Mild], 2[Moderate], 3[Severe]

LEFT VENTRICULAR SYSTOLIC FUNCTION PARAMETERS

	DURING HOSPITALISATION	AFTER 1 MONTH
LVIDd (cm)		
LVIDs (cm)		
2D-EDV		
2D-ESV		
2D-EF		
3D-EDV		
3D-ESV		
3D-EF		

GLOSSARY FOR MASTER CHART

H.NO: Hospital number

AGE (in years)

1= 20-39yrs

2= 40-59yrs

3= 60-79yrs

4= ≥80yrs

SEX: 1=MALE], 2=FEMALE

RISK FACTOR: 1=PRESENT, 2=ABSENT

STEMI: Site of STEMI

1= AWMI

2= IWMI

DM: Diabetes Mellitus

HTN: Hypertension

SM: Smoker

DL: Dyslipidemia

FH: Family history of CAD

SITE OF MYOCARDIAL INFARCTION (MI): 1=AWMI, 2=IWMI

REP: REPERFUSION

1=THROMBOLYSIS), 2=PCI, 3=Miscellaneous

EF: Ejection fraction

LVF: LEFT VENTRICULAR SYSTOLIC (LV) FUNCTION (%)

Normal: 1= ≥55%

Mild Dysfunction : 2= 45-54%

Moderate Dysfunction: 3= 30-44%

Severe Dysfunction: 4= <30%

BODY MASS INDEX (BMI)

Overweight: 1= 24.9

Normal: 2= 18.4-24.9

Underweight: 3= <18.4

MITRAL REGURGITATION (MR)

0= Absent

1= Mild

2= Moderate

3= Severe

MRJA: MR jet area

LAA: Left atrium area

PLAX: Parasternal long axis view

A4C: Apical 4 chamber view

VC: Vena contracta

RAD: Proximal isovelocity surface area radius

EROA: Effective regurgitant orifice area

PISA: Proximal isovelocity surface area

R Vol: Regurgitant volume

LVIDd: Left ventricular internal diameter in diastole

LVIDs: Left ventricular internal diameter in systole

2D EDV: 2D end-diastolic volume

2D ESV: 2D end-systolic volume

3D EDV: 3D end-diastolic volume

3D ESV: 3D end-systolic volume

2D EF: 2D ejection fraction

3D EF: 3D ejection fraction

MR STATUS

1= Improvement

2= Persistent

3= Deterioration

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PROFORMA FOR PATIENT'S DATA COLLECTION

"ATRIAL FIBRILLATION AND THROMBOEMBOLIC RISK-DEMOGRAPHIC, CLINICAL AND ECHOCARDIOGRAPHIC (TRANSTHORACIC VS. TRANSOESOPHAGEAL) EVALUATION"

Name **Age** **Sex** **Address**

Symptoms

Dyspnoea Class Duration

Orthopnoea

PND

Palpitation Class Duration

Odema legs

Thromboembolic phenomena

Stroke

TIA

Peripheral embolism

Chest pain

Haemoptysis

Others

Cardiac failure/LV dysfunction

Hypertension diabetes age ≥75 y ;65-74 y; <65 years

Vascular disease-PAD/MI

Signs

Pulse BP JVP

Apex

S1

A2 P2

OS

MDM/PSM/ESM

ECG

CXR PA VIEW LATERAL VIEW

TRANSTHORACIC ECHOCARDIOGRAM

Chamber dimensions & function

LV RV

LVEF by M MODE(PLAX/PSAX)

RA volume – A4C

LA volume –A4C, A2C (volume assessed by modified simpson's method)

MR TR PAP

Other valves

Thrombus Site Size

LA
LAA
LA –SEC

TRANSOESOPHAGEAL ECHOCARDIOGRAPHY

LA-SEC
LAA Thrombus Present /Absent
Site
Size
Mobility
LA Appendage peak emptying velocity cm /sec

Any other interesting finding

Medical treatment

Digoxin Lasix Aldactone Penicillin KCL
Verapamil Others

Oral Anticoagulation-Acitrom(Acenocomorol) mgs OD daily

Scoring for non valvular heart disease

CHADS2 score

CHA2DS2-VaSc score

Master Chart - Baseline characteristics at index hospitalization

	H.No.	Age	Sex	STEMI	DM	HTN	SM	DL	BMI	FH	REP	MRJA(PLAX)	MRJA(A4C)	VC	Rad	ERO	R Vol(ml)	MR	LVIDd	LVIDs	2D EDV	2D ESV	2D EF	LV F	3D EDV	3D ESV	3D EF
1	054103F	47	2	2	1	1	2	1	1	2	2							0	3.8	2.5	43	22	51.2	2	58.6	25.6	56.4
2	238274C	60	1	1	1	1	1	1	2	2	1							0	3.9	2.9	65.9	30.9	53.2	3	63.5	30.4	52.1
3	057118F	55	2	1	2	1	2	1	1	1	3							0	5.4	4.6	109	68	37.6	3	98	56.2	42.6
4	064339F	48	1	1	2	2	1	1	2	2	1	2.4/11.6	2/8.3	2.5	0.2	0.02	2	1	4.9	3.9	113.5	67.4	40.6	3	62.2	29	53.4
5	065890F	72	1	2	2	2	1	1	1	2	1							0	5	4	118.2	70	40.8	3	73.3	42.3	42.3
6	055388F	50	1	2	2	1	1	1	1	2	1							0	4.1	3.1	59	28	52.5	2	58.1	24.6	57.7
7	054675F	55	1	2	2	2	2	1	1	2	1	1.78/10.4	2/14.8	2.6	0.3	0.03	5	1	4.7	3.6	101.5	54.5	46.3	2	97.5	55.2	43.4
8	054634F	43	1	1	2	2	1	1	2	1	2							0	5	3.9	82.5	51.6	37.5	3	76.3	49.9	34.6
9	054488F	49	2	2	2	1	2	1	1	1	2							0	3.7	2.5	56.2	25.3	55	1	74.6	41.3	44.6
10	054408F	41	1	2	2	2	2	1	1	2	2	1.8/15.8	2.1/15.4	2.4	0.3	0.04	6	1	4.9	3.5	70	66	51.5	2	84.5	43.4	48.6
11	054547F	35	1	1	1	2	1	1	2	2	1							0	4.7	3.8	93	51	45.2	2	88.9	47.8	46.2
12	050273F	68	1	1	1	2	2	1	1	2	3							0	4.7	3.6	85	32	62.4	1	80.7	33.2	58.7
13	057169F	37	1	2	2	2	2	1	2	1	3							0	4.2	2.9	76.8	35.3	54	2	84.2	41.4	50.8
14	077453A	48	1	1	1	1	1	1	1	2	2							0	3.6	2.6	54.4	24.6	54.8	2	50.5	22.4	55.6
15	069862F	65	2	2	1	2	2	1	2	2	1	3.7/14.7	4.5/16.5	5.2	0.4	0.07	9	1	4.7	3.6	102.4	54.4	46.8	2	75.2	34	54.7
16	882378D	73	1	2	1	1	2	1	1	2	2	5.8/17.6	6.3/18	4.4	0.6	0.14	24	2	4	3.3	70.4	43.1	38.8	3	69.1	38.9	43.7
17	073346F	50	1	2	2	2	2	1	1	2	1	4.4/13.2	1.6/8.68	2.9	0.4	0.11	15	1	4	2.8	67.9	29.6	56.5	1	59	27.7	53.5
18	077605F	61	1	1	1	2	2	1	1	1	2							0	4.1	2.8	74.2	28.7	61.3	1	63	32.4	48.5
19	077583F	60	2	1	2	1	2	1	2	2	1							0	3.7	2.8	58.1	29.6	49.2	2	57.4	37.9	34
20	225068D	68	1	1	2	1	2	1	1	2	2							0	4.4	3.2	87.7	41.7	52.4	2	69.1	38.9	43.7
21	077403F	49	1	1	2	1	2	1	1	2	2							0	5.1	4	123.8	72.1	41.8	3	74.4	29.9	59.8
22	107333F	49	2	1	2	2	2	1	1	2	2							0	3	2.5	35	22.3	36.2	3	67.9	39.5	41.8
23	107374F	45	1	2	2	1	2	1	1	2	1							0	3.7	2.6	58.1	24.6	57.7	1	39.7	27.8	29
24	107254F	29	1	1	2	2	1	1	2	1	1							0	4.3	3.2	85.4	39.4	53.8	2	70	34.6	50.6
25	107146F	50	2	2	2	2	2	1	1	2	1							0	3.9	2.4	65.9	20.2	69.4	1	82.2	28.3	65.6
26	107169F	55	1	1	2	2	1	1	1	1	1							0	5.2	3.6	129.5	54.4	58	1	62.3	31.2	50
27	102418F	38	1	2	2	2	2	1	1	2	2							0	4.2	3.3	78.6	44.1	43.8	3	84.3	44.8	46.8
28	107046F	32	1	1	2	2	1	1	1	2	1							0	5	3.8	118.2	62	47.6	2	103.6	48	53
29	188849C	56	1	1	2	1	1	1	1	1	2							0	5	4.1	121	76.4	36.9	3	72.9	39.9	45.3
30	107022F	68	1	2	2	1	2	1	1	2	2	1.7/11	1.2/9.5	3.6	0.4	0.07	10	1	4.4	3.5	87.7	50.9	42	3	164	76.6	53.6
31	102288F	42	1	1	1	1	1	1	2	2	2							0	4.1	3.2	76.4	41	46.4	2	56.8	28.7	49.5
32	102275F	59	1	2	2	2	1	1	1	2	2							0	4.8	3.5	107.5	50.9	52.7	2	46.6	27.9	52.2

33	102272F	45	1	1	2	2	1	1	2	2	1							0	4.2	3.1	78.6	37.9	51.7	2	69.7	28.7	58.8
34	102281F	45	1	2	1	1	2	1	2	2	1							0	4.7	3.3	38	17	55.3	1	40.5	28.8	28.8
35	119004F	30	1	1	1	2	1	1	1	2	2							0	4.1	3.2	56.8	34	40	3	50.2	27.6	45
36	112993F	52	2	1	1	1	2	1	1	2	2							0	3.5	2.5	51.6	21.4	58.4	1	64	28	56.2
37	112996F	61	1	2	2	2	2	1	2	2	1							0	4	3.1	67.9	39.4	42	3	75.6	50.8	32.8
38	729726C	36	1	2	2	2	1	1	1	2	2							0	4.5	3.5	94.4	51.4	45.5	2	98.6	60.5	38.6
39	054139F	60	1	1	1	2	2	1	1	2	2							0	4.6	3.8	97.3	62	36.4	3	88	50.68	42.4
40	112859F	52	1	1	1	1	2	1	2	2	2							0	5.7	4.7	160	102.4	36	3	61.9	40.4	34.8
41	118041F	59	1	2	2	2	1	1	1	2	1	3.7/10.9	4/11.7	3.1	0.4	0.06	10	1	6.1	4.3	186.2	85.4	54.2	2	78.9	43.4	45
42	112856F	31	1	2	2	2	1	1	2	2	2	3.6/18	5/17.6	5.2	0.3	0.04	6	1	5.6	4.1	153.7	74.2	51.7	2	103.1	53.4	48.1
43	115998F	43	1	1	2	2	2	1	1	1	2							0	3.4	2.7	47.4	27	43	3	56.8	31.7	44.2
44	110143F	49	1	1	1	1	2	1	1	2	2							0	4	3.1	70	37.9	45.8	2	66.2	26.2	60.5
45	112533F	61	1	2	1	1	2	1	2	2	3	1.7/12.4	1.8/9.5	2.3	0.3	0.03	6	1	4.1	3.2	74.2	41	44.8	2	84	48.6	42.2
46	112611F	66	1	1	2	2	2	1	1	2	1							0	4.3	3.3	54.6	31.7	42	3	58.7	30.8	40.7
47	112508F	39	2	1	2	2	2	1	1	2	3							0	4.4	3.5	89.3	50.9	43	3	39.5	14.2	64
48	102124F	39	1	1	2	2	2	1	2	1	3							0	5.1	4	123.8	70	43.5	3	45.9	31.3	31.8
49	101269F	55	1	2	2	2	1	1	2	2	1							0	3.9	2.7	65.9	27	59	1	51.7	17.8	65.6
50	098767F	51	1	1	2	2	1	1	1	2	2							0	4.2	3.2	78.6	41	47.9	2	72.4	39.7	45.1
51	098764F	50	1	2	2	2	2	1	2	2	2							0	4.5	3.2	90.1	41	54.5	2	72.6	32	55.9
52	098685F	55	1	1	2	2	1	1	2	2	1							0	4.9	4	112.8	70	38	3	78.3	49.2	37.1
53	090246F	45	1	2	2	2	2	1	1	2	3							0	4.2	3.3	78.6	44.1	43.8	3	57.5	30.6	46.8
54	927328D	57	1	1	1	2	2	1	1	1	3							0	4.9	4.1	112.8	74.2	34.2	3	56.7	35.5	37.3
55	662271C	38	1	2	2	2	2	1	2	1	2							0	5.1	4	123.8	70	43.5	3	56.8	31.7	44.2
56	094969F	59	1	2	1	2	2	1	2	2	1	2.6/12.8	3.4/13.6	1.5	0.3	0.04	5	1	4	2.9	70	32.2	54	1	37.1	13.9	62.5
57	098619F	50	2	2	1	1	2	1	2	2	1	3.1/10.6	6.8/12.3	4.6	0.6	0.16	28	2	3.5	2.7	50.9	27	46.9	2	53.7	34.1	36.4
58	098590F	43	1	2	2	2	2	1	1	2	1							0	4.5	3.4	92.4	47.4	48.7	2	75.2	37.3	50.5
59	098521F	52	1	2	1	2	1	1	2	2	2	2.1/13.9	2.6/14.2	2.5	0.4	0.07	4	1	6	4.5	180	90.1	50	2	87.6	56.4	35.6
60	094810F	65	1	1	1	1	1	1	2	2	2	2.3/8.4	1.6/6	2.5	0.2	0.02	2	1	5	4	118.2	70	40.8	3	82.4	57.4	30.3
61	578325C	55	1	2	1	2	1	1	2	2	2	1.7/8	1.4/7.2	3.1	0.4	0.07	8	1	4.9	3.6	112.8	54.4	51.8	2	100.8	46.4	54
62	097655F	60	1	1	1	2	1	1	2	2	2	2.2/12.6	2.5/11.4	2.5	0.3	0.04	4	1	5.4	4.6	141.3	95.7	32.3	3	107.9	71.1	39.1
63	094712F	55	1	2	2	2	2	1	2	2	2							0	4.8	3.3	107.5	44.1	59	1	98.8	43.1	56.4
64	094702F	65	1	2	1	2	1	1	2	2	2	1.9/11.8	2.2/11.3	2.7	0.3	0.04	6	1	4.9	3.8	110.2	62	43.8	3	109.5	58.8	46.3
65	094553F	36	1	2	2	2	1	1	1	1	1							0	4	2.6	67.9	24.6	63.8	1	94.7	44.3	53.2
66	094459F	44	1	2	2	2	1	1	1	2	2	1.8/15.7	1.4/8.6	2.6	0.2	0.02	3	1	4.8	3.2	107.5	41	61.9	1	73.9	37.5	49.3

67	093552F	65	1	2	1	1	1	1	1	2	2	1.3/11	1.2/12	3.5	0.2	0.02	3	1	3.9	2.7	63.9	27.8	56.4	1	56.8	27.1	52.3
68	092687F	60	2	1	2	1	2	1	2	2	1							0	4.5	3.5	92.4	50.9	45	2	64.8	27.1	58.2
69	089713F	65	2	1	2	1	2	1	1	2	1							0	4.3	3.3	80.8	44.1	45.4	2	71.3	42.6	40.2
70	089728F	58	2	2	1	2	1	1	1	2	3							0	4.1	3.1	74.2	37.9	48.9	2	49.7	26.9	45.9
71	089921F	53	2	2	2	2	2	1	1	2	2	2.3/9.1	2.7/8.9	1.9	0.5	0.1	14	1	3.7	2.3	58.1	18.1	68.8	1	50.3	26.7	46.9
72	685616C	51	1	1	2	1	2	1	1	2	1							0	4.9	3.9	112.8	65.9	41.6	3	102.4	57.9	43.4
73	089991F	70	2	2	2	2	2	1	3	2	1	5.3/17.4	5.1/13/	2.6	0.4	0.07	11	1	3.9	2.6	65.9	24.6	62.7	1	78.4	32.8	58.2
74	089887F	65	2	1	2	2	2	1	1	2	1							0	4.1	3.2	68.4	41	40	3	76.4	46.8	38.8
75	088032F	40	1	2	2	2	1	1	2	2	2							0	4.2	3.1	78.6	38.9	50.5	2	75.2	33.1	56
76	089857F	50	2	1	2	1	2	1	1	2	3							0	4.6	3.5	88.2	52.2	40.8	3	97.4	56.4	42.1
77	089599f	78	1	1	2	1	1	2	2	2	2							0	5.5	4.4	146.8	87.7	40.3	3	136.2	82.3	39.6
78	089863F	61	1	2	2	1	1	1	1	2	1							0	4.5	3.4	90.1	49.1	45.4	2	97.3	50	48.6
79	088472F	45	2	1	1	2	2	1	2	2	2							0	2.9	2.3	32.2	18.1	43.7	2	56.7	30.6	46.1
80	089412F	53	1	1	2	1	1	1	2	2	2							0	4.8	3.5	76.2	39.6	48	2	56.9	29.5	48.1
81	089405F	56	1	1	2	2	1	1	2	2	2							0	5.1	4	123.8	70	43.5	3	86.6	46.2	46.7
82	084441F	40	1	2	2	2	1	1	2	2	2							0	5	3.5	118.2	50.9	57	1	82.2	45.1	45.1
83	300574C	59	1	2	1	2	2	1	2	2	2							0	4.4	3	86.1	36.3	57.8	1	88.6	50.1	43.5
84	085060F	43	1	1	2	2	1	1	1	2	1							0	4.1	3.2	74.2	41	44.8	2	114.9	60.1	47.7
85	077488F	67	1	2	1	1	1	1	2	2	2							0	4.9	3.8	112.8	63.9	43.3	3	103.1	74.1	28.1
86	077667F	70	2	1	1	1	2	1	1	2	1	4.3/17.4	5/18.2	3.3	0.4	0.06	9	1	4.2	3.4	78.6	47.4	39.6	3	88.2	44.7	49.3
87	077610F	82	1	1	2	1	2	1	2	2	1	2.4/15.3	2.7/13.8	2.3	0.4	0.07	12	1	5	4.1	121	74.2	38.7	3	61.3	37.8	38.3
88	368074A	77	1	2	2	1	2	1	1	1	2							0	3.6	2.9	54.4	32.2	40.8	3	67.4	38.9	42.3
89	054634F	43	1	1	2	2	1	1	1	2	2							0	4.5	3.6	92.4	54.4	41.1	3	98.3	61.1	37.8
90	080409F	60	1	1	1	2	2	1	1	2	1							0	4.5	3.5	94.9	50.9	46.4	2	53	32.6	38.1
91	328853F	35	1	1	2	2	1	1	2	1	1							0	4.6	3.8	99.8	62	37.9	3	89.7	52.5	41.5
92	331075F	65	1	2	2	2	1	1	2	2	1	1.21/15	1.99/13	2.9	0.2	0.06	8	1	4.5	3.1	92.4	37.9	59	1	90.3	49.2	45.5
93	322267F	47	1	1	2	2	1	1	2	2	1							0	4.1	3.2	74.2	41	44.8	2	47	32.2	31.6
94	495506C	64	1	2	1	2	1	1	1	2	2	1.4/11.9	3.3/17.5	4.9	0.5	0.04	39	2	4.9	3.9	112.8	65.9	41.6	3	110.8	67.6	39
95	322632F	58	1	2	1	1	1	1	1	1	2							0	5.2	4.1	129.5	73.5	43.2	3	132.5	77.8	41.3
96	327344F	80	2	2	1	1	2	1	1	2	2							0	4	3.2	70.1	41.5	40.8	3	64.2	45.5	29.1
97	327352F	65	2	2	2	2	2	1	2	2	2	0.9/14	3.95/16.6	3.1	0.3	0.12	10	1	4.6	3.7	97.8	58.1	40.6	3	67.4	33.2	43
98	322650F	45	1	2	2	2	1	1	2	2	2							0	4.2	3.1	80.1	36.6	54.3	2	62.3	31.8	49
99	322636F	47	1	1	1	1	2	1	1	2	2							0	3.9	2.8	67.9	28.3	58.4	1	72	40.1	44.3
100	433108D	40	1	1	2	2	1	1	1	2	1							0	5	4	121	72.1	40.4	3	76.5	46.8	38.8

101	347512F	63	2	1	2	1	2	1	1	2	3		2.61/14.5(PL	4.9	0.3	0.04	5	1	4.7	3.8	100.7	62	38.5	3	116.1	74	36.3
102	327307F	41	1	2	2	2	1	1	2	2	2							0	5.6	3.9	153.7	65.9	57.1	1	86.8	51.5	40.6
103	288407F	48	1	1	2	2	2	1	2	2	2							0	4.2	3.2	78.4	41.4	47.2	2	84	46	45.2
104	287354F	52	1	2	1	1	2	2	1	2	2							0	3.9	1.2	129.5	65.9	49.1	2	40	20	50
105	291306F	65	1	1	2	2	1	1	2	2	2							0	3.8	2.9	62	32.2	48	2	66.8	35.8	46.5
106	256769D	60	2	1	1	1	2	1	1	2	2							0	4	3.2	70	41	41.5	3	100	57.5	42.5
107	286849F	46	1	1	2	1	1	1	2	2	2							0	5	4.2	118.5	78.6	33.7	3	86	56.3	34.5
108	299314F	56	1	2	2	1	2	1	2	2	2							0	4.5	3.2	92.4	40.3	56.4	1	88.7	37.3	58
109	299336F	82	1	2	2	2	2	1	1	2	2							0	4.9	3.6	112.3	55.5	50.5	2	114.6	59.13	48.4
110	309758F	45	1	1	2	1	2	1	2	2	2							0	3.8	3	62	35	43.5	2	56	33	41.1
111	761606D	62	1	2	1	1	1	1	2	2	2							0	4.3	3.2	85.4	41	52	2	73	35.6	51.3
112	981786A	47	1	2	2	2	2	1	2	2	2							0	4.8	3.7	107.5	58.1	45.9	2	118	65	44.9
113	316403F	48	1	2	2	2	1	1	3	2	2							0	5.2	4.1	128.7	76.3	40.7	3	75	44	41.3
114	316458F	50	1	1	2	1	1	1	1	2	2							0	3.8	2.8	62.4	29.6	52.6	2	44	18	59.1
115	040901F	45	1	1	2	2	1	1	1	2	3							0	4.7	3.1	103.9	39.1	62.3	1	85.9	30.92	64
116	077397F	56	1	2	2	2	1	1	1	2	1							0	4.3	3.1	85	45	47.1	2	76	40.6	46.6
117	089817F	70	1	2	2	2	1	1	2	2	2							0	4.7	3.7	39	23	41	3	54.6	34	37.8
118	354481F	50	1	1	2	1	1	1	1	2	1							0	5.3	3.7	88	36	59.1	1	60.7	25.2	58.2
119	354493F	55	1	1	2	2	2	1	1	2	1							0	3.7	3	74	43	41.9	3	70.1	41.9	40.3

Follow-up data after 1 month

	H.No.	MRJA(PLAX)	MRJA(A4C)	VC	Rad	ERO	R Vol(ml)	MR	LVIDd	LVIDs	2D EDV	2D ESV	2D	LV F	3D EDV	3D ESV	3D EF
1	054103F							0	3.6	2.6	54.4	24.6	54.8	2	50.5	22.4	55.6
2	238274C							0	4.5	3.2	90.1	41	54.5	2	66.2	26.2	60.5
3	064339F							0	4.9	3.5	70	66	51.5	2	76.4	33.1	56.7
4	065890F							0	5.3	4.2	180	113	37.2	3	104.3	68.6	34.2
5	055388F							0	3.9	2.7	63.9	27.8	56.4	1	80.5	27.5	65.9
6	054675F							0	5	3.8	118.2	62	47.6	2	46.6	27.9	52.2
7	054634F							0	3.8	2.9	66	32	51.6	2	81	38.8	52.1
8	054408F							0	3.7	2.8	58.1	29.6	49.2	2	88.9	47.8	46.2
9	077453A							0	3.7	2.6	58.1	24.6	57.7	1	58.6	25.6	56.4
10	069862F	1.8/11	1.6/15	3.1	0.4	0.06	10	1	4.7	3.5	80	38	52.5	2	61.1	20.2	67
11	882378D							0	3.7	2.8	58.1	29.6	49.2	3	87.4	45.7	48
12	073346F							0	3.5	2.4	68	26	61.8	1	59	26.3	55.5
13	077605F							0	4.3	2.9	65	24	63.1	1	71.2	35.4	50.3
14	225068D							0	3.7	2.6	60.4	26.6	56	1	78.7	32.8	58.4
15	107254F	1.8/11	1.9/10.7(A4C	2.6	0.4	0.07	13	1	4.5	3.1	81	43	59	1	86.3	42.5	50.8
16	107146F	4.3/15.4	5.45/16(A4C)	3.5	0.3	0.04	7	1	4.1	2.9	120	43	56.6	1	113.6	63	44
17	107169F							0	5.2	3.6	129.5	54.4	58	1	64	28	56.2
18	102418F							0	4.7	3.8	75	42	44	3	75.7	38.6	49.1
19	107046F							0	4.8	3.5	107.5	50.9	52.7	2	74.4	29.9	59.8
20	188849C							0	6.4	5.1	124	81	34.7	3	91.4	52	43.2
21	107022F	2.4/8.4	2.8/7.44(A4C	3.4	0.3	0.04	5	1	5.6	3.4	79	24.5	69.1	1	56.2	28.9	48.6
22	102288F							0	5	3.8	62	28	54.8	2	62	29.2	52.9
23	102275F							0	4.7	3.3	38	17	55.3	2	72.6	32	55.9
24	102272F							0	4.9	3.3	63	26	58.7	1	102.1	45.8	55.2
25	102281F							0	5.4	3.7	76	39	48.7	2	63.8	39	38.8
26	119004F							0	4.5	3.6	111	66	40.5	3	88.9	52	41.5
27	112996F	1.4/13.8	1.2/14.2(A4C	2.3	0.3	0.04	5	1	4.9	3.8	97	55.3	43	3	63.6	36.9	42
28	118041F	2.5/11.6	3.8/12.8(A4C	2.1	0.2	0.01	2	1	5.6	4.2	158	91.64	42	3	113.4	58.97	40.8
29	112856F	6.7/22	7.7/22.5(A4C	5.1	0.5	0.1	10	1	5.6	4.8	163	110.84	32	3	146.6	106.2	27.6
30	115998F							0	5.2	4.2	105	63.74	39.3	3	93.1	55.3	40.6
31	110143F							0	4.8	3.2	146	65.7	55	1	58.7	27	54
32	112533F							0	4.5	3.2	90.1	41	54.5	2	78.4	32.8	58.2

33	112611F							0	4.7	3.5	74	26	64.9	1	148.9	76.3	48.7
34	098767F							0	4.2	2.6	70	28	60	1	75.4	38	49.6
35	098764F							0	4.6	3.4	131	61	53.4	2	55.9	32.4	42.1
36	098685F							0	4.5	3.4	68	30	55.9	1	105.6	43.6	58.7
37	090246F							0	4.2	3.3	78.6	44.1	43.8	3	57.5	30.6	46.8
38	927328D							0	4.9	4.1	98.6	64.9	34.2	3	66.7	43.4	35
39	662271C							0	4.4	2.6	79	45	43	3	78.6	42.9	45.4
40	094969F	2.3/8.6	2.2/11.4	2.5	0.4	0.07	4	1	4.3	3.3	80.8	44.1	45.4	2	71.3	42.6	40.2
41	098590F							0	3.5	2.7	50.9	27	46.9	2	53.7	29.6	44.8
42	098521F							0	5.2	4.1	120	63	47.5	2	90	58	35.6
43	578325C	3.9/15.2	4.53/16.2	4.2	0.5	0.11	26	2	4.9	3.5	93	52	44	3	84.7	52.4	38.1
44	094712F							0	5.5	3.4	120	68	43.3	3	58.5	31.8	45.6
45	094702F							0	5.3	4	98	48	51	2	131.6	100	24
46	094553F							0	4.2	2.8	88	38	56.8	1	80.9	32.5	59.8
47	094459F							0	4.4	3	86.1	36.3	57.8	1	69	28.4	58.8
48	093552F							0	4.8	3.2	107.5	41	61.9	1	74.2	28.7	61.3
49	089728F							0	4.7	3.4	89	22	75.3	1	71	38.7	45.4
50	089921F							0	4.1	2.5	90	34	62.2	1	56.7	20.4	64
51	685616C							0	4.1	2.7	59	31	47.5	2	67.4	35	48
52	089887F							0	4.1	3.2	68.4	40	40	3	80	48.9	38.8
53	088032F							0	4.7	3.4	81	36	55.6	1	69.1	34.7	49.8
54	089857F							0	5.3	4	86	38	55.8	1	82.7	38	54.1
55	089599f							0	5.2	3.5	129.5	52	59.8	1	66.6	38.2	42.6
56	088472F							0	3.5	2.5	89	39	56.2	1	57.9	23.7	59.1
57	089412F							0	5.3	4	66	23	65.2	1	69	28.4	58.8
58	089405F							0	4.5	2.9	116	35.1	46	2	65.4	35.2	46.2
59	300574C							0	4.4	3.2	65	36	44.6	3	62.8	35.7	43.1
60	077488F							0	5.5	4.5	93	58.04	37.6	3	95.5	63.3	33.7
61	077667F	3.09/9.68	4.23/15.7	2.4	0.3	0.03	6	1	5.5	4.4	146.8	87.7	40.3	3	61.3	37.8	38.3
62	368074A							0	4.1	2.7	67	31	53.7	2	60.9	31.3	48.6
63	054634F							0	4.5	3.5	94.9	50.9	46.4	2	53	32.6	38.1
64	080409F							0	4.5	3.8	89.8	54.4	39.4	3	89.7	52.5	41.5
65	328853F							0	4.5	3.1	88.6	36.3	59	1	87.8	47.8	45.5
66	331075F	2.35/12.4	2.35/9.22	3.2	0.4	0.06	9	1	4.2	3.3	132	72	45.5	2	79.4	35.7	55.1

67	322267F							0	4.8	3.4	107.5	47.4	55.9	1	60.9	25.5	58.2
68	322632F							0	4.2	3.2	78.4	41.4	47.2	2	84	46	45.2
69	327352F	1.8/14	2.5/15.8	3.1	0.3	0.12	10	1	4.1	3.2	74.2	41	44.8	3	86.8	51.5	40.6
70	322650F							0	4.6	3.3	97.3	44.1	54.7	2	73	43.7	40.2
71	433108D							0	5.2	4	129.5	70	45.9	2	68.2	44.8	34.3
72	347512F							0	4.8	3.6	107.5	56.3	47.7	2	73.7	42.1	42.9
73	288407F							0	4.5	3.4	92.4	47.4	48.7	2	63	33	47.6
74	287354F							0	5.7	4.5	163.1	94.3	42.2	3	48	27	43.8
75	291306F							0	4	2.9	71	32	55	1	82.6	40	54
76	256769D	2.3/17.8	2.8/18.2	2.4	0.3	0.04	6	1	4.6	3.4	97.8	47.4	51.5	2	87.8	48.9	44.3
77	286849F							0	6.2	4.9	194	115	41	3	188	108.8	42.1
78	299314F	4.7/14.8	5.6/18.3	5.4	0.6	0.14	28	2	4.4	3.1	87.8	37.9	56.8	1	92.2	41.1	55.4
79	299336F							0	4.1	2.9	73	33	55	1	78.4	37.3	52.4
80	309758F							0	5.6	4.2	155.8	80.1	48.6	2	76	39	48.7
81	761606D							0	4	2.8	70	29.6	57.8	1	89	44	50.6
82	981786A							0	4.8	3.6	109.6	52.8	51.8	2	82	34	58.5
83	316403F							0	5.6	4.4	151	87	42.4	3	76	44	42.1
84	316458F							0	4	2.9	70	32.2	54	1	87	38	56.3
85	040901F							0	4.9	3.3	112.8	44.1	60.9	1	85	41	51.8
86	077397F							0	4.1	3.1	56	21	62.5	1	93.8	32.2	56.4
87	89817F							0	4.3	3.2	83	39.4	52.5	2	47.9	16	66.5
88	354481F							0	4.3	3.2	81	38	53.1	2	81.6	46.8	42.6
89	354493F							0	5	3.4	112	54	51.8	2	79	35.55	55

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Thesis- Prevalence and Echocardiographic Quantification of Mitral Regurgitation including 3D-EF [Ejection fraction] assessment in Acute ST Elevation Myocardial Infarction by Amit Hooda 16101751 D.M. Cardiology

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INTRODUCTION

1**MR is a frequent complication of coronary artery disease. It**

was often under-rated because it is clinically silent, but with the use of echocardiography this complication

4**is observed between 15%-20% after** a **myocardial infarction.**

1

1**When compared with patients without MR, the patients with acute** myocardial **infarction and** mitral regurgitation **are older, more** often in **female** and frequently **have a history of previous**

ischaemic heart disease.2 Its presence and degree have major prognostic implications and underscore the importance of its detection and quantification. Ischaemic mitral regurgitation can independently predict cardiovascular death with a relative risk of 2.3 In a community trial, Bursi et al found that mitral

regurgitation predicted heart failure as well as mortality among 1 month survivors independent of age, gender, ejection fraction, and Killip Class.4 Even mild MR was shown to increase the mortality in SAVE trial (Survival and Ventricular Enlargement) 3 hence, detection and quantification of MR is crucial. MR can be estimated by different techniques on echocardiography. Color flow imaging allows an easy visualization of MR, but was found to overestimate the MR.5 Mccully et al demonstrated that the same jet area corresponds to smaller regurtitant volumes in functional MR as compared to organic MR.5 Doppler echocardiography allows accurate assessment of regurgitant volume and effective regurgitant orifice and thus provide the tools to reliably evaluate the prognosis and mechanism. Doppler methods are simple, fast, reproducible and proven to be more reliable bur sparsely applied in routine clinical evaluation. Current guidelines advocate quantification of MR by the measurement of

7**vena contracta and proximal isovelocity surface area (PISA),**

the most recommended quantitative approach whenever feasible. The semi-quantitative evaluation should be abandoned.6 Echocardiography is the most common method to assess left ventricular systolic function. It can efficiently predict the outcome and help in determining the treatment modalities like CRT-D implantation etc. Routine 2D EF measurement has several limitations in AMI patients due to problems of foreshortening and geometric assumptions.3D echo LVEF is much more accurate especially in presence of regional wall-motion abnormalities as it does not have geometric assumptions and is found to have comparable with present day ‘‘gold standard’’ for systolic function , cardiac MRI .7 It can automatically calculate ejection fraction and left ventricular mass using the automated softwares, and is therefore more reproducible. It is several folds accurate as compared to conventional echo. As there is no data for prevalence of Mitral Regurgitation in Indian population, this study was undertaken. We evaluated the prevalence and degree of Mitral Regurgitation in

4**the acute phase and after 1**

month of STEMI. AIMS AND OBJECTIVES PRIMARY AIM a. To study the following parameters

4**in Acute ST Elevation Myocardial Infarction[STEMI] patients**

i. Prevalence of mitral regurgitation[MR] by echocardiography in acute MI and during 1 month follow up ii. 3D-EF(ejection fraction) assessment SECONDARY AIM a. Correlation of 2D-EF, 3D-EF and MR in STEMI patients REVIEW OF THE LITERATURE

13**INTRODUCTION Mitral regurgitation** (MR) **is defined as systolic retrograde flow from left ventricle** (LV) to **left atrium**

(LA) because of pressure gradient between the two chambers. 8 The

1**term ischaemic MR does not necessarily imply the presence of true myocardial** ischemia, **it is in fact an abridgment,** characterizing **a clinical situation corresponding to chronic coronary artery disease with frequently a prior history of one or more myocardial infarctions** leading to **progressive global or regional** pathological LV **remodelling, usually in the absence of reversible ischaemia.** 9 Ischemic **MR is a** type **of**

secondary/functional MR due to coronary artery

1**disease. Secondary MR is defined as functional MR, due to LV remodelling by idiopathic** cardiomyopathy **or coronary artery disease.**

8, 10

1**It is important to distinguish between primary MR due to organic disease of one or more components of the mitral valve apparatus and secondary MR which is not a valve disease, but** represents **the valvular consequences of a LV disease.**

1**There are however limitations in both terms: functional and** ischemic. **Indeed, recent studies have demonstrated evidence of structural changes in the mitral leaflets in response to tethering on them by LV pathological remodelling. The leaflet adaptation includes enlargement** and **increased stiffness.**

11 PREVALENCE MR is a frequent accompaniment of ischaemic heart disease. Clinical presentation is variable from silent to severe MR presenting with hemodynamic instability. It may be an incidental finding on echocardiography or catheterization .3 Its importance was often underscored because of low murmur intensity but with the use of echocardiography, MR is observed between 15%- 20% of patients with acute myocardial infarction.1Different investigators have found variable incidence of MR in acute MI with the help of different imaging modalities.Lehmann et al found 13 % incidence of mitral regurgitation early in the course of acute myocardial infarction with the help of contrast left ventriculography.2 Tcheng et al reported incidence of post-infarction mitral regurgitation was to be 17.9% of patients within hours of infarction.12 Indeed, when it is sought by doppler, MR has been reported to occur in up to 39% of patients with MI. 13,14 With the recent advances in non-invasive doppler echocardiography ,it is possible to accurately assess the regurgitant volume and effective regurgitant orifice. Old age, diabetes, past history of MI, severe CAD are more frequently associated with STEMI with MR than patients with STEMI without MR.2,

12, 15 Its presence and degree have major prognostic implications and mandates its detection and quantification. PATHOPHYSIOLOGY Normal mitral valve function depends on perfect delicate interplay

> 2**between the mitral leaflets, the subvalvular- apparatus** (which includes: **chordae tendineae and papillary** muscle), **the mitral annulus, and the left ventricle.**

Pathophysiology of ischemic MR is perplexing. Myocardial damage and LV dysfunction usually precedes MR. Ischemic MR is characterized by normal leaflets and subvalvular apparatus and occurs due to restricted motion of the leaflets. According to the Carpentier's classification, ischaemic mitral regurgitation is classified as type 3. 16 Given below is the classification based on motion of leaflet

> 6**in relation to the mitral annular plane** (figure **1)** 1: **normal leaflet motion.**

Perforation of the leaflet due to traumatic injury or endocarditits, or annular dilatation, which may cause left ventricular disease, is the cause of MR in type1. 2:

> 9**excessive leaflet mobility accompanied by displacement of the free edge of one or both leaflets beyond the mitral annular plane**

into the left atrium.degenerative cardiac diseases may cause leaflet prolapse. 3: leaflet restriction. It is further subclassified into 2 varities:

> 6**3a, where the restriction** occurs **throughout the cardiac cycle, i.e.** both **in systole and diastole** due to shortening **of** the chordae **and/**

> 2**or leaflet thickening such as in rheumatic disease,**

> 6**3b, where the leaflet restriction is seen in systole** only **(usually the result of regional wall motion abnormalities** seen **in** ischaemic **mitral regurgitation).**

16 Figure 1: Carpentier's functional classification of Mitral Regurtitation17 Mitral Leaflet closure is mainly an intricate interplay between the forces of tethering and ventricular forces (figure 2, 3). Increase in tethering forces will not allow adequate

1**closure of the mitral leaflets.** 8, 18 **The**

most frequent pattern seen is posterior infarction, more commonly trans mural,

1**leading to local** left ventricular **pathological remodelling and** thereby **contributing to** posterior, **apical and lateral displacement of the posterior papillary muscle.** As **the papillary muscle** extends **non-extensible** chordate **to both** the **leaflets, its displacement results in a more apical** tethering **of the leaflets and their coaptation point, and a characteristic deformity of the anterior leaflet** which is **described as** the **'seagull sign'.** 8, 19 **The tethering process produces the shape** like that **of a tent between the annular plane and the displaced leaflets. The tenting volume closely** estimates **the regurgitant orifice area.8,**

20 Tenting area is asymmetric in case of posterior infarction and regional remodelling,

1**predominates on the posterior leaflet close to the medial commissure.** It is **accompanied by** decreased **mobility of the posterior leaflet. In** another subgroup of **patients**

1**with previous anterior** infarction **or both anterior and posterior infarctions,**

1**LV dilatation is more global, LV is more spherical, both papillary muscles are displaced, the tenting area is symmetric, the regurgitant jet is central** and **the contribution of annular dilatation and flattening is more important.**

Second important determinant is decrease in ventricular closing forces, includes

1**altered systolic annular contraction** ,LV dysfunction **,reduced synchronicity between the two papillary muscles and global LV dyssynchrony, especially in basal segments.**

8Factors aggravating the mitral regurgitation are

3**dilatation of the mitral annulus and the decrease in systolic annular contraction, but isolated annular dilatation does not create functional mitral regurgitation.**

18 Figure 2: Left figure: Normal coaptation is seen. Right figure: tethering of leaflet due to papillary muscle displacement and annular dilatation

3**AO, aorta; Inf PM, inferior papillary muscle; LA, left atrium; LV, left ventricle; MR, mitral regurgitation. (Reproduced from**

3**Levine RA, Hung J, Otsuji Y, et al. Mechanistic insights into functional mitral regurgitation. Curr Cardiol Rep 2002; 4:125–9)**

Occasionally, leaflet prolapse can occur as a result of fibrotic elongation of papillary muscle which may be followed by an event such as myocardial infarction and this can result in MR. (Carpenters' Type 2). The consequences of MR depend on the following underlying factors a. Severity of regurgitation b. LA compliance c. LV-LA gradient (the driving force) d. Duration of the lesion Acute MR can occur secondary to two rare causes:

1**rupture of a papillary** muscles resulting from **acute myocardial infarction and**

transient active ischemia leading to true ischemic MR. The

1**rupture of a papillary muscle,** more often **in**

the location of

1**head of the** posteromedial papillary **muscle, is a** catastrophic **complication of**

actual MI

1**with a high mortality if** emergency **surgery is not**

done.8, 21 In majority of patients with chronic ischemic MR complicating left ventricular dysfunction and heart failure, LA is enlarged and has a greater compliance with low driving force. The volume overload

resulting from MR contributes to a vicious cycle : the more remodelling of left ventricle, the more severe MR begets MR, so greater the severity of MR, larger the volume overload on LV which finally leads to LV remodelling.LV becomes more and more dilated and spherical in accordance to laplace law, which further propentiates the MR. Despite a reduction in LV impedance, LV wall stress increases ,finally translating into LV dysfunction.22Chronic ischaemic MR finally leads to development of

1**pulmonary arterial hypertension.** Another **important** feature **of ischaemic MR is its**

dynamicity. 23 The

1**degree of MR is best** quantified **by the effective** regurgitant **orifice (ERO) area.** 24 **The regurgitation area**

keeps on changing throughout the systole due to dynamic changes in transmitral pressure, though it is of lesser importance in midsystole when compared to other phases of systole.25,26 ERO is load dependent, therefore affected by daily activities. Another evidence of the dynamicity of ischaemic MR ↑ tethering forces ↓ Ventricular forces (left ventricle dysfunction) Ischemic MR LA Enlargement ↑ Left Ventricular wall stress AF, PAH left ventricle Remodelling (Annular dilation, papillary muscle displacement) Figure 3: Pathophysiology

1**of Ischaemic MR is a reduction** of **regurgitant volume related to a reverse LV remodelling obtained by appropriate medical treatment.**

27 Dynamic nature of MR can be very well

1**appreciated during an exercise doppler echocardiogram.** 28 **The degree of MR** seen **at rest is** not related **to exercise-induced changes in ERO area or** regurtitant **volume.**

29 Exercise-induced changes are quite variable in different individuals. In some individuals

1**with moderate or severe MR at rest, a decrease in ERO area can be observed with exercise and usually results from contractile reserve of the LV, in particular of the postero-basal segment and/or a reduction in intra LV**

dyssynchrony.30 Around

1**30% of** these **patients develop** an **increase in**

the severity of regurgitation

1**and in systolic pulmonary artery pressure during exercise. The degree of exercise-induced increase or decrease in MR relates to changes in** valve deformation, **LV remodelling and**

papillary muscles synchronicity. DIAGNOSIS AND QUANTIFICATION Clinical examination in ischaemic MR may reveal a regurgitant murmur of low grade or may even be silent or inaudible .It is an insensitive method for ischaemic MR diagnosis due to subtle or near normal auscultatory findings in many patients. This can be explained from the fact that cardiac output is low, LV contractility is compromised and atrial pressure is high thereby they cause lower regurgitant volume, consequently low grade murmur in ischemic MR compared to organic MR. There is no correlation between intensity of murmur and severity of ischaemic MR. The

1**diagnosis of ischaemic MR is usually** made **by** using **imaging**

modalities like doppler echocardiography. Doppler echocardiography is a useful tool in diagnosis and is superior to other techniques like contrast ventriculography. Importance of doppler echocardiography in routine clinical practice is undisputed. Clinically subtle findings like low intensity murmurs

3**should always lead to a careful echocardiographic examination.** Quantification of MR **is**

also crucial. Echocardiography plays a key role not only in diagnosis of regurgitant lesion but also in the assessment of the mechanism and the severity of MR. It also has a role in determining treatment options as it helps in determining the feasibility of valve repair versus replacement. Assessment of Mitral Regurgitation by echo can be (a) qualitative (b) quantitative. QUALITATIVE METHODS

2**Colour flow imaging Colour flow imaging is the most** widely used method **to assess MR severity**

echocardiographically .32 This measurement is poorly reproducible and influenced by various factors. Though it allows an easy visualization of the regurgitation and frequency of MR, it has major limitations in assessing the severity of MR. 5, 33 It tends to overestimate the severity of regurgitation. It is generally assumed that with increasing MR, the

> 5**size and extent of the** regurgitant **jet** in **LA**

is increased.

> 2**Larger colour jets** extending **deep into LA represent** greater severity of **MR than small thin jets that appear just beyond the mitral leaflets. However, the jet size**

may be influenced by other factors such as technical and hemodynamic influences and therefore caution must be exercised in interpretation of jet severity based on jet size. For the same severity of MR ,

> 5**patients with increased LA pressure,** enlarged LA **or** wall hugging **eccentric**

jet may show

> 2**smaller jets area** when compared **with normal LA pressure, size or with central jets.**

6

> 2**In acute MR, even centrally directed jets may be misleadingly small.**

Nevertheless,

> 2**a large eccentric jet adhering, swirling and reaching the posterior wall of the LA**

favours significant MR and smaller thin jets appearing

> 5**just beyond the mitral leaflets usually**

is an indicator of mild MR. Continous Wave Doppler of MR jet

> 5**Continuous wave doppler of mitral regurgitation jet**

is another qualitative parameter which is used to measure the severity of mitral regurgitation.

> 2**The signal intensity (jet density) of the CW envelope of the** mitral regurgitant **jet can be** used as **a qualitative** indicator **to** mitral regurgitation **severity. A dense** triangular mitral regurgitation **signal with a full envelope** indicates **severe** mitral regurgitation **than a faint signal.**

> 2**Truncated (notch)** envelope **with a triangular contour and an early peak velocity (blunt) indicates elevated LA pressure or a prominent regurgitant pressure wave in the LA due to severe MR. In** case of **eccentric** mitral regurgitation; **it may be difficult to record the full CW envelope of the jet,**

while the density may be used as indicator for assessing the severity. SEMIQUANTITATIVE MEASURES

> 1**The semi-quantitative evaluation of** regugitant **jet area should** not **be**

used.6 It is recommended that these measures should only be used for diagnosing mitral regurgitation, and not to quantify the severity of MR.

> 2**A more quantitative approach is** recommended **when more than a small central MR jet is** seen. **Vena contracta width** (VCW) **The vena contracta is the** narrowest portion **of the** MR **jet** downstream from **the orifice; it reflects the** effective **orifice area.**

34-36 Whenever feasible measure the dimensions of vena contracta, which can help in quantification of MR. Using a careful probe angulation and

> 2**adapted Nyquist limit (colour Doppler scale) (40–70 cm/s), the**

> 2**vena contracta is typically imaged in a view perpendicular to the** commissural **line (e.g. the parasternal long-axis or the apical four chamber view)**

to

2**identify the neck or** the **narrowest portion of the jet.** This **narrowest doppler colour sector scan** can be **coupled with the zoom mode to improve resolution and**

for more accurate measurement (Figure 4). It is recommended that if possible averaged measurements over at least three beats should be taken and measurements should be taken from two orthogonal planes. A vena contracta, < 3 mm is considered as an indicator of

2**mild MR whereas a width ≥7 mm defines severe** Mitral Regurgitation, **values**

in between 3 to 7 mm are ambiguous and need further confirmation by a more quantitative method.6 The

2**concept of vena contracta is based on the assumption that the** regurgitation **orifice is almost circular,**

this assumption holds true in cases of organic MR but in functional MR the results may not be accurate as the orifice may be non circular and

5**elongated along the mitral coaptation line.**

37, 38 Thus, it could look

2**narrow in four-chamber view and broad in two-chamber view. Conventional 2D colour Doppler imaging does not provide appropriate orientation of 2D scan planes to obtain an accurate cross-sectional view of the vena contracta. The vena contracta can be classically well identified in both central and eccentric jets. In case of multiple MR jets, the respective widths of the vena contracta are not additive. Such characteristics may be better appreciated and measured on 3D echocardiography. In** cases of **functional MR, a mean vena contracta width (four- and two chamber views) has been shown to be better correlated with** calculation done using **the 3D vena contracta.**

41 3D echo

5**assessment of the vena contracta is**

not used routinely and currently it is used for research purposes.

2**A mean value >8 mm on 2D echo has been reported to define severe MR for all**

5**aetiologies of MR including functional MR,**

though it needs confirmation in further studies.39 Figure 4. Measurement of Vena contracta width in Mitral Regurtiation. Pulmonary venous flow Doppler It is an additional parameter for evaluation of MR severity. Normally, if there is no diastolic dysfunction in venous flow Doppler we get

2**a positive systolic wave (S)** which is **followed by a smaller diastolic wave (D).**

As the

2**severity of MR** increases, **there is a** blunting **of the S wave velocity.**

Systolic blunting or systolic flow reversal will be seen in moderate and severe MR respectively. QUANTITATIVE METHODS

5**Doppler volumetric method Doppler** volumetric **method can**

calculate regurgitant volume by finding the difference between measured mitral and aortic stroke volume.43.It can be inferred using 2D echocardiograph by calculation of LVEDV and LVESV which are calculated using biplane method of disks. 42 Same jet areas correspond to smaller RVol in ischemic MR than in organic mitral regurgitation. However, this method is cumbersome and time consuming. It is not recommended as first line investigation for quantification of regurgitant volume. Flow Convergence Method Flow-convergence method is the most frequently quantitative method for estimation of MR in current practice.44It is based on law of conservation of flow; its basis lies in the modified form of continuity equation. It enables the measurement of ERO area and regurgitant volume with precision.45 As the flow convergence is proximal to the regurgitant orifice it forms the basis of analysis.46

2**The apical four-chamber view is** classically **recommended for** enabling good **visualization of the proximal** isovelocity **surface area** (figure 5). **However,**

in

5anterior mitral valve prolapse the calculation of

PISA should be done in the parasternal long- or short-axis view. By lowering the image

2depth and reducing the Nyquist limit to 15–40 cm/s,

flow velocity at a hemispheric surface proximal to regurtitant orifice can be determined.6 The

2radius of the PISA is measured at mid-systole using the first aliasing. Regurgitant volume (R Vol) and effective regurgitant orifice area (EROA) are obtained using the standard formula.

Regurtitant flow = 2 Π (radius of the flow convergence) 2 x aliasing velocity ERO is the ratio of regurgitant flow /peak mitral regurgitant velocity Regurtitant volume (RVol) is calculated as product of ERO and MR TVI.

2Qualitatively, the presence of flow convergence at a Nyquist limit of 50–60 cm/s is an indicator to the presence of significant MR. 6 Grading of organic MR

6 Mild Moderate Severe EROA (mm2) <20 20–29; 30–39

2≥40 R Vol (mL) <30 30–44; 45–59

≥60 Moderate regurgitation group can be further classified

2into 'mild-to-moderate' (EROA of 20–29 mm2, R Vol of 30–44 mL) and 'moderate-to-severe' (EROA of 30–39 mm2 or R Vol of 45–59

2mL). In ischaemic MR, the thresholds of severity, which are of prognostic value, are 20 mm2 and 30 mL, respectively. 47 EROA is the most robust parameter as it represents a marker of lesion severity. A large EROA can lead to large regurgitant kinetic energy (large R Vol) as well as to potential energy, with low R Vol but high LA pressure.

Ischemic MR Low Risk EROA<20mm2 RVol<30ml High Risk EROA>20mm2 RVol>30ml Figure 5: Ischaemic MR Grading (6, 48) This method is simple, fast, and reproducible and has been validated by multiple investigators.46; 49It precisely calculates the RVol, which indicates the volume overload induced by MR, and the effective regurgitant orifice (ERO), which delineates the severity of anatomic lesion. PISA radius Figure 5. Determination of radius of proximal isovelocity surface area (PISA) in ischaemic Mitral Regurgitation.

1**There are several limitations of the proximal isovelocity surface area (PISA) approach.** 8,46 **First, the PISA radius changes during systole is larger in early and late systole, and smaller in** midsystole **when the LV pressure is maximal.** 50 **Ideally, the PISA radius should not be measured at only one time point, but averaged through systole. Second, for an accurate measurement, the flow convergence should be hemispheric.**

In cases of functional MR, the

1**flow convergence—a three-dimensional structure—is frequently hemielliptic** (Fig 6), **implying an underestimated calculation of ERO and regurgitant volume,**

particularly

2**when the ratio of long-axis length to short-axis length of the 3D regurgitant orifice is >1.5.**

38, 51-52 Third, multiple jets can

1**be present; the addition of several flow-convergence regions has not been validated.**

Fourth, it is more accurate for central jet. It

2**may not hold for eccentric jets,** several **jets, or complex or elliptical regurgitant orifices. Practically, the geometry of the PISA varies** based **on the shape of the orifice and mitral valve leaflets surrounding the orifice.**

Figure 6: 3Dimensional

> 5**shape of the** convergence **flow in** (a) **functional**

MR (b) organic MR (Reproduced from EHJ guidelines

> 1**for the assessment of** the **valvular regurgitation**

2010)

> 1**Thus, practically, the most reliable calculation of regurgitant volume and ERO area is the averaging of the quantitative doppler and the PISA methods**

.However, this approach is time consuming.8 Invasive assessment Mitral regurgitation could be assessed by invasive ventriculography. Some schools of thought have considered Left ventriculography

> 3**as the reference** methodology **for assessment of mitral regurgitation.** However **this**

method of grading of MR is also subject to limitations and cannot thereby be considered gold standard because of influence of loading conditions affecting the MR severity. Comparatively, Quantitative Doppler echocardiography is non invasive and also provides more objective data for grading and prognostic information about regurgitation than ventriculogram.53 PROGNOSIS The presence of ischaemic MR

> 4**is an important** indicator **for long term**

morbidity as well as mortality. It

> 4**is an independent risk factor for the** same. The presence **of**

ischaemic MR may result from acute infarction resulting in regional left ventricular dilation and consequent loss of contractile mechanism or in some instances it may be a previously existing lesion which went undiagnosed. Several studies have clearly shown that ischaemic mitral regurgitation can predict cardiovascular mortality independently.2-4,8, 12, 54 Relative risk was found to be quite variable ranging from 1.48 - 7.5.8

1**Worse long term prognosis** was seen **in patients** presenting **with non ST elevation**

myocardial infarction .55 A community based

1**study has also confirmed the prognostic importance of** ischaemic **MR**

among one month survivors of MI:

1**its presence is associated with a three-fold increase in the risk of heart failure and a 1.6-fold increased risk of death at 5-year follow-up, independent of LV ejection fraction, Killip class, age and gender.**

4,8 Barzilai et al found that AMI patients with a murmur suggestive of MR had a 12-month mortality of 36% compared with 15% for patients without an MR murmur. 56SAVE study investigators also showed that mild MR was associated with high mortality. Greater the severity of mitral regurgitation, worser was the prognosis.48 Even uncorrected mild MR, as well as moderate to severe ischaemic MR is found to be associated with higher mortality on long term.

1**However, the severity of ischaemic MR tends to follow the severity of the LV dysfunction causing the MR; the worse the MR, the worse the LV** functions. Till date, **there are no studies**

to prove that ischaemic MR is a predictor of long term prognosis irrespective of severity of LV dysfunction present.8 No studies have proved that correction of mitral regurgitation will mitigates the long term mortality independent of left ventricular systolic dysfunction8 Though small case series has shown that coronary revascularisation in acute MI has reduced the severity of MR in selected patients, it tend to persist in > 50% of patients of MI on follow up.12 Therefore, even coronary revascularisation may not halt its progression during long term. Prognosis is also found to be related to the dynamicity of component of ischaemic mitral regurgitation. A 5

1**fold increase in the relative risk of death with an exercise-induced increase of ≥13** mm2 **of the ERO area**

was found.8, 57 It is the best predictor of hospitalisation and cardiovascular morbidity as compared to severity of mitral regurgitation at rest. Its deleritious effects are related to several factors like sudden increase in R Vol (regurgitant volume) and with rapid QRS widening due to increases in

1**ventricular wall stress leading to** worsening **LV**

dyssynchrony.58 In

1**patients with LV systolic dysfunction, acute pulmonary oedema**

which may develop due to sudden worsening of dynamic MR leading to acute increase in left atrial pressures.8, 59 Greater exercise-induced regurgitant volume and systolic pulmonary arterial pressure may cause exertional dyspnea.60 Around 20% may have

1**an improvement in the severity of ischaemic** mitral regurgitation **during exercise,** who **have a** favourable **long term prognosis.**

57 This is thought to happen

1**in patients with contractile reserve** in **posterior**

segment.29 MANAGEMENT Numerous treatment options have been proposed but the treatment of ischaemic mitral regurgitation still remains a complex issue and needs further research and trials to find an ideal treatment modality with long term benefits. In current clinical approach at most places ring annuloplasty is preferred treatment modality. However, long term benefits of this technique remains obscured as it has no role in correction of local alteration due to left ventricular remodelling. Medical Management Standard anti-failure medications such as angiotensin-converting enzyme (ACEI) inhibitor or ARBs if the ACEI is not well tolerated), aldosterone antagonist and beta-blockers .8, 61 It may help in alleviating the severity of mitral regurgitation by producing reverse left ventricular remodeling.8, 62 Cardiac resynchronization therapy Though biventricular pacing per se is not an treatment modality for ischaemic mitral regurgitation, it is an indication to consider CRT in patients of ischemic MR with reduced left ventricular ejection fraction ,functional class III or more even with medical treatment and ecg showing QRS of more than 120 ms.63 Cardiac resynchronization therapy resynchronize the papillary muscles and increase the closing force which helps in immediate reduction in MR.8,64- 65 There is further more reduction in the severity of MR in long term that is after few weeks or months as it plays a role in LV reverse remodelling, through a reduction in tethering .It can also reduce dynamic MR.66 Magnitude of MR induced by exercise attenuate significantly in parallel to reverse Left Ventricular remodelling over a period of three months and result in improved cardiopulmonary performance.8, 67 Despite a reduction in the severity of MR, residual MR frequently persists. Immediate recurrence of MR has been seen post withdrawal of CRT due to dyssynchronization of the papillary muscles leads to. 68-70 Percutaneous coronary revascularization It may help in reducing the severity of mitral regurgitation at rest as well as during exertion in the subset where it is directly induced by ischaemia. .8 Surgical Management Surgical approach for management of ischemic MR can only reduce its severity, not eliminate it completely.

Coronary artery bypass grafting by itself is regarded insufficient in correction of MR. 71 Persistence of even little residual mitral regurgitation postoperatively has been shown to be associated with higher mortality 72 With the use of an undersized prosthetic (preferably two- sizes) ring 73,

1**reduction in LV volume** has been seen **and even a small increase in LV ejection fraction**

has been documented , 74 but the long-term benefits could not be proved.75,76 Several studies have shown that long-term outcomes in terms of survival benefit or functional outcome is questionable by combined surgery. 75,77-78 In a recent randomized control trial it has been shown that mitral valve repair done along with CABG was associated with improvement of NYHA class, LVEF, and reduction in left ventricular diameter, left atrial size and PAP(pulmonary artery presence) .79It

1**was not powered** enough **to analyse the effect on**

mortality . To conclude it may be said that fixing some valves may help, but it is difficult to identify which ones.80 Recently published

1**meta-analysis** showed **that mitral valve repair for ischaemic** mitral regurgitation **is associated with better**

survival compared with MVR (mitral valve replacement). 81 The European Society of Cardiology

1**guidelines recommend that patients with severe** ischemic mitral regurgitation **(ERO area ≥20**

mm2) undergoing

1**CABG should be treated by combined surgery (class I, level of evidence**

C). 8,82Mitral valve repair may be considered

1**in symptomatic patients with severe** mitral regurgitation **who cannot be revascularized** is **questionable**

(class IIb).82 Mild mitral regurgitation should be managed conservatively. Due to the lacuna of well defined guidelines and evidence, the management of ischemic MR should be individualized. Assessment of

myocardial viability, especially in region of posterior basal wall, inducible ischemia and the dynamic component of MR aids in decision making. Biphasic response or regional contractile reserve during stress testing usually have exercise-induced reduction in mitral regurgitation, can be help decision making. Patients with exercise-induced increase in effective orifice area area ≥13 mm2 could be taken up for combined surgery. Severity of MR is always underestimated even with intra-operative TEE. Pharmacological measures like phenylepherine or rapid fluid challenge may be used to assess the ischaemic MR.83 Parameters like grossly dilated left ventricle, multiple regurgitant jets , systolic sphericity index, wall motion score index, ESV(end-systolic volume), severe MR, >2.5 cm2 systolic tenting area, , large angle (≥45°) of the posterior leaflet, >1 cm distance between coaptation point and mitral annulus are recognized as predictors of bad outcome of procedures like mitral valve repair by annuloplasty .84-86 Several adjunctive techniques have been proposed like chordal cutting, internal direct repositioning or external repositioning of the displaced papillary muscle. 8, 87 However, they are not yet clinically approved for routine management of ischaemic mitral regurgitation. PERCUTANEOUS REAPIR Percutaneous edge-to-edge Alfieri procedure has been used for the treatment of MR due to either ischaemic or organic cause. In it, the central parts of both mitral leaflets are apposed producing a double orifice. 8, 88 Many researchers have developed the devices which can be delivered in coronary sinus and reduce the severity of mitral regurgitation by pushing the PML forward.89-90 Long term effects of these devices needs to be studied. FORTHCOIMG THERAPIES Future targets like transplanting autologous myoblast has potential proven to cause localized LV reverse remodelling and appears to be a promising approach in decreasing ischaemic MR. More understanding of our concepts of leaflet adaptation in LV dysfunction can help us in developing potentially better therapies in future. 91 3D EF Measurement in Myocardial Infarction Echocardiography is the most common method to assess left ventricular systolic function. It can efficiently predict the outcome and help in determining the treatment modalities like CRT-D implantation etc. Routine 2D EF measurement has several limitations in AMI patients due to problems of foreshortening and geometric assumptions.3D echo LVEF is much more accurate especially in presence of regional wall-motion abnormalities as it does not have geometric assumptions and is found to have comparable with present day ‘‘gold standard’’ cardiac MRI .(5) It can automatically calculate ejection fraction and left ventricular mass using the automated softwares, and is therefore more reproducible. It is up to 3 times more accurate than 2DE LVEF.7 Figure 7.Measurement of 3D EF in echocardiography through Q lab analysis DESIGN AND METHODOLOGY Study Design:

11**This is a single centre** prospective observational **study**

done in the department of Cardiology, Christian Medical College (CMCH), Vellore. SETTING

11**Study was** done **in the** Cardiology **department of Christian Medical College and**

Hospital, a tertiary care hospital in South India.119 consecutive patients with STEMI were assessed for mitral regurgitation using various echocardiographic parameters. STUDY PARTICIPITANTS Inclusion criteria: All patients older than 18 yrs old, who sustained STEMI between September 2011 to August 2012. Exclusion criteria: Patients were excluded from the study if they had 1. Rheumatic heart disease 2.

Persistent arrythmias 3. Known coronary artery disease(CAD) 4. Cardiogenic shock 5. Trivial MR Methods: 1. Demographic and clinical profile of patients were collected were collected once they consented 2. All patients underwent echo once they were stable during index admission. Mitral regurgitation quantified using jet width[vena contracta], jet area

7**and proximal isovelocity surface area(PISA)**

,if central jet is present 3. Left ventricular

7**ejection fraction were** assessed **by** both **Simpson's method**

as well as 3D echocardiography STATISTICAL ANALYSIS Statistical analysis was done using commercially available statistical software ('IBM SPSS software version 15', Illinois, Chicago). All

10**continuous variables** are **expressed as mean ± SD** and **categorical variables** are **expressed as** number **(percentages).** Independent samples **T test was** used **for** comparative analysis **of**

two groups with a normally distributed continuous variables. Comparison of categorical variables was done using Chi square test. Pearson correlation coefficient was used to analyze the correlation between two continuous variables with a normal distribution. Comparative

8**analysis was performed** by one **way analysis of variance (ANOVA). A p value** less than **0.05 was considered statistically significant** for all test **results.** RESULTS **1.** STUDY PROFILE **AND**

BASELINE CHARACTERISTICS

4**A total of** 119 **patients** of STEMI **were evaluated**

for ischaemic MR during the study period.

4**Mean age of** patients in **the** whole **study population was**

53.42 ± 11.47 years. Majority patients (57.1%) were found to be in the age group of 40-59 years, with least number was in >80 yrs (2.5%).10.9% patients were young, <40 years having MI. Number of males outnumber within each group.Ratio of Males: Female is 96:23. 31.9%(38) of the patients has type 2

diabetes mellitus,98.3%(117) of patients had dyslipidemia, 37.8(45) % of the patients had hypertension ,54.6% (65) were obese , 47.1%(56) were current smoker and 13.4%(16) had positive family history of coronary artery disease(CAD). On an average all patients were had at least 2 risk factors. Baseline characteristics of both groups with Anterior wall MI (AWMI) and Inferior wall MI (IWMI) were comparable without any significant statistical difference except baseline 2D EF, which was higher in IWMI group (table 1). Patients presenting with AWMI were having slightly higher proportion of hypertension, though it was statistically insignificant. Characteristic AWMI IWMI p value Age 52.30±11.11 54.58±11.81 .281 Male 47(78.3%) 49(83.1%) .515 Female 13(21.7%) 10(16.9%) .515 Diabetes 19(31.7%) 19(32.2%) .85 Hypertension 27(45%) 18(30.5%) .103 Smoking 29(48.3%) 27(45.8%) .779 Dyslipidemia 59(98.3%) 58(98.3%) .990 Obesity 35(58.3%) 30(53.1%) .293 Positive Family History 10(16.7%) 6(10.2%) .299 Baseline 2D EF 44.94+7.5 50.7+7.4 .000(significant) Baseline 3D EF 45.42+8.5 46.96+8.6 .33 Table 1.Baseline characteristics of patients according to the type of STEMI 2. Prevalence of MR 27(22.7%) patients were found to have MR during index admission for MI (Figure 8), out of which 24(88.9%) had mild MR and 3(11.1%) had moderate MR based on quantitative measurements. None of the patients were found to have severe MR. Mean Vena contracta (VC) in mild and moderate MR patients at presentation were 2.91±0.94 and 3.54±0.25 respectively. Mean PISA radius, effective regurtitant orifice area (ERO) and regurgitation volume in mild MR patients at presentation were 0.315±0.08, 0.05±0.03 and 7.07±3.65 respectively (table 2). MR VC(mm) PISA ERO(cm2) MR radius(cm) Volume(ml) MILD(n=24) 2.91±0.94 MODERATE(n=3) 3.54±0.25 AFTER 1 MONTH MILD(n=12) 2.97±0.55 MODERATE(n=2) 4.8±8.5 0.315±0.08 0.05±0.03 7.07±3.65 0.44±0.06 0.10±0.06 30.33±7.77 0.38±0.81 0.05±0.03 6.9±3.17 0.55±0.07 0.125±0.02 27±1.41 Table 2.Quantitative echocardiographic parameters of MR at presentation and after 1 month Mean age of patients presenting with ischaemic MR at onset was 59.2 ± 10.82(figure 9), population includes 74.1% males (20) and 25.9 %(7) females. Majority of patients presenting with MR at admission were in the age group of 60-79 years (figure 9).Among the patients having MR at admission included 48.1%(13) type 2 diabetics, 100%(27) dyslipidemics, 33.3 % (9) hypertensive's, 44.4% (12) obese, 44.4 %(12) current smoker, 22.2%(6) had AWMI, 77.8%(21) had IWMI and none had a positive family

4**history of coronary artery disease (CAD).**

Though there was trend towards females being more commonly associated with MR, it was found to be statistically insignificant (figure 10). None of the risk factors predicted of onset of MR in STEMI patients at admission and during follow up on statistical analysis except age, diabetes and site of STEMI(Table 3).IWMI patients were more likely to develop MR at presentation (table 3).Male gender was found to have higher prevalence of absence of MR during follow up. MR 22.7 PRESENT 77.3 ABSENT Figure 8.Prevalence of MR at admission 60 Number of STEMI patients 50 40 30 MR ABSENT 20 MR PRESENT 10 0 20-39 40-59 60-79 >80 Age groups Figure 9.Prevalence of MR according to the age groups 100 100 90 80 79.2 77.8 78.6 76.1 80 70 65.2 65.8 60 50 40 30 20 20.8 34.8 34.2 22.2 21.4 23.9 20 PRESENT ABSENT 10 0 0 Figure 10.Proportion of baseline risk factors of patients with and without MR During follow up after 1 month, MR was found to be present in 15.7% of patients despite a dropout of 30(25.2%) patients (figure 11).MR continue to persist in 10.1 %(9) patients with improvement in severity in 13.5 %(12) and new onset in 5.6 %(5) patients (figure 12).Among 14 patients who were having MR at follow up, 3(21.4%) had AWMI and 11(78.6%) had IWMI at baseline. None of the baseline characteristic was found to be predictor of mitral regurgitation during follow up (table 3) excluding sex and site of STEMI.AWMI and

males tend to have lesser prevalence of mitral regurgitation at follow up (table 4). IWMI patients continue to have higher incidence of Mitral Regurgitation which was persistent and also developed new onset MR, but it was not statistically significant (p-0.647).Females have higher prevalence of Mitral Regurgitation during follow up visit(table 3).None of the patients with positive family history had Mitral Regurgitation at onset. Development of MR in STEMI patients was not influenced by the treatment modality used (figure 13). MR 15.7 84.3 ABSENT PRESENT Figure 11.Prevalence of MR after 1 month 14 13.5 12 10.1 Number of patients 10 8 6 4 5.6 2 0 MR Figure 12.Profile of MR after 1 month Proportion of patients having greater severity of MR after 1 month was found to be slightly higher, despite being reduction in absolute number of patients having moderate MR (figure 14).Initially, 3(11.1%) patients had moderate MR, but at 1 month, only 2 patients had moderate MR. IWMI patients were found to have higher prevalence of MR (figure 15). 60 51 50 Number of patients 40 31 MR PRESNT 30 MR ABSENT 20 11 14 10 10 2 0 THROMBOLYSIS PRIMARY PTCA OTHERS Figure 13.Prevalence of MR in relation to treatment strategies Characteristic Baseline MR p value MR at 1 p value month Age (yrs) Group 1 (20-39) 1(3.7) 2(14.3) Group 2 (40-59) 11(40.7) 0.024* 5(35.7) 0.132 Group 3 (60-79) 14(51.9) 7(50) Group 4 (≥ 80) 1(3.7) 0(0) Sex Male(96) Female(23) 20(74.1) 7(25.9) 0.323 9(64.3) 5(35.7) 0.007* Site of STEMI AWMI(60) IWMI(59) 6(22.2) 21(77.8) 0.001* 3(21.4) 11(78.6) 0.03* Diabetes(n=38) 13(48.1) 0.04* 5(35.7) 0.612 Hypertension(n=45) 9(33.3) 0.585 4(28.6) 0.615 Smoking(n=56) 12(44.4) 0.757 5(35.7) 0.210 Dyslipidemia(n=117) 27((100) 0.44 14(100) 0.539 Obesity(n=65) 12(44.4) 0.36 5(35.7) 0.257 Positive Family History(n=16) 0(0) 0.02* 1(7.1) 0.458 Baseline 2D EF 48.17±8.93 50.2±8.6 Baseline 3D EF 46.24±7.68 0.769 50.37±8.61 0.216 Reperfusion modality Thrombolysis (n=45) Primary PCI (n=62) Miscc(n=12) 11(40.7) 14(51.9) 2(7.4) 0.744 8(57.1) 6(42.9) 0(0) 0.134 Table 3.Comparison of various variables with MR at onset and during follow up *statistically significant MR Sex Total p value 1(Male) 2(Female) Absent Number of patients 69 7 76 (88.5%) (58.3%) 84.4% 0.019* Present Number of patients 9 5 14 (11.5%) (41.7%) 15.6% Total Total no. 78 12 90 % within sex 100.0% 100.0% 100.0% Table 4. Association of sex with the prevalence of Mitral Regurgitation at 1 month Severity Baseline MR MR at FU Mild 24(88.9) 12(85.7) Moderate 3(11.1) 2(14.2) Severe - - Figure 14.Prevalence of severity of MR at onset and after 1 month 100% 90% 80% 70% 38 60% 53 MR ABSENT 50% MR PRESENT 40% 30% 20% 21 10% 7 0% AWMI IWMI Figure 15.Prevalence of MR in relation to type of MI 3. Correlation among 2D and 3D EF in STEMI Mean 2D EF in AWMI group at presentation was 44.94% ± 7.5% and in IWMI group was slightly higher 50.7% ± 7.4.4%.LV systolic functions was found to be better in IWMI patients on presentation. After 1 month, there was an increase in 2D EF by 6.9%(51.83±8.06) in AWMI group and negligible change in IWMI group (51.05±8.4).2D EF was found to strongly correlate with 3D EF at admission and during follow up irrespective of type of STEMI (table 5), though poor image quality was one of the hindering factor in some of the patients. Figure 14 shows the scatter plot displaying the distribution of 2D and 3D EF at baseline. 2D and 3D EF Correlation p (2 tailed) coefficient, r At admission 0.525 0.01 At 1 month 0.609

4**0.01 Table** 5.Correlations **of 2D and 3D**

EF at admission and after 1 month 70 y = 0.5651x + 19.179 60 R² = 0.2756 50 Baseline 3D

14**EF 40 30 20 10 0 0 10 20 30 40 50 60**

70 80 Baseline 2D EF Figure 16.Scatter plot showing relationship of 2D-EF and 3D-EF at admission (Pearson correlation coefficient r, 0.525) *

12**Correlation is significant at the 0.01 level (2-tailed). DISCUSSION The present study**

is a prospective observational study which evaluated the prevalence of functional (ischaemic) mitral regurgitation in patients with STEMI at presentation and during 1 month of follow up.

4**Mean age of patients was** 53.42 ± **11.** 47 **years**

with majority of them being males (83%). Most common age group was found to be 40-59 years (57.1%), with least patients in >80 yrs (2.5%).10.9% patients had MI in young (<40 years).Our results are found to be similar as observed in a large retrospective analysis by Brijesh et al92 done in our institute. Most common risk factor was found to be dyslipidemia(98.3%) , followed by obesity(54.6%),smoking (47.1%),diabetes(31.9 %), hypertension (37.8%) and positive family history of coronary artery disease(13.4%). This data is different from create study where diabetics 34% had diabetes; 37.7% had hypertension; and 40.2% were smoker.93 All patients were having multiple coronary risk factors.LV systolic function was found to be better in IWMI patients at presentation as lesser territory was compromised by ischaemia. Similar results were observed by Darbar et al and our findings are consistent with it.94 With anterior infarction, the injury is exclusively in the left ventricle, whereas inferior infarction is associated with injury to both ventricles, causing less impairment of left ventricular function despite an equivalent overall myocardial insult. After 1 month, there was a trend in the increase in 2D EF by 6.9% in AWMI group due to revascularisation therapy.95 MR was found in 22.7% at presentation of STEMI in our study population, which is in accordance with older studies including angiographic ones (table 5). It was found to be higher in older age group, diabetics and IWMI patients at the onset, which was consistent with previous studies.2, 12, 15 There was a trend toward an excess of women in the MR group, though it was not statistically significant due to under representation of females in present study. Similar data on the demographics of MR after AMI have been presented earlier by Lehmann, Tcheng, and Barzilai.2, 12, 15 IWMI involves the posterior wall of LV leading to left ventricle remodelling and distortion. This result in apico-lateral as well as posterior displacement of papillary muscle, which in turn leads to apical displacement of mitral leaflet coaptation point, producing the ischaemic mitral regurgitation.8 Mostly patients had mild MR and none had severe MR which is possibly due to exclusion of very sick patients like cardiogenic shock. During follow up after 1 month, MR was found to be in 15.7% of patients despite a dropout of 30(25.2%) patients. Some patients with MR tend to improve with the resolution of acute ischaemia due to revascularisation as well as favourable LV remodelling and improvement in LV systolic function, while some had deteriorated with worsening mitral regurgitation due to adverse left ventricular remodelling with passage of time after STEMI. Treatment modality used didn't influence the development of MR as shown earlier by Tcheng JE et al. Acute reperfusion with thrombolysis or angioplasty did not reliably reverse valvular incompetence as seen in earlier observational studies. None of the baseline risk factor except diabetes, territory involved and older age group ,can reliably predict the development of MR at onset and left ventricle systolic function, though this study was not powered enough to study those predictors. IWMI patients tend to have higher

prevalence of MR during the STEMI as well as during follow up secondary to tethering effect on the mitral valve leaflet which may be a harbinger of chronic MR later on. Treatment modality didn't influence the severity of MR in STEMI patients. Author Year No of Modality used Prevalence patients of MR (%) Barzilai B et al15 Tcheng JE et al12 1988 1480 Echo 39 Lehmann KG et al2 1992 1480 Echo 17.9 1992 206 LV ventriculography 13 Gervasio A. Lamas et al3 1997 727 LV ventriculography 19.4 Present study 2013 119 Echo 22.7 2D EF was found to correlate linearly with 3D EF irrespective of type of STEMI. In a recently published metanalysis, Jennifer L. Dorosz et al96 showed similar results. With EF, there is no difference in the bias between 3DE and 2DE, and the difference in the variance is modest (± 4.7%). Despite being subjected to errors due to foreshortening, poor endocardial definition, narrow echocardiographic windows, and assumptions about LV shape, it remains a ubiquitous tool for assessing LV size and systolic function in day to day clinical practise. Although 3DE shows promise in providing the accessibility of echocardiography and the multi- planar imaging of CMR, this nascent technology still has limited spatial and temporal resolution compared with gold standard modality of CMR. Despite its limitations, 3DE may be superior to 2D techniques. Our single centre study shades light on the prevalence of Mitral Regurgitation in acute STEMI in Indian population. MI is most prevalent in middle age persons with ischaemic Mitral Regurgitation in slightly older age group. Modalities of revascularisation (mechanical vs thrombolytic or medical treatment doesn't influence the course of Mitral Regurgitation in short term follow up. However, these findings need to be confirmed in larger study population MI. STUDY LIMITATIONS The main limitation of this study was smaller sample size, which was not powered enough to study the predictors of development of MR in STEMI patients. Moreover, females were underrepresented in the study group, which may have negated the gender effect on ischemic MR. Critically ill patients , cardiogenic shock etc were not included in whom ,there is a probability of having severe mechanical complications of STEMI like severe MR. There was a significant drop out during follow up, which may have influenced the statistical analysis. Only echocardiographic LV systolic function measurements were used and were not compared with other imaging modalities like MRI, which is gold standard for determining EF in patients with regional wall motion abnormalities. Longer follow up periods are required for assessing the development of chronic ischaemic MR. CONCLUSION STEMI patients have 22.7% prevalence of MR at onset, which is more likely in older age group, diabetics and IWMI patients and independent of gender and left ventricle systolic dysfunction. Despite under-representation of females in our study population, they seem to carry higher risk of development of ischaemic Mitral Regurgitation in India. Most commonly, ischaemic MR is of milder severity at onset which tends to persist in 15.7% of patients during follow up. There is a significant association of development of ischaemic MR during acute STEMI with IWMI. Some patients may develop new MR later on depending on the LV remodelling. 2D EF estimation with a properly acquired good image is comparable to more precise 3D EF in STEMI patients. 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53

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INTRODUCTION MR is a frequent complication of coronary artery disease. It was often under-rated because it is clinically silent, but with the use of echocardiography this complication is observed between 15%-20% after a myocardial infarction.1 When compared with patients without MR, the patients with acute myocardial infarction and mitral regurgitation are older, more often in female and frequently have a history of previous ischaemic heart disease.2 Its presence and degree have major prognostic implications and underscore the importance of its detection and quantification. Ischaemic mitral regurgitation can independently predict cardiovascular death with a relative risk of 2.3 In a...