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Mitral Regurgitation Severity with Left Atrial Volume Index as a Guide to the Early Myocardial Infarction Prognostic Outcome

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Author's contribution

The sole author designed, analyzed and interpreted and prepared the manuscript.

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Original Research Article

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ABSTRACT

Background: Mitral regurgitation and the increase in left atrial volume are seen frequently in severe acute myocardial infarction. They are associated with left ventricular dysfunction and may predict the prognosis and the outcome for long term follow up myocardial infarction. It is important to understand the effect of both in early admission to intensive care unit especially on the development of shock, heart failure, dysrhythmia and the mortality.
Methods: This is a prospective study carried out at Al Sader Teaching Hospital in Najaf City and in Cardiac Care Unit (CCU) from March 2014 to November 2014. 150 Patients with acute myocardial infarction were followed during their admission in CCU. Recording was done to the variables like age, sex, STEMI (ST Elevation Myocardial Infarction) or NSTEMI (Non ST Elevation Myocardial Infarction) types, the site of infarction, presence or absence of shock, pulmonary edema and dysrhythmia. All patients were studied by Echo-Doppler and mitral regurgitation severity was recorded as well as measurement of the left atrial volume index and both were correlated with the variables.

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Results: Mean age 66±15, 52.52% females, NSTEMI 65%, 30% atrial arrhythmia, 32% ventricular arrhythmia, left atrial volume index increased in 59%, mitral regurgitation in 56%. Severity grading of mitral regurgitation and the increase in left atrial volume index were significantly associated with shock p value 0.001, pulmonary edema p value 0.001 and arrhythmia P value 0.001. The mortality in acute myocardial infarction patients found to be significantly associated with the increase in Left Atrial Volume Index p value 0.0001 and with the severity of Mitral Regurgitation p value 0.013.
Mortality of acute myocardial infarction was also significantly associated with pulmonary edema 0.001, shock p value 0.03 and site of infarction p value 0.017as well as the type of the infarction p value 0.007.
Conclusion: Both mitral regurgitation severity and left atrial volume can predict the early outcome of Myocardial Infarction in early Cardiac Care Unit admission.

Keywords: Mitral regurgitation; left atrial volume; myocardial infarction.

1. INTRODUCTION

Acute myocardial infarction is one of the major causes of cardiovascular morbidity and mortality [1]. Mitral regurgitation is a frequent finding while evaluating myocardial infarction patients by Echocardiography and Doppler study and may reach 45% [2]. Mild cases of mitral regurgitation can be detected by the Echocardiography and Doppler study and may be difficult to detect by clinical examination [3]. On other hand severe mitral regurgitation with papillary muscle rupture may end with severe heart failure, pulmonary edema and even death. The rupture occurs in the first week after myocardial infarction and often compromises 6-12 times more the posteromedial muscle than the anterolateral muscle [4,5]. The posteromedial papillary muscle vascularization is supplied by the interventricular artery which is a branch of the right coronary artery or from the circumflex coronary artery and may aggravate infarction heralded by occlusion in such vessels. Severe mitral regurgitation with papillary muscle rupture can occur as early as 13 hours from the onset of the attack and found to occur with shock (7% of all cardiogenic shock) although its incidence can be decreased by the early use of fibrinolytic therapy [6]. Ischemic mitral regurgitation is associated with complications of the Myocardial infarction and its occurrence with STEMI type Infarction is considered as independent risk factor for long term mortality [7]. The Left Atrial Volume (LAV) can help in the evaluation and the prognosis of the patients with myocardial infarction [8]. It seems to be correlated with clinical left ventricular systolic and diastolic dysfunction [9]. Both the left atrial volume and mitral regurgitation are believed to have a role in the outcome for the long follow up of the patients [10,11]. Restrictive left ventricular filling with the occurrence of left ventricular diastolic dysfunction has an impact on the prognosis of post myocardial infarction which had been seen in patients with the increase in the left atrial volume and mitral regurgitation [12]. Echocardiography and Doppler study is noninvasive imaging assessment technique that is available and can identify mechanical complications such as an acute mitral regurgitation in the setting of an acute myocardial infarction as well as estimation of different dimensions [13].

1.1 Objective of the Study

To evaluate the effect of both mitral regurgitation and left atrial volume characterized on Echocardiography and Doppler study on the early follow up of Patients with acute myocardial infarction.

2. MATERIALS AND METHODS

This is non -randomized prospective study with 150 patients with acute myocardial infarction during their intensive care treatment period.

2.1 Data Collection

Data Collection was obtained in CCU and recovery ward by three specialists who are well trained in Echocardiography Doppler study, while the registration of the clinical characteristics and the complications of acute myocardial infarction were done by 2 senior house officer doctors.

2.2 Ethics Consideration

The study was approved by the ethics committee of the Sader Teaching Hospital. Verbal consent of all patients were obtained prior to recruitment. Echo Doppler study is currently used to investigate every patient admitted to the cardiac care unit in the first 48 hours.

2.3 Duration of the Study

The study was started from the early hours of admission in the cardiac care unit. The Echocardiography Doppler study was done within the first 48 hours of admission to CCU. The patients were followed in the recovery ward till the patient discharged or died. (The duration of the study was within the first two weeks of the admission).

2.4 Follow up of the Patients

The patients were admitted in the CCU and then to the recovery room after they passed the critical period and they showed better improvement in their clinical condition. They were followed up by continuous monitoring that records all the abnormal cardiac atrial or ventricular arrhythmias and by the clinical examination detecting cardiogenic shock, pulmonary edema and any new murmur of mitral regurgitation.

2.5 Inclusion and Exclusion Criteria

All acute myocardial infarction patients who were admitted to the cardiac care unit were included in the study. The Exclusion was to those who died before doing the Echocardiography and Doppler study.

2.6 Variables Estimation

These include the age, sex and type of Myocardial Infarction whether ECG finding of ST elevation (STEMI) or not. Types of myocardial infarction whether Anterior, Lateral or Inferior all were recorded. The associated pulmonary edema, cardiogenic shock, dysrhythmia whether Atrial or Ventricular one and the death all estimated during the cardiac care unit admission.

2.7 Left Atrial Volume Index Estimation

Using the Echo Doppler type left atrial volume measurement was done at the end of the diastolic frame just before mitral valve closure [14] and by using Biplane area – Length Method. Orthogonal apical views apical four and two chambers views are obtained for determination of left atrial area and length. The length is determined from the middle of the plane of mitral annulus to the posterior wall.

Left atrial volume were calculated on the basis of algorithm (0.85XA1XA2)/L A1 is the left atrial area estimated by four chamber view and A2 is the area of left atrium in two chambers view and L is the shortest lengths obtained from the orthogonal views and left atrial volume index is obtained by dividing the volume by the body surface area [15]. According to this method the Normal left atrial volume index is 16-28 ml/m^2 , Mild increase 29-33 ml/ m^2 , Moderate 34-39 ml/m^2, Severe 40 ml/m^2 [16].

2.8 Mitral Regurgitation Estimation

Mitral regurgitation was estimated using the Color Doppler and through the mitral valve annulus by measuring the jet flow tent. Mild mitral regurgitation with less than 0.4 cm/s while Severe one with 1 cm/s.

The Moderate severity is in between the two reading [17].

2.9 Statistical Analysis

Statically Package for Social Sciences (SPSS) Version 18 was used for data entry and analysis. The quantitative variables were described as mean and standard deviation. Chi square and Fisher's exact probability tests were used to test association between qualitative variables. In places where Chi square test was not applicable, Tables were condensed for the sake of statistical analysis. The significance level adopted for all tests was two-tailed $P < 0.05$.

3. RESULTS

A total of (150) patients were enrolled during study period.

3.1 Base Line Characteristic of Patients

The mean age of patients was 66 years and ±15 years.

Out of 150 patients there were 78 females (52%). The main clinical characteristics that include the type of myocardial infarction, the site of the infarction, the complications of the myocardial infarction, the mortality with the severity grading of mitral regurgitation and the Left atrial volume index all shown in (Table 1).

3.2 Cross-tabulation of Data

We cross tabulated between mortality and age, sex, MI (STEMI and NON-STEMI, site of infarction, shock status, presence of Pulmonary

edema, presence of arrhythmias, LAVI and MR. This is shown in Table 2.

Table 1. Distribution of patients according to demographical and clinical characteristics

Variables		No.	%
Gender	Male	72	48%
	Female	78	52%
Myocardial infarction	STEMI	52	35%
	NON-STEMI	98	65%
Shock	Yes	30	20%
	No	120	80%
Infarction site	Anterior	107	71%
	Inferior	26	17%
	Lateral	17	12%
Pulmonary edema	Yes	39	26%
	No	111	74%
Arrhythmias	Ventricular	32	22%
	Atrial	45	30%
	No	73	48%
Left atrial volume index	Normal	62	41%
	Mild	61	41%
	Moderate	21	14%
	Severe	6	4%
Mitral regurgitation	No mitral regurgitation	67	45%
	Mild	45	30%
	Moderate	32	21%
	Severe	6	4%
Mortality	Yes	7	5%
	No	143	95%

4. DISCUSSION

It was found in this current study that the increase in left atrial volume index significantly associated with the increase in the mortality of acute myocardial infarction in early days of CCU admission. This can be explained by strong association with serious complications like pulmonary edema, cardiogenic shock and arrhythmias. Guyton and Lindsey demonstrated in dogs that pulmonary edema occurred with increase in left atrial pressure when the level of the plasma albumin was normal [18]. It was found that reversion of cardiogenic shock occurred when left atrial to femoral arterial bypass assistance used that caused improvement in cardiac index from 1.7 L/min/m^2 to 2.4 L/min/m^2 with decrease in mortality to 44% at 30 days follow up [19]. These results explained the importance of left atrial pressure on the mortality and heart failure. In the Framingham heart study and in clinical application found that the increase of 5 mm in left atrial dimension can lead to 39% increase in development of atrial fibrillation [20]. Because the left atrium is exposed to left ventricular filling pressure through the open mitral orifice during diastole and its size is influenced by the same factors that determine diastolic filling pressure however in contrast to other Doppler variables of left ventricular diastolic dysfunction affected by acute hemodynamic changes, left atrial volume is more stable parameter integrating the effects of elevated left ventricular filling pressure from preexisting cardiovascular conditions as well as acute disease [21]. Tsang et al. [22] had demonstrated the close association between left ventricular diastolic function and left atrial volume which provides a sensitive morphophysiological expression of diastolic dysfunction severity and appears to be useful index of cardiovascular risk. Roy Binnart et al. [21] found that the increase in left atrial volume index more than 32 ml/m^2 in early 48 hours post myocardial infarction can be used as predictor of five years mortality as it was associated with more heart failure cases (24% compare with 12%). Left atrial volume is affected by pathological conditions like hypertension or diabetes and may become a sensitive predictor of the prognosis and earlier than left ventricular dysfunction [23]. Left atrial volume regarded as a powerful predictor of the prognosis when compared with other parameters like EF, end left ventricular systolic volume and Mitral regurgitation [24]. Left atrial volume index is less influenced by acute changes and reflects subacute and chronic left ventricular diastolic dysfunction [25]. The early evaluation of left atrial volume in the first 48 hours and try to see its role on long term survival may not explained all the truth as there is remodeling process in the ischemic myocardial infarction and a change in the left atrial volume [26,27]. In this current study the mitral regurgitation severity found to be associated with increase in the mortality and with serious complications of acute myocardial infarction. Bursi et al. [28] described similar findings regarding the role of mitral regurgitation severity in the first month after acute myocardial infarction and found out of 773 patients with ischemic mitral regurgitation 50% increase in heart failure. Ischemic mitral regurgitation as it is associated with left ventricular dysfunction causes elevation of pulmonary capillary pressure and leads to fluid filtration and pulmonary edema [28]. The fluid filtration was found to be completed within the first 4 hours from the elevated capillary pulmonary pressure [29]. In patients with left ventricular systolic dysfunction acute pulmonary edema is associated with dynamic changes in ischemic mitral regurgitation

and the resulting increase in the pulmonary vascular pressure [30]. The mechanism of ischemic mitral regurgitation includes reduced closure force of the left ventricle centrality, altered annulus centrality, reduce synchronicity of the two papillary muscles, the dyssynchronicity of the left ventricle and increase Tethering Forces [31]. Local pathological remodeling of ischemic left ventricle and distortion leads to displacement in the apical posterior and lateral papillary muscles [32]. Actually the ischemic mitral regurgitation differs from other types of causes of mitral regurgitation as there is effect of abnormal left ventricular function and abnormal geometry [33,34]. The severity of ischemic mitral regurgitation depends on the severity of regurgitation and also on the left atrial compliance and so the relation between the increase in the left atrial volume may reflect the severity of regurgitation especially the organic one and the left atrial volume index can predict the long term prognosis of mitral regurgitation [35]. The occlusion of circumflex coronary artery as it is associated with mitral regurgitation can cause acute pulmonary edema [36,37]. Most clinician are familiar with the pathophysiology and hemodynamic impact of chronic regurgitation but the stark difference between the acute and chronic regurgitation is important in making the diagnosis and understand the acute regurgitation. Left ventricular end diastolic volume remains normal unless there is left ventricular diastolic dysfunction. The left ventricle needs time for dilatation adaptation. The stroke volume and hence the systolic left ventricular function is much depressed if there is no good adaptation. The back flow of blood depresses the forward stroke volume and this results eventually with hypotension ,organs failure and cardiogenic shock. The backflow leads to increase of pulmonary capillary pressure causing pulmonary edema. The more remodeling in the left ventricle, the more severe mitral regurgitation the more left ventricular volume overload and with vicious cycle leads to more mitral regurgitation and left ventricular dilatation leads to increase in stress force and increase in left atrial pressure causing pulmonary edema [38]. Long term prognosis for moderate to severe mitral regurgitation found to be independent risk for post myocardial infarction mortality and the current early use of percutaneous coronary intervention (PCI) may decrease mortality 15% Shijun LI [39].

Table 2. The association between demographic, clinical and echocardiographic characteristics and mortality in patients with MI

Characteristics		Alive no. (%)	Dead no. (%)	P value
Age	≤ 50	24 (16%)	0 (0.00%)	
	> 50	126 (84%)	7 (100%)	0.59
Sex	Male	72 (48%)	2 (28.6%)	
	Female	78 (52%)	5 (71.4%)	0.18
Type of MI	STEMI	52 (34.7%)	6 (85.7%)	
	N-STEMI	98 (65.3%)	1 (14.3%)	0.007
Site of MI	Inferior	26 (17%)	2 (28.6%)	
	Anterior	107 (71%)	5 (71.4%)	0.017
Shock	Shock	30 (20%)	4 (57.1%)	
	No shock	120 (80%)	3 (42.9%)	0.03
Pulmonary edema	PO	39 (23.1%)	6 (85.7%)	
	No PO	111 (76.9%)	1 (14.3%)	0.001
Arrhythmia	Atrial	45 (30%)	4 (57.1%)	1.00
	Ventricular	32 (21.3%)	3 (42.9%)	
MR	mild	45 (54.5%)	0 (0%)	0.013
	moderate	32 (38.5%)	2 (28.5%)	
	Severe	6 (7%)	5 (71.5%)	
LAVI	Mild	61 (69.4 %)	0 (0%)	0.0001
	Moderate	21 (23.8%)	1 (14.3%)	
	Severe	6 (6.8%)	6 (85.7%)	

Table 3. Association of mitral regurgitation severity and complications in acute myocardial infarction

Complications	Normal	Mild MR	Moderate MR	Sever MR
P. edema	7	12	16	4
No p edema	55	49	5	2
Shock	3	12	10	5
No shock	59	49	11	1
Atrial arrhythmia	5	20	16	4
No atrial arrhythmia.	57	41	5	2
Ventricular arrhythmia	18	2	7	5
No ventricular arrhythmia	44	59	14	1

P Value 0.001 for all associations

Table 4. Association between the increase in left atrial volume index and complications in patients with acute myocardial infarction

Complications	Normal	Mild LAVI	Moderate LAVI	Sever LAVI
P. edema	1	8	25	5
No p edema	66	37	7	1
Shock	4	5	15	6
No shock	63	40	17	0
Atrial arrhythmia	32	4	6	3
No atrial arrhythmia.	35	41	26	3
Ventricular arrhythmia	7	1	19	5
No ventricular arrhythmia	60	44	13	1

P Value 0.001 for all associations

Left ventricular EF remains most established and commonly used estimated risk factor after myocardial infarction but in the presence of significant mitral regurgitation it may be prone to be overestimated of true systolic function [40]. Echocardiography and Doppler study is recommended to be done from 0-48 hours to estimate baseline of left ventricular dysfunction and to detect the new mechanical flow abnormalities like new mitral regurgitation or ventricular septal defect [41]. Dynamic evaluation during exercise can estimate more data information on the mitral regurgitation role in the prognosis for long term follow up of patients with chronic myocardial infarction and the worsening of mitral regurgitation during the dynamic Echocardiography Doppler study reflects active myocardial ischemia [42]. As we cannot use dynamic Echocardiography in the early intensive care we used the static one for evaluation of mitral regurgitation and left atrial volume index.

5. CONCLUSION AND RECOMMENDATION

Left atrial volume index and mitral regurgitation severity grading can predict the early morbidity and the mortality of acute myocardial infarction patients in their early intensive care admission. Both left atrium volume index and mitral valve regurgitation severity are important parameters in early Echo Doppler study and should be included to the other left ventricular dysfunction parameters in the acute myocardial infarction.

COMPETING INTERESTS

Author has declared that no competing interests exist.

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