Original Article

Association of Left Atrial Volume Index with Adverse In-Hospital Outcome in Patients with ST-Elevated Acute Myocardial Infarction

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Abstract:

Background: Coronary heart disease is the leading cause of death worldwide, with acute STEMI being the most severe manifestation. Left atrium (LA) plays a major role in left ventricular performance. LA function is a surrogate marker of LV diastolic dysfunction. In recent past, several studies conducted in different parts in the world have focused on the effect of ASTEMI on the volume and function of left atrium. So assessment of left atrial volume index (LAVI) by 2D echocardiography in patients who have suffered an acute STEMI helps to predict the adverse cardiovascular outcome.

Objective: The aim of the study is to assess the LAVI for prediction of adverse in-hospital outcomes following acute STEMI patients admitted in a tertiary care hospital.

Methods: This Hospital based prospective observational study was conducted in the department of cardiology in DMCH over 1-year period. Patients with acute STEMI admitted in the CCU of DMCH were approached for inclusion in the study. Clinical and echocardiographic parameters were collected within 48 hours of admission. LA volume is measured and then indexed to body surface area called LA volume index (LAVI) and the population was divided according to LAVI. The study comprised of 150 acute STE-MI patients and were divided into two groups, including 75 patients in each group. Patients with LAVI>34 ml/m^{2}and LAVI ≤34 ml/m^2 were assigned as Group I and Group II respectively & followed up for adverse in-hospital outcome . All necessary information were recorded in a pretested case record form. Statistical analyses were done by SPSS 17.0.

Result: The mean age was 57.7 ± 7.0 years ranging from 39 to 80 years. Most of the patients were male 109 (72.7%). Majority of the patients had anterior wall (anterior, antero-septal & extensive anterior) myocardial infarction (85%).It was observed that patients with LAVI>34 ml/m^2 (Group I) had more adverse in-hospital outcomes than patients with LAVI ≤34 ml/m2(Group II) (46.7% vs 14.7 % ; p< 0.001). By multivariate logistic regression analysis, LAVI>34 ml/m2 emerged as an independent significant predictor of adverse in-hospital outcome(Odds Ratio 6.55,95% confidence interval: 2.069 – 20.735, p = 0.001)

Conclusion: In patents with acute STEMI , with LAVI>34 ml/m^2 had more adverse in-hospital outcomes than patients with LAVI ≤34 ml/m^2. So early assessment of LAVI by echocardiography is useful to predict adverse in-hospital outcome

Key Word: LAVI, Acute ST-segment elevated myocardial infarction, Outcome.

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Introduction:

Cardiovascular diseases (CVD) are the most prevalent cause of death and disability worldwide and this is true for developed countries as well as developing countries.[1] The average prevalence of ischemic heart disease (IHD)

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according to three small scale population based studies in Bangladesh found that it was 6.56/1000.The prevalence of IHD was 3.3/1000;[2] 3.38/1000 ;[3] 13/1000 .[4]Acute Myocardial Infarction (AMI) is the leading cause of death in pointing to the serious health hazard as well as economic burden .[2] As a result of socioeconomic transition, lifestyle, as well as, the dietary pattern is changing in Bangladesh. Increasing prevalence of obesity, tobacco use, high intake of processed foods and less physical activity accompany the transition.[5] In Bangladesh, ACS is the major presenting form of CAD and accounts for 45% of all cause cardiac hospitalization.[6]Many factors have been shown to have prognostic value in STEMI. Demographic variables, symptoms, severiry, physical signs, echocardioagraphic and radiological measurements, hemodynamic and neuro-hormonal parameters, high TIMI and Mayo risk score, reduced exercise capacity have been shown to be associated with poor outcome .[7] Various degrees of left ventricular systolic and diastolic dysfunction occur during STEMI.[8]The enlargement of the LA has been associated with an increased incidence of atrial fibrillation, stroke, congestive heart failure, and mortality, especially in elderly people.[9,10,11] demonstrated that left atrium (LA) size has a greater predictive value compared with left ventricular (LV) diastolic function measurements and filling pressures, which are substantially influenced by hemodynamics. The prognostic usefulness of LA volume persisted after adjustment for clinical predictors of outcome and conventional echocardiographic indices of LV systolic and diastolic function. If confirmed in prospective studies, measurement of LA volume could emerge as a simple and important tool for risk stratification and as a guide for future surveillance and therapy in patients with AMI. Estimation of LA volume by Simpson 's method of disc is well validated and recommended by the American Society of Echocardiography (ASE) guidelines. LA volume is then indexed to body surface area and called LAVI. The upper normal limit for 2D echocardiographic LA volume is 34 mL/m2 for both sexes.[12] CHD encompasses a wide clinical spectrum ranging from silent ischemia to sudden death. Within this spectrum, acute ST-segment elevation myocardial infarction (STEMI) is the most significant form of disease with respect to its diagnosis, treatment, and prognosis. By identifying association of increase LAVI with adverse in-hospital outcome in the patients suffering from acute STEMI and we can be able to predict averse in-hospital outcome by only doing the LAVI in any low resource setting hospital in our country

Materials & Methods:

This prospective observational study was conducted at Department of Cardiology, Dhaka Medical College Hospital, Dhaka,from October' 2017 to September' 2018. A total of 150 patients with ST elevation acute myocardial infarction admitted in the CCU, department of Cardiology, DMCH, Dhaka, within the study period were included in this study by purposive sampling method after considering inclusion & exclusion criteria. Patients with unstable angina, significant valvular heart disease, congestive heart failure, post-PCI, post-CABG, cardiomyopathy and patient with not thrombolysed were excluded from the study. Written consent was taken from all the study subjects. Detailed history, physical examination was done before enrolling them in the study. All the subjects were evaluated for demographic profile (age, sex, weight & height); risk factors for coronary artery disease like diabetes, hypertension, smoking, overweight/obesity and family history of premature coronary artery disease; necessary investigations were done to evaluate the cardiac status and other comorbid conditions. Echocardiography was done to assess the LA diameter, LA volume, LA volume index (LAVI) and LV function within 48 hours of hospital admission. The enrolled patients were followed up till discharge or death. Patients were classified into two groups based on LAVI (Lang et al.,2015) Group I: Patients with LAVI >34 ml/m2 Group II :Patients with LAVI ≤34 mL/m². All the patients were treated with standard treatment protocol of the institute. After collecting the data, it was edited, coded and entered into the computer. Statistical analysis of the study was done by computer software device as the Statistical Package for Social Science (SPSS) version 17.0. The results were presented in tables, figures and diagrams. Confidence interval was considered at 95% level. The qualitative variables were expressed as frequency and percentage and the quantitative variables were expressed as mean with standard deviation. All the patients included in this study were informed about the nature, of risk and benefit of the studies.

Results:

The main objective of the study was to assess the association of left atrial volume index (LAVI) with in-hospital outcome of acute ST-elevated myocardial infarction (STE-MI) patients. Patients with LAVI>34 ml/m2and LAVId"34 ml/m2 were assigned as Group I and Group II respectively. The findings were documented below:

Table-I

Age distribution of the study population (n=150)

Age in years	Group I (n=75) Number (%)	Group II (n=75) Number (%)	Total (n=150) Number (%)	P value
≤40	0(0.0)	8(10.7)	8(5.3)	0.01^{s}
41-50	9(12.0)	16(21.3)	25(16.7)	0.13^{ns}
51-60	37(49.3)	25(33.3)	62(41.3)	0.03^{s}
>60	29(38.7)	26(34.7)	55(36.7)	0.61^{ns}
Mean±SD (in years)	59.4±6.7	55.9±6.9	±57.7±7.0	0,002^{s}
Range (in years)	45-80	39-66	39-80	

Table I shows that the mean age of group I was higher than group II (59.4±6.7 vs.55.9±6.9, p=0.002) with statistically significant difference. The study population of group I was older than group II. The mean age of the total studied patients was 57.7±7.0 years ranging from 39 to 80 years. It was also observed that majority of the patients were in the age group of 51-60 years with 49.3% in group I and 33.3% in group II with statistically significant association (p=0.03).

Regarding the gender 109 (72.7%) patients were male and 41 (27.3%) patients were female. There was no statistical significant difference between two groups in terms of gender (p=0.58)

Table-II

Comparison of risk factors profile between the groups (n=150).

Risk Factors	Group I (n=75) Number (%)	Group II (n=75) Number (%)	Total (n=150) Number (%)	P value
Smoking	47(62.6)	44(58.6)	91(60.6)	0.61^{ns}
Hypertension	40(53.3)	35(46.7)	75(50.0)	0.41^{ns}
Diabetes Melitus	34(45.3)	32(42.7)	66(44.0)	0.74^{ns}
Dyslipidaemia	33(44.0)	34(45.3)	67(44.7)	0.87^{ns}
Family H/O CAD	28(37.3)	22(29.3)	50(33.3)	0.29^{ns}
Obesity	6(8.0)	5(6.6)	11(7.3)	0.75^{ns}

Table II shows that all traditional risk factors of CAD were found higher in group I than group II but failed to reach the level of significance (p>0.05).

Table-III

Location of MI of the study population (n=150).

Location of STEMI	Group I (n=75) Number (%)	Group II (n=75) Number (%)	Total (n=150) Number (%)	P value
Anterior	23(30.67)	14(18.67)	37(24.67)	0.08^{ns}
Inferior	16(21.33)	29(38.67)	45(30.00)	0.06^{ns}
Anteroseptal	5(6.67)	10(13.33)	15(10.00)	0.17^{ns}
Extensive anterior	17(22.67)	14(18.67)	31(20.67)	0.54^{ns}
Inferior + posterior	5(6.67)	2(2.67)	7(4.67)	0.44^{ns}
Inferior+Posterior+RVI	4(5.33)	3(4.00)	7(4.67)	1.00^{ns}
Anterior + Inferior	3(4.00)	2(2.67)	5(3.33)	1.00^{ns}
Inferior+Posterior+ Lateral	2(2.6)	1(1.3)	3(2)	1.00^{ns}

Table III shows that anterior MI was higher in group I than group II. On the other hand, inferior MI was higher in group II than group I. All the above location of MI were not statistically significant between two groups

Table-IV

Comparison of LVEF between two groups (n=150).

Ejection fraction (percent)	Study Patients Group I (n=75) Number (%)	Group II (n=75) Number (%)	Total (n=150) Number (%)	P value
<30 (Severe)	11(14,7)	5(6.7)	16(10.7)	0.11^{ns}
30-40 (Moderate)	14(18.7)	12(16.0)	26(17.3)	0.60^{ns}
41-49 (Mild)	36(48.0)	8(10.7)	33(29.3)	0.001^{s}
≥50 (Normal)	14(18.7)	50(66.7)	64(43.7)	0.004^{s}
Mean±SD (%)	47.8±8.2	51.7±8.1	49.8±8.3	0.004^{s}
Range (%)	(32-57)	(34-59)	(32-59)	

Table V shows that the mean LVEF in group I was significantly lower than in group II (47.8±8.2% vs. 51.7±8.1%, p = 0.004) .Mild LV dysfunction was higher in group I than group II (48.0% vs 10.7%, p= 0.001) with statistically significant difference. Normal LVEF was higher in group II than group I with statistically significant difference (66.7% vs 18.7%, p= 0.004).

Table-V

Comparison of LA diameter, LAV and LAVI between two groups (n=150)

Variables	Group I (n=75) Number (%)	Group II (n=75) Number (%)	P value
LA diameter (mm)			
Increased (>40mm)	7(9.3)	3(4.0)	0.32^{ns}
Normal(≤40 mm)	68	25(33.3)	
LAV(ml)	59.5±4.2	27.4±2.9	<0.001^{s}
Mean±SD (Range)	(39 – 66)	(20 – 36)	
LAVI(ml/m^2)	44.7±6.5	26.1±4	<0.001^{s}
Mean±SD (Range)	(35 – 60)	(19.5–34)	

Table V shows that increased LA diameter was higher in group I than group II with statistically insignificant (9.3% vs. 4.0%, p=0.32) .The mean LAV was found significantly higher in group I

than group II (59.5±4.2 vs 27.4±2.9,p<0.001) . The mean LAVI in group I was significantly higher than group II (44.7±6.5 vs. 26.1±4, p<0.001)

Table-VI

In-hospital outcomes variables in the study population (n=150)

Outcome variables	Group I (n=75) Number (%)	Group II (n=75) Number (%)	Total (n=150) Number (%)	P value
Acute heart failure	23(30.7)	8(10.7)	31(20.7)	0.002^{s}
Recurrent ischemia	6(8.0)	3(4.0)	9(6.0)	0.31^{ns}
Cardiogenic Shock	8(10.7)	3(4.0)	11(7.3)	0.20^{ns}
Significant arrhythmia	14(18.7)	5(8.7)	19(12.7)	0.03^{s}
Death	2(2.7)	0(0.0)	2(1.3)	0.49^{ns}

Table VI shows that Acute heart failure was significantly higher in group I than group II (30.7% vs. 10.7%, p=0.002). It was also observed that total significant arrhythmia (AF, VT, VF & 2°/3° AV block) was occurred more in group I than group II (18.7% vs. 8.7%, p=0.03) with significant association. There were 02 patients died in group I.

Table-VII

In-hospital adverse outcome according to LAVI in the study population (n=150).

Adverse in-hospital outcome	Group I (n=75) Number (%)	Group II (n=75) Number (%)	Total (n=150) Number (%)	P value
Present	35(45.7)	11(14.7)	46(30.7)	<0.001^{s}
Absent	40(53.3)	64(85.3)	104(69.3)	

Table VII shows that the occurrence of total adverse in-hospital outcomes 46.7% of the patients in Group I had adverse in-hospital outcomes while in Group II 14.7% patients had adverse inhospital outcomes and the difference was statistically significant (p<0.001)

Table VIII demonstrates the logistic regression analysis of Odds Ratio for characteristics of the subjects likely to cause in-hospital cardiac events. The above mentioned variables of interest are all entered into the model directly as confounding independent exposures for the developing of in-hospital outcomes (dependent variable). The variables age>50 years, low LVEF, obesity and LAVI>34 mL/m^2 were found to be significantly associated with in-hospital outcomes with the ORs being 10.05, 1.92, 1.17 and 6.55 respectively.

Table-VIII

Multivariate logistic regression analysis of in-hospital cardiac events with confounding factors.

Variables interest of Regression factors (β)	Regression Factors	Odds Ratio (OR)	95% CI of OR	P value
Advance age >50 yrs	2.308	10.05	1.058-102.536	0.04^{s}
Smoking	2.308	1.21	0.637-5.282	0.26^{ns}
Diabetes mellitus	2.308	0.69	0.163-2.187	0.43^{ns}
Hypertension	-0.537	0.59	0.165-2.073	0.40^{ns}
Dyslipidaemia	-0.077	0.92	0.320-2.681	0.88^{ns}
Family history of CAD	-0.472	0.62	0.206-1.887	0.40^{ns}
Low LVEF%	0.501	1.92	1.111-8.917	0,01^{s}
Obesity	1.880	1.17	1.019-6.412	0.04^{s}
LAVI	1.880	6.55	2.069-20.735	0.001^{s}

s= Significant ns= Not significant

Discussion:

The study comprised of 150 newly diagnosed acute STE-MI patients and were divided into two groups, including 75 patients in each group. Patients with LAVI>34 ml/m2 and LAVI ≤34 ml/m^2 were assigned as Group I and Group II respectively.The mean age of the study population was 57.7 ± 7.0 years ranging from 39 to 80 years. Mean age of group I was higher than group II (59.4±6.7 vs.55.9±6.9, p=0.002) with statistically significant difference. Majority of the patients were in the age group of 51-60 years with similar age distribution in both groups. Ristow, et al.,[13] observed that the mean age of patients was 66±11 years in LAVI <40 ml/m^2 group and was 69±11 years in LAVI> 40m1/m2group. Pritchett, et al.,[14] observed the mean age was 61±10 years in higher LAVI group. Similarly, Meris, et al.,[15] observed that mean age was 67.9± 10.4 years in LAVI < 32ml/m^2 Group and mean age 70.2±9.7 years in LAVI ≥32ml/m2patients group. Moller, et al.,[10] observed the mean age of LAVI < 32ml/m2 patients group was 65 years with range from 53-75 years and mean age in LAVI ≥32m1/m^2 patients group was 76 years with range from 67-82 years. The higher mean age and age range obtained by the above authors may be due to geographical variations, racial, ethnic differences and genetic causes that had significant influence on coronary artery disease in their study subjects. Male patients were predominant in study population than female, male female ratio being 2.6:1. There was no significant difference between two groups in terms of gender distribution (72.7%vs.27.3%;p=0.58).In almost all studies related to coronary artery disease (CAD) similar male preponderance was found. As females are given less attention and access for them to the health care facilities is limited particularly in low socioeconomic population like our country may contribute for this male predominance. However, gender differences in LA Volume index does not occur as per reviewed literatures Spencer, et al.,16 and Pritchett, et al.,[17]. This study found smoking as the most prevalent (60.6%) risk factor for CAD. Among the other risk factors for CAD, diabetes mellitus was found in 44% of the study subjects, hypertension in 50%, dyslipidemia in 44.7%, obesity in 7.3% and family history of premature CAD in 33.3% and there was no statistically significant difference in risk factor prevalence between the two groups. Akanda, et al., [18] found smoking as the most prevalent (60%) risk factor among the patients of coronary artery disease of the Bangladeshi population. Islam and Majumder.,[5] reported high prevalence of hypertension in elderly Bangladeshi population (40-65%) to contribute to CAD. These differences might be due to variation in the life style. In the article by Tsang, et al.[19] they showed that LAVI correlated positively with hypertension, diabetes mellitus, dyslipidemia and smoking. These risk factors in the study population was consistent with those found by Matsushima, et al. [20] and Wang, et al.,[20]. Anterior MI was higher in number in group I than group II. Though inferior MI was higher in group II than group I. But it was not significant difference between two groups. Bacaksiz, et al.,[21] also showed no differences in location of MI in the study population. In this study, it was found that LA Diameter was Increased (>40mm) in Group I than Group II with no statistical significant difference (9.3% vs.4.0%; p=0.32).The mean LAV was found significantly higher in number in group I than group II (p <0.001) . So mean LAVI in group I was significantly higher than group II (44.7±6.5 vs. 26.1±4, p<0.001). Bacaksiz, et al.,[21] in their study also showed significant differences between the two groups. Increased left atrial volume index (LAVI) is consistent with chronic elevation of LV filling pressure and may be an indicator of increased cardiovascular risk (Tsang, et al.[20] 2002). LAVI has been showed to be highly predictive of cardiovascular risks including arrhythmias, atrial fibrillation, left ventricular failure, stroke and death after acute myocardial infarction (Tsang, et al.,[19] Moller, et al.,[10] and Beinart, et al.,[11].Mean left ventricular ejection fraction (LVEF) of the study population was 49.8 ± 8.3. Mean LVEF was less in Group I than Group II with statistically significant difference (47.8±8.2 vs. 51.7±8.1,p = 0.004).Among the adverse in-hospital outcomes acute left ventricular failure was significantly high in group I than group II (30.7% vs.10.7 %;p=0.002). Among the other in-hospital outcomes significant arrhythmia was high in group I than group II with statistically significant difference (18.7% vs. 12.7%;p=0.03) and mean hospital stay period also high in Group I than Group II (5.0 ±2.2 vs 4.4±2.4;p=0.03) .Other in-hospital outcomes like recurrent ischaemia , cardiogenic shock were high in group I than group II but there was no statistically significant difference. 2.7% died during the follow-up period in group I but no one died in group II and there was no statistically significant difference. Regarding the occurrence of total adverse in-hospital outcomes 46.7% of the patients in Group I had adverse in-hospital outcomes while in Group II 14.7% patients had adverse in-hospital outcomes and the difference was statistically significant (p<0.001). Moller, et al.,[10] demonstrated that, LAVI was a predictor of mortality after AMI, even after adjustment for conventional indices of systolic and diastolic function and concluded that LA volume could emerge as a simple and important tool for risk stratification and as a guide for future surveillance and therapy in patients with AMI.

Other study also showed that LAVI was associated with systolic and diastolic dysfunction which may result left ventricular failure. In a study by Teresa, et al.,[21] found that LA volume correlate positively with the grade of diastolic dysfunction, and negatively with LV systolic dysfunction. Moller, et al., [10] in their study proved that there is a positive correlation with the wall motion score index (WMSI) and LA volume index >32 ml/m2. Greenberg, et al.,[21] suggested that when LV dysfunction is present with increased stiffness or non-compliance, LA pressure rises to maintain adequate LV filling and the increased atrial wall tension leads to chamber dilatation and stretch of the atrial myocardium. Gottdiener, et al.,[22] suggested that LA size is increased and LA emptying decreased in patients with either systolic or diastolic heart failure and it is associated with the new development of LV failure.

In this study, after multivariate logistic regression analysis LAVI>34 mL/m2 emerged as a significant predictor of in-hospital outcome (odds ratio: 6.55, 95% confidence interval: 2.069-20.735, p=0.001). Other significant predictors were age>50 years (odds ratio: 10.05, 95% confidence interval : 1.058-102.536, p =0.04), LVEF (odds ratio: 1.92, 95% confidence interval:1.111-8.917,p=0.01), obesity(odds ratio: 1.17, 95% confidence interval: 1.019-6.412,p=0.04).Receiver perating characteristic curve (ROC) analysis identified an optimal cut off value for LAVI 34 ml/m2 to predict the cardiac outcomes, with a sensitivity of 76.1% and specificity of 61.5% (area under the curve: 0.786, p=0.000). Hence the prediction in multivariate logistic regression analysis was significantly accurate. In a study Tsang, et al.,[19] showed Indexed LA volume ≥28 ml/m^2 was 82.0% sensitive and 93.0% specific and indexed LA volume ≥27 ml/m^2 was 89.0% sensitive and 86.0% specific for the detection of abnormal diastolic function. Indexed LA volume ≥32 ml/m^2 was 100.0% specific for the detection of abnormal diastolic function, although the sensitivity decreased to 76.1%, which are comparable with the current study. Finally, in the present study by ROC analysis it was found that LAVI with a cut off value of 34 ml/m^2 can predict adverse in-hospital outcome in patients of acute STEMI who received thrombolysis with a sensitivity of 76.1% and specificity of 61.5%.

Conclusion:

The findings of the present study showed significant association between increased LAVI (>34 ml/m^2) and adverse in-hospital outcome in patients with acute STEMI. LAVI can be measured by 2D Echocardiography machine in any low resourced setting hospital in our country and hence it can be used as a cost effective tool for prediction of adverse cardiovascular outcome in acute STEMI.

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