Left Ventricular Filling Pressure Assessed by Doppler Echocardiography as a Predictor of In-hospital Outcome in Patients of ST-segment Elevation Myocardial Infarction

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Key wards:
Left ventricular filling pressure, Doppler echocardiography, ST-segment elevation myocardial infarction.

Abstract:

Background: *Left ventricular (LV) filling pressure is an important predictor of short and long term outcome in patients with coronary artery disease. Non invasive assessment of this pressure by Doppler echocardiography provides valuable information regarding the prognosis of patient with ST-segment elevation myocardial infarction. Elevated filling pressure is associated with increased incidence of morbidly and mortality due to ventricular remodeling, neuro-hormonal activation & increased excitability. The aim of this study was to assess LV diastolic dysfunction and left ventricular filling pressure in patients of ST-segment elevation myocardial infarction to predict their in-hospital outcome.*

Methods: *The prognostic cohort study was conducted in National Institute of Cardiovascular Diseases, Dhaka from May 2011 to November 2011. A total of 100 Patients with acute ST-segment elevation myocardial infarction who has received streptokinase therapy were enrolled by purposive sampling. In addition to normal 2D & M mode study, Pulsed wave Doppler assessment of mitral valve inflow patterns was done in apical 4-chamber view to see Peak early (E) and peak late (A) flow velocities, E/A ratio and deceleration time of early mitral flow velocity (DT). Tissue Doppler Imaging (TDI) assessment was done at the lateral mitral annulus in apical 4-chamber view to assess Mitral annular diastolic velocity (E') and E/E' ratio. Patients were divided into two groups based on Doppler echocardiography derived Left ventricular filling characteristics. In group I 50 patients with E/E' ratio ≤15 and in group II 50 patients with E/E' >15. Patients were followed up for next 7 days and in-hospital outcomes were compared between groups.*

Results: *The mean age of group-I & II were 53.84 ± 9.2 & 55.14 ± 8.5 years respectively. Male female ratio was 8.9:1.1. Age, sex and risk factors between two groups were statistically insignificant. Regarding in-hospital out come in group-I were hospital stay 5.28 ± 1.06 days, heart failure 28%, arrhythmia 8% and mortality was 2%. On the other hand in group-II hospital stay was 6.04±1.07 days, heart failure 68%, and arrhythmia 24% & mortality was 6%. All these were statistically significant between two groups except mortality.*

Conclusion: *From this study it may be concluded that, left ventricular filling pressure assessed by Doppler echocardiograph predicts in-hospital outcome after acute ST segment myocardial infarction and prognosis is worse with increased left ventricular filling pressure.*

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Introduction:

Coronary Heart Disease (CHD) is a major cause of mortality globally and this health problem is reaching epidemic in both developed, as well as in developing countries.[1] Three studies were conducted to see the prevalence of ischemic heart disease (IHD) among rural population of Bangladesh. The prevalence of IHD was observed to be 3.3 to 13/1000 populations (average 6.56/1000).[2]

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In the ischemic cascade left ventricular filling pressure is an important event. It is also an important predictor of short and long term outcome in patients with CAD. Noninvasive assessment of diastolic filling by Doppler echocardiography provides important information about left ventricular status in patients with acute myocardial infarction (AMI). Echocardiographic indexes of elevated LV filling pressures are associated with adverse remodeling, an increased incidence of heart failure, and worse survival.[3]

The mean LV diastolic pressure (M-LVDP) was used as a surrogate for mean left atrial pressure in the clinical utility of Doppler echocardiography and Tissue Doppler Imaging in the estimation of left ventricular filling pressures. Isolated parameters of transmitral flow correlated with M-LVDP only when ejection fraction <50%. The ratio of mitral velocity to early diastolic velocity of the mitral annulus (E/E´) showed a better correlation with M-LVDP than did other Doppler variables for all levels of systolic function.[4]

Elevated pulmonary capillary wedge pressure (PCWP) is associated with a higher mortality rate after acute MI.[5] There are several potential explanations for this. Higher LV filling pressures are usually indicative of larger infarcts with more severe systolic dysfunction.[3] In addition, LV pressure overload predisposes to ventricular remodeling; neurohormonal activation and increased excitability all of which would be expected to adversely affect the outcome. Despite its prognostic value, the measurement of PCWP has obvious drawbacks.

In contrast, Doppler echocardiographic assessment of transmitral flow provides a noninvasive means of identifying patients with elevated left atrial pressures.[6] In the acute setting, elevated E/E' is moderately correlated with traditional transmitral Doppler evidence of elevated LV filling pressures, but is a more powerful prognostic indicator.[7]

The E/E´ ratio correlates well with filling pressure, even in patients with a normal LVEF. E/E´ratio >15 was a significant predictor of an adverse outcome, regardless of LVEF , the presence or absence of ST-segment elevation, or drug therapy on hospital discharge. The E/E´ratio was superior to conventional parameters of LV systolic function, such as LVEF, for prediction of prognosis. However, it is important to recognize that measurement of E/E´provides complementary prognostic data, with the maximum information obtained by combining this with clinical, systolic, and conventional diastolic parameters.[8]

Materials and methods:

The prognostic cohort study was conducted in National Institute of Cardiovascular Diseases, Dhaka from May 2011 to November 2011. A total of 100 Patients with acute ST-segment elevation myocardial infarction who received streptokinase therapy were enrolled by purposive sampling. Objective of the study was to evaluate the prognostic value of left ventricular filling pressure in patients with acute ST segment elevation myocardial infarction. Patients were divided into two groups based on Doppler echocardiography derived Left ventricular filling characteristics. In group-I 50 patients with E/E′ ratio ≤15 and in group-II 50 patients with E/E' >15 were included. Patients were followed up for next 7 days and in-hospital outcomes were compared in between groups. The study protocol was approved by the ethical review board.

In addition to normal 2D & M mode study Pulsed wave Doppler assessment of mitral valve inflow patterns was done in apical 4-chamber view to see Peak early (E) and peak late (A) flow velocities ,E/A ratio and deceleration time of early mitral flow velocity (DT). Tissue Doppler Imaging (TDI) assessment was done at the lateral mitral annulus in apical 4-chamber view to assess Mitral annular diastolic velocity (E′) and E/E′ ratio.

Statistical Methods:

All data were recorded systematically in preformed data collection form and data were expressed as mean and standard deviation and qualitative data as frequency distribution and percentage. Risk factors were analyzed by logistic regression model. Statistical analysis was performed by using SPSS version 16. 95% confidence limit was taken. Probability value <0.05 was considered as level of significance. Comparison between two groups was done by 2-tailed Student's t- test, chi-square test, as applicable.

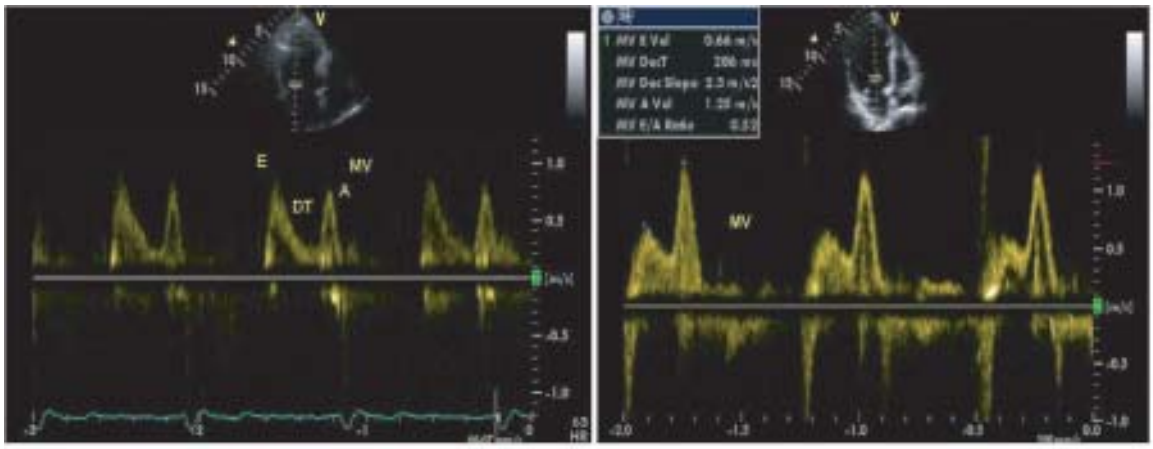

Fig.-1: *Normal Pulsed Wave Doppler (left panel), and Grade-I left ventricular diastolic dysfunction (right panel).*

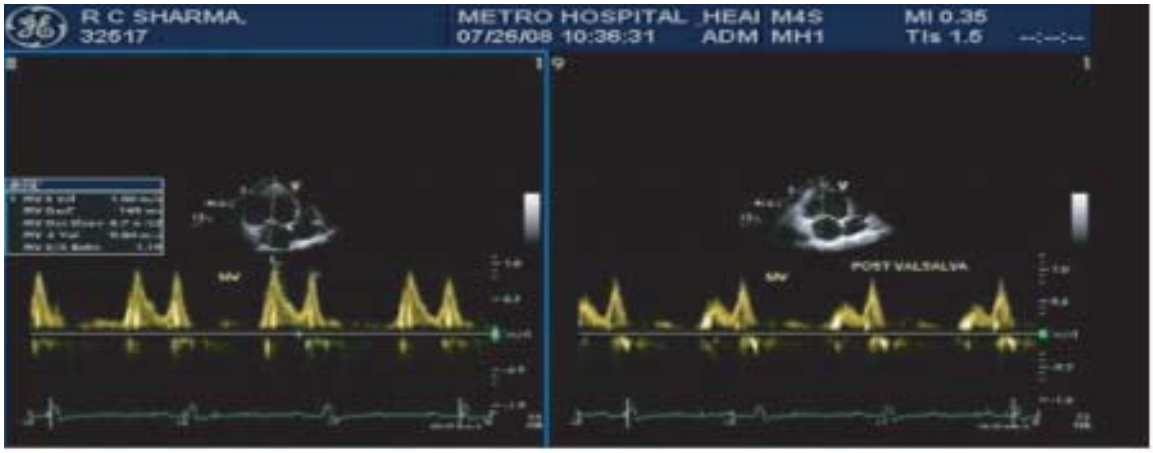

Fig.-2: *Mitral Doppler with a pseudonormal pattern (Grade II diastolic dysfunction) changing to impaired relaxation following valsalva (right panel).*

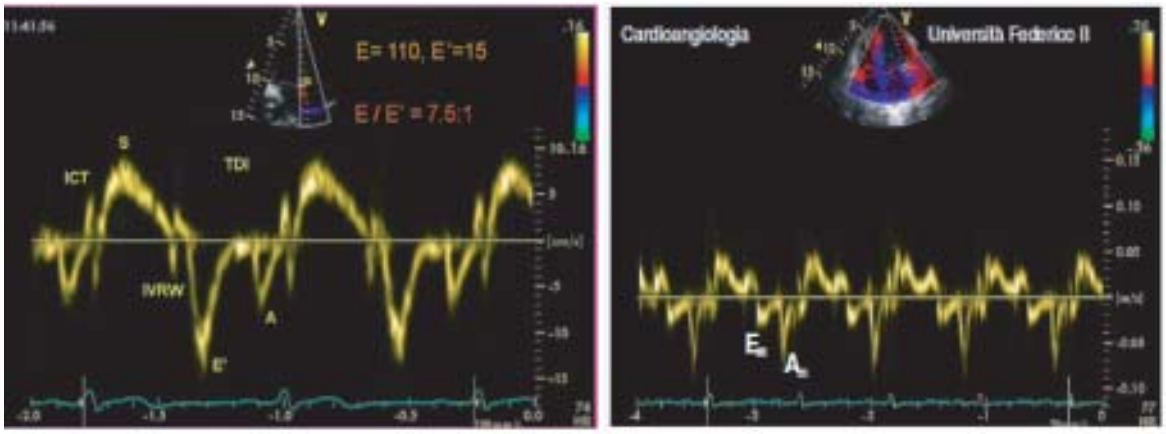

Fig.-3: *Normal tissue Doppler imaging (TDI) (left panel)and pattern of abnormal myocardial relaxation (right panel) . The tissue Doppler recording at the lateral edge of the mitral annulus gave a peak E' of 15 cm / s , Am = myocardial atrial velocity (cm / s), Em (E2)= myocardial early-diastolic velocity (cm / s).*

Results:

Age distribution was almost identical between study population of group I and group II (53.84±9.20 vs 55.14±8.43 years, $p=0.46^{NS}$) (Table I). No statistically significant sex difference was found between patients of study groups (p>0.05) (Table II). There were no statistically significant risk factors difference between the study groups (p>0.05) (Table III). There were no statistically significant hemodynamic parameters difference between the study groups (p>0.05) (Table IV). Mean blood sugar mmol/L were (7.4±1.88 vs 7.42±1.92) and S.creatinine mg/dl were (1.16±0.29 vs 1.19±0.31) in group I and II respectively and not

Table-I

Distribution of the study populations by age (n=100).

Age group	Study group		*p value*
	Group-I (E/E2 ≤15)	Group-II (E/E2 >15)	
30-39 years	03	02	
40-49 years	14	10	
50-59 years	20	25	
60-69 years	10	10	
≥70 years	03	03	
Total	50	50	
Mean ±SD	53.84±9.20	55.14±8.43	0.46^{NS}

Table-II

Risk factors distribution of the study populations (n=100)

Risk factor	Study group		*p value*
	Group-I (E/E2 ≤15)	Group-II (E/E2 >15)	
Smoking	28(56%)	31(62%)	0.54^{NS}
Dyslipidemia	12(24%)	16(32%)	0.50^{NS}
Diabetes	12(24%)	13(26%)	1.0^{NS}
Hypertension	09(18%)	12(24%)	0.62^{NS}
Family H/O CAD	07(14%)	09(18%)	0.58^{NS}

Table-III

Hemodynamic parameters between the study groups (n=100)

HaemodynamicParameters	Study group		*p value*
	Group-I (E/E2 ≤15)	Group-II (E/E2 >15)	
Pulse/min	80.84(±11.47)	82.05(±11.86)	*.68*
Systolic blood pressure	115.6(±17.51)	112.8(±17.34)	*.74*
Diastolic blood pressure	73.0(±10.20)	71.38(±9.52)	*.58*

Table-IV

Biochemical parameters between the study groups (n=100).

Parameters	Study group		*p value*
	Group-I (E/E2 ≤15)	Group-II (E/E2 >15)	
Blood Sugar(mmol/L)	7.4±1.88	7.42±1.92	*0.94*
S.Creatinine(mg/dl)	1.16±0.29	1.19±0.31	*0.55*
Lipid Profile:			
TC(mg/dl)	196.44±24.01	207.54±33.48	*0.06*
LDL-C(mg/dl)	149.32±34.09	152.5±39.98	*0.67*
TG-C(mg/dl)	203.02±64.75	198 ±88.42	*0.75*
HDL-C(mg/dl)	33.95±4.8	35.95±6.06	*0.06*

Table-V

Incidence of heart failure between group-I and group-II (n=100)

	Study group		*p value*
	Group-I (E/E2 ≤15)	Group-II (E/E2 >15)	
Heart failure (Any class)	14(28.0)	34(68.0)	*<0.001*
Killip class-I	01(02.0)	02(04.0)	*1.0^{NS}*
Killip class-II	08(16.0)	15(30.0)	*0.03*
Killip class-III	04(08.0)	10(20.0)	*0.02*
Killip class-IV	01(02.0)	07(14.0)	*0.02*

Table-VI

In hospital outcome between two groups (n= 100).

In-hospital outcome	Group 1 (n=50) Number	Group II (n=50) Number	*p value*
Hospital stay (days)	5.28±1.06	6.74±1.53	*0.001[a]*
Heart failure (Any class)	14 (28%)	34(68%)	*0.001**
Arrhythmias	4 (8%)	12 (24%)	*0.02**
Death	1 (2%)	3 (6%)	*0.16**

statistically significant. Lipid profile shows that mean of total cholesterol (TC) in group--I 196.44±24.01mg/dl and Group II was 207.54±33.48mg/dl. The mean low density lipoprotein (LDL) was 149.32±34.09 mg/dl vs. 152.5±39.98 mg/dl respectively between Group I and Group II. The mean triglyceride (TG) of group I was 203.02±64.75 mg/dl and that of Group II was 198 ±88.42 mg/dl. The mean high density lipoprotein (HDL-C) was 33.95±4.8 mg/dl vs 35.95±6.06 mg/dl between groups There were no statistically significant biochemical parameters difference between the study groups (p>0.05) **(Table V). Table VI** showed that heart failure (any type) was 28% in group I and 68 % in group II which was statistically significant. In group I Killip class-I was 2%, Killip class-II 16%, Killip class-III 8%, 2% had cardiogenic shock. On the other hand, in group II, it was found that Killip class-I was 4%, Killip class-II 30%, Killip class-III 20% and 14% had cardiogenic shock. Killip class-II and III heart failure and cardiogenic shock were significantly more among the group II (16% vs. 34%, p 0.03; 8% vs. 24%, p 0.02; 2% vs. 14%, p 0.02). The incidence of Killip class-I heart failure was statistically non-significant in these two groups. **Table VII** showed that In group-I hospital stay (days) was 5.28±1.06 days, heart failure (any class) 28%, Arrhythmias 8% (Ventricular tachycardia-2 , complete heart block-1, Ventricular fibrillation-1) and 2% had death. On the other hand, in group II, it was found that hospital stay (days) was 6.74±1.53 days, heart failure (any class) 68%, Arrhythmias 24% (Ventricular tachycardia-7, Complete heart block-2, Ventricular fibrillation-3) and 6% had death. All these were statistically significant between the two groups except for mortality which was statistically non-significant.

Discussion:

The mean age of Group I and Group II patients were (53.84 ± 9.2 vs 55.14±8.4 years. P=0.46) ranging from 35 to 70 years. The highest number of patients was in the age group (50-59) years. Similar pattern of age distribution were reported by the studies done in NICVD in recent years Mallick, showed higher mean age in their study (male: 67±17; female: 68±14 years). [10] This lower mean age of presentation of ischemic heart disease in our country is may be due to some key lifestyle factors like imbalanced nutrition, reduced physical activity and increased tobacco consumption.[11]

Statistically not significant mean sex difference was found between patients of study group (p>0.05). The numbers of female patients were less in almost all studies. The study carried out by Mallick showed 73% patients were male and only 27% were female,[10] Courtois also showed that 88% of his

study patients were male and 12% were female.[12]

There were no statistically significant risk factors difference between smoking, diabetes mellitus and family history of CAD in between study groups (p>0.05). Mallick observed similar pattern of risk factors distribution. The investigators reported that 63.3% patients were smoker, 56.7% were hypertensive, 46.7% were diabetic, 36.7% were dyslipidaemic and 13.3% had positive family history of CAD.[10] Mahajan showed in their study that hypertension was the most common risk factor in both study groups (83% and 70%) followed by dyslipidaemia (64% and 68%) and diabetes mellitus (40% and 30%).13 But in their study, only 23-28% patients were smokers. In the study carried out by Valente, 71.4% had dyslipidaemia, 69%was smoker and 62.4% had hypertension. There is a decreasing trend of smoking among western people as a part of health awareness and this may be the cause of difference of smoking among the studies. 14 There were no statistically significant hemodynamic parameters difference between the study groups (p>0.05)

In hospital outcomes after Acute STEMI of both groups were found that in group-I hospital stay (days) was 5.28±1.06 days, heart failure (any class) 28% Arrhythmias 8% and 2% had death. On the other hand, in group II, it was found that hospital stay (days) was 6.74±1.53 days, heart failure (any class) 68%, Arrhythmias 24% and 6% had death. All these were statistically significant between the two groups except for mortality which was statistically non-significant. Mortality was not significant because the present study looked at in-hospital outcome at a mean of about 7 days. Hillis et al showed that mortality was 12% during a median follow-up of 13 months. *Teixeira et al* showed that cumulative mortality 1 year was 12.8%. [15]

The data of similar study Teixeira , 2011 showed that length of hospital stay was 5.2±2.5 days in group I and 5.9±3.7 days in group II (LVEDP raised), in-hospital mortality 2.4% in group I and 4.9% in group II.[16] The data of another study Hillis , 2004 showed that Killip class ≥2 heart failure was found 31 % in group I (E/E2 ≤15) and 67 % in group II (E/E2 > 15). This report was consistent with the findings of present study.[15]

Conclusion:

From the findings of the present study it can be concluded that left ventricular filling pressure assessed by Doppler echo cardiograph predicts in-hospital outcome after acute ST segment myocardial infarction and prognosis is worse with increased left ventricular filling pressure.

Study limitations

There were some limitations in this study. Sample size taken in this study was small and it was a non randomized sampling method. Follow up time was limited and invasive monitoring were not done.

Conflict of Interest - None.

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