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Original Research Article

Correlation of In-Hospital Outcome with Myocardial Performance Index and Left Ventricular Systolic Function in Patients with First Attack of ST Elevated Myocardial Infarction

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Abstract: ***Introduction*:** ST-elevation myocardial infarction (STEMI) is a leading cause of cardiovascular death and thus accounts for a high burden on health careservices worldwide. Traditionally, assessment of left ventricular systolic function is concentrated on measurement of left ventricular ejection fraction (LVEF) which is load dependent and sensitive to the preload and after-load. However, myocardial performance index (MPI) demonstrates supremacy over older established indexes. ***Objective*:** The purpose of the study is to correlate in-hospital outcome with myocardial performance index(MPI) and left ventricular systolic function in first attack of ST elevated myocardial infarction. ***Methods*:** This cross-sectional analytical study was conducted in Dpt. Of Cardiology, Mymensingh Medical College Hospital, Mymensingh, Bangladesh from January to December 2022. Total 120 patients inflicted with first attack of ST elevated myocardial infarction were included considering inclusion and exclusion criteria. The sample population was divided into three groups: Group–I: Patients with mild LV systolic dysfunction (LVEF: 45- 54%), Group–II: Patients with moderate LV systolic dysfunction (LVEF: 35-44%) & Group–III: Patients with severe LV systolic dysfunction (LVEF: <35%). Then In-hospital outcome, LVEF and MPI values were correlated. ***Results*:** In this study 120 patients were enrolled. The mean age of the study group was 54.47±11.65, among them male were 105 (87.5%) & female were 15 (12.5%). 81 (54.7%) were hypertensive, 70 (47.3%) were diabetic, 27 (18.2%) having positive family history of CAD, 81 (54.7%) are current smoker, 99 (66.9%) dyslipidaemic & 15 (10.1%) were asthmatic. The mean Troponin-I & NT- Pro BNP levels were 20.57±10.73 & 183.02±29 respectively. The mean LVEF of the groups were: 47.30±3.08, 36.17±1.51 & 25.00±6.05 respectively. The mean MPI of the groups were: 0.32±0.15, 0.45±0.05 & 0.75±0.18 which were statistically significant. Analysis showed that patients with highest level of MPI had severe left ventricular systolic dysfunction (LVEF <35%) with worse in-hospital outcome and vice versa-the patients with the lowest levels of MPI had better systolic function (LVEF ≥ 45%) & in-hospital outcome. ***Conclusion*:** The research team was able to conclude that left ventricular ejection fraction and myocardial performance index were significantly correlated with each other & in-hospital outcome; more severe function, more the myocardial performance index with worse in-hospital outcome.

Keywords: Doppler echocardiography, Myocardial performance index, ST elevated myocardial infarction.

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INTRODUCTION

In the diagnosis of patients with left ventricular dysfunction in acute ST elevated myocardial infarction, prediction of left ventricular systolic function plays the pivotal role. Thus, it is hypothesized that a combination of left ventricular performance may be more reflective of overall cardiac function than individual assessment of systolic and diastolic function. Traditionally, assessment of left ventricular systolic function is concentrated on measurement of left ventricular ejection fraction (LVEF) which is load dependent and sensitive to the preload and after-load. However, myocardial performance index (MPI) demonstrates supremacy over older established indexes. Recent studies have documented the frequent coexistence of systolic and diastolic dysfunction in people [1, 2]. ST-elevation myocardial infarction (STEMI) is a leading cause of cardiovascular death and thus accounts for a high burden on health care services worldwide. According to the heart disease and stroke statistics update 2016 of the American Heart Association (AHA), the estimated annual incidence of coronary attack in America is approximately 660000 new attacks and 305000 recurrent attacks [3]. The systolic dysfunction is reflected in a decrease in left ventricular ejection fraction and a prolongation of the pre-ejection and shortening of the ejection phases of the cardiac cycle [4-7]. The diastolic dysfunction is reflected in alterations in pattern of the inflow velocity of the left ventricle in early and late diastole [8, 9] as well as the prolongation of the relaxation phase of the cardiac cycle [10]. Left ventricular (LV) systolic function is an important prognostic factor, associated with increased mortality in patients with STEMI [11, 12]. LV function is measured by Two-dimensional (2D) echocardiography, M-mode echocardiography, Doppler echocardiography, and 3D echocardiography, both during systole as well as diastole [13]. A LV function is assessed by LV systolic function and diastolic function. Traditionally, assessment of LV function is focused on measurement of left ventricular ejection fraction (LVEF). Main limitations of LVEF are the load dependency, sensitivity to the alterations in preload and after- load and the geometrical assumptions involved in estimation of LVEF may not be appropriate in conditions like myocardial infarction where considerable alteration in the shape of LV occurs [14-16]. The present study was designed to find out correlation between myocardial performance index with left ventricular ejection fraction (LVEF) in patients with first attack of ST elevated myocardial infarction. This index of left ventricular dysfunction takes advantage of the ease of measurement of the isovolumetric and ejection phases of the cardiac cycle that becomes available in the echocardiographic Doppler recording of the mitral and aortic flow velocity profile [17].

METHODS

This cross-sectional analytical study was conducted in Dept. Of Cardiology, Mymensingh Medical College Hospital, Mymensingh, Bangladesh from January to December 2022. Total 120 patients who sustained first attack of ST elevated myocardial infarction were included in the study considering inclusion and exclusion criteria. Purposive sampling was done using a structured case record form. Study population was divided into three groups to study and compare myocardial performance index (MPI) with left ventricular systolic function depicted as left ventricular ejection fraction (LVEF). Age, Sex, BMI, Smoking, Hypertension, Diabetes Mellitus, Dyslipidemia, F/H of CAD, Heart rate, Blood pressure (systolic & diastolic), Troponin-I, NT-pro BNP, Left Ventricular Ejection Fraction (LVEF), Myocardial performance index (MPI) and in-hospital outcome.

Group-I comprised of 35 patients with mild LV systolic dysfunction (LVEF: 45-54%). Among them 25 were males, 10 were females having mean age of 52.44±13.55 years. Group-II consisted of 55 patients with moderate LV systolic dysfunction (LVEF: 35-44%). Among them 49 were male & 06 were females having mean age of 54.48±10.45 years. Group-III consisted of 30 patients with severe LV systolic dysfunction (LVEF: <35%). Among them 27 were males & 03 females having mean age of 56.50±10.40 years. All the study subjects were selected on the basis of following inclusion and exclusion criteria.

Inclusion Criteria:

1. Patients with first attack of ST segment elevation myocardial infarction.

Exclusion Criteria:

1. Patients with unstable angina and non- ST elevated myocardial infarction.
2. Patients with valvular heart disease and congenital heart disease.
3. Patients had major non- cardiovascular disorder causing elevation of Troponin-I mmmmm such as severe renal impairment, prolonged immobilization, major surgery, chest trauma, myocarditis (pericarditis), acute pulmonary embolism, prolonged tachyarrhythmia.
4. Any systemic infection.
5. Patients were under chemotherapy on discovery of malignancy.
6. Patient not willing to get themselves enrolled in study.

Before examination a detailed briefing about the purpose of the study was given to the subjects and

written consents were taken for all of the study population.

Total 120 cases were enrolled in the study after qualifying the inclusion & exclusion criteria.

Study Procedures

All patients received guideline directed medical therapy at the time of admission. All patients were undergone for either primary PCI or thrombolytic (Tenecteplase or Streptokinase). All patients underwent conventional estimation of ejection fraction and LV end- systolic volume by a Bi-plane modified Simpson's method at the time of presentation, immediately after thrombolysis (120 minutes) and before discharge on 3rd to 6th days. They were followed-up during the period of hospitalization and monitored for the occurrence of recurrent ischemia, acute left ventricular failure, different types of arrhythmias (like sinus tachycardia, sinus bradycardia, ventricular tachycardia, ventricular fibrillation etc.), acute mechanical complication (like mitral regurgitation), hospital stay and death.

Echocardiographic examination

A complete two-dimensional pulsed wave, continuous wave and colour flow Doppler echocardiographic examination using Vivid E9 Pro of General Electronics Inc. Limited, USA was performed [18, 19]. Left ventricular dimensions were measured at mid-ventricular level from the two- dimensional guided M-mode echocardiogram obtained by directing the cursor perpendicularly to the para sternal short axis view. Left ventricular ejection fraction (LVEF) was measured by using Bi-plane modified Simpson's volumetric method because of pronounced segmental asynergy in some patients.

Doppler examination

The mitral velocity inflow pattern was recorded from the apical four chamber view with the Pulsed wave Doppler sample volume positioned at the tip of mitral leaflets during diastole. Following this the left ventricular outflow velocity was recorded from the apical long axis view with the pulsed wave Doppler sample volume positioned just below the aortic annulus. Doppler colour flow imaging was used to semi- quantitate mitral regurgitation.

Echo/ Doppler measurements

For echo/ Doppler parameters three consecutive beats were measured and averaged for each parameter. Figure 1 shows a schema for analysis of Doppler time intervals. Mitral closure-to-opening interval (a) is the time from the cessation to the onset of mitral in-flow. Ejection time (ET) was measured as the duration of left ventricular outflow (b). Isovolumetric Contraction Time (ICT) + Isovolumetric Relaxation Time (IRT) were obtained by subtracting 'b' from 'a' and an index: (ICT+IRT)/ET was derived as (a-b)/b. To compare this index to traditional parameters IRT, ICT and Pre-ejection period (PEP) were also measured. IRT was measured as (c- d) by subtracting the interval between the Electrocardiography (ECG) R wave and the cessation of left ventricular outflow from the interval (c) between the R wave and the onset of mitral flow. ICT was obtained by subtracting IRT from (a-b). PEP was measured from the onset of the QRS waveform to the onset of left ventricular outflow. Reported normal range for LV myocardial performance index is 0.39±0.05. MPI values greater than 0.45, were considered abnormal. Mitral regurgitation was diagnosed by color Doppler echocardiography and the severity of mitral regurgitation semi- quantitated from the area of the maximum regurgitant jet [20].

Statistical Method and analysis

The data were processed and analyzed by computer software SPSS (Statistical package for social science) Version 22. Level of significance was considered as p value less than 0.05 ($p < 0.05$). Continuous data were expressed as mean ± SD. Categorical data were analyzed with x^2 test. Student's t" test was used for analysis of continuous variables. Comparison between groups was done by unpaired t-test.

RESULTS

Table-1: Demographic characteristics of the study population (n=120)

Age	Group 1		Group 2		Group 3		Total	
	N	%	N	%	N	%	N	%
20-30	3	2.50	2	1.66	1	0.83	6	5.0
31-40	5	4.16	10	8.34	2	1.66	17	14.17
41-50	12	10.0	28	23.33	5	4.16	45	37.5
51-60	6	5.0	8	6.66	11	9.17	25	20.84
61-70	7	5.83	4	3.33	3	2.50	14	11.66
71-80	6	5.0	3	2.50	2	1.67	11	9.17
81-90	0	0.0	1	0.83	1	0.83	2	1.66
Sex								
Male	29	24.16	53	44.17	24	20.0	106	88.33
Female	8	6.67	4	3.33	2	1.66	14	11.67
Anthropometric Parameter								
BMI	24.84±3.37		25.77±3.75			26.06±4.99		0.015^s

s means significant

Total 120 patients were included considering inclusion and exclusion criteria. Table 1 showed the age distribution of the study population. Majority of the study population were in the 41-50 years age group. Then 51-60 years group & 31-40 years group subsequently. Statistical analysis showed significant age difference between the groups ($p<0.05$). Majority of the study population were male (87.5%). Statistical analysis showed significant sex difference between the groups ($p<0.001$). It showed group-III people were more obese than rest of the groups. Statistical analysis showed significant difference between the groups ($p<0.05$).

Table-2: Risk factor analysis of the study population (n=120)

Risk factor	Group 1		Group 2		Group 3		Total	
	N	%	N	%	N	%	N	%
HTN	8	6.67	40	33.33	23	19.16	71	59.16
DM	12	10.0	15	12.5	31	25.83	58	48.33
F/H of CAD	1	0.83	3	2.5	19	15.83	23	19.16
Smoker	8	6.67	42	35.0	23	19.16	73	60.83
DLP	13	10.8	14	11.67	50	41.67	77	64.16
Bronchial Asthma	3	2.5	2	1.67	1	0.83	6	5.0

s means significant, ns means not-significant

Table 2 showed the risk factor analysis of the study population. It showed majority of the study population were dyslipidaemic & hypertensive. Then diabetic, current smoker & asthmatic. Statistical analysis showed diabetic, dyslipidaemia, smoking & bronchial asthma were significantly different between the groups ($p<0.05$).

Table 3: Sub-group analysis of dyslipidaemia among the study population (n=120)

Lipid Profile	Group-I	Group-II	Group-III	p-Value
Total Cholesterol	175.64±35.70	195.02±38.63	207.39±37.18	<0.001s
LDL	132.11±22.72	142.91±18.33	160.91±47.60	<0.001s
HDL	55.55±5.47	54.64±6.86	45.27±7.28	<0.001s
Triglyceride	170.25±53.73	185.08±91.95	198.15±72.70	<0.018s

s means significant

Table 3 showed the sub-group analysis of dyslipidaemia among the study population. It showed group-III were high in total cholesterol, LDL, HDL & triglyceride. Statistical analysis showed significant difference between the groups ($p<0.05$).

Table 4: Cardiac profile of the study population (n=120)

Cardiac Profile	Group-I	Group-II	Group-III	p value
Heart Rate	88.76±10.83	98.60±13.36	102.28±17.30	<0.001s
Systolic BP	156.01±20.99	147.90±21.13	137.34±18.14	<0.048s
Diastolic BP	99.90±12.63	89.57±12.45	85.82±10.16	<0.040s

s means significant

Table 4 showed the cardiac profile among the study population. It showed all parameters are important factors to influence global cardiac function. Statistical analysis showed significant difference between the groups ($p<0.05$).

Table 5: Cardiac biomarker level of the study population (n=120)

Parameter	Group-I	Group-II	Group-III	p-Value
Troponin-I	8.94±4.97	16.41±9.58	36.37±17.64	<0.001s
NT- pro BNP	121.36±5.78	141.60±253.08	300.15±249.41	<0.001s

s means significant

Table 5 showed the Troponin-I & BNP level of the study population. It showed people of the group-III had the highest level of Troponin-I & NT-pro BNP level. Statistical analysis showed significant difference between the groups ($p<0.05$).

Table 6: Echo profile of the study population (n=120)

Echo Parameters	Group-I	Group-II	Group-III	p-Value
LVEF	47.30±3.08	36.17±1.51	25.00±6.05	<0.001s
Ejection Time	423.84±46.19	393.76±40.27	297.17±48.28	<0.001s
ICT	94.89±17.32	98.69±16.70	88.24±15.55	<0.001s
IRT	96.09±19.45	108.38±19.54	99.26±17.88	<0.001s
MPI	0.32±0.15	0.45±0.05	0.75±0.18	<0.001s

s means significant

Table 6 showed the echo parameters among the study population. It showed group-III of the study population had the majority of the lowest indices of cardiac function & highest MPI level. On the other hand, group-I study population had the highest indices of cardiac function but lowest MPI level. Statistically significant difference was found between the groups (p<0.05).

Table-7: Mitral Regurgitation profile of the study population (n=120)

Mitral Regurgitation	Group 1		Group 2		Group 3		Total	
	N	%	N	%	N	%	N	%
Severe	**0**	**0.0**	**0**	**0.0**	**0**	**0.0**	**0**	**0.0**
Moderate	**0**	**0.0.**	**3**	**2.5**	**2**	**1.67**	**5**	**4.17**
Mild	**3**	**2.5**	**4**	**3.33**	**3**	**2.5**	**10**	**8.33**
Trivial	**9**	**7.5**	**28**	**23.33**	**18**	**15.0**	**55**	**45.83**
Nil	**21**	**17.5**	**20**	**16.67**	**9**	**7.5**	**50**	**41.67**

s means significant

Table-7 showed the mitral regurgitation profile among the study population. It showed majority had trivial to mild regurgitation. Statistically significant difference was found between the groups (p<0.05).

Table 8: Group with <45% & >45% (n=120)

	LVEF: <45%	LVEF: >45%	p-Value
Total number	83 (69.2%)	37 (30.8%)	
In-hospital complication	55/83 (66.3%)	13/37 (35.1%)	0.003s
Acute left ventricular failure	8/83 (9.6%)	4/37 (10.8%)	0.02s
In-hospital arrhythmias	29/83 (34.9%)	8/37 (21.6%)	<0.002s
Post MI angina	2/83 (2.4%)	19/37 (51.4%)	<0.001s
Hospital stay (days)	6.0±1.5	3.5±1.3	0.02s
MPI			
0’	0.51	0.46	0.134ns
120’	0.48	0.41	0.254ns
5th day	0.47	0.39	0.031s
Mitral Regurgitation			
0’	16/83 (19.3%)	12 (32.4%)	0.541ns
120’	11/83 (13.3%)	8 (21.6%)	0.81ns
5th day	8/83 (9.6%)	05 (13.5%)	0.74ns
Death	2/83 (2.4%)	00 (0.0%)	0.65ns

s means significant, ns means not significant

Table 8 shows that more depressed LV function patients more the complications. Statistical analysis showed significant differences between groups (<0.05).

Table 9: Group with <35% & >35% (n=120)

	LVEF: <35%	LVEF: >35%	p-Value
Total number	27 (22.5%)	93 (77.5%)	
In-hospital complication	19/27 (70.3%)	29/93 (31.2%)	0.004s
Acute left ventricular failure	12/27 (44.4%)	6/93 (6.5%)	0.001s
In-hospital arrhythmias	21/27 (77.8%)	8/37 (21.6%)	<0.001s
Post MI angina	2/27 (7.4%)	19/37 (51.4%)	<0.003s
Hospital stay (days)	7.0±3.1	5.5±2.3	0.01s
MPI			
0’	0.59	0.55	0.364ns

	LVEF: <35%	LVEF: >35%	p-Value
120’	0.54	0.51	0.813ns
5th day	0.51	0.46	0.031s
Mitral Regurgitation			
0’	09/27 (33.3%)	20/93 (21.5%)	0.74ns
120’	07/27 (25.9%)	13/93 (14.0%)	0.854ns
5th day	05/27 (18.5%)	10/93 (10.8%)	0.004s
Death	06/27 (22.2%)	03/93 (3.2%)	<0.001s

means significant, ns means not significant

Table 9 shows that more depressed LV function patients more the complications. Statistical analysis showed significant differences between groups (<0.05).

Table 10: Group with ST segment resolution <50% and >50% at 120 minutes (n=120)

	STR <50%	STR >50%	p-Value
Total number	34/120 (28.3%)	86/120(72.5%)	0.005
In-hospital complication	21/34 (61.8%)	24/86 (27.9%)	0.345ns
Acute left ventricular failure	04/34 (11.8%)	01/86 (1.2%)	0.001s
In-hospital arrhythmias	22/34 (64.7%)	16/86 (18.6%)	0.451ns
Post MI angina	9/34 (26.5%)	20/86 (23.3%)	0.653ns
Hospital stay (days)	8.0±2.1	4.5±1.3	0.81ns
MPI			
0’	0.56	0.55	0.364ns
120’	0.53	0.49	0.813ns
5th day	0.41	0.41	0.631ns
LVEF			
0’	48.1%	50.1%	0.453ns
120’	42.3%	52.1%	0.561ns
5th day	45.5%	54.3%	0.367ns
Mitral Regurgitation			
0’	21/34 (62.5%)	28/86 (32.6%)	0.94ns
120’	26/34 (75.0%)	20/86 (23.3%)	0.754ns
5th day	14/34 (41.2%)	11/86 (12.8%)	0.348ns
Death	02/34 (5.9%)	00/86 (0.0%)	0.453ns

s means significant
ns means not significant

Table 10 shows that ST segment resolution <50% causes more complications than ST segment resolution >50%.

Table 11: Total study population with MPI <0.5, 0.5-0.59 and >0.6 (n=120)

	MPI <0.5	MPI 0.5-0.59	MPI >0.6
Total number	33/120 (27.5%)	33/120 (27.5%)	55/120 (45.8%)
In-hospital complication	17/33 (51.5%)	25/33 (75.8%)	36/55 (65.5%)
Acute left ventricular failure	02/33 (6.1%)	11/33 (20.0%)	15/55 (45.5%)
In-hospital arrhythmias	12/33 (36.4%)	12/33 (36.4%)	42/55 (74.5%)
Post MI angina	10/33 (30.3%)	8/33 (24.2%)	18/55 (32.7%)
Hospital stay (days)	5.1±1.3	6.2±3.5	9.0±3.2
LVEF			
0’	51.3%	43.1%	42.5%
120’	50.2%	46.2%	45.1%
5th day	47.5%	47.6%	41.2%
Mitral Regurgitation			
0’	12/33 (36.4%)	13/33 (39.4%)	20/55 (36.4%)
120’	14/33 (42.4%)	10/33 (30.3%)	12/55 (21.8%)
5th day	10/33 (30.3%)	07/33 (21.2%)	06/55 (10.9%)
Death	01/33 (3.0%)	03/33 (9.1%)	02/55 (3.6%)

s means significant, ns means not significant

Table 11 shows out of 104 patients who had LVEF <40%, mean LV MPI value was 0.53 as compared with a mean LV MPI of 0.50 in patients with LVEF >40% at the time of presentation. Even though this difference was not significant at the time of presentation, a significant difference was found on the 5th day (MPI 0.43 in LVEF <40% group, compared to 0.49 among those with LVEF >40% (p=0.031).

DISCUSSION

Global left ventricular performance is a function of both ventricular function & ejection. Numerous parameters are used to assess systolic or diastolic function till now. Since diastolic dysfunction is an integral part of systolic dysfunction [21, 22] a measure of both combinedly may better reflect 'global' function rather assessing them isolately. In this study, we tried to assess global cardiac function which incorporates factors related to both systolic & diastolic function. Earlier studies showed isovolumic contraction time (ICT) & isovolumic relaxation time (IRT) reflect systolic & diastolic function of heart respectively [23-25]. They correspond with the active ventricular contraction & early relaxation [26]. Although individual measurements of ICT & IRT were required but MPI can be calculated from two easily measured Doppler time intervals (mitral closure-to-opening interval and ejection time). In these cases, 'duration of mitral closure-to-aortic-opening' and 'duration of aortic-closure-to mitral opening' are more appropriate variables to be considered. However, for easy understanding in this study we used considered ICT & IRT. The rationale of the utility of MPI in the left ventricular dysfunction lies in the fact that (ICT+IRT)/ET corresponds with the important periods of contraction & relaxation of cardiac cycle. Calcium transportation at the myocellular level regulates the different cellular mechanisms of ICT & IRT [27]. Active myocardial processes are used to be suppressed in congestive heart failure and result in prolongation of active contraction & relaxation. Active contraction is reflected by an increase in ICT [28]. On the other hand, prolonged relaxation is initially associated with an increase in IRT but progressively worsening degree of ventricular dysfunction will influence this factor due to the involvement of other factors like left atrial pressure and the degree of mitral regurgitation [29]. Although due to the different factors, the present study proved that the sum of ICT & IRT proportionately increased as the left ventricular function depressed [30-32]. Ejection time (ET) was shorter in patients with severe left ventricular dysfunction compared to mild dysfunction. Thus, with worsening left ventricular dysfunction (ICT+IRT)/ET increases disproportionately to any change of individual components. Ejection fraction (EF) is the most commonly used index for the assessment of systolic function. It has served consistently as a good indicator of cardiovascular outcome and thus has great clinical relevance [33]. However, EF may not hold the true reflection of function in absence of normal shaped ventricles [34]. The adjunctive use of MPI may potentially provide useful support in these circumstances. Use of EF alone may erroneously assess the contractility and thus function in patients with mitral regurgitation [35]. This limitation can be overcome by using MPI in adjunction with EF for the assessment of global function. Present study also comes out with similar observations. Out of 104 patients who had LVEF <40%, mean LV MPI value was 0.53 as compared with a mean LV MPI of 0.50 in patients with LVEF >40% at the time of presentation. Even though this difference was not significant at the time of presentation, a significant difference was found on the 5th day (MPI 0.43 in LVEF <40% group, compared to 0.49 among those with LVEF >40% (p=0.031). However, the difference was insignificant when the parameters like arrhythmic and mechanical complications, post infarction angina etc. were compared between the groups with MPI >0.5 and <0.5. This was probably due to selection criteria because of which a smaller number of complications occurred in the study patients. Yuasa *et al*., study reported 80 patients with anterior wall myocardial infarction (MI). It showed that a mean LV MPI value of 0.59 can predict mortality with a sensitivity and specificity of 77% and 86% respectively [36]. Because of fewer mortality (n=2) in this study, the variable was not analyzed between the groups with variable MPI and LVEF. The low mortality of STEMI in this study could be related to the available newer treatment modalities. Patients with MR were only of trivial degree. This finding is similar to most of the series of STEMI [37]. Authors found a significant correlation between MR and LVEF in this study. In patients with LVEF <35%, the incidence of MR was significantly higher on the 5th day. Majority of life-threatening arrhythmias were tachyarrhythmias with few bradyarrhythmia which were not statistically significant. This finding is also consistent with the previously reported incidences of arrhythmias in MI.

CONCLUSION

The study team concluded that in ST-elevation myocardial infarction patients, poor left ventricular ejection fraction and higher myocardial performance index at presentation and on 5th day significantly correlated with in-hospital outcome. Myocardial performance index was also able to give a hint for adverse cardiac events during the hospital stay. The research team also appreciate its use to assess both systolic and diastolic myocardial function in patients with unstable angina as well as non- ST elevated myocardial infarction. We also welcome

further study to clarify the utility of MPI in other patient populations and in the determination of cardiovascular outcome and prognosis.

REFERENCES

1. Grossman, W. (1990). Diastolic dysfunction and congestive heart failure. *Circulation*, *81*(2 Suppl), III1-7.
2. Nishimura, R. A., Abel, M. D., Hatle, L. K., & Tajik, A. J. (1989, February). Assessment of diastolic function of the heart: background and current applications of Doppler echocardiography. Part II. Clinical studies. In *Mayo Clinic Proceedings* (Vol. 64, No. 2, pp. 181-204). Elsevier.
3. Members, W. G., Mozaffarian, D., Benjamin, E. J., Go, A. S., Arnett, D. K., Blaha, M. J., ... & American Heart Association Statistics Committee. (2016). Executive summary: heart disease and stroke statistics--2016 update: a report from the American Heart Association. *Circulation*, *133*(4), 447-454.
4. Weissler, A. M., Peeler, R. G., & Roehll Jr, W. H. (1961). Relationships between left ventricular ejection time, stroke volume, and heart rate in normal individuals and patients with cardiovascular disease. *American heart journal*, *62*(3), 367-378.
5. Weissler, A. M., Harris, W. S., & Schoenfeld, C. D. (1968). Systolic time intervals in heart failure in man. *Circulation*, *37*(2), 149-159.
6. Garrard Jr, C. L., Weissler, A. M., & Dodge, H. T. (1970). The relationship of alterations in systolic time intervals to ejection fraction in patients with cardiac disease. *Circulation*, *42*(3), 455-462.
7. Ahmed, S. S., Levinson, G. E., Schwartz, C. J., & Ettinger, P. O. (1972). Systolic time intervals as measures of the contractile state of the left ventricular myocardium in man. *Circulation*, *46*(3), 559-571.
8. Kitabatake, A., Inoue, M., Asao, M., Tanouchi, J., Masuyama, T., Abe, H., ... & Matsuo, H. (1982). Transmitral Blood Flow Reflecting Diastolic Behavior of the Left Ventricle in Health and Disease: A Study by Pulsed Doppler Technique: SYMPOSIUM ON HEART MECHANICS IN DIASTOLE. *Japanese circulation journal*, *46*(1), 92-102.
9. Appleton, C. P., Hatle, L. K., & Popp, R. L. (1988). Relation of transmitral flow velocity patterns to left ventricular diastolic function: new insights from a combined hemodynamic and Doppler echocardiographic study. *Journal of the American college of cardiology*, *12*(2), 426-440.
10. Klein, A. L., Hatle, L. K., Burstow, D. J., Seward, J. B., Kyle, R. A., Bailey, K. R., ... & Tajik, A. J. (1989). Doppler characterization of left ventricular diastolic function in cardiac amyloidosis. *Journal of the American College of Cardiology*, *13*(5), 1017-1026.
11. Ng, V. G., Lansky, A. J., Meller, S., Witzenbichler, B., Guagliumi, G., Peruga, J. Z., ... & Stone, G. W. (2014). The prognostic importance of left ventricular function in patients with ST-segment elevation myocardial infarction: the HORIZONS-AMI trial. *European Heart Journal: Acute Cardiovascular Care*, *3*(1), 67-77.
12. Mateus, P. S., Dias, C. C., Betrencourt, N., Adão, L., Santos, L., Sampaio, F., ... & Ribeiro, V. G. (2005). Left ventricular dysfunction after acute myocardial infarction--the impact of cardiovascular risk factors. *Revista portuguesa de cardiologia: orgão oficial da Sociedade Portuguesa de Cardiologia= Portuguese journal of cardiology: an official journal of the Portuguese Society of Cardiology*, *24*(5), 727-734.
13. Chengode, S. (2016). Left ventricular global systolic function assessment by echocardiography. *Annals of cardiac anaesthesia*, *19*(Suppl 1), S26.
14. St. John Sutton, M., & Wiegers, S. E. (2000). The Tei index—a role in the diagnosis of heart failure?. *European heart journal*, *21*(22), 1822-1824.
15. Cameli, M., Mondillo, S., Solari, M., Righini, F. M., Andrei, V., Contaldi, C., ... & Mele, D. (2016). Echocardiographic assessment of left ventricular systolic function: from ejection fraction to torsion. *Heart failure reviews*, *21*, 77-94.
16. Smith, M. D., MacPhail, B., Harrison, M. R., Lenhoff, S. J., & DeMaria, A. N. (1992). Value and limitations of transesophageal echocardiography in determination of left ventricular volumes and ejection fraction. *Journal of the American College of Cardiology*, *19*(6), 1213-1222.
17. Alpert, N. R., & Mulieri, L. A. (1982, February). Heat, mechanics, and myosin ATPase in normal and hypertrophied heart muscle. In *Federation proceedings*, 41(2), 192-198.
18. Tajik, A. J., Seward, J. B., Hagler, D. J., Mair, D. D., & Lie, J. T. (1978, May). Two-dimensional real-time ultrasonic imaging of the heart and great vessels. Technique, image orientation, structure identification, and validation. In *Mayo Clinic Proceedings*, 53(5), 271-303.
19. Mishimura, R. A., Miller, F. A., & Callahan, M. J. (1985). Doppler echocardiography: theory, instrumentation, technique, and applicationMayo. In *Clinic Proc,* 60, p. 321-334.
20. Quiñones, M. A., Waggoner, A. D., Reduto, L. A., Nelson, J. G., Young, J. B., Winters Jr, W. L., ... & Miller, R. R. (1981). A new, simplified and accurate method for determining ejection fraction with two-dimensional echocardiography. *Circulation*, *64*(4), 744-753.
21. Grossman, W. (1990). Diastolic dysfunction and congestive heart failure. *Circulation*, *81*(2 Suppl), III1-7.
22. Nishimura, R. A., Abel, M. D., Hatle, L. K., & Tajik, A. J. (1989, February). Assessment of diastolic function of the heart: background and current applications of Doppler echocardiography. Part II. Clinical studies. In *Mayo Clinic Proceedings* (Vol. 64, No. 2, pp. 181-204). Elsevier.
23. Wolk, M. J., Keefe, J. F., Bing, O. H., Finkelstein, L. J., & Levine, H. J. (1971). Estimation of Vmax in auxotonic systoles from the rate of relative increase of isovolumic pressure:(dp/dt) kP. *The Journal of Clinical Investigation*, *50*(6), 1276-1285.
24. Grossman, W., Mclaurin, L. P., & Rolett, E. L. (1979). Alterations in left ventricular relaxation and diastolic compliance in congestive cardiomyopathy. *Cardiovascular research*, *13*(9),

514-522.

25. Papapietro, S. E., Coghlan, H. C., Zissermann, D., Russell Jr, R. O., Rackley, C., & Rogers, W. J. (1979). Impaired maximal rate of left ventricular relaxation in patients with coronary artery disease and left ventricular dysfunction. *Circulation*, *59*(5), 984-991.
26. Weissler, A. M. (1968). The heart in heart failure. *Ann Intern Med*, 69, 929-940.
27. Alpert, N. R., & Mulieri, L. A. (1982, February). Heat, mechanics, and myosin ATPase in normal and hypertrophied heart muscle. In *Federation proceedings* (Vol. 41, No. 2, pp. 192-198).
28. Matsuda, Y., Toma, Y., Matsuzaki, M., Moritani, K., Satoh, A., Shiomi, K., ... & Katayama, K. (1990). Change of left atrial systolic pressure waveform in relation to left ventricular end-diastolic pressure. *Circulation*, *82*(5), 1659-1667.
29. Burwash, I. G., Otto, C. M., & Pearlman, A. S. (1993). Use of Doppler-derived left ventricular time intervals for noninvasive assessment of systolic function. *The American journal of cardiology*, *72*(17), 1331-1333.
30. Cooper, J. W., Nanda, N. C., Philpot, E. F., & Fan, P. (1989). Evaluation of valvular regurgitation by color Doppler. *Journal of the American Society of Echocardiography*, *2*(1), 56-66.
31. Johnson, A. D., O'Rourke, R. A., Karliner, J. S., & Burian, C. (1972). Effect of myocardial revascularization on systolic time intervals in patients with left ventricular dysfunction. *Circulation, 45*(Suppl I), I 91-6.
32. Hodges, M., Halpern, B. L., Friesinger, G. C., & Dagenais, G. R. (1972). Left ventricular preejection period and ejection time in patients with acute myocardial infarction. *Circulation*, *45*(5), 933-942.
33. Cohn, P. F., Gorlin, R., Cohn, L. H., & Collins Jr, J. J. (1974). Left ventricular ejection fraction as a prognostic guide in surgical treatment of coronary and valvular heart disease. *The American Journal of Cardiology*, *34*(2), 136-141.
34. Braunwald, E. (1992). Assessment of cardiac function in heart disease: A Textbook of Cardiovascular Medicine (ed by Braunwald E), 4th Ed. WB Saunders, Philadelphia, pp 419-443.
35. Carabello, B. A., Nolan, S. P., & McGuire, L. B. (1981). Assessment of preoperative left ventricular function in patients with mitral regurgitation: value of the end-systolic wall stress-end-systolic volume ratio. *Circulation*, *64*(6), 1212-1217.
36. Poulsen, S. H., Jensen, S. E., Nielsen, J. C., Møller, J. E., & Egstrup, K. (2000). Serial changes and prognostic implications of a Doppler-derived index of combined left ventricular systolic and diastolic myocardial performance in acute myocardial infarction. *The American journal of cardiology*, *85*(1), 19-25.
37. Møller, J. E., Egstrup, K., Køber, L., Poulsen, S. H., Nyvad, O., & Torp-Pedersen, C. (2003). Prognostic importance of systolic and diastolic function after acute myocardial infarction. *American heart journal*, *145*(1), 147-153.