# Myocardial Performance Index as a Predictor of IN-Hospital and Short Term Outcome after First Acute Myocardial Infarction


## Abstract

**Introduction**: Acute myocardial infarction (MI) remains a leading cause of morbidity and mortality worldwide. It affects both systolic and diastolic functions. The Doppler index of combined systolic and diastolic function (Tei index) was found to be able to separate patients with normal ventricular function from patients with ventricular dysfunction. (Tei) index has been reported to correlate better with patients outcome than conventional echocardiographic parameters in different myocardial diseases.

**Objectives**: The aim of this study is to assess the value of the left ventricular myocardial performance index (MPI) in the prediction of in hospital and short term outcome after first acute myocardial infarction.

**Material and Methods**: Sixty patients admitted to the coronary care unit with first attack of acute myocardial infarction and sixty healthy age and sex comparable group were included. Doppler waves from inverted simultaneous display of the mitral inflow and left ventricular outflow was recorded. Isovolumetric contraction time (IVCT), isovolumetric relaxation time (IVRT) and ejection Time (ET) were measured and then MPI was calculated using the formula (MPI2=IVCT+IVRT/ET).

**Results**: Doppler derived MPI was significantly higher in myocardial infarction patients complicated by heart failure, arrhythmias, post myocardial infarction angina and cardiac death. MPI was inversely correlated with Ejection fraction and positively correlated with EDD and ESD.

**Conclusion:** Myocardial performance index predicts in-hospital and short term outcomes after first acute myocardial infarction.


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## Introduction

Acute myocardial infarction (MI) remains a leading cause of morbidity and mortality worldwide [1]. It affects both systolic and diastolic functions [2]. In hospital complications of myocardial infarction include arrhythmia, heart failure, post infarction angina and death [2]. Conventional echocardiographic indices that are routinely applied for the estimation of cardiac function face a number of limitations. The ejection fraction, the most reliable estimator of systolic function, is prone to significant inaccuracies when the elliptical cardiac chamber is transformed to a spherical one. On the other hand, transmitral flow, which is the most frequent method for evaluation of diastolic function, is dependent on age, heart rate as well as loading conditions [3]. The Doppler index of combined systolic and diastolic functions (Tei index) was found to be able to separate patients with normal ventricular functions from patients with ventricular dysfunctions [4]. Tei index which is defined as the sum of isovolumetric contraction time and isovolumetric relaxation time divided by ejection time was found to be independent from left ventricular geometry and heart rate. It correlate well with invasive measures of systolic and diastolic left ventricular function [5]. It has been reported to correlate better with patients outcome than conventional echocardiographic parameters in different myocardial diseases [6].

Little information is available about the clinical value of the MPI in patients with acute myocardial infarction. Because morbidity and mortality from AMI was affected by both systolic and diastolic myocardial dysfunction, a parameter that integrates both components might be of particular value in this setting. Tei index was found to be the strongest independent predictor of the development of in-hospital congestive heart failure in a small group of patients with acute myocardial infarction [7]. It has been suggested that in the acute phase of myocardial infarction, the myocardial performance index measured at entry may be useful to predict which patients are at high risk for in hospital cardiac events [8].

## Patients

This study included 60 patients with first acute myocardial infarction and 60 healthy age and sex comparable as control group. Inclusion criteria: This study included 60 patients (48 males and 12 females) with mean age (57.3+-6.2) admitted to the coronary care unit presenting with suspected acute myocardial infarction (STEMI & NSTEMI), defined by rise in cardiac markers (troponin & CK-MB) and one or more of the following characteristics: symptoms compatible with acute myocardial infarction, development of new Q waves, development of ST-T abnormalities considered of ischemic origin and new onset

LBBB. Exclusion criteria includes, previous myocardial infarction, patients with significant valvular lesions, patients with chronic atrial fibrillation, advanced systemic (liver and renal) disease

## Methods

All patients were evaluated clinically including: History taking and clinical examination, Routine biochemical tests including complete blood count, blood sugar, serum creatinine, urea, lipid profile (cholesterol, triglycerides, LDL & HDL) and cardiac enzymes (troponin & CK-MB) and written informed consent were obtained from all participants and the study protocol was approved by the local ethic committee. Echocardiography was performed for all patients within 24 hours of patients' admission to coronary care unit using (GE Vingmed Ultrasound) with multifrequency (2.5 and 3.5 MHz) transducer performed in the lateral decubitus [9]. Standard views for M-Mode, two dimensional and Doppler studies were obtained according to the recommendations of American society of echocardiography [10]. M-mode study wes performed in the parasternal long axis view and the following parameters were obtained Left ventricular (LV) end systolic diameter (ESD) and end diastolic diameter (EDD), maximal septal wall thickness (SWT) and maximal posterior wall thickness (PWT) in diastole, LV Ejection fraction (EF %) and Maximal left atrial diameter (LAD) at the level of aortic root [11].

### Two-dimensional Doppler echocardiography

LV end-diastolic and end-systolic volumes and ejection fraction (EF) were determined from apical 2 and 4-chamber views by the Simpson's biplane formula according to the recommendations of American Society of Echocardiography [11]. Tracing of endocardial borders in end-diastole and end-systole was performed in the technically best cardiac cycle. Regional wall motions abnormalities were assessed and wall motion score index (WMSI) was determined according The American Society of Echocardiography which recommended a 16- segment model. This model consists of six segments at both the basal and mid-ventricular levels and four segments at the apex [12]. The attachment of the right ventricular wall to the left ventricle defines the septum, which is divided at basal and mid-left ventricular levels into antero-septum and infero-septum. Continuing counterclockwise, the remaining segments at both basal and mid-ventricular levels are labeled as inferior, infero- lateral, antero-lateral and anterior. The apex includes septal, inferior, lateral and anterior segments. Each segment was analyzed and scored on the basis of its motion and systolic thickening. Segments were scored as (1 = normal, 2 = hypokinetic, 3 = akinitic, 4 = dyskinetic, 5 = aneurysmal) [13].

LV diastolic filling patterns were determined by the mitral inflow pulsed wave Doppler examination. In the apical 4-chamber view, the Doppler sample volume was placed in the middle of LV inflow tract 1cm below the plane of mitral annulus between the mitral leaflet tips, where maximal flow velocity in early diastole was recorded [14]. Special care was taken to align the sample volume as close to perpendicular as possible to the mitral annular plane. The LV outflow pattern was recorded from the apical 5-chamber view with the pulsed Doppler positioned just below the aortic valve. Doppler measurements were calculated from an average of 3 consecutive cardiac cycles.

Doppler time intervals were measured from mitral inflow and LV outflow velocity. Tei index was measured by Doppler echocardiography by the same previously discussed manner in patients after 3 months (Figure 1).

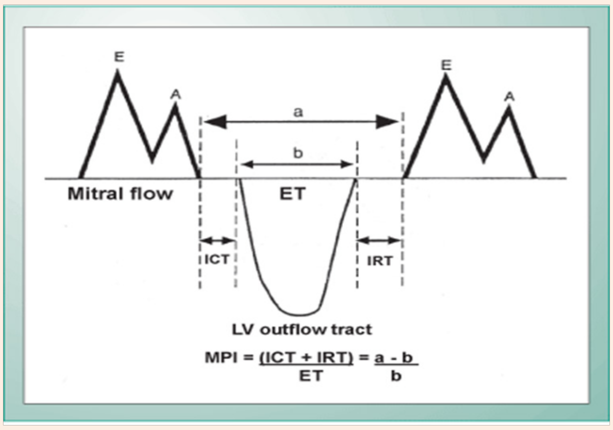


**Figure 1:** Schema for measurements of Doppler intervals.
The interval "a" from the cessation to the onset of mitral inflow was equal to the sum of isovolumetric contraction time, ejection time and isovolumetric relaxation time. The interval "b"(LV ejection time) was the duration of LV outflow velocity profile.

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The myocardial performance index (Tei index) was expressed by the ratio (a - b) / b. The interval between the R wave and the onset of the mitral inflow (interval "c") and between R wave and the cessation of LV outflow (interval "d") used to assess the value of isovolumetric relaxation time (c - d) and isovolumetric contraction time (a -b) - isovolumetric relaxation time.

### Statistical analysis

Descriptive: no, %, mean and SD.

Analytical: This included,

A. Student's t-test: It is a single test used to collectively indicate the presence of any significant difference between two groups for a normally distributed quantitative variable.

B. Chi-Squared ($\chi 2$): It is used to compare between two groups or more regarding one qualitative variable in 2x2 contingency table or r c complex table.

C. Z test: It is used to compare between two proportions.

D. Paired t test: It is a single test used to collectively indicate the presence of any significant difference between two time sequences for a normally distributed quantitative variable.

E. Pearson's correlation: it is used to show association between two qualitative variables.

F. P value: P <0.05 indicates significant difference. P <0.001 indicates high significant difference.

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Receiver operating characteristic (ROC curve): is a graphical plot of the sensitivity, vs. false positive rate (one minus the specificity). The ROC is also known as a Relative Operating Characteristic curve, because it is a comparison of two operating characteristics (TPR & FPR).

Sensitivity: Ability of the test to detect true positive cases.

Specificity: Ability of the test to detect true negative cases.

a) Sensitivity or true positive rate (TPR) = True +ve / (True +ve + False -ve).

b) Specificity (SPC) or True Negative Rate = True -ve / (True -ve + False +ve).

c) Accuracy (ACC) = (True +ve) + (True –ve) / (Positive + Negative)

d) Positive predictive value (PPV): True +ve / (True +ve + False +ve).

e) Negative predictive value (NPV): True -ve / (True -ve + False - ve).

## Results

The demographic characteristics of patients and control are summarized in Table 1, where age and sex were not different between patients and control groups .As regard risk factor prevalence, DM was present in 20 patients (33.3%), HTN was present in 26 patients (43.3%), 60% of patients were smokers, 20% of patients had positive family history, while 36.7% of patients were hyperlipidemic (Table 1).

**Table 1:** Demographic criteria of patients and control groups.

| Demographic Data | Patients (n=60) mean± SD | | Controls (n=60) mean± SD | | t test | P value |
|---|---|---|---|---|---|---|
| Age | 57.3±6.2 | | 57.4±4.6 | | 0.02 | >0.05 |
| | no | % | no | % | X2 | P value |
| Sex | | | | | | |
| Males | 48 | 80 | 48 | 80 | 0 | >0.05 |
| Females | 12 | 20 | 12 | 20 | | |
| Risk factors | | | | | | |
| DM | 20 | 33.3 | | | | |
| HTN | 26 | 43.3 | | | | |
| Smoking | 18 | 60 | | | | |
| Family history | 12 | 20 | | | | |
| Dyslipidemia | 22 | 36.7 | | | | |

Table 2: As regard the occurrence of complications in hospital there was heart failure in 13.3% of patients (8 patients) in hospital and 6.7% (4 patients) 3 months later (no new cases developed heart failure after 3 months and four cases of the old cases died during follow up). There was arrhythmias in 6.7% of patients (4 patients) in hospital and 6.7% (4 patients) 3 months later. There was no sudden cardiac death in any patients in hospital while sudden cardiac death occured in 6.7% (4 patients) 3 months later. There was post MI angina in 3.3% of patients (2 patients) in hospital and 3.3% (2 patients) 3 months later.

**Table 2**: Complications In-hospital and 3 months later.

| Complications | In hospital | | After 3 months | |
|---|---|---|---|---|
| | % | no | no | % |
| Heart failure | 13.3 | 8 | 4 | 6.7 |
| Arrhythmia | 6.7 | 4 | 4 | 6.7 |
| Sudden cardiac death | 0 | 0 | 4 | 6.7 |
| Post MI angina | 3.3 | 2 | 2 | 3.3 |

Table 3: Patients without hospital complications in the present study were 46 patients having mean age of (55.26±4.7) while patients with complications were 14 patients having mean age of (64.0±6.1) which is significantly higher (P < 0.01). As regard sex and risk factors there was no significant difference between complicated and non complicated subgroups (P>0.05).

**Table 3**

| Cases | Non complicated subgroup (n=46) | | Complicated subgroup (n=14) | | t test | P value |
|---|---|---|---|---|---|---|
| | mean± SD | | mean± SD | | | |
| Age | 55.26±4.7 | | 64.0±6.1 | | 4 | < 0.01 |
| | no | % | no | % | Fisher's exact test | P value |
| Sex Males Females | 36 5 | 78.3 21.7 | 12 2 | 85.7 14.3 | 0.19 | >0.05 |
| Risk factors | | | | | | |
| DM | 14 | 30.4 | 6 | 42.9 | o.73 | >0.05 |
| HTN | 18 | 39.1 | 8 | 57.1 | 0.71 | >0.05 |
| Smoking | 26 | 71.4 | 10 | 56.5 | 0.49 | >0.05 |
| Family history | 12 | 26.1 | 0 | 0 | 2.28 | >0.05 |
| dyslipidemia | 16 | 34.8 | 6 | 42.9 | 0.15 | >0.05 |

Table 4: In hospital mean Tei index in patients with complications (14 patients) was (0.69 ± 0.05) and in patients without complication (46 patients), it was (0.44 ± 0.06) with highly significant difference (P< 0.001).

**Table 4**

| | No Complications | | Complications | | t test | P Value |
|---|---|---|---|---|---|---|
| Patients Tei index | no | mean± SD | no | mean± SD | | |
| In hospital | 46 | 0.44 ± 0.06 | 14 | 0.69 ± 0.05 | 10.23 | < 0.001 |
| After 3 months | 46 | 0.40 ± 0.08 | 10 | 0.67± 0.08 | 6.51 | < 0.001 |

After 3 months, mean Tei index in patients with complications (10 patients) was (0.67± 0.08) and in patients without complication (46 patients), it was (0.40 ± 0.08) with highly significant difference (P< 0.001).

## Discussion

Hemodynamically derived Tei index has shown potential clinical implication in various cardiac disorders as dilated cardiomyopathy, cardiac amyloidosis, RV function in primary pulmonary hypertension, Ebstein's anomaly and RV affection in congenital heart disease. Poulsen et al. [7] hypothesized that the Tei index can potentially reflect hemodynamic abnormalities for patients with acute MI and demonstrated that the Tei index was significantly greater for patients with congestive heart failure (Killip calss II-IV) compared with those without it. So it was proved to have a powerful diagnostic and prognostic value. These findings offered support that Tei index is a reliable non geometric noninvasive measure of global ventricular function.

Because both LV systolic and diastolic functions are affected in AMI, and the left ventricle is demonstrated during the LV remodeling process, the index could theoretically be an attractive alternative to standard measures of LV function after AMI. The present study founded that Tei index was significantly higher in complicated than non complicated patients in hospital (p 0.001). Also Tei index was significantly higher in complicated than non complicated patients after three months (p 0.001). Thus the Tei index was useful as a predictor of outcome after AMI as this is accordance to [8]. Ascione et al. [8] who studied the ability of a doppler index of global myocardial performance (Tei index) measured at entry, to predict in-hospital cardiac events in aseries of patients with first acute MI. The mean value of the myocardial performance index (Tei index) was significantly higher in patients with cardiac events than in those without events (p 0.001) so myocardial performance index measured at entry may be useful to predict which patients are at high risk for in hospital cardiac events.

Jacob et al. investigated the value of the Doppler-derived myocardial performance index to predict early left ventricular (LV) dilatation and cardiac death after first acute myocardial infarction (AMI). Doppler echocardiography was performed within 24 hours of hospital admission, on day 1,5 and 90 after (AMI) in 125 consecutive patients. The index measured on day 1 correlated well with the change in end-diastolic volume index observed from day 1 to 90 following AMI (p 0.001). The conclusion of the study was that the myocardial performance index is a predictor of LV dilatation and cardiac death after AMI.

Rahman et al. studied the non-invasive prediction of ST elevation myocardial infarction complication by left ventricular Tei index showing the the Tei index was correlated with outcome in patients with acute ST elevation MI.

In the present study there was no significant difference between sex and risk factors (diabetes mellitus, hypertension, smoking, and hyperlipidemia) regarding Tei index in hospital and after 3 months [P>0.05] as well as there was no significant difference between patients with and without complications as regard sex and risk factors [P>0.05] while there was significant difference as regard age [P<0.01], where patients with complications were significantly older and Tei index was significantly higher and this was in accordance to Ascione et al., 2003 where patients with acute MI of complicated course were significantly older with no significant difference regarding sex and risk factors.

The present study showed that, Tei index was significantly higher among patients in hospital than among patients after three months [P<0.001] this in accordance to Karatzis et al. [3], who demonstrated significant reduction during the early and late phases of MI of both LV and RV indices over time. The present study showed that, Tei index was significantly higher in patients complicated by heart failure than non complicated patients in hospital [P<0.001]. Also Tei index was significantly higher in patients complicated by heart failure than non-complicated patients after three months [P<0.001] this in accordance to: Haralambos et al., who found that, the more severe the clinical condition of the patient at presentation the higher the value of the index.

In the present study, Ejection fraction was significantly lower in patients with AMI than in control subjects [P<0.001] (Table 4). Also there was a highly significant inverse correlation between the Tei index and Ejection fraction [P<0.001] as the lower the ejection fraction, the higher Tei index and this is in accordance to Karatzis et al. [3], who found that a strong inverse relation with ejection fraction and the higher the value of the index, the lower the ejection fraction and vice versa.

Left ventricular dysfunction results in the prolonging of both ICT and IRT, and in the shortening of ET. Thus, the Tei index is increased in patients with LV dysfunction and it was shown to be useful for assessing global LV function. In the present study Tei index value of 0.60 showed a sensitivity of 100% and a specificity of 89% for identifying patients complicated with heart failure. Sutton and Wiegers, studied The usefulness of the index in the detection of patients with mild to moderate heart failure. The Tei index was significantly greater in patients with heart failure and was correlated with LV end-diastolic pressures. Values >0.47 identified heart failure patients with a sensitivity of 86% and a specificity of 82%.

In the present study, there was positive significant correlations between Tei index and ESD & EDD [P<0.001]. The higher ESD & EDD, the higher Tie index. This was in accordance with previous observation recorded in patients with acute myocardial infarction where Uzunhasan et al., studied the Correlation of the Tei index with left ventricular dilatation and mortality in patients with acute myocardial infarction concluding that the Tei index is an important indicator of left ventricular dysfunction and death after AMI. A greater Tei index at the onset of AMI is associated with a higher incidence of subsequent cardiac death, CHF, and progressive LV remodeling.

The present study demonstrated that, The Doppler index of global myocardial performance (Tei index) was useful as an indicator of LV function and predictor of outcome after AMI. The Doppler index incorporated systolic and diastolic time intervals, is reproducible, easily obtained, and is not limited by LV geometry.

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Thus, the index is proposed as a measure of global ventricular function.

## Conclusion

Doppler derived myocardial performance index (Tei index) was significantly higher in patients complicated by heart failure, arrhythmia, post infarction angina and cardiac death than non-complicated patients in hospital and after 3 months.

## References

1. Michael H Bolooki, Arman Askari (2010) Acute Myocardial Infarction. Cleveland clinic, centre for continuing education.
2. Schiller NB, Shalt PM, Crawford M, DeMaria A, Devereux R, et al. (1989) Recommendations for quantitation of the left ventricle by two-dimensional echocardiography. J Am Soc Echocadiography 2(5): 358-367.
3. Karatzis EN, Giannakopoulou AT, Papadakis JE, Karazachos AV, Nearchou NS (2009): Myocardial Performance Index (Tei Index): Evaluating its Application to Myocardial Infarction Hellenic J Cardiol 50(1): 60-65.
4. Tei C, Ling LH, Hodge DO, Bailey KR, Oh JK, et al. (1995) New index of combined systolic and diastolic myocardial performance: a simple and reproducible measure of cardiac function: a study in normal and dilated cardiomyopathy. J Cardiol 26(6): 357-366.
5. Tei C, Nishimtira RA, Seward JB, Tajik AJ (1997) Noninvasive Doppler derived myocardial performance index: correlation with simultaneous measurements of cardiac catheterization measurements. J Am Soc Echocardiogr 10(2): 169-178.
6. Dujardin KS, Tei C, Yeo TC, Hodge DO, Rossi A, et al. (1998) Prognostic value of a Doppler index combining systolic and diastolic myocardial performance in idiopathic- dilated cardiomyopathy. J Am Cardiol 82(9): 1071-1076.
7. Poulsen SB, Jensen SE, Tei C, James BS, Kenneth E (2000) Value of Doppler index of myocardial performance in the early phase of myocardial infarction. J Am Soc Echocardiogr 13(8): 723-730.
8. Ascione L, De Michele M, Accadia M, Rumolo S, Damiano L, et al. (2003) Myocardial global performance index as a predictor of in-hospital cardiac events in patients with first myocardial infarction. J Am Soc Echocardiogr 16(10): 1019-1023.
9. Sahn D, Maria A, Kisslo J, Weyman A (1978) Recommendations regarding quantization in M- mode echocardiography: results of a survey of echocardiography measurements Circulation 58(6): 1072-1083.
10. Weyman AE (1994) Appendix A: Normal cross-Sectional echocardiographic measurements. Principles and Practice of echocardiography. Lea & Febiger, Philadelphia, USA.
11. Schiller NB, Shalt PM, Crawford M, DeMaria A, Devereux R, et al. (1989): Recommendations for quantitation of the left ventricle by two-dimensional echocardiography. J Am Soc Echocadiography 2(5): 358-367.
12. Lang RM, Bierig M, Devereux RB, Flachskampf FA, Foster E, et al. (2005) Recommendations for Chamber Quantification: a Report from the American Society of Echocardiography's Guidelines and Standards Committee and the Chamber Quantification Writing Group, Developed in Conjunction with the European Association of Echocardiography, a Branch of the European Society of Cardiology. J Am Soc Echocardiogr 18(12): 1440-1463.
13. Feigenbaum H (1994) Text book of Echocardiography. (5th edn.), Lea & Febiger, Philadelphia, USA.
14. Appleton CP, Hatle LK, Popp RL (1988) Relation of transmitrai flow velocity patterns to left ventricular diastolic function: new insights from a combined hemodynamic and Doppler echocardiographic study. J Am Coll Cardiol 12(2): 426-440.

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