



## ASSESSMENT OF MYOCARDIAL PERFORMANCE INDEX OF LEFT VENTRICLE BY ECHO & ITS CORRELATION WITH SYNTAX SCORE IN ACUTE STEMI PATIENTS

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### ABSTRACT

#### Aims and Objectives

- To assess the role of Left Ventricular Myocardial Performance Index in Acute STEMI patients using both conventional Pulse Wave Doppler and Tissue Doppler Echocardiography.
- To study the complexity of coronary artery disease in Acute STEMI patients undergoing coronary angiogram by using SYNTAX score.
- To evaluate if myocardial performance index predicts Angiographic severity of coronary artery disease in STEMI patients.
- To assess the relationship between myocardial performance index and the systolic, diastolic dysfunction in acute STEMI patients.
- The Prognostic value of myocardial performance index in predicting the in-hospital morbidity

#### Methods

- Hospital - based observational study of 150 Patients who were admitted to ICCU, thrombolysed for first episode of acute STEMI were included.

#### Results

- MPI is significantly higher in anterior MI than in Inferior MI patients ( $0.59 \pm 0.07$  vs  $0.51 \pm 0.06$ ,  $p=0.001$ ).
- The myocardial performance index is significantly elevated in Triple Vessel Disease compared to Double Vessel Disease and Single Vessel Disease. (MPI- TD:  $0.64 \pm 0.075$  vs.  $0.53 \pm 0.068$ ,  $p=0.001$ )

#### Conclusions

SYNTAX score has high positive correlation with MPI derived by conventional Pulsed Wave Doppler and Tissue Doppler method. So the Left ventricular MPI apart from assessing overall LV function can help in predicting severity of coronary artery disease. Tei index has good correlation with Ejection Fraction which is the most commonly used parameters for predicting outcomes in Myocardial infarction patients. Thus the MPI/Tei index which combines the systolic and diastolic myocardial performance is easily to obtain at the patient's bedside, a useful noninvasive method to predict clinical outcome, severity of coronary artery disease in patients with acute myocardial infarction

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### INTRODUCTION

Coronary artery disease (CAD) accounts for 30% of all global deaths, represents the single most common cause of adult mortality.<sup>1,2</sup> South Asians have a high prevalence of risk factors for coronary artery disease and they present with ischemic heart disease at an earlier age than people in developed countries.<sup>3,4</sup>

In India, the incidence of CAD is increasing over the last 30 years, while a declining trend noted in the western population.<sup>5</sup> Reports have shown that Asian Indians have 3-4 times higher risk of CAD than white Americans, 20 times

higher than Japanese and six times higher than Chinese.<sup>6,7</sup> CAD at younger ages during an individual's working years has resulted in high loss of potentially productive years of life in India.

Acute ST-segment elevation myocardial infarction is the most dramatic manifestation of CAD with high morbidity and mortality. STEMI occurrence is a fatal event in approximately 20 to 30% of patients. Nearly one-third of death occurs within 1 hour are mainly due to ventricular arrhythmias. But the late mortality is mainly depended on LV function. Thus LV function assessment is an integral part of any patient with acute STEMI.

Several methods are available for assessing LV function; Echocardiography is the most readily available and commonly used method for the assessing LV function. LV function derangement can affect systolic function, diastolic function or both. 2D Echocardiography is well suited for

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studies systolic function, and Doppler echocardiography provides a noninvasive technique for the assessing diastolic function. These measurements are load dependent and change with the location of the sample volume, rhythm, heart rate and quality of the image. The systolic and diastolic dysfunction often coexists, only few Doppler echocardiography variables will measure both systolic and diastolic performance. The Tei index / Myocardial Performance Index (MPI) is a ratio of systolic and diastolic time intervals can be obtained from Doppler echocardiography. The timing ratio, derived by the sum of the isovolumetric contraction time and isovolumetric relaxation time divided by the overall ejection time, has been well validated in assessing overall global myocardial performance in both pediatric and adult populations.<sup>8,9</sup>

The Tei index is not a frequently used measurement in assessing cardiac function in current clinical practice, there is evidence suggesting that the Tei index is a simple reliable and reproducible measurement in patients with congestive heart failure, congenital heart disease, cardiac rejection post-transplantation and various heart diseases.<sup>10</sup> It is a reliable index for evaluating LV systolic and diastolic performance in acute coronary syndrome. The MPI has also shown prognostic value in patients with cardiac amyloidosis and dilated cardiomyopathy.<sup>11,12</sup> MODIFIED TEI INDEX a modification was proposed for measuring TEI index by using Tissue Doppler.<sup>13</sup>

The SYNTAX score (SS) is a lesion-based angiographic scoring system, was initially devised to grade the complexity of coronary artery disease.<sup>14</sup> This scoring system was able to aid revascularization decisions and predict mortality and morbidity in patients with CAD.<sup>15</sup> The SYNTAX score(SS) which was developed to assess the severity and complexity of coronary artery disease in order to determine the appropriate revascularization strategy.<sup>16</sup> The Syntax score(SS) evaluated the severity of lesions, not only by luminal stenosis but also by plaque vulnerability, which is an essential aspect of coronary artery anatomy in patients having acute STEMI. Various trials demonstrated that SYNTAX score was related to procedural no-reflow, renal functions, mortality, and increased target vessel revascularization rate in patients who underwent primary PCI.

In this study Left ventricular Myocardial performance Index, which is derived using both conventional Pulse Wave Doppler and Tissue Doppler method is studied for its correlation with angiographic severity of CAD using SYNTAX score in STEMI patients

**Aims and Objectives**

- To assess the role of Left Ventricular Myocardial Performance Index in Acute STEMI patients using both conventional Pulse Wave Doppler and Tissue Doppler Echocardiography.
- To study the complexity of coronary artery disease in Acute STEMI patients undergoing coronary angiogram by using SYNTAX score.
- To evaluate if myocardial performance index predicts Angiographic severity of coronary artery disease in STEMI patients.
- To assess the relationship between myocardial performance index and the systolic, diastolic dysfunction in acute STEMI patients.

- The Prognostic value of myocardial performance index in predicting the in-hospital morbidity.

**METHODOLOGY**

**Study design:** Hospital - based observational study.

**Study setting:** ICCU & Cath lab in the department of cardiology KGH, Visakhapatnam. Duration of study: 1st March 2020 to 28th Feb 2021.

**Study population:** Patients who were admitted to ICCU, thrombolysed for first episode of acute STEMI were included. The diagnosis of first episode of MI was determined if the previous ECG was normal or there was no history or symptoms suggestive of acute coronary disease.

**Sample size:** All patients who have fulfilled the inclusion criteria, who are willing to give consent during study period were enrolled in study. (n=150)

**Consent:** written informed consent taken from each patient enrolled in the study in the patient’s understandable language.

**Inclusion Criteria**

- Patients of age above 20 years admitted with first episode of acute STEMI.
- The diagnosis of the first episode of MI was determined if the previous ECG was normal or there was no history or symptoms suggestive of acute coronary disease.

**Exclusion Criteria**

- Patients with Unstable angina, NSTEMI, Re-MI
- History of CABG or PTCA
- Known valvular heart disease / underwent valvular surgery
- Previous History of heart failure.
- Pericardial diseases
- History of congenital heart disease
- Known atrial flutter/fibrillation.
- Those who are having underlying chronic kidney disease and elevated serum creatinine >1.7mg%.
- History of cardiomyopathy.
- Associated co-morbid conditions like Liver disease, History of chronic obstructive pulmonary disease or any other chronic respiratory conditions.
- Patients who were not willing for coronary angiogram.

**RESULTS**

**Table 1** Base Line Characteristics of Study Population

Base line characteristics of study population(n=150)	
Age (years)	55.8 ± 9.2
Male : female ratio	2:1
Hypertensive’s	73 (48.7%)
Diabetes	60 (40%)
Smoker	50 (33%)
Obese	10 (6.7%)
Number of Anterior STEMI patients	84 (56%)
Number of Inferior STEMI patients	66 ( 44%)

**Table 2** Grading of the Syntax Score in the Study Group.

	Frequency	Percent
Low risk	135	90.0
Intermediate risk	13	8.7
High risk	2	1.3
Total	150	100.0

**Echocardiographic Parameters**

**Base line Echocardiographic characteristics of study population**

**Table 3** Baseline Echocardiographic Parameters

	DT	IVRT	MPI(TD)	MPI(PW)	SYNTAX
Mean	156.200	88.987	.5559	.5319	11.457
Median	160.000	88.500	.5500	.5300	9.000
Std. Deviation	30.9019	12.4943	.08084	.07725	7.3155
Minimum	90.0	67.0	.39	.38	2.0
Maximum	215.0	140.0	.80	.75	34.5

**Table 4** E/E' Ratio Vs MPI And Syntax

E/E'	N	Mean	Std. Deviation	P VALUE
<8	9	.4944	.08383	.060
MPI(TD) 8-12	72	.5579	.08740	
>12	69	.5617	.07054	Not significant
<8	9	.4678	.07934	.029
MPI(PW) 8-12	72	.5321	.08302	
>12	69	.5401	.06727	Not significant
<8	9	10.556	8.5163	.891
SYNTAX 8-12	72	11.694	8.2729	
>12	69	11.326	6.0899	Not significant

**Mitral flow E/A ratio vs. MPI & SYNTAX score:** E/A ratio when analyzed with MPI (TD) showed that mean MPI was higher when the ratio was <1 compared to 1-2.

**Table 5** Diastolic Mitral Flow Velocity E/ARatio With MPI & Syntax

	E/A	N	Mean	Std. Deviation	P VALUE
MPI(TD) <1	46	.5852	.08921	.003	
1 TO 2	104	.5429	.07363	Significant	
SYNTAX <1	46	12.533	7.8828	.232	
1 TO 2	104	10.981	7.0373	Not significant	

**Table 6** MPI and Syntax Score Among Patient with Anterior and Inferior Stemi

	Deceleration Time	PW-A (IVCT+E T+IVRT)	PW- B(ET)	MPI- PW A-B / B	TD- A' (IVCT+E T+IVRT)	TD-B' (ET)	MPI- TD A'- B' / B'
Anterior STEMI	152 ± 31	406 ± 29	260 ± 19.9	0.56 ± 0.07	414 ± 26	261 ± 20.9	0.59 ± 0.07
Inferior STEMI	161 ± 30	415 ± 33	281 ± 19.7	0.49 ± 0.06	424 ± 17	281 ± 19.6	0.51 ± 0.06
P Value	0.099	0.094	0.001	0.001	0.012	0.001	0.001

**Triple Vessel Disease**

Out of 150 patients 28 patients had TVD (triple vessel disease), the corresponding MPI is significantly high then patients without TVD (MPI 0.64 ± 0.075 vs. 0.53 ± 0.068, p=0.001)

**Table 7** MPI - Tissue Doppler & Syntax Score in Triple Vessel Disease

	TVD	N	Mean	Std. Deviation	P VALUE
MPI(TD) YES	28	.6404	.07555	.001	
NO	122	.5365	.06886	Significant	
SYNTAX YES	28	20.607	6.6519	.001	
NO	122	9.357	5.6749	significant	

**Ejection Fraction**

Left Ventricle systolic dysfunction occur in patients with STEMI; especially anterior wall MI. There is a statistically significant difference in mean MPI values in patients with various ejection fractions. In Severe LV systolic dysfunction (EF <30%) Tei index is 0.67 ± 0.028, and patient with good LV function (EF > 50%) it is 0.50 ± 0.057. The corresponding syntax score is also higher in patients with severe LV systolic dysfunction which is statistically significant.

**SYNTAX Scores Vs MPI**

Syntax score used to classify coronary artery disease severity in patient with multi vessel disease/LMCA disease. The anatomical severity score graded as Low (0- 22), Intermediate (23-32 and Severe (33 or more). There is significant differences in mean MPI values in the three groups with positive linear relationship of syntax score and Tei index derived from both Pulse wave and Tissue Doppler method. Mean syntax score was 11.057 with standard deviation of 7.31. (Range was 2 to 34.5)

When the syntax score of study population was subdivided into tertiles of <6, 6-9.10-15 and >15 and the relation to Tei index was evaluated. It showed statistically significant linear correlation with MPI derived by Pulse wave method & Tissue Doppler method.

**Correlation Studies**

In This study for correlation between the myocardial performance index values derived from Pulse wave and Tissue Doppler method, and the severity of CAD based on angiographic anatomical syntax score showed - a very high positive correlation between MPI derived from the two methods with Pearson coefficient value 0.956. Also the correlation of SYNTAX score with MPI by PW (0.701) and TD (0.700) was highly positive

**Table 8** Correlation Study - MPI Derived By Pw & Td with SyntaxScore

		MPI (TD)	MPI (PW)	SYNTAX
MPI(TD)	Pearson Correlation	1	.956**	.700**
	P VALUE		.001	.001
MPI(PW)	Pearson Correlation	.956**	1	.701**
	P VALUE	.001		.001
SYNTAX	Pearson Correlation	.700**	.701**	1
	P VALUE	.001	.001	
	N	150	150	150

\*\* . Correlation is significant at the 0.01 level (2-tailed).

**DISCUSSION**

This study was done to demonstrate the role of Left Ventricular Myocardial Performance Index in patients with first-episode acute STEMI and about it's correlation with the angiographic severity of CAD using Syntax Score.

In the present study, the mean age of presentation of patients with acute STEMI was 55.87 + 9.26 years. In the present study, male: female ratio of the study population was 2:1, and Male patients outnumbered females in both groups.

In the present study, the majority of patients, 84 (56%) suffered with anterior STEMI and the rest 66(44%) with

inferior STEMI. All the patients included in the study were thrombolysed and the study enrolled only patients with the first episode of STEMI.

In the present study, the analysis of MPI values in anterior MI and inferior MI, there was a significant difference of the mean MPI. In anterior STEMI, it was  $0.56 \pm 0.07$ , and in Inferior wall STEMI  $0.49 \pm 0.06$  with pulse wave method ( $p=0.001$ ). With Tissue Doppler method the MPI was  $0.59 \pm 0.07$  and  $0.51 \pm 0.06$  in anterior and inferior respectively. ( $P=0.001$ ). The Tei index in anterior MI is higher than inferior MI.

The various studies showed Anterior wall MI has higher MPI than inferior : Sekuri C, *et al*<sup>39</sup> in their study with 50 patients with acute Q-wave MI at early phase the mean MPI was  $0.54 \pm 0.1$  in all patients. In anterior MI it was  $0.61 \pm 0.07$  vs.  $0.46 \pm 0.06$  in inferior MI ( $p < 0.001$ ).

### Ejection Fraction

In the present study on analyzing the relation between LV Ejection Fraction with myocardial performance index (Tissue Doppler), we found that with decreasing level of EF there was an increase in MPI. When EF  $> 50\%$  the MPI is  $0.50 \pm 0.57$  (PW with EF 40% - 49% the MPI is  $0.58 \pm 0.05$ , in patients with EF 30%-39% the MPI is  $0.66 \pm 0.09$ , and in patients with severe LV systolic dysfunction - EF  $< 30\%$  the MPI is  $0.67 \pm 0.02$  . So the data showed inverse relation between ejection fraction and Tei index, implying higher pathological values of MPI with reduction in LV systolic function.

The ejection fraction when correlated with SYNTAX score, the data showed with increase in the anatomical complexity of CAD there was statistically significant decrease in LV ejection fraction in ejection. In patients with normal EF  $> 50\%$  the mean SS is  $8.45 \pm 5.8$ , in patients with EF 40% - 49% the SS is  $12.8 \pm 7$  , with EF of 30%- 39 % the mean SS is  $19.67 \pm 6.8$ , where as in patient with EF  $< 30\%$  the mean syntax score is  $21.5 \pm 2.8$ . This shows significant inverse relation between SYNTAX SCORE (SS1) & EF.

In a study by Ascione L *et al*;<sup>47</sup> the myocardial performance index of 96 patients with first episode of Myocardial Infarction were evaluated for predicting in-hospital adverse events .The study stated that the EF was reduced ( $40 \pm 10\%$  vs.  $52 \pm 10\%$ ,  $P.0001$ ) and the mean value of the MPI was significantly higher in patients with cardiac events than the patients without events ( $0.65 \pm 0.20$  vs.  $0.43 \pm 0.16$ ,  $P .0001$ ).

### Diastolic function Parameters

On analyzing the echo data, for the correlation of MPI with diastolic function parameters like E/A ratio, DT, IVRT, and E/E' ratio. We found that MPI shows significantly association with IVRT, E/E', DT. Syntax score showed statistically significant association with IVRT and DT.

### MPI in Triple Vessel Disease

Among the 150 patients we studied, 80 patients had Single Vessel Disease, 41 patients had Double Vessel disease and 28 patients had Triple Vessel Disease

Among the 23 patients with Triple Vessel Disease the Mean MPI value is  $0.64 \pm 0.75$  and compared to others  $0.53 \pm 0.06$ . Patients with Triple Vessel Disease have significantly higher MPI ( $P=0.001$ ) than patient with SVD & DVD. In Triple vessel disease mean SYNTAX score was  $20.60 \pm 6.65$ , and in

others it was  $9.35 \pm 5.67$ , which is considerably higher ( $p=0.001$ ).

Maller JE, *et al*.<sup>50</sup> in their study showed that MPI was higher in patients with multivessel disease compared to single vessel disease ( $0.53 \pm 0.16$  vs.  $0.44 \pm 0.11$ ,  $p=0.03$ ).

### Correlation between MPI and Syntax Score

In the study population, the mean Syntax score was  $11.45 \pm 7.31$ , the lowest score was 2 and the highest score 34.5.

On sub classifying the study population based on SYNTAX score: LOW ( $< 22$ ), Intermediate (23-32) and High ( $> 33$ ). The low SS was seen in 135 (90%) patients, intermediate score in 13 (8.7%) patient, and high score in 2 (1.3%). The most of the patients in this study belonged to low score as most of the patient in the present population had single ( $n=80$ ) and double vessel diseases ( $n=41$ ).

In the present study, the patients were sub-classified based on SYNTAX score into tertiles of  $< 6$ , 6-9, 10-15 and  $> 15$  group. The Tei index and modified Tei index (TD) both showed progressively increase in their mean values as syntax score severity increased. For SS  $< 6$  tertiles mean MPI(TD) was  $0.49 \pm 0.05$ , for SS 6-9 it was  $0.52 \pm 0.05$ , for SS 10-15 it was  $0.56 \pm 0.06$  and with SS  $> 15$  MPI was  $0.66 \pm 0.08$  ( $p=0.001$ )

### Correlation between MPI Derived By Pw & Td with Syntax Score

In the present study, Myocardial Performance Index of Left Ventricle derived by conventional PW & Tissue Doppler Echocardiography, and its correlation with SYNTAX score was analyzed. The study data showed a very high positive correlation between MPI derived by Pulsed wave Doppler method and Tissue Doppler (Pearson coefficient of 0.956). The mean MPI values derived by Tissue Doppler are higher than that of Pulsed wave Doppler method. And there was high positive correlation between SYNTAX score with MPI (PW) / Tei index with Pearson correlation value of 0.700, and with Tissue Doppler derived (Modified Tei index) it was 0.701 in the current study. Thus the current study shows a significant positive correlation between SYNTAX score and MPI.

## CONCLUSIONS

SYNTAX score has high positive correlation with MPI derived by conventional Pulsed Wave Doppler and Tissue Doppler method. So the Left ventricular MPI apart from assessing overall LV function can help in predicting severity of coronary artery disease. Tei index has good correlation with Ejection Fraction which is the most commonly used parameters for predicting outcomes in Myocardial infarction patients.

Thus the MPI/Tei index which combines the systolic and diastolic myocardial performance is easily to obtain at the patient's bedside, a useful noninvasive method to predict clinical outcome, severity of coronary artery disease in patients with acute myocardial infarction.

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