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Original Article

Non-Invasive Prediction of ST Elevation Myocardial Infarction Complications by Left Ventricular TEI Index

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Abstract

Objective: To investigate association between the Tei index and cardiac complications of ST elevation of Myocardial Infarction.

Patients and Methods: A total of a 202 adult consecutive patients with first ST elevation MI (STEMI) were studied. Tei index was obtained as: (a _ b)/b, where "a" is the interval between the cessation and onset of mitral flow and "b" is the ejection time of aortic flow measured with the help of pulsed Doppler echocardiography. Subsequent complications, included Death, Congestive Heart Failure (CHF), Cardiogenic shock, Atrial Flutter/ Atrial Fibrillation, Sustained ventricular tachycardia, Advanced Atrio- Ventricular Clock (AV Block), Myocardial Infarction (MI), Readmission (due to any cardiac cause) and Revascularization during the 30 days after the onset of Acute STEMI were prospectively evaluated and compared with the initial Tei index at admission.

Results: Complications were noted in 60% of the patients with acute STEMI. The Tei index was significantly increased for patients with complications compared with those without them (0.66 ± 0.13 vs. 0.30 ± 0.10, P < .0001). When Tei index > 0.40 was used for the criteria, the sensitivity, specificity, and overall accuracy to predict subsequent complications were 86%, 82%, and 83%, respectively.

Conclusion: Tei index allows approximate but quick and practical noninvasive prediction of complications in patients with STEMI (JPMA 59:75; 2009).

Introduction

Ventricular impairment induced by a recent MI is responsible for an increase in ventricular volumes and reduction of myocardial kinetics, with an increase of wall motion score index (WMSI). It can also induce changes in ventricular contraction and relaxation times, with derangement in left ventricular (LV) function.[1-2] To evaluate this impairment, Tei et al proposed a new Doppler index, so called index of myocardial performance (IMP), to define ventricular function.[3] This proposed Tei index is defined as the sum of isovolumic contraction time (ICT) and isovolumic relaxation time (IRT) divided by ejection time (ET).[4-6]

This noninvasive Echocardiographic index of ventricular function is of clinical significance in diagnosing risk of heart diseases.[7] Tei index is easily obtainable and has been clinically useful in assessing global ventricular function in both adults and children.[6-7] The index combines systolic and diastolic time intervals and independent of heart rate and ventricular geometry.[8]

Tei index also allows noninvasive prediction of the prognosis of patients with cardiac amyloidosis, dilated cardiomyopathy, and primary pulmonary hypertension.[9-11] This also allows prediction of the development of CHF in patients with acute MI.[3,12-14]

However, the relationship between the Tei index and various complications of acute ST Elevation Myocardial Infarction (STEMI) has not been fully investigated in Pakistan.

Therefore, the purpose of this study was to investigate the relation between Tei index and cardiac complications in STEMI.

Patients and Method

This was a prospective study done at the department of cardiology, The Aga Khan University Hospital, Karachi, Pakistan. This study was carried out over a period of one year after the acceptance of Synopsis, i.e. from June 2006 to June 2007. Two hundred and two patients with acute STEMI were selected without gender discrimination. The criteria for inclusion in the study were: age more than or equal to 30 years, all patients with acute STEMI, according to ACC/AHA criteria (Typical rise and gradual fall (troponin) or more rapid rise and fall (CKMB) of biomedical markers with at least one of the following: Symptoms, Development of pathologic Q waves on ECG, ECG changes suggestive of ischemia, Coronary Artery intervention and Pathological findings of acute MI), adequate 2D echo images along with adequate doppler signals to accurately assess the Echocardiographic parameters.

The criteria for exclusion from the study were: significant mitral regurgitation (more than mild), significant Aortic Stenosis (more than mild), inadequate 2D echo images with inadequate Doppler signals and congenital heart disease.

The study was approved by ethical review committee of

Aga Khan University Hospital, Karachi, Pakistan. Written informed consent was obtained from all the patients.

Patients were divided in two groups with regard to tei index of < 0.4 and > 0.4. A predefined questionnaire containing demographic data, clinical variables and echocardiographic measurements were filled.

Two-dimensional, pulsed Doppler and colour flow Doppler echocardiography examinations were performed by single institutional sonographer, immediately after patient's arrival in the coronary care unit. The cardiac ultrasonographic unit, Sonos 5500 Philips Echo Machine, with a 2.5-MHz transducer was used. All two-dimensional echocardiography data were stored digitally on the DVD/CD, and a standard videocassette recorder was used to store pulsed Doppler data measurements on high quality videotape for later analysis. Left ventricular volumes and ejection fractions were measured with Simpson's biplane disk plane method.[15] Left ventricular volumes were corrected for body surface area and a mean of three measurements were used. The mitral inflow velocity pattern was recorded with the pulsed wave Doppler sample volume positioned between the tips of the mitral leaflets. The LV outflow pattern was recorded from the apical 5-chamber view with the pulsed wave Doppler sample volume positioned just below the aortic valve. Each Doppler profile was analyzed by a digital tracing, and Doppler measurements were calculated from an average of five consecutive cardiac cycles.

Measurement of Tei Index

Doppler time intervals were measured from mitral inflow and LV outflow velocity-time intervals. The interval "a" from the cessation to the onset of mitral inflow was equal to the sum of ICT, ET, and IRT. Left ventricular ET "b" was the duration of LV outflow velocity profile. Thus the sum of ICT and IRT was obtained by subtracting "b" from "a".

The index of combined LV systolic and diastolic function (the sum of ICT and IRT divided by ET) was calculated as (a - b) / b.3 (Figure). In addition, patient's heart rate and Blood Pressure were also taken at the time of admission.

Complications with acute MI were divided in two groups. Cardiac death, cardiogenic shock and STEMI were major outcome complications. Need for revascularization, readmission due to cardiac reasons, CHF, cardiac arrhythmias and advanced atrioventricular block were the minor outcome complications. All patients were prospectively evaluated for 30 days after the onset and compared with the initial cardiac function evaluated with Doppler echocardiography at the time of admission in the acute phase, for major outcome complications. For minor outcome complications, patients were followed during hospital stay. Follow up was done by chart review, where required. Any cardiac complications as per definition were recorded on a predefined Performa. Definitions

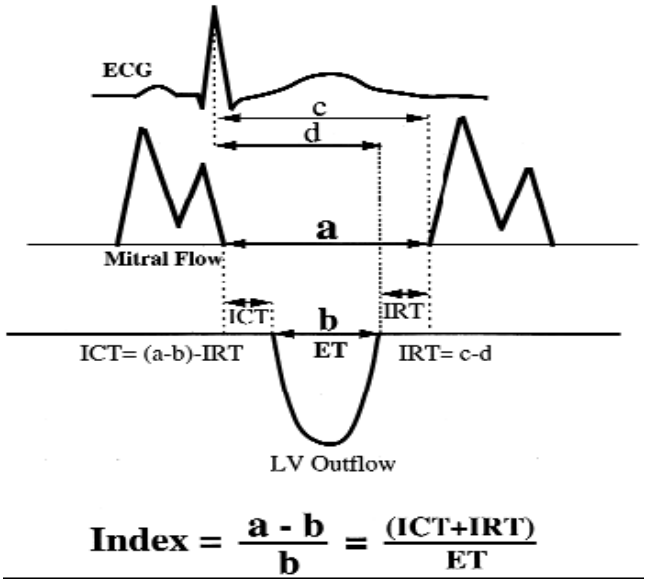

Figure: Schema for measurements of Doppler intervals. The index is defined as (a - b) / b, in which "a" is the interval between cessation and onset of mitral inflow, and "b" is the ejection time (ET) of left ventricular (LV) outflow. Isovolumetric relaxation time (IRT) is measured by subtracting the interval "c", between the R wave and the cessation of mitral inflow. Isovolumetric contraction time (ICT) is obtained by subtracting IRT from a - b.
ECG, Electrocardiogram; d, time interval between R wave and the cessation of LV Out flow.

of the complications are summarized in (Table 1).

All the Echocardiographic measurements were done by the single observer, who was unaware of the clinical and hemodynamic information, to avoid technical errors. Data was obtained from three consecutive cardiac cycles and was averaged.

Results were expressed as the means. Variables were compared with the Tei Index by Chi Square Test. Presence of Cardiac complications in patients with acute STEMI were presented by frequency distribution. Fisher Exact Test was applied to test an association between tei index (categorized as < 0.4 and > 0.4) and development of any one of the end points after STEMI. A $P < 0.05$ was considered statistically significant. Tie index was also measured as a continuous variable.

Results

Total of 202 patients having STEMI were enrolled in the study, out of which 157 were male patients and 44 were female. Out of these patients 24% were hypertensive, 19 % diabetic, 32 % had dyslipidemia and 13 % had renal failure with average tei index of 0.49, 0.54, 0.48 and 0.47 respectively. Out of 202 patients, 121 (60%) developed complications. The absolute Tei Index values with Odd and Hazard ratio in different cardiac complications is shown in Table 2.

Relations between Complications and Functional Indices LV EF were significantly reduced ($P \leq .001$). The Tei index was also significantly increased for patients with complications compared with those without i.e. The overlap

Table 1: Cardiac Complications with Acute STEMI.

Cardiac Complications	Definition
Cardiac Death	Caused by congestive heat failure and arrhythmias.
ST Elevation MI	Recurrent myocardial infarction: increase in ST segment elevation from initial rise along with further increase in troponin with and without ischemic symptoms.
Cardiogenic Shock	Systolic blood pressure less than 90 mm of Hg with evidence of hypo perfusion of vital organs.
Arrhythmias	Atrial flutter and fibrillation (newly developed after myocardial infarction), Sustained ventricular tachycardia (lasting more than 30 seconds) / ventricular fibrillation or survival of cardiac arrest.
Advanced Atrioventricular Blocks	Type 2 second degree and complete heart block.
Congestive Heart Failure	Defined as Killip class 2 -4
Revascularization	Requiring percutaneous intervention or coronary artery bypass surgery

Table 2: Tei Index values with odd and hazard ratios in different cardiac complication.

Complications	Number of Patients	Average Value of Tei Index	Average EF	Odds Ratio	Hazard Ratio	P Value
Cardiogenic Shock	51	0.6	45%	2.1 (2.1 - 3.8)	2.5 (1.7 -3.6)	0.008
Cardiac Death	3	0.56	50%	1.7 (1.2 - 2.2)	2.0 (1.4 -2.9)	0.30
Revascularization	40	0.62	45%	2.2 (1.7 -2.7)	2.0 (1.6 -2.7)	0.023
Readmission	5	0.66	40%	1.1 (0.9 -1.3)	1.3 (1.1 -1.4)	0.016
Congestive Heart Failure	15	0.66	30%	2.1 (1.6 -2.9)	2.0 (1.6 -2.7)	0.041
Secondary Arrhythmias	4	0.56	60%	1.8 (1.3 - 2.3)	1.5 (1.1 -1.9)	0.32
Advanced AV Block	3	0.58	60%	1.5 (1.4 -2.2)	1.4 (1.2 -1.7)	0.03

of the Tei index between the two groups was relatively small (Table 2). Sensitivity and Specificity of Tie index and EF was compared and shown in Table 3. Tei index >0.40 and EF <45% were found as significant predictors of subsequent complications, but this was found that tei index of > 0.4 has better sensitivity and specificity in predicting cardiac complications after acute STEMI. About 22% of the patients with normal EF, showed abnormal Tie Index. Out of these 22%, 97% of the patients developed cardiac complications.

Table 3: Prediction of Cardiac Complications with Acute ST elevation Myocardial Infarction by Tei Index.

	Sensitivity	Specificity	Accuracy
Tei Index > 0.40	86%	82%	83%
EF < 40%	65%	50%	58%

Discussion

Acute MI is characterized by variable degrees of LV systolic and diastolic dysfunction, which have both been reported to have independent prognostic value.[16-20] It is hypothesized that a measure of combined systolic and diastolic myocardial function is a better predictor of global LV function and outcome in patients with acute STEMI. Abnormalities and changes in LV systolic and diastolic time intervals have been described but less thoroughly studied in relation to outcome. In the present study, the Tei index, which combines systolic and diastolic time intervals, was compared with conventional echocardiographic variable (EF) and was correlated with outcome in patients with acute ST elevation MI. The isovolumetric contraction time was significantly prolonged (100msec) and ejection time shortened (150msec) in patients with MI. These alterations in time intervals resulted in a significant increase in the value of the Tei index in patients with MI.

An abnormal index (>0.40) was found in 90.6 % of the patients with MI, whereas an ejection fraction (<50%) was present in 98%. The index was significantly more sensitive than the ejection fraction in the prediction of LV dysfunction based on the clinical development of cardiac complications. The index was significantly higher and the ejection fraction lower in patients with cardiac complications than in those without heart failure. Shortening of the ejection time and prolongation of the isovolumetric contraction time has previously been demonstrated in patients with cardiac complications, consistent with the findings in this study.[21] Ejection fraction as measured by 2-dimensional echocardiography has a good interest correlation when the LV geometry is uniform. However, if the

ventricular chamber is irregular, as is typical after infarction, the true volume by echocardiography is less accurate.[21] Thus measurement of ejection fraction after MI may be less reliable by the biplane Simpson method because it depends on ventricular geometry, which is abnormal.[15] In contrast, the Tei index does not depend on ventricular geometry and incorporates diastolic function in addition to systolic function. Thus the index is expected to be more sensitive than simple measurement of the systolic ejection fraction, which was confirmed in the present study according to sensitivity and specificity results. Furthermore, the index is easily obtained within a few minutes and therefore does not substantially prolong the acquisition time of the echocardiographic examination.

A prediction of complications with STEMI from echocardiographic functional indices has been investigated. Fleischmann et al found that WMSI, Left Ventricular EF, and restrictive LV filling enable the prediction of complications.[22] Møller et al have differentiated normal from pseudo normal/restrictive mitral flow and shown that pseudo normal or restrictive mitral flow pattern enables the prediction of complications after a first acute MI[23] The use of the Tei index has been demonstrated in relation to patient prognosis, haemodynamic condition, right ventricular function, evaluation of restenosis after percutaneous transluminal coronary angioplasty, and other conditions.[24] However, study confirmed that Tei index which measures both systolic and diastolic dysfunction can predict cardiac complications more accurately.

Possible limitations in this study can be: Mitral and aortic flow velocity was recorded separately, with potential measurement variability. Although there was significant correlation between the Tei index and cardiac complications for patients with STEMI, the same correlation was not significant for patients with abnormal right ventricular function, abnormal atrioventricular conduction, in addition to LV function, can be significant determinants of hemodynamics in patients with these patients, which may result in the lack of significant correlation.

Further studies are needed to assess the long-term predictive value of the Tei index and the value of the Tei index during the post-MI remodeling process.

References

1. Zhang Y, Takagawa J, Sievers RE, Khan MF, Viswanathan MN, Springer ML et al. Validation of the wall motion score and myocardial performance indexes as novel techniques to assess cardiac function in mice after myocardial infarction. Am J Physiol Heart Circ Physiol; 2007: 292: H1187-H1192.
2. Cacciapuoti F, Arciello A, Fiandra M, Manfredi E, Cacciapuoti F, Lama D. Index of myocardial performance after early phase of myocardial infarction in relation to its location. J Am Soc of Echocardiogr 2004; 17: 345-49.
3. Tei C, Ling LH, Hodge DO, Bailey KR, Oh JK, Rodeheffer RJ, et al. 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 1995; 26:357-66.
4. Otsuji Y, Chuwa Tei C. Evaluation of left ventricular filling pressures by the Tei index: Reply Am Soc Echocardiogr - 2004; 17; 710.
5. Tham E, Silverman NH. Measurement of the Tei index: A comparison of M-mode and pulse Doppler methods J Am Soc Echocardiogr 2004; 17: 1259-65.
6. Cui W, Roberson DA. Left Ventricular Tei Index in Children: Comparison of Tissue Doppler Imaging, Pulsed Wave Doppler, and M-Mode Echocardiography, Normal Values. J Am Soc Echocardiogr 2006; 19: 1438-45.
7. Ärnlöv J, Ingelsson E, Risérus U, Andrén B and Lind L. Myocardial performance index, a Doppler-derived index of global left ventricular function, predicts congestive heart failure in elderly men. European Heart Journal 2004 25:2220-5.
8. Lind L, Andrén B, and Ärnlöv J. The Doppler-Derived Myocardial Performance Index Is Determined by Both Left Ventricular Systolic and Diastolic Function as Well as by after load and Left Ventricular Mass. Echocardiography 2005; 22: 211-6.
9. Kim WH, Otsuji Y, Yuasa T, Minagoe S, Seward JB, and Tei C. Evaluation of right ventricular dysfunction in patients with cardiac amyloidosis using Tei index . J Am Soc Echocardiogr 2004; 17: 45-49.
10. Boissiere J,Gautier M, Machet MC, Hanton G, Bonnet P, Eder V. Doppler tissue imaging in assessment of pulmonary hypertension-induced right ventricle dysfunction. Am J Physiol Heart Circ Physiol 2005; 289: H2450-H2455.
11. Nunes MCP, Rocha MOC, Ribeiro ALP. Right ventricular dysfunction is an independent predictor of survival in patients with dilated chronic Chagas' cardiomyopathy. Internat J Cardiol 2008; 127: 372-9.
12. Kirkpatrick JN, Vannan MA, Narula J, Lang J, Lang RM. Echocardiography in Heart Failure J Am Coll Cardiol, 2007; 50: 381-96.
13. Bruch C, Schmermund A, Martin D, Katz M, Bartel T, Schaar J, Erbel R. Tei-Index in patients with mild-to-moderate congestive heart failure . European Heart Journal 2000; 21:1888-95.
14. Popovic A, Neskovic N, Marinkovic J, Lee JC, Tan M, Thomas JD. Serial assessment of LV chamber stiffness after acute MI. Am J Cardiol 1996; 77:361-4.
15. Schiller NB, Shah PM, Crawford M, Cerqueira MD, Weissman NJ, Dilsizian V. American Society of echocardiography Committee on standards, Sub committee on Quantification of two dimensional echocardiograms. Recommendations for quantification of left ventricle by Simpson's rule via two dimensional Echocardiography. J Am Soc Echocardiogr 1989; 2:358-67
16. Tei C, Dujardin KS, Hodge DO, Kyle RA, Tajik AJ, Seward JB. Doppler index combining systolic and diastolic myocardial performance: clinical value in cardiac amyloidosis. J Am Coll Cardiol 1996; 28:658-64.
17. Yeo TC, Dujardin KS, Tei C, Mahoney DW, McGoon MD, Seward JB. Value of a Doppler-derived index combining systolic and diastolic time intervals in predicting outcome in primary pulmonary hypertension. Am J Cardiol 1998; 81: 1157-61.
18. Dujardin KS, Tei C, Yeo TC, Hodge DO, Rossi A, Seward JB. Prognostic value of a Doppler index combining systolic and diastolic performance in idiopathic-dilated cardiomyopathy. Am J Cardiol 1998; 82: 1071-6.
19. Poulsen SH, Jensen SE, Tei C,. Seward JB, Egstrup K. Value of the Doppler Index of Myocardial Performance in the Early Phase of Acute Myocardial Infarction. J Am Soc Echocardiogr 2000; 13: 723-30.
20. Poulsen SH, Jensen SE, Nielsen JC, Møller JE, Egstrup K. Serial changes and prognostic implications of a Doppler-derived index of combined left ventricular systolic and diastolic myocardial performance in acute myocardial infarction. Am J Cardiol 2001; 87:128.
21. Darasz KH, Underwood SR, Bayliss J, Forbat SM, Keegan J, Poole-Wilson PA, et al., Measurement of left ventricular volume after anterior myocardial infarction: comparison of magnetic resonance imaging, echo and radionuclide ventriculography. Internat J Cardiovascular Imaging 2002; 18: 387-90.
22. Fleischmann KE, Lee TH, Come PC, Goldman L, Cook EF, Caguoia E, et al. Echocardiographic Prediction of Complications in patients with chest pain. Am J Cardiol. 1997; 79:292-8.
23. Moller JE, Bergeron S, Bailey KR, Chen HH, Burnett JC, Pellikka PA. Serial changes in regional diastolic left ventricular function after acute ST elevation myocardial infarction. J Am Soc Echocardiogr 2005; 18: 1173-80.
24. Takasaki K, Otsuji Y, Yoshifuku S, Kuwahara E, Yuasa T, Rahim AE et al. Noninvasive estimation of impaired hemodynamics for patients with acute myocardial infarction by Tei index. J Am Soc Echocardiogr 2004; 17: 615-21.