The Egyptian Heart Journal (2011) **63**, 1–6

Egyptian Society of Cardiology

The Egyptian Heart Journal

www.elsevier.com/locate/ehj
www.sciencedirect.com

ORIGINAL ARTICLE

Conventional and segmental myocardial Tei indices measurement in patients with acute ST-segment elevation myocardial infarction: Is there a relation?

Eid M. Daoud

The Department of Cardiology, Faculty of Medicine, Mansoura University, Mansoura, Egypt

Received 20 February 2011; accepted 23 March 2011
Available online 9 November 2011

KEYWORDS

Tei index;
Myocardial infarction;
Tissue Doppler imaging

Abstract *Background:* Myocardial infarction (MI) results in impairment of left ventricular (LV) systolic and diastolic functions to various degrees. The tissue Doppler image derived Tei index (TDI-Tei index) has recently been used to assess LV function, and like the conventional Tei index, it was also found to be useful for global function. There are a small number of studies which apply TDI-Tei index to assess regional function and whether it varies according to the degree of changes in wall motion in various LV segments.

Objectives: This study was conducted to assess the changes of segmental myocardial Tei index by TDI according to the degree of changes of wall motion in the patient with acute ST-segment elevation myocardial infarction (STEMI) and its correlation with Tei index derived by conventional Doppler.

Patients and methods: This study was carried out on thirty patients with acute STEMI selected from Coronary Care Unit, Cardiology Department, Mansoura Specialized Hospital, Mansoura University, Egypt. The study group was subjected to clinical assessment, electrocardiography (ECG), routine laboratory profile and Doppler echocardiography (conventional and pulsed wave tissue Doppler imaging "PW-TDI"). Tei index was calculated from the sum of isovolumetric contraction time (IVCT) and isovolumetric relaxation time (IVRT), divided by ejection time (ET) which were measured from pulsed wave Doppler imaging of the trans-mitral inflow and LV outflow tracts. Myocardial velocities and TDI-Tei index were measured at basal and mid-segments of LV walts from apical 4, 2 and 5-chamber views using 16-segment model. Average values of myocardial velocities and TDI-Tei indices were obtained from normal, hypokinetic and akinetic segments then compared.

E-mail address: eiddaoud@yahoo.com

Peer review under responsibility of Egyptian Society of Cardiology.
doi:10.1016/j.ehj.2011.08.002

ELSEVIER **Production and hosting by Elsevier**

Results: The mean values of left ventricular ejection fraction (LVEF), mitral E/A ratio and conventional Tei index were 51.83 ± 5.15%, 1.18 ± 0.15 and 0.63 ± 0.07 ms, respectively. Segmental myocardial TDI-Tei index was correlated positively with conventional Tei index ($r = 0.648$, $P < 0.001$). TDI-Tei indices were significantly higher in akinetic and hypokinetic segments than those of normal segments (0.70 ± 0.09, 0.64 ± 0.05 vs 0.63 ± 0.05, $P < 0.001$).
Conclusions: Tei index (either conventional or TDI) is superior to EF in evaluation of LV performance in patients with acute STEMI. Tei index derived by myocardial segments by TDI is correlated with conventional Tei index. Segmental TDI-Tei index values differ according to the grade of dysfunctional wall motion.

1. Introduction

Myocardial infarction results in impairment of left ventricular (LV) systolic and diastolic functions to various degrees.[1] These functions are energetically and tightly coupled at different three levels: (1) cellular level, since adenosine triphosphate is a substance essential for both active contraction and relaxation,[2] (2) myocardial level, because regional wall motion asynchrony influences global LV diastolic function (contraction-relaxation axis)[3] and (3) hemodynamic level, because systolic function indirectly affects LV filling pressures.[4]

The Tei index is a Doppler-derived time interval index that combines both systolic and diastolic cardiac performances. The Tei index is easily derived using conventional pulsed Doppler echocardiography, as previously described by Tei and colleagues.[5]

The tissue Doppler image derived Tei index (TDI-Tei index) has recently been used to assess LV function, and like the conventional Tei index, it was also found to be useful for global function.[6–8]

There is a small number of studies which apply TDI-Tei index to assess regional function and whether it varies according to the degree of changes in wall motion in various LV segments.

2. Objectives

This study was conducted to assess the changes of segmental myocardial Tei index by TDI according to the degree of changes of wall motion in patient with acute ST-segment elevation myocardial infarction (STEMI) and its correlation with Tei index derived by conventional Doppler.

3. Patients and methods

3.1. Study populations

This study was carried out on 30 patients with acute STEMI selected from Coronary Care Unit, Cardiology Department, Mansoura Specialized Hospital, Mansoura University, Egypt, from December 2010 to April 2011. Patients with atrial fibrillation, left bundle branch block and inadequate echocardiographic evaluation of myocardial segments were excluded from this study.

The study group was subjected to clinical assessment, electrocardiography (ECG), routine laboratory profile and Doppler echocardiography (conventional and pulsed wave tissue Doppler imaging "PW-TDI").

3.2. Clinical assessment

All patients were subjected to thorough history taking, full physical examination with special focusing on age, sex and coronary artery disease risk factors.

3.3. Echocardiography

M-mode, 2-dimensional and pulsed wave echocardiography was performed according to 2005 American Society of Echocardiography recommendations.[9] Using GE (vivid 3 pro) NORWAY with 2.5 MHz multifrequency transducer.

M-mode and 2-dimensional echocardiography: done to measure LV dimensions wall thickness and LV ejection fraction (LVEF) measured by modified Simpson's biplane method. Regional wall motion was assessed according to 16-segment model and classified as normal, hypokinetic and akinetic depending on visual assessment.
Conventional Tei index was calculated from the sum of isovolumetric contraction time (IVCT) and isovolumetric relaxation time (IVRT), divided by ejection time (ET) which was measured from pulsed wave Doppler imaging of the trans-mitral inflow and LV outflow tracts.

3.4. Tissue Doppler imaging: done to measure

Myocardial velocities of each cardiac segments; systolic (Sm), early (Em) and late (Am) diastolic velocities.
Tissue Doppler imaging Tei index: IVCT, IVRT and ET were measured from pulsed wave-TDI on myocardial segments.
Myocardial velocities and TDI-Tei index were measured at basal and mid-segments of LV walts from apical 4, 2 and 5-chamber views.
Average values of myocardial velocities and TDI-Tei indices were obtained from normal, hypokinetic and akinetic segments then compared.

3.5. Statistical analysis

Data were analyzed using SPSS (Statistical Package for Social Sciences) version 10. Qualitative data were presented as number and percent. Quantitative data were tested for normality by Kolmogorov–Smirnov test. Normally

distributed data were presented as mean ± SD. *F*-test (one way Anova) was used to compare between more than two groups. Pearson's correlation coefficient was used to test the correlation between variables. $P < 0.05$ was considered to be statistically significant.

4. Results

Table 1 summarize baseline clinical characteristics of 30 patients with acute STEMI.

Table 1 Baseline clinical characteristics of the study group ($n = 30$ patients).

Age (years)	50.7 ± 7.8
Gender	
Male (*n*, %)	22 (73.3%)
Female (*n*, %)	8 (26.7%)
Diabetes mellitus (*n*, %)	17 (56.7%)
Hypertension (*n*, %)	20 (66.7%)
Hypercholesterolemia (*n*, %)	16 (53.3%)
Smoking	
Current (*n*, %)	16 (53.3%)
Ex smoker (*n*, %)	8 (26.7%)
Non-smoker (*n*, %)	6 (20%)
Type of myocardial infarction (site of ST elevation)	
Anterior	10 (33.3%)
Inferior	6 (20%)
Lateral	3 (10%)
Antero-septal	4 (13.3%)
Inferolateral	3 (10%)
Anterior and inferior	4 (13.3%)

Table 2 shows the mean values of LVEF, mitral E/A ratio and conventional Tei index are 51.83 ± 5.15%, 1.18 ± 0.15 and 0.63 ± 0.07 ms, respectively. Segmental myocardial Tei index, Em and Am were measured by PW-TDI at 282 myocardial segment and there mean values 0.64 ± 0.06 ms, 5.3 ± 1.2 cm/s, 5.8 ± 1.34 cm/s and 6.1 ± 1.09 cm/s, respectively. There are significant decreases of Sm, Em and Am among dysfunctional segments (akinetic $n = 54$ and hypokinetic $n = 48$) in comparison with normal segments ($n = 180$) ($P < 0.05$, Table 3). Also there is significant increase of average value of TDI-Tei index among dysfunctional segments when compared with normal segments (0.70 ± 0.09, 0.64 ± 0.05 vs 0.63 ± 0.48, respectively, $P < 0.001$, Table 3).

Table 2 Echocardiographic data of study group ($n = 30$ patients).

EDD (cm)	5.5 ± 0.38
ESD (cm)	3.67 ± 0.30
PWT (cm)	1.18 ± 0.13
IVST (cm)	1.18 ± 0.15
LVEF (%)	51.83 ± 5.15
Mitral E/A ratio	1.14 ± 0.36
Conventional Tei index (ms)	0.63 ± 0.07
Sm (cm/s)	5.3 ± 1.2
Em (cm/s)	5.8 ± 1.34
Am (cm/s)	6.1 ± 1.09
TDI-Tei index (ms)	0.64 ± 0.06

EDD = End diastolic diameter.
ESD = End systolic diameter.
PWT = Posterior wall thickness.
IVST = Interventricular septum thickness.
LVEF = Left ventricular ejection fraction.
Mitral E/A ratio = Mitral early to late diastolic velocity.
Sm = Systolic myocardial velocity.
Em = Early diastolic myocardial velocity.
Am = Late diastolic myocardial velocity.
TDI-Tei index = Tissue Doppler imaging derived Tei index.

On study of the correlation between segmental myocardial TDI-Tei index and some of echocardiographic variables (Table 4 and Figs. 1 and 2). There are negative correlation between

Table 3 Segmental tissue Doppler echocardiographic data ($n = 282$ segments).

	Normal segments ($n = 180$)	Hypokinetic segments ($n = 48$)	Akinetic segments ($n = 54$)	*P* value
Sm (cm/s)	6.12 ± 0.79	5.22 ± 0.68	4.56 ± 0.60	< 0.001
Em (cm/s)	6.34 ± 1.3	5.62 ± 1.29	5.60 ± 1.22	0.040
Am (cm/s)	6.99 ± 1.34	5.94 ± 1.26	5.79 ± 1.19	< 0.001
TDI-Tei index (ms)	0.63 ± 0.05	0.64 ± 0.05	0.70 ± 0.09	< 0.001

Sm = Systolic myocardial velocity.
Em = Early diastolic myocardial velocity.
Am = Late diastolic myocardial velocity.
TDI-Tei index = Tissue Doppler imaging derived Tei index.

Table 4 Correlation between TDI-Tei index and some echocardiographic variables.

Variable	Conventional Tei index	LVEF	Mitral E/A ratio	Sm
TDI-Tei index				
r	0.648	−0.352	−0.301	−0.459
P	< 0.001	0.046	0.105	0.011

LVEF = Left ventricular ejection fraction.
Mitral E/A ratio = Mitral early to late diastolic velocity.
Sm = Systolic myocardial velocity.

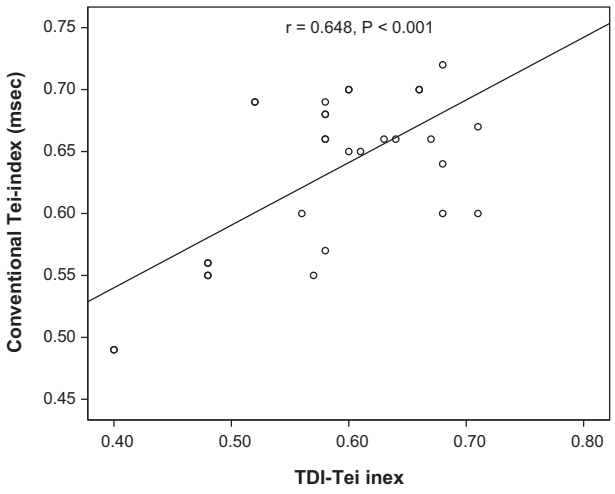

Figure 1 Correlation between segmental myocardial TDI-Tei index and conventional Tei index.

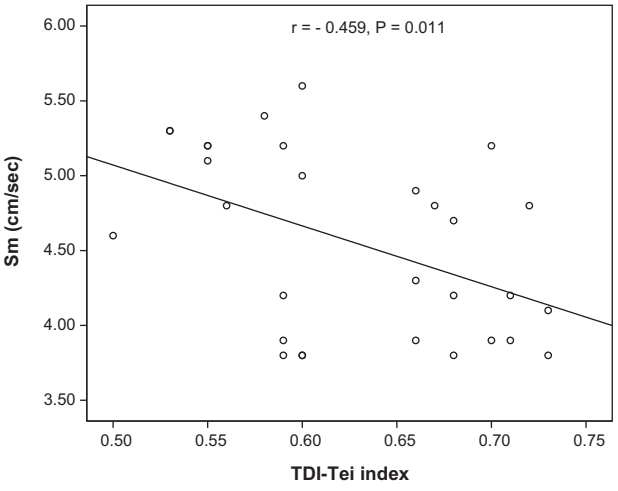

Figure 2 Correlation between segmental myocardial TDI-Tei index and systolic myocardial velocity.

TDI-Tei and LVEF and Sm ($P < 0.05$) and positive correlation between TDI-Tei index and conventional Tei index ($P < 0.001$).

5. Discussion

The Tei index appears to have close correlation with the widely accepted systolic and diastolic hemodynamic parameters[10,11] as well as potential for clinical application in the assessment of overall cardiac performance.[12,13] Furthermore, during its short life span from 1995 until today, the Tei index has been shown to have a strong prognostic value in severe cardiac diseases, such as dilated cardiomyopathy,[13,14] cardiac amyloidosis[12] pulmonary hypertension[15,16] and recently in myocardial infarction.

The Tei index is simple, non-invasive, easy to estimate and reproducible.[5,12,17] A number of studies have documented that the Tei index is independent of arterial pressure,[18–20] heart rate[21] ventricular geometry, atrioventricular valve regurgitation,[22,23] after load[24] and preload in patients who are in a supine position.[25]

The mean normal value of the Tei index by conventional pulsed Doppler echocardiography is 0.39 ± 0.05 ms for the LV.[5] Higher index values correspond to more pathological states with overall cardiac dysfunction.

Doppler index of myocardial performance considered as a unique indicator of global ventricular function and as a prognostic predictor in post-myocardial infarction.[5,17]

Recent studies have shown that TDI-Tei index could be measured at the mitral annulus and correlated well with the conventional Tei index,[26,27] Baek and his colleagues[28] were the first group to study the usefulness of segmental derived TDI-Tei index in patients with regional wall motion abnormalities.[28] Therefore, the current research study the changes of segmental myocardial Tei index by TDI according to the degree of changes of wall motion in patient with acute STEMI and its correlation with Tei index derived by conventional Doppler.

On reviewing the conventional echocardiographic parameters we found in patients with STEMI have decreased the mean value of LVEF and E/A ratio (Table 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 spherical one.[29] On the other hand, trans-mitral flow, which is the most frequent method for the evaluation of diastolic function is dependent on age,[30] heart rate,[31] as well as loading conditions.[32]

The present study reveals a significant negative correlation between LVEF and Tei index either derived by conventional or tissue Doppler imaging and this matched with the results of Lacorte et al.[11] who demonstrated that Tei index maintains a strong inverse relation with ejection fraction.

Poulsen et al.[33] demonstrated that in early phase of myocardial infarction the index is more sensitive in the detection of LV dysfunction and of the rate of heart failure development. In the late post-infarction phase, the sensitivity of the index was higher than that of EF in patients with an adverse outcome as concluded by Poulsen et al.[34]

Many of the studies have shown that the Tei index reflects the severity of LV diastolic dysfunction in the hyperacute[33] and chronic phases[34] of myocardial infarction, while it pseudonormalizes during the acute phase of myocardial infarction in patients with restrictive physiology[35] as well as in patients with isolated diastolic heart failure.[36]

In this research, there is a strong positive correlation between the Tei index calculated by conventional Doppler and segmental myocardial TDI-Tei index in patients with acute STEMI, and this result matched with the results of Baek et al.[28] and Duzenli et al.[37]

There was a weak negative correlation between segmental myocardial Tei index and systolic velocity calculated by PW-TDI on each myocardial segment and this may be attributed to the assessment of systolic velocity in the early phase of acute MI.

Baek et al.[28] demonstrated that the sum of segmental TDI-Tei indices correlated with the conventional Tei index, each value was significantly different according to the degree of wall motion abnormalities. Also, there was a significant negative correlation between the TDI-Tei index and Sm.

In this study, the segmental myocardial TDI-Tei index shows significant increase when comparing the akinetic and hypokinetic segments with normal segments. On the other hand, there is significant decrease of systolic velocity (Sm) studied by TDI for different segments, and this results supported by the results of Baek et al.[28] who demonstrate that myocardial TDI-Tei indices were significantly increased in dysfunctional segments.

6. Study limitations

This study evaluates the Tei index (either by conventional or TDI) in the early phase of acute STEMI and a long-term study is needed to evaluate more prognostic value.

This study evaluates the LV segmental TDI-Tei index without respect to the location of myocardial infarction. Tei index for the LV of the patient who has an anterior myocardial infarction is significantly higher than that of those with an inferior myocardial infarction.[18,34,38]

Individual myocardial segmental TDI-Tei indices were significantly different and so not sufficient to represent the global LV function in patients with segmental wall motion abnormalities.

In this work, TDI-Tei index evaluated in the early phase without studying the effect of early reperfusion (either by thrombolysis or primary PCI). Large study needed to study the effect of revascularization options on the segmental myocardial performance indices.

Unreliable and difficult determinations of Tei index in patients with atrial fibrillation, ventricular extrasystole, atrioventricular and intraventricular conduction disturbances which are common in patients with acute STEMI.

7. Conclusions

Tei index (either conventional or TDI) is superior to EF in the evaluation of LV performance in patients with acute STEMI.

Tei index derived by the myocardial segments by TDI is correlated with conventional Tei index.

Segmental TDI-Tei index values differ according to the grade of dysfunctional wall motion.

A long-term study is required before TDI-Tei index introduction into routine clinical evaluation of LV performance in patients with STEMI.

References

1. Karatzis EN, Giannakopoulou AT, Papadakis JE, Karazachos NS, Nearchou NS. Myocardial performance index (Tei-index): evaluating its application to myocardial infarction. *Hellenic J Cardiol* 2009;**50**:60–5.
2. Bonow R, Udelson J. Left ventricular diastolic dysfunction as a cause of congestive heart failure. Mechanisms and management. *Ann Intern Med* 1992;**117**:502–10.
3. Perrone F, Bacharach S, Dilsizian V, Bonow R. Effects of regional systolic asynchrony on left ventricular global diastolic function in patients with coronary artery disease. *J Am Coll Cardiol* 1992;**19**:739–44.
4. Yamamoto K, Nishimura R, Chaliki H, Appleton C, Holmes D, Redfield M. Determination of left ventricular filling pressure by Doppler echocardiography in patients with coronary artery disease: critical role of left ventricular systolic function. *J Am Coll Cardiol* 1997;**30**:1819–26.
5. Tei C, Ling L, Hodge D, et al. New index of combined systolic and diastolic myocardial performance: a simple and reproducible measure of cardiac function – a study in normals and dilated cardiomyopathy. *J Cardiol* 1995;**26**:357–66.
6. Abd El-Rahman MY, Hui W, Dsebissowa F, et al. Comparison of the tissue Doppler-derived left ventricular Tei index to that obtained by pulse Doppler in patients with congenital and acquired heart disease. *Pediatr Cardiol* 2005;**26**:391–5.
7. Su HM, Lin TH, Voon WC, et al. Differentiation of left ventricular diastolic dysfunction, identification of pseudonormal/restrictive mitral inflow pattern and determination of left ventricular filling pressure by Tei index obtained from tissue Doppler echocardiography. *Echocardiography* 2006;**23**:287–94.
8. Sohn IS, Hang HS, Kim SJ, et al. Tissue Doppler image-derived myocardial performance (Tei index) as a simple assessment of global cardiac function in adults. *Korean Circ J* 2005;**35**:315–21.
9. Lang RM, Bierig M, Devereux RB, et al. 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* 2005;**18**:1440–63.
10. Tei C, Nishimura R, Seward J, Tajic A. Noninvasive Doppler derived myocardial performance index: correlation with simultaneous measurements of cardiac catheterization measurements. *J Am Soc Echocardiogr* 1997;169–78.
11. Lacorte J, Cabreriza S, Rabkin D, et al. Correlation of the Tei index with invasive measurements of ventricular function in a porcine model. *J Am Soc Echocardiogr* 2003;**16**:442–7.
12. Tei C, Dujardin K, Hodge D, Kyle R, Tajik A, Seward J. Doppler index combining systolic and diastolic myocardial performance: clinical value in cardiac amyloidosis. *J Am Coll Cardiol* 1996;**28**:658–64.
13. Dujardin K, Tei C, Yeo T, Hodge D, Rossi A, Seward J. Prognostic value of a Doppler index combining systolic and diastolic performance in idiopathic dilated cardiomyopathy. *Am J Cardiol* 1998;**82**:1071–6.
14. Ikeda R, Yuda S, Kobayashi N, et al. Usefulness of right ventricular Doppler index for predicting outcome in patients with dilated cardiomyopathy. *J Cardiol* 2001;**37**:157–64.
15. Yeo T, Dujardin K, Tei C, Mahoney D, McGoon M, Seward J. 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.
16. Grapsa I, Pavlopoulos H, Dawson D, Gibbs JS, Nihoyannopoulos P. Retrospective study of pulmonary hypertensive patients: is right ventricular myocardial performance index a vital prognostic factor? *Hellenic J Cardiol* 2007;**48**:152–60.
17. Tei C. New non-invasive index of combined systolic and diastolic ventricular function. *J Cardiol* 1995;**26**:135–6.
18. Nearchou N, Tsakiris A, Stathakopoulos D, Loutsidis K, Skoufas P. A new Doppler index combining systolic and diastolic myocardial performance. Behavior and significance during hospitalization of patients with acute myocardial infarction. *Hellenic J Cardiol* 1999;**40**:486–96.
19. Moller J, Sondergaard E, Poulsen S, Appleton C, Egstrup K. Serial Doppler echocardiographic assessment of left and right ventricular performance after a first myocardial infarction. *J Am Soc Echocardiogr* 2001;**14**:249–55.
20. Bruch C, Schmermund A, Marin D, et al. Tei index in patients with mild to moderate congestive heart failure. *Eur Heart J* 2000;**21**:1888–95.

21. Poulsen S, Nielsen J, Andersen H. The influence of heart rate on the Doppler derived myocardial performance index. *J Am Soc Echocardiogr* 2000;**13**:379–84.
22. Tei C, Dujardin K, Hodge D, et al. Doppler echocardiographic index for assessment of global right ventricular function. *J Am Soc Echocardiogr* 1996;**9**:838–47.
23. Lengyel M. Effect of chronic amiodarone therapy on left ventricular function in dilated cardiomyopathy studied by the new Doppler-index. *Orv Hetil* 1998;**139**:1147–51.
24. Nishimura E, Ikeda S, Naito T, et al. Evaluation of right-ventricular function by Doppler echocardiography in patients with chronic respiratory failure. *J Int Med Res* 1999;**27**:65–73.
25. Moller J, Poulsen S, Egstrup K. Effect of preload alterations on a new Doppler echocardiographic index of combined systolic and diastolic performance. *J Am Soc Echocardiogr* 1999;**12**:1065–72.
26. Baykan M, Erem C, Gediki O, et al. Assessment of the Tei index by tissue Doppler imaging in patients with acromegaly: serum growth hormone level is associated with the Tei index. *Echocardiography* 2008;**25**:374–80.
27. Harada K, Tamura M, Toyono M, Yasuoka K. Comparison of the right ventricular Tei index by tissue Doppler imaging to that obtained by pulsed Doppler in children without heart disease. *Am J Cardiol* 2002;**90**:566–9.
28. Baek HK, Park TH, Park JS, Seo JM, Park SY, Kim BG, et al. Segmental tissue Doppler image-derived Tei index in patients with regional wall motion abnormalities. *Korean Circ J* 2010;**40**:114–8.
29. Kuroda T, Seward J, Rumberger J, Yanagi H, Tajik A. LV volume and mass: comparative study of two-dimensional echocardiography and ultrafast computed tomography. *Echocardiography* 1994;**11**:1–9.
30. Bryg R, Williams G, Labovitz A. Effect of aging on left ventricular diastolic filling in normal subjects. *Am J Cardiol* 1987;**59**: 971–4.
31. Harrison M, Clifton G, Pennell A, Demaria A. Effect of heart rate on left ventricular diastolic transmitral flow velocity patterns assessed by Doppler echocardiography in normal subjects. *Am J Cardiol* 1991;**167**:622–7.
32. Berk M, Xie G, Kwan O, et al. Reduction of left ventricular preload by lower body negative pressures alters Doppler transmitral filling patterns. *J Am Coll Cardiol* 1990;**16**:1387–92.
33. Poulsen S, Jensen S, Tei C, Seward J, 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.
34. Poulsen S, Jensen S, Nielsen J, Moller J, 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* 2000;**85**:19–25.
35. Nearchou N, Tsakiris A, Tsitsirikos M, et al. Tei index as a method of evaluating left ventricular diastolic dysfunction in acute myocardial infarction. *Hellenic J Cardiol* 2005;**46**:35–42.
36. Bruch C, Schmermund A, Dagres N, Katz M, Bartel T, Erbel R. Tei index in coronary artery disease validation in patients with overall cardiac and isolated diastolic dysfunction. *Z Kardiol* 2002;**91**:472–80.
37. Duzenli MA, Ozdemir K, Aygul N, Soylu A, Aygul MU, Gok H. Comparison of myocardial performance index obtained either by conventional echocardiography or tissue Doppler echocardiography in healthy subjects and patients with heart failure. *Heart Vessels* 2008;**24**:8–15.
38. Nearchou N, Tsakiris A, Lolaka M, et al. Influence of angiotensin II receptors blocking on overall left ventricle's performance of patients with acute myocardial infarction of limited extent. Echocardiographic assessment. *Int J Cardiovasc Imaging* 2006;**22**:191–8.