The Tei Index: Methodology and Disease State Values

Andrew A. Pellett, Ph.D., R.D.C.S.,* William G. Tolar, B.S.,† Darrin G. Merwin, B.S.,† and Edmund K. Kerut, M.D., F.A.C.C., F.A.S.E.‡,§

*Department of Cardiopulmonary Science, Louisiana State University Health Sciences Center, New Orleans, Louisiana, †Medical Center of Louisiana at New Orleans, New Orleans, Louisiana, ‡Heart Clinic of Louisiana, Marrero, Louisiana, §Division of Cardiology, Tulane University School of Medicine, New Orleans, Louisiana

Systolic and diastolic ventricular dysfunction frequently coexist. Both are important determinants of prognosis; consequently, a clinical measurement that assesses both systolic and diastolic function may be more useful than one that addresses only one aspect of ventricular function. Recently, a Doppler-derived index (referred to as the Tei index, or myocardial performance index) that combines systolic and diastolic time intervals has been developed to assess global cardiac function.[1] In this brief review we will discuss the measurement and utility of the Tei index.

The Tei index, which may be used to assess either left or right ventricular function, is equal to the sum of the isovolumic contraction time (ICT) and isovolumic relaxation time (IRT) divided by ejection time (ET). As originally described by Tei,[1] the time intervals used to calculate the index are measured using pulsed-wave Doppler velocity spectra of ventricular inflow and outflow. Mitral or tricuspid flow velocity spectra are obtained by positioning the pulsed-wave Doppler sample volume at the tips of the mitral or tricuspid valve leaflets in the apical four-chamber view. Left ventricular outflow velocity spectra may be obtained from either the apical five-chamber or the long-axis view, by positioning the pulsed-wave Doppler sample volume at the level of the aortic annulus. Right ventricular outflow velocity spectra are obtained from the parasternal short-axis view, with the pulsed-wave Doppler sample volume positioned at the pulmonic annulus. Calculation of the Tei index (Fig. 1) involves measuring the time interval a, extending from the cessation of mitral or tricuspid inflow to its subsequent onset, and ejection time b, which is the duration of the left or right

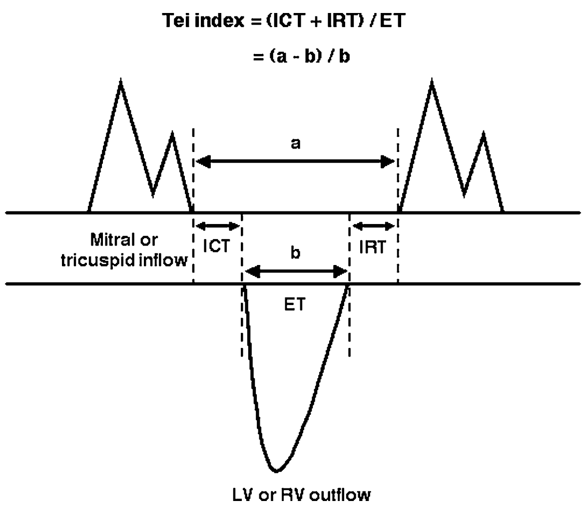

Figure 1. *Schema of Doppler flow velocity spectra representing the time intervals used for calculation of the Tei index. Interval 'a' extends from the cessation to the onset of mitral or tricuspid inflow. It includes the isovolumic contraction time, ejection time, and isovolumic relaxation time. Interval 'b' is the duration of left or right ventricular outflow (ejection time). The Tei index is equal to $(a - b)/b$. ET, ejection time; ICT, isovolumic contraction time; IRT, isovolumic relaxation time.*

Address for correspondence and reprint requests: Andrew A. Pellett, Ph.D., Associate Professor of Cardiopulmonary Science, Department of Cardiopulmonary Science, Louisiana State University Health Sciences Center, 1900 Gravier Street, New Orleans, LA 70112. Fax: 504-599-0410; E-mail: apelle@lsuhsc.edu

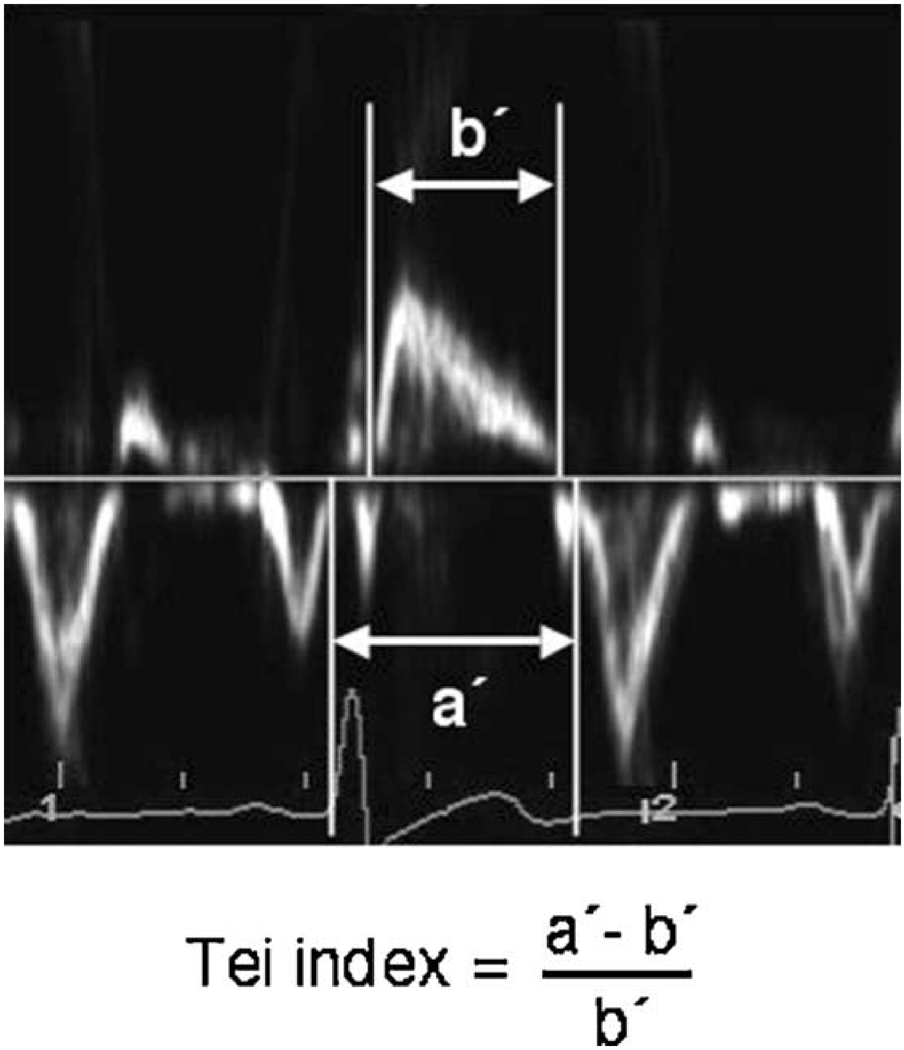

Figure 2. *Mitral annular velocity spectra obtained from tissue Doppler imaging. Interval a′ extends from the cessation of mitral inflow to its subsequent onset. Interval b′ extends from the beginning to the end of systolic mitral annular motion. The Tei index is equal to (a′ − b′)/b′.*

ventricular outflow velocity spectrum. As the time interval a includes the ICT, ET, and IRT, the Tei index can be expressed as follows:

$$\text{Tei index} = \frac{(\text{ICT} + \text{IRT})}{\text{ET}} = \frac{(\text{a} - \text{b})}{\text{b}}.$$

Typically, time intervals are measured at a sweep speed of 100 mm/sec and are averaged over at least 3–5 cardiac cycles.

A potential source of measurement error is the inability to acquire inflow and outflow velocity spectra during the same cardiac cycle. Therefore, pulsed-wave tissue Doppler imaging (TDI) has been introduced as another method of measuring time intervals.[2,3] From an apical four-chamber view, the TDI sample volume is positioned at the lateral aspect of the mitral or tricuspid annulus. Annular motion is recorded over at least 3–5 cardiac cycles at a sweep speed of 100 mm/sec. The Tei index is calculated with TDI using the same formula applied with conventional Doppler (Fig. 2). A close agreement exists between these two methodologies.[2,3]

Another method that avoids the potential for time interval measurement error has also been recently introduced.[4] It uses left ventricular area waveforms obtained with acoustic quantification to calculate the index.

TABLE I

Values of Tei Index in Patients with Cardiac Disease

Ventricle	Method	Diagnosis	Tei Index Control	Tei Index Disease	Reference
LV	Dopp	CHF (EF < 40%)		0.69 ± 0.30	14
	Dopp	CHF (EF < 30%)		0.86 ± 0.39	15
	Dopp	DCM (EF = 30–50%)	0.39 ± 0.05	0.59 ± 0.10	5
	Dopp	DCM (EF = 17%)	0.39 ± 0.05	1.06 ± 0.24	5
	Dopp	DCM	0.37 ± 0.05	0.85 ± 0.32	11
	Dopp	DCM (children)		0.78 ± 0.28	16
	Dopp	<3 years	0.40 ± 0.09		16
	Dopp	3–18 years	0.33 ± 0.02		16
	Dopp	DCM	0.36 ± 0.04	0.82 ± 0.20	2
	TDI	DCM	0.36 ± 0.04	0.82 ± 0.19	2
	Dopp	Systolic dysfunction	0.46 ± 0.08	1.07 ± 0.28	4
	AQ	Systolic dysfunction	0.51 ± 0.07	1.08 ± 0.26	4
	Dopp	Isolated diastolic dysfunction	0.46 ± 0.08	0.69 ± 0.11	4
	AQ	Isolated diastolic dysfunction	0.51 ± 0.07	0.68 ± 0.09	4
	Dopp	AMI		0.43 ± 0.12	17
	Dopp	AMI		0.43 ± 0.16	18
	Dopp	AMI (normal mitral flow)		0.47 ± 0.06	19
	Dopp	AMI (pseudo/res mitral flow)		0.66 ± 0.11	19
	Dopp	AMI (with CHF)	0.40 ± 0.04	0.65 ± 0.14	20
	Dopp	Amyloidosis	0.39 ± 0.04	0.81 ± 0.21	12
	Dopp	Allograft rejection	0.42 ± 0.12	0.83 ± 0.33	21
	Dopp	Aortic stenosis	0.40 ± 0.11		22
	Dopp	EF > 45%		0.29 ± 0.12	22
	Dopp	EF < 45%		0.78 ± 0.28	22
RV	Dopp	PPH	0.28 ± 0.04	0.84 ± 0.20	13
	Dopp	PPH	0.28 ± 0.04	0.89 ± 0.25	6
	Dopp	COPD, IPF, SPD		0.51 ± 0.23	23
	Dopp	Ebstein's anomaly		0.63 ± 0.09	24
	Dopp	Children	0.32 ± 0.03		24
	Dopp	Adults	0.28 ± 0.04		24
	Dopp	CC-TGA		0.72 ± 0.17	24
	Dopp	ASD (adults)		0.38 ± 0.04	24
	Dopp	Pulmonic stenosis		0.32 ± 0.06	24

AMI = acute myocardial infarction; AQ = acoustic quantification; ASD = atrial septal defect; CC-TGA = congenitally corrected transposition of the great arteries; CHF = congestive heart failure; COPD = chronic obstructive pulmonary disease; DCM = dilated cardiomyopathy; Dopp = conventional Doppler; EF = ejection fraction; IPF = idiopathic pulmonary fibrosis; LV = left ventricle; PPH = primary pulmonary hypertension; Pseudo/res = pseudonormal/restrictive; RV = right ventricle; SPD = suppurative pulmonary disease; TDI = tissue Doppler imaging.

The Tei index is a particularly useful means of assessing global ventricular function because it is simple and reproducible, is independent of ventricular geometry, and is not significantly affected by heart rate[5–8] or blood pressure.[5] Ventricular loading conditions also do not appear to affect the index to a clinically meaningful extent.[9] The index agrees with invasive measures of systolic and diastolic function[7,10] and can be used to determine prognosis in patients with various cardiac disorders including dilated cardiomyopathy, amyloidosis, and primary pulmonary hypertension.[11–13] Normal (control) and disease state values of the Tei index are provided in Table I.

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