Tissue Doppler Imaging and Doppler Studies in Patients with Transmural and Non-transmural Myocardial Infarction

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Abstract

Background-Myocardial longitudinal shortening play an important role in cardiac contraction(1,2).Tissue velocity imaging (TVI) is an ultrasonographic technique that measure myocardial motion and providing a quantitative agreement of left ventricular regional myocardial function in different modalities (3). The present review discusses the most recent development in the application of TDI in coronary artery disease .

Methods- Seventy patients with myocardial infarction (transmural and nontransmural) were included in the study. These subjects were diagnosed with recent myocardial infarction according to electrocardiography, cardiac enzymes and history. The basal segments of septal wall(septal side of mitral annulus) and basal segment of base of RV free wall were examined for tissue Doppler study with complete transthoracic echocardiography study.

Results- Mean age in group of inferior MI,anterior MI and non Q wave MI are as follows: 61.87±10.7, 57.04±10.7,58.45±9.2. Sm was significantly reduced in anterior MI groups than non Q wave MI (PV=0.01).In patients with inferior myocardial infarction 88% of patients had left ventricular ejection fraction (LVEF)>45% and in patients with anterior MI 18.2% patients had EF>45%.In non Q wave MI groups 60% patients had LVEF >45%.

Conclusion- Except for Sm, other TDI parameters had no significant difference between two groups (transmural and nontransmural infarction) but it has significant changes in reduced left ventricle function and could be of determinants for prognosis ***(Iranian Heart Journal 2011; 12 (4):25-29*****).**

Myocardial longitudinal shortening plays an important role in cardiac contraction.[1,2] Tissue velocity imaging (TVI) is an ultrasonographic technique that measures myocardial motion and provides a quantitative agreement of the left ventricular regional myocardial function in different modalities.[3] Tissue Doppler imaging (TDI) is a modification of conventional color Doppler technology in which directional velocity signals arising from the tissues are analyzed. Tissue Doppler (TD) velocities may be displayed either in color-encoded two-dimensional mode, M mode, or as a spectral pulsed wave (PW). TD, when performed online during the examination, measures instantaneous myocardial velocities.[3] The pulsed Doppler method of blood flow measurement has conventionally been applied to the evaluation of the cardiac function as tissue Doppler imaging.[4]

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In Doppler techniques for measuring the blood flow, a high pass filter is used to eliminate the high amplitude, low frequency signals from the moving tissues such as the vessel walls. In tissue Doppler imaging, the opposite is done, the low amplitude, high frequency signals from the blood are filtered away and the high amplitude, low velocity data from the moving muscle are preserved.[5]

Different studies have shown that TDI is more sensitive than conventional echocardiography in determining clinical myocardial abnormalities before the occurrence of left ventricular dilation and dysfunction.[5, 6] TDI is a diagnostic method that provides quantitative data about the myocardial function. Currently, a great deal of research is being conducted to explore the velocities of TDI in the diagnosis of myocardial ischemia. In ischemic segments, myocardial velocities are reduced. TDI parameters improve the prognostic evaluation. For example, a high Sm value in the basal segments represent lower mortality in patients with coronary artery disease.[7] The present review discusses the most recent development in the application of TDI in coronary artery disease.[5]

Methods

Study Population

Seventy patients with myocardial infarction (transmural and non-transmural) were included in the study. There were 54 men and 16 women with a mean age of 60 years (ranging from 34 to 80 years). These subjects were diagnosed with recent myocardial infarction (transmural and non-transmural infarction) according to electrocardiography, cardiac enzymes, and history. The patients were evaluated during the first week of the diagnosis of myocardial infarction. The basal segments of the septal wall (septal side of mitral annulus) and the basal segment of the base of the right ventricle free wall were examined for tissue Doppler study. The exclusion criteria were the absence of sinus rhythm, presence of left ventricular hypertrophy, pericardial diseases, infiltrative myocardial diseases, or abnormal septal wall motion caused by right ventricular pressure or volume overload.

Technique

All the patients underwent a complete transthoracic echocardiography study (2D, Doppler, color study), which was performed during the first week of admission, with GE vingmed vivid 7, with a 3.5-MHz transducer. The subjects were examined in the left lateral decubitus position and views were obtained at end expiration. Ejection fraction was determined visually and by using the modified Simpson's rule. The mitral and tricuspid flows were recorded with the pulsed Doppler technique in the apical window, with the sample volume placed at the tip of the valve leaflets. The Tei index of the right and left hearts was evaluated. The flow of the right upper pulmonary vein was also obtained. Then TVI mode was activated and the myocardial Doppler image with at least three consecutive cardiac cycles in the apical four-chamber view was digitized and stored on hardware for later review and analysis before online analysis could also be done.

Longitudinal wall motion velocity profiles were taken at the annulus (base of interventricular septum) and lateral of the right ventricle wall. The left ventricle segmentation scheme was based on the guidelines of the American Society of Echocardiography.[8] The following specific longitudinal wave form velocities, as noted in previous studies, were measured in 3 cardiac cycles and averaged: Sm (myocardial systolic shortening wave), Em and Am (early and late myocardial diastolic lengthening waves of the left ventricle, respectively) and STC, ETC and ATC (tissue Doppler study of lateral tricuspid annulus). The right upper pulmonary vein flow was obtained in the apical four-chamber view. The ratio between the early and late diastolic myocardial peak velocities (Em/Am ratio) for each segment was determined.

Data Analysis and Statistics

The reproducibility of the velocity measurement was tested with the use of TVI tracing from the septal left ventricle wall and lateral right ventricle wall in a subgroup of 15 randomly selected subjects by 2 independent blinded observers. The values were reported as mean ±SD. The means values were compared using the Student paired *t*-test or analysis of variance as appropriate. The reproducibility of the myocardial velocity measurements (intraobserver and interobserver) was calculated with the use of the correlation and repeatability coefficient (95% of differences <2SD) as adapted by the British Standard of Institution.[9,10] All values at $P<0.05$ were considered statistically significant.

Results

The mean age in the groups of inferior myocardial infarction (MI), anterior MI, and non Q wave MI are as follows: 61.87±10.7, 57.04±10.7, and 58.45±9.2, respectively. The Doppler flow velocity profiles across the mitral valve are summarized in Table I

Table I. EF and Doppler flow velocities across mitral and tricuspid valves, pulmonary vein, M (mitral), TC (tricuspid), PV (pulmonary vein)

	Anterior MI	Inferior MI	Non Q MI
EF	36	48.6	42.5
MVE(cm/s)	.66	.75	.7
MVA(cm/s)	.71	.78	.73
MV DT(ms)	197	220	228
MV E/A	.95	.96	1.05
IVRT(ms)	96	106	106
TCE(cm/s)	.41	.44	.43
TCA(cm/s)	.45	.43	.41
TC DT(ms)	253	273	267
PVs m/s	.45	.49	.46
PVD m/s	.43	.44	.42
PVAR m/s	.22	.25	.24
S/D ratio	1.11	1.2	1.13
Right Tei	.29	.33	.35
Left Tei	.44	.38	.46

Longitudinal Myocardial Velocity Components

Prominent or major velocity waveforms of the following Sm (an apically directed, positive deflection), Em (early or rapid filling phase), and Am (late or atrial contraction phase) were obtained, and these parameters were also obtained from the right ventricle lateral wall (Table II).

Table II. Longitudinal myocardial velocity, MI (myocardial infarction)

	Inferior MI	Anterior MI	Non Q MI
Sm	5.52	4.87	5.95
Em	6.64	5.3	5.65
Am	7.6	6.76	7.83
Em/Am	.83	.85	.79
STC	12.07	11.2	12.41
ETC	8.6	8.1	8.76
ATC	15	15	15.7

Sm was significantly reduced in the anterior MI group by comparison with that in the non Q wave MI group (P=0.01). In the group with inferior MI, 88% of the patients had left ventricular ejection fraction (LVEF)>45%; in the group with anterior MI, 18.2% of the patients had LVEF>45%; and in the non Q wave MI group, 60% of the patients had LVEF >45%.

The right Tei index of the right ventricle had no significant difference between the patients with inferior, anterior, or non Q wave MI.

A wave of the pulmonary vein was significantly reduced in the anterior MI group in comparison with that in the non Q wave MI group (P=0.02) (Tables III and IV).

Table III. LVEF 1 (left ventricular ejection fraction) 1=0-30%, LVEF 2=31-49%, LVEF 3=50-65%

	LVEF 1	LVEF 2	LVEF 3
R Tei	.41	.28	.3
L Tei	.52	.42	.38
S/D	1.03	1.15	1.3
S pv	.39	.47	.49
D pv	.4	.43	.42
AR pv	.23	.22	.24
Sm	4	5.6	5.8
Em	5	5.4	6.2
Am	5.9	7.5	7.9
Em/Am	.95	.77	.75
STC	10	12.16	12.25
ETC	8.6	8.4	8.3
ATC	155	14.6	15
ESV	61	56	43

Table IV. LVEF 1=0-30%, LVEF 2=31-49%, LVEF 3=50-65%

	LVEF 1	LVEF 2	LVEF 3
E mit	.66	.67	.7
A mit	.78	.72	.72
E/A mit	.82	1.05	.95

Sm was significantly reduced in the patients with LVEF< 30% in comparison to those with LVEF>=50% (P=.05). Am was reduced in the patients with LVEF<30% (P=.01), STC was reduced in the patients with LVEF<30% (P=.05), and S pv was reduced in the patients with LVEF<30% (P=.03).

Except for Sm, the other TDI parameters had no significant difference between the two groups of transmural and non-transmural infarction; however, it had significant changes in reduced left ventricular function and could be a determinant for prognosis.

Study Limitations

Avoiding noise and obtaining clear myocardial velocity profiles require good 2D color Doppler images. Thus, this technique might not be well applicable to images with poor echocardiographic windows.

Discussion

Myocardial longitudinal shortening plays an important role in cardiac contraction[1,2] Tissue velocity imaging (TVI) is an ultrasonographic technique that measures myocardial motion and provides a quantitative agreement of the left ventricular regional myocardial function in different modalities.[3] Indices derived from TDI, including systolic velocity (S') and early (E') and late (A') diastolic velocities of the lateral mitral annulus, are reduced in heart failure patients (LVEF < 30%) and portend a poor prognosis.[11]

In our study, Sm was significantly reduced in the patients with LVEF< 30% in comparison to those with LVEF>=50% (P=.05). Furthermore, Am was reduced in the patients with LVEF<30% (P=.01), STC was reduced in the patients with LVEF<30% (P=.05), and S pv was reduced in the patients with LVEF<30% (P=.03).

With the exception of Sm, the other TDI parameters had no significant difference between the two groups of transmural and non-transmural infarction. Be that as it may, it had significant changes in reduced left ventricle function and could be a determinant for prognosis.

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