ORIGINAL ARTICLE

ASSESSMENT OF LEFT VENTRICULAR SYSTOLIC AND DIASTOLIC FUNCTION BY TISSUE DOPPLER IMAGING AFTER ACUTE MYOCARDIAL INFARCTION

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Objective: To evaluate left ventricular systolic and diastolic function by Tissue Doppler imaging after acute myocardial infarction. **Methods:** It was a hospital based, prospective descriptive study, from 1st July 2010 to 31st Dec. 2010. Total of 200 patients having acute myocardial infarction underwent detailed tissue Doppler imaging (TDI) echocardiographic examination for evaluation of left ventricular systolic and diastolic function on day 3, in echocardiographic section of Govt. Lady Reading Hospital, Peshawar. Peak systolic (Sm), peak early diastolic (Em) and peak late diastolic (Am) velocities were recorded at 4 different sites of the mitral annulus. The ejection fraction and pulse wave TDI diastolic parameters were also recorded. Using SPSS version 16 data was analysed, frequencies and Mean±SD were determined for categorical and numerical variables, respectively. A *p*-value ≤0.05 was considered significant. **Results:** Total study sample was 200 patients having acute myocardial infarction (MI). The sample was divided into 4 groups, i.e., anterior MI, inferior MI, septal MI, and lateral MI. There were 122 men and 78 women and the mean age was 42±5 SD. There was a marked reduction in Sm velocity at mitral annulus, especially at the infarction sites. The mean peak systolic velocity from 4 mitral annulus sites was well correlated with ejection fraction (p=0.0001). Similar to systolic velocities, Em velocity was also reduced, especially at the infarction sites. The mean peak early diastolic velocity from 4 mitral annulus sites was well correlated with ejection fraction (p=0.0001). The mean Em velocity was correlated well with isovolumic relaxation time (IVRT). There was no correlation between mean Em velocity and deceleration time (DT). **Conclusion:** Tissue Doppler Imaging is a reliable, accurate and easily reproducible modality of echocardiography. The reduced peak systolic velocity and reduced peak early diastolic velocity seems to be an expression of regionally reduced systolic and diastolic functions, respectively. While the reduced mean systolic velocity and reduced mean early diastolic velocity from 4 mitral annulus sites are expressions of globally reduced systolic and diastolic functions, respectively and were correlated well with the ejection fraction.

Keywords: Tissue Doppler imaging, ejection fraction, peak systolic velocity, peak early diastolic velocity, deceleration time, isovolumic relaxation time

INTRODUCTION

Coronary artery disease is the leading cause of mortality and morbidity globally and acute myocardial infarction is the commonest mode of presentation.[1,2] In patients with acute myocardial infarction heart failure is characterized either by systolic dysfunction alone or by both systolic and diastolic dysfunction. Diastolic dysfunction has been recognised during the early as well as during the post myocardial infarction phase with or without left ventricular systolic dysfunction.[3,4]

Diastolic dysfunction is an important marker of outcome following myocardial infarction because it is related to progressive LV dilatation, development of heart failure and cardiac death.[5,6] Systolic and diastolic velocities of cardiac cycle can be recorded quantitatively by Tissue Doppler Imaging (TDI) and thereby provide a newer way of assessing left ventricular function which may be more sensitive than traditional methods.[7,8]

TDI has a high feasibility, reproducibility and ease of application in clinical setting. TDI has the ability to measure global as well as regional left ventricular systolic and diastolic function by placing the sample volume at the desired region of left ventrical.[7–10] The decreased early diastolic tissue velocity (Em) indicates diastolic dysfunction.[11–13] The TDI parameters, i.e., systolic velocity (Sm), early diastolic velocity (Em) and late diastolic velocity (Am) are powerful predictors of cardiac mortality.[14,15] The early diastolic tissue velocity (Em) at mitral annulus is a powerful predictor of cardiac mortality in patients with left ventricular systolic impairment.[16] The Em velocity <3cm/s is the best prognosticator in long term follow up and incremental to other clinical and echocardiographic variables. An Em <3cm/s, Sm <3cm/s, Am <4cm/s, and E/Em >20 can identify patients at very high risk of cardiac death in the subsequent two years.[17–19]

The aim of this study is to evaluate left ventricular systolic and diastolic function by Tissue Doppler imaging after acute myocardial infarction. We evaluated TDI parameters and explored the need, and will recommend the use of TDI examination for every

patient after acute myocardial infarction for the accurate assessment of left ventricular function.

MATERIAL AND METHODS

This was a cross-sectional descriptive study carried out in Department of Cardiology, Lady Reading Hospital, Peshawar. The study duration was 6 months and was approved by hospital ethical committee. A total of 200 patients had been recruited full filling the inclusion criterion of having acute myocardial infarction (MI), after taking informed written consent from them. Patients with old MI, congestive cardiac failure, valvular lesions, arrhythmias, cardiomyopathy, left bundle branch block, hypertension, age >50 years, coronary artery bypass grafting and diabetes mellitus were excluded from the study.

Patients with acute MI admitted to coronary care unit of Cardiology department LRH Peshawar were evaluated thoroughly after taking informed consent. Every patient on 3rd day of admission underwent detail TDI echocardiography examination with Acuson CV70 (Siemens) system equipped with TDI technology.

Ejection Fraction was calculated from apical 4- and 2-chamber views with Modified Simpson's method. The pulsed wave TDI was performed on four different sites on the mitral annulus, i.e., lateral, septal, anterior and inferior. For lateral and septal sites apical 4-chamber view and for anterior and inferior sites apical 2-chamber view was used. Peak systolic velocity (Sm), peak early diastolic velocity (Em) and peak late diastolic velocity (Am), E-wave deceleration time (DT) and isovolumic relaxation time (IVRT) were measured at all four sites of the mitral annulus. All echocardiography measurements were analysed without operator knowledge of the clinical data.

RESULTS

Total number of patients were 200 having acute MI and were divided into 4 groups, i.e., anterior MI, inferior, septal and lateral MI. There were 122 men and 78 women and the mean age was 42±5 years. Anterior MI occurred in 88 (44%), inferior in 82 (41%), septal in 10 (5%), and lateral in 20 (10%) patients. On TDI left ventricular (LV) systolic function was preserved in 112 (56%) and impaired in 88 (44%) patients. The frequency of left ventricular systolic function on TDI among all four myocardial infarctions is given in Table-1.

In case of preserved LV systolic function on TDI there was a mild reduction in mitral annular peak systolic velocity (Sm) only at the site of infarction, while in case of LV systolic dysfunction the velocity was markedly reduced at all sites with maximum reduction at the site of infarction followed by septum (Figure-1–4).

LV diastolic function on TDI was impaired in 116 (58%) but preserved in 84 (42%) patients. Table–2 further segregate diastolic dysfunction detected by TDI. In LV diastolic dysfunction on TDI there was a marked reduction in mitral annular early diastolic velocity (Em) at all sites with maximum reduction at the site of infarction followed by septum. There was no marked change in late diastolic mitral annular velocity (Am) at infarction site.

The mean systolic velocity (mean Sm) from 4 mitral annular sites was correlated well with the LV ejection fraction (p=0.0001) (Figure-5). Similarly the mean early diastolic velocity (mean Em) from 4 mitral annular sites was correlated well with the LV ejection fraction (p=0.0001) (Figure-6), and with isovolumic relaxation time (IVRT) (p=0.004) (Figure-7). However there was no correlation between the mean Em velocity and deceleration time (DT) (p=0.315) (Figure-8).

Table-1: Frequency of left ventricular systolic function on TDI of all FOUR MI's

	Systolic Function on TDI		Total
Type of MI	**Preserved**	**Dysfunction**	
Anterior	18	70	88
Inferior	64	18	82
Septal	10	–	10
Lateral	20	–	20
Total	112 (56%)	88 (44%)	200

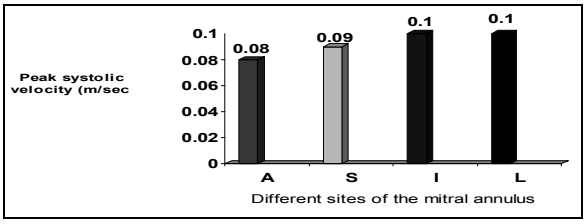

Figure-1: Mitral annular peak systolic velocities in Anterior MI with preserved Systolic function on TDI (A: anterior, S: septal, I: inferior, L: lateral)

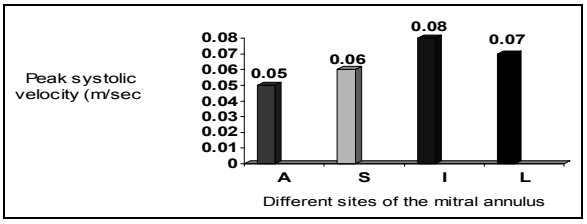

Figure-2: Mitral annular peak systolic velocities in anterior MI with systolic dysfunction on TDI

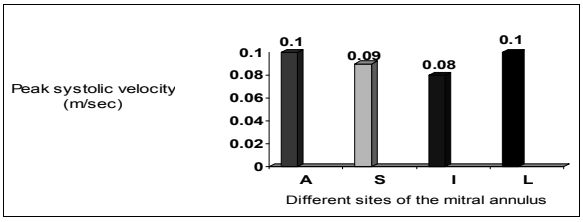

Figure-3: Mitral annular peak systolic velocities In inferior MI with preserved systolic function on TDI

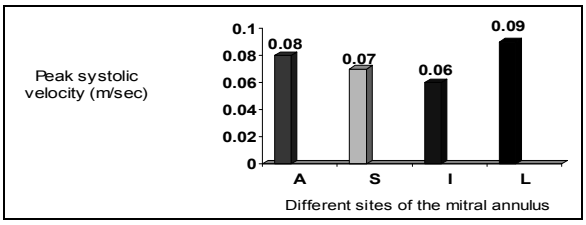

Figure-4: Mitral annular peak systolic velocities in inf. MI with systolic dysfunction on TDI

Table-2: Frequency of type of diastolic dysfunction on TDI

Diastolic Dysfunctiom		
Impaired	**Pseudonormal**	**Restrictive**
38 (19%)	44 (22%)	34 (17%)
Total	116 (58%)	

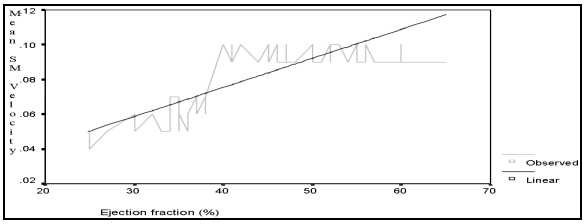

Figure-5: Correlation between mitral annular mean systolic velocity (Sm) on TDI and ejection fraction. (*p*=0.0001)

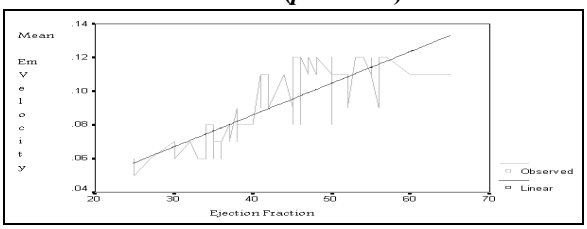

Figure-6: Correlation between mitral annular mean early diastolic velocity (Em) on TDI and ejection fraction, (*p*=0.0001)

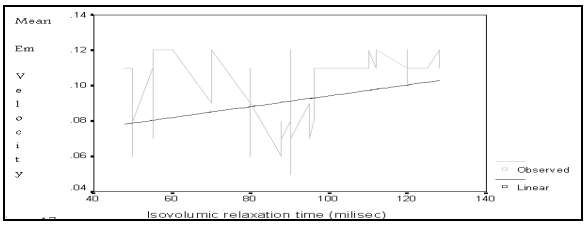

Figure-7: Correlation between mitral annular mean early diastolic velocity (Em) on TDI and isovolumic relaxation time (IVRT). (*p*=0.004)

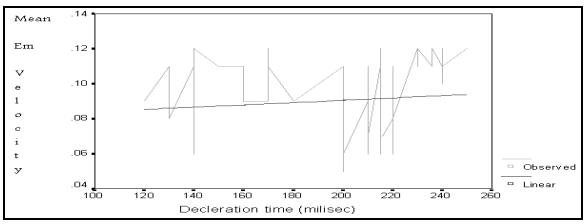

Figure-8: Correlation between mitral annular mean diastolic velocity (Em) on TDI and deceleration time (DT). (*p*=0.315)

DISCUSSION

Analysis of mitral annulus by quantifying the myocardial velocities with the use of TDI opens up a new possibility of assessing LV function along the long axis.[7] We were able to record LV pulse wave TDI velocities at all the LV sites in all the patients. In addition, the method is highly reproducible with low interobserver and intraobserver variabilities.[7] Introduction of pulsed wave TDI at different mitral annular sites of the left ventricle opens up a new possibility.

In our study population, 56% has been preserved systolic functions while it has been reported as 48% by Wang M *et al.*[19] In the present study, after a first MI, a significant regional difference was found in the peak systolic velocity at the mitral annulus related to the infarction site. Anterior MI patients had lower peak systolic velocities at the anterior wall and septum than at other sites, and same is true for inferior, lateral and septal MI's, same observations were reported by Zaca V *et al.*[12] In addition to the reduced peak systolic velocity at the infarction sites, the systolic velocity at the non-infarction sites was also reduced. It is difficult to explain this phenomenon. We do not know whether the spirally oriented myocardial fibre, which causes the shortening of the left ventricle along its long axis, might have some action beyond the infarction area. Mollema SA *et al*[15], Salehi R *et al*[17] and Siddique T *et al*[18] reported a relatively good and highly significant correlation between the mean peak systolic velocity (Sm) of the mitral annulus and the LV ejection fraction and we documented the same findings.

Diastolic dysfunction was reported as 58% in our study and nearly same figure was documented by Sherif F *et al*[8], i.e., 55%. In our study patients with diastolic dysfunction on TDI has marked reduction in early peak diastolic velocity at all sites with a maximum reduction at the site of infarction, as was reported by Sherif F *et al*[7] but the late peak diastolic velocity was mildly reduced. Ali L *et al*[13] documented that mean peak early diastolic mitral annular velocity (Em) correlated well with the LV ejection fraction and with the isovolumic relaxation time (IVRT) but there was no correlation between mean Em velocity and deceleration time (DT) and exactly the same findings were observed in our study.

The early diastolic mitral annular velocity measured by TDI has been postulated to be independent of the filling pressure.[11] This may be the reason for the good correlation between the early diastolic velocity (Em) determined by TDI and the LV ejection fraction. Thus, by using the mitral annular peak early diastolic velocity, it may be possible to assess the diastolic dysfunction after MI.

CONCLUSION

Tissue Doppler Imaging is a reliable, accurate and easily reproducible modality of echocardiography. The reduced peak systolic velocity and reduced peak early diastolic velocity seems to be an expression of regionally reduced systolic and diastolic functions, respectively. While the reduced mean systolic velocity and reduced mean early diastolic velocity from 4 mitral annulus sites are expressions of globally reduced systolic and diastolic functions, respectively and were correlated well with the ejection fraction.

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