Predicting the Severity of Left Ventricular Dysfunction with Mitral Regurgitation, Left Ventricular Diastolic Dysfunction and Right Ventricular Dysfunction Among Dilated Cardiomyopathy Patients.

Concise title: Assessment of dilated cardiomyopathy by echocardiogram

Yamini B[1], Uma Maheswari G [1], Dhandapani V E[1*]

1 – Department of Cardiology, SRM Medical College Hospital and Research Centre, SRMIST, Kattankulathur – 603204.

Yamini B, M.Sc., (Echo&CVIT)

Ph.D. Scholar (Full Time) Department of Cardiology,

SRM medical college hospital and research centre Kattankulathur – 603203, Tamil Nadu, India.

Phone No. +91 9840502170, Email Id: Yamini.17b@gmail.com

Uma Maheswari G, M.Sc., (Echo&CVIT)

Ph.D. Scholar (Full Time) Department of Cardiology,

SRM medical college hospital and research centre Kattankulathur – 603203, Tamil Nadu, India.

Phone No. +91 8754331653, Email Id: uma14297@gmail.com

*Correspondence & reprints should be addressed to:

Dr. Dhandapani V E,

Professor and Head, Department of Cardiology,

SRM medical college hospital and research centre Kattankulathur – 603203, Tamil Nadu, India.

Phone No. +91 9443212121, Email Id: dhandape@srmist.edu.in

Abstract

Objective

The aim is to evaluate the LV diastolic dysfunction, grading the severity of mitral regurgitation and right ventricular dysfunction in dilated cardiomyopathy patients with severe left ventricular systolic dysfunction (LVEF < 30%) which helps to predict the cardiovascular mortality.

Methodology

This study was conducted among 66 patients, aged over 25yrs with electrocardiographic evidence of dilated cardiomyopathy. Clinical examination and electrocardiography was to assess the status of mitral regurgitation, left ventricular diastolic dysfunction and right ventricular dysfunction. Ejection fraction was measured by Simpson's method - qualitatively evaluated.

Result

The study showed, 53% patients had diastolic dysfunction, 62% patients had mitral regurgitation and around 50% patients had right ventricular dysfunction. Mitral regurgitation and diastolic dysfunction are correlated with the severity of LV systolic dysfunction through LVEF with a significant P - value of 0.004 and <0.001 respectively. However, right ventricular dysfunction parameters does not correlate with severity of LV systolic dysfunction but has a major clinical importance is management of and treatment of DCM.

Conclusion

In our study, the mitral regurgitation and diastolic dysfunction are correlated with severity of LV

systolic dysfunction. Detailed assessment of these parameters in DCM patients - severe LV systolic dysfunction helps in aiding treatment and to predict the cardiovascular mortality.

Keywords

Dilated cardiomyopathy; mitral regurgitation; diastolic dysfunction; right ventricular dysfunction; systolic dysfunction; echocardiogram.

1. Introduction

Dilated cardiomyopathy (DCM) is a primary myocardial disease. It is defined as dilatation of all chambers of the heart with ventricular systolic dysfunction. Due to the dilatation, the ventricular wall becomes thinner and spherical. DCM is the commonest type of cardiomyopathy which results in heart failure. DCM can be genetic, although it is typically brought on by a number of conditions, such as coronary artery disease, thyroid illness, diabetes, viral infections of the heart, and anomalies of the heart valves. Idiopathic cardiomyopathy, ischemic cardiomyopathy (severe dysfunction due to diffuse coronary disease and chronic ischemia is considered a form of cardiomyopathy), Familial cardiomyopathy, non-compacted myocardium, peripartum cardiomyopathy (during pregnancy or postpartum), infections (post viral myocarditis, HIV, sepsis), toxic cardiomyopathy (alcohol, chemotherapy-induced)

In DCM hepatic veins, inferior vena cava (IVC) and superior vena cava (SVC) may be dilated with effusion in pericardial and pleural cavity. Mitral regurgitation (MR) is well demonstrated by the color flow doppler. The right ventricular (RV) systolic pressure is measured using tricuspid regurgitation (TR) velocity, in the absence of RV outflow obstruction and pulmonary arterial systolic pressure. Primary MR occurs due to disease in the mitral valve apparatus. Secondary MR occurs due to the functional abnormality of the left ventricle. MR frequently accompanies DCM which is associated with morphologicaland functional abnormalities of the left heart and mitral valve annulus. Dilatation of the heart results in mitral annular dilatation, changes in size and shape of the left ventricle.

Echocardiography helps in assessing the severity of MR using color flow doppler. Central and eccentric jets are seen due to abnormalities in the mitral valve. In severe MR, echo imaging shows dilatation of left atrium (LA) and LV with an increase in both chambers' systolic motion. The underlying causes of MR are chordate tendinae in MVP, rheumatic mitral disease, a flail leaflet, vegetation and regional or global left ventricular (LV) dilation with leaflet tethering which can often be determined by echocardiography. In secondary MR, mitral valve (MV) function is related to LV function. MR occurs due to the papillary muscle displacement as a result in impairment of ventricular function in DCM. Therefore, there is a dysfunctional operation of normal leaflets when ventricular function is impaired. Tethering force, annular dilation, LV dilation, papillary muscle displacement, LV sphericity and decreased LV contractility leads to this condition.

In the LA during systole, MR reveals a high velocity jet by Doppler method. The regurgitation severity is measured with the width of the jet across the MV and the size of the LA. Qualitative assessment using color flow imaging is well correlated with the quantitative method. Supportive evidence of MR severity can be found in pulmonary venous flow, where a normal systolic wave greater than diastolic wave generally indicates mild MR and systolic reversal indicates severe MR. Commonly blunted pattern (S<D) may be seen in all degrees of MR. A transmitral E wave greater than 1.2m/sec is supportive of severe MR, whereas a pattern with E<A indicates severe MR. Diastolic dysfunction exists in all patients with dilated cardiomyopathy (mostly restrictive filling pattern). Diastolic dysfunction can be assessed using echocardiography by using PWD (pulse wave doppler) at mitral inflow and tissue doppler imaging (TDI) at mitral annulus.

In DCM, LV dysfunction and pulmonary artery (PA) pressure determines the RV function. Mechanism of RV dysfunction is assessed in DCM to determine function and volume of RV in relation to LV function. With this the study was carried out to assess LV diastolic dysfunction, MR and RV dysfunction in patients with DCM to predict early stages of cardiac morbidity which helps the clinician to have better prognosis and treatment.

2. Methodology

Study setting and participants

The study was performed for a period of 20 months with patients diagnosed with DCM in our tertiary teaching institution, department of Cardiology. Patients >25 years of age with evidence

of DCM through echocardiogram are included. Valvular diseases and other systemic disease patients were excluded. 66 patients were taken up for this study.

Data collection

Demographic data and history about risk factors were collected using a structured proforma. A single investigator conducted the clinical examination, which included collecting the vitals of the patient. An echocardiography was performed to determine the status of MR, LV and RV function to assess the DCM condition.

The severity of MR was graded by colour doppler and was quantified as mild, moderate and severe depending upon the ratio of jet-area / LA area, vena contracta (VC) width and regurgitant volume method. The grading of diastolic dysfunction was measured by E/E' ratio, deceleration time (DT) and isovolumetric relaxation time (IVRT). RV function was quantified by TAPSE and myocardial performance index (MPI). Using simpson's method, the severity of LV systolic dysfunction was measured based on LV ejection fraction (LVEF).

➢ The severity of mitral regurgitation is graded by colour doppler, as follows:

– Mild: Ratio of jet-area / LA area < 20%, VC width of 3mm and regurgitant volume of 30ml.

– Moderate: Ratio of jet-area / LA area ratio 20-40%, VC width of 3 – 6mm and regurgitant volume of 30 – 60ml.

– Severe: Ratio of jet-area / LA area area ratio >40%, VC width of ≥7mm and regurgitant volume of >60ml.

➢ The diastolic dysfunction is graded based on mitral inflow velocities as follows:

– Grade I: Ratio of E/A < 0.9, E/E' < 8, DT > 240ms, IVRT > 90ms.

– Grade II: Ratio of E/A 0.9 – 1.5, E/E' 9 – 12, DT 140 – 240ms, IVRT 60 – 70ms.

– Grade III: Ratio of E/A > 1.5, E/E' > 15, DT < 140ms, IVRT < 70ms.

➢ The RV function is graded using TAPSE as follows:

– Mild RV dysfunction: 1.3 – 1.5cm.

– Moderate RV dysfunction: 1.0 – 1.2cm.

– Severe RV dysfunction: < 1.0cm.

And, MPI for RV dysfunction by pulse wave doppler is < 0.40 and by tissue doppler imaging is < 0.55.

Ethical

The Institutional Ethics Committee approval was obtained prior to collecting data. Each participant was fully informed about the study and provided with their consent.

Statistics

By using SPSS-20 all the data was analyzed. Percentage were tabulated for the categorical variables like age groups, gender. Annova and correlation coefficient test was applied and equal or less than 0.05 p value was taken as significant.

3. Results

The study outcomes were, 9% patients in of 31 – 40 years of age, 64% between 41 – 60 years and 14% between 61 – 70 years. Out of 66 participants, 39 (59%) male and 27 (41%) female (Table 1). Percentage levels of mitral regurgitation, LV diastolic dysfunction and RV function based on its severity were measured (Table 2).

Table 1: Baseline demographic characteristics of the study population

S. No	Parameters	N = 66	Percentage (%)
1.	**Gender**		
	Male	39	59
	Female	27	41
2.	**Age**		
	<30	3	4
	30-40	6	9
	40-50	21	32

	50-60	21	32
	60-70	9	14
	>70	6	9

Table 2: Pattern of mitral regurgitation, LV diastolic dysfunction, RV function based on its severity

Mitral Regurgitation			
Parameters	**Mild**	**Moderate**	**Severe**
Jet area / LA area ratio	9 %	59 %	32 %
LV Diastolic Dysfunction			
Parameters	**Grade I**	**Grade II**	**Grade III**
E / E'	5 %	45 %	50 %
RV Dysfunction			
Parameters		**Normal RV function**	**RV dysfunction**
TAPSE		27 %	55 %

The parameters were graded based on its severity as follows (Table 3), 1) MR severity based on jet area / LA area ratio, 2) LV diastolic dysfunction based on E/E' and 3) RV dysfunction based on TAPSE.

Table 3: Correlation of mitral regurgitation, LV diastolic dysfunction, RV function with LVEF based on its severity.

Mitral Regurgitation									
Parameters	Mild			Moderate			Severe		
	No	Correlation-coefficient	p Value	No	Correlation-coefficient	p Value	No	Correlation-coefficient	p Value
Jet area / LA area ratio	6	0.056	0.0243	39	0.131	0.008	21	0.257	0.006
LV Diastolic Dysfunction									
Parameters	Grade I			Grade II			Grade III		
	No	Correlation-coefficient	p Value	No	Correlation-coefficient	p Value	No	Correlation-coefficient	p Value
E/E'	6	0.511	<0.001	27	0.310	<0.001	33	0.189	<0.001
RV dysfunction									
Parameters	Normal RV function			RV dysfunction					
	No	Correlation-coefficient	p Value	No	Correlation-coefficient	p Value			
TAPSE	18	0.633	0.919	48	0.856	0.457			

Among 66 patients, 11% - grade I diastolic dysfunction, 36% - grade II diastolic dysfunction and 53% - grade III diastolic dysfunction. Correlation of LV diastolic dysfunction with LVEF was statistically significant (p – value <0.001) (Table 4). Similarly, 14% had mild MR, 62% had moderate MR, 24% had severe MR. Correlation of MR with LVEF was statistically significant with P – value of 0.004 (Table

4). In this study RV dysfunction is found in 55% by TAPSE and 45% by MPI. Correlation of RV dysfunction with LVEF was less significant statistically (p – value 0.221) (Table 4).

Table 4: Overall correlation of mitral regurgitation, diastolic dysfunction and RV dysfunction with LVEF in dilated cardiomyopathy patients.

DCM classification	Mitral Regurgitation			Diastolic dysfunction			RV dysfunction		
	No	Correlation-coefficient	p Value	No	Correlation-coefficient	p Value	No	Correlation-coefficient	p Value
Severe LV systolic dysfunction	66	0.353	0.004	66	0.2007	<0.001	66	0.604	0.221

4. Discussion

This study systematically analyzed the prevalence and the effects of MR, diastolic dysfunction and RV function in terms of LV systolic dysfunction. The main findings were correlated with severity of disease in terms of LVEF, as follows 1) moderate to severe MR occurred in more than half in DCM patients and has a significant correlation with LV dysfunction severity; 2) diastolic dysfunction is associated with DCM and also has a significant correlation with LV dysfunction severity; 3) RV function was analyzed and RV dysfunction shows very less significance on correlation with LV dysfunction severity.

The most prevalent kind of cardiomyopathy, dilated cardiomyopathy, has a variety of reasons. Dilatation and reduced contraction of ventricles develop in this condition[1]. Furthermore, modest localized scarring of the MV and annular dilatation are frequently observed. A poor prognosis is associated with MR in groups that are at high risk for complications and it is frequently seen in cardiac disease. It is common to practice to evaluate MR using echocardiography[2]. MR was assessed which showed mild MR in 14% of patients, moderate MR in 62% and severe MR in 24%. The percentage of MR was graded based on its severity (Table 2) and correlated with severity of LV dysfunction in terms of LVEF (Table 3). The jet area / LA area ratio parameter of MR and LV systolic dysfunction in terms of LVEF has a significant correlation (Figure 1) with P-value of 0.004 statistically (Table 4). Both ventricular and valvular remodeling is linked to the mitral regurgitation that is associated with DCM and congestive HF[3].

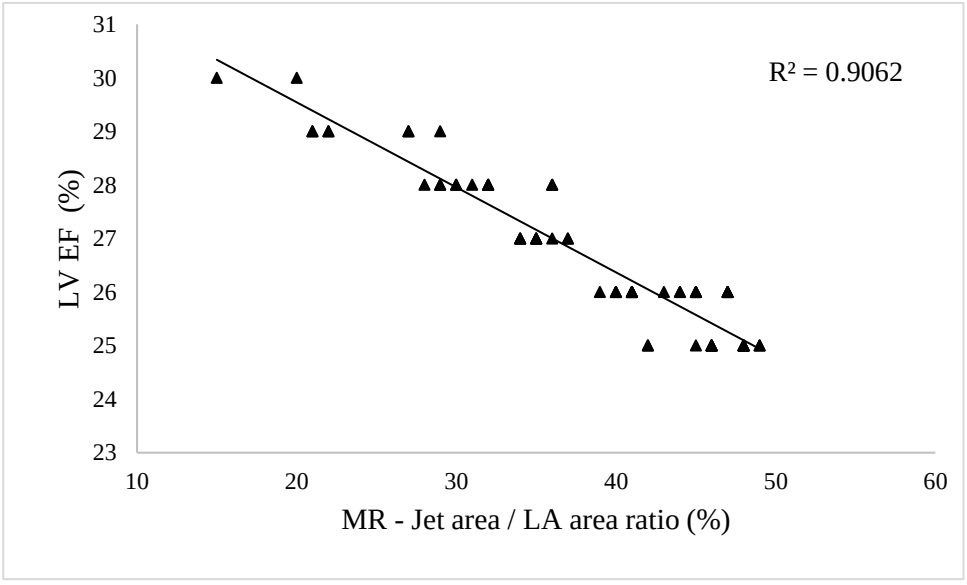

Figure 1: Correlation between Left ventricular ejection fraction (LVEF) with mitral regurgitation (MR) – jet area / LA area ratio

The common indicator of dilatation is a rise in the LA volume and the volume index, which is linked to other cardiac chambers such the right ventricle, right atrium, and left atrium in dilated cardiomyopathy. A DCM's enlarged left atrium is a result of left atrial pressure overload brought on by persistently high left ventricular diastolic filling pressures[4]. LV diastolic dysfunction was assessed which showed Grade I diastolic dysfunction in 11%, Grade II diastolic dysfunction in 36% and Grade III diastolic dysfunction in 53% I total population. The percentage of LV diastolic dysfunction was graded based on its severity (Table 2) and correlated with severity of LV dysfunction in terms of LVEF (Table 3). The E/E' ratio of diastolic dysfunction and LV systolic dysfunction in terms of LVEF has a significant correlation (Figure 2) with P-value of <0.001 statistically (Table 4). In DCM patients the diastolic dysfunction significantly worsens the prognosis independent of LVEF[5].

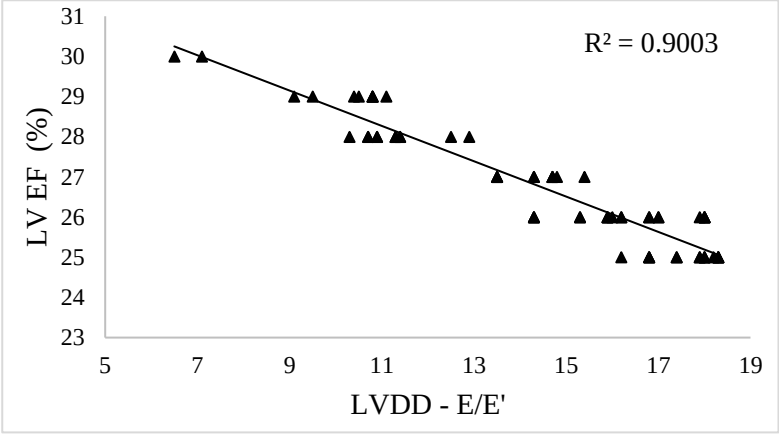

Figure 2: Correlation between left ventricular ejection fraction (LVEF) with left ventricular diastolic dysfunction (LVDD) – E / E' (E – Early diastole; E' – mitral annular early diastolic velocity)

In DCM and ischemic heart disease, LV dysfunction and PA (pulmonary artery) pressure determines the RV function. It has been shown that DCM worsens RV function[6]. RV function was assessed which showed 55% of patients with RV dysfunction by TAPSE and 45% of patients with RV dysfunction by MPI. Thus for evaluation of RV dysfunction TAPSE had better sensitivity to detect compared to MPI and percentage of TAPSE was calculated (Table 2), there was no significant correlation statistically with LV systolic dysfunction in terms of LVEF (Figure 3) with a P-value of 0.221 (Table 4). Elevated filling pressure and PAP may need to be treated more aggressively or with novel therapeutic approaches[7]. Therefore, to protect the RV, assessment of RV function is also important in DCM for clinical management and prognosis.

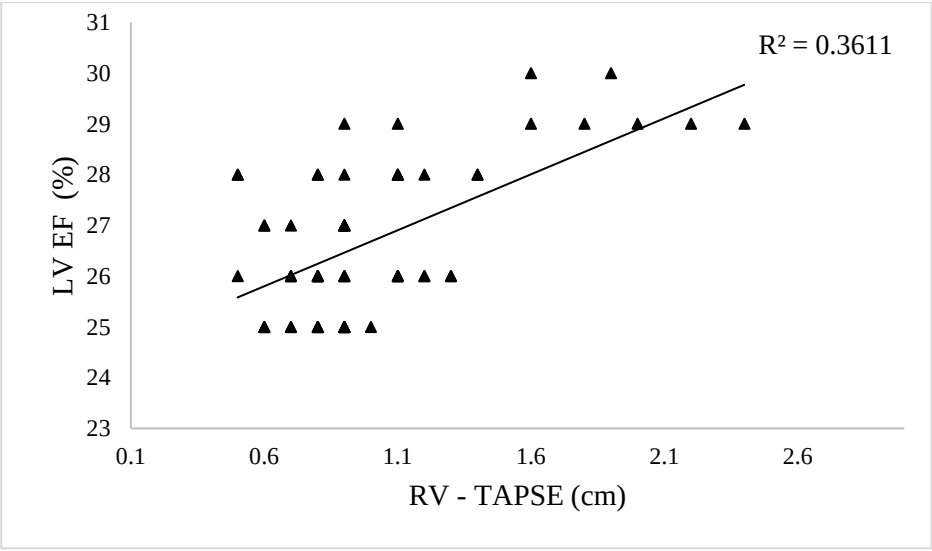

Figure 3: Correlation between left ventricular ejection fraction (LVEF) with right ventricular (RV) –TAPSE (TAPSE – Tricuspid annular plane systolic excursion)

5. Conclusion

In summary this study demonstrates the correlation of LVEF severity, as follows, i) MR and diastolic dysfunction are significantly correlated and ii) RV dysfunction has no significant correlation but has a major clinical importance in management and treatment of DCM. Detailed assessment of all these parameters in patients with DCM helps in aiding treatment and to predict the cardiovascular mortality.

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Conflict of Interest – Nil

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