Echocardiographic Assessment of Right Ventricular Function in Patients of Ischemic Dilated Cardiomyopathy

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Abstract: Objectives: The aim of this study is to assess the right ventricular (RV) function in patients of ischemic dilated cardiomyopathy. **Background:** It should be considered that right ventricular dysfunction may affect left ventricular function, not only by limiting left ventricular preload, but also by adverse systolic and diastolic interaction via interventricular septum and the pericardium (ventricular interdependance) and also right ventricular function has been shown to be a major determinant of clinical outcome, so (RV) function assessment is of great clinical value especially in ischemic dilated cardiomyopathy (IDCM) patients. **Methods:** A total of 80 persons were included in the study, divided into 2 groups: first group (Group 1) is the case group which consists of 50 patients of ischemic dilated cardiomyopathy, and second group (group2) is the control group which consists of 30 normal healthy individuals. Ischemic aetiology of cardiomyopathy in group1 is proved by Coronary angiography. RV function assessment was done and both groups were compared to each other to perform a case control study. **Results:** Study consisted of two groups, (group I) consists of 50 patients (mean age, 56.04 years) and (group II) consists of 30 healthy individuals (mean age, 53.13 years). Group I comprised 35 (70%) males and 15 (30% females), group II comprised 15 (50%) males and 15 (50%) females. The results as regard the right ventricular function assessment revealed, significant dilatation of right ventricular dimensions in group I than group II as RV mid-cavitary diameter in group I (51.62±8.39 mm) more than group II (25.90±6.47mm), RV basal diameter in group I (56.84±7.98 mm) more than group II (35.90±4.82 mm) and RV longitudinal diameter in group I (93.59±12.57mm) more than group II (71.53±7.75 mm). The RV area either end-diastolic or end-systolic revealed significant increasement in group I than group II, as RV end-diastolic area in group I (39.60±3.35 mm^2) more than group II (17.97±4.80 mm^2) and RV end-systolic area in group I (29.58±6.05 mm^2) more than group II (8.80±2.77 mm^2). RV fractional area change revealed significant difference between groupI (26.23±8.46%) which was less than group II (50.97±7.98%). RV ejection fraction revealed highly significant difference as it was (30.60±6.33%) in group I which was less than group II (59.07±7.83%). RV myocardial performance index (Tei index) revealed highly significant difference between group I(0.71±0.09) and group II (0.40±0.10). Early diastolic wave (Ewave) velocity measurement revealed non significant difference between group I (48.74±6.26 cm/s) and group II (50.47±11.73 cm/s). A wave velocity measurement revealed non significant difference between group I (30.34±6.13 cm/s) and group II (32.70±10.17 cm/s). E/A ratio revealed non significant difference between group I (1.67±0.38) and group II (1.61±0.33). E prime wave velocity revealed highly significant difference between group I (10.82±4.74cm/s) and group II (13.67±3.66cm/s). A prime wave velocity revealed non significant difference between group I (12.30±0.04cm/s) and group II (12.10±3.95cm/s). Eprime/Aprime ratio calculation revealed highly significant difference between group I (0.94±0.44) and group II (1.20±0.34). E/Eprime Ratio calculation revealed significant difference between group I (3.25±1.21) and group II (3.96±1.90). IVCT revealed highly significant difference between group I (83.72±5.69ms) and group II (46.37±13.44ms) **Conclusion:** In conclusion, our results suggest that the right ventricular function assessed by echocardiography in patients of ischemic dilated cardiomyopathy was deteriorated even in absence of right ventricular ischemic involvement.

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Key words: Right Ventricular Function, Ischemic Dilated Cardiomyopathy (IDCM)

1. Introduction:

Currently, the leading cause of heart failure in developed countries is CAD, in the United States CAD and its complications account for two thirds to three fourths of all cases of heart failure. In many patients the progressive nature of heart failure reflects the progressive nature of the underlying CAD[(1)].

Despite many advances in the management of coronary artery disease (CAD) which represents the major cause of congestive heart failure (CHF), the prevalence and incidence of left ventricular

dysfunction secondary to CAD, are increasing dramatically leading to a heavy burden on healthcare systems. Ischemic cardiomyopathy is the most common type of cardiomyopathies in the US. It affects approximately 1 out of 100 people, most often middle - aged to elderly men. In the older age ranges, the gender difference becomes less pronounced[2].

Coronary arteriography, helps to distinguish between myocardial infraction as a result of obstructive coronary artery disease and extensive localized myocardial fibrosis secondary to severe dilated cardiomyopathy in the absence of coronary artery obstruction[3].

RV dysfunction may affect left ventricular (LV) function, not only by limiting LV Preload, but also by adverse systolic and diastolic interaction via the interventricular septum and the pericardium (ventricular interdependence). Moreover, RV function has been shown to be a major determinant of clinical outcome[4].

Compared with other modalities, Echocardiography offers the advantages of versatility and availability, Also Doppler- derived indices of RV function, such as the myocardial performance index and tricuspid annular isovolumic acceleration (IVA), are emerging as promising parameters of RV function. An ideal index of contractility should be Independent of after load and preload, sensitive to change in Inotropy, Independent of heart size and mass easy and safe to apply, and proven to be useful in the clinical setting.[5]

The aim of this study is to assess the right ventricular function in patient of ischemic dilated cardiomyopathy.

2. Patients and methods:

This was a case control study. We enrolled 80 subjects divided into case and control group, 50 of them were patients of ischemic dilated cardiomyopathy representing group 1 (Case group) and 30 of them were healthy individuals representing group 2 (Control group). Group 1 was diagnosed to be ischemic by History, ECG and coronary angiography. The study was performed in Al-Azhar University Hospitals between May 2015 and November 2016.

Full history tacking with history of risk factors, medication, general and cardiac examination.

12 lead electrocardiography.

Routine laboratory investigation including renal functions, liver functions.

Transthoracic echo-Doppler study with special emphasis on all measurement using the recommendation of the American Society of Echocardiography. All echocardiographic examinations were done using Vivid E95 machine:

From parasternal long axis view: LA antero-posterior diameter (mm²). LVEDD & LVESD using M-mode (mm²). LV ejection fraction (LVEF)(%). LV Fractional shortning (LVFS) (%). RV end diastolic diameter M-mode (mm²). From parasternal short axis view: Mitral valve area (mm²) using planimetry at the level of mitral valve. RVOT assessment at the level of great vessels. From apical four chamber view: LV Ejection fraction using simpson method (%). Systolic pulmonary artery pressure using tricuspid regurgitant jet peak velocity using modified Bernoulli equation. RV end diastolic & end systolic areas to calculate Pulsed wave Doppler tissue imaging: Tei index of RV myocardial performance. Peak myocardial velocities during systole, early & late diastole together with the isovolumic contraction time at a sweep speed of 100 mm/s by placing sample volume at lateral side of the tricuspid annulus. Myocardial acceleration during isovolumic contraction. RV fractional area change (RVFAC). RV ejection fraction (2D). Tricuspid annular plane systolic excursion (TAPSE).

From pulsed Doppler on tricuspid inflow:

E & A waves (cm/s) & E/A ratio. Pulsed wave Doppler tissue imaging: Tei index of RV myocardial performance. Peak myocardial velocities during systole, early & late diastole together with the isovolumic contraction time at a sweep speed of 100 mm/s by placing sample volume at lateral side of the tricuspid annulus. Myocardial acceleration during isovolumic contraction.

The exclusion criteria included patients with the following:

Atrial Fibrillation.
Left Side Valvular heart disease.
Pulmonary obstructive airway disease.
Pulmonary vascular disease.
Congenital heart disease.
Right ventricular infarcted patients.

3. Results:

Study consisted of two groups, (group I) consists of 50 patients (mean age, 56.04 years) and (group II) consists of 30 healthy individuals (mean age, 53.13 years). Group I comprised 35 (70%) males and 15 (30% females), group II comprised 15 (50%) males and 15 (50%) females.

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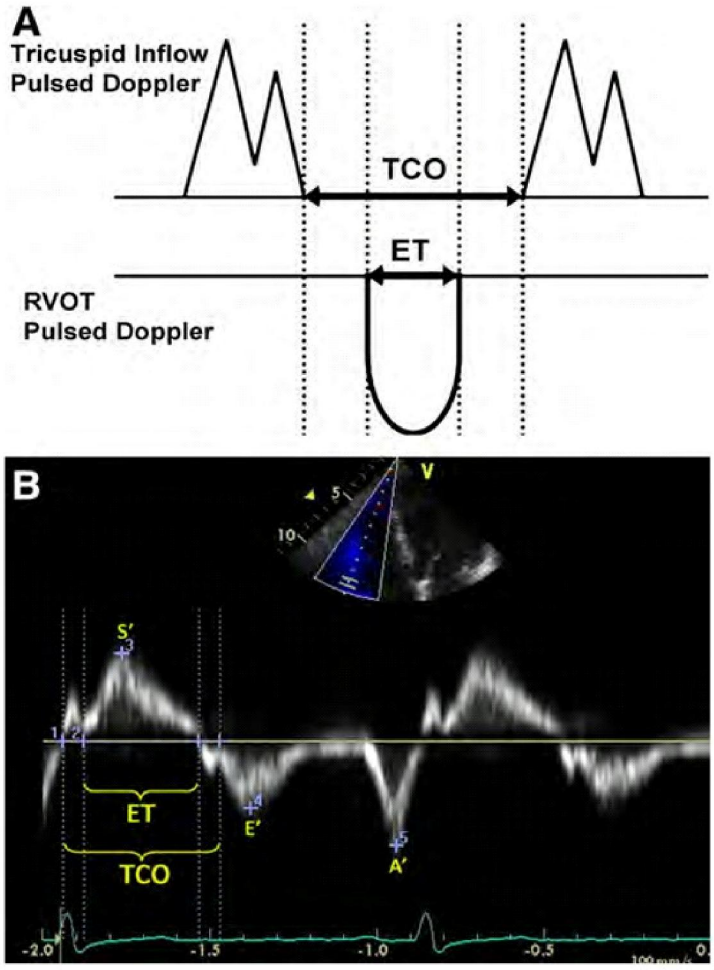

Figure 1: Calculation or right ventricular myocardial performance index (MPI) by pulsed Doppler (A), and pulsed tissue Doppler (B) The tricuped valve closure opening time(TCO) encompasses isovolumic contraction time, ejection time and isovolumic relaxation time. In the pulsed Doppler method TCO can also be measured by the duration of tricuspid regurgitation continuous wave Doppler signal (MPI)= TCO-ET/ET. Note That $S^{/}$, $E^{/}$ and $A^{/}$ are also measured from the same pulsed Doppler tissue image.

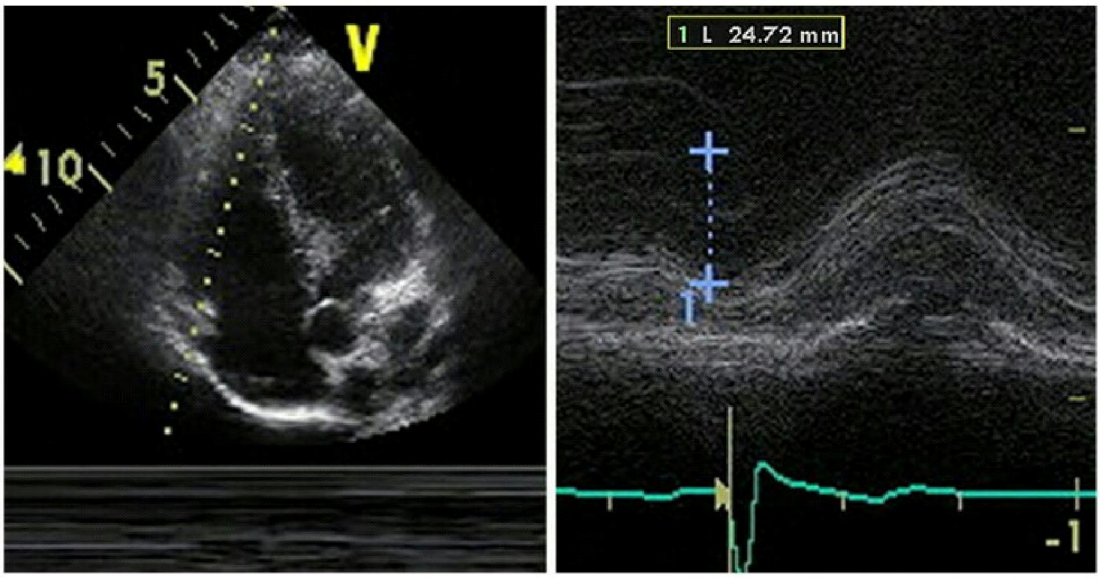

Figure 2: Measurment of tricuspid annular plane systolic excursion (TAPSE)

Table 1: Comparison between the two groups as regard the Echocardiographic data.

Variable	Group I(Cases)	GroupII(control)	P.Value	Significance
LVEDD	6.62±0.48	4.52±0.74	0.001	Highly significant
LVESD	5.54±0.60	2.92±0.72	0.001	Highly significant
LVEF(M.mode)	31.02±10.08	62.73±7.99	0.001	Highly significant
LVEF(Simpson)	32.16±9.38	67.33±5.89	0.001	Highly significant
LVFS	16.32±5.01	35.79±7.43	0.001	Highly significant
RV mid.Cav.diameter	51.62±8.39	25.90±6.47	0.039	Significant
RV Basal diameter	56.48±7.98	35.90±4.82	0.046	Significant
RV longitudinal diameter	93.59±12.57	71.53±7.75	0.035	Significant
RV end-diastolic area	39.60±5.35	17.97±4.80	0.018	Significant
RV end-systolic area	29.58±6.05	8.80±2.77	0.022	Significant
RV FAC	26.23±8.46	50.97±7.98	0.019	Significant
RV 2D EF	30.60±6.33	59.07±7.83	0.001	Highly significant
TAPSE	11.08±2.30	20.97±3.79	0.001	Highly significant
RV MPI	0.71±0.09	0.40±0.10	0.001	Highly significant
S wave velocity	12.72±2.26	14.07±2.80	0.021	Significant
E wave	48.74±6.26	50.47±11.73	0.393	Non-significant
A wave	30.34±6.13	32.70±10.17	0.198	Non-significant
E/A Ratio	1.67±0.38	1.61±0.33	0.471	Non-significant
e/	10.82±4.74	13.67±3.66	0.006	Highly significant
a/	12.30±0.04	12.10±3.95	0.829	Non-significant
e//a/	0.94±0.44	1.20±0.34	0.007	Highly significant
E/e/	3.25±1.21	3.96±1.46	0.023	Significant
IVCT	83.72±5.69	46.37±13.44	0.001	Highly significant

LVEDD=left ventricular end-diastolic diameter, LVESD=left ventricular end-systolic diameter, EF=Ejection Fraction, FS=Fractional Shortning, FAC=Fractional Area Change, TAPSE=Tricusped Annular Plane Systolic Excursion, RV=Right Ventricle, MPI=Myocardial Performance Index, IVCT=Isovolumic contraction Time.

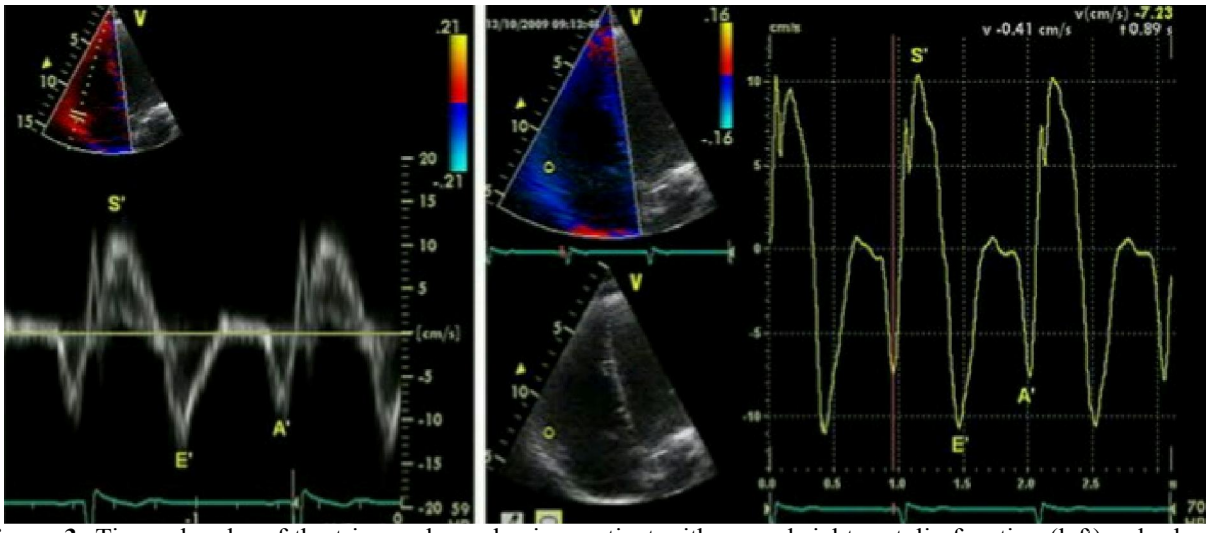

Figure 3: Tissue doppler of the tricusped annulus in a patient with normal right systolic function (left) pulsed and (right) color coded offline analysis

4. Discussion:

As regard the gender, our study include 50 patient (Group 1), 35 males (70%) and 15 females(30%), male gender predominance in Group 1 can be explained by higher incidance of CAD in males than females.

The age of patients of IDCM ranging from 41 to 70 years old (mean 56.04 ± 7.88), there old age is coinciding with previous reports of Windler et al who explained this finding by the fact that acute coronary syndromes are more prevalent in older patients.[6]

As regard to incidance of risk factors for coronary artery disease (CAD) among studied groups. There was significant difference between the studied groups as incidance of DM and HTN was higher in group 1 than group 2. This came in agreement with Marijana Tadic et al. which conclude that RV impairment is more common in DM and hypertensive patient.[7] Mytas et al. revealed that diabetic patients have impaired diastolic function in both ventricles either with conventional or tissue doppler echocardiography. The involvment of both ventricles in DM patients, suggest that diabetes cause a global toxic effect on myocardial cells. Also the close correlation of the two ventricles as well as the sharing of the interventricular septum, pericardium and ventricular interdependance may have a role.[8] In contrary to the present study Kosmola et al. do not find any contributing effect of coexisting hypertension to RV dysfunction in contrast to the LV, The adverse influence of HTN is much more evident for the LV, which is perminantly exposed to the pressure overload. Kosmola also shows no significant increase in RV wall thickness.[9]

In the present study the RVD were found to be increased relative to control group, this may be related to deteriorated RV systolic function and consequently prescance of volume overload with stretched walls and dilated cavity.

RVFAC shows significant difference (P=0.019) between the case and control group, this came in Agreement with the echocardiographic substudy of the Survival And Ventricular Enlargment (SAVE) trial Zornoff L et al**.,** in which RV dysfunction assessed by RV fractional area change (RVFAC) was found in post MI patients with LV dysfunction (LVEF<40%).[10]

The RVEF shows highly significant difference (P value=0.001) between the case and control group, which is concordant with Santamore et al. who concluded that that global RV dysfunction is significantly related to the echocardiographic parameters of LV function. As we have Known, the two ventricles of the heart are not only interconnected anatomically but are also functionally dependant. Alteration of LV finction may impair RV function on the systole, and vice versa.[11]

TAPSE showed highly significant difference between the case and control group (P value=0.001), this is concordant with a study of RV function Popescu et al. evaluated the patterns of RV functional recovery using TAPSE in 500 patients with acute MI (GISSI 3 ECHO substudy) and also found that early (24-48 hours) RV systolic function was significantly lower in patients with LVEF lass than 45% than in patients with LVEF of 45% or more.[12]

In the present study RVMPI showes highly significant difference between the case and control group (p value=0.001), this is concordant with Monika et al. who made a study compromised of 50 patients with isolated LV-AMI with strict exclusion of any associated RV infarction by electrocardiography,

Echocardiography and right coronary angiography. The findings in this study demonstrated that even in patients with isolated LV-AMI there is RV dysfunction due to ' ventricular interdependance', and concluded that RV-MPI is a senstive, non geometric echocardiographic parameter, to detect RV dysfunction at an early stage so as to reduce morbidity and mortality in these patients.[13]

In the present study the $S^{/}$ shows a significant difference between the case and control group (P value =0.021), Meluzin et al. Showed that an S wave velocity less than 11.5 cm/s was predictive of RVEF less than 45% with a senstivity of 90% and specificity of 85% created three levels of S velocity (< *9*, 9-12, > *12* cm/s) to distinguish three levels of RVEF (< *30*, 30-55 and > *55*%), Meluzin results were concordant with our study results.[14]

In contrast to our study and the previous mentioned trials and studies, Leonardo et al., Suggests that RV function is largely independent of LV function, and that RV dysfunction may be more dependant on the location and extent of infarction than on extent of LV dysfunction.[15]

Conclusion:

In conclusion, our results suggest that the right ventricular function assessed by echocardiography in patients of ischemic dilated cardiomyopathy was deteriorated even in absence of right ventricular ischemic involvement.

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