

Left Ventricular Diastolic Parameters in Dilated Cardiomyopathy: Are We Missing Out on Something?

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Abstract

Equilibrium radionuclide ventriculography is an established modality to assess the left ventricular (LV) systolic function in several clinical situations. Diastolic parameters can also be extracted from this investigation. The aim of our study is to assess the diastolic function of the left ventricle in cases of idiopathic dilated cardiomyopathy (IDCM) and ischemic cardiomyopathy, where systolic dysfunction has been considered of prime pathologic significance. We conducted a retrospective analysis of 89 patients who had undergone radionuclide ventriculography at our department with established diagnosis of IDCM in 59 patients and ischemic cardiomyopathy in remaining 30 patients. Peak filling rate (PFR) was assessed. The PFR was significantly lower in both patients with IDCM (median = 1.61 end diastolic volumes [EDV]/s) and ischemic cardiomyopathy (median = 2.005 EDV/s). 33% of the patients with ischemic cardiomyopathy and ejection fraction (EF) >45% had diastolic dysfunction while 25% of patients with IDCM and EF >45% had low PFR. Diastolic dysfunction can coexist in patients with dilated cardiomyopathy and even in patients with preserved LV EF. Routine evaluation of diastolic function in patients with heart failure can help in elucidation of pathogenesis and management of patients.

Keywords: Cardiomyopathy, diastolic function, ejection fraction, multiple gated acquisition, radionuclide ventriculography, systolic function

Introduction

Equilibrium radionuclide ventriculography (ERNV) is an established modality for assessment of left ventricular (LV) systolic function. It is credited to be more accurate and reproducible and less dependent on the observer. Use of ERNV has been well-established in several clinical conditions like congestive heart failure and monitoring of drug toxicity for evaluation of LV function. ERNV technique also yields significant data regarding the diastolic component of LV function. The peak filling rate (PFR) and time to peak filling are the parameters that can be extracted from ERNV. The aim of our study was to find out the status of diastolic function in

patients with dilated cardiomyopathy (DCM), including specifically idiopathic and ischemic types, where systolic dysfunction is considered the prime pathology.

Materials and Methods

A retrospective analysis of all cases with a diagnosis of DCM referred for radionuclide ventriculography (RNV) was done. RNV was performed after *in vivo* red blood cell labeling with technetium-99m. Images were acquired under a single head gamma camera (Millennium MPR, GE healthcare, Milwaukee, USA) coupled with a low energy general purpose collimator. Gated data were acquired in 24 bins. All the studies were acquired in the 45° left anterior oblique view or view with the best septal separation. Prospective gating was done. Images were acquired for a total of 1 million counts. The diastolic parameters were analyzed with commercial software available with the processing workstation (Xeleris, GE healthcare, Milwaukee, USA). The software accepts the ventricular volume curve as input and generates a derivative curve from which the diastolic parameters can

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be estimated. PFR, mean filling rate diastolic parameters were assessed in all the patients.

Statistical analysis

Descriptive statistics were used to describe the data. The Levene's test was used to test for equality of variances of the parameters of age, heart rate, PFR, and ejection fraction (EF). Unpaired *t*-test was used to test the difference between the idiopathic dilated cardiomyopathy (IDCM) group and ischemic cardiomyopathy group.

Results

Data of 89 patients (28 females, 61 males; mean age 45.9 years) were analyzed. Diagnosis of ischemic cardiomyopathy was established in 30 patients while the rest of the 59 patients had a diagnosis of IDCM. The mean heart rate at the time of scan was 77/min (range: 54-114) in patients with ischemic cardiomyopathy, while it was 86.5/min (range: 46-132) in the subset of patients with IDCM. The parameters of age, PFR, and EF showed equal variance. Patients in both groups had comparable mean age ($P = 0.9$).

The mean and median values for the EF were 40.4% and 39.5%, respectively for patients with ischemic cardiomyopathy and 32.6% and 28%, respectively for patients with IDCM [Figure 1]. The median PFR was 2.005 end diastolic volumes (EDV/s) in the group with ischemic cardiomyopathy while it was 1.61 EDV/s in the group with IDCM [Figure 2]. Nine patients with ischemic cardiomyopathy had an EF value of >45% of whom three patients (33%) had low PFR while in the subgroup with IDCM 12 patients had an EF >45% with 3 (25%) showing reduced PFR.

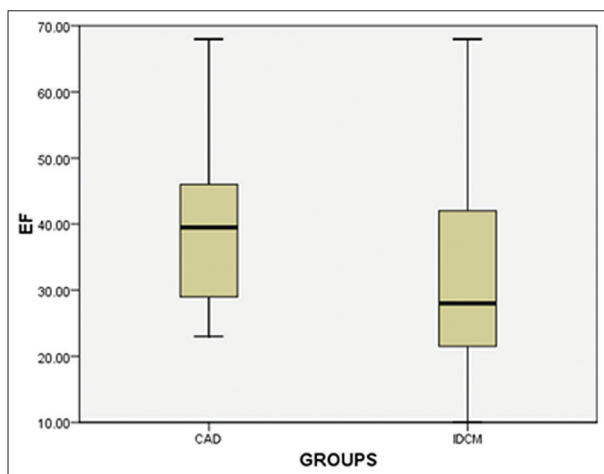


Figure 1: Box plot showing the distribution of ejection fraction (EF) among the two study groups of ischaemic cardiomyopathy (labelled CAD for coronary artery disease) and Idiopathic dilated cardiomyopathy (IDCM)

Discussion

Diastole is the period of ventricular relaxation. It is classified into stages of isovolumic relaxation, rapid filling, diastasis, and atrial contraction. The principal focus in congestive heart failure is on the systolic function of the heart. However, several studies have shown the importance of diastolic phase in the pathogenesis of heart failure. The abnormalities of diastolic failure constitute the principal component in hypertrophic cardiomyopathy and restrictive cardiomyopathies. Diastolic heart failure is a distinctly defined entity.^[1] Its incidence has been estimated to be approximately 38-54% of all heart failure cases.^[2,3] The prognosis of patients suffering from diastolic failure is as grave as those with systolic failure.^[4]

Diastolic function of the heart can be assessed by angiography, echocardiography as well as RNV. ERNV technique has the advantage over other modalities that the data are collected over several cardiac cycles and therefore is more precise. The phase of isovolumic relaxation starts with the end of systole until the mitral valve opens. Rapid filling phase begins with the opening of the mitral valve and filling depends on the thickness of the ventricular wall, its viscoelastic properties and on external constraints. Diastasis is the phase when the atrial and ventricular pressures are equal. The final component of the diastole is atrial contraction.

Aging,^[5]hypertension,^[6]hypertrophy of the left ventricle^[7] and restrictive conditions all result in reduction of the diastolic function of the heart. However, our aim was to assess the status of the diastolic function in IDCM and in ischemic DCM, where systolic failure is considered primary. In our study, the PFR was significantly reduced in both the subgroups compared with the lower normal

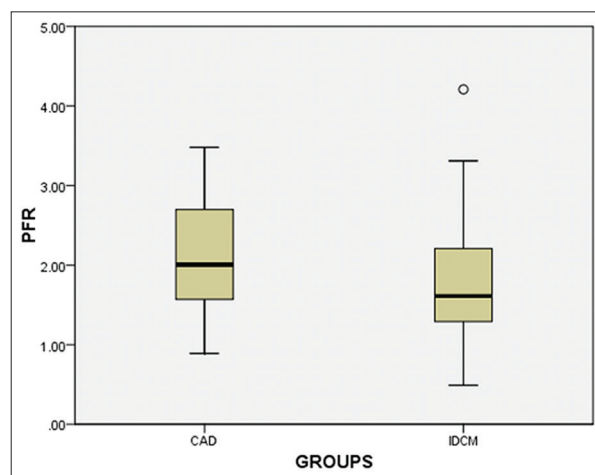


Figure 2: A Box plot showing the median Peak Filling Rates (PFR) for the two study groups of ischaemic cardiomyopathy (labelled CAD for coronary artery disease) and Idiopathic dilated cardiomyopathy (IDCM)

of 2.5 EDV/s. This highlights that diastolic component has a role if not significant, in patients with DCM. Bonow *et al.*^[8] showed that 91% of all patients and 89% of patients with normal systolic function with chronic coronary artery disease had abnormal LV filling. The reasons for development of diastolic dysfunction are varied. In ischemic condition a proposed reason is the depletion of high energy phosphates and thereby impairment of calcium sequestration in the sarcoplasmic reticulum.^[9] In DCM, changes of LV remodeling such as myocardial fibrosis, and changes in the cardiac myofilaments proteins like titin^[10] and matrix metalloproteinases constitute a major factor in altering the muscle tension and elastic properties. External restriction from dilatation of all the chambers itself may result in impaired relaxation. The common and significant factor in all these conditions is alterations in calcium handling by the cardiac myocytes that result in impaired relaxation.

Time from systole to peak filling is another diastolic parameter that can be extracted from ERNV technique and our study has a drawback of not analyzing it. Other drawbacks of our study are that the correlation between the stage of heart failure and diastolic parameters is not available. However, when compared with EF, in the subgroup of patients with ischemic cardiomyopathy with EF >45%, up to 33% patients had reduced PFR, while in the subgroup with IDCM 25% of patients with EF >45% had reduced PFR. Our study therefore highlights the importance of often missed finding of diastolic parameter abnormalities in patients with heart failure. The significance of finding diastolic dysfunction clinically transforms directly into management changes in the form of use of modalities like beta blockers and calcium channel blockers to enhance the relaxation of the ventricle. A prospective planned study might throw more light on the derangements of diastolic function in DCM with correlation to the etiology and the stage of the heart failure.

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