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# Left Atrial Volume Index in Patients with Dilated Cardiomyopathy—Correlation with Left Ventricular Function

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## Abstract

**Background:** The aim of this study was to determine the relation of left atrial (LA) volume and LA volume index with left ventricular function and to determine the association of duration of symptoms and left atrial volume index in patients with dilated cardiomyopathy. **Materials and Methods:** This was an observational, single centre study conducted in India. A total of 50 patients who were admitted to department of cardiology from July, 2008 to February, 2009 with diagnosis of dilated cardiomyopathy and an ejection fraction of <40% were included. **Results:** Of the 50 patients, 34 (68%) were males. 27 (54%) patients were in NYHA class II and 23 (46%) patients were in NYHA class III. LA volume was found to be ≥40 ml in all patients. LV function and LA volume were found to be correlated ($r = -0.789$, $p < 0.01$). Similarly, there was a correlation between LV function and LA volume index ($r = -0.826$, $p < 0.01$). There was no correlation between LA volume index and duration of symptoms ($r = 0.04$). **Conclusion:** It can be concluded that there is a strong inverse correlation between LA volume and left ventricular function and also between LA volume index and left ventricular function. The patients with NYHA class III were having larger left atrial volume than those with NYHA class II. Moreover, the duration of symptoms has no correlation with left atrial volume index.

## Keywords

Ejection Fraction, Dilated Cardiomyopathy, Left Atrial Volume Index, Left Ventricular Function

## 1. Introduction

Dilated cardiomyopathy is a syndrome characterized by enlargement of cardiac chambers and compromised systolic function of one or both ventricles [1]. It is largely asso-

ciated with poor prognosis. Substantial variability has been reflected in the clinical course and the morphologic and hemodynamic features of the patients [2].

In patients with dilated cardiomyopathy, left atrial (LA) sizes have varied largely [3] [4]. The prognostic impact of this observation had been scrutinized in the Studies Of Left Ventricular Dysfunction (SOLVD) population [5]. Patients with a reduced left ventricular (LV) ejection fraction (EF) had an escalated risk proportional to the increase in the size of LA [6]. The eminent contributing factors of LA volume are degree of ventricular remodeling, mitral regurgitation (MR) and the presence of atrial fibrillation (AF) [7]. Yet, it is indistinct whether the prognostic power of the LA enlargement might be the result of LV diastolic dysfunction or the presence of MR or AF; such that, all of these pathophysiologic variables influence both enlarging the atrial chamber and prognosis in patients with a decreased EF [6].

It has been demonstrated that the size of the LA is better described by volume rather than diameter. Lester *et al.* [8] suggested that LA may become less spherical as it enlarges and thus, that LA volume may be a more sensitive index of LA enlargement. Though atrial enlargement has been associated with an augmented mortality rate [9], the pathophysiologic determinants of atrial size have not been routinely examined, specifically in patients with ventricular diseases. Thus, the aim of this study was to determine the relation of left atrial volume and left atrial volume index with left ventricular function and to determine the association of duration of symptoms and left atrial volume index in patients with dilated cardiomyopathy.

## 2. Materials and Methods

### 2.1. Study Design and Patient Population

This was an observational, single centre study in which a total of 50 consecutive patients admitted to department of cardiology at a centre in India, from July, 2008 to February, 2009 were included. The inclusion criteria constituted of patients with diagnosis of dilated cardiomyopathy and an ejection fraction of <40%.

Patients with organic mitral or aortic valve disease and those with incidence of a recent myocardial infarction (<6 months) of any type were excluded. All participants gave their informed consent and the study complies with Declaration of Helsinki and study protocol was approved by Institutional Ethics Committee.

### 2.2. Study Procedure

A detailed history and physical examination was done in all patients. A standard 12-lead electrocardiogram and chest X-ray was taken. Echocardiographic evaluation was done with Philips HD 11 XE machine, with Doppler facilities. From the standard parasternal long axis view, left ventricular dimension, left atrial size and ejection fraction were measured. Both apical 4 chamber and 2 chamber views were obtained.

The area-length method was used for LA volume measurement, by $(0.85 \times A1 \times A2)/L$ formula [10]. Here, A1 is the area in apical four chamber view; A2 is the area in apical two chamber view; L is the linear dimension from the centre of the mitral annu-

lus to the superior border of the chamber. Left atrial volume index was calculated by left atrial volume/body surface area. Body surface area was determined from body weight and height. The LA volume index of 22 ± 6 ml/m$^2$ was considered normal; 29 - 33 ml/m$^2$ implied mild elevation of LA volume index; 34 - 39 ml/m$^2$ implied moderate elevation of LA volume index; >40 ml/m$^2$ implied severe elevation of LA volume index [11].

Mitral regurgitation (MR) was semi-quantitatively assessed by colour flow Doppler echocardiography and regurgitation grades were determined. Grade for MR were—0 for no MR; 1 for trace MR; 2 for mild MR; 3 for moderate MR; 4 for severe MR.

Chest X-ray was examined and LA enlargement was noted in three grades. Grade 1—LA border is inside right atrial (RA) border; Grade 2—LA border approximate with RA border; Grade 3—LA border beyond RA border. ECG was analysed and Macruz index was calculated.

### 2.3. Statistical Analysis

Statistical analysis was performed with the use of Statistical Package for Social Sciences (SPSS; Chicago, IL, USA) program, version 15. Continuous variables are presented as mean ± standard deviation (SD) and categorical variables as counts and percentages. The parameters of the patients were compared with non-paired Student t-test. $P < 0.05$ was considered significant.

## 3. Results

Of the 50 patients who were enrolled in the study, 34 (68%) were males and 16 (32%) were females. 27 (54%) patients were in NYHA class II and 23 (46%) patients were in NYHA class III. On chest X-ray examination, 9, 36, and 5 patients were observed to have Grade 1, 2 and 3 LA enlargements, respectively. The baseline clinical parameters of patients are detailed in Table 1.

On echocardiography, LA volume was found to be ≥40 ml in all patients. 11 patients had LA volume of >60 ml. Mild elevated LA volume index was observed in 16 patients, whereas 28 and 6 patients had moderately and severely elevated LA volume index, respectively. Mild, moderate and severe LV dysfunction was found in 34, 11, and 5 patients, respectively (Table 2).

Table 3 demonstrates correlation between MR and other echocardiographic parameters like left atrial volume, left atrial volume index and ejection fraction. There was significant correlation of all echocardiographic parameters with the severity of MR.

Correlation between NYHA functional class and other echocardiographic parameters are depicted in Table 4. Ejection fraction and LA volume were significantly correlated with NYHA class presentation ($p < 0.05$). However, the study does not reveal any significant correlation between functional status of the patient and LA volume index. This may be due to higher body surface area of patients belonging to functional class III.

Correlation between LV function and LA volume was found to be highly significant ($p < 0.01$) (Table 5). A strong negative correlation was seen between them ($r = -0.789$).

Table 1. Baseline parameters of the patients.

| Parameters | Patients (N = 50) |
|---|---|
| Age (range, years) | 29 - 88 |
| Sex (Male/Female) | 34/16 |
| ***NYHA functional class*** | |
| Class II, n (%) | 27 (54%) |
| Class III, n (%) | 23 (46%) |
| Duration of symptoms (mean (range), months) | 12 (3 - 36) |
| Diabetes, n (%) | 29 (58%) |
| Atrial fibrillation, n (%) | 8 (16%) |
| ***Clinical presentation*** | |
| Idiopathic cardiomyopathy, n (%) | 24 (48%) |
| Ischemic cardiomyopathy, n (%) | 26 (52%) |
| STEMI, n (%) | 18 (36%) |
| NSTEMI, n (%) | 8 (16%) |
| ***Chest X-ray and left atrial enlargement*** | |
| Grade 1, n (%) | 9 (18%) |
| Grade 2, n (%) | 36 (72%) |
| Grade 3, n (%) | 5 (10%) |

NYHA—New York Heart Association; STEMI—ST Elevation Myocardial Infarction; NSTEMI—Non ST Elevation Myocardial Infarction.

Table 2. Echocardiographic parameters of the patients.

| Parameters | Patients (N = 50) |
|---|---|
| ***Left atrial volume*** **(ml)** | |
| 40 - 50, n (%) | 16 (32%) |
| 50 - 60, n (%) | 23 (46%) |
| >60, n (%) | 11 (22%) |
| ***Left atrial volume index*** **(ml/m²)** | |
| 28 - 34, n (%) | 16 (32%) |
| 34 - 40, n (%) | 28 (56%) |
| >40, n (%) | 6 (12%) |
| ***Ejection fraction*** **(%)** | |
| 31 - 40, n (%) | 34 (68%) |
| 21 - 30, n (%) | 11 (22%) |
| <20, n (%) | 5 (10%) |

**Table 3.** Correlation between mitral regurgitation, left atrial volume, left atrial volume index and ejection fraction.

| | Grade 1 | Grade 2 | Grade 3 | p-value |
|---|---|---|---|---|
| Left atrial volume (mean, ml) | 48.74 | 57.36 | 69.2 | <0.01 |
| Left atrial volume index (mean, ml/m$^2$) | 30.21 | 33.98 | 40.77 | <0.01 |
| Ejection fraction (mean, %) | 36.59 | 30.19 | 22.14 | <0.01 |

**Table 4.** Correlation between NYHA functional classes, left atrial volume, left atrial volume index and ejection fraction.

| | NYHA class II | NYHA class III | p-value |
|---|---|---|---|
| Left atrial volume (mean, ml) | 53.60 | 59.00 | <0.05 |
| Left atrial volume index (mean, ml/m$^2$) | 32.61 | 34.94 | NS |
| Ejection fraction (mean, %) | 33.03 | 29.13 | <0.05 |

NYHA—New York Heart Association; NS—Non Significant.

**Table 5.** Correlation between left atrial volume, left atrial volume index, ejection fraction, and duration of symptoms.

| | r-value | p-value |
|---|---|---|
| Ejection fraction and LA volume | −0.789 | <0.01 |
| Ejection fraction and LA volume index | −0.826 | <0.01 |
| LA volume index and duration of symptoms | 0.004 | 0.9 |

LA—Left Atrial.

Similarly, there was a strong inverse correlation between LV function and LA volume index ($r = -0.826$, $p < 0.01$). There was no correlation between LA volume index and duration of symptoms ($r = 0.04$). This may be probably due to patients having asymptomatic LV dysfunction before becoming symptomatic.

## 4. Discussion

The prognosis of patients with dilated cardiomyopathy has been gloomy, with an average survival of two years following diagnosis. In spite of various advancements; this disease still has awful prognosis [12]. The LA volume is a predictor of cardiovascular events in patients with cardiac failure [6] [13] [14]. Moreover, LA volume is associated with the presence of symptoms in such patients [13]. Though LA dilatation is a marker of LV diastolic dysfunction and can also occur secondarily to MR, it has been imprecise about the determinants of LA enlargement in patients with dilated cardiomyopathy [15]. Present study showed that LA remodeling is frequent with dilated cardiomyopathy. LA volume was found to be a powerful marker adding important clinical information. LA volume is mainly determined by degree of LV dilatation, LV function, extent of MR and atrial fibrillation.

Functional MR is a major confounding factor in the hemodynamics of patients with

LV systolic dysfunction [16] [17]. MR volume is a key determinant of atrial volume [18] which may reflect the severity, duration and prognosis of MR [19]. Present study revealed direct correlation of severity of MR and increment of LA volume.

Literature suggests that LA volume stores information on the history of illness [20] highlighting its duration [3]. But in our study, duration of symptoms does not have any correlation with the degree of left atrial enlargement. This may be due to the fact that sufficient number of patients may be passing through asymptomatic left ventricle dysfunction phase while the LA may be dilating. Moreover, Rossi *et al.* [6] also showed only a weak correlation with the duration of symptoms and LA size.

In this study, the LA volume and EF were found to have a strong inverse correlation ($r = -0.789$). Whereas in a recent study, these were found to be weakly correlated ($r = -0.36$, $p < 0.01$) in patients with non-ischemic dilated cardiomyopathy [15]. Previously, studies [21] had utilized LA size for prediction of disease progression, but their study was based on LA dimension, not LA volume. LA volume is a more sensitive prognostic marker in cardiovascular disease [22], therefore we evaluated the prognostic significance of LA volume index. Various studies have revealed that an increased LA volume index is allied to augmented morbidity and mortality in patients with cardiovascular disease [14] [23] [24]. Moreover, Yang WI *et al.* [25] have demonstrated lower event-free survival rates in patients with hypertrophic cardiomyopathy with LA volume indexes > 39 ml/m$^2$ than those with LA volume indexes ≤ 39 ml/m$^2$ ($p < 0.01$). Thus LA volume and LA volume index depict to be useful echocardiographic predictors of prognosis in patients with dilated cardiomyopathy.

## 5. Conclusion

In light of the results, it can be concluded that there is a strong inverse correlation between left atrial volume and left ventricular function and also between left atrial volume index and left ventricular function. The patients with NYHA class III were having larger left atrial volume than those with NYHA class II. Moreover, the duration of symptoms has no correlation with left atrial volume index.

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