

# Assessment of Left Ventricular Function in Acute Ischaemic Stroke

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**Abstract:** Cardiac diseases are a major risk factor for stroke after hypertension and diabetes. Cardiac diseases mainly Heart failure that may be systolic dysfunction or diastolic dysfunction are one of the causes of athero thrombotic stroke. During the occurrence of acute ischaemic stroke it is surely essential to evaluate the risk of mortality and morbidity for the patient during the hospital stay. Left ventricular dysfunction assessment in stroke patients is a great prognostic factor in assessing the prognosis of the patient during hospital stay including mortality. In this study we evaluated left ventricular dysfunction in stroke patients and its association with in patient mortality.

**Keywords:** Stroke, left ventricular dysfunction

## 1. Introduction

Cardiac disease is a major risk factor for stroke, ranking third after age and hypertension.<sup>1</sup> Congestive Cardiac failure ranks second in cardiogenic stroke risk<sup>1</sup>, with a two fold to three fold relative risk<sup>1,2</sup>. The prevalence of cardiac failure increases substantially in prevalence as the population ages. Cardiac failure is also associated with high mortality, with a 15 year total mortality rate estimated at 39% for women and 72% for men<sup>3</sup>.

LVSD is common and treatable, accounting for 8% of people aged 25-75 years and 12% of 45-75 years. Of the 8%, 4% are asymptomatic<sup>6</sup>. The patients who appear to be at high risk of LVSD are those with ischaemic heart disease, hypertension or diabetes, and smokers<sup>9</sup>. However, echocardiographic screening of all hypertensives, all diabetics and all smoker for LVSD would be a daunting and costly process. A more cost- effective approach might be to wait for the first presentation of a vascular episode, and to perform routine echo screening at that time. The first vascular episode could be either a myocardial infarction (MI), a transient ischaemic attack (TIA), a cerebro vascular accident or peripheral vascular disease. In normal clinical practice, MI patients are now a days screened for LVSD during their hospital admission, but, patients who have had CVA/ TIA/ PVD are not routinely screened for LVSD. Yet, the presentation with one vascular episode in the form of stroke could be a golden opportunity to detect and treat LVSD, and thereby reduce the subsequent incidence of overt heart failure, and perhaps even sudden cardiac death.

## 2. Aim of the Study

- To study and evaluate left ventricular function in patients with ischaemic stroke.

- To analyse whether LV dysfunction could be a surrogate marker for in hospital mortality in patients developing ischaemic stroke.

## 3. Materials and Methods

### Study Design

Randomised prospective observational study

### Setting

ICU and Medical wards of Sree Balaji Medical College, Chennai

**Study group:** 142 patients diagnosed as ischaemic stroke.

**Period of study:** April 2017 to September 2018.

LV function was assessed by trans thoracic 2 - dimensional echo cardiography in patients admitted with ischaemic stroke under various medical units of SBMCH.

### Exclusion Criteria

- Patients under the age of 39 yrs were excluded from the study group.
- Patients with haemorrhagic stroke were excluded from the study group.
- Patients with valvular heart disease were excluded from the study group.

All the study group patients underwent transthoracic echocardiography as a part of the study.

All patients had a thorough clinical, neurological examination with careful evaluation of history. Importance was given to symptoms and signs of cardiac disease in addition to neurological findings.

Routine laboratory tests included urine analysis, complete blood counts, serum electrolytes, blood glucose and

serum cholesterol determination. Arterial hypertension was defined as presence of a positive history of antihypertensive treatment or blood pressure values >140 /90 mm hg on admission. Hypercholesterolemia was defined as a total serum cholesterol >240mg /dl. or presence of appropriate drug treatment earlier. Diabetes mellitus was defined based on abnormal fasting glucose >125mg /dl, positive history or presence of oral hypoglycemic agents intake or insulin treatment. Coronary artery disease included history of myocardial infarction or typical angina or the patients reporting of a positive diagnostic test (stress test, Coronary angiography) or drug treatment, 12 lead ECG and CXR were taken for all the patients. The neurological work up included head CT and the patients showing haemorrhage on the CT were excluded from the study group.

**Echocardiographic Evaluation**

Transthoracic two dimensional echocardiography was performed in all study patients.

**LVEF was measured by the following formula**

$LVEDV - LVESV$

$LVEDV$

LVEDV = LV end diastolic volume

LVESV = LV end systolic volume

LVEF was then categorised as

Normal = >50%

Mildly decreased = 41-50%

Moderately decreased = 31-40%

Severely decreased = 30% or less

**LV diastolic dysfunction was graded as**

- Normal
- Grade I (delayed relaxation)
- Grade II (Pseudo normal filling)
- Grade III (restrictive filling) based on mitral flow velocities and filling times.

**LVH was defined as** Increase in interventricular septal thickness and posterior wall thickness beyond 1.1cm during diastole as excess by M-mode LV measurements in parasternal long axis and apical views in left lateral position.

**LV mass was derived using the formula described by Devereux and associates**

$LV\ mass\ (grams) = 0.80 \times 1.04 [(VSTd + LVIDd + PWTd)^3 - (LVIDd)^3] + 0.6$

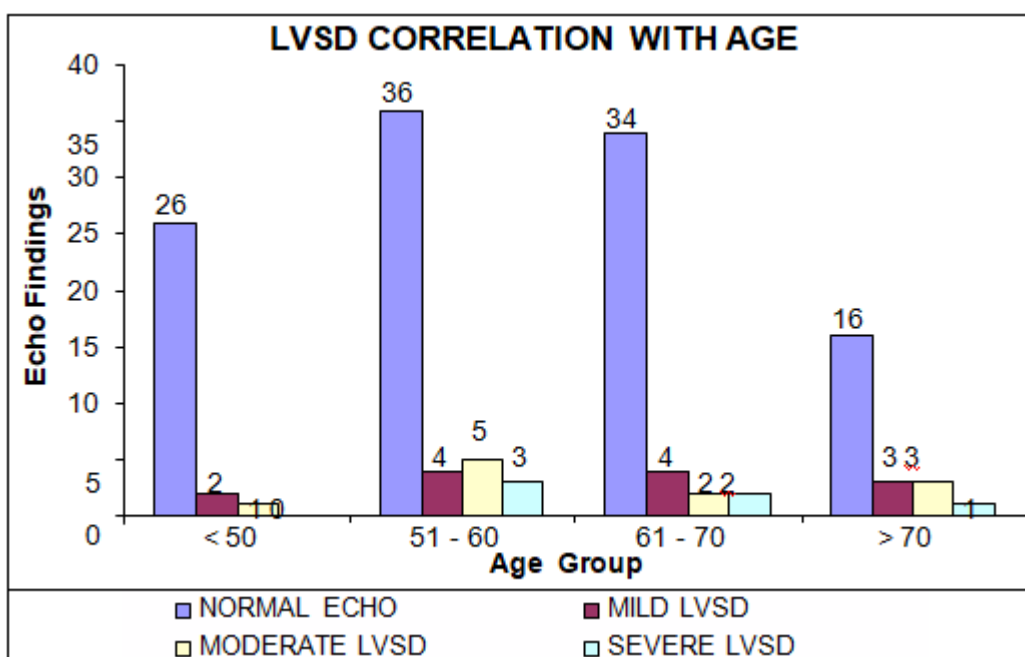
- VSTd is ventricular septal thickness at end diastole
  - LVIDd is LV internal dimension at end diastole
  - PWTd is LV posterior wall thickness at end diastole.
- LV mass was corrected for height <sup>2.7</sup> (LVMI), and expressed in units of grams/meter (g/m <sup>2.7</sup>). The presence of left ventricular hypertrophy was defined for LVMI >51g/m <sup>2.7</sup> in either gender.

**4. Results**

142 Patients of the study group were divided into various sub groups. Ischaemic stroke was most commonly observed between 51-60 years of age followed by patients aged 61-70 years .The mean age of the patients was `58 years.

**Echocardiographic Changes**

- 112 out of 142 patients had normal left ventricular systolic function echocardiographically.
- 13 patients had mild left ventricular systolic dysfunction (9.15%).
- 11 patients had moderate left ventricular systolic dysfunction (7.75%).
- 6 patients had severe left ventricular systolic dysfunction (4.23%).



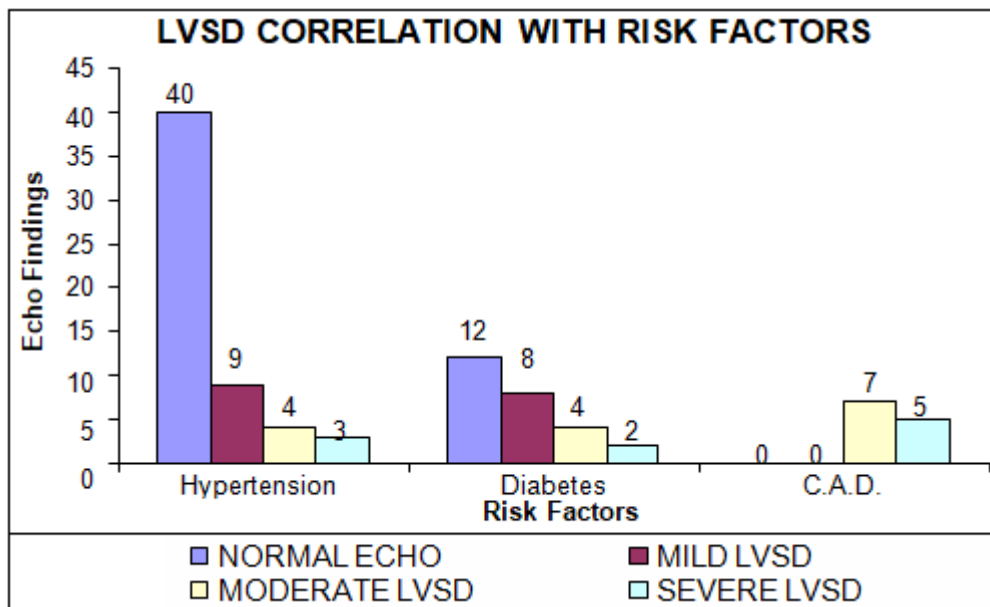
More number of patients were in the age group between 51-60 years followed by 61-70 years.

More men had left ventricular systolic dysfunction when compared to women in the ratio of 18:12.

16 hypertensives had left ventricular systolic dysfunction (P value = 0.12). 14 diabetic patients left ventricular systolic dysfunction which was statistically

significant (P value .00). All the 12 C.A.D patients had moderate to severe left ventricular systolic dysfunction (P value = 0.00).

14 patients with N.Y.H.A class III symptoms had L.V.S.D (P value = .00).



**Left Ventricular Hypertrophy**

Left ventricular hypertrophy was observed in 65 patients. echocardiographically .Most of them were in the age group between 60-70 years followed by 50-60 years of age. More number of men had L.V.H when compared to women in the ratio of 41:24. L.V.H. was observed commonly in 39 smokers followed by 29 hypertensives. It was also evident in 13 alcoholics. 15 patients with L.V.H had history of angina and palpitation. NYHA class I symptoms where frequently observed in patients with L.V.H

(P value = 0.09). 16 patients with LVH had dense hemiplegia

(P value = 0.03). Massive infarct on C.T was evident in 18 patients

(P value = 0.04). 6 patients had associated diastolic dysfunction echocardiographically.

However this association was not statistically significant. 19 patients with E.C.G. changes of LVH had LVH echocardiographically. 11 patients with cardiomegaly on chest x-ray had L.V.H echocardiographically 9 patients with L.V.H had left ventricular systolic dysfunction echocardiographically. This association was statistically significant (p value= 0.02). 3 patients with L.V.H had in hospital mortality.

**Diastolic Dysfunction**

12 out of 142 patients had diastolic dysfunction echocardiographically. 5 patients were in the age group between 51-60 years followed by 4 patients in the age group less than 50 years. The number of men with diastolic

dysfunction was more when compared to women in the ratio of 7:5.

There is no statistically significant association between diastolic dysfunction and history of angina, palpitation and symptoms of left heart failure 5 hypertensive patients had diastolic dysfunction. 2 diabetic patients had diastolic dysfunction. One patient with history of C.A.D had diastolic dysfunction. There was no statistically significant association between D.D.F and chest X- ray, E.C.G changes.

An attempt was made to correlate the clinical parameters of stroke -including severity of stroke, altered mentation, extent of stroke on C.T and mortality with L.V function. L.V diastolic dysfunction had statistically significant association with mortality when compared to L.V systolic dysfunction.

**In Hospital Mortality**

9 out of 142 patients had in hospital mortality. The average period of hospital stay was 12 days among this group. 3 were aged between 51 to 60 years and above 70 years. Death was observed more commonly in men (ratio of men: women being 5:4). Among those who expired, hypercholesterolemia was seen in 7 patients. Hypertension was observed in 5 patients. 2 patients had diabetes mellitus. One patient had coronary artery disease. 5 patients had symptoms of cardiac dysfunction on admission. This association between the symptoms of left heart failure and mortality had statistical significance (p value .00). cardiomegaly on chest skiagram was observed in 4 out

of 9 patients. This association was statistically significant (p value .00). Echocardiographic evidence of left ventricular dysfunction was observed in 4 patients. Out of which 2 patients had L.V. systolic dysfunction and 2 patients had L.V. diastolic dysfunction. The association between L.V. diastolic dysfunction and mortality was statistically significant (P value 0.00).

## 5. Discussion

E.C.G changes in stroke patients were analysed by DS. Goldstein during 1979. In SOLVD study, heart failure in stroke patients was evaluated.

### Age Incidence

Among the patients studied 33% were between 51-60 years followed by 29% between 61-70 years. The average age of patients studied was 58 years. The lesser incidence in people below 50 years of age could be because in our study we excluded patients with valvular heart disease and the causes of young stroke. The number of patients of over 70 years was also less is possibly because less no of people live beyond this age. The age incidence in the current study was similar to the northern manhattan study. In the NOMA study also the age of patients more than 70 and younger than 50 years was less.

### Sex Incidence

66% of patients in the present study were men as against 34% who were women. This is probably because smoking and intake of alcohol was observed in a majority of men in our group. This contrasts with the manhattan study figures (NOMA study) where 56% were women against 44% men. The higher incidence of stroke in women of NOMA study could be due to the associated habits of smoking and alcohol intake in western women.

## 6. Risk Factor Profile

### Smoking

51% of patients in current study were chronic smokers where as in NOMA study 23% were smokers. This difference could be due to the higher incidence of smoking in Indian men when compared to people of Western country where the habit of smoking was comparatively less than alcohol intake. The present study showed statistically significant association between smoking, hypertension and diabetes. The association between smoking and clinical severity and morbidity of the stroke was also statistically significant in the present study.

### Alcohol

The incidence of alcohol intake was more in the NOMA study when compared to the present study. It was 40% in the NOMA study as compared to the 23% of present study. This difference could be attributed to the higher incidence of alcohol intake in Western countries when compared to our country.

### Hypercholesterolemia

The incidence of hypercholesterolemia was more in the present study (54%) where as it was less in the NOMA

study (38%). The above difference could be due to the changes in the life style pattern of the people of our country with associated alcohol intake and smoking and also due to the increase in associated co morbid conditions like atherosclerosis, diabetes hypertension and C.A.D.

### Hypertension

The incidence of hypertension was 39% in present study which was less when compared to NOMA study (i-e 78%). This could be due to the difference in the incidence of comorbid conditions like diabetes, C.A.D, dyslipidemia. The association of hypertension and C.A.D was statistically significant in the present study. The ECG changes of LVH and hypertension was statistically significant in the present study.

### Diabetes Mellitus

The incidence of diabetes in the present study was 18.3% as compared to the NOMA study of 43%. The above difference due to the sedentary lifestyle of the western people and also due to the higher incidence of obesity among the people of western countries. There was a statistically significant correlation between diabetes and LVSD. In hospital stay mortality was statistically significant among diabetic patients.

### Coronary Artery Disease

The incidence of C.A.D. was 8.4% in the present study as compared to the NOMA study of 31% the above difference could be due to the higher incidence of CAD in Western countries. Also this could be attributed to increase in associated comorbid conditions like diabetes, hypertension and dyslipidemia. The severity of the symptoms of left heart failure had statistically significant correlation with CAD in present study. ECG changes of M.I and CXR changes of cardiomegaly had significant correlation with CAD in present study. LVSD was more commonly observed in present study with statistical significance

### Symptoms of CAD and Cardiac Dysfunction

Since we were assessing the echocardiographic evidence of LV dysfunction, we evaluated the cardiac dysfunction in detail. The symptoms of cardiac dysfunction was observed in the study group patients on admission. 20% had H/O angina and 49 patients had shortness of breath of varying degree. 4 patients had shortness of breath at rest. There was significant correlation between shortness of breath of severity and E.C.G changes of previous M.I. Shortness of breath of at rest had a significant correlation with LVSD in present study. Clinical picture of stroke with altered mentation and severity of the stroke had statistically significant correlation with cardiac symptoms.

### Past History of Stroke

Past history of stroke was obtained in all stroke patients in the present study. This was elicited to evaluate the significance of recurrent stroke in study group patients. H/O of recurrent of stroke was observed in more men when compared to women in the present study. This could be attributed to the difference in the number of men and

women of study group. Associated smoking and alcohol habits were observed in men which was not observed in women. The severity of the stroke and clinical picture had significant statistical correlation with past H/O of stroke (p value = .00). The recurrent stroke rate is much higher than the rate of first-ever stroke in patients with cardiac failure. Sacco et al<sup>54</sup>. found a 45% 5- year recurrent stroke rate in patients with cardiac failure.

**Electrocardiographic Changes**

E.C.G changes in the stroke patients were compared with a study of E.C.G changes in stroke patients by DS Goldstein 1979<sup>53</sup>.

<i>DS Goldstein study 1979 (Number of patients = 150)</i>	<i>Present Study (Number of patients=142)</i>	
Abnormal E.C.G (Total)	92%	53%
E.C.G. changes of arrhythmias (including tachycardia)	28%	14%
LVSD Mild	26%	16.9%
Moderate /severe	20%	11%
E.C.G changes of -B.B.B	20%	12%

The present study group patients had less frequency of E.C.G changes when compared to DS Goldstein study. However, the E.C.G changes of L.V.H and E.C.G changes of arrhythmias followed by E.C.G changes of previous M.I were commonly observed in both the studies. The above E.C.G. changes could be attributed to the underlying hypertensive, atherosclerotic cardiovascular disease, sympathetic hyperactivity, and possibly myocardial necrosis.

The current study showed that the E.C.G changes of previous M.I had a statistically significant correlation with severe heart failure symptoms of NYHA class III and IV (P value =.00). The above patients also had a statistically significant association with chest x- ray changes of cardiomegaly (p value =.00).

**Chest X-Ray Changes**

Chest x- ray changes of cardiomegaly was observed in 23 patients. Out of the 23 patients 14 had NYHA class III and IV symptoms with statistical significance (P value = .00). The above patients also had left ventricular systolic dysfunction echocardiographically. However, this association was not significant statistically. 3 patients had diastolic dysfunction echocardiographically. This association had no statistical significance. The patients with chest x- ray changes of cardiomegaly had significant dense hemiplegia and massive infarct on C.T. This association between CXR changes of cardiomegaly with clinical severity and extent of stroke had statistical significance (p value .00).

16% of the patients had cardiomegaly on CXR. Studies in ischaemic stroke patients on CXR findings are not much. However, in U.K T.I. A study showed an association of 8% cardiomegaly in T.I.A patients. The above difference could be attributed to the more incidence of cardiomegaly in completed stroke patients.

**Echocardiographic Changes**

30 patients had left ventricular systolic dysfunction in the present study (21.13%). The L.V.S.D changes of present study group was compared with L.V.S.D changes of NOMA study group as follows:

NOMA study (1994-1997) number of patients - 270	Present study number of patients -142	
LVSD Mild	10.7%	9.1%
Moderate /severe	13.3%	11.98%
LVSD any level	24.1%	21.13%

LVSD of any degree was more frequent in stroke patients of the present study group. The incidence of LVSD was comparatively similar in both study groups. However, in the present study more men had LVSD than women in the ratio of 18:12. This association of higher incidence of LVSD in men was not statistically significant (p value = .13). In NOMA study, incidence in men and women was not much different (p value= .65).

LVSD was more common in the age group between 50-60 years followed by 60-70 years in the present study (P value 0.78). LVSD of any degree was significantly associated with ischaemic stroke among all age groups in NOMA study (P value 0.57).

16 hypertensives had L.V.S.D in the present study (p value= 0.12). 14 diabetic patients had LVSD with statistical significance (p value=0.00) All the patients with E.C.G changes of previous M.I had LVSD of moderate to severe degree with statistical significance (p value = 0.00). Clinical symptoms of severe heart failure (NYHA class III - IV) had a statistically significant correlation with LVSD (p value 0.00).The patients with dense hemiplegia, altered sensorium associated with massive infarct on C.T had significant association with LVSD( p value = 0.00). LVSD had no statistically significant correlation with mortality in the present study.

In the survival and ventricular Enlargement (SAVE) study, patients with an EF of 29% to 35% had a stroke rate of 0.8% per year; the rate in patients with EF of 28% or less was 1.7% per year. There was an 18% increment in the risk of stroke for every 5% decline in EF.

**Diastolic Dysfunction**

12 patients had diastolic dysfunction in the present study. Most of them were between 51-60 years followed by less than 50 years. The number of men was more than women in the ratio of 7:5.

Diastolic dysfunction was more frequent in hypertensives than diabetics in the ratio of 5:2. One patient with C.A.D had diastolic dysfunction. There is no statistically significant association between history of angina, palpitation and symptoms of left heart failure and diastolic dysfunction. The association between D.D.F and chest x- ray, E.C.G changes is also statistically not significant. There is no significant association between diabetes, C.A.D and diastolic dysfunction in the present study. However, association between mortality and

diastolic dysfunction was statistically significant (P value = 0.01).

### In Hospital Mortality

9 patients had in hospital mortality in the present study. Mortality was more in men than women in the ratio of 5:4. 7 out of 9 patients had hypercholesterolemia. 5 patients had hypertension. Two patients had diabetes mellitus. One patient had coronary artery disease.

NYHA class I symptoms was observed in two patients on admission (P value = 0.00). Cardiomegaly on chest x-ray was observed in four patients. This association was statistically significant (P value = 0.00). The clinical picture and extent of stroke was also severe among the patients with diastolic dysfunction. Four patients had altered sensorium, 5 patients had massive infarct on C.T, one patient had dense hemiplegia (P value = 0.04)

## 7. Conclusion

- LVSD was observed in 30 patients of the present study (21.13%).
- LV Diastolic dysfunction was observed among 12 patients (3.4%).
- Association of LVSD with clinical severity and extent of the stroke had of positive correlation statistically.
- Association of LVSD with in hospital stay mortality was not significant.
- Hypercholesterolemia was observed as the most common risk factor among the ischaemic stroke patients.
- Coexisting coronary artery disease and diabetes mellitus had positive correlation with left ventricular systolic dysfunction.
- Patients with symptomatic heart failure of NYHA class III and IV had a positive correlation with left ventricular systolic dysfunction and clinical morbidity in ischaemic stroke.
- Chest x-ray changes of cardiomegaly was observed among 4 out of 9 patients with in hospital stay mortality.
- LV Diastolic Dysfunction was associated with in patient mortality which was statistically significant.

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