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To Estimate Left Atrial Volume Index in Patients with Ischemic Stroke Using 2d Echocardiography

Dr Karandeep Kaur[1], Dr Gaurav Mohan[2*]

[1]3rd Year Medicine Resident, SGRD Institute of Medical Sciences and Health Research, Amritsar, Punjab India.
[2*]Professor, Department of Cardiology, SGRD Institute of Medical Sciences and Health Research, Amritsar, Punjab India.

Correspondence Author: Dr Gaurav Mohan
Email Id: gauravmohan80@yahoo.co.in

Abstract
Aim: The aim of the present study was to estimate left atrial volume index in patients with ischemic stroke using 2D Echocardiography.
Methods: The Patients of ischemic stroke who were admitted to emergency or ward SGRD Hospital, Amritsar were enrolled in the study. Patients of acute ischemic stroke from 01st January 2023 to 31st March 2024 getting enrolled in emergency/ward of SGRDIMSAR Amritsar were selected. Informed consent was taken from patients for participation in the study.
Results: Majority of the patients (40%) were more than 65 years old followed by 55-65 years (27.7%), 45-55 years (23.1%), 35-45 years (6.2%), and 25-35 years (3.1%). Mean age of the patients was 62.20±13.16 years. 53.8% were males and 46.2% were females. 66.2% patients had BSA <1.7 m2, 27.7% had 1.7-2 m2, and 6.2% had >2 m2. Mean BSA was 1.5874±0.23250 m2. According to TOAST Criteria, 63.1% belonged to class I, 16.9% belonged to class II, 16.9% belonged to class III and 3.1% belonged to class V. Mean total cholesterol levels were 184.5385+62.05393, mean triglyceride levels were 169.1231+80.39522, mean HDL cholesterol levels were 45.0769+23.93305, and mean LDL cholesterol levels were 98.6923+33.14029. Mean LAVI of patients with TOAST classification 1 was 34.1933+2.20066, class 2 was 34.0500+2.13605, class 3 was 36.4600+1.97687 and class 5 was 31.4333+2.20530. We found a statistically significant difference in mean values of LAVI in Class 3 and Class 5 patients.
Conclusion: In conclusion, LAVI was significantly associated with class III (cardio embolic) and class V (stroke of undetermined etiology) strokes according to TOAST criteria. We also found significantly increased LAVI with larger left atria. We suggest that further prospective observational studies studying the relationship between atrial parameters and stroke subtypes should be performed as they provide useful insight into unraveling mechanisms of strokes in individual patients especially those with perhaps multiple overlapping proximate causes of stroke, with increasing atrial dilation.

Keywords: Left Atrial Volume Index, Ischemic Stroke, 2D Echocardiography.

1. INTRODUCTION

Recent evidence highlight the importance of enlarged left atrium (LA) as a barometer of diastolic burden and a good predictor of cardiovascular outcomes - including heart failure (HF), atrial fibrillation, stroke, and mortality.[1] It is considered a marker of chronically increased left

atrial pressure and/or volume. LA volume has been compared to the "glycated hemoglobin of diabetes mellitus",[2] as it is a reflection of a long-standing hemodynamic condition. Because left atrial size can be measured noninvasively by echocardiography, measurement of LA size is part of the standard echocardiographic examination.

The traditional method of assessing maximal end-systolic anteroposterior dimension of LA from the parasternal long-axis view in M-mode is simple and convenient but its accuracy may be limited by the anatomical confinement afforded by the spine and sternum and the resulting asymetrical or pillow-shaped enlargement of the left atrium.[3] Hence, measurement of a single LA diameter may underestimate actual LA size. For these reasons, multiple linear dimensions or measurement of left atrial volume (LAV) especially when corrected for body size (LAVi) is a more accurate representation of true LA size.[4] Atherosclerosis leading to hypertension is mirrored on an echocardiogram as left ventricular hypertrophy.[5] Historically, echocardiographic predictors of vascular outcome have focused on left ventricular morphology. Left ventricular mass was found to predict stroke and coronary artery disease.[6] In the Framingham Study, for each 50-g increase in LVM, there was 1.5-fold increase in relative risk for subsequent cardiovascular events.[7] Recent studies have reported left atrial diameter and left atrial volume index to be associated with chronic hypertension and stroke.[8] Although these values have helped in predicting ischemic stroke, their association with specific stroke subtypes has not been established.

Left atrial volume index (LAVI) is less sensitive to acute variations, reflecting subacute or chronic changes in diastolic function.[9,10] Individuals with increased LAVI, i.e., with significant diastolic dysfunction, are at high risk for complications and could benefit from choosing the most appropriate treatment.[11] Thus, increased LAVI is associated with risk of ischemic stroke and value of LAVI correlates with stroke subtype as at mild increases in left atrial volume indices (28-32 ml/m2) there were more atherothrombotic strokes patients but at higher left atrial volume index (32-36 ml/m2 and >36 ml/m2) there was more cardioembolic stroke.

The aim of the present study was to estimate left atrial volume index in patients with ischemic stroke using 2D Echocardiography.

2. MATERIALS AND METHODS

The Patients of ischemic stroke who were admitted to emergency or ward SGRD Hospital, Amritsar were enrolled in the study. Patients of acute ischemic stroke from 01st January 2023 to 31st March 2024 getting enrolled in emergency/ward of SGRDIMSAR Amritsar were selected. Informed consent was taken from patients for participation in the study.

Inclusion Criteria

All Patients diagnosed as ischaemic stroke on brain imaging were included. Stroke was subcategorized on the basis of TOAST classification

CLASS 1	**LARGE ARTERY ATHEROSCLEROSIS (LAA)** Includes patients with clinical and and brain imaging findings of either significant (more than 50%) stenosis or occlusion of a major brain artery or cortical artery branch, probably due to atherosclerosis.
CLASS 2	**SMALL VESSEL OCCLUSION(SVO)** Includes patients with classical lacunar syndromes and no evidence of cardioembolism and significant large artery stenosis
CLASS 3	**CARDIOEMBOLISM (CE)**

	Included patients with cereberal infarction probably due to an embolus originated in the heart.
CLASS 4	**STROKE OF OTHER DETERMINED ETIOLOGY** Includes patients with rare causes of stroke such as non-atherosclerotic vasculopathies, hypercoagulable state or haematologic disorders.
CLASS 5	**STROKE OF UNDETERMINED ETIOLOGY** Includes patients with stroke whose cause cannot be identified with any degree of evidence.

Exclusion Criteria

1. Patient with a past history of stroke
2. Patient with haemmorrhagic stroke

Methodology

Proper history from the patient was taken and general physical and systemic examination was done and final diagnosis was made after doing all necessary baseline investigations CBC, RFT, LFT, Serum Electrolytes, Lipid Profile, ECG, Brain Imaging (MRI) and 2D Echo was done routinely. LAVI was measured using biplanar area length method on 2D Echocardiography.

Statistical Analysis

The recorded data was compiled and entered in a spreadsheet computer program (Microsoft Excel 2010) and then exported to data editor page of SPSS version 22 (SPSS Inc., Chicago, Illinois, USA). Descriptive statistics included computation of percentages, means and standard deviations will be calculated. Statistical test applied for the analysis will be Pearson chi-square test, student t-test, One-way ANOVA and Pearson correlation coefficient. The level of confidence interval and p-value were set at 95% and 5%.

3. RESULTS

Table 1: Patient Characteristics

Age (In Years)	Frequency (n)	Percent
25-35	2	3.1
35-45	4	6.2
45-55	15	23.1
55-65	18	27.7
>65	26	40.0
Total	65	100.0
Mean±SD	62.20±13.16	
Gender		
Female	30	46.2
Male	35	53.8
Total	65	100.0
BSA (m2)		
<1.7	43	66.2
1.7-2	18	27.7
>2	4	6.2
Total	65	100.0
Mean±SD	1.5874±0.23250	

HTN		
Present	58	89.3
Absent	7	29.7
Total	65	100.0
Diabetes Mellitus		
Present	29	44.6
Absent	36	55.4
Total	65	100.0

Majority of the patients (40%) were more than 65 years old followed by 55-65 years (27.7%), 45-55 years (23.1%), 35-45 years (6.2%), and 25-35 years (3.1%). Mean age of the patients was 62.20±13.16 years. 53.8% were males and 46.2% were females. 66.2% patients had BSA <1.7 m2, 27.7% had 1.7-2 m2, and 6.2% had >2 m2. Mean BSA was 1.5874±0.23250 m2. Out of 65 patients, 89.2% patients had hypertension. 44.6% patients had diabetes mellitus.

Table 2: Distribution According to TOAST Criteria, Lipid Profile

TOAST CLASS	**Frequency**	**Percent**
Class 1	41	63.1
Class 2	11	16.9
Class 3	11	16.9
Class 5	2	3.1
Total	65	100.0

Lipid profile (mg/dl)	**N**	**Mean**	**Std. Deviation**
TC	65	184.5385	62.05393
TGL	65	169.1231	80.39522
HDL	65	45.0769	23.93305
LDL	65	98.6923	33.14029

According to TOAST Criteria, 63.1% belonged to class I, 16.9% belonged to class II, 16.9% belonged to class III and 3.1% belonged to class V. Mean total cholesterol levels were 184.5385+62.05393, mean triglyceride levels were 169.1231+80.39522, mean HDL cholesterol levels were 45.0769+23.93305, and mean LDL cholesterol levels were 98.6923+33.14029.

Table 3: Distribution According to LVEF (%) and LA SIZE (Mm/M2)

LVEF	**Frequency**	**Percent**
≤40	10	15.4
41-49	5	7.7
>50	50	76.9
Total	65	100.0
LA Size (mm/M2)		
30-35	2	3.1
35-40	29	44.6
40-45	26	40.0
45-50	8	12.3

Total	65	100.0
Mean±SD	41.4154±3.81564	

76.9% patients had LVEF >50, 15.4% had <40, 7.7% had 41-49. Mean LA size was 41.4154±3.81564 mm/m2. 44.6% had LA size 35-40 mm/m2 followed by 40-45 mm/m2 (40%), 45-50 mm/m2 (12.3%), and 30-35 mm/m2 (3.1%).

Table 4: Distribution According to LV MASS Index (Gm/M2) and Valvular Heart Disease

LV mass Index (gm/m2)	Frequency	Percent
<70	5	7.7
70-100	7	10.8
100-130	18	27.7
>130	35	53.8
Total	65	100.0
Mean±SD	146.2740±62.78292	
Mitral Stenosis		
Absent	60	92.3
Present	5	7.7
Total	65	100.0

Mean LV mass index in study population was 146.2740±62.78292. Majority of the patients (53.8%) had LV mass index >130 followed by 100-130 (27.7%), 70-100 (10.8%), and <70 (7.7%). Mitral stenosis was present only in 7.7% patients.

Table 5: Association between Mean Value of LAVI and TOAST Criteria

Toast classification	N	Mean LAVI	Std. Deviation
1	45	34.1933	2.20066
2	12	34.0500	2.13605
3	5	36.4600*	1.97687
5	3	31.4333*	2.20530
Total	65	34.2138	2.29605

Mean LAVI of patients with TOAST classification 1 was 34.1933+2.20066, class 2 was 34.0500+2.13605, class 3 was 36.4600+1.97687 and class 5 was 31.4333+2.20530. We found a statistically significant difference in mean values of LAVI in Class 3 and Class 5 patients.

4. DISCUSSION

Strokes constitute a global health epidemic and are the leading cause of sustained disability.[12] Ischemic stroke is a heterogeneous disease, the two main subtypes being cardioembolic stroke and atherosclerotic stroke.[13] It is important to be able to identify these subtypes since therapeutic decisions for future prevention may differ.[14] The underlying pathological processes are different in the two subtypes; while advanced atherosclerotic stenosis is deemed to be the major mechanism in athero-thrombotic stroke, it is the underlying cardiac abnormalities with relatively preserved architecture of blood vessels that eventually manifests as cardioembolic strokes. Ischemic stroke is caused by the obstruction of a blood vessel to the brain by a blood

clot or a narrowing of a blood vessel to such extent that the brain parenchyma does not receive sufficient oxygen.[15] Ischemic stroke is the most common form of stroke and is the cause of about 80-85% of all stroke cases in western countries. ICH is caused by spontaneous non-traumatic bleeding in the brain parenchyma or ventricular system, leading to a local accumulation of blood.[15] ICH is caused by microangiopathy and cerebral artery malformation. ICH cases encompass roughly 10-15% of all stroke cases.

In present study, majority of the patients (40%) were more than 65 years old followed by 55-65 years (27.7%), 45-55 years (23.1%), 35-45 years (6.2%), and 25-35 years (3.1%). Mean age of the patients was 62.20±13.16 years. Pearson correlation between Age and LAVI was significant. In a similar study done by Alonso A et al[16] median age was 75 years. 53.8% were males and 46.2% were females in present study. In a study done by Alonso A et al[16] and Leung DY et al[17] 45% were females and 55% were males. In present study, 66.2% patients had BSA <1.7 m2, 27.7% had 1.7-2 m2, and 6.2% had >2 m2. Mean BSA was 1.59±0.23 m2.Body size is a major determinant of LA size. To adjust for this influence, LA size should be indexed to a measure of body size, most commonly to body surface area.[18, 19]

According to TOAST Criteria, 63.1% belonged to class I (large-artery atherosclerosis), 16.9% belonged to class II (cardioembolism), 16.9% belonged to class III (small-vessel occlusion) and 3.1% belonged to class V (stroke of undetermined etiology) in present study. Mean LAVI of patients with TOAST classification 1 was 34.19+2.20, class 2 was 34.05+2.14, class 3 was 36.46+1.98, and class 5 was 31.43+2.20. We found a statistically significant difference in mean values of LAVI in Class 3 and Class 5 patients. In study conducted by Kamel H et al[20] LAVI varied significantly across subtypes ($P < 0.001$), from 48.8 mL/m2 in cardioembolic strokes to 30.3 mL/m2 in small-vessel strokes. Patients with embolic strokes of undetermined etiology (ESUS) had significantly larger LAVI than those with small- or large-vessel strokes ($P = 0.01$). Although there was substantial overlap in LAVI between these two groups, they found a curvilinear relationship between LAVI and the likelihood of ESUS (vs. small- or large-vessel stroke). In present study, mean LVEF values were 57.49±12.22 and 76.9% patients had LVEF >50. In similar study conducted by Yedidiya Y et al[21] a total of 84% had an LVEF ≥ 50%. In present study, mean LAVI in patients with LVEF <40% is 35.17+1.96, in LVEF 41-50% is 33.18+3.49, in LVEF >50% is 33.99+2.49. Association between LAVI and LVEF was found to be non-significant. In present study, patients with LA size<40 mm had mean LAVI of 32.65+2.23 and patients with LA size>40 mm had mean LAVI of 35.43+1.97. The difference was statistically significant.

In the present study, increasing LAVI was significantly associated with Class III (Mean LAVI 36.46+1.98) as compared to class V (Mean LAVI 31.43+2.20) of TOAST classification, presence of AF (Mean LAVI of 36.82+2.21), increasing grades of Hypertension, and increasing LA size. In study conducted by Patel DA et al[22] with increasing LAVI, the prevalence of frank LVH significantly increased. In our study, patients having left ventricular hypertrophy had mean LAVI 34.05+2.45, while others had 34.25+2.71 and the difference was not statistically significant. Increasing LAVI was also associated with lower LVEF, older age, LV end-diastolic diameter, LVMI, and mortality. In the Framingham Heart Study, adjusting for LV mass negated the relationship between LA size and mortality.[23] In the Kuopio Ischaemic Heart Disease (KIHD) Risk Factor Study[24] significant association between LA size and mortality was found after adjusting for LVH.

5. CONCLUSION

In conclusion, LAVI was significantly associated with class III (cardio embolic) and class V (stroke of undetermined etiology) strokes according to TOAST criteria. We also found significantly increased LAVI with larger left atria. We suggest that further prospective

observational studies studying the relationship between atrial parameters and stroke subtypes should be performed as they provide useful insight into unraveling mechanisms of strokes in individual patients especially those with perhaps multiple overlapping proximate causes of stroke, with increasing atrial dilation. This insight will eventually contribute to better and effective secondary prevention in individual patients.

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