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Original Research Paper

General Medicine

LEFT VENTRICULAR FUNCTION AND OUTCOMES IN PATIENTS WITH CEREBROVASCULAR ACCIDENT: A PROSPECTIVE OBSERVATIONAL STUDY

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ABSTRACT

Background: Stroke is a critical health issue often resulting in severe disability or death, caused by interrupted blood flow to the brain. The left ventricle's function is pivotal, with impaired performance leading to worsened stroke outcomes. Patients experience a range of physical, cognitive, and emotional challenges post-stroke. The assessment of left ventricular function is essential for early diagnosis and risk stratification in stroke care, given its significant correlation with stroke severity and outcomes. **Methods:** This prospective observational study aims to investigate the relationship between left ventricular function and the outcomes of patients who have experienced a cerebrovascular accident. The study comprised 50 ischemic and 50 hemorrhagic stroke patients, selected through a non-random, convenient sampling method. **Results:** In the current study, participants had an average age of 58.32, with a majority being male and over 60. Hypertension, alcoholism, and smoking were prominent risk factors. The study revealed a notable presence of left ventricular systolic dysfunction in both ischemic and hemorrhagic stroke cases, with more severe dysfunction observed in the latter. A significant correlation emerged between the mean ejection fraction and stroke severity and functional outcome. The findings underscore the intricate relationship between cardiac and neurological health in stroke outcomes, emphasizing the need for comprehensive assessments to optimize patient care. **Conclusion:** The study found one-third of stroke patients exhibited left ventricular dysfunction, more severe in hemorrhagic cases. This dysfunction correlated with stroke severity and patient outcomes, suggesting the need for its assessment in stroke patient evaluations for enhanced risk stratification.

KEYWORDS :

INTRODUCTION:

Stroke or Cerebrovascular diseases include some of the most common and devastating disorders: ischemic stroke, hemorrhagic stroke, and cerebrovascular anomalies such as intracranial aneurysms and arteriovenous malformations (AVMs). Cerebrovascular accidents (CVAs), commonly known as strokes, are significant medical events that can lead to severe disability or death. They are primarily caused by an interruption in the blood supply to the brain, either due to a blocked artery (ischemic stroke) or a burst blood vessel (hemorrhagic stroke). According to the Global Health Observatory (GHO), stroke has been the second most common cause of death during the last decade with a rising trend. (1)

The outcomes of CVAs can be influenced by various factors, both intrinsic and extrinsic.

One such intrinsic factor that has garnered attention in recent years is the function of the left ventricle of the heart. The left ventricle is crucial in pumping oxygenated blood into the systemic circulation. Its function can be a determinant of the overall cardiovascular health of an individual. Impaired left ventricular function can lead to conditions like heart failure, which can, in turn, affect the outcomes in patients who suffer a CVA. (2)

The effects of stroke can vary enormously, depending on the area of the brain that has been damaged and the extent of the damage. Clinical features vary from paralysis and communication difficulties (problems with speaking, reading, writing, and understanding) to difficulties with mental processes, such as learning, concentration, and memory. Some patients can present with visual disturbances, urinary incontinence, swallowing difficulties, and emotional problems etc. It can take time for the full implications of a stroke to sink in. It has physiological, economic, and psychological impacts on the patients. (3)

Post-stroke complications have been studied both in the acute phase and in the rehabilitation phase. They can be categorized into 3 groups: neurological complications (cerebral edema, stroke progression, stroke recurrence, seizures, anxiety, and depression), cardiovascular complications, and complications of immobility (chest infection, urinary tract infection, other infections, dehydration, venous thromboembolism, falls, pressure sores, and pain). (4) P. Sasikumar et al. (2017) carried out research to evaluate the left ventricular function in patients suffering from ischaemic stroke. Authors utilized trans-thoracic 2-dimensional echocardiography to assess the left ventricular (LV) function in these patients, who were admitted to various departments of a government hospital. The study included 142 male patients, who were categorized into different subgroups. The study concluded that the left ventricular systolic dysfunction (LVSD) in 21.13% (30 patients) of the cases. Diastolic dysfunction was noted in 3.4% (12 patients). A statistically positive correlation was established between LVSD and the clinical severity and extent of the stroke, but not with in-hospital stay mortality. Hypercholesterolemia emerged as the predominant risk factor for ischaemic stroke. A positive statistical correlation was also observed between coexisting coronary artery disease and diabetes mellitus with LVSD.(5)

Patients experiencing symptomatic heart failure, classified under NYHA class III and IV, also showed a positive correlation with LVSD and clinical morbidity in ischaemic stroke. In the study, cardiomegaly, as evidenced by chest X-ray changes, was noted in 4 out of 9 patients who faced in-hospital mortality. A significant statistical association was established between left ventricular diastolic dysfunction and in-patient mortality.(6)

Sung PH et al. conducted a prospective clinical study at a tertiary medical center in southern Taiwan from November 2015 to October 2017. The study aimed to explore the theory that patients with higher NIHSS or mRS[modified rankin

scale] scores would have a reduced LVEF. The primary focus was on the relationship between LVEF and NIHSS or MRS scores. A total of 99 acute ischemic stroke (AIS) patients were methodically enrolled and divided into two groups according to their National Institute of Health Stroke Scale (NIHSS) scores. Group 1 consisted of 50 patients with NIHSS scores less than 6, while Group 2 comprised 49 patients with scores of 6 or above. The authors concluded that acute ischemic stroke patients with an NIHSS score of 6 or higher exhibited a reduced LVEF, increased clinically dominant mitral regurgitation compared to those with an NIHSS score below 6.(7)

Jeong-Yoon Lee et al. (2018) conducted research in order to determine if left ventricular ejection fraction (LVEF) has the potential to forecast cardiovascular events and mortality in patients with acute ischemic stroke (AIS) who do not have atrial fibrillation (AF) and coronary heart disease (CHD). The researchers reviewed the clinical data and echo cardiographic LVEF of 1,465 patients, excluding those with AF and CHD. The findings of the study indicated that LVEF can serve as an independent predictor for cardiovascular events and mortality following AIS when AF and CHD are not present.(8)

Tiffany L. Mathias et al. (2013) conducted a cross-sectional study that explores the relationship between cardiac function and the immediate outcomes in patients suffering from acute ischemic stroke (AIS). The research aims to understand how various aspects of cardiac health, including left ventricular ejection fraction (LVEF) and other cardiac parameters, influence the recovery and health outcomes of AIS patients in the short term. By analyzing these relationships, the study seeks to provide insights that could enhance the clinical management and treatment strategies for improving the prognosis of patients afflicted with AIS, thereby reducing the associated morbidity and mortality rates.(9)

This prospective observational study aims to investigate deeper into the relationship between left ventricular function and the outcomes of patients who have experienced a cerebrovascular accident. By understanding this relationship, healthcare professionals can better predict prognosis, tailor treatments, and potentially improve the outcomes for stroke patients.

The objectives of the study were:

1. Assessment of left ventricular function on the next day of admission with clinical profile of CVA.
2. Assessment of left ventricular function and in hospital stroke severity in patients of CVA using NIHSS Score.
3. Assessment of left ventricular function and outcome of CVA using modified Rankin scale.

Methodology:

The study was conducted at MGM Hospital, Kamothe, and involved a prospective observational analysis of 100 newly admitted stroke patients aged 39 and above, diagnosed via CT Brain plain and contrast or MRI brain plain and angiogram. The study was conducted between January 2020 to December 2022, comprised 50 ischemic and 50 hemorrhagic stroke patients, selected through a non-random, convenient sampling method. Inclusion criteria encompassed patients of both genders aged 39 or above, diagnosed with acute onset ischemic or hemorrhagic stroke, and those with coexisting hypertension or diabetes mellitus. Exclusions were made for patients below the age of 39, those with valvular heart disease, and patients with a history of previous stroke.

The study was conducted adhering to ethical guidelines, ensuring informed consent was obtained from all participants, and their privacy and confidentiality were maintained throughout the study. All participants provided informed consent before being included in the study, ensuring ethical standards were maintained.

Each patient underwent a comprehensive evaluation, including a detailed history intake and a thorough physical and systemic examination, following a standardized proforma. Patients admitted with ischemic or hemorrhagic stroke were assessed for left ventricular function using transthoracic 2-dimensional echocardiographs. This assessment was conducted across various medical units within our hospital at the time of admission. The outcomes of stroke were quantified using a specific ranking scale. Additionally, the severity of the stroke during the hospital stay was measured using the NIHSS (National Institutes of Health Stroke Scale) score to provide a comprehensive view of the patients' health status. Patients were monitored for a period of 15 days post-admission to observe and document the progression and outcomes of their stroke. This short-term follow-up allowed for an immediate assessment of the impact of left ventricular function on stroke outcomes.

Data was systematically recorded in a pre-established study proforma. Qualitative data was presented as frequency and percentage and assessed for associations using the Chi-Square test. Quantitative data was expressed as Mean ± SD and analyzed using the unpaired t-test for normally distributed data, or the Mann-Whitney Test for non-normally distributed data. A p-value of less than 0.05 indicated statistical significance. Results were visually represented through graphs as appropriate, utilizing SPSS Version 26.0 for analysis and Microsoft Excel 2021 for graphical illustrations.

RESULTS:

Table 1 presents the demographic and clinical characteristics of the study participants. The average age was 58.32 (±4.16) years, with 58% of the participants being over 60 years old. The study group had a higher proportion of males (74%) compared to females (26%). Hypertension was the most prevalent associated risk factor at 55%, followed by a history of alcoholism (49%) and smoking (44%). Other identified risk factors included dyslipidemia (47%), diabetes (30%), and ischemic heart disease (IHD) (24%). The study comprised an equal number of ischemic and hemorrhagic stroke cases, total 50 cases each.

Table 1. Distribution of study subjects according to demographic and clinical characteristics

	Frequency	Percentage
Age		
<=40	3	3.0%
41-50	9	9.0%
51-60	30	30.0%
>60	58	58.0%
Mean Age = 58.32±4.16 years		
Gender		
Male	26	26.0%
Female	74	74.0%
Risk Factors		
DM	30	30.0%
HT	55	55.0%
IHD	24	24.0%
Alcohol	49	49.0%
Smoking	44	44.0%
Dyslipidemia	47	47.0%
Type of stroke		
Hemorrhagic	50	50.0%
Ischemic	50	50.0%

Table 2 shows association of type of stroke with left ventricular systolic dysfunction. 2-D echocardiography revealed that left ventricular systolic dysfunction was present in 32% of ischemic and 36% of hemorrhagic stroke cases. Severe dysfunction was identified in 8% of the hemorrhagic stroke

cases, while none was observed in the ischemic stroke cases, which primarily exhibited mild dysfunction (p-0.04). Left ventricular hypertrophy was observed in 54% of hemorrhagic stroke cases and 38% of ischemic stroke cases, with a p-value of 0.16 indicating no significant difference between the two groups. Left ventricular diastolic dysfunction was observed in 8% of hemorrhagic stroke cases and 2% of ischemic stroke cases, with a p-value of 0.36, indicating no significant statistical difference between the two groups.

Table 2. Association of type of stroke with left ventricular systolic dysfunction

Study Variable		Type of Stroke				Total		P-value
		Hemorrhagic		Ischemic				
		n	%	n	%	n	%	
LVSD	No	34	68.0%	32	64.0%	66	66.0%	0.04*
	Mild	6	12.0%	14	28.0%	20	20.0%	
	Moderate	6	12.0%	4	8.0%	10	10.0%	
	Severe	4	8.0%	0	0.0%	4	4.0%	
LVH	No	23	46.0%	31	62.0%	54	54.0%	0.16,
	Yes	27	54.0%	19	38.0%	46	46.0%	NS
LVDD	No	46	92.0%	49	95.0%	95	95.0%	0.36,
	Yes	4	8.0%	1	5.0%	5	5.0%	NS

**: Significant at 5% level of significance, NS: Not significant*

Table 3 indicates the comparison of mean left ventricular ejection fraction (LVEF) with type of stroke. The average left ventricular ejection fraction was notably lower in cases of hemorrhagic stroke compared to ischemic stroke cases (55.62% vs 59.9%; p=0.04), indicating a significant difference.

Table 3. Comparison of mean left ventricular ejection fraction (LVEF) with type of stroke

Type of Stroke	n	Mean	SD	p-value
Hemorrhagic	50	59.9	18.44	0.044*
Ischemic	50	55.62	12.21	

Table 4 shows association of functional outcome in ischemic stroke and Hemorrhagic Stroke patients with left ventricular ejection fraction (LVEF). In ischemic stroke cases, the mean ejection fraction was 72% for those with an mRS score of 1 and 2, and significantly lower, at 51.6% and 37.25%, for those with an mRS score of 5 and 6, respectively. This data indicates a significant correlation between the mean ejection fraction and the functional outcome in ischemic stroke cases (p<0.01). In hemorrhagic stroke cases, the mean ejection fraction was 61.2% and 58.79% for patients with an mRS score of 1 and 2, respectively. This was higher compared to a mean ejection fraction of 51.33% and 47.75% in patients with an mRS score of 5 and 6, respectively. These findings indicate a significant relationship between the mean ejection fraction and functional outcomes in hemorrhagic stroke cases (p<0.01). The results were also shown in the figure 1.

Table 4. Association of functional outcome in ischemic stroke and Hemorrhagic Stroke patients with left ventricular ejection fraction (LVEF)

mRS	Ischemic Stroke		Hemorrhagic Stroke	
	N	LVEF (%)	N	LVEF (%)
1	5	72.00 (8.82)	6	61.20 (4.97)
2	4	64.17 (1.16)	16	58.79 (5.13)
3	17	60.10 (10.57)	16	56.70 (9.92)
4	11	54.60 (16.15)	5	51.10 (23.63)
5	5	51.60 (25.50)	3	51.33 (20.26)
6	8	37.25 (20.10)	4	47.75 (19.6)
Total	50	59.90 (18.40)	50	55.62 (12.21)

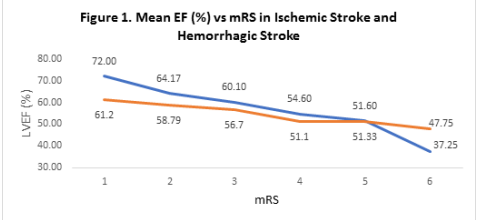

Table 5 indicates association of severity of ischemic and hemorrhagic stroke with left ventricular ejection fraction (LVEF). The severity of stroke was evaluated using the NIHSS score, with a score exceeding 20 indicating a severe stroke. In both ischemic (57.9% vs 60.29%) and hemorrhagic stroke cases (50.67% vs 57.74%), a significant reduction in ejection fraction was observed in severe stroke instances (p<0.01).

Table 5. Association of severity of ischemic and hemorrhagic stroke with left ventricular ejection fraction (LVEF)

Type of Stroke	Severe Stroke (NIHSS>20)	Mean LVEF (%)	SD	P-value
Ischemic	No (n=21)	60.29	8.99	<.01**
	Yes (n=29)	57.9	23.13	
Hemorrhagic	No (n=35)	57.74	8.18	<.01**
	Yes (n=15)	50.67	17.94	

***: Significant a5 1% level of significance*

Table 6 shows the correlation of mRS and NIHSS scale with ejection fraction in Ischemic Stroke and Hemorrhagic Stroke. A significant inverse correlation was found between the functional outcome and severity of stroke with ejection fraction in both ischemic (r value: -0.35; p<0.01) and hemorrhagic stroke cases (r value: -0.30; p<0.01). This indicates that as the severity of the stroke increases, the ejection fraction decreases, impacting the functional outcome.

Table 6. Correlation of mRS and NIHSS scale with ejection fraction

	Left ventricular ejection fraction (LVEF)%	r-value	p-value
Ischemic Stroke	NIHSS	-0.30	<.01**
	mRS	-0.35	<.01**
Hemorrhagic Stroke	NIHSS	-0.29	<.01**
	mRS	-0.24	<.01**

***: Significant a5 1% level of significance*

DISCUSSION:

A stroke, also known as a cerebrovascular accident, occurs suddenly, leading to a neurological deficit due to a specific vascular issue.(10) The impact of a stroke can be diverse, influenced by the affected brain area and the damage extent. (3) Complications arising post-stroke are typically neurological, cardiovascular, or related to immobility. Cardiac disease, particularly Left Ventricular Systolic Dysfunction (LVSD), is a significant stroke risk factor, following age and hypertension.(11) LVSD is prevalent yet manageable, affecting 8% of individuals aged 25-75 and 12% of those between 45-75 years. Among these, 4% are asymptomatic.(12) Individuals with ischemic heart disease, hypertension, diabetes, or those who smoke are at elevated risk for LVSD. (13–15) Universal echocardiographic screening for LVSD among all individuals with hypertension, diabetes, or smokers could be complex and expensive. An alternative, cost-effective strategy could involve conducting echo screenings following the initial occurrence of a vascular event. In our current study, we focused on evaluating the left ventricular function and outcomes in patients experiencing cerebrovascular accidents, including both ischemic and hemorrhagic strokes. Our objective also extended to exploring the correlation between left ventricular function, functional outcomes, and in-hospital stroke severity, assessed using the modified Rankin scale and NIHSS Score. Our study encompassed 50 ischemic and 50 hemorrhagic stroke patients, with the assessment of Left Ventricular function conducted through Transthoracic 2-dimensional echocardiographs and ECGs.

Demography

In the current study, the average age of the participants was 58.32 years, with 58% being over 60 years old. There was a significant male dominance, with the gender distribution being 74% male and 26% female. The prevalence of stroke is well-documented to increase with age, as supported by

various studies. (5,6,8,9,16–21) However, findings regarding the gender distribution among stroke patients are inconsistent across different studies. For instance, Sasikumar PS et al. (5) study involved 142 male patients, with the most common age range for stroke occurrence being 51-60 years, followed by the 61-70 age group. In contrast, a study by Pavan MR et al. (18) reported an equal gender distribution among 100 stroke patients, with an average patient age of 61.01±14.1 years. Somasundaran et al. found that out of 464 patients, 44.6% were female and 55.4% were male, with an average age of 64.3 years. Chukwuonye et al. reported an average age of 66.5±2.6 years among their subjects, with a higher percentage of females (58%) compared to males (42%).

Risk factors

In our research, hypertension was the most prevalent risk factor, identified in 55% of the cases, followed by a history of alcoholism and smoking at 49% and 44% respectively. Other identified risk factors were dyslipidemia (47%), diabetes (30%), and ischemic heart disease (IHD) (24%). These findings align with a South Indian study on 109 stroke patients aged 15-45, where a majority were smokers (69.7%), alcoholics (48.6%), diabetics (54.1%), and hypertensives (72.5%). Another retrospective review of 177 patients in Kerala revealed a significant prevalence of hypertension, smoking, alcohol consumption, and hyperlipidemia among stroke cases. (22) A Taiwanese study (16) identified hyperlipidemia (53.1%), smoking (49.8%), hypertension (45.8%), and a family history of stroke (29.3%) as the top four risk factors for stroke. Strong et al. reported hypertension in 54% of stroke cases. Pavan et al. (18) associated hypertension (37%), smoking (26%), diabetes (18%), alcohol (13%), history of transient ischemic attack (TIA) (11%), and cardiovascular disease (CVD) (5%) with stroke patients. Bansal BC et al. (23) noted hypertension in over a third of stroke cases, with the presence of CVD in 42.8%, smoking in 51%, diabetes in 18.9%, and hyperlipidemia in 16.3%. Sridharan SE et al. (24) found hypertension in 83.2% of patients, with half having diabetes and 26% with dyslipidemia.

Stroke & Left ventricular Function

In this study, we observed left ventricular systolic dysfunction in 32% of ischemic and 36% of hemorrhagic stroke cases. Hemorrhagic stroke cases exhibited severe dysfunction in 8%, while ischemic cases primarily showed mild dysfunction (p-0.04). Left ventricular hypertrophy was more prevalent in hemorrhagic (54%) than in ischemic cases (38%, p-0.16). Diastolic dysfunction was noted in 8% of hemorrhagic and 2% of ischemic cases (p-0.36). Hemorrhagic stroke cases had a lower mean ejection fraction (55.62%) compared to ischemic cases (59.9%, p-0.04). A significant correlation was found between mean ejection fraction and both functional outcome (as measured by the mRS scale) and stroke severity (as indicated by an NIHSS score >20) for both types of stroke ($p<0.01$). Stroke cases with mRS scores of 1 and 2 had higher mean ejection fractions than those with scores of 5 and 6. Severe stroke cases, both ischemic (57.9% vs 60.29%) and hemorrhagic (50.67% vs 57.74%), had significantly lower ejection fractions ($p<0.01$). An inverse correlation was noted between stroke functional outcome and severity and ejection fraction in both stroke types (ischemic r value: -0.35, hemorrhagic r value: -0.30; $p<0.01$). Previous studies, such as those by Sasikumar PS et al.(5) and Bhargav VY et al. (6), reported a positive statistical correlation between left ventricular systolic dysfunction and the clinical severity and extent of the stroke. Hays AG et al. (19) found that even mild left ventricular dysfunction was independently associated with an increased risk of ischemic stroke. Other researchers, including Sung PH et al. (7) and Rahmayani F et al. (17), noted a significant negative correlation between left ventricular ejection fraction and stroke severity and outcome.

In conclusion, our findings indicate that approximately one-third of both ischemic and hemorrhagic stroke cases exhibited left ventricular dysfunction, with more severe dysfunction noted in hemorrhagic cases. This dysfunction was significantly associated with stroke severity and poor functional outcome. We recommend incorporating left ventricular function assessment into the acute stroke patient evaluation protocol to facilitate early cardiac dysfunction diagnosis and patient risk stratification.

CONCLUSIONS:

The current study revealed that left ventricular dysfunction was identified in one-third of cerebrovascular accident cases. Notably, the severity of this dysfunction was more pronounced in patients with hemorrhagic strokes compared to those with ischemic strokes. There was a significant association between left ventricular dysfunction and both the severity of the stroke and the patient's functional outcome, as evaluated by the NIHSS and mRS scales. Based on these findings, we advocate for the integration of left ventricular function assessments into the standard evaluation protocols for acute stroke patients. This inclusion aims to facilitate the early identification of cardiac dysfunction and enable more precise risk stratification for affected individuals.

Conflict of interest: None

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