International Journal of Medical Research Professionals
P-ISSN: 2454-6356; E-ISSN: 2454-6364
DOI: 10.21276/ijmrp

IJMRP

Original Research Article

Study of Echocardiographic and ECG Abnormalities in Stroke Patients and Their Prognostic Significance

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ABSTRACT

Objective: To study the changes in the echocardiography and ECG of patients with stroke along with prognostic significance of these changes.

Methods: A retrospective cross-sectional study evaluating 100 stroke patients. The study population was divided into two groups- ischemic and hemorrhagic stroke on the basis of CT brain findings. ECG and transthoracic echocardiography was done within 72 hours of onset of symptoms. Prognosis was decided on the basis of mortality within five days after onset of stroke.

Results: In our study 66% patients have echocardiographic abnormalities and 73% have ECG abnormalities. Echocardiographic abnormalities were more common in patients with hemorrhagic stroke (76.66%) as compared to ischemic stroke (61.42%). ECG abnormalities were also more common in hemorrhagic stroke (83.33%) as compared to ischemic stroke (68.58%). Most common echocardiographic abnormality in ischemic and hemorrhagic stroke was LVH and diastolic dysfunction respectively. QTc prolongation was most common ECG abnormality seen in ischemic and hemorrhagic stroke. 11 patients of ischemic stroke and 13 patients of hemorrhagic stroke expired within five days of stroke onset. In ischemic stroke, there was significantly higher mortality among those with LV systolic dysfunction (p=0.006) and spontaneous echo contrast (p=0.013) on echocardiography, and with atrial fibrillation (p=0.0001) on ECG.

Conclusion: LV systolic dysfunction, spontaneous echo contrast and atrial fibrillation have prognostic significance in predicting the mortality in ischemic stroke. Echocardiographic and ECG abnormalities in hemorrhagic stroke do not have any prognostic significance.

Key words: Stroke, ECG Abnormalities, Echocardiographic Abnormalities, LV Systolic Dysfunction, Spontaneous Echo Contrast, Atrial Fibrillation.

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Article History:

Received: 24-01-2017, **Revised:** 17-02-2017, **Accepted:** 27-02-2017

Access this article online	
Website: www.ijmrp.com	Quick Response code
DOI: 10.21276/ijmrp.2017.3.2.012	

INTRODUCTION

Cardioembolic stroke has been associated with recurrence and higher in-hospital mortality. In order to establish an adequate preventive strategy it is crucial to identify the cause of the embolism. After complete diagnostic workup up to 30% of ischemic strokes remains with an undetermined cause. In this regard, echocardiography serves as a cornerstone in the evaluation of these patients.[1] Some echocardiographic findings such as intra-cardiac thrombus, infective endocarditis and intra-cardiac tumors will clearly alter the management of stroke patients.[2]

Some studies show the wall motional abnormalities in SAH. There is limited existing literature characterizing the prevalence of cardiac complications in the setting of intracerebral hemorrhage. Ischemic stroke patients undergo echocardiograms evaluating for a cardioembolic source, with no recommendations regarding management of systolic or diastolic dysfunction. In future interventions such as cardiac augmentation may benefit such a subset of stroke patients.[3]

Stroke is frequently accompanied by a variety of ECG abnormalities some of which may be indistinguishable from those seen in association with an episode of myocardial ischemia. Stroke patients often have simultaneous hypertension or coronary atherosclerosis, leading to ECG abnormalities. Hence, it is crucial to distinguish stroke induced ECG changes from ECG changes due to concomitant IHD. Atrial fibrillation is the most common cause of cerebral embolism overall, in this regard ECG helps to identify the cause of ischemic stroke.[4]

Therefore, we designed this study to investigate the echocardiographic and ECG abnormalities in stroke patients and to evaluate the prognostic significance of these abnormalities.

MATERIALS AND METHODS

This study has been carried out on 100 patients of stroke admitted to MBS Hospital, Kota from January 2015 to December 2015. The diagnosis of acute stroke was made on the basis of temporal profile of clinical syndrome, clinical examination and CT scan of brain. Enrolled cases were the patients diagnosed with acute stroke and echocardiography and ECG performed within 72 hours of onset of stroke. We exclude patients with other cause of stroke i.e. infection, malignancy, bleeding diathesis, patients on oral anticoagulation therapy, venous sinus thrombosis and stroke cases with known underlying cardiac diseases. Prognosis was decided on basis of mortality within five days of onset of stroke. Prognosis was divided into two categories: "Live" and "Dead".

A detailed history was taken and examination was done as per the proforma. Purpose of this study was explained to the study subject and relative and an informed written consent was taken. ECG and transthoracic echocardiography was done within 72 hours of onset of symptoms. All echocardiograms were done on Mylab-50CV machine (ESAOTE SpA, Genoa, Italy) with PA 230 E probe. Transthorasic echocardiography was done in supine and left lateral position. Transthoracic echocardiography was done in various cardiac sections based on position of transducer as parasternal, apical, subcostal and suprasternal. On basis of plane of cardiac anatomy, following views were taken as long axis, short axis, 4 chamber, 3 chamber and 2 chamber view. Modified Simpson's rule was used to assess LVEF. Criterions by American society of echocardiography's guidelines and standards committee and the chamber quantification writing group-2004 were applied in analysis of echocardiographic finding.

The study population was divided into two groups ischemic stroke and hemorrhagic stroke. Hemorrhagic stroke group include patients of intracerebral hemorrhage and subarachnoid hemorrhage. Categorical variables were expressed in actual number and percentage in both groups. Categorical variables were compared by performing Chi-square test. P value <0.05 was considered as statistically significant.

Table 1: Echocardiographic abnormalities in stroke patients

S. no	Echocardiographic abnormalities	Ischemic Stroke (n=70)		Hemorrhagic Stroke (n=30)	
		No.	%	No.	%
1	Enlarged left atrium	8	11.42%	0	0
2	Spontaneous echo contrast	3	4.28%	0	0
3	Mitral stenosis	4	5.71%	0	0
4	Mitral regurgitation	17	24.28%	8	26.66%
5	Mitral annulus calcification	18	25.71%	8	26.66%
6	Aortic stenosis	2	2.85%	0	0
7	Aortic regurgitation	8	11.42%	2	6.66%
8	Aortic valve calcification	10	14.28%	7	23.33%
9	LV systolic dysfunction	16	22.85%	3	10.00%
10	Dilated left ventricle	8	11.42%	2	6.66%
11	LVH	31	44.28%	18	60.00%
12	Diastolic dysfunction	26	37.14%	19	63.33%
13	RWMA	9	12.85%	3	10.00%

Table 2: ECG abnormalities in stroke patients

S. no	ECG abnormalities	Ischemic Stroke		Hemorrhagic Stroke	
		No.	%	No.	%
1	QTc prolongation	26	37.14%	17	56.66%
2	ST segment depression	17	24.28%	14	46.66%
3	T wave inversion	25	35.71%	10	33.33%
4	U wave	20	28.57%	14	46.66%
5	Left atrial abnormality	4	5.71%	0	0
6	LBBB	2	2.85%	0	0
7	Atrial fibrillation	8	11.42%	1	3.33%
8	Other arrhythmia	4	5.71%	2	6.66%
9	LVH	15	21.42%	9	30.00%

RESULTS

A total of 100 patients of stroke who fulfilled the inclusion criteria were included in study. The study population included 57% males and 43% females, with male to female ratio of 1.32:1. The age of cases ranged between 16-85 years of age with mean age of 62.05 ± 16.87 years. Maximum numbers of cases (37%) were in the age group of 61-70 years. Hypertension was the most common risk factor in 80% of cases followed by smoking in 38%, diabetes mellitus 23%, hyperlipidemia 13%, alcoholism 9% and prior stroke or TIA 7% of cases. In present study incidence of ischemic stroke and hemorrhagic stroke was 70% and 30% respectively.

Echocardiographic abnormalities were present in 66% of stroke cases. It was more common in patients with hemorrhagic stroke (76.66%) as compared to ischemic stroke (61.42%). But this relation is statistically insignificant (p=0.214). Echocardiographic abnormalities in stroke patients are shown in **Table 1**.

In ischemic stroke most common echocardiographic abnormality was LVH (44.28%), followed by diastolic dysfunction (37.14%), mitral annulus calcification (25.71%), mitral regurgitation (24.28%), LV systolic dysfunction (22.85%), aortic valve calcification (14.28%), RWMA (14.28%), enlarged left atrium (11.42%), aortic regurgitation (11.42%), dilated LV (11.42%), mitral stenosis (5.71%), spontaneous echo contrast (4.28%) and aortic stenosis (2.85%). In hemorrhagic stroke most common echocardiographic abnormality was diastolic dysfunction (63.33%), followed by LVH (60.00%), mitral regurgitation (26.66%), mitral annulus calcification (26.66%), aortic valve calcification (23.33%), LV systolic dysfunction (10.00%), RWMA (10.00%), aortic regurgitation (6.66%) and dilated LV (6.66%).

ECG abnormalities were present in 73% of stroke cases. It was more common in hemorrhagic stroke (83.33%) as compared to ischemic stroke (68.58%). But this difference is statistically insignificant (p=0.201). ECG abnormalities in stroke patients are shown in **Table 2**. Here most common ECG abnormality was QTc prolongation (37.14%), followed by T wave inversion (35.71%), U wave (28.57%), ST segment depression (24.28%), LVH (21.42%), atrial fibrillation (11.42%), Left atrial abnormality (5.71%), other arrhythmia (5.71%) and LBBB (2.85%).

In patients with hemorrhagic stroke most common ECG abnormality was QTc prolongation (56.66%) followed by ST segment depression (46.66%), U wave (46.66%), T wave inversion (33.33%), LVH (30.00%), other arrhythmia (6.71%) and atrial fibrillation (3.33%).

Out of 70 patients with ischemic stroke, 11(15.71%) had in-hospital mortality and 59 (84.28%) had non-fatal ischemic stroke. Out of 30 patients with hemorrhagic stroke, 13 (43.33%) had in-hospital mortality and 17 (56.66%) had non-fatal hemorrhagic stroke. Abnormal echocardiography was more prevalent in those cases who died (87.50%) within five days of stroke onset as compared to those who remained alive (59.22%). This correlation between mortality and abnormal echocardiography was statistically significant (p=0.021).

In ischemic stroke mortality was significantly higher in patients with LV systolic dysfunction (p=0.006) and in patients with spontaneous echo contrast (p=0.013). Echocardiographic and ECG abnormalities do not show any significant association with prognosis in hemorrhagic stroke. In present study in ischemic stroke, there was statistically significant association present between Atrial fibrillation and mortality (p=0.0001).

Table 3: Correlation between echocardiographic abnormalities and prognosis in ischemic stroke

S.no	Echocardiographic abnormalities	Alive(n=59)		Dead(n=11)		P value
		No.	%	No.	%	
1	Enlarged left atrium	5	8.47%	3	27.27%	0.072
2	Spontaneous echo contrast	1	1.69%	2	18.18%	**0.013**
3	Mitral stenosis	2	3.38%	2	18.18%	0.052
4	Mitral regurgitation	14	23.72%	3	27.27%	0.801
5	Mitral annulus calcification	16	27.11%	2	18.18%	0.533
6	Aortic stenosis	1	1.69%	1	9.09%	0.176
7	Aortic regurgitation	5	8.47%	3	27.27%	0.072
8	Aortic valve calcification	8	13.56%	2	18.18%	0.592
9	LV systolic dysfunction	10	16.94%	6	54.54%	**0.006**
10	Dilated left ventricle	5	8.47%	3	27.27%	0.072
11	LVH	26	44.06%	5	45.45%	0.932
12	Diastolic dysfunction	22	37.28%	4	36.36%	0.953
13	RWMA	6	10.16%	3	27.27%	0.119

Table 4: Correlation between echocardiographic abnormalities and prognosis in hemorrhagic stroke

S.no	Echocardiographic abnormalities	Alive(n=17)		Dead(n=13)		P value
		No.	%	No.	%	
1	Mitral regurgitation	5	29.41%	3	23.07%	0.697
2	Mitral annulus calcification	5	29.41%	3	23.07%	0.697
3	Aortic regurgitation	1	5.88%	1	7.69%	0.843
4	Aortic valve calcification	5	29.41%	2	15.38%	0.368
5	LV systolic dysfunction	2	11.76%	1	7.69%	0.712
6	Dilated left ventricle	1	5.88%	1	7.69%	0.843
7	LVH	9	52.94%	9	69.23%	0.366
8	Diastolic dysfunction	10	58.82%	9	69.23%	0.557
9	RWMA	1	5.88%	2	15.38%	0.389

Table 5: Correlation between ECG abnormalities and prognosis in ischemic stroke

S. no	ECG changes	Alive (n=59)		Dead (n=11)		P value
		No.	%	No.	%	
1	QTcprolongation	21	35.59%	5	45.45%	0.534
2	ST segment depression	13	22.03%	4	36.36%	0.308
3	T wave inversion	20	33.89%	5	45.45%	0.462
4	U wave	17	24.28%	3	27.27%	0.917
5	Left atrial abnormality	3	5.08%	1	9.09%	0.599
6	LBBB	2	3.38%	0	0%	0.535
7	Atrial fibrillation	3	5.08%	5	45.45%	**0.0001**
8	Other arrhythmia	4	6.79%	0	0%	0.373
9	LVH	12	20.33%	3	27.27%	0.606

Table 6: Correlation between ECG abnormalities and prognosis in hemorrhagic stroke

S.no	ECG changes	Alive (n=17)		Dead (n=13)		P valve
		No.	%	No.	%	
1	QTc prolongation	10	58.8%	7	53.84%	0.785
2	ST segment depression	6	35.2%	8	61.53%	0.153
3	T wave inversion	6	35.2%	4	30.76%	0.794
4	U wave	9	52.9%	5	38.46%	0.430
5	Atrial fibrillation	0	0	1	7.69%	0.244
6	Other arrhythemia	2	11.7%	0	0%	0.200
7	LVH	5	29.4%	4	30.76%	0.935

DISCUSSION

Acute central nervous system injury has long been associated with myocardial injury and dysfunction. The mechanisms by which acute cerebrovascular events cause ECG changes are unsettled. It has been suggested that changes in the autonomic nervous system activity can be primarily responsible for ischemic, arrhythmic, and repolarization changes. Sustained sympathetic stimulation results in structural damages to the myocardium, which may be mediated by a sudden increase in intracranial pressure, hypothalamic and cardiac nerve stimulation or through an arrhythmogenic center in the insular cortex.[5]

In present study males were outnumbering females with male:female ratio of 1.32:1 which is comparable with that found in studies of Vaidya CV et al[6] and Venketasubramanian et al[7]. In present study cases of stroke among males and females aged, ≤ 60 years were 27.00% and 14.00%; and > 60 years were 30.00% and 29.00% respectively. Venketasubramanian et al[7] in his study in Indian population found that incidence of stroke among male and female aged ≤ 60 years was 13.88% and 5.55%; and > 60 years was 41.66% and 38.88%. Age-specific incidence rates are substantially lower in women than men in younger and middle age groups, but these differences tends to decreases with age. Explanation of this may be because of longer life expectancy and estrogen in females. In present study 7% cases had their first ever stroke onset before age 40 years which is comparable with that found in the study of Das et al[8] i.e. 8% of total cases.

In our study abnormal echocardiography finding was present in 61.42% cases of ischemic stroke and in 76.66% cases of hemorrhagic stroke. H Amin et al[9] in their study found echocardiographic abnormality was present in 67% cases of ischemic stroke and in 41% cases of hemorrhagic stroke.

In present study among ischemic stroke, frequency of most echocardiographic abnormalities in our study population is in line with the frequency reported in the studies of H. Amin et al[9], Y. Bahnacy et al[10] and MA Khan et al.[11] Frequency of LVH, dilated left atrium, MS, AS and aortic valve calcification in present study differ from studies of H. Amin et al[9], Y. Bahnacy et al[10] and MA Khan et al.[11] Data on the prevalence of spontaneous echo contrast are not published in previous studies but are presented in the present study in Table 1. Among hemorrhagic stroke group prevalence of diastolic dysfunction, aortic valve calcification, mitral annulus calcification and mitral regurgitation in present study is comparable with studies of H. Amin et al[9] and KC. Albright et al.[12] Frequency of LVH, dilated left ventricle, left ventricular systolic dysfunction in present study differ from previous studies.

In our study abnormal ECG finding was present in 68.58% cases of ischemic stroke and in 83.33% of hemorrhagic stroke, which is comparable with studies of Bozluolcay M et al[13] and Dimant J et al.[14] In present study, QTc prolongation is the most common ECG abnormality seen in ischemic and hemorrhagic stroke patients. Among ischemic stroke group, prevalence of ECG abnormalities is almost comparable with studies of Goldstein et al[15] and Bozluolcay M et al.[13]

In hemorrhagic stroke group, frequency of prolongation of QTc interval, T wave inversion, ST depression, LVH and presence of U wave is in line with the frequency reported in the studies of Goldstein et al[15] and Arruda WO et al.[16] Frequency of atrial fibrillation and other arrhythmia in present study is less as compared to studies of Goldstein et al[15] and Arruda WO et al.[16]

In present study, mortality was significantly higher (p=0.004) in hemorrhagic stroke (43.33%) as compared to ischemic stroke (15.71%). Transtentorial herniation is mainly responsible for death of stroke patients in first week after stroke onset. Hemorrhagic stroke are associated with rapid raised of intracranial pressure because of mass effect resulting from hematoma, edematous tissue surrounding hematoma and obstructive hydrocephalus.

Raised intracranial pressure leads to brainstem compression and death. In hemorrhagic stroke intracranial pressure raised rapidly and more marked as compared to ischemic stroke and account for higher mortality.[17,18]

In present study out of those ischemic stroke patients who died 54.54% had LV systolic dysfunction whereas those who remained alive 16.94% had LV systolic dysfunction. This correlation between mortality and LV systolic dysfunction was statistically significant (P=0.006). Wira et al[3] found significant association between mortality and LV systolic dysfunction in ischemic stroke patients. Kevorkian GC et al[19] also observed that systolic dysfunction is associated with high mortality in ischemic stroke patients. The mechanism by which LV systolic dysfunction increased mortality is not clear. It is possible that after stroke patients may have an acute change in cardiac contractility. Our results support the need for further investigation in this relatively unexplored area. Mortality was also significantly higher in patients who show spontaneous echo contrast on echocardiography. In present study 18.18% patients who had both spontaneous echo contrast and atrial fibrillation show higher mortality as compared to 1.69% patients with spontaneous contrast alone. Our result is also supported by study of Bernhardt et al[20] who in their study found that patients with AF and dense spontaneous echo contrast have an increased risk of clinically apparent cerebral embolism and death. In present study among ischemic stroke patients mortality was significantly high in patients with atrial fibrillation (P=0.0001). Wong et al[18], Wira et al[3] and Kimura et al[21] also observed significant association between atrial fibrillation and early in hospital mortality**.** Atrial fibrillation leads to cardioembolic stroke, which is associated with early higher mortality as compared to other stroke type. In present study this may be reason for high mortality in ischemic stroke patients with atrial fibrillation. Echocardiographic and ECG abnormalities in hemorrhagic stroke do not have any prognostic significance.

LIMITATIONS

Our study included only 1 case of TR and 1 case of PR. Hence, their association with mortality in stroke could not be ascertained as numbers of cases were very few.

CONCLUSION

Our study showed that LV systolic dysfunction and spontaneous echo contrast on echocardiography, and atrial fibrillation on ECG can predict the mortality in ischemic stroke. Echocardiographic and ECG abnormalities in hemorrhagic stroke do not have any prognostic significance.

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Source of Support: Nil. **Conflict of Interest:** None Declared.

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Cite this article as: Girish Chandra Verma, Anil Kumar, Abdul Wahid, C.P. Meena, Durbadal Mohanta, A.R. Pathan. Study of Echocardiographic and ECG Abnormalities in Stroke Patients and Their Prognostic Significance. Int J Med Res Prof. 2017; 3(2):63-67. DOI:10.21276/ijmrp.2017.3.2.012