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Study of ECG and echocardiographic outcomes in stroke patients in a tertiary care hospital

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Abstract

Introduction - *Cardiac injury is common in patients with cerebrovascular disease. Cardiac dysfunction after stroke may be caused by several mechanisms, including activation of the HPA axis, sympathetic and parasympathetic regulation, catecholamine surge, gut microbiome dysbiosis, & immune responses and inflammation.[11] These changes include ST-T changes, QTc prolongation, abnormal U waves etc.[8-10] Few studies have also demonstrated 2D echocardiographic changes in stroke patients in the form of LV dysfunction, aortic valve abnormality, mitral valve abnormality, etc.[11]*

Hence the present study was done with the objectives, to study different ECG and Echocardiographic changes in different types of strokes , as well as to correlate ECG & Echocardiographic findings between ischaemic and haemorrhagic group of stroke patients. Methods - The study was conducted with 180 patients of CVA, both male and female, age more than 18 years, admitted within 72 hours after the onset of stroke admitted in AGMC & GBP Hospital, Agartala between Jan, 2020 to June, 2021. This was a cross sectional study.

Result - In Hemorrhagic stroke, 32 (50.8%) patients had QTc prolongation.In Ischemic stroke, 33 (28.2%) patients had QTc prolongation.Association of QTc prolongation with Types was statistically significant (p=0.0026).In Hemorrhagic stroke, 25 (39.7%) patients had ST segment depression.In Ischemic stroke, 22 (18.8%) patients had ST segment depression.Association of ST segment depression with Types was statistically significant (p=0.0023). In Hemorrhagic stroke, 47 (74.6%) patients had Abnormal Echo and 16 (25.4%) patients had Normal Echo.In Ischemic stroke, 62 (53.0%) patients had Abnormal Echo and 55 (47.0%) patients had Normal Echo.Association of Echo with Types was statistically significant (p=0.0046). ***Chi-square value:****37.6745;* ***p-value:*** *<0.0001.****Odds ratio:*** *0.1274(0.0637, 0.2551)*

In Hemorrhagic stroke, 46 (73.0%) patients had LV dysfunction.In Ischemic stroke, 30 (25.6%) patients had LV dysfunction.Association of LV dysfunction with Types was statistically significant (p<0.0001).In Ischemic stroke, 10 (8.5%) patients had AV dysfunction.Association of AV dysfunction with Types was statistically significant (p=0.0169).In Ischemic stroke, 23 (19.7%) patients had MV dysfunction.Association of MV dysfunction with Types was statistically significant (p<0.0001).

Conclusion - ECG and Echo changes are frequently seen in selected patients with both Hemorrhagic and Ischaemic stroke. Hence all the patients presenting with stroke should undergo ECG and 2D Echocardiography as a part of the initial evaluation.

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I. Introduction

Stroke is conventionally described as a neurological deficit attributed to an acute focal injury of the central nervous system (CNS) by a vascular cause, including cerebral infarction, intracerebral haemorrhage (ICH), and subarachnoid haemorrhage (SAH) which accounts for major cause of disability and death worldwide.The commoner type is an ischemic stroke, accounts for 85% of all acute stroke and 15% are haemorrhagic strokes.

Cardiac injury is common in patients with cerebrovascular disease[1-3]. Stroke (ischemic stroke, brain haemorrhage and subarachnoid haemorrhage (SAH)) induces neurovascular uncoupling and disrupts cerebral auto- regulation, which then renders cerebral blood flow directly dependent upon cardiac function[5]. Myocardial

injury, ischemia like electrocardiographic (ECG) changes and arrhythmias are frequently encountered in acute stroke patients, even in the absence of primary heart disease, which support a central nervous system (CNS) origin of these ECG abnormalities[1-3,6]. Many studies done earlier has shown that ECG changes can occur in stroke patients even without any underlying cardiac abnormalities. Cardiac dysfunction after stroke may be caused by several mechanisms, including activation of the HPA axis, sympathetic and parasympathetic regulation, catecholamine surge, gut microbiome dysbiosis, & immune responses and inflammation. [11] These changes include ST-T changes, QTc prolongation, abnormal U waves etc.[8-10] Few studies have also demonstrated 2D echocardiographic changes in stroke patients in the form of LV dysfunction, aortic valve abnormality, mitral valve abnormality, etc.[11]

Hence the present study was done with the objectives, to study different ECG and Echocardiographic changes in different types of strokes , as well as to correlate ECG & Echocardiographic findings between ischaemic and haemorrhagic group of stroke patients.

Methods

The study was conducted with 180 patients of CVA, both male and female, age more than 18 years, admitted within 72 hours after the onset of stroke admitted in AGMC & GBP Hospital, Agartala between Jan, 2020 to June, 2021. This was a cross sectional study.

Sample Size was calculated as $N=(1.96)^2 \times pq/l^2$

(N=sample size; p=prevalence; q=100-p; l=margin of error 5%; confidence interval =95%) here prevalence= 10%)

$N=(1.96x1.96x90x10)/(5)^2$= 138 =Rounded up to 140

Cases of CVA admitted within 72 hours after the onset of stroke, confirmed by imaging were included in the study whereas 1)Traumatic cases producing neurological deficits,2) Infections and neoplastic cases producing CVA, 3)CVA cases with known underlying cardiac diseases, which produce ECG and echocardiographic changes,4)Old cva cases, 5)Those who refuse to give consent and 6)Discharged against medical advice, immediate referral cases, and death within 1 day of admission, were excluded from the study.

For statistical analysis data were entered into a Microsoft excel spreadsheet and then analyzed by SPSS (version 27.0; SPSS Inc., Chicago, IL, USA) and Graph Pad Prism version 5. Data had been summarized as mean and standard deviation for numerical variables and count and percentages for categorical variables. Two-sample t-tests for a difference in mean involved independent samples or unpaired samples. Paired t-tests were a form of blocking and had greater power than unpaired tests. One-way analysis of variance (one-way ANOVA) was a technique used to compare means of three or more samples for numerical data (using the F distribution). A chi-squared test ($\chi 2$ test) was any statistical hypothesis test wherein the sampling distribution of the test statistic is a chi-squared distribution when the null hypothesis is true. Without other qualification, 'chi-squared test' often is used as short for Pearson's chi-squared test. Unpaired proportions were compared by Chi-square test or Fischer's exact test, as appropriate.

Explicit expressions that can be used to carry out various *t*-tests are given below. In each case, the formula for a test statistic that either exactly follows or closely approximates a *t*-distribution under the null hypothesis is given. Also, the appropriate degrees of freedom are given in each case. Each of these statistics can be used to carry out either a one-tailed test or a two-tailed test.

Once a *t* value is determined, a *p*-value can be found using a table of values from Student's t-distribution. If the calculated *p*-value is below the threshold chosen for statistical significance (usually the 0.10, the 0.05, or 0.01 level), then the null hypothesis is rejected in favor of the alternative hypothesis.

p-value ≤ 0.05 was considered for statistically significant.

Ethical consideration: The protocol of the thesis was submitted to the committee for Ethical approval -AGMC & GBP Hospital. The study was conducted after due approval from the committee.

II. Result

Table: Distribution of ECG, QTc prolongation, T wave inversion, ST segment depression and U waves

		Frequency	Percent
ECG	**Abnormal**	119	66.1%
	Normal	61	33.9%
	Total	180	100.0%
QTc prolongation	**Absent**	115	63.9%
	Present	65	36.1%
	Total	180	100.0%
T wave inversion	**Absent**	141	78.3%
	Present	39	21.7%
	Total	180	100.0%
ST segment depression	**Absent**	133	73.9%

	Present	47	26.1%
	Total	180	100.0%
U waves	**Absent**	142	78.9%
	Present	38	21.1%
	Total	180	100.0%

ECG
In our study, 119 (66.1%) patients had AbnormalECG and 61 (33.9%) patients had Normal ECG.
QTc prolongation

In our study, 65 (36.1%) patients had QTc prolongation.
T wave inversion
In our study, 39 (21.7%) patients had T wave inversion.
ST segment depression
In our study, 47 (26.1%) patients had ST segment depression.
U waves
In our study, 38 (21.1%) patients had U waves.

Table: Distribution of Echo, LV dysfunction, LA thrombosis, MV dysfunction and AV dysfunction

		Frequency	**Percent**
Echo	**Abnormal**	109	60.6%
	Normal	71	39.4%
	Total	180	100.0%
LV dysfunction	**Absent**	104	57.8%
	Present	76	42.2%
	Total	180	100.0%
LA thrombosis	**Absent**	180	100.0%
	Total	180	100.0%
MV dysfunction	**Absent**	157	87.2%
	Present	23	12.8%
	Total	180	100.0%
AV dysfunction	**Absent**	170	94.4%
	Present	10	5.6%
	Total	180	100.0%

Echo
In our study, 109 (60.6%) patients had Abnormal Echo and 71 (39.4%) patients had Normal Echo.
LV dysfunction
In our study, 76 (42.2%) patients had LV dysfunction.
MV dysfunction
In our study, 23 (12.8%) patients had MV dysfunction.
AV dysfunction
In our study, 10 (5.6%) patients had AV dysfunction.

TYPES					
QTc prolongation	**Hemorrhagic stroke**	**Ischemic stroke**	**TOTAL**	**P value**	
Absent	31(49.2%)	84(71.8%)	115		
QTc prolongation	32(50.8%)	33(28.2%)	65	0.0026	
T wave inversion					
Absent	47(74.6%)	94(80.3%)	141		
Present	16(25.4%)	23(19.7%)	39	0.3727	
ST segment depression					
Absent	38(60.3%)	95(81.2%)	133		
Present	25(39.7%)	22(18.8%)	47	0.0023	

U waves				
Absent	45(71.4%)	97(82.9%)	142	

Present	18(28.6%)	20(17.1%)	38	0.0719

In Hemorrhagic stroke, 32 (50.8%) patients had QTc prolongation.
In Ischemic stroke, 33 (28.2%) patients had QTc prolongation.Association of QTc prolongation with Types was statistically significant (p=0.0026).
In Hemorrhagic stroke, 16 (25.4%) patients had T wave inversion.In Ischemic stroke, 23 (19.7%) patients had T wave inversion.Association of T wave inversion with Types was not statistically significant (p=0.3727).
In Hemorrhagic stroke, 25 (39.7%) patients had ST segment depression.In Ischemic stroke, 22 (18.8%) patients had ST segment depression.Association of ST segment depression with Types was statistically significant (p=0.0023).
In Hemorrhagic stroke, 18 (28.6%) patients had U waves.In Ischemic stroke, 20 (17.1%) patients had U waves.Association of U waves with Types was not statistically significant (p=0.0719).

Echo	**Hemorrhagic stroke**	**Ischemic stroke**	**TOTAL**
Abnormal Row % Col %	47 43.1 74.6	62 56.9 53.0	109 100.0 60.6
Normal Row % Col %	16 22.5 25.4	55 77.5 47.0	71 100.0 39.4

LV dysfunction	**Hemorrhagic stroke**	**Ischemic stroke**	**TOTAL**
Absent Row % Col %	17 16.3 27.0	87 83.7 74.4	104 100.0 57.8
Present Row % Col %	46 60.5 73.0	30 39.5 25.6	76 100.0 42.2
TOTAL Row % Col %	63 35.0 100.0	117 65.0 100.0	180 100.0 100.0

	TYPES		
LA thrombosis	**Hemorrhagic stroke**	**Ischemic stroke**	**TOTAL**
Absent Row % Col %	63 35.0 100.0	117 65.0 100.0	180 100.0 100.0
TOTAL Row % Col %	63 35.0 100.0	117 65.0 100.0	180 100.0 100.0

MV dysfunction	**Hemorrhagic stroke**	**Ischemic stroke**	**TOTAL**
Absent Row % Col %	63 40.1 100.0	94 59.9 80.3	157 100.0 87.2
Present Row % Col %	0 0.0 0.0	23 100.0 19.7	23 100.0 12.8
TOTAL Row % Col %	63 35.0 100.0	117 65.0 100.0	180 100.0 100.0

AV dysfunction	**Hemorrhagic stroke**	**Ischemic stroke**	**TOTAL**
Absent Row % Col %	63 37.1 100.0	107 62.9 91.5	170 100.0 94.4
Present Row % Col %	0 0.0 0.0	10 100.0 8.5	10 100.0 5.6
TOTAL	63	117	180

Row % Col %	35.0 100.0	65.0 100.0	100.0 100.0

In Hemorrhagic stroke, 47 (74.6%) patients had Abnormal Echo and 16 (25.4%) patients had Normal Echo.In Ischemic stroke, 62 (53.0%) patients had Abnormal Echo and 55 (47.0%) patients had Normal Echo.Association of Echo with Types was statistically significant (p=0.0046). **Chi-square value:**37.6745; **p-value:** <0.0001.**Odds ratio:** 0.1274(0.0637, 0.2551)

In Hemorrhagic stroke, 46 (73.0%) patients had LV dysfunction.In Ischemic stroke, 30 (25.6%) patients had LV dysfunction.Association of LV dysfunction with Types was statistically significant (p<0.0001).

In Ischemic stroke, 10 (8.5%) patients had AV dysfunction.Association of AV dysfunction with Types was statistically significant (p=0.0169).

In Ischemic stroke, 23 (19.7%) patients had MV dysfunction.Association of MV dysfunction with Types was statistically significant (p<0.0001)

III. Discussion

We examined that 119 (66.1%) patients had Abnormal ECG and 61 (33.9%) patients had Normal ECG. 65 (36.1%) patients had QTc prolongation. 39 (21.7%) patients had T wave inversion. 47 (26.1%) patients had ST segment depression. 38 (21.1%) patients had U waves.

Our study showed that 109 (60.6%) patients had Abnormal Echo and 71 (39.4%) patients had Normal Echo. 76 (42.2%) patients had LV dysfunction. 23 (12.8%) patients had MV dysfunction. 10 (5.6%) patients had AV dysfunction.

Present study showed that in Hemorrhagic stroke, 46 (73.0%) patients had Abnormal ECG and 17 (27.0%) patients had Normal ECG and in Ischemic stroke, 73 (62.4%) patients had Abnormal ECG and 44 (37.6%) patients had Normal ECG which was not statistically significant (p=0.1509).

Dogan A et al [8](2004) found study consisted of 162 patients (92 male, age 64 ± 14 years) with first ischaemic stroke presenting to hospital during 18 months. One-month mortality was analysed by means of ischaemia-like ECG changes, long QT and arrhythmia. Ischaemia-like ECG changes were observed in 79% of stroke patients and long QTc in 26% and arrhythmias in 44%. Early mortality rate was 27% (n = 44). Age, ST-segment change and abnormal U wave were univariate predictors of early mortality (each p < 0.05).

Niveditha R et al [13](2017) vascular ST segment depression (53.1%) and U-waves (56.2%) followed by QTc prolongation (0.5±0.7 ms) were the most common abnormalities in haemorrhage group. Whereas in infarct type of stroke U-wave was the most common ECG finding (50.0%) among infarct group followed by QTc (0.45±0.08 ms) and T-wave inversion (29.4%).

Purushothaman S et al [9](2014) found that the patients were divided into ischemic and hemorrhagic group depending on the nature of lesion. Out of 100 cases, 58 were ischemic and 42 were hemorrhagic. The ECG changes were noted in 78 patients. Among the ischemic group, the changes noted in the ECG were: T wave inversion (34.48%), ST segment depression (32.75%), QTc prolongation (29.31%), and presence of U waves (27.58%). In cases of hemorrhagic stroke, it was: T wave inversion (33.33%), arrhythmias (33.33%), U waves (30.95%), and ST segment depression (23.80%). Mortality was higher in patients with ST-T changes in ischemic group (66.66%) and in patients with positive U waves (60%) in hemorrhagic group. In acute stroke patients, changes in ECG were commonly seen. The changes varied from T-wave inversion to ST segment depression in ischemic stroke. In hemorrhagic stroke it consisted of T wave inversion and arrhythmias. Overall mortality was high in cases of hemorrhagic compared to ischemic group.

Elansary M et al [15](2014) found that the study included 60 patients with non hemorrhagic stroke. During 1 week of continuous ICU monitoring, 30% of patients had PAF (group 1), the remaining 42 patients did not develop PAF (group 2). All patients were subjected to detailed history taking, thorough clinical examination including NIHSS, serial ECGs for calculation of maximum and minimum P wave duration (Pmax, and Pmin) & P wave dispersion (Pdis), and transthoracic echocardiography for calculation of left atrial volume (LAV), and left atrial volume index (LAVI).

In our study, in Hemorrhagic stroke, 16 (25.4%) patients had T wave inversion and in Ischemic stroke, 23 (19.7%) patients had T wave inversion and it was not statistically significant (p=0.3727). In Hemorrhagic stroke, 18 (28.6%) patients had U waves and in Ischemic stroke, 20 (17.1%) patients had U waves which was not statistically significant (p=0.0719).

We examined that in Hemorrhagic stroke, 32 (50.8%) patients had QTc prolongation and in Ischemic stroke, 33 (28.2%) patients had QTc prolongation which was statistically significant (p=0.0026).

Our study showed that, in Hemorrhagic stroke, 25 (39.7%) patients had ST segment depression and in Ischemic stroke, 22 (18.8%) patients had ST segment depression which was statistically significant (p=0.0023).

Present study showed ECG changes more commonly in Haemorrhagic stroke (73%) compared to Ischaemic stroke (62.4%). And common ECG abnormalities seen are QTc prolongation (50.8%), ST depression (39.7%), U wave inversion (28.6%) followed by T Wave inversion (25.4%).

We found that in Hemorrhagic stroke, 47 (74.6%) patients had Abnormal Echo and 16 (25.4%) patients had Normal Echo. In Ischemic stroke, 62 (53.0%) patients had Abnormal Echo and 55 (47.0%) patients had Normal Echo. This was statistically significant (p=0.0046).

Goldstein DS et al [12](1979) found that electrocardiographic records of 150 patients with acute stroke and 150 age- and sex-matched controls, to assess the relative frequencies of ECG abnormalities among the pathophysiologic categories of stroke, and to distinguish new abnormalities at the time of the stroke from those noted on prior tracings. Of the 150 patients with stroke, 138 (92%) showed ECG abnormalities.

Anakal MG et al [14](2006) showed that mortality was high in patients with abnormal ECG (79%) (p>0.5). 79% of patients survived with abnormal ECG. So was statistically insignificant (p>0.5). Mortality was high in patients with abnormal 2D echocardiography (90.91) (p<0.001). ST segment depression, QTc prolongation and U-waves are the common ECG abnormalities in hemorrhagic strokes. QTc prolongation and U-waves are the common ECG abnormality in ischemic stroke. LV dysfunction is the most common 2D echocardiographic abnormality in stroke patients. ECG abnormalities in stroke patients do not have any prognostic significance. LV dysfunction has prognostic significance in predicting mortality in CVA.

Niveditha R et al [13](2017) found that LV dysfunction, the most common abnormality was (29.4%) in infarct and haemorrhage (46.9%) stroke. LV dysfunction did not show significant impact on mortality in either of stroke subtypes (p>0.05). In their experience, both ECG and ECHO abnormalities in stroke patients do not have any prognostic significance predicting mortality in CVA.

Present study showed that, in Hemorrhagic stroke, 46 (73.0%) patients had LV dysfunction and in Ischemic stroke, 30 (25.6%) patients had LV dysfunction which was statistically significant (p<0.0001). In Ischemic stroke, 23 (19.7%) patients had mitral valve dysfunction and this was statistically significant (p<0.0001). In Ischemic stroke, 10 (8.5%) patients had aortic valve dysfunction and it was statistically significant (p=0.0169).

IV. Conclusion

We concluded that the ECG changes are frequently seen in selected patients with both Hemorrhagic and Ischaemic stroke. In acute stroke patients, changes in ECHO were commonly seen. Common ECG changes seen in stroke patients are QTc prolongation, ST segment changes, T wave inversion, U waves. However, in contrast 2D echocardiographic abnormalities especially LV dysfunction can predict the abnormal chances in patients with stroke. Hence all the patients presenting with stroke should undergo ECG and 2D Echocardiography as a part of the initial evaluation.

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