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RESEARCH ARTICLE

PATTERN OF ELECTROCARDIOGRAPHIC CHANGES IN ACUTE ISCHEMIC STROKE AND ITS CORRELATION WITH OUTCOME

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Abstract

Background: Acute ischemic stroke is frequently associated with various changes in ECG. Patients of ischemic stroke with ECG changes also have a poor clinical outcome. The objectives were to study the pattern of electrocardiographic changes in acute ischemic stroke and to find the correlation of ECG changes with the outcome of patients with ischemic stroke.

Materials and Methods: Cross sectional observational study was conducted in 90 patients of acute ischemic stroke with detailed history, Imaging, ECG monitoring and blood investigations. Patients grouped as those with electrocardiographic changes and those without changes. Outcome was assessed by modified NIHSS score.

Results: modified National Institute of Health Stroke Scale (mNIHSS) was higher in patients having ECG changes with median 12(9, 21.5) for patient with changes, 8(6-10) for patients without changes ($p<0.0001$). In patients with no ECG changes, score significantly improved from day 1 to 5($p<0.0001$) compared to patients with changes who doesn't show any improvement in score($p>0.05$). Maximum number of patients were having ECG change of T inversion (25.6%) and QTc prolongation(20.0%). The average duration of hospital stay for patients with ECG change was 8.80 ± 2.850 in comparison with patients without ECG changes having 7.10 ± 2.417.

Conclusion: Characteristics of ECG changes have important reference value in evaluation of severity and prognosis of ischemic stroke patients. Patients with ECG changes have poor outcome.

Introduction:-

Stroke is an important cause of mortality, morbidity and disability in developed as well as developing countries. Stroke is classically characterized as a neurological deficit attributed to an acute focal injury of the central nervous system (CNS) by a vascular cause, including cerebral infarction, intra cerebral hemorrhage (ICH), and subarachnoid hemorrhage (SAH), and is a major cause of disability and death worldwide.[1] Ischemic stroke occurs due to blockage of blood vessel which limits the blood supply to the brain whereas hemorrhagic stroke occurs due to rupture of blood vessel leading spillage of blood in the intracranial cavity.

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The incidence of stroke in world is 146-168 per 100,000 and in India it is 119-145/100,000 based on the recent population based studies. The estimated adjusted prevalence rate of stroke range, 84-262/100,000 in rural and 334-424/100,000 in urban areas according to Pandian*et al*. 2013[2]. In patients between 20 and 64 years of age, the prevalence of ischemic stroke has nearly doubled globally from 1990 to 2013, with an increase of 37.3% in associated disability-adjusted life years. The incidence of ischemic stroke was higher in men (133 cases per 100,000 person-years) than in women (99 cases per 100,000 person-years) in the 2013 Global Burden of Disease Study by Feigin*et al.*2017[3]. Electrocardiographic abnormalities are also observed in patients with acute ischemic stroke. Frontal lobe, insular cortex and amygdala play an important role in regulation of heart via sympathetic and parasympathetic system.[4]Majority of studies suggest that the insular cortex has a pivotal role in integrating autonomic response and is strongly associated with adverse cardiac events after neurological injury. Right middle cerebral artery strokes were associated with increased incidence of supraventricular tachy-arrhythmias. Left parieto insular stroke was associated with an increased incidence of new onset atrial fibrillation.[5] .The possible pathogenesis of cardiac arrhythmias in acute ischemic stroke is autonomic system activation.[6] Ischemic-like and repolarization ECG changes that occur in patients with acute stroke have been thought to be also due to neural myocardial stunning, changes in autonomic nervous system, and catecholamine-mediated injuries.[7]

In acute ischemic stroke patients, various Electrocardiographic changes were reported in many studies. The changes varied from T-wave inversion to ST segment depression in ischemic stroke. Considering the outcome, mortality was higher in stroke group with abnormal ECG.[8]. PaymanAzadi*et al.* 2019[9] found that occurrence of ECG changes following ischemic stroke, increases the odds of 1-year mortality about 4 times. Koochaki*et al.* 2014[10]also suggested that ischemic stroke patients with ECG changes got poor prognosis.

Only a few studies had been reported regarding the pattern of Electrocardiographic changes within India in general and northeastern states of India in particular.

Materials and Methods:-

Hospital basedCross sectional observational study conducted in Department of Medicine, Jorhat Medical College and Hospital, Jorhat, Assam upon 90 patientsover a period of one year 1st July 2020- 30th June 2021. Patients clinically diagnosed as ischemic stroke confirmed by neuro imaging [MRI / CT], admitted to the ICU and medicine wards taken as samples.

Inclusion Criteria

1. Patients admitted with diagnosis of acute ischemic stroke
2. Patients with age ≥ 18 years admitted under Department of Medicine, JMCH.

Exclusion Criteria

1. Hemorrhagic stroke.
2. All cases who are having documented cardiac diseases like Rheumatic Heart Disease, Hypertensive heart disease, Cardiomyopathies, Ischemic heart disease, electrolyte imbalance and thyroid disorders.
3. Those patients who are not giving consent to participate the study.

After history and clinical examination, CT/MRI Brain was done for diagnosis of acute ischemic stroke and a 12 lead ECG with rhythm strip was taken in all patients. 2D Echo was done whenever necessary to rule out preexisting cardiac disorders.Routine blood investigations was done to detect co-morbidities and to rule out patients with electrolyte and thyroid disorders. Patients were then grouped as those with electrocardiographic changes and those without electrocardiograph changes. Outcome of the patients was assessed by modified NIHSS score day 1 and day 5, GCS score, duration of hospital stay and in-hospital mortality of patients.

All the descriptive data analysis for nominal data used number and percentage; for all parametric data, descriptive analysis done using mean with standard deviation and for non-parametric data, used median with interquartile range was used. Modified NIHSS score for day 1 and day 5 were presented as descriptive statistics. Comparing the Modified NIHSS score for these 2 days, the in-hospital mortality, and also the duration of stay in the hospital, the patients were analyzed according to their presence or absence of ECG changes.

Categorical variables like association between electrocardiographic changes with the clinical improvement was done using chi-square test/Fischer's exact test, while continuous variables was compared using Students t test.For two

unrelated samples, used Mann Whitney U test for analysis and for 2 related samples used Wilcoxon's signed rank test.

All reported p values are two tailed with a p value less than 0.05 indicating statistical significance. Statistical analysis was performed using the IBM SPSS statistical software (version 23.0: SPSS Inc,Chicago,Illinois, USA)

Results:-

The present study comprised of total of 90 patients of acute ischemic stroke with 58 were male and 32 were females. There was male preponderance compared to females making male-female ratio of 1.8:1.

Table 1:- Baseline characteristics

Sex	Number of patients	Percentage
Male	58	64.4%
Female	32	35.6%
Total	90	100.0%

The age of the patients in the present study varied from 40 to 89 years with mean age 61.57±10.60 in males and 65.25±11.49 in females.Most of the patients had Hypertension (85.6%) followed by Diabetes Mellitus (47.8%) and Dyslipidemia (44.4%).Patients with different risk factors had no significant difference with presence or absence of ECG changes.In our study, 49 patients (54.4%) of the acute ischemic stroke patients had ECG changes and 41 patients (45.6%) of acute ischemic stroke didn't have any ECG changes.

Table 2:- Risk factors and presence of ECG changes

Risk factor	ECG changes present (n=49)	ECG changes absent (n=41)	Chi Square value	p value
Hypertension	43	34	0.421	0.559
Diabetes Mellitus	28	15	3.781	0.060
Dyslipidemia	20	20	0.573	0.525
Alcohol	9	11	0.925	0.446
Smoking	6	11	3.099	0.106
Prior stroke	7	8	0.439	0.577

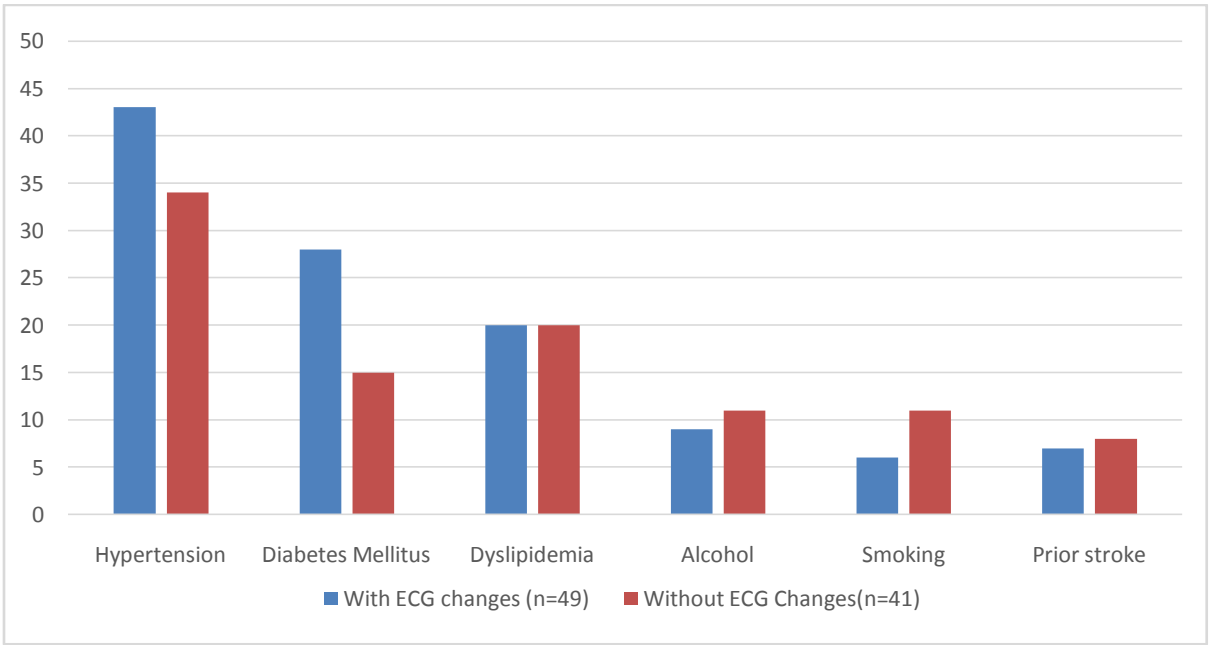

Fig 1:- Bar diagram showing distribution of risk factors and presence of ECG changes.

Most common ECG pattern obtained in patients with Acute ischemic stroke was T wave inversion (25.6%) followed by QTc prolongation (20.0%), Sinus bradycardia (12.2%) and ST segment depression (12.2%).

Table 3:- Pattern ECG changes in Acute Ischemic Stroke Patients.

Pattern of change	Number of patients	Percentage
T wave inversion	23	25.6%
QTc prolongation	18	20.0%
Sinus Bradycardia	11	12.2%
ST Segment depression	11	12.2%
ST Segment elevation	9	10.0%
Tall T waves	2	2.2%

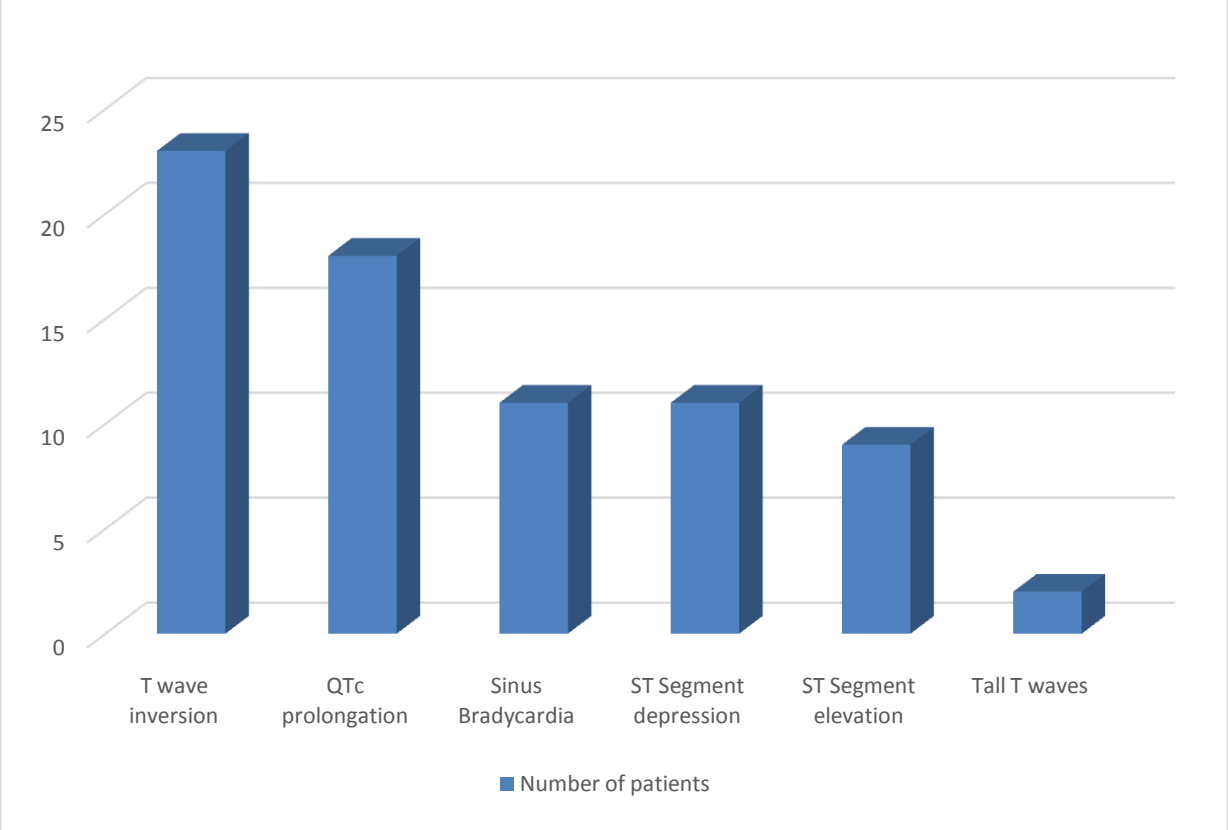

Fig 2:- Bar diagram showing pattern of ECG changes in acute ischemic stroke patients.

The average duration of hospital stay for patients with ECG change was 8.80 ± 2.850 and in patients without ECG, it was 7.10 ± 2.417. By independent samples T test, it has got significance. ($p<0.05$)

Table 4:- Average duration of Hospital stay.

ECG changes	Average duration of hospital stay	p value
Present	8.80 ± 2.850	<0.01
Absent	7.10 ± 2.417	

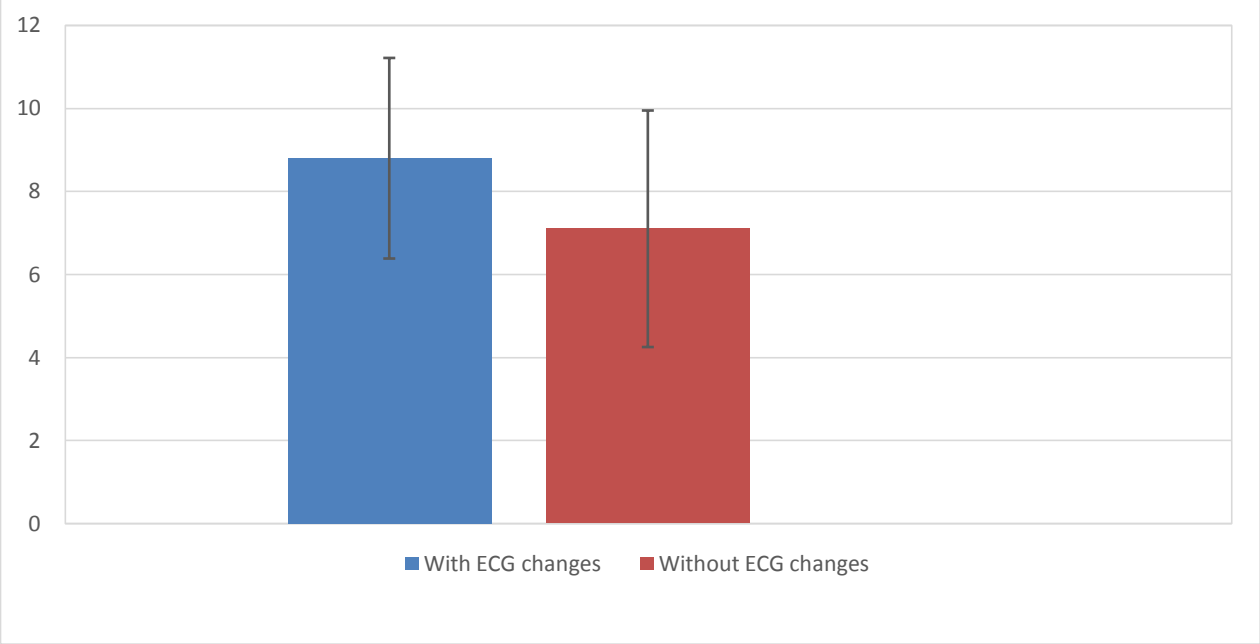

Fig 3:- Bar diagram showing average duration of hospital stay.

Two unrelated samples ie; presence of ECG changes and mNIHSS score was analyzed using Mann Whitney U test. According to the data, patients with ECG changes got no change in median mNIHSS in comparison with patients without ECG changes, where there is a decrease in mNIHSS seen. Two unrelated samples ie; presence of ECG changes and GCS was analyzed using Mann Whitney U test.

Table 5:- Difference in mNIHSS on Day 1 and Day 5 with respect to ECG change.

		Median with Inter Quartile Range	p value
mNIHSS DAY 1	ECG Change +	12(9-21.5)	<0.0001
	ECG Change -	8(6-10)	
mNIHSS DAY 5	ECG Change +	12(8-22)	<0.0001
	ECG Change -	5(3.5-7)	

According to the data, patients with ECG changes got a low median GCS score- 12(3-13), in comparison with patients without ECG changes where it is 14 (12-15), which was significant (p<0.001).

Table 6:- GCS with respect to presence of ECG changes.

		Median(IQR)	p value
GCS	ECG Changes present	12(8-13)	<0.001
	ECG Changes absent	14(12-15)	

Discussion:-

In our study, common changes in ECGs of the patients were inverted T wave (25.6%), QTc prolongation (20.0%), Sinus bradycardia (12.2%), ST segment depression (12.2%) and ST segment elevation (10%). Some of the patients had presence of 2 or more ECG changes together. In different studies, findings regarding the most common ECG changes observed vary. In the study by Koochaki*et al.* 2012[10], inverted T wave and ST segment elevation/ depression were the most common changes observed in ECG of the patients, both of which had a prevalence of 27.93%. Most common patterns observed in study by Kaya *et al.* 2018[11] in ischemic stroke patients were QTc prolongation (31%) and ST depression (24%). In a similar study by Togha*et al.* 2013[12] , the most common ECG abnormalities associated with stroke were T-wave abnormalities, prolonged QTc interval and arrhythmias, 28.9%, 30.7%, and 16.2% respectively of the patients with no primary cardiac disease. Study by Vinodkumarkandala*et al.* 2018 [13] had ST segment depression (33.3%) as the most common ECG finding followed by QTc prolongation (29%), T wave inversion (22.2%) and Sinus bradycardia (20%).

In the study by Koochaki*et al.* 2012[10], it was shown that ECG abnormalities are common in patients with acute ischemic stroke and a detailed cardiac evaluations should have predictive value. In present study, patients with ECG changes has got more severe mNIHSS score in comparison with patients without ECG changes. Patients with ECG changes had a day 1 mNIHSS of 12(9-21.5) in comparison with patients without ECG changes who had a score of 8(6-10). The median GCS obtained in the present study was 13(8.5-14) on day 1 in patients with ECG changes in comparison with patients without ECG changes, where it was 14(14-15). There was a decline in GCS median from day 1 to day 5 in patients with ECG changes, who had 13(8-14) score on day 5.

In a study by PaymanAzadi*et al.* 2019[9], it was revealed that ECG changes in patients with stroke increase the odds of mortality about 4 times and also mortality rate was 14.1% among patients with stroke with normal ECG, while in stroke patients with abnormal ECG the rate increased to 45.1%. In a study by Aydin kaya *et al.* 2018[11],severity of stroke higher measured with NIHSS score and ECG changes were more prevalent in patients who died/having more disability.

In the present study, patients with ECG changes have comparatively high mortality than patients without ECG changes. 13 with ECG changes expired in comparison with patients without ECG changes where one patient only expired ($p<0.05$). In a study by Sujapurushothaman*et al.* 2014[8],the patients with abnormal ECG (17.95%) had high mortality in contrast to those who had normal ECG (9.09%).

The change in mNIHSS score observed in present study was significant in patients without ECG changes (from score of 8(6-10) to a score of 5(3.5-7), $p<0.01$) in comparison with patients having ECG changes where no significant change in mNIHSS score was present. Also in a study Goldstein *et al.* 1979 [14], it was reported that changes in ECG elevate the probability of mortality to 4.82 times. PaymanAzadi*et al.* 2019[9], concluded that ECG changes, especially ST segment changes and inverted T waves are very common in patients with ischemic stroke and are associated with increased mortality in these patients along with factors such as age and presence of cardiac diseases.

Limitations

The sample size of this study was relatively small, also some of the potential factors affecting the outcome of patients with ischemic stroke, such as the size of the ischemic region, were not evaluated.

Conclusion:-

The findings of present study suggest that ECG changes are very common in patients with acute ischemic stroke. The most common pattern of ECG change observed in this present study was T wave inversion followed by QTc prolongation, Sinus bradycardia and ST segment changes. In patients with acute ischemic stroke with ECG changes had higher mNIHSS and lower GCS score

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