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Original Research Article

INCIDENCE AND PATTERN OF ELECTROCARDIOGRAPHIC CHANGES IN ACUTE ISCHEMIC STROKE AND THEIR CORRELATION WITH EARLY CLINICAL OUTCOME

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ABSTRACT

Background: Electrocardiogram (ECG) abnormalities are common in acute ischaemic stroke and may be a manifestation of neurogenic cardiac involvement, autonomic deregulation or underlying cardiovascular disease. In many situations, their prognostic relevance is still unknown. **Objective:** To determine the frequency and pattern of ECG changes in patients with acute ischaemic stroke and their association with early clinical outcome as measured by the modified National Institutes of Health Stroke Scale (mNIHSS). **Materials and Methods:** An observational study was conducted in a tertiary care hospital in Kerala for 18 months. Inclusion criteria: Adults > 18 years of age with acute ischaemic stroke confirmed by neuroimaging. All participants had a 12-lead ECG and stroke severity/outcome was assessed using the mNIHSS on day 1, day 5, day 7 or at discharge. Chi-square or Fisher's exact test was used to analyse associations between ECG findings and outcome. **Results:** We studied 51 patients in total. ECG changes were found in 52.9% of patients. The most frequent abnormality was T wave inversion (59%), followed by sinus tachycardia (17%), atrial fibrillation (14%), and ST-T changes (10%). Based on mNIHSS change, 33.3% were improved, 51.0% unchanged and 15.7% worse. There was no statistically significant association between ECG abnormalities and clinical outcome: T-wave inversion (p=0.671), ST-T changes (p=0.148), atrial fibrillation (p=0.661), and tachycardia (p=0.336). **Conclusion:** ECG abnormalities are common in acute ischaemic stroke and the commonest abnormality is T-wave inversion. However, in the present study, ECG changes were not significantly associated with early neurologic outcome. Further multicenter studies are warranted to better define the prognostic impact of ECG changes in acute ischaemic stroke.

Keywords: Acute ischemic stroke, Electrocardiographic changes, T-wave inversion, Atrial fibrillation, mNIHSS, Prognosis.

INTRODUCTION

Stroke remains a leading cause of death and long-term disability worldwide.[1-3] Among the most common types of stroke is acute ischaemic stroke and this type is often complicated by cardiac and systemic abnormalities.[4] Of these, ECG changes are particularly important, as they may reflect autonomic dysfunction, stress-induced myocardial injury or unsuspected cardiac disease.[5-7]

The brain–heart axis is a major player in the cardiovascular changes following stroke8. Involvement of the cortical and subcortical autonomic centers, particularly the insular cortex, could result in sympathetic overactivity, a catecholamine surge, arrhythmias, repolarisation

abnormalities, and QT changes.[9] These changes may develop even without primary cardiac disease.
ECG abnormalities in acute stroke are well described, but their clinical significance is still debated. Some studies suggest ECG changes are associated with worse outcomes and increased mortality, whereas others have not shown a clear prognostic relationship.[10-12] In this context, the present study was designed to find the frequency and pattern of ECG changes in acute ischaemic stroke and to assess their association with early clinical outcome by using mNIHSS.

MATERIALS AND METHODS

Study design: Prospective cohort study for a period of 18 months.
Study setting: The study was conducted in the Department of General Medicine, Pushpagiri Institute of Medical Sciences and Research Centre, Thiruvalla, Kerala, India. The institute is a tertiary care referral center with inpatient medical wards and intensive care facilities.
Study Population: We included all patients admitted with a clinical diagnosis of acute ischaemic stroke confirmed by neuroimaging (CT or MRI brain).
Inclusion Criteria: Age >18years; male & female patients; acute ischaemic stroke confirmed by neuroimaging; written informed consent obtained from patient or legally acceptable relative.
Exclusion Criteria: were: hemorrhagic stroke, unwillingness of the patient to participate in the study and inability to obtain informed consent.
Sample size calculation: Sample size was calculated based on the expected prevalence of new changes in ECG in acute ischaemic stroke as per previous literature. The calculated minimum sample size was 51 patients with 95% confidence level and acceptable absolute precision.
Study tools: 12 lead electrocardiography; Modified National Institutes of Health Stroke Scale (mNIHSS); structured proforma for demographic, clinical and laboratory data.
Data collection Method: All eligible patients were assessed clinically after admission. A detailed history was taken and a general and neurological examination was performed. At baseline, all patients had a 12-lead electrocardiogram (ECG) recorded. ECG findings: rate & rhythm, T-wave inversion, ST-T changes, atrial fibrillation, tachycardia and other abnormalities if present. Stroke outcome was assessed using mNIHSS at day 1, day 5, day 7, or at discharge. Improvement was defined as a decrease in mNIHSS score, worsening as an increase in score, and no change as stable across follow-up assessments.
Statistical Analysis: The data were entered into Microsoft Excel and were analysed in SPSS version 20.0. Categorical variables were described as frequencies and percentages. The association between ECG abnormalities and stroke outcome was analysed using the chi-square test or Fisher's exact test, as appropriate. Statistical significance was considered at a p-value <0.05.

RESULTS

A study was conducted in 51 patients with acute ischaemic stroke. Table 1 shows the baseline demographic and clinical characteristics of the participants.53.0% of the study population was males and 47.0% were females. The most frequent vascular risk factors were hypertension (66.7%), diabetes mellitus (52.7%), dyslipidaemia (29.4%) and coronary artery disease (19.6%).
Pattern of electrocardiographic abnormality is shown in Table 2. In total, 52.9% of patients had one or more abnormal ECGs. The most common finding was T-wave inversion (59.0%) followed by sinus tachycardia (17.0%), atrial fibrillation (14.0%) and ST-T segment changes (10.0%).
Table 3 shows early neurological outcome according to change in mNIHSS. The majority of patients (51.0%) remained clinically unchanged during the follow-up period, 33.3% improved and 15.7% deteriorated.
Table 4 describes the association of specific ECG abnormalities with early stroke outcome. T-wave inversion was not statistically significantly associated with outcome (p = 0.671), nor were ST-T changes (p = 0.148), atrial fibrillation (p = 0.661) or tachycardia (p = 0.336).
The distribution of the location of the infarct, the presenting symptoms, the imaging modality used, and the associated risk factors are shown in Table 5. Motor deficit with cranial nerve involvement was the most common presenting symptom and cortical was the most common infarct location. Neuro-imaging confirmation was done by CT/MRI brain.
In general, ECG changes were frequently observed in acute ischaemic stroke. But there was no statistically significant correlation between ECG changes and early neurological outcome.

Table 1: Baseline characteristics of study participants (n = 51)

Variable	Category	Frequency (%)
Sex	Male	53.0
Sex	Female	47.0
Hypertension	Present	66.7
Type 2 diabetes mellitus	Present	52.7
Dyslipidemia	Present	29.4
Coronary artery disease	Present	19.6

Table 2: Pattern of ECG changes in acute ischemic stroke (n = 51)

ECG finding	Frequency	Percentage (%)
Any ECG change	27	52.9
T-wave inversion	16	59.0
Sinus tachycardia	5	17.0
Atrial fibrillation	4	14.0
ST-T changes	3	10.0

Table 3. Clinical outcome based on modified NIHSS change (n = 51)

Outcome category	Frequency	Percentage (%)
Improved	17	33.3
Unchanged	26	51.0
Worsened	8	15.7

Table 4. Association between ECG abnormalities and stroke outcome

ECG abnormality	Chi-square value	p-value	Interpretation
T-wave inversion	0.798	0.671	Not significant
ST-T changes	3.817	0.148	Not significant
Atrial fibrillation	0.828	0.661	Not significant
Tachycardia	2.183	0.336	Not significant

Table 5. Distribution of infarct location and presenting symptoms

Variable	Observation
Common presenting symptom	Motor deficit with cranial nerve involvement
Most common infarct site	Cortical area
Neuroimaging modality used	CT/MRI brain
Most common associated risk factors	Hypertension, diabetes mellitus, dyslipidemia
Most frequent ECG abnormality	T-wave inversion

DISCUSSION

This prospective observational study aimed to evaluate the frequency and pattern of electrocardiographic abnormalities in patients with acute ischaemic stroke and to analyse their association with early neurological outcome. The main finding was that ECG abnormalities were common and occurred in more than half the study population, but were not significantly associated with short-term outcome as measured by change in mNIHSS.

The prevalence of ECG abnormalities in this study is generally consistent with prior reports on the frequent association of rhythm disturbances and repolarisation changes with acute ischaemic stroke.[11-14] These abnormalities are believed to be caused by disruption of central autonomic regulation after stroke. Cortical and subcortical damage, especially of the insular cortex, may cause sympathetic overactivity, catecholamine surge, and altered cardiac repolarisation, which can be expressed as T-wave inversion, ST-T changes, tachycardia, or atrial fibrillation.

In the present study T-wave inversion was the most common ECG abnormality. This finding is consistent with previous data showing repolarisation abnormalities among the most common ECG findings in acute stroke.[15] T wave inversion may be associated with transient neurogenic myocardial dysfunction or cardiac stress, rather than primary coronary artery disease, although it is often difficult to distinguish between the two on a single ECG.

The study population was burdened with a high prevalence of traditional vascular risk factors, particularly hypertension and diabetes mellitus. These comorbidities are clinically important as they contribute to baseline ECG abnormalities and increase the risk of stroke. Hypertension can lead to left ventricular strain and chronic repolarisation changes16-18. Diabetes and coronary artery disease can also influence ECG patterns and complicate interpretation in the acute setting.[19]

ECG abnormalities were common, but there was no statistically significant association between ECG changes and early neurological outcome. Several explanations could account for this finding. First, modest prognostic effects may have been missed due to small sample size. Second, outcome assessment based on short-term mNIHSS change may not account for delayed neurological deterioration or longer-term functional recovery. Third, some of the abnormalities in the electrocardiogram may have been pre-existent cardiac disease rather than acute neurogenic effects of stroke. Finally, variability in stroke severity and infarct location may have diluted any potential association between specific ECG patterns and outcome.

The lack of significant association in this study suggests that, although ECG abnormalities are common in acute ischaemic stroke, the prognostic value of ECG abnormalities may be limited when assessed with a single baseline ECG and a short follow-up period. Nevertheless, ECG continues to be an important part of the acute stroke assessment, particularly in identifying atrial fibrillation and other arrhythmias that could influence secondary preventive strategies. Thus, ECG changes should

not be viewed as isolated predictors of neurological outcome but rather in the larger clinical context.

Conversely to studies20-24 that showed a strong association between ECG abnormalities and poor outcomes, the present study could not find such a relationship. The discrepancy may be explained by different sample size, patient characteristics, stroke severity, timing of ECG recording, outcome definitions, and follow-up duration. Studies involving serial ECGs, continuous cardiac monitoring, cardiac biomarkers and echocardiography may improve understanding of brain-heart interaction in acute stroke.

In summary, the present results support the view that ECG abnormalities are common in the setting of acute ischaemic stroke, but their prognostic significance remains uncertain. Detection of ECG abnormalities is clinically important for identifying occult atrial fibrillation and other cardiovascular abnormalities that may guide treatment and secondary prevention.[25]

Limitations of the Study

Several limitations exist in this study. Limitations of single center study are its generalisability. The sample size was fairly small, which may have decreased statistical power. Follow-up was short, so long-term neurological and functional outcomes could not be assessed.ECG findings may have been confounded by pre-existing cardiac disease. Serial Holter monitoring and cardiac biomarker assessment was not performed which may have limited detection of transient or subtle cardiac abnormalities.

CONCLUSION

ECG abnormalities are frequent in patients with acute ischaemic stroke, the most common being T-wave inversion. But in this study, ECG changes were not significantly associated with early neurological outcome. Electrocardiography remains an important bedside tool in acute stroke assessment, particularly for detecting arrhythmias and underlying cardiac disease.

Recommendations

These findings merit validation in larger multicenter studies. Continuous cardiac monitoring may be useful for detecting transient ECG abnormalities that are missed on a single recording. Future studies should correlate ECG changes with cardiac biomarkers, echocardiography and long-term functional outcomes. Risk stratification for acute ischaemic stroke should consider neurological severity and cardiovascular assessment.

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