IOSR Journal of Dental and Medical Sciences (IOSR-JDMS)
e-ISSN: 2279-0853, p-ISSN: 2279-0861.Volume 17, Issue 5 Ver. 1 (May. 2018), PP 29-32
www.iosrjournals.org

Electrocardiographic Changes in Acute Stroke: Early Predictor of Ischemic or Hemorrhagic Nature of Stroke?

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Abstract:
Background: *ECG changes have been widely reported in stroke patients, but these have neither been adequately interpreted, nor they have been studied along with the nature of the stroke or its location.*
Aims & Objective: *To study the incidence and pattern of ECG changes in patients with cerebrovascular accidents.*
Material & Method:
Result:

Date of Submission: 17-04-2018 Date of acceptance: 05-05-2018

I. Introduction

The Central nervous system regulates the blood pressure, heart rate, vasomotor tone, and cardiac output and plays a major role in myocardial metabolism and cardiac contraction. The actual mechanism for electrocardiograph changes in acute stroke patients is unclear. An acute stroke event may be thought to cause catecholamine mediated cardiac changes.[1]

In the Indian population of 20-40 years age group, the prevalence of stroke has been estimated at 0.2% whereas the overall prevalence in all age groups stands at 12%. Mortality rate in the younger age groups is estimated to be 1.2%, whereas it is around 2.4% in the older age groups.

The present study was undertaken to review the pattern of ECG changes associated with different categories of acute stroke among patients without cardiovascular disease.

II. Aim & Objective

1. To study the incidence and pattern of ECG changes in patients with cerebrovascular accidents.
2. To assess the relation of ECG changes in acute cerebrovasular accidents to the location of the lesion.

III. Material and Methods

Study Population

The study was conducted at Mahatma Gandhi Medical College & Hospital during the years 2015 to 2017. Acute Cerebrovascular Accident patients admitted under the Department of medicine were evaluated.

Type of Study: An Observational, Non interventional, Retrospective / Prospective study .
Study population: 50 Patients

Inclusion Criteria
All patients with acute cerebrovascular accidents.

Exclusion Criteria
- Patients with underlying heart diseases.
- Patients on drugs.
- Previously diagnosed patients with electrolyte abnormalities.
- Patients with hepatic or renal diseases.

IV. Methodology

All patients with acute cerebrovascular accidents were studied. They were evaluated with X ray, serum electrolytes, blood sugar and blood urea.
12 lead ECG was done on the day of admission. CT scan was done within 24-48 hrs.
Screening ECHO was done on all patients with ECG changes.
Patients were categorized based on CT findings as - cerebral infarction, cerebral hemorrhage(ICH) or sub-arachnoid hemorrhage(SAH). ECGs were then analysed in terms of rate, rhythm, ST segment, QRS complex, T wave amplitude and morphology, QT interval and QTc interval. (Bazett's formula)

V. Results

The majority of cases (84%) were from in 51-70 years of age group, followed by 12% patients in 40-50 years of age group and minimum cases (only 4%) were seen in more than 70 years of age group. (Table 1)

Table-1: Age wise distribution of cases

Age group (yrs)	**Number**	**Percentage**
40-50 yrs	6	12%
51-60 yrs	19	38%
61-70 yrs	23	46%
>70 yrs	2	4%
Total	50	100%

Table-2: The Incidence of ST Segment Changes in the Study Group

Study group	**Total no. of cases**	**ST Segment Elevation**	**ST Depression Segment**	**Percentage With ST Segment Changes**
Cerebral Infarction	26	1 (3.84%)	8 (30.76%)	9(34.61%)
Cerebral Hemorrhage	21	9 (42.85%)	3 (14.28%)	12 (57.14%)
Subarachnoid hemorrhage	3	1 (33.33%)	0 (0%)	1(33.33%)

ST segment changes were most commonly noted after cerebral hemorrhage. 31% of patients with infarction had ST depression. ST elevation was found in 43% of patients with ICH. (Table 2)

Table-3 The Incidence of T Wave Changes in the Study Group

Study group	Total no. of cases	Tall T Wave	T Wave Inversion	Percentage With T Wave Changes
Cerebral Infarction	26	2 (7.69%)	5 (19.23%)	7(26.92%)
Cerebral Hemorrhage	21	8 (42.85%)	3 (14.28%)	11 (52.38%)
Subarachnoid hemorrhage	3	1 (33.33%)	0 (0%)	1(33.33%)

T wave changes were present in 52.38% 0f patients with ICH whereas only 27% of patient with infarct had T wave changes. (Table 3)

Table-4 The mean value of QT & QTc Interval in study group

Study group	**QT (Mean±SD)**	**QTC (Mean±SD)**
Cerebral Infarction	0.3719±0.04secs	0.4370±0.06 secs
Cerebral Hemorrhage	0.4205±0.08 secs	0.456±0.054 secs
Subarachnoid hemorrhage	0.3367±0.045 secs	0.4567±0.1343 secs

Mean value of QT and QTC interval in infarction was 0.3719±0.04 & 0.4370±0.06 respectively and in hemorrhage was 0.4205±0.08 & 0.456±0.054 respectively. (Table 4)

Table-5: The mean value of sodium & potassium ions in study group

Study group	**Sodium (Mean±SD)**	**Potassium (Mean±SD)**
Cerebral Infarction	136.0±4.067mEq/L	3.670±0.2233 mEq/L
Cerebral Hemorrhage	135.4±3.801 mEq/L	3.655±0.221 mEq/L
Subarachnoid hemorrhage	134.7±2.517 mEq/L	3.700±0.100 mEq/L

The mean value of sodium and potassium ions in infarction was 136.0±4.067mEq/L & 3.670±0.2233 mEq/L respectively and in hemorrhage was 135.4±3.801 mEq/L & 3.655±0.221 mEq/L respectively which were comparable in all groups. (Table 5)

Table-6: Incidence of Rhythm Disturbances in the Study Group

Study group	Total no. of cases	Sinus Tachycardia	Sinus Bradycardia	Percentage With T Wave Changes
Cerebral Infarction	26	3 (11.53%)	0 (0%)	3(11.53%)
Cerebral Hemorrhage	21	3 (14.28%)	5 (23.80%)	8 (38.09%)
Subarachnoid hemorrhage	3	1 (33.33%)	0 (0%)	1(33.33%)

Rhythm disturbances were present in only 11.53% of patients with infarct whereas 38% of patients with ICH had rhythm changes of which 14.28% had sinus tachycardia and 24% had sinus bradycardia. 33.33% of patients with SAH had sinus tachycardia.

Table-7: Specific ECG Changes as related to site of lesion

Cerebral Lesion	Rhythm Disturbance	ST Segment Changes	T Wave Changes
Basal Ganglion	0	1	1
Thalamus	2	1	2
Capsulo-ganglion	7	16	11
Frontal	2	0	1
Tempo-parietal	1	3	2
Parietal	0	1	1
Occipital	1	0	0

Capsulo-ganglionic region was the most frequently affected area in both infarct and hemorrhage in the studied subjects. In ECG, rhythm disturbance, ST segment changes & T wave changes were also more commonly associated with this region.

VI. Discussion

The present study was carried out with the objective of evaluating ECG changes in patients with cerebrovascular accidents, with the view to differentiating them from changes caused due to pre-existing or concurrent cardiac disease.

Out of the 50 patients included in our study 84% of stroke patients were from the 51-70 years age group. The 40-50 year age group accounted for 12% of stroke patients. These observations were similar to those made by Bozluolcay M et al. (2003)[2] who recorded a mean age of 65.5 ± 11.9 (range 31- 91 years).

T wave inversion was observed in 14% of patients with intracerebral hemorrhage and 29% patients with cerebral infarction in our study.

The mean value of QT and Q-TC interval in infarction was 0.3719±0.04 sec & 0.4370±0.06 sec and in hemorrhage, 0.4205±0.08 sec & 0.456±0.054 sec respectively.

In 1954, Burch, Myers, and Abildskov[3] reported a pattern of QT prolongation, abnormal T waves, and U waves which they considered unique for acute cerebrovascular stroke. The observations in the present study are very much similar to those made in the above studies.

‘‘New T wave abnormalities appeared in approximately 15 % of patients with acute stroke, even in the absence of electrolyte disturbance or primary ischemic heart disease’’. The inverted or flat T waves have also been reported in up to 55% of patients with subarachnoid hemorrhage, the stroke with lowest prevalence of coexistent cardiac diseases.[4,5]

Burch and colleagues[6] reported ‘‘abnormal T waves, prominent U waves, long Q-Tc in patients with Cerebrovascular accident’’. Similar observation were found in the present study too.

Mansoureh Togha et al (2013)[7] reported ‘‘ECG abnormalities associated with stroke were T-wave abnormalities, prolonged Q-Tc interval and arrhythmia, which were respectively found in 39.9%, 32.4%, and 27.1% of the stroke patients’’.

Abhilash Somasundaran et al (2015)[8] reported that ECG changes included T inversions (22.3%) and ST depressions (17.2%) predominantly.

The next common abnormality noted was tall T waves, which was observed in 43% of patients with intracerebral hemorrhage. Our findings are consistent with Byer and colleagues (1947) who reported marked QT prolongation with large T and U waves on the ECG of four patients with stroke.[9]

The most common abnormality noted was ST segment changes (57%) in patient with cerebral hemorrhage. Of which 43% had ST segment elevation and 14% had ST segment depression. The findings were in conflict with Dimant J, Grob D (1977)[10] who found that Cerebrovascular accident had a 7 to 10 fold higher incidence of ST segment depression.

Kono and colleagues performed detailed cardiac evaluation of patients with acute subarachnoid hemorrhage and reported that ST elevation in the ECG may be due to apical wall motion abnormalities on the echo-cardiogram, but found no evidence of coronary artery stenosis or coronary artery vasospasm on angiography.[11]

In the present study rhythm disturbances were present in 11.53% of patients with infarct. 38% of patients with Intracerebral hemorrhage had changes, of which 14.28% had sinus tachycardia and 24% had sinus bradycardia. 33.33% of patients with SAH had ECG changes.

In the study done by Goldstein's he observed bradycardia in 8% and tachycardia in 2% of patients with acute stroke.[12] These changes coincide with the observations of the present study too.

Akbar MA et al reported ‘‘sinus tachycardia (HR>=100/min) in 63.8% patients among ischemic cerbrovascular accidents and 30.95% of the hemorrhagic group’’.[13]

Our study showed that the mean value of sodium and potassium ions in infarction was 136.0±4.067 mEq/L & 3.670±0.2233mEq/L respectively and in hemorrhage was 135.4±3.801mEq/L & 3.655±0.221 mEq/L respectively. ECG changes did not conform to the electrolyte disturbance, there by suggesting that pathogenesis of these changes was different.

Regarding the relationship between the locations of Cerebrovascular hemorrhage lesions and ECG abnormalities, Frentz and Gormsen (1962) ‘‘ECG changes appeared to bear no relationship to arteriographic findings’’.

We also tried to correlate the ECG changes with any specific area of cerebral lesion. However in our study there was no specific correlation of ECG changes with site of cerebral lesion.

Recently, however Yamour Et Al. using the computerized tomographic (CT) scan, suggested that frontal lobe hemorrhages were associated especially with the ECG abnormalities of corrected QT interval (QTC) prolongation and neurogenic T waves. Sites which contribute to regulation of the cardiovascular function are known to be the anterior half of the cerebral cortex which includes the top of the frontal lobe, the motor and premotor cortex, and anterior part of the temporal lobe, hypothalamus, the limbic system, and the cerebellar hemisphere. The intimate functional connections between the hypothalamus, and posterior orbital and anterior insula and those between the hypothalamus and peripheral sympathetic nerves have also been demonstrated.

These findings suggest that the structures related to cardiovascular function are widely distributed within the central nervous system. Therefore, it is likely that Cerebrovascular accident lesions not only in the frontal lobe, but also in the temporo-parietal lobe and basal ganglia can destroy or irritate such widely spread neurons or pathways regulating the cardiovascular system, resulting in ECG changes.

VII. Conclusion

An Observational, Non interventional, Retrospective / Prospective study conducted on 50 Patients of Acute Cerebrovascular Accident at Mahatma Gandhi Medical College & Hospital during the years 2015 to 2017 noted ECG changes in terms of Tachy and Bradycardia, ST segment elevation or depression, Tall T waves or T wave inversion as also QT interval or QTC interval changes in as many as 44% of the patients in the study group. These changes were seen to occur in patients who had no pre-existing cardiac disease . Also these changes in ECG tracings were independent of any changes in Electrolyte Concentrations of Sodium or Potassium ions. There was no specific predilection for the changes for lesions of either, ischemic or haemorrhagic stroke, nor for any specific area of the Central Nervous System.

In view of the findings of the present study, as also the observations of previous researchers, we conclude that cardiac disturbances are diverse and frequent in the setting of acute neurological injury. More importantly the presence of cardiac abnormalities has significant impact on clinical management and affects cardiac and neurological outcomes. Understanding that these ECG changes occurring in patients with Cerebrovascular Accident may lead to erroneously judging these patients to be afflicted with Coronary artery disease and prescribing treatment thereSof. Thus it should be borne in mind that, unless proved beyond reasonable doubt, these patients should not be considered as cardiac patients and subjected to unnecessary medication thereof.

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