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Evaluation of Cardiac Status in Cerebrovascular Accidents

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Abstract: ***Introduction:*** *Cerebrovascular accident (CVA) or stroke is the most common life threatening disorder. It is the third leading cause of death in the developed countries after cardiovascular disease and cancer.[1]Electrocardiographic (ECG) and changes can occur in cardiac as well as extracardiac conditions. Abnormalities of ECG are extremely useful in recognition of heart disease, but can occur in a variety of other conditions that are extracardiac. Among these neurologic disease is of special interest. In present study an attempt has been made to identify the electrocardiographic changes produced primarily due to cerebrovascular accidents and its correlation with echocardiography and cardiac enzyme CPK MB.* ***Methods:*** *This was an observational study done at G.M.C Medical College and associated Hamidia hospital Bhopal. Over a period of one year 100 patients fulfilling inclusion criteria, were included and patients were broadly categorized according to type of cerebrovascular accident i.e. cerebral thrombosis and cerebral hemorrhage. 12 lead ECG was done for all cases as soon as patient was admitted. A repeat ECG was done on 3rd and 7th days in all patients who survived. 2D ECHO was done with in 72 hours of admission, CPK MB and other routine investigations were done on admission.* ***Results:*** *In this study the correlation of ECG changes, ECHO changes and serum CPK MB levels and Glasgow Coma Scale on admission, with mortality at the end of 1 week was determined. Among ECG changes QTc prolongation was significantly associated with mortality (p<0.001). 2D ECHO changes were seen in 76% of patients but did not provide any prognostic information and correlation with mortality(p=0.125).CPK MB levels were found to be elevated in 46% of patients. Patients having high CPK MB levels were found to have higher mortality(p<0.0001).* ***Conclusion:*** *ECG and ECHO changes are common in CVA patients but only few (QTc prolongation) are associated with significantly worse prognosis or mortality. Serum CPK MB when elevated denotes poorer prognosis, same is the case with low GCS on admission which is an independent risk factor.*

1. Introduction

Cerebrovascular accident (CVA) or stroke is the most common life threatening disorder. It is the third leading cause of death in the developed countries after cardiovascular disease and cancer.[1] Cerebral infarction is responsible for about 80% of all first ever in a lifetime strokes, primary intracerebral hemorrhage (PICH) for 10%, subarachnoid hemorrhage for 5% and 5% of cryptogenic CVA.Electrocardiographic(ECG) and changes can occur in cardiac as well as extracardiac conditions. Like other ECG abnormalities with an extracardiac basis, those of neurogenic origin should not be taken as evidence of primary heart disease.Findings consist of large T waves of either polarity, prominent U waves and prolongation of QT or QU intervals and abnormalities of ST-T deflection[2]. Papers by koskeloet al[3] (1965) suggested that abnormal ECG in patients with brain damage may mimic cardiac condition. As cerebrovascular accidents are more common in older patients, ischemic heart disease may co-exist in many cases; and if a patient survives, one may be in doubt whether an abnormal ECG should be explained on the basis of heart disease or cerebrovascular accident or a combination of both conditions[4].Serum creatine kinase levels with ECG may be more helpful than ECG alone in evaluating the extent of myocardial damage and in predicting mortality in patients with stroke.[5,6]

Today, echocardiography is the most valuable medical imaging technique for the non-invasive assessment of cardiac function and morphology.Measurements of cardiac chamber size, ventricular mass and LV function are the most clinically important and most commonly requested tasks of echocardiography and are important clinical variables with respect to diagnosis, management, and prognosis in patients with cardiac disease[7,8]. Heart chamber volumes provide information of diagnostic and prognostic[9].Recent studies have indicated that 6% to 24% of ischemic strokes are associated with atrial fibrillilrion[10]. Population-based studies indicate a fivefold increased risk in patients with atrial fibrillation when compared to their age-matched controls.Though various earlier studies have shown patients with stroke who had ECG changes had increased mortality than those who had normal ECG. According to studies, the reports at the third day mortality were 14.8% in patients with ECG abnormalities whereas it was 8.5% in the patients without ECG changes, although its correlation with echocardiography hasn't been done adequately .Echocardiography provides information that facilitates identification of individuals at high risk for stroke and transient ischemic attack.In present study an attempt has been made to identify the electrocardiographic changes produced primarily due to cerebrovascular accidents and its correlation with echocardiography and cardiac enzyme CPK MB and to know whether the electrocardiographic and echocardiographic changes in cerebrovascular accidents have any prognostic significance.

2. Material and Methods

Study design: An prospective observational study
Study period: June 2014 to October 2015.

Inclusion Criteria:
Cases of CVA (CT scan proved) admitted within 72 hours after the onset of stroke were selected for the study, patients admitted beyond 72 hours after onset of stroke were excluded as the incidence of ECG changes beyond this period would be infrequent.

Exclusion Criteria:
Traumatic cases producing neurological deficits, infection, neoplastic cases producing CVA, CVA cases with known underlying cardiac diseases, which produce ECG and echocardiographic changes, were excluded.

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The material for present study comprises 100 patients admitted in dept. of medicine, hamidia hospital, Bhopal. Detailed clinical history was taken in particular reference to the central nervous system and cardiovascular system. Care was taken in eliminating any patient from the present study with evidence of ischemic heart disease, congenital, valvular or chronic respiratory disease. However patients with hypertension were included in study. Electrolyte profile was done in all patients and patients having electrolyte abnormalities were excluded from study.

A thorough physical examination was done with special emphasis to nervous system and cardiovascular system. Investigations done included complete blood picture, urine examination, chest x ray, ECG, blood urea, creatinine, electrolytes, lipid profile, CPK-MB, CT Head (P),2D echocardiography. 12 lead ECG was done for all cases as soon as patient was admitted. A repeat ECG was done on 3rd and 7th days in all patients who survived.

Patients were assigned to one of the following types of cerebrovascular accident based on clinical and CT scan findings:

a) Cerebral thrombosis.
b) Cerebral hemorrhage.

In analyzing the **ECG**following criteria were used to recognize the abnormality:

1) Sinus arrhythmia was considered when there were alternating periods of gradually lengthening and gradually shortening P-P intervals with a normal P wave and PR interval.
2) Sinus tachycardia was considered when heart rate exceeded 100/min and sinus bradycardia when heart rate was less than 60/min.
3) P pulmonale if P waves were tall peaked with amplitude greater than 2.5mm seen in II,III and avF.
4) P mitrale: bifid P wave >100milisec in lead II and/or p-terminal force in V1 exceeding 0.03 sec.
5) Q waves were considered significant (unless confined to lead III) if they were greater than 40milisec in duration and ¼ of the R wave for the lead.
6) ST segment elevation of more than 1mm or depression more than 0.5mm (in the absence of digoxin treatment) were taken abnormal.
7) T wave was considered abnormal when there were inversion of T waves, flat T waves or abnormally tall T waves in mid precordial leads (exceeding 60% of the height of R wave)
8) U wave was taken significant when exaggeration of U wave voltage was noted, when appeared in more than 2 leads, when appeared in leads in which it is not normally seen (V2-v4), inverted U waves.
9) QT_c interval: QT interval was measured and corrected for the heart rate. It was taken as prolonged when QT_c exceeded 0.44 sec.
10) Left ventricular hypertrophy was considered when
    SV1 + RV6 > 35mm
    Strain pattern
11) Right ventricular hypertrophy :
    R wave voltage was greater than S in V1 with ST segment depression and T wave inversion in V1-V3.
    Persistent S wave in V5-V6.
12) RBBB was identified by
    rsR' complexes in V1-V2
    wide S in V5-V6
    QRS interval >0.12 sec
    ST depression and T wave inversion in V1-V3
13) LBBB was identified by:
    Wide slurred R in V4-V6 with absent Q wave in these leads.
    Slurred S wave in V1
    QRS interval > 0.12 sec
    ST depression and T wave inversion in V4-V6.

Table 1: Following criteria were used to analyze ECHO findings:

Entity	Reference Range	Mildly Abnormal	Moderately Abnormal	Severely Abnormal
LV Systolic Function (LVEF in %)	>= 55	45-54	30-44	<30
LVH with Diastolic DYSF.(LV MASS in grams)	66-150	151-171	172-182	>182
LV Diastolic VOL.(in ml)	56-105	105-117	118-130	>=130
LA VOL. (in ml)	22-52	53-62	63-72	>=73

Data was tabulated in Microsoft excel and later SPSS software and OPEN EPI version 2.3.1 was used for analysis of data. Fisher's exact test, One way Analysis of Variance with Bonferroni adjustment, Pearsons Chi square test and univariate logistic regression analysis was used to analyse qualitative data. By using the above mentioned tests, test of significance was calculated. A 'p' value less than 0.05 is statistically significant.

3. Results

The present study includes 100 cases of CT scan proved ischemic and hemorrhagic stroke patients admitted in hamidia hospital, Gandhi medical college, Bhopal with no prior evidence of heart disease. Out of 100 patients 55 were males and 45 females. Of 55 male patients 31 had cerebral infarct while 24 had hemorrhage while out of 45 females 32 had infarct and 13 had hemorrhage. Cerebral hemorrhage was commoner among male patients(43.6%) as compared to females(28.8%).

Of 100 patients studied 64 patients(64%) had abnormal ECG while 36 patients(36%) had normal ECG.ECG changes were seen in 78.3%patients in hemorrhagic stroke as compared to 58.7% patients of ischemic stroke(P=0.002).ST segment changes was the most common abnormality, seen in 45% of patients followed by T wave changes(37%), QTc prolongation(23%), sinus tachycardia(20%), sinus bradycardia(10%) and atrial fibrillation(8%). Among ECG findings association of QTc prolongation mortality was prognosticallysignificant(P=0.001).

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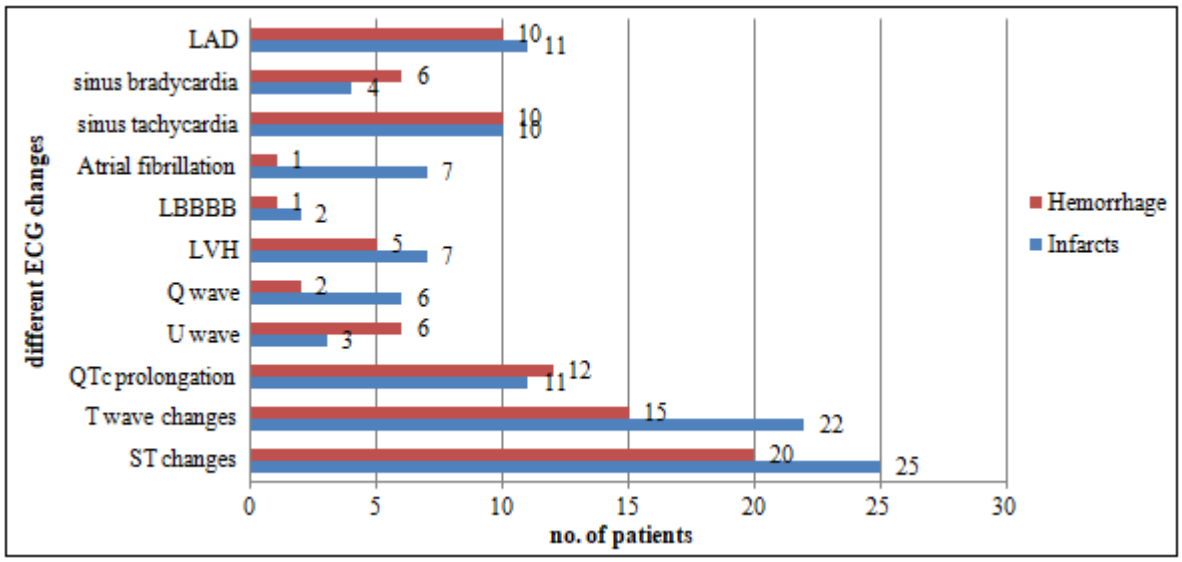

Figure 1: Depicting different ECG changes in stroke patients

Different Echo Findings

Of 100 patients studied 75 patients(75%) had abnormal ECHO while 25 patients(25%) had normal ECHO. ECHO changes were more common in hemorrhagic stroke(83.7%) as compared to ischemic stroke(69.8%) but showed no prognostic significance(P=0.125).

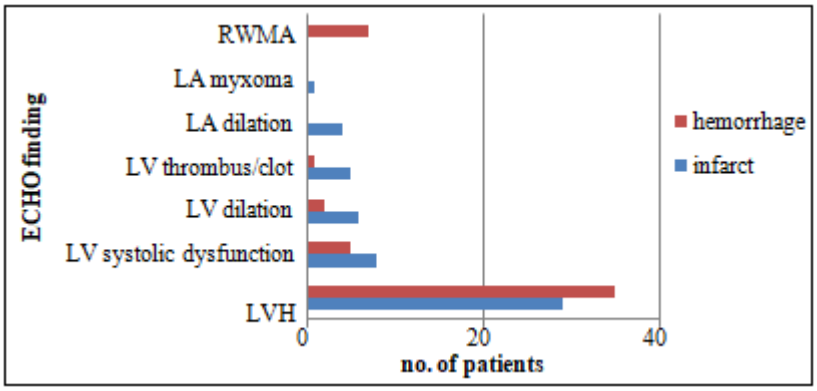

Figure 2: The above mentioned figure shows different ECHO changes seen in ischemic and hemorrhagic stroke

LVH was the most commonly seen abnormality (64%), followed by LV systolic dysfunction (13%), LV dilatation (8%), LV thrombus or clot(6%), regional wall motion abnormality (7%) and left atrial myxoma(1%).

CPK MB

In present study 100 patients were studied. CPK MB was found to be raised in 46% of patients. Of 37 patients with hemorrhagic stroke 26 patients had raised CPK MB. Mean CPK MB level in hemorrhagic stroke came out to be 88 IU/dl while in ischemic stroke it was 36 IU/dl. Standard deviation was 33 and 24 IU/dl in hemorrhagic and ischemic stroke respectively. Patients having high CPK MB levels were found to have higher mortality($p<0.0001$).

Mortality in Stroke

Table 2: Mortality in different types of strokes:

Type of Stroke	Total No. of Patients	No. of Deaths	Death Percentage
Ischemic	63	11	17.46
Hemorrhagic	37	17	45.94
Total	100	28	28

In present study 28% of total patients died. As evident from the above table death percentage was more among patients of hemorrhagic stroke (45.94%) as compared to ischemic stroke (17.46%).

4. Discussion

In present study 100 patients of cerebrovascular accident were studied to evaluate their cardiac status following CVA. In all the cases ECG and serum CKMB were done on admission and 2DECHO was done with in 72hrs of admission. All the cases who survived had repeat ECG done after 1 week and findings were compared between above mentioned 2 groups and correlated with in hospital mortality.

In present patients of 100 patients 66 patients (66%) had ECG changes while 34 patients (34%) had normal ECG in contrast to 138 patients (i.e. 92%) with abnormal ECG changes according to study by Goldstein[11]. In study by Goldstein there were 150 patients and majority of them had hemorrhagic stroke which according to his study produced more ECG changes when compared to ischemic stroke and

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more so in subarachnoid hemorrhage.[12,13,14] This finding was confirmed in present study also where more ECG changes were observed in hemorrhagic stroke patients (28 patients out of 37; 78.3%; p=0.002) as compared to ischemic stroke (37 patients out of 63; 58.7%).In hemorrhagic stroke patients ECG changes are due to stimulation of area 13.[14]which is on the orbital surface of frontal lobe or around the circle of willis. Stimulation of this area leads to alteration of sympathetic and parasympathetic tone mediated by fibers from orbitofrontal area to heart.

Table 3: Comparison of ECG Changes in Present Study and Goldstein

ECG Findings	Goldstein 1979N (%)	Present Study (%)
Normal	8	34
Abnormal	92	66
QTc prolongation	45	23
T wave changes	29	26
U wave	28	9
ST changes	27	32
Sinus tachycardia	28	14
LVH	26	30
Sinus bradycardia	7	7
Atrial fibrillation	14	8
Other arrhythmia	7	0
Q waves	2	8

The most common changes in present study were ST changes (32%) that were more common in hemorrhagic stroke (44%) as compared to ischemic stroke (28%). According to study by Goldstein[11] 27% patients had ST changes.T wave changes were second most common ECG changes observed in present study(26%) and T wave changes were more common in hemorrhagic stroke (38%) as compared to ischemic stroke (21%) similar to study by Goldstein[11]where 29.3% patients showed T wave changes.

QTcprolongation were seen in 23% patients compared to 45% in Goldstein study. The changes were more common in hemorrhagic stroke (32.4%) as compared to ischemic stroke (17.4%). Similar observations were seen in the studies by Rudehil[15] (30%), Dipasquale[16](42%), Cropp and Manning[17] (66%) and Hersch[18] (45%). QTc prolongation was mainly due to direct consequences of adrenergic response.

Sinus tachycardia was seen in 14% patients as compared to 28% in Goldstein study[11]. sinusbradycardia was seen in 7% of patients of which 5 patients were of hemorrhagic stroke(71%). 5 out of 37 patients(13.5%) of hemorrhagic stroke had sinus bradycardia. It was partly due to vagal action[19,20,21] and partly due to cerebral edema.According to Dipasquale[15],Rudhill[16] and Cruickshank[22]sinus bradycardia was seen in 39%,25% and 22%.LVH by voltage criteria was seen in 30% of patients similar to 26% in Goldstein study.

Atrial fibrillation was seen in 8% of patients as opposed to 14% in Goldstein study[11]. It was more common in ischemic stroke. The repeat ECG that was done on seventh day showed restoration of sinus rhythm in surviving patients.

Of 100 patients 68 patients had repeat ECG done at seventh day of with 39 ECGs returned back to normal(57.3%) and of the remaining 29, 12 patients had normal ECG at the time of discharge.

The incidence of mortality was higher among hemorrhagic stroke patients(45.9%; 17 out of 37; p=0.002) as compared to ischemic stroke patients(17.4%; 11 out of 63). Mortality in this group was 56% and 90.9% according to studies by Goldstein and Dalal[23]respectively. The mortality in present study was 28 patients out of 100 patients, 17 of whom had hemorrhagic stroke while 11 had ischemic stroke. In present study 46% patients had abnormal raised CPK MB levels of which 20 had hemorrhagic stroke while 26 had ischemic stroke. 54% of patients had high CPK levels in hemorrhagic group while 41% patients in ischemic group. Incidence of mortality was higher in patients with raised CPK MB ($p<0.001$). In Goldstein[11] study Thirty-eight patients with stroke (25%) had CPK levels measured during their hospitalization, including 5 patients whose strokes occurred while being hospitalized for myocardial infarction. Of the 33 patients with stroke without recently diagnosed myocardial infarction, 29 had raised CPK MB.

Mortality varied significantly with QTc prolongation, type of stroke, level of CPK on admission. Mortality did *not* relate significantly with any other ECG abnormality, history of hypertension, type 2 DM or any ECHO abnormality.

5. Conclusion

ECG changes are commonly seen in stroke patients, more common in hemorrhagic stroke than ischemic stroke. ECG changes like ST changes, QTcprolongation,were more common in hemorrhagic stroke patients.Among ECG changes QTc prolongation was significantly associated with mortality.2D ECHO changes were common but did not provide any prognostic information and correlation with mortality.

CPK MB levels when elevated indicate poorer prognosis. Patients having high CPK MB levels were found to have higher mortality.

Most of the ECG changes that were seen, reverted back to normal in patients those who survived emphasizing the fact that the CVA related changes were transient and were due to altered autonomic tone associated with stroke and not due to cardiac disease.

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