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Cardiac Electrophysiological Evaluation in Stroke Patients without Cardiac Abnormalities

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Abstract

Background Physicians have known for centuries that primary cardiac disorders can lead to stroke, but the realization that strokes may result in the cardiac abnormalities is much more recent. Cardiac disturbances are common following stroke such as cardiac arrhythmias or repolarization abnormalities. To provide optimal care, it is essential to distinguish whether cardiac abnormalities are caused by acute stroke or unrelated to it.

Objectives To evaluate the cardiac electrophysiological changes in patients with stroke and study the correlation of stroke type, electrocardiographic and echocardiographic findings with the holter findings.

Methods A case control study was conducted on 52 persons of either sex; involving 32 patients suffering from stroke for the first time without underlying cardiac disease, and 20 healthy persons. Electrocardiographic examination to record cardiac electrical changes, holter record for one hour to detect changes in heart rate variability parameters and echocardiogram to asses heart function have been done for each patient and subject control.

Results No significant difference was found between patient and control groups regarding sex and age, but there was a significant difference between the two groups regarding the SDNN, SDANN, rMSSD parameters, QT dispersion, ST segment shape and T wave shape.

Conclusion The Electrocardiographic changes can occur in stroke patients without cardiac problems. The non-invasive parameters (heart rate variability, QT dispersion) are useful tests in patient with stroke to assess cardiac abnormalities.

Key words Electrocardiographic changes, stroke, cardiac problem.

List of abbreviation: CNS = central nervous system, ECG = electrocardiography, SAH = subarachnoid hemorrhage, VC = ventricular contraction, NSVT = non-sustained ventricular tachycardia, SVT = supraventricular tachycardia, PVC = premature ventricular contraction, PSVC = paroxysmal supra ventricular contraction.

Introduction

Cardiac electrophysiological changes suggestive of cardiac pathology can be associated with intracranial pathology, most notably cerebral hemorrhage. Delay of operative therapy may have catastrophic results. Experimental data indicates massive sympathetic outflow results from stimulation of the lateral and posterior hypothalamic regions. Large amounts of norepinephrine are released into the systemic circulation, resulting in hypertension, tachycardia, dysrhythmias and electrocardio-graphic (ECG) changes.

Myocardial ischemia and injury can occur from the effects of this excessive sympathetic stimulation [(1)].

The association between central nervous system (CNS) disease and ECG changes was first described in 1938 [(2)]. These ECG changes were further detailed and categorized, and their frequent association noted in the presence of spontaneous subarachnoid hemorrhage (SAH) [(3)]. It is estimated that approximately 50% of patients with aneurismal SAH will have ECG

abnormalities [2]. One case report describes a patient with a known aneurismal SAH who had a preoperative ECG consistent with an anterior wall myocardial infarction. For this reason the operation was canceled, and the patient died soon afterward of a second hemorrhage. The autopsy revealed a normal heart with no evidence of recent infarction [3]. Cardiac abnormalities are present in more than 50% of patients with subarachnoid hemorrhage [4].

Several studies investigated the effect of brain injury on the heart but very few studies have addressed the prognostic significance of these changes. These abnormalities can lead to diagnostic and therapeutic difficulties for cardiologists and neurologists [3]. Khechinashvili *et al* in a systematic review compiled all information found in the literature on the prevalence of the ECG changes and QT prolongation during the acute phase of stroke and their coexistence with other abnormal cardiac findings [3]. Abnormalities, such as ischemic-like ECG changes and/or QT prolongation were present in more than 90% of unselected patients with ischemic stroke and intracerebral hemorrhage, but the prevalence was much lower after exclusion of patients with preexisting heart disease [5]. In patients with ischemic stroke and intracerebral hemorrhage, these ECG abnormalities (and QT prolongation) most often represent preexisting coronary artery disease. They found that the specificity of ECG changes to diagnose acute myocardial infarction is low in the acute phase of stroke [4]. In some cases ECG changes have been mistaken for those of myocardial infarction with resulting inappropriate treatment, especially the use of anticoagulants or delay of surgery [2]. Therefore, it is important to determine whether or not there is primary heart disease and subarachnoid hemorrhage or reversible cardiac abnormalities secondary to subarachnoid hemorrhage [6].

An understanding of the role the CNS plays in the genesis of ECG abnormalities has been obtained through numerous animal studies [7]. Apparently, the stimulation of certain central autonomic centers results in a massive sympathetic outflow, with a consequent release of large amounts of norepinephrine from the adrenal medulla. These centers in humans have been identified as lying in the lateral and posterior hypothalamic regions. These regions are stimulated by increased intracranial pressure, the irritant effect of blood, ischemia or a combination of these factors. Once stimulated, central efferent pathways produce norepinephrine release into the general circulation, with resultant acute hypertension and cardiac manifestations [8]. This study was conducted to evaluate the cardiac electrophysiological changes in patients with stroke and study the correlation of stroke type, electrocardiographic and echocardiographic findings with those of holter study.

Methods

A case control study was conducted on 52 persons with acute stroke attack who were attending Al Hussein Teaching hospital in Karbala Province for management, from December 2013 to June 2014. The study population consisted of two groups: thirty two patients with acute stroke attack for the first time without cardiac abnormalities and 20 healthy age and sex matched subjects were included in the study as control group.

Diagnosis of acute ischemic attack was established in all the patients by computed tomography (CT scan). Detailed history of hypertension, diabetes mellitus and neurological findings were recorded in all the patients. All the patients were evaluated for cardiac disease by detailed history and clinical examination. They were submitted to ECG recording and Holter monitoring for one hour, and also chest X-ray. Patients with history or clinically proved acute myocardial infarction, unstable angina or cardiac diseases were excluded from the study.

ECG findings done on the day of admission were considered for the analysis. Consultant expert cardiologists analyzed the electrocardiographic findings and cardiac

evaluation using echocardiography for all cases. ECG abnormalities were grouped into: invert T-wave, ST segment elevation/ depression.
The Holtor records were estimated by specialist physician and the following parameters were measured (SDNN, SDANN, rMSSD and Q-T dipersion)
To detect underlying cardiac disease, clinical and paraclinical evaluations were done by consultant cardiologists.

Statistical analysis

The data was analyzed using SPSS program version 17.0 and Excel program. The results were expressed as (mean ±SD). Student t- test was used to compare parametric values. While Chi- square test was used to compare non parametric values. For all these statistical comparisons, the threshold of significance was chosen as p=<0.05. The statistical significance was determined using the chi-square test and a p value of < 0.05 was considered significant

Results

The study included 32 patient group (range 32 - 80 yrs), 20 females and 12 males and the mean age was (61.31 ± 11.43). The control group consisted of 20 healthy persons, 16 females and 4 males and the mean age was (56.55 ± 9.93), (range 38 - 80 yrs) there is no significant differences in sex and age between two groups (Table 1).

Table 1. Demographic data of control group and patients group

Parameters	Control N=20		Patients N=32		*P* value
	Frequency	%	Frequency	%	
Male	4	20	12	37.5	**0.184**
Female	16	80	20	62.5	
Age (Years)	56.55 ± 9.93		61.31 ± 11.43		**0.131**

In stroke group 15 (46%) patients were hypertensive and 12 (37%) were hypertensive and diabetic, 4 (12%) of them were no hypertensive and no diabetic, 1 (3%) had only diabetes. In control group, history of no hypertension nor diabetes was found in 9 (45%), both hypertension and diabetes was found in 2 (10%) subjects and hypertension was found in 7(35%) subjects and diabetes mellitus in 2 (10%) subjects. The frequency of the abnormal ECG changes observed in 24 (75%) of patients with acute cerebral infarct (p = 0.0054) and 2 (10%) of the control group (p = 0.0103) (Table 2).

Table 2. Comparison between patients group and control group regarding ST segment and T wave shapes in patients group by Chi square test

Parameters		Patients N=32		Control N=20		*P* value
		No.	%	No.	%	
ST segment Shape	**Normal**	22	68.75	20	100	**0.0054**
	Abnormal	10	31.25	0	0.00	
T wave Shape	**Normal**	18	56.25	18	90.00	**0.0103**
	Abnormal	14	43.75	2	10.00	

ECG changes that were observed in stroke patients were inverted T-wave in 14 patients (43.75%), ST segment elevation/depression in 10 patients (31.25%).

Inversion of T wave and ST segment changes were the most common findings. The observed abnormalities were mostly related to myocardial repolarization abnormalities. In most of these patients ECG changes were transient according to follow- up period recordings.

All the HRV parameters showed a significant lower mean value in patients group with a significant differences (p = <0.05).

Values of SDNN, SDANN, rMSSD parameters in patients group were significantly lower than those of the control group (p = <0.0001, p = <0.0001, p = <0.0001, respectively).

Table 3. Comparison of holter finding between control group and patients group by t test

Parameters	Control (n=20) Mean ± SD	Patients (n=32) Mean ±SD	P value
Mean NN (ms)	725.45 ± 118.06	774.97 ± 129.44	0.1715
SDNN (ms)	127.15 ± 16.08	92.69 ± 13.58	<0.0001
SDANN (ms)	111.7 ± 14.44	58.19 ± 9.84	<0.0001
r MSSD (ms)	29.65 ± 7.3	17.13 ± 3.99	<0.0001

Discussion

The CNS regulates the heart rate, blood pressure, vasomotor tone, and cardiac output and plays an important role in myocardial metabolism and cardiac contraction. Further, the CNS can affect the cardiovascular system by altering fluid and electrolytes balance. Cardiac systolic function also is affected after an acute CNS [(9)].

Coronary artery disease and ischemic cerebrovascular disease are leading causes of morbidity and mortality. Coronary artery disease often coexists with asymptomatic carotid artery atherosclerosis, transient ischemic attacks, or ischemic stroke. Numerous studies have shown that mortality from all forms of ischemic cerebrovascular disease is primarily due to coronary artery disease. Thus, there is increasing interest in identifying coronary artery disease in patients with cerebrovascular disease, including those without clinical manifestations of heart disease. ECG changes are common in patients with ischemic stroke. ECG changes suggestive of ischemic heart disease were the common findings in this study [(10,11)].

In the current study there were cardiac electrical changes rather than structural cardiac disease. This is in agreement with most of the studies that prove the association between neural injury and the cardiac electrical defects; yet, the study groups were less selected than the aforementioned studies regarding the utility of ECG in the setting of acute stroke [(12,13)].

The study of relationship between HRV and acute cerebral stroke allows for the description of the arrhythmic profile of the acute phase of ischemic stroke in patients without heart disease. In particular previous studies it was noted in right-sided brain infarctions were found to be associated with more frequent arrhythmias than left-sided lesions [(14-16)]. Furthermore, right insular damage was associated with more complex dysrhythmias, namely ventricular contraction (VC), non sustaintained ventricular tachycardia (NSVT), and supraventricular tachycardia (SVT), than any other localization. These findings once more suggest a major role of the right insula in the pathogenesis of cerebrogenic cardiac disturbances [(17)].

Another interesting aspect of this study is the analysis of the possible interplay between HRV

abnormalities with acute brain infarction. To the best of our knowledge, this is the first study reporting the existence of a significant negative correlation between a specific HRV parameter, namely SDNN in the acute phase of ischemic stroke. In fact, lower values of 24-hour SDNN were associated with a higher number of premature ventricular contraction (PVC) and paroxysmal supra ventricular contraction (PSVC) and also predicted the presence of more complex arrhythmias, such as VC, NSVT, and SVT. Actually, SDNN, which is an estimate of the overall 24-hour HRV behavior, is the best known, best validated, and easiest HRV index to use [18-20].

A decrease of SDNN has been considered to reflect a diminished vagal activity directed to the heart, which may lead to a relative prevalence of sympathetic modulation and to a cardiac electrical instability [19-21]. This interpretation is in agreement with the clinical evidence that SDNN reduction is an independent predictor of an increased arrhythmic mortality in several conditions characterized by autonomic imbalance, such as heart failure, diabetes, and coronary artery disease [10,13,14]. Actually, HRV abnormalities associated with cardiac damage may be determined by derangement of neural activity of cardiac origin.

In particular, changes in the geometry of the beating heart, caused by the presence of diseased non contracting ventricular segments, may abnormally increase the firing of sympathetic afferent fibers [10,15]. This overflow of sympathetic nerve traffic may in turn attenuate vagal activity. However, in the acute stroke setting, cardiac autonomic abnormalities should have a central origin, despite being similar in terms of HRV behavior. Accordingly, acute brain and acute heart damage show the same final expression, with HRV abnormalities and arrhythmias representing a final common effect, possibly determined by a relative sympathetic prevalence on the sinus node and on the myocardium. A follow-up study clearly would be useful in order to assess the prognostic value of Troponin T and ECG changes in the longer term, not only regarding neurological sequels but also regarding cardiologic complications such as recurrent ischemia, myocardial infarction and congestive heart failure amongst these patients [21].

In conclusion, ECG changes can occur in stroke patients without cardiac problems; the non invasive parameters (HRV, QT dispersion) are useful tests to in patients with stroke to assess cardiac abnormalities and finally stroke may be associated with cardiac abnormalities.

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Author contributions

Dr. Hussein and Al-Hashimi analyze, interpret, writ and revise the manuscript.

Conflict of interest

The authors declare no conflict of interest.

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