

Risk Factors for Ischemic Stroke: Electrocardiographic Findings

Elley H.H. Chiu^{1,2}, Teng-Yeow Tan^{1,3}, Ku-Chou Chang^{1,3}, and Chia-Wei Liou^{1,3}

Abstract-

Background: Standard 12-lead electrocardiography is a routine and mandatory cardiovascular examination in the evaluation of stroke patients. This study investigates the relationship of electrocardiography findings and first-ever ischemic stroke.

Methods: This hospital-based case-control study consisted of 238 consecutively hospitalized cases of first-ever ischemic stroke and 238 healthy age- and sex-matched control subjects. Multivariate logistic regression analyses were performed to evaluate the risk factors and electrocardiography findings.

Results: Atrial fibrillation [odds ratio (OR) = 6.8, 95% confidence interval (CI) = 1.90-24.45], myocardial ischemic change (OR = 5.0, 95% CI = 2.22-11.06), left ventricular hypertrophy (OR = 3.9, 95% CI = 2.02-7.39) and sinus bradycardia (OR = 0.37, 95% CI = 0.18-0.79) were significantly related with first-ever ischemic stroke.

Conclusions: Electrocardiography findings of atrial fibrillation, myocardial ischemic change and left ventricular hypertrophy as risk factors for ischemic stroke were similar to those from other studies. Additional studies are needed to assess the role of sinus bradycardia for ischemic stroke, which was less common in patients with stroke than in controls.

Key Words: Electrocardiography, Ischemic stroke, Risk factor

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INTRODUCTION

Standard 12-lead electrocardiography (ECG) is a routine and mandatory test in stroke patients for cardiovascular examination. Abnormal ECG findings may indicate a direct cardiac cause of the patient's symptoms or may identify a condition, such as atrial fibrillation

(AF), that may alter the treatment in the secondary prevention of stroke⁽¹⁾. Left ventricular hypertrophy (LVH) and AF by ECG are well known risk factors for ischemic stroke⁽²⁾. Studies had shown that certain ECG findings predict short-term and long-term cardiac morbidity after transient ischemic attack⁽³⁻⁵⁾. However, the relationship of ECG findings other than LVH and AF

From the ¹First Department of Neurology, and ²Division of Acupuncture, Department of Chinese Medicine, Chang Gung Memorial Hospital-Kaohsiung Medical Center, ³Chang Gung University College of Medicine, Kaohsiung, Taiwan.
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Reprint requests and correspondence to: Teng-Yeow Tan, M.D. First Department of Neurology, Chang Gung Memorial Hospital, No. 123, Ta-Pei Road, Kaohsiung, Taiwan.
E-mail: tengyeowtan@adm.cgmh.com.tw

with ischemic stroke is poorly understood. It is the aim of this study to investigate the role of ECG findings in first-ever ischemic stroke.

MATERIALS AND METHODS

Chang Gung Memorial Hospital, Kaohsiung, Taiwan, is a medical center, and the source of patients and controls for this study. It is a main referral hospital which serves a catchment area of three million inhabitants in southern Taiwan. It is easily accessible to all kinds of stroke patients.

Cases

Patients admitted to Department of Neurology of this hospital between September 1998 and October 1999, were recruited for this study. Only patients with first-ever ischemic stroke were enrolled. Diagnosis of stroke was based on World Health Organization criteria. All patients received standard 12-lead ECG examination within 24 hours of admission.

Controls

Controls were selected from people who visited the study hospital for physical checkup. A control was

selected by identifying a person of the same sex who was born in the same year as one of the patients but who had not had a prior stroke and had normal clinical neurological examination. All the controls received ECG examination during the checkup period.

The ECG results were abstracted from the official reports of cardiologists in the hospital. ECG findings included any of the following diagnoses in the ECG report: normal, myocardial ischemic change, LVH, AF, atrioventricular conduction abnormalities, bundle branch block, atrial or ventricular premature contractures and sinus bradycardia. Patients and controls with possible drug-induced sinus bradycardia, especially those using beta blockers were excluded.

DATA GATHERING AND ANALYSES

All the data were expressed as mean and standard deviation, unless otherwise stated. Comparisons between patients and controls were performed using Student's two-tailed t-test for independent samples. R x C-contingency tables were analyzed by χ^2 tests, $p < 0.05$ was considered statistically significant.

Univariate analyses were performed to assess ECG findings and vascular risk factors including: hyperten-

Table 1. Univariate Logistic Regression Analysis of risk factors and ECG findings in cases and controls for first ischemic stroke*

Risk factors and ECG findings	Cases (n=238)		Controls (n=238)		P
	No.	%	No.	%	
Hypertension	137	57.6	87	36.6	< 0.001
Diabetes mellitus	65	27.3	41	17.2	0.001
Total cholesterol level \geq 200 mg/dL	81	47.4	90	52.6	0.14
Triglyceride level \geq 150 mg/dL	82	59.4	56	40.6	0.04
Smoking	58	24.4	34	14.3	0.04
Alcohol	17	7.1	21	8.8	0.30
Sinus bradycardiac	13	5.8	39	16.8	< 0.001
Left ventricular hypertrophy	57	25.4	17	7.3	< 0.001
Myocardial ischemic change	37	16.6	10	4.3	< 0.001
Atrial fibrillation	19	8.5	3	1.3	< 0.001
Bundle branch block	11	4.9	16	6.9	0.42
Atrioventricular conduction abnormalities	9	4	12	5.2	0.48
Atrial or ventricular premature contracture	12	5.4	7	3	0.32

*unknown or missing data occurred in the following variables: cigarette smoking in 1 control, total cholesterol level in 9 cases and 20 controls, triglyceride level in 9 cases and 22 controls, sinus bradycardia in 15 cases and 6 controls, LVH in 14 cases and 5 in controls, ischemic change in 15 cases and 5 controls, AF in 14 cases and 5 controls, bundle branch block in 15 cases and 5 controls, atrioventricular block in 14 cases and 5 controls, atrial or ventricular premature contracture in 14 cases and 5 controls.

sion, diabetes mellitus, dyslipidemia, smoking and alcohol consumption. To estimate the odds ratio (OR) and the resulting 95% Confidence Intervals (CI) for the matched case-control pairs, multivariate logistic regression was performed. Only variables with $p < 0.2$ in the univariate analyses were included in the multivariate analyses. We first included all the risk factors and ECG findings as a full model and then reduced the model to include only ECG findings.

In our analysis, the logistic procedure eliminated pairs in which either the cases or the controls had missing values for a particular variable. Unknown or missing data occurred in the following variables: cigarette smoking in 1 control, total cholesterol level in 9 cases and 20 controls, triglyceride level in 9 cases and 22 controls, abnormal ECG in 15 cases and 4 controls, sinus bradycardia in 15 cases and 6 controls, LVH 14 cases and 5 in controls, ischemic change in 15 cases and 5 controls, AF in 14 cases and 5 controls, bundle branch block in 15 cases and 5 controls, atrioventricular conduction abnormalities in 14 cases and 5 controls, atrial or ventricular premature contracture in 14 cases and 5 controls. Data were analyzed by using SPSS version 10.0 for Windows.

RESULTS

There were 238 patients of first-ever ischemic stroke included in this study. Among them, 153 (64.3%) were male. The mean age was 61.8 ± 11.8 (median 63, range 18-87) years old. Table 1 shows the risk factors and ECG

Table 2. Multivariate Regression Analysis of risk factors and ECG findings in cases and controls for first ischemic stroke*

Risk factors and ECG findings	OR	95% CI	P
Hypertension	1.8	1.19- 2.84	0.006
Diabetes mellitus	1.7	0.98- 2.97	0.06
Total cholesterol level ≥ 200 mg/dL	0.7	0.47- 1.16	0.19
Triglyceride level ≥ 150 mg/dL	1.3	0.78- 2.08	0.33
Smoking	1.8	1.04- 3.19	0.04
Sinus bradycardia	0.37	0.18- 0.79	0.01
Left ventricular hypertrophy	3.9	2.02- 7.39	< 0.0001
Myocardial ischemic change	5.0	2.22-11.06	< 0.0001
Atrial fibrillation	6.8	1.90-24.45	0.003

*Matched for age and sex.

OR: odds ratio; CI: confidence intervals.

findings that were studied and the frequency of cases and control subjects with each risk factor and ECG findings. Among the studied risk factors, hypertension, diabetes mellitus, hypertriglyceridemia and smoking were higher among cases than controls. For the ECG finding, the frequencies of LVH, myocardial ischemic change and AF were higher among cases than controls whereas the frequency of sinus bradycardia was higher among controls than study cases.

Table 2 and 3 show the multivariate estimates of the OR with 95% CI. In the multivariate analysis, hypertension, smoking, myocardial ischemic change, LVH and AF were significantly related to an increase risk of stroke whereas sinus bradycardia was significantly related to a lower risk of stroke.

DISCUSSION

To our knowledge, this is the first study to find that sinus bradycardia was suggestive of lowering the risk of ischemic stroke. Other ECG findings including myocardial ischemic change, LVH and AF were risk factors for stroke as shown in other studies⁽²⁾; whereas bundle branch block, atrioventricular conduction abnormalities and atrial or ventricular premature contractures were not.

Abnormal resting ECG findings have been associated with an increased incidence of cardiac morbidity in some studies^(6,8). Certain ECG findings including LVH, AF, atrioventricular conduction abnormalities, new-onset AF and myocardial ischemia predict short-term cardiac morbidity after transient ischemic attack^(3,5). ECG examination should be performed in all stroke patients not only for detection of a possible cardiac source for the stroke in question, but also in identified groups of patients who are at substantial risk for future recurrent

Table 3. Multivariate Regression Analysis of ECG findings in cases and controls for first ischemic stroke*

ECG findings	OR	95% CI	P
Sinus bradycardia	0.42	0.21- 0.82	0.012
Left ventricular hypertrophy	4.5	2.47- 8.15	< 0.0001
Myocardial ischemic change	5.3	2.52-11.15	< 0.0001
Atrial fibrillation	7.7	2.20-26.84	0.001

*Matched for age and sex.

stroke or other cardiovascular events. Furthermore, the pathological changes detected by means of ECG appear to be the better predictors of early cardiac events than medical history alone. ECG findings of AF, LVH and myocardial ischemic change are well-known for altering the regimen of secondary stroke prevention, but the relationship between other ECG findings and ischemic stroke is poorly understood and has not been formally assessed or evaluated.

The effect of stroke, especially in its acute stage, on ECG findings has been widely discussed⁽⁹⁻¹⁰⁾ and further, it's recognized that myocardial infarction and cardiac arrhythmias are potential complications of acute ischemic stroke⁽¹¹⁾. The most common arrhythmia detected in the setting of stroke is AF⁽¹²⁻¹³⁾ whereas sinus bradycardia has not been discussed in stroke patients whether in the acute or chronic stage. We found a statistically significant negative association between sinus bradycardia and ischemic stroke suggesting that sinus bradycardia may predict a lower risk for stroke. Some studies have suggested that beta blockers significantly reduced the risk of stroke compared with placebos in hypertensive patients⁽¹⁴⁻¹⁷⁾. The reduction of the stroke risk is due to the lowering of the blood pressure and might also be due to a reduced heart rate as shown in our study.

Since this was a hospital-based case-control study, the results should not necessarily be generalized to the whole population. Although our findings showed that sinus bradycardia may be a predictor for lower risk of stroke, these results should be interpreted cautiously. Many of the ECGs in stroke patients were done acutely as part of the emergency department work-up, it is likely that many patients were in acute stress at the time ECG examinations were performed, so, the percentage of the acute stroke patients having sinus bradycardia was probable underestimated.

This study confirms the utility of the routine ECG in the evaluation of ischemic stroke. AF, myocardial ischemia change and LVH were the risk factors for ischemic stroke. Although the ECG finding of sinus bradycardia may be a predictor for lower stroke risk in this study, this result needs to be clarified and affirmed by future studies.

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