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Original Article

Stroke risk in hypertensive patients

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Abstract: This study aims to explore the risk factors for stroke in hypertensive patients and to provide a reference for the comprehensive prevention of the disease. A total of 185 hypertensive patients who suffered a stroke and who were admitted to our hospital from February 2014 to December 2017 were recruited for this study in order to evaluate their lifestyle habits, mean arterial pressure, and blood test indicators. A multivariate analysis of the risk factors was conducted, and 140 non-stroke patients with hypertension and admitted to our hospital were recruited for the study as a control group. A logistic univariate regression analysis showed that gender, smoking, drinking, a high salt diet, a high fat diet, mean arterial pressure, HDL-C, CRP, and NLR were related to stroke, but age, a high sugar diet, LDL-C, and brain stroke were not significantly related. In conclusion, lifestyle habits, mean arterial pressure, and blood test indicators were significantly associated with stroke in hypertensive patients, with alcohol intake, high-fat diets, average arterial pressure, HDL-C, and NLR as independently related factors.

Keywords: Hypertension, stroke, risk factors

Introduction

Hypertension is a non-communicable disease. Its current incidence and subsequent complications have become a global public health problem [1, 2], especially in developing countries. Studies have predicted that the number of people with hypertension will increase to 30% by 2025, and hypertension is also an important risk factor for cardiovascular and cerebrovascular diseases in China [3]. Hypertension has many complications. Stroke is one of its most serious complications bringing a high disability rate, and which seriously affects people's survival and quality of life. Both hypertension and stroke are cardiovascular related diseases and have common risk factors, and the former are risk factors for the latter. In addition, from the point of view of the additive effect of risk factors for cardiovascular disease, the addition of a risk factor such as hypertension will greatly increase the risk of stroke. Although the molecular and genetic mechanisms of stroke risk factors have been studied in detail, the task of identifying stroke risk patients in clinical diagnosis and treatment is still inseparable from their medical history and related blood test indicators. The risk factors are high. The influence of the occurrence and development of stroke on blood pressure is still a research hotspot. This study reviewed the data of 325 patients admitted to the Department of Neurology and Cardiology of our hospital from February 2014 to December 2017 and investigated the risk factors for stroke in hypertensive patients.

Materials and methods

General information

With the approval of the Medical Ethics Committee of Guizhou People's Hospital, we selected 325 patients with hypertension admitted to the Department of Neurology and Cardiology of our hospital from February 2014 to December 2017. Among them, 185 patients with hypertension were admitted to the Department of Neurology. Inclusion criteria: ① Patients consistent with the hypertension diagnostic criteria in the 2010 Hypertension Prevention Guidelines: systolic blood pressure (SBP) ≥140 mmHg and/or diastolic blood pressure (DBP) ≥90 mmHg, continuous measurement of blood pressure through the upper arm of with Omron medical electronic sphygmoma-

nometer HBP-9021J for three days; ② The "Guide to the Prevention and Treatment of Cerebrovascular Diseases in China" and the "Ischemic Stroke Diagnosis and Treatment Guidelines 2014 in China" were adopted for the diagnosis of ischemic stroke standard [1, 2]. Diagnostic criteria for stroke in traditional Chinese medicine: referring to the diagnostic criteria for stroke in the internal medicine of Chinese medicine in the planning textbook of higher Chinese medicine colleges and universities [3] and the "Evaluation criteria for the diagnosis and treatment of stroke disease" formulated by the Encephalopathy Emergency Research Collaborating Group of the State Administration of Traditional Chinese Medicine [4]. In the Department of Cardiology, 140 patients with hypertension were hospitalized during the same period. Patients were randomly selected according to the diagnostic criteria for hypertension in the 2010 Hypertension Prevention Guidelines. The exclusion criteria for all enrolled patients were as follows: ① patients who had cardiovascular and cerebrovascular diseases other than hypertension and stroke; ② patients with severe liver and kidney damage, circulatory system, rheumatic, and endocrine systemic diseases; ③ patients with tumors, infections, or other diseases; ④ patients who were unable to cooperate with the completion of the study due to mental illness or deafness; ⑤ patients who participated in other similar medical studies.

Treatment methods

One hundred and eighty-five hypertensive patients with stroke were treated as the observation group, and 140 patients without stroke were treated as the control group. The two groups of patients were evaluated in terms of their lifestyles (smoking, drinking, high sugar, high salt, high fat diet), mean arterial pressure, blood test indicators [high-density lipoprotein cholesterol (HDL-C), low-density lipoprotein cholesterol (LDL-C), C-reactive protein (CRP), neutrophil-lymphocyte ratio (NLR), and glycated hemoglobin]. By taking each patient's medical history, the patient's information about his or her lifestyle is collected in detail. Smoking: more than 1 cigarette a day; drinking: more than 100 ml daily; high sugar diet: more than 50 mg of free sugar daily; high fat diet: patients with greasy food habits and a daily intake of fried foods, animal fats, butter products, *etc.*; high-salt diet: daily intake of sodium over 3300 mg; a family history of stroke: both or one parent were stroke patients. The duration of hypertension is divided into three levels according to the length of time a patient suffers from hypertension: less than 5 years, 5 years to 10 years, and more than 10 years. Mean arterial pressure (MAP) = (systolic pressure + 2 × diastolic pressure)/3. At the time of admission, fasting venous blood was collected from the upper arm of all the enrolled patients. After centrifugation, the serum was collected and stored in a freezer at -80°C. The measurement items included HDL-C, LDL-C, CRP, and NLR, which were determined by the laboratory of our hospital.

Statistical analysis

SPSS 19.0 software was used for the statistical analysis. The measurement data were tested using independent samples t-tests. The enumeration data were tested using two independent samples of chi-squared. The relationship between the above risk factors and hypertensive stroke were analyzed using a logistic regression analysis. First, a single factor logistic regression analysis was used. Risk factors (P<0.1) were included in the regression equation analysis.

Results

Living habits data and related detection indicators

The lifestyle data such as smoking, drinking, and the diet preference of the groups were recorded, and blood tests were conducted to facilitate the following analysis. The patients' ages in the observation and control groups had no significant differences, P>0.05. But the smoking, drinking, diet, mean arterial pressure, HDL-C, LDL-C, CRP, and NLR had significant differences, P<0.05. (**Table 1** and **Figure 1**).

A logistic regression analysis using stroke as the dependent variable was performed

A logistic regression analysis using stroke as the dependent variable was performed, *i.e.* stroke Y (Yes = 1, No = 0). The below risk factors were independent variables: sex (X_A) (male = 1, female = 0), age (X_B) (≥60 years = 1, <60 years = 0), smoking (X_C) (Yes = 1, No = 0), drinking (X_D) (Yes = 1, No = 0), high-sugar diet (X_E)

Table 1. Lifestyle data and blood index test results

Indicators	Observation	Control	t/χ^2	P
Gender (male) cases (%)	114 (61.6%)	57 (40.7%)	96.51	<0.001
Number of smoking cases (%)	76 (41.1%)	25 (17.8%)	104.93	<0.001
Drinking cases (%)	90 (48.6%)	33 (23.6%)	103.88	<0.001
High-sugar diet cases (%)	128 (69.2%)	67 (47.8%)	12.33	<0.01
High salt diet cases (%)	138 (74.6%)	61 (43.6%)	43.05	<0.001
High-fat diet cases (%)	122 (65.9%)	71 (50.7%)	7.42	<0.01
Mean arterial pressure ($\bar{x} \pm s$, mmHg)	112.8±17.4	107.2±14.5	3.03	<0.05
Age ($\bar{x} \pm s$, year)	65.8±8.4	65.3±8.3	0.3	0.77
HDL-C ($\bar{x} \pm s$, mmol/L)	1.1±0.43	1.5±0.3	2.6	<0.01
LDL-C ($\bar{x} \pm s$, mmol/L)	2.9±0.8	2.4±0.7	2.94	<0.01
CRP ($\bar{x} \pm s$, mg/L)	7.3±1.1	4.5±1.5	20.3	<0.001
NLR ($\bar{x} \pm s$)	4.6±0.5	2.5±0.3	7.4	<0.01

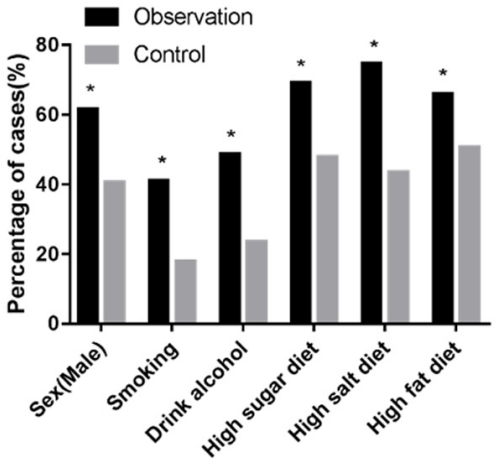

Figure 1. Lifestyle data and blood test results. The original data such as smoking, drinking and diet preference of the groups were recorded and blood tests were conducted. The observation and control group had no significant differences, P>0.05.

(Yes = 1, No = 0), high fat diet (X_F) (Yes = 1, No = 0), high salt diet (X_G) (Yes = 1, No = 0), mean arterial pressure (X_H) (Yes = 1, No = 0) (≥110 mmHg = 1, <110 mmHg = 0), HDL-C (X_I) (≥1.68 mmol/L = 1, <1.68 mmol/L = 0), LDL-C (X_J) (≥3.88 = 1, <3.88 = 0), CRP (X_K) (≥5 mg/L = 1, <5 mg/L = 0), NLR (X_L) (≥2.13 = 1, <2.13 = 0) (**Figure 2**).

Binary logistic multivariate regression analyses on the 10 factors

We conducted binary logistic multivariate regression analyses on 10 factors, including statistically significant factors such as the single factor analysis above. The results showed that drinking, a high-fat diet, mean arterial pressure, HDL-C, and NLR were independently associated with stroke (**Table 2**).

Discussion

With the advances of science and technology in other fields and the guidance of constantly updated, evidence-based medical data, people began to consciously prevent strokes, thus controlling their high morbidity rate. In June 2017, the National Cerebrovascular Disease Prevention and Control Office announced that the mortality rate of stroke in China had reached a turning point. The decrease in standardized stroke mortality, especially the standardized mortality rate of hemorrhagic stroke, reflects the effect of the prevention and control of hypertension in China [4]. The prevention of stroke must focus on the prevention of its risk factors. However, the distribution of the risk factors for stroke is not fixed. It varies with time and geography. Controlling stroke is still a difficult task. Hypertension itself is not only a cardiovascular disease, but it is also a key risk factor for stroke, which deserves attention. With the exception of hypertension, the rela-

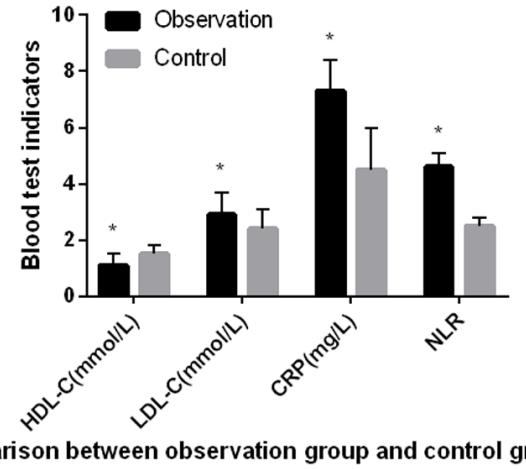

Figure 2. A logistic regression analysis using stroke as the dependent variable was performed. In the observation and control groups the HDL-C, LDL-C, CRP, and NLR levels had significant differences, P<0.05.

tionship between other risk factors and the occurrence and development of stroke remains unclear. In this study, the risk factors of cerebral stroke and non-hypertensive stroke patients were compared to further investigate the current stroke patients with hypertension.

The risk factors are divided into unchangeable risk factors and modifiable risk factors [5]. The risk factors for this study were age and gender. There was no statistically significant difference in age between the two groups in this study, suggesting that age was not significantly related to stroke in hypertensive patients, which is consistent with the findings of Li Xiaoping [6], but domestic and foreign research data suggest that hypertension is related to stroke. Wang et al. [7] found that hypertensive stroke patients are older than those who have not had a stroke, and the differences were statistically significant. The possible causes of the differences are geographical differences and risk factors with genetic characteristics such as ethnicity. Genetic factors have a certain correlation in the incidence of stroke. In the Framingham study [8], adjusted for stroke risk factors, IS parental history below 65 years of age was associated with a 2.22-fold (P<0.05) increase in offspring IS risk. However, this study failed to find a suitable program to quantify genetic risk factors and therefore lacked other genetic risk factors. Furthermore, the small sample size of this study is also one of its influencing factors. As another immutable risk factor, the gender factor is different in the two groups of people, which means that gender and hypertensive patients are associated with the development of stroke. This result is basically consistent with similar studies [9, 10]. Differences in strokes between men and women are mainly differences in lifestyle and hormone levels. The differences in lifestyle between men and women mainly involve smoking and drinking, and premenopausal women have a lower stroke incidence than postmenopausal women. The former is lower than the latter [11]. Clinical and basic studies have also looked at the mechanism of strokes, suggesting that estrogen produces neuroprotective effects by activating receptors such as ERα, ERβ, and G protein-coupled receptors 30, reducing the incidence of stroke [12, 13].

Variable risk factors include lifestyle and blood testing indicators. There were statistical differences in lifestyle risk factors such as smoking, drinking, high-salt diets, and high-fat diets in the two groups, differences which are consistent with domestic and international research. The number of patients exposed to smoking risk factors in the observation group was 7.702 times that of the control group, indicating that this factor may be related to stroke. Cigarette smoke inhalation brings a series of harmful chemical substances into the human body, including components such as nicotine and other cigarette extracts, and has been used to build animal models to study the mechanisms by which cigarette smoke damages blood vessels [14]. Smoking reduces blood supply to the brain mainly through vascular endothelial injury and the development of atherosclerosis, causing nerve damage and promoting the development of a stroke. The risk factors for exposure to alcohol in the observation group were 11.576 times, indicating that drinking may be associated with stroke. Excessive drinking can significantly increase the risk of stroke. Studies differ on how and whether mild and moderate alcohol consumption lead to strokes. Zhang [15] believes that low-dose alcohol consumption is associated with a lower incidence of stroke, but Ikehara [16] found that there is no connection

Table 2. Stroke logistic regression analysis results

Indicators	β-coefficient	SD	P	OR	95% CI of OR
Gender	2.497	0.575	0.008	7.018	2.188~17.302
Age	0.001	0.006	0.084	1.003	0.884~1.026
Drinking alcohol	2.503	0.688	0.001	7.507	3.137~13.464
Smoking	2.541	0.236	0.032	11.497	6.840~18.583
High-fat diet	1.510	0.004	0.041	4.427	2.742~7.123
High sugar diet	0.205	0.227	0.07	1.228	0.787-1.926
High salt diet	0.589	0.220	0.042	1.825	1.184~2.763
Mean arterial pressure	2.374	0.365	0.017	5.354	2.935~10.054
LDL-C	1.621	0.036	0.084	1.120	0.910~1.932
HDL-C	-2.582	0.617	0.012	6.446	2.865~11.964
CRP	0. 183	0.014	0.007	2.467	1.940~2.633
NLR	2.113	0.563	0.000	4.652	1.440~13.758

between the two. This study failed to accurately group low- and high-dose alcohol intake. The next step is to proceed with prospective cohort observation studies. High-salt diets increase sodium levels in the body and raise blood pressure. Long-term blood pressure in the blood vessels can cause calcification, harden the blood vessels or stenosis, and increase stroke risk. A long-term, high-fat diet increases blood lipids and increases blood viscosity. Lipid deposition, which damages the endothelium and causes atherosclerosis, increases the risk of stroke if it occurs in the cerebral arteries. We found was no statistical differences in the high-sugar diets in the two groups. At present, there is no evidence that the long-term excessive intake of sugar and diabetes cannot be equated. At the same time, there are many causes of diabetes, some of which are related to heredity, infection, and lipids. This study explained that a high-sugar diet is indirectly associated with stroke through the initiation of diabetes, but the effect is less than smoking, a high-fat diet, of other factors. However, studies have confirmed that hyperglycemia can affect the mitochondrial electron chain transmission, resulting in oxidative stress and injury to blood vessels [17, 18].

The HDL-C, CRP, and NLR levels were statistically different between the two groups. However, the LDL-C levels had no significant differences in the two groups. The HDL-C concentration in the stroke group was higher than it was in the non-stroke group. This is different from previous studies. For example, Huang Zhonghong et al. [19] showed that the LDL-C concentration is associated with hypertension, but this may be related to the limited sample size. Inflammation can damage the vascular endothelium, and its response index CRP has clinical significance in this study. In recent years, studies [20, 21] have suggested that another inflammatory index, NLR, is associated with the prognosis of stroke. In this study, there were also differences in NLR between the two groups. The latter had higher NLR, suggesting that it is another risk factor for stroke in hypertensive patients. In addition to the above-mentioned risk factors, the study also explored the risk factors associated with hypertension. It is undeniable that hypertension is a risk factor for stroke. However, whether there are correlations between the other related indicators of hypertension has also been studied in recent years, with more studies on mean arterial pressure. Sesso et al. [22] considered that mean arterial pressure was more predictive than pulse pressure in the middle-aged population.

Hypertension patients are a special population, and stroke, as a common complication, brings huge economic and medical burdens. We should start with its risk factors, especially the risk factors associated with stroke, such as gender, smoking, high-fat diets, HDL-C, mean arterial pressure, CRP, and NLR. In terms of lifestyle, patients should quit smoking and alcohol and follow low-salt and low-fat diets to avoid long-term bad lifestyles and an increase of the risk of stroke. At the same time, the risk of stroke in hypertensive patients is also assessed by regularly monitoring HDL-C, mean arterial pressure, CRP, and NLR. The inadequacy of this research is that this study was a single-center retrospective study, and the sample size was too small.

Disclosure of conflict of interest

None.

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