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Analysis of Risk Factors for Ischemic Cerebrovascular Events by Carotid Artery Ultrasound

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Abstract: *Objective*: Analysis of risk factors for ischemic cerebrovascular events using carotid artery ultrasound. *Method*: A total of 3500 patients who underwent carotid ultrasound examination at the encephalopathy department of our hospital from March 2022 to March 2023 were selected as the study subjects. 1731 males and 1846 females; the age ranged from 20 to 95 years, with an average of 61.48 ± 12.55 years. All patients were divided into age groups under 40 years of age, 41-60 years of age, and over 60 years of age. According to carotid ultrasound results, the study subjects were divided into normal carotid ultrasound, stenosis rate<50%, and stenosis rate ≥ 50%. To observe the incidence of carotid stenosis, compare the differences in the degree of carotid stenosis among patients of different ages and diseases, and use logistic regression analysis to analyze the influencing factors of carotid artery stenosis and predict the risk of ischemic cerebrovascular events. *Result*: Of the 3500 patients, 2609 had carotid stenosis, with a detection rate of 74.54%. Among them, the carotid stenosis rate was less than 50% in 2472 cases, and the stenosis rate was ≥ 50% in 137 cases; the positive rate was 74.54%. Multivariate logistic regression analysis showed that age, diabetes, hypertension, dyslipidemia, smoking history and cerebral infarction were independent risk factors for carotid artery stenosis (P<0.05). *Conclusion*: Early carotid ultrasound screening and regular reexamination in high-risk stroke populations are necessary. Constructing a logistic regression model based on high-risk factors can predict the risk of cerebrovascular events as early as possible, providing a reliable basis for timely formulation of prevention and treatment measures in clinical practice. There are many factors influencing cerebrovascular events. Regular monitoring of blood pressure, blood sugar, and blood lipids, and determination of arterial stenosis by carotid ultrasound to predict cerebrovascular events are of great significance for the prevention and treatment of stroke high-risk populations. At the same time, attention should be paid to young people, and correctable risk factors should be identified in a timely manner for early intervention to minimize the risk of stroke in asymptomatic populations.

Keywords: Carotid Artery Stenosis, Ultrasound, Ischemic, CerebrovascularRisk Factors

1. Introduction

Cerebrovascular events are the world's most serious public health problem, with approximately 25.7 million stroke patients worldwide [1]. In 2019, the population of stroke patients aged 40 and above in China reached 17.04 million, and the overall risk of stroke incidence ranked first in the world (39.9%). As of 2018, approximately 1.94 million people died from stroke [2]. Most ischemic stroke originates from the area supplied by the internal carotid artery, when lipids in the blood accumulate and adhere to the arterial wall, it can cause the intima of the carotid artery to gradually proliferate and form plaques, occupying the arterial lumen and causing narrowing or even occlusion, resulting in hemodynamic changes. This can easily lead to ischemic diseases or plaque detachment, leading to cerebral artery embolism and inducing ischemic stroke. Therefore, carotid artery stenosis caused by carotid atherosclerosis (CAS) plaque is considered to be the main cause of ischemic cerebrovascular events. Ultrasound is one of the important methods for evaluating and diagnosing carotid artery lesions. This study aims to analyze the factors that affect the occurrence of carotid artery stenosis through carotid artery

ultrasound examination, provide reference for the screening effect of stroke prevention and treatment centers in this region, and provide scientific basis for the prevention of first stroke and recurrent stroke.

2. Materials and Methods

2.1. Clinical Data

Select 3500 patients who underwent extracranial carotid artery ultrasound screening after seeking treatment in the Department of Cerebrology at our hospital from March 2022 to March 2023. Among them, there were 1731 males and 1846 females; the age range is 20-95 years old, with an average of 61.48 ± 12.55 years old. Exclude patients with cerebrovascular disease caused by trauma, patients with tumor or acute infectious diseases, patients with serious mental illness, pregnant women and lactating women, and patients with poor compliance who cannot cooperate.

2.2. Research Method

All 3500 patients underwent carotid artery ultrasound screening using the GE Logiq E9 color Doppler ultrasound diagnostic instrument with probe frequencies of 3.5MHz, 9MHz, and 12MHz. The systolic and end diastolic flow velocities of the innominate artery, bilateral subclavian artery, common carotid artery, carotid bulb, internal carotid artery and vertebral artery were measured and recorded. When plaque was found, the residual lumen and the original lumen diameter were measured, and the proximal and distal flow velocities of the stenotic artery were measured to judge the degree of stenosis.

According to the standards released at the 2003 North American Radiology Conference [3], the carotid artery stenosis rate of patients was evaluated, which was divided into normal carotid artery ultrasound examination, stenosis rate<50%, and stenosis rate ≥ 50%. Logoistic regression was used to analyze the risk factors for the formation of carotid artery stenosis.

2.3. Statistics

Use SPSS 26.0 statistical software for data analysis. Counting data is represented by $\bar{x} \pm s$, qualitative data is represented by [n (%)], and inter group differences are tested using a 2-test. The difference was statistically significant with P<0.05. Using the indicators selected from univariate analysis as independent variables and positive carotid artery ultrasound as dependent variables, a multivariate logistic regression analysis was conducted.

3. Results

3.1. Basic Information

A total of 891 cases of normal carotid artery were screened, with a carotid artery stenosis rate of<50% in 2472 cases and a stenosis rate of ≥ 50% in 137 cases; The positive rate is 74.54%.

3.2. Title Univariate Analysis of Carotid Artery Stenosis (Table 1)

There were statistically significant differences between the patients with carotid stenosis and those with normal carotid artery in age, sex, smoking history, hypertension, diabetes, dyslipidemia, cerebral infarction, and cervical spondylosis (P<0.05).

Table 1. *Univariate analysis of carotid artery stenosis (n/%).*

Factor	Class	Normal carotid artery (n=891)	Stenosis rate<50% (n=2472)	Stenosis rate≥50% (n=137)	χ^2	*P*
Age	Under 40 years old	101/11.3	76/2.91	0/0.0		
	41-60 years old	458/51.4	1019/39.1	20/7.7	210.801	0.000
	Over 60 years old	332/37.3	1377/52.8	117/4.5		
Sex	Male	243/27.3	1346/54.4	97/70.8	223.003	0.000
	Female	648/72.7	1126/45.6	40/29.2		
Smoking history	Yes	285/31.9	1822/73.7	49/35.8	886.788	0.000
	None	606/68.0	650/26.3	88/64.2		
Hypertension	Yes	182/20.4	1834/74.2	46/33.6	819.945	0.000
	None	709/79.6	638/25.8	91/66.4		
Diabetes	Yes	124/13.9	1606/64.9	32/23.4	724.316	0.000
	None	767/86.1	866/35.0	105/76.6		
Dyslipidemia	Yes	108/12.1	766/30.9	15/10.9	138.735	0.000
	None	783/87.8	1706/69.0	122/89.1		
Cerebral infarction	Yes	81/10.2	1051/42.5	50/36.5	327.629	0.000
	None	810/90.9	1421/57.5	87/63.5		
Cervical spondylosis	Yes	339/61.2	211/38.1	4/0.7	55.322	0.000
	None	2133/72.4	680/23.1	133/4.5		

3.3. Multivariate Logoistic Regression Analysis of Carotid Artery Stenosis

Using the presence or absence of carotid artery stenosis as the dependent variable, assign values to the indicators with P<0.05 in univariate analysis (Table 2), and perform multivariate logistic regression analysis with carotid artery stenosis=1 and no carotid artery stenosis=0. The results showed that age, diabetes, hypertension, dyslipidemia, smoking history and cerebral infarction are independent risk

factors for carotid artery stenosis (P<0.05) (Table 3).

Table 2. *Single factor analysis indicators and assignment.*

Factor	Assignment Description
Age	Under 40 years old=0, 41 to 60 years old=1, over 60 years old=2
Sex	Male=0, Female=1
Smoking history	None=0, Yes=1
Hypertension	None=0, Yes=1
Diabetes	None=0, Yes=1
Dyslipidemia	None=0, Yes=1
Cerebral infarction	None=0, Yes=1
Cervical spondylosis	None=0, Yes=1

Table 3. *Univariate analyMultivariate Logoistic Regression Analysis of Carotid Stenosis.*

Influence factor	B	SE	Waldχ2	*P*	OR	95%*CI*
Age	0.817	0.065	157.381	0.000	2.263	[1.992,2.572]
Sex	-1.194	0.085	197.747	0.000	0.303	[0.257,0.358]
Smoking history	1.396	0.108	166.562	0.000	4.038	[3.267,4.992]
Hypertension	1.849	0.117	249.930	0.000	6.354	[5.053,7.992]
Diabetes	2.095	0.128	268.794	0.000	8.126	[6.326,10.439]
Dyslipidemia	1.493	0.135	122.442	0.000	4.449	[3.415,5.795]
Cerebral infarction	1.336	0.148	81.179	0.000	3.805	[2.845,5.088]
Cervical spondylosis	0.718	0.098	53.858	0.000	2.050	[1.692,2.483]

4. Discussion

Carotid artery stenosis is a disease in which the carotid artery becomes narrow or even occluded due to the progressive accumulation of plaques in the blood. Carotid artery is the main channel for blood supply to the brain. The decrease of the distal flow rate after artery stenosis leads to the decrease of the volume of intracranial arterial blood blood, which leads to focal cerebral blood supply and insufficient oxygen supply, leading to brain dysfunction and a series of symptoms. Carotid artery stenosis is closely related to the occurrence and development of ischemic stroke (ICS). 10-25% of ischemic stroke patients are caused by carotid artery stenosis [4], which is the primary disease causing death and disability in adults in China. CAS is the main cause of carotid artery stenosis, and the formation of CAS plaques leads to stenotic lesions and instability of plaques, which not only reflect the degree of intracranial artery lesions in patients, but also one of the important reasons for ICS. Therefore, early detection and diagnosis of carotid artery stenosis, risk assessment and stratification of patients, mitigation of risk factors leading to plaque rupture, and effective intervention measures have a positive window effect on preventing the occurrence of acute ischemic cerebrovascular events. The results of this study showed that there were statistically significant differences between the carotid stenosis group and the normal carotid group in terms of age, sex, diabetes, hypertension, dyslipidemia, smoking history, cerebral infarction, and cervical spondylosis (P<0.05). Multivariate Logistic regression analysis showed that age, diabetes, hypertension, dyslipidemia, smoking history and cerebral infarction were independent risk factors for carotid artery stenosis (P<0.05), indicating that independent risk factors for carotid artery stenosis mainly included the following. 1. Age: The surface of normal blood vessels is covered by highly differentiated endothelial cells. As age increases, vascular endothelial function may become disrupted, leading to a decrease in arterial flexibility and vasodilation function in the body. The structural and functional changes of arteries result in a decrease in blood flow velocity, making it easier for lipids to deposit in the arterial intima, leading to intimal thickening, plaque formation, and obstruction of blood flow, increasing the risk of arterial stenosis. Although young people suffer fewer chronic diseases than the elderly [5], the rate of diabetes and dyslipidemia among young people over 40 years of age is also increasing year by year. Bad living habits and psychological and mental factors are more common among young people [6], and with the increase of age, the proportion of large atherosclerosis and small vessel occlusion increases, while young stroke patients have poor timeliness of medical treatment, and the trend of young people at high risk of stroke is obvious. 2. diabetes: microvascular dysfunction is a common phenomenon in diabetes patients, including the impact on the brain [7]. Prolonged increase in blood sugar can alter plasma viscosity, increase red blood cell fragility, and easily lead to platelet dysfunction, non-enzymatic glycosylation of structural proteins in blood vessel walls, leading to endometrial damage; High blood sugar also leads to an increase in coagulation factors, which are stimulated by inflammation to promote the secretion of various cytokines in the body, leading to and exacerbating insulin resistance and abnormal lipid metabolism, promoting the formation and development of AS. 3. Hypertension: hypertension and dyslipidemia have been proved to be independent predictors of many cardiovascular and cerebrovascular events [8, 9]. Long term hypertension causes proliferation and fibrosis of smooth muscle cells in the middle layer of small arteries in the whole body, tube wall thickening and lumen stenosis, and

accompanying risk factors lead to ischemia of internal and external arteries, promoting the formation and development of atherosclerosis. In 2020, the prevalence rate of hypertension among people under 40 years of age in China will reach 8.9%～13.4% [10], and more than half of the adult residents' blood pressure will be in a normal height state. 4. Abnormal blood lipids: when the cholesterol content in the blood is too high, low-density lipoprotein enters the tunica intima, the endothelial cells of the arteries are damaged, platelets adhere and gather, and the hemodynamics changes. The lipid deposition on the vessel wall will gradually form atherosclerotic plaque, and in serious cases, the blood flow is blocked, forming thrombus. 5. Smoking: closely related to carotid artery plaques [11]. In 2018, Braillon [12] pointed out in the European Journal of neurology that smoking is the cause of ischemic cerebrovascular events, not a risk factor. Tobacco enters the human body through mucosal absorption, directly or indirectly invading the cell membrane. When harmful free radical clearance is disrupted, oxidative stress reaction products are produced, leading to endothelial dysfunction and inflammation, accelerating vascular aging, affecting cholesterol metabolism levels and plaque stability. Smoking not only directly damages body function through inflammatory reactions, but also interacts with other risk factors, accelerating the pathological process of CAS and increasing the risk of ischemic cerebrovascular events. Nearly one-fifth of the population aged 15 and above worldwide smoke [1], with over 300 million in China. The level of stroke deaths caused by smoking among residents increases with age, and males are higher than females [13]. The health damage caused by smoking only occurs for 10-20 years or even longer, so smokers often do not recognize the dangers of smoking in the short term. 6. History of cerebral infarction: for a period of time after the occurrence of cerebral infarction, the reactivity of inflammatory substances and coagulation factors in the blood increased and maintained at a high level, and the internal and external intracranial arteries were more prone to atherosclerosis and thrombosis, leading to an increase in the incidence of carotid stenosis. In stroke patients, several risk factors often coexist and interact with each other. Therefore, Furie [14] in the United States calls for stroke prevention to start with young people, changing their lifestyle and dietary structure, and providing treatment for risk factors, which is crucial for maintaining brain health throughout the entire life cycle.

5. Conclusion

The limitation of this study is that there are relatively few cases with a carotid artery stenosis rate of ≥ 50%, the sample size is limited, and the population with a carotid artery stenosis rate of ≥ 50% in each age group has not been subdivided. In the future, more cases with a carotid artery stenosis rate of ≥ 50% need to undergo detailed research to confirm the results of this study, while collecting high-risk signs of plaques to more accurately determine the factors affecting cerebrovascular events. Although the majority of cases in this study have a stenosis rate of<50%, many carotid artery plaques with low stenosis levels have high-risk features, which can also increase the occurrence of ischemic cerebrovascular events [15]. In the 2019 Healthy China Action, emphasis was placed on measuring basic blood pressure for people over 35 years old at their first visit, standardizing the management of hypertension, hyperglycemia, and dyslipidemia, while expanding the scope and depth of scientific popularization of cerebrovascular diseases, changing attitudes, and reducing the incidence of cerebrovascular events in young people [2].

To sum up, the elderly, diabetes, hypertension, dyslipidemia, smoking history and cerebral infarction are independent risk factors for carotid artery stenosis and cerebrovascular events, which can be used as high-risk population for carotid artery ultrasound screening. Therefore, it is of great significance to regularly monitor and determine the degree of carotid artery stenosis and plaque characteristics through carotid ultrasound to predict cerebrovascular events, minimize the risk of stroke in asymptomatic populations, gradually build a comprehensive regional stroke intervention system, and form a long-term mechanism for stroke health management.

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