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THE BENEFITS OF DUPLEX SCANNING OF EXTRACRANIAL CAROTID PATHOLOGIES FOR RISK STRATIFICATION OF ISCHEMIC STROKE

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ABSTRACT

Introduction: Recent retrospective cohort study demonstrated the benefit of duplex scanning in the examination of the extracranial carotid artery pathologies for preventing cerebrovascular disorders.

The aim of this study: was to evaluate the clinical and demographical characteristics and outcome in patients treated at National Scientific Center of Surgery, after detecting extracranial carotid artery stenosis $\geq 70\%$.

Material and methods: A retrospective cohort study was conducted; 204 patients were included.

Results: The most significant risk factors were: ischemic heart diseases – 95.6%, arterial hypertension – 80.1%, chronic heart failure – 83.8%, cholesterol level above the norm of 5.2 mmol/L-39.2%; 30.4% of patients had a history of postinfarction atherosclerosis. There were a significant statistically difference between the prevalence of extracranial carotid artery stenosis depending on the risk factors (blood cholesterol levels, a clinical history of chronic heart failure, and acute cerebrovascular diseases $p=0.048$, $p=0.003$, $p=0.048$ respectively ($p>0.05$)).

Conclusion: In summary, we conclude that surgery should be considered, and duplex ultrasound plays a crucial role in assessing the severity of carotid stenosis in atherothrombotic stroke patients with severe external carotid stenosis. These data indicate that physicians, should be aware of the usefulness of carotid duplex ultrasound scanning in stratifying the risk of cerebral and cardiovascular diseases based on various aspects.

Keywords: extracranial carotid artery, ischemic stroke, acute disorders, cerebral circulation, carotid artery stenosis.

INTRODUCTION

Acute ischemic stroke is one of the most common causes of death and disability worldwide. The high prevalence of mortality and severe disability of the population as a result of ischemic

stroke have become a common heavy medical and social burden [Tsao C et al., 2023]. According to the World Health Organization, over the past 16 years, stroke has been the second leading cause of

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death in the world, after coronary heart disease [Giroud M et al., 2014; Feigin, V et al., 2014; 2015; 2017; 2022; Sejvar J, 2017; Krishnamurthi R et al., 2020; Tsao C et al., 2022]. According to the official data of the Ministry of Health of the Republic of Kazakhstan, the overall incidence of the population cardiovascular diseases registered in medical and preventive organizations has increased almost three times over the past 20 years from 5891.3 cases per 100 thousand people from 1998 to 16360.6 in 2017 [Akhmetzhanova Z et al., 2019]. Ischemic stroke remains the most frequent causes of death in 2019, followed by chronic obstructive pulmonary disease. Stroke imposes special obligations on family members of the patient and lays a heavy social and economic burden on society [Zhakhina G et al., 2022].

The Global Stroke Factsheet released in 2022 reveals that lifetime risk of developing a stroke has increased by 50% over the last 17 years and now 1 in 4 people is estimated to have a stroke in their lifetime. From 1990 to 2019, there has been a 70% increase in stroke incidence, 43% increase in deaths due to stroke, 102% increase in stroke prevalence and 143% increase in Disability Adjusted Life Years [Feigin V et al., 2017; 2021; Zheng B et al., 2023]. The most striking feature is that the bulk of the global stroke burden (86% of deaths due to stroke and 89% of Disability Adjusted Life Years) occur in lower and lower-middle-income countries [Pandian J, Sebastian I, 2021; Feigin V et al., 2022]. This disproportionate burden experienced by lower and lower-middle income countries has posed an unprecedented problem to families with less resources.

Stroke is considered a disease that can develop as a result of long-term exposure to lifestyle-related risk factors. Over the past quarter of a century, significant efforts have been made in a number of countries to reduce the mortality of population from non-communicable diseases, which ultimately made it possible to significantly affect overall mortality from them. However, the problem of the demographic and economic burden of non-communicable diseases, including stroke, remains very relevant for most countries. The main issue and real challenge for many states has become the unresolved problem with risk factors, the rapidly growing prevalence of obesity, which is a

main cause of arterial hypertension, diabetes mellitus, and their disabling and fatal complications, such as stroke.

Among all strokes, 87% are ischemic strokes. Moreover, 95% of ischemic strokes and transient ischemic attacks are associated with embolic complications from plaques localized in the extracranial parts of the arterial system [Faiz K et al., 2019; Tsao C et al., 2023]. It should also be emphasized from our research, that only 15% of stroke patients had a history of the presence of neurological symptoms in the form of transient ischemic attacks. In recent years, the frequency of ischemic strokes has become 2-3 times higher than the number of heart attack.

According to the World Health Organization, the risk factors associated with stroke can be summarized in four categories [Goyal K et al., 2022; Gandolfo C et al., 2022]:

1. The main modified risk factors (high blood pressure, diabetes mellitus, high cholesterol, low physical activity, obesity, smoking, atrial fibrillation and other heart diseases).
2. Other modified risk factors (social status, psychiatric disorders, chronic stress, alcohol abuse, drug use, certain medications)
3. Unmodified risk factors (age, heredity, nationality, race, gender).
4. "New" risk factor (hyperhomocysteinemia, vasculitis, violation of blood clotting system).

Extracranial carotid stenosis is a treatable cause of ischemic stroke and can be diagnosed by using ultrasonography [Yinn C et al., 2015; Bains N et al., 2023]. Extracranial carotid atherosclerosis is the third leading cause of ischemic stroke in the general population [Fisher M et al., 2005].

According to the Framingham Heart Study and the Cardiovascular Health Study, the prevalence of >50% carotid stenosis is approximately 9% in men and 6-7% in women [Mahmood S et al., 2014; Tsao C, Vasan R, 2015]. More than 5% of persons over 65 years of age have extracranial stenosis of the carotid arteries of 50% or more [Roger V et al., 2011].

Thus, timely diagnosis for choosing a method for the treatment of extracranial carotid stenosis is a preventive intervention that prevents the risk of developing primary and recurrent strokes, deaths and disability associated with a stroke. Screening for carotid stenosis by ultrasound is important not

only for the daily clinical setting, but also for the management of patients with acute ischemic stroke. Screening for carotid stenosis is important, and whether routine carotid ultrasound is recommended in the general population for the prevention of ischemic stroke remains controversial.

MATERIALS AND METHODS

This was a non-randomized, observational study of retrospectively collected data from the Registry the of JSC National Scientific Center of Surgery named after A.N. Syzganov, Almaty Kazakhstan. The study included 204 patients who underwent a surgical treatment with “Atherosclerosis. Takayasu syndrome” diagnosis in the Department of Vascular Surgery from January 2017 to May 2023. Patients who had an extracranial ICA stenosis of $\geq 70\%$ verified by duplex ultrasound examination or occlusion of presumed atherosclerotic origin, were included.

The volume of clinical measures corresponded to current standards of medical care and clinical recommendations.

Upon admission, all patients underwent a detailed clinical history, physical examination, general clinical and biochemical blood tests.

Statistical analysis was performed using Stat-Tech v. 3.1.7 (Developer - StatTech LLC, Russia). Quantitative variables were assessed for normality using the Kolmogorov-Smirnov test. Quantitative variables following a normal distribution were described using mean (M) and standard deviation (SD), 95% confidence interval (95% CI) for the mean were estimated.

Quantitative variables following non normal distribution were described using median (Me) and lower and upper quartiles (Q1 – Q3). Categorical data were described with absolute and relative frequencies. The reliability of differences between two independent groups was determined using the Mann-Whitney U test for quantitative variables and using the Pearson’s χ^2 test or Fisher’s exact test for qualitative variables. The level of statistical significance is determined at the level of $p < 0.05$.

RESULTS AND DISCUSSION

Among the 204 patients, the average age was ranged from 48 to 85 (67 – 73 95% CI / Q1 – Q3), 69.6 ± 6.65 years respectively, 20,1% (41 people)

were women, 79,9 (163 people) (Table 1).

The most significant risk factors were: ischemic heart diseases – 95.6, arterial hypertension – 80.1%, Chronic heart failure – 83.8%, cholesterol level above the norm of 5.2 mmol/L-39.2%; 30.4% of patients had a history of postinfarction atherosclerosis.

In order to reveal the relationship between the clinical characteristics of patients and the development of stenosis, we conducted an analysis of risk factors (Table 2).

When analyzing the prevalence of extracranial stenosis of the carotid artery depending on the risk factors, a statistically significant difference was noted: blood cholesterol levels, a clinical history of chronic heart failure, and acute cerebrovascular diseases ($p=0.048$, $p=0.003$, $p=0.048$ respectively).

We analyzed the 5-year survival rate after treatment. The mortality rate was 20% (42 patients). We further analyzed the main factors that could affect mortality. There was no statistically significant difference among patients depending on gender and age. If we consider the effect of concomi-

TABLE 1

Clinical characteristics of patients			
Variables	Categories	Abs.	%
Gender	female	41	20.1
	male	163	79.9
Ischemic heart diseases	IHD+	195	95.6
	IHD-	9	4.4
Cardiosclerosis	cardiosclerosis +	62	30.4
	cardiosclerosis -	142	69.6
Chronic heart failure	CHF+	171	83.8
	CHF-	33	16.2
Encephalopathy	ENC+	50	24.5
	ENC-	154	75.5
Acute cerebrovascular disorders	ACVD+	45	22.1
	ACVD-	159	77.9
Transient ischemic attacks	TIA+	5	2.5
	TIA-	199	97.5
Diabetes mellitus	D+	45	22.1
	D-	159	77.9
Hypertension	1 degree	57	27.9
	2 degree	2	1.0
	3 degree	145	71.1
Smoking	smoking+	76	37.3
	smoking-	128	62.7
Alcohol	Alcohol+	2	0.6
	Alcohol-	309	99.4
Cholesterol level	5.2 mmol/L	124	60.8
	up to 5.2 mmol/L	80	39.2

TABLE 2

The relationship between the clinical characteristics of patients and the development of stenosis

Predictor	Estimate	SE	Z	p value
Ischemic heart diseases	1.24301	0.9862	1.6038	0.208
Postinfarction atherosclerosis	0.01884	0.4360	0.04320	0.966
Chronic heart failure	-1.74092	0.5940	-2.93102	0.003
Encephalopathy	0.14376	0.4527	0.31756	0.751
Atherosclerotic cardiovascular disease	-0.91809	0.5543	-1.65639	0.048
Transient ischemic attacks	-16.11290	1001.8002	-0.01608	0.987
Diabetes mellitus	-0.67527	0.5134	-1.31526	0.188
Carotid murmur:	-0.35258	0.4662	-0.75632	0.449
Smoking	-0.10934	0.4075	-0.26833	0.788
Alcohol:	-15.70716	2399.5448	-0.00655	0.995
Cholesterol	-0.91809	0.5543	-1.65639	0.048

NOTES: Binomial Logistic Regression, p value <0.05

tant cardiovascular diseases on the mortality of this category of patients, then a statistically significant relationship was found for severe chronic heart failure (OR 5.25, 95% CI: 1.21-22.7, p=0.016), the presence of Acute cerebrovascular disorders (OR 3.42, 95 % CI: 1.33-8.84, p=0.03). The presence of a history of heart attack also did not affect the mortality of patients with extracranial carotid artery stenosis. (OR 0.78, 95% CI: 0.49-1.25, p=0.36 and OR 1.62, 95% CI: 0.99-2.67, p=0.08, respectively).

The dependences obtained are presumably related to the fact that the above conditions significantly aggravate the severity of patients. At the same time, hypertension, coronary artery disease

in history did not affect mortality.

CONCLUSION

In conclusion, this population based retrospective cohort study suggests considering surgery for atherothrombotic stroke patients with severe internal carotid stenosis. Additionally, the use of duplex ultrasound plays crucial role in assessing the severity of carotid stenosis. Physicians should be aware of the usefulness of carotid ultrasound in stratifying the risk of cerebral and cardiovascular diseases based on various aspects. In addition, visual assessment or dynamic changes with carotid ultrasound can provide different and valuable insights in outpatient settings.

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