ORIGINAL RESEARCH

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Evaluation of Laboratory Findings for Treating Acute Ischemic Stroke

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Abstract

Objective: Acute ischemic stroke is an emergency clinical condition resulting from occlusion of intracranial arteries leading to neural tissue destruction. In this study, we evaluated whether lactate levels and monocyte/high-density lipoprotein (HDL) ratio can be used as a marker in predicting treatment outcomes in patients who underwent intravenous thrombolysis (IVT) or mechanical thrombectomy (MT) after IVT.

Materials and Methods: In this retrospective study, demographic data, clinical status, radiological results, laboratory data, the National Institutes of Health Stroke Scale (NIHSS) scores on admission and after treatment, and clinical data of patients who were diagnosed with acute ischemic stroke and underwent IVT or IVT + MT between January 01, 2019 and December 31, 2019 in the Emergency Medicine Clinic of University of Health Sciences Turkey, Şişli Hamidiye Etfal Training and Research Hospital were evaluated. The vessels of the patients causing ischemic pathology were evaluated and divided into three groups as middle cerebral artery (MCA), posterior cerebral artery (PCA), and anterior cerebral artery (ACA). The distribution of quantitative data was evaluated using the Kolmogorov-Smirnov test. The Kruskal-Wallis and Mann-Whitney U tests was used to compare independent quantitative data between groups.

Results: A total of 189 cases (male: 57.7%) with a mean age of 69.5±12.9 years were included in our study. Monocytes/HDL and lactate levels were similar between the MCA, PCA, and ACA groups. The total cholesterol/HDL ratio was found to be significantly higher in the PCA group than in the MCA group ($p<0.05$). There was a significant decrease in the NIHSS scores of the patients after treatment compared with the scores at the time of admission ($p<0.05$). No significant differences between the groups were observed with regard to the changes in NIHSS scores.

Conclusion: It was shown that monocyte/HDL ratio and lactate levels were not significant in predicting the success of treatment and neurological improvement in patients with acute ischemic stroke.

Keywords: Monocyte/HDL ratio, lactate, ischemic stroke

Introduction

Stroke is defined as regardless of a cause other than a vascular cause, a sudden onset clinical condition that causes focal or global cerebral dysfunction, lasting 24 h or longer, and may cause death. It is the second most common cause of mortality after cardiovascular diseases and the primary cause of disability and loss of job. Its etiology consists of two types of strokes as ischemic (85%) and hemorrhagic (15%) [1-3]. Risk factors that cannot be altered for stroke are age, gender and genetic factors, while hypertension, diabetes, atherosclerosis, obesity, smoking, and alcohol use are among modifiable risk factors. Prevention and reduction of modifiable risk factors are critical in alleviating the stroke incidence [4-6].

Monocytes and lipid-laden macrophages formed by monocyte activation play an important role in the synthesis and release of proinflammatory and prooxidant cytokines. Monocytes, constituting 3-8% of leukocytes in peripheral blood, have important roles in controlling inflammatory processes [4-7]. High-density lipoprotein (HDL) cholesterol is been shown to be antithrombotic, anti-inflammatory, antioxidant, and inhibit the oxidation of low-density lipoprotein (LDL) cholesterol. Recent studies have suggested that the monocyte/HDL ratio (MHR)

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may be a unique marker of inflammation and oxidative stress. With this aspect, it can be used as a criterion that is calculated easily showing the presence and prognosis of inflammatory and inflammation-related diseases. Studies have shown that increased lactate, which is a marker of tissue hypoperfusion, may also have a role in stroke prognosis [7-10]. Therefore, in our study, we investigated the effects of lactate levels and MHR on mortality and stroke treatment.

Materials and Methods

Patients and Study Design

This retrospective study was conducted in the University of Health Sciences Turkey, Şişli Hamidiye Etfal Training and Research Hospital Emergency Medicine Clinic between January 01, 2019 and December 31, 2019 (University of Health Sciences Turkey, Şişli Hamidiye Etfal Training and Research Hospital Ethic Committee approval date: 30.06.2020, no: 1560). Patients who were treated with intravenous thrombolytic administration or thrombolytic + thrombectomy treatment in the emergency department with the diagnosis of acute cerebrovascular disease were included in the study. Demographic data, clinical features, radiological results, laboratory data, and National Institutes of Health Stroke Scale (NIHSS) scores of the patients were recorded at admission and after treatment. The patients who were admitted to the emergency department due to ischemic cerebrovascular disease without thrombolytic indication, patients who underwent thrombectomy only, those with hemorrhagic cerebrovascular disease, patients referred to an external center, patients who do not accept thrombolytic therapy, and patients who died after treatment were excluded from the study. All patients between the ages of 18-99 who were not excluded with the above reasons and who underwent thrombectomy and thrombolytic therapy together were included. NIHSS scores at admission to the emergency department and NIHSS scores after treatment were calculated and recorded.

Statistical Analysis

In the statistical analysis, IBM SPSS 22.0 (Armonk, New York) software was used. Mean, standard deviation, median, maximum, minimum, frequency, and ratio values were used in descriptive statistics of the numeric data. The distribution of numeric variables was evaluated using the Kolmogorov-Smirnov test. Kruskal-Wallis and Mann-Whitney U tests was used to compare the independent quantitative data between the groups. For the analysis of independent qualitative data, the chi-square test was used. Fischer's exact test was used when chi-square test conditions were not met. In cases where the p value was less than 0.05 in a 95% confidence interval, the results of statistical analysis were considered as significant.

Results

Our study included 189 patients with a mean age of 69.5±12.9 years and 57.7% of them were male. Of all patients, 88.4% of them had comorbidities. Lactate levels were 1.75±1.18 and MHR was 0.02±0.01 at the time of admission to the emergency department. The NIHSS scores at admission were 11.4±5.3, and post-treatment NIHSS scores were 7.52±5.03 (Table 1).

The patients were divided into groups according to the occluded intracranial artery causing ischemia. There was no

Table 1. Demographic data and laboratory findings of the patients

		Minimum-maximum	Median	Mean ± SD/n-%
Age (years)		30-96	70	69.5±12.9
Gender	Female			80-42.3
	Male			109-57.7
Comorbidity	(-)			22-11.6
	(+)			167-88.4
Monocyte/HDL		0.00-0.16	0.01	0.02±0.01
Lactate		0.60-9.70	1.40	1.75±1.18
NLR		0.60-23.00	2.53	3.54±3.05
Cholesterol		101.0-352.0	200.0	202.7±48.8
Non-HDL cholesterol		45.0-303.0	159.0	160.7±46.4
Total cholesterol/HDL		1.80-9.07	4.82	4.95±1.23
NIHSS at admission		1.0-22.0	11.0	11.4±5.3
NIHSS after treatment		0.00-22.00	7.00	7.52±5.03
NIHSS change		-18.0-12.0	-3.0	3.9±4.5

Statistical analysis: chi-square test, HDL: High-density lipoprotein, NIHSS: National Institutes of Health Stroke Scale, SD: Standard deviation, NLR: Neutrophil-to-lymphocyte ratio

significant difference between the anterior cerebral artery (ACA), middle cerebral artery (MCA), and posterior cerebral artery (PCA) groups in terms of patients' age, gender, and the distribution of comorbidities (p>0.05). Cholesterol, triglyceride, LDL, HDL, non-HDL, lactate and monocyte levels and neutrophil-to-lymphocyte ratio (NLR) and MHR did not differ significantly between the MCA, ACA, and PCA groups (p>0.05). The total cholesterol/HDL ratio was significantly higher in the PCA group than the MCA group (p<0.05). The total cholesterol/HDL ratio in the ACA group did not differ significantly from the MCA and PCA groups (p>0.05) (Table 2).

NIHSS scores at admission and after treatment differed significantly between the MCA, ACA, and PCA groups (p<0.05). However, there was no significant difference between the groups in terms of changes in the NIHSS scores at admission and after treatment (p>0.05) (Table 3).

There were no significant associations in terms of NIHSS score at admission, after treatment, change in NIHSS scores, and laboratory parameters (Table 4).

Discussion

Increased age is among the risk factors that cannot be change in stroke etiopathogenesis, and the stroke incidence increases with age. The annual incidence of stroke was 1.3-3.6/1.000 in the 55-64 age group, 4.9-8.9/1.000 in the 65-74 age group, and

Table 2. Demographic data and laboratory findings according to the occluded cerebral artery

			MCA	ACA	PCA	p
Age	Mean ± SD		70.7±12.5	68.3±12.2	65.3±15.1	0.128[A]
	Median		70.5	68.0	70.0	
Gender	Female	n%	60-46.2	11-33.3	9-34.6	0.286[X²]
	Male	n%	70-53.8	22-66.7	17-65.4	
Comorbidity	(-)	n%	13-10.0	3-9.1	6-23.1	0.146[X²]
	(+)	n%	117-90.0	30-90.9	20-76.9	
Monocyte/HDL	Mean ± SD		0.0±0.0	0.0±0.0	0.0±0.0	0.466[K]
	Median		0.0	0.0	0.0	
Lactate	Mean ± SD		1.7±1.0	1.8±0.8	2.0±2.2	0.318[K]
	Median		1.4	1.6	1.4	
NLR	Mean ± SD		3.7±3.3	3.3±2.6	2.9±1.8	0.082[K]
	Median		2.5	2.7	2.1	
Cholesterol	Mean ± SD		199.2±48.4	208.7±47.7	212.5±51.8	0.217[A]
	Median		195.2	212.0	225.5	
Non-HDL cholesterol	Mean ± SD		156.6±46.6	166.4±43.3	173.7±47.7	0.125
	Median		152.5	165.0	180.0	
Total cholesterol/HDL	Mean ± SD		4.8±1.3	5.0±1.0	5.5±1.0	**0.039**[A]
	Median		4.7	4.9	5.4	

[A]: One-Way ANOVA, [K]: Kruskal-Wallis test (Mann-Whitney U test), [X²]: Chi-square test, MCA: Middle cerebral artery, ACA: Anterior cerebral artery, PCA: Posterior cerebral artery, HDL: High-density lipoprotein, NLR: Neutrophil-to-lymphocyte ratio, SD: Standard deviation

Table 3. Evaluation of the NIHSS score according to the occluded cerebral artery

		MCA	ACA	PCA	p
NIHSS at admission	Mean ± SD	11.3±5.3	11.9±6.0	11.0±4.9	0.854[K]
	Median	10.0	11.0	10.5	
NIHSS after treatment	Mean ± SD	7.4±5.0	8.1±5.0	7.2±5.5	0.574[K]
	Median	7.0	7.0	5.0	
NIHSS change	Mean ± SD	-3.9±4.6	-3.8±4.5	-3.7±3.7	0.898[K]
	Median	-3.0	-3.0	-3.5	
Intragroup change p		**0.000**[W]	**0.000**[W]	**0.000**[W]	

[K]: Kruskal-Wallis test, [W]: Wilcoxon test, MCA: Middle cerebral artery, ACA: Anterior cerebral artery, PCA: Posterior cerebral artery, NIHSS: National Institutes of Health Stroke Scale, SD: Standard deviation

Table 4. Evaluation of laboratory findings according to the NIHSS

	NIHSS at admission		NIHSS after treatment		NIHSS change	
	r	p	r	p	r	p
Monocyte/HDL	0.009	0.903	0.042	0.565	0.007	0.922
Lactate	0.091	0.214	0.124	0.089	-0.020	0.780
NLR	0.037	0.613	0.014	0.853	-0.033	0.650
Cholesterol	-0.037	0.610	-0.053	0.469	-0.014	0.850
Non-HDL cholesterol	-0.042	0.566	-0.056	0.447	-0.013	0.856
Total cholesterol/HDL	-0.053	0.466	-0.054	0.461	-0.004	0.961

Spearman correlation, NIHSS: National Institutes of Health Stroke Scale, HDL: High-density lipoprotein, NLR: Neutrophil-to-lymphocyte ratio

13.5-17.9/1.000 in the >75 age group. It has been reported that approximately 70% of stroke patients are over the age of 65 [11]. Boğdaycıoğlu [12] reported the mean age of stroke patients as 71.5±12 years. In our study, the mean age of the patients was found to be 69.5±12.9, which is consistent with other studies.

Gender is one of the important factors in the etiology of stroke, and the rate of male stroke patients is higher than female patients in the literature [13,14]. Gender, which is one of the unchangeable risk factors, was higher in males in our study, in line with the literature.

Stroke patients are often elderly patients, and the rate of comorbidity increases with age. In our study, the most common comorbidities were hypertension, diabetes mellitus, and ischemic heart disease, respectively. There was no significant difference between the ischemic vessel in terms of comorbidity. In the study by Boğdaycıoğlu [12], the rate of comorbidity was found to be 76.3%. In our study, the rate of comorbid disease was 88.4%, consistent with the literature. In our study, different than the literature, MHR values were low and there was no significant difference between the groups, whereas the MHR was 0.67±0.59 in stroke patients. In addition, when we evaluated the NLR values, there was no significant difference in terms of ischemic vessels.

In the study of Jo et al. [15], increased lactate levels were reported as an independent risk factor for poor clinical outcome and are associated with increased mortality. There are various studies in which lactate levels are associated with mortality. In our study, it was shown that lactate levels were not different in terms of vascular pathologies and were not associated with poor outcome. In the study by Boğdaycıoğlu [12], the total cholesterol/HDL ratio was found to be 5.22±1.59, and it was concluded that the total cholesterol/HDL-C ratio in females was associated with ischemic stroke. In the study of Zhang et al. [16], low HDL and high total cholesterol/HDL ratio were associated with the risk of ischemic stroke. In our study, where we focused on the effect of occluded artery on ischemia, the total cholesterol/HDL ratio in the PCA group was significantly higher than that in the MCA group, but the total cholesterol/HDL ratio was not in the ACA group. It is different from the MCA and PCA groups.

It was concluded that high cholesterol ratios were associated with ischemic stroke, but cholesterol/HDL ratio was not significantly associated with vessels with ischemic pathology. When cholesterol, non-HDL cholesterol, and triglyceride levels were evaluated in terms of vessels causing ischemic pathology, no significant difference was found.

In the study by Ülker et al. [17], it was shown that the NIHSS score at admission to hospital is an important marker in determining the early prognosis. In our study, when the NIHSS scores at hospitalization were compared with the NIHSS scores after treatment, a significant decrease was observed on discharge. The efficacy of thrombolytic therapy was demonstrated in accordance with the literature. No relationships between NIHSS scores on admission and post-treatment scores and monocyte levels, HDL levels, monocyte/HDL levels, lactate levels, neutrophil levels, lymphocyte levels, NLR value, cholesterol levels, non-HDL cholesterol levels, total cholesterol/ HDL value, triglyceride levels, and LDL levels. It can be concluded that laboratory parameters do not affect the outcome of the treatment applied

Conclusion

Monocyte/HDL ratio and lactate levels have no effect on prognosis in patients with ischemic stroke patients.

Ethics

Ethics Committee Approval: University of Health Sciences Turkey, Şişli Hamidiye Etfal Training and Research Hospital Ethic Committee approval date: 30.06.2020, no: 1560.

Informed Consent: Retrospective study.

Peer-review: Externally peer-reviewed.

Authorship Contributions

Surgical and Medical Practices: D.K., D.Ö., E.A., Concept: D.K., D.Ö., A.M., E.A., Design: D.K., A.M., E.U., E.A., Data Collection or Processing: D.K., A.M., E.U., E.A., Analysis or Interpretation: D.K., A.M., E.U., E.A., Literature Search: D.K., E.U., E.A., Writing: D.K., D.Ö., E.A.

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