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ORIGINAL ARTICLE

Radiological Imaging and Analysis of Laboratory Values in Case of Acute Ischemic Stroke

Akut İskemik İnme Vakalarında Radyolojik Görüntüleme ve Laboratuvar Değerlerinin Analizi

[1]Mustafa Alpaslan, [2]Necmi Baykan

[1]Nevşehir Devlet Hastanesi, Acil Tıp Kliniği
[2]Sağlık Bilimleri Üniversitesi, Kayseri Sağlık Uygulama Ve Araştırma Merkezi, Acil Tıp Anabilim Dalı

Correspondence

Mustafa Alpaslan, Nevşehir Devlet Hastanesi, Acil Tıp Kliniği

E-Mail: mustafalpaslan@gmail.com

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ABSTRACT

Aim: The rate of death and disability due to acute ischemic stroke ranks second in the world. In this study it was planned to analyze the demographic characteristics and additional diseases in the etiology as well as radiological imaging and laboratory values in patients with ischemic stroke.
Material Method: This study was conducted retrospectively by analyzing the patients hospitalized in the emergency department with the diagnosis of ischemic stroke between 01.01.2022 and 31.12.2022. Routine laboratory values, lipids, vitamin levels, radiological imaging and tests for etiology were analyzed in the patients.
Results: One hundred seventy-seven patients were analyzed in the study. 53.1% of the patients were male. The mean age was 75±12.75 years. The most common comorbidities were hypertension, diabetes and hyperlipidemia. As ischemic infarction, involvement was most common in the areas fed by the middle cerebral artery. In the carotid and/or vertebral doppler ultrasonography performed in the patients, plaque was observed in the vessels at a rate of 83.1%. According to the transthoracic echocardiographic findings, 79.3% of the patients were found to have heart valve pathology. Pathologically the majority of patients had hyperglycemia, vitamin D deficiency and low HDL cholesterol levels. Thrombolytic therapy was applied in six patients and three patients benefited and one patient died due to bleeding. 13.6% of the patients were treated in the intensive care unit.
Conclusion: The risk of ischemic stroke increases in advanced age. Hypertension and diabetes are among the most important risk factors. Vitamin D and vitamin B12 deficiency and folic acid deficiency pose a risk in terms of atherosclerosis. At the same time, low HDL cholesterol levels increase the risk of stroke. These factors which are considered as preventable causes in etiology should be controlled with treatment.

Keywords: Emergency department, Acute ischemic stroke, Cerebrovascular disease

ÖZ

Amaç: Akut iskemik inmeye bağlı ölüm ve sakatlık oranı dünyada ikinci sırada yer almaktadır. Bu çalışmada, iskemik inme geçiren hastalarda demografik özellikler ve etiyolojide yer alan ek hastalıklar ile yapılan radyolojik görüntüleme ve laboratuvar değerlerinin analizinin yapılması planlandı.
Materyal Metod: Bu çalışma retrospektif olarak 01.01.2022-31.12.2022 tarihleri arasında acil servisten iskemik inme teşhisi ile hastaneye yatırılan hastaların analizi ile yapılmıştır. Hastalarda rutin laboratuvar değerleri, lipitler, vitamin düzeyleri, radyolojik görüntülemeler ve etiyolojiye yönelik testler analiz edilmiştir.
Bulgular: Çalışmada 177 hasta analiz edildi. Hastaların %53,1'i erkekti. Yaş ortalaması 75±12,75 oldu. Ek hastalık olarak en sık hipertansiyon, diyabet ve hiperlipidemi olduğu görüldü. İskemik infarkt olarak en sık orta serebral arterin beslediği alanlarda tutulum görüldü. Hastalarda yapılan karotis ve/veya vertebral doppler ultrasonografide damarlarda %83,1 oranında plak olduğu görüldü. Transtorasik ekokardiyografi bulgularına göre hastaların %79,3'ünde kalp kapak patolojisi olduğu saptandı. Hastalarda patolojik olarak çoğunlukta hiperglisemi, D vitamini eksikliği ve HDL kolesterol seviyesinde düşüklük olduğu gözlendi. Altı hastada trombolitik tedavi uygulandı ve üç hasta fayda görürken bir hasta kanama gelişerek öldü. Hastaların %13,6'sı yoğun bakımda tedavi edildi.
Sonuç: İskemik inme görülme riski ileri yaşlarda artmaktadır. Hipertansiyon ve diyabet en önemli risk faktörlerindendir. Vitamin D ve vitamin B12 eksikliği ile folik asit eksikliği ateroskleroz açısından risk arz etmektedir. Aynı zamanda düşük HDL kolesterol düzeyi de inme riskini artırmaktadır. Etiyolojide önlenebilir nedenler olarak değerlendirilen bu faktörler tedavi ile kontrol altına alınmalıdır.

Anahtar Kelimeler: Acil servis, Akut iskemik inme, Serebrovasküler hastalık

Introduction

Stroke is a disease that occurs after focal loss of function in the brain and generally develops due to vascular causes (1,2). The lifetime risk of stroke is 25% in adults over the age of 25 (3). The second most common cause of disability and death in the world is stroke (4). Although the symptoms last longer than 24 hours, partial or complete recovery can be seen over time, while on the other hand, they can also result in disability and death. The clinic usually develops suddenly and is related to vascular pathologies (1,2). Strokes are divided into hemorrhagic and ischemic. The rate of ischemic stroke is higher than 87% (1,2,5). The most common causes in etiology are atherothrombotic and cardioembolic causes. Fat and plaques accumulating in the vascular tissue cause clot formation and cause atherothrombotic-induced ischemic stroke (2). Infarct

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Complaints: geneltip@selcuk.edu.tr

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due to embolism occurs as a result of occlusion of the vessel by embolism in a distal area in the collateral arterial structure. The heart and proximal arteries may be sources of embolism (6). In some patients, ischemic stroke may develop due to vascular tissue disorders, coagulation disorders and disorders of hemoglobin tissue (7). In cases where adequate nutrition cannot be provided due to the deterioration of blood flow in the brain tissue, permanent damage begins to develop rapidly. The brain cannot be adequately nourished due to a complete or partial decrease in blood flow. Perfusion in the brain may also decrease in conditions such as hypotension, heart failure and blood loss. In ischemic strokes, the infarct area should be detected by imaging methods and the etiology should be investigated (6,7).

When the risk factors in etiology are examined, two groups emerge. While gender, age and race are in the unchangeable risk group, habits such as hypertension, diabetes, coronary artery diseases, dyslipidemia, atherosclerosis, obesity, alcohol and smoking are in the modifiable risk group (4). The incidence of ischemic stroke can be reduced by eliminating modifiable causes or by properly treating the diseases currently under treatment.

Current studies on ischemic stroke should be done and new data should be added to the literature. In this study, we planned to analyze the demographic characteristics and additional diseases in the etiology as well as radiological imaging and laboratory values of patients hospitalized with the diagnosis of ischemic stroke in the emergency department.

Material and Methods

This descriptive study was conducted retrospectively among patients who were diagnosed with acute cerebrovascular disease and received inpatient treatment in the adult and pediatric emergency department of a secondary care hospital. Before the study, Nevşehir Hacıbektaş Veli University non-interventional clinical research publication ethics committee approval was obtained with the decision number 2023/6 dated 19.04.2023.

The study population consisted of patients hospitalized with the diagnosis of 'cerebrovascular disease' in the neurology service, other services and intensive care units of the hospital between 01.01.2022 and 31.12.2022. Among the patients, those diagnosed with cerebrovascular disease due to hemorrhagic reasons (epidural, subdural, ventricular, subarachnoid hemorrhage) were excluded from the study. The data obtained in the analysis of the patients were accessed through the program called SISOFT operating system used in the hospital information operating system. Age, gender, admission times and known comorbidities of the patients were analyzed. Apart from the hemogram and biochemical parameters that are routinely evaluated in the patients, blood levels of vitamin B12, vitamin D, iron, folate, triglyceride, LDL, HDL and INR were analyzed. Brain CT (computed tomography) diffusion MR (magnetic resonance) images and doppler ultrasonography (USG) images of the carotid and vertebral arterieswere evaluated through reports prepared by radiologists. Transthoracic echocardiography (ECHO) reports made by cardiologists were accessed. The treatments and results were obtained from the epicrisis reports recorded on the information operating system of the patients. During the process the records of 244 patients were reviewed and 67 patients were excluded from the study due to missing data. Of the repetitive applications in the same year, only the first application was evaluated. The planning of the study is shown in figure 1.

Statistical Method

Statistical Package for Social Sciences for Windows 21.0 (SPSS 21.0) was used to analyze the data. After the data were entered into the system, age ranges and application time intervals were created. Additional disease data were combined. Laboratory values were divided into three classes as low, normal and high. As statistical analysis, descriptive statistics (frequency, percentage distribution) and chi-square test were used to compare categorical variables between the two groups. Results were evaluated as mean ± SD, or frequency (percentage), and $p < 0.05$ was considered statistically significant at the 95 percent confidence interval.

Results

Data of 177 patients were analyzed in this study. 53.1% of the patients were men. The lowest age of the patients was 24, the highest was 96 and the mean age was 75±12.75. Looking at the age ranges, the lowest number of applications was between the ages of 20-40 and the highest number of applications was between the ages of 60-80 (Table 1). No patient under the age of 20 was diagnosed with ischemic stroke. When the patient applications were analyzed by time period, it was observed that the most common application was in October (13%), the most common day was Friday (17.5%) and the most common time of application was between 08.00-15.59 hours (57.5%). The patients' previous and diagnosed diseases were examined. The most common comorbidity was hypertension (59.5%) followed by diabetes mellitus (37.2%) (Table 1).

Laboratory data of the patients were analyzed. It was observed that blood glucose level was above the normal range in 143 (80.8%) patients. Vitamin D levels and HDL levels were below the normal range in 132 (74.6%) and 116 (65.5%) patients respectively. Blood sodium, potassium, AST, ALT, white blood cell, hemoglobin, thrombocyte and INR values were within the normal range in most of the patients. Blood laboratory analysis results are given in table 4 and figure 2. Vitamin D levels were compared according to gender and no significant difference was found (Chi-square: 3.816, $p>0.05$). HDL cholesterol levels were compared according to gender and there was no significant difference(Chi-square: 6.179, $p>0.05$). Vitamin D levels were compared according to age and no significant difference was observed (Chi-

square: 70.516, p>0.05). HDL levels in blood were compared according to age, and HDL levels were lower especially over 65 years of age (Chi-square: 221.736, p<0.001).

Table 1. Analysis of demographic data

Demographic Data	Number of Patients (n) / Ratio (%) / Standard Deviation (SD)		
Gender			
Male	94 (53.1)		
Female	83 (46.9)		
Average Age	75 ± 12.75		
Age Ranges	Male	Female	Total
0-20	0 (0)	0 (0)	0 (0)
20-40	5 (2.8)	2 (1.1)	7 (3.9)
40-60	14 (7.9)	6 (3.4)	20 (11.3)
60-80	57 (32.2)	49 (27.7)	106 (59.9)
>80	18 (10.2)	26 (14.7)	44 (24.9)
Additional illness		(n / %)*	
Hypertension		106 (59.5)	
Diabetes Mellitus		66 (37.2)	
Hyperlipidemia		43 (24.2)	
Coronary Artery Disease		33 (18.6)	
Presence of Atrial Fibrillation		32 (18)	
Past Ischemic Stroke		37 (20.9)	
Past Embolism /Thrombosis		4 (2.2)	
Past Surgical Operation		5 (2.8)	
Other **		27 (15.2)	
No Additional Disease		32 (18)	

*This is the ratio given according to the total number of patients.

**Asthma, Chronic obstructive pulmonary disease, Chronic kidney failure, Cancer disease

According to CT reports, 67% of patients had old or new infarct findings in imaging. According to the diffusion MRI reports, the most infarct areas were seen in the regions fed by the middle cerebral artery (30%). According to the results of the comparative analysis between demographic data and imaging methods, cerebellar infarction development was significantly higher in male patients (p<0.001, Chi-square: 14.198). No significant differences were observed in the comparison of the affected regions in the brain according to gender and age ranges (p>0.05) (Table 3). According to carotid and vertebral doppler USG reports, intravascular plaques were observed in 83.1% of the patients (Table 3). According to the results of transthoracic echocardiography performed by cardiologists, heart valve pathology was detected in 79.3% of the patients. The mean heart ejection fraction (EF) rate of the patients was 60% ±9.24, and the EF rate was between 40-60% in 88.7% of the patients.

Table 2. Analysis of the laboratory values of the patients after admission

Parameter*	Average	Lowest	Highest	Normal range (n/%)**	Standard range
Glucose	132±80.30	65	550	30 / 16.9	70-100 mg/dL
Urea	40±26.44	1.92	212	81 / 45.8	16-38 mg/dL
Creatinine	0.89±0.80	0.06	7.70	73 / 41.2	0.5-0.9 mg/dL
Sodium	139±3.01	129	148	153 / 86.4	135-145 mmol/L
Potassium	4.3±,0.54	3.2	6.5	153 / 86.4	3.5-5.1 mmol/L
AST	18±17.45	8	163	153 / 86.4	0-32 U/L
ALT	14±13.25	3	78	156 / 88.1	0-33 U/L
CRP	5.3±35.07	0.1	311	86 / 48.6	0-5 mg /dL
WBC	7.9±3.98	3.9	33	130 / 73.4	4.3-10.7 10^3/ mm^3
Hemoglobin	14±1.85	8.4	18	151 / 85.3	11.7-17.2 g/dL
Platelet	242±97.35	54	812	158 / 89.3	150-450 10^3/ mm^3
INR	1.1±0.36	0.1	3.6	138 / 78	0.8-1.22
Vitamin B12	288±216.36	19	2000	129 / 72.9	191-633 ng/dL
Vitamin D	14±10.32	2	72	42 / 23.7	20-50 µg/dL
Iron	59±31.06	9	188	146 / 82.5	33-193 µg/dL
Folate	7.53±6.42	0.5	79	160 / 90.4	3.8-16 µg/dL
Tryglicéride	129±74.7	57	531	149 / 84.2	0-200 mg/dL
LDL	104±37.95	8	267	136 / 76.8	0-130 mg/dL
HDL	15.27	5	144	116 / 65.5	45-100 mg/dL

*AST: Aspartate transaminase, ALT: Alanine aminotransferase, CRP: C-Reactive protein, WBC: White blood cell, INR: International normalized ratio, LDL: Low density lipoprotein, HDL: High density lipoprotein

**Number and rates of patients with laboratory values within the normal range

It was observed that the heart valve pathology increased as the age of the patients increased, and the comparative data were significant (Chi-square: 21.155, p<001). Comparative analysis between the findings of carotid and vertebral doppler USG results and age ranges showed significant results (p<0.001, 37.415). According to these results, there were more plaques and stenosis in the 60-80 age range (Table 3).

Intravenous thrombolytic administration was performed in six of the analyzed patients, considering the duration of admission and indication requirement. One of the patients showed complete recovery and two showed significant improvement. While positive response was not obtained in two patients at the end of the treatment, death occurred in one patient with bleeding into the ventricle. 13.6% of the patients were followed in the intensive care unit (24 patients) while the other patients were followed up in the service. A total of two patients resulted in death. Comparative analysis of patient hospitalizations according to demographic data, imaging results and laboratory data is given in table 4.

Table 3. Diffusion MRI, carotid and vertebral doppler ultrasonography and transthoracic echocardiography findings and comparative analysis by age and sex

Results*	Gender (n / %)		Statistical Analysis (p value/ chi square)	Age Range (n /%)				Statistical Analysis (p value/ chi square)	Total (n %)
Ischemic Area	Male	Female		20-40	40-60	60-80	>80		
MCA areas	24 (45.2)	29 (54.8)	0.174 / 1.845	0 (0)	5 (9.4)	30 (56.6)	18 (34)	0.161 / 5.154	53 (30)
Thalamic area	20 (50)	20 (50)	0.655 / 0.200	0 (0)	3 (7.5)	29 (72.5)	8 (20)	0.206 / 4.568	40 (22.6)
Cerebellar area	18 (90)	2 (10)	0.000 / 14.198	3 (15)	3 (15)	11 (55)	3 (15)	0.042 / 8.200	20 (11.3)
Lacunar area	1 (33.3)	2 (66.7)	0.601 / 0.476	0 (0)	1 (33.3)	1 (33.3)	1 (33.3)	0.598 / 1.879	3 (1.7)
Pons area	5 (71.5)	2 (28.5)	0.450 / 0.982	0 (0)	0 (0)	6 (86)	1 (14)	0.522 / 2.251	7 (3.9)
Other cortical areas	27 (50)	27 (50)	0.626 / 0. 301	4 (7)	8 (14)	28 (52.6)	14 (26.4)	0.254 / 4.065	54 (30.5)
Carotid and Vertebral Doppler USG									
Normal	16 (64)	9 (36)	0.305 / 3.624	4 (16)	7 (28)	12 (48)	2 (8)	0.000 / 37.415	25 (14.1)
Plaques	77 (52)	70 (48)		2 (1,3)	12 (8.1)	91 (61.9)	42 (28.7)		147 (83.1)
Shortness	1 (25)	3 (75)		1 (25)	0 (0)	3 (75)	0 (0)		4 (2.3)
Thrombus	0 (0)	1 (100)		0 (0)	1 (100)	0 (0)	0 (0)		1 (0.5)
Transthoracic Echocardiography									
Heart Valve Pathology									
Yes	69 (49)	72 (51)	0.028 / 4.483	2 (1.4)	12 (8.5)	86 (60.9)	41 (29.2)	0.000 / 21.155	141 (79.7)
No	25 (69.4)	11 (30.6)		5 (13.8)	8 (22.2)	20 (55.5)	3 (7.5)		36 (20.3)
Ejection Fraction Ratio									
0-20	0 (0)	0 (0)	0.957 / 0.087	0 (0)	0 (0)	0 (0)	0 (0)	0.000 / 32.519	0 (0)
20-40	1 (50)	1 (50)		0 (0)	0 (0)	2 (100)	0 (0)		2 (1.1)
0-60	84 (53.5)	73 (46.5)		2 (1.2)	17 (10.8)	97 (61.7)	41 (26.3)		157 (88.7)
>60	9 (50)	9 (50)		5 (27.7)	3 (16.7)	7 (38.9)	3 (16.7)		18 (10.2)

*MCA: Main Cerebral Artery, USG: Ultrasonography

Table 4. Comparison of patients' ward and intensive care unit hospitalizations with demografic data, laboratory data and imaging results

	Service (n/%)	Intensive Care (n/%)	Statistical Analysis
Gender			
Male	83 (47)	11 (6.5)	p=0.512, Chi square: 0.590
Female	70 (39.5)	13 (7)	
Age Ranges			
0-20	0 (0)	0 (0)	p=0.007, Chi square: 9.301
20-40	7 (4)	0 (0)	
40-60	20 (11)	0 (0)	
60-80	93 (52)	13 (7)	
>80	33 (19.5)	11 (6.5)	
Ischemic Area			
Main cerebral artery areas	38 (22.5)	15 (8.5)	p=0.001, Chi square: 11.796
Thalamic area	37 (21)	3 (1.5)	p=0.295, Chi square: 1.619
Cerebellar area	18 (10)	2 (1)	p=0.622, Chi square: 0.244
Lacunar area	3 (1.5)	0 (0)	p=0.489, Chi square: 0.479
Pons area	7 (4)	0 (0)	p=0.596, Chi square: 1.343
Other cortical areas	50 (28)	4 (2)	p=0.153, Chi square: 2.509
Carotid Doppler Ultrasonography			
Normal	24 (13.5)	1 (0.5)	p=0.350, Chi square: 3.280
Plaques	124 (70.5)	23 (13)	
Shortness	4 (2)	0 (0)	
Thrombus	1 (0.5)	0 (0)	
Transthoracic Echocardiography			

Heart Valve Pathology			
Yes	119 (67.5)	22 (12.5)	p=0.172, Chi square: 2.470
No	34 (19)	2 (1)	
Ejection Fraction Ratio			
0-20	0 (0)	0 (0)	p=0.194, Chi square: 3.277
20-40	1 (0.5)	1 (0.5)	
40-60	135 (76.5)	22 (12.5)	
>60	17 (9.5)	1 (0.5)	
Laboratory Paremeter*			
Glucose			
Low	4 (2)	0 (0)	p=0.325, Chi square: 2.250
Normal	28 (16)	2 (1)	
High	121(68.5)	22 (12.5)	
Urea			
Low	2 (1)	0 (0)	p=0.331, Chi square: 0.212
Normal	73 (41)	8 (4)	
High	78 (46)	16 (8)	
Creatinine			
Low	15 (8.5)	4 (2)	p=0.348, Chi square: 2.110
Normal	66 (37.5)	7 (3.5)	
High	72 (40.5)	13 (7)	
Sodium			
Low	19 (11)	4 (2)	p=0.033, Chi square: 6.383
Normal	134 (75.5)	19 (11)	
High	0 (0)	1 (0.5)	
Potassium			
Low	6 (3.5)	1 (0.5)	p=0.022, Chi square: 7.637
Normal	136 (76)	17 (10)	
High	11 (6.5)	6 (3.5)	
AST			
Low	0 (0)	0 (0)	p=0.016, Chi square: 5.770
Normal	136 (76)	17 (10)	
High	17 (10)	7 (4)	
ALT			
Low	0 (0)	0 (0)	p=0.434, Chi square: 0.612
Normal	136 (76)	20 (11.5)	
High	17 (10.5)	4 (2)	
CRP			
Low	0 (0)	0 (0)	p=0.001, Chi square: 11.325
Normal	82 (46)	4 (2)	
High	71 (40.5)	20 (11.5)	
WBC			
Low	5 (3)	0 (0)	p=0.019, Chi square: 7.907
Normal	117 (66)	13 (7.5)	
High	31 (17.5)	11 (6)	
Hemoglobin			
Low	23 (13)	1 (0.5)	p=0.122, Chi square: 4.204
Normal	129 (72.5)	22 (13)	
High	1 (0.5)	1 (0.5)	
Platelet			
Low	12 (7)	1 (0.5)	p=0.799, Chi square: 0.449
Normal	136 (76)	22 (13)	
High	5 (3)	1 (0.5)	
INR			
Low	1 (0.5)	0 (0)	p=0.757, Chi square: 0.558
Normal	118 (67)	20 (11.5)	
High	34 (19)	4 (2)	

Vitamin B12			
Low	33 (19)	4 (2)	
Normal	109 (61)	20 (11.5)	p=0.304, Chi square: 2.380
High	11 (6.5)	0 (0)	
Vitamin D			
Low	115 (65.5)	17 (9.5)	
Normal	36 (20)	6 (3.5)	p=0.585, Chi square: 1.072
High	2 (1)	1 (0.5)	
Iron			
Low	23 (13)	8 (5)	
Normal	130 (73)	16 (9)	p=0.028, Chi square: 4.809
High	0 (0)	0 (0)	
Folate			
Low	10 (6)	3 (1.5))	
Normal	139 (78)	21 (12.5)	p=0.437, Chi square: 1.658
High	4 (2)	0 (0)	
Trygliceride			
Low	0 (0)	0 (0)	
Normal	128 (84.5)	20 (11.5)	p=0.903, Chi square: 0.015
High	4(2)	4 (2)	
LDL			
Low	0 (0)	0 (0)	
Normal	118 (66)	18 (10)	p=0.798, Chi square: 0.053
High	35 (20)	6 (4)	
HDL			
Low	100 (57)	16 (8)	
Normal	52 (30.5)	8 (4)	p=0.921,Chi square: 10.165
High	1 (0.5)	0 (0)	

*AST: Aspartate transaminase. ALT: Alanine aminotransferase. CRP: C-Reactive protein. WBC: White blood cell. INR: International Normalized Ratio. LDL: Low density lipoprotein. HDL: High density lipoprotein

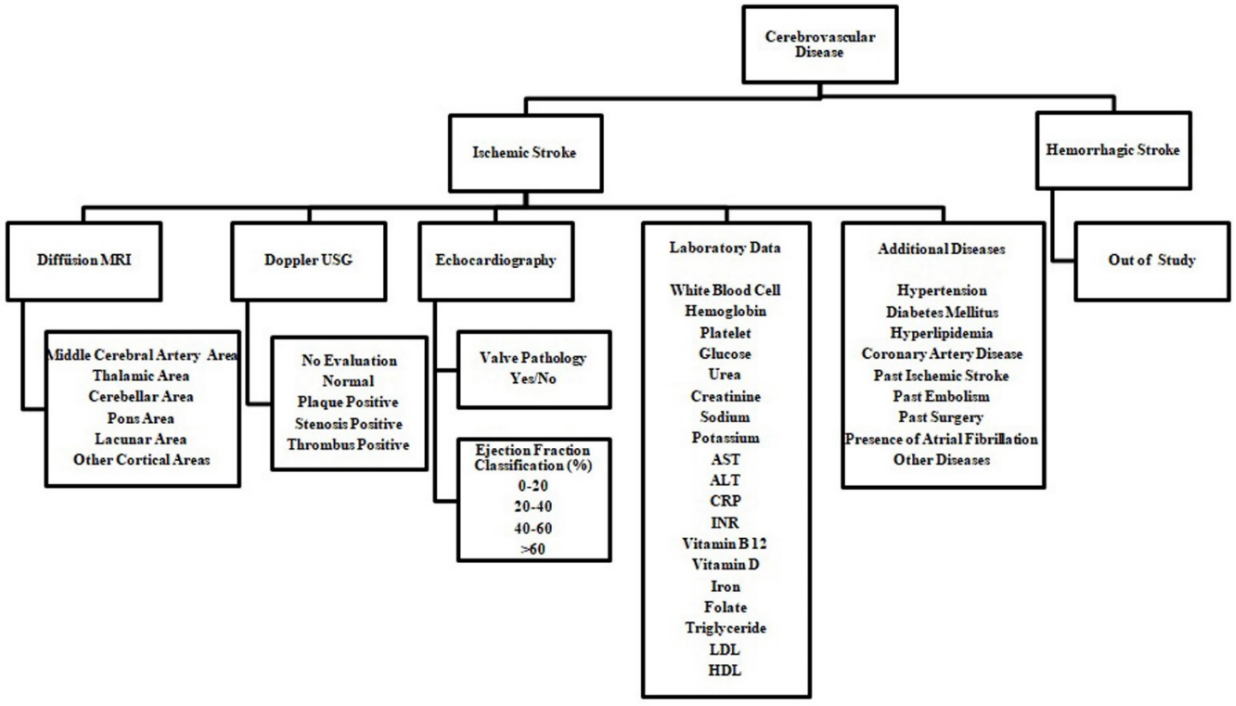

Figure 1. Study Plan

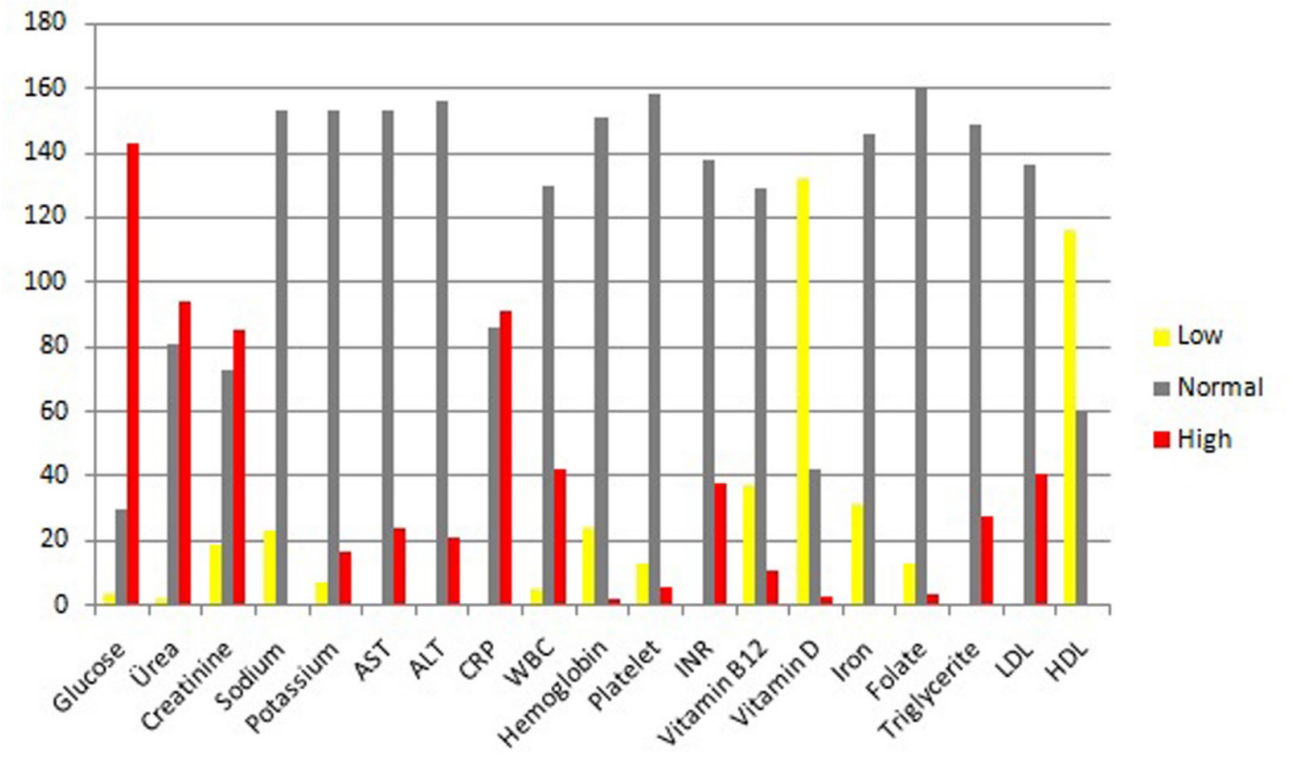

Figure 2. Distribution of patient numbers according to laboratory data

Discussion

Ischemic strokes constitute approximately 80-85% of patients evaluated with acute cerebrovascular disease. The most common causes of ischemic stroke are hypoperfusion, atherothrombosis and embolism. The most common cause of ischemic strokes caused by cardiac causes is atrial fibrillation (8).

Age is an important factor in stroke and it has been reported that 70% of patients with stroke are over 65 years of age (9). In our study, the mean age was 75±12.75 years and the highest number of admissions was in the 60-80 age range. In similar studies conducted on the subject, the mean age range was 60-80 years and our study is compatible with the literature (10-14). In a study by Kiyan et al. it was observed that 5% of ischemic stroke cases were young patients who had stroke under the age of 45 years (15). In our study, the number of patients under 45 years of age was 4.5%. In a similar study, the rate of patients under 45 years of age was found as 6.55% (10).

In similar studies in which stroke patients were analyzed, the rate of male patients was higher (10,13-15). Similarly, 53.1% of the patients were male in our study. In a study conducted by Mozaffarian et al., it was analyzed that stroke was more common in males than females at younger ages, and in patients over 75 years of age, stroke was more common in the female gender (16). Similarly, in our study, 70.3% of patients under the age of 60 years were male and 60% of patients over the age of 80 years were female. Likewise, Öztürk et al. reported that the cases seen after the age of 80 years were mostly in the female gender in their study (14).

In our study, we observed that hypertension and diabetes were the most common comorbidities in stroke patients. In the study conducted by Soyudogru et al., hypertension and diabetes were the most common comorbidities in patients who had a stroke, as in our study (10). Inan et al. reported in a study they conducted that hypertension was the most common cause with a rate of 46% in young patients with ischemic stroke (17). In the study of Morkavuk et al. in which they examined vitamin D levels in patients with ischemic stroke, it was found that 85.2% of the patients had hypertension and 53.7% had diabetes (18). The data in our study was similar to the data in the literature.

In this study, we wanted to examine the laboratory values of ischemic stroke cases. As a result, we observed high blood glucose levels in 143 (80.7%) patients. Studies show that high glucose levels have an effect on survival and clinical prognosis of patients (19, 20). In our study, the mean glucose level was 132±80.30 mg/dL, and there was no significant difference in the comparison between glucose levels and intensive care admissions (Table 4). In the study of Aksoy et al., glucose level was measured as 124.83±50.72 mg/dL, and no significant difference was found between patients with poor prognosis and patients with good prognosis (p=0.009), (13). Glucose level may vary according to additional diseases and differences between hunger and satiety. In studies to be carried

out on the subject, long term follow up of patients and analysis of glucose values by monitoring them at certain periods will be beneficial.

There are studies showing that acute phase reactants are effective in mortality and restroke in ischemic stroke. Some studies show that C-reactive protein (CRP) levels are effective in predicting one year survival after stroke (21, 22). On the contrary, there are studies showing that CRP levels are not significant in stroke (23, 24). In our study, the CRP level was 5.3±35.07. Similarly, in a study comparing CRP and internal carotid artery intima thickness in ischemic stroke patients, the mean CRP level was measured as 7.95±3.81 (25). High levels of CRP in the blood may indicate that plaques in the vessels may become unstable and atherosclerosis may develop. In a study, it was seen that the unstableness and size of the plaques in the carotid vessels were associated with the elevation of CRP (26). In our study, the number of patients with plaque in the vessels was 147 and no significant relationship was found between the elevation of CRP and the number of patients with plaques (p=0.083). In the study conducted by Şengül et al., there was no significant relationship between high CRP and plaque formation in 21 patients (p=0.380) (25). In our study, an evaluation was made between CRP level and intensive care admissions and no significant relationship was found (Table 4). In addition, it was observed that the CRP level was high in patients due to reasons such as infection and malignancy. It would be more appropriate to examine the effect of CRP level in ischemic stroke in more comprehensive studies and in isolation in patients without additional disease.

It is stated that hematological parameters are effective on prognosis in ischemic stroke, and hemogram tests are routinely performed because they are fast and inexpensive. However, since the clinical course of patients is affected by many factors, it is not meaningful to evaluate them alone(27). In our study, white blood cell count was 7.9±3.98 103/mm3, hemoglobin was 14±1.85 g/dL, and platelet was 242±97.35 103/mm3. Aksoy et al. in their study, the laboratory value of white blood cell count was 7.58±2.41 103/mm3, hemoglobin was 12.8±1.70 g/dL and platelet was 239.87±68.42 103/mm3 in patients with good prognosis, and in patients with poor prognosis, white blood cell count was 9.26±4.18 103/mm3, hemoglobin was 13.07±1.91 g/dL and platelet was 248.25±73.63 103/mm3 (13). They reported that there was a significant correlation between the height of white blood cell and poor prognosis (p>0.05) (13). In the study of Kaşıkçı et al., in surviving patients white blood cell was 11.12±4.48 103/mm3, hemoglobin was 11.37±2.43 g/dL and platelet was 258.63±128.18 103/mm3, and they found in patients who ended in death that white blood cell count was 11.31±7.45 103/mm3, hemoglobin 11.65±1.93 g/dL and platelet was 286.79±106.96 103/mm3 (28). They stated that there was no significant relationship between hematological parameters between surviving and deceased patients (28). In our study an evaluation was made between the patients admitted to the intensive care unit and the patients hospitalized in the ward and no significant differences were found in terms of hemogram values (white blood cell; p=0.585, hemoglobin; p=0.924, thrombocyte; p=0.442).

Homocysteine plays an important role in the development of atherogenic events and this is due to thrombus formation resulting from endothelial damage and platelet activation (29). Vitamin B12 plays an important role in the functioning of enzymes activated in the homocysteine remethylation pathway (30). Therefore, vitamin B12 deficiency is considered as a risk factor in the occurrence of ischemic stroke. In this study, we found that 20.9% of the patients had low vitamin B12 levels. Another factor affecting homocysteine level is folic acid level. In this study, we found that 7.7% of the patients had folate levels below the normal range. Comparative analysis between vitamin B12 and folate levels and homocysteine levels could not be performed because homocysteine levels could not be measured in the center where our study was conducted.

Studies have reported that vitamin D plays an important role in maintaining the integrity of the blood brain barrier and is a good neuroprotective agent (31,32). In our study, the mean blood vitamin D level was 14±10.23µg/dL. Vitamin D level was low in 132 (74.5%) of the patients. In a study, it was reported that low vitamin D level in patients with hypertension, dense plaque in the vessels as a result of carotid doppler and low HDL cholesterol level posed a cardiovascular risk (18). In our study, it was observed that vitamin D levels were low in patients with low HDL cholesterol, valvular pathology in the heart, and plaque on carotid and/or vertebral doppler examination. According to a study conducted by Manouchehri et al. in 2017, the risk of ischemic stroke increased 7-fold in people with vitamin D deficiency (33). Longer-term and large-scale studies are needed to indicate that vitamin D poses cardiovascular risk and is an important factor in stroke.

According to studies that analyzed lipid parameters as factors increasing the risk of stroke, high total cholesterol and LDL cholesterol and low HDL cholesterol increase the risk of stroke (34). In our study, mean triglyceride level was 129±74.7 mg/dL, LDL cholesterol level was 104±37.95 mg/dL and HDL cholesterol level was 15.27 mg/dL. HDL cholesterol levels were low in 116 (65.5%) of the patients. In the study conducted by Yılmaz et al., no statistically significant differences were found between the triglyceride, LDL and HDL cholesterol levels measured in the patient and control groups (35). Aksoy et al., on the other hand, measured the mean triglyceride level as 155.15±78.40 mg/dL and LDL cholesterol level as 121.03±33.04 mg/dL in patients with a good prognosis (13). In the same study, mean triglyceride level was measured as 152.42±71.30 mg/dL and LDL cholesterol level as 113.81±33.31 mg/dL in patients with poor prognosis, and no statistical difference was found between good and poor prognosis (13). Yucel et al. examined lipid parameters in patients with and without hypertension in their study

and reached the similar values in our study, and they found that HDL cholesterol level was below the normal value in the majority of patients (36). According to the results of the same study, total cholesterol and LDL cholesterol levels were found significantly higher in patients with hypertension compared to those without but there was no significant relationship between blood lipid parameters and prognosis in general (36). In our study, lipid levels and intensive care hospitalizations were compared and no significant difference was found (Table 4).

In this study, all patients underwent brain CT and diffusion MR imaging. In particular, brain CT evaluation was used to exclude hemorrhagic stroke cases. Infarct areas seen in the patients were classified based on radiological evaluations. According to the results of our study, it was observed that infarcts were most common in the areas fed by the middle cerebral artery. In similar studies, Soyudogru et al. reported according to the evaluation made with MR imaging that infarct was most common in the middle cerebral artery area with a rate of 53.2% (10), Kıyan et al., on the other hand, evaluated with CT imaging in their study and found 15.3% of infarcts in the anterior cerebral artery area(15). In the study conducted by Uzar et al. in young patients who had a stroke, it was found that infarcts were more common in the middle cerebral artery area with a rate of 39.6% (37). Naess et al. stated in their study that infarcts were more common in the middle cerebral artery area with a rate of 62.5% (38).

In our study, 147 patients (83.1%) had plaques in their vascular structures in the carotid and/or Doppler USG examinations of the patients. Similarly, Damar et al. found in their study that 76% of the patients had plaques in the vascular structure (39). Uncu et al. examined the carotid and vertebral artery doppler USG results in patients in their study and found 40% stenosis and occlusion (40).

Atrial fibrillation is the most common cardiac arrhythmia in adults. Impairment of atrial myocardial function causes clot formation in the left atrium and indirectly increases the risk of ischemic stroke (41). In our study, we found that 18% of the patients received treatment for atrial fibrillation. At the same time, 79.7% of the patients who underwent transthoracic echocardiography were found to have heart valve pathology. Kiyan et al. observed 11.3% of atrial fibrillation in electrocardiography (ECG) results of stroke patients (15). In the study of Aksoy et al., the rate of patients who received atrialfibrillation treatment was 11% (13). In the study conducted by Inan et al. on young ischemic stroke patients, the rate of atrial fibrillation was found as 3.3% (17). Diker et al. reported the rate of atrial fibrillation as 62.5% in patients with recurrent stroke (42).

In ischemic stroke, intravenous tPA therapy is an effective treatment when applied to the appropriate patient. Hemorrhages seen after treatment are the most common clinical concern and may occur within the first 36 hours (43). In our study, tPA treatment was applied in six patients, three of them recovered, two did not benefit and one patient developed bleeding and resulted in death. Our patient who developed bleeding was an 83-year-old female patient. Eren et al. observed in their study on patients who received thrombolytics that hemorrhage developed in 12 of 97 patients (44). Since our study is a retrospective study, it was insufficient to evaluate the future outcomes of patients who received thrombolytic therapy.

Conclusion

As a result, the risk of ischemic stroke increases with advanced age. Hypertension and diabetes are among the most important risk factors. Vitamin D and vitamin B12 deficiency and folic acid deficiency pose a risk in terms of atherosclerosis. At the same time low HDL cholesterol levels increase the risk of stroke. These factors, which are considered as preventable causes in etiology, should be controlled with treatment. More studies should be done on the application of thrombolytic therapy and the treatment process should be accelerated by early diagnosis in patients. There are differences between studies in the literature. Therefore, there is a need for more comprehensive studies on laboratory, imaging and treatment applications related to ischemic stroke patients.

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