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Clinical and radiological observation of stroke cases in the emergency department of a university hospital

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Abstract

Stroke is an important cause of mortality and morbidity. In our study, the accuracy relationship of the radiological imaging methods within themselves, together with the existing risk factors of stroke patients diagnosed in the emergency department, and their mortality status were examined. This study was conducted with 252 patients. The patients' ages and sexes, clinical features, arterial blood pressure and laboratory findings, history of diseases, vascular imaging methods, thrombolytic therapy applications, length of stay, and mortality rates were examined retrospectively. There was no statistical difference between stroke types and age and sex (p=0.73, p=0.53). While 65 patients had a recurrent stroke, male patients were dominant in this group (p=0.00). Hypertension was the most common comorbid disease with a frequency of 64.4%. Hemiparesis, speech disorder, headache, and hypoesthesia symptoms were prominent symptoms in patients with ischemic stroke, while changes in consciousness were the most prominent symptom in patients with hemorrhagic stroke (p=0.00). In 90.9% of the 59 patients who underwent both doppler ultrasonography (USG) and angiography examinations, doppler USG determined cases without 70% and higher stenosis as significant. The length of intensive care unit stay for hemorrhagic stroke was significantly longer (p=0.03), and the mortality rates of patients with 70% and higher stenosis and undergoing digital subtraction angiography (DSA) were found to be significantly higher (p=0.01). We observed that doppler USG was not an adequate method in detecting significant stenoses (70% and higher), but it was an important examination method for showing cases without significant stenosis. Furthermore, the longer length of intensive care unit stay in patients with hemorrhagic stroke and the higher mortality rate in patients with 70% and higher stenosisand undergoing interventional angiography are other important results.

Keywords: Stroke, doppler ultrasonography, angiography, mortality

Introduction

Cerebrovascular disease (CVD), also known as stroke, is an event that occurs acutely after occlusionor rupture in the brain vessels [1]. CVD is the main cause of ischemic or hemorrhagic events in brain tissue, and it can cause neurological deficits and even death [2]. CVD has been the second most common cause of death in both sexes in the last decade [3]. According to the World Health Organization, cerebrovascular diseases caused the death of 6.2 million people in 2015 (about 11.1% of all deaths worldwide) [3]. Stroke accounted for 14% of all deaths in females and 9% of all deaths in males in Europe [4]. In the USA, it was the fifth leading cause of death in males and the fourth leading cause of death in females [5].

It is estimated that the incidence of stroke will be more than twice by 2050 [6]. Despite recent advancements in stroke treatment, it is of great importance to effectively prevent primary stroke by controlling vascular risk factors [6]. Epidemiological studies have demonstrated that hypertension, diabetes mellitus, atrial fibrillation, transient ischemic attack, hypercholesterolemia, smoking, and carotid stenosis are risk factors for stroke [6]. However, only three-quarters of all strokes could be attributed to these known risk factors [7].

Stroke can generally be defined as ischemic (occlusion of a vessel) and hemorrhagic (bleeding of a vessel) [8]. Of stroke cases, 87% are ischemic stroke caused by the occlusion of a cerebral artery, 10% are intracerebral hemorrhage, and 3% are subarachnoid hemorrhage [8].

In this study, the admission complaints, clinical features and history, radiological imaging and laboratory tests of patients who were admitted to the emergency department and diagnosed with stroke were examined according to ischemic-hemorrhagic

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stroke subtypes. Especially in ischemic strokes, patients who might have the chance of thrombolytic embolectomy in the emergency department or intra-arterial embolectomy in stroke units were investigated for early diagnosis and treatment before the deterioration of their clinical picture.

Materials and Methods

Case selection and data collection

Our study was initiated after obtaining approval from Inonu University Scientific Research and Publication Ethics Committee with the decision dated 19.03.2019 and numbered 2019/6-13. This study was completed with 252 patients diagnosed with stroke in the emergency department for 1 year between 01.01.2018 and 31.12.2018. Patients with metabolic and infectious conditions, subdural-epidural hemorrhage, subarachnoid hemorrhage, vascular aneurysm and arteriovenous malformation, which were likely to be confused with the clinical picture ofstroke, were excluded from the study. The patients' information was scanned retrospectively from the hospital automation system. The ages and sexes, clinical characteristics, arterial blood pressure and laboratory findings, history of diseases, radiological imaging methods (magnetic resonance imaging (MRI), computed tomography (CT), color-flow Doppler ultrasound, CT angiography and digital subtraction angiography (DSA), acute treatment methods, length of service or intensive care unit stay, and mortality rates of patients diagnosed with stroke were recorded.

Statistical analysis

The statistical analysis of all data obtained was performed using IBM SPSS (version 20.0; SPSS ™, Chicago, IL) software. While the numerical data obtained by measurement were presented as mean and standard deviation (SD), numerical categorical data were presented as number (n) and percentage (%). The statistical analysis of categorical variables was performed using Pearson's chi-square test. Student's t-test was used to compare variables between the two groups. One-Way ANOVA analysis was applied to compare four independent groups with normal distribution. The value of $p<0.05$ was considered significant in all tests.

Results

Of the 252 patients included in our study, 222 (88%) had an ischemic stroke, and 30 (12%) had a hemorrhagic stroke. While 120 (54%) of the patients with ischemic stroke were male, 102 (46%) were female. There was also the dominance of male patients with a rate of 60% in patients with hemorrhagic stroke (Table 1). No significant difference was found between stroke subtypes and sex (p=0.53). However, recurrent stroke was detected in 65 patients (25.8%), while the number of male patients (n=43) was found to be significantly higher in this group (p=0.00).

The mean age of all patients was 69.11 (24-100) years, while it was 69.33 ± 13.62 years in the ischemic stroke group and 67.47 ± 14.15 years in the hemorrhagic stroke group. There was no significant difference between stroke subtypes and mean age (p=0.73).

When patients' symptoms during admission to the emergency department were examined, it was observed that 111 (44%) patients had a loss of strength in one or more extremities. Concerning the remaining patients, 50 (19.8%) patients had speech disorder, 31 (12.3%) patients had changes in consciousness ranging from fainting to coma,31 (12.3%) patients had a headache, and 29 (11.6%) patients had hypoesthesia in one or more extremities (Table 1). In the patients' history of diseases, hypertension (HT) was present in 161 (64.4%) patients, coronary artery disease (CAD) in 87 (34.8%) patients, diabetes mellitus (DM) in 78 (31.2%) patients, arrhythmia in 69 (27.6%) patients, and hyperlipidemia in 37 (14.8%) patients (Table 1). The mean systolic blood pressure of all patients was 153.47 mmHg, and their diastolic blood pressure was measured as 86.06 mmHg. The mean arterial blood pressure (ABP) was 150.88/84.78 mmHg in patients with ischemic CVD, and the mean ABP was measured as 169.94/94.24 mmHg in patients with hemorrhagic CVD.

Table 1. Demographic data of patients with ischemic and hemorrhagic CVD

	Variables	Number (n)		Percentage (%)
		Ischemic Stroke	Hemorrhagic Stroke	
Sex	**Male**	120	18	54.8
	Female	102	12	45.2
Admission Complaints	**Hemiparesis**	102	9	44.0
	Speech disorder	49	1	19.8
	Changes in consciousness	11	20	12.3
	Headache	23	8	12.3
	Hypoesthesia	28	1	11.6
History of Diseases	**Hypertension**	136	25	64.4
	Coronary artery disease	81	6	34.8
	Diabetes mellitus	72	6	31.2
	Arrhythmia	65	4	27.6
	Hyperlipidemia	36	1	14.8
Hospitalization-Discharge	**Hospitalization**	212	28	95.3
	Discharge	10	2	4.7
Mortality	**Exitus**	50	10	23.8
	Survived	172	20	76.2

The mean and standard deviation (SD) values of the hematological parameters of both stroke subtypes were analyzed. There was no significant difference between leukocyte, hemoglobin (Hb), platelet (Plt), activated partial thromboplastin time (aPTT), and international normalized ratio (INR) values (Table 2).

For the etiology of ischemic stroke, color-flow Doppler ultrasonography (USG), brain computed angiography, and digital subtraction angiography (DSA) were applied to the patients as a vascular examination. While there was 70% and higher stenosis in 48 (30.7%) of 156 (61.9%) patients who underwent color-flow Doppler USG, no significant stenosis was detected in 108 (69.3%) patients. Forty-six (95.8%) of the patients with significant stenosis in Doppler USG were also patients with ischemic CVD. This situation was found to be statistically significant (p=0.00) (Table 3). Among 55 (21.8%) patients who underwent CT angiography, there were 16 (30.1%) patients with 70% and higher stenosis and 37 (69.9%) patients with normal results (Table 3).While significant stenosis was detected in 43 (55.8%) of 77 (30.5%) patients who underwent brain DSA, it was reported that there was no vascular occlusion in the angiography in 34 (44.2%). Of these, 66 (85.7%) had ischemic CVD, while 11 (14.3%) had hemorrhagic CVD. Forty-two of the patients with significant stenosis had ischemic CVD type,and one had hemorrhagic CVD type. This result was statistically significant (p=0.00) (Table 3).

On the other hand, 43 of the patients with ischemic stroke were admitted to our emergency department within the first 1-4 hours and received intravenous recombinant tissue plasminogen activator (IV-rtPA) treatment (19.3%).

Table 2. Laboratory values in patients with ischemic and hemorrhagic CVD

Variables	CVDType	Mean ± SD
Leukocyte (10^3/µl)	**Ischemic**	9.68 ± 3.60
	Hemorrhagic	10.42 ± 4.23
Hb (g/dL)	**Ischemic**	13.62 ± 1.88
	Hemorrhagic	13.54 ± 2.22
Plt (10^3/µl)	**Ischemic**	243.00 ± 84.73
	Hemorrhagic	242.32 ± 83.82
APTT (sec)	**Ischemic**	16.65 ± 9.98
	Hemorrhagic	15.66 ± 8.42
INR	**Ischemic**	1.27 ± 1.58
	Hemorrhagic	1.36 ± 1.88

n:number; SD: Standard Deviation, Hb: Hemoglobin, Plt: Platelet, aPTT: activated partial thromboplastin time, INR: International Normalized Ratio, Sec: second

Both Doppler USG and angiography examinations were performed in 59 patients with ischemic stroke. In 13 of these patients, significant stenosis (70% and higher) was detected in both Doppler USG and angiography, while no significant stenosis (70% and higher) was observed in both Doppler USG and angiographic examinations of 30 patients. However, while significant stenosis (70% and higher) was detected in Doppler USG of 3 patients, no significant stenosis was observed in angiography imaging. While there was no significant stenosis in Doppler USG of 13 patients, it was observed that there was 70% and higher stenosis in angiography. While the sensitivity of Doppler USG was 50%, its specificity was found to be 91%. While the positive predictive value of Doppler USG in detecting 70% and higher stenosis was 81.3%, its negative predictive value was 70%, and it was found to be quite successful in showing that there was no stenosis (Table 4).

Table 3. Comparison of CVD types and vascular examination, clinical features, and length of stay

Variables	CVD Types	p-value
Color-Flow Doppler Ultrasonography	**Ischemic***	0.00
	Hemorrhagic	
Brain Computed Angiography	**Ischemic**	0.26
	Hemorrhagic	
Digital Subtraction Angiography	**Ischemic***	0.00
	Hemorrhagic	
Length of intensive care unit stay	**Ischemic**	0.03
	Hemorrhagic*	
Changes in consciousness	**Ischemic**	0.00
	Hemorrhagic*	
Hemiparesis, speech disorder, headache, hypoesthesia	**Ischemic***	0.00
	Hemorrhagic	

p-values were found according to Pearson's chi-square test, fields designated with * indicate which one is significant

Concerning the hospitalization and discharge status, 12 (4.7%) patients were discharged from the emergency department, while 240 (95.3%) patients were hospitalizedin the service and stroke units. In the analysis of the exitus and life status of the patients, the number of exitus patients was 60 (23.8%), and the number of survived patients was 192 (76.2%) (Table 1). The mean length of service stay was 13.91 days, and the mean length of stroke unit stay was 8.00 days. The mean length of total stay was 13.25 days for patients with ischemic CVD and 18.77 days for patients with hemorrhagic CVD. When the length of stroke unit stay was examined, it was calculated that the mean length of stay was 7.13 days for patients with ischemic CVD and 14.10 days for patients with hemorrhagic CVD. The longer length of intensive care unit stay in patients with hemorrhagic CVD was found to be statistically significant (p=0.03) (Table 3).

Exitus developed in 10 (33.3%) of hemorrhagic CVD cases and in 50 (22.5%) of ischemic CVD cases. Although the mortality rate was higher in the hemorrhagic type, this was not statistically significant (p=0.19). Furthermore, 27 (45%) of the exitus patients were patients who underwent brain DSA. Significant stenosis was detected in 17 of them (62.9%), and this result was statistically significant (p=0.01). In addition, the mortality rate was significantly higher in patients with paresis in one or more extremities (p=0.003).

Table 4. Comparison of vascular examinations in detecting stenosis levels

	Angiography 70% and higher stenosis (n)	Angiography stenosis lower than 70% (n)	Total (n)
Doppler USG 70% and higher stenosis (n)	13	3	16
Doppler USG stenosis lower than 70% (n)	13	30	43
Total (n)	26	33	59

Discussion

Stroke, which is a neurological dysfunction caused by impaired cerebral blood flow, is divided into two groups: ischemic (85%) and hemorrhagic (15%) [9, 10]. In a study conducted by Kumral et al. on 2000 patients, 77% of all strokes were found to be ischemic [11]. In our study, the majority of strokes (88%) were ischemic. Age is an important risk factor for stroke, and in this study, the mean age in ischemic strokes was 63 ± 12, and the mean age in hemorrhagic strokes was 59 ± 12 [11]. In a study carried out by Andersen et al.and comparing stroke types, no significant difference was observed between ages [12]. In our study, the mean age according to stroke subtypes was similar to the literature.

Differences between sexes in stroke are an important research subject. While the incidence of stroke is higher in males until the advanced age, it has been shown that stroke is more common in females after the age of 85 [13]. In our study, although stroke was more common in male patients with ischemic and hemorrhagic stroke, no significant difference was observed between sexes in stroke type. However, when recurrent strokes were examined, it was observed that this rate was more significant in males (p<0.05). In their study, Chen et al. reported that the frequency of recurrent stroke in patients with a high degree of carotid stenosis was a significant risk factor in males (p=0.004) [14]. In a study by Jing Han et al in which the rates of recurrent stroke occurring within 1 year and 5 years after stroke were investigated, 71 cases of recurrent stroke were observed within 1 year and 202 within 5 years [15]. While the rate of all recurrent strokes was 5.7% (men 6.9%, women 4.6%) within 1 year, it was 22.5% (men 24%, women 20.2%) within 5 years [15]. The higher incidence of recurrent strokes in men was attributed to younger age of onset of stroke in this population and poor management of post-stroke risk factors [15]. In our study, we found recurrent stroke in 65 patients (25.8%), among which we found the number of male patients (n=43) to be significantly higher (p=0.00).

Stroke patients are admitted to emergency departments with different clinical presentations. In a study conducted by Fekadu et al., it was reported that stroke patients were most frequently admitted with complaints of headache (75%), aphasia/dysphasia (60.3%), and hemiparesis (53.4%) [16]. Furthermore, it was stated in this study that changes in consciousness such as coma were observed at a significantly higher rate in patients with hemorrhagic stroke [16]. Likewise, in our study, hemiparesis, speech disorder, hypoesthesia, and headache were the common symptoms, respectively, in patients with ischemic stroke. Change in consciousness was found to be a more prominent clinical admission symptom in patients with hemorrhagic stroke. In a study conducted with 124 patients with ischemic stroke and addressing predisposing diseases, 58.8% of the patients had hypertension, 35.0% had DM, 25% had CAD, 20.1% had previous CVD, and 9.6% had chronic obstructive pulmonary disease [17]. In our study, in line with the literature, the most common risk factor was HT in 161 patients (64.4%). Although HT was the most common comorbid disease in both ischemic and hemorrhagic stroke patients, there was no significant difference between mean blood pressure values in stroke subtypes.

In the vascular examination of patients admitted to our emergency department with the clinical picture of stroke, carotid and vertebral Doppler USG was the most commonly used method because it is easier to access and has no side effects, and a contrast agent cannot be given to people with impaired renal function. However, while only 30% of these patients had 70% and higher significant stenosis, we obtained similar results in half of the patients evaluated by computed or interventional angiography. However, similar results were found in angiography in 91% of the patients who did not have significant stenosis in Doppler USG. This showed that color-flow USG was not an adequate examinationin detecting symptomatic carotid stenosis.

In a study carried out by Griewing et al., color-flow Doppler and power Doppler USG were compared with DSA in patients with 50% and higher extracranial internal carotid artery stenosis [18]. Power Doppler USG was shown to be significantly superior to

color-flow Doppler USG in the diagnosis of stenosis degrees and determination of plaque surface morphology [18]. The preference of power Doppler USG in ultrasonographic examinations can be considered a more accurate method in stenosis detection.

Thrombolytic therapy is a form of treatment that has been used in Turkey for more than twenty years and has a significant effect on survival and disability in the acute period in patients with ischemic stroke [19]. The peripheral administration of IV-rtPA is applied with considerable success in experienced stroke centers. In general, approximately one-fourth of patients with acute ischemic stroke are admitted to emergency departments within the first 2 hours, but a sufficient number of patients cannot benefit from this treatment [20]. It was reported that only 12% of patients with acute ischemic stroke receive IV-rtPA treatment, even in developed countries [21]. In our study, 19.3% of the patients with ischemic stroke were provided with IV-rtPA treatment in our emergency department. There are several important factors in the higher number of patients receiving thrombolytic therapy compared to the literature. With the early recognition of stroke, early admission to the hospital, and the increased experience of physicians, more patients were identified with early diagnosis in acute cases.

In a study performed in Turkey, it was reported that the length of stay in patients with hemorrhagic stroke was longer when the stroke subtypes and the length of hospital stay were compared [22]. In our study, it was observed that the length of intensive care unit stay was significantly longer in patients with hemorrhagic stroke ($p=0.03$). This suggests that it may be related to higher arterial blood pressure values in hemorrhagic strokes and increased intracranial pressure in the early period. However, more data are needed in this regard. Although the relationship between mortality rates and the stroke type varies, it was observed that there was a relationship between the size of stroke and mortality rather than the stroke type [23]. Considering the mortality rates of the patients in our study, we determined that the mortality rate in patients with hemorrhagic stroke was higher than in patients with ischemic stroke. Cerebral angiography is an imaging method with a higher risk of complications compared to other vascular examinations [24]. We also found that the mortality rate of patients with 70% and higher stenosis in DSA was significantly higher ($p=0.01$). The increased mortality risk in these patients may be associated with both angiography complications and the patient's extensive vascular occlusion.

Limitations of the study

The limitations of this study, in which we examined stroke cases, are the small number of patients, the limited examination period of one year, the lack of the NIHS scores of patients diagnosed with acute ischemic stroke, and lack of the echocardiography and rhythm holter data of patients. Conducting these studies with a higher number of patients and for a longer period may contribute further to the literature.

Conclusion

While recurrent strokes are more common in males, we found HT to be the most common comorbid disease. We observed that Doppler USG was not an adequate method in detecting significant stenosis (70% and higher), but it could be used as an important examination method in showing cases without significant stenosis and also in patients to whom angiography could not be applied. We found that patients with hemorrhagic stroke had a higher length of intensive care unit stay, and the mortality rate was significantly higher in patients who had 70% and higher stenosis and underwent interventional angiography.

Conflict of interests
The authors declare that they have no competing interests.

Financial Disclosure
All authors declare no financial support.

Ethical approval
For our study, ethics committee approval was obtained from Inonu University Scientific Research and Publication Ethics Committee with the decision number of 2019/6-13, dated 19.03.2019.

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