

# Evaluation of ABCD<sub>2</sub> score during the development of stroke in COVID-19 patients diagnosed with transient ischemic attack in the emergency department

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*Background:* The aim of the present study is to reveal the association between the risk of stroke using ABCD<sub>2</sub> score and COVID-19 in patients who presented to our emergency department during the pandemic and were diagnosed with TIA. *Methods:* According to the recommendations of the European Stroke Association, patients with an ABCD<sub>2</sub> score of <4 were classified as low-risk, and patients with an ABCD<sub>2</sub> score of ≥4 were classified as high-risk. Within 90 days of the patient's admission to the emergency room, the development of stroke was tracked and recorded on the system. *Results:* Stroke occurred in 35.78% of the patients. Regarding COVID-19, 75.34% of stroke patients were positive for COVID-19 and 65.75% had COVID-19 compatible pneumonia on 'thoracic CT'. Regarding mortality, 16.4% of the patients who were positive for COVID-19 and developed a stroke died. The presence of COVID-19 compatible pneumonia on thorax CT, PCR test result and ABCD<sub>2</sub> score were determined as independent risk factors for the development of stroke. According to the PCR test results, the probability of having a stroke decreases 0.283 times in patients who are negative for COVID-19. According to the PCR test results, the probability of having a stroke increased 2.7 times in COVID-19 positive patients. *Conclusions:* Adding the presence of COVID-19 and the presence of COVID-19 pneumonia to the ABCD<sub>2</sub> score, based on the information about the increased risk of stroke in TIA patients, improves the predictive power of the score. More studies are needed in this regard.

**Keywords:** SARS-CoV-2—Pandemic—Transient Ischemic Attack—ABCD<sub>2</sub> Score  
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## Introduction

Transient ischemic attack (TIA) is defined by the American Stroke Association (ASA) as a transient episode of neurological dysfunction caused by an inability to supply blood to the brain for a certain period.<sup>1,2</sup> Some 240,000 TIAs are reported in the United States annually.<sup>3</sup> Transient ischemic attacks are associated with a 5% permanent stroke risk within 48 hours and 10% within 3 months, unless specifically treated.<sup>4</sup> In other words, TIAs can be considered a precursor to an ischemic CVE, making it

important to subject patients presenting with TIAs to careful examination. The main purpose of evaluating patients presenting with TIAs in the emergency department is to identify any risk factors that may cause stroke and to prevent potential strokes with appropriate treatment.<sup>1,5</sup> Studies have reported that the SARS-CoV-2 virus, which has been affecting the whole world for over two years, can cause cerebrovascular events due to the increased risk of thrombosis and neurotropic effects.<sup>6–8</sup>

The ABCD<sub>2</sub> score, as recommended in guidelines, is the scoring system most commonly used for the determination of the risk of stroke in TIA patients.<sup>9,10</sup> An easy and practical tool, the ABCD<sub>2</sub> score has been found to accurately distinguish between TIA patients who develop a stroke within 7–90 days and those who do not.<sup>11</sup> To date, however, the presence of COVID-19 has not been included in any risk scoring system used to predict the risk of stroke in TIA patients.

The present study investigates the association between the risk of stroke identified based on the ABCD<sub>2</sub> score

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and COVID-19 in patients who presented to our emergency department during the pandemic and were diagnosed with TIA.

## Materials and method

### *Study design and setting*

This observational and retrospective study was conducted at a single center, and was approved by the Turkish Ministry of Health (Date: 01.10.2021 and No: T15-17-23) and the Ethics Committee of Izmir Katip Çelebi University (Date: 21.10.2021 and No: 0434). Included in the study were patients who presented to the emergency department of our hospital between 30.04.2019 and 30.09.2021 and who met the inclusion criteria.

### *Study population*

The data of patients who presented to the emergency department of our hospital during the pandemic and who were diagnosed with TIA based on examination, tests and a neurological assessment were reviewed retrospectively within the hospital automation system. Included in the study were patients who were over the age of 18, with no trauma, who were not pregnant and whose accessed files contained the necessary data.

### *Data collection*

The age, gender, blood pressure and fever of the patients were recorded. Heart rhythm and any abnormalities on the electrocardiograms of the patients were recorded. The complaints of the patients at admission to the emergency department were classified as loss of strength and/or sensation (lower extremities, upper extremities, lower and upper extremities), speech disturbances, and other findings (amnesia, dizziness, clouding of consciousness, vision loss, facial paralysis). TIA is defined by the World Health Organization (WHO) as an acute loss of focal cerebral or ocular function with symptoms lasting less than 24 hours, and which after adequate investigation, are presumed to be due to embolic or thrombotic vascular disease.<sup>5,12,13</sup> As per the recommendations<sup>5,1</sup> in TIA management guidelines of the American Heart Association/American Stroke Association (AHA/ASA) and the European Stroke Association (ESO), the CT brain, CT brain-neck angiography (GE Revolution EVO<sup>®</sup> 128-slice) and diffusion MRI (Siemens Magnetom Aera<sup>®</sup> 1.5 tesla) results were recorded. The patients without acute ischemic restricted diffusion on MRI were considered to have TIA, while those with unilateral/bilateral, complete/partial occlusion/plaque in the internal carotid artery, external carotid artery or carotid artery on CT brain/neck angiography were defined as having a vascular pathology.

The ABCD<sub>2</sub> score was calculated as follows: age >60 (1 point); blood pressure >140/90 mmHg (1 point); clinical

features – unilateral weakness (2 points) or speech disturbance without weakness (1 point); duration of symptoms >60 minutes (2 points) or 10–59 minutes (1 point); and diabetes mellitus (1 point)<sup>5</sup>. Blood pressure was identified based on a systolic pressure of >140 mmHg and/or a diastolic pressure of >90 mmHg at admission. Diabetes mellitus was defined based either on existing history or a new diagnosis.<sup>9,10</sup> As per the recommendations of the European Stroke Association, patients with an ABCD<sub>2</sub> score of <4 were classified as low-risk, and those with an ABCD<sub>2</sub> score of ≥4 as high-risk.<sup>5</sup>

COVID-19, following the Diagnosis and Treatment Protocol for Novel Coronavirus Pneumonia (Trial Version 7), was diagnosed based on the viral nucleic acid determination through the reverse transcription-polymerase chain reaction (Biospeedy<sup>®</sup> RT-PCR test) testing of nasopharyngeal swab samples.<sup>13</sup> Patients with two negative test results were considered negative. The patients were divided into COVID-19 positive and COVID-19 negative groups based on the RT-PCR test results. All acute patients with respiratory system complaints underwent a low-dose thoracic computed tomography (CT). The Thoracic Computed Tomography (TBT) findings for COVID-19 pneumonia were assessed according to the Radiological Society of North America (RSNA) criteria.<sup>14</sup> Patients reported as type 1 and type 2 were considered COVID-19 compatible (Group 1), and those reported as type 3 and type 4 were considered COVID-19 incompatible (Group 2).

The hospitalization type (intensive care/ward) and mortality of the patients were recorded, and the e-Nabız system of the Turkish Ministry of Health was used to learn whether the patients had any CVE within 90 days. Patients who presented to any healthcare facility, including our hospital, within 90 days of the TIA diagnosis, who had focal neurological symptoms and signs persisting for at least 24 hours, who had no signs of mass/bleeding on a brain CT scan, who had MRI findings of acute ischemia and who were diagnosed with acute ischemic stroke after assessment by a neurologist according to the World Health Organization criteria were defined as patients with stroke.<sup>12</sup>

### *Statistical analysis*

The study data was assessed using IBM SPSS Statistics (Version 20.0. Armonk, NY: IBM Corp.). Frequency and percentage distribution were calculated for descriptive statistics, and mean, standard deviation, and minimum and maximum values for continuous variables. Kolmogorov-Smirnov and Shapiro-Wilk ( $p < 0.05$ ) tests were used to analyze the normality of the continuous variables, based on which it was selected whether to use either parametric or non-parametric tests.

Chi-Square test statistics were used to compare the categorical variables between groups, while Mann-Whitney U

statistical analyses were used for comparisons of two groups when the continuous data consisted of non-normally distributed values.

A Binary Logistic Regression model was used to examine the effect of the variables on stroke and the cause-effect relationship between the dependent variable and independent variables.

## Results

The study included 204 patients, 46.08% of which were male, and the mean age was 63±13 years. Stroke occurred in 35.78% of the patients, and 53.43% of the stroke patients were male. There was a statistically significant difference in the patients' blood pressure, fever, ECG findings, presence of DM, and mortality according to stroke status ( $p < 0.05$ ). The majority of patients had symptoms lasting 10–60 min, and the risk of stroke was higher in patients with this duration of symptoms. CT angiography revealed no pathology in the extracerebral arteries in 65.2% of the patients and in 36.98% of the stroke patients. Concerning COVID-19, 75.34% of the stroke patients were COVID-19 positive and 65.75% had COVID-19-compatible pneumonia on "thoracic CT" (Table 1).

Regarding COVID-19 and stroke, the patients who were positive for COVID-19 and who developed stroke were in the advanced age group (67±14), 32.7% had no pathology in the extracerebral arteries, 69.1% had COVID-19 compatible pneumonia and 74.5% had an ABCD<sub>2</sub> score of >4. Concerning mortality, 16.4% of the patients who were positive for COVID-19 and who developed stroke died (Table 2).

Finally, a Binary Logistic Regression analysis was conducted to identify the variables that may affect stroke development in patients diagnosed with TIA. "Stroke Status" was determined as the response variable and the effects of variables that may affect stroke were examined. The presence of COVID-19-compatible pneumonia on thoracic CT, PCR test results and ABCD<sub>2</sub> scores were identified as independent risk factors determining the development of stroke in the patients ( $p < 0.05$ ).

As the ABCD<sub>2</sub> score ( $p = 0.008$ , Exp (B) = 0.399) decreases, so does the probability of stroke up to 0.399 times. The higher the ABCD<sub>2</sub> score, the higher the probability of stroke. Patients with high ABCD<sub>2</sub> scores were 1.5 times more likely to have a stroke than those with low scores. The absence of COVID-19-compatible pneumonia on thoracic CT ( $p = 0.004$ , Exp (B) = 0.240) reduces the probability of having a stroke up to 0.240 times. The probability of stroke increases approximately 3 times in patients identified with COVID-19-compatible pneumonia on thoracic CT. The probability of stroke decreases 0.283 times in patients who are COVID-19-negative based on PCR test results ( $p = 0.001$ , Exp (B) = 0.238). The probability of stroke increases by 2.7 times in

COVID-19-positive patients identified from PCR test results (table 3).

Based on these findings, the parameters with the highest level of effect on stroke risk in TIA patients were identified as ABCD<sub>2</sub> score, PCR test result and the presence of COVID-19-compatible pneumonia on thoracic CT. After determining the variables to be included in the model, first, the effect of the ABCD<sub>2</sub> score, estimating the risk of stroke in patients presenting with TIA, was analyzed (Step 1). Then, two variables (PCR test and thoracic CT) that are used to determine the presence of COVID-19 were added to the ABCD<sub>2</sub> score to assess their effects on stroke (Step 2).

The effect of the score variable on stroke status (Step 1) was found to be significant with a specificity of 87.0%, a sensitivity of 42.8% and a correct classification rate of 72.6%. The Nagelkerke R<sup>2</sup> value was 0.217 and the percentage of variation in the response variable (stroke status) explained by the model was 21.7%. The model was then extended with the addition of PCR test results and the presence of COVID-19-compatible pneumonia on thoracic CT next to the ABCD<sub>2</sub> score, and this model (Step 2) was found to be significant with a specificity of 87.0%, a sensitivity of 54.8% and a correct classification rate of 77.5%. The Nagelkerke R<sup>2</sup> value was 0.331 and the percentage of variation in the response variable (stroke status) explained by the model was 33.1% (Step 2) (table 4).

The Hosmer–Lemeshow test value, which indicates the effectivity of the final model (step 2) in defining the response variable, that is, how well the model fits the data, was found to be significant ( $p = 0.906$ ), which is indicative of a good fit.

## DISCUSSION

Stroke is a medical emergency for which prompt treatment is crucial, as early diagnosis and treatment can prevent permanent brain damage. About a quarter of stroke patients have a TIA prior to the stroke,<sup>5</sup> and TIAs are associated with a permanent stroke risk of 5% at 48 hours and 8–12% at 3 months unless specifically treated. All patients presenting to the emergency department with symptoms suggestive of a TIA require extensive research, aggressive treatment and/or hospital admission, and the identification of those who are most likely to benefit from the treatment. The best-known transient ischemic attack scoring tool for triage is the ABCD<sub>2</sub> score, and some guidelines recommend that all patients with a suspected TIA should undergo triage in the acute phase using the ABCD<sub>2</sub> score.<sup>12</sup>

In the present study, the risk of stroke in TIA patients increased 1.5 times with increases in the ABCD<sub>2</sub> score, three times in the presence of COVID-19-compatible pneumonia on thoracic CT, and 2.7 times with COVID-19 positivity. Based on these findings, we believe that the

**Table 1.** Comparison of general characteristics of patients and parameters in terms of stroke

Variables		All patients n=204 Mean $\pm$ SD (Min -Max)	Developing stroke n=73 Mean $\pm$ SD (Min -Max)	Non- stroke n=131 Mean $\pm$ SD (Min -Max)	p
Age	63 $\pm$ 13 (32 - 90)	65 $\pm$ 15 (32- 90)	62 $\pm$ 12 (33 -86)	0,1	
Systolic BP	137 $\pm$ 25 (96 - 240)	143 $\pm$ 22 (100 - 206)	135 $\pm$ 27 (96 - 240)	0,02	
Diastolic BP	78 $\pm$ 15 (54 - 135)	81 $\pm$ 14 (58 - 135)	77 $\pm$ 15 (54 - 126)	0,01	
Fever	36,9 $\pm$ 0,8 (36,0 - 38,7)	37,16 $\pm$ 0,73 (36 - 38,6)	36,81 $\pm$ 0,73 (36,0 - 38,7)	0	
Gender	Male	94 (46,08)	39 (53,43)	55 (41,98)	0,11
	Female	110 (53,92)	34 (46,57)	76 (58,01)	
ECG	AF	32 (15,69)	16 (21,91)	16 (12,22)	0,07
	SR	172 (84,31)	57 (78,09)	115 (87,78)	
Motor Weakness	Lower Extremity	2 (0,98)	0 (0)	2 (1,56)	0,47
	Upper Extremity	55 (26,96)	21 (28,76)	34 (25,95)	
	Lower and Upper Extremities	41 (20,09)	15 (20,54)	26 (19,84)	
	None	106 (51,96)	37 (50,68)	69 (38,69)	
Speech Disorder	Exist	92 (45,1)	39 (53,43)	53 (40,45)	0,74
	None	112 (54,9)	34 (46,57)	78 (59,54)	
Other Findings	Amnesia	16 (7,84)	5 (6,84)	11 (8,39)	0,34
	Dizziness	16 (7,84)	5 (6,84)	11 (8,39)	
	Consciousness	8 (3,92)	3 (4,1)	5 (3,81)	
	Vision Loss	20 (9,8)	4 (5,47)	16 (12,23)	
	Facial Paralysis	17 (8,3)	6 (8,2)	11 (8,39)	
	None	127 (62,25)	50 (68,49)	77 (52,28)	
Duration of Symptoms	10 min<	72 (35,29)	17 (23,28)	55 (17,77)	0,01
	10-60 min	83 (40,69)	31 (42,46)	52 (32,41)	0,7
	>60 min	50 (24,51)	26 (35,61)	24 (27,18)	0,01
HT	Exist	102 (50)	41 (56,17)	61 (46,57)	0,19
	None	102 (50)	32 (43,83)	70 (53,43)	
DM	Exist	50 (24,51)	31 (42,46)	19 (14,51)	0
	None	154 (75,49)	42 (57,53)	112 (85,49)	
Mortality	Exist	13 (6,37)	9 (12,33)	4 (3,05)	0,01
	None	191 (93,63)	64 (87,67)	127 (96,94)	
Results of CT Angiography	Carotis	6 (2,94)	3 (4,1)	3 (2,29)	0
	No vascular occlusion	133 (65,19)	27(36,98)	106 (80,91)	
	ECA	14 (6,86)	9 (12,32)	5 (3,81)	
	ICA	51 (25)	34 (46,57)	17(12,97)	
Thoracic CT	Covid Compatible	72 (35,29)	48 (65,75)	24 (18,32)	0
	Covid Noncompatible	70 (34,31)	19 (26,03)	51 (38,93)	
	None	62 (30,39)	6 (8,22)	56 (42,74)	
PCR	Covid Negative	108 (52,94)	18 (24,65)	90 (68,70)	0
	Covid Positive	96 (47,06)	55 (75,34)	41 (31,29)	
ABCD2 Score	<4	112 (54,9)	24 (32,87)	88 (67,17)	0

SD: Standart Deviation BP: Blood Pressure ECG: Electrocardiogram AF: Atrial Fibrillation SR: Sinus Rhythm

HT: Hypertension DM: Diabetes Mellitus CT: Computed Tomography ECA: External Carotid Artery

PCR: Polymerase Chain Reaction ICA: Internal Carotid Artery

presence of COVID-19 infection should also be considered when determining the risk of stroke in TIA patients. The model we created by adding COVID-19 positivity and the presence of pneumonia on thoracic CT to the ABCD<sub>2</sub> risk score predicted the risk of stroke with a

specificity of 87%, a sensitivity of 54.8% and an accuracy of 77.5%. The rate of stroke risk estimated by this model was 11.4% higher than that by the ABCD<sub>2</sub> score alone (without adding COVID-19 positivity or thoracic CT findings).

**Table 2.** Evaluation of patients in terms of COVID-19 positivity and stroke development status

		No stroke		Developing stroke	
		Covid Negative Mean + Standard Deviation (Min - Max)	Covid Positive Mean + Standard Deviation (Min - Max)	Covid Negative Mean + Standard Deviation (Min - Max)	Covid Positive Mean + Standard Deviation (Min - Max)
<b>Age</b>		61±12 (33-86)	63±13 (36-84)	60±16 (32-85)	67±14 (32-90)
<b>Systolic BP</b>		132±25 (96-206)	140±30 (110-240)	133±22 (100-188)	146±22 (110-206)
<b>Diastolic BP</b>		76±15 (54-116)	78±16 (57-126)	78±13 (60-110)	82±15 (58-135)
<b>Fever</b>		37±1 (36-39)	37±1 (36- 38)	37±1 (36-39)	37±1 (36-39)
<b>ECG</b>		n (%)	n (%)	n (%)	n (%)
	AF	6 (6.7)	10 (24.4)	1 (5.6)	15 (27.3)
	SR	84 (93.3)	31 (75.6)	17 (94.4)	40 (72.7)
<b>Motor Deficit</b>	Lower Extremity	1(1.11)	1 (2.43)	0 (0)	0 (0)
	Upper Extremity	21(23.33)	13 (31.7)	7(38.88)	14(25.45)
	Lower+Upper Extremity	18 (20)	8(19.51)	2(11.11)	13 (23.63)
	None	50 (55.6)	19 (46.3)	9 (50)	28 (50.9)
<b>Aphasia</b>	Exist	35 (38.9)	18 (43.9)	11 (61.1)	28 (50.8)
	None	55 (61.1)	23 (56.1)	7 (38.9)	27 (49.1)
<b>Other Findings</b>	Amnesia	8 (8.9)	3 (7.31)	0	5 (9.1)
	Dizziness	6(6.66)	4(9.75)	0 (0)	5(9.1)
	Consciousness	3(3.33)	2(4.87)	0 (0)	3(5.45)
	Vision Loss	11 (12.2)	5 (12.19)	2 (11.1)	2 (3.6)
	Facial Paralysis	10(11.11)	2(4.87)	2(11.1)	3(5.45)
	None	52 (57.8)	25 (61)	14 (77.8)	36 (65.5)
<b>Duration of Symptoms</b>	10 min <	41 (45.6)	14 (34.1)	7 (38.9)	10 (18.2)
	10-60 min	32 (35.6)	20 (48.8)	11 (61.1)	20 (36.4)
	>60 min	17 (18.9)	7 (17.1)	0 (0)	25 (45.5)
<b>HT</b>	Exist	41 (45.6)	20 (48.8)	11 (61.1)	30 (54.5)
	None	49 (54.4)	21 (51.2)	7 (38.9)	25 (45.5)
<b>DM</b>	Exist	8 (8.9)	11 (26.8)	5 (27.8)	26 (47.3)
	None	82 (91.1)	30 (73.2)	13 (72.2)	29 (52.7)
<b>Mortality</b>	Exist	2 (2.2)	2 (4.9)	0	9 (16.4)
	None	88 (97.8)	39 (95.1)	18 (100)	46 (83.6)
<b>Vascular Pathology</b>	Carotis	0 (0)	3(7.31)	1(5.55)	2(3.63)
	No Vascular Occlusion	74 (82.2)	32 (78)	9 (50)	18 (32.7)
	ECA	4(4.44)	1 (2.43)	3(16.66)	6(10.90)
	ICA	12(13.33)	5(12.19)	5(27.77)	29(52.72)
<b>Thoracic CT</b>	Covid compatible	10 (11.1)	14 (34.1)	10 (55.6)	38 (69.1)
	Covid noncompatible	31 (34.4)	20 (48.8)	4 (22.2)	15 (27.3)
	None	49 (87.5)	7 (17.1)	4 (22.2)	2 (3.6)
<b>ABCD2 Score</b>	Low Risk	67 (74.4)	21 (51.2)	10 (55.6)	14 (25.5)
	High Risk	23 (25.6)	20 (48.8)	8 (44.4)	41 (74.5)

ABCD2: Age, Blood Pressure, Clinical Features, Duration of TIA, Diabetes BP: Blood Pressure ECG: Electrocardiogram AF: Atrial Fibrillation SR: Sinus Rhythm

HT: Hypertension DM: Diabetes Mellitus CT: Computed Tomography

Among the clinical features identified in the present study, as one of the parameters assessed when calculating the ABCD<sub>2</sub> score, speech disturbance and weakness in the upper extremities were the most common presenting symptoms at the time of admission to the emergency

department with TIA. Similarly, the study by Ilstet et al. of TIA patients reported speech disturbance (aphasia and dysarthria 46.2%) and weakness in the upper extremities (34.1%) to be the most common presenting symptoms.<sup>15</sup> Purroy et al. also reported speech disturbance and motor

**Table 3.** Binary Logistic Regression analysis for variables that may affect the risk of stroke development in patients

		Variables in the Equation							
		B	S.E.	Wald	df	Sig.	Exp(B)	95% C.I. for EXP(B)	
								Lower	Upper
Step 2	ABCD2 SCORE (1)	-,919	,346	7,064	1	,008	,399	,203	,786
	CT(1)	-1,428	,496	8,276	1	,004	,240	,091	,634
	PCR(1)	-1,264	,364	12,087	1	,001	,283	,139	,576
	Constant	,767	,255	9,036	1	,003	2,153		

**Table 4.** Model created using parameters found to be effective on the risk of stroke development

Step	Specificity	Sensitivity	Overall Percentage
Step 1	87,0	42,8	72,6
Step 2	87,0	54,8	75,5

weakness to be the most common presenting symptoms, but underlined that the presenting symptom alone was not a determining factor for the risk of stroke.<sup>16</sup> The present study revealed no difference in symptoms between those with and without stroke, although the duration of symptoms, blood pressure and presence of DM, which are among the parameters measured in ABCD<sub>2</sub> scoring, were statistically different between those with and without stroke. When the calculated ABCD<sub>2</sub> score was assessed based on these parameters, stroke was seen to occur in 53.26% of the patients with an ABCD<sub>2</sub> score of  $\geq 4$  in the present study. Similar to our findings, Johnston et al. reported the ABCD<sub>2</sub> score to be an independent predictor of 2, 7 and 90-day stroke risk.<sup>9</sup> According to our findings, and in line with these studies, these parameters should be considered when assessing TIA patients in the emergency department, and it should also be considered that TIA patients are at risk of SARS-CoV-2 infection during the pandemic. The present study is the first to evaluate the impact of COVID-19 on the risk of stroke in TIA patients.

The CNS effects of the SARS-CoV2 virus have yet to be clarified, although it has been suggested that the virus causes neuronal damage by directly passing through the blood-brain barrier through neurotropism and increases the thrombotic tendency, leading to venous and arterial thromboembolism.<sup>7,17,18</sup> A clinical study reported that cerebrovascular events occurred in the early stages of the disease in all four of their stroke cases and were also positive for COVID-19.<sup>19</sup> Oxley et al. reported a case of stroke due to thrombosis in five large vessels among COVID-19 patients,<sup>20</sup> and further studies have suggested that hypoxia due to cardiac and respiratory involvement and the cytokine storm caused by the virus may impair blood flow to the brain, causing ischemia in stroke patients with no vascular pathology who are considered

cryptogenic.<sup>21–23</sup> AHA and European Stroke Organization (ESO) guidelines recommend the imaging of the brain-neck arteries.<sup>1,5</sup> Siegler et al. assessed stroke in COVID-19 patients and reported the detection of no extracerebral artery occlusion in 42% of the 156 stroke patients examined.<sup>23</sup> Evaluating the presence of COVID-19 in stroke patients, Dhamoon et al. also reported a high rate of stroke of undetermined origin (cryptogenic stroke) among COVID-19-positive patients.<sup>22</sup> In a similar study, Topçuoğlu et al. compared 355 COVID-19 negative and 37 COVID-19 positive patients with ischemic stroke, and reported intensive care unit admission, the need for mechanical ventilation and mortality to be significantly higher in COVID-19-positive patients, and that COVID-19 was associated with poor prognosis. In the study, 110 patients were diagnosed with TIA, and of the four who were positive for COVID-19, three were classified as cryptogenic.<sup>21</sup> The present study identified no arterial pathology in 32.7% of the COVID-19-positive patients who had a stroke, which leads us to believe that the presence of COVID-19 should be considered when estimating the risk of stroke in TIA patients with normal CT brain-neck angiography.

There have been a number of studies reporting cerebrovascular events to be associated with a poorer prognosis in severe COVID-19 cases with pneumonia.<sup>18,22</sup> Görgülü et al. assessed the neurological findings accompanying COVID-19 and reported that 62% of the patients were positive for COVID-19, while 59.5% developed ischemic stroke. The common feature of all patients was the presence of COVID-19-compatible pneumonia.<sup>18</sup> Dhamoon et al., on the other hand, reported 38% of 277 stroke patients to be positive for COVID-19, and further, that 67.7% of these patients had COVID-19-compatible pneumonia, with stroke, hemorrhage and TIA being more common in COVID-19-positive patients. The authors also reported a poor prognosis in these patients.<sup>22</sup> In the present study, 65.75% of the stroke patients had COVID-19-compatible pneumonia, compared to 69.1% in those with COVID-19-compatible pneumonia in addition to COVID-19 positivity. It can be argued that the presence of COVID-19-compatible pneumonia in addition to COVID-19 positivity further increases the risk of stroke. We believe, thus, that patients who classified as TIA during the pandemic

should also be examined for COVID-19 positivity and COVID-19 pneumonia.

COVID-19 has been identified by the World Stroke Organization as a risk factor for stroke.<sup>24</sup> The first symptoms of COVID-19 can be neurological, and can be the precursor of stroke.<sup>19</sup> Studies have reported varying levels of stroke risk in COVID-19 patients. Mao et al. reported that approximately 6% of their COVID-19 patients experienced a stroke.<sup>25</sup> Qureshi et al. examined 8,163 COVID-19 in patients from multiple centers in the United States and detected ischemic stroke in 1.3%,<sup>26</sup> while study by Marcus et al. reported that 2.8–6% of COVID-19 patients had neurological symptoms that manifested as acute stroke, and most (80%) were ischemic.<sup>24</sup> Consistent with these studies, the present study identified the ABCD<sub>2</sub> score, the presence of COVID-19 (PCR) and the presence of COVID-19-compatible pneumonia (on thoracic CT finding) as the primary factors affecting the risk of stroke in patients with TIA.

## Conclusion

The inclusion of COVID-19 and COVID-19 pneumonia to the ABCD<sub>2</sub> score, which is used for the prediction of risk in TIA patients, based on information about the increased risk of stroke in TIA patients, improves the predictive power of the tool. We believe that PCR test results and the presence of COVID-19 pneumonia should be considered in the stroke risk assessment of TIA patients, although more comprehensive studies are needed in this regard.

## Conflicts of interest

Each author declares that he or she has no commercial associations (e.g. consultancies, stock ownership, equity interest, patent/licensing arrangement, etc.) that may be considered a conflict of interest in connection with the submitted article.

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