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Research Paper

Investigating Cerebrovascular Events in Brain CT Scan of COVID-19 Patients

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ABSTRACT

Background and Aim: The present study was conducted to investigate cerebrovascular accidents in brain computerized tomography (CT) scans of COVID-19 patients during 6 months in Ali Ibn Abi Talib Hospital in Rafsanjan City, Iran.

Materials and Methods: The present research was descriptive and correlational. The statistical population of this research included the records of all patients referred to Ali Ibn Abi Taleb Hospital from October 2019 to March 2020, whose corona test results were positive and they underwent brain imaging (computerized tomography [CT] scan). The results were obtained from the patient's files and the census sampling method. After collecting the data, SPSS software was used to analyze the data.

Results: The results showed no relationship between the variables of age, sex, medical and drug history, disease severity, and outcome (death, recovery) with the occurrence of acute cerebral hemorrhage ($P>0.05$). However, a relationship is observed between the variable of medical and drug history, disease severity, and outcome (death, recovery) with the incidence of ischemia ($P<0.05$)

Conclusion: Considering the relationship between the patient's medical and drug history, the severity of the patient's disease, and the outcome (death, improvement) of the disease on the patient with the occurrence of acute ischemia, it is suggested that the results of this research be investigated more precisely.

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1. Introduction

The novel coronavirus started in December 2019 and spread rapidly around the world, leading to a global pandemic [1-3]. This virus has similarities in cellular involvement and symptoms with the severe respiratory syndrome of COVID-19 and it is called severe respiratory syndrome of the severe acute respiratory syndrome coronavirus 2(SARS-CoV-2), which leads to COVID-19. While severe acute respiratory syndrome coronavirus (SARS-CoV-2) is known to cause severe respiratory distress, an increasing number of neurologic manifestations have been reported [4-6]. Various types of neurological manifestations have been reported in COVID-19, affecting 36.4% of patients according to a report from Wuhan, China [7]. Clinically, acute ischemic infarction and intracranial bleeding have been observed in these patients [8]. Considering the change of mental state in patients with COVID-19 secondary to respiratory distress, brain imaging is often considered [9].

Neuroimaging findings in patients with COVID-19 that have been reported so far include encephalitis/meningitis, posterior reversible encephalopathy syndrome (PRES) (a neurotoxic condition secondary to dysregulation of the posterior circulation in response to acute changes in blood pressure), acute disseminated encephalomyelitis (ADEM) (characterized by acute monophasic inflammation and myelination of white matter after viral infection) [10-12], cerebral venous thrombosis, and acute ischemic stroke [13, 14]. While articles describing neurologic symptoms in patients with COVID-19 are growing, little information has been published about neuroimaging findings except for case reports and fewer cases. We aim to report neuroimaging findings in a cohort of patients with to COVID-19 in Ali Ibn Abi Taleb hospital centers in Rafsanjan City. The spread and the global epidemic of COVID-19 as a new disease create many questions in the mind. With increasing awareness of this disease, many non-pulmonary symptoms are also recognized, especially central nervous system (CNS) and peripheral nervous system (PNS) neurological symptoms, which include dizziness, headache, nausea, vomiting, and hypoesthesia, indicating that the virus enters the central nervous system (CNS) and then damages certain nuclei and nerve pathways. According to the studies conducted, patients with COVID-19 suffer from stroke, cerebral hemorrhage, and other disorders affecting the brain. Experiences have also shown that neurological symptoms are associated with more severe respiratory disease. Imaging methods help doctors confirm the form and severity of the disease and help make the final decision about how to care for patients.

Cerebrovascular events may be caused by abnormal blood clotting indirectly caused by this virus. According to the scattered reports of the complications of this disease, such as neurological complications in this study, we decided to investigate these cases in our region and their relationship with the COVID-19 disease.

2. Material and Methods

This study was a retrospective analysis. In this study, the files of all patients referred to Ali Ibn Abi Taleb Hospital from October 2019 to March 2020, whose corona test results were recorded during hospitalization positive with positive neurological symptoms undergoing brain imaging (computerized tomography [CT] scan) were included in the study. The sampling method was census and 312 people were included in the study. Health records and neuroimaging studies for age, sex, type of patient (outpatient or inpatient), clinical symptoms for brain imaging (from clinical notes), imaging findings, and the 2-week outcome (mortality, transfer to hospital or intensive care unit (ICU) or care status, improved or stable clinical status) were analyzed. All imaging was reviewed by a neurologist and data were recorded. Also, the laboratory information of the patients was recorded to find causal relationships in the patients with COVID-19. Finally, all the collected data were entered into SPSS software version 22 and analyzed with independent t-tests and Fisher's exact test. A statistically significant level of 0.05 was considered for all tests.

3. Results

A total of 147 female patients (47.1%) and 165 male patients (52.9%) were studied. The age of most patients referred with COVID-19 (42.32) is between 50 and 70 years and the least of them (4.8) are over 90 years. Table 1 presents the frequency of disease history, the severity of COVID-19, disease outcome, acute cortical hemorrhage, and acute ischemia.

No significant statistical relationship was observed between CT scan results, acute bleeding with age (P=0.95), sex (P=0.56), underlying disease history (P=0.88), disease severity (P=0.73), and outcome (P=0.46). In the case of acute ischemia, no significant statistical relationship was observed between age (P=0.44), and gender (P=0.66). Regarding the history of underlying disease in patients who suffered from acute ischemia, 27 patients (8.7%) had an underlying disease and 3 patients (1%)

Table 1. Descriptive statistics for patients' demographic information

Variables			No. (%)
Age (y)	>50		37(11.9)
	50-70		134(42.9)
	70-90		126(40.4)
	<90		15(4.8)
Clinical symptoms	Fever	Yes	231(74)
		No	81(26)
	Cough	Yes	200(64.1)
		No	112(35.9)
	Dyspnea	Yes	148(47.4)
		No	164(52.6)
	Others	Yes	140(44.9)
		No	172(55.1)
PMH		Yes	177(56.7)
		No	135(43.3)
History of underlying disease	HTN	Yes	131(42)
		No	181(58)
	DM	Yes	103(33)
		No	209(67)
	CVD	Yes	130(41.7)
		No	209(67)
	RF	Yes	69(22.1)
		No	243(77.9)
	Respiratory diseases	Yes	97(31.1)
		No	215(68.9)
	Cancer	Yes	39(12.5)
		No	273(87.5)
Habitual history		Yes	45(14.4)
		No	267(85.6)
Smoker		Yes	23(7.4)
		No	289(92.6)
Severity	Mild		83(26.6)
	Moderate		92(29.5)
	Severe		109(34.9)
	Very severe		28(9)
Outcome	Alive		280(89.7)
	Death		32(10.3)
Acute cortical hemorrhage		Yes	5(1.6)
		No	307(94.8)
Acute ischemia		Yes	30(9.6)
		No	282(90.4)

PMH: Past medical history; HTN: Hypertension; DM: Diabetes mellitus; CVD: Cardiovascular diseas; RF: Rheumatoid factor.

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did not have an underlying disease, and a statistically significant relationship was observed between acute ischemia and underlying disease (P=0.00). The severity of the disease in patients with acute ischemia was as follows, 5 patients (1.6%) had mild disease severity, 4 patients (1.3%) had moderate disease severity, 10 patients (3.2%) had severe disease, and 11 patients (3.5%) had severe ischemia. A statistically significant relationship was observed between acute ischemia and the severity of the disease (P=0.00). Regarding the outcome with acute ischemia, the results showed that recovery occurred in 19 patients (6.1%) who suffered from acute ischemia, and death occurred in 11 cases (3.5%). A statistically significant relationship was observed between the outcome and acute ischemia (P=0.00) (Table 2).

4. Discussion

Our study showed no relationship between age and the occurrence of acute cerebral hemorrhage and the occurrence of acute ischemia in people with COVID-19. The result of the research is consistent with the previous research [15], showing different results for age during COVID-19 and its impact on neurological and brain problems. In using the survey tool, the correct selection of the statistical sample and the predictability of the relationship between the variables were considered due to the absence of a relationship between age and the incidence of cerebral hemorrhage/acute ischemia in people with COVID-19. Also, in these studies, different results of the gender variable existed during COVID-19 and its impact on neurological and brain problems. It seems that the reason for the alignment of the present research results with the previous research expressed in the use of the survey tool is the correct selection of the statistical sample and the predictability of the relationship between the variables. In our study, no relationship is observed between gender and the incidence of cerebral hemorrhage/acute ischemia in people with COVID-19.

Based on the results of many studies, the presence of diseases in the study area has shown that the prevalence of stroke in men is slightly higher than in women [16]. Also, in our study, a statistically significant relationship was observed between acute ischemia and the underlying disease. The result of the present research is consistent with Radmensch et al. [17], Mao et al. [4], Wang et al. [18], and Koralnik et al.'s studies [19]. It seems that the reason for the alignment of part of the hypothesis with previous studies is the predictability of general and global results and the common impact over time, and the inconsistency of the research result with part of the previous research results is expressed in the use of survey tools, statistical sample selection, as well as the unpre-

Table 2. Computerized tomography (CT) scan findings with demographic variables of patients

Variables		Acute Bleeding		P	Acute Ischemia		P
		No. (%)/Mean±SD			No. (%)/Mean±SD		
		Yes	No		Yes	No	
Age (y)		68.2±15.12	67.75±16.1	0.95	69.9±15.01	67.53±16.18	0.44
Sex	Female	3(1)	144(2.46)	0.56	13(2.4)	134(9.42)	0.66
	Male	2(6)	163(2.52)		17(4.5)	148(4.47)	
PMH	Yes	3(1)	174(8.55)	0.88	27(7.8)	150(1.48)	0.00
	No	2(6)	133(6.42)		3(1)	132(3.42)	
Severity	Mild	1(3)	82(3.26)	0.73	5(6.1)	78(25)	0.00
	Mod	2(6)	90(8.28)		4(3.1)	88(2.28)	
	Severe	1(3)	108(4.36)		10(2.3)	99(7.31)	
	Very severe	1(3)	27(7.8)		11(5.3)	17(4.5)	
Outcome	Recovery	4(3.1)	276(5.88)	0.46	19(1.6)	261(7.83)	0.00
	Death	1(3)	31(9.9)		11(5.3)	21(7.6)	

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dictability of the relationship between the variables. Consistent with the results obtained, it can be stated that the spread of the coronavirus to the body does not only cause lung involvement but can also cause serious damage to the brain and its vessels. In other words, this disease lurks with an unknown behavior to cause damage to the human brain which is a critical issue.

One of the mechanisms of the coronavirus is its attack on the conduction system of the human heart and brain, which causes a person to experience an increase or decrease in heart rate. This cardiac disease harms the process of brain function. Another complication of this virus is the formation of blood clots in the blood vessels of the brain and stroke in some patients. According to the observations made in global research, about four to five percent of patients with COVID-19 have had strokes. On the other hand, about 25% to 30% of the patients who have problems related to the brain and nerves are infected with the coronavirus. The research results have shown that in terms of the severity of the disease, COVID-19 disease has four spectrums, mild, moderate, severe, and critical [20]. As it is clear from the results, a relationship was observed between the outcome variable (death, recovery) and the incidence of ischemia. The result of the research is consistent with the results of Sharifian et al.'s study [21]. Therefore, while most people with COVID-19 recover and return to their normal health, some patients can have symptoms that may persist for weeks or even months after recovery and people may even die. Even people who are not hospitalized and have a mild illness can experience persistent or late symptoms. COVID-19 can cause blood cells to clot and cause heart and brain attacks, but it is believed that most of the heart damage caused by COVID-19 comes from very small clots that clog small blood vessels which block the capillaries in the heart muscle. Other parts of the body that are affected by blood clots include the lungs, legs, liver, and kidneys.

COVID-19 can also weaken blood vessels and cause them to leak, leading to possible long-term liver and kidney problems. The organs (heart and blood vessels, lungs, brain, etc.) of the recovered person's body may be damaged. Many of the long-term effects of COVID-19 are still unknown, and future clinical research will shed light on many of these issues. In a review study conducted in Iran, it was stated that cerebral vein thrombosis is commonly present in hospitalized patients with COVID-19. Therefore, cerebral venous thrombosis should be included in the differential diagnosis of neurologic syndromes associated with COVID-19 infection [18].

In another study conducted in Iran, it was stated that the infection of COVID-19 increases the risk of acute ischemic stroke [19]. One of the limitations of this study is that due to the high prevalence of COVID-19 at the time of the study and a large number of hospitalized patients and the existence of limitations, such as the presence of only one magnetic resonance imaging (MRI) machine, patients who presented with neurological symptoms were 1st subjected to a CT scan of the brain, showing hemorrhage and ischemia in a limited number of patients whose symptoms persisted, but the CT scan was reported to be normal. It was tried to repeat the CT scan as much as possible, and in rare cases, MRI was performed if no diagnosis was made. Therefore, the MRI findings were not included in our study due to their incompleteness. Also, in this study, the person who was hospitalized with symptoms of COVID-19 and lung involvement, whether with or without ischemia or bleeding (based on a primary CT scan or control CT scan), the arterial or venous pattern of ischemia was not stated as part of the study objectives because the purpose of the study was CT scan and detailed examination of these patterns or thrombus examination with magnetic resonance venography (MRV). It is suggested to identify the underlying diseases and the severity of the diseases in the young and the elderly, it should be done regularly every few months so that people become aware of their physical weaknesses and self-care solutions should be added to mass media programs so that people consider health techniques and measure their physical conditions better and find ways to improve their diseases as much as possible.

5. Conclusion

Considering the variable relationship between the patient's medical and drug history, the severity of the patient's disease, and the outcome (death, improvement) of the disease on the patient with the occurrence of acute ischemia, it is suggested that the results of this research be investigated in a more detailed investigation and recognition.

Ethical Considerations

Compliance with ethical guidelines

This article has been approved by the Ethics Committee of Rafsanjan University of Medical Sciences with the code of ethics (IR.RUMS.REC.1400.159).

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Authors' contributions

All authors participated in the design, execution, and writing of all parts of this research.

Conflict of interest

All authors declare no conflict of interest.

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