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Article

Is There Any Importance of Brain Tomography and Diffusion Magnetic Resonance Imaging in COVID-19 Patients?

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Abstract: Background: As coronavirus (COVID-19) continues to pose a threat to the entire world, it is critical to developing strategies for containing its spread. The purpose of this study was to assess the demographic characteristics, brain tomography characteristics, and diffusion magnetic resonance findings of COVID-19 positive individuals. Material and Method: Between January 1 and December 31, 2021, 317 patients over the age of 18 were admitted to the emergency department with symptoms consistent with COVID-19. Three groups were formed based on clinical findings in patients, divided into light, medium, and severe, and four groups were formed based on radiological imaging findings. Results: The mean age of the 317 patients included in the study was 67.28±12.06 years, with a range of 28-91 years. The clinical classification of the patients was based on laboratory parameters and radiological imaging, not on their age or gender. Mild cases were classified as CO-RADS 0-4; moderate and severe cases were classified as CO-RADS 5-6 (p=0.001). While 60 (18.9%) of patients were followed outpatient, 144 (45.4%) were admitted to the hospital, 73 (23%) were admitted to the intensive care unit, and 40 (12.7%) died (p=0.001). Direct radiographs revealed bilateral involvement in 224 (70.7%) cases, peripheral involvement in 259 (81.7%) cases, and mid-lower lobe lung involvement in 194 (61.2%) cases (p=0.001). Brain tomography revealed infarction in 42 (13.2%) of the patients who were followed and hospitalized and hemorrhage in 22 (6.9%) of the patients. Magnetic resonance imaging revealed diffusion involvement in 68 (21.5%) of the cases (p=0.001). Conclusion: A standardized reporting system for COVID-19 data is required, and it must be simple to use, quick to understand, and focused on determining the risk of pneumonia. Additionally, the diagnostic role of radiological imaging, prognosis prediction, and severity scoring of lung involvement should be included.

Keywords: Emergency department; COVID-19; lung radiography; computed tomography; diffusion magnetic resonance

1. Introduction

Coronavirus disease (COVID-19), which is caused by severe acute respiratory syndrome coronavirus-2 (SARS-CoV-2), can cause viral pneumonia, which has a high mortality rate, particularly in the elderly and chronically ill [1]. COVID-19 enters human cells via Angiotensin-Converting Enzyme-2 (ACE-2) receptors, according to data [2]. Since the virus began rapidly spreading in early 2020, findings on the imaging of COVID-19 patients have taught the medical community a great deal. Due to the disease's primary focus on the respiratory system, radiological imaging methods have been thrust into the spotlight. Lung radiography is associated with false negativity in 30-35 percent of patients with COVID-19 pneumonia at an early stage. Although lung radiography has a sensitivity of 30-60%, its specificity can approach 90% in patients with typical clinical findings and cases with a high incidence in society [3]. As a result, thoracic computed tomography (CT) is the most frequently used technique for diagnosing COVID-19. Although thoracic CT has a higher sensitivity than the current Real-Time Polymerase Chain Reaction (RT-PCR)

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method [4], it is worth noting that CT results may appear normal during the early stages of the disease. The normal chest CT examination does not rule out the possibility of COVID-19. COVID-19 is a multisystem disease with a predominance of lung involvement. According to some studies, lung findings on CT were found in 80 percent of symptomatic patients and 54 percent of asymptomatic patients [5]. Additionally, no lung findings were detected on CT in 4–14% of all COVID-19 cases confirmed by RT-PCR, regardless of whether symptoms of lung disease were present [6,7]. Imaging is not recommended in asymptomatic patients or those with mild clinical situations if there are no risk factors for disease progression. Imaging is recommended for patients who have a moderate or severe clinical situation regardless of the RT-PCR test result, as well as for patients who have a positive test result in the event of progression [8].

In a case series involving 214 patients with COVID-19, it was discovered that, in addition to systemic symptoms, 36.4 percent of patients experienced neurological complications [9]. The most common neurological findings include headache, dizziness, impaired consciousness, encephalitis, encephalopathy, cerebrovascular disease, peripheral nervous system damage, and neuromuscular disorders [9,10]. These clinical findings necessitate immediate treatment to avert further morbidity and/or mortality. Anamnesis, a neurological examination, determination of the stroke scale, and cranial CT imaging are used to diagnose acute cerebrovascular disease. It is recommended to perform a non-contrast cranial CT scan within 25 minutes of the onset of acute cerebrovascular disease and to evaluate within 45 minutes. Among the advanced examination imaging techniques necessary to avoid delaying thrombolytic therapy in a patient with no evidence of bleeding, the most critical is diffusion magnetic resonance imaging (dMRI), which can be used rapidly [10,12].

Each day, new information about COVID-19 infections that have spread across the globe becomes available. They can cause lung disease, but they can also result in serious systemic diseases. As such, we sought to determine the relationship between COVID-19 patients' clinical, COVID-19 Reporting and Data System (CO-RADS), laboratory, and radiological imaging findings and their mortality rates.

2. Material and methods

Study Design and Population

This study included 317 patients over the age of 18 (135 women and 182 men) who were admitted to the emergency department with COVID-19 between January 1 and December 31, 2021. The mean patient age was 67.28±12.06 years and the distribution was 28-91 years.

All patients tested positive for RT-PCR. Mild, moderate, and severe were classified according to their clinical status at the time of emergency admission. During these patients' admissions, hemograms, biochemistry, C-reactive protein, albumin, D-Dimer, fibrinogen, ferritin, and troponin I were evaluated. Each patient was admitted to the emergency department and underwent computed tomography (CT) of the thorax with direct lung radiography. Brain CT and diffusion magnetic resonance imaging (dMRI) were performed on outpatients and hospitalized patients in response to changes in their clinical status. Additionally, chest X-rays, thorax and brain CT scans, and dMRI imaging were performed on patients admitted to the intensive care unit with a poor clinical outcome, a low coma score, or who were intubated in the emergency department. For these imaging procedures, informed consent was obtained from the patient and/or relatives.

The study included all patients over the age of 18 who were admitted to the emergency department with positive RT-PCR results and underwent clinical, laboratory, and radiological imaging.

On the other hand, patients with a history of cerebrovascular disease, those who were pregnant, and those who did not have hemogram, biochemistry, or other laboratory results, direct lung radiography, thorax, or brain CT or dMRI were excluded from the study.

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***Clinical classification*:** COVID-19 infections are classified clinically as mild, moderate, or severe (critical) illness. Mild disease is used to describe cases with mild symptoms and, at the most severe, mild pneumonia. This classification applies to 81% of all cases. Moderate illness refers to cases with severe symptoms such as dyspnea or hypoxia, or to cases in which more than 50% of the lungs are affected within the first 24 to 48 hours after diagnosis. This group accounts for 14% of all cases. Critical (severe) illness indicates cases requiring intensive care monitoring due to a severe clinical presentation, such as respiratory failure, shock, or multiorgan failure. This group accounts for 2.3 percent of all cases [13].

The patients were classified into seven groups using the C0-RADS classification [14]. Four groups were established based on the patients' termination status in the emergency department: outpatient follow-up, hospitalization, intensive care unit, and mortality.

Regarding radiological imaging, four groups were established: direct radiography, thoracic CT, brain CT, and diffusion MRI. Three classifications were established based on direct radiographs of lung involvement. Between themselves, these were classified as normal, unilateral, bilateral, central, peripheral, upper lop, middle-lower lop, and multiple. Nine conditions were defined based on the pathological appearance of the lungs on thoracic CT scans. Brain CT scans were classified as infarction or hemorrhagic. Infarction and hemorrhagic conditions were classified into nine subgroups based on vascular or parenchymal involvement in the brain. Nine groups were established based on changes in the clinical status of the patients using dMRI imaging.

All patients' demographic, clinical, and laboratory data, as well as radiological imaging, were analyzed and recorded using the hospital automation system. The study was approved by the local ethics committee in accordance with the Helsinki Declaration's principles.

Statistical Analysis

The data from this study were analyzed using the SPSS 20.0 software package (SPSS Inc., Chicago, IL, USA). The normal distribution of variables was investigated using Shapiro Wilk's method. For continuous variables, descriptive statistics were presented as mean standard deviation or median (minimum-maximum), while nominal variables were presented as some cases and percentages. Because the variables did not follow a normal distribution, the Mann-Whitney U and Kruskal Wallis-H tests were used to determine the differences between the groups. P0.05 was considered statistically significant when interpreting the results.

3. Results

According to the clinical conditions of the patients, there was no significant difference between age and gender. Clinical classifications being, blood sugar 158.27±63.44 mg/dL (p=0.012), urea, uric acid, aspartate aminotransferase, alanine aminotransferase, alkaline phosphatase, lactate dehydrogenase, bilirubin, creatine kinase, C-reactive protein 65.41±37.02 mg/dL (p=0.001), D-dimer 588.23±207.64 ugFEU/mL (P=0.001), ferritin 225.85±127.78 ml/ng (p=0.001), fibrinogen 414.06±131.81 mg/dL (p=0.001), albumin 3.61±0.62 mg/dL (p=0.006), Troponin I 0.34±0.34 ng/mL (p=0.001), white blood cell (WBC) 17.85±5.65 10^^{3}/UL (p=0.001), platelet 236.75±83.26 x 10^3/μL (p=0.001), neutrophil 8.42±2.33 10^^{3} /μL (p=0.003) and neutrophil lymphocyte ratio (NLR) 4.79±2.19% (p=0.001); there was a significant differentiation between groups. However, there was no statistically significant difference in creatinine, creatine kinase-MB, hemoglobin and lymphocyte (**Table 1**).

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Table 1. Clinical and laboratory findings of COVID-19 patients.

Clinical Classification of COVID-19 Patients						
Clinics		All Patient n:317 Mean±SD	Mild n:96 Mean±SD	Moderate n:113 Mean±SD	Severe n:108 Mean±SD	p-value
Age, year		67.28±12.06	66.62±12.07	68.76±12.03	66.31±12.05	0.389
Gender (Female/Male)		135/182	39/57	48/65	48/60	0.582
Laboratory Findings						
Biochemistry	**Blood Sugar,** mg/dL	158.27±63.44	145.26±42.12	160.56±79.45	167.43±58.84	**0.012**
	Creatinine, mg/dL	0.98±0.64	0.88±0.30	1.02±0.75	1.03±0.73	0.453
	Urea, mg/dL	42.91±23.92	37.04±17.38	45.08±27.35	45.85±24.37	**0.003**
	Uric acid, mg/dL	6.71±2.04	6.69±1.33	7.03±2.03	6.38±2.50	**0.004**
	AST, U/L	37.28±23.41	36.53±19.41	45.58±27.94	29.27±18.15	**0.001**
	ALT, U/L	32.81±23.24	30.92±20.08	40.54±25.33	26.42±21.41	**0.001**
	ALP, mg/dL	118.67±60.72	120.09±61.90	128.21±61.17	107.42±57.82	**0.015**
	LDH, U/L	392.73±141.78	358.75±134.78	429.73±131.96	384.23±149.85	**0.001**
	Bilirubin, mg/dL	0.59±0.36	0.85±0.40	0.81±0.43	0.59±0.37	**0.001**
	CK, U/L	149.48±108.36	149.83±116.42	169.22±122.65	128.50±77.70	**0.013**
	CK-MB, ng/mL	30.13±18.02	29.59±16.49	31.18±17.88	29.52±19.51	0.732
	CRP, mg/dL	65.41±37.02	28.81±17.02	74.92±32.22	88.00±29.87	**0.001**
	D-Dimer, ugFEU/mL	588.23±207.64	469.17±184.39	608.62±196.64	672.73±190.52	**0.001**
	Ferritin, mL/ng	225.85±127.78	155.60±76.43	225.98±132.80	288.17±127.93	**0.001**
	Fibrinogen, mg/dL	414.06±131.81	351.04±158.53	441.52±106.96	441.35±109.12	**0.001**
	Albumin, g/dL	3.61±0.62	3.78±0.65	3.58±0.63	3.49±0.55	**0.006**
	Troponin I, pg/mL	0.34±0.34	0.20±0.27	0.35±0.36	0.46±0.33	**0.001**
Hemogram	**WBC, $10^3/\mu L$**	17.85±5.65	14.50±3.61	18.63±4.41	20.01±6.84	**0.001**
	Hemoglobin, g/dL	13.07±1.91	13.01±1.81	12.85±2.02	13.34±1.85	0.134
	Platelet, $10^3/\mu L$	236.75±83.26	290.61±88.80	232.77±76.38	193.05±53.06	**0.001**
	Neutrophil, 10^3/UL	8.42±2.33	8.07±2.32	8.10±2.10	9.06±2.45	**0.003**
	Lymphocyte, 10^3/UL	2.07±0.76	2.26±0.88	1.99±0.76	1.98±0.59	0.059
	NLR, %	4.79±2.19	4.07±1.91	4.98±2.15	5.23±2.31	**0.001**

SD: Standard Deviation, ALT: Alanine Aminotransferase, AST: Aspartate Aminotransferase, ALP: Alkaline Phosphatase, LDH: Laktat Dehidrogenaz, CK: Creatine Kinase, CK-MB: Creatine Kinase-MB, CRP: C-reactive protein, WBC: White Blood Cell, NLR: Neutrophil Lymphocyte Ratio

According to the clinical characteristics of the patients, those with the mild clinical course were found to have CO-RADS 0-4, and moderate and severe patients had CO-RADS 5-6 (p=0.001). A total of 60 (18.9%) were hospitalized after outpatient follow-up, 144 (45.4%) were hospitalized 73 (23%) were admitted to the intensive care unit, and 40 (12.7%) resulted in mortality (p=0.001). For the direct radiographs, 54 (17%) were considered unilateral, 224 (70.7%) were bilateral, 32 (10.1%) were central, 259 (81.7%) were peripheral, 20 (6.3%) were upper lobe, 194 (61.2%) were mid-lower lobe, and 79 (24.9%) had multiple lung involvement (p=0.001). As for thoracic CT, 81 (25.6%) had frosted glass opacity, 42 (13.2%) had consolidation, 24 (7.6%) had paving stone, 41 (12.9%) had air bronchogram, 17 (5.4%) had airway alteration/ air cyst, reticular appearance was detected in 33 (10.4%), nodular appearance in 23 (7.3%), vascular expansion in 30 (9.5%) and multiple lung involvement in 14 (4.4%) (p=0.003) (**Table 2**).

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Table 2. Chi-square analysis of clinical classification of COVID-19 patients with variables.

Clinical Classification of COVID-19 Patients						
Clinics			**Mild n:96(%)**	**Moderaten:113(%)**	**Severe n:108(%)**	***P-value***
Gender		**Female**	39(40.6)	48(42.5)	48(44.4)	0.582
		Male	57(59.4)	65(57.5)	60(55.6)	
CO-RADS		**0**	16(16.7)	0(0)	0(0)	**0.001**
		1	7(7.3)	0(0)	0(0)	
		2	13(13.5)	0(0)	0(0)	
		3	23(24)	0(0)	0(0)	
		4	27(28.1)	16(14.2)	16(14.8)	
		5	10(10.4)	67(59.3)	61(56.5)	
		6	0(0)	30(49.5)	31(28.7)	
Prognosis		**Regular outpatient follow-up**	55(57.3)	4(3.5)	1(0.9)	**0.001**
		Service Admission	22(22.9)	74(65.5)	48(44.4)	
		Intensive Care Unit	13(13.5)	21(18.6)	39(36.1)	
		Mortality	6(6.3)	14(12.4)	20(18.5)	
Direct Radiological Imaging	**1**	**Normal**	39(40.6)	0(0)	0(0)	**0.001**
		One sided	12(12.5)	26(23)	16(14.8)	
		Bilateral	45(46.9)	87(77)	92(85.2)	
	2	**Normal**	26(27.1)	0(0)	0(0)	**0.001**
		Central	10(10.4)	11(9.7)	11(10.2)	
		Peripheral	60(62.5)	102(90.3)	97(89.8)	
	3	**Normal**	24(25)	0(0)	0(0)	**0.001**
		Upper Lope	7(7.3)	6(5.3)	7(6.5)	
		Mid-Lower Lope	52(54.2)	72(63.7)	70(64.8)	
		Multiple	13(13.5)	35(31)	31(28.7)	
Thorax Computerized Tomography Imaging		**Normal**	12(12.5)	0(0)	0(0)	**0.003**
		Frosted glass opacity	28(29.2)	26(23)	27(25)	
		Consolidation	13(13.5)	17(15)	12(11.1)	
		Paving stone	4(4.2)	12(10.6)	8(7.4)	
		Air bronchogram	8(8.3)	14(12.4)	19(17.6)	
		Airway change/ Air cyst	5(5.2)	6(5.3)	6(5.6)	
		Reticular view	7(7.3)	11(9.7)	15(13.9)	
		Nodular appearance	7(7.3)	9(8)	7(6.5)	
		Vascular enlargement	7(7.3)	13(11.5)	10(9.3)	
		Multiple	5(5.2)	5(4.4)	4(3.7)	
Total			96(100)	113(100)	108(100)	

CO-RADS: Reporting and Data System

Regarding infarct areas in computed tomography of the patients, the brain CT of 275 (86.8%) patients was normal, and infarction was detected in 42 (13.2%). Infarction was present in the lacunar in 9 (2.8%), cerebral stem in 8 (2.5%), basal ganglia in 7 (2.2%), and thalamus in 6 (1.9%) of the patients. In other areas, infarcts were detected with decreasing frequency. The hemorrhagic evaluation was performed on CT of the cases; 295 (93.1%) of patients were normal, and 22 (6.9%) of them had hemorrhaged. In DMRI, 249 (78.5%) of the patients were normal, and 68 (21.5%) of the patients had involvement in different areas. Of these involvements 23 (7.3%) were lacunar infarcts, 19 (6%) infarcts were observed in the middle cerebral artery area, 8 (2.5%) infarcts were observed in the brain stem, and a small contingent in different areas of the brain (**Table 3**).

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Table 3. Chi-square analysis of clinical classification of COVID-19 patients with radiological imaging methods.

Clinical Classification of COVID-19 Patients					
Clinics		**Mild n:96(%)**	**Moderate n:113(%)**	**Severe n:108(%)**	***P-value***
Computerized Brain Tomographic Imaging (Infarct)	**Normal**	91(94.8)	97(85.9)	87(80.6)	0.195
	Basal Ganglion	1(1)	2(1.8)	4(3.7)	
	Thalamus	1(1)	3(2.7)	2(1.9)	
	Corona radiata	1(1)	0(0)	2(1.9)	
	Caudate nucleus	0(0)	1(0.9)	0(0)	
	Lacunar infarct	1(1)	3(2.7)	5(4.6)	
	Brainstem	1(1)	3(2.7)	4(3.7)	
	Cerebellum	0(0)	1(0.9)	3(2.8)	
	Multiple	0(0)	3(2.7)	1(0.9)	
Computerized Brain Tomographic Imaging (Hemorrhage)	**Normal**	92(95.8)	104(92)	99(91.7)	0.402
	Putamen	1(1)	1(0.9)	2(1.9)	
	Thalamus	2(2.1)	1(0.9)	0(0)	
	Caudate	0(0)	1(0.9)	0(0)	
	Pons	0(0)	2(1.8)	4(1.3)	
	Into the ventricle	1(1)	2(1.8)	1(0.9)	
	Cerebellum	0(0)	1(0.9)	1(0.9)	
	Subarachnoid	0(0)	1(0.9)	0(0)	
	Reticular formation	0(0)	0(0)	1(0.9)	
Diffusion Magnetic Resonance Imaging	**Normal**	85(88.5)	91(80.5)	73(67.6)	**0.017**
	Anterior Cerebral Artery Area	2(2.1)	0(0)	0(0)	
	Middle Cerebral Artery Area	3(3.1)	6(5.3)	10(9.3)	
	Posterior Cerebral Artery Area	1(1)	2(1.8)	1(0.9)	
	Lacunar infarct	2(2.1)	7(6.2)	14(13)	
	Watershed	1(1)	0(0)	2(1.9)	
	Brainstem	1(1)	3(2.7)	4(3.7)	
	Cerebellum	1(1)	1(0.9)	3(2.8)	
	Multiple	0(0)	3(2.7)	1(0.9)	
Total		96(100)	113(100)	108(100)	

There was no correlation with gender at decontamination of patients (p=0.109). The most common CO-RADS rate detected was 0-3 in outpatient follow-up, 5 in hospitalization, and 5-6 in mortality cases (p=0.001). A lesion was detected on direct lung radiography and chest CT of all patients admitted to the Intensive Care Unit (ICU) as well as the mortality cases (p=0.001). Of those patients who did not survive, 19 (47.5%) were revealed to have infarcts after brain CT and dMRI imaging, and CT revealed hemorrhage in 13 (32.5%). Out of patients hospitalized in the intensive care unit, infarct was observed in 22 (30.1%), bleeding was observed in 8 (11%), and diffusion involvement was observed in 44 (60.3%) (p=0.001, **Table 4**).

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Table 4. Chi-square analysis of the prognosis of COVID-19 patients with radiological imaging and other variables.

Prognosis in Covid -19 patients							
Prognosis			**Regular outpatient follow-up n:60 (%)**	**Service Admission n:144 (%)**	**Intensive Care Unit n:73 (%)**	**Mortality n:40 (%)**	***P-value***
Gender		**Female**	22(36.7)	60(41.7)	29(39.7)	24(60)	0.109
		Male	38(63.3)	84((58.3)	44(60.3))	16(40)	
CO-RADS		**0**	15(25)	1(0.7)	0(0)	0(0)	**0.001**
		1	7(11.7)	0(0)	0(0)	0(0)	
		2	12(20)	1(0.7)	0(0)	0(0)	
		3	18(30)	2(1.4)	2(2.7)	1(2.5)	
		4	7(11.7)	31(21.5)	16(21.9)	5(12.5)	
		5	1(1.7)	85(59)	35(47.9)	17(42.5)	
		6	0(0)	24(16.7)	20(27.4)	17(42.5)	
Direct Radiological Imaging Finding	**1**	**No**	36(60)	3(2.1)	0(0)	0(0)	**0.001**
		Yes	24(40)	141(97.9)	73(100)	40(100)	
	2	**No**	24(40)	2(1.4)	0(0)	0(0)	**0.001**
		Yes	36(60)	142(98.6)	73(100)	40(100)	
	3	**No**	22(36.7)	2(1.4)	0(0)	0(0)	**0.001**
		Yes	38(63.3)	142(98.6)	73(100)	40(100)	
Thorax Computerized Tomography Imaging Finding		**No**	12(20)	0(0)	0(0)	0(0)	**0.001**
		Yes	48(80)	144(100)	73(100)	40(100)	
Computerized Brain Tomographic Imaging (Infarct) Finding		**No**	60(100)	143(99.3)	51(69.9)	21(52.5)	**0.001**
		Yes	0(0)	1(0.7)	22(30.1)	19(47.5)	
Computerized Brain Tomographic Imaging (Hemorrhage) Finding		**No**	60(100)	143(99.3)	65(89)	27(67.5)	**0.001**
		Yes	0(0)	1(0.7)	8(11)	13(32.5)	
Diffusion Magnetic Resonance Imaging Finding		**No**	60(100)	139(96.5)	44(60.3)	21(52.5)	**0.001**
		Yes	0(0)	5(3.5)	29(39.7)	19(47.5)	
Total			60(100)	144(100)	73(100)	40(100)	

CO-RADS: Reporting and Data System

4. Discussion

Numerous studies and evaluations of COVID-19's effects and radiological imaging have been conducted. However, a few small studies have been conducted in which lung radiography, thoracic and brain CT, and dMRI are all used concurrently to examine the disease. This circumstance prompted us to conduct research on the effect of radiological imaging on COVID-19. We have demonstrated that when radiologic imaging findings progress, the COVID-19 disease CO-RADS classification increases significantly, as does ICU hospitalization and mortality. Additionally, we demonstrated that radiological imaging of COVID-19-infected patients admitted to emergency departments, regardless of age, has an effect on the relationship between follow-up, treatment orientation, and mortality.

Males' advanced age and the presence of comorbidity have been shown to increase the risk of severe disease in cases with a positive RT-PCR test [15-17]. Karvar et al. [18] reported that 54% of patients were male, the average age was 45.5±17.5 years, and the average age of patients with a severe clinical presentation was 60.2±15.0 years in their similar study of 278 cases. The mean age of 317 patients in our study was 67.28±12.06 years, and 57.3 percent were male.

COVID-19 patients are classified into several severity groups based on their clinical manifestations. 80.9% of all cases are mild to moderate in severity, 13.8% are serious, and

4.7% are classified as critical [19]. According to published studies, between 25% and 30% of patients require intensive care. The elderly and patients with an underlying comorbid disease are more likely to experience worsening conditions and death [20]. The case fatality rate for critically ill patients varies between 50% and 75%, but was reported as 49% in China's largest epidemiology study [19,20]. Although mortality rates in hospitalized adult patients range between 4-11%, when all cases are evaluated, the mortality rate is estimated to be 2-3% [20]. In our study, 30.3% of cases were considered mild, 35.6% were considered moderate, and 34.1% were considered severe. Our study is unique in that these cases were chosen concurrently with lung radiography, thorax and brain CT, and dMRI images. Additionally, our patients required intensive care as a result of their progressive clinical conditions: 13.5% had mild conditions, 18.6% had moderate conditions, and 36.1% had severe conditions. Mild cases had a mortality rate of 6.3 percent, moderate cases had a mortality rate of 12.4%, and severe cases had a mortality rate of 18.5%.

Infections with COVID-19 have been associated with pathological changes in hematological, biochemical, and coagulation tests [21]. Additionally, meta-analyses revealed that elevations in white blood cell, C-reactive protein, aspartate aminotransferase, lactate dehydrogenase, and creatine kinase values were associated with an increase in leukopenia, lymphopenia, and thrombocytopenia associated with severe clinical findings [22]. Although troponin I elevation is uncommon in COVID-19 patients, it is significantly more common in severe cases than in mild cases [23]. Laboratory parameters significantly differed between mild, moderate, and severe patients in our study. The parameters were found to increase significantly as the clinical manifestations of the cases became more severe. Additionally, similar studies have discovered that mortality increases with the parameters specified and with age. NLR, albumin, platelet, fibrinogen, ferritin, D-dimer, and troponin I levels were found to be significantly higher in mortality cases.

The lung is the most susceptible organ to COVID-19 infection [24]. As a result, it is critical to demonstrate lung involvement radiographically. Although the RT-PCR test is the gold standard for disease diagnosis, radiological imaging has been used extensively in cases where the test is unavailable or to re-evaluate a possible false-negative result [6,25]. Lung radiography should be the first imaging modality used to detect COVID-19 pneumonia. The sensitivity of lung radiography in detecting disease involvement has been reported to be between 30% and 60% [26]. On peripheral weighted lung radiography, bilateral irregular limited density increase and consolidation, particularly in the middle and lower zones, is observed. It is important to remember that a normal lung radiography result does not rule out this disease, and that cases with clinical compatibility should undergo CT evaluation. Lung radiography was performed on all of our patients. 70.7 % involved bilateral involvement, while 17% involved unilateral involvement. Additionally, 10.1% of cases involved the central nervous system, while 81.7% involved the peripheral nervous system. 0.6% of patients had upper lobe placement, 61.2% had middle-lower lobe placement, 24.9% had multiple placements, and the remaining patients had normal placements. COVID-19 pneumonia of various sizes was detected on lung radiography of 98 % of hospitalized patients who died.

Thoracic CT is critical for diagnosing COVID-19 and evaluating any treatment-related complications [23]. The RT-PCR test was found to have a sensitivity of 71% at an early stage of the disease, while the thoracic CT had a sensitivity of 98 % [6,25]. Thorax CT is recommended primarily in cases of symptomatic and suspected lung radiography, as well as in cases of suspected complications. The most frequently encountered thoracic CT findings in patients with COVID-19 are frosted glass, septal thickening, and consolidation areas [22,28]. In a meta-analysis of thoracic CT findings, the incidence of any finding was found to be 89% (50-100%) in COVID-19 patients [22]. Thoracic CT sensitivity was reported to be 97 percent in patients with pneumonia in studies conducted in China and Italy [28,29]. Another study evaluated 104 cases and discovered at least one thoracic CT finding in 79% of symptomatic patients and 54% of asymptomatic patients [30]. COVID-19 pneumonia of various degrees was detected in 13% of mild cases at the time of disease

onset and in 87.5 percent of cases on days 5-7 in our study. Additionally, all moderate and severe cases had lung involvement. COVID-19 pneumonia was detected in 80% of outpatient follow-up cases and 100% of those admitted to the hospital. Bilateral, middle-lower lobe, and peripheral locations were found to be the most prevalent in patients who died or were admitted to the intensive care unit.

Throughout our patients' follow-up, brain CT imaging was performed to assess for hemodynamic disturbances such as deteriorating condition, change in consciousness, and one or more falls in coma score in their current clinical situation. For patients who were not found to be bleeding, dMRI was performed after the appropriate conditions were met. Infarction in various areas of the brain was detected on brain CT in 5.2% of mild cases, 14.1% of moderate cases, and 19.5% of severe cases. Infarction was detected most frequently in the basal ganglia, thalamus, and brain stem. Additionally, none of the outpatient follow-up patients had an infarction. Infarction at various stages was detected in 0.7% of hospitalized patients, 30.1% of ICU patients, and 47.5% of those who died. 4.2 % with cerebral hemorrhage had a mild clinical picture, 8% had a moderate clinical picture, and 8.3 % had a severe clinical picture. None of the patients who underwent outpatient follow-up demonstrated any signs of bleeding. However, bleeding was detected in one hospitalized patient, eight (11%) of those admitted to the intensive care unit, and thirteen (32.5%) of those who died. In patients who underwent dMRI, various degrees of infarction were observed: 11.5% in mild cases, 19.5% in the middle group, and 32.4% in severe cases. No infarction was detected in outpatient follow-up patients, but infarction was detected in various areas in 3.5% of those hospitalized, 39.7% of those admitted to intensive care units, and 47.5% of those who died. It was most frequently discovered in the area of the brain supplied by the middle cerebral artery. Lacunar infarction was the most frequently detected type of infarction. One of the reasons for the high rate of infarction and bleeding is believed to be the patients' advanced age. Additionally, the virus's invasion of the brain via neurotropic action, secondary inflammatory damage, and effect on the respiratory and cardiac systems can result in hypoxemia in the brain. As a result of the resulting inflammation, coagulation parameters are altered, resulting in an increase in cerebrovascular disease.

Our study had some limitations. The most critical of these was the study's retrospective nature and monocentric focus. Additionally, due to the small number of cases displaying lung radiography, thorax, brain CT, and dMRI, only approximately 12 thousand cases were screened. Another reason is that records could not be maintained at the desired level due to the pandemic's difficulties and large number of cases.

5. Conclusion

According to the data collected, advanced age and abnormal laboratory results were associated with increased clinical severity. Additionally, in severe clinical patients, a higher rate of thoracic CT findings was observed. Serious conditions that are associated with mortality on brain CT and dMRI should not be overlooked in patients admitted to the intensive care unit or who develop mortality. These findings may aid in comprehending the distinctions between clinical classes in COVID-19 patients. However, even when laboratory and radiological findings are normal, the clinical severity may be severe, particularly in cases of advanced age and comorbidity.

Supplementary Materials: The following supporting information can be downloaded at the website of this paper posted on Preprints.org.

Author Contributions: For research articles with several authors, a short paragraph specifying their individual contributions must be provided. The following statements should be used “Conceptualization, A.C. and F.T.T; methodology, A.C.; software, F.T.T.; validation, A.C., and F.F.T.; formal analysis, A.C.; investigation, F.T.T.; resources, A.C.; data curation, F.T.T.; writing-original draft preparation, A.C.; writing-review and editing, F.T.T.; visualization, A.C.; supervision, F.T.T.; project

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Informed consent statement: The study group as the study was retrospective in nature and no specific intervention was described by the author's methodology. The medical research center waived the informed consent for the project.

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