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The Diagnostic and Prognostic Role of Non-Contrast Chest CT in COVID-19 Primary Infected Patients

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

Background: Chest computed tomography (CT) has shown to have a significant role to help in diagnosis of coronavirus disease 2019 (COVID-19) also assessing the disease progression and monitoring the response to treatment since it is less expensive, readily accessible, safe and saves time. This research objects to evaluate the diagnostic and prognostic role of non-contrast chest CT in COVID-19 primary infected patients. This prospective research involved 100 COVID-19 infected patients as proven by polymerase Chain Reaction (63 females and 37 males). Initial and follow up CT scans were performed.
Results: There was a positive significant correlation between CT severity score and diabetes mellitus, malignancy, and other immune-compromised disease. There was a positive significant correlation between CT severity score and age ($r=0.830$, $p<0.001$) and smoking ($r=0.231$, $p=0.020$). Age, smoking and CT severity score were significant predictors for incidence of fibrotic changes.

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Conclusion: This study confirmed the great significance of chest CT for the differentiation between pulmonary changes occurred during infection and follow up and predict the risk factors that can affect the prognosis of the disease.

Keywords: Diagnostic; prognostic; non-contrast chest CT; COVID-19; primary infected patients.

ABBREVIATIONS

ALT : Alanine transaminase;
AST : Aspartate transaminase;
COVID-19 : Coronavirus disease 2019;
CRP : C-reactive protein;
CT : Computed tomography;
DM : Diabetes mellitus;
GGO : Ground glass opacities;
GIT : Gastrointestinal tract;
Hb : Hemoglobin;
HCT : Hematocrit;
IL-6 : Interleukin 6;
MDCT : Multi-Detector CT;
MERS : Middle East respiratory syndrome;
PCR : Polymerase Chain Reaction;
SARS-CoV2 : Severe acute respiratory syndrome coronavirus 2;
WBCs : White blood cells.

1. INTRODUCTION

In December of 2019, a highly contagious illness caused severe respiratory distress syndrome in Wuhan, China. It was subsequently determined that the condition was caused by a new coronavirus. On March 11, 2020, the World Health Organization designated the illness Coronavirus disease 2019 (COVID-19) and proclaimed it a pandemic. In the weeks that followed, the illness swiftly spread throughout the majority of the world's nations, generating a worldwide health crisis. As of April 14, 2020, the overall number of cases has surpassed 1.8 million, with over 110 thousand fatalities [1].

Chest computed tomography (CT) has shown to have a significant role to help in diagnosis of this deadly disease also assessing the disease progression and monitoring the response to treatment as it is less expensive, readily accessible, safe and saves time [2].

Various investigations have documented a broad range of CT results associated with COVID-19. It is including bilateral multifocal patchy areas of ground glass opacities (GGO), consolidation with air bronchogram, crazy pavement appearance that mostly present sub pleural and predominantly involving the lower lung lobes and posterior segments & other different signs that vary depending to illness stage, disease severity, and related co-morbidities [3,4].

COVID-19 is yet to reveal its long-term effects. According to studies, some individuals with viral lung infections caused by COVID-19 exhibit symptoms of overall improvement after recovery [5]. In other cases, they show irreversible pulmonary dysfunction and demonstrate residual imaging include worsening GGOs or consolidations, fibrotic band formation, and organizing pneumonia [6].

This research objects to evaluate the diagnostic and prognostic role of Non Contrast chest CT in COVID19 primary infected patients.

2. PATIENTS AND METHODS

This prospective research involved 100 COVID-19 infected patients as proven by Polymerase Chain Reaction (PCR) (63 females and 37 males) who were referred to Radio-diagnosis and Medical Imaging Department at the local institution. Their ages ranged from 27 to 75 years old. Initial and follow up CT scans were performed. Lung changes and CT extent scores were recorded from March 2021 to May 2022.

We included moderate to severe cases of COVID-19 that tested positive by PCR. (Patients were categorized according to Ministry of Health and Population protocol definition of moderate and severe cases. Moderate cases have COVID pneumonia manifestations on chest CT associated with clinical symptoms &/Or leucopenia or lymphopenia. Severe cases have increased respiratory rate, decreased Oxygen saturation % in room air and more progressive chest CT findings), Patients who have significant travel history or have close contact with person who has infected by COVID-19.

Exclusion criteria were pregnant females, patients less than 18 years and who refuse undergo chest CT.

All subjects underwent complete history taking include:

Personal history: as regards the name, age and gender, residence and phone number, Clinical data for any complain as (fever, cough, dyspnea, sore throat, fatigue, loss of smell and taste, abdominal pain, nausea, vomiting, diarrhea, body aches, headache, runny nose, skin rash, redness of the eye), history of any comorbidities such as systemic hypertension, diabetes mellitus, tobacco smoke and others.

Clinical examination and evaluating vital signs such as heart rate, respiratory rate, body temperature, blood pressure and oxygen saturation in room air.

Laboratory investigations including: Hemoglobin level (Hb), Hematocrit level (HCT), white blood cells count (WBCs count), lymphocyte count, platelet count, C-reactive protein (CRP), D-dimer, aspartate transaminase (AST) and alanine transaminase (ALT) levels.

Non contrast Multi-Detector CT (MDCT) chest examination during infection and follow up CT scan after 3 months from symptoms' onset.

2.1 The Chest CT Examination

The MDCT Equipment: MDCT was performed with a 128 Slice CT scanner (Optima CT660, GE healthcare) using 120 KV and slice thickness 5 mm. The non-enhanced chest CT was acquired from the thoracic inlet to the diaphragm. Acquisition will be achieved in the axial plane with coronal and sagittal reconstruction.

MDCT Imaging Protocol:

- The examination is initially explained to the patient. The complete immobilization of the patient throughout the test is crucial.
- The patients were positioned in the supine, head-first posture.
- A single breath-hold scan is planned from the level of the lung apex to the end of both costophrenic angles.
- All patients underwent follow up non-contrast chest CT examinations after 3 months from symptoms onset with the same scanners used for initial CT scans.
- The CT images were evaluated for each Patient regarding lesion distribution and the presence of typical findings of COVID-19 pneumonia (sub pleural unilateral or bilateral GGO in the lower lobes with a peripheral or posterior distribution), presence of consolidation or other possible associated findings including interlobular septal thickening, crazy-paving pattern, air bronchogram sign, halo sign and others.

Post Processing: On a workstation, image reconstruction and alteration were conducted. Multiplanner reconstruction with axial, sagittal and coronal images were done in both mediastinal and lung windows. Nonetheless, examination of the axial source pictures remains a key component of the evaluation.

Chest CT Severity Score: Using a simple CT score, the degree of lung involvement in each patient was examined. Each lobe could receive a CT score ranging from 0 to 5 depending on the percentage of involvement, which was classified as score 0 (0% or none), score 1 (1-5% or minimal), score 2 (6-25% or mild), score 3 (26-49% or moderate), score 4 (50-75% or severe), and score 5 (greater than 75% or extensive). The total CT score for the five lobes was the sum of the individual lobar values and ranged from 0 (no involvement) to 25 (severe involvement) (maximum involvement). Total CT Score less than 7 is considered mild COVID-19, score from 8 to 16 is considered moderate COVID-19 and score from 17 to 25 is considered severe COVID-19. It was necessary to examine both lungs as a whole in axial, coronal, and sagittal reconstruction planes in order to precisely estimate the extent of the affection.

2.2 Statistical Analysis

Statistical analysis was done by SPSS v28 (IBM Inc., Armonk, NY, USA). Quantitative variables were expressed as mean and standard deviation (SD). Qualitative variables were expressed as frequency and percentage and were analyzed utilizing the Chi-square test. Spearman coefficient to correlate between two normally distributed quantitative variables. Logistic regression is also used to estimate the relationship between a dependent variable and one or more independent variables.

3. CASES

3.1 Case 1

Clinical data: 43 years old male patient with coronavirus disease had no comorbidities.

Imaging findings: A, Axial and B, coronal chest CT images (lung window) obtained after the onset of symptoms show extensive GGO at both upper lung lobes. C, Axial and D, coronal scans

obtained at follow up show marked regression of previously seen GGO Fig. 1.

3.2 Case 2

Clinical data: a 57 years old female patient with coronavirus disease and has history of malignancy.

Imaging findings: chest CT scans show (a) Axial image obtained after the symptoms onset exhibits bilateral GGO and consolidation at lower lung lobes. (b) Axial image obtained after recovery show obvious regression of previously seen opacities with still seen small residuals Fig. 2.

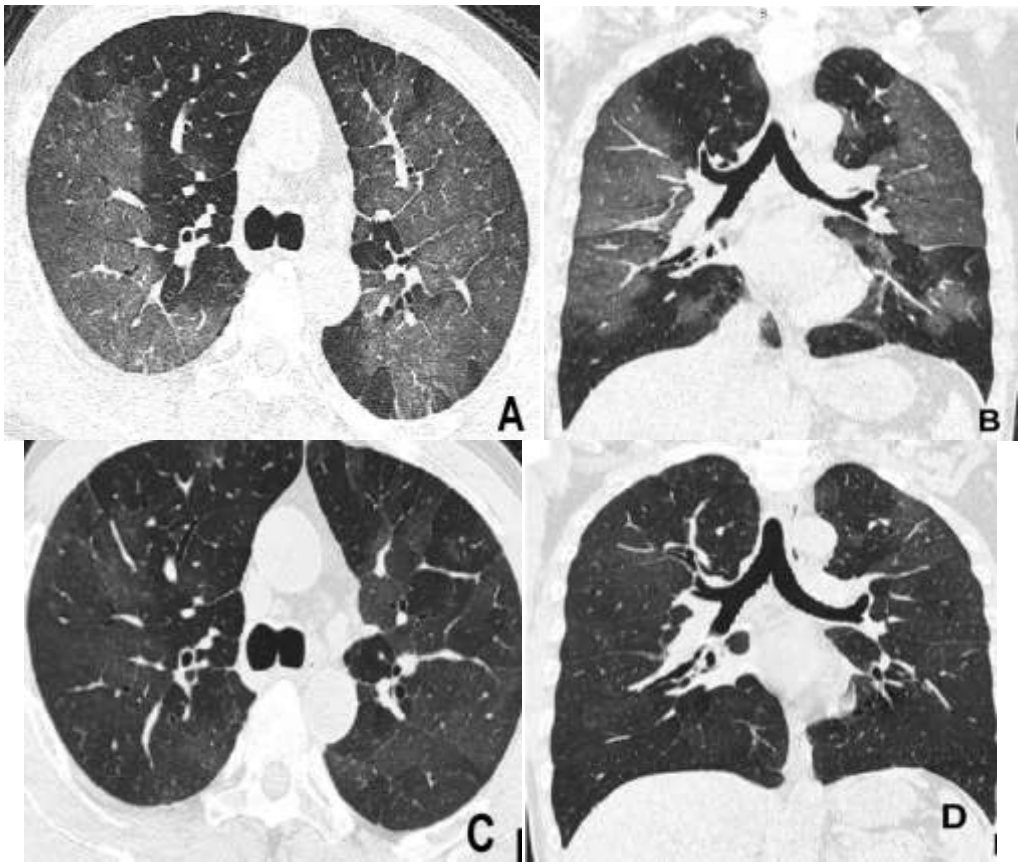

Fig. 1. A, C Axial and B, D coronal chest CT images (lung window)

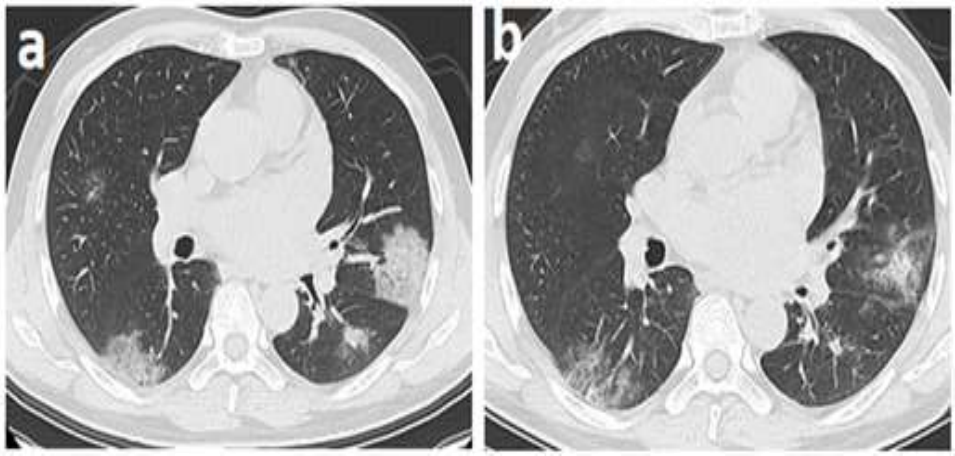

Fig. 2. (a and b) axial chest CT images (lung window)

4. RESULTS

Baseline characteristics are presented at Table 1.

Laboratory investigations are presented at Table 2.

Lung involvement and Pattern of distribution of lung opacities in the studied patients Table 3.

Main Chest findings and other associated chest CT during infection and chest CT score of the studied patients are presented at Table 4.

There was a significant difference between severity of COVID-19 infection and comorbidities as diabetes mellitus (DM), malignancy, and other immunocompromised disease (P<0.05). There was an insignificant difference between severity of COVID-19 infection and hypertension. Most of cases of DM, malignancy, and other immunocompromised disease had Severe CT score while cases of hypertension had mild and moderate CT score Table 5.

There was a positive significant correlation between CT severity score and DM (r=0.302, P=0.002), malignancy (r=0.251, P=0.012), and other immune-compromised disease (r=0.253, P=0.011). There was a positive significant correlation between CT severity score and age (r=0.830, p<0.001) and smoking (r=0.231, p=0.020) Table 6.

Regarding the chest CT findings of the studied patients at 3 month follow up scan, complete radiological resolution of previous opacification occurred in 39 (39%) patients, partial regression with residual opacifications occurred in 27 (27%) patients and fibrotic like changes occurred in 34 (34%) patients Table 7.

There was a significant relationship between fibrotic changes and age, smoking and CT severity score >17. Cases with old age >50 had fibrotic changes (85.3%) higher than younger age <50 (14.7%) (P<0.001). Smoker had fibrotic change (58.82%) higher than non-smoker (41.17%) (P<0.001). Cases with CT severity score >17 had fibrotic changes (70.58%) higher than cases with CT severity score<17(29.41%) (P<0.001) Table 8.

Age, smoking and CT severity score were significant predictors for incidence of fibrotic changes (P<0.05) Table 9.

Table 1. Demographic data and comorbidities, smoking status and clinical complain of the studied patients of the studied patients

			N=100
Age (years)		**Mean ± SD**	56.4 ± 8.98
		Range	27 - 75
Sex		**Male**	37 (37%)
		Female	63 (63%)
Comorbidities	**None**		26 (26%)
	Diabetes mellitus		22 (22%)
	Malignancy		19 (19%)
	Hypertension		17 (17%)
	Other immune-compromised disease:	**1-chronic kidney disease**	16 (16%)
		2-collagen diseases	
Smoking		**Smokers**	26 (26%)
		Non-smokers	74 (74%)
Fever			74 (74%)
Cough			60 (60%)
Dyspnea			42 (42%)
Sore throat			30 (30%)
Runny nose			17(17%)
Smell and taste disorders			36 (36%)
Fatigue			38 (38%)
Muscle or body aches			31 (31%)
Headache			18 (18%)
Abdominal pain			20 (20%)

			N=100
Diarrhea			28 (28%)
Nausea			18 (18%)
Vomiting			19 (19 %)
Skin rash			6 (6%)
Redness of the eye			5 (5%)
Vital signs	**Heart rate (beat/minute)**	**Mean ± SD**	90.3 ± 14.01
		Range	62 – 118
	Respiratory rate (breath /minute)	**Mean ± SD**	21.7 ± 5.44
		Range	12 – 30
	SBP (mmHg)	**Mean ± SD**	124.6 ± 9.21
		Range	110 – 140
	DBP (mmHg)	**Mean ± SD**	74.3 ± 9.12
		Range	60 – 90
	Oxygen saturation % in room air	**Mean ± SD**	94.6 ± 2.03
		Range	92 – 98

Data is presented as frequency (percentage), mean ± SD and range, SBP: systolic blood pressure, DBP: diastolic blood pressure

Table 2. Laboratory investigation of the studied patients

		N=100
Hb (gm/dL)	**Mean ± SD**	11.4 ± 0.7
	Range	9.5 – 13
HCT (%)	**Mean ± SD**	39.1 ± 5.69
	Range	30.7 - 49.7
WBCs (x 10^3 cells/µl)	**Mean ± SD**	7.1 ± 1.55
	Range	4.5 - 9.7
Lymphocyte (x 10^3 cells/µl)	**Mean ± SD**	2.1 ± 0.78
	Range	0.8 - 3.5
Platelets(x 10^3 cells/µl)	**Mean ± SD**	250.2 ± 55.8
	Range	145 – 350
CRP (mg/L)	**Mean ± SD**	28.8 ± 10.1
	Range	10 – 45
D-dimer (µg/mL)	**Mean ± SD**	1.2 ± 0.49
	Range	0.4 – 2
AST (U/L)	**Mean ± SD**	34.97 ± 9.87
	Range	19 – 54
ALT (U/L)	**Mean ± SD**	36.3 ± 13.55
	Range	15 – 62

Data is presented as mean ± SD and range, Hb: Hemoglobin, HCT: Hematocrit, WBCs: White blood cells, CRP, C-reactive protein, AST: Aspartate aminotransferase, ALT: Alanine aminotransferase

Table 3. Lung involvement and Pattern of distribution of lung opacities in the studied patients

		N=100
Bilateral		88 (88%)
Unilateral		12 (12%)
Pattern of distribution of lung opacities	**Sub pleural**	52 (52%)
	Diffuse	12 (12%)
	Peribronchial	5 (5%)
	Mixed	31 (31%)
Right upper lobe	**Apical**	32 (32%)
	Posterior	66 (66%)
	Anterior	36 (36%)
Right middle lobe	**Lateral**	55 (55%)
	Medial	20 (20%)

		N=100
Right lower lobe	**Superior**	79 (79%)
	Posterior	84 (84%)
	Medial	41 (41%)
	Anterior	33 (33%)
	Lateral	71 (71%)
Left upper lobe	**Apico-posterior**	60 (60%)
	Anterior	31 (31%)
	Superior lingula	39 (39%)
	Inferior lingula	35 (35%)
Left lower lobe	**Superior**	77 (77%)
	Antero-medial	28 (28%)
	Lateral	76 (76%)
	Posterior	81 (81%)

Data is presented as frequency (percentage)

Table 4. Main Chest findings and other associated chest CT during infection and chest CT score of the studied patients

		N=100
Ground glass opacities		62 (62%)
Consolidation		14 (14%)
Mixed ground glass opacities and consolidation		24 (24%)
Interlobular septal thickening		35 (35%)
Subpleural fibrotic line		34 (34%)
Air bronchogram sign		30 (30%)
Crazy paving pattern		24 (24%)
Mosaic pattern		22 (22%)
Pleural thickening		20 (20%)
Pleural effusion		15 (15%)
Reticular pattern		14 (14%)
Nodule		13 (13%)
Bronchiectasis		12 (12%)
Bronchial wall thickening		11 (11%)
Halo sign		10 (10%)
Mediastinal lymphadenopathy		10 (10%)
Pericardial effusion		5 (5%)
Chest CT score	**Score less than 7 (Mild)**	18 (18%)
	Score from 8 to 16 (Moderate)	46 (46%)
	Score from 17 to 25 (Severe)	36 (36%)

Data is presented as frequency (percentage)

Table 5. Relation between severity of COVID-19 infection and clinical findings and some comorbidities

	N=100	Mild	Moderate	Severe
Fever	74 (74%)	25%	29%	20%
Cough	60 (60%)	15%	19%	26%
Dyspnea	42 (42%)	3%	13%	26%
Sore throat	30 (30%)	8%	17%	5%
Runny nose	17(17%)	9%	6%	2%
Smell and taste disorders	36 (36%)	12%	14%	10%
Fatigue	38 (38%)	9%	10%	19%
Muscle or body aches	31 (31%)	6%	9%	16%
Headache	18 (18%)	10%	5%	3%
Abdominal pain	20 (20%)	3%	6%	11%
Diarrhea	28 (28%)	4%	10%	14%

	N=100	Mild	Moderate	Severe	
Nausea	18 (18%)	11%	5%	2%	
Vomiting	19 (19 %)	4%	6%	9%	
Skin rash	6 (6%)	0	2%	4%	
Redness of the eye	5 (5%)	0	2%	3%	
	Mild (n=18)	**Moderate (n=46)**	**Severe (n=36)**	**P value**	
DM	2 (11.11%)	6 (13.04%)	14 (38.89%)	0.009*	P1=0.883 P2=0.031* P3=0.006*
Malignancy	2 (11.11%)	5 (10.87%)	12 (33.3%)	0.047*	P1=0.512 P2=0.024* P3=0.012*
Hypertension	3 (16.67%)	14 (30.43%)	0 (0.0%)	0.262	
Other immunocompromised disease	1 (5.56%)	5 (10.87%)	10 (27.78%)	0.047*	P1=0.512 P2=0.049* P3=0.048*

Data is presented as frequency (percentage),: significant as p value <0.05, P1: p value between mild and moderate cases, P2: p value between mild and severe cases, P3: p value between moderate and severe cases, DM: Diabetes mellitus*

Table 6. Correlation between CT severity score and DM, malignancy, other immune-compromised disease, age, smoking

	CT severity score	
	R	**P value**
DM	0.302	0.002*
Malignancy	0.251	0.012*
Other Immuno-compromised disease	0.253	0.011*
Age	0.830	<0.001*
Smoking	0.231	0.020*

*r: spearman correlation, *: significant as P value <0.05, CT: Computed tomography, DM: Diabeted mellitus*

Table 7. Chest CT findings of the studied patients at 3 month follow up scan

	N=100
Complete radiological resolution of previous opacification	39 (39%)
Partial regression with residual opacifications	27 (27%)
Fibrotic like changes	34 (34%)

Data is presented as frequency (percentage). CT: Computed tomography

5. DISCUSSION

This study aimed to evaluate the role of chest CT in COVID-19 primary infected cases during and after convalescence [7-9].

Female COVID-19 cases were more prevalent in our research than males; with 63% of the study patients were females and 37 % of the study patients were males. This was going with Nabahati et al. [10] who found that of 173 COVID-19 included patients, 57 (32.9%) were male and others were female.

Concerning comorbidities, among the studied patients, there were 26 (26%) patients had no comorbidities, 22(22%) patients were diabetic, 19 (19%) had malignancy, 17 (17%) had hypertension and 16 (16%) had other immune-compromised diseases (chronic kidney disease, collagen diseases). This was similar to Ding et al. [11] who reported that COVID-19 cases with chronic diseases as hypertension, diabetes, autoimmune diseases, chronic renal disease, and cancer were commonly found COVID-19 hospitalized patients.

Regarding clinical complain of the studied patients, 74 (74%) patients had fever, 60 (60%) patients had cough, 42 (42%) patients had dyspnea, 30 (30%) patients had sore throat, 17 (17%) patients had runny nose, 36 (36%)

Table 8. Comparison between age, smoking and CT severity score based on the Chest CT findings of the studied patients at 3 months' follow-up scan

		Fibrotic like changes (n=34)	No fibrotic like changes (n=66)	P value
Age	**>50**	29 (85.3%)	21 (31.18%)	<0.001*
	<50	5 (14.7%)	45(68.81%)	
Smoking	**Smoker**	20 (58.82%)	6 (9.09%)	<0.001*
	Non- smoker	14 (41.17%)	60(90.90%)	
CT severity score	**>17**	24(70.58%)	12(18.18%)	<0.001*
	<17	10(29.41%)	54 (81.81%)	

*Data is presented as frequency (percentage), * significant as P value < 0.05, CT: Computed tomography*

Table 9. Logistic regression of different variables for prediction of incidence of fibrotic changes

	Coefficient	Std. Error	$r_{partial}$	t	P
Age	0.01262	0.002501	0.4543	5.048	<0.0001*
Smoking	0.8250	0.08583	0.6966	9.612	<0.0001*
CT severity score	0.03183	0.007907	0.3767	4.026	0.0001*

** significant as P value < 0.05, CT: Computed tomography*

patients had smell and taste disorders, 38 (38%) patients had fatigue , 31 (31%) had muscle or body aches, 18 (18%) patients had headache , 20 (20%) patients had abdominal pain, 28 (28%) patients had diarrhea , 18 (18%) had nausea , 19 (19%) patients had vomiting, 6 (6%) patients had skin rash and 5 (5%) patients had redness of the eye. Our result is supported by Dawoud et al. study [12].

This comes consistent with what was previously described that severe acute respiratory syndrome coronavirus 2 (SARS-CoV2) shares symptoms with SARS-COV and Middle East respiratory syndrome (MERS), including fever, coughing, and shortness of breath [9,13,14].

In this research, WBCs ranged from 4.5 - 9.7 x 10^3 cells/µl with a mean of 7.1 ± 1.55 x 10^3 cells/µl, and lymphocytes ranged from 0.8 - 3.5 x 10^3 cells/µl with a mean of 2.1 ± 0.78 x 10^3 cells/µl. This tendency towards relative lymphopenia was in congruence with Wu et al. [15] who found that pooled ORs of lymphopenia were significantly associated with hospitalization due to COVID.

In the context of the biochemical analysis, the current work demonstrated that CRP was increased in all cases, with a range of 10 – 45 mg/L and a mean of 28.8 ± 10.1 mg/L. Several studies shown that CRP level may act as a predictor of illness severity [7,14,16].

In our research, we also revealed that the hospitalized COVID-19 cases had high D-dimer levels with the levels ranged from 0.4 – 2 µg/mL, and the mean was 1.2 ± 0.49 µg/mL. In accordance, Kaftan et al. [17] found that elevated D-dimer was associated with an increased hospitalization due to COVID-19.

The AST ranged from 19 – 54 U/L with a mean of 34.97 ± 9.87 U/L, and the ALT ranged from 15 – 62 U/L with a mean of 36.3 ± 13.55 U/L. Our result is similar to Dawoud et al. [12] study that showed that some COVID-19 patients had elevated AST and ALT levels.

In this work, we performed CT evaluation for the study patients, which showed that bilateral lung involvement occurred in 88 (88%) patients whereas unilateral lung involvement occurred in 12 (12%) patients. The pattern of distribution of lung opacities in studied patients was mainly sub pleural (52% of patients). Similar to Haseli et al. [18] study, our research showed that, Lower lobes of the lungs were affected more often.

Regarding the chest CT score for assessment of severity of pulmonary involvement, most of the patients had moderate disease (46%) or severe disease (36%). This high percentage is due to we recruited our sample from patients indicated hospitalization. Given the shortage of available beds during the pandemic, they were kept for the more severe cases. Similar to Teima et al. [19] study, our study showed that dyspnea, cough, fatigue and muscle or body ache were significantly elevated in severe cases.

In this research, GIT signs was significantly elevated in severe cases. The most common reported GIT symptom was diarrhea. Our result is strongly supported the study of Kumar et al. [20].

In consistency with our findings, Bersanelli [21,22] reported that cancer is one of the most widespread and well-known illnesses that impair the immune system and increase disease severity. Concerning the chronic renal disease, Bigdelou et al. [23], in their recent study stated that chronic kidney disease is associated with oxidative stress and elevated expression of ACE-2 and cytokines, including interleukin 6 (IL-6) and CRP.

The present study revealed that patients with severe disease by the CT severity score were significantly older in age. These findings go in consistency with several studies that demonstrated deteriorating results among ageing people [24-26].

Regarding the chest CT findings of the studied patients at 3 month follow up scan, complete radiological resolution of previous opacification occurred in 39 (39%) patients, partial regression with residual opacifications occurred in 27 (27%) patients and fibrotic like changes occurred in 34 (34%) patients. our findings are comparable with Solomon et al. [27] who described that More than fifty percent of previously hospitalized survivors of SARS-CoV-2 infection will exhibit abnormalities on CT, with parenchymal or subpleural bands, reticular abnormality, indications of fibrotic abnormality, and air trapping being the most prevalent.

Our study demonstrated that there was a significant relationship of the CT severity score, the patients' age, and smoking with the follow-up fibrotic changes. In line with these findings. Also, Nabahati et al. [10] found that elevated CT severity scores at admission were associated with elevated risk of fibrotic abnormalities observed at 3-month CT follow-up. Ali & Ghonimy [28] declared that older age, cigarette smoking, and elevated CT severity score were predictors of post COVID-19 fibrotic changes. Multiple studies indicate smoking to be a risk factor for lung fibrotic alterations after COVID-19 infection [29-31]. This is likely attributed to what has been proposed by Rai et al. [32] that Compared to nonsmokers, smokers are 1,4 times more likely to have severe COVID-19 symptoms and 2,4 times more likely to need intensive care unit admission and mechanical ventilation or die. Each of all these factors increases the risk for developing pulmonary fibrosis.

The same results for age, and CT severity score were observed in Han et al. [33] as well. Sansone et al. [34] who stated that following MERS and SARS-CoV 2, the risk of developing pulmonary fibrosis among the elderly is higher. Our research has limitations including the following: First, the interval between CT scans was just three months. To assess if fibrotic-like alterations are persistent, progressive, or reversible, patients with fibrotic-like changes need extended follow-up. Second, the lack of knowledge on pulmonary function testing.

6. CONCLUSION

This study confirmed the great significance of chest CT for the differentiation between pulmonary changes occurred during infection and follow up and predict the risk factors that can affect the prognosis of the disease as well as identify the relation between severity of the infection and other associated clinical findings and comorbidities.

ETHICAL APPROVAL AND CONSENT

This research was conducted after the approval of the institutional ethical committee. Informed written consent was obtained from all patients.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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