Med. J. Cairo Univ., Vol. 90, No. 5, September: 1531-1542, 2022
www.medicaljournalofcairouniversity.net

Initial Chest CT Scan as a Marker for Clinical Severity and Predictor for Outcome in COVID-19 Patients

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Abstract

Background: Chest computed tomography (CT) is a considered best imaging modalityfor COVID-19 infection diagnosis, even in asymptomatic patients. Apart from being a diagnostic tool, CT can also potentially help in evaluating the disease progression and monitoring the response to therapy. Early and accurate diagnosis of the disease helps in accurate management of the patients and good prognosis. Newly emerging radiological classifications have been published in literature trying to classify chest radiological findings as Coronavirus disease 2019 (COVID-19) imaging reporting and data system (CO-RADS) to help in early diagnosis of the disease. Also, other CT chest severity scoring (CT-SS) systems were reported, aiming to quantify disease severity through radiological findings aiming to triage, along with clinical and laboratory findings, patients who need intensive care.

Aim of Study: The goal of our study is to evaluate the role of initial CT imaging in the diagnosis of the disease, and prediction of patients' outcome as it is a rapid, easy and available method for investigation.

Patients and Methods: This a prospective cohort study of 70 patients with PCR-confirmed COVID-19 who underwent chest CT. CT Radiological findings and CT-SS were compared between patients according clinical severity and the need for ICU.

Results: Seventy patients were included in the study. The mean was 44.9±20.71 (5 months-82 years), 34 females (48.6%) and 36 males (51.4%). Severe and critical COVID-19 group was associated with statistically significant increase in the incidence of GGO, consolidation, crazy paving, vascular thickening, bronchial dilatation , nodules and Median CT-SS (p=0.045, 0.008, <0.001, 0.016, 0.031, <0.001 and <0.001 respectively with cut off value >7.5 showing 81.8% sen. and 70.8 spes. and AUC 0.855. The cases who were admitted into ICU were associated with statistically significant increase in the incidence of GGO, consolidation, crazy paving, vascular thickening, atelectatic bands, bronchial dilatation, nodules and The median CT-SS (p=0.049, 0.001, 0.002, 0.04, 0.021, 0.003 and <0.001 respectively) best cutoff point of chest CT score for detection of cases who were admitted into ICU was >8 with 90.9% sen. and 75% spe. and AUC 0.908.

Conclusion: CT chest along with CT-SScan be used as rapid, widely available and accurate imaging tool in detection of disease severity and in predicting for ICU admission which could help clinicians to treat the diseaseearly and accurately.

Key Words: *Chest CT – COVID-19 – Chest severity scoring.*

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Introduction

LATE December 2019 was the onset of an epidemic of viral pneumonia and the detection of novel Coronavirus Disease-2019 (COVID-19) as its cause. It spreaded rapidly throughout China and then through the world. The main clinical symptoms were fever, cough, myalgia or fatigue, expectoration, and dyspnea **[1-3].**

Chest computed tomography (CT) is found to be a distinguishing feature of COVID-19 infection, which was reported in many systematic review and meta-analysis. Ground-glass opacities (GGO) and bilateral pneumonia were characteristic findings COVID-19 infectionon CT chest **[4-7].**

Newly emerging radiological classifications have been published in literature trying to classify chest radiological findings as Coronavirus disease 2019 (COVID-19) imaging reporting and data system (COVID-RADS) and the classification

List of abbreviation:

COVID-19	: Coronavirus disease 2019.
CT	: Computed tomography.
GGO	: Ground glass opacity.
CO-RADS	: COVID-19 Reporting and Data System.
CT-SS	: CT chest severity scoring.
PCR	: Polymerase chain reaction.
SpO2	: Oxygen saturation.
ICU	; Intensive care unit.
FOV	: Field of view.
Kvp	: Kilovoltage peak.
mAs	: Milliampere-seconds.
SD	: Standard deviation.
ROC	: Receiver Operating Characteristic.

consensuses by Society of Thoracic Radiology, American College of Radiology, and Radiological Society of North America (RSNA) aiming to help accurate COVID-19 radiological diagnosis performance **[8]**. Also, other CT chest severity scoring (CT-SS) systems as Chest CT score **[9]**, Chest CT severity score **[10]**, Modified total severity score **[11]** and 3 level chest severity score **[12]** were reported, were used to assess clinical severityaiming to quantify disease severity through radiological findings aiming to triage, along with clinical and laboratory findings, patients who need intensive care. All of them showed excellent inter-observer agreement, good performance **[13]**.

Aim of the work:

The goal of our study is to evaluate the role of initial radiological imaging in the diagnosis of the disease, and prediction of patients' outcome as it is a rapid, easy and available method for investigation.

Patients and Methods

This prospective study was conducted at the main Mansoura University Hospital and isolation Hospital, between June 2020 and May 2022. The local institutional review board (IRB) approval was obtained. Its number was MS 20.07.1177.

Inclusion criteria:

Eighty-seven patients with Polymerase chain reaction (PCR) confirmed COVID-19 who agreed to join the study according to the ethical considerations and underwent chest CT from June 2020 to May 2021 were initially enrolled. They were referred from COVID-19 specialized clinic to radiology department for initial CT chest examination.

Exclusion criteria:

Seventeen patients were excluded; 8 patients showed motion artifacts on chest CT, and we missed clinical data for 9 patients. Seventy patients were finally included. They were 34 females (48.6%) and 36 males (51.4%), their mean age was 44.9± 20.71 (5 months-82 years).

Clinical severity and outcome:

Patients were classified at time of initial CT acquisition into mild. Moderate, severe and critical: Mild-cases group is by symptoms of COVID-19 infection (e.g. fever, cough, and fatigue) without evidence of viral pneumonia or hypoxia. Moderate-cases group is presented with clinical signs of pneumonia but no signs of severe pneumonia and with oxygen saturation (SpO_2) ≥90% while breathing normal room air. Severe-cases group is presented by clinical signs of pneumonia plus one of the following: Respiratory rate >30 breaths/min; severe respiratory distress; or SpO_2 <90% on room air-based. The final outcomes of clinical course were assessed for all patients regarding the need for intensive care unit (ICU) admission and ventilation support.

Image acquisition:

Chest CT examinations were conducted with commercially available 128-multidetector CT and 64-multidetector CT machines. All patients were examined in supine position through the entire thorax, in inspiratory phase with no contrast media by using the following parameters: FOV: 50cm, Kvp: 40, mAs: 400, rotation time 0.5 second; pitch 1.0 and Thickness: 0.6mm.

Image analysis:

All data exported to the Synapse Picture Archiving Sand Communication System (PACS), interpretation was done using axial and reformatted imaging. The following CT features were assessed: GGO, consolidation, crazy paving, vascular thickening, atelectatic bands, bronchial dilatation, nodular opacities, lung cavitations, mediastinal lymph nodes enlargement and pleural effusion. The level of suspicion was assessed by CORADS system as following: (1=very low probability; 2=low probability; 3=uncertain; 4=high probability; 5=very high probability **[8]**.

For calculating Chest CT-SS, the extend of parenchymal involvement was calculated for each lobe per case from 0-5 for < 5%, 5-25%, 26-50%, 51-75% and > 75% involvements respectively. The resulting total CT score is the sum ranging from 0 (no involvement) to 25 (maximum involvement) **[9]**.

Statistics:

Data were expressed as mean ± SD (Standard deviation), median (range) and frequencies and relative percentages. Analysis conducted using the SPSS) version 27. *p*-values <0.05 are significant, and *p*-values <0.01 are highly significant.

To The patient was classified into two groups: non-severe/critical cases (mild and moderate cases) and severe/critical. Chi-sauqure, Monte Carlo and Fisher exact test, and Receiver Operating Characteristic (ROC) curve assessment were conducted to assess the diagnostic performance of the radiological findings and scoring in detection the clinical severity and predicting the outcome.

Results

This current study included 70 cases fulfilling the inclusion criteria, the mean age of the included cases was 44.9±20.71 (5 months-82 years), 34 females (48.6%) and 36 males (51.4%). There were only 10 smokers (14.3 The most common associated comorbidities were the cardiovascular diseases in 24 cases (34.3%) and diabetes mellitus in 21 cases (30%) (Table 1).

Table (1): Demographic data and clinical history.

Items	Study cases N = 70	
Mean ± SD	44.9±20.71	
Age (years):		
Median (min-max)	49 (0.42-82)	
	Number	Percent
Sex:		
Male	36	51.4
Female	34	48.6
Smoking:		
No	60	85.7
Yes	10	14.3
	41	58.6
All comorbidities	24	34.3
CVS	21	30.0
DM	4	5.7
Lung diseases	4	5.7
Renal diseases	0	0
Liver diseases	1	1.4
Cancer		
Other diseases	1	1.4
Anemia	1	1.4
AVSD and PHTN	1	1.4
Bipolar	1	1.4
CP and ICH	1	1.4
DKA on admission	2	2.9
Hypothyroidism	1	1.4
Hypothyroidism and Delirium	1	1.4
HX of HCV	1	1.4
Hyperthyroidism	4	5.7
IHD	1	1.4
IHD and MM on chemo	1	1.4
Kawasaki with coronary aneurysm	2	2.9
Kidney transplant	1	1.4
Lymphoma	1	1.4
Myocarditis	1	1.4
OSA	1	1.4
Osteoarthritis	1	1.4
Removed spinal cord tumor	2	2.9
Sciatica	1	1.4
Stroke		

Continuous data expressed as mean ± SD and median (range).
Categorical data expressed as Number (%).

Regarding the severity of symptoms, mild disease was shown in 34.3%, moderate disease in 34.3%, severe disease in 24.3% and critical disease in 7.1%. The RR was normal in 71.4% and high in 28.6%. Oxygen saturation was low in 44.3% and 41.4% of the cases required ventilation. Among the included cases, 65.7% required admission into isolation ward while 31.4% required ICU administration. The mean duration of admission was 12.13±9.35 days with range between 1 and 48 days (Table 2).

Table (2): COVID-19 clinical severity and outcomes related data in the cases of the study.

Items	Study cases N = 70	
	Number	Percent
Admission to isolation ward:		
No	24	34.3
Yes	46	65.7
Severity of symptoms:		
Mild	24	34.3
Moderate	24	34.3
Severe	17	24.3
Critical	5	7.1
RR:		
Normal	50	71.4
High/tachypnea	20	28.6
Saturation:		
Normal	39	55.7
Low	31	44.3
Ventilation:		
No	41	58.6
Yes	29	41.4
ICU Admission:		
No	48	68.6
Yes	22	31.4
Duration of admission (Days):		
Mean ± SD	12.13±9.35	
Median (min-max)	9 (1-48)	
Outcome:		
Discharge	65	92.9
Died	5	7.1

Continuous data expressed as mean ± SD and median (range).
Categorical data expressed as Number (%).

The radiological findings shown in (Table 3) revealed that were GGO was the most common radiological findings and as regard CORADS categories, CORADS 5 represented in 80% of the cases. The mean total chest CT score was 7.29± 5.12 (0-24).

Clinical severity:

Severe and critical COVID-19 group was associated with statistically significant increase in the incidence of GGO, consolidation, crazy paving, vascular thickening, bronchial dilatation and nodules (p=0.045, 0.008, <0.001, 0.016, 0.031 and <0.001 respectively) (Table 3).

Median Chest CT score in the cases with Severe + critical disease severity was 12 (2-24) that was statistically significantly higher as compared to the cases with Mild + Moderate disease severity (p<0.001) and cut off value >7.5 showing 81.8 % sensitivity and 70.8 septicity. However, there was no statistically significant difference regarding the CORADS classification between the cases with Mild + Moderate disease severity and the cases with Severe + critical disease severity (p= 0.096) Tables (3,4) & Figs. (1,2).

Outcome:

The cases who were admitted into ICU were associated with statistically significant increase in the incidence of GGO, consolidation, crazy paving, vascular thickening, atelectatic bands, bronchial dilatation and nodules (p=0.049, 0.001, 0.002, 0.04, 0.021 and 0.003 respectively) Tables (5,6).

The median Chest CT score in the cases who were admitted into ICU was 12 (5-24) that was statistically significantly higher as compared to the cases who were didn't admitted into ICU (p<0.001). Shows that the best cutoff point of chest CT score for detection of cases who were admitted into ICU was >8 with 90.9% sensitivity and 75% specificity. However, there was no statistically significant difference regarding the CORADS classification between the cases who were admitted and the cases who weren't admitted into ICU (p= 0.064) Tables (5,6) & Figs. (1,2).

Table (3): Relations between clinical severity and Radiological findings, CORADS and chest CT scoring.

	Severity of the disease			Test of significance	p-value
	Mild + Moderate disease severity (N=48)	Severe + critical disease severity (N=22)			
GGO	39 (81.2%)	22 (100%)	61 (87.1%)	χ^2=4.734	0.030*
Consolidation	22 (45.8%)	18 (81.8%)	40 (57%)	χ^2=7.977	0.005*
Crazy paving	29 (60.4%)	22 (100%)	51 (72.9)	χ^2=11.953	0.001*
Pleural effusion	1 (2.1%)	0 (0%)	1 (1.4)	FET=0.465	0.495
Vascular thickening	16 (33.3%)	14 (63.6%)	30 (42.9%)	χ^2=5.657	0.017*
Atelectatic bands	31 (64.6%)	19 (86.4%)	50 (71.4%)	χ^2=3.507	0.061
Mediastinal LNs	4 (8.3%)	4 (18.2%)	8 (11.4%)	FET=1.446	0.229
Bronchial dilatation	27 (56.2%)	19 (86.4%)	46 (65.7%)	χ^2=6.072	0.014*
Cavitation	5 (10.4%)	0 (0%)	5 (7.1%)	FET=2.468	0.116
Nodules	1 (2.1%)	4 (18.2%)	5 (7.1%)	FET=5.895	0.015*
CORADS categories:					
CORAD 1	9 (18.8%)	0 (0%)	9 (12.9%)	MC=6.336	0.096
CORAD 3	1 (2.1%)	1 (4.5%)	2 (2.9%)		
CORAD 4	1 (2.1%)	2 (9.1%)	3 (4.3%)		
CORAD 5	37 (77.1%)	19 (86.4%)	56 (80)		
Chest CT scoring:					
Score	5 (0-14)	12 (2-24)	7.29±5.12	z=–4.439	<0.001*

χ^2: Chi-square test. MC: Monte-Carlo test. FET: Fischer's exact test. *t*: Independent samples *t*-test.

Table (4): Diagnostic performance of CT findings and chest CT score for identification of cases with severe and critical disease severity.

	Cutoff point	AUC	Sensitivity (%)	Specificity (%)	PPV (%)	NPV (%)	Accuracy (%)	p-value
GGO			100	18.8	36	100	44	0.049
Consolidation			81	54	45	86.6	62.9	0.008
Crazy paving			100	60.4	43.1	100	58.57	<0.001*
Bronchiectasis			86.4	43.8	41.3	87.5	57.2	.016
Nodule			18.2	97.9	80	69.1	72.9	.031
Chest CT score	>7.5	0.855	81.8	70.8	76.4	72.2	74.2	<0.001*

AUC: Area under the curve. PPV: Positive predictive value. NPV: Negative predictive value.

Table (5): Relations between outcome and Radiological findings, CORADS and chest CT scoring.

	ICU admission		Test of significance	*p*-value
	No (N=48)	Yes (N=22)		
GGO	39 (81.3%)	22 (100%)	χ^2_2=4.437	0.030*
Consolidation	21 (43.8%)	19 (86.4%)	χ^2_2=11.186	0.001*
Crazy paving	29 (60.4%)	22 (100%)	χ^2=11.953	0.001*
Pleural effusion	1 (2.1%)	0 (0%)	FET=0.465	0.495
Vascular thickening	15 (31.3%)	15 (68.2%)	χ^2_2=8.402	0.004*
Atelectatic bands	30 (62.5%)	20 (90.9%)	χ^2_2=5.966	0.015*
Mediastinal LNs	5 (10.4%)	3 (13.6%)	FET=0.154	0.694
Bronchial dilatation	26 (54.2%)	20 (90.9%)	χ^2=9.039	0.003 *
Cavitation	4 (8.3%)	1 (4.5%)	FET=0.326	0.568
Nodules	1 (2.1%)	4 (18.2%)	FET=5.895	0.015 *
CORADS:				
CORAD 1	9 (18.8 %)	0 (0%)	MC=7.247	0.064
CORAD 3	2 (4.2 %)	0 (0%)		
CORAD 4	1 (2.1 %)	2 (9.1%)		
CORAD 5	36 (75 %)	20 (90.9%)		
Chest CT score:				
Score	5 (0-14)	12 (5-24)	z=–5.470	<0.001*

χ^2: Chi-square test. MC: Monte-Carlo test. FET: Fischer's exact test. *t*: Independent samples *t*-test.

Table (6): Diagnostic performance of CT findings and chest CT score for identification of cases with ICU admission.

	Cut off point	AUC	Sensitivity (%)	Specificity (%)	PPV (%)	NPV (%)	Accuracy (%)	*p*-value
GGO			100	18.8	36	100	44.3	0.049
Consolidation			86.4	56.3	47.5	90	65.7	0.001
Crazy paving			100	39.6	43.1	100	58.6	.002
Vascular thickening			68.2	68.8	50	82.5	68.5	.004
Atelectasis			90.9	37.5	40	90	54.2	.021
Bronchiectasis			90.9	45.8	43.5	91.7	60	.003
Nodule			18.2	97.9	80	72.3	72.9	.031
Chest CT score	>8	0.908	90.9	75	62.5	94.7	80	<0.001*

AUC: Area under the curve. PPV: Positive predictive value. NPV: Negative predictive value.

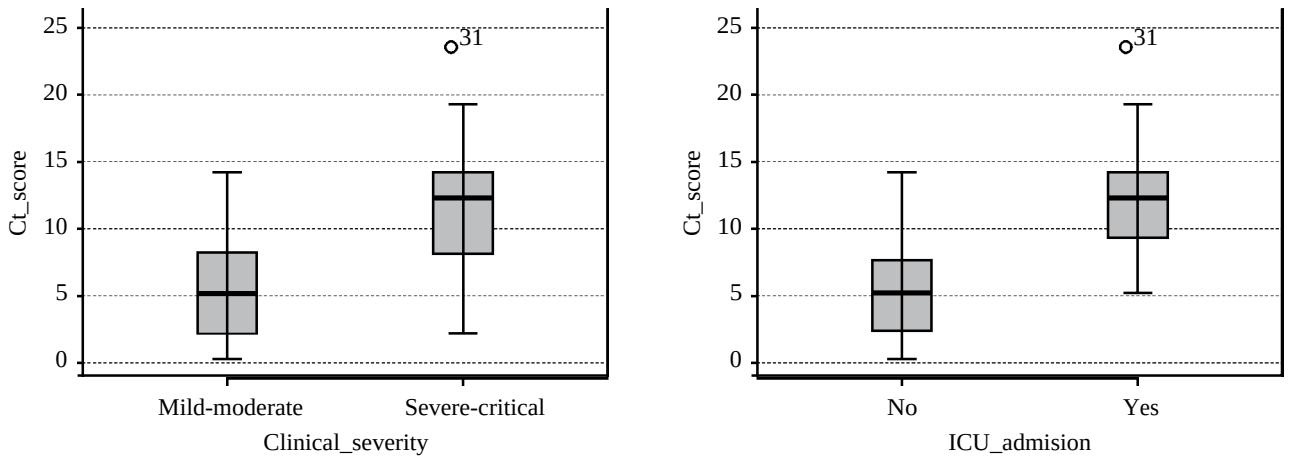

Fig. (1): Chest CT score for identification of cases with severe and critical disease severity (a) and ICU admitted patients (b).

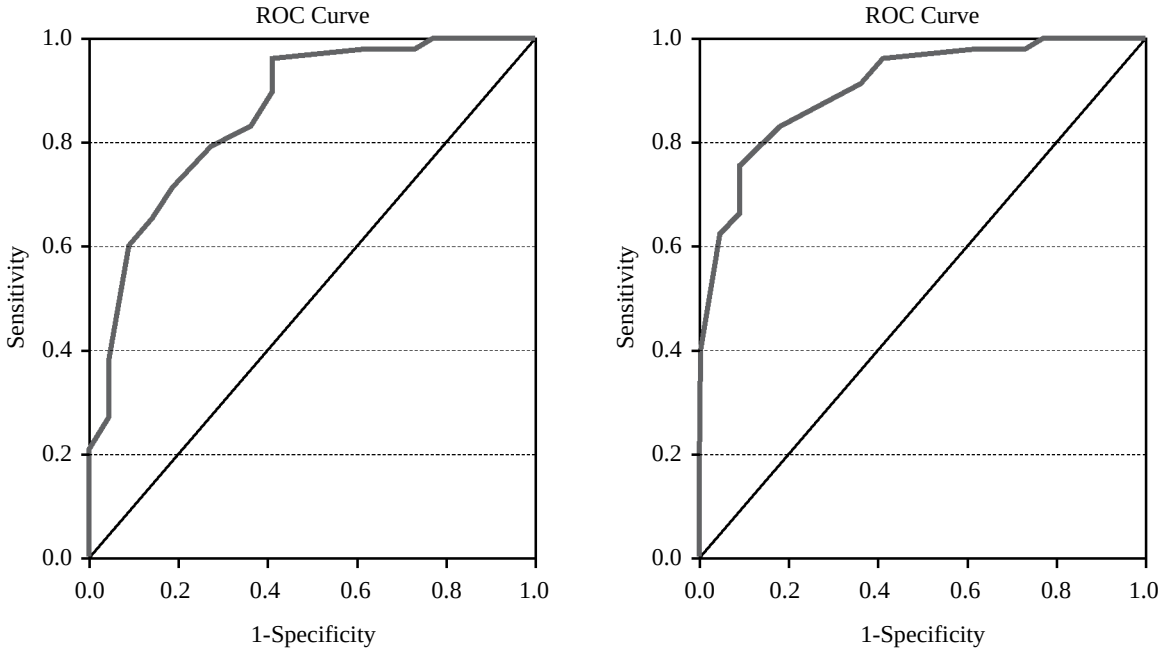

Fig. (2): ROC Curve for chest CT score for identification of cases with severe and critical disease severity (a) and ICU admitted patients (b).

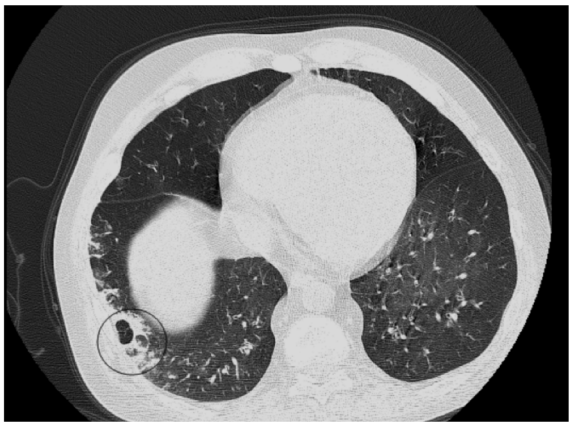

Fig. (3): Male patient aged 48 years. Non contrast chest CT after 17 days of the mild clinical course of COVID-19 infection shows CT findings consistent with CORADS 5 category and CT severity score (5). Axial cuts at the same level in lung a sub-segmental area of consolidative changes located peripherally associated with cavity formation is seen at the right lower lung lobe (circles). No ventilation needed and discharge was decided after 14 days of isolation.

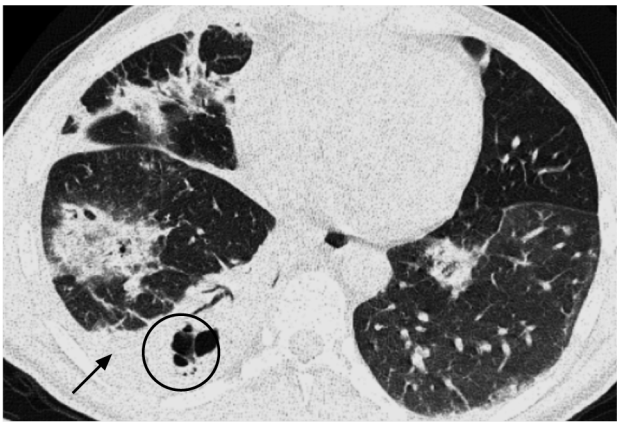

Fig. (4): A 57-year-old male patient was hospitalized for COVID-19 pneumonia 12 days after a progressive course of increasing dry cough, generalized weakness and fever (severe clinical presentation). Non contrast CT chest axial cuts revealed that the posterior basal segment of the right lung lower lobe shows consolidation (arrow) along with cavitation (circle) associated with patches of GGO and crazy paving of both lower lung lobes and right middle lung lobe and right fissure thickening. CT findings were consistent with CORADS 5. Chest CT severity score was 10. Initially, the patient was isolated in a regular ward. On the 12th day of the clinical course, oxygen saturation dropped to 78% and ICU admission was decided. The patient was returned to the regular ward after ten days and discharge was decided therefore.

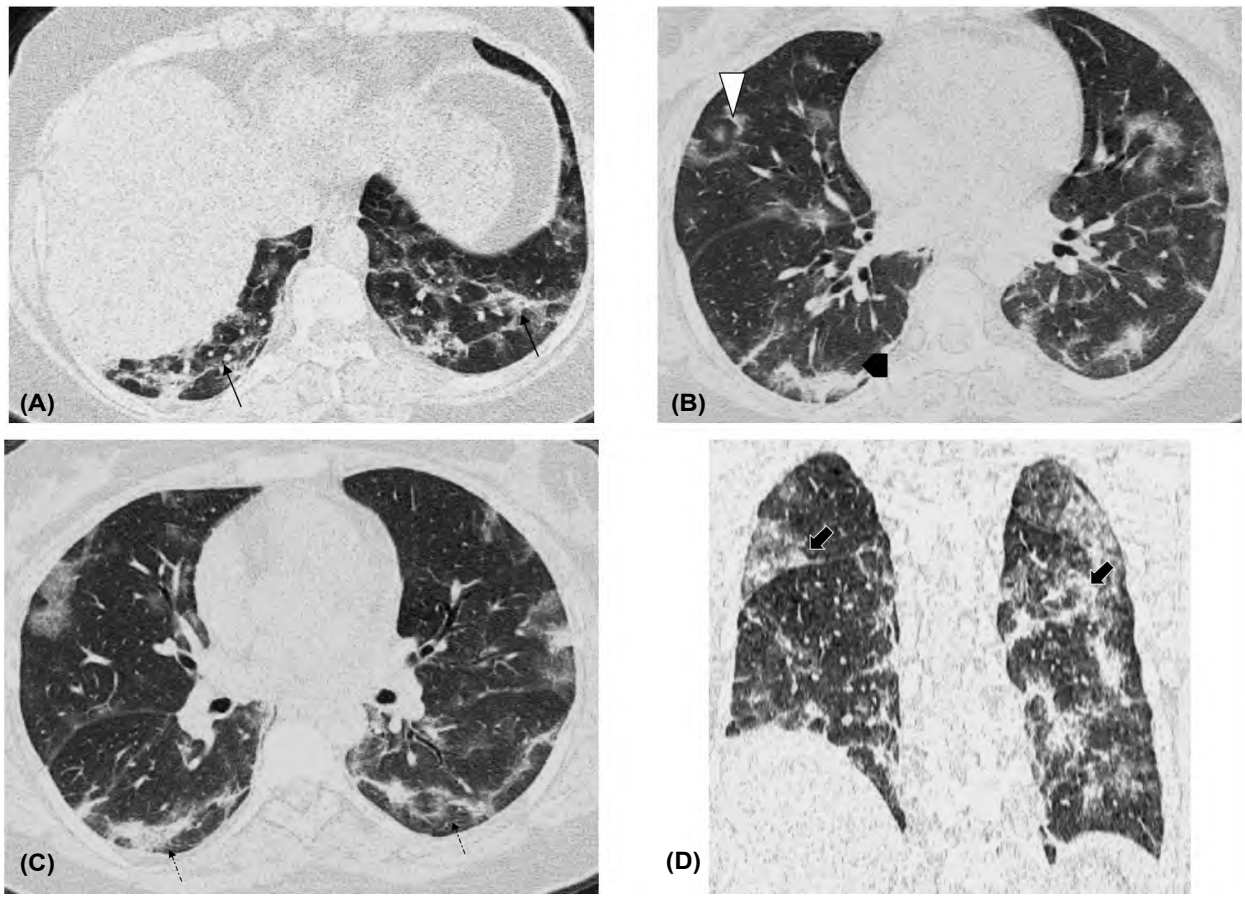

Fig. (5): 48 year-old Female patient, presented with mild symptoms of COVID-19 pneumonia. Her Chest CT findings were coping with CO-RADS 5 category and CT score was 8. The patient wasadmitted to isolation ward and discharged after 14 days with no need for supportive ventilation. Non contrast CT chest: A. Axial image shows bilateral lower lobe subpleural GGO with atelectatic bands (thin black solid arrows). B. Axial CT image shows right middle lobe halo sign (white arrowhead) and right lower lobe consolidation opacifications (thick black arrow). C. Axial CT image shows bilateral lower lobe subpleural GGO (thin black dashed arrows). D. CT images with coronal reconstruction show bilateral GGO with lower lobes and peripheral predominance (thick black arrow).

Discussion

As regard the pandemic of COVID-19 infection-which was identified in December 2019, Pneumonia is the most frequent presentation leading to high morbidity and mortality. It is important to be diagnosed choose accurate treatment **[14-16]**.

Much availability, high spatial resolution, variable post-processing techniques, diagnostic performance and accuracy of CT as fast scan makes it favored imaging modality for pneumonia **[17]**. The current study was conducted to detect the statistical significance value of initial radiological chest scan in diagnosis of patients with COVID-19 infection and in prediction of their outcomes.

This current study included 70 patients with COVID-19 infection. The mean age of the included cases was 44.9±20.71 years and the median age was 49 years with range between 5 months and 82 years. There was slightly higher male predominance as there were 34 females (48.6%) and 36 males (51.4%) in the included cases. Within the same context, Mohammed et al., included 164 patients diagnosed as COVID-19, 86 were male (52.4%), and 78 were female (47.6%); ranging in age from 1 to 85 years (mean age 44.3±16.5 years) **[18]**.

Chest CT findings in diagnosis of COVID-19:

Among CT findings included in this study, GGO was the most frequent sign, concomitant with the global criteria of COVID-19 diagnosis **[19]**. Fig. (4). Its pathogenesis presumed to be a resultant fromalveolar edema, alveolar exudate and hyaline membrane. This was the most common finding among the included cases and were reported in 87.1% of the cases. This was in the same line with the retrospective study conducted in Egypt by Samir et al. & Hefeda et al., reported that GGO is the earliest dependable sign for diagnosis COVID-19 associated pneumonia. Its incidence found to be 65%-100% in published literature **[20-24]**.

In the current study, the second most common finding was the crazy paving in 72.9% of the cases. Our results agreed with previous studies described the “crazy-paving” pattern in 100% of their severe patients, including Ghweil et al., Metwally et al. and Osman et al., **[25-27]**. The crazy paving was reported in 92% of cases which is considered adistinct sign of COVID 19 pneumonia, itcould be explained by associated alveolar edema and interstitial inflammation, and **[28]**. Mohammed et al., who showed that although the low incidence of crazy paving and reverse halo signs, they were specific for COVID 19 pneumonia **[18]**.

In the current study, atelectatic bands were the third most common detected CT finding among the included cases and seen in 71.4%. These findings are greatly matching with a meta-analysis involved 2738 COVID-19 patients, in which typical CT signs were GGOs (83.31%), GGOs with consolidation (58.42%) and interlobular septal thickening (48.46%) Fig. (4) **[29]**.

Bronchiectasis was reported in some cases of COVID-19 patients. In the current study, bronchial dilatation was reported in 65.7% of the cases. There was in agreeing with Zhao et al., who reported bronchiectasis in 52.5% of their patients **[30,31]**.

In the current study, consolidation was seen in 57.1% of the cases. The multiple segment affection was characteristic of COVID-19 pneumonia in which canhelp in the diagnosis of COVID-19 pneumonia rather than bacterial pneumonia Figs. (4,5) **[22]**. This was in accordance with Tabatabaei et al. who showed that consolidation, as the second most common feature after GGOs **[32]**. Consolidation was defined as an exudate or other product of disease that replaces alveolar air. In this scenario, it could be related to diffuse alveolar damage **[14]**.

In the current study, vascular thickening was reported in 42.9% of the cases.This signs were also observed in the studies of Zhao et al., (71.3%), and Zhou et al., (45.2%), and it has been considered as predictor of lung affection in early phases, explained by hyperemia produced from the acute inflammatory response **[31,33-35]**.

In the current study, Mediastinal lymphadenopathy was reported in 11.4% of the cases. This agreed with most of the studies in the literature as Abd elnaby et al who showed that the mediastinal and/or hilar lymphadenopathy (6.25%) **[36]** Azadbakht and his colleagues reported lymphadenopathy in 2.4% and Bao et al., who showed that lymphadenopathy was detected in (3.38%) **[37,29]**. Cau et al., CT reposrted lymphadenopathy in 27% of the patients analyzed The higher prevalence could be explained as that study included only cases admitted into ICU **[38]**.

In the current study, pulmonary nodules were reported in 7.1% of the cases. Higher percentage was reported by Hafez et al., who reported nodules in 20% of the patients which were small and showed variable shapes (round, oval, or irregularly) **[39]**.

In the current study, cavitation was reported in 7.1% of the cases which could be due to resorption of consolidation; This was in accordance with Hafez et al., who showed that 10% of the patients had air-containing cysts. This also agreed with Shi et al.'s who found that found cysts in 10% of the cases **[39,40]**.

Chest CT and severity of COVID-19:

In the current study, the cases with severe and critical COVID-19 was associated with statistically significant increase in the incidence of GGO, consolidation, crazy paving, vascular thickening, bronchial dilatation and nodules. This agreed with Hafez et al., who showed a significant correlation was found between disease severity and consolidation, crazy paving, interlobular septation, bronchial thickening/dilatation, pulmonary nodule, and lymphadenopathy **[39]**.

Li et al., found that consolidation was significantly more common in severe and critical patients in comparison with ordinary groups **[3]**. This shows that the alveoli are completely full with inflammatory exudate which means that the virus diffuses into the respiratory epithelium, ending in necrotizing bronchitis, extensive alveolar damage and finally death **[41]**.

In the current study, there is an increase in the CORADs classification with increasing the disease severity, but it didn't reach a statistically significant value. This agreed with Zayed et al., who showed that the CO-RAD score was significantly higher in severe case than in mild/moderate one; thus, the mean CO-RAD was 5 as opposed to 2 in other groups, $p<0.001$ **[42]**. The lack of significance in our study is mostly due to small sample size.

In the current study, the median CT score was statistically significantly higher as compared with the cases with mild and moderate disease severity ($p<0.001$). This was in accordance with Parmer et al. and Francone et al., who showed that the mean chest CT-SS score was significantly higher in critical and severe patients than common patients **[10,42,43]**.

In the current study, the best cutoff point of chest CT score for detection of cases with severe and critical COVID-19 symptoms was >7.5 with 81.8% sensitivity and 70.8% specificity there was in agreement with Zayed et al., who concluded in a retrospective study CT-SS score of less than 7.5 could rule out severe COVID-19 disease. The chest CT score is a good indicator of the extent of systemic inflammation and pneumonia involvement with differentiation of common, severe and critical types and helps clinicians achieve early diagnosis and accurate management **[42].**

CT Chest as prognostic indicator among COVID-19 patients:

In the current study, CT chest scans were associated with statistically significant increase in the incidence of GGO, consolidation, crazy paving, vascular thickening, bronchial dilatation and atelectatic changes in the COVID-19 cases who were admitted into ICU. This was in accordance with Cau et al., who found a significantly different CT imaging features of ICU patients affected by COVID-19 compared with non-ICU patients. Patients in the ICU had higher incidence of GGO, consolidation and mixed of GGO and consolidation (p<0.05) **[38].**

Within the same line, Tabatabaei et al., reported that carzy paving was the more frequent sign in patients admitted to ICU and dead patient's Meiler et al., also reported that crazypaving sign as the only independent predictor of poor outcome which explained by presence of acute respiratory distress syndrome and pulmonary edema **[32,44].**

In our study, there is an increase in the CORADs classification with increasing percent of ICU admitted patients with COVID-19 infection, but it didn't reach a statistically significant value. We found that 90.9 patients who were required ICU admission are given CORADs 5 category and 9.1 of them had CORADs 4 category. This was in agreed with Inanc et al., who showed that most patients transferred to the ICU had CO-RADS score of 5. The CO-RADS score was 4 and above in 89.2 patients who were transferred to the ICU due to worsening of clinical condition (p<0.001) **[45].**

In the current, the median Chest CT score (CTSS) in the cases who were admitted into ICU was 12 (range 5-24) that was statistically significantly higher as compared to the cases who were didn't admitted into ICU (p<0.001). The best cutoff point of chest CT score for detection of COVID-19 cases who admitted to ICU symptoms was >7.5 with 90.9% sensitivity and 75% specificity. A similar kind of study was conducted by Bellos et al., on 42 patients, which showed a similar conclusion, stating the threshold of 10.5/25 for the prediction of admission to the ICU with sensitivity and specificity of 75% and 70% respectively **[46].**

On the same context, Jay et al., concluded that CTSS has good discriminating power for predicting disease severity and mortality in patients with COVID-19. Evaluation of CTSS can help clinicians in recognizing possibly severe cases in early triage, assist clinicians to become aware of potentially severe cases early, conduct early triage and initiating effective COVID-19 control in a timely manner which may lower the mortality of COVID-19 **[47].**

Limitations:

This study has several limitations. First, given the small sample size, further studies with a larger sample size are still recommended. Second, it is a single center study and further multicenter studies are mandatory. Finally, the role of automatic volumetric analysis of pulmonary affection and artificial intelligence integration in chest severity scoring should be assed especially in time consuming and avoiding bias of human factor.

Conclusion:

CT chest along with CT-S Scan be used as rapid, widely available and accurate imaging tool in detection of disease severity and in predicting for ICU admission which could help clinicians to treat the diseaseearly and accurately.

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فحص الأشعة المبدئى للصدر كمؤشر تشخيصى ومصيرى لمرضى فيروس كورونا المستجد-١٩ (كوفيد-١٩)

\المقدمة : يعد تصوير الأشعة المقطعية للصدر من أهم وسائل لتشخيص العدوى بفيروس كورونا المستجد، حتى فى المرضى الذين لا تظهر عليهم أعراض. بصرف النظر عن كونه أداة تشخيصية، يمكن أن يساعد التصوير بالأشعة المقطعية أيضاً فى التنبؤ وتقييم تطور المرض ومراقبة الاستجابة للعلاج. حديثاً تم نشر تصنيفات تحاول تصنيف النتائج الإشعاعية للصدر سواء للتشخيص مثل CORAD-s أو تقيم شدة الإصابة بالالتهاب الرئوى ذلك من قبل جمعية أشعة الصدر، والكلية الأمريكية للأشعة، والجمعية الإشعاعية لأمريكا الشمالية التى تهدف إلى المساعدة فى التشخيص الإشعاعى الدقيق لفيروس كورونا المستجد. الهدف من دراستنا هو تقييم دور التصوير الإشعاعى الأولى فى تشخيص درجة الإصابة المرض، والتنبؤ بنتائج المرض مما قد ينعكس على اختيار كيفية العلاج والتنبأ باحتياج المريض للدخول للعناية المركزة من عدمه.

هدف \البحث : الهدف من الدراسة الحالية هو اكتشاف القيمة الإحصائية لفحص الصدر الإشعاعى الأولى فى تشخيص المرضى المصابين بعدوى كورونا المستجد وفى التنبؤ بنتائجهم.

\المرضى وطرق \البحث : هذه دراسة مستقبلية لسبعين مريضاً مصاباً بفيروس كورونا المستجد المؤكد ٢٠١٩ تم تشخيصهم بالفعل عن طريق تفاعل البوليميراز المتسلسل وخضعوا للتصوير بالأشعة المقطعية للصدر. تمت مقارنة نتائج الأشعة المقطعية للصدر بين المرضى حسب الشدة السريرية والحاجة للأقامة وحدة العناية المركزة.

\النتائج : تضمنت الدراسة سبعين مريضاً. كان متوسط عمر المرضى ٢٢.٧±٤٤.٩ (٥ أشهر –٢٨ سنة)، ٣٤ إناث (٤٨.٦٪) و ٣٦ ذكور (٥١.٤٪). ارتبطت مجموعة المرضى ذوى درجات الإصابة الشديدة والحرجة بزيادة إحصائية فى حدوث العتامة الزجاجية، والتوحيد، والرصف المجنون، وسماكة الأوعية الدموية، وتوسع الشعب الهوائية والعقيدات (p=0.045، ٠.٠٠٨، <٠.٠٠١، ٠.٠١٦، ٠.٠٣١ و <٠.٠٠١ على التوالى). كان متوسط درجة التصوير بالأشعة المقطعية المحوسب للصدر فى الحالات المصابة بمرض (شديد + خطير) ١٢ (٢–٢٤) أعلى بشكل ملحوظ من الناحية الإحصائية مقارنة بالحالات ذات شدة المرض (الخفيفة + المتوسطة) (p<٠.٠٠١). فباعتبار ٧.٥ حد أدنى للتفريق بين شدة المرض تكون دقة التشخيص ٨١.٨٪ للحساسية و ٧٠.٨٪ للخصوصية.

\الاستنتاج : هناك أهمية كبيرة لإستخدام نتائج التصوير بالأشعة المقطعية للصدر وبالأخص تصنيفات شدة الإصابة بالأشعة المقطعية فى التمييز بين شدة الإصابة الإكلينيكية من بسيطة ومعتدلة لشديدة والحرجة وذلك للمرضى المصابين بعدوى كورونا المستجد ٢٠١٩ للرئة، وأيضاً للتنبؤ بالحاجة للإقامة بوحدة العناية المركزة. يساعد الأطباء فى علاج المرض مبكراً وبدقة.