HRCT Chest For Prediction of COVID-19 and Non COVID-19 Disease

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ABSTRACT

Background: High resolution chest computed tomography (HRCT) plays vital role in finding of COVID-19 and differentiation between COVID-19 with other types of chest infection.

Objective: The aim of the present study was to assess HRCT chest's usefulness in identifying COVID-19 pneumonia and distinguishing it from other chest infections.

Patients and methods: Our comparative study included 50 patients and HRCT was performed for all cases. A total of 38 patients were confirmed to have COVID-19 by typical HRCT findings and PCR, and 12 patients were confirmed non COVID-19 by history, lab investigations and atypical CT finding. All cases were graded using CORADS scoring system.

Results: Common CT findings included ground-glass concentrations in the periphery and subpleura. Prominent interlobular septations; also, vascular dilatation, consolidation, fibrotic streaks, atelectatic bands are also CT findings. Consolodations, cavitations, calcifications pleural effusion are more common in other types of chest infections.
Conclusion: CORADS system helps radiologists grading typical CT finding and making decision of presence of COVID-19 or other types of chest infection.

Keywords: COVID-19, HRCT, Chest infection, Comparative study, Menoufia University.

INTRODUCTION

First identified in Wuhan, Hubei Province, China, the severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) causing coronavirus disease 2019 (COVID-19) is rapidly spreading to other domestic cities and countries outside of China [(1)].

COVID-19 has a diverse range of clinical presentations. The most common symptoms of COVID-19 include fever, coughing, exhaustion, and expectoration. Anorexia, chest pain, dyspnea (shortness of breath) and muscle aches are also frequent. In addition to problems with smell and taste, it seems that this is a common symptom. However, headaches, pharyngalgia, diarrhoea, chills, vomiting and abdominal discomfort are also possible, albeit less common, side effects. The list of possible COVID-19 symptoms is so broad that literally anything could be a symptom. As more is learned about COVID-19, the list of possible symptoms may also grow [(2)].

Uncertain variables, such as cytotoxicity and lymphopenia [(3)] as well the ensuing inflammatory response, contribute to the development of the disease into overt lung damage and acute respiratory distress syndrome (ARDS). Inflammatory markers such as D-Dimer, ferritin and interleukin-6 (IL-6) that are overexpressed are associated with a bad prognosis [(4)].

Today, chest computed tomography images are a crucial non-invasive tool for accurately detecting various pneumonia subtypes [(5)]. The gold standard for confirming COVID-19 is a virus-specific reverse-transcriptase polymerase chain reaction (RT-PCR) [(6)].

Pneumonias can be a result of a wide variety of species, although they often present radiographically similarly [(7)].

Individuals with COVID-19 often had ground-glass opacities on chest computed tomography scans, most often in the lower and peripheral lobes, as well as bilateral numerous lobular with subsegmental regions of consolidation. Researchers discovered that the severity of an illness was proportional to the number of lung segments affected [(8)].

Pleural effusion (seen in only almost 5% of chest CT scans), masses, cavitations and lymphadenopathies were also atypical CT findings [(9)].

Lesions of different types of pneumonia are shown at distinct scales, shapes, and locations on chest CT scan, allowing for easy visual separation. For instance, in contrast to the diffuse distribution of the other non-COVID-19 VP, aberrant results from ground-glass opacities in individuals with COVID-19 are typically multifocal, bilateral, and peripheral. Opacities in the lungs can be segmental (in the case of bronchopneumonia) or lobar (in the case of lobar pneumonia) when bilateral pneumonia is present [(10)].

People with moderate to severe symptoms can benefit greatly from the Coronavirus Disease 2019 (COVID-19) Reporting and Data System (CO-RADS), a categorical evaluation scheme for pulmonary manifestations of COVID-19 at unenhanced chest CT with substantial interobserver agreement, particularly in categories 1and 5 [(11)].

The simplicity of this classification is its greatest strength, leading to fair to good agreement between observers, even among radiologists of varying levels of experience. When compared to a clinical diagnosis and positive results for RT-PCR assays, the classification also shows strength in being able to distinguish among radiological abnormalities associated with a high or low risk of COVID-19 [(12)].

The aim of the present study was to assess high resolution chest computed tomography (HRCT) chest's usefulness in identifying COVID-19 pneumonia and distinguishing it from other chest infections.

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PATIENTS AND METHODS

Our comparative study included 50 patients and HRCT was performed for all cases. The age range was 30 to 85 years, and 28 patients were males and 22 were females.

A total of 38 patients were diagnosed by radiologist as COVID-19 and 12 were diagnosed as other types of pneumonia. They referred to the Radiology Department of Menoufia University and Chest Hospital Shibin Elkom over the time span from May 2020 and to June 2022.

Participants who presented with at least one of the following symptoms were directed to HRCT for evaluation: Cough, shortness of breath, sore throat fever, boneache and diarrhea.

All patients were subjected to the following:

A complete history was taken, including date of birth, gender and physical description. Analyzing previous tests performed on the participant, such as a sputum culture along with polymerase chain reaction, chest X-ray as well HRCT of the chest without oral or intravenous contrast, reevaluation of the patients' past radiological exams (x-ray and HRCT).

Images were first analyzed for the presence of COVID-19 pneumonia hallmarks including bilateral multilobe posterior peripheral ground-glass opacities. The severity was then determined after visually inspecting each affected lobe. Presence of atypical finding for COVID-19 as unilateral consolidation, presence of calcifications, enlarged LN, cavitation, provisional imaging diagnosis.

There are 4 categories of possible COVID-19 infection: The CO-RADS index If a CT scan is negative or there are other signs of a non-infectious condition, CO-RADS 1 state that a diagnosis of COVID-19 is doubtful. CO-RADS 2: CT results are compatible with other infections and there is a low suspicion of COVID-19 infection; CO-RADS 3: Indeterminate or uncertain COVID-19 infection; chest computed tomography abnormalities suggest infection but it is not clear if COVID-19 is the cause; Suspicion is strong, and most CT findings are not highly typical, for instance unilateral ground- glass, confluent, or multifocal consolidations in an atypical place; this also corresponds to a CO- RADS 4 score. Typical imaging results raise the suspicion level to a CO-RADS 5 status.

In the course of this research, persons were scanned with the assistance of a 16-channel multislice CT scanner (Alexion; Toshiba Medical Systems).

Participants were given the instruction to carry out the breath-holding procedure and asked not to move during the scan. They were scanned from apices the lung to lower lobes during single breath hold Images were taken with the person being examined laying supine on the exam table, with the thorax centered within the gantry and the arms raised to the level of the ears. Several subsequent specifications used; tube voltage 120 kVp, tube current 25 MA, interval 1mm, slice thickness 1.25mm, fov 351, total exposure time 0.8s, window level 40, window width 350H. Axial images used for multiplanar reconstructions: pictures taken perpendicular to the body axis (axial) and perpendicular to the body's long axis (coronal) strictly sagittal to the body axis, with the sternum as well as spinal column at the center of the image.

Ethical Consideration:

This study was ethically approved by the Institutional Review Board of the Faculty of Medicine, Mansoura University. After providing the patient with a brief and understandable summary of the aims of the study, a written informed permission was collected from either the patient or his or her legal guardian. The consent form was crafted in accordance with the standard of Egypt's Quality and Improvement System, which is housed at the Ministry of Health. This study was executed according to the code of ethics of the World Medical Association (Declaration of Helsinki) for studies on humans.

Statistical Analysis

IBM SPSS Statistics version 26 (IBM Corp., Armonk, NY) and MedCalc® Statistical Software version 20 (MedCalc Software Ltd., Ostend, Belgium; https://www.medcalc.org; 2021) were used to collect data, tabulate statistical analysis as well as calculate overall sensitivity, specificity, positive and negative predictive values for the role of CT chest in management of COVID-19.

RESULTS

Table 1 shows no significant alteration amongst the studied groups regarding sex. On the other hand, there is a significant disparity among them where the mean age of the studied COVID-19 persons (45.16) is lower than non COVID-19 patients (54.67).

Table 1: Patients' Characteristics in COVID-19 and non COVID-19 patients.

Variable	COVID		Non-COVID		Total		Test of sig.	P value
	N=38	%	N=12	%	N=50	%		
Sex								
Male	23	60.5	6	50	29	58	0.415*	0.52
Female	15	39.5	6	50	21	42		
Age group								
≤35	11	28.9	0	0	11	22	4.6	0.102
36-50	15	39.5	6	50	21	42		
>50	12	31.6	6	50	18	36		
Age								
Mean±SD	45.16±11.9		54.67±12.5		47.44±12.6		2.377**	0.022
Range (years)	29-69		37-79		29-79			

Table 2 and **Figures 1 and 2** show significant change among the examined groups concerning CT abnormalities, site of lesion, pure GGO, GGO+/- consolidation, consolidation and vascular dilatation, where the lung lesion was peripheral 57.9% of COVID-19 and 9.1% of non COVID-19 patients. Also 86.8% and 92.1% of COVID-19 patients had pure GGO and GGO+/- consolidation respectively, in contrast to non COVID-19 patients who pure GGO and GGO+/- consolidation are absent in 83.3% and 75% of them respectively. Besides, lung vascularity increased in 60.5% of COVID-19 patients in contrast to 25% of non COVID-19 patients.

Table 2: CT abnormalities in the studied patients.

Variable	COVID-19		Non COVID-19		Total		Fisher's exact test	P value
	N=38	%	N=12	%	N=50	%		
Site of lesion								
Peripheral	22	57.9	1	9.1	23	46.9	14.1*	0.001
Central	2	5.3	5	45.5	7	14.3		
Peripheral and central	14	36.8	5	45.5	19	38.8		
Pure GGO	33	86.8	2	16.7	35	70	21.39	<0.001
GGO+/- consolidation	35	92.1	3	25	38	76	22.5	<0.001
Consolidation	3	7.9	7	48.3	10	20	14.5	<0.001
Nodules	8	21.1	0	0	8	16	3.008	0.08
Tree in bud	2	5.3	2	16.7	4	8	1.6	0.204
Calcifications	2	5.3	0	0	2	4	0.658	0.417
Lymphadenopathy	12	31.6	5	41.7	17	17	0.414	0.52
Vascular dilatation	23	60.5	3	25	26	52	4.6	0.032
Pleural effusion								
No	34	89.5	9	75	43	86	3.67*	0.159
Unilateral	0	0	1	8.3	1	2		
Bilateral	4	10.5	2	16.7	6	12		
Atelectasis	15	39.5	4	33.3	19	38	0.146	0.702
Cavities	2	5.3	2	16.7	4	8	1.6	0.204
Reversed halos	1	2.6	0	0	1	2	0.322	0.57
Crazy paving	1	2.6	0	0	1	2	0.322	0.57

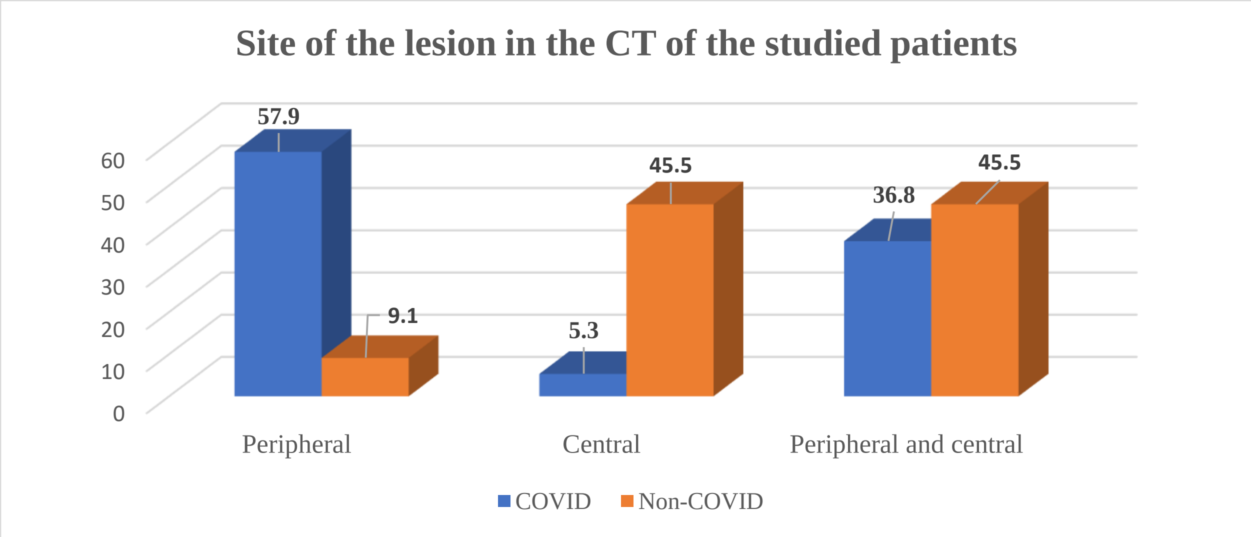

Figure (1): site of the lesion in the CT of the studied patients.

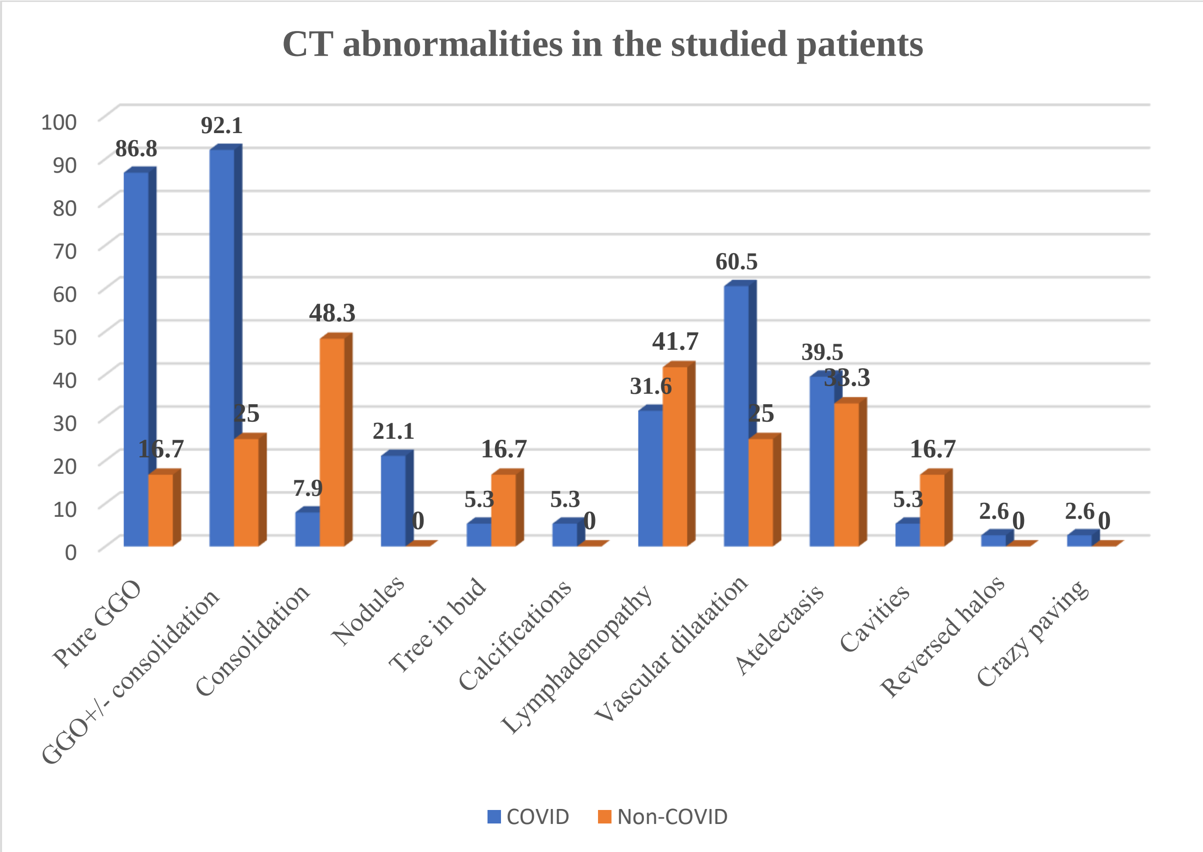

Figure (2): CT abnormalities in the studied patients.

Table 3 and **Figure 3** show more significant alteration among the researched groups, as 68.4% of COVID-19 patient had CO-RADS 6, while 58.3% of non COVID-19 had CO-RADS 2.

Table 3: COVID CO-RADS classification in the studied patients.

Variable	COVID		Non-COVID		Total		X2	P value
	N=38	%	N=12	%	N=50	%		
CO-RADS 1	1	2.6	2	16.6	3	6	34.2	<0.001
CO-RADS 2	1	2.6	7	58.3	8	16		
CO-RADS 3	3	7.9	3	25	6	12		
CO-RADS 4	1	2.6	0	0	1	2		
CO-RADS 5	6	15.8	0	0	6	12		
CO-RADS 6	26	68.4	0	0	26	52		

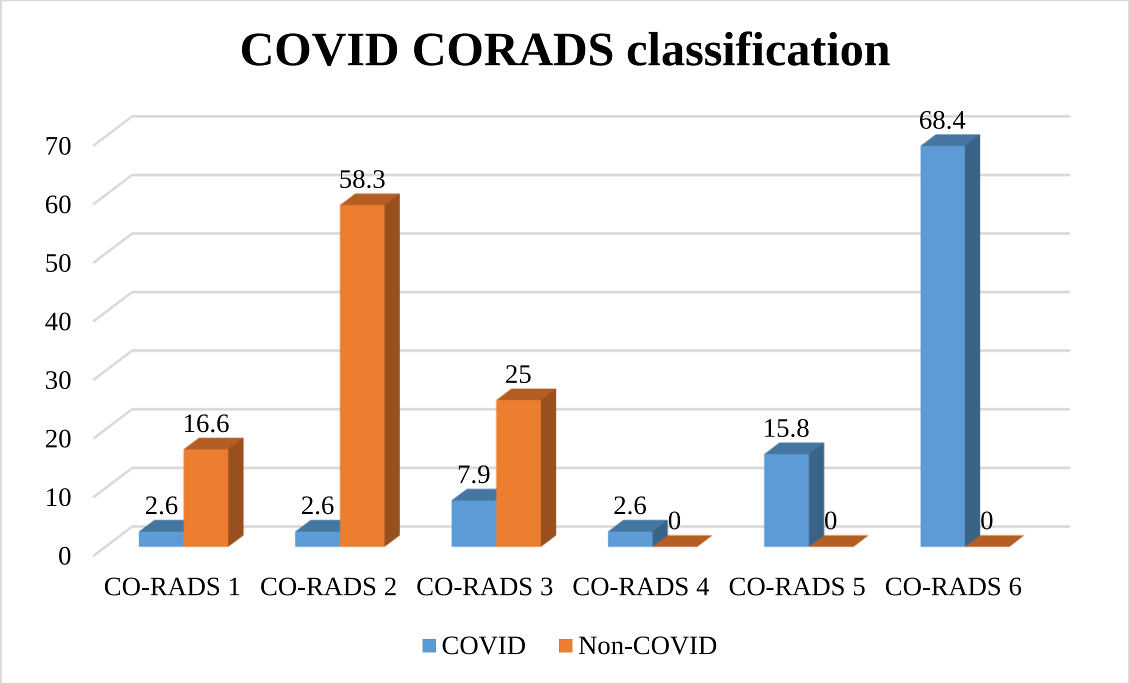

Figure (3): COVID CORADS classification.

Table 4 and **Figure 4** express the rationality of CO-RADS in prediction of COVID-19, where at 2.5 cutoffs, sensitivity 94.7%, specificity 75%, PPV 92.3% and NPV 81.8%.

Table 4: Validity of CO-RADS in prediction of COVID-19.

Variable	AUC	Cuttoff	P value	Sensitivity	Specificity	PPV	NPP
CO-RADS	0.95	2.5	<0.001	94.7%	75%	92.3%	81.8%

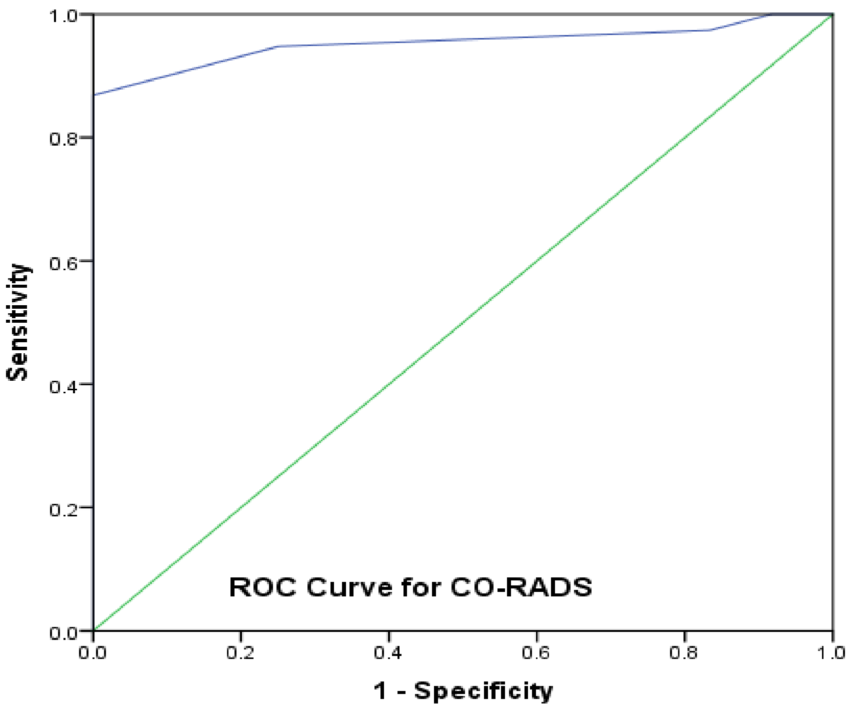

Figure (4): ROC curve for validity of CO-RADS for prediction of COVID-19.

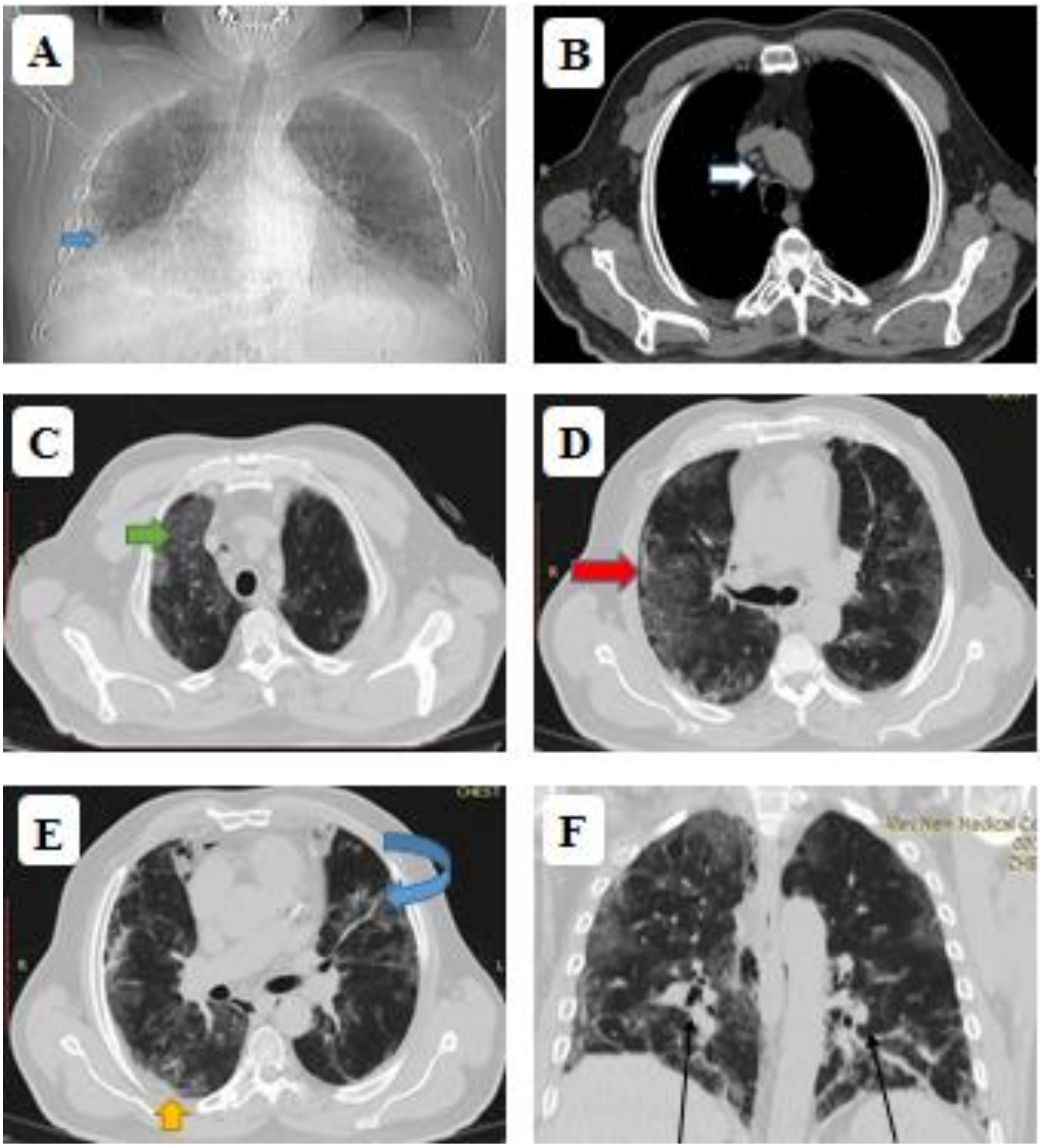

Figure (5): Male patient 70 years old (a) X ray showing bilateral cystic changes and right lower lobe opacity (blue arrow) (b) HRCT chest without contrast axial cut mediastinal window showing multiple small pretracheal lymph nodes (white arrow) (c, d, e) HRCT axial cuts lung window showing bilateral scattered patches of GGOs more peripheral and subpleural With thickened interlobular septations making crazy paving appearance (green arrow) more evident in right upper lobe subpleural band (black arrow) and vascular dilatation (blue curved arrow) in left upper lobe pleural Thickening (yellow arrow) (f)) coronal cut shows cystic bronchiectatic changes (black thin arrows), architecture distortion also airbubbles noted in the mediastinum denoting pneumomediastinum diagnosed COVID-19 pneumonia (CORADS 5).

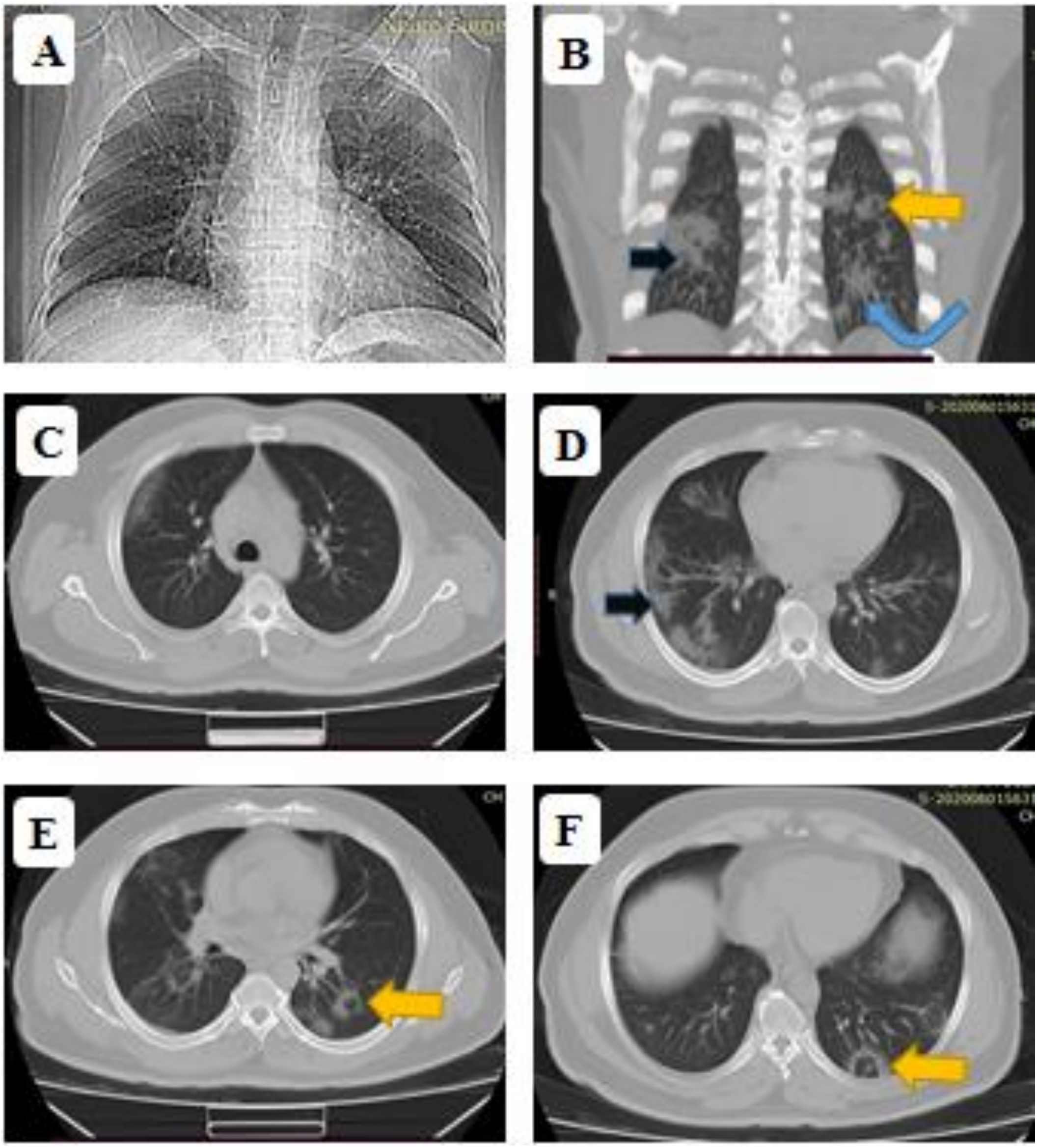

Figure (6): Male patient 55 years old (A) X-RAY chest PA erect film relatively normal (b) HRCT CHEST lung window contrast coronal cut shows multiple patches of GGOs some with reversed halo and increase in vascularity (c, d, e, f) axial cuts showing multiple Bilateral patches of ground glass opacities (black arrow) mostly ill-defined involving all lung lobes more peripheral and subpleural some of them showing reversed halo sign (atoll) sign evident mainly in left lower lobe (yellow arrows) with some dilatation in vessels (blue arrow) diagnosed as COVID-19 pneumonia (CORADS 6).

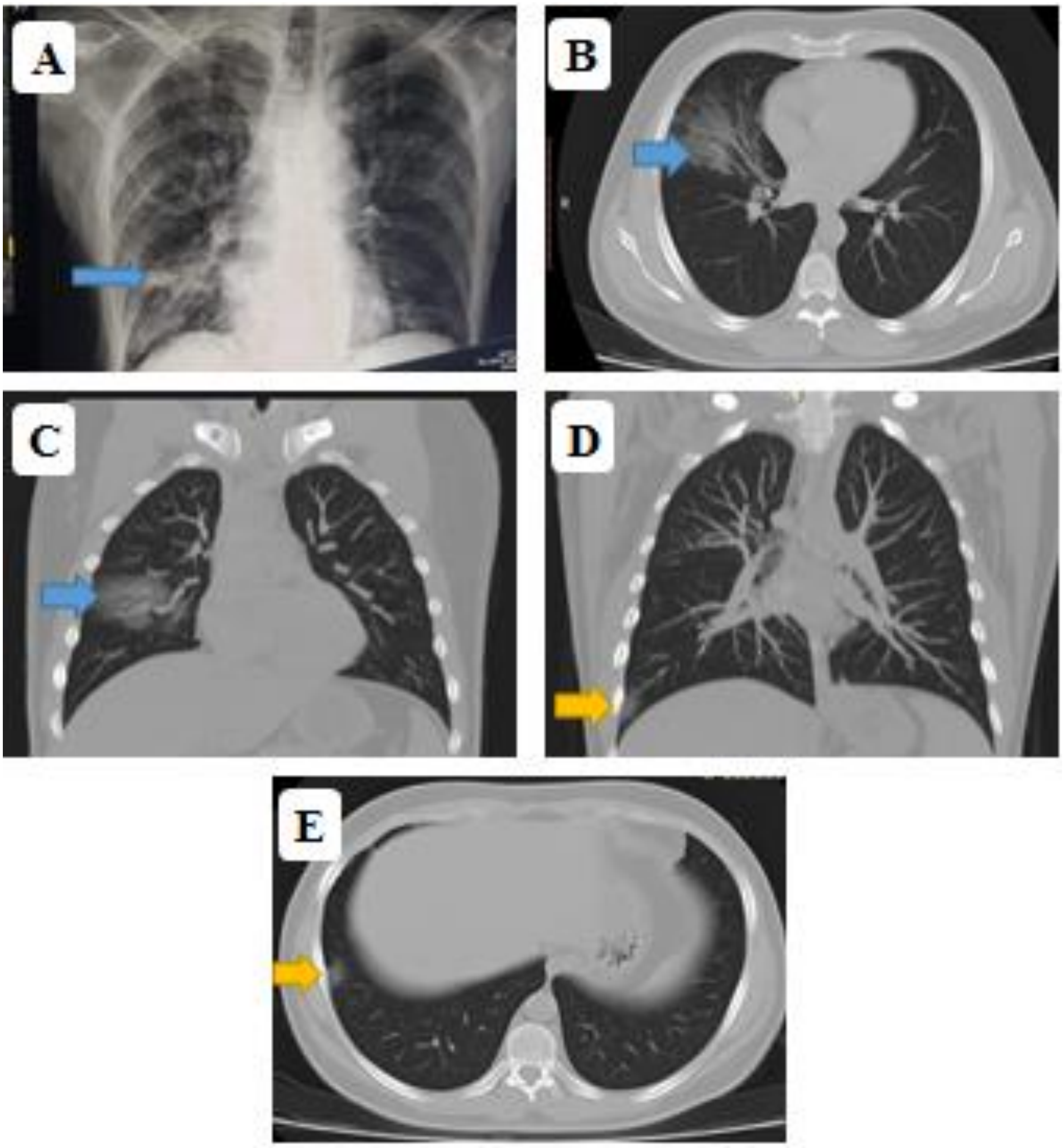

Figure (7): Male patient 29 years old (a) X-ray chest erect film showing right mid zonal opacity (blue arrow) (b, c) HRCT chest without contrast axial and coronal cuts lung window showing Single large relatively ill-defined unilateral right middle lobar patch of ground glass opacity (blue arrows) with dilated vessels (d, e) axial and coronal cuts at lower levels showing another small right lower lobe peripheral subpleural patch (yellow arrows) diagnosed COVID-19 pneumonia (CORADS 6).

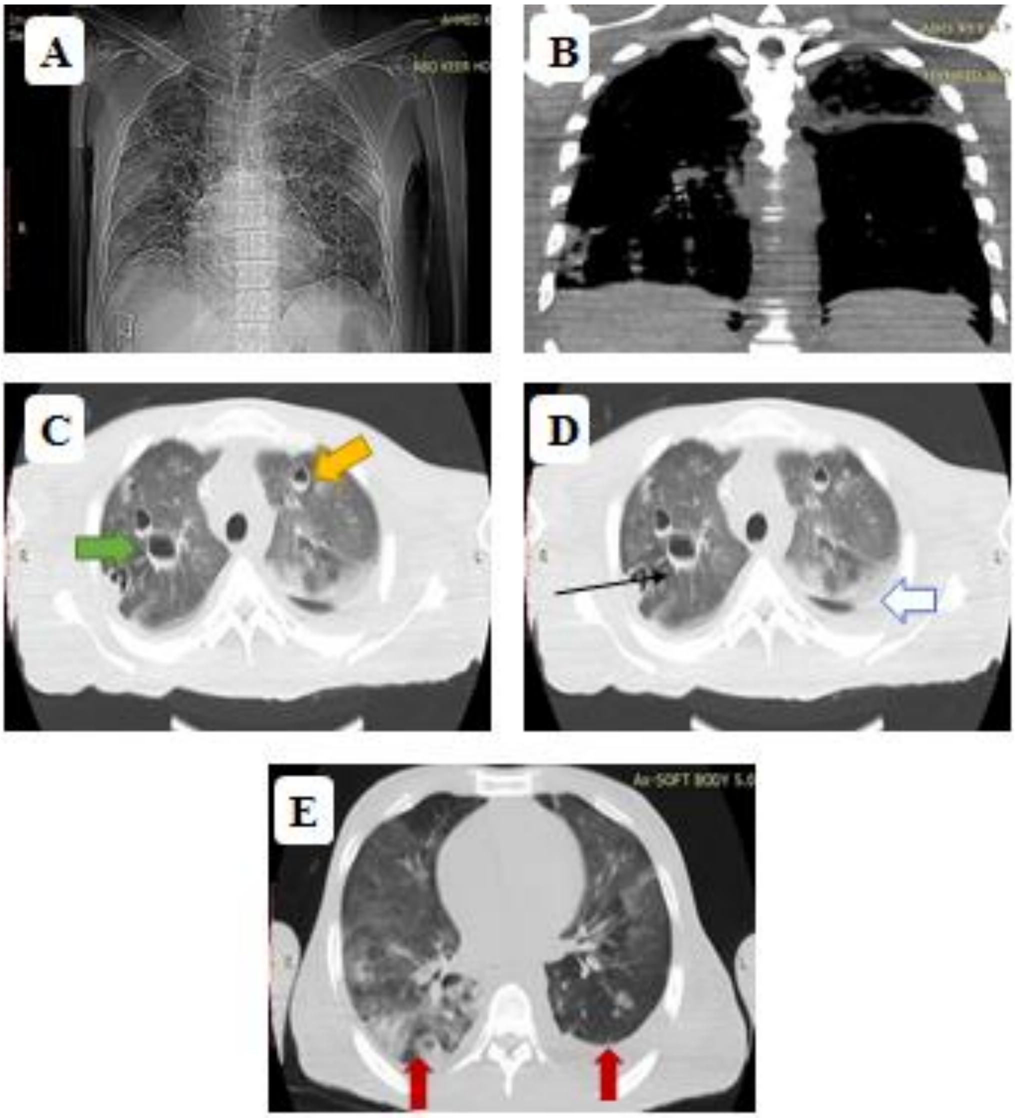

Figure (8): Male patient 38 years old a) X-ray pa film showing multiple cavities (b) coronal mediastinal window (c, d, e) axial cuts lung window showing multiple cavitary lesions (green arrow) with thickened wall varying in size (some showing fluid level) in all lung lobes, feeding vessel sign is noted (black thin arrow), Bilateral pleural effusion (red arrow) and fissural effusion (white arrow) diagnosed multiple septic emboli (CORADS 2)

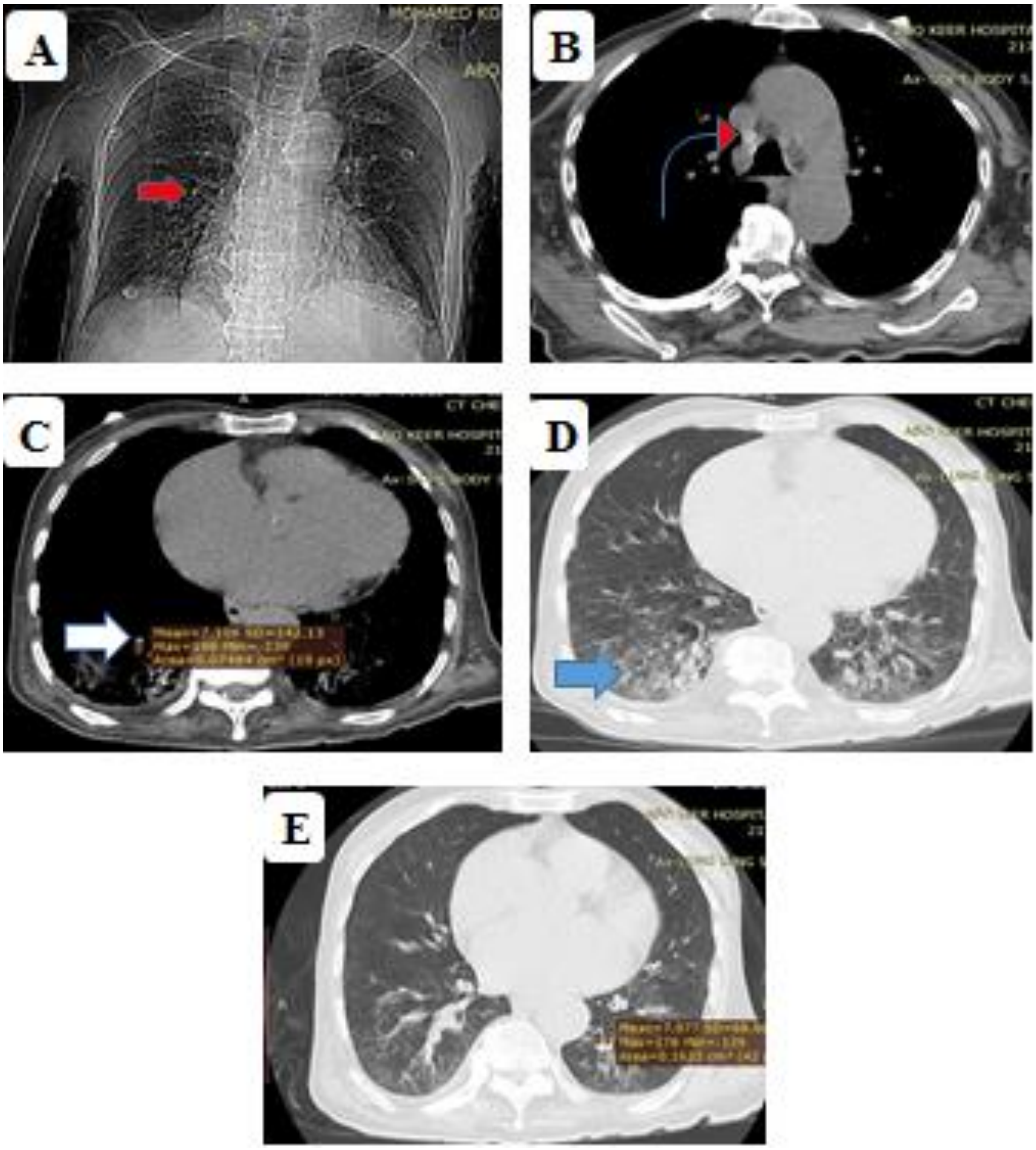

Figure (9): Male patient 66 years old (a) X-ray film showing multiple dense spots midzonal in both lungs b) HRCT chest without contrast mediastinal window showing calcified pretracheal LN (thin curved arrow) (c) axial mediastinal window showing bilateral lower lobe high density spots of calcifications (white arrow) (d, e) axial cuts lung window showing bilateral basal tree in bud opacities (blue arrow) with bronchiectatic changes diagnosed active on top of chronic TB (CORADS 2).

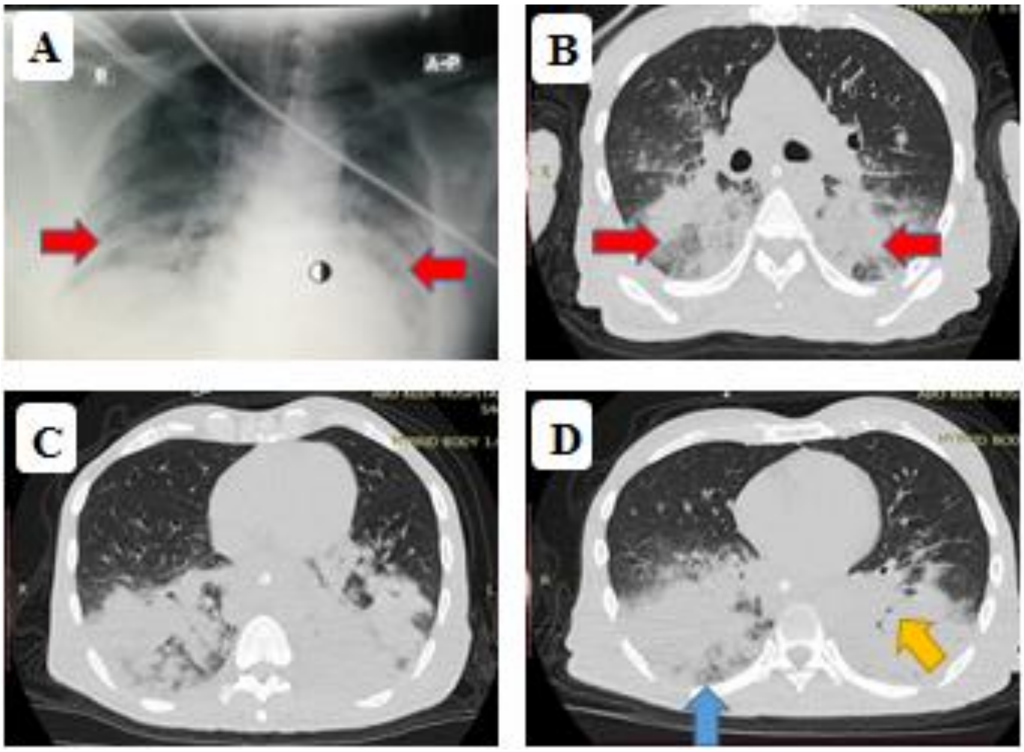

Figure (10): Male patient 45 years old (A) chest X-RAY showing bilateral lower lobe opacification (red arrows) (b, c, d) HRCT chest axial cuts lung window showing Bilateral lower lobe dense consolidations (red arrows) with faint areas of GGOs (blue arrow) and air bronchogram (yellow arrow) diagnosed aspiration pneumonia (CORADS 1).

DISCUSSION

According to the findings of the trial, there is a material distinction in terms of gender amongst each of the groups (COVID-19 and non COVID-19) as 60.5% of COVID-19 patient are males and no sex difference between males 50% and females 50% in non COVID-19 patients.

This is not matching with study made by **Luo *et al*.** [13] There was no statistically significant variations in the proportion of males to females amongst the COVID-19 as well as non COVID-19 groups.

Another study made by **Kharroubi and Diab-El-Harake,** [14] which proved that there is There were statistically significant gender variations in socioeconomic status and comorbidity (P <0.05).

This study also showed that COVID-19 has higher incidence, below age of 35 years (28%), than non COVID-19 that was not reported below this age.

This correspond to study done by **Habiloglu *et al*.**[15] which said that People in CoV group were detected to be younger than CAP group and found as statistically significant in our study.

Of COVID-19 patients 29 (76.3%) were confirmed as COVID-19 positive and 9 (23.7%) were negative by RT-PCR, of non COVID-19 patients 12 (100%) were determined to be negative for COVID-19 and positive for other infections or clinical therapy by RT-PCR.

Regarding CT abnormalities we observed significant alteration amongst COVID-19 and non COVID-19. Pure GGO present in 85% of COVID-19 patient but seen in only 16 % of non COVID-19 patients. Also we noticed that nodules of GGO, atelectasis bands, and reversed halo sign and are more prominent in COVID-19 patients (21.1 %, 39.5%, and 2.6 %). Besides, lung vascularity increased in 60.5% of COVID-19 patients in contrast to 25% of non COVID-19 patients.

This correspond to study made by **Elmokadem *et al*.** [16] that A higher percentage of COVID-19 cases (21.5% vs. 13%) had isolated ground-glass opacity.

This also matching with another study done by **Hefeda,** [17] the typical appearance of COVID-19 pneumonia is bilateral patchy areas of ground glass infiltration, more in the lower lobes.

On the other hand, pure consolidation seen in 48 % of non COVID-19 patients and only 7% of COVID-19 patients, pleural effusion is relatively less common in both COVID-19 and non COVID-19 patients, tree in bud, cavitations, calcifications are seen more with non COVID-19 patients and not seen with COVID-19 patients, also atelectatic bands seen more with COVID-19 patients 39.5 % and 33.3% for non COVID-19.

This agrees also with study made by **Franquet,** [18] according to which, there is some overlap among the imaging features of viral and bacterial pneumonia, although bacterial pneumonia is more likely to cause lobar/segmental pneumonia or bronchopneumonia, as well as localized or multifocal consolidations along with less frequently, GGOs. In contrast to COVID-19 pneumonia, bacterial pneumonia is considerably more likely to cause pleural effusion, peribronchial thickening and centrilobular nodular opacities.

Lymphadenopathy was seen more in non COVID-19 patients (41.7%) and rarely seen in COVID-19 patients (31.6%).

This corresponds to study made by **Bai *et al*.** [19] research demonstrated that peripheral distribution, ground-glass opacity, fine reticular opacity, vascular thickness, and the reverse halo sign were all more common in COVID-19 pneumonia than in non-COVID-19 pneumonia. A central or peripheral distribution, air bronchogram, pleural thickening, pleural effusion, or lymphadenopathy is less common.

Regarding zonal affection lower lobes affection more significant in COVID-19 patients rather than non COVID-19 patients specially left lower lobe as involvement of left lower lung lobes in 92.1% and 58.3% of COVID-19 and non COVID-19 patients respectively.

This correspond to study made by **Haseli *et al.*** [20], More often than not, it was the lower right (87.3% of cases) or left (85.7% of cases) lobes that were at fault. Although all lung segments can be involved, there was a slight predilection for the right lower lobe, as demonstrated by the research conducted by **Shi et al.** [21] in which 225 (27%) of 849 affected segments among the participants were located in the posterior segment of the left lower lobe.

This study demonstrated that the bilaterality of the lesion showed statistical significant difference where the lesions were bilateral in 92.1% and 63.6% of COVID-19 and non COVID-19 patients respectively also number of affected lung lobes is more common in COVID-19 patients in contrast to non COVID-19 where unilaterality and single lobe affection are more evident.

This correspond to study made by **Parekh *et al.*** [22] which confirmed that ground-glass opacities, most prominent on the periphery, are a common CT finding among individuals with COVID-19. By using the CORADS in this study highly significant alteration amongst the studied groups, as 68.4% of COVID-19 patient had CO-RADS 6, while 58.3% of non COVID-19 had CO-RADS 2; sensitivity 94.7% and specificity 75%.

This corresponds to study made by **Penha,** [12] that observed a mean sensitivity of 87.8% (range, 80.2-93.4%) as well as a mean specificity of 66.4% (range, 51.3-84.5%) in a research involving 154 patients with clinical suspicion of COVID-19. The best CO-RADS cutoff was 4, with sensitivity of 89.4% (95%CI 84.7-93) and specificity of 87.2% (95%CI 83.9-89.9), according to a separate investigation by **Lieveld et al.** [23].

CONCLUSION

The assessment of the CORADS is essential for proving the presence of typical COVID-19 CT findings and help clinicians to achieve the determination of early diagnosis and accurate treatment. We recommend use of HRCT in diagnosis of COVID-19 because of easy availability and high sensitivity for early diagnosis and making initial idea about presence of COVID-19 or other type of chest infections.

DECLARATIONS

- **Consent for publication:** I attest that all authors have agreed to submit the work.
- **Availability of data and material:** Available
- **Competing interests:** None
- **Funding:** No fund
- **Conflicts of interest:** no conflicts of interest.

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