

## Highlights on Radiological Features of Chest Computed Tomography Scan in Patients with COVID-19 Pneumonia in Latakia, Syria

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### Abstract

Our aims in this study were to describe the radiological features on CT scan of patients with COVID-9 pneumonia and identify whether there is any peculiarity of our geographic area. This was an observational descriptive cross-sectional study done in Medical Imaging and Diagnostic Radiology Department at Tishreen University Hospital, Latakia, Syria; between July 2020 and January 2021. Our study included 297 patients (106 females, 191 males, age range 12-90 years) who were clinically suspected to have COVID-19 pneumonia and then proved by positive RT-PCR results for it. All patients underwent unenhanced high resolution computed tomography HRCT scan. CT scans were reviewed by two 10 year experienced radiologists and classified according to CO-RADS classification from CO-RADS 1 to CO-RADS 5. We found ground glass opacities GGOs in 82.2% (11.1% unilateral, 88.9% bilateral). In the most of the cases, GGOs were peripheral in distribution (72.5%). GGOs were found in the inferior lobes in majority of cases (98%) with mosaic attenuation pattern in 79.9%. GGOs were mostly accompanied with consolidation in 39.4%. We did not detect any case with pulmonary cavitations. CO-RADS 5 were the most accounted category in 44.4%.

We were be definitely able to categorize our patients as CO-RADS 5, as we found bilateral, peripheral and rounded ground glass opacities.

**Keywords:** COVID-19; Corona Virus Disease 2019, CO-RADS; Corona Virus Disease Reporting and Data System; GGOs; Ground Glass Opacities, HRCT; High Resolution Computed Tomography; RT-PCR; Reverse Transcription Polymerase Chain Reaction

### Abbreviations

HRCT: High Resolution Computed Tomography; RT-PCR: Reverse Transcription Polymerase Chain Reaction; GGOs: Ground Glass Opacities; CO-RADS: Corona Virus Disease Reporting and Data System; MDCT: Multi Detector Computed Tomography

### Introduction

The existing outbreak of COVID-19 was officially known as pandemic by the World Health Organization (WHO) on 11, March 2020 [1,2]. First cases of COVID-19 pneumonia began in Wuhan, China, in December 2019 as a cluster of pneumonia cases with unknown etiol-

ogy, then spreading all around the world, causing more than 2.7 million deaths and 120 million confirmed cases [1,2]. COVID-19 is a new infectious disease also known as severe acute respiratory syndrome corona virus 2 or SARS-CoV-2, confirmed to be caused by a novel strain of corona virus [2-4].

We depend on a positive RT-PCR test to make the diagnosis, which has been showed a high specificity [5,6].

Radiological features, especially in HRCT, play an important role in the diagnosis and management of the illness, but it should not be recognized as a gold standard method because it has a higher sensitivity but lower specificity [7,8].

Despite of the high specificity of RT-PCR test, it has a lower sensitivity estimated to be 65 - 95% [6]. According to its lower sensitivity, it can give negative results while the patient is actually infected. As well as, the result may take at least 24 hours to be available, which means we have to wait it to start the management, while computed tomography can give important information and findings immediately [6,9,10].

Based on the latest researches about COVID-19 pneumonia and its radiological profile, ground glass opacities (GGOs) pattern was the most common radiological finding. They detected to be multiple and bilateral, as well as peripheral in distribution in the majority of the proved cases. They were usually located in the lower zones of lungs [7,8,11].

Also, CT findings can help to give a radiological score of disease severity and its development stages.

We can classify patients with suspected COVID-19 pneumonia in moderate to high prevalence environment in a consolidated reporting system called the CO-RADS [12].

According to the features of CT scan, we can predict the level of suspicion of COVID-19 pneumonia and grade it from CO-RADS 1 up to CO-RADS 5, which means from no suspicion of COVID-19 till very high suspicion.

CO-RADS 1 reflect normal CT scan or non-infectious abnormalities. Abnormalities consistent with infections other than COVID-19 are classified as CO-RADS 2. When it is unclear whether COVID-19 is present as a causative etiology of CT features, we give CO-RADS 3. The suspicion of COVID-19 pneumonia will be high in CO-RADS 4 which means that the abnormalities are suspicious but not typical. When the radiological findings are typical for COVID 19, then the classification will be CO-RADS 5 [12-14].

## Materials and Methods

### Participants

We reviewed 297 patients presented to Tishreen University Hospital in Latakia, Syria with suspected COVID-19 pneumonia from July 2020 to January 2021.

A clinically suspected COVID-19 pneumonia patient was defined as a patient with criteria for COVID-19 pneumonia: fever; a low lymphocyte count, and no relief of symptoms with usage of antimicrobial or ant influenza drugs at least for 3 days. All 297 patients were confirmed to diagnose with COVID-19 based on the positive findings of real-time reverse-transcription-polymerase chain reaction (RT-PCR).

### Investigations

A detailed history was taken and detailed clinical examination was done.

All the patients underwent HRCT. They also underwent RT-PCR test for COVID-19.

### HRCT protocol

Unenhanced HRCT was performed for all patients using either the 16-MDCT scanner or the 128-MDCT scanner. The patient was scanned with 1 mm section thickness after reconstruction.

Two 10 years experienced radiologists reviewed the CT images, in both lung and mediastinal windows settings.

We studied the following lung changes: ground-glass opacities (Laterality, Location, predominant distribution, quantity, pattern, and morphology), centrilobular nodules/tree-in-bud sign, solid nodules, air space consolidation, presence of lymphadenopathy and its location, presence of pleural effusion and its size, presence of mucoid impaction, bronchial wall thickening, presence of interlobular septal thickening (mild, moderate, and severe), and pulmonary cavities. We assist the CO-RADS of each scan and categorized them from CO-RADS 1 to CO-RADS 5.

### Statistical analyses

This was an observational descriptive cross-sectional study performed during 7 months from July 2020 to January 2021. It was performed using IBM SPSS statistics (version 2020). Descriptive statistics including proportions, median and range were estimated.

### Results

We included 297 cases of patients who presented to Tishreen University Hospital in Latakia, Syria with a clinical history suggesting of COVID-19 pneumonia.

### Participants characteristics

The age of the patients was between 12 and 90 years. Out of the 297 patients 191 (64.3%) were male, and 106 (35.7%) were female. All patients underwent to complete physical exam. All of them were positive for COVID-19 according to the results of RT-PCR tests.

### HRCT evaluation

Out of our 297 patients, CT scans showed an isolated single lesion in 9 patients (3.7%), with CT performed within first 5 days after the onset of symptoms. COVID-19 pneumonia was seen as multiple lesions on CT scan in 235 patients (96.3%), with CT performed 7 - 14 days after the onset of symptoms, which is obviously a longer interval than that in patients with a solitary lesion. Of the 297 patients, we found ground glass opacities GGOs in 244 patients (82.2%). GGOs were unilateral in 27 patients (11.1%) and bilateral in the other 217 ones (88.9%). Peripheral distribution was the most common type, and detected in 177 patients (72.5%), followed by diffuse pattern in 60 cases (24.6%), whether the central distribution was the least in 12 patients (4.9%). GGOs were detected in the inferior lobes of the lung in 293 cases (98%), in the right middle lobe and lingula in 183 patients (75%), and in the superior lobes in 173 patients (70.9%). GGOs appeared as mosaic attenuation in 195 patients (79.9%). There were crazy paving pattern in 29 patients (11.9%). We found reverse halo sign in 3 patients (1.2%). We detected centrilobular nodules/tree-in-bud sign in 15 (5.1%) patients, solid nodules in 43 patients (14.5%), consolidation (39.4%) in 117 patients, mucoid impaction in two (0.7%) patients, and bronchial wall thickening in 53 patients (17.8%). We did not found pulmonary cavities in any one of those cases. Pleural effusion which was detected in 24 patients (8.1%) was small in size in 17 (5.7%) cases, moderate in 4 patients (1.3%), and large in 3 patients (1%). Lymphadenopathy was not a significant finding and

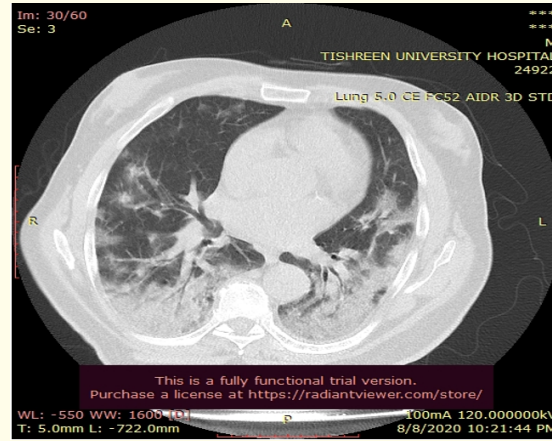
we found it in 53 patients (17.8%) as mediastinal lymph nodes in 47 (12.8%) cases and hilar nodes in 6 patients (2%). There were interlobular septal thickening in 70 patients (23.6%) (mild in 57 patients; 19.2%, and moderate in 12 patients; 4%) (Table 1 and 2) (Figure 1).

Radiological Features on HRCT	Number (%) of patients (n = 297)
Ground Glass Opacities (GGOs)	244 (82.2%)
Centrilobular Nodules	15 (5.1%)
Solid Nodules	43 (14.5%)
Consolidation	117 (39.4%)
Bronchial wall thickening	53 (17.8%)
Mucoid Impactions	2 (0.7%)
Septal thickening	70(23.6%)
Cavitations	0 (0%)
Lymphadenopathy	53 (17.8%)
Pleural effusion	24 (8.1%)

**Table 1:** Radiological features seen on HRCT of patients with COVID-19 pneumonia in Tishreen University Hospital.

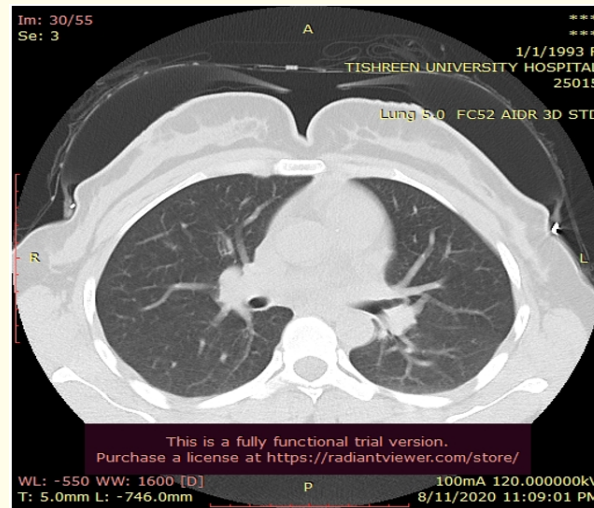
Ground glass opacities (GGOs)	Number (%) of patients (n = 244)
<b>Laterality</b>	
Right-sided	17 (7%)
Left-sided	10 (4.1%)
Bilateral	217 (88.9%)
<b>Location</b>	
Peripheral	177 (72.5%)
Central	12 (4.9%)
Diffuse	60 (24.6%)
<b>Predominant distribution</b>	
Superior zone	173 (70.9%)
Middle zone	183 (75%)
Inferior zone	239 (98%)
<b>Solitary</b>	9 (3.7%)
<b>Multiple</b>	235 (96.3)
<b>Pattern</b>	
Mosaic	195 (79.9%)
Crazy paving	29 (11.9%)
Reverse halo sign	3 (1.2%)
<b>Shape</b>	
Rounded	135 (55.3%)
Not rounded	169 (69.3%)

**Table 2:** Ground glass opacities (GGOs).

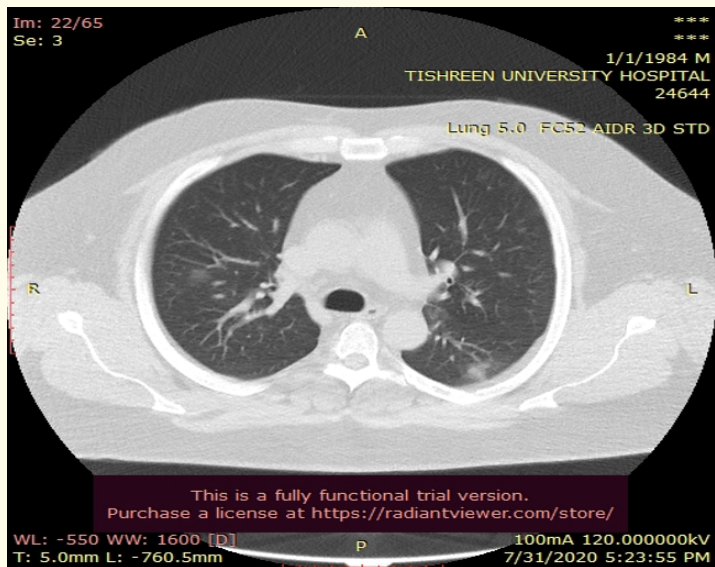


**Figure 1:** 65-years-old male patient. CT image with parenchymal windowing shows GGOs accompanied with air-space consolidation in the lower aspects of both lungs. CT scan was done 6 days after the onset of symptoms.

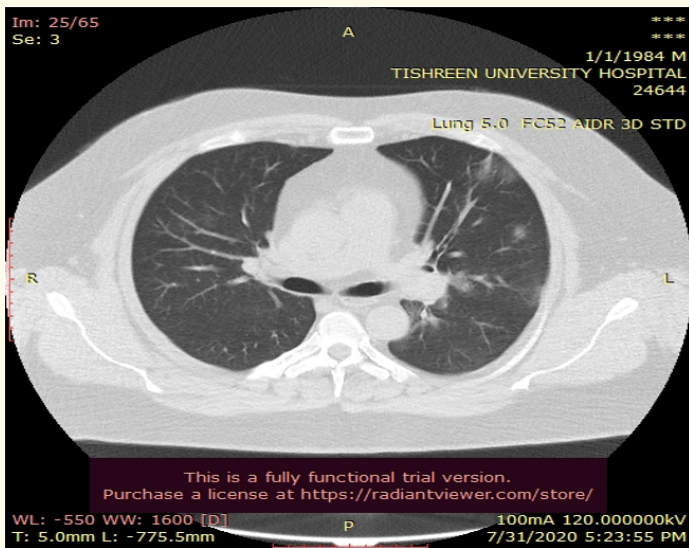
We assist CO-RADS for all 279 patients according to the criteria made by The Dutch Radiological Society. CO-RADS 5 was the most accounted category in 132 patients (44.4%) (Figure 5), followed by CO-RADS 3 in 60 (20.2%) patients (Figure 4), then CO-RADS 4 in 49 cases (16.5%), and CO-RADS 2 in 30 patients (10.1%) (Figure 3). The least accounted category was CO-RADS 1 in 26 patients (8.8%) (Figure 2 and table 3).



**Figure 2:** 28-years-old female patient. CT image with parenchymal windowing shows normal appearance of both lungs. This study was done 3 days after onset of the signs and symptoms and classified as CO-RADS 1.

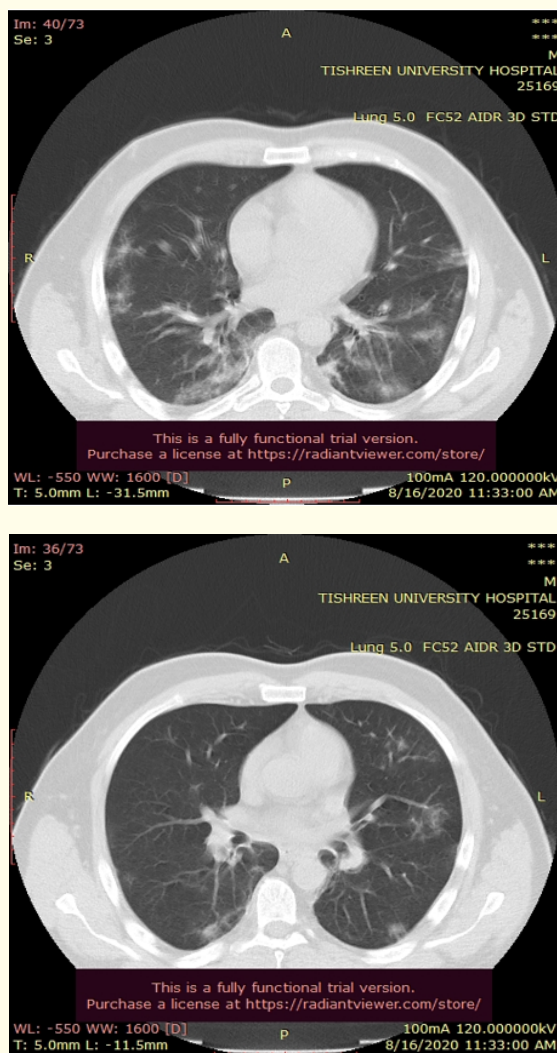


**Figure 3:** 37-years-old male patient. CT image with parenchymal windowing shows an isolated GGO in the left lung. This opacity is round-shaped opacity. It is located in the posterior peripheral aspect of the left lower lobe. This was classified as CO-RADS 2.



**Figure 4:** 37-years-old male patient. CT image with parenchymal windowing shows unilateral, rounded-shape and multiple GGOS. This was classified as CO-RADS 3.

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**Figure 5:** 35-years-old male patient. CT image with parenchymal windowing shows multiple, bilateral, rounded GGOs within lower zones of lungs. This CT scan was classified as CO-RADS 5.

COVID-19 CO-RADS	Number (%) of cases (n = 297)
CO-RADS 1	26 (8.8%)
CO-RADS 2	30 (10.1%)
CO-RADS 3	60 (20.2%)
CO-RADS 4	49 (16.5%)
CO-RADS 5	132 (44.4%)

**Table 3:** COVID-19 CO-RADS classification.

## Discussion

COVID-19 pneumonia is a novel type of viral pneumonia caused by a new strain of corona virus. In our study, we studied 279 patients presented to Tishreen University Hospital in Latakia, Syria with clinical profile suggesting COVID-19 pneumonia and confirmed by RT-PCR results. The vast majority of the patients were male (634.3%). In terms of findings seen in CT scans of 297 patients with confirmed COVID-19 pneumonia, the most of the cases manifested as multiple GGOs (96.3%) and the other 3.7% manifested as single ground glass opacity.

Out of these cases, 88.9% were bilateral and 11.1% unilateral. Considering the extent of involvement, peripheral distribution of the lesions was the predominant type (72.5%); however GGOs were central in 4.9% and diffuse in 24.6%. Lesions occurred in the inferior lobes in 98%, middle lobes in 75%, and superior lobes in 70.9%. Considering the type of GGOs, we found that the lesion showed mosaic attenuation pattern in 79.9%, crazy paving in 11.9%, and reversed halo sign in 1.2%. We found different CT patterns of COVID-19 pneumonia other than GGOs, which include consolidation (39.4%), centrilobular nodules (5.1%), solid nodules (14.5%), mucoid impaction (0.7%), bronchial wall thickening (17.8%), lymphadenopathy (17.8%) which was mediastinal in the vast majority of cases (15.8%) and hilar in the other 2%, pleural effusion in 8.1%, and interlobular septal thickening in 23.6%.

Patients, who showed lymphadenopathy, were scanned with HRCT 7 - 14 days after the onset of symptoms. Pleural effusion was relatively rare compared with other signs in the early phase of the disease. According to criteria of CO-RADS system, we found that the vast majority of our patients were classified as CO-RADS 5. We found that those 44.4% with CO-RADS 5 were scanned 8 days after the onset of symptoms at least.

## Conclusion

According to the findings seen on HRCT of our 297 confirmed COVID-19 pneumonia patients, we can see that this novel type of pneumonia can manifest as mixed and different patterns, including both lung parenchymal and interstitial pattern of lung disease.

The presence of peripheral GGO in the inferior lobes in mosaic attenuation pattern is highly suggesting of COVID-19 pneumonia and consisting with higher CO-RADS classification as CO-RADS 5.

Pleural effusion is rare finding in the early phase of the disease and might occur in the advanced phase. Lymphadenopathy is not a common finding in the course of the disease, but we can find it during the late phase.

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