



SPECTRUM OF HRCT CHEST FINDINGS IN COVID-19

Radiodiagnosis

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ABSTRACT

INTRODUCTION: Coronavirus (COVID-19) pandemic is current ongoing pandemic in world since its outbreak in Wuhan China in December 2019. It has affected 78.8 million people with 1.7 million deaths worldwide till date (23rd December 2020). **AIMS:** To evaluate spectrum of HRCT Chest findings in patients infected with SARS-CoV-2 i.e. COVID-19. **MATERIAL AND METHODS:** HRCT were done in 242 patients with SARS-CoV-2 RT-PCR positive status admitted in our COVID CARE CENTRE. HRCT is useful in assessment of severity of COVID-19 infection and subsequent plan for the treatment. HRCT of the chest obtains thin-slice chest images and process in a high-spatial-frequency reconstruction algorithm. This technique obtains images with exquisite lung detail, which are ideal for the assessment of diffuse lung diseases. **RESULTS:** Ground glass opacification is predominant finding present in majority of cases of COVID-19. Other common findings include crazy paving pattern, consolidation, vascular dilation and subpleural linear opacities. These findings can aid in early diagnosis of COVID-19. **ABBREVIATIONS:** HRCT (High-resolution computed tomography), COVID-19 (Coronavirus disease-19), SARS-CoV-2 (severe acute respiratory syndrome coronavirus 2), GGO (ground glass opacification), ARDS (acute respiratory distress syndrome), RT-PCR (reverse transcriptase-polymerase chain reaction), DIC (disseminated intravascular coagulation), DVT (deep vein thrombosis).

KEYWORDS

HRCT, COVID-19, SARS-CoV-2, GGO, Crazy Paving Pattern, consolidation, Subpleural Linear Opacities, Reverse Halo Sign, Pleural Effusion.

INTRODUCTION

First cases of novel severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) causing COVID-19 (Coronavirus disease 2019) pneumonia were seen in December 2019 in Wuhan, Hubei province, China. It was linked to a seafood and wet animal market in Wuhan (1). As of 23rd December 2020, it has affected 78.8 million people with 1.73 million deaths worldwide. USA and India are worst hit countries with 18.8 million and 10.1 million cases respectively (2). The World Health Organization declared the outbreak a Public Health Emergency of International Concern in January 2020 and a pandemic in March 2020 (3).

Transmission of SARS-CoV-2 occurs primarily through the human-to-human transmission virus through coughing, sneezing and the spread of respiratory droplets or aerosols (4). Common clinical manifestations of COVID-19 include fever (80-85%), cough (65-70%), anosmia and gustatory dysfunction (40-45%), fatigue (35-40%), expectoration (35-40%) and breathlessness (30-35%) (5). Significant minority of individuals infected with SARS-CoV-2 remain asymptomatic and act as carriers. Common Complications of COVID-19 include ARDS, acute thromboembolic disease such as DIC, pulmonary thromboembolism and DVT.

Although the definitive diagnostic test for SARS-CoV-2 is the real-time reverse transcriptase-polymerase chain reaction (RT-PCR) test, it is time consuming and false positive results may occur due to technical errors and reagent contamination (5). HRCT has a low rate of missed diagnosis of COVID-19 and may be useful as a standard method for the rapid diagnosis and severity of COVID-19 to optimize the management of patients (6).

In this article, we overview chest HRCT findings of patients with COVID-19 at our Covid Care Centre.

AIMS AND OBJECTIVES

- To evaluate spectrum of HRCT findings in RT-PCR positive COVID-19 patients.
- To provide pictorial review of the different patterns of COVID-19 findings using HRCT technique.

LITERATURE REVIEW

Initially published chest HRCT findings of COVID-19 included bilateral lung involvement, ground glass opacities (**Figure 1**), vascular enlargement (**Figure 2,3**), lower lobe, peripheral and posterior predilection in the majority of hospitalized patients. Other typical findings include crazy paving appearance (GGOs and inter-/intra-lobular septal thickening) (**Figure 3**), airspace consolidation (**Figure 5**). While atypical findings include mediastinal lymphadenopathy, pleural effusion, multiple tiny pulmonary nodules (centrilobular, "tree in bud" appearance), pneumothorax, cavitation (7).

The pulmonary histologic findings of COVID-19 are characterized by acute and organizing diffuse alveolar damage (8).

Four categories for standardized COVID-19 reporting were proposed to help radiologists recognize the findings of COVID-19, decrease reporting variability, reduce uncertainty in reporting findings potentially attributable to COVID-19 infection. The four categories include "typical appearance" (peripheral, bilateral GGOs with or without consolidation, Reverse halo/Atoll sign), "indeterminate appearance" (multifocal diffuse perihilar or unilateral GGOs with or without consolidation that are non-rounded and non-peripheral), "atypical appearance" (isolated lobar or segmental consolidation without GGO, discrete small nodules, lung cavitation, smooth interlobular septal thickening with pleural effusion) and "negative for pneumonia" (no CT features to suggest pneumonia) (9).

MATERIAL AND METHODS

This is a cross sectional retrospective case series study involving 242 patients with RT-PCR positive status for SARS-CoV-2 who may need to go chest imaging irrespective of age group or sex, admitted in our Covid Care Centre from May 2020 to December 2020.

Multislice plain thin 1mm serial axial sections obtained of the whole chest during a single inspiratory breath hold on 128 slice SIEMENS SOMATOM Perspective CT scanner machine with patient in supine position with tube voltage 130 kV, mAs 120, pitch 1.2, and rotation time 0.6 s. The mediastinal and lung windows were assessed using the dedicated workstation. Multiplanar reconstruction (coronal and sagittal) were done. CT severity scoring were given.

RESULTS

SPECTRUM OF CHEST HRCT FINDINGS IN COVID 19

There were 180 men and 82 women studied irrespective of age group. Of the 242 patients, 217 (89.6%) showed chest CT findings while 25 (10.3%) had normal chest CT scans (Table 1). Of the 217 patients with chest CT findings, ground-glass opacities was the predominant finding in 207 patients (85.5%)(Figure 1). Most of the GGOs showed typical rounded morphology. GGOs also showed typical subpleural distribution in majority of cases (207 cases-62%)(Figure 2). Followed by lower lobe predominance in 115 (47.5 %) peripheral in 91 (37.6%), posterior in 97 (40%)(Figure 1, Figure 5), and central or peribronchovascular in 5 (2%) cases. 147 patients had bilateral lung involvement. While 53 (22%) cases had diffuse lung disease with central and peripheral distribution (Figure 7)(Table 2).

GGO with superimposed interlobular and intralobular septal thickening (Crazy paving) (Figure 3) was second most common finding in 130 cases (53.7 %)(Table 1). Consolidation was present in 58 (24%) patients. Out of which 55 (23%) had both GGO with consolidation (Figure 4) and 3 (1.2%) had consolidation in the absence of ground-glass opacification (Figure 5) (Table 2). Vascular dilation was noted in 88 cases (36%)(Figures 2,3)(Table 1). Combination of one or more above findings were seen in moderate to severe forms of the disease based on CT severity scoring.

TABLE 1: SPECTRUM OF HRCT CHEST FINDINGS IN COVID-19

	CASES (n)	%
A) Typical findings:		
1) Ground glass opacification(GGO)	207	85.5%
2) Crazy paving	130	53.7%
3) Vascular dilation	88	36%
4) Subpleural linear opacities	76	31.4%
5) Consolidation	58	24%
B) Atypical findings:		
1) Mediastinal or hilar lymphadenopathy	16	6.7%
2) Pleural effusion	13	5.3%
3) Bronchiectasis	13	5.3%
4) Lung Cyst	12	5%
5) Emphysema	9	3.7%
6) Pulmonary nodule	5	2%
7) Mosaic attenuation	5	2%
8) Atelectasis	4	1.6%
9) Reverse Halo/Atoll sign	3	1.2%
10) Cavitation	2	0.8%
11) Pneumothorax	1	0.4%
12) Pericardial effusion	1	0.4%
C) Normal Chest HRCT	25	10.3%

Subpleural linear opacities or bands (Figure 6) are thin curvilinear opacities, 1-3 mm in thickness, lying less than 1 cm from and parallel to the pleural surface, were present in 76 cases (31.4 %).

TABLE 2: GROUND GLASS OPACIFICATION AND CONSOLIDATION WITH THEIR DISTRIBUTION

	CASES (n)	%
--Subpleural distribution	150	62%
--Bilateral lung disease	147	61%
--Lower lobe predominance	115	47.5%
--Posterior predilection	97	40%
--Peripheral distribution	91	37.6%
--Diffuse involvement(Central and peripheral)	53	22%
-- Central (peribronchovascular) distribution	5	2%
--GGOs with consolidation	55	23%
--Consolidation without GGOs	3	1.2%

Uncommon or atypical findings accounted for <10 % in all cases. These include, hilar or mediastinal lymphadenopathy in 16 cases (6.7 %), pleural effusion in 13 (5.3%), bronchiectasis in 13 (5.3%)(Figure 9b), lung cysts in 12 (5%), emphysema in 9 (3.7%), pulmonary nodule

in 5 (2%), Mosaic attenuation in 5 (2%), atelectasis in 4 (1.6%), cavitation in 2 (0.8%) and pneumothorax & pericardial effusion in 1 (0.4%) cases each. Reverse halo aka Atoll sign (Figure 8) refers to central ground-glass opacity surrounded by denser consolidation of crescentic shape or complete ring of at least 2 mm in thickness (10). It was seen only in 3 cases (1.2%)(Table 1).

Late stage COVID-19 changes were present in the form of subpleural interstitial septal thickening, fibrosis, subpleural atelectasis and tractional bronchiectasis (Figure 9a & b).

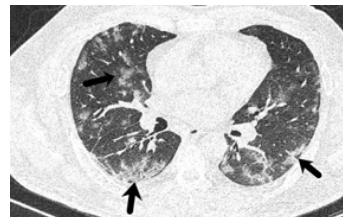


Figure 1. Axial nonenhanced CT lung window in 53-year-old male patient showing typical CT feature of COVID-19 with well-defined rounded GGOs (arrows) scattered at both lungs with lower lobe predominance.

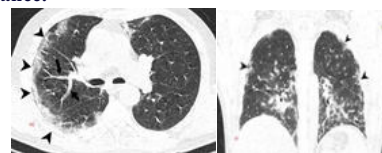


Figure 2. Nonenhanced CT lung window in a) Axial sections of 45-year-old male patient with typical subpleural distribution of GGOs (arrowhead). Note adjacent vascular dilation (arrow) b) Coronal sections of 54-year-old male patient with peripheral subpleural distribution of GGOs with lower lobe predominance.

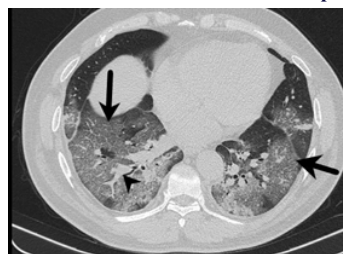


Figure 3. Axial nonenhanced chest CT image shows ground-glass opacities, with superimposed interlobular and intralobular septal thickening i.e. Crazy-paving pattern (arrows) in the both lower lobe in a 50-year-old man with COVID-19. Note adjacent vascular dilation (arrowhead).



Figure 4. Axial nonenhanced chest CT image in 65 year old female showing GGOs (arrow) with coexisting consolidation (arrowhead).

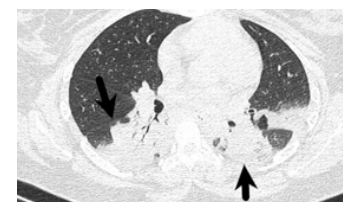


Figure 5. Axial nonenhanced CT lung window showing isolated consolidation (arrow) with air bronchogram in 26 year old female with lower lobe and posterior predilection.

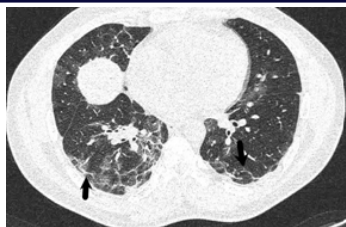


Figure 6. Axial nonenhanced CT lung window in 35 year old male showing subpleural linear opacities or bands (arrow) in both lower lobes.

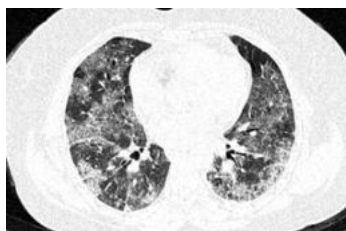


Figure 7. Axial nonenhanced chest CT showing diffuse bilateral distribution of GGOs with crazy paving pattern in both lower lobes in a 55-year-old female.

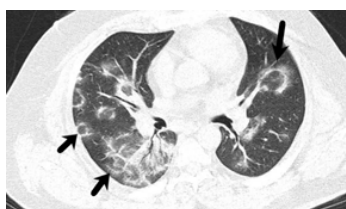


Figure 8. Axial nonenhanced CT lung window section of 43 year old male showing Reverse halo aka Atoll sign (arrow) i.e. ground-glass opacity surrounded by denser consolidation of crescentic shape or complete ring.

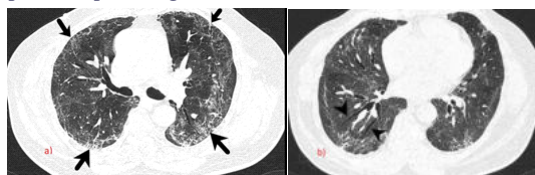


Figure 9. Axial nonenhanced CT lung window section in 71 year old male in late recovering stage of COVID-19 showing a) Subpleural interstitial septal thickening, fibrosis, Subpleural atelectasis (arrow) and b) tractional bronchiectasis (arrowhead).

DISCUSSION

The National Health Commission of the People's Republic of China has encouraged diagnosis based on clinical and chest CT findings owing to the possibility of false-negative real-time RT-PCR results (11). In our study, it was observed that 217 out of 242 patients (89.6%) showed positive findings on chest HRCT. Thus, HRCT can be used as quick diagnostic tool for COVID-19 even if RT-PCR swab report is awaited.

In our study, GGO is predominant finding with its subpleural, peripheral, bilateral, lower lobe & posterior predilection patterns as the chest CT hallmark of COVID-19 infection. This pattern of disease is somewhat similar to earlier coronavirus outbreaks such as severe acute respiratory syndrome and Middle East respiratory syndrome. Other common findings include crazy paving pattern, consolidation, vascular dilation and subpleural linear opacities which are consistent with COVID-19 viral pneumonitis, and are closely correlated with disease progression and severity.

Atypical findings include, hilar or mediastinal lymphadenopathy, pleural effusion, bronchiectasis, lung cysts, emphysema, lung nodule, reverse halo sign, Mosaic attenuation, atelectasis, cavitation, pneumothorax & pericardial effusion. One or more of these findings are also consistent with another diagnosis than of COVID-19, although COVID-19 cannot be completely eliminated from the differential diagnosis (12). These chest CT findings may only occur in some

patients later in the course of disease.

CONCLUSION

HRCT thus plays a crucial role in providing wide spectrum of chest findings in COVID-19. GGO with its subpleural, peripheral, bilateral, lower lobe & posterior predilection patterns is highly diagnostic of COVID-19. Combination of one or more findings with lung involvement based on CT severity scoring can be helpful in predicting disease progression and deciding line of management. Early diagnosis can be life saving owing to the fact that the positive chest findings with severity assessment can prompt respective line of management.

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