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Original Research Article

To Illustrate the Range of Chest CT Findings Associated with Coronavirus Illness (COVID-19) in a Rural Community

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Abstract

Aim: To illustrate the range of chest CT findings associated with coronavirus illness (COVID-19) in a rural community.

Material and Methods: This study was conducted in the Department of Radiology, Bhagwan Mahavir Institute of Medical Sciences, Pawapuri and Darbhanga medical college and Hospital, Darbhanga, Bihar, India for one year. We performed non-contrast chest CT in 179 non-consecutive RT-PCR confirmed SARS-CoV-2 infected patients. Bilateral, peripheral and basal ground-glass opacities with multilobe involvement have been described as the initial CT manifestations of COVID-19 pneumonia. During the intermediate stage of disease, progressive transformation of GGOs into consolidations occurs with the development of interlobular septal thickening producing characteristic crazy paving patterns.

Results: We performed non-contrast chest CT in 179 non-consecutive RT-PCR confirmed SARS-CoV-2 infected patients. Among the total study population, 152 (84.9%) patients were symptomatic and 27 (15.1%) patients were asymptomatic. Among the symptomatic patients, the most common symptoms reported were fever (73%), cough (49%), myalgia (61%), fatigue (66%), sore throat (23%), breathlessness (9%), hyposmia/anosmia (4%) and dysguesia (3%).

Conclusion: In conclusion, chest CT imaging reveals a spectrum of manifestations in COVID-19, ranging from early GGOs to extensive consolidations and interstitial changes. These findings reflect the dynamic nature of the disease and provide critical information for diagnosis, management, and prognostication.

Keywords: CT findings, COVID-19, Rural community

Introduction

The coronavirus disease 2019 (COVID-19) pandemic, caused by the severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2), has led to unprecedented global health challenges since its emergence in late 2019. Chest computed tomography (CT) has played a crucial role in the diagnosis and management of COVID-19, especially in detecting pulmonary manifestations and assessing disease severity. [1] The spectrum of chest CT findings in COVID-19 patients is diverse, reflecting the varying stages and severity of the disease. COVID-19 primarily affects the respiratory system, and chest CT is instrumental in identifying characteristic imaging features. Ground-glass opacities (GGOs) are the most common and earliest findings, typically appearing as bilateral, multifocal, and peripheral lesions. GGOs represent alveolar spaces filled with fluid and inflammatory cells, indicative of acute lung injury. As the disease progresses, GGOs often coalesce and evolve into more extensive consolidations, reflecting increasing pulmonary involvement and alveolar damage. [2-4] These consolidations can be patchy or confluent and are often seen in conjunction with GGOs. Reticular and linear opacities are also frequently observed in COVID-19 patients, representing interstitial thickening and fibrosis. These findings are more common in the later stages of the disease and may indicate a chronic or resolving phase. Pleural effusions and lymphadenopathy are less common in COVID-19 but can occur, particularly in severe cases. Pleural effusions were noted in 5-15% of

patients, often correlating with a poorer prognosis. Additional CT features such as crazy-paving patterns, which consist of GGOs with superimposed inter- and intralobular septal thickening, are indicative of extensive alveolar and interstitial involvement. [5-8] The temporal progression of chest CT findings in COVID-19 provides valuable insights into the disease course. In the early phase (0-4 days), GGOs predominate, while the progressive phase (5-8 days) shows increasing GGOs and the appearance of consolidations. The peak stage (9-13 days) is characterized by extensive consolidations and crazy-paving patterns, followed by the absorption phase (≥14 days), where consolidations gradually resolve, leaving residual GGOs and linear opacities. CT imaging not only aids in the diagnosis of COVID-19 but also plays a vital role in monitoring disease progression and guiding clinical management. Serial CT scans help assess the response to therapy, detect complications such as secondary infections or thromboembolic events, and evaluate the resolution of pulmonary lesions. The severity of chest CT findings has been correlated with clinical outcomes, with extensive lung involvement associated with higher mortality and prolonged hospitalization. [9-13]

Material and Methods

This study was conducted in the Department of Radiology, Bhagwan Mahavir Institute of Medical Sciences, Pawapuri and Darbhanga medical college and Hospital, Darbhanga, Bihar, India for one year. We performed non-contrast chest CT in 179 non-consecutive RT-PCR confirmed SARS-CoV-2 infected patients. Bilateral, peripheral and basal ground-glass opacities with multilobes involvement have been described as the initial CT manifestations of COVID-19 pneumonia. During the intermediate stage of disease, progressive transformation of GGOs into consolidations occurs with the development of interlobular septal thickening producing characteristic crazy paving patterns. The CT findings reach a crescendo around the tenth day of symptom onset. Some patients deteriorate and develop extensive lung opacities leading to acute respiratory distress syndrome (ARDS), which is the main cause of death. In patients with clinical recovery, there is a gradual resolution of consolidative changes with a reduction in both the size and number of these opacities with a new development of reticulations and fibrous stripes, usually observed after 2 weeks. Pleural effusion, pericardial effusion, mediastinal lymphadenopathy, halo sign or reverse halo sign are uncommon but possible CT features of COVID-19 seen with disease progression.[7-15]

Results

We performed non-contrast chest CT in 179 non-consecutive RT-PCR confirmed SARS-CoV-2 infected patients. Among the total study population, 152 (84.9%) patients were symptomatic and 27 (15.1%) patients were asymptomatic. Among the symptomatic patients, the most common symptoms reported were fever (73%), cough (49%), myalgia (61%), fatigue (66%), sore throat (23%), breathlessness (9%), hyposmia/anosmia (4%) and dysgeusia (3%). The CT findings of our study cohort are summarized in Table 2.

Table 1: CT findings in RT-PCR confirmed SARS-CoV-2 infected patients in our study

Parameter	All patients (*n*=179)	Symptomatic patients (*n*=152; 84.9%)	Asymptomatic patients (*n*=27; 15.1%)
CT findings			
Present	104 (58.1%)	95 (62.5%)	9 (33.3%)
Absent	75 (41.9%)	57 (37.5%)	18 (66.7%)
Laterality of lung involvement			
Unilateral	19 (18.3%)	13 (13.7%)	6 (66.7%)
Bilateral	85 (81.7%)	82 (86.3%)	3 (33.3%)
Focality			
Unifocal	9 (8.7%)	4 (4.2%)	5 (55.5%)
Multifocal	95 (91.3%)	91 (95.7%)	4 (44.5%)
Axial distribution			
Peripheral predominant	96 (92.3%)	88 (92.6%)	8 (88.9%)
Central and peripheral	8 (7.7%)	7 (7.4%)	1 (11.1%)
Antero-posterior distribution			
Posterior predominant	91 (87.5%)	84 (88.4%)	7 (77.8%)
Anterior and posterior	13 (12.5%)	11 (11.6%)	2 (22.2%)
Type of lung opacity			
Pure GGO	64 (61.5%)	56 (58.9%)	8 (88.9%)
GGO with consolidation	18 (17.3%)	18 (18.9%)	-

Crazy-paving pattern	14 (13.5%)	14 (14.7%)	-
Pure consolidation	6 (5.8%)	6 (6.3%)	-
Nodules	2 (1.9%)	1 (1.1%)	1 (11.1%)
Additional CT findings			
Vessel dilatation sign	71 (68.3%)	71 (74.7%)	-
Reverse Halo sign	17 (16.3%)	15 (15.8%)	2 (22.2%)
Halo sign	1 (0.9%)	1 (1.1%)	-
Bronchial dilatation	5 (4.8%)	5 (5.3%)	-
Bronchial wall thickening	4 (3.8%)	4 (4.2%)	-
Air bubble sign	6 (5.8%)	5 (5.3%)	1 (11.1%)
Reticulations	14 (13.5%)	10 (10.5%)	4 (44.4%)
Subpleural lines	13 (12.5%)	10 (10.5%)	3 (33.3%)
Fibrous stripes	6 (5.8%)	6 (6.3%)	-
Perilobular sign	5 (4.8%)	5 (5.3%)	-
Pleural thickening	4 (3.8%)	4 (4.2%)	-
Pleural effusion	4 (3.8%)	4 (4.2%)	-
Mediastinal lymphadenopathy	3 (2.9%)	3 (3.2%)	-
Important negative findings			
Tree-in-bud appearance	0		
Cavitation	0		
Pneumothorax	0		
Pericardial effusion	0		

GGO is a descriptive term that denotes an area of increased lung attenuation on CT through which vascular and bronchial structures can be seen [Figure 1]. It results from the partial filling of alveoli with fluid, blood or cells or due to the thickening of pulmonary interstitial. COVID-19 has been typically described to present with multifocal GGOs with a basal, peripheral and posterior distribution. The GGOs can be patchy or confluent, rounded or elongated. Salehi *et al*. [7] in a systematic review of 22 studies found GGO as the commonest CT manifestation in COVID-19 with a cumulative prevalence of 88%. Parry *et al*. [8] reported GGO with a cumulative prevalence of 100%. Bernheim *et al*. [9] reported the presence of pure GGOs in 34% and GGOs mixed with consolidation in 41%. Caruso D *et al*. [16] reported GGOs in 100% of their patients.

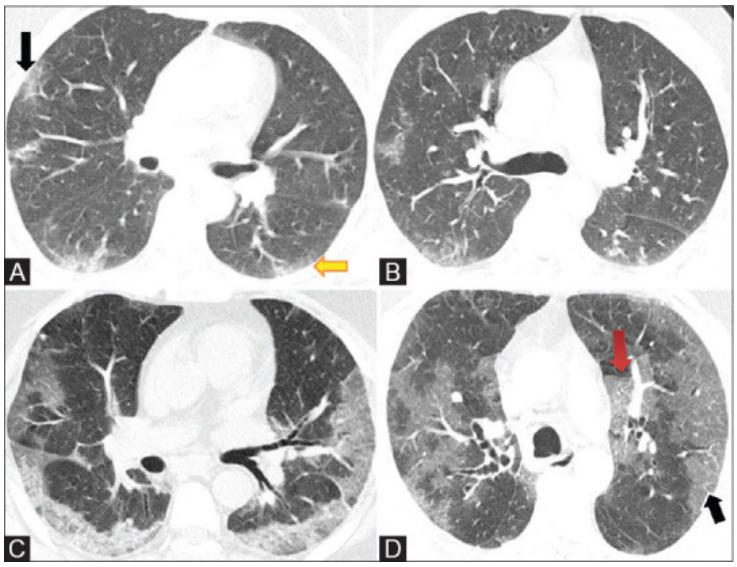

Figure 1 (A-D)

42-year-old man presenting with fever and cough with RT-PCR confirmed COVID-19 (A and B). Non-contrast axial chest CT images (A and B) performed 5 days after symptom onset reveal multiple small peripheral patchy wedge shaped GGOs (black arrow in A) with posterior distribution (yellow arrow in A) in both lungs. 65-year-old (C) and 62-year-old (D) male patients presenting with fever, cough and dyspnea with RT-PCR confirmed COVID-19. Axial CT images performed 7 days after symptom onset in both patients showing extensive

bilateral, confluent and elongated GGOs in both lungs with posterior and peripheral predominance

Crazy-Paving Pattern

It refers to GGO with superimposed interlobular thickening producing a crazy pavement like pattern thus earning it the moniker of the crazy-paving pattern [Figure 2]. Crazy-paving pattern has been variably reported from 5% to 40% in COVID-19 pneumonia.[9,13,17] Its incidence also increases with the progression of disease and is seen predominantly around the eighth day of infection.

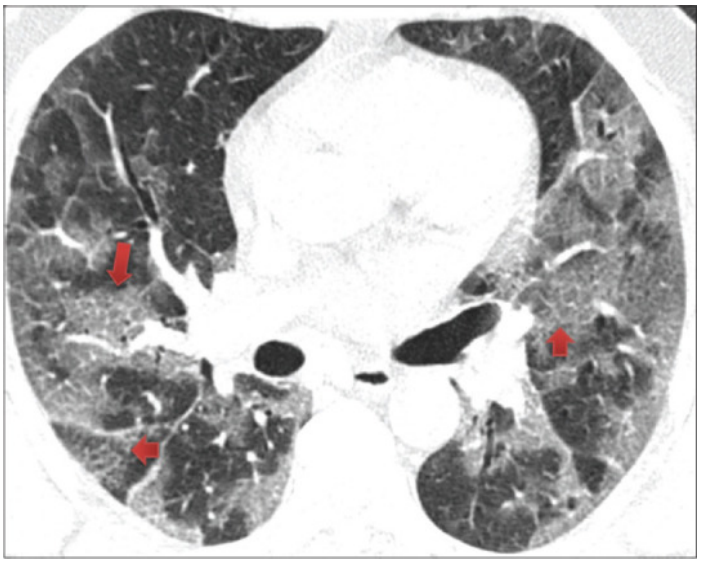

Figure 2

59-year-old male presenting with fever, cough and dyspnoea with RT-PCR confirmed COVID -19. Non-contrast axial chest CT image performed 8 days after symptom onset showing combined peripheral-central and predominantly posterior ground glass opacities with associated interlobular septal thickening forming the typical crazy paving pattern (red arrows)

Consolidation

Consolidation connotes an increase in pulmonary attenuation with obscuration of underlying vascular and bronchial structures and pathologically represents flooding of air-filled alveolar spaces with fluid, blood or inflammatory cells [Figure 3]. Consolidations are seen increasingly in COVID-19 as the infection progresses with a peak incidence at 13–16 days. Consolidations are found more commonly superimposed on GGOs whereas pure consolidations are less common.[7,8] Consolidations also have a peripheral and bilateral distribution akin to GGOs. Unilobar pure consolidation is seldom a feature of COVID-19 and should alert one to consider an alternate diagnosis of bacterial pneumonia.

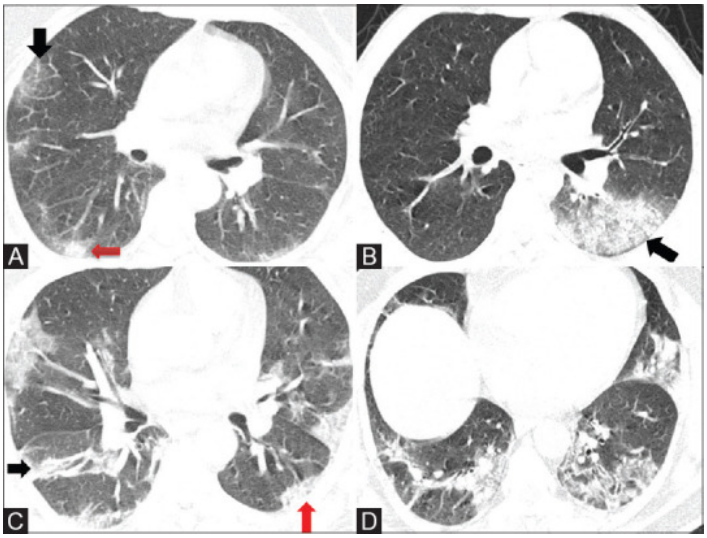

Figure 3 (A-D)

42-year-old (A) and 24-year-old (B) male patients presenting with cough and fever with RT-PCR confirmed COVID -19. Non-contrast axial chest CT images performed on 4th (A) and 6th (B) day of illness respectively, show peripheral GGOs (arrows in A) and large consolidation in superior segment of left lower lobe (black arrow in B). Another 36-year-old male patient presenting with fever and cough with RT-PCR confirmed COVID -19 (C and D). Non-contrast axial chest CT images (C and D) performed 10 days after symptom onset showing multifocal peripheral consolidations in both lungs (red arrow in C). One broncho centric consolidation (black arrow in C) is also seen

Reticular Pattern

Reticular pattern is characterized by a collection of innumerable interweaving linear or wavy shadows producing a mesh-like pattern on CT and results from a varying combination of interlobular and intralobular septal thickening [Figure 4]. They are found during the resorptive phase of the disease.[8,18]

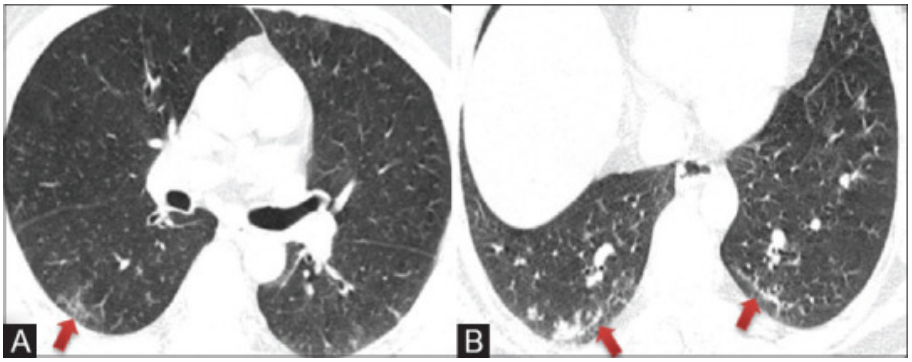

Figure 4 (A and B)

33-year-old asymptomatic patient with RT-PCR confirmed COVID -19 (A). Axial chest CT image (A) shows reticular pattern in superior segment of right lower lobe (red arrow in A). 52-year-old asymptomatic patient with RT-PCR confirmed COVID -19 (B). Axial chest CT image (B) shows curvilinear subpleural lines in lower lobes of both lungs (red arrows in B)

Subpleural Curvilinear Lines

On chest CT subpleural lines are represented by thin (1-3mm) curvilinear shadows lying within 1cm of pleural margin and coursing parallel to it [Figure 4]. It is pathologically represented by pulmonary oedema or developing fibrosis. It has been reported with an incidence of 17–28% in COVID-19 patients.[8,12]

Air Bubble Sign

Air bubble sign is the presence of a small air containing latency within a GGO or consolidation and possibly represents entrapped physiological air space or cross-section of a small dilated bronchus or might represent the early evidence of resorption of consolidation [Figure 5]. It was initially reported in COVID-19 patients by Shi *et al*. [18] who called it round cystic change followed by Kong *et al*. [3] who referred to it as a cavity sign. But a glance through the depicted pictures in these studies led us to conclude that air bubble lucency would be an appropriate term for it.

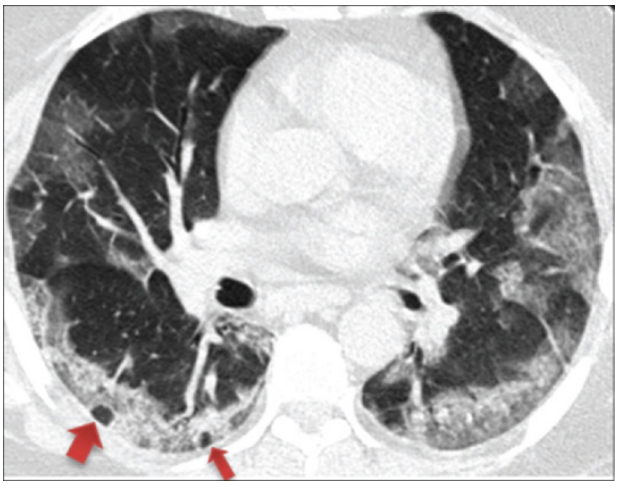

Figure 5

65-year-old male patient presenting with fever, cough and dyspnea with RT-PCR confirmed COVID -19. Non-contrast axial chest CT image obtained 9 days after symptom onset shows confluent elongated ground glass opacities in both lungs with posterior and peripheral predominance with few rounded latencies within the GGOs (red arrows) producing air bubble sign

Pulmonary nodules

Nodule represents a round or irregular opacity less than 3cm in the longest dimension [Figure 6]. Nodules are uncommonly encountered in COVID-19. It has been variably reported in COVID-19 with an incidence of 3–32% [11,19,20,21]

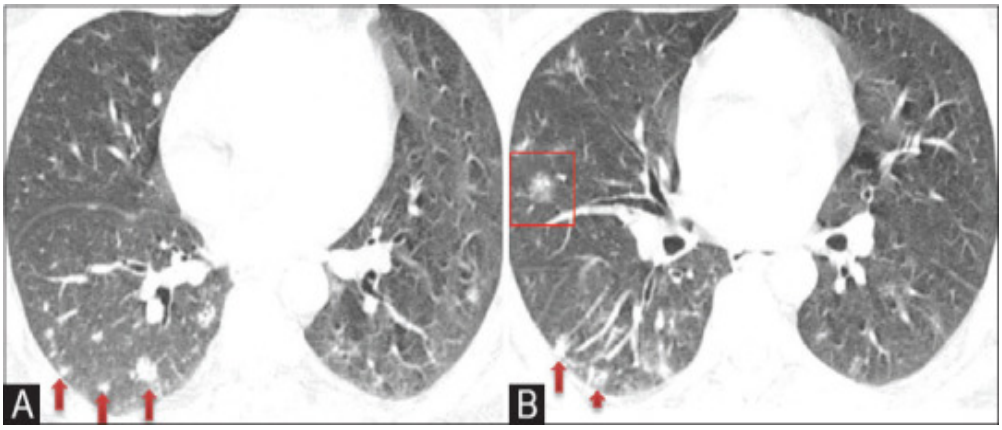

Figure 6 (A and B)

43-year-old male patient presenting with fever and cough with RT-PCR confirmed COVID -19. Non-contrast axial chest CT images obtained 8 days after symptom onset show few ill-defined nodules (red arrows in A & B) with one of the nodules showing surrounding ground glass haze suggestive of halo sign (red frame in B)

Halo sign

It represents a ground-glass haze surrounding a nodule on CT [Figure 6]. Though classically seen in Angio invasive aspergillosis and hyper vascular metastasis where it represents the area of perilesional haemorrhage it has been reported in COVID-19 with a frequency of 3–12%[16,18]

Reverse Halo sign or atoll sign

It manifests as a region of ground-glass haze surrounded by a complete or incomplete ring of consolidation [Figure 7]. Thought initially to be specific of cryptogenic organizing pneumonia (COP) it was subsequently reported in other pathologies. It has been seen in progressive or resorptive stages of COVID-19.[14,22] It might represent disease progression with peripheral areas of GGO transforming into consolidation. The converse is also possible where central GGO might be an area of resorption in the midst of a consolidation.

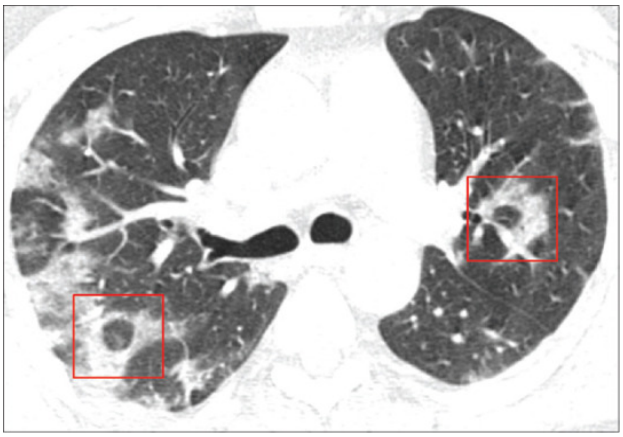

Figure 7

61-year-old male patient presenting with fever, cough and dyspnoea with RT-PCR confirmed COVID -19. Non-contrast axial chest CT image obtained 13 days after symptom onset shows bilateral organizing consolidations with reverse halo (atoll) sign (red frames)

Fibrosis

Fibrous stripes or areas of fibrosis in COVID-19 were reported by Pan *et al*.[14] in 17% of patients. It represents the healing of areas of pneumonia with the formation of fibrosis [Figures [Figures8 and and9].

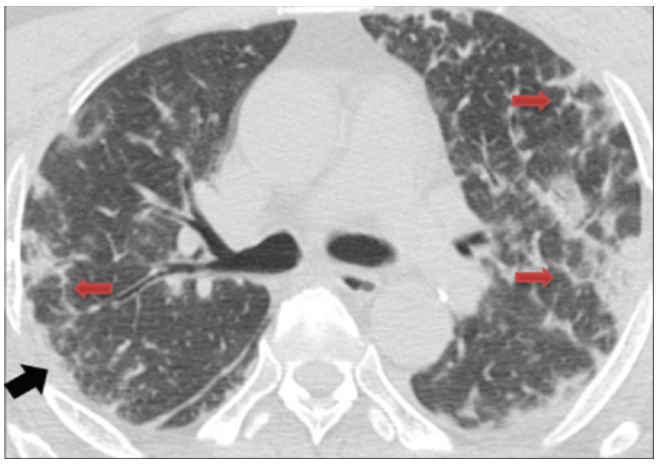

Figure 8

55-year-old female patient presenting with fever and cough with RT-PCR confirmed COVID -19. Non-contrast axial chest CT image obtained 18 days after symptom onset shows bilateral curvilinear or wavy opacities. The wavy opacities (red arrows) assume arc like shapes and represent peri lobular opacities suggesting organizing pneumonia with formation of fibrous stripes. Note is also made of pleural thickening on right side (black arrow)

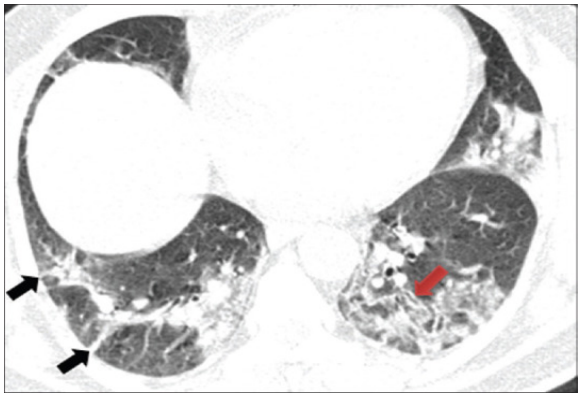

Figure 9

36-year-old male patient presenting with fever, cough and dyspnoea with RT-PCR confirmed COVID -19. Non-contrast axial chest CT image obtained 16 days after symptom onset shows multifocal peripheral consolidations in both lungs with formation of fibrous stripes (black arrows on right side) and segmental bronchial wall thickening (red arrow on left side)

Airway Changes

Bronchial wall thickening and bronchial dilatation may be secondary to bronchial wall inflammation and destruction with surrounding pulmonary parenchymal damage also partly contributing to the bronchial dilatation [Figure 9]. [17]

Bronchial wall thickening has been reported in around 9–29% COVID-19 patients whereas bronchial dilatation has been reported in some cases. [12,21]

Vascular Changes

Segmental or subsegmental pulmonary vascular enlargement on CT chest seems to be a specific feature associated with COVID-19 [Figure 10]. Parry *et al*. [8] and Caruso D *et al*. [16] reported vascular enlargement in 70% and 89% of COVID-19 pneumonia, respectively. Bai *et al*. [21] described vascular enlargement to be frequently associated with COVID-19 pneumonia compared to non-COVID-19 pneumonia with a significant *P* value (<0.001). Small pulmonary vessel enlargement has been linked to the in-situ immune thrombosis of small pulmonary vessels in COVID-19 pneumonia. [23]

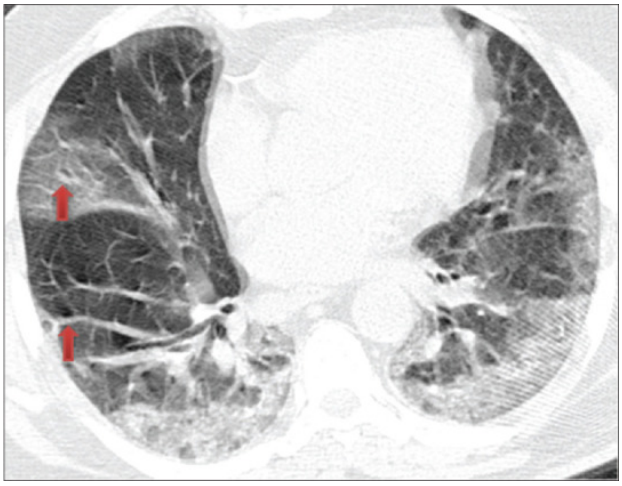

Figure 10

56-year-old male patient presenting with fever, cough and dyspnoea with RT-PCR confirmed COVID -19. Non-contrast axial chest CT image obtained 5 days after symptom onset shows confluent elongated ground glass opacities in both lungs with posterior and peripheral predominance with vascular enlargement (red arrows on right side)

Pleural changes

Pleural effusion [Figure 11] has been reported uncommonly in COVID-19 patients with a varying incidence of 1–14%.[12,17] Pleural thickening [Figure 8] has been reported in some patients.[19,21]

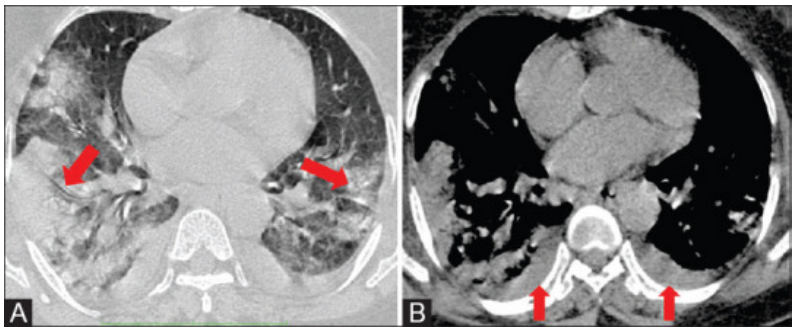

Figure 11 (A and B)

Axial CT images in lung window (A) and mediastinal window (B) of a 62-year-old COVID-19 female patient with severe illness obtained on 8th day of illness show bilateral consolidations with air bronchogram (red arrow in A). Bilateral pleural effusion is also noted (red arrows in B)

Pericardial effusion

Pericardial effusion is uncommonly seen in COVID-19 patients. It has been reported to occur in severe or critically ill patients and possibly represents florid inflammation [8,18]

Mediastinal lymphadenopathy

Enlargement of mediastinal nodes (>10mm in short axis) has been infrequently seen in COVID-19 patients especially in critically sick COVID-19 patients and was thus considered as a risk factor of severe or critical disease.[12,19] However, the presence of lymphadenopathy with effusion and numerous pulmonary nodules may suggest bacterial superinfection.

Peri lobular opacities and organizing pneumonia

Understandably, there is a paucity of literature regarding the long term pulmonary sequelae of COVID-19. The follow-up imaging late in the course of the disease (>2 weeks) usually shows a reduction in the extent of GGO with development of a mixed pattern of lung abnormalities consisting of arc-like peri lobular opacities, subpleural curvilinear lines and subpleural fibrous stripes with architectural distortion of lungs [Figure 12]. The development of peri lobular opacities suggests organizing pneumonia.[22] Viral pneumonias like severe acute respiratory syndrome (SARS), Middle East respiratory syndrome (MERS) and influenza are known to produce secondary organizing pneumonia. The currently available evidence also points to the development of secondary organizing pneumonia in the survivors of COVID-19.

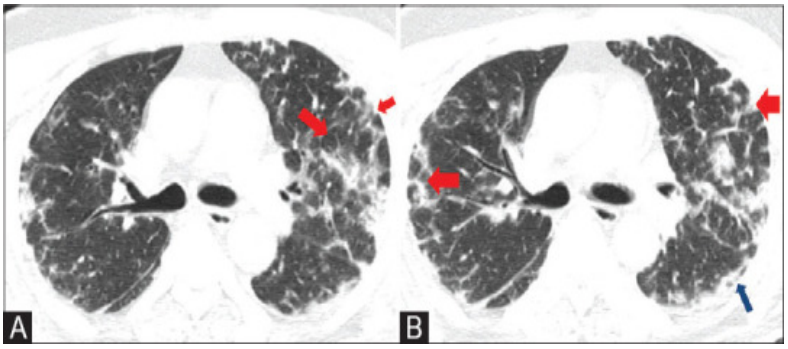

Figure 12 (A and B)

60-year-old male patient presenting with fever and cough with RT-PCR confirmed COVID -19. Non-contrast axial chest CT images acquired on 26th day of illness show multiple arc like peri lobular opacities referred to "peri lobular sign" which is a typical feature of organizing pneumonia (red arrows in A and B). Curvilinear subpleural lines are also seen (blue arrow in B)

Organizing pneumonia is the precursor to the development of lung fibrosis. However, given the fact that corticosteroid therapy has been previously shown effective in the treatment of organizing pneumonia, use of follow-up CT scans to detect the development of organizing pneumonia in COVID-19 patients and early institution of corticosteroid therapy may reduce the possibility of development of lung fibrosis in the survivors.[22]

Conclusion

In conclusion, chest CT imaging reveals a spectrum of manifestations in COVID-19, ranging from early GGOs to extensive consolidations and interstitial changes. These findings reflect the dynamic nature of the disease and provide critical information for diagnosis, management, and prognostication.

References

1. Bernheim A, Mei X, Huang M, et al. Chest CT findings in coronavirus disease-19 (COVID-19): relationship to duration of infection. Radiology. 2020;295(3):200463. doi:10.1148/radiol.2020200463.
2. Pan F, Ye T, Sun P, et al. Time course of lung changes on chest CT during recovery from 2019 novel coronavirus (COVID-19) pneum onia. Radiology. 2020;295(3):715-721. doi:10.1148/radiol.2020200370.
3. Shi H, Han X, Jiang N, et al. Radiological findings from 81 patients with COVID-19 pneumonia in Wuhan, China: a descriptive study. Lancet Infect Dis. 2020;20(4):425-434. doi:10.1016/S1473-3099(20)30086-4.
4. Bai HX, Hsieh B, Xiong Z, et al. Performance of radiologists in differentiating COVID-19 from viral pneumonia on chest CT. Radiology. 2020;296(2). doi:10.1148/radiol.2020200823.
5. Fang Y, Zhang H, Xie J, et al. Sensitivity of chest CT for COVID-19: comparison to RT-PCR. Radiology. 2020;296(2). doi:10.1148/radiol.2020200432.
6. Albano D, Bertagna F, Bertoli M, Bosio G, Lucchini S, Motta F, et al. Incidental findings suggestive of COVID-19 in asymptomatic patients undergoing nuclear medicine procedures in a high-prevalence region. *J Nucl Med.* 2020;61:632–6.
7. Salehi S, Abedi A, Balakrishnan S, Gholamrezanezhad A. Coronavirus disease 2019 (COVID-19): A systematic review of imaging findings in 919 patients. *AJR Am J Roentgenol.* 2020;215:87–93.
8. Parry AH, Wani AH, Yaseen M, Jehangir M, Choh NA, Dar KA. Spectrum of chest computed tomographic (CT) findings in coronavirus disease-19 (COVID-19) patients in India. *Eur J Radiol.* 2020;129:109147.
9. Bernheim A, Mei X, Huang M, Yang Y, Fayad ZA, Zhang N, et al. Chest CT findings in coronavirus disease-19 (COVID-19): Relatio nship to duration of infection. *Radiology.* 20 20;295:200463.
10. Guan WJ, Ni ZY, Hu Y, Liang WH, Ou CQ, He JX, et al. Clinical characteristics of coronavirus disease 2019 in China. *N Engl J Med.* 2020;382:1708–20.
11. Ai T, Yang Z, Hou H, Zhan C, Chen C, Lv W, et al. Correlation of chest CT and RT-PCR testing in coronavirus disease 2019 (COVID-19) in China: A report of 1014 cases . *Rad iology.* 2020:200642. doi:10.1148/radiol.2020 200642.
12. Zhao W, Zhong Z, Xie X, Yu Q, Liu J. Relation between chest CT findings and clinical conditions of coronavirus disease (COVID-19) pneumonia: A multicenter study. *Am J Roentgenol.* 2020;214:1072–7.
13. Han R, Huang L, Jiang H, Dong J, Peng H, Zhang D. Early clinical and CT manifestations of coronavirus disease 2019 (COVID-19) pneumonia. *AJR Am J Roentgenol.* 2020:1–6 . doi: 10.2214/AJR.20.22961.
14. Pan Y, Guan H, Zhou S, Wang Y, Li Q, Zhu T, et al. Initial CT findings and temporal changes

in patients with the novel coronavirus pneumonia (2019-nCoV): A study of 63 patients in Wuhan, China. *EurRadiol.*2020;30:3306–9.
15. Zhang R, Ouyang H, Fu L, Wang S, Han J, Huang K, et al. CT features of SARS-CoV-2 pneumonia according to clinical presentation: A retrospective analysis of 120 consecutive patients from Wuhan city. *Eur Radiol.* 2020;30:4417–26.
16. Caruso D, Zerunian M, Polici M, Pucciarelli F, Polidori T, Rucci C, et al. Chest CT Features of COVID-19 in Rome, Italy . *Radiology* . 2020:201237. doi: 10.1148/radiol.2020201237.
17. Parry AH, Wani AH, Yaseen M, Jehangir M. Chest CT features of coronavirus disease-19 (COVID-19) pneumonia: Which findings on initial CT can predict an adverse short-term outcome? *BJR | Open.* 2020;2:2020016. doi. org/10.1259/bjro.20200016
18. Ye Z, Zhang Y, Wang Y, Huang Z, Song B. Chest CT manifestations of new coronavirus disease 2019 (COVID-19): A pictorial review . *Eur Radiol.* 2020;30:4381–9.
19. Akın Ç, Cenk H, Selen B, Naim C, Recep S. CT Imaging features of COVID-19 pneumonia: Initial experience from Turkey . *Diagn Interv Radiol.* 2020;26:308–14.
20. Parry AH, Wani AH. Segmental pulmonary vascular changes in COVID-19 pneumonia . *AJR Am J Roentgenol.* 2020:W1.
21. Bai HX, Hsieh B, Xiong Z, Halsey K, Choi JW, Tran TM, et al. Performance of radiologists in differentiating COVID-19 from viral pneumonia on chest CT . *Radiology.* 2020:200823. doi: 10.1148/radiol.2020200823.
22. Wang Y, Dong C, Hu Y, Li C, Ren Q, Zhang X, et al. Temporal changes of CT findings in 90 patients with COVID-19 pneumonia: A longitudinal study. *Radiology.* 2020:200843 . Doi: 10.1148/radiol.202.
23. Parry AH, Wani AH, Yaseen M, Dar MI. Demystifying pulmonary vascular complications in severe coronavirus disease-19 pneumonia (COVID-19) in the light of clinico-radiologic-pathologic correlation. *Thromb Res* . 2020 doi: 10.1016/j.thromres.2020.06.043.