Review Article

Imaging manifestations of corona virus disease 2019(COVID-19) on CT chest: A pictorial review

Senthil Kumar Aiyappan, Meenakshi Kochuvilayil Rajeev, Aparajita Singh, Vinayagam Shanmugam

Abstract

Corona virus disease 2019(COVID-19) caused by novel severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) has become a global pandemic in short time. Computed tomography (CT) of the chest can help in diagnosis, staging of the disease and various imaging manifestations of the disease on CT have been extensively reported in the literature but Indian studies are relatively little. In this pictorial review we would like to highlight the common and uncommon CT manifestations of COVID-19 disease.

Keywords: COVID-19; CT chest; Ground glass opacities; consolidation

Introduction

Coronavirus disease 2019 (COVID-19) is a highly infectious disease which was first reported in Wuhan city of china and has now become a global pandemic.[1] Real-time reverse transcription polymerase chain reaction (RT-PCR) of viral nucleic acid is the reference standard for diagnosis, however there are many studies which report a high sensitivity of multidetector computed tomography (MDCT) in diagnosis of corona virus disease.[2] RT-PCR test can be time consuming and can be false negative in few cases if the viral load is not adequate in the specimen collected or because of laboratory error.[3] In these cases MDCT chest can be helpful in establishing the diagnosis especially in patients with exposure and typical clinical symptoms and these patients can be isolated and subjected to repeat RT-PCR examination. In this short pictorial essay we would like to present the most common patterns of COVID19 disease in CT chest. These patterns will help in establishing proper diagnosis of the disease on CT chest.

COVID-19: CT MANIFESTATIONS

Ground glass opacity (GGO)

Ground glass opacity is defined as an area of increased lung density through which vessels and bronchial structures can be seen. GGO is due to partial filling of alveolar spaces, thickening of alveolar walls or thickening of the interstitium.[4] Ground glass opacity with or without consolidation close to visceral pleural surface including fissures with multifocal bilateral involvement is considered as the obligatory feature in diagnosing COVID-19 disease on CT chest [Figure.1a and b].[5] Immediate subpleural sparing can be present [Figure 1c].5 The most common imaging finding in COVID-19 is the occurrence of GGO which can be upto 98%.[6] GGO can be accompanied by consolidation or septal thickening or halo sign. The GGO can be sharp and rounded [Figure 1d] or can have unsharp demarcation [Figure 1and b].

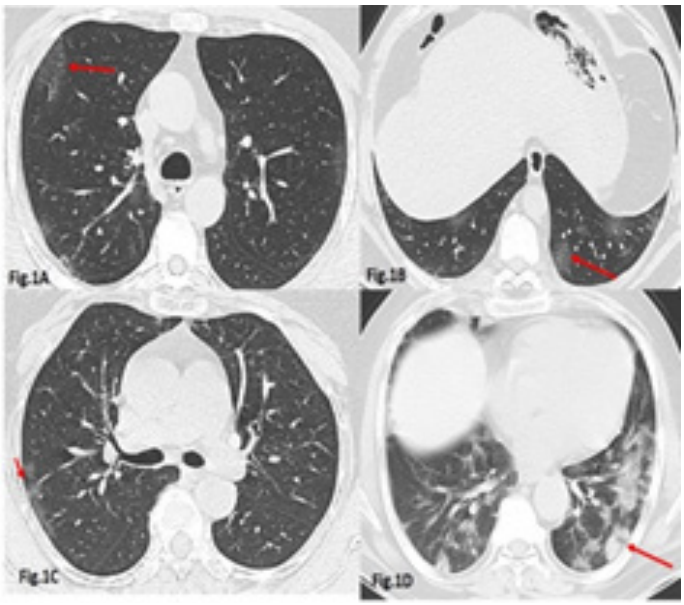

Figure 1: 1A and B -showing bilateral peripheral subpleural ground glass opacities with unsharp demarcation more involving lower lobes. 1C -showing immediate subpleural sparing. 1D-showing subpleural rounded GGO/Consolidation.

Consolidation and Airbronchogram

When the air in the alveoli is replaced by fluid or cells it is called consolidation.[7] Consolidation obscures the margins of the vessels and bronchi unlike GGO. Consolidation represents disease progression and can coexist with GGO.[8,9] Consolidation can be present in subpleural location or along the bronchovascular bundle [Figure 2a and b]. If the time interval between onset of symptoms and CT is more, then the predominant pattern will be consolidation indicating that GGO has progressed to consolidation.8,9 Consolidation can be mainly seen in elderly population.[4] Airbrochogram is visibility of air filled bronchi in a background of high attenuation lung.[7] Consolidation or GGO can be asso-

Senthil Kumar Aiyappan, Professor, **Meenakshi Kochuvilayil Rajeev**, Junior resident, **Aparajita Singh**, Junior resident, **Vinayagam Shanmugam**, Prof. and Head of department, Department of Radiodiagnosis, SRM Medical College Hospital and Research Centre, Kattankulathur, Potheri, Chengalpattu, Tamil Nadu-603203, India.

Corresponding author: Senthil Kumar Aiyappan
Email: asenthilkumarpgi@gmail.com

ciated with airbronchogram [Figure 2c and d]. Airbronchogram indicates large amount of exudates within the alveoli.[4]

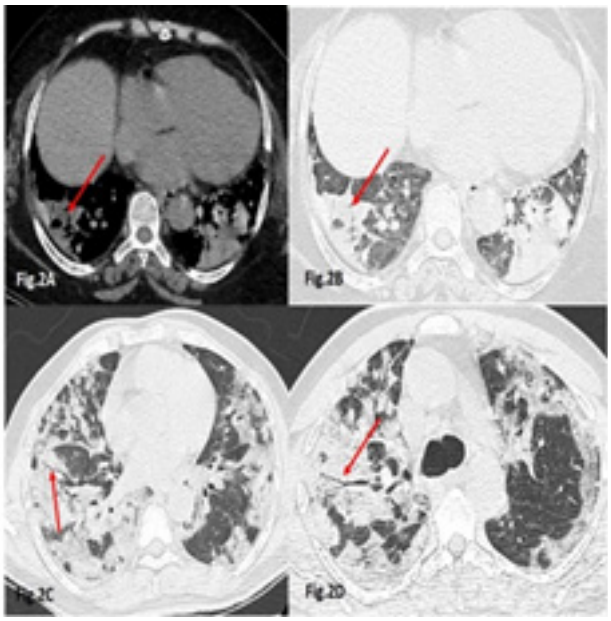

Figure2: 2A and B- showing bilateral lower lobe consolidation without airbronchogram. 2C and D- showing diffuse consolidation with airbronchogram.

Reticular Pattern and Crazypaving

Reticular pattern is thickening of pulmonary interstitium due to lymphocyte infiltration and causes inter and intralobular septal thickening. Few studies have shown reticular pattern as the next common pattern after GGO and consolidation [Figure 3a and b]. [10,11] Crazypaving is defined as ground glass opacity superimposed with inter and intralobular septal thickening resembling irregularly placed paving stones [Figure 3c and d]. This is due to edema of the alveolus along with the inflammatory infiltrates in the interstitium causing interstitial thickening. This finding usually indicates peak stage of the disease. It is reported in 5 to 36 % of patients.[12,13]

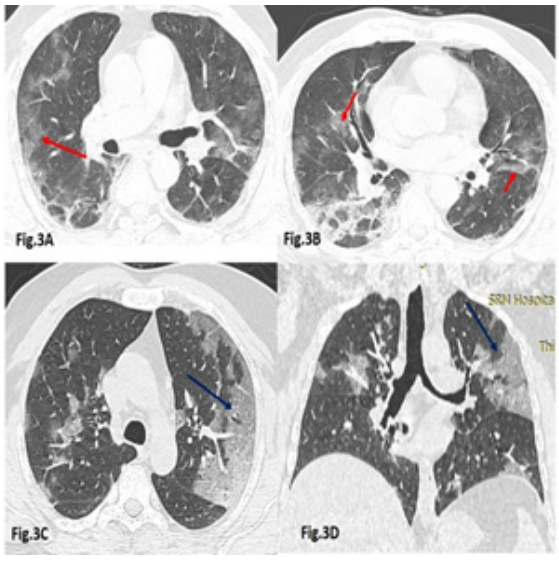

Figure 3: 3A and B- showing GGO with interstitial thickening. 3C and D- Showing GGO intermixed with septal thickening suggestive of crazy paving.

Vascular Dilatation

Vascular dilatation is considered as dilated vessels within the parenchymal abnormalities found in COVID-19 patients [Figure 4a and b]. It is considered one of the confirmatory patterns of the disease and commonly seen.[5] The cause is due to the damage of capillary walls by the inflammatory mediators with increased blood flow to the inflammatory area.[4,14]

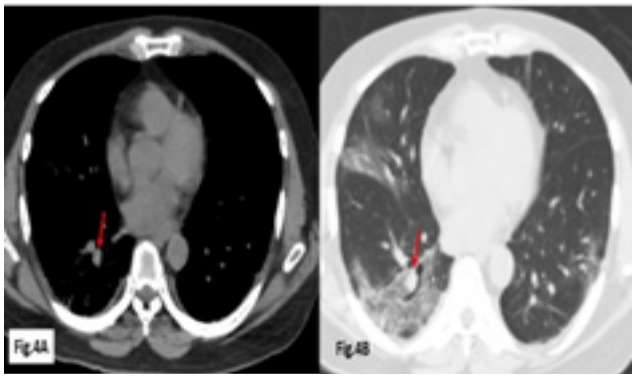

Figure 4 A and B: Showing right lower lobe GGO with consolidation with vascular dilatation.

Subpleural Bands, Architectural Distortion and Linear Stripes

Subpleural curvilinear bands, architectural distortion and linear stripes are also characteristic of the corona virus disease -19 and are seen in late phase of the disease [Figure 5a and b]. [9,15] Whether they progress to pulmonary interstitial fibrosis is still debatable.

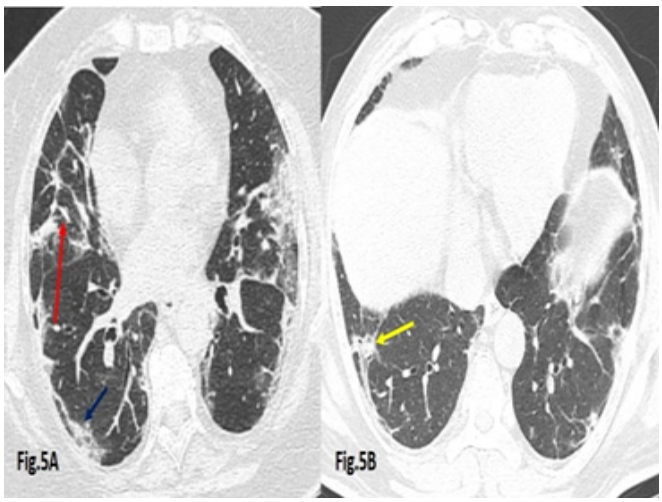

Figure 5A and B: Showing subpleural bands (blue arrow), architectural distortion with linear stripes (red) and fibrotic bands (yellow)

Bronchial Wall Thickening And Bronchiectasis

Inflammatory damage of the bronchial wall can lead of bronchial wall thickening, proliferation of fibrous tissue around the bronchus causing deformation of bronchial wall with bronchial

obstruction and traction bronchiectasis or bronchiolectasis [Figure 6 a and b].[4] The incidence of bronchial wall abnormalities are more in critically ill patients than in ordinary patients and are usually seen in advanced stage of the disease.[13]

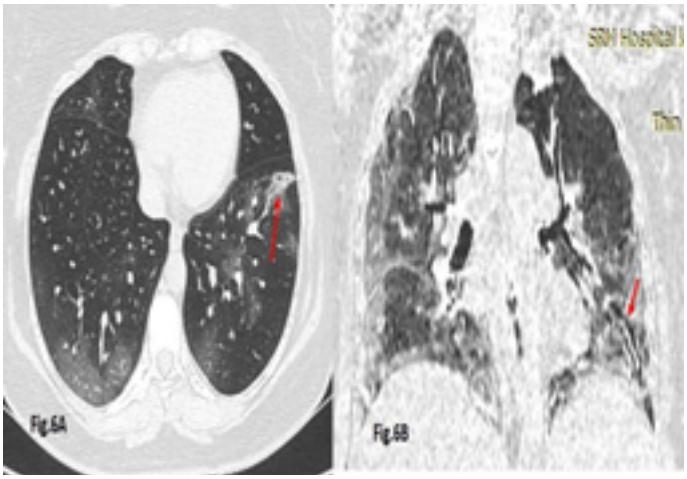

Figure 6: 6A- Showing left lower lobe focal bronchial wall thickening. 6B- Showing mild bronchial dilatation with bronchial wall deformation in left lower lobe.

Pleural Thickening

Pleural thickening and retraction is one of the common imaging finding of COVID-19 disease [Figure 7a]. Pleural thickening and retraction are due to the inflammatory reaction associated with the disease. Pleural thickening is seen in 32 to 48.4 % cases according to various studies. [8,12,17] and pleural thickening with adhesion is commonly reported in autopsy studies of COVID-19 cases.[16]

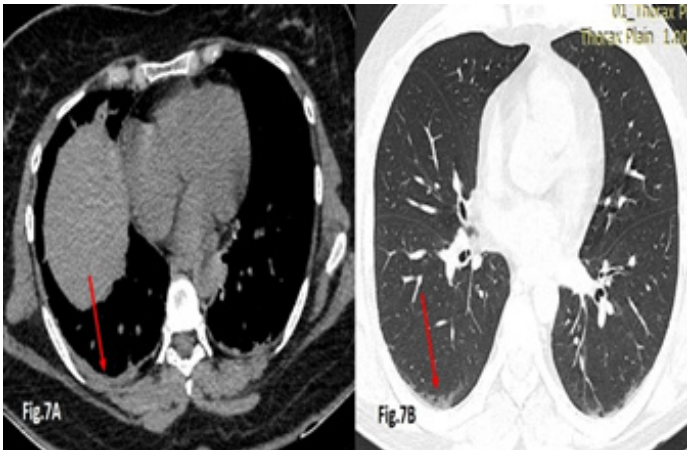

Figure 7: 7A-Showing bilateral pleural thickening. 7B- Showing bilateral Subpleural curvilinear lines.

Subpleural Line

Subpleural curvilinear lines are thin curvilinear opacity noted just within 1 cm from pleural surface and lying parallel to pleura and chest wall [Figure 7b]. The reported incidence is about 20 to 27.9%.[18]

Air Bubble Sign

Air bubble sign is small air-containing space inside the opacity which may be due to pathological enlargement of bronchiole [Figure 8 a and b]. [4] Air bubble sign has been called under different names like cystic air space, round cystic changes, air-containing space, sieve-hole sign, and vacuolar sign. [4,17] The cause may be related to the pathological expansion of alveolar sacs or bronchioles or the absorption process of consolidation. Around 10.2% of patients had this sign in one study. [18]

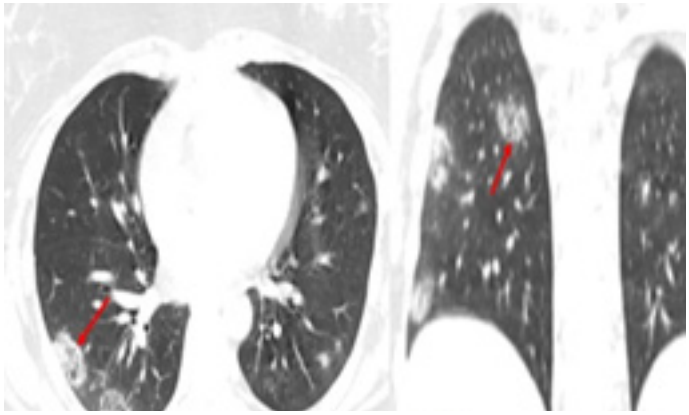

Figure 8A and B: Showing Rounded consolidations with cystic lucencies within it suggestive of airbubble sign.

Halo Sign and Reverse Halo Sign

Halo sign is defined as nodule or consolidation surrounded by ground glass opacity and is due to perilesional hemorrhage [Figure 9a]. It can be seen in many other conditions like angioinvasive fungal infections, viral pneumonias and hypervascular metastasis.[4,13] It is not specific to COVID-19 disease. Halo sign was seen in approximately 11% of cases in few studies.19 Reverse halo sign or atoll sign is GGO surrounded by ring like consolidation which was previously thought specific for cryptogenic organizing pneumonia but it can be seen in COVID-19 disease [Figure 9b]. Reverse halo sign is less common.19 It may either represent progressive disease like consolidation developing around GGO or may indicate resolution with resorption of central consolidation.[4]

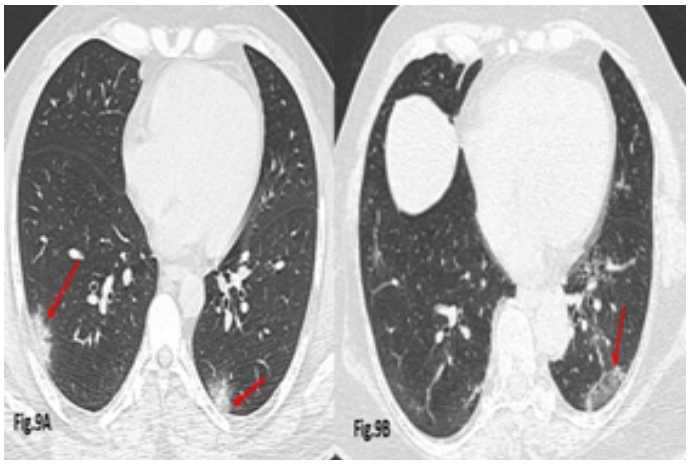

Figure 9: 9A-Showing subpleural consolidation with surrounding ground glass density suggestive of Halo sign. 9B-Subpleural Ground glass opacity surrounded by ring like consolidation sug-

gestive of reverse halo sign.

Mediastinal Lymphadenopathy and Pleural Effusion

In less number of patients with COVID-19 disease, significant mediastinal lymphadenopathy was present and is considered to have adverse prognosis [Figure 10 a]. If it is associated with tiny nodules and pleural effusion, may indicate superadded bacterial infection.[20] Pleural effusion was considered rare but recently pleural effusions are reported in increasing frequency especially in late stages of the disease [Figure 10b].[21]

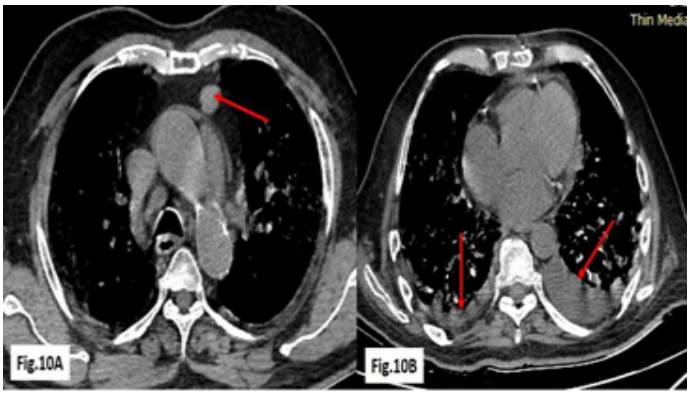

Figure10: 10A-Showing enlarged mediastinal lymphnode. 10B-Showing bilateral pleural effusion.

Conclusion

By this pictorial essay we have tried to familiarize the important imaging characteristics of corona virus disease-19 on CT. CT plays an important role in the diagnosis and management of COVID-19 and can assess the severity and stage of the disease. Although lot of studies are available regarding the imaging manifestations and common patterns of involvement of corona virus disease-19, only limited number of studies are available regarding follow up of these patients. Whether there is complete resolution of the disease or residual fibrosis develop on follow up CT still needs to be investigated.

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