

CT findings and clinical features of corona virus disease-19 (COVID-19) in 50 RT-PCR confirmed patients: an Indian study

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Abstract

Objective: To characterize the clinical features, laboratory and CT findings of 50 RT-PCR proven patients with COVID-19.

Materials and methods: A retrospective study of 50 patients with RT-PCR confirmed COVID-19 was performed. CT images were reviewed by two experienced radiologists. Clinical data was also recorded. The percentage of each CT findings was evaluated. Patients were divided into early and advanced phase depending on symptom onset which is less than or equal to 7 days and 7 to 14 days. Chi-square test was used to compare the CT features of early and advanced phase of COVID-19 pneumonitis.

Results: There were totally 50 patients included in the study and among them 33 patients were male and 17 were female. The age group ranged from 22 to 87 years with median age of 48 years. There were 26 patients who underwent CT in early stage and 24 patients in advanced stage. Most of the patients presented with fever and cough with lymphocytopenia and elevated CRP being the most common lab finding. The most common finding in CT scan was ground glass opacities which was seen in 41(82%) patients. GGO with consolidation was seen in 20(40%) patients and GGO with interstitial thickening or crazy paving was seen in 10(20%) patients. Air bubble sign was seen in 2 (4%) patients. Vascular dilatation was seen in 9(18%) patients. Subpleural fibrotic bands, architectural distortion were seen in 8(16%) patients. Subpleural line and halo sign was seen in 2(4%) patients. Nodules were seen in 1 (2%) patient. Air bronchogram within the consolidation was seen in 8(16%) patients. Bronchial dilatation and distortion was seen in 4 (8%) patients. Pleural thickening (18%) was common than pleural effusion (8%). Mediastinal lymphadenopathy and pericardial effusion were seen in 4% cases. In the early phase, GGO were more common and was seen in all 26 patients in early phase. Consolidation, air bronchogram, bronchial abnormalities and pleural effusion were more common in the advanced phases and was statistically

significant. Rest of the other parameters did not show any statistical significance. The sensitivity of CT in diagnosing COVID-19 pneumonia was 96.15% in early phase and 83.33% in advanced phase and 90% overall.

Conclusion: Fever and cough were the most common clinical finding. Elevated CRP and lymphocytopenia were the most common lab finding. Multifocal GGO with peripheral, posterior, lower lobe and bilateral involvement was the most common imaging finding. CT can stage the disease as GGO was common in early phase and consolidation in later phases. CT is indicated in patients with moderate to severe symptoms and in RT-PCR negative cases with symptoms suggestive of COVID-19.

Keywords: COVID-19; CT; GGO; 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 with India being one of the countries with maximum number of cases.^{1,2} Realtime reverse transcription polymerase chain reaction (RT-PCR) of viral nucleic acid is the gold standard test for diagnosing this infection.²⁻⁴ RT-PCR test can be time consuming and can be false negative in some of the cases if the specimen is not properly collected or because of laboratory error.⁴ In these cases CT chest can be helpful in establishing the diagnosis, hence the knowledge of imaging findings of COVID-19 on CT is very important. The information about the Chest CT findings is constantly evolving and various studies are available in the literature.⁴⁻⁷ Hereby we present one such Indian study in which we are analyzing the clinical, lab and CT features of COVID-19 with emphasis to specific CT findings according to stage of the disease.

Material and Methods

After getting approval from our Institutional Ethical Committee, we retrospectively reviewed clinical features and chest CT findings of 50 patients with reverse transcription-polymerase chain reaction (RT-PCR) proven COVID-19 infection. The study was conducted in the department of Radiology, SRM medical college hospital and

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research centre, Chengalpattu, Tamilnadu and Chest CT cases between May 2020 and July 2020 were included in the study. The first 50 cases of RT-PCR proven COVID-19 patients who underwent chest CT examinations were included in the study. The patient's clinical features and laboratory data were noted down from the case sheet. CT was done on a 128 slice-MDCT (Optima CT 660, GE health care) from lung apex till dome of diaphragm with reconstruction of 1.3 mm which is the standard CT protocol in our department. The study was acquired in axial plane and reconstructions were done in sagittal and coronal plane. Technologist who performed CT examinations was required to wear personal protective equipment.

Image interpretation

Two experienced radiologists of 7 to 11 years' experience interpreted the CT chest imaging findings and any discrepancy was solved by consensus. The images were interpreted in GE workstation with proper multiplanar reformatted technique. The images were evaluated for the following parameters which include the presence of ground glass opacity, consolidation, air bronchogram, interstitial thickening, subpleural bands, fibrosis, architectural distortion, halo sign, reverse halo sign, air bubble sign, bronchial wall abnormalities, bronchial dilatation, pleural thickening, pleural effusion, pericardial effusion, presence of nodules, mediastinal lymphadenopathy and also the lobe of the lung involved. The clinical features, lab parameters, day of CT scan after symptom onset and day of RT-PCR confirmation were also noted. If chest radiograph is available, the findings of chest radiograph were also noted. The patients were divided into two groups with early stage being less than or equal to 7 days within symptom onset and advanced being 8 to 14 days of symptom onset. The typical CT features suggestive of COVID-19 include presence of ground glass opacities (GGO) with or without consolidation in lung regions close to visceral pleural surfaces including the fissures and multifocal bilateral distribution with preferential lower lobe involvement. Immediate subpleural sparing can be present. Interstitial thickening, crazy paving, thickened vessels within the parenchymal abnormalities and patterns compatible with organising pneumonia were also included as typical CT features. If these features are present then the patient is termed to have COVID-19 pneumonitis on CT. Otherwise it is termed not suggestive of COVID-19. All these features were then analysed and the sensitivity of CT was calculated with RT-PCR as gold standard.

Statistical analysis

Data was entered in Microsoft excel and statistical test was done using latest version of SPSS software. The frequency of CT findings were given as percentages and the occurrence of specific CT findings in early and advanced stage of the disease were analysed using chi-square test and p

value less than 0.05 was considered significant.

Results

Demographics and clinical features

There were totally 50 patients included in the study and among them 33 patients were male and 17 were female. The age group ranged from 22 to 87 years with median age of 48 years. There were 26 patients who underwent CT in early stage which is less than 7 days after symptom onset and 24 patients in advanced stage which is 8 to 14 days after symptom onset. Out of 50 patients, 13 patients showed CT findings of COVID-19 pneumonia even before the test results came. In 4 patients with positive CT findings, RT-PCR was initially negative inspite of patient being symptomatic; however on second time it became positive. Contact history was available only in 7 out of 50 patients. Chest radiograph was done in all the patients and 34 radiographs showed findings suggestive of infectious etiology in the form of patchy and diffuse consolidation. Most of the patients presented with fever and cough (Table 1). Fever (88%) and cough (46%) were the most common symptoms followed by breathlessness (36%), myalgia (32%), and fatigue (24%). Diarrhoea was seen in 16% of the patients. There were no asymptomatic patients in our study since CT was not done in asymptomatic patients. Blood investigations were performed in all the patients according to institution protocol (Table 1). 41 (82%) patients had lymphocytopenia, erythrocyte sedimentation rate (ESR) was elevated in 39 (78%) patients, C-reactive protein (CRP) was elevated in 47 (94%) patients, D-dimer was elevated in 25 (50%) patients, raised interleukin-6 was seen in 23 (46%) and raised lactate dehydrogenase level was seen in 41(82%) patients. Comorbidities were seen in 20 (40%) patients (Table 1). The most common comorbidity was diabetes mellitus associated with 11(22%) patients. 46 patients got discharged and 4 patients expired. Out of those 4 patients 2 had diabetes and 2 did not have any comorbidity.

Table 1: Clinical and lab characteristics of patients with COVID-19 pneumonia

Clinical Features	Number of patients	Percentages
Fever	44/50	88
Cough and sputum	23/50	46
Chills	Mar-50	6
Myalgia	16/50	32
Sorethroat	Nov-50	22
Headache	Oct-50	2
Breathlessness	18/50	36

Gastroenteritis	Aug-50	16
Fatigue	Dec-50	24
LAB FINDINGS		
Lymphocytopenia	41/50	82
Raised ESR	39/50	78
Raised CRP	47/50	94
Raised D-Dimer	25/50	50
Raised IL-6	23/50	46
Raised LDH	41/50	82
Comorbidities	20/50	40
Diabetes mellitus	Nov-50	22
Hypertension	May-50	10
Malignancy	Jan-50	2
Chronic kidney disease	Mar-50	6

CT findings

Out of 50 patients included in the study, only one had normal chest CT. Rest 49 patients had positive CT findings (Table 2). All the cases showed bilateral involvement and lower lobe involvement was seen in 30 (60%) patients. Posterior predominance was seen in 24(48%) patients. Subpleural/peripheral distribution of GGO was the most common pattern seen in 28(56%) cases followed by diffuse involvement seen in 11(22%) patients. The most common findings in CT scan were ground glass opacities which were seen in 41(82%) patients (Figure 1a and 1b). GGO with consolidation was seen in 20(40%) patients (Figure 1c) and vascular dilatation was seen in 9(18%) patients (Figure 1d). GGO with interstitial thickening or crazy paving (Figure 2a) was seen in 10(20%) patients. Subpleural fibrotic bands, architectural distortion was seen in 8(16%) patients (Figure 2b). Bronchial dilatation and distortion was seen in 4 (8%) patients (Figure 1c and 2c). Pleural thickening (18%) was seen in 18% patients (Figure 2d). Nodules were seen in 1 (2%) patient (Figure 3a). Air bubble or vacuolar sign which is small air containing space within consolidation was seen in 2 (4%) patients (Figure 3b). Pleural effusion was seen in 8% cases (Figure 3c). Mediastinal lymphadenopathy (Figure 3d) and pericardial effusion (Figure 3c) were relatively rare seen in 4% cases.

Subpleural line and halo sign was seen in 2(4%) patients. Airbronchogram within the consolidation (Figure 1c) was seen in 8(16%) patients.

Figure 1: 1a and b) Axial and coronal CT sections showing multifocal peripheral ground glass densities predominantly involving bilateral lower lobes. 1c)axial CT sections showing diffuse consolidation with airbronchogram and bronchial deformation on right side 1d) axial CT sections showing vascular dilatation within the GGO on left side.

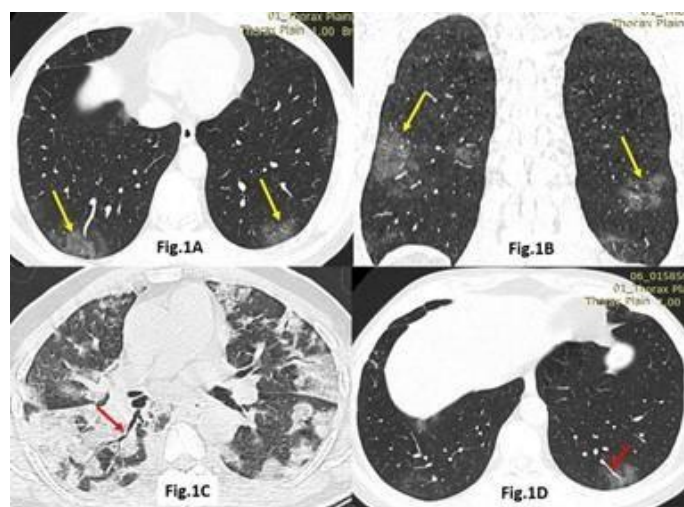


Figure 2: Axial CT sections 2a)showing GGO with reticular thickening 2b)subpleural fibrotic bands with architectural distortion on left side. 2c)bronchial wall thickening on right side 2d)Pleural thickening on right side

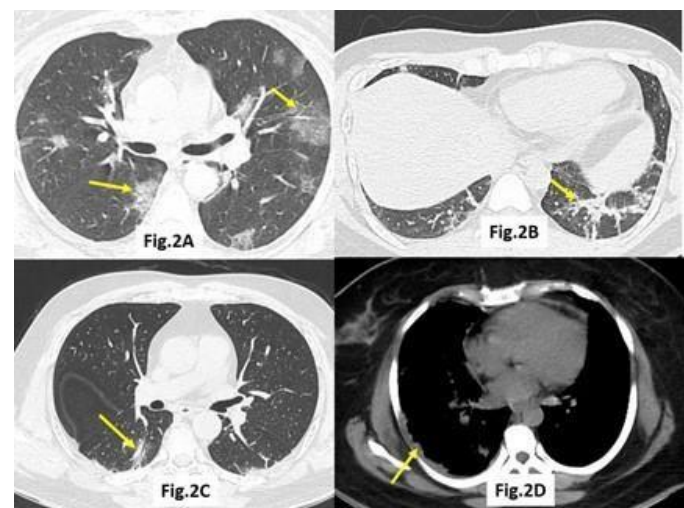


Figure 3: Axial CT sections 3a) Showing nodules in right upper lobe 3b) Showing airbubble/vacuolar sign on right side 3c) Showing bilateral mild pleural and pericardial effusion 3d) Showing mediastinal lymphadenopathy

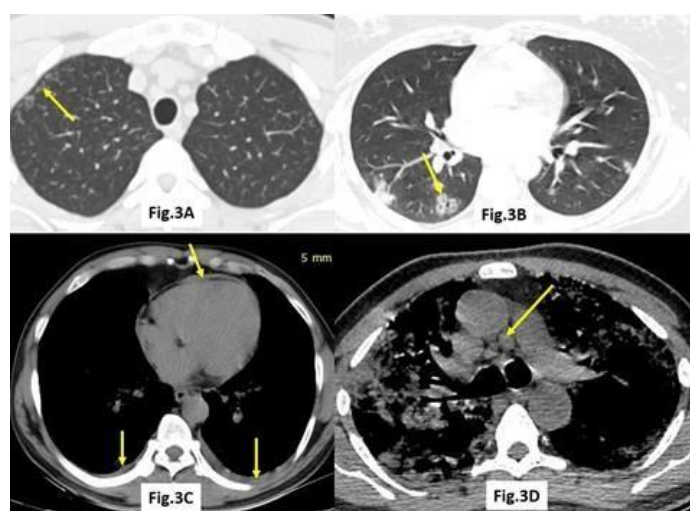


Table 2: Chest CT imaging findings in corona virus disease-19 (COVID-19)

CT Findings	Number(%) of patients(n=50)
Lung changes	
GGO	41(82%)
GGO with consolidation	20(40%)
GGO with interstitial thickening/crazy paving	10(20%)
Air bubble or vacuolar sign	2 (4%)
Vascular dilatation	9(18%)
Subpleural fibrotic bands, architectural distortion	8(16%)
Subpleural line	2(4%)
Nodules	1(2%)
Halo sign	2(4%)
Reverse halo sign	0
Bronchial change	
Bronchiectasis/Bronchiol-ectasis	4(8%)
Bronchus distortion	4(8%)
Air bronchogram	8(16%)
Pleural changes	
Pleural thickening	9(18%)
Pleural effusion	4(8%)
Mediastinal lymphadenopathy	2(4%)

Pericardial effusion	2(4%)
Pattern of lung involvement	
Unilateral	0
Bilateral	49(98%)
Posterior predominance	24(48%)
Lower lobe involvement	30(60%)
GGO/consolidation pattern	
Subpleural	28(56%)
Peribronchovascular	2(4%)
Diffuse	11(22%)
Immediate subpleural sparing	7(14%)

The CT findings were analysed by separating the course of disease into two phases (Table 3). In the early phase which is less than or equal to 7 days, GGO were more common and was seen in 26 (100%) patients and in advanced phases GGO were seen in 15 (63%) patients. Consolidation, air bronchogram, bronchial abnormalities and pleural effusion were more common in the advanced phases which are more than 7 and less than 14 days and were statistically significant. Rest of the other parameters did not show any statistical significance. The sensitivity of CT in diagnosing COVID-19 pneumonia was calculated. The specificity was not calculated as we did not include RT-PCR negative patients. The sensitivity of CT was 96.15% in early phase and 83.33% in advanced phase and 90% overall.

Table 3: CT features of COVID-19 patients in early and advanced phases.

CT Feature	Early Phase (n=26)	Advanced Phase (n=24)	Chi-Square Test	P
GGO	26	15	11.89	0.0005*
GGO with Consolidation	5	15	9.736	0.002*
GGO with reticular thickening	4	6	0.721	0.395
Air bubble sign	0	2	2.257	0.133

Sub-pleural fibrotic strands	0	8	10.317	0.001*
Subpleural line	0	2	2.257	0.133
Sub-pleural sparing	5	2	1.231	0.267
Air bronchogram	1	7	5.953	0.015*
Bronchus distortion	0	4	4.71	0.023*
Pleural thickening	3	6	1.532	0.215
Pleural effusion	0	4	4.71	0.023*
Vascular dilation	6	3	0.946	0.331

Discussion

COVID-19 is a highly infectious pneumonia caused by a novel corona virus (SARS-CoV-2) which was first reported in Wuhan city of china. Men (66%) were more commonly involved than females (34%). The commonest clinical presentation in our study was fever and cough. This is similar to the study done by Zhao D et al in which fever and cough were the most common symptoms. Fatigue, breathlessness, sore throat and myalgia were other less common symptoms in our study which was similar to the study by Zhao D et al and Ge H et al.^{8, 9} An Indian study also says fever and cough were the most common symptoms.¹⁰ 8 (16%) had gastroenteritis as the initial symptom in our study. This was similar to the study by Zhou et al in which 14.5% patients presented with abdominal symptoms.¹¹ This may be due to virus binding to angiotensin converting enzyme inhibitor in gastrointestinal tract. The most common laboratory finding in our study was raised CRP (94%) and lymphocytopenia (82%) which was similar to the study done by Zhao D et al.¹² In a review by Frater JL et al lymphocytopenia was seen in 35-75% of patients and elevated CRP was seen in 75-93% of patients.¹²

CT has proven to be a sensitive investigation and can supplement RT-PCR which is the gold standard test for diagnosing COVID-19.¹³ Although there are numerous articles published about the CT manifestations of the disease, the CT findings are constantly evolving.¹⁴ The commonest pattern on CT for COVID-19 pneumonitis in our study was ground glass opacities which was seen in 40 (82%)

patients. This was similar to the most of the studies published previously.¹⁴⁻¹⁸ In a study by Wang et al all their 138 patients had ground glass opacities.¹⁸ Bilateral, lower lobe involvement, subpleural and posterior predominance were the most common pattern distribution of GGO in our study. In our study bilateral, lower lobe involvement, subpleural and posterior predominance was noted in 98%, 60%, 56% and 48% cases respectively out of which posterior and lower lobe predominance was relatively less in our study when compared with meta-analysis study by Salehi et al and Ojha et al.^{16 14} (Table 4). In our study, GGO alone or GGO with consolidation were the most common imaging findings followed by GGO with reticular thickening. This was similar to most of the previous reported studies.¹⁴⁻¹⁸ The other common CT findings in our study were pleural thickening, lung fibrosis, air bronchogram and vascular dilatation. Less common findings include bubble sign, halo sign, nodules, bronchiectasis, bronchial wall thickening, pleural effusion, pericardial effusion and mediastinal lymphadenopathy. These were in accordance with the previous studies published in the literature.^{14, 16}

Table 4: Comparison of GGO and consolidation pattern with previous meta-analysis studies

	Re-view-Salehi et al (919 patients)	Re-view-Ojha et al(4410 patients)	Our study (50 patients)
GGO	88%	50.20%	82%
BILATERAL	87.50%	84%	98%
LOWER LOBE	NA	84%	60%
SUBPLEURAL	76.00%	68.80%	56%
POSTERIOR	80.40%	77.70%	48%
GGO WITH CONSOLIDATION	31.80%	44.40%	40%

In our study we divided the patients into two groups early and advanced and the CT findings were analysed statistically. There were 26 patients in early phase which is less than or equal to 7 days and 24 patients in advanced phase which is 7 to 14 days. The frequency of GGO was more in early phase with significant statistical significance. However the frequency of consolidation, air bronchogram, pleural effusion, fibrotic streaks and bronchial wall abnormalities were more common in advanced phase which was also statistically significant. Rest of the imaging findings like interstitial thickening/crazy paving, air bubble sign, subpleural line and halo sign were not statistically significant although they were seen more in advanced phase. Vascular dilatation although more seen in early phase was also not statistically significant. The findings

of our study were almost similar to the study by Zhou S et al except that in our study consolidation also showed statistical significance appearing in advanced phase.¹¹ Vacuolar sign, subpleural line, reticular thickening were common in advanced phase in both our study, however they did not show statistically significant difference in our study. The temporal evolution of the disease shows that initial manifestation of the disease will be multifocal ground glass opacities which will progress to mixed areas of GGO with consolidation and reticular thickening/crazy paving.¹⁹⁻²¹ The peak of the CT lesions are reached in 10-11 days and they gradually resolve completely or with fibrosis. In severe cases it may progress to white out lung or acute respiratory distress syndrome.

The imaging findings of COVID-19 are variable and it is constantly evolving. RT-PCR can be false negative and its sensitivity can be as low as 60-70%. The reported CT sensitivity for detection of COVID-19 is as high as 98%.^{13,22} In our study the sensitivity of CT was 96.15% in early phase and 83.33% in advanced phase and 90% overall. This was similar to previous studies published in literature. As the disease progresses most of the GGO in early phase develop into consolidation, reticular pattern with development of subpleural fibrotic bands and architectural distortion and it will not follow the classical subpleural, lower lobe and posterior predominance. In severe disease and in patient with comorbidities it may progress to white out lung. Hence the sensitivity of CT decreases in advanced phase. In the initial 0-2 days after symptom onset, CT may not show positive findings. Hence CT is not routinely recommended for asymptomatic patients, for screening and patients with mild symptoms. In our study, only one patient had normal CT because all the patients in our study had moderate to severe symptoms and hence was subjected to CT examination.

Limitations

Our study did not include RT-PCR negative patients and hence specificity of CT could not be calculated. Our retrospective study did not have patients with mild symptoms. The patients were not followed up so that progression or complete resolution was not documented. The sample size is small.

Conclusion

CT plays an important role in the diagnosis and monitoring the patients with COVID-19. The commonest clinical symptom in our study was fever and cough and the commonest CT finding was multifocal GGO with peripheral, posterior, lower lobe and bilateral involvement. GGO was common in both early and advanced phase and consolidation, pleural effusion and bronchial abnormalities were common in advanced phase. Reticular and pleural thick-

ening although was more seen in advanced phase, it was not statistically significant.

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