ORIGINAL RESEARCH

HRCT finding in COVID 19 infected patients

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ABSTRACT
The information about imaging findings of COVID-19 disease on HRCT is evolving every day and is widely distributed across numerous publications Main objectives of our study were to identify important imaging manifestations, atypical manifestations and distribution of the lesions in the patients with COVID-19 to help the fellow radiologists and physicians globally so that it ensures proper clinical management. Our study is a multi-centric retrospective study done on a total of 81 COVID-19 affected symptomatic patients. HRCT was done on all the patients and detailed history of the patient's symptoms and characteristics are recorded. The most common symptoms observed were fever, cough and dyspnoea. On HRCT the most common finding observed was ground glass opacities, seen in 28 cases which comprise 35% of the study population. Consolidation alone and combined consolidation & ground glass opacities were observed in 12(15%) and 17(21.1%) cases respectively. Among other ancillary findings air-bronchogram, sub-pleural lines and fibrotic opacities were most commonly observed. Most of the cases showed peripheral or sub-pleural involvement and both lower lobes are the most affected regions of the lungs. In our study we found that ground glass opacities are the most common findings in the lungs of COVID-19 patients. The sub-pleural or peripheral lung fields and the lower lobes are the most affected regions of the lungs. Most of the COVID-19 cases show region s of sub-pleural fibrosis as evidenced by presence of sub-pleural lines.
Keywords: COVID-19, HRCT, Ground glass opacities, consolidation, sub-pleural lines.

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INTRODUCTION
In late December 2019, a mysterious pneumonia like disease was found to affect the human characterized by signs and symptoms like fever, dry cough, GIT symptoms and fatigue in a seafood wet market, the Huanan Seafood Wholesale Market, in Wuhan, Hubei, China. The pathogen of the outbreak was later identified as a novel beta-coronavirus, named 2019

novel coronavirus (2019-nCoV).[1] Corona virus belongs to the Orthocoronavirinae subfamily, is an enveloped, positive single-strand RNA virus. It has characteristics of "crown like" appearance of spike on their surfaces.[1]

To stop the transmission of virus strict lockdown is being followed in most of the countries including India, which leads to global economic, social, historical, institutional and scientific impact. The scientist community is still working to find out the pathogenesis of COVID-19 and vaccine to boost the immunity against the virus.

Few hypothesis has been put forward to discuss about the pathogenesis of COVID-19. Francesca Coperchini et al in June 2020 has reported about the 'cytokine storm' which stated thatthe 'Cytokine storm' appears as one of the most dangerous and potentially life-threatening event related to COVID-19 sustaining its major clinical consequences.[2] Another theory has been hypothesized by Joseph A. Roche&Renuka Roche in May, 2020 on the rule of dysregulated Bradykinin for development of different respiratory symptoms stating that depletion of angiotensin converting enzyme-2 increases levels of a bioactive metabolite of bradykinin called des- Arg(9)- bradykinin (DABK) which is one of the reason for lung injury and inflammation in COVID-19 patient.[3] G M-K Tse et al have done a study in march 2020 to see the pathological features of COVID-19 in patients with severe acute respiratory syndromes (SARS). They have reported that lung findings are mainly consistent with diffuse alveolar damage in the presence of multinucleated pneumocytes. There were few cases of fibrogranulation tissue proliferation in small airways and airspaces (bronchiolitis obliterans organising pneumonia-like lesions) in subpleural locations.[4]

CT imaging features of COVID-19:

As diagnosis of COVID-19 is more consistent with the detection of virus on RT-PCR in nasopharyngeal or oropharyngeal swab, demonstration of characteristic HRCT findings helps in monitoring disease course to ensure on-time treatment. Hallmark features of COVID-19 on HRCT is presence of patchy ground glass opacities (GGOs) in bilateral lungs that may consolidate, mainly distributed peripherally under the pleura and along the bronchovascular bundles. As the disease progresses, the numbers of lesions may increase and involve the central lung fields. Other HRCT imaging features of COVID-19 includes mediastinal lymphadenopathy, Subpleural bands, bronchiectatic changes, bronchial wall thickening, pleural effusion, pericardial effusion, interlobular and intralobular septal thickening, reverse halo sign and pleural thickening.[5]

MATERIALS AND METHODS

Our study was a retrospective study done in multiple centres in Dibrugarh, Assam which were carried out on confirmed covid-19 positive cases. The patients were selected from the confirmed COVID infection from the month of July and August of 2020. All patients were confirmed to be positive in RT-PCR or RAT who presented with lower respiratory tract symptoms and had detailed recordings of basic clinical characteristics (age, sex, smoking history, comorbidities), exposure history (residency or travel to COVID affected areas, or close contact with the confirmed/suspected COVID patients), clinical symptoms (including but not limited to fever, chill, cough, sputum, fatigue. dyspnea and diarrhea), and laboratory findings (white blood cell and lymphocytes count).

Imaging analysis:

Each case was assessed for the presence, anatomy distribution and severity of the major pulmonary abnormalities including ground-glass opacity (GGO), consolidation and fibrosis. Along with these findings, few other ancillary findings like interlobular septal thickening, intralobular septal thickening, crazy paving pattern, vascular enlargement, reversed halo sign,

air bronchogram, bronchial wall thickening, subpleural line, nodule, pleural effusion, pleural thickening, lymphadenopathy, pericardial effusion, cavitation, pulmonary fibrosis, bronchus distortion and bronchiectasis are also evaluated.

The GGO was defined as areas of increased lung parenchymal opacification without obscuration of the underlying vessels.[6] Consolidation was defined as areas of increased lung parenchymal opacification with obscuration of the underlying vessels.[7] Fibrosis was defined as the presence of any of the following findings: irregular linear opacities, parenchymal bands, traction bronchiectasis and lung distortion.[8]

Distribution pattern of the pulmonary abnormalities were classified into right upper, right middle, right lower lobe, left upper and left lower lobe. After assessing the whole lung field it was decided if the abnormal findings had a predominant distribution pattern (peripheral, basilar or subpleural, peribronchovascular, or random).[7]

RESULTS AND OBSERVATION

Total of 81 RT-PCR or RAT positive COVID 19 patients who had lower respiratory tract symptoms were included in our study. The most common symptom observed in our study population were fever, cough and dyspnea. On HRCT the most common finding observed was ground glass opacities, seen in 28 cases which comprise 35% of the study population. Subsequently consolidation alone and combined consolidation and ground glass opacities were observed in 12(15%) and 17(21.1%) cases respectively. The distributions of GGO observed are mainly subpleural in location. Beside these, few ancillary findings were also observed and are elaborated in the table 1. Bilateral lung involvement was most commonly seen, while only 3 cases of unilateral lung involvement were observed in our study.

Among the ancillary findings air-bronchogram, subpleural lines and fibrotic opacities were most commonly observed, comprising 22.2%, 20.9% and 32.0% respectively. Besides above findings few cases also showed interlobular septal thickening, intralobular septal thickening, crazy paving pattern, cavitations and bonchiectasis.

**Table 1: Pooled incidence of various radiological findings on chest CT in Covid-19 patients**

	Number of cases	Pooled incidence (as per total number of CT performed)
Ground glass opacities	28	35%
Consolidation	12	15%
Consolidation and ground glass opacities(mixed)	17	21.2%
Interlobular septal thickening	14	17.5%
Intralobular septal thickening	10	12.3%
Crazy paving pattern	4	4.9%
Cardiac/Vascular enlargement	3	3.7%
Reversed halo sign	1	1.2%
Air bronchogram	18	22.2%
Bronchial wall thickening	8	9.8%
Subpleural line	17	20.9%
Fibrotic nodule	11	13.5%
Pleural effusion	9	11.1%

Pleural thickening	11	13.5%
Cavitation/ Cysts	6	7.2%
Fibrotic opacities	26	32.0%
Bronchiectasis	8	9.8%

**Table 2: Distribution of findings in COVID-19 patients with abnormal CT**

Distribution	No. of cases	Percentage
Laterality		
Unilateral	6	7.4%
Bilateral	75	92.6%
Axial distribution		
Central/Peri-hilar	4	4.9%
Peripheral/Sub-pleural	57	70.3%
Central and peripheral	20	24.6%
Lobar distribution		
Right upper lobe	11	13.5%
Right middle lobe	15	18.5%
Right lower lobe	74	91.3%
Left upper lobe	22	27.1%
Left lower lobe	71	87.6%

According to distribution of findings in the CT images it was found that 75 cases out of 81 showed bilateral lung involvement which is 92.6% of the total study group. Most of the cases showed peripheral or sub-pleural involvement and both lower lobes are the most affected regions of the lungs as right and left lower lobes are affected in 91.3 and 87.6% of cases respectively.
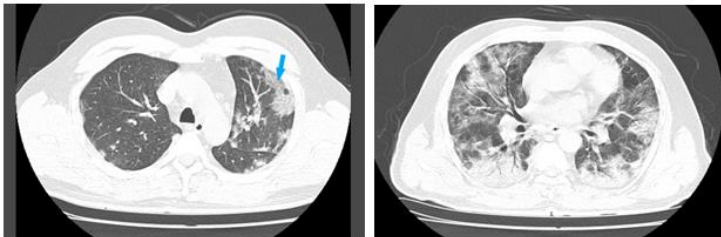

Figure 1: Axial HRCT upper lobe. image of the lung of a 32 yr old male patient showing crazy paving pattern (blue arrow) in the anterior segment of the left

Figure 2: Axial HRCT image of the lung of a 55 yr old male patient showing diffuse ground glass opacities and consolidation with air bronchogram. The figure also shows bronchial dilatation with bronchial wall thickening.
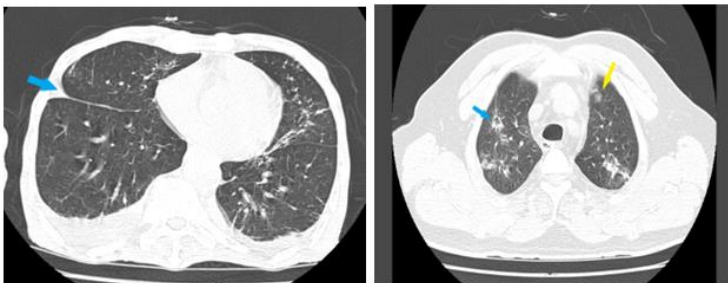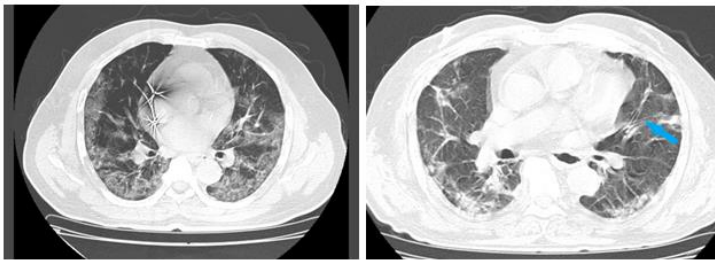

Figure 3: Axial HRCT image of the lung of a 61 yr old male patient showing interlobar septal thickening (blue arrow) along with bilateral pleural effusion.

Figure 4: Axial HRCT image of the lung of a 45 yr old female patient showing the reverse halo sign (blue arrow) along with patchy ground glass opacities (yellow arrow).
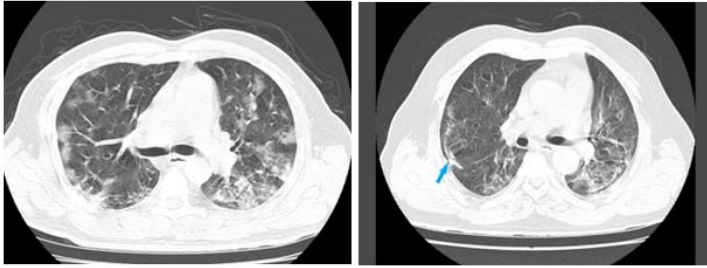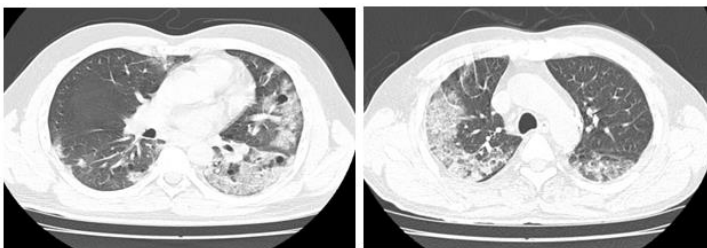
Figure 5: Axial HRCT image of 44yrs olf male patient showing subpleural distribution of ground glass opacities in the right lung.
Figure 6: Axial HRCT image of the lung of a 51 yr old male patient showing subpleural lines (blue arrow) along with interlobular septal thickening in the left lung.

Figure 7: Axial HRCT image of the lung of a 46 yr old male patient showing diffuse subpleural ground glass opacities.
Figure 8: Axial HRCT image of a 51 yr old male patient showing tractional bronchiectatic changes (blue arrow)

Figure 9: Axial HRCT image of a 39 yr old COVID patient showing cystic changes in the left lung.
Figure 10: Axial HRCT image of 49 yr old female patient showing intralobular septal thickening in the right lung.

DISCUSSION

Since the diagnosis of 1st case in December, 2019 WHO declared the COVID-19 situation as pandemic on the basis of" alarming levels of spread and severity, and by the alarming levels of inaction".[9] Though clinical pattern starts with initial mild respiratory symptoms but it can vary from mild symptoms up to severe disease manifestations. The most common symptoms are cough, fever, myalgia and headaches.[11] In our study we have found that GGOs contributes the highest percentage of findings in COVID-19 patient (35%). While pulmonary fibrosis, consolidation with GGOs, consolidation, intralobular septal thickening, lymphadenopathy and subpleural line are seen in 32%, 21.2%, 15%, 17.5%, 17.2% and 20.9% respectively. The findings of our study mostly comparable to studies done by Yan Li and Liming Xia[11] and Vineeta Ojha et al[12].

CONCLUSION

In our retrospective study, we included a group of total of 81 cases who were either RAT or RT-PCR positive. Prevalent lung findings in our study include GGOs, mixed pattern of GGOs with consolidation, fibrotic opacities and subpleural lines.

LIMITATIONS

However, a larger study population and a more detailed analysis will shed more light on the given topic. We also agree that presence of different scanners, acquisition parameters, and the experience of the interpreting radiologists may lead to some variability in the reported CT findings.

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