HRCT chest in patients suffering from COVID-19: Experience from a tertiary care centre in India during second wave of the pandemic

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ABSTRACT

Aim: The objective of the present study is to describe high-resolution CT (HRCT) chest manifestations of coronavirus disease 2019 (COVID-19) patients during second wave of the pandemic in a tertiary care hospital in New Delhi, India. We also aim to compare the findings on the HRCT chest during the second wave of COVID-19 with the data from earlier outbreaks and to look for any features specific to the second wave and thus indirectly to the delta variant of SARS-CoV-2. We also assessed the severity of the pulmonary involvement based on HRCT findings.

Methods: We analysed HRCT chest findings in 237 patients with COVID-19 admitted at our institute from 1st April 2021 to 31st May 2021. Covid-19 infection was confirmed by reverse transcription polymerase chain reaction (rt-PCR) or rapid antigen test (RAT) in all these patients.

Results: The mean age in our study group was 51.3 ± 12.1 years (range 19–79 years) comprising of 136 males (57.4%) and 101 females (42.6%). The majority of the patients showed bilateral (95.3%) and peripheral (42.6%) distribution of the disease. Ground glass opacities were the most common finding, seen in 214 (90.3%) patients, followed by interlobular septal thickening in 202 (85.8%) and crazy paving in 194 (81.3%) patients. Majority (36.7%) of these patients had a CT severity score above 20 indicating severe disease.

Conclusion: A typical pattern of peripheral subpleural often bilateral distribution of ground glass opacities on HRCT chest usually points to the possibility of COVID-19 pneumonia. The higher incidence of abnormalities on HRCT chest in patients with infection mainly from the delta variant of SARS-CoV-2 was mainly because of the more severe disease in the population. More research is needed to further evaluate the role of HRCT chest in the diagnosis of COVID-19 caused by different strains of the virus.

KEYWORDS

COVID-19, HRCT, CT scan, coronavirus, delta variant

Introduction

The first case of Coronavirus disease 2019 (COVID-19) caused by the severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) infection was reported in India from Thrissur, Kerala, on January 30, 2020. Later the number of cases of the infection increased exponentially and over 27 million cases and more than 300 thousand deaths were reported in India. The initial peak declined in September 2020 but small number of cases continued to be reported [1]. In the due course many new variants of this virus have been identified notable among them is the delta variant (B.1.617.2); first reported in India in December 2020 [2].
A few months later, in the spring of 2021 overwhelming number of COVID-19 cases were reported from various cities which is often referred to as second wave of pandemic in India. In New Delhi, the capital city of India, the second wave of the pandemic started with around 3000 new cases per day in first few days of April 2021 and peaked in third week of April with more than 28,000 confirmed new cases every day. This number began to decline in later part of May 2021 when daily new cases decreased to fewer than 1000 per day [3]. During this second wave large number of cases were reported from other major cities of India too. In New Delhi the hospitals were running their full capacity and there were reports of severe shortage of hospital beds and medical oxygen. Given the circumstances only moderate to severe cases of COVID-19 were being hospitalised and patients with mild symptom were managed at home [4]. This deadly second wave of COVID-19 in New Delhi was largely driven by Delta variant of SARS-CoV-2 [5]. The health department of Government of New Delhi reported that Delta variant of coronavirus was detected in 53.9% of the samples in April and 81.7% of the samples in May 2021 (n = 5752) [6].

Symptoms of COVID-19 include fever, cough and other nonspecific symptoms like sore throat, dyspnoea, headache, muscle soreness, and fatigue [7]. The reverse transcription polymerase chain reaction (rt-PCR) nasopharyngeal swab was used as a reference diagnostic test for disease confirmation. Besides rt-PCR, the SpO2 levels, laboratory investigations and diagnostic imaging significantly helps clinicians ensuring effective and timely management [8]. High-resolution computed tomography (HRCT) of chest has an important role in the initial assessment of the severity of lung disease, monitoring treatment response and in the diagnosis of pulmonary complications during or after treatment. Some studies have investigated the correlation between clinical severity of COVID-19 upon presentation and the severity of pulmonary involvement in their chest CT scans [9]. The quantitative severity can be assessed using a visual method (as in our study) or a software that determines the percentage of affected lung volumes using the machine learning algorithms [8]. In this study, we analyse HRCT chest findings in 237 patients with COVID-19, admitted at our institute from 1st April 2021 to 31st May 2021 (second wave of pandemic in New Delhi, India). The aim of our study is to evaluate the spectrum of HRCT findings in COVID-19 patients during the second wave of pandemic which was largely driven by delta variant of SARS-CoV-2. We also aim to compare the findings on the HRCT chest during first and second wave of COVID-19 and to find any features specific to the second wave and thus indirectly to the delta variant of SARS-CoV-2. We also assessed the severity of the pulmonary involvement based on HRCT findings.

**Patients & methods**

The study was carried out in accordance with the Declaration of Helsinki. All subjects provided written informed consent and the Institutional Review Board approved this study. The study population includes patients (a) who got admission in our hospital during second wave of the COVID-19 pandemic, (b) who tested positive for COVID-19 by reverse transcription polymerase chain reaction (rt-PCR) or rapid antigen test (RAT) and (c) who underwent chest CT within 1 week of the rt-PCR or RAT. Patients (a) with suspected COVID-19 but with negative rt-PCR/RAT and (b) who were under 18 years of age were excluded from this study. During this period our department performed CT scans for COVID-19 patients as well as patients suffering from other diseases. Thus to minimise cross exposure time slots were allotted to COVID patients two to three times daily depending upon the number of requests for CT scan. A “green corridor” would be announced while transporting the patients from the wards or ICU’s to the CT scan and back. This consisted of exclusive transportation of COVID patients in a corridor and restriction of other patients and staff through that particular corridor during that particular time slot. All the patients wore masks. The radiology technicians who performed CT of patients were required to wear personal protective equipment including N95 masks. HRCT scans were performed on a 16 Slice CT Scanner (Siemens Somatom Emotion eco). Each scan was thoroughly evaluated for presence of typical findings of COVID-19 pneumonia (bilateral, multilobar, posterior peripheral ground-glass opacities) as defined by The Radiological Society of North America (RSNA) Consensus statement [8]. Severity category was assigned using the scoring system based on the visual assessment of the involvement of the each lobe. Score of 1 was assigned for involvement less than 5%, 2 for 5%–25%, 3 for 26%–49%, 4 for 50%–75% and 5 for >75% for each lobe separately. The scores from each lobe are then added and the sum represents the severity categories; (a) 7 or less for mild, (b) 8–17 for moderate and (c) 18 or more for severe disease. Data was analysed by using Microsoft excel.

**Results**

The mean age in our study group was 51.3 ± 12.1 years (range 19–79 years) comprising of 136 males (57.4%) and 101 females (42.6%). Fever followed by generalised fatigue and sore throat were the most common presenting symptoms (Table 1). In this study all patients were found to have abnormal findings on HRCT of chest.

GGOs were the most common finding, seen in 214 (90.3%) patients, followed by interlobular septal thickening in 202 (85.8%) and crazy paving in 194 (81.3%) of study patients (Figs 1–3; Table 2).

Other HRCT findings observed were: subpleural bands in 181 (78.4%), vascular dilatation in 132 (55.7%) patients, consolidation in 102 (43%), bronchial wall thickening in 84 (35.4%) patients. Pleural effusion was noted in only 11 (4.6%), lymphadenopathy in 22 (9.3%), and parenchymal nodules in seven (2.9%) study patients.
The majority of the patients showed bilateral (95.3%) and peripheral (42.6%) distribution of the disease process (Figs 1–7; Table 2).

An unusually high number of patients had traction bronchiectasis ($n = 66, 27.8\%$) or fibrotic changes ($n = 83, 35\%$). Thirty four (14.3\%) patients who had an initial normal chest radiograph showed abnormalities on HRCT affecting one or multiple lobes of lungs (Table 2). In this study majority (36.7\%) of the patients had a CT severity score above 20 indicating severe disease while only 3.8\% has CT severity score below 5 (Table 3).

**Discussion**

Until the middle of March 2021, there was a sense that India had somehow miraculously controlled the COVID-19 pandemic. The first wave had almost fully abated by the end of 2020, and life was returning to normal. Then came the ferocious second wave of COVID-19 beginning early March.
2021 and soon the number of cases overwhelmed the existing healthcare capacity. There was acute shortage of beds and many hospitals reported shortage of medical oxygen [10]. The second wave of COVID in India was largely driven by delta variant of the SARS-CoV2 [5]. Considering this fact we aimed to study the HRCT features of the patients who developed COVID-19 during the second wave in Indian capital city of New Delhi and thus to indirectly study the HRCT features of COVID-19 disease by the delta variant.

Given that COVID-19 commonly presents as pneumonia, imaging has an important role in diagnosis, management and follow-up [5]. People of all ages are at risk of contracting this disease, however, individuals aged ≥60 years and those with underlying comorbidities have an increased risk of developing severe form of COVID-19 [5].

In our study more males were hospitalised with COVID-19 infection (M:F = 1.4:1). Some studies suggest that males may be affected more commonly due to factors like disparity in behaviour and the possible protective effect of oestrogen [8]. Male patients are also at increased risk of severe illness and increased mortality due to COVID-19 [5].

Fever, shortness of breath and fatigue were the most common symptoms in our study population as noted in the rest of the World. Stokes et al. reported that among 373,883 COVID-19 cases in the United States, 70% of them had fever, cough, shortness of breath, 36% had myalgia and 34% reported headache [11].

On chest X-ray the findings of COVID-19 vary, ranging from normal in the early stages to lung opacities with strikingly peripheral distribution in severe cases. Studies have reported a relatively low sensitivity (69%) of plain radiography for the diagnosis of COVID-19 [12]. In our study, however,
Table 4. Incidence of abnormalities on HRCT in our study and comparison with Meta-analysis by Ishfaq A. et al.

<table>
<thead>
<tr>
<th>Abnormalities on HRCT</th>
<th>Meta-analysis by Ishfaq A. et al.</th>
<th>Present study</th>
</tr>
</thead>
<tbody>
<tr>
<td>GGOs</td>
<td>71.64%</td>
<td>90.3%</td>
</tr>
<tr>
<td>interlobular septal thickening</td>
<td>43.28%</td>
<td>85.8%</td>
</tr>
<tr>
<td>crazy paving</td>
<td>24.47%</td>
<td>81.3%</td>
</tr>
<tr>
<td>subpleural bands</td>
<td>55.61%</td>
<td>78.4%</td>
</tr>
<tr>
<td>vascular dilatation</td>
<td>65.41%</td>
<td>55.7%</td>
</tr>
<tr>
<td>consolidation</td>
<td>29.15%</td>
<td>43%</td>
</tr>
<tr>
<td>bronchial wall thickening</td>
<td>20.71%</td>
<td>35.4%</td>
</tr>
<tr>
<td>lymphadenopathy</td>
<td>7.64%</td>
<td>9.3%</td>
</tr>
<tr>
<td>pleural effusion</td>
<td>5.09%</td>
<td>4.6%</td>
</tr>
<tr>
<td>parenchymal nodules</td>
<td>14.84%</td>
<td>2.9%</td>
</tr>
</tbody>
</table>

GGOs = ground glass opacities.

85.7% confirmed cases of COVID-19 demonstrated findings on plain radiography. This is likely due to more severe disease of the study population in our cohort because of triaging of the patients (selective hospital admission of moderate to severe cases and home care of mild cases) during the second wave of COVID-19 in India. Given its high sensitivity HRCT of chest is the imaging modality of choice in evaluating COVID-19 pneumonia, especially when associated with disease progression [13]. However, The American College of Radiology recommends against HRCT chest’s use as a screening tool for COVID-19 [14].

In this study the abnormalities observed on HRCT chest were GGOs in 90.3%, interlobular septal thickening in 85.8%, crazy paving in 81.3%, subpleural bands in 78.4%, vascular dilatation in 55.7% patients, consolidation in 43%, bronchial wall thickening in 35.4%, lymphadenopathy in 9.3%, pleural effusion in 4.6% and parenchymal nodules in 2.9% of the study patients. A recent meta-analysis conducted by Ishfaq A. et al. found GGOs in 71.64%, interlobular septal thickening in 43.28%, crazy paving in 24.47%, subpleural bands in 55.61%, vascular dilatation in 65.41%, consolidation in 29.15%, bronchial wall thickening in 20.71%, lymphadenopathy in 7.64%, pleural effusion in 5.09%, and parenchymal nodules in 14.84% of COVID-19 patients (Table 4) [13]. The overall increased incidence of abnormal findings on HRCT in our study is possibly again attributed to the more number of moderate and severe cases in our study population. Besides, we did not observe any significant abnormality on HRCT which could be called pathognomonic for the delta variant of SARS-CoV-2.

Majority of the patients showed bilateral (95.3%) and peripheral (42.6%) distribution of the disease. This agrees fairly with the meta-analysis conducted by Ishfaq A. et al. who found bilateral pneumonia in 71.75% and peripheral parenchymal lung involvement in 54.63% patients [13].

An unusually high number of patients had traction bronchiectasis (n = 66, 27.8%) or lung fibrosis (n = 83, 35%). Medical records of these patients revealed history of pulmonary tuberculosis and these findings were a sequela thereof. This is also in accordance with the higher number of active and healed tuberculosis cases in India [15].

Assessment of disease severity with HRCT chest in COVID-19 may help in clinical decisions related to the need for hospital admission, prognosis and therapeutic efficacy. HRCT severity scoring is reproducible and quantitative. HRCT severity scores has also shown correlation with serum markers of disease severity [12]. In our study 36.7% patients had CT severity index of 20 or above. This again highlights the higher percentage of moderate and severe cases in our study population.

There are several limitations of our study. Being a retrospective study we cannot calculate the exact sensitivity and specificity of HRCT in making a diagnosis of COVID-19. Besides, we did not have genome sequencing of all the individual patients in this study and presumed that the majority of them had delta variant of SARS CoV-2 infection based on the overall trends in the country at that period of time. Other limitations include use of RAT in some patients for diagnosis of COVID-19, use of 16 slice CT scanner and subjective estimation of bronchial wall thickening instead of any objective criteria.

Conclusions

A typical pattern of peripheral subpleural often bilateral distribution of lung opacities on HRCT chest usually helps radiologists to diagnose or suspect COVID-19 pneumonia. Besides CT severity score correlates with overall clinical severity of patients with COVID-19 infection. In this study there was a higher incidence of abnormalities on HRCT chest in patients with infection mainly from the delta variant of SARS-CoV-2, however, no pathognomonic abnormality was associated with this variants of the virus. More research is needed to further evaluate the role of HRCT chest in the diagnosis of COVID-19 caused by different strains of the virus.

Authors’ contribution: All authors contributed to the study conception and design. Material preparation, data collection and analysis were performed by R.F.S., P.M., A.H.M. and A.V. The first draft of the manuscript was written by R.F.S. and all authors commented on previous versions of the manuscript. All authors read and approved the final version of the manuscript, and agreed to submit it to IMAGING for publication.
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REFERENCES