

## Research Article

### Spectrum of High Resolution Computed Tomography Findings in COVID-19 Infection

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#### Abstract

Coronavirus disease 2019 (COVID-19) is an infectious disease which is caused by a newly discovered virus named Corona Virus.

**Objective:** To explore HRCT findings of COVID-19 related pulmonary disease in Pakistan.

**Methods:** A prospective study involving 316 patients (age 18-40 years) with suspicion of coronavirus and symptoms such as cough and dyspnea was conducted from 20th March 2020 to 20th May 2020( 2 month period) at Radiology Department, Fatima Jinnah Medical University affiliated sir Ganga Ram Hospital, Lahore. The sample collection was non probability consecutive technique. All patients underwent RT-PCR and chest CT. Appearances of HRCT were assessed in those patients who had positive RT-PCR as well as had findings on HRCT i.e had positive HRCT. Patients excluded from study on basis of indications other than COVID-19, poor quality of images due to breathing artefact and failure to get consent for imaging.

**Results:** A total of 316 patients participants with suspected coronavirus were included in consecutive study as per inclusion and exclusion criteria. Of these, 182 patients were male and 134 patients were female. They range in age from 18 to 89 years having a mean of 57±17 y.

Out of 316 patients, 179, 154 patients had positive PCR and positive HRCT findings, 25 had positive PCR but no HRCT findings.

Ground glass opacity and multilobe involvement ( $\geq 2$  lobes) was present in (85%) patients, consolidation in (77%) patients, air bronchogram in (61%) patients and bronchiectasis in (41%) patients. Of study participants 27% patients had pleural effusion (20%) had mediastinal lymphadenopathy.

**Conclusion:** The ground glass opacification was found to be most common HRCT finding in patients with COVID-19 pulmonary involvement. These ground glass opacities were commonly found to be located posteriorly and peripherally involving multiple lobes of both lungs in majority of the cases. Other common findings include consolidation associated with air bronchogram and bronchiectasis.

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**Keywords** | COVID-19, High Resolution Computed Tomography (HRCT), ground glass opacity.

## Introduction

Coronavirus disease 2019 (COVID-19), which has taken the form of a pandemic is an infectious disease whose pathogen has been identified to be severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2). This virus has its origin in China, and has rapidly spread beyond confines of China in a matter of months.<sup>4</sup> Detection of real-time polymerase chain reaction (RT-PCR) has been accepted as reference standard in its diagnosis; however role of imaging is gaining increasing importance particularly in cases with false negative PCR.<sup>5,6</sup> Since this virus causes alveolar cell damage, High Resolution Computed Tomography can be useful in detection and assessment of degree of damage<sup>8</sup> and recent studies have proved its sensitivity of up to 98%.<sup>7</sup>

Initially ground glass opacities (GGO) with posterior and peripheral pulmonary distribution were found to be the hallmark of COVID related pulmonary disease.<sup>9,10</sup> However, a wide variety of HRCT findings have been documented with further ongoing research. These include reversed halo sign, crazy paving pattern, reticular pattern, airway changes, etc.<sup>11-13</sup> Similar were the results of recent study by Kay et al<sup>14</sup> describing variable appearances of COVID-19.

After a thorough review of studies available till now and the frontline exposure of imaging of patients of COVID-19, we aimed to study the the HRCTs of COVID related pulmonary disease in terms of typical and atypical appearances.

## Methods

This research was conducted at Radiology department, Fatima Jinnah Medical University affiliated Sir Ganga Ram Hospital, Lahore, from 20th March 2020 to 20th May 2020 (2 month period). A total of 316 patients (age 18-80 years, both genders) who were suspected to have coronavirus with or without respiratory symptoms were randomly divided into 2 groups with positive and negative PCR test.

This was a prospective study which was presented to our local Ethical Review Committee for clearance. All patients were elaborated about study and written informed consent was signed by patient or a blood relation depending upon circumstances.

Patients were consecutively enrolled for study via outdoor, Emergency or indoor (corona isolation ward

of Ganga Ram Hospital) during a time period of March 20 TO May 20, 2020.

Patients excluded from study on basis of indications other than COVID-19, poor quality of images due to breathing artefact and failure to get consent for imaging.

Clinical information was obtained on a pre screening performa by researcher and contained information about symptoms of the patient and results of RT-PCR.

High Resolution Computed Tomography (HRCT) was performed. Plain, supine images obtained in end inspiratory phase. Scanner used for imaging was our 4-slice CT (Aquilion-4 Toshiba Medical systems). The images acquired at tube voltage of 120 kV and tube current of 300 mAs keeping slice thickness at 2mm. Reconstructions were made using a sharp algorithm (bone algorithm). Since scanner was being used for COVID patients, room was disinfected after the scan with ethanol or hydrogen peroxide. DICOM data was then transferred to workstation (Vitrea Vital) for image interpretation.

HRCT which were selected for documentation include:<sup>16</sup> (a) ground-glass opacification, (b) multi-lobe involvement, (c) bilateral distribution, (d) interlobular septal thickening, (e) consolidation, (f) air bronchogram, (g) bronchiectasis, (h) pulmonary nodules, (i) mediastinal lymph node enlargement (short axis measuring more than 10mm), (q) pericardial and (r) pleural effusion.

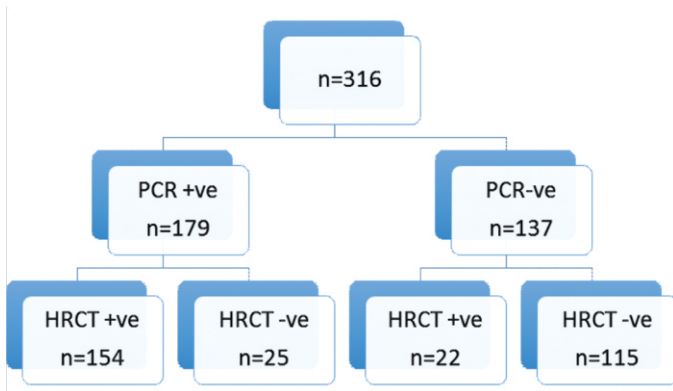
All continuous variables were stated as medians and ranges, and discrete variables were defined in terms of counts and percentages.

## Results

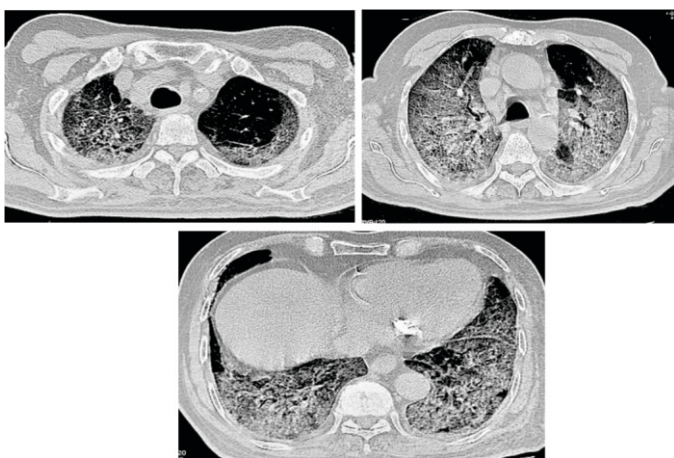
A total of 316 patients participants with suspected coronavirus were included in consecutive study as per inclusion and exclusion criterias. Out of these, 182 patients were male and 134 patients were female. They range in age from 18 to 89 years having a mean of 57±17 y

- Fever was present in 190/316 patients (60%). Cough was documented in 172/316 (54%) and dyspnea were present and 98/316 (31%) patients, respectively.

- Patients were divided into groups and subgroups as follows;
- Only the subgroup with positive PCR and HRCT was studied to assess various CT features in covid-19 infection.



- Ground glass opacity was seen in all 154/154 patients (100%), bilateral involvement in 142/154 patients (92%), peripheral and posterior distribution of ground glass opacity was observed in 139/154 (90%) and 138/154 (89.6%) patients respectively. Multilobe involvement ( $\geq 2$  lobes) was present in 131/154 (85%) patients, consolidation in 118/154 (77%) patients, air bronchogram in 94/154 (61%) patients and bronchiectasis in 64/154 (41%) patients. 42/154 (27%) patients had pleural effusion, 31/154 (20%) had mediastinal lymphadenopathy whereas septal thickening and pulmonary nodules were appreciated in less than 20% of patients.
- Commonly observed HRCT findings shown in Figure 1 to 4.



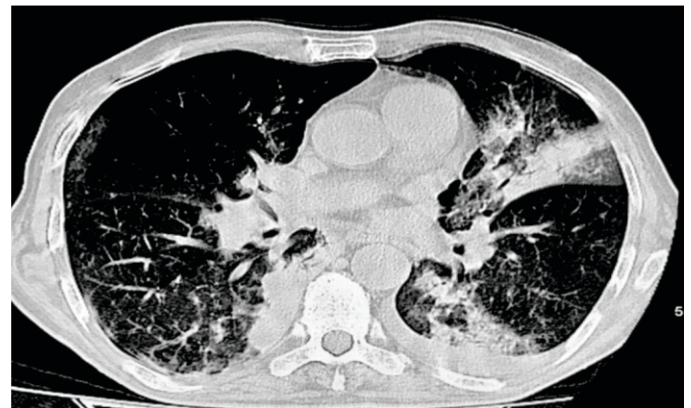
**Figure 1:** Axial Sections of HRCT Performed in 84 years male who presented with cough and dyspnea with decreased oxygen saturation.

CT demonstrates diffuse, bilateral, confluent ground

*glass opacities with multilobar involvement*

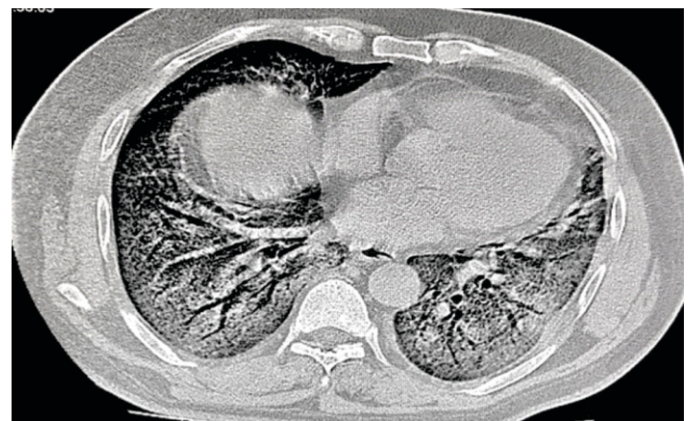


**Figure 2a**

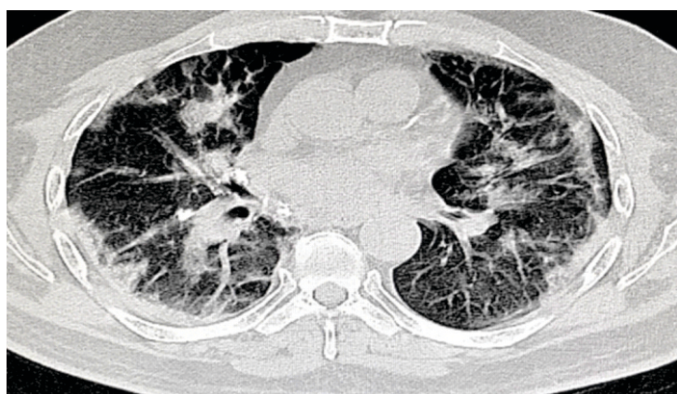


**Figure 2b**

*Axial sections of HRCT performed in a 70 years old male patient who presented with fever and cough. (a,b) CT illustrates multiple segmental areas of consolidation in right and left middle and lower lobes alongwith patchy areas of ground glass opacification and left sided pleural effusion.*



**Figure 3:** Axial Section of HRCT Illustrates diffuse Ground Glass Opacification with Air Bronchogram



**Figure 4:** Axial Section HRCT Demonstrates Posterior and Peripheral Distribution of Disease Process

**Table 1:** HRCT Features in Patients with RT-PCR Confirmed COVID-19 Infection

CT Features	Patients (N=154)	% (95% CI)
Ground Glass Opacity (GGO)	154	100%
Bilateral distribution	142	92%
Peripheral location	139	90%
Posterior involvement	138	89.6%
Multilobe involvement(>2 lobes)	131	85%
Consolidation	118	77%
Air bronchogram	94	61%
Bronchiectasis	64	41%
Pleural effusion	42	27%
Lymphadenopathy	31	20%
Septal thickening	29	18%
Pulmonary nodules	2	12%

## Discussion

Uptil now, the majority of studies on HRCT findings in COVID-19 pneumonia were from Chinese population. We performed a study in our department so as to evaluate disease pattern in our population. RT-PCR tests were performed in all patients to confirm if COVID-19 infection was present or not. Among 154 patients, most common HRCT finding was ground glass opacification which was observed in all patients with COVID-19 pulmonary involvement. Posterior, peripheral distribution with bilateral involvement was also typically present in patients with Covid-19 pneumonia. Other common manifestations include consolidation with air bronchogram and bronchiectasis. Pleural effusion and septal thickening were seen less commonly. Atypical features include presence of pulmonary nodules.

Zhu et al. conducted a study in which ground glass opacification was found in just 47% of patients<sup>19</sup> as compared to 100% in our study. Salehi et al<sup>17</sup> also lead

a systemic review on 919 patients which has results comparable to our study except for a few differences. We observed a greater incidence of consolidations (77% vs 31%) in our patients. Peripheral involvement of lungs and ground glass opacification were also amongst the features which had higher prevalence (90% vs 76%) and (100% vs 88%), respectively.

Study performed by Chung et al was different in having a small sample size (21 patients), and showing presence of crazy paving pattern in a few patients<sup>18</sup> which we did not find in any of our patients. Enlarged mediastinal lymph nodes were not common in our study (20%).

Bai et al described increased calibre of pulmonary vessels at subsegmental level in 59% of the covid-19 patients.<sup>15</sup> Albarello et al also documented this unusual finding of presence of enlarged sub segmental pulmonary vessels in 2 patients.<sup>18</sup> None of our study participants showed this feature however. Cause of enlargement of pulmonary vessels was thought to be due to inflammatory factors by Ye et al.<sup>16</sup> Presence of increase in size of these subsegmental vessels in different variable studies could be attributed to hyperemia caused by COVID-19 infection as compared to other viral pneumonias.<sup>21,22,23</sup>

While we had advantage of constant referral of COVID-19 patients from Corona Isolation Unit in our hospital, there were few limitations too. Clinical information was not that freely accessible due to the minimal physical interaction between isolation unit and other departments and so was the laboratory data. Limited sample size was used and we are not yet aware of patient outcomes.

## Conclusion

The ground glass opacification was found to be most common HRCT finding in patients with COVID-19 pulmonary involvement. These ground glass opacities were commonly found to be located posteriorly and peripherally involving multiple lobes of both lungs in majority of the cases. Other common findings include consolidation associated with air bronchogram and bronchiectasis.

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