Original Research Article

Segmental Scoring In Covid 19 Pneumonia On HRCT Chest

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Abstract

Aim:To understand the common patterns of CT Chest in Indian population who have proven to be RT-PCR COVID positive and/or suspected COVID with RT-PCR negative.**Settings and Design**: Descriptional study done in patients of Dr. D.Y. Patil Hospital and Yashwantrao Chavan hospital which have COVID-19 wards. Methods and Material:CT chest was employed in patients with both confirmed and suspected COVID-19 pathology have been recognized in our study. Association with COVID-19 infection was based on Reverse transcription polymerase chain reaction (RT-PCR) method. Statistical analysis used: The data was entered in MS EXCEL spreadsheet and analysis done using licensed Stastical Package for Social Sciences (SPSS) version 21.0.Descriptive statistics for each parameter were computed for different variables. **Results:**Commonly found patterns were ground glass opacities, consolidations, septal thickening often showing bilateral involvement. New segmental scoring system is provided with division based on the anatomical bronchopulmonary segments. Grading done <12-Mild, 12-24 – Moderate, > 24 – Severe. Conclusions:Study provides us with knowledge to use CT thorax as an excellent modality in the initial evaluation as well as follow up in COVID-19 positive and suspected cases.

Keywords: COVID, Pandemic, Pneumonia, Viral

Introduction

World Health Organization has confirmed over five million cases of COVID-19 in India. First case of COVID-19 in Maharashtra was confirmed on 9th of March, 2020[1].It initially emerged in Wuhan, China as several cases of pneumonia, which was later identified as severe acute respiratory syndrome coronavirus 2 (SARSCoV-2). It is known to have multi-system involvement, primarily involving the pulmonary system and hence CT chest is robustly advocated for initial evaluation and follow up in suspected cases of COVID-19. CT findings have been demonstrated to be useful and diagnostic in many cases even with an initial false-negative RT-PCR (Reverse transcriptase polymerase chain reaction) test. Studies in laboratory confirmed cases also revealed abnormal CT chest findings in all cases [3-6].COVID-19 outbreak has raised global concerns and hence understanding of the chest imaging findings and its atypical features in Indian population is of utmost importance for effective patient management

Subjects and Methods: Patients with both confirmed and suspected COVID-19 pathology have been recognized in our study. Association with COVID-19 infection was based on Reverse transcription polymerase chain reaction (RT-PCR) method.CT chest for patients who were either COVID positive or ones with symptoms like fever, cough and breathlessness have been done in this study. Included patients from Dr. D.Y. Patil Hospital and Yashwantrao Chavan hospital which have COVID-19 wards.

Study included 2000 patients out of which 1240 patients were RT-PCR (Reverse transcriptase polymerase chain reaction) positive and their CT findings were retrospectively correlated.760 patients who presented with respiratory symptoms like fever,cough or breathlessness with COVID negative status through RT-PCR.

Image acquisition

Volumetric CT images of reformatted lung and soft tissue windows were obtained at 1mm slice thickness without intravenous contrast administration. Local protocols with usual acquisition parameters were incorporated for all of the radiologic studies.

Classification of Images was based as follows-

1) GGO's (ground glass opacities)/ patches of consolidation/ cavitates/ nodular opacities.
2) Distribution of lung changes –
- ✈ According to lobes –
- ➢ In the right lung: 1) Upper lobe predominance 2) Middle lobe predominance 3) Lower lobe predominance.
- ➢ In the left lung: 1) Upper lobe predominance 2) Lingula involvement 3) Lower lobe predominance.
- ✈ According to the region – peripheral or central predominance or neither

3) presence of pericardial or pleural effusions
4) presence of mediastinal or hilar lymph nodes (only considered as short axis measurement ≥ 10mm).
5) presence of other lung pathologies such as fibrosis or emphysema.
6) Other abnormalities like, "reversed halo" sign, linear radiopacities, radiopacities with a "crazy-paving" pattern, and radiopacities with intralesional cavitations.

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Results

Stages of COVID -19 Disease: Various studies have mentioned and classified the CT temporal stages of this disease and the most commonly practiced is as follows,

Four stages on CT are described as [7, 8, 9, 10] –

- Early/initial stage (0-4 days)
- Progressive stage (5-8 days)
- Peak stage (9-13 days)
- Absorption stage (>14 days)

Early initial CT (Fig. - 1) within 4 days of symptoms showed normal CT as well as positive findings. It was positive in 348 patients (17.4%) out of which unilateral, ground glass opacities were the most common finding to be observed.Within 5 – 8 days (Progressive stage) (Fig. - 2) of onset of symptoms, 964 patients (48.2%) showed unilateral or bilateral ground glass opacities mainly involving the lower lobes, unilateral consolidations often of peripheral and lower lobe predominance.In the peak stage (9-13 days), 82.4% of patients showed findings on HRCT chest. A total of 1649 patients were observed to have ground glass opacities, involving bilateral lower zones, bilateral consolidations, crazy paving and other commonly found patterns were also noted in this stage. (Fig. - 3) The 10th day from symptom onset is of great significance with majority of scans showing HRCT findings.In the absorption stage, 14 days after symptoms, patients had different CT Chest appearances based on improvement or deterioration of their SpO2 levels.

They were broadly classified in this study as (Fig- – 4)

- Regression
- Progression
- Resolution

In regression – There was decrease in the ground glass opacities as well as improvement in the Spo2 saturation levels.

In progression – There was worsening of saturation levels with increased ground glass opacification and consolidations. Progression to marked severe fibrosis depicting a picture as an Interstial lung disease was also seen.

In resolution – The lung fields appeared markedly clear with disappearance of GGO's. However, fibrotic and atelectatic bands were commonly found in these patients (Fig-5).

Varied patterns and distributions were found on the chest CT (Table - 1). Out of all the patterns, ground glass opacities (88%) were the most common CT findings to be seen. Ground glass opacities were commonly seen in bilateral lung zones (92%), predominantly in sub pleural (73.8%) location, involving more than one lobe (59.6%).

In lobar involvement, lower lobe (57.7%) only was more involved than the upper lobe (26.7%) followed by only middle lobe (15.6%) (Fig. – 6, 7 and Table- 2, 3, 4).Consolidation was the next most common finding seen in 52% of patients. Ground glass opacities in combination with consolidation were commoner than isolated consolidations. They presumed more peripheral locations with greater predilection to the lower lobes.Septal thickening (20%) and crazy paving (16%) patterns (Fig-8, 9) were also frequently seen. Septal thickening also involved sub pleural locations than central. Crazy paving was infrequently noted with upper and lower lobe predominance than middle lobe in the right lung field. Lower lobes and lingula showed more predilection rather than upper lobe in the left lung field.Out of 2000, 200 patients showed pleural effusions (10%) and showed more bilateral predilection than unilateral (Figure-10, 11). Emphysematous changes were seen in 250 patients, that involves 12.5% of the total study population. Patients had centrilobular involvement in the apical segments more frequently. Few patients also showed sub pleural emphysematous changes and bullae but was considered non-specific. Least commonly noted were enlarged lymph nodes and cavitations. Only 2% of the entire study population showed cavitations which were frequently noted in the apical segment of right upper lobe.Subcentimeter sized lymph nodes were noted in only 10 patients (0.5%) and was the least common finding to be seen in this study.Follow up HRCT Thorax in obtained few patients showed resolution of ground glass opacities with patchy areas of fibrosis (Figure 12 and 13).

Segmental scoring (Table-5) for each segment of each lobe has been done – Each segment involved is given a score as follows: <50% involvement – 1

>50% involvement- 2

Maximum score being 36 and minimum score is 0 - for the 18 segments of right and left lung.Most commonly involved segments are the lower posterior basal segment followed by lower lateral basal and lower superior segment in the right lung. In the left lung lower posterior and lower lateral are equally followed by lingula.

Score was categorised as-

- Mild - <12
- Moderate 12-24
- Severe - >24

SpO2 was measured before performing the scan in patients and corroborated with the segmental scoring. Patients with score < 12 the SpO2 measured was between 87-94% at room air. In patients graded as moderate SpO2 was averaging between 76-86% at room air. In severe cases SpO2 levels had a broad range with minimum record of 58% and maximum up to 70-72% at room air.Table -6 shows - Out of 2000 patients, 1240 were COVID 19 antigen positive patients. Out of which 95% (1180 out of 1240) had positive HRCT findings.

However, 680 out of 760 patients i.e., 86% of patients who were RT-PCR negative for COVID 19 antigen also showed positive HRCT findings similar to COVID 19 viral pneumonia pattern. This shows the usefulness of HRCT Thorax in patients with acute onset of breathlessness despite of RT-PCR status.

Discussion

So, our study emphasizes the excellent role of HRCT Thorax in evaluation of COVID 19 in RT-PCR positive and negative patients.

Various temporal stages of evolution on CT Thorax have been described by various studies[7,8,9,10]the early/initial stage before 4 days of symptom onset yielding normal scans or with unilateral ground glass opacities., followed by progression involving bilaterally in the next stage, the peak stage between 9-13days after symptoms showing the classical bilateral, peripheral distribution of ground glass opacities.

In the absorption stage, depending on the SpO2 levels, there was progression with resultant fibrosis in deteriorating oxygen saturation of about 62-68% and resolution with atelectatic bands or complete regression with normal appearance on CT Thorax in improving oxygen saturation of 90-95% at room air.

The most common findings to be seen were ground glass opacities (88%) in bilateral lung zones (92%), predominantly in sub pleural (73.8%) location, involving more than one lobe (59.6%). Consolidation was observed as the 2nd most common finding (52%), septal thickening, crazy paving was also evident. Pleural effusions (10%) that is in 200 patients was noted and with bilateral predilection than unilateral.

Emphysematous changes (12.5%) had centrilobular involvement in the apical segments more frequently. Least commonly noted were enlarged lymph nodes and cavitations. Various studies have been described to categorize and score the chest CT findings.

One being the COVID-19, Reporting and Data System (CORADS) which categorises CT Chest on the basis of suspicion and there are Categories from 0 to 6 (CORADS)[11]

- Category 0- Scan is insufficient or incomplete.
- Category 1 – Normal CT Chest or findings of non-infectious origin.
- Category 2 – Infectious origin but likely of other causes than COVID-9.
- Category 3 – Indeterminate findings – Findings that are seen in COVID but may also be seen in other diseases.
- Category 4 – High suspicion of COVID-19

- Category 5 – Typical for COVID-19
- Category 6 – In a case where RT-PCR is positive for COVID-19 Antigen.

Another study by Marco Francone, et al.,[12] calculated the lobar involvement semi-quantitatively., as involvement of

- < 5% is scored as 1
- 5–25% is scored as 2
- 26–50% is scored as 3
- 51–75% is scored as 4
- > 75% is scored as 5

Total score is of 0–25 as each scoring is employed for three lobes on the right and two on the left. A cut off of 18 was taken and >18 highly predictive of short-term mortality in patients.A study done by Ran Yang, et al.,[13] in which similar segmental scoring as ours of 0 to 40 scoring was employed with left upper lobe being divided as anterior posterior and apical segments. However, our scoring system included in this study is based on the anatomical lung broncho pulmonary segments[14] as done under standard protocol involving 10 segments in the right and 8 segments in the left lung field.So scoring was based on

- less than 50% involvement
- more than 50% involvement

Graded as –

- Mild if score <12
- moderate if between 12- 24
- Severe more than 24.

In patients with score < 12 the SpO2 measures was ranging between 87-94% at room air. In patients graded as moderate SpO2 was averaging between 76-86% and in severe cases SpO2 of even 58% was recorded.Most commonly involved segments are the lower posterior basal segment followed by lower lateral basal and lower superior segment in the right lung. In the left lung lower posterior and lower lateral are equally followed by lingula.Our study included patients with positive RT-PCR for COVID 19 Antigen as well as patients with acute onset of breathlessness with or without fever and 86% patients with negative RT-PCR results showed positive HRCT findings similar to those who were positive.So, this provides us with knowledge to use CT thorax as an excellent modality in the initial evaluation as well as follow up.

Fig 1:Ground glass opacities (GGO's) are noted in the left lower lobe predominantly peripheral in distribution. Early CT in <4 days of symptom onset.

Fig 2:Bilateral GGO's in right and left lower lobes – Progressive stage between 5-8 days of symptom onset.

Fig 3:Extensive dense consolidations in bilateral lower lobes with air-bronchograms - – Peak stage between 9-13 days of symptom onset.

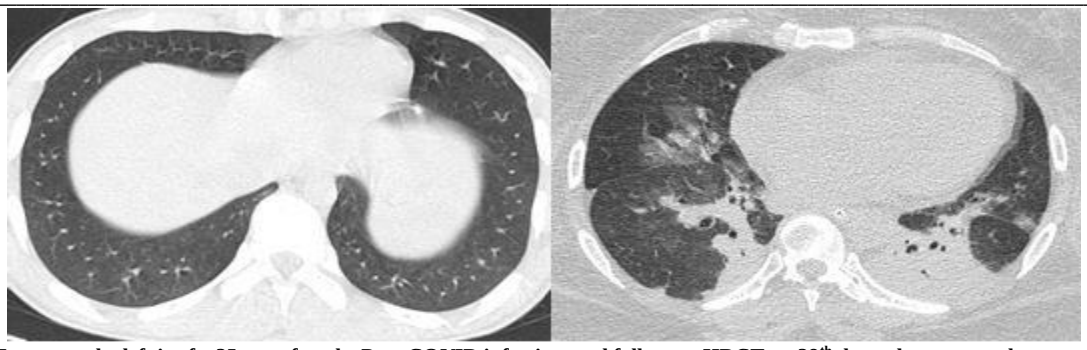

Fig 4 :Image on the left is of a 35-year female, Post-COVID infection, and follow up HRCT on 28th day - shows normal appearance of bilateral lung fields. The image on the right shows another patient with progression to increased dense consolidations, bilaterally.

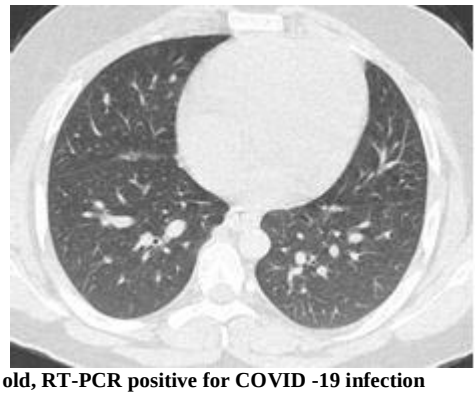

Fig 5: A 43 year old, RT-PCR positive for COVID -19 infection shows disappearance of GGO's which were previously noted in the right lower lobe leaving thin atelectatic bands.

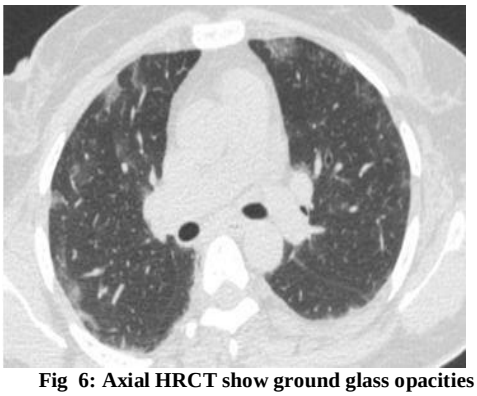

Fig 6: Axial HRCT show ground glass opacities predominantly in the periphery involving all segments of bilateral lung fields.

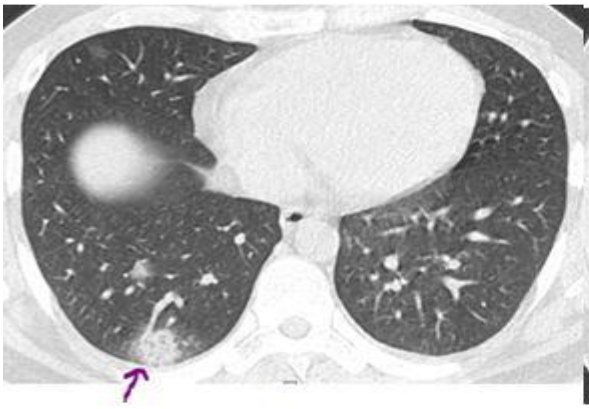

Fig 7a -Axial HRCT in a 26year old patient showing ground glass opacities predominantly in the peripheral region (Purple arrow) of right lower lobe. COVID test was negative.

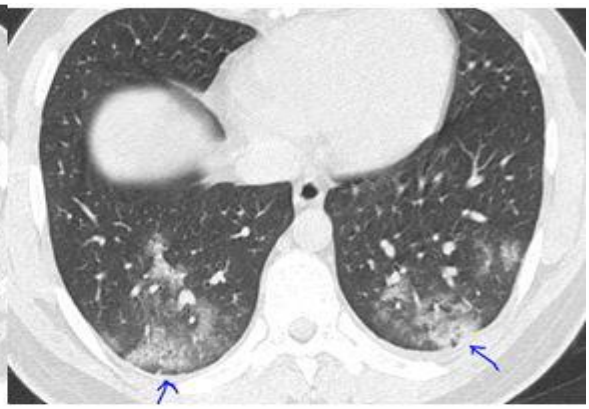

Fig 7b - A week later in the same patient, ground glass opacities are noted involving both (Blue arrows) the lower lobes. Repeat test showed COVID RT-PCR – Positive.

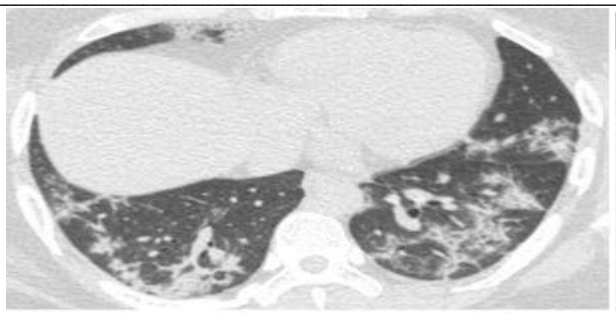

Fig 8: LAxial HRCT Thorax showing crazy paving pattern in a COVID 19 RT-PCR positive.

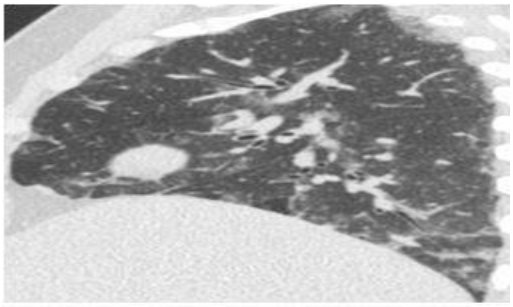

Fig 9: Sagittal reformatted HRCT of another patient- shows ground glass opacities predominantly in the periphery. Few areas also show interlobular septal thickening.

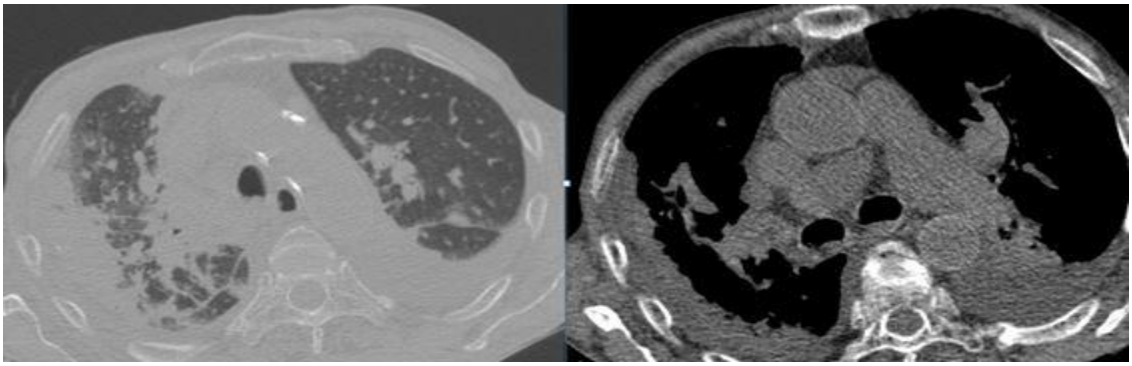

Fig 10 :AXIAL HRCT thorax lung and soft tissue window (left image, right image) showing bilateral pleural effusions in the dependent regions with underlying consolidation.

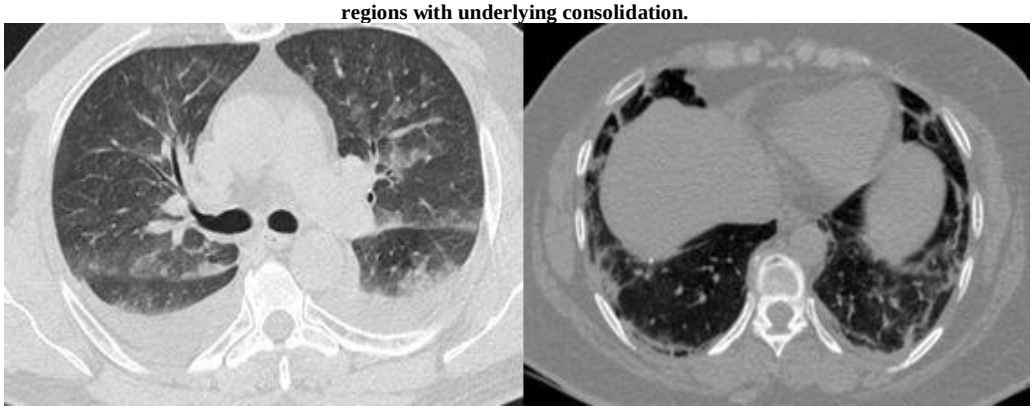

Fig 11:Axial HRCT shows sub pleural band with consolidation involving bilateral lower lobes.

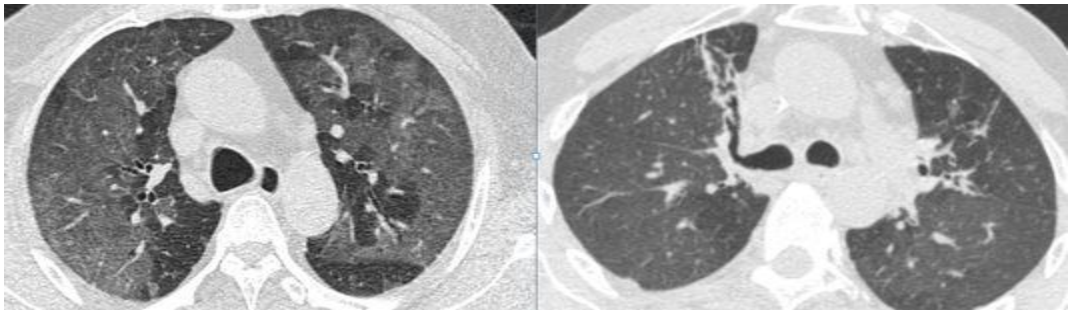

Fig 12:HRCT Thorax of a 56-year-old male patient initially shows multiple areas of ground glass attenuation (Image on the left). Repeat Axial HRCT shows patchy areas of fibrosis (Image on the right).

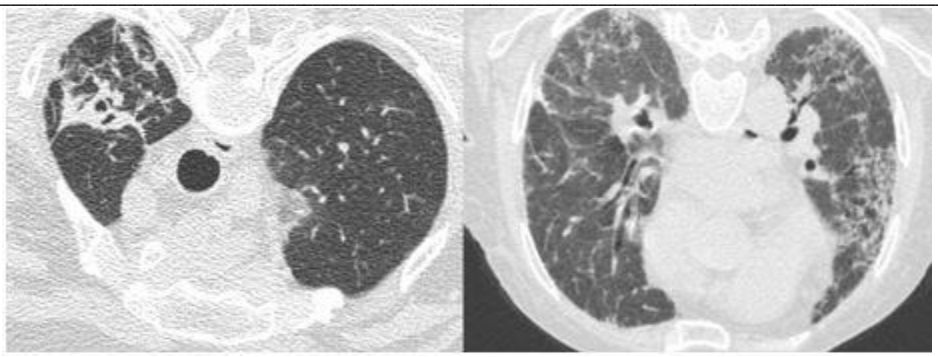

Fig 13:Follow up HRCT of a patient previously positive for COVID 19 antigen shows areas of fibrosis as seen above

Table 1: Patterns on CT Chest

Ground glass opacities	Number of patients	Percentage
Unilateral	140	7.9%
Bilateral	1620	92%

Table 2: Location of ground glass opacities

Location of Ground glass opacities	Patients	Percentage
Subpleural	1300	73.8%
Central	200	11.3%
Subpleural and central	260	14.8%

Table 3: Lobar involvement of ground glass opacities

Ground glass opacities	Patients	Percentage
Multi-lobar (More than 1 lobe)	1050	59.6%
Upper lobe	190	26.7%
Middle lobe	110	15.6%
Lower lobe	410	57.7%

Table 4: Segmental involvement of both lungs

Right lung segments	Patients	Percentage	Left lung segments	Patients	Percentage
Upper apical	380	21.5%	Upper apicoposterior	680	38.6%
Upper anterior	300	17.4%	Upper anterior	360	20.4%
Upper posterior	610	34.6%	-	-	-
Middle lobe – Medial	450	25.5%	Lingula	1220	69.3%
Middle lobe- Lateral	680	38.6%	-	-	-
Lower lobe – Superior basal	1140	64.7%	Lower lobe – Superior basal	840	47.7%
Lower lobe – Anterior basal	300	17.4%	Lower lobe – Anterior basal	450	59.2%
Lower lobe – Posterior basal	1680	95.4%	Lower lobe – Posterior basal	1600	90.9%
Lower lobe – Medial basal	610	34.6%	Lower lobe – Medial basal	620	35.2%
Lower lobe – Lateral basal	1450	82.3%	Lower lobe – Lateral basal	1600	90.9%

Table 5: Correlation between RTPCR status and HRCT findings

RT-PCR	HRCT Positive	HRCT Negative
COVID-19 Antigen Positive	1180	60
COVID-19 Antigen Negative	680	80

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