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Original Research Paper

Radiology

A SINGLE-CENTRE RETROSPECTIVE AND OBSERVATIONAL INVESTIGATION ON THE MANIFESTATIONS OF COVID-19 ON CHEST HRCT IN THE POPULATION OF ANDHRA PRADESH, INDIA

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ABSTRACT

Background: The clinical symptoms of COVID-19 in conjunction with chest high resolution computed tomography (HRCT) can give quick screening and determine the disease's severity. HRCT plays an important role in the evaluation and clinical management of COVID-19, which would benefit from a more comprehensive overview of its clinical diagnosis and therapy. **Objective:** To define the spectrum of HRCT results in COVID 19 individuals with symptoms and to connect HRCT findings with clinical symptoms of the disease. **Methods:** A retrospective research of 1513 COVID patients recently diagnosed with COVID-19 and positive RT-PCR test findings; both sexes were included from the middle of March to the end of May 2021. The patients were separated into three age groups and their HRCT CT severity scores (CTSS) were evaluated. Different age groups' clinical symptoms were connected with the derived CTSS. **Results:** The average age of the patients was 50.14 percent, with 34% falling between the ages of 35 and 54. The majority of them had fever, cough, dyspnea, myalgia, and headache, but other symptoms like sore throat, diarrhoea, nausea, anosmia, and chest discomfort were less common. In the current study, clinical characteristics had the strongest relationship with moderate CTSS. HRCT findings include ground-glass opacity (GGO), consolidation, bronchovascular thickening, crazy paving look, subpleural bands/fibrosis, and bronchiectasis. In moderate and severe patient groups, the CTSS link with lung lobe distribution and gender was highly significant. Bilateral lung distribution changes (83.6%) were more common in group 2 than central and peripheral distribution changes (70.5%), with lower lobe involvement in both genders. **Conclusion:** HRCT helps identify COVID-19's pulmonary symptoms in diagnosis and treatment. Imaging patterns depending on infection duration help understand pathophysiology and predict illness development and effects. This study may link clinical symptoms to CTSS and COVID-19 pulmonary changes. It could mean understanding the following wave's features and management. HRCT chest detects early parenchymal abnormalities, measures disease severity in all symptomatic patients, and diagnoses COVID infection regardless of RT-PCR status.

KEYWORDS : COVID-19, SARS-CoV-2, HRCT, CT severity score, ground-glass opacity, pandemic, lung diseases, India

INTRODUCTION

In India, an unprecedented upsurge of COVID-19 disease cases and deaths have occurred in the second wave of the COVID-19 pandemic that had severe consequences in the form of an increased number of cases, reduced supply of essential treatments, and intensified deaths, particularly in a younger population.

Over a year since COVID-19 was declared a pandemic by World Health Organization on 11th March 2020, this harmful SARS-CoV-2 virus continues to disorder the public life worldwide until the 3rd week of June 2021. Whether it is 1st or 2nd wave, the predominant clinical symptoms of COVID-19 in affected individuals are fever, cough, fatigue, and dyspnea, which leads to acute respiratory distress syndrome (ARDS) followed by renal failure, shock, and death[1,2]. The standard diagnostic reference for this disease confirmation is a nasopharyngeal swab for the reverse transcription-polymerase chain reaction (RT-PCR) test. However, there is a possibility that a small but significant proportion of false-negative results and time-consuming RT-PCR may affect the efficacy of this test though it was supported with chest computed tomography (CT)[3-6]. Furthermore, the RT-PCR doesn't give any evidence about the involvement of the lung in COVID-19 cases where pneumonia is the most common origin of severe morbidity and mortality[7,8]. Universally, chest high-resolution computed tomography (HRCT) is presently utilised to evaluate and manage patients affected with COVID-19. The HRCT is used primarily to assess the lung status for any viral pneumonia cases because pulmonary damage is the leading cause of most morbidity and mortality[9-14].

Most of the radiologic literature has focused on the distinctive chest CT abnormalities caused by COVID-19, which includes peripheral basal-predominant areas of ground-glass opacities and/or consolidation, often in a bilateral distribution[15-17]. According to the literature, the chest HRCT from COVID-19 positive cases with moderate to severe symptoms is scored with COVID-19 Reporting and Data System (CO-RADS)18, mainly based on the Radiological Society of North America's recommendations[8,19]. Moreover, the CT severity score (CTSS) is a scoring system used to evaluate the lung changes by COVID-19 infection, based on an approximate assessment of lung lobes involvement[20]. Both the CO-RADS and CTSS are used to rule out the severity of COVID-19 infection[21]. Still, the scoring from the CTSS is clinically significant for the radiologists and clinicians who are evaluating and treating the COVID-19 infected patients[22]. As HRCT plays an essential role in evaluating COVID-19 even, sometimes before the clinical symptoms become apparent (4), the present study was undertaken to describe the correlation between chest CTSS and the clinical picture of patients with

2nd wave COVID-19 disease in the Andhra Pradesh population of India.

2. Materials and methods

2.1 Study design and patient groups

The present study is a single-centred, retrospective, and observational study carried out by the collaboration of the Radiodiagnosis, Anatomy and Community Medicine departments, Narayana Medical College, Nellore (tier-2 city), Andhra Pradesh, India. It is one of the Government nominated hospitals to treat patients with SARS-CoV-2 pneumonia. A total of 1513 (59.95% male & 40.05% female) COVID patients were admitted from the middle of March 2021 to the end of mid-June 2021. The patients included were diagnosed with COVID-19 with laboratory-confirmed positive RT-PCR test results[23] and clinically symptomatic for the disease, and no patients underwent vaccination against COVID-19 infection. The patient's clinical data were collected from the Medical Records Department (MRD) of the Institute with authorisation from the Institutional ethical committee (IEC), and IEC waived the informed consent requirement.

The patients' age was grouped into young adulthood/Group-1 (18-34 years), middle-age/Group-2 (35-54 years), and older adulthood/Group-3 (55 and above years). The inclusion criteria are 1) first time affected with COVID-19; 2) symptomatic with fever, sore throat, cough, shortness of breath, cough, fever, nasal congestion, gastrointestinal symptoms such as diarrhoea, vomiting, or belly pain, fatigue, insomnia, ageusia, alternative signs of respiratory infections and spO2 levels or asymptomatic patients but with positive for chest HRCT; 3) history of recent contacts with confirmed COVID-19 infected patients with positive chest HRCT; 3) positive or negative for RT-PCR test but with positive chest HRCT. The exclusion criteria are 1) symptomatic patients with COVID-19 infection but with normal chest HRCT scan; 2) a gap of seven or more days between the RTPCR test result positive with COVID-19 and HRCT scan; 3) immunocompromised individuals or those on immuno suppressants; 4) pregnant and lactating women and 5) pediatric patients of less than 18 years.

2.2 Chest HRCT protocol

All the patients underwent non-contrast chest high-resolution computed tomography (HRCT) scans performed on the day of the patient's appearance. Later these scans were evaluated using the Picture Archiving and Communication Systems (PACS). The chest HRCT was performed using a 16-slice Siemens CT Scanner (Somatom Scope M-CT 160, Jiangsu, PR China). The scanning parameters were as follows: scan direction – craniocaudally; tube voltage – 120kV; slice collimation – 64X0.62mm; width – 0.625X0.625mm; rotation time– 0.5s and scan length – 60-1300s. Each subject was positioned supine with a single breath-hold, and no intravenous contrast media was administered.

2.3 HRCT Image interpretation

Two experienced radiologists evaluated the chest HRCT images and were blinded to the patient's sex, age, and RT-PCR test results to determine the CT severity score (CTSS). In all axial CT scans, a 0–5 point scale was assigned to five lung lobes (three on the right side and two on the left) based on lesion involvement, where 0 (zero) has no severity and 5 signifies the maximum severity of the COVID-19 disease. The summation of these points from all the lobes gives the CT severity score (0-5points×5lobes), ranging from 0-to 25. Further, the CTSS of COVID-19 cases were grouped into mild (score >16)[4].

All the scan images were investigated for the presence of one or a combination of the following radiological patterns such as ground-glass opacity (GGO), consolidation, consolidation with GGO (C-GGO) – mixed attenuation, crazy-paving, organising pneumonia pattern, interlobular septal thickening, parenchymal bands, halo-sign, air-bronchogram, traction bronchiectasis, cavitation, nodules, subsegmental vessel enlargement, pleural effusion, and lymphadenopathy24,25.

2.4 Statistical and quantitative image analysis

The data obtained were analysed using MS Office Excel and SPSS software version 16.0 for Windows (SPSS Inc., Chicago, IL. USA). For quantitative data, mean ± SD was used; numbers and percentages were used for qualitative data. The independent sample T-test was used to compare two quantitative data with a normal distribution. In contrast, one-way ANOVA compared multiple quantitative data sets with a normal distribution. The Chi-square test evaluated the relationship between CTSS and the patient's gender, with a significance level of $p<0.05$.

3. Results

3.1 Patient profile:

This study was a retrospective study of 1513 symptomatic patients with proven COVID-19, with 907 males (59.95%) and 606 females (40.05%). Patients' ages ranged from 21 to 81, with 50.14 years. 34% of patients were within the age group of 35-54 years, and among this, 56% of patients were aged >40 years. The age and sex distribution among the groups were shown in Table I.

The symptoms of 2nd wave COVID-19 patients, irrespective of gender, showed fever (83.2%), cough (78.35%), shortness of breath (41.2%), sore throat (21.94%), headache (19.5%), diarrhoea (19%), nausea/vomiting (21%), loss of smell or taste (39%) and pain in chest and abdominal regions (16% & 19% respectively).

Group 1 patients had a mild fever, cough, sore throat, nasal congestion, and myalgia (93.4 %). In most of them, oxygen saturation (SpO2) levels were between 90-94%, except for those who had an old history of COPD.

The patients in Group-2 had a fever (100%), cough (92.3%), dyspnea or shortness of breath (86.6%), myalgia (20.1%), sore throat (15.2%), headache (37.1%); diarrhoea (14.8%), nausea/vomiting (14%), loss of smell or taste (22%) and abdominal pain (16.3%). Overall, 86.3% of patients had oxygen saturation (SpO2) levels between 90-94% (Table II).

In contrast, all the patients in Group-3 showed 100% fever, dyspnea, cough with a sore throat, myalgia and headache (9.2%), nausea/vomiting (9%), loss of smell or taste (23.4%), and abdominal pain in 38.2%.

Approximately 1343 (88.8%) patients whose SpO2 level was less than 90% (Table II). The most widespread comorbidity seen in the present study was diabetes mellitus (54.4%), hypertension (48.8%), old history of COPD (13%), coronary artery disease (10.8%), anaemia (6.3%) and hypothyroidism (4.64%). In COVID-19 patients, diabetes was the significant comorbidity ($p<0.007$).

3.2 HRCT findings:

The lesions of the lung were seen predominantly in peripheral and subpleural areas. The most expected CT findings were a combination of GGO and consolidation (Fig.1-5) ($p<0.0001$), principally seen on HRCT, and these may be single or multiple and irregular. Some of the severe CTSS patient's HRCT also displayed fibro-cavitatory changes (Fig.6a&b & Fig.7a-c) with bronchiectasis (19.4%) (Fig.8a-d) which was seen extra on bilateral upper lobes and more on right than left. Other pulmonary findings of COVID-19 were enlisted in Table III (Fig.6c&d). Out of 1513 patients, chest-HRCT showed different lung lobe distribution of opacities. Among the study population, 941 (62.2%) patients had right upper lobe

involvement, 1151 (76%) had right middle lobe involvement, and 1447 (95.6%) had right lower lobe involvement. On the left side, 1084 (71.6%) patients showed upper lobe involvement, whereas lower lobe involvement was found in all the left lungs (1513, 100%). Among the right and left lungs (3026), the lower lobes of the right and left were more affected (97.8%; Chi-square $p<0.001$) than the remaining lobes. The details of gender and lung lobe distribution are provided in Table IV.

3.3 CTSS:

The age group, gender, and CTSS had a significant relationship (one-way ANOVA, $p<0.0001$). The patients developing critical illness were directly proportional to higher chest CTSS (4.9 ± 2.1 vs 12.2 ± 2.2 vs 18.61 ± 1.9; $p<0.0001$). The details of incidence of CTSS with gender and lung lobe distribution were given in Table V and Graph-1.

4. DISCUSSION

COVID-19 is a highly contagious disease that poses a severe threat to public health across the globe26,27. On 15th February 2020, only 3 cases of COVID-19 were recorded in India, whereas one year later, on 15th February 2021, it was around 10,925,311 cases. During the second wave, there was a rapid surge of COVID-19 infected patients from mid-March to the middle of June 202128,29. The highest number of cases in India was recorded in a single day30 on 7th May 2021 are 4,14,188. Later from the 3rd week of June 2021 onwards, the average daily new COVID-19 infections dropped, which indicated the waning effects of the second wave31, but not been completely exterminated until today! With the continuing pandemic of COVID-19 and the increasing number of patients suspected or confirmed with the disease, the radiologists have been acquainted particularly with chest CT investigatory techniques because of the paramount role of imaging in the present scenario.

Chest HRCT is a robust investigative algorithm for COVID-19 suspected patients with a mixed positive or negative result of diagnostic kits. In the present study, a total of 1513 patients with clinical symptoms expressive for COVID-19 infection were tested compulsorily for RT-PCR and compared for pulmonary radiological features between three age groups. Those who tested positive for COVID-19 undertook chest-HRCT at the earliest of their result, which can successfully demonstrate the pattern and extent of the lesion involvement in the lungs of COVID-19 patients.

The clinical symptoms of dyspnea, fever, and cough were well-versed with the CT severity of disease in all three groups, being more common in moderate and severe CTSS patients. Other clinical features such as headache, myalgia, sore throat, agnosia, diarrhoea, nausea, and abdominal pain were minimum in mild cases, according to the other reports of covid 1932-35. Patients with moderate and severe CTSS index correlated well with pulmonary radiological features.

The early HRCT investigations in this study showed GGO, the most common findings found in all three groups being highest in group-2 (86%) with or without consolidation changes36. There was a minimum number of cases of cavitation, bronchiectasis, crazy paving appearance, bronchovascular thickening, tree-in-bud appearance and nodules observed in our patients, which may be lung infection sequelae. However, these features probably develop in the long-term, and it is considered as late findings of the disease in COVID-19 cases37,38.

The majority of COVID-19 studies published so far have also mentioned GGO, consolidation, and bronchial dilation as the main characteristic findings37,39. The radiologic patterns of lung parenchymal involvement are not pathognomonic. In conditions of influenza, interstitial lung diseases, such as organising pneumonia or non-specific interstitial pneumonitis (NSIP), predominant peripheral GGO or diffuse GGO are similar to COVID- 19 infection37,40,41.

Since the predominant pattern is GGO in almost all the cases in the present study, the superiority of CT scan over chest radiography can be justified in COVID-19 disease prognosis owing to their higher resolution.

Bilateral and peripheral lung distribution was higher in all three groups when compared to central lung distribution, which are CT hallmarks of COVID 19. Subpleural bands and fibrosis was found to be higher in group-2. Most of the covid pulmonary manifestations in the present case were higher in group-2, which comprised of the middle-aged, compared to group 3, older adults. At least in group-1, younger people, this was consistent with the study done by Anchal Gupta et al.42, in which it was reported that bronchiectasis was mainly seen in the second week than the first week.

The lung lobe involvement was bilateral, with predominant lower lobe involvement and found more in males than females with a high significance43.

CTSS findings were moderate with a very high significance, including a more significant number of male patients. Overall gender distribution patterns represented by the histogram (Graph 1) of all the three age groups showed a more substantial number of males than females in the present study44.

A retrospective study of COVID-19 patients reported that the elderly population is more susceptible to the disease and is more likely to be admitted to the ICU with a higher mortality rate. However, the relationship between age and clinical symptoms could differ across the history of patients because of the different conditions of comorbidities45. Thus, decision-making based on appropriate clinical findings is crucial for the correct diagnosis of the disease and its progression.

The current study has several limitations. First, it is a retrospective study with sporadic documentation of the patients' exposure history. The initial HRCT investigations were undertaken within seven days of the positive result of COVID. There has been a lag in collecting patients' complete data due to the time and workload constrain of the healthcare team involved in the study.

The present study concluded a significant association between age-related changes in COVID and elevated CTSS. A higher number of GGO cases were seen in groups-2 and 3, even within a week of the positive results of COVID. The clinical presentation was milder, and minimal lung lobe complications were seen in group 1, younger patients, compared with group-2 and 3. Special attention is required for the geriatric population as they are more likely to have a poor outcome.

CT was better at detecting the type and extent of pulmonary involvement. HRCT chest in COVID-19 patients had significant diagnostic and prognostic importance as positive CT findings were more prominent in symptomatic and co-morbid patients. This finding could help the medical staff with limited healthcare resources to predict cases with a possible worse outcome when triaging patients. Overall, imaging is valuable for early suspicion of the disease and follow-up and evaluation of disease severity. In terms of providing immediate results, detecting disease severity, and predicting prognosis, HRCT outperforms RT-PCR. It is more sensitive and time effective in screening the patients with high clinical suspicion. More research, however, is required to shed light on the radio-clinical correlation between this disease and its treatment. As many countries have seen the 2nd wave with a massive loss of countless lives, the 4th wave is predicted to

hike in June 202246. Despite the improved technological and logistical capacity of the developed countries in detecting and diagnosing this disease, the incidence of infection in the early months of the pandemic was much higher than reported. To overcome and as a preventive measure for the upcoming wave, more such studies from different populations are needed for more advanced and accurate disease management.

Table I. Gender and age distribution of 2nd wave COVID-19 patients

Variables		Count (%)	Male (%)	Mean ±SD	Female (%)	Mean ±SD	t -value	p -value
Age	18-34	502 (33.2)	286 (57.0)	31.25± 3.35	216 (43.0)	31.55± 3.5	1.0	0.33 *
	35-54	529 (34.9)	323 (61.0)	44.57± 6.37	206 (39)	43.41± 6.70	2.0	0.04 **
	55 & above	482 (31.9)	289 (60.0)	62.79± 5.86	193 (40.0)	63.44± 5.98	1.1	0.24 *

*-not significant; **-significant

Table II. Symptomatic findings of 2nd wave COVID-19 patients

Variables	Group-1 Mild (n=502)	Group-2 Moderate (n=529)	Group-3 Severe (n=482)	Total patients affected (n=1513)
Fever	418 (83.2%)	529 (100%)	482 (100%)	1429 (p<0.001)
Cough	395 (78.7%)	488 (92.2%)	482 (100%)	1365 (p<0.03)
Dyspnea	207 (41.2%)	458 (86.6%)	482 (100%)	1147 (0.06)
Myalgia	16 (3.2%)	106 (20.1%)	468 (97.1%)	590
Sore throat	110 (21.9%)	80 (15.2%)	19 (3.9%)	209
Headache	98 (19.5%)	196 (37.1%)	477 (98.8%)	771
Diarrhoea	146 (29%)	131 (24.8%)	108 (22.4%)	385 (p<0.0001) *
Nausea/vomiting	105 (21%)	74 (14%)	43 (9%)	222 (p<0.01)
Anosmia/Loss of smell	196 (39%)	116 (22%)	113 (23.4%)	425
Pain in chest /abdomen	95 (19%)	86 (16.3%)	184 (38.2%)	365

Table III. Pulmonary findings in HRCT images from different age groups of 2nd wave COVID-19 affected patients.

S.No.	Variables	Group-1 Mild (n=253)	Group-2 Moderate (n=932)	Group-3 Severe (n=328)
1	GGO	233 (92%)	803 (86.2%)	289 (88%)
2	Consolidation	75 (29.5%)	410 (44%)	64 (17%)
3	C-GGO	30 (12%)	277 (29.7%)	159 (42%)
4	Bronchovascular thickening	54 (21.5%)	121 (13%)	44 (11.7%)
5	Crazy paving appearance	45 (17.7%)	267 (28.6%)	173 (45.8%)
6	Tree-in-bud appearance	14 (5.5%)	110 (11.8%)	36 (9.6%)
7	Pulmonary nodules	12 (4.8%)	15 (1.6%)	35 (9.3%)
8	Bilateral lung distribution	196 (77.5%)	779 (83.6%)	282 (74.6%)
9	Central lung distribution	28 (11%)	126 (13.5%)	54 (14.2%)
10	Peripheral lung distribution	143 (56.5%)	321 (34.4%)	166 (44%)
11	Central & peripheral lung distribution	54 (21.4%)	373 (40%)	203 (53.7%)
12	Manifold-lobar distribution	168 (66.4%)	657 (70.5%)	268 (71%)

Table IV. Incidence of gender and lung lobe distribution among the 2nd wave COVID-19 patients

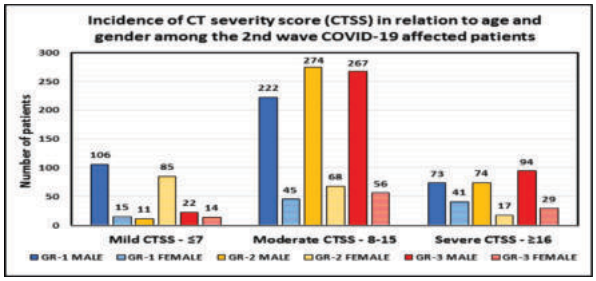
Variables	Side	Incidence of Lung lobes affected				Chi-square value	P -value
		Upper	Middle	Lower	Total lobes		
Male (n=907) patients with 4535 lobes (right 2721 + left 1814)	R	592	716	659	1967	713.38	0.000 1α)
	L	626	NA	907	1533		
Female (n=606) patients with 3030 lobes (right 1818 + left 1212)	R	349	435	788	1572	390.07	0.000 1α)
	L	458	NA	606	1064		
Total	R&L	2025	1151	2960	6136		

N, number of cases observed; α) P-value by Chi-square test, very highly significant; R&L-right and left respectively.

Table V. Incidence of computerized tomographic severity score (CTSS) concerning gender and lung lobe distribution among the 2nd wave COVID-19 patients

Variables	Gender	N (1513)	Mean± SD	95% CI for Mean		t	P -value
				Lower	Upper		
Mild (CTSS ≤7) n=253	Male	139	5.1±1.6	4.87	5.42	1.8	.073 α)
	Female	114	4.7±2.6	4.17	5.15		
Moderate (CTSS 8-15) n=932	Male	763	12.4±2.0	12.27	12.56	7.6	.000 b)
	Female	169	11.0±2.7	10.60	11.42		
Severe (CTSS ≥16) n=328	Male	241	18.6±1.9	18.32	18.80	-.747	.455 c)
	Female	87	18.7±1.9	18.33	19.14		

N-number of cases observed; CTSS-CT severity score; t and p values are derived from Independent Sample Test; α)-provisionally significant or slightly non-significant; b)-very highly significant; c)-not significant.



Graph 1. Incidence of computerized tomographic severity score (CTSS) with gender and age group among the 2nd wave COVID-19 patients

Figure 1a&b – Axial and coronal chest HRCT images of a 21-year-old male showing the few ill-defined GGO in left upper lobe and bilateral lower lobes; the remaining bilateral lung parenchyma appears normal. The designated CTSS score was 04/25. **Figure 1c&d** – Axial and sagittal HRCT images of a 67-year-old male showing the multiple ill-defined consolidatory changes with surrounding GGO seen in peripheral regions of all the segment of bilateral lungs. The designated CTSS score was 10/25.

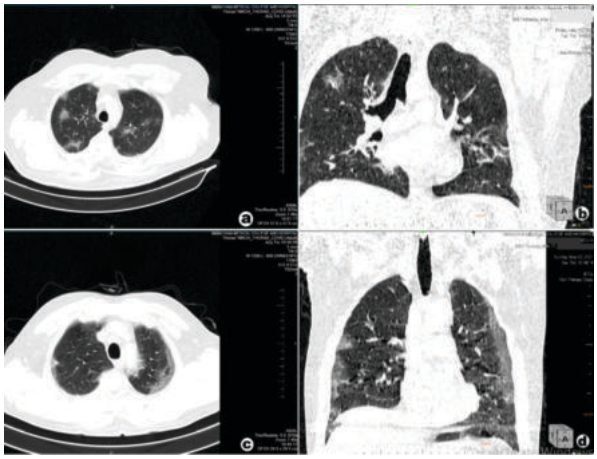


Figure 2a&b – Axial and coronal HRCT images of a 48-year-old male showing the multiple ill-defined patchy sub-pleural GGO and sub-pleural linear bands noted in bilateral lung parenchyma. The designated CTSS score was 11/25. **Figure 2c&d** – Axial and coronal HRCT images of a 43-year-old male showing multi-focal ill-defined subpleural and peribronchovascular GGO noted in bilateral lung parenchyma. The designated CTSS score was 14/25.

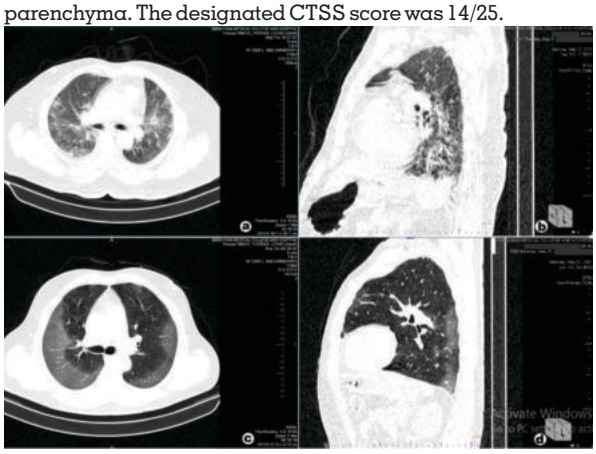


Figure 3a&b – Axial and sagittal HRCT images of a 65-year-old male showing the multiple ill-defined consolidatory changes with surrounding GGO noted in all segment of bilateral lung parenchyma. The designated CTSS score was 17/25. **Figure 3c&d** – Axial and sagittal HRCT images of a 56-year-old male showing the multiple confluent areas of GGO noted in sub-pleural region of all lobes of bilateral lungs. The designated CTSS score was 17/25.

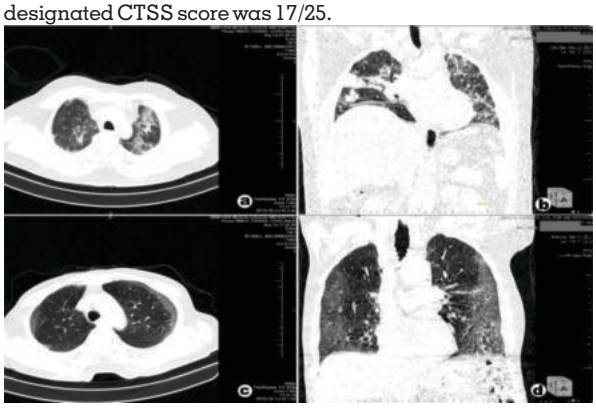


Figure 4a&b – Axial and coronal HRCT images of a 39-year-old male showing consolidatory changes with surrounding GGO in all segments of bilateral lung parenchyma. The designated CTSS score was 18/25. **Figure 4c&d** – Axial and coronal HRCT images of an 81-year-old male showing the ill-defined sub-pleural GGO with few consolidatory changes in all the segments of bilateral lung parenchyma. The designated CTSS score was 19/25.

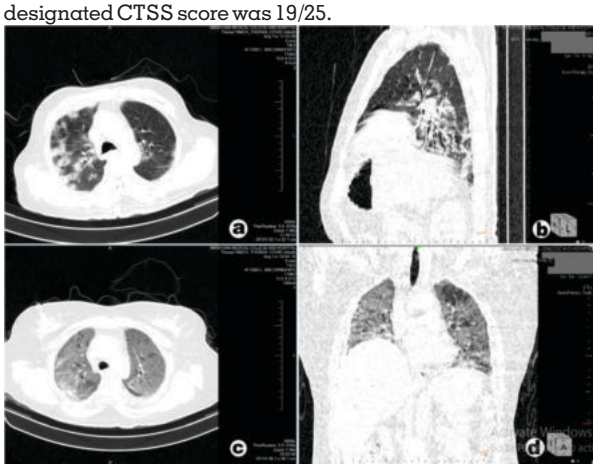


Figure 5a&b – Axial and sagittal HRCT images of a 63-year-old female showing the diffuse consolidatory changes with few areas of adjacent GGO noted in all the lobes of bilateral lung parenchyma. The designated CTSS score was 20/25. **Figure 5c&d** – Axial and coronal HRCT images of a 45-year-old female showing the multiple diffuse confluent areas of GGO and consolidatory changes seen in all lobes of bilateral lungs. The designated CTSS score was 24/25.

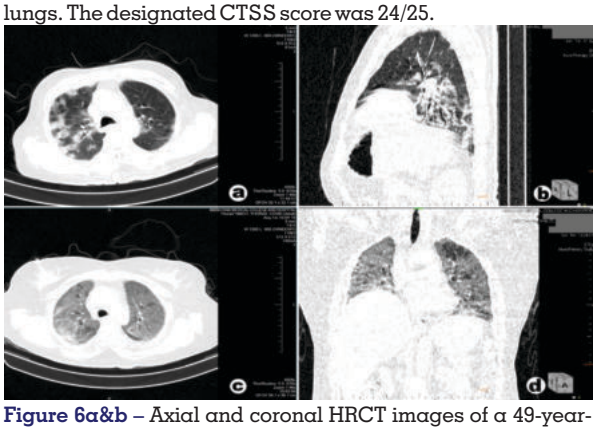


Figure 6a&b – Axial and coronal HRCT images of a 49-year-old female showing the cavitation on apicoposterior segment of left upper lobe with surrounding consolidation and GGO. **Figure 6c&d** – Axial and sagittal HRCT images of 49-year-old

female showing the tree-in-bud appearance on left side, GGO and consolidation.

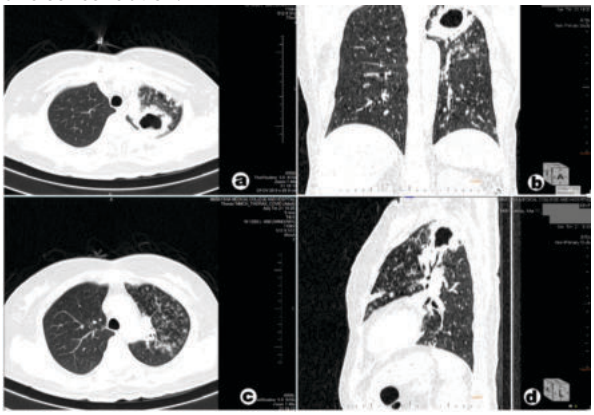


Figure 7a-c – Axial (a&b) and sagittal (c) chest HRCT images of 19-year-old female showing the features of mixed alveolar and interstitial fibrosis with localised pneumothorax (red arrows) on right side and mixed areas of consolidatory changes with surrounding GGO in bilateral lungs.

Figure 8a-d – Axial (a-c) and sagittal (d) chest HRCT images of 70-year-old female showing the features of multiple fibro-bronchiectatic with few calcific foci changes and GGO in the bilateral lungs predominantly in right upper lobe. This may be due to lung infection sequelae.

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