

Spectrum of HRCT Chest Findings in RT-PCR positive COVID-19 Patients at a Tertiary Care Center in Mid-Western Nepal: A Retrospective Cross-Sectional Study

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Article Info:

Received Date: Dec, 2024

Acceptance Date: Jan, 2025

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Funding sources: None

Conflict of interest: None

Abstract

Introduction: Severe Acute Respiratory Syndrome Coronavirus 2 (SARS-CoV-2) causes a pulmonary infection called as coronavirus disease (COVID-19). High-resolution computed tomography (HRCT) of the chest plays a crucial role in diagnosis, assessing the lung involvement with its severity in COVID-19. The objective of this study was to describe the pattern of HRCT chest findings in lab-proven, real-time RT-PCR-positive COVID-19 patients.

Methods: This was a descriptive, cross-sectional study conducted at Rapti Academy of Health Sciences (RAHS), the designated COVID-19 patient treatment site in Lumbini province, from September to December, 2024, with data collected from the hospital records of 78 RT-PCR-positive COVID-19 patients based on their HRCT chest findings, and who underwent HRCT chest scans at the Radiology department of RAHS from February to October, 2021. Data collection was done after receiving ethical approval from the Institutional Review Committee of RAHS. Data analysis was performed using Statistical Package for the Social Sciences version 27.

Results: Among 78 RT-PCR-positive COVID-19 patients, 51 were male and 27 were female, with a mean age of 51.28 ±14.36 years. HRCT chest showed ground glass opacities (GGO) in 74 (94.87%), followed by atelectatic band in 24 (30.77%), interlobular septal thickening in 22 (28.21%), consolidation in 20 (25.64%), GGO and consolidation in 17 (21.79%), crazy-paving pattern in 11 (14.1%), and other chest findings in 5 (6.41%) patients.

Conclusion: The most common HRCT chest findings of COVID-19 were ground-glass opacities, while atelectatic band, interlobular septal thickening, consolidation, and crazy-paving pattern were other important findings. Thus, HRCT chest imaging is crucial for both diagnosing and assessing the severity of COVID-19 patients.

Keywords: Consolidation, coronavirus; COVID-19, ground-glass opacities; HRCT, RT-PCR, SARS-COV-2

Access the article online



DOI: doi.org/10.70027/jrahs34

Introduction

The first reported case of coronavirus disease 2019 (COVID-19) was in Wuhan City, China, in December 2019, while in Nepal, it was in January 2020 in a 21-year-old student who had returned from Wuhan, China.¹ The World Health Organization (WHO) declared the outbreak on

January 30, 2020. This new coronavirus was called Severe Acute Respiratory Syndrome Corona Virus 2 (SARS-CoV-2), and the WHO officially announced this disease as coronavirus disease 2019 (COVID-19) on February 12, 2020.²

The COVID-19 disease is primarily transmitted through the

Citation:

BC B, Khanal B, KC A, Subedi RK, KC A. Spectrum of HRCT chest findings in RT-PCR positive COVID-19 patients at a tertiary care center in mid-western Nepal: a retrospective cross-sectional study. *J. Rapti A. Health Sci.* 2024;1(2):1-5.

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respiratory droplets that infect the lungs.³ These patients mostly present with fever, cough, and myalgia, while others can have severe pneumonia and acute respiratory distress syndrome and may develop multiple-organ failure, which can lead to death.⁴

The gold standard for diagnosing COVID-19 infection is nasopharyngeal swab RT-PCR.^{5,6} Multifocal peripheral patchy radioopacities in the chest X-ray are reported only in the late phase, while HRCT chest has higher sensitivity (97.41%) and specificity (80%), detecting disease early and can assess the severity and prognosis of the disease.^{5,7,8} Other imaging modalities include point-of-care ultrasound (POCUS), while CT pulmonary angiography is performed for cases of pulmonary embolism.⁹

On HRCT chest, bilateral lung ground-glass opacities (GGO) with or without consolidation in posterior and peripheral lungs were the hallmark of COVID-19.^{10,11} The other CT imaging features include the crazy-paving pattern, airway changes, reversed halo sign, etc., which may be due to lung injury.^{12,13} An editorial by Kay et al. encouraged researchers to deal with the diverse imaging findings of COVID-19 for its timely recognition and accurate diagnosis to manage the cases early, preventing deadly complications.¹⁴ We aim to describe the pattern of HRCT chest findings in lab-proven real-time RT-PCR positive cases for COVID-19 at RAHS, Dang.

Methods

This was a single-center retrospective cross-sectional study of COVID-19 patients admitted at RAHS, Ghorahi, Dang, the designated COVID-19 patients' treatment site with positive RT-PCR for SARS-CoV-2, and undergone HRCT chest scan at the Radiology department of RAHS from February to October, 2021. The study was conducted from September to December, 2024. From the census of the medical record of RAHS, all RT-PCR-positive COVID-19 patients undergoing HRCT chest scans during the same period, and aged 18 years and above with no previous history of tuberculosis, interstitial lung disease, or other chronic lung disease, were taken in the study. HRCT chest scan reports of these patients during the same period were collected from the Radiology Department of RAHS in prepared working patient study forms. The data were then collected using a structured questionnaire, which included socio-demographic and clinical profile sheets. The former included cases' age and gender, while the latter included COVID-19 status and HRCT chest findings/abnormalities with respect to the morphology of the lesion and its distribution pattern. The study was conducted after the approval of this study was obtained from the Institutional Review Committee (IRC) of RAHS (ref no: 377 dated 8th September 2024). We guaranteed the confidentiality of all the cases.

HRCT chest scans were performed using a single inspiratory phase in helical multi-detector CT scanners (Neu Viz 128, Neusoft Medical Systems, China). To minimize motion artifacts, patients were instructed on breath-holding; CT images were acquired during a single breath-hold in a supine position. For CT acquisition, the tube

voltage was 120 kVp with a tube current of 250 mAs and a slice thickness of 1.0 mm, with a reconstruction interval of 0.6 mm by using a sharp reconstruction algorithm. All the acquired images were viewed on lung settings (WW: 1500, WL: -700) and mediastinal settings (WW: 350, WL: 40). The mean CTDIvol was 16.7 mGy.

The chest CT findings were recorded based on the Fleischner Society glossary of terms:^{15,16} the presence of ground-glass opacity (GGO), consolidation, and intra- or interlobular septal thickening. The number of lobes involved and the laterality of lung abnormalities were determined. A semi-quantitative scoring system was used to quantitatively estimate the pulmonary involvement of all these abnormalities on the basis of the percentage of the total lung involved per lobe, scored from 0 to 5 as follows: score 1, 1%–5% involvement; score 2, 6%–25% involvement; score 3, 26%–50% involvement; score 4, 51%–75% involvement; score 5, 76%–100% involvement with total lung scores, calculated as the sum of individual lobe scores, and it was further divided into mild (≤ 7), moderate (8–17), and severe (≥ 18) as the CT severity score.^{8,17}

The collected data was entered into the Excel sheet and transferred to SPSS 27. Descriptive analysis of data was performed using SPSS software version 27. Data was expressed in frequency with percentage and presented in tables and diagrams.

Results

Demographics and frequencies of HRCT chest findings of COVID-19 cases are summarized in Table 1. The study population comprised 78 RT-PCR-positive COVID-19 cases, with a mean age of 51.28 ± 14.36 years (range: 27–82 years); 51 male (65.38%) and 27 (34.62%) female. The lower lobe of both lungs was the most commonly involved lobe, in 76 (97.44%) cases with bilateral lung involvement in 75 (96.15%) cases, and multiple lesions were present in all the cases. The most common HRCT chest findings were ground-glass opacities (GGO) in 74 (94.87%) (figure 1), followed by the atelectatic band in 24 (30.77%), interlobular septal thickening in 22 (28.21%), consolidation in 20 (25.64%), GGO and consolidation in 17 (21.79%), crazy-paving pattern in 11 (14.1%), pleural effusion in 2 (2.56%), pneumomediastinum in 2 (2.56%), and mediastinal lymphadenopathy in 1 (1.28%) of cases.

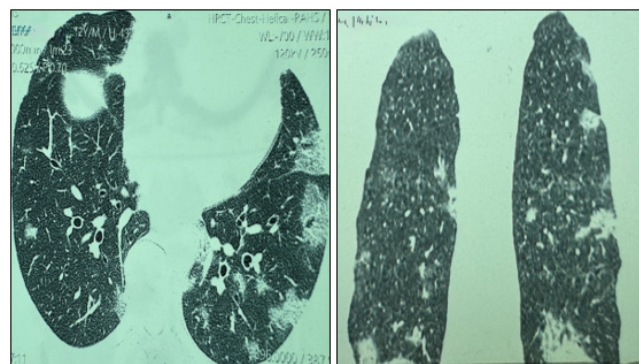


Figure 1: Axial and coronal HRCT chest images showing predominantly peripheral multifocal ground-glass opacities in B/L lungs (left > right)

Table 1: HRCT details of COVID-19 patients

S.N.	Particulars	Values
1	Mean age (years)	51.28 ±14.36
2	Sex:	
	Male	51
	Female	27
3	HRCT Chest Findings:	
	Lobar involvement	
	Right lobe	
	Lower lobe:	76 (97.44%)
	Upper lobe:	68 (87.18 %)
	Middle lobe:	66 (84.62 %)
	Left lobe	
	Lower lobe:	76 (97.44%)
	Upper lobe:	70 (89.74%)
	Bilateral:	75 (96.15 %)
	Unilateral:	3 (3.85 %)
	Number of lesion	
	Multiple:	78 (100%)
	Single:	0 (0%)
	Characteristic HRCT chest findings	
	Ground glass opacities (GGO):	74 (94.87%)
	Atelectic band:	24 (30.77%)
	Interlobular septal thickening:	22 (28.21%)
	Consolidation:	20 (25.64%)
	GGO and consolidation:	17 (21.79%)
Crazy paving pattern:	11 (14.1%)	
Pleural effusion:	2 (2.56%)	
Pneumomediastinum:	2 (2.56%)	
Mediastinal lymphadenopathy:	1 (1.28%)	

There were 47 cases (60.26%) with moderate CT severity scores, followed by 22 mild (28.20%) and 9 (11.54%) with severe CT severity scores. The mean score was 11.46±4.98 (minimal score of 3 and maximum of 23). There was a higher proportion of male cases compared to female cases with higher CT severity scores without a statistically significant association between CT severity scores and sex. Findings are summarized in Table 2.

Table 2: CT severity scores in COVID-19 patients

CT Severity Score	Male n (%)	Female n (%)	Total n (%)
Mild (≤7)	12 (23.53)	10 (37.04)	22 (28.20)
Moderate (8-17)	31 (60.78)	16 (59.26)	47 (60.26)
Severe (≥18)	8 (15.69)	1(3.70)	9 (11.54)

Discussion

The main objective of our study was to describe the pattern of HRCT chest findings of RT-PCR-positive COVID-19 patients attending Rapti Academy of Health Sciences (RAHS), Ghorahi, Dang, the designated COVID-19 patients' treatment site. A total of 78 RT-PCR-positive cases for COVID-19 were taken in our study with 51 males and 27 females; the mean age was 51.28±14.36 years (range 27–82 years). These demographics of our study are comparable to the study done by Zhou et al.¹⁸ where the study included 62 confirmed COVID-19 patients (34 male, 28 female; age range 20–91 years). Likewise, the above demographics are also comparable with the study done by Chen et al.⁴ where they enrolled 99 patients with COVID-19 pneumonia (average age was 55.5 years, including 67 male and 32 female) in their study.

The commonest HRCT chest finding in our study was GGO in 74 (94.87%), followed by atelectatic band in 24 (30.77%), interlobular septal thickening in 22 (28.21%), consolidation in 20 (25.64%), GGO and consolidation in 17 (21.79%), crazy paving pattern in 11 (14.1%) and other findings in 5 (6.4%) cases. The majority of studies^{4,8,19–22} showed GGO (> 60% to 100% of cases) as the commonest HRCT chest findings with other important chest findings, to which our findings are comparable to validate our study. The proportion of consolidation findings is relatively less in our study, which may be due to cases coming at an early stage of the disease seeking treatment.

The parenchymal abnormalities are multifocal in all the cases of our study comparable to the various studies;^{4,19,21,22} that showed multiple lesions in >80% of their study cases. 96.15% of cases in our study showed bilateral lung involvement, and only 3.85% had unilateral lung involvement. The study by Inui et al.¹⁹ showed B/L lung involvement in 95% of cases and the study by Picchi et al.²¹ in 90.3% of cases. Likewise, parenchymal lesions had lower lobe predominance in both lungs (97.44% of cases) in our study cases. The study by Ojha et al.²⁰ and Inui et al.¹⁹ had around 84% and 77% of the cases with lower lobe lung lesions, respectively. Our study findings of B/L lung involvement and lower lobe predominance in both lungs are comparable to the results of the studies mentioned.

There were 47 cases (60.3%) with moderate CT severity score in our study, followed by 22 mild (28.2%) and 9 (11.5%) cases with a mean CT severity score of 11.46±4.98, showing most of the COVID-19 patients affected had moderate CT severity score. No relevant study is available in this regard for comparison. Our study cases might have attended the hospital seeking treatment, likely due to the increased severity of the COVID-19, which might be the

cause for the increased CT severity score in the majority of the cases. There is a higher proportion of male cases compared to female cases with higher CT severity scores, although there was no statistically significant association between the CT severity score and sex. The higher male cases and higher CT severity scores in them might be due to more outdoor-working male people in Nepal, thus increasing chances of exposure and severity.

The primary manifestation of the COVID-19 disease is pneumonia. The symptomatic COVID-19 infection has been classified by WHO based on severity into four categories: mild cases, pneumonia, severe pneumonia, and critical disease; the latter includes sepsis, septic shock, and/or ARDS.²³ It takes at least a week for a chest CT scan to identify abnormalities in the lung parenchyma, while the virus can be isolated from infected individuals as early as six days before symptoms appear.^{24,25} Thus, HRCT chest imaging aids in prognostication, disease progression assessment, and therapeutic response monitoring in RT-PCR-confirmed COVID-19 cases.²⁰

Our study has some limitations. This study was a descriptive cross-sectional study done in a single center with a small sample size and no controls enrolled. So, results cannot be generalized. Moreover, the study would have been more extensive and informative if the clinical findings and other relevant laboratory investigations were also included as study variables. More studies with large sample sizes and controls are recommended for further study and validation of the findings.

Conclusion

This study describes the HRCT chest imaging features for the diagnosis of COVID-19 patients. The most common CT chest manifestation of this study was ground-glass opacities, while atelectatic bands, interlobular septal thickening, consolidation, GGO and consolidation, and crazy-paving pattern were other important findings. The lesions were multifocal, involving both lungs with lower lobe predominance. HRCT chest can also give a CT severity score based on the lobar area of lung involvement. Thus it is pertinent to be familiar with the various CT chest imaging findings in COVID-19 cases for timely diagnosis and to prognosticate for proper management of these patients.

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