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ORIGINAL RESEARCH ARTICLE

CLINICAL CHARACTERISTICS AND CHEST X-RAY AND COMPUTED TOMOGRAPHY FINDINGS IN DIFFERENT CLINICAL SEVERITY GRADING OF COVID-19 PATIENTS

Sailesh Gurung[1,*], Shital Adhikari[1], Madhur Dev Bhattarai[1], Basanta Gauli[1], Deepak Adhikari[2], Bigyan Poudel[2], Niraj Puri[1], Pratik Wagley[1], Sunil Patel[1]

[1]Department of Pulmonary and Critical Care Medicine, Chitwan Medical College Teaching Hospital, Bharatpur, Nepal
[2]Department of Radiology, Chitwan Medical College and Teaching Hospital, Bharatpur, Nepal

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***Correspondence to:** Sailesh Gurung, Department of Pulmonary and Critical Care Medicine, Chitwan Medical College Teaching Hospital, Bharatpur, Nepal.*
Email: docsai4u@gmail.com

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ABSTRACT

Background: Clinical assessment, chest X-ray (CXR) and high-resolution computed tomography (HRCT) are used in the Corona virus disease-19 (COVID-19) management. The aim of the study was to determine the clinical characteristics and CXR and HRCT findings in COVID-19 patients with different clinical severity.

Methods: This was a hospital-based cross-sectional study conducted at Chitwan Medical College, Department of Pulmonary and Critical Care Medicine from September to December 2020. Data from sixty adult patients with moderate (non-severe), severe, and critical COVID 19 disease having both CXR and HRCT were collected and were analyzed using SPSS version 16.

Results: Median age of patients in our hospital-based study was 59.9 years and 76.7% were male, 30% had diabetes, and 35% had hypertension. Respiratory rate (p=0.001) and shortness of breath (p= 0.011) significantly increased and oxygen saturation (SpO2) (p<0.001) decreased with increase in clinical severity of COVID-19 disease. Among the moderate, severe and critical clinical severity groups, there was significant difference in the HRCT findings like ground-glass opacity (GGO), consolidation, septal thickening, crazy paving pattern, bronchiectasis and fibrosis (p<0.05). GGO was the most common finding. Bilateral consolidation in CXR and multiple lobes in both lungs involvement in HRCT were similar across the moderate, severe and critical clinical severity (p>0.05).

Conclusions: There was no difference in CXR and HRCT findings across moderate, severe and critical clinical severities of COVID-19; future study performing CXR whenever HRCT is done for any indication may similarly indicate the situation in mild COVID-19 disease.

INTRODUCTION

The symptoms of Corona virus disease-19 (COVID-19) infection include fever, cough, shortness of breath, fatigue, loss of taste and smell, diarrhea and others.[1-8] Pneumonia and respiratory failure are common complications and causes of death. Chest X-ray (CXR) is used in the diagnosis of pneumonia. Typical CXR appearances in COVID-19 are now described.[9-12] High-resolution computed tomography (HRCT) of chest is sensitive to detect pneumonia in COVID-19.[13,14] There are studies of CXR and HRCT with some of them focusing on their diagnostic performance of COVID-19 pneumonia.[15-17] Hospitalized patients with COVID-19 are categorized into non-severe, severe, and critical as per the clinical characteristics,[18] and they are treated accordingly managing complications and comorbidities. There are, however, scarce reports of clinical characteristics and CXR and HRCT findings.

The aim of the study was to determine the clinical characteristics and CXR and HRCT findings in patients with different COVID-19 clinical severity grading.

METHODS

This was a hospital-based cross-sectional study conducted during the first wave of COVID 19 pandemic over four months 1st September 2020 to 31st December 2020 (2077/5/16 to 2077/9/16) in the COVID-19 wards and intensive care unit of Chitwan Medical College and Teaching Hospital (CMCTH), Bharatpur Nepal. From the nasopharynx and oropharyngeal swabs COVID-19 infection was diagnosed by reverse transcription polymerase chain reaction (RT-PCR) test, which is the currently the gold standard diagnostic test for COVID-19 with sensitivity of >70%.[9] The patients were managed by the pulmonary and critical care unit. Consecutive Covid-19 adult patients age 18 years and above admitted in the COVID-19 wards and intensive care unit (ICU) having both Chest X-ray and HRCT imaging were included in this study. Written informed consent was taken from the patients. Ethical approval was taken from the CMCTH Institutional Review Board.

Patients with clinical signs of pneumonia with respiratory rate >30 breaths per min, SpO2 <90% on room air, or signs of severe respiratory distress (accessory muscle use and inability

to complete full sentences) were included in the severe group and patients with acute respiratory distress syndrome, sepsis, shock or other conditions requiring life-sustaining therapies in critical illness group.[18] Hospitalized patients without such signs were included as moderate (non-severe) illness group in our study. HRCT scan was performed using multi detector 128 slice system Siemens Somatom definition AS CT scanner. Reconstructed section thickness was 0.75 mm for lung parenchyma and 1.5mm for mediastinal window. All examinations were non-enhanced and no intravenous contrast medium was administered. The HRCT interpretation was performed by two senior consultant radiologists.

The patients were examined and demographics and clinical characteristics like age, gender, duration of symptoms, presenting symptoms, comorbidities, and clinical severity were noted. Chest X-ray findings like consolidation and reticulations, fibrosis and collapse and HRCT findings like ground-glass opacity (GGO), consolidation, septal thickening, crazy paving pattern, bronchiectasis and fibrosis were noted. Clinical, chest X-ray and HRCT findings were recorded in the proforma.

Data was entered in SPSS version 16.0. Median values and interquartile range (IQR) were calculated. Chi square, Fisher's exact and Kruskal Wallis H test tests were used to analyze the data of the participants. P value <0.05 was considered statistically significant.

RESULTS

Total 60 patients with RT-PCR COVID positive admitted in our center were included in the study. The median age of the patients was about 60 years and over three-fourth were male (Table 1). The median duration of the symptoms before admission was 5 days. Fever, cough, and shortness of breath were the most common presentations and diarrhea was uncommon. Shortness of breath was the predominant cause for admission in hospitals in this study. Hypertension was present in more than one-third of the patients and diabetes in about one-third. More than half of the patients had moderate clinical severity, one-third severe clinical severity and remaining critical clinical severity (Table 1).

Table 1: Demographics and clinical characteristics of COVID-19 patients (n = 60)

Characteristics	Frequency (%)
Age (years), median (IQR)	59.5 (46.2 – 69.7)
Gender	
Male	46 (76.7)
Female	14 (23.3)
Duration of symptoms (days), median (IQR)	5 (3 – 7 days)
Presenting symptoms	
Fever	55 (91.7)
Cough	54 (90.0)
Shortness of breath	42 (70.0)
Fatigue	24 (40.0)
Muscle soreness	19 (31.7)
Loss of taste/smell	17 (28.3)
Headache	6 (10.0)
Diarrhea	4 (6.7)
Comorbidity, n (%)	
Hypertension	21 (35.0)
Type 2 diabetes	18 (30.0)
Chronic obstructive lung disease	3 (5.0)
Clinical severity, n (%)	
Moderate	36 (60)
Severe	20 (33.3)
Critical	4 (6.7)

Median age of the patients with critical COVID-19 severity was 66 years and symptoms like fever, fatigue and loss of taste/smell were more common but duration of symptoms were shorter in critical COVID-19 severity group. However, the clinical severity groups were not significantly different by age, gender, duration of symptoms, fatigue, loss of taste/smell and hypertension or diabetes status (p>0.05) (Table 2). Respiratory rate (p=0.001) and frequency of patients with shortness of breath (p= 0.011) significantly increased and oxygen saturation (p<0.001) decreased as the clinical severity of COVID-19 increased (Table 2). Respiratory rate was high and oxygen saturation (SpO2) was low in the critical COVID-19 severity group.

Table 2: Demographics and clinical characteristics of the patients categorized according to COVID-19 clinical severity (n = 60)

Variables	Moderate COVID-19 (n = 36)	Severe COVID-19 (n = 20)	Critical COVID-19 (n = 4)	p-value
Age (years), median (IQR)	59.5 (44.2 – 67.2)	55 (46.2 – 70.8)	66 (59.7 – 75.2)	0.380
Age category, n (%)				
≤ 55 years	16 (44.4)	10 (50.0)	0 (0.0)	0.313
56 – 64 years	8 (22.2)	2 (10.0)	1 (25.0)	
≥ 65 years	12 (33.4)	8 (40.0)	3 (75.0)	
Gender, n (%)				
Male	31 (86.1)	12 (60.0)	3 (75.0)	0.091
Female	5 (13.9)	8 (40.0)	1 (25.0)	
Duration of symptoms (days), median (IQR)	5 (4 – 7)	6 (3 – 7)	3 (3 – 4.5)	0.215
Symptoms, n (%)				
Fever	33 (91.7)	18 (90.0)	4 (100.0)	0.804

Shortness of breath	20 (55.6)	18 (90.0)	4 (100.0)	0.011
Fatigue	14 (38.9)	7 (35.0)	3 (75.0)	0.322
Loss of taste/smell	10 (27.8)	4 (20.0)	3 (75.0)	0.092
Comorbidity, n (%)				
Hypertension	11 (30.5)	9 (45.0)	2 (50.0)	0.132
Type 2 diabetes	12 (33.3)	5 (25.0)	1 (25.0)	0.321
Clinical variables, median (IQR				
Respiratory rate	22 (20 – 24)	26 (22 – 26)	36 (34 – 38)	0.001
Oxygen saturation (SpO_2)	94 (92 – 95)	85 (78 – 89)	76 (64 – 85)	<0.001

The number of lobes and lungs involved in HRCT were not significantly associated with clinical severity of COVID-19 (p >0.05). Similarly, there was no difference in CXR findings between different clinical severities of COVID-19 (p >0.05) (Table 3). Chest X-ray findings primarily showed bilateral consolidation in most patients in the three severity groups. Similarly, HRCT showed multiple lobes and both lungs involved in most patients in the three severity groups. Among the moderate, severe and critical clinical severity groups, there was difference in the distribution of HRCT findings like ground glass opacity (GGO), consolidation, septal thickening, crazy paving pattern, bronchiectasis and fibrosis (p <0.05) (Table 3). GGO was the most common finding. Fibrosis and bronchiectasis were also found to be quite common. Lung fibrosis was noted in up to the half of the total participants. Bronchiectasis was found in one fourth of the patients with critical COVID-19 severity.

Table 3: Chest X-ray (CXR) and high-resolution chest tomography (HRCT) characteristics of the patients with different COVID-19 clinical severity

Variables	Moderate COVID-19 (n = 36)	Severe COVID-19 (n = 20)	Critical COVID-19 (n = 4)	p-value
CXR findings, n (%)				
B/L consolidation	35 (97.2)	20 (100.0)	4 (100.0)	0.234
Reticulations	1 (2.8)	-	-	
HRCT findings				
No. of lobes involved, n (%)				
0	1 (2.8)	-	-	0.112
2	-	1 (5.0)	-	
3	1 (2.8)	-	-	
4	1 (2.8)	-	1 (25.0)	
5	33 (91.7)	19 (95.0)	3 (75.0)	
Lungs involved, n (%)				
No involvement	1 (2.8)	-	-	0.124
Unilateral lung	-	1 (5.0)	-	
Bilateral lungs	35 (97.2)	19 (95.0)	4 (100.0)	
Involved lung lobes, n (%)				
Right upper lobe	34 (94.4)	19 (95.0)	4 (100.0)	0.354
Right middle lobe	33 (91.7)	19 (95.0)	4 (100.0)	
Right lower lobe	35 (97.2)	19 (95.0)	4 (100.0)	
Left upper lobe	35 (97.2)	19 (95.0)	4 (100.0)	
Left lower lobe	35 (97.2)	20 (100.0)	4 (100.0)	
Lesions, n (%)				
GGO*	35 (97.2)	20 (100.0)	4 (100.0)	0.049
Consolidation	4 (11.1)	3 (15.0)	1 (25.0)	
Septal thickening	8 (22.2)	8 (40.0)	2 (50.0)	
Crazy paving pattern	7 (19.4)	8 (40.0)	2 (50.0)	
Fibrosis	17 (47.2)	9 (45.0)	2 (50.0)	
Bronchiectasis	3 (8.3)	2 (10.0)	1 (25.0)	

* Ground-glass opacity

DISCUSSION

In-patients with moderate, severe, and critical grades of clinical severity having chest X-ray (CXR) and HRCT were included in the study. Fever was the most predominant symptom being present in more than 90% of the patients followed by

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cough, shortness of breath and others. In one similar study of hospitalized patients, fever was present in only 44% at hospital admission but eventually 89% of patients had fever sometime during hospitalization.[12]

The median age of the total participants in our hospital-based study was about 60 years, more than three-fourth were male and about one-third had diabetes. This indicates the increased risk of hospital admission among male, increased age and diabetic population due to COVID-19 infection. Median age of the patients with critical COVID-19 severity was 66 years and fever, fatigue and loss of taste/smell were more and duration of symptoms shorter in the critical COVID-19 severity group. However, the clinical severity grading was not significantly different by age, gender, duration of symptoms, fatigue, loss of taste/smell, and hypertension or diabetes status in our study. Diabetes is not a risk factor for COVID-19 infection, though people with both type 1 and type diabetes are at greater risk for a severe course of the disease and mortality.[19-20] In a study of COVID-19 patients undergoing invasive mechanical ventilation in Nepal, presence of diabetes was associated with increased mortality.[21] There were lesser number of participants in the critical COVID-19 clinical severity group as compared to the moderate and severe groups in our study, which may be the reason of lack of observation of significant critical outcomes of COVID-19 infection in people with diabetes or other risk factors like age. As the inclusion criteria in the study was hospital admitted COVID-19 patients having both Chest X-ray and HRCT imaging, it might not have been possible to get the HRCT done in the critically ill-patients.

In our study, respiratory rate and frequency of patients with shortness of breath significantly increased and oxygen saturation decreased as the clinical severity of COVID-19 increased. In other similar studies, shortness of breath was more commonly reported among people who were hospitalized with COVID-19 than among non-hospitalized patients with milder disease.[22,23] Atypical presentations of COVID-19 occur often; and older adults and people with medical comorbidities experienced fever and respiratory symptoms later during the course of illness than people who are younger or who do not have comorbidities.[24,25]

In our study, chest X-ray findings as well as the number of lobes and lung involved and distribution of involved lung lobes in HRCT were not significantly associated with clinical severity of COVID-19. Both chest X-ray and HRCT similarly indicated the lung involvement in moderate, severe and critical clinical severity groups. HRCT showed multiple lobes and both lungs involved in most patients in the three severity groups and chest X-ray findings primarily showed bilateral consolidation in most patients in the severity groups. Typical chest X-ray findings in COVID-19 infection include bilateral patchy opacities with mid to lower lung zone predominance, often peripheral and rounded, bilateral multifocal or diffuse air space disease.[9-11] Bilateral lower zone consolidation is frequently seen in COVID-19.[11] In the studies of chest X-ray and HRCT focusing on their diagnostic performance of COVID-19 infection, HRCT scan is reported to have better performances than chest X-ray in detecting the positive COVID-19 infection.[15-17] Influenza and other viral pneumonia, organizing pneumonia, drug toxicity and connective tissue disease can, however, cause a similar imaging pattern like the typical HRCT appearance of COVID-19.[9] The American College of Radiology strongly urges caution that an abnormal HRCT is not specific for COVID-19 diagnosis.[26] For infective conditions, microbiological diagnosis is required. Imaging is not recommended for screening and the role of chest imaging is best utilized for the management of COVID patients with moderate or severe and/or worsening symptoms to look for complications.[9,27]

The number of pulmonary lobes involved in HRCT were not significantly associated with clinical severity of COVID-19 ($p > 0.05$). Similarly, there was no difference in CXR findings between different clinical severities of COVID-19 ($p > 0.05$) (Table 3). Chest X-ray findings primarily showed bilateral consolidation in most patients in the three severity groups. Similarly, HRCT showed multiple lobes and both lungs involved in most patients in the three severity groups. Among the moderate, severe and critical clinical severity groups, there was significant difference in the distribution of HRCT findings like ground glass opacity (GGO), consolidation, septal thickening, crazy paving pattern, bronchiectasis and fibrosis. GGO, the most common finding, consolidation, septal thickening and crazy paving patterns were present as per the literature.[13,14] Fibrosis and bronchiectasis were, however, found to be quite common. Fibrosis finding was noted in up to half of the total participants and bronchiectasis in one fourth of the patients with critical COVID-19 severity. Such findings may be due to the combination of various reversible or irreversible acute lesions or the preexisting undiagnosed lung diseases. Preexisting bronchiectasis and fibrosis not only may make the lung vulnerable to have severe COVID-19 pneumonia but also may be falsely ascribed to the post-COVID effect if there is no baseline scan.

Respiratory rate and oxygen saturation along with other clinical characteristics are the criteria of defining clinical severity in COVID-19.[18,28] In our study, though shortness of breath, increased respiratory rate and decreased oxygen saturation were significantly associated with clinical severity of COVID-19, consolidation findings in chest X-ray and multiple lobes and both lungs involvement in HRCT were similar across the moderate, severe and critical clinical severity. Due to the ergonomical nature of CXR, several professional societies have indicated its preferable use in the routine management of COVID-19 unless the features of respiratory worsening and complications warrant the need of HRCT.[9,27] As such, in critical patients on mechanical ventilation and other life-sustaining therapies, it may be difficult to transport them for CT scan. Most of the radiological societies, do not promote Point of Care Ultrasound (POCUS) in the diagnosis or management of COVID-19 pneumonia.[9] The American College of Radiology recommends that CT chest should be used sparingly and reserved for hospitalized, symptomatic patients with specific clinical indications for CT.[26] Chest X-ray has, thus, emerged as the frontline diagnostic modality in COVID-19 management in conjunction with clinical assessment and laboratory

parameters.[9] Others have also concluded that clinical triage is safely assisted by chest X-ray and an integrated algorithm using first-line chest X-ray and contingent use of HRCT can help optimize management and prognostication of COVID-19.[16] The approach to the management of COVID-19 patients is based on clinical assessment and oxygen saturation along with monitoring and management of associated complications and co-morbidities.[18,28] Clinical assessment including SpO2 along with first-line chest radiography use can guide the management of COVID-19 patients which can be supported by further required use of CT chest and other investigations. There were several limitations in our study. The inclusion criteria of having both HRCT and chest X-ray might have limited the achievement of a larger sample size. Our present sample size was mostly achieved due to the high number of COVID-19 patients admitted in the CMCTH from different parts of plain region of Nepal; it was more than seventeen hundred in one year. Furthermore, due to the possible reasons of difficulty in transferring the critical patients for HRCT, there were lesser number of patients included in critical COVID-19 clinical severity group. The patients were, however, distributed across both moderate and severe COVID-19 clinical severity. Increasing the duration of study could have increased the total and critical patient numbers. Similarly, chest X-Ray and HRCT might also have been selectively done in the study by the physicians managing the patients and some of the imaging might have been done from outpatient or emergency department and the day of chest X-ray and HRCT might not have been matched. We did not compare the CT Severity Score (CTSS) and X-Ray Chest Severity Score (CXRSS) in our study. The maximum CTSS is 25 and maximum CXRSS 8.[9,14,29,30] The severity score with limited range may have lesser chance of showing statistical difference than the severity score with wider range. Lastly, due to the bilateral lung involvement in moderate, severe and critical COVID-19 pneumonia, there might not have been difference chest radiograph and HRCT involvement among them in our study. As it is a hospital-based study, there were no COVID-19 patients with milder severity and imaging findings, where HRCT could have shown lesions not detected by Chest X-ray. However, the imaging may be normal in the first week of COVID-19 infection and imaging is not indicated for patients with mild features of COVID-19 unless they are at risk for disease progression.[9,27]

CONCLUSION

The study of clinical characteristics, chest X-ray and computed tomography of chest findings in the hospitalized patients with different COVID-19 clinical severity grading found that shortness of breath and respiratory rate increased and SpO2 decreased as the clinical severity of COVID-19 increased and there was no difference in CXR and HRCT involvement across different clinical severities of COVID-19. GGO was the commonest finding in HRCT chest and consolidation in CXR. Clinical assessment of shortness of breath, respiratory rate and oxygen saturation (SpO2) along with chest X-ray can, thus, lead the routine management of COVID-19 patients which can be supported by further required use of CT chest and other investigations. Future study performing CXR whenever HRCT is done for any indication may similarly indicate the situation in mild COVID-19 disease.

CONFLICT OF INTEREST: None

FINANCIAL DISCLOSURE: None

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