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Computed Tomography Chest Findings in COVID-19 Patients

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ABSTRACT

Background: COVID-19 which has caused significant morbidity and mortality around the world has been declared by the World Health Organization to be a global health emergency. Our objective was to find out the lung parenchymal patterns commonly evident in high resolution Computed Tomography in patients with COVID-19 pneumonia.

Methods: A retrospective cross-sectional study was conducted at a tertiary multi-specialty hospital in Kathmandu, Nepal. With ethical clearance from the institutional review board, a total of 235 patients with positive reverse transcriptase polymerase chain reaction for COVID-19 and having respiratory symptoms were included in the study. High Resolution Computed Tomography images of chest were retrieved from picture archiving and communication systems retrospectively and studied for the findings commonly attributed to COVID-19 pneumonia. The data was then analyzed using Stata version 14 (Stata Corp, College Station, TX, USA). Descriptive statistics were presented as mean and median while chi-square test was used to assess the association between socio-demographic characteristics and CT severity indices.

Results: Out of 235 patients, 174 (74.0%) were males and 61(26%) were females with a mean age of 54.8±14.5 years. The most commonly encountered pattern of pulmonary changes was bilateral involvement in 222 (94.5%) patients followed by ground-glass opacities in 218 (92.8%) patients and peripheral predominance of ground-glass opacities in 211 (89.8%) patients.

Conclusions: Chest Computed Tomography abnormalities are common in COVID-19 positive patients with respiratory symptoms. These findings can guide in the assessment of the severity of the disease as well as patient management.

Keywords: Computed Tomography; COVID-19; ground-glass opacities; reverse transcriptase polymerase chain reaction

INTRODUCTION

Cases of pneumonia of unknown aetiology were reported in China on December 31, 2019.[1] On January 9, 2020, Chinese scientists identified the pathogen to be coronavirus, named the novel coronavirus 'SARS-CoV-2' by the International Committee on Taxonomy of Viruses and later 'COVID-19' by the World Health Organization (WHO). COVID-19 was then declared as a global pandemic, by the WHO on March 11, 2020.[2]

Several studies have described chest findings on computed tomography (CT) of COVID-19 pneumonia. Most common abnormalities found are ground-glass opacities (GGO), consolidation and interlobular septal thickening.[3]

COVID-19 infection is also rampant in Nepal with approximately 757,000 positive cases and approximately 10,000 deaths by the end of July 2021.[4] However, limited studies have been conducted in Nepal in the CT findings of COVID-19 pneumonia. So this study was conducted to find the CT abnormalities in COVID-19 positive patients with respiratory signs and symptoms.

METHODS

A retrospective cross-sectional study was conducted in Grande International Hospital, Nepal, a tertiary level Hospital from March 2020 to November 2020. After obtaining ethical approval from Grande International Hospital Institutional Review Committee (Reference no. 21/2020), a total of 235 patients with COVID-19 infection confirmed by laboratory testing with reverse transcriptase polymerase chain reaction (RT-PCR) of respiratory secretions obtained by nasopharyngeal

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swab and oropharyngeal swab and having respiratory symptoms were included in the study. Computed Tomography images with significant artefacts were excluded from this study.

Volume scan was obtained from lung apices to upper abdomen in supine position in end-inspiration in Toshiba Prime Aquilion 160 slice CT scan. High resolution images with slice thickness of 1 mm were then reconstructed using appropriate reconstruction algorithm. Non-ionic intravenous contrast was used in the patients who required pulmonary angiography.

CT images were independently reviewed by at least two radiologists with experience of 5 to 13 years using a high-resolution Toshiba Vitrea workstation & the picture archiving and communicating system (Magnum imaging software).

Ground glass opacity (GGO) was defined as hazy increased lung attenuation with preservation of bronchial and vascular margins and consolidation as opacification with obscuration of margins of vessels and airway walls. Crazy paving pattern was described as scattered or diffuse GGO with superimposed interlobular septal thickening and intralobular lines. For each patient, the chest CT scan was evaluated for the following characteristics (Fig. 1 and 2): GGO; consolidation; peripheral predominance of GGO and consolidation; interlobular septal thickening, bilateral involvement, crazy paving pattern, halo sign, lower lobe involvement, subpleural band, vascular dilatation, associated fibrotic changes, bronchiectasis, associated lung nodules, pleural effusion, pericardial effusion, presence of thoracic lymphadenopathy (defined as lymph node size of >10 mm in short-axis dimension), presence of underlying lung disease such as emphysema or fibrosis and dilated main pulmonary artery (defined as >29mm in diameter).[5]

The CT severity score index was also evaluated which is a scoring system that assesses the lung involvement by COVID-19 pneumonia based on an approximate estimation of areas of lung parenchymal involvement as described by Pan et al.[6] Each of the five lung lobes was visually scored and given a score from 1 to 5:- 1 representing less than 5% lobar involvement, 2: 5-25% lobar involvement, 3: 26-50% lobar involvement, 4: 51-75% lobar involvement and 5: > 75% lobar involvement. Then, the final score was the summation of individual lobar scores and will be out of 25 (total score).The total lung involvement (severity index) is then obtained by multiplying the total score times 4.[6-8]

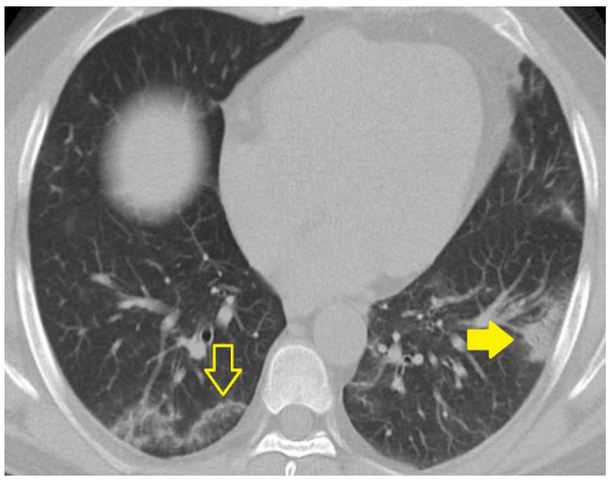

Figure 1. CT chest axial section showing areas of consolidation (solid arrow) and subpleural bands (hollow arrow) with posterior and lower lobar predominance.

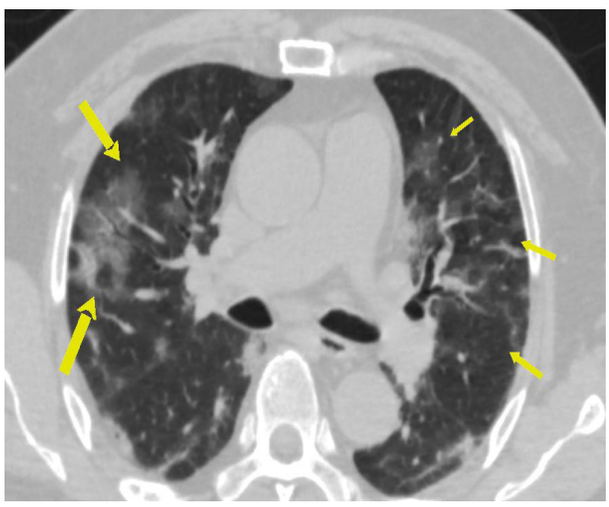

Figure 2. CT chest axial section showing patchy areas of GGO with peripheral predominance in bilateral lung field.

Statistical analysis: Data were collected using EpiCollect version 5.0 and analyzed using Stata version 14 (Stata Corp, College Station, TX, USA). Descriptive statistics were presented as mean, standard deviation and median (interquartile range IQR) based on the distribution for continuous variables and proportions for categorical variables. Chi-square test was used to assess the association between socio-demographic characteristics and CT severity indices.

RESULTS

A total of 235 patients with positive RT-PCR reports for COVID-19 were included in the study. Of total, 174 (74.0%) were males and 61 (26.0%) were females. The mean age of the patients was 54.8 ± 14.5 years. The most commonly encountered pattern of pulmonary changes was bilateral involvement (94.5%) followed by GGO (92.8%) and peripheral predominance of GGO (89.8%) (Table 1).

The median (IQR) CT severity score was 11 (range 8-14). Of total, 14 (6%) patients were in the severe (score > 18) category and maximum number of patients (129; 54.9%) had CT total lung involvement score of 3 (Table 2).

Out of the 79 patients who had more than 50 % involvement, 28 were more than >60 years of age and 47 were between 30-60 years of age (Table 3).

There was no significant association between CT severity index with gender (p = 0.53) and age category (p =0.19).

Table 1. CT findings in patients with COVID-19 (n=235)

Findings	Frequency	Percentage (%)
ILS thickening	154	65.5
GGO	218	92.8
Consolidation	197	83.8
Bilateral	222	94.5
Crazy paving	48	20.4
Peripheral involvement	211	89.8
Lower lobe involvement	181	77.0
Sub pleural band	116	49.4
Bronchiectasis	25	10.6
Vascular dilatation	29	12.3
Fibrotic change	48	20.4
Lung nodules	12	5.1
Pleural effusion	27	11.5
Pericardial effusion	20	8.5
LN	57	24.3
PAH	19	8.1

ILS = interlobular septa, GGO = ground glass opacities, LN = lymph node, PAH = pulmonary arterial hypertension

Table 2. CT severity score and total lung involvement with COVID-19. (n=235).

CT severity score	Frequency	Percentage (%)
Non severe	221	94.0
Severe (> 18)	14	6.0
CT total lung involvement		
Score 1 (< 5%)	3	1.2
Score 2 (5-25%)	24	10.2
Score 3 (26-50%)	129	54.9
Score 4 (51-75%)	65	27.7
Score 5 (> 75%)	14	6.0

Table 3. Association between CT severity index with gender and age with COVID-19 (n=235).

	Total	Score 1	%	Score 2	%	Score 3	%	Score 4	%	Score 5	%	p value
Gender												0.53
Male	174	2	1.2	15	8.6	94	54.0	52	29.9	11	6.3	
Female	61	1	1.6	9	14.8	35	57.4	13	21.3	3	4.9	
Age category (in years)												0.19
< 30	12	0		4	33.3	4	33.3	2	16.6	2	16.6	
30 - 59	138	2	1.5	13	9.5	76	55	40	29	7	5	
> 60	85	1	1.2	7	8.2	49	56.7	23	27.0	5	5.9	

DISCUSSION

The ongoing COVID-19 pandemic has seen millions of people infected worldwide, affect the whole of humanity and has warranted significant international attention. Typical CT imaging features in patients with COVID-19 pneumonia have been described in detail in previous studies. It has been widely accepted that Chest CT imaging plays a very important role in the diagnosis and thorough evaluation of COVID-19 pneumonia. Evaluation of CT imaging features of COVID-19 has become crucial in clinical practice for effective patient management.

In this study, more males were affected as compared to females. This was in agreement with the study done by Borghasi et al. in Italian patients which showed that COVID-19 infection affected males more than females, which might be attributed to the biological /socio-cultural, differences between men and women.[9] In our study there was no significant association between CT

severity index with gender (p-value = 0.53) and age category (p=0.19). The discrepancy could be due to early hospital presentation of patients of advanced age who are afraid of more complications and late presentation of young- middle age patients (30-60 years) who are more reluctant to visit the hospital without severe discomfort. Another explanation for this could be early lockdown imposed by the government, which significantly restricted movement of the elderly population; however, the lockdown saw movement of essential workers, which mostly included young to middle aged people.

The current study revealed that the bilateral lung involvement was the most common encountered pattern of pulmonary changes. Ground glass opacities, peripheral and lower lobe predominance were common findings. Pleural effusion, pericardial effusion and lymphadenopathy were uncommon findings. This was similar to a study done by Hugo J.A.Adams et al., which showed posterior predilection in 90.0% of cases, ground-glass opacity in 81.0%, bilateral abnormalities in 75.8%, and right lower lobe involvement in 72.2%.[10] Another meta-analytic study done by Xiuxiu Zhou et al.[11] also showed similar findings in 2630 patients, in which bilateral distribution (seen in 74% of patients), peripheral distribution (81% of patients), thickening of small vessels (70% of patients), GGO (68% of patients) and patchy (60% of patients) were the most common CT features. While findings such as pleural effusion, pericardial effusion, mediastinal lymphadenopathy, and lung nodules were less common in this systematic review which is similar to the findings in our study.

However, this study had some limitations; which include absence of clinical correlation, the unavailability of other laboratory data and absence of follow up studies. Furthermore, this is a hospital not a population-based study. It is thus recommended to perform future studies with inclusion of aforementioned factors to better understand the spectrum of covid-19 infection.

CONCLUSIONS

High resolution computed tomography demonstrates characteristic findings in patients with COVID-19. Cluster of CT lung parenchymal pattern commonly observed with COVID-19 pneumonia can help identify the COVID-19 pneumonia and can act as a solution to diagnostic dilemma if such a situation arises where other diagnostic tests are inconclusive.

CONFLICT OF INTEREST

The authors declare no conflict of interest

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