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CT Imaging Features of Patients with COVID-19 at a Tertiary Care Hospital: Experience from Pakistan

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A B S T R A C T

Background: Coronavirus disease 2019 (COVID-19) patients' manifest symptoms of mild to severe disease leading to acute respiratory distress syndrome (ARDS) and multi-organ dysfunction. Chest computed tomography (CT) is considered as one of the important modalities for the diagnosis and assessment of progression of disease. Bilateral ground glass opacification with a predominant peripheral distribution seen with consolidation and interstitial thickening on CT scan are currently considered the radiological hallmarks of the disease.

Objective: The objective of the present is to determine the salient features of CT chest in patients with COVID-19 from the largest tertiary care centre in Karachi, Pakistan.

Methodology: This cross-sectional research study was conducted at the Aga Khan University Hospital from April 2020 to December 2020. Adult patients who had a positive COVID-19 PCR and underwent CT scan chest were included in the study. Patients were scanned in supine position using either non-contrast high-resolution CT (HRCT), arterial phase chest CT, or CT pulmonary angiogram (CTPA). The CT findings recorded included presence or absence of ground glass opacity (GGO), consolidation, air bronchogram, vascular enlargement, linear opacities, crazy paving, halo sign, reverse halo sign, fibrosis, cavities, tree in bud, mediastinal/hilar lymphadenopathy, pleural effusion, and any additional finding such as pneumothorax or pneumomediastinum or traction bronchiectasis.

Results: Of 110 patients, 70 (63.7%) were males and 40 (36.3%) were females with mean age of 56.5 ± 14.8 years (range 46-67 years). Ground glass opacity (GGO) was the most common (79.1%) CT feature, followed by consolidation (56.4%), linear opacities (40%), and crazy paving pattern (32.7%). The common distribution of the abnormalities according to HRCT and contrast CT were peripheral (54.1%) and both peripheral & central (60%), respectively.

Conclusion: GGO is the most common CT scan feature in patients with COVID-19, followed by consolidation, linear opacities, and crazy paving pattern.

Key words: Coronavirus; COVID-19; Computed Tomography; HRCT; Ground Glass Opacity

Introduction

Coronavirus disease 2019 (COVID-19) pandemic has affected and taken the lives of millions of individuals. Labelled as global pandemic by the World Health Organization (WHO), the disease is a major challenge for the health care worldwide.[1] Majority of the patients usually manifest symptoms of mild to moderate disease while few, especially those with co-morbidities and those who are elderly, might progress to severe disease leading to acute respiratory distress syndrome (ARDS) and multi-organ dysfunction.[2]

Chest computed tomography (CT) is considered as one of the important modalities for the diagnosis and assessment of progression of disease. Bilateral ground glass opacification with a predominant peripheral distribution seen with consolidation and interstitial thickening on CT scan are currently considered the radiological hallmarks of the disease.[3] Multiple studies have mentioned the classical imaging features of chest CT in COVID-19.[4-6] Among the 121 patients selected by Bernheim et al., ground glass opacity (GGO) and consolidation were the most common findings reported on CT.[7] Another study performed at New York comprising of 76 patients with COVID-19 who underwent abdominal CT scan reported peripherally distributed GGOs as their major finding.[8] Alam S et al. described CT scan features in patients with COVID-19 in Bangladesh and found that GGOs with consolidation was the most frequent abnormality seen.[9] Study from India and Iran also reported GGOs as the most frequent abnormality with bilateral involvement and peripheral predominance.[10-11] Studies from Pakistan also highlight similar findings of GGO and consolidation.[12-14] Therefore, the present study aimed to determine the salient features of CT chest in patients with COVID-19 from the largest tertiary care centre in Karachi, Pakistan.

Methodology

This cross-sectional research study was conducted at the Aga Khan University Hospital from April 2020 to December 2020. Adult patients who had a positive

Table 1. CT Scan Findings (n=110)

CT Features	Total	HRCT; 79 n (%)	Contrast; 31 n (%)
Patterns of disease			
Ground glass opacity	87 (79.1)	60 (75.9)	27 (87.1)
Consolidation	62 (56.4)	44 (56.4)	18 (58.1)
Halo sign	1 (0.9)	1 (1.3)	
Reverse Halo sign	2 (1.8)	2 (2.5)	
Crazy paving pattern	36 (32.7)	22 (27.8)	14 (45.2)
Tree in bud	1 (0.9)	1 (1.3)	
Vascular enlargement	27 (24.5)	13 (16.5)	14 (45.2)
Pleural effusion	8 (7.3)	4 (5.1)	4 (12.9)
Air bronchogram	34 (30.9)	21 (26.6)	13 (41.9)
Linear opacities	44 (40)	30 (38)	14 (45.2)
Fibrosis/fibrotic bands	21 (19.1)	15 (19)	6 (19.4)
Cavities	2 (1.8)	2 (2.5)	
Lymphadenopathy	7 (6.4)	4 (5.1)	3 (9.7)
Distribution			
Peripheral		40 (54.1)	12 (40)
Central		1 (1.4)	0
Peripheral & Central		31 (41.9)	18 (60)
CT severity score; n=101			
Mild		25 (35.2)	2 (6.7)
Moderate		24 (33.8)	7 (23.3)
Severe		22 (31)	21 (70)

Abbreviations: CT, Computed Tomography; HRCT, High Resolution Computed Tomography

COVID-19 PCR and underwent CT scan chest were included in the study. Five hundred and eighteen patients who underwent CT scan chest during the study period were selected for screening. One hundred and twelve patients with positive COVID-19 PCR were selected for review and two patients were later excluded as they had chronic changes on CT scan due to underlying comorbidities.

CT Protocol

Patients were scanned in supine position using either non-contrast high-resolution CT (HRCT), arterial phase chest CT, or CT pulmonary angiogram (CTPA) according to the departmental protocols on a 640 slice multidetector CT scanner (One Aquilion, Toshiba America Medical Systems, Inc). Axial images along with sagittal and coronal reformations were available in all cases. The scanner and the room were appropriately disinfected after each patient according to the recommendations of the institute's infectious disease committee.

CT Image Analysis

The chest CT images were reviewed individually by two radiologists with more than 12 years of experience on a picture archiving and communication system (PACS). Any discrepancies in interpretation were resolved by consensus. The radiologists were aware of the RT-PCR test results.

Chest CT images were evaluated on both mediastinal (width 400 HU, level 40 HU) and lung (width 1600 HU, level -700 HU) windows.

HRCT findings were described according to the recommendations of the Nomenclature Committee of the Fleischner Society.[15] The CT findings recorded included presence or absence of ground glass opacity (GGO), consolidation, air bronchogram, vascular enlargement, linear opacities, crazy paving, halo sign, reverse halo sign, fibrosis, cavities, tree in bud, mediastinal/hilar lymphadenopathy, pleural effusion, and any additional finding such as pneumothorax or pneumomediastinum or traction bronchiectasis. The presence of pulmonary embolism was assessed in patients undergoing contrast enhanced CT scans.

The distribution of the abnormalities was recorded as either central (involving inner two-third of lung), peripheral (involving outer one-third) or both. A semi-quantitative visual severity score was employed for each lung lobe: score 0 (0% involvement); score 1 (<50% involvement); score 2 (> or =50% involvement) giving a final cumulative severity score from 0 to 10 for each patient. The severity of the disease was graded as no disease (score of 0); mild (cumulative score of 1-3); moderate (cumulative score of 4-6) and severe (cumulative score of 7-10).

Statistical Analysis

The statistical analysis was performed with Statistical Package for Social Sciences (SPSS). Categorical data

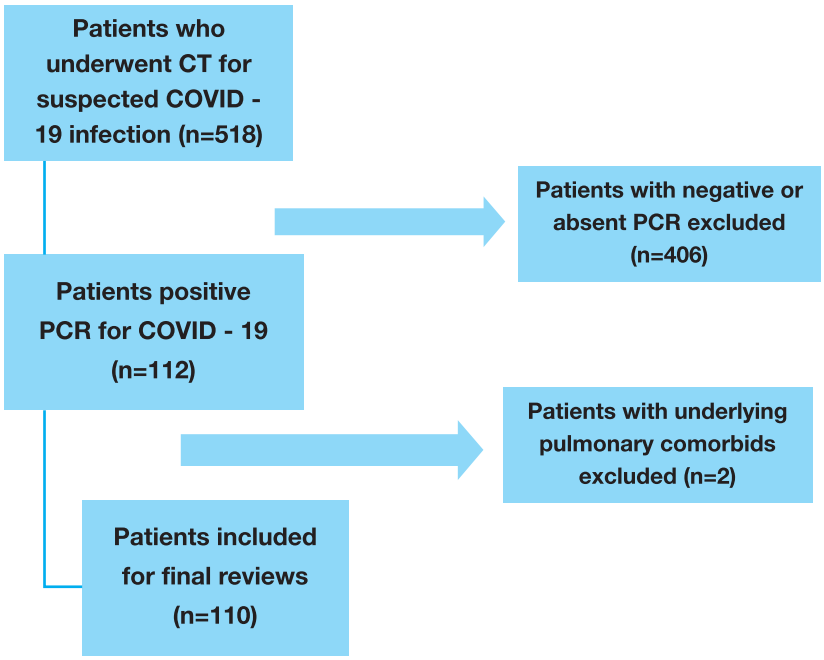

Figure: Selection of Patients

were reported as frequencies and percentages, and continuous variables were expressed as mean ± standard deviation or as median and interquartile range unless stated otherwise.

Results

Among the study cohort of 110 patients, 70 (63.7%) were males and 40 (36.3%) were females with mean age of 56.5 ± 14.8 years (range 46-67 years). Seventy nine of the 110 patients underwent HRCT scan and 31 underwent contrast chest CT scan on the discretion of the attending physician. Ground glass opacity (GGO) was the most common (79.1%) CT feature, followed by consolidation (56.4%), linear opacities (40%), and crazy paving pattern (32.7%). The common distribution of the abnormalities according to HRCT and contrast CT were peripheral (54.1%) and both peripheral & central (60%), respectively. The results of the analysis are shown in Table 1.

Discussion

CT scan chest is a key tool of investigation in diagnosis of COVID-19 disease. Studies from across the world have identified specific CT scan patterns that can aid in the diagnosis of the disease. We conducted a retrospective study and analysed the spectrum of CT scan features in our population. Our study concluded that GGOs are the most common abnormality found in chest CT scan of COVID-19 patients, followed by consolidation. Certain atypical CT features like halo sign, lymphadenopathy and cavitation were also seen.

In accordance with the findings of studies done in China, Bangladesh, India, and Iran, we found that GGOs were the most frequent abnormality seen in our cohort. In our population, 79% of the patients had GGOs in comparison with 94% in Iran , 100% in India and Italy , and 91% and 86% in China. Consolidation was seen as the second most frequent abnormality 56.4%, followed by crazy paving pattern 32.7%.

Our results are in accordance with the systematic reviews done by Zhonghua et al. and Sana et al. with GGOs and consolidation being the most common CT abnormalities. However, our population showed slightly higher prevalence of GGOs (79% versus 69.9%) in comparison with Cao et al. Our results also elaborated that majority of the GGOs are peripheral and basal in location which is in accordance with the findings of Ng et al. and Sana et al. Lymphadenopathy, an atypical feature, was seen in 6.36% of patients in our population as compared to 58% in Italy, 4% in China, and 0% in India.

Halo sign and cavitation are CT scan features rarely documented in COVID-19. Only 12% of patients in Italy had halo sign and none had cavitation. Cavitation has not been documented from study in India; however, halo sign has been mentioned in the meta-analysis by Cao et al. . In our study, we had 1.8% of the patients with cavitation and 0.9% patients with halo sign.

An interesting Chest CT feature was the presence of fibrotic bands in 19.1% patients in our cohort. Although not a sign of early or acute disease, fibrotic changes have been defined previously in acute as well as recovery phase of the COVID-19 disease .

Limitations: Our study had few limitations. Sample size was too small. No correlation was addressed between laboratory parameters and chest CT scan findings and only 11 patients underwent follow up chest CT scans.

Conclusion

In conclusion, GGO is the most common CT scan feature in patients with COVID-19, followed by consolidation, linear opacities, and crazy paving pattern. The common distribution of the abnormalities according to HRCT and contrast CT are peripheral and both peripheral & central, respectively. Over two-third of the COVID-19 patients demonstrate severe disease on contrast chest CT.

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