Original Article

Imaging of COVID-19: Experience in BIRDEM General Hospital

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ABSTRACT

Background: *Pneumonia associated with the coronavirus disease 2019 (COVID-19) emerged in Wuhan of China which was recognized as a global health emergency. Role of imaging, specially high resolution computed tomography (HRCT) of chest is considered as an important tool in the early diagnosis, evaluation of disease progression and prompt management of COVID-19 patient in this global health pandemic. This study was designed to report the spectrum of HRCT imaging findings in COVID-19 infected patients.*

Methods: *This cross-sectional study included 30 consecutive reverse transcriptase polymerase chain reaction (RT-PCR) positive COVID-19 patients who underwent HRCT chest from 1st of September 2020 to 30th October 2020 in BIRDEM General Hospital. Dhaka, Bangladesh. Prevalence, distribution, extent and type of abnormal lung findings were recorded.*

Results: *Total 30 patients diagnosed with COVID-19 were included. Among them, 26 (86.6%) patients had fever and 17 (66.66%) patients had fatigability. The most frequent CT abnormality was ground glass opacity in (26, 86.67%). Crazy-paving pattern was found in 19 (63.33%) cases. Most patients had multiple lesions and involved all the 5 lobes The lesions were mostly peripheral (26, 86.6%) in distribution. Most commonly involved lobe is right lower lobe (27, 90%).*

Conclusion: *Radiology & Imaging, specially HRCT of chest is an excellent modality in diagnosis of disease, evaluation of progression of disease, evaluation of post COVID-19 patient and prompt management of COVID-19 patient in this global health emergency.*

Key words: *corona virus disease 2019, ground glass opacity, high resolution computed tomography, reverse transcription polymerase chain reaction, World Health Organization.*

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INTRODUCTION

Coronavirus disease 2019 (COVID-19) is an infectious disease caused by severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2), a strain of coronavirus.[1] The first cases were seen in Wuhan, China, in December 2019 before spreading globally, with more than 1.2 million deaths and 47 million cases now confirmed. The current outbreak was officially recognized as a pandemic by the World Health Organization (WHO) on 11 March 2020. Until 10th of October 2020, the number of confirmed cases in Bangladesh has risen to 421921, of which 6092 have died.

This new corona virus spread from one person to another primarily through respiratory droplets generated when an infected person coughs or sneezes. COVID-19

usually presents with fever (85%), cough (70%) and shortness of breath (43%), but abdominal and other symptoms are possible and the disease can be asymptomatic.[1,2]

At present, the diagnosis of COVID-19 pneumonia is based on clinical symptoms, contact history of epidemic area, imaging diagnosis and nucleic acid detection. Definitive diagnosis of COVID-19 requires a positive RT-PCR test which is highly specific and less sensitive. Sensitivity is reported as low as 60-70% and as high as 95-97%. Thus, false negatives are a real clinical problem.[3]

Imaging plays a vital role for the diagnosis, management and follow up of COVID-19 patient. High resolution computed tomography (HRCT) of the chest is increasingly recognized as strong evidence for early diagnosis. It has a higher sensitivity but lower specificity. The changes in chest imaging sometimes may be earlier than clinical symptoms and thus HRCT scan plays an early warning role in the diagnosis of COVID-19.[4]

The non-specific imaging findings are most commonly of atypical or organizing pneumonia, typically with a bilateral, peripheral and basal predominant distribution.[2] This study aimed to evaluate the spectrum of HRCT chest findings in COVID-19 patients, to find out grading, severity and percentage of lung involvement in COVID patients and to measure CT severity scoring (CSS) of lung involvement in COVID-19 infection.

METHODS

Study design and subjects

A descriptive cross-sectional study was done on RT-PCR positive COVID-19 patients, who were referred to Department of Radiology & Imaging of BIRDEM General Hospital for HRCT of chest.

Study place and duration

This study was carried out in Radiology & Imaging Department, of BIRDEM General Hospital, Dhaka from 1stSeptember 2020 to 30th October 2020. Verbal consent was obtained from all potential participants/guardians. The aims and benefits of the present study were explained to all the participants in details. Medical history of all study subjects were thoroughly reviewed directly from participants themselves and from case sheet.

Image evaluation

All HRCT chest images were evaluated by the radiologists to detect pulmonary manifestations of COVID-19. Patterns and distributions of lung involvement were observed. Visual quantitative evaluation for each of the five lung lobes were also assessed for degree of involvement. The total severity score and percentage of lung involvement were calculated by summing the score of all five lobes (range of total severity score is 0-25).

Data analysis

The data were collected from CT reports and then stored in data sheet which prepared specially for this task. Data were analyzed by using Microsoft excel and statistical package for the social sciences (SPSS) IBM version 25. Continuous variables were expressed as mean, ranges and standard deviation, whereas categorical variables were expressed as counts and percentages.

HRCT protocol (parameters used)

For all scanning techniques (axial, coronal and/or sagittal), Siemens SOMATOM Definition AS Hi-speed 128 slice multi-detector CT scanner was used to obtain the HRCT of chest. The scanning parameter was 120 kV, 200mAs; matrix was 512×512; scanning time was 0.55 s/circuit; collimator was 0.625 m; pitch was 0.89, FOV 360 mm; scanning thickness was 0.7 mm; reconstruction algorithm: high spatial frequency, level of inspiration: full inspiration. Images were reconstructed using increment of 0.7 mm in to1 mm thick slices. The images were viewed in both lung window set-tings (width 1200–1500 HU; centering -500 to -600HU) and mediastinal window (width 300"400HU; centering 40HU). The scan ranged from the thoracic entrance to the angle plane of the bilateral rib. Proper protections of all the radiology staffs were taken.

RESULTS

Total patients were 30 including 8 (26.67%) females. The demographic data are shown in Table I. Their mean age was 53.97±12.6 years. Highest number of the patients (7, 23.33%) was in age group 61-70 years. Most of the patients presented with fever (26, 86.6%). The patients were also presented with sore throat (14, 46.6%), dry cough (8, 26.6%), headache (11, 36.66%), fatigue (17, 56.66%), shortness of breath (24, 80.0%)

and few were asymptomatic (2, 6.66%). Among 30 patients with RT-PCR positivity, we have found positive HRCT findings in 29 cases. In 1 case the lung findings were normal. Thus in our study we have found that HRCT has a sensitivity of 96.67%.

The most frequent CT abnormalities observed were ground glass opacities (GGO) in 26 (86.67%) cases, GGO plus consolidations in 22 (73.33%) cases and pure GGO were observed in14 (46.67 %) cases. Crazy-paving pattern was seen in 19 (63.33%) cases. Most of the lesions were multiple. GGO with interlobular septal thickening and intralobular lines producing crazy paving pattern was seen in 17 (56.67%) cases.

Thickened vessels were also evident in 21 (70%) cases. A small number of cases showed halo sign (5, 16.67%), sub-pleural band (7, 23.33%), enlarged lymph nodes (2, 6.66%). Thus the most common consistent finding was GGO in peripheral and posterior distribution. There was no significant gender differentiation of HRCT chest findings.

Traction bronchiectasis was observed in 8 (26.67%) cases. Reticulations were seen in 18 (60 %) cases. In 16 (53.3%) cases the distributions were diffuse but predominantly peripheral. The distribution of the lesions in the 30 patients with confirmed COVID-19 pneumonia most commonly involved lobe was right lower lobe (27/30, 90%), followed by left lower lobe (23/30, 76.67%), left upper lobe (16/30, 53.3%), right middle lobe (12/30, 40%) and right upper lobe (13/30, 43.3%).

Out of 29 positive HRCT findings, all 5 lobes were involved in 11 (36.67%) cases, 4 lobes were involved in 6 (20.0%) cases, 3 lobes were involved in 5 (16.67%) cases, 2 lobes were involved in 5 (16.67%) cases and only one lobe was involved in 2 (6.67%) cases. No involvement was seen in only one case (3.33%).

The distribution patterns were as follows: predominant peripheral distribution (26/30, 86.6%) and predominant central distribution (3/30, 10%). Except for 2 patients (2/30, 6.66 %) with a single lesion, the majority of patients (27/30, 90%) had multiple CT abnormalities.

Total severity score was categorized into 6 groups (0, 1-5, 6-10, 11-15, 16-20, 21-25). Ten (33.3%) patients were in total severity score ranging from 16-20. Among others sequential distribution of total severity score ranges are 1-5 (5, 16.67%), 6-10 (4, 13.3%), 11-15 (8, 26.67%), 21-25 (2, 6.67%) and severity score 0 was of 1, 3.33% patients.

In case of total percentage of lung involvement maximum patients 10 (33.3%) were in the range of 61-80% and maximum lung involvement (81-100%) was seen in 2 (6.67%) cases as shown in Table IV.

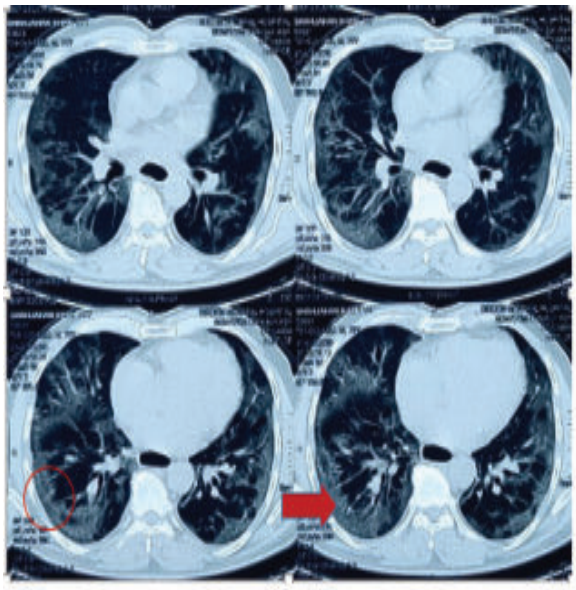

Figure 1 Widespread GGOs with crazy paving without consolidation without architectural distortion

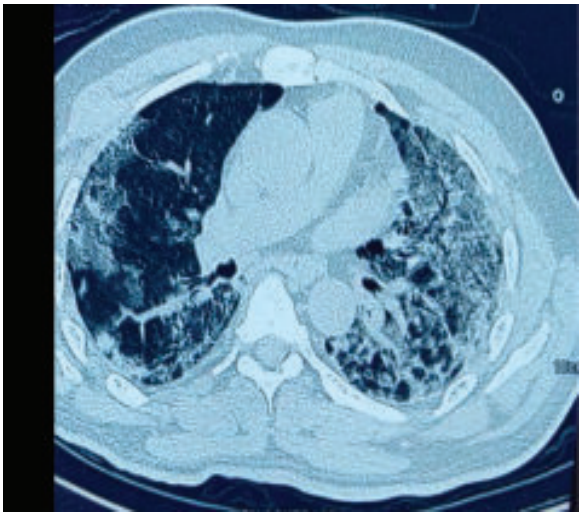

Figure 2 GGOs with consolidation showing air bronchogram

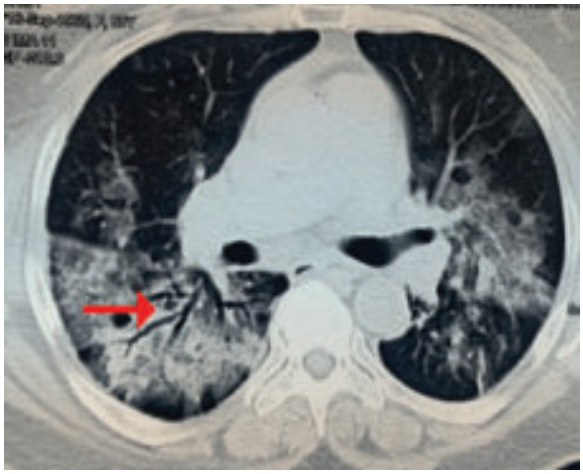

Figure 3 GGOs with traction bronchiectasis

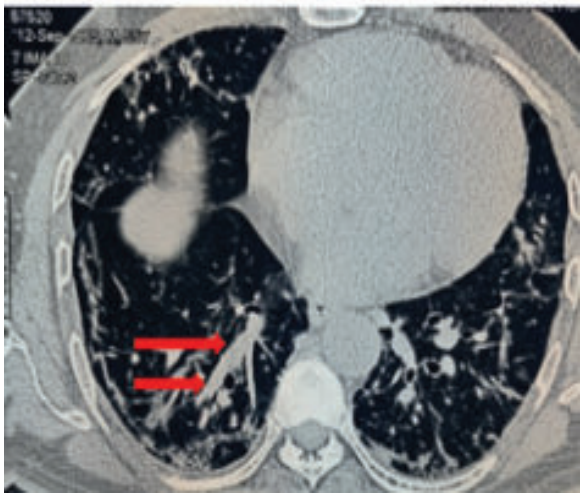

Figure 4 GGOs with dilated vessel

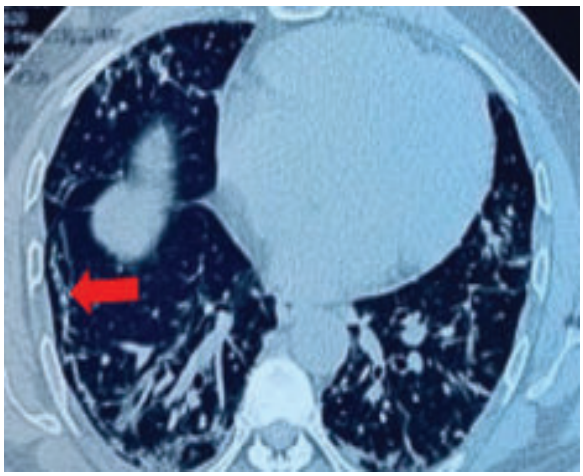

Figure 5 Subpleural bands and architectural distortion

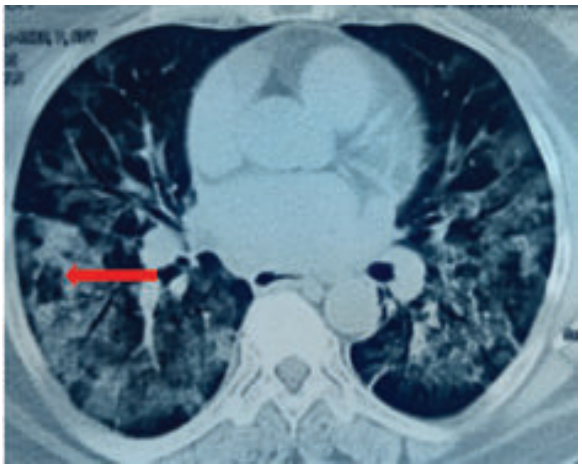

Figure 6 GGOs with reverse halo sign

Table I Demographics and clinical variables of COVID-19 infected patients (N=30)

Characteristics	Number	Percentage
Age (years)		
22-30	2	6.67
31-40	5	16.67
41-50	5	16.67
51-60	6	20
61-70	7	23.33
71-78	5	16.67
Sex distribution		
Male	22	73.33
Female	8	26.67
Clinical features		
Fever	26	86.6
Breathlessness	24	80
Sore throat	14	46.6
Fatigue	17	56.6
Dry cough	8	26.6
Headache	11	36.6
Runny nose	4	13.3
Others	4	13.3

Table II Types of HRCT findings with staging of COVID-19 patients (N=30)

Findings	Number of patients (percentage)
HRCT Patterns	
Ground glass opacity (GGO)	26 (86.67)
GGO with consolidation	22 (73.33)
Crazy paving pattern	19 (63.33)
Reticulations	18 (60)
Thickened vessels	21 (70)
Traction bronchiectasis	8 (26.67)
Reverse halo sign	5 (16.67)
Sub-pleural band	7 (23.3)
Enlarged mediastinal nodes	2 (6.67)
Pleural effusion	0
Stages	
Early (1-4 days)	3
Progressive (5-10 days)	11
Peak (10-13)	10
Absorption (14 or more)	5

Table III Distribution of HRCT findings in COVID-19 cases (N=30)

Number of lobes involved	
0	1 (3.33)
1	2 (6.67)
2	5 (16.67)
3	5 (16.67)
4	6 (20)
5	11 (36.67)
Distribution of involvement	
Predominantly central	3 (10)
Peripheral	29 (96.67)
Diffuse predominantly peripheral	26 (86.67)
Frequency of lobar involvement	
Right lower lobe	27 (90)
Left lower lobe	23 (76.67)
Left upper lobe	16 (53.3)
Right middle lobe	15 (50)
Right upper lobe	11 (36.67)

Table IV CT severity score and lung involvement in COVID-19 cases (N=30)

Findings	Number of patients (%)
Distribution on the basis	
of total severity scor	1 (3.33)
1-5	5 (16.67)
6-10	4 (13.3)
11-15	8 (26.67)
16-20	10 (33.3)
21-25	2 (6.67)
Total percentage of lung involvement	
0%	1 (3.33)
1-20%	5 (16.67)
21-40%	4 (13.3)
41-60%	8 (26.67)
61-80%	10 (33.3)
81-100%	2 (6.67)

DISCUSSION

Chest HRCT manifestations of COVID-19 pneumonia have been widely reported. It has been observed that asymptomatic patients can have a positive chest CT. The converse has also been reported, where symptomatic patients had a negative CT especially during the early phase of the illness.[1]

The present study was conducted on 30 confirmed cases of COVID-19 (RT-PCR positive) in BIRDEM General Hospital Dhaka. In our study we observed that HRCT chest has a sensitivity of 96.67% in diagnosing COVID-19 pneumonia which is similar to other studies. Alam et al reported a sensitivity of about 96.09% in a similar study performed in Combined Military Hospital, Dhaka.[2] Ai T et al in a study to find out the correlation of chest CT and RT-PCR testing in COVID-2019 in China concluded that HRCT has 97% sensitivity in diagnosing COVID-19.[3] Wen Z et al found that HRCT chest has a sensitivity of 93%.[4] A retrospective analysis of Islam et al. done in 250 Bed District Hospital, Moulvibazar showed that the sensitivity of initial HRCT was 95.45%.[5] These studies suggest that HRCT can be used as a standard imaging tool in prompt and timely management of patients.

Among the total study cohort of 30 patients, 22 (73.33 %) were males and male predominance is similar to previous study done by Alam et al and Chen N et al.[6] The reduced susceptibility of females to viral infections might be attributed to the protection from X chromosome and sex hormones, which play an important role in innate and adaptive immunity.[7]

In our study most common symptoms of patients included fever and respiratory distress which are consistent with reports from various countries.[2] However, few patients presented initially with atypical symptoms, such as diarrhea, nausea and vomiting.[8]

Among the patients with lung parenchymal abnormalities on chest CT, bilateral and multilobar distribution of pulmonary opacities with a peripheral predilection were commonly observed. GGO in the form of isolated GGO (46.67 %), GGO with superimposed crazy paving pattern (56.67 %) or GGO admixed with consolidation (73.33 %) were the most dominant lung parenchymal abnormality encountered in all the cases. These findings are in concordance with the multiple studies summarized in the systematic review by Salehi et al.[9] The relative dominance of consolidation may be due to reason of more cases of peak stages. Wu J et al in a study in china found crazy paving pattern in 76.9% cases which is slightly different to our study 63%.[10] The relative dominance of consolidation rather than crazy paving may be due to reason of more cases of peak stages. Wu J et al in another study showed that crazy paving pattern appear in 29% of cases. Thus crazy paving pattern has a wide range of appearance in different study.[11] Peri-lesional or intralesional segmental or subsegmental pulmonary vessel enlargement was observed in 21 (70%) cases which is similar to the study of Parry et al.[1]

Peripheral distribution was found in all patients except one patient. Among them 26 (86.67%) cases showed diffuse predominantly peripheral and only 3 (10%) showed predominantly central distribution. In terms of distribution of the pulmonary opacities Wen Z et al found that out of 82, in 63 (77%) cases the distribution of the lung opacities were peripheral, in 3 (4%) cases the distribution were central and in 16 (20%) cases the distribution were both central and peripheral.[4] Caruso D et al also showed in their study that out of 58 HRCT chest peripherally distributed cases were 52 (89% with a CI of 81-98%) which is similar to our study.[12]

In our Study, maximum patients 33.33% were in group of total severity score 16-20 and highest score 21-25 was found in 2 (6.6%) patients, which is different to the result reported by Alam et al. The difference is probably due to admission of more aged patients in our hospital. The total percentage is calculated by summation of involved percentage of each 5 lobes divided by 5. The result was the near possible percentage of total lung parenchymal involvement which was finally re-assessed visually as the pattern of involvement is not same in all patients as well as all lobes are not equal in size.

In our study, we got 11 (36.67%) cases in 5-10 days stage of which most of patients were with moderate lung involvement. In stage of 10-13 days, most cases had moderate and severe involvement of lung parenchyma. Zhou et al in a study on imaging features and evolution on CT in 100 COVID-19 pneumonia patients in Wuhan concluded with the inference that the early rapid progressive stage is 1-7 days from onset of symptom, the advanced stage with peak levels of abnormalities on CT is 8-14 days and the abnormalities started to improve after14 days.[13]

Conclusion

HRCT provides the distribution, pattern and extent of lung lesions, as well as some typical, atypical and vary atypical CT findings of COVID-19 pneumonia. Degree and severity of lung involvement can be assessed by HRCT of chest. It can also play an important role in management of COVID-19 patients and evaluation of post COVID syndromatic patients. So the combination of clinical features, exposure history and typical HRCT findings should be considered for diagnosis and prompt management of COVID-19 patients in this global pandemic period.

Authors' contribution: MAT has designed the study, diagnosed the cases included in this study, drafted the manuscript. JS has diagnosed the cases included in this study, revised the manuscript. IMB & MS collected & analyzed the data, edited the manuscript. MAT was the overall supervisor of the research.

All authors have read and approved final manuscript to be submitted.

Conflicts of interest: Nothing to declare.

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