Original Research Article

Spectrum of Chest CT Findings in The Patient of Covid-19: Relationship to the Patient Age Group and Duration of Infection, in Al-Dhafra Hospitals, Abu Dhabi

Abstract: …….

Purpose:

This study aims to identify the CT findings of chest among the asymptomatic and symptomatic COVID-19 positive patients in Al Dhafra Hospitals and review the common CT findings in relationship to the different age group of the patients and duration of symptoms.

Methods:

Data of the 301consecutive patients, who have been confirmed with COVID-19 infection, using RT-PCR, and subsequently underwent chest CT, presented to our hospital, were collected from 1st April 2020 to 31st May. They were further classified according to the time after the onset of the initial symptoms, namely stage-1 (0–4 days); stage-2 (5–8 days); stage-3 (9–14 days); stage-4 (14+ days); and according to the age of the patient in four groups (Group A- <18 years, Group B- 18–44 years, Group C- 45–59 years, Group D- ≥60 years). We analyzed the Prevalence, distribution, type of abnormal lung findings and extent of involvement of affected lobes by ground-glass opacities (GGO), crazy-paving pattern and consolidation, in five categories of percentual severity by semi-quantitative CT score (maximum CT score, 25).

Result:

Multiple small patchy, rounded, pure ground-glass opacity (GGO) and mixed GGO with consolidations were the main HRCT signs in 231 patients with confirmed COVID-19 infections. Both of these were predominant patterns in the young, middle and elderly groups (>18 to >60 years). However, crazy paving pattern were more common in 45 to <60 years aged groups. The peripheral disease distribution was seen in 100 % cases and both peripheral and central type of distribution of opacities were most common in elderly group (>60 years) in 73.3%. Bilateral involvement were common in all groups but unilateral involvement was fairly common in age group of >18 to 44 years. Both the mean number of lesions and CT score were higher in 44 to <69 years & >69 years aged groups than >18 to 44 years and lower lobes had relatively higher number of lesions & CT score than other lobes in all age groups.

Normal CT findings among symptomatic patients were seen in early stage (0–4 days) & progressive stage (5-8 days) of disease, 36.3 % and 6.6% accordingly. Peripheral mixed GGO with consolidation & pure GGO were the most important imaging manifestation in early and progressive stages of disease. CT features of the lesions were variable in the peak (9-13 days) & late stages- (14+ days) showed mixture of GGO, crazy-paving pattern, consolidation and linear opacities. Both "Reverse Halo sign" & "Halo sign" were seen, predominately in early stage of disease (0 to 8 days) in 52 patients (22.5%) and in 16 patients (6.9%), respectively. The number of lesions per capita, mean number of lesions in different lobes of both lungs & CT score were higher in progressive and peak stage of the disease than early stage and then gradually decreased in late

stage of disease. We also observed relatively greater number of lesions in both lower lobes than in upper lobes and a smaller number of lesions in right middle lobe, in all stages.

Conclusion:

The commonest HRCT findings in patients with COVID-19 pneumonia were peripheral, bilateral, rounded pure ground glass opacities and mixed GGO with consolidation. Early stages of disease may present with normal CT chest findings. Chest HRCT manifestations in patients with COVID-19 are related to patient's age & duration of symptoms, and HRCT signs are relatively milder in younger patients & early stage of disease. CT could serve as a useful tool for evaluating the changes of pulmonary abnormalities in patients during different stages and age groups (especially in elderly groups), for optimal management.

Keywords: COVID-19, ground-glass opacities (GGO), Halo sign, consolidation

Introduction:

In December 2019, a lower respiratory tract febrile illness of unknown origin was reported in a cluster of patients in Wuhan City, Hubei Province, China. A novel strain of coronavirus isolated from the broncho-alveolar lavage of the patients was determined to be responsible for the outbreak. The pulmonary syndrome was later named coronavirus disease 2019 (COVID-19) by the World Health Organization (1, 2). On January 29, the Ministry of Health and Prevention (MoHAP) confirmed the UAE's first case of COVID-19 disease (3). In early March 2020, the WHO declared this outbreak a global pandemic. According to the World Health Organization (WHO) 27 April 2021, there have been 147,539,302 confirmed cases of COVID-19, including 3,116,444 deaths (4).

SARS-CoV-2 is an enveloped single-stranded RNA virus (5, 6). The clinical presentation ranges from asymptomatic, mildly symptomatic cases to severely ill (7, 8). Imaging findings of COVID-19 closely resemble other viral pneumonias. Clinical recovery is associated with a gradual resorption of pulmonary opacities. In some patients the clinical course is complicated by acute respiratory distress syndrome (ARDS) or pulmonary embolism, the main causes of death (9, 10). Chest high-resolution computed tomography (HRCT) is an important method for detecting lung abnormalities. It plays an irreplaceable role in the screening of suspected patients, the diagnosis and differential diagnosis of diseases, clinical classification, assessment of disease progression, detection of pulmonary complications, and follow-up after discharge (11).

The aim of the present study is to identify the CT findings of chest among the asymptomatic and symptomatic patients and review the common CT findings in relationship to the different age group of the patients and duration of symptoms.

Methodology

Data Collection:

This retrospective study was approved by the Ethics Review Committee of Department of Health, Abu Dhabi, UAE. The informed consent was waived off as per the committee. We collected clinical and laboratory data for analysis, derived from electronic medical record system, concerning patients presented to our hospital from 1st April 22, 2020 to 31st May, who been confirmed as having COVID-19 infection, using RT-PCR. Chest HRCT images evaluated using the Picture Archiving and Communication Systems

(PACS). The study population includes all patients with COVID-19 Positive undergone CT chest, irrespective of age.

CT Protocol:

CT scans were performed at the end-inspiration level with patients in supine position and arms raised. Scanning parameters were tube voltage (100 kV), tube current (100−240 mA), slice thickness (5 mm), interval between slices (5 mm), consecutive 1.25 mm slices for high-resolution reconstruction scan, and scanning time (<5 s).

HRCT Image Analysis:

Two radiologists, with more than 10 years of experience in radiology, independently reviewed CT images in PACS. The readers categorized the predominant patterns on CT scans (Lung lesions were categorized using Fleischner society glossary of terms for thoracic imaging) as ground-glass opacification (GGO, hazy areas of increased attenuation without obscuration of the underlying vessels), crazy-paving pattern (GGO with interlobular and intralobular septal thickening), consolidation (homogeneous opacification of the parenchyma with obscuration of the underlying vessels), and linear opacities (disordered arrangement of coarse linear or curvilinear opacities or fine subpleural reticulation). Other abnormalities, including opacities with a rounded morphology, opacities with a "Halo" or "reverse halo" sign also identified. (12). On the scans, some other minor signs such as air bronchogram, cavitation, bronchiectasis, pleural effusion, pericardial effusion, pneumothorax and mediastinal lymphadenopathy (defined as a lymph node greater than 1 cm in short-axis diameter) were also noted.

In this study, lung lobe distribution information included the right upper lobe, the right middle lobe, the right lower lobe, the left upper lobe, and the left lower lobe. The distribution of the lung field included the periphery (the outer one-third region of the lung), the central zone (the area inside the inner two-third region of the lung), and whether the peripheral and central zones were affected simultaneously.

The severity of disease according to the extent of GGO, crazy-paving pattern and consolidation at thin-section CT was also evaluated. Bilateral lungs were divided into five lung zones according to the anatomical structure of lung: left upper lobe, left lower lobe, right upper lobe, right middle lobe and right lower lobe. Each lung lobe was assigned a score which was based on the following criteria: score 0, 0% involvement; score 1, less than 5% involvement; score 2, 5% to less than 25 % involvement; score 3, 25 % to less than 50 % involvement; score 4, 50 % to less than 75 % involvement; and score 5, 75 % or greater involvement. Summation of scores provided a semi-quantitative evaluation for overall lung involvement (maximal CT score for both lungs was 25) (13, 14).

After evaluation, the scans were categorized according to the period between the onset of initial symptoms and the CT scans: stage-1 (0–4 days, n =171); stage-2 (5–8 days, n = 91); stage-3 (9–13 days, n =20); stage-4 (14+days, n = 6). Chest HRCT findings of infected patients were also categorized in four age groups (Group A<18 years--n= 1), B (18–44 years--n= 162), C (45–59 years--n= 115), D (≥60 years--n= 23) and compared.

Statistical Analysis:

Measurement data are expressed as mean ± standard deviation, and numerical data are described as frequency.We mainly used one-way ANOVA analysis of variance (post-hoc multiple comparisons using least significant difference [LSD] and a q-test), Kruskal-Wallis test among multiple groups to

compare the HRCT signs of COVID-19-infected patients in different age groups & different stages, and the difference was statistically significant with a P-value <0.05

Results

Baseline Information:

Our population included 301 consecutive patients who were COVID-19, Positive (using RT-PCR as a gold standard test) underwent CT chest, irrespective of age. Of them, men were, 243 (80.7%) and women 58 (19.26%), ranging in age from 15 to 91 years (Mean age, 44.5 ± 11.6 years): Among them, according to the period between the onset of initial symptoms and the CT scans: stage-1 (0–4 days, n =170); stage-2 (5–8 days, n = 91); stage-3 (9–13 days, n =20); stage-4 (14+days, n = 6). 13 patients (4.32) were as asymptomatic at the time of CT scan.

Chest HRCT findings of infected patients were categorized in four age groups (Group A<18 years--n= 1), B (18–44 years--n= 162), C (45–59 years--n= 115), D (≥60 years--n= 23) and compared. The most prevalent presenting symptoms at onset of illness were dry cough (75.7 %), fever (71.1%), fatigue (54.5 %), sore throat (53.8 %), dyspnea (21.9 %), abdominal pain/diarrhea (3.4%) and anosmia (2.0 %). Less common symptoms were expectoration, hemoptysis, abdominal pain and diarrhea, headache, nausea and vomiting and palpitation. (Table 1).

Laboratory results showed 56(18.6 %) patients had abnormal white blood cell (normal value 1.5-4T×T109/L) counts (decreased WBC counts, n = 51; elevated WBC counts, n = 5). Low platelet count (normal value 1.5-4T×T109/L) in 30 patients (9.9%), elevated CRP (normal value ≤5 mg/L) in 188 patients (62.5%), high d-dimer (normal value ≤0.5 mcg/mL) in 79 patients (26.2%). (Table-1)

Table - 1

Gender	
Male	243 (80.7%)
Female	58 (19.26)
Age	
Age	Range = 15 - 91 years
Mean ± Standard Deviation	44.5 ± 11.6
Initial symptoms	
Dry cough	n= 228 (75.7%)
Fever	n= 214 (71.1%)
Fatigue	n= 164 (54.5%)
Sore throat	n= 162(53.8%)
Dyspnea	n= 67(21.9%)
Abdominal pain/Diarrhea	n= 11(3.4%)
Anosmia	n= 6 (2.0%)
Laboratory Investigations	
Abnormal WBC count n= 56 (18.6%)	
High WBC count	n=5(11.7%)
Low WBC count	n=51 (16.9%)
Low Platelet	n=30 (9.9%)
Elevated C-Reactive Protein (CRP)	n=188 (62.5%)
High D-Dimer	n=79 (26.2%)

HRCT Evaluation:

Total of 301 patients who had HRCT scan done were included in the assessment. The scans were positive in 231 patients (76.7%) and negative in 70 patients (23.3%).

Mixed ground glass opacities (GGO) with consolidation pattern, n= 163/231 (70.6%) were the most common HRCT manifestation among the positive patients in our study. Pure ground glass pattern was seen in (44.2%) followed by crazy paving pattern in 24.2%. Both "Reverse Halo sign" & "Halo sign" were seen, predominately in early stage of disease (0 to 8 days) in 52 patients (22.5%) and in 16 patients (6.9%), respectively.

The pattern of the opacities were rounded in 79.7% and linear in 21.6%.The peripheral disease distribution was seen in 100% (n=231) and both in central & peripheral were 37.2%.
In asymptomatic patients (n=13), four case had negative CT findings. Rest nine cases show predominately rounded, pure GGO (4/9) and mixed GGO with consolidation (4/9) in peripheral distribution (9/9). Both Halo (2/9) and reverse halo sign (1/9) were also seen.

Lung shows bilateral involvement in 91.3% (n=211), only consolidation in 0.5%, bronchiectasis in 11.3% pleural effusion in 1.3% (n=3, unilateral in 2 and bilateral in one case, seen only in stage-4 of the disease), and cavitation in 0.4%. (Table 2).

Table - 2
Overall CT findings (Opacities) & distribution of lesions (n= 301)

Normal CT findings	n= 70 (23.3%)
Abnormal CT findings	n= 231 (76.7%)
Types of Lesions	
Pure GGO	n= 102 (44.2%)
Mixed GGO with consolidation	n= 163 (70.6%)
Only consolidation	n= 1 (0.4%)
GGO with crazy paving	n= 56 (24.2%)
Reverse Halo sign	n= 52 (22.5%)
Halo sign	n= 16 (6.9%)
Pattern of Lesion	
Rounded	n= 184 (79.7%)
Linear	n= 50 (21.6%)
Distribution of Lesions	
Peripheral	n= 231 (100%)
Only central	n= 0(0%)
Peripheral + central	n= 86 (37.2%)
Bronchiectasis	n= 26(11.3%)
Cavitation	n= 1(0.4%)
Pleural effusion	n= 3(1.3%)
Pericardial effusion	n= 0 (0%)
Pneumothorax	n= (0%)
Lung Involvement	

Unilateral	n= 20 (8.7%)
Bilateral	n= 211 (91.3%)

Chest HRCT findings of infected patients were then categorized in four age groups (Group A<18 years--n= 1), B (18–44 years--n= 162), C (45–59 years--n= 115), D (≥60 years--n= 23) and compared in terms of bilateral/unilateral lung and lobe involvement, distribution, pattern & number of opacities and CT score.

Table -3

Overall CT findings (Opacities) & distribution of lesions in different age groups (n= 301)

	Group A (<18 years) n=1	**Group B (18-44 years) n= 162**	**Group C (45- 59 years) n=115**	**Group D (>60 years) n=23**
CT findings				
Normal	1	47 (29.0%)	18 (15.7%)	4 (17.4%)
Abnormal	0	115 (71%)	97 (84.3%)	19 (82.6%)
Types of opacities				
Pure GGO	0	47(40.9%)	41(42.3%)	12(63.2%)
Mixed GGO with consolidation	0	81 (70.4%)	70 (72.2%)	12 (63.2%)
Only consolidation	0	1 (0.9%)	0 (0%)	0 (0%)
GGO with crazy paving	0	16 (13.9%)	34 (35.1%)	6 (31.6%)
Reverse Halo sign	0	27(23.5%)	23(23.7%)	2(10.5%)
Halo sign	0	11(9.5%)	3(3.1%)	2(10.5%)
Pattern of lesions				
Rounded	0	98 (85.2%)	70 (72.2%)	16 (63.2%)
Linear	0	17 (14.8%)	30 (30.9%)	3 (15.8%)
Distribution of lesions				
Peripheral	0	115 (100%)	97 (100%)	19(100.0%)
Only Central	0	0 (0)%	0 (0)%	0 (0)%
Peripheral + central	0	39 (33.9%)	33 (34.0%)	14 (73.6%)
Others				
Bronchiectasis	0	9 (7.8%)	16 (16.5%)	1(5.3%)
Pleural effusion	0	0 (0%)	2 (2.1%)	1 (5.3%)
Pericardial effusion	0	0 (0%)	0 (0%)	0 (0%)
Pneumothorax	0	0 (0%)	0 (0%)	0 (0%)
Lymphadenopathy (mild)	0	7 (6.1%)	5 (5.2%)	3 (15.8%)

In Group A we found only one patient of 15 years old symptomatic patient, who had negative CT findings. Group B (18-44 years) presented with highest number of negative CT findings (47/162-29%), followed by C(18/115) and D(4/23). We identified 211 (91.3%) patients with bilateral and 20 (8.7 %) patients with unilateral lung involvement. There were fewer cases of unilateral lung involvement in group C & D than in patients in group B. Although bilateral lung involvement were common in all groups (except A). Group C showed the highest, almost all (96/97), followed by Group D(89.5%) and B(85.2%). (Table-4).

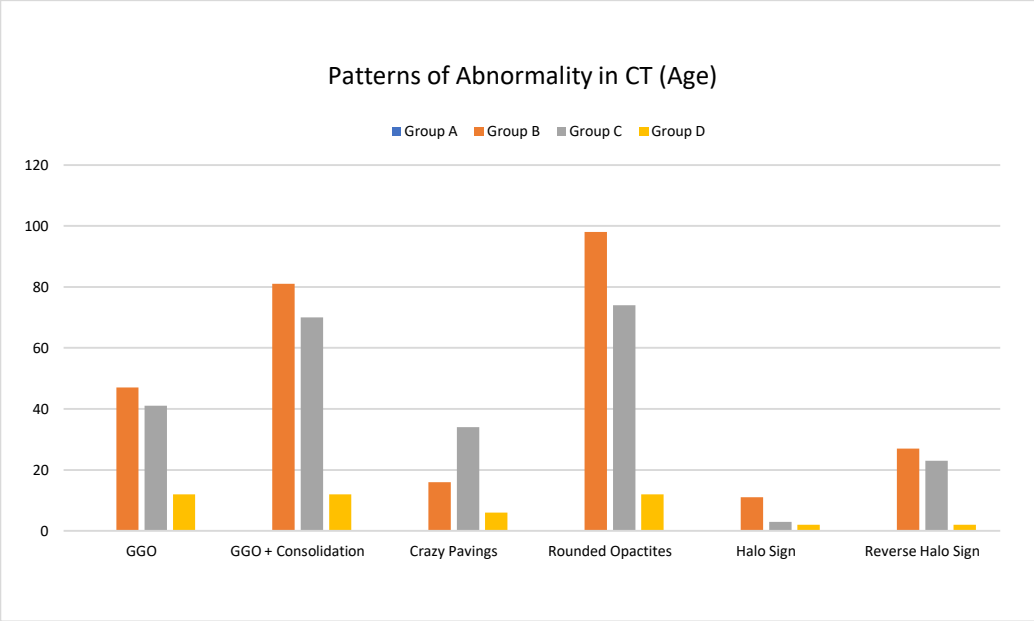
Among the density characteristics of each lesion, as detailed in (table-3) mixed GGO with consolidation is most commonly observed HRCT finding in patients of all age groups (C,B & D

accordingly). Pure GGO were more common in Group D (62.3%) and GGO with crazy paving were common in group C & D (35.% & 31.6%) accordingly. Rounded pattern were most prevalent pattern, in all age group, highest in group B (85.2%). Linear pattern most commonly seen in group C.

In our study, we found peripheral distribution of lesions in all patients, in all age groups. However, centrally located lesions along with peripheral, seen most commonly in elderly group D, in 73.6% cases and least commonly in younger group B(33.9%).

"Reverse Halo sign (RHS)" and "Halo sign (HS)" were found in all age group (B, C & D). RHS was found almost in same incidence in group B (23.5%) and C (23.7%) and fewer in group D (10.5%). On the other hand, Halo sign was found almost equally distributed in group D and B (10.5% & 9.5% accordingly) and fewer in group C.(Table-3).

Graph – I : Patterns of Abnormality in CT (Age)



Bronchiectasis were observed in Group C (16.5%), in highest percentage among all. Small pleural effusion in Group C (2.1%) and D (5.3%). No pleural effusion in young age group (B.)

The number of lesions per capita and mean number of lesions in different lobes of both lungs were higher in group C and D than in B. However, there was no significant difference in the number of lesions in the different age groups ($P > 0.05$). We also observed relatively greater number of lesions in both lower lobes than in upper and a smaller number of lesions in right middle lobe, in all age group, which were also not statistically significant (Table-4).

The same observation (as in distribution and number of lesions) reflected in the CT score in the different age groups and shows no significant differences in mean of scores in between both lung and different lobes, in different groups. (Table-5)

Table - 4

Distribution of number of lesions in the lungs, in different age groups.

	Group A (<18 years) n =1	Group B (18-44 years) n= 162	Group C (45- 59 years) n=115	Group D (>60 years) n=23	P
RUL	0	2.76 ± 0.92	4.91 ± 2.95	4.47 ± 2.99	0.575
RML	0	1.64 ± 2.01	2.36 ± 2.06	2.41 ± 2.38	0.126
RLL	0	4.05 ± 3.06	5.87 ± 2.79	5.24 ± 2.53	0.906
LUL	0	2.66 ± 3.19	3.81 ± 2.76	4.12 ± 2.76	0.787
LLL	0	4.03 ± 3.03	5.19 ± 2.81	4.81 ± 2.70	0.943
Total	0	1773	2000	353	0
No. of lesions per Capita	0	3.03±0.92	4.44±1.23	4.21±0.97	0
Unilateral	0	18 (15.6%)	1 (1.0%)	1(1.0%)	0
Bilateral	0	98 (85.2%)	96 (98.9%)	17 (89.5%)	0

Mean difference is significant at a level of 0.05.
Data were analyzed using a one-way ANOVA analysis of variance.

Table - 5

CT severity score in different age groups

	Group A (<18 years) n =1	Group B (18-44 years) n= 162	Group C (45- 59 years) n=115	Group D (>60 years) n=23	P
Right lung	0	1.29 ± 1.26	1.88 ± 1.61	1.79 ± 1.21	0.704
Left lung	0	1.48 ± 1.28	2.11 ± 1.15	2.26 ± 1.29	0.792
Right upper	0	1.19±1.21	1.91 ± 1.07	1.58 ± 1.04	0.788

lobe					
Right middle lobe	0	0.86 ± 1.02	1.17 ± 0.96	1.21 ± 0.95	0.6416
Right lower lobe	0	1.83 ± 1.34	2.56 ± 1.01	2.58 ± 1.18	0.9437
Left upper lobe	0	1.15 ± 1.19	1.82 ± 1.15	2.05 ± 1.36	0.4831
Left lower lobe	0	1.81 ± 1.28	2.41 ± 1.07	2.47 ± 1.36	0.8875

Mean difference is significant at a level of 0.05.
Data were analyzed using a one-way ANOVA analysis of variance

We then analyzed the data according to the period between the onset of initial symptoms and the CT scans: stage-1 (0–4 days, n =170); stage-2 (5–8 days, n = 91); stage-3 (9–13 days, n =20); stage-4 (14+days, n = 6). In most patients, the lesions were present in bilaterally, in multiple lobes, with the lowest rate (92.9 %) at stage-2 and the highest rate (100 %) at stage-4. In the early stage of the disease (Stage-1), CT scans showed 15.6 % unilateral lung involvement.

The most frequent CT findings of COVID-19 pneumonia were GGO, mixed GGO with consolidation, crazy-paving pattern. The predominant patterns of abnormality changed over time. In the early stage (Stage-1), pure GGO & mixed GGO with consolidation were the most important imaging manifestation (55.0% & 63.3% accordingly), and in some patients, crazy-paving pattern were present (22,9%), as well as Reverse halo sign (21.1%), and Halo sign (6.4%). Pure GGO was found in highest percentage, among all stages.

In stage-2 & stage-3 mixed GGO with consolidation were predominant pattern (83.5% & 83.3%) and tended to decrease in later stages, and at stage-4 (44.4%). GGO with crazy paving showed mild increase in distribution from stage-1 (22.9%) to stage-4 (50%). “Reverse Halo sign” was seen stage-1(21.1%), Stage-2 (22.2%) & Stage-3 (16.7%) of disease. On the other hand, Halo sig found only in stage-1 (6.4%) & stage 2 (8.2%) disease. Bronchiectasis was common finding in stage-4 patients (100%). We found three patients with small pleural effusion (one bilateral, two unilateral); all were in stage-4 (50%.) Table-

Table - 6
Overall CT findings (Opacities) & distribution of lesions in stages of disease (n= 301)

	Stage-1 (0-4 days) n= 171	Stage-2 (5-8 days) n=91	Stage-3 (9-13 days) n=20	Stage-4 (14+ days) n=06	Asymptomatic n=13
AGE (years)	43.5±12.0	45.5±10.1	45.0±8.6	55.1±10.4	48.8 ± 21.7
CT findings					
Normal	62 (36.3%)	06 (6.6%)	02 (10.0%)	0 (0%)	4(30.8%)
Abnormal	109 (63.7%)	85 (93.4%)	18 (90%)	06 (100%)	9(69.2%)
Types of Opacities					

Pure GGO	60 (55.0)	31(36.5%)	4 (22.2%)	3(50%)	4(44.4%)
Mixed GGO with consolidation	69(63.3%)	71 (83.5%)	15 (83.3%)	4 (66.7%)	4(44.4%)
Only consolidation	1(0.9%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
GGO with crazy paving	25(22.9%)	20 (23.5%)	7 (38.9%)	3 (50%)	1(11.1%)
Reverse Halo sign	23(21.1%)	23(27.1%)	4(22.2%)	1(16.7%)	1(11.1%)
Halo sign	7 (6.4%)	7(8.2 %)	0 (0%)	0 (0%)	2(22.2%)
Pattern of lesions					
Rounded	90(82.6%)	69 (81.2%)	16(88.9%)	3 (50%)	6 (100%)
Linear	21(19.3%)	14 (16.5%)	9 (50%)	5 (83.3%)	1(11.1%)
Distribution of lesions					
Peripheral	109(100%)	85 (100%)	20 (100%)	6 (100.0%)	9 (100%)
Only Central	0 (0%)	0 (0)%	0 (0)%	0 (0)%	0 (0%)
Peripheral + central	40 (36.7%)	33 (38.8%)	8(44.4%)	1 (16.7%)	4(44.4%)
Others					
Bronchiectasis	13 (11.9%)	7(8.2%)	5(27.8%)	6 (100%)	0 (0%)
Pleural effusion	0	0 (0%)	0 (0%)	3 (50.0%)	0 (0%)
Pericardial effusion	0	0 (0%)	0 (0%)	0 (0%)	0(0%)
Pneumothorax	0	0 (0%)	0 (0%)	0 (0%)	0(0%)

We observed, the mean number & distribution of lesions and CT score were progressively higher from stage-1 to stage-3, where it reached to maximum and then decreased. These observations were seen in between the stages, lobes of each lung & between both lungs. Number of lesions and CT score were relatively higher in lower lobes of both lungs. We didn't find any statistically significant difference between them. (Table 7& 8).

Graph – II : Patterns of Abnormality in CT (Duration of Symptoms

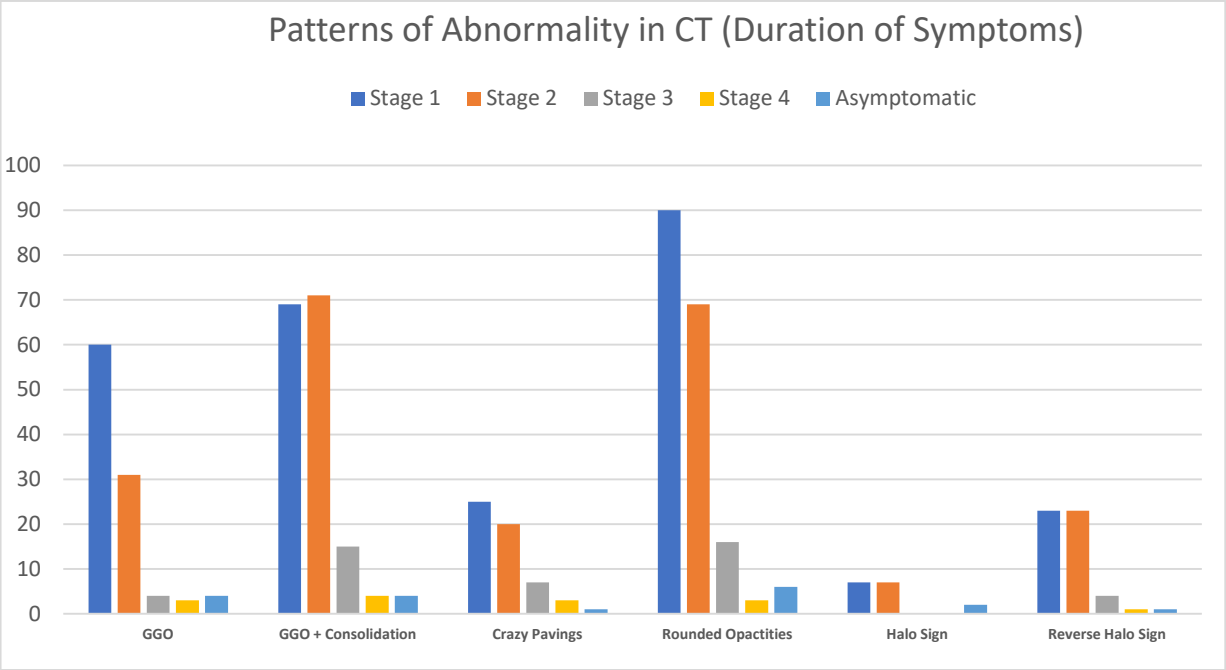


Table-7

Distribution of number of lesions in the lungs, in different stages (duration of symptoms)

	Stage-1 (0-4 days) n= 171	Stage-2 (5-8 days) n=91	Stage-3 (9-13 days) n=20	Stage-4 (14+ days) n=06	Asymptomatic n=13
Right Lung	3.07 ± 3.06 (1150)	4.14 ± 2.83 (1036)	5.56 ± 3.06 (218)	3.46 ± 2.97 (45)	2.26 ± 2.85 (52)
Left Lung	3.28 ± 2.96 (826)	4.48 ± 2.81 (734)	6.65 ± 3.35 (173)	3.57 ± 2.26 (25)	2.07 ± 2.02 (31)
RUL	3.10 ± 3.06 (388)	4.55 ± 2.89 (378)	6.08 ± 3.34 (79)	5.50 ± 3.20 (22)	2.50 ± 3.08 (20)
RML	1.65 ± 1.95 (204)	2.50 ± 2.31 (210)	3.23 ± 2.04 (40)	1.60 ± 1.50 (8)	0.88 ± 1.05 (7)
RLL	4.43 ± 3.31 (558)	5.40 ± 2.45 (448)	7.46 ± 1.45 (97)	3.75 ± 1.92 (15)	3.57 ± 3.25 (25)
LUL	2.46 ± 2.66 (312)	4.11 ± 2.86 (337)	5.85 ± 4.28 (76)	3.33 ± 2.62 (10)	1.13 ± 1.69 (9)
LLL	4.11 ± 3.03 (514)	4.84 ± 2.72 (397)	7.46 ± 1.69 (97)	3.75 ± 1.92 (15)	3.14 ± 1.81 (22)
Unilateral	17 (15.6%)	2 (7.1%)	0	0	1
Bilateral	102(93.6%)	79 (92.9%)	17 (94.5)	6 (100%)	7 (53.8%)

Mean difference is significant at a level of 0.05.
Data were analyzed using a one-way ANOVA analysis of variance

Table 8
CT severity score in different stages (Duration of Symptoms)

	Stage-1 (0-4 days) n= 171	Stage-2 (5-8 days) n=91	Stage-3 (9-13 days) n=20	Stage-4 (14+ days) n=06	Asymptomatic n=13	P Value
Right lung	1.34 ± 1.21	1.81 ± 1.22	2.31 ± 1.23	2.06 ± 1.27	1.19 ± 1.19	0.797
Left lung	1.53 ± 1.24	2.01 ± 1.21	2.80 ± 1.17	2.50 ± 0.96	1.22 ± 1.08	0.98
Right upper lobe	1.21 ± 1.12	1.84 ± 1.16	2.27 ± 1.06	2.17 ± 1.07	1.00 ± 0.94	0.851
Right middle lobe	0.89 ± 0.97	1.17 ± 1.05	1.33 ± 0.79	1.17 ± 1.07	0.56 ± 0.50	0.774
Right lower lobe	1.92 ± 1.27	2.41 ± 1.11	3.33 ± 0.87	2.83 ± 1.07	2.00 ± 1.41	0.973
Left upper lobe	1.24 ± 1.22	1.73 ± 1.16	2.20 ± 1.17	2.33 ± 1.11	0.78 ± 0.92	0.83
Left lower lobe	1.82 ± 1.19	2.29 ± 1.20	3.40 ± 0.80	2.67 ± 0.75	1.67 ± 1.05	0.966

Mean difference is significant at a level of 0.05.
Data were analyzed using a one-way ANOVA analysis of variance

Discussion:

A wide spectrum of clinical manifestations can be seen with COVID-19(15). The nasal epithelium is one of the first sites of infection with SARS-CoV-2 (16, 17). In our study, respiratory symptom like dry cough (75.7%) & fever (71.1%), were the most common manifestations of COVID-19. The systematic review performed by Grant *et al*. of 24,410 adults with confirmed COVID-19 infection from 9 countries; fever (78%), and cough (57%) were also the most prevalent symptoms. (18) Although olfactory dysfunction was (41.0%) relatively frequent symptom (19), in our study it was relatively rare (2.0%).

Laboratory results showed 56(18.6 %) patients had abnormal white blood cell counts, Low platelet count 9.9%, elevated CRP (62.5%), high d-dimer in (26.2%). It has been suggested that raised CRP and d-dimer levels are linked to a poor outcome in patients with COVID-19 disease (20). These informations are critical for the diagnosis of COVID-19.

We found, 13 asymptomatic patents (4.3%) with positive CT findings in 9 cases (69%) and normal findings in 4 cases (31%). According to Inui S et al (21), the incidence of normal chest CT findings in asymptomatic patients with COVID-19 is considerably high (an estimated

46% of patients). Low viral loads, confinement to the upper respiratory tract and host factors are plausible explanations for negative chest CT findings in COVID-19 patients (22, 23).

Among the symptomatic group, 70 (23.3%) patients had normal CT findings. Ling Z et al found 17% of their patients presented negative chest CT images at initial presentation; One third of them, who had a repeat CT scan that became positive (after 3–6 days) for COVID-19 pneumonia. Two third patients showed persistent negative CT images (after 3–14 days). In our study, 68/70 patients with normal CT scan findings found within 0 to 8 days of duration of symptoms (stage-1 & 2), this approximately close to the observation of Ling Z et al (24) observation. Slightly higher percentage of negative scan, in our study might reflect the massive screening effect in our population for quick detection and isolation of positive cases. Chest CT was used initially as quick screening method adjunct to PCR, due to delayed PCR test results. The WHO advised the use of chest imaging as part of diagnostic workup of COVID-19 disease whenever RT-PCR testing is not available, in case of delayed test results or when there is a clinical suspicion of COVID-19 with initial negative RT-PCR testing (25).

Mixed GGO with consolidations (70.6%) & pure ground-glass opacity (GGO--44.2%), were the most common findings followed by crazy paving (24.2%). These observations are slightly different, observed by Salehi et al as 31% & 88% accordingly (26). We believe, host's age & immune response has significant role of these variable imaging appearance. On the other hand, peripheral GGO distribution (100% vs 76%) & bilateral involvement (91.3 % vs 87.5%) were almost similar to Salehi et al report (27). We found only one patient of 15 years old symptomatic patient, in group A as youngest patient, who had negative CT findings. This probably represents low incidence of Covid infection in this age group, in our population. Group B (18-44 years) presented with highest number of negative CT findings (47/162-29%), followed by C(18/115) and D(4/23) and these can be explained by the better immune response of the relatively young individuals, than elderly.

Patients of middle aged Group (45–59 years) and aged ≥60 years had more bilateral lung, lung lobe, and lung field involvement, and greater lesion numbers than patients aged 18-44 years. The lesions were relatively more in the lower lobe of both lungs, slightly higher in right. This finding may be related to the thick and short physiological structure of the right lower lobe bronchus, which may have allowed the virus to enter this area more easily. The peripheral involvement (100%) probably because the virus mainly affects the terminal bronchioles and lung parenchyma around the respiratory bronchioles in the early stage (27). Bilateral lung involvement is common in all ages but unilateral involvement predominately a feature of younger/middle age.

In the early stage of symptomatic COVID-19 (0–4 days) & progressive stage (5-8 days), 36.3 % and 6.6% of the CT scans showed no abnormalities (consistent with ref 8). In case of CT abnormalities, peripheral mixed GGO with consolidation (63.3% & 83.5% accordingly) & pure GGO (55% & 36.5% accordingly) were the most important imaging manifestation, indicating the disease may mainly invade the terminal respiratory bronchi or alveoli at first and then rapid progression of the disease with poor prognosis or shorter course with good prognosis (28).
In the peak (9-13 days) & late stages- (14+ days), the CT features of the lesions were variable. Crazy-paving pattern, consolidation and linear opacities increased significantly, indicating

interstitial edema and alveolar exudation and those decreased thereafter. It has been reported that unilateral involvement is only present in the early and late phases (29). It should also be noted that the temporal evolution and extent of lung abnormalities are heterogeneous among different patients, dependent on the severity of the disease (30, 31, 32).

The number of lesions per capita, mean number of lesions in different lobes of both lungs & CT score were higher in group C (44-59 years) and D (>60 years) than in B (18-45 years). However, there was no significant difference in the number of lesions & mean CT score in the different age groups or between lungs/ lung lobes ($P > 0.05$). We also observed relatively greater number of lesions in both lower lobes than in upper and a smaller number of lesions in right middle lobe, in all age group, which were also not statistically significant.
The same observation (as in distribution and number of lesions) reflected in the CT score in the different age groups and shows no significant differences in mean of scores in between both lung and different lobes, in different groups.

Conclusion:

The clinical presentation, course, and outcome of COVID-19 are heterogeneous, and this also applies to the degree of pulmonary involvement. Performing CT in patients with suspected or proven COVID-19 requires comprehensive precautionary safety measures. Low-radiation-dose chest CT is recommended unless CT pulmonary angiography is required to evaluate for PE. Several chest CT features are commonly seen in COVID-19 (including ground-glass opacities, vascular enlargement, bilateral abnormalities, lower lobe involvement, and posterior predilection), whereas others are not, and this may help in diagnostic decision making.

The commonest HRCT findings in patients with COVID-19 pneumonia were peripheral, bilateral, rounded pure ground glass opacities and mixed GGO with consolidation. Early stages of disease may present with normal CT chest findings. Chest HRCT manifestations in patients with COVID-19 are related to patient's age & duration of symptoms, and HRCT signs are relatively milder in younger patients & early stage of disease. CT could serve as a useful tool for evaluating the changes of pulmonary abnormalities in patients during different stages and age groups (especially in elderly groups), for optimal management.

The appearance of COVID-19 on chest CT images follows a somewhat predictable pattern over time. Notably, asymptomatic patients with SARS-CoV-2 infection frequently have normal chest CT examination results, and the proportion of symptomatic patients with COVID-19 and a normal chest CT examination is no negligible. Furthermore, lung abnormalities on chest CT images are nonspecific for COVID-19. Owing to these limitations, chest CT should not be used as an independent diagnostic tool to exclude or confirm COVID-19. RT-PCR test results are the standard for diagnosis and key component in clinical decision making.

Nevertheless, chest CT has been suggested to have potential value as a rapid triaging tool in patients with moderate to severe respiratory symptoms in a resource-constrained environment where COVID-19 is highly prevalent. In addition, chest CT may be performed if an alternative diagnosis is suspected. Typical or indeterminate features of COVID-19 pneumonia may be incidentally detected at CT performed for other reasons. In these cases, the interpreting radiologist should discuss the possibility of COVID-19 with the referring physician in a timely manner. Standardized reporting according to guidelines such as those proposed by the RSNA can facilitate this information transfer. Furthermore, chest CT may be valuable to evaluate patients with clinical deterioration for COVID-19 progression or secondary cardiopulmonary complications such as ARDS, PE, superimposed pneumonia, or heart failure. Future studies that define the prognostic role of chest CT in COVID-19 are needed.

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