Original Article

Chest CT findings in COVID 19 disease in relation with duration of illness: A study of two hundred cases.

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Abstract

Background:

Chest CT scans of 200 symptomatic patients infected with COVID 19 from different health facilities and home were reviewed for common CT findings in relationship with their clinical symptoms, comorbidities and the time between symptom onset and the initial CT scan was studied in this cross-sectional study. Cases were categorized into three groups according to the timing of HRCT, 10 cases were in early (0-2days), 56 cases in intermediate (3-5days) and 110 cases were in late (6-12days) groups. Chest CT scan images showed bilateral peripheral ground glass opacities 96.63%, pulmonary consolidations 15.9%. Notably 29.54% patient had normal CT scan chest and 60% of them were imaged at early phase. With a longer duration of symptoms, chest CT findings were more typical including GGO, consolidation with greater total lung involvement. Bilateral peripheral GGO was observed in 20% patients at early phase while 53.57% and 64.54% were observed at intermediate and late phase of illness. Among the symptoms cough and dyspnea were observed more related with typical CT changes (95%). Diabetes and Hypertension (58% of patients) were the leading comorbidities that were found related with GGO and other typical CT findings. Mean time duration between symptom onset and positive RT PCR, CT scan changes were 4.79 and 7.55 respectively.

Key words: *COVID 19 disease, HRCT, clinical spectrum*

Introduction: The emerging pandemic of COVID 19 increases its death tool throughout the worldsinceits outbreak in Wuhan, China in December 2019[1]. Widespread human to human transmission has resulted in billions of cases in almost all countries with increasing death toll and post covid morbidity and mortality[2].This is the seventh known corona virus to infect humans1. Two other notable examples include severe acute respiratory syndrome and Middle East respiratory syndrome, the former of which began in southern China and resulted in 774 deaths in 8098 infected individuals in 29 countries from November 2002 through July 2003 and the latter of which originated in Saudi Arabia and was responsible for 848 deaths among 2458 individuals in 27 countries through July 2019[3,4]. The most common clinical symptoms at presentation are fever and cough in addition to other nonspecific symptoms including dyspnea, headache, muscle soreness, and fatigue[5]. About 20% of cases are severe and mortality is approximately 3%[6]. The World Health Organization declared a global health emergency on January 30, 2020[7]. An initial prospective analysis in Wuhan revealed bilateral lung opacities on 40 of 41 (98%) chest CT scans in infected patients and described lobular and sub segmental areas of consolidation as

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the most typical findings[8]. Other investigators examined chest CT scans in 21 infected patients and found high rates of ground-glass opacities and consolidation, sometimes with a rounded morphology and peripheral lung distribution[9]. Another group evaluated lung abnormalities related to disease time course and found that chest CT showed the most extensive disease approximately 10 days after symptom onset[10]. Thoracic radiology is often key to the evaluation of patients suspected of COVID-19 infection. Prompt recognition of disease is invaluable to ensure timely treatment, and from a public health perspective, rapid patient isolation is crucial for containment of this communicable disease. Timely done CT Chest may reveal early lung involvement in COVID19 infection. So correct timing of requesting CT scan of chest in relation with clinical symptoms and clinical course of disease help early diagnosis of disease severity and initiation of treatment promptly. This study was built on clinical parameter and early investigations during the first few weeks of infection by evaluating imaging features as the disease moves into the more sub acute phase. We hypothesized that certain CT findings may be more common depending on the time course of infection.

Materials and Methods

This Cross-sectional study was done from January 2021 to July 2021, 200 adult confirmed COVID-19 patients under gone HRCT chest at radiology department of popular diagnostic center Dhaka, Bangladesh were enrolled in our study. The exclusion criterion was patient age younger than 18 years and pregnancy. Convenient sampling technique was applied and 200 cases were enrolled. In addition to age and sex, clinical information collected including comorbid conditions. All patients were positive for COVID-19 at laboratory testing with real-time reverse transcriptase polymerase chain reaction (RT-PCR) of nasopharyngeal swab, or pharyngeal swab. The number of days between symptom onset and date of the first positive test was tracked. The RT-PCR test kits used in this study were manufactured by Sansure Biotech (Changsha, China), Shanghai Zhejiang Biotechnology (Shanghai, China), or Da An Gene (Guangzhou, China). All patients underwent CT without intravenous contrast at popular diagnostic center Dhaka. Only the initial chest CT scans were evaluated; follow-up CT were not analyzed for this study. All CT images were reviewed by two radiologists using a viewing console. No negative control cases were examined. For each patient, the chest CT scan was evaluated for the characteristics such as presence of ground-glass opacities; consolidation; laterality of ground glass opacities and consolidation; number of lobes affected; presence of nodules; presence of a pleural effusion; presence of thoracic lymphadenopathy (defined as lymph node size of 10 mm in short-axis dimension); airways abnormalities (including airway wall thickening, bronchiectasis, and endoluminal secretions) and presence of underlying lung disease such as emphysema or fibrosis. Other abnormalities, including linear opacities, opacities with a rounded morphology, opacities with a reverse halo sign, opacities with a crazy-paving pattern, and opacities with intralesional cavitation, were noted. Ground-glass opacification was defined as hazy increased lung attenuation with preservation of bronchial and vascular margins, whereas consolidation was defined as opacification with obscuration of margins of vessels and airway walls. The amount of time between the initial appearance of patient symptoms (e. g, fever and cough) and the date of both the first positive real-time RT-PCR test as well as the date of the initial chest CT examination was noted for each patient. If the time between the first clinical symptom and CT was 2 days or less, the patient was considered to have been imaged in the early phase of illness. If the time between symptom onset and CT was between 3 and 5 days, the patient was considered to have been imaged in the intermediate phase of illness. If the time between symptom onset and CT was between 6 and 12 days, the patient was considered to have been imaged in the late phase of illness. Radiological findings of CT chest were analyzed with three groups of patients in relation with clinical course (ie early, intermediate, late). All cases were classified according to clinical features into mild, moderate, severe and critical groups (COVID management guideline version 9, DGHS, Bangladesh) and relationship with CT chest findings was analyzed by SPSS software, versions 22.0. Continuous data that were normally distributed was summarized in mean, standard deviation, median, minimum, maximum. Categorical or discrete data was summarized in frequency counts and percentages. For end points analysis, chi square test was used for categorical variables and an analysis of variance (one-way ANOVA Test) for continuous outcomes. A two-sided P value of less than 0.05 was considered to indicate statistical significance.

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Result

Among 200 cases most of the patient were male (52.27%) and of age group 16 to 76 with a mean age 42.27 ± 15.02 years and mostly presented at late phase of illness (62.5%). Total 110 cases presented at late stage and among them maximum patients were of age group 18 to 76 (mean 48.32 ± 15.06). Whereas those presented early are younger, mean age was 38.1 ± 12.71 years (p =0.041). Patients were mostly symptomatic; only 7(3.97%) patients were symptomless. Mean time between symptom onset and positive RT-PCR was 4.79 ± 2.86 days. Fever 127 (72.15%), cough 142 (80.68%) and breathing difficulties 40 (22.72%) were the dominant symptoms and diabetes 47 (26.70%) and hypertension 56 (31.81%) dominated the associated comorbid condition (Table 1). Irrespective of symptoms and comorbidities all patients had undergone CT scan of chest at their late stage of disease. 52 (29.54%) patients were reported normal CT scan of chest and among them 26 (23.63%) patients had their scan done at late stage. Ground Glass Opacity 117 (66.47%) which was bilateral 90 (51.17%) and peripheral 118 (67.04%) was the dominant CT finding. Again, the characteristic GGO was mostly observed on CT scan done on late phase of illness 81 (73.63%) then early and intermediate phase (p = 0.000). It was also found that GGO were not a scare finding even at early part of illness, 2 (20%) was found in early phase and 34 (60.71%) in intermediate phase. Septal thickening 76 (43.18%), crazy paving 27(15.34%) and consolidation 28 (15.90%) were among other CT findings (Table 2). Maximum lung involvement between progressive 26 (14.77%), progressive to peak stage 26 (14.77%) and peak stage 18 (10.22%) was observed. Among them most of the cases were found at late stage than early phase of illness. Interestingly post covid sequel was found in four cases in late phase of illness. Severity of lung involvement was found more in late phases (23 ± 19%) then early phase (15 ± 9 %) and intermediate phase (18 ± 12%), though this finding were not statistically significant. The more the age of the patient the more was the CT changes though this finding was not statistically significant. However, duration of illness had no relation with CT severity as also with the time duration of RT-PCR positivity (figure1A and1B).

Table 1: Clinico- demographic profile among the study cases (N=176)

Variable	Total	Early phase <2 days (10)	Intermediate phase (3-5 days) (56)	Late phase >6 days (110)	P Value
Age (mean± SD) years	47.27 ± 15.02 (16-76)	38.1 ± 12.71 (18-54)	45.73 ± 15.25 (16-26)	48.32 ± 15.06 (18-76)	**0.041**
Sex					
Male	92 (52.27%)	4 (40%)	26 (46.42%)	62(56.36%)	0.348
Female	84(47.72%)	6 (60%)	30 (53.57%)	48 (43.63%)	
Duration of illness	7.57 ± 4.45 (1-30)	1.75 ±0.46 (1-2)	4.33 ± 1.45 (2-12)	9.70 ± 4.25 (3-30)	**0.000**
Asymptomatic	7 (3.97%)	2 (20%)	2 (3.57%)	3 (2.72%)	**0.027**
symptomatic	169 (96.02%)	8 (80%)	54 (96.42%)	107 (97.27%)	
Symptomatic					
Fever	127 (72.15%)	7 (70%)	37 (66.07%)	83 (75.45%)	0.323
Cough	142 (80.68%)	4 (40%)	43 (76.785)	95 (86.36%)	**0.009**
Chest pain	28 (15.90%)	0	8 (14.28%)	20 (18.18%)	0.357
Breathing difficulty	40 (22.72%)	2 (20%)	7 (12.5%)	31 (2818%)	0.078
Anosmia	21(11.93%)	0	3 (5.35%)	18(16.36%)	0.068
Sore throat	13 (7.38%)	0	5 (8.92%)	8 (7.27%)	0.650
Generalized weakness	10 (5.68%)	0	4(7.14%)	6 (5.45%)	0.692
Co morbidity					
DM	47 (26.70%)	1 (10%)	15 (26.78%)	31 (28.18%)	0.539
HTN	56 (31.81%)	2 (20%)	14 (25%)	40 (36.36%)	0.270
IHD	8 (4.54%)	1 (10%)	3 (5.35%)	4 (3.63%)	0.554
CKD	8 (4.54%)	0	4 (7.14%)	4 (3.63%)	0.472
Asthma	7 (3.97%)	1 (10%)	3 (5.35%)	3 (2.72%)	0.383
RT PCR testing					
Mean time between symptom onset and positive RT-PCR	4.79 ± 2.86 (1-17)	1.40 ± 0.54 (1-2)	2.87 ± 1.06 (1-5)	5.91 ± 2.91 (1-17)	0.000

Table 2: HRCT findings among the study cases (N=176)

HRCT findings	Total	Early phase <2 days (10)	Intermediate phase (3-5 days) (56)	Late phase >6 days (110)	P Value
HRCT					
Time duration for HRCT (Mean ± SD) days	7.55 ± 4.49 (1-30)	1.80 ± 0.42 (1-2)	4.22 ± 0.83 (3-5)	9.81 ± 4.28 (6-30)	**0.000**
Normal	52(29.54%)	6 (60%)	20 (35.71%)	26 (23.63%)	
Typical appearance	103 (93.63%)	2 (20%)	30 (53.57%)	71(64.54%)	0.08
Indeterminate	16 (14.54%	1 (10%)	4 (7.14%)	11 (10%)	
Atypical appearance	5 (4.54%)	1 (10%)	2 (3.57%)	2 (1.81%)	
Bilateral	90 (51.17%)	2 (20%)	27 (48.21%)	61 (54.95%)	
Unilateral					
Right lungs	29 (26.36%)	1 (10%)	7 (12.5%)	21 (19.09%)	0.216
Left Lungs	5 (2.84%)	1 (10%)	2 (3.57%)	2 (1.81%)	
Lesion					
Focal	30 (17.04%)	2 (20%)	10 (17.85%)	18 (16.36%)	0.358
Multifocal	94 (53.40%)	2 (20%)	26 (46.42%)	66 (60%)	
Peripheral	118 (67.04%)	3 (30%)	35 (62.5%)	80 (72.72%)	
Peri-hilar	6 (3.40%)	1 (10%)	1 (1.78%)	4 (3.63%)	0.145
Ground glass appearance	117 (66.47%)	2 (20%)	34 (60.71%)	81 (73.63%)	**0.000**
Consolidation	28 (15.90%)	0	5 (4.54%)	23 (20.90%)	0.139
Crazy paving	27 (15.34%)	1 (10%)	9 (16.07%)	17 (15.45%)	0.851
Septal thickening	76 (43.18%)	2 (20%)	22 (39.28%)	52 (47.27%)	0.874
Fibrosis	9 (5.11%)	1 (10%)	2 (3.57%)	6 (5.45%)	0.366
Lung involvement (%)		15± 9 (4-20)	18± 12 (4-50)	23± 19 (4-80)	0.379
Stages of lung involvement					
Early stage	32 (18.18%)	1 (10%)	9 (16.07%)	22 (20%)	
Early to progressive	5 (2.84%)	1 (10%)	1 (1.78%)	3 (2.72%)	
Progressive	26 (14.77%)	0	7 (12.5%)	19 (17.27%)	0.674
Progressive to peak	26 (14.77%)	1 (10%)	8 (14.28%)	17 (15.45%)	
Peak stage	18 (10.22%)	0	6 (10.71%)	12 (10.90%)	
Post COVID squeal	4 (2.27%)	0	1 (1.78%)	3 (2.72%)	

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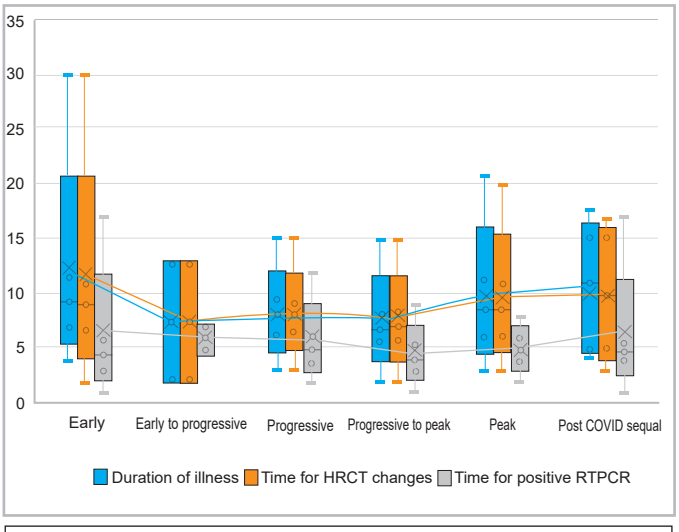
	Early Stage (32)	Early to progressive (6)	Progressive (27)	Progressive to peak (27)	Peak (27)	Post COVID squeal (5)	P Value
Age	45.21 ± 13.50	45.50 ± 10.91	45.59 ± 15.03	56.81 ± 10.85	55.94 ± 12.39	53.66 ± 14.11	**0.002**
Duration of illness	9.25 ± 6.18	7.40 ± 4.27	7.84 ± 3.53	6.88 ± 2.94	8.68 ± 5.16	11.00 ± 4.24	0.370
Time for positive RT-PCR	5.04 ± 3.63	6.00 ± 0.81	5.00 ± 2.74	4.18 ± 2.38	5.00 ± 1.88	3.67 ± 3.78	0.753
Time duration for HRCT changes	9.03 ±6.79	7.40 ± 4.27	7.80 ± 3.12	6.96 ± 2.80	8.57 ± 5.06	10.00 ± 4.39	0.605



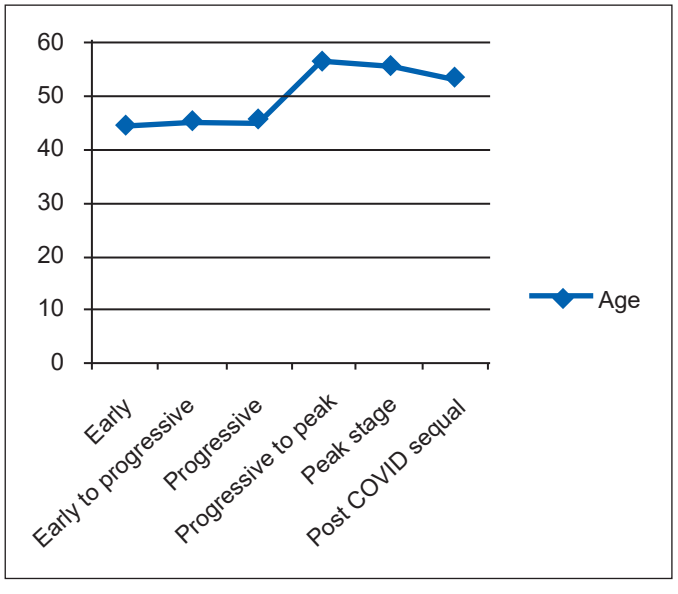


Figure 1A: Relation between severity of lung involvement and time duration of illness (p=0.320), positive RT-PCR (p=0.754) and Time required for HRCT changes (p= 0.549); 1B: Relation between severity of lung involvement and age (p=0.002). *One way ANOVA

Discussion

Clinical and demographic profile of our cases had shown similarities with other study done at COMBINED Military Hospital.[11] This finding also matches with that of an Indian study done at a government hospital in Kashmir.[12] These similarities may be duo to common population characteristics health facilities in south Asia. Another study done at China showed same clinical but little differences in age and sex distribution where there was male female ratio was 1 and predominant age group was below 48.[13] These dissimilarities do not make any impact on study conclusion. Among comorbities DM and HTN were predominant (47% and 56%). as was the results in the Indian study done at Kashmir but at a lesser percentage (6.1% and 3.1% respectively)[14] This difference might be duo to the fact that mean age of our study population was 47, higher than that in the Indian study. We have reported 52 normal CT scan though they were RT-PCR positive. Study at China showed 56% normal CT report.[13] A Indian study at Kashmir showed a high proportion of normal CT scan chest in COVID 19 confirmed patient (96/147). This contrast in results might be due to selection bias of study population.[14] This finding may make an impression of low sensitivity of early CT scan for the diagnosis of COVID 19 infection. GGO are the most common and early CT findings in three studies done in Bangladesh, India and China[11,12,13]. GGO in pure form 93% and in late phase of disease with superimposed crazy paving pattern was 71% found in our study was in concordance with the multiple studies summarized by Saleh at al.[14] This may make a sense of high sensitivity of GGO for a characteristic diagnostic clue. Pulmonary vascular enlargement seems to have a diagnostic value in an infectious setting. Bari et al reported vascular enlargement to be frequently associated COVID19 pneumonia[15]. We found a single report of pulmonary vascular enlargement in a follow up CT scan, hence it was not calculated. So, these important findings of vascular enlargement should be a point of interest in CT findings of COVID patient. Mean time duration of illness and positive CT finding was 7.55 days which was 10 days in Chinese study[13].

This difference in mean duration of illness with CT positivity may be influenced by genetic nature of the patient and the SARS COV2 strain as well. In the Indian study 5.8 days (range 3-9 days) were reported to be taken before CT scan was asked.[12]

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The sub acutenature of disease course in relation with CT positive findings is similar and this may make a clinical point to consider regarding the time of requesting a CT scan of chest. Post COVID sequalae as bronchial wall thickening and dilation was observed in four of our cases where as it was seen in 12% of cases in Chinese study.[13] However, this finding should be reviewed at follow up CT scan which was not done in our study.

Conclusion

Ground glass opacity was the most prominent HRCT chest finding of COVID 19 infection which was distributed peripherally in both lungs and this change was evident on sub-acute stage of the diseases. So clinical symptoms and disease duration is a clue to consider for requesting a CT scan of chest.

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Conflict of interest:

The authors hereby declare that no conflict of interest exists on behalf of the authors in conducting this study. Furthermore, the findings of this study do not constitute any conflict of interest for the authors.

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Ethical issue:

This study was approved by ethical review committee of Cumilla Medical College.

Limitation

Early interventions like steroid and oxygen therapy may make changes in the course of illness as well as CT findings. Many of our patients had early inadvertent therapy which was not considered in this study. Follow up CT scan should be done to evaluate the post COVID sequelae. There may be a selection bias in terms of which patient was asked for a CT scan.

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