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Original Research Article

A Retrospective Study to Assess Spectrum of High-Resolution Computed Tomography Chest Findings in COVID 19 Patients

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Abstract

Aim: The aim of the present study was to assess the role of high-resolution computed tomography chest findings in COVID 19 in Bihar region.

Methods: This retrospective study was conducted in 50 patients aged 22 to 83 years who were tested positive for COVID-19 by RT-PCR along with simultaneous conduction of HRCT chest in Radiology Department for the period of 10 months.

Results: Out of total 50 patients, 28 (56%) were males and 22 (44%) were females. Age ranged from 22 to 83 years with mean age of 51 years±15 years. Fever was seen in 49 (98%), cough in 34 (68%) and shortness of breath in 32 (64%) patients. Diabetes and hypertension were the major comorbidities 6 (12%). The most frequent finding on HRCT chest was combined GGO and consolidation 24 (48%) with posterior and sub-pleural distribution 41 (92%). Among two patients of early stage (0-2 days), one had normal HRCT, while other had GGO alone. Consolidation, crazy-paving and vascular enlargement was absent. Of 12 patients of progressive stage (3-5 days), combined GGO and consolidation 8 and GGO alone 5 were seen. During late stage (6-12 days), among 33 patients, combined GGO and consolidation 16, sub-pleural lines/bands 17, vascular enlargement 15 and crazy paving pattern 13 were noted. The distribution of disease was posterior, sub-pleural in 33, bronchovascular in 25, peri hilar in 14 and diffuse in 7 during late stage.

Conclusion: HRCT chest evolving characteristics are effective in understanding variation in pattern of coronavirus disease. Identification of imaging patterns with respect to infection time course is an effective paramount for disease diagnosis, understanding progression and potential complications of disease. CT-SS plays an important role in predicting disease severity, prognosis and clinical outcome. We recommend that early HRCT chest scan will leads to better diagnosis and management of COVID-19 patients.

Keywords: High resolution computed tomography (HRCT), COVID 19

Introduction

COVID 19 (Coronavirus Disease 19) caused by SARS CoV 2 (Severe Acute Respiratory Syndrome Coronavirus 19). [1] Global pandemic of COVID 19 declared by WHO in March 20201. Clinical features of COVID 19 infection include fever, dry cough, smell and taste disturbances, myalgia, breathlessness etc. [3] Gold standard test for diagnosis of this disease is RTPCR (Reverse transcriptase polymerase chain reaction). [2] HRCT chest is a non- invasive, nonoperator dependent effective imaging modality and modality of choice for detection of lung parenchymal, airway, pleural changes. [4] Chest CT has a potential role in the diagnosis, detection of complications, and prognostication of coronavirus disease 2019 (COVID- 19). [4]

It has been found that this coronavirus infection passes through three distinguishable phases, the first stage in which SARS-CoV-2 has not manifested its sign and symptoms in its host, the second stage in which symptoms have developed but they are less intense and in third stage symptoms become intense and COVID-19 virus has reached to its maximum number by multiplication. [5] In the early phases of this epidemic, it was considered that this SARS-COV-2 can only affect the elderly population. [6] As the epidemic spread, it was found that this disease not only affects the elderly population but also virulent in young individuals. [7] Coronavirus possesses a very high ability to transmit as well as very high virulence. The mode of transmission of SARS-CoV-2 is direct touch as well as droplets of

cough and sneeze of an infected person. [8] The pathogenesis of SARS-COV-2 lead to the development of clinical manifestations that appear within two days or it may take almost two weeks after getting in contact with the infected person. [9] According to the basic structure of SARS-COV-2, it bears spikes made-up of glycoprotein on its envelope. It is an RNA-containing virus and is very small in size with a diameter of 65-125 nm. The sub-groups of coronaviruses are as follows: alpha (α), beta (β), gamma (γ), and delta (δ). [10]

Chest computed tomography plays significant role in the detection, evaluation and management of coronavirus infection. [11] Computed tomography has superiority over plain chest imaging because it is very easy to miss GGO by using plain radiography. So, it is recommended to use computed tomography for the early detection of coronavirus infection. [12] The important characteristic of the scanning is to focus the GGO along with or without solid masses near the borders of the inferior and dorsal pulmonary areas. [13] The unusual findings are fluid in the pleural cavity, lymph enlargement, lung cavitation and calcification as well. [14] Thin-section chest computed tomography is effectual in the diagnosis of lung infection caused by a coronavirus and assess the progression of the disease. [15] The severity of lung involvement in coronavirus disease 2019 is assessed by the radiologic features of chest CT scan. [16]

The aim of the present study was to assess the role of high-resolution computed tomography chest findings in COVID 19 in Bihar region.

Materials and Methods

This retrospective study was conducted in 50 patients aged 22 to 83 years who were tested positive for COVID-19 by RT-PCR along with simultaneous conduction of HRCT chest in Radiology Department, Indira Gandhi Institute of medical sciences, Patna, Bihar, India for the period of 10 months. These patients presented in either outpatient or emergency with symptoms of fever, cough/sore throat, or shortness of breath. PCR negative patients with positive HRCT chest findings for COVID-19 were excluded.

All images were taken on 128 slice CT scanner with patient in supine position and scanning done from lung apices to costo-phrenic angles. The main scanning parameters were 120 KVP, 450 mAs, pitch 1.4, FOV of 406 mm and slice thickness of 1mm. CT was done without contrast. Images were sent to workstation and picture archiving and communication systems (PACS).

Two radiologists with seven and nine years of experience respectively reviewed all HRCT Chest images and described the findings as unilateral or bilateral ; pattern of involvement as GGO alone, combined GGO with consolidation, consolidation alone, crazy paving pattern, vascular enlargement, round opacity, reverse halo, sub-pleural lines/bands; segments and lobes involved; distribution as sub pleural/ peripheral, anterior or posterior, peri hilar/ central, bronchovascular or diffuse. [16] Associated findings as emphysema, bronchiectasis, pleural effusion or lymphadenopathy were noted. Time between onset of symptoms and CT conduction was determined and patients were divided into early (0-2 days), progressive (3-5 days) or late (6- 12 days) stage of disease. [17]

According to WHO clinical classification, patients were divided into mild, moderate, severe or critical stages. Mild patients had clinical symptoms without evidence of viral pneumonia or hypoxia. Moderate disease had clinical signs of pneumonia with respiratory rate <30 breaths / minutes and oxygen saturation >90%. Severe cases have clinical signs of pneumonia with respiratory rate >30 breaths / min and oxygen saturation <90%. Critical cases have septic shock, acute respiratory distress syndrome or needs mechanical ventilation. [18,19] For sake of convenience, mild and moderate groups were merged while severe and critical cases were also combined into single group in this study. The CT-SS describes extent of involvement of 20 lung segments with 0: no parenchymal involvement, 1: <50% parenchymal involvement and 2: >50% parenchymal involvement. Total score is obtained by adding individual segments score ranging from 0 to 40. [20]

The collected data was entered into SPSS 23 version and analyzed. Quantitative variable including age and CT-SS were described as mean or standard deviation. Qualitative variables including clinical history, HRCT chest findings, lung lobes and segment involvement were described as frequency and percentages. CT-SS in mild and severe group were compared. ROC curve was drawn with threshold value for severe disease determined along with calculation of area under the curve. The inter-rater reliability score between two radiologists was calculated.

Results

Table 1: Demographic and Clinical features of COVID-19

Age groups in years	**N (%)**
20-40y	14 (28%)
41-60y	27 (54%)
61-80y	7 (14%)
>80y	2 (4%)
Gender	
Male	28 (56)
Female	22 (44)
Symptoms	
Fever	49 (98%)
Cough	34 (68%)
Sputum	1 (2%)
Loss of taste or smell	10 (20%)
Shortness of breath	32 (64%)
Respiratory rate	
<30	22 (44%)
>30	28 (56%)
Oxygen Saturation	
>93%	23 (46%)
<93%	27 (54%)
Comorbidities	
Diabetes & Hypertension	6 (12%)
Diabetes	5 (10%)
Diabetes & Ischemic heart disease	4 (8%)
Hypertension	4 (8%)
Pancreatitis	1 (2%)
Liver parenchymal disease	1 (2%)

Out of total 50 patients, 28 (56%) were males and 22 (44%) were females. Age ranged from 22 to 83 years with mean age of 51 years±15 years. Fever was seen in 49 (98%), cough in 34 (68%) and shortness of breath in 32 (64%) patients. Diabetes and hypertension were the major comorbidities 6 (12%).

Table 2: HRCT Chest findings of coronavirus disease according to duration of infection

CT Findings	*Total N=50*	*Early (0-2 days) n=5*	*Progressive (3-5 days) n=12*	*Late (6-12days) n=33*
GGO alone	18	3	5	10
Consolidation alone	7	0	1	6
GGO & consolidation	24	0	8	16
Pattern of Air bronchogram	16	0	4	12
Consolidation Segmental	5	0	2	3
Sub segmental	12	0	3	9
Segmental & sub segmental	2	0	0	2
Crazy paving pattern	15	0	2	13
Sub-pleural lines/bands	17	0	0	17
Vascular enlargement	18	0	3	15
Round opacity	6	0	4	2
Reverse Halo	6	0	6	0
Distribution Posterior	45	2	10	35
Anterior	34	0	4	30
Sub-pleural	41	2	8	33
Central /perihilar	17	0	3	14
Broncho-vascular	30	0	5	25
Diffuse	10	0	3	7

The most frequent finding on HRCT chest was combined GGO and consolidation 24 (48%) with posterior and sub-pleural distribution 41 (92%). Among two patients of early stage (0-2 days), one had normal HRCT, while other had GGO alone. Consolidation, crazy-paving and vascular

enlargement was absent. Of 12 patients of progressive stage (3-5 days), combined GGO and consolidation 8 and GGO alone 5 were seen. During late stage (6-12 days), among 33 patients, combined GGO and consolidation 16, sub-pleural lines/bands 17, vascular enlargement 15 and crazy paving pattern 13 were noted. The distribution of disease was posterior, sub-pleural in 33, bronchovascular in 25, peri hilar in 14 and diffuse in 7 during late stage.

Discussion

The city of Wuhan in China became the epicenter of spread of novel COVID-19 infection. Progressing from an epidemic to a global pandemic, this ailment penalized the mankind within no time. Due to rapid transmission via air-borne droplets and highly virulent nature of virus, a large number of patients have emerged creating a havoc. SARS- CoV-2 was declared new name for causative agent of coronavirus disease due to genetic relation with SARS. [21] Apart from the reported high sensitivity of CT scan as compared to RT-PCR, CT has proved to be an ideal tool for monitoring the disease course. [22] COVID-19 presents with fever of varying degrees, cough, dyspnea, diarrhea, change of sense of taste or smell, and myalgia. Many asymptomatic carriers are also identified. Elderly with co- morbids is at a greater risk of acquiring severe infection with resultant mortality. [23]

Out of total 50 patients, 28 (56%) were males and 22 (44%) were females. Age ranged from 22 to 83 years with mean age of 51 years±15 years. Fever was seen in 49 (98%), cough in 34 (68%) and shortness of breath in 32 (64%) patients. Diabetes and hypertension were the major comorbidities 6 (12%). The most frequent finding on HRCT chest was combined GGO and consolidation 24 (48%) with posterior and sub-pleural distribution 41 (92%). Among two patients of early stage (0-2 days), one had normal HRCT, while other had GGO alone. Consolidation, crazy-paving and vascular enlargement was absent. Of 12 patients of progressive stage (3-5 days), combined GGO and consolidation 8 and GGO alone 5 were seen. During late stage (6-12 days), among 33 patients, combined GGO and consolidation 16, sub-pleural lines/bands 17, vascular enlargement 15 and crazy paving pattern 13 were noted. The distribution of disease was posterior, sub-pleural in 33, bronchovascular in 25, perihilar in 14 and diffuse in 7 during late stage. The reason for GGO alone for being second prevalent feature is that majority of patients had CT done in late stage of disease when GGO alone is less frequently seen. Due to lack of awareness about the early utility of CT scan, very few patients were being imaged in less than two days' time. Song et al [24] described pure GGO in 77%, GGO with consolidation in 59% and pure consolidation in 51% with bilateral lung involvement (86%) in sub-pleural posterior distribution mainly in lower lungs. Zhoa et al [25] reported GGO alone, combined GGO and consolidation and vascular enlargement in 87 (86.1%), 65 (64.4%) and 72(71.3%) patients respectively. Zhou et al[26] described fever in 87%, cough in 56% and dyspnea in 27% cases. He also reported GGO and reticular pattern (58%) along with GGO and consolidation in early progressive stage (1-7 days), while increase frequency of sub-pleural lines, fibrotic stripes, GGO and consolidation in advanced stage (8-14 days). [26]

Bernheim et al. reported linear opacity, crazy paving and reverse halo in 20%, 20%, and 4% in late stage. Total 56% patients in early stage had normal CT without any GGO or consolidation. The most frequent lobe involvement was lower lobe(Right 65%, Left 63%)and left upper lobe in 48%. [27] Zhou et al [28] in another study in 62 patients in Wuhan ,China reported a significant difference in early and late phase CT findings of ground glass opacity (47% vs 27%),ground glass with reticular opacity (50% vs 86%) and air bronchogram (62% vs 90% respectively).

Conclusion

HRCT chest evolving characteristics are effective in understanding variation in pattern of coronavirus disease. Identification of imaging patterns with respect to infection time course is an effective paramount for disease diagnosis, understanding progression and potential complications of disease. CT-SS plays an important role in predicting disease severity, prognosis and clinical outcome. We recommend that early HRCT chest scan will leads to better diagnosis and management of COVID-19 patients.

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