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HIGH RESOLUTION COMPUTED TOMOGRAPHY FINDINGS IN CORONAVIRUS DISEASE 2019 (COVID-19)

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ABSTRACT

Purpose: To assess the HRCT findings of symptomatic COVID-19 patients with positive reverse transcriptase polymerase chain reaction (RT-PCR).**Methods:** This was a prospective observational study comprising 100 consecutive reverse transcriptase polymerase chain reaction (RT-PCR) positive patients who underwent CT chest. Distribution, extent and type of abnormal lung findings were observed. **Results:** Among the total study cohort of 100 patients, 64 (64 %) were males and 36 (36 %) were females with mean age of 42.1± 15.6 years. We observed lung parenchymalabnormalities in 55(55 %) cases whereas 45 (45 %) RT-PCR positive cases had a normal chest CT. Only 11 % of the patients were dyspneic, 6 % had desaturation, 9 % had increased respiratory rate and 15 % had comorbidities.Among the patients with abnormal CT findings bilateral 44/55 (80 %), multilobar 49/55 (89 %) lung involvement with a predominant peripheral and posterior distribution was commonly observed. With regards to the type ofopacity, ground glass opacity (GGO) was the dominant abnormality found in all 55 (100 %) cases. Pure GGO was observed in 16 (29.1%), GGO with septal thickening was seen in 28 (50.9 %) and GGO mixed with consolidation was noted in 11(20 %).**Conclusion:** In this study population predominantly with mild symptoms and few comorbidities, 45% ofRT-PCR positive patients had a normal chest CT; whereas the remaining 55% patients showed typical findings ofpredominant GGOs with a bilateral distribution and peripheral predominance.

INTRODUCTION

Coronavirus disease 2019 (COVID-19) is a contagious disease caused by severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2). The first case was identified in Wuhan, China, in December 2019. The disease has since spread worldwide, leading to an ongoing pandemic. According to World Health Organization (WHO) more than 6.5 million positive cases have been reported with 387177 deaths as of June 05, 2020 [1].

SARS-CoV-2 is an enveloped single-stranded RNA virus [2,3]. The clinical presentation ranges from asymptomatic, mildly symptomatic cases to severely ill[4,5]. Typical CT findings include bilateral pulmonary parenchymal ground-glass and consolidative pulmonary opacities, sometimes with a rounded morphology and a peripheral lung distribution. There is a gradual transformation of GGOs into consolidations during the intermediate stage of the disease. The extent of lung abnormalities at CT peaked during illness days 6–11 [6]. Clinical recovery is associated with a gradual resorption of pulmonary opacities with development of subpleural lines, reticulations, fibrous stripes and perilobular opacities, usually apparent after the second week. In some patients the clinical course is complicated by acute respiratory distress syndrome (ARDS) or pulmonary embolism, the main causes of death [7]. Pleural effusion, pericardial effusion, mediastinal lymphadenopathy are seen in patients with severe disease [8,9].

MATERIAL AND METHODS

1.1 Patient cohort and study design

This was a prospective observational study from 16, August 2020 to 15, September 2020, conducted in our hospital inJLN Hospital, Ajmer, Rajasthan, India, which was a designated COVID-19 Care Centre (CCC) with separate inpatient, intensive care unit (ICU) and quarantine facilities. 100 symptomatic patients admitted with positive nasopharyngeal swab for SARS-CoV-2 by RT-PCR method were subjected to High resolution CT of chest.

2.1.1. Inclusion criteria

Symptomatic patients with RT-PCR confirmed SARS-CoV-2 infection.

2.1.2. Exclusion criteria

Asymptomatic patients with RT-PCR confirmed SARS-CoV-2 infection.

Patients with severe illness requiring intensive care and mechanical ventilation were admitted to intensive care unit and those with symptoms but no signs of respiratory failure were admitted in routine wards. Asymptomatic patients were isolated and managed in quarantine facility.

The age, gender, history of contact/travel, clinical symptoms, co-morbid conditions and laboratory investigations of the patients were collected and analysed.

2.2CT protocol

Chest CT was performed between3–7 days after the onset of symptoms. High resolution chest CT was performed using a 16-Slice CT scanner (Philips MX 16) with the following parameters: Tube voltage 90–120 kVp, tube current 130-200 mAs, collimation of 16 × 0.6 and a pitch of 0.75.The CT images were acquired in a single inspiratory breath-hold.Images were reconstructed using increment of 0.5mm to 1mm thick slices.The images were viewed in both lung window settings (width 1200–1500 HU; centering -500 to -700HU) and mediastinal window (width 300 400HU; centering 40HU). After every scan decontamination of the CT suite was performed using 0.1 % sodium hypochlorite.

2.3 CT Image interpretation

The CT patterns were described according to the terms defined by the Fleischner Society and peer-reviewed literature on viral pneumonia [10,11]. The CT images were assessed for the presence of ground-glass opacity (hazy areas of increased attenuation without obscuration of the underlying vasculature), consolidation (homogeneous

opacification with obscuration of the underlying vasculature), reticular pattern (consisting of either coarse linear or curvilinear opacity or fine subpleural reticulation without substantial ground-glass opacity) and mixed pattern (combination of consolidation, ground-glass opacity, and reticular opacity in the presence of architectural distortion). Perilesional and intralesional vasculature were assessed for vascular dilatation. Furthermore, the involvement was described based on **(a)**axial distribution- central (central 2/3rd)or peripheral (peripheral 1/3rd) or diffuse involvement, **(b)** involvement of one or both lung and**(c)**lobar involvement. In addition, the presence of pleura effusion, pneumothorax, emphysema, or mediastinal lymphadenopathy (short axis diameter >1.0 cm) were also noted.

RESULTS

3.1. Demographics, clinical characteristics and laboratory findings

Out of a cohort of 100 patients included in the study, 64 (64 %) were males and 36 (36 %) were females with mean age of 42.1± 15.6 years (range 20–74 years). A history of close contact with an infected patient or a history of travel to a high-risk zone within or outside the country was present in 68% of cases. Fever was the commonest symptom seen in 55 (55 %) followed by fatigue or malaise in 43(43 %), cough in 35(35 %) and sore throat in 32 (32 %). Only 11 (11 %) of the patients were dyspnoeic, 9(9 %) had increased respiratory rate and 6 (6 %) had desaturation. Anosmia and loss of taste were seen in 8 (8%), diarrhoea in 3 (3%) and abdominal pain in 2 (2%) cases.Comorbidities were present in 15 (15 %) patients. C-reactive protein was elevated in 59 (59 %) patients.Patient demographics, clinical features and laboratory investigations are summarized in Table 1.

Table 1 Demographics, Clinical features, comorbidities and Laboratory investigations in COVID-19 positive patients.

Patient demographics	Number of patients (%) (n=100)
Mean age(years) ± S.D	42.1±15.6 years
Gender	
Male	64
Female	36
History of contact with a COVID-19 patient o travel to a high risk zone	
Present	62
Absent	38
Co-morbid illness	15
Hypertension	10
Diabetes Mellitus	9
Bronchial asthma	2
Chronic obstructive lungdisease	2
Clinical features	
Fever	55
Cough	35
Sore throat	32
Malaise/Fatigue	43
Anosmia	8
Loss of taste	8
Diarrhea	3
Abdominal pain	2
Dyspnea	11
Increased Respiratory rate (> 30 /min)	9
Reduced Oxygen Saturation (< 90%)	6
Lab Investigations	
Increased C-Reactive protein (normal value < 10 mg/L)	59

3.2. Chest CT findings

Lung parenchymal abnormalities were observed in 55 (55 %) cases, whereas 45 (45 %) RT-PCR positive cases had a normal chest CT. Among the patients with abnormal CT findings, bilateral lung involvement was the commonest, observed in 44 (80 %). Multiple lobe involvement was seen more frequently 49 (89.1 %). 25 (45.4%)had involvement of all the 5 lobes whereas two lobe and single lobe involvement was seen in 7 (12.7%) and 6(10.9%) respectively. In terms of axial distribution, peripheral distribution was the commonest, seen in 55 (100 %) cases among which 43 (78.2 %) had only peripheral distribution whereas as 12 (21.8 %) had both peripheral and central distribution. None of the patients showed purely central distribution.

Findings	No. of Patients (n = 100)	%
1. Findings		
Present	55	55
Absent	45	45
2. Opacities		
Pure GGO	16	29.1
GGO with septal thickening	28	50.9
Pure consolidation	0	0
GGO withConsolidation	11	20
3. Lung involvement		
Unilateral	11	20
Bilateral	44	80
4. Axial Distribution		
Central	0	0
Peripheral	43	78.2
Diffuse	12	21.8
5. Vascular involvement		
Present	8	14.5
Absent	47	85.5
6. Other findings		
Pleural Effusion	3	5.5
Pneumothorax	0	0
Mediastinal Lymphadenopathy	5	9.1
Emphysema	4	7.3
Fibrosis	2	3.6
Lung parenchymal Abnormalities	Number of patient	%
Lobar Involvement		
Right upper	32	58
Right Middle	28	50.1
Right Lower	31	56.4
Left Upper	33	60
Left Lower	26	47.3
No of Lobes		
5	25	45.4
4	13	23.6
3	4	7.3
2	7	12.7
1	6	10.9
CT Severity Index		
1-8	36	65.5
9-15	11	20
16-25	8	14.5

Fig (a)

Fig (b)

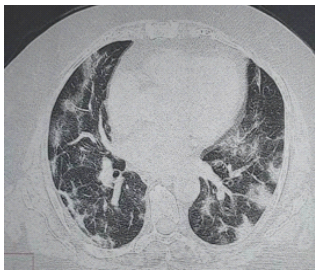

Fig (c)

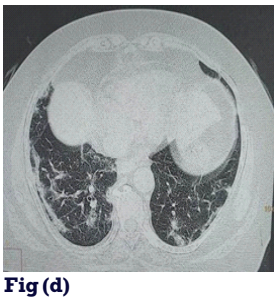

Fig (d)

Non-contrast axial chest CT images inthe lung window setting of a 48-year-old maleCOVID-19 positive patient, obtained 7 daysafter symptom onset, at the carinal (a), upper lobes (b), mid-basal (c) and basal (d) levelsshowing bilateral elongated, confluent groundglass opacities with pronounced peripheral andposterior distribution with interlobular septalthickening producing crazy-paving patternwith early progression to consolidation formation.

DISSCUSSION

Various studies have been done on radiological findings of COVID-19 pneumonia. Many asymptomatic patients can have a positive chest HRCT findingwhereas it has also been observed that many symptomatic patients can have a negative CT especially during the early phase ofthe illness [12]. A prospective observational study was conducted at JLN Hospital, Ajmer, Rajasthanto describe the HRCTfindings of symptomatic COVID-19 patients in our population. There were 65.5% mild, 20 % moderate and 14.5 % severe-critical illness cases in thisstudy. In an environmentally homogenous cohort (Diamond PrincessCruise ship), Inui S et.al [12] reported a normal chest CT in 21 % ofsymptomatic COVID-19 cases with cough (20 %), fever (11 %) anddyspnoea (3%). They further observed that nearly half (54 %) of thesymptomatic cases had an abnormal CT. In contrast, 55%of the cases in our study with varying severity of symptoms had abnormal CT.The low prevalence of CTfindings in laboratory confirmed symptomatic SARS-CoV-2 patients in our population compared to the reported data from other countries raises the possibility of divergentcourse of the disease in different populations. Putatively,three factors inisolation or in varying combinations could account for this discrepancy.First, a low prevalence of abnormal CT scans in our population maybe because CT scans were performed in very early phase of the disease SARS-CoV-2, withmost patients having a mild illness.Second, a low prevalence of comorbidities in our study cohort withno known immune compromised patients (like cancer patients onchemotherapy) may have contributed to low CT positivity rate. Co-morbid illnesses are known to be associated with increased severity of COVID-19 disease [13]. Third, it may be reflective of a less severe form of the diseasein our population which is tentatively indicated by low CFR in ourpopulation so far. The less severity of the disease may in turn resultfrom a less virulent strain of virus or a robust immune status of the population. The loss of follow-up imaging precludes us from conclusivelyrefuting this possibility. Weimaged patients between 3–7 days after thesymptom onset.Among the patients with lung parenchymal abnormalities on HRCT, bilateral and multilobar distribution of pulmonary opacities with aperipheral distribution was commonly observed. Our results fairlycorroborate the distribution and type of pulmonary opacities reportedin COVID-19 pneumonia. The most common lung parenchymal abnormalities encountered were GGO in the form of pure GGO (29.1%), GGO with septal thickening (50.9 %) or GGO admixed with consolidation (20%). The various putactiveetiologiesthat have been put forth to account for this uniquefinding ofvascularenlargement include,vasodilatation induced by the release ofproinflammatory cytokines, small vessel pulmonary embolism and infection induced pulmonary vasculitis [14]. Thefinding of pulmonary avascular enlargement seems to have a diagnostic value as it has notbeen reported previously in any infectious disease settings. Bai et al. [15] reported vascular enlargement to be frequently associated withCOVID-19 pneumonia compared to non–COVID-19 pneumonia. The presence of enlarged vessel sign mayhelp discriminate COVID-19 pneumonia from non–COVID-19 pneumonia. However, the small number of patientswith severe disease precluded us from performing a meaningful correlation analysis within the subsets.CT is not recommended as a screening tool for the diagnosis ofCOVID-19 [16,17]. However, CT can contribute to the clinical management of the COVID-19 disease and in our understanding of thedisease. According to the German Radiological Society, CT may aid inassessing the initial extent of the lung involvement, help in recognitionof the pneumonia-associated complications and also help in monitoringthe progression of the disease in severe cases [16]. According toAmerican College of Radiology (ACR) guidelines, CT should be reservedfor hospitalized, symptomatic patients with specific clinical indicationslike worsening respiratory status [17]There are several limitations to our study. First, we focused on initial or baseline CTfindings and did not perform follow-up CT examinations. This may result in non-inclusion of symptomatic cases thatmay have developed lung changes late in the course of disease andhence a spurious high rate of negative CTs in the study population.Second, there may have been a selection bias as imaging was performedin all symptomatic cases regardless of the severity of illness. The smallsize of study population is also a limitation.

The CT findings of COVID-19 pneumonia reflected a typical lung injury of viral pneumonia, which was characterized by a rapid change as seen in severe acute respiratory syndrome and Middle East respiratory syndrome [11,18,19]

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