Spectrum of Chest HRCT findings in covid-19 pneumonia

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Abstract

Introduction: The pandemic disease COVID-19 has varied presentations clinically and even radiologically. Early diagnosis and treatment help in containment of the disease. Therefore, assessing the radiological patterns in order to contribute to the diagnosis COVID-19 is the aim of this study.
Materials and method: A cross-sectional descriptive study from January 2021 to June 2021 was carried out on 165 patients suspected of COVID-19 with delayed RT-PCR report or in cases with initial RT-PCR negative, but having high clinical of suspicion of COVID-19. HRCT pattern in such cases were documented and correlated with the repeat RTPCR and other laboratory parameters such as Interleukin IL-6, serum ferritin, C-reactive protein, Lactate Dehydrogenase.
Results: Most common HRCT pattern was bilateral multifocal peripheral ground glass opacities predominantly involving posterior segments. Other common patterns were crazy paving and consolidation.
Conclusion: Specific patterns on the HRCT can be used in diagnosis of COVID-19 when there is high clinical likelihood, however the study should be used judiciously only when indicated.

Keywords: Chest HRCT, COVID-19, Pneumonia

Introduction

COVID-19 is a viral infectious disease, announced as pandemic, caused by coronavirus or SARS-CoV presenting with varied clinical features. Most common clinical features are fever, dry cough and generalised myalgia.
The diagnosis of COVID-19 is currently confirmed by lab testing through reverse transcriptase polymerase chain reaction (RT-PCR) by identification of viral RNA. Imaging of the chest is a part of the diagnostic workup of patients with suspected or probable COVID-19 disease where RT-PCR is not available or results are delayed or are initially negative in the presence of symptoms suggestive of COVID-19. Imaging has been also considered to complement clinical evaluation and laboratory parameters in the management of patients already diagnosed with COVID-19 [1].

Materials and method

Height resolution CT of chest was performed in COVID-19 patients who were suspected positive or RT- PCR positive, using 16 slice Philips CT machine with all the precautions as recommended by Indian Radiological and Imaging Association (IRIA) [2].

Study design: Cross sectional descriptive study.

Study was performed on 165 patients coming to the Department of radiodiagnosis, Bidar Institute of Medical Sciences, BRIMS, Bidar, for a period of 6 month, from January 2021 to June 2021.
All CT Requisitions were analysed for appropriateness before the procedure. Patients were masked during imaging. Two radiology technicians performed the CT scanning. One technician used PPE kit (Personal protective equipment) and set up the patient on the CT imaging table, while the other technician operated the CT console. After the CT was performed, scanner and console rooms were sanitized with 1% sodium hypochlorite solution. Room downtime was around 40 to 45 minutes.

Inclusion criteria

1) HRCT was performed for diagnosis in suspected COVID-19 patients with delayed RT-PCR testing results and in cases with initial RT-PCR negative, but having high clinical of suspicion of COVID-19.
2) HRCT was performed to assess severity in confirmed or suspected COVID-19 patients to decide on hospital admission and therapeutic management [1].

Exclusion criteria: CT was not used as a screening tool

1) Asymptomatic contacts of patients with COVID-19, CT is not performed for the diagnosis of COVID-19.
2) Symptomatic patients with suspected COVID-19, chest imaging is not used for the diagnostic workup of COVID-19 when RT-PCR testing is available with timely result.

Varied HRCT patterns were documented. CO-RADS [3] (assigning level of disease suspicion) and CT severity scores [4] (out of 25 with maximum of 5 score for each lung) were given for each case.

Statistical analysis

Sample size was calculated using the formula: $n=(Z\alpha/2)^2 \times P(1-P) d^2$.
Data was entered into Microsoft Excel Sheet and was analysed using SPSS 22 version software. Categorical data was represented in the from of Frequencies and proportions and continuous data was represented as mean and standard deviation.
Graphical representation of data: MS Excel and MS word was used to obtain graphs such as bar diagram. P value of <0.05 was considered as statistically significant after assuming all the rules of statistical tests.

Result

HRCT patterns of all 165 Cases were evaluated. The following observations were made.
Demographic data: Age ranged from 14-85yr with mean age of ~38yr.

Table 1: Various patterns on HRCT

Prevalence of HRCT findings	*N* (165)	Percentage
Distribution of findings		
• Bilateral involvement	148	89.6
• Apical predominance	19	11.5
• Basal predominance	146	88.4
• Hilar predominance	63	38
• Peripheral predominance	135	81.8
• Posterior predominance	102	61.8
Lung Opacities		
• Ground glass opacities:	157	95
Multifocal distribution	138	83.6
Round shape	89	54
Unsharp margin	94	57
• Crazy paving	86	52
• Reverse Halo	11	6.6
• Consolidation	90	54.5
• Cavitation	17	10.3
• Calcification	14	8
• Mosaic attenuation	30	18
• Tree-in-bud opacities	26	15
• Mass	0	0
Airway findings		
• Bronchial wall thickening	24	14
• Bronchiectasis	42	25
Vascular findings		
• Vascular tree-in-bud	18	10
• Widening of vessels	86	52
Pleural findings		
• Pleural effusion	26	15
• Pleural thickening	34	20
• Subpleural bands	58	35
Mediastinal findings		
• Subcentimetric mediastinal lymph nodes	138	83.6

Among 165 cases, approximately 90% of cases showed bilateral involvement with apico-basal gradient, affecting peripheral lung in ~82% cases and involving posterior lobes in ~62% patients.

Most common HRCT pattern was multifocal ground-glass opacities accounting for ~95% patients. Cases also had overlapping patterns of crazy paving, consolidation and mosaic attenuation. Less common findings were cavitation, calcification and tree-in-bud opacities.

Other important findings were widening of the vessels in the regions of ground glass opacities seen in around 52% of cases. Vascular tree-in-bud were identified in 18 cases.

Airway findings were less common, such as bronchial wall thickening and bronchiectasis present in 24 and 42 cases respectively.

Many cases (~35%) had subpleural fibrotic bands. Pleural effusion (~15%) and pleural thickening (~20%) were less commonly seen. Few subcentimetric mediastinal lymph nodes were noted in around 84% of patients.

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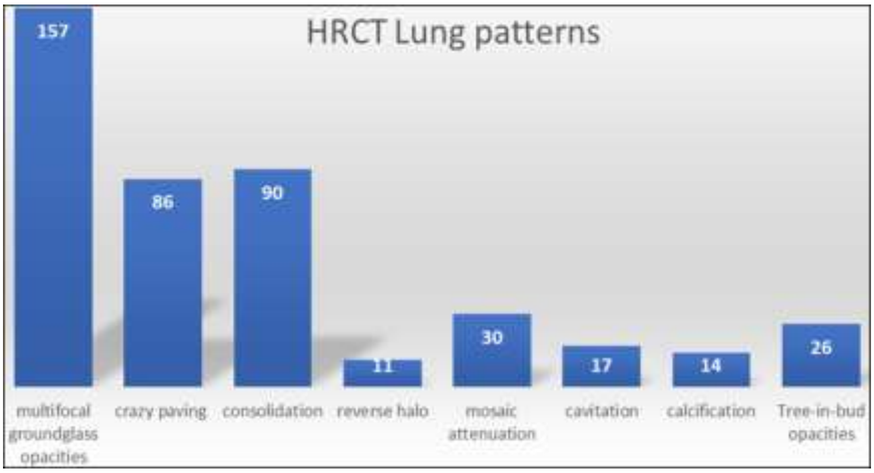

Fig 1: HRCT Lung patterns in COVID-19 patients

Fig 2: Bilateral multifocal round ground glass opacities with unsharp margins predominantly located in posterior segments

Fig 3: Bilateral crazy paving pattern i.e., ground glass opacities (GGO) with smooth interlobular septal thickening. Widened vessels seen in the areas of GGO

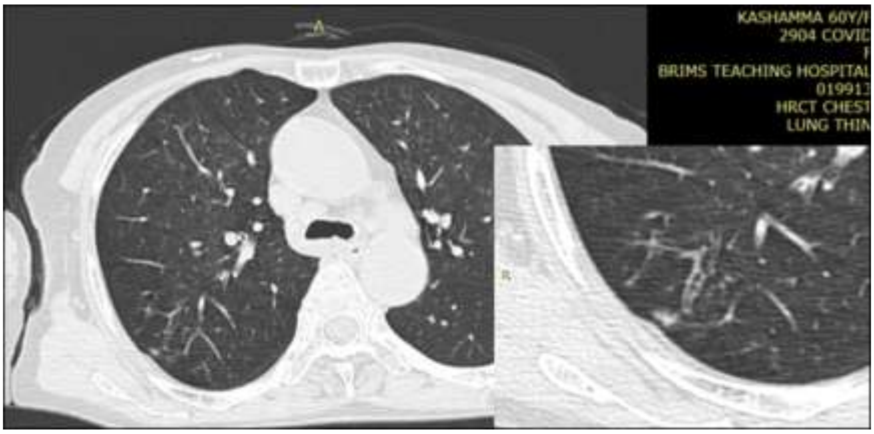

Fig 4: Vascular tree-in-bud appearance indicating inflammation involving vessels

Discussion

HRCT patterns of COVID 19 infection are related to the pathogenesis of the viral infection [5]. Pneumonia caused by coronaviridae family exhibit similar pattern on the HRCT lung. Our study showed ground glass opacities and consolidation to be the most common CT features (95% and 54.5% cases respectively), comparible with other studies such as, study conducted by Yan Li and Liming Xia also showed singular or multiple irregular areas of ground glass opacities or consolidation or both in 49 of the 51 cases (96.1% patients) [6]. Angiotensin converting enzyme II (ACE II) is essentially involved in the development and progression of acute lung injury [7]. SARSCoV causes direct lung injury by involving angiotensin cinverting enzyme, which leads to diffuse alveolar damage [5]. This probably explains the pathologic mechanism of ground glass opacities and consolidation.

Crazy-paving pattern defined as thickened interlobular and interlobular septa superimposed on diffuse ground-glass opacities by the Fleischner Society [8] is also commonly seen in around ~52% of cases. Crazy paving pattern may indicate interstitial inflammation and alveolar damage in COVID-19, which had been previously noted in patients with Middle East Respiratory Syndrome (MERS) and the Severe Acute Respiratory Syndrome (SARS) [9]. Increase in ground glass opacities and crazy paving patterns with emergence of pleural effusion occurs in late stage of the disease.

Cavitations were less common findings in our cases. The exact mechanism of cavitation in COVID-19 pneumonia is unknown, can be multifactorial, may be related diffuse alveolar damage, intra-alveolar haemorrhage and necrosis [10]. Other contributing factors include, bacterial and fungal co-infection; the immunosuppressive effects of glucocorticoids and tocilizumab; SARS-CoV-2 specific inflammatory pathways; the COVID-19 related predisposition to venous thromboembolism and potential to cause infarct and micro-infarcts leading to cavitation; and the severe morbidity of this patient population [11].

Tree-in-bud opacities were also seen in few cases. Few reports also showed tree-in-bud nodules in patients with COVID-19, however superimposed bacterial infections or aspiration should be considered first when these nodules are detected [12-15].

The reversed halo sign or Atoll sign is a central ground glass opacity surrounded by rim of consolidation. This sign was found in approximately 7% of cases which is consistent with other studies such as Bernheim *et al.* [16] reported in 1.7% cases and Wang *et al.* [15] study showed this sign in 5.1% cases.

Pulmonary vessels and perfusion are often abnormal in COVID-19 pneumonia, which is mostly affecting the medium-to-small vessels causing its dilatation. The vascular involvement is not just confined to the areas of diseased lung, it frequently involves subpleural vessels, indicating a diffuse vascular process [17]. Our study also showed widening of vessels in the areas of ground glass opacities as documented by other reports [18, 19]. The pulmonary response to pneumonia is usually

vasoconstriction in the region of parenchymal disease, to shunt the blood flow toward less affected area in order to match ventilation and perfusion. Our finding of vasodilatation in the regions of diseased lung may be suggestive of disordered vasoregulation, leading to substantial ventilation and perfusion mismatch even early in the disease. This finding may explain in part the hypoxemia that can occur in COVID-19 pneumonia despite normal pulmonary compliance [17].
Air way changes were less commonly seen in our report. Literature also showed bronchiectasis, bronchiectasis and bronchial wall thickening in COVID-19 cases [20, 21]. The prevalence of bronchial wall thickening was significantly higher in patients with severe clinical features [20, 22]. Subpleural bands were noted in around ~35% of cases indicating fibrosis in this region. Both Wu *et al*. [20] and Li *et al*. [23] reported this finding in approximately 20% cases.
Pleural involvement such as pleural effusion and focal pleural thickening is less commonly seen in our study. Pleural pathologies are usually seen in the later stages of the disease and pleural effusion is thought to be a sign of poor prognosis in COVID-19 pneumonia [24-26].

Conclusion

Clinical and radiological presentation of COVID-19 are varied depending on degree of pulmonary involvement, other co-infections and secondary/superinfections. Certain HRCT chest findings are commonly seen in COVID-19 such as bilateral peripheral ground-glass opacities, vascular enlargement and has preferable lower lobe involvement, and this may help in diagnostic analysis.
However, HRCT should be used judiciously as diagnostically it does not provide clinical benefit and could lead to false security if results are negative. Positive findings on HRCT can only be believed if the pre-test probability of disease is high and correlates with clinical and laboratory parameters.

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