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Original Research Article

A Retrospective Assessment of Spectrum of HRCT Findings in COVID‑19 Infected Patients and Severity of the Disease Based on HRCT Findings to Establish the Role of HRCT Chest as an Investigative Modality of Choice for Prognosis of COVID‑19 Infected Patients

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Abstract

Aim: The aim of our study was to evaluate the spectrum of HRCT findings in COVID‑19 infected patients, to assess the severity of the disease based on HRCT findings and to establish the role of HRCT chest as an investigative modality of choice for prognosis of COVID‑19 infected patients.

Methods: The Retrospective Study was conducted in the department of Radio-diagnosis, Indira Gandhi Institute of Medical Sciences, Patna, Bihar, India for one year and 200 patients were included in the study.

Results: The study included 130 males (65%) and 70 females (35%). Most of the patients belonged to age groups 31-40 and 21-30. Many travelers whose nasopharyngeal swabs were tested positive for COVID infection were asymptomatic (140 cases, 70%), 60 patients (30%) had mild symptoms. Out of 100 cases of abnormal HRCTs, 90 of them (90%) had bilateral lung involvement, while 7 (7%) had only right lung involvement and 3 (3%) had only left lung involvement. Sore throat followed by generalized malaise, fever and cough were the common presenting symptoms. In our study 26 patients (13%) had abnormal chest X ray and HRCT's while only 64 patients (32%) had abnormal HRCT but normal chest X rays. Ground glass opacities (GGO's) were the most common finding seen in almost all patients who showed some finding on HRCT. 90 out of 100 (90%) patients who showed findings on HRCT had ground glass opacities.

Conclusion: Typical peripheral sub pleural distributions of GGO's with bilateral asymmetrical lung involvement are characteristic features of COVID19 pneumonia. Chest HRCT can be a very useful and standard imaging method to assess the severity and progression of the disease and thereby optimizing the management of patients. With increasing case load all over the world HRCT can be used as a one stop radiological investigation for the diagnosis and prognosis of corona virus disease.

Keywords: Atoll sign; coronavirus; COVID-19; crazy –paving; ground glass opacities; PPE; RT-PCR; SARS-CoV-2.

Introduction

COVID-19 is caused by an RNA virus, SARS CoV-2 (severe acute respiratory syndrome coronavirus 2) which is part of the Coronaviridae family (which includes SARS-CoV and MERS(Middle East respiratory syndrome)-CoV). [1,2] The virus infects the upper respiratory tract, can cause pneumonia, and is easily transmitted from human to human. The initial epicenter was in Wuhan, the capital city of China's Hubei province, back in December 2019.

For instance, 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 the most typical findings. [3] 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. [4] 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. [5] Thoracic radiology evaluation 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.

The most common clinical symptoms at presentation are fever and cough in addition to other nonspecific symptoms including dyspnea, headache, muscle soreness, and fatigue. [6] About 20% of cases are severe, and mortality is approximately 3%. [7] The World Health Organization declared a global health emergency on January 30, 2020. [8] 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. [9]

The aim of our study was to evaluate the spectrum of HRCT findings in COVID‑19 infected patients, to assess the severity of the disease based on HRCT findings and to establish the role of HRCT chest as an investigative modality of choice for prognosis of COVID‑19 infected patients.

Materials and Methods

The Retrospective Study was conducted in the department of Radio-diagnosis, Indira Gandhi Institute of Medical Sciences, Patna, Bihar, India for one year and 200 patients were included in the study.

Inclusion criteria

All patients diagnosed to be infected with COVID‑19 virus by RT‑PCR testing method tested at approved laboratory at the Dept of Microbiology of our institute.

Exclusion criteria

Pregnant patients and debilitated patients requiring Ventilator Support not in a position to be shifted to CT Department

Methodology

Our institute was designated as a dedicated COVID care Hospital by the district administration. To avert any potential breach of confidentiality, patient's names were not revealed. Institutional Ethics committee approval was taken. 200 COVID‑19 positive patients admitted to our hospital who underwent chest HRCT were enrolled in our study. Patient selection was consecutive. In addition to age and sex, clinical information collected

included travel and exposure history (when known). The Government of India had divided all districts of the country into three zones namely Red, Orange and Green. Accordingly, all travellers who traveled from red zone who entered Patna District were stopped at the district entry point and sent to our institute, wherein they underwent compulsory swab testing and thereafter Institutional Quarantine at Govt designated public and private places for asymptomatic individuals and hospitalization for symptomatic people. All patients were tested for COVID‐19 infection at approved laboratory testing at Dept of Microbiology of this institute as well as at the National Institute of Virology, Pune, with real‐time reverse‐transcriptase polymerase chain reaction (RT‐PCR) of secretions obtained by nasopharyngeal swab. All CT scans were performed on Somatom Duo 128 slice CT scanner (Siemens Healthineers, Erlangen, Germany).

Conventional non‐contrast HRCT was performed with the patient in the supine position during end‐inspiration. The patients who were referred from wards to CT Department wore personal protective equipment (PPE) andN95 masks, as well as the CT technicians who performed CT of patients with suspected COVID‐19 were required to wear protective garments. Standard CT protocol was applied with topogram length of 512 cm, 120 kV and 35 mA. Images were obtained in axial mediastinal window and reconstructed in thin 1.25 mm lung window. All CT images were reconstructed to 1.25‐mm thin slices. Multiplanar images were obtained using the multiplanar reformatting (MPR) technique on a workstation. After the CT scans of all daily appointed positive patients was done, the CT department was fumigated for at least 4 hours using 20% Baccishield, followed by cleaning of CT gantry, CT table and floor by 1% hypochlorite solution and left to dry for 30 minutes. [10] For each patient, the chest CT scan was thoroughly evaluated for presence of opacities and lesions. [11] Each of the five lung lobes were assessed for degree of involvement, which was classified as none (0%), minimal (1%–25%), mild (26%–50%), moderate (51%–75%), or severe (76%–100%). No involvement corresponded to a lobe score of 0, minimal to a lobe score of 1, mild to a lobe score of 2, moderate to a lobe score of 3, and severe to a lobe score of 4. An overall lung total severity score was reached by summing the five lobe scores (range of possible scores, 0–20). [12]

Results

Table 1: Patient details

Gender	**N%**
Male	130 (65)
Female	70 (35)
Age groups in years	
0-10	30
11-20	20
21-30	50
31-40	55
41-50	30
51-60	10
61-70	3
>70	2
Spectrum of cases	
Symptomatic	60 (30)
Asymptomatic	140 (70)

Laterality of lung Involvement N=100	
Bilateral	90
Left	7
Right	3

The study included 130 males (65%) and 70 females (35%). Most of the patients belonged to age groups 31-40 and 21-30. Many travelers whose nasopharyngeal swabs were tested positive for COVID infection were asymptomatic (140 cases, 70%), 60 patients (30%) had mild symptoms. Out of 100 cases of abnormal HRCTs, 90 of them (90%) had bilateral lung involvement, while 7 (7%) had only right lung involvement and 3 (3%) had only left lung involvement.

Table 2: Symptomatology of COVID Positive cases

Symptoms	N%
Fever	28 (46.66)
Fever, Cough	42 (70)
Dyspnoea	10 (16.66)
Sore throat	45 (75)
Abdominal Pain 8 (10.6%)	6 (10)
Generalised malaise 36 (48%)	29 (48.33)
Asymptomatic	140 (70)

Sore throat followed by generalized malaise, fever and cough were the common presenting symptoms.

Table 3: Chest X Rays & HRCT Findings

Radiological Investigation	N%
Chest X Ray & HRCT both normal	110 (55%)
Chest X ray & HRCT both abnormal	26 (13%)
HRCT abnormal but Chest X ray Normal	64 (32%)

In our study 26 patients (13%) had abnormal chest X ray and HRCT's while only 64 patients (32%) had abnormal HRCT but normal chest X rays.

Table 4: HRCT Findings in COVID patients

HRCT Findings	N%
Ground Glass Opacities (GGO'S)	90 (90%)
Presence Of Both GGO's & Consolidation	10 (10%)
GGO's With Septal Thickening/Crazy Paving Pattern	55 (55%)
GGO's With Reversed Halo Or Atoll Sign	18 (18%)
GGO's With Pulmonary Nodules	27 (27%)
Pleural Effusion	0
Mediastinal Lymphadenopathy	16 (16%)
Fibrosis, Tractional Bronchiectasis, Volume Loss, Calcified Granulomas	8 (8%)

Ground glass opacities (GGO's) were the most common finding seen in almost all patients who showed some finding on HRCT. 90 out of 100 (90%) patients who showed findings on HRCT had ground glass opacities.

Table 5: CT Severity Grading

CT Severity Grading	N%
0	108 (54%)
1‑2	28 (14%)
3‑5	55 (27.5%)
6‑10	6 (3%)
11‑20	3 (1.5%)

The CT severity score directly correlated with clinical severity of disease.

Table 6: Age Distribution of patients with moderate to severe symptoms

Age	No of patients with moderate to severe symptoms	Death
0‑20	0	0
21‑40	0	0
41‑60	10	1
61‑80	5	1
>80	1	1
Total	16	3

The mortality rate of COVID‑19 infection in our study was 1.5% (3 deaths out of 200 patients). These 3 deaths were seen in above 40 age group.

Discussion

An outbreak of coronavirus disease 2019 (COVID‑19) infection began in December 2019 in Wuhan, in China's Hubei province. [13,14] The novel coronavirus was named severe acute respiratory syndrome coronavirus 2 (SARS‑CoV‑2) by the International Committee on Taxonomy of Viruses. [15] India reported an average of 6500 new cases of COVID‑19 per day16 since our preliminary research paper was submitted for peer review on May 31, 2020. Just as clinicians are evaluating more patients suspected of having COVID‑19, radiologists are similarly interpreting more chest CT scans in those suspected of infection. [16]

Our study showed 140 (70%) asymptomatic cases which is a significant number and can be attributed to the demography of the district and hence a large influx of imported cases of migrants and working middle class people who travelled back to their native district as soon as nationwide lockdown was being gradually weaned off. chest HRCT scores over X‑ray

Other findings of this work largely concur with work by Adam B et al. [12] and Yan Li et al. [17] that demonstrated preponderance of ground‑glass abnormality in early disease, followed by development of crazy paving and, finally, increasing consolidation later in the disease course insofar as this pattern of ground glass and consolidative pulmonary opacities, often with a bilateral and peripheral lung distribution, is emerging as the chest CT hallmark of COVID‑19 infection as also described by Kamal Kant et al. [18] The findings in our study, represent the CT correlate for the underlying pathophysiology of the disease process as it organizes. Moreover, the notable absence of ancillary chest CT findings such as lymphadenopathy, pleural effusions, pulmonary nodules, and lung cavitation likewise are consistent with early case descriptions.

In this study of 200 patients with confirmed COVID‑19 infection, it is noteworthy that 110 of the 200 patients

(55%) had a normal HRCT scan with complete absence of ground‑glass opacities and consolidation, suggesting that real-time RT‑PCR is positive even in patients with normal chest CT scans. Chest CT therefore cannot be used as a reliable standalone tool to rule out COVID‑19 infection. These findings do not concur with a large study of cases carried out by Yiecheng F et al. [19] and Tao Ae et al. [20] wherein they proposed to utilize HRCT as a surveillance tool to detect COVID‑19 patients owing to its high sensitivity of 98% in their study. We still believe that RT‑PCR may be more reliable tool for mass screening and diagnosis of COVID‑19, while the role of HRCT would be established in the country as a modality to triage patients, when the community level transmission of COVID infection occurs.

Furthermore, initial CT severity score may give an idea of the severity of infection and aggressive management protocols may be initiated by treating clinicians so as to prevent the morbidity and mortality associated with the disease. The low patient mortality rate in our study ‑1.5% (3 deaths out of 200 patients) as compared to the national mortality rate of 3.6% and global mortality rate of approximately 6% as per WHO situation report [21] can be attributed to the better clinico‑radiological correlation which led to aggressive clinical monitoring and treatment of patients with higher CT severity scores. Hence, Chest CT is vital component in the diagnostic algorithm for patients suspected of having COVID‑19 infection and should be used with increasing frequency, as also outlined by Kohli A in their study. [22]

There are several limitations of this study. This study being a retrospective study done in already diagnosed COVID cases, hence it cannot be utilized in calculating the exact sensitivity and specificity of HRCT in making a diagnosis of COVID 19 infection. There is no comparison between RT‑PCR and HRCT in diagnosing coronavirus infection. As our intention to publish the study was to familiarize radiologists with HRCT findings in COVID infection and underline its role in prognosis, the sample size of the study is relatively smaller. Meanwhile, the outbreak is at a stage of evolving from the acute to a more subacute phase in many patients. Recognizing imaging patterns based on infection time course is paramount for not only understanding the pathophysiologic features and natural history of infection, but also for helping to predict patient progression and potential complication development. Eventually, as infection duration in a large number of patients extends from the acute and subacute phases to either a completely healed outcome or to a chronic phase in patients over the coming several weeks and months, future investigators may evaluate imaging findings in the chronic phase. Such work could evaluate if long‑term complications absent in this study (e.g., pleural effusions, empyema, lymphadenopathy, and lung cavitation) potentially arise. [23]

Conclusion

Thus, to summarize, a typical pattern of peripheral subpleural more often bilateral and asymmetrical distribution of lung opacities is becoming the hallmark of COVID infection related pneumonias on HRCT and should help Radiologists to diagnose COVID pneumonias with increasing confidence. HRCT Chest should be increasingly used in COVID 19 pandemic as it definitely has a greater role to play in evaluating the disease severity at presentation and subsequent prognosis of the disease. HRCT Chest examinations done during the course of disease aids in patient management and a better clinico‑radiological correlation would benefit in further reducing the mortality rate associated with COVID‑19 infection. Whether HRCT scores over RT‑PCR as a

mass screening tool is a matter of further research and discussion, however with increasing number of subclinical cases in the community as the disease is progressing into community level transmission, RT‑PCR should be presently considered as a gold standard test to identify subclinical cases.

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