HRCT Chest as an Indispensable Tool for Early Diagnosis of COVID-19: A Retrospective Study

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ABSTRACT

Background: In coronavirus disease-19 (COVID-19), infected people will exhibit mild to moderate respiratory illness. The present study was aimed to evaluate the diagnostic efficacy of High-Resolution Chest Computed Tomography (HRCT) chest findings in tandem with the RT-PCR status in COVID-19 infected patients.

Methods: A total of 100 patients visiting the diagnostic imaging centre were subjected to HRCT chest. Subjects who tested negative for HRCT were excluded from the study. Furthermore, the HRCT positive patients were divided into three groups as mild, moderate, and severe depending upon the involvement of lung lobes.

Result: Maximum representation (63%) of cases were males and a higher percentage (58%) of patients were older than 60years. 86% of the subjects were in agreement with COVID-19 findings. However, normal findings were present in 14 subjects with suspected COVID-19 infection. Among HRCT positive patients, we observed 81.39% patients with RTPCR positive initially and 13.9% patients turned RT-PCR positive when advised repeat sampling as per strong suspicion on HRCT. Among 86 HRCT positive subjects, 37(43%) were categorised as mild, 29(33.7%) as moderate, and 20(23.3%) were categorised as severe. We observed a higher percentage of cases with lower lung lobe and bilateral lung involvement. Similarly, subpleural Ground Glass Opacities (GGO's) and vascular enlargement were observed in the majority of subjects with the percentage of 99.3% and 84.0% respectively. Pneumomediastinum occurrence in one (01) patient was one of the interesting findings of the current study.

Conclusion: The study shows that HRCT is an indispensable imaging tool to diagnose and categorise the severity of COVID-19 infection for optimum disease management.

Keywords: COVID-19, Diagnosis, HRCT Imaging, Kashmir.

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Introduction

The Coronavirus disease-19 (COVID-19), caused by a single-stranded RNA corona virus-SARS COV 2 is closely related to the SARS-CoV virus.[1-3] As of 26th June 2021, the statistics of the World Health Organization (WHO) reported 18,01,06,548 laboratory-confirmed cases and 38,83,272 number of mortalities. The infection arose all over the globe after its occurrence in late December 2019.[4,5] Since its emergence, the disease has caused severe disturbances across most of the countries of the world causing a global health emergency.[6,7] Patients with this infection can develop clinical presentation ranging from asymptomatic, mild to severely symptomatic like Acute Respiratory Distress Syndrome (ARDS).[8-10] Considering the infectious nature of this disease, the need of the hour is to look for rapid, and accurate diagnostic tools for its early detection and a number of techniques have been employed globally. As of now, numerous studies have shown (Reverse Transcription Polymerase Chain Reaction) RT-PCR as a standard tool for ruling out COVID-19 infection. However, patients with negative RTPCR results had pulmonary abnormalities consistent with COVID-19[12], indicating the limited sensitivity of RT-PCR. Additionally, Lung being involved in the majority of COVID-19 patients, radiological imaging in the form of High-Resolution Computed Tomography (HRCT) can be considered as an alternate method for the early diagnosis of this disease. Although HRCT imaging could rule out the staging and severity of the disease there is a paucity of literature in showing the efficacy of HRCT as a supplement to RT-PCR in diagnosing the disease, particularly in this part of the world. Therefore, the present study was designed to report the sensitivity of HRCT in making early diagnosis, staging, and rapid isolation to minimise the spread of this dreadful infection.

Methods and Study Design

The current study was a retrospective observational study conducted from June 2020 to August 2020, in an imaging centre in Srinagar Kashmir, the northern most UT of India. A total of 100 patients having symptoms of concomitant cough, sore throat, body ache, breathing difficulty, and fever were subjected to HRCT chest on a 16-slice CT scanner. RTPCR status was co-related as per HRCT findings. The details of the subject selection for HRCT and RTPCR are provided in **Figure 1.**

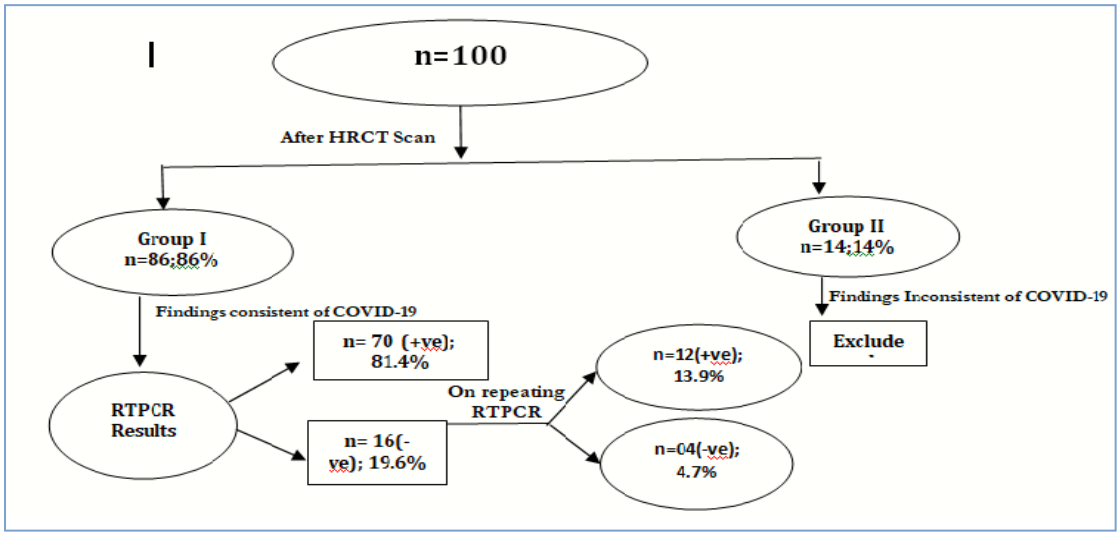

Figure 1: Flow Chart of COVID-19 Patients, depicting the result of HRCT Chest in tandem with RTPCR results.

Model and Acquisition Protocol: Model and acquisition protocol: KVp-100 mAS-80 Pitch-1.2. Slice thickness-1 mm. Matrix 512 × 512. A total of 100 symptomatic patients were scanned by HRCT. The patients showing positive HRCT findings were further divided into three subgroups, mild, moderate, and severe depending upon the CT severity score. HRCT chest was done to evaluate the pulmonary abnormalities like ground-glass opacities (GGOs), vascular prominence, septal thickening, consolidations, pleural effusion, nodules, etc. Subjects with strong positive HRCT findings but negative RTPCR reports were followed for their repeated RTPCR results.

Analysis of HRCT Images: Two radiologists (ZA and NA with an experience of more than 10 and 15years respectively) reviewed the patient's CT images. In case of any non-compliance between the two radiologists regarding the interpretation of results, SAD with experience of more than 20 years confirmed the final results. The interpreters assessed the various lung abnormalities including GGO's (increased density of lung with non-obscuration of vascular and bronchial structures). Moreover, consolidation is defined as increased density of pulmonary tissue through which bronchial and vascular structures were not visible. Additionally, the presence of pleural, vascular, and mediastinal abnormalities was also noted. As per the percentage of lobar involvement, CT severity score was adapted for calculating lobe involvement and suitable disease localization.

Statistical Analysis

Statistical analysis was performed using STATA software, version 12 (STATA Corp., College Station, TX, USA). The continuous variables were expressed as mean and standard deviation. Whereas categorical variables were expressed as counts and percentages.

Results

In this retrospective study, 100 patients with clinically COVID-19 like illnesses were included. Among them 63%subjects (63/100) were males and 37% (37/100) were females. The age group included patients ranging from 15 to 80 years in which 10% of the patients were < 20 years, 32% of the patients were from 20-60 years and 58% were >60 years (Table 1). HRCT scan revealed the typical abnormalities of COVID-19 pneumonia in 86/100 cases. Therefore, on the basis of positive HRCT findings the patients (n=100) were divided into two groups.

Group I: 86 patients with findings suspicious or classical of COVID-19.
Group II: 14 patients showing findings in consistent with COVID-19.

On stratifying the recruited patients on the basis of RTPCR findings, we observed that in group I RTPCR was positive in 70 (81.4%) patients. The remaining clinically suspected COVID-19 patients 16 (18.6%) patients had positive HRCT findings but negative RTPCR at first instance (**Fig. 2a,b**). However, among 16 previously negative RTPCR subjects, 12 tested positive and the remaining 4 patients with positive HRCT findings again tested negative for RTPCR.

Figure: 2a A 55 year male patient with HRCT positive findings but RTPCR negative

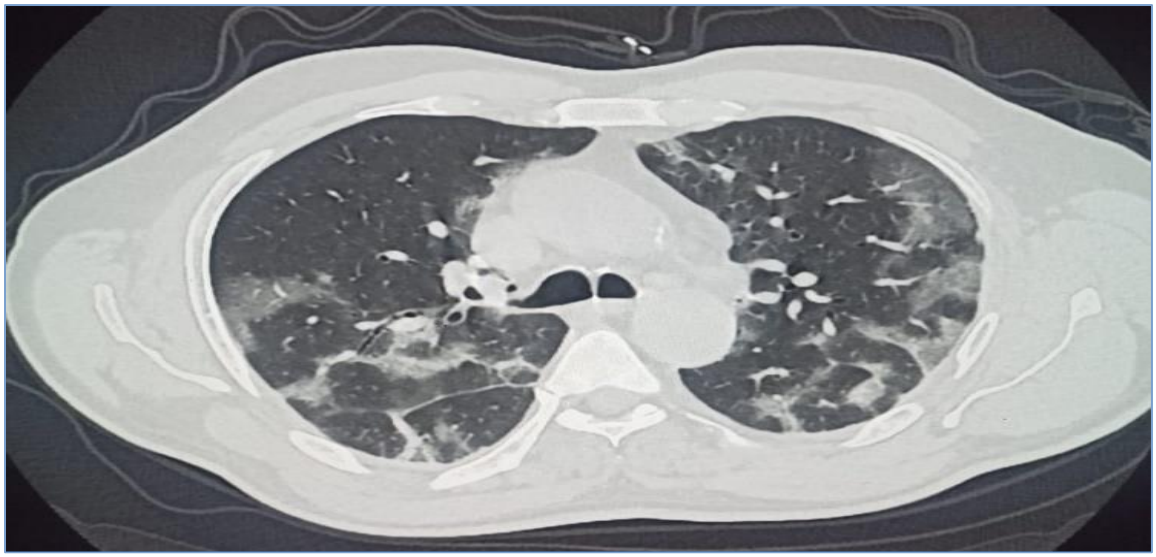

Figure: 2b A patient with both HRCT and RTPCR positive findings

Group 1 patients were further classified on the basis of area of lung involvement and CT severity score (CTSS) of the patients, 37 (43%) were categorised mild, 29 (33.7%) as moderate, and 20 (23.3%) patients were categorised as severe. It was found that 7/86 (8.1%) of the patients had unilateral involvement whereas; 79/86 (91.8%) patients had bilateral lung involvement. Moreover, the percentage involvement of the lung lobes was also calculated and was found to be 45.3%, 43.0% 83.7%, 44.1%, and 80.2% for the right upper lobe, right middle lobe, right lower lobe, left upper lobe and lower left lobe respectively. It was found that the majority of the subjects had lower lung lobe involvement (**Table 2**).

HRCT Findings

On the basis of the type of opacity, a higher number (82/86; 99.3%) of cases presented with subpleural GGO'S followed by vascular enlargement (73/86; 84.8%), bronchial wall thickening (63/86; 73.2%), and septal thickening seen in 51/86 (59.3%) of cases (**Fig.**

3a, b). The consolidations, sub-pleural bands, and crazy paving patches were found in 47/86 (54.6%), (30/86; 34.8%), and 51/86 (59.3%) cases respectively (**Fig. 4a, b**). Air bronchogram (58/86; 67.4%) and reverse halo sign (31/86; 36.0%), were also seen in the patients (**Fig. 5**). Lymphadenopathy (3/86; 3.4%) and cysts (7/86; 8.1%) were less frequently seen (**Fig. 6**). Moreover, Pleural effusion was not seen in any of the cases. Although rare, a case of pneumomediastinum was seen in one of the patients (**Fig. 7**). The lung parenchymal anomalies and damages are summarised in **Table 3.**

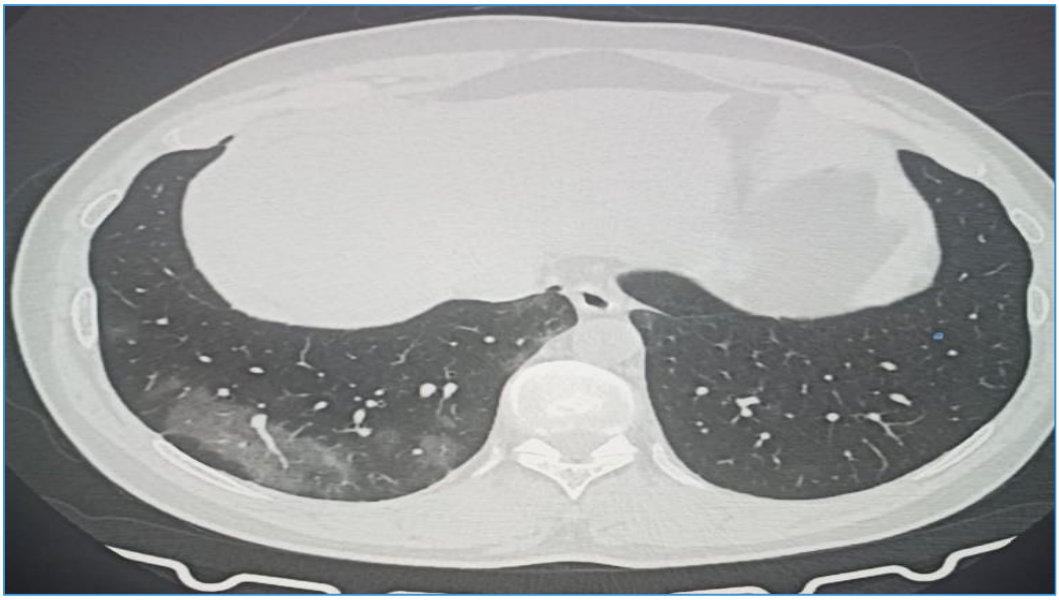

Figure 3a: Axial HRCT Chest showing unilateral sub pleural GGOs with vascular enlargement.

Figure 3b: Axial HRCT chest showing bilateral subpleural GGOs with bronchial wall thickening.

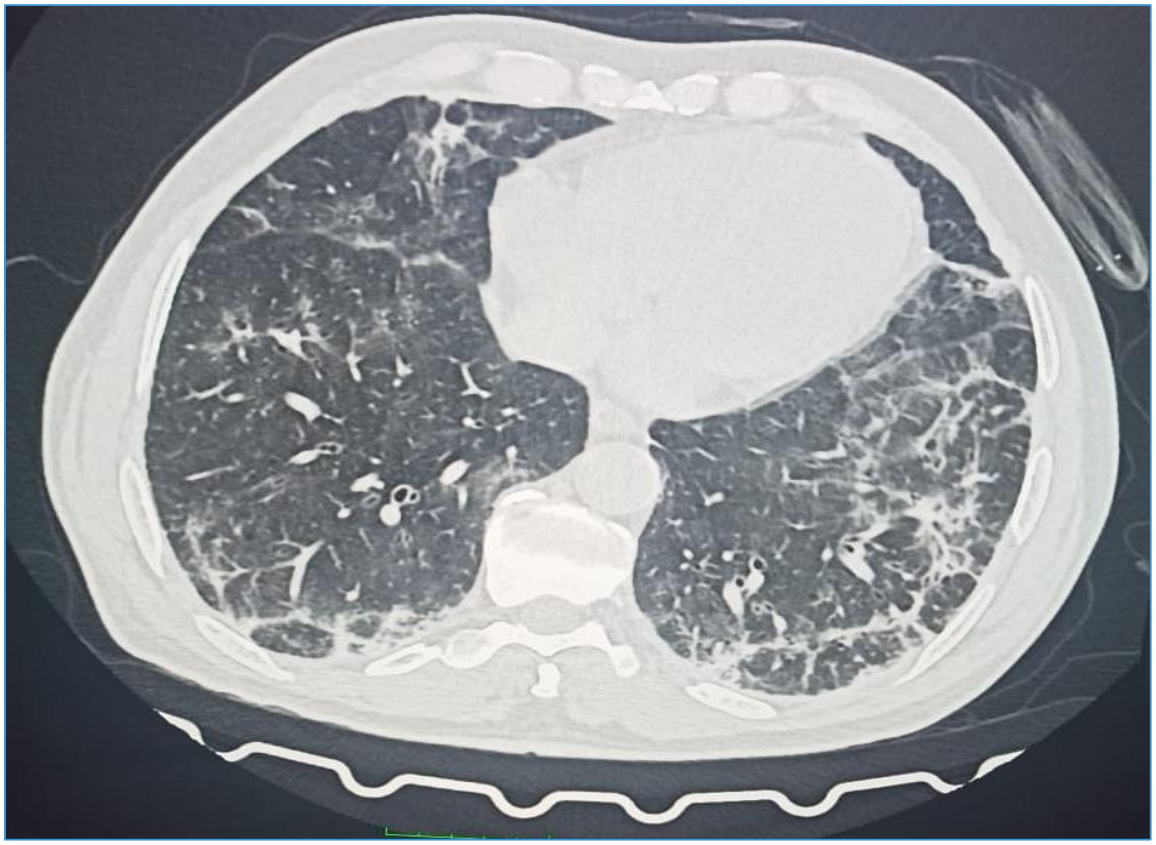

Figure 4a: Axial HRCT chest image showing bilateral subpleural consolidation with sub pleural bands.

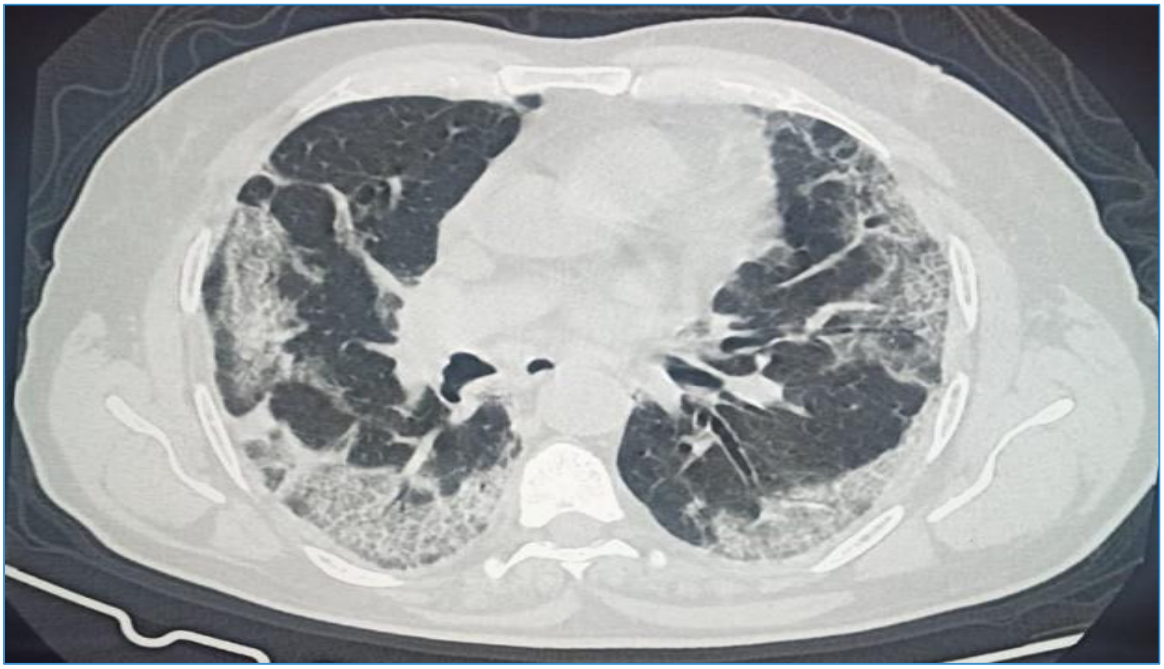

Figure 4b: Axial HRCT Chest showing bilateral sub-pleural GGOs, septal thickening and crazy paving.

Figure 5: Axial HRCT chest image showing consolidation with reverse halo sign

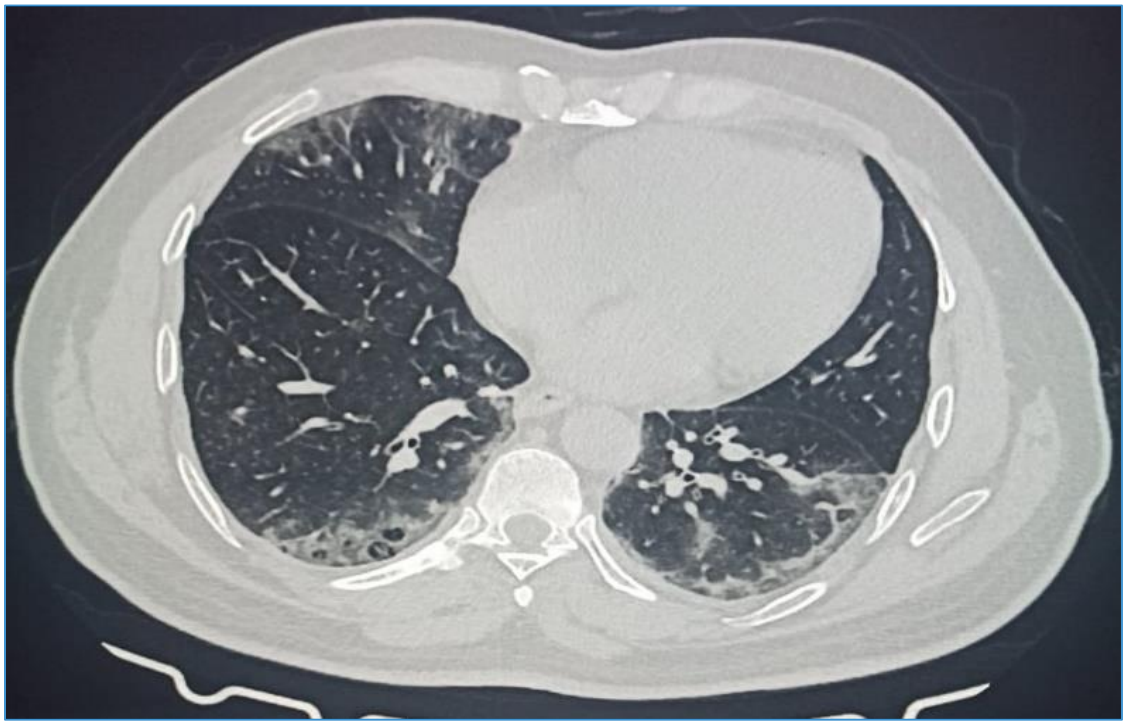

Figure 6: Axial HRCT chest showing bilateral subpleural GGOs with cysts.

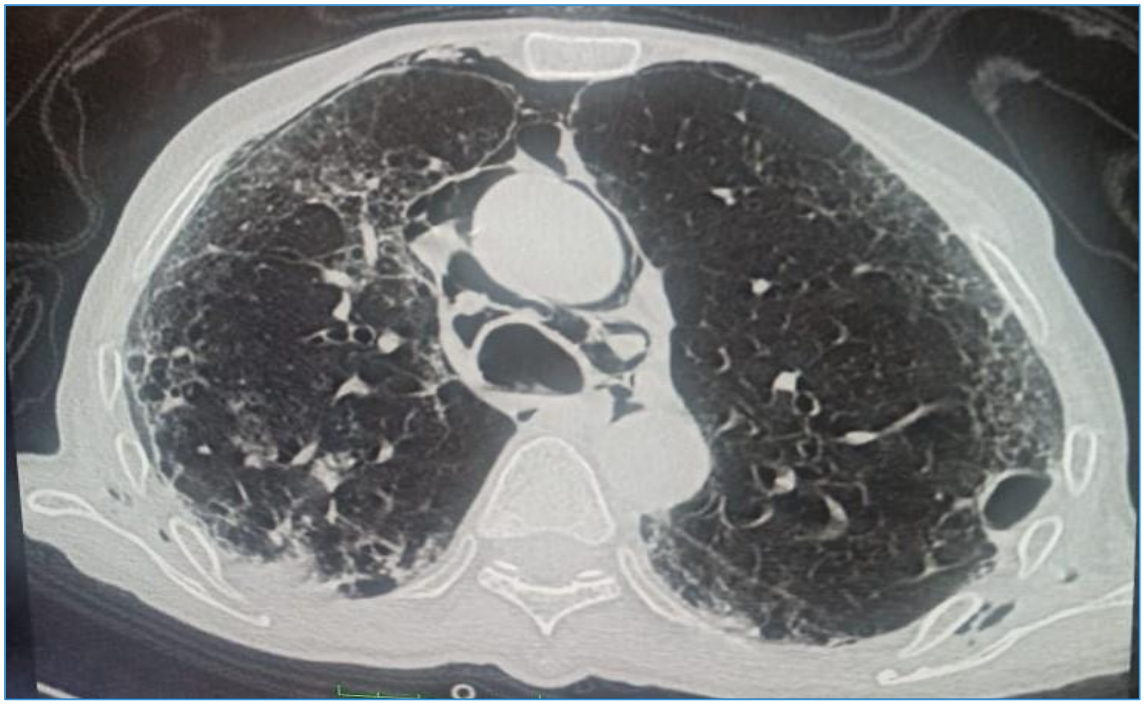

Figure 7: Axial HRCT chest showing pneumomediastinum GGOs with cysts.

Table 1: General characteristics of study subjects	
Variable	**N (%age)**
Gender	
Male	63 (63.0)
Female	37 (37.0)
Age	
<20years	10 (10.0)
20 – 60years	32 (32.0)
>60 year	58 (58.0)
HRCT findings	
HRCT Positive Cases	86 (86.0)
HRCT Negative Cases	14 (14.0)
RTPCR	
Positive	70 (81.4)
Negative	16 (18.6)
RTPCR Repeat sampling (out of 16)	
Positive	12 (13.9)
Negative	04 (4.6)
RTPCR Finding (out of 86 +ve HRCT cases)	
Positive	70 + 12*=82 (95.3)
Negative	04 (4.7)

*12 subjects were detected RTPCR positive after repeating the test.

Table 2: CT severity score as per percentage of lobar involvement	
1	<5%
2	5- 25%
3	26 – 50%
4	51 – 75%
5	>75%
Severity of Lung Involvement as per CTSS (out of 25)	
Mild (≤7)	37 (43.0)
Moderate (8 - 15)	29 (33.7)
Severe (>15)	20 (23.3)
Laterality	
Lower lung lobe	72 (83.7)
Unilateral	07 (8.1)
Bilateral	79 (91.8)
Lobe Involvement	
Right Upper Lobe	39 (45.3)
Right Middle Lobe	37 (43.0)
Right Lower Lobe	72 (83.7)
Left Upper Lobe	38 (44.1)
Lower Left Lobe	69 (80.2)

Table 3 : HRCT Findings with lung parenchymal anomalies and damage	
GGO'S	82 (99.3)
Vascular enlargement	73 (84.0)
Bronchial wall thickening	63 (73.2)
Air broncho gram	58 (67.4)
Septal thickening	51 (59.3)
Crazy paving	51 (59.3)
Consolidation Patches)	47 (54.6)
Sub-pleural bands	30 (34.8)
Reversal Halo sign	31 (36.0)
Cysts	07 (8.1)
Lymphadenopathy	03 (3.4)
Pnemomediastinum	01 (1.2)
Pleural effusion	0 (0.0)

Discussion

COVID-19 infection, a pneumonia epidemic has been issued as a public health emergency of international concern by the WHO.[13,14] From the Huanan seafood market in Wuhan, China, SARS-CoV-2 made its transition from animals to humans. However, the exact route of transmission is yet mixed rather than conclusive. Pneumonia, as a first clinical sign of the SARS-CoV-2-related disease, was used as an indication for case detection. It occurs mostly in the second or third week of symptomatic

infection and can become severe in about 75% of patients.[14] Blood gas deviations change visible through chest X-rays and other imaging techniques, with ground glass abnormalities, patchy consolidation, alveolar exudates, and interlobular involvement, are some of the prominent signs of viral pneumonia, which eventually lead to deterioration.

To combat the diagnostic situation of COVID-19 infection, various techniques like RTPCR have proved to be of immense help. However, it has been found that RTPCR has limited sensitivity.[12,16] In order to improve the therapeutic strategy for early diagnosis and management of COVID-19infection HRCT chest can reliably supplement RTPCR. Moreover, HRCT imaging can demonstrate typical patterns of imaging manifestations that could be used to diagnose COVID-19 infection. In the current study, we observed a high percentage of COVID-19 infection subjects with positive HRCT findings. 95.2% of the patients screened through HRCT chest, were positive for RTPCR as well. However, 4.6% of the patients with positive HRCT findings had negative RTPCR. This is in accordance with the study carried out by Li et al reporting a CT positivity rate of 71.8% in confirmed COVID-19 cases with clinical symptoms.[17] Similarly, Yu et al reported a CT positivity rate of 100% in their cohort study.[18] Moreover, the patients having positive HRCT findings tested negative for RTPCR initially but turned out RTPCR positive on subsequent sampling. Therefore, our study demonstrates that HRCT chest might play a crucial role in the early diagnosis of COVID-19, especially in patients with a negative RT-PCR.

The majority of the patients had lower and bilateral lung involvement, with predominant peripheral distribution as compared to unilateral lung involvement in the current study which is in agreement with earlier published reports.[19-21] Regarding lobe involvement, we observed a slightly higher number of cases with the right lower lobe affected (83.7%) than the left lower lobe (79.06%). In compliance with most of the other viral pneumonia, opacities were located in the lower lobes.[22,23] None of the imaging features described here existed alone in COVID-19 pneumonia but appeared together with multiple other characteristics. For subjects with lung parenchymal anomalies and damage, sub-pleural GGO'S was the most dominant abnormality found in all (99.3%) cases followed by vascular enlargement (73/86; 84.8%). Our findings are in concurrence with earlier studies reported by Caruso D et al and Yan Li, et al who reported vascular enlargement in 89% of patients.[24,25] The vascular enlargement found in our case might be due to small vessel pulmonary embolism and infection-induced pulmonary vasculitis. It has been reported that vascular enlargement is frequently associated with COVID-19 pneumonia as compared to non-COVID-19 pneumonia.[26] Moreover, our results fairly validate the distribution and type of pulmonary opacities as reported in COVID-19 pneumonia.[18,27] The common imaging signs seen included crazy paving pattern, consolidation patches, sub-pleural bands, Reversal Halo sign, air bronchogram, and Bronchial wall thickening. Lymphadenopathy, cysts, and pleural effusion were seen rarely, which is in agreement with previous studies.[28-30] One patient had pneumomediastinum in our study, which is a rare COVID-19 presentation. It is likely that pneumomediastinum might be due to alveolar rupture as reported earlier.[31,32] Therefore, HRCT chest can manifest different imaging features or patterns in COVID-19 patients with a different time course and disease severity. So, we conclude that HRCT chest is a reasonably accurate and sensitive

imaging tool to diagnose, rule out and categorize the severity of COVID-19 infection.

Though this study could be helpful in detecting the COVID-19 infections at an earlier stage, a number of limitations cannot be ruled out like a limited number of samples, incomplete history of patients regarding any other co-morbidities which could interfere with chest imaging. Secondly, there is a possibility of selection bias as negative HRCT subjects were not followed which may have developed pulmonary abnormalities in the late course of the disease a common feature found in a number of symptomatic COVID-19 patients.

Conclusion

HRCT chest is an indispensable imaging tool to diagnose and categorise the severity of COVID-19 infection for optimum disease management. Owing to its easy availability, rapid interpretation, and high accuracy, we advocate the use of HRCT Chest as a supplement or alternative to RTPCR testing for early diagnosis of covid-19 infection.

Abbreviations

COVID-19: Coronavirus disease-19
HRCT: High Resolution Chest Computed Tomography
RT-PCR: Reverse Transcription Polymerase Chain Reaction
GGO's: Ground Glass Opacities
WHO: World Health Organization
ARDS: Acute Respiratory Distress Syndrome
UT: Union Territory

References

1. RJ. M. Pathogenesis of COVID-19 from a cell biologic perspective. . Eur Respir J 2020; in press doi: https://doi.org/10.1183/13993003.00607-2020
2. Velavan TP, Meyer CG. The COVID-19 epidemic. Tropical medicine & international health. 2020; 25(3):278. doi: https://doi.org/10.1111/tmi.13383
3. Zhou P, Yang X, Wang X, Hu B, Zhang L, Zhang W, et al. R.; Zhu, Y.; Li, B.; Huang, C. L, Chen H–D, Chen J, Luo Y, Guo H, Jiang R–D, Liu M–Q, Chen Y, Shen X–R, Wang X, Zheng X–S, Zhao K, Chen Q–J, Deng F, Liu L–L, Yan B, Zhan FX, Wang Y–Y, Xiao G–F, Shi Z–L A pneumonia outbreak associated with a new coronavirus of probable bat origin Nature. 2020; 579:270-3, doi: https://doi.org/10.1038/s41586-020-2012-7
4. Li Q, Guan X, Wu P, Wang X, Zhou L, Tong Y, et al. Early transmission dynamics in Wuhan, China, of novel coronavirus–infected pneumonia. New England Journal of Medicine. 2020. Doi: https://doi.org/10.1056/NEJMoa2001316
5. Xiang N, Havers F, Chen T, Song Y, Tu W, Li L, et al. Use of national pneumonia surveillance to describe influenza A (H7N9) virus epidemiology, China, 2004–2013. Emerging infectious diseases. 2013; 19(11):1784. doi: https://dx.doi.org/10.3201%2Feid1911.130865
6. Acter T, Uddin N, Das J, Akhter A, Choudhury TR, Kim S. Evolution of severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) as coronavirus disease 2019 (COVID-19) pandemic: A global health emergency. Science of the Total Environment. 2020:138996. doi: https://doi.org/10.1016/j.scitotenv.2020.138996
7. Ali SA, Baloch M, Ahmed N, Ali AA, Iqbal A. The outbreak of Coronavirus Disease 2019 (COVID-19)—An emerging global health threat. Journal of infection and

public health. 2020; 13(4):644-6. doi: https://doi.org/10.1016/j.jiph.2020.02.033

8. Huang C, Wang Y, Li X, Ren L, Zhao J, Hu Y, et al. Clinical features of patients infected with 2019 novel coronavirus in Wuhan, China. The lancet. 2020; 395(10223):497-506. doi: https://doi.org/10.1016/S0140-6736(20)30183-5
9. Wu C, Chen X, Cai Y, Zhou X, Xu S, Huang H, et al. Risk factors associated with acute respiratory distress syndrome and death in patients with coronavirus disease 2019 pneumonia in Wuhan, China. JAMA internal medicine. 2020; 180(7):934-43. doi: https://doi.org/10.1001/jamainternmed.2020.0994
10. Kong W-H, Li Y, Peng M-W, Kong D-G, Yang X-B, Wang L, et al. SARS-CoV-2 detection in patients with influenza-like illness. Nature microbiology. 2020; 5(5):675-8. doi: https://doi.org/10.1038/s41564-020-0713-1
11. HuangCL W. Clinical features of patients infected with 2019 novel coronavirus in Wuhan. China. 2020; 395(10223):497-506. Doi: https://doi.org/10.1016/s0140-6736(20)30183-5
12. Fang Y, Zhang H, Xie J, Lin M, Ying L, Pang P, et al. Sensitivity of chest CT for COVID-19: comparison to RT-PCR. Radiology. 2020; 296(2):E115-E117. doi: https://doi.org/10.1148/radiol.2020200432
13. Zhu N, Zhang D, Wang W, Li X, Yang B, Song J, et al. A novel coronavirus from patients with pneumonia in China, 2019. New England journal of medicine. N Engl J Med 2020; 382:727-733; doi: https://doi.org/10.1056/nejmoa2001017
14. Guan W-j, Ni Z-y, Hu Y, Liang W-h, Ou C-q, He J-x, et al. Clinical characteristics of 2019 novel coronavirus infection in China. MedRxiv. 2020. doi: https://doi.org/10.1101/2020.02.06.20020974
15. Chen Y, Liu Q, Guo D. Emerging coronaviruses: genome structure, replication, and pathogenesis. Journal of medical virology. 2020; 92(4):418-23. Doi: https://doi.org/10.1002/jmv.25681
16. Ai T, Yang Z, Hou H, Zhan C, Chen C, Lv W, et al. Correlation of chest CT and RT-PCR testing for coronavirus disease 2019 (COVID-19) in China: a report of 1014 cases. Radiology. 2020; 296(2):E32-E40. doi: https://doi.org/10.1148/radiol.2020200642
17. Li K, Fang Y, Li W, Pan C, Qin P, Zhong Y, et al. CT image visual quantitative evaluation and clinical classification of coronavirus disease (COVID-19). European radiology. 2020; 30(8):4407-16. doi: https://doi.org/10.1007/s00330-020-06817-6
18. Yu M, Xu D, Lan L, Tu M, Liao R, Cai S, et al. Thin-section chest CT imaging of COVID-19 pneumonia: a comparison between patients with mild and severe disease. Radiology: Cardiothoracic Imaging. 2020; 2(2):e200126. doi: https://doi.org/10.1148/ryct.2020200126
19. Chung M, Bernheim A, Mei X, Zhang N, Huang M, Zeng X, et al. CT imaging features of 2019 novel coronavirus (2019-nCoV). Radiology. 2020; 295(1):202-7. doi:

https://doi.org/10.1148/radiol.2020200230

20. Lei J, Li J, Li X, Qi X. CT imaging of the 2019 novel coronavirus (2019-nCoV) pneumonia. Radiology. 2020; 295(1):18. Doi: https://doi.org/10.1148/radiol.2020200236
21. Wang Q, Zhang Z, Shi Y, Jiang Y. Emerging H7N9 influenza A (novel reassortant avian-origin) pneumonia: radiologic findings. Radiology. 2013; 268(3):882-9. Doi: https://doi.org/10.1148/radiol.13130988
22. Koo HJ, Lim S, Choe J, Choi S-H, Sung H, Do K-H. Radiographic and CT features of viral pneumonia. Radiographics. 2018; 38(3):719-39. doi: https://doi.org/10.1148/rg.2018170048
23. Liang T, Liu Z, Wu CC, Jin C, Zhao H, Wang Y, et al. Evolution of CT findings in patients with mild COVID-19 pneumonia. European radiology. 2020; 30(9):4865-73. Doi: https://doi.org/10.1007/s00330-020-06823-8
24. Caruso D, Zerunian M, Polici M, Pucciarelli F, Polidori T, Rucci C, et al. Chest CT features of COVID-19 in Rome, Italy. Radiology. 2020; 296(2):E79-E85. Doi: https://doi.org/10.1148/radiol.2020201237
25. Li Y, Xia L. Coronavirus disease 2019 (COVID-19): role of chest CT in diagnosis and management. American Journal of Roentgenology. 2020; 214(6):1280-1286. doi: https://doi.org/10.2214/ajr.20.22954
26. Bai HX, Hsieh B, Xiong Z, Halsey K, Choi JW, Tran TML, et al. Performance of radiologists in differentiating COVID-19 from non-COVID-19 viral pneumonia at chest CT. Radiology. 2020; 296(2):E46-E54. doi: https://doi.org/10.1148/radiol.2020200823
27. Pan Y, Guan H, Zhou S, Wang Y, Li Q, Zhu T, et al. Initial CT findings and temporal changes in patients with the novel coronavirus pneumonia (2019-nCoV): a study of 63 patients in Wuhan, China. European radiology. 2020; 30(6):3306-9. https://doi.org/10.1007/s00330-020-06731-x
28. Valette X, du Cheyron D, Goursaud S. Mediastinal lymphadenopathy in patients with severe COVID-19. The Lancet Infectious Diseases. 2020; 20(11):1230. doi: https://doi.org/10.1016/s1473-3099(20)30310-8
29. Shi H, Han X, Jiang N, Cao Y, Alwalid O, Gu J, et al. Radiological findings from 81 patients with COVID-19 pneumonia in Wuhan, China: a descriptive study. The Lancet Infectious Diseases. 2020; 20(4):425-34. doi: https://doi.org/10.1016/S1473-3099(20)30086-4
30. Wu J, Wu X, Zeng W, Guo D, Fang Z, Chen L, et al. Chest CT findings in patients with coronavirus disease 2019 and its relationship with clinical features. Investigative radiology. 2020; 55(5):257-261. https://doi.org/10.1097/rli.0000000000000670
31. Volpi S, Ali JM, Suleman A, Ahmed RN. Pneumomediastinum in COVID-19 patients: a case series of a rare complication. European Journal of Cardio-Thoracic Surgery. 2020; 58(3):646-647. doi:

https://doi.org/10.1093/ejcts/ezaa222

32. Mohan V, Tauseen RA. Spontaneous pneumomediastinum in COVID-19. BMJ Case Reports CP. 2020; 13(5):e236519. doi: https://doi.org/10.1136/bcr-2020-236519
33. Romano N, Fischetti A, Melani EF. Pneumomediastinum related to Covid-19 pneumonia. The American Journal of the Medical Sciences. 2020; 360(6):e19-e20. doi: https://doi.org/10.1016/j.amjms.2020.06.003

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