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Original Research Article

Correlation between Chest CT Severity Score and Oxygen Requirement in Patients with COVID-19 Infection in the Indian Population in a Tertiary Healthcare Set-Up

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Abstract

Aim: The study aimed to correlate the chest CT severity score and oxygen requirement in patients with COVID-19 infection in the Indian population in a tertiary healthcare set-up.

Methods: A cross-sectional retrospective hospital-based study included 138 patients conducted at the Department of Radiology, in a tertiary healthcare centre in Western India from 1st December 2021- 30th November 2022.

Results: Out of 138 subjects in this study, the maximum number of subjects (55) required no oxygen support, 22 subjects were on nasal prongs, 30 were on face masks and 26 subjects required NRBM. The least number of subjects (5) were on HFNC/BIPAP. Most of the patients with a mild CT severity score (86.1 %) required no supplemental oxygen while the majority of the patients with severe CT severity scores (60%) were on NRBM. There is a positive correlation between the chest CT severity score and the oxygen requirement in these patients.

Conclusion: The COVID-19 pandemic shows waxing and waning, frequently exhibiting a significant surge in cases, particularly with the appearance of more potent SARS-CoV-2 viral subtypes. As of 8 April 2023, there are 31,194 active COVID-19 cases in India with the number rising steadily. There is a significant statistical correlation between the chest CT severity score and the oxygen requirement of COVID-19 patients. Our study thus confirms that CT severity score can be a useful tool to access disease severity and guide prompt management.

Keywords: COVID-19; CT chest; CT severity score

Introduction

The COVID-19 pandemic has affected thousands of people and disrupted the global economy with a significant burden on the healthcare delivery systems. Several pneumonia cases with an unknown cause were recorded in Wuhan, China, in December 2019. On January 7, 2020, a novel coronavirus strain with the scientific name severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) was discovered in the patient's respiratory tract secretions. [1]

On January 30, 2020, the World Health Organization (WHO) declared the SARS-CoV-2 outbreak a Public Health Emergency of International Concern. The WHO then proclaimed the new coronavirus (COVID-19) outbreak a worldwide pandemic on March 11, 2020. [2]

The nasopharyngeal swab Real-Time Reverse Transcription – Polymerase Chain Reaction (RT-PCR) test has been the diagnostic test used for disease confirmation. However, the RTPCR test can give false negatives, has low sensitivity and results take hours or even days. [3] Pneumonia is the most common cause of severe morbidity and mortality in COVID-19, but the RTPCR test does not give any insight into pulmonary involvement. High-resolution computed tomography (HRCT) chest imaging in patients with COVID-19 plays an important role in early disease detection, determining the disease severity and monitoring the course of the disease. [4]

Chest computed tomography (CT) scan is an important method in the diagnosis of pulmonary abnormalities and is useful in the evaluation of patients with suspected or known COVID-19 in whom other diagnoses, such as pulmonary embolism, are possible alternative causes of the symptoms. Bilateral peripheral subpleural areas of ground-glass opacity, septal thickening and consolidation are the CT findings in COVID-19. [5]

Various CT scoring systems have been used to determine the extent of lung involvement and thus to try to assess the severity of COVID-19. Chang et al. described a 25-point semi-quantitative CT severity score method based on an approximation of the area of the lung parenchyma affected by COVID-19. Based on the level of involvement, each of the five lung lobes is assigned a score between one and five with an overall score of 25. [6-8]

Materials and Methods-

This is a cross-sectional hospital-based study which included 138 patients conducted at the Department of Radiology, in a tertiary healthcare centre in Western India for a period of one year. It was a retrospective study and was based on the data of the previous 12 months collected from the medical records section of the institution. A prior ethics approval was obtained from Departmental Review Board and Institutional ethics committee. The informed consent was waived off as per the ethics committee. Epidemiological factors of patients were recorded which include age and initials of the patient name. Necessary history, pre-existing conditions and oxygen requirement at the time of admission were noted.

All the HRCT chest scans were obtained from the database of the Department of Radiology. All the HRCT chest scans used for the study were performed on 160-slice MDCT scanner Toshiba Aquilion prime and PHILLIPS 64 slice Brilliance Computed Tomography unit. HRCT chest with a slice thickness of 0.5 mm was done. The scan was performed with the patient holding their breath in full inspiration.

Two investigators blinded to the patient's oxygen requirement reported the CT severity score. First, the scans were evaluated for typical findings of COVID-19 pneumonia. The severity was then evaluated based on a visual evaluation of

each lobe. Each of the five lung lobes was visually scored and given a score from 1 to 5:

1 representing less than 5% lobar involvement ;
2 representing 5–25% lobar involvement ;
3 representing 26–50% lobar involvement;
4 representing 51–75% lobar involvement; and
5 representing > 75% lobar involvement.

Then, the final score was the summation of individual lobar scores out of 25 (total score).

The average of the scores of the two investigators was used for statistical analysis.

The data obtained were entered into Microsoft Excel (Windows 7; Version 2007) and analyses were done using the Statistical Package for Social Sciences (SPSS) for Windows

software (version 22.0; SPSS Inc, Chicago). Descriptive statistics such as mean and standard deviation (SD) for continuous variables, frequencies and percentages were calculated for categorical Variables were determined. The association between Variables was analyzed by using the Chi-Square test for categorical Variables. Bar charts and Pie charts were used for the visual representation of the analyzed data. The level of significance was set at 0.05.

Results

The patients in our study were admitted to our institution after they tested positive for the COVID-19 RT-PCR test. HRCT chest scan was done at the time of admission. The inclusion criteria for the study were confirmed COVID-19 cases diagnosed by RTPCR admitted in our institution on an indoor basis having an age of more than 18 years. We excluded patients with known pulmonary or cardiac disease and patients with CT chest findings not typical of COVID-19. Also, patients having suboptimal HRCT scans due to motion artefacts were excluded. A total of 138 patients were studied.

The major CT chest findings were ground glass opacities, crazy-paving pattern and consolidation predominantly in subpleural locations showing lower lobe and posterior predominance (Figure 1a,b).

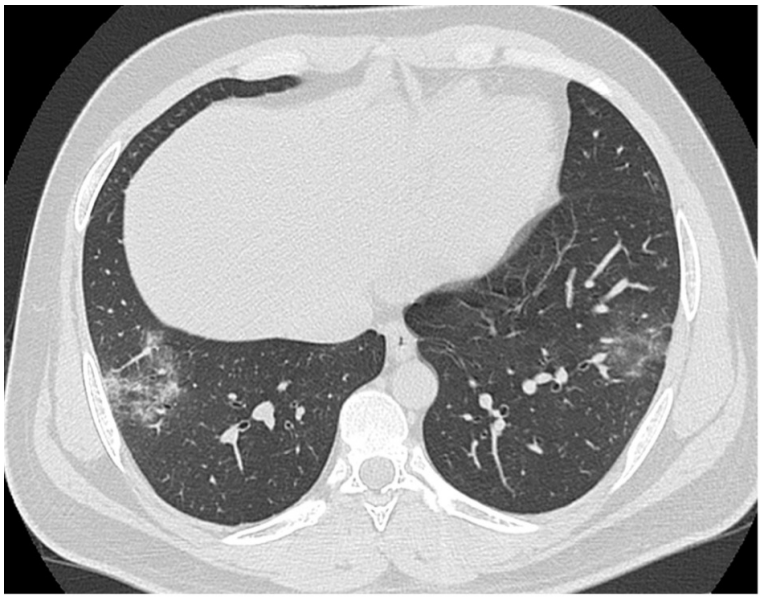

Figure 1a- Axial HRCT chest image of a 31-year-old man with COVID-19 shows patchy peripheral ground glass opacities in both lower lobes. There is associated interstitial septal thickening in the right lower lobe.

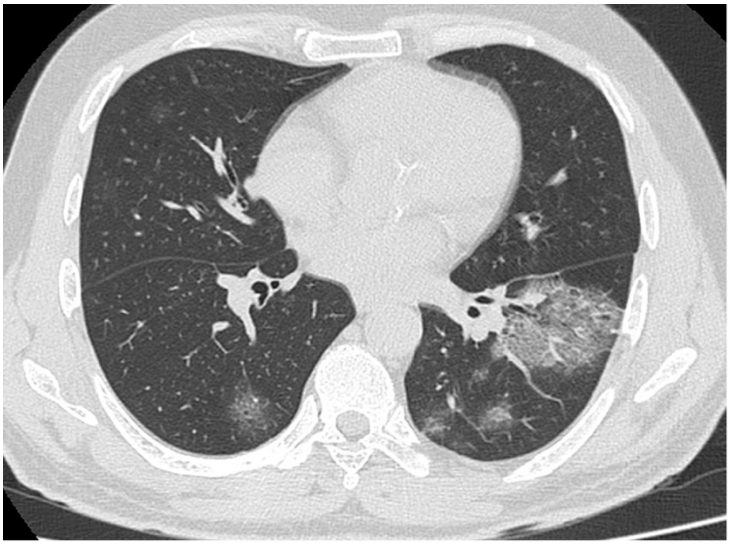

Figure 1b- Axial HRCT chest image of a 35-year-old man with COVID-19 shows patchy ground glass opacities in both lungs with a large area of ground glass opacity in the left lower lobe associated with septal thickening giving a crazy paving appearance.

The average of the CT severity scores of the two investigators was used for statistical analysis. The CT severity score was then classified into three categories. A score of 7 or less was categorized as mild; a score of 8–17 was considered moderate and a CT severity score of 18 or more was classified into the severe category. The oxygen requirement of the patients was divided into the following categories: On room air-not requiring supplemental oxygen (RA); On Nasal Prongs (NP); On Face mask (FM); On Non-Rebreather Mask (NRBM); On High Flow nasal cannula/Bilevel Positive Airway Pressure (HFNC/BiPAP) and Intubated.

The mean age of the subjects was 49.72 years with a standard deviation of 14.81. The youngest subject was 20 years old and the oldest was 88 years old (Fig 2a). Of the total subjects, 82 (59.4 %) were males and 56 (40.6%) were females. (Fig 2b

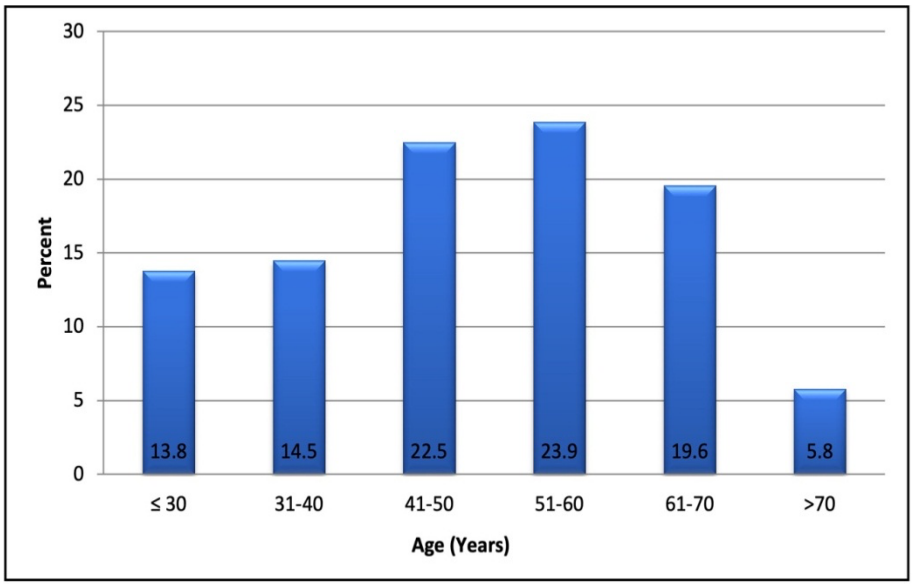

Figure 2a- Bar Graph shows the age distribution of the study population. Most patients were 40-70 years old

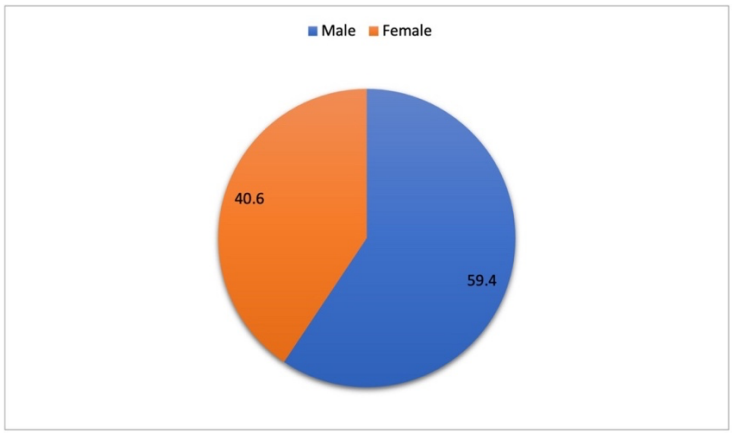

Figure 2b- The pie chart shows the gender distribution of the study population. 59.4 % were male and 40.6% of the total subjects were females.

Out of 138, 55 subjects required no oxygen support (RA), 22 of the subjects were on nasal prongs (NP), 30 subjects were on face masks (FM) and 26 subjects required NRBM. The least number of subjects (5) were on HFNC/BIPAP. (Table 1 and Fig 3)

Table 1: Distribution of study subjects according to the oxygen requirement

Oxygen requirement	No.	Percent
RA	55	39.9
NP	22	15.9
FM	30	21.7
NRBM	26	18.8
HFNC/BIPAP	5	3.6

Table 1 shows the distribution of study subjects according to the oxygen requirement.

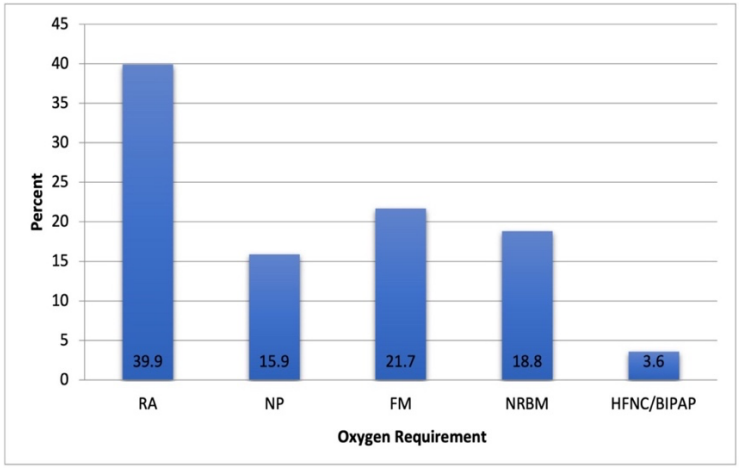

Figure 3 – The bar graph shows the oxygen requirement distribution of the study population.

The maximum number of subjects i.e. 82 out of 138 (59.4 %) had moderate CT severity scores. Out of the remaining subjects, 36 (26.2%) had mild CT severity scores and 20 subjects (14.5 %) had severe CT severity scores.

(Table 2 and Fig 4) Most of the patients with a mild CT severity score (86.1 %) required no supplemental oxygen, while 8.3% were on NP while 5.6% were on FM. None required NRBM or HFNC/BIPAP.

Table 2: Distribution of study subjects according to the CT severity score

CT severity score	No.	Percent
Mild	36	26.2
Moderate	82	59.4
Severe	20	14.5

Table 2 shows the distribution of study subjects according to the CT severity score

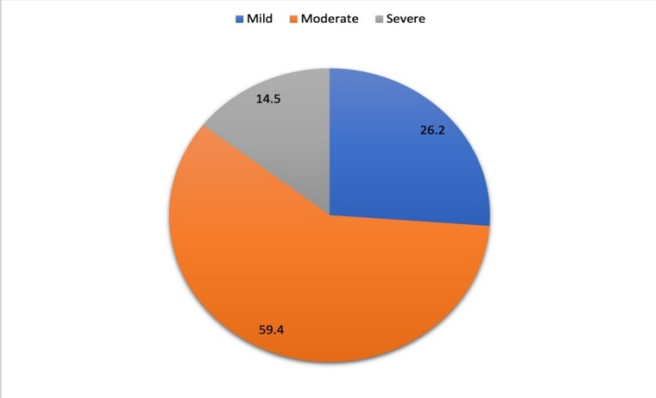

Figure 4-The pie chart shows the distribution according to the CT severity score categories. The maximum number of subjects had a moderate CT severity score.

In patients with moderate CT severity score, 29.3 % required no supplemental oxygen, 22% were on NP, 28% on FM, 17.1 % on NRBM and 3.6% required HFNC/BIPAP. The majority of the patients with severe CT severity scores (60%) were on NRBM, 25% were on FM,10% on HFNC/BIPAP and 5% on NP. Using the Chi-square test, a significant correlation was found between oxygen requirement and the CT severity score categories with a P value <0.001. (Table 3) There was no significant correlation between CT severity score and age or gender in our study.

Table 3: Association between CT severity score and oxygen requirement

Oxygen requirement	CT severity score		
	Mild	Moderate	Severe
RA	31	24	-
% Within O2	56.4	43.6	--
% Within CT	86.1	29.3	-
NP	3	18	1
% Within O2	13.6	81.8	4.5
% Within CT	8.3	22.0	5.0
FM	2	23	5
% Within O2	6.7	76.7	16.7
% Within CT	5.6	28.0	25.0
NRBM	-	14	12
% Within O2	-	53.8	46.2
% Within CT	-	17.1	60.0
HFNC/BIPAP	-	3	2
% Within O2	-	60.0	40.0
% Within CT	-	3.6	10.0
Chi-Square Test, P Value <0.001, Significant			

Table 3 shows a significant association between the oxygen requirement and the CT severity score categories with a P value <0.001.

Discussion-

The first report describing the use of non-contrast chest CT in 41 patients with confirmed COVID-19 was published by Huang et al. in February 2020. Since then, the clinical indications for chest CT have continued to change while the scientific evidence for COVID-19 has evolved rapidly. [9] HRCT chest is crucial in the management of patients with COVID-19 in addition to its detection in suspected cases. Similar to other pneumonias, the severity of COVID-19 is strongly correlated with the results of a chest CT scan. [10]

Additionally, chest CT is useful for monitoring COVID-19 disease development. Pan et al, conducted a study to determine the changes in chest CT findings associated with COVID-19 from initial diagnosis until patient recovery. It was a retrospective study in which twenty-one patients with confirmed COVID-19 were evaluated. Repeat chest CTs were carried out every four days. A semi-quantitative CT severity score method first described by Chang et al. was utilised to quantify pulmonary involvement. In most patients, as the chest CT abnormalities increased, so did the total CT score peaking at approximately ten days after the onset of symptoms, and then gradually decreased. [11]

Saeed et al. conducted a study to correlate the 25-point chest CT Severity scores and the clinical parameters of Patients with COVID-19. A total of 902 patients were included in the study. There was a significant correlation between the CT severity score and lymphopenia, elevated serum CRP, d-dimer, and ferritin levels. In patients with COVID-19 infection, the CT severity score also showed a positive correlation with the length of hospital stays and oxygen requirement. [12] Aalinezhad M et al. studied the relationship between CT Severity Score and capillary blood oxygen saturation in patients with COVID-19 infection. A different CT severity scoring system was used. The 18 lung segments were divided into 20 separate areas. Patients with hypoxia had CT severity scores that were considerably higher. Also, patients with hypertension and a history of previous illness had CT severity scores that were noticeably higher. [13]

Francone et al. investigated the relationship between the severity of the COVID-19 disease and the CT severity score. For this single-centre investigation, 130 symptomatic SARS-CoV-2 patients were included, and chest CT scans were retrospectively assessed. Critical and severe patients had CT scores that were significantly higher than mild patients, and late-phase patients had higher CT scores than early-phase patients. CRP and D-dimer levels substantially correlated with the CT score. Both univariate and multivariate analyses revealed that a CT score of ≥18 was linked with an elevated mortality risk. [14]

In another study, Zhou et al. evaluated 134 patients with confirmed COVID-19.

In comparison to the recovered patients, the overall CT score was noticeably higher in the deceased patients. Comparing patients with total CT scores below 16 points to those with total CT scores above 16, it was shown that the mortality risk was increased by 6.9 times with scores ≥16 points. [15]

A study was conducted by Kohli et al.to study the role of AI-based CT severity scoring system in the triage of patients with Covid-19 as regards to oxygen requirement. This was a prospective observational study conducted at a tertiary care hospital. Each patient was assessed using three criteria: 20-point CT score, 25-point CT score and opacity percentage. The severity scores and the need for oxygen, need for a hospital, ICU admission, and mortality had a statistically significant relationship. [16]

Our study showed a significant correlation between the CT severity score and the oxygen requirement of COVID-19-positive

patients (P Value <0.001). These findings were consistent with the earlier published studies. The CT severity score accurately predicts the severity of CT chest findings and thus the overall disease severity in COVID-19 patients. It can be a useful indicator of disease severity and prognosis and help guide management in COVID patients.

Our study had a few limitations. The first limitation was the retrospective nature of the study with limited sample size, as the study was undertaken during the waning period of the pandemic. The second limitation was the subjective nature of the visual assessment of the CT severity score. Due to the unavailability of software in our study, we used visual assessment for the calculation of the CT severity score. There were two readers to evaluate the CT severity score to reduce this subjective bias. The outcome of the disease and the need for oxygen can both be influenced by factors such as additional comorbidities and inflammatory markers. In our study, we did not independently analyse the effect of these parameters.

Conclusion:

CT chest plays an invaluable role in the diagnosis, prognosis of COVID-19 and detection of its complications. Despite not being as specific, CT is highly sensitive and can be useful for accelerating the diagnosis and guiding the management of COVID-19. It can help offset some of the RT-PCR assay's known drawbacks, including its low sensitivity and lengthy turnaround time.

The COVID-19 clinical severity and the 25-point CT severity score have a strong correlation. Our study confirms that the COVID-19 illness prognosis can be predicted with the help of the chest CT scoring system, which has a strong relationship with the oxygen requirement of the patients. The worsening of the CT severity score can predict disease progression, which can help physicians triage patients and promptly start symptomatic treatment. Timely supportive treatment can help reduce mortality rates.

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