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Original Article

Radiology Section

Role of HRCT in Assessing Requirement of Oxygen for COVID-19 Patients: A Retrospective Study from Amalapuram, Andhra Pradesh, India

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ABSTRACT

Introduction: Coronavirus Disease 2019 (COVID-19) infection has affected many countries in the world with its high rate of infectivity and created havoc with its mortality rate. A High Resolution Computed Tomography (HRCT) thorax scan is useful in detection and to assess the involvement of lung which is helpful to plan the management.

Aim: To assess the oxygen requirement in COVID-19 patients based on the lung involvement using HRCT scan.

Materials and Methods: A retrospective study was conducted from 1st May to 30th June 2021 in the Department of Radiodiagnosis, Konaseema Institute of Medical Sciences and Research Foundation, Amalapuram, Andhra Pradesh, India. HRCT thorax scans of 600 patients with COVID-19 infection were included. The patients were categorised based on their lung involvement into three groups (mild, moderate, severe) and then they were followed-up for the oxygen support that each patient received during their stay in hospital.

Results: Among the 184 mild COVID-19 infection cases none required Bilevel Positive Airway Pressure (BiPAP)/ intubation. Sixty four out of 340 moderate COVID-19 infection cases required BiPAP and intubation and 28 out 76 severe COVID-19 infection cases required BiPAP and intubation. None in mild cases, 60 (17.6%) in moderate cases, and 32 (42.1%) in severe cases had mortality. The rate of oxygen support and risk of intubation increased as the score increases ($p<0.001$). The Computed Tomography Severity Index (CTSI) also showed significant difference with the age and co-morbidities of the patients ($p<0.01$).

Conclusion: The HRCT is helpful in assessing the requirement of oxygen support in COVID-19 patients and to plan the management. There is increased non invasive and invasive ventilatory support along with increased morbidity and mortality as the score increases.

Keywords: Coronavirus disease 2019, High resolution computed tomography, Reverse transcriptase polymerase chain reaction

INTRODUCTION

COVID-19, a viral pneumonia that was discovered in Wuhan, China on March 11th, 2020, was officially declared the first coronavirus pandemic. Severe Acute Respiratory Syndrome Coronavirus (SARS-CoV-2) infection with symptoms of upper respiratory infection primarily affects lungs, and extrapulmonary manifestations and complications [1]. The most common clinical symptoms of COVID-19 patients include fever, cough, dyspnea, fatigue, these appear similar to SARS-CoV-2 [2]. However, severe cases lead to Acute Respiratory Distress Syndrome (ARDS) or even cause death. Based on the severity of patients condition the treatment protocol changes from antivirals, oxygen therapy, and symptomatic support. Older age group people and with underlying co-morbidities like cardiovascular diseases, hypertension, diabetes are more prone for severe illness [3].

The CT could be used to provide objective assessment about the extension of the lung opacities, which could be used as an imaging surrogate for disease burden [4]. Aim of the present study was to assess the relation between the CT severity score and the requirement of oxygen in COVID-19 patients.

MATERIALS AND METHODS

This present retrospective study was done in the Department of Radiology, Konaseema Institute of Medical Sciences and Research Foundation, Amalapuram, Andhra Pradesh, India from 1st May to 30th June 2021, data analysis was done from July 15th 2021. In this study, 600 patients who had a positive Reverse Transcriptase Polymerase Chain Reaction (RT-PCR) test and were diagnosed with COVID-19 infection and were referred to the radiology department for HRCT scan form the sample population. The Institutional Ethical Committee (IEC) approval (IEC/PR/2019: 06/20.04.2021) was obtained. Written informed consent was obtained from the participants.

Inclusion criteria: All COVID-19 patients who were tested positive with RT-PCR and HRCT was done were included.

Exclusion criteria: All patients who were tested negative in RT-PCR and pregnant women who were tested RT-PCR positive were excluded.

The GE Revolution series 16 Slice spiral CT scanner was used. All of the patients were assessed in the supine position and HRCT pictures were acquired. The scan was carried out from the apex of the lung to the upper abdomen. HRCT scan parameters: 140 KVp, 145 mAs; rotation time: 0.5 second; pitch: 1.0; section thickness: 5 mm; intersection space: 5 mm; slice thickness: 0.625 mm, a lung window with a width of 1200 HU and a level of -600 HU, and a mediastinal window with a width of 350 HU and a level of 40 HU; X-ray tube parameters: 140 KVp, 145 mAs.

COVID-19 infected patients were categorised based on age as young (18-44 years), middle age (45-59 years) and old age (>60 years).

COVID-19 lung involvement was assessed using the CTSI [5], which is based on the approximate involvement of pulmonary lobes. Each of the five lobes of the lungs is assigned a score ranging from 1-5:

1: represents <5% lobar involvement.

2: 5-25% involvement.

3: 26-50% lobar involvement.

4: 51-75% lobar involvement.

5: >75% lobar involvement.

The sum of individual lobar scores give the final score out of 25 (total score) and were categorised based on scores as 7 or less as mild, 8-17 as moderate, or more as severe lung involvement [6].

STATISTICAL ANALYSIS

Statistical analysis was performed using MS excel, 2019 version and statdisk office, version 13.0.1. HRCT scan of COVID-19 patients with CTSI as mild, moderate, severe (continuous data) and oxygen support requirement (categorical data) were analysed to assess the relation between the CT severity score and the requirement of oxygen in COVID-19 patients, using Chi-square test and p-value <0.05 was considered as statistically significant.

RESULTS

Among the young cases (18-44 yrs), there were 172 males and 56 females, and among old age (>60 yrs) 96 were males and 80 were females. Mean age of the total population was 50.4±14.36 years [Table/Fig-1].

Age group	Male	Female	Total
Young (18-44 yrs)	172 (42.1%)	56 (29.1%)	228 (38%)
Middle age (45-59 yrs)	140 (34.3%)	56 (29.1%)	196 (32.7%)
Old age (>60 yrs)	96 (23.5%)	80 (41.6%)	176 (29.3%)
Total	408	192	600

[Table/Fig-1]: Demographic characteristics of the participants.

It was observed that 324 patients (120-mild, 172-moderate, 32-severe) had no history of any co-morbidities [Table/Fig-2].

Co-morbidities	Mild (n=184)	Moderate (n=340)	Severe (n=76)	Total
None	120 (65.2%)	172 (50.6%)	32 (42.1%)	324
Co-morbidities (diabetes, hypertension, cardiovascular diseases)	64 (34.8%)	168 (49.4%)	44 (57.9%)	276

[Table/Fig-2]: Co-morbidities and severity distribution.

Among the total patients 92 were admitted under ICU care, 64 (18.8%) cases from moderate CTSI, and 28 (36.8%) cases from severe CTSI [Table/Fig-3].

Variables	Mild (n=184)	Moderate (n=340)	Severe (n=76)
ICU admission	-	64 (18.8%)	28 (36.8%)
Mortality	-	60 (17.6%)	32 (42.1%)

[Table/Fig-3]: Severity and distribution of ICU admission, mortality.

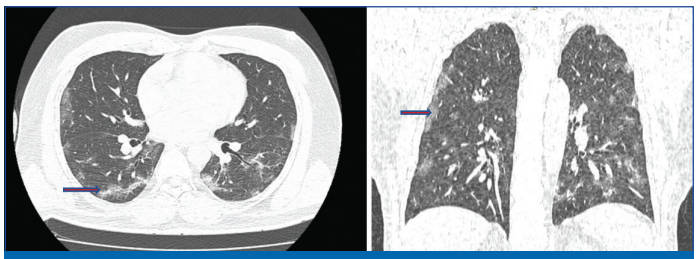
Among 184 mild COVID-19 infection [Table/Fig-4] cases, 84 were young, 56 were middle aged and 44 were under old age category [Table/Fig-5].

[Table/Fig-4]: RT-PCR COVID-19 positive patient with HRCT in axial reformat shows focal ground glass opacity in the posterior segment of left upper lobe, CTSI-1/25. (Mild Infection)

Age group	Mild (n=184)	Moderate (n=340)	Severe (n=76)
Young age	84 (45.6%)	116 (34.2%)	28 (36.8%)
Middle age	56 (30.4%)	112 (32.9%)	28 (36.8%)
Old age	44 (24%)	112 (32.9%)	20 (26.4%)

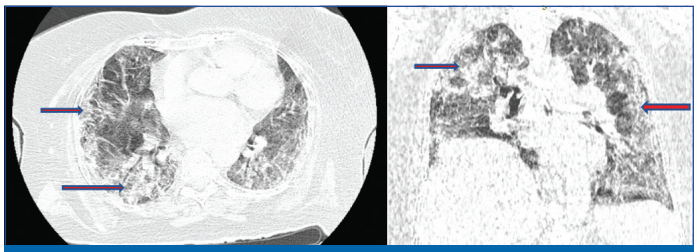
[Table/Fig-5]: Severity of COVID-19 infection based on CTSI in different age groups.

Among 340 patients with moderate COVID-19 infection scan findings 64 patients required ICU admission and 104/340 (30.5%) did not require any oxygen support. On follow-up, we found 60 (17.6%) patients were deceased among them 12 young, 16 middle aged and 32 were old patients and all had co-mordities (like diabetes, hypertension and cardiovascular diseases) [Table/Fig-6].



[Table/Fig-6]: A 69-year-old male RT-PCR positive patient with HRCT in axial & coronal reformat shows multifocal peripheral and peribronchovascular ground glass opacities in bilateral lower lobes and associated interlobular septal thickening. CT SS-10/25-moderate infection.

Among 76 patients of severe COVID-19 infection scan findings 28 patients' required ICU admission and 04/76 (5.2%) did not require oxygen support. On follow-up, 32 (42.1%) patients were deceased among them 12 young, eight middle aged and 12 were old patients had co-mordities (like diabetes, hypertension and cardiovascular diseases) [Table/Fig-7].



[Table/Fig-7]: A 36-year-old male RT-PCR positive patient with HRCT in axial and coronal reformat shows diffuse ground glass opacities with vascular engorgement-CT severity score 20/25.

Thereby, CTSI showed significant difference with the age and co-morbidities of the patients (p<0.01) [Table/Fig-8].

CTSI	Young (18-44 y)	Middle age (45-59 y)	Old age (≥60 y)	Total
Mild	0	40	24	64
Moderate	24	72	72	168
Severe	8	20	16	44
Total	32	132	112	276

[Table/Fig-8]: Age distribution among co-morbid cases.

The oxygen requirement and CT severity scores were found to have statistically significant association. {Chi-square test was used with p-value <0.01} [Table/Fig-9].

Variables	Mild (N=184)	Moderate (N=340)	Severe (N=76)
No oxygen requirement	156 (84.7%)	104 (30.5%)	04 (5.2%)
Nasal cannula	02 (1.08%)	56 (16.4%)	08 (10.5%)
Face mask	02 (1.08%)	64(18.8%)	12 (15.7%)
Non rebreather mask	24 (13%)	52 (15.2%)	24 (31.5%)
BiPAP/HFNC	-	40 (11.7%)	08 (10.5%)
Intubation	-	24 (7.0%)	20 (26.3%)

[Table/Fig-9]: Association between oxygen requirement with mild, moderate, severe CTSI.

DISCUSSION

The World Health Organisation (WHO) suggested to use chest imaging for diagnostic work-up of COVID-19 disease if RT-PCR testing cannot be done, not available, in case of test results getting delayed or when clinician suspects of COVID-19 infection with initial RT-PCR testing negative [7,8]. Kohli A et al., studied 740 patients and showed as the score increases, the requirement of oxygen and intubation chances also increase [9]. Majority of them belonged to the mild group (77%, 81% and 85% based on OS1, OS2 and OP, respectively). Only 0.67% from OS, 0.67% from OS2 and 1.5% from OP patients from severe group were on room air. Only 10% of the patients were on low oxygen (oxygen requirement 1-6 L/min). Majority of them belonged to mild group followed by moderate group. Only 22% (based on OS1), 21% (based on OS2) and 29% (based on OP) of the patients were from severe group. A clear majority of patients who were on high oxygen, HFNC/NIV and intubated belonged to the severe group".

In a study conducted by Saeed GA et al., there was an increase in oxygen support to the COVID-19 patients as the CT severity score increases [10]. The pathology behind the increase in requirement of oxygen can be due to virus causing inflammatory response in wall of alveoli which limits the exchange of oxygen, causing direct damage to lungs which leads to acute respiratory distress, pulmonary fibrosis, and eventually death. They concluded that CT scans plays an important role in helping the clinicians in planning their management and is useful in knowing the disease severity and possible outcome. The positive correlation between the oxygen requirement and CT severity score is established. The findings of the above study were in agreement with the findings of present study.

In COVID-19 affected patient, hypertension, cardiovascular disease and diabetes and other co-morbidities are noted in severe patients, which has also been mentioned in study done by Wang D et al., [11]. Study conducted by Zhou F et al., also stated that as the age is increased there is associated mortality in COVID-19 patients [12]. Even in present study, it was observed that patients with old age were prone for the oxygen support when compared to young people. In older age, ARDS, lymphocytopenia and high CT score were risk factors for high morbidity and mortality in severe COVID-19 patients. Hence, patients with the co-morbidities and old age have to undergo HRCT scan after hospital admission to assess the outcome and assess the requirement of ICU admission and the oxygen support they need [13].

Aalinezhad M et al., stated that hypoxic patients showed higher CT severity score with a significant reverse relationship between oxygen saturation and CT severity score (r= -0.44, p<0.001) and even among patients with co-morbidities (r= -0.28, p=0.01) and oxygen saturation and age showed no significant correlation (p=0.19) [14]. Wang K et al., study on 114 cases showed weak correlation between SpO_2 and CT staging with results of p<0.05 and r=-0.446 [15]. Dai H et al., did a multi-centered study on 234 inpatients from 13 hospitals [16]. They stated that there were significant correlations among the Arterial Blood Gases (ABG) analysis indices- PaO_2, SpO_2 and OI, as well as among the CT scores of ground glass opacities, consolidation, fibrosis and air trapping".

Sharwat A et al., did a study on 1000 patients to correlate the CTSI with SpO_2 values and to establish the HRCT thorax as early predictor for hypoxaemia [17]. They clearly stated that CT score was significantly higher in the severe CT category (17.4±3.1) than the mild CT category (8.7±4). Majority of patients in CTSI category 1, 2 and 3 were having SpO_2 levels ≥95%, 90-94% and <90%, respectively. Statistical correlation between CTSI and SpO_2 levels at the time of initial scan was significant (Pearson's correlation coefficient (r)=-0.261 and p-value <0.01). Negative Pearson's correlation coefficient suggest the fall in patients SpO_2 levels with increase in CTSI.

Mohammed SA et al., stated that all patients with mild clinical presentation showed clinical improvement over the next 14-21 days [18]. It was observed that 37/57 patients (65%) with borderline severity had a follow-up assessment with CT pulmonary angiography protocol after the deterioration of clinical condition into severe/critical status (O2 saturation dropped below 93%). Thirty-one patients received High Flow Nasal Cannula (HFNC) while six patients needed mechanical ventilation later on. It was observed that 22/24 critical patients (91.7%) showed deterioration in the clinical condition regarding the O_2 requirements; 20 patients needed mechanical ventilation while two patients had sudden death before ventilation. Only bed-side X-ray was used for follow-up of these patients. Osman AM et al., stated that "Oxygen saturation was considered as one of the main important parameters that indicated disease severity and progression [19]. They noticed an inverse relationship between the CT severity and the level of oxygen saturation, as the higher the CT severity score was, the lower the level of oxygen saturation".

Limitation(s)

Present study was restricted to a particular and small population and therefore, more studies on larger populations should be performed. As this was the retrospective study which has its inherent bias.

CONCLUSION(S)

The HRCT scans play an important role in helping the clinicians to diagnose the COVID-19 patients and plan the management, assess the oxygen support, outcome. As with increased CT severity scores there is increased invasive and non invasive ventilatory support and also increase in morbidity and mortality.

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