RESEARCH ARTICLE

Correlation between oxygen saturation of patient and severity index of Covid 19 pneumonia on CT

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Abstract

Objective: To investigate the correlation between capillary blood oxygen saturation and computerised tomography severity index in patients with coronavirus disease-2019 pneumonia.

Method: The cross-sectional analytical study was conducted at the coronavirus disease-2019 ward of Nishtar Medical University and Hospital, Multan, Pakistan, June 1, 2020, to June 1, 2021. At the time of admission, capillary oxygen saturation of all patients was measured. Pulmonary computerised tomography scans were then performed, and computerised tomography severity index was calculated. Data was analysed using SPSS 18.

Results: Of the 170 patients, 90 (52.9%) were males and 80(47%) were females. The overall mean age of the sample was 56.32±12.45 years. At the time of admission, the mean oxygen saturation was 88.9±6.53% and the mean severity index was 15.01±7.79. Overall, 22(12.9%) patients had hypoxia and the severity index reading was significantly high in these patients (p=0.001). Chronic obstructive pulmonary disease, hypertension and diabetes were significantly related to reduced blood oxygen saturation (p<0.05). Patients with hypertension had significantly raised computerised tomography scores. A significant inverse correlation was found between capillary oxygen saturation and computerised tomography severity index (p<0.01).

Conclusions: A significant inverse correlation was found between capillary oxygen saturation and computerised tomography severity index. Underlying comorbidities also affected the severity index.

Keywords: Covid-19, Hypoxia, Capillary oxygen saturation, Chest CT, CT severity index.

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Introduction

Coronavirus comprises a large group of viruses, such as the common cold virus and the virus responsible for causing severe acute respiratory syndrome (SARS). Recently, a novel coronavirus affected the world in the shape of a pandemic.[1,2] The World Health Organisation (WHO) termed the virus coronavirus disease-2019 (COVID-19) whereas the resulting disease was named SARS coronavirus 2 (SARS-CoV-2).[3]

The severity of the disease varies in different individuals, based on several confounding factors, but major infestation includes headache, cough, myalgia, upper airway inflammation, reduced blood oxygen saturation (O2Sat) levels, acute respiratory distress syndrome (ARDS) and variable levels of involvement of pulmonary airways.[3] Moreover, pulmonary involvements majorly define the prognosis in COVID-19 patients.

Computed tomography (CT) is one of the most reliable methods for screening, diagnosis and classification of pulmonary pathologies.[4] CT scans also assist clinicians in following up on patients after discharge from hospital. Studies based on CT scans conducted on COVID-19 patients found that this novel virus majorly affects peripheral and lower lobes of the lungs, while the infection pattern commonly gives bilateral and multilobar ground-glass appearance.[5,6] Besides, reverse halo sign, airway change and crazy paving pattern are some of the other radiological patterns found in such patients.[4] Some studies have concluded that CT scan findings strongly correlated with the clinical conditions of the patients and helped in predicting the spread of the disease. CT severity index (CTSI) is an output of a semi-quantitative scoring system that determines the extent and severity of pulmonary damage in viral pneumonia.[7,8]

Capillary oxygen saturation level measurement is a critical step and is performed in almost all COVID-19 patients at admission.[9] This measurement indicates hypoxia in such patients and calls for intensive management strategies.[10,11] So far, only a few studies have investigated the association between quantitative imaging severity scores and clinical conditions of the patients, whereas no such study is conducted in Pakistan. The current study was planned to fill the gap by investigating the correlation between capillary blood O_2Sat and CTSI score

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in patients with COVID-19 pneumonia.

Patients and Methods

The cross-sectional analytical study was conducted at the COVID ward of Nishtar Medical University and Hospital, Multan, Pakistan, from June 1, 2020, to June 1, 2021. After approval from the institutional ethics review committee, the sample size was calculated using Epi 7 info[12] with 95% confidence interval (CI) and 5% margin of error in the light of literature.[13] The sample was raised using consecutive sampling technique. Those included were patients of either gender aged >14 years of age who were positive for COVID-19 on the basis of polymerase chain reaction (PCR) and who underwent capillary O_2Sat and CT pulmonary scans. Patients with inherited or chronic lung and cardiac disorders, haemoglobinopathy, or those with atypical CT scans were excluded. Informed consent was obtained from all those included.

Demographic data of all patients was collected and previous medical history was noted. Major underlying comorbidities were documented and CTSI and O_2Sat values were compared between patients with and without the comorbidities.

Pulmonary CT scan was performed on all patients in supine position (Toshiba Asteion 4). The images were assessed by two independent radiologists with at least 3 years of experience each, and CTSI scores were computed by dividing 20 segments of both lungs into 20 separate regions such that the apicoposterior segment was divided into posterior and apical regions, while the antromediobasal segment was divided into basal and anterior regions. In doing so, all the regions were assessed by radiologists and the presence and extent of opacity were scored for each region; 0 was designated for 0% opacity, 1 for <50%, and 2 for >50%. Pulse oximetry was used for measuring capillary blood O_2Sat, and hypoxia was diagnosed in patients who had O_2Sat <95% at the time of admission. The CT scan was performed with a difference of a maximum of 1 day after oximetry.

Data was analysed using SPSS 18. Pearson correlation, Mann-Whitney U test and independent t-test were performed to assess the correlation between different study variables. P<0.05 was considered statistically significant.

Results

Of the 170 patients, 90 (52.9%) were males and 80(47%) were females. The overall mean age of the sample was 56.32±12.45 years. At the time of admission, the mean O_2Sat value was 88.9±6.53% (range: 45-100%). and the mean CTSI score was 15.01±7.79 (range: 10-38).

Table-1: Gender-based analysis of oxygen saturation and computerised tomography (CT) severity index.

Variable	Gender	Mean (SD)	P-value
Age	Female	62.05 (15.01)	0.81
	Male	61.37 (16.12)	
Oxygen saturation	Female	87.79 (8.26)	0.51
	Male	90.12 (4.80)	
CT severity index	Female	17.01 (8.01)	0.004
	Male	13.02 (7.58)	

SD: Standard deviation.

Table-2: Comorbidities and their association with oxygen saturation.

Comorbidities	Frequency (%)	Oxygen saturation mean (SD)		P-value
Diabetes mellitus	52 (30%)	Without	118 (89.99 (6.65))	0.01*
		With	52 (86.05 (10.37))	
Hypertension	65 (38.2%)	Without	105 (92.09 (5.59))	0.001*
		With	65 (87.26 (10.94))	
Chronic heart disease	3 (1.7%)	Without	167 (89.95 (7.51))	0.76
		With	3 (88.01 (5.76))	
Chronic renal failure	5 (2.9%)	Without	165 (89.87 (7.13))	0.82
		With	5 (86.25 (9.75))	
Chronic lymphocytic leukaemia	1 (0.58%)	Without	169 (89.14 (10.23))	0.6
		With	1 (88.65 (0.0))	
Cholesterolemia	8 (4.7%)	Without	162 (89.89 (7.38))	0.72
		With	8 (88.54 (8.66))	
Interstitial lung disease	1 (0.58%)	Without	169 (90.74 (9.22))	0.84
		With	1 (89.60 (0.0))	
COPD	7 (4.1%)	Without	163 (89.95 (7.79))	0.03*
		With	7 (85.32 (8.93))	
Thalassemia	2 (1.17%)	Without	168 (89.97 (7.32))	0.53
		With	2 (91.65 (1.9))	
Asthma	4 (2.3%)	Without	166 (89.95 (9.19))	0.07
		With	4 (83.12 (5.43))	
Pulmonary infection	1 (0.58%)	Without	169 (89.12 (8.32))	0.62
		With	1 (88.76 (0.0))	
Hyperthyroidism	4 (2.3%)	Without	166 (89.39 (9.11))	0.64
		With	4 (91.4 (6.43))	

SD: Standard deviation, COPD: Chronic obstructive pulmonary disease.
* Statistically significant with respect to Mann-Whitney test.

Overall, 22(12.9%) patients had hypoxia and the severity index reading was significantly high in these patients (p=0.001). CTSI score was significantly lower in males (p=0.04) (Table-1).

Chronic obstructive pulmonary disease (COPD), hypertension (HTN) and diabetes mellitus (DM) were significantly related to reduced O_2Sat (p<0.05) (Table-2). Patients with HTN had significantly raised CTSI scores (Table-3).

A significant inverse correlation between O_2Sat and CTSI score was found (r=-0.41, p<0.01). This correlation was

Table-3: Comorbidities and their association with computerised tomography (CT) severity index.

Comorbidities	Frequency (%)	CT severity index mean (SD)		P-value
Diabetes mellitus	52 (30%)	Without	118 (13.50 (8.89))	0.07
		With	52 (18.01 (7.79))	
Hypertension	65 (38.2%)	Without	105 (14.07 (7.73))	0.001*
		With	65 (16.65 (6.74))	
Chronic heart disease	3 (1.7%)	Without	167(15.78 (9.53))	0.81
		With	3 (15.83 (7.40))	
Chronic renal failure	5 (2.9%)	Without	165 (14.73 (6.03))	0.76
		With	5 (15.24 (5.83))	
Chronic lymphocytic leukaemia	1 (0.58%)	Without	169 (14.64 (6.17))	0.31
		With	1 (6.51 (0.0))	
Cholesterolemia	8 (4.7%)	Without	162 (16.16 (7.34))	0.45
		With	8 (16.80 (8.75))	
Interstitial lung disease	1 (0.58%)	Without	169 (16.32 (7.52))	0.09
		With	1 (22.65 (0))	
COPD	7 (4.1%)	Without	163 (16.3 (7.76))	0.51
		With	7 (15.45 (8.34))	
Thalassemia	2 (2.3%)	Without	168 (14.87 (7.75))	0.63
		With	2 (13.42 (6.35))	
Asthma	4 (2.3%)	Without	166 (15.74 (7.54))	0.73
		With	4 (16.3 (5.39))	
Pulmonary infection	1 (0.58%)	Without	169 (14.41 (6.51))	0.78
		With	1 (6.32 (0.0))	
Hyperthyroidism	4 (2.3%)	Without	166 (16.32 (7.65))	0.51
		With	4 (21.43 (5.42))	

SD: Standard deviation, COPD: Chronic obstructive pulmonary disease.
* Statistically significant with respect to Mann-Whitney test.

significant in both patients with comorbidities (r=-0.49, p<0.01) and without comorbidity (r=-0.33, p=0.001).

Discussion

The study found that COVID-19 patients whose O2Sat level reduced to the condition of hypoxia had significantly raised CTSI score. Moreover, COPD, HTN and DM had a significant impact on decreasing O_2Sat levels in patients with COVID-19. Similarly, patients with HTN had a significantly raised CTSI score, and there was a significant reverse correlation between O_2Sat levels and CTSI scores.

To date, few studies have investigated such a correlation and contradictory results have been reported. Yang et al. in China investigated the association between chest CT scan indicators and clinical conditions of patients with COVID-19. A total of 102 patients were investigated and it was found that the CTSI score was raised in highly critical patients compared to those with mild symptoms. The study suggested that the CTSI score can be a useful indicator of the extent of pulmonary damage.[14] In the same study, clinical severity was described as the condition where respiratory distress is >30 beats/min and resting capillary O_2Sat level is <93%. These results comply with the current findings which indicated a significantly higher CTSI score in hypoxic patients. Similarly, Zhao et al. conducted a study on 101 COVID-19 patients to evaluate the possible association between the medical condition of patients and chest CT quantitative and semi-quantitative data. The study found ground-glass or mixed ground-glass opacity, vascular enlargement or consolidation as the most reported CT patterns among COVID-19 patients and also recommended reliance on chest CT findings for predicting clinical outcomes in patients. The study suggested that the CTSI score can assist in evaluating the extent of pulmonary involvement.[15] These findings are similar to the current findings. However, the current study was unable to find an association between the CTSI score and previous medical conditions.

The significance of CT severity in diagnosing the extent of COVID-19 and its prognostic value have been discussed in a few other studies, too,[16-18] but none of them could specify specific clinical features that correlated with the index. A Chinese study on 42 COVID-19 patients found out that the patients usually presented with the round-glass pattern on CT scans, which, according to the study, correlated with raised lactate dehydrogenase, erythrocyte sedimentation rate (ESR), and C-reactive protein (CRP). However, no clinical feature was found to be related to rising CTSI score.[19] Such a difference in blood indicators could be due to the effect of different confounding factors. Fang et al. tried to compare the findings of reverse transcription-PCR (RT-PCR) and CTSI score in 51 COVID-19 patients, and found that CTSI score had significantly higher sensitivity than RT-PCR (98% versus 71%) and that patients with raised CTSI score experienced more severe infection in the follow-up period.[20] These results indicated an association between higher CTSI score and critical clinical condition of the patients. In the current study, raised CTSI score in hypoxic conditions also matched such a finding.

Recently, Yang et al. conducted a descriptive study to explain the imaging characters and clinical manifestations in 149 COVID-19 patients. The findings supported the predominance of multifocal ground-glass pattern in infected patients and that the severity of imaging characters was associated with severity in the clinical condition of some patients.[21] Cheng et al. evaluated CT scans of suspected COVID-19 patients and reported that consolidation, mixed ground-glass opacity (GGO), and pure GGO pattern in the lower lung were suspicious of COVID, but no relation between CT scan findings and clinical manifestations could be established in the study.[22]

The current study has limitations in terms of sample size and study design. Larger studies over a longer period evaluating the two parameters and their correlation during the disease course are recommended.

Despite the limitations, the current study is the first in Pakistan to have evaluated the correlation between capillary O_2Sat level and CTSI score, and may assist the clinicians in determining the clinical condition of patients with COVID-19 pneumonia.

Conclusions

There was a significant inverse correlation between capillary O_2Sat level and CTSI score. Moreover, underlying comorbidities can also affect the CTSI score.

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Conflict of Interest: None.

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