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ORIGINAL ARTICLE

Correlation between Oxygen Saturation of patient and Severity Index of Covid 19 Pneumonia on CT

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ABSTRACT

Aim: To investigate the correlation between capillary blood oxygen saturation and Computerized tomography (CT) severity index in patients with Covid-19 pneumonia.
Study design: A cross sectional study design
Setting & duration: Ibne-sina hospital Multan Medical & Dental College Multan, from 1st June 2020 to 1st June 2021
Methods: A cross-sectional analytical study was conducted at the COVID-19 ward of Ibne-sina hospital Multan Medical & Dental College Multan for 1 year. At the time of admission, all capillary oxygen saturation of all the included patients was measured. Pulmonary CT scans were then performed on these patients and CT severity index was calculated. SPSS was used for data analysis.
Results: A total of 170 Covid-19 infected patients were included in the study. At the time of admission, the mean oxygen saturation was found to be 88.9%±6.53%. Whereas, the mean severity index was15.01±7.79. 22 patients had hypoxia when presented in hospital and a significantly high iCT severity index was found in these patients (p=0.001). Chronic obstructive pulmonary disease (COPD), hypertension, and diabetes were significantly related to reduced blood oxygen saturation ($p<0.05$). A significant inverse correlation was found between capillary oxygen saturation and CT severity index ($r = -0.41$, $p< 0.01$).
Conclusions: The study revealed a significant inverse correlation between capillary oxygen saturation and CT severity index. Moreover, it was found that underlying commodities (i.e., past medical history) can also affect the CT severity index.
Keywords: Covid-19, hypoxia, capillary oxygen saturation, Chest CT, CT severity index.

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 has introduced the world to yet another pandemic[1,2]. The World Health Organization (WHO) termed the virus COVID-19 whereas the resulting disease is named "acute respiratory syndrome coronavirus 2" (SARS-CoV-2)[3].

The severity of the disease varies in different individuals, based on several confounding factors; however, major infestation includes headache, cough, myalgia, upper airway inflammation, reduced blood oxygen saturation levels, acute respiratory distress syndrome (ARDS), and variable levels of involvement of pulmonary airways are found in imaging studies[3]. Moreover, the pulmonary involvements majorly define the prognosis in the COVID-19 affected 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 with patients following their discharge from the hospital. CT-scans studies conducted on COVID-19 patients have found this novel virus majorly affects the 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 COVID-19 infected patients[4]. Some of the studies have concluded that CT scan findings strongly correlate with the clinical conditions of the patients and help in predicting the spread of the disease. CT severity index 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 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 on a population of Pakistan. Therefore, given the prevalence and importance of COVID-19 in Pakistan, the present study was designed to investigate the correlation between capillary blood oxygen saturation (at the time of admission) and Computerized tomography (CT) severity index in patients with Covid-19 pneumonia.

The objective of the study was to determine the severity of the condition in the infected patients through the correlation of the evaluated parameters.

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MATERIALS & METHODS

A cross-sectional analytical study was conducted at the COVID ward of Ibne-sina hospital Multan Medical & Dental College Multan for 1 year from 1st June 2020 to 1st June 2021. The study included patients of older than 14 years of age, PCR positive COVID-19 patients, and those who underwent capillary oxygen saturation, and CT pulmonary scans. Whereas, patients with inherited or chronic lung and cardiac disorders, hemoglobinopathy, or those with atypical CT scans were excluded from the study. Epi 7 info[12] was used for the calculation of sample size by considering 95% confidence interval and 5% margin of error, as used by Wang et al[13]. The participants who complied with inclusion criteria were consecutively selected according to sample size. All included participants were informed of the study's objectives and approval was sought. Similarly, ethical approval ref#28-76 dated 29-05-2020 was taken from the ethical committee of the hospital. Demographic data of all patients were collected and previous medical history was noted. The major underlying comorbidities were documented and CT scan severity index and oxygen saturation were compared in people with and without such comorbidities.

The pulmonary CT was performed on all patients in the supine position and the images were obtained by Toshiba Asteion 4 device. The average oxygen saturation at the time of CT scan was 87%. These images were then assessed by two independent radiologists with at least 3 years experience and CT severity scores were computed. The severity score was calculated 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 such a way all the regions were assessed by radiologists and the presence and extent of opacity were scored for each region such that 0 was designated for 0% opacity, 1 for less than 50%, and 2 for more than 50%. Pulse

oximetry was used for measuring capillary blood O_2 saturation while hypoxia was designated to patients who had oxygen saturation < 95% at the time of admission. It is worth mentioning that a CT scan was performed with a difference of a maximum of 1 day after oximetry. Oxygen saturation refers to the percentage of oxygen in blood and it is 95-100% in a healthy person, if it is below this range he may face difficulty in breathing. CT severity index refers to CT scores of individual lung areas. SPSS version 18.0 was used for statistical analysis. Pearson correlation, Mann-Whitney U test, Independent t-test were performed to assess the correlation between different study variables. A p-value less than 0.05 was considered statistically significant.

RESULTS

A total of 170 patients qualified for the study. The mean age of participants was 56.32±12.45 years. At the time of hospital admission, the mean capillary oxygen saturation level was found to be 88.9±6.53% (range= 45–100%). CT scan analysis revealed a mean severity index of 15.01±7.79 (range= 10–38). 22 patients had hypoxia when presented in hospital and a significantly high CT severity index was found in these patients (p=0.001). Patients with hypoxia had a mean CT severity index of 17.65±6.13 while those without had a mean score of 12.64±8.15. Gender classification of patients based on CT severity index and oxygen saturation level revealed that CT severity index was significantly lower in males (p=0.04) (Table 1).

Analysis of Patients' history indicated that about 40% of patients experienced at least 1 medical disease, besides COVID-19. Diabetes mellitus 52(30%) and hypertension 65(38.2%) were the most common comorbidities. On investigating the association between comorbidities and oxygen saturation level, it was found that chronic obstructive pulmonary disease (COPD), hypertension, and diabetes were significantly related to reduced blood oxygen saturation (p<0.05) (Table 2).

We also investigated the association between CT severity index and comorbidities and found a significant association between hypertension and CT severity index (p=0.001) (Table 3).

Pearson's correlation analysis found a significant inverse correlation between oxygen saturation and CT severity index (r=−0.41, p<0.01). This correlation was significant in both patients with comorbidity (r= −0.49, p< 0.01) and without comorbidity (r= −0.33, p= 0.001).

Table 1: Gender-based analysis of oxygen saturation and CT severity index in the study population

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)	

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 leukemia	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))	

COPD, chronic obstructive pulmonary disease * Statistically significant with respect to Mann-Whitney test

Table 3: Comorbidities and their association with 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 leukemia	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))	

* Statistically significant with respect to Mann-Whitney test

DISCUSSION

The present study found that COVID-19 patients whose oxygen saturation level reduced to the condition of hypoxia had significantly raised CT severity index. Moreover, COPD, hypertension, and diabetes mellitus had a significant impact on decreasing oxygen saturation levels in patients with COVID-19. Similarly, patients with hypertension had a significantly raised CT severity index. Our data concluded a significant reverse correlation between oxygen saturation and CT severity index, which has strong clinical significance.

To date, few studies have investigated such correlation but contradictory results have been reported. Yang et al. conducted a study in China to investigate 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 CT severity index was raised in highly critical patients when compared with those with mild symptoms. The authors also recommended that the CT severity index can be a useful indicator of the extent of pulmonary damage[14]. Moreover, in the same study clinical severity was described as the condition where respiratory distress is greater than 30 beats/min and resting capillary O_2 saturation level is less than 93%. These results comply with our study findings that indicated a significantly higher CT severity index 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 pattern among COVID-19 patients and also recommended the reliance on chest CT findings for predicting the clinical outcomes in patients. The authors suggested that the CT severity index can assist in evaluating the extent of pulmonary involvement[15]. These findings are similar to our observation. However, we were unable to find an association between the CT severity index and previous medical conditions in the established literature.

The significance of CT severity in diagnosing the extend of COVID-19 and its prognostic value has been discussed in a few other studies, too[16-18] but none of them could specify specific clinical features that correlate with this index. A Chinese-based study was performed by Xion et al. on 42 COVID-19 infected patients to draw a possible association between the clinical condition of patients and chest CT findings. The study found out that infected patients usually present with the round-glass pattern on CT scans which according to them correlates with raised lactate dehydrogenase, erythrocyte sedimentation rate, and C-reactive protein. However, no clinical feature was found to be related to rising CT severity index[19]. We anticipate that 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-polymerase chain reaction (RT-PCR) and CT severity index in 51 COVID-19 infected patients. The researchers found out severity index had significantly higher sensitivity than that of RT-PCR (98% against 71%, respectively) and that patients with raised severity index experienced more severe infection in follow-up period[20]. These results developed an association between higher CT index and critical clinical condition of patients. In our study, raised CT severity index in hypoxic conditions also justifies the above-discussed finding.

Recently, Yang et al conducted a descriptive study to explain the imaging characters and clinical manifestations in 149 COVID-19 infected 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 COVID-19 suspected patients and reported that consolidation, mixed ground-glass opacity (GGO), and pure GGO pattern in the lower lung are suspicious of COVID but no relation between CT scan findings and clinical manifestations could be established in this study, too[22].

The study is limited in terms of the limited study sample and study designs. Therefore, it is suggested to conduct larger studies for a longer period in which the two evaluated parameters are correlated during the disease course.

CONCLUSIONS

The study revealed a significant inverse correlation between capillary oxygen saturation and CT severity index. Moreover, it was found that underlying commodities can also affect the CT severity index. So far, no research in Pakistan has evaluated the correlation between capillary oxygen saturation and CT severity index. Therefore, our study can significantly assist clinicians to determine the clinical condition of the patient through these inversely related parameters.

Authors Contribution: Samreen,Sadia: conceived, designed and did statistical analysis & editing of manuscript, did data collection and manuscript writing Sattar, did review and final approval of manuscript

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